



Invasive Plant Management in Glacier Bay National Park and Preserve

Summer 2009 Field Season Report



Figure 1 – A native dandelion *Taraxacum officinale* ssp. *ceratophorum* goes to seed in Dry Bay. This summer it was determined that native dandelions dominate in the preserve, but invasive dandelions are spreading from at least three locations.

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Executive Summary

For the sixth consecutive year, the Exotic Plant Management Team (EPMT) performed intensive inventory work at Glacier Bay National Park and Preserve (GLBA) to document the distribution and abundance of nonnative plant species. Within the 87 ha (215 acres) of the park and adjoining lands that were surveyed in 2009, one new species, herb Robert (*Geranium robertianum*), was documented. Additionally, three species, smooth brome (*Bromus inermis*), curly dock (*Rumex crispus*), and thyme-leaf speedwell (*Veronica serpyllifolia*), previously seen in Gustavus were first observed in the park in Bartlett Cove this year. The all year summary of the number of infested acres documented is 474 ha (1171 acres) within and around the park or 38.3% of the 1237 ha (3058 acres) surveyed.

The most widespread species is common dandelion (*Taraxacum officinale* ssp. *officinale*), which has invaded coastal meadows and anthropogenically-disturbed areas in many areas of the park. The Bartlett Cove developed area hosts the highest diversity of nonnative species present in the park. In the backcountry of Glacier Bay proper, shepherd's purse (*Capsella bursa-pastoris*), mouse-ear chickweed (*Cerastium fontanum*), foxtail barley (*Hordeum jubatum*), oxeye daisy (*Leucanthemum vulgare*), reed canarygrass (*Phalaris arundinaceae*), annual bluegrass (*Poa annua*), red raspberry (*Rubus idaeus*), perennial sowthistle (*Sonchus arvensis*), chickweed (*Stellaria media*), and common dandelion (*Taraxacum officinale* ssp. *officinale*) have been detected. Dry Bay's (Glacier Bay National Preserve) greatest threat is bigleaf lupine (*Lupinus polyphyllus*), which is successfully outcompeting other species in both open meadows and shaded understory areas. Control efforts in Dry Bay have focused on oxeye daisy removal. Within Gustavus, several aggressive invasive exotic species such as Canada thistle (*Cirsium arvense*), orange hawkweed (*Hieracium aurantiacum*), and yellow toadflax (*Linaria vulgaris*), are present and may spread to areas within the park.

Throughout the season, control efforts removed approximately 575 kg (1268 lb) of nonnative plants by hand pulling or digging in Bartlett Cove, the backcountry of Glacier Bay proper, and in Dry Bay. Several plant infestations have been eradicated, including common burdock (*Arctium minus*), Canterbury bell's (*Campanula medium*), hairy cat's ear (*Hypochaeris radicata*) in GLBA, white sweetclover (*Melilotus alba*), red clover (*Trifolium pratense*) in Dry Bay, perennial ryegrass (*Lolium perenne* ssp. *perenne/multiflorum*), and common wheat (*Triticum aestivum*). To date, the total count of nonnative plant species observed in GLBA is 34 with an additional 17 species observed in Gustavus, beyond the park boundary. Four species are monitored but no management activities are planned due to questionable nativity. Five species have been fully eradicated from the survey areas to date. Two species are eradicated from the park but still present in Gustavus.

Once again outreach and education efforts have been aimed at educating staff, visitors, and local residents about the threat invasive species pose. The team has also maintained its monitoring efforts for invasive animal species, including marine tunicates and European green crabs.

In subsequent years, monitoring should aim to determine the rate of spread of plant species already present, detect new species colonization, and evaluate control effectiveness. Control efforts should continue to focus on removing small, disjunct infestations of high-priority species

and those in areas less disturbed by human activity. Outreach and education programs will continue to be an important component of the program to educate park staff, Gustavus residents, and park visitors.

Introduction

Since 2001, baseline surveys for nonnative plant species have been carried out on National Park Service (NPS) lands in Alaska. These surveys serve as the baseline data to formulate long-term monitoring and control plans for exotic plant species in Alaska's NPS units. Exotic plant species are a concern to resource managers because they threaten the genetic integrity of native flora through hybridization (D'Antonio et. al 2001), can outcompete resident plant species for limited resources, and can change the structure and function of ecosystems through alterations of geochemical and geophysical processes (Ruesnik et. al 1995, Gordon 1998). Already, 1.1 million ha (2.6 million acres) or over 3% of the 34 million ha (83 million acres) managed by the NPS nationwide are infested with nonnative plant and animal species (Drees 2004). Conservative estimates of the economic costs of biotic invasions are \$120 billion in the United States annually (Pimentel et al. 2005).

In Alaska, NPS lands have thus far avoided invasion by many pernicious exotic species found in the lower 48 states (Westbrooks 1998). Several factors have contributed to this legacy. The first is climate. Circumboreal floras are adapted to a wide range of climatic conditions that exotic plants typically cannot tolerate. In addition, many parklands in Alaska have remained relatively free of anthropogenic disturbances, such as livestock grazing, wildfire suppression, and altered hydrological regimes that encourage the introduction of exotic species. Consequently, the remote wilderness parks in Alaska retain all of their major floral and faunal ecosystem components (Densmore et. al 2001). Despite these protective factors, the threat of exotic plant invasion is increasing due to factors including global warming, increases in construction-related disturbance, and tourism. Throughout Alaska, over 280 nonnative plant species have been documented, accounting for approximately 13.5% of the flora (Carlson and Shephard 2007). Fortunately, the NPS in Alaska has the opportunity to stay ahead of exotic plant introductions before they become a serious problem, but research and active management must begin now (Spencer 2001).

GLBA is unique among Alaska NPS units with respect to exotic plants for several reasons. Two factors make it vulnerable to invasion: 1) GLBA protects a large land area in the most temperate region of the state, and 2) the terrestrial landscape is undergoing transformation across a mosaic of successional stages via the ongoing colonization of areas recently exposed by glacial retreat. On the other hand, there are very limited avenues for the introduction of exotic plants to the park. Only the immediate frontcountry of GLBA is accessible by vehicles (which must be barged into Gustavus), and most visitors never step ashore in the rest of the park. Compared to NPS units beyond Alaska, there are relatively few introduced species present in Gustavus or the park, but the threat of exotic plant introduction to park lands is aided by the influx of summer visitors, the escape of planted cultivars from Gustavus, ongoing maintenance activities that disturb the soil and facilitate the establishment of exotic species, climate change, and post-glacial successional processes. GLBA has fared well in its isolation and has a real opportunity to avoid the problems

lower-48 parks are experiencing, but park managers must remain vigilant. Compared to the other Alaskan NPS units, however, the Glacier Bay area has the greatest number of exotic plant species (58 species observed at any time) and the greatest number of documented infested acres (1003.188 acres within park), which highlights its vulnerability.

Exotic plant surveys in GLBA during the 2009 field season were conducted to provide information on the distribution, abundance, and species composition of exotic plants in four general areas: Bartlett Cove, Dry Bay, Gustavus, and the West Arm. In addition to making comparisons to survey work from 2004-2008 (Heys and McKee 2004, Rapp 2005, 2006, 2007, 2008), new areas were examined, particularly in Rendu and Charpentier Inlets and in Gustavus, to broaden the knowledge of the distribution of invasive plants. Exotic plant control activities focused on the most aggressive species, disjunct infestations, and populations with the greatest threat of spreading into less infested areas. Education and outreach activities targeted park staff, park visitors, Gustavus residents and students, and SAGA Americorps crews to make them more aware of the threats nonnative species pose to native ecosystems. Information gathered in 2009 will be used to help prioritize areas in the park and the state for long-term monitoring and control.

Legislation focusing on Invasive Species

By no means exhaustive of the regulations, the following section describes some of the legislation in place to help prevent and manage invasive species.

Federal Level

Plant Protection Act of 2000

7 U.S.C. 7701

http://www.access.gpo.gov/uscode/title7/chapter104_.html

This Act consolidated many previous agriculture-related laws into a comprehensive law. Noxious weeds are defined as “any plant or plant product that can directly or indirectly injure or cause damage to crops (including nursery stock or plant products), livestock, poultry, or other interests of agriculture, irrigation, navigation, the natural resources of the United States, the public health, or the environment.” It recognizes that the “detection, control, eradication, suppression, prevention, or retardation of the spread of plant pests or noxious weeds is necessary for the protection of the agriculture, environment, and economy of the United States.” It includes interstate transport, importation, and exportation regulations.

Federal Noxious Weed Act of 1974

7 U.S.C. 2814

http://www.access.gpo.gov/uscode/title7/chapter61_.html

Although most of the Act was repealed with the Plant Protection Act, this legislation still describes the management of undesirable plants on Federal lands, including staffing and funding management programs, developing cooperative agreements with state agencies, and developing integrated management programs to control or contain undesirable plants.

Noxious Weed Regulations

7 CFR 360

http://www.access.gpo.gov/nara/cfr/waisidx_07/7cfr360_07.html

This regulation contains a list of the federally recognized “noxious weeds” as defined in the Plant Protection Act and further restricts their movement. Of the species listed, GLBA has none.

Noxious Weed Seed Regulations

7 CFR 361.6

http://www.access.gpo.gov/nara/cfr/waisidx_07/7cfr361_07.html

This regulation contains two lists of federally recognized noxious weed seeds, the first with no tolerance for introduction and the second with acceptable tolerances for introduction. Of the species listed, GLBA currently has *Sonchus arvensis* and *Agropyron repens* (now *Elymus repens*), which are present in the second list.

Executive Order 13112

<http://www.nepa.gov/nepa/regs/eos/eo13112.html>

Created February 3, 1999 by President Bill Clinton, this order defined many key terms, including “invasive species” means an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health.” In addition, it directed federal agencies to prevent, detect, control, and monitor invasive species; restore native species; conduct research regarding invasive species; and promote education on invasive species. Federal agencies were no longer able to cause or promote the introduction or spread of invasive species.

Other Federal Regulations:

- § National Environmental Policy Act of 1969, as amended (42 U.S.C. 4321 et seq.);
- § Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, as amended (16 U.S.C. 4701 et seq.);
- § Lacey Act, as amended (18 U.S.C. 42);
- § Federal Plant Pest Act (7 U.S.C. 150aa et seq.);
- § Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.).

Alaska State Level

Alaska State Plant Seed Regulations

11 AAC 34.020-030

<http://www.legis.state.ak.us/cgi-bin/folioisa.dll/aac/query=fjump!3A!27title1!chap34!27/doc/{@45497}?>

The state of Alaska maintains a list of prohibited and restricted noxious weeds with regulations intended to prevent their occurrence as seed contaminants. Of those prohibited, *Galeopsis tetrahit*, *Hieracium aurantiacum*, *Agropyron repens* (now *Elymus repens*), *Sonchus arvensis*, and *Cirsium arvense* presently grow in GLBA or Gustavus. From the restricted list, *Poa annua* and *Linaria vulgaris* presently occur.

HB 330 – 25th Legislature

Amended AS 03.05

In 2008, the Alaska Legislature passed "An Act relating to noxious weed, invasive plant and agricultural pest management and education," which is effectively the first state law aimed at invasive plant management. The act created a state coordinator to cooperatively manage invasive plant issues.

National Park Service Level

NPS Management Policies 4.4.4

http://www.nps.gov/policy/mp/policies.html#_Toc157232715

The 2006 NPS Management Policies succinctly articulate that “exotic species will not be allowed to displace native species if displacement can be prevented.” Policy is to eliminate the introduction of exotic species into parks and remove exotic species if:

- (1) control is prudent and feasible, and
- (2) the exotic species
 - § interferes with natural processes and the perpetuation of natural features, native species or natural habitats, or
 - § disrupts the genetic integrity of native species, or
 - § disrupts the accurate presentation of a cultural landscape, or
 - § damages cultural resources, or
 - § significantly hampers the management of park or adjacent lands, or
 - § poses a public health hazard as advised by the U. S. Public Health Service (which includes the Centers for Disease Control and the NPS public health program), or
 - § creates a hazard to public safety.

NPS Organic Act

16 USC 1

http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=browse_usc&docid=Cite:+16USC1

The Act creating the NPS states the NPS will “... conserve the scenery and the natural and historic objects and the wild life therein and ... provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.”

Alaska National Interest Lands Conservation Act

<http://alaska.fws.gov/asm/anilca/toc.html>

Title 1 of the Alaska National Interest Lands Conservation Act (ANILCA) establishes the purposes for most of the NPS and other conservation system units in Alaska. Section 101 states the units are established to “... preserve for the benefit, use, education, and inspiration of present and future generations certain lands and waters in the State of Alaska that contain nationally significant natural, scenic, historic, archeological, scientific, wilderness, cultural, recreational, and wildlife values.”

Furthermore, this section states:

It is the intent of Congress in this Act to preserve unrivalled scenic and geological values associated with natural landscapes; to provide for the maintenance of sound populations of, and habitat for, wildlife species of inestimable value to the citizens of Alaska and the Nation, including those species dependent on vast relatively undeveloped areas; to preserve in their natural state extensive unaltered arctic tundra, boreal forest, and coastal rainforest ecosystems; to protect resources related to subsistence needs; to protect and preserve historic and archeological sites, rivers, and lands, and to preserve wilderness resource values and related recreational opportunities including but not limited to hiking, canoeing, fishing, and sport hunting, with large arctic and subarctic wildlands and on free flowing rivers; and to maintain opportunities for scientific research and undisturbed ecosystems.

Glacier Bay National Park and Preserve Vegetation Management Plan

The Vegetation Management Plan, although still in draft form, provides guidelines for invasive species, as well as removal of other native vegetation in all areas of GLBA. Of particular relevance are sections that direct residents to prevent the spread of nonnative species near their homes, that direct the park to follow best management practices (BMPs) to prevent nonnative introductions, and that specify that only native species should be intentionally planted.

Glacier Bay National Park and Preserve General Management Plan (1984)

“Exotic plants may be eradicated in the Bartlett Cove developed area, although no formal program is necessary.” (p. 54)

Glacier Bay National Monument Proclamation (1925)

The first proclamation (1925) for Glacier Bay National Monuments by Calvin Coolidge lists one of the primary reasons for conservation as “the region is said by the Ecological Society of America to contain a great variety of forest covering consisting of mature areas, bodies of youthful trees which have been established since the retreat of the ices which **should be preserved in absolutely natural condition**, and great stretches now bare that will become forested in the course of the next century.” (emphasis added)

Methods and Materials

Fieldwork at GLBA occurred from May through September 2009 following the protocol developed by the Alaska Region Exotic Plant Management Team (EPMT) (Rapp 2009). The field crew was Whitney Rapp (NPS), Adam DiPietro (SCA intern), Addison Kasmarek (NPS), and Max Gerth (International Volunteer). An AmeriCorps SAGA crew assisted in Bartlett Cove for a week in June and July, and other volunteers helped throughout the summer. The 2009 field season received the assistance of 1480 volunteer hours.

Areas inventoried included parts of Bartlett Cove; many of the established ORV trails in Dry Bay; selected areas of the Glacier Bay backcountry; and a portion of the Gustavus road system.

Digital photos were taken opportunistically while on site. Where feasible and strategic, infestations were controlled through hand-pulling and digging.

Trimble GeoXT 2003, 2005, and 2008 GPS units were used for all data collection during inventory and control events. Equipped with the Alaska EPMT standardized data dictionary (Table 1), the GeoXT can achieve submeter accuracy and ensure data integrity. Areas with and without nonnative species were inventoried at a resolution to allow interannual comparisons of plant distributions. The data dictionary provides sufficient detail for describing the size, diversity, and severity of exotic plant infestations and for population of two distinct databases: APCAM (Alien Plant Control and Monitoring – a nationwide NPS database for exotic plant data) and AKEPIC (Alaska Exotic Plant Information Clearinghouse - a collaborative, interagency, web-based database for tracking Alaskan weeds).

The data collected using the GPS were differentially corrected using the closest base station (Gustavus, AK) when available and farther base stations (Juneau and Biorka Island, AK and Whitehorse, YT) when the Gustavus station was unavailable. The data were edited in GPS Pathfinder Office (Trimble, version 4.10). The corrected files were then exported as shapefiles for use in ArcGIS (ESRI, version 9.3). The permanent dataset is a multi-year, multi-park geodatabase maintained by the Alaska Region EPMT.

Table 1 – Fields used in GPS data dictionary and GIS shapefile for invasive plant surveys, summer 2009.

Location_Name	Location ID (bartlett_cove, beardslees, dry_bay, east_arm, glacier_bay_other, gustavus, main_bay, or west_arm).
Disturbance_Type	Disturbance Type (coastal, stream, river, glacier, fill importation, trampling, windthrow, slide, animal, material extraction, ORV disturbance, mowing, wildfire, logging, mining, grazing, plowing, brush cutting, herbicide, wind, thermal, volcano, abandoned homesite, or other). Because most of Alaska’s exotic plants grow only on disturbed sites, we are tracking what disturbance types are being invaded by what species in NPS units.
Site_Description	Description of location.
Buffer_Distance_M	Buffer distance (in meters) to convert points and lines to polygons.
Taxon	This is the dominant exotic plant species of a particular infestation. All species that have been reported from Alaska NPS units are on this list. “Other” is used for species not previously recorded with a description in the Remarks field. If the mapped area is free of exotic plants, “None” is used.
Phenology	Phenology of dominant exotic species (rosette, no_flower, full_flower, in_seed, stand_dead, or none).
%_Cover	Cover class percentage of dominant exotic species (0, 1, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 95, 100).
Stem_Count	The stem count of the dominant exotic species. A blank field or “-9” indicates the number of plants were not counted.
Action	“Inventory” is the first documentation of a particular infestation, whereas “Monitor” is a follow-up visit to a previously inventoried site from this year or previous years. “Treatment” is the first control effort for a particular infestation and “Retreatment” applies to any subsequent control efforts in either the same or successive years. “Manual” involves pulling or digging. “Mechanical” involves actions like mowing, weed-whacking, chain-sawing, etc. “Chemical” involves the use of herbicides.
%_Treated	Percent of area treated in bands of 0%, 1-25%, 26-50%, 51-75%, 76-95%, 96-100%.
CntrlEffrt	Projected/actual control effort (low <1 hour, medium 1-8 hours, high >8 hours for one person).
Control_pers_hrs	Actual person hours spent doing control work
Is_Exhaustive	“Yes” if all the exotic plants encountered are recorded. “No” if only a subset of species are

	recorded.
Comments	Any additional remarks.
Park_Unit	Associated park (GLBA).
Is_Inside_Park	“Yes” if the area mapped is located on park land. “No” if it lies outside of the park boundary or on inholdings.
Recorder_Name	Recorder (WSR = Whitney Rapp; CCE= Charlotte Ely; AFJ=Ashley Jacobs; SJK=Sarah Kindschuh).
Team_Name	AKEPMT = Alaska Exotic Plant Management Team or Volunteer= majority of work by volunteer crew.
2Taxon, 3Taxon... 2Phenology, 3Phenology... ...	Additional fields for 9 other exotic taxa for each unique site including fields for Phenology, Percent Cover, Stem Count, Action, Percent Treated, and Control Effort.
Spatial Accuracy Fields	Range of attributes to describe spatial information and precision.
Date/Time	When the record was collected.
Acres	GIS-calculated acreage of each area.

Results and Discussion

During the 2009 field season, approximately 87 ha (215 acres) were recorded via GPS in 1191 polygon features with the focus of the effort on areas frequented by people both currently and historically in Bartlett Cove, Dry Bay, and Gustavus, as well as revisiting areas with previous control work. Survey work during 2009 added significantly greater resolution to data on distribution and abundance of the known nonnative species, particularly along roads in Gustavus. Since the program’s inception in 2004, 1237 ha (3058 acres) of non-overlapping area have been surveyed in or near GLBA.

Inventory work in 2009 resulted in the documentation of one new nonnative species, herb Robert (*Geranium robertianum*), growing in the parking area near the Grant’s house (GBQ04). Additionally, three species previously observed in Gustavus, smooth brome (*Bromus inermis* ssp. *inermis*), curly dock (*Rumex crispus*), and thyme-leaf speedwell (*Veronica serpyllifolia*), were observed within the park this year. Appendix A summarizes mapped acreage by species and location and when the species has been observed. Table 2 categorizes and summarizes the species seen in GLBA and Gustavus.

The regional total of documented invasive species is 53 currently and 58 at any time. As of 2007, 283 nonnative taxa have been recorded throughout Alaska with an average of three new species documented per year since 1968 (Carlson and Shephard 2007).

Appendix B maps the locations of many of the nonnative species observed during 2004-2009. The geodatabase (accessible from the Alaska NPS Permanent GIS Dataset) stores each year’s data and may be used in GIS to access additional information, including the assessment of invasive plant densities and the estimated control effort needed for eradication.

Table 2 – Categorization and summarization of nonnative plant species seen in and around Glacier Bay National Park and Preserve.

Park – 34 Species			
<i>Alchemilla mollis</i>	<i>Lamium album</i>	<i>Poa annua</i>	<i>Taraxacum officinale</i> ssp. <i>officinale</i>
<i>Alopecurus pratensis</i>	<i>Leucanthemum vulgare</i>	<i>Poa palustris</i>	<i>Trifolium hybridum</i>
<i>Bromus inermis</i> ssp. <i>inermis</i>	<i>Lupinus polyphyllus</i>	<i>Poa pratensis</i>	<i>Trifolium pratense</i>
<i>Capsella bursa-pastoris</i>	<i>Matricaria discoidea</i>	<i>Ranunculus acris</i>	<i>Trifolium repens</i>
<i>Centaurea montana</i>	<i>Mentha</i>	<i>Ranunculus repens</i>	<i>Veronica serpyllifolia</i> ssp. <i>serpyllifolia</i>
<i>Cerastium fontanum</i>	<i>Myosotis asiatica/Myosotis scorpoides</i>	<i>Rumex acetosella</i>	<i>Viola tricolor</i>
<i>Dactylis glomerata</i>	<i>Phalaris arundinacea</i>	<i>Rumex crispus</i>	
<i>Elymus repens</i>	<i>Phleum pratense</i>	<i>Sonchus arvensis</i>	
<i>Geranium robertianum</i>	<i>Plantago major</i>	<i>Stellaria media</i>	
		<i>Symphytum officinale</i>	
Park, but species not managed as invasive – 4 Species			
<i>Allium schoenoprasum</i>	<i>Hordeum jubatum</i>	<i>Rheum rhabarbarum</i>	<i>Rubus idaeus</i>
Gustavus only – 17 species			
<i>Achillea ptarmica</i>	<i>Hieracium aurantiacum</i>	<i>Pascopyrum smithii</i>	<i>Tanacetum vulgare</i>
<i>Aegopodium podagraria</i>	<i>Hypochaeris radicata</i>	<i>Polygonum aviculare</i>	<i>Veronica spicata</i>
<i>Cerastium tomentosum</i>	<i>Leucanthemum x superbum</i>	<i>Rosa rugosa</i>	
<i>Cirsium arvense</i>	<i>Linaria vulgaris</i>	<i>Rosa</i> sp.	
<i>Galeopsis tetrahit</i>	<i>Lychnis chalcedonica</i>	<i>Sorbus aucuparia</i>	
Eradicated completely – 5 species			
<i>Arctium minus</i>	<i>Lolium perenne</i>	<i>Triticum aestivum</i>	
<i>Campanula medium</i>	<i>Melilotus alba</i>		
Eradicated from park – 2 species			
<i>Hypochaeris radicata</i>	<i>Sorbus aucuparia</i>		

Manual control efforts of nonnative species were focused primarily in Bartlett Cove, Dry Bay, and in areas with small infestations of less common species. Since 2007, treatment of common dandelions was significantly de-emphasized, except on the slopes around the maintenance building and immediately near the Visitor Information Station (VIS) when the SAGA crew assisted. This shift in treatment was in response to past control ineffectiveness and the perception by some members of the public that the program may be investing effort inefficiently.

A high priority area in 2009 was again the recently revegetated slopes around the maintenance building, which now support populations of Johnny-jump-up violet (*Viola tricolor*), perennial cornflower (*Centaurea montana*), common dandelion (*Taraxacum officinale* ssp. *officinale*), mouse-ear chickweed (*Cerastium fontanum*), common plantain (*Plantago major*), quackgrass (*Elymus repens*), reed canarygrass (*Phalaris arundinacea*), common timothy (*Phleum pratense*), and sheep sorrel (*Rumex acetosella*).

Oxeye daisies were removed from all located sites within Bartlett Cove and Dry Bay. All previously controlled populations of reed canarygrass were again controlled in Bartlett Cove. During July through September, other grasses, including common timothy, meadow foxtail, quackgrass, and orchardgrass, were removed from roadside locations in much of Bartlett Cove. All the comfrey plants found growing near the Bartlett Cove depot were again removed in June this year. We continued our efforts controlling tall buttercup near the VIS from June through August. All located red and alsike clovers were removed again this summer. New infestations of herb Robert and curly dock were treated. Opportunistically throughout the summer, other species, including plantain, white clover, and mouse-ear chickweed, were removed.



Figure 2 - The generator exhaust room becomes filled with weeds during the summer as they are drying prior to incineration. The addition of screen bags in 2009 helped speed the process, but overall drying the plants is a laborious process. The exhaust fans should be fitted with a filter to prevent escaping wind-born seeds.

Throughout the field season, over 575 kg (1268 lb) of nonnative plants were removed. Again this year, the wet weeds were pre-dried in the generator building (Figure 2) prior to incineration. The dried plant weight was 200 kg (441 lb), which represents over a 65% decrease in mass. The resulting dried plants were more combustible in the park incinerator, which resulted in less fossil fuel use.

Compared to recent years, the 2009 summer was warmer and drier, which resulted in drought stress in many native and nonnative plants.

Region Summaries

Bartlett Cove

The slopes near the maintenance building were again a focal part of Bartlett Cove work this year now that the fencing has been removed and the slopes have been stabilized. Regrettably, more than ten invasive species have occupied the slopes. The erosion control matting has been very effective at preventing erosion; however, it is very difficult to hand pull or dig plants through the matting and the revegetation process has been retarded. In particular, reed canarygrass and white clover have established across the south and east slopes and will require significant labor and ground disturbance to control. This would be an ideal opportunity to test limited use of herbicides. The even distribution of these invasive plants and the presence of three species never

observed elsewhere in the park suggests that the soil, seed, or equipment brought in to complete the project were likely vectors of the invasive species. This further reiterates the critical need to implement best management practices (BMPs) at all stages of construction to prevent the introduction and spread of invasive plants (Appendix C).

Another high priority in Bartlett Cove was the treatment of several grass species, primarily along the Park Road. Reed canarygrass is the highest ranked species growing in the park. Through this season, more than 70 discrete infestations have been located ranging in size from 0.001 acres to 2.332 acres. With the exception of the largest infestation near the maintenance building, all other infestations were treated again in 2009. With the exception of very small infestations, few of the infestations have been eradicated, although the biomass has decreased. No hybrid wheat or perennial ryegrass was observed for the second year in Bartlett Cove, so these species are being considered locally eradicated.

Control work on oxeye daisies is showing excellent results with the eradication of several infestations. We once again controlled the common comfrey near the depot. The plants were smaller than last year, but they were still vigorous. Control efforts on tall buttercup were carried out throughout the summer. Creeping buttercup treatments were once again humbling with little or no progress realized nor anticipated. Control efforts on sheep sorrel were minimal in 2009 following previous poor results. Both of these species are likely uncontrollable with manual methods. Red and alsike clover control occurred throughout Bartlett Cove. There was no evidence of common burdock, hairy cat's ear, Canterbury bells, wheat, or perennial ryegrass in Bartlett Cove this year, and they are consequently being considered locally eradicated.

Backcountry

In 2009, two site visits to Strawberry Island were made to show the perennial sowthistle infestation to Craig Smith (Chief of Resources), Bobbi Simpson (Acting EPMT Liaison), and Bonnie Million (EPMT Liaison). Reid Inlet was visited again in August 2009; however, no oxeye daisies were detected at the previous infestation. A survey trip by kayak of Rendu and Charpentier Inlets was conducted in August. No invasive plants were detected in either inlet, but common dandelions were detected at the entrances.

Dry Bay

A single trip to Dry Bay occurred July 10-16, 2009. This period allowed the best observation to date of native and nonnative *Taraxacum* species. To date, almost all flowers observed have had horned involucre bracts (native) despite leaf and plant morphology, particularly near the East Alsek, that suggests nonnative plants. Flowers without horns are localized at the rafter outhouse, Swanson cabin, and Varni's cabin. Genetic analysis may be warranted to determine hybridization.

The control effort in Dry Bay once again centered on controlling the oxeye daisies, which includes the largest infestation found in any Alaska NPS unit. Although only single plant infestations have been eradicated and new infestations are still being discovered, the control effort is decreasing each year as we steadily deplete the soil's seed bank. Aside from the daisies,

we worked to control the creeping buttercup, which is present only at the Swanson cabin. Last year's infestation of tall buttercup was undetected this year. A few other incidental infestations were treated. None of the other species present in Dry Bay, including the most widespread species, bigleaf lupine, were controlled in 2009.

Gustavus

The roadside survey work in Gustavus continued this year with completion of all roads west of the Salmon River. At tenth mile intervals, both sides of the road were surveyed for invasive plants. Of the 453 survey points, only 12 (2.6%) had no detectable invasive species. The most widespread species was common dandelion. Additional species are described in Table 3.

Table 3 – Invasive species detected during survey effort along roads in Gustavus in 2008 and 2009.

Taxon	Number of Sample Points	Percent of Sample Points
<i>Alopecurus pratensis</i>	3	0.7%
<i>Bromus inermis</i>	45	9.9%
<i>Cerastium fontanum</i>	84	18.5%
<i>Dactylis glomerata</i>	15	3.3%
<i>Elymus repens</i>	31	6.8%
<i>Leucanthemum vulgare</i>	17	3.8%
<i>Lupinus polyphyllus</i>	5	1.1%
<i>Matricaria discoidea</i>	5	1.1%
<i>Myosotis scorpioides</i>	9	2.0%
<i>Phalaris arundinacea</i>	11	2.4%
<i>Phleum pratense</i>	167	36.9%
<i>Plantago major</i>	168	37.1%
<i>Poa annua</i>	7	1.5%
<i>Ranunculus acris</i>	1	0.2%
<i>Ranunculus repens</i>	1	0.2%
<i>Sorbus aucuparia</i>	2	0.4%
<i>Tanacetum vulgare</i>	2	0.4%
<i>Taraxacum officinale</i> ssp. <i>officinale</i>	441	97.4%
<i>Trifolium pratense</i>	9	2.0%
<i>Trifolium repens</i>	192	42.4%
None	12	2.6%

Species Summaries

With the identification of another new nonnative species within GLBA this year, the urgency of continued monitoring and control to protect the native plant community continues to be compelling. In terms of distribution, *Taraxacum officinale* ssp. *officinale* has the most widespread distribution throughout the park. In Dry Bay, the species of greatest concern is *Lupinus polyphyllus* based on its current extent and ability to displace native species. Following

many recent construction-related disturbance events, a number of invasive species have become well established in Bartlett Cove and will challenge management in the future. Other plant populations of continued concern are oxeye daisy, perennial sowthistle, and reed canarygrass.

Sneezeweed – Achillea ptarmica

Sneezeweed has been planted ornamentally in Gustavus. It persists despite no long term care; however, there is not yet evidence of it spreading. Monitoring should continue for this species.

Bishop’s Goutweed - Aegopodium podagraria

The variegated form of goutweed has been widely planted in Gustavus as a groundcover. In a number of locations, this species has spread beyond the bounds of the maintained landscape and is displacing native vegetation. At this point, it is not known to be growing in the park. The species appears to spread vegetatively, so it is unlikely that seeds will be transported to the park to begin a new population.



Figure 3 – Although intentionally relocated within Dry Bay for culinary uses, the wild chives growing in the preserve are likely native.

Lady’s Mantle – Alchemilla mollis

Lady’s mantle is spreading from a planted container at GBQ09A into the surrounding lawn. This invasive habit has also been observed at the Gustavus Library. Treatment should commence in the park since other Southeast Alaska communities have similarly documented invasiveness in this species.

Wild Chives - Allium schoenoprasum

An *Allium* species (Figure 3) that keys out to be wild chives (*A. schoenoprasum*) grows in several places in Dry Bay. In addition, residents of Dry Bay have intentionally planted this and cultivated chives near their cabins. This species is listed as nonnative by some sources (ITIS.gov, plants.usda.gov), and a native circumboreal species by other sources (Hultén 1968, Hitchcock and Cronquist 1973, Welsh 1974, Cody 2000, Klinkenberg 2004,). Further work is needed to verify the taxonomy and nativity of this species to determine whether it should be a species of management concern.

Meadow Foxtail - Alopecurus pratensis

Meadow foxtail was collected from Bartlett Cove in 1961 and archived in the GLBA herbarium. For the first time, the EPMT relocated and removed this species growing in Bartlett Cove in 2007. In 2008, two plants were removed from Bartlett Cove. This year more than two dozen plants were removed. It is uncertain whether this species is becoming more widespread or if detection rates are increasing.

Common Burdock - Arctium minus

A single flowering specimen of common burdock, one of the first records for the state, was found growing at the margin of the seasonal housing parking lot in 2006. Monitoring of this area since 2006 has not found any additional plants. Continued monitoring of this location and other margins of the gravel roads should be continued since the gravel, which originated in British Columbia, may have been the source of the plant.

Smooth Brome - Bromus inermis ssp. inermis

Smooth brome (Figure 4) is growing densely along roadsides in Gustavus (9.9% of survey points in 2008 and 2009), as well as on the GLBA park property in Gustavus near the school. In 2009, the first specimen was observed and removed in the park near the depot. This species should be searched for in future inventories since suitable habitat is available in Bartlett Cove and elsewhere, and it is a known invader of wetland habitats in the lower 48 states. There are a number of native bromes, but most have evident awns.



Figure 4 – Smooth brome was first seen in the park this year, although it is common along roads in Gustavus.

Canterbury Bells – Campanula medium

No evidence of the Canterbury bells plants removed last year were found this year. Monitoring should continue to confirm the species has been eradicated.

Shepherd's Purse - Capsella bursa-pastoris

Common in disturbed areas of Gustavus, including near the airport, shepherd's purse has been found growing in the depot area of Bartlett Cove and on Lone Island. No concerted effort was expended looking for the species this year. Late summer (late August to early September) is the best time to identify the species based on its unique heart-shaped seed pods.

Since Lone Island is a wildlife protection area closed to human use and shepherd's purse is not considered a high-risk species (40, Appendix A), management of this species on this active bird nesting island should occur only after August, if at all. The species has been present on the island since at least 1971 when Greg Streveler collected an herbarium specimen.

Perennial Cornflower – Centaurea montana

Perennial cornflower is a showy plant often planted for ornamental purposes. It has been observed in Gustavus persisting and spreading at old homesteads. In 2007-2009, it was evenly distributed on the east and south slopes near the maintenance building with more than 80 discrete infestations. It is likely that the soil, seed, or equipment used during the slope stabilization/revegetation project introduced the species, which confirms the critical need to plan for and adhere to BMPs (Appendix C). Monitoring of the site in 2010 will be necessary since non-flowering plants were likely overlooked during the removal of the 90 plants in 2009, which is higher than the 44 and 56 removed in 2007 and 2008. There is also very strong correlation between where plants have been previously removed and where they are found growing subsequently, suggesting that manual removal is not very effective.

Mouse-ear Chickweed - Cerastium fontanum

Mouse-ear chickweed (Figure 5) is common in Bartlett Cove and Gustavus growing along roadsides and in disturbed areas. In addition, it has been observed in Bartlett Cove well beyond disturbed areas in the area south of the park road near the boundary. The species is also present in numerous locations in Dry Bay, near Reid Glacier, on Young Island, in North Sandy Cove, in Excursion Inlet, along the Bartlett River, and multiple locations in the East Arm. Aside from dandelions, this is the most frequently observed invasive plant in the backcountry.

Efforts to control the Reid Inlet population have occurred since 2006. The slopes near the Bartlett Cove maintenance facility are infested with the species; however, efforts were resumed in 2008 by both the EPMT and SAGA to control the species. Other areas were controlled opportunistically.



Figure 5 – Mouse-ear chickweed grows throughout Bartlett Cove and the backcountry.

Hand-pulling the species is challenging since it has a weak stem and frequently breaks near ground level. In addition, it very effectively integrates with native vegetation making detection and selective removal challenging. Despite its wide distribution and ability to invade low disturbance areas in Glacier Bay, mouse-ear chickweed has a relatively low risk ranking (36, Appendix A), suggesting it need not be a high-priority species for control.

Snow in Summer - Cerastium tomentosum

This is a persistent ornamental species observed in Gustavus. Thus far, it has not been observed in the park.

Canada Thistle - Cirsium arvense

Canada thistle is an aggressive exotic species (ranking 76, Appendix A) that has been in Gustavus since at least 1970 when it was collected by Greg Streveler near the Gustavus Inn. The Gustavus Inn still works to control the species using herbicides. At least two other infestations are known to exist in Gustavus, including a large area near Toshua and Heather Parker's residence and near the Wagner's home. Jim Wagner indicated that the plants appeared following importation of hay from the lower 48 for his horse. Despite its name, it is not native to Canada or North America.

Orchardgrass - Dactylis glomerata

Orchardgrass (Figure 18) has been found growing scattered along the roads in Bartlett Cove and in Gustavus. Since it is growing in relatively low (controllable) densities, it has been the focus of effective control efforts since 2005. The best time for control activities is late-July to late-August.

Quackgrass - Elymus repens

This grass is growing on and around a soil pile at the Bartlett Cove depot



Figure 6 – SAGA helped remove quackgrass, including this long rhizomatous specimen.



Figure 7 - Quackgrass is abundant inside the fence at the depot. Most years, the area is weed whacked down, but not in 2009.



Figure 8 – Hempnettle growing in Gustavus.

(Figure 7). It was controlled again in 2009 by EPMT and SAGA staff (Figure 6). Larger infestations grow within the depot fence area and on the slopes near the maintenance building. The species has also been found growing on the GLBA property in Gustavus, as well as along the roads. In the 1990s, Koren Bosworth documented this species growing near the Glacier Bay Lodge; however, it has not since been observed in that area. Efforts in 2010 should focus on the removal of the species.

Hempnettle – Galeopsis tetrahit/G. bifida

Hempnettle (Figure 8) was found growing in Gustavus for the first time in 2007. The distribution and extent of the species is unknown, but monitoring should occur in subsequent years.

Herb Robert – Geranium robertianum

A surprisingly well-established infestation of herb Robert (Figure 9) was found for the first time this year growing near GBQ04 (Grant residence). Control



Figure 9 – Herb Robert was found in a dense infestation in near GBQ04 this year.

activities occurred, but the plants were already in seed. The plants had very fine hair-like roots, which may be problematic for effective control.

Orange Hawkweed - *Hieracium aurantiacum*

Orange hawkweed has not yet been located within GLBA; however, it has been included in multiple arrangements by Gustavus residents at the 4th of July contest, which suggests it is growing in several places within Gustavus. The Bruno home off Church Road is one known infestation, although treatment of the infestation is ongoing. Another larger population of orange hawkweed is known to be growing in Gustavus according to Jamie Ogilvy (former owner of Bruno home), but its specific location is unknown.

Foxtail Barley - *Hordeum jubatum*

Although considered native by most (Pojar and MacKinnon 1994, ITIS.usda.gov), foxtail barley can become very weedy in some areas of Alaska and may represent nonnative cultivars. Although it has been detected in several areas within the park including Dry Bay, Strawberry Island, South Sandy Cove, Bartlett Cove, and Excursion Inlet, it does not appear to be an invasive threat since its density is relatively low and it is mixed with diverse native species in coastal meadows. Continued monitoring of the species is warranted.

Hairy Cat's Ear - *Hypochaeris radicata*

A single specimen of hairy cat's ear was removed from the Bartlett River trailhead in 2005. It is now considered locally eradicated in Bartlett Cove. In 2006, a large infestation of the species was found growing in Gustavus throughout the softball field behind the U.S. Post Office, in the meadow between the Post Office and the school, and in the playground area of the school. Although outside of the park's work area, this species should be the focus of Gustavus community weed control efforts. The species is best targeted in late-July to early-August.



Figure 10 – Removal of white deadnettle near the Glacier Bay Lodge requires extensive searching through the surrounding vegetation.

White Deadnettle - *Lamium album*

In 2005, 2006, 2008, and 2009, all observed specimens of white deadnettle were removed from near the Glacier Bay Lodge (Figure 10). Based on the plant's variegated foliage and its close proximity to the Lodge, it is likely that this is an escaped ornamental species. The Glacier Bay Lodge Landscape Management Plan includes an objective to "prevent proliferation of exotic plant species." As part of that, they are to 1) avoid using fill from outside the park, 2) plant nonnative species in planter boxes only after consultation with NPS, and 3) discourage exotics in disturbed areas using mechanical and/or chemical methods. To date, the Glacier Bay Lodge has not been proactive in removing exotic species. Although the use of chemical control at the lodge is a provision, Marilyn Trump of the GLBA Concession Division is not aware of any instances where herbicides have been used. In future years, the EPMT team should be consulted regarding the suggested nonnative species to be planted and only native plants or non-invasive exotic species should be used. White deadnettle should be removed in early summer 2010 since it is anticipated that it can be eradicated from the park.

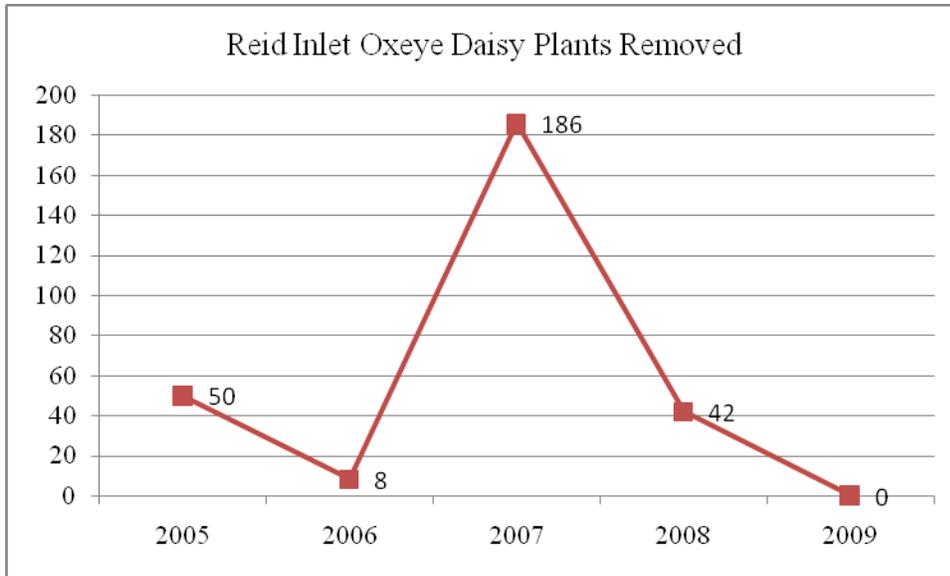
Oxeye Daisy - *Leucanthemum vulgare*

Oxeye daisies have proven very successful at growing in the vicinity of GLBA. As a result, this species was targeted for removal again in 2009. All known plants were removed in Bartlett Cove. Most often a single plant is located, indicating that it is likely the first year of establishment. In other areas, multiple plants indicate that the species has been present and reproducing for many years. A new, well-established infestation was found in the yard of GBQ04 this summer, which will need multiple years of treatment.

Finding seedlings is challenging since they are small and inconspicuous. In 2009, corn gluten was applied to an areas of high seedling density at the water towers (Figure 11). Corn gluten, an all-natural by-product of corn milling, is a known pre-emergent that prevents seeds from developing roots during germination. Therefore, germinating seeds will not survive, but existing vegetation will be unaffected. It is best to apply corn gluten 4-6 weeks before germination at a rate of 20 lbs per 1000 sq. ft. (Christians 2009). Due to persistent snow, the corn gluten was applied at the end of April. At this point, oxeye daisy plants were already evident in the area. No noticeable difference in oxeye daisy germination was observed. Remaining corn gluten should be applied earlier in the spring of 2010 if snow conditions allow.



Figure 11 – Near the Bartlett Cove water storage tanks, abundant oxeye daisy seedlings carpet the ground.



A single infestation of daisies growing in a mountain-avens (*Dryas drummondii*) mat at a popular camping area in Reid Inlet was visited again in August this year. No daisies were detected (Figure 12). The surrounding vegetation was extremely drought stressed and daisy seedlings may have suffered from insufficient water. Monitoring should

Figure 12- The number of oxeye daisies removed from the site near Reid Inlet since 2005 shows that the seed bank may have finally been exhausted, but continued monitoring is warranted. Since 2006, only seedlings have been found.

continue for several years.

Dry Bay has the most severe daisy problems of any area of GLBA or the entire NPS Alaska Region. All infestations of daisies in Dry Bay were controlled again in July 2009, including near

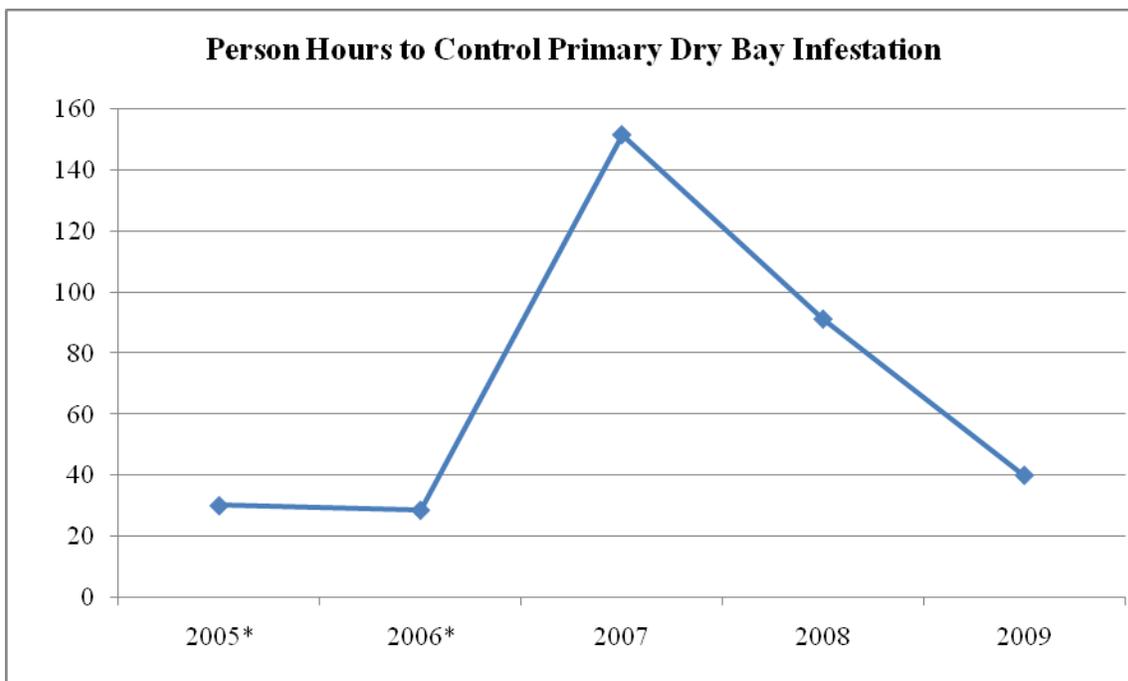


Figure 13 - In 2005 and 2006, the area was partially mowed and only flowering plants were removed. Since 2007, efforts have focused on trying to remove all detected flowering plants and seedlings with mowing being delayed until after treatment. Treatment time and the number of detected plants continues to decline.



Figure 14 - The maximum extent (1.079 acres) of the Dry Bay runway oxeye daisy infestation. With successive treatments, the time needed to remove plants has decreased by nearly 75%.



Figure 15 - A mutant oxeye daisy was found growing in Dry Bay this summer.

the fish plant, near the rafter outhouse, at the Moody residence, at the Swanson residence, at the Hazen residence, and along the runway near Johnny's East River Lodge. Areas that were mowed in previous years but were not mowed in 2009 revealed previously undetected infestations of daisies. Once again, several new areas of daisies were found and controlled in 2009, indicating that the species is likely spreading and that monitoring and control need to continue. Untreated infestations on US Forest Service land adjoining Dry Bay will continue to be sources for new infestations.

The infestation near the rafter outhouse was likely a result of moving seed-contaminated soil from near the fish plant to the outhouse area for construction. If further construction is intended for this site, it is imperative the best management practices (Appendix C) be followed. In general, areas surrounding flowering daisy populations have abundant seedlings, which are often cryptic due to their low-growing rosette of leaves. Consequently, all areas where daisies were controlled in 2005-2009 should be monitored and re-treated in 2010 and subsequent years. Although the large Dry Bay infestations persists (Figure 14), the effort required to control the plants each year is decreasing (Figure 13). At least 40 person hours should be allocated for oxeye daisy control in Dry Bay for 2010.

Oxeye daisies are very prevalent in Gustavus, and landowners are very fond of the showy flowers and low-maintenance plants. Daisy populations are likely being spread along the dirt roads in Gustavus by the graders that level the roads, vehicles, bikes, and other sources. Outreach efforts should continue to educate Gustavus residents about the risk posed by the species to the native flora. Shasta daisies, which are also nonnative but less invasive, may provide a suitable alternative, but seed and plant labeling do not always correctly distinguish between the two species. A mixed patch of oxeye and Shasta daisies on Mary's Road suggests that the Shasta

daisy may also spread beyond where it was initially planted. Additionally, the native arctic daisy (*Dendranthema arcticum*) was transplanted to two gardens in Gustavus in 2005 to see how it performs in cultivation. It has over-wintered and successfully flowered since 2006 at one residence, demonstrating its potential as a suitable landscape alternative.

Yellow Toadflax - *Linaria vulgaris*

Yellow toadflax, also called butter and eggs, is common in some areas of Gustavus, but fortunately, it has not yet been detected in GLBA. Annual monitoring for this species should continue, and outreach efforts should emphasize that this plant is very difficult to eradicate once established.

Perennial Ryegrass - *Lolium perenne* ssp. *perenne*/multiflorum

Both *Lolium perenne* ssp. *perenne* (perennial ryegrass) and *L. perenne* ssp. *multiflorum* (Italian ryegrass) have been identified growing along the roadsides in Bartlett Cove. Both subspecies were seeded as part of the revegetation process after the road paving that occurred in 2002. Once again this summer, no perennial ryegrass was observed, which suggests the short-lived plant has been eradicated.

Bigleaf Lupine - *Lupinus polyphyllus*

Bigleaf lupine is native to the Pacific Northwest, but most authorities consider the species introduced to Alaska (Hultén 1968). Alternatively, the plants may be Russell hybrid lupines, which are ornamental crosses between *L. arboreus* and *L. polyphyllus*. In addition to the visual differences between the bigleaf and native Nootka lupine, particularly in the shape and number of leaflets, the bigleaf lupine is very fragrant.

In Gustavus, a pink-flowered cultivar is commonly planted and spreading, but it has not yet been observed in Bartlett Cove. In Dry Bay, the more common purple-flowered form is very widespread, particularly near the Alsek River. Occasional white and bicolored flowering plants are also present. The species occupies both open meadow and shaded understory (Figure 16) habitats in very dense colonies that exclude native species. It appears that plants are spreading both vegetatively and by seed. The distribution of bigleaf lupine



Figure 16 – In addition to invading open meadows, *Lupinus polyphyllus* appears to spread vegetatively in the shaded understory of Dry Bay’s forests.

does not appear to be restricted to areas of human disturbance. This unfortunately leaves most of Dry Bay vulnerable to invasion. The Alsek floodplain is suitable for colonization, and once seedlings establish, plants spread through the till with extensive rhizomes. In 2009, the river rose to heights not seen in recent years. Plants were being uprooted and washed downstream, including out the mouth and onto the beach. Additionally, the weather was unseasonably warm and dry, which resulted in plants showing extensive drought stress (Figure 17). At this point, the species is not present on the successional younger dunes, more open areas, and very wet areas. However, it may have been transported to areas, such as the Rohloff cabin, where it might not have dispersed naturally. Dry Bay cabin permits should restrict planting and moving plant species to and within the Preserve.

It is difficult to know when the species was introduced to Dry Bay. Although it was absent from the GLBA herbarium, Greg Dudgeon, a former ranger in Dry Bay, can remember the species as being prevalent as early as 1990. Pat Pellett, a resident of the Forest Service (USFS) portion of Dry Bay, remembers the bigleaf lupines when he first started coming to the area in the late 1960s to early 1970s. Lisa Robbins, who spends time on both sides of the Alsek River, indicated that the species is prevalent on the west side of the Alsek as well as near the Akwe River. She speculated that the species spread with the Yakutat and Southern Railroad (1903- mid-1960s) that brought fish from the Situk River to Yakutat. From photos on the USFS website (http://www.fs.fed.us/r10/tongass/forest_facts/resources/heritage/ysrailroad.shtml), it appears the lupines are present near the Situk River. Nevertheless, this is still 65 km (40 miles) from the Alsek River and Dry Bay.

Since *L. polyphyllus* is growing in the same habitats with the native *L. nootkatensis*, it is possible that the two are hybridizing. Plants with intermediate morphological characteristics were observed in 2005 and 2008. Teresa Sholars (pers. comm.), author of the lupine section of the *Flora of North America* and professor at College of the Redwoods, was not aware of

hybridization of the species, but indicated that it was possible.



Figure 17 - The unusual hot and dry weather in 2009 left the invasive bigleaf lupines in Dry Bay showing excessive drought stress.

Maltesecross* - *Lychnis chalconica

Maltesecross is an ornamental species that can become invasive. It has been documented in Gustavus and has been included in several of the 4th of July flower arrangements from Gustavus residents. Other related flowers, including bladder campion, are known to be growing in Gustavus. Future inventories should continue to look for these species.

Pineapple Weed - Matricaria discoidea

Pineapple weed is found in continuously disturbed areas, including near the depot and in parking areas in Bartlett Cove, on ORV trails in Dry Bay, and in Gustavus. The species has not been observed spreading into nearby less disturbed habitats or displacing native species. Therefore, although it is nonnative, it is not of high management concern (32, Appendix A).

White Sweetclover - Melilotus alba

An herbarium specimen of white sweetclover was collected near the Gustavus airport in 1970. According to Greg Streveler (pers. comm. 2006) the area where the species was growing was paved during airport improvements, and the species has not been seen since then. This species is very invasive along roads and rivers in Alaska. Since it is growing in Haines and Skagway, it is possible for seeds to be transported with people, gear, or planes to Gustavus. Continued monitoring is necessary. Additionally, the Tatshenshini-Alsek Rivers could be conduits for establishment since both white and yellow sweetclover grow in Haines Junction and on the Haines Highway.

Mint - Mentha sp.

A small area of mint was found and removed from behind the Bartlett Cove fitness/e-cache building in 2006. The species has not been relocated in this area since then; however, an extensive patch was found near the Hazen cabin in Dry Bay that is kept in check by mowing the perimeter. Mint should not be allowed to escape into natural areas.

Forget-me-not - Myosotis scorpioides and M. alpestris ssp. asiatica

Taxonomy and nativity of the forget-me-not genus is unsettled. *Myosotis scorpioides*, often listed as *M. palustris*, is definitely present in Bartlett Cove and Gustavus and is a European introduction. Work performed by Whitney Rapp at the ALA herbarium in Fairbanks, AK in 2006 and subsequent communication with Carolyn Parker of the ALA, has revealed that the Alaska state flower, *M. alpestris ssp. asiatica*, has few records from Southeast Alaska. Consequently, it may be native to this range and rare, or introduced through cultivation (Parker 2006 pers. comm.). Some botanists split these species further (such as *M. sylvatica*), but the distinguishing characteristics are not definitive and lead to significant doubt when classifying species (Parker 2006 pers. comm.). Subsequent inventory efforts should collect forget-me-not specimens to determine what species are present. The shape of the calyces is the best means for determination.

Most likely because of plant/seed availability and the ignorance of the difference among species and nativity, the European species has been planted widely, including in planter boxes at the Glacier Bay Lodge in 2005. They have escaped cultivation around the Glacier Bay Lodge, near where the NPS trailers were in the Admin area, and in Gustavus, particularly in drainage ditches.

Efforts should be made to remove all *M. scorpioides* plants in Bartlett Cove in June 2010 before seed is set. In addition, Glacier Bay Lodge should be encouraged to plant native species and not to sell “Alaska” wildflower mixes, which often include invasive species.

If *M. alpestris* ssp. *asiatica* is located, the population should be monitored to determine if it is spreading. Any information about the population’s origin should also be gathered to better determine whether the species is native or introduced.

Western Wheatgrass – *Pascopyrum smithii*

A grass tentatively keyed out to be western wheatgrass is growing in Gustavus between the U.S. Post Office and school in a dense, monocultural stand. The distribution of this species beyond this location is unknown, so monitoring should be continued.

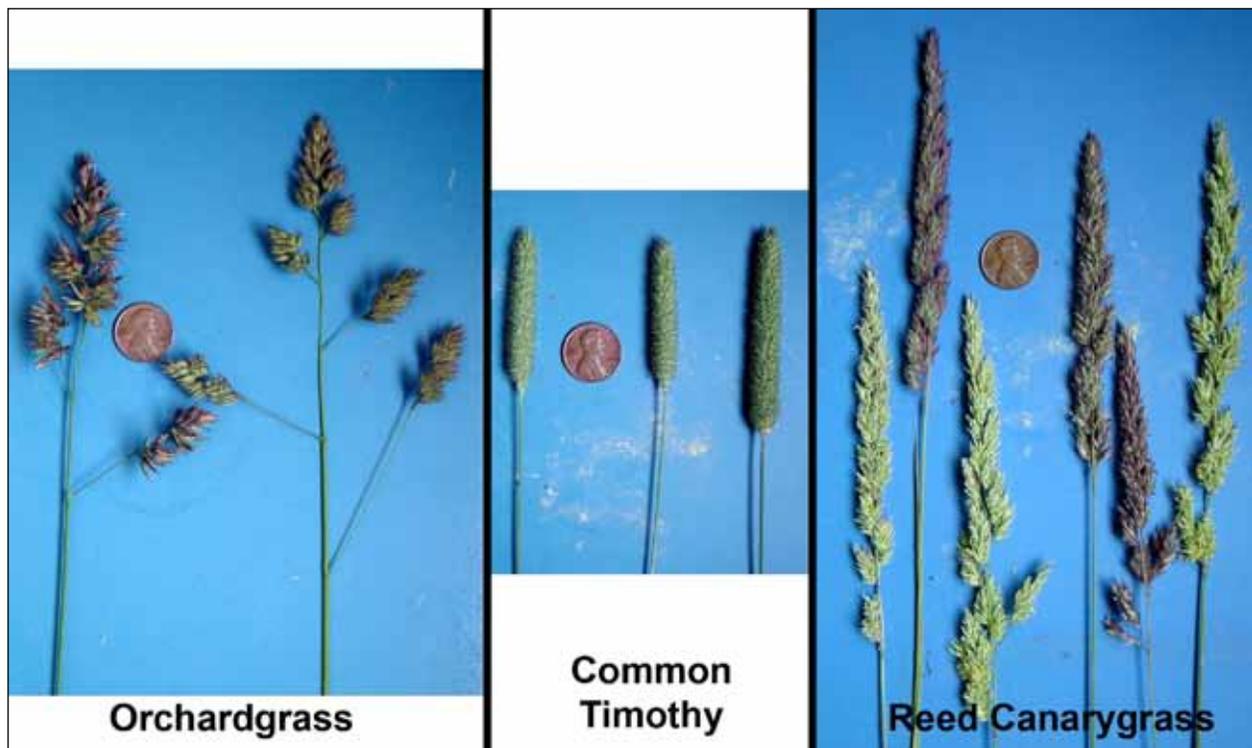


Figure 18 – Inflorescences of the three most common exotic grasses in Bartlett Cove: orchardgrass, common timothy, and reed canarygrass.

Reed Canarygrass - *Phalaris arundinacea*

Reed canarygrass (Figure 18) is definitely native to Europe, although some people believe the species may have a circumboreal distribution. The species has a long agricultural record, including cultivation for forage as early as 1749 in Sweden. In the U.S., the first agronomic trials probably began in the 1830s when New England farmers began experimenting with crosses to increase palatability to livestock. With subsequent breeding for vigorous growth and drought tolerance, super-strains of canarygrass were developed that have become problematic as they



Figure 19 – Whitney Rapp holding a single plant from an area repeatedly controlled since 2005. Although the above ground growth is minimal, the below ground rhizome is still extensive. Without complete removal of the rhizome, the plants regrow.

have escaped. In addition to agricultural uses, reed canarygrass has often been used for erosion control due to its tolerance of wet areas and its ability to spread rapidly (Lyons 2006). Since there is some question regarding the species nativity, management of the species becomes questionable. Populations growing south of the Alaska Range are generally associated with anthropogenic disturbance and are most likely introduced or introgressed genotypes (Lapina and Carlson 2006). Since reed canarygrass is most frequently associated with human disturbances, it is most likely a result of human introduction.

Reed canarygrass is the highest ranked species (83, Appendix A) currently present in GLBA due to its threat to the native ecosystems. This grass forms dense monospecific stands that displace all other species, provides poor habitat for wildlife, and affects soil hydrology. Stands of this grass within Bartlett Cove were removed in 2005-2009. Biomass declines have been noted, yet few of the infestations have been eradicated after multiple years of treatment and extensive disturbance to the ground and surrounding native vegetation (Figure

19). In addition, several new infestations were again located in Bartlett Cove this past year. Control of the expanding infestations on the slopes surrounding the maintenance building exceed the capacity of our crew and warrant herbicide use, particularly since manual methods would require digging that could destabilize the steep slopes. The erosion matting will also impede control of the species.

In 2006, several small populations of reed canarygrass were found in the backcountry, including near the former fox farm on Strawberry Island and at two locations in Excursion Inlet. In 2009, a few stems of reed canarygrass were again found in the same location on Strawberry Island. This infestation does not show the aggressive spreading habits of other infestations. No trips to Excursion Inlet were made.

Within Gustavus, reed canarygrass has affected a significant area, although most residents are unaware of the situation since grasses are often overlooked (Figure 20). Although the species is best known for adversely affecting riparian habitat in other areas, reed canarygrass seems very successful in colonizing any modestly open habitat in Gustavus - probably due to the consistently wet soils. An article was published in the Fairweather Reporter this summer discussing the successful hay production this summer in town from a field that had been previously seeded with canary grass. This may also explain the high correlation between reed canarygrass and leach fields in Gustavus since those installing the field may be reseeding with invasive grasses.

A stand of a variegated cultivar of reed canarygrass was planted beside Andy Varni's home in Dry Bay (Figure 21). This stand is bounded by the home and a walkway and does not appear to be spreading as vigorously as the non-variegated forms. In 2009, Varni indicated he would make efforts to remove the plants. No other reed canarygrass has been observed in Dry Bay.



Figure 20 – Reed canarygrass is abundant in Gustavus as this meadow demonstrates. Education and outreach efforts in the community should raise awareness of the concerns this species poses.



Figure 21 – A variegated cultivar of *Phalaris arundinacea* grows along the foundation of Andy Varni's home in Dry Bay, which also has a high concentration of other exotic species.

Common Timothy - *Phleum pratense*

Common timothy (Figure 18) is abundant throughout Gustavus and common in Bartlett Cove. It was likely introduced through hay or grown for grazing animals. In Bartlett Cove, it is prevalent along the recently disturbed roadsides. Once again in the late summer of 2009, all plants growing along the road were removed. Although there are reports of the species in the backcountry, all specimens observed thus far appear to be the native alpine timothy (*Phleum alpinum*).

Plants with intermediate morphological characteristics are routinely observed in Bartlett Cove, which is similar to other places where the native and non-native species grow together (KLGO, WRST, KEFJ). Alan Stewart (2009) of New Zealand provided insights on *Phleum* hybridization this summer. *Phleum alpinum* is from an older lineage of tetraploid species. In contrast, *Phleum pratense* is from a more recent line of hexaploid species. Stewart indicated that hybridization between these two groups is difficult, rare, and leads to high degrees of sterility. Diagnostic features between the two species should better be outlined to help in positive identification.

Common Plantain - *Plantago major*

Common plantain grows in recently disturbed locations in Bartlett Cove and Dry Bay such as along roads, in parking areas, and along trails. Although prevalent, it does not appear to be spreading outward into less disturbed areas or displacing native species. This species has not been recorded in the backcountry. As a result, this species' presence should continue to be

monitored and plants can be controlled as time permits. Plantain need not be a top management priority.

Annual Bluegrass - Poa annua

Annual bluegrass is a commonly seeded grass for turf. It is common in Gustavus and present in Bartlett Cove. Specimens of a *Poa* species thought to be *Poa annua* were collected from Lone Island in 2006 and sent to the regional office for positive identification. Due to the difficulty of definitively identifying *Poa* species, management of this species may be challenging.

Fowl Bluegrass - Poa palustris

Some time ago, a single herbarium specimen of fowl bluegrass was collected from Drake Island. The herbarium sheet is housed at the USFS office in Juneau, so subsequent confirmation of the taxonomy has not been made. Additional training in grass identification and more survey effort are needed to relocate this species, if present. It is likely that other nonnative *Poa* species are also present within the park.

Kentucky Bluegrass - Poa pratensis

Kentucky bluegrass, another commonly seeded lawn grass, was found growing in Bartlett Cove and Gustavus in 2006. Due to low confidence in distinguishing this species from native bluegrass species, control and inventory efforts will continue to be hindered.

Prostrate Knotweed - Polygonum aviculare

Prostrate knotweed was a newly documented species for the area in 2006. It was observed growing in Gustavus in the abandoned driveway on Tom and Sal McLaughlin's property. Although locally abundant, its distribution appears to be restricted to the most disturbed areas. It could be confused with the native *Polygonum fowlerii*, so care in identification is needed.

Tall Buttercup - Ranunculus acris

Tall buttercup is growing in a dense stand between the Bartlett Cove fuel and public use docks near the former location of the kayak racks. The plants were dug out in 2005, but they were already dropping seed. In 2006, efforts to remove the plants were made, but concerns about contact with cow parsnip, which can cause skin blistering, prevented effective removal of the species. The 2007 control efforts removed most, if not all, flowering plants before seed set. A similar level of treatment with follow-up spot checks was done throughout 2008 and 2009. In future years, it may be warranted to cut the leaves of cow parsnip in areas being treated to minimize exposure to the phototoxic chemical compounds. Although this would cause greater

disturbance and possibly enhance growth of exotic species due to increased available light, it would protect the health of those controlling buttercup. Another concern regarding tall buttercup treatment is that it is difficult to distinguish the seedlings of *R. acris* from the native *R. uncinatus* and other buttercup species. In flower, however, the species are distinguishable by the much showier flower of tall buttercup and the clasping sepals. This site will need to be resurveyed and treated before early July 2010.

