



Exotic Plant Management in Acadia National Park, Maine

2019 Annual Report

ACAD NR Report #: 2020-01



ON THE COVER

(Biotech Jim Burka treats Canada thistle behind Sand Beach: July 2020)

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Maine**

2019 Annual Summary Report

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Executive Summary

In 2019, Acadia National Park's (ANP) Invasive Plant Management Team (IPMT, formerly Exotic Plant Management Team) **surveyed just over 1295 acres** to detect the presence of **26 high-priority** invasive plant species including the park's biggest threats; glossy buckthorn (*Rhamnus frangula*), Japanese barberry (*Berberis thunbergii*), Asiatic bittersweet (*Celastrus orbiculatus*), and exotic bush honeysuckle (*Lonicera morrowii* and other *Lonicera* spp.). Surveying involves careful, thorough and systematic field inspections of infested sites or potentially infested sites to locate invasive plants (see **Figure 1** for treated and searched areas). It also allows team leaders the opportunity to identify potential hazards and plan follow-up treatments.

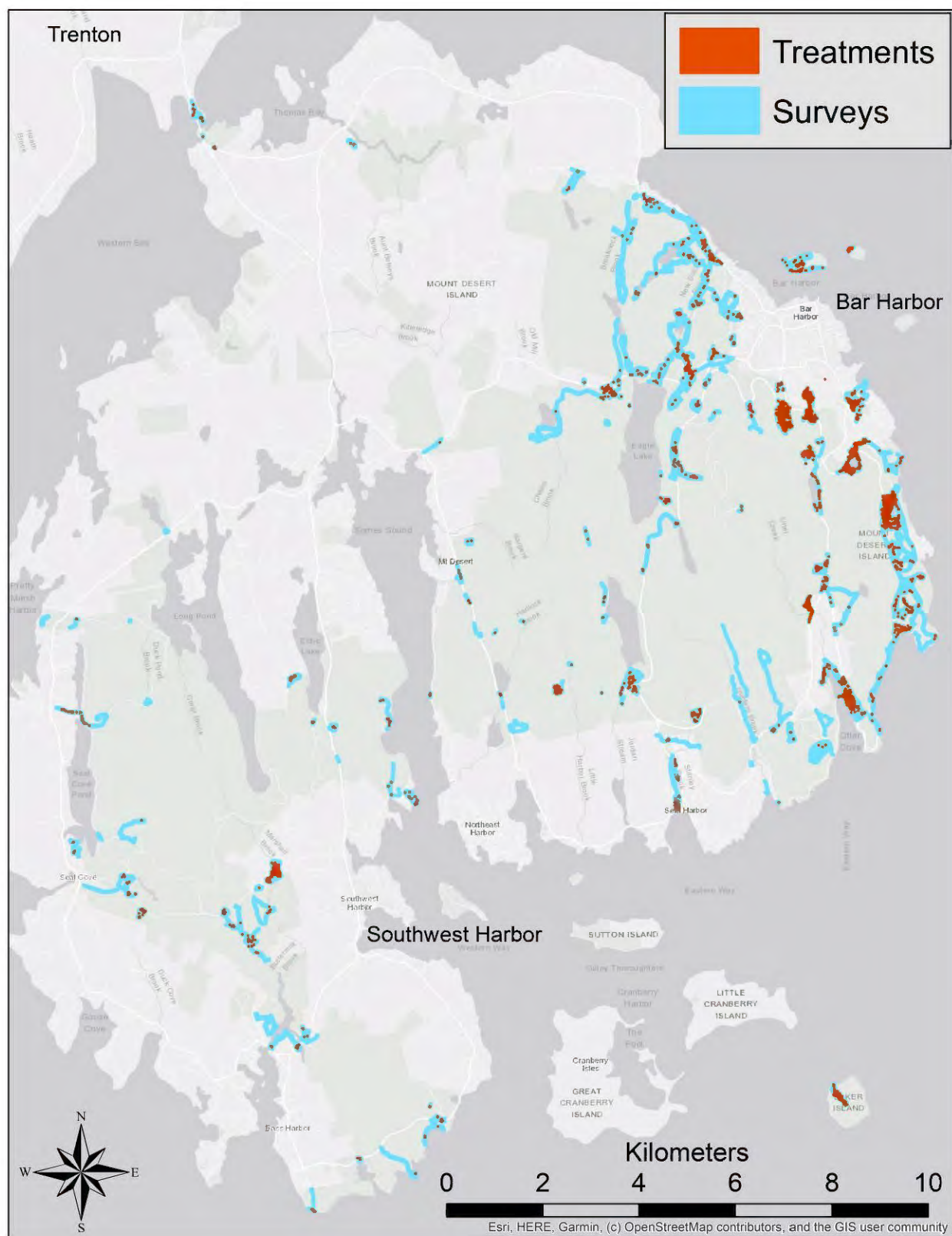
The IPMT treated **1.52 infested acres*** (approx. 50% decrease from 2018) of invasive plants (**Figure 2**) at **106 project sites** (approx. 45% increase from 2018). This means if you clumped together all the invasive plants that were treated on all sites they would cover 1 ¼ football fields. Most of the record number of project sites were small and consisted of follow-up treatments from the year before – this explains the drastic reduction of infested acres.

We have managed several species at our population goals of either “full suppression” or “reduced below maintenance level effort”. These include; Amur maple (*Acer ginnala*), autumn olive (*Elaeagnus umbellata*), burning bush (*Euonymus* spp.), giant hogweed (*Heracleum mantegazzianum*), Amur honeysuckle (*Lonicera mackii*), Japanese honeysuckle (*Lonicera japonica*), spotted knapweed (*Centaurea stoebe*), multiflora rose (*Rosa multiflora*), and foxglove (*Digitalis purpurea*). Most of the remaining species have made progress toward their management goals during 2019. The four-person crew logged over **1,562 hours** (with volunteers contributing an additional **62 hours**) toward managing invasive plants and rehabilitating landscapes.

In 2019 the team continued to develop and maintain partnerships with local and state organizations, increased outreach efforts through public talks, presenting posters at events, educated interested visitors and local landowners, and maintained commercial pesticide applicator licenses. We continued to maintain native plantings in cultural landscapes at Sieur de Monts, and assisted with a revegetation research project on the Cadillac Mountain summit. The IPMT monitored transects and plots for glossy buckthorn, purple loosestrife (*Lythrum salicaria*), and Norway maple (*Acer platanoides*), and assisted visiting scientists in setting up and collecting data for their experimental vegetation plots. Norway maple management began in earnest with the first round of treatments in January 2018, followed by a larger second round in November, focusing on larger specimens using both cut-stump and hack-and-squirt methods.

Direct program costs for the fiscal year 2019 was \$288,717. This program is funded primarily through four grants and other “soft” funding sources, including NPS recreational fee revenues, Centennial matching funds (NPS & Donation), and donations from Friends of Acadia. This figure includes personal services for the crew and a portion of the park's Vegetation Program Manager's salary, as well as supplies, equipment, and limited training and travel.

**{Infested acres are defined as the total area of leaf canopy cover of invasive plant species at 100% density. In other words, this figure represents the total acreage that would be covered if the entire leaf canopy area of all treated invasive plants were gathered together at full coverage.}*



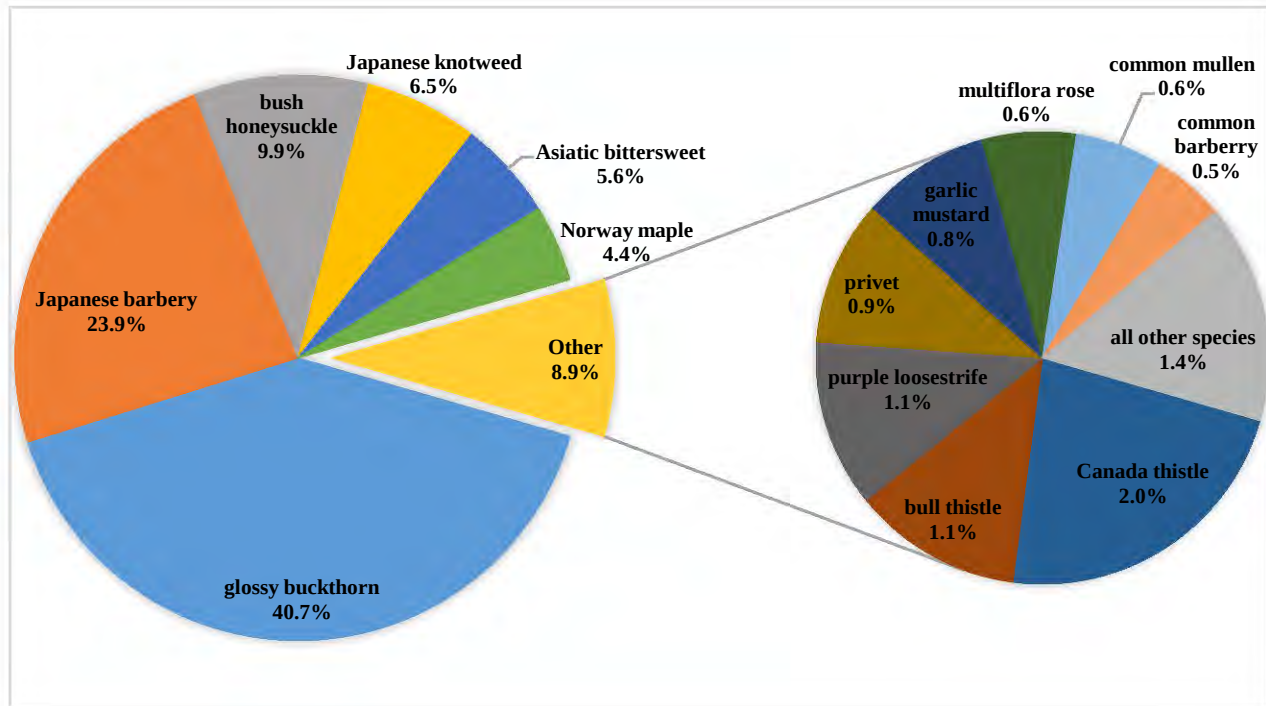


Figure 2. Pie graph of total EPMT treated acres (**1.52 acres**) for all species in 2019. Species grouped together in the “all other species” section of the right graph acres include: narrow leaf bitter cress, spotted knapweed, purple foxglove, autumn olive, winged burning bush, dames rocket, yellow flag iris, golden chain tree, Japanese honeysuckle, black locust, and coltsfoot in order of infested acres treated.

Goals and Management Objectives

Identified as a key issue in Acadia’s Foundation Document (2016), nonnative invasive species negatively impact natural and cultural resources. Managers have been managing invasive plants at Acadia since 1989 and has had a dedicated program addressing these problems since 2008.

The Acadia National Park Invasive Plant Management Program goals are to:

- (1) Preserve healthy habitats using **Early Detection and Rapid Response (EDRR)** to prevent invasive plant populations from becoming established;
- (2) **Manage existing populations** of invasive plants to prevent their spread and reduce their populations to thresholds under which they no longer adversely impact native ecosystems (Fully suppressed / Maintenance level); and,
- (3) Employ a professional crew that **safely, effectively and efficiently meets the park’s invasive plant management needs** using a science-based Integrated Pest Management (IPM) approach.

The IPMT's goal regarding established populations of invasive plants is to first remove mature, reproductive plants to prevent further seed production (initial attack), and then to reduce the population of all managed invasive plant species to < 1% total cover of the management unit (suppression; see **Figure 2** below). Afterward, the site is below our management threshold and is monitored regularly to determine the need for follow-up, maintenance level treatments, and detection of any new or recurring invasions. Ideally, sites at a level below management threshold are monitored once a year for three years; if invasive plants are absent by that point, monitoring frequency will reduce to once every five years. Although initial treatment efforts can be time- and labor-intensive, once invasive plant populations have significantly reduced the management of low-level populations through cyclic maintenance requires much less investment.

Park resource managers have also developed management goals for 23 invasive plant species of greatest concern; including targets for the 2020 field season (see **Table 1** below). Although there are more than 23 IEP species in the park, these particular species were chosen for active management based on species biology, invasive plant inventories and management plans (Reiner and McLendon 2002, Greene et. al. 2004, and Weber and Rooney 2007), and where control is prudent and feasible (NPS Management Policies 4.4.4, 2006). We then prescribe management plans based on NPS Integrated Pest Management approaches, with maximum efficacy and minimum toxicity. Eleven other species are also listed in **Table 1** which are either incidentally managed when treating other targets or are under monitoring and review.

Personnel involved with invasive plant management were Term Biological Technicians Jesse Wheeler and Nicholas (Nick) Stevenson, as well as Seasonal Biological Technicians Alexander (Alex) Fetgatter and James (Jim) Burka. The State of Maine's Board of Pesticide Control licensed all employees as Commercial Pesticide Applicators. Jesse, Alex, and Nick maintained Commercial Master level, while Jim maintained a Commercial Operator certification. This document reports all activities related to invasive plant management for the year 2019.

Table 1. Management status of invasive exotic plant species in 2019 and 2020 management goals for Acadia National Park.

