



Exotic Plant Management in Acadia National Park, Maine

2016 Annual Summary Report

ACAD NR Report #: 2017-8



ON THE COVER

Acadia National Park staff with Maine Volunteer Lake Monitoring Program (VLMP) Volunteers getting ready at Ikes Point boat launch on Echo Lake to conduct a full shoreline survey for Invasive Aquatic Plants. (NPS staff pictured are Shannon Wiggin, James Burka, Alex Fetgatter, Adam Thime and Jesse Wheeler)

Photo: Roberta Hill / MEVLMP staff

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Executive Summary

In 2016 the Acadia National Park Exotic Plant Management Team (EPMT) systematically surveyed 759 acres of forest, wetland, riparian and other habitats for the presence of Invasive Exotic Plant (IEP) species prioritized for management (**Figure 1**). Invasive plants were managed on 70 sites, with treatment area totaling 3.55 infested acres*.

A total of 24 IEPs were managed in 2016 with manual and chemical control methods both at Acadia National Park and Saint Croix Island International Historic Site. Five of these species are managed at our target population goals of full suppression or reduced below management threshold - Amur maple (*Acer ginnala*), autumn olive (*Elaeagnus umbellata*), burning bush (*Euonymus spp.*), foxglove (*Digitalis purpurea*) and spotted knapweed (*Centaurea stoebe*), whereas the remaining species have made progress toward their management goals during 2016. The four person crew logged over 1,695 hours (with volunteers contributing an additional 200 hours) toward managing IEPs and rehabilitating landscapes. 6.37 gallons of undiluted herbicide were applied over 759 acres of park land containing invasive plants. The EPMT also expanded monitoring efforts of infestations to assess treatment effectiveness and habitat restoration.

Throughout 2016 the team continued to develop and maintain partnerships with local and state organizations, increased outreach efforts by presenting posters and participating in Acadia Centennial events, and maintained commercial pesticide applicator licenses. The EPMT continued to restore and maintain native plantings in cultural landscapes at Sieur de Monts, Schoodic Education and Research Center, and Thompson Island. The EPMT also helped restore natural vegetation communities along trailside areas of Acadia Mountain Trail and Bar Island Trail.

Direct program costs for calendar year 2016 were \$277,393. 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 half of the park’s vegetation program manager’s salary, as well as supplies, equipment, and limited training and travel. This figure also includes \$24,475 of mitigation funds used to purchase a replace work truck. 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}



2016 Acadia Exotic Plant Treatment Areas

Isle au Haut & St. Croix Island International Historic Site Not Pictured

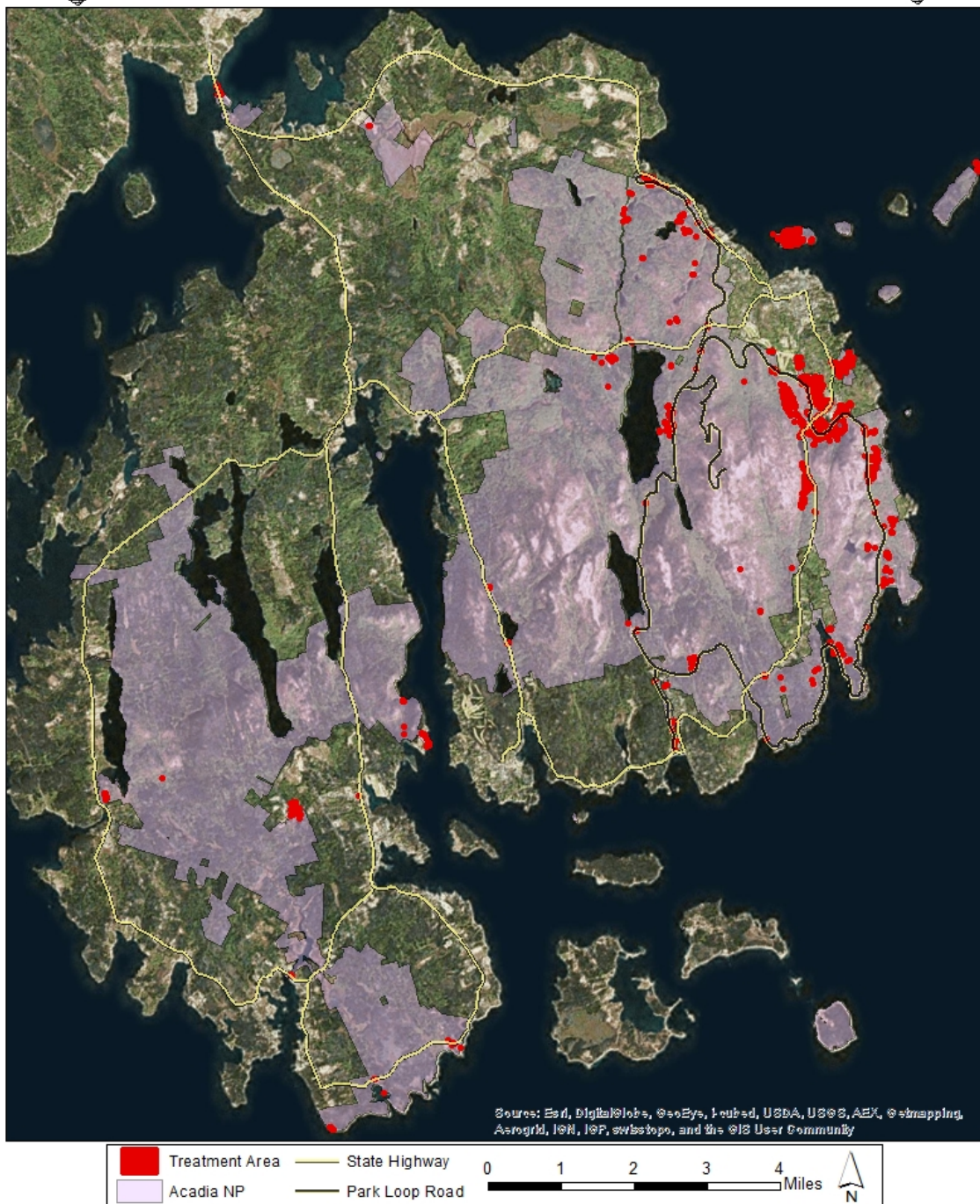


Figure 1. Map of locations of invasive exotic plant populations detected, controlled, re-treated or monitored during 2016 in the Mount Desert Island district of Acadia National Park. Treatment and survey efforts of 24 invasive exotic species covered over 750 acres May through October. Management areas on Isle au Haut, Schoodic Peninsula and Saint Croix Island International Historic Site are not presented here. Map created by Joseph Kelley, NPS.

Introduction

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.

EDRR addresses either a newly introduced species not previously found in the Park such as black swallow-wort (*Vincetoxicum nigrum*), or a new population of a species already existing elsewhere in the Park such as glossy buckthorn (*Rhamnus frangula*, previously *Frangula alnus*). Correct identification of the species in question is the first step in the process, particularly with species that are new to the area. Once a species has been positively identified, information is gathered on its biology and proven best management practices. If a “new” invasive plant species can be detected and treated before it has a chance to fully establish itself, the possibility of eradicating it from the site is greatly increased. As time goes by the combination of site disturbance, accumulation of seed, and population spread to surrounding areas decreases the likelihood of eradicating the plant from the site. Furthermore, the cost in time and resources needed for treatment increases dramatically.

Current EDRR efforts are focused on areas of the park where IEPs have been previously detected or are most likely to occur. These include former homesites where they may have been introduced by residents, as well as disturbed areas such as Wildwood Stables and the carriage road system where horses, their feed, and vehicles can introduce and move weed seeds. At construction sites ground disturbance may create a habitat for IEP species, and vehicles and heavy equipment can carry weed seeds from infested areas. In high visitor-use areas (e.g., trails and parking lots) foot traffic compacts soil and tramples vegetation, creating disturbance that favors pioneer IEPs. EDRR efforts are also focused on high-value habitats. These include wetlands such as Bear Brook and the Tarn, both of which have a history of heavy glossy buckhorn and purple loosestrife (*Lythrum salicaria*) infestation.

Managing IEPs is an ongoing process requiring a long-term commitment. Enduring seed banks, undetected individuals and dispersing populations from adjacent private lands mean that while we can reduce populations below damage thresholds where environmental harm occurs, total eradication over a long time is often unlikely. Long-term management goals are determined by species and usually focus on either full population suppression or, at the very least, population maintenance at low enough levels to prevent environmental harm. Just as a historic building or landscape requires cyclic maintenance following significant rehabilitation, IEP management on natural landscapes usually requires an initial high-intensity effort to significantly reduce long-established populations followed by cyclic, lower-intensity efforts to protect natural habitats and maintain the views of Acadia's natural environment unchanged by IEPs.

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 at maintenance level and will be monitored regularly to determine the need for follow-up treatments and detect any new exotic plant invasions. Ideally, sites at maintenance level will be monitored once a year for three years; if IEPs are absent by that point, then once every five years. Although initial treatment efforts can be time- and labor-intensive, once exotic plant populations are significantly reduced then management of low-level populations through cyclic maintenance requires much less investment (**Figure 2**).

All management actions (initial treatments, surveys or re-visits) are logged on standard data sheets that record the following information: treatment location, personnel involved, hours worked, weather, amount and type of herbicide used, treatment methods, level of infestation and the phenology of the dominant exotic species present. All treatment areas are mapped using Global Positioning System (GPS) and Geographic Information System (GIS) technology to record the location of the infestation. Photographs at established locations are taken pre- and post-treatment whenever possible to help monitor changes in populations over time.

With many sites and species scattered throughout ANP it is necessary to prioritize which species are treated 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 between past years, watersheds are further described using work location names (e.g. Sieur de Monts, Great Meadow). These management units and watersheds have been mapped using GPS and GIS and 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 25 of the IEP species of greatest concern, including plans for the 2017 field season (**Table 1**). Although there are more than 25 IEP species in the park, these particular species were chosen for active management in 2016 based on species biology. Important management criteria include invasiveness, the threat posed to park resources (the ecological or cultural values at risk from the plant), and the feasibility that we can successfully manage them. Much of the inventory work, literature review

and initial prioritization for management in Acadia can be found in Reiner and McLendon 2002, Greene et. al. 2004, and Weber and Rooney 2007. The management plans produced from thorough assessment describe species abundance and location within the park, and provide information about habitat, species identification and best management practices. Review of the latest scientific literature is 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.



