Clear As A Lake

A Resource Guide to Invasive Aquatic Plants and Non-Toxic Treatment Alternatives

MASSACHUSETTS ENVIRONMENTAL TRUST

TOXICS ACTION CENTER

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At Toxics Action Center, we believe that everyone has the right to breathe clean air, drink clean water and live in a healthy community. For 21 years, Toxics Action Center has assisted residents and community groups across New England to address toxic pollution issues. For more information about Toxics Action Center, please contact our offices at the number below or online at www.toxicsaction.org.

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Executive Summary

Lakes and ponds are complex systems that provide a home for many species of plants and animals. They also provide humans with a place to relax, play, and enjoy nature. When invasive plants are introduced to lakes and ponds, they can drastically change the characteristics of these complex aquatic systems. Invasive aquatic plants are a serious problem and can take over an entire lake and make it unusable, not only by other plants and animals, but also by humans.

Control of invasive aquatic plants is most common via waterborne pesticides or herbicides. In Massachusetts alone approximately 230 water bodies are commercially treated with herbicides each year in an attempt to reduce or control invasive plants or other aquatic weeds. We now know that these toxic chemicals can be linked to a wide range of public health and environmental concerns. They can be dangerous to other plants, animals, and most importantly human health. Potentially more troubling is the vast amount that we still do not know about pesticides and their impact on people - especially children - and our environment.

This resource guide provides a basic explanation of the aquatic invasive plant problem currently facing many lakes and ponds across the United States. Included are eight profiles of invasive aquatic plants commonly found in the Northeastern United States. This guide also provides information about the environmental and human health risks connected with the chemical treatment of invasive plants. Included is information on the six chemicals that serve as the main active ingredients in aquatic herbicides and 15 alternative treatment techniques that can be used to reduce or control invasive aquatic weed problems. The guide also contains a case study on Lake Cochituate in Natick, MA where state and town officials have launched a pilot project to manage invasive aquatic weeds using non-toxic techniques. Finally, the manual provides a list of resources available to concerned citizens interested in learning more about managing invasive plants in lakes and ponds across the region.

Recommendations

Protect your Lake or Pond using Preventative Measures

The best way to control invasive aquatic plants is to stop the invasion before it starts. In order to prevent invasive aquatic plants, the plant must first be identified at the source of infiltration, such as along the bottom of a boat, and then stopped from entering the lake or other water body. This strategy involves public education, constant monitoring and rapid action. If you are a boat owner, be sure to thoroughly clean your boat, trailer, fishing gear and any other items that travel from water body to water body. If you have an aquarium, never dump its contents into lakes, ponds, drainage ditches or down street drains – some aquarium plants are invasive species. Dispose of all invasive or exotic plant species properly – in a dry area, away from water bodies and in an appropriate receptacle such as a compost bin.

Manage Invasive Species by Using Non-Toxic Methods of Control

Once a body of water is infested with an invasive plant, a combination of eradication and suppression techniques can be employed. Communities can implement invasive plant control strategies that consider the area to be managed and select the correct mix of tools to reduce the population of invasive weed and maintain it at the lowest level possible. Eradication of aquatic invasive plants is difficult if not impossible. Communities should instead seek to manage invasive plant growth using methods that minimize adverse impacts on native species, water quality, and public health.

Recent lack of federal leadership to strengthen pesticide-use laws and regulations means that much of the work to reduce toxic pesticide exposures falls on states and local communities. An effective way for communities to keep their environment and their population healthy is to learn from and engage other towns that have had success, or are considering using non-toxic methods of invasive aquatic species control. The decision for lake management begins at the local level, at town Conservation Commissions.

Phasing Out Persistent Toxic Chemicals

Every year, the United States Environmental Protection Agency (EPA) reviews an average of 1,700 new chemical compounds. The 1976 Toxic Substances Control Act requires that these compounds be tested for any ill effects before approval only if evidence of potential harm exists. Frequently, this evidence is not yet available for new chemicals, which leads to the approval of about 90 percent of new chemicals without restriction. Only a quarter of the approximately more than 82,000 chemicals used in the U.S. have been tested for toxicity.[1]

We are seeing chemicals take their toll on our health, as illnesses continue to rise. For example, over the last two decades, autism increased tenfold, male birth defects doubled and childhood brain cancer was up 40 percent.[2] According to the U.S. EPA, more than 70 active pesticide ingredients known to cause cancer in animals are allowed for use. Exposure to tiny amounts of mercury, lead, dioxins, PCBs or other chemicals, which may have little impact on an adult, can greatly harm children whose bodies are still developing.

All chemicals on the market should be tested and approved from a precautionary viewpoint. We must ensure that unnecessary chemical use does not occur and that all chemicals used are the safest options.

Chapter I: Introduction to the Problem of Invasives

Invasive species are plants or animals that have been introduced to an area where they were not previously found and/or do not occur naturally.[3] Without human involvement, this species can reproduce and spread widely, vastly changing the ecosystem. Invasive species can refer to plants or animals but for the sake of this report "invasive species" will refer to non-native, invasive aquatic plants.

It is important to note that there are many plants introduced to new environments that do not spread rapidly; these plants are not considered invasive species, just *non-native* or *exotic species*. They do not pose the same threat to native animal and plant life as invasive species. What truly makes a species invasive is that it out-competes native plants, rapidly expanding and covering large areas quickly. As the invasive plant takes over the land or water, it also takes over the available nutrients from that lake or pond, making the area uninhabitable for native plants and animals, and sometimes rendering the area unusable for human recreational or drinking purposes.

History

Many invasive aquatic plants appeared in America very early in our nation's history. For example, Purple Loosestrife was introduced to America in the 1800s, both unintentionally on ships' ballasts and intentionally as a medicinal herb and decorative plant.[4] Some invasive species, including the Purple Loosestrife, which has attractive purple flowers, were purposely planted in lakes for aesthetic value. However, once in their new habitats these plants have spread quickly crowding out native plant variety and making the lake habitat unsuitable for many native fish, amphibians and other wildlife. Certain states ban the purchase and sale of invasive species, but some nurseries still sell invasive plants. Be sure to always confirm that the plant you are purchasing is NOT an invasive species. Check with your local government and keep updated on what is legal and illegal in your state. Whether introduced accidentally or deliberately, many invasive plants have had devastating effects on native aquatic plants and animals, and even water quality.

An infestation of Eurasian milfoil in Squam Lake in New Hampshire.

(http://www.des.state.nh.us/wmb/exoticspecies/photos.htm)

Today, the most common way invasive species are introduced is by clinging to boats that are moving from lake to lake. Pieces of invasive plants attach to the trailers or the propellers of the boat, and once the boat or trailer enters the new water body the plant pieces are washed loose, seeding an entire new colony of invasive plants. For more information about how boaters can keep from the spreading invasive plants, visit the Boat Massachusetts website at www.boat-ed.com/ma.

Additionally, invasive plants have also been known to spread through animal migrations or movements. For example, Canadian Geese have been spotted in flight with Water Chestnut seeds

attached to their feathers. Unfortunately, there is little that humans can do to prevent migrating animals from spreading invasive plants.

A Worsening Trend

This photo of Long Lake in Littleton, Massachusetts shows invasive aquatic plants which have grown rapidly in response to nutrients from runoff.

(http://www.mass.gov/envir/lid/examples.htm)

Many invasive plants have been around for decades but are increasingly problematic today. Human modification of the environment, the increasing popularity of boating as a recreational activity, and the continual development of rural and wilderness areas has caused the spread of invasive plants to quicken. Since 1800, more than 50,000 foreign plant and animal species have established themselves in the United States, and about 1 in 7 has become invasive.[5] As human activities increasingly affect lakes, ponds and other water bodies, more animals and plants are endangered or threatened by decreasing habitat. Invasive species can cause drinking restrictions if the infested lake or pond is a potable water source. The more invasive plants in an aquatic ecosystem, the less recreational or potable water is available for human and animal use.

Additionally, infestation can decrease the property value of the land surrounding the lake by clogging the lake (limiting its uses), creating bad smells and accelerating the natural aging of the lake. Invasive species can block entranceways and decrease the depth of lakes making swimming, fishing and boating impossible. The overgrowth of invasive species has even resulted in lake and pond closures.

Chapter II: Commonly Found Invasive Species

The following pages are brief summaries of some of the most problematic invasive aquatic plants found in the Northeastern United States. For a more in-depth, scientific, or nationwide description of aquatic invasive species, consider looking at some of the national websites suggested in the appendix of this guide.

Eurasian Watermilfoil (*Myriophyllum spicatum*)

Eurasian Milfoil is a submerged, rooted plant that grows throughout the year. It has long underwater stems that branch out and produce finely divided leaves as it reaches towards the surface. It reproduces primarily through vegetative means (spreads through fragmentation of plant tips or through the root system). Eurasian Watermilfoil is the most widespread invasive aquatic plant in North America, found in over 45 states, and commonly referred to as simply "milfoil." The earliest confirmed record is 1942 in the District of Columbia but milfoil is thought to have originally been brought over around 1900.[6]

(http://www.nps.gov/plants/alien/fact/mysp1.htm)

Even a tiny piece of a milfoil leaf can reseed an entire new colony elsewhere. Milfoil forms extremely dense mats of vegetation on the surface of the water, which limits and eventually prevents swimming, fishing and other recreational activities. Milfoil can interfere with irrigation or power generation by clogging water intake valves. It has less value as a food source for waterfowl than the native plants it replaces. Milfoil has can completely infest a lake in as short of a period as two years.

There are at least 20 insects that feed on milfoil, but few have been as thoroughly researched or are as widely available as the weevil. The weevil appears to be the most promising long-term solution to controlling the milfoil population in a lake or pond.

(http://www.adkinvasives.com/aquatic/PlantID/Pondweed.html)

Curly-Leaf Pondweed (*Potamogeton Crispus*)

Curly-Leaf Pondweed is a hardy, aggressive plant with hard leaves that have founded tips and a prominent red mid-vein. It emerges in spring and dies back by June or July and can grow in water up to 15 feet deep. It is a native to Africa, Australia and Eurasia.

It is thought that Curly-Leaf Pondweed has infested most of North America.[7] The plant has spread rapidly due in part to fisheries and hatcheries using the plant as source of food and habitat for their animals.

Curly-Leaf Pondweed is characterized by lasagna-like leaves, which are stiff and semitransparent with serrated edges. The leaves are arranged alternating up the stem with increasing frequency as they

approach the tip. Only a flower stalk emerges above the water; the rest of the plant grows beneath the surface of the water.

Non-toxic methods of controlling Curly-Leaf Pondweed include encouraging phytoplankton or algae blooms to reduce the sunlight reaching the plant. However algae growth and excessive phytoplankton can cause other problems like nuisance blooms, odors, and toxic conditions.[8] These outcomes must be carefully considered. Also, grass carp have been employed and used with success to control Curly-Leaf Pondweed.

