



Exotic Plant Management in Acadia National Park, Maine

2017 Annual Summary Report

ACAD NR Report #: 2018-1



ON THE COVER

Exotic Plant Management Team (EPMT) Member James (Jim) Burka and Data Manager Nicholas (Nick) Stevenson performing foliar herbicide applications on exotic bush honeysuckle on The Hop, 9 August 2017. (NPS Photo)

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Executive Summary

In 2017 the Acadia National Park (ANP) Exotic Plant Management Team (hereafter the EPMT) systematically surveyed 936 acres of forest, wetland, riparian and other habitats for the presence of Invasive Exotic Plant (IEP) species prioritized for management (**Figure 1**). Of these surveyed acres, 77 were outside of Acadia National Park on partner organizations' lands. Invasive plants were managed at 72 sites, with treatment area totaling 4.01 infested acres*. All these values have increased from those in 2016.

A total of 24 IEPs were managed in 2017 with manual and chemical control methods at ANP. Of these, 21 are species of greatest management concern. Six species from our target list are managed at our population goals of either full suppression or reduced below management threshold - Amur maple (*Acer ginnala*), autumn olive (*Elaeagnus umbellata*), burning bush (*Euonymus spp.*), foxglove (*Digitalis purpurea*), giant hogweed (*Heracleum mantegazzianum*), and spotted knapweed (*Centaurea stoebe*) - whereas most of the remaining species have made progress toward their management goals during 2017. The four person crew logged over 1,609 hours (with an Acadia Scholar Intern and volunteers contributing an additional 130 hours) toward managing IEPs and rehabilitating landscapes. In total, 8.3 gallons of undiluted herbicide were applied in addition to mechanical treatments.

In 2017 the team continued to develop and maintain partnerships with local and state organizations, increased outreach efforts by presenting posters at events, educated interested visitors and local landowners, and maintained commercial pesticide applicator licenses. The EPMT continued to restore and maintain native plantings in cultural landscapes at Sieur de Monts, and assisted with a revegetation project on the Cadillac Mountain summit. The EPMT also monitored research transects or plots for glossy buckthorn (*Rhamnus frangula*, syn. *Frangula alnus*), purple loosestrife, and Norway maple, and assisted visiting scientists in setting up and collecting data for their own experimental vegetation plots.

Direct program costs for fiscal year 2017 were \$211,339. This program is funded primarily through four grants and other "soft" funding sources, including a donation from the Federal Aviation Administration to mitigate wetland impacts from expanding the runway at the Hancock County Airport, NPS recreational fee revenues and a grant from Canon USA, Inc. procured by 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. Maintenance and administrative support, offices, storage, vehicle maintenance, and fuel were funded through other NPS operational funds and are not included in the figure above.

**{Infested acres are defined as 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 100% density.}*



2017 Acadia National Park Exotic Plant Management Work Sites

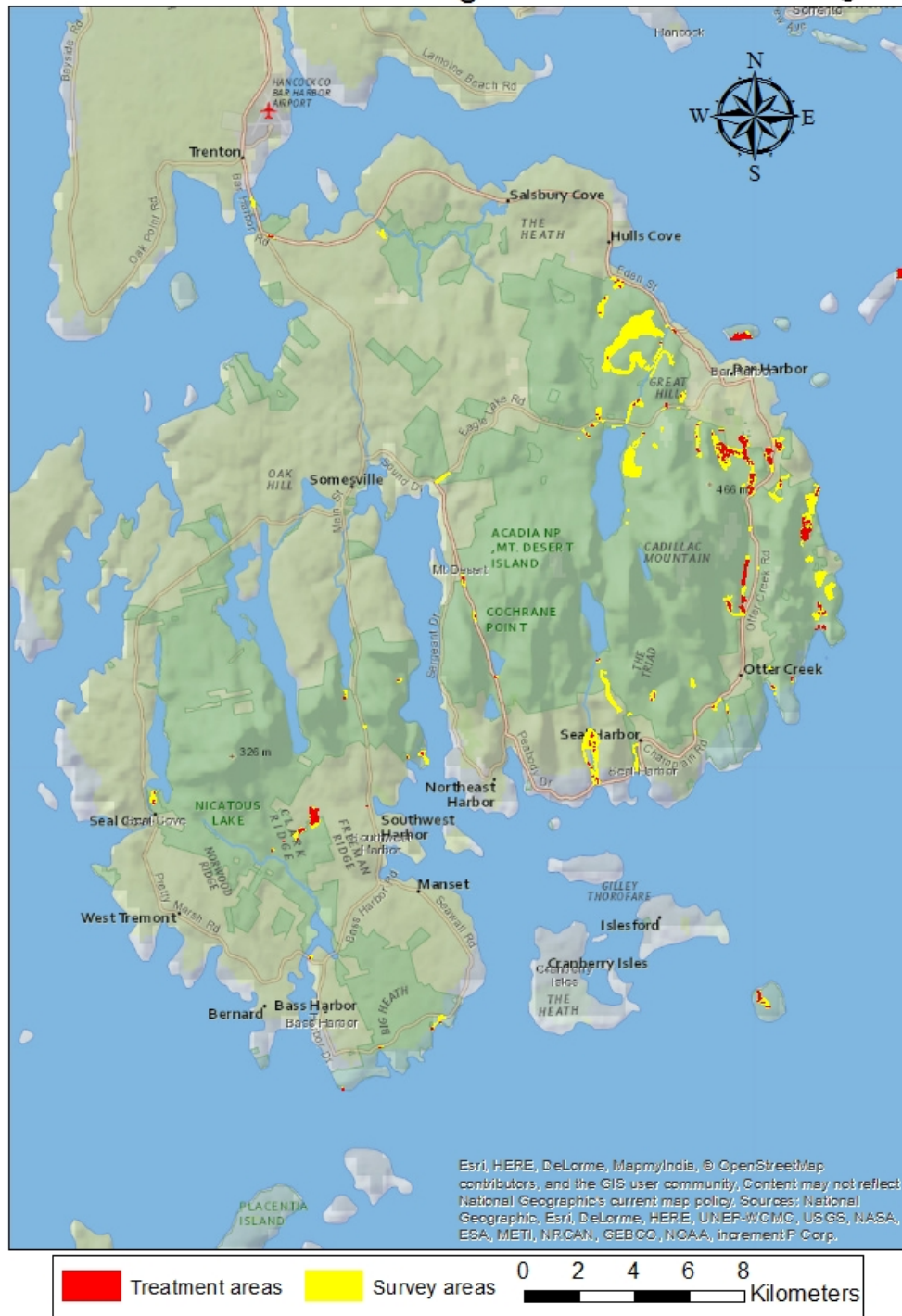


Figure 1. Map of locations of invasive exotic plant populations treated or surveyed during the 2017 field season on Mount Desert Island. Treatment and survey efforts of 24 invasive exotic species covered over 940 acres.

Introduction

Identified as a key issue in Acadia's Foundation Document (2016), nonnative invasive species negatively impact natural and cultural resources. Invasive Exotic Plants (IEPs) are a significant threat to the ecosystems of Acadia National Park (ANP), in particular those lands managed on Mount Desert Island (MDI). These lands have a long history of human disturbance, which increases the likelihood that IEP populations will establish. This area also saw the introduction of horticultural plants that later proved invasive and ecologically damaging. IEPs can degrade or destroy native habitats by displacing the native species that inhabit the area. In extreme cases, IEPs out-compete native plants and form dense monocultures. This has far-reaching consequences for other components of the ecosystem (both flora and fauna) that rely on these native plants for habitat and food. IEPs can also mar views enjoyed by park visitors, damage structures, and degrade cultural resources of the park.

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

- (1) Preserve healthy habitats using **Early Detection and Rapid Response (EDRR)** to prevent IEP populations from becoming established;
- (2) **Manage existing populations** of IEPs 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 exotic plant management needs** using a science-based Integrated Pest Management (IPM) approach.

This document reports all activities related to IEP management for the year 2017. Personnel involved with exotic plant management were Term Biological Technicians Jesse Wheeler, Alexander (Alex) Fetgatter, Joseph (Joe) Kelley, and Nicholas (Nick) Stevenson, as well as Seasonal Biological Technician James (Jim) Burka. In cooperation with College of the Atlantic, Acadia Scholar Intern Gemma Venuti joined the crew in July and August.

Goals and Management Objectives

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



Figure 2. Cyclic maintenance is carried out in some locations, including this spotted knapweed (*Centaurea stoebe*) population at ANP Headquarters in Bar Harbor, ME. This population is small enough that plants only need to be pulled one day a year, or less if the seed bank is depleted from numerous past year visits. Over time we expect this population to significantly reduce in cover or be eliminated entirely. (7 August 2017, NPS Photo)

All management actions (initial treatments, surveys, or re-visits) are logged by hand on standard data sheets that record the following information: treatment location, personnel involved, hours worked, weather, amount and type of herbicide used, and treatment methods, as well as level of infestation and phenology of the exotic species present. All treatment areas are mapped using Global Positioning System (GPS) and Geographic Information System (GIS) technology to record the spatial parameters of the infestation. Photo points (photographs at established locations) are taken pre- and post-treatment whenever possible to help monitor changes in populations over time; some of these points are visited on an annual basis to help gauge long-term population trends.

With many sites and species scattered throughout ANP it is necessary to prioritize which species to treat, and when. To that end we make an effort to manage IEPs in the park by watershed (e.g., Cromwell Brook) or project focus (e.g. Champlain Mountain region). To maintain continuity with past years when naming conventions were not watershed-based, areas within watersheds are

further described using historic work location names (e.g., Sieur de Monts, Great Meadow). The IEP populations within these management units and watersheds have been mapped using GPS and GIS; these areas will continue to be surveyed for the presence or absence of targeted IEPs. Management by species and location are reported here to summarize management actions.

Park resource managers have also developed management goals for 26 of the IEP species of greatest concern, including targets for the 2018 field season (**Table 1**). Although there are more than 26 IEP species in the park, these particular species were chosen for active management based on species biology and where control is prudent and feasible (NPS Management Policies 4.4.4, 2006). Important management criteria include invasiveness, the threat posed to park resources (i.e., the ecological or cultural values at risk from the plant), and the likelihood of successful management. Much of the inventory work, literature review, and initial prioritization for management in Acadia can be found in the Vegetation Management archives: Reiner and McLendon 2002, Greene et. al. 2004, and Weber and Rooney 2007. The management plans produced from thorough assessment describe species abundance and distribution within the park, and provide information about habitat, species identification and best management practices. Review of the latest scientific literature and previous management activities are used to update action plans on an annual basis. This ensures they prescribe management strategies based on the latest IPM approaches, with maximum efficacy and minimum toxicity.

All exotic plant management plans and actions are based on the following principals of IPM:

- 1: Survey the area to identify resources at risk, and determine the location and extent of IEP infestations.
- 2: Prioritize infestations for management based on threat posed, potential rate of spread, distribution, and feasibility of successful treatment.
- 3: Review scientific literature and base future management actions on a thorough understanding of IEP biology, treatment alternatives, and potential effects.
- 4: Consider all available treatment options and select the methods that will most effectively treat the species of concern with the least potential environmental damage.
- 5: Monitor treated areas to determine treatment success and the need for re-treatment or restoration with native species.
- 6: Evaluate treatment results and use them to guide future management actions.

Due to the many hazards associated with exotic plant management, as well as the demanding and technical nature of the work, it is of the utmost importance that the park's EPMT be well-trained and professional. To this end crew members and staff all take part in a comprehensive training program, and are licensed by the State of Maine Board of Pesticides Control as Commercial Pesticide Applicators. Program leaders participate in regional professional meetings, such as the Maine Invasive Species Network (MISN) Annual Meeting, to stay abreast of research and improve partnerships and collaboration. Acadia staff also complete mandatory NPS training including personnel management, computer security, hazardous materials communication, and supervision. Field crew training for new staff starts with two weeks of classroom and field training beginning in early May, and is continued throughout the season with frequent safety and IEP species reports and tailgate safety sessions.

Table 1. Status of invasive exotic plant species management in 2017 and 2018 management goals by species, for Acadia National Park.

