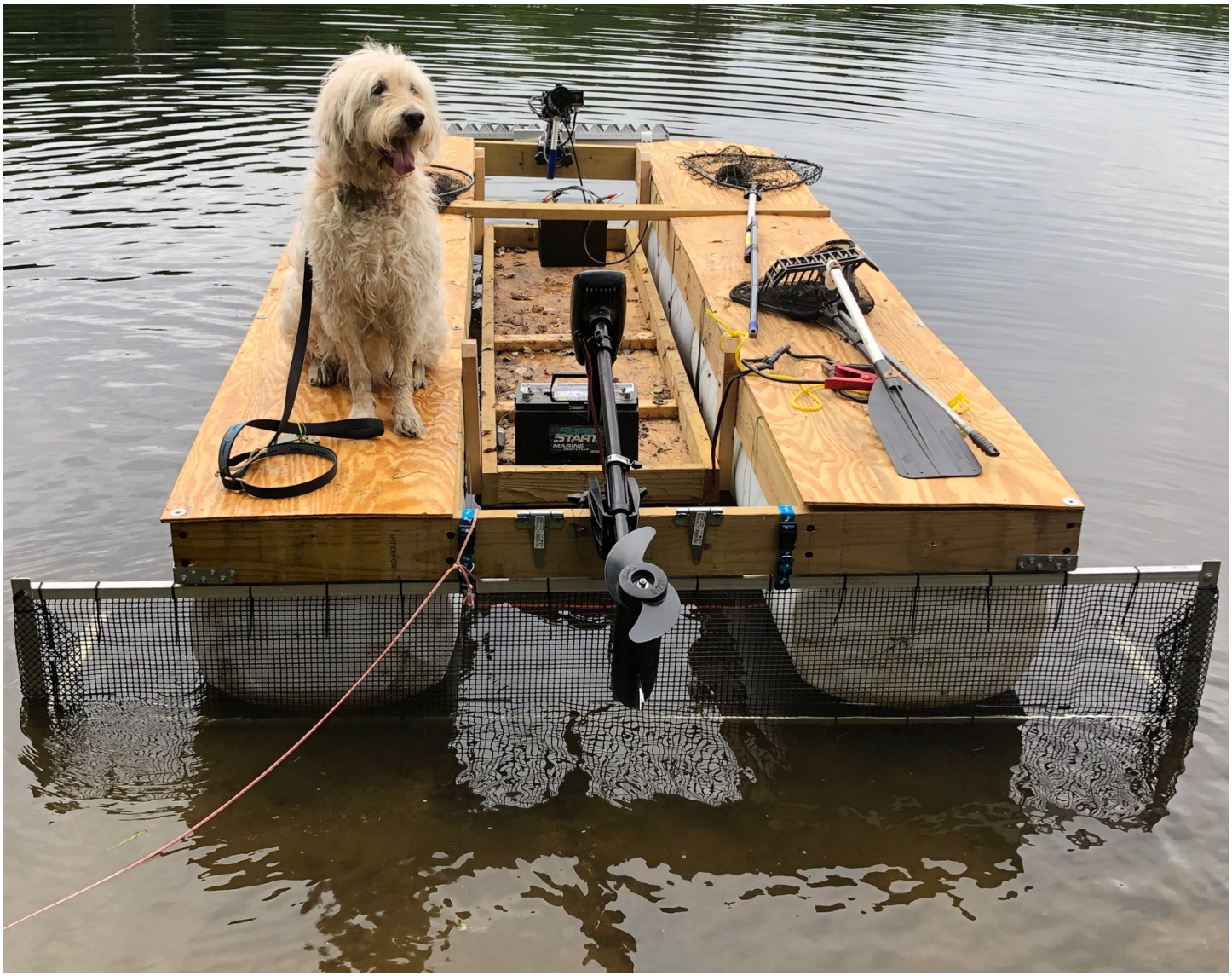
FROM: pmaleady0786@charter.net
SUBJECT: An Inexpensive Aquatic Vegetation Combine Harvester of Water Chestnut/Hydrilla.
DATE: Nov20-Nov21, 21Mar22 (See: UPDATE at bottom.)

