Adirondack Park Invasive Plant Program

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The Actual and Potential Economic Impact of Invasive Species on the Adirondack Park: A Preliminary Assessment



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The authors hope this report will contribute to a more informed discussion of the economic impacts of invasive species on the Adirondack Park.

Cover Images (Clockwise from Top Left): Hydrilla, Photo by Robert Vidéki, Doronicum Kft., Bugwood.org; Asian Longhorned Beetle, Photo by Kenneth R. Law, USDA APHIS PPQ, Bugwood.org; Emerald Ash Borer, Photo by Debbie Miller, USDA Forest Service, Bugwood.org; Aquatic Plant Removal, Photo by Adirondack Park Invasive Plant Program; Asian Clam, Photo by U.S. Geological Survey Archive, U.S. Geological Survey, Bugwood.org; Eurasian Watermilfoil, Photo by Alison Fox, University of Florida, Bugwood.org; Spiny Water flea, Photo by Dave Brenner, Michigan Sea Grant College Program; Managing terrestrial plants, Photo by Adirondack Park Invasive Plant Program; Japanese Knotweed, Photo by Paul Rischmiller.

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Executive Summary

This report, commissioned by the Adirondack Park Invasive Plant Program (APIPP),[i] explores the actual and potential economic impact of invasive species on specific sectors of the economy of the Adirondack Park. Previous research with respect to invasive species has tended to focus on their biology and ecological impacts, strategies to control them, and methods to restore invaded habitat. Consideration of the economic impacts, beyond the direct costs of control, has received relatively little attention though these impacts may be substantial. This assessment focuses on economic impacts. It is a starting point; research on the economic impact of invasive species is a maturing science. Eight high priority species are used to illustrate impacts on the Adirondack Park. The analysis compares current investments related to invasive species prevention and control in the Adirondack Park with the potential economic consequences of species spread.

The purpose of this report is to provide a preliminary foundation for informed discussion about economic risks of invasive species and associated costs and benefits of taking action. It looks at both public and private sector investments and highlights the network of organizations and volunteers committed to protecting the Adirondack Park from invasive species through prevention, early detection and rapid response, education, legislation and enforcement and, where necessary and appropriate, ongoing control and management. This study provides a baseline for future discussion and evaluation. It is based on the best information available. Additional information is welcomed and encouraged to refine the analysis and projections of economic impact.

Methodology

A combination of primary and secondary data collection methods were used in this research. An advisory committee of experts on invasive species, economics, and policy led by the Director of the Adirondack Park Invasive Plant Program provided guidance throughout the project.

Primary research began with a list of 26 invasive species that pose the greatest threat to the Adirondacks and a list of the economic sectors in the Adirondack Park most likely to be affected by invasive species. Yellow Wood Associates conducted key informant interviews with 32 people at 23 organizations active in nine economic sectors including agriculture and horticulture, conservation, forestry and forest products, human health, local governments, real estate and construction, recreation and tourism, state government, and utilities. Economic activity in the Adirondack Park is heavily dependent on government and tourism (including second homeowners). Smaller sectors include construction, forestry, agriculture, and manufacturing. Interviewees were asked to select the one or two invasive species of greatest concern within their sector and to describe the nature of the impacts of concern to them. The final selection of eight species was informed by the results of key informant interviews and finalized by the advisory committee.

The eight species highlighted in this report include five that are currently present in the Park (Eurasian watermilfoil, Asian clam, spiny water flea, Japanese knotweed, and spotted wing drosophila) and three that are present nearby and of concern (hydrilla, emerald ash borer, and Asian longhorned beetle).[ii] The intention was to include a mix of aquatic and terrestrial species that have or could have direct economic impacts on the

[i] For more information on APIPP, go to http://adkinvasives.com/.

[ii] Resources available dictated the parameters of selecting eight species. The top species that were identified through informant interviews determined the species selected for further analysis in this report, which did not include an invasive fish species, such as round goby.

Adirondack economy, as well as a range of species that have already been identified in the Adirondacks and species that have not yet been identified in the Adirondacks but are present in surrounding areas. To better understand activities underway to protect the Park from invasive species, and the extent of existing investment related to invasive species, an online survey was sent out to 274 individuals across economic sectors in the Adirondacks in March of 2014. One-hundred-twenty-four people responded to the survey for a survey response rate of 44%. Activities and expenditures cited are based on best available information provided by respondents completing the survey. These data provide the most comprehensive overview available of investments related to invasive species in the Adirondack Park. Additional primary research was conducted to inform brief case studies of several species (or groups of species) including beech bark disease, Eurasian boar, and aquatic invasive species, in addition to the eight targeted species.

Secondary research involved compiling data from existing studies and data centers related to economic sectors in the Adirondack Park[iii] and collecting and analyzing information from existing studies of the economic impacts of invasive species conducted in other areas. Wherever possible, we used studies of economic impacts from nearby regions and regions with some similarities to the Adirondacks.

Limitations

The estimates of economic impacts are meant to provide insights into the order of magnitude of impacts we might see in the Adirondack Park. The emphasis in this report is on direct economic impacts, e.g. loss of timber value, and not the indirect and induced impacts (often referred to as "multipliers"), such as loss of wages for sawmill workers and loss of retail spending by sawmill workers. Estimates do not include the added costs of prevention and control, cumulative impacts of multiple species, or the costs associated with the loss of ecosystem services.[iv] In that sense, they should be considered conservative.

In some cases, we were not able to find studies that offered useful guidance on the time frame and/or likely magnitude of impacts, so we have had to make assumptions, which are transparent. More accurate estimates will be possible as more and better information becomes available.

Invasive Species and the Adirondack Park

The Adirondack Park is one of the largest intact temperate forests in the world and represents one-fifth of New York's land area and contains more than 3,000 lakes and ponds. Compared to other areas of comparable size in the Northeast, the Adirondack Park remains relatively free of invasive species, which are non-native plants, animals, insects, and pathogens that cause harm to ecosystems and the economic activities that depend on them. The economy of the Adirondack Park and region is heavily natural-resource dependent. Second home ownership, tourism and the hospitality industry, forestry and forest products, and agriculture all provide employment and help sustain the many small communities, extensive private forestland holdings, and service providers in the Park. However, as more and more invasive species appear within and near the Park's borders, the economy of the Park becomes increasingly vulnerable.

[iii] The Adirondack Park is delineated by the Blue Line which intersects ten counties and encompasses two counties. The Adirondack region refers to the 12 counties in and around the Park (Clinton, Essex, Franklin, Fulton, Hamilton, Herkimer, Lewis, Oneida, St. Lawrence, Saratoga, Warren, and Washington). In many sectors, data is not readily available for the Park as a unit, and data for some or all of the counties that have some land inside the Adirondack Park was used in its place. The definition of "Adirondack" varies from study to study. Significant variations have been footnoted.

[iv] One way to think of the value of ecosystem services is to determine what it would cost to replicate them by technological or engineered means, such as stormwater-capture infrastructure.

How Invasive Species Create Direct Economic Impact

Each invasive species has its own way of impacting the economy, and multiple species may produce cumulative impacts. Aquatic invasive species, such as Eurasian watermilfoil, have been shown to impact the desirability of property on and near recreational waterbodies. Property values can also be impacted by hydrilla, which has characteristics similar to Eurasian watermilfoil. Any reduction in property value due to invasive species will affect local government revenues as well as the personal wealth of owners of property in the Adirondack Park.

Forest invasive species, such as the Asian longhorned beetle, kill maple (and other) trees that produce timber, sap for maple syrup, and fall colors that attract tourists. Controlling Asian longhorned beetle involves removing infested trees as well as removing unaffected trees nearby that are suitable hosts. Dead trees also create hazards on driveways and roads and in utility corridors and increase the cost of maintenance and safety precautions. Emerald ash borer kills ash trees, which are also important to the wood products industry and poses similar health and safety impacts.

Other invasive species, such as Asian clam, degrade specific recreational experiences, including swimming, and can also clog water pipes used for irrigation, fire protection, manufacturing, and water supply. Several of the species reviewed in this report, including Eurasian watermilfoil, hydrilla, and Japanese knotweed, increase the likelihood of flooding by reducing the capacity of channels to carry floodwater. Japanese knotweed also has the capacity to grow through pavement and increase the costs of infrastructure maintenance. It has even affected the mortgage eligibility of properties.

The direct economic impacts of some species are quite specific: spotted wing drosophila is an agricultural invasive species that attacks berries and other soft fruits, while the spiny water flea, an aquatic invasive, primarily impacts anglers by disrupting sport fisheries and altering the aquatic food chain.

Although there are not sufficient data to estimate direct economic impacts on other sectors in the Adirondack Park, evidence from elsewhere points to direct impacts on the construction industry through increased costs of site preparation, equipment cleaning, and inspection of materials; the real estate industry through reduced property values and decreased demand for properties; hydro-electric power generation through clogged water pipes; and, human health through an increased incidence of allergic reactions to aquatic and terrestrial invasive species, such as wild parsnip, and the contribution of invasive species to the spread of disease by, for example, causing water to stagnate and create breeding groups for mosquitos.

The Potential Direct Economic Impact of Eight Invasive Species

The potential direct economic impact from the eight species evaluated in this study is estimated at $468–$893 million.[v] Of this, $46–$51 million represents an annual potential loss in direct visitor spending, $2.3–$2.5 million in annual potential loss in agriculture and primary forest production value, and $420–$840 million loss in property value that will affect the tax base and borrowing ability of property owners on an ongoing basis.

Total direct economic loss from the invasive species evaluated in this report to the recreation and tourism sector in the Adirondack region, including impacts on swimmers, boaters, anglers, and fall tourists, is estimated at $46–$51 million a year.

[v] This estimate does not account for cumulative impact and avoids double-counting.

- Sixty-nine percent of those surveyed in the White Mountain Region of New Hampshire, similar in some ways to the Adirondacks, said they would decrease visitation if water clarity and purity deteriorated (invasive species can exacerbate issues related to water quality and water purity). This was the most significant deterrent to visitation and was estimated to result in a decrease of 17.5% in visitor days, total sales, household income, and jobs.[1]
- If a significant reduction in fall colors due to forest pests and pathogens were to affect even 10% of visits to the Adirondacks, the potential economic impact on tourist spending is on the order of $30 million a year.

Emerald ash borer and Asian longhorned beetle, neither of which was detected within the boundary of the Adirondack Park as of July 2014, are estimated to cost the forest and forest products sector in the Adirondack region $2.2 million per year or 5% of the total value of annual production through a combination of loss of stumpage value and loss of maple syrup production — even a 5% decrease in the maple syrup harvest would result in a $650,000 in annual loss. This does not include impacts on the rest of the industry.

The total value of berries grown in Adirondack counties is $225,000. Based on experiences elsewhere in New York, spotted wing drosophila can eliminate 10–80% of the berry crop in any given year, resulting in direct economic impact of $22,500 to $180,000 and presenting many of the small agricultural operations in the region with economic hardship.

The largest share of the total estimated direct economic impact is the potential impact on property values. The impact of aquatic invasive species, particularly Eurasian watermilfoil, on property values has been studied and found to range from 1% to 16%.[2] Other studies confirm that a reduction in water clarity (and its diminishment from cultural and non-cultural eutrophication) results in decreasing property values. A study in the Adirondacks found that multiple measures of water quality, including the presence of Eurasian watermilfoil, have significant effects on property values overall, *even for properties that are not directly on the water*. According to this study, the presence of invasive species on the nearest lake decreases property values by $10,459.[3]

The total value of residential properties in the Adirondack Park is estimated to be approximately $14 billion.[vi] If we assume a conservative impact of 3% on property values Park-wide, approximately $420 million in property value could be at risk from increasing numbers and densities of aquatic invasive species, such as Eurasian watermilfoil. A slightly less conservative estimate of 6% impact that is still within the low end of the range suggested by the research increases this impact to $840 million. While this is a simplistic method of computing impact, it is a reasonable (and likely conservative) indication of the order of magnitude of the impact if an aquatic invasive species, in isolation or in combination with others, were to spread throughout the Park. Currently, second homeowners pay a premium for property within the Park. The presence of aquatic invasive species can be expected to have a dampening effect on their willingness to pay a premium, which will also have a dampening effect on property values.

> ***"I had a good buyer in the $2 million range. They looked on Lake George and ended up not purchasing because of fear of invasives. ~Dan Davies, Co-Owner, Davies, Davies & Associates Real Estate, LLC***

[vi] 47,131 residential parcels owned locally + 31,978 residential parcels owned non-locally = 79,109 (total residential partners) x $179,163 (average parcel price) = $14,173,405,767.

Current Investment Related to Invasive Species in the Adirondacks[vii]

Our survey findings show that approximately $3.56 million was spent by 88 organizations on invasive species in the Adirondacks in 2013. More than half reported that their spending had increased over the past five years and expect their spending to increase over the next five years, signifying an increase in the invasive species threat and subsequent demand for action.

The approximately $3.56 million does not include the value of more than 12,000 volunteer hours valued at $708,000.[viii] Taken together, *this $4.27 million is less than one percent of the lowest estimated potential direct economic costs of eight invasive species.*

Of the $3.56 million, non-profits raised and spent $931,313 (26% of overall annual investment); state government, 896,400[ix] (25%) associations,[x] $568,393 (16%); academic institutions, $559,850 (16%); local governments, $426,076 (12%); other types of organizations, $137,275 (4%); and for profit businesses, $43,650 (1%). and.[xi]

Under Governor Cuomo, the State of New York has invested in strengthening the tourist economy in the Adirondack Park. Tourists to the Adirondack Park and region generated an estimated nearly $153 million in state and local taxes in 2012.[xii] The natural resource base in the Adirondacks and the amenities (lodging, attractions, etc.) that have been built around it are the foundation for these revenues. If invasive species undermine the viability of the tourist economy, tax revenues will go down (not only from tourism, but in all impacted economic sectors).

There are five relatively standard categories of activity on the invasive species spectrum of strategies: 1) Prevention, 2) Early Detection and Monitoring, 3) Rapid Response, Control and Management, 4) Education, Outreach and Training, and 5) Enforcement and Legislation. Organizations across the Adirondack region are investing in activities in all of these categories (Figure 1). The survey found the largest proportion of investment was in prevention (with 31% of the total spending) followed by rapid response, control and management (28%). Education and outreach and early detection and monitoring each captured about a sixth of the spending (17% and 14% respectively), followed by enforcement and legislation (6%) and other types of spending (5%). Examples of other types of spending include disease sampling, working with New York State Department of Environmental Conservation, treatments, coordination, special reports, harvesting, equipment maintenance, salaries, training, and volunteers.[xiii]

[vii] All data in this section comes from the *Survey to Capture Spending on Invasive Species in the Adirondacks*, administered to 274 individuals in March 2014. The survey had a response rate of 44% or 124 usable responses.

[viii] Based on the value of one hour of volunteer time of $28.73, established by New York State. "Economic Impact: 36 Adirondack Nonprofits." 2013. https://www.generousact.org/leading/economic-impact-study Accessed 06/09/14.

[ix] State funding includes annual support of the Adirondack Park Invasive Plant Program, a regional invasive species partnership program housed at the Adirondack Chapter of The Nature Conservancy.

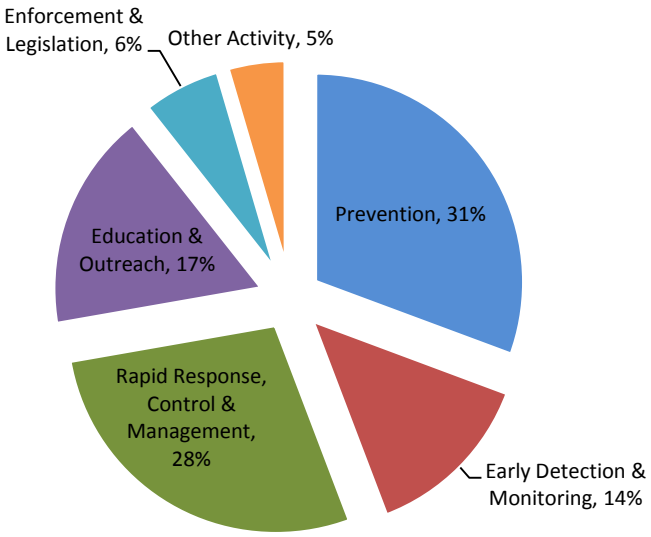
[x] This group of respondents is composed of 30 lake associations, one forest products association and one agricultural association.

[xi] These figures include all reported investments in the Adirondacks by a total of 88 organizations. Each survey was linked to an email address to allow for tracking of each survey response. Additionally survey respondents were required to provide the name of the organization and/or department for which they were responding, allowing us to identify and remove any duplicative responses and avoid double counting.

[xii] *Tourism Economics, The Economic Impact of Tourism in New York, Adirondacks Focus, 2012 Calendar Year.*

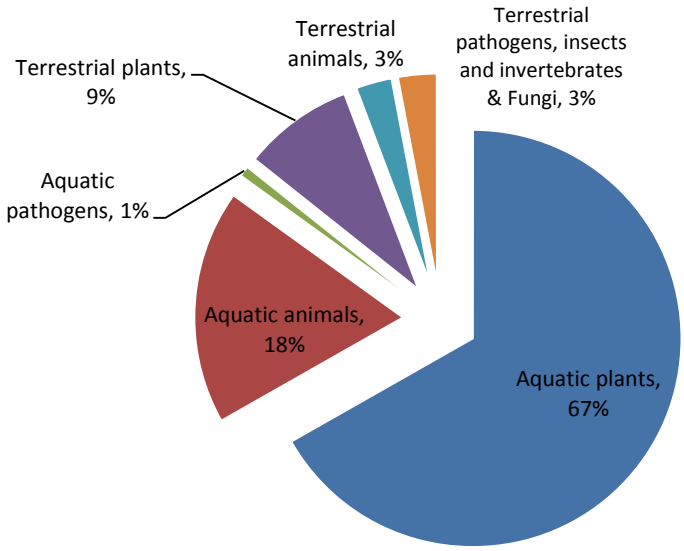
[xiii] Though we provided guidance to survey respondents on the types of activities included in each category, it can be difficult to delineate hard lines when interpreting which activities are aligned with each strategy and differentiating expenditures between these types of activities.

Figure 1: Proportion of Survey Respondent Spending by Category of Activity, 2013[xiv]



Eighty-five percent of all reported investments on invasive species were directed at aquatic invasive species with 15% targeted at terrestrial invasive species (Figure 2). Aquatic plants (e.g. Eurasian watermilfoil) are currently receiving over half of the total investment in invasive species in the Adirondacks.

Figure 2: Proportion of Survey Respondent Spending by Category of Species, 2013



[xiv] Specific descriptions of types of activities associated with each strategy can be found on in the section of this report titled "Existing Investments in Preventing and Managing Invasive Species in the Adirondack Park."

Lessons Learned about Spending on Prevention and Control of Invasive Species

Our research revealed several important lessons learned in the Adirondacks and elsewhere about spending in relation to invasive species.

1. Prevention is less costly than control. Control costs escalate rapidly once invasive species are present. Experience in the Adirondacks to-date illustrates this.
2. While prevention is less costly than control, for species that are already present in the Adirondack Park, control of small, relatively isolated populations is less costly than control of widely dispersed populations.
3. Very few invasive species can be eradicated once established. Control often involves actions that are implemented in perpetuity and should include ongoing monitoring to ensure success.
4. The most cost effective approach to prevention is to focus on the pathways that transport invasive species from one location to another.

Invasive species pose a significant threat to the Adirondack Park economy, and it warrants putting systems into place to address both invasive species present in the Park and those that have not yet arrived. Although there have been successes, such as the Town of Inlet's work to control Japanese knotweed, control of Eurasian watermilfoil in Upper Saranac Lake, and the Raquette Lake Preservation Foundation's well-organized aquatic invasive species prevention efforts, the cost has been high and the limited resources of volunteers, local governments, state governments, and non-profit organizations are all stretched thin.

Considerations Going Forward

The Adirondack Park is a unique and valuable asset for the State of New York. To the extent that it can remain a landscape relatively free of invasive species, it will become an even more valuable asset over time. There is likely to be considerable interest in lessons learned in the Adirondack Park and region since the spread of invasive species is likely to continue with increased impacts in rural areas.

Invasive species cannot be effectively addressed by one-time activities or one-time investments. A long-term approach to prevention and targeted control that includes monitoring and habitat restoration is essential to ensure success. The costs to control invasive species in the Adirondacks are escalating. Local governments and lake associations are particularly concerned about not having the resources needed to address additional threats.

> ***"We have been fighting milfoil for 20 to 25 years and we are spending hundreds of thousands to manage it. We can't afford to get 5 or 10 or 15 more [invasive species]." ~Fred Monroe, Supervisor, Town of Chester; Executive Director, Adirondack Park Local Government Review Board***
>
> ***"We are seeing donor fatigue, as this limited donor base is being asked to address a problem that will be ongoing and far exceeds the amounts that can be raised from the small, highly seasonal population." ~Respondent to Survey to Capture Spending on Invasive Species in the Adirondacks***

At the same time, property owners in the Park recognize the threat of invasive species and are concerned that the spending levels are too low.

The current focus of spending is overwhelmingly on invasive aquatic plants, but forest invasive species, aquatic animals, and pathogens including those not covered in this report also pose significant threats to the economy of the region. The costs of control exceed the costs of prevention, so it makes economic sense to focus resources on prevention wherever possible, while, at the same time, maintaining adequate resources for targeted control of existing species where success is likely.

Prevention, early detection and rapid response require advance planning for both private and public lands, since invasive species make no distinction and the Adirondack landscape has such mixed ownership. Planning for prevention on public lands is particularly important with respect to forest invasive species, since so much of the public land in the Park is forested and since invasive species management on public land is complex.

Current patterns of investment suggest a need for greater attention to prevention of forest invasive species overall. Once an appropriate prevention infrastructure is in place, it must be sustained to be effective. A one year hiatus in activity could result in re-infestation and nullify the value of prior investments.

The most cost effective approach to addressing invasive species is prevention, and the most cost effective approach to prevention is to address the pathways that transport invasive species from one location to another. Based on our review of existing conditions and best practices research, there appear to be four key areas to consider prioritizing investments to avoid or minimize economic impacts: 1) pathway management, 2) public education, 3) rapid response and strategic control, and 4) regulation and enforcement. Focusing on these areas will limit further degradation and spread of invasive species already present in the Park while also reducing the likelihood of future introductions. Control and management of the majority (if not all) of invasive species requires years of work, including habitat restoration, and ongoing monitoring to be effective.

The magnitude of potential economic impacts of invasive species on the Adirondack Park and region is extensive, and the benefits to New York of a healthy natural resource-based economy (tax revenues, reduced transfer payments,[xv] stronger communities, etc.) are considerable. There are recurring costs associated with prevention and control of invasive species. Experience elsewhere tells us that prevention is less expensive than control and the failure to prevent and/or control invasive species will result in economic harm. Our analysis evaluated only eight of more than 70 invasive species in the Adirondack region: more than 100 others are in surrounding areas.