Population Goal			Level of Effort				
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.			Active = management time devoted specifically to this species, usually on an annual or re-occurring basis. Working toward maintenance level effort			Inactive = Management of species is not targeted due to low priority and/or incomplete management plan.	
Fully Suppressed = Known populations are small and very few, contain no known reproductive plants; seed bank may still be viable. Maintenance level effort only.			Active (High) = crew works on this plant for 100+ person hours/season			Incidental = Plant managed when encountered during targeted management of other species.	
Nearly Suppressed / Reduced = Known populations small and contain few reproductive individuals; seed bank managed regularly. Recent decrease of treated infested acres.			Active (Med) = crew works on this plant for 30-100 person hours/season			Rapid Response = active management occurs when population is discovered.	
Population Contained = Infested acres remain constant and established populations are prevented from spreading to uninfested areas.			Active (Low) = crew works on this plant for 1-30 person hours/season			Volunteer = Treatment carried out primarily by volunteers to improve outreach and education or efficiency.	
Population Unknown / Increasing = Extent of infestation unknown due to insufficient monitoring efforts or lack of knowledge. Species likely spread over many sites in Acadia.			Maintenance Level = New and small recurring populations only. Effort varies between Active (Low) and no treatment per year.				
Species (in alphabetical order by common name)	Initial Work	Most Recent Date / Level of Effort	Long-Term Goal	Population Status	2018 Level of Effort	Primary Treatment Method	Notes
Amur maple (<i>Acer ginnala</i>)	2006	2016 / Incidental	Full Suppression	Fully Suppressed	Maintenance	Foliar and cut-stump herbicide	Goal currently met
Asiatic bittersweet (<i>Celastrus orbiculatus</i>)	2010	2017 / Active (High)	Full Suppression	Population Unknown/Increasing	Active (High)	Foliar and cut-stump herbicide	
Autumn olive (<i>Elaeagnus umbellata</i>)	2013	2016 / Rapid Response	Reduce Below Mgmt. Threshold	Below Mgmt. Threshold	Rapid Response	Foliar and cut-stump herbicide	Goal currently met
Barberry (Japanese, common) (<i>Berberis thunbergii, vulgaris</i>)	2006	2017 / Active (Med)	Full Suppression	Population Unknown/Increasing	Active (Med)	Foliar herbicide	
Bittersweet nightshade (<i>Solanum dulcamara</i>)	2012	2016 / Incidental	Reduce Below Mgmt. Threshold	Population Unknown/Increasing	Incidental	Foliar herbicide, hand pulling	
Bull thistle (<i>Cirsium vulgare</i>)	2014	2017 / Active (Low)	Reduce Below Mgmt. Threshold	Population Contained	Active (Low)	Hand pull	Hand pull second year, flowering stems
Burning bush (<i>Euonymus spp.</i>)	2011	2017 / Rapid Response	Reduce Below Mgmt. Threshold	Below Mgmt. Threshold	Rapid Response	Foliar and cut-stump herbicide	Goal currently met
Canada thistle (<i>Cirsium arvense</i>)	2011	2017 / Active (Med)	Reduce Below Mgmt. Threshold	Population Unknown/Increasing	Active (Med)	Foliar herbicide	
Coltsfoot (<i>Tussilago farfara</i>)	2002	2017 / Active (Low)	Population Contained	Population Unknown/Increasing	Incidental	Foliar herbicide	
Common mullein (<i>Verbascum thapsus</i>)	2011	2017 / Incidental	Population Contained	Population Unknown/Increasing	Incidental	Hand pull	
Common reed (<i>Phragmites australis</i>)	2014	2014 / Rapid Response	Full Suppression	Not in Park yet	Rapid Response	Foliar herbicide	Two known sites on Mount Desert Island
European bittercress (<i>Cardamine impatiens</i>)	2005	2017 / Incidental	Reduce Below Mgmt. Threshold	Population Contained	Active (Low) / Volunteer	Hand pull / foliar herbicide	Start monitoring transects in 2018
Exotic bush honeysuckle species (<i>Lonicera spp.</i>)	2003	2017 / Active (High)	Full Suppression	Population Contained	Active (High)	Foliar and cut stump herbicide	More of a focus in 2017 compared to 2016
Foxglove (<i>Digitalis purpurea</i>)	2003	2016 / Incidental	Reduce Below Mgmt. Threshold	Below Mgmt. Threshold	Maintenance	Hand pull	Goal currently met

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Table 1 (continued). Management status for 2017 and 2018 management goals for invasive exotic plant species in Acadia National Park.							
Species (in alphabetical order by common name)	Initial Work	Most Recent Date / Level of Effort	Long-Term Goal	Population Status	2018 Level of Effort	Primary Treatment Method	Notes
Garlic mustard (<i>Alliaria petiolata</i>)	2003	2017 / Active (Med)	Full Suppression	Nearly Suppressed / Reduced	Active (Med)	Hand pull	Decreasing for several years
Giant hogweed (<i>Heracleum mantegazzianum</i>)	2003	2017 / Active (Low)	Reduce Below Mgmt. Threshold	Fully Suppressed	Rapid Response	Foliar herbicide	Goal met inside Park boundary
Glossy buckthorn (<i>Frangula alnus</i>)	2006	2017 / Active (High)	Full Suppression	Population Increasing	Active (High)	Foliar and cut stump herbicide	
Japanese honeysuckle (<i>Lonicera japonica</i>)	2012	2012 / Rapid Response	Reduce Below Mgmt. Threshold	Below Mgmt. Threshold	Rapid Response	Foliar herbicide	Goal currently met
Japanese knotweed (<i>Fallopia japonica</i>)	2003	2017 / Active (Med)	Full Suppression	Nearly Suppressed / Reduced	Active (Med)	Cutting then foliar herbicide	
Lupine (<i>Lupinus polyphyllus</i>)	2004	2017 / Active (Low)	Education / Monitor	Population Unknown / Increasing	Active (Low) / Volunteer	Seed pod removal; hand-pulling near milkweed	
Multiflora rose (<i>Rosa multiflora</i>)	2006	2017 / Active (Low)	Reduce Below Mgmt. Threshold	Fully Suppressed	Rapid Response	Foliar herbicide	
Norway maple (<i>Acer platanoides</i>)	2017	2017 / Incidental	Full Suppression	Population Contained	Active (Med)	Cut stump herbicide	Test plots treated only winter 2018
Privet (<i>Ligustrum spp.</i>)	2016	2017 / Active (Low)	Full Suppression	Nearly Suppressed / Reduced	Active (Low)	Cut stump herbicide	High management in 2016
Purple loosestrife (<i>Lythrum salicaria</i>)	1988	2017 / Active (Med)	Full Suppression	Nearly Suppressed / Reduced	Active (Med)	Foliar herbicide and seed removal	All historic sites visited / treated in 2017
Spotted knapweed (<i>Centaurea stoebe</i>)	2010	2017 / Rapid Response	Full Suppression	Nearly Suppressed / Reduced	Rapid Response	Hand pull	Two new sites and one historic treated in 2017, first treatment since 2013
Yellow iris (<i>Iris pseudacorus</i>)	2003	2017 / Active (Low)	Reduce Below Mgmt. Threshold	Population Contained	Active (Low)	Seed pod removal and cut stem herbicide	Cut stump treatments tested in 2017, and seed pod removal in 2016
Currently Under Review, Management N/A							
Black locust (<i>Robinia pseudoacacia</i>)	N/A	N/A	Allow natural range expansion	Population Unknown	Inactive	N/A	
Forest woodrush (<i>Luzula luzuloides</i>)	2011	N/A	Under Review	Population Unknown	Inactive	Foliar herbicide	
Golden chain tree (<i>Laburnum watereri</i>)	N/A	N/A	Under Review	Population Unknown	Inactive	Cut stump herbicide	
Ninebark (<i>Physocarpus opulifolius</i>)	N/A	N/A	Allow natural range expansion	Population Unknown	Inactive	N/A	
Reed canary grass (<i>Phalaris arundinacea</i>)	2010	N/A	Under Review	Monitoring	Inactive	Foliar herbicide	
Shrubby St. John’s-wort (<i>Hypericum prolificum</i>)	2008	2016 / Active (Low)	Under Review	Monitoring	Inactive	Foliar herbicide	Apparent native range expansion

Program Accomplishments

In 2017, 24 invasive exotic species were actively managed with manual and chemical control methods in Acadia National Park. The 4 person EPMT logged over 1,609 hours (with an Acadia Scholar Intern and volunteers contributing an additional 130 hours) toward managing IEPs and rehabilitating landscapes. More than half this time was spent at four sites (out of 72 sites total): Great Meadow, Kent Field, Canon Brook/Otter Creek and The Hop Island. This year the EPMT surveyed a record 936 acres for invasive plants across varied terrain.

This year's increase in surveyed acres (up from 759 in 2016) was accomplished in part by moving quickly over larger areas that are lightly infested with invasive plants. Among the 72 sites managed in 2017, a majority of the time and effort was spent on five locations. These were new treatment areas such as the Otter Creek watershed, as well as follow up work in heavily infested sites including Kent Field, Great Meadow Drive, the Jackson Lab surroundings, and the Great Meadow north of Sieur de Monts. These sites are predominantly invaded by glossy buckthorn, which remains the park's biggest exotic plant challenge. Glossy buckthorn accounted for more than half our treatment efforts in 2017 (**Figure 3**).

To get a better idea of the efficacy of glossy buckthorn treatment efforts, the EPMT established long-term monitoring transects in the Otter Creek watershed, near Rt. 3 and the Canon Brook confluence (**Figure 4**). These transects measure buckthorn population density as well as reproductive capability (i.e., presence of fruiting versus non-fruiting individuals per square meter). Initial attack treatment was completed in this area in 2017; annual measurements in ensuing years will tell us the efficacy of this and any follow-up treatments. Glossy buckthorn was also targeted for the second straight year in a 50 acre portion of the Kent Field wetland complex between Schooner Head Road and the Park Loop Road. This area needed treatment of stump sprouts and immature plants to prevent seed production that may be carried by wildlife to other wetland habitats in Acadia. Since the seeds of glossy buckthorn remain viable for three years or more, future visits will be needed to remove young seedlings. Both the Otter Creek and Kent Field wetland basins are viewed by many visitors climbing historic trails up Champlain, Dorr, and Cadillac Mountains, so maintaining a naturally authentic landscape is crucial.

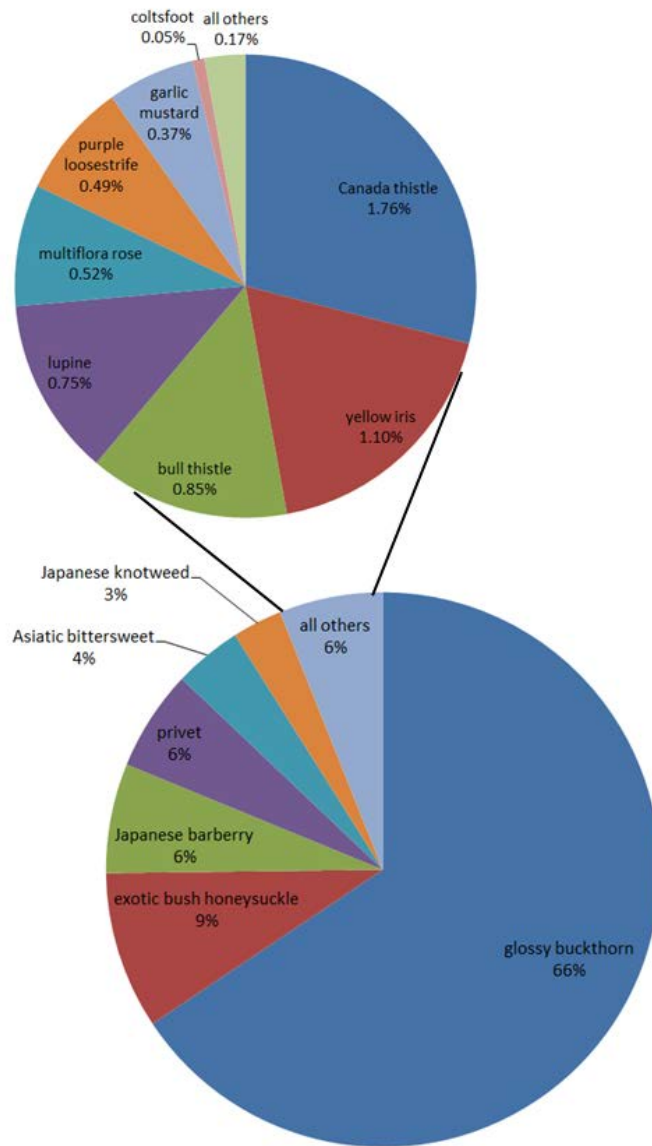


Figure 3. Pie graph of total EPMT treated acres (**4.01 acres**) for all IEPs in 2017. Species grouped together in the “all others” section of the upper chart have treated acre values ≤ 0.002 acres. These species include: giant hogweed, winged euonymus, common burdock, spotted knapweed, English ivy, mullein, common barberry, and narrowleaf bittercress.

EPMT crew members worked with Schoodic Institute staff to establish pre-treatment Norway maple monitoring plots in the Compass Harbor, Duck Brook, and Great Meadow Drive (a.k.a., Ledge lawn) areas of the Park. These long-term monitoring plots will help characterize the vegetation composition and structure in forest areas that contain non-native invasive Norway maple. Once this tree species is managed and canopy gaps are created starting winter 2018, it will be important to re-measure these plots on an annual basis to see what kind of vegetation, native or non-native, becomes established. Full suppression of Norway maple in Acadia is a goal

that will be a long-term process. As a start small, isolated trees will be targeted in undisturbed forests during the next few years.



Figure 4. EPMT Members Jim Burka (left) and Alex Fetgatter (right) collect glossy buckthorn population data along one of four transects near the confluence of Canon Brook and Otter Creek, 7 June 2017. (NPS Photo)

We increased control efforts for Japanese knotweed in 2017. The bamboo-like plant will grow to 10 feet tall in one season, often forming dense stands that crowd out scenic views and native plants. The number of locations treated jumped 64% since 2016; a majority of sites are along road shoulders where the plant can spread via roots and tiny plant fragments transported in construction fill. Multiple treatments over several years are needed to fully suppress Japanese knotweed; this means 2018 and beyond could require increased effort, especially if new locations keep getting discovered.

In partnership with the College of the Atlantic, student Gemma Venuti was selected for one of two Acadia Scholar Internships and worked with the EPMT in July and August. She also completed an independent research project, entitled *Roads and Trails as Corridors for the Dispersal of Invasive Plant Species in Acadia National Park*. Gemma's enthusiasm and intellect were a welcome addition to the team. Gemma was especially helpful as we managed bush honeysuckle (*Lonicera spp.*) on The Hop Island, tackling glossy buckthorn in the Otter Creek/Canon Brook watershed, and establishing Norway maple (*Acer platanoides*) treatment study plots.

Throughout 2017 the team continued to develop and maintain partnerships with local and state organizations including Friends of Acadia, Mount Desert Land & Garden Preserve, The Jackson Laboratory, Somes-Meynell Wildlife Sanctuary, Maine Coast Heritage Trust, Maine Department of Agriculture, Conservation and Forestry (including both Maine Forest Service and Maine Natural Areas Program), US Forest Service, and Maine Volunteer Lake Monitoring Program. Vegetation staff also attended the Maine Invasive Species Network (MISN) Annual Meeting to discuss current invasive species threats to the State, earning continuing education credits to maintain Commercial Pesticide Applicator licenses in the process. The team increased outreach efforts by presenting posters on exotic plant management techniques at both the MISN Annual Meeting and College of the Atlantic's Acadia Science Symposium. Team members participated in local community outreach efforts by presenting to the Ellsworth Garden Club, as well as meeting with landscape managers at The Jackson Laboratory and the Mount Desert Land & Garden Preserve to discuss invasive plant management strategies on their neighboring properties near Bar Harbor and Seal Harbor. During the winter staff kept their "search image" for plants sharp by helping with projects at the College of the Atlantic / Acadia Herbarium, including mounting voucher specimens and photographing mounted plants.

