Spreading the Word About Weeds

Community Action on Invasive Alien Plants
in Nova Scotia's Annapolis Valley

Marika Godwin
October 2007

Clean Annapolis River Project

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Funded by the Invasive Alien Species Partnership Program (IASPP),
A Government of Canada Initiative

Canada

Cover Photo: Oriental or Asiatic bittersweet (*Celastrus orbiculatus*) growing over trees and shrubs along Highway 201, West Paradise, NS. Taken by Heather Stewart, Applied Geomatics Research Group.

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Acknowledgements

The *Community Action on Invasive Alien Plants* project was funded by the Invasive Alien Species Partnership Program (IASPP), Environment Canada. In-kind support for this project was provided by the Applied Geomatics Research Group (AGRG) at the Nova Scotia Community College (NSCC), the Harriet Irving Botanical Gardens (HIBG) and E.C. Smith Herbarium, both at Acadia University, and by Gini Proulx, a highly respected naturalist and botanist. Project guidance was provided by Andy Sharpe, Clean Annapolis River Project (CARP).

Botanical expertise was provided by the following people:

Sean Blaney — Botanist, Assistant Director, Atlantic Canada Conservation Data Centre
Diane LaRue — Vegetation Consultant, Environmental Services Group, NS Department of Transportation and Public Works
Ruth Newell — Botanist, Curator, E.C. Smith Herbarium, K.C. Irving Environmental Science Centre & Harriet Irving Botanical Gardens, Acadia University
Marian Munro — Botanist, Curator (botany), NS Museum of Natural History
Melanie Priesnitz — Conservation Horticulturist, Harriet Irving Botanical Gardens, Acadia University
Gini Proulx — Amateur Botanist, Annapolis Field Naturalists Society
Heather Stewart — Botanist, Research Scientist, Applied Geomatics Research Group, Nova Scotia Community College.

Garden plant species input was provided by the following Annapolis Valley garden clubs: Wilmot Garden Club, Valley Gardeners, Champlain Garden Club, Clements Garden Club, and Bridgetown Garden Club.

Wayne Kelley and Scott Crowell of the Grand Pré National Historic Site, Parks Canada, generously donated the use of the multi-purpose room at the historic site, and facilitated the set-up and clean-up of a meeting about garlic mustard management in July 2007.

Brian Van Rooyen and Denise Young of Valley Waste Resource Management (VWRM) edited the invasive plants contribution to VWRM's 2007 Waste Management Calendar, and graciously donated the space.

CARP also acknowledges the citizens of the Annapolis Valley who were engaged in invasive alien plants by this project, and reported sightings and control information.

Executive Summary

The Annapolis Valley, NS has the oldest record of European settlement in Canada, and as such has a long history of anthropogenic disturbance. In addition, the Valley contains and is adjacent to natural areas of regional, national, and international significance. Little work on invasive alien terrestrial plants had previously been conducted in this area, so the Clean Annapolis River Project (CARP) saw an opportunity to conduct research on local problematic plant species, and use this knowledge to engage local communities. The goal of the *Community Action on Invasive Alien Plants* project was to minimize the risk and impact of invasive alien plants on the human and natural environments of the Annapolis Valley, and in doing so, contribute to the goals of Canada's national invasive species strategy.

After researching and creating a local invasive alien plant species list, CARP spread the word about weeds to more than 650 people throughout the Annapolis Valley. Project outreach activities included talks, PowerPoint presentations, guided walks of natural areas, plant identification, plant mapping, weed pulling exercises, and control demonstrations. These presentations were tailored to the specific audience, which included school children, university students, naturalists, gardeners, park employees, woodlot owners, land managers, and other scientists. Other project activities included the establishment of a toll-free reporting line, the development of an invasive plants webpage for dissemination of information, research and development of local better management practices (BMP) for priority plant species, and research of monitoring methods and a volunteer monitoring trial. CARP continues to receive reports of invasive plant observations, and requests for outreach presentations.

Introduction

As a result of the culminating interest in invasive species across Canada, Clean Annapolis River Project (CARP) wanted to initiate some research on invasive alien plants that could potentially impact the human and natural environments of the Annapolis River watershed. In the document *An Invasive Alien Species Strategy for Canada* (Environment Canada 2004), the federal government identified the need for Canadians to take measures to address invasive alien species as essential. This publication spawned three working groups that were tasked to develop action plans to address aquatic organisms, terrestrial plants and plant pests, and terrestrial animals and animal diseases, respectively. All of the documents produced by the afore-mentioned working groups acknowledge the inadequacy of current Canadian measures to address the impacts of invasive species, and highlight the gaps in our initiatives. They also identify the important role that can be played by municipalities and community groups in the prevention, detection, and management of invasive species. Education and public awareness were cited as strategies to be used to meet the objectives outlined in the *Action Plan for Invasive Alien Terrestrial Plants and Plant Pests, Phase 1 — Key Initiatives* (TPPWG 2004). CARP and its partners felt that they could contribute to these objectives by conducting research on local problematic plant species, then using this knowledge to engage the local community.

Despite the documented presence of invasive alien plants in the province of Nova Scotia, there is very little local research and reference material available. For example, a population of *Gallerucella* sp. beetles was released as an experiment in biological control of purple loosestrife (*Lythrum salicaria*) in the Belleisle Marsh, Belleisle, NS from 1997-1999. This was a joint project by Ducks Unlimited and the NS Department of Natural Resources. Though follow-up of these releases is ongoing (Glen Sampson, personal communication 2007), finding information about this project in print or on the Internet is virtually impossible.

In 2005, the Applied Geomatics Research Group (AGRG) conducted an inventory of invasive alien plants in Kejimkujik National Park (Stewart 2005). From this, AGRG identified species of concern, developed an invasive plant monitoring program for park staff, and contributed to the long-term management program for the park. Also in 2005, an Acadia University student initiated some research on addressing the problem of invasive plants by creating community partnerships (Gupta 2005). Gupta's undergraduate thesis was followed by a summer alien plant project that included outreach education and plant mapping activities. Though there is considerable interest in invasive species in the Annapolis Valley, there is no ongoing work involving local communities. *The Community Action on Invasive Alien Plants* project was designed to build on previous projects and existing partnerships, and integrate the work of CARP, AGRG, and Acadia University. All of these groups have an interest in the identification, distribution, and management of invasive alien plants.

Invasive Species

It is widely accepted that invasive species are the second greatest threat to native biodiversity worldwide. In Canada alone, more than 20% of our "species at risk" are threatened with extinction by invasive alien species (Environment Canada 2004). While it's true that most introduced species do not become aggressive invaders, the few that do can cause serious damage.

Across the country, approximately 27% of vascular plant species are not native. Nova Scotia has one of the highest proportions of exotic plants, making up approximately 36% of our total plants (CESCC 2006). By reducing the natural

diversity of plants and animals, and by lowering the value of aquatic and terrestrial wildlife habitats, invasive alien plants may have a serious impact on Nova Scotia's natural areas.

There is a diversity of terminology used in reference to invasive alien species. In fact, the very definition of an invasive alien species can be ambiguous. For the purposes of this project, and all outreach activities conducted as part of this work, CARP used the following definitions, based on those used by the Canadian government:

> Alien species — Any species (plant, animal, microbe) introduced by human action outside its natural range.
>
> Invasive alien species (IAS) — Alien species whose introduction and/or spread threatens the environment, the economy, or society (including human health).

Alien species originate on another continent, in another country, or in another part of Canada. As such, they must be transported to their new locations. This movement of species is facilitated by intentional or accidental human action. The means by which a species arrives at a new location is referred to as a pathway. The most common pathways vary by the type of alien species. For example, many aquatic invaders are transported in the ballast water of shipping vessels, or by recreational boaters and anglers. One of Canada's most notorious alien invaders, the zebra mussel (*Dreissena polymorpha*), was introduced to the Great Lakes in discharged ballast water in 1986 (Dextrase 2002). Invasive alien insects are often hidden in packing materials, or wood products. The European brown spruce longhorn beetle (*Tetropium fuscum*) arrived in Halifax in 1990 (though not correctly identified until 1999) in wood packing materials (Hendrickson 2002). Invasive animals are often purposely introduced. In the case of invasive alien plants, many are escaped ornamental plants, originally planted in someone's garden. Unfortunately, due to increases in global trade, travel, and resource extraction, species introductions are on the rise. It is important to remember that not all aliens are invasive. Many alien species happily co-exist with native species, and have no measurable effect on native ecosystems, while others have been very beneficial to the North American economy. Some of these beneficial aliens include cattle, wheat, honeybees, and many ornamental plants (eg. tulips).

Outside of their home ranges, invasive alien species lack the natural controls that keep their populations in check. High productivity, good dispersal, long growth periods, and lack of natural controls contribute to their success in new environments. While purple loosestrife is the virtual "poster-child" for invasive alien plants, there are a number of less well known exotic beauties that are equally, if not more, detrimental. Their effects on native plants may include direct impacts, ecosystem alteration, and genetic dilution.

Direct impacts include competition for light, water, and nutrients; physical displacement; and toxicity. Native ecosystems can be altered by changes to the hydrological cycle; fire frequency; soil erosion rates; and soil chemistry. By displacing native plants, or by hybridizing with them, invasive plants have the potential to reduce genetic diversity. Alternatively called alien, exotic, foreign, introduced, weed, non-native, or non-indigenous, these plants may present real problems for native ecosystems.

Many invasive plants remain weeds of human-disturbed landscapes, including roadsides, trails, abandoned lots, old homesteads, etc. However, invasions can also occur after natural disturbances, such as animal trails, floods, forest fires, hurricanes, and others. This relationship between invasive species and disturbance gives us an idea of where we are likely to locate invasions. Some highly invasive plants such as garlic mustard (*Alliaria petiolata*) may initially become established in disturbed areas, and then move into undisturbed habitats.

Canada's cool climate may work in our favor to prevent the establishment and spread of some of the world's most invasive species. Our current climate is limiting to a number of invasive species that cannot tolerate our cold winters (Blaney 2001). However, as the climate changes with global warming, conditions may become more favourable for the establishment of species that are currently limited by temperature. As such, Nova Scotians need to be vigilant about monitoring the introduction of new species. Prevention and early detection are the most cost effective means of managing invasive species. Raising awareness now could save the future loss of money, and more importantly, loss of native biodiversity.

Priority Invasive Plants in the Annapolis Valley

The primary objective of this project was to identify priority invasive plants for the Annapolis Valley area (Figures 1a and 1b), and document them for future use. A survey was created, based on existing lists and studies, and sent out to botanists, vegetation managers, naturalists, ecologists, and ecosystem scientists who have a knowledge of the flora of Kings, Annapolis, and Digby counties. The survey responses, in conjunction with relevant literature, discussions with experts, and lists from adjacent geographic areas (eg. Stewart 2005) were used to create a list of priority invasive plants in the Valley. It is important to remember that this list is not concrete. Catling (2005) emphasized that lists of the most threatening invasive plants are subject to rapid change. New introductions are occurring continuously, and we should always remain on the lookout for new occurrences of invasive plants, and for invasive qualities exhibited by the species in our own back yards.

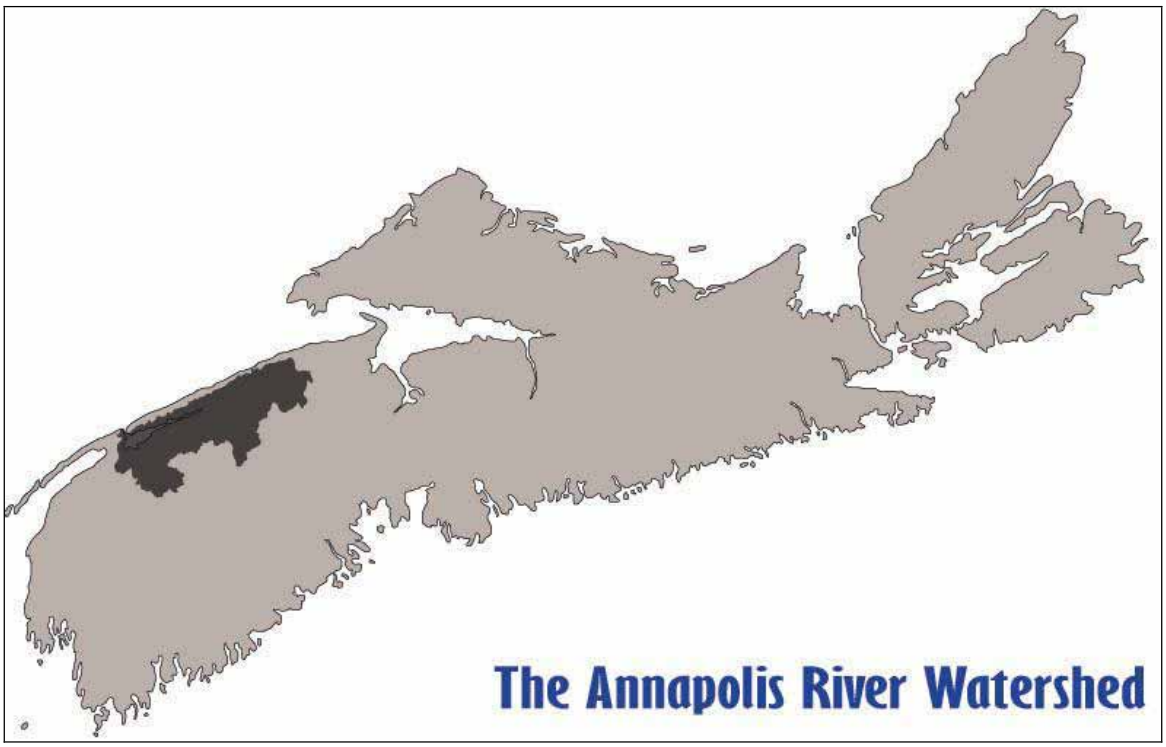

Figure 1a. Map of Nova Scotia, depicting the Annapolis River Watershed, within the Annapolis Valley.