Four additional locations on the Park Road and one location on the beach trail from the VIS had tall buttercup. The species grows in dense infestations in Gustavus as well. The small infestation located in Dry Bay in 2008 was not evident this year.

Creeping Buttercup - *Ranunculus repens*

Cooper (1939) collected creeping buttercup in a beach meadow near Bartlett Cove in 1935. Today this species is abundant in a few locations within Bartlett Cove including the Larson (in yard and along trail to seasonal housing - GBQ 03), Bredow (GBQ 09A), and Martinez residences; near the kayak concessionaire buildings (Figure 22); near the depot; five locations along the Park Road; and at the Swanson cabin in Dry Bay. Control of this species is challenging due to the rooting at each node and its ability to integrate into mowed lawns. Attempts in 2009 to focus on the removal of the species from the area near the concessionaire buildings and the Swanson cabin were very labor intensive and not very successful.

Like *R. acris*, it is difficult to distinguish seedlings of *R. repens* from native buttercups. The species is most easily identified in mid-summer when the flowers are blooming. Since this species has proven very invasive in other areas of Southeast Alaska such as Sitka National Historical Park (Rapp 2006), early investment of resources to control the relatively small initial infestations of this species is warranted. Like *R. acris*, this species commonly grows beneath cow parsnip, so control efforts need to avoid contact with cow parsnip.



Figure 22 – Creeping buttercup carpets the vegetative understory along the old road near the kayak concession buildings.

Rhubarb - *Rheum rhabarbarum*

Although not invasive, rhubarb is persistent in Alaska. For this reason, locations of rhubarb, particularly in Dry Bay, are being recorded for future management if cabins are abandoned. For example, the abandoned cabin at the end of the Bear Island Trail has rhubarb that could be removed.

Rugosa rose and other roses - Rosa rugosa and Rosa sp.

The rugosa rose, locally referred to as the Sitka rose, is a native of China, Japan, and Korea that has been well documented to escape cultivation and effectively naturalize. The origin of the “Sitka” rose likely dates back to the establishment in Sitka of the Alaska Agricultural Experimental Station and its first superintendent Charles Georgeson who introduced the species between 1903-1921 and later sent it to other areas of Alaska for cultivation (Holloway 2006). Rugosa rose is naturalizing in the meadow near the Gustavus dock and near many homes in Gustavus. To date, it has not been observed within GLBA.

The only native rose to the region is the Nootka rose (*Rosa nutkana*), which is infrequently seen. Although many in Gustavus think they are planting Nootka roses, often other rose species or cultivars are being planted that have an invasive habit. One of these nonnative horticultural roses grows on the GLBA Gustavus property near the Gustavus School. Along the margins of Parker Road, roses are spreading widely.

Red Raspberry - Rubus idaeus

Although red raspberries are native to Alaska, the range map in Hultén (1968) does not show the species to be present in the coastal areas of Southeast Alaska. In addition, there are no collected specimens from this area in either the GLBA or the University of Alaska herbaria. All of the *R. idaeus* populations found to date within GLBA can be associated with current or historic human use, so it is probable that the plants were introduced for cultivation. Due to the uncertainty of nativity, this species will be treated as native until management decides otherwise.

Sheep Sorrel - Rumex acetosella

Sheep sorrel is known to be growing in four locations in GLBA, all in the Bartlett Cove developed area: behind the depot building, near the Seraphin/Bredow residence (GBQ 09A), between the fuel and public use docks, and at the base of the slopes at the maintenance building. Efforts to control the species between the Bartlett Cove docks and at the maintenance building were performed with the assistance of the TCCC crew in 2007. No control efforts were made in 2008. Removal of above ground growth was resumed in 2009. The species forms extensive, weak roots that break easily. Due to the limited size of these populations, efforts should be made to control them again in 2010 and judge the effectiveness of control. At the Gustavus dock and much of the Nature Conservancy land east of the dock, there is considerable invasion of the meadow areas by sheep sorrel, which demonstrates what can and likely will happen if this species is not controlled within the park.

Curly Dock - Rumex crispus

Curly dock (Figure 23), not to be confused with the native western dock (*R. occidentalis*), was first observed growing in the park along the side of the entrance road to the generator area. The



Figure 23 – The first curly dock was removed from Bartlett Cove this year.

plant with an extensive root system was removed. Monitoring for this species in the future is needed.

Perennial Sowthistle - Sonchus arvensis

Perennial sowthistle is well established in approximately 2.5 acres of the supratidal meadow near the former fox farm on Strawberry Island (Figure 24 and Figure 25). It is likely that the species was introduced while the fox farm was in operation, which was before the late 1930s. Two infestations

separated by a wet meadow are growing in the herbaceous areas between the forest and the shoreline. The larger area appears bound by physical conditions of hydric soils, the intertidal zone, and the shaded forest margin that prevent continued vegetative expansion. The smaller, more eastern area appears to have room for continued vegetative expansion northeastward. In addition, this species could spread by seed to start new populations elsewhere.

In 2006, two control events occurred to try removing plants. The first event on May 26, 2006 involved ten people, including the TCCC crew, and yielded a disheartening 6 kg (14 lbs.) of plant material from a relatively small area. Once the plants grew larger, a second control effort was conducted on August 18 with another ten people. Although this second trip yielded 86 kg (190 lbs.), relatively little progress was made compared to the full extent of the infestation. Based on 2006 effort and acreage controlled, it is estimated that completely clearing the areas of perennial sowthistle by manual hand-pulling could require a crew of 70 people working 8 hours a day for a week. To further compound the issue, hand-pulling is effective at removing above-ground biomass, but very little of the rhizomes are removed, which suggests the plants are likely to re-grow.

In 2007, no control efforts were conducted; however, the site was revisited to remap the perimeters of the infestations to assess any changes. Surprisingly, areas where plants were removed in 2006 were still clearly visible, and the native vegetation was rebounding well. This still does not diminish the estimated effort required to effectively control the species, but it does create hope for other smaller populations.

In 2008, the EPMT and SAGA crews spent two days on Strawberry Island in July. Four replicates of three treatments were established. The treatments occurred in delimited 5m x 5m squares in the western infestation. The three treatments were: 1) control – plants were counted



Figure 24 - Perennial sowthistle monopolizes the beach meadow on the south side of Strawberry Island with a density of over 80 plants per square meter. In July, the plants usually begin to bolt.



Figure 25 - Bonnie Million shows that by September the perennial sowthistle are waste high and flowering. Viable seed set is dependent on the weather with many summers not being long enough.

2007, very few plants were relocated and none appeared to reach flowering. In 2008, a few plants were observed in this location. According to Gustavus resident Carole Baker, another population of perennial sowthistle grows along the banks of the Salmon River near City Hall.

In other areas of Southeast Alaska, including Juneau, Hoonah, and Hyder, perennial sowthistle is very effective at forming dense infestations in coastal meadows, which suggests that GLBA should make the control of this species a high management priority. It is also known that the species is best controlled with herbicides. Depending on the outcome of the current Invasive Plant Management Plan Environmental Assessment that is considering the use of herbicides, the GLBA population of perennial sowthistle should be considered for herbicide treatment. If approval to use herbicides is not provided, it is suggested that alternative treatments, including covering the coastal meadows with thick black plastic sheeting for at least a year, be attempted. This would kill most or all plants, including native species, non-selectively. Once the sheeting is removed, the entire area would need to be revegetated with native seeds and/or plants.

(and consequently trampled), but not removed, 2) pulled – plants were counted and pulled with little attention given to removing below ground growth, and 3) dug – plants were counted and dug using a weed digger, which is not likely to have removed all below-ground roots. On average, 80-100 plants per square meter were growing. The four corners of each square were GPSed and have a ground staple that may still contain neon green flagging. Evaluation of the sites in 2009 was not done; however, the area was visited twice to assess the plant's phenology and extent.

An infestation of *S. arvensis* has also established along the roadside near the Gustavus Inn in Gustavus. In 2005, it appeared to be restricted to the south side of the road. In 2006, it was present on both sides of the road. The Gustavus Inn treated the plants with Spectracide Brush Killer herbicide (2,4-D principal ingredient) as they were beginning to flower in August 2006, which caused browning of the plants. In

European Mountain-ash - *Sorbus aucuparia*

European mountain-ash trees have been planted by landowners around Gustavus. The prolific production of red berries, which are consumed by birds and then redistributed, has resulted in mountain-ash trees germinating in new locations throughout Gustavus. Although it is possible that *S. aucuparia* may hybridize with the native *S. sitchensis*, the mountain-ashes observed in Gustavus display the characteristics of the nonnative species, in particular the distinctive whitish hairs on new growth (Figure 26) compared to reddish hairs of the native species (Table 4). Trees are easily located in early spring since they leaf out earlier than most of the native vegetation.

Table 4 – Comparison of traits of native and nonnative mountain-ash species (Klinkenberg 2004, Hultén 1968). The trait that most easily separates the species is the color of the hairs on the new growth.

	European Mountain-ash <i>Sorbus aucuparia</i> (nonnative)	Sitka Mountain-ash <i>Sorbus sitchensis</i> (native)
Height	Small tree, 5-15 m	Medium to tall shrub, 1-4 m
Trunk/Stem	Primarily single stem, grayish, branched	Multi-stem, grayish-red, sparingly branched
Winter buds/ young growth	Grayish soft-hairy	Somewhat rusty-hairy
Leaves	11 to 15 (17) leaflets, sharp pointed at the tip, mostly smooth, saw-toothed almost to the base	7 to 11 leaflets, rounded to blunt at the tip, sometimes rusty-hairy below, coarsely saw-toothed for not more than $\frac{3}{4}$ their length
Flowers	Flat-topped; branches white-hairy; calyces hairy	Half-rounded; branches rusty-hairy; calyces mostly smooth
Fruits	Globe-shaped; not glaucous	Globe-shaped to ellipsoid; glaucous
Habitat	Cultivated, and escaped	Woods, up into subalpine region

No trees were observed in 2009 in the park, including in the area near the depot where a seedling was removed in 2007. Since this species has become problematic in other Southeast Alaskan communities such as Sitka (Rapp 2006), continued monitoring and education efforts are recommended. In addition, the use of the native Sitka mountain-ash in landscape settings (instead of *S. aucuparia*) should be encouraged.

Chickweed – *Stellaria media*

Chickweed is a weedy species of disturbed areas such as vegetable gardens in Gustavus. Additionally, it has been found growing on the GLBA property in Gustavus near the school, at the



Figure 26 - The European mountain-ash has distinctive white hairs on new growth and more leaflets that aid in distinguishing it from the native species.

Bredow/Seraphin residence (GBQ 09A) in Bartlett Cove, and on Lone Island in the backcountry of GLBA. The abundance of chickweed found on Lone Island in 2006 was quite surprising and may be a reflection of the constant disturbance and ample fertilization by nesting birds. Chickweed has shown an affinity for seabird colonies in other regions and is considered a greater ecological concern in these habitats (Lapina and Carlson 2006). Although controlling exotic species in the backcountry is generally a high priority, the importance of this island for nesting birds indicates that control efforts should not occur before September, if at all.

There are native *Stellaria* species that are prevalent in coastal meadows in some areas of the park. Compared to the exotic species, they are generally more diminutive, and the lower leaves are attached to the stem or on short stalks. In contrast, the exotic species has lower leaves on long stalks.

Common Comfrey - *Symphytum officinale*

Common comfrey has been planted for its ornamental and herbal properties in Dry Bay, at the Bartlett Cove depot, on the GLBA property in Gustavus, and on private property in Gustavus. The Dry Bay population at the Robbins cabin is still within the bounds where it was planted, but both of the other populations have spread by seed to form new plants. Lisa Robbins, a Dry Bay cabin permit holder, has been informed of comfrey's habit of spreading and was advised to keep the plants contained to the planted area. All plants in Bartlett Cove were removed in 2006-2009, but the depot area should be resurveyed in 2010 to remove any persisting plants since they regrow well from small root fragments. The plants in Gustavus on GLBA property should also be removed since the original plantings have been abandoned.

Common Tansy - *Tanacetum vulgare*

Tansy is another species often planted as an easy-care ornamental; however, it has the ability to reproduce and invade natural areas. To date it has been observed in Gustavus only, including along Mountain View Highway, near the abandoned buildings preceding the airport where Dan Foley operated a fish processing plant, on the corner of Dock Road and Church Road, on Hi Glen Rd, and near the Gustavus dock. Future inventory work should determine whether the species is spreading into the park.

Common Dandelion - *Taraxacum officinale* ssp. *officinale*

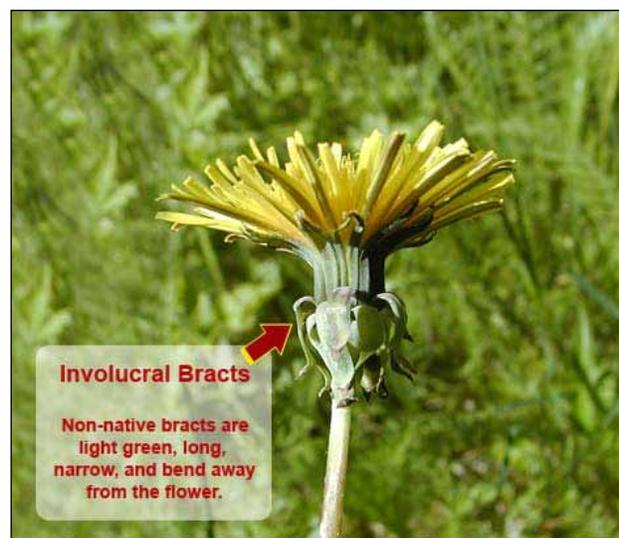


Figure 27 - A nonnative *Taraxacum officinale* ssp. *officinale* flower head showing the involucre bracts that bend away toward the flower to the stem.



Figure 28 - A native *Taraxacum officinale* ssp. *ceratophorum* flower head highlighting the distinct horns on the involucre bracts, which also do not bend toward the stem.



Figure 29 - A native horned dandelion (*Taraxacum officinale* ssp. *ceratophorum*) plant looks similar to the invasive dandelion; however, it is smaller, has horned involucre bracts on the flower head, and has more delicate leaves.

In 1935, William S. Cooper collected a dandelion (*Taraxacum officinale*) from only one study site, the Bartlett Cove area (Cooper 1939). Today it is common to find dandelions in open, non-wetland areas and particularly in the herbaceous area above the intertidal throughout most of Glacier Bay proper. Although their distribution is still patchy near the glaciers, they have the ability to establish in very young soils previously colonized only by native, early-successional species.

Control effectiveness on common dandelions has been low, mostly due to the extensive roots that break and can regenerate plants (Figure 31). This year corn gluten was applied in late April to the planted areas near the VIS to determine if it retarded dandelion seed germination. No noticeable improvement was observed; however, additional corn gluten should be applied next spring as soon as the snow melts.

Native *Taraxacum officinale* ssp. *ceratophorum* are well-distributed in Dry Bay following the initial realization in 2006. The timing of this year’s trip to Dry Bay confirmed that except for areas near the Varni cabin, Swanson cabin, and the rafter outhouse, all other observed dandelion flowers had horns on their involucre bracts (Figure 28). Earlier survey work that documented invasive dandelions throughout Dry Bay was amended this year to reflect this new information. Plants along the Northern Lights Lodge runway frequently exceed 14-18” heights, which is very unusual for the native species, but all flowers had horns. This may be evidence of hybridization of native and nonnative congeners. Other areas have shown that *T. officinale* ssp. *officinale* is capable of hybridizing with native species and completely displacing them (Brock 2004).



Figure 30 – Dandelion roots can exceed 2 feet in length, as this plant shows with a nickel for scale.

Survey work in Dundas Bay in 2005 resulted in finding no invasive species, including dandelions. Observations made by Sean and Janet Neilson, Gustavus residents and GLBA employee, in Lituya Bay in May 2005 indicate that dandelions are scattered throughout the bay. In areas of lower dandelion densities, it would be most valuable to survey during May and June when the plants are in full bloom and more easily observed.

Arresting the spread of this species will be extremely labor- and time-intensive because of its widespread distribution and its ability to disperse seeds long distances by wind and animals. For example, South Marble Island in the middle of Glacier Bay proper glows yellow from dandelion flowers in early spring despite the fact that this island is not visited by humans and is 2.6 km (1.6 miles) from the next closest island.

Native *Taraxacum* species have been identified within Glacier Bay, such as the East Arm, so future monitoring should be careful to distinguish the variations. The native species are smaller, often grow in undisturbed areas and alpine meadows, and their involucre bracts have a different form (Figure 29). The invasive species' lower involucre bracts are long, smooth, bright green and curl downward away from the flower head (Figure 27). In contrast, the native species' involucre bracts may be dark-colored, widely triangular, clasping the flower, or have horns (bumps on the tips) (Figure 28). Influences of *T. officinale* ssp. *officinale* on postglacial plant successional processes in Glacier Bay could be substantial and may warrant establishing long-term monitoring plots to assist in understanding the effects.

Additional questions remain unanswered as to why common dandelions are so much larger here compared to plants in the



Figure 32 – Adam proudly displays his catch, a gargantuan common dandelion, that he wrestled from the ground.



Figure 31 – Bobbi Simpson, CA-EPMT liaison, showing that Alaskan dandelions are as large as the state.

lower 48 (Figure 31 and Figure 32). Is the climate and daylight the factor or is there a genetic variation? Do the size of dandelions here foreshadow the stature of other invasive species to come?

Alsike Clover - Trifolium hybridum

Although frequently observed in other areas of Alaska, alsike clover is not prevalent in Gustavus. Continued monitoring should occur for this species.

Red Clover - Trifolium pratense

Red clover has a patchy distribution throughout Bartlett Cove and Gustavus. The plants are easily removed, so all known plants in Bartlett Cove were controlled in 2005-2009. It is uncertain whether plants are sprouting from a seed bank or if pulling/digging the plant is ineffective in killing the plants since the same areas continually support the plants. In Dry Bay, a single red clover specimen was found in the garden of Brad Swanson in 2005. The plant was not flowering during the 2006 visit. Since 2007, the plant could not be found.

White Clover - Trifolium repens

Since the recent paving (2001-2002), revegetation (through 2004), and erosion control (through 2005) work on the Park Road, white clover (Figure 33) has become well established along the length of the disturbed road shoulders. White clover is particularly difficult to remove manually since it roots at each node. As a result, the entire mat must be pulled up with a hoe or cultivator, creating significant soil disturbance and disruption of all neighboring plants, which in turn promotes the establishment of yet more invasive plants. The distribution of white clover is too large in Bartlett Cove to manually control at this point. Fortunately, the species has not yet been located in the backcountry or Dry Bay. Efforts should be made to prevent the introduction of the species to these areas.



Figure 33 - White clover with interspersed dandelions forms a dense mat that becomes very difficult to remove since it forms roots at the branch nodes.

Common Wheat - Triticum aestivum

Wheat hybrid seeds were sown along most of the roadways in Bartlett Cove during the revegetation/erosion control process after the road was paved. Both Regreen (a sterile wheat x

wheatgrass hybrid) and Pioneer/Quickguard Sterile Triticale (a sterile wheat x rye hybrid) were hydroseeded multiple times over several years (2002-2005). Some of the seeds proved fertile since viable seed was produced in 2004 and 2005. Many of these seeds germinated while still in the seed head in September to October in both years and may have perpetuated the species. In early spring 2006, germination was observed along the road in the vicinity of seasonal housing. Fortunately, subsequent late frosts appear to have killed many of the plants. Since 2007, no wheat hybrids were observed in Bartlett Cove. At this time, it appears that this species has been eradicated.

Thyme-leaf Speedwell – Veronica serpyllifolia

Thyme-leaf speedwell, a species that has both native and invasive varieties, has been observed in Gustavus. This year, it was located at both the Glacier Bay Lodge and near GBQ09A residence. The variety observed appears to be the nonnative form. Treatment in the park should begin.

Spiked Speedwell – Veronica spicata

The ornamental spiked speedwell has been observed in Gustavus in areas formerly planted. It has invasive tendencies in other locations, so monitoring should continue in this area.

Johnny-jump-up Violet – Viola tricolor

Johnny-jump-up violets were first observed in 2007 on the slopes around the Bartlett Cove maintenance building. All observed plants have been removed each year (n=87 in 2007 and n=17 in 2008, n=4 in 2008), but future treatments are necessary to ensure the removal of missed plants and new seedlings. Additionally this year, a plant was found growing along the road between the admin turn off and the Bartlett River trailhead and other plants were found at GBQ09A.

Outreach/Education

Several outreach/education programs were conducted in the park and to other groups in 2009. In April, Whitney Rapp presented to the SAGA crew leaders at their training in Juneau. She also gave a PowerPoint program to the interpretive division during their April training. In May, Whitney led the regional EPMT training in Anchorage (Figure 35). In June, Whitney gave an invasive species presentation to SAGA corps members in Indian, AK. As part of the statewide Alaska Weed Awareness Week, the Whitney coordinated daily AK2Day stories to appear from parks throughout the region.



Figure 34 – The AK EPMT May 2009 training in Anchorage. L to R Bobbi Simpson (CA-EPMT), Jessica Wilbarger (KLGO), Whitney Rapp (GLBA), Max Gerth (GLBA), Katie Laushman (WRST), Adam DiPietro (GLBA), Wendy Mahovlic (DENA), Miranda Terwilliger (WRST), Addison Kasmarek (GLBA), Brianne Athearn (AACD), Joe Donohue (WRST), Deb Kurtz (KEFJ), Blaine Spellman (HSWCD), Lil Gilmore (WRST), and Tamara Harper (WRST).



Figure 35 – One of the 4th of July flower arrangements featuring invasive plants growing in Gustavus.

On July 4th, we once again hosted an outreach event at the Salmon River Park. Dandelion essential oil lotion bars and an olive-sheep sorrel dip were featured attractions developed by Addison Kasmarek. Invasive plant flower arrangements were again featured (Figure 36). The interactive electronic game board that illuminates when the participant correctly matches the name and photo of the plant (Figure 37) was used again. In addition, we provided informational materials and answered questions throughout the day.

When the SAGA crew arrived, Whitney oriented them to Glacier Bay and showed them the native and nonnative plants of the area.

Whitney and Addison worked with the Juneau Boys and Girls club during their field trip to Glacier Bay.

Addison Kasmarek developed a brochure on the risk of marine invasive through hull fouling and a sowthistle/Canada thistle poster.

All GLBA employees received a program updates by email in July.



Figure 36 – Max (L) and Addison (R) ready to answer the public’s questions and hand out information on the 4th of July.

For 2010, training should be provided for the interpretive rangers who interact with the visitors and for maintenance employees that will be working in the field. The 4th of July festivities are an excellent opportunity to reach many Gustavus residents. Work with Gustavus schoolchildren, including control events, should be prioritized when school is in session. Finding ways to attract more volunteers to help with control efforts, collect native plant seeds, or otherwise assist the program is also important.

Other Thoughts

Although GLBA and Gustavus are geographically isolated, they are not immune to invasion by nonnative species. To date, 53 nonnative species have been identified within GLBA and Gustavus, but many more species in nearby communities have yet to be observed, including aggressive species like Japanese knotweed (*Polygonum cuspidatum*) and garlic mustard (*Alliaria petiolata*). Resources, including time, money, equipment, and personnel, to continue to inventory and control invasive species must be made available consistently for the long-term. Without these resources, the challenges of maintaining the unique assemblage of native species and preserve the vast wilderness in its natural condition will be monumental.

GLBA needs to ensure that all future anthropogenic disturbances be mitigated in the most ecological manner, including pre-construction removal and storage of native vegetation and topsoil for replanting, collection of local native seeds, restoration, and subsequent control of nonnative species. A nursery area and seed bank should be created to facilitate revegetation efforts. Christina Gladmon began a seed bank and seed collection protocol in 2006, to which Julie da Silva added significantly in 2007. Additional seeds were collected in 2008. All seeds are stored in the RM cache freezer. Furthermore, park staff, partners, and visitors should be aware to check their gear to prevent transporting invasive plants to new areas.

In addition to the species documented in this report, there are several cultivated vegetable and flower species including chives, asparagus, irises, and lettuce growing near the homes in Dry Bay and on the Gustavus property owned by GLBA. None of these species currently displays invasive tendencies, but a long-term plan should be in place to remove these plants if the residences become abandoned.

Partnerships focusing on exotic plants should be established with neighboring land managers, including the U.S. Forest Service, City of Gustavus, State of Alaska, and The Nature Conservancy. In addition, relationships should be strengthened with groups such as the Boy Scouts, Girl Scouts, and the Gustavus School from whom control events may be able to recruit volunteers.

Other Non-Plant Exotic Species

Marine/Aquatic

Within Alaska, there is growing concern about exotic marine species invading. Species already present along the west coast of North America but not yet in Alaska include European green crab (*Carcinus maenas*), Chinese mitten crab (*Eriocheir sinensis*), and smooth cordgrass (*Spartina alterniflora*). Exotic 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. A drift card study to model the potential dispersal of smooth cordgrass seeds from established populations in California, Oregon, Washington, and British Columbia resulted in cards being found within the Gulf of Alaska, including Kodiak Island and near Ketchikan (Howard 2009). 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.

In 2009, GLBA continued as one of around a dozen sites along the Pacific coast between Tijuana Slough, CA and Port Valdez, AK monitoring for invasive marine tunicates. In March, June, and September, PVC settlement plates are retrieved and deployed as part of a larger Smithsonian Environmental Research Center (SERC) monitoring program. To date, no invasive tunicates have been detected in GLBA, but other Alaskan sites have detected invasive tunicates, including nearby Sitka. Specimens of a solitary tunicate are awaiting determination by Sarah Cohen of San Francisco State University. Specimens of *Alcyonidium* bryozoans were sent to Linda McCann of SERC. Her tentative identification is that there are two species, but species names are awaiting revision of the nomenclature of the genus. NPS involvement in this multi-agency program is important to show our commitment to the early detection of marine invasions.

GLBA continued European green crab monitoring in 2009. Modified Fukui fish traps were deployed during the four lowest tides of the summer (June to September) for a 24-hour soak. Once retrieved, all species were identified, quantified, and measured. No European green crabs or other invasive species were detected. This monitoring effort is also a collaborative effort between multiple agencies, principally Alaska Department of Fish and Game (ADFG – Tammy Davis) and National Marine Fisheries Service (NMFS – Linda Shaw).

An Atlantic salmon (*Salmo salar*) was observed in the upper Doame River of Dry Bay around 2000 (Capra pers. comm. 2006). On July 3, 2008, a significant escape (~30,000 Atlantic salmon) occurred at British Columbia's Marine Harvest Canada's Frederick Arm aquaculture site. In 2008, 39 Atlantic salmon were reported to ADFG, including one caught on power troll gear in Cross Sound and many near Sitka. This is significantly more than most recent years (Davis pers. comm.).

In freshwater systems, didymo/rock snot, New Zealand mud snails, whirling disease, and other pathogens are of concern to Alaska. Sport anglers are a potential vector for transporting invasive species to new systems, particularly through the use of felt soled waders. By January 1, 2011, felt-soles will be prohibited from use in fresh waters of Southeast Alaska (ADF&G 2009).

Terrestrial

The slug survey of 2008 confirmed the presence of European black slugs (*Arion ater*) (Figure 38) in Gustavus. A group of Gustavus residents led by Dena Matkin have been working to control the slugs with more than 900 killed during the late summer. This slug has become a severe nuisance in communities such as Cordova, AK (see <http://www.alaskamastergardeners.org/pdf/2005/AMGANov05.pdf>). Eugene Kozloff (1976) writes "*Arion ater* reaches a length of almost 15 cm and seems always ravenous... If you have to hate anything, let it be this slug, a cruelly destructive pest if there ever was one. Fortunately, it comes enthusiastically to slug baits."

While in Lituya Bay this summer, Craig Murdoch photographed slug and worms on Cenotaph Island, which may be non-native.



Figure 37 – More than 900 European black slugs (*Arion ater*) were killed this summer near the Good River corner from efforts led by Dena Matkin.

Although few inventory efforts have been made to document other exotic taxa, some incidental observations and conversations have identified additional nonnative animals. Sitka black-tailed deer, which are native to Southeast Alaska but not prevalent in GLBA, were transported to Willoughby Island in Glacier Bay proper around the 1920s and have persisted. In 2006, tracks of Sitka black-tailed deer were seen by Ranger Jim Capra on the beach in Dry Bay near the Grand Plateau Glacier outwash (Capra pers. comm. 2006). The Dry Bay deer are likely from those introduced to the Yakutat area (Merriam et al. 2003).

European starlings are occasionally observed in Gustavus (Drumheller pers. comm. 2006). In 2007, Nat Drumheller observed a Eurasian collared dove at GLBA in Bartlett Cove for the

first time. This summer multiple Eurasian collared doves (Figure 39) were repeatedly observed in Gustavus, Bartlett Cove, and Johns Hopkins Inlet (Drumheller pers. comm. 2009). A summary of Southeast Alaska bird observations (Heinl and Piston 2009) begins

Certainly the most notable event of summer 2009 was the June invasion of Eurasian collared-doves. The few doves that appeared in late May were followed by sightings throughout Southeast Alaska in June, with a final total of more than 35 birds at a dozen locations, many of which remained throughout the summer.

Other exotic bird species not yet observed in the park are rock pigeons and house sparrows. Alaska's first confirmed successful nesting of house sparrows was reported in Ketchikan this year (Heinl and Piston 2009). North American native bird species with expanding ranges, which now include Gustavus, include brown-headed cowbirds and barred owls (Drumheller pers. comm. 2006). Brown-headed cowbirds were sighted on cruiseships near Lamplugh glacier (Drumheller pers. comm.. 2009) this year.

Ants range from being locally abundant to absent in different areas, and it is unknown what species are present and whether they are native. A similar pattern is present with earthworms. Hobo spiders and other "unusual" spiders have also been reported, although it is unclear whether species have been definitively identified. There are likely other exotic invertebrates and pathogens present, but no monitoring effort is occurring.



Figure 38 – A Eurasian collared dove photographed in Bartlett Cove June 30, 2009 by Nat Drumheller.

Recommended Plans for 2010 Field Season

Prevention and proactive removal will save time and money in the future with regard to invasive plant issues. Well-trained personnel are essential for monitoring and control efforts. In addition, park projects should use best management practices (Appendix C) to avoid introducing or spreading exotic plants. Educational programs for park staff, Gustavus residents, and visitors will further develop awareness of the issue. This heightened consciousness will improve recruitment of volunteers for control events.

Priority Species for Treatment:

HIGHEST PRIORITY – treat all infestations annually

lady's mantle	quackgrass	common timothy	common dandelion in
meadow foxtail	herb Robert	tall buttercup	Dry Bay
smooth brome grass	white deadnettle	creeping buttercup	red and alsike clover
Canterberry bells	oxeye daisy	curly dock	thyme-leaf speedwell
perennial cornflower	forget-me-not	perennial sowthistle	Johnny-jump-up violet
orchardgrass	reed canarygrass	common comfrey	

INTERMEDIATE PRIORITY – treat as resources allows

mouse-ear chickweed in backcountry	chickweed	common dandelion in prominent Bartlett	Cove locations (VIS, lodge, etc)
sheep sorrel	common dandelion in upper East Arm		

LOWEST PRIORITY – contain current infestations and prevent spread to other areas

shepherd's purse	pineapple weed	fowl bluegrass	white clover
mouse-ear chickweed in frontcountry	mint	Kentucky bluegrass	
bingleaf lupine	common plantain	common dandelion elsewhere in park	
	annual bluegrass		

NO MANAGEMENT – species not currently considered invasive

wild chive	foxtail barley	rhubarb	red raspberry
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PRESENT ONLY BEYOND BOUNDARY – monitor to prevent introduction and work with community to manage species

sneezeweed	orange hawkweed	western wheatgrass	common tansy
bishop's goutweed	hairy cat's ear	prostrate knotweed	spiked speedwell
snow in summer	Shasta daisy	rugosa and other roses	
Canada thistle	yellow toadflax	European mountain-	
hempnettle	maltesecross	ash	

April

- Provide educational program to interpretive rangers during their training.
- Plan for the 2009 field season, including ensuring adequate field assistance will be available.
- Prioritize what infestations to treat and develop a plan to monitor progress (ArcGIS and Excel spreadsheets).

May

- Provide educational program to maintenance employees working outside and interested community members.
- Survey for common dandelions when they are in peak bloom. Recruit volunteer crews to remove plants from most frequented areas near the Lodge and VIS. Try using pre-emergent controls, such as all-natural corn gluten.
- Encourage Glacier Bay Lodge to plant native species and/or review plant choices.
- Plan and deliver a program for the Gustavus School before the school year ends.
- Provide educational programs for park staff, community members, and visitors.
- Collect specimens absent from park herbarium.

June

- Continue inventorying and controlling all nonnative species.
- Spend a week controlling dandelions in the East Arm focusing on Wachusett Inlet, then upper Muir, then Adams Inlet.
- Remove forget-me-not, white deadnettle, and common comfrey plants from Bartlett Cove.
- Provide educational programs for park staff, community members, and visitors.
- Alaska Invasive Weeds Awareness week last week of the month.
- Collect specimens absent from park herbarium.
- Ongoing data processing.

July

- Continue inventorying and controlling all nonnative species.
- Sponsor 4th of July contest at Gustavus celebration.
- Re-treat tall buttercup, oxeye daisy, reed canarygrass, perennial cornflower, Canterbury bells, and Johnny-jump-up violet in Bartlett Cove.
- Go to Dry Bay before the middle of the month for inventory and control work. Focus on controlling oxeye daisy and invasive dandelions, monitoring bigleaf lupine, and re-inventorying for native and exotic *Taraxacum*. Allocate at least 40 hours for daisy control.
- Provide educational programs for park staff, community members, and visitors.
- Collect specimens absent from park herbarium.
- Ongoing data processing.

August

- Control meadow foxtail, timothy, orchardgrass, quackgrass, and red/alsike clover, particularly along the road.
- Search for and remove shepherd's purse near the depot.
- Continue inventorying and controlling all nonnative species.
- Provide educational programs for park staff, community members, and visitors.
- Collect specimens absent from park herbarium.
- Ongoing data processing.

September

- Continue inventorying and controlling all species.
- Provide educational programs for park staff, community members, and visitors.
- Collect specimens absent from park herbarium.
- Ongoing data processing.

October - November

- Complete data processing and write reports.
- Plan for 2011.

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Figure 39 – The 2009 GLBA EPMT following daisy removal at the Hazen cabin in Dry Bay. L to R Max Gerth, Whitney Rapp, Addison Kasmarek, and Adam DiPietro.



Figure 40 – The GLBA EPMT and SAGA crews on the slopes near the maintenance building.

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Appendices

Appendix A – List of known invasive plants within or near GLBA with total non-overlapping acres mapped through 2009

Common Name	Scientific Name	When Observed ^a	Bartlett Cove	Back-country	Dry Bay	Gustavus	All Year Total Mapped Acreage	AK Weeds Ranking ^b	Invading Low-Disturbance, Natural Areas
sneezeweed	<i>Achillea ptarmica</i>	7				.014	.014	46	no
bishop's goutweed	<i>Aegopodium podagraria</i>	4				0.783	0.783	not ranked	no
lady's mantle	<i>Alchemilla mollis</i>	7	0.007			0.007	0.014	not ranked	no
wild chive	<i>Allium schoenoprasum</i> **	3-7	.004		39.971		39.975	not ranked	no
meadow foxtail	<i>Alopecurus pratensis</i>	1, 5-7	0.008			0.021	.029	not ranked	no
common burdock	<i>Arctium minus</i>	4	eradi-cated 2007				eradicated	not ranked	no
smooth brome	<i>Bromus inermis</i> ssp. <i>inermis</i>	1-7	.001			1.696	1.697	62	no
Canterberry bells	<i>Campanula medium</i>	6	eradi-cated 2009				eradicated	not ranked	no
shepherd's purse	<i>Capsella bursa-pastoris</i>	1, 3-5, 7	0.052	0.362		0.372	0.786	40	yes
perennial cornflower	<i>Centaurea montana</i>	5-7	0.020			0.315	0.335	not ranked	no
mouse-ear chickweed	<i>Cerastium fontanum</i>	1-1	87.644	29.173	210.065	18.458	345.340	36	yes
snow in summer	<i>Cerastium tomentosum</i>	7				0.007	0.007	not ranked	no
Canada thistle	<i>Cirsium arvense</i>	4, 7				0.822	0.822	76	yes
orchardgrass	<i>Dactylis glomerata</i>	3-7	0.027			0.141	0.168	53	no
quackgrass	<i>Elymus repens</i>	3-7	2.100			1.597	3.697	59	no
hempenettle	<i>Galeopsis tetrahit</i> / <i>G. bifida</i>	5				0.001	0.001	40	no
herb Robert	<i>Geranium robertianum</i>	7	0.014				0.014	not ranked	no
orange hawkweed	<i>Hieracium aurantiacum</i>	3, 4, 6				0.276	0.276	79	no
foxtail barley	<i>Hordeum jubatum</i> **	1, 3, 4, 6, 7	X	0.109	0.003		0.112	63	yes
hairy cat's ear	<i>Hypochaeris radicata</i>	3, 4, 7	eradi-cated 2006			4.945	4.945	not ranked	no
white deadnettle	<i>Lamium album</i>	3-7	0.010				0.010	not ranked	no
oxeye daisy	<i>Leucanthemum vulgare</i>	2-7	0.416	0.020	2.064	1.364	3.864	61	yes
Shasta daisy	<i>Leucanthemum x superbum</i>	7				0.023	0.023	not ranked	no

Common Name	Scientific Name	When Observed ^a	Bartlett Cove	Back-country	Dry Bay	Gustavus	All Year Total Mapped Acreage	AK Weeds Ranking ^b	Invading Low-Disturbance, Natural Areas
yellow toadflax	<i>Linaria vulgaris</i>	1, 7				0.076	0.076	69	no
perennial ryegrass	<i>Lolium perenne</i> ssp. <i>perenne/multiflorum</i>	1-4	eradicated 2008				eradicated	41	no
bigleaf lupine	<i>Lupinus polyphyllus</i> **	2-7			387.968	0.369	388.337	55	yes
maltesecross	<i>Lychnis chalconica</i>	2				0.001	0.001	not ranked	no
pineapple weed	<i>Matricaria discoidea</i>	1, 3-7	0.109		30.037	1.441	31.587	32	no
white sweetclover	<i>Melilotus alba</i>	1				eradicated	eradicated	80	no
mint	<i>Mentha</i> sp.	4-7	eradicated 2008		0.003	X	0.003	not ranked	no
forget-me-not	<i>Myosotis scorpioides/M. asiatica</i>	1, 3, 4, 6, 7	0.102			0.070	0.172	not ranked	yes
western wheatgrass	<i>Pascopyrum smithii</i> (identification still pending)	4, 5				X	present	not ranked	no
reed canarygrass	<i>Phalaris arundinacea</i>	1-7	2.590	0.137	0.002	1.974	4.703	83	yes
common timothy	<i>Phleum pratense</i>	1-7	3.101			4.65	7.751	56	no
common plantain	<i>Plantago major</i>	2-7	95.604		197.547	4.813	297.964	44	no
annual bluegrass	<i>Poa annua</i>	4-7	1.5	X	4.528	0.049	6.077	46	no
fowl bluegrass	<i>Poa palustris</i>	1		X			present	not ranked	no
Kentucky bluegrass	<i>Poa pratensis</i>	4, 6	0.007			X	0.007	52	no
prostrate knotweed	<i>Polygonum aviculare</i>	4				0.032	0.032	45	no
tall buttercup	<i>Ranunculus acris</i>	3-7	0.091		0.001	0.038	0.130	54	no
creeping buttercup	<i>Ranunculus repens</i>	3-7	0.492		0.009	2.196	2.697	54	yes
rhubarb	<i>Rheum rhabarbarum</i>	3-7	X		0.778	X	0.778	not ranked	no
rugosa rosa	<i>Rosa rugosa</i>	4, 5, 7				0.261	0.261	not ranked	no
rose	<i>Rosa</i> sp.	3-5, 7				0.001	0.001	not ranked	no
American red raspberry	<i>Rubus idaeus</i> **	1, 3-7	0.007	2.057	0.107	1.283	3.454	not ranked	yes
sheep sorrel	<i>Rumex acetosella</i>	1, 3-7	0.251			0.446	0.697	51	yes
curly dock	<i>Rumex crispus</i>	3, 7	0.001			X	0.001	48	no
perennial sowthistle	<i>Sonchus arvensis</i>	3-7		2.389		0.032	2.421	73	yes
European mountain-ash	<i>Sorbus aucuparia</i>	3-7	eradicated 2008			2.930	2.930	59	yes
chickweed	<i>Stellaria media</i>	1, 3, 4, 6, 7	0.006	0.713		1.248	1.967	42/54	yes
common comfrey	<i>Symphytum officinale</i>	3-7	0.261		0.007	1.283	1.551	not ranked	no

Common Name	Scientific Name	When Observed ^a	Bartlett Cove	Back-country	Dry Bay	Gustavus	All Year Total Mapped Acreage	AK Weeds Ranking ^b	Invading Low-Disturbance, Natural Areas
common tansy	<i>Tanacetum vulgare</i>	2-7				0.044	0.044	57	no
common dandelion	<i>Taraxacum officinale</i> ssp. <i>officinale</i>	1-7	138.963	426.329	0.555	22.215	588.062	58	yes
alsike clover	<i>Trifolium hybridum</i>	3, 5, 7	0.001			X	0.001	57	no
red clover	<i>Trifolium pratense</i>	1-7	0.003		eradicated 2007	0.197	0.201	53	no
white clover	<i>Trifolium repens</i>	1-7	87.959			15.280	103.239	59	no
common wheat	<i>Triticum aestivum</i>	2-5	eradicated 2007				eradicated	not ranked	no
thyme-leaf speedwell	<i>Veronica serpyllifolia</i>	5, 7	0.007			0.006	0.013	not ranked	no
spiked speedwell	<i>Veronica spicata</i>	7				0.007	0.007	not ranked	no
Johnny-jump-up violet	<i>Viola tricolor</i>	5-7	1.729				1.729	not ranked	no

^a - 1 = Herbarium specimen; 2 = 2004 Exotic Plant Inventory; 3 = 2005 Exotic Plant Inventory; 4 = 2006 Exotic Plant Inventory; 5 = 2007 Exotic Plant Inventory; 6 = 2008 Exotic Plant Inventory; 7 = 2009 Exotic Plant Inventory

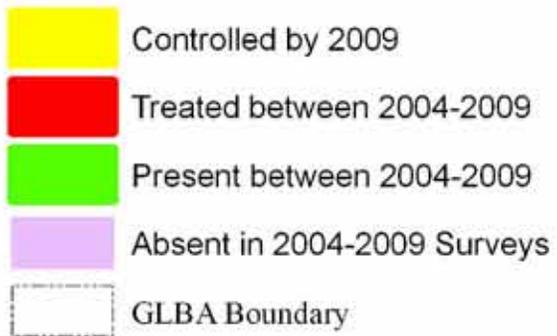
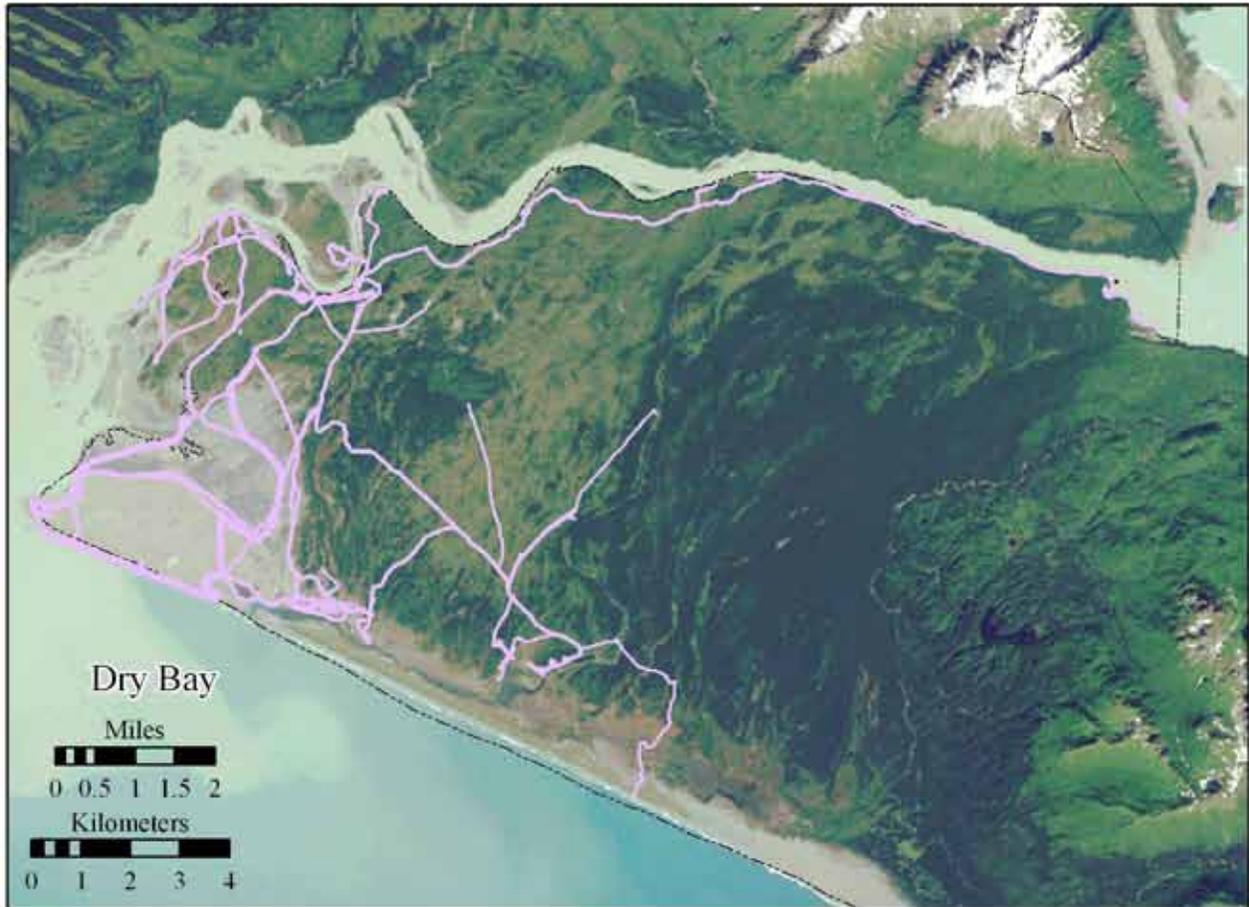
^b - Ranking according to threat to native ecosystems in Alaska from low (0) to high (100) (http://akweeds.uaa.alaska.edu/akweeds_ranking_geo.htm) accessed 10/22/2007. For *Stellaria media*, the first number corresponds to disturbed sites and the second to seabird colonies.

** - Species nativity in question for this location

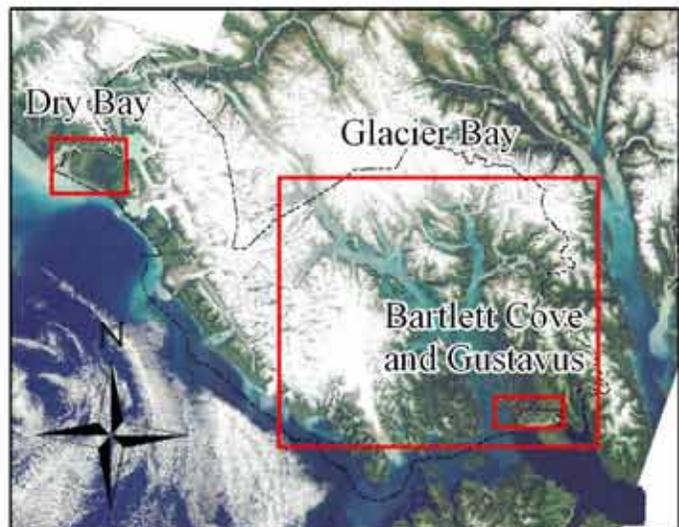
In 2009, all prior data was reviewed and polygons that were no longer accurate or too general in their extent were flagged and not included in the summarized acres. This accounts for the change in acres for some species from previous values. Excluded data is flagged by a "No" value in field Is_Current in the geodatabase.

Appendix B – 2004-2008 location maps of selected invasive plants in GLBA

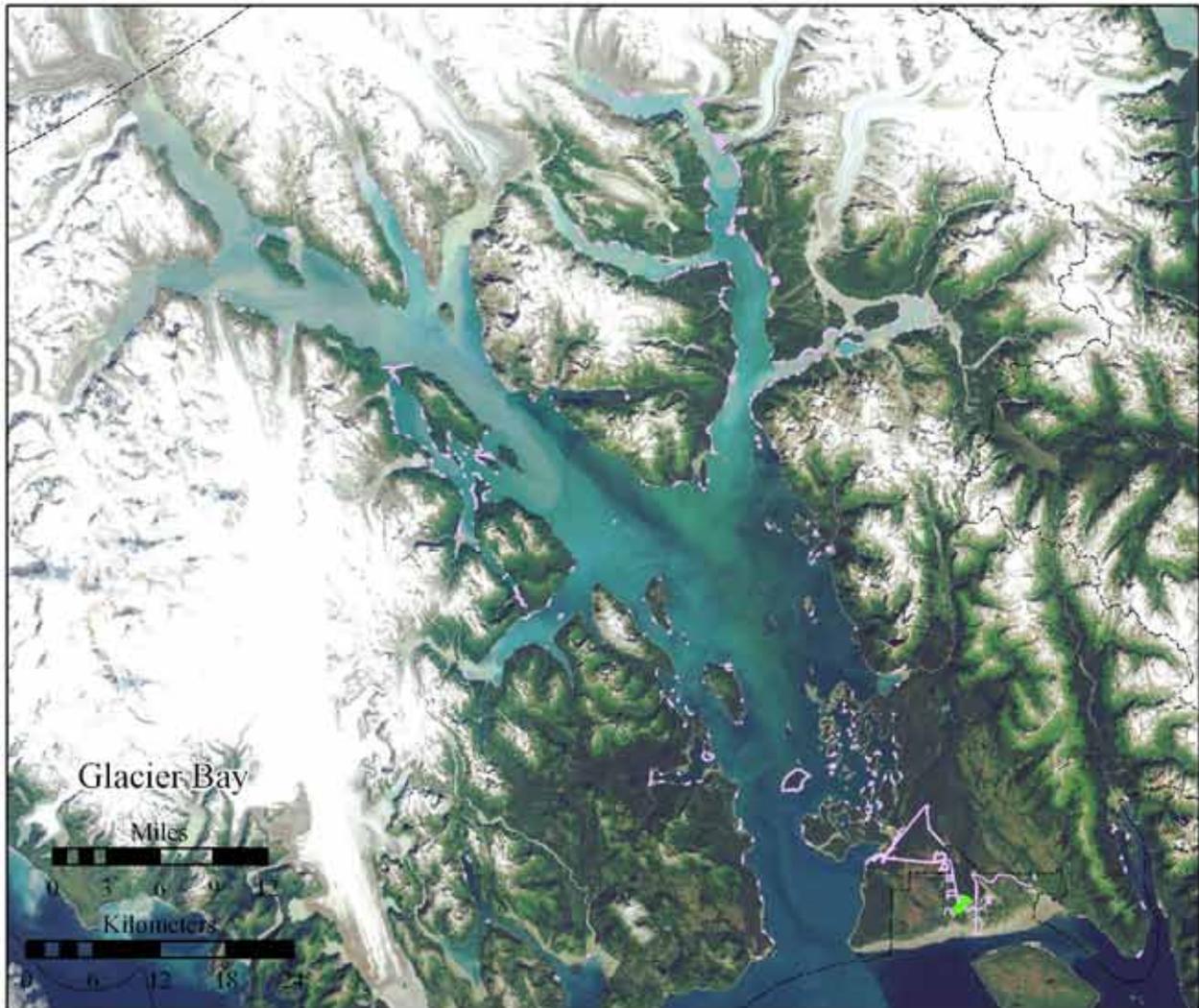
Sneezeweed - *Achillea ptarmica* in Glacier Bay National Park and Preserve



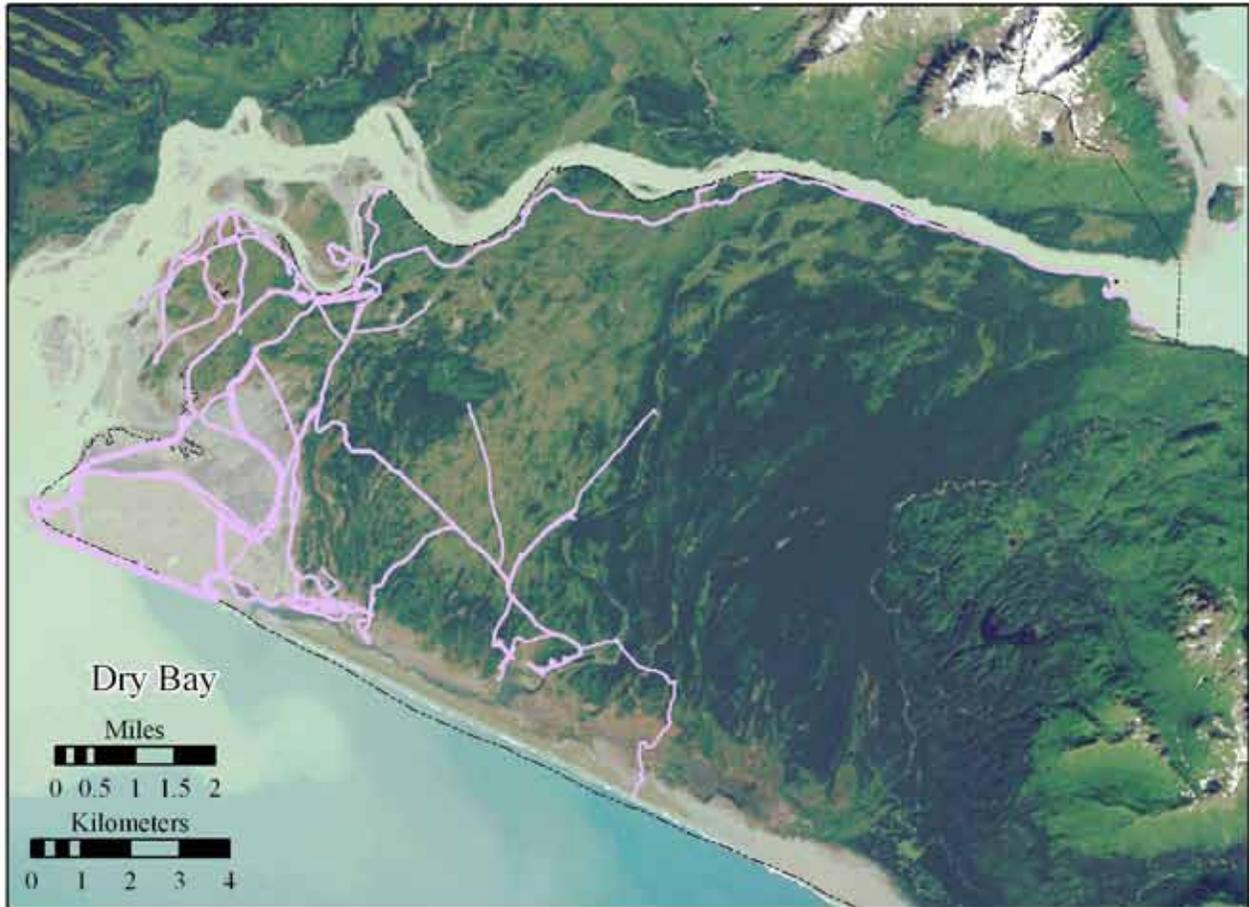
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Sneezeweed - *Achillea ptarmica*



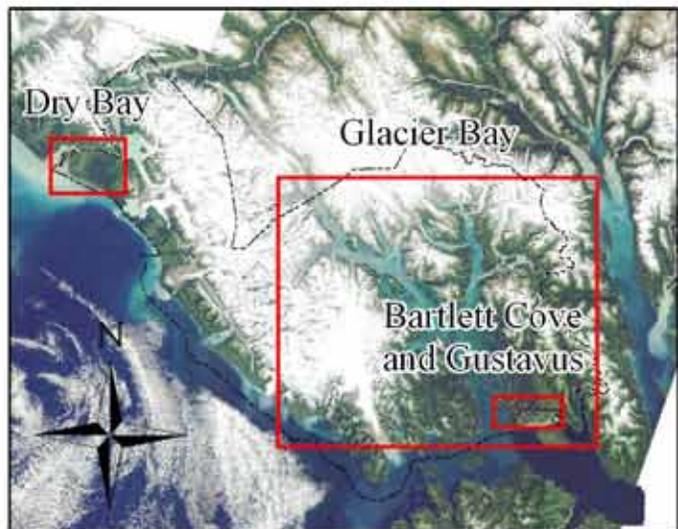
Bishop's Goutweed - *Aegopodium podagraria* in Glacier Bay National Park and Preserve



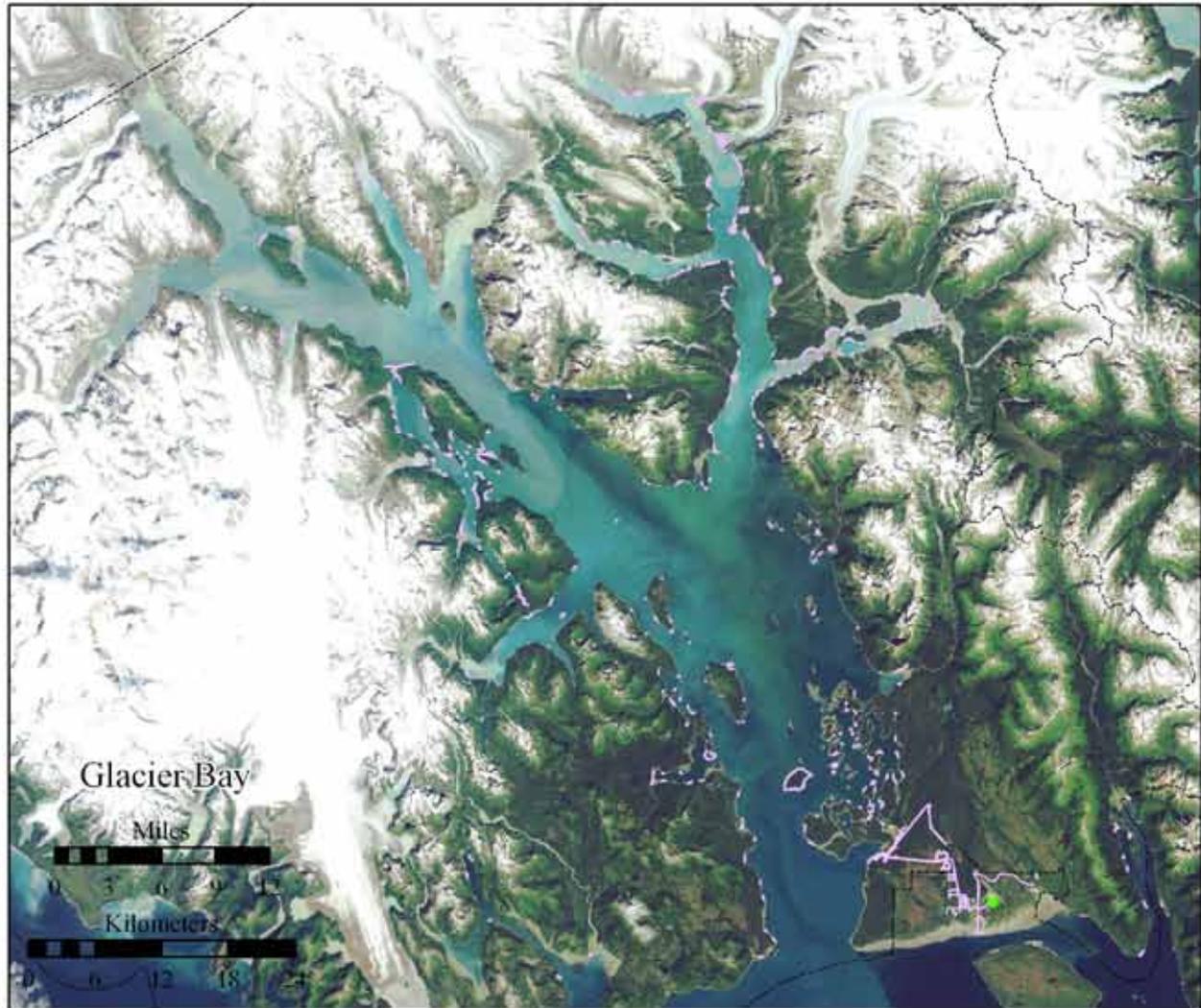
- Controlled by 2009
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Bishop's Goutweed - *Aegopodium podagraria*



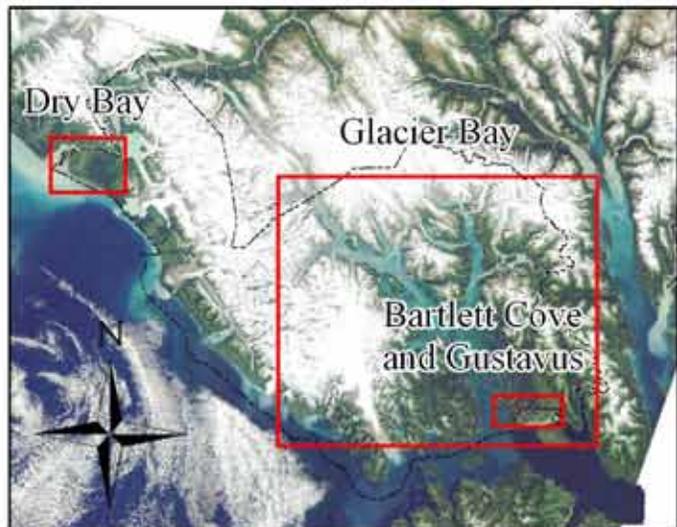
Meadow Foxtail - *Alopecurus pratensis* in Glacier Bay National Park and Preserve



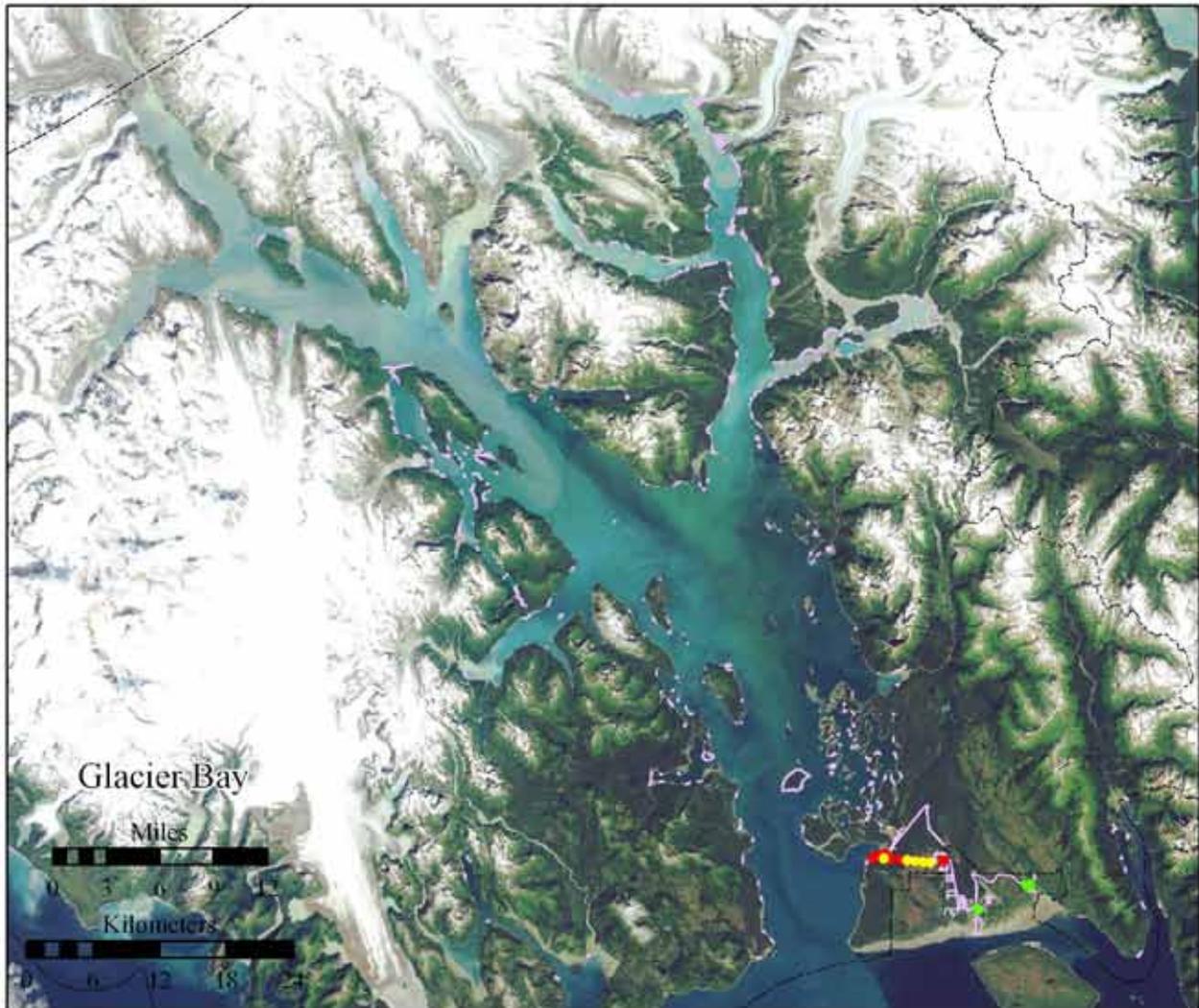
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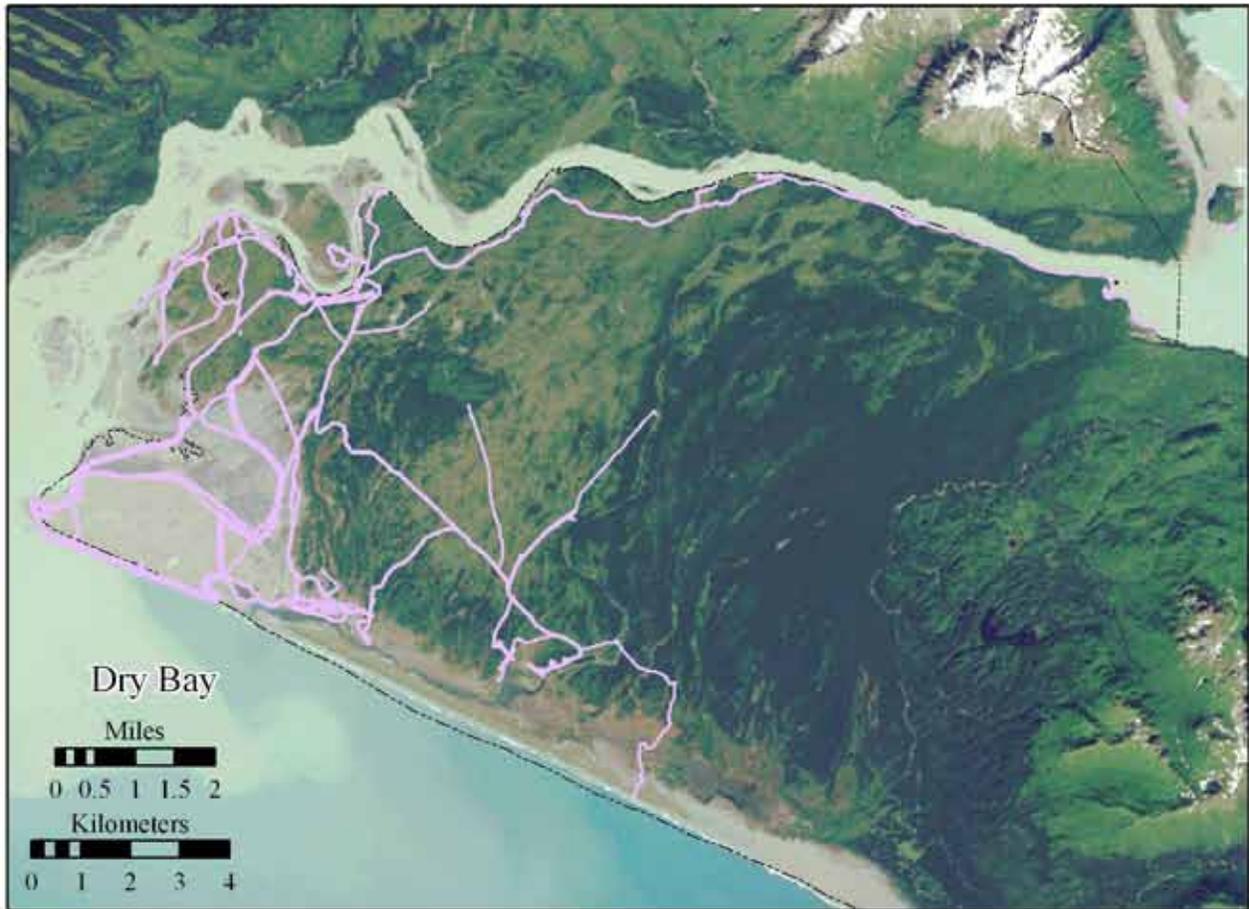
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Meadow Foxtail - *Alopecurus pratensis*