Fanwort (*Cabomba Caroliniana*)

Fanwort is a freshwater, submersed perennial that can be floating or rooted. It is native to the Southeastern United States but is considered invasive in the Northeast and the West. Fanwort is known for forming dense strands of plant growth that make water unusable for recreation, while simultaneously crowding out native plants and animals. The plant prefers muddy, shallow and stagnant water that is common in small ponds, slow moving streams and ditches. Because of its attractive leaves it has been a popular aquarium plant.

(http://aquarium-journal.com/2007/05/carolina-fanwort-cabomba-caroliniana.html)

The Fanwort's leaves are less then 1/2 inch long and are narrow ranging in color from green to reddish-brown. The flowers are white and small, usually less then 1/2 inch in diameter. These flowers float on the water and can be seen from May to September. Fanwort can reproduce vegetatively from breaks of stems or leaves. Grass carp have been used to control Fanwort however it is not their preferred food.

(http://dnr.wi.gov/invasives/fact/hydrilla_photos.htm)

Hydrilla (*Hydrilla Verticillata*)

Hydrilla is a non-native plant that has a long slender stem that branches profusely as it approaches the surface of the water. Hydrilla can form dense colonies of plants up to 20 feet deep and can reproduce through seeds, fragments of the plant, roots and buds. It creates dense mats preventing the recreational use of the water body. Hydrilla is a native to Europe and Asia it was first brought here for the aquarium trade in the 1950s.[9]

Hydrilla leaves are blade like and usually 5-8 inches long with a pointed tip and a mid-vein on each leaf. Female flowers are white while male flowers are greenish in tint. It can be identified by the rough feel to the underside of

the leaves.

Ducks have been known to eat Hyrdilla, but it is not their first choice of food. There is a leaf-mining fly (*Hydrilla pakistanae*) which is being studied as a control mechanism.[10] It has been shown to provide short-term control. Weevils have also been employed with some success.

(http://plants.usda.gov/java/profile?symbol=PHAU7)

Phragmites (*Phragmites Australis*)

Phragmites is often referred to as the Common Reed and is found in every state of the continental United States. It can live in fresh or brackish water, however it prefers slow moving and slightly brackish water like that found in small ponds or on roadside ditches. Phragmites is well-known as a hardy and persistent species, it exists on every continent except Antarctica. It has many commercial uses including being used to create pen tips, papers, mats and can be used to clean sewage or polluted waters. Phragmites can create a potential fire hazard when it dries in fall and winter.[11]

Phragmites is a tall perennial grass that can grow up to 16 feet tall. It has wide stiff leaves and a hollow stem, and flowers that start purple and eventually turn white as the plant matures. Phragmites is a colonial plant in that is spreads through underground root system.

Due to its large size and the denseness of the mats that it forms there are limited mechanical control mechanisms for the Phragmites. Cutting and mowing can be used; however, this can actually increase its growth. Cutting or mowing and then applying covers can be extremely effective as it completely kills the plant including the root system. Additionally, controlled burns and dredging have been used. Changing the ecological balance of the area by adjusting the salinity or water velocity can make the habitat unsuitable for the reed. There are 26 known herbivorous species that attack the Common Reed, however only a few are native. These include the Yuma skipper (*Ochlodes yuma*), a Dolichopodid fly (*Yhrypticus*), a gall midge (*Calamomvia phragmites*), and a native broad-wing skipper (*Poanes viator*).[12]

Purple Loosestrife (*Lythrum Salicaria*)

Native to Europe, Purple Loosestrife is thought to have been introduced to the United States in the 1800s. It was introduced accidentally on ships' ballasts and then purposefully as a decorative plant and a medicinal herb. It is estimated that 190,000 acres of land (wet or dry) are invaded each year by Purple Loosestrife. Even though many states consider this plant to be an exotic, invasive species you can still purchase it at some nurseries. It is a hardy species that can establish thick stands in many different types of wetlands.[13]

The leaves are heart shaped at their base and arranged in opposite pairs up the stem, which can grow

(http://www.nps.gov/plants/alien/fact/lysa1.htm)

to over 6 feet in height. The stem is distinctive in that it is four sided and woody. Fully grown plants may have 30 to 50 stems rising from one single rootstock. Purple flowers appear from July to September. These flowers have five to seven petals each. Purple Loosestrife reproduces vegetatively through underground stems. Fragments can reseed a new colony elsewhere.[14]

Hand pulling, mowing and burning are common mechanical techniques for control. Covers can be used once the plant has been cut back to increase the level of success. Additionally, five insects have been approved in the United States for use as biological controls, including leaf-eating beetles and stem boring weevils. Biological controls have seen great success Vermont and Rhode Island.

South American Waterweed (*Egeria Densa*)

The South American Waterweed is a submerged, robust invasive aquatic plant that is native to South America. It is also referred to as the Brazilian Waterweed or Anacharis. It can survive in many different types of habitat but prefers stagnant water that is slightly acidic and does not range into high temperatures. All South American Waterweed found in America seems to reproduce vegatatively, as no seeds or female flowers have been found.[15]

South American Waterweed is a very leafy plant with the majority of its biomass located near the surface of the water. Leaves are thin and bright green with their tips ending in a point. The stems are thick and also bright green with branches coming from double nodes based on the thick stem. Flowers appear approximately one inch above the surface of the water and are white with three petals. Waterweed can grow in water up to 20 feet deep.[16]

(http://www.mass.gov/dcr/waterSupply/lakepond/factsheet/South%20American%20Waterweed.pdf)

Benthic barriers in localized areas have been successful in controlling Waterweed. Draw-downs have also been successful, especially when done consecutively and combined with freezes. Hand pulling, raking, and rotovation should be used with caution since the plant readily fragments and reproduces. Also, research has identified a fungus (*Fusarium* sp.) in Brazil which controls the plant but more testing outside of the laboratory is needed. Grass carp will eat Waterweed although they may also eat other native aquatic plants and should be carefully monitored and controlled. Grass carp have been successfully applied to manage South American Waterweed in Devil's Lake and Silver Lake, Oregon.

Water Chestnut (*Trapa Natans*)

Water Chestnut is an annual, rooted, floating non-native plants that forms dense (often impenetrable) mats at the water's surface and can reproduce vegetatively. This plant can grow up to 16 feet long and looks similar to several native plants however its "nutlets" make the plant distinctive. It is spread primarily by boat traffic, however Canadian geese have been seen migrating with nutlets attached to their feathers. Water Chestnut seeds can lay dormant for up to 12 years.[17]

(http://tncweeds.ucdavis.edu/esadocs/Trapnata.html)

Water Chestnut has green, triangular, floating leaves that attach to the main stem by a floating stem, which can reach up to 15 feet in length. The triangular leaves are smooth and waxy on the top, rough to the touch on the bottom, and have toothed edges. Water Chestnut produces thorny nutlets with four points in early summer. Each nutlet contains 100 or more seeds and can cause injury if stepped on.[18]

Hand pulling is the most widely used method for removing the plant because the floating tops and thin roots make removal easy. In 2005 in East Hartford, Connecticut 400 pounds of water chestnuts were hand pulled from Vinton's Mill Pond. A lighter load appeared in 2006, giving volunteers hope that repeated hand pulling would greatly reduce and eventually control the invasive plant. Research on biological controls involving specific moths, weevils and some other insects found naturally in Asia is currently being completed, however no major controlling insect has yet been identified and thoroughly tested.

Chapter III: Commonly Used Aquatic Herbicides

Pesticides are Persistent in our Environment

According to the U.S. EPA, a pesticide is "a substance or mixture of substances intended for preventing, destroying, repelling or mitigating any pest."[19] A "pest" is any plant or animal that threatens our immediate environment, our food supply, our comfort or our health.[20] The most common types of pesticides are 1) *fungicides* that control fungi such as athlete's foot, ringworm, and mushrooms, 2) *Insecticides* that control insects, 3) *Rodenticides* that control rodents like rats and mice, and 4) *Herbicides* that control any unwanted land or aquatic plant. There are many other types of pesticides, but this report we are most interested in the most widely used type of pesticide, *herbicides*.

The modern pesticide industry began after World War II, when companies that produced chemical and biological weapons for the military needed a new market for their products. The chemical industry saw money-making opportunities in the products and practices of postwar America. Chemical companies like Dow and Dupont produced the pesticides, and pesticide applicators and product manufacturers marketed them to consumers and the government. Today, pesticides include components of war-time defoliants like Agent Orange, nerve-gas type insecticides, and artificial hormones.

Many Americans grew up thinking that the prevalence of pesticides in our environment was healthy and normal. We were taught that pesticides keep dangerous mosquitoes off our children and our crops plentiful. When Rachel Carson wrote Silent Spring in 1962, she raised public awareness about the effects of pesticide use on our health and the environment. However, forty years after Carson drew attention to the health and environmental impacts of DDT, the use of equally hazardous pesticides has only increased.

Today pesticides are found in the air we breathe, on the food we eat, along the roads we travel, and in the lakes where we swim. While pesticides are designed to kill, they may not always kill the targeted pests. And in the process, pesticides cause acute and chronic health effects ranging from nervous system disorders to blistering of the skin to reproductive dysfunction, cancer and learning disabilities. For example, a 1999 study by the American Cancer Society showed an increase in non-Hodgkin's lymphoma for individuals who used herbicides and fungicides, with the biggest impact from exposure to the pesticide MCPA. Similarly, a 2006 Denmark study showed that prenatal exposure to eight of the most abundant persistent pesticides, through significantly elevated levels in breast milk, indicated a higher rate of male children with undescended testicles. Children's health is even more at risk as a result of pesticide exposure. Disturbingly, acute pesticide poisoning is often misdiagnosed because acute symptoms are similar or identical to those caused by other illnesses. Additionally, chronic health effects from pesticides are challenging to study in humans because most people are exposed to low doses of pesticide mixtures, and delayed health effects are difficult to link to past exposures.

Pesticides can threaten the environment as well, potentially impacting ground water and non-target organisms such as pets, fish, birds, or amphibians. David Pimentel of Cornell University conservatively estimates that the number of birds lost each year to pesticides is 67 million – on farmland alone. And pesticides account for the majority of wildlife poisonings reported to the United States Department of Environmental Protection (U.S. EPA).

Notable Moments in Pesticide History

1800s: American farmers use **copper and sulfur based chemicals** to control pests in their fields. This resulted in dangerous health effects and almost no selectivity in which plants were being targeted.

1930s: The true era of chemical use begins with **development of synthetic** (man-made), **organic** (containing carbon) **compounds** for use as pesticides. Referred to as "2nd generation" pesticides.

1939: **DDT is introduced** and widely used (the creator, Paul Miller, won the Nobel Prize for his invention). The devastating effects of DDT were not realized until after widespread public and private use.