Exotic plant management field operations ran until October 19th, 2017. Afterward Alex, Jim, Nick, and Jesse continued field work in a different capacity by aiding the Maintenance Division's efforts to rehabilitate historic vistas along carriage and motor roads, as well as clear hazard trees and roadside vegetation along motor roads. Assisting tree-felling operations, they made cut-stump herbicide treatments to prevent deciduous trees from stump sprouting, looked for woody invasive plants, and provided on-site plant identification to the roads crew.

Invasive Exotic Plant Species of Greatest Concern Managed in 2017

A total of 4.01 infested acres were managed on NPS and adjacent private lands with written permission of landowners. Of these, six of the most heavily-managed species are highlighted in **Table 2**: garlic mustard, Japanese barberry, Asiatic bittersweet, Japanese knotweed, bush honeysuckle, and glossy buckthorn. Several other IEPs are less widespread and either fall below ecological impact thresholds and are thus managed incidentally, or are managed at single locations with less coverage in the park (**Table 3**).

Table 2. 2017 surveyed and infested acres of invasive plants by species (in alphabetical order by scientific name) managed to significantly reduce populations in designated treatment areas (Population Reduced, Nearly Suppressed or Contained).

Species	Site / Location	Surveyed Acres	Infested Acres
garlic mustard (<i>Alliaria petiolata</i>)	Bass Harbor	0.972	0.00086
	Compass Harbor	8.865	0.00732
	Fernald Point	0.0038	0.00004
	Holy Redeemer Cemetery	0.866	0.00004
	Jordan Pond Carriage Road	0.649	0.00005
	Jordan Pond Rd. Erosion Site	2.572	0.00092
	Ledgelawn	15.416	0.00309
	Otter Cliffs Road	1.332	0.00209
	Seawall	0.111	0.00023
	Stanley Brook	21.47	0.0003
<i>Herbicide concentrate used:</i> None (manual control)	Total	52.2568	0.01494
Japanese barberry (<i>Berberis thunbergii</i>)	Bar Island	23.697	0.1684
	Blackwoods	1.21	0.00001
	Breakneck Brook	13.75	0.0002
	Canon Brook	3.15	0.0002
	Cleftstone	5.863	0.0028
	Duck Brook	4.039	0.0011
	Duck Brook Road Wetland	14.92	0.0029
	Eagle Lake	7.688	0.0062
	Fernald Point	10.457	0.0018
	Great Meadow	0.743	0.0032
	Hulls Cove House	0.17	0.0002
	Jackson Lab	3.96	0.0011
	Jordan Pond Rd. Erosion Site	0.44	0.00001
	Kebo Brook	8.68	0.0007
	Kent Field	2.92	0.0012
	Ledgelawn	6.29	0.0005
	Liscomb Pit	1.556	0.0002
	Little Long Pond	61.84	0.0028
	Man of War Rd.	1.18	0.0034
	Marshall Brook	24.417	0.0017
	McFarland Hill	2.28	0.0014
	Otter Cove	1.063	0.0035
	Stanley Brook	5.14	0.0003
	Thailand	24.443	0.04
	Visitor Center	3.236	0.0016
	White Birches Campground	8.84	0.0022
	Witch Hole	209.55	0.0089
<i>Herbicide concentrate used:</i> Rodeo: 81.715 oz.	Total	451.522	0.2564

Table 2 (continued). 2017 surveyed and infested acres of invasive plants by species (in alphabetical order by scientific name) (Population Reduced, Nearly Suppressed or Contained).

Species	Site / Location	Surveyed Acres	Infested Acres
glossy buckthorn (<i>Rhamnus frangula</i>)	Cadillac Mountain Entrance	0.403	0.0003
	Canon Brook	29.284	0.4786
	Cleftstone	5.77	0.00002
	Compass Harbor	1.22	0.0103
	Duck Brook	5.04	0.000001
	Duck Brook Road Wetland	14.92	0.004
	Eagle Lake	0.4	0.0002
	Fernald Point	7.15	0.000008
	Great Meadow	88.145	0.2581
	Jackson Lab	15.34	0.9355
	Jordan Pond House	0.56	0.00008
	Kebo Brook	10.41	0.0777
	Kent Field	50.65	0.5149
	Ledgelawn	12.57	0.2559
	Liscomb Pit	1.09	0.00002
	Little Long Pond	61.84	0.0447
	Marshall Brook	24.417	0.0008
	Nursery	7.69	0.0001
	Route 198	4.58	0.00004
	Sand Beach	3.99	0.0001
	Schooner Head	13.399	0.00001
	Shooting Range	3.38	0.0011
	Thailand	0.71	0.00001
	Upper Hadlock Pond	0.46	0.00002
	White Birches Campground	8.84	0.000008
	Total	372.258	2.5825
Japanese knotweed (<i>Fallopia japonica</i>)	Cadillac Mountain Entrance	0.24	0.0015
	Cadillac Mountain Road	1.15	0.0001
	Compass Harbor	11.37	0.0055
	Duck Brook	0.52	0.0152
	Eagle Lake	0.42	0.00003
	Echo Lake	1.99	0.0013
	Holy Redeemer Cemetery	1	0.0009
	Hulls Cove House	1.98	0.0004
	Jordan Pond Rd. Erosion Site	1.74	0.0004
	Ledgelawn	2.239	0.0004
	McFarland Hill	0.059	0.0009
	Route 198	9.97	0.0021
	Intersection Rte. 233/Rte. 198	2.71	0.0006
	Intersection Rte. 3/Cooksey Dr.	0.19	0.0002
	Route 3 / Tarn	0.71	0.00001
	Satterlee Pit	1.47	0.0835
	Shooting Range	2.66	0.0013
	Sieur de Monts	0.01	0.00001
	Thailand	8.44	0.0008
	Thompson Island	1.79	0.0007
	White Birches Campground	8.84	0.0008
	Witch Hole	197.9	0.00002
	Total	257.398	0.1168

Herbicide concentrate used:
Garlon 3A: 94.38 oz.
Garlon 4 Ultra: 0.125 oz.
Rodeo: 565.3375 oz.

Herbicide concentrate used:
Garlon 3A: 1 oz.
Rodeo: 16.725 oz.

Table 2 (continued). 2017 surveyed and infested acres of invasive plants by species (in alphabetical order by scientific name) (Population Reduced, Nearly Suppressed or Contained).

Species	Site / Location	Surveyed Acres	Infested Acres
exotic bush honeysuckle (<i>Lonicera spp.</i>)	Bar Island	10.412	0.0244
	Cadillac Mountain Entrance	0.403	0.0014
	Cadillac Mountain Orchard	2.431	0.0006
	Canon Brook	24.82	0.0003
	Cleftstone	5.77	0.0001
	Compass Harbor	1.22	0.0001
	Duck Brook	9.57	0.0006
	Duck Brook Bridge	0.49	0.0001
	Duck Brook Road Wetland	9.56	0.0013
	Eagle Lake	9.428	0.0027
	Fernald Point	10.457	0.0008
	Great Meadow	70.797	0.0138
	Jackson Lab	10.94	0.0551
	Jordan Pond House	0.6	0.0016
	Kent Field	8.15	0.0018
	Ledgelawn	5.29	0.0053
	Liscomb Pit	16.355	0.00002
	Little Long Pond	61.84	0.0008
	McFarland Hill	2.28	0.0029
	Nursery	11.244	0.0089
	Ocean Path	0.126	0.0006
	Otter Cove	1.063	0.0004
	Sand Beach	3.99	0.0015
	Satterlee Pit	0.99	0.0005
	Sawyer's Point	0	0.0002
	Schooner Head	13.399	0.0035
	Schooner Head Overlook	0	0.00002
	Shooting Range	5.25	0.0003
	Thailand	22.798	0.0062
	The Hop	12.41	0.2272
	Thompson Island	2.19	0.00004
	Tremont School	1.08	0.0001
<i>Herbicide concentrate used:</i> Garlon 4 Ultra: 2.5 oz. Rodeo: 115.0025 oz.	Upper Hadlock Pond	0.46	0.00002
	White Birches Campground	8.84	0.0047
	Witch Hole	10.375	0.0001
	Total	355.028	0.3681

Table 2 (continued). 2017 surveyed and infested acres of invasive plants by species (in alphabetical order by scientific name) (Population Reduced, Nearly Suppressed or Contained).

Species	Site / Location	Surveyed Acres	Infested Acres
Asiatic bittersweet (<i>Celastrus orbiculatus</i>)	Bar Island	1.62	0.0129
	Bear Brook	0.616	0.00003
	Cleftstone	5.77	0.001
	Compass Harbor	8.225	0.0037
	Duck Brook	3.72	0.0001
	Duck Brook Road Wetland	9.56	0.00004
	Eagle Lake	1.53	0.0008
	Fernald Point	7.15	0.0023
	Flying Mtn. Parking Lot	0.39	0.0001
	Great Meadow	59.507	0.0032
	Headquarters	0.35	0.0003
	Jackson Lab	6.98	0.009
	Jordan Pond House	0.56	0.0001
	Kent Field	10.93	0.0016
	Ledgelawn	13.69	0.0034
	Liscomb Pit	1.556	0.0012
	Little Long Pond	61.84	0.0156
	McFarland Hill	2.28	0.0175
	Nursery	6.068	0.003
	Sand Beach	3.99	0.0042
	Sawyer's Point	8.15	0.0201
	Schooner Head Overlook	1.16	0.0001
	Seal Cove Road	0.38	0.0012
	Seawall	0.67	0.0005
	Stanley Brook	26.61	0.0006
	Thailand	27.218	0.0411
	The Hop	5.18	0.0015
	Upper Hadlock Pond	0.46	0.0031
	White Birches Campground	8.84	0.0106
	Total	285	0.159
<i>Herbicide concentrate used:</i>			
Garlon 3A: 21.12 oz.			
Garlon 4 Ultra: 0.75 oz.			
Rodeo: 54.77 oz.			

Table 3. Acres infested and surveyed of invasive plant species managed below ecological impact thresholds in 2017 (Fully or Nearly Suppressed - Maintenance level; listed in alphabetical order by scientific name). Some of these require only incidental management, meaning surveys are not conducted specifically for these species; rather they are treated as encountered on a case-by-case basis.

Species	Site / Location	Surveyed Acres	Infested Acres
Amur maple (<i>Acer ginnala</i>)*	no treatment in 2017	n/a	n/a
common burdock (<i>Arctium minus</i>)*	Duck Brook	0.81	0.0003
	Otter Cove	0.61	0.0004
	Satterlee Pit	1.25	0.0004
<i>Herbicide concentrate used:</i>	Wildwood	4.7	0.0001
None (manual control)	Total	7.37	0.0012
common barberry (<i>Berberis vulgaris</i>)*	Fernald Point	7.15	0.00004
	Kent Field	2.84	0.00004
<i>Herbicide concentrate used:</i>	Ledgelawn	4.11	0.00004
Rodeo: <1 oz.	Total	14.1	0.00012
European bittercress (<i>Cardamine impatiens</i>)*	Ledgelawn	4.11	0.00002
<i>Herbicide concentrate used:</i>	Total	4.11	0.00002
None (manual control)			
Canada thistle (<i>Cirsium arvense</i>)	Baker Island	12.14	0.045
	Bar Island	11.95	0.0118
	Beaver Dam Pond	12.46	0.00003
	Breakneck Brook	13.75	0.0001
	Duck Brook	0.14	0.0001
	Fabbri Memorial	0.24	0.0015
	Great Meadow	1.89	0.0012
	Headquarters	0.84	0.0001
	Kent Field	0.34	0.00004
	Ledgelawn	1.06	0.0002
	Nursery	5.17	0.0015
	Otter Cove	0.61	0.0004
	Pooler Farm	3.32	0.0005
	Sand Beach	3.47	0.0008
	Satterlee Pit	1.25	0.0004
	Seawall	3.7	0.0062
	Ship Harbor	0.36	0.00001
	Shooting Range	5.25	0.0001
	Sieur de Monts	0.76	0.00001
	The Hop	11.92	0.0004
	Thompson Island	1.25	0.00002
<i>Herbicide concentrate used:</i>	Tremont School	1.08	0.00003
Milestone: 4.58925 oz.	Visitor Center	0.22	0.00002
Rodeo: <1 oz.	Wildwood	4.7	0.00002
	Total	97.87	0.0705

Table 3 (continued). Acres infested and surveyed of invasive plant species managed below ecological impact thresholds in 2017 (Fully or Nearly Suppressed - Maintenance level; listed in alphabetical order by scientific name).

Species	Site / Location	Surveyed Acres	Infested Acres
bull thistle (<i>Cirsium vulgare</i>)	Baker Island	12.14	0.0052
	Bar Island	11.95	0.0236
	Beaver Dam Pond	12.46	0.0005
	Breakneck Brook	13.75	0.00004
	Compass Harbor	3.57	0.00002
	Echo Lake	0.15	0.0001
	Fernald Point	0.8	0.00003
	Headquarters	1.6	0.0006
	Hulls Cove House	0.48	0.0001
	Jackson Lab	4.03	0.00003
	Marshall Brook	9.35	0.00002
	Sand Beach	3.47	0.0001
	Satterlee Pit	2.53	0.0016
	Seawall	3.7	0.0009
	The Hop	0.49	0.0001
	Thompson Island	1.25	0.000004
	Visitor Center	6.62	0.0001
	Wildwood	4.7	0.0011
	Total	93.04	0.0342
<i>Herbicide concentrate used:</i> Milestone: .0425 oz.	no treatment in 2017	n/a	n/a
autumn olive (<i>Elaeagnus umbellata</i>)*	no treatment in 2017	n/a	n/a
winged euonymus (<i>Euonymus alatus</i>)*	Compass Harbor	4.62	0.0002
	Little Long Pond	19.38	0.0001
	Thailand	8.44	0.0011
	Total	32.44	0.0014
<i>Herbicide concentrate used:</i> Rodeo: .05 oz.			
Giant hogweed (<i>Heracleum mantegazzianum</i>)	Liquor Locker	0.17	0.0018
	Stanley Brook	5.14	0.0002
	Total	5.31	0.002
<i>Herbicide concentrate used:</i> Rodeo: 0.69 oz.			
shrubby St. John's-wort (<i>Hypericum prolificum</i>)*	no treatment in 2017	n/a	n/a
yellow iris (<i>Iris pseudacorus</i>)	Satterlee Pit	1.98	0.0441
	Total	1.98	0.0441
<i>Herbicide concentrate used:</i> Rodeo: 21.25 oz			
privet (<i>Ligustrum spp.</i>)	Bar Island	11.91	0.2337
	Blackwoods	1.21	0.000004
	Eagle Lake	7.69	0.0006
	Great Meadow	3.67	0.00001
	Jackson Lab	4.03	0.00002
	Ledgelawn	8.23	0.001
	Sawyer's Point	8.15	0.00008
	White Birches Campground	8.84	0.0002
	Total	53.73	0.2356
	<i>Herbicide concentrate used:</i> Rodeo: 32.765 oz.		