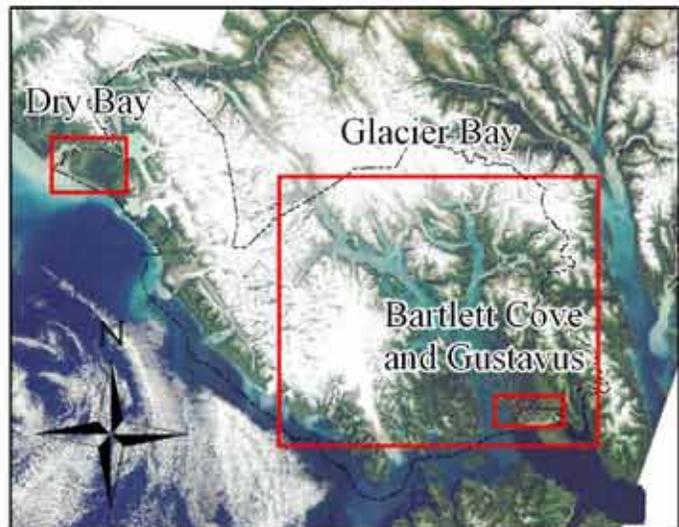
Common Burdock - *Arctium minus* in Glacier Bay National Park and Preserve



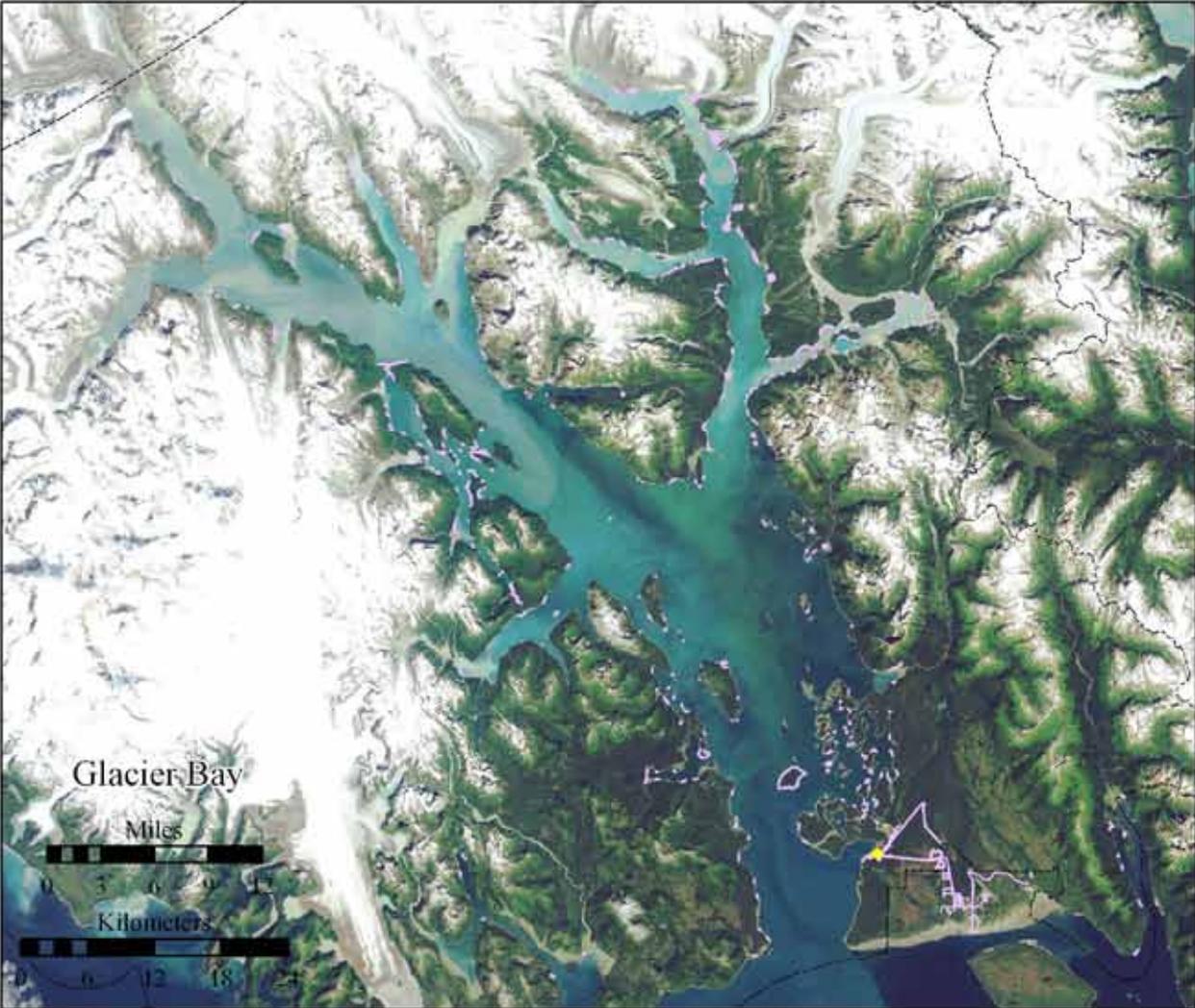
- Controlled by 2009
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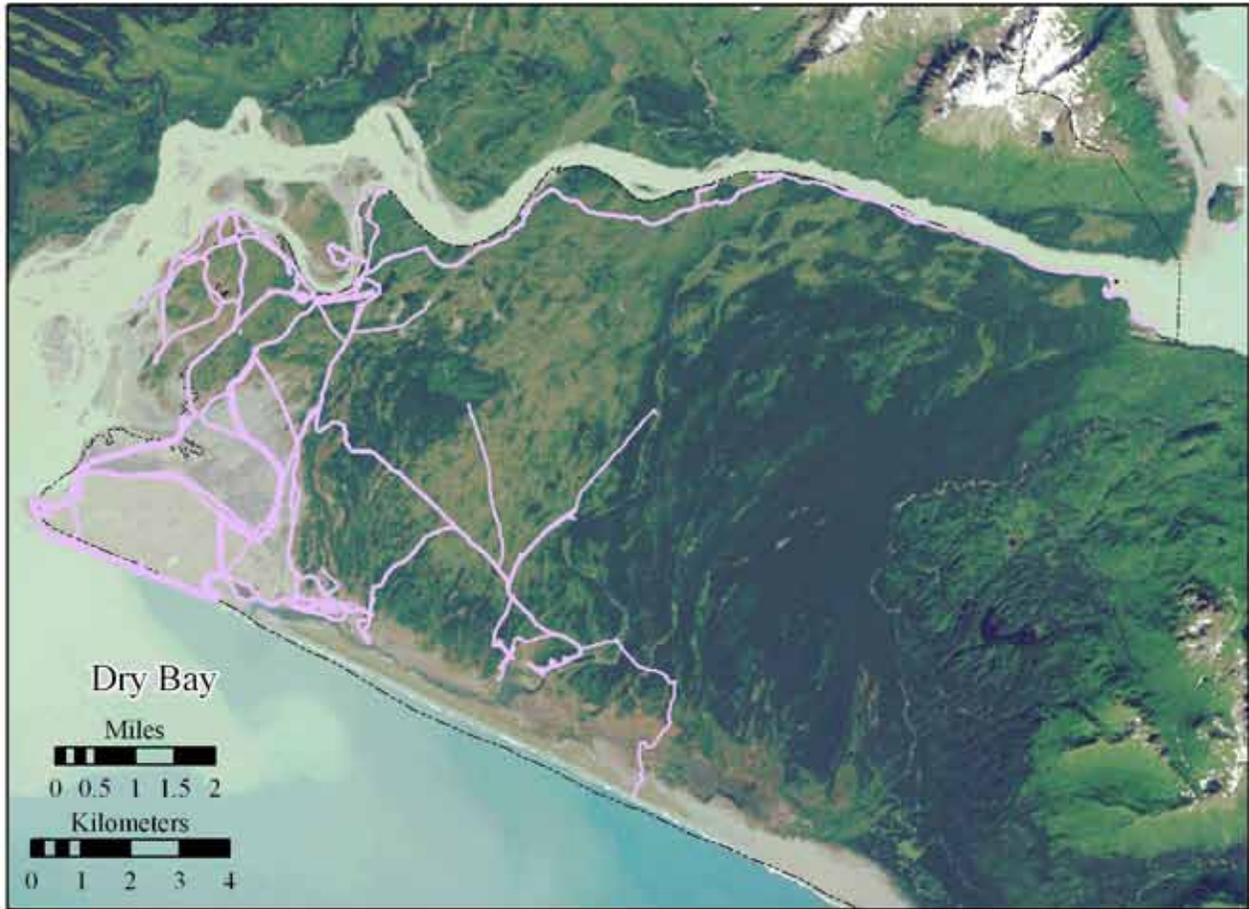
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Common Burdock - *Arctium minus*



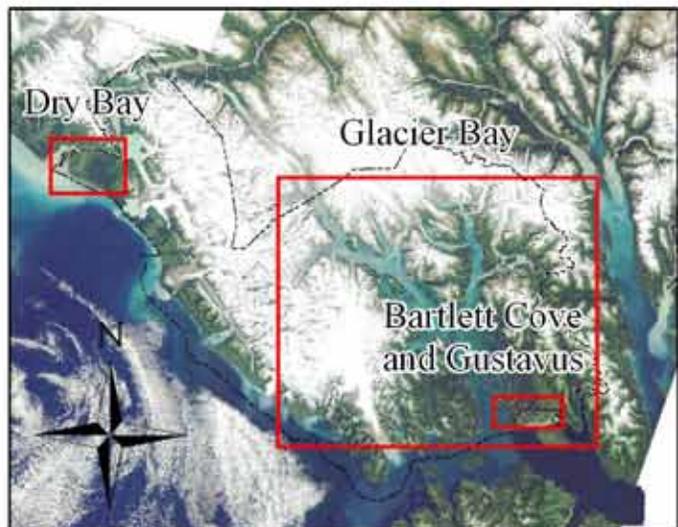
Smooth Brome Grass - *Bromus inermis* in Glacier Bay National Park and Preserve



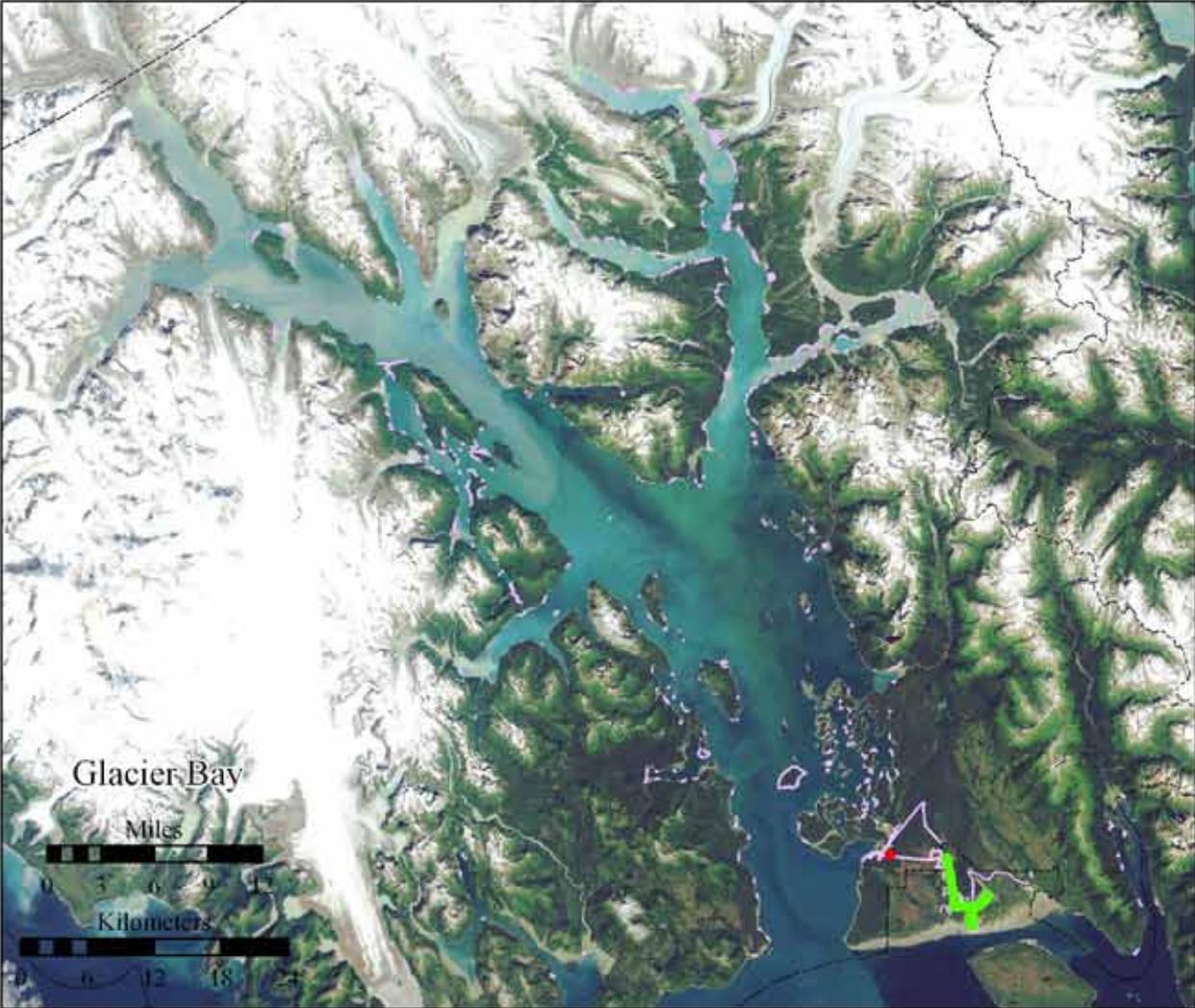
- Controlled by 2009
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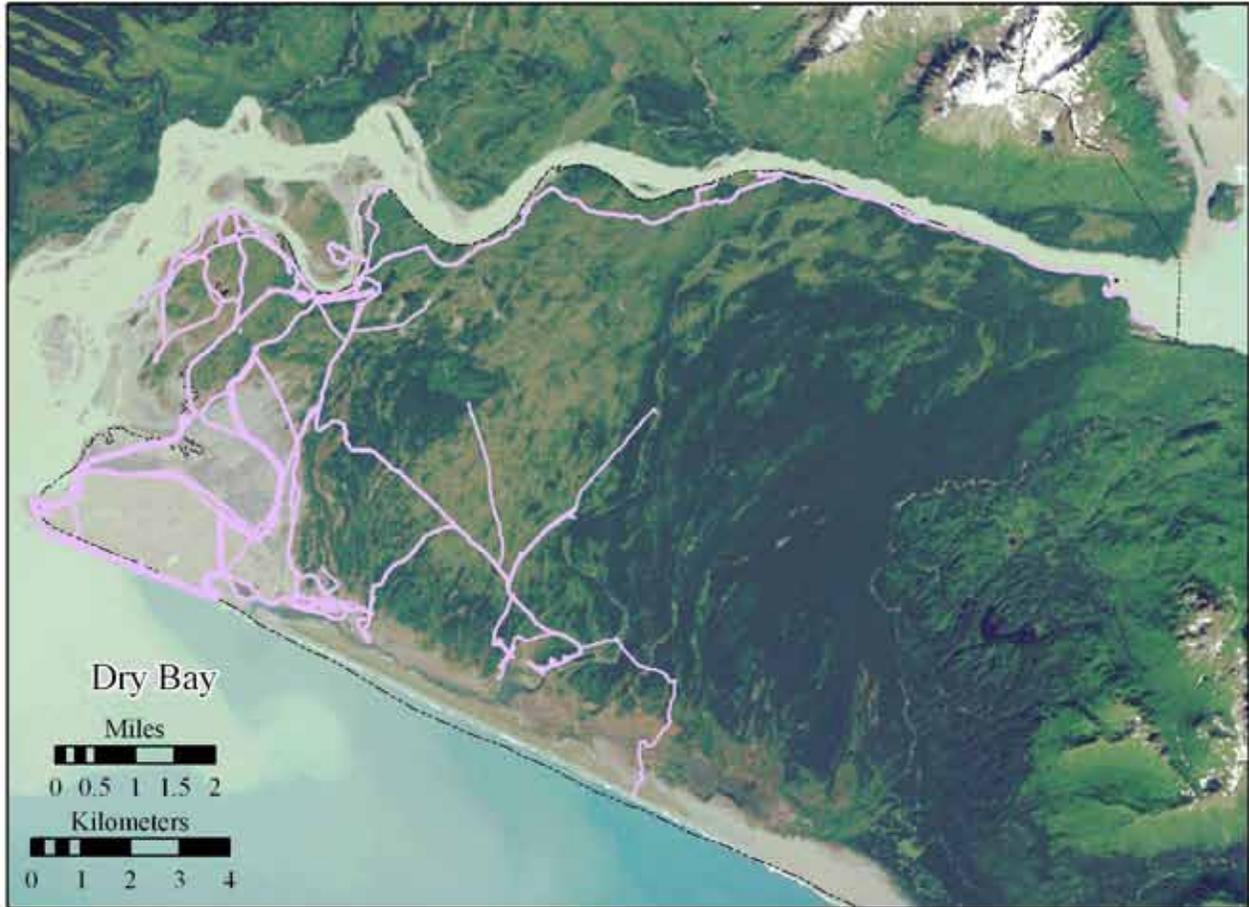
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Smooth Brome Grass - *Bromus inermis*



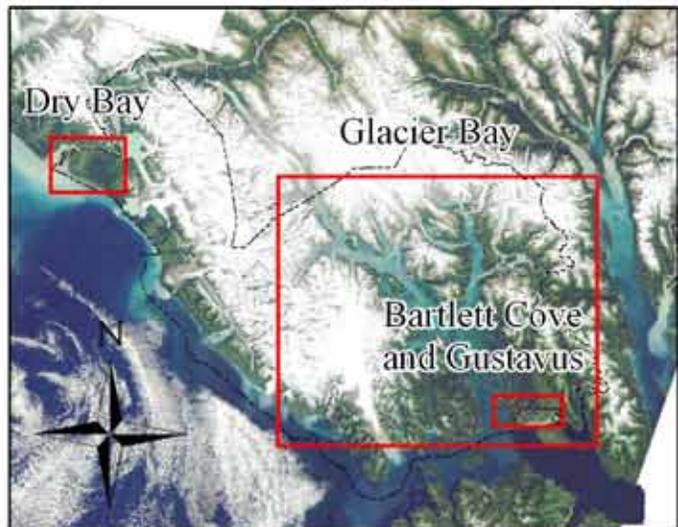
Canterberry Bells - *Campanula medium* in Glacier Bay National Park and Preserve



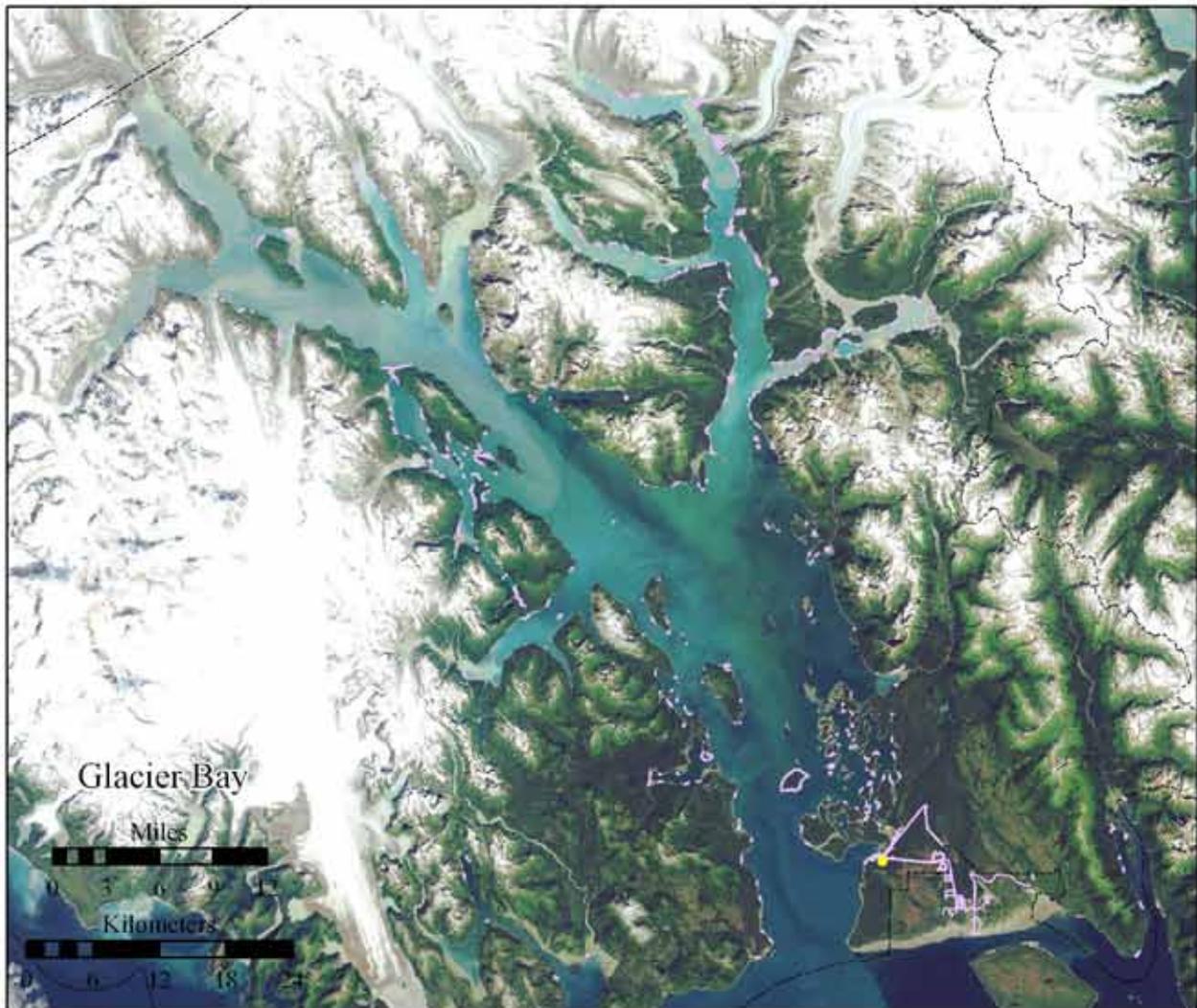
- Controlled by 2009
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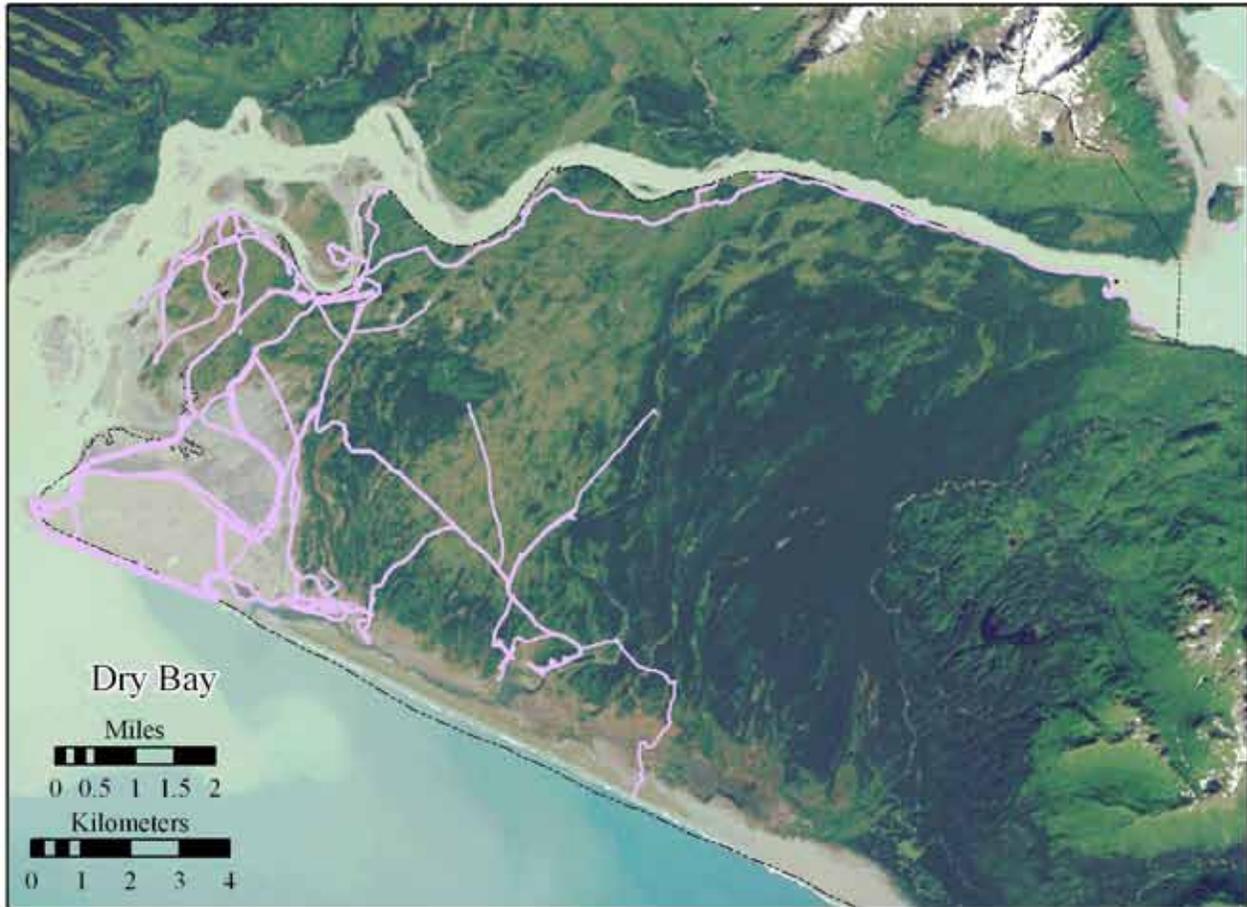
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Canterberry Bells - *Campanula medium*



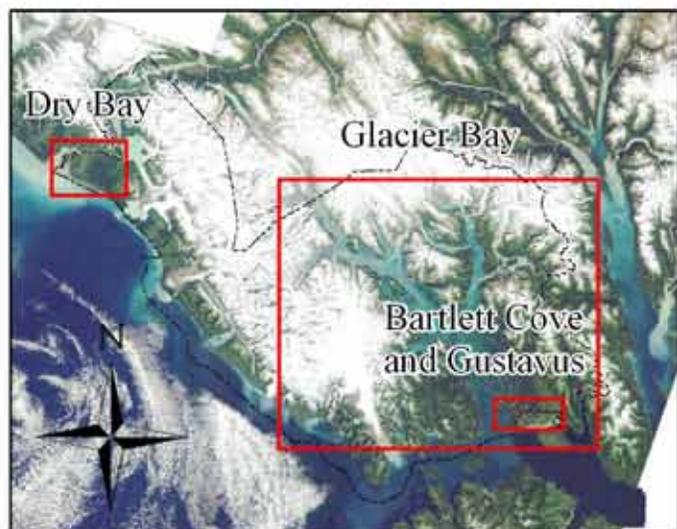
Shepherd's Purse - *Capsella bursa-pastoris* in Glacier Bay National Park and Preserve



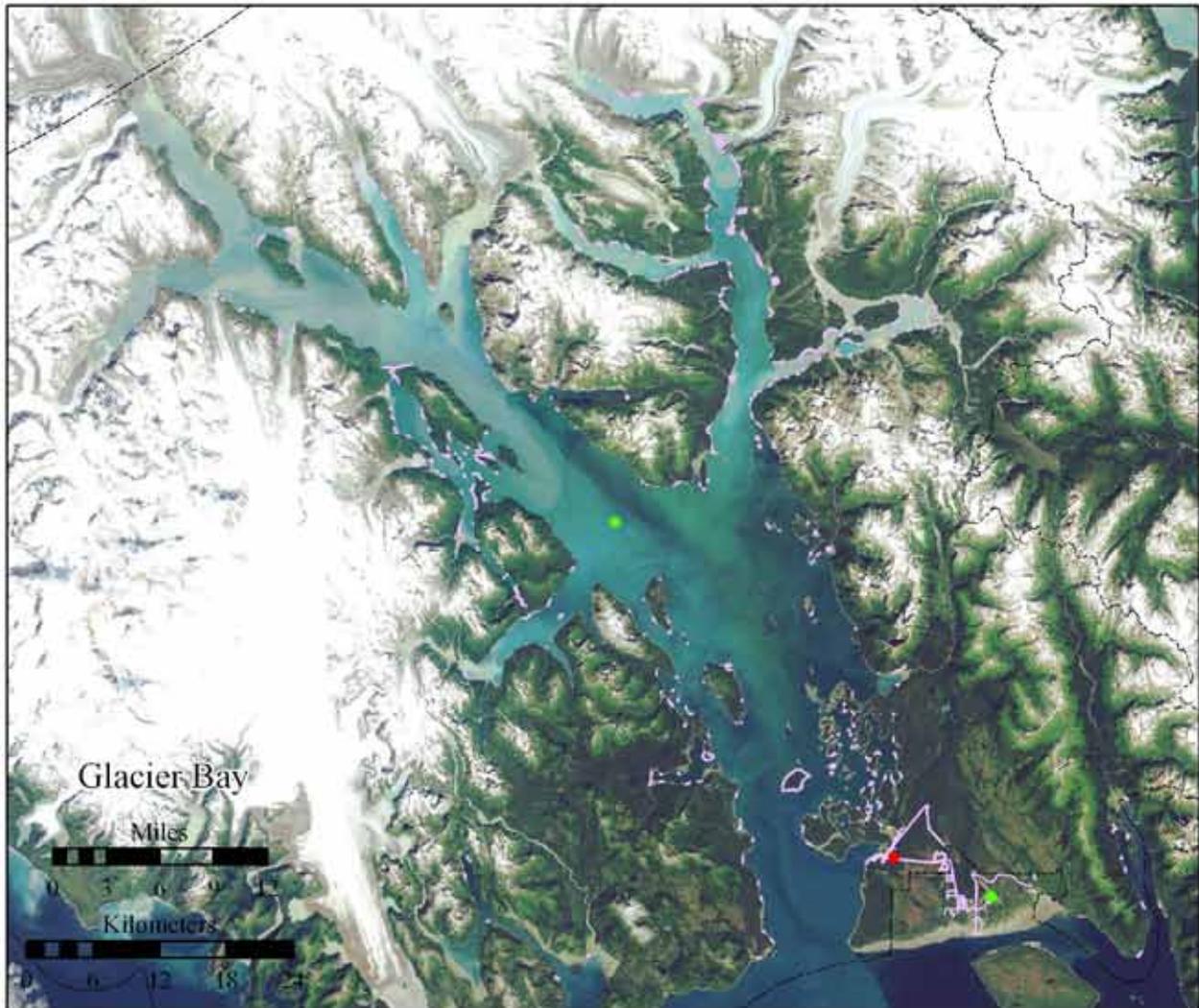
- Controlled by 2009
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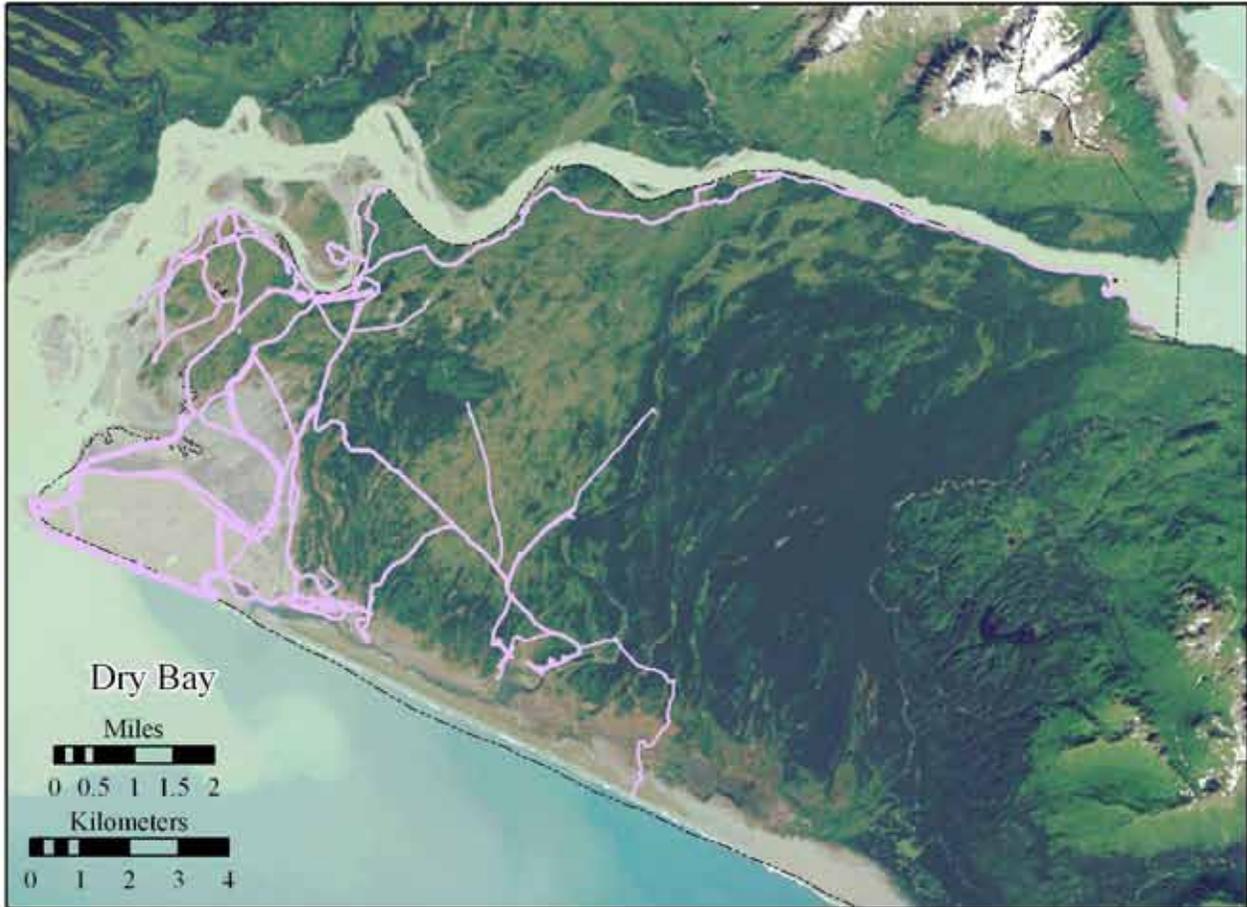
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Shepherd's Purse - *Capsella bursa-pastoris*



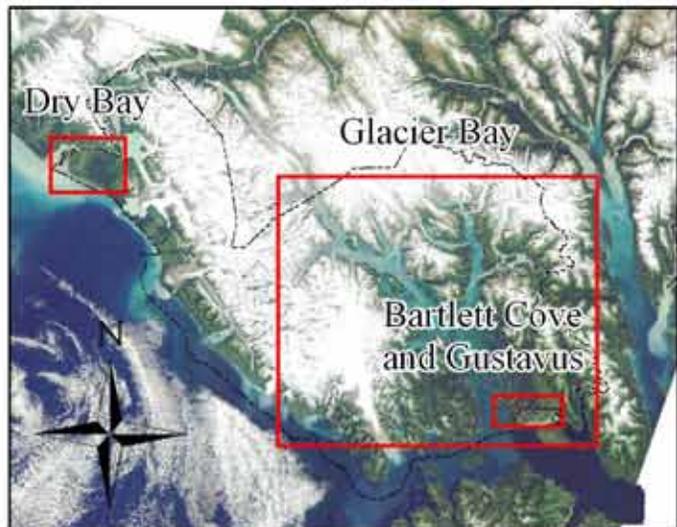
Perennial Cornflower - *Centaurea montana* in Glacier Bay National Park and Preserve



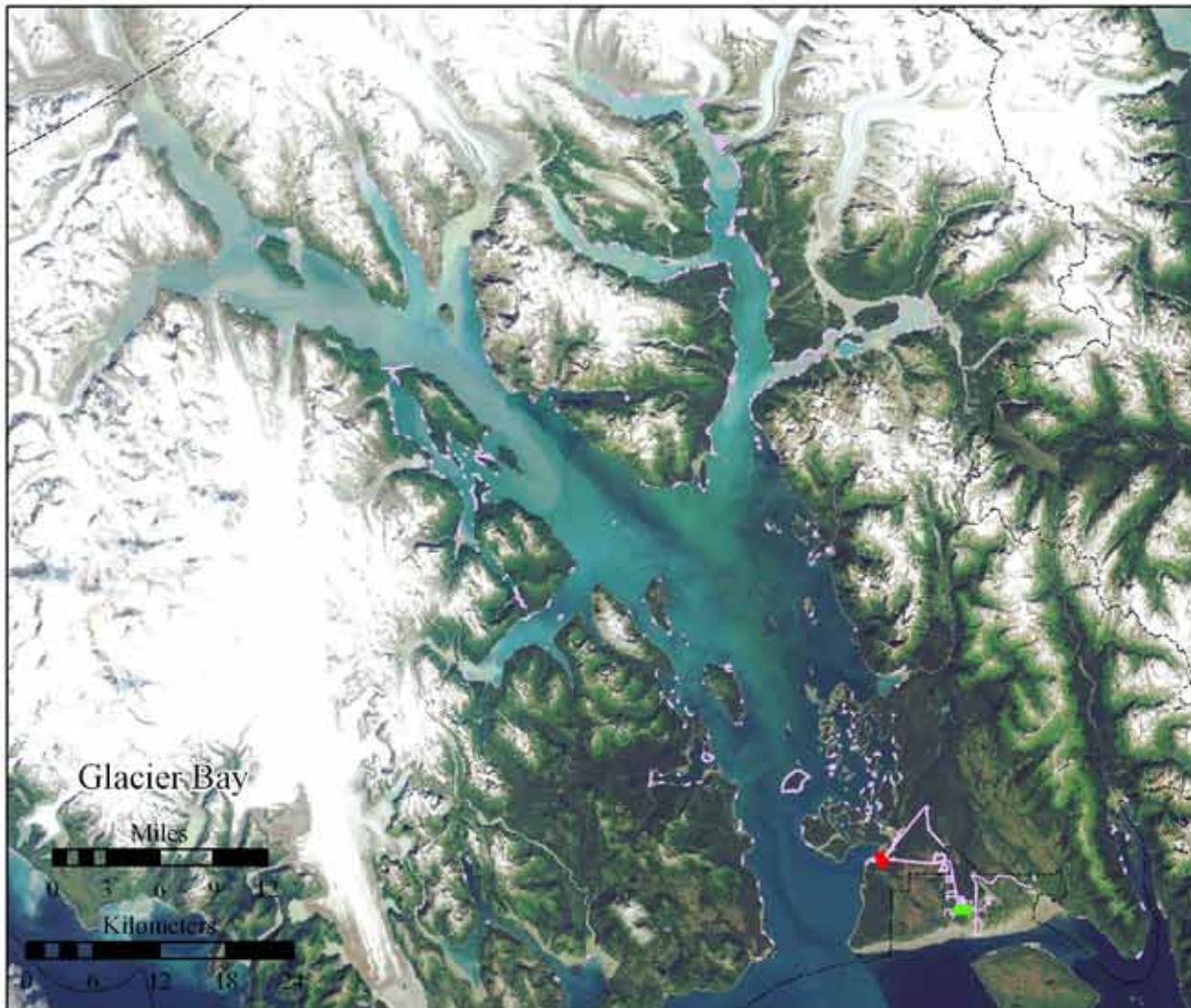
- Controlled by 2009
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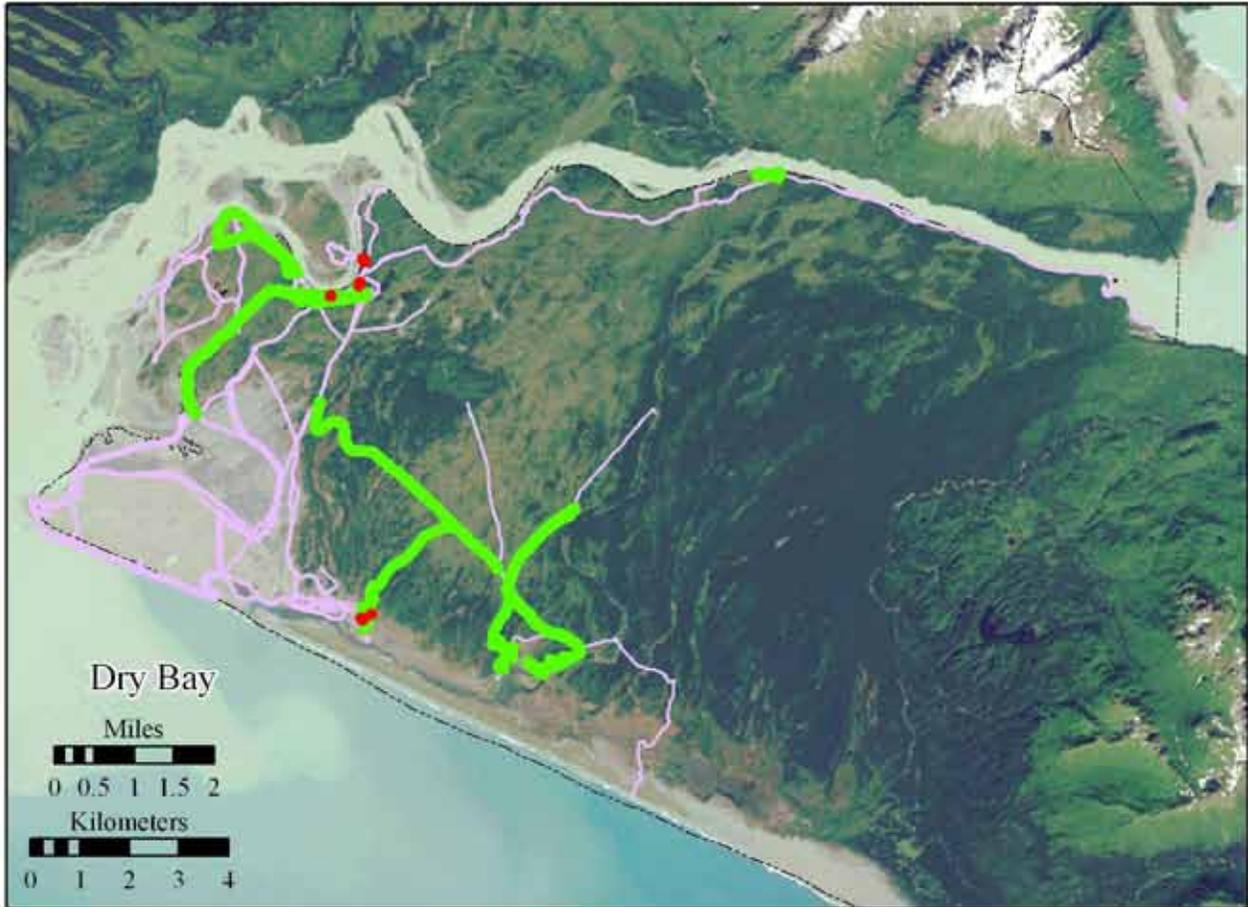
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Perennial Cornflower - *Centaurea montana*



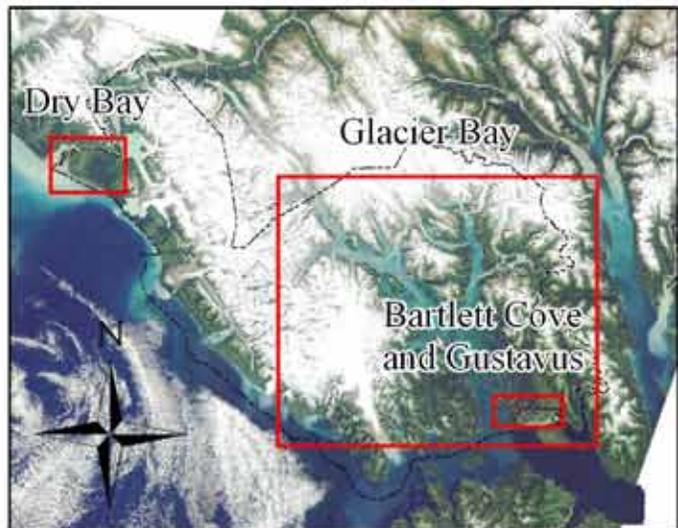
Mouse-Ear Chickweed - *Cerastium fontanum* in Glacier Bay National Park and Preserve



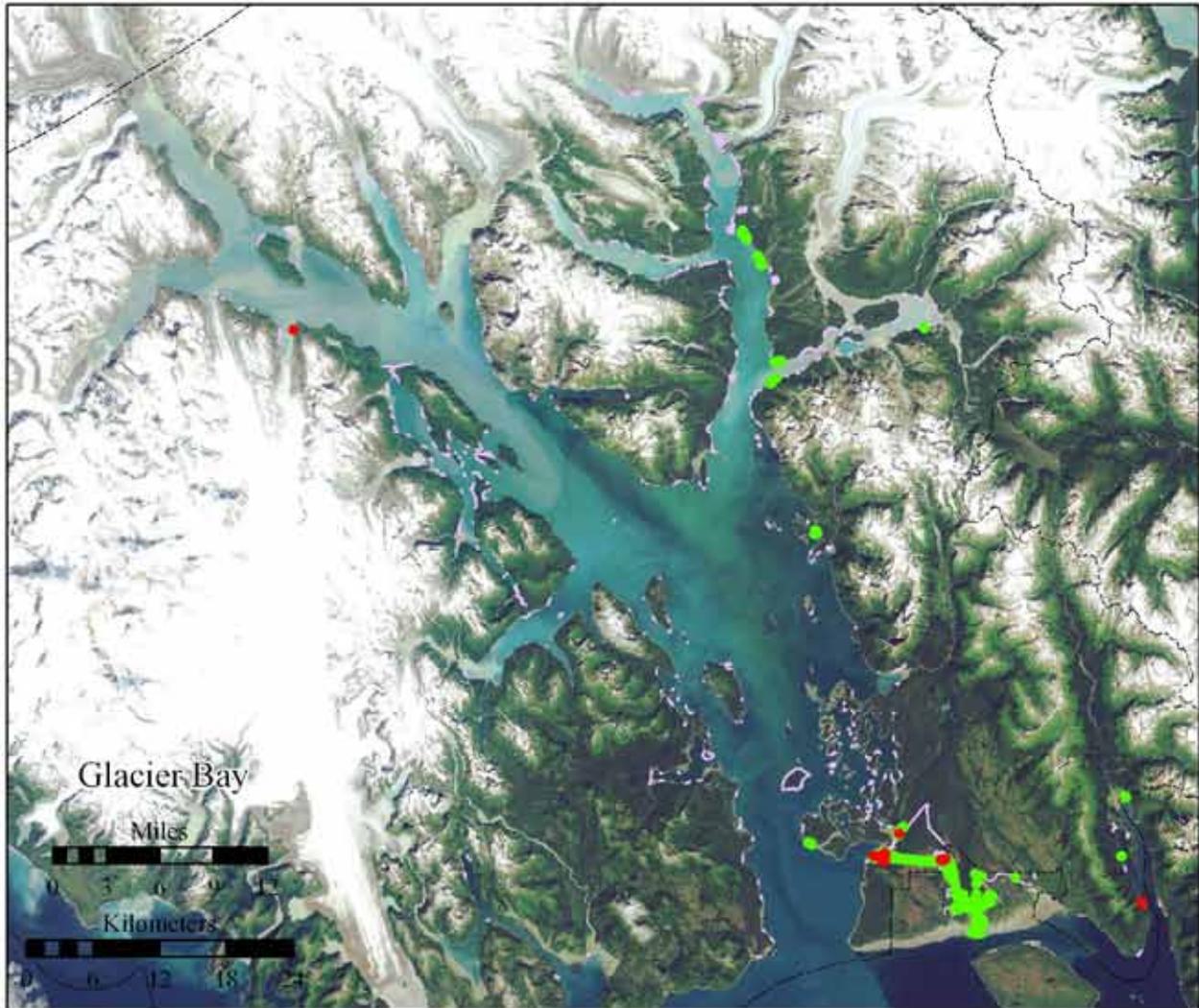
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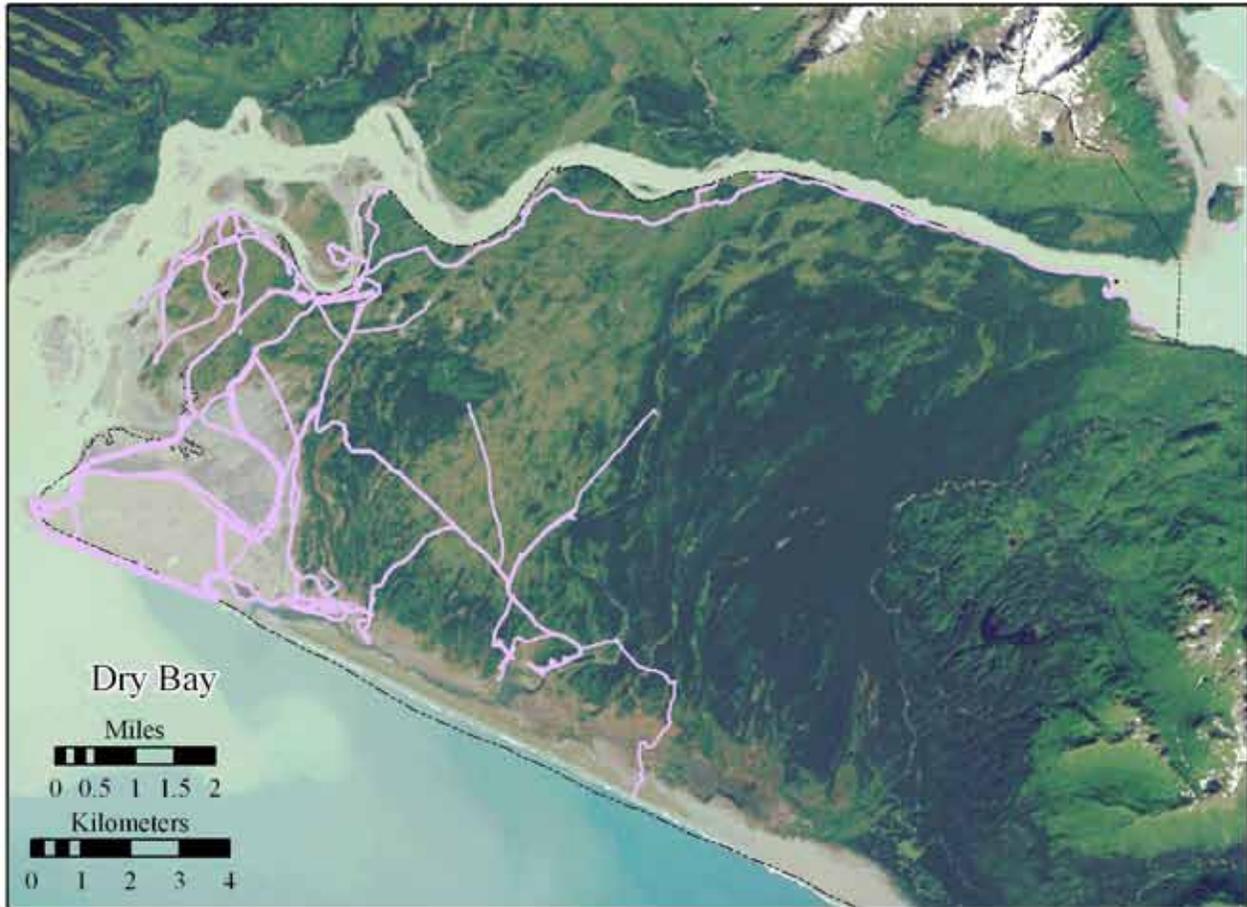
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Mouse-Ear Chickweed - *Cerastium fontanum*



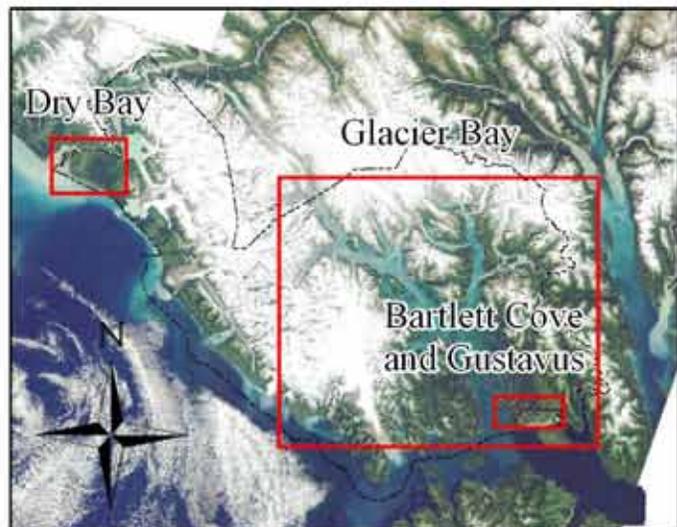
Snow In Summer - *Cerastium tomentosum* in Glacier Bay National Park and Preserve



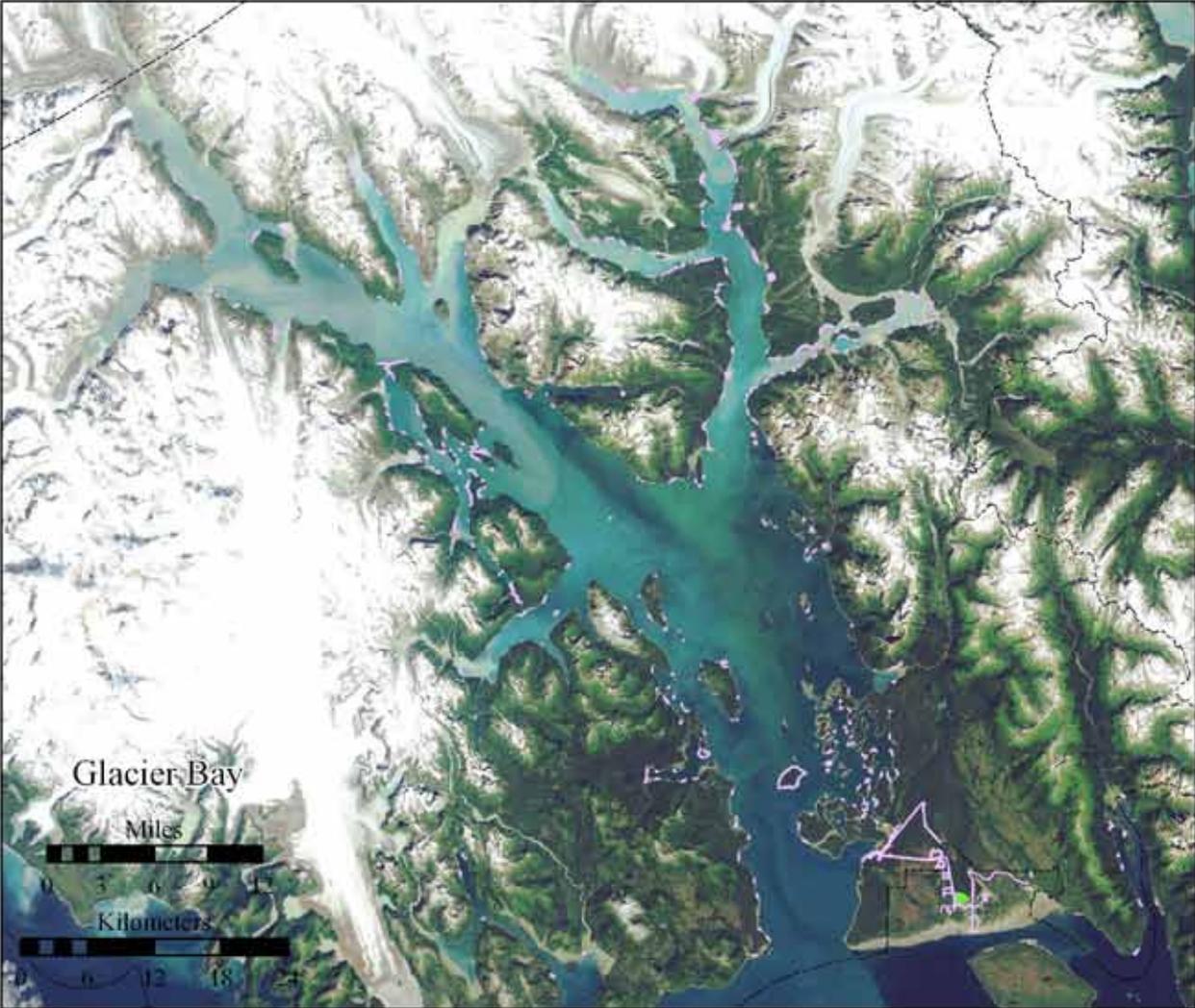
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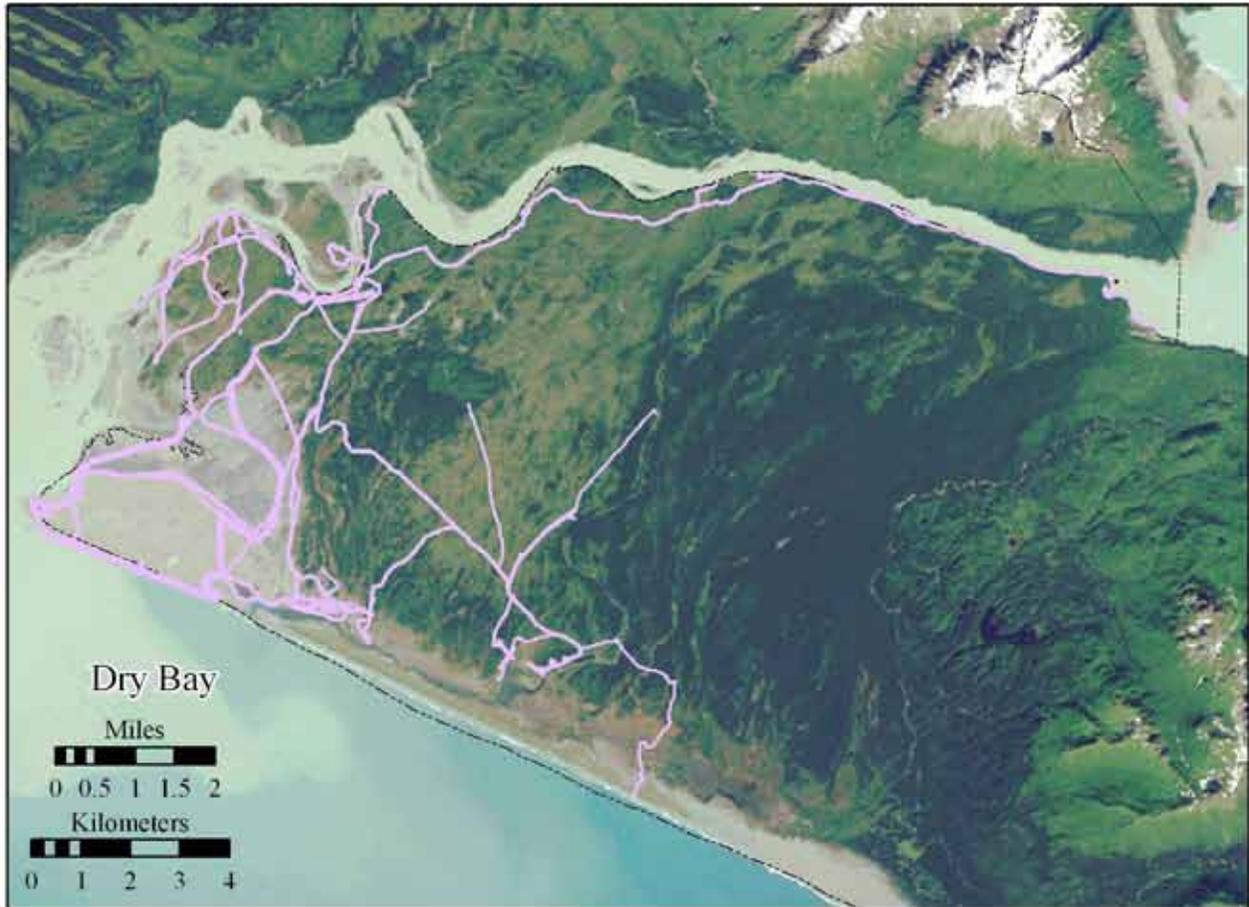
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Snow In Summer - *Cerastium tomentosum*



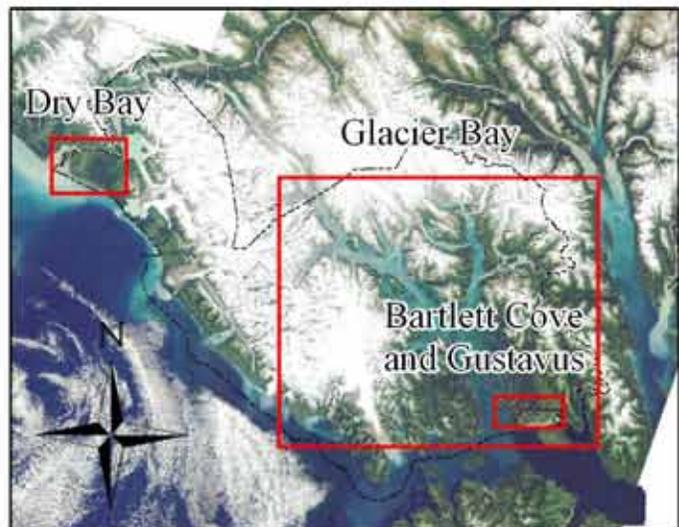
Canada Thistle - *Cirsium arvense* in Glacier Bay National Park and Preserve



