Chapter 3

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Lake Issues and Management

Storm Water Issues

One of the greatest threats to the quality of water in our lakes and ponds and the health of the aquatic environment is storm water pollution. When it rains or snows, the water rushes over highways, parking lots, streets and lawns and collects nutrients, oils, toxins, sediments and other pollutants. This untreated water flows into storm drains and frequently empties into our lakes or ponds. Storm water poses a greater threat to water quality in urban and agricultural areas than in undeveloped lands. In forested areas, the earth absorbs most of the storm water and the soil and vegetation filters out pollutants. In developed areas there is a larger percentage of impervious surfaces, including pavement, roofs, and asphalt, which prevent water from soaking into the ground. As a watershed becomes increasingly developed the percent of land that is covered by impervious surfaces increases and more storm water runs off into receiving water bodies.

Storm water is an example of nonpoint source pollution because the pollution comes from a very broad area rather than a single identifiable source such as a pipe. Nonpoint source pollution is harder to control because it results from many activities that occur in our watersheds, including development, fertilizing, and other human activities. In addition, rain absorbs pollutants from the atmosphere and deposits them on the ground or in water bodies.

EPA

Point Source Pollution vs. Non-point Source Pollution

Nancy Rose

Contaminants in Storm Water:

Storm water can carry a variety of contaminants that may degrade the receiving waterbody including: nutrients, sediments, bacteria, metals, toxic substances, trash, and warmer water with low dissolved oxygen.

Nutrients: Excess levels of phosphorus and nitrogen are introduced to water bodies from a variety of sources including; failing septic systems, sewer overflow, urban storm water runoff (carrying detergents, fertilizers, organic debris) and atmospheric deposition from industry and automobiles. Phosphorus is relatively rare in lakes and ponds and therefore, the level of available phosphorus frequently controls the amount of plant growth. When additional large amounts of phosphorus are introduced to a water body, algal blooms may result. The decomposition of algae utilizes the available oxygen, and fish often perish as the oxygen level drops. In addition, many toxins and pollutants are released from the sediments and become more water soluble under low oxygen (anoxic) conditions. Additionally excess nutrients accelerate the rate of eutrophication.

Sediments from a variety of sources are carried via stormwater runoff into water bodies. Although a lot of sediment can come from construction and agriculture, there are also many urban activities including winter road sanding, landscaping, loss of vegetation (which leads to erosion) and the development of new drainage pathways, which can be a source of sediments. Increasing the load of sediments into a lake or pond has many harmful effects. The sediments slowly fill in the lake basin, causing the lake to become increasingly shallow and less capable of retaining and storing floodwaters.

Sediments can trap solar radiation, which increases water temperature while simultaneously decreasing the water clarity. The breakdown of organic particles in the sediments can also deplete the available oxygen in a lake. This negatively impacts cold water fish that are dependent on cool, clear, oxygenated waters. Suspended sediment particles reduce light transmission, which may negatively impact the plant growth that bass and other fish require for shelter.

Bacteria and Pathogens: Many disease causing organisms can be carried via stormwater runoff into lakes and ponds when they are released from failing septic systems, agriculture waste, animal waste from pets or wildlife, and wastewater treatment plants. Although most bacteria are beneficial, some strains of bacteria can cause disease, alter the color, taste and odor of the water or force swim beach closures.

Metals pose a serious risk to our lakes and ponds, as they can be highly toxic to aquatic animals. Metals from industry and commercial waste materials, atmospheric deposition, mining and automobile emissions all contribute metals to water bodies. Some metals found in storm water include copper, zinc, lead, chromium, and cadmium. Metals can accumulate in animal's tissue and increase over time (bioaccumulation) leading to impaired reproduction, growth and development or even death. Humans who consume fish with an accumulated level of mercury or other toxic metals are also at great risk. Mercury is toxic to humans, causing hearing and vision loss, kidney failure and even death.

Oils and Grease from vehicles build up over time on the surface of the roads. During a rainstorm, water washes these toxins off the road and carries them to nearby storm drains where they are transported to nearby water bodies.

Pesticides, Organic Compounds, and Salts: Oil leaks, pesticides, road salts and other toxic compounds are often spilled or incorrectly disposed off, and then are carried via storm water runoff to lakes and ponds. These compounds can reduce oxygen levels in a lake and are often lethal to juvenile fish or sensitive organisms. Many of these chemicals contaminate groundwater and other drinking water supplies.

