

3.5 Mechanical Control of Aquatic Weeds

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Introduction

The term “mechanical control” as used in this chapter refers to control methods that utilize large power-driven equipment. The simplest method of mechanical control might be the dragging of an old bedspring or other heavy object behind a boat to rip up and remove submersed weeds from a beach used for swimming. Mechanical control has been practiced in the US for over a century and almost every engineer has a conceptual idea of how to build the “perfect aquatic weed harvester.” One major obstacle to designing a universal mechanical harvester is the diversity of plants and environments where the equipment will be employed. This has led to the development – and ultimate abandonment – of a plethora of various types of equipment throughout the years. Primary factors to be considered when selecting a mechanical control method are the types of weeds to be controlled and the habitats they occupy.



Wetland or emergent weeds

Wetland habitats are typical marsh ecosystems with periodically inundated soils, a high water table and/or water depths of up to two feet. Emergent plants such as phragmites (Section 2.15), purple loosestrife (Section 2.16), native cattails (*Typha* spp.) and other wetland plants are common in these areas. Mechanical control is employed on a very limited basis in these “protected” habitats because access is often difficult and the destruction and alteration of protected wetlands in the US is highly regulated.

While there is very limited mechanical weed control conducted in wetlands, the mechanical control method most commonly employed by land managers is mowing. For example, dense stands of phragmites may be mowed during dry seasons or under drought conditions to provide temporary control. Also, chain saws and hand-pulling have been used in wetlands of southern Florida for control of melaleuca (*Melaleuca quinquenervia*) trees and seedlings, respectively. Ducks Unlimited and other resource agencies have used dredges and choppers of various types to reclaim or restore wetlands, but the primary purpose of these activities is not solely weed control. Overall, mechanical weed control is rarely used for invasive species management in wetlands and shallow-water areas due to the likelihood of creating significant environmental damage.

Floating weeds

Most mechanical weed control occurs in water greater than 2 feet deep and the type of plant to be controlled (floating or submersed) must be taken into consideration when selecting a mechanical control method. Floating plants should be evaluated separately from submersed plants because floating plants produce 10 to 20 times more biomass than submersed plants – biomass that has to be chopped, picked up or otherwise moved away from the harvesting site. For example, the standing crop or biomass of an acre of undisturbed waterhyacinth (Section 2.11) can weigh 200 to 300 tons per acre, whereas an acre of hydrilla (Section 2.2) or Eurasian watermilfoil (Section 2.3) may only weigh 10 tons or less per acre. Most mechanical harvesters are able to pick up and transport less than 5 tons of biomass per load, so there is a huge difference in the time, effort and expense required to mechanically harvest floating plants compared to submersed aquatic weeds.

Two additional problems associated with floating plants are their ability to move by wind or water currents and their location in lakes and rivers. For example, there may be only one access point where plants can be loaded onto trucks for disposal. Plants may initially be located close to the work site, but on another day – after a change in wind direction – plants may be on the other side of the lake and will need to be transported a long distance before they can be off-loaded. Also, floating plants are often blown into shallow waters along shorelines, which may be lined with cypress or willow trees. Most harvesters cannot work in water less than 2 feet deep and cannot navigate in and among trees, rocks or stump-fields in flooded reservoirs.

Submersed weeds

Mechanical harvesting of submersed weeds, primarily curlyleaf pondweed (Section 2.4) and Eurasian watermilfoil, has been widely used in the Northeast and Midwest. The shallow shores of even very deep lakes in these regions often support the growth of these submersed weeds and multiple harvests provide control during the recreational season. Governmental entities (including state, county and local governments) have subsidized weed removal from public lakes in some locations to maintain high use areas and to promote tourism and general utilization of the water resource. In other areas, lake associations and groups of homeowners often hire aquatic management companies for weed removal services. Although mechanical harvesting is often used in northern lakes to control submersed weeds, this method has less utility in southern states due to longer growing seasons and much larger-scale coverage of weeds in the shallow lakes and reservoirs more commonly encountered in the Southeast.

