This Guide is based on a study commissioned by the Kawartha Lakes Stewards Association, conducted by four Ecosystem Management Technology students at Sandford Fleming Collegefrom January to April 2011. Their assignment was to collect information on the use of the milfoil weevil to manage Eurasian watermilfoil, including:

- A comprehensive review of available literature
- A resident survey
- A review of important legislative considerations

Also contributing to the Guide is Kyle Borrowman, M.Sc. student in Environmental and Life Sciences at Trent University, who is actively surveying the milfoil weevil's presence in Ontario lakes.

KLSA has commissioned further research on the Eurasian milfoil weevil in 2011. Results will appear in the KLSA Annual Report to be published in print and on this website in April 2012.

Summary

A native aquatic weevil which lives exclusively on watermilfoil has been found in many of the Kawartha Lakes. It shows promise as a biological control mechanism for the invasive Eurasian watermilfoil. However natural weevil densities do no typically reach levels that cause significant declines of Eurasian watermilfoil. This leads to stocking or augmenting native weevil populations to levels that can cause significant declines. Currently, there is no legislation that allows the release of the milfoil weevil into the Kawartha Lakes, other than for research purposes. If release were permitted, stocking lakes with this weevil would be expensive, costing upwards of $10,000 per initial stocking. Because it appears to be so effective, however, collaborative efforts among applicable authorities and those groups who are affected may be merited. Further study is needed.

Introduction

Eurasian watermilfoil (*Myriophyllum spicatum*, herein referred to as EWM) is an invasive aquatic plant that has become widespread throughout North America, including many lakes and water systems in Southern Ontario. Millions of dollars are spent every year on this continent on physical and chemical management techniques to control nuisance populations of milfoil.[1] Many of these methods are expensive, provide only temporary results and may have negative impacts on the surrounding ecosystem.

In addition to physical and chemical management, biological control of EWM using the milfoil weevil (*Euhrychiopsis lecontei*) has been tried throughout the United States since the 1990s and has recently received growing interest in Ontario including stocking projects in Puslinch Lake, Scugog Lake, and Jack's Lake among others. This insect is native to North America, feeds specifically on milfoil (plants within the *Myriophyllum* genus) and is commercially available as a biological control agent.[2]

GETTING TO KNOW EURASIAN WATERMILFOIL (*Myriophyllum spicatum*)

Ecology

Distribution
Eurasian watermilfoil (EWM) is a submersed aquatic plant native to Europe and Asia that has become widespread throughout North America since the 1960s. Within Ontario, nuisance populations of milfoil have been identified historically throughout the Kawartha Lakes region of the Trent-Severn Waterway and in the Rideau Lakes system. Currently, populations of Eurasian milfoil have been identified across the province, most notably in southern Ontario and the Greater Sudbury Area. Milfoil has also been identified in the Muskoka lakes, Haliburton lakes and in several waterways along the north channel of Lake Huron.[4]

Growth and Habitat

Reproduction of EWM is possible by seed, stolon production and stem fragmentation. Most reproduction occurs through fragmentation caused by disturbance, such as boat motors or cutting, or by autofragmentation, a response to nutrient availability. Fragmented stems float through the water column until they lose buoyancy and root in the receiving sediments. Stem fragmentation is responsible for new invasions and long-distance dispersal as fragments become attached to boats and boat trailers and are transported to new waterways.[3]

Growth occurs early in the growing season once water temperatures reach 10ºC. Upon reaching the surface, the milfoil stem branches profusely, blocking available sunlight to other submersed plants underneath the canopy. This growth habit often results in dense monocultures of Eurasian watermilfoil.[3] EWM typically grows in mesotrophic* to moderately eutrophic* lakes in depths of one to four metres, although it has been found in areas up to 10 metres in depth. Depth range is limited by wave action and competition in shallow water, and typically by water clarity in deeper waters. In general, low density sediments with approximately 20% organic matter are sufficient for milfoil.[3]

* *Mesotrophic lakes commonly have clear water, with beds of submerged aquatic plants and medium levels of nutrients.*

A eutrophic body of water has excessive nutrients and is subject to algal blooms resulting in poor water quality. The bottom waters of such bodies are commonly deficient in oxygen. Eutrophic waters commonly lack fish species like trout which require cold, well-oxygenated waters.