Litter: Plastics, organic litter, and toxic debris often degrade lakes and ponds when they are carried by storm water into the water body. Not only does the aesthetic appeal of the lake decline as trash accumulates, but animals can become entangled in the debris and the breakdown of certain products release toxins into the water column.

Warm Water/ Low Dissolved Oxygen: Stormwater is often heated as it flows over surfaces that have been warmed by the sun, and consequently may increase the water temperature of the receiving lakes and ponds. Warmer water holds less oxygen and can raise the lake's temperature to the point that cold water species, including trout and salmon, become stressed and die. In addition, elevated temperatures often accelerate the breakdown of toxic substances and the release of contaminants from the soil.

Invasive Species

What is an Invasive Species?


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Many plants that are found in Massachusetts were originally brought here from other places around the world and these plants are called non-native or exotic. Although many non-native species such as Purple Loosestrife (right photograph) are beautiful, they can be extremely destructive to the environment because they disrupt the delicate balance of the ecosystem. Some exotic species are harmless, but others can have a very detrimental impact on the environment by out-competing native species and taking over the water body. Once a species, native or non-native, dominates or disrupts the biological community it is considered invasive.

How did exotic species arrive here?

Exotic, or non-native species have been introduced to Massachusetts in a variety of ways including unintentional introduction in ship ballast water and accidental release through the aquarium or water garden trade. Others were deliberately imported and planted as colorful additions to gardens and ponds.

Why are they harmful?


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Since exotic species originated in other regions, most have not evolved natural predators in this region to keep their populations in control. In recent years, exotic invasive species have been spreading throughout Massachusetts' lakes at an alarming rate. Exotic invasive species out-compete other species for space, light and nutrients. Since these plants often do not provide ideal sources of food and shelter, as native plants die, many of the animals that were dependent on native plants must attempt to relocate or perish. In essence, exotic invasive species often create single species stands, thus reducing biodiversity (left photo).

Once established in a lake they are almost impossible to eradicate and managing them is very costly. Invasive species can impede recreational activities and, in cases when dense mats have formed, boat navigation is no longer possible (see top photograph). In addition, infestations of invasive species can lower property values, decrease aesthetic values, restrict movement of vertebrates, stunt fish growth, displace wildlife and in some cases damage docks, dive gear and boat motors.


Michelle Robinson

What is being done to control invasive species?

The best method for controlling exotic invasive plants is to prevent them from becoming established in a water body. The Department of Conservation and Recreation's Lakes and Ponds Program offers aquatic plant training to citizens through the Weed Watcher Program, in an effort to promote early detection and rapid response. Additionally, the Lakes and Ponds Program provides informative brochures, places signs at public access points, and posts boat ramp monitors at state boat ramps. Massachusetts is an active member of the Aquatic Nuisance Species (ANS) regional task force, which is a federally funded program working to develop tighter regulations on the sale and transportation of exotic plants and to promote education.

The Most *Un*-Wanted Aquatic Exotic Species

Fanwort
Cabomba caroliniana

Eurasian Milfoil
Myriophyllum spicatum

Variable Milfoil
Myriophyllum heterophyllum

Hydrilla
Hydrilla verticillata

South American Waterweed
Egeria densa

Curly-leaved Pondweed
Potamogeton crispus

Water Chestnut
Trapa natans

Common Reed
Phragmites australis

Purple Loosestrife
Lythrum salicaria

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Asian Clam

Potential Threats

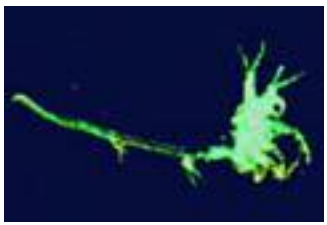
There are several exotic species including the Asian Clam, Zebra Mussel, Spiny-tailed Water Flea, Parrot Feather and Flowering Rush that have not yet invaded Massachusetts. The Zebra Mussel can be found in neighboring states and threatens to enter our state in the near future. It is important to learn to recognize these species and always remember to inspect your boat motor, trailer, bait buckets and gear to prevent their spread to Massachusetts' water bodies.

If you find any of these species, please report the sighting to:

Massachusetts Department of Conservation and Recreation
Michelle Robinson 617-626-1382
Jim Straub 617-626-1411

© Charles Ramcharan

Zebra Mussel



J. Lindgren

Spiny Water Flea

Vic Ramey UFL

Parrot Feather

Lad Johnson NOAA

You Can Make a Difference!

