A management strategy for emerald ash borer in St. Lawrence Islands National Park

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ABSTRACT

This article presents a strategy for managing emerald ash borer (EAB) in the St. Lawrence Islands National Park (SLINP), which is located in the United Counties of Leeds and Grenville in eastern Ontario along 100 km of Lake Ontario shoreline and the St. Lawrence River. Background information about EAB and SLINP is followed by an outline of the possible ecological impacts of an EAB infestation on the Park, predictions of where infestations are more likely to occur and how quickly they could spread, whether there will be interactions between EAB-affected stands and invasive vegetation, and whether visitor safety may be compromised. Recommendations to slow the spread of EAB in the Park, prepare for and attempt to mitigate its impacts, contribute to scientific research to better understand it, and conserve ash genetic material include: 1) implement a ban on outside firewood; 2) develop and implement a seed collection program; 3) prioritize invasive vegetation control activities in areas at risk of EAB infestation; 4) establish an EAB detection program for high-traffic areas of the Park; 5) compile a forest resource inventory of the Park and tree inventories of high-traffic areas; 6) conduct branch sampling to determine if EAB is present on Main Duck Island, and if not, consider closing the island to the public; 7) develop and implement a strategic EAB communications plan; and 8) develop a cross-section committee to oversee EAB management.

Key words: emerald ash borer, national park, ash conservation, invasive species, visitor safety, pest management, insect management, EAB detection and control, strategic plan, forest conservation

RÉSUMÉ

Cet article présente une stratégie de contrôle de l'agrile du frêne (AF) dans le parc national des Îles du Saint-Laurent (PNISL), situé dans les Comtés unis de Leeds et de Grenville dans l'est de l'Ontario et qui s'étend sur 100 km le long des rives du lac Ontario et du fleuve St-Laurent. Une description générale de l'AF et du PNSIL est suivie par la présentation d'un aperçu des impacts potentiels de l'épidémie d'AF dans le parc, des prédictions sur les zones les plus susceptibles d'être ravagées et sur la rapidité de l'infestation et s'il y aura des interactions entre les peuplements ravagés par l'AF et la végétation concurrente et si la sécurité des visiteurs pourrait être affectée. Les recommandations pour ralentir la dispersion de l'AF dans le parc, pour être préparé et tenter de réduire les impacts, pour participer aux recherches scientifiques visant à mieux comprendre le phénomène et pour préserver le matériel génétique lié au frêne comprennent : 1) l'interdiction d'introduire dans le parc du bois de chauffage provenant de l'extérieur du parc ; 2) le développement et l'implantation d'un programme de récolte des semences; 3) la priorisation des activités de contrôle de la végétation concurrente dans les zones pouvant être infestées par l'AF; 4) la mise en place d'un programme de détection de l'AF pour les zones très fréquentées du parc; 5) la réalisation d'un inventaire des ressources forestières du parc et d'un inventaire des arbres dans les zones très fréquentées; 6) la réalisation d'un échantillonnage des branches afin de déterminer la présence de l'AF dans l'île Main Duck, et si ce n'est pas le cas, étudier la possibilité d'interdire au public l'accès à l'île; 7) l'élaboration et l'implantation d'un plan stratégique de communication sur l'AF et 8) la création d'un comité formé par les intervenants pour superviser la gestion de l'AF.

Mots clés : agrile du frêne, parc national, protection du frêne, espèce envahissante, sécurité des visiteurs, contrôle des ravageurs, contrôle de l'insecte, détection et contrôle de l'AF, plan stratégique, protection des forêts

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Background

Emerald ash borer (*Agrilus planipennis* Fairmaire), a wood-boring insect accidentally introduced to North America from Asia sometime in the 1990s, was first detected near Detroit, Michigan in 2002 (Haack *et al*. 2002, Poland and McCullough 2006). Since then, the emerald ash borer (EAB) has devastated ash populations in Michigan, Ohio and southern Ontario. Although EAB is considered a minor pest in its native range in Asia and rarely kills Manchurian ash (*Fraxinus mandshurica* Rupr.), ash species in North America have not co-evolved with this pest and are severely stressed by its activities (Rebek *et al.* 2008). Green ash (*Fraxinus pennsylvanica* Marsh.), white ash (*Fraxinus americana* L.), black ash (*Fraxinus nigra* Marsh.) and blue ash (*Fraxinus quadrangulata* Michx.) are all attacked by EAB, with most trees dying within one to four years following infestation.