Table 3 (continued). Acres infested and surveyed of invasive plant species managed below ecological impact thresholds in 2017 (Fully or Nearly Suppressed - Maintenance level; listed in alphabetical order by scientific name).

Species	Site / Location	Surveyed Acres	Infested Acres
lupine (<i>Lupinus polyphyllus</i>)	Great Meadow	2.71	0.0302
<i>Herbicide concentrate used:</i>			
None (manual control)	Total	2.71	0.0302
purple loosestrife (<i>Lythrum salicaria</i>)	Beaver Dam Pond	15.89	0.001
	Compass Harbor	1.01	0.0027
	Kent Field	2.79	0
	Marshall Brook	24.417	0.0158
	Rte. 102 at Echo Lake		
	Entrance	0.53	0.00001
<i>Herbicide concentrate used:</i>	Satterlee Pit	1.85	0.00002
Rodeo: 7.62 oz.	Witch Hole	197.9	0.00004
	Total	244.387	0.0196
bittersweet nightshade (<i>Solanum dulcamara</i>)*	no treatment in 2017	n/a	n/a
multiflora rose (<i>Rosa multiflora</i>)*	Duck Brook Road Wetland	5.36	0.00004
	Great Meadow	9.47	0.0032
	Jackson Lab	6.98	0.000006
	Ledgelawn	8.23	0.0002
	Marshall Brook	24.417	0.0009
<i>Herbicide concentrate used:</i>	Seal Cove Road	0.38	0.0009
Rodeo: 0.12oz.	White Birches Campground	8.84	0.0154
	Total	63.677	0.0207
coltsfoot (<i>Tussilago farfara</i>)*	Echo Lake	1.7	0.000003
	Fernald Point	7.15	0.000463
<i>Herbicide concentrate used:</i>	White Birches Campground	8.84	0.001556
Rodeo: 0.03 oz.	Total	17.69	0.002022
mullein (<i>Verbascum thapsus</i>)*	Cleftstone	5.77	0.0002
	Isle au Haut	0.1	0.00004
	Kent Field	0.91	0.0001
	Sand Beach	3.47	0.0001
<i>Herbicide concentrate used:</i>	Visitor Center	3.23	0.000008
None (manual control)	White Birches Campground	8.84	0.0002
	Total	22.32	0.0006

*indicates this species is treated incidentally, meaning it is treated when encountered but is generally not specifically searched / scouted for.

Management Activities by Species

Purple Loosestrife

Purple loosestrife management continues in several wetlands throughout ANP, with control efforts at historically low rates due to the success of previous years' treatments. In July and August of 2017, the EPMT visited all wetland locations where the plant was managed in 2016, and spent a total of 64 work hours searching for and treating stems with herbicide, in addition to cutting and bagging flower heads to prevent seed maturation and dispersal. Seven of the fourteen locations contained purple loosestrife, and most of them had very few individuals. Marshall Brook and Beaver Dam Pond continue to be the two sites 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 24 acres in Marshall Brook and 15 acres in Beaver Dam Pond. Using binoculars at the wetland edges, crew members scouted almost 200 acres in the Witch Hole Pond region, which includes previous purple loosestrife sightings in an area stretching from Half Moon Pond to the Halls Cove Visitor Center. Surveyed acre numbers for wetlands are often high relative to person hours spent because they include areas of open water that fall within the scouting perimeter.

The EPMT revisited long-term loosestrife monitoring transects in the Tarn and around Beaver Dam Pond in 2017, recording density of flowering and vegetative stems. Of the five original transects in each location (Grid), transect number one was randomly chosen as a sub-sample of the whole site. Loosestrife densities have been low since the early 2000's, thus only one transect has been measured per site per year since then. We surveyed transects up to a 50 m distance, or until open water was encountered. The transect on Grid Five (at The Tarn) had zero stems of flowering or vegetative plants along the 50m x 1m belt transect. Only Grid Seven (on Beaver Dam Pond) contained purple loosestrife, totaling 20 vegetative (non-reproductive) stems. No flowering stems were surveyed in transects in either the Beaver Dam Pond area or The Tarn.

Purple loosestrife management in Acadia continues to operate at modest levels. Annual time investments range between 30-100 person hours, where most of this time is spent scouting wetlands for the signature purple flower. Scouting is scheduled for late July / early August to ensure flowers are at their peak, and thus most visible from long distances. Infested acres remain low at "Near suppression" levels, where control efforts are limited to a few flowering plants and some emerging new plants from the extant seed bank.

Japanese Barberry

Early spring field work in May included surveying and treating Japanese barberry (one of the first shrubs to leaf out in spring) in large areas around Witch Hole Pond, Bar Island, and Thailand (east of Schooner Head Rd.), among other locations (**Figure 5**). The EPMT has been getting more reports of barberry shrubs in recent years, spread across MDI in both disturbed landscapes and relatively undisturbed areas of intact forest. Several reports have come from park staff, volunteers, and community residents. These new reports may indicate recent expansion of barberry populations or, just as likely, a more educated community making informed observations. Though very dense infestations are rare, the dispersal of this species is one of the widest among the top two dozen species of IEPs managed at Acadia. 2017 efforts treated 0.26 infested acres among 451.52 surveyed acres at 27 different sites around MDI. Japanese barberry

management efforts account for the largest surveyed acreage of any exotic species, yet only 8% of the total treated infested acreage for all exotic plants in 2017. Surveyed acres in 2016 were about half (240.78 ac.) that of 2017, while the treated area (infested acres) has remained roughly the same (0.20 ac.). Much of 2017 search efforts were in the Witch Hole Pond area, accounting for 209.55 survey acres. Several sites are new locations, including Canon Brook, Kebo Brook, Liscomb Pit Rd., Stanley Brook, the Marshall Brook wetland north of Seal Cove Rd., a newly-acquired parcel (formerly White Birches Campground), and adjacent landowners' property (The Jackson Laboratory and The Mount Desert Land & Garden Preserve at Little Long Pond).

Japanese barberry, and to a lesser extent common barberry, have been known across many locations of MDI and Acadia National Park. However, it is still unclear if the overall population is increasing, decreasing, or persisting due to the challenge of implementing a new inventory across the whole Park. In the technical report, *Invasive Plant Species Distribution and Abundance in Acadia National Park* (Greene 2004), the author reported Japanese barberry as the most widely distributed exotic species at Acadia, in large part because of its ability to colonize natural areas in addition to disturbed sites. In 2004, barberry spp. occurred most frequently on the east side of MDI near old estates and carriage roads, as well as the watersheds of Duck Brook, Breakneck Brook, and wetland complexes like Witch Hole Pond and Great Meadow; this continues to be the pattern seen in 2017. The future distribution of Japanese barberry is likely to be determined by where seeds are able to disperse along waterways, and where new plants can get a start within newly-disturbed areas in and near ANP. In the coming years surveyed acres and control effort will likely increase to meet the program's management goal of full suppression of Japanese barberry across ANP.

2017 Japanese Barberry Treatments and Surveys Insert

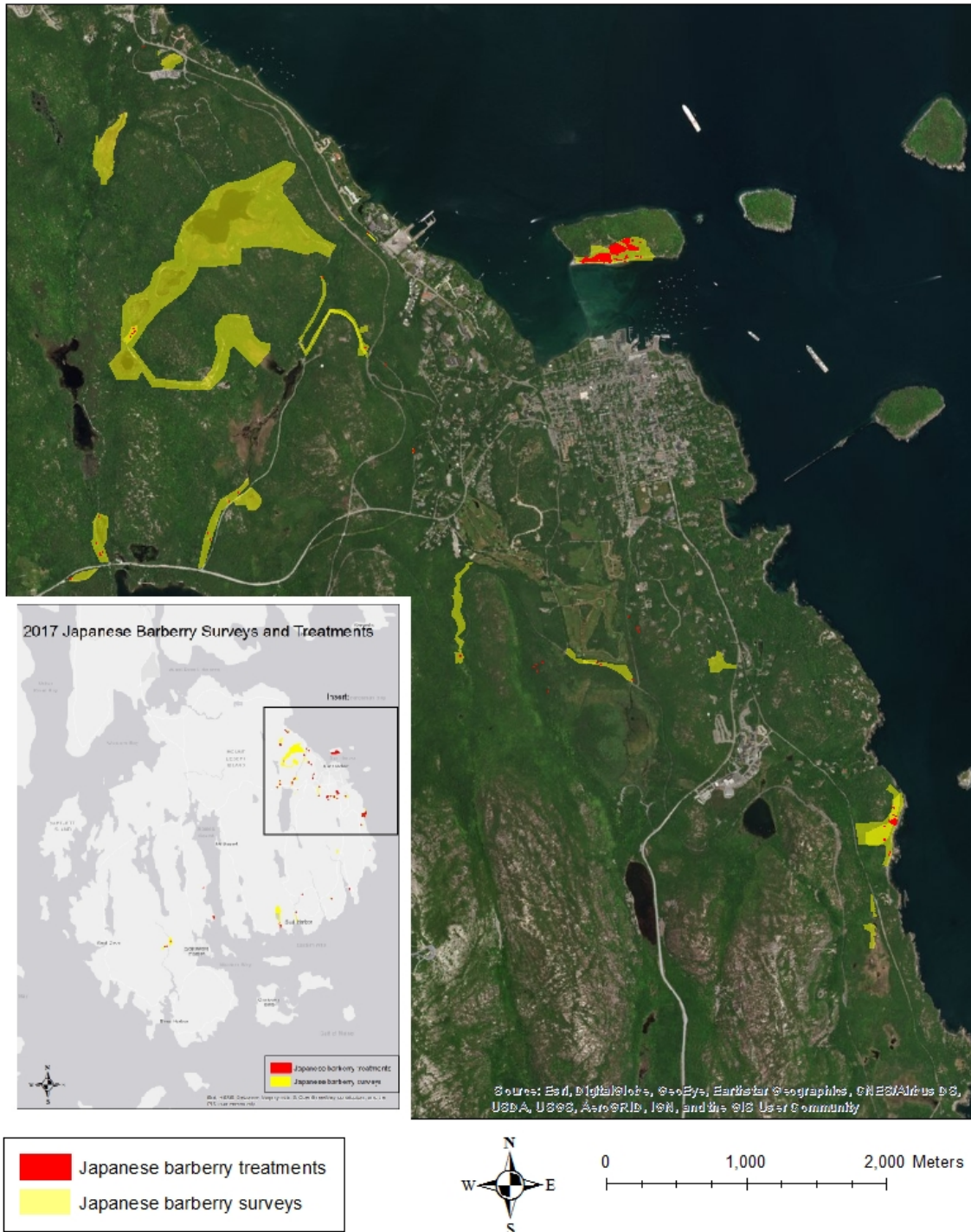


Figure 5. Map showing 2017 surveyed and treatment areas of Japanese barberry in and adjacent to Acadia National Park.

Norway Maple

In conjunction with Schoodic Institute, the EPMT set up forest vegetation monitoring plots to measure baseline data prior to treatment of Norway maple. The Norway maple monitoring protocol can be found in ANP Vegetation Stewardship data archives. These plots will be monitored annually to assess changes in forest composition and structure related to the removal of Norway maple in and around them. Three sites were selected for monitoring: Compass Harbor (four plots), Duck Brook (three plots), and Great Meadow Drive (a.k.a. Ledge lawn; three plots). One plot from each site was selected as a control, where mature Norway maple was already absent. Plots occupy a ten meter radius around a permanent marker; eight microplots radiate out from plot center (**Figure 6**).

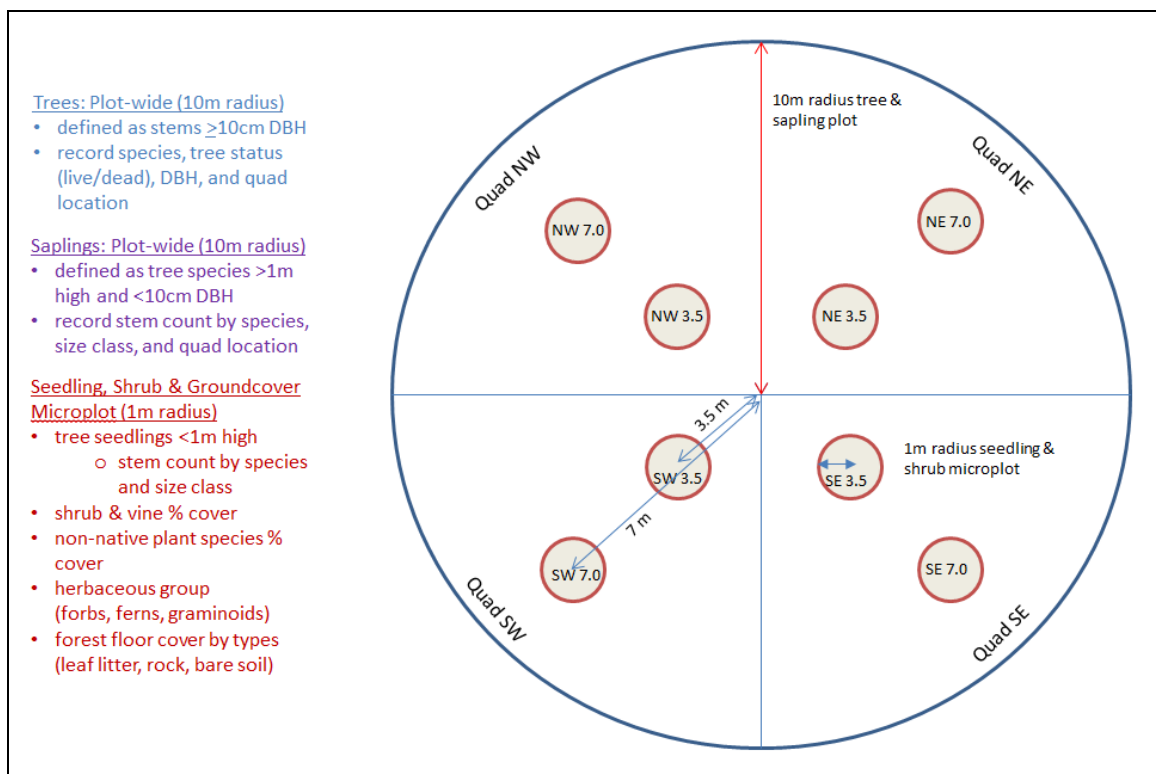


Figure 6. Diagram of the forest vegetation monitoring plots set up by the EPMT to monitor Norway maple treatment effects.