I developed the Aquatic Vegetation Combine Harvester (AVCH, pronounced "Ouch") concept during nine years of Water Chestnut/SAV management. It consists of an inexpensive, affordable, stable, ergonomically efficient, pontoon hull, work boat, a small outboard motor, an aquatic mower, an hydraulic pump and some harvest baskets or bio-degradable bags.

I built a 16'x6' (1672) AVCH pontoon in 2019. I designed it for season long WC/SAV harvesting on a severely infested lake. Using materials I already had on hand, it cost about $100.

The 1672 turned out to be too ponderous for most purposes. I reduced the size to 1272 and produced a lighter pontoon which was handier on the water and easier to beach or trailer. Cheaper too.

Pictured bellow, stern to, is a 1272 AVCH equipped with a 4' wide Jensen Lake Mower and 8' wide Collection Basket. It is powered here by a 12v 40 pound thrust trolling motor.



(No dogs were harmed in the testing of this product!)

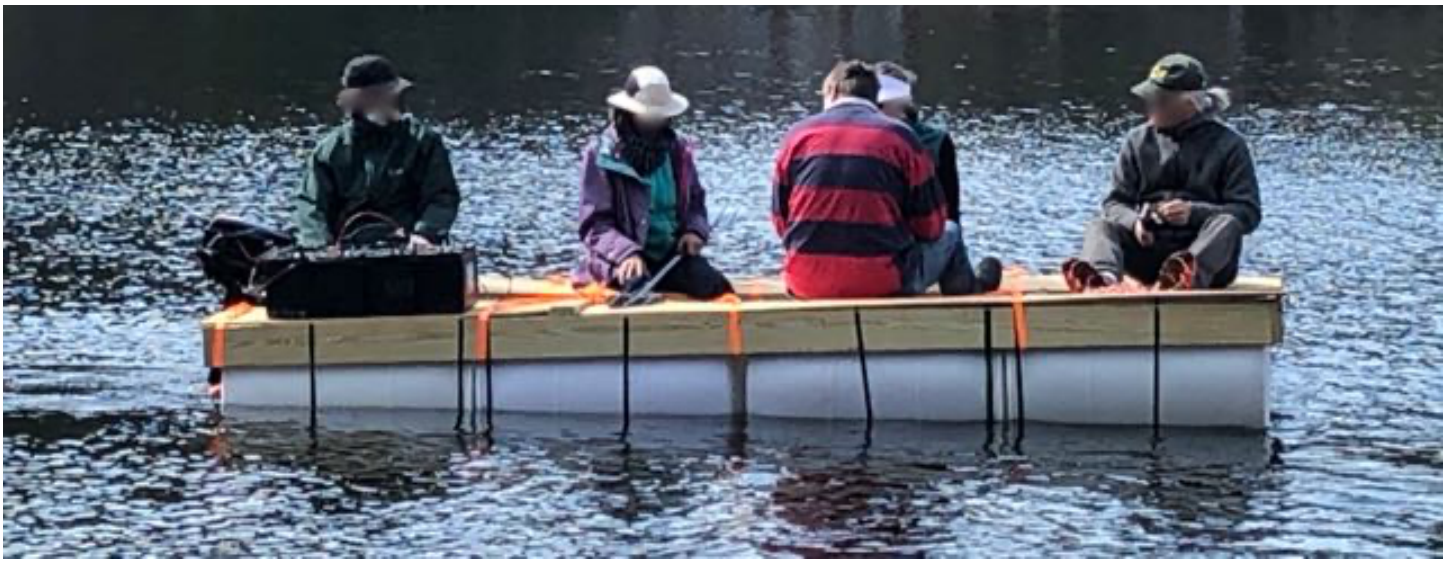
The aquatic sickle mower cuts four wide swaths of aquatic vegetation. The pontoon hull form allows direct observation of the mower head. The center deck is adjustable in height above the water line. The

pontoons and vanes channelize the cuttings. The 8' wide collection basket captures vegetation fragments which are forked into containers to be drained and then transported to shore.