Figure 2. Cyclic maintenance is carried out in some locations, like this site in Compass Harbor, south of downtown Bar Harbor, ME. This photo shows late spring growth of Japanese knotweed (*Fallopia japonica*) in the forest understory. Such populations are treated every summer following a “spray-cut-spray” protocol (i.e., an initial foliar treatment when initial spring growth reaches waist height, followed by mechanical cutting [without herbicide] for the regrowth after this initial foliar treatment, followed by a second foliar treatment for any regrowth after the mechanical cutting). Over time this treatment regimen should significantly reduce or eliminate this population. (NPS Photo, May 23, 2016)

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 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 early May, and is continued throughout the season with frequent safety and IEP species reports and tailgate safety sessions. The team operates on the following principles, each one building on the next:

Work Safely

Exotic plant management is hazardous. Herbicide, hand tools, exposure to ticks and tick-borne diseases, physically demanding work, remote job sites and steep terrain are all part of the team's daily operations. To enhance safety the team incorporates frequent training sessions and discusses hazards on the job (and how to mitigate them).

Work Effectively

The EPMT has limited time and resources. To best protect Acadia's natural areas and meet program goals, crew members must be proficient at using and caring for tools, vehicles and equipment. This includes handling, transporting, maintaining, storing and using herbicides in the most safe and efficient manner possible.

Work Efficiently

Time is always a factor in exotic plant management. Longer IEP infestation in a given area results in more seed production, more site disturbance and greater potential for spread to surrounding sites.

Working in a safe, effective and efficient manner allows the EPMT to best utilize its time and resources.

Table 1. Status of invasive exotic plant species management in 2016 and 2017 management goals by species for Acadia National Park.

Population Goal			Level of Effort				
Fully Suppressed = Density or cover below Management Level threshold (no reproductive plants known); seed bank may still be viable			Active = management time devoted specifically to this species, usually on an annual or re-occurring basis			Inactive = Management of species is not targeted due to low priority and/or incomplete management plan	
Nearly Suppressed = Known populations are small and contain few reproductive individuals; seed bank managed regularly			Active (High) = crew works on this plant for 100+ person hours/season			Incidental = this plant managed when encountered during management of other species	
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			Rapid Response = active management occurs when population is discovered	
Population Increasing = Infested acres are increasing or likely expanding to uninfested areas			Active (Med) = crew works on this plant for 30-100 person hours/season			Volunteer = Treatment primarily carried out by volunteers to improve outreach and education	
Population Reduced = Infested acres reduced from the previous year			Maintenance Level = New and small recurring populations only (Less than 5 known populations)				
Species (in alphabetical order by common name)	Initial Work	Most Recent Date / Level of Effort	Long-Term Goal	Population Status	Level of Effort	Primary Treatment Method	Notes
Amur maple (<i>Acer ginnala</i>)	2006	2016 / Incidental	Full Suppression	Fully Suppressed	Incidental	foliar and cut-stump herbicide	Goal currently met
Asiatic bittersweet (<i>Celastrus orbiculatus</i>)	2010	2016 / Active (Med)	Full Suppression	Nearly Suppressed	Active (High)	foliar and cut-stump herbicide	
Autumn olive (<i>Elaeagnus umbellata</i>)	2013	2016 / Rapid Response	Reduce Below Mgmt. Threshold	Maintenance Level	Rapid Response	foliar and cut-stump herbicide	Goal currently met - managed at St. Croix IHS in 2016
Barberry (Japanese, common) (<i>Berberis thunbergii, vulgaris</i>)	2006	2016 / Active (High)	Near Suppression	Population Reduced	Active (High)	foliar herbicide	
Bittersweet nightshade (<i>Solanum dulcamara</i>)	2012	2016 / Incidental	Reduce Below Mgmt. Threshold	Selective Control	Incidental	foliar herbicide	pulled mostly at Isle au Haut during surveys for thistle
Burning bush (<i>Euonymus spp.</i>)	2011	2016 / Rapid Response	Reduce Below Mgmt. Threshold	Maintenance Level	Rapid Response	foliar and cut-stump herbicide	Goal currently met
Coltsfoot (<i>Tussilago farfara</i>)	2002	2016 / Active (Low)	Reduce Below Mgmt. Threshold	Selective Control	Incidental	foliar herbicide	
Common mullein (<i>Verbascum thapsus</i>)	2011	2016 / Incidental	Reduce Below Mgmt. Threshold	Selective Control	Incidental	hand pull	
Common reed (<i>Phragmites australis</i>)	2014	2014 / Rapid Response	Full Suppression	Not in Park yet	Rapid Response	foliar herbicide	the only site managed is on Maine Coast Heritage Trust easement on Babson Creek; one other known MDI population located on Crooked Road east of Town Hill; also known at SERC campus
European bittercress (<i>Cardamine impatiens</i>)	2005	2016 / Volunteer (Low)	Reduce Below Mgmt. Threshold	Population Contained	Volunteer (High)	hand pull / foliar herbicide	
Exotic bush honeysuckle species (<i>Lonicera spp.</i>)	2003	2016 / Active (Med)	Full Suppression	Nearly Suppressed	Active (Med)	foliar and cut stump herbicide	incidental cut/stump in 2016 during roadside veg. management
Foxglove (<i>Digitalis purpurea</i>)	2003	2016 / Incidental	Fully Suppressed	Fully Suppressed	Active (Low)	hand pull / foliar herbicide	Goal currently met
Garlic mustard (<i>Alliaria petiolata</i>)	2003	2016 / Active (Med)	Full Suppression	Population Reduced	Active (Med)	hand pull	

Table 2 (continued). Status of invasive exotic plant species management in 2016 and 2017 management goals by species for Acadia National Park.

Species (in alphabetical order by common name)	Initial Work	Most Recent Date / Level of Effort	Long-Term Goal	Population Status	Level of Effort	Primary Treatment Method	Notes
Giant hogweed (<i>Heracleum mantegazzianum</i>)	2003	2016 / Active (Low)	Reduce Below Mgmt. Threshold	Maintenance Level	Rapid Response	foliar herbicide	
Glossy buckthorn (<i>Rhamnus frangula</i>)	2006	2016 / Active (High)	Full Suppression	Population Reduced	Active (High)	foliar and cut stump herbicide	
Japanese honeysuckle (<i>Lonicera japonica</i>)	2012	2012 / Rapid Response	Reduce Below Mgmt. Threshold	Maintenance Level	Rapid Response	foliar herbicide	looked for at Thailand in 2016, not observed
Japanese knotweed (<i>Fallopia japonica</i>)	2003	2016 / Active (Med)	Full Suppression	Population Reduced	Active (Med)	“spray-cut-spray” (see caption in Figure 2)	
Lupine (<i>Lupinus polyphyllus</i>)	2004	2016 / Volunteer (Low)	Education / Monitor	Population Unknown	Volunteer (Low)	seed pod removal; hand-pulling near milkweed	
Multiflora rose (<i>Rosa multiflora</i>)	2006	2016 / Active (Low)	Reduce Below Mgmt. Threshold	Nearly Suppressed	Rapid Response	foliar herbicide	
Privet (<i>Ligustrum spp.</i>)	2016	2016 / Active (High)	Full Suppression	Population Increasing	Active (High)	cut stump herbicide	
Purple loosestrife (<i>Lythrum salicaria</i>)	1988	2016 / Active (Med)	Full Suppression	Nearly Suppressed	Active (Med)	foliar herbicide	all historic sites visited / treated in 2016
Spotted knapweed (<i>Centaurea stoebe</i>)	2010	2013 / Incidental	Reduce Below Mgmt. Threshold	Maintenance Level	Rapid Response	foliar herbicide	Goal currently met
Yellow iris (<i>Iris pseudacorus</i>)	2003	2016 / Volunteer (Low)	Reduce Below Mgmt. Threshold	Population Contained	Active (Low)	seed pod removal and cut stem herbicide	removed seed pods at Satterlee Pit with Maine Natural Areas Program (MNAP) staff; plan to use herbicide in 2017
Currently Under Review, Management N/A							
Black locust (<i>Robinia pseudoacacia</i>)	N/A	N/A	Allow natural range expansion	Monitoring	Inactive	N/A	
Forest woodrush (<i>Luzula luzuloides</i>)	2011	N/A	Under Review	Monitoring	Inactive	foliar herbicide	
Golden chain tree (<i>Laburnum watereri</i>)	N/A	N/A	Under Review	Monitoring	Inactive	cut stump herbicide	
Ninebark (<i>Physocarpus opulifolius</i>)	N/A	N/A	Allow natural range expansion	Monitoring	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	not targeted in 2016; management under review due to apparent native range expansion

Program Accomplishments

In 2016, 24 invasive exotic species were actively managed with manual and chemical control methods in Acadia National Park and Saint Croix Island International Historic Site. The four person EPMT logged over 1,695 hours (with volunteers contributing an additional 200 hours) toward managing IEPs and rehabilitating landscapes. Almost half this time was spent at three of our major sites (out of 70 sites total): Great Meadow, Bar Island and Kent Field (**Figure 3**). This year the EPMT treated a greater number of sites and more infested acres of IEPs, but with less herbicide than last year. In 2015, 7.99 gallons of total herbicide were applied over almost 556 acres. This year, we applied 6.37 gallons of total herbicide over 759 acres. This is because we are moving from treating areas of mature, dense exotic shrubs concentrated in small areas to treating more sparsely dispersed seedlings and re-sprouts with foliar applications, which involve a lower concentration of herbicide.

Due to a warmer than usual spring, the 2016 field season began in late April, a couple weeks earlier than in years past. Early-blooming species such as coltsfoot (*Tussilago farfara*), garlic mustard (*Alliaria petiolata*) and Japanese barberry (*Berberis thunbergii*) were surveyed and managed in these initial weeks. Returning employee James Burka started in May as a Temporary Seasonal, GS-05 Biological Science Technician. Term employees Alexander Fetgatter, Joseph Kelley and Jesse Wheeler worked most of the year aside from some short furloughs. Moving forward these Term positions are in a full-time year-round capacity for Joe and Jesse, and a Full-time / Part-time year-round status for Alex.