Boaters:

- Remove all plant fragments and animals from your boat motor, trailer, anchors, fishing gear and dive gear. Dispose of plant matter on dry land away from shore or in a trash can.
- Dispose of live well, bait and cooling water away from the shore after each use.
- If you are leaving a water body known to be infested, wash your boat with hot water and allow it to completely dry before entering another body of water.
- Never release a species into a body of water unless it came out of that body of water.

Everyone:

- Help spread the word and inform other boaters about exotic invasive species.
- Never dump aquariums or water garden contents in to a water body.
- Join the Massachusetts Weed Watchers program and help identify and eradicate new infestations in your lake before they become permanently established.
- Request a free "Stop the Spread of Invasive Species" sign for your boat ramp from the Department of Conservation and Recreation.
- Familiarize yourself with the exotic species by requesting a free color guide from the Department of Conservation and Recreation.

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Alison Fox

Algae

Algae are microscopic plants that grow naturally in lakes and ponds but are able to adapt to a wide range of conditions and are found in oceans, rivers, ponds, deserts and hot springs. Algae are photosynthetic yet lack vascular tissue such as roots and leaves and are considered to be evolutionarily less advanced than higher plants, such as macrophytes. Algae are the primary producers in the aquatic environment and provide food and energy for other animals. In addition, during photosynthesis, algae release oxygen into the water body.

Michelle Robinson

Although algae are an important part of the lake ecosystem, a rapid growth of their population can create a condition called an algal bloom. Algal blooms can form scum or dense mats on the water's surface and may also affect water color, odor and taste. During an algal bloom the excess algae die, and the decomposition process consumes oxygen. This may result in an anoxic condition, which is harmful or fatal to some aquatic animals.

Diatoms and blue-green algae cause the most common algal blooms. Diatoms affect the water color, turning it bright green or brown, but rarely create an offensive odor or scum and may even occur unnoticed. On the other hand, blue-green algal blooms are rarely undetected. The wind can concentrate blue-green algae (cyanobacteria) into dense, unsightly surface mats, or surface scum, which may wash up on shore and produce a noxious odor as it decays.

Some species of blue-green algae, such as *Anabaena aphanizomenoides*, produce toxins that may be harmful to pets and small children if consumed in quantity. Although there are a variety of causes of algal blooms, the primary cause is the introduction of excess nutrients, such as phosphorus from fertilizers and detergents, into a water body. Unlike rooted macrophytes that draw their nutrients from the sediment, algae obtain essential nutrients directly from the water column. Storm water runoff, loaded with nutrients generated from a variety human activities, flows over the land or though a storm drain system into a water body. Excess nutrients entering the aquatic system allow algae populations to explode.

If your lake experiences algal blooms, it is important to complete a watershed assessment to evaluate land use, soil types, erosion, point sources (such as leaking septic systems) and other possible causes of nutrient loading. The lake's nutrient chemistry, fish population, dissolved oxygen and flow all should be examined as these various factors can also effect the algal population in your lake.

Although an introduction of excess nutrients to the waterbody is usually the culprit, it is not the sole cause of algal blooms. The size of the algal population is also controlled by microscopic herbivores, called zooplankton, which graze heavily on algae and keep the algal population under control. Zooplankton are in turn eaten by small fish, so an increase of small fish in the lake can result in an algal bloom

There are many management options for controlling algae, but there is no "quick fix" solution except to reduce the level of nutrients in the watershed.