Identification

Eurasian watermilfoil is a rooted, submersed, perennial herb with finely dissected leaves.[3] These leaves are located along the stem at every node in whorls of four. Leaves become dense toward the upper portions of the plant and around the stem. Each dissected leaf generally consists of 12 or more paired divisions. Flowering consists of tiny pink flowers that develop on red spikes that stand above the water. Winter buds can also occur and are often red or green in colour.[5] The stems of younger shoots are green in colour; as they grow they turn beige and resemble spaghetti in appearance.

Water-milfoil

Myriophyllum: Water milfoil

Each leaf resemble a feather with threadlike leaflets on either side of a central axis. Eurasian milfoil has 12 to 20 leaflets on each side of the central stem (upper drawing). Northern milfoil, which is native to the Kawarthas, has 11 or fewer on each side (lower drawing).

Drawing by Colleen Middleton and Jessica Middleton for KLSA.

Proper identification of EWM can be difficult. There are several similar milfoil species native to Ontario, as well as other aquatic plant species that bear a resemblance. To make matters worse, EWM apparently hybridizes with its closest native relative, northern watermilfoil (*Myriophyllum sibiricum*) making identification reliant on genetic analysis in some cases.[6]

Despite their similarities, it is possible to make somewhat accurate identification of EWM and northern milfoil in the field. The lack of winter buds on northern watermilfoil and the number of leaf segments per leaflet are the most distinguishable differences between the two. Typically, northern watermilfoil consists of leaflets with less than 12 paired divisions whereas EWM consists of more than 12 paired divisions. Five leaves of EWM become closely arranged towards the apical meristem* of the plant; this is not as noticeable in northern milfoil. In addition, when pulled out of the water, leaves of EWM typically collapse onto the stem where as northern milfoil is somewhat rigid and the leaves hold their form out of the water.

Since identification can be difficult, we encourage people to collect samples or take pictures of the plant in question (including close-up pictures of the leaves, stems and flowers if possible) for identification by scientific advisors who work with our association. Consider uploading your pictures to KLSA's Facebook page.

**Meristem: undifferentiated plant cells, an area where growth can take place.*

Negative Impacts of EWM Infestations

Environmental

EWM can alter many aspects of an aquatic ecosystem. It can reduce oxygen exchange and deplete the level of available dissolved oxygen in the water needed for a healthy lake. It may increase water temperatures, sedimentation and the loading rates of nutrients. It can cause a decrease in biodiversity by taking over areas once populated by native plant species. Reduced drainage and increased flooding are also negative effects that may occur when populations are very high.[3] The consequences of herbicide use for EWM control can also have adverse effects on natural ecosystems.[1]

Tangled biomass of Eurasian water milfoil (Borrowman, 2010)

Economic and Social

Property values may drop when an invasion of aquatic plants affects recreational activities and the health of the lake. Tourism and local economies suffer if fewer tourists visit beaches and lakes, where aquatic plants make swimming, boating, fishing and commercial navigation a frustrating experience. Herbicide use as a control agent may cause water to become unsafe for drinking, swimming or fishing. Milfoil may also block intakes for hydroelectric turbines, drinking water and irrigation.[3]

Current Management Techniques

Mechanical Harvesting

Mechanical harvesting entails removal by physical means such as cutting, mowing, dredging, or hand harvesting. Mechanical harvesters and cutters can remove plants at desired depths. Although mechanical harvesting is effective, it is labour intensive and may actually increase seasonal biomass and exacerbate the nuisance problem. This is because milfoil fragments will root and re-establish themselves if they are not properly collected and removed. Large mechanical harvesters and cutters are not species specific and may remove beneficial native plants along with the milfoil.[3]

Chemical

Chemical methods such as herbicides are usually effective but a last resort due to the harmful effects on the environment. Herbicides used for aquatic plant management are often broad spectrum and do not target specific plant species. The use of such herbicides could be detrimental to beneficial native plant and invertebrate communities. In some cases, such as treatment of *Hydrilla spp.*, herbicide application has led to the production of resistant plant strains and the need for stronger herbicide dosage. Some herbicides that have been used to manage EWM include: 2, 4-diclorophenoxy, fluridone, triclopyr, diquat, and endothall dipotassium salt. Diquat is the only herbicide used inOntariowhile the others are heavily used in theUnited States.

