Devils Lake Water Improvement District

www.DLWID.org

Mechanical Harvesting

Description: Floating harvesters that "mow" the lake. They would be able to clear about 1 to 2 acres per day at a depth of 5ft to 10ft, in a swath 6ft to 20ft wide, depending on the harvester used. Harvesters use a conveyer belt method to scoop up chopped vegetation and store on the harvester. Once the harvester has a full load of vegetation it can be deposited on a barge or taken to an offload trailer on shore. Offload trailers are essentially a flatbed trailer partially in the water with a conveyer belt for transporting vegetation from the harvester to a truck for transportation away from the lake. As harvesters are not very fast machines barges can also be used to store cut vegetation from the harvester. This reduces the time the harvester must spend traveling to the offload site and increases its time spent cutting. The barge can then be motored to the offload site at the end of the day and the cut plants can be taken to a dump site.

Advantages	**Disadvantages**
• Immediate results	• High initial cost
• Cheap long-term cost if a harvester is purchased by the district	• Could be seen as dangerous to people or operator in rough water conditions
• Maintains some habitat for fish and other wildlife	• Could have detrimental effects to fish
• Can cover large areas	• Require nearby dumpsite or dump barge
• Low environmental or toxicity concerns	• Not species selective

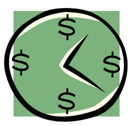
Application: This method is best applied on a large scale in deeper waters (over 3 ft). Because these boats are often large they are difficult to use in tight spaces such as boat docks or shallow, debris filled water. The speed with which a harvester can work also benefits its use in open waters.

Efficacy: Harvesters do create an immediate and very noticeable difference in the vegetation cover in a short period of time. However it is very much like mowing the grass, it will never really be done. Mechanical harvesting does do a great job a at reducing large amounts of milfoil quickly and efficiently, but it is not a long term solution. In a study done on Halverson lake, Wisconsin harvesting was seen to have removed 50% of the vegetation in one growing season, and 70% of vegetation the following year (Painter 1988). This suggests that harvester use may be reduced each year. Although vegetation was removed it was observed to grow back to its full length within 3 weeks between June and July, but stayed low after July (Engel 1990). During the second harvest in July it was also found that the vegetation, while the same length as the time at the first harvest, was twice as thick (Engel 1990).

Longevity: Mechanical harvesting is not a long term solution to the vegetation problem. It's like mowing the grass, it will always have to be done again later when it grows back. harvesters also fragment milfoil which can further the spread of the plant because fragmented shoots can re-root to the bottom. In a study done on Halverson lake, Wisconsin harvesting was seen to have removed 50% of the vegetation in one growing season, and 70% of vegetation the following year (Painter 1988). This suggests that harvester use may be reduced each year. Harvesters are made that can pick up the cut vegetation, but this is not 100% effective, which could lead to the spread and increase of certain aquatic plants (Engel 1990). The cut vegetation must then be transported to land, hauled away and dumped somewhere away from all other water bodies.

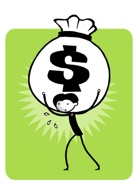
Capital Expense: The initial cost of purchasing the harvesters is very high as they are not cheap machines. Aquatic Harvesting Inc. sell their harvesters for $130,000 while Inland Lake Harvester sells their largest harvesters for around $180,000. There is also a used market for harvesters where they could be purchased for a cheaper price from other lake associations. The lake could be contracted out to various companies for 'mowing' each year. This way a bid system could be set up and the lowest bidder could be obtained.

Operating Costs: Aquatic Harvesting Inc. quotes $1200 to $1500 a day for contracting their services. This includes operator, harvester and offloading trailer along with waste removal. 1 to 2 acres can be harvested per day, per harvester. With one harvester working to cut 100 acres in the summer that would cost between $60,000 and $75,000 per summer. That's just one cut, its probable that cutting would have to take place one to three times per growing season. It would take one harvester nearly a year (340 days) to cut the entire 680 acres of the lake at a cost of $408,000 to $510,000 yearly. With three harvesters working it still requires about 113 days to cut the entire lake. Waste removal is done by a local trucking company contracted by the harvesting company or DLWID. If a suitable area for composting the vegetation, such as agricultural land, is obtained than then the vegetation can be disposed of for no, or very minimal cost rather than paying landfill fees. Operating costs for harvesters range from $35 to $55 per hour depending on the size of the harvester. Running a harvester for 500 to 600 hours during the summer would cost about $19,000 for a smaller harvester and $30,000 for a larger one.