A hydraulic vegetation collection pump can also be mounted. The intake nozzle, observable in operation, sucks up the cut vegetation and pumps it into a small, easily lifted, draining containers which are then emptied into collection bags for removal and composting. The AVCH can do all these things in combination. Which is why it is called a Combine Harvester.

An aquatic mower is expensive but optional. It is principally incorporated to cut vegetation from its roots in order to avoid disturbing contaminated bottom sediment. Where that isn't an overriding concern, an inexpensive, 6.5hp, 3", 200+ gallons per minute hydraulic pump will easily snap immature Water Chestnut stems, shred immature SAV and suck them both up. The inlet nozzle can be configured (see below) for minimal bottom disruption during surface collection or positioned deep enough to pull up root systems. The inlet and outlet nozzles can even be configured to propel to boat. For those concerned about fauna, I haven't found any in my harvest baskets; the cutter and pump vibration and turbulence chases macro fauna away.

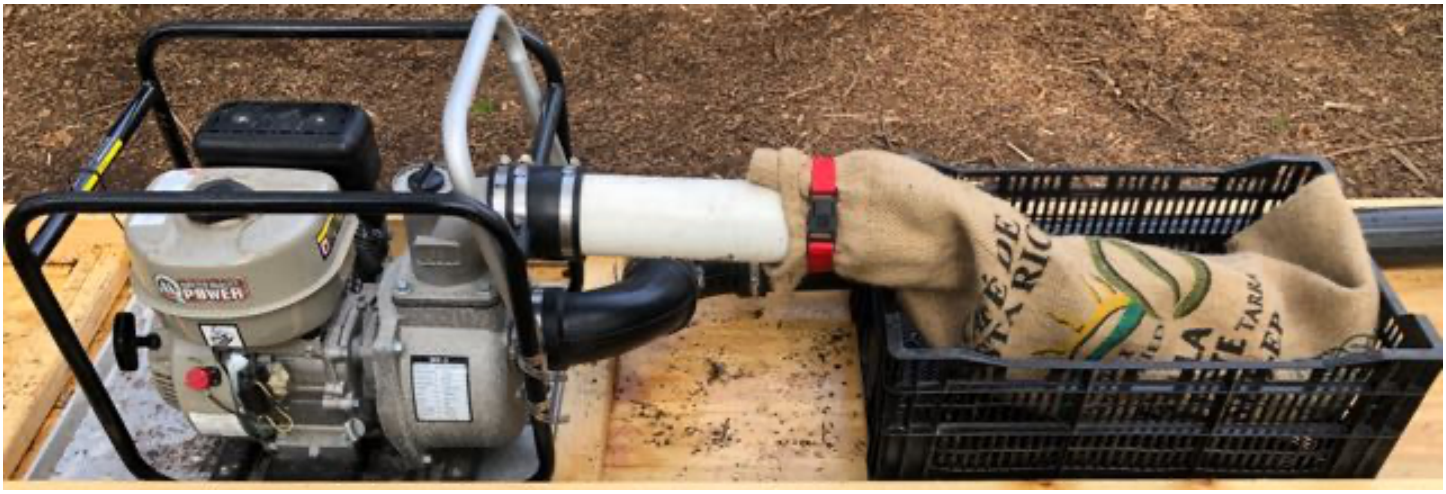
Don't think of the AVCH as some special, complex tool. It isn't. It is just a simple combination of proven, efficient, readily available aquatic tools that can be used to periodically manage aquatic vegetation. Exactly the way you groom your lawn, only wetter! It will do the work of a dozen volunteers in an hour or two. It doesn't displace the volunteers, they'll still be needed for detail work. But it will make them far more efficient.



Pictured above is a 1272 pontoon boat, powered here by a 5hp electric outboard, while test loaded with over 1200 pounds. It still had 300+ pounds of reserve buoyancy! This boat was used in 2021 in a ConsCom/MassDEP approved and permitted, three year, multi species vegetation management plan.