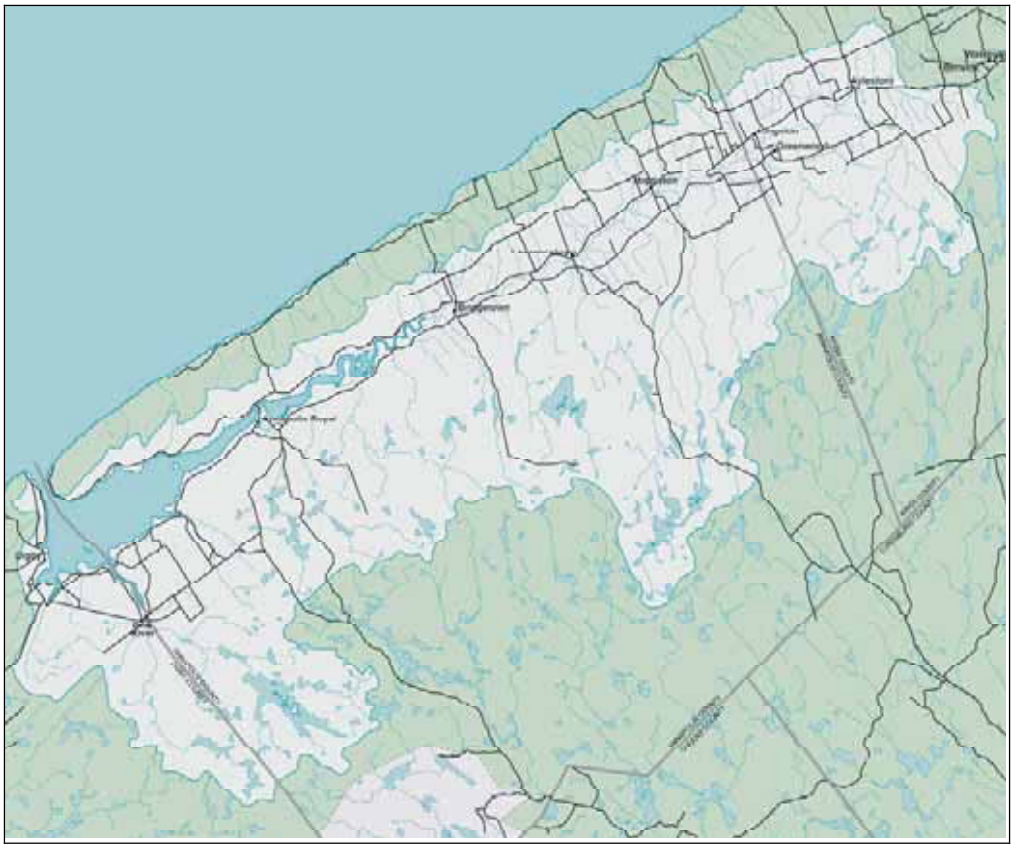

Figure 1b. The Annapolis River Watershed.

The species most frequently identified as problematic by experts were prioritized. The first eight species on the list are the ones that pose the greatest risk to our native ecosystems, noted in order of perceived threat. Other species on the list are invasive plants known to be present in Nova Scotia's Annapolis Valley. A complete checklist of invasive alien plants, and list references are provided in Appendix A. The eight high priority plants were identified as follows:

1 — glossy & common buckthorn (*Rhamnus frangula* & *R. cathartica*)
2 — Japanese knotweed (*Polygonum cuspidatum*)
3 — purple loosestrife (*Lythrum salicaria*)
4 — common reed (*Phragmites australis*)
5 — garlic mustard (*Alliaria petiolata*)
6 — Scotch broom (*Cytisus scoparius*)
7 — multiflora rose (*Rosa multiflora*)
8 — Canada thistle (*Cirsium arvense*)

The number of high priority species on the list was deliberately kept to a minimum, in order to make it easier to teach people to identify them. By naming all of the other invasive plants, those who have an interest in botany or invasion biology can work at learning to identify more species. Many invasive plants remain weeds of disturbed landscapes, and do not pose a real threat to native ecosystems. Those identified as high priority are the plants that have the potential to cause detrimental impacts on the natural environments of the Annapolis Valley.

In April 2007, an Annapolis Valley resident reported an "out of control" vine to CARP. Upon closer investigation, with the expertise of botanist Heather Stewart of AGRG, the woody vine was identified as Oriental or Asiatic bittersweet (*Celastrus orbiculatus*). Though it had not previously been reported for this area, some specimens were close to 30 years old, determined by collection of core samples. This discovery reinforces the need for continued monitoring and education. It also supports Catling's (2005) observation about the changing nature of lists.

Invasive Garden Plants

In meeting with garden club members, it was discovered that many people experience invasion problems with their garden plants. In order to broaden the scope of the CARP invasive plant list, gardeners were asked to identify their most problematic species. There was some overlap with already-listed plants, but other plants were new additions. These are noted under the heading "Problems in the Garden" on the species list in Appendix A. As many invasive aliens originated as ornamental plants, gardeners can play an important role in recognizing invasive qualities, and preventing new invasions and subsequent spread.

Additional Invasive Plants Affecting Canadian Forests

Forest management practices often result in the creation of disturbed areas, and in implementing them managers may unknowingly introduce or spread invasive plants (Evans et al. 2006). These practices may include recently harvested blocks, silviculture treatments, roads, landing areas, and others. As such, woodlot owners and forest managers may wish to include invasive alien species in their management plans to minimize the risks posed by certain species. For example, numerous invasive plants may colonize areas of natural regeneration, and plantation establishment. The reason for this association is that most invasive plants are not shade-tolerant, and cannot survive in natural, closed-canopy forested areas. Unfortunately, there are some that can, and these have the potential to threaten the integrity of forest ecosystems (eg. garlic mustard).

The Canadian Council of Forest Ministers uses the number of invasive alien forest-associated species as an indicator of species diversity, within the context of biological diversity (CCFM 2006). In conducting outreach activities with woodlot owners, CARP distributed a list of alien plants in Canadian forests in effort to raise awareness about proper identification, and prevention. This list was adapted from the CCFM (2006) document, and can be seen in Appendix B. Woodlot owners were encouraged to remove invasive plants from their properties, and were informed of removal and disposal techniques.

Outreach Education – Spreading the Word about Weeds

After the list of priority invasive alien plants was generated, the second project task was to raise awareness about the risks associated with these plants, and IAS in general. A number of outreach education presentations were prepared and delivered to school children, university students, naturalists, gardeners, park employees, woodlot owners, and other scientists. These presentations were tailored to the specific audience and included talks, power point presentations, guided walks of natural areas, plant identification, plant mapping, and weed pulling exercises. Project pamphlets, copies of the species list, and other related materials were distributed to people attending these events. A summary of presentations delivered is given in Table 1.

Table 1. Summary of invasive alien plants outreach presentations delivered by CARP between September 2006 and September 2007.

Date of Presentation	Audience (# People)	Presentation Type
13 September 2006	Annapolis Field Naturalists Society (30)	short talk and plant identification
20 September 2006	Acadia University Estuarine Ecology Course students (15)	short PowerPoint and guided walk
21 September 2006	Annapolis Field Naturalists Society & varied garden club members (12)	guided walk and plant identification
18 October 2006	Wilmot Garden Club (40)	long PowerPoint, plant identification, and discussion
28 October 2006	Mersey Tobeatic Research Institute (MTRI) Woodlot Tour (researchers, woodlot owners, general public) (25)	short talk and plant identification
30 October 2006	Environment Canada Regional Director General (Atlantic) (15)	discussion and guided walk
21 March 2007	Annapolis Valley Regional School Board (Grade 10-12 students) (~100)	booth and discussions of CARP activities (including invasive alien plants)
16 April 2007	Valley Gardeners Garden Club (45)	long PowerPoint, plant identification, and discussion
20 April 2007	Environment Canada Director, Strategic Integration (15)	short PowerPoint and discussion
27 April 2007	MP Gerald Keddy Announcement of IASPP funding at Mersey Tobeatic Research Institute (MTRI) (25)	short PowerPoint (presented by CARP Executive Director)
02 May 2007	Dalhousie University Environmental Science Field Course students (15)	discussion and native plant planting demonstration
10 May 2007	Champlain Garden Club (22)	long PowerPoint, plant identification, and discussion
28 May 2007	Ecological Monitoring and Assessment Nework (EMAN) Monitoring Workshops x 2 (15) & (13)	long PowerPoint, guided walk, and discussion x 2
06 June 2007	Clements Garden Club (20)	long PowerPoint, plant identification, and discussion
07 June 2007	Annapolis West Education Centre Grade 10/11 French Immersion Class (15)	guided walk and discussion (French)
23 July 2007	Garlic Mustard Management Meeting (CARP, AGRG, Acadia, NS Department of Natural Resources, NS Department of Transportation and Public Works, Parks Canada) (9)	PowerPoint and discussion
1-5 August 2007	Nature Canada Annual General Meeting	unmanned static display

		(unknown)	
11 August 2007		Annapolis Royal Flower Show (~40)	static display, plant identification, and discussion
14 August 2007		Grand Pré Community Information Night (20)	PowerPoint and discussion
18 August 2007		Valley Gardeners Flower Show (~40)	static display, plant identification, and discussion
29 August 2007		Dalhousie University Environmental Science Field Course students (20)	discussion and invasive plant inventory trial
04 September 2007		Hampton Community Hall Lunch (Community Group) (~30)	short PowerPoint, plant identification, and discussion
04 September 2007		Bridgetown Garden Club (12)	long PowerPoint, plant identification, and discussion
26 September 2007		Atlantic Environment and Invasive Plants Workshop (70)	short PowerPoint and discussion (presented by CARP Science Coordinator)
TOTALS	25 presentations	~663 people	

A permanent display panel (Figures 2a and 2b) on invasive alien plants was commissioned in May 2007. This panel, along with others related to CARP projects, is part of a static display that is erected in the CARP Environmental Resource Centre. The centre is open weekdays, and regularly receives local, national, and international visitors, particularly in the high tourist season (May to September).

Figure 2a. Permanent display panel as part of a larger information display on invasive alien plants. Photo: Marika Godwin.

Figure 2b. Permanent display panel on invasive alien plants. Photo: Marika Godwin.

It was determined that guided walks and other hands-on exercises are the most effective way to teach plant identification, and to garner interest in this emerging issue. Thus, time of year has emerged as an important component of an outreach education program. Identification of plants after they finished flowering, and after they are no longer green is challenging without a botany background. Engaging people on the subject of plants is easier in the spring and summer months (May to September).

In addition to delivering outreach presentations, a number of other small public education efforts were executed. In October 2006, a letter was sent to the Annapolis District Planning Commission (ADPC) to inform them of the presence of a large population of Japanese knotweed on a property scheduled for re-zoning in the town of Bridgetown. The letter included specific planning recommendations for management of this species (Appendix C). When an advertisement for retirement living at the property in question appeared in the local newspaper in April 2007, a second letter was written to the ADPC Planning Director. Recent correspondence has confirmed that this development is on hold due to financing issues. A copy of the letter expressing CARP's concerns with the removal and disposal of Japanese knotweed from this property was forwarded to the developer, Tarrco Developments.