Labor Requirements: Labor is incorporated into the cost of the contractor. If the job is not contracted out and a laborer is hired for the job then these machines can be run by a single operator. A single operator working full time from May through September would cost $16,000. That’s assuming an hourly wage of $12 per hour and insurance cost of $8 per hour. A 2 man crew working a typical work week May through September is about $26,000.

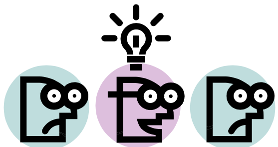
25 Year Cost: Harvesting 100 acres every summer for 25 years contracted to Aquatic Harvesting Inc would cost $1.5 million to $1.9 million respectively. This cost assumes a free disposal area of aquatic plants in a method such as composting. This cost doesn't factor in inflation costs as oil prices rise and operating costs subsequently rise.



Economic Summary:

Equipment Cost	$120,000 to $180,000
Cost per Acre	$600 to $750
25 Year Cost	$1.3 million to $1.9 million based on using one harvester cutting approximately 100 acres

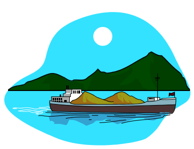
Species Selective: These machines are not species selective and cut everything in their path. The major drawback to this is the damage it can have on wildlife as they have been known to catch fish, amphibians and turtles. This can also be detrimental to the native plants.



Employee Risk: These machines can be difficult to operate and use very dangerous cutting equipment. They are also made more dangerous by the fact that they are operated on the water and can be unstable, especially when waited with a full load of water soaked vegetation. Taking waves broadside, or being pushed by heavy winds has been known to tip these machines over. Employee's would require at least one month of training by an experienced operator. Knowledge and previous experience on the water would be highly preferred.

Effects on Wildlife: The affects on wildlife can be highly detrimental as the harvester picks up everything in its path. As John D. Madsen PHD biologist for the U.S. Army Corps of Engineers states "The harvester acts as a large, nonselective predator "grazing" in the littoral zone." They have been known to kill significant amounts of juvenile fish, between 3 and 30% of all fishes in harvested area (Engel 1990 and Booms 1999). This is a sensitive subject in a lake that supports native Coho, Steelhead and sea run cutthroat trout. This fact alone could deem these harvesters illegal by NOAA fisheries in salmon rearing habitat. Little to no research has been done on the west coast of the effects of these harvesters on fish, so it is difficult to determine the effect that a harvester could have on salmonids. Larger fish can be spotted by the operator and knocked back into the water. Damage to the surface vegetation may also disturb invertebrate habitat, limiting nutrients for fish. On the plus side the harvester does leave deeper vegetation unharmed, preserving habitat for fish.

Effect on Sediment: Harvesters leave the majority of the sediment undisturbed as they don't cut all the way down to the bottom. However in the shallow areas of the lake the cutter and propulsion can churn up the sediment and create turbidity in the water. This makes harvester use in very shallow areas relatively ineffective.



Toxicity Concerns: Toxicity concerns are relatively low. They are mostly limited to chemical spills such as hydraulic fluid, oil or fuel.

Public Acceptance: This may be of adverse opinion amongst the public as it does offer immediate results and can effectively clear vegetation. However it may be seen as costly and dangerous considering the risk of tipping over the harvester in high winds. It's effects on fish will most likely receive negative results as well due to the native Coho population.

Case Studies
Long-term effects of mechanical harvesting on Eurasian watermilfoil

Contacts
Rick at Aquatic Harvesting 925 786 0095

Rick Knauff of Aquatic Weed Harvester in Wisconsin 1 612 868 0143 rick@aquaticweedharvester.com

Aquarius Systems harvesting 262 392 2162 info@aquarius-systems.com

References
Engel, S. 1990. Ecological Impacts of Harvesting Macrophytes in Halverson Lake, Wisconsin. Journal of Aquatic Plant Management 28: 41-45.

Mikol, G. F. 1985. Effects of Harvesting on aquatic vegetation and juvenile fish populations at Saratoga Lake, New York. Journal of Aquatic Plant Management 23:59-63

Long-term Effects of Mechanical Harvesting on Eurasian Watermilfoil

Aquaharvesting.com, Rick Hatton
Booms, Travis. "Vertebrates removed by mechanical weed harvesting in Lake Keesus, Wisconsin." journal of aquatic plant management. 37. (1999): 34-36. Print.