EAB infestations between Essex County in southwestern Ontario and the United Counties of Leeds and Grenville where the St. Lawrence Islands National Park (SLINP) is located, as well as in Ottawa, Gatineau and Montreal, have killed millions of ash trees to date. EAB has also proven extremely costly for parks and regional and municipal governments, which are coping with the relatively sudden effects, including widespread canopy loss and large numbers of hazard trees (Coalition for Urban Ash Tree Conservation 2011). The risks of being caught without a strategy when an infestation is confirmed are myriad and include risks to public safety, economic pressure, negative public reaction, and ecosystem degradation.

St. Lawrence Islands National Park is situated along 100 km of Lake Ontario shoreline and the St. Lawrence River, and consists of 26 islands and 80 islets, along with a handful of mainland properties dispersed throughout a landscape that includes major roads, significant human habitation, industry and agriculture (Parks Canada 2010). Approximately 250 000 people live in the region surrounding the Park. It is located within a UNESCO World Biosphere Reserve and is a component of the Frontenac Arch Biosphere Reserve, a network of over 80 organizations. It is part of an international wildlife connectivity corridor, and the health of its ecosystem has a direct impact on the long-term ecological health of the Algonquin-to-Adirondacks region (Parks Canada 2010).

The Park receives an average of approximately 42 000 visitors a year, with most arriving by boat to island properties (Parks Canada 2010). "Uncontrolled access" to the Park's islands presents a major challenge to the protection of the Park's ecological integrity (Parks Canada 2010). Although permits must be purchased in order to moor at island docks, and despite the efforts of the SLINP's few wardens, visitors by canoe or anchoring off-shore are often able to circumvent the permit system and access the islands without restriction. The density of visitors to the islands in the high season is staggering—amounting to 7283 visitors per square kilometre of the Park's island properties during spring and summer (Parks Canada 2010).

Considering that emerald ash borer is difficult to detect visually for the first two to four years of an infestation (Poland and McCullough 2006), and that EAB has been confirmed in the United Counties of Leeds and Grenville at a rest stop on Highway 401 within a kilometre of the SLINP's border, it is reasonable to assume that EAB is present in the Park. Therefore, there is an immediate need for a strategy that addresses the possible outcomes of an EAB infestation, and that recommends the best courses of action to address the needs of Park stakeholders while minimizing negative ecological impacts.

The precedent, motivation for and commitment to action on EAB infestation in the St. Lawrence Islands National Park is clear and well-supported by corporate strategic documents, including the 2006 Integrated Vegetation Management Strategy (IVMS) and the 2010 Park Management Plan.

In order to make informed management decisions, SLINP resource conservation staff need to be aware of the possible ecological impacts of an EAB infestation, where infestations are more likely to occur and how quickly they could spread, whether there will be interactions between EAB-affected stands and invasive vegetation, and whether visitor safety may be compromised.

Outcomes of EAB Infestation at SLINP: Research and Predictions

EAB spread

EAB spreads over long distances by transport in infested materials such as firewood, nursery stock or wood packaging; and over shorter distances by adult beetles flying to new host trees (Haack *et al.* 2002, Poland and McCullough 2006). Natural dispersal is affected by flight capability, density and distribution of host trees, wind and meteorological conditions, and physical barriers.

Personal communication with resource conservation staff at Ontario's Point Pelee National Park, which has been experiencing an EAB infestation since the mid-2000s, revealed that there was no single epicentre of infestation; rather, several infestations were discovered dispersed throughout the Park. In landscapes such as parks and urban areas, where the risk of human-assisted spread of EAB is high, it would be imprudent to assume there would be one "ground-zero" of infestation. Instead, it should be assumed that multiple infestation epicentres are likely to exist.