1940s: The **use and creation** of synthetic chemicals in the form of pesticides **rises dramatically** with new and more dangerous chemicals entering the market including chlorinated hydrocarbons and organophosphates.

1950s: Appearance of **pesticide resistant insects** and effects on non-target organisms become apparent. For example, DDT is detected in woman's breast milk.

1960s: Rachel Carson writes *Silent Spring* which brings public awareness to the **unknown long-term effects of the use of pesticides** and begins the modern day environmental movement. **IPM** (Integrated Pest Management) begins to really be developed and considered as a feasible alternative to blanket chemical use.

1972: **Federal ban on DDT is enacted** because of dangerous effects on human health and the environment.

1980s: Development of synthetic chemicals that are "low-dose" or "selective" which means they are **more concentrated, acutely toxic** and often **more water soluble**.

1990s: Coalition of environmental groups wins a precedent setting campaign that successfully forced the Environmental Protection Agency to disclose most of the "inert" ingredients in six common pesticide products.

Commonly Used Aquatic Herbicides

The problem of invasive plants is real, and these plants must be managed or they will take over an entire water body. Chemical treatment is the oldest method used to control nuisance weeds in lakes, and unfortunately, despite increasing evidence of the dangers of pesticides, is the most commonly used aquatic weed-control technique in Massachusetts. Additionally, evidence shows that chemical treatments performed over a number of years become less effective at controlling invasive plants. They may be a quick fix but have not been proven as a long-term solution for invasive species like milfoil.

The dumping of herbicides into our water bodies can cause nutrient and pH imbalances, kill off beneficial organisms, contaminate drinking water supplies, and harm people. For example, the Vermont Fish and Wildlife Department recently released two studies detailing a history of failure for chemical treatments in two Vermont lakes. The state's studies claim that not only did herbicides fail to control milfoil over a number of years, but they also posed a substantial threat to fish populations and native vegetation.[21]

2,4-D *(Stands for 2,4 –Dichlorophenoxyacetic Acid)*

2,4-D is a systemic herbicide, which means that the chemical is absorbed by roots or foliage and distributed throughout the plant. It inhibits cell division in new tissue and stimulates growth in older tissue resulting in cell disruption. 2,4-D can be applied as a liquid or in granular form, usually during the early growth stages of the plant.[22]

2,4-D made up about 50% of Agent Orange, a defoliant used in the Vietnam war that has been linked with widespread poisoning, birth defects and health problems. It is the oldest organic (containing carbon) aquatic herbicide approved for use in the United States. 2,4-D has been detected in groundwater in at least 5 states. Treatment costs are estimated around $300-$800 per acre, depending on degree of infestation and company used. Repeat treatments will be necessary at least once per season.[23]

2,4-D is fast acting and allows for some selectivity depending on application timing and concentration. It is most commonly used to control Water Chestnuts, Eurasian Milfoil and Curly-Leaf Pondweed.[24] 2,4-D has been linked to cancer, endocrine disruption, reproductive toxicity, neurotoxicity, and kidney/liver damage. It does not affect seeds, which means that applications must be repeated every season. It restricts the use of water for irrigation or recreation after application. 2,4-D cannot be used in water for drinking and has the ability to leach into nearby groundwater supplies.[25]

Copper *(Also known as Copper Sulfate)*

Copper is a contact herbicide, which means that it must come in direct contact with the target species to be effective. Copper is toxic to plant cells, disrupting proper cellular function, inhibiting photosynthesis, and possibly affecting the nitrogen metabolism of the plant. It is usually applied in granular form (it can also come in liquid form) and is often put in bags which are towed behind the application boat.[26]

Different forms of Copper are generally combined with other herbicides or pesticides to make them

more effective agents of weed control. The copper ion is persistent in the environment and will either accumulate in soil or move downstream to accumulate there.[27] Treatments typically cost $50-$100 per acre although repeat applications are required and there must be extensive monitoring of the site which will add to the overall cost of application.

(http://www.chss.montclair.edu/~pererat/0000d.jpg)

Copper is often used as an algal control agent.[28] However, copper is highly toxic to zooplankton (*Daphnia* sp.) which eat the algae that Copper Sulfate is used to control. So applying Copper Sulfate to control algae can actually eliminate the natural controlling agent of algae. Additionally, Copper Sulfate is potentially toxic to all aquatic plant species and lacks selectivity. If not carefully applied, it can also create oxygen depletion leading to fish kills and damage to other non-target plants and animals.

Diquat Bromide *(Commercial Products: Reward)*

Diquat Bromide is a non-selective, contact herbicide, algaecide, desiccant and defoliant used against broadleaf and grassy weed species in aquatic areas. It is applied in a liquid form, often times mixed with Copper. Diquat Bromide is absorbed by foliage, not only by the roots, which means it only affects the area of the plant that it comes in contact with.[29]


(http://www.dep.state.fl.us/lands/invaspec/images/Chem_control_airboat.jpg)

Manufacturing of Diquat Bromide creates a chemical named Ethylene Dibromide (EDB), a known carcinogen which is banned from use in the United States. Diquat Bromide can be fatal to humans if swallowed, inhaled or absorbed through the skin. Treatment usually costs between $200-$500 per acre with repeat applications required.

Diquat Bromide is fast acting, and is known to control Eurasian Milfoil, Brazilian Elodea, and Curly-Leaf Pondweed. Diquat Bromidde provides moderate control of immersed plant species and moderate to high control of floating or submersed species.[30] It is non-selective in the target area, meaning that plants and animals that are not necessarily the target can be negatively impacted or harmed.

When Diquat Bromide is used, there must be a 24 hour swimming restriction, a three day domestic water restriction, and a two to five day irrigation restriction on use of water after application. Regrowth of species will occur, so repeat application is necessary. Diquat Bromide forms strong bonds with clay and soil particles, making it ineffective in muddy or murky water and increasing its tendency to have long-term persistency in the soil. The chemical is listed as toxic to animals and has caused cancer in rats in laboratory studies.[31]

Endothall *(Commercial Products: Aquathol, Des-I-Cate, Tri-endothall, Ripenthol and Hyrdothol)*

Endothall is a contact herbicide, so only the parts of the plant that come in direct contact with the chemical deteriorate. Endothall limits the plant's use of oxygen by inhibiting photosynthesis and disrupting the cell membrane. It causes structural deterioration of the plant but does not affect the root system of the plant. It is usually applied in liquid or granular form.[32]

It is actually the Dipotassium salt of Endothall which is used in aquatic herbicides. It is not an eradication technique, as it can only be used to control invasive plant numbers. Because it is a contact herbicide, it is generally used for spot treatments, not whole lake treatments. The Endothall label advises a three day fish consumption restriction after application. Treatment usually costs $400-$700 per acre with repeat applications and monitoring required.[33]

Endothall is fast acting, and is commonly used to control Hydrilla, Eurasain Milfoil and Curly-Leaf Pondweed among other species, usually floating or submersed types of aquatic plants.[34] In addition to the three day fish consumption restriction, there is a 14 day restriction on using treated water for irrigation or for stock watering. Endothall rapidly kills plants, creating a buildup of decaying plant matter which can lead to oxygen depletion and fish kills. Endothall is non-selective in target areas and is potentially toxic to all aquatic fauna. There is a recommended restriction on swimming after application. It cannot be used in drinking water supplies.[35]

Fluridone *(Commercial Products: Sonar, Pride, Brake, Rodeo)*

Fluridone is a systemic herbicide, which means that the chemical is absorbed by the leaves or roots and then spreads throughout the rest of the plant, killing it. It interferes with the plants' ability to photosynthesize. It is a slow acting chemical that must be in contact with the plant for 45 to 60 days, which leads to repeat applications and extended exposure time. Fluridone works best when applied as a liquid or in granular form during the early growth phase of the plant.[36]

(http://aquat1.ifas.ufl.edu/seagrant/sgherb2.jpg)

Highly water soluble, Fluridone remains in the water one to fifty-two weeks. It is restricted from use within 1/4 mile of any drinking water supplies (both surface and well). Costs can range from $500-$1000 per acre for the first treatment and then up to $2000 for the subsequent treatments.

Floridone has been shown to control Eurasian Milfoil, Fanwort, Hydrilla and Curly-Leaf Pondweed among other invasive plants. It kills plants slowly, limiting the chance that oxygen levels in the lake will be effected therefore reducing the probability of fish kills.[37] Its slow acting nature means that it must remain in the water for long periods of time to be effective. Additionally, it is difficult to perform partial lake treatments because Fluridone is extremely water soluble. Lab tests have shown that Fluridone has chronic adverse effects to the eyes, liver, kidney and can cause testicular atrophy.[38]

Glyphosate *(Commercial Products: Roundup, Tumbleweed, Rodeo, Gallup, Touchdown)*

Glyphosate is a systemic herbicide which is absorbed through the leaves. The chemical disrupts enzyme formation, but scientists aren't sure how exactly it kills the plant. It is applied as liquid spray to the targeted area.[39]

The cost for treatment is about $500-$1000 per acre, depending on density of infestation. Glyphosate is not for use within 1/2 mile of drinking water intakes. Glyphosate is fast acting and can be used selectively if applied extremely carefully, and is known to control emergent and floating plant species. Additionally, Glyphosate requires no time delays for use of water when applying per label instructions.[40]

Glyphosate will not work if there are large amounts of suspended particles or if the water is muddy or highly murky. It is easily absorbed by clay and soil particles, which means there is the chance that it will persist in soil after application. Additionally, there are serious concerns over the health effects of Glyphosate, especially when combined with inert ingredients or other herbicides. Though touted by manufacturers as relatively safe and nontoxic, glyphosate can in fact cause serious health repercussions, especially eye and skin irritations that can sometimes quite severe and can persist for months.[41] Glyphosate has been linked to non-Hodgkin's lymphoma.[42]

Overuse of Pesticides: Existing Laws Do Not Protect Us

Even if regulators know that a pesticide causes severe health and environmental impacts, including cancer and genetic damage, it may still be approved for use. The U.S. EPA may determine that a cancer-causing chemical may be used despite its public health hazard if its "economic, social or environmental" benefits are deemed greater than its risk. According to the U.S. EPA, more than 70 active pesticide ingredients known to cause cancer in animals are allowed for use. Although the pesticide industry tests for a wide range of environmental and health impacts, the vast majority of pesticides currently on the market have not been fully tested.

Federal law requires active ingredients to be labeled on pesticide products, but even with these labels, the actual make-up of the product remains unclear. Active ingredients can be as little as 1% of the product. And the vast majority of inert ingredients is not disclosed by the pesticide manufacturers or applicators, but can cause the majority of harm to the public health and the environment. Federal regulations allow information on inert ingredients to be kept secret when the manufacturers request confidentiality of their pesticide mixture as "trade secrets." Most manufacturers claim this confidentiality, leaving consumers in the dark. While the U.S. EPA can mandate disclosure of inert ingredients, currently only eight out of 2,300 inert ingredients are required to be listed by the U.S. EPA. In August 2006, fourteen states, including Connecticut, Maine, Massachusetts and Rhode Island launched a campaign to force the Bush administration to require manufacturers to disclose "inert" ingredients.[43] The US EPA already requires inert ingredients to be listed on nonprescription drugs, foods and cosmetics.