Valley Waste Resource Management (VWRM) handles all of the waste generated in the Annapolis Valley, with the exception of the Town of Annapolis Royal, which manages its own waste. VWRM distributes a wall calendar to all Valley residents, which includes important collection dates, as well as information on a variety of waste-related issues. After corresponding with VWRM's Policy Manager on the importance of proper disposal of invasive alien plants and invasive alien plant material, CARP made a submission for inclusion in their 2007 calendar. The September 2007 page of the VWRM Waste Management Calendar, including CARP's contribution can be seen in Appendix D.

Recommendations were made by CARP and Gini Proulx to the Nova Scotia Wild Flora Society for the removal of some invasive plants from their website. Each page on their site displays a number of photographs depicting "Nova Scotia wild flora". The site had two invasive alien plants on it; Canada thistle, and wild morning glory or bindweed (*Convolvulus arvensis*), the latter of which also had an incorrect Latin name. In Nova Scotia, field bindweed is listed as a noxious weed, and is legislated by the NS Department of Agriculture's Noxious Weed Act. As a result of these recommendations, the Wild Flora Society has redesigned their website, and removed the non-native species.

In March 2007, CARP was invited to attend an Activities and Ideas Brainstorming Meeting for the development of an Acadian Forest Ecology Unit and Classroom Kit for Grade 11 Biology students in Nova Scotia. This project is part of an ongoing partnership between the Annapolis Valley Regional School Board (AVRSB), Harriet Irving Botanical Gardens (HIBG), and the Department of Biology at Acadia University. Agenda items included the primary learning outcomes to be addressed, potential classroom activities, potential field trip activities, video-conferencing options, and a CD ROM/video component. CARP contributed ideas related to invasive alien plants in the Acadian Forest, and their impacts on ecology and biodiversity. The unit and classroom kit were being developed based on the outcomes of this meeting, and other research. Recent correspondence has revealed that work on this unit has been postponed until the school board's next budget year, due to funding issues. Three Annapolis Valley teachers are currently implementing the partially completed unit in their classrooms, as a trial.

Materials Produced and Distributed

To enhance their outreach education efforts for the *Community Action on Invasive Alien Plants* project, CARP produced a brochure, a poster, species factsheets, a plant list (Appendix A), and several "Have You Seen This Plant?" information

flyers. These items were distributed at outreach presentations, including static displays, and from the CARP office, and HIBG, Acadia University. The species factsheets are included in CARP's better management practices document *Invasive Alien Plants and You*, available at CARP's Environmental Resource Centre. A copy of the brochure, the poster and the information flyers are located in Appendix E.

Media Attention and Invasive Plants Inquiries

Throughout the duration of the project, CARP was successful at garnering media attention in various forms. Radio items, newsprint media, and publications are summarized in Table 2.

Table 2. Summary of media coverage of CARP's *Community Action on Invasive Alien Plants* project received between September 2006 and September 2007.

Date	Media Type	Subject/Title
22 March 2007	*The Digby Courier* — newspaper article, regional	invasive plants — *Search for aliens in your backyard*
05 April 2007	*The Annapolis County Spectator* — newspaper article, regional	common reed — *Listen to the legend of the elephant grass*
10 April 2007	*NovaNewsnow.com* — newspaper article, regional	invasive plants — *Prevent the spread of invasive alien plants, CARP can help homeowners curb the problem*
17 May 2007	*The Annapolis County Spectator* and *NovaNewsnow.com* — newspaper article, regional	invasive plants — *CARP continues Invasive Species research and public education, Spread of invasive plants and animals leads to loss of biodiversity worldwide*
04 July 2007	*Tree Talk* — weekly segment on a daily radio program (*Resources Today* on FM 97.7), regional	garlic mustard — *Alien invaders in the forest*
17 July 2007	*NovaNewsnow.com* — newspaper article, regional	volunteer plant mapping — *Invasive alien plants to be monitored*
19 July 2007	*The Grapevine* — Wolfville community newsletter, local	multiflora rose and volunteer plant mapping — *Let it Grow — wild roses*
03 August 2007	*CBC News* — segment on French CBC daily radio news program, provincial	invasive species in southwest Nova Scotia
14 August 2007	*Information Morning* — segment on CBC radio one daily program, provincial	garlic mustard
30 August 2007	*The Annapolis County Spectator* — newspaper article, regional	garlic mustard — *Valley on watch for pesky weed*
September 2007	Valley Waste Resource Management (VWRM) — 2007 Waste Management Calendar	disposal of invasive alien plants and plant material
September 2007 issue	*Rural Delivery* — magazine article, Atlantic Canada	multiflora rose — *Taking root in Nova Scotia, The Multiflora rose is really an invasive species*
TOTALS	12 reports	3 species

Naturally, media articles spawned inquiries about invasive alien plants. In 2007, CARP received in excess of 20 inquiries through their toll-free phone number, and e-mail. Inquiries included questions about plant identification, Latin names, native plants, and most commonly, control/eradication and disposal. In addition, at least 3 individuals

came to the CARP office with weedy specimens for identification. In most cases, CARP staff members were able to identify specimens using their library resources, but on occasion had to rely on the botanical expertise of others. Additional inquiries about plant identification and control were received at virtually every outreach presentation. These inquiries were not documented, as they were often addressed on site. In instances where plants were not immediately identifiable, they were brought back to the CARP office for proper identification, and follow-up with the individuals who made the inquiries.

Monitoring

The Ecological Monitoring and Assessment Network (EMAN) is a network of federal, provincial, and municipal governments, as well as numerous organizations, industry, environmental organizations, academic institutions, and other groups involved in ecological monitoring. EMAN facilitates monitoring, assessment, and research across the network, and collects and interprets ecological monitoring data. A longtime partner of CARP on various projects, EMAN asked CARP to prepare and deliver two presentations about monitoring invasive alien plants for their Terrestrial Biodiversity Monitoring Workshop, held in May 2007. This involved researching existing monitoring protocols, and preparing a PowerPoint summary of existing protocols, monitoring considerations, and the importance of monitoring invasive plants. A list of online monitoring resources compiled by CARP is given in Appendix F. This was the first time that EMAN has included invasive alien terrestrial plants in their biodiversity monitoring training, and the session was attended by all CARP scientific and technical staff. It was very well received by EMAN staff and workshop participants, and has led to interest in further collaboration between CARP and EMAN for invasive plant research.

A lack of spatial data on the occurrence of invasive alien plants in the Annapolis Valley motivated CARP to consider using citizen scientist volunteers to map plant populations. The ongoing success of CARP's Annapolis River Guardians water quality monitoring program has demonstrated that volunteers can collect valid scientific data. If successful, volunteer monitoring could be a means of evaluating new species introductions, and tracking the spread of existing populations.

When an environmental science class from Dalhousie University approached CARP about participating in a project for a half day on 29 August 2007, it presented an opportunity to trial a roadside survey for invasive plants using volunteers. Rough survey methods were designed, and the students were given brief training in the use of hand held GPS units, survey techniques, and plant identification. To simplify the trial, volunteers were required to survey for only one plant species, purple loosestrife. As the class was comprised of 3rd and 4th year university science students, all had previous experience using GPS technology.

In a total of 4 hours, CARP provided training to 20 people who tallied thousands of purple loosestrife plants along approximately 3km of trails in the Belleisle Marsh, Belleisle, NS (Figure 3). Feedback from trial participants was recorded for future consideration. Based on this trial data collection exercise, CARP will develop volunteer survey methods, and pilot them in the fall of 2007.

Figure 3. Dalhousie University Environmental Science students conducting a roadside survey for purple loosestrife (*Lythrum salicaria*) in the Belleisle Marsh, Bellisle, NS, 29 August 2007. Photo: Marika Godwin.

CARP also monitored the outcomes of 3 local control trials, implemented in partnership with various individuals and agencies. Further details on these trials are located in Appendix G.

Management

Riparian Habitat Restoration Using Native Trees and Shrubs

CARP saw a good opportunity to further raise awareness about invasive species by bridging its invasive alien plant work with its ongoing riparian habitat restoration work. The riparian work includes fencing to exclude livestock from waterways, bank stabilization for erosion control, and is subject to signed stewardship agreements between CARP and the landowners. In the past, riparian area planting has been completed using donated trees and shrubs. Unfortunately, this has often resulted in planting species in sites to which they are not well suited. As such, survival of planted seedlings has been less than 50% on some sites. It seems logical that if trees and shrubs are planted in areas in which they are likely to establish and succeed, CARP will see higher survival rates of planted species, and as a result, more success in riparian habitat restoration work.

As a trial, CARP purchased 57 native trees and shrubs from the Sweetwater Native Plant Nursery at Windhorse Farm, New Germany, NS. 22 bareroot tree seedlings, and 35 potted shrubs were planted on selected sites on 3 private farm properties. Species were distributed and planted as documented in Table 3.

Table 3. Summary of native trees and shrubs planted on 3 private farm properties in the Annapolis Valley in May and June 2007.

Property Name and Location	Tree and Shrub Species Planted	Survival Notes
Beviss – Bridgetown, NS 275m^2 planted	balsam fir (*Abies balsamea*) - 8 red spruce (*Picea rubra*) - 8 white birch (*Betula papyrifera*) - 6 red maple (*Acer rubrum*) - 1 common elder (*Sambucus canadensis*) - 2 red osier dogwood (*Cornus stolonifera*) - 1 hobblebush (*Viburnum alnifolium*) - 1 high bush cranberry (*Viburnum trilobum*) - 2	• 93.3% survival • 1 tree, and 1 shrub lost (unknown cause). • Very good growth exhibited on surviving trees and shrubs.
Roosje – Clarence, NS 720m^2 planted	red maple (*Acer rubrum*) - 1 common elder (*Sambucus canadensis*) - 3 red osier dogwood (*Cornus stolonifera*) - 1 high bush cranberry (*Vibrnum trilobum*) – 6 arrowwood (*Viburnum dentatum*) – 1 beaked hazel (*Corylus cornuta*) - 2	• 92.9% survival • 1 shrub lost (insect foraging). • Difficulty with foliage-eating insects in mid-summer, but plants recovered well.
Longley – Carleton Corner, NS 470m^2 planted	red maple (*Acer rubrum*) - 4 red osier dogwood (*Cornus stolonifera*) – 1 hobblebush (*Viburnum alnifolium*) - 1 high bush cranberry (*Vibrnum trilobum*) – 3 beaked hazel (*Corylus cornuta*) - 5	• 85.7% survival • 2 shrubs lost (deer browse and/or insect foraging). • Good growth exhibited on surviving shrubs.
TOTALS 1465m^2 planted	22 bareroot trees + 35 potted shrubs = **57 native plants**	Average survival = **90.6%**

As expected, preliminary surveys indicate that survival of native trees and shrubs that are planted in carefully chosen riparian sites have higher survival rates than trees and shrubs planted solely on the basis of species availability, that may or may not have been planted in appropriate sites. Figure 4a depicts new growth on a balsam fir tree, and Figure 4b is a native hobblebush, both planted as part of this project.

Figures 4a and 4b. Native tree and shrub species planted as part of CARP's riparian habitat restoration work. 4a is a balsoam fir (*Abies balsamea*) with new growth, and 4b is a hobblebush (*Viburnum alnifolium*). Photos: Jenna Gaul.

Case Study – Grand Pré, NS

Garlic mustard is an invasive alien herb, known to succeed in woodland sites at the expense of native flora, including woody species. It's invasive potential is high (CCFM 2006), and it may pose a threat to the integrity of Acadian Forest ecosystems. Its potential impacts on forest productivity are unknown (Blossey et al. 2002).

A 2km linear (approximate size) population of garlic mustard was discovered in Grand Pré, NS in 2002. Plants occur on federal, provincial, and private property. Botanists have been recording the spread of this population since it's establishment (unknown source), as depicted in Figure 5. Despite the potential threat posed to Acadian Forests, no management action has been taken to prevent further spread.