Permits
No known permits required.

Photos

Videos
http://www.youtube.com/watch?v=-3jw4u4cIok&feature=endscreen&NR=1

Devils Lake Water Improvement District

www.DLWID.org

Diver Assisted Suction Harvesting

Description: Diver Assisted Suction Harvesting (DASH) is essentially a small scale dredging operation that doesn't remove bottom sediments, but focuses on removing aquatic vegetation instead. A diver works with a long suction hose on the bottom to selectively remove the vegetation by hand which is then sucked to the surface by a vacuum pump where it is sorted out by a filtration system. This system removes the plant material but returns any sediment that may have been removed from the bottom. These boats can also be modified to use for sucking debris from the surface such as trash, plant matter or algae. The hydraulic vacuum system can be created using a gas or diesel pump mounted to a barge or a boat at the surface. A simple perforated wet well can work as the filtration system, allowing water and sediment to be deposited back into the lake while containing the plant material.

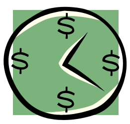
Advantages	Disadvantages
• Low impact to fish and wildlife	• Slow, tedious process
• Effective and long term control of plants as root system is removed	• Areas must be constantly surveyed for re-growth
• Employs local residents for summer jobs	• Permits required from Department of State Lands and U.S. Army Corps of Engineers
• Effective around docks and other tight spaces	• Disturbs sediment
• Species selective	• Labor intensive

Application: This method would best be applied on a smaller scale as it is time consuming work. It can be applied on a lake wide scale but with higher costs and a larger workforce needed. It's most effective use would be around docks and marinas in shallow water where a harvester would have difficulty maneuvering or in other nearshore areas of the lake.

Efficacy: Diver Assisted Suction Harvesting of milfoil can be highly effective on a small scale. It can remove over 95% of the vegetation within a targeted area and is highly effective in removing vegetation in difficult to reach places, such as log jams or in areas with lots of debris (Gibbons et. al. 1999). It is not very effective on a large scale however due to its relatively high cost and time consuming work. It is estimated that a team of two men operating one suction harvester could probably eradicate Eurasian milfoil between 5 to 15 acres of the lake over the period of one growing season (May through September) depending on density. Aquacleaner Environmental estimates their rate of removal to be anywhere from 200 to 600 sq ft per hour with just a two man team. At an average of 400 sq ft per hour that's about 14 days of work time to clear 1 acre.


Longevity: Suction harvesting can have lasting beneficial effects. It has been observed that areas being re-harvested the following year have required 64 to 89% less work time than in initial harvesting efforts (Eichler et. al. 1993, Kelting and Laxson 2010). Substantial reduction in the biomass of watermilfoil has been demonstrated using these suction harvester techniques.

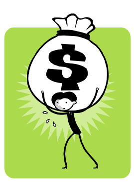
Capital Expense: Suction harvesters can be purchased from contract companies such as Aquacleaner Environmental for a substantial cost or they can possibly be built from materials purchased and assembled by the district. The cost of purchasing one suction harvester from Aquacleaner Environmental is $30,000 for a new machine or $20,000 for a refurbished machine. Jobs can be contracted out to companies for about $15,000 per acre for vegetation removal. This cost could be lowered if contracted for large acreage jobs. Permits from the department of state lands and U.S. Army Corps of Engineers are required as it is considered a form of dredging.



Operating Costs: Operating costs would be incurred if the job is ran by the district. Operating costs include fuel and oil for the suction harvester and labor wages. Fuel used is about 1 gallon per running hour with these machines. If they are ran full time, 8 hours a day throughout the growing season (May through September) then an estimated $3,200 could be expected in diesel fuel costs annually. Disposal of the collected plant material also incurs costs. Ideally a nearby agricultural area could be located for organic disposal of the waste in a compost for no cost. Possibly somewhere along the lake shoreline may be suitable for composting of plant matter. Otherwise the material may have to contracted to be disposed of at a landfill. North Lincoln Sanitary charges $6 per cubic yard of plant material for disposal at their site. The plant matter must also be trucked away from the site. This offers two advantages however in that it makes the lake look better and helps prevent fragmented plants from re rooting in new areas of the lake.

Labor Requirements: Labor can be hired out by the district or contracted from companies. The suction harvester machine can be operated by just two people. Two people at 10$ per hour per person would cost about $16,500 for a 8 hour day, 5 day work week running from the 1st of May through the end of September. Insurance costs of $5 per employee would bring this total cost to $26,160.