Poor federal regulations persist in part because powerful special interests have significant influence on pesticide policies in the United States. From 1979-1994, Monsanto and Dow, two of the leading chemical producers on the planet, gave $42.5 million to foundations and universities, much of it to

research pesticides.[44] A great deal of advice that farmers and urban pest managers receives comes from the chemical industry, whose profits stem directly from the sale of their pesticide products

As a result of the lack of existing federal leadership to strengthen pesticide laws and regulations, much of the work falls on the states and local communities. At the state level, the political climate does not, generally, support a full ban on pesticides, and only nine states are able to ban pesticides without U.S. EPA approval. This fact forces environmental organizations and activists to work to strengthen pesticide laws and phase out chemicals statewide and locally, to limit pesticide practices through the regulatory process, and to target the industry directly.

Chapter IV: Alternatives to Aquatic Herbicides

The Pesticide Action Network estimates that worldwide that there are 200,000 deaths per year from pesticide poisoning. Herbicides can leach from lakes and ponds into nearby wells or drinking water supplies. Additionally, there is the danger of direct contact with the water after application. Pesticides have been linked to a wide range of human health hazards, ranging from short-term impacts-such as headaches and nausea-to chronic impacts like cancer, reproductive harm, and endocrine disruption. Acute dangers - such as nerve, skin, and eye irritation and damage, headaches, dizziness, nausea, fatigue, and systemic poisoning can sometimes be dramatic, and even occasionally fatal. In 1994, 1,332 pesticide-related illnesses were reported to the California Department of Pesticide Regulation.[45] A study of reported pesticide illnesses from 1983-1990 found over 19,000 poisonings, including over 9,000 in non-agricultural settings. It is likely that these numbers vastly underestimate the number of actual poisoning incidents, because many of the symptoms associated with pesticide poisoning are similar to those associated with the flu.

Chronic health effects may occur years after even minimal exposure to pesticides in the environment, or result from the pesticide residues which we ingest through our food and water. Pesticides are linked to many types of cancer in humans. Some of the most prevalent forms include leukemia, non-Hodgkin's lymphoma, as well as brain, bone, breast, ovarian, prostate, testicular, and liver cancers. Pesticides can also disrupt the endocrine system, playing havoc with the complex regulation of hormones, the reproductive system, and embryonic development.[46]

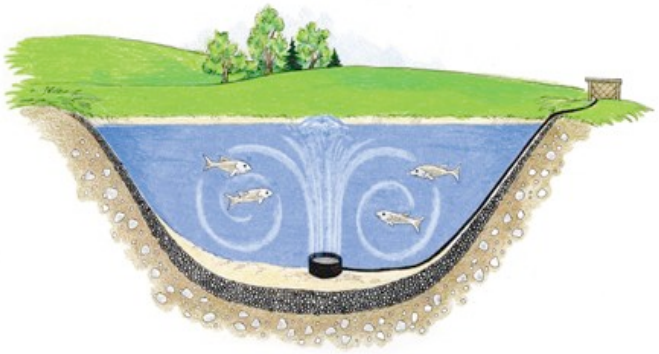
The combination of likely increased exposure to pesticides and lack of bodily development to combat the toxic effects of pesticides means that children are suffering disproportionately from their impacts. According to a 1990 assessment by the U.S. Congress Office of Technology, "research demonstrates that pesticide poisoning can lead to poor performance on tests involving intellectual functioning, academic skills, abstraction, flexibility of thought, and motor skills; memory disturbance and inability to focus attention; deficits in intelligence, reaction time, and manual dexterity; and reduced perceptual speed. Increased anxiety and emotional problems have also been reported."[47] In addition to the serious human health concerns that pesticides cause, they also have adverse affects on the environment. Herbicides usually have harmful effects on other, non-target native plants, animals, and the ecosystem as a whole.

The following pages include summaries of some, but not all, of the common types of alternative treatment techniques for lakes and ponds that have been infested by invasive aquatic plants or that have aquatic weed problems. More research on these techniques along with new and innovative approaches are being developed everyday, and they should be considered when choosing to control an invasive species.

There are benefits and trade-offs for every type of alternative treatment technique. Good management strategies often include combining several different types of treatments to achieve the desired control of the invasive plant based on needs and desires for the lake or pond. Wetlands are extremely complicated and unique systems with many variables that must be considered when choosing a treatment technique or group of techniques.

Artificial Aeration/Circulation

Artificial aeration or circulation is the use of air to keep water in motion in order to change oxygen levels in different areas of the body of water. By increasing oxygen circulation, the amount of internal phosphorus recycling is reduced thus limiting the food available for plant growth. Aeration apparatuses come in many different forms, from circulation devices (bubblers, fountains and diffusers) which can been seen on the surface, to devices which function completely underwater (subsurface aerators).



Aeration also can help to reduce the release of nutrients from the sediment, minimize algae blooms, and enhance the breakdown of organic material. Prior to considering the implementation of this management tool one should investigate the source of nutrient loading, the type of algae blooms that persist in the system, and the water quality conditions in the water body. Cost depends greatly on the equipment and company used. Estimates put the maintenance and electricity costs between $200 to $3,000 dollars plus the cost of initial purchase and installation.[48]

Advantages:

- Limited impact on non-target species and no negative health affects for humans.
- Wide variety of devices and companies to choose from when selecting an aeration device.
- New models currently being developed and tested. For example, the Solarbee is an aeration device used to control algae blooms that is being studied to reduce invasive plant growth as well. The Solarbee runs on solar power, thus limiting electricity costs. For more information, see http://www.solarbee.com/.

Disadvantages:

- Costs for installation and maintenance on some models can be high.
- Possibility of vandalism
- Recreation may be restricted within close proximity of circulation/aeration machine depending on the product.
- Potential that the machine may spread localized impact by circulating fragments or seeds.[49]

Barley Straw (*Hordeum vulgare*)

The use of barley straw as an algae control agent began in England in the 1900s and as been used there in large reservoirs and canals. Recommended application is 225 pounds of barley straw per acre of the lake being treated. It is best to apply in small sections throughout the pond, and it is important to apply before algae establishes itself in the lake or pond.

Straw should be contained in netting to hold it together in the area where applied. The exact mechanism by which barley straw prevents algae growth is unknown, however it is thought that the rotting barley releases a chemical that prevents the growth of algae.[50]

Advantages:

- Non-chemical method of controlling algae growth and could also provide limited control of other aquatic plants.
- Cost is relatively cheap and labor is minimal.
- Material is readily available at local nurseries, garden shops and on the internet.

(http://www.iecat.net/institucio/societats/ICHistoriaNatural/Bages/planes/Imatges%20grans/07-LESMO.jpg)

Disadvantages:

- Still being researched with mixed results in U.S. although success has been confirmed in Europe.
- Ponds or lakes that are murky and have a high suspended particle count will require additional amounts of barley straw and may be prone to less success.[51]
- Prevents growth of algae but does not kill existing algae.
- Decomposition of barley straw is temperature dependent.

Benthic Barriers *(Commercial Names: Aquascreen, Texel)*

Benthic barriers are simply bottom covers that limit the amount of light available to aquatic plants. This reduces or prevents photosynthesis and kills the plants. There are a variety of porous and solid materials that have been developed for these barriers, including polyethylene, polypropylene, fiberglass and nylon. Benthic barriers usually used in localized areas like around docks.

There are strengths and weaknesses to both solid and porous materials respectively:

- *Solid Materials*—effectively kill plants, but need venting to allow gases to escape and need to be staked down well
- *Porous Materials*—can billow which allows for less securing and weighting of the material but plants can root on top of the material increasing the maintenance requirements

(http://el.erdc.usace.army.mil/aqua/apis/mechanical/image/barrier1.gif)

Benthic barriers can be used in coordination with draw-downs to reduce plant height and density and make installation easier.[52]

Advantages:

- After initial cost for design and purchase of material the annual cost is limited to installation, maintenance and storage during the winter months.
- Material cost can vary from .22 cents to $1.25 per square foot. Commercial installation costs will also vary greatly depending on the retailer and material chosen.
- You do not necessarily need a professional to design, install or maintain the barrier.

- Good for use with invasive plants that reproduce vegetatively because the plants will not be cut or fragmented by the benthic barrier, limiting the chance that the treatment technique will actually exacerbate the problem.[53]

Disadvantages:
- Maintenance can be difficult and/or time consuming.
- Only practical on a small scale; not for whole lake treatments.
- Problems have been reported regarding keeping the covers in place and installing the covers over dense and tall plant growth.[54]

Draw-downs

Managers of reservoirs and some lake systems have the ability to lower the water level as a method of controlling aquatic plants; this is called a draw-down. The process is usually done in autumn, when the best results are yielded. A drying and then a freezing period can increase the success of draw-downs. The water should be removed slowly over a period of two to three weeks to prevent erosion, downstream flooding and harm to wildlife.

(http://aquat1.ifas.ufl.edu/guide/physcon10js.jpg)

Though it appears to be a simple technique, there are many variables that must be considered including plant types, seasonal temperatures and surrounding or dependent water bodies. The process can be inexpensive if the infrastructure is already in place for a drawdown (i.e. dam, water pump system or existing outlet facility). If equipment is not in place, the price could be $100,000 or more to build the infrastructure.[55]

Advantages:
- Relatively little impact on wildlife as long as the process is done gradually.
- Reports of great success, eradication of Brazilian Elodea in Black Lake, Louisiana.
- Draw-downs also provide a great opportunity to have a shoreline clean-up removing litter and large items that are normally covered with water.[56]

Disadvantages:
- If infrastructure is not already in place, then cost is probably prohibitive.
- All plants (invasive and non-invasive) are killed in the draw-down area.
- Can temporarily reduce well water levels of those nearby the lake and draw-down area.
- Often requires permits, public notice and a discussion period. Check with local and state governments for rules or regulations.[57]

Dredging *(Types: Wet, Dry or Hydraulic)*

Dredging is the physical removal of sediment and any rooted plants by excavation. Hydraulic or pneumatic dredging is used when removing sediment and plants from within the lake; wet or dry dredging is employed when working along the shoreline.