Throughout 2016 the team continued to develop and maintain partnerships with local and state organizations including Friends of Acadia, Maine Coast Heritage Trust, Maine Department of Agriculture, Conservation and Forestry (including both Maine Forest Service and Maine Natural Areas Program), US Forest Service, Maine Volunteer Lake Monitoring Program, and Somes-Meynell Wildlife Sanctuary. Vegetation staff also attended the annual Maine Invasive Species Network (MISN) meeting to discuss current invasive species threats to the State, earning continuing education credits to maintain Commercial Pesticide Applicator licenses in the process. We increased outreach efforts by presenting posters on exotic plant management on Bar Island and the Cromwell Brook Watershed at both the MISN meeting and the Acadia Science Symposium. We participated in local community outreach efforts by discussing invasive forest pests and non-native plants both at the Acadia Centennial Science Day and through programs with area middle and high school students. 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 14th, 2016. Afterward Alex, James, Joe 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 and provided plant identification and technical expertise to the crew.

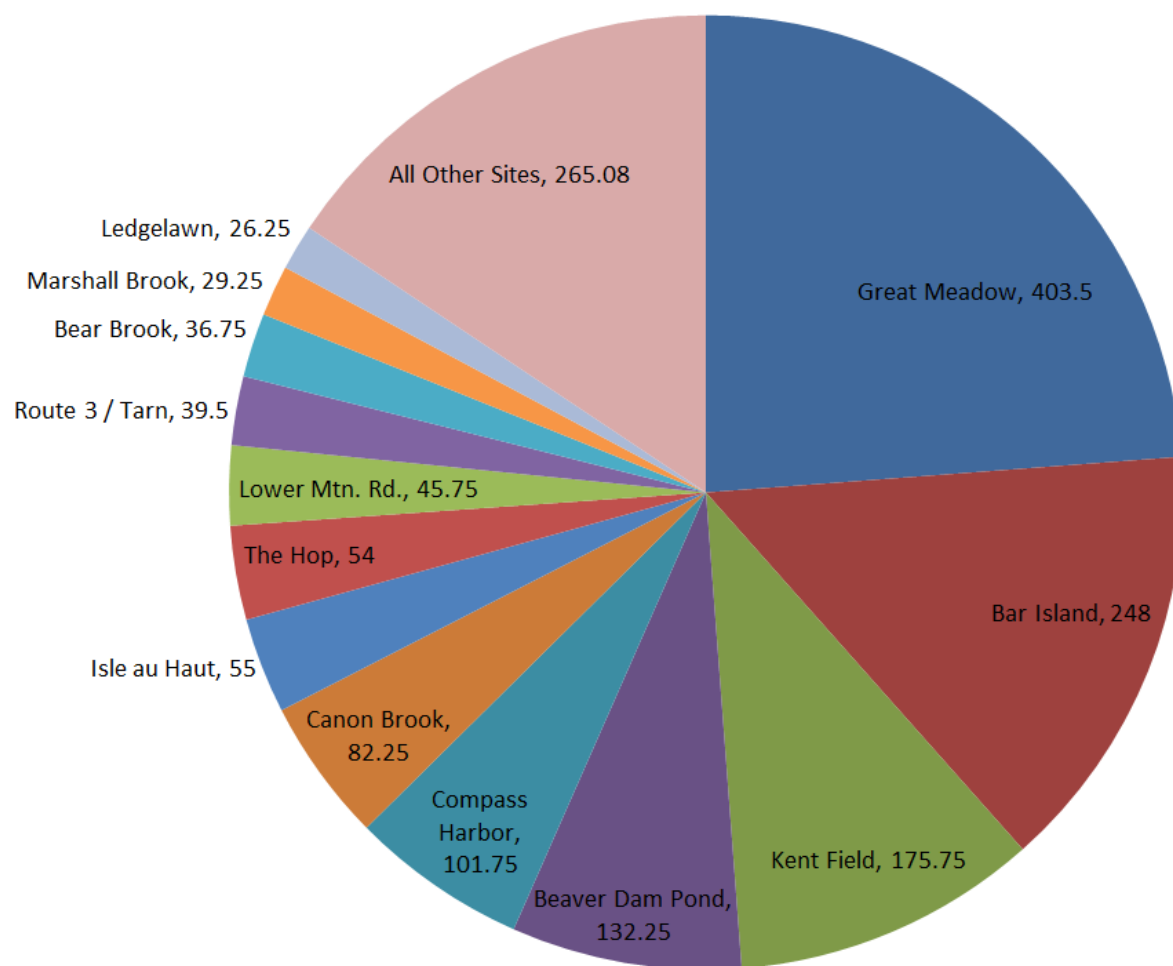


Figure 3. Pie graph illustrating Total EPMT person hours (1,695) worked per site for all IEPs in 2016. Volunteer hours, travel and office time managing data and producing reports are not included in these figures.

Invasive Exotic Plant Species of Greatest Concern Managed in 2016

In 2016, 24 species of IEPs were surveyed and treated at 70 work sites. A total of 3.55 infested acres (measured as species leaf canopy cover at 100% distribution) 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 (*Celastrus orbiculatus*), Japanese knotweed, bush honeysuckle (*Lonicera spp.*) 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 3. 2016 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	0.41	0.0021
	Compass Harbor	17.66	0.0316
	Fernald Point	0.06	0.00001
	Holy Redeemer Cemetery	0.19	0.0001
	Jordan Pond Carriage Road	0.33	0.012
	Jordan Pond Road Erosion Site	0.7	0.0002
	Great Meadow Drive (Formerly Ledge-lawn Avenue Extension)	5.37	0.0341
	Otter Cliffs Road	1.03	0.0018
	Otter Cove	0.27	0.00001
	Seawall	0.46	0.00011
	Thailand (east of Schooner Head Road)	3.86	0.00001
	Total	30.34	0.08204
Japanese barberry (<i>Berberis thunbergii</i>)	Bar Island	27.96	0.1096
	Beaver Dam Pond	2.76	0.0001
	Blackwoods	0.55	0.0004
	Breakneck Brook	2.8	0.0013
	Cadillac Mountain Entrance	0.62	0.0005
	Compass Harbor	15.4	0.0024
	Duck Brook	0.29	0.0002
	Fernald Point	1.7	0.0016
	Great Meadow	29.45	0.0062
	Headquarters	2	0.0014
	Hulls Cove House	1.7	0.0002
	Isle au Haut	13.74	0.0022
	Kent Field	15.9	0.005
	Lower Breakneck Pond	28.3	0.002
	Lower Mountain Road	42.8	0.0251
	Otter Cove	0.27	0.0001
	Saint Croix IHS	6.5	0.005
	Visitor Center	6.2	0.01
	Western Mountain Road	9.14	0.0006
	Wildwood Stables	14.7	0.0201
	Witch Hole Pond	18	0.01
	Total	240.78	0.204

Table 2 (continued). 2016 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
Asiatic bittersweet (<i>Celastrus orbiculatus</i>)	Bar Island	12.168	0.00545
	Compass Harbor	15.4	0.0135
	Frazer Point	2.59	0.00325
	Great Meadow	16.3	0.0001
	Park Headquarters	0.04	0.001
	Jordan Pond House	0.37	0.0024
	Kent Field	3.7	0.0002
	Lower Mountain Road	0.23	0.0022
	Otter Cliffs Road	0.53	0.00005
	Paradise Hill	0.4	0.0004
	Sand Beach	0.6	0.00003
	Flye Farm	1.27	0.048
	Seawall	1	0.01
	Stanley Brook	3.25	0.0021
	Thailand (east of Schooner Head Road)	0.07	0.007
	Thompson Island	0.2	0.001
	Upper Hadlock Pond	0.23	0.009
	Total	58.348	0.10568
Japanese knotweed (<i>Fallopia japonica</i>)	Cadillac Mountain Road	0.33	0.004
	Compass Harbor	21.86	0.0575
	Eagle Lake	0.16	0.0005
	Holy Redeemer Cemetery	0.39	0.0009
	Hulls Cove House	1.7	0.004
	Jordan Pond Road Erosion Site	1.4	0.00075
	Great Meadow Drive (Formerly Ledge lawn Avenue Extension)	2.38	0.0023
	Liscomb Pit	6.13	0.0005
	Parkman Mountain	0.15	0.00002
	Route 3 / Tarn	0.4	0.007
	Satterlee Pit	0.06	0.0004
	Shooting Range	0.72	0.0051
	Sieur de Monts	0.76	0.00018
	Saint Croix IHS	6.5	0.00007
	Total	42.94	0.08322

Table 2 (continued). 2016 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
Exotic bush honeysuckle (<i>Lonicera spp.</i>)	Bar Island	24.748	0.12435
	Cadillac Mountain Entrance	0.13	0.005
	Cadillac Mountain Road	0.3	0.00005
	Canon Brook	74.17	0.00055
	Compass Harbor	17.9	0.0202
	Dick Wolf Overlook	0.14	0.002
	Duck Brook	0.71	0.0002
	Duck Brook Bridge	0.47	0.0005
	Eagle Lake	0.11	0.0003
	Enoch Mountain	9.08	0.0012
	Fernald Point	0.06	0.001
	Great Meadow	28.37	0.004
	Jordan Pond House	0.34	0.004
	Kent Field North	1.17	0.0004
	Lower Breakneck Pond	28.3	0.0004
	Otter Cliffs Road	8.33	0.0121
	Otter Cove	1.42	0.009
	Paradise Hill	0.17	0.0005
	Sand Beach	0.6	0.003
	Satterlee Pit	1.37	0.003
	Seawall	1	0.001
	The Hop	2.68	0.0246
	Thompson Island	2.6	0.0009
	Valley Cove	2.6	0.00045
	Witch Hole Pond	18	0.002
	Total	224.768	0.2207
Glossy buckthorn (<i>Rhamnus frangula</i>)	Bear Brook	23.96	0.01156
	Beaver Dam Pond	49.59	0.17382
	Cadillac Mountain	2.94	0.0006
	Cadillac Mountain Entrance	0.13	0.002
	Canon Brook	91.26	0.1024
	Compass Harbor	13.8	0.01465
	Duck Brook Road Wetland	3.37	0.00001
	Enoch Mountain	9.08	0.0055
	Great Meadow	109.32	0.5392
	Kebo Brook	1.6	0.001
	Kent Field	24.88	0.9811
	Kent Field North	1.17	0.0034
	Great Meadow Drive (Formerly Ledge-lawn Avenue Extension)	0.04	0.0001
	Marshall Brook	17.07	0.0001
	Route 3 / Tarn	3.09	0.0226
	Sand Beach	0.6	0.00003
	Satterlee Pit	1.37	0.04
	Valley Cove	2.6	0.0007
	Total	355.87	1.89877