Population Goal				Level of Effort		Targeting Strategy	
Below Management Threshold = Density or cover below Management level threshold (no reproductive plants known, very few immature plants). Not actively managed, incidental only. Monitor sites for species reestablishment.				High = crew works on this plant for 100+ person hours/season		Active = Management time devoted specifically to this species, usually on an annual or recurring basis. Working toward maintenance level effort.	
Fully Suppressed = Known populations are small and very few, contain no known reproductive plants; seed bank may still be viable. Maintenance level effort only.				Medium = crew works on this plant for 30-100 person hours/season		Inactive = Management of species is not targeted due to low priority and/or incomplete management plan.	
Nearly Suppressed / Reduced = Known populations small and contain few reproductive individuals; seed bank managed regularly. Recent decrease of treated infested acres.				Low = crew works on this plant for 1-30 person hours/season		Incidental = Plant managed when encountered during targeted management of other species.	
Population Contained = Infested acres remain constant and established populations are prevented from spreading to uninfested areas.				Maintenance = New and small recurring populations only. Effort varies between Active (Low) and no treatment per year.		Rapid Response = Early detection species actively sought out and managed, if found.	
Population Unknown / Increasing = Extent of infestation unknown due to insufficient monitoring efforts or lack of knowledge. Species likely spread over many sites in Acadia.						Volunteer = Treatment carried out primarily by volunteers to improve outreach and education or efficiency.	
Species (by 2019 Infested Acres Treated)	Years Managed	2019 Effort / Targeting Strategy	Long-Term Goal	Population Status	Projected 2020 Effort / Strategy	Primary Treatment Method	Notes
Glossy buckthorn (<i>Frangula alnus</i>)	2006 - 2019	High / Active	Nearly Suppressed / Reduced	Population Increasing	High / Active	Foliar and cut stump herbicide	2019 new sites: Bass Harbor Marsh, Duck Brook Wetlands, Kent South
Barberry (Japanese, common) (<i>Berberis thunbergii</i> , <i>B. vulgaris</i>)	2006 - 2019	High / Active	Full Suppression	Population Unknown / Increasing	High / Active	Foliar and cut-stump herbicide	Large increase in 2019 effort due to new sites and returning to old ones
Bush honeysuckle species (<i>Lonicera spp.</i>)	2003 - 2019	High / Active	Full Suppression	Population Contained	High / Active	Foliar and cut stump herbicide	New sites in 2019 included New Mill Meadow field and historic points
Japanese knotweed (<i>Fallopia japonica</i>)	2003 - 2019	Medium / Active	Full Suppression	Population Contained	Medium / Active	Cutting then foliar herbicide	Milestone used in 2018 and 2019 on trial basis
Asiatic bittersweet (<i>Celastrus orbiculatus</i>)	2010 - 2019	High / Active	Full Suppression	Population Contained	High / Active	Foliar and cut-stump herbicide	Will likely have an increased effort in 2020
Norway maple (<i>Acer platanoides</i>)	2017 - 2019	Low / Active	Full Suppression	Population Contained	Low / Active	Cut stump herbicide	“Contained” means kept from natural areas
Canada thistle (<i>Cirsium arvense</i>)	2011 - 2019	Medium / Active	Reduce Below Mgmt. Threshold	Population Unknown / Increasing	Medium / Active	Foliar herbicide	Several small new sites found in 2019, widespread
Bull thistle (<i>Cirsium vulgare</i>)	2013 - 2019	Low / Active	Reduce Below Mgmt. Threshold	Population Unknown / Increasing	Low / Active	Hand pull	Hand pull second year, flowering stems; outer island population status unknown
Purple loosestrife (<i>Lythrum salicaria</i>)	1988 - 2019	High / Active	Full Suppression	Nearly Suppressed / Reduced	High / Active	Foliar herbicide and deadhead	
Privet (<i>Ligustrum spp.</i>)	2016 - 2019	Low / Active	Full Suppression	Nearly Suppressed / Reduced	Medium / Active	Cut stump and foliar herbicide	Anticipated privet in 2020 include Compass Harbor and Bar Island
Garlic mustard (<i>Alliaria petiolata</i>)	2003 - 2019	Medium / Active	Full Suppression	Nearly Suppressed / Reduced	Medium / Active	Hand pull	Some small sites have disappeared
Multiflora rose (<i>Rosa multiflora</i>)	2006 - 2019	Low / Active	Reduce Below Mgmt. Threshold	Nearly Suppressed / Reduced	Low / Active	Foliar herbicide	
Autumn olive (<i>Elaeagnus umbellata</i>)	2013 - 2019	Low / Rapid Response	Reduce Below Mgmt. Threshold	Below Mgmt. Threshold	Maintenance / Rapid Response	Foliar and cut-stump herbicide	Goal currently met
Burning bush (<i>Euonymus spp.</i>)	2011 - 2019	Low / Rapid Response	Reduce Below Mgmt. Threshold	Fully Suppressed	Maintenance / Rapid Response	Foliar and cut-stump herbicide	

Table 1 (continued). Management status of invasive exotic plant species in 2019 and 2020 management goals for Acadia National Park.

Species (by 2019 Infested Acres Treated)	Years Managed	2019 Effort / Targeting Strategy	Long-Term Goal	Population Status	Projected 2020 Effort / Strategy	Primary Treatment Method	Notes
Japanese honeysuckle (<i>Lonicera japonica</i>)	2012 & 2019	Maintenance / Rapid Response	Reduce Below Mgmt. Threshold	Fully Suppressed	Maintenance / Rapid Response	Foliar herbicide	Treated off great meadow drive (Ledgelawn) in 2019
European bittercress (<i>Cardamine impatiens</i>)	2005 - 2019	Low / Volunteer	Nearly Suppressed / Reduced	Population Unknown / Increasing	Low / Volunteer	Hand pull / foliar herbicide	Monitoring transects at Ledgelawn
Foxglove (<i>Digitalis purpurea</i>)	2003 - 2019	Maintenance / Rapid Response	Reduce Below Mgmt. Threshold	Fully Suppressed	Maintenance / Rapid Response	Hand pull	
Lupine (<i>Lupinus polyphyllus</i>)	2004 - 2017	Inactive / Volunteer	Population Contained	Population Contained	Low / Volunteer	Deadhead / hand pull	“Contained” means kept from natural areas goal currently met
Spotted knapweed (<i>Centaurea stoebe</i>)	2010 - 2019	Maintenance / Rapid Response	Reduce Below Mgmt. Threshold	Nearly Suppressed / Reduced	Maintenance / Rapid Response	Foliar herbicide / hand pull	
Yellow iris (<i>Iris pseudacorus</i>)	2003 - 2019	Maintenance / Incidental	Reduce Below Mgmt. Threshold	Population Contained	Low / Active	foliar and cut stump herbicide	Past treatments included seed pod removal
Amur maple (<i>Acer ginnala</i>)	2006 - 2016	Maintenance / Rapid Response	Full Suppression	Fully Suppressed	Maintenance / Rapid Response	Foliar and cut-stump herbicide	Goal currently met
Common reed (<i>Phragmites australis</i>)	2013- 2014	Maintenance / Rapid Response	Full Suppression	Not in Park Yet	Maintenance / Rapid Response	Foliar herbicide	Two sites on Mount Desert Island; one in wastewater treatment pools at SERC
Giant hogweed (<i>Heracleum mantegazzianum</i>)	2003 - 2018	Maintenance / Rapid Response	Full Suppression	Fully Suppressed	Maintenance / Rapid Response	Foliar herbicide	None found in 2019

Table 1 (continued). Management status of invasive exotic plant species in 2019 and 2020 management goals for Acadia National Park

Incidental / Under Review Species (by 2019 Infested Acres Treated)	Years Managed	2019 Effort / Targeting Strategy	Long-Term Goal	Population Status	Projected 2020 Effort / Strategy	Primary Treatment Method	Notes
Common mullein (<i>Verbascum thapsus</i>)	2011 - 2019	Low / Incidental	Population Contained	Population Unknown / Increasing	Low / Incidental	Hand pull	Large increase on The Hop in 2019
Golden chain tree (<i>Laburnum x watereri</i>)	2012 - 2019	Low / Incidental	Under Review	Population Contained	Maintenance / Inactive	Cut stump herbicide	
Common Burdock (<i>Arctium minus</i>)	2012 - 2019	Low / Incidental	Population Contained	Population Unknown / Increasing	Low / Incidental	Hand pull and digging	
Coltsfoot (<i>Tussilago farfara</i>)	2002 - 2019	Low / Incidental	Population Contained	Population Unknown / Increasing	Low / Incidental	Foliar herbicide	
Black locust (<i>Robinia pseudoacacia</i>)	2019	Low / Incidental	Under Review	Population Unknown	Low / Inactive	Cut stump herbicide	
Dames Rocket (<i>Herperis matronalis</i>)	2019	Maintenance / Incidental	Population Contained	Population Unknown / Increasing	Maintenance / Incidental	Hand pull	Treated at several sites in 2019
Bittersweet nightshade (<i>Solanum dulcamara</i>)	2012 - 2016	Inactive	Under Review	Population Unknown / Increasing	Inactive	Foliar herbicide	
Forest woodrush (<i>Luzula luzuloides</i>)	2011	N/A	Under Review	Population Unknown	Maintenance / Incidental	Foliar herbicide	Treat as found in natural areas for 2019
Ninebark (<i>Physocarpus opulifolius</i>)	2012	N/A	Under Review	Population Unknown	Inactive	N/A	Several escaped populations in the park
Reed canary grass (<i>Phalaris arundinacea</i>)	2010	N/A	Under Review	Population Unknown	Inactive	Foliar herbicide	
Shrubby St. John's-wort (<i>Hypericum prolificum</i>)	2008 - 2016	Inactive	Under Review	Population Contained	Low / Monitor Transects	Foliar herbicide	Monitor for population expansion outside Great Meadow

Management Activities by Species

Purple Loosestrife

Purple loosestrife (*Lythrum salicaria*) management continued in 10 wetland sites throughout ANP with no new locations documented in 2019. Marshall Brook and Beaver Dam Pond/Bear Brook continue to be the two areas in the Park where a modest number of blooming plants are still found, albeit in far fewer numbers compared to previous years. The EPMT surveyed and treated over 17 acres in Marshall Brook near Seal Cove Rd. and 16 acres around Beaver Dam Pond and Bear Brook. The area surveyed surrounding Beaver Dam Pond and Bear Brook was a four-fold increase over 2018. Interestingly, several *Galerucella* spp. beetles and beetle caused defoliation were seen on purple loosestrife plants in the Bear Brook area (**Figure 3**). This particular species of beetle are a common bio-control of purple loosestrife; some have been released in the area before, but none in the park.

The IPMT monitored all seven grids for purple loosestrife in 2019 at Bear Brook, Beaver Dam Pond, and The Tarn. We found similar patterns in 2019, with no flowering or vegetative stems encountered in monitoring transects at the Tarn or Beaver Dam Pond, but some vegetative stems were seen at Grids 6 and 7 at Bear Brook. Monitoring crews observed flowering stems just outside of transect locations.

The team checked wetlands where the flower has been seen in the past. Notable locations where purple loosestrife has been managed but was not found in 2019 were: Witch Hole, Eagle Lake, Kent Field South, Duck Brook Road Wetland, and Rt. 102 ditch near Eagle Lake Beach entrance.

Purple loosestrife management in Acadia continues to operate at modest levels. Annual time investments typically range between 30-100 person-hours, where most of this time is spent scouting wetlands for the signature purple flower. In 2019, the team spent more time than this range because of extra effort spent on Jackson Laboratory property and ANP areas of Bear Brook that had not seen management for several years. Infested acres remain low at “Nearly Suppressed / Reduced” levels, where control efforts are limited to a few flowering plants and some emerging new plants from the extant seed bank.



Figure 3. Galerucella beetle feeding on the foliage of purple loosestrife in Bear Brook. NPS photo, 2020.

Japanese Barberry

The acres of Japanese barberry treated in 2019 were more than double those in 2018. Most of this is due to several new sites discovered while checking historical reports mapped from 2003 to 2008. By far the largest of these is the Amphitheater site, located on the eastern slope of Cedar Swamp Mountain just uphill from the carriage road. This accounted for 60% of the year's barberry efforts (**Figure 4**). This population is unusual in that it is not obviously associated with historic land use and it occurs in an otherwise pristine forest environment. We established monitoring line transects here to measure treatment success over time. More survey work and follow up treatments are needed next year at this site. Other newly treated sites of note include Beech Hill Road, St. Sauvier, the Duck Brook Road Wetlands, and new populations off Seal Cove Road.

We surveyed and treated all known barberry sites around the Visitor Center, Witch Hole, and Duck Brook in the spring. Surveys were also expanded into surrounding areas to cover more historic reports, often finding small populations. The Lower Mountain Road was also re-visited, and new barberry patches were found on the uphill side of the road across from previously known infestations. The team found barberry up two creeks coming off the west slope of Cadillac Mtn., but more work is needed in 2020 north of the two waterways.