(http://www.lakesidemc.com/customers/10308261439 3383/images/dredging.001.jpg)

Dredging is usually conducted when attempting to increase lake depth; algal or plant removal is merely a side effect, and is most often performed only on systems that are severely affected due to high costs and implementation difficulties. The costs vary considerably depending on what type of dredging is implemented, the amount of soil removed, accessibility of the area to be dredged, the disposal cost of soil if contaminated, permitting costs, and other various costs associated with the technique.[58]

Advantages:

- Can restore a severely impacted lake or pond to a usable depth and quality.
- Can remove polluted soil from lake or pond bottom.
- Can completely eradicate an invasive species from the water body if done correctly.[59]

Disadvantages:

- Costs can be extremely high and the time required to complete the project can take years.
- Dredging will restrict access to the area of the lake or pond being dredged.
- There is a large impact on the ecosystem, not only on the animals and plants in the lake but also on the surrounding area due to machinery movement, worker traffic, downstream runoff and the disposal of removed sediment.
- The permitting and planning process can be lengthy. Some states restrict dredging if the soil is contaminated.
- This is a large-scale project with considerable impacts and costs.[60]

Dyes *(Commercial Name: Aquashade)*

Dyes prevent light from fully transmitting through the water thus limiting an invasive species' ability to photosynthesize, reducing the plant population. Dyes can cost from $100-$500 per acre depending on the amount of dye needed, monitoring, planning, etc. Dyes require repeat treatment because they eventually wash out.

Aquashade is the only colorant registered with the U.S. EPA for aquatic plant growth control. One gallon of Aquashade can treat one acre of four foot deep water and costs around $40.[61]

Advantages:

- Dyes can limit algal and rooted plant growth without the use of herbicides and other toxic chemicals.
- Generally non-toxic to all aquatic species.
- Can make water more aesthetically pleasing.
- Aquashade will not cloud the water, it simply adds a tint.
- No restrictions for recreation or to livestock are necessary after application.[62]

(http://www.aquaticbiologists.com/pic4.html)

Disadvantages:

- Not target specific; limits light for all plant species, not just the invasive species.
- Not effective in shallow water that is less then two feet deep.
- Requires repeat treatments.
- Can actually cause anoxic conditions or increase thermal stratification which can harm aquatic animals. However, careful monitoring and application can prevent this.
- Once applied you simply have to wait for it to wash out, the dye can not be removed.
- Does not have an affect on surface floating plants since dyes will not interfere with their photosynthesis.[63]

A Case Study:
Lake Cochituate in Natick, Massachusetts

(http://lakecpowr.tripod.com/index.html)

Natick is a town of 32,000 residents located just 15 miles west of Boston and borders Lake Cochituate alongside Framingham and Wayland. The 614 acre lake is divided into three distinct basins: North Pond, Middle Pond and South Pond. Middle Pond is home to Cochituate State Park and is used extensively for boating, swimming and fishing.

Eurasian milfoil was discovered in Lake Cochituate in 2002. The Massachusetts Department of Conservation and Recreation (DCR) responded by calling for an assessment of the lake and the development of a Long Term Vegetation Management Plan, which Aquatic Control Technologies Inc. (ACT) completed in February 2003. ACT, a supplier of herbicides, found that the milfoil coverage of Lake Cochituate was quite extensive and represented a high percentage of the total plant coverage in all three basins.

ACT's recommended short-term control tactics for dealing with the milfoil infestation, including chemical treatments for an estimated 50-60 acres, installation of bottom weed barriers, suction harvesting and the employment of divers to hand-pull the widely scattered milfoil plants.[64] In 2003, DCR proposed using diquat and endothall to kill weeds in the lake. This plan was met with approval by the Natick Conservation Commission and protest by the Natick Board of Health. Citizens appealed and the proposal was withdrawn. In 2006, high doses of Fluridone (in the form of the herbicide Sonar) were recommended for application, with the predicted re-growth rate of 50% likely to occur the following year. In addition, a combination of various other herbicides and non-chemical methods were proposed for Middle Pond and North Pond, all of which are displayed below in the estimated budget put forth by ACT, presented in Appendix B. ACT's report concludes by stating that there currently is no technique which permanently eradicates milfoil and that herbicides are the most cost-effective tool for managing milfoil in Lake Cochituate.[65] The process outlined above would then have to be repeated annually or bi-annually in order to control the milfoil.

In order to apply fluridone, ACT needed approval from the Natick Conservation Commission, which requested an opinion from the Natick Board of Health regarding the matter. The Board of Health asked the DCR to hire an independent consultant to provide expert advice and information regarding the usage and subsequent risks of herbicides in Lake Cochituate. Warren J. Lyman, PhD. was enlisted to investigate the issue and submit a report, which he did on March 7, 2006, presenting his findings at a public hearing two weeks later. Due to citizen concerns and the research presented, at the conclusion of the public hearing, the Board of Health voted unanimously to recommend against the use of herbicides, especially fluridone, on the grounds that it is "almost a certainty" that if fluridone is used in the lake it will enter the groundwater and be present in the town drinking water wells at levels high enough to kill household plants.[66] As information was being gathered by officials and experts, local residents also began to wonder, if fluridone could do this to the plants, what could it do to them? A study released by the U.S. EPA confirmed citizens' fears and revealed that the side effects of fluridone include decreased body and organ weights, bone malformations, skin fibrosarcomas, and eye irritation.[67] The Board of Health felt that alternative solutions had not been fully explored and due to all of these reasons, they could not recommend the use of herbicides in Lake Cochituate.[68]

The Natick Board of Selectmen had also sent a letter to the Conservation Commission to "express its grave concern with the DCR plan to use herbicides in Middle Pond and South Pond of the Lake, and to express its support for the use of non-chemical methods to control invasive growth in."[69] Additionally, a plant biologist who specialized in the study of biological controls of pest species testified against the use of herbicides at Lake Cochituate due to the unintended long term effects that would result from utilizing the herbicides and the short term nature of the solution. She affirms that alternative uses (specifically the milfoil weevil) would be safer, more cost-effective and a more sustainable solution for reducing the prevalence of milfoil in the lake.[70] Many others, including the Vice President of the Conservation Law Foundation and Richard F. Yuretich, Professor of Geosciences at the University of Massachusetts at Amherst, also expressed similar opinions regarding the use of herbicides.[71]

These expert opinions were organized and compiled by a group of concerned Natick residents who were worried about the quality of their drinking water and the safety of their children. These neighbors began meeting informally to discuss their concerns, and eventually formed the community group Protect Our Water Resources (POWR). POWR worked with attorney Martin Levin to educate and encourage the Natick Conservation Commission and the DCR to choose non-toxic methods for the removal of the milfoil weeds.

(http://www.toxicsaction.org/issues.htm)

A symposium was held at the Natick Town Hall on September 19th, 2005, where presenters included John Todd, Ph.D., Ocean Arks International, Research Professor and Distinguished Lecturer at the University of Vermont and Senior Partner at John Todd Research & Design, and Martin Hilovsky, President of EnviroScience, Inc. The speakers described the situation from their respective fields and presented alternative methods to solving the lake's milfoil dilemma.[72] Representatives of the herbicide products also held public hearings and distributed information in support of the employment of chemicals. Experts like Dr. Howard Horowitz of Ramapo College and local citizens created reasonable doubt regarding many of the herbicide industry's claims, and the Natick Conservation Commission reversed their position and denied the proposal for the chemical solution, opting for non-chemical weed control instead.

The process of researching and implementing alternative methods is still in progress. Two SolarBees were installed in October of 2007, one on South Pond and one on Middle Pond, as alternative methods for managing the milfoil. A SolarBee "incorporates patented near-laminar radial flow technology that provides high-flow, long-distance circulation™ (LDC) to improve water quality."[73]

Definitive data on the effectiveness of the SolarBees in Lake Cochituate is expected to be released in October 2009 by Tufts University researchers studying the project, and Natick recently received state funding to use a harvester. Although the problem of managing weeds in Lake Cochituate is not yet over, it is a step in the right direction. The pilot study is ongoing.

For more information, see Appendix B.

Hand Harvesting *(Also called: Hand Pulling)*

Hand harvesting is exactly what it sounds like: people or divers physically pull plants from the lake or shoreline. Hand pulling can include tools like rakes, cutters, nets, etc. Cost of hand harvesting depends if you are using divers or simply hand pulling in shallow waters or from the deck of a boat. The density of plant infestation will also affect the price. Volunteers or interns can be recruited to do hand pulling cheaply. Permits may be required for hand harvesting. Check with your local and state government for rules and regulations. Hand harvesting is the most accepted method for removal of Water Chestnuts.[74]

(http://www.pbs.org/wgbh/nova/algae/images/abou-program.jpg)

Advantages:

- Highly selective method which allows only the target invasive species to be removed.
- Works well in small patches or where invasive species have not yet become dominant.[75]

Disadvantages:

- This technique is highly labor intensive and will most likely need to be repeated annually. However, it is generally reported that the population of the invasive plants decreases each year after hand pulling efforts.
- Incomplete pulling or breaking of certain species can increase spread of infestation so nets should be utilized to catch any fragmented pieces.
- Hand harvesting can temporarily increase the turbidity of the lake.[76]

Herbivorous Fish

This method includes purposely adding sterile fish to a lake or pond who specifically feed on the target invasive plant. Triploid Grass Carp (*Ctenopharyngodon idella*), sterile grass carp, are the most commonly used fish in the United States for biological control because of their ability to handle a wide range of temperatures. Cost estimates for implementing triploid grass carp range from $50-$300 per acre including planning and monitoring. Seven to 15 fish per acre should be stocked; one stocking should last around five years.

(http://www.aquaticmanagement.com/graphics/amur1.jpg)

Another useful type of herbivorous fish is the African Cichlid; however, the African Cichlid can only live in water with temperatures greater then 50 degrees Fahrenheit so they are not a viable option for Northern climates. Plant control effectiveness is site specific, and significant control of vegetation is not apparent until two to four years following introduction.[77]

Advantages:

- Has been used and proven successful in the United States.
- Can provide multiple years of control with a single stocking.
- Faster acting then insect stocking and can reduce biomass in one season.
- People can fish for the herbivorous fish, increasing the recreational use of the lake, although this will then in turn impact the successfulness of the plant control.
- When Triploids are stocked the fish are sterile so there is no chance of the population getting too large. Also, if a fish escapes it will not populate elsewhere.[78]

Disadvantages:

- Fish are bred to be sterile so eventually restocking will be required.
- May impact non-target species of plants or eliminate too much of the plant life; careful monitoring is required.
- Risk of fish escaping upstream or downstream, which would eliminate their effectiveness.
- Results may vary and are hard to predict.
- Illegal in some states. For example, Grass Carp (even the triploid variety) are illegal in the state of Massachusetts.
- Risk of new fish population causing or spreading fish diseases among native fish.
- Difficult to determine correct stocking amount required for plant control but not plant elimination or eradication.[79]

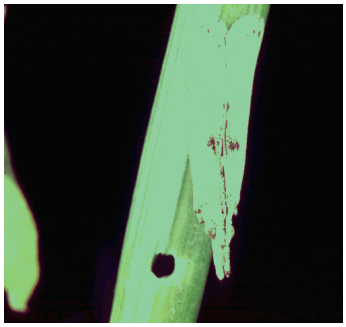
Herbivorous Insects

(Common Types: Weevils, Midges, Aquatic Moths, Flies)