This AVCH is able to employ a 4-6' wide lake mower and a 3" hydraulic pump and a three layer, multi-filtered, bio-degradable bag, collection system designed (only partially shown here) to strictly control SAV fragments. Where this is not an overriding concern, a simple basket attached to the stern of the pontoon boat, as seen above, is very effective at capturing cuttings. Our latest innovation is a simple, vaned, hinged scoop that collects cuttings and is then flipped up onto the center deck to dump them.

Pictured below is a 6.5hp, 200+gpm hydraulic trash pump harvester.



6.5hp, 200+ gpm pump Inlet (black) Outlet (white) Harvest bag/harvest basket/drainage tray

There is one significant down side to this AVCH design. The inexpensive drum pontoons are difficult to clean and sterilize. Once they are in a water body, safely moving them to another water body involves a lengthy decontamination protocol. Once one of these is launched, it should stay in its home waters all season.

The ACVH pontoon boats are inexpensive enough to have several, prepositioned where they are needed, and to transfer an outboard, mower and pump (after sterilization!) to where they are needed.

What's the bottom line for a full AVCH system? It costs less than $450 in the Autumn of 2021 to build the 1272 pontoon boat pictured above. It can be trailered to and from sites or assembled on site and left there. Small outboard motors to propel it are widely and inexpensively available. It handles remarkably well in calm waters with an inexpensive 40-86 pound thrust trolling motor. A 3" hydraulic pump with hosing/piping costs about $540. The Lake Mower costs about $3800.

A few of these strategically positioned along the Connecticut River would be well suited to efficiently and affordably help manage Water Chestnut/Hydrilla infestations.

Note: I have no financial interest in promoting this AVCH concept. All my research and equipment has been personally funded. I'll be pleased to provide design and source information and help anyone who wants to assemble an AVCH. There is no charge for my advice, it's free, take it or leave it.

Legal & Permitting issues:

Massachusetts law defines hand pulling aquatic weeds as Mechanical Harvesting! Furthermore, using a motor to propel your boat clearly constitutes mechanical harvesting. As does using any form of power to harvest aquatic vegetation. There is no question that an aquatic sickle mower or hydraulic pump are mechanical. But there is a peculiarity in Mass law that relates what you are doing to its effect on the bottom. And this affects permitting through local Conservation Commissions. If what you are doing has no effect on the bottom you may not, under strict interpretation of Mass law, require a permit. Which is one reason why I keep emphasizing doing nothing to effect the bottom. The AVCH is neither a hydro-rake nor a dredge! It is specifically designed to harvest aquatic vegetation without disturbing the bottom.

I am not familiar with applicable Connecticut, New Hampshire and Vermont laws or permitting in or on the Connecticut River. I'm sure this AVCH qualifies as a mechanical harvester, as it should be. But unlike the traditional mechanical harvester, it is not designed to or even capable of ravaging an aquatic ecology.

Alternative designs:

A pontoon boat is the clear choice from the standpoint of ergonomics. But you may have other options available to you.

A 1436-1648 size jon boat. Unfortunately, jon boat prices have risen three to five fold since the advent of the Coronovirus pandemic and high side, heavy gauge, work boats are hard to find. I have rigged both my 6'

Jensen Lake Mower & 3" and 4" Pump Harvesters on both my 1636 and 1648 jon boats. I normally power them with a 7.5hp mud motor or 55 pound thrust trolling motor. It's a workable if not optimal set up. Boat, mower, pump, tools, motor, safety gear, trailer, insurance & registrations can easily rise to $10-15,000, excluding a tow vehicle. And the combination of tools requires a skilled, and safe, operator.

Large inflatables are ill suited and too expensive.