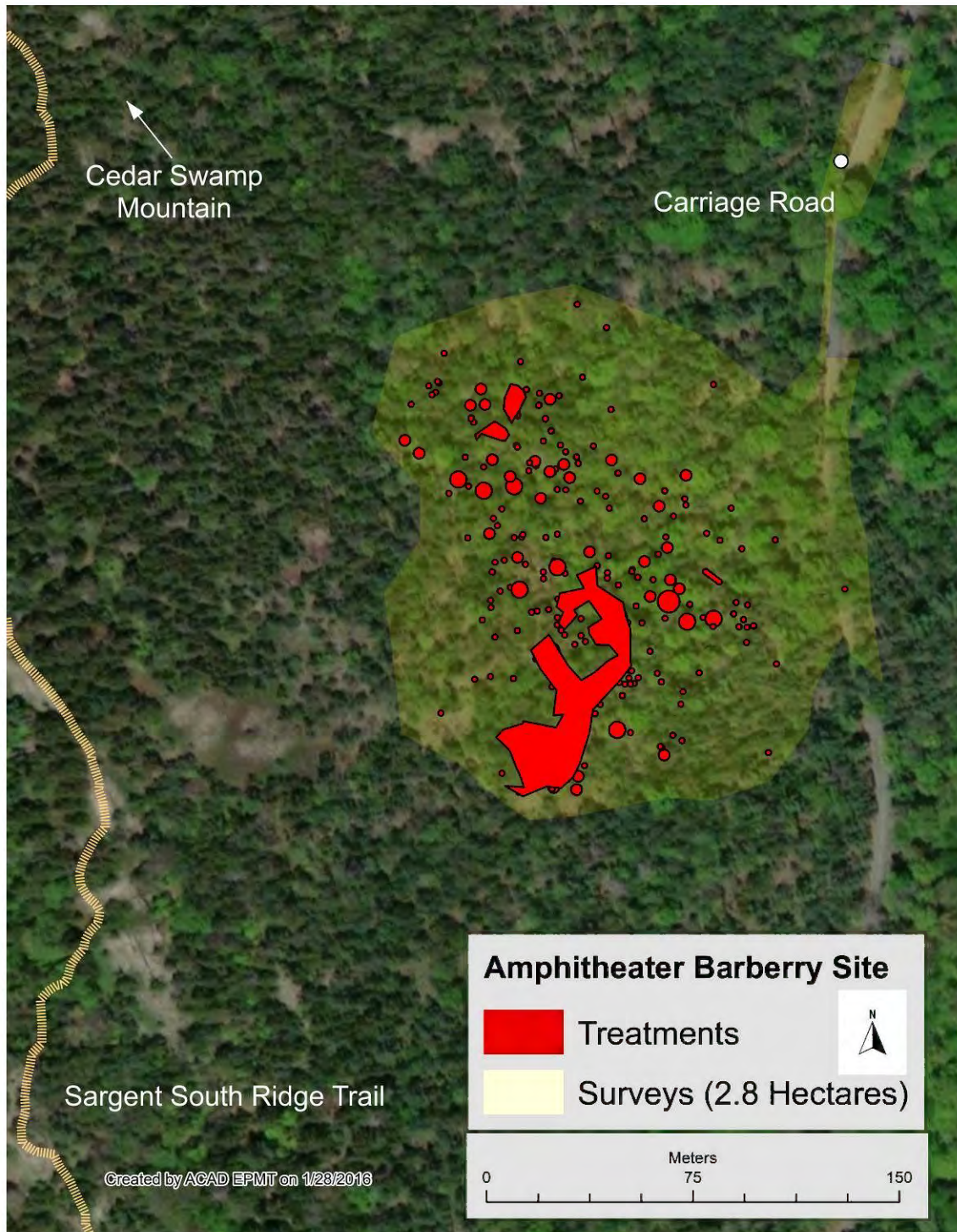


Figure 4. Japanese barberry work near the Amphitheater carriage road in 2019. Note the room for further surveys in the future.

Exotic Bush Honeysuckle

Invasive honeysuckle is one of the most ubiquitous species in Acadia National Park. In 2019 it was managed at 67 locations, and a few of these held large populations. The New Mills Meadow Field site was discovered while checking historically mapped points (1980s – 2000s) and it was found to be invaded by numerous mature honeysuckles as well as Japanese barberry, Canada thistle, and glossy buckthorn. These were treated twice during the field season (**Figure 5**), and accounted for 40% of the 2019 honeysuckle infested acres. Prior to treatment, the team also set up and assessed the park's first honeysuckle monitoring plots.

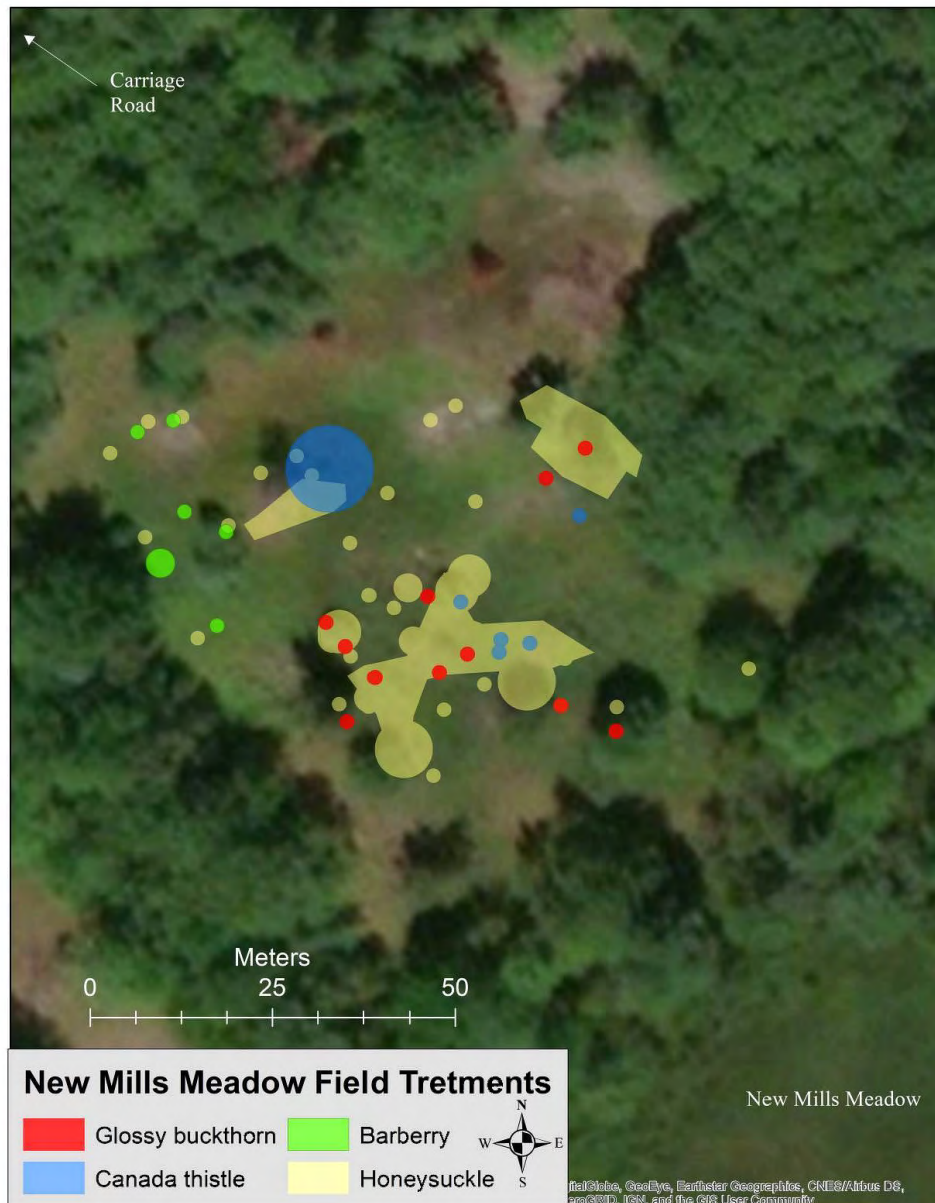


Figure 5. New Mills Meadow Field treatments in 2019. More infested acres of honeysuckle were treated here than anywhere else during this year.

Most of the park north and east of Otter Cove was also grid searched for honeysuckle and other exotic plants (**Figure 6**). Most of this area had never been surveyed, and scattered invasives were found and treated. New populations of honeysuckle were also found and treated at Saterlee Pit, Long Pond Fire Road, Seal Cove Road, and Adams Bridge. The other two big honeysuckle efforts occurred on Sheep Porcupine and The Hop islands and these are discussed in the “Outer Islands” section.

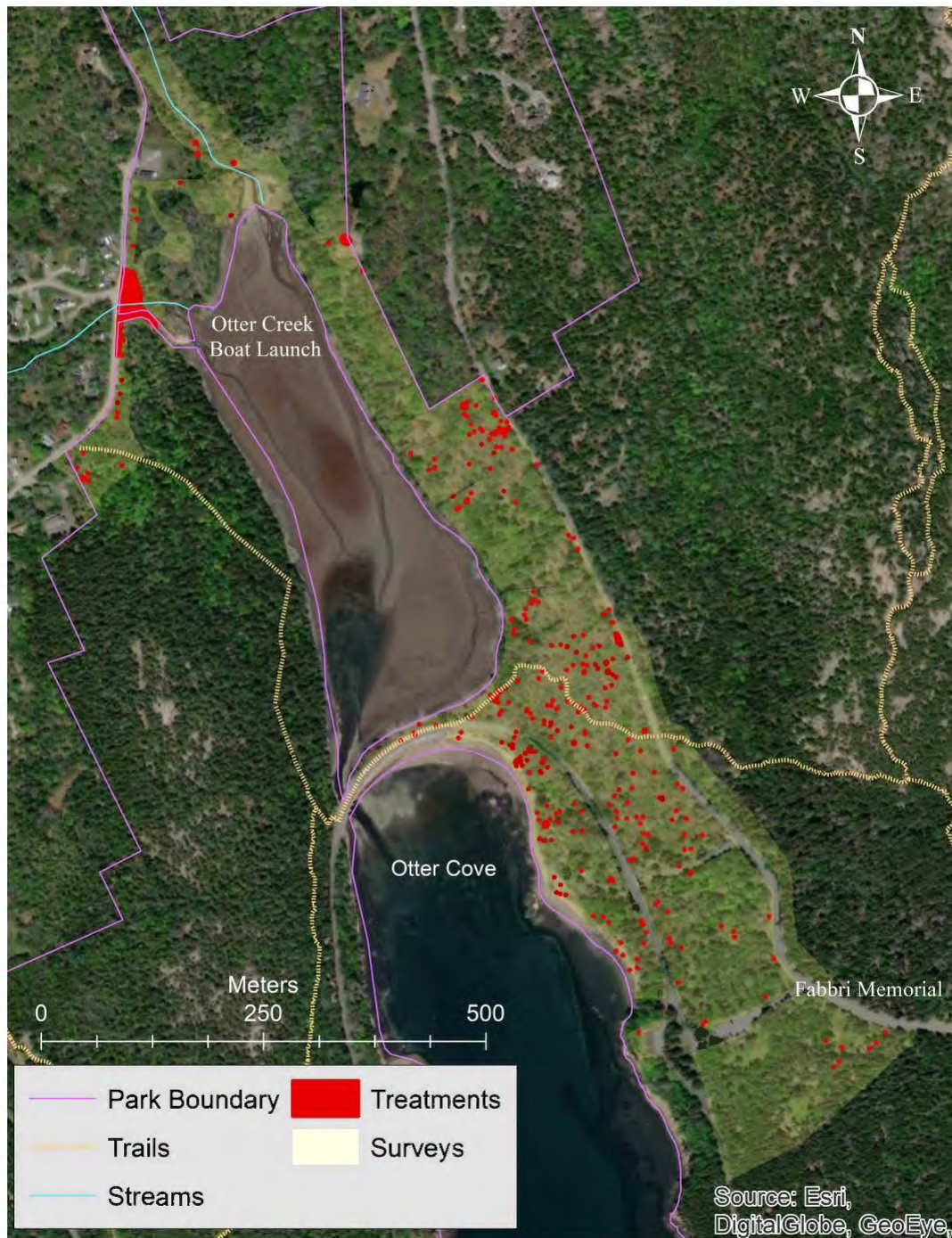


Figure 6. Greater Otter Cove treatments and surveys in 2019. Sections of this area had previously been treated, but this was the first time it was fully grid searched.

Norway Maple

Monitoring

In August 2019 the IPMT visited the 10 Norway maple (*Acer platanoides*) forest monitoring plots at Compass Harbor, Ledge lawn and Duck Brook to track changes in forest characteristics after the first round of treatments in January 2018. The most obvious change between the pre-removal of mature Norway maple and 2019 was the increased sunlight to the forest floor and the subsequent germination of tree seedlings. Though much of the canopy remained intact following Norway maple removal, there has been an explosion of young native and invasive tree seedlings. White ash (*Fraxinus americanus*, FRAAME), red maple (*Acer rubrum*, ACERUB), and Norway maple (ACEPLA) seedlings (<15 cm) increased substantially in Compass Harbor, where some plots had major increases in canopy gaps, particularly COHA plot #3. Ledge lawn plot #2 saw gains in white ash seedlings with small changes in the canopy, while Duck Brook plot #1 had little native or invasive seedling establishment with more available sunlight (**Table xx**). We plan to re-census the monitoring plots in 2-3 years to see if any secondary invasions or native tree regeneration has taken place.