Invasive species negatively impact a variety of sectors; and all sectors — public and private — have a vested interest in preventing and controlling the spread of invasive species. The economic consequences of an uncontrolled onslaught of invasive species in the Adirondack Park and region would not only undermine the current economy of the Park and region, but, once forests are damaged and waters are fouled, there will be fewer opportunities for long-term economic development.

[xv] Transfer payments refer to subsidies to support individuals who are not able to find employment due to a weak economy.

Introduction

The Adirondack Park is one of the largest intact temperate forests in the world. Established in 1892 to protect water quality for New York City and environs, the Adirondack Park contains 12 major watersheds, over 3,000 lakes and ponds and 30,000 miles of rivers and streams and represents one-fifth of New York's land area. Approximately 45% of the Park's 5.8 million acres is owned by the State of New York with the remaining 57% in private ownership.[4] Investments have been made in protecting 13% of the land in private ownership in the Park through conservation easements.[5] Compared to other areas of comparable size in the Northeast, the Adirondack region[xvi] remains relatively free of invasive species: aggressive, non-native plants, animals, insects, and pathogens that cause harm to ecosystems (including native species) and the economic activities that depend on them. However, as more and more invasive species appear near and within the Park's borders, it becomes increasingly vulnerable.

The Park is home to approximately 132,000 people and attracts millions of visitors each year who spend over $1.2 billion annually.[6] Approximately one in every four residential properties in the Park is a second home, and, in some communities, the percentage of second homes is as high as 80%.[7] Individuals with mailing addresses outside the Park own about 40% of the parcels listed as residential, which constitute over half of the total residential property value.[8]

Year-round and part-time residents of the Park alike have an interest in the successful management of the Park's biological resources. The economy of the region depends to a great extent on healthy forest and aquatic habitats. Yet, the introduction of invasive species has the potential to adversely impact the livelihoods of people that live and work in and around the Park and on owners of property in the Park.

The Adirondack Park Invasive Plant Program (APIPP)[xvii] commissioned this study to explore the potential impact of invasive species in general, and eight high priority invasive species in particular, on specific sectors of the economy of the Adirondack Park and region. APIPP is one of eight PRISMs (Partnerships for Regional Invasive Species Management) that serve the state of New York.[xviii] APIPP has been working since 1998 to address invasive species in the Adirondacks and served as a model for the seven other regional partnerships. In its 2013 Invasive Species Strategic Plan, APIPP makes clear that the Adirondack Park, with much of its ecosystems still intact, provides an opportunity to prevent widespread degradation by invasive species.[9]

This report provides an overview of key sectors in the Adirondack Park economy and an introduction to invasive species and investments related to invasive species in the Adirondack Park. It profiles eight high priority invasive species, including costs associated with control, their impacts on specific economic sectors or subsectors, and the potential consequences of no action. A final section contains a summary of findings, recommendations, and additional research.

[xvi] The Adirondack Park is delineated by the Blue Line which cuts through ten counties and encompasses two counties. The Adirondack region refers to the 12 counties in and around the Park (Clinton, Essex, Franklin, Fulton, Hamilton, Herkimer, Lewis, Oneida, St. Lawrence, Saratoga, Warren, and Washington).

[xvii] For more information on APIPP, go to http://adkinvasives.com/.

[xviii] Partnerships for Regional Invasive Species Management are funded, in part, by the New York State Environmental Protection Fund administered by the New York State Department of Environmental Conservation. Funding for this report was provided by a private foundation.

Methodology

Advisory Group

This work proceeded in stages, beginning with convening an advisory committee of experts on invasive species, economics, and policy. Members included Dr. Jeff Corbin, Associate Professor of Biological Sciences, Union College; Meg Modley, Aquatic Invasive Species Management Coordinator, Lake Champlain Basin Program; Dan Kelting, Executive Director, Adirondack Watershed Institute and Professor of Environmental Sciences, Paul Smith's College; Fred Monroe, Supervisor, Town of Chester and Executive Director, Adirondack Park Local Government Review Board; Amanda Lefton, Policy Advisor, The Nature Conservancy; and Elizabeth Codner Smith, Environmental Economist, The Nature Conservancy. The committee was chaired by Hilary Smith, Director, Adirondack Park Invasive Plant Program.

Preliminary Species Identification

There are hundreds of invasive species threatening to enter the Adirondack Park and impact the water quality, forest health and a wide range of economic sectors in the Adirondacks. For this study, APIPP identified 26 invasive species that pose the greatest threat to the Adirondacks. The list included plants, animals, insects, and pathogens that live on land and in the water, with an emphasis on those species that can have direct economic impacts.[xix] Yellow Wood worked with APIPP and the advisory committee to identify economic sectors in the Park that would likely be affected by invasive species. Sectors included agriculture and horticulture, conservation, forestry and forest products, human health, local governments, real estate and construction, recreation and tourism, state government, and utilities.[xx] Throughout the report, we have included examples of impacts on specific sectors where data was available; based on existing data, we summarized specific Park-wide economic impacts for four sectors including agriculture and horticulture, forestry and forest products, local governments, and recreation and tourism. Investments by the conservation sector are also described in detail.

Key Informant Interviews

As part of this work, we conducted 23 key informant interviews with 32 people at 23 organizations active in the nine economic sectors in the Adirondacks most likely to be impacted by invasive species to understand the current impacts of invasive species on their work and which species are a priority from their perspective. During each of the interviews, participants were asked to select the one or two invasive species that this study should focus on from the perspective of their sector. Quotes from key informants appear throughout this document.

[xix] More than 70 invasive species — plants, animals or pathogens — are in the Adirondack region, representing both terrestrial and aquatic organisms. Many more are approaching the region. The Adirondack Park Invasive Plant Program selected 26 invasive species for Yellow Wood to canvass sectors and constituents about importance level and known or potential economic impacts. Considerations included invasive species that 1) were in the park and those approaching the park; 2) represented different taxonomic groups; 3) were representative of various impacted habitat types; and 4) represented various impacts, including agriculture and human health. The original 26 species included Alfalfa Snout Beetle, Asian Clam, Asian Longhorned Beetle, Beech Bark Disease, Black Swallow-Wort, Brown Marmorated Stink Bug, Common Reed Grass, Emerald Ash Borer, Eurasian Boar, Giant Hogweed, Hemlock Woolly Adelgid, Hydrilla, Japanese Knotweed, Japanese Stiltgrass, Kudzu, Mile-A-Minute Vine, Swallow-Wort, Purple Loosestrife, Quagga Mussel, Snakehead, Spiny Waterflea, Watermilfoils (Eurasian and Variable Leaf), Virburnum Leaf Beetle, West Nile Virus, Wild Parsnip, and Zebra Mussel.

[xx] The conservation sector is part of the non-profit sector and includes organizations whose primary mission is environmental conservation.

Final Species Selection

Interview responses were tallied and then reviewed by the advisory committee, which worked with APIPP and Yellow Wood to prioritize eight species that covered a range of aquatic and terrestrial species as well as a range of species that have already been identified in the Adirondacks and species that have not yet been identified in the Adirondacks but are present in surrounding areas (Table 1).[xxi]

Online Survey

To better understand activities already underway to protect the Park from invasive species, and the extent of existing investment related to invasive species, Yellow Wood conducted an online survey and collected data from 125 survey respondents.[xxii] Quotes from survey respondents appear in this document without specific attribution due to confidentiality provisions. Even without attribution, these quotes illustrate the range of opinions and concerns of people living and working in affected sectors in the Park.

Case Studies

Finally, in addition to research into the economic impacts of the eight target species, brief case studies of experiences in the Park related to three additional species (or groups of species) of concern were also developed. The case studies include beech bark disease, Eurasian boar and aquatic invasive species.

What is an Invasive Species?

The New York Invasive Species Council bases its definition of invasive species on the federal definition: an invasive species is a species that is: 1) non-native to the ecosystem under consideration, and; 2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health (that significantly outweighs any benefits).[10] Invasive species can be plants, animals, insects, and pathogens that live on land or in the water. Invasive species are not considered harmful everywhere; in their places of origin, the environment is well adapted to their presence and there are natural mechanisms that keep them from spreading out of control. However, when they are transported to new locations, into habitats without these natural mechanisms, they can reproduce rapidly and become dominant, crowding out native species and, over time, often changing the underlying ecology of the area they infest. Their capacity to alter ecosystem functioning also means that they can alter the economic services that humans derive from ecosystems, such as flood control or water purification.

[xxi] Resources available dictated the parameters of selecting eight species. The top species that were identified through informant interviews determined the species selected for further analysis in this report, which did not include an invasive fish species, such as round goby.

[xxii] In March of 2014, an online survey link was sent to 274 individuals across eleven types of businesses and organizations in the Adirondacks, including Agriculture, Forestry, Colleges and Universities, Conservation, Federal Government, Lake Associations, Local Government, Real Estate and Construction, Recreation and Tourism, State Government, and Utilities. 124 people responded to the survey (for a 44% response rate) from across all eleven sectors.

Table 1: Eight Priority Species

Common Name	*Latin/Scientific Name*	*Aquatic/ Terrestrial*	*Plant/ Animal/ Pest*	*Actual/ Future*
Asian Clam	*Corbicula fluminea*	Aquatic	Animal	Actual
Eurasian Watermilfoil	*Myriophyllum spicatum*	Aquatic	Plant	Actual
Hydrilla	*Hydrilla verticillata*	Aquatic	Plant	Future
Spiny Water flea	*Bythotrephes longimanus*	Aquatic	Animal	Actual
Asian Longhorned Beetle	*Anoplophora glabripennis*	Terrestrial	Pest	Future
Emerald Ash Borer	*Agrilus planipennis*	Terrestrial	Pest	Future
Spotted Wing Drosophila	*Drosophila suzukii*	Terrestrial	Pest/Pathogen	Actual
Japanese Knotweed	*Polygonum cuspidatum (Fallopia japonica)*	Terrestrial	Plant	Actual

Economic Impacts: Approach and Limitations

Previous research with respect to invasive species has tended to focus on their biology and ecological impacts, strategies to control them, and methods to restore invaded habitat. Consideration of the economic impacts, beyond the direct costs of control, has received relatively little attention though these impacts may be substantial. This report compiles information from existing studies of the economic impacts of invasive species with data on the economy of the Adirondack Park and region to develop estimates of potential impacts by sector. Wherever possible, we have used studies of economic impacts from nearby regions and/or regions with some similarities to the Adirondacks.

These estimates are meant to provide insights into the order of magnitude of impacts we might see. In most instances, estimates are based on direct impacts, e.g. loss of timber value, and not indirect and induced impacts (often referred to as "multipliers"), such as loss of wages for sawmill workers and loss of retail spending by sawmill workers. In that sense, they can be considered conservative. In some cases, we were not able to find studies that offered useful guidance on the time frame and/or likely magnitude of impacts, so we have had to make assumptions. We have made all of our assumptions transparent. More precise estimates will be possible as more and better information becomes available.

Although invasive species do affect ecosystem services, such as flood control, soil control, and carbon sequestration, that have real value in avoided costs, if not in the marketplace, we have not included the value of ecosystem services in our estimates of economic impacts. Finally, although we have estimated impacts by individual species, in reality, economic impacts (like ecological impacts) are likely to be cumulative. For example, several invasive species in combination may have a greater impact on property values than any one by itself. There is very little research on the cumulative economic impact of invasive species.

The Economy of the Adirondack Park

Economic activity in the Adirondack Park is heavily dependent on government and tourism (including second homeowners). Smaller sectors include construction, forestry, agriculture, and manufacturing.[11] A single invasive species can have impacts across more than one sector. This report examines the impacts of

eight invasive species across five sectors: local and state government, recreation and tourism, forestry and forest products, agriculture and horticulture, and conservation.[xxiii] Each sector is briefly described below.

Local and State Government

The Adirondack Park contains 103 towns and villages, two counties and parts of 10 additional counties.[12,13] Local and state governments together employ an estimated 30% of people in the Park. It costs municipalities wholly within the Park more than twice the amount of surrounding municipalities on a per capita basis to provide local government services to their residents and approximately 9 million visitors a year. Total debt for all park local governments increased by 135% between 1980 and 2006, compared with a debt increase of 20% for local governments in rural counties outside the Park.[14] Of the 12 Adirondack counties, St. Lawrence and Franklin Counties are considered to be under significant fiscal stress, and Saratoga County under moderate fiscal stress.[15]

Local Government

Invasive species will increase the cost of providing local government services, including maintaining water systems and roads, recreational services, and providing fire protection (by affecting water quality and/ or quantity). Local government costs will also increase to the extent that local governments take responsibility for prevention, control, and management of invasive species.

> ***"We have been fighting milfoil for 20 to 25 years and we are spending hundreds of thousands to manage it. We can't afford to get 5 or 10 or 15 more [invasive species]." ~Fred Monroe, Supervisor, Town of Chester; Executive Director, Adirondack Park Local Government Review Board***

Local governments are funded primarily through property and sales taxes. A recent study showed that the greater the share of seasonal homes in a municipality, the lower the property tax rate and the lower the property tax burden (property taxes as a percentage of median household income).[16] Therefore, anything that contributes to a decrease in the value and/or desirability of second homes in the Adirondacks will have an adverse impact on local governments and property tax payers.

> ***"When buyers research a parcel they research the water body and compare it to other lakes in New Hampshire or Maine. They do their homework in what is affecting those lakes. There has been a tremendous amount of press about invasives in Lake George. People ask: 'What's going on?' 'How are they managed?' 'What do they do [to manage it]?' 'Who does it [manage]?' 'Who is spending the money on it [management]?' 'Am I going to be taxed?' " ~Dan Davies, Co-owner, Davies Davies & Associates Real Estate, LLC***

The combination of increased costs for managing invasive species and increased costs for providing services, combined with the potential loss of revenues from declining property values, would create increasing fiscal stress for local governments in the Park.

State Government

State government has numerous responsibilities within the Adirondack Park, including responsibility for state roads and state-owned land and waters, as well as the implementation of regulations governing their use. The

[xxiii] Sufficient secondary data for these sectors was available to assess specific aspects of actual and potential economic impact Park-wide, with the exception of the conservation sector, for which primary data was collected. Other sectors with potential to be impacted by invasive species include, but are not limited to, real estate, construction, utilities, and human health.

presence of invasive species increases the cost of state government and creates real opportunity costs. For example, dead and dying trees create hazards on roadways, at campgrounds, and on trails: an increasing number of dead and dying trees will create increasingly more hazards. Ninety percent of the state roads in the Adirondack Park go through forests.

> ***"Anything that affects trees will have a huge impact. We already spend a lot of resources to deal with hazard trees (in the Adirondacks)." ~Ed Frantz, Adirondack Park and Forest Preserve Manager, New York State Department of Transportation (NYSDOT)***

State government agencies, such as the Adirondack Park Agency and the Department of Environmental Conservation, also have direct responsibilities related to invasive species. Within existing resource limitations, the time state staff spends dealing with invasive species affects the time available for other mission-related work.

> ***At the Adirondack Park Agency: "Right now our fresh water analyst spends 70% of his time on invasives. They have had to shift their responsibilities from analyzing permits for water quality to a focus on aquatic invasives." ~Ed Snizek, Supervisor, Resource Analysis and Scientific Services, Adirondack Park Agency***

If more invasive species enter the Park, costs related to permitting and enforcement of regulations related to invasive species may also increase.

Recreation and Tourism

More than 20,000 jobs in the Adirondacks, or nearly one in every five, are directly related to tourism,[17] the highest ratio for any region of New York.[xxiv] Tourism generates an estimated $1.2 billion in revenue in the Adirondacks on an annual basis. Tourism contributed nearly $153 million in state and local taxes in 2012 and sales, property, and hotel bed taxes contributed an additional $85 million in local taxes. Warren County produced 43% of the region's tourism tax base.[18] The trends for Adirondack tourism are positive, with a steady increase in overall spending and tax receipts since 2010. The Essex County Profile, released in April 2014, cites tourism as a bright spot in the county's economy.[19] The significance of the outdoor recreation component of the tourism industry in the Adirondacks has not gone unnoticed. Governor Cuomo has made many investments and focused on promoting tourism and economic opportunity in the Adirondack Park, including launching a new Adirondack Park Recreation web portal in January, 2014, to promote tourism and economic opportunity.[20]

Tourists come to the Adirondacks primarily from New York State and eastern Canada as well as from major metropolitan areas in the Northeast and smaller local metropolitan areas, such as Burlington, Vermont.[21] Over a quarter of all tourists to the Adirondacks come from out of state, bringing new money into the state and region.[22] Many come to hike, paddle, fish, ski, boat, camp, golf, and swim. The majority of visits occur in the summer months, followed by foliage season (September and October). Over half of all spending by tourists in the Adirondacks is on lodging and food, followed by retail and services. Tourist spending is critical to the Adirondack economy and to the ability of towns, villages, and hamlets to maintain retail and related services for year-round residents.

[xxiv] *The Economic Impact of Tourism in New York, 2012 Calendar Year, Adirondack Focus* from which these numbers are derived defines the Adirondack Region as Clinton, Essex, Franklin, Hamilton, Lewis, and Warren counties.

Tourism presents a challenge and an opportunity when it comes to protecting the Adirondacks from invasive species. On the one hand, it is in the self-interest of tourists to help maintain the pristine quality of the Park to enhance their own (and the next generation's) recreational experience. Three quarters of visitors that responded to a survey of Essex County tourists stated that ecological or environmental sensitivity of their destination is "important" or "very important" to their travel planning.[23] Tourists also create opportunity for the transport of invasive species to the Park. One small fragment of an invasive plant transported from elsewhere can become a major infestation. If invasive species continue to spread in the Park, its attractiveness as a tourist destination may decrease, along with a reduction in tourist spending.[xxv]

> ***"When you look at what we have to sell, we have beautiful scenery and mountains. We have a lot of undeveloped land because of the Adirondack Park. We have pristine, clean, clear lakes. Pristine, clean, clear lakes are a very special thing. The water is very important to our economy, as are our trees. I don't think that it [invasive species] has the importance that it should. It is one of those things that until it blows up in your face, people are not concerned about it." ~Ed Weibrecht, Owner/Managing Partner, Whiteface Club & Resort; Owner/Operator, Mirror Lake Inn Resort & Spa***

Forestry and Forest Products

Approximately 93%, or 5.4 million acres, of the Adirondack Park is forested, mostly in what is classified as sugar maple/beech/yellow birch forests.

Timber

The state owned portion of the Park (45%) is classified as "forever wild" and no timber can be harvested on these lands. The remaining lands are privately held and harvesting timber on private lands is part of the Park's economic activity. Neither the New York State Department of Environmental Conservation nor the United States Forest Service aggregates timber harvest data at the Park level, but estimates suggest that roughly 16% of the roundwood logs harvested in New York in 2007 were harvested in the Park.[24] The estimate of timber harvest value in the Park for 2009 was $15 million in sawtimber and $5.4 million in pulpwood/chip wood of all species including hardwoods and softwoods combined.[25] This represents stumpage value only and does not take into account the full economic value of timber harvests, including wages paid to loggers, truckers, and mill workers and value added at the mill.

Stumpage price data also do not account for the indirect and induced contributions of the industry to the economy. The North East State Foresters Association identifies a total of approximately 20 hardwood and softwood mills of various sizes inside the Park.[26] In addition, some landowners in the Adirondacks rely on sales of timber and pulpwood to pay their property taxes. If invasive species damage trees, or if markets cannot be found for infested wood, more households may be unable to afford to keep their property.

Some invasive species, including two of those profiled in this report (Asian longhorned beetle and emerald ash borer), can have devastating impacts on forests resulting in increased tree mortality. Controlling these pests also requires removal of healthy trees in proximity that may or may not be at an optimum age for removal. Though these two species are not present in the Park as of the writing of this report, they are located in nearby forests and are thought to have the potential to invade in the future.

[xxv] There is no way to know the impacts on tourism of a relative decline in recreational conditions in the Park compared with surrounding areas and states. If the Park is affected, but relatively less than elsewhere, we cannot determine the absolute impact. However, there is evidence to suggest that any tourists will note and respond to any significant negative change in conditions in a given location.

Maple

Maple syrup production is another important aspect of the forest products economy in the Adirondacks. The value of maple syrup produced in the Adirondack region is estimated at over $13 million.[xxvi] This figure does not include wages paid to workers in the industry including foresters, harvesters, truckers, packers, boilers, etc. nor does it account for indirect or induced economic impacts.

Agriculture

Agriculture is a relatively small, but growing, pocket of economic activity within the Adirondack Park. The Adirondack Farmers Market Cooperative sponsors 10 farmers markets throughout the Park that provide market opportunities for approximately 46 growers and producers of value-added food products.[27] Adirondack Harvest lists 61 farmers markets and 102 farm stands in and around the Adirondack Park.[28]

Most farms within the Park are found at lower elevations near lakes or rivers, though there are some at higher elevations as well. Farmers use high tunnels and other techniques to extend the growing season and produce a wide range of fruits and vegetables in response to growing demand for local food. Farming in the Park is already a challenging undertaking. Growing seasons are short, and costs of production relatively high due to season extension and irrigation requirements.

Invasive species impose additional costs and challenges to the success of local agriculture. These costs include crop losses and obstruction of irrigation pipes as well as the costs of controlling invasive species. Organic producers are particularly at risk due to the limited availability of organically certified products to combat invasive species.

> ***"It's going to be very challenging to make a profit growing produce organically when all these new pests settle in here. I wish them [farmers] well, but they have the challenge of limited products they can use, labor intensive practices to try to reduce infestations, and price competition from conventionally grown products." ~Amy Ivy, Executive Director, Clinton County Agricultural Team, Cornell Cooperative Extension***

Many growers supplement their farm stands with produce from Canada. Restrictions on the flow of produce across the border put in place to control invasive species may have an impact on these growers.[29] Increased regulation may also affect the ability of nurseries, greenhouses, and landscaping businesses to obtain the plant materials they need. This is another way in which the presence of invasive species can impact the agricultural economy.

> ***"The number of invasives that are having a significant negative impact on local agriculture continues to escalate despite redoubling of resources; it doesn't feel like we are making the necessary headway." ~Respondent to 2014 Survey to Capture Spending on Invasive Species in the Adirondacks***

Conservation

In addition to the 45% of land area in the Adirondack Park that is conserved by the State of New York, another approximately 13% has been conserved by private owners, often with the assistance of regional non-profit organizations, such as The Nature Conservancy, the Adirondack Land Trust, the Open Space Institute, and others. For example, in 2010 the State of New York's Environmental Protection Fund invested $30

[xxvi] See Asian longhorned beetle section of this report for the basis for this estimate.

million in a conservation easement on 89,000 acres of Adirondack forest that was brokered by The Nature Conservancy. The intent of New York State's conservation easement purchase was to preserve timber industry jobs, boost the tourism and recreation economy, and preserve ecologically important land.[30]

Invasive species that damage timber, reduce the brilliance of fall foliage, foul waterways, and lead to changes in ecosystems threaten to reduce the value of investments in conservation. In addition, the cost of efforts to prevent the spread of invasive species increases the cost of doing business for conservation organizations.