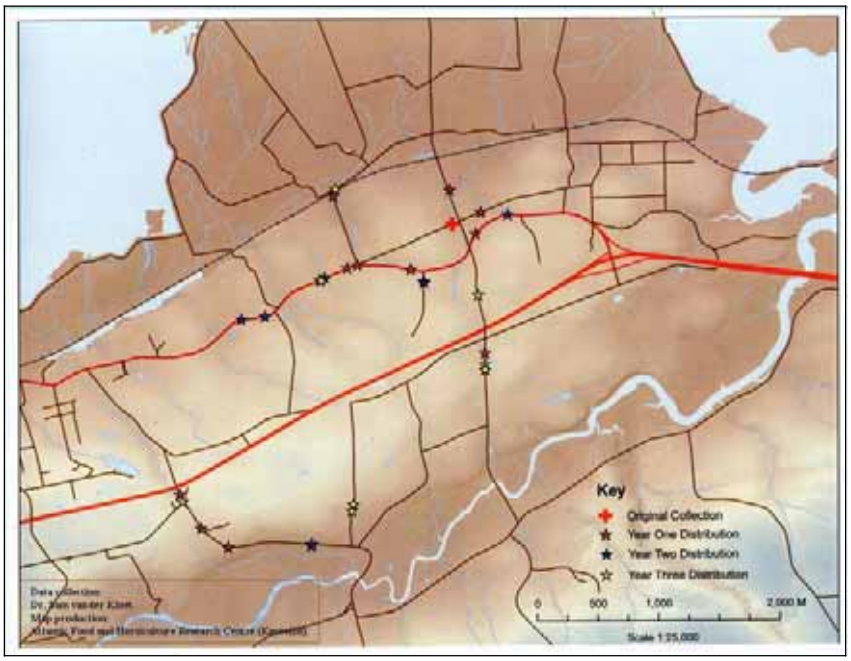

Figure 5. Spread of garlic mustard (*Alliaria petiolata*) from the point of original collection in Grand Pré, NS. Year one was 2005, year two was 2006, and year three was 2007. Data collected by Sam Vander Kloet, and map produced by the Atlantic Food and Horticulture Research Centre.

In an effort to initiate some discussion about the management of this isolated population of garlic mustard, CARP organized a meeting of managers from key government agencies. The meeting was held in the multi-purpose room at the Grand Pré National Historic Site, Grand Pré, NS. Attendees at the 23 July 2007 meeting included representatives from Parks Canada, the NS Department of Transportation and Public Works (DTPW), the NS Department of Natural Resources, Wildlife and Forestry Divisions (DNR), the Acadia University E.C. Smith Herbarium, and a volunteer with the Nova Scotia Nature Trust. The NS provincial Weed Inspector (Department of Agriculture) was also invited, but was unable to attend. The objectives of this meeting were identified as follows:

- Raise awareness about garlic mustard;
- Identify partners who will collaborate to create and implement a management plan for garlic mustard;

- Develop components of a management strategy to deal with current outbreak of garlic mustard at Grand Pré, NS, and beyond;
- Establish a timeline for management;
- Identify management milestones (within accepted timeline).

Unfortunately, no agency was able to take leadership on this initiative. It was decided that further public outreach and spatial data collection should be the next steps taken towards management of the garlic mustard population. DTPW requested that some better management practices (BMP) for working in garlic mustard infested ditches be developed for operational consideration.

CARP organized and led a community information session for the residents of Grand Pré and surrounding area, held on 14 August 2007. The goals were to increase public awareness about garlic mustard, and engage community members to take action. A good turnout of 20 local people and ensuing lively discussion were encouraging. CARP hopes to follow-up on this initiative by conducting further public outreach in the fall of 2007 and winter of 2008.

BMP for working in ditches containing garlic mustard were researched, written and forwarded to the DTPW for their consideration. After circulating the BMP document to their Operations staff, the Environmental Services Section of DTPW has committed to implementing the recommendations in the spring of 2008. Clarification on some items, including disposal of plant material, is required before management actions are implemented. CARP will be working with DTPW, the community of Grand Pré, and other agencies through the fall of 2007 and winter of 2008 to develop an action plan.

As demonstrated by the Grand Pré case study, timely management action is not feasible without a provincial framework in place. Time spent making efforts to coordinate a response to a biological outbreak and potential invasion has resulted in another year of seed production. A changing climate, increasing forest fragmentation, and increasing global trade and travel will all contribute to increased potential for establishment of invasive alien plants in the Acadian Forest. Without a mechanism in place for early detection and rapid response, forest managers in the Acadian Forest are not equipped to respond to an invasion by garlic mustard in a timely and cost-effective manner. The need for management leadership, and the requirement to strengthen the science around invasive alien plants in Atlantic Canada has never been more evident.

Local Control Trials

In an effort to obtain locally applicable management information, CARP conducted 2 experiments relating to glossy buckthorn. The first assessed the effect of salt-water inundation on seed germination, and the second assessed the effectiveness of 3 different control treatments. The complete experiment write-ups are in Appendix G.

In addition, CARP worked with a private landowner who conducted a control trial on Japanese knotweed on his own property. The experiment assessed the effectiveness of stem applications of 4 different chemicals for as control treatments. The results of this trial are also included in Appendix G.

The results of these local experiments are included with other management information in CARP's BMP document *Invasive Alien Plants and You*, available at CARP's Environmental Resource Centre.

Disposal of Invasive Alien Plants and Invasive Alien Plant Parts

A common question posed by concerned citizens is "How do I dispose of my invasive alien plant material once I have removed it from my property?" Ideally, all plant material could be composted. Composting recycles nutrients, and reduces waste in landfills. However, in the case of invasive plants, the answer is not that simple. Most backyard composters do not reach high enough temperatures to completely decompose all plant material. As such, persistent seeds, pieces of roots, and other plant parts may remain viable throughout the composting process. Because complete decomposition does not occur, using this compost may then actually contribute to the spread of alien invaders.

Results from a British study (Ward 2003) suggest that in order to prevent regeneration of Japanese knotweed, plant material must be composted at a temperature greater than 55ºC for a minimum of 1 week. Even after high-temperature commercial composting, Ward (2003) suggests that there would be a small risk of spread.

Northridge Farms in Aylesford, NS, who are contracted to compost all green-cart material for Valley Waste Resource Management (VWRM), in the Annapolis Valley, have a 3-fold composting process (Dwight Horsnell, personal communication 2006). The first cycle involves heating the compost to 140ºF (just over 60ºC) for 1 day, during which the compost is also exposed to air. The second cycle includes 7 days at a temperature of 130ºF (approximately 55ºC). The final cycle is a lengthy process during which the organic material is left outdoors and turned regularly. The complete composting process takes 3 months, from start to finish.

Although it is likely that the Northridge Farms composting process is hot enough and lengthy enough to kill plant material, there can be no guarantee. Japanese knotweed, purple loosestrife, glossy and common buckthorn, and garlic mustard can be especially persistent. Therefore, it is recommended that highly invasive plants and highly invasive plant material not be composted.

There is also always a risk of spread associated with transporting invasive plant material. By disposing of plant material on the property from which it was removed, risk of spread is minimized. In cases where this is not possible (eg. too much plant material, fire ban, etc), green invasive material should be double-bagged in a regular garbage bag for transportation to an alternate disposal site.

The first step to responsible disposal of invasive plants is drying them out. Some plants, such as knotweed, can take root from any part of the plant stem or root coming in contact with bare mineral soil. Drying should be done on a tarp, or other inorganic material (eg. concrete, wood, etc) to prevent rooting or sprouting from seed. Removing plants before they produce seed is a good way to minimize the risk of spread. Once the plant material is completely dry, it can then be burned (ideally), or put in a garbage bag for disposal in a landfill.

The province of Nova Scotia has a ban on burning organic material. Though the objective of the ban, implemented in 1998, was likely to increase composting, it poses a problem for the disposal of large quantities of invasive plant material. CARP will be working with the province and the waste management authority (VWRM) to come up with a disposal solution for the garlic mustard that will be removed from Grand Pré in the spring of 2008. On private property, the next best solution is to dry and bag invasive plant material for disposal in a landfill.

It is possible to try composting after the invasive plant material has been dried, but it is imperative that there are no living parts. Even then, it is recommended that use of the compost be tracked to see if any invasive alien plants spring up where it has been spread. Never move the compost off the property from which it originated.

The Future of Invasive Plants in Nova Scotia

CARP was invited to participate in an Atlantic Canada workshop on 26 and 27 September 2007, held in Truro, NS. Titled *Atlantic Environment and Invasive Plants — Who, What, When, Where, Why, and Weeds: Looking into collaborative possibilities for managing invasive plants*, the workshop aimed to discuss the current situation and explore possibilities for moving forward collaboratively on the issue of invasive plants.

One of four groups (one from each Atlantic province) asked to deliver a presentation, CARP described the work they conducted in the Annapolis Valley for this IASPP project. In addition, presenters were encouraged to identify challenges they had encountered with invasive plant management in Atlantic Canada. CARP identified a number of needs for Nova Scotia, as follows:

- Provincial-level leadership;
- Collaboration among provincial departments (DNR, DTPW, Department of Environment and Labour (DOEL), & agencies dealing with aquatic plant species);
- Detailed management framework for rapid response for all IAS;
- IAS council whose partners include federal agencies, provincial agencies, ENGOs, first nations, and others;
- Improved communication and information sharing between groups working with different IAS.

The outcome of this workshop was that each province formed a working group whose primary goal is to move the invasive plants agenda forward in their province. Each working group will nominate 2 or 3 people to sit on a regional (Atlantic) council within the first few months of formation. Each working group will also organize a workshop to determine invasive species priorities for their province within 12 months. The regional council, comprised of representatives from each Atlantic province, will organize a second regional workshop within 12 months.

CARP volunteered to be a member of the provincial working group for Nova Scotia, and will participate in a meeting in late October 2007 to determine goals, objectives, and responsibilities. Having secured additional IASPP funding, CARP will also continue its invasive alien plant work in the Annapolis Valley, with a focus on plant mapping, and database creation.

Conclusions

Overall, the *Community Action on Invasive Alien Plants* project outcomes met the project objectives. In the case of outreach education, CARP exceed the project objective by 36%. Evidently, there was a significant amount of local interest in the project. In an effort to reach as large an audience as possible, CARP made an effort to deliver a presentation to every group that requested one. The plot-based monitoring objectives were deferred to due staffing issues at a partner agency. Despite this minor setback, CARP was able to use the funds allocated to monitoring towards several other valuable outcomes, including a trial volunteer monitoring exercise. In response to continued demand for

invasive species information, CARP had scheduled presentations into the end of November 2007, a testament to the importance and continuing validity of this work.

Some important project successes included the following:

- Raised awareness about IAS in the Annapolis Valley;
- Strengthened existing community connections, and created new ones;
- Conducted site visits with landowners and communities;
- Garnered local and regional media attention for IAS;
- Strengthened existing partnerships, and created new ones;
- Initiated spatial data collection;
- Collected local management information;
- Posted information for public access on the CARP website;
- Procured funds for continued invasive plant work;
- Garnered commitment to management action on garlic mustard at Grand Pré, NS.

There were 2 elements of this project that were underestimated by CARP at the outset. The first is that, in general, knowledge about invasive species, and especially plants, within general and targeted audiences was much less than expected. This coincides with what CARP discovered to be a lack of readily available local relevant information on invasive species. The second is that the issues of control/eradication and disposal are of the greatest interest to most audiences. Everyone is looking for a quick solution to their own problem plant.

Some project challenges included the following:

- Administrative delays, resulting in lack of funding for approximately half of the total project duration;
- Difficulty engaging non-target audiences in plants;
- The feeling that there is a lot of work left to do on the subject of invasive species. Since the project terminated on 30 September 2007, CARP has received 5 requests for presentations on the subject of invasive alien plants.

It was discovered that botanical expertise is essential in working with plants. People frequently require help in identifying their weedy species. To meet the federal objective of early detection, taxonomic expertise is necessary for identification of invasive alien plants. In the 13-month course of this project there were several new occurrences reported that required species verification. Fortunately for CARP, a strong network of amateur and professional botanists is present in and around the Annapolis Valley. Botanists Heather Stewart (AGRG), Ruth Newell (E.C. Smith Herbarium, Acadia University), and Gini Proulx contributed significantly to the success of this project.

In wrapping up this project, it became evident that work on invasive alien plants in the Annapolis Valley has only just begun. Having a person in place at a local level enables communities to deal with local problems, and as such CARP feels that having a "warm body" on the ground is important. CARP is planning to move forward on the momentum generated by this project by continuing to work locally, and by contributing to the planned provincial and regional invasive species networks. What is ultimately required is a long-term commitment by the province of Nova Scotia to take action to reduce the impacts of invasive alien species on the human and natural environments of the province.

Tracking and control of invasive plants in natural areas has the potential to constitute a lifetime of work. It is important to keep in perspective that invasive species is a broad topic, with many research and action opportunities. Plants are only one component of the global problem.

Recommended Resources

The following are a sample of websites and written material for further information on the subject of invasive alien plants.