Table 2. Seedling establishment and canopy gap (openness) changes in monitoring plots, before Norway maple canopy removal and 2 years later.

Site	Seedlings <15cm (2017)	Seedlings <15cm (2019)	Canopy Gap (2017)	Canopy Gap (2019)
Compass Harbor (overall)	10 (ACEPLA) 0 (ACERUB) 1 (FRAAME)	179 (ACEPLA) 161 (ACERUB) 598 (FRAAME)	15%	22%
Compass Harbor Plot 3	4 (ACEPLA) 0 (ACERUB) 0 (FRAAME)	120 (ACEPLA) 127 (ACERUB) 359 (FRAAME)	13%	24%
Compass Harbor Control (Plot 4)	2 (ACEPLA) 1 (ACERUB) 2 (FRAAME)	1 (ACEPLA) 32 (ACERUB) 35 (FRAAME)	20%	20%
Duck Brook (overall)	12 (treatment avg.) 14 (control)	12 (treatment avg.) 28 (control)	16% (treatment) (19%-control)	32% (treatment) (22%-control)
Ledge lawn Plot 2	4 (FRAAME) 1 (control)	101 (FRAAME) 1 (control)	17% (treatment) (23%-control)	16% (treatment) (22%-control)

Treatment

The IPMT removed mature Norway maple trees and saplings at sixteen sites in 2019; the largest sites were along Duck Brook close to Route 3 and Paradise Hill area near the closed section of Duck Brook Road. The team focused on removing trees in the dormant months of November-March in hopes that future management can focus on the seedling and sapling stage year-round. Several mature trees growing near powerlines, structures or other potential hazards were left untouched.

Glossy Buckthorn

Glossy buckthorn remains the IPMT's largest management effort in time and acres treated (**Figure 2**), and in 2019 follow up maintenance treatments were made at numerous sites. The largest of these include Canon Brook, the Great Meadow, Ledgelawn, Beaver Dam Pond, and Bear Brook, and these sites are covered in more depth in their respective sections. Kent Field North was another large effort, and the entire area was gridded. Foliar treatments were conducted almost everywhere, except the eastern side of the wetland which only received cut stump treatments in the fall. The total infested acres treated for Kent Field North was less than a quarter that of the last big treatment in 2017 (0.52 infested acres in 2017 versus 0.12 in 2019) despite some resprouting from cut stumps. A different infestation at Bubble Brook was treated using only mechanical means and volunteers since it is in proximity to Bar Harbor public water supply, Eagle Lake. The IPMT will cut back new shoots over several years in hopes this will suppress the glossy buckthorn's growth and reproductive output. A map of glossy buckthorn management on the east side of MDI is shown in **Figure 7**.

The IPMT continued to find new glossy buckthorn sites in 2019. Several surveys were conducted on the island's west side and the population near Tremont school was found to be far larger than previously thought. Dense populations exist on both sides of Bass Harbor Marsh here, and some scattered patches were also found up Marshall Brook and Heath Brook. The later were treated, and with the help of an IPMT grant, the Bass Harbor Marsh population will be a major focus in 2020.

Another survey effort found a large glossy buckthorn infestation along Liscomb Brook in the Duck Brook Road Wetlands. Cut stump efforts were initiated, but not completed in 2019. There were also numerous Japanese barberry here, which were treated in 2019. The third large glossy site, found surveying in late fall, was at Kent Field South. Only a portion of this site had been surveyed previously, and outside these large mature patches of glossy buckthorn were found. The main infestations are around an old beaver pond and running between the meadow and the park road. Some treatments were made while surveying, but most of the dense patches remain and will be a priority in 2020. The full extent of each of the above described sites is still not known, and more surveying will be needed in addition to finishing treatments, especially in the Bass Harbor Wetland Complex.

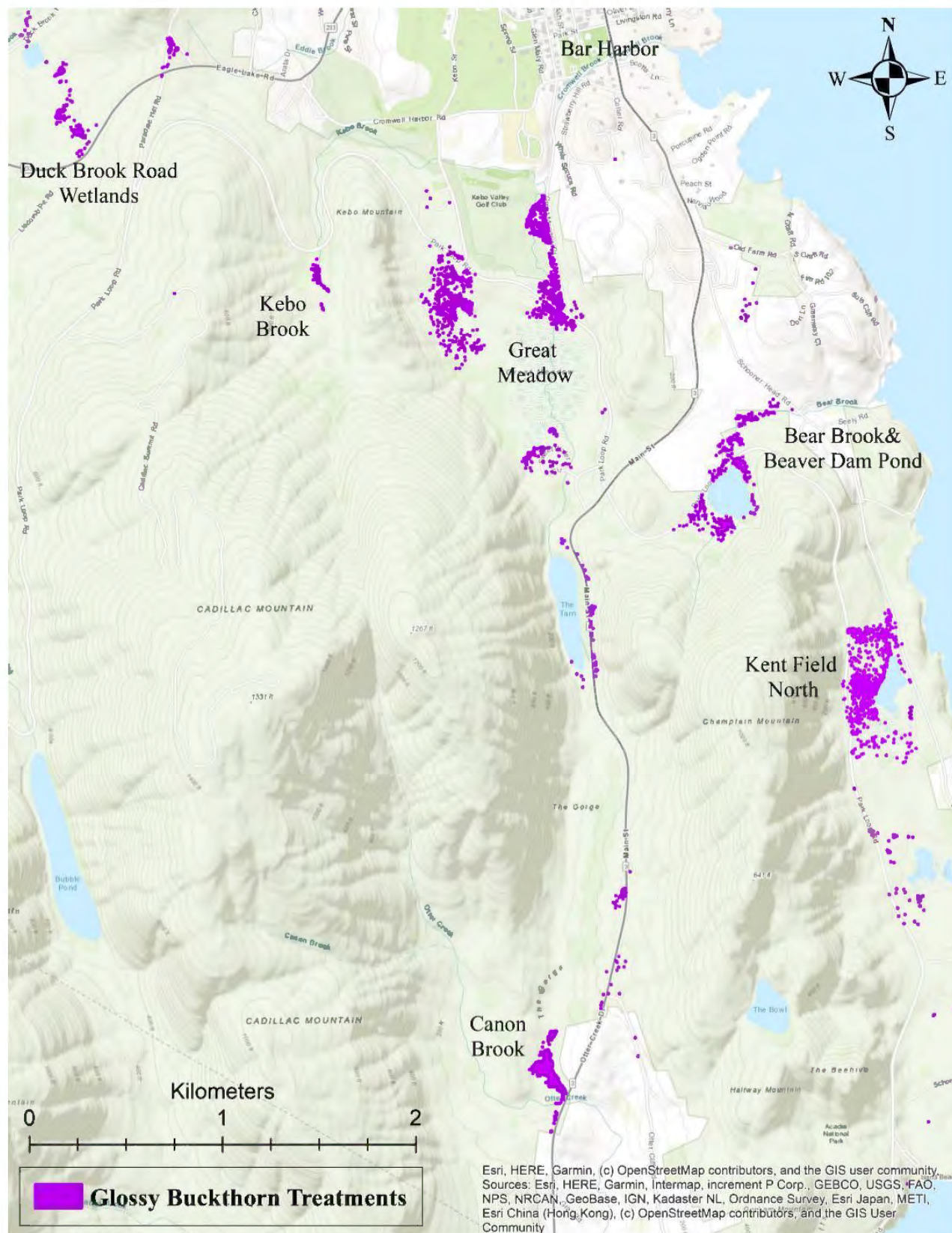


Figure 7. Glossy buckthorn management on the east side of Mount Desert Island in 2019.

Management Activities by Location

Saint Croix Island International Historic Site

The IPMT spent one-day managing eight invasive species at St. Croix. We surveyed the entire mainland area, approximately seven acres, and conducted both mechanical and chemical treatments on eight exotic invasive species. The last time this site was visited was in 2016, but despite this, the treatment efforts seemed consistent with previous years. The team did not make it out to the island on this trip, and it should be visited on the next trip, though only bull thistle was found there previously. The crew also compiled a list of all other non-native species present here.

Schoodic Peninsula

The crew managed all known invasive populations on the Schoodic Peninsula in 2019. This area has fewer invasives than most other parts of the park, and we completed it with one long day of work. The most invaded sites here include Frazer Point, Schoodic Woods Visitor Center parking lot, and the Schoodic Institutes Campus. The later could use further surveys since new patches of herbaceous invasive plants continue to be discovered there. The Schoodic Woods parking lot had several mid sized autumn olives growing in the planted area, and how they got there is an interesting question. The team also completed a partial survey of Little Moose Island and found only bull thistle, but the rest of the island is a good future survey area; especially directly across from Schoodic Island which is heavily invaded by thistle.

Outer Islands

In 2019, the island management efforts were similar in magnitude to those conducted in previous years. On Sheep Porcupine Island one day was spent cut stumping bush honeysuckle (*Lonicera morrowii*), barberry (*Berberis spp.*), and Asiatic bittersweet (*Celastrus orbiculatus*). The heaviest known infestation on the island's western shore, predominately honeysuckle, has now been fully managed for reproductive plants. Scattered invsives remain along the rest of the island's shore, these will be treated next visit(**Figure XX**). Eagle nesting closes the island until August 31, so consider this when planning future trips.

The IPMT also spent one day conducting follow up honeysuckle treatments on The Hop Island. The entire site was gridded except its northeast corner. Even though this section, perhaps 20% of the island, was missed, the amount of chemical sprayed dropped drastically from 2018 to 2019 (**Table 3**). Infested acres also dropped by 86%, suggesting this site has entered a lower priority maintenance stage and will not require annual visits in the future. It is worth noting that we did see an unexpected explosion in common mullein here. These were hand-pulled, but the population and our treatment method's effectiveness should be monitored during future trips. It is possible that repeated pulling will disturb the soil, encouraging even more mullein growth.

Table 3. Treatment efforts from 2017 to 2019 on Baker Island, Isle au Haut, and The Hop.

	Infested Acres Treated		
	2017	2018	2019
Baker Island	0.050200	0.115201	0.014509
Isle au Haut	Not Visited	0.038493	0.022075
The Hop	0.229160	0.080012	0.013794
	Herbicide Concentrate Sprayed (oz)		
	2017	2018	2019
Baker Island	2.64	2.77	0.50
Isle au Haut	Not Visited	4.32	3.55
The Hop	103.49	47.06	3.03
	Crew and Volunteer Work Hours		
	2017	2018	2019
Baker Island	25	15.25	14
Isle au Haut	Not Visited	58.25	56
The Hop	122.5	26.66	16.5

The EPMT made two overnight trips to Isle au Haut this past year. The first was in late May and its purpose was to revisit the Japanese barberry patch (*Berberis thunbergii*) discovered in 2018 and complete its treatment. In addition, the crew surveyed most of the wetlands and streams in this wetland complex and treated any satellite populations found (**Figure 8**). The second trip targeted Canada and bull thistle (*Cirsium arvense* and *C. vulgare*) at coastal locations where they are known to occur. The Canada thistle populations were greatly reduced from 2018, though the bull thistle seemed to have increased in spots.

Baker Island also had a large decrease in Canada and bull thistle from 2018 to 2019 (**Table 3**). This reduction may be due to treatments conducted annually since 2017, but it is worth noting that there was also a prescribed burn conducted here in the spring. Finally, the IPMT made several shorter trips to Bar Island in 2019. The crew surveyed the northern wooded portion of the island, last managed in 2016, and few surviving barberry were found. The heavily infested southern portion of the island was not gridded as it was in 2017 and 2018, though some spot treatments were made. There are invasive plants here but they are small or herbicide damaged, so treatments were postponed. This area should be checked for possible management in the spring of 2020.



Figure 8. Isle au Haut barberry treatments and surveys conducted in May 2019 and July 2018 treatments.

Canon Brook / Otter Creek Watershed

In 2019 the IPMT performed the third round of glossy buckthorn treatments in the Canon Brook watershed, as a follow-up to the initial attack cut-stump treatments in 2017. These were primarily foliar applications mixed with as-needed cut-stump treatments for either larger individuals that were missed during the first two treatments. Only the southern portion of the Canon Brook corridor was treated in 2019, generally the areas surrounding the monitoring transects. The rest of the Canon Brook and Otter Creek watershed should be treated in 2020.

The four glossy buckthorn monitoring transects established in 2017 were revisited before beginning treatments for 2019, so the effects of the 2017 and 2018 treatment could be accurately captured (**Figure 9**). Reproductive (i.e., fruiting) stems decreased after two treatments from approximately 1.00 stems/m² down to 0.04 stems/m². This is as expected since most mature reproductive individuals were removed during the initial attack and followup treatments.

The number of vegetative (i.e., non-fruiting) stems increased after the first treatment but then decreased slightly after the second treatment that involved heavy foliar herbicide application.

The average percent cover of glossy buckthorn (both vegetative and reproductive) decreased from 11.5% before treatment to 1.9% cover after two years of cut/stump and foliar herbicide treatments (**Table 4**).