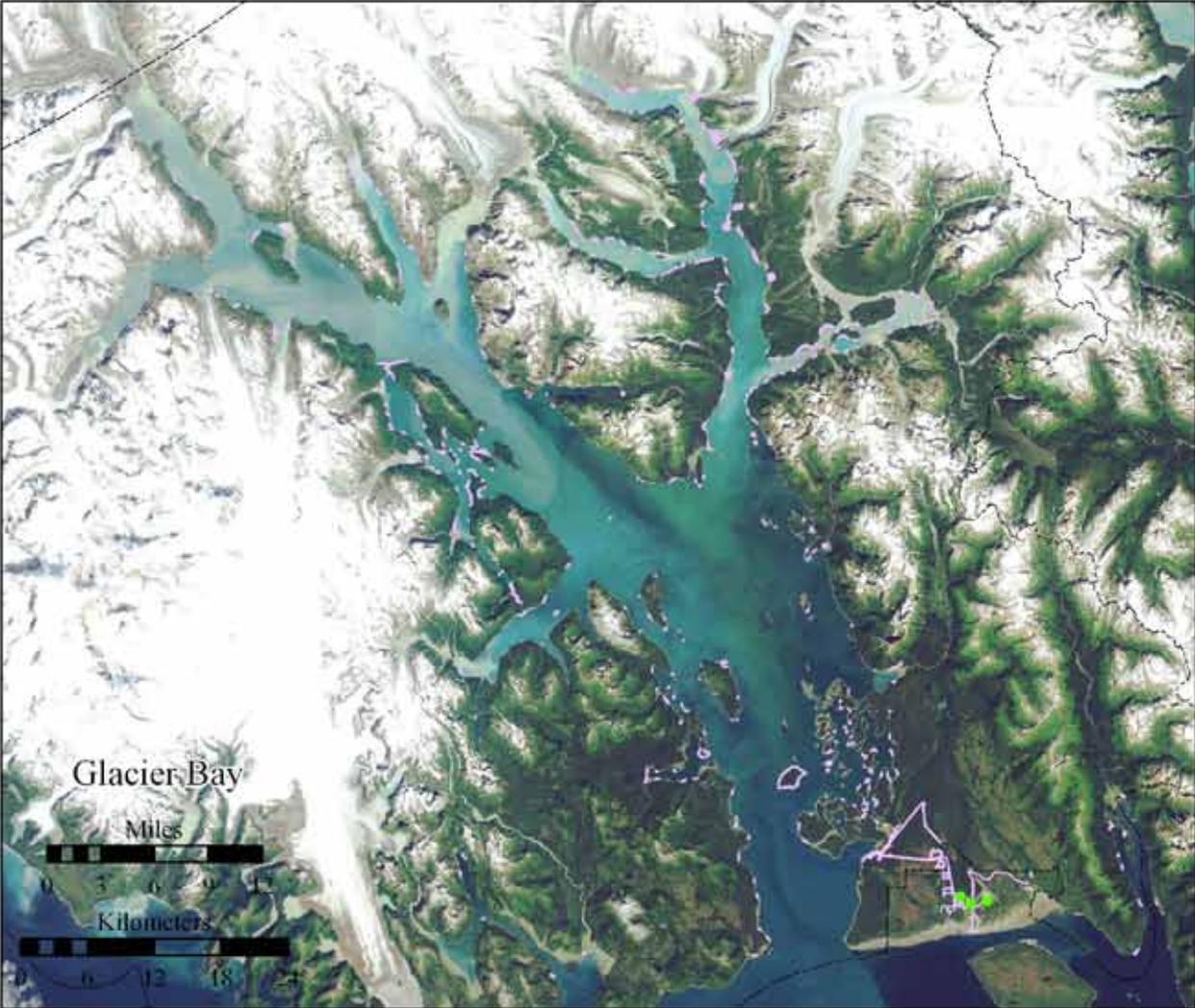
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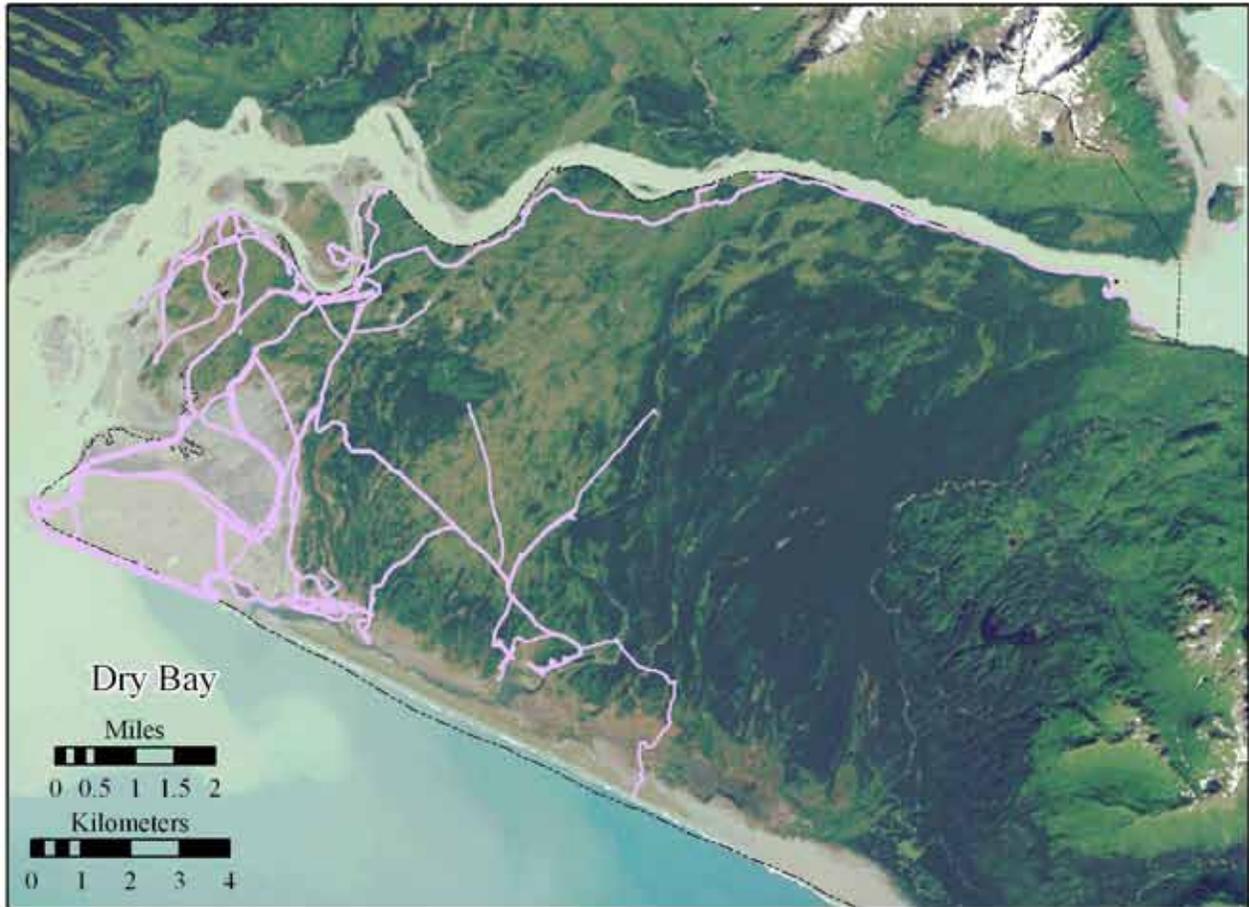
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Canada Thistle - *Cirsium arvense*



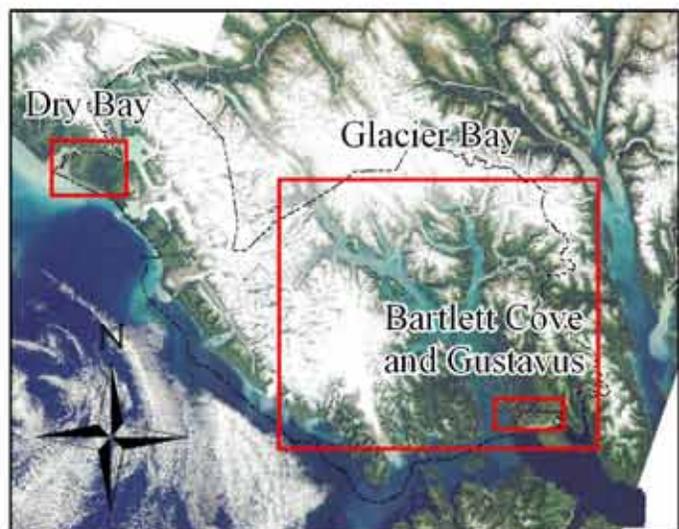
Orchard Grass - *Dactylis glomerata* in Glacier Bay National Park and Preserve



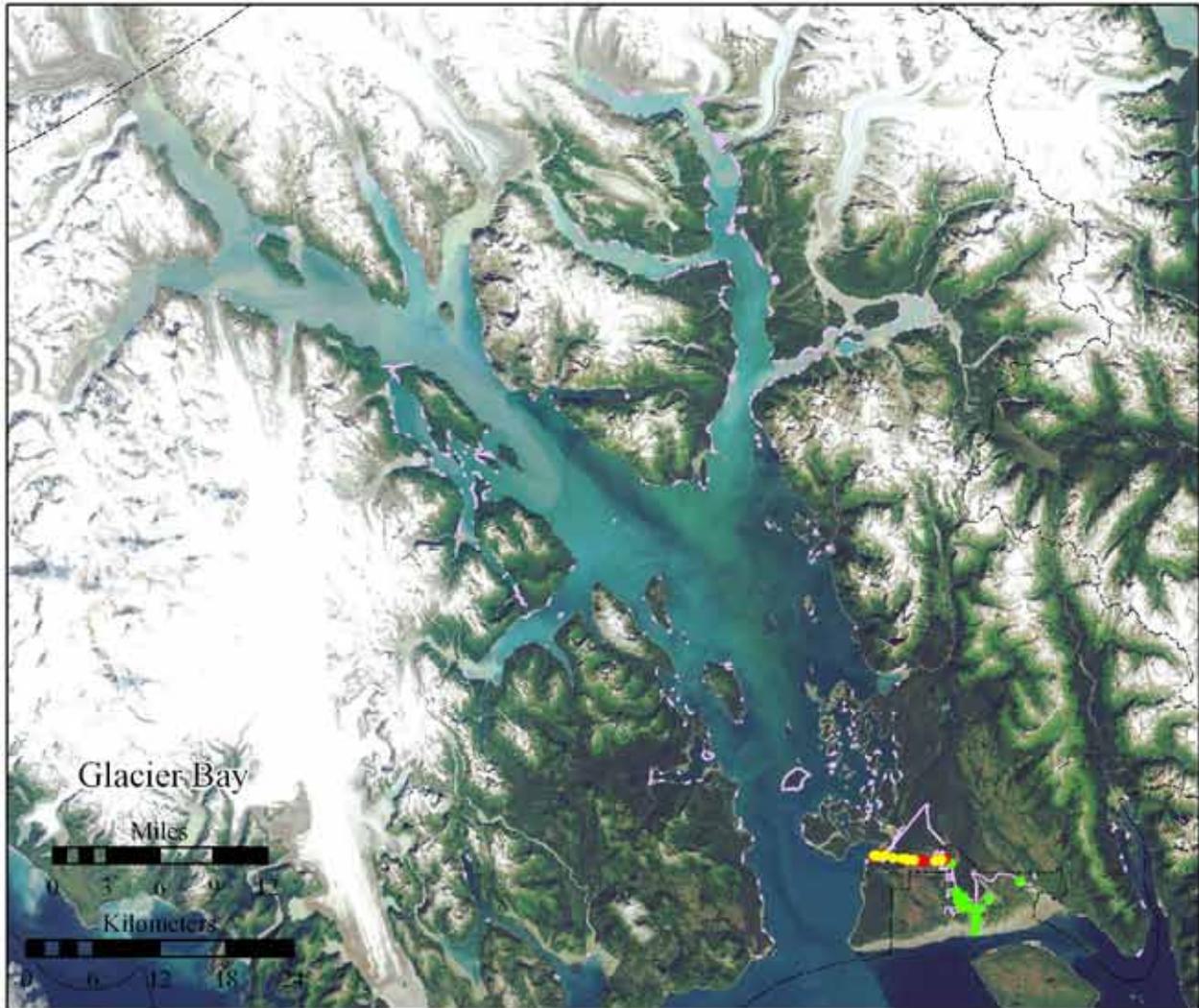
- Controlled by 2009
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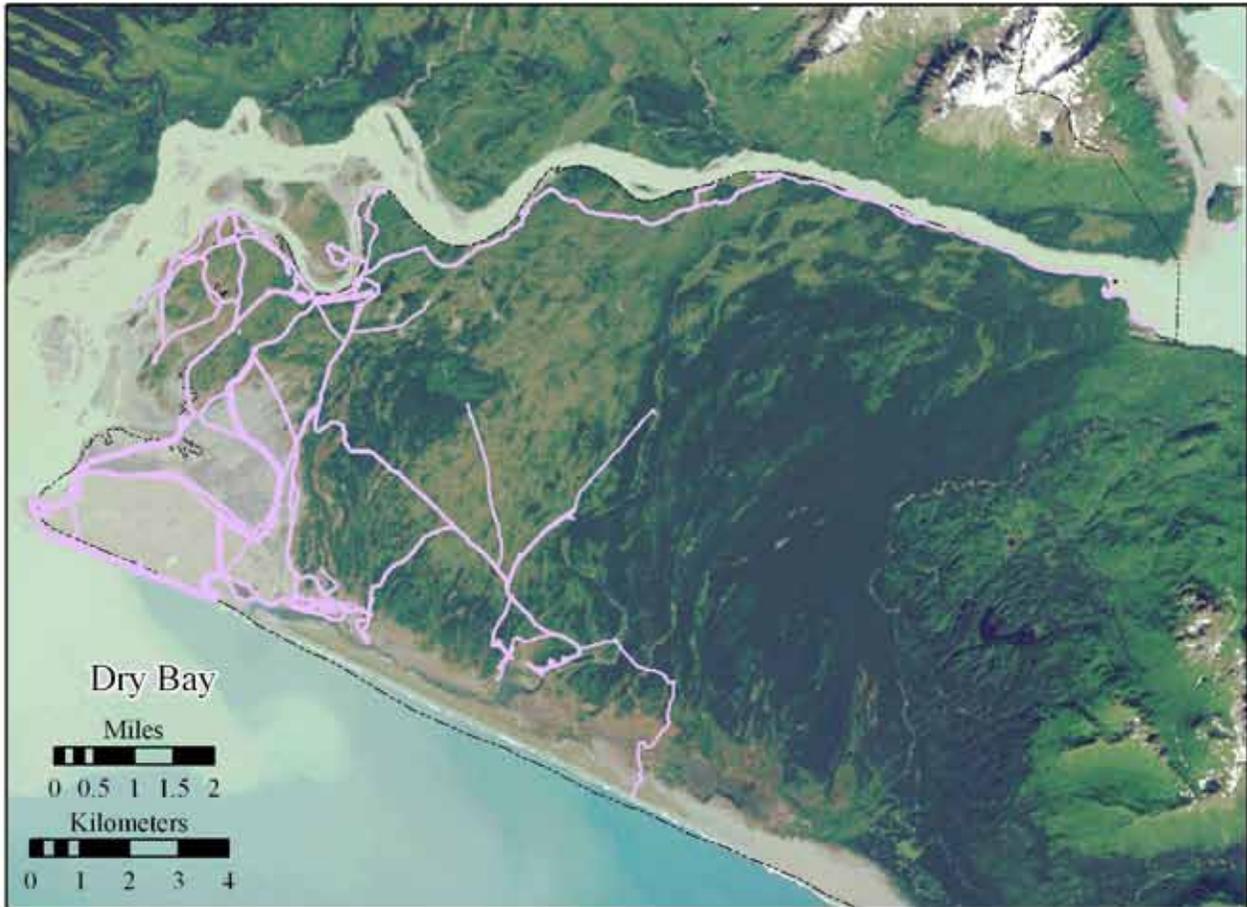
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Orchard Grass - *Dactylis glomerata*



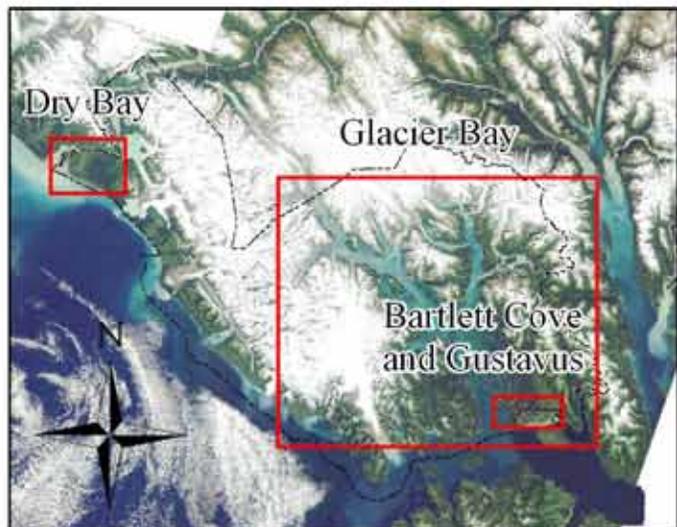
Quackgrass - *Elymus repens* in Glacier Bay National Park and Preserve



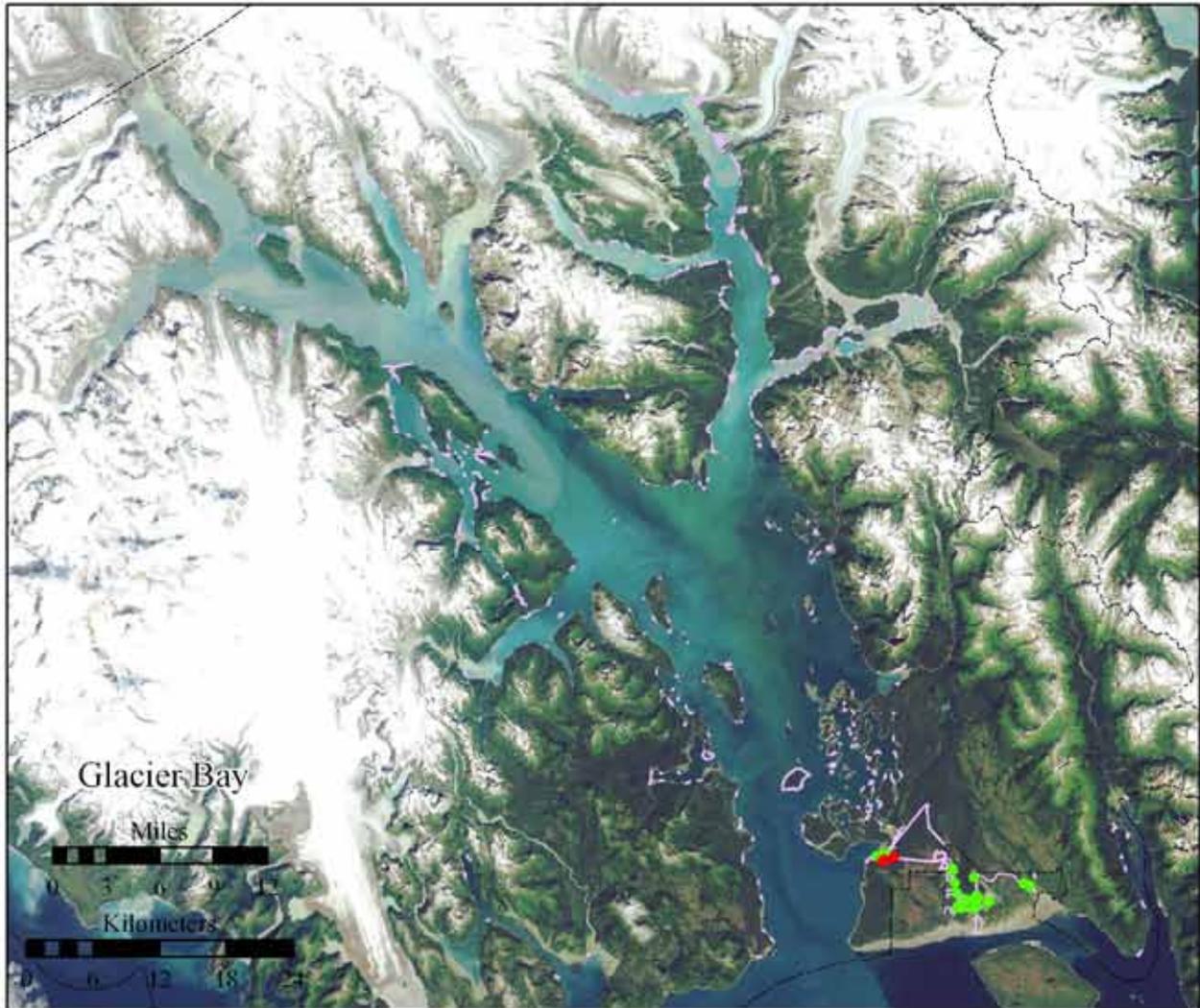
- Controlled by 2009
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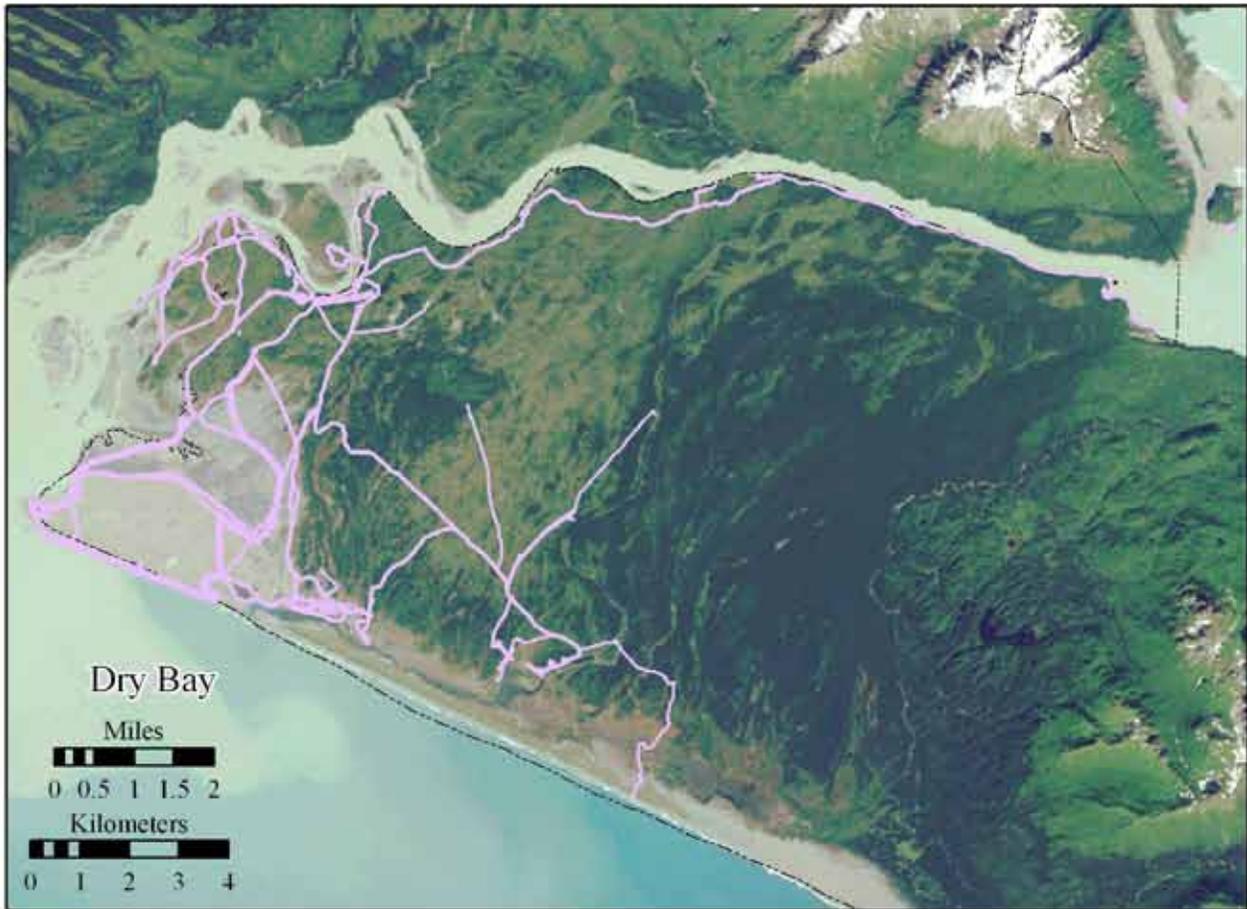
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Quackgrass - *Elymus repens*



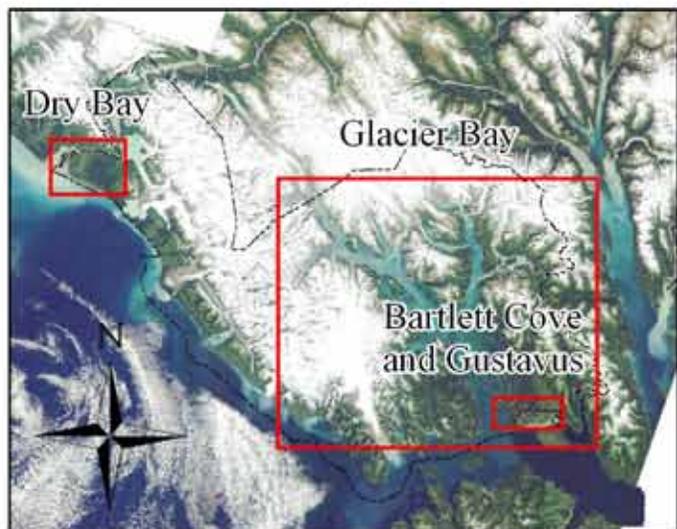
Hempnettle - *Galeopsis tetrahit* in Glacier Bay National Park and Preserve



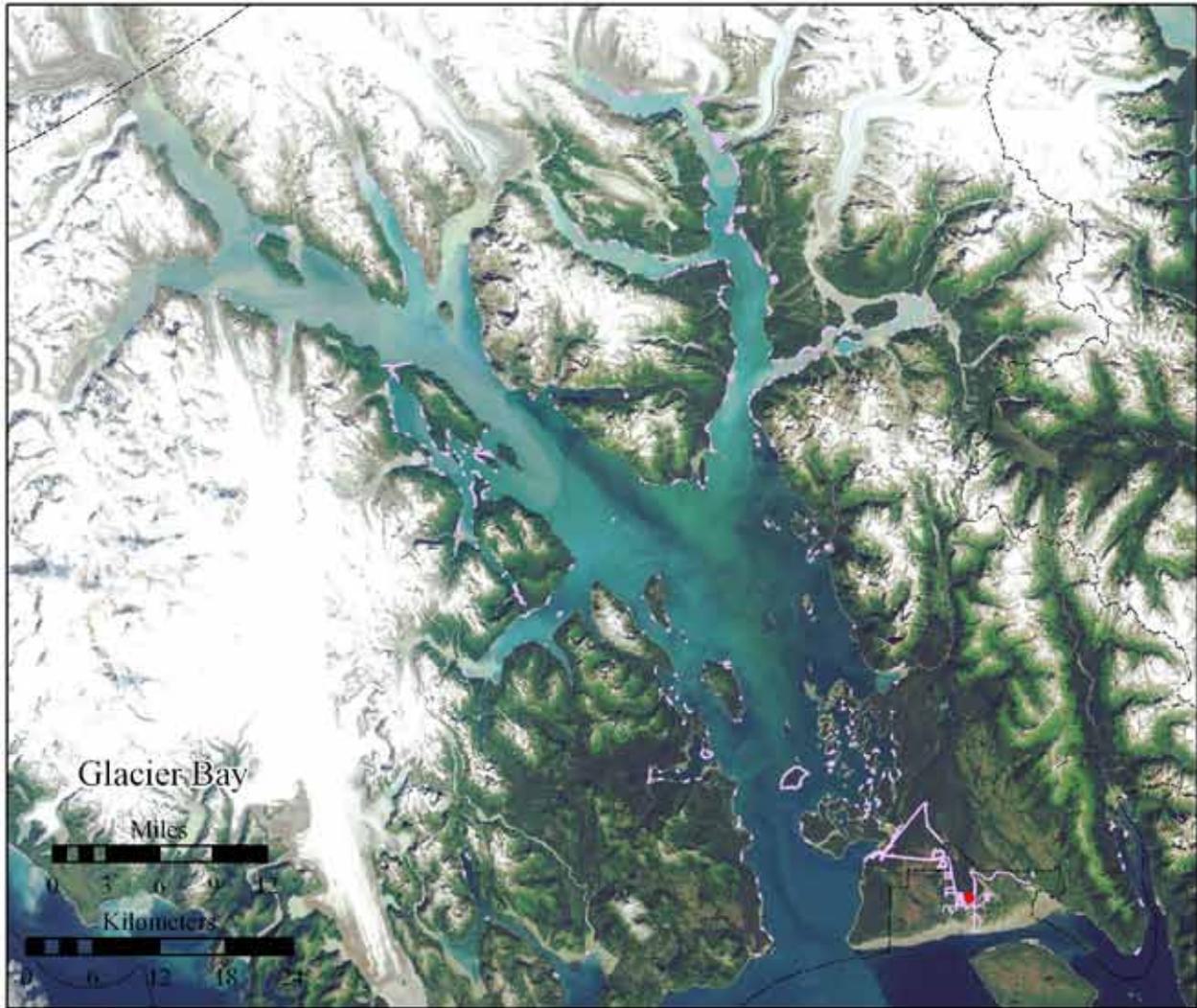
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Hempnettle - *Galeopsis tetrahit*



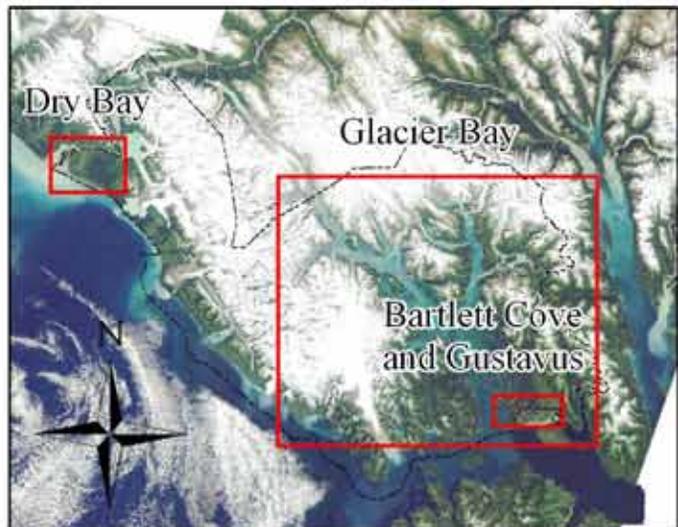
Herb Robert - *Geranium robertianum* in Glacier Bay National Park and Preserve



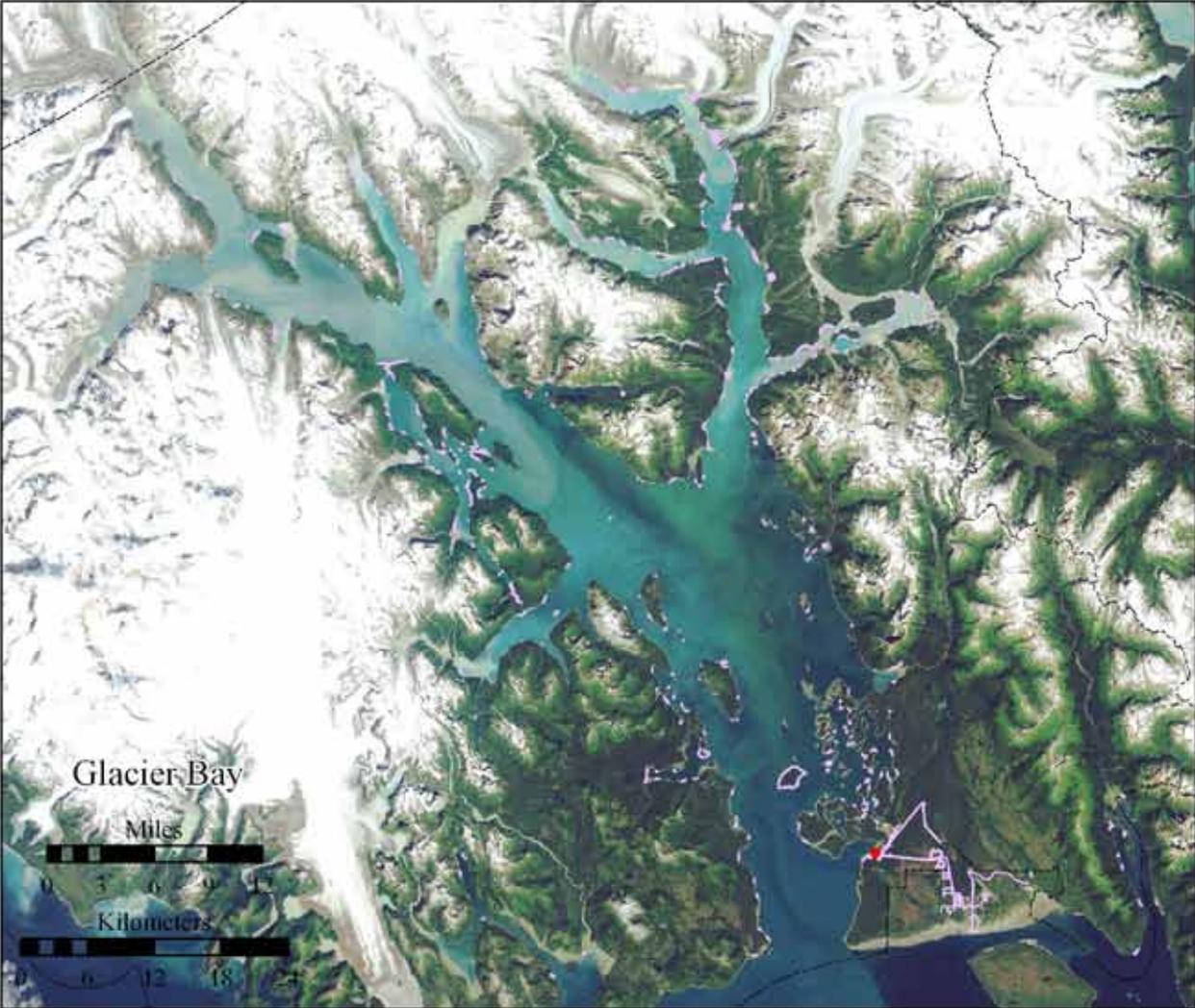
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Herb Robert - *Geranium robertianum*



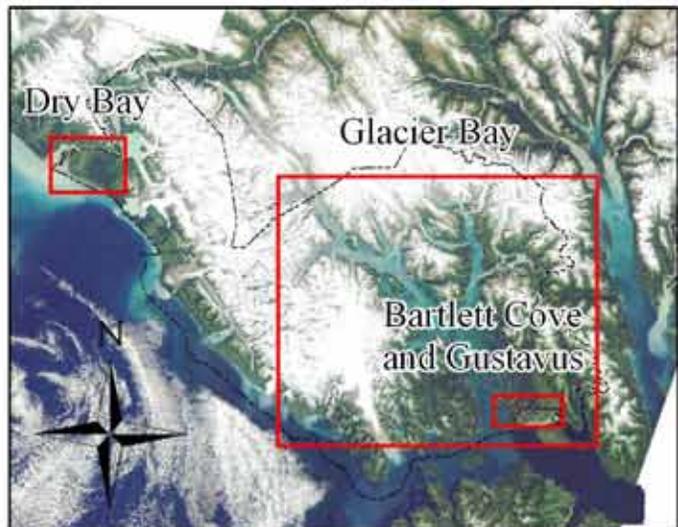
Orange Hawkweed - *Hieracium aurantiacum* in Glacier Bay National Park and Preserve



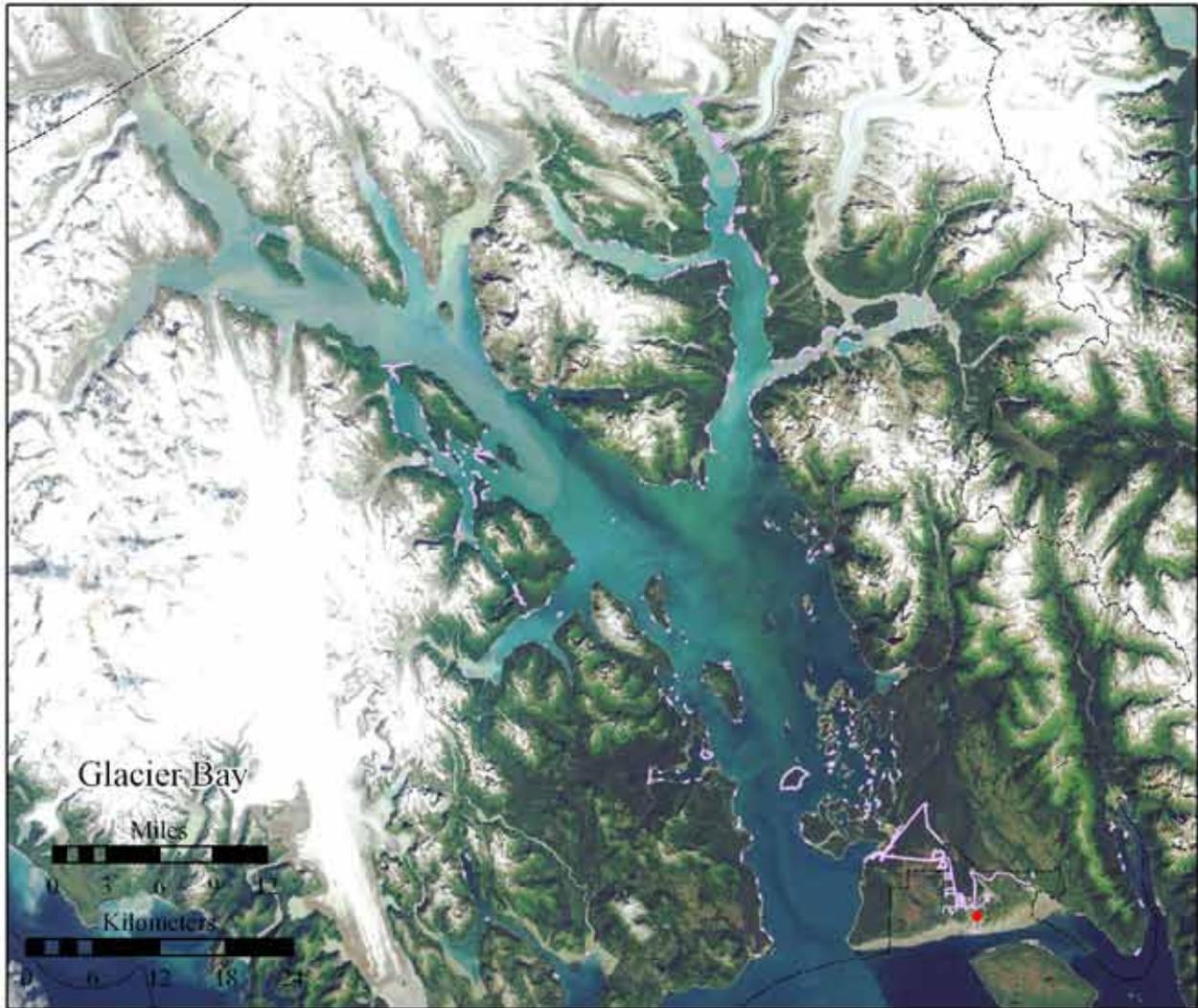
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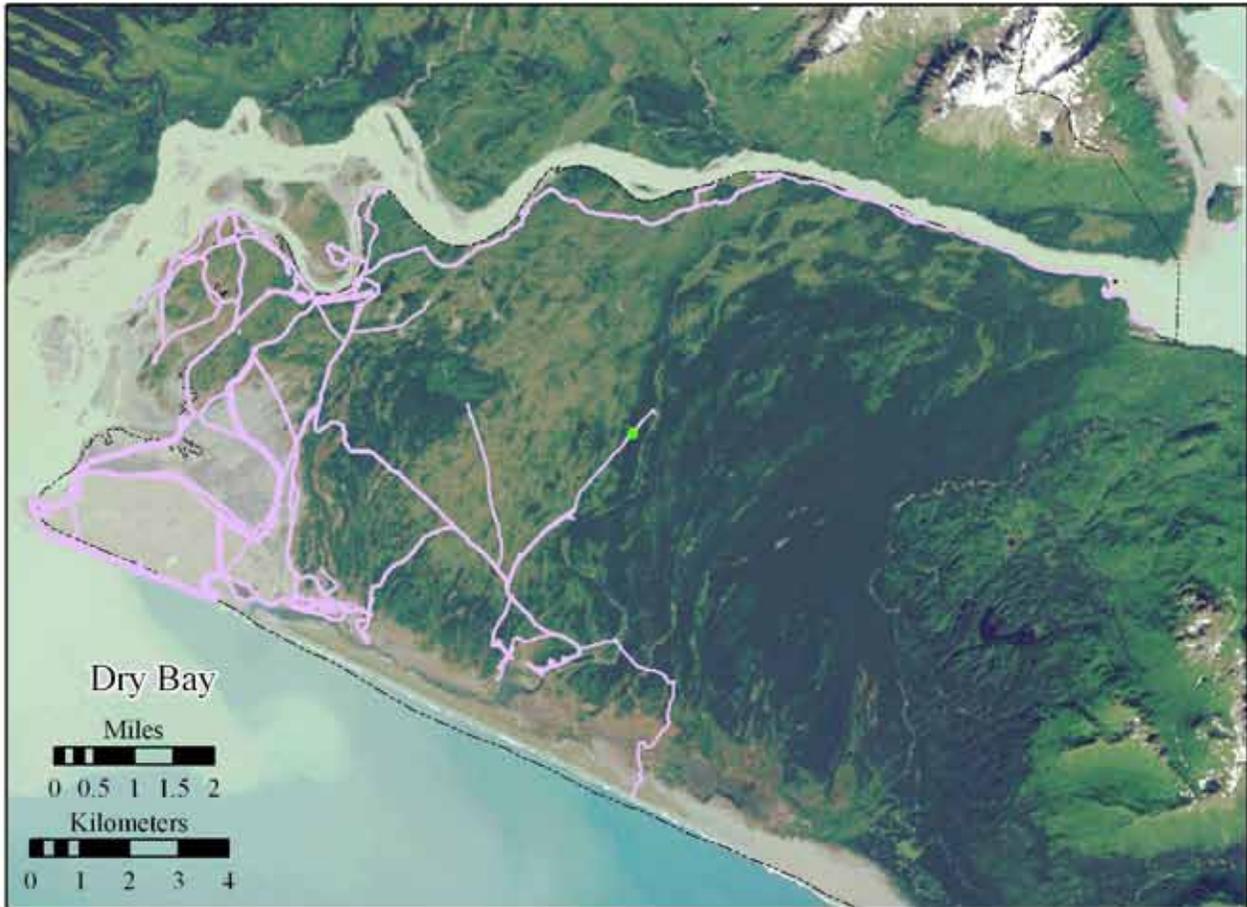
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Orange Hawkweed - *Hieracium aurantiacum*



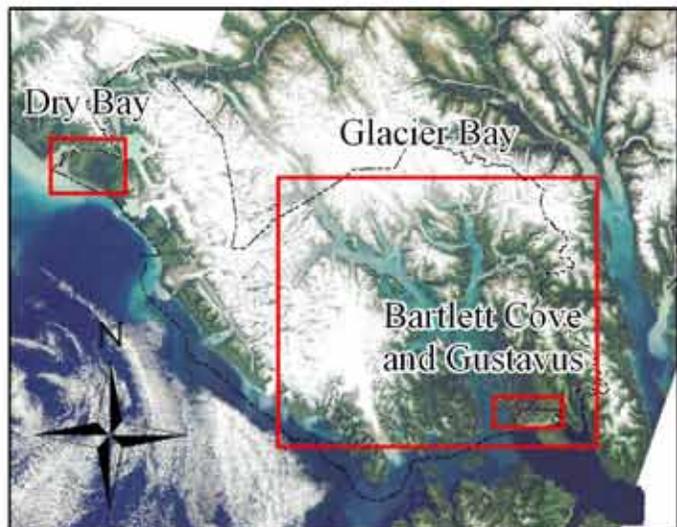
Foxtail Barley - *Hordeum jubatum* in Glacier Bay National Park and Preserve



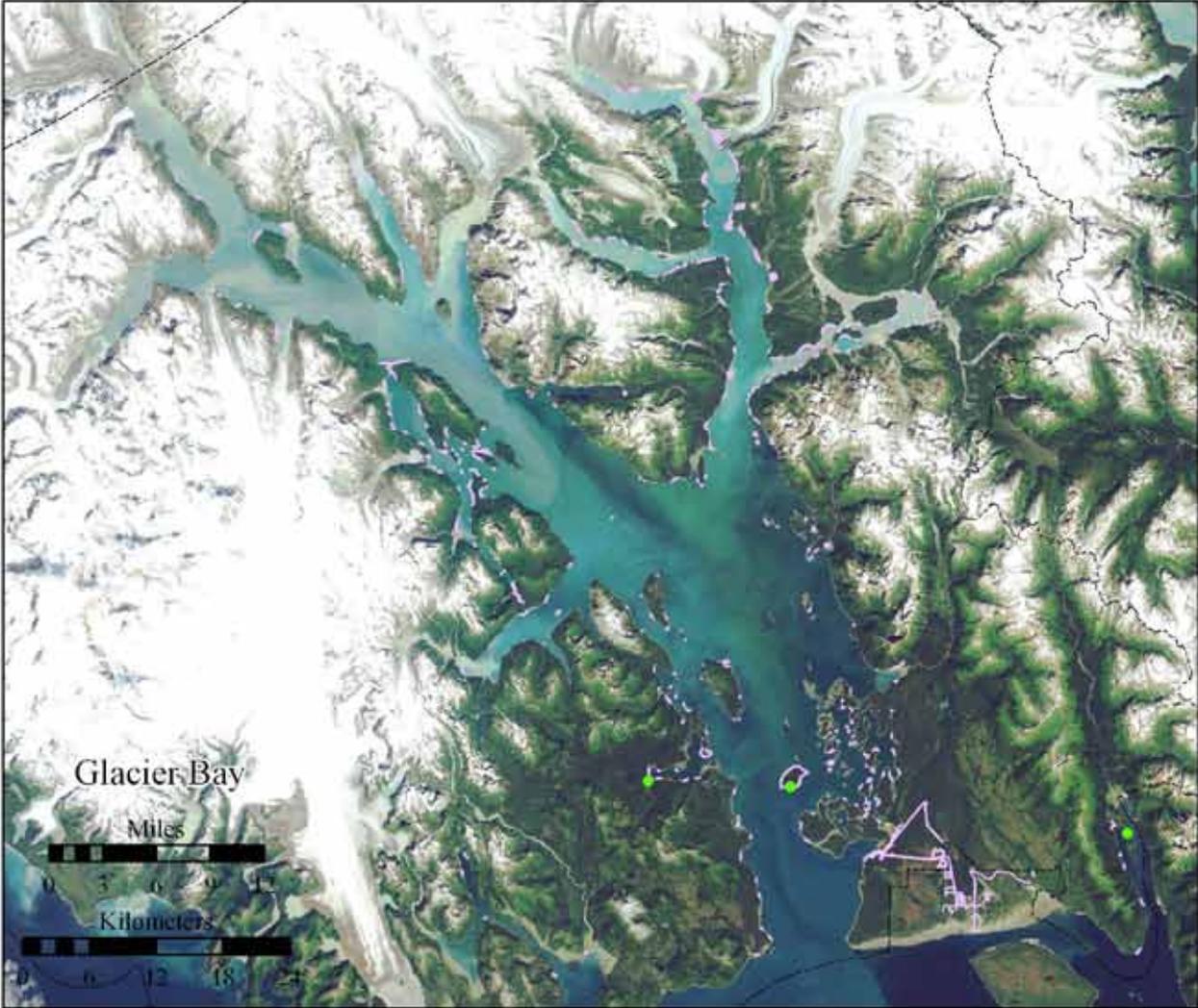
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- Absent in 2004-2009 Surveys
- GLBA Boundary



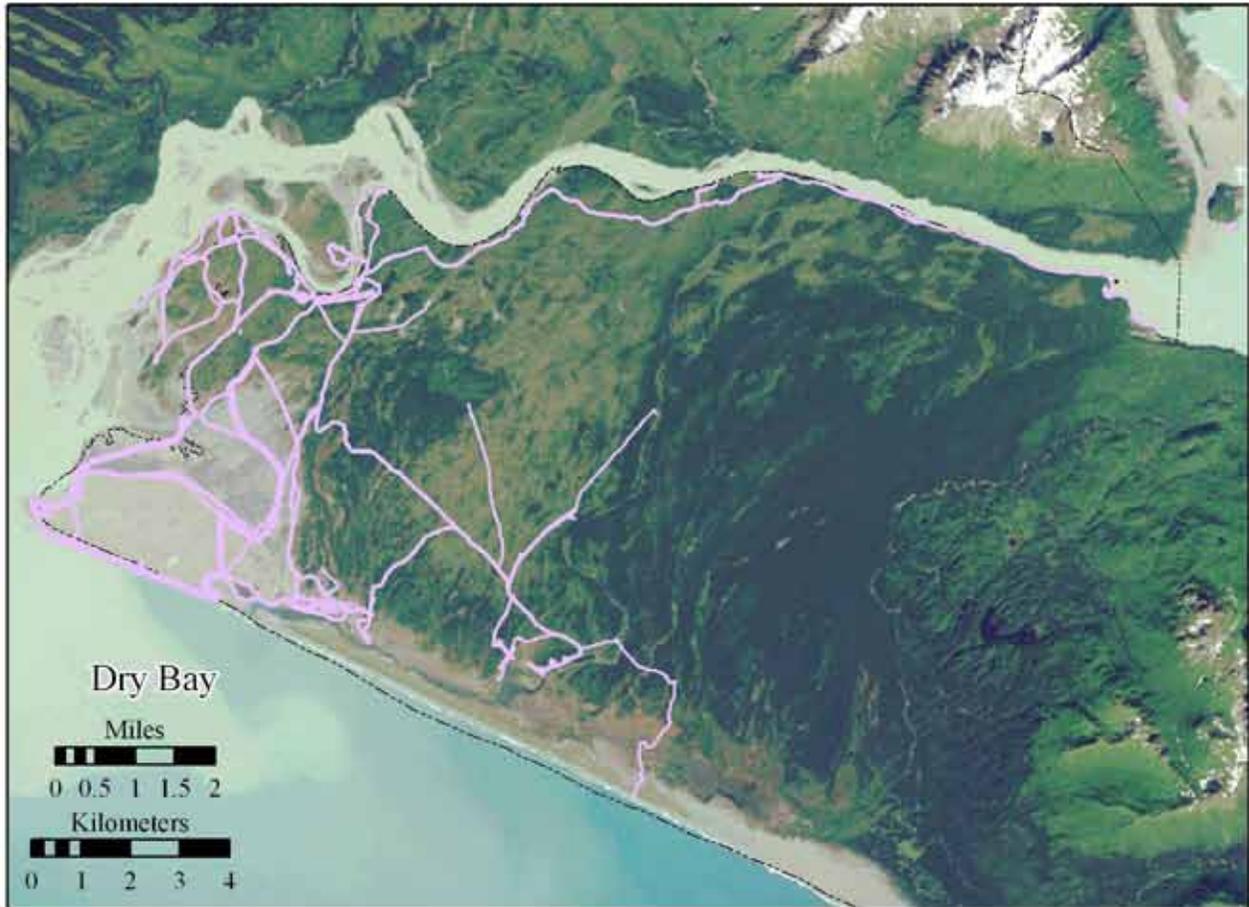
Alaska Region
Exotic Plant Management Team
Projection: UTM 8N, NAD 83
Created: September 2009



Foxtail Barley - *Hordeum jubatum*



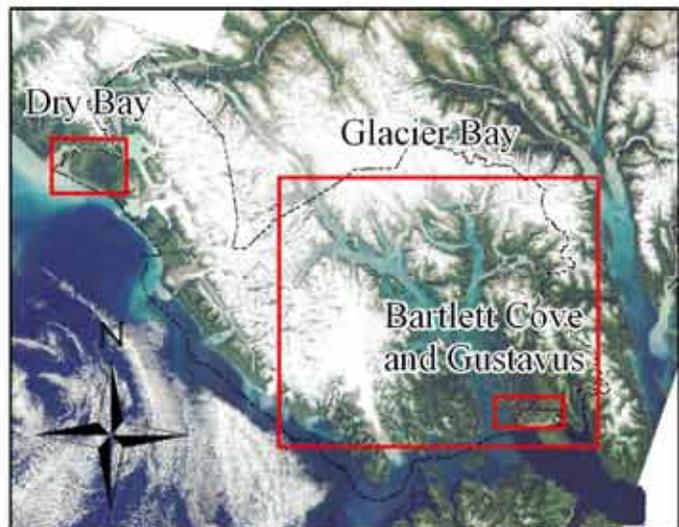
Hairy Cat's Ear - *Hypochaeris radicata* in Glacier Bay National Park and Preserve



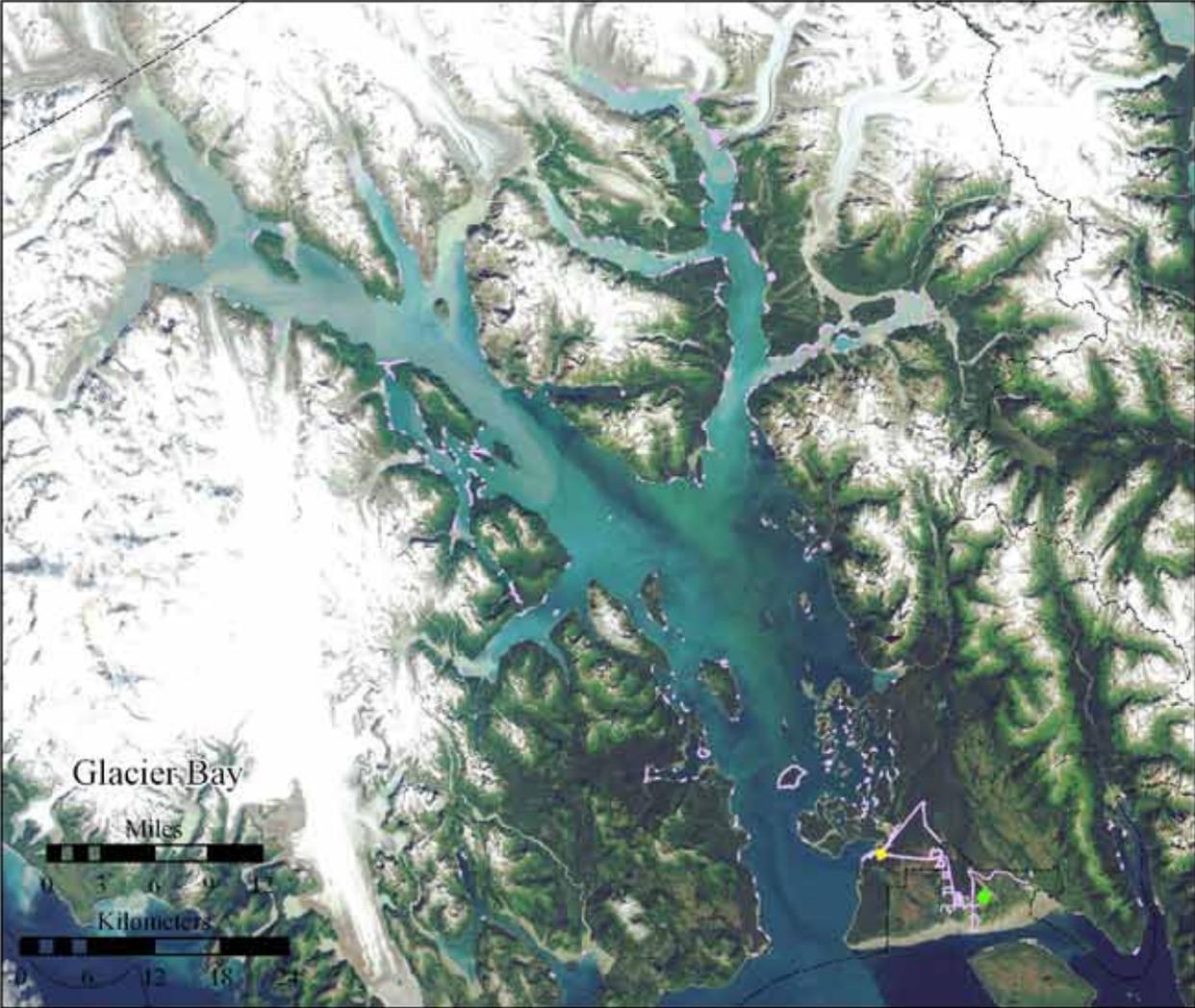
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- Treated between 2004-2009
- Present between 2004-2009
- Absent in 2004-2009 Surveys
- GLBA Boundary



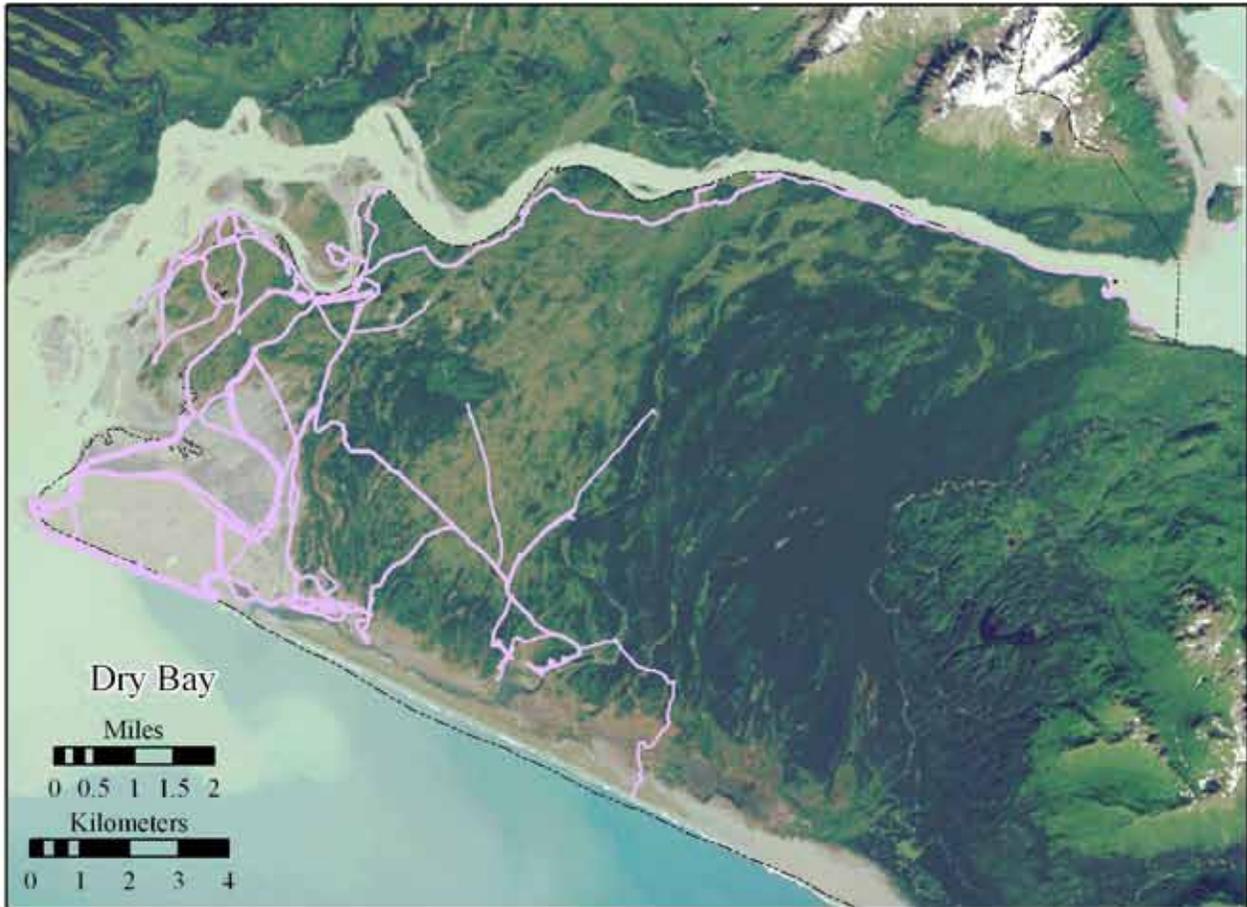
Alaska Region
Exotic Plant Management Team
Projection: UTM 8N, NAD 83
Created: September 2009



Hairy Cat's Ear - *Hypochaeris radicata*



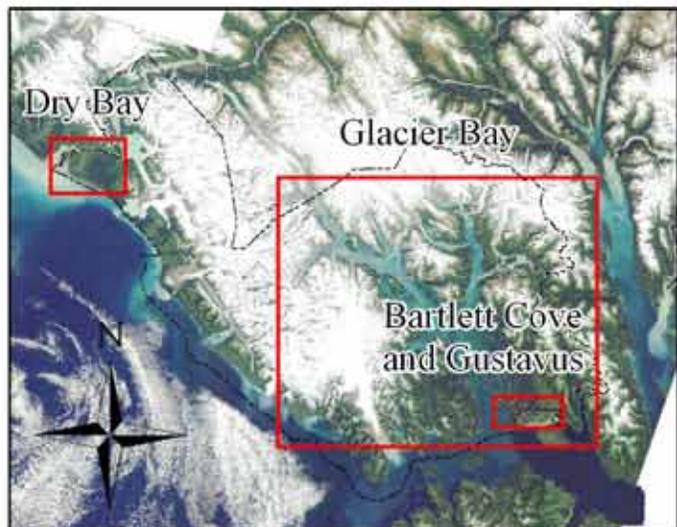
White Deadnettle - *Lamium album* in Glacier Bay National Park and Preserve



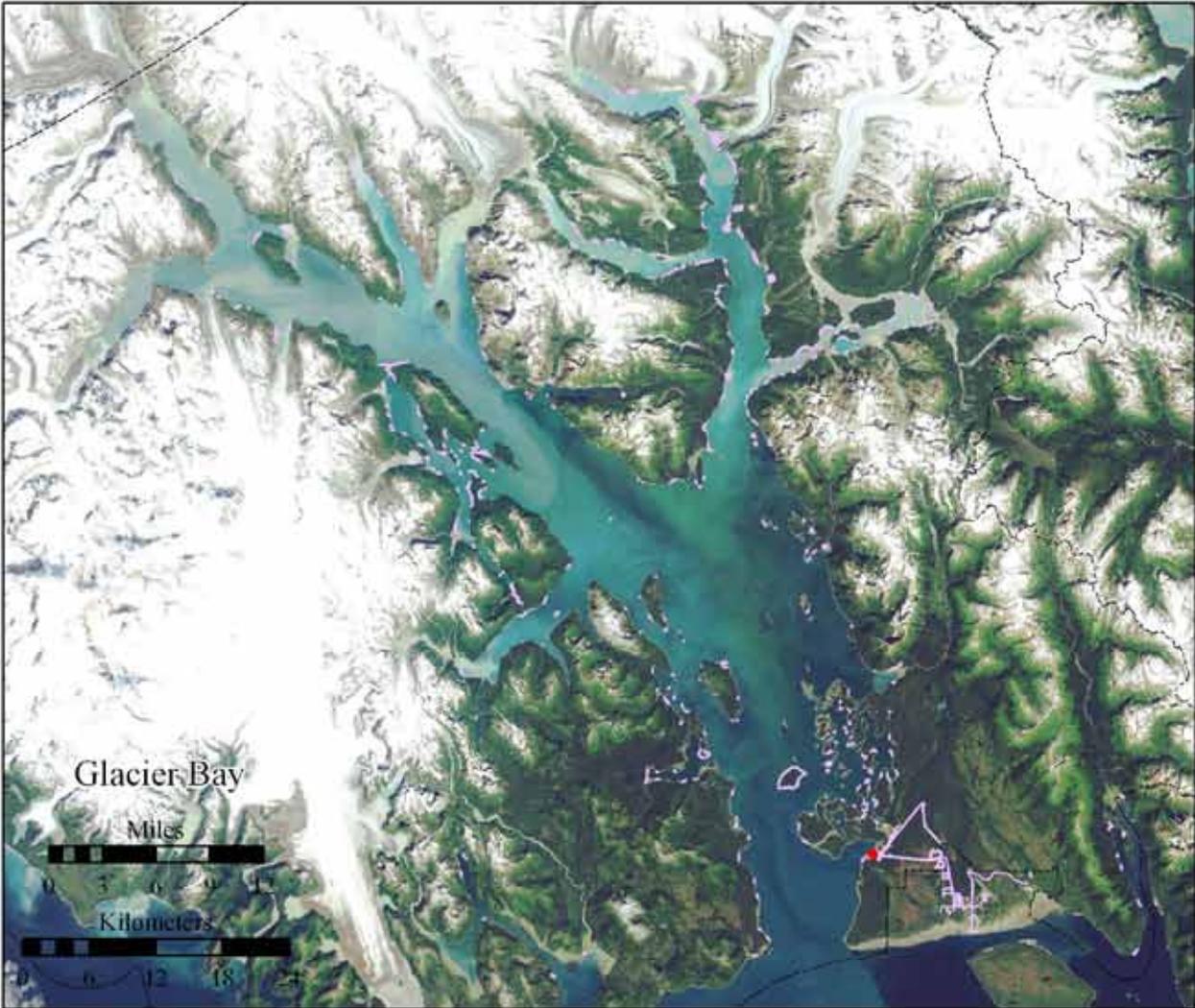
- Controlled by 2009
- Treated between 2004-2009
- Present between 2004-2009
- Absent in 2004-2009 Surveys
- GLBA Boundary



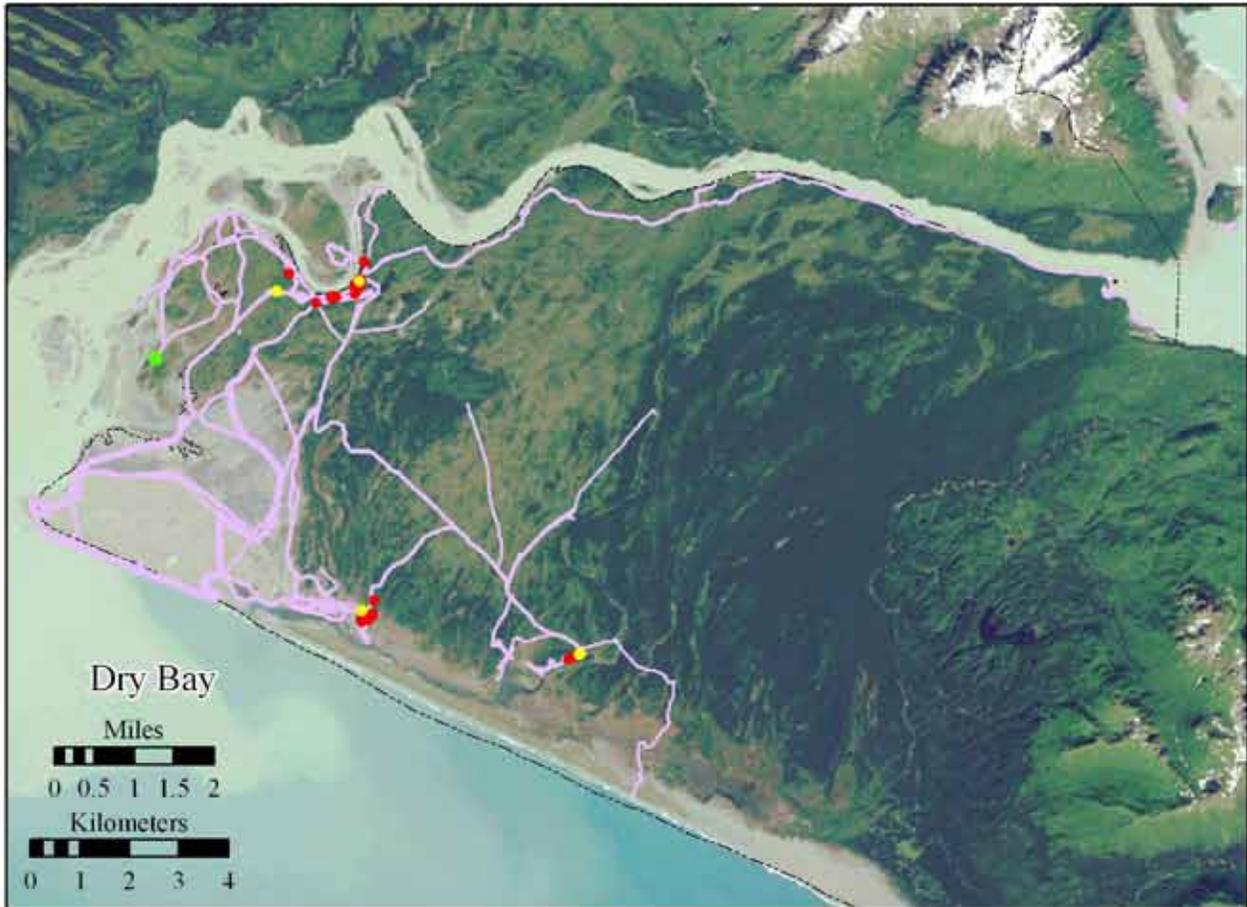
Alaska Region
Exotic Plant Management Team
Projection: UTM 8N, NAD 83
Created: September 2009