> ***"When I go to water quality conferences, it used to be non-point source pollution, run-off, phosphorus, etc — and now the focus is more so on invasive species. It is not like those other things got fixed, it is just that now invasive species has taken over. When you get something in your lake you want to act before it spreads. It means we have less resources to work on other problems." ~Emily DeBolt, Outreach Coordinator, Lake George Association***

Depending on the invasive species, and the difficulty of control, it may become necessary to focus limited resources on control for a limited number of properties, thus increasing the vulnerability of other areas. This is, in fact, already happening.

> ***"If you look at the APIPP report we have 94 infested water bodies right now in the park. We are issuing [APA] permits for 23 of those 94 water bodies. That means there is nothing being done on the remaining 71." ~ Ed Snizek, Supervisor, Resource Analysis and Scientific Services, Adirondack Park Agency***

Forty-three non-profit respondents to the *2014 Survey to Capture Spending on Invasive Species in the Adirondacks* (including 29 lake associations) reported approximately 34 paid full-time equivalent (FTE) staff deployed to work on invasives.[xxvii] While many organizations are involved, the number of full-time equivalent positions devoted to this work is limited and more than half of survey respondents reported 0 FTE in 2013.

Non-profit and lake association respondents to the survey also reported the coordination of more than 9,000 hours of volunteer time at a value of $259,000[xxviii] and close to $1.5 million of investments on invasive species in 2013.

> ***"Invasive species matter to us because they have a proven effect on water quality and make it harder for us to protect the resources we are trying to protect. It is the same for land. If someone is protecting a valuable ecosystem or habitat they [invasive species] impact the resource we are protecting." ~Emily DeBolt, Outreach Coordinator and Walt Lender, Executive Director, Lake George Association***

The critical mass and connectedness of the conservation sector in the Adirondacks, as evidenced by the award-winning Adirondack Park Invasive Plant Program (APIPP) and the extensive collaborative network it has engaged, provides a solid foundation and capacity for addressing invasive species on a regional basis.

[xxvii] Full-time equivalent (FTE) is the number of employees working full-time plus the number of employees working on part-time schedules converted to a full-time business. For example an employee who works 40 hours per work is equivalent to 1 FTE and someone that works 40 hours per week seasonally (for 3 months per year) is equivalent to 0.25 FTE. The 34 FTE reported by non-profits is the sum of all FTE reported — the maximum number of FTE reported by non-profits was four.

[xxviii] The value of volunteer hours is calculated by multiplying the number of volunteer hours reported by survey respondents by $28.73 – the value of one hour of volunteer time in New York State. Source: "Economic Impact: 36 Adirondack Nonprofits." 2013. https://www.generousact.org/leading/economic-impact-study *Accessed 06/09/14.*

Partner networks are in place, including numerous and diverse governmental and non-governmental organizations and community groups. More than 700 volunteers are engaged. The Adirondack region also benefits from robust research conducted at nearby academic institutions, including Paul Smith's College, Darrin Fresh Water Institute supported by Rensselaer Polytechnic Institute, Clarkson University, State University of New York (SUNY) College of Environmental Science and Forestry, SUNY Potsdam, St. Lawrence University, and Lake Champlain Research Institute, among others. The presence of invasive species is already increasing demand for conservation activity.[31]

> ***"The Adirondacks represent a regional block where invasives can be controlled. Because of the work of APIPP and the rapid response team they have shown that you can keep this area relatively free and it is worth putting the time and energy into it from conservation sector. You have a rare opportunity to hold the wall." ~Raul (Rocci) Aguirre, Director of Conservation, Adirondack Council***

Knowledge and experience gained in the Adirondacks could be highly valuable elsewhere as invasive species continue to spread and new invasive species are identified. This knowledge and experience could itself become an Adirondack "export" contributing to the economy and unique comparative advantage of the region with expertise shared through training, field research, and learning opportunities hosted in the Adirondacks for people from other places with similar concerns.

Priority Species

There are hundreds of invasive species threatening the water quality, forest health and wide range of economic sectors in the Adirondacks.

The eight species highlighted in this report include five that are currently present in the Park (Eurasian watermilfoil, Asian clam, spiny water flea, Japanese knotweed, and spotted wing drosophila) and three that are present nearby and of concern (hydrilla, emerald ash borer, and Asian longhorned beetle).

Status in the Adirondacks

Priority Aquatic Plants and Animals

Eurasian watermilfoil was first discovered in 1979 in Chateaugay Lake in the Adirondack Park and has spread to more than 55 waterbodies in the Adirondacks, making it the most widespread of the priority aquatic invasive species evaluated in this report.[32,33] New York's iMapInvasives Waterbodies Report[34] identifies Eurasian watermilfoil in the 12 Adirondack counties. Spiny water flea has been identified in five counties — Fulton (Peck Lake), Hamilton (Scandaga Lake, Piseco Lake, and Lake Pleasant), Saratoga (Great Scandaga Lake and Stuart's Bridge Reservoir), and Warren and Washington Counties (Lake George). Asian clam has been identified only in Warren and Washington Counties (Lake George).

Hydrilla has not yet been identified in the Adirondacks but has been identified in more than 15 waterbodies spanning at least seven New York counties.

All four of these aquatic invasive species can be spread from one waterbody to the next by recreational boaters and/or anglers. Eurasian watermilfoil and hydrilla can reproduce from a plant fragment. Asian clam juveniles and resting egg stages of spiny water flea can survive in a thimble of water and are not visible to the naked eye.

The *2014 Survey to Capture Spending on Invasive Species in the Adirondacks* found that Asian clam, spiny water flea, and Eurasian watermilfoil were all identified in the top ten species that are receiving targeted attention.

Priority Pests and Pathogens

The Asian longhorned beetle and emerald ash borer are both pests that attack trees that are important components of the Adirondack forest. While the emerald ash borer lives only on ash trees, the Asian longhorned beetle survives on a number of host trees, including maple, horse-chestnut, birch, sycamore, poplar, willow, mountain ash, and elm. The Asian longhorned beetle has been detected in Brooklyn, Amityville, Queens, Islip, Manhattan, Staten Island, and, most recently, Babylon, NY (and subsequently eradicated in Islip, Manhattan, and Staten Island), according to New York's Department of Environmental Conservation.[35]

The emerald ash borer has been identified in at least 21 New York counties. The Southern half of the state is in an emerald ash borer quarantine area (which prohibits the movement of materials that may be harboring forest insects or forest tree diseases outside of the quarantine area). As of July 2014, the quarantine area had not reached the Adirondacks but included small portions of Oneida, Herkimer, Fulton, and Saratoga Counties.[36,37]

Spotted wing drosophila is an agricultural pest that attacks soft fruits (primarily berries) and has been impacting berry growers in the Adirondacks since 2012. This pest, which can decimate entire berry crops if untreated, requires expensive, and labor intensive, management.

Priority Terrestrial Plants

Japanese knotweed is a shrub-like perennial that is widespread across the Adirondack region with thousands of infestations across the 12 counties. APIPP has identified Japanese knotweed on at least 20 Forest Preserve Units.

Priority Species Impacts

This report presents information about each of the eight priority invasive species. This information includes costs associated with control, impacts on specific economic sectors or subsectors, and the potential consequences of no action.

New York State adopted an invasiveness index and completed an *Invasiveness Ranking Form* and conducted a socio-economic assessment for some, but not all, of the priority invasive species included in this report. Where that information is available, it has been included.[xxix]

Each invasive species has direct economic effects on multiple economic sectors and sub-sectors. Table 2 shows which sectors each species impacts. For species currently present in the Adirondacks, these are actual and potential economic impacts. For species which have not yet been detected in the Adirondacks, these are potential economic impacts.

[xxix] The Invasiveness Ranking Form (and ranking system), developed in 2008 by The Nature Conservancy and Brooklyn Botanic Garden and adopted by the New York Invasive Species Council, considers a species' known and potential distribution within New York State; ecological impacts, biological characteristics and dispersal ability; distribution within both its native landscape and other places it has been introduced; difficulty of detection, and control; and likelihood of hybridization. Higher scores reflect a higher risk. The Invasive Species Socio-economic Assessment Form was developed in addition to the invasiveness assessment to gather information about the socio-economic values of the non-native species. The socio-economic ranking summary allows for positive impacts, scored with positive numbers, and negative impacts, scored with negative numbers. The maximum potential positive score on the socio-economic ranking assessment is 100 while the maximum negative score is -100. The total score combines any positive and negative impacts identified by the scientists completing the ranking. (New York Invasive Species Council. "Final Report: A Regulatory System for Non-Native Species." June 2010. http://www.dec.ny.gov/docs/lands_forests_pdf/invasive062910.pdf)

Table 2: Priority Species Economic Impact on Five Sectors

	Aquatic Invasive Species				*Terrestrial Invasive Species*			
	Asian Clam	**Eurasian Water-milfoil**	**Hydrilla**	**Spiny Water Flea**	**Asian Longhorned Beetle**	**Emerald Ash Borer**	**Spotted Wing Drosophila**	**Japanese Knotweed**
Local & State Government								
Fire Protection[xxx]	**+$**	**+**	**+**					
Road Maintenance					**+**	**+**		**+$**
Flood Control		**+**	**+**		**+**	**+**		**+**
Recreation &Tourism								
Boating		**+**	**+$**					
Fishing		**+**	**+**	**+$**				**+**
Hunting					**+**	**+**		**+**
Swimming	**+$**	**+**	**+$**					
Visitor Days	**+$**	**+**	**+$**		**+$**			
Wildlife Viewing		+	+		+	+		**+**
Forestry & Forest Products								
Timber					**+$**	**+$**		+
Maple Syrup					**+$**	**+**		
Manufacturing	**+**				**+**	**+**		
Property Value								
Property Value	**+**	**+$**	**+**		**+**	**+**		**+**
Agriculture & Horticulture								
Irrigation	**+$**	**+**	**+**	**+$**				
Soft Fruit (berries)							**+$**	
Key	**+** indicates sectors that could be impacted by this species **+$** indicates impacted sectors covered in greater detail in this report							

[xxx] Invasive aquatic species can clog water pipes and make it more difficult and expensive to maintain fire protection systems.

Asian Clam

The Asian clam (*Corbicula fluminea*) is a roughly dime-sized, golden yellow/green bivalve native to southern Asia. It arrived in North America in 1938, either as a food item used by Chinese immigrants or by accompanying imports of the giant Pacific oyster, also from Asia.[38]

Image 1 Asian clam found underwater in Lake Tahoe. Photo: UC Davis Tahoe Environmental Research Center

Asian clam reached New York in 1983 and was first detected in Lake George in the Adirondack Park in 2010, though it is believed to have arrived around 2008. The Asian clam is hermaphroditic and also can reproduce by self-fertilization. A single adult can reproduce up to twice a year and produces 2,000–4,000 juveniles per year. Asian clam settles in sandy and mixed sand and gravel substrate. Established colonies of Asian clam can grow into densities of up to 6,000 clams or more per square meter.[39] Scientists gave Asian clam a New York invasiveness ranking of 73.68 — putting it in the "high" invasiveness category.[40]

Asian clam creates direct impacts on the recreational economy, as well as water pipes used for industry, private drinking water supplies, firefighting, and irrigation, and may contribute to human health hazards. High concentrations of Asian clam shells in beach or swimming areas can cause lacerations that repel users. Concentrations of Asian clam shells also form a high calcium substrate attractive to other invasive species, such as zebra and quagga mussels. Drinking water and irrigation pipes are affected when the very small juvenile clams easily pass through filters on water pipes and then settle into the sand that accumulates in the pipes, grow, and begin to reproduce. This leads to blocked pipes, altered flows, and increased rates of sedimentation.

Asian clams affect ecosystems by filtering and feeding on large quantities of phytoplankton and other particles in the water and excreting significant amounts of nitrogen, phosphorous, and ammonia into the bottom sediments and the water. Nitrogen and phosphorous stimulate the growth of certain algae and contribute to algal blooms that can create human health risks as well as aesthetic issues that repel users, while ammonia can be toxic to native fish and other living creatures. The extent to which Asian clams compete for food resources with native species has not been scientifically established.[41]

We have identified two potentially beneficial uses of Asian clam. The first is as a food source. It is a common base ingredient in Asian soups, chowders, and broths.[42] In addition, Asian clam is used as a folk remedy for liver disease in Asia and an extract from it has been found to reduce cholesterol and hepatic lipids in rats.[43] Neither of these uses is commercially established in the U.S.

Asian clam is spread through its use as live bait and accidental or intentional release of clams (marketed as golden clams) acquired through the aquarium trade and dumped from aquaria, as well as through sand imported to create beaches and by bilge water or in anchor mud.[xxxi]

[xxxi] The importation and sale of freshwater clams is prohibited in New York, but "golden clams" may be acquired from sources outside New York.

In the larval stage, clams can attach to vegetation or floating debris for long distance dispersal and can also be carried by lake currents or surface currents produced by motorized boats. Asian clams can live in rivers and streams as well as lakes.[44] Juvenile clams can travel in bilge and livewell water and on vegetation attached to anchors or trailers or in sediment left on anchors.

Though Asian clam is not currently established in Park lakes outside Lake George, officials fear that it could be a source that facilitates the spread of Asian clam to other lakes. Indeed, Lake George was one of the first lakes in the Adirondacks to experience Eurasian watermilfoil, in the 1980's and 1990's, before it spread more widely. Lake George's popularity and the high volume of boat traffic it attracts may have contributed to the spread of Eurasian watermilfoil throughout the Park. The fear is that the same thing could happen with Asian clam.[45] The Asian clam expands very rapidly, as evidenced in Lake George, even where control measures are being taken. In Lake Tahoe (in California and Nevada), Asian clam was first observed in 2002, and by 2010 it was associated with notable localized environmental impacts including algae blooms.[46]

Socio-economic Impact of Asian Clam

Scientists ranked the Asian clam *Moderate Negative* (-50 points) in the socio-economic assessment from New York State Department of Environmental Conservation. The socio-economic assessment identified low human health benefits, low economic benefits, and low cultural benefits. The ranking identified moderate human health risks, high economic detriment, and moderate cultural detriment.[47]

Methods and Costs of Control for Asian Clam

Benthic barriers and suction harvesting are two techniques for controlling Asian clam infestations. Research has shown that mats made of PVC, called benthic barriers, can be used to suffocate concentrated infestations of Asian clam. If the mats are left in place for approximately 90 days, nearly 100% mortality can be achieved, even in water temperatures below 10 degrees C (50 degrees F).[48] However, benthic barriers are not effective close to shore where wave action undermines the seal on the lake bottom. This is especially a problem where there are seawalls or other solid structures that strengthen wave action. Suction harvesting, in which a diver literally vacuums clams off the lake bottom, can be used close to shore and around obstructions that prevent the use of benthic barriers.

Benthic barriers and suction harvesting have been tried on Lake George. Despite the use of benthic barriers and suction harvesting on carefully targeted infestations beginning in 2011, and evidence of effective mortality of adult clams, by 2013, clam infestations were still spreading. The benthic barrier matting was found to be effective while the suction harvesting was less effective.[49] One explanation of their spread is that juvenile clams were released from infested sites prior to matting efforts.[50]

Because a single clam can reproduce at a rapid rate, re-establishment is common and total eradication requires ongoing vigilance. The least expensive option, as with all invasives, is prevention. Other techniques, including chemical and heat treatments, have been found to be ineffective or significantly less effective than benthic barriers and suction harvesting. Another type of harvesting, using a cockle harvesting boat, has been shown to be a successful control method, significantly reducing the Asian clam population over time in the River Barrow in Ireland.[51]

The estimated cost of treating and monitoring two half-acre sites in Lake Tahoe was reported as $648,000 for the 2010–2011 season. The cost per square foot for treatment by diver assisted suction removal was $24.71 and the cost per square foot of ethylene propylene diene monomer (EPDM) bottom barrier treatment was

$2.58. This total does not include costs associated with research and development of the management strategies.[52]

The projected cost for rapid response and adaptive management treatment of 5.23 acres of Lake George in 2011 was over $400,000, or approximately $76,500 per acre. The management goal at Lake George has evolved from eradication to population control and containment; efforts must continue for multiple years to be effective.[53]

Potential Economic Impacts of Asian Clam on the Adirondack Park

If the Asian clam were to spread throughout the Adirondacks, the most significant direct economic impacts would likely be on outdoor recreational tourism in the summer months, local government expenditures on firefighting systems that draw water from lakes, ponds, and/or streams, and farmers and manufacturers that draw irrigation water from the same sources. It could also impact households that use lake or surface water. We are assuming that the majority of drinking water used in municipal systems in the Adirondacks comes from groundwater sources and would not be impacted.[54] Indirect economic impacts would likely include a reduction in lake and near lake property values associated with increased infestation of beach areas and increased algal blooms.

In order to arrive at a rough estimate of the potential economic impact of the Asian clam on the Adirondack economy, we began by characterizing the value of summer tourism.

Summer Tourism

More tourists come to the Adirondacks in peak summer, July and August, than in any other time of the year. Just over a third of all visits occur during this period. The majority are repeat visitors,[55] attracted by the quality of their previous experiences. The substantial majority are primarily interested in outdoor recreation. There is some evidence that ecological or environmental sensitivity influences their decision to visit the Adirondacks. Hiking is the number one favorite outdoor activity, followed by canoeing/kayaking, fishing, and, in fifth place (after skiing/boarding), boating. Though swimming is not listed as a standalone activity, it is likely that many hikers, paddlers, anglers, and boaters and their families enjoy this activity as well. Camping, golf, and swimming were the three most common responses in the "other" category.[56] If infestations of Asian clam were to result in beaches and shallow water bottoms filled with sharp shells and a significant increase in algal blooms, it is reasonable to expect that this would lead to a decrease in visitation over time.

If we use the 2012 estimate of total visitor spending in the Adirondacks of $1.2 billion,[57] and assume that one-third of that spending occurs in the months where the impacts of Asian clam would be most severe, then a total of $396 million per year is spent during summer months.

A study of the impacts of negative changes to water quality on resident and non-resident recreationalists who fish, boat, and swim in New Hampshire found that about 12.6% of all summer tourism spending statewide is by those who swim in freshwaters. If we assume that is also true for the Adirondacks, it would mean that approximately $50 million per year is spent by visitors that swim in the Adirondacks and may be impacted by deteriorating water (and beach) quality. Sixty-nine percent of those surveyed in New Hampshire said they would decrease visitation if water clarity and purity deteriorated. This was the most significant deterrent to visitation. In the White Mountain Region of New Hampshire, similar in some ways to the Adirondacks, this was estimated to result in a decrease of 17.5% in visitor days, total sales, household income, and jobs.[58]

If we apply the same proportion to the Adirondacks, approximately $9 million per year in direct visitor spending is at risk from Asian clam (and other contributors to degraded water quality). This is likely an underestimate since it does not factor in the impact on paddlers, boaters, and anglers. A study of the potential economic impacts of aquatic invasive species on the Lake Tahoe Region suggests that a decrease of 20–80% in swimming participation is reasonable, depending on the density of vegetative growth and sharp shells on beaches.[59]

Fire Protection

Approximately 60% of municipalities allocate funds for fire protection services through their municipal budgets and 43% through a single, community-wide tax district. Costs for fire protection are already rising due to state standards for upgraded equipment, increased firefighter training requirements, and federal regulations (National Fire Protection Association (NFPA) and Occupational Safety and Training Association (OSHA)). Nearly half (45%) of municipalities and fire departments that responded to the community survey as part of the Adirondack Park Regional Assessment Project report issues with water supply as a significant challenge for their fire departments.[60] Without more information, it is impossible to know how many draw water from surface water sources and, therefore, how impacted they might be by the Asian clam that has the capacity to block water pipes and alter water flows.

Irrigation

Irrigation is going to become increasingly important to successful agricultural production as climate variability increases. The Office of Real Property Assessment identified 52,177 acres in Adirondack towns and village as agricultural in 2007.[61] While relatively few acres in and around the Adirondacks are currently irrigated, those tend to be acres producing high value crops. There were 355 farms with a total of 2,660 irrigated acres in the 12 Adirondack counties in 2007 and 437 farms with a total of 2,737 irrigated acres in 2012.[62] If Asian clams become a persistent problem in the ponds and streams from which irrigation water is drawn, growers will face added cost in maintaining their irrigation systems. Profit margins in agriculture are generally tight to begin with, so any added cost may be a deterrent to the continued growth of agriculture and local food systems in and around the Adirondacks.

> ***"We have been pushing our growers to get serious about irrigation. A lot of them are starting to look at ponds, and those are starting to get gummed up. Anything affecting ponds and stream sources for irrigation will be a concern." ~Amy Ivy, Regional Specialist, Eastern NY Commercial Horticulture Program***

Manufacturing

Manufacturers in the Adirondack Park that make use of surface water supplies may be affected by Asian clam, which, like zebra mussels can obstruct the flow of water through water pipes. Zebra mussels are having an impact on the costs of doing business for the International Paper mill in Ticonderoga.

> ***Zebra mussels accumulate in our water intake system and need to be removed on a regular basis. Additionally, we hire divers to go down annually to clean zebra mussels and other aquatic invasives (milfoil and water chestnut) from our lake water intake. Water is highly important in our process. The mill uses approximately 15 million gallons of water daily, so our ability to bring in water is critical. ~Donna Wadsworth, Communications Manager, International Paper***

Eurasian Watermilfoil

Eurasian watermilfoil *(Myriophyllum spicatum)*, commonly referred to as milfoil, is a highly adaptable submersed plant that takes root in ponds, lakes, and shallow pools that vary in depth from a few centimeters to more than 30 feet.[xxxii] Once rooted, it overwinters in the sediment and grows rapidly when favorable temperatures are reached. Eurasian watermilfoil spreads most rapidly in warm water temperatures, between 86 and 95 degrees Fahrenheit, but can photosynthesize in water as low as 50 degrees.[63,64] As it grows, it forms dense canopies near, and at, the surface of the water.