Table 4. Acres infested and surveyed of invasive plant species managed below ecological impact thresholds in 2016 (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>)	Great Meadow	incidental	0.0016
Common burdock (<i>Arctium minus</i>)	Saint Croix Island IHS	incidental	0.0033
Common barberry (<i>Berberis vulgaris</i>)	Great Meadow	incidental	0.0022
	Nursery	incidental	0.007
	Total	incidental	0.0092
European bittercress (<i>Cardamine impatiens</i>)	Compass Harbor	2.96	0.006
	Otter Cliffs Road	1.03	0.00035
	Stanley Brook	1.97	0.00003
	Total	5.96	0.00638
Canada thistle (<i>Cirsium arvense</i>)	Bar Island	7.78	0.0057
	Frazer Point	2.59	0.0001
	Great Meadow	1.02	0.0014
	Park Headquarters	0.66	0.0008
	Hulls Cove House	1.67	0.00005
	Isle au Haut	48.26	0.0124
	Kent Field	2.26	0.0002
	Nursery	2.78	0.0005
	Otter Cove	0.64	0.0006
	Parkman Mtn.	0.16	0.0001
	Pooler Farm	1.7	0.0003
	Sand Beach	2.7	0.0002
	Satterlee Pit	1.37	0.0009
	Ship Harbor	0.36	0.0015
	Shooting Range	0.36	0.0001
	Sieur de Monts	0.48	0.0002
	Saint Croix IHS	6.5	0.0103
	The Hop	0.87	0.0008
	Thompson Island	2.6	0.0001
	Tremont School	2.1	0.0001
	Visitor Center	3.91	0.0003
	Total	90.77	0.03665

Table 3 (continued). Acres infested and surveyed of invasive plant species managed below ecological impact thresholds in 2016 (Fully or Nearly Suppressed - Maintenance level).

Species	Site / Location	Surveyed Acres	Infested Acres
Bull thistle (<i>Cirsium vulgare</i>)	Bar Island	7.78	0.0017
	Beaver Dam Pond	16.45	0.0003
	Fernald Point	0.19	0.0042
	Park Headquarters	1.94	0.0001
	Hulls Cove House	3.34	0.00025
	Isle au Haut	51.7	0.0101
	Nursery	2.78	0.0004
	Pooler Farm	1.7	0.001
	Sand Beach	2.7	0.0002
	St. Croix IHS	5.47	0.0032
	Visitor Center	3.91	0.0014
	Wildwood Stables	5.03	0.014
	Totals	102.99	0.03685
Foxglove (<i>Digitalis purpurea</i>) (no treatment in 2016)	--	--	--
Autumn olive (<i>Elaeagnus umbellata</i>)	Saint Croix IHS	incidental	0.00095
Winged euonymus (<i>Euonymus alatus</i>)	Compass Harbor	--	0.0217
	Great Meadow Drive (Formerly Ledge lawn Avenue Extension)	--	0.0001
	Saint Croix IHS	--	0.0025
	Thailand (east of Schooner Head Road)	--	0.055
	Total	incidental	0.0793
Giant hogweed (<i>Heracleum mantegazzianum</i>)	Liquor Locker	0.14	0.0008
Shrubby St. John's-wort (<i>Hypericum prolificum</i>)	Great Meadow	1	0.0004
Yellow iris (<i>Iris pseudacorus</i>)	Satterlee Pit	0.26	0.0001
Privet (<i>Ligustrum spp.</i>)	Bar Island	45.883	0.5392
	Compass Harbor	15.4	0.0021
	Stanley Brook	3.25	0.0012
	Total	64.533	0.5425
Lupine (<i>Lupinus polyphyllus</i>)	Bar Island	0.43	0.13
	Great Meadow	0.32	0.0005
	Headquarters	0.2	0.07
	Total	0.95	0.2005

Table 3 (continued). Acres infested and surveyed of invasive plant species managed below ecological impact thresholds in 2016 (Fully or Nearly Suppressed - Maintenance level).

Species (total infested, total surveyed in acres)	Site / Location	Surveyed Acres	Infested Acres
Purple loosestrife (<i>Lythrum salicaria</i>)	Bear Brook	12.94	0.00015
	Beaver Dam Pond	8.48	0.0013
	Blackwoods	0.55	0.0001
	Compass Harbor	0.61	0.004
	Duck Brook	0.29	0.00004
	Duck Brook Rd. Wetland	3.37	0.00002
	Hulls Cove House	2.84	0.0003
	Kent Field	4.56	0.00054
	Marshall Brook	17.07	0.016
	Route 3 / Tarn	2.75	0.0005
	Satterlee Pit	1.37	0.0004
	SERC Campus	0.11	0.00002
	Stanley Brook	3.25	0.0004
	Witch Hole Pond	2.22	0.00003
	Total	60.41	0.0238
Bittersweet nightshade (<i>Solanum dulcamara</i>)	Frazer Point	--	0.00005
	Stanley Brook	--	0.00015
	Total	incidental	0.0002
Multiflora rose (<i>Rosa multiflora</i>)	Beaver Dam Pond	--	0.0005
	Compass Harbor	--	0.0016
	Duck Brook Rd. Wetland	--	0.00003
	Ocean Path	--	0.002
	Ship Harbor	--	0.0002
	Total	incidental	0.00433
Coltsfoot (<i>Tussilago farfara</i>)	Blackwoods	0.01	0.00002
	Jordan Pond Rd. Erosion	1.4	0.0012
	Otter Cliffs Road	2.38	0.00095
	Quarry Path	1.25	0.00003
	Sand Beach	0.17	0.00018
	Seawall Picnic Area	0.15	0.00001
	Stanley Brook	1.97	0.00001
	Total	7.44	0.0024
Mullein (<i>Verbascum thapsus</i>)	Great Meadow Drive (Formerly Ledgelawn Avenue Extension)	incidental	0.0008

Management Activities by Species

Purple Loosestrife

The invasive wetland plant purple loosestrife has been treated by the Acadia exotic plant management program for decades. The successful suppression of purple loosestrife populations in many of the park's wetlands means only a few days of maintenance work are required of the EPMT at certain spots every year. In July and August of 2016, the EPMT visited all known locations where the plant has been managed at any point since 1988. Fourteen of these historical locations contained purple loosestrife, and most of them had very few individuals. Marshall Brook and Beaver Dam Pond are two sites in the Park where we still find a modest number of blooming plants, though not as significant as in years past. We surveyed and treated over 17 acres in Marshall Brook and 8.5 acres in Beaver Dam Pond. The original monitoring transect markers at Beaver Dam Pond were not found in 2016; however efforts should be taken to locate these for re-sampling in the future.

Garden Lupine

Garden or big-leaf lupine (*Lupinus polyphyllus*) has been managed as an invasive exotic plant in Acadia since 2004. Active treatment of lupine populations has mostly been limited to pulling or cutting stems in natural areas such as Great Meadow, and some roadside areas where the plant has appeared to expand in size or compete with native plants such as milkweed, the host plant for monarch butterflies. In 2006 all known populations of lupine in and around the park were mapped and inventoried. Park staff recorded flowering stems and vegetative stems at some sites. Seed heads were cut and bagged to fill six garbage bags at Great Meadow near the Park Loop Road and Great Meadow Drive intersection. However, since a comprehensive population study hasn't been completed and flower head inventories are spotty, we decided to re-map some of the 2006 sites in 2016 to look for possible population expansion.

In 2016 the EPMT mapped lupine population boundaries in two areas of the Great Meadow using GPS. The polygon areas for 2016 were no larger than 2006, both years representing approximately 1300 m² (1/3 of an acre). In the southern area, located on an old road bed in the meadow, the population may be decreasing in size (645 m² in 2006 vs. 340m² in 2016) and possibly density (1% cover in 2016, unknown for 2006). The EPMT also started counting milkweed stems growing among lupine populations in an effort to track the competitive relationship between these two meadow herbs over time. Data were insufficient this year to ascertain if the lupine population is expanding in the park. However, using volunteers to help remove seed heads and count milkweed stems proved an effective way to educate people (including passing visitors on Bar Island) and contain lupine infestations simultaneously. We plan to continue managing seed production with volunteers and continue enhanced monitoring of populations in 2017.

Japanese Barberry

Early spring field work in May included surveying and treating of Japanese barberry (one of the first shrubs to leaf out) in large areas around Witch Hole Pond, the east side of Eagle Lake and on Bar Island, among others. The EPMT has been finding more barberry shrubs in recent years in many locations throughout the park. Several reports have come from park staff, volunteers and community residents. Though very dense infestations are rare, the dispersal of this species is one

of the widest among the top two dozen species of IEPs we manage at Acadia. 2016 efforts treated 0.2 infested acres among 240.78 surveyed acres at 21 different sites. Several of these sites are new locations, including Thailand (Palmer home site east of Schooner Head Road, approximately 5 acres), the south end of Kent Field, Blackwoods Campground and the beaver pond southwest of Witch Hole Pond and just north of Halfmoon Pond. A large focus for May 2017 will be survey and treatment of Japanese and common barberry in many of these locations, as well as other areas in which barberry have been spotted but not yet treated.

Management Activities by Location

Saint Croix Island International Historic Site

The EPMT travelled to Saint Croix Island International Historic Site (SACR) in August to manage invasive plants; SACR relies on Acadia staff to protect resources. Bull thistle (*Cirsium vulgare*), barberry, winged burning bush (*Euonymus alata*), autumn olive (*Elaeagnus umbellata*), Japanese knotweed and burdock (*Arctium minus*) were treated on the mainland section (**Figure 5**). Autumn olive is a shrub that seems to be just showing up in roadside and open field areas of eastern Maine. The prolific berries are attractive to birds, whereby seeds are dispersed. In central New England autumn olive has infested many old field sites. Management of the Japanese knotweed population at SACR in previous years appears to have been effective, as is evident from very little growth this year. The crew was also able to visit Saint Croix Island for the first time to survey for IEPs, and treated a small population of bull thistle in the field on the south end of the island (**Figures 4 and 5**). We were pleased to find only a few non-native plants on the island, with only the bull thistle needing management due to its invasive potential.