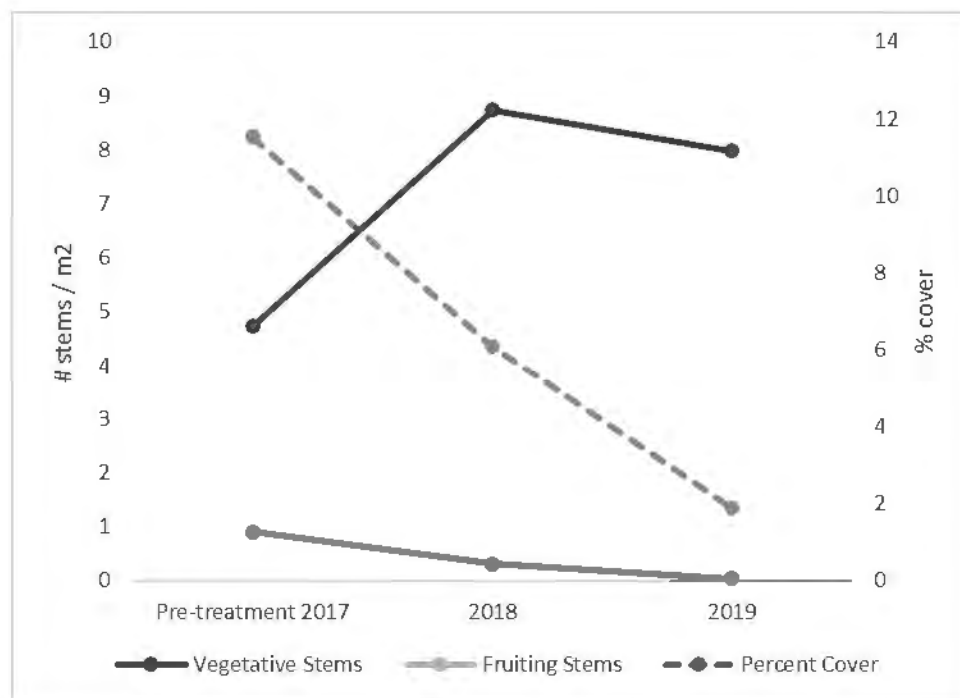


Figure 9: Changes in average stem counts (vegetative and reproductive) and percent cover of glossy buckthorn in Canon Brook between 2017 and 2019.

Table 4: Average stem counts (vegetative and reproductive) and percent cover of glossy buckthorn for Canon Brook Transects 1 – 4. 2017 data reflect glossy populations before any treatment, where 2018 and 2019 transects were monitored before annual treatments.

Non-fruiting Stems / m2					
	Transect 1	Transect 2	Transect 3	Transect 4	Average
Pre-treatment 2017	2.68	9.18	4.74	2.29	4.73
2018	3.70	22.56	5.32	3.39	8.74
2019	3.72	16.82	6.00	5.35	7.97
Fruiting Stems / m2					
	Transect 1	Transect 2	Transect 3	Transect 4	Average
Pre-treatment 2017	0.22	1.4	0.26	1.73	0.9
2018	0.04	0.24	0.14	0.84	0.31
2019	0.00	0.00	0.00	0.14	0.04
Percent Cover Class / m2					
	Transect 1	Transect 2	Transect 3	Transect 4	Average
Pre-treatment 2017	1.28	3.52	1.5	2.04	2.09
2018	0.84	2.96	1.26	1.90	1.74
2019	0.98	1.74	1.08	1.27	1.27

Greater Cromwell Brook Watershed: Bear Brook and Beaver Dam Pond

The IPMT made the Bear Brook and Beaver Dam Pond site management priorities in 2019 (**Figure 10**). Glossy buckthorn treatments occurred on the brook corridor and around the pond, where the entire edge was surveyed in the wet forests to the southwest. The last time this entire area was checked was 2016. More glossy buckthorn treatments are still needed along the Jackson Lab property and Route 3 to the west where the highest densities were previously found. Purple loosestrife infested acres treated in 2019 skyrocketed nearly seven times those in 2018 (see **Appendix A**). This was due to increased survey area in Bear Brook on the Jackson Lab's property, but it was also a result of more thorough gridding on park property. A challenge here is most loosestrife treated were small and lacked flowers due to their age or deer browsing. Therefore, future management here should use tight careful grids and possibly a follow-up check of the most infested areas.

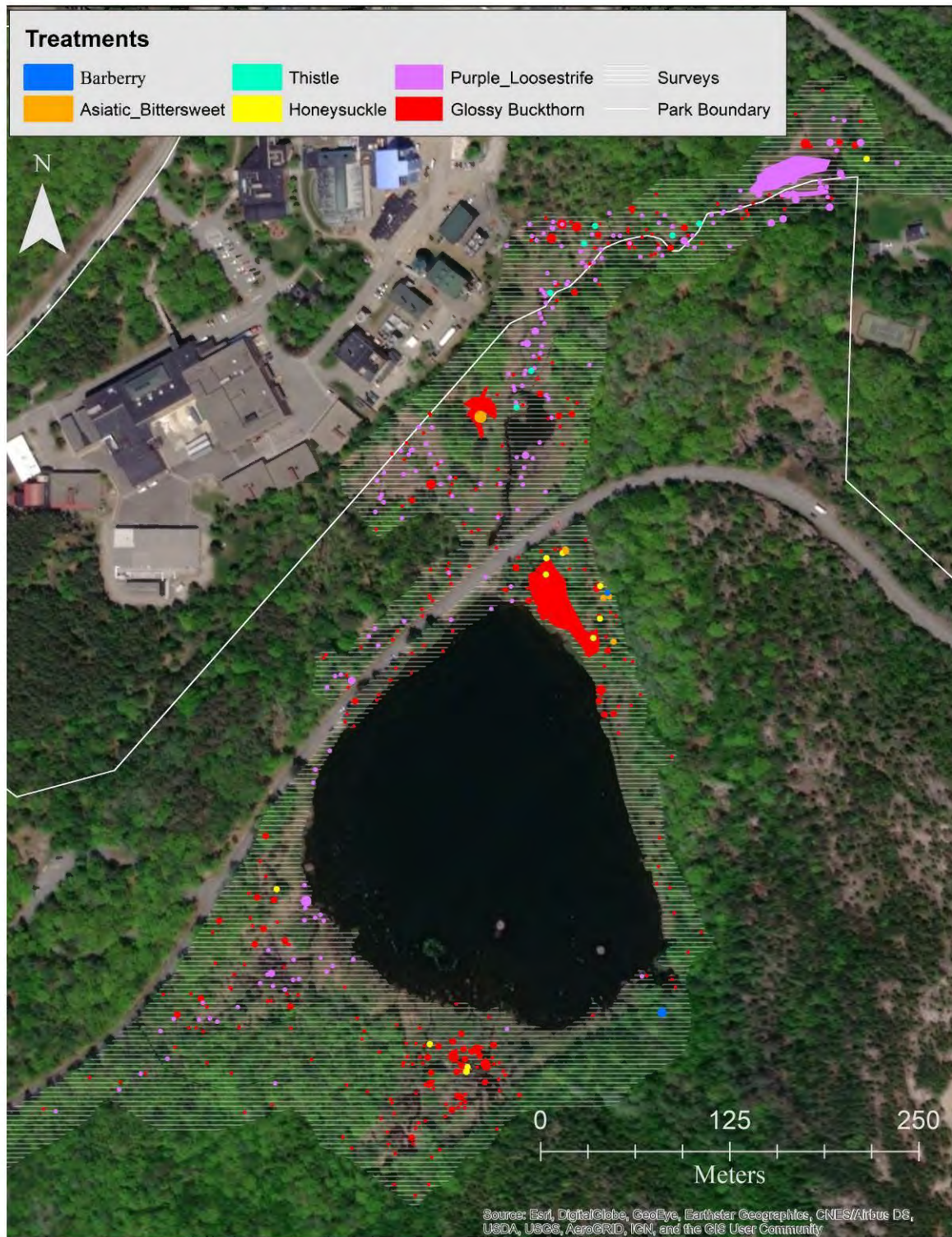


Figure 10. Management activities at Bear Brook (to the North of the Park Road) and at Beaver Dam Pond (to the South) in 2019. Note the work conducted on the Jackson Lab's property.

Greater Cromwell Brook Watershed: Great Meadow Units

The team continued to manage glossy buckthorn and other invasives in the Cromwell Brook Watershed's Great Meadow in 2019. This large area is broken up into units to better plan management efforts, and some of these are named by their number and some by their location as seen in **Figure 11**. Due to limitations on time, only some of these areas can be treated each year. In this season the IPMT treated most or all of Unit 6, Ledgelawn, and Sieur de Monts. Other units were only partially treated in the most invaded areas including Units 18, 10, 17, and 9 (**Figure 11**). The rest of these units will have to be addressed in the future, and early season surveys should be used to identify priority treatment areas within each unit. The recommended treatment areas for 2020 can be seen in "Program Recommendations" at the end of this report.

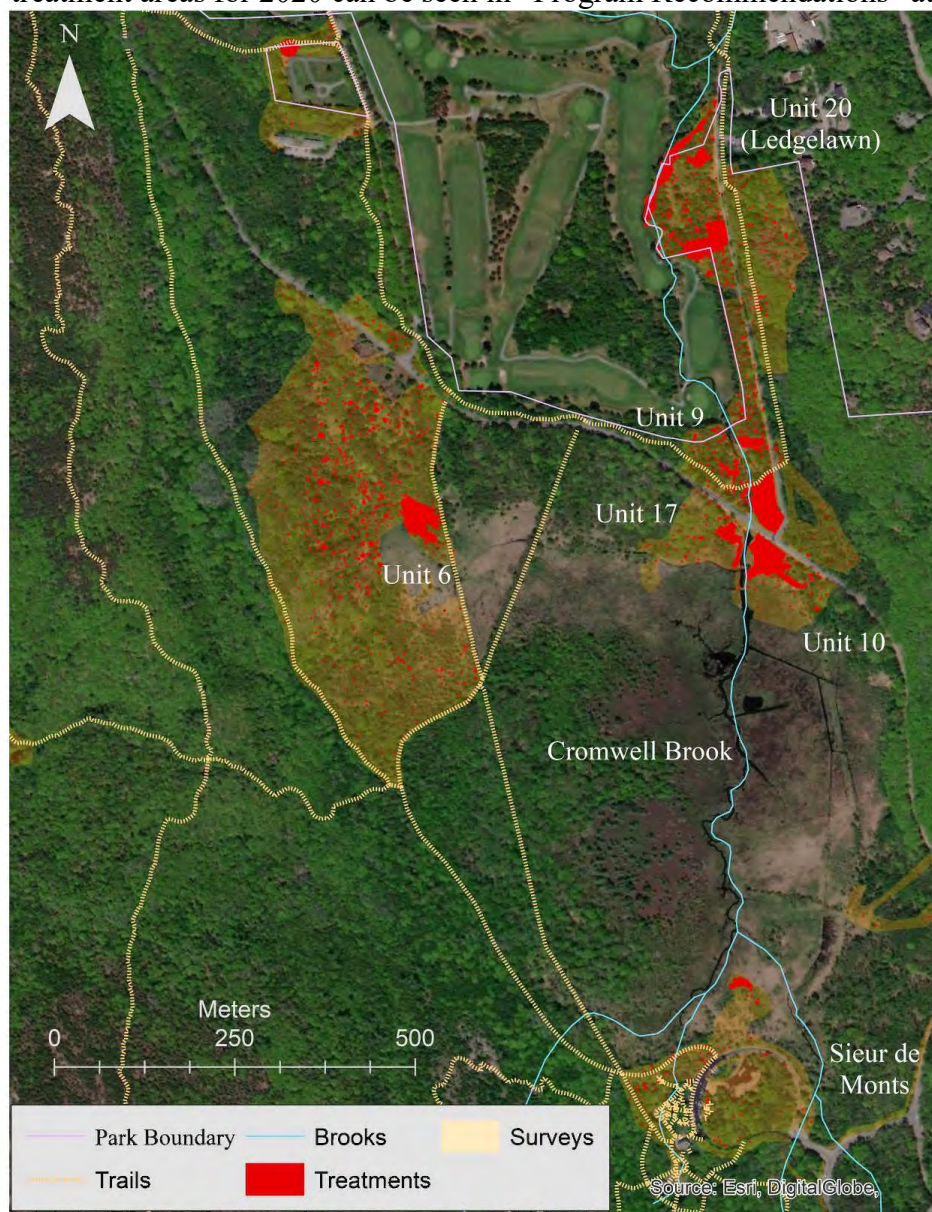


Figure 11. Invasive plant management activities in the Great Meadow region of the Cromwell Brook watershed in 2019.

