The biggest disadvantage of using aquatic herbicides is the challenge of gaining public acceptance. The methods by which herbicides work are not readily observed or understood, thus they are an unknown entity to many people. The abstract nature of herbicide chemistry may elicit a negative response from the public; therefore extensive educational efforts are often required before herbicides are accepted as a Eurasian watermilfoil management tool.

Eurasian Watermilfoil Facts: Midwest APMS

As plant densities increase beyond a certain threshold, water movement within the Milfoil bed is severely restricted and reduced light levels result in a curtailment of photosynthetic production oxygen.

As Eurasian watermilfoil density increases, native plant diversity decreases.

Native plant beds provide twice as many invertebrates per square meter than Eurasian watermilfoil beds.

Reduced levels of dissolved oxygen, the release or build up of nutrients, and other changes in water chemistry may provide unfavorable conditions for both micro invertebrates and fish.

Three to four times the number of fish was observed in native plant beds versus Eurasian watermilfoil beds.

Because it can grow at a peak rate of about 2 inches per day it can increase its coverage and area density by 5 to 10 times each year. In three years, milfoil went from about 1% coverage in Lower Suncook Lake (New Hampshire) to 100% coverage of areas that contained silt and sediment.

Eurasian watermilfoil is opportunistic and extremely aggressive. It is commonly found growing in areas that are not highly disturbed but seems to reach nuisance production levels more rapidly in disturbed areas ***created by inappropriately applied lake management strategies***. These strategies include ***mechanical harvesting***, recreational uses and other anthropogenic (human induced) ecosystems disturbances, such as accelerated sediment loading as a result of development and agriculture. It consistently demonstrates an ability to grow earlier and much faster than competing native plants in such disturbed areas.

Most experts agree that vegetative spread is its chief form of dispersal. A fragment, including a single node, is capable of producing a new plant, and any mechanical disturbances of this plant (i.e. boat motors, aquatic plant harvesting, etc.) will dramatically enhance its dispersal and dominance of native lake flora. Plant fragments are also known to withstand the rigors of desiccation, as might be encountered on a boat motor or trailer as it is transported from lake to lake.

Eurasian watermilfoil will also spread by means of stolons, which are specialized stems that "creep" over the bottom of the lake. This type of spread is commonly observed in the autumn through the early summer of each proceeding season.

Recent research indicates that Eurasian milfoil has begun to hybridize with native milfoil species There is concern that these hybrid milfoils may grow more aggressively, and exhibit increased tolerance to herbicidal and biological control measures.

Michigan State University: Water Quality Series WQ-56
"Integrated Pest Management for Nuisance Exotics in Michigan Inland Lakes"
"Avoid using control tools that will spread Eurasian milfoil, such as harvesting machines, unless the plant is already spread over the entire lake. Never use harvesters to remove milfoil if your lake has an outlet that connects to another lake".

Management Strategies of Eurasian watermilfoil

Mechanical harvesting is not recommended for control of Eurasian watermilfoil by the **Midwest Aquatic Plant Management Society** for two reasons.

1. The potential for plant fragmentation by mechanical harvesters can serve to spread Eurasian watermilfoil beyond the management area(s) and intensify problems throughout an infested lake.

2. Eurasian watermilfoil will usually dominate the re-growth community and gain further advantages over native plant species because of its faster relative growth rate.

The use of selective, systemic aquatic herbicides has proven to be the best management tool to control Eurasian watermilfoil to date. 2,4-D and fluridone products have been the two top choices in this chemical category.

Herbicide Options & Weevil

2,4-Dichlorophenoxyacetic acid

In 2004, curators of The Henry Ford organization, a multivenue destination founded by automotive pioneer Henry Ford, identified the discovery of 2,4-D as one of the 75 most important innovations in the past 75 years.

2,4-Dichlorophenoxyacetic acid, more commonly referred to as 2,4-D, is one of the most widely used herbicides throughout the world. It effectively controls unwanted and invasive weeds across agricultural fields, lawns, public parks, lakes and more. Introduced in 1946, 2,4-D is among the most rigorously researched and regulated molecules of all time. 2,4-D is labeled for use on 65 agricultural crops and have been registered by the EPA since the 1950's

Very few substances have been subjected to the extensive examination and review that 2,4-D has withstood, and as a result, more is known about 2,4-D than almost any other chemical on the planet. Just as it has for more than 60 years, 2,4-D continues to be one of the most important herbicides for homeowners, land managers and farmers across the globe.