White Deadnettle - *Lamium album*



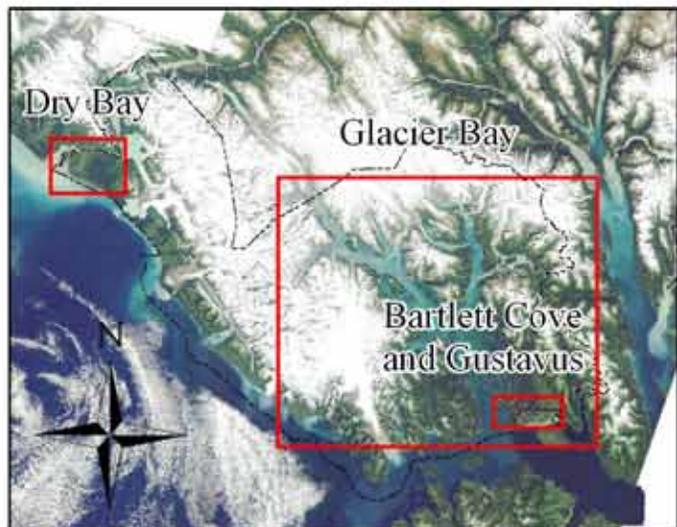
Oxeye Daisy - *Leucanthemum vulgare* in Glacier Bay National Park and Preserve



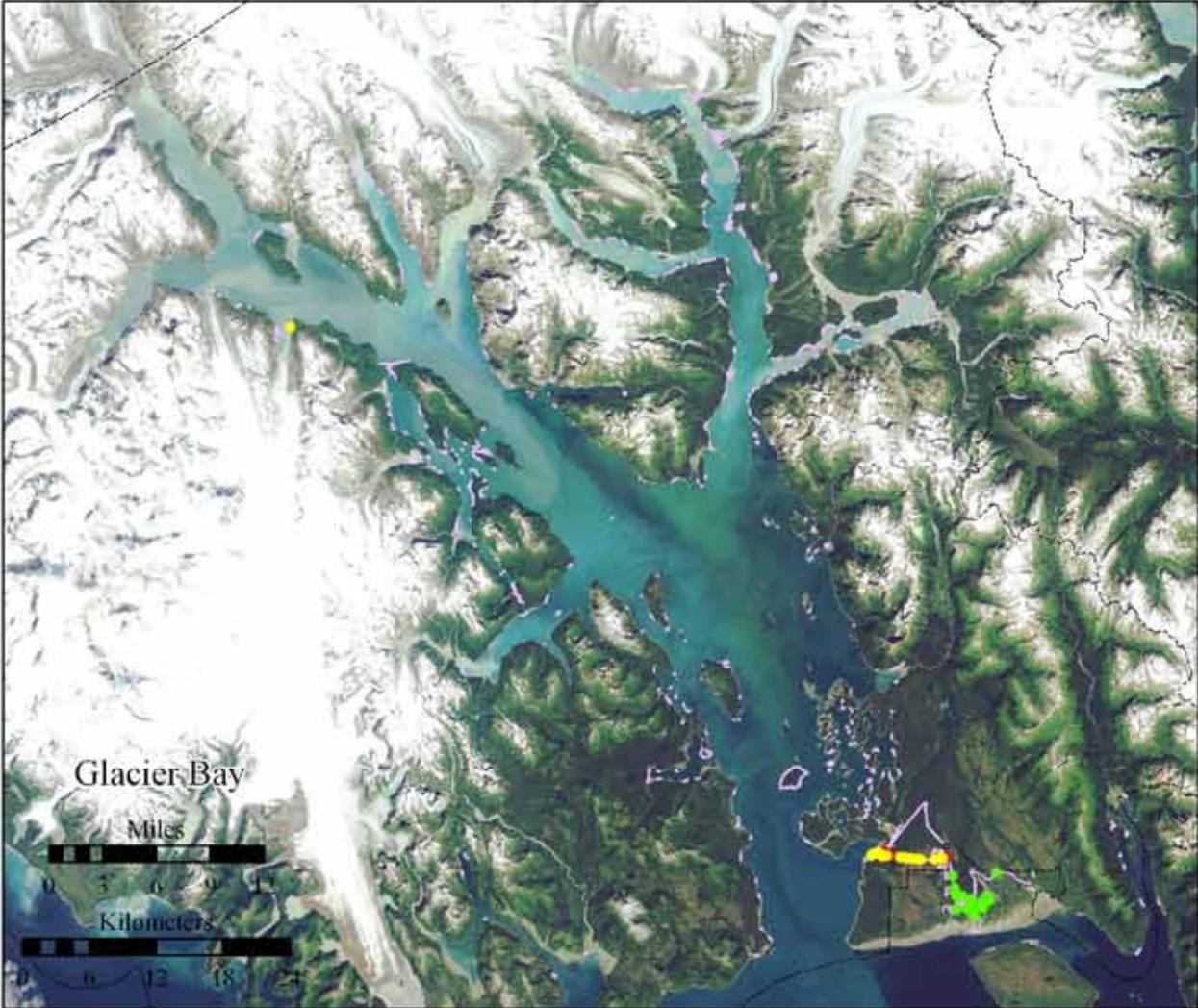
- Controlled by 2009
- Treated between 2004-2009
- Present between 2004-2009
- Absent in 2004-2009 Surveys
- GLBA Boundary



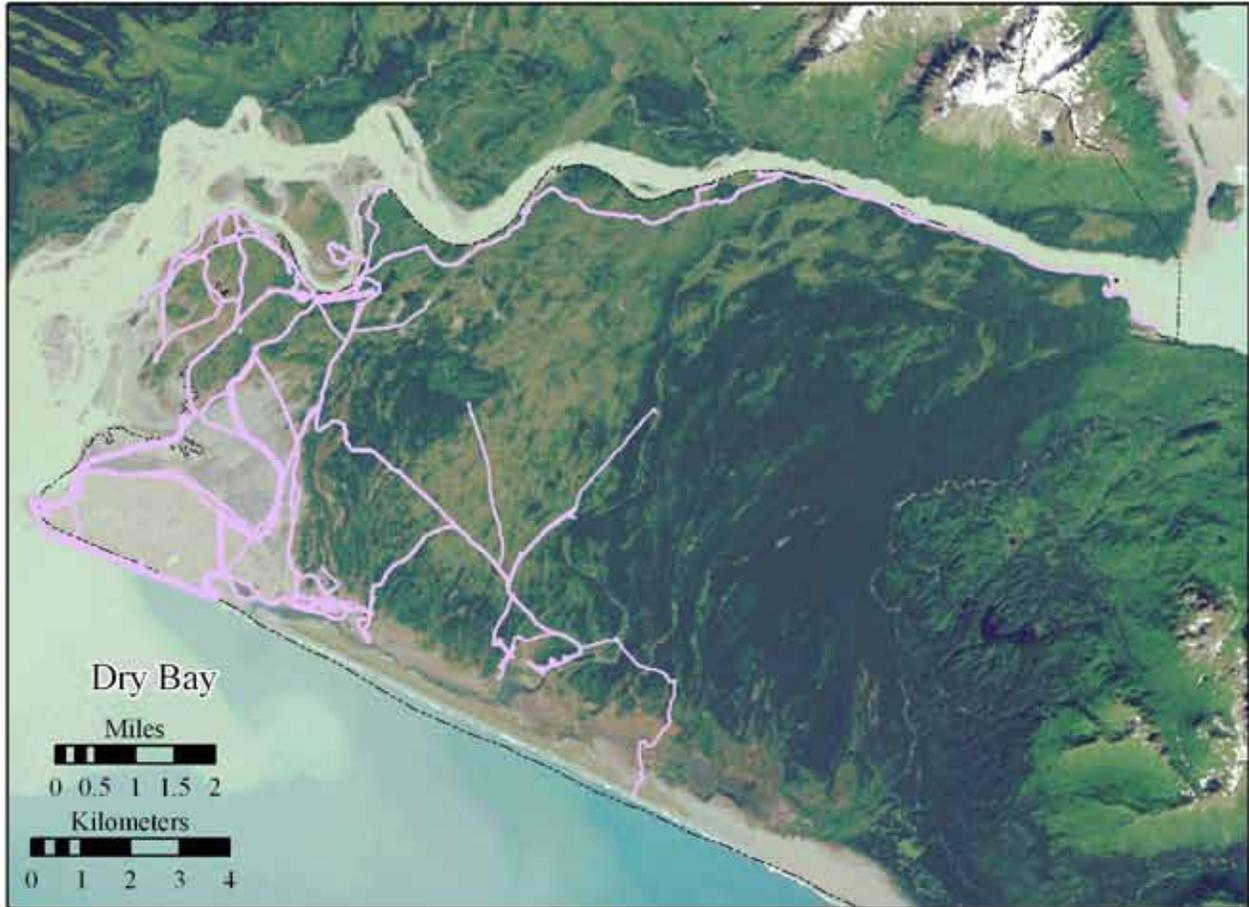
Alaska Region
Exotic Plant Management Team
Projection: UTM 8N, NAD 83
Created: September 2009



Oxeye Daisy - *Leucanthemum vulgare*



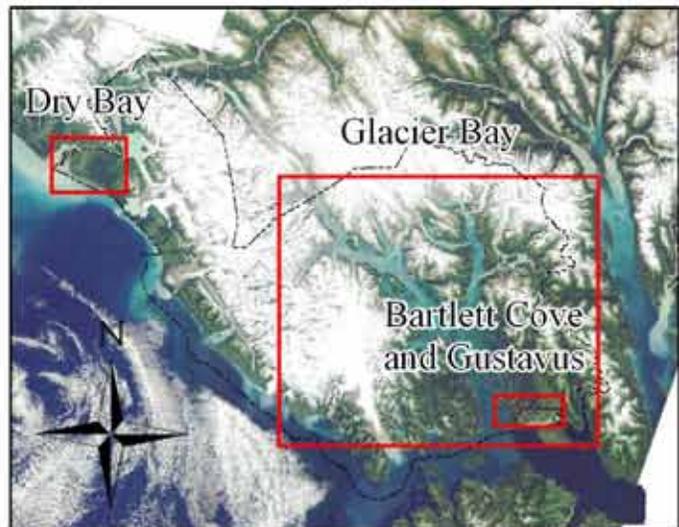
Yellow Toadflax - *Linaria vulgaris* in Glacier Bay National Park and Preserve



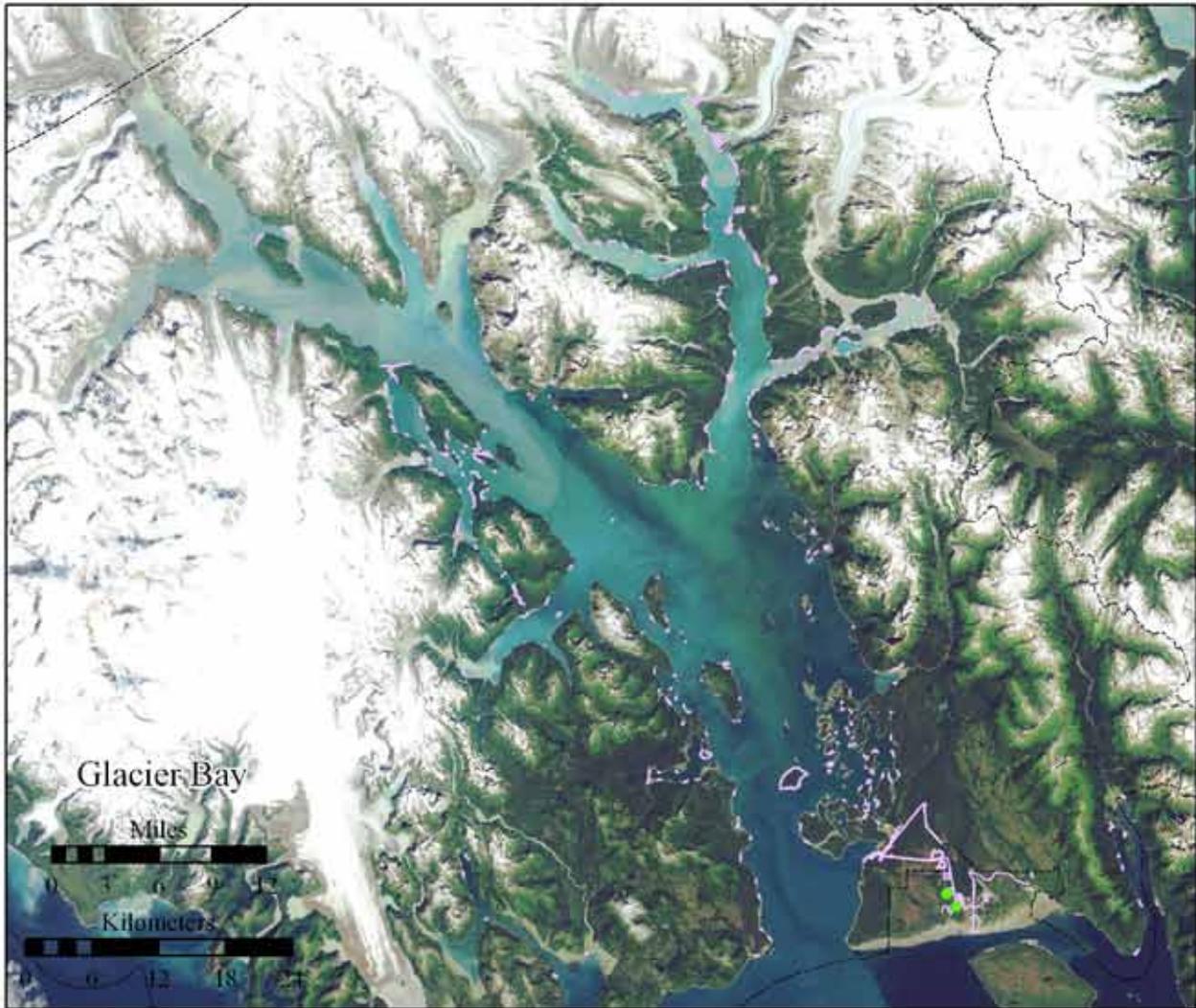
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- Present between 2004-2009
- Absent in 2004-2009 Surveys
- GLBA Boundary



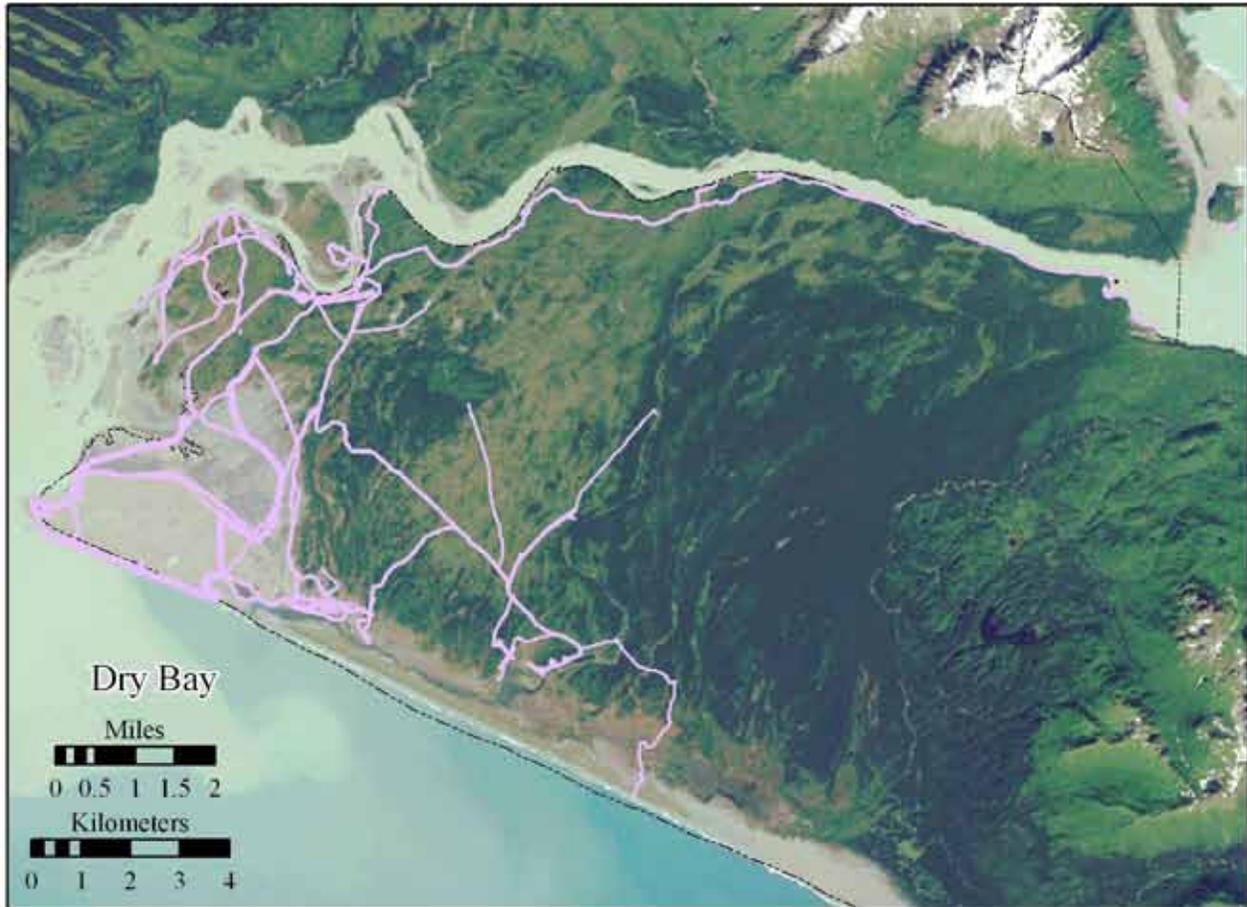
Alaska Region
Exotic Plant Management Team
Projection: UTM 8N, NAD 83
Created: September 2009



Yellow Toadflax - *Linaria vulgaris*



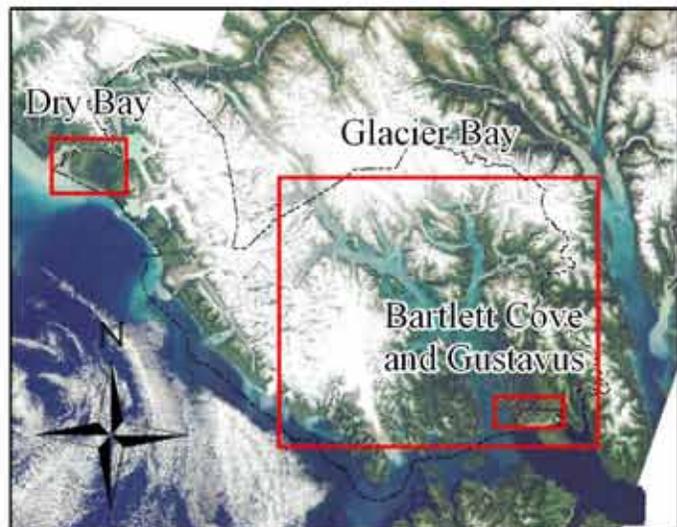
Perennial Ryegrass - *Lolium perenne* in Glacier Bay National Park and Preserve



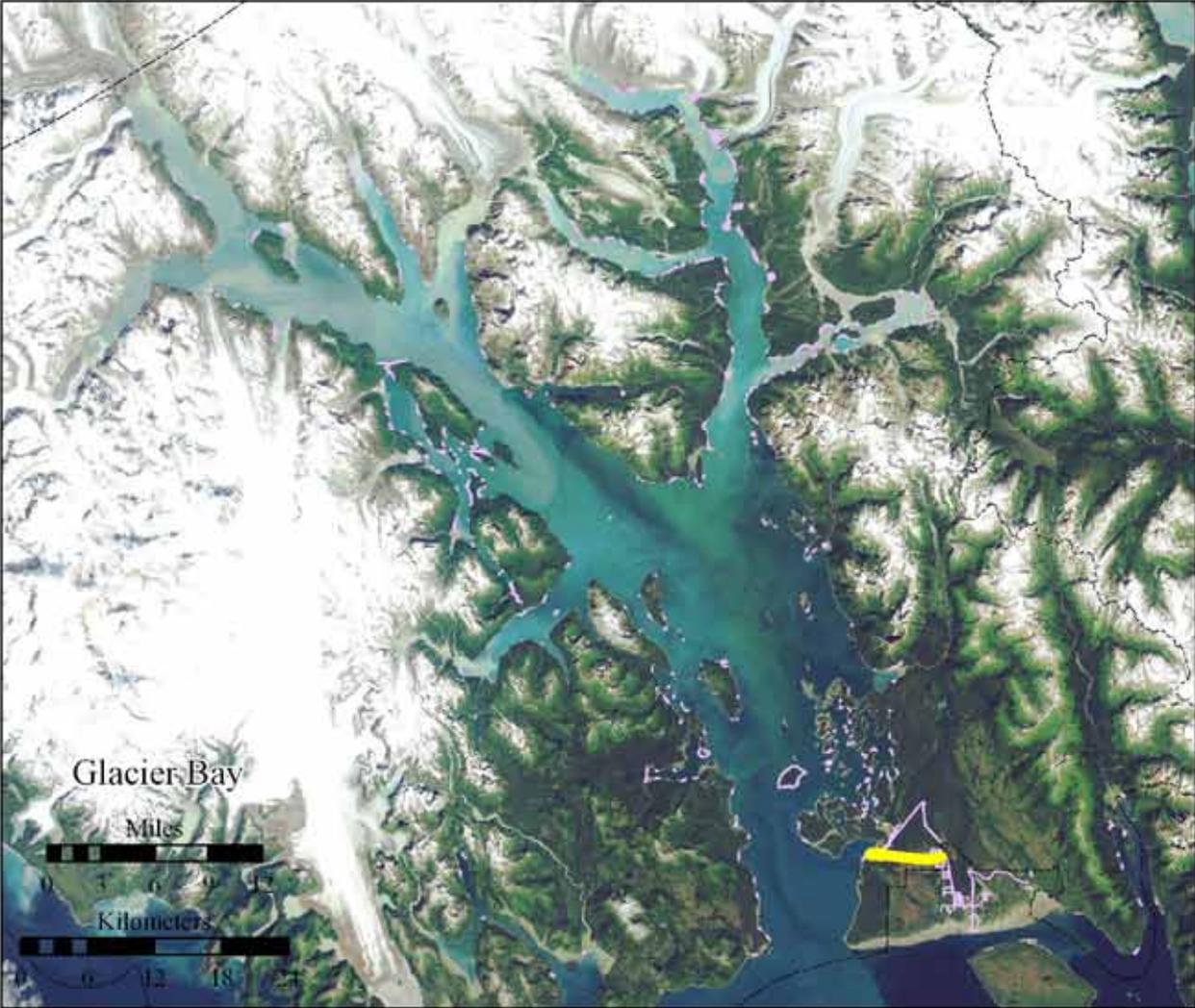
- Controlled by 2009
- Treated between 2004-2009
- Present between 2004-2009
- Absent in 2004-2009 Surveys
- GLBA Boundary



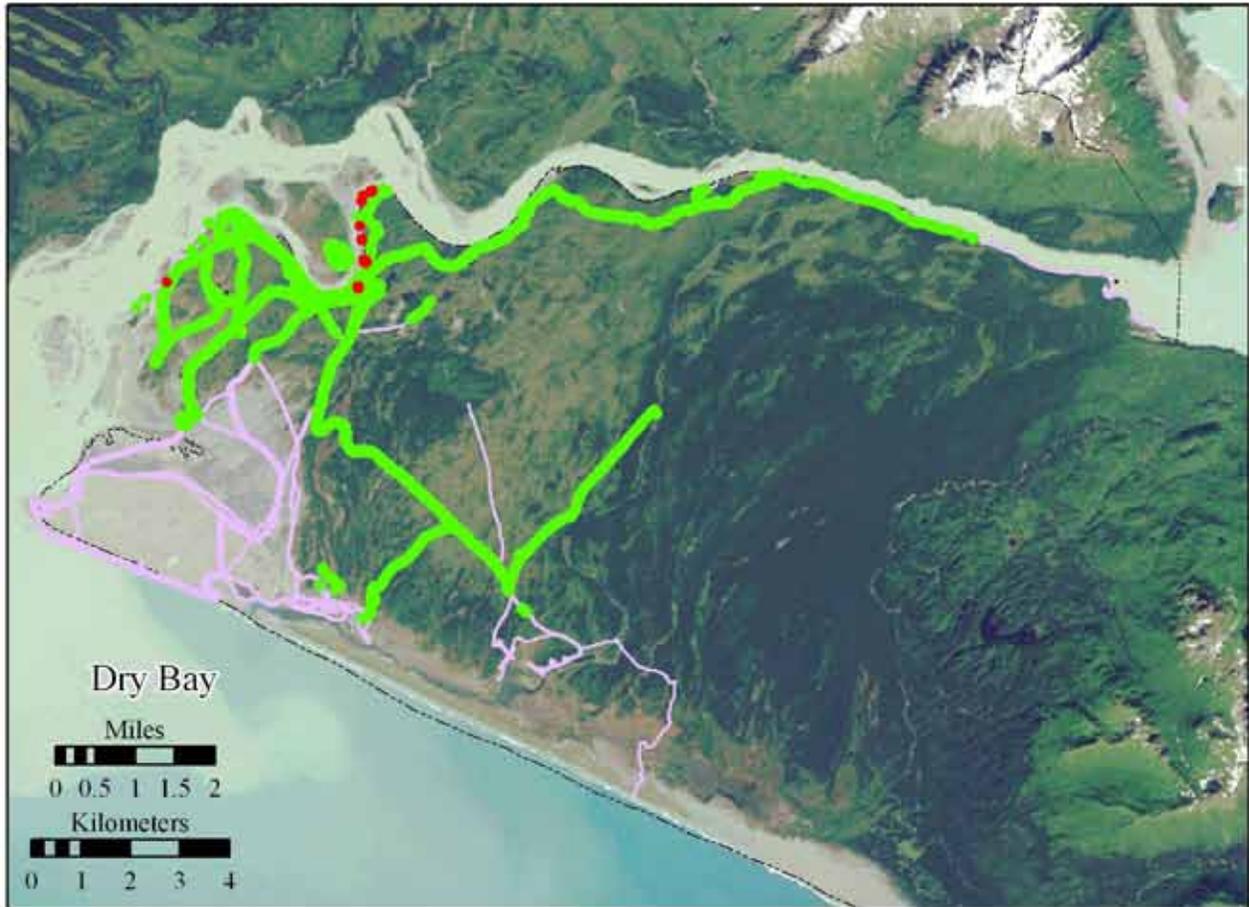
Alaska Region
Exotic Plant Management Team
Projection: UTM 8N, NAD 83
Created: September 2009



Perennial Ryegrass - *Lolium perenne*



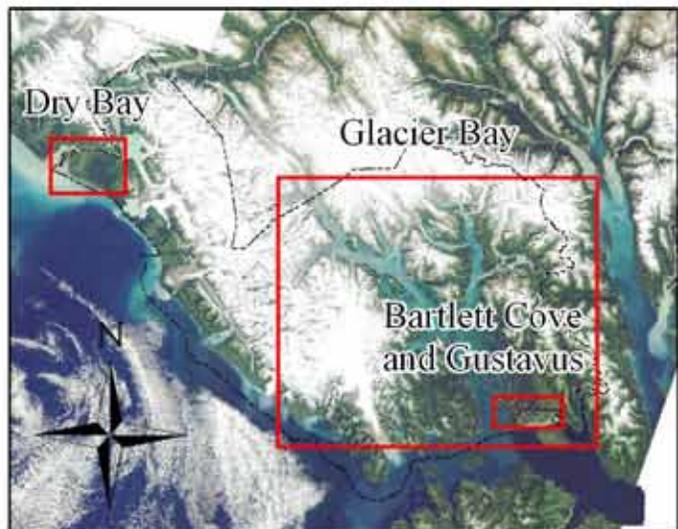
Bigleaf Lupine - *Lupinus polyphyllus* in Glacier Bay National Park and Preserve



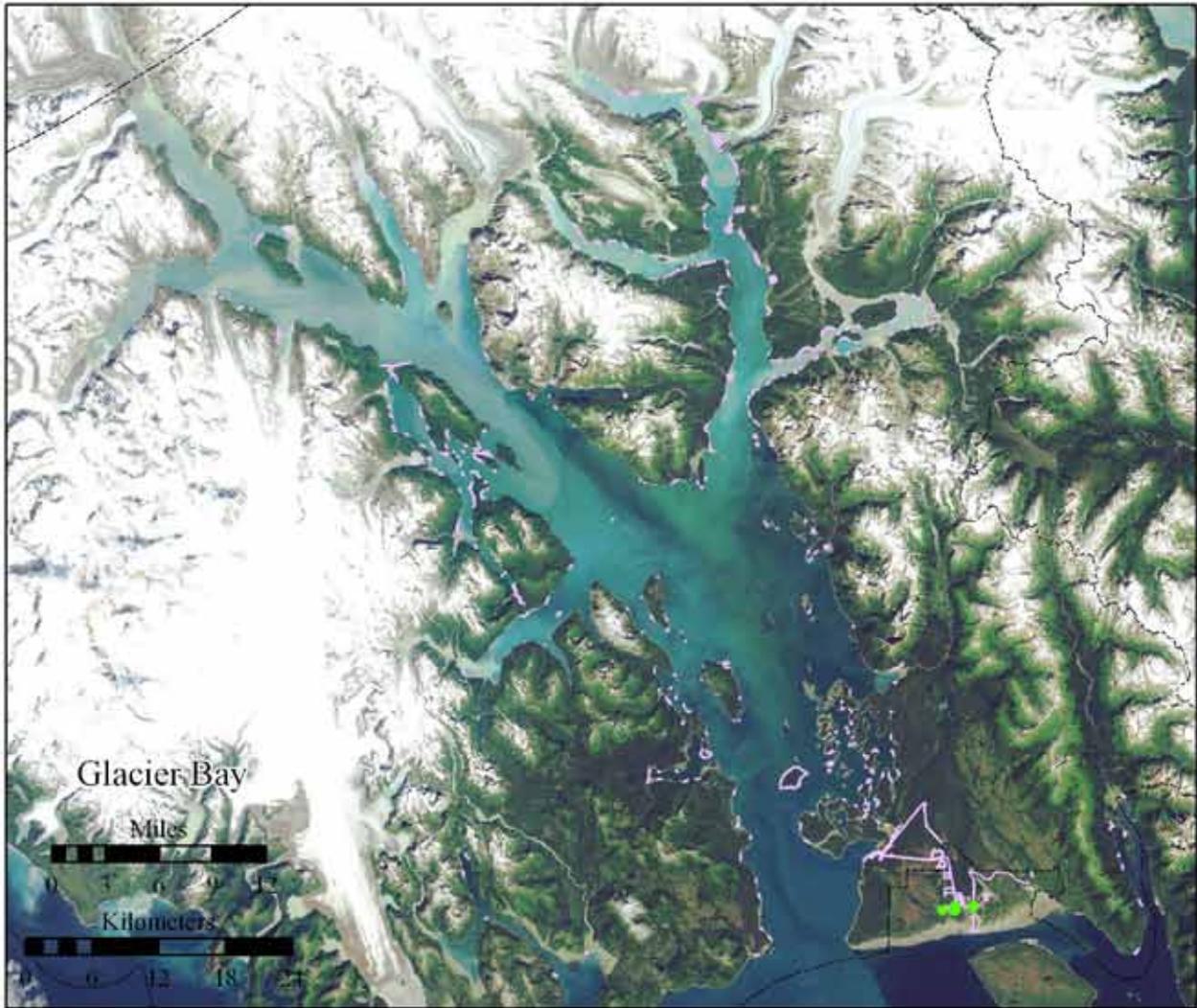
- Controlled by 2009
- Treated between 2004-2009
- Present between 2004-2009
- Absent in 2004-2009 Surveys
- GLBA Boundary



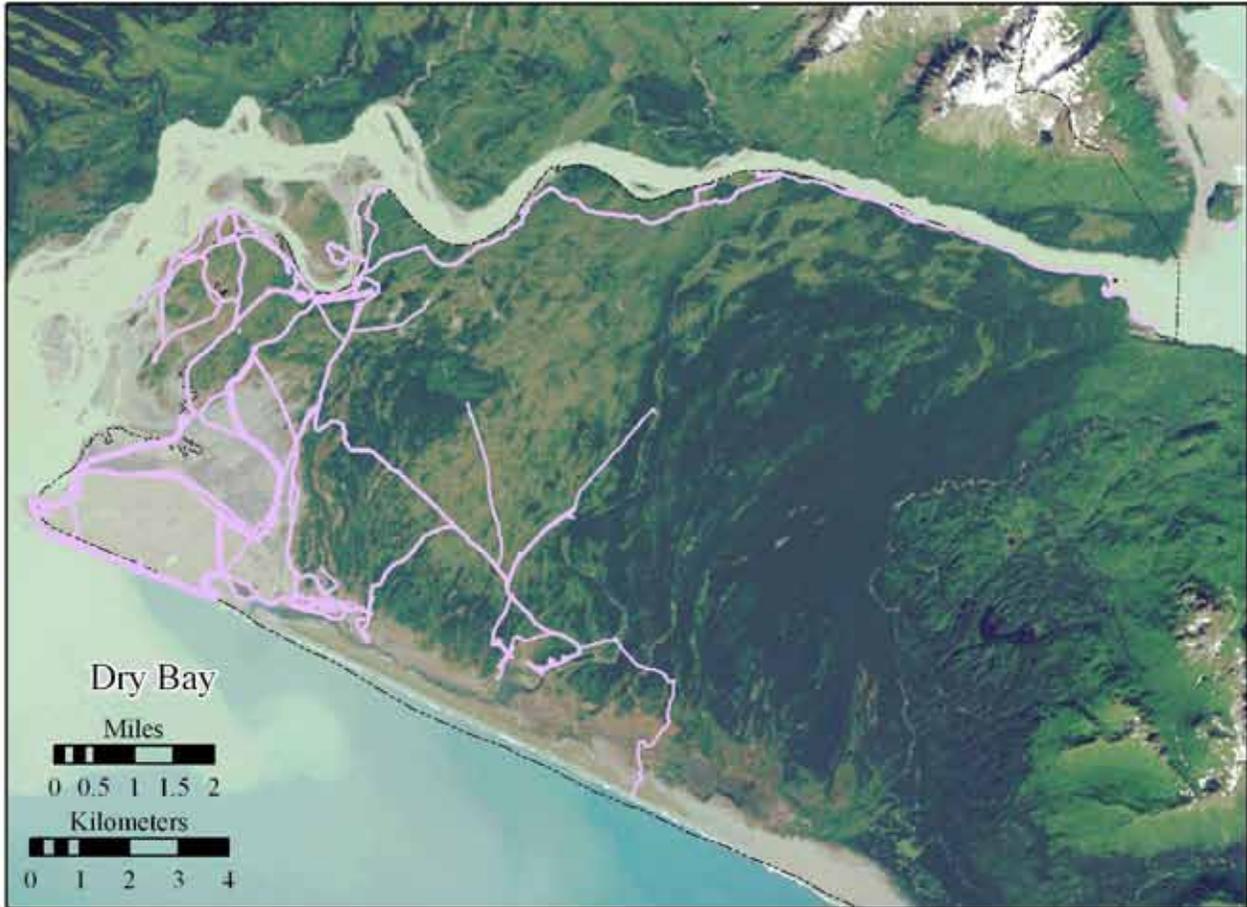
Alaska Region
Exotic Plant Management Team
Projection: UTM 8N, NAD 83
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Bigleaf Lupine - *Lupinus polyphyllus*



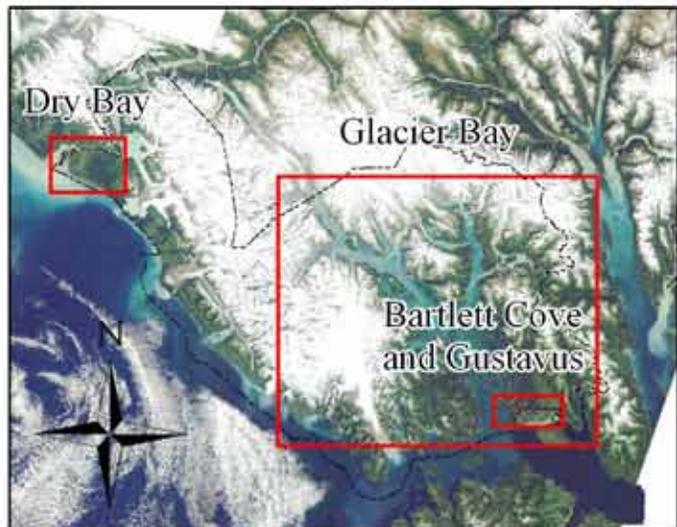
Maltesecross - *Lychnis chalconica* in Glacier Bay National Park and Preserve



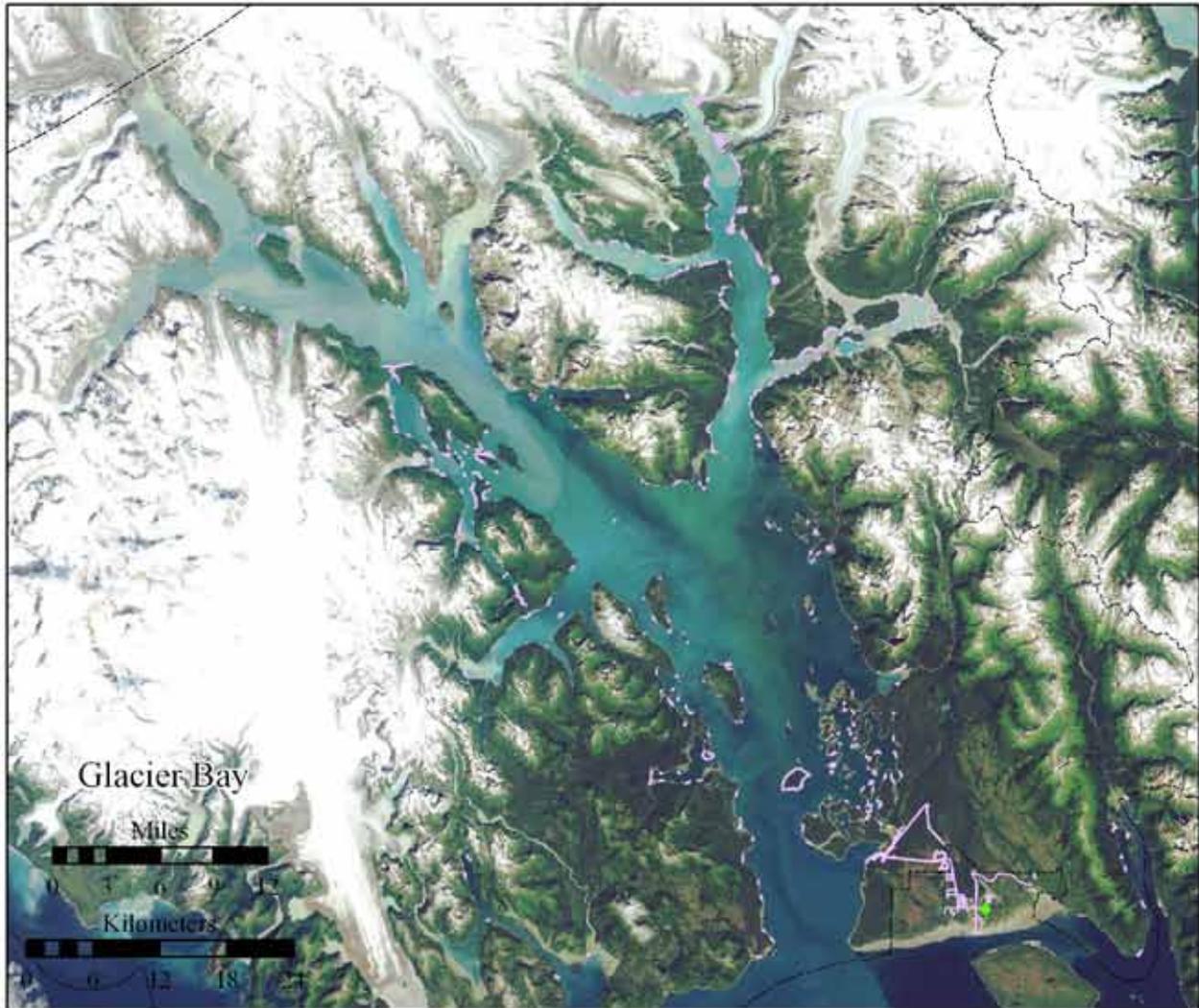
- Controlled by 2009
- Treated between 2004-2009
- Present between 2004-2009
- Absent in 2004-2009 Surveys
- GLBA Boundary



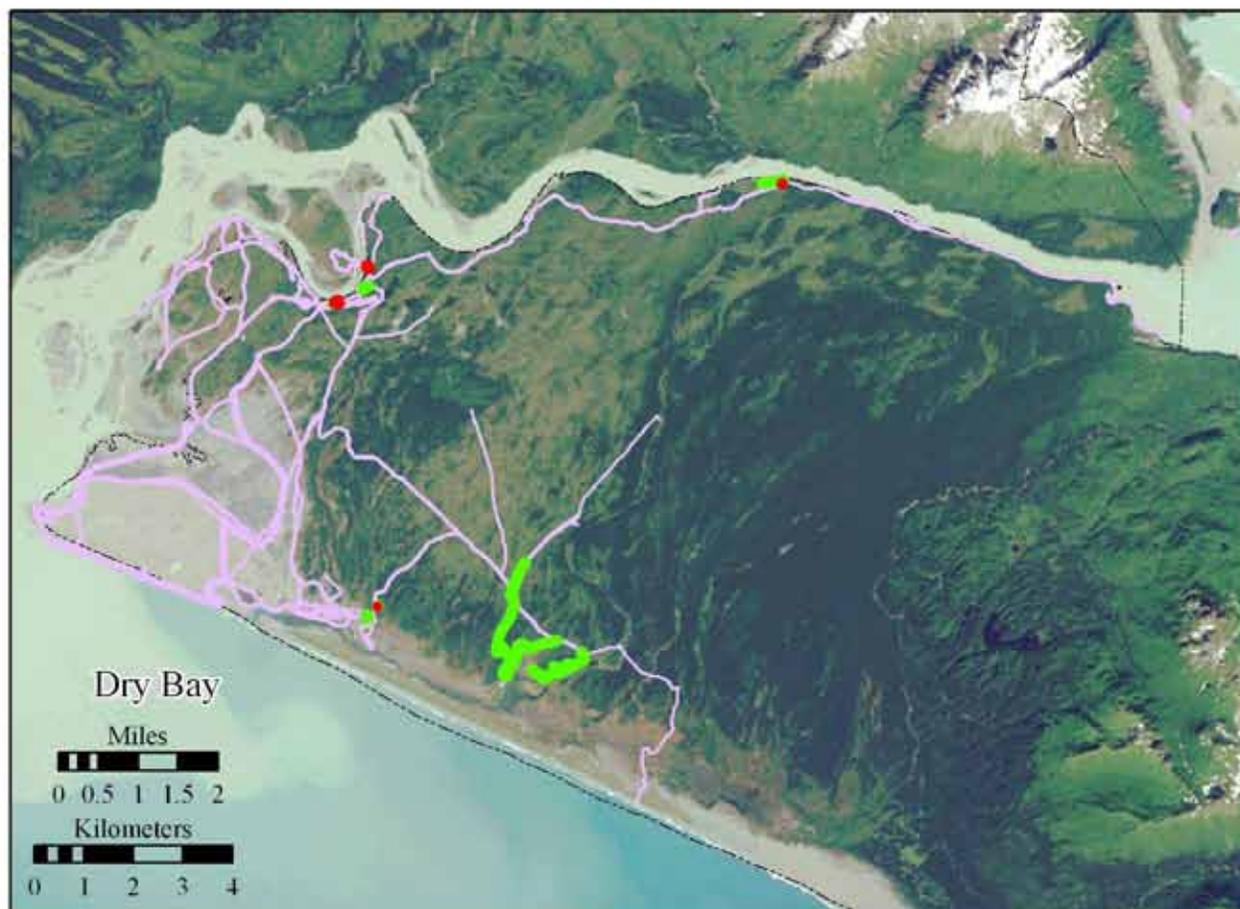
Alaska Region
Exotic Plant Management Team
Projection: UTM 8N, NAD 83
Created: September 2009



Maltesecross - *Lychnis chalcedonica*



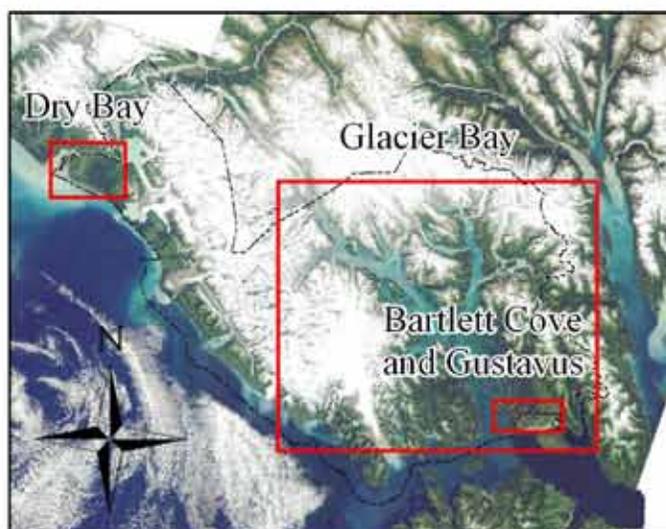
Pineapple Weed - *Matricaria discoidea* in Glacier Bay National Park and Preserve



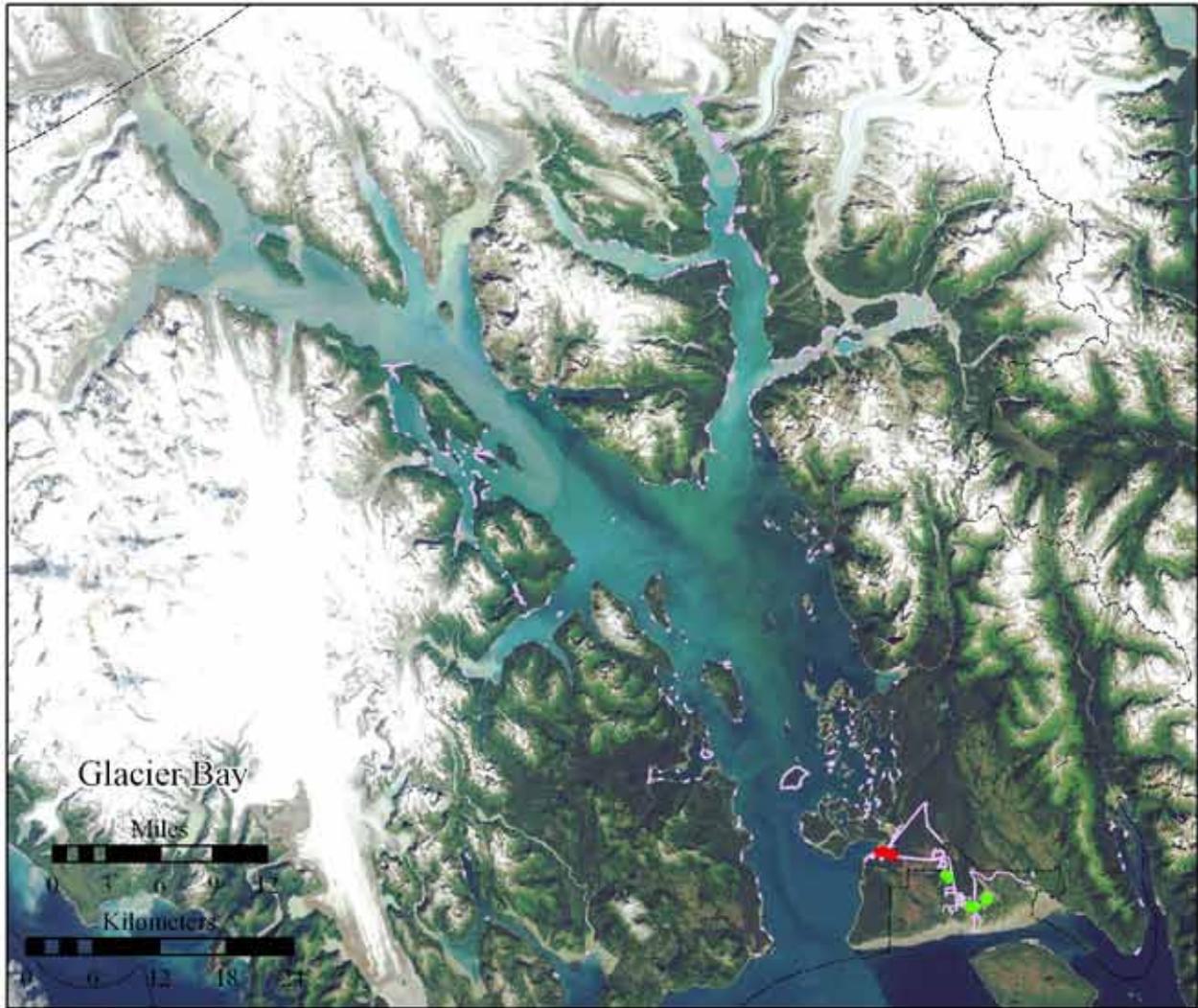
- Controlled by 2009
- Treated between 2004-2009
- Present between 2004-2009
- Absent in 2004-2009 Surveys
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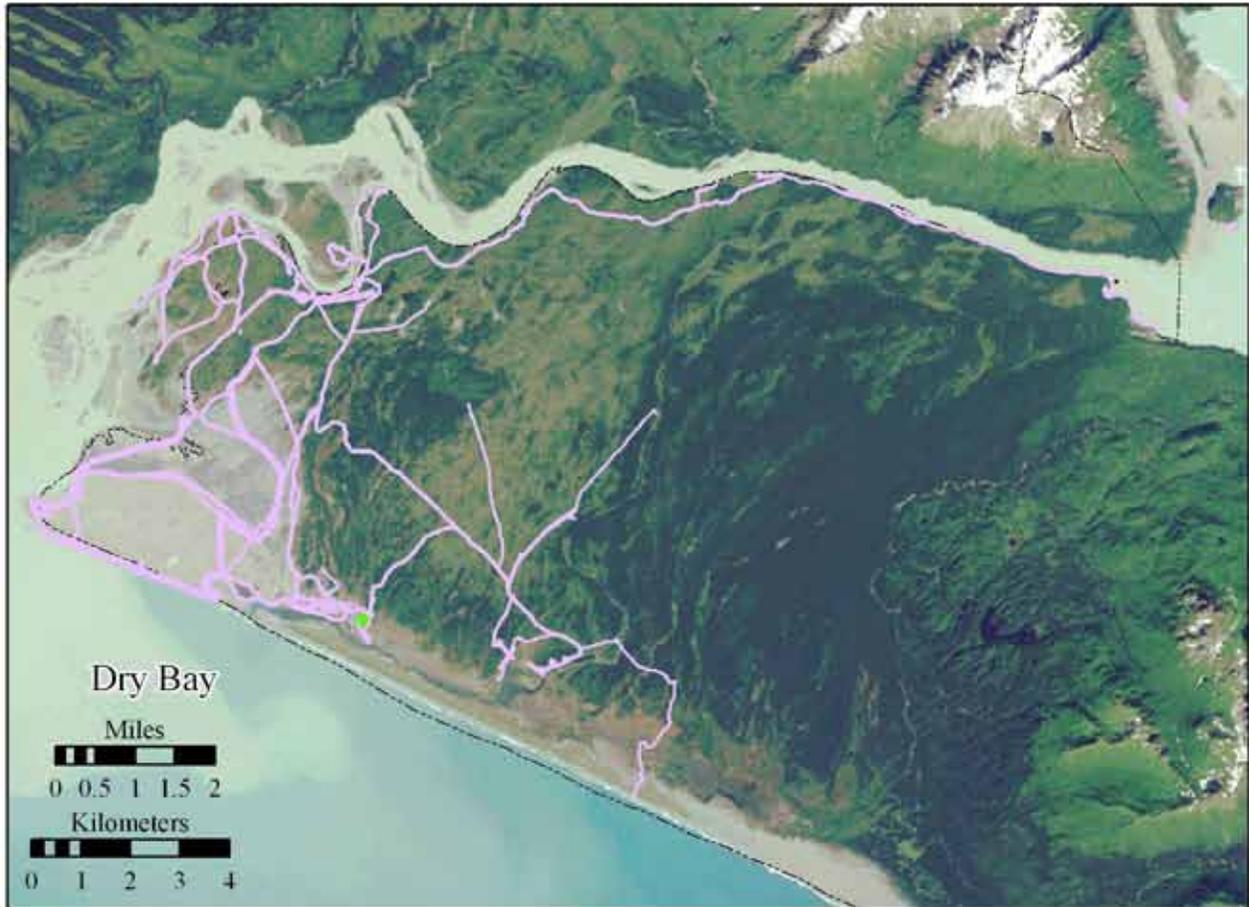
Alaska Region
Exotic Plant Management Team
Projection: UTM 8N, NAD 83
Created: September 2009



Pineapple Weed - *Matricaria discoidea*



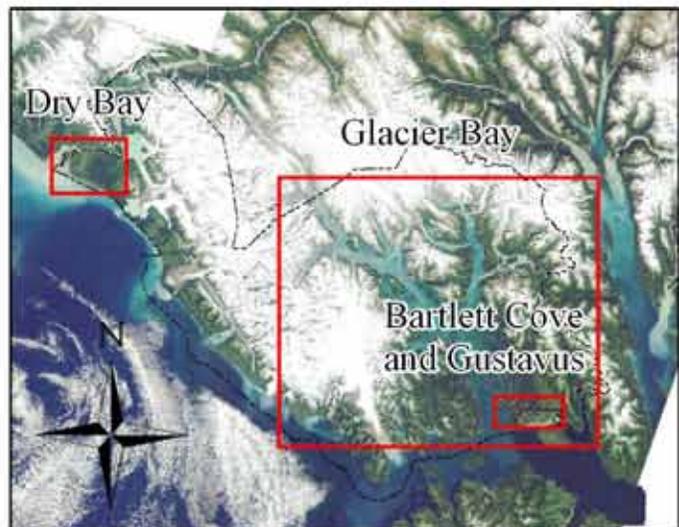
Mint - *Mentha* in Glacier Bay National Park and Preserve



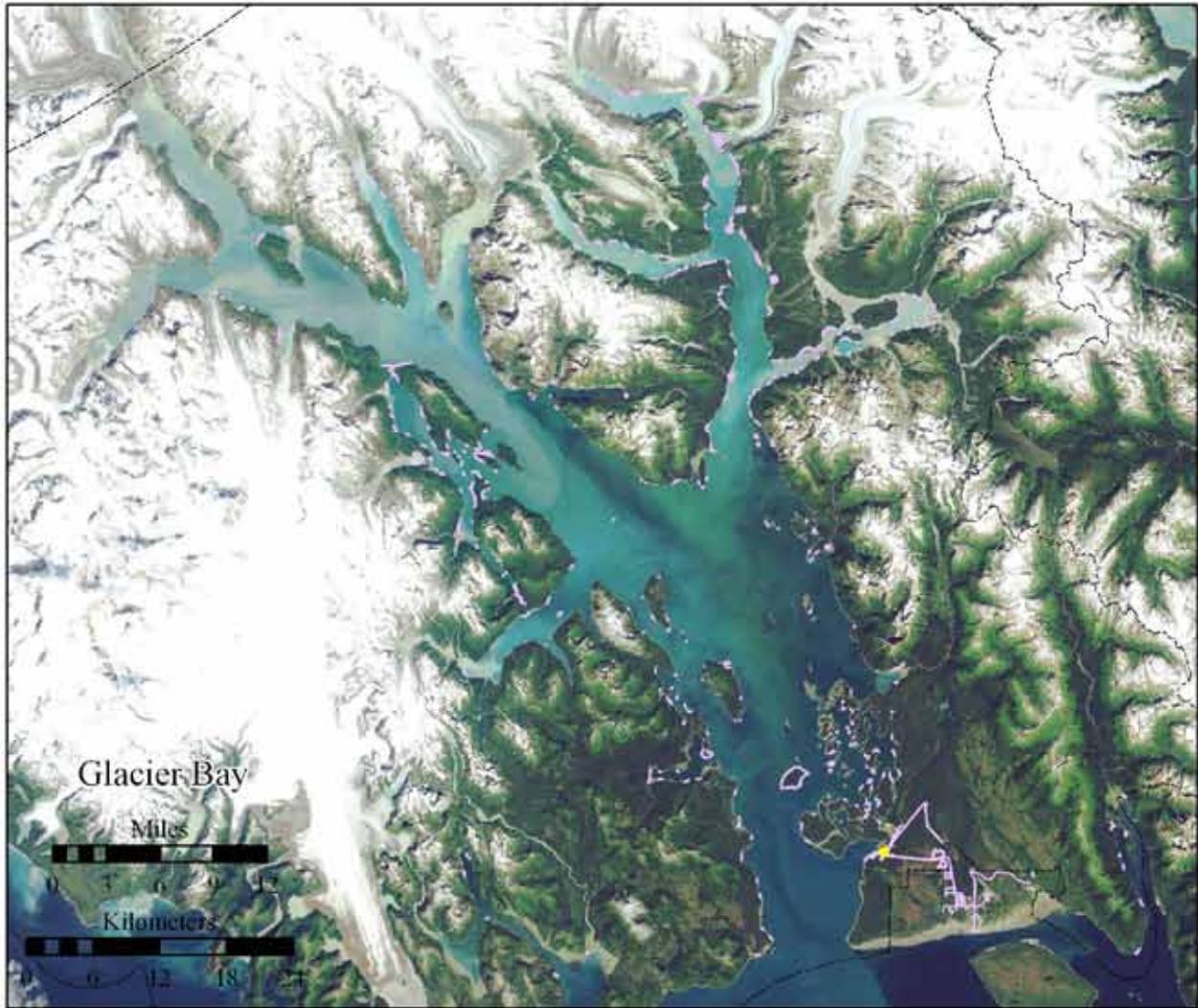
- Controlled by 2009
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- Present between 2004-2009
- Absent in 2004-2009 Surveys
- GLBA Boundary



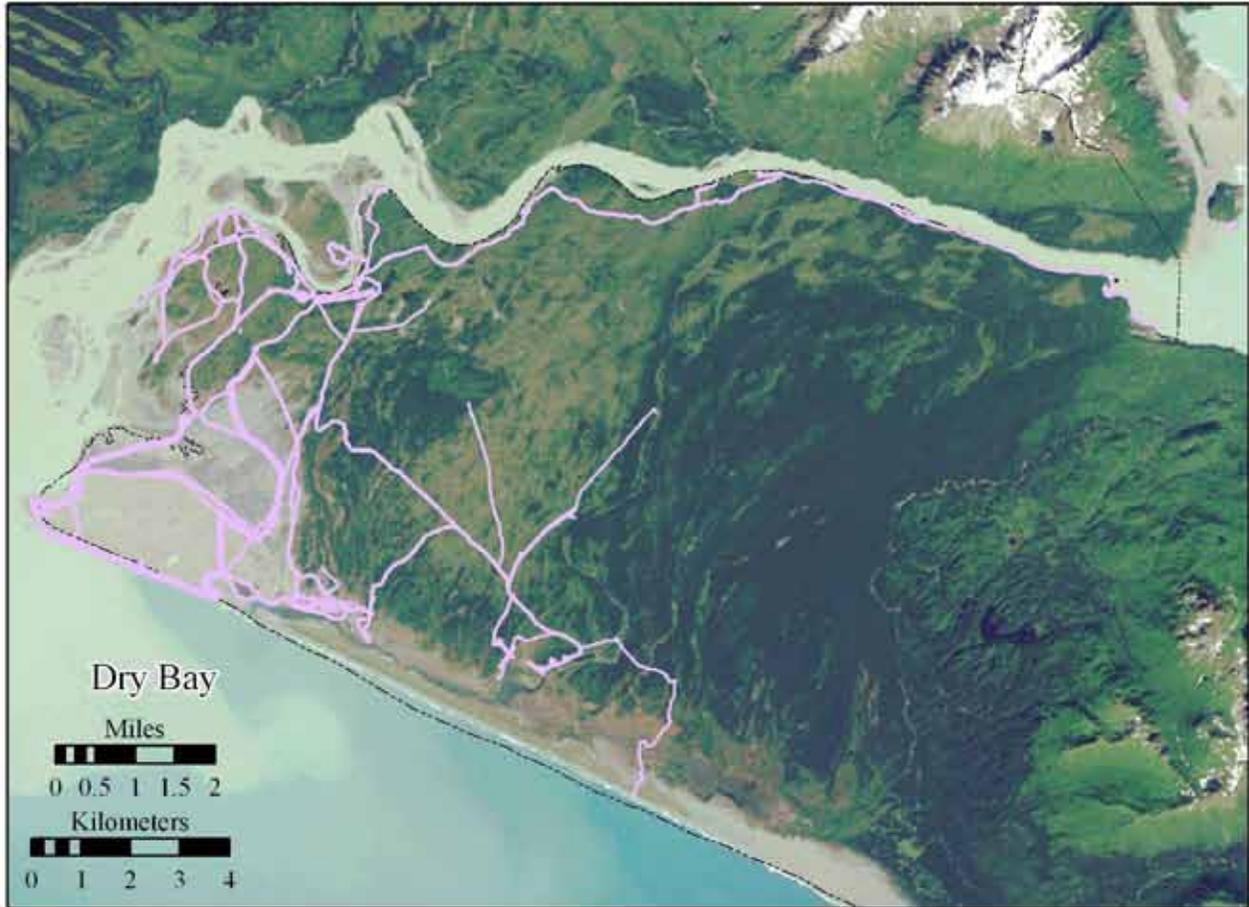
Alaska Region
Exotic Plant Management Team
Projection: UTM 8N, NAD 83
Created: September 2009



Mint - *Mentha*



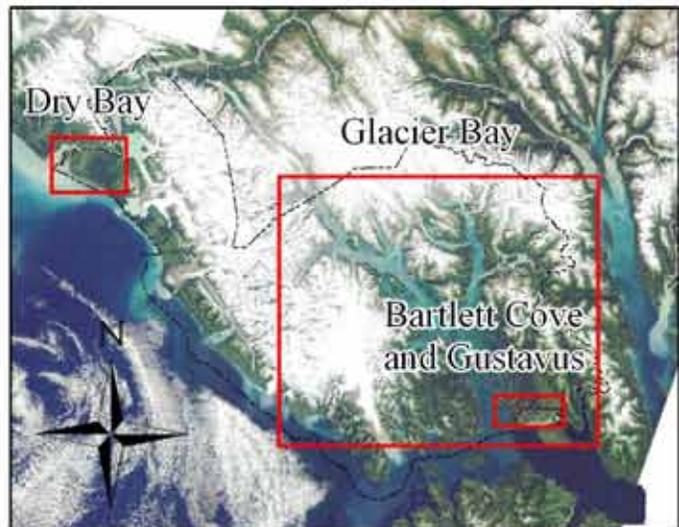
Alpine or True Forget-Me-Not - *Myosotis* spp. in Glacier Bay National Park and Preserve



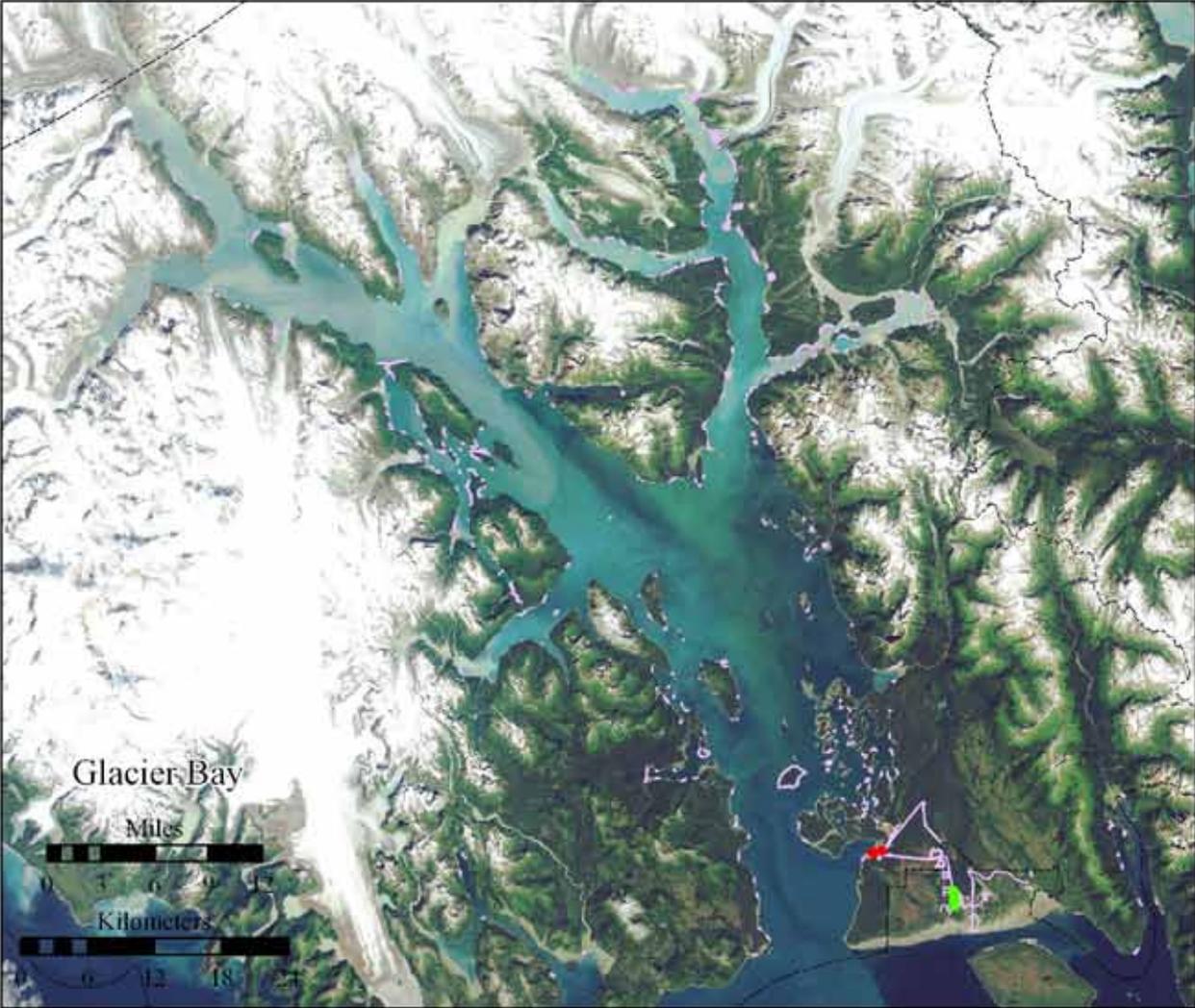
- Controlled by 2009
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- Absent in 2004-2009 Surveys
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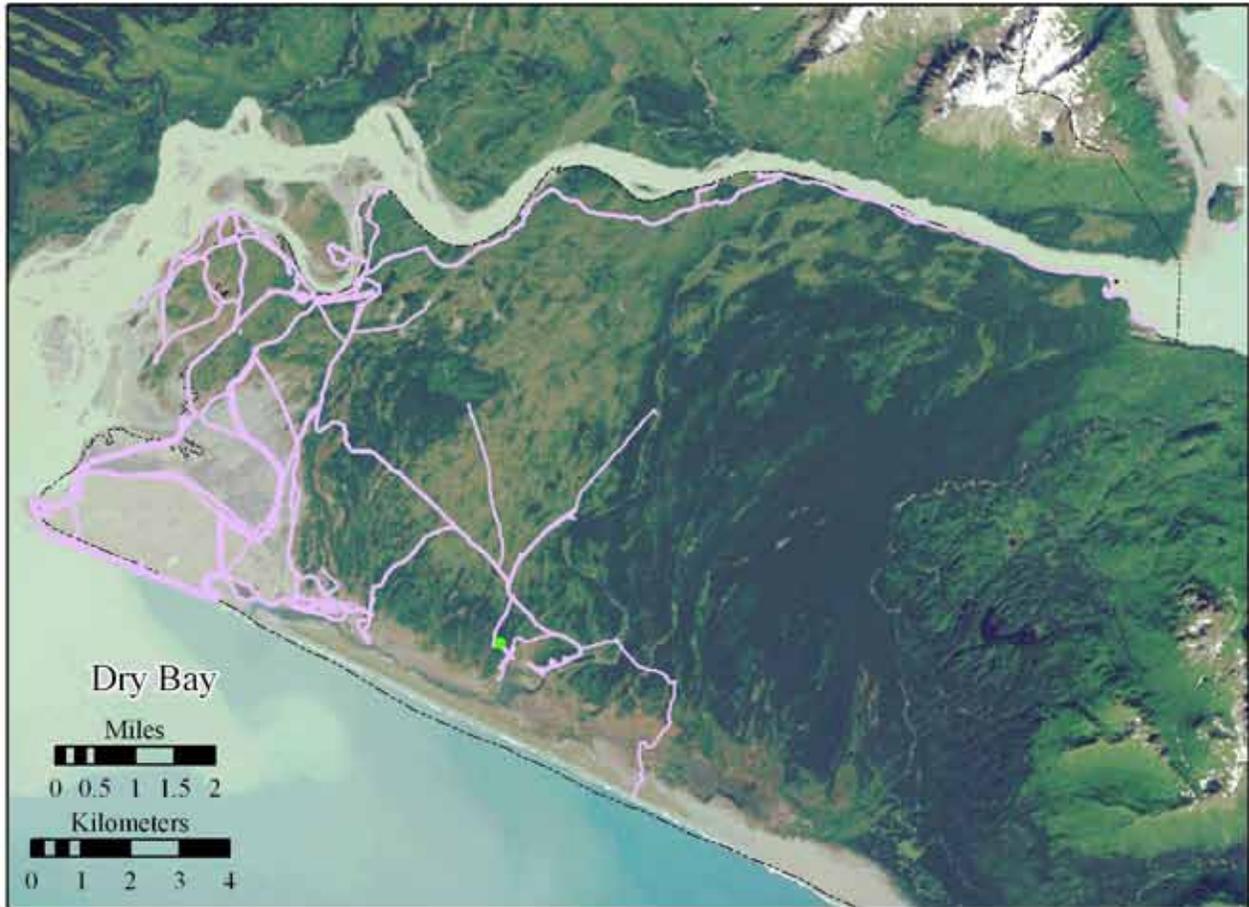
Alaska Region
Exotic Plant Management Team
Projection: UTM 8N, NAD 83
Created: September 2009



Alpine or True Forget-Me-Not - *Myosotis* spp.