If no other infestations are located on or near SLINP property (an unlikely scenario) and if the Park was able to prevent any human vectoring of the insect, the infestation at the Mallorytown location near Highway 401 would still likely spread into mainland Park property, but there might be a chance that some remote island properties, such as Main Duck Island, could escape infestation. When attempting to predict where EAB might be located in the Park, it is reasonable to assume that the probability of EAB infestation increases in areas where there is an abundance of ash near campsites, fire-pits or other high-traffic areas, or an already-established infestation.

Ecological impacts

The role of ash in forest ecosystems in the eastern United States and Canada and the monitoring of the impacts of other alien forest insect pests, such as gypsy moth and woolly adelgid, suggest that EAB's impacts could be profound (Cappaert *et al.* 2005, Poland and McCullough 2006, Gandhi and Herms 2010).

Ash trees are prolific mast trees in the Park, providing food for ducks, song birds, game birds, small mammals and insects. They also provide browse, thermal cover and protection for larger mammals (Cappaert *et al.* 2005). In northern areas, black ash may be the only species found in bogs or swampy areas, and thus the effects of widespread mortality of black ash in these ecosystems would be especially difficult to predict (Cappaert *et al.* 2005, Poland and McCullough 2006, Gandhi and Herms 2010). Green ash is especially common in the canopy along riparian corridors, and its disappearance is also likely to have significant effects (Poland and McCullough 2006).

Successional trajectories

Ash mortality in an EAB-infested stand can reach nearly 100% within six years of infestation, regardless of initial ash density, size, habitat, or diversity (Knight *et al.* 2010a). Current research in southeast Michigan near the site of the original EAB infestation suggests that EAB populations increase rapidly, peak, and then decline as the infestation progresses through the landscape and the EAB carrying capacity of the forest decreases (Knight *et al.* 2010, Herms 2011). EAB then persists at low densities and kills small ash saplings as they reach susceptible size (3 cm DBH) (Knight *et al.* 2010). It still remains to be seen what the ultimate fate of ash in these forests will be (Herms 2011).

What happens successionally in individual stands at SLINP that experience ash mortality will depend on what survives in the seed bed, and whether EAB will decline as the carrying capacity of affected stands declines. Carrying capacity could decline as large ash succumb and the beetle is left with only small saplings graduating from an extensive seedling cohort (Herms 2011). A decline in EAB density in a stand may give ash a chance to persist, though perhaps in lower numbers.

White ash-dominated areas in SLINP may see a shift towards canopies dominated by cherry (*Prunus* species), hickory (*Carya* species), sugar maple (*Acer saccharum* Marsh.) and ironwood (*Ostrya virginiana* [Mill.] K. Koch), while green ash in riparian corridors may give way to those species and to white birch (*Betula papyrifera* Marsh.), yellow birch (*Betula alleghaniensis* Britt.), and red maple (*Acer rubrum* L.). Black ash-dominated areas may shift to a more red maple-dominant canopy. All of these species are present in SLINP's forested areas. As no canopy inventory has been conducted, predicting successional trajectories of ash-dominated stands is speculative unless it is possible to observe what is present in the understory. However, depending on the accuracy of the predictive vegetation models for SLINP, they could be used to predict whether there might be shade-intolerant and early successional species, such as black cherry (*Prunus serotina* Ehrh.), present in areas of abundant ash that could take advantage of the canopy gaps created by ash mortality.

Interaction with invasive vegetation

It is speculated that EAB may facilitate the spread of invasive plants through canopy gap creation, which increases light at the forest floor (Herms *et al.* 2008).

A rapid assessment of invasive vegetation populations was carried out in 2010 and further assessment continued during the 2011 monitoring season. Garlic Mustard (*Alliaria petiolata* [M. Bieb.] Cavara & Grande), Tatarian Honeysuckle (*Lonicera tatarica* L.) and Dog-Strangling Vine (*Cynanchum rossicum* [Kleopow] Borhidi) are among the highest management priority invasive vegetation species currently present in SLINP (McPherson 2006).