Examples of mechanical equipment

Cutter boats have been used in the US in one form or another for decades. For example, a small barge with a steam engine powered an underwater sickle bar mower in the Upper Chesapeake Bay/Potomac River area at the turn of the century. Submersed plants cut by the barge floated from the harvested area via river and tidal currents. Also, the US Army Corps of Engineers built sawboats in the early 1900s for use in navigable waters of Louisiana and Florida. These boats had gangs of circular saws mounted about an inch apart on a spinning shaft that was mounted at the bow of the boat and only penetrated the top inch or two of the water. These sawboats chopped up waterhyacinth, alligatorweed (*Alternanthera philoxeroides*) and grasses which formed intertwined mats of floating vegetation. The chopped vegetation was allowed to flow downstream or to salt water. Cutter boats have been used more recently to clear navigation channels, but this equipment is not usually used in lakes and non-flowing systems because most cut weeds float and survive for long periods of time. Fragments such as these can establish in other parts of the water body or wash up on swimming beaches. Cutter boats create large amounts of fragments and vegetative cuttings, so the ability of the target weed to spread and grow from fragments should be evaluated before cutter boats are employed as a primary mechanical control method.

Shredding boats are used to control emergent and floating plants. The most common type of shredder is the “cookie cutter,” which consists of two spinning blades (3 to 4 feet wide) that are mounted behind a steel hood on the front of a small but powerful barge. The boat is propelled by hydraulically raising and lowering the blades and changing the direction of the blades (see <https://texasaquaticharvesting.com/>). Recently, bow mounted high-speed flail mower blades



have been tested for chopping and shredding floating and emergent plants. Similar to other mechanical control equipment, shredder boats are very specialized pieces of equipment, are non-selective and create many plant fragments. However, they work well when used in the areas for which they are designed and are frequently used in wetland restoration projects, where removal of cut vegetation is too expensive or not feasible.

Rotovators are highly specialized large aquatic rototillers. The rotovator head is lowered onto the lake or river bottom and “tills” the sediments, which chops up and cuts loose submersed plants. A floating boom is usually placed around the work area while the rotovator spins on the lake bottom; uprooted plants float to the surface and are removed from along the barrier by hand or mechanical means. Rotovators have been used mostly in the Pacific Northwest, where the submersed weed Eurasian watermilfoil grows in rocky bottom areas and roots in the shallow soil between and among small rocks. The rotovator head moves the rocks around and uproots the weeds from the shallow soils and rock crevasses.

Dredges are not usually used for aquatic weed control due to high costs associated with their operation, but weed control can be a benefit of dredging that is done for other reasons. Shallow ponds and lakes that have filled with silt and organic matter over time may only be 3 to 4 feet deep and provide an ideal environment for excessive growth of submersed weeds and native plants such as cattail and waterlily. If the water depth of the pond is increased to 6 to 10 feet by dredging, it is unlikely that emergent plants such as cattail will continue to grow. However, submersed weeds will almost certainly still infest the pond if water depth and clarity requirements for growth of the weeds are met.

Cut and removal harvesters are the most widely used types of equipment employed for mechanical control in the US. The first machines were developed in the 1950s by a Wisconsin company to harvest Eurasian watermilfoil and curlyleaf pondweed from the edges of the hundreds of lakes in the Upper Midwest. These lakes are generally deep in the middle and aquatic weeds naturally grow in the shallow littoral areas, which receive intensive use for swimming and docking over the 3 to 4 month summer season. These harvesters are powered by side-mounted paddle wheels which operate independently in forward or reverse. As a result, they are highly maneuverable around docks and boat houses. Also, the machines can operate in as little as 12 to 18 inches of water. These harvesters typically cut plants off at depths to 5 feet deep and in swaths 8 feet wide with a hydraulically operated cutter head and convey the cut plants into a storage bay on the harvester. When the harvester is full, it offloads harvested plants onto a transport barge by conveyer belts and the transporter takes the vegetation to shore, where it is dropped onto a conveyor to elevate the load to a truck for disposal. If you have read this carefully, you have counted four pieces of equipment: a harvester, a transporter, a shore conveyor and a truck. All this equipment may not be necessary, as mechanical harvesting is obviously tailored to a particular situation and is very site-specific. Also, some harvester trailers have been modified to allow them to transport cut weeds to the disposal site. This system or a setup with similar equipment has been used for 50 years in lakes from New England to California, but is mostly employed in northern lakes where one or two harvests during spring and summer can provide nearly weed-free conditions for the seasonal summer use of these lakes.