Eurasian watermilfoil is native to Europe, Asia, and North Africa and was first discovered in the United States in a Washington D.C. pond in 1942. It is believed that its introduction was through the dumping of aquaria into local waterbodies or through dumping of ballast water in the first half of the twentieth century.[65] Eurasian watermilfoil has been found in more than 55 lakes and ponds in the Adirondacks.[66] It is the most widespread aquatic invasive in the Park. Scientists assessed Eurasian watermilfoil with an invasiveness ranking of 100 — putting it in the "high" invasiveness category.[67]

Image 2 Eurasian Watermilfoil. Photo by Alison Fox, University of Florida, Bugwood.org

Eurasian watermilfoil can spread through both sexual reproduction and stem fragmentation. Fragmentation allows it to be easily spread on natural and manmade water currents and through recreational boating, which is considered the most likely mode of spread in the Northeast.[68]

Dense pockets of Eurasian watermilfoil provide poor habitat for waterfowl, fish, and other wildlife and alter water quality by decreasing available oxygen and increasing water temperature, leading to a reduction in native plants and animals, including fish. Phosphorous and nitrogen concentrations in water increase due to the decomposition of plant material from Eurasian watermilfoil at the end of the growing season.[69] Eurasian watermilfoil infestations create pockets of stagnant water that provide breeding grounds for mosquitos. The physical presence of Eurasian watermilfoil interferes with swimming, boating, and fishing and has been shown to reduce tourism and property values.[70]

Methods and Costs of Control for Eurasian Watermilfoil

A wide variety of strategies to control and remove Eurasian watermilfoil have been used in New York and elsewhere, including, but not limited to, mechanical harvest, herbicides, sterile grass carp, drawdown, and biological controls, such as midges, weevils, and moths. Costs of control vary by the technique(s) used. In New York, mechanical harvesters, which are specialized motorboats, cost over $200,000 per unit. In addition to the harvester, this control option also requires a vessel to transport the harvested material back to shore and a large truck to transport the plants to a dumping site. Costs vary depending on the distances involved and the number of trips made with each of these vehicles. The cost of herbicides to chemically treat aquatic plants can range from a couple hundred dollars to over $1,000 per acre, depending on the chemical used and the dosage level.[71]

[xxxii] In the Adirondacks the maximum depth for Eurasian watermilfoil is about 30 feet, with 12–15 feet being more typical. Source: Dan Kelting, Executive Director, Paul Smith's College Adirondack Watershed Institute, Professor of Environmental Sciences

In the Adirondacks, sponsors of management projects, such as local governments, must also secure permits from the Adirondack Park Agency if they plan to use herbicides as a treatment for invasive species.

> ***"We had one bay in [Loon] lake that got so congested [with milfoil] that you couldn't get a canoe through it. Our consultants recommended we used Renovate (herbicide) in that bay — APA gave us the permit. The permit application was 300 pages long, it was a third of my time for five months putting in the permit. We started the application process in October of 2012, we got APA permit in February and then DEC didn't give us the permit until a week before we started in May.***
>
> ***We had to test lake-wide before we applied, then we did one [testing] just before the treatment and then we did testing every week after for 10 weeks — $1,200 a week. We had to buy a curtain to isolate the bay from the rest of the lake — $20,000. We had to take water samples at 6 locations on the lake and on Chester Creek and on Schroon River. Then we had to get it to the lab in North Carolina within 24 hours."***
>
> ***[Did it work?]***
>
> ***"Yes — it worked great." ~Fred Monroe, Supervisor, Town of Chester; Executive Director, Adirondack Park Local Government Review Board***

Several studies have concluded that the benefits of control more than justify the costs. For example, a study of the benefits of the British Columbia Aquatic Plant Management Program assessed results and costs of the program in 16 British Columbia lakes. "The Province provides most of the control equipment, gives technical advice on control methods and approaches, provides 75% of the funding, and monitors performance. Local authorities administer control, decide on treatment priorities, hire staff to operate equipment, and provide the remaining operational funds." The analysis showed that control has promoted economic development, most residents and tourism operators are satisfied, and that control is cost effective. The analysis projected that termination of the control program (at a cost of $350,000 or approximately $2,000 per acre per year in 1990) would lead to about $85 million decline of regional tourism revenues, and effect about 1,700 tourism industry jobs and $360 million of real estate values."[72] These costs do not include costs associated with habitat restoration.

There is evidence that both Eurasian watermilfoil and hydrilla will re-establish themselves after removal in the absence of intentional re-establishment of native vegetation.[73] There is also some evidence from the Adirondack Park that native plants recover after hand harvesting, depending on the extent of the infestation and abundance of native plants in proximity.[74] The full cost of controlling Eurasian watermilfoil (and hydrilla) may need to include habitat restoration depending on the severity of the infestation. Costs of habitat restoration vary considerably.

Potential Economic Impacts of Eurasian Watermilfoil on the Adirondack Park

The spread and increased concentration of Eurasian watermilfoil is likely to have negative impacts on outdoor recreation in the summer months, particularly swimming, boating, and fishing. Since Eurasian watermilfoil is highly visible and the most widely established aquatic invasive in the Park today, it is likely to trigger reductions in use that will only be exacerbated by other invasives, such as spiny water flea (that primarily impacts fishing), Asian clam (that primarily impacts swimmers), and hydrilla (that has impacts similar to Eurasian watermilfoil on swimmers, boaters, and anglers).

In addition to reduced recreation and tourism, Eurasian watermilfoil, like hydrilla, may adversely impact irrigation and industrial use of surface waters, and contribute to flooding. These impacts are discussed in greater detail in the section on hydrilla.

Property Values

The most significant economic impact of Eurasian watermilfoil (and/or hydrilla) not covered elsewhere in this report is likely to be on property values. A 2009 study of the effect of Eurasian watermilfoil on property values over 170 lakes in Vilas County, Wisconsin (where 20% of the lakes had milfoil) showed that a milfoil infestation reduces average property values by approximately 8%.[75] Another 2008 study of Wisconsin Lakes found that lakes with milfoil experienced an average 13% decrease in land values after invasion.[76] A 2010 study on the effects of milfoil on lakefront property values on four lakes in Vermont showed that Eurasian watermilfoil "significantly and substantially" affects lakefront property values as the primary component of aquatic plant growth in the lake. This study found that the impact on property values was linked with the level of infestation, ranging from a 0.33% up to 16% decrease in property values.[77]

A study of the contribution of water clarity (and its diminishment from cultural and non-cultural eutrophication) in Maine lakes found changes in average property prices ranging from $11 per foot of lake frontage to $200 per foot of lake frontage. These figures equate to millions of dollars per lake in improved property prices.[78] A study in the Adirondacks found that multiple measures of water quality, including the presence of water milfoil, have significant effects on property values overall, even for properties that are not directly on the water. According to this study, the presence of invasive species on the nearest lake decreases property values by $10,459.[79] The presence of aquatic invasive species can be expected to have a dampening effect on the willingness of non-residents to pay a premium for property within the Park.

> ***"If they [invasives] were to completely take over the lake — you could see [50]% decrease in value, a million dollar property will go for $500,000; this has happened in the Thousand Islands, if the entire lake loses its pristineness — that could happen."***
> ***~Dan Davies, Co-Owner, Davies, Davies & Associates Real Estate, LLC***

As of 2007, there were 47,131 residential parcels owned by people with zip codes within the Park (6.3% of the land area) and 31,978 parcels owned by non-residents (5.1% of the land area).[80] Between 2001 and 2009, the average sales price of a property in the Park within 250 feet of water was $362,557. The average price of all parcels sold over the same period was $179,163. About 1,000 new structures are built in the Adirondacks each year, mostly along the shorelines of lake and rivers, and property in the region turns over every seven years on average.[81,82]

The total value of residential properties in the Adirondack Park is estimated to be approximately $14 billion.[xxxiii] The impact of aquatic invasive species, particularly Eurasian watermilfoil, on property values has been studied and found to range from 1% to 16%.[83] If we assume a conservative impact of 3% on property values Park-wide, approximately $420 million in property value could be at risk from increasing numbers and densities of aquatic invasive species, such as Eurasian watermilfoil. A slightly less conservative estimate of 6% impact that is still within the low end of the range suggested by the research increases this impact to $840 million. While this is a simplistic method of computing impact, it is a reasonable (and likely conservative) indication of the order of magnitude of the impact if an aquatic invasive species, in isolation or in

[xxxiii] 47,131 residential parcels owned locally + 31,978 residential parcels owned non-locally = 79,109 (total residential partners) x $179,163 (average parcel price) = $14,173,405,767.

combination with others, were to spread throughout the Park. Currently, second homeowners pay a premium for property within the Park.

There is evidence of separate real estate markets in the Adirondacks for local and non-resident buyers, with second home buyers willing to pay a premium for being on or near a lake, and close to roads or seasonal properties.[84] The presence of aquatic invasive species can be expected to have a dampening effect on the willingness of non-residents to pay a premium, which will also have a dampening effect on property values.

> ***"I had a good buyer in the $2 million range. They looked on Lake George and ended up not purchasing because of fear of invasives." ~Dan Davies, Co-Owner, Davies, Davies & Associates Real Estate, LLC***

Realtors operating in the Park will be adversely impacted by declining sales and/or property prices. There are approximately 350 realtors in the Northern Adirondacks.[xxxiv]

> ***"On Loon Lake we have assessed [property] value of $260 million. I was worried that people living on the lake would be concerned about the money we were spending but it was the opposite, people are saying you need to protect our property values, you're not spending enough." ~Fred Monroe, Executive Director, Adirondack Local Government Review Board; Town Supervisor, Town of Chester***

Any reductions in property values will also impact revenues available to local governments. There will be fewer tax dollars available to offset the increased cost of managing invasive species and the increased cost of services due to the presence of invasive species.

[xxxiv] Essex, Franklin and portions of Clinton and St. Lawrence included in the Northern Adirondack Board of Realtors. Mike Damp, personal communication 1/14/14.

Hydrilla

Hydrilla (*Hydrilla verticillata*) is an aquatic plant that roots in relatively shallow water (1.5 feet to more than 20 feet) and grows to the water's surface where stems branch and form dense mats. Hydrilla adapts readily to a wide variety of freshwater habitats, including canals, springs, streams, ponds, lakes, rivers, and reservoirs. Hydrilla is believed to have made its way to the United States via India and Korea in the 1950s and 1980s respectively.[85] Hydrilla can reproduce from tubers, stem fragments, turions, and seeds. A turion is a wintering bud that becomes detached and remains dormant at the bottom of the water. Turions can survive over four years in undisturbed sediment and for at least 12 months without water. Only one whorl of leaves is needed to start a new infestation, making it extremely difficult to control. Hydrilla can grow as rapidly as one inch per day.[86] Scientists gave hydrilla a New York invasiveness ranking of 91.40 — putting it in the "very high" invasiveness category.[87]

Image 3 Emergent stems and leaves of hydrilla. Photo: David J. Moorhead, University of Georgia, Bugwood.org

Hydrilla was discovered in the Cayuga Lake Inlet in the Finger Lakes in 2011 and is present in at least 15 waterbodies in NY.[88] Hydrilla has not yet been reported in the Adirondacks.[89]

The most common pathway for spreading hydrilla is through plant fragments attached to boats, trailers, or fishing gear.[90,91] Articles of clothing, e.g. water shoes, or pets can also transfer fragments of hydrilla from one waterbody to another, as can wildlife and natural or artificially induced water currents. Once hydrilla becomes established, boat traffic can fragment plants and lead to its spread throughout the water body. In addition, hydrilla is often a contaminant on popular water garden plants, leading to its establishment in private ponds. It is sold in the aquarium trade, leading to the potential for infestation through aquaria dumping.[92] Fragments of hydrilla consumed by wildlife will not grow after passing through the digestive tract, but undigested fragments, as well as turions and tubers, do pose a threat.[93] Hydrilla is very opportunistic and can often be found taking over water that has had populations of milfoil chemically removed without a management plan for reestablishing native vegetation.[94]

Methods and Costs of Control for Hydrilla

Many methods for controlling hydrilla have been tested and mostly found wanting. Mechanical harvesting is expensive and creates fragments that can lead to re-infestation. Harvested materials have low nutrient value and low fiber content.[95] Chemicals are costly and generally only suited for small, enclosed areas, not open waters. Non-target impacts must also be considered. Water drawdowns can also have negative ecosystem impacts and regrowth from tubers can occur. Suction harvesting is problematic since it is likely to create fragments and does not remove underground tubers that can regrow. Much attention has been given to biological controls for hydrilla through snails, insects, pathogens, and sterile carp. Insects have not proven effective in uncontrolled environments thus far.[96,97] Many of the biological control agents originate overseas and the overall impact of their introduction into the U.S. is unknown.

From 1989 through 1996, a total of 768,500 grass carp were stocked in a 48,000 acre manmade and highly managed reservoir system in South Carolina in which 38,000 acres were infested with hydrilla. By 1997, hydrilla was reported to be largely eliminated and remained sparse through 2004 with carp densities of approximately one fish for every seven previously infested acres.[98] Use of carp to control hydrilla is controversial because it can be difficult to assure sterility, they consume plants indiscriminately, including

native vegetation, it is difficult to prevent their spread in connected waterways, and effective methods of recapture have not been developed.[99]

Costs to control hydrilla vary by the method used. Treatment costs for Cayuga Inlet, which is roughly 6–8 acres in size, were estimated at $350,000 to $400,000 (at approximately $44,000 to $67,000 per acre) in 2012 with similar expenditures required in 2013.[100] It cost approximately $1,200 per acre to harvest hydrilla on the Potomac River in order to clear boat lanes. Since 2002, Massachusetts has spent approximately $40,000 per year (a combination of state, town, and private funding) to manage hydrilla in a single pond in Barnstable County.[101] The U.S. Army Corps of Engineers spends more than $1 million per year to suppress hydrilla populations in the Jacksonville District in Florida and more than $400,000 a year to treat infestations at Lake Seminole, a 30,000 acre lake on the borders of Florida, Alabama, and Georgia.[102]

Whatever method is used, treatment of hydrilla, once it is established, is a recurring annual cost. Researchers and managers expect 10–13 years of consecutive chemical treatment to deplete the tuber banks in the sediment.[103] There is evidence that hydrilla will re-establish itself after removal in the absence of intentional re-establishment of native vegetation.[104] Therefore, the full cost of controlling hydrilla may also include habitat restoration.

Economic Impacts

Hydrilla has been shown to have negative economic impacts on sport fishing, boating, and swimming as well as on industrial, agricultural, hydroelectric, and other commercial operations.[105] Hydrilla can also contribute to the severity of flooding and related losses.

Sport Fishing

Impacts on sport fishing occur as matted vegetation blocks sunlight from reaching native plants below, displacing native vegetation and impacting the physical and chemical characteristics of a waterbody. While a study of anglers in South Carolina found that all categories of anglers agreed that hydrilla was beneficial to fishing efforts, and some scientists agreed that small populations of hydrilla can have a desirable effect on sport fishing (by providing food and habitat for forage fishes), hydrilla spreads quickly, and, as it spreads, positive impacts on sport fishing are lost.[106,107]

As large hydrilla mats form, they prevent access to fishing locations and low oxygen levels in these mats make them unsuitable for the growth and survival of sport fishes and most other aquatic animals.[108] Scientists have found that hydrilla infestations lead to stratification of the water column and decreased dissolved oxygen levels that can lead to fish kills; infestations that cover more than 25%–30% of the surface in large lakes ultimately eliminate fish habitat, cause growth stunting, and reduce the number of harvestable fish.[109,110] Hydrilla has also been linked to bacteria which causes avian vacuolar myelinopathy (AVM), an avian disease affecting waterbirds.[111]

Recreational Users

Impacts of hydrilla on recreational users such as swimmers, boaters, and paddlers have also been shown to be significant. A study of the impacts of hydrilla on Lake Istokpoga, Highlands County, Florida, estimates a reduction in the number of visitor days to the lake based on interviews and surveys with visitors. This study estimates loss of visitor days (and resulting economic impacts) based on the extent of hydrilla coverage of the lake surface: 5%–10% coverage — no reduction in visitor days; 25% coverage — 24.27% reduction in visitor days; 50% coverage — 35.1% reduction in visitor days.[112]

Irrigation

Thick mats of hydrilla can reduce flow rates in irrigation operations by as much as 90% and impede the operation of irrigation infrastructure.[113] Hydroelectric generation can be impacted when hydrilla builds up on infrastructure and clogs intakes. In drainage canals it reduces flow, which can result in flooding and damage to canal banks and structures.[114] Thick mats of hydrilla hamper progress of propeller driven boats and have led to the closing of boat marinas in rivers, lakes, and reservoirs across the country.[115]

Flooding

Hydrilla, and other aquatic invasive plants, can contribute to flooding by blocking the natural flow of water — land is at great risk of flooding when dense growths of hydrilla combine with heavy rainfall.[116]

Potential Economic Impacts of Hydrilla on the Adirondack Park

If hydrilla establishes in the Adirondacks, the sectors most likely to be impacted are outdoor recreation, especially paddling, boating, fishing, and swimming, and, potentially, hydroelectric installations, irrigation,[xxxv] and industries that use surface water. Unfortunately, we do not have sufficient data regarding hydroelectric or industrial use of surface water in the Adirondacks to construct even a very rough estimate of potential economic impacts. Hydrilla is also likely to impact property values in ways similar to Eurasian watermilfoil.[xxxvi] The impacts of aquatic plant invasive species on property values are detailed in the section of this report about Eurasian watermilfoil. Here, we detail the economic impacts of hydrilla on boating recreation.

A 2007 study of paddler recreation in the Adirondacks found that approximately 28,000 visitors spent a total of 104,020 days paddling the Fulton Chain of Lakes and the Raquette River, a 58 mile portion of the Northern Forest Canoe Trail between the towns of Old Forge and Long Lake. The majority of paddlers spent money in towns adjacent to the waterway. Estimated direct spending by paddlers was $4.4 million, with indirect and induced spending of $3.3 million. Paddling in this portion of the Adirondacks was estimated to support 134 jobs and provide $2.1 million in personal income per season.[117]

A study of the impacts of negative changes to water quality on resident and visiting recreational users who fish, boat, and swim in New Hampshire found that about 9.7% of all summer tourism spending statewide is made by boaters (including paddlers).[xxxvii] If we use the 2011 estimate of total visitor spending in the Adirondacks of $1.2 billion,[118] and assume that visitor spending is stable throughout the year, and that one-third of that spending occurs in the months where the impacts of hydrilla would be most severe, then a total of $396 million per year is spent by visitors during summer months, of which an estimated $38 million is spent by boaters.

Sixty-one percent of boaters in New Hampshire said they would cease or decrease visitation if water quality conditions worsened. Worsened water quality was specifically defined to include Eurasian watermilfoil or other invasive plants like hydrilla. In the White Mountains, similar in some ways to the Adirondacks, this was estimated to result in a loss of approximately 17.5% in visitor days, total sales, household income, and jobs.[119] If we apply the same proportion to the Adirondacks, approximately $6.65 million per year in direct visitor

[xxxv] Please see Asian clam for a discussion of estimates of economic impacts on the Adirondacks related to irrigation disruption.

[xxxvi] See Eurasian watermilfoil for a discussion and estimates of economic impacts of aquatic plants on Adirondack property values.

[xxxvii] Please see Asian clam for estimates of economic impacts on swimmers and spiny water flea for estimates of economic impacts on fishing. In each case, the presence of hydrilla could both hasten the onset of economic impacts and increase their severity.

spending (total sales) is at risk from hydrilla.[xxxviii] If we apply the higher estimate of approximately 25% loss in visitor days associated with 25% coverage of hydrilla from the South Carolina study, the loss in direct sales increases to approximately $9.5 million per year over current levels of spending.[xxxix]

[xxxviii] $38 million x 0.175 = $6.65 million

[xxxix] $38 million x 0.25 = $9.5 million

Spiny Water Flea

The spiny water flea (*Bythotrephes longimanus*) is a half-inch long zooplankton with a barbed tail that is thought to have arrived in North America from northern Europe in the early 1980s in ballast water emptied into the Great Lakes.[120] Genetic testing has traced its origins to St. Petersburg, Russia.[121] It is not an insect, but a small crustacean that thrives in deep, cool waters. The spiny water flea has a high reproductive rate and lays eggs every two weeks in the summer. Scientists ranked spiny water flea at 82.42, putting it in the "very high" invasiveness category.[122]

Image 4 Spiny Water Flea on Fishing Line. Photo: Lake George Mirror Magazine.

Spiny water flea was discovered in Lake George in August 2012[123] and is present in at least seven waterways in the Adirondack Park.[124]

Spiny water flea impacts sport fishing by getting caught on fishing rods and fishing lines and by consuming native zooplankton, thus interrupting the food chain and reducing available food for juvenile and small fish.[125] Its spiky tail injures small fish that try to eat it and causes it to catch in fishing lines and reels, making fishing for larger fish difficult. Larger fish can consume spiny water flea, but there is no evidence that it is a better food source for larger fish than the native zooplankton it displaces.[126] According to the United States Environmental Protection Agency (EPA), spiny water flea competes directly with small fish and can have impacts on the zooplankton community.[127]

According to the *2014 Technical Memorandum from National Oceanic and Atmospheric Administration* (NOAA), spiny water flea outcompetes some native species for available resources causing noticeable stress or decline and alters predator prey relationships, significantly altering the food web.[128] Over time, spiny water flea poses a very serious threat to North American pelagic (open water) biodiversity.[129] The impacts of the spiny water flea seem to set back the recovery of lakes recovering from acid rain, which is significant because the Adirondack region "may exhibit the most severe ecological impacts from acidic deposition of any region in North America."[130,131]

Spiny water flea is spread from one waterway to another by boaters and fishermen. Research has shown that the spread of spiny water flea is best predicted by the quantity, quality, and frequency of human activity.[132] According to Sikes (2002), "Predictions can be made on the invasion potential for surrounding areas using the vectors of transfer, namely humans. One main factor is the lakes proximity to major roads and lakes within 3.4 km [2.17 miles] show particular vulnerability." It is important to target prevention to the areas of greatest vulnerability to maximize returns on dollars spent.[133]

The spread of spiny water flea is difficult to prevent, in part, because its eggs pass through bait fish intact, so any bait fish taken from an infested lake can excrete viable eggs into uninfested waters. Boats and gear with attached spiny water fleas or eggs can also cause new infestations, as can hitchhikers in bilge water and livewells.[134]

Socio-economic Impact of Spiny Water Flea

Scientists ranked the spiny water flea *High Negative* (-80 points) in the socio-economic assessment from the New York State Department of Environmental Conservation. The socio-economic assessment identified no

human health benefits, no economic benefits, and no cultural benefits. The ranking identified no human health risks, high economic detriment, and moderate cultural detriment. Economic costs associated with spiny water flea are primarily associated with both the recreational and commercial fishing industries.[135]

Methods and Costs of Control for Spiny Water Flea

Today, the only effective strategy for controlling spiny water flea is to prevent its spread from infested waters and prevent introduction into new bodies of water. There are no techniques for removing spiny water flea from infested areas; therefore, there are no estimates of costs to control this invasive species once it has invaded. However, the initial presence of spiny water flea does not necessarily result in permanent establishment, particularly in relatively shallow lakes that suffer occasional hot summers.[136] There is strong evidence that early seasonal introductions and large organism size promote establishment of spiny water flea. The over-wintering survival of spiny water flea eggs can be surprisingly low, and turnover of resting eggs within a year can be surprisingly high.[137] Climate change contributes to uncertainty in invasive species planning. A warming trend may help to hinder the spread of some species but may also mitigate the spread of others, such as spiny water flea, that flourish in cool water and die at temperatures above 25°C (77°F).[138]

Recommendations made by the Lake Champlain Basin Rapid Response Task Force for preventing the spread of spiny water flea from Lake George included ongoing monitoring of connected waterways and inland waterbodies in the region, decontamination of boats, trailers, and recreational equipment for recreationists arriving at and leaving Lake George, and signage to alert boaters, anglers, and other recreational enthusiasts to take precautions to avoid transporting this and other invasive species.