Visitor safety

Dead standing ash trees may present elevated risks to visitor safety and could become liabilities for SLINP if they are near hiking trails or campgrounds, or in other high-traffic areas. According to the Integrated Vegetation Management Strategy, fallen trees are considered a 'natural event' and not moved or altered unless they fall across trails or in campsites. Standing dead trees are also left in place "unless they pose a risk to the public or to a park facility" (McPherson 2006), but more intensive management of snags may be necessary if an EAB infestation occurs near a campground or other heavily used public areas. Due to the tendency of widespread ash mortality to occur relatively rapidly following infestation (over three to five years beginning in year five to seven), there will be a large number of trees dying more or less at the same time, creating numerous potentially high-risk snags in ash-populated stands.

Economic impacts

SLINP can expect varying necessary expenditures due to EAB infestation. These costs (including staff time) could include: tree removal and disposal, treatment (stem injection of TreeAzin™ insecticide), monitoring, seed collection, enforcement, and public communications and related materials. There is a possibility that stands of dead ash might render certain areas of the Park too dangerous to be used by visitors until tree removals can take place, which would result in lost revenues. Dead ash stands may also reduce the attractiveness of certain areas of the Park. Costs will vary depending on what management actions staff decide to undertake.

Impacts on the greater SLINP community

The Mohawks of Akwesasne First Nation work closely with SLINP to steward the greater ecosystem of which SLINP is a part. Black ash is a culturally significant species to the Mohawks and as such they may express an interest in facilitating its preservation, where possible, from EAB.

Numerous landowners hold property that borders SLINP, both on islands and on the mainland, and their cooperation in combating EAB infestation through preventative measures, and perhaps through treatment of infested trees on their properties, will be critical to successfully slowing the spread of EAB into the Park. They will expect to be informed of management actions SLINP undertakes regarding EAB and many can be expected to respond favourably to offers of advice and instruction about how best to steward their own properties.

Recommended Actions

EAB's presence in the forests of SLINP poses a direct threat to the health of the Park's ecosystems due to its hosts' lack of defences against it. Although there is no effective treatment for eradicating EAB in forest landscapes, there are ways to slow its spread, prepare for and attempt to mitigate its impacts, contribute to the growing scientific research being conducted to better understand it, and conserve ash genetic material before living ash trees become scarce. Recommendations to achieve the above goals:

Recommendation 1: SLINP should implement a ban on outside firewood

Although the Canadian Food Inspection Agency has prohibited the movement of firewood across the borders of Leeds and Grenville, because EAB is confirmed as present within the region, the Park is not protected from contaminated firewood that originates inside Leeds and Grenville. The most direct action the Park could take to slow the spread of EAB due to human vectoring is to ban outside firewood from being brought onto Park property and provide firewood certified EAB-free onsite purchased from a supplier.

Not only could a ban on outside firewood prevent EAB from being brought into the Park via firewood, it could also reduce the risk of Asian longhorned beetle (*Anoplophora glabripennis* Motschulsky) and other pests and pathogens from entering the Park, since many can also be vectored by firewood (CFIA 2011). Point Pelee National Park instituted a firewood ban when EAB entered its region and has no plans to lift it because of the ban's overall utility in preventing the spread of invasive insects (T. Dobbie, Park Ecologist, Point Pelee National Park, personal communication 2011).

Because campsites are located on 12 different islands (Parks Canada 2010), to avoid severely inconveniencing Park visitors, it would be necessary to sell firewood at each of these islands, and also potentially partner with other organizations at alternative points of entry to the Thousand Islands area. Such points of entry may include kayak and boat rental facilities and boat tour companies. Staffing the islands directly is likely not an option given limited available resources and would not be cost-effective given that some islands have only a handful of campsites. Providing firewood on-site with a pay-per-use system, similar to the system used for mooring boats at the Park, could overcome this difficulty. Enforcement would still be a challenge, however, as it would be difficult to differentiate between wood purchased at the Park and wood brought in from elsewhere.