Figure 4. Photo of Exotic Plant Management Team (EPMT) crew members (from left to right) Joseph Kelley, Alex Fetgatter and James Burka treating bull thistle in a field on the south end of Saint Croix Island, 2016. This was the first year the EPMT surveyed and managed IEPs on the island portion of Saint Croix Island International Historic Site. (NPS photo).



2016 St. Croix Exotic Plant Treatment Areas



Figure 5. Map of invasive exotic plant species managed at Saint Croix Island International Historic Site in 2016. Due to the site's small size of about 6 acres, the Exotic Plant Management Team was able to survey almost the entire property this year, including the island.

Outer Islands (Isle au Haut & The Hop)

In an effort to manage IEPs on Park islands, the EPMT tries to visit several islands only accessible by boat every year. In addition to Saint Croix Island, in 2016 the crew managed IEPs on Isle au Haut (IAH) and The Hop. Efforts to visit the Porcupine Islands were thwarted due to weather and scheduling conflicts. The EPMT spent two days on IAH. Following tips from the Forest Inventory and Monitoring crews, extensive surveys were conducted at the edge of a wetland near the north end of the park boundary. A few Japanese barberry plants were found and treated. The crew also treated Canada thistle (*Cirsium arvense*) and bull thistle on the shorelines and road edges within the park boundary (**Figure 6**). Abundance of thistle appears to be lower than past years, which gave the crew more time to scout areas not surveyed before. These include Eastern Head on the southeast end of the island and Western Ear, a small island at the southwest end of IAH only accessible around low tide (**Figure 7**).

The EPMT took three trips to The Hop in Frenchman Bay, treating 0.025 infested acres of exotic bush honeysuckle and many Canada thistles. The infestation levels of honeysuckle appeared heavier in 2016 than indicated by scouting in previous years. More visits are needed in the future to remove all reproductive plants and prevent further spread by birds and small mammals. Unfortunately bad weather limited the crew's time on The Hop, leaving important work to be done in 2017.



Figure 6. Photo of Alex Fetgatter managing Canada thistle on the northwest coast of Western Ear Island off Isle au Haut, July 2016. Along with the plants in the center and foreground of this image, most thistles growing on island shorelines are chemically treated with hand sprayers to avoid off-target drift. This is particularly important near water to prevent herbicide contamination. (NPS photo).



2016 Isle au Haut Exotic Plant Treatment Areas

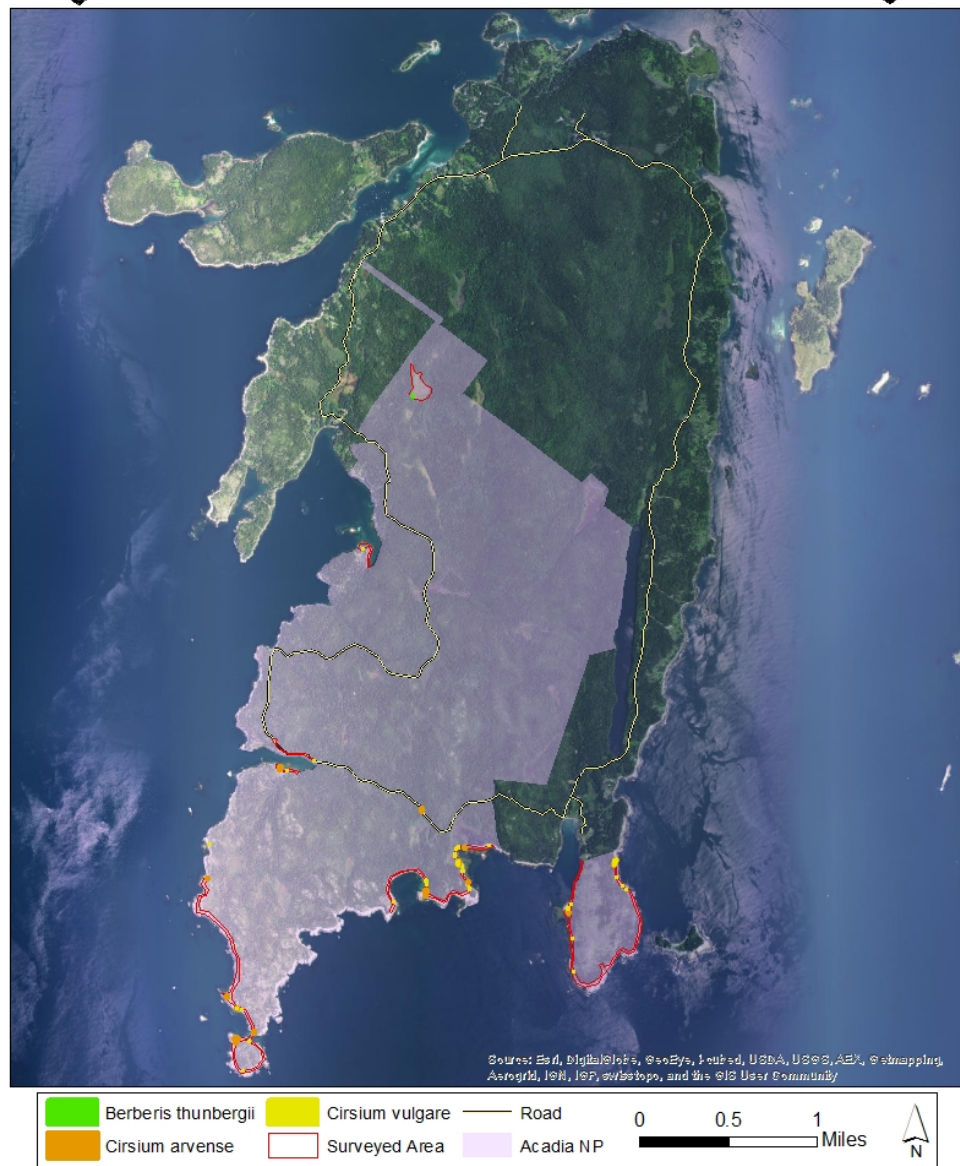


Figure 7. Map of invasive plant species surveyed and managed on Isle au Haut in 2016. The focus of this year's visit was to survey as much shoreline and roadside as possible for Canada and bull thistle.

Bar Island

Efforts on Bar Island for the 2016 field season were primarily focused on Japanese barberry and privet (*Ligustrum spp.*). A total of 248 person hours were devoted to treatment of all IEPs on the island. 31.25 of these were spent on Japanese barberry, while privet hours totaled 189.75. The major thrust for Japanese barberry treatment occurred in the first half of May, with foliar applications of 3% Rodeo (**Figure 8**). Early May is an ideal time for these treatments as barberry is typically one of the first woody perennials to leaf out after the spring thaw, facilitating location and identification. After the initial foliar effort, incidental barberry found intermixed with privet populations were treated with cut-stump applications along with the privet.

Active management of privet in 2016 began May 10 and lasted until late June, when other priority species necessitated work at other sites. Other than a few incidental foliar applications during the Japanese barberry effort, treatments were exclusively cut-stump. By far the largest patch of privet is located just south of the meadow area, and forms a near monoculture as the understory of a large aspen grove there. Due to the density of this population, brush cutters were utilized to speed up the work. While this frenetic pace of cutting can result in a greater proportion of stumps being overlooked for herbicide application, the efficiency with which large areas can be cleared makes up for this. Combined with the fact that we will be returning to this site for follow-up treatments of re-sprouts / new growth in future years, it was determined that brush cutters were the best tool for the job. This work was showcased in an article in the June 23, 2016 edition of the Mount Desert Islander. In the article, entitled “Acadia battling invasive ‘aliens,’” Islander reporter Dick Broom outlined Acadia’s exotic plant program (**Figure 9**; full article can be found here: <http://www.mdislander.com/maine-news/environment/acadia-battling-invasive-aliens>).

The main privet population under the aspen grove spills over and down the precipitous slope on the south edge of the island, facing downtown Bar Harbor. Hand tools were chosen for cut-stump treatments on this terrain, as unwieldy brush cutters would have proven far too dangerous (**Figures 10 and 11**). In addition to management of satellite populations, plans for 2017 include follow-up visits to this main population for foliar treatments on re-sprouts and any new growth. The map in **Figure 12** gives a breakdown of IEP distribution and treatments on Bar Island in 2015 and 2016.

The last visit to Bar Island for the 2016 season was August 23, for Canada and bull thistle foliar treatments. Compared to 2015, 2016 surveyed acres for all IEPs on the island increased nearly six-fold, with 59.59 acres surveyed as compared to 2015’s 10.85 acres. This is largely explained by the heavy focus on gridding for Japanese barberry in the early part of the field season. Of the surveyed acres in 2016, 0.916 were treated as compared to 1.46 treated acres in 2015. As with the trend in the Great Meadow (see the “Great Meadow” narrative section below), this is explained by a heavier focus on foliar applications after completion of “initial attack” cut-stump treatments (with the exception of privet). Privet accounted for over half of the 2016 treated acres, at 0.54. These cut-stump treatments effectively eradicated all seedbearing privet specimens on Bar Island (with the caveat, of course, that some may have been missed due to human error). Japanese barberry accounted for 0.11 of the total treated acres.