The following categories of data were collected to paint a clearer picture of the forest structure in and near dense Norway maple populations (**Figure 7**): for trees and saplings (defined as specimens taller than 1 meter), counts, species, location, and size in diameter at breast height (DBH) was collected; within the eight microplots, stem counts of tree seedlings (defined as trees $\leq 1\text{m}$ tall) were recorded by species and size class; percent cover for other plant species (including non-natives) as well as for rocks, downed wood, soil and leaf litter (among other groundcover classes) was also documented in the microplots; and plot-wide estimates of deer browse, earth worm activity, and percent canopy cover.



Figure 7. (from left to right) College of the Atlantic Acadia Scholar Intern Gemma Venuti, Exotic Plant Management Program Coordinator Jesse Wheeler, and Schoodic Institute Intern Alex Gould collect baseline monitoring data for Norway maple at Compass Harbor, 16 August 2017. (NPS photo)

Initial treatments will focus on tree removal (defined as specimens with $DBH \geq 10\text{cm}$), and across all three sites Norway maple is by far the most numerous tree species. With an average DBH of 21.4cm, 78 Norway maple trees were recorded within all seven treatment plots (**Table 4**). This count is nearly four times higher than the second most numerous species, white ash (*Fraxinus americana*), with 20 individuals at 27.31cm average DBH. White birch (*Betula papyrifera*) and white pine (*Pinus strobus*) follow in abundance (13 and 12 individuals, respectively).

Table 4. Tree abundance and size across seven Norway maple treatment plots in Acadia National Park.

Tree Species	Average DBH (cm)	# of Trees	Average # per Plot	% of Total Trees	Combined DBH (cm)	Average Combined DBH per Plot (cm)	% of Combined DBH
Norway maple	21.4	78	11.14	45.61	1669	238.43	40.37
white ash	27.31	20	2.86	11.7	546.2	78.03	13.21
white birch	17.14	13	1.86	7.6	222.8	31.83	5.39
white pine	33.8	12	1.71	7.02	405.6	57.94	9.81
white spruce	18.27	9	1.29	5.26	164.4	23.49	3.98
northern white cedar	29.59	9	1.29	5.26	266.3	38.04	6.44
apple	17.38	6	0.86	3.51	104.3	14.9	2.52
red maple	27.82	5	0.71	2.92	139.1	19.87	3.36
shadbush	11.83	4	0.57	2.34	47.3	6.76	1.14
northern red oak	31.8	4	0.57	2.34	127.2	18.17	3.08
big-toothed aspen	24.93	3	0.43	1.75	74.8	10.69	1.81
quaking aspen	45.05	2	0.29	1.17	90.1	12.87	2.18
black locust	54.65	2	0.29	1.17	109.3	15.61	2.64
maple spp.	25.1	1	0.14	0.58	25.1	3.59	0.61
red spruce	19	1	0.14	0.58	19	2.71	0.46
willow spp.	90.6	1	0.14	0.58	90.6	12.94	2.19
linden spp.	33	1	0.14	0.58	33	4.71	0.8
Total	24.18 (Avg.)	171	24.43		4134.1	590.59	

Northern red oak (*Quercus rubra*) dominates in the three control plots (**Table 5**), followed closely by big-toothed aspen (*Populus grandidentata*). Similar to the treatment plots, white birch and white pine are tied as the third most dominant species. Interestingly, white ash accounts for 11.7% of the total number of trees within the seven treatment plots, while it makes up only 1.49% in the three control plots. Conversely, northern red oak makes up only 2.34% of the tree count total within the treatment plots, yet makes up over a quarter of all trees (28.36%) in the control plots. In the coming years it will be interesting to see how well northern red oak and white ash regenerates after treatment of Norway maple. The high concentration of mature white ash in the treatment areas may offer a good seed source for seedling establishment.

Table 5. Tree abundance and size across three Norway maple control plots in Acadia National Park.

Tree Species	Average DBH (cm)	# of Trees	Average # per Plot	% of Total Trees	Combined DBH (cm)	Average Combined DBH per Plot (cm)	% of Combined DBH
northern red oak	22.95	19	6.33	28.36	436.1	145.37	28.92
big-toothed aspen	20.79	17	5.67	25.37	353.4	117.8	23.43
paper birch	18.77	7	2.33	10.45	131.4	43.8	8.71
white pine	30.61	7	2.33	10.45	214.3	71.43	14.21
red spruce	20.1	6	2	8.96	120.6	40.2	8
white spruce	18.24	5	1.67	7.46	91.2	30.4	6.05
red maple	27.43	3	1	4.48	82.3	27.43	5.46
northern white cedar	29.6	2	0.67	2.99	59.2	19.73	3.93
white ash	19.7	1	0.33	1.49	19.7	6.57	1.31
Grand Total / Average	22.51	67	22.33		1508.2	502.73	

Several other metrics of the Norway maple monitoring data (tree sapling and seedling counts, presence and density of invasive exotic plants, presence and density of other native woody [non-tree] vegetation, percent canopy cover, and groundcover makeup [e.g., bare soil, rock, coarse woody debris, etc.]) are summarized in detail in a 2017 report entitled “Characterizing Norway Maple (*Acer platanoides*) Forest in Acadia National Park.” This report can be found in the ANP Vegetation Stewardship archives, including tables and narrative analyses that describe characteristics of the forest vegetation prior to the first wave of Norway maple treatments.

In January 2018 the EPMT completed initial control of Norway maple within the treatment plot locations and their immediate vicinity. Treatments focused on the larger reproductive trees; many were felled where feasible, while very large or entangled specimens were girdled around the base. A mixture of Garlon 4 Ultra herbicide (25%) and basal oil was applied to the stump perimeter or the girdle band to prevent re-sprouts. In some sparsely infested plots (e.g., in Duck Brook) all present Norway maple were treated, while in other more heavily infested plots (e.g., in Compass Harbor) some mature specimens were left alive to maintain some canopy cover. This will reduce the potential for invasive plant emergence due to increased light conditions. Taking a lesson from Gettysburg National Historical Park (Comiskey and Burkart, 2011. unpublished), where forest canopy gaps were created to enhance forest regeneration with the unintended consequence of increasing invasive plant cover, we will remove the canopy slowly over the course of several years.

The plot locations occur in forests with different species compositions, disturbance regimes, and invasion levels, so treatment methods must be tailored to the specific needs of each. In total, 38 trees were treated across all infested plots. Any remaining Norway maple trees, saplings, seedlings, and specimens outside the plots will be addressed in the future, guided by the data collected during the annual plot monitoring. In particular, the EPMT is curious to see what moves into these forest systems to take advantage of the increase in light and nutrients; it could be native species, more Norway maple, or other exotic plants found in the same area.

Management Activities by Location

Outer Islands (The Hop & Baker Island)

In an effort to manage IEPs on Park islands, the EPMT tries to visit several islands only accessible by boat every year. Commonly found on coastal islands in Maine, Canada thistle (*Cirsium arvense*) and bull thistle (*Cirsium vulgare*) have dispersed along many island shorelines in Acadia. In 2017, thistle species were found and targeted on Baker Island and The Hop, the two outer islands visited this year. The EPMT also managed exotic bush honeysuckle heavily on The Hop, requiring 3 separate trips in the summer of 2017.

The Hop Island

Exotic bush honeysuckle was first managed on The Hop during 2003-2006 (**Figure 8**), with a break in the action until revisits began in 2015. Initial treatments in the mid-2000s were focused on cutting and treating vegetative stems, amounting to 170 person hours of work. An increase in effort in the last three years (2015-2017) resulted in 0.36 infested acres treated across the whole island, requiring 234 personnel hours (**Table 6**).



Figure 8. These photos, looking west toward Long Porcupine Island, document the same area on The Hop where exotic bush honeysuckle was managed in 2003 (left photo) and in 2015 (right photo). This site remains mostly treeless with shallow soils, dominated by grasses and shrubs. Note that mature honeysuckle is present in both photos. (NPS photos)

Table 6. Exotic bush honeysuckle treatment history on The Hop island showcasing the two different periods of management. Treatment methods remain similar, while treatment area measurements change from stem counts to infested acres.

Year	Stems	Infested acres	Method	Phenology	Herbicide	Concentrate Volume (oz.)	EPMT hours
2003	867	N/A	Cut/stem	vegetative	Garlon 3A	8.9	42
2004	1000	N/A	Cut/stem	vegetative	Garlon 3A	2.6	12
2005	Too many to count	N/A	Cut/stem	N/A	Garlon 3A	40	24
2006	Too many to count	N/A	Cut/stem	N/A	Garlon 3A	43	92
2003-2006 combined					Total	94.5	170
2015	N/A	0.11	Cut/stem	Seed	Rodeo / Garlon 4 Ultra	34	73
2016	N/A	0.02	Cut/stem	Seed	Rodeo	24	54
2017	N/A	0.23	cut/stem, foliar	Seed	Rodeo	103	107
2015-2017 combined	N/A	0.36	cut/stem, foliar		Total	161.0	234

In 2015, the EPMT discovered dense areas of exotic bush honey suckle on The Hop, with many mature, fruiting shrubs that were growing in areas littered with honeysuckle stumps that were cut

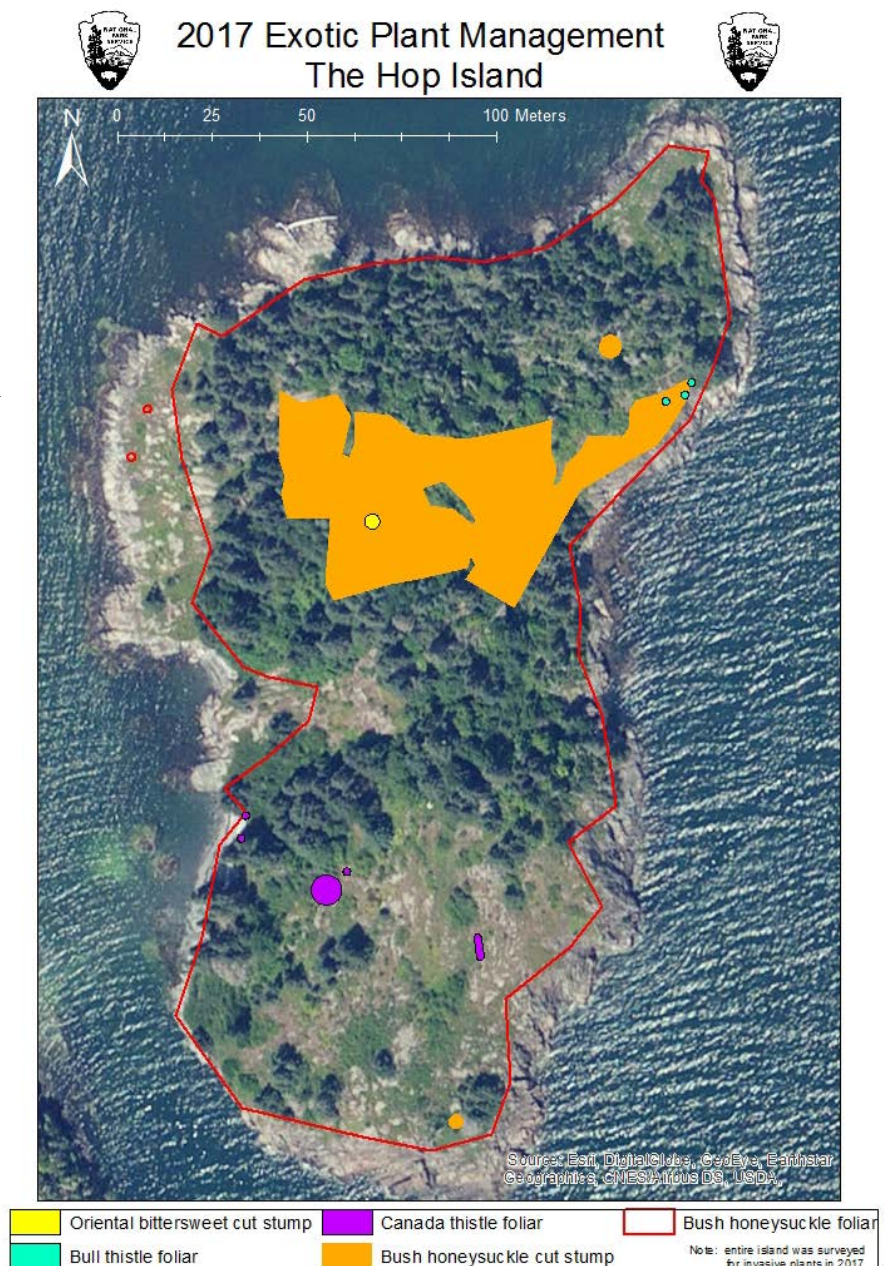


more than a decade ago (**Figure 9**). We suspect that after many of the shrubs were initially cut and treated from 2003-2006, there was still a viable seedbank that germinated in ensuing years. With 8-13 years of unchecked growth, exotic bush honeysuckle was able to repopulate forest understories and open areas of The Hop, creating a need for “initial attack” treatments again by the EPMT. In 2017 the EPMT was able to finish cut/stem applications on a majority of the fruiting honeysuckle shrubs and start foliar spraying vegetative stems with Rodeo (glyphosate herbicide) on the third day out on The Hop (**Figure 10**).