More research is needed to better inform managers of best options to reduce the spread of this and other open water invaders.[139] The Canadian Aquatic Invading Species Network (CAISN) selected spiny water flea as its model open water invader due to its rapidity of spread, and is, therefore, a potentially significant research partner.[140]

The estimated annual cost, including the costs of damage and control, associated with spiny water flea in the United States was $5 million in 2005.[141]

Sector of Impact: Recreational Fishing

The greatest direct economic impact of the spiny water flea is likely to be on reduced expenditures by anglers in the Adirondack Park. Fifty-four percent of all expenditures by anglers are trip-related including food and lodging, transportation, equipment rental, bait, and fuel. Thirty-nine percent of expenditures are on fishing and related equipment purchased in New York. Other expenditures include spending on magazines, membership dues, licenses, etc. Indirect economic impacts of the spiny water flea could include reduction in property values for lakeshore and other second home and primary residence properties.

There are over 3,000 lakes and ponds in the Adirondack Park. Two of the five counties in New York with the highest angler expenditures in the location fished are the Adirondack counties of St. Lawrence and Warren. Together, estimated expenditures in St. Lawrence and Warren counties exceeded $31 million in 2007. Freshwater anglers are most interested in being able to fish in a water that contains species of interest like black bass, trout, walleye, and yellow perch. Most (79%) want to fish a water that does not have a contaminant advisory. Many (34%) express the desire to have new experiences — go to new places to fish, and would like to see an increase in the number of fishing sites, improved facilities at the sites, expanded opportunities to catch larger fish, and increased opportunities to catch wild fish.[142]

Potential Economic Impacts of Spiny Water Flea on the Adirondack Park

In order to arrive at an estimate of the economic impact of the spiny water flea on the economy of the Adirondack Park, it is necessary to estimate the number and value of angler days in the Park and the extent to which they may be impacted by increased interference with fishing equipment and/or the decline in the number of large fish.

There is no reliable data on the number of anglers or angler days in the Adirondack Park. We do know that 143,072 sportsmen's licenses that include fishing were issued in the 12 Adirondack Counties during the 2012/2013 season.[xl] We also know that there were an estimated 289,011 angler days in Lake George in 2007.[143]

The U.S. Fish and Wildlife Services' *2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation: New York* reports that the average number of fishing days per angler in New York is 16 for both residents and non-residents. Approximately 16% of anglers in New York are non-residents.

There was a 63% increase in the number of anglers in New York between 2006 and 2011 and a 76% increase in state resident anglers. Expenditures by U.S. anglers increased 90% and expenditures for New York resident anglers by 131% from 2006 to 2011. The average expenditure per day for New York anglers in 2011 was $35, which includes fishing in the Great Lakes, freshwater except the Great Lakes, and saltwater. Average trip expenditures per day for freshwater anglers in New York (except the Great Lakes) in 2011 was $18 a day. Many anglers fish in more than one type of water.[144]

Although we do not know exactly how a reduction in desirable freshwater fishing opportunities in the Adirondacks would affect angler expenditures, we can offer an estimate based on the following assumptions, using Lake George as a metric:

1. If the average angler days spent in 2007 was 16,[xli] there were approximately 18,063 anglers at Lake George during 2007.
2. Lake George represents approximately 8% of the water area in the Adirondack Park.[xlii] Because it is easily accessible, while many lakes and ponds in the Park are not, we will assume that 30%[xliii] of all angler days in the Adirondacks (excluding Lake Champlain) are associated with Lake George. This means the total number of anglers in the Adirondacks would be approximately 54,736 and, together, they would spend an estimated 875,776 angler days fishing in the Park. The related expenditures, at an average of $18 per day, would be $14,012,416 per year.

Another way to estimate the value would be to assume that residents of the 12 Adirondack counties with fishing licenses spend 10% of all their angler days in the Park (excluding Lake Champlain).[xliv] In this case, the annual value of their angler days, based on average spending of $18 per day, would be $4,120,474.

[xl] Including Clinton, Essex, Franklin, Fulton, Hamilton, Herkimer, Lewis, Oneida, St. Lawrence, Saratoga, Warren, and Washington Counties.

[xli] 16 is the average number of angler days in 2011; the average for 2007 may have been lower based on statewide trends.

[xlii] The area of Lake George is approximately 28,200 acres (http://www.lakegeorgeguide.com/regional-area-info/did-you-know/) and the area of water in the Adirondack Park is approximately 334,584 acres according to the APA Land Use Classifications May 2014.

[xliii] We were unable to find data to provide a factual basis for this estimate, therefore it is a "guesstimate" that can be refined through additional research.

[xliv] 16 days x 143,072 licenses = 2,289,152 angler days x 10% = 228,915 angler days in the Adirondacks (excluding Lake Champlain) x $18 per day = $4,120,474 in angler expenditures.

These two estimates provide an estimated range of angler spending on the economy of the Adirondack Park of between $4.1 million and $14 million per year. It takes time between the introduction of the spiny water flea into new waters and the appearance of significant impacts, both mechanical (interference with fishing apparatus) and ecological (reduction in fish due to reduced feedstocks). The time frame will vary based on many factors including, but not limited to, environmental conditions, temperature, density of contamination, etc. What we do know is that, once introduced, impacts will occur over time.

For purposes of illustration, if spiny water flea infestations were to result in an annual 10% decrease in angler visitation over the first five years, and a 20% decrease over the next five years, the direct economic impacts would range from something on the order of $412,047 to $1.4 million per year for the first five years (total of $2 million to $7 million) and $824,000 to $2.8 million per year for the next five years (total of $4.12 million to $14 million over the next five years), or a total of $6.1 million to $21 million over the next ten years. These estimates do not take indirect or induced impacts of angler spending into account, nor do they include impacts such as reductions in property value or other sports and outdoor related activities often combined with fishing. These percentages are in line with estimates of the impact of invasive species on recreational fishing in the Great Lakes in which annual participation in recreational fishing was estimated to be 11%–35% less than it would have been without invasive species.[145]

Asian Longhorned Beetle

The Asian longhorned beetle (*Anoplophora glabripennis*) is a shiny black beetle with irregular white spots on a body that is about one inch long with antennae that are 1.3 times their body length in females, and 2.5 times their body length in males. The Asian longhorned beetle is native to China and the Korean peninsula and was first identified in Brooklyn and Long Island in 1996.[146] It is believed that Asian longhorned beetle was inadvertently transported to the United States in infested solid wooden pallets and crates used in packing and shipping.

Scientists gave Asian longhorned beetle a New York invasiveness ranking of 72 — putting it in the "high" invasiveness category.[147]

The Asian longhorned beetle reproduces by mating after which the adult female chews cavities in tree bark, deposits a single egg at the bottom of each cavity, and covers the cavity with a cement-like secretion. In about a week, a larva hatches and feeds on the inside of the tree, while burrowing deep into the tree's heartwood. After feeding, the larva pupates and the adult beetle chews its way to the surface, creating an exit hole in the tree.[148] Adult insects emerge in late spring to mid fall and may live for two months or more.[149] Adults mate and the cycle begins again. Each female lays between 60 and 120 eggs in its life. Tunnels severely weaken or kill infested trees within two to five years. The beetles tend to infest the same tree until it dies.

Image 5 Asian longhorned beetle boring into tree. Photo: Michael Bohne, Bugwood.org.

The Asian longhorned beetle has been detected in Brooklyn, Amityville, Queens, Islip, Manhatten, and Staten Island, and, most recently, Babylon, NY (and subsequently eradicated in Islip, Manhattan, and Staten Island) according to New York's Department of Environmental Conservation.[150] The Asian longhorned beetle has the potential to affect maple, such as sugar, red, and silver, and boxelders as well as alder, birches, elms, horsechestnuts, poplars, and willows.

Asian longhorned beetle is most likely to be spread to the Adirondacks through the transport of larvae in contaminated firewood, logs, pallets, crates, and other solid wood products. In response, many states have imposed quarantine regulations that place restrictions on movement of all hardwood species of firewood, cuttings, and nursery stock of Asian longhorn beetle's host trees and anything else deemed at risk of spreading the beetle.[151] In December 1998, the U.S. Animal and Plant Health Inspection Service put in place an interim rule requiring all solid wood packing materials entering the United States from China to be heat treated, fumigated, or treated with preservatives. In 2002, the United Nation's Food and Agriculture Organization Interim Commission on Phytosanitary Measures imposed a global standard for treating wood packaging to limit the entry and spread of pests of plants and plant products. In 2008, the New York State Department of Environmental Conservation (NYSDEC) enacted regulations forbidding the importation of untreated firewood into the state and the long-distance transportation of untreated firewood within the state.[152] Recent research based on infestations in heavily forested areas in Massachusetts (in contrast to the

more urban and suburban areas in which eradication has been successful thus far) suggest that, if left uncontrolled, Asian longhorned beetle can readily disperse into natural forest landscapes and "alter the makeup of North America's hardwood forest region."[153]

Methods and Costs of Control for Asian Longhorned Beetle

Asian longhorned beetle has no known natural enemies in the United States. It is difficult to control because larvae penetrate where pesticides cannot reach them, and infestations often begin at the tops of trees where they are more difficult to spot. However, unlike most invasives, there is strong evidence that, with proper response, Asian longhorned beetle can be eradicated. Infestations have been discovered and eradicated in Chicago, Illinois, Hudson County, New Jersey, and Islip, Manhattan, and Staten Island, New York.[154] In New Jersey, eradication took eight years and required the removal, destruction, or treatment of over 50,000 trees in four towns and their replacement with "safe" species.[155] However, successful eradication has thus far been limited to urban/suburban environments. There are concerns that eradicating the established infestation in Massachusetts may prove more difficult because it is extensive and embedded within the Northeastern maple forest, home for many susceptible species (similar to the Adirondacks).[156]

Asian longhorned beetle outbreaks have been controlled through a combination of early detection and rapid response. Public education campaigns have contributed to early detection. In most cases, it was an informed and engaged public that provided early detection of trees showing signs of attack.[157] Once an outbreak is confirmed, scouts conduct a visual inspection of trees for signs of Asian longhorned beetle. A half mile zone is established around any infested area and all trees of host species within the treatment zone are either removed or chemically treated by a combination of soil or trunk injections and/or bark spraying with pesticides. Removed trees are chipped down to no more than one inch pieces, at which point the wood is no longer subject to federal regulations and may be disposed of freely.[158] However, there is generally a cost associated with tree disposal. The infested area is re-surveyed at least once a year for the next five years after beetles are found.[159] Pheromone lures are being developed to aid eradication efforts.[160]

Control of Asian longhorned beetle is highly labor intensive. Collectively, from 1997 to 2006, the U.S. Animal and Plant Health Inspection Service and the states of New York, New Jersey and Illinois and local governments spent more than $800 million on Asian longhorn beetle eradication measures.[161] Haack's study (2009) on managing invasive populations of Asian longhorned beetle worldwide found that in 2008, $373,430,000 had been spent in the United States for the treatment of 866,583 treated trees (including 8,543 infested trees cut and 33,595 high risk trees cut) in Illinois, Massachusetts, New Jersey, and New York.[162] The Government Accountability Office found that most officials involved in the program believed Asian longhorned beetle, unlike most invasive species, could be completely eradicated,[xlv] if adequate funding is provided.[163]

[xlv] Article 14 of the State Constitution does not prevent all tree cutting to address a forest health pest or disease. That said, the decision to cut trees and the extent of trees to be cut depends on the facts and the science of the situation. New York State Department of Environmental Conservation has the statutory responsibility to "provide for the care, custody and control of the Forest Preserve." The Courts have determined that "all things necessary were permitted, such as measures to prevent forest fires...which did not call for the removal of the timber to any material degree." MacDonald, Court of Appeals (1930). An immaterial level of tree cutting is permissible by the State should such action be deemed to be in the best interest and in protection of the Forest Preserve. Personal communication, Robert Davies, August 7, 2014.

The likelihood of establishment and spread of Asian longhorned beetle can be addressed through increasing species diversity within landscapes at risk, limiting fragmentation, and generally improving and maintaining species health.[164]

Potential Economic Impacts of Asian Longhorned Beetle on the Adirondack Park

Direct economic costs associated with Asian longhorned beetle are related to the loss of hardwood trees of a variety of species and their timber value. This will affect the forest products industry in the Adirondacks. In addition, the loss of maple trees in particular has the potential to affect the maple syrup industry. Destruction of maple trees may also negatively impact the fall foliage tourism industry, since it is the color provided in large part by maple trees that attracts tourists. Other industries that could be negatively impacted by Asian longhorned beetle include furniture manufacturers, firewood producers, and commercial tree nurseries.[165] Harvesting of infested trees may have adverse impacts on aesthetics, property values, and ecosystem services, such as flood control and natural cooling, depending on the extent and location of the infestation. Economic benefits could accrue to local wood chip users since the supply of wood chips would increase as a byproduct of Asian longhorned beetle control efforts. However, woodchip suppliers may face declining prices due to increased supply.

Fall Tourism

If a combination of the Asian longhorned beetle and measures to control its spread were to result in a substantial reduction in maple trees in the Adirondacks, it is likely that some proportion of fall tourists that come to Adirondacks to see the fall colors would choose another destination (assuming other such destinations still existed) or an alternative form of recreation. Today, foliage season (September–October) is the second most popular season for visiting the Adirondacks, after the summer months. Approximately 25% of visits occur during foliage season.[166] There is evidence that this market has not yet been saturated. In 2003, 36,639 people responded to the Adirondack Regional Touring Council's Adirondack North Country Fall Scenic Byways Advertising Campaign, resulting in over $30 million in direct visitor spending.[167]

If we use the 2011 estimate of total visitor spending in the Adirondacks of $1.2 billion,[168] and assume that visitor spending is stable throughout the year, and that one-quarter of that spending occurs in the months where the impacts of Asian longhorned beetle would be influential, then a total of $300 million per year is spent during foliage season. If a significant reduction in fall colors were to affect even 10% of visits to the Adirondacks, the potential economic impact on tourist spending is on the order of $30 million a year.

Timber

A report looking at the threat of the Asian longhorned beetle in Iowa determined potential economic loss to landowners, sawmills, and manufacturers based on a stumpage value of $0.25 per board foot for each of these categories and assuming an annual maple harvest of 23,155,030 board feet. The estimated loss was $17,366,272 for the forest products industry ($0.25 per board foot to landowners, $0.25 per foot to sawmills, and $0.25 per board foot to manufacturers).[169] The study's net present value calculation identified a potential total loss to the Iowa wood products industry of $222 million or an annualized loss of $18 million.[170]

There are approximately 4.5 billion board feet of hard maple and 3.7 billion board feet of soft maple in the 12 Adirondack counties.[171] At an average stumpage price of $350 per 1,000 board feet for hard maple and $150 per 1,000 board feet for soft maple,[172] the value of the standing timber is approximately $1.575 billion for hard maple and $555 million for soft maple. The U.S. Forest Service estimated that 107.3 million board feet of maple saw timber trees (81.7 million of hard maple and 25.9 million of soft maple) were harvested from

the 12 Adirondack counties in 2012.[173] The value of this harvest on private harvestable lands, based on 2014 stumpage prices and 2012 volumes, is approximately $31 million per year. If even 5% of the trees in the 12 county region were affected, either directly or indirectly (e.g. had to be harvested to prevent further spread), the approximate loss in stumpage value could be over $1.5 million a year. There will be additional losses to sawmills in the region that rely on these trees and to landowners if harvest has an impact on property values, as well as impacts on employment, income, and tax revenues in the industry as a whole. While employment for foresters and loggers may increase in the short run, long-term employment prospects for truckers, mill workers, and others that depend on predictable wood harvested from harvestable lands, will be reduced. Trees removed prior to Asian longhorned beetle infestation or as a deterrent to the spread of infestation may not lose value (unless they are harvested prematurely), but trees removed post infestation will.

Maple Syrup Industry

According to the U.S. Department of Agriculture, there were 480 commercial maple syrup producers with a total of 788,226 taps producing 154,626 gallons of syrup in the 12 Adirondack counties in 2010.[174] This is the most recent data available. According to Michael Farrell, Director of the Cornell Uihlein Sugar Maple Research and Extension Field Station in Lake Placid, actual levels of maple syrup production are likely twice the levels reported in 2010.[175] The average price per gallon for maple syrup in New York in 2013 was $43.60. If we assume that approximately 300,000 gallons of syrup were produced in the 12 Adirondack counties in 2013, the value of that syrup is over $13 million. In addition to tree mortality, treatment of Asian longhorned beetle using approved pesticides can render maple trees untappable.[176] We were unable to locate research on the actual impacts of Asian longhorned beetle on the maple industry, but numerous sources suggest it could be devastating. Even a 5% decrease in the maple syrup harvest would result in a $650,000 annual loss[xlvi].

> ***"Maple is the preferred species for the beetle. If it is discovered, you would have to clear cut all potential host species in a large radius. It would be devastating to the maple industry." ~Mike Farrell, Director, Cornell Uihlein Sugar Maple Research & Extension Field Station***

There may be more severe effects on maple syrup producers in areas affected by both the Asian longhorned beetle and the emerald ash borer. Many maple syrup producers have large components of ash in their maple forests that could be devastated by the emerald ash borer. The loss of a significant percentage of the natural forest can cause severe ecological impacts to the forest ecosystem itself, and may affect the health and productivity of maple trees.[177]

[xlvi] This is a conservative estimate of impact. At a rate of decrease of 5% per year, maple syrup production would end within 20 years. If ALB spreads more quickly, impacts will occur sooner.

Case Study: Beech Bark Disease — Impacts from an established forest invader

Beech is an important part of the ecology of northern forests, and one of the primary mast producing trees. Beech bark disease, caused by a complex of a beech bark scale (*Cryptococcus fagisuga*) and species of Nectria fungi, has been a problem in the Northern Forest since the late 1960s and leads to mortality rates of 50% of mature beech. Remaining trees are highly defective and have little economic value.

Image 6 Beech Bark Disease. Photo: Joseph O'Brien, UDSA Forest Service

Once beech is diseased, the bark gets cankers, making it hard to debark the logs. It is very labor intensive to get any value out of a diseased log. Beech is not a high value species, but sawlogs can be used as railroad ties and heavy duty construction grade lumber. Once trees are diseased, they tend to be processed as pulpwood, resulting in some loss of value to the landowner.

Beech bark disease can also create a safety hazard because it results in the tops of beech trees dying and branches snapping. Furthermore, the presence of beech bark disease makes it very difficult to sustain sugarbushes and to regenerate more desirable species of trees because, as diseased beech trees die, they send up many suckers and the understory of the forest gets overtaken by beech, which limits the regeneration of maples and yellow birch, both higher value species.[a] This cycle is hard to break.

The costs to control beech bark disease are high. Control requires a very heavy cut of beech in the infested area that leaves the other trees (sugar maple, yellow beech, cherry) as seed trees. By harvesting beech in the summer when it has fewer reserves in its root system to sprout, the odds of successful regeneration by other species are increased. Pesticides are another option for control, but on a commercial basis they are cost prohibitive since direct application to the stump is required. Flame-weeding is also labor intensive and hazardous. Removing beech in an area that has already sprouted can be hazardous to the health of workers.

> *"You get beech whips in eyes and ears from working in a sugarbush overtaken with beech thicket. We have had two workers end up in the ER after having small, pointy branches get into their eyes and ears. "* ~Mike Farrell, Director, Cornell Uihlein Sugar Maple Research and Extension Field Station

Cutting beech on forestland often requires putting in a winter road that can cost over $25,000. Landowners see truck after truck of low grade wood go by and at the end of the winter they make $10,000 or $15,000 because it was a salvage operation.[b] Landowners lose money in the short run by trying to control beech bark disease, hoping that higher value trees will replace the beech and provide longer term profits.

Preventing the spread of beech bark disease in the Northern Forest has proved more challenging than expected. Trees that have died from beech bark disease within the past 12 months can still have scales or scale eggs present. If the wood is moved, beech bark disease may spread into areas currently unaffected. Beech that is infested with beech scale may be removed and utilized for firewood or other projects if certain conditions are met. Most of the activities related to prevention include obtaining and using firewood within 25 miles of where it was harvested and not transporting beech firewood or logs between July 15 and November 15 when the crawlers are present and could be blown off the wood and start additional infestations.

> *"We started controlling beech bark disease in the 60s and we hoped it would be gone in 20 years, but that is not the case."* ~Len Cronin, Regional Forest Manager, Finch Paper

[a] Michael L. Farrell, Director of the Cornell Uihlein Sugar Maple Research and Extension Field Station personal communication by email, 1/18/14.

[b] Len Cronin, Regional Forest Manager, Finch Paper, Finch Forest Management, personal communication, 01/08/14

Emerald Ash Borer

The emerald ash borer (*Agrilus planipennis*) is a dark metallic green beetle about half an inch long that attacks and kills all species of ash trees. Emerald ash borer (EAB) was first detected in Michigan in 2002 but was likely introduced into North America sometime in the 1990s. It originates in Northeast Asia and is believed to have traveled in infested wooden cargo crates from Asia. The emerald ash borer spread to multiple states and Canada within five years. Since it can travel only short distances under its own power (usually less than half a mile per year), the interstate spread is believed to be due primarily to the transport of firewood, nursery stock, unprocessed logs, and other ash commodities that are infested with eggs, larvae, or pupae.[178] This spread has occurred despite federal and state quarantines.

Image 7 Adult emerald ash borer in larval tunnel. Photo courtesy of the Virginia Cooperative Extension.