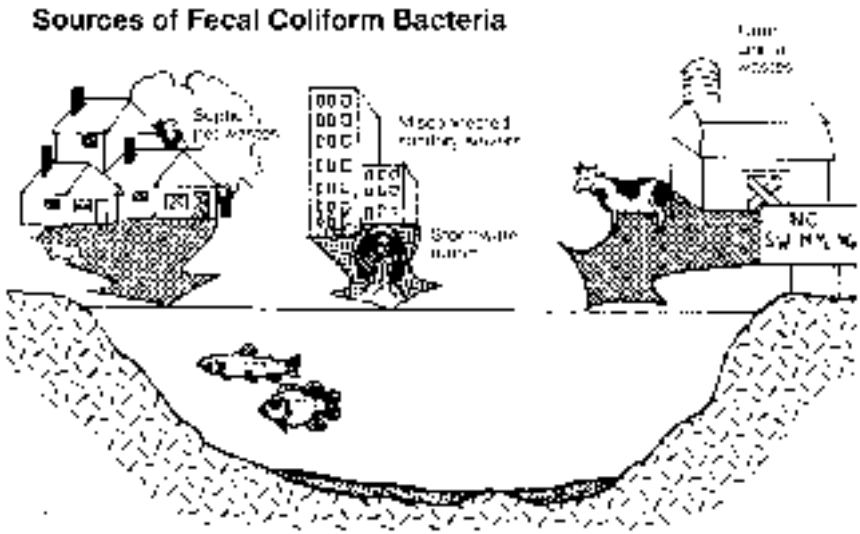
Bacteria

Bacteria are single-cell organisms that live in our environment. Although many are harmless, others are capable of causing serious health problems for humans. The majority of beach closings in Massachusetts are a result of high levels of the type microorganisms that are found in sewage. The state of Massachusetts routinely monitors public swimming areas during the summer, and weekly water tests are performed, to ensure that the water conforms to the standards set by the Department of Public Health. If the test fails, then the swim beach is closed until a second test can be completed and passes.

There are different types of bacteria that contribute to the total fecal coliform count; however, testing water samples for each and every type of disease-causing bacteria is very costly. Samples are only tested for the presence of *E. coli*, a generally harmless type of bacteria that lives in the intestines of all warm-blooded animals including humans, beaver, geese and dogs. Since *E. coli* occurs in high numbers in human sewage it is used as an indicator organism. Large amounts of *E. coli* indicate a **possible** source of contamination from sewage, thus indicating that other disease-causing bacteria could potentially be present in the water.

There are many possible sources of fecal coliform, including failing septic systems, waterfowl, farm animaland pet waste, polluted storm water runoff and wildlife (see illustration). Septic systems near water bodies can fail and release raw sewage into the lake or pond. Run off from agriculture can also contribute bacteria to the lake. Storm drains may be overloaded after heavy rainfall and overflow, discharging polluted storm water into nearby lakes and ponds.

It is very hard to predict the levels of fecal coliform in the water at any given time because levels fluctuate after rainstorms or periods of direct sunlight. However, if a lake continuously has high *E. coli* counts, other tests are available to examine the genetic material (RNA) of the bacteria to determine exactly which species of animal is responsible for adding the bacteria to the water. By knowing whether to focus on inspecting septic systems, improving storm drains, reducing waterfowl, or addressing agricultural runoff, lake managers are better able to control the bacteria loading to a lake.



Common Lake Issues

Murky Colored Water

During the summer, lake water may turn murky and have an unpleasant odor. The scum looks like blue-green paint and often drifts to the windward shore. This may be an algal bloom. Algae are microscopic plants that are natural components of lakes. Algal blooms are often the result of excess phosphorus (often from lawn fertilizers or other sources) entering a water body.

Yellow Green Dust

During the early summer months a yellow dusting may appear on your lake or pond. This dust is likely pollen from nearby pine trees. Over time the pollen will become water logged and sink to the lake bottom.

Dark Oily Cloud

The dark oily cloud may be insect cases left behind from a hatch of aquatic insects. The wind can concentrate the cases along the shore, and as they decompose, an oily sheen forms.

Vermont DEC

Dead Fish

An occasional dead fish is not cause for alarm. Sometimes anglers release an injured fish or the mid-summer stress due to warm water and disease may be the culprit. If you notice numerous dead fish, especially of more than one species, please contact the Department of Fisheries and Wildlife.

Foam (suds) on the shore

Foam on the shore is often natural and occurs when the surface tension of water is reduced and air mixes with the water, creating bubbles. This natural foam will have an earthy or fishy aroma. Many natural organic compounds are capable of reducing the surface tension of water.

Green Cotton-like Clouds

Green clouds floating in shallow water may be filamentous algae and their presence does not necessarily indicate a water quality problem. The clouds often occur after heavy runoff in the spring or a heat wave in the summer. However, if the algae are found only in specific areas, it may indicate a source of local pollution such as a failing septic system or a contaminated stream.