There are also options for contracting out the job to a landscaping company to have their insurance cover the employees or to have contracted aquatic suction company employees to operate the machine. These costs could be higher, but would take away the insurance cost and need for training the employees.

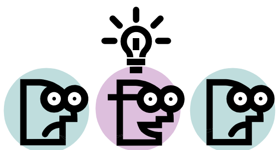


25 Year Cost: At $26,160 a year for a two man operating crew the 25 year cost would amount to $654,000. The Initial purchase of one machine could range from $20,000 to $40,000 plus an annual maintenance cost of $5,000 yearly for fuel and repairs brings the 25 year cost to $809,000. Ideally a diver can remove about 500 sq ft of vegetation per hour. That's about 1 acre every 80 work hours at a cost of $2800 per acre. Since suction harvesting has been observed to decrease the yearly amount of re-growth of plants such as Eurasian watermilfoil it could be expected that less area would have to be managed each year. In this case the 2 man team could possibly scale down its work time in subsequent years. Because the vegetation still hasn't reached the level to where it is unmanageable it is entirely possible that if this team is set up before the vegetation can re-establish itself, than a 2 man team could effectively manage most of the vegetation before it gets out of control. This scenario does require the team to vigilantly survey the lake for any vegetation that may grow.

Economic Summary:

Equipment Cost	$20,000 to $40,000 for a machine
Cost per Acre	$15,000 per acre
25 Year Cost	$809,000 based on a two person operating crew, yearly maintenance cost of $5,000 and initial purchase of machine at $30,000.

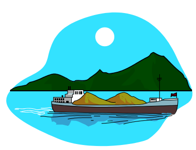
Species Selective: This method is highly species selective as the invasive noxious weeds can be targeted specifically while the native vegetation can be left alone. Training in identifying different aquatic plants would be required for each diver though as many plants look very similar.



Employee Risk: Minimized with proper training. The use of a "hookah" system eliminates the need for diver certification because the air tank is at the surface and compressed air is not used. The local pool has a similar system they use for cleaning their pool. This significantly lowers the risks.

Effects on Wildlife: The effect on wildlife would be very low as only certain vegetation would be targeted for removal. This would leave in place and even increase native vegetation, preserving habitat for fish and invertebrates.

Effect on Sediment: This method does affect the sediment but in a minimal way. Turbidity would be highly increased in a localized area for a short period of time (about 24 hours) as sediment resettles to the bottom. Turbidity could also be controlled by the use of barriers around the working area to control the spread of sediment.



Toxicity Concerns: Environmental concerns should be very low as the only real danger could be the possibility of oil or fuel spills from the pump. A protocol for such an event should be well outlined and equipment for cleanup should be readily available in the working area.

Public Acceptance: Due to very low environmental impacts this could be seen with high approval. May have a negative view when taken into account that there will be workers underwater so boaters will have to be cautious when in areas where the harvesters are working

Case Studies
Suction harvesting of Eurasian watermilfoil and its effect on native plant communities

Contacts
Jerry Davis at Aquacleaner Environmental 585 752 7930 jerry@aquacleaner.com

References
Eichler. L. et. al. 1993. Suction Harvesting of Eurasian Watermilfoil and Its Effect on Native Plant Communities. Journal of Aquatic Plant Management. 31:144-148

Kelting, D.L. and C.L. Laxson 2010. Cost and Effectiveness of Hand Harvesting to Control the Eurasian Watermilfoil Population in Upper Saranac Lake, New York. Journal of Aquatic Plant Management. 48:1-5

Dirty Jobs with Mike Rowe. 2012. video. Aquacleaner Environmental, New York. Web. 3 Jan 2012. <http://www.aquacleaner.com/>.

Permits
This is technically considered as a form of dredging by the state of Oregon. Permits from the Department of State Lands and the U.S. Army Corps of Engineers are required

Photos

Videos
http://www.aquacleaner.com/

Devils Lake Water Improvement District

www.DLWID.org

Bottom Barriers

Description: Bottom Barriers could be built and constructed with supplies bought at the local hardware store. Instructions exist on line at http://www.ecy.wa.gov/programs/wq/plants/management/index.html for building the barriers. They can be rolled up and compacted for easy storage and transportation. Barriers can be placed in the water very simply by dragging them out to the desired area, letting them sink, then weighting them with anchors such as sandbags, rebar stakes or concrete blocks.