Herbivorous insects are insects that are identified as natural predators of certain problem weeds. These insects are then purposely added or "stocked" into a lake or pond to eat the problem weed. The insects are stocked as larvae or adults depending on the insect species and the extent of the plant infestation. Plant control is a rolling cycle: the plant dies back— followed by the insect

The milfoil weevil (*Euhrychiopsis lecontei*) is a known control for Eurasian Milfoil.
(http://www.ecy.wa.gov/programs/wq/plants/management/weevil.html)

Midges are also a method of biologically controlling invasive plants.
(http://www.bbc.co.uk/earth/nature/uk/record/1471)



The Alligator Weed Stem Borer (*Vogtia Malloi*) has been used to control Alligator Weed populations.
(http://aquat1.ifas.ufl.edu/leafm.jpg)

population dying back– then the plant returns– followed by a surge in the insect population– which then once again reduces the plant population. The plant and insect populations will oscillate. Both native and non-native insects are being studied as control devices; however, it is always better to try and use native species. Treatment costs can range from $300-$200,000 per year depending on the size of the body of water, the type of insect stocked, the amount stocked and surveying and project management costs.[80]

Advantages:

- Insects facilitate long-term control with limited active management on the part of the lake managers or residents.
- Insects are chosen to control a specific plant so there is little or no effect on non-target species.
- Little or no restrictions on use of the treated water. Some insects need to be stocked in low recreation zones though so that they are not disturbed.
- No human health risks. Most of the insects are too small to even notice and do not destroy property or harm humans.[81]

Disadvantages:

- Plants die back slowly as insects eat them, therefore the invasive plant problem will not be solved in one season. Herbivorous insects are a multi-year solution often requiring restocking for several years so that the insect population has the opportunity to establish itself.[82]

Hydroraking

Hydroraking is the equivalent of using a backhoe in the water to remove floating islands, stumps, large amounts of debris or thick stands of invasive aquatic plants. The cost of removal of submerged plants will vary greatly depending on the company used and the density/extent of the plant problem; estimates can be between $1,500 and $4,000 per acre. As with submerged plants, the cost to remove surface varieties depends on the company and density/extent of plant problem; estimates can be between $6,000 and $10,000 per acre.[83]

(http://www.aquaticanalysts.com/clamrpic1.htm)

Advantages:

- Hydroraking can additionally be used to physically remove large objects like bulk trash pieces that have been dumped in the lake or pond.
- A relatively quick process that removes large, dense stands of aquatic invasive plants.[84]

Disadvantages:

- It is not a very delicate process and will stir up large amounts of dirt and mud, which could be a problem if there are toxins embedded in the soil and sediment.

- The process is very disruptive to animal life and the area surrounding the lake or pond.
- It is non-selective and will remove both native and non-native plants in the area of treatment.
- Will not completely remove the invasive plant population and may actually spread the problem through fragmentation or debris.[85]

Management of Nutrient Input

There are two main types of nutrient management: point source and non-point source. Point source pollution comes from a specific, known source, usually a regulated industry like a waste water treatment plant. Potential tactics for management include increasing discharge requirements, creating a diversion of point source waste, requiring operational adjustments, and implementing pollution prevention plans. Point source pollution management has the potential to create a large reduction of nutrients but can also be very expensive and politically difficult to implement.

Point source pollution dumping excess nutrients into stream.

(http://www.unce.unr.edu/western/SubWebs/NEMO/Images/Examples%20of%20NPS/paint%20pollution%20from%20Snohomish%20County%20Website.jpg)

Non-point source pollution is when nutrients do not come from a specific source; common examples include septic systems, yard fertilizer run-off, aerial pesticide drift, and street drain run-off. Non-point source pollution management tactics include changing land use bylaws, requiring the use of alternate (non phosphorus or nitrogen) fertilizers, pollution trapping through constructed wetlands, storm-water collection, inlet devices, and installing a septic system on the town sewer. This type of management requires gradual implementation and education of the public, but is a highly flexible approach that can create systemic and lasting change while addressing a wide range of pollutants.[86]

The management of nutrient inputs into a lake or watershed usually focuses on phosphorus since it is a key component that plants need to survive and grow. Nutrient management strategies are most effective when used before infestation or with other in-lake treatment methods. Nutrient management strategies alone will not remove invasive species from a lake or pond.

Advantages:

- It is treating the cause of the invasive plant problem—not just the symptom; excess nutrients in lakes and ponds are what allow invasive plants to spread rapidly.
- Often reduces amount of pollution entering the lake or watershed.[87]

Disadvantages:

- Most effective prior to plant invasion, or when nutrient recycling in lake is not the main cause of excess plant growth.
- It takes long periods of time for any improvements to be seen.
- If a problem with invasive species already exists in the lake or pond other treatment methods will be needed in addition to nutrient management to control and stop the spread of the

species.[88]

Mechanical Harvesting

Mechanical harvesting can encompass a variety of different methods but the most common is simply using a machine to cut the vegetation. There are many commercial harvesters who can be contracted to cut the vegetation. Varying cost depending on company used, plant you are targeting, its density and the area to be covered. Estimates range from $300 to $500 per acre for normal infestation.[89]

Advantages:

- Good for quick removal of thick and dense stands of plant growth without risking oxygen depletion.[90]

(http://www.ecy.wa.gov/programs/wq/plants/management/aqua026.html)

Disadvantages:

- This is a non-selective process and both native and non-native varieties will be removed.
- There is the risk of fragmentation leading to further infestation of the lake.
- Mechanical cutting can actually stimulate re-growth of the plant and more then one cutting per season will most likely be required.
- Risk of fuel spill or leakage from harvesting machine.
- The process is disruptive to aquatic plants and animals in the area of the cutting and some animals might be harmed or killed by the harvesting machine.
- Machine needs to be operated by a professional.[91]

Rotovation

Rotovation is the removal of plants with an underwater tiller. The tiller disrupts the soil, ripping out root formations. Cost estimates are around $500 to $2,000 per acre depending on the company used, type of plant slated for removal, and the density of the plant infestation. It is a technique that was originally developed by the British Columbia Ministry of Environment to combat noxious weeds in Canada's rivers and lakes. The Minister of Environment was looking for a mechanical method to control weeds because chemical control methods were not yet readily available. Rotovation can reach bottom sediments to the depth of 20 feet.[92]

Advantages:

- Rotovation can provide longer control of invasive plant species as compared to other cutting or harvesting techniques (if rotovation is done correctly).
- Can provide two full seasons of control with one rotovation.[93]

Disadvantages:

- Can cause a certain amount of sediment disruption. If there are contaminates in the soil it can be dangerous to disturb them.
- If not done properly, control of the invasive species will not be achieved. The root system must be completely disrupted and pulled up from the sediment.
- Not effective or realistic in areas with large amounts of underwater disturbances like tree stumps or other large trash items.
- If large amounts of plant material are tilled, the plant material might need to be removed from the lake bottom after tilling to remove biomass, prevent possible oxygen depletion, and limit the chance of fish kills.
- Risk of spreading invasive plant through fragmentation.[94]

(http://el.erdc.usace.army.mil/aqua/apis/mechanical/image/rotovatr.gif)

Selective Plantings *(Types: Native or Non-Native)*

(http://outdoors.mainetoday.com/trailhead/cat_trail_tales.html)

Selective planting involves planting native or non-native plants that are resistant to undesirable species. The theory is that if native or non-native (non-invasive) plants are taking up the land and nutrients then invasive species will not be able to take root.
Usually this approach is used after a drawdown or after the use of a benthic barrier. When used in combination with these methods, selective plantings are more successful.[95]

Advantages:

- Planting native varieties can help restore the aquatic ecosystem to it natural state and can help keep invasive plants from re-infesting the body of water or at least slow their reestablishment.
- Relatively inexpensive. The cost of the native plants and the labor is all that is required.
- Provides food and a habitat for native animal species.[96]

Disadvantages:

- Use of non-native plants might have negative impact on the ecosystem.

- Depending on the situation of the lake or pond the labor required to do the selective planting might be time consuming.
- The selected plants may not take root or establish successfully.
- Must be done in coordination with other treatment techniques to be successful.
- Requires professionals to research native plant species to determine suitable candidates that are resistant to the invasive plants.[97]

Surface Covers

This approach is very similar to benthic barriers, but the cover is put on the surface of the water. There has been limited use of surface covers because of the restrictions they impose on recreational use of the water. Mostly used in limited, small areas like around docks. It takes two to three weeks to work but it effectively limits plant growth under the surface area where it is placed.[98]

Advantages:

- It is an inexpensive method that can be implemented by property owners or other lake users.
- Almost any type of material can be used for the surface cover although opaque covers tend to work more quickly.
- Targets floating invasive plants which benthic barriers do not affect.[99]

Disadvantages:

- Completely limits the use of the area where the surface cover is installed.
- Needs to be repeated at the beginning of every season to prevent growth.
- Is relatively slow acting, taking several weeks to kill plant life under the surface cover.
- Can only be used in limited areas. For example, you couldn't cover the whole lake because it would harm aquatic animals as well.
- It is a non-selective approach which will limit or kill all the plant life under the surface cover, not just the target species.[100]

Appendix A: Further Resources for Management of Aquatic Invasive Species

The American Chemical Society
http://acswebcontent.acs.org/home.html

Beyond Pesticides
http://www.beyondpesticides.org/

Boat Massachusetts
www.boat-ed.com/ma

Extoxnet
http://extoxnet.orst.edu/

Center for Aquatic and invasive Plants: Institute of Food and Agriculture Services - University of Florida
http://plants.ifas.ufl.edu/

Invasive and Exotic Species Website
http://www.invasives.org

Invasive Species Information Center
http://www.invasivespeciesinfo.gov

LakeNet
http://www.worldlakes.org

Pesticide Action Network
http://www.panna.org/

Protect Our Water Resources
http://lakecpowr.tripod.com/index.html

The Western Aquatic Plant Management Society
http://www.wapms.org

United States Department of Agriculture Natural Resource Conservation Service
http://www.fs.fed.us/invasivespecies/index.shtml

USGS Nonindigenous Aquatic Species Website
http://nas.er.usgs.gov

Appendix B: Lake Cochituate Case Study Materials

Year 1 Budget Estimates for Integrated Vegetation Management Plan at Lake Cochituate[101]