Websites

Atlantic Canadian Organic Regional Network (ACORN)
www.acornorganic.org

Canadian Food Inspection Agency (CFIA)
www.inspection.gc.ca/english/plaveg/invenv/invenve.shtml
*Links to many other Canadian sites and programs

Canadian Invasive Species Councils
www.invasiveplants.ab.ca
www.invasiveplantcouncilbc.ca

Canadian Museum of Nature, Native Plant Crossroads
www.nature.ca/plnt
*Links to many other Canadian sites and programs

Center for Invasive Plant Management
www.weedcenter.org

Dave's Garden
davesgarden.com

Environment Canada, Canadian Biodiversity Information Network (CBIN)
www.cbin.ec.gc.ca/issues/ias.cfm?lang=e

Invasive and Exotic Species, Invasive.org
www.invasive.org

Ontario Federation of Anglers and Hunters (OFAH), Invading Species
www.invadingspecies.com

The Nature Conservancy (TNC), the Global Invasive Species Initiative
www.tncweeds.ucdavis.edu

United States Department of Agriculture, Natural Resources Conservation Service
www.plants.usda.gov

Wild Species, General Status of Species in Canada
www.wildspecies.ca

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Appendix A – List of terrestrial invasive alien plants for the Annapolis Valley, NS, including problematic garden plants (with references).

(N) = native plant

High Priority

1 – glossy & common buckthorn (*Rhamnus frangula* & *Rhamnus cathartica*)
2 – Japanese knotweed (*Polygonum cuspidatum*)
3 – purple loosestrife (*Lythrum salicaria*)
4 – common reed (*Phragmites australis*)
* NOTE: There is also a native Common Reed, and they are difficult to distinguish
5 – garlic mustard (*Alliaria petiolata*)
6 – Scotch broom (*Cytisus scoparius*)
7 – multiflora rose (*Rosa multiflora*)
8 – Canada thistle (*Cirsium arvense*)
9 – Oriental/Asiatic bittersweet (*Celastrus orbiculatus*) *NEW ADDITION*

Other Known Invasives

10 – Manitoba Maple (*Acer negundo*)
11 – Norway Maple (*Acer platanoides*)
12 – goutweed (*Aegopodium podagraria*)
13 – flowering-rush (*Butomus umbellatus*)
14 – cuckoo flower (*Cardamine pratensis*)
15 – spotted knapweed (*Centaurea maculosa*)
16 – celandine (*Chelidonium majus*)
17 – leafy spurge (*Euphorbia esula*)
18 – dame's-rocket (*Hesperis matronalis*)
19 – St.John's-wort (*Hypericum perforatum*)
20 – tatarian honeysuckle (*Lonicera tatarica*)
* NOTE: All of the exotic shrub honeysuckles (*Lonicera sp.*) should be considered potentially invasive
21 – moneywort (*Lysimachia nummularia*)
22 – sweet clover (*Melilotus sp.*)
23 – wild marjoram (*Origanum vulgare*)
24 – Scots/Scotch pine (*Pinus sylvestris*)
25 – white poplar (*Populus alba*)
26 – black locust (*Robinia pseudo-acacia*)
27 – coltsfoot (*Tussilago farfara*)
28 – valerian (*Valeriana officinalis*)

Plants to Keep an Eye on

29 – (N) common (annual) ragweed (*Ambrosia artemisiifolia*)
30 – lesser burdock (*Arcticum minus*)
31 – hairy crabgrass (*Digitaria sanguinalis*)
32 – false baby's breath/bedstraw/cleavers (*Galium mollugo*)
33 – ornamental jewelweed/Himalayan balsam (*Impatiens glandulifera*)
34 – common nipplewort (*Lapsana communis*)
35 – wild parsnip (*Pastinaca sativa*)

Problems in the Garden

A — Already Listed

goutweed (*Aegopodium podagraria*)
spotted knapweed (*Centaurea maculosa*)
crabgrass (*Digitaria sanguinalis*)
moneywort/creeping Jennie (*Lysimachia nummularia*)
purple loosestrife (*Lythrum salicaria*)
wild parsnip (*Pastinaca sativa*)
common reed/giant reed (*Phragmites australis*)
Japanese knotweed (*Polygonum cuspidatum*)

B — Other

yarrow (*Achillea millefolium*)
lady bells/ladybells (*Adenophora confusa*)
creeping bellflower/rapion bellflower/rover bellflower (*Campanula Rapunculoides*)
field bindweed (*Convolvulus arvensis*)
couch grass (*Elymus repens*)
(N) field horsetail/western horsetail/scouring rush (*Equisetum arvense*)
cypress spurge (*Euphorbia cyparissias*)
creeping Charlie/ground ivy (*Glechoma hederacea*)
Scotch thistle (*Onopordum acanthium*)
Japanese lantern (*Physalis franchetii*)
(N) choke cherry (*Prunus virginiana*)
sheep sorrel/field sorrel/red sorrel/dock (*Rumex acetosella*)
dandelion (*Taraxicum officinale*)
red clover (*Trifolium pratense*)
comfrey (*Symphytum officinale*)
(N) stinging nettle (*Urtica diocia*)

References for CARP List of Invasive Alien Plants (Terrestrial)

Survey Respondents

Gini Proulx — Amateur Botanist, Naturalist
Heather Stewart — Botanist, Applied Geomatics Research Group (AGRG)
Jon Percy — President (past), Annapolis Field Naturalists Society
Marian Munro — Botanist, Curator (botany), NS Museum of Natural History
Rob Cameron — Ecologist, Protected Areas Branch, NS Department of Environment and Labour
Ruth Newell — Botanist, Curator, E.C. Smith Herbarium, K.C. Irving Environmental Science Centre & Harriet Irving Botanical Gardens
Sean Blaney — Botanist, Assistant Director, Atlantic Canada Conservation Data Centre

Other Contributors

Diane LaRue — Vegetation Consultant, Environmental Services Group, NS Department of Transportation and Public Works
Suman Gupta — MSc Candidate, Biology Department, Acadia University

Participating Garden Clubs

Wilmot Garden Club, October 2006
Valley Gardeners, April 2007
Champlain Garden Club, May 2007
Clements Garden Club, June 2007
Bridgetown Garden Club, September 2007

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Appendix B – List of terrestrial invasive alien plants affecting Canadian forests, including the Acadian Forest.

This species list was adapted from Table 1.2e (p.46) of the publication *Criteria and Indicators of Sustainable Forest Management in Canada, National Status 2005*, Canadian Council of Forest Ministers, 2006, Canadian Forest Service, Natural Resources Canada, Ottawa, ON, 154p.

May Impact Forest Ecosystem Integrity

Norway maple (*Acer negundo*) — NS
garlic mustard (*Alliaria petiolata*) — NS
Scotch broom (*Cytisus scoparius*) — NS
tartarian honeysuckle (*Lonicera tatarica*) — NS
white mulberry (*Morus alba*)
Norway spruce (*Picea abies*) — NS
Scots/Scotch pine (*Pinus sylvestris*) — NS
glossy buckthorn (*Rhamnus frangula*) — NS
English ivy (*Hedera helix*)
common gorse (*Ulex europaeus*)

May Impact Natural Regeneration or Plantations

silver birch/European white birch (*Betula pendula*) — NS
diffuse knapweed (*Centaurea diffusa*)
spotted knapweed (*Centaurea maculosa* or *C. biebersteinii*)
bull thistle (*Cirsium vulgare*)

May Impact Urban Forests or Open Areas

wild chervil (*Anthriscus sylvestris*) — NS
ground ivy (*Glechoma hederacea*) — NS
English holly (*Ilex aquifolium*)
privet (*Ligustrum* sp.) — NS
white poplar (*Populus alba*) — NS
European/common buckthorn (*Rhamnus cathartica*) — NS
black locust/false acacia (*Robinia pseudo-acacia*) — NS
Siberian elm (*Ulmus pumila*)

NS = known to be present in Nova Scotia

Appendix C – Letter written to the Annapolis District Planning Commission (ADPC) regarding planning recommendations for the management of Japanese knotweed on a property in Bridgetown, NS.

Roger Sturtevant
Planning Director
Annapolis District Planning Commission
26 Bay Road
Bridgetown, NS B0S 1C0

10 October 2006

Dear Mr. Sturtevant;

Re: Application to rezone parcel on 30 Water Street.

The rezoning of the 30 Water Street parcel came to our attention in the 21 September 2006 issue of the Annapolis County Spectator, in which the Annapolis District Planning Commission (ADPC) and the Town of Bridgetown posted a notice of public hearing.

The Clean Annapolis River Project (CARP) is currently working on a project to raise awareness about the threats posed by invasive alien plants. One of the priority plants on our list of invaders is Japanese knotweed (*Polygonum cuspidatum*), also known as Japanese or Mexican bamboo. This plant is a very aggressive exotic species that is extremely difficult to control and eradicate. It's rapid growth and thicket-forming tendencies enable it to out-compete native flora. Knotweed poses a significant threat to riparian areas as it can withstand flooding, and quickly colonizes scoured shorelines and islands.

There is a significant population of Japanese knotweed along the Annapolis River shoreline that borders Jubilee Park, adjacent to the 30 Water Street property. The edges of the small creek flowing out to the river between these 2 properties have been invaded. Large clumps of this species are also present along the river edge (North and South sides), East of the Water Street property, on private property. Disturbing the large, spreading roots of this plant will encourage growth, and it won't take much to create a continuous strip of this invader along Bridgetown's shoreline, and beyond.

Attempts to prevent a riverside monoculture of Japanese knotweed should include the following planning considerations:
Preserve native vegetation along shoreline wherever possible;
Prevent spread of existing clumps of Japanese knotweed wherever possible;
Do not disturb the roots of existing clumps, as this may encourage growth;
If removing knotweed is required, dispose of all plant waste on site by drying and burning, or by burying green plant material to a depth of at least 10 feet – do not compost.

There are a number of methods used to control knotweed populations, though all are laborious and time consuming. By preventing the spread of invasive alien species we are contributing to the conservation of our native biodiversity. If you have any questions about Japanese knotweed, or any other invasive alien plants in the Annapolis Valley, please contact me.

Sincerely,

Marika Godwin

Appendix D – The September 2007 page of the Valley Waste Resource Management (VWRM) Waste Management Calendar, including CARP's contribution on the disposal of invasive alien plants.

Appendix E – Outreach education materials distributed by CARP throughout the *Community Action on Invasive Alien Plants* project.

Brochure outside:

Invaders in the Annapolis Valley

While Purple Loosestrife is the virtual "poster-child" for invasive alien plants, there are a number of less well known exotic beauties that are equally, if not more, detrimental. It is important to remember that this list is not concrete. New introductions are occurring, and we should always remain on the lookout for new occurrences of invasive plants, and for invasive qualities exhibited by the species in our own back yards. These 8 species are ones that may pose a risk to our native ecosystems, and they are all present in the Annapolis Valley.

1 – Glossy & Common Buckthorn (*Rhamnus frangula* & *Rhamnus cathartica*)

2 – Japanese Knotweed (*Polygonum Cuspidatum*)

3 – Purple Loosestrife (*Lythrum salicaria*)

4 – Common Reed (*Phragmites australis*)

5 – Garlic Mustard (*Alliaria petiolata*)

6 – Scotch Broom (*Cytisus scoparius*)

7 – Multiflora Rose (*Rosa multiflora*)

8 – Canada Thistle (*Cirsium arvense*)

Cirsium arvense - Chris Evans, University of Georgia, www.forestryimages.org

Winter *Rosa multiflora* - Marika Godwin, CARP

NOTE: Visit our website for more species information: www.annpolisriver.ca

Do Your Part

10 Responsible Practices for All Nova Scotians

1 – Don't buy, plant, grow, or transport known invasives.
2 – If you don't know it, don't grow it.
3 – Use caution when purchasing mail-order plants, and avoid seed mixtures (wildflowers) as they are often not properly labeled.
4 – Consider gardening with native plants.
5 – Properly dispose of invasive plants and garden cuttings to prevent their spread.
6 – Clean off your boots, clothes, pets, and vehicles prior to visiting a new natural area, and when you leave. Remember to stay on the trail!
7 – Use caution when transporting soil, sod, wood or wood products, gravel, and animal feed out of your local area. Never transport organic material across international borders.
8 – Learn to recognize common invaders.
9 – Spread the word about weeds.
10 – If you are suspicious of a plant (or any invader), tell someone – early detection could prevent an invasion!