Advantages	Disadvantages
• Non-toxic and environmentally friendly	• Require inspection on a regular basis
• Easily applied around docks, boat launches, swimming areas and other high use areas	• Require the use of scuba divers in water over 6ft deep
• Simple to use and can be reused for many years	• Can create hazards to boaters and swimmers if anchors fail
• Creates an immediate effect	• Not species selective
• Cheap and effective on small scales	• Plants can grow on top of barriers if sediment is deposited on them

Application: Bottom barriers would be best applied around swimming areas, boat launches and docks. They would be reasonable on a scale of a few acres throughout the lake, not a lake-wide solution. They are also highly effective over small, dense patches that need to be highly controlled. The barrier will kill 99% of vegetation below.

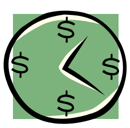
Efficacy: Seem to be good at controlling small populations of Eurasian watermilfoil and Brazilian Elodea.

However newly covered areas must be closely monitored for first few weeks to make sure growth is not occurring. Installing screens when there is minimal vegetation cover, such as during the winter months or beginning of growing season, is optimal as it reduces the amount of gas buildup beneath the screens from decaying vegetation. They can be moved about every 3 to 4 weeks to cover another area. Screens may be attached to frames for easier movement of screens (Washington state department of ecology). Screens can accumulate large amounts of silt on top of them in just a matter of weeks. If screens are left in place for long amounts of time this silt accumulation could lead to growth of milfoil on top of screens (Mayer, J.R. 1978, Engel 1984). The screens can be left in one area and be effective for multiple seasons with proper maintenance and inspection for accumulation of sediments. If screens are moved every few weeks, and removed once the growing season has ended they still seem to be effective while lengthening the life of the screens. Coupling this physical control with other methods of control such as diver operated suction, hand pulling or raking could be highly effective in controlling the majority of milfoil in Devils Lake before it can reestablish itself.

Longevity: Bottom screens can be made more effective if they are regularly maintained and used only during the primary growing season. They can be damaged by fishing gear, boat motors, anchors and other things. Depending on the type of material used and the length of time spent in the water bottom barriers can last anywhere from 2 to 5 years (Mayer, J.R. 1978). Materials such as burlap are cheaper and all natural, but will degrade at a faster rate then something like plastic, fiberglass or garden tarps. Barriers only need be to be placed in one area for 3 weeks to a month to be effective, they can then be moved to treat another area or stored away for the winter.

Capital Expense: It is relatively cheap to implement bottom screen over a relatively large area. Material costs an estimated $.20 to$.77 per sq foot. materials such as burlap can be purchased in 1,000 sq ft rolls for only $100 (catalogclearance.com). That's about $4300 per acre covered with burlap material, not including the cost of the anchor system or labor cost. aquascreen can be purchased in 700 sq ft rolls for $425 (http://www.clearpond.com/docs/articles/aquascreen.php). That's approximately $26,000 dollars per acre of material. This material, while more expensive, is stronger and will last longer than burlap would. Installation is estimated to be another $.25 to $.50 per sq ft. There are numerous vendors for bottom screening material in the Pacific Northwest based on what sort of material is purchased, burlap or synthetic. It is estimated that it will cost between $10,000 and $20,000 for installation per acre for professional installation. Using Barriers in only small patches over the densest growth areas would minimize costs.

Operating Costs: The operating costs could remain low as checking the barriers and replacing them as needed over time is relatively simple. This does however require frequent labor during the growing season months as the barriers must be monitored weekly to monthly during that time. This could most likely be done by the DLWID staff.



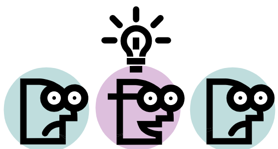
Labor Requirements: Time to install the barriers should be relatively minimal as its as easy as swimming the barrier to the desired location, sinking it, and anchoring it. In deeper waters it may be necessary to use diving equipment, in which case divers may have to be contracted. Once again time to place the barriers is highly dependent on how many barriers are placed. Costs could be kept low if a volunteer work day was organized over the summer and volunteers came out to help install barriers and pull weeds. The barriers should be inspected often (weekly or monthly) to make sure they are not damaged, stay sunk, and no plant growth occurs on top of the barriers. This can be conducted relatively easily by DLWID staff.