Figure 9. Photo of exotic bush honeysuckle on The Hop, July 2017. Note the 10-13 year old honeysuckle stump in the foreground from previous treatments. (NPS photo)

The Hop is a small island with open fields and patchy mixed forest, which makes it an attractive pit stop for resident and traveling bird species foraging for a snack. Birds likely disperse honeysuckle seed because fruiting times of bush honeysuckle and other invasive plants (July-September) overlap with early fall migration, including juvenile birds hopping along the coastline searching for calories (pers. comm., Bruce Connery, Acadia NP Wildlife Biologist). Extra care should be taken to make periodic treatments of honeysuckle in future years so the population doesn't explode again.

Figure 10. Map of invasive plant species surveyed and managed on The Hop in 2017. This island is where exotic bush honeysuckle management started in Acadia in 2003. Renewed efforts in 2015 have knocked back most of the fruiting stems after a decade with no management.



Baker Island

The EPMT spent 20 personnel hours on Baker Island in 2017, treating Canada and bull thistle. The team focused efforts on approximately 12 acres of open meadow between the light house and the northern shore. The thistle populations appeared a bit larger this year than in past years. Unfortunately, the team did not visit Baker in 2016, and the 2017 treatment was a little late in the season (8/29/17); as a result, many of the plants had gone to seed (**Figure 11**). The 2015 treatment was on July 14 and no seed were present at that time. In 2017 the seeding Canada thistle plants (which are perennial) were dead-headed and bagged to remove seed prior to spraying with herbicide. Seeding bull thistle, a biennial, was dead-headed and manually removed. Thistle species found within 25 feet of shoreline are deadheaded, but not applied with herbicide so as not to contaminate waterways. Many island shorelines invaded with thistle spp. are notoriously difficult to control because of the constant disturbance and effective wind dispersal of seed. Plans for future treatment seasons should incorporate at least one full day on Baker Island every year, within the ideal flowering window (June to July).



Figure 11. Photo of Baker Island's northern shoreline in August 2017. Note the seeding Canada thistle in the center and the larger bull thistles surrounding it to the left and right. (NPS Photo)

Bar Island

In May 2017 exotic plant management efforts focused on the southern half of Bar Island with post- initial attack treatment of species in the suppression phase, working toward maintenance level. Within a two acre area a total of 0.23 infested acres of young stems of Privet (*Ligustrum* spp.) were foliar and cut/stump treated with Rodeo® herbicide (concentration of 3% Rodeo® for foliar and 25% for cut/stump). Reproductive stems of this shrub were first targeted on Bar Island in 2016. Spot treatments of two other exotic shrub species, Japanese barberry and bush honeysuckle, were carried out for the third straight year. These efforts focused on both newly-

emerged stems as well as mature individuals missed during previous treatments. The EPMT treated 0.168 infested acres of Japanese barberry and 0.024 infested acres of bush honeysuckle. Asiatic bittersweet (*Celastrus orbiculatus*) was also located within a 1.6-acre survey area, and 0.013 infested acres were cut/stump and foliar treated with herbicide (25% Rodeo® for cut/stump applications, and 3% Garlon 3A® for foliar). Later in the summer (mid-August) Canada and bull thistle were treated within 12 acres of the island's open meadows, resulting in a combined 0.035 infested acres treated as part of annual maintenance-level management. In all, just under 50 person hours were necessary for 2017 management on Bar Island, contrasted with the nearly 250 person hours spent in 2016 and just over 450 hours in 2015. If the EPMT is able to continue annual visits, and no new infestations take hold, future exotic plant management efforts on Bar Island should fall to the range of 10-20 hours per year.

Kent Field

Exotic plant management at Kent Field is focused primarily on glossy buckthorn. This site has been a focus for the EPMT since 2015; Acadia Recreation Fee project funding supports exotic plant work in the Champlain Mountain region. In 2015 mature stands were selectively cut stump treated in the northeastern portion of the area surrounding the northern wet meadow. In 2016 more systematic gridding of the northwestern section, between the Orange and Black trail and Murphy Lane, was completed. The emphasis here was still on cut stump treatment of mature individuals. Surveys were also conducted just south of Murphy Lane, and scattered plants were found but not treated.

In 2017 the EPMT revisited most of the areas from 2015 and 2016, focusing on foliar treatments for stump sprouts and new seedlings (**Figure 12**). Some of these were already producing seeds, especially those growing along the sunny edges of the field. This suggests that glossy buckthorn management should ideally target both mature and immature plants in prime habitat within a two year timeframe. The EPMT occasionally performed cut-stump treatment of any remaining larger individuals from previous years.

The EPMT also surveyed and treated the far southern section of Kent Field between Schooner Head Road and the southern wet meadow. Scattered small plants were found, with the highest densities along the meadow edge. The EPMT worked in Kent Field from July to mid-October, and the crew spent 255.75 hours treating more than 0.5 infested acres during 50.65 acres of surveys. In 2018 the heavily infested sections north of Murphy Lane should be foliar treated again; the northeast side of the meadow, which was not targeted in 2016 or 2017, should also be revisited. In addition, the area south of Murphy Lane and north of the southern wet meadow should be further surveyed, and gridded if necessary. This middle section of Kent Field may not have seen any treatments since at least 2016, when a brief survey of the entire site was conducted.

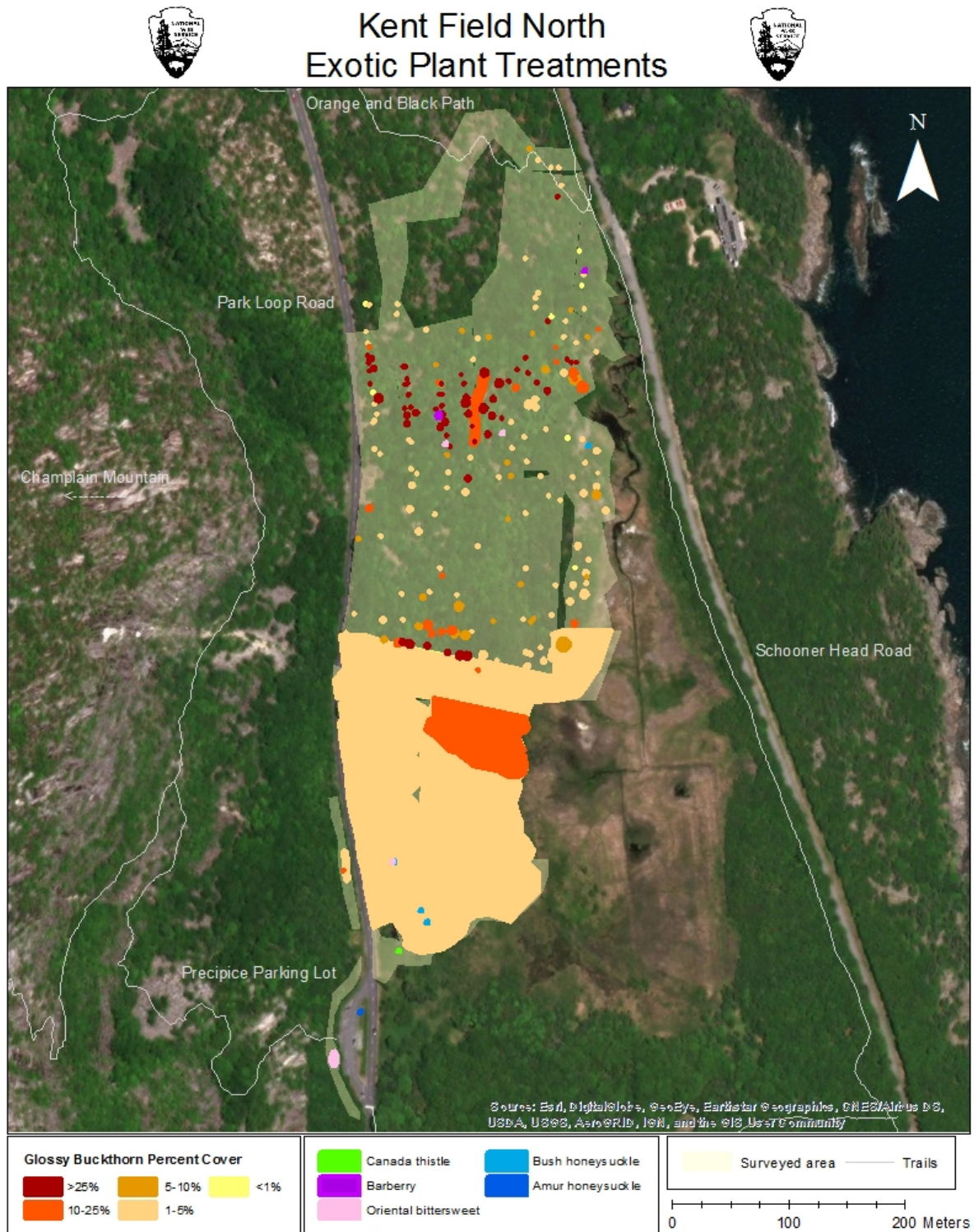


Figure 12. Map of the glossy buckthorn infestation surveyed and treated in the northern section of Kent Field, between the Park Loop Road and Schooner Head Road, during the 2017 field

season. The yellow to red color range shows glossy buckthorn percent cover. Other incidentally-treated exotics are also mapped.

Canon Brook / Otter Creek Watershed

The southern end of the Canon Brook corridor, near the confluence with Otter Creek, was a new treatment site for glossy buckthorn in 2017. The EPMT treated glossy buckthorn in previous years along the northern section of Canon Brook, near the inflow of The Tarn. As mentioned in the Program Accomplishments section, four 50-meter transect lines were established to monitor glossy buckthorn along the brook near the Route 3 crossing. The EPMT counted stems of fruiting and non-fruiting glossy buckthorn, as well as overall percent cover for each square meter along the transect (**Table 7**). These transects will be revisited in subsequent years to measure the effectiveness of control efforts. The glossy buckthorn infestation at Canon Brook occupies the stream edges and surrounding low lands from Route 3 north all the way to The Tarn; while there are occasional breaks in the population, many areas are heavily invaded.

Table 7. Summary of the 2017 Canon Brook / Otter Creek glossy buckthorn monitoring data.

Transect #	# Non-fruiting Stems/m²	# Fruiting Stems/m²	Percent Cover/ m²	GPS Coordinates*	Bearing**
1	2.68	0.22	1.28	4909233N by 463254E 4909234N by 563208E	280°
2	9.18	1.40	3.52	4909288N by 563209E 4909300N by 563158E	280°
3	4.74	0.26	1.50	4909341N by 563195E 4909348N by 563144E	280°
4	2.29	1.73	2.04	4909477N by 563198E 4909521N by 563217E	20°

*top coordinates represent the southern point of each transect (declinated 18° west) ** compass bearing true north

2017 treatments began along Canon Brook in late June and continued into September, with the EPMT targeting only larger reproductive glossy buckthorn (**Figure 13**). The EPMT employed cut-stem treatments with 25% Rodeo® herbicide on fruiting stems while the crew tightly gridded the Canon Brook gulch. The wet conditions of the gulch make the use of aquatic-labeled herbicides, such as Rodeo®, a requirement. In total, the EPMT surveyed more than 29 acres and treated 0.47 infested acres in 2017, requiring 187.5 staff hours and 11.75 volunteer hours. These efforts started where Route 3 crosses over Otter Creek, and headed north along Canon Brook until tying in to the section south of the Tarn, for which Initial Attack treatments were completed in 2016. Glossy buckthorn was also present and treated along Otter Creek, upstream from where it joins Canon Brook at the Route 3 confluence, heading up the southern slopes of Cadillac Mountain. See **Figure 14** for the treatments, survey areas, and long term monitoring transect

locations of south Canon Brook. This site is a high priority to revisit in 2018 to conduct foliar treatments on smaller seedlings and saplings which were passed over in 2017, in addition to stump re-sprouts. The 2016 “initial attack” area south of The Tarn will also require a revisit during the 2018 growing season to address plants maturing to reproductive size.



Figure 13. EPMT member Jim Burka assesses a large clump of reproductive glossy buckthorn before beginning cut-stump treatment, Canon Brook. (29 June 2017, NPS Photo)

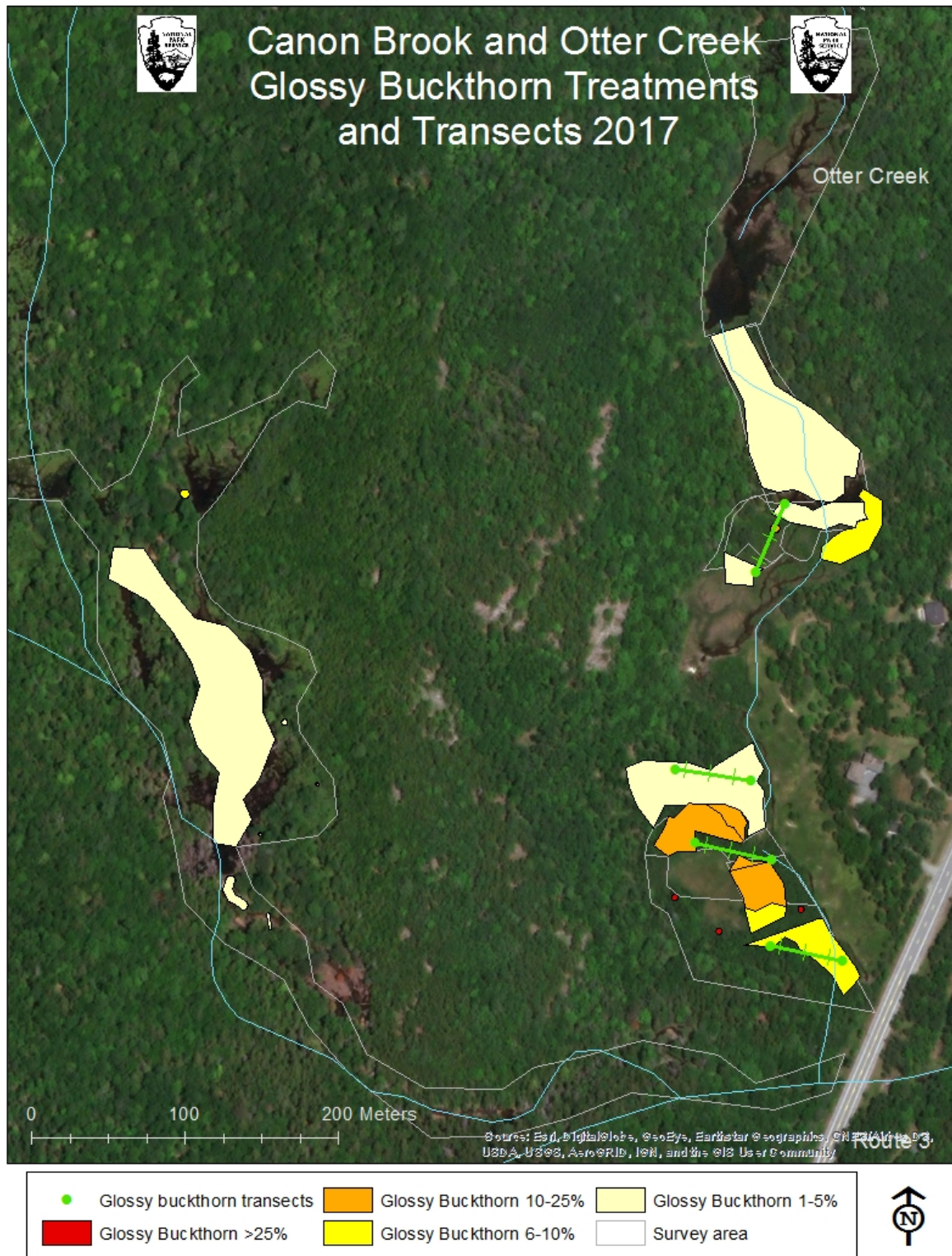


Figure 14. The south section of the Canon Brook management area showcasing treated glossy buckthorn density, survey areas, and long term monitoring transect locations.