Large pontoon boats can be converted to an AVCH. I own a 24' long Pontoon boat equipped with a 6' wide aquatic mower and two 4" hydraulic pumps. It is expensive, requires a crew and support infrastructure and is only suitable for season long deployment on larger water bodies.

tinypontoonboats.com makes modular pontoon boats but they cost some $3-6,000 just for the hulls, which weigh twice what my 55 gallon drum pontoons do. But they are better streamlined and more rugged. They also make bombproof aluminium frames. But they require a custom built trailer.

Weedoo.com makes excellent, well proven tools that come with a custom trailer but they cost $$,$$$.

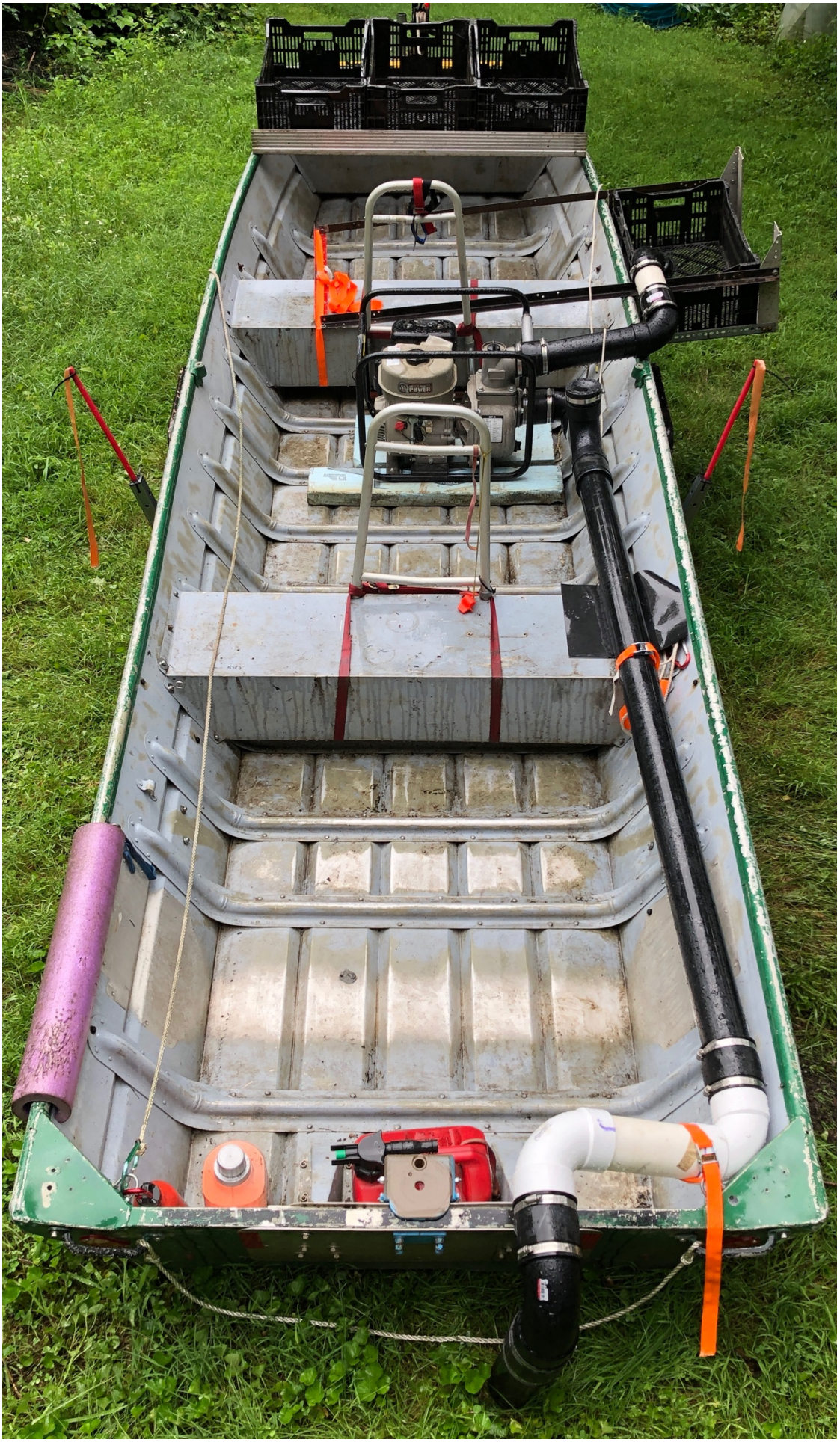
Face it, most small lake and pond groups don't have much money. A key factor in affordability is what you already have or can beg, borrow or steal. There are thousands of jon boats, old motors, and plastic barrels out there somewhere with which to construct pontoons and even a few small recreational pontoons that might need re-decking just for the asking and some fix up labor.