Figure 8. (left) Photo of Japanese barberry in early leaf-out on Bar Island, May 5, 2016; (below right) photo of dead Japanese barberry stems on Bar Island five months after foliar treatment, October 13, 2016. (NPS Photos)



Figure 9. Photo of EPMT members James Burka and Alex Fetgatter use a brush cutter for cut-stump treatment of privet, June 23, 2016. (Photo credit: Dick Broom, Mount Desert Islander)



Figure 10. Photo of volunteer Shari Latulippe using hand tools for cut-stump treatment of privet on Bar Island's steep south-facing slope, June 13, 2016. (NPS Photo)



Figure 11. Photos of before (left, taken June 13, 2016) and after (right, taken June 23, 2016) treatment of the privet population on the south-facing slope of Bar Island. The orange arrows point to the same tree in both photos. (NPS Photos)

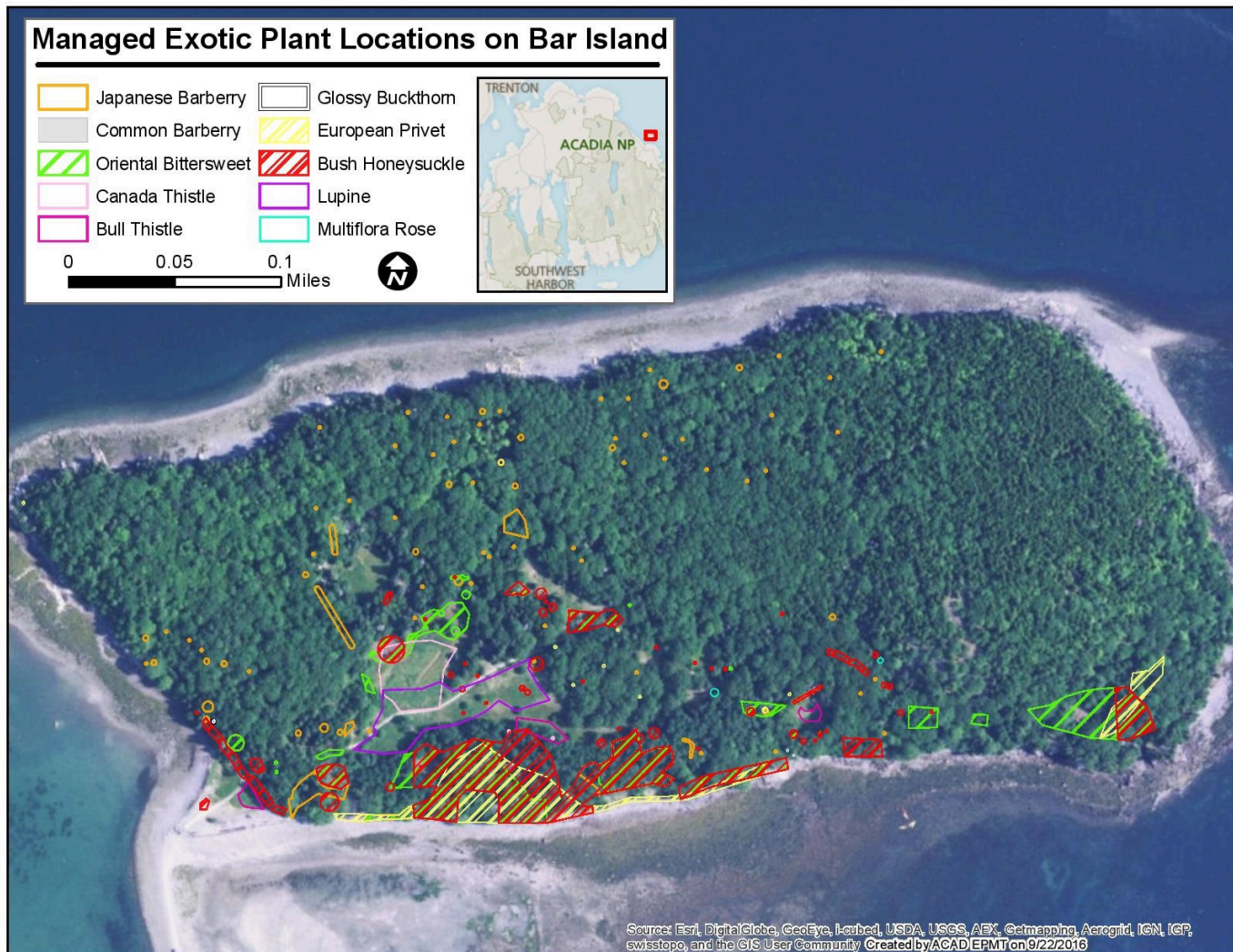


Figure 12. Map of invasive exotic plant species surveyed or treated on Bar Island, 2015-2016. Most of the work in 2016 involved management of European privet on the south shore and Japanese barberry peppered throughout the island.

Kent Field

To put the EPMT's 2016 Kent Field efforts in context some explanation of the 2015 efforts is in order, since that was the first year of concerted glossy buckthorn treatment there. In 2015 large stands of mature glossy buckthorn were located and treated in the western half of Kent Field, north of Murphy Lane. Cut-stump and foliar treatments were, however, completed using the gridding method (full systematic searches of an area) in the eastern half of Kent Field north of Murphy Lane. These efforts were largely "seek and destroy," meaning only the dense populations were targeted. It made the most sense to get those out of the way before gridding through the area systematically. All in all, 90 person hours were spent treating buckthorn in Kent Field in 2015, with 7.93 acres surveyed, and 0.32 acres (1,295 m²) treated.

In 2016, the western half of Kent Field north of Murphy Lane was the major area of focus for glossy buckthorn treatment. From early May to late August the EPMT surveyed this entire section. Cut-stump treatments were used both to "mop up" mature stands that were started in 2015 as well as to manage new areas (**Figure 13**). All mature seedbearing individuals have now been treated in this area, roughly from the Orange and Black trail south to Murphy Lane (**Figure 14**). Follow-up foliar treatments will be needed here in 2017 to suppress re-sprouts and new growth. All told the EPMT spent 168.5 person hours treating glossy buckthorn in Kent Field in 2016. A total of 85.15 acres were surveyed, and of those 0.98 acres (approximately 4000 m²) of glossy buckthorn vegetation was treated. The EPMT also conducted surveys along the edge of Kent Field south of Murphy Lane, represented by the southernmost yellow outline on the map in **Figure 14**. Evidence of more stands of mature buckthorn in the interior of this area indicates that plans for 2017 should include a thorough grid approach here.



Figure 13. Photo of EPMT member James Burka performing a cut-stump treatment on a stand of mature glossy buckthorn on the western edge of Kent Field near the Precipice Trailhead on the Park Loop Road, July 21, 2016. (NPS Photo)



Glossy Buckthorn Infestation in Greater Kent Field

Individual grid cell size is 10m x 10m

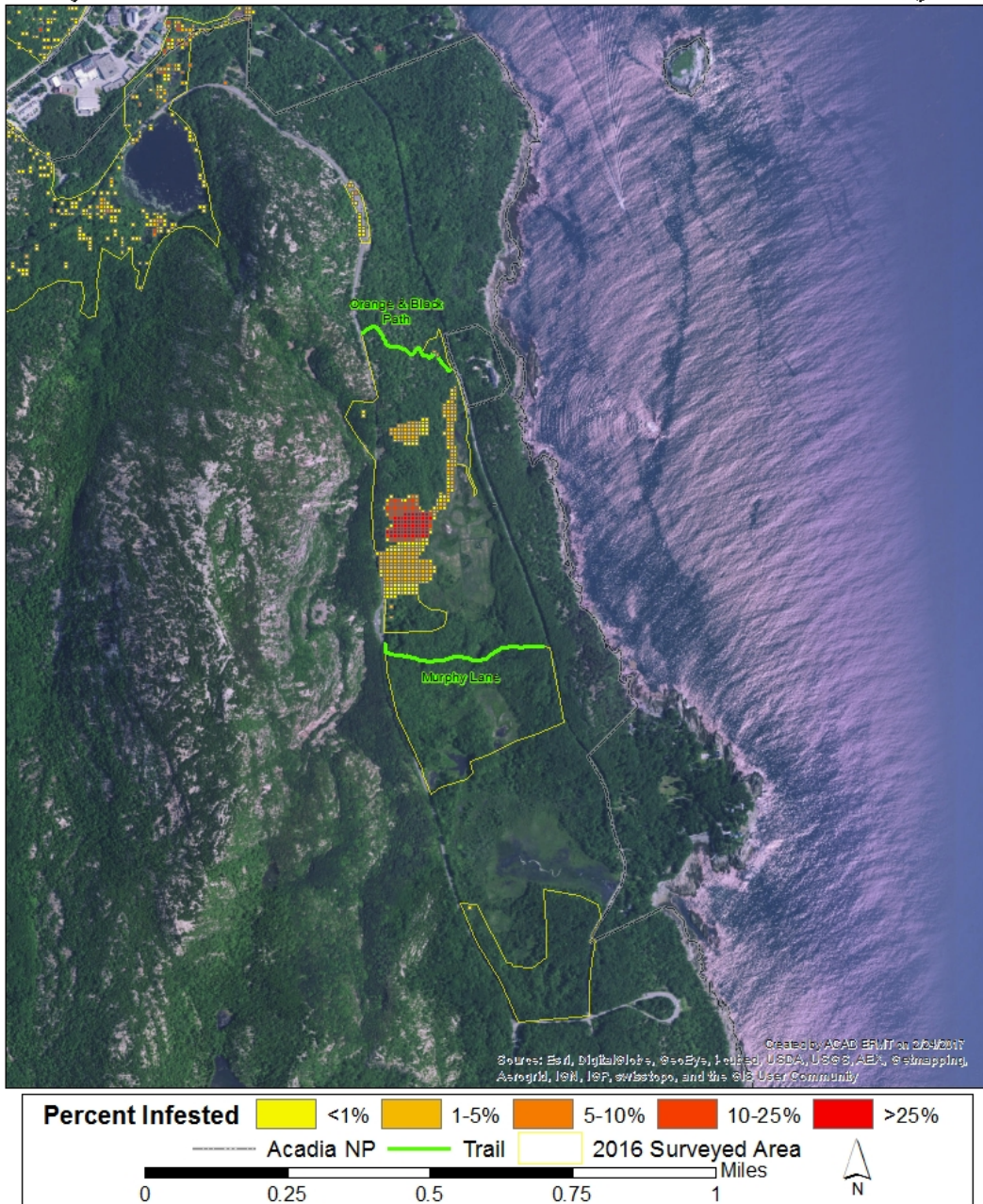


Figure 14. Map of the glossy buckthorn infestation surveyed and treated in the Kent Field area between the Park Loop Road and Schooner Head Road during the 2016 field season. Infested grid cells show percent cover of glossy buckthorn foliage in locations that were treated in 2016.

Greater Cromwell Brook Watershed

In May 2016 the EPMT resumed treating glossy buckthorn and several other exotic species in the Greater Cromwell Brook Watershed. The yellow outline on the map in **Figure 15** shows the areas surveyed during the 2016 field season. While a large portion of this area falls within this watershed (outlined in light blue on the map), the surveyed area extends outside this boundary along Canon Brook south of the Tarn, as well as along the Park Loop Road east of Route 3 around the Bear Brook Picnic Area and Beaver Dam Pond. Additional buckthorn populations surveyed outside this watershed boundary were located in park lands adjacent to Jackson Lab property west of Route 3, as well as a satellite population along the Gorge Path at Kebo Brook. While watersheds remain a logical way to delineate natural areas, the distribution of this glossy buckthorn meta-population demonstrates that wildlife-dispersed plants (invasive or otherwise) do not always adhere to neat boundary lines. Of particular importance regarding this treatment area are the large patches of buckthorn with >25% cover found in the wooded area of Great Meadow east of the Jesup Path and north of Sieur de Monts (again see **Figure 15**). Prior to treatment this area had by far the heaviest density of mature buckthorn, making it a priority target for the EPMT to reduce seed production as quickly as possible.