Scientists gave the emerald ash borer a New York invasiveness ranking of 96 — putting it in the "very high" invasiveness category.[179]

The emerald ash borer has been identified in at least 21 New York counties but, as of July 2014, not in any of the 12 Adirondack counties.[180]

Emerald ash borers attack otherwise healthy trees. A single female emerald ash borer can lay 90 to 200 eggs in the cracks of ash tree bark. They generally start laying at the top of the tree and work their way down. When the eggs hatch into larvae, the larvae eat their way into the layer of wood under the bark, leaving tunnels or "galleries" that have a distinct S-shaped pattern. If enough galleries accumulate on a single tree, it can kill the tree within two to four years. Emerald ash borer pupae overwinter just underneath the bark of the tree and become mature beetles that chew their way through the bark between mid-May and mid-September, creating distinct D-shaped exit holes.[181]

Methods and Costs of Control for Emerald Ash Borer

Unlike the Asian longhorned beetle, efforts to prevent the spread of the emerald ash borer have not been successful, and scientists are not optimistic about the prospects for eradication.[182] The emerald ash borer has killed more than 25 million trees in spite of tens of millions spent on control measures, and it continues to spread.[183] The U.S. Forest Service has developed an integrated plan to reduce the negative impacts of the emerald ash borer that includes preventing its spread through a combination of regulation and public education combined with cost-effective phytosanitation and disposal techniques;[xlvii,184] helping landowners prepare for adverse impacts through inventories and mitigation plans;[xlviii] rapid response that may include use of insecticides, biological control options, and/or tree removals;[185] improved utilization of ash wood and

[xlvii] Pathways of particular concern include businesses that import firewood from non-local and non-certified sources; local campgrounds or festival grounds where overnight camping and firewood use might occur; developments or subdivisions built within the last 10–15 years; industries that utilize raw ash products, such as mills and furniture manufacturers; and, industries and businesses that import goods shipped in solid wood packaging materials from Asia.

[xlviii] Early detection (which may include branch peeling, visual surveys, and traps) and inspections at campgrounds and industries that use ash.

fiber, including marketing of emerald ash borer infected wood; and, developing resistant species of ash and diversifying tree plantings in settled areas.[186]

The southern half of New York is in an emerald ash borer quarantine area (which prohibits the movement of materials which may be harboring forest insects or forest tree diseases outside of the quarantine area).[187] In 2012, the State conducted 245 inspections at establishments that handle wood products to determine compliance with the emerald ash borer regulations.[188]

Based on data derived from surveys of 33% of the communities in Ohio, Sydnor et al. (2007) estimated that total costs to Ohio residents of damage from emerald ash borer would range from $1.8 to 7.6 billion or $157 to $665 per resident (man, woman, or child). This total included tree removal costs ($0.7–2.9 billion), tree replacement costs ($0.3–1.3 billion), and losses in landscape value ($0.8–3.4 billion). These costs represent the impact of a single invasive species in one state.[189] A study looking at the cost of potential emerald ash borer damage in the United States from 2009 to 2019 simulated emerald ash borer infestation over a decade and estimated the discount cost of ash treatment, removal, and replacement across 25 states. The base case model estimated 2,047,000 ash trees in developed areas of New York and that 419,000 trees would be treated or removed at a cost of $203 million.[190,xlix] Similar to Asian longhorned beetle, experience in treating emerald ash borer has been predominantly in urban and suburban landscapes. The extent of damage it could do in heavily forested landscapes like the Adirondacks is not yet well understood.

Potential Economic Impacts of Emerald Ash Borer on the Adirondack Park

Forest Products Industry

Direct economic impacts of the emerald ash borer in the Adirondacks will be primarily on the forest products industry through increased costs of regulatory compliance and reduced value and availability of product over time. Efforts to prevent the spread of emerald ash borer are already impacting the New York forest industry. Enforcement of regulations includes inspections of mills, growers, dealers, transporters, mulch/chip operations, and researchers. According to Eric Carlson, Executive Director of the Empire State Forest Products Association, the forest industry in New York spends over $2 million annually to comply with regulatory requirements related to invasive species.[191]

Areas at high risk for impacts related to production are those with a concentration of ash trees. There are approximately 53 million ash trees greater than 5 inches in diameter in the 12 Adirondack counties; about one in every twenty trees throughout the region is an ash. A report looking at the threat of the emerald ash borer in Iowa determined potential annual economic loss to landowners, sawmills, and manufacturers based on a value of $0.20 per board foot for each of these categories and assuming an annual ash harvest of 2,108,000 board feet. The estimated loss is $1,264,800 for the forest products industry. The study's net present value calculation identified a potential total loss to the Iowa wood products industry of $27 million or an annualized loss of $11 million.[192]

There are an estimated 1.084 billion board feet of ash sawtimber in the 12 Adirondack counties.[193] At an average stumpage price of $150 per 1,000 board feet,[194] the standing ash is worth approximately $162.6 million. The U.S. Forest Service estimated that 10.5 million board feet of ash was harvested from the 12 Adirondack counties in 2012.[195] Using a value of $0.15 per board foot (the average stumpage price for ash in

[xlix] New York State Department of Environmental Conservation estimates that ash trees make up 8% of all trees in the state and that there are more than a billion ash trees in New York.

the Adirondack region in winter 2014), the stumpage value of an annual harvest is estimated at $1.6 million.[196] If 5% of the harvestable ash trees in the 12 county region were affected, either directly or indirectly (e.g. had to be harvested to prevent further spread), the approximate loss in stumpage value could be $80,000 a year.[1] Trees removed prior to infestation to prevent its spread will not lose value (unless there is significant downward price pressure due to an oversupply of ash in the short term relative to market demand and/or they are removed prematurely).

> ***"If we have an owner in a quarantined area, they can sell as long as there is a mill in the [quarantine] area that takes ash. Once you are in a quarantine area, everyone wants to salvage all at once and you get a flood of product to the market and that decreases the value of the product." ~Len Cronin, Regional Forest Manager, Finch Paper***

According to Eric Carlson of the Empire State Forest Products Association, ash is currently a preferred species, especially by countries like Turkey, Vietnam, Korea, and China, which are buying about 50% of all ash being harvested. This means that landowners are proactively harvesting ash thus gaining some current value while losing ash from the forest for the future.[197] Over time, infested ash will lose value. The loss will be the difference between the value of the tree as sawtimber and its value as woodchips. The price of delivered woodchips in New York is approximately $40 a ton.

In an estimate of the annualized damage in the United States associated with emerald ash borer, researchers found the timber loss to forest landowners was only about 3% of total costs. Other costs included federal government expenditures (2%), local government expenditures (51%), household expenditures (21%), and residential property value loss (23%).[198] These figures are derived largely from experiences in urban and suburban areas, but they suggest that costs will be far greater than simply the loss of stumpage value.

> ***"Most concerned are saw mills that mill ash — they are concerned if it is widespread there won't be ash to cut. If they are cutting good material, they have to use extra paperwork to document what they do." ~Greg Mayes, Fiber Supply Manager, International Paper***

In an area like the Adirondacks with an active forest industry, the loss is not only to the landowners, but to the industry as a whole. If it becomes difficult to find markets for ash from infested regions, the industry will suffer.

> ***"Our most lucrative ash market for Adirondack ash right now is the Ames True Temper mill in Wallingford, VT. We ship there weekly. Our concern would be if the quarantine moves north of interstate 90 — once EAB is found in the Adirondacks it will quarantine the whole state and we won't be able to sell to VT or Canada. There is a small window in the winter when they allow the logs to be sold out of the quarantine area because the bug can't live in the cold temperatures. But the paperwork is close to a chain of custody ticket [a requirement related to Forest Stewardship Council certification]. Whatever mill receives the wood has to chip or burn the bark so that the forest pest isn't being transmitted. Most people don't want to deal with it." ~Len Cronin, Regional Forest Manager, Finch Paper***

[1] This is a conservative estimate that assumes impacts are spread over time. At a rate of decrease of 5% per year, there would be no remaining harvest after 20 years. If EAB spreads more quickly, impacts will occur sooner.

Emerald ash borer will also impact the maple syrup industry because ash trees can be a main component in sugarbushes. Maple producers manage their forests for not just maple. Having dying ash trees lowers the diversity of the sugarbushes.[199]

Local and State Governments

Emerald ash borer may cause property damage from dead trees or branches falling in roadways and on buildings, cars and/or people. Utility companies and the New York State Department of Transportation are both concerned about impacts. Campgrounds and trails are also made more hazardous by dead trees. There are a total of 7,502 miles of roads in the Adirondack Park, including 4,388 miles of town and village roads, 1,552 miles of county roads, and 1,562 miles of state roads, and the vast majority is flanked by forests.[li]

> ***"The emerald ash borer has the potential to be a huge cost. We will likely have to hire outside contractors, tree companies, because we won't be able to manage it ourselves." ~Ed Frantz, Adirondack Park and Forest Preserve Manager, New York State Department of Transportation***

Estimates of the cost to Ulster County in New York from the emerald ash borer based on a recently completed windshield survey of ash trees in proximity to the right-of-way along county roads identified 8.2 ash trees per mile. The total cost for ash removal was estimated at $936,360 or $2,200 per mile for ash management along county roads. This does not include the cost for managing ash trees adjacent to state and local roads.[200] If we apply the Ulster figure of $2,200 per miles, the cost of managing dead and dying ash trees in the Adirondack Park could be as high as $16.5 million, assuming tree density similar to Ulster County and a removal cost of $270 per tree.[lii] If the density of ash is greater along Adirondack roads than it is in Ulster County, or the cost of removal per tree is greater, the per mile costs will be even higher. Cost increases will be faced by both the public and private sector, including local municipal and county governments, as well as by owners of campgrounds and recreational trails.

Utility Companies

Utility companies are facing increased costs for line maintenance as a result of invasive species. National Grid has hired one staff person full time to handle forestry issues related to emerald ash borer and Asian longhorned beetle.[201] New York utilities work together through Environmental Energy Alliance New York (EEANY) that has developed a set of best management practices for invasive species approved by New York State Department of Environmental Conservation.

> ***"The EAB is unique in how it kills the tree, it deprives it of nutrients, killing it quite quickly. The ash tree becomes very brittle. Within two years it is a hazard tree that may be extremely dangerous for the crews to remove safely. We are very worried about it. One tree could knock out power to hundreds or thousands of customers." Teri Niedzielski, Lead Vegetation Strategy Specialist, National Grid***

[li] This includes roads within perimeter towns that are outside the Blue Line.

[lii] This assumes an average diameter at breast height of 10 inches and a cost/diameter inch of $27.

Utility companies that operate in the Adirondacks are particularly concerned about the emerald ash borer because they have so many miles of lines that run through forested areas. National Grid estimates 242 trees per mile along their power rights-of-way in New York. There are a total of approximately 105,855 miles of power rights-of-way in New York that are vulnerable to trees falling on them. If 20% of these trees are ash, and a conservative estimate to remove these trees is $300 per tree,[liii] then the cost to rate payers statewide would be $1.54 billion.[202]

[liii] The cost of removal per tree is higher for utility companies than for governments because trees along utility corridors are generally harder to reach.

Spotted Wing Drosophila

Spotted wing drosophila (*Drosophila suzukii*) is a small fruit fly, about one-tenth of an inch long. Unlike most fruit flies, spotted wing drosophila (SWD) attacks otherwise sound ripening fruit. Female spotted wing drosophila cut through the surface of fruit into the flesh where they deposit 1–3 eggs per fruit. The eggs turn into larvae that feed inside the fruit and cause the skin to collapse, making the fruit unmarketable. Egg laying also introduces fungal pathogens that rot the fruit.[203] Adult female spotted wing drosophila live between two and nine weeks and can lay more than 300 eggs in that time. Spotted wing drosophila has many hosts, including wild hosts like crabapple and wild rose, but is most attracted to soft fruits like grapes, cherries, peaches, blueberries, raspberries, and strawberries. Spotted wing drosophila produce roughly 10 generations per year in the United States.[204]

Image 8 & 9 Spotted Wing Drosophila on Raspberry. Raspberry infected with Spotted Wing Drosophila. Photos by Tim Baker, copyright 2013

Spotted wing drosophila is a native of Japan and is believed to have been transported to the United States on infested fruit. It was first discovered in the western United States in 2008 and is now well established throughout the country.[205] Spotted wing drosophila was first discovered in New York in 2011 and was detected in Clinton, St. Lawrence, Herkimer, Washington, and St. Lawrence Counties in 2013.[206,liv] Although it does not winter over in the region, the pest moves up from the South each year and gets worse as the summer progresses.[207]

Spotted wing drosophila appears to spread by natural means within limited areas and through transporting of infected fruit over larger distances.

Methods and Costs of Control for Spotted Wing Drosophila

The first step in control of spotted wing drosophila is sanitation, which includes the elimination of wild hosts, such as wild blackberries, as well as removing overripe fruit to reduce habitat availability. Infested fruit must also be immediately disposed of. Fruit growers must continuously monitor to detect the presence of spotted wing drosophila. Monitoring generally requires the use of traps set out prior to fruit ripening and serviced on a weekly basis. Insects caught in traps must be examined under a microscope to make a positive identification.[208] Once spotted wing drosophila has laid its eggs in fruit, it can no longer be controlled with pesticides. In addition, spotted wing drosophila can be difficult to control with pesticides due to its short lifecycle with overlapping generations that make it difficult to know when to spray. Multiple sprayings in a given season can lead to pesticide resistance.[209]

[liv] As of July 2014, spotted wing drosophila had not yet been identified in the Adirondack Park, but it is expected to arrive later in the summer (in 2013 it was discovered in Adirondack counties in August).

"To try to control the spotted wing drosophila (a kind of fruit fly), you have to spray every 3–5 days as the berries ripen. That is a lot of expensive product, and a lot of time and fuel for the grower. If they try to economize, and spray only every 10 days, it's not going to be effective, and their efforts will be a waste." ~Amy Ivy, Regional Specialist, Eastern NY Commercial Horticulture Program

Surveys of berry growers in the Eastern United States on the impact of spotted wing drosophila in 2013 found that 88% of growers reported increasing their use of pesticides and an increased average cost of $165 per acre. Average costs vary by crop and range from $341 per acre for respondents growing only blackberries to $95 per acre for respondents growing only blueberries. In addition to increased costs for pesticides, growers experienced an average 12% increase in labor costs associated with spotted wing drosophila. Dale Ila M. Riggs, President, New York State Berry Growers Association and owner of The Berry Patch in Stephentown, NY reports that the New York raspberry and blueberry industries lost $2–$3 million in value of an $8 million crop in 2012, with many growers losing 100% of their fall raspberry crop.

Control efforts can have a significant positive effect on reducing the economic costs caused by spotted wing drosophila. In New York, crop value losses for blueberries, raspberries, and strawberries fell dramatically between 2012 and 2013. For example, the estimated crop value loss for blueberries in 2012 was $3,893,000 for the 15 grower respondents, and this fell to $77,860 in 2013. Similar reductions occurred across all crops; however the value of loss for raspberries remained particularly high in New York at $2,742,500 in 2013.[210] The reduction in reported loss suggests that existing protocols can be used to effectively limit, if not eliminate, damage from spotted wing drosophila, though whether the same protocols will continue to be effective in the future is uncertain.

Potential Economic Impacts of Spotted Wing Drosophila on the Adirondack Park

Spotted wing drosophila's direct economic impact is on growers of soft fruits including blueberries, strawberries, raspberries, cranberries, grapes, peaches, mulberries, persimmons, tomatoes, and cherries. In the 12 Adirondack counties, there are 306 farms growing 602 acres of berries valued at $225,000 in 2012.[211]

At an increased average cost of production of $165 per acre, spotted wing drosophila will cost these farmers approximately $99,330 per year or 44% of the value of their crop. This is assuming controls are successful and losses are minimal.

If crop losses are added to this figure, the impact is even greater. Crop losses in New York in 2012 due to spotted wing drosophila were reported to range from 80% for raspberries and blackberries to 30% for cultivated blueberries and 10% for strawberries.[212] Data at the county level is not available by type of berries but we can assume, based on the crop losses reported in 2012, an annual berry crop loss between $22,500 and $180,000.

"Pest management is much more complicated now, for both conventional and organic growers. The old way of agriculture was more formulaic. The folks switching to organic have extra challenges to keep pest populations down enough to not decrease the crop's yield." ~Amy Ivy, Regional Specialist, Eastern NY Commercial Horticulture Program

It is worth noting that the number of farms growing berries and/or acres in berries increased between 2007 and 2012 in every Adirondack county but one (Fulton), probably in response to new market opportunities created through consumer interest in local food products, and berries in particular. *Produce News* reports that

the growing trends of convenience, naturalness, and intrinsic health benefits are all contributing to strong growth in demand for berries.[213] Spotted wing drosophila will substantially undercut the benefits to growers of this emerging trend. Many growers in the Adirondack region use organic and/or sustainable growing practices that do not include the use of pesticides. Control options for these growers are more limited and more labor intensive.

Case Study: Eurasian Boar

New York populations of Eurasian boar, also known as feral swine, have most likely emerged from escaped and abandoned Eurasian boars kept in captivity and at hunting preserves. Eurasian boar crossbreed readily with domestic pigs, which has resulted in a wide range of coat colors and body shapes.[a] In 2010, the New York Department of Environmental Conservation (NYSDEC) was notified by a person hired by a farmer who thought he was having nuisance deer issues. NYSDEC issued the farmer permits to cull the deer. When the hunters were lined up to shoot, they found that it was not deer, but Eurasian boar. "At that point, we knew we had a problem," explained Lance Durfey, Regional Wildlife Manager, NY Department of Environmental Conservation, Region 5. The boar were reported to have escaped from a New York facility that raised them for shooting preserves; these animals reproduced and established a population in the Town of Peru in Clinton County.

Image 10 Feral Swine at night. Photo: Lance Durfey

NYSDEC's efforts, which spanned two years, stopped in 2013 as a result of a new five year contract with USDA Wildlife Services for Eurasian boar in New York. Durfey explains, "We feel fairly confident that we eliminated that population. We have had no further reports of feral swine in that area. In other regions of the country, no one's real anxious to declare victory."

The labor-hour estimates by the Bureau of Wildlife for this work in FY 2011–2013 (as of 9/20/12) was $52,998. Expenses incurred in the same time period total $15,400 on items such as trail cameras, cell service contracts for the cameras, camera batteries, corn for bait, travel and per diems, ammunition, corral trap materials and construction, volunteer mileage reimbursement, and miscellaneous supplies and materials. One animal can cause up to $1,000 of damages in one night.[b] Agricultural damage estimates in NYSDEC Region 5 for calendar years 2011 and 2012 total $20,000. Eurasian boar also can transmit and are reservoirs for serious diseases of humans and livestock, such as brucellosis, pseudobrucellosis, and trichinosis.[c]

Key informant interviews about the threat of invasive species to the Adirondack economy identified Eurasian boar as an issue across six economic sectors (Agriculture, Conservation, Forestry, Local Government, Recreation and Tourism and State Government).

> "If there is anything on this list [of priority invasive species] that has the ability to run into millions of dollars in terms of agricultural damage, it is the swine." ~Greg Mayes, Fiber Supply Manager, International Paper

The New York State Department of Environmental Conservation Commissioner has announced new regulations that would prohibit hunting or trapping of free-ranging Eurasian boars in New York. In addition, Governor Cuomo signed legislation on October 21, 2013 which immediately prohibited the importation, breeding or introduction to the wild of any Eurasian boars. Furthermore, the law prohibits possession, sale, transport or marketing of live Eurasian boars as of September 1, 2015.

Durfey believes that success in Region 5 has resulted from New York's capacity for rapid response.

[a] New York Invasive Species Information. Feral Swine. http://nyis.info/index.php?action=invasive_detail&id=18 *Accessed 06/27/14.*
[b] Pimental, David, Rodolfo Zuniga and Doug Morrison. "Update on the environmental and economic costs associated with alien-invasive species in the United States." Ecological Economics. 52 (2005) 273–288.
[c] Davis, D.S. and P.H.Elzer, *Brucella* vaccines in wildlife, Veterinary Microbiology, Volume 90, Issues 1–4, pages 533–544, 20 December, 2002.

Japanese Knotweed

Japanese knotweed (*Polygonum cuspidatum – or Fallopia japonica*) is a hardy, shrub-like perennial with three to six inch long oval leaves and stout, hollow, bamboo-like stems that can grow to 14 feet in height. It is native to Japan, Korea, Taiwan, and Northwest China and was introduced to Britain in 1825 as an ornamental plant for large gardens.[214] From there, it was introduced to the United States in the late 1800s and has since spread to at least 41 states. Japanese knotweed spreads rapidly due to its ability to reproduce from rhizomes (underground stems with lateral shoots), root fragments, and cut or broken above-ground stems as small as half an inch. Knotweed seeds remain viable for up to 15 years, however, relatively little spread is thought to be from seed dispersal.[215]

Image 11 Japanese Knotweed growing through the pavement. Photo: http://www.wiseknotweed.com/japanese-knotweed-identification/summer/

Japanese knotweed can be transported by natural causes, including flooding and erosion, and through human assisted activities, such as roadside clearing, use of contaminated fill material, illegal dumping, and contaminated road and construction equipment, etc. Japanese knotweed is commonly found in roadside ditches, along rivers and creeks, railroad rights-of-way, unmanaged lands, and private residences. It grows in both dry and wet conditions.[216]

Scientists assessed Japanese knotweed at a New York invasiveness ranking of 97.94 — putting it in the "very high" invasiveness category.[217]

Japanese knotweed has been present in the Adirondack Park since at least the 1970s.

Japanese knotweed is most aggressive on sites that have been disturbed by natural or human activity. Its massive growth quickly forms dense thickets, out-competing native plants through a combination of limiting available light, altering the nutrients available, and emitting toxic or inhibiting chemicals. It has been known to block wildlife corridors, such as rivers, rail beds, and roadsides.

When established along riverbanks, Japanese knotweed can contribute to flooding by reducing the capacity of channels to carry floodwater and to erosion when its large, fibrous roots and stems wash into the water during periods of peak flow. It can block or interfere with access to waterways for paddling, boating, angling, and swimming.[218] In addition, Japanese knotweed is known for its ability to penetrate asphalt and cracks in concrete,[219] causing damage to underground structures like drains and buried services, as well as roads, driveways, and buildings. It can grow through concrete/asphalt up to 8 cm thick as well as through building foundations. It is of particular concern in new housing developments.[220] In Great Britain, the presence of Japanese knotweed close to or on a person's property has an impact on the actual and perceived value of the property. A study on the economic costs of non-native species in Great Britain found that banks were denying mortgage applications on the grounds that Japanese knotweed was present on the property.[221]

Japanese knotweed has potential as an edible plant, a homeopathic remedy, and a source of resveratrol, a potent antioxidant, though none of these uses are widespread at this point in time.[222] In Japan, knotweed is known by the name Itadori, meaning "heals the sick."[223] Knotweeds are an excellent food source for honeybees.[224]

Methods and Costs of Control for Japanese Knotweed

It is difficult to prevent the introduction of Japanese knotweed due to the number of ways in which it can be spread, which include natural and manmade pathways. The best way to control Japanese knotweed is through early detection and eradication of infestations. Early action can significantly reduce the costs of control. Established stands of Japanese knotweed have required 5–10 years of active control to achieve eradication. If control measures are not repeated, the Japanese knotweed that has been disturbed will increase its density over time. Mulching and/or replanting immediately with cover crops can prevent other invasives from germinating in disturbed soil.[225] Mismanagement of Japanese knotweed through cutting, for example, will increase its spread.