Biological

Several native insects, and some naturalized ones as well (non-native and non-invasive) feed on and thereby suppress the growth of Eurasian watermilfoil. These include the milfoil weevil *Euhrychiopsis lecontei*, an aquatic moth *Acentria nivea*, the milfoil midge *Cricotopus myriophylli*, and to a lesser extent some caddisflies *Tricoptera*.   Of these, the milfoil weevil is considered to be the most likely candidate for biological control of EWM.[2]

MEET THE MILFOIL WEEVIL

Weevils at work

The milfoil weevil is an aquatic beetle from the *Curculionidae* family and is native to North America. It is present in the Kawartha Lakes and is greatly distributed throughout southern Ontario and the northern United States. This herbivorous insect feeds solely on plants within the milfoil genus *Myriophyllum species,* and completes all life stages on its host. [2]

The milfoil weevil is visible to the naked eye, although it takes a bit of training to spot one. The best way to observe the weevil is to snorkel through the milfoil patch focussing on the upper 30 centimetres of the milfoil plants. Weevils are about the size of a sesame seed, (two to three millimetres long, with a typical "weevil like" elongated nose (proboscus) and a yellow shell with black blotches or stripes. The underside (abdomen) is silvery in colour; in sunny conditions the silvery flash is what gives away their location. Weevils are very active as adults moving, feeding and mating as they travel along the stem or meristem of the plant. Not only are these critters small, they are also somewhat elusive, much like a squirrel around a tree. Milfoil weevils use the stem as cover to avoid predation and in some cases will play dead until they feel the threat has passed. This is often noticed when observing weevils in a sample tray.

Other signs of weevil presence are milfoil stem damage and the presence of eggs. These are easily viewed by collecting stems of milfoil (by snorkelling or by boat), then submersing them in water in a white tray. Stem damage consists of stem burrowing and pupae chambers. Burrowing is caused by feeding during the larval stage; the plant stem is hollowed out and sometimes breaks off. It is very noticeable when held up to light. Sometimes larvae can be spotted within the stem or along the outside of the plant. Pupae chambers form later in the life stage and further down the stem, typically 30 to 50 cm below the meristem. This will appear as a dark spot and bulge with a pupating weevil inside. If the adult has emerged from pupation, the dark spot will become a circular or elliptical hole about the size of an adult weevil.

Distribution

The milfoil weevil is distributed across North Americain a range similar to the northern watermilfoil. Populations of the milfoil weevil have been identified within Quebec, Ontario, British Columbia, Albertaand Saskatchewanand in at least 44 states including Idaho, Colorado, Connecticut, Minnesota, Wisconsin, New York, and Washington.[2,7,8,9]

Lifecycle

After ice-out each spring, the milfoil weevil moves from its winter hibernation site on shore, out into the milfoil patches. Once water temperatures reach 15^{O}C, the female begins to lay eggs. It takes the milfoil weevil typically 17 to 30 days to complete its lifecycle, and multiple generations are possible per year. The weevil spends the summer months submersed and feeding on watermilfoil throughout all life stages, then adults leave the water in mid-September in search of natural shoreline sites for overwintering. They have a 60 percent rate of survival past winter, a mortality rate which is not severe. The weevil has four life stages: egg, larvae, pupa and adult as described below.[2]

Egg: 3 to 6 days

Weevil eggs are typically laid on the plant meristem and upper layers. They are yellowish, elliptical and about 0.5mm long. Eggs are difficult to see and are sometimes confused with blobs of algae, which have a fuzzy appearance compared to the solid colour of the weevil eggs.