25 Year Cost: The long term cost of this strategy remains low as the barriers can be kept in place and used for multiple seasons. Barrier usage should decrease in total square footage each year as plants die back and cant re-establish themselves for sometime, diminishing the yearly cost every year (Mayer, J.R. 1978).

Economic Summary:

Equipment Cost	ranges from $0.25 to $1.00 per sq ft
Cost per Acre	$10,000 and $20,000
25 Year Cost	$130000 dollars per acre based on $26,000 per acre and material being replaced every 5 years

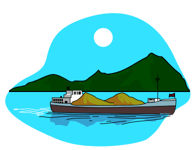
Species Selective: This method is not species selective which can be a disadvantage. It stops all vegetation from growing. This can be effective in areas dominated by one species, but could be detrimental in areas of high aquatic plant diversity, as it will destroy the native plants as well as the noxious invasive ones. But, through the elimination of noxious invasive, its possible to increase the viability in which native plants can re colonize an area.



Employee Risk: There is risk involved with divers laying the mats down in deeper parts of the lake. Areas over 4ft deep will require certified divers to properly position and anchor the mats. It's important for the divers to work carefully and avoid stirring up sediments as this decreases visibility and increases difficulty and risks.

Effects on Wildlife: There is little prolonged detrimental effects to fish and wildlife. It has been observed that these barriers do eliminate nearly all the macro invertebrates from covered areas, primarily due to lack of habitat, but they quickly re-inhabit the area once the barriers are removed (Ussery, Eakin, et al. 1997). It has not been observed that barriers cause any major ecological stress however (Mayer, J.R. 1978, Ussery, Eakin, et al. 1997).

Effect on Sediment: While these barriers do block the sunlight from reaching the sediment and remove the benthic invertebrates directly underneath them, they appear to have little effect on the chemical composition or physical attributes of the sediment (Ussery, Eakin, et al. 1997). Any effects they do have are highly localized to their area and do not play a large role throughout the ecosystem.



Toxicity Concerns: There is very little toxicity concern with these barriers. Organic materials such as burlap are environmentally preferable as they naturally decay over time. Synthetic material such as plastic does pose a mild concern with the possibility of the sheets degrading and ripping apart, possibly spreading plastic throughout the lake. This is highly unlikely and minimized if the material is properly anchored to the bottom and properly maintained.

Public Acceptance: Bottom barriers or lake mats could be well marketed to the public as they pose little or no environmental damage unlike chemical controls. If bottom barriers were used in conjunction with diver assisted hand pulling and suction then it could easily be marketed as a 'green' solution to the milfoil problem in Devils lake.

Case Studies
Lake Sutherland milfoil report

Aquatic weed management by benthic semi-barriers

Contacts
Kathy Hamel kham461@ECY.WA.GOV

Andrew Lewis andrew@milfoilremoval.com 240-818-1070

References
Mayer, J. R. 1978. Aquatic Weed Management by Benthic Semi-Barriers. Journal of Aquatic Plant Management. 16:31-33

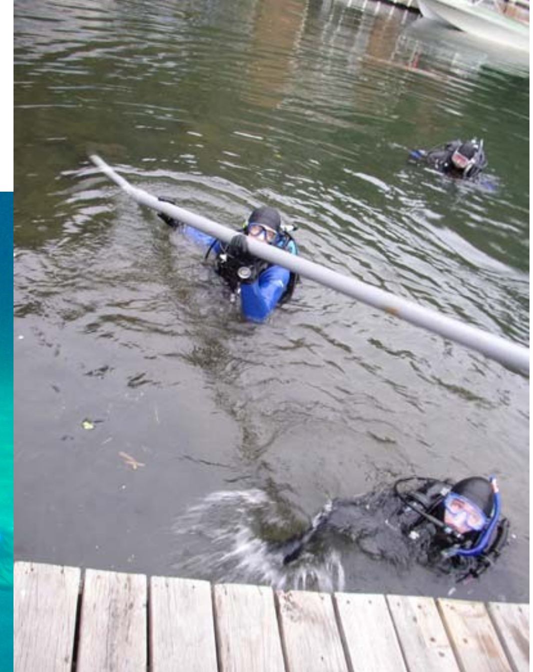
Ussery, Thomas A., H.L. Eakin, et al. "Effects of benthic barriers on aquatic habitat conditions and macroinvertebrate communities." journal of aquatic plant management. 35. (1997): 69-73. Print.