Control measures for Japanese knotweed include[226,227] digging or excavation and disposing of material at landfills; burying at least 15 feet deep; matting for up to three seasons with thick tarps; and chemical treatments, either through foliar application or stem-injection of herbicide. All methods of controls must be repeated and regularly monitored for five to 10 years.

Young Japanese knotweed shoots are edible for livestock and horses when they first appear in early spring. Grazing will not eradicate knotweed, but can suppress its growth and prevent spread, especially when used in combination with other control measures.[228] There are no approved biological controls for Japanese knotweed.[229]

The Town of Inlet and surrounding communities in Hamilton County in the Adirondack Park have been controlling Japanese knotweed since 2008 at a cost of $15,000–$21,000 per year. In 2013, they spent an estimated $21,000 and treated approximately 60,000 knotweed canes in more than 200 sites, including prior sites, new sites in the towns with prior infestations, and new sites in new towns.[230] The Town of Inlet estimates it costs approximately $75 per treatment for 50–100 canes that are marked and injected with herbicide. This includes the cost of the applicator, herbicide, fundraising, and administration. Inlet's success has led to an increasing number of requests for assistance from other towns and counties in the Park, as well as interest from New York State Department of Transportation in using Inlet as a teaching site for road crews. Inlet reports great progress and continues to monitor treated sites, scout for new infestations, and repeat or initiate treatment, as needed. Inlet is encouraging other communities to start their own programs. [231]

Potential Economic Impacts of Japanese Knotweed on the Adirondack Park

The economic impacts of Japanese knotweed in the Adirondacks are likely to be most significant for state and local governments and the construction industry, but it may also impact recreational users, especially hunters and wildlife viewers.

Local and State Government

Local and state governments will face increased costs in dealing with deterioration in the quality of road surfaces and related infrastructure and maintaining public safety through visibility. A study of Japanese knotweed control found highway departments in the United Kingdom were spending the equivalent of $11.66 per mile (assuming $7.32 per £1.00 and 0.62 miles per kilometer). Additional costs will be incurred if governments choose to invest in early detection and control strategies.

> ***"We have had some visibility issues along the Northway with invasive species like Japanese knotweed. That is a safety issue. One of these locations is Pottersville. There is the cost of going out to manage species for safety issues." ~Ed Frantz Adirondack Park and Forest Preserve Manager, New York State Department of Transportation***

Construction Industry

Japanese knotweed may also have direct economic impacts on the construction industry, which is a significant source of employment in the Adirondacks. Construction of new nonresidential structures and construction of commercial and health care structures are among the top 10 industries by employment in the Park. Together they employ almost 2,500 people and generate over $100 million in labor income.[232] The study of Japanese knotweed impacts in the United Kingdom found that the presence of knotweed on a construction site added 10% to the cost of development in order to cover removal and legal disposal of the topsoil contaminated with viable root material.[233] Added costs will depend on the regulatory regime in place. In Ontario, a municipality can pass a property standards bylaw under the Building Code Act to address the presence of plants deemed noxious or a threat to the environment or human health and safety. A municipality can also regulate Japanese knotweed due to concerns for flooding and infrastructure damage. Increasing costs of construction may dampen demand, leading to a loss of jobs. In the Adirondacks, the presence or potential for the introduction of invasive species is an important consideration when issuing construction permits.

> ***"In permits we issue from our agency we have specific conditions that we build in to reduce the spread of invasive species. We require the use of straw bales instead of hay bales. We require projects to use a clean fill source. We also have conditions in our permits that construction vehicles must be sanitized before moving to another site. We understand that this is an additional expense but it is essential in preventing the spread of invasives and mitigating the costs associated with invasive eradication and management." ~Dan Kelleher, Special Assistant, Economic Affairs, Adirondack Park Agency***

All these requirements increase the cost of construction. In the United Kingdom, the presence of knotweed has started to impact mortgage eligibility.[234]

Recreation

Other areas of impact include damage caused by flooding and loss of recreational access and visibility for hunting, fishing, wildlife viewing, boating, and swimming. A study estimating the net loss in recreation use values from non-indigenous invasive plants in general in Nevada found losses in the range of 3–29% in hunting, fishing, and wildlife viewing.[235] Research specific to the economic impacts of Japanese knotweed on recreation could not be found.

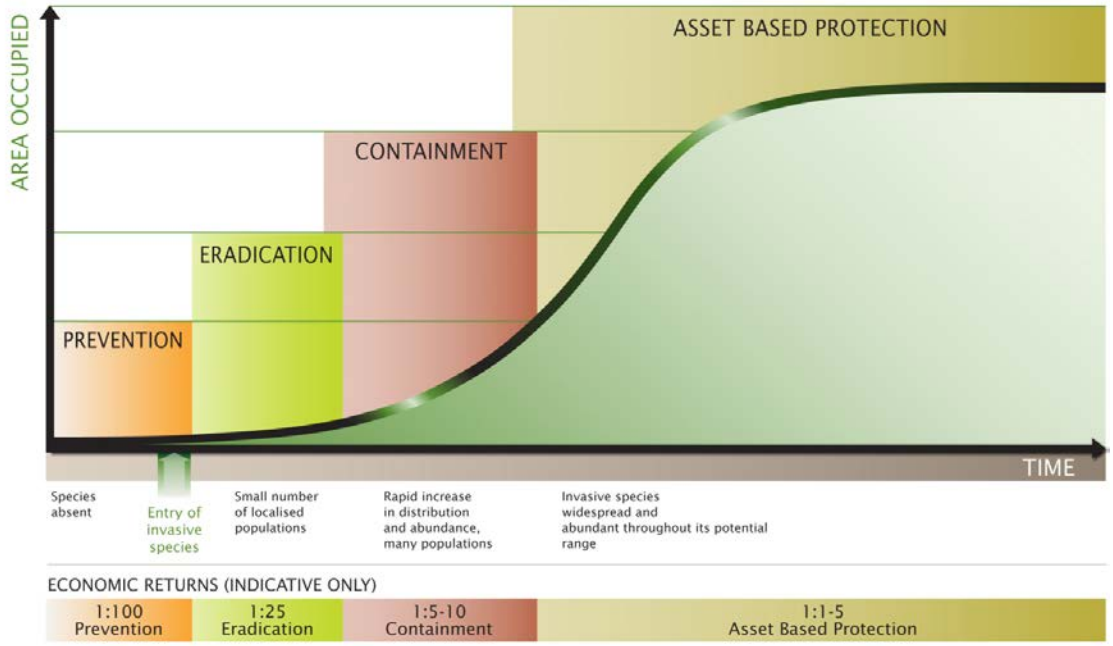
> ***"Japanese knotweed is on a lot of our little streams. It chokes them off and makes it impossible to fish. It's ruined the scenery down along the Boquet. Many sections are now impassable. It used to be ferns, now they are all gone. You don't see the deer that you used to see." ~Joe Hackett, Owner, Tahawus Unlimited***

Overview of Costs of Prevention and Control of Invasive Species

The continued spread of invasive species in the Adirondack Park will have significant actual and potential economic consequences, based on our review of eight priority invasive species. This section of the report provides general information on the economics of prevention and control of invasive species, as well as the status of current efforts in the Adirondack Park.

While most people understand that preventing the introduction and spread of invasive species is the first line of defense for minimizing their impacts, attention to invasive species in New York and across the United States has historically been reactive.[236] The figure below, developed by the Australian State Government of Victoria Department of Environment and Primary Industries, shows the environmental (abundance) and economic (control) costs of not being proactive when it comes to invasive species.

Figure 3: Generalized Invasion Curve Showing Actions Appropriate to Each Stage of Invasive Species Response[237]



There are generally five categories of activity on the invasive species spectrum of strategies: 1) Prevention, 2) Early Detection and Monitoring, 3) Rapid Response, Control, and Management, 4) Education, Outreach, and Training, and 5) Enforcement and Legislation. Prevention, early detection, monitoring, and rapid response occur during "prevention" and "eradication" stages while control and management fall into the "containment" and "asset-based protection" stages (Figure 3). While education, outreach, and training usually begin in these later stages, they should be a component of prevention. Enforcement and legislation are also often reactive but can play a key role in a successful proactive strategy.

Costs of Control Versus Eradication

When an invasive species becomes established and spreads, control becomes necessary. Control and management is a broad term to define containing, suppressing, or eradicating (eliminating) an invasive species; however, here, control refers to actions to contain or suppress an infestation at low enough levels to prevent its spread, and eradication describes the condition when an invasive species is eliminated from an area for at least three years with no signs of re-infestation. Incremental control costs often increase as the population of any given invasive species declines. Therefore, rather than eliminating the invasive, it may be less expensive to maintain a small target population level, using control measures to remove new growth and new entrants from a particular region and prevention measures to reduce the rate of new introductions. In some cases, allowing low populations of an invasive species to survive may be economical because of the difficulty and extreme cost of finding and eliminating each organism.[238, 239]

While prevention is less costly than control, for species that are already present in the Adirondack Park, control of small, relatively isolated populations is less costly than control of widely dispersed populations, and control of small, relatively isolated populations may be costly than total eradication.

Existing Investments in Preventing and Managing Invasive Species in the Adirondack Park

In order to better understand the level of investments related to invasive species in the Adirondack Park, Yellow Wood conducted a survey of municipal governments, state agencies, landowners, private businesses, lake associations, and non-profit organizations to capture baseline information on spending on invasive species in the Adirondacks including who is spending money, how much money is being spent, and how that money is being spent.[lv] Approximately $3.56 million was spent by 88 organizations on invasive species in the Adirondacks in 2013.[lvi] More than half reported that their spending had increased over the past five years and expect their spending to increase over the next five years. One-third of survey respondents reported that private funding sources (such as operating capital, member dues, and donations) supported their invasive species work; a quarter reported funding from state agencies, one-fifth from foundation grants, and one tenth from federal sources. More than 40% reported funding from other sources such as Town funding/budget, General Fund, Local Taxes, County Funding, Rate Payers, and Revenue.

In addition to these monetary investments, survey respondents reported coordinating more than 12,000 volunteer hours in 2013 at an approximate value of $708,000.[lvii]

While the survey was designed to collect baseline data on invasive species investments in 2013, 80% of respondents have been involved in work related to invasive species for five years or more and half have been making investments for more than 10 years. Just under half of these organizations report that invasive species are significant, or central to their mission.

[lv] The following includes the sectors with the proportion of overall responses that came from that sector: Agriculture (2%), Colleges and Universities (6%), Conservation (9%), Federal Government (2%), Lake Associations (25%), Local Government (26%), Real Estate and Construction (3%), Recreation and Tourism (4%), State Government (17%), and Utilities (2%).

[lvi] Yellow Wood and APIPP worked with individual respondents to understand reporting about spending as identified when there was a potential for double counting (eg. when one organization provided funding to another organization that was also responding to the survey). Any duplicative counting of investments was manually removed from the data as identified.

[lvii] The value of volunteer hours is calculated by multiplying the number of volunteer hours reported by survey respondents by $28.73 — the value of one hour of volunteer time in New York State. Source: "Economic Impact: 36 Adirondack Nonprofits." 2013. https://www.generousact.org/leading/economic-impact-study *Accessed 06/09/14.*

"Our team has funded our instruction and testing materials on our own. Our Lake Association does not have the ability to finance a large scale clean up and we are hoping that we will not have to face one. There are many infested lakes near us and we are worried." ~Respondent to 2014 Survey to Capture Spending on Invasive Species in the Adirondacks

Investments by Activity

The survey identified five categories of activity on the invasive species spectrum of strategies: 1) Prevention, 2) Early Detection and Monitoring, 3) Rapid Response, Control, and Management, 4) Education, Outreach, and Training, and 5) Enforcement and Legislation.[lviii] Organizations across the Adirondack region are investing in activities in all of these categories (Figure 4). The largest proportion of investment was in prevention (with 31% of the total spending) followed by rapid response, control, and management (28%). Education and outreach and early detection and monitoring each captured about a sixth of the spending (17% and 14% respectively), followed by enforcement and legislation (6%) and other types of spending (5%).

Figure 4: Proportion of Survey Respondent Spending by Category of Activity, 2013

Examples of "Other Activity" include: Disease sampling, working with DEC, treatments, education, coordination, special reports, harvesting, equipment maintenance, salaries, training, volunteers.

Prevention

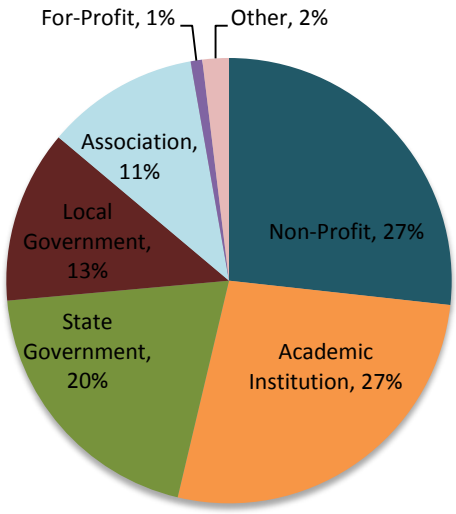
Prevention refers to activities that prevent the spread of invasive species. These may include, but are not limited to, inspections of watercraft, policies related to the movement of firewood, or other efforts to identify and limit points of entry and vectors of species introduction.

A majority of respondents (78%) reported making investments in prevention activities (Figure 5). Non-profit organizations and academic institutions make up close to two-thirds of the investments in prevention activities, with state and local government investing a third and associations, businesses, and other types of organizations providing the remaining investments.[lix]

[lviii] Though we provided guidance to survey respondents on the types of activities included in each category, it can be difficult to delineate hard lines when interpreting which activities are aligned with each strategy and differentiating expenditures between these types of activities.

[lix] Examples of organizations that chose "**local government**" include Towns, County Soil and Water Conservation Districts, and regional planning boards. Examples of organizations that chose "**state government**" include NYSDOT, NYSDEC, Adirondack Park Agency, Lake George Park Commission, Department of Health, and Department of Agriculture and Markets. Examples of organizations that chose "**non-profit**" include conservation organizations, lake associations, landowner associations, and cooperative extension. Examples of organizations that chose "**for-profit**" include businesses in the forest products industry and real estate and construction sector and marinas. Examples of organizations that chose "**academic institution**" include colleges, universities, and

Figure 5: Proportion of Spending on Prevention Activities by Sector, 2013



Respondents identified prevention activities focused in three main areas:

1) Boat Launches (including deployment of boat launch stewards, doing inspection and monitoring of boats and trailers and boat wash/decontamination);
2) Outreach and Education (to boaters, consumers, land managers, land/homeowners, renters, maple syrup producers, association members, neighbors, and the public); and
3) Training (for construction workers, maintenance workers, farmers, land managers, loggers, foresters, millworkers, and volunteers).

Other prevention activities identified by survey respondents included advocating for prevention policy and funding and activities such as stocking sterile carp or installing a containment curtain.

Early Detection and Monitoring

Early detection and monitoring activities are those that detect and report new infestations. These may include, but are not limited to, maintaining comprehensive lists of invasive species and experts in identification, mapping, monitoring, coordination, monitoring protocols, and volunteer programs. The majority of respondents (78%) reported making investments in early detection and monitoring activities. State Government (28%),[lx] non-profit organizations (22%), and academic institutions (20%) made up the majority of investments in early detection and monitoring, while associations invested 16% and the remainder was invested by local government (3%), businesses (2%), and other types of organizations (9%).

Early detection and monitoring activities were focused on conducting monitoring, survey and mapping of lakes (shoreline, surface, and bottoms) and terrestrial areas as well as a door-to-door effort to monitor Eurasian boar. Some respondents reported volunteer monitoring while others paid for these services or used a combination of paid and volunteer monitoring. Respondents also solicit early detection or monitoring

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cooperative extension. Examples of organizations that chose "**association**" include Empire Forest Products Association, Adirondack Harvest and 29 lake associations. Examples of organizations that chose "**other**" include Federal Government agencies, utilities, private land-owners, and lake associations.

[lx] State Government expenditures include funding for the Adirondack Park Invasive Plant Program (APIPP).

reports from the public or employees and respond to requests to verify a species. Other types of early detection and monitoring activities included reporting invasive species (findings of monitoring), providing education and training to conduct monitoring, and providing financial reports for early detection and monitoring activities.

Rapid Response, Control, and Management

Rapid response, control, and management of invasive species are those activities which strategically manage existing infestations and limit their spread, as well as those that support the capacity and implementation of swift control on new infestations. These may include, but are not limited to, rapid response teams and protocol for, and implementation and coordination of, containment strategies.

Just over half of respondents (54%) reported making investments in rapid response, control, and management activities. The majority of investments in rapid response, control, and management came from non-profit organizations (34%) and associations (29%) with state (14%) and local government (11%) making up another quarter of investment. Academic institutions (9%), businesses (1%), and other types of organizations (2%) made up the remainder of investments.

Activities fell into two main categories: 1) rapid response or management plan/team (including an aquatic response team, terrestrial response team, and an Eurasian boar response team); and 2) specific management activities. Specific management and control activities included cutting and bagging vegetation, hand harvesting, placing mats (bottom of pond/lake), deploying chemicals and herbicides, controlling Eurasian boar, and pond reclamation. These activities were conducted by volunteers or through paid/contracted services.

Other activities included issuing permits for control and management activities, helping others to provide rapid response and control protocols, applying for funding for management activities, and providing financial support for rapid response, control, and management activities.

Education, Outreach, and Training

Education, outreach, and training may include guidance on best practices, information sharing and activities that increase awareness of invasive species, communication of key invasive species messages, and training on citizen prevention, detection, and management of invasive species.

A large majority of respondents (85%) reported making investments in education, outreach, and training. State government (39%) and non-profit organizations (17%) and associations (16%) made the majority of investments in education, training, and outreach; academic institutions provided 15% and the remaining investments were made by local government (5%), businesses (2%), and other types of organizations (5%).

Survey respondents reported education for a range of audiences (including boaters, land/homeowners, members, staff, students, tourists, and farmers) and training for boat launch stewards, foresters, loggers, employees, and volunteers. Many respondents also reported on the development and distribution of educational material, including public presentations, brochures, fact sheets, newsletters, signage, and posters. Outreach was also targeted at the media and developed for online applications. Others pay for training for their employees (such as becoming a licensed applicator of approved pesticides or training utility workers in approved protocols for cleaning equipment) or provide financial support to other organizations for education and outreach activities.

Enforcement and Legislation

Enforcement and legislation activities are those that administer invasive species regulations, improve enforcement of invasive species laws and regulations, and identify and support invasive species legislation.

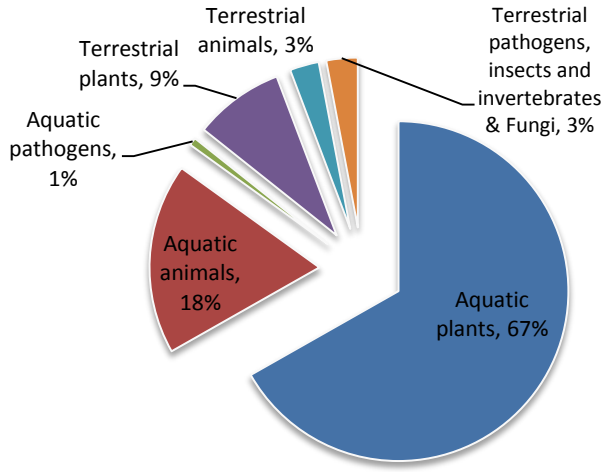
Just over a third of respondents reported investing in enforcement of legislation activities. Three quarters (76%) of investment in enforcement and legislation activities came from state government. Non-profit organizations provided 19% of investment and the remaining investments came from local government (1%), academic institutions (1%), associations (>1%), and businesses (<1%).

Activities fell into three main categories: 1) legislation; 2) passing a local or county law; and 3) enforcement. Survey respondents advocated for invasive species legislation, provided input on legislation, and educated law makers. Local or county laws passed included transport laws, mandatory inspections, and imposing a fine for not cleaning water craft. Enforcement activities were focused on aquatic invasive species and marine patrol.

Investments by Species

Survey respondents reported that approximately 85% of all investments for invasive species were directed at aquatic invasive species (including aquatic animals, plants, and pathogens), with 67% of investments going toward aquatic plants, 12% of investments focused on terrestrial plants and animals, and 3% of investments on fungi and terrestrial pathogens, insects, and other invertebrates (Figure 6).

Figure 6: Proportion of Survey Respondent Spending by Category of Species, 2013



Aquatic invasive species made up the majority of investments for all sectors (ranging from 83%–98% of investments) except for-profit respondents (where there were also big investments in terrestrial plants and terrestrial insects and other invertebrates) and respondents that identified themselves as within an "other" sector where there were more investments in terrestrial invasive species.

Case Study: Aquatic Invasive Species in the Adirondacks

The Adirondacks contain more than 3,000 waterways that contribute to the natural, social, and economic value of the region in a multitude of ways. As of May 2014, survey results from more than 320 water bodies show that aquatic invasive species had been identified in more than 90 of those waterways, and 230 of the waters surveyed are free of invasive species.[a] Individuals and organizations across the Adirondacks are making investments to limit the spread of aquatic invasive species within the region. The results of the *2014 Survey to Capture Spending on Invasive Species in the Adirondacks* found that 85% of all investments related to invasive species in the Adirondack region were directed at aquatic invasive species. These investments are being made by local governments, state agencies, non-profit organizations, businesses, academic institutions, and landowner associations. Often individuals and organizations from across these sectors are working together to impact aquatic invasive species in the Adirondacks. These are just a few examples of the work currently underway.

The Raquette Lake Preservation Foundation (RLPF) adopted a "prevention is better than correction" philosophy nearly 10 years ago. Raquette Lake has three main launch sites for motorized boats: two are at local marinas and one, owned by Raquette Lake Supply Company, is in the Village. Several groups of camps have control of private launch ramps. Access to the lake via canoe or kayak can be gained at any number of spots. In addition, there are four informal canoe launch sites around the area. With this number of launch sites, there is opportunity for the introduction of invasive aquatic species. In the past year, RLPF has adopted a risk management approach, which has led to a proactive program to encourage self-inspection by boaters who use the lake. Paul Smith's College Adirondack Watershed Institute has been successful in getting grant money to support boat launch ramp stewards that assist people in inspecting and cleaning their boats prior to launch and after putting the boat back on the trailer. RLPF also uses local donations to fund a program to eliminate variable leaf watermilfoil. In addition, volunteers survey most of the shoreline and bays every year to detect new threats and record the size and location of nuisance plants, as well as sponsor educational seminars and classes on plant and animal identification and control.