Larva: 8 to 15 days

Larva phase (Newman ,2008)

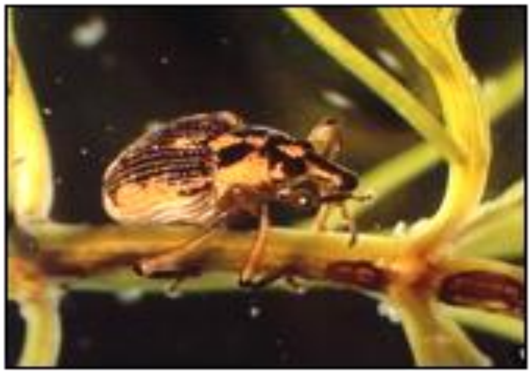
Once the eggs have hatched, the larvae feed on the upper portions of the host and are usually three to five millimetres in length. Larvae spend the first three to five days of this stage feeding on the meristems*, eventually burrowing into the stem (also known as stem mining). Larvae cause the most damage to milfoil at this stage and on average consume 15 centimetres of stem. Then they begin to hollow out a pupal chamber, ready for the next stage of life.[2]

Pupa: 9 to 12 days

Pupa phase (Newman, 2008)

Pupation takes place 60 to 90 centimetres down the stem of the plant. Researchers believe this happens further down the shoot because the weevil prefers thicker stems for pupation. Studies indicate that at this stage weevils need minimal temperatures of 10˚C to successfully morph into adults.[2]

Adult



Adult weevil on watermilfoil stem (Johnson, 2006)

The adult weevil can grow to be two or three millimetres long at this final phase. They have been recorded living up to 162 days in laboratory studies.[19] Females lay their eggs upon the apical (top) meristem of their host and can produce two to four eggs daily with a maximum of five generations per summer. Adults primarily feed upon the milfoil's leaves but also eat stem tissues. Seasonally, the last generation of adults refrain from reproducing; instead, they store energy for development of wings and fat stores. This prepares them for the overwintering process, which has been observed occurring in leaf litter and other organic matter near the shoreline.

Making it through the winter

Weevils typically overwinter on shore in the top five centimetres or so of leaf litter, dry duff and soil. A study by weevil expert Raymond Newman in Wisconsin found highest overwinter weevil densities one metre from shore; at some sites it was not uncommon to find weevils overwintering on land up to six metres from shore. This is reassuring for weevil survival in the Kawarthas, where water levels change dramatically in November and April.

If they are still on land, weevils have been reported to head for the water shortly after the ice goes out, and have been collected on plants at this time. It is when water temperatures reach 10 to 15ºC that weevils begin to actively feed and reproduce. It takes about a week at 15ºC for a female to lay eggs. Other literature confirms that weevils should be in the water by mid-May. This seems to be a safe time for shore dwellers to rake up accumulated debris, without fear of removing precious weevils.

Choosing a host plant: native, Eurasian or hybrid?

The weevil is a selective diner. It lives only on watermilfoil plants, and does not spread to others. It is endemic to North America, which indicates that its original host plant choice was the northern watermilfoil. The spread of invasive EWM across North American regions has allowed EWM exposure to the milfoil weevil.

Laboratory studies have revealed that weevil growth and development occurs over a shorter period of time on EWM in comparison to northern milfoil, and EWM is preferred over its native counterpart for egg laying.[2, 10] Further studies have found hybrids of Eurasian and northern watermilfoil occurring throughout Ontario and the midwest United States. This includes several of the Kawartha Lakes (Lower Buckhorn, Pigeon, Scugog and Stony) as well as theRideauLakes system. In laboratory studies milfoil weevil performance on hybrid milfoil is intermediate in comparison with EWM and northern milfoil.

One might wonder, then, if hybrids could be more invasive (through hybrid vigour and fragmentation) and be less susceptible to the milfoil weevil because of a natural resistance inherited from northern watermilfoil. Although this is possible, early surveys of hybrid milfoil populations throughout Ontario have determined that the milfoil weevil does naturally occur on these hybrids in similar densities to those on EWM. There is a need for more research in order to fully understand the relationship between weevils and hybrid watermilfoil.[10]

Impact of the weevil on EWM

The greatest threat to milfoil survival occurs when the weevil larvae burrow into the stem and consume cortical and vascular tissue. This mining action interrupts the flow of nutrients through the plant. Stem mining also forms holes in the shoot's walls, releasing gases that keep the plant upright. Reduced buoyancy makes the plant sink out of the water column inhibiting root production and eventually leading to the collapse of entire EWM beds[2]. Weevils survive and reproduce abundantly on EWM, and populations can reach levels capable of controlling EWM biomasses. Conversely, on native milfoil plants, weevil populations are said to remain low, and they generally do not negatively affect the native milfoil population. However, weevil densities in most lakes are not adequate to control the invasive EWM without stocking methods.[2]