Kebo Brook

The glossy buckthorn infestation along Kebo Brook was a new discovery of large mature plants late in the 2017 field season. A small population of mostly non-reproductive individuals had been treated in previous years just off the Gorge Path south of the Park Loop Road, and in 2017 the area was surveyed more thoroughly. Searching along the Kebo Brook streambed, the EPMT found scattered glossy buckthorn individuals, eventually leading to a large population of mature, reproductive specimens. Many here stood five to ten meters tall, and the presence of large dead trunks suggest this stand was decades old. The EPMT cut down and treated all reproductive plants found here, and surveyed more than 10 acres along the brook. This work took 30.75 crew hours, and smaller scattered plants were discovered all the way to the Kebo Valley Golf Club property (**Figure 15**). Follow up treatments should occur in 2018 using foliar applications for the remaining smaller glossy buckthorn.



Figure 15. Map of the glossy buckthorn infestation discovered along Kebo Brook in September 2017.

Greater Cromwell Brook Watershed

The EPMT continued concerted glossy buckthorn management in the Greater Cromwell Brook Watershed in 2017, with a focus on the management units surrounding Great Meadow to the north and east (**Figure 17**). Most of the densest buckthorn populations are located in the transition zones between the low-lying wet areas of the meadow and the upland forest. Due to other priority sites around MDI, the EPMT only has time to cover roughly half of this transition zone each year. Because of its large size, this watershed is divided into distinct management units to facilitate tracking of treatment progress as well as for planning work from season to season. These units are divided by natural features such as trails, streams, or topography. The goal for each treatment season is to alternate the units treated on a bi-annual basis, such that all management units to the north and east of the Great Meadow are treated one year, followed by those to the south and west the next year.

Several management units both within and surrounding this watershed have particularly dense glossy buckthorn populations; many have seen active treatment since the EPMT began buckthorn management in the early 2000's. These work areas include: Unit 6 - a particularly dense area bordered by the Stratheden Path to the west, the Jesup Path to the east and the Park Loop Road to the north; Unit 12, mix of dry and wet area of the Bear Brook Picnic Area and parts of Jackson Lab property (partially within the Cromwell Brook watershed); Units 8 and 20, which border Great Meadow Drive (a.k.a., Ledge lawn Avenue Extension; **Figure 16**); and Unit 1, particularly the wetland area south of The Tarn.



Figure 16. (from left to right) EPMT Crew Member Jim Burka, Data Manager Nick Stevenson, and Crew Member Alex Fetgatter conduct foliar herbicide treatments on glossy buckthorn stump

sprouts and seedlings/saplings near the intersection of Great Meadow Drive (a.k.a., Ledgelawn Avenue Extension) and the Park Loop Road, 24 August 2017. (NPS photo)

A prescribed burn was conducted in spring of 2017 by Acadia’s Fire Management Program in The Motor Road Vista #56, a shrub dominated area within Unit 6 just across the Park Loop Road from the south end of Kebo Street. This area is also known as the “Bottling Plant Vista” due to its proximity to a historic spring water bottling facility. The purpose of the burn was to suppress re-sprouts of trees that had been cut in January 2016 during cyclic vista maintenance and seedlings of tree and shrub species. Prior to the burn, this area had last seen herbicide treatment (both foliar and cut-stump) of glossy buckthorn in 2015 as part of the EPMT’s bi-annual Great Meadow treatment rotation, in addition to previous treatments back to 2009. The EPMT utilized this unique opportunity to collect data on the effects, if any, of fire on glossy buckthorn populations. Four belt transects were established in September 2016 perpendicular to the Park Loop Road to measure glossy buckthorn population density, as well as reproductive potential, prior to the scheduled burn. These transects were then revisited in September 2017 to collect post-burn data; this late summer date allowed enough time in the growing season for the fire effects, if any, to be measurable. No herbicide treatments had occurred within the burn area in the intervening time since the last transect measurements, so any measured effects could reliably be attributed to the isolated fire variable.

Based on comparisons between the 2016 and 2017 data, it was found that the prescribed burn correlates with a reduction in the buckthorn population at this vista. These results agree with a study that showed a reduction of glossy buckthorn seedlings in burned areas (Neumann and Dickmann, 2001). As shown in **Table 8**, all four transects showed a reduction in all three population parameters (vegetative stem count, reproductive stem count, and overall percent cover) between 2016 and 2017. Foliar herbicide treatments on buckthorn were conducted on this vista in 2017 after transects were measured, so future monitoring will not reveal further population effects based solely on fire.

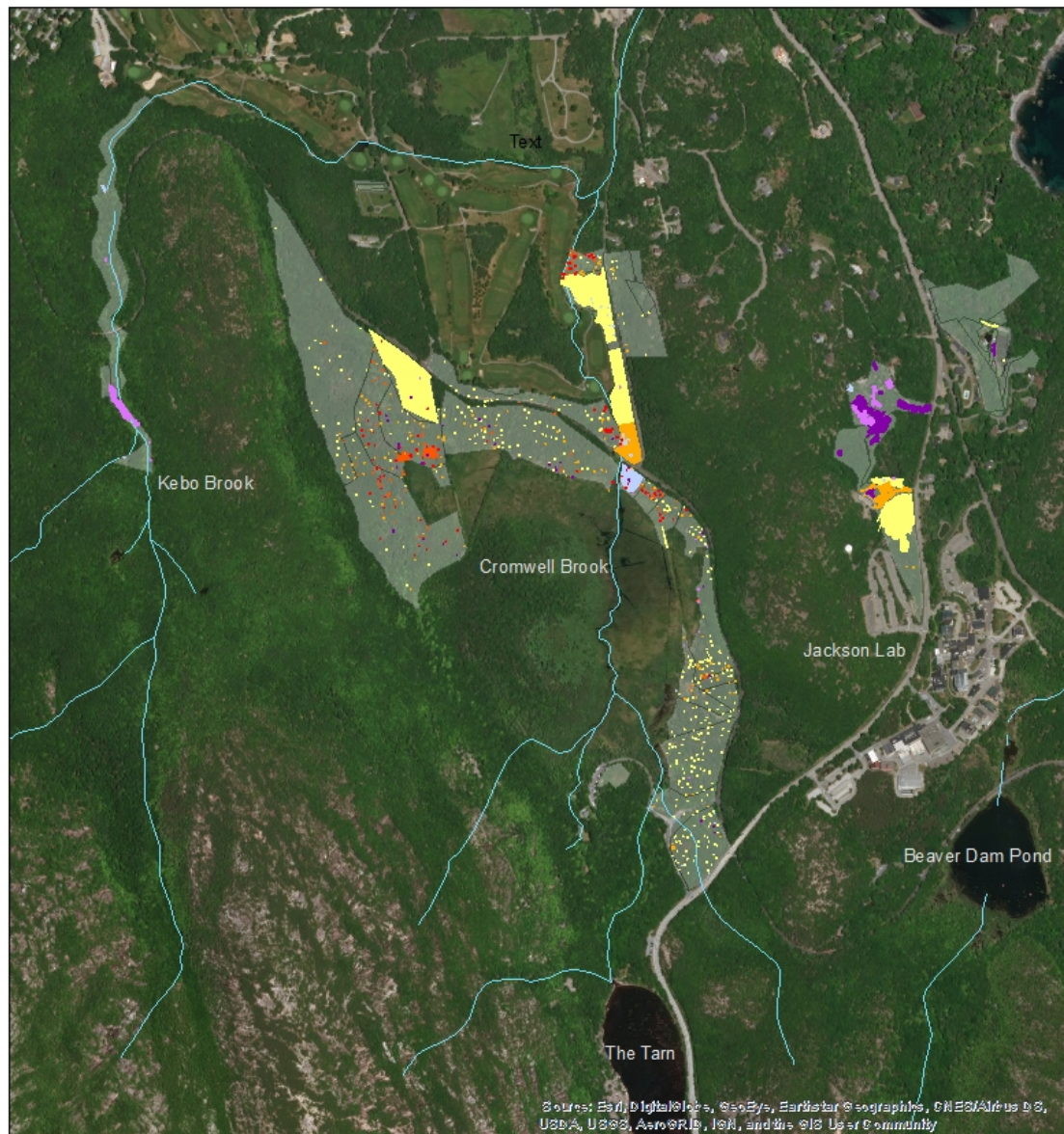
Table 8. Pre- prescribed burn (2016) and post- prescribed burn (2017) glossy buckthorn population data at the “Bottling Plant Vista”, showing stem density and percent cover of glossy buckthorn foliage several months after fire.

	Year	Vegetative Stems	Reproductive Stems	Average Percent Cover
Transect 1	2016	9	3	1.1
	2017	3	0	0.2
Transect 2	2016	81	7	7.0
	2017	69	3	1.7
Transect 3	2016	271	19	8.9
	2017	123	0	1.4
Transect 4	2016	110	0	2.5
	2017	39	0	0.5

Before 2016 the major management efforts in the Greater Cromwell Brook Watershed involved cut-stump treatments of large mature glossy buckthorn to suppress new seed production. In 2016 and 2017 mature plants were fewer, and management shifted to foliar treatment of smaller non-reproductive plants with herbicides. To illustrate this, in 2017 the EPMT used 218.9 oz. of herbicide concentrate for foliar treatments compared to 5.2 oz. for cut-stump treatments. The total acreage of foliar treated glossy buckthorn for 2017 (if all treated leaf surfaces were gathered edge-to-edge in one location) was .4788 acres, versus .0352 acres controlled with the cut-stump method. Foliar treatments utilize backpack or hand sprayers, and apply a three percent mixture of herbicide (Rodeo® or Garlon 3A®), as well as 0.5% spreader-sticker surfactant (CWC 90®), diluted with water. Total glossy buckthorn work in the Greater Cromwell Brook Watershed in 2017 took the EPMT 325.25 person hours, and covered over 95 acres. The EPMT manages other invasive plants in this area incidentally, usually encountered while gridding for glossy buckthorn; these include: Japanese and common barberry, exotic bush honeysuckle, privet, multiflora rose, Canada thistle, garlic mustard, Japanese knotweed, and Asiatic bittersweet. It should be noted that invasive plant management conducted in the neighboring Kebo Brook and Jackson Lab sites is not included in this section; both sites are covered independently in their own sections of this report.

The Greater Cromwell Brook Watershed is one of the largest and most heavily infested glossy buckthorn sites in the park, and work efforts will continue to be high here for several years. In spite of the challenges, management is moving beyond the initial attack and suppression stages and towards a maintenance level where only new seedlings are encountered. This should allow staff to cover more ground in less time, and reduce the frequency of treatments, while still addressing the seed bank and any long distance arrivals.

Glossy Buckthorn Treatments Greater Cromwell Brook Watershed



Glossy Buckthorn Percent Cover

Cut stump 11-25%	Foliar <5%	Foliar >25%
Cut stump >25%	Foliar 5-10%	
Cut stump <10%	Foliar 11-25%	

0 400 800 Meters

Streams
Surveyed area



Figure 17. Map of the glossy buckthorn infestation surveyed and treated in the Greater Cromwell Brook Watershed during the 2017 field season. Colors represent treatment type (cut stump versus foliar) and percent cover. The neighboring Jackson Lab and Kebo Brook sites are also shown, but are described in separate sections of this report.

Collaborations and Partnerships

In 2017 the EPMT continued to strengthen existing partnerships with adjacent landowners, in addition to forging new relationships. Collaboration with staff at Jackson Laboratory began with purple loosestrife control in the Bear Brook watershed back in the late 1980's. Since then, glossy buckthorn management in the same watershed pressed managers to work with Jackson Laboratory again to allow the EPMT to treat glossy buckthorn on Lab property.

A new cooperative relationship was initiated in 2017 with the Mount Desert Land and Garden Preserve (LGP), a neighboring landowner of approximately 1,000 acres bordering Acadia. Exotic Plant Management Program Coordinator Jesse Wheeler leveraged his contacts there to schedule two work days alongside staff from the LGP Landscape Crew. Work took place along the shores of Little Long Pond near Seal Harbor, with a primary focus on glossy buckthorn. The EPMT also expanded existing partnerships with the Maine Volunteer Lake Monitoring Program (VLMP) and Somes-Meynell Wildlife Sanctuary by inviting the LGP and new volunteers to assist in aquatic invasive plant surveys.