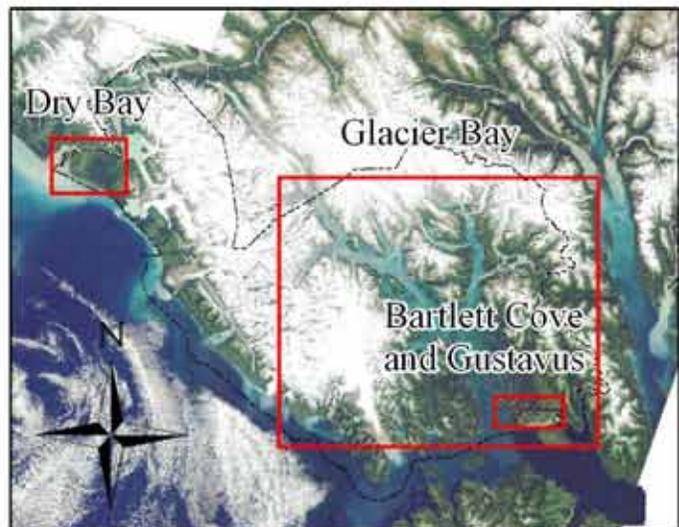
Reed Canarygrass - *Phalaris arundinacea* in Glacier Bay National Park and Preserve



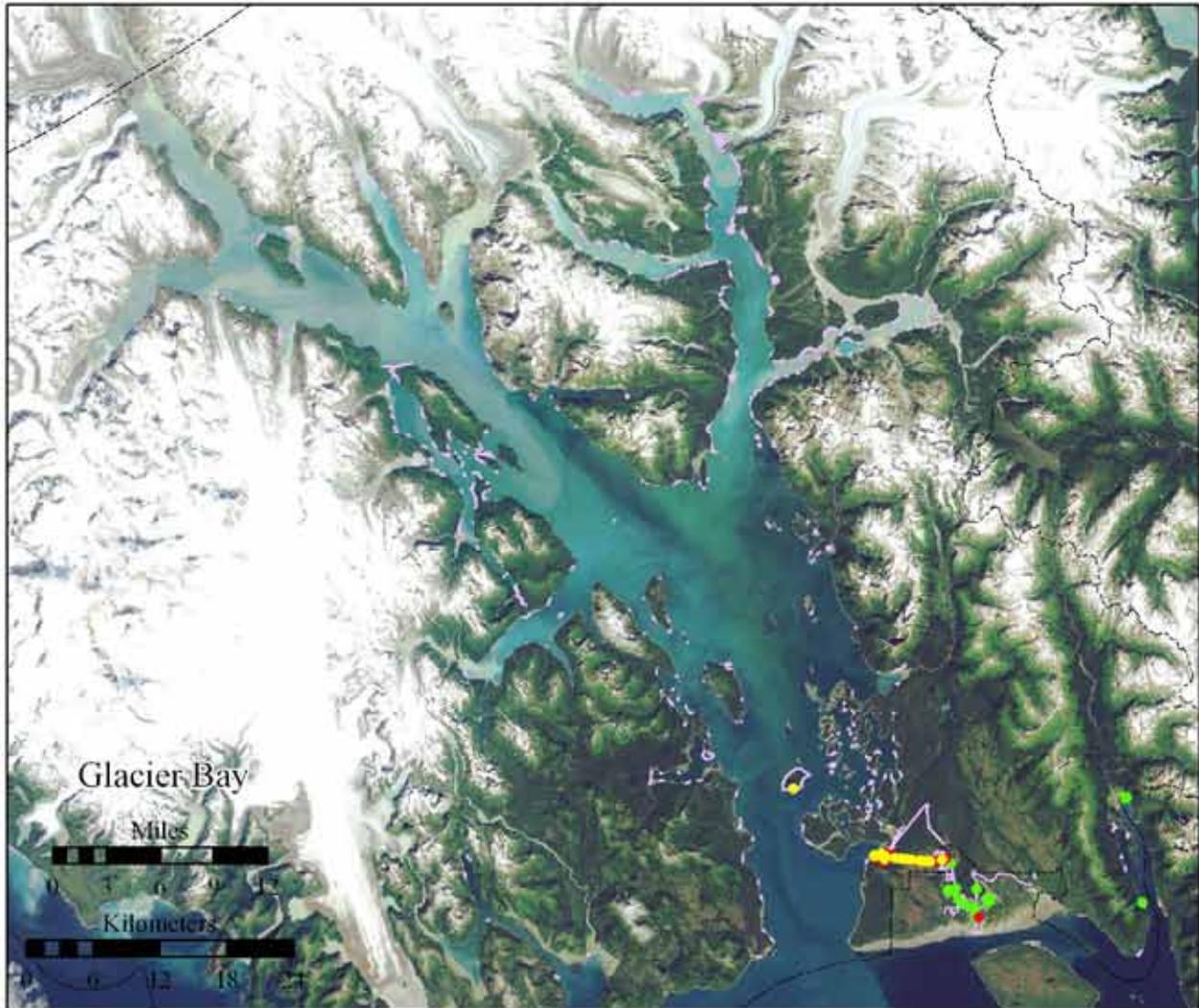
- Controlled by 2009
- Treated between 2004-2009
- Present between 2004-2009
- Absent in 2004-2009 Surveys
- GLBA Boundary



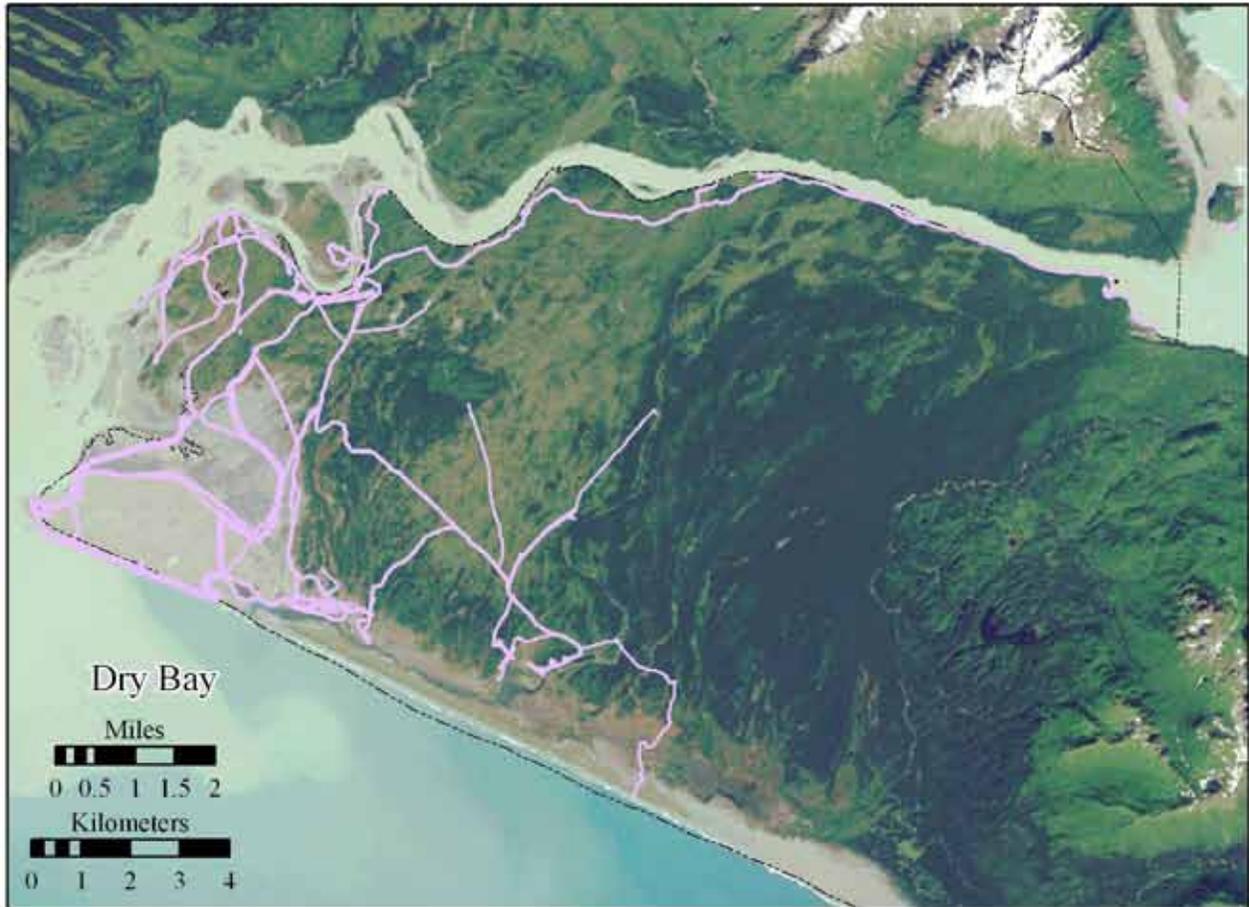
Alaska Region
Exotic Plant Management Team
Projection: UTM 8N, NAD 83
Created: September 2009



Reed Canarygrass - *Phalaris arundinacea*



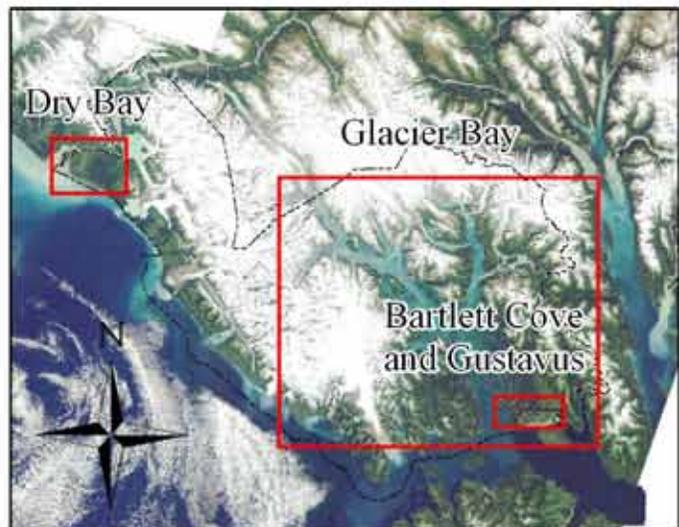
Common Timothy - *Phleum pratense* in Glacier Bay National Park and Preserve



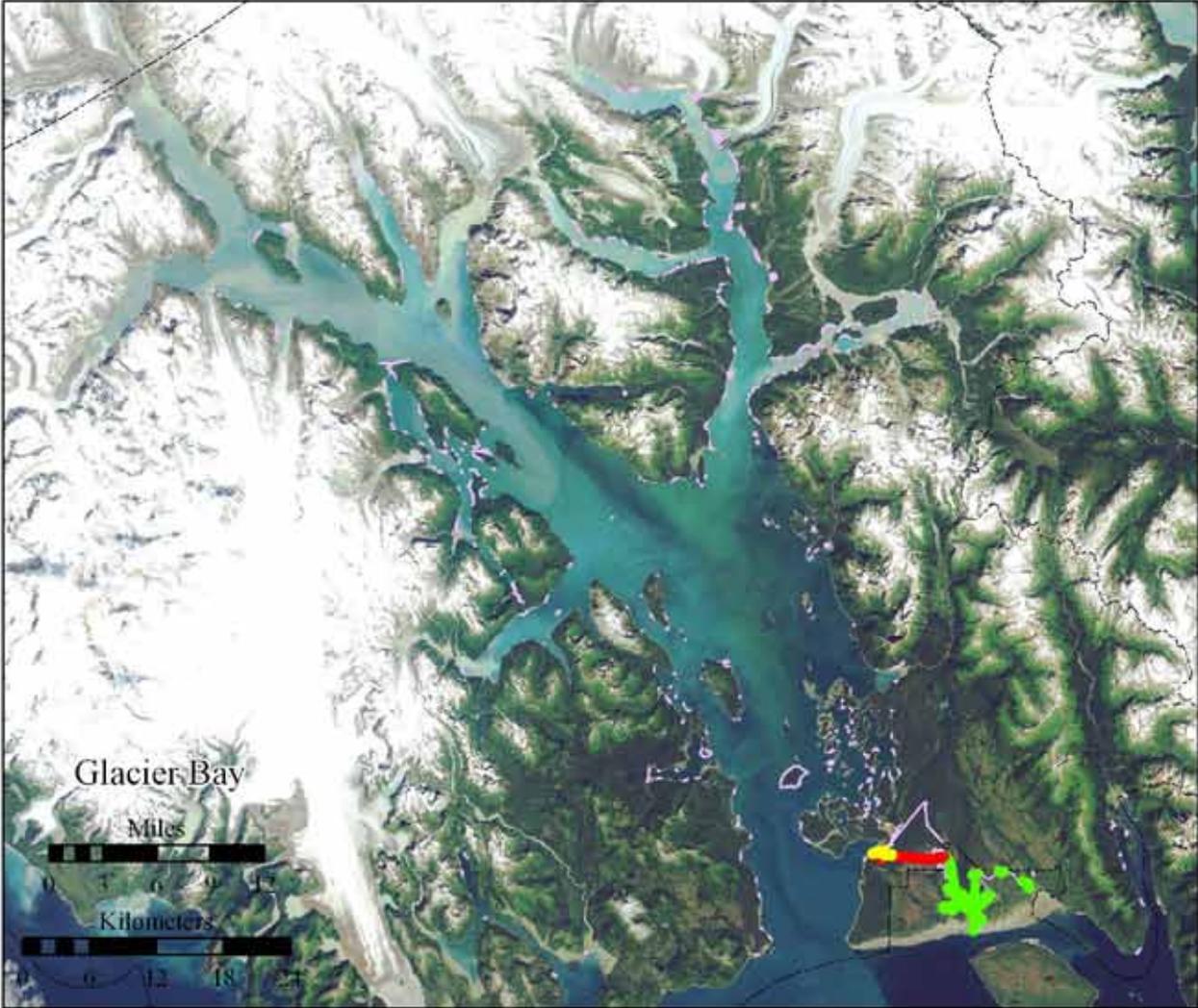
- Controlled by 2009
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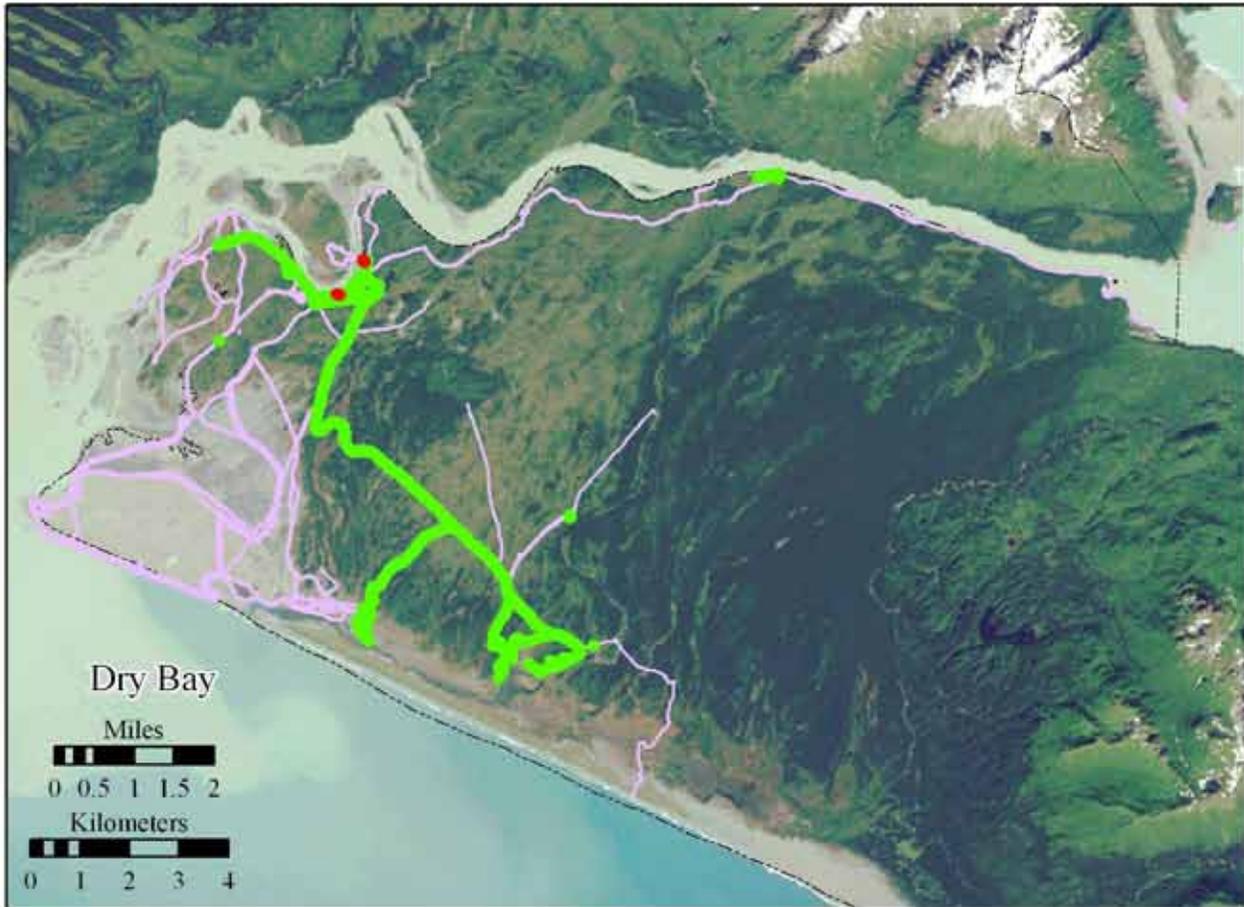
Alaska Region
Exotic Plant Management Team
Projection: UTM 8N, NAD 83
Created: September 2009



Common Timothy - *Phleum pratense*



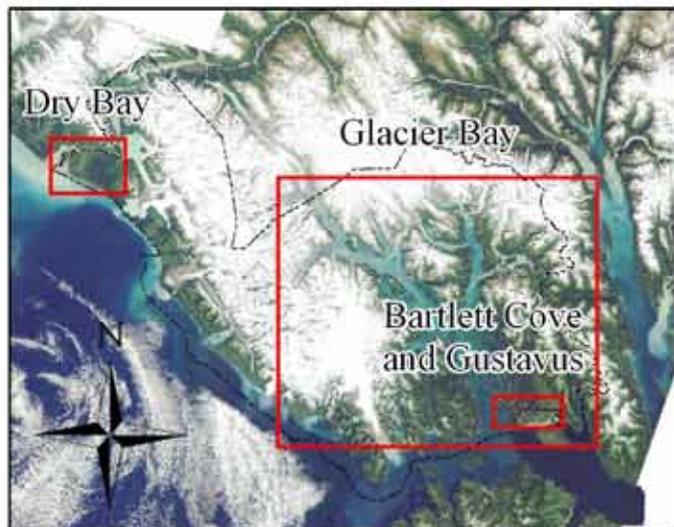
Common Plantain - *Plantago major* in Glacier Bay National Park and Preserve



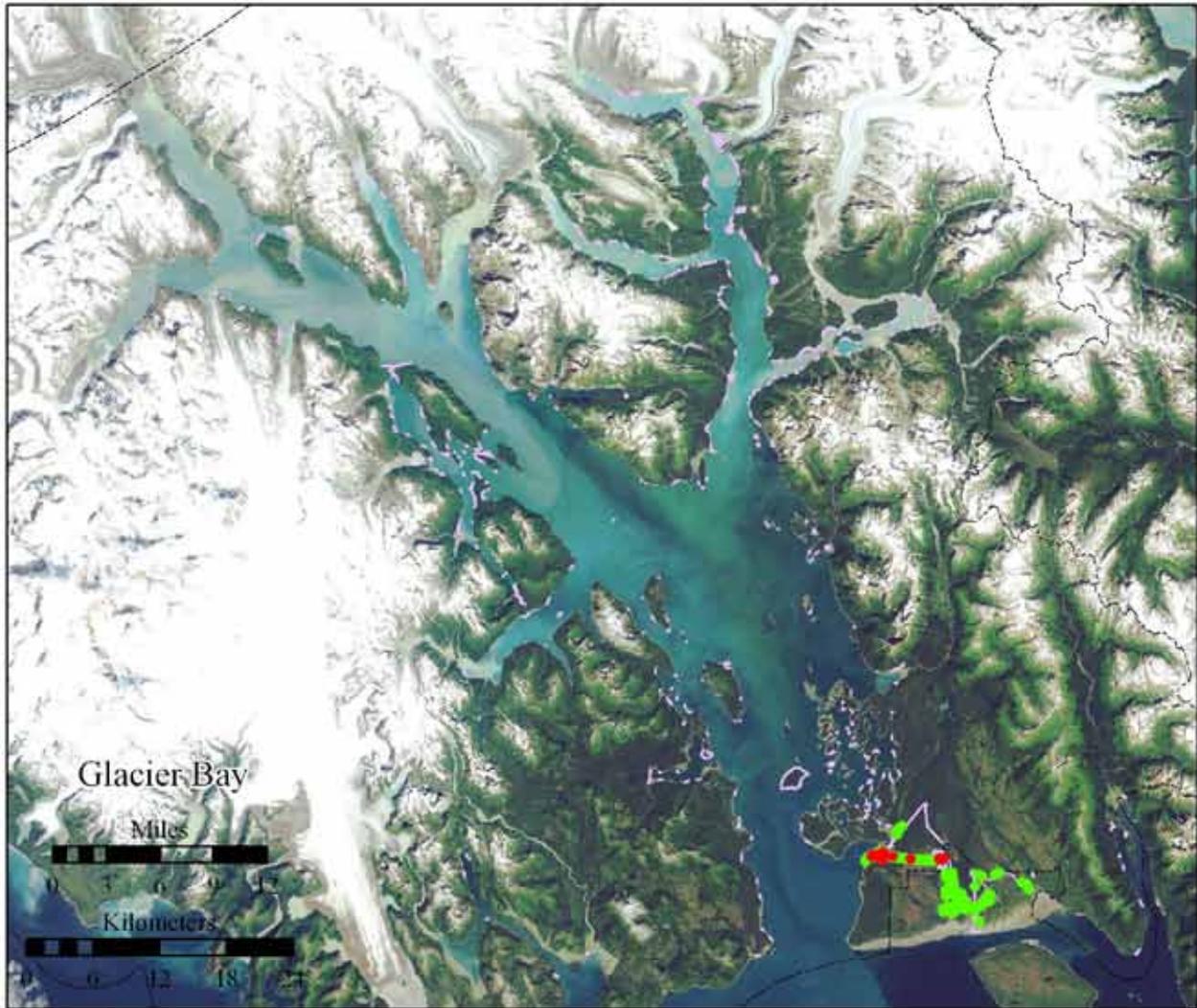
- Controlled by 2009
- Treated between 2004-2009
- Present between 2004-2009
- Absent in 2004-2009 Surveys
- GLBA Boundary



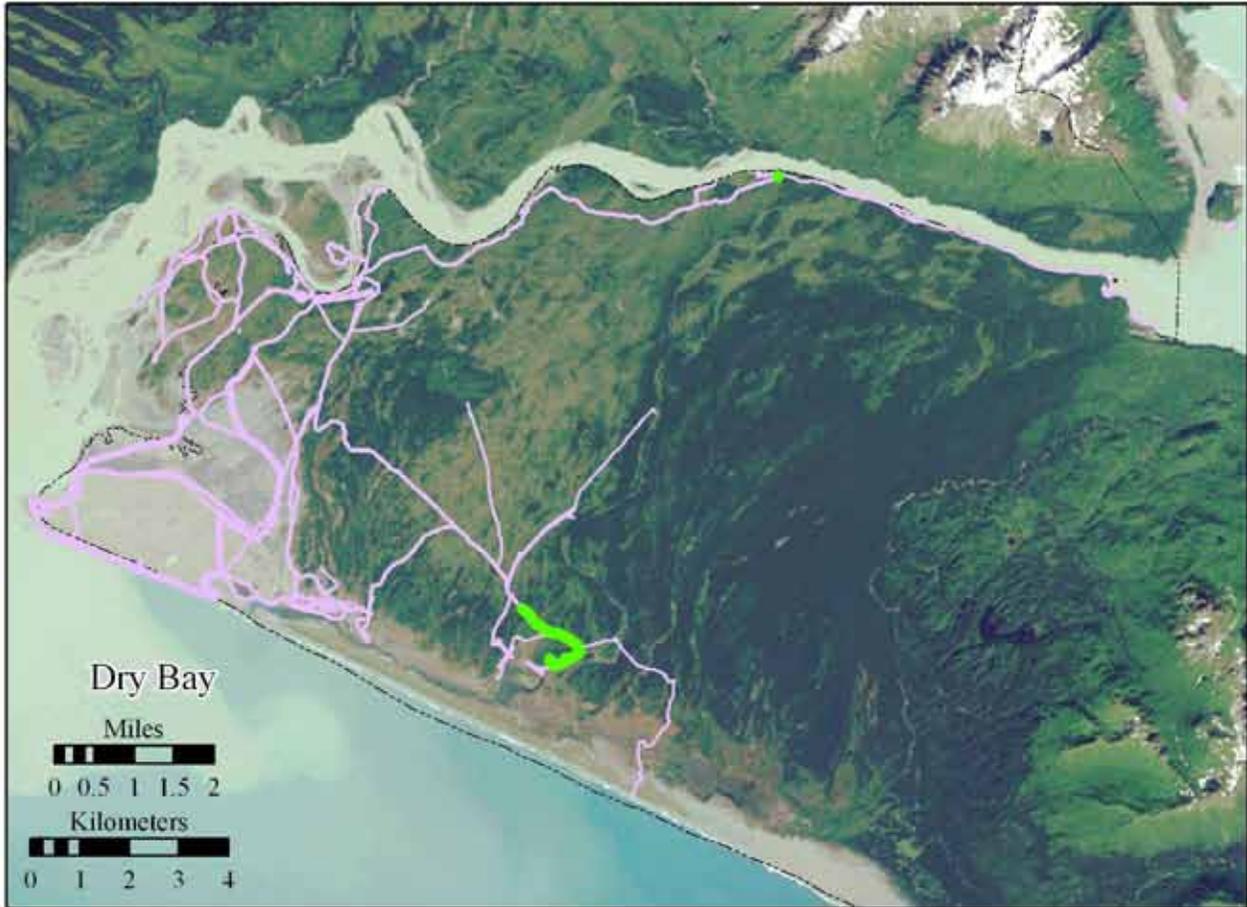
Alaska Region
Exotic Plant Management Team
Projection: UTM 8N, NAD 83
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Common Plantain - *Plantago major*



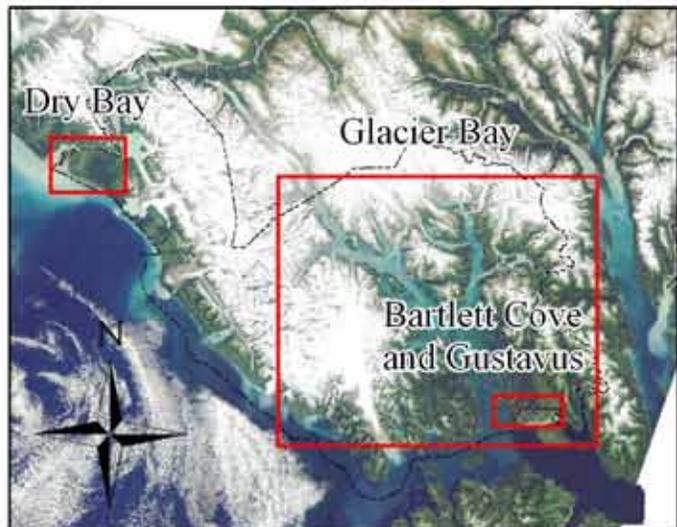
Bluegrass - *Poa* spp. in Glacier Bay National Park and Preserve



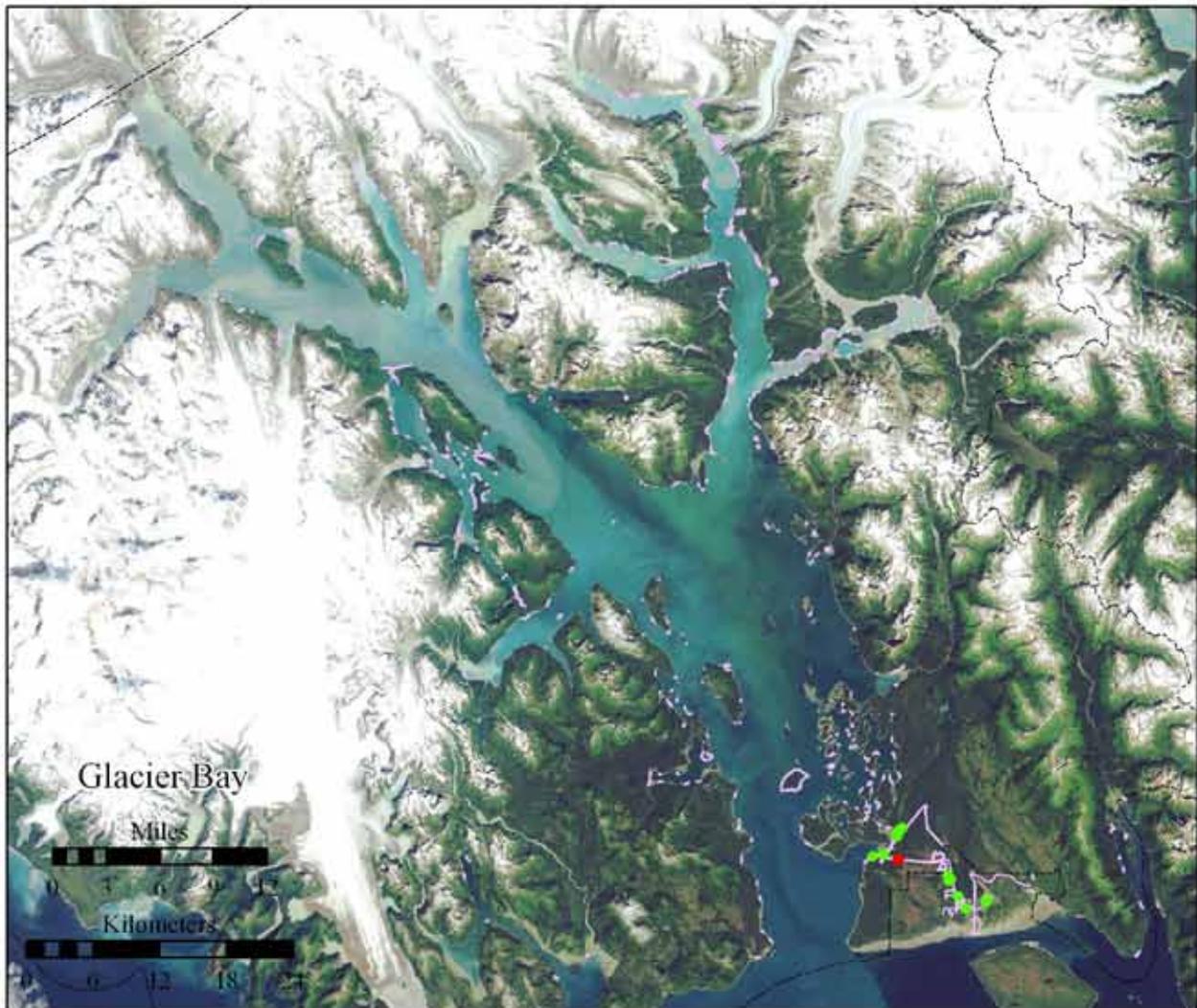
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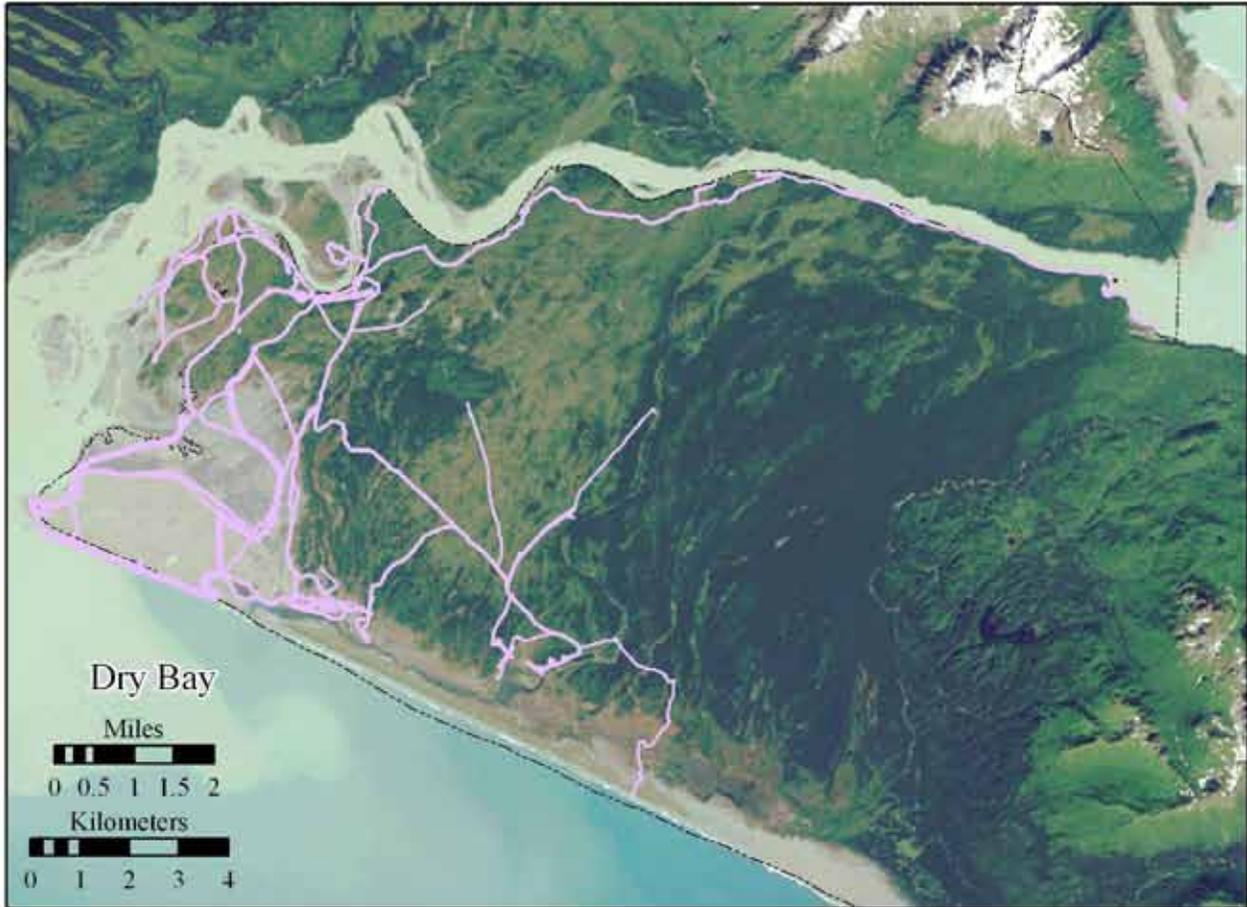
Alaska Region
Exotic Plant Management Team
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Bluegrass - *Poa* spp.



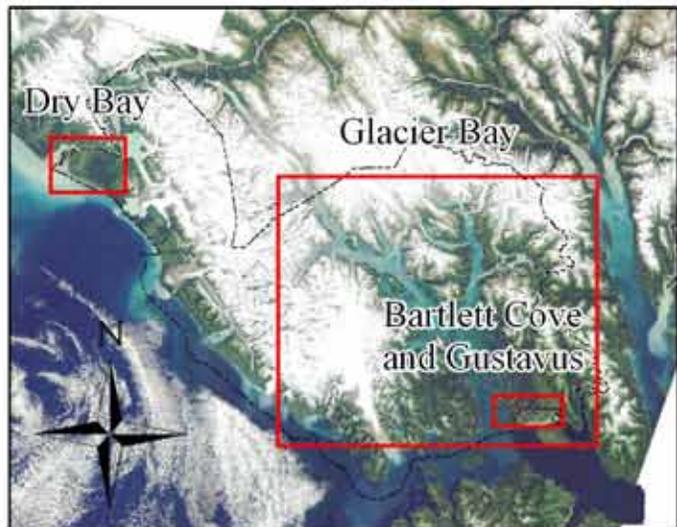
Prostrate Knotweed - *Polygonum aviculare* in Glacier Bay National Park and Preserve



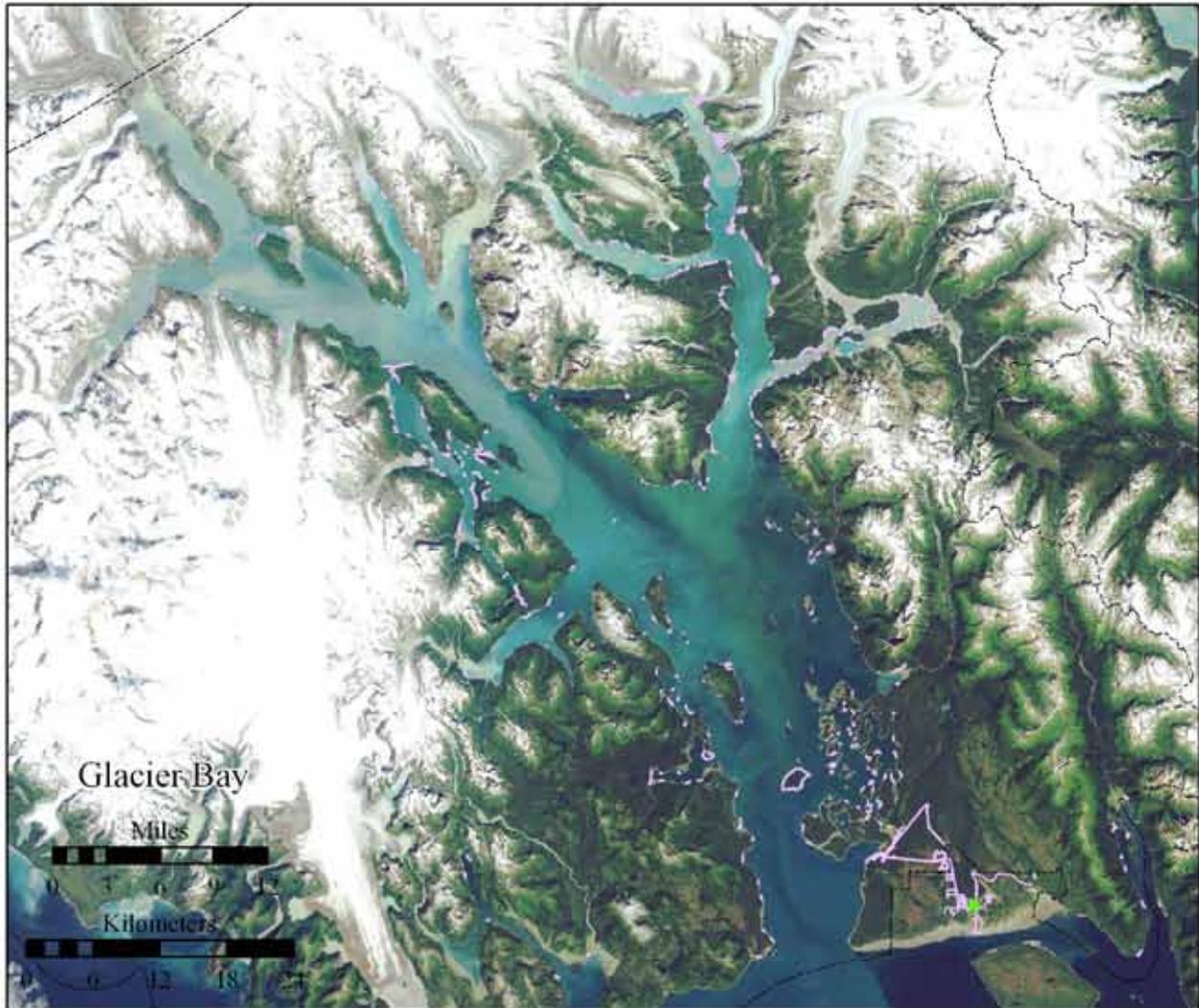
- Controlled by 2009
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- Absent in 2004-2009 Surveys
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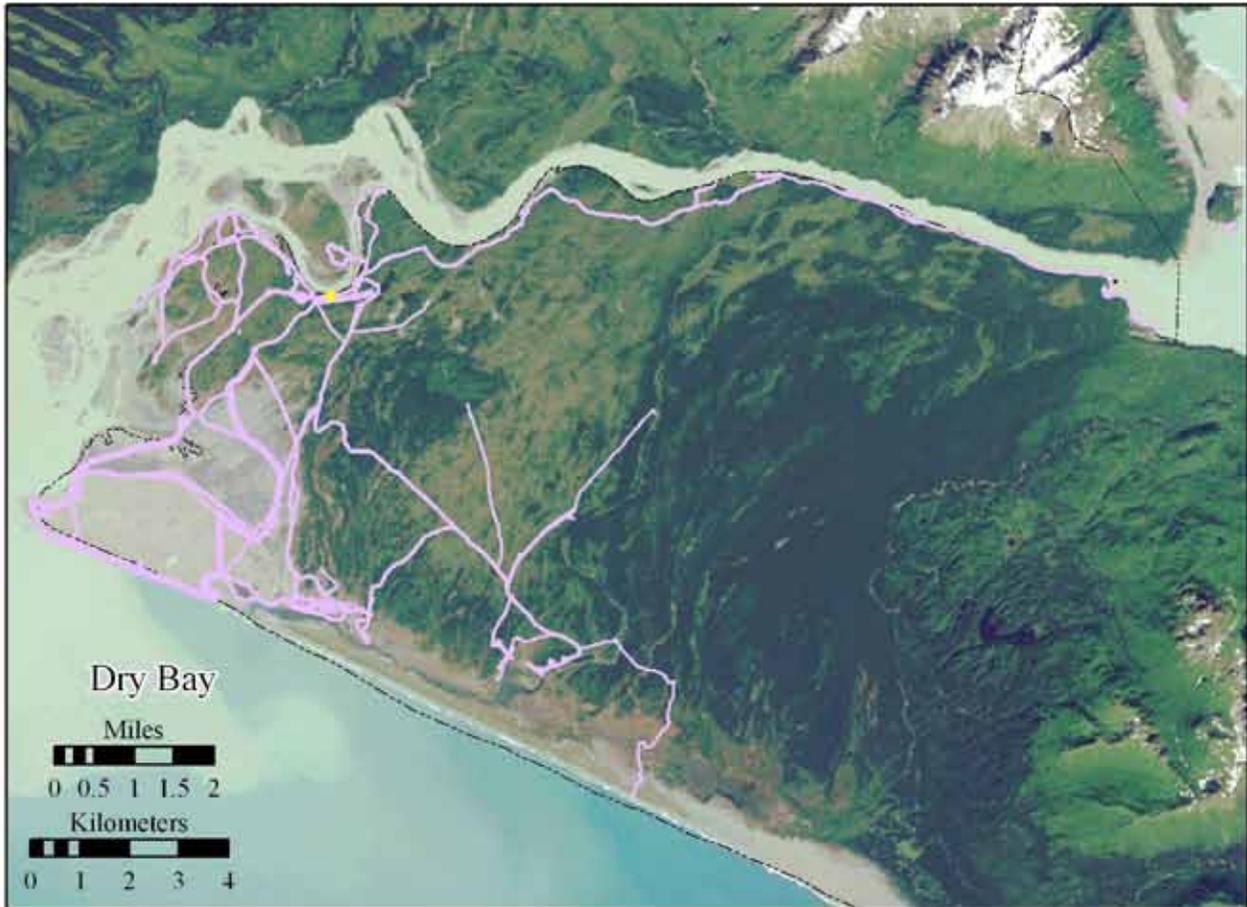
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Prostrate Knotweed - *Polygonum aviculare*



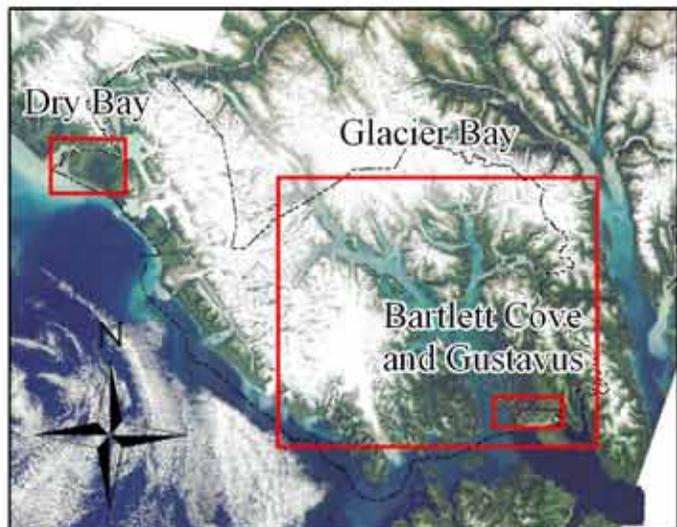
Tall Buttercup - *Ranunculus acris* in Glacier Bay National Park and Preserve



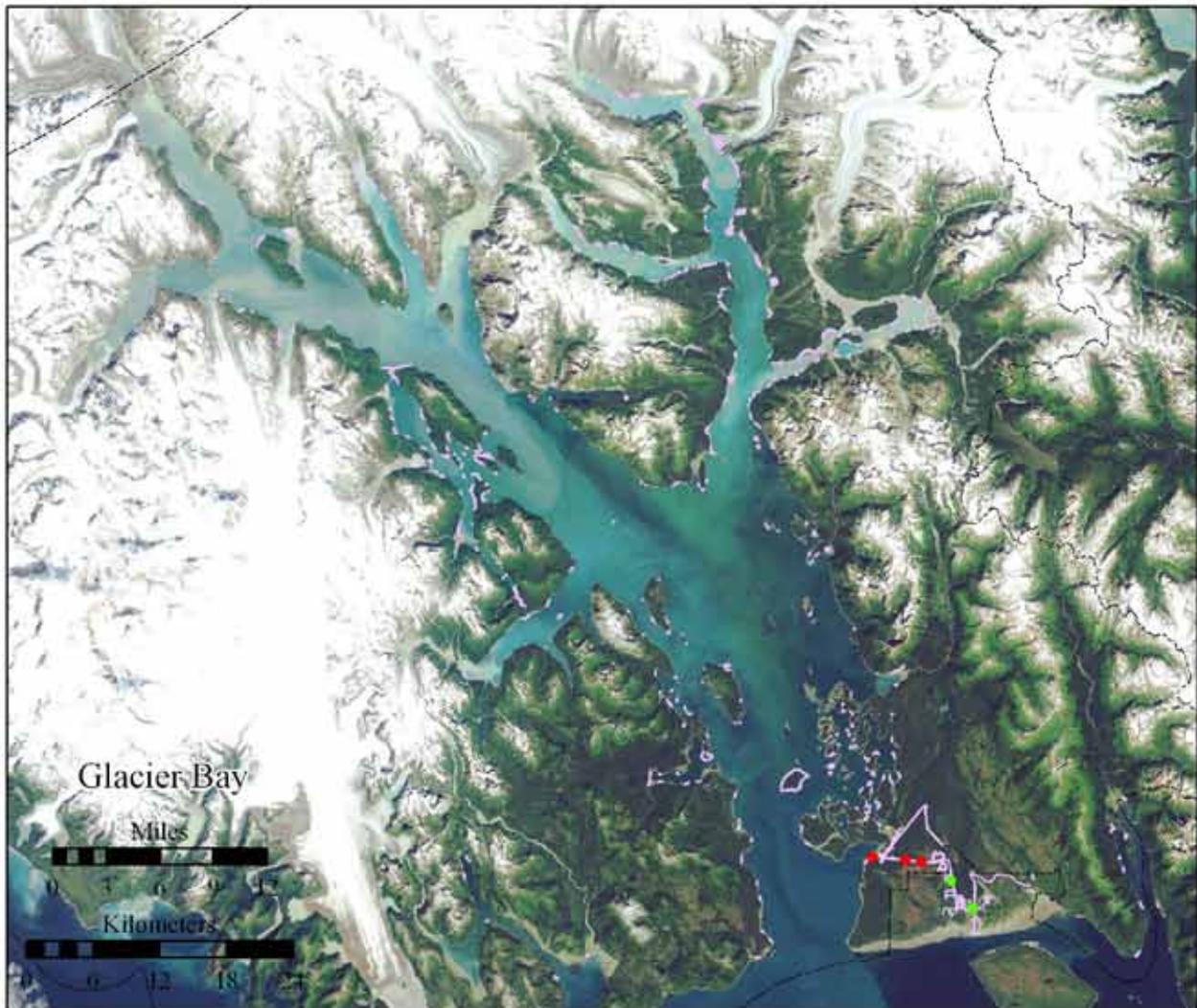
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Created: September 2009



Tall Buttercup - *Ranunculus acris*



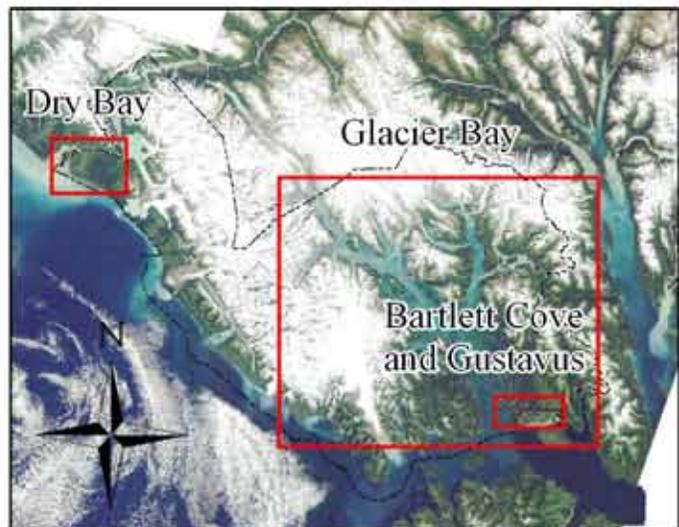
Creeping Buttercup - *Ranunculus repens* in Glacier Bay National Park and Preserve



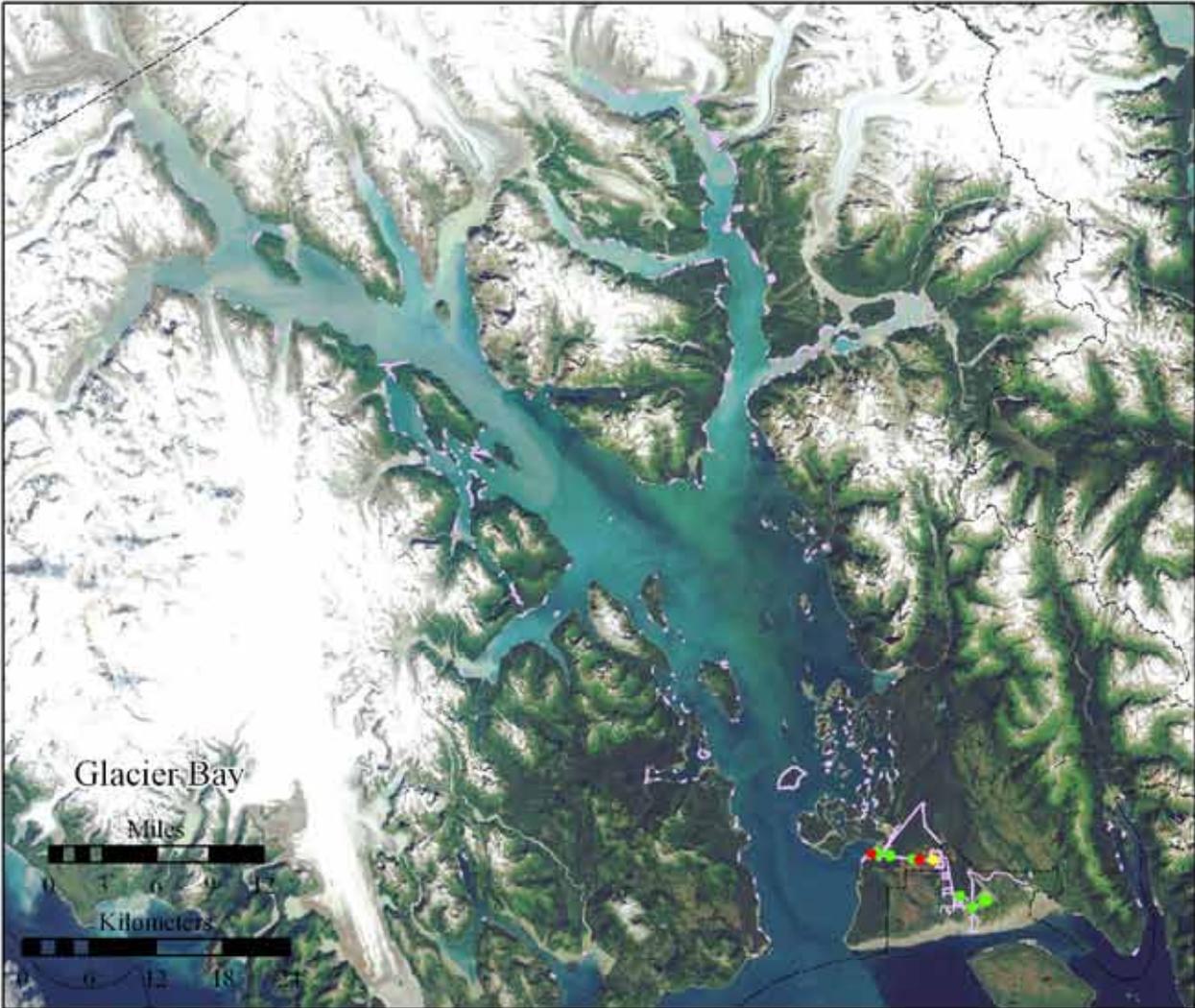
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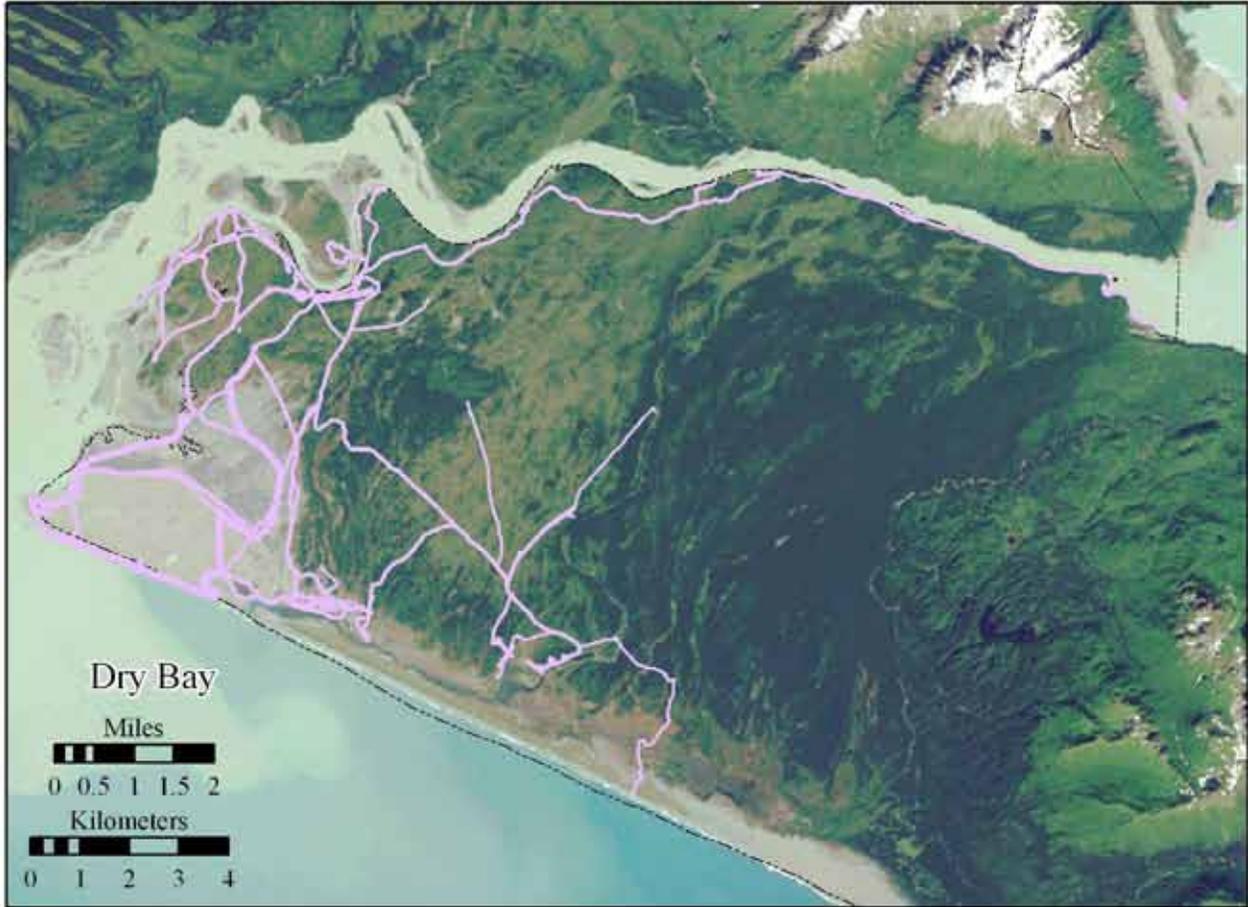
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Exotic Plant Management Team
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Creeping Buttercup - *Ranunculus repens*



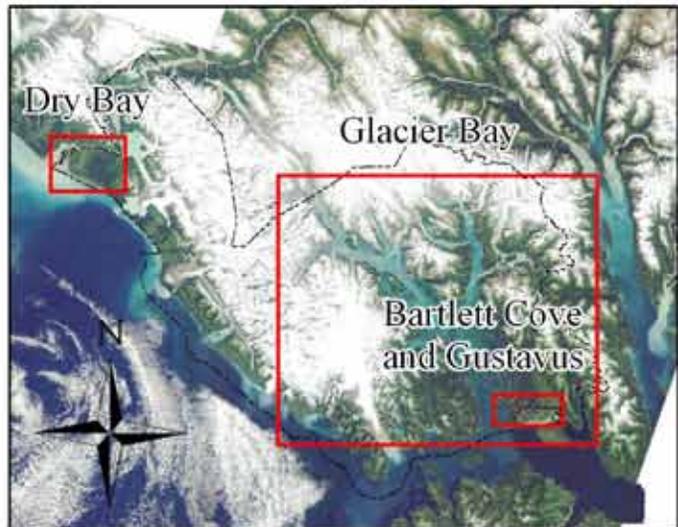
Rugosa Rose - *Rosa rugosa* in Glacier Bay National Park and Preserve