Advantages and disadvantages

There are many advantages to mechanical harvesting. These include:

- Water can be used immediately following treatment. Some aquatic herbicides have restrictions on use of treated water for drinking and irrigation. Also, plants are removed during mechanical harvesting and do not decompose slowly in the water column as they do after herbicide application. In addition, oxygen content of the water is generally not affected by mechanical harvesting, although turbidity and water quality may be affected in the short term.
- Nutrient removal is usually insignificant because only small areas of lakes (1 to 2%) are typically harvested; however, some nutrients are removed with the harvested vegetation. It has been estimated that aquatic plants contain less than 30% of the annual nutrient loading that occurs in lakes, but this value varies widely between lakes and their water catchment areas.
- The habitat remains intact because most harvesters do not remove submersed plants all the way to the lake bottom. Like mowing a lawn, clipped plants remain rooted in the sediment and regrowth begins soon after the harvesting operation.
- Mechanical harvesting is site-specific because plants are removed only where the harvester operates. If a neighbor wants vegetation to remain along their lakefront, there is no movement of herbicides out of the intended treatment area to impact the neighbor's site.
- Herbicide concerns remain widespread despite extensive research and much-improved application, use and registration requirements that are enforced by regulatory agencies (Section 3.7). Mechanical harvesting, despite some environmental concerns (as outlined below), is perceived to be environmentally neutral by the public.
- Utilization of harvested biomass is thought by many to be a means of offsetting the relatively high costs and energy requirements associated with mechanical harvesting. Unfortunately, no cost-effective uses of harvested vegetation have been developed, despite much research examining the utility of harvested plant material as a biofuel, cattle feed, soil amendment, mulch or even as a papermaking substrate. As much as 95% of the biomass of aquatic plants is water, so 5 tons of Eurasian watermilfoil yields only 500 pounds of dry matter. In addition, cut plants in northern lakes are only available for 3 to 4 months of the year.



The easiest way to highlight the disadvantages of mechanical harvesting is to point out that major producers of farm equipment (for example, John Deere or New Holland) do not mass-produce equipment designed for the mechanical

harvesting of aquatic weeds. Farmers are famous for efficiently cutting, harvesting and moving hay, corn and grain crops; they constitute a large market and specialized equipment is available to them. On the other hand, the demand for aquatic weed harvesters is very small, so the equipment associated with these operations is often custom-made and expensive. Other disadvantages include:

- The area that can be harvested in a day depends on the size of the harvester, transport time, distance to the disposal site and density of the weeds being harvested. These factors can result in a wide range of costs. The cost of harvesting is site-specific, but mechanical harvesting is generally more expensive than other weed control methods due to the variables noted above and the generally high capital outlay required to purchase equipment that may only be used for 3 or 4 months per year.



- Mechanical harvesters are not selective and remove native vegetation along with target weeds. However, this is probably not a significant disadvantage since native plants and weeds will likely return by the next growing season, if not sooner.
- By-catch, or the harvesting of nontarget organisms such as fish, crayfish, snails and frogs along with weeds, may be more of a concern, but the degree or extent of harvesting should be considered. Research on fish catch during mechanical harvesting of submersed vegetation has shown that 15 to 30% of some species of fish can be removed with cut vegetation during a single harvest. If the total area of a lake that is harvested is 1, 5 or 10% of the lake's area, this will likely be of little consequence. However, if the management plan for a 10-acre pond calls for complete harvests 3 times per year, then the issue of by-catch of fish deserves more consideration.
- Regrowth of cut vegetation can occur quickly. For example, if hydrilla can grow 1 inch per day as reported, a harvest that cuts 5 feet deep could result in plants reaching the water surface again only two months after harvesting. Speed of regrowth depends on the target weed, time of year harvested, water clarity, water temperature and other factors.
- Floating plant fragments produced during mechanical harvesting can be a concern because most aquatic weeds can regrow vegetatively from even small pieces of vegetation. If an initial infestation of aquatic weeds is located at a boat ramp, care should be taken to minimize the spread of fragments to uninfested areas of the lake by maintaining a containment barrier around the area where mechanical harvesting will take place. On the other hand, if a lake is already heavily infested with a weed, it is unlikely that additional fragments will spread the weeds further. However, homeowners downwind of the harvesting site may not appreciate having to regularly rake weeds and floating fragments off their beaches.
- Disposal of harvested vegetation can be an expensive and difficult problem after mechanical harvesting. Research during a project in the 1970s on Orange Lake in Florida compared the costs of in-lake disposal to the transport, off-loading and disposal of cut material at an upland site. As water levels on Orange Lake decreased during a drought period, the mechanical harvester was allowed to off-load cut vegetation along the shoreline among emergent vegetation instead of transporting harvested plants to the shore for disposal. The cost of in-