The Environmental Protection Agency (EPA) product label for Navigate® , the only registered granular 2,4-D BEE product currently on the market, lists no water use restrictions for swimming or fish consumption following treatment. The EPA lists 2,4-D as a Class D herbicide which means there is insufficient data to classify the compound as a carcinogen or harmful to humans. The University of Michigan School of Public 87 Health conducted a review of more than 160 toxicological and epidemiological studies on 2,4-D and concluded that there was insufficient evidence to link 2,4-D exposure to any forms of cancer. In addition, 2,4-D from treated lakes has not been reported to contaminate well

water adjacent to treated areas. A Michigan Department of Environmental Quality 4-year study found no traces of 2,4-D in drinking water wells adjacent to twelve lakes heavily treated with the herbicide. 2,4-D biodegrades quickly in aquatic environments and does not bioaccumulate. For example, even if fish consume 2,4-D pellets, the chemical is quickly excreted without entering muscle tissues. For these reasons, there are no label restrictions on fish consumption.

2,4-D has been used extensively for the management of Eurasian watermilfoil in many lakes and ponds for many years with a great deal of success. 2,4-D can also be used as a "spot-treatment" tool and has repeatedly been proven to be highly selective against Eurasian watermilfoil when used at a narrow range of application rates. Nearly all of the native submersed plant species are unaffected by 2,4-D when used at the rates required for the management of Eurasian watermilfoil.

2,4-D is commonly applied to a variety of crops such as wheat, corn, rice, Invasive species in aquatic and federally protected areas and broadleaf weeds in turf grass. An economic evaluation by the U.S. Department of Agriculture (NAPIAP Report 1-PA-96) concluded that the loss of 2, 4-D would cost the U.S. economy $1.7 billion annually in higher food production and weed control expenses. EPA first considered Special Review for 2,4-D in 1986, and after more than 21 years of research and agency review, EPA was able to determine that no correlation exists between 2,4-D and human cancer. "Based on extensive scientific review of many epidemiology and animal studies, the Agency finds that the weight of the evidence does not support a conclusion that 2,4-D, 2,4-DB and 2,4-DP are likely human carcinogens.

Aquatic Invasive Plant Control

Aquatic vegetation plays an important role in the health of the aquatic ecosystem. Aquatic plants affect water movement, sedimentation, and water quality. However, a dilemma in the aquatic environment is in the form of invasive vegetation that is causing significant ecological and economic impact on precious aquatic, wetlands, and riparian systems. Although aquatic vegetation comes in several forms, including both submerged and emerged plants, today's greatest challenges involve the management of exotic plants that degrade water quality, human health, fisheries, water-bird habitat recreation, aesthetics and property values. 2,4-D is particularly useful because it is inexpensive and highly selective for Eurasian watermilfoil and water hyacinth when used at the labeled rate, leaving native aquatic species relatively unaffected.

Aquatic dissipation

Aquatic dissipation studies show that 2,4-D had an apparent half-life in natural water of one to two weeks, although in areas such as a treated rice paddy, the halflife was as short as one day. (Table 1) The main route of degradation is by microorganisms. 2,4-D amine salts and 2,4-D esters are not persistent under most environmental conditions, water or soil. 2,4-D amine salt dissociation is expected to be instantaneous (<3 minutes) under most environmental conditions. 2,4-D ester hydrolyzes rapidly to the acid in normal agriculture soil and natural water conditions (<2.9 days). Under these conditions, the environmental exposure from 2,4-D esters and 2,4-D amines is expected to be minimal in both terrestrial and aquatic environments. The acid form of 2,4-D, as well as the amine and ester chemical groups, metabolized to compounds of nontoxicological significance and ultimately to forms of carbon. Thus, 2,4-D is considered a biodegradable compound. Under normal conditions, 2,4-D residues are not persistent in soil, water, or vegetation.[2]

All of our medicines are chemicals; most will cause serious damage or worse if the dose is not correct or followed carefully. People can die if they drink too much water in a short time, but it is critical to sustaining life. It is the dose and not the chemical that is critical to maintain our confidence in the chemicals we use and to maximize their benefit while minimizing the potential to do harm. This also applies to the synthetic version of indole acidic acid, namely 2,4D. It is one of the most benign chemicals. It has no effect on animals when used properly, and generally biodegrades in 3-10 days. It just happens to act as an herbicide on variable milfoil because variable milfoil is one of the fastest growing weeds we know. It is applied to the water as a pellet that sinks to the sediments and dissolves near the plant roots. It remains mostly concentrated on the bottom but can reach levels in the lake water column that are just above the safe drinking limit. This is 100 times less than the OSHA (Occupational Safety and Health Administration) permissible exposure limit (PEL) of 10 ppm. In comparison, one glass of wine exceeds by 120 times the PEL of 1000 ppm.