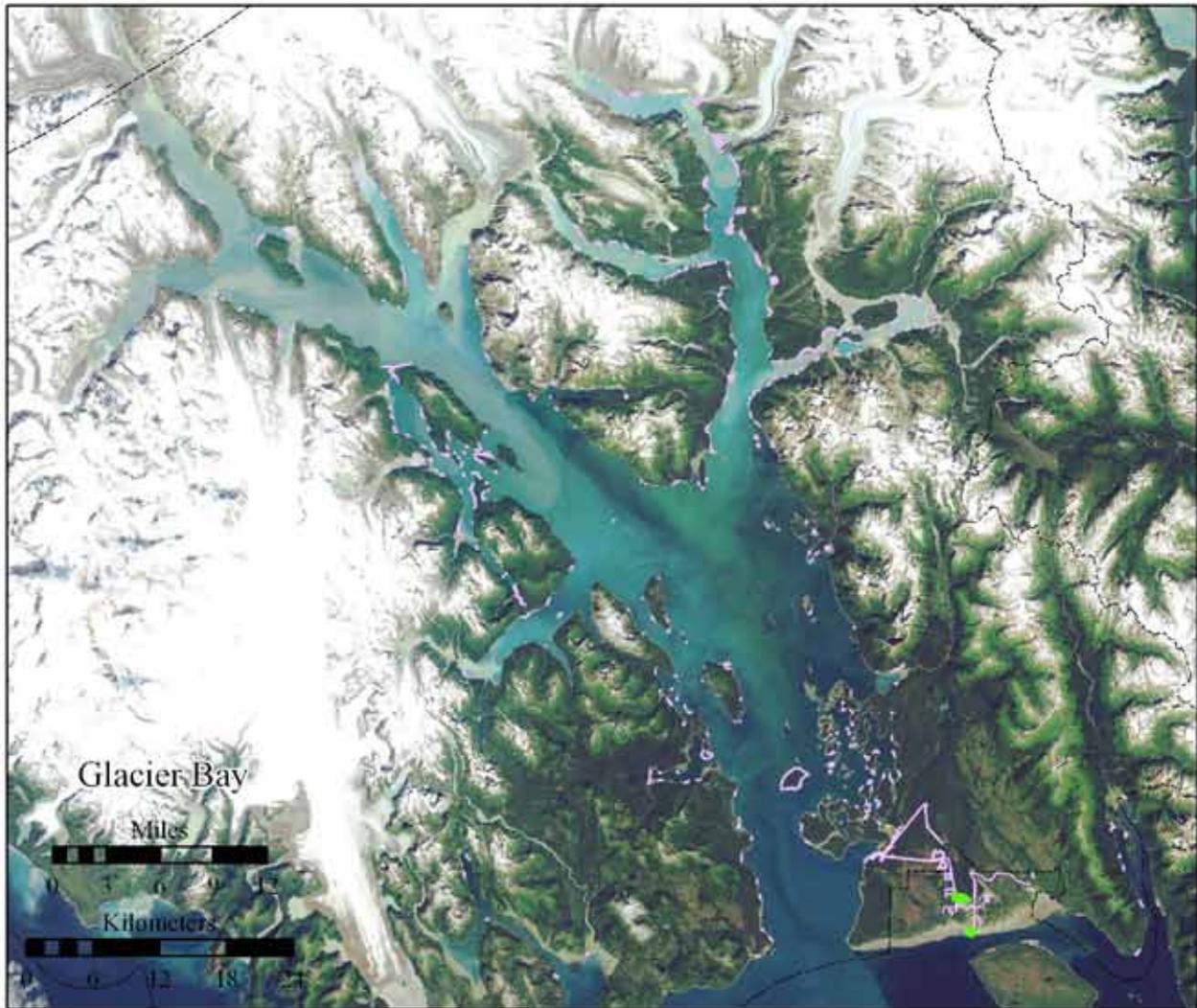
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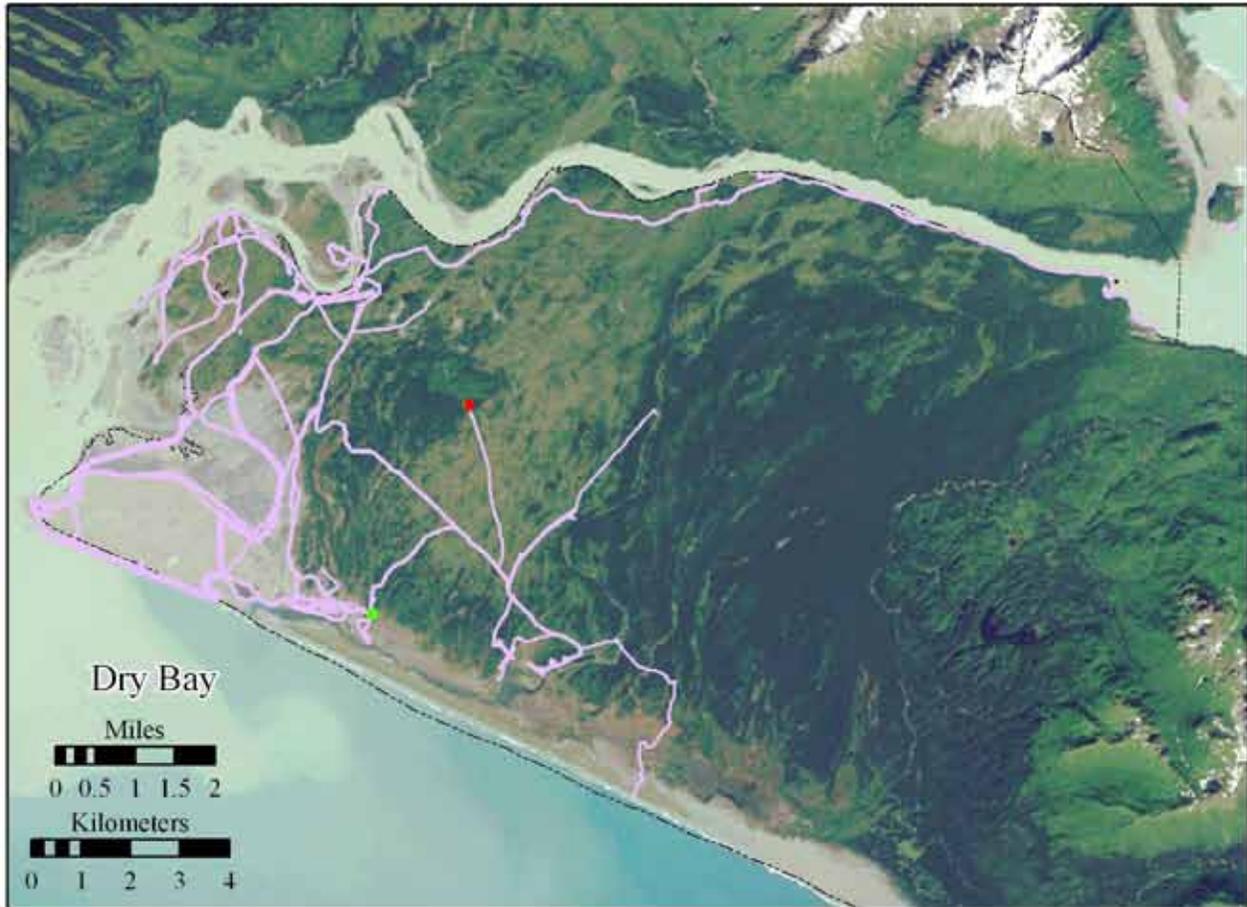
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Rugosa Rose - *Rosa rugosa*



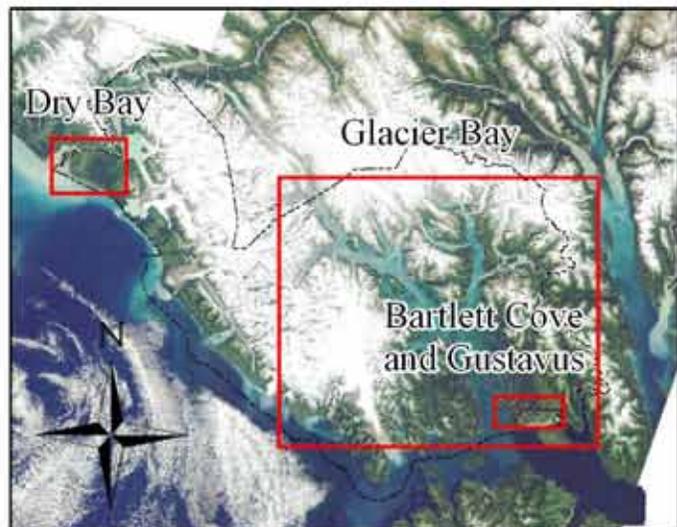
Red Raspberry - *Rubus idaeus* in Glacier Bay National Park and Preserve



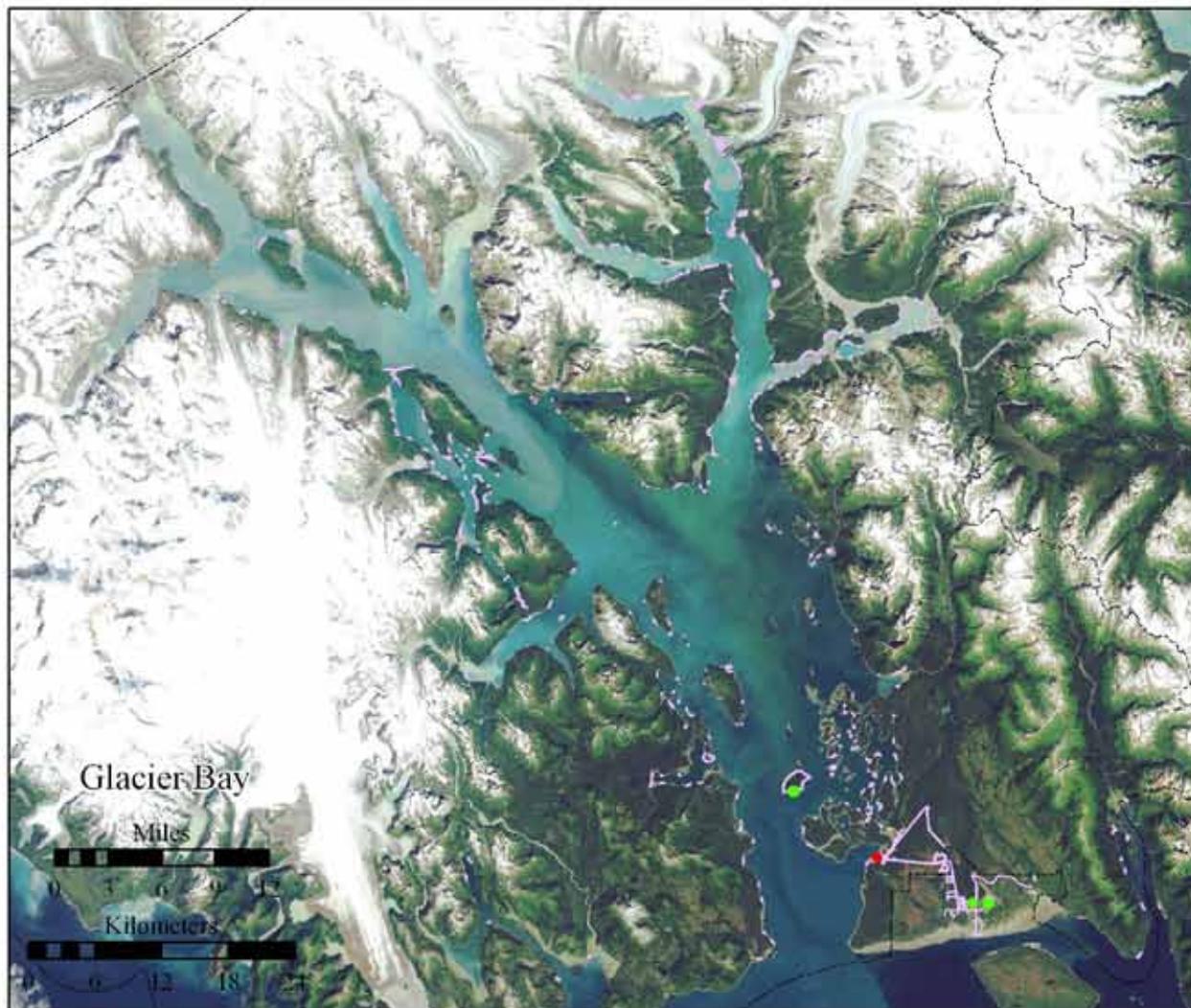
- Controlled by 2009
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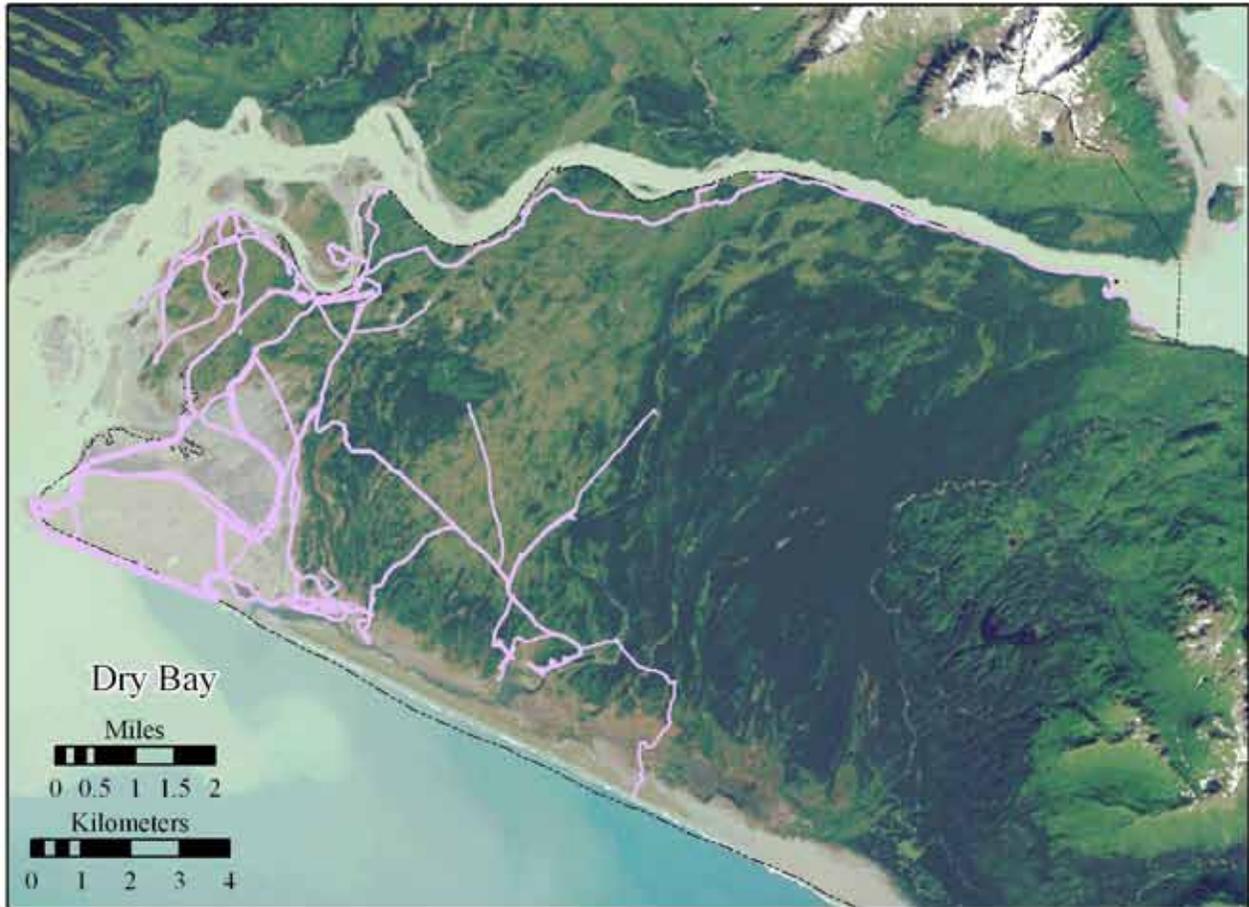
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Red Raspberry - *Rubus idaeus*



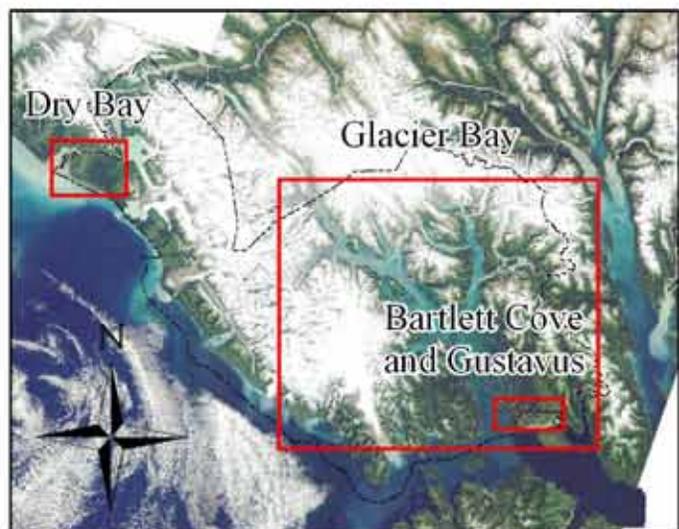
Common Sheep Sorrel - *Rumex acetosella* in Glacier Bay National Park and Preserve



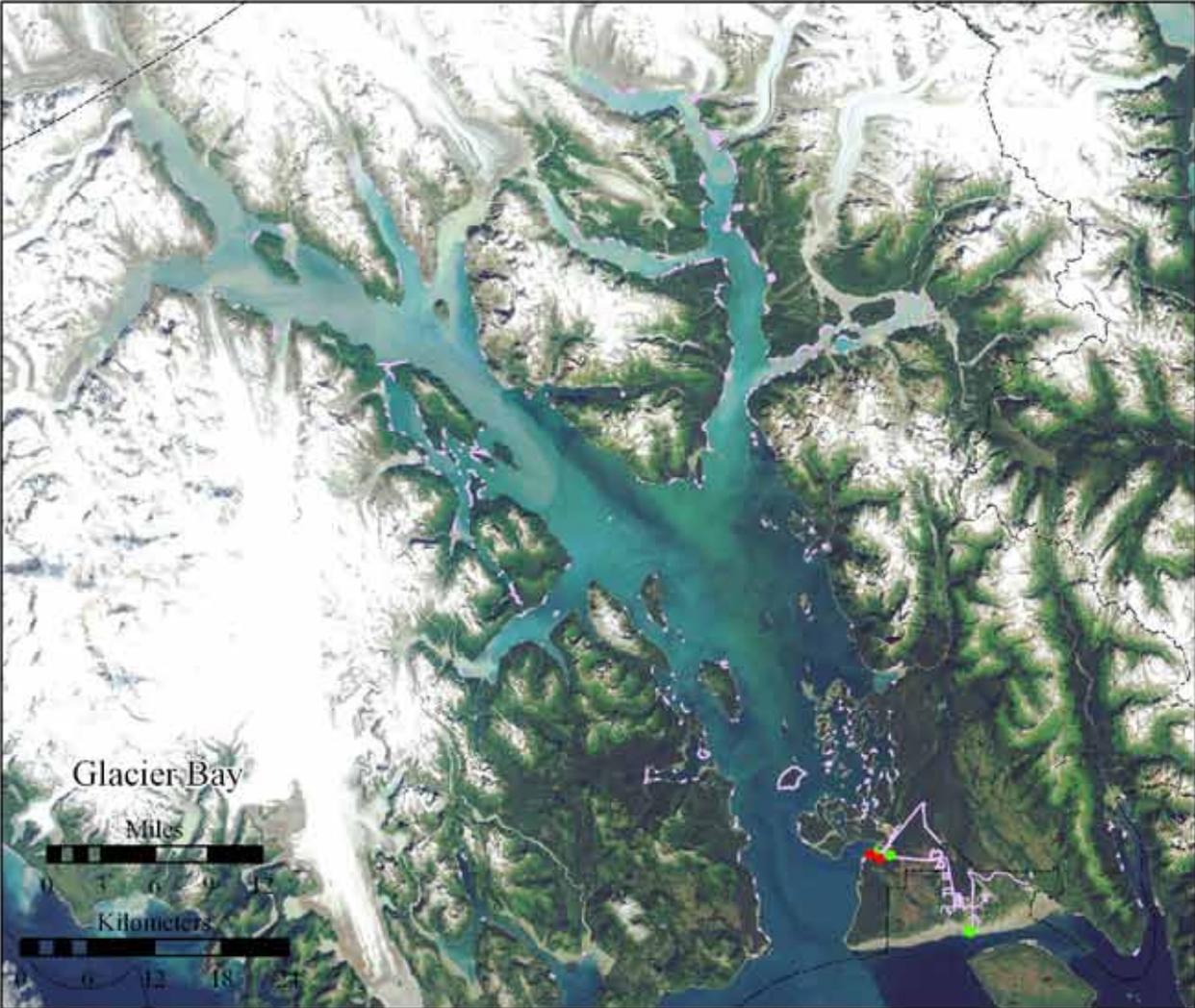
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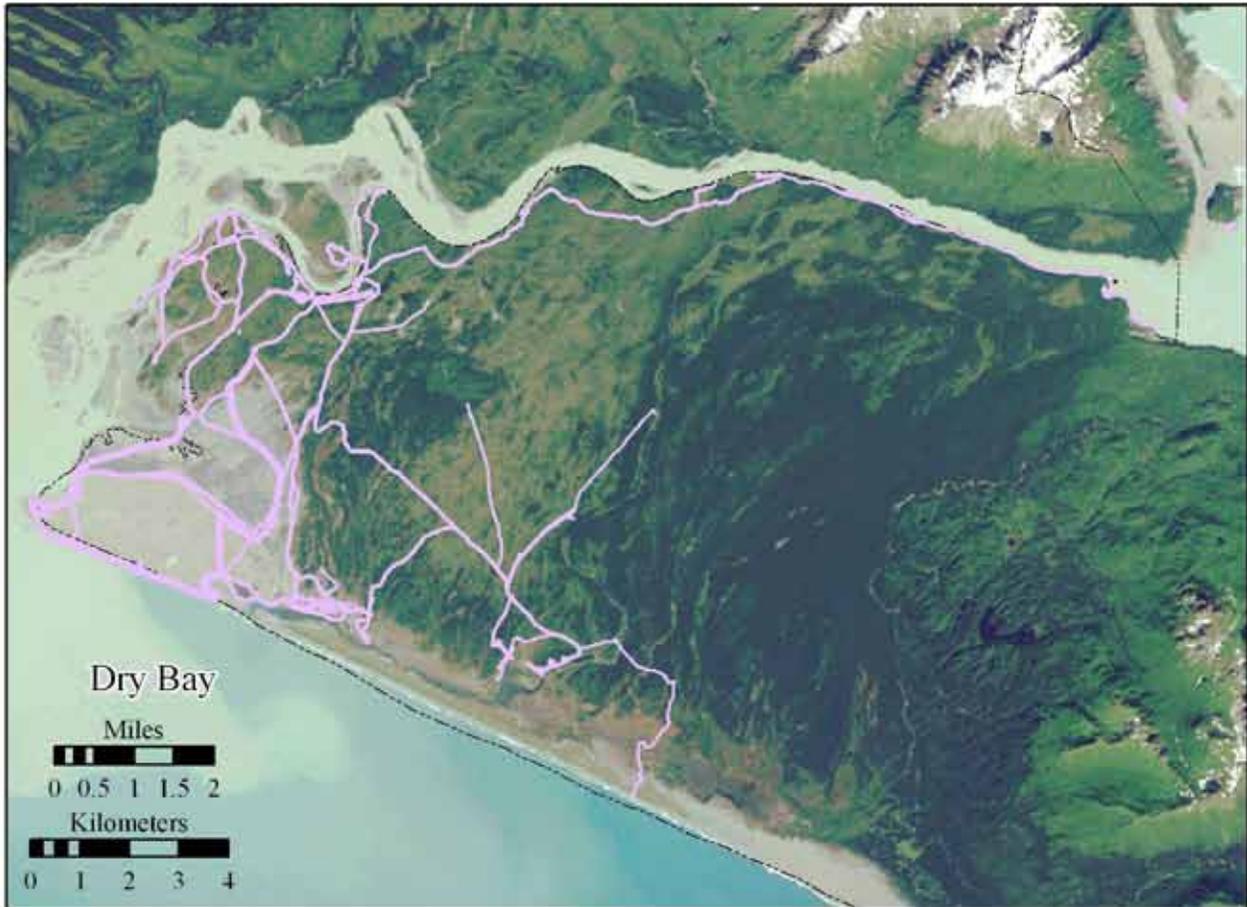
Alaska Region
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Common Sheep Sorrel - *Rumex acetosella*



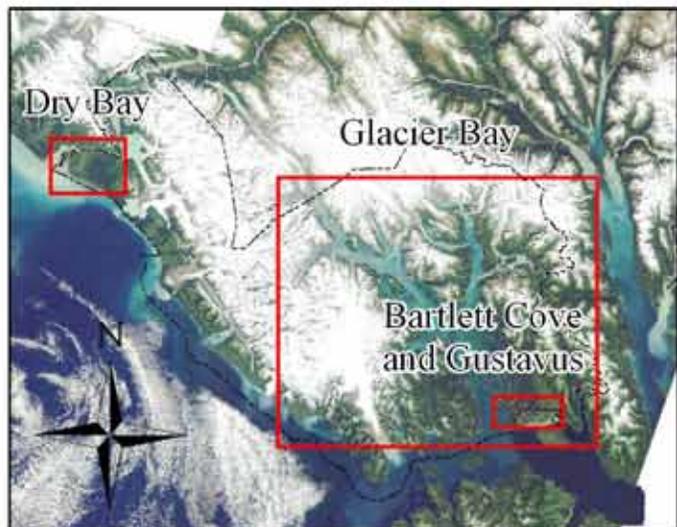
Curled Dock - *Rumex crispus* in Glacier Bay National Park and Preserve



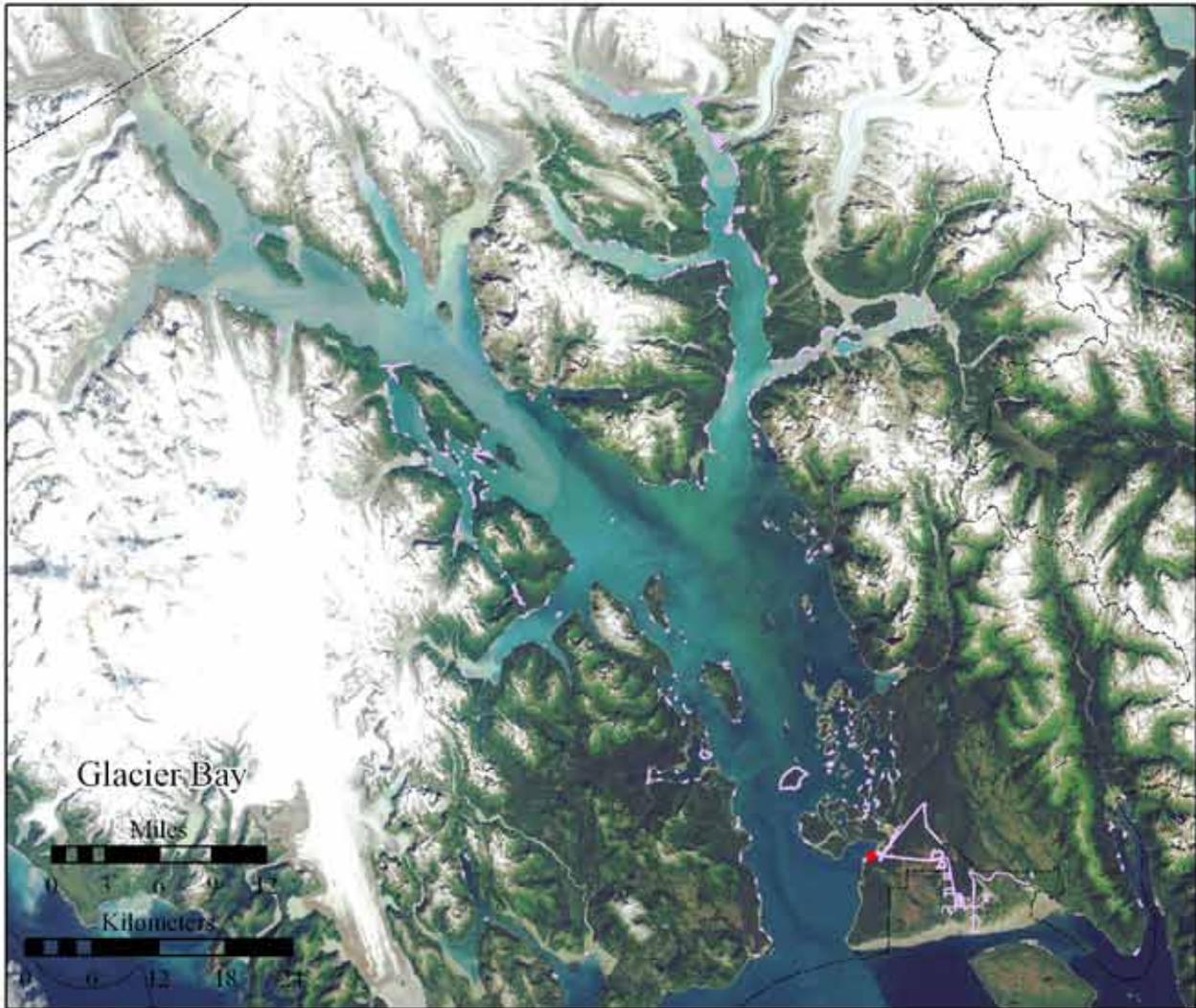
- Controlled by 2009
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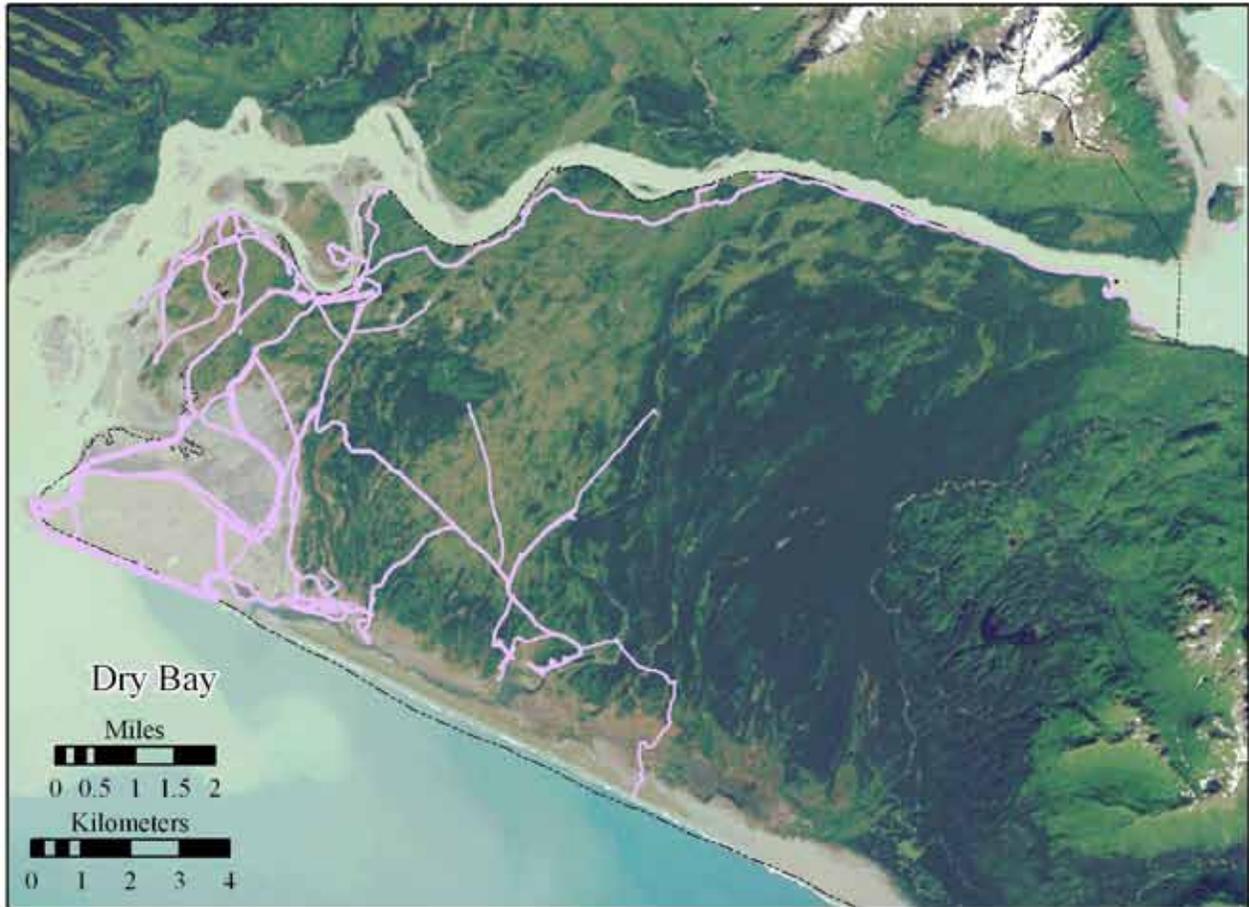
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Curled Dock - *Rumex crispus*



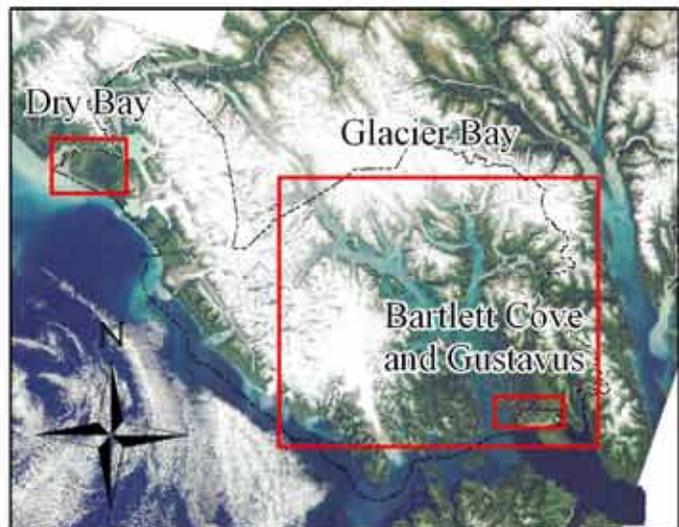
Perennial Sowthistle - *Sonchus arvensis* in Glacier Bay National Park and Preserve



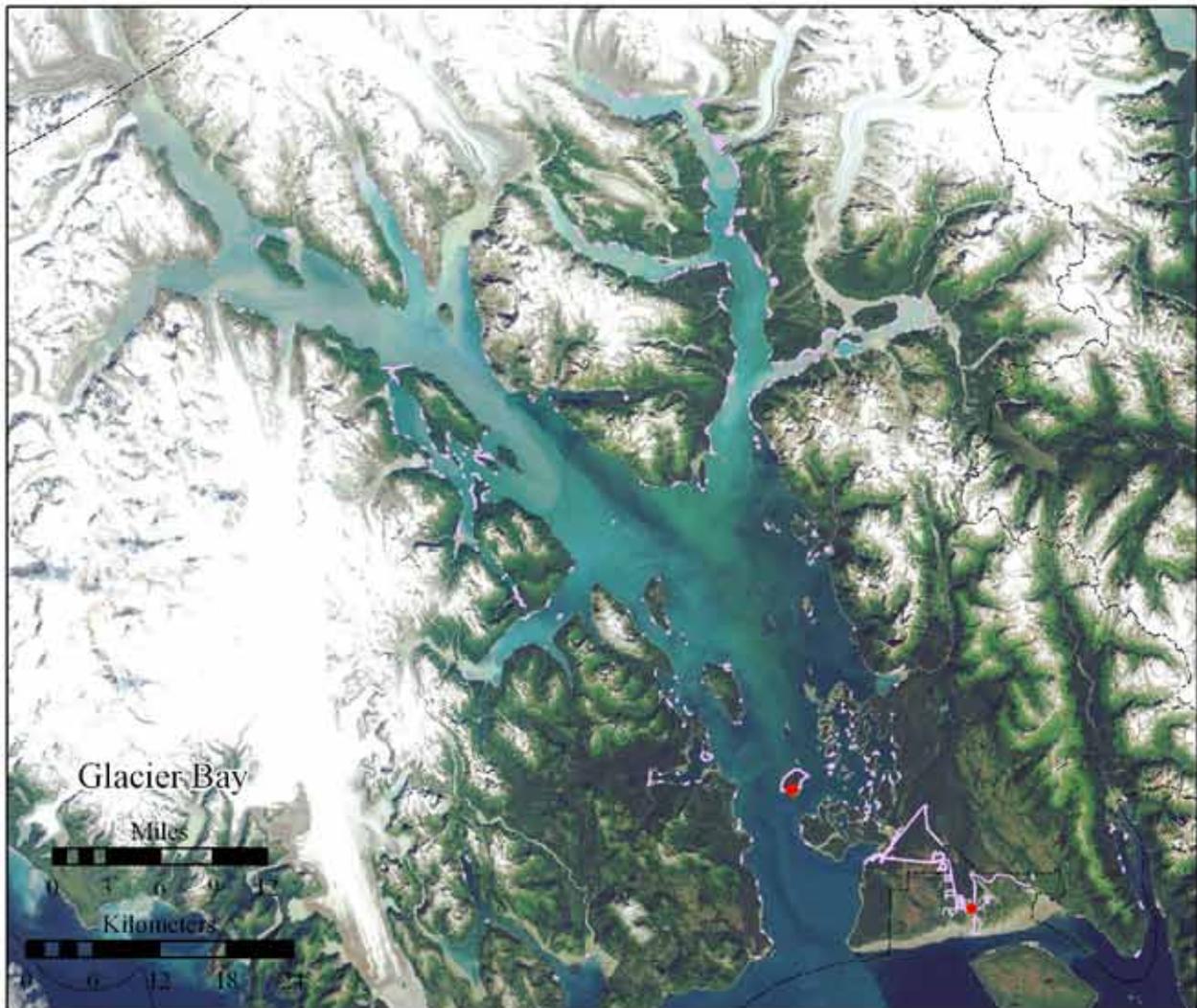
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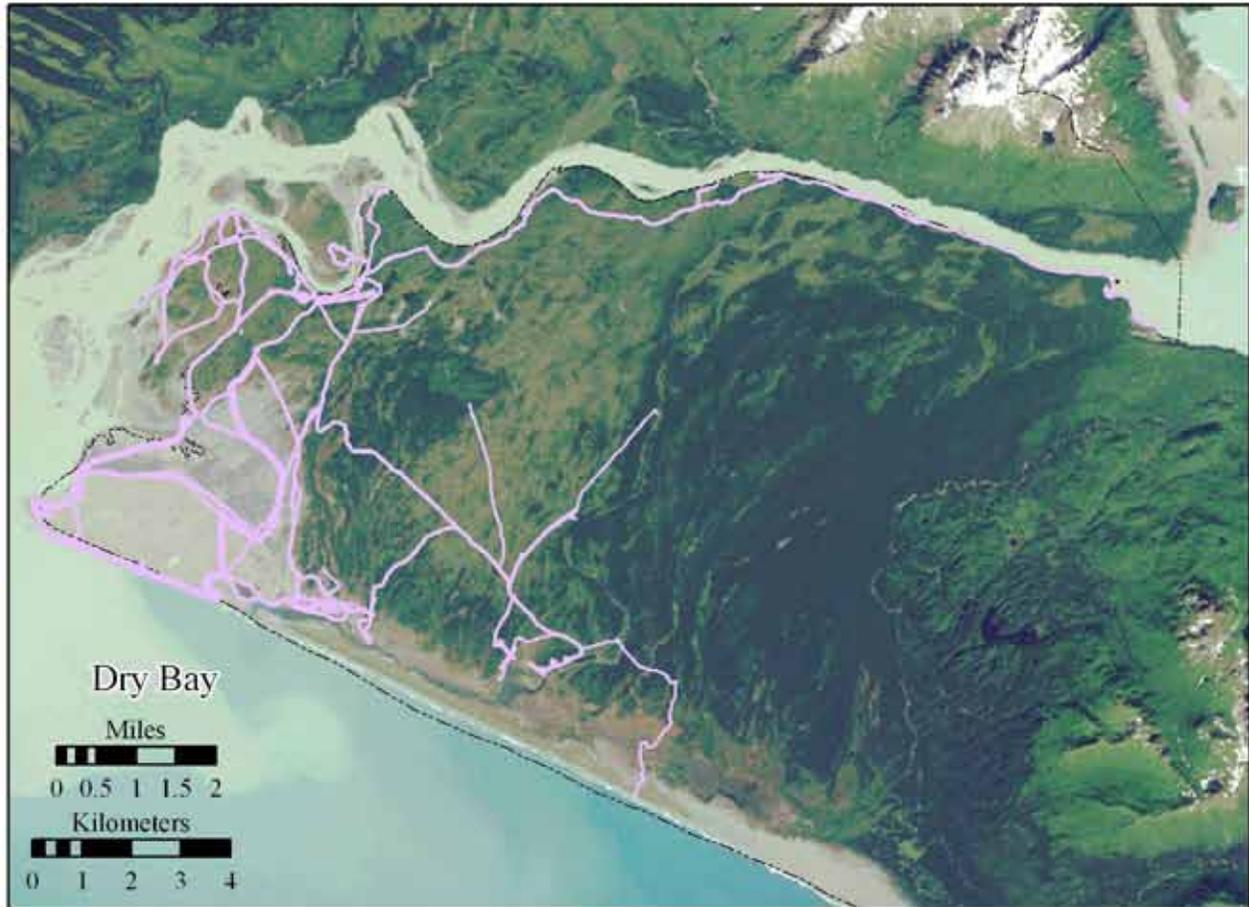
Alaska Region
Exotic Plant Management Team
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Perennial Sowthistle - *Sonchus arvensis*



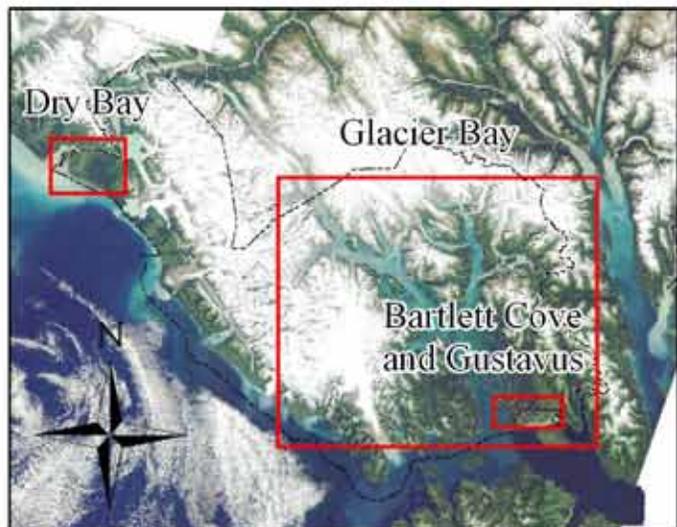
European Mountain-Ash - *Sorbus aucuparia* in Glacier Bay National Park and Preserve



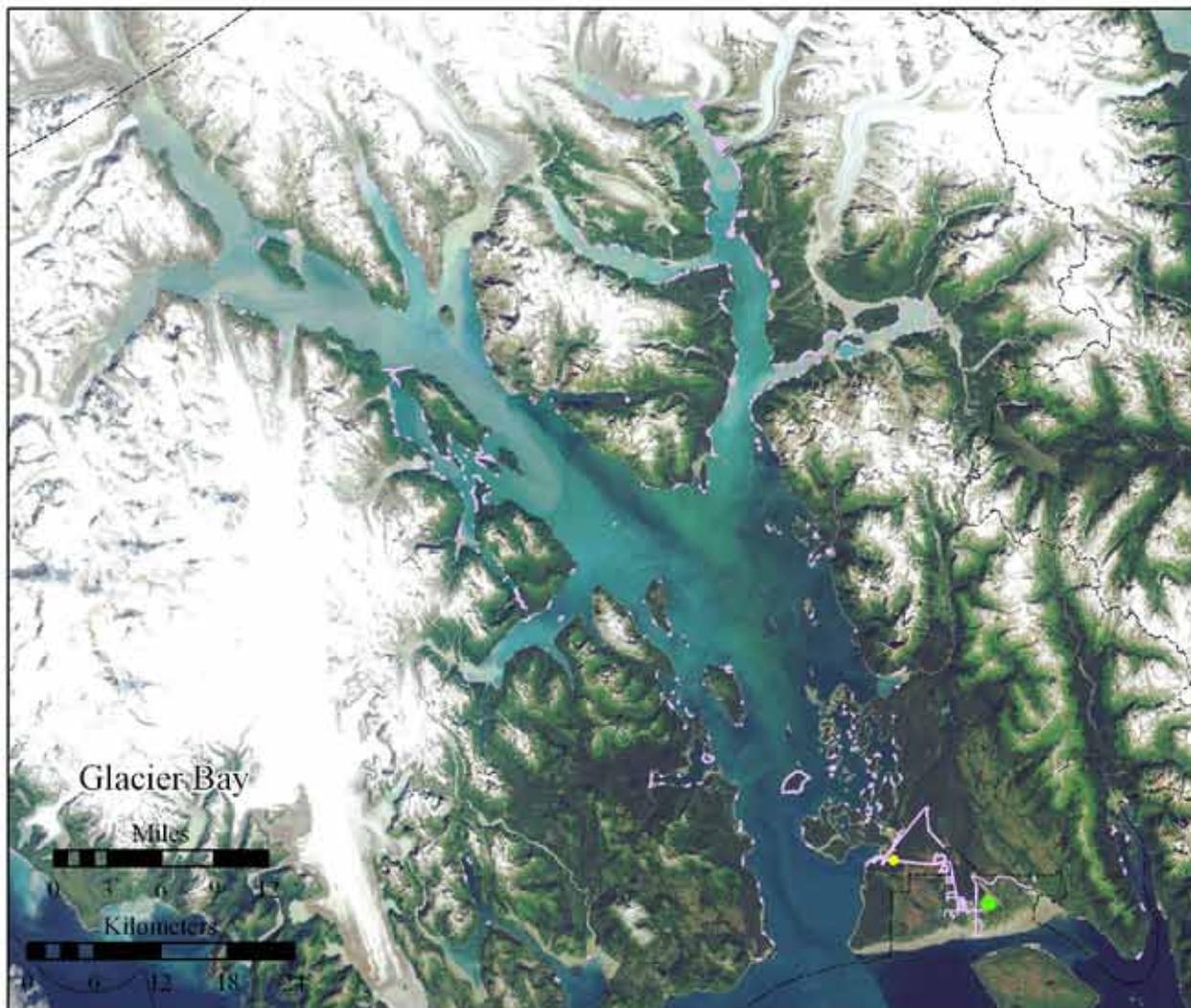
- Controlled by 2009
- Treated between 2004-2009
- Present between 2004-2009
- Absent in 2004-2009 Surveys
- GLBA Boundary



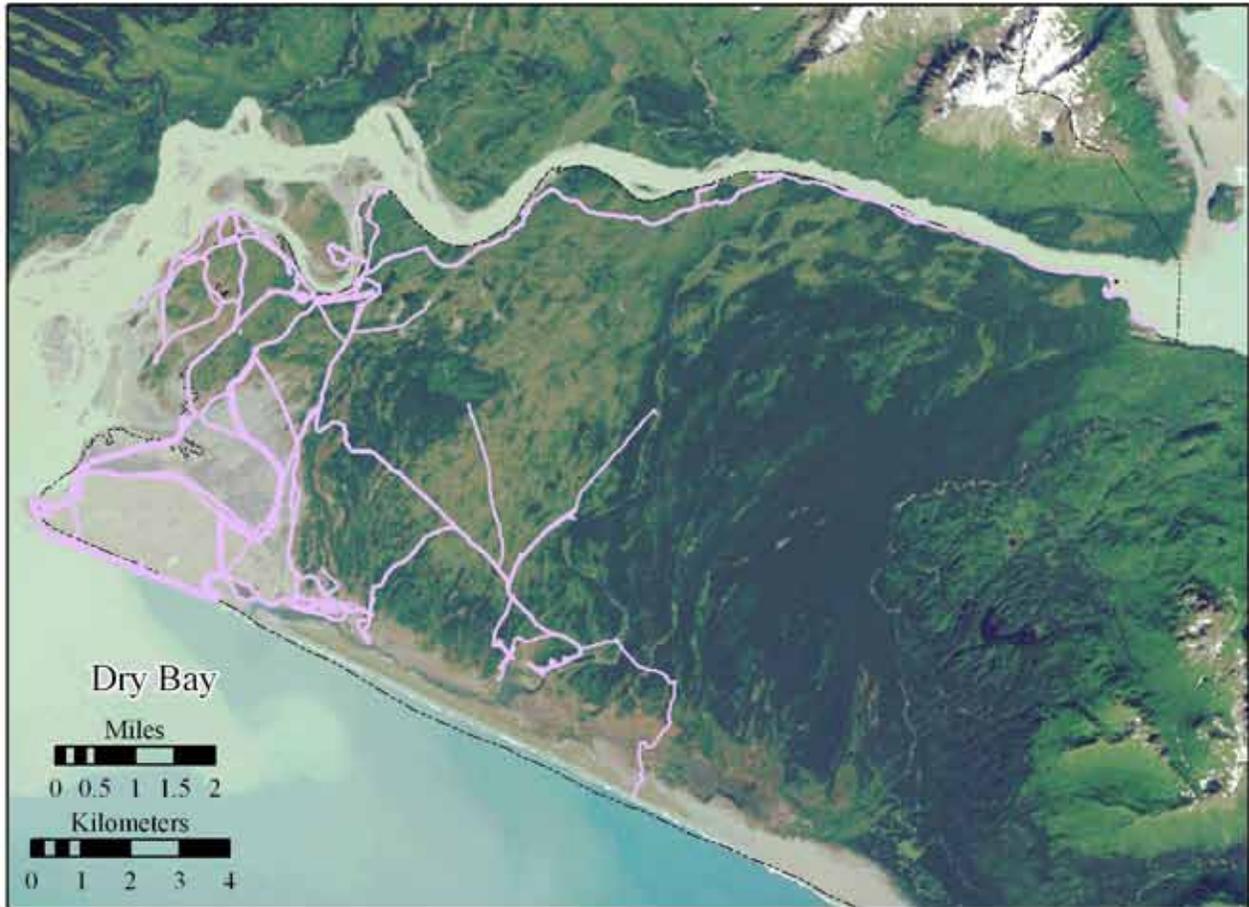
Alaska Region
Exotic Plant Management Team
Projection: UTM 8N, NAD 83
Created: September 2009



European Mountain-Ash - *Sorbus aucuparia*



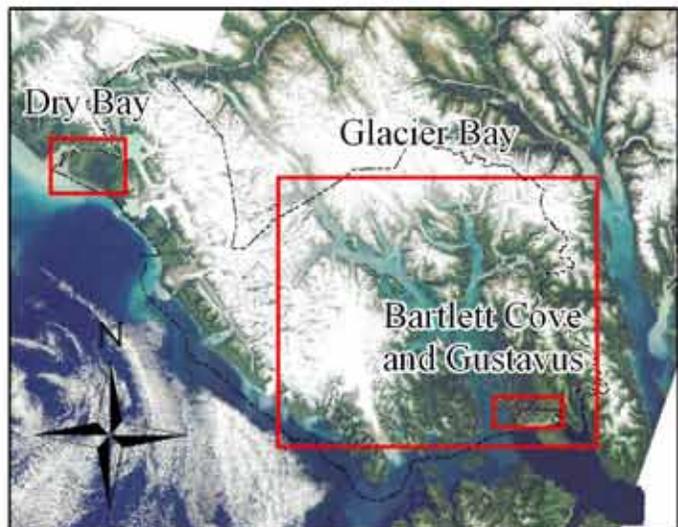
Common Chickweed - *Stellaria media* in Glacier Bay National Park and Preserve



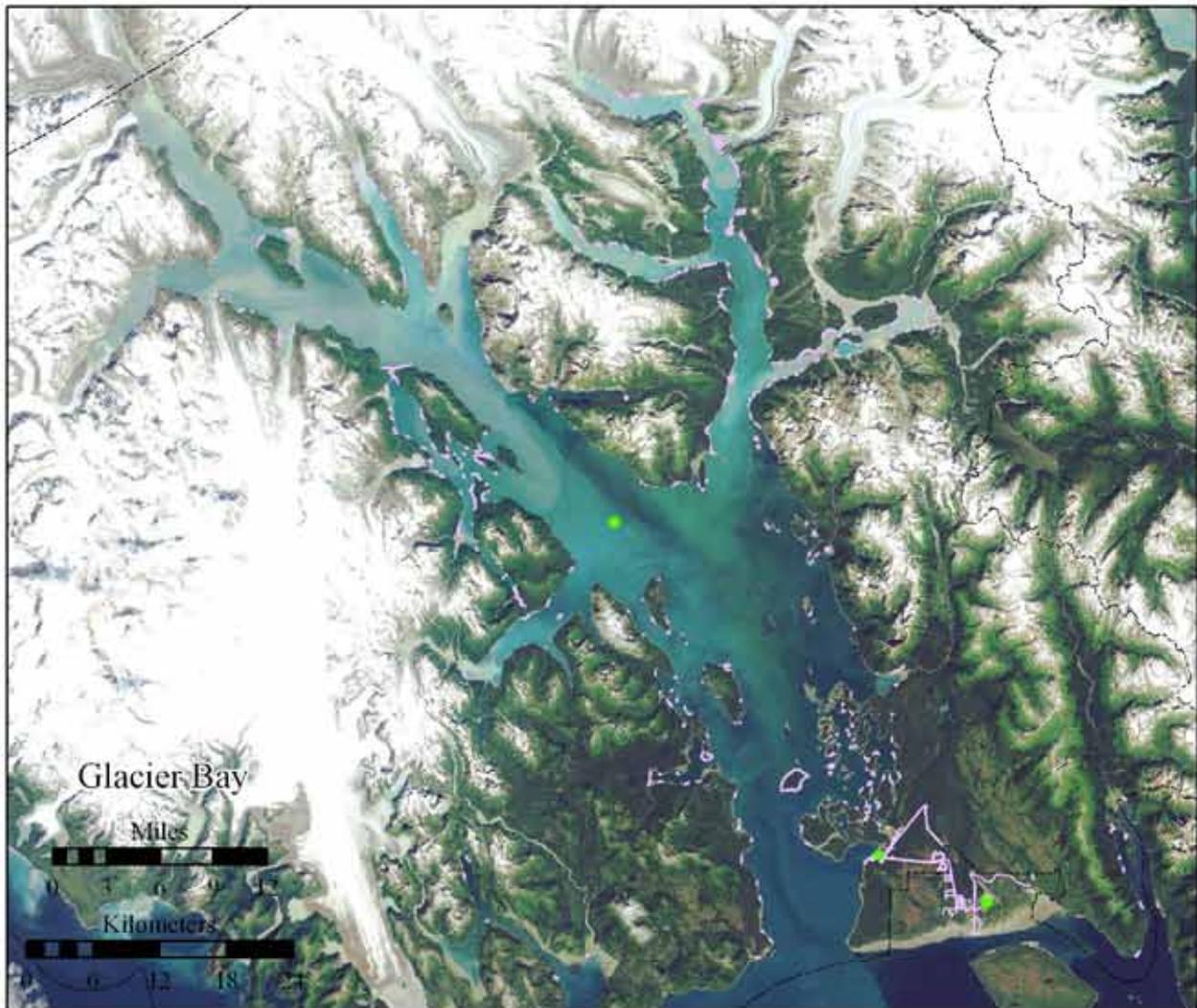
- Controlled by 2009
- Treated between 2004-2009
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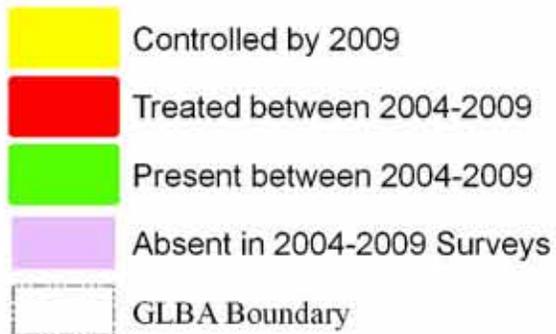
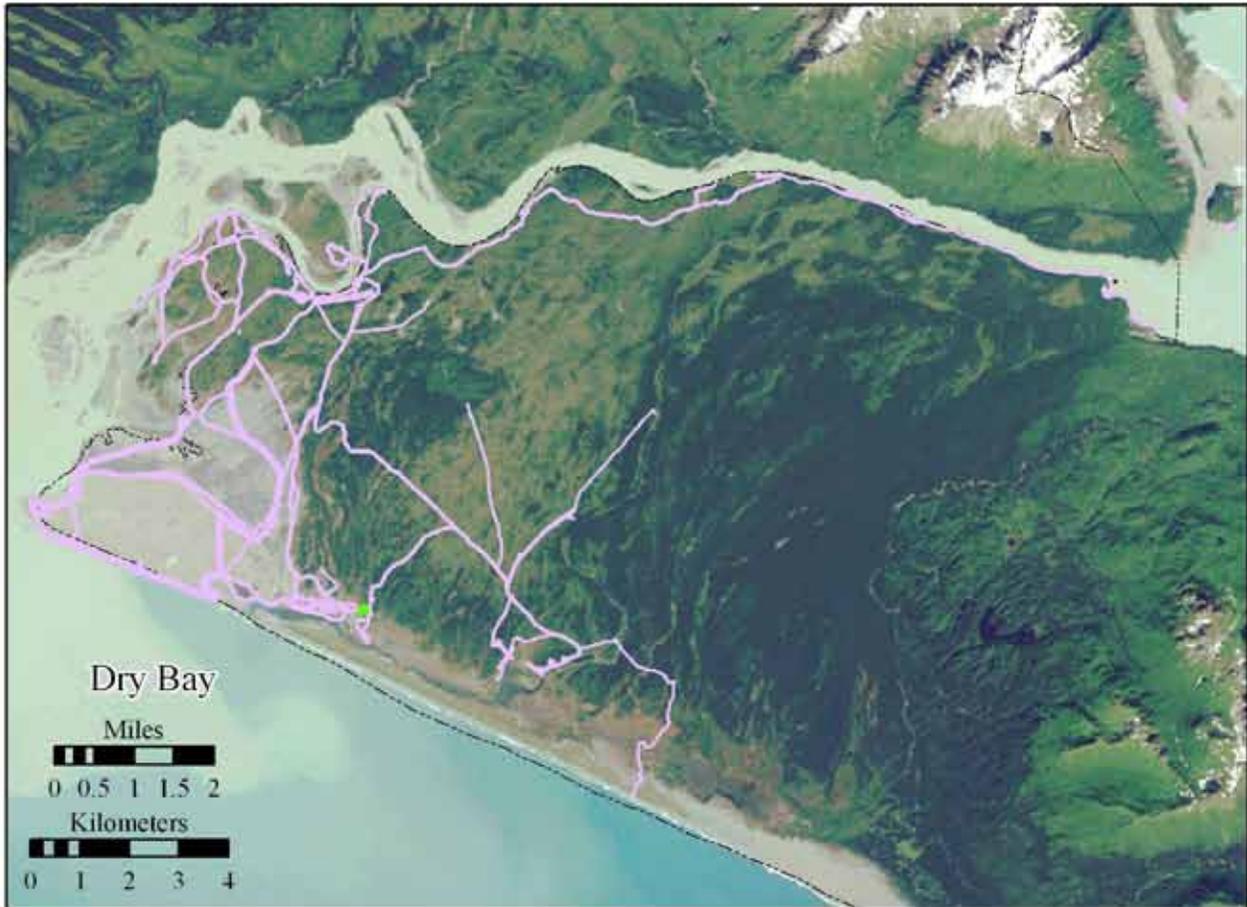
Alaska Region
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Created: September 2009



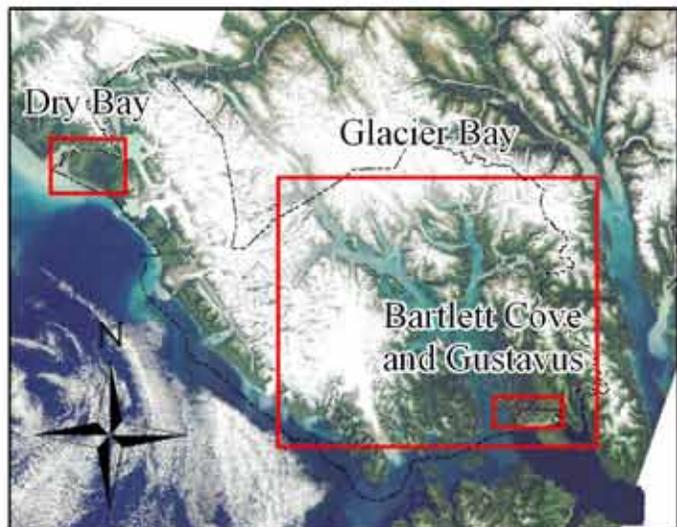
Common Chickweed - *Stellaria media*



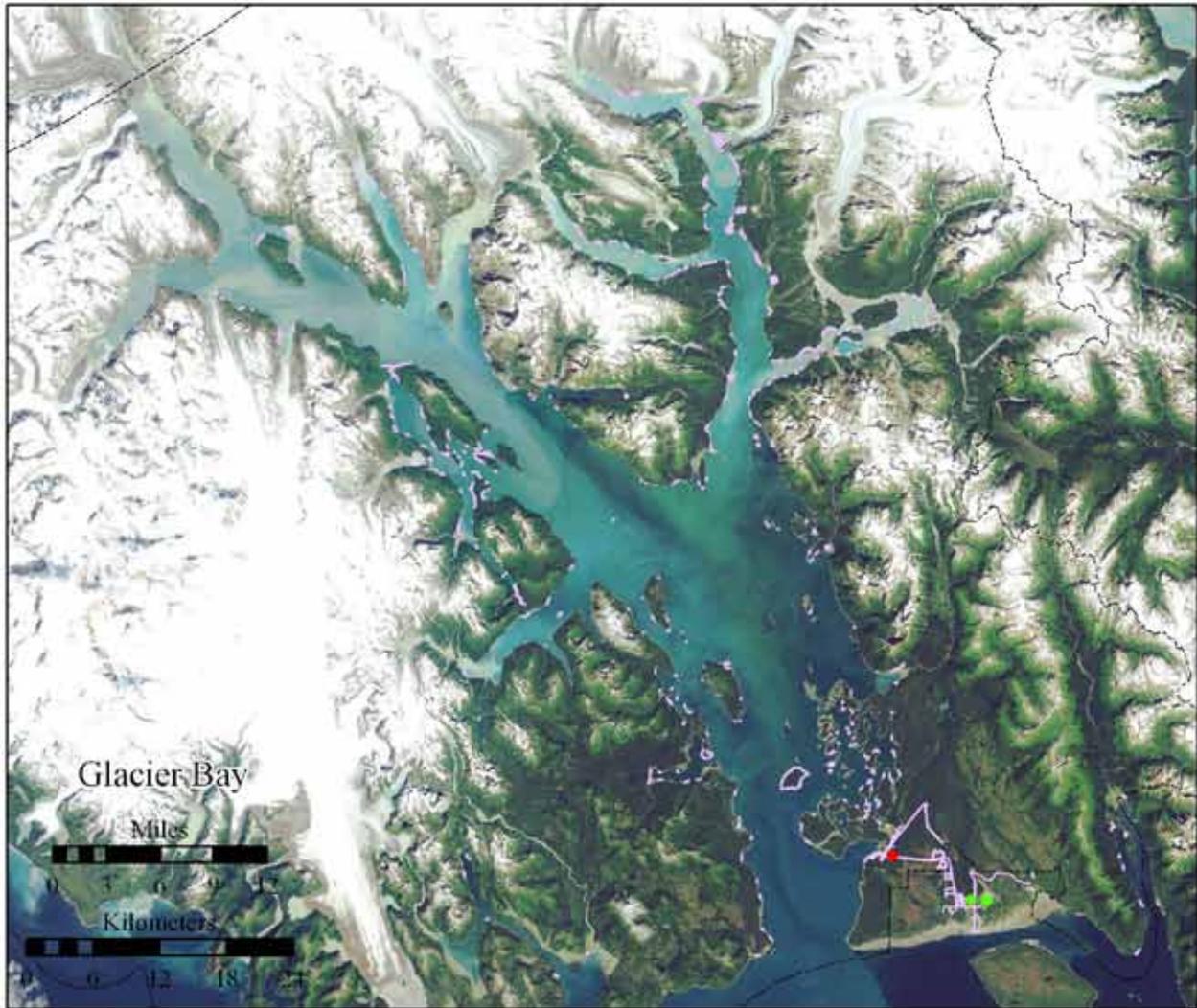
Common Comfrey - *Symphytum officinale* in Glacier Bay National Park and Preserve



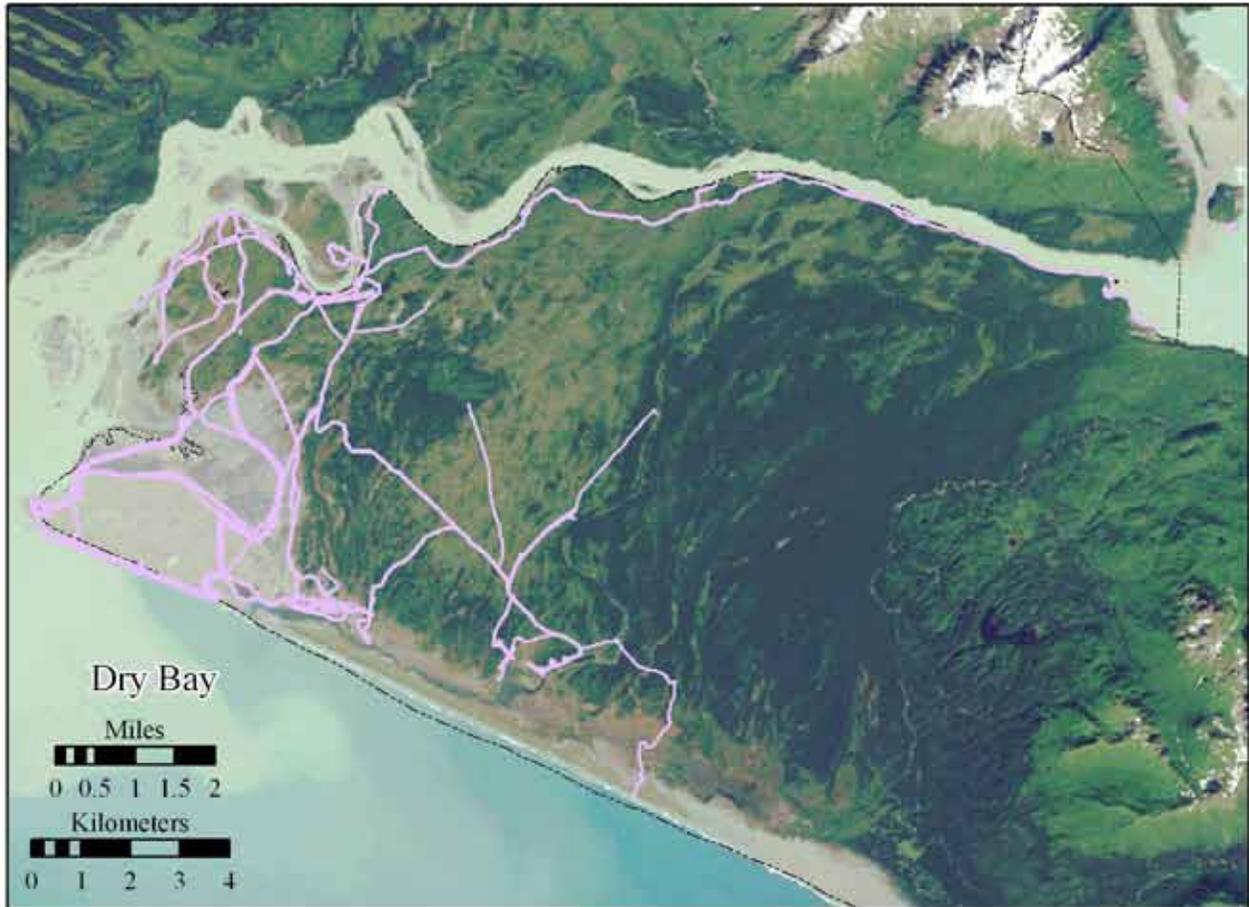
Alaska Region
Exotic Plant Management Team
Projection: UTM 8N, NAD 83
Created: September 2009



Common Comfrey - *Symphytum officinale*



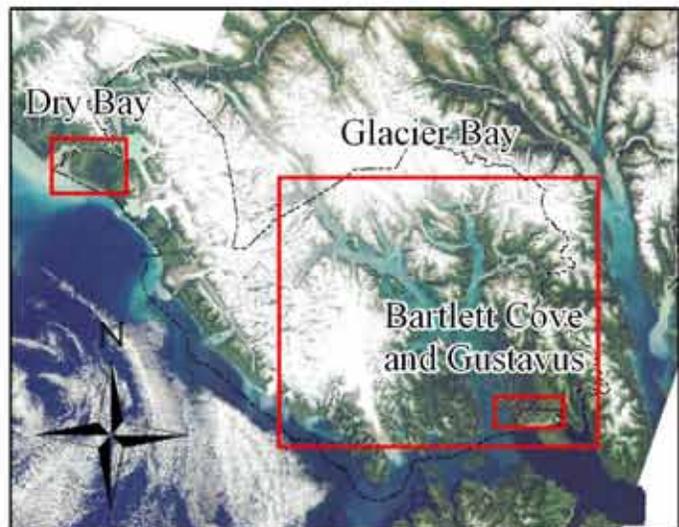
Common Tansy - *Tanacetum vulgare* in Glacier Bay National Park and Preserve