lake disposal reduced the per-acre cost by about half when compared to transporting the vegetation to shore, loading it into a truck and disposing of the plant material in an old farm field.

- Some lakes or rivers may not be suitable for mechanical harvesting. If there is only one public boat ramp on a lake and it is not close to the area to be harvested, the costs of moving the cut vegetation from the harvester to shore will add significantly to the cost of the operation. Harvesters are not high-speed machines and move at 3 to 4 mph, so if a river flows at 2 mph and the harvester has to travel upstream to the off-loading site, well, do the math! Off-loading sites usually must have paved or concrete surfaces because the weeds are wet and an unpaved off-loading site can quickly become a quagmire.

Recent advances in deep-water harvesting

The rising cost of herbicides for hydrilla control and the development of fluridone-resistant populations of hydrilla in Florida lakes served as the stimulus for a multi-agency evaluation of improved mechanical control techniques for hydrilla control during the early 2010s (see <http://www.fapms.org/aquatics/issues/2012fall.pdf>). Improved efficiency and reduced costs associated with mechanical harvesting would likely result if: 1) harvesters were larger, since this would reduce the number of trips and transport time needed to offload harvested material; and 2) deeper harvesting was possible, since this would reduce weed biomass in deeper waters, resulting in longer intervals between harvesting events because weeds would require more time to regrow to problematic levels.

To test this theory, a 70-foot harvester with a cutter head capable of harvesting weeds in water as deep as 10 feet was developed by a commercial firm. The harvester was also equipped with a GPS tracking unit to allow the operator to harvest plants that are difficult or impossible to see from the operator's position on the harvester. This equipment was used in an early-season (March) operation to remove hydrilla that was 3 to 6 feet tall and growing in 8 to 9 feet of water and allowed harvesting of 2 to 4 acres per hour. Topped-out or surface-matted hydrilla can weigh as much as 14 tons (fresh weight) per acre, but this low-growing hydrilla, which was harvested from the soil line up through the water column, averaged only 1,000 pounds per acre. Fish by-catch was greatly reduced during this operation compared to previous operations in surface-matted hydrilla because: 1) oxygen levels were consistent throughout the water column due to less dense weed populations than those encountered later in the season, so fish did not preferentially inhabit weed beds; and 2) the relatively low weed density entangled fewer fish, so fish could escape the harvester. This early-season deep-water harvesting operation had a negligible impact on water quality because the harvester's propulsion unit was farther away from the lake bottom and sediments were not disturbed as they would be in shallower water. In addition, control was achieved for 5 to 7 months; this is a decided improvement over the 2 to 3 months of control provided by shallow-water harvesting and could allow longer intervals between harvesting, which would significantly reduce the costs associated with mechanical harvesting. Additional trials are planned, but it appears that the strategy of using a GPS-assisted larger harvester to manage less dense weed infestations in deeper water may significantly increase the efficiency of mechanical harvesting of submersed weeds.

Summary

This discussion is not intended to include all the machines that are available for mechanical control of aquatic weeds and it is likely that new ideas and equipment will be developed as time passes. It is important to remember that each site and each weed has characteristics that may require a particular type of mechanical harvester and may preclude the use of other mechanical methods of control. There is a vast repository of information available on the internet and the best source of information is the conservation or regulatory agency in your state. In fact, most states require that permits for mechanical harvesting be obtained before work can begin.

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