Gathering information about where and when visitors currently purchase their firewood would provide valuable insight for operations and communications staff who may need to alter protocols and provide messaging at different points of entry (e.g., when purchasing a camping or mooring permit). Alternatively, an awareness campaign without an explicit ban on firewood could be implemented by the Park to encourage visitors to purchase firewood from local sources. However, although such a campaign would comply with the CFIA's directive that firewood in an infested region not cross that region's borders, it would not prevent EAB-infested firewood from entering Park property, as SLINP is located within an infested region.

Any prohibition on firewood cannot be enacted without first developing comprehensive operational and communications strategies to implement and support the prohibition. Failure to implement these strategies in tandem would jeopardize the success of a firewood ban.

Recommendation 2: SLINP should develop and implement an ash seed collection program

With no eradication or control options for naturally forested areas available to stop EAB from causing near-100% ash mortality in infested forests, efforts to conserve ash species must be directed towards germplasm collection. Collecting ash seeds now would help ensure an adequate supply exists for re-introduction in the event of the eradication of EAB, or for use in projects to create EAB-resistant ash varieties that could potentially be introduced to the landscape.

Ash germplasm can be preserved in seed form, and the National Tree Seed Centre operated by Natural Resources Canada is collecting ash seed from sources across Ontario, Quebec, Manitoba and the Maritime provinces. No collection currently exists for SLINP. The Centre provides literature and direction on seed collection methods. A seed collection program would provide an opportunity to engage local landowners in collecting seed both on and off Park property. Such a community engagement project could fall under the Park's already-established citizen science program or become a new initiative. With the help of volunteers, seed collection would be a feasible undertaking and could be completed in one to two seasons.

Recommendation 3: SLINP should prioritize invasive vegetation control activities in areas at risk of EAB infestation

Measures to control invasive vegetation were carried out in 2011 on prioritized and mapped areas of Garlic mustard, Tatarian honeysuckle and Dog-strangling vine, and the mapping and control of invasive vegetation at the Park is an ongoing project.

Shifting the focus of the existing program towards areas where the risk of EAB infestation is higher, which includes any area with a significant density of ash that is close to campsites or areas of heavy use by the public, as well as areas within approximately 500 metres of confirmed infestations, would minimize the risk of gaps created by dead ash assisting the spread of invasive vegetation. This in turn could give native vegetation a chance to establish in these stands and outcompete invasive species.

Recommendation 4: SLINP should establish a detection program for high-traffic areas

In order to plan for future tree removals necessary to preserve public safety in high-traffic areas such as mooring docks, campgrounds/sites, and perhaps even heavily used hiking trails, an EAB detection program should be implemented in these areas. A systematic program of branch sampling, observation and prism trapping in high-traffic areas will enable the Park to plan for the extra expenditures and staff time necessary to conduct removals that may be needed in large numbers in one season, depending on how infestations spread. Once infested, ash typically succumb to EAB in four to six years, and ash are known to begin falling within two years following mortality due to root and stem base decay.

Branch sampling will be especially important because it is the most effective way to detect the presence of EAB before external symptoms are visible. Once symptoms are visible, an infested tree could have as little as one year before it succumbs, depriving the Park of a longer-term planning horizon. Knowing that EAB is present in a stand as close to the beginning of an infestation as possible will give the Park time to plan management actions and spread the costs of tree injection or removal.

Predicting EAB's spread is difficult due to the observed sporadic nature of infestation caused by human vectoring. Because large areas of SLINP are not near camping facilities, however, once one infestation is detected, it may be possible to predict with some accuracy where it will progress season-to-season by looking at ash concentrations nearby. Proximity to detected infestations coupled with ash phloem density and prevailing winds can be a significant factor when predicting the dispersal of EAB from an original infestation (Siegert *et al.* 2010).