I'm happy to help anyone adapt whatever you have. Maybe you'll come up with a better idea than I have and I'd like to know if you do.

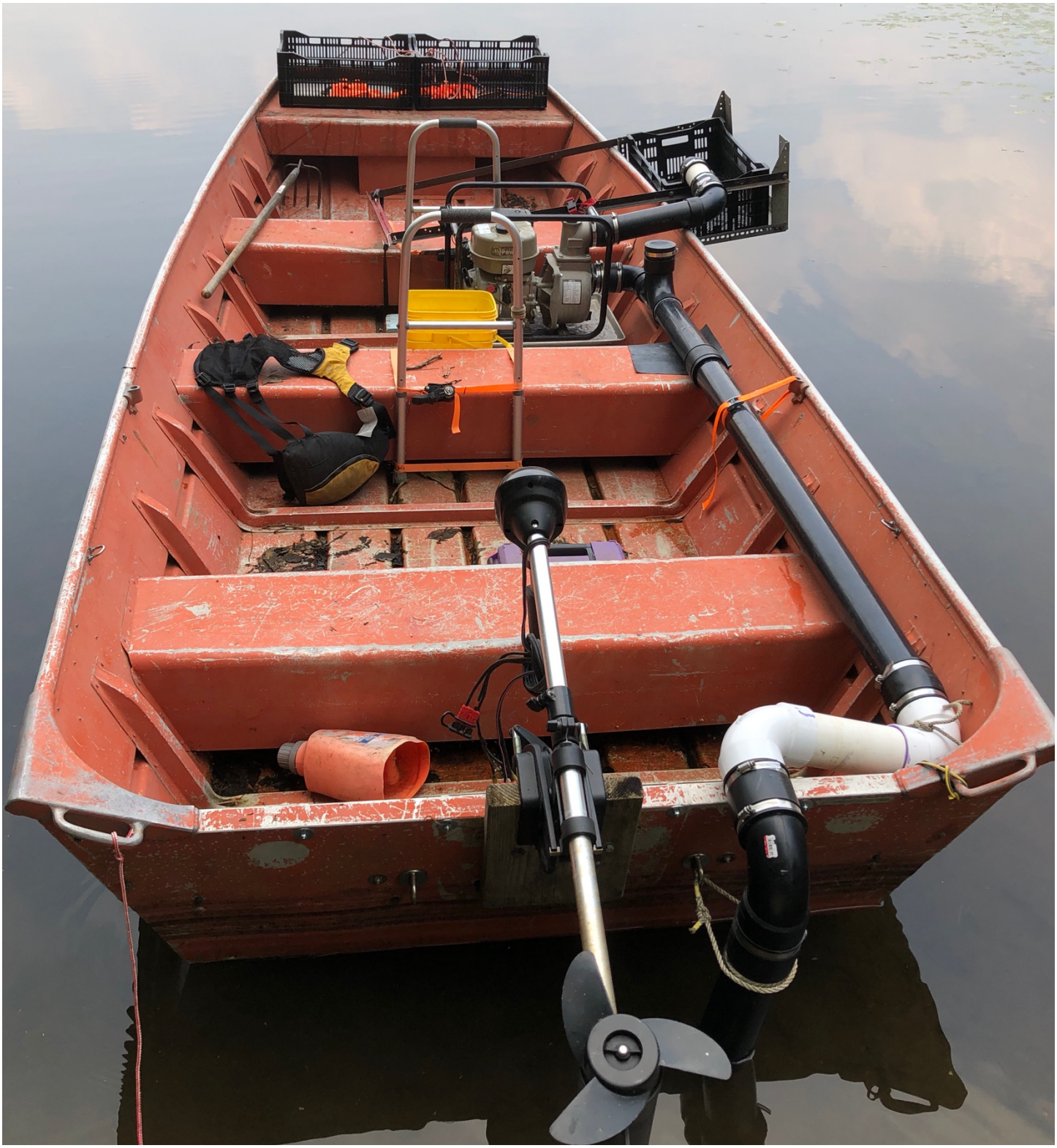
These AVCH concepts work best when combined with a small support boat capable of collecting harvested weed and delivering it to the shore while the AVCH concentrates on efficient harvesting. It could be a large canoe or small jon boat, preferably powered. I've also designed an inexpensive weed collection barge which can be towed by the AVCH, pulled ashore on an extended tongue, roller equipped trailer and towed to the compost heap. An organization I work with has developed a wheeled, floating collection trailer boat that can be hooked to a tractor and towed from the water to a vegetation composting site. A fine example of a local solution to a universal problem.