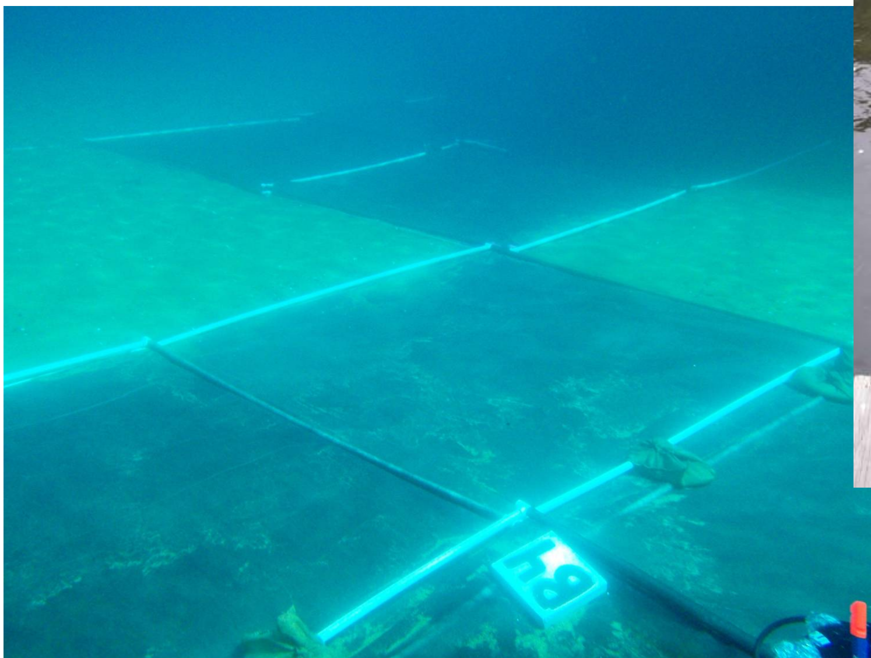
Engel, S. 1984. Evaluating stationary blankets and removable screens for macrophyte control in lakes. Journal of Aquatic Plant Management. 22:43-48

Kelting, D.L., C.L. Laxson 2010. Cost and Effectiveness of Hand Harvesting to Control the Eurasian Watermilfoil Population in Upper Saranac Lake, New York. Journal of Aquatic Plant Management. 48:1-5
Emerald Bay Bottom Barrier. 2011. video. YoutubeWeb. 3 Jan 2012. <http://www.youtube.com/watch?v=IC9pmfyAkUw>.

Permits
Permits are required from the Department of State Lands because anchoring systems such as concrete blocks or sandbags are considered "fill."

Photos





Videos
http://www.youtube.com/watch?v=IC9pmfyAkUw

Devils Lake Water Improvement District

www.DLWID.org

Diver Assisted Hand Pulling

Description: Manually pulling and removing aquatic vegetation from an area using simple tools such as rakes, hand shovels and other cutting devices. Plants cut must be kept in collection bags while cutting and disposed of in the proper place later on. In deeper waters, over 3ft or so, more technical equipment may be needed such as snorkel or scuba gear.

Advantages	**Disadvantages**
• Can be cheap if vegetation level are kept very low	• Not cost effective over large scale areas with dense weeds
• Could employ people from the community or involve the community in the lake through community work days	• Time consuming and labor intensive
• Very little effect on environment, fish and wildlife	• Divers may be impaired by visibility conditions as they increase turbidity in the water
• Species selective	• May be difficult to collect all plant fragments
• Can significantly reduce re-growth	• May be difficult for workers to remove all the plant roots, resulting in possible re-growth in a treated area

Application: This method is best applied around docks, swimming areas and shallow waters 3ft deep or less. Its not very applicable on a lake-wide scale due to the time consuming, laborious work.

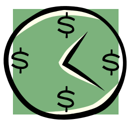
Efficacy: Effective on a small scale area, especially in shallow waters, 3ft deep or less. In shallow waters plants can be removed by laborers with simple hand tools. In deeper waters special equipment must be used such as snorkels or scuba gear. Can remove all of the infestation over a small scale area but ineffective and costly over large scale area. One hand pulling session can effectively remove vegetation for about a year if the roots are removed, until the next growing season.

Longevity: This technique can be effective for up to one year, but will be ultimately determined by the amount of vegetation in the surrounding area and the success with which the root systems are pulled. the procedure may have to be repeated twice a season depending on the length of primary growing season. It has been observed that plots with thorough eradication of milfoil saw a 67% reduction in milfoil the following year and a 97% reduction by the third year (Kelting and Laxson 2010).