Detection activities are also recommended in the area of the Park nearest to the Mallorytown infestation, and any subsequently confirmed infestations in the region. Though it is not recommended that management activities aimed at controlling the spread of EAB be implemented in infested areas in the Park, staff may choose to monitor EAB's ecological impacts on SLINP's forests. Gaps exist in our understanding of EAB's ecosystem effects, and most of the research undertaken to date has been in Carolinian forests, which do not share many of SLINP's unique vegetative and faunal communities. Other gaps in current research include EAB's indirect effects on small mammals, forest birds and other fauna.

Recommendation 5: SLINP should compile a forest resource inventory of the Park property, and tree inventories of high-traffic areas

In order to predict with any accuracy the effects that an invasive insect like EAB might have on SLINP's ecosystem and the reverberating consequences, it is essential to have an accurate picture of the canopy composition on all SLINP properties. The predicted vegetation maps referenced in this management strategy were produced through predicted vegetation modeling, which uses statistical methods to produce models based on field-collected vegetation data from plots scattered throughout the Thousand Islands Ecosystem, along with environmental information and satellite imagery (OMNR 2008). The maps produced are thus predictions only and may not accurately reflect forest stand composition.

The tree and vegetation community of SLINP is an ecological, recreational, cultural and educational resource. To manage any resource, it is necessary to have a clear understanding of what it comprises. Although a forest resource inventory is a significant undertaking that will likely take too long to inform management decisions for EAB, beginning to compile it now will leave SLINP in a much better position to prepare for and manage the effects of any disturbance to its forests in the future. A useful inventory that details stem frequency and density data along with measures of physical characteristics, height and diameter for stems of each species present in a given stand can be obtained using the point-centre-quarter method. This information can then be disseminated through GIS to create accurate maps of SLINP's forest resources, informing managers what species grow where, in what densities, and at what ages and sizes. Predicting outcomes of infestations of EAB or other insects or of wind and other weather events will become easier and predictions themselves will become more accurate.

Urban foresters continually promote tree inventories as the first step to proactive, efficient and economical forest conservation and management. Although an inventory accurate to tree level is impractical in all natural forest settings, SLINP could compile a tree inventory for high-traffic areas such as campgrounds, campsites and mooring docks. This would enable intensive management at the individual tree level through insecticide injection and pre-emptive removal of ash trees and accurate predictions of the costs that will be incurred due to dead ash trees as EAB moves through these areas. This, in turn, could provide the option of spreading management costs over longer periods of time.

Recommendation 6: SLINP should conduct branch sampling to determine if EAB is present on Main Duck Island, and if it is not, consider closing the island to the public

Located in the eastern tip of Lake Ontario and acquired by SLINP in 1977, Main Duck Island presents an opportunity for SLINP to preserve stands of ash from EAB infestation, if it is determined that the beetle is not present. Main Duck Island is located approximately 20 km from the nearest mainland and is managed as a nature preserve. It has no facilities, docks or campsites. It is, however, visited by boaters and as with all of SLINP's islands, preventing the public from accessing Main Duck Island by boat is difficult. SLINP should, however, consider the feasibility of officially closing this island to the public to preserve the ash there from EAB infestation. A concerted public awareness campaign would need to accompany such a closure, and extensive on- and off-site signage and other communications tactics would need to be leveraged.

Recommendation 7: SLINP should develop and implement a strategic EAB communications plan

The status and impacts of an EAB infestation at SLINP will need to be communicated to internal staff, the Park's partners in stewardship including area provincial parks, municipalities, conservation authorities, the Mohawks of Akwesasne First Nation, the Frontenac Arch Biosphere Reserve, the Regional Forest Health Network and others on an ongoing basis. As infestations become more visible in Leeds and Grenville, a media plan will need to be created to address questions about SLINP's management decisions and actions to address EAB.

An outreach and education campaign about firewood movement will be necessary to inform landowners and Park visitors about the risks of EAB spread, as will an information campaign for local landowners that teaches them about EAB and directing them to useful resources for managing the insects if they appear on their property. As ash begin to succumb in the park, further communication to visitors who may witness large areas of dead ash will also be necessary.

Existing channels for education and communication, such as children's and family interpretation programming and school programs, should be utilized to disseminate information, especially regarding preventative and mitigating measures visitors themselves can take.