Lake Basin	Vegetation Management Strategies & Associated Tasks	Recommended Budget
South Pond	Sonar (fluridone) herbicide treatment of entire pond	$65,000[1]
	Additional management of *M. heterophyllum* – follow-up treatment with Reward (diquat) herbicide or hand-pulling if plants are not completely controlled by Sonar	$5000
Middle Pond	Reward (diquat) herbicide treatment of 15 acres between the boat ramp and connection to North Pond ($400-$500/acre)	$7500[1]
	Aquathol K (endothall) and Reward (diquat) treatment of 2.5 acres around the State Park beach and swim area ($600-$700/acre)	$1750[1]
	Treatment with Reward of the milfoil cover along the southern shoreline and in the small cove leading to Carling Basin (2.5 acres @ 400-500/acre)	$1250
	Hand-pulling of sparse milfoil cover primarily found along the eastern shoreline (1.7 acres @ $2500/acre)	$4250
North Pond	Hand-pulling and/or benthic matting placement to control moderate milfoil cover in the small cove on the eastern shoreline adjacent to Wayland Town Beach (0.4 acres @ $2,500/acre)	$1000
	Hand-pulling of sparse milfoil cover primarily found near shore in the southern half of the basin (1.4 acres @ $2500/acre)	$3500
Other Program Costs	Permitting – prepare and file NOI applications in 3 communities, prepare and file DEP License to Apply Chemicals	$10,000
	Fragment barrier deployment and maintenance to contain milfoil fragments during suction harvesting and hand pulling operations	$7500
	Project oversight, inspections and reporting	$30,000
	Contingency budget – 10% of total project cost	$14,000
	ESTIMATED TOTAL COST OF YEAR 1 PROGRAM	**$150,750**

Letter from the Natick Board of Health to the Natick Conservation Commission

OFFICE OF THE
Board of Health
13 EAST CENTRAL STREET
NATICK MASSACHUSETTS 01760

April 19, 2006

Natick Conservation Commission
13 East Central Street
Natick, MA 01760

Re: Lake Cochituate Aquatic Plant Management Program

Attention: Matthew Gardner, Ph.D, Chairman

Dear Dr. Gardner:

In January of this year the Board of Health was advised by Mike Gildesgame, Mass. DCR, that DCR would be filing two Notices of Intent for the treatment of invasive nuisance weeds in Lake Cochituate. Mr. Gildesgame said he anticipated that the Conservation Commission would likely request an opinion or recommendation from the Board of Health concerning the portion of these NOI's that included the use of chemical herbicides in the lake.

The Board of Health requested that DCR engage an independent consultant, to be selected from a list of qualified consultants submitted by the Board, to provide the Board with expert technical advice in this matter. The consultant was to be expert in water chemistry and the fate and transport of chemicals in the environment, and was not to be employed by the lake treatment or chemical herbicide industries.

Ultimately the State engaged Warren J. Lyman, Ph.D from the Board's list list. Dr. Lyman submitted a report which the Board received electronically on March 7, 2006. A copy of Dr. Lyman's report, dated MaRCH 7, 2006, is attached.

The Board held a public hearing on this matter on March 27, 2006. Dr. Lyman was in attendance at this public hearing where he gave an overview of his report and responded to questions from Board members and from the public.

Prior to the March 27th public hearing, the Board had received written materials, including some from DCR and some from interested citizens, several of whom also addressed the Board, at their earlier meeting of February 27th.

At the conclusion of their March 27th hearing, having reviewed all of the material submitted, the Board of Health voted unanimously to recommend against the use of chemical herbicides, especially fluridone, in Lake Cochituate as proposed in the NOI's for the following reasons:

1. According to Dr. Lyman's report, and also according to the report from the Mass. DEP Office of Research and Standards which was submitted by DCR, it is "almost a certainty" that if fluridone is used in the lake it will enter the groundwater and be present in the Town drinking water wells at the Springvale site.

2. Although fluridone is approved by the EPA for use in drinking water supplies for controlling aquatic weeds, this approval applies only applicable to surface water supplies, since groundwater supplies would not have any weeds to control.

3. In groundwater fluridone is a contaminant since there is no practical reason to introduce it into groundwater.

4. Regardless of the level of fluridone that might be present in Natick's drinking water it is contrary to public health principles to permit a contaminant to be deliberately introduced into the water supply.

5. Further, it is contrary to the principles of wellhead protection and drinking water supply protection to permit the

introduction of a contaminant into the water supply.

6. Finally, the Board felt that control methods not relying on chemical herbicides had not been fully explored in these NOI's, and that accordingly these were not proper circumstances for consideration of the introduction of chemical herbicides into the Town's water supply.

For these reasons we recommend that the Conservation Commission not approve the use of chemical herbicides in Lake Cochituate.

Very truly yours,

NATICK BOARD OF HEALTH

Roger J. Wade, MSPH
Director of Public Health

Cc: Board of Selectmen
Water Dept.

Letter from the Natick Selectboard to the Natick Conservation Commission

Town of Natick
Massachusetts 01760
Home of Champions

Charles M. Hughes ,Chairman
John Ciccariello, V. Chairman
Carol A. Gloff, Clerk
John Connolly
Joshua Ostroff

April 19, 2006

Mathew Gardner, Chairperson
Natick Conservation Commission
Natick Town Hall
13 East Central Street
Natick, MA 0 1760

Dear Mr Gardner;

As you know, the state Department of Conservation and Recreation (the "DCR") is before the Natick Conservation Commission requesting an approval to use various chemical herbicides to control the growth of three invasive plant species found in Middle Pond and South Pond of Lake Cochituate. The Natick Board of Selectmen, acting in its capacity as Water Commissioners for the Town of Natick, is sending this letter to express its grave concern with the DCR plan to use herbicides in Middle Pond and South Pond of the Lake, and to express its support for the use of non-chemical methods to control invasive growth instead. Our concerns and support are expressed below.

A. With regard to the use of chemical herbicides in general in these bodies of water, in summary our concerns are:

1. Two of Natick's drinking water supply well fields are located next to the Lake. The Springvale Wells are located next to South Pond and the Evergreen Wells are located next to Middle Pond.

2. Both Middle Pond and South Pond are surface water bodies that recharge the aquifer used by both Springvale and Evergreen well fields.

3. It is estimated that as much as 65% of the Springvale well water comes from the Lake, indirectly via the aquifer.

4. Consequently, the use of any chemical herbicide in these bodies of water has the potential to contaminate our water supply.

B. Looking specifically at the proposed use of fluridone, as an example of one of the chemicals planned for use by the DCR, we raise the following points:

1 . A study completed for the Natick Board of Health and submitted as testimony to the Natick Conservation Commission in the Lake Treatment NOI concluded that fluridone could travel from the Lake to the Springvale Wells with just one year's usage to treat the Lake. The Department of Environmental Protection's Office of Research and Standards reached the same conclusion in its review of the Natick Board of Health study, and further stated a possible drinking water concern with the use of fluridone as a chemical herbicide in the Lake for more than one year.

2. The present treatment system for groundwater at the newly upgraded Springvale Water Treatment Plant will not effectively remove fluridone from the water.

3. Expensive carbon filtration would be effective in removing a contaminant such as fluridone from the water supply. However, the use of carbon filtration for the Town's water supply is not possible on a permanent or even a temporary

basis for the following reasons:

a. The site at the Springvale Water Treatment Plant is limited preventing the construction of permanent carbon filtration;
b. The Springvale Water Treatment Plant provides 100% of the Town's water needs at certain times of the year; and
c. Temporary carbon filtration will not provide enough water to meet the Town's water needs for most of the year, even with draconian water conservation measures;

4. Consequently, although fluridone concentrations following Lake treatment for one year will not exceed health limits set by the Environmental Protection Agency either in the treatment concentrations in the Lake or in the lesser concentrations estimated to be found in the ground water, given the preceding concerns, the Natick Board of Selectmen, acting in its capacity of Water Commissioners for the Town of Natick does not support the treatment of the Lake with fluridone or other chemical herbicides at this time.

C. The Natick Board of Selectmen understands the need to control the three invasive plant species currently found in the Lake. Information provided to our Board indicates that non-chemical means can be effective in controlling these species. The Board supports the use of non-chemical means to control invasive plant species within the Lake.

In conclusion, the chemical herbicide fluridone used to treat the Lake for just one year is likely to reach the Springvale Wells; if fluridone is used in more than one year it could pose a health risk in drinking water; the Town has no present means and very little future ability to remove herbicides in general from its drinking water; and non-chemical means are available to control these invasive species. The Board of Selectmen, as Natick's Water Commissioners, therefore respectively request that chemical herbicides not be used, and instead request that non-chemical means be used, to control the invasive species present in the Lake.

Sincerely,
Charles M. Hughes
Board of Selectmen, Chairman

Philip Lemnios, Town Administrator
Roger Wade, Director, Board of Health
Charles Sisitsky, Director, Department of Public Works
Natick Conservation Commission

Testimony from a Plant Biologist Regarding the Proposal to Use Aquatic Herbicides

Attention: Matthew Gardner, Chairman Conservation Commission, Town Of Natick
April 12, 2006

Dear Mr. Chairman,

I wish this following letter to be submitted and recorded as testimony in the upcoming hearing scheduled for April 20th 2006. Filing number:
Notice of Intent to Control Nuisance Aquatic Vegetation with
Herbicides, Lake Cochituate, Natick, Ma, Prepared for DCR Lakes and
Ponds Program, Prepared by ESS Group, Inc., Project No. D 147-000.2

My name is Catherine Paris and I am a plant biologist formerly employed by the USDA Animal Plant Health Inspection Service, Plant Protection and Quarantine in the study of biological controls of pest species. I also have an extensive background in agriculture and ecology.

Since the late 70's I have come from believing that pesticides were useful and necessary to knowing that they rarely accomplish what we wish them to and often have long term and lasting negative effects. I cite the example of the gypsy moth which in 1900 the Commonwealth of Massachusetts spent over two million dollars eradicating by widespread use of arsenic. Since then, various municipalities and the US Government has spent and introduced hundreds of millions more and dosed the environment with millions of pounds of pesticides. It is VERY likely that you will see a return of the gypsy moth to your community this year. Another famous example is the dandelion another introduced European specie which is rampant throughout the US despite the widespread use of herbicides. The point I'm making is that an introduced specie comes into our Massachusetts environment and after gaining a foothold, can not only exist but spread and rapidly out compete local species throwing our long evolved habitats out of sync. The application of pesticides appears (but only appears) to control these invasions. In fact, what actually happens is a large void is created. In the case of Eurasian milfoil one would see an absence of milfoil on the surface and to look beneath the surface you'd see an area completely devoid of any plant life. As we all know, nature abhors a vacuum. Meaning essentially that you have a lake with high levels of nutrients, plenty of sun, no shelter for the vertebrate or invertebrates that would control an overgrowth of water weeds. In summary, a perfect habitat for a weed specie to take over. You are back where you've started but much poorer and potentially less healthy than you were.