Clean Annapolis River Project

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Website: www.annapolisriver.ca

Funded by the Invasive Alien Species Partnership Program (IASPP), Government of Canada

Canada

Community Action on Invasive Alien Plants

Winter *Polygonum cuspidatum* - Marika Godwin, CARP

Alliaria petiolata - Chris Evans, University of Georgia, www.forestryimages.org

Cytisus scoparius - Mike Townsend, AGRG

Rhamnus frangula - Heather Stewart, AGRG

Clean Annapolis River Project

Brochure inside:

What Every Nova Scotian Should Know

Invasive Alien Species (IAS)

What - An invasive alien species is an alien species whose introduction and/or spread threatens the environment, the economy, or society (including human health). It may be any species of plant, animal, or microbe introduced by human action (intentionally or accidentally) outside of its natural range.

How - Common vectors for the introduction of alien species include: ballast water from ships, recreational boating, aquarium and pet trades, horticulture, "hitchhikers" on commodities, "stowaways" in transportation, and disease in wildlife.

Spread - High productivity, good dispersal, long growth periods, and lack of natural controls contribute to their success in new environments. Due to increases in global trade, travel, and resource extraction, species introductions are on the rise.

Lyhtrum salicaria - John D. Byrd, Mississippi State University, www.forstryimages.org

IMPORTANT: Remember that not all aliens are invasive. In fact, some species introductions have been very beneficial to the North American economy, including cattle, wheat, honeybees, and many ornamental plants (eg. tulips, chrysanthemums).

The Climate Change Connection

Could Nova Scotia forests one day look like this? A US forest completely covered in Kudzu, a highly invasive vine.

Pueraria montana - John D. Byrd, Mississippi State University, www.forestryimages.org

Canada's frosty climate may work in our favor to prevent the establishment and spread of some of the world's most invasive species. However, as climates change with global warming, Canada may become more susceptible to biological invasion. Warmer temperatures may enable new invasive aliens to thrive here, or may present the perfect conditions for current non-native residents to become invasive. So, in addition to combating climate change by reducing our greenhouse gas emissions, Canadians also need to be vigilant about monitoring the introduction of new species.

IAS MOTTO:
ARRIVE – SURVIVE – THRIVE

Why Does CARP Care? (Why You Should Too)

Environment:

- IAS are the second biggest threat to biodiversity worldwide
- IAS alter habitats and ecosystem functions
- IAS threaten "Species at Risk"
- IAS cross borders

Economy & Society:

- Annual cost of IAS to Canadians = $7.5 billion!
- IAS cause lost income
- IAS (plants) devalue property
- IAS impact social values (e.g. pesticide use)
- IAS impact national and international trade
- Some IAS, such as West Nile Virus, can harm human health
- And many more reasons...

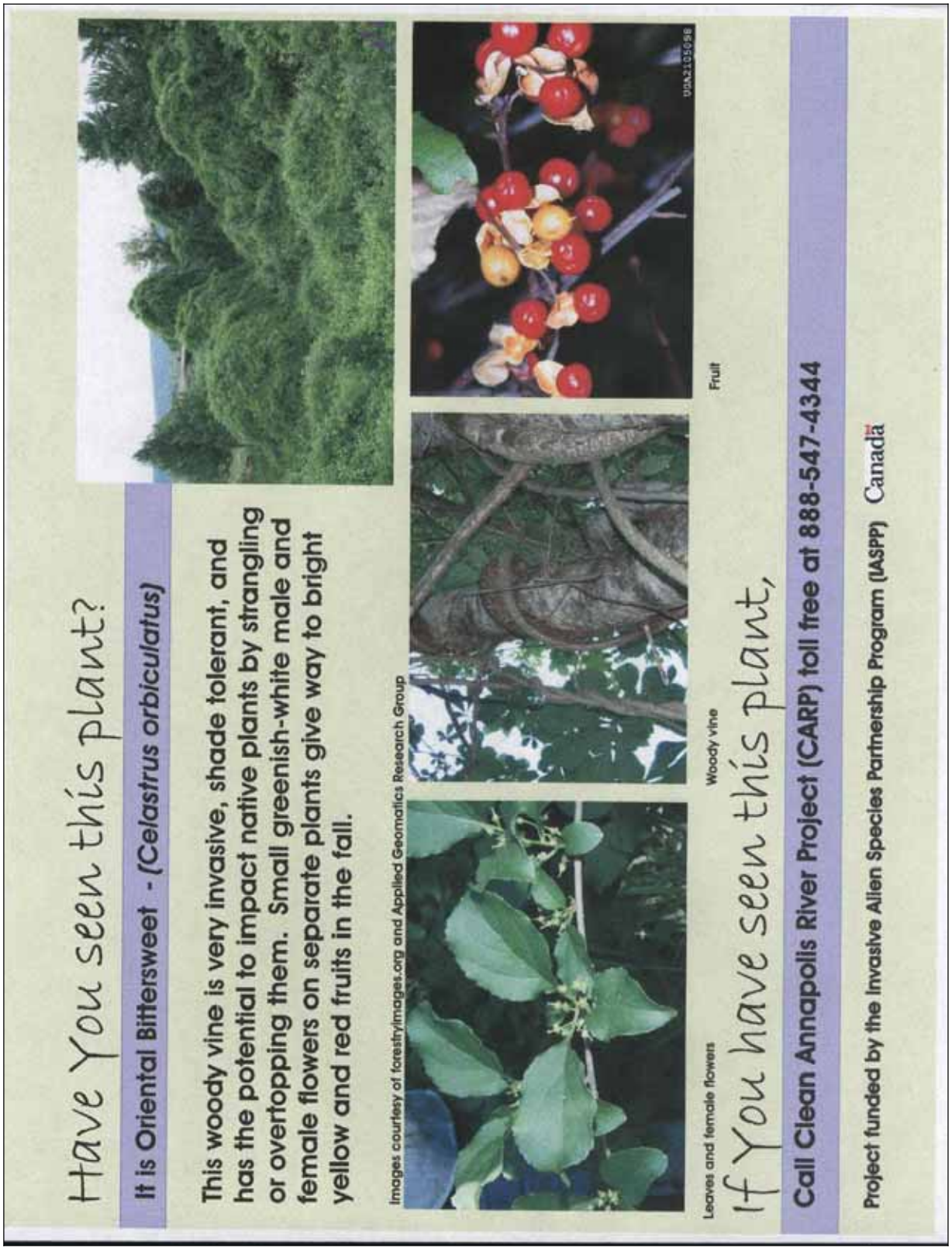
Why Plants?

- In NS, alien plants account for >30% of our vascular plants!
- Effects on native plants include direct impacts, ecosystem alteration, and genetic dilution.
- Little local information on invasive plants.

Aliases:
alien - exotic - foreign - introduced - weed - non-native - non-indigenous

Have you seen this plant? Information flyer for garlic mustard:

Have you seen this plant? Information flyer for Oriental or Asiatic bittersweet:



Poster front:

Community Action on Invasive
ALIEN PLANTS
Clean Annapolis River Project

1. Japanese Knotweed
(*Polygonum cuspidatum*)

PROBLEMS:
This herbaceous perennial is virtually impossible to eradicate.
Dense shade prevents anything from growing up underneath it.
* Major problem in the UK.

2. Glossy & Common Buckthorn
(*Rhamnus frangula & cathartica*)

PROBLEMS:
Very prolific seed has potential for long-range spread by birds, making control difficult.
This shrub has the potential to invade forest understories, and prevent regeneration of

3. Purple Loosestrife
(*Lythrum salicaria*)

PROBLEMS:
This perennial herb outcompetes native plants in numerous wetland habitats.
Prolific seed production creates an enormous seed bank
Eradication of large populations is very difficult.
* Major problem in Ontario wetlands.

4. Common Reed
(*Phragmites australis*)

PROBLEMS:
This perennial grass outcompetes native species in various wetland habitats.
Dense monocultures prevent anything from growing underneath it.
Extensive spreading roots make eradication very difficult.
May be hard to differentiate from the native variety.

Have You Seen These ALIENS on Your Property? Learn to Recognize the Annapolis Valley's PUSHIEST PLANTS

5. Garlic Mustard
(*Alliaria petiolata*)

PROBLEMS:
This biennial herb has the potential to invade forest undertsories.
Studies indicate that this plant may actually produce chemicals that suppress the growth of other plants.
* Major problem in Ontario.

6. Scotch Broom
(*Cytisus scoparius*)

PROBLEMS:
This shrub has the potential to invade open forest understories, and prevent regeneration of native plants.
* Major problem in BC.

7. Multiflora Rose
(*Rosa multiflora*)

PROBLEMS:
This shrub's very prolific seed has potential for long-range spread by birds.
Difficult to eradicate thickets because it's hard to handle.

8. Canada Thistle
(*Cirsium arvense*)

PROBLEMS:
This herbaceous perennial outcompetes native plants in open areas.
Large populations are difficult to eradicate.

FOR MORE INFORMATION:
Clean Annapolis River Project (CARP) - 151 Victoria Street, PO Box 395, Annapolis Royal, NS B0S 1A0
Toll Free: 888 547 4344 Phone: 902 532 7533 Website: www.annapolisriver.ca

Photos: 1. Jil M. Swearingen, USDI National Park Service, www.forestryimages.org 2. Heather Stewart, Applied Geomatics Research Group (AGRG) 3. John D. Byrd, Mississippi State University, www.forestryimages.org 4. & 7. Marika Godwin, Clean Annapolis River Project (CARP) 5. & 8. Chris Evans, University of Georgia, www.forestryimages.org 6. Mike Townsend, AGRG

Poster back:

Identifying the Annapolis Valley's WORST WEEDS

Clean Annapolis River Project

Japanese Knotweed (*Polygonum cuspidatum*)

PHYSICAL DESCRIPTION:

Form – upright, usually in clumps (shrublike)
Height – may be taller than 3m
Leaves – large, simple, alternate, smooth, oval with pointed tip
Flowers – in linear clusters, greenish-white colour, very small
Fruit – small, winged, containing tiny, triangular seeds
Blooms in - August and September
Other Features – very extensive, creeping roots; large, hollow stems with pronounced nodes resemble bamboo

Likely to be lurking: riparian areas, ditches, yards

Glossy & Common Buckthorn (*Rhamnus frangula & cathartica*)

PHYSICAL DESCRIPTION:

Form – shrub or small tree
Height – up to 7m
Leaves – simple, alternate, oval, smooth (Glossy) or finely toothed (Common)
Flowers – in clusters, greenish-yellow colour, small regular flowers, 5 petals (Glossy) or 4 petals (Common)
Fruit – berries, red turning to black when ripe, each with 3-4 seeds
Blooms in – spring through fall
Other Features – Common Buckthorn may have small spines at twig tips; keeps foliage, flowers, and berries longer than most native shrubs (long growing season)

Likely to be lurking: open woods, wetlands, gardens and yards

Purple Loosestrife (*Lythrum salicaria*)

PHYSICAL DESCRIPTION:

Form – upright, stout, branched stem
Height – 0.5m to 1.5m
Leaves – simple, opposite, or in whorls of 3, smooth, no stalks, downy
Flowers – in spikes, magenta colour, small regular flowers, 5-7 petals
Fruit – small capsule (6mm long) containing many dark seeds
Blooms in – July through September (and later)
Other Features – stem feels square, whole plant usually covered in downy hairs, may have many stems (up to 50) on one plant

Likely to be lurking: wetlands, ditches, gardens

Common Reed (*Phragmites australis*)

PHYSICAL DESCRIPTION:

Form – very tall, usually in dense, single species stands
Height – can exceed 5m!
Leaves – simple, long, narrow, smooth, wide (up to 4cm)
Flowers – in plume like spikes (up to 30cm long), purple colour (changing to grey in late summer), individual flowers have long silky hairs
Fruit – flower heads look fluffy as seeds within mature
Blooms in – late July and August
Other Features – extensive, creeping roots
NOTE: There is also a native Common Reed, and they may be difficult to distinguish

Likely to be lurking: wetland fringes, including salt marshes

Garlic Mustard (*Alliaria petiolata*)

PHYSICAL DESCRIPTION:

Form – first year plant is a rosette, second year plant is an erect stem
Height – 0.6m to 1.05m
Leaves – simple, alternate, triangular, serrated (toothed)
NOTE: on the first year rosette, leaves are more kidney shaped, and round-toothed (less serrate) than on the second year plant
Flowers – in clusters, white colour, small regular flowers, 4 petals in cross shape
Fruit – oblong pod (up to 10cm long) containing seeds
Blooms in – spring, plants dead by late June
Other Features – crushed stem and leaves have garlic odour

Likely to be lurking: shady forest understories

Scotch Broom (*Cytisus scoparius*)

PHYSICAL DESCRIPTION:

Form – stiff, bushy, usually in clumps
Height – 2m to 3m
Leaves – small, lower have 3 leaflets, upper may be simple
Flowers – bright yellow colour, regular, pea-like
Fruit – pod (4-5cm long) with long hairs along seam
Blooms in – June and July
Other Features – up to 3500 seeds explode out of each seed pod when ripe, and can survive in the soil for decades!