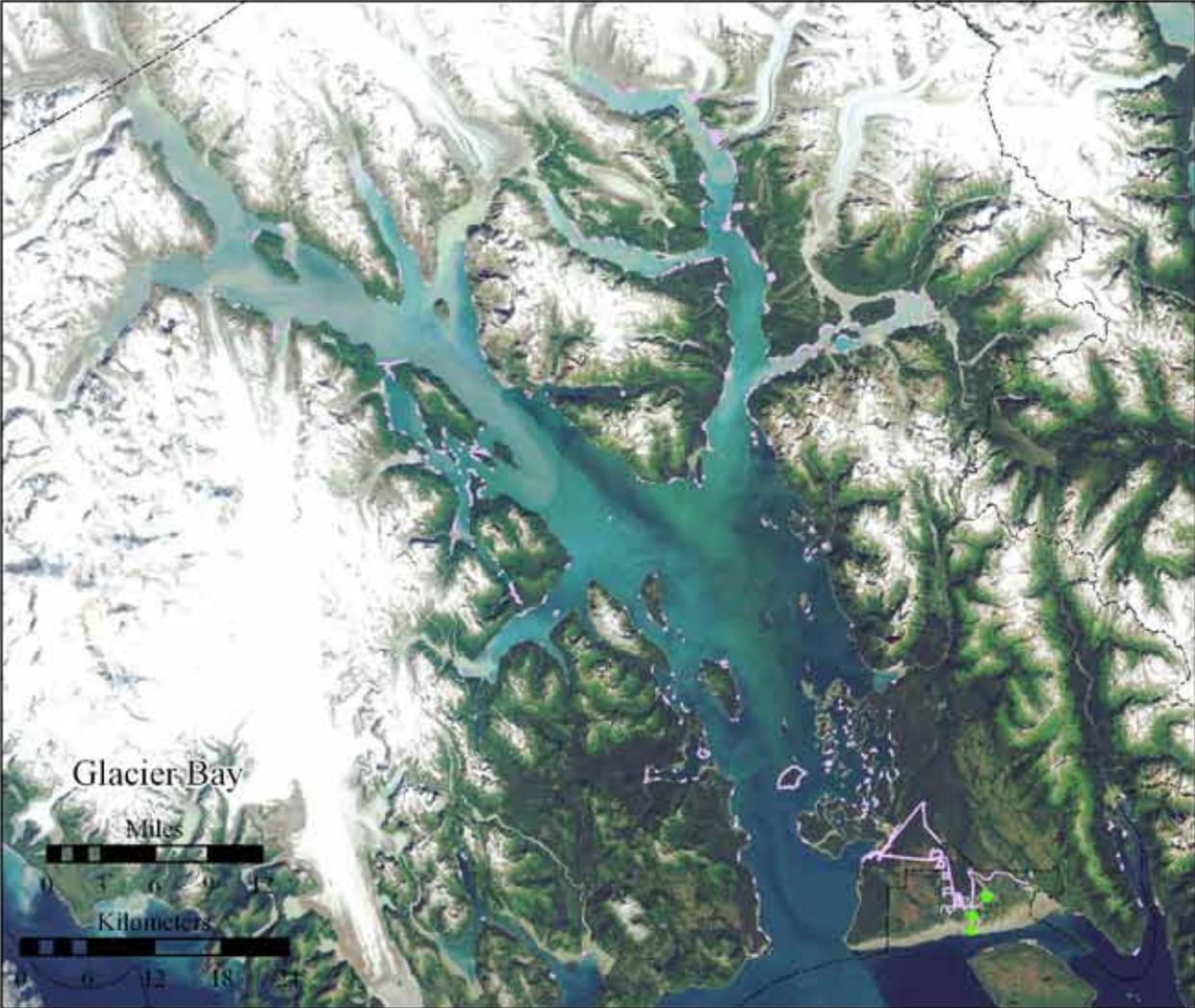
- Controlled by 2009
- Treated between 2004-2009
- Present between 2004-2009
- Absent in 2004-2009 Surveys
- GLBA Boundary



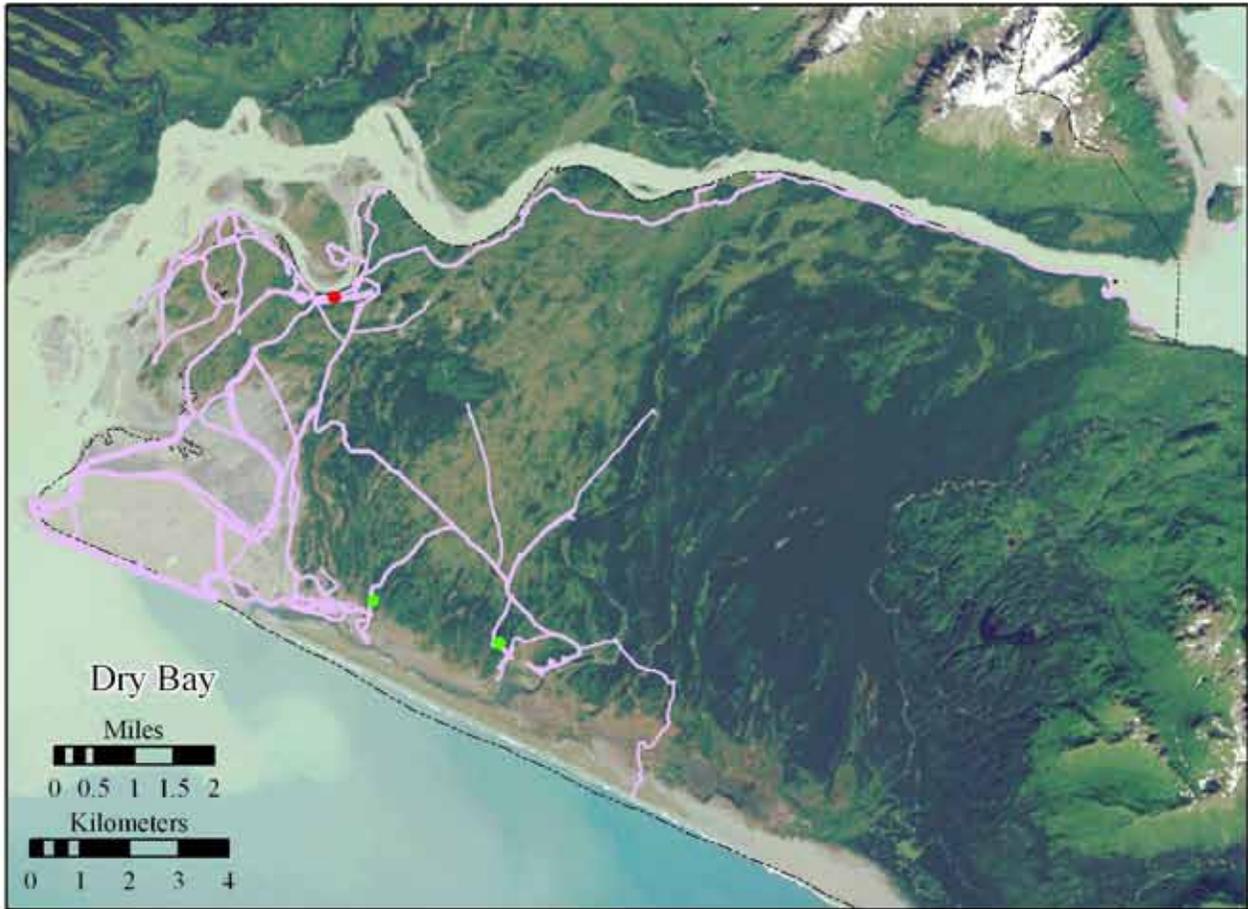
Alaska Region
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Projection: UTM 8N, NAD 83
Created: September 2009



Common Tansy - *Tanacetum vulgare*



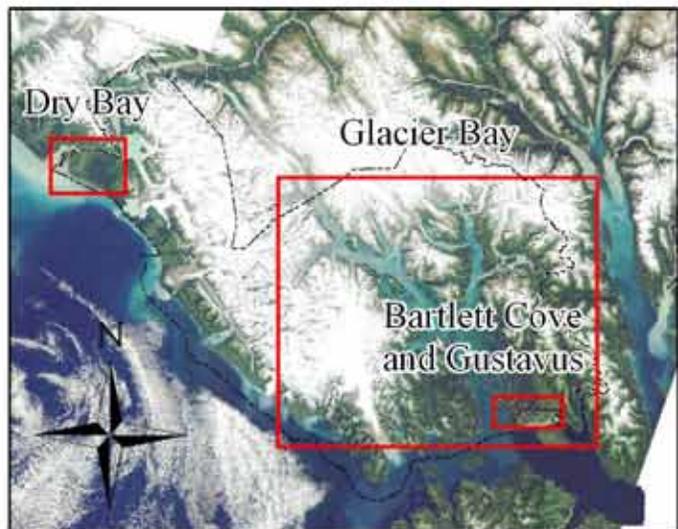
Common Dandelion - *Taraxacum officinale* ssp. *officinale* in Glacier Bay National Park and Preserve



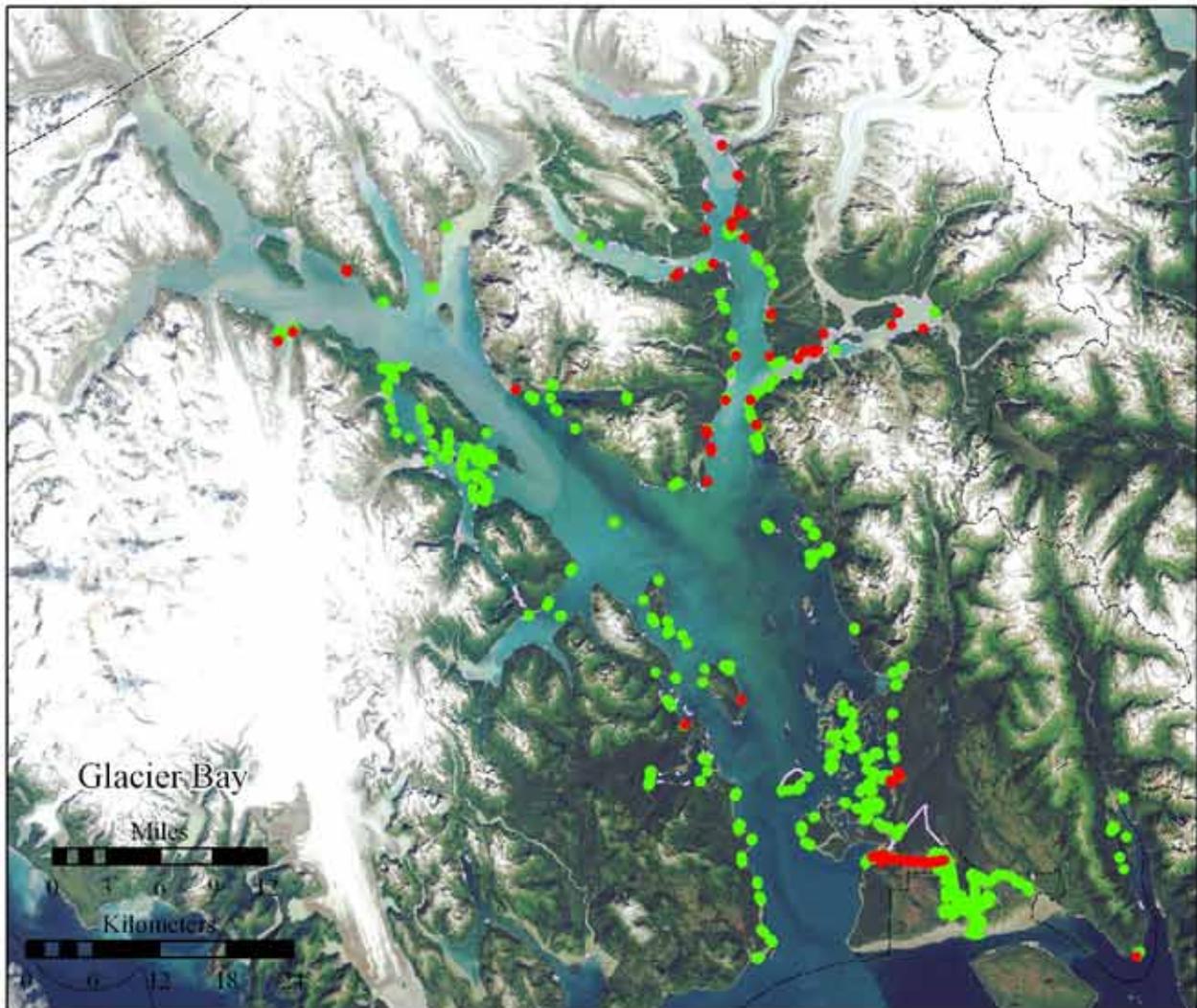
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- Present between 2004-2009
- Absent in 2004-2009 Surveys
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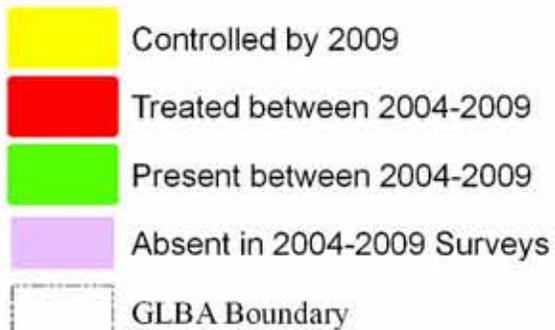
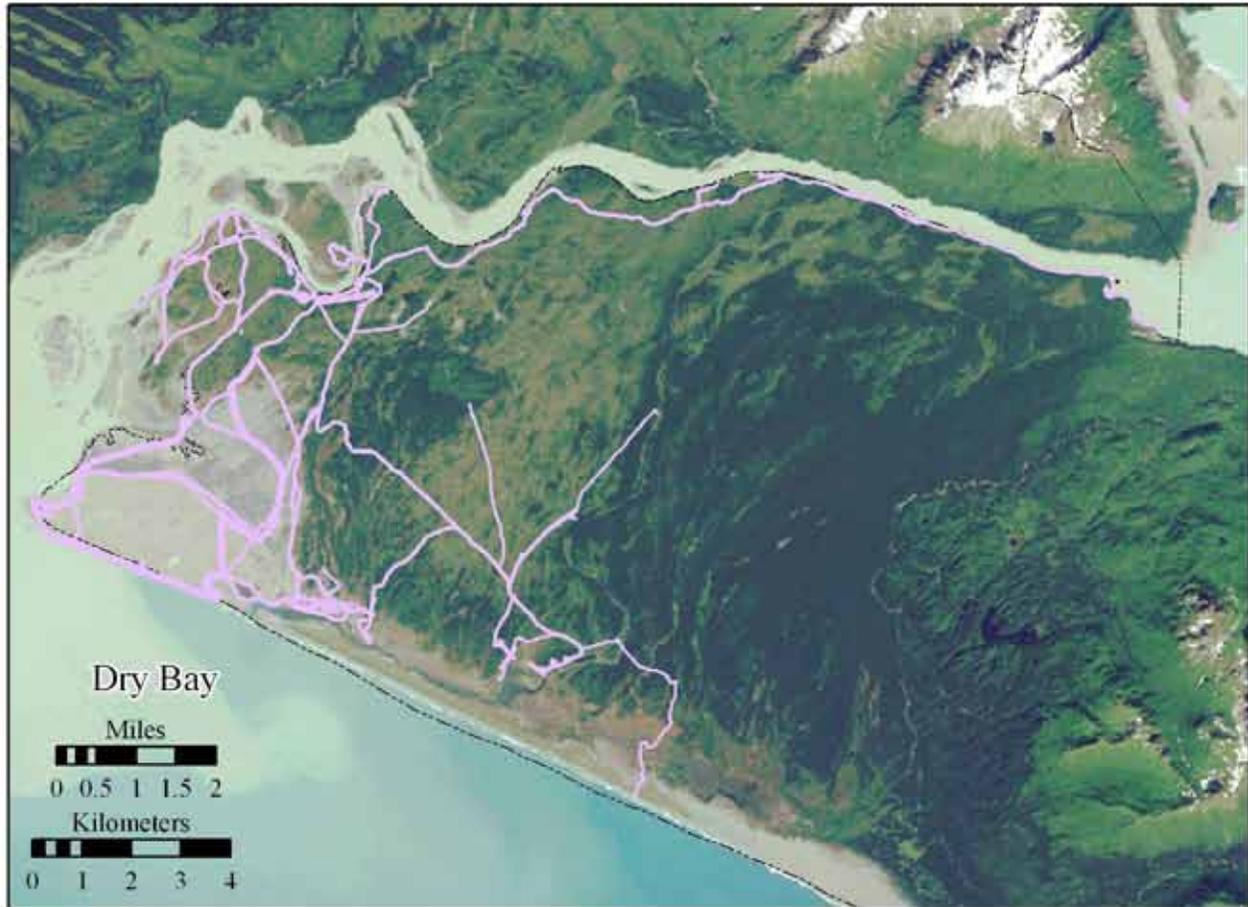
Alaska Region
Exotic Plant Management Team
Projection: UTM 8N, NAD 83
Created: September 2009



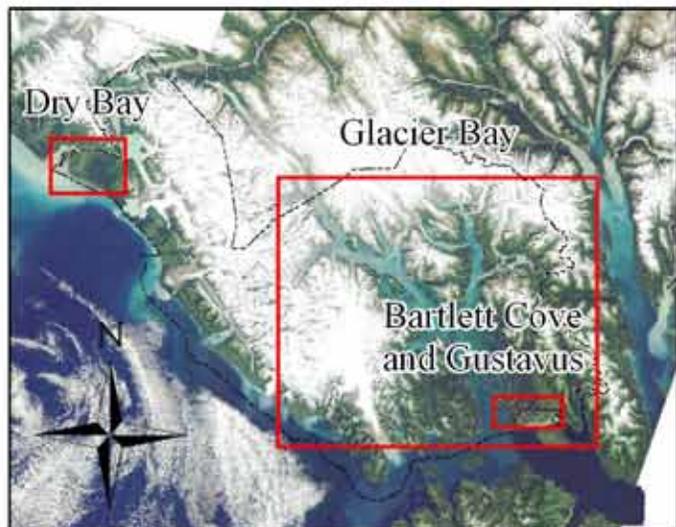
Common Dandelion - *Taraxacum officinale* ssp. *officinale*



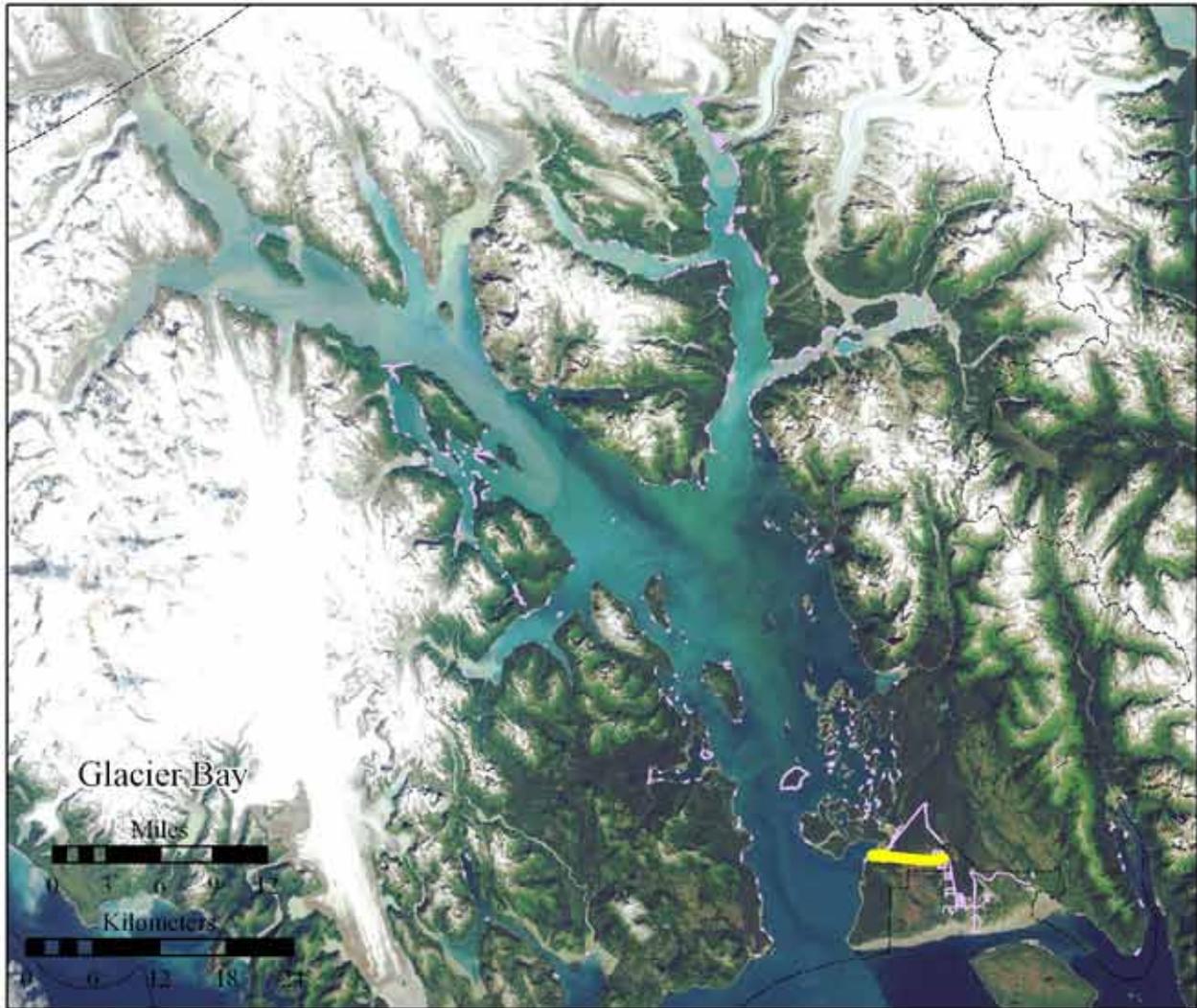
Common Wheat - *Triticum aestivum* in Glacier Bay National Park and Preserve



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Created: September 2009



Common Wheat - *Triticum aestivum*



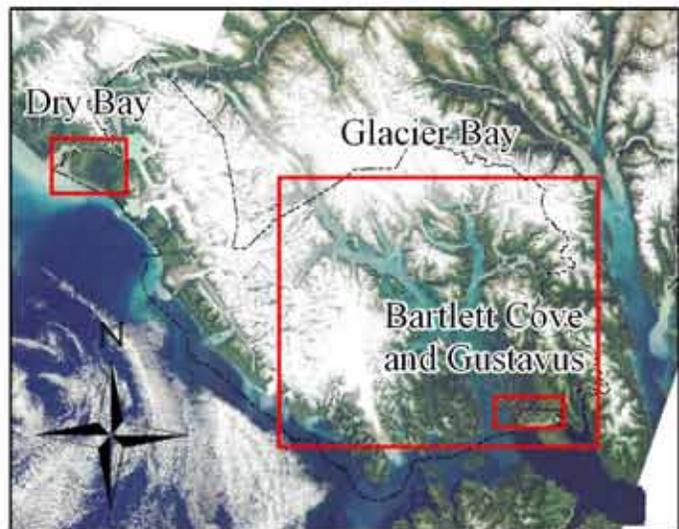
Alsike and Red Clover - *Trifolium hybridum* and *Trifolium pratense* in Glacier Bay National Park and Preserve



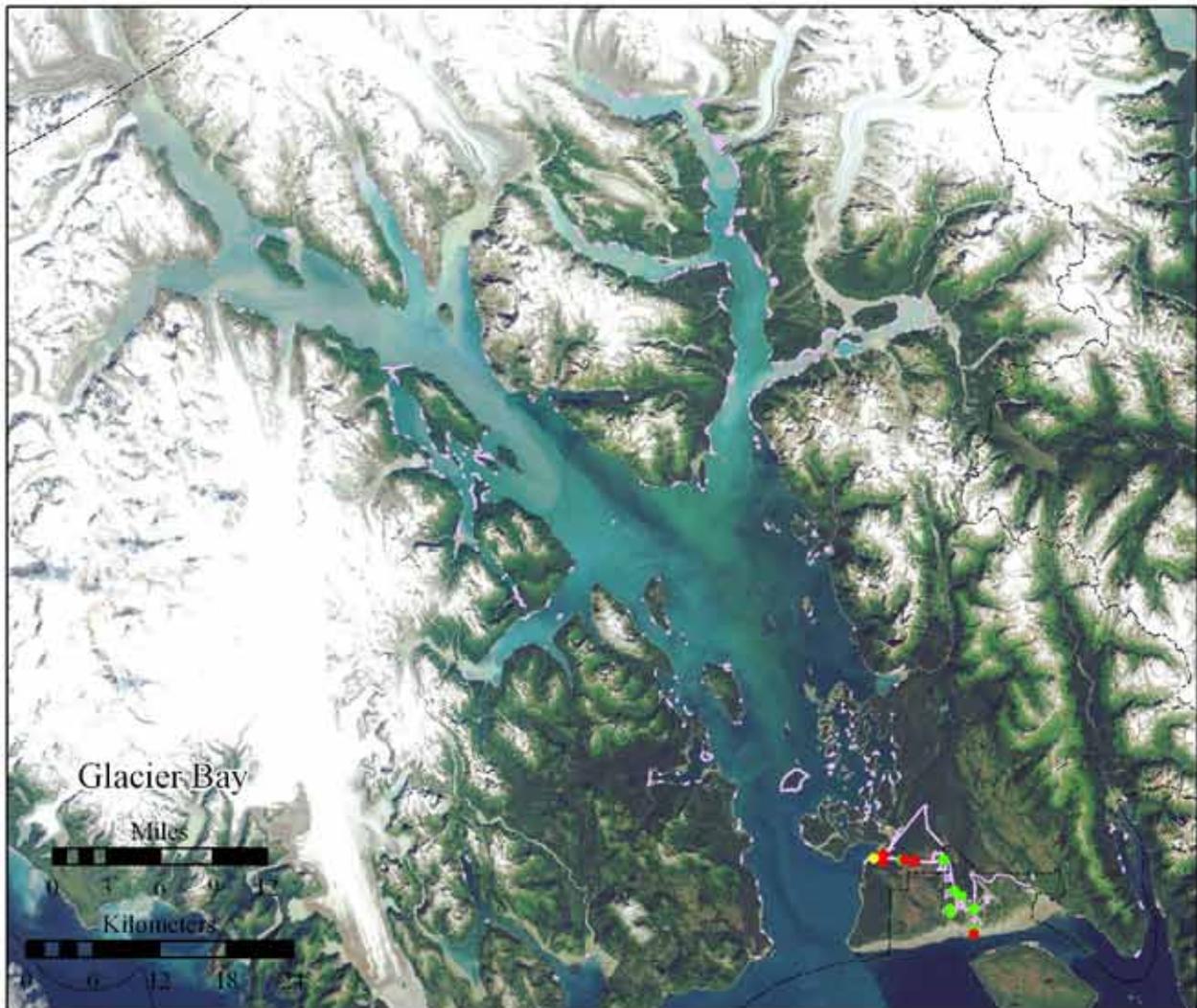
- Controlled by 2009
- Treated between 2004-2009
- Present between 2004-2009
- Absent in 2004-2009 Surveys
- GLBA Boundary



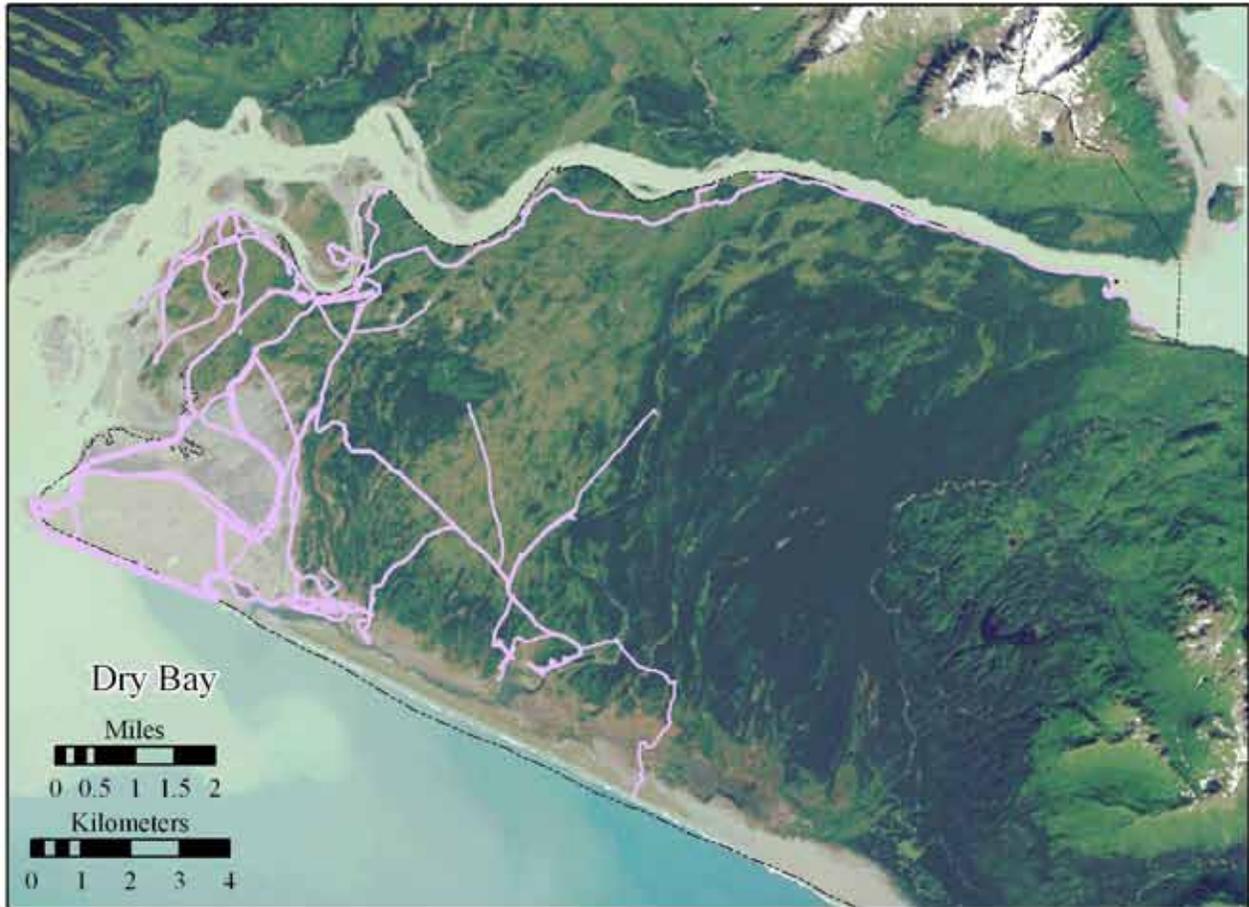
Alaska Region
Exotic Plant Management Team
Projection: UTM 8N, NAD 83
Created: September 2009



Alsike and Red Clover - *Trifolium hybridum* and *Trifolium pratense*



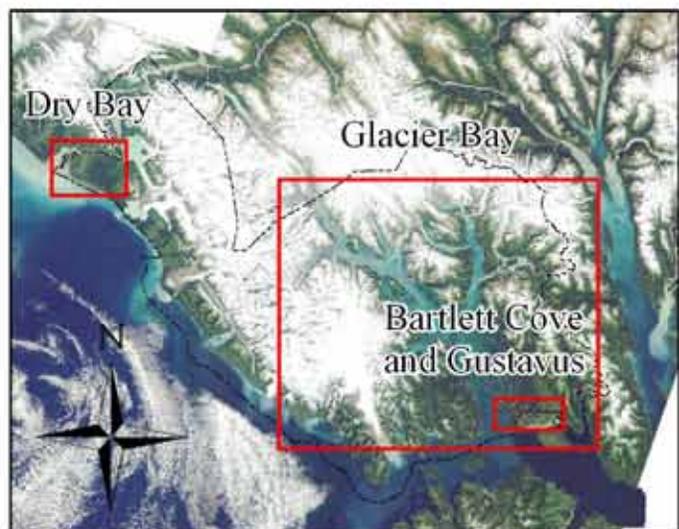
White Clover - *Trifolium repens* in Glacier Bay National Park and Preserve



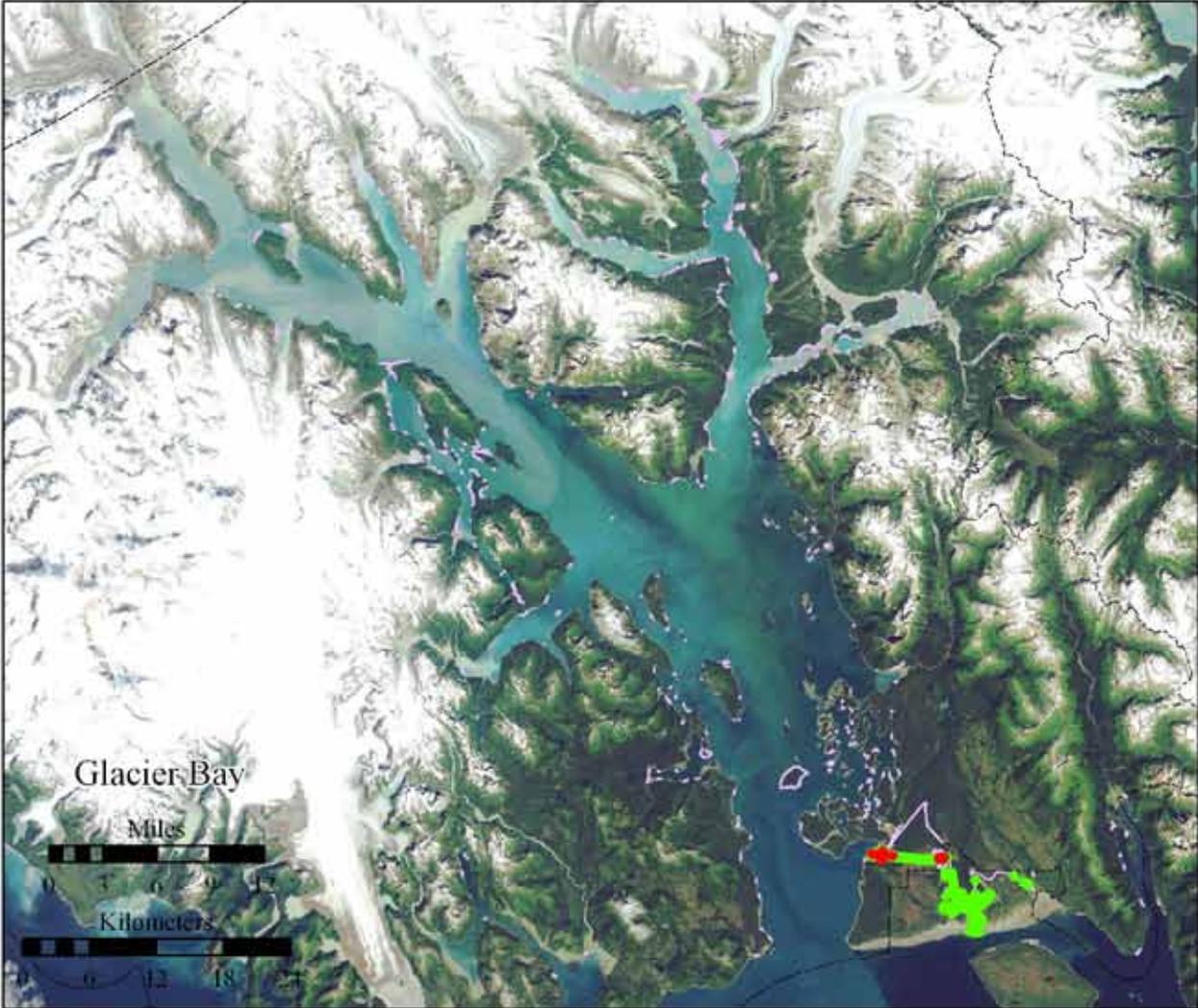
- Controlled by 2009
- Treated between 2004-2009
- Present between 2004-2009
- Absent in 2004-2009 Surveys
- GLBA Boundary



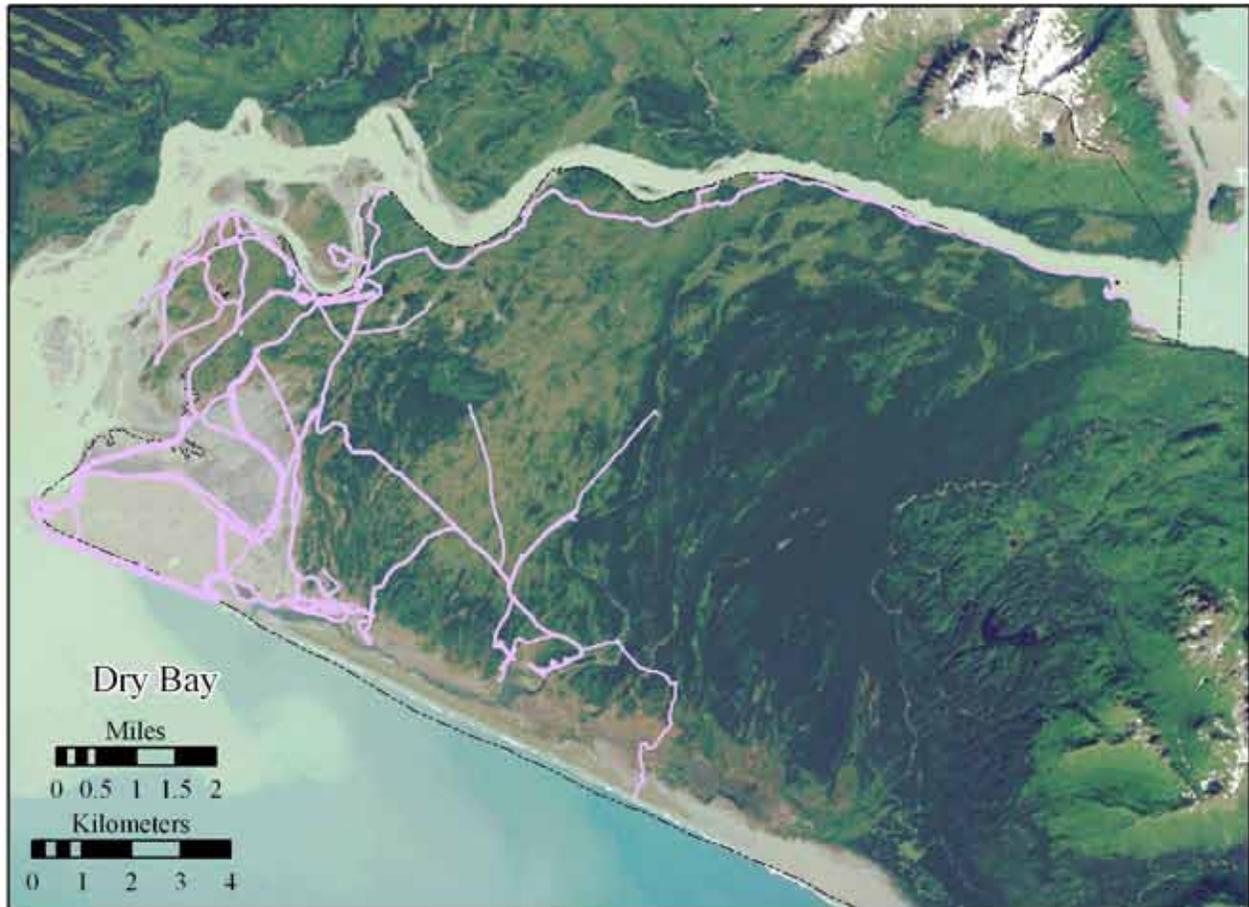
Alaska Region
Exotic Plant Management Team
Projection: UTM 8N, NAD 83
Created: September 2009



White Clover - *Trifolium repens*



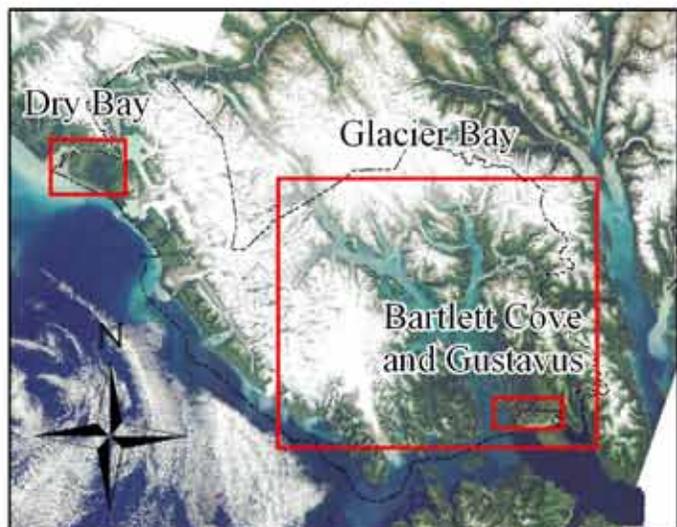
Thyme-Leaf Speedwell - *Veronica serpyllifolia* ssp. *serpyllifolia* in Glacier Bay National Park and Preserve



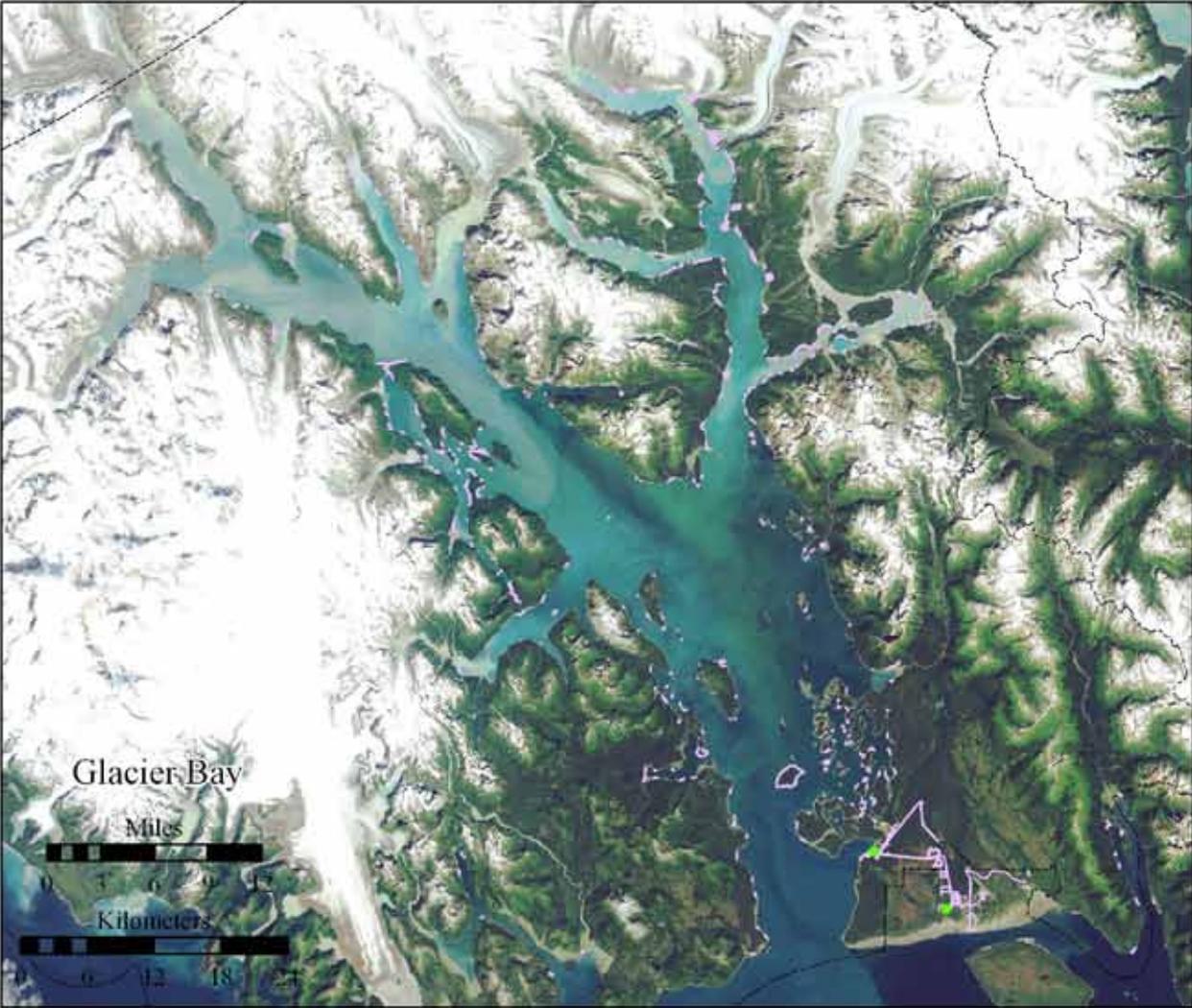
- Controlled by 2009
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- Present between 2004-2009
- Absent in 2004-2009 Surveys
- GLBA Boundary



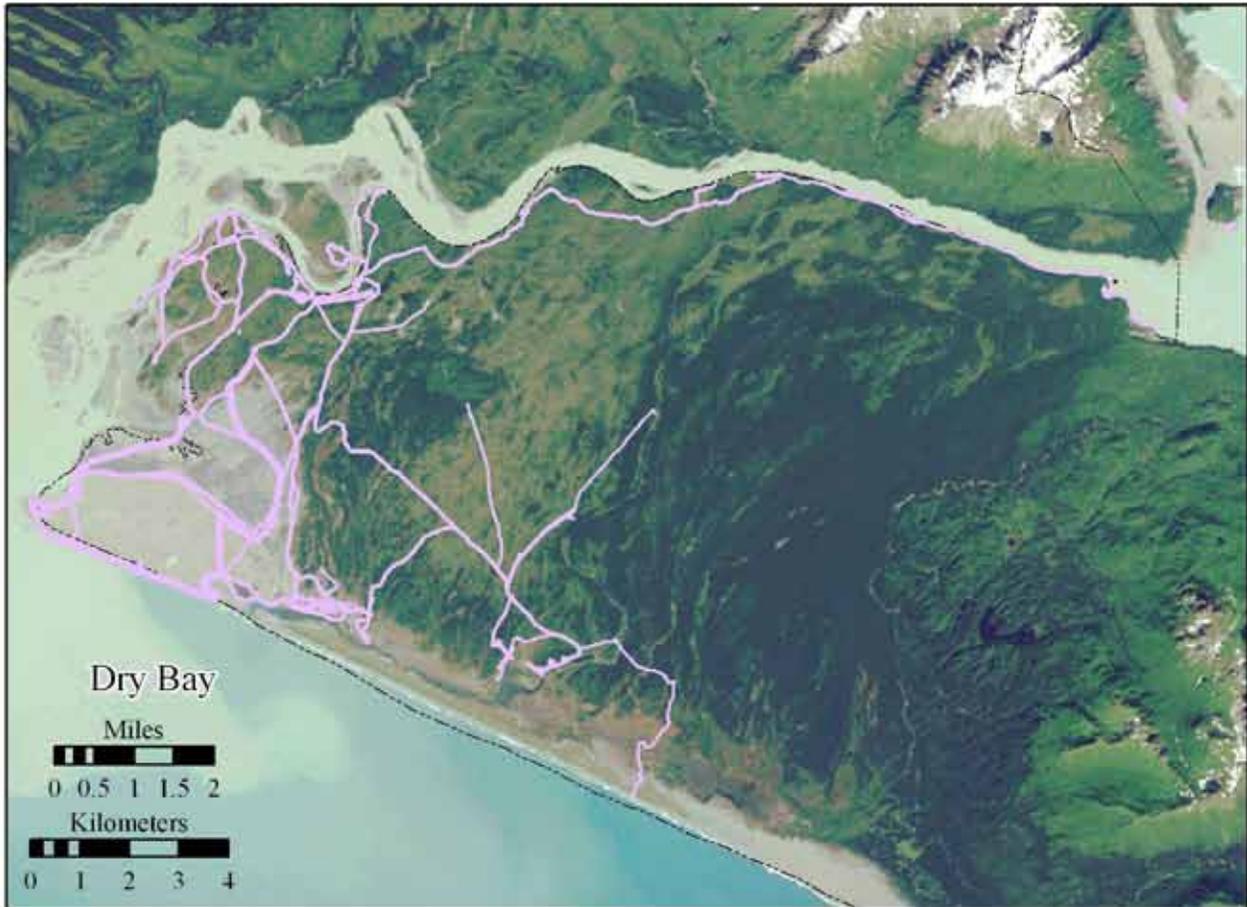
Alaska Region
 Exotic Plant Management Team
 Projection: UTM 8N, NAD 83
 Created: September 2009



Thyme-Leaf Speedwell - *Veronica serpyllifolia* ssp. *serpyllifolia*



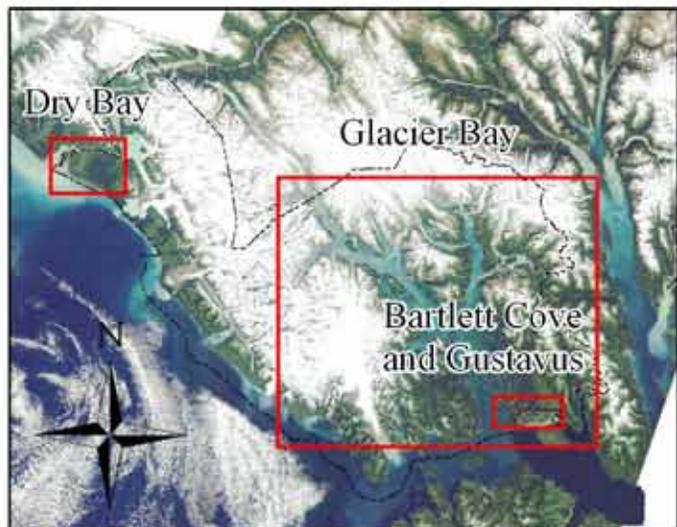
Johnny-Jump-Up Violet - *Viola tricolor* in Glacier Bay National Park and Preserve



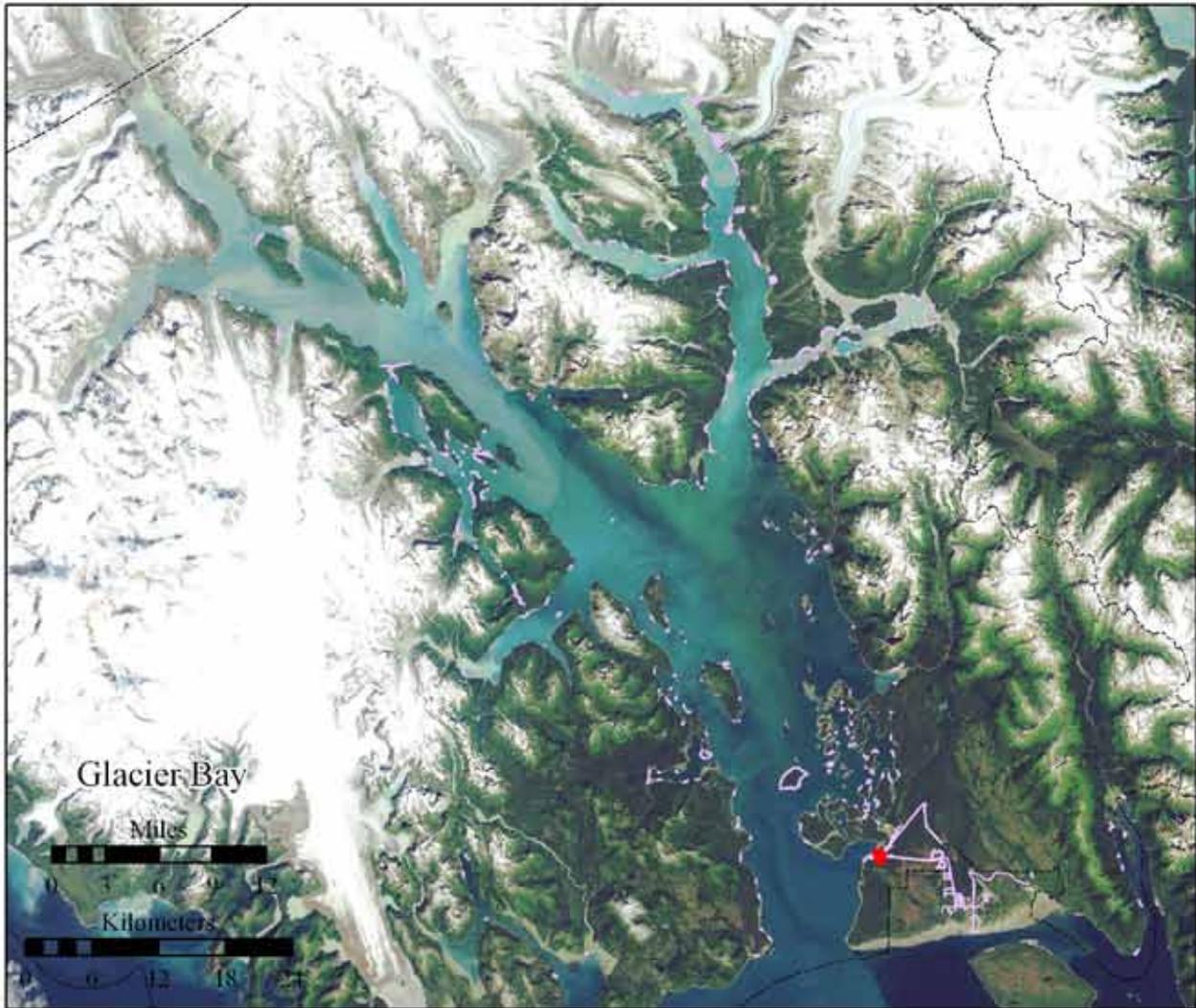
- Controlled by 2009
- Treated between 2004-2009
- Present between 2004-2009
- Absent in 2004-2009 Surveys
- GLBA Boundary



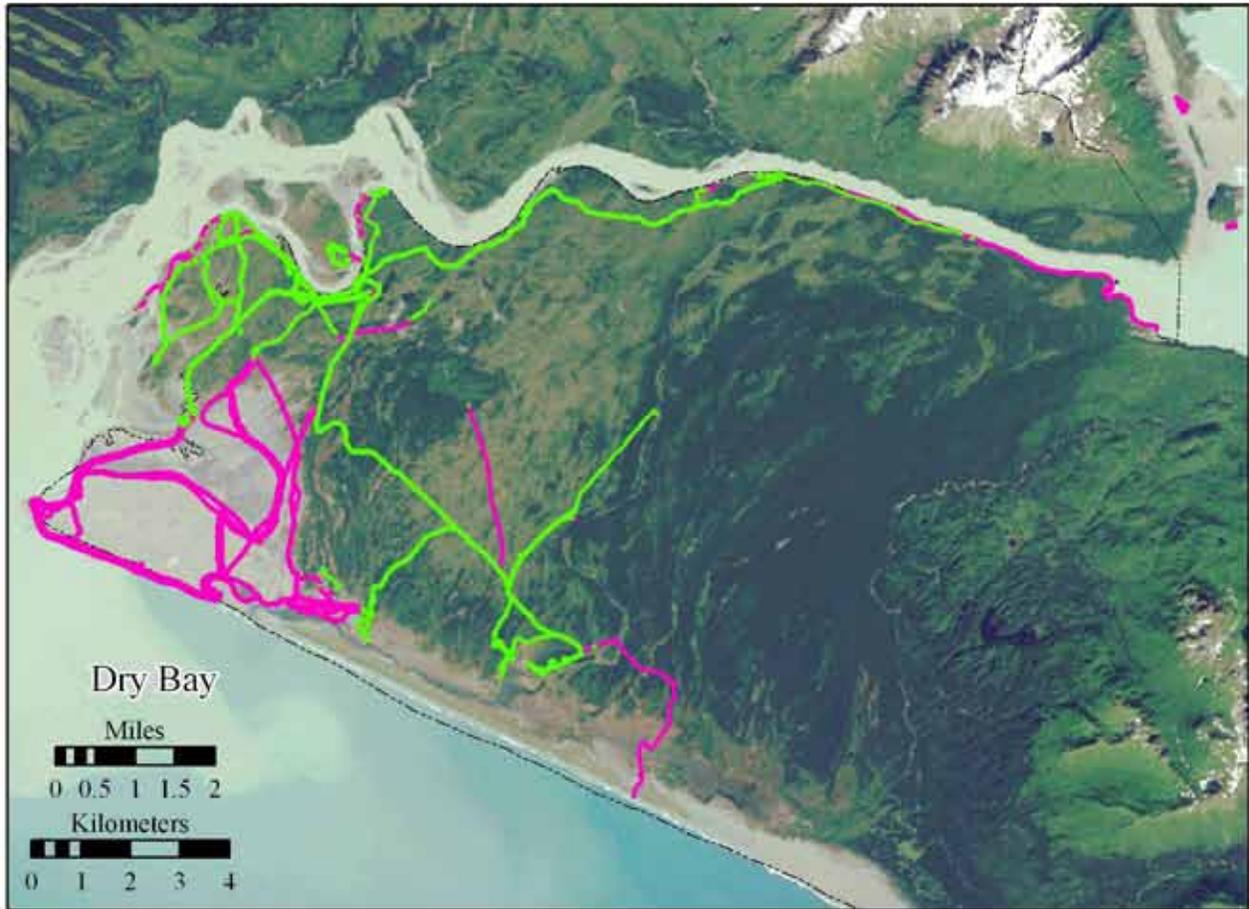
Alaska Region
Exotic Plant Management Team
Projection: UTM 8N, NAD 83
Created: September 2009



Johnny-Jump-Up Violet - *Viola tricolor*



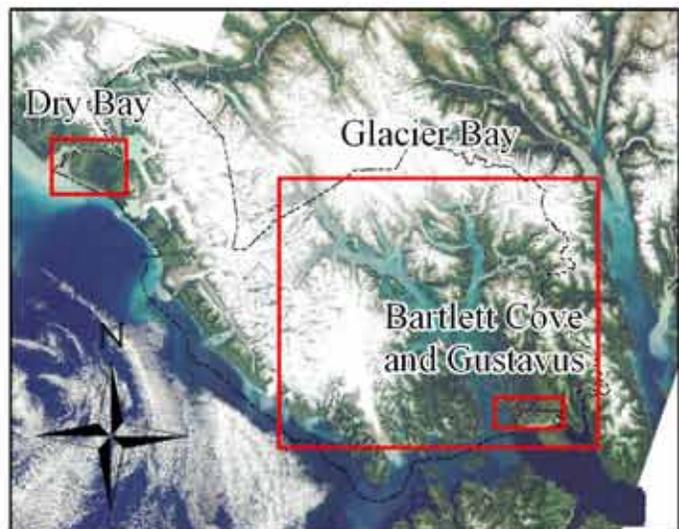
Presence/Absence of Invasive Plants in Glacier Bay National Park and Preserve



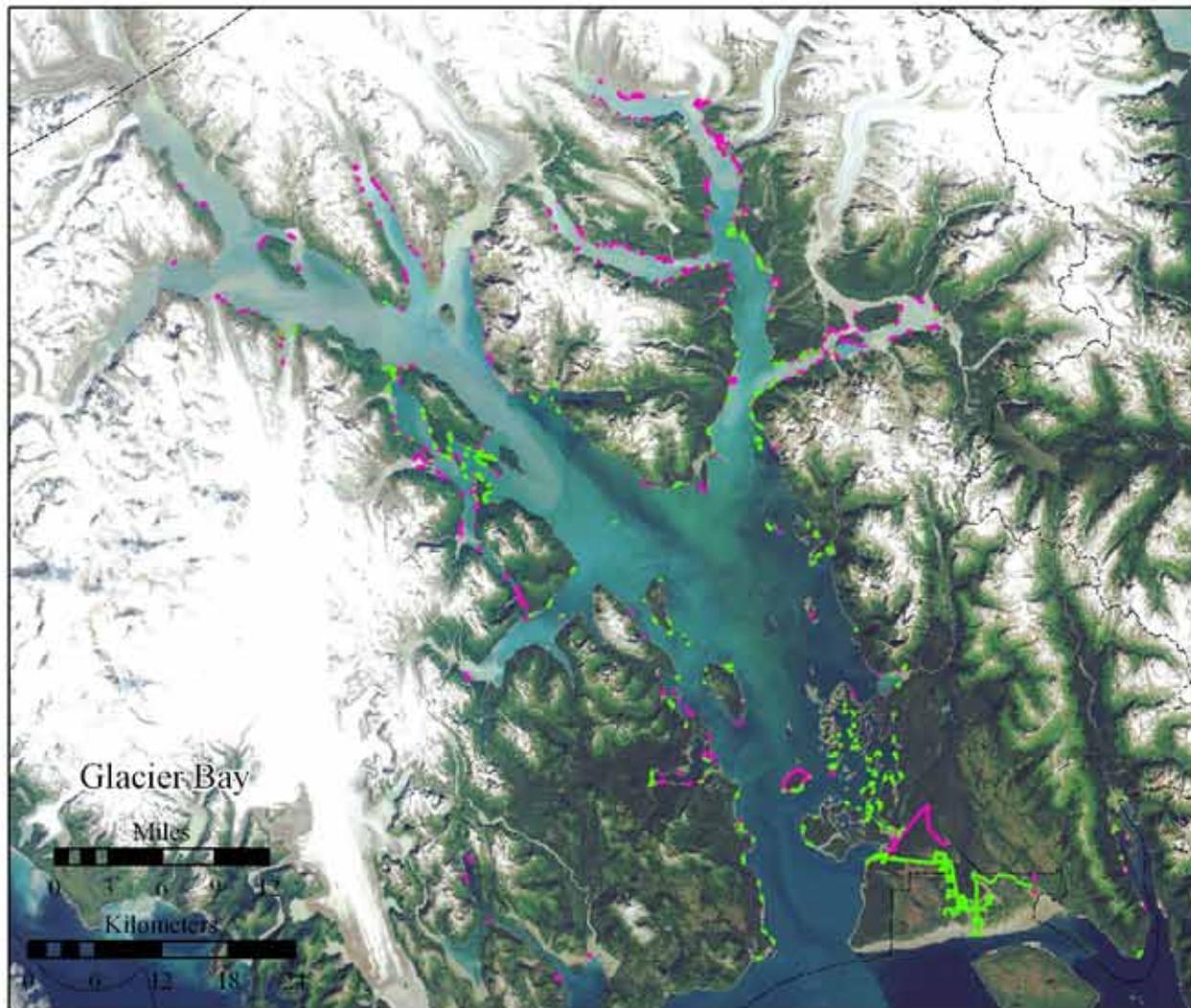
- Invasive Plant Present
- No Invasive Plants
- GLBA Boundary



Alaska Region
 Exotic Plant Management Team
 Projection: UTM 8N, NAD 83
 Created: September 2009



Presence/Absence of Invasive Plants



Appendix C – Best Management Practice Recommendations

BEST MANAGEMENT PRACTICE RECOMMENDATION: GLACIER BAY NATIONAL PARK AND PRESERVE

Linnea Rowse – August 2007

Amended by Whitney Rapp – January 2008

A nonnative species is any animal or plant that occurs in a given location as a result of direct, indirect, deliberate, or accidental actions by humans (NPS). The purpose of the National Park Service is “...to promote and regulate the use of the...national parks...which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.” As such, nonnative species should be prevented from initially entering the park, and if they have already been established in the park, measures need to be taken to prevent further spread. This document establishes a set of guidelines for preventing the introduction and spread of invasive plant species in Glacier Bay National Park and Preserve.

1) Disturbance due to construction or other activities

a) Pre-construction site preparation

- Inventory native and invasive plants prior to disturbance and complete necessary control of invasive plants.
- Collect native seeds from the site and transplant native plants to a nursery area.
- Stockpile topsoil for use after construction.
- Install fences around the site to minimize the impact area and to minimize soil compaction.
- Thoroughly clean all construction equipment to prior to entry into the park or before use. High-pressure washing of the body, wheels, and undercarriage of vehicles can be done at the Glacier Bay National Park maintenance facility.
- Set up a weed-free staging area for vehicle inspection prior to entry into the construction site.
- Minimize or avoid travel through weed-infested areas, especially during a seed production period.

b) Post-construction

- After construction, workers need to check their clothing for seeds or plant parts and properly dispose of any they find.
- Clean equipment if used in an area with invasive plants.
- Any fill materials (e.g. gravel or topsoil) or seed mixes for revegetation need to be “certified weed free”.

c) Edge management

- Control weeds along edges of roads, runways, and trails to reduce the spread of invasive plants via transport on maintenance equipment or vehicles.
- Complete weed control prior to maintenance activity along edges.

2) Recreational user or researcher park access

a) Bartlett Cove

- Visitor Information Station staff should include an information section on invasive plant awareness in the camper orientations.
- Visitors should clean off boots, clothing, and gear before entering the park by road or from watercraft.
- Pet owners should check pets for seeds before entering the park.

b) Backcountry

i) Personal gear

- Clean boots, packs, clothing, tents, and other equipment in a control area within Bartlett Cove or prior to entry into the park.
- The Bartlett Cove campground is a suitable control area, considering the relative ease of removing invasive plants that might grow in this area versus controlling invasive plants in the backcountry.

ii) Vehicles

- Clean all vehicles entering the backcountry of the park prior to entry.
- Inspect airplanes before and after use of unpaved airstrips.
- Clean plant material off float planes when moving from one location to the next in the backcountry.
- Regularly clean all-terrain vehicles (ATVs) of mud and organic matter to prevent the spread of seeds and other viable plant parts.
- Thorough cleaning includes the body, undercarriage, and wheels of a vehicle.

3) Revegetation

a) Collect native plant seeds annually to more easily facilitate revegetation in disturbed areas.

b) Transplant native plants from a land disturbance site prior to the event.

- Set up a nursery for storage of native plants during disturbance.
- After disturbance has occurred, replant the native plants to instigate revegetation and reduce growth and spread of invasive plants.
- Continue to monitor and control invasive plants following disturbance and revegetation efforts.

For further reference:

Alaska committee for noxious and invasive plants management. <http://www.uaf.edu/ces/cnipm/>.

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http://165.83.62.205/NatRes/EPMT/Pages/EPMT_Home.html.

Gladmon, C. Seed Collection Protocol 2006. August 2006.

Invasive species management: A strategic plan for managing invasive nonnative plants on National Park System lands.
http://www.nature.nps.gov/biology/invasivespecies/strat_pl.cfm.

National Sustainable Agriculture Information Service. <http://attra.ncat.org/attra-pub/nursery.html#integrated>.

Preventing noxious weed invasion, from the Montana State University Extension Service.
<http://www.montana.edu/wwwpb/pubs/mt9517.html>.

Suggested construction contract wording for weed prevention.
<http://www.dcnr.state.pa.us/forestry/invasivetutorial/Prevention.htm#suggested>.

Weeds gone wild: Alien plant invaders of natural areas.
<http://www.nps.gov/plants/alien/bkgd.htm>.

Wright, Stoney J. Alaska Revegetation Manual
http://www.dnr.state.ak.us/ag/pmcweb/PMC_reveg.htm