Over time we've learned that these invasives are best controlled with the introduction of a specie that will consume or interrupt the life cycle of the weed. Again nature has shown us the answer because every environment is a balance of specie. When we tip that balance by loading nutrients into a water body the first line of defense is to stop adding food for the plants to proliferate. The second would be to introduce a weed eating insect that would flourish on these lush stands of vegetation. Eventually, because there is a huge amount of readily available eurasian milfoil for the weevil to consume, its weevil population would keep multiplying and thereby stop the spread and in some cases completely eradicate the milfoil. An herbicide application prior to the introduction of a biocontrol specie is folly. It is the very large scale prevalence of the milfoil that allows the weevil introduction to be successful.

In short, as representatives of your town folk, I want you to realize that herbicide application is not going to remove eurasian milfoil from your lake. This milfoil is long established in the northeast. Every citizen that boated or swam in your lake is a potential reintroduction source. Even one single plant from an aquarium could refill your swimming and boating areas. Why not spend the money and invest in a long term solution that would be both safe and effective. It is our money afterall.

Sincerely,
Catherine Paris

Letter from the Conservation Law Foundation to the Massachusetts Department of Conservation and Recreation's Stewardship Council

Richard H. Cross, Chair
Massachusetts DCR Stewardship Council
251 Causeway Street
Boston, MA 02114

CONSERVATION LAW FOUNDATION

March 2, 2006

RE: Mass. DCR Pesticide Spraying Program - Lake Cochituate

Dear Mr. Cross:

I have been meaning to write for some time to comment on the DCR's approach to invasive vegetation management in Lake Cochituate and elsewhere. I attended the Stewardship Council's meeting at the Community Boating House last month where the matter was discussed and came away from that meeting more convinced than ever that the Department needs to seriously re-evaluate its pest management program from top-to-bottom.

The DCR presentation in favor of their herbicide program was more directed at justifying the conclusion that they had already reached than it was at illuminated the costs and benefits of the various options. The presentation was unpersuasive to me both with respect to its efficacy in ultimately controlling the milfoil, its impacts on non-target biota, its ability to control or even understand the unintended consequences of the chemical approach, as well as its long-term cost-effectiveness. Given the expected continued budgetary restrictions on DCR for years to come, any program that poses additional environmental risks, generates such substantial community opposition, and costs scarce dollars for marginal, if any, long-term benefits should be given the strictest scrutiny. I do not believe that the agency's program as it is currently designed can bear that standard.

I was heartened to hear the well-reasoned ecological perspective of Dr. Agyeman at the meeting in Boston and encourage the Stewardship Council to take a close look at this topic through its policy committee. Poisoning DCR lakes "to save them" is dubious public policy and should be a last resort. Indeed, we would anticipate that this strategy is only contemplated where there are no viable alternatives and where there are compelling off-setting human health circumstances. In my opinion, the Lake Cochituate situation - which seems to be driven by recreational use issues -does not rise to that level.

If we can be of any assistant to the Council in this process, I am happy to offer our services.

Peter Shelley
Vice President

cc: Commissioner Stephen R. Burrington
Michael Gildesgame, DCR

Letter from University of Massachusetts Professor of Geosciences to the Natick Board of Health and the Natick Conservation Commission

Richard F. Yuretich
Professor of Geosciences
UNIVERSITY of MASSACHUSETTS at Amherst
DEPARTMENT OF GEOSCIENCES
February 27, 2006

Gentlemen:

I have been reviewing the documents concerning the vegetation control proposed for Lake Cochituate in order to evaluate the migration of proposed herbicides into the groundwater and public water supply of the Town of Natick. I am familiar with the geology and hydrology of the lake and Springvale well field as described in written testimony prepared for an administrative hearing concerning a Superseding Order of Conditions that was issued on March 9, 2004. The current Notice of Intent proposes to use the chemical fluridone in addition to the other herbicides originally planned.

I have subsequently reviewed several documents pertaining to the behavior of fluridone in the environment. Fluridone has somewhat different properties than the other chemicals that are proposed for use in Lake Cochituate. Although the numerical data are sparse, many of the documents note that fluridone is not retained appreciably in "hydrosoils" or lake sediments, but is released into water where "photolysis" (destruction of the compound by light) occurs. This is fine for surface waters exposed to sunlight, but water in Lake Cochituate recharges the aquifer system, as outlined in my previous testimony, and the water will not be exposed to sunlight by the time it reaches the town wells. Accordingly, the fluridone will likely be preserved in the groundwater.

The documents also point to a half-life of about 21 days for fluridone. This is the time when the amount of fluridone decreases to half its original concentration. This half-life is based upon the breakdown of fluridone by photolysis, which will not occur in groundwater. The minimum estimate of travel time of groundwater from Lake Cochituate to the wells, as mentioned in the testimony, is about 1 month. Accordingly, it is possible that fluridone could reach the Springvale wells without significant degradation. Given that 50% of the water in the Springvale wells is derived from Lake Cochituate, then half of the original applied concentration could appear in the public water supply. The NOI states that the intent is to keep the fluridone levels in the water elevated for up to 90 days. This would serve to increase the probability that the chemical will enter the groundwater and subsequently migrate to the town wells.

Given the possible migration into the water supply of the Town of Natick, I recommend against using fluridone and the other herbicides to control invasive vegetation in Lake Cochituate.

Respectfully,
Richard F. Yuretich
Professor of Geosciences

Appendix C: Rutland Herald news article regarding aquatic herbicides.

RUTLAND HERALD
WINNER 2001 PULITZER PRIZE
RUTLAND, VERMONT, U.S.A.
RUTLANDHERALD.COM

June 11, 2006

Chemical use in two lakes is under fire

DENNIS JENSEN Staff Writer

Further chemical treatment of milfoil on the waters of Lake St. Catherine and Lake Hortonia cannot be justified since the chemicals have failed to stop the return of the exotic plant and because the use of the chemicals results in the loss of fish habitat and aquatic vegetation cover, says two studies released by the Vermont Fish & Wildlife Department.

The two studies, written by Fish & Wildlife fisheries biologist Shawn Good and dated April 5 and April 7, are reviews of the applications made by the Lake St. Catherine Association and the Town of Sudbury to treat areas of the two lakes and Burr Pond. In the studies, Good spells out why further chemical treatments are both harmful and have a track record of failure.

Good wrote that both applications for further chemical treatments should be denied. "The significant loss of fish habitat and cover in the form of submerged aquatic vegetation in treated lakes also raises many concerns regarding the potential impact to fish populations," he said.

The Lake St. Catherine Association and Lake Hortonia Association have both financed the chemical treatments of their respective lakes.

"While aquatic vegetation control may be considered a 'benefit' to lake association members, the threats and negative impacts vegetation control programs pose to recreation angling quality and opportunities in state waters cannot be considered a public benefit or in the public good," he wrote.

Good said that his research and personal observations show that chemical treatment of milfoil is a waste of money and a threat to game fish populations, particularly largemouth bass, in the lakes. "… It is generally accepted that control and eradication (of Eurasian milfoil) in most every situation is difficult, if not impossible," he said.

Lake Hortonia and Burr Pond were both treated with chemicals in 2000.

"The earliest treatments in Vermont (Lake Hortonia and Burr Pond) were considered failures in controlling" milfoil, Good said. Meanwhile, a spokesman for the Lake Hortonia Association said that Good's analysis could not be further from the truth.

Carole Silvera, who lives in Round Lake, N.Y., and who owns a summer camp on the lake, said in an interview that chemical treatment on Lake Hortonia has been an unqualified success. She also said that fishing on the Rutland County lake is far better since the lake has been treated with chemicals.

"There is absolutely no truth to what he is talking about," Silvera said of Good's report. "We have no other choice but to clean up the milfoil so the fish have place to swim and breed, and people have a place to swim again and to water ski in the lake."

Silvera said that the fishing, and particularly the bass fishing, has improved immensely since the association began to apply chemicals into the lake.

"Over the years, since the milfoil has come in, it's actually made the fishing a lot worse," she said. "Since we treated the lake, we're seeing largemouth bass right off the dock. We're seeing more bass in the lake than we've seen in 10 years."

The association last week received its permit for further chemical treatment of the lake and for Burr Pond, set for sometime in July, Silvera said, but she added, "We need to work out the details to make sure that we can fill all of the requirements in time to do the treatment."

Silvera said that the association, with financial assistance from the State of Vermont, has spent more than $150,000 for chemicals to treat the lake. "The property owners around the lake are so thankful that we've done the work. Taxes are going up because it's more desirable summer property," she said. "We consider it (chemical treatment) highly successful." Further treatment is still needed, Silvera said, in several areas of Lake Hortonia and Burr Pond.

"We are halting the growth of it (milfoil) in a huge way but there have been a couple of areas on the lake that need to be treated with spot treatment because the milfoil wasn't eradicated there as much as in the rest of the lake," she said.

Silvera said she believes that chemical treatment of Lake Hortonia and Burr Pond have improved the quality of fishing, boating and swimming and that further treatments will make both bodies of water even better.

"I can't tell you how thankful people are that they can fish on the lake again," she said. "We wouldn't be doing this if we didn't want the lake to stay alive. There will be no bass in there if they let the lake die."

Bass and milfoil

In his report, Good said that largemouth bass and milfoil appear to have a healthy relationship. Largemouth bass are a particularly popular gamefish in waters throughout Vermont.

"Eurasian milfoil is not considered to be problematic for bass or other species of fish in these lakes," he said. "Largemouth bass populations are extremely healthy and the removal of Eurasian watermilfoil will not improve their population dynamics." Good went on to say that, conversely, the loss of milfoil will have a detrimental effect on largemouth bass populations.

"All stages of largemouth bass rely on aquatic plants for protection from predation and as foraging areas to hunt and consume invertebrates and prey fish," he said. "Juvenile largemouth bass are particularly dependent on areas of submerged aquatic vegetation and alteration or loss of this may reduce bass growth, overwinter survival and recruitment." Good also said that the 2004 chemical treatment on Lake St. Catherine "did not effectively control" milfoil.

Attempts to reach a spokesman for the Lake St. Catherine Association were unsuccessful. Rather than turning to chemicals, Good said that there are other, less-drastic ways to treat milfoil infestation.

"Usually, the most feasible options are to manage around the problems brought about by invasive species." He said.

One way to deal with the fast-growing, thick weed, which hampers boating and grows around docks and along lakefronts. is through biological control, Good said. "One non-chemical control technique that does not seem to have been seriously considered in Vermont is that of biological control," he said.

Good said that, according to a number of studies, declines in milfoil abundance in North America have been attributed to feeding damage by three insects - a midge, a weevil and an aquatic moth.

"The most promising of the three are the pyralid moth and the native weevil," he said. Cayuga Lake, in New York, has experienced "long-term declines" in milfoil abundance and the recovery of native plant species, thanks to these insects that feed on milfoil, Good said.

Good said that biological remedies to milfoil take longer than chemical methods. But some people don't want to wait for long-term results, he said.

"Pressure by lake associations for quick and immediate control and reductions of Eurasian watermilfoil likely have played a role in preventing a longer-lasting, ecologically-sound and less-expensive biological control program from being fully investigated," he wrote.

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