Last year (2015) the EPMT surveyed 118.57 acres in the Greater Cromwell Brook Watershed; if one were to consolidate into a single area all the leaf cover of treated IEPs within this survey area, it would total 2.36 acres (2.11 of which were infested with glossy buckthorn). Total person hours spent in this area for IEPs in 2015 was 457; of these, 422.5 hours were spent on glossy buckthorn. In 2016, 208.48 acres of the greater watershed area were surveyed, of which 0.81 acres were treated for IEPs; of these, 0.75 acres were infested with glossy buckthorn. 647.5 person hours were committed to the area for all IEPs in 2016, 605 of which were devoted to glossy buckthorn. It took four times longer (800 hours / acre in 2016 vs. 200 hours / acre in 2015) to remove the same leaf area of glossy buckthorn. These figures demonstrate the magnitude of this meta-population, and put it well within the parameters of “Active (High)” management level for both 2015 and 2016.

The vast majority of 2016 glossy buckthorn management in the Greater Cromwell Brook Watershed was devoted to foliar herbicide treatments. Of the 605 total glossy buckthorn hours, 513.5 hours were spent on foliar applications. This indicates that, in previous years, we were largely successful in treating the more mature (and seed-producing) individuals, and thus this year we were able to focus more on smaller stems and seedlings. The majority of this work was in the heavily-infested wooded area in the Great Meadow east of the Jesup Path (**Figure 16**).

The 2016 field season saw completion of the removal effort for reproductive glossy buckthorn in the Greater Cromwell Brook Watershed (with the caveat that some scattered individuals remain due to human error). This allowed a new management phase to begin, wherein new/young growth is actively suppressed to deplete the seed bank. Glossy buckthorn seed bank viability is largely understudied, but some research suggests the seed remains viable for at least two years and perhaps longer (<https://www.fs.fed.us/database/feis/plants/shrub/fraaln/all.html>). It is interesting to note that while the greater watershed surveyed area total for 2016 (208.48 acres) is almost double that from 2015 (118.57 acres), the total area treated for glossy buckthorn in 2016 (0.75 acres) is roughly one-third that of 2015 (2.11 acres). Simply put, in 2016 more ground was

covered while less volume of buckthorn was encountered. This is largely explained by the small size of the specimens treated in 2016 versus 2015. 2015 efforts were largely “initial attack” treatments, the focus being to cut-stump all known stands of mature, seed-producing buckthorn, whereas 2016 efforts were largely foliar follow-up treatments on immature specimens.

In the three field seasons it took to completely cover the Greater Cromwell Brook Watershed area for all IEPs (2014-2016), 1,940.5 person hours were committed and 444.92 acres were surveyed. 5.768 of these acres were treated for IEPs generally, 5.137 acres of which were infested with glossy buckthorn. The years of focus here are limited to 2014-2016 because that is the period for which the most consistent data is available. Upon his hiring in spring 2014, EPMT Data Manager Joseph Kelley implemented protocols that streamlined and standardized our data collection process, improving our ability to compare numbers from year to year. The last three years have shown that glossy buckthorn management in the Greater Cromwell Brook Watershed is no small task. While it is anticipated that total person hours spent per year will decrease as the population gets closer to “Fully Suppressed” status, it is not unreasonable to expect that hundreds of hours per field season will be required over at least the next few years.

The long-term outlook is promising, however. Four vegetation monitoring transects in the Great Meadow section of this greater watershed area were revisited by the EPMT in 2016. The 2016 numbers indicated a significant reduction in the glossy buckthorn population over the last eight years. In 2008 a total of 846 non-reproductive stems were counted, as compared to 102 in 2016. For reproductive stems, nine were found in 2008 as compared to zero in 2016. This decrease can be taken as evidence that glossy buckthorn treatment efforts in the Great Meadow have been largely successful for at least the past eight years.

We also revisited shrubby St. John’s-wort (*Hypericum prolificum*) monitoring transects that were originally sampled in 2008. Two of the four transects were relocated and sampled for immature and reproductive stems. After a couple removal efforts in this area since 2008, monitoring results show shrubby St. John’s-wort stem counts have remained roughly the same. Only Transect 1 was sampled in 2008, where 57 vegetative stems and 14 reproductive stems were observed. The same transect in 2016 revealed 55 vegetative stems and 13 reproductive stems within the 60m² sample area.

In addition to the quantity of hours worked, qualitatively the Greater Cromwell Brook Watershed is not lacking in physical challenges that make this work more difficult. Steep slopes covered with loose rocks and soil characterizes much of the terrain between Great Meadow Drive (formerly Ledgelawn Avenue Extension) and Jackson Lab. Lack of shade in open areas exacerbates the heat during summer months. Dense, chest-high groundcover in these same areas (e.g., *Rhodora canadensis* and *Gaylussaccia baccata*) makes it nearly impossible to see where one is stepping and makes maneuverability an often laughable endeavor (**Figure 17**). To increase range of motion in such thickets, the EPMT opted against using backpack sprayers and instead employed “Iron Dog” belt-loop holders, by which handheld spray bottles were carried that housed the foliar herbicide solution (in this case, 3% Garlon 3A). To save trips back and forth to the truck for re-filling, we often carried an extra 2.5-gallon container of pre-mix to the work site for in-field refills.



Glossy Buckthorn Infestation in Greater Cromwell Brook Watershed

Individual grid cell size is 10m x 10m



Figure 15. Map of the glossy buckthorn infestation surveyed and treated in the Greater Cromwell Brook Watershed during the 2016 field season. Infested grid cells show percent cover of glossy buckthorn foliage in locations that were treated in 2016.



Figure 16. Photo of EPMT members James Burka and Alex Fetgatter using 3% Garlon 3A for foliar treatments of immature glossy buckthorn in the Great Meadow. Photo taken just east of the Jesup Path, June 8, 2016. (NPS photo)



Figure 17. Photo of EPMT members James Burka and Alex Fetgatter fighting their way through dense wetland shrub cover while grid searching for glossy buckthorn in the Great Meadow, June 22, 2016. (NPS photo)

Collaborative Work

Invasive Aquatic Plants

Jesse Wheeler, Exotic Plant Management Program Leader, organized and led an interagency effort with the Maine Volunteer Lake Monitoring Program (VLMP) and Somes-Meynell Wildlife Sanctuary to search for aquatic invasive plants in Somes Pond, Long Pond and Echo Lake. Eleven aquatic invasive plants are regulated in Maine because they pose a huge environmental and economic threat to fresh water bodies. Aquatic invasive plants can completely choke out lakes and ponds, not only making them ecological deserts but also reducing opportunities for boating and swimming. In July 2016 the EPMT attended a workshop on invasive aquatic plant identification led by VLMP staff. During the weekend of September 10 & 11, the VLMP conducted a training workshop for Invasive Plant Patroller volunteers on survey methods using canoes and kayaks. Following the training, experienced VLMP aquatic plant survey volunteers from around the state conducted a full shoreline survey of the littoral zones of Long Pond, Somes Pond and Echo Lake. No invasive aquatic plants were detected in 2016! Acadia hydrologic technicians Shannon Wiggin and Adam Thime, and EPMT staff James Burka, Jesse Wheeler and Alex Fetgatter participated in the Echo Lake surveys. These efforts will be carried over to 2017, with surveys planned for Seal Cove Pond, Eagle Lake and Jordan Pond.

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 departments, we have established an integrated team approach between the EPMT and the Roads/Vista crew during the fall and winter. Some cooperative projects, including vista and roadside vegetation maintenance, have worked well in recent years by bringing on personnel from the EPMT in the fall and winter to help the Vista / Roads / Arborist crews fell trees, treat stumps with herbicide, and identify hazard trees for removal. This timing fits nicely within the seasonal Maintenance schedule, as temporary employees leave in the fall and create a void that should be filled with 4-6 people. With several of the EPMT staff employed year-round, there is the possibility of these folks having a mixed schedule to work on vegetation when the weather is good and in the office on exotics data management, reporting and planning during foul conditions. The fall and early winter of 2016 was successful in this regard, in which the EPMT stepped in to work with the Vista crew seamlessly.

In addition to the successful projects mentioned above, we have identified areas of overlapping interest / skills between these teams that may increase overall efficiencies and address unmet needs for resource and infrastructure maintenance. These opportunities / needs include:

- Continued vista management work, cyclic roadside clearing and hazard tree removal
- Cultural landscape maintenance / rehabilitation (apple tree pruning, horticultural landscape restoration, etc.)
- Norway Maple (*Acer platanoides*) management (tree removal planned to start Fall 2017)
- Reestablish a revegetation program or similar in-house ability to address degraded areas such as carriage road intersections, trailside social trails or post-construction sites

- Developing a tablet-based mapping system with GPS information including locations of vistas, known rare plant sites, disturbed areas, repeated washouts, known bat roosts, etc.
- Timing tree removal to protect bats (late September- late March)
- 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 road systems)

Native Plant Restoration

In 2016 the EPMT continued its revegetation work on sites from previous years, in addition to some new areas. Beginning with traditional sites, in June the team visited the Thompson Island Visitor Center to weed the native plant beds and spread bark mulch to suppress further weed growth (**Figure 18**). Labels were also added to help visitors identify the plantings, in addition to an informational sign that explains to visitors the benefits of using native plants in their own landscaping and gardens. Extensive weeding was also completed around the native plant beds surrounding the Moore Auditorium at the Schoodic Education and Research Center (SERC). A full day was spent here and, with the help of a number of Acadia's valued VIPs (Volunteers-in-Parks), the beds were successfully cleaned. Particular care was needed for this area, as a large portion of the weeds were entangled with the low-lying native Bar Harbor juniper (*Juniperus horizontalis* "Bar Harbor") covering much of the beds. Spring cleanup in anticipation of the Acadia Centennial Science day was also done in June on the native plantings surrounding both the spring pool (**Figure 19**) and the Dorr Memorial at Sieur de Monts; this included weeding, mulching, cleaning leaves out of the spring pool, and thinning the hay-scented fern lining the stone pathway to the Dorr Memorial. In addition, surplus ostrich ferns were harvested from the Wild Gardens and transplanted to fill in gaps near the spring pool, while some new winterberry shrubs were added to the area near the Dorr Memorial.