Darker areas of the milfoil stem depicting weevil damage (Ross, 2010)

Relationship to other plants and the surrounding ecosystem

Being an herbivore and a specialist, the weevil has only been observed on watermilfoil species. In laboratory tests weevils did not lay eggs on non-watermilfoil species, and did little damage to other plants. Overstocking of weevils can have adverse effects on native watermilfoil populations but there is no evidence to suggest that the weevil has any negative impacts on surrounding ecosystems and environments.[2] The weevil's high affinity for EWM means that weevils will have no impact on other aquatic plants such as the wild rice species in our lakes.

Stocking issues affecting success and failure of the milfoil weevil

Results from lakes that were stocked with weevils varied from year to year, mainly because weevil densities did not remain consistent enough to biologically control the EWM.

Studies have shown that weevils are successful at controlling EWM populations if weevil population densities are high and remain constant from year to year. In many lakes milfoil weevil density is too low to naturally cause significant milfoil declines. Weevil densities of roughly one weevil per stem or higher is considered to cause significant declines in milfoil populations. There are many possible causes of reduced weevil densities. These include fish and invertebrate predation, water temperature, pH and alkalinity, plant nutrient content, suitable overwintering habitat and milfoil harvesting.[2]

On developed shorelines, the natural debris that harbours the weevil during winter will not have a chance to accumulate, a threat to survival. Mechanical cutting removes weevils clustered on the upper stems, while the lower plant remains rooted in the sediment, and cut plant fragments develop into new plants. In these ways, weevil populations decline.

In summary, milfoil weevil stocking has mixed results, as no two lakes are the same. However studies demonstrate that the weevil is the best option for controlling invasive EWM populations. The milfoil weevil is endemic toNorth America, is specific to watermilfoil species, and does not produce the adverse effects associated with other methods of control. The only impediment to the weevil's ability to control EWM populations is its inability to maintain high population densities. As more information becomes available through application and monitoring, the formula needed for project success becomes clearer.

The weevil in the Kawarthas

By the 1970s, milfoil dominated aquatic plant communities within the Kawarthas. The Ontario Ministry of Natural Resources spent $150,000 annually, and the private sector about $60,000 trying to control rampant colonies with harvesting and herbicides.

By the early 1980s, major declines in milfoil populations were observed throughout the Kawarthas, especially in BuckhornLakewhere aerial cover of Eurasian watermilfoil declined from 78% to 1% with drastic changes in 1979 and 1986. Lake Scugog also went through a noticeable decline, as did milfoil stands in Wisconsin, Vermont and Minnesota, which led to extensive research on the cause. Two suspects were identified: an aquatic moth, *Acentria spp*., and a native milfoil weevil, *Euhrychiopsis lecontei.* The weevil was soon picked as the best candidate for biological control of milfoil due to its species-specific feeding preference. Stocking projects began throughout theUnited States.

In July 2009, the Scugog Lake Stewards with the assistance of the Baagwating Community Association commercially stocked 20,000 weevils into Lake Scugog to tackle a nuisance population of Eurasian watermilfoil. By the end of August there appeared to be dramatic differences between the stocked weevil site and the control site, where stocking did not occur. In 2010 the remaining stems of milfoil within the treatment area appeared to be severely damaged by milfoil weevil feeding.

This project sparked interest, not only because of the weevil's effectiveness, but because researchers made the first positive identification of a hybrid milfoil within Ontario lakes, a plant with characteristics of both native and Eurasian milfoil. This in turn led to many more questions. Does the milfoil weevil naturally occur on hybrid milfoil? Are there environmental and geographical factors that limit hybrid milfoil populations inOntario? Are we seeing an emergence of hybrid milfoil across the province? Does weevil population vary depending on the presence of hybrids or the nutrient content of the plant? Are milfoil hybrids more or less invasive?