This system has now been in operation for an entire season. We've learned in the process and made several modifications to the first 1272 AVCH pontoon. We've reinforced the frame. We've modified the Lake Mower mount twice. We've tried at least four different propulsion systems and are experimenting with motor mounts and locations. We have experimented with crew size and locations and tool control stations. We've tried four different collection basket configurations. We've experimented with pump nozzles, locations and depths. We've experimented with a larger, more powerful 4" hydraulic pump. We plan to disassemble the first 1272 pontoon this winter and rebuild it with some modifications. I've now built and tested five AVCH pontoon configurations and I've configured two jon boat versions. I've built another pontoon which we hope to equip with a conveyor collection system. I designed a variable width frame to accommodate this or other tools. We can do these things because we have evolved an affordable, modular approach to multi-species aquatic vegetation management. We've also emphasized a community based, local solution approach to lake vegetation management. And our aim, first and foremost, is to produce a healthy water body.

My 1636 jon boat AVCH (photo below) and a 1272 AVCH pontoon will be available in 2022 for those interested in observing them in action. I plan on selling my orange 1648 jon boat (photo below) and my 24' AVCH pontoon in 2022.

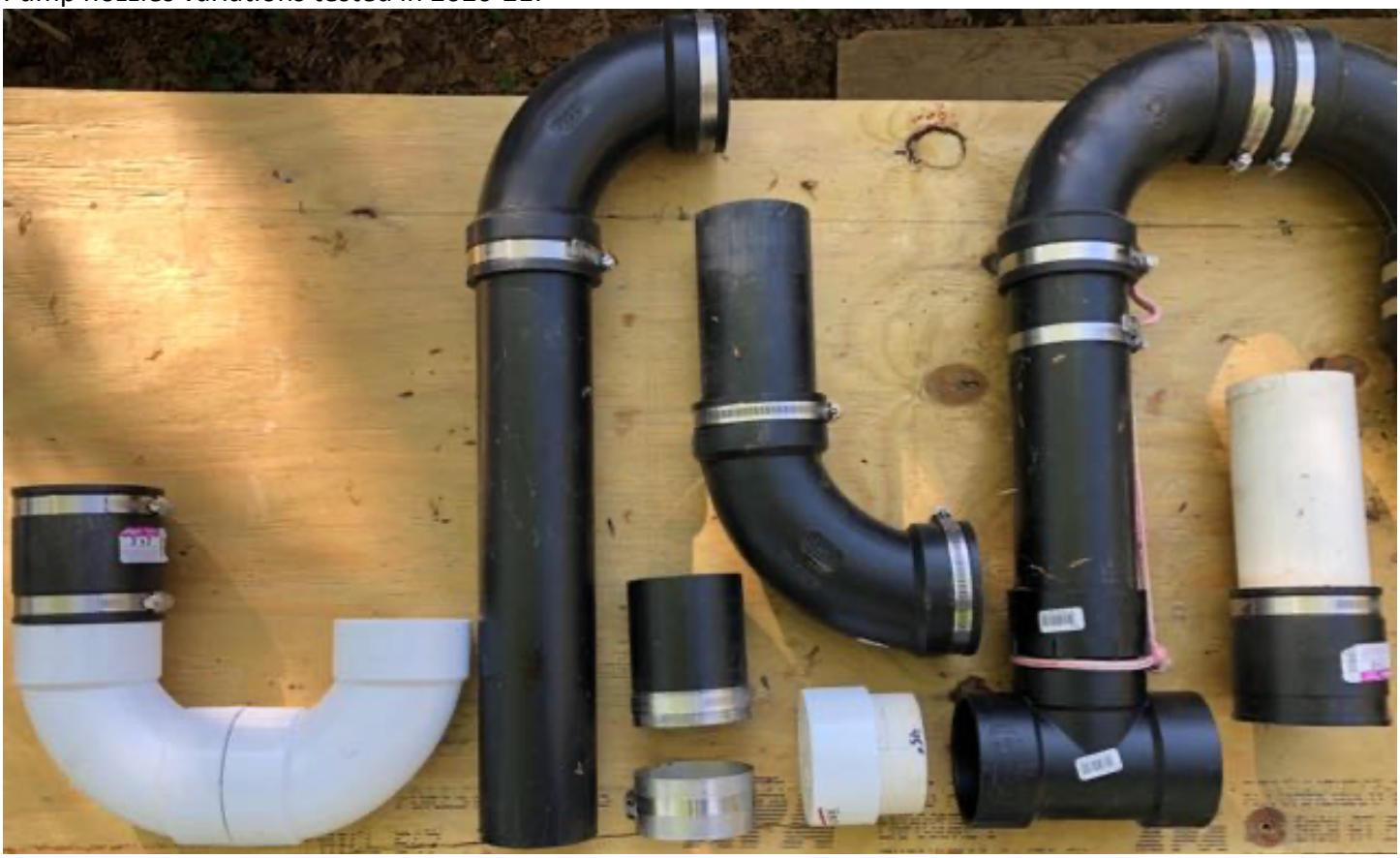


1636 jon boat AVCH



1648 jon boat AVCH powered by a 12v 55 pound thrust trolling motor employed to harvest SAV with a 3" hydraulic pump.