Recommendation 8: SLINP should establish a cross-section committee to oversee EAB management

A cross-section committee would ensure all departments have input into the strategic actions in which the Park will engage, their timing, how they will be carried out and by whom. It will also ensure open lines of communication reaching down to staff in administration, resource conservation, operations and maintenance, law enforcement and interpretation and communications, as all will be involved in SLINP's effort to deal with EAB. Representatives from external partners could also be included where appropriate.

Other management considerations

SLINP could consider injecting high-value trees with TreeAzin™––an insecticide derived from the extracts of the neem tree currently used by several Ontario municipalities to prolong the life of ash trees in infected areas and perhaps preserve them––if only to spread the costs that will be incurred by tree removal. Until forest resource inventories in natural areas and tree inventories in high-traffic areas are compiled, deciding if and where intensive management actions would be necessary will be difficult. For this reason, intensive management is not recommended at this time. However, if some level of inventory is carried out, even on only some islands where ash is abundant, or in major campgrounds, SLINP should consider intensive management activities including pre-emptive tree removal and injection of high-value trees, according to a decision matrix that could be developed for that purpose.

The above recommendations are strategic approaches that will each require their own action plan. The order in which they are addressed depends to some extent on staffing and budgetary constraints. However, EAB is likely already present in the Park and it will not wait for money, time or staff to continue its infestation.

Firewood restrictions and their attendant operational and communications plans should be enacted immediately to slow the spread of EAB. The design and implementation of a seed collection program and an EAB detection program for high-traffic areas, and branch sampling on Main Duck Island, are time-sensitive to preserve the genetic diversity of the ash species present in the Park. A strategic communications plan is essential as there will be questions from visitors, partners and the media as soon as EAB damage becomes more visible. Having a communications strategy in place now to outline strategic activities and firewood restrictions will enable collaboration with landowners and partners, and will prevent the Park from being forced into a defensive position by criticism.

Invasive vegetation control in areas at risk of infestation would ideally begin in the spring and summer of 2012 since control of Dog-strangling vine and Garlic mustard takes several seasons to achieve. However, if only limited staff resources are available, detection and seed collection should take precedence for the upcoming season.

Though essential for informed future management of SLINP's forests, compiling a forest resource inventory, even for only some areas or islands, and tree inventories for high-traffic areas, will likely not be completed early enough to inform management decisions about EAB. If funds are available, the mapping of SLINP's forest resources should be contracted out.

It is difficult, however, to separate the importance of any of these strategic priorities from each other; ideally all would occur in tandem. A forest resource inventory would assist in designing a seed collection program as well as identifying areas for invasive control and would provide SLINP with enough information to consider the intensive management of ash through injection and pre-emptive removals. However, the Park cannot afford to spend a season compiling an inventory at the expense of detection monitoring, seed collection and invasive control; the threat of EAB is too imminent.

Effective public and internal communication is essential for the success of a firewood ban, the potential closure of Main Duck Island, to uphold the Park's commitments to its community partners, to procure volunteers for seed collection, and to gain information about infestation locations from local landowners. The picture is incomplete without a comprehensive strategic plan to open all these lines of communication, and a cross-sectional committee to develop and oversee EAB management in the coming years.

Conclusion

The threat to the St. Lawrence Islands National Park from EAB infestation is imminent and action is required as soon as possible to minimize EAB spread from human vectoring, keep its facilities and trails safe for visitor use, maintain positive relations with the community, and contribute to research on EAB's impacts on ecosystems to inform future management and prevent negative interactions between canopy gaps created from ash mortality and invasive vegetation. Preserving the genetic heritage of the ash species in the Park is possible and achievable, especially with the help of the Park's community partners and local landowners. EAB invasion provides an opportunity to leverage the expertise of staff from all sections of the Park to collaborate on long-term strategies to mitigate and study the impacts of an invasive species on the Park's ecosystems. It provides the motivation to create protocols such as strategic communications and operational plans and collect information on forest resources that will make future prevention and management of invasive species more effective.

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