Image 12 A student worker for the Adirondack Watershed Institute inspecting kayaks. Photo: Adirondack Watershed Institute. http://www.paulsmiths.edu/awi-worker-inspecting-boats

Websites: Raquette Lake Preservation Foundation, http://www.rlpf.org/; Paul Smith's College Adirondack Watershed Institute, http://www.paulsmiths.edu/adirondack-watershed-institute

The Lake Pleasant Sacandaga Association (LPSA), in partnership with the Town of Lake Pleasant, has supported a lake steward at the public boat ramp at Moffitt's Beach State Campsite on Sacandaga Lake for about 10 years. Each year an average of 10 aquatic invasive plants are intercepted on boats at the Moffitt's ramp. In addition, LPSA members are organized into teams of "lake monitors," each responsible for an assigned segment of the lakeshore. Each monitor is given an information packet describing invasive plants, a procedure to follow as they survey their lake segment, and explicit instructions to collect suspect plants and give them to the LPSA director for identification. The intent is to monitor the entire shoreline of the five lakes under LPSA management. As a third level of protection, LPSA also pays a Certified Lake Manager to survey the five lakes for invasive species on a three-year rotation (each lake is surveyed every third year). All this work has paid off for the LPSA as there are no invasive aquatic plants in any of their lakes — Sacandaga, Lake Pleasant, Oxbow, Echo and Whitaker — all of which are in the Town of Lake Pleasant.

Website: Lake Pleasant Sacandaga Association, http://lakepleasant.mylaketown.com/

Aquatic Invasive Species Local Regulations

Tax District

The Town of Chesterfield established the Augur Lake Aquatic Plant Growth Control District in 2009. The District works closely with the Augur Lake Property Owner's Association to address issues, including aquatic invasive species, related to the lake. The cost to set up the district and maintain its administrative capacity on an annual basis is estimated at $0.48 per $1,000 in assessed value as of 2009. This amounts to $48 for a lake property assessed at $100,000. This does not include the cost of implementing prevention and/or control measures for invasive species. A fish barrier and stocking of sterile grass carp to control Eurasian watermilfoil were two of its first investments.

Aquatic Invasive Species Prevention Law

Working together in 2009, Lake Pleasant Sacandaga Association and the Town of Lake Pleasant, located in Hamilton County, wrote and approved a local law prohibiting anyone from entering or exiting any of the Town lakes with aquatic vegetation on their boats or trailers. The Town of Lake Pleasant Aquatic Invasive Species Prevention Law states that,

> *"no watercraft or trailer shall enter or exit a water body of the Town unless the boater removes all aquatic plants and/or animals from inside and outside his/her vehicle, watercraft, trailer, or any other equipment that had previously come into contact with any water body. The boater must also remove any standing water that is visible to the unaided eye from the boat and trailer before they enter a water body. Removed items must be discarded away from the shoreline."*

The penalty for noncompliance is a $250 fine.

Warren County passed a similar law in 2011 that makes the introduction and transport of aquatic invasive species into Warren County waterbodies illegal. Their penalty is $5,000 and up to 15 days in jail for violators. In addition to these laws, Washington and Essex Counties have passed aquatic invasive species prevention laws (only for Lake George) as have towns in Franklin (Santa Clara, Harrietstown, Brighton, and Franklin) and Essex (North Elba and Schroon) Counties. The Town of Webb in Herkimer County and the Town of Forestport in Oneida County are also considering local aquatic invasive species prevention laws.

[a] Johnstone, M., H. Smith, E. Holmlund, M. Modley, E. DeBolt, K. Rohne. 2014. Boat inspection and decontamination for aquatic invasive species prevention: recommendations for the Adirondack region. 2014. http://adkinvasives.com/wp-content/uploads/2014/05/Boat_Inspection_Decontamination_Adirondack_Recommendations_March-2014_.pdf *Accessed 6/19/14.*

Summary and Recommendations

Invasive species pose a serious threat to the economy of the Adirondack Park.

The tables below provide a summary of the potential direct economic impacts of eight species by sector for Recreation and Tourism; Property Value (Real Estate, Local Government); Agriculture; and, Forestry and Forest Products. Impacts are annual for Recreation and Tourism, Agriculture, and, Forestry and Forest Products. Impacts on Property Value are assumed to occur over time and will not be repeated on an annual basis. These estimates are intentionally conservative.[lxi] They do not take into consideration the indirect and induced economic impacts, often referred to as "multipliers," nor do they include the added costs of control, or the costs of the loss of ecosystem services (e.g. flood control). It should also be noted that they do not account for the cumulative impact of infestations by multiple invasive species, including the many additional species already present or anticipated that could be added to this list (e.g. impacts for swimming are based on Asian clam and do not take into account the potential for additional impacts by aquatic invasive plants, such as hydrilla and Eurasian watermilfoil). This analysis also does not take into account additional costs associated with the priority species for which adequate data was not available to estimate costs.[lxii] Impacts of a reduction in Property Value on the tax base and private wealth will also continue over time and have not been included in this estimate.

Table 3: Summary of Potential Annual Direct Economic Impacts of Eight Invasive Species by Sector for the Adirondack Park

Area of Impact	***Estimated Value***	***Estimated Loss***
Recreation & Tourism		
Summer tourism visitor spending — swimming	$50 million	**$8.75 million** (17.5%)
Summer tourism visitor spending — boaters	$38 million	**$6.65–$9.5 million** (17.5%–25%)
Summer tourism visitor spending — anglers	$4.1–$14 million	**$0.4–$2.8 million** (10%–20%)
Fall tourism visitor spending	$300 million	**$30 million** (10%)
Total Recreation & Tourism		**$46–$51 million**
Agriculture		
Berries grown in Adirondack Counties	$225,000	**$22,500–$180,000** (10%–80%)
Forestry & Forest Products		
Annual Maple (soft & hard) stumpage (ADK Counties)	$31 million	**$1.5 million** (5%)
Annual Ash stumpage (ADK Counties)	$1.6 million	**$80,000** (5%)
Annual Maple Syrup harvest (ADK Counties)	$13 million	**$650,000** (5%)
Total Forestry & Forest Products		**$2.2 million**
Total Estimated Annual Loss		**$48–$53 million**

[lxi] Areas in which additional research would be helpful in estimating the economic impacts of invasive species on the Adirondack Park include, but are not limited to, estimates of jobs created through conservation activities related to invasive species; costs associated with flooding and industrial activity, including hydropower in the Park; and, industrial/manufacturing/construction activity in the Park.

[lxii] Property value data is specific to the Adirondack Park; the remaining data is for the Adirondack region, variously defined in the relevant research.

Table 4: Summary of Potential Direct Economic Impacts of Eight Invasive Species on Adirondack Park Property Values

Area of Impact	*Estimated Value*	*Estimated Loss*
Property Value		
Value of property in Adirondack Park	$14 billion	**$420–$840 million** (3% - 6%)
Total Estimated Property Value Loss		**$420–$840 million**
Total Estimated Annual Loss + Total Estimated Property Value Loss		**$468–$893 million**

Even these conservative values, for only eight species, suggest an annual economic impact of $48 to $53 million with a total estimated property value loss of $420 to $840 million. The level of current spending reported on the *2014 Survey to Capture Spending on Invasive Species in the Adirondacks* related to Prevention, Early Detection, Rapid Response, Control and Management, and Enforcement and Legislation in the Adirondack Park is approximately $3.56 million a year with more than 12,000 volunteer hours in 2013 at an approximate additional value of $708,000.[lxiii] *Together, this is less than one percent of the potential negative economic consequences of the spread of invasive species.*

Distribution of Investments: Aquatic and Terrestrial

Current investments are heavily weighted toward aquatic species with 85% of all reported investments for invasive species directed at aquatic invasive species. A significant amount of this investment is for Eurasian watermilfoil and Asian clam control: costs that may have been avoided with more effective prevention programs. If these invasive species continue to spread to new waterbodies and/or new species are introduced that require control, the associated costs will continue to rise. Control of invasive species is a recurring cost; even when control appears to be effective, habitat restoration and continuous monitoring is required for long-term success.

> ***"I would prefer we were spending less on management and more on other projects. We would do better to focus on prevention, monitoring, education, and outreach rather than a million dollars on management." Emily DeBolt, Outreach Coordinator, Lake George Association***

While it makes sense to prioritize aquatic species given their potential impacts on recreation and tourism and property values for residents and second homeowners, safeguards against terrestrial invasive species are also important. Their actual and potential impact on the forest and forest products industry, including private owners of forest land, and local and state governments, is also substantial.

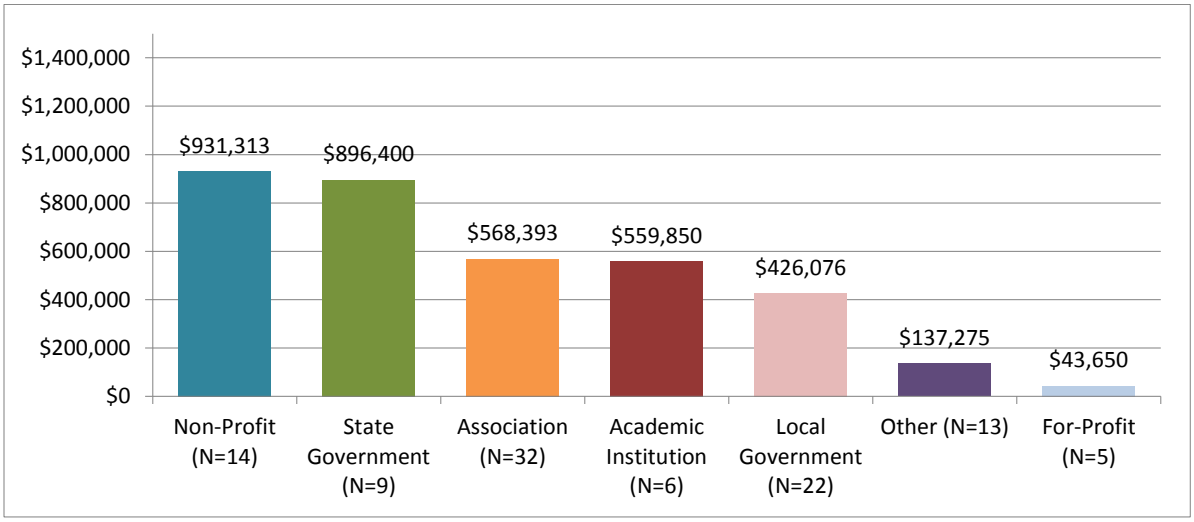
> ***"While beech bark disease has had a tangible impact on the ecology of northern forests, the forests have been remarkably resilient and free of more severe pests to date. With climate change, the ability of these pests to spread north could potentially mirror the types of impacts we are currently seeing with aquatic invasives." ~William (Willie) Janeway, Executive Director, The Adirondack Council***

[lxiii] The value of volunteer hours is calculated by multiplying the number of volunteer hours reported by survey respondents by $28.73 – the value of one hour of volunteer time in New York State. Source: "Economic Impact: 36 Adirondack Nonprofits." 2013. https://www.generousact.org/leading/economic-impact-study *Accessed 06/09/14.*

Distribution of Investments by Sector

While investments by type of invasive species are concentrated, investments by type of organization are more widely distributed. All sectors surveyed are making some level of investment in invasive species prevention and/or management (Figure 7).

Figure 7: Total Value of Reported Investments by Type of Organization, 2013[lxiv]



Non-profit organizations are spending more on invasive species than any other group, and local governments are spending nearly half the amount of state government. More than half (56%) of all reported volunteer hours were attributed to associations, at an estimated value of more than $197,000 in 2013. Non-profits, local governments, and "other" organizations are also heavily dependent on volunteers (with a combined estimated value of volunteers of more than $134,000). Even with this volunteer involvement, comments from key informants and survey respondents suggest that local governments and lake associations are increasingly concerned about the costs associated with prevention and control of existing invasive species and lack confidence regarding their capacity to tackle new species without more public sector support.

> ***"We are seeing donor fatigue, as this limited donor base is being asked to address a problem that will be ongoing and far exceeds the amounts that can be raised from the small, highly seasonal population." ~Respondent to 2014 Survey to Capture Spending on Invasive Species in the Adirondacks***

While some for-profit organizations recognize the significance of the threat of invasive species, spending by private sector businesses (as opposed to individual property owners) appears to be minimal, according to data contributed by survey respondents. On the other hand, some academic institutions are spending significantly, not only on research but also on prevention, early detection and monitoring, rapid response, control and management, and outreach and training.

[lxiv] One-hundred-twenty-four respondents completed the survey; however, only 101 provided spending data.

Only ten percent of survey respondents reported that their spending on invasive species had decreased over the past five years, while 55% reported it had increased. The increases were primarily in the areas of Prevention and Education, Outreach, and Training, with stable spending for more than half the respondents in Early Detection and Rapid Response and Enforcement and Legislation. Over the next five years, more than half the respondents expect to see a need for increased spending in Education and Outreach and over 40% expect to see a need for increased spending in Prevention, Early Detection and Rapid Response, and Control and Management, signifying an increase in the invasive species threat and subsequent demand for action. Whether or not the anticipated increase in spending will occur will depend on the availability of resources.

Possible Supplemental Investments to Improve the Effectiveness of Invasive Species Prevention and Control

Based on our review of existing conditions and best practices research, there appear to be four key areas in which greater investment would be particularly beneficial: 1) pathway management, 2) public education, 3) rapid response and strategic control, and 4) regulation and enforcement.

Pathways Approach to Prevention

> ***"Our best approach, the approach I always advocate for, is a pathways approach. You are always going to have a few priority species; [but] you have an infinite number of species that can be spread through a limited number of pathways. If we attend to the top 20% of pathways, we will probably prevent 80% of the species that come in." ~Kathy Moser, Assistant Commissioner, Natural Resources and Leslie Surprenant, Director, Invasive Species Coordination Unit, New York State Department of Environmental Conservation***

Pathways are the means and routes by which invasive species are spread and/or introduced to new environments. The "pathways" approach to control invasive species focuses on reducing the various ways in which multiple invasive species move from one place to another versus focusing on a specific species. In this approach, strategies are developed to eliminate any species that might be transported via a certain pathway. An example of this is the heat treatment of firewood, which kills any forest pest that might be attached to, or inside, the wood. Another example is boat decontamination, which, through high pressure hot water washing, can remove a wide variety of aquatic plants and animals attached to recreational water craft and gear.[lxv] The pathways approach makes sense from an economic standpoint because it promotes targeting resources to efforts that will have the greatest success at slowing the spread of the greatest number of species.

There are high priority species that may require highly focused and specific prevention efforts, but focusing prevention efforts on pathways generally allows for the prevention of multiple species (including ones that have not yet been identified as a threat) with a single effort.

Key pathways for the priority species reviewed in this report include water-based recreation, firewood, land development and construction, canals, and transportation of goods, packing material and infested nursery stock. Evaluating opportunities to improve access to infrastructure to mitigate pathways of spread, such as access to boat decontamination stations, heat-treated firewood, weed-free soils and fill, and steam-cleaning

[lxv] In addition to humanistic pathways, many invasive species spread naturally or as a result of natural events (such as hurricanes and flooding) — natural pathways are not addressed here.

for construction equipment, etc., could represent economic development opportunities for the region's entrepreneurs. Building market-driven solutions into prevention and control of invasive species can help to offset ongoing costs.

Public Education

While there is investment in prevention and control of invasive species in the Adirondack Park, there is an opportunity to do more to engage visitors and property owners, including owners of properties that are not on a lake shore. The purpose of education could go beyond traditional audiences (e.g. user groups) and conventional messaging by also conveying information about ways in which visitors, residents, and property owners, as well as non-traditional audiences, can contribute to the effort to prevent and control invasive species. Contributions can include identifying and reporting sightings of invasive species, financial contributions to specific projects, as well as changes in behavior to prevent spreading invasive species. Sharing sobering stories of impact as well as successes of investments is important to let people know that their efforts really do make a difference.

Collaborating with new partners, such as tourism and industry professionals, will help to expand the reach of influence and raise awareness. For instance, real estate agents are ambassadors for the Adirondacks and should be well informed about invasive species and the steps that are and can be taken to prevent and control their spread. Adirondack tourism websites (several reviewed make no mention of invasive species) could inform visitors of their role in protecting the Park, the care they are expected to take, and the shared responsibility they have to preserve the beauty and ecosystems of the Park. Rather than attempt to hide or downplay the presence of invasive species, another approach would inform visitors (and others) of the unique opportunity to preserve the Adirondacks as a relatively "invasive species-free" zone. It would view visitors as co-producers of stewardship and engage them actively in efforts to conserve the Adirondacks in its natural state.

Rapid Response and Strategic Control

The most cost effective strategy, after prevention, is investment in capacity to detect new infestations early, and, when discovered, rapidly respond to them when the likelihood of successful control is highest. Therefore, early detection and rapid response are vital tools that need to be utilized to adequately manage invasive species.

> ***"My dream is to have the equivalent of a spills response fund. Have a contract for delimiting where a species is, assessing possible treatment, selecting treatment, getting a permit and treating." ~Kathy Moser, Assistant Commissioner, Natural Resources, New York State Department of Environmental Conservation***

When infestations go undetected, they spread to an extent where management is complex and costly, and economic impacts are realized. Managers are then faced with the difficult decision of no action, due to limited resources (e.g. capacity, funding) and chance of success. Control of invasive species is only as good as the weakest provider of control, whether that provider is in the public, private, or nonprofit sector. Invasive species do not recognize the distinction. All sectors can contribute to the capacity for rapid response and strategic control. [240]

Regulations and Enforcement

The regulated environment of the Adirondack Park provides unique opportunities as well as challenges. Regulations on the use of clean fill in construction, for example, can help prevent the spread of invasive species. However, regulations are only as effective as their enforcement. Both regulation and enforcement can help maintain the Adirondack Park as a relatively "invasive species-free" zone. New York State Department of Environmental Conservation has regulations regarding the transport of firewood, in addition to regulations addressing other invasive species pathways, and recently received additional authority to address the recreational boating pathway; effective enforcement of these laws will help reduce the likelihood of invasive species introductions.

In other areas, more attention may be needed to developing new regulations. Regulatory consistency would also help reduce the costs and confusion associated with compliance and enforcement.

On the permitting side, procedures that support the capacity of local governments, lake associations, utilities, and others to respond rapidly to early detection of invasive species, while also complying with state requirements, will enable them to act in a timely manner.

> ***"We have developed general permits to help people out — to streamline permits for hand harvesting and mats. It used to take 3 months, now it takes about a week to get a permit. We try to work with lake associations to get the information they need for the permit, we want to make it easier for people to get these permits and have them spend their money on management, not getting the permit." ~Ed Snizek, Supervisor, Natural Resource Analysis, Adirondack Park Agency***

To the extent that existing permitting, especially across agencies, is not yet well coordinated in this regard, steps to improve it will promote efficiencies and cost savings.

Coordination: The Basis for Future Efforts

The good news is that New York does not have to start from scratch or re-invent a structure for addressing invasive species in the Adirondack Park. There is an active and dedicated cadre of organizations and individuals in the region that already know about and are engaged in addressing the threats posed by invasive species. The Adirondack Park Invasive Plant Program, which is funded, in part, by the NYS Environmental Protection Fund and administered by the NYS Department of Environmental Conservation via a contract with The Nature Conservancy, provides coordination, and, in collaboration with many partners, leads program development and implementation for an integrated and comprehensive invasive species program. Organizations are not working in isolation; our survey found that there is already a significant amount of collaboration taking place both within and across the public, private, and non-profit sectors with 99% of respondents reporting that they collaborate with partners in their invasive species work. For example,

> ***"We are a totally volunteer organization that works collaboratively with our local municipality (Town of Bellmont), professional businesses (Aquatic Invasive Management) and professional experts (Adirondack Watershed Institute and Adirondack Lake Assessment Program)." ~Respondent to 2014 Survey to Capture Spending on Invasive Species in the Adirondacks***

More than half of respondents collaborate with partners across four or more sectors, three-quarters collaborate with partners in more than one sector and 17% collaborate with partners in all seven sectors that

include municipal governments, state agencies, landowners, private businesses, lake associations, and non-profit organizations.[241]

Conclusion

There are significant actual and potential direct economic costs associated with invasive species in the Adirondack Park. There are also recurring costs associated with prevention and control of invasive species. Experience elsewhere tells us that prevention is less expensive than control and the failure to prevent and/or control invasive species will result in economic harm. Our analysis evaluated only eight of more than 70 invasive species in the Adirondack region: more than 100 others are in surrounding areas. Invasive species negatively impact a variety of sectors; and all sectors — public and private — have a vested interest in preventing and controlling the spread of invasive species.

The introduction of invasive species is a consequence of an increasingly inter-connected world that is likely to continue to present challenges, particularly in natural resource-dependent rural areas, for many years to come. New York has a unique opportunity to build on the network of activities, relationships, partnerships and coordination already working in the Adirondacks within and beyond the Adirondack Park Invasive Plant Program and make the region a national/international model for prevention and control of invasive species, an emerging field that is ripe for applied leadership. Expertise gained in the Adirondacks could form the basis for a new export industry as more and more rural regions face the need to organize to deal with invasive species.

Future Discussion

Our analysis unveiled a series of complex questions for future consideration: What is the role of non-profits, state and local governments, academic institutions, lake associations, and volunteers, among others, working on the ground to protect their livelihoods and properties from the threat of invasive species? What level of effort is required in a landscape that is more pristine than most and heavily dependent economically on the health of its natural resource base? How much spending is appropriate and justifiable? How can the State best invest to support the local and regional economy in ways that also achieve effective protection? This report, while it does not answer these questions, is an effort to provide an analysis of preliminary economic impacts that can help inform further discussion.[lxvi]

[lxvi] This work identified a variety of opportunities for further research to better, and more accurately, understand the economic impacts of invasive species on the Adirondack Park, including: 1) Better data on the full extent of the forest products industry in the Adirondacks — e.g. number of loggers, truckers, mills, kilns, secondary manufacturers; 2) Better data on hydro-electric and manufacturing operations in the Park; 3) Better data on flooding incidents, areas at risk, and costs associated with flooding; 4) Better data on where people fish in the Park, where they come from to fish, number of angler days in the park; 5) Clearer idea of which local governments are engaged in work related to invasives and how and where; 6) Tourism data on the Park as opposed to the six northernmost counties or just Essex County; 7) More complete data on state staffing related to invasive species in the Park; 8) More and better data on the extent to which basic services in Adirondack communities depend on tourists and second homeowners; 9) More complete data on the real estate sector; and 10) More complete data on the construction sector.

Endnotes

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