Current milfoil research in the Kawarthas

In the summer of 2010 a Trent University team commissioned by the Kawartha Lake Stewards surveyed 21 lakes in central Ontario including the Kawarthas and the greater Sudbury area. The milfoil weevil was present within all lakes surveyed including Lake Scugog, Pigeon Lake, Big Bald Lake, Lower Buckhorn Lake, Stony Lake, Coon Lake and Jacks Lake.

Milfoil weevil density in the Kawarthas was above the average density for all lakes surveyed at 0.41 weevils per stem, with the exception ofBig Bald Lake with only 0.27 weevils per stem. However the target density to create a significant decline of milfoil is 1.0 weevils per stem, roughly double the natural density in the Kawarthas. A side discovery was the presence of hybrid milfoil in Lower Buckhorn Lake, Pigeon Lake and Big Bald Lake.

Studies like this one are adding pieces to the puzzle, but they also create new questions. The team will continue monitoring and exploring various aspects of the weevil-milfoil relationship in summer 2011. Although there are no stocking projects in the Kawarthas slated for 2011, monitoring of the 2009 pilot project in Lake Scugog will continue. In this way we produce a better picture of the successes and limitations of biological control of Eurasian watermilfoil.

REGULATORY ISSUES AND PROTOCOLS FOR WEEVIL USE IN THE KAWARTHA LAKES

Trent-Severn Waterway (TSW) The Trent-Severn Waterway is a branch of Parks Canada which governs all in-water and shoreline works and related activities that occur in the Trent-Severn Waterway and theRideau Canal. All activities require written permission from Parks Canada in accordance with the Historic Canals Regulations and other legislation. In-water and shoreline work permit applications are available on the TSW website:

http://www.pc.gc.ca/eng/docs/r/poli/page03.aspx

Currently, there is no legislation that allows the release of the milfoil weevil in theKawartha Lakes, other than for research purposes.

Canadian Food Inspection Agency (CFIA)

Under the National Animal Health Program, the CFIA establishes import requirements for all animals and animal products that enterCanada. An import permit is required to bring milfoil weevils across the border intoCanada. If anOntariosource of weevils is found, then the import permit is not required. Permit applications are available at:

http://www.inspection.gc.ca/english/anima/imp/perme.shtml

Ontario Ministry of Natural Resources (OMNR)

Under the Fish and Wildlife Conservation Act section 54 (1) (Release of Imports), "except with the authorization of the Minister, a person shall not release wildlife or an invertebrate that has been transported intoOntarioor has been propagated from stock that was transported intoOntario." However, this Act does not apply if an import permit is issued by the Canadian Food Inspection Agency.

Curve Lake First Nation

TheKawartha Lakesare situated within the traditional territory of Curve Lake First Nation. The First Nation territory is incorporated within the Williams Treaty Territoryand is the subject of a claim underCanada's Specific Claims Policy. Consultation with Curve Lake First Nation's Rights and Resources committee is a very important step and also an obligatory duty outlined by the Supreme Court of Canada. To set up a meeting, contact their cultural outreach coordinator at:

culturaloutreach@curvelakefn.ca

ECONOMICS OF TYPICAL WEEVIL CONTROL PROJECTS

Cost

Budgeting can be the one factor that contributes to the success or failure of EWM biological control methods. As discussed below, the cost can be prohibitive. However investment in biological methods for control of the EWM plant and for spread prevention are reasonable considerations for communities troubled by this nuisance species.

What Eurasian watermilfoil costs

Millions of dollars are spent annually on control of EWM in the United Statesincluding mechanical, physical and biological management techniques and invasion prevention programs. In addition to control costs, EWM may contribute to billions of dollars in lost revenue from recreational activities such as swimming, boating and fishing, which are hindered during peak seasons in lakes across the United Statesand Canada.[14]

What weevils cost

Nancy Cushing of the U.S.company EnviroScience Inc. estimates a cost of $1.00 to $1.20 per weevil, with a minimum of 10,000 to 50,000 milfoil weevils needed to start introductory EWM plant control.[15] A single EWM biological control project can cost up to $95,000 but this estimate is not typical; it allows for unexpected circumstances during the project start up. Madsen et al. (2000) stated that weevils were sold in units of 1000 individuals. Generally, 3000 weevils per acre were needed for efficient control.[14] The cost for lake surveying, weevil application and post application monitoring can range from $1,000 to $3,000 per step for a typical lake project. Other control methods such as herbicides can cost up to $110,000 and harvesting may be even more expensive.[15] In perspective, using the milfoil weevil to control EWM is not only a more cost effective method but it is also sustainable in the long term, with ecological benefits.[15]