Can 2,4-D affect other plants? It can, particularly if they are a broadleaf type of plant. In this case, it is again important to remember that dosing matters. Concentrations of herbicides that work on one species of plant, will not work, or will have little effect on another species of plant.

Fluridone (Sonar) Whole Lake Treatment.

As the active ingredient in Sonar® aquatic herbicide, fluridone acts systemically and kills the entire plant (shoot and roots). Fluridone prevents photosynthesis, and thus plants cannot produce food for continued growth. Affected plants show pale or bleached new growth and slowly die over the course of 45-90 days provided a phytotoxic dose of fluridone is maintained over this period. The slow mode-of-action of fluridone allows it to be used for EWM control in entire lake systems with minimal risks of oxygen depletion and other water quality issues. EWM is more sensitive to fluridone exposure than most native aquatic plant species. Therefore, with low-dose protocols plus detailed residue monitoring and management, Sonar® has been used operationally to selectively control EWM throughout many areas of the northern United States. With a focus on selective control, MDEQ permits for spring treatments require a 6 ppb fluridone treatment to the top 10 feet of the water column (assumed littoral zone) followed by second 'booster' or 'bump' treatment at 14-21 days after the initial application. The second bump application brings the dose back up to 6 ppb and increases exposure period out to the 60-90 days needed for control in most cases.

MDEQ permits require a 6 ppb fluridone treatment to the top 10 feet of the water column, based on Pine Lake mean depth and Thermocline the concentrations may not be enough to kill all the EWM.
(**395 Acre Feet x 10ft Deep = 1,287,111,450 Gallons ☺)**

Studies in laboratory animals show that the lethal dose from a single oral exposure of Sonar® is greater than 10,000 mg/kg. To put this into perspective, an adult would have to drink over one million gallons of Sonar®-treated water (at the 0.15 [150 ppb] ppm maximum allowable limit) to receive a dose of 10,000 mg/kg; a 20-kg child would have to drink approximately 350,000 gallons

Sonar® inhibits a plant's ability to make food. Specifically, Sonar® inhibits carotenoid synthesis, a process specific only to plants. Carotenoids (yellow, orange and red pigments) are an important part of the plant's photosynthetic (food making) system. These pigments protect the plant's green pigments (called chlorophyll) from photo degradation or breakdown by sunlight. When carotenoid synthesis is inhibited, the chlorophyll is gradually destroyed by sunlight. As a plant's chlorophyll decreases, so does its capacity to produce carbohydrates (its food source) through photosynthesis.

Without the ability to produce carbohydrates, the plant dies. Humans do not have carotenoid pigments. Therefore, the property of Sonar that makes it an effective herbicide at low doses does not affect the human body.

Extensive testing of a wide range of water bodies has shown no significant changes in water quality after Sonar treatment. In fact, Sonar has a practical advantage over certain other aquatic herbicides in this area. Specifically, the dissolved oxygen content of the water does not change significantly following Sonar treatment because the relatively slow herbicidal activity of the product permits a gradual decay of the treated vegetation. Maintaining adequate dissolved oxygen levels are critical to fish and other aquatic animals, which require oxygen to survive.

Weevil:

In 2009, Long Lake, Iosco County, Michigan, implemented a Milfoil Solution® (formerly MiddFoil®) program using the milfoil weevil, a native North American beetle, as a long-term biological control for EWM. In the first year, a monitoring site and two stocking sites (11,000 weevils/site) were established. Due to a lake-wide increase in EWM during 2009 a more aggressive stocking strategy was implemented in 2010. Weevils were stocked in the two existing sites and three additional sites were established. A total of 95,000 weevils were stocked between the five sites in 2010. This report summarizes the to-date progress of the Milfoil Solution® program and provides future recommendations for EWM management in Long Lake. The table below outlines the program's schedule, site establishment, and number of weevils stocked thus far.

Yearly Summary of Expenses

Year	Survey Cost	Report Cost	Weevils	Weevil Cost	Total Cost
2010	$3,269.40	$750.00	95,000	$76,000.00	$80,019.40
2011	$3,215.90	$787.50	60,000	$48,000.00	$52,003.40
2012	$4,380.20	$909.48	40,000	$32,000.00	$37,289.68
2013	$2,049.54	$1,041.84	0	0	$3,091.38
Total	**$12,915.04**	**$3,488.82**	**195,000**	**$156,000.00**	

Total Cost of the Project **$172,403.8**