The Jackson Laboratory

In 2017 the EPMT resumed concerted glossy buckthorn control efforts on Jackson Lab property, after a hiatus during the 2016 treatment season. The EPMT has treated buckthorn on Lab property off and on since 2012 in cooperation with Greg Forrest, the Lab's Grounds Supervisor. Treatment efforts in 2012 – 2013 focused primarily on the southwest corner of the Lab's property, bordered by the Park Loop Road to the southeast and Bear Brook picnic area to the southwest. This time period was devoted to initial attack cut-stump treatments for mature, reproductive individuals, in addition to follow-up foliar treatments for immature specimens and re-sprouts. Beginning in 2014 the EPMT shifted its focus to the northwestern corner of the Lab's property, on which lies perhaps the largest known concentration of mature glossy buckthorn on MDI, forming a near monoculture in the forest understory. This is the area on which the EPMT focused in 2017.

Three full days (two in July and one in September) were spent at Jackson Lab in 2017, focused on both "initial attack" cut-stump treatments of mature buckthorn, in addition to follow-up foliar treatments for areas already cut-stumped in 2014 - 2015. Initial attack methods this year utilized motorized brush-cutters and a chainsaw (teams of three) to cut down as many fruiting specimens as possible (**Figure 18**). The brush-cutter operator was followed by a swamper, whose responsibility it was to move the cut brush out of the way, and an herbicide applicator, who ensured the cut stumps were treated. Only hand tools (loppers, hand pruners, and handsaws) were used to cut-stump during the 2014 treatment season. While this process reduces the number of missed stumps during herbicide application because it is slower and more methodical, it was decided in 2015 that the rate of cutting needed to be sped up to suppress as many reproductive specimens as possible within our limited timeframe at this site; thus brush-cutters replaced hand tools. While more stumps may be missed during herbicide application due to the fast pace of the brush-cutter, this drawback was outweighed by the sheer volume of fruiting individuals cut down. Follow-up foliar applications will occur at this site in the future, providing an opportunity to treat coppiced growth on any stumps missed the first go-round.

Of the 15.34 total acres surveyed for buckthorn at Jackson Lab in 2017, we cut-stump treated 0.875 infested acres as initial attack. Follow-up foliar applications were completed on 0.060 infested acres.

Greg Forrest (Lab Grounds Supervisor) devoted several of the employees under his supervision to work with and learn from the EPMT during their time there. Lab staff participated directly in invasive exotic plant management, primarily glossy buckthorn. EPMT members provided on-the-job training on plant identification (invasive as well as native, particularly native look-alikes), mechanical and manual cutting methods (e.g., brush-cutters as well as hand tools), and herbicide application (cut-stump treatments as well as foliar applications using backpack sprayers). The EPMT also provided written treatment recommendations for distribution to Lab staff. With all this information in hand, Mr. Forrest intends to task his staff with glossy buckthorn management on Lab property as time and project needs allow.



Figure 18. Three-person brush-cutter team conducting “initial attack” cut-stump treatment of mature glossy buckthorn on Jackson Laboratory property near Acadia National Park. From left to right: A Jackson Lab Grounds Crew Member swamps brush while EPMT member Nick Stevenson uses the brush-cutter and EPMT member Joe Kelley applies herbicide to the cut stumps. 12 July 2017. (NPS Photo)

Mount Desert Land and Garden Preserve

In 2017 the EPMT spent one full work day in August and another in September alongside staff from the LGP. This is a new cooperative relationship as of this year, and these two collaborative workdays helped lay a solid foundation for continued cooperation in future years. EPMT members provided on-the-job training for LGP staff in herbicide handling and application.

The lands surrounding Little Long Pond near Seal Harbor, Maine are of particular interest for the EPMT. This pond is connected to Jordan Pond via Jordan Stream in Acadia National Park, which could serve as a conduit for invasive plant dispersal. Small populations of glossy buckthorn, Asiatic bittersweet, exotic bush honeysuckle and Japanese barberry were known to exist on the southern shores of the pond. This new partnership allowed the EPMT to scout the entire shore of Little Long Pond to determine the extent of these infestations, as well as conduct treatments to

reduce the chance that populations will spread toward the culturally- and historically- significant Jordan Pond area. The addition of members of the LGP Landscape Crew allowed the EPMT to cover more ground in less time by splitting up into separate groups to “divide and conquer” the Little Long Pond shoreline.

In total the group surveyed 61.84 acres around Little Long Pond. Within this area, buckthorn was the most heavily treated species at 0.045 infested acres. This is roughly three times greater than the next most heavily-treated species, Asiatic bittersweet at 0.016 infested acres. We also treated Japanese barberry (0.003 infested acres) and exotic bush honeysuckle (0.001 infested acres), but populations were significantly smaller. All herbicide treatments at Little Long Pond were cut-stump applications (**Figure 19**), per request by LGP management. Foliar applications would be too visible to LGP visitors, in addition to posing a hazard to off-leash dogs (dogs are not required to be leashed here as they are within Park boundaries). Most buckthorn treatments were on reproductive specimens, so follow-up will be needed in the future to suppress new growth from the seed bank as well as to treat specimens as they mature to reproductive stage (i.e., those that were passed over this year because they were small and not producing fruit).



Figure 19. Mount Desert Land & Garden Preserve Lands Foreman, Jesse Hartson, and EPMT member Alex Fetgatter conducting cut-stump treatments on Asiatic bittersweet on the southeastern shore of Little Long Pond. This edge habitat bordering the carriage road contained the densest bittersweet population found by EPMT staff on LGP lands. 10 August 2017. (NPS Photo)

Invasive Aquatic Plants

In 2017 Jesse Wheeler organized and led an interagency effort with the VLMP and Somes-Meynell Wildlife Sanctuary to search for eleven aquatic invasive plants that are regulated in Maine. Building on 2016 efforts, this second year's work focused on MDI lakes and ponds that hadn't received intensive surveys yet. During the weekend of September 9 & 10 the VLMP conducted a training workshop for Invasive Plant Patroller (IPP) volunteers on survey methods using canoes and kayaks. Following the training, surveys were conducted by experienced IPPers from western and southern Maine, VLMP, Acadia National Park, LGP, Somes-Meynell Wildlife Sanctuary staff, and local volunteers. These surveys covered the entire littoral zone (i.e., the area where light can reach the bottom of the lake and plants can grow, usually the entire perimeter plus other shallow areas) of Round Pond, Seal Cove Pond, Hodgdon Pond, Eagle Lake, Hamilton Pond, Upper and Lower Hadlock Ponds, and Little Long Pond. No invasive aquatic plants were detected in 2017! Efforts will continue in 2018, with surveys planned for Jordan Pond and repeat surveys along shorelines of high risk areas such as boat launches. There is continued emphasis to build a cohort of local volunteers to conduct annual surveys on MDI waterbodies for invasive aquatic plants.

Cultural Vegetation Management – Historic Vistas and Roads

In an effort to incorporate the vegetation management program into a more unified and efficient working relationship with other Acadia work groups, the EPMT has established an integrated vegetation team with the Roads/Vista Crew during the fall and winter. Working cooperatively, the Maintenance and Resource Management Divisions collaborate to provide expertise in cultural landscape management, invasive plant identification, and a well-rounded assessment of Acadia's vegetation resources. Below are some identified additional areas of overlapping interest and skills between these teams that may increase overall efficiencies and address unmet needs for both resource and infrastructure maintenance:

- Continued vista management work, cyclic roadside clearing, and hazard tree removal
- Cultural landscape maintenance / rehabilitation (e.g., apple tree pruning, horticultural landscape restoration, etc.)
- Norway maple management (tree removal initiated in winter 2018)
- Continue to develop a tablet-based ArcGIS Collector mapping system with GPS information including locations of vistas, disturbed areas, repeated washouts, problem culverts, hazard trees, etc.
- Response to current and future forest pest outbreaks (e.g., red pine scale, hemlock woolly adelgid, emerald ash borer)
- Re-establish a revegetation program or similar in-house ability to address degraded areas such as carriage road intersections, trailside social trails, and post-construction sites
- Sharing of Knowledge, Skills & Abilities (e.g., teaching safe and effective tree-felling / processing techniques to the EPMT, teaching IEP identification to the Roads Crew, and providing IEP treatment training and equipment to the Roads Crew so they can manage incidental populations on the Park's road systems)
- IEPs are sometimes encountered on road shoulders or within historic vistas; having members of the EPMT work in these areas allows for immediate management response and increases surveillance in the fall and winter

Native Plant Restoration and Research Assistance

In 2017 the EPMT restored native vegetation to degraded sites using salvaged native plants from research plots or construction projects. In April and May, crews picked the Bar Island trail entrance and the Cadillac Mountain summit (Blue Hill Overlook and areas off the paved summit trail) as locations that were both in need of restoration as well as being good fits for the low shrub species salvaged from abandoned research plots on Cadillac Mountain. The Bar Island site is still recuperating from intensive exotic plant removal (**Figure 20**), and the Cadillac Summit sites have been trampled by visitor foot traffic (**Figure 21**). The EPMT also salvaged a truck load of native shrubs along the sidewalk of the Cadillac Mountain summit loop ahead of construction and re-design of the sidewalk near the gift store and bathrooms. The rescued plants were transplanted to degraded areas inside roped “restoration area” enclosures near the terminus of the North Ridge Trail on the summit of Cadillac.



Figure 20. Native plant restoration and soil amendment at the Bar Island trail entrance. In the background are (from left to right) EPMT members Jim Burka and Joe Kelley, along with College of the Atlantic Acadia Scholar Intern Gemma Venuti. 2 May 2017. (NPS Photo).



Figure 21. EPMT members Jim Burka (left) and Joe Kelley planting salvaged native plants into a restoration site at Cadillac Mountain's Blue Hill Overlook. 19 April 2017. (NPS Photo)

In 2016 and 2017, EPMT members assisted researchers on a project to develop climate change-resilient restoration techniques on Cadillac Mountain. The New England Wildflower Society grew native plants from seeds collected on Cadillac Mountain last winter, and planted them in research plots set up in two locations atop the Cadillac summit. Botanists monitored edaphic conditions, seed germination, and survivability of seedlings in the plots. They are experimenting with different species and techniques that could be used in the future to help restore soils and native vegetation on the summit that has been lost due to trampling. In addition to their iconic

topography, Acadia's summits harbor several species of state-listed rare plants. Partners on the project include Schoodic Institute, as well as local botanists Jill Weber, Arthur Haines, and Glen Mittelhauser.

During the 2017 field season EPMT crew members helped plant native species and monitor plots established in 2016, in addition to moving sand bags and top soil for the setup of new seed-sown test beds. EPMT member Jim Burka led a volunteer group from Purchase College in filling sand bags needed to create new research plots. These new plots will test how varying soil depth and organic content changes the survivability of seeds and native plant seedlings.

In absence of a dedicated gardener for Acadia's cultural landscapes, EPMT members conducted annual spring cleanup of the native plantings surrounding both the spring pool and the Dorr Memorial at Sieur de Monts; this included weeding, mulching, cleaning leaves out of the spring pool, and repairing native plant labels displayed for visitor education.

Treatment Summary

The following summarizes the exotic plant management work completed by Acadia National Park's EPMT in 2017.

Total Infested Acres Treated	4.01*
Total Acres Surveyed	940
Total EPMT Hours	1,609
Total Volunteer Hours	130
Number of Species Treated	24
Estimated Program Costs (Fiscal Year 2017)	\$211,129

**{Infested acres are defined as 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 100% density.}*

Herbicides Used in 2017

Table 9. Herbicides used at Acadia National Park for exotic plant management in 2017, with the total acres treated and ounces of chemical concentrate sprayed.

Herbicide*	Treated (Infested) Acres	Herbicide Concentrate Used (oz.)
Garlon 3A®	0.292	155.0
Garlon 4 Ultra®	0.021	3.4
Milestone®	0.086	4.6
Rodeo®	3.470	900.6

* 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 Tables 2 and 3 of this report.

Program Recommendations and Objectives for 2018

- Early spring emphasis on foliar treatment of Japanese barberry shrubs. Since shrubs treated with foliar herbicide hold on to their dead branches for years, we plan to use mechanical removal methods when soil disturbance is minimal and the whole plant can be removed. This is especially desired in areas adjacent to motor and carriage roads, as well as trailside where visitors are likely to encounter them.
- Use volunteers for manual control efforts of garlic mustard, European bittercress, spotted knapweed, Asiatic bittersweet near public drinking supplies, and glossy buckthorn 1-2 year seedlings.
- Continue collaborative work with the Maine Volunteer Lake Monitoring Program. Conduct the third year of “Jump Start” efforts to engage the local community and survey Jordan Pond and Bubble Pond for invasive aquatic plants.
- Continue Norway maple treatments in areas outside the long-term vegetation plots of Great Meadow Drive (a.k.a., Ledge Lawn Avenue Extension), Compass Harbor, and Duck Brook. Priority sites include the old Satterlee Estate area, the Park Loop Road near Cromwell Brook, and Duck Brook west of Rt. 3. Re-survey vegetation plots after Norway maple treatments.
- Begin / continue Initial Attack and Maintenance phase of glossy buckthorn treatment in large populations at the following locations:
 - o Greater Cromwell Brook Watershed (including Jackson Laboratory property) - foliar treatment of seedlings in the central areas of the Great Meadow, as well as west of Kebo Street.
 - o Kent Field – continue removing reproductive individuals in new areas, and revisit areas for foliar treatment that were cut-stumped in 2016 and 2017.
 - o Canon Brook / Otter Creek – continue foliar treatment of seedlings and stump sprouts in areas that were cut-stumped in 2016; begin foliar treatment of seedlings and stump sprouts in areas that were cut-stumped in 2017.
- Re-survey monitoring transects for glossy buckthorn in the Canon Brook / Otter Creek watershed.
- Procure a used truck to eventually replace the aging Ford crew cab.
- Continue expanding natural and cultural landscape restoration projects to develop diverse skills and abilities for EPMT staff.
- Continue and expand work on Acadia’s outer islands:
 - o Follow-up foliar applications for privet on Bar Island.
 - o Follow-up foliar applications of exotic bush honeysuckle on The Hop.
 - o Start initial treatments on Bald Porcupine Island.
 - o Revisit Baker Island to treat both Canada and bull thistles.
 - o Revisit Isle au Haut to treat both Canada and bull thistles (last visit was in 2016).

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