Red Itchy Rash on Swimmers

This rash may be Swimmer's Itch, which is caused by a larval stage of a parasitic fluke, *Schistome*. When a larva encounters a swimmer it will penetrate the swimmer's skin. The body's reaction to the presence of the larva results in red spots and swelling, similar to a mosquito bite. To avoid Swimmer's Itch towel off briskly after a swim, or try swimming in a different area of the lake.

Leeches

These are flat worm-like animals that attach to exposed skin and draw blood. Leeches are found in shallow protected waters and are most active on hot summer days and at night. Leeches are drawn to the disturbances in the water near docks and swim beaches. To avoid leeches, swim in deeper waters off docks and floats. Leeches are mostly found in organic sediments or debris, so try to avoid these areas if leeches are known to be in the pond.

Best Management Practices

What are Best Management Practices (BMP'S)?

There are many actions that will help reduce the harmful effects of polluted stormwater. BMP's, or best management practices, have been developed for town planners to enable them to make wise choices for the town's future. BMP's are either non-structural, (education, build-out assessments), or structural (installing new systems, creating wet ponds). A few have been listed below. For a complete list contact The Department of Environmental Protection or NALMS (pg 45).

Non-Structural Best Management Practices

• ***Zoning and Land Use Planning:*** By studying a town's current demographics, economics, existing natural resources, current land uses and forecasted growth, planners are able to create zoning plans and land use controls that will ensure protection of water resources and critical areas. These projects, called build out assessments, include simple steps such as determining minimum lot sizes, creating development plans with the least fragmentation, and determining best land use. These plans will help to insure a healthy future for the town and its fragile resources.

• ***Education*** is a critical component in any watershed management or town plan, and can be geared towards both municipalities and citizens alike. Training programs offered by the town or others help to introduce employers to stormwater management issues and new design technologies. Development of interactive community programs, including: storm drain stenciling, rain gardens, hazardous waste recycling days, responsible pet clean-up, water conservation education, holding lake-friendly home design workshops and promoting phosphorus-free fertilizer rebates help to encourage citizen involvement and increase public education.

• ***Routine Storm Drain Maintenance/ Mapping:*** Routine street sweeping and catch basin cleaning prevents an overflow of sediments and other contaminants into water bodies. It is also important to have current GIS mapping and ground-truthing of storm drain locations for each town.

• ***Source Reduction:*** There are many bylaws that towns can adopt to reduce the volume of stormwater contaminants, including; reducing road sanding and salting, banning fertilizers that are high in phosphorus, encouraging recycling of hazardous materials and reducing litter.

• ***Maintain Riparian Areas and Buffer Strips:*** Riparian areas and buffer strips are complex ecosystems established along drainage areas that function to slow/reduce storm water velocity, trap suspended sediments, filter out contaminants, absorb nutrients and reduce erosion.

• ***Site Planning:*** Unlike watershed planning, site planning is a small-scale approach. The soils, potential land uses, location in the watershed, topography and impacts of the proposed activities are all evaluated as part of the planning or subdivision process. There are several BMP's that can be followed when designing a home, and during construction, that can reduce the negative impacts of stormwater. These may include minimizing the driveway surface area and increasing areas of natural vegetation.

• ***Preventative Construction Techniques:*** Protecting exposed soils with tarps and hay bales, careful storage and removal of chemicals or other waste, installing washing areas, protecting storm drains and utilizing secure sanitary facilities will help to prevent stormwater contamination during construction.

Michelle Robinson

Structural Best Management Practices

Structural Best Management Practices include pre-treating the stormwater with a variety of new technologies, filtering, storing and moving stormwater, preventing erosion and upgrading existing systems.

• ***Pre-treatment of Stormwater:*** There are many new designs that towns can implement to improve the quality of stormwater before it reaches its destination. Some of these include using porous pavement, which allows a greater percentage of water to infiltrate into the soil, thus reducing the volume of runoff and recharging groundwater. Implementing new storm drain designs, including porous French Drains and Infiltration Basins, which allow water to slowly filter out into surrounding soils. Dry wells collect runoff primarily from rooftops and direct it into infiltration pipes where it can seep into the surrounding soils rather than rush into storm drains.

• ***Filtration of Stormwater:*** Sand filters, which allow stormwater to pass through layers of sand that filter out metals, bacteria, sediments and other contaminants, can be added to most storm drain systems to improve the quality of the stormwater.

• ***Transport of Stormwater:*** Vegetated swales can be constructed along roadsides to collect and filter street runoff.