PUBLIC PERCEPTION OF BIOLOGICAL CONTROL METHODS

Public perception of invasive species and biological control methods plays a large role in the practice of biological control. There are five 'publics' involved in any biological control project:[16]

- Client communities, for example land managers and shoreline property owners
- Funders, which may include cottage associations and municipalities
- Regulators
- Potential scientific allies
- Contrarians, people who are opposed to biological control

Open communication with all five parties is essential at all times in any project. The science of biological control is a public-interest science, which means that practitioners need to understand the public and cultivate public support for their work.[16] The public's perception of the potential risks and benefits associated with biological control methods plays a key role in the success or failure of a project.

How people perceive risk is key. In biological control, risk is measured by quantifying potential damage to the public, such as the sport fishing industry, or to beneficial native plant species such as wild rice, through a risk assessment process.

Ethics is not often discussed in the context of biological control programs, despite the fact that ethical and emotional decisions must be made when considering the release of any biological control agent. For control programs to be ethical, all reasonable alternatives must be listed and people choose objectively among them to compare the consequences of actions.[17] This helps to inform and reassure everyone involved. There are a number of things that biological control scientists can do to quantify, predict and minimize risks. Proper risk assessment is vital to the success of any proposed project.

Results of an online survey on biological control

One way to assess public interest in biological control methods is through a survey. Surveys give the public an opportunity to voice their support, ask questions and share concerns about invasive species and control methods. The Kawartha Lakes Stewards Association invited 350 members to take a survey on invasive species control during a two week period spanning February and March of 2011, hosted on SurveyMonkey.com. 90 of the 350 people completed the survey, a response rate of 25.7%. This rate is very high, and indicative of the interest level amongst KLSA members.

Of those who completed the survey, 77% have noticed an increase in the presence and/or density of Eurasian watermilfoil or other aquatic plants in recent years (Figure 8). 69% polled are able to identify Eurasian watermilfoil, but only 47% are aware that a native aquatic insect, the milfoil weevil, can be used to reduce the abundance and density of Eurasian watermilfoil in lakes. It is interesting to note that 100% of participants consider the problem of invasive, exotic plants to be important or very important. These results indicate that people are concerned about invasive aquatic plants.

NEXT STEPS

Use of the milfoil weevil to control Eurasian watermilfoil in theKawartha Lakescomes with a number of ecological, economic, regulatory and social considerations. All four of these spheres must be considered from the outset of any project, and all stakeholders should be included in the discussion from the very beginning. Based on our research into the ecology, feasibility, and regulatory considerations of using the weevil to control Eurasian watermilfoil in the Kawartha Lakes, here are recommendations for any group wishing to pursue this form of biological control.

1. Map the location and density of Eurasian watermilfoil in this area. This will help to determine where the problem areas are, and where research should be focused.
2. Disseminate information on biological control of Eurasian watermilfoil by the milfoil weevil toKawartha Lakesresidents. This will better inform the public of the problem of invasive species, and the potential of biological control methods.
3. Hold an information session to discuss the project with potential stakeholders and residents who may be affected by a biological control project. Deal with concerns and considerations that come to light, before the implementation stage.
4. Encourage invasive species scientists to produce more research on weevil control programs, the establishment of baselines for monitoring, and long-term effects.
5. Encourage legislation that allows the release of the milfoil weevil in the Kawartha Lakes, other than for research purposes. This will require collaboration to produce a studied and persuasive case for further biological control projects.
6. Contact other lake associations throughout the United States and Canada to inquire about their weevil stocking experience.
7. Set up a monitoring program to collect information before and after to determine the success of the project. Excellent information is available through the Citizen Lake Monitoring Network in Wisconsin, USA, including a guide to weevil and milfoil monitoring. Visit http://www.uwsp.edu/cnr/uwexlakes/clmn/AIS-Manual/12weevil10.pdf
8. Establish a lead authority to pursue recommendations prompted by this report.

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