The IPMT also continued to monitor the glossy buckthorn transects in Unit 6 at Motor Road Vista 56, or the Bottling Plant Vista. This vista was burned in 2016 for vista management, and it was treated for invasive plants in 2016 and 2017, so the monitoring results reflect this management and are shown in **Table 5**. The vegetative stems in 2019 continued to decline, but reproductive stems increased greatly, and percent cover also went up. This area is good habitat for glossy buckthorn, and this increase is likely due to a lack of treatments in 2018. Some of the increase in reproductive stems may also be attributed to the previous year's vegetative stems maturing. It is worth noting that the entire vista was mowed in 2019. This occurred after monitoring, but it did prevent our planned treatments there, and the site will need to be treated in 2020. At this time Acadia's Fire Program has no plans to burn vistas anymore, so treatment timing will need to be coordinated with the Maintenance mowing crews.

Table 5. The average number of reproductive plants, vegetative plants, and percent cover per transect of glossy buckthorn at the Great Meadow Unit 6 monitoring site.

*percent cover classes: (0) = 0% cover; (1) = <1% cover; (2) = 1-5%; (3) = 5-10%; (4) = 10-25%; (5) = 25-50%; (6) = 50-75%; (7) = 75-95%; (8) = 95-100%

	Vegetative Stems	Reproductive Stems	Avg. Percent Cover Class*
2016	118	7.25	N/A
2017	59	0.75	0.93
2018	48	2.25	0.94
2019	32	10.25	0.98

Collaborations, Native Plant Restoration, and Outreach

In 2019 the EPMT continued to develop and maintain partnerships with Friends of Acadia (FOA), Schoodic Institute, College of the Atlantic (COA), Maine Coast Heritage Trust, Maine Forest Service, US Forest Service, Animal and Plant Health Inspection Service (APHIS), Jackson Laboratory, Somes-Meynell Wildlife Sanctuary, Mount Desert Land & Garden Preserve and the Maine Invasive Species Network to protect native plants.

We increased our public outreach and education with presentations to the Maine Woodland Owners, Friends of Acadia Stewardship Volunteer Leaders, COA students, Mount Desert Invasive Species Forum, and Schoodic Institute brown bag series. We have shared our expertise through public outreach and inquiry with local gardeners, community members, park staff and volunteers, and private land managers to protect natural communities on private lands. To facilitate education and outreach the IPMT assembled a traveling, potted garden of labeled invasive plants to show and display at events and presentations.

The IPMT continued professional development through the following training opportunities; Wilderness First Aid, Chainsaw Safety Program for Non-Wildland Fire Operations, Climate Adaptation and Science Communication, and Pesticide Applicator Continuing Education training. The IPMT presented a poster at the Acadia Science Symposium titled; *Acadia's Long-forgotten Invasive Plants Become New Targets*. The poster communicated our efforts hunting down old reports of invasive plants in the park; botanists and resource managers inventoried invasive plant locations throughout Acadia National Park in the 1990s and early 2000s. The IPMT investigated these reports in 2018 and 2019, only to find a whole range of outcomes.

Many invasive observations from 15 or more years ago have stayed small and isolated, though some are now large populations that have gone unchecked.

For a third year, the IPMT assisted the Native Plant Trust (formerly the New England Wildflower Society) in planting native plants into new research testbeds filled with weed-free soil on the Cadillac Mountain summit. The IPMT sterilized soil for this work in 2019 at Park Headquarters in the Maintenance gym using an electric soil sterilizer. The group filled newly selected restoration areas with sterilized soil and planted with modules and plugs of native plants grown from seed at the trust's Nasami Farms in Framingham, Massachusetts (see **Figures 13**).

Working with FOA Wild Acadia Coordinator, Brian Henkel, the IPMT assisted with the restoration of the old septic field at Sieur de Monts. Contractors regraded soil, added wetland top-soil, and planted native seed, shrubs, and trees. The IPMT provided some large logs for Course Woody Debris and hand-pulled young cattail sprouts to give the desirable plants a competitive advantage.



Figure 12. Cadillac summit restoration, 06/10/2019.

Cultural Vegetation Management

In 2019 the IPMT assisted maintenance and other divisions in managing native plants in cultural landscapes and developed sites. The biggest project was Schoodic powerline corridor cutting in February and March. This job involved the collaboration of the IPMT, maintenance, fire, law enforcement, and trails crew and was run with the incident command system. The team safely and efficiently cleared trees from more than 2 km of powerline in preparation for the lines replacement in 2020. Most of the felled trees were burned in piles away from wetland habitats, which the IPMT helped to locate.

Other vegetation management projects in 2019 included hazard tree mitigation at Seawall Campground, treating stumps on Day Mountain with herbicide behind felling crews, and helping the fire crew by herbicide treating cut stumps cut around structures. The IPMT also mechanically cut and foliar treated poison patches along the Ocean Path between Sand Beach and Otter Point. Some trail blocking and moving of rope fencing was also completed to reduce the social trails in ivy patches, and the crew opportunistically repaired these fences and restoration signs. Poison ivy was also treated along the Hunters Beach Trail, and on the Witch Hole carriage road intersection #2 to protect maintenance and Land and Garden Preserve workers during construction and trail maintenance. The impacted carriage road ditches were also surveyed for rare plants to protect or salvage.

2019 Treatment Summary

The following summarizes the exotic plant management work completed by Acadia National Park's IPMT in 2019.

Total Infested Acres Treated	1.52*
Total Acres Surveyed	1,295
Total EPMT Work Hours	1,562
Total Volunteer Work Hours	62
Number of Species Treated	26
Estimated Program Costs (Fiscal Year 2019)	\$ 288,717

**{Infested acres are defined as the total area of leaf canopy cover of invasive plant species at 100% density. In other words, this figure represents the total acreage that would be covered if the entire leaf canopy cover of all treated invasive exotic plants were gathered together at full coverage.}*

Herbicides Used in 2019

Table 13. Herbicides used at Acadia National Park for exotic plant management in 2018, with total acres treated and ounces of herbicide concentrate sprayed. These numbers are reported to the NPS Pesticide Use Proposal System (PUPS) on an annual basis.

Herbicide and Concentrations Used*	Treated (Infested) Acres	Herbicide Concentrate Used (oz.)
Garlon 4 Ultra® (cut stump 25%)	0.02	4.78
Pathfinder 2® (cut stump 100% premixed)	0.09	119.76
Garlon 3A® (foliar 3% or 5% for CELORB)	0.34	110.26
Milestone® (foliar 0.25% for CIRARV or 0.4% for FALJAP)	0.09	2.28
Rodeo® (cut stump 33%, foliar 3% or 5% for FALJAP)	0.88	289.01

* Additional information on each herbicide and how they are utilized by the EPMT can be found in the 2015 and 2016 Exotic Plant Management Annual Reports. Herbicide use by species is presented in **Appendix A** of this report. Numbers rounded to two decimals.

Program Recommendations and Objectives for 2020

- Increase NPS field crew members from three to four (in addition to the program leader) and add an SCA Intern.
- Split crew up more when applicable to quickly complete small treatments/projects (e.g. knotweed and Canada thistle).
- Continue to regularly monitor and document treatments from the past and during the 2020 field season.
- Continue to survey exotic plant monitoring transects and plots.
- Conduct potential herbicide comparison studies for glossy buckthorn cut-stump treatments and Asiatic bittersweet foliar treatments and continue to evaluate the use of Milestone® for Japanese knotweed.
- Test basal bark applications with Pathfinder II using different band heights for invasive tree species during March and April.
- Run another spring data collection training and go through the entire data process.
- Recruit volunteers for mechanical treatments on garlic mustard, narrowleaf bittercress, Asiatic bittersweet, lupine, and glossy buckthorn seedlings near motor road vistas, Sieur de Monts (particularly Unit 3. Work with larger groups for moving glossy buckthorn brush in the Bass Harbor Marsh area. Establish regularly scheduled projects for volunteer drop-in days.
- Continue to utilize the invasive species garden to communicate what we do to a variety of audiences.
- Continue the habit of disinfecting boots and using a boot brush after each site
- Document and formalize safety sessions. Bring a first aid kit, eyewash, and handwash into the field when working far from the vehicles.
- Increase programs web presence and update existing web articles.
- Salvage native plants from carriage road ditches and construction areas and store at the nursery for revegetation efforts. This is another volunteer opportunity.
- Use the early field season for foliar treatment of **barberry and honeysuckle** shrubs:
 - Amphitheater: return for follow up treatments on barberry and more survey efforts.
 - Paradise Hill: grid the northern portion of the site between the closed part of Duck Brook Road and the private boundary for several invasive species.
 - Lower Mountain Road: survey the uphill side of the road for barberry north of the creeks treated in 2019.
 - New Mills Meadow Field: return for follow up treatments of the honeysuckle and other invasives here.
- Continue ongoing **glossy buckthorn** management and expand to new sites:
 - Kent Field South: treat the new populations found during 2019 fall surveys.
 - Duck Brook Road Wetlands: continue the initial attack and foliar treatments of the wetlands while surveying further afield.
 - Canon Brook: foliar treat the entire corridor.
 - Great Meadow Units: mostly foliar treatments at numerous units – Unit 18 meadow edges and peninsula, finish unit 3, Unit 8 treat the edge of the road, Unit 14 grid the corner by Ledge lawn and by the Jackson Lab, Unit 12 by the historically heavy spots near Route 3 and along the Jackson Lab boundary, and finally survey and possibly manage areas last visited in 2017 – Units 5, 10, 17, and 19.

- Bass Harbor Marsh/Tremont School: conduct further surveys of this area and conduct initial cut stump treatments.
- MR Vista 5: hand pull seedlings with volunteers and followup with foliar treatment as needed
- MR Vista 56 (bottling plant): foliar treat seedlings and mowed glossy buckthorn shrubs in the entire vista.
- Saterlee Pit: foliar treat the new patch found in fall 2019 and by the Great Head Parking Lot.
- Kent Field North: spot foliar treat the two heavy areas on the east side of the wetlands.
- Jackson Lab: collaborate with Lab staff and manage glossy buckthorn with both cut stump and foliar methods.
- Survey watersheds not yet known to contain glossy buckthorn, or with unknown populations.
- Other invasive plant species management:
 - Sawyer's Point (Flye Farm): foliar treat the woods and meadow areas.
 - Sand Beach / Nursery: retreat the bittersweet here that did not die from 2018 foliar treatments.
 - Compass Harbor: grid the areas of heavy bittersweet and privet infestation.
 - White Birches Campground: follow up treatments on this site, and survey between here and Marshall Brook for glossy buckthorn and other invasives.
- Conduct work on Acadia's outer islands:
 - Isle au Haut: visit for two nights to treat thistle and check on the barberry patch along Moore's stream and bog wetlands.
 - Sheep Porcupine: manage the honeysuckle and other woody invasives as soon as allowable, or after August 31 (when the island re-opens after bald eagle nesting).
 - Burnt and Bald Porcupine: these islands have known populations of honeysuckle and bittersweet and should be visited and treated.
- Spend one day managing the known invasive sites on the Schoodic Peninsula, and survey likely areas for new infestations.
- Continue Norway maple management in the fall including the trees on Bar Island.
- Continue expanding natural and cultural landscape restoration projects and exploring new training opportunities to develop diverse skills and abilities for IPMT staff.

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Appendix A: Table of Species Treated By Location in 2019

This table lists all species managed at Acadia National Park and St. Croix Island International Historic Site in 2019. Species and locations are organized alphabetically, survey acres are rounded to two decimal places, and infested acres are rounded to six decimal places. The survey acreage shown is the sum of each treatment where at least one plant was found or where no plants were found but that was a primary search target. The amount of herbicide concentrate sprayed is recorded by site, so the values shown are based only on the primary invasive plant treated. For species that were only sprayed incidentally, concentrate used is described as “Documented Elsewhere”.