Likely to be lurking: open woods, gardens, disturbed areas

Multiflora Rosa (*Rosa multiflora*)

PHYSICAL DESCRIPTION:

Form – shrub, forms dense thickets, arching stems
Height – generally forms a 1m to 2m thicket, but can climb trees, attaining great heights
Leaves – compound, alternate, finely toothed, 5-11 leaflets (generally 7 or 9)
Flowers – in clusters, white colour, small regular flowers, 5 petals
Fruit – rose hips, small, red, remaining on plant through winter
Blooms in – June and July
Other Features – can be distinguished from native roses by fringed bracts at base of each leaf stalk, and by arching stems

Likely to be lurking: open woods, gardens, fields, many habitats

Canada Thistle (*Cirsium arvense*)

PHYSICAL DESCRIPTION:

Form – erect, branched stem
Height – 0.3m to 1.5m
Leaves – simple, alternate, lance-shaped, deeply lobed, spiny, may clasp stem
Flowers – generally in clusters, purple or pink colour,
Fruit – small, dry, single-seeded (up to 4cm long), feathery structure attached to seed base
Blooms in – June through October
Other Features – extensive, creeping roots
NOTE: thistles may be difficult to distinguish from one another – if you're not sure, ask for help

Likely to be lurking: meadows, fields, crops, waste areas

Invasive species are a global problem—we are all part of the

Project funded by the Invasive Alien Species Partnership Program (IASPP), Government of Canada

Appendix F – List of existing monitoring protocols applicable to invasive alien plants, compiled by CARP.

Canada

Ecological Monitoring and Assessment Network (EMAN)
Guide to Monitoring Exotic and Invasive Plants
www.eman-rese.ca/eman/ecotools/protocols/terrestrial/exotics

Canadian Food Inspection Agency (CFIA)
*Links to many other Canadian sites and programs
http://www.inspection.gc.ca/english/plaveg/invenv/invenve.shtml

Canadian Museum of Nature
Native Plant Crossroads
*Links to many other Canadian sites and programs
www.nature.ca/plnt

Ontario Federation of Anglers and Hunters (OFAH)
Invading Species — *aquatic invaders*
www.invadingspecies.com

St. Lawrence Centre (Government of Canada)
Introduction of Alien Species
www.qc.ec.gc.ca/csl/pro/pro001_e.html

McGill University
Invasive Tracers — *marine invaders*
http://biology.mcgill.ca/faculty/leung/invasivetracers/

British Columbia Forest Service
Invasive Alien Plant Program
www.for.gov.bc.ca/hfp/invasive

United States Department of Agriculture (USDA)
National Invasive Species Information Centre – Canada
http://www.invasivespeciesinfo.gov/international/canada.shtml

International

National Park Service, US Department of the Interior (NPS)
*Extensive list of links for monitoring invasive plants
http://science.nature.nps.gov/im/monitor/invasives/invasives_Protocols.cfm

The Nature Conservancy (TNC)
The Global Invasive Species Initiative
*Links to "Weed Watchers" volunteer monitoring programs
http://tncweeds.ucdavis.edu/

Australian Government, Department of the Environment and Water Resources
Invasive Species Homepage
http://www.environment.gov.au/biodiversity/invasive/

NatureServe
*Links to other sites and access to data on invasive species (Get Data)
http://www.natureserve.org/consIssues/invasivespecies.jsp

Appendix G – Methods and results for local control trials.

Effect of Salt-Water Inundation on the Germination of Glossy Buckthorn (*Rhamnus frangula*) Seed

Question

What is the potential for using salt-water inundation as a method for inhibiting glossy buckthorn (*Rhamnus frangula*) seed germination?

Purpose

To determine the effect of salt-water on germination of glossy buckthorn seeds.

Methods

More than 300 ripe fruit were hand picked from glossy buckthorn shrubs in the Annapolis Royal Marsh (old salt-water marsh) in November 2006. On 01 December 2006, 162 fruits were hand cleaned, and the seeds were extracted. Average yield was 3 seeds per fruit. A total of 135 fruits underwent 5 treatments, as described in Table 1.

Table 1. Description of salt water seed treatments given to glossy buckthorn fruits. Each fruit represents 2-4 cleaned seeds.

Treatment #	Treatment Description	Number of Fruits
1	no treatment	27 (54-108 seeds)
2	30 minute immersion in salt water	27 (54-108 seeds)
3	2 x 30 minute immersion in salt water at 12 hr intervals	27 (54-108 seeds)
4	4 x30 minute immersion in salt water at 12 hr intervals	27 (54-108 seeds)
5	24 hr immersion in salt water	27 (54-108 seeds)

The 30 minute treatments at 12 hour intervals were designed to approximate a natural tide cycle.

Upon completion of the treatments, the seeds were planted in organic potting soil (with no additions), and left to over-winter uncovered, outdoors. All planting occurred between 01 and 05 December 2006, and all treatments were moved outdoors on 07 December 2006.

Seeds were left outdoors in an attempt to mimic natural conditions. Glossy buckthorn seeds require scarification for germination. With little budget to accord this experiment, it was felt that the cold temperature seed treatment would be achieved by over-wintering outdoors. Daily checks for germination were conducted beginning 30 April 2007.

Methods – Revisions

While checking for any signs of germination, it was noted that many of seeds were resting on top of the soil, uncovered. It is suspected that frost caused the seeds to be moved to the soil surface over the winter. In an effort to salvage the experiment, additional organic potting soil (same used initially) was added, and the seeds were re-buried on 08 May

2007. Daily checks for germination were conducted from that day. Germination period was to be considered complete once there were no new seedlings in a period of 2 weeks, but this never occurred.

Results and Discussion

In conducting daily germination checks, evidence of herbivory was noted. For example, on 29 June 07, one of the Treatment #4 groups had 4 seedlings present, but on 03 July 07, the same group had no seedlings present. Seedlings were noted again, and disappeared again within this group throughout the duration of the experiment. Depressions in the soil were also noted after seedlings disappeared. Chicken wire was secured in place over all of the treatments when they were initially placed outdoors, in an effort to minimize loss of seed to herbivory. The wire was not removed or damaged until the experimented was terminated.

Despite the over-wintering damage, seeds germinated in every treatment group (Table 2). Given that each cleaned fruit rendered 2-4 seeds, the average number of seeds per fruit was 3. Each treatment comprised 27 fruits, or 81 seeds (average). Total number of seedlings germinated in each treatment ranged from 15-29, with an average of 20 seedlings per treatment type. This represents an average germination success of 24.7%, within a range of 18.5%-35.8%.

Table 2. Total number of glossy buckthorn seedlings germinated per treatment.

Treatment #	Number of Seedlings	Date of First Germination
1	16	21 June 2007
2	20	15 June 2007
3	20	19 June 2007
4	15	15 June 2007
5	29	19 June 2007

Conclusion

Salt-water inundation appears to have no negative impact on the germination of glossy buckthorn seeds. Despite frost damage and herbivory, all salt-water treated groups of seed experienced germination success. It may not be possible to use salt-water inundation to prevent germination of glossy buckthorn seed.

CARP is currently conducting a salt marsh restoration feasibility study for a dyked salt marsh in Annapolis Royal, NS. This former salt marsh is now heavily populated by glossy buckthorn shrubs. It was hoped that by removing the dyke, the resulting salt-water inundation would render the seedbank sterile. Results of this experiment indicate that salt-water tidal flooding may not be an effective management strategy for glossy buckthorn shrubs.

Partners

Julianne Butt, Volunteer, Middleton Regional High School

Effectiveness of Cutting, Hand Pulling, and Herbicide Application as Control Treatments for the Invasive Alien Shrub Glossy Buckthorn (*Rhamnus frangula*) in the Woodland Trails at Acadia University, Wolfville, NS

Question

Does glossy buckthorn (*Rhamnus frangula*) respond to control treatments in the Annapolis Valley in the same manner described in literature from other geographic areas?

Purpose

To evaluate the effectiveness of management actions on an understory population of glossy buckthorn in the Acadia University Woodland Trails (Wolfville, NS), and to obtain locally relevant invasive alien plant control information.

Methods

Methods for controlling buckthorn species include mechanical, chemical, and fire-based treatments. Mechanical methods include cutting, hand pulling, and girdling. Chemical methods include foliar herbicide applications (broadcast spraying), and herbicide applications to freshly cut stumps. Other methods include prescribed burning, and flame torch applications to stems less than 4.5cm in diameter. The dense understory cover of glossy buckthorn in the Acadia University Woodland Trails prohibits the use of very labour intensive management strategies. Invasive species management is only one of numerous objectives for the Trail Manager (a seasonal employee), so the most cost effective method is desired. Thus, girdling, and flame torch applications to individual plants are not practical. Additionally, prescribed burning, and foliar herbicide applications are not feasible options. The trails are a public use system within town limits, and include native vegetation that could be impacted by these treatments. The remaining treatments include cutting, hand pulling, and individual plant herbicide application.

CARP established 2 (10m X 10m) plots, each having 4 (5m X 5m) quadrats within it, as per Ecological Monitoring and Assessment Network (EMAN) recommendations (Haber 1997).

Plot #1 – Site Description

Location: Acadia University Woodland Trails, Wolfville, NS
Forest Type: Mature poplar (*Populus tremuloides*) stand
Canopy Closure: Approximately 50% over total plot area
Slope: 10 degrees (North facing)
Overstory Trees: Poplar (*Populus tremuloides*)
Average Height: 15-20m (45-60ft)
Average DBH: 26.9cm
Understory Trees: Sparse red spruce (*Picea rubens*), white birch (*Betula papyrifera*), and glossy buckthorn (*Rhamnus frangula*)
Average Height: 6m (18ft)

Average DBH: 8cm

Shrubs and Ground Cover: Virtual monoculture of glossy buckthorn with occasional native tree seedlings and ground vegetation

Average Height: 0-200cm (0-6ft)

Plot #2 – Site Description

Location: Acadia University Woodland Trails, Wolfville, NS (see attached map)
Forest Type: Mature poplar (*Populus tremuloides*) stand
Canopy Closure: Approximately 25-50% over total plot area
Note: Canopy closure over 2m wide adjacent trail is the same as over plot
Slope: 5 degrees (North facing)
Overstory Trees: Poplar (*Populus tremuloides*)
Average Height: 15-20m (45-60ft)
Average DBH: 22.5cm
Understory Trees: Sparse Red Spruce (*Picea rubens*), Sugar Maple (*Acer saccharum*), and Red Oak (*Quercus rubra*)
Average Height: 8m (24ft)
Average DBH: 6cm
Shrubs and Ground Cover: Virtual monoculture of Glossy Buckthorn with occasional native tree seedlings and ground vegetation
Average Height: 0-200cm (0-6ft)

Plots were laid out using a compass and measuring tape. The SE corner was selected by CARP staff to ensure that all quadrats would fall within the same forest stand, and marked with a wooden stake. Starting from this point, a N bearing was taken, and a 10m distance was measured. The NE corner was then marked with a wooden stake. From this point, a W bearing was taken, and a 10m distance was measured. The NW corner was then marked with a wooden stake. From this point, a S bearing was taken, and a 10m distance was measured. The SW Corner was then marked with a wooden stake. An E bearing was taken, and a 10m distance was measured to ensure than SW and SE corners were 10m apart. Diagonal distances from SE to NW corners and from SW to NE corners were measured to confirm that each was 14.5m long. Equal diagonal distances confirm that a plot is square.

Prior to the application of any treatment, all plots were surveyed for the presence of native woody species $>$10cm tall. All native trees identified were flagged to ensure that they were not cut with the brush saw. After treatments were applied, total number of cut stumps, total number of seedlings, and total number of native species were recorded.

Treatments within the plots were applied as follows:

Quadrat #1 - a control, received no treatment;
Quadrat # 2 - all plants cut at 10cm height with a brush saw;
Quadrat #3 - all plants cut at 10cm height with a brush saw, followed by a stump application of consumer-grade glyphosate (Roundup) painted on stems 4cm in diameter;
Quadrat #4 – all seedlings hand pulled, followed by all remaining plants cut at 10cm height with a brush saw.