• ***Settling of Stormwater:*** Wet ponds are capable of retaining storm water and later releasing it at a controlled rate, while constructed wetlands detain and treat stormwater before it is released. Both of these reduce the velocity of stormwater, allow it to be filtered first and then released slowly.

• ***Erosion Control:*** Vegetated buffers provide natural protection to sensitive areas by slowing approaching runoff and filtering contaminants. By slowing the velocity of runoff, erosion is decreased and infiltration increased.

• ***Installing New Technological Systems:*** Many companies have created systems to treat stormwater by filtering out grease, sediments and other contaminants. Some of the many available systems include: StormTreat, AquaShield, StormFilter, and Vortechs.

In-lake Management Techniques

General guidance on solving several common in-lake problems and some advantages and disadvantages of each are listed below. Because each lake or pond is unique, before implementing any method, an initial study should be performed to identify the cause of the problems noted. Most techniques require permits and need to be implemented by a professional. For detailed information on management techniques, refer to the Massachusetts Generic Environmental Impact Report (GEIR) and the accompanying Practical Guide to Lake and Pond Management in Massachusetts.

Method	Advantages	Disadvantages
Aluminate sulfate (alum treatment)	Lowers phosphorus levels. Blocks the release of phosphorus from sediments. Increases water clarity.	May result in an increase in plant growth due to improved water clarity.
Artificial Circulation	May prevent/disrupt stratification. Increases the levels of oxygen in the water and extends aerobic zone.	May increase turbidity. Will not affect plant/algae growth. May have negative impacts on cold water fish species.
Bio-manipulation (altering the fish community in the lake)	Usually increases the number of zooplankton that eat algae.	Hard to accomplish; may not be effective if other sources of nutrients are present.
Dilution (flush the lake)	Removes algae on the surface. Lowers the levels of nutrients.	Requires a large amount of water. Will not affect the inputs of phosphorus to the water body.
Dredging	Deepens the lake by removing the accumulated sediments and increasing the water volume. Improves clarity. Removes aquatic plant matter. Reduces littoral zone.	Temporarily disturbs the habitat and increases turbidity. Expensive. May release toxins from sediment.
Hypolimnetic Aeration	Adds oxygen to deep waters. Limits the release of phosphorus from sediments.	May cause destratification. Will not control macrophytes. May cause algal blooms.
Water Drawdown	A control technique for macrophytes. Allows for dock repair/maintenance.	Negative impact on fish and other organisms. Not ideal for some climates. May have negative impact on out flowing streams due to reduced water flow.

Aquatic Plant Management Techniques

Method	Advantages	Disadvantages
Manual Methods (hand pulling, cutting)	Inexpensive and non-toxic. Affects only the target plant species. Does not harm beneficial plants.	Not practical for very large areas. Need divers for deeper waters. Labor intensive. Stirs up sediment.
Benthic Barriers (bottom covers)	Restricts upward plant growth. Limits light to lake bottom. Good for small areas near docks or beaches without affecting the rest of the water body. Non-toxic.	Harmful to benthic community. Accumulated sediments must be removed. Need to inspect often. May be damaged by anchors. Must anchor barrier securely as gasesfrom decomposition may cause the barrier to float up.
Mechanical Cutting (clipping plants below the water surface)	Inexpensive. Immediate results. Targets one area of the water body. Fairly species specific. Non-toxic.	May produce plant fragments which can regrow. Roots may regrow. Must do several cuts each season. Not species specific.
Mechanical Harvesting	Removes plants from the area. Requires no herbicides.	Labor intensive and expensive. Does not target specific plants. Plant fragments may regrow. Can only cut up to 5' below surface.
Hydro-raking	Removes plants and roots.	Disturbs sediments which negatively impacts bottom dwellers, increases turbidity, and may release nutrients and toxins from sediments. Causes fragments which may regrow.
Biocontrols (weevils etc.)	Species specific and non-toxic. Potential for long-term control.	Will not remove all the plants. Expensive. Slow response.
Herbicides	Very effective and ideal for large areas. May be used to spot treat specific plants.	May harm beneficial plants. Decomposing plant matter may release nutrients and decrease oxygen levels in the water. Recreational activities may be temporarily restricted.
Drawdowns	Non-toxic and works on many plants.	May be an inconvenience for dock owners. Not species specific and may affect other organisms. Weather conditions may alter effectiveness/ feasibility. May affect out-flowing streams.