Species	Site Location	Survey Acres	Infested Acres
<i>Acer platanoides</i> (Norway maple)	Brown_Mountain_Gatehouse	3.02	0.000000
	Bubble_Pond	1.02	0.000000
	Cadillac_Mountain_Entrance	5.10	0.000132
	Cadillac_Mountain_Road	2.07	0.000147
	Canon_Brook	6.40	0.000618
	Cleftstone	2.59	0.007168
	Compass_Harbor	7.72	0.003671
	Duck_Brook	10.46	0.022657
	Frazer_Point	5.33	0.004863
	Great_Meadow	0.09	0.000465
	Harden_Farm	2.68	0.004829
	Headquarters	1.93	0.008863
	Hulls_Cove_House	1.79	0.000000
	Jordan_Pond_Carriage_Road	3.69	0.000000
	Jordan_Pond_House	6.17	0.000062
	Jordan_Pond_Road	0.38	0.001178
	Jordan_Pond_Road_Erosion	0.29	0.000000
	Long_Pond_Fire_Road	11.63	0.000008
	Otter_Cove_Boat_Launch	2.03	0.000596
	Paradise_Hill	7.43	0.011298
	Route_198	0.50	0.000000
	Route_3/Tarn	3.30	0.000023
	Sand_Beach	1.20	0.000000
	Shooting_Range	0.59	0.000000
	Thailand	4.24	0.000000
	Visitor_Center	0.50	0.000000
	Total	92.15	0.066578
<u>Herbicide Concentrate Used:</u>			
Garlon 3A: 0.12 oz			
Pathfinder II: 28.7 oz			
Rodeo: 5.50 oz			
<i>Alliaria petiolata</i> (Garlic Mustard)	Bass_Harbor	1.69	0.001738
	Compass_Harbor	11.69	0.008722
	Fernald_Point	5.79	0.000051
	Headquarters	0.84	0.000064

<i>Herbicide Concentrate Used:</i> None - Mechanical only	Holy_Redeemer_Cemetery	1.06	0.000109
	Jordan_Pond_Carriage_Road	0.42	0.000080
	Jordan_Pond_House	5.18	0.000062
	Jordan_Pond_Road	3.87	0.000366
	Jordan_Pond_Road_Erosion	1.91	0.000109
	Ledgelawn	11.70	0.000675
	Nursery	0.61	0.000016
	Otter_Cliffs_Road	25.45	0.000200
	Otter_Cliffs_Road_North	1.29	0.000004
	Otter_Cove	5.21	0.000049
	Otter_Cove_Boat_Launch	3.22	0.000002
	Seawall	1.27	0.000120
	Sand_Beach	0.11	0.000000
	Thailand	6.56	0.000015
	Wildwood	7.89	0.000002
	Total	95.76	0.012384
<i>Arctium minor</i> (common burdock) <i>Herbicide Concentrate Used:</i> None - Mechanical only	Bubble_Pond	0.84	0.000039
	Eagle_Lake	0.28	0.000070
	New_Mills_Meadow	0.86	0.000039
	Sand_Beach	2.74	0.000054
	Schoodic_Campus	4.41	0.000620
	St_Croix	6.99	0.001460
	Wildwood	7.89	0.000883
	Total	24.01	0.003165
<i>Berberis thunbergii</i> (Japanese barberry)	Adams_Bridge	0.58	0.001235
	Amphitheater	9.68	0.216427
	Aunt_Betty_Pond	23.10	0.000620
	Bar_Island	19.65	0.001339
	Beaver_Dam_Pond	6.32	0.000124
	Beech_Hill_Road	6.66	0.006330
	Breakneck_Brook	25.11	0.000906
	Cadillac_Mountain_Orchard	4.94	0.000038
	Cleftstone	2.59	0.000194
	Compass_Harbor	4.92	0.000070
	Duck_Brook	22.23	0.013623
	Duck_Brook_Road_Wetland	25.70	0.047355
	Eagle_Lake	3.33	0.000822
	Eagle_Lake_Pumphouse	2.72	0.000009
	Eagles_Craig	7.50	0.000000
	Fernald_Point	5.32	0.000100
	Flying_Mountain_Parking	2.87	0.000465
	Frazer_Point	4.98	0.000218
	Great_Meadow	24.78	0.000108

	Harden_Farm	3.43	0.000046
	Headquarters	1.97	0.000208
	Heath_Brook	9.00	0.000659
	Hulls_Cove_House	7.25	0.001014
	Hunters_Brook	8.00	0.000597
	Isle_au_Haut	37.25	0.006269
	Jordan_Pond_House	6.17	0.000101
	Jordan_Pond_Road	0.44	0.000232
	Kebo_Brook	5.32	0.000002
	Ledgelawn	9.10	0.000569
	Liscomb_Pit	19.40	0.000465
	Long_Pond_Fire_Road	11.63	0.001389
	Lower_Mountain_Road	37.36	0.016991
	Man_of_War_Road	1.20	0.000092
	Marshall_Brook	16.68	0.001738
	McFarland_Hill	0.31	0.000504
	New_Mills_Meadow_Field	23.70	0.003835
	Otter_Cliffs_Road	25.21	0.000350
	Otter_Cliffs_Road_North	15.69	0.000620
	Otter_Cove	4.57	0.001092
	Otter_Cove_Boat_Launch	5.25	0.001514
	Paradise_Hill	26.66	0.000315
	Route_3/Tarn	9.79	0.002879
	Quarry_Path	4.49	0.000000
	Sand_Beach	7.10	0.000029
	Sargeant_Brook	2.95	0.001883
	Saterlee_Pit	35.28	0.000549
	Schooner_Head	0.05	0.000046
	Shooting_Range	2.68	0.000000
	Seal_Cove_Road	13.46	0.011156
	Sheep_Porcupine	1.64	0.001590
	Ship_Harbor	0.81	0.000697
	St_Sauvier	4.31	0.004340
	Stanley_Brook	5.98	0.005653
	Start_of_One_Way	1.68	0.000194
	Thailand	1.57	0.000085
	Valley_Cove	3.57	0.000711
	Visitor_Center	33.68	0.000437
	Wildwood	7.89	0.000649
	Witch_Hole	25.05	0.003094
	Total	640.55	0.362577
<i>Berberis vulgare</i> (common barberry)	Amphitheater	4.88	0.005289

Herbicide Concentrate Used:

Garlon 3A: Documented Elsewhere

Garlon 4 Ultra: 1.73 oz

Milestone: 0.14 oz

Pathfinder II: 11.00 oz

Rodeo: 91.25 oz

<u>Herbicide Concentrate Used:</u> Documented Elsewhere	Beaver_Dam_Pond	0.83	0.000031
	Lakewood	13.60	0.001456
	Sheep_Porcupine	1.64	0.000271
	Total	20.95	0.007047
<i>Cardamine impatiens</i> (narrowleaf bittercress) <u>Herbicide Concentrate Used:</u> None - Mechanical only	Bass_Harbor	0.36	0.000004
	Compass_Harbor	1.14	0.000015
	Jordan_Pond_Carriage_Road	0.19	0.000006
	Jordan_Pond_Road_Erosion	1.60	0.000086
	Ledgelawn	1.03	0.000004
	Otter_Cliffs_Road	16.63	0.000121
	Thailand	0.21	0.000038
	The_Hop	5.62	0.000004
	Total	26.78	0.000278
<i>Celastrus orbiculatus</i> (Asiatic bittersweet)	Amphitheater	0.61	0.000002
	Bar_Island	7.05	0.000126
	Bear_Brook	4.15	0.000347
	Beaver_Dam_Pond	0.83	0.000193
	Bubble_Rock	0.59	0.001149
	Cadillac_Mountain_Entrance	3.45	0.000296
	Cadillac_Mountain_Orchard	1.24	0.001564
	Canon_Brook	4.25	0.000012
	Cleftstone	2.59	0.000008
	Compass_Harbor	14.25	0.005948
	Duck_Brook_Road_Wetland	2.80	0.000041
	Eagle_Lake	2.90	0.000031
	Eagle_Lake_Pumphouse	5.11	0.002062
	Fernald_Point	8.95	0.000503
	Flying_Mountain_Parking	1.43	0.000705
	Frazer_Point	3.79	0.000309
	Great_Head_Trail	6.39	0.001198
	Great_Meadow	37.78	0.004038
	Harden_Farm	0.75	0.000009
	Headquarters	6.65	0.003475
	Hulls_Cove_House	3.40	0.000039
	Jordan_Pond_Carriage_Road	5.80	0.000081
	Jordan_Pond_House	14.57	0.004149
	Kent_Field_North	31.08	0.005421
	Ledgelawn	11.81	0.000427
	Long_Pond_Fire_Road	11.63	0.000224
	Lower_Mountain_Road	4.19	0.001344
	McFarland_Hill	0.69	0.000155
	Nursery	2.77	0.000736
	Ocean_Drive	12.43	0.001096

-	Otter_Cliffs_Road	25.31	0.003062
	Otter_Cliffs_Road_North	1.29	0.000046
	Otter_Cove	0.36	0.000363
	Otter_Cove_Boat_Launch	4.25	0.000742
	Paradise_Hill	7.43	0.000155
	Parkman_Mountain	0.55	0.000048
	Pooler_Farm	2.83	0.001598
	Route_3/Tarn	4.73	0.007752
	Sand_Beach	9.84	0.000141
	Sargeant_Drive	0.38	0.020519
	Seal_Cove_Road	7.04	0.000791
	Seawall	9.21	0.006046
	Sheep_Porcupine	1.64	0.000170
	Sieur_de_Monts	4.98	0.000059
	Stanley_Brook	13.83	0.003641
	Thailand	3.66	0.000025
	The_Hop	5.62	0.000007
	Thompson_Island	2.86	0.000588
	Upper_Hadlock_Pond	0.45	0.004206
	Wildwood	7.89	0.000054
	Witch_Hole	0.19	0.000015
	Total	328.27	0.085716
<i>Centaurea stoebe</i> (spotted knapweed)			
<u>Herbicide Concentrate Used:</u> Garlon 3A: 15.55 oz Milestone: 0.02 oz Pathfinder II: 17.86 oz Rodeo: 14.40 oz	Headquarters	3.06	0.000159
	Schoodic_Peninsula	9.31	0.000031
	Total	12.37	0.000190
<i>Cirsium arvense</i> (Canada thistle)			
	Adams_Bridge	0.23	0.002875
	Baker_Island	9.28	0.013713
	Bar_Island	7.05	0.000660
	Bear_Brook	4.46	0.000054
	Breakneck_Brook	11.23	0.000062
	Bubble_Rock	0.15	0.000020
	Cadillac_Mountain_Orchard	0.75	0.001012
	Canon_Brook	0.02	0.000062
	Duck_Brook	0.19	0.000004
	Fabbri_Memorial	0.23	0.000077
	Frazer_Point	3.79	0.000023
	Great_Meadow	17.71	0.001058
	Headquarters	0.84	0.000023
	Hulls_Cove_House	2.10	0.000053
	Isle_au_Haut	29.00	0.004471
	Kebo_Brook	5.32	0.000023

<u>Herbicide Concentrate Used:</u> Garlon 3A: Documented Elsewhere Milestone: 1.21 oz Rodeo: 0.72 oz	Kent_Field_North	0.12	0.000039
	Ledgelawn	4.53	0.000779
	New_Mills_Meadow	1.32	0.000092
	New_Mills_Meadow_Field	1.49	0.001668
	Nursery	2.98	0.000177
	Ocean_Drive	6.84	0.000062
	Otter_Cove	1.74	0.000929
	Pooler_Farm	2.83	0.000033
	Sand_Beach	2.74	0.000169
	Saterlee_Pit	1.23	0.000038
	Sawyers_Point	1.66	0.000116
	Schoodic_Campus	4.41	0.000054
	Seawall	6.03	0.001235
	Ship_Harbor	0.81	0.000031
	Shooting_Range	1.22	0.000077
	Sieur_de_Monts	0.61	0.000000
	St_Croix	6.99	0.000837
	Thailand	0.32	0.000004
	The_Hop	5.62	0.000022
	Thompson_Island	2.02	0.000039
	Tremont_School	0.90	0.000023
	Wonderland	5.72	0.000085
	Total	154.48	0.030699
<i>Cirsium vulgare</i> (bull thistle) <u>Herbicide Concentrate Used:</u> Milestone: Trace Rodeo: 0.72 oz (Manual removal of flowering plants is the primary treatment method)	Baker_Island	9.28	0.000796
	Bar_Island	19.65	0.003036
	Bear_Brook	8.61	0.000077
	Compass_Harbor	2.12	0.000004
	Echo_Lake	0.35	0.000000
	Fernald_Point	3.63	0.000062
	Headquarters	2.71	0.000101
	Hulls_Cove_House	3.40	0.000008
	Isle_au_Haut	42.92	0.010948
	Jordan_Pond_House	4.57	0.000031
	Little_Moose_Island	8.68	0.000187
	Marshall_Brook	1.01	0.000031
	New_Mills_Meadow	1.55	0.000031
	Saterlee_Pit	1.23	0.000258
	Schoodic_Campus	4.41	0.000240
	Seawall	6.03	0.000015
	Visitor_Center	0.80	0.000008
	Wildwood	7.89	0.000566
	Total	128.84	0.016399

<i>Digitalis purpurea</i> (purple foxglove) <u>Herbicide Concentrate Used:</u> None - Mechanical only	Schoodic_Campus	4.41	0.000015
	Wildwood	7.89	0.000190
	Total	12.30	0.000205
<i>Elaeagnus umbellata</i> (autumn olive) <u>Herbicide Concentrate Used:</u> Rodeo: 0.89 oz	Otter_Cliffs_Road	16.73	0.004230
	Otter_Cove_Boat_Launch	0.09	0.001081
	Schoodic_Peninsula	9.31	0.000504
	Total	26.13	0.005815
<i>Euonymus alatus</i> (winged burning bush) <u>Herbicide Concentrate Used:</u> Garlon 3A: Documented Elsewhere Pathfinder: Documented Elsewhere Rodeo: Documented Elsewhere	Compass_Harbor	5.81	0.000664
	Duck_Brook	7.81	0.000310
	Great_Meadow	7.54	0.000003
	Kent_Field_North	5.16	0.000012
	Ledgelawn	4.42	0.000015
	Long_Pond_Fire_Road	11.63	0.000015
	Paradise_Hill	7.43	0.000039
	Seal_Cove_Road	7.04	0.000031
	St_Croix	6.99	0.000812
	Total	63.83	0.001901
<i>Fallopia japonica</i> (Japanese Knotweed)	Blackwoods	7.14	0.000154
	Bubble_Pond	1.05	0.000225
	Bubble_Rock	0.07	0.000000
	Compass_Harbor	6.31	0.007986
	Duck_Brook	0.60	0.031135
	Eagle_Lake	0.33	0.000023
	Echo_Lake	0.39	0.000240
	Holy_Redeemer_Cemetery	0.73	0.000239
	Hulls_Cove_House	3.99	0.000228
	Jordan_Pond_Road	0.18	0.000811
	Jordan_Pond_Road_Erosion	1.15	0.000077
	Lakewood	1.07	0.000077
	Ledgelawn	3.14	0.000131
	Liscomb_Pit	0.17	0.000504
	McFarland_Hill	0.57	0.000034
	New_Mills_Meadow	0.69	0.000008
	Otter_Cove_Boat_Launch	1.48	0.051445
	Parkman_Mountain	0.46	0.000000
	Route_198	3.53	0.000236
	Route_233/198	1.64	0.000100
	Route_3/Cooksey	0.37	0.000000
	Route_3/Tarn	0.21	0.000000
	Saterlee_Pit	0.42	0.000109
	Seawall	2.75	0.003856
	Shooting_Range	2.09	0.000201
	Sieur_de_Monts	0.23	0.000000