Plot #2 was designed to be a replicate of Plot #1. Because of a miscommunication, the area selected for this plot was cut with a brushsaw before the plot was established. As a result, plot design had to modified. No control quadrat (#1) could be set up, and no herbicide treatment (Quadrat #3) was feasible. The resulting plot was 2 quadrats, #2 and #4. Uncut seedlings were hand pulled from Quadrat #4.

Results and Discussion

Initial Buckthorn Seedling Density – 29 August 2006

Due to high density of glossy buckthorn seedlings, counting all seedlings in the (5m X 5m) quadrats was not possible. Instead, 4 (1m X 1m) plots were used to count seedlings. All $1m^2$ plots had the main plot center stake as a corner. Summary of seedling density in Plot 1 is presented in Table 1. Plot 1, Quadrat 3 had 2 overstory glossy buckthorn trees. These were cut, and their stumps were painted with Roundup.

Table 1. Buckthorn seedlings counted in Quadrats 1, 2, 3, and 4, in Plot #1, on 29 August 2006. Includes *Rhamnus frangula* (glossy) and *Rhamnus cathartica* (common) seedlings. Common much less frequent than glossy.

Quadrat Number	Number of Buckthorn Seedlings (>10cm tall)	Seedlings per Hectare
1	27	270,000
2	16	160,000
3	25	250,000
4	32	320,000

Plot 2 was cut with a brushsaw approximately one week before the plots were established. As a result, no pre-treatment seedling counts were possible. Density plots were done in an adjacent uncut area of the same stand type. Due to the quantity of seedlings, 2 (1m X 1m) plots were used to count. Plot corners were chosen randomly, and boundaries were delineated using a compass and measuring tape. Summary of estimated seedling density for Plot 2 is presented in Table 2.

Table 2. Buckthorn seedlings counted in adjacent to Quadrats 1, and 2, in Plot #2. Includes *Rhamnus frangula* (glossy) and *Rhamnus cathartica* (common) seedlings. Common much less frequent than glossy.

Quadrat Number	Number of Buckthorn Seedlings (>10cm tall)	Seedlings per Hectare
1	24	240,000
2	20	200,000
Average	22	220,000

Re-measured Buckthorn Seedling Density – 06 July 2007

Replicating the initial survey, 4 (1m X 1m) plots were used to count seedlings. All $1m^2$ plots had the main plot center stake as a corner. Summary of seedling density in Plot 1 is presented in Table 3. Only Quadrats 1 and 2 contained common buckthorn seedlings, having 3, and 2 seedlings, respectively.

Table 3. Buckthorn seedlings counted in Quadrats 1, 2, 3, and 4, in Plot #1, on 06 July 2007. Includes *Rhamnus frangula* (glossy) and *Rhamnus cathartica* (common) seedlings. Common much less frequent than glossy.

Quadrat Number	Number of Buckthorn Seedlings (>10cm tall)	Seedlings per Hectare
1	40	400,000
2	49	490,000
3	24	240,000
4	13	130,000
Average	31.5	315,000

Using the original survey methods, 2 (1m X 1m) plots were used to count seedling densities. Both $1m^2$ plots had the S center stake as a corner. Summary of seedling density in Plot 2 is presented in Table 4. No common buckthorn seedlings were observed.

Table 4. Buckthorn seedlings counted in Quadrats 1, and 2, in Plot #2, on 06 July 2007. Includes *Rhamnus frangula* (glossy) and *Rhamnus cathartica* (common) seedlings. Common much less frequent than glossy.

Quadrat Number	Number of Buckthorn Seedlings (>10cm tall)	Seedlings per Hectare
1	24	240,000
2	94	940,000
Average	59	590,000

As the initial 2 (1m X 1m) plots were done in an adjacent uncut area of the same stand type for Plot 2, CARP did not compare the re-measurement data for this plot.

In Plot 1, there were significant increases in buckthorn seedling density in Quadrats 1(untreated) and 2 (cut) between 2006 and 2007, as would be expected. Buckthorn shrubs build up an enormous persistent seed bank in the soil. Quadrat 3 (cut with herbicide application) saw virtually no change in the number of buckthorn seedlings from one year to the next. The 2 cut stumps in that quadrat that were painted with Roundup did not re-sprout. Quadrat 4 (hand pulled) saw a 40.6% reduction in the number of buckthorn seedlings from 2006 to 2007.

Initial Presence of Native Tree Species – 29 August 2006

Each quadrat was surveyed for presence of native tree species >10cm tall. Results for Plot 1 are displayed in Table 5. Efforts were made to leave native trees intact while using the brushsaw.

Table 5. Native trees counted in Quadrats 1, 2, 3, and 4, in Plot #1, on 29 August 2006.

Quadrat	Species	Number in Understory	Number in Overstory
1	***Betula papyrifera***	2	
	Populus tremuloides		1
Total		2	1
2	***Betula papyrifera***	12	2
	Populus tremuloides		1
	Acer saccharum	1	

	Ulmus sp.	1	
Total		14	3
3	***Betula papyrifera***	3	
	Populus tremuloides		1
	Acer rubrum	1	
Total		4	1
4	***Betula papyrifera***	10	2
	Populus tremuloides		1
	Picea rubens		1
	Fraxinus sp.	1	
	Ulmus sp.	1	
	Sorbus sp.	1	
Total		13	4

Because Plot 2 was cut with a brushsaw approximately one week before the plots were established, no pre-treatment survey for presence of native tree species >10cm could be conducted. The brushsaw operator cut all vegetation, regardless of species. The quadrats were surveyed, but no native trees were identified.

Re-measured Presence of Native Tree Species – 06 July 2007

Each (1m x 1m) plot was surveyed for presence of native tree species >10cm tall. Results for Plot 1 are displayed in Table 6.

Table 6. Native trees counted in Quadrats 1, 2, 3, and 4, in Plot #1, on 06 July 2007.

Quadrat	Species	Number in Understory	Number in Overstory
1	*Populus tremuloides*	1	1
	Acer rubrum	1	
Total		2	1
2	*Betula papyrifera*		2
	Populus tremuloides	1	1
	Acer rubrum	2	
	Prunus sp.	8	
Total		11	3
3	***Populus tremuloides***	3	1
	Acer rubrum	35	
Total		38	1
4	***Betula papyrifera***		2
	Populus tremuloides	1	1
	Acer rubrum	5	
	Picea rubens		1
	Prunus sp.	2	
Total		8	4

No native species were present in Plot 2.

In Plot 1, there was a significant increase in native tree seedling density in Quadrat 3 (cut with herbicide application). The reason for this observation is unclear, as the number of buckthorn seedlings in this quadrat did not decrease. The

canopy was opened up by cutting 2 overstory glossy buckthorn trees, so perhaps the resulting increased light levels facilitated the germination of the native species. Quadrats 1, 2, and 4 all saw a decrease in native tree seedlings. In Quadrats 1 and 2, these decreases correspond to increases in the number of buckthorn seedlings between 2006 and 2007. Glossy buckthorn seedlings form dense colonies on the forest floor, and often exclude other species (Kaufman and Kaufman 2007). The reason for the decline in native tree seedlings in Quadrat 4 is unknown. Possible explanations include trampling, or the accidental hand pulling of seedlings when buckthorn seedlings were pulled.

Conclusion

As indicated in other literature (eg. IPSAWG 2001), hand pulling of glossy buckthorn seedlings resulted in decreased population densities. Cutting with a brushsaw resulted in increased seedling densities. Cutting of mature female shrubs can be effective in reducing the amount of seed contributed to a seedbank in one season (George Alliston, pers. com. 2007), thereby decreasing seedling density over time. Cut stump applications of consumer-grade Roundup (glyohosate) were 100% effective in preventing re-sprouting of cut trees. All of the results of this experiment were expected, based on literature review.

Partners

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Effectiveness of Four Chemicals as Control Treatments for the Invasive Alien Plant Japanese Knotweed (*Polygonum cuspidatum*) on Private Property in Tupperville, NS

Question

How does Japanese knotweed (*Polygonum cuspidatum*) respond to chemical control treatments in the Annapolis Valley, and are all chemicals created equal for knotweed control?

Purpose

To evaluate the effectiveness of four chemicals as management options for a population of Japanese knotweed on private property in Tupperville, NS, and to obtain locally relevant invasive alien plant control information.

Methods

On 10 September 2007, Clean Annapolis River Project (CARP) established 6 (1m X 1m) plots in a monoculture of Japanese knotweed on private property in Tupperville, NS. Plots were laid out using a rigid $1m^2$ quadrat, immediately adjacent to one another in a line. Plot corners were marked using pin flags. All of the knotweed surrounding the plots was cut using a mowing attachment on a tractor. This was done to increase accessibility to the plots, and as part of the landowner's ongoing efforts to control the spread of the plant. The experimental plots had been cut 3 times in 2006, and were notably shorter than knotweed stems on a neighbouring property, which were not cut in 2006. Repeated cutting of Japanese knotweed throughout a growing season is known to weaken the plant (eg. University of Maine 2001).

Prior to the application of any treatment, stem density was tallied for each plot. The only other species growing at this site was spotted touch-me-not (*Impatiens capensis*), a native annual plant.

Treatments within the plots were applied as follows:

Plot #1 – all stems injected with 5mL undiluted consumer grade herbicide "Roundup" (active ingredient glyohosate);
Plot #2 – all stems injected with 5mL 5% acetic acid (white vinegar);
Plot #3 – all stems cut to 10cm height, and treated with 1tbsp of sodium bicarbonate (table salt), poured directly into cut stem;
Plot #4 – all stems injected with 5mL undiluted consumer grade herbicide "Killex" (active ingredients 2,4-D, Mecoprop-P, and Dicamba);
Plot #5 – a control, received no treatment;
Plot #6 – a control, received no treatment.

Stem injections were carried out by the landowner using a 60cc syringe with an 18 gauge needle on the tip. Stems were injected between the first and second nodes above ground (as per Crockett et al. 2004), and a different needle was used for each chemical.

Results and Discussion

Pre-treatment stem densities averaged 40.2 stems/m^2, or 402,000 stems/ha. Stems smaller than approximately 1.5cm in diameter are too small to treat with both the stem injection method used for chemicals, and the direct pouring method used for sodium bicarbonate. The average number of stems treated per plot was 17.5 stems/m^2, or 43.7% of total stems. Stem density and stems treated are summarized by plot in Table 1.

Table 1. Japanese knotweed stems counted and treated in Plots 1 — 6, on 10 September 2007.

Plot Number	Stem Density ($1m^2$)	Stems per Hectare	Number Stems Treated
1	54	540,000	19 (35.2%)
2	33	330,000	16 (48.5%)
3	29	290,000	16 (55.2%)
4	36	360,000	19 (52.8%)
5	40	400,000	NA
6	49	490,000	NA
Average	40.2	402,000	17.5 (43.7%)

Most herbicides are effective within 24 hours of application. Five categories for measuring treatment effectiveness were determined, as follows:

1 — Number of dead or dying stems, by plot, 24 hours after treatments applied;
2 — Number of dead or dying stems, by plot, 48 hours after treatments applied;
3 — Number of dead or dying stems, by plot, 7 days after treatments applied;
4 — Number of dead or dying stems, by plot, 14 days after treatments applied;
5 — Number of dead or dying stems, by plot, 28 days after treatments applied.

Experimental results, as reported by the landowner, are noted in Table 2. As the experiment was conducted late in the growing season, it is possible that the effects of the sodium bicarbonate treatment (Plot #3) will not be seen until next spring (2008).

Table 2. Number of dead or dying Japanese knotweed stems counted in Plots 1 — 6, for five treatment effectiveness categories, observed between 11 September 2007 and 08 October 2007.

Plot Number	Number Stems Treated	Number of Dead or Dying Stems per Effectiveness Category				
		1	2	3	4	5
1	19	0	0	0	0	0
2	16	0	0	0	0	0
3	16	0	0	0	0	0
4	19	0	0	0	0	0
5	NA	NA	NA	NA	NA	NA
6	NA	NA	NA	NA	NA	NA

Conclusion

Based on these results, "Roundup" (glyphosate), "Killex" (2,4-D, Mecoprop-P, Dicamba), and 5% acetic acid are not effective for controlling Japanese knotweed when applied using a stem injection method. The effectiveness of table salt as a control will be re-examined in the spring of 2008.

There is documented effectiveness of glyphosate-based herbicide being used as a chemical control for Japanese knotweed when applied using stem injection methods (eg. Crockett 2005). It is speculated that either the application methods in this experiment were flawed, or not properly implemented, or the consumer-grade chemical concentrations were not strong enough. Time of year may have also contributed to the results. It is likely that CARP will revise the methods and ask the landowner to replicate this experiment in 2008.

Partners

Private landowner.

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