Capital Expense: Equipment costs are relatively low and the only major cost incurred is that of labor. The

average cost of hand harvesting can range anywhere from $240 to $728 per hectare depending on vegetation density (Kelting and Laxson 2010). At 277 hectares that a total cost of $66,480 to $201,656 to hand harvest the entire lake. If current low level vegetation levels are maintained then a simple 2 person team may effectively manage the lake throughout the summer months. Emplying a 2 man work crew would be$26,160 per year based on a two man crew working a typical work week from May through September, the typical growing season, being paid $10 per hour with an insurance cost of $5 . This two person work team would involve approximately 1744 work hours. Another alternative to this might be to hold two or three volunteer work party days over the summer to pull any weeds that may have grown. If 1744 hours of work could be compiled over these volunteer days it could be assumed that the same goal may be achieved at little or no cost to the district, that is if they are able to field enough volunteers to reach 1744 work hours.

Operating Costs: Operating costs are very low such as costs for maintaining and operating a boat to shuttle workers around the lake.



Labor Requirements: Labor must be trained to identify between different aquatic plants. Wetsuits or

possibly dry suits would be required along with dive belts and fins. Safety protocols would have to be made. The use of "hookah" systems over scuba systems significantly reduces danger to the laborer and lowers insurance cost because it eliminates the need for diver certification.

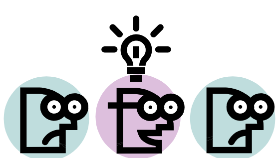
25 Year Cost: If vegetation levels are managed and maintained at low levels then the annual cost of

maintenance can be kept very low. The cost of employing a two man team to manually survey and pull weeds around the lake all summer (May 1 to September 30th) would be $26,160. That's $10 an hour for paid hourly rate and $5 per hour for insurance costs. That's $15 per hour per person. That's a 25 year cost of $654,000.

Economic Summary:

Equipment Cost	No equipment required
Cost per Acre	$96 to $300
25 Year Cost	$654,000 based on employing two person team to work average work week from May through the end of September

Species Selective: This method is highly species selective because the diver is able to directly see the



plants he/she is removing. However good training on identifying native vs. non-native is required to minimize the effects to the native vegetation and to target the non-native noxious plants. In areas where there is too much of everything it is entirely possible to just remove all the vegetation.

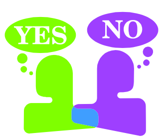
Employee Risk: Employee risk must be taken into consideration. When diving there is always risk but it can be minimized with proper safety protocols, training and equipment. Insurance costs will have to be taken into account and disability insurance will be needed. The hookah system uses an air compressor at the surface with a hose running to the diver, a more efficient and safe system then an air tank on the back of a diver and it increases the air supply for the diver, lengthening the amount of time they can spend in the water.

Effects on Wildlife: Effects on wildlife will be quite minimal. This method is species selective so natural vegetation will remain in the area and could even possibly increase habitat for macro invertebrates and will certainly maintain habitat for fish and other aquatic organisms. If anything this process may be beneficial as it targets the invasive non-native species and leaves the natural ones in tact.

Effect on Sediment: While this method does create turbidity in the water and may cloud the water for a few days, no sediment is actually removed. Turbidity of the water can also be minimized by enclosing the targeted area with a simple barrier.

Toxicity Concerns: Very low. Disrupting the sediment may could the water for a while but it will quickly settle back to the bottom and the use of a turbidity barrier reduces the area effected.

Public Acceptance: There are no detrimental environmental effects associated with hand harvesting which is a very positive issue with the public. The program could even be seen as employing members of the community over the summer time and benefiting the economy. To that regard people may not want their tax dollars being spent on people pulling weeds in the lake that they may claim "provides them no benefit."



Case Studies
Cost and effectiveness of hand harvesting to control the Eurasian watermilfoil population in Upper Saranac lake, New York

Contacts
Guy Middleton Lakemanager@uslf.org 518-796-1052

Andrew Lewis andrew@milfoilremoval.com 240-818-1070

References
Kelting, D.L., C.L. Laxson 2010. Cost and Effectiveness of Hand Harvesting to Control the Eurasian Watermilfoil Population in Upper Saranac Lake, New York. Journal of Aquatic Plant Management. 48:1-5

Permits
No permits required

Photos

Videos
None