On top of revisits to the traditional revegetation sites described above, two new sites were added to the EPMT's portfolio. The entrance area to the Bar Island path presented a golden opportunity for native plantings after removing the thick stands of bush honeysuckle, Japanese barberry and Asiatic bittersweet in 2015. Species including sensitive fern, lowbush blueberry, goldenrod and native Virginia rose (*Rosa virginiana*) were planted in September for aesthetics as well as to discourage off-trail hiking in this heavily trampled area (**Figure 20**). Specimens for these plantings were salvaged from both the Seawall Campground leach field (prior to the construction) as well as the old native plant nursery at the EPMT's storage area off Schooner Head Road. Revisits in 2017 will be necessary to assess the survival of these plantings, as the soil at this site is incredibly dry and subject to heavy foot traffic.

The other new revegetation site in 2016 was the Acadia Mountain Trail. The ANP Trail Crew rehabilitated the trail that summer and, in the process, created a series of tiered water checks / planting beds ideal for revegetation. Blueberry sod was salvaged from the Seawall Campground leach field and planted here in September. The coming of spring in 2017 will reveal how successful these efforts were, but buds were found in December so the outlook is promising.



Figure 18. Photo of EPMT Data Manager / Field Crew Leader Joe Kelley cleaning up after weeding and mulching the native plant beds at the Thompson Island Visitor Center, June 22, 2016. (NPS Photo)

Figure 19. Photo of the lovely cardinal flower (*Lobelia cardinalis*) in bloom at the Sieur de Monts spring pool, August 24, 2016. (NPS Photo)



Figure 20. Photo of Exotic Plant Program Leader Jesse Wheeler installing a “Restoration Area” sign to discourage trampling on new native plantings near the entrance to the Bar Island path, September 8, 2016. (NPS Photo)

Treatment Summary

The following summarizes the exotic plant management work completed by the ANP EPMT in 2016.

Total Infested Acres Treated	3.55*
Total Acres Surveyed	759.21
Total EPMT Hours	1,695
Number of Species Treated	24
Estimated Program Costs (Fiscal Year 2016)	\$277,393

**{Infested acres are defined as total amount of leaf canopy cover of invasive plant species at 100 % distribution}*

2016 Work Sites

Bar Island	Lower Breakneck Pond
Bass Harbor Head Lighthouse	Lower Mountain Road
Bear Brook	Marshall Brook
Beaver Dam Pond	Nursery
Blackwoods Campground	Ocean Path
Breakneck Brook	Otter Cliffs Road
Cadillac Mountain	Otter Cove
Cadillac Mountain Entrance	Paradise Hill
Cadillac Mountain Road	Parkman Mountain
Canon Brook	Pooler Farm
Compass Harbor	Quarry Path
Dick Wolf Overlook	Route 3 / Tarn
Duck Brook	Sand Beach
Duck Brook Bridge	Satterlee Pit
Duck Brook Road Wetland	Sawyer's Point
Eagle Lake	Seawall Campground
Enoch Mountain	Seawall Picnic Area
Fernald Point	Schoodic Education and Research Center
Frazer Point	(SERC) Campus
Great Meadow	Ship Harbor
Headquarters	Shooting Range
Holy Redeemer Cemetery	Sieur de Monts
Hulls Cove House	Saint Croix Island
Hulls Cove Visitor Center	Saint Croix Visitor Center
Hunter's Brook	Stanley Brook
Isle au Haut	Thailand (Schooner Head Road)
Jordan Pond Carriage Road	The Hop
Jordan Pond House	Thompson Island
Jordan Pond Road Erosion Site	Tremont School
Jordan Pond House	Upper Hadlock Pond
Kebo Brook	Valley Cove
Kent Field (North)	Western Mountain Road
Great Meadow Drive (Ledgelawn Extension)	Wildwood Stables
Liquor Locker	Witch Hole Pond
Liscomb Pit	

Herbicides Used in 2016

Garlon 4 Ultra®: active ingredient triclopyr

Garlon 4 Ultra® is a broadleaf-specific herbicide applied by the EPMT during cut-stump applications in cold weather. It is generally more effective on perennial broadleaf species than glyphosate. Triclopyr's broadleaf-specificity allows its application to broadleaved exotic plants in grassy areas or comingled with evergreens without causing non-target damage to these native species. Garlon 4 Ultra® is an ester formulation that can be mixed with a plant-based oil diluent. The oil-based diluent allows for a longer time period between the stem being cut and an effective application of herbicide. It also extends efficacy below temperatures at which a water diluent would render the solution ineffective (i.e., below freezing). Garlon 4 Ultra® is a growth regulator, and works particularly well in the early part of the growing season when plants are actively growing. Garlon 4 Ultra® was applied at the rate of 25% during cut-stump treatments. The diluent was basal bark oil, which has the added benefit of being a bark penetrant. Oil-based blue dye was used for color.

Herbicide	Acres Treated	Gallons Used
Garlon 4 Ultra®	47.2*	0.7925*

*These numbers do not include the Garlon 4 Ultra® used in fall 2016 with the historic vista rehabilitation program.

Species treated: Japanese barberry, privet species, European barberry (*Berberis vulgaris*), Asiatic bittersweet, winged euonymus, glossy buckthorn, bush honeysuckle species and multiflora rose (*Rosa multiflora*).

Rodeo®, active ingredient glyphosate

Rodeo® is a broad-spectrum herbicide applied by the EPMT during both foliar and cut-stump applications. It is widely used in exotic plant management because of its effectiveness on many different species and its low toxicity to non-plant species. It is also effective on perennial grasses such as reed canary grass. Glyphosate is an amino acid disrupter. While it can be used throughout the growing season, it is particularly effective in the fall when perennial plants are sending resources to their roots. During foliar treatments Rodeo® was applied at the rate of 3 - 5%, and during cut-stump applications at a rate of 25%.

Herbicide	Acres Treated	Gallons Used
Rodeo®	615.922*	2.80469*

*includes St. Croix IHS numbers

Species Treated: Japanese barberry, Asiatic bittersweet, autumn olive, winged euonymus, Japanese knotweed, glossy buckthorn, giant hogweed (*Heracleum mantegazzianum*), bush honeysuckle species, purple loosestrife, multiflora rose, poison ivy* (*Toxicodendron radicans*),

coltsfoot, common mullein (*Verbascum thapsus*), Shrubby St. John's-wort, Amur Maple, and privet species.

*native species treated for visitor and employee safety along the Ocean Path

Milestone[®], active ingredient aminopyralid

Milestone[®] is a broadleaf-specific herbicide used by the EPMT in foliar applications only. The active ingredient in Milestone[®] is aminopyralid, which works through an auxin growth regulator. Milestone[®] is particularly effective on bull thistle and Canada thistle. According to the label Milestone[®] cannot be applied directly to water, so the ANP EPMT does not apply Milestone[®] within 50 feet of any water source or wetland with standing water. The EPMT chose this herbicide to manage thistles and spotted knapweed because neither Garlon 3A[®] nor Rodeo[®] are very effective against these herbs. Milestone[®] was used for foliar applications at a rate of 0.25%.

Herbicide	Acres Treated	Gallons Used
Milestone [®]	130.214	.189453

Species Treated: Canada thistle and bull thistle.

Garlon 3A[®], active ingredient triclopyr

Garlon 3A[®] is a broadleaf-specific herbicide applied by the EPMT during cut-stump and foliar applications. It is generally more effective on perennial broadleaf species than glyphosate. Triclopyr's broadleaf-specificity allows application to broadleaved exotic plants in grassy areas or comingled with evergreens without causing non-target damage to these native species. It is a salt formulation acting as an auxin mimic that deregulates plant growth metabolic pathways. It accumulates in the plant meristems (growth regions), causing uneven cell division and growth. Garlon 3A[®] was used for foliar applications at a rate of 3%.

Herbicide	Acres Treated	Gallons Used
Garlon 3A [®]	309.91	2.58457

Species Treated: Glossy buckthorn, privet species, poison ivy*, bush honeysuckle species, Japanese barberry and Asiatic bittersweet.

*=native species treated for visitor and employee safety along the Ocean Path

Program Recommendations and Objectives for 2017

- Early spring emphasis on foliar treatment of Japanese barberry shrubs in the following locations: the beaver ponds between Witch Hole Pond and Half Moon Pond, Thailand (east of Schooner Head Road), Bar Island, Lower Mountain Road, Wildwood Stables near Day Mountain, and Carriage Road Intersection 38 as well as Vistas 133 and 134. Incidental treatment of barberry will occur later in the season at other locations.
- Fill the EPMT Field Crew Leader / Data Manager position.
- Continue to improve the EPMT data management program by exploring potential uses of Collector for ArcGIS using our iPad.
- Continue collaborative work with the Maine Volunteer Lake Monitoring Program (VLMP). Conduct the second year of “Jump Start” efforts to engage the local community and survey Jordan Pond, Eagle Lake, Round Pond and Seal Cove Pond for invasive aquatic plants.
- Finalize a Norway Maple Management Plan and start treatment and monitoring efforts. The first locations will likely be near the intersection of Great Meadow Drive and the Park Loop Road, the Satterlee Estate area, and near the mouth of Duck Brook.
- Return to areas of glossy buckthorn infestation for spot treatments (e.g. Kebo Brook and Seal Cove Road).
- 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 northern and eastern areas of the Great Meadow.
 - o Kent Field – continue removing reproductive individuals in new areas (with particular focus south of Murphy Lane) and revisit areas for foliar treatment that were cut-stumped in 2016.
 - o Canon Brook / Otter Creek – continue Canon Brook management with foliar treatment of seedlings and cut-stump treatment of reproductive plants; start Otter Creek treatment by removing reproductive individuals.
- Set up monitoring transects for glossy buckthorn in new areas of Canon Brook / Otter Creek.
- Return to Flye Farm to treat mature Asiatic bittersweet (and perhaps Norway maple).
- 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 of EPMT staff.
- Continue and expand work on Acadia’s outer islands:
 - o Follow-up foliar applications for privet on Bar Island.
 - o Continue Initial Attack of bush honeysuckle on The Hop.
 - o Start initial treatments on other Porcupine Islands.
 - o Revisit Baker Island to treat both Canada and bull thistles.

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