<u>Herbicide Concentrate Used:</u> Milestone: 0.82 oz Rodeo: 5.82 oz	St_Croix	6.99	0.000186
	Stanley_Brook	3.15	0.000031
	Start_of_One_Way	1.09	0.000047
	Thailand	6.96	0.000103
	Thompson_Island	0.45	0.000308
	White_Birches	0.25	0.000004
	Total	59.65	0.098498
Frangula alnus (glossy buckthorn)	Adams_Bridge	0.58	0.002645
	Amphitheater	9.07	0.000271
	Bass_Harbor_Marsh	13.36	0.001246
	Bear_Brook	10.42	0.015226
	Beaver_Dam_Pond	14.96	0.028561
	Bubble_Brook	4.31	0.004616
	Cadillac_Mountain_Entrance	7.97	0.006209
	Cadillac_Mountain_Road	1.93	0.000232
	Canon_Brook	6.38	0.155518
	Compass_Harbor	4.01	0.002417
	Duck_Brook_Road_Wetland	26.65	0.050261
	Eagle_Lake	3.05	0.000552
	Eagles_Craig	7.50	0.000000
	Great_Meadow	45.10	0.113521
	Harden_Farm	3.43	0.000631
	Headquarters	5.28	0.000321
	Heath_Brook	9.00	0.001634
	Kebo_Brook	5.32	0.011864
	Kent_Field_Central	2.34	0.000046
	Kent_Field_North	52.26	0.121221
	Kent_Field_South	11.08	0.013702
	Ledgelawn	9.29	0.053525
	Marshall_Brook	32.93	0.010287
	McFarland_Hill	0.61	0.000004
	New_Mills_Meadow	3.48	0.000046
	New_Mills_Meadow_Field	4.14	0.000221
	Nursery	2.98	0.000008
	Ocean_Drive	6.84	0.000027
	Otter_Cliffs_Road_North	4.99	0.001620
	Paradise_Hill	7.43	0.000001
	Round_Pond	0.83	0.000000
	Route_3/Tarn	10.58	0.013548
	Saterlee_Pit	17.19	0.001384
	Sawyers_Point	3.69	0.000004
	Schooner_Head	2.89	0.000659
	Seal_Cove_Road	2.67	0.004801

<u>Herbicide Concentrate Used:</u> Garlon 3A: 93.85 oz Milestone: .09 oz Pathfinder II: 10.50 oz Rodeo: 115.92 oz	Ship_Harbor	0.81	0.000015
	Sieur_de_Monts	6.58	0.001017
	Stanley_Brook	5.98	0.000132
	Tremont_School	9.49	0.000000
	Western_Mountain_Road	4.31	0.000031
	Total	381.71	0.618124
Hesperis matronalis (dame's rocket) <u>Herbicide Concentrate Used:</u> None - Mechanical only	Bubble_Pond	0.90	0.000031
	Echo_Lake	0.29	0.000004
	Jordan_Pond_House	7.47	0.000108
	St_Croix	6.99	0.000239
	Total	15.65	0.000382
Iris pseudacorus (yellow iris) <u>Herbicide Concentrate Used:</u> Rodeo: Documented Elsewhere	Saterlee_Pit	1.23	0.000092
	Total	1.23	0.000092
Laburnum x watereri (golden chain tree) <u>Herbicide Concentrate Used:</u> Pathfinder: 1.00 oz Rodeo: 0.53 oz	Great_Meadow	2.03	0.000968
	Jordan_Pond_House	2.90	0.000093
	Paradise_Hill	7.02	0.000015
	Start_of_One_Way	0.96	0.004674
	Total	12.91	0.005750
Ligustrum spp. (privet) <u>Herbicide Concentrate Used:</u> Garlon 3A: 0.2 oz Garlon 4 Ultra: .50 oz Pathfinder II: 7.00 oz Rodeo: 2.11 oz	Bar_Island	19.65	0.004691
	Beech_Hill_Road	5.28	0.000163
	Compass_Harbor	11.17	0.001569
	Great_Meadow	7.54	0.000004
	Marshall_Brook	7.83	0.000008
	Otter_Cliffs_Road	5.70	0.000310
	Otter_Cove	4.57	0.002339
	Paradise_Hill	20.13	0.000054
	Stanley_Brook	5.98	0.005007
	Total	87.85	0.014145
Lonicera japonica (Japanese honeysuckle) <u>Herbicide Concentrate Used:</u> Garlon 3A: Documented Elsewhere	Ledgelawn	0.50	0.001499
	Total	0.50	0.001499
Lonicera spp. (bush honeysuckle)	Adams_Bridge	0.81	0.001317
	Bar_Island	19.65	0.000981
	Bear_Brook	1.81	0.000031
	Beaver_Dam_Pond	9.78	0.000125
	Beech_Hill_Road	5.28	0.000015
	Blackwoods	29.10	0.001737
	Breakneck_Brook	10.14	0.000039
	Cadillac_Mountain_Entrance	0.00	0.000573
	Cadillac_Mountain_Orchard	2.56	0.000039
	Canon_Brook	7.97	0.001666

Cleftstone	2.59	0.000016
Compass_Harbor	9.74	0.000159
Dick_Wolf_Overlook	0.17	0.000387
Duck_Brook	17.80	0.000186
Duck_Brook_Bridge	2.21	0.000202
Duck_Brook_Road_Wetland	17.52	0.000231
Eagle_Lake	2.90	0.000077
Fabbri_Memorial	0.28	0.000488
Fernald_Point	5.59	0.000031
Flying_Mountain_Parking	1.43	0.000008
Frazer_Point	1.54	0.000262
Furnace	2.62	0.000178
Great_Head_Trail	6.22	0.000030
Great_Meadow	39.78	0.002983
Harden_Farm	3.43	0.000051
Headquarters	1.81	0.000051
Hulls_Cove_House	3.40	0.000039
Jordan_Pond_House	2.90	0.000031
Jordan_Pond_Road	0.44	0.000035
Jordan_Pond_Road_Erosion	0.77	0.001561
Kent_Field_Central	11.50	0.000147
Kent_Field_North	17.49	0.000139
Kent_Field_South	3.48	0.000972
Lakewood	2.06	0.000008
Ledgelawn	20.91	0.002131
Liscomb_Pit	19.40	0.000542
Long_Pond_Fire_Road	11.63	0.001887
Marshall_Brook	16.68	0.000132
Motor_Vista_57	0.44	0.000000
New_Mills_Meadow	3.50	0.001364
New_Mills_Meadow_Field	4.14	0.059290
Nursery	6.05	0.000162
Ocean_Drive	9.93	0.000217
Otter_Cliffs_Road	41.21	0.013474
Otter_Cliffs_Road_North	4.99	0.000194
Otter_Cove	7.69	0.003833
Otter_Cove_Boat_Launch	6.12	0.001054
Paradise_Hill	26.81	0.000262
Pretty_Marsh	2.55	0.000000
Route_3/Tarn	6.28	0.000604
Sand_Beach	9.84	0.001975
Saterlee_Pit	14.44	0.005052
Schoodic_Campus	4.41	0.000480

<i>Herbicide Concentrate Used:</i> Garlon 3A: 0.55 oz Garlon 4 Ultra: 2.30 oz Milestone: Documented Elsewhere Pathfinder II: 43.50 oz Rodeo: 30.30 oz	Schoodic_Peninsula	14.03	0.000062
	Schooner_Head	2.89	0.000089
	Seal_Cove_Road	7.04	0.001741
	Seawall	3.18	0.001286
	Sheep_Porcupine	1.64	0.028630
	Shooting_Range	3.03	0.000093
	Sieur_de_Monts	0.02	0.001235
	St_Croix	6.99	0.000209
	Stanley_Brook	5.98	0.000822
	Thailand	1.46	0.000008
	The_Hop	5.62	0.007799
	Thompson_Island	2.86	0.000348
	Upper_Hadlock_Pond	0.30	0.000217
	Visitor_Center	4.03	0.000155
	Wildwood	7.89	0.000124
	Witch_Hole	35.41	0.000487
	Total	564.16	0.150753
<i>Lythrum salicaria</i> (purple loosestrife) <i>Herbicide Concentrate Used:</i> Garlon 3A: Documented Elsewhere Rodeo: 20.43 oz	Bear_Brook	10.42	0.004818
	Beaver_Dam_Pond	12.26	0.001084
	Duck_Brook	0.94	0.000000
	Compass_Harbor	5.75	0.004369
	Eagle_Lake	0.14	0.000000
	Great_Meadow	11.42	0.000004
	Hulls_Cove_House	2.06	0.000015
	Liscomb_Pit	0.68	0.000000
	Kent_Field_Central	2.34	0.000479
	Kent_Field_North	7.80	0.000276
	Kent_Field_South	2.03	0.000000
	Marshall_Brook	17.26	0.005036
	Route_102/Echo_Lake	0.21	0.000000
	Route_3/Tarn	2.55	0.000023
	Stanley_Brook	3.15	0.000084
	Witch_Hole	0.10	0.000000
	Total	79.11	0.016188
<i>Robinia pseudoacacia</i> (black locust) <i>Herbicide Concentrate Used:</i> Garlon 4 Ultra: 0.25 oz Pathfinder II: Documented Elsewhere	Blackwoods	0.11	0.000185
	Jordan_Pond_House	6.17	0.000775
	Total	6.28	0.000960
<i>Rosa multiflora</i> (multiflora rose)	Blackwoods	0.11	0.001583
	Canon_Brook	1.01	0.000349
	Compass_Harbor	3.71	0.002639
	Duck_Brook_Road_Wetland	9.05	0.001968

<i>Herbicide Concentrate Used:</i> Garlon 3A: Documented Elsewhere Garlon 4 Ultra: Documented Elsewhere Pathfinder II: 0.20 oz Rodeo: 0.99 oz	Great_Meadow	18.21	0.000116
	Kebo_Brook	5.32	0.000015
	Ledgelawn	4.68	0.000236
	Long_Pond_Fire_Road	11.63	0.000070
	Marshall_Brook	16.25	0.000132
	Ocean_Drive	6.84	0.000093
	Otter_Cove_Boat_Launch	2.29	0.000852
	Parkman_Mountain	0.55	0.000116
	Schoodic_Peninsula	9.31	0.000736
	Seal_Cove_Road	7.04	0.000116
	Shooting_Range	1.81	0.000039
	White_Birches	1.55	0.000000
	Total	99.36	0.009060
<i>Tussilago farfara (coltsfoot)</i> <i>Herbicide Concentrate Used:</i> Rodeo: Documented Elsewhere	Breakneck_Brook	11.23	0.000054
	Jordan_Pond_Carriage_Road	5.80	0.000015
	Kent_Field_North	1.98	0.000008
	Otter_Cliffs_Road	0.16	0.000062
	Otter_Cove	1.74	0.000012
	Quarry_Path	1.59	0.000000
	Route_198	2.82	0.000016
	Schoodic_Peninsula	9.31	0.000023
	St_Croix	6.99	0.000777
	Total	40.03	0.000967
<i>Verbascum thapsus (common mullen)</i>	Amphitheater	2.78	0.000093
	Bar_Island	19.65	0.000302
	Blackwoods	6.24	0.000116
	Duck_Brook	0.95	0.000008
	Fernald_Point	4.10	0.000055
	Headquarters	1.21	0.000100
	Isle_au_Haut	42.92	0.000387
	Jordan_Pond_House	7.47	0.000448
	Jordan_Pond_Road_Erosion	0.31	0.000008
	Liscomb_Pit	0.68	0.000081
	McFarland_Hill_North	0.51	0.000008
	Nursery	0.01	0.000039
	Otter_Cove	4.57	0.000015
	Sand_Beach	2.74	0.000155
	Sawyers_Point	5.35	0.000311
	Schoodic_Campus	4.41	0.000279
	Seal_Cove_Road	7.04	0.000008
	Sieur_de_Monts	0.45	0.000008
	St_Croix	6.99	0.000031

Herbicide Concentrate Used: Rodeo: Documented Elsewhere	The_Hop	5.62	0.005962
	Thompson_Island	2.02	0.000031
	Witch_Hole	0.70	0.000038
	Total	126.72	0.008483

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