Pump nozzles variations tested in 2020-21:



White "U"	Straight up	Knife, saw	Directional	Bi-directional	Dredge nozzle
Surface fragment collection	SAV	stem cutters	Lateral	Lateral	Uncontrolled
Turbulence: surface, 12-16"	12-18"	12-18"	-18"	-18"	0"
Effect on bottom: minimal	Depends on Depth		Depends on Depth Propels boat!	Depends on Depth	Severe AN AVCH IS NOT A DREDGE!

The white cap turns the Bi-directional inlet nozzle into a uni-directional inlet which provides propulsion. It can also be made steerable.

You can also rig the outlet in order to create a jet drive.

A note on fragmentation. SAV left in the water rots in the water. Hand harvesting supposedly eliminates fragmentation. We all know it doesn't. Mowing produces a lot of fragments. But 80% or more are easily swept up and harvested. Will there still be fragments in the water? Yes, some will sink beyond observation or reach. Will they be viable? Maybe. But they'll still amount to at least 80% less than the original 100% viable, unharvested biomass. The suction systems described about produce fragments approximately 0.25-1" long as evidenced by those trapped in our filters.

Alternative harvesting of cuttings: I am actively experimenting with different mechanisms for harvesting cuttings or fragments. These include an electrically powered conveyor belt and various hand operated harvest baskets like the one pictured above.

UPDATE: The 1672 AVCH pontoon depicted above is being converted in 2022 to variable width up to 96". This will allow us to experiment with better canalization and more efficient harvesting of cuttings/fragments. I have constructed a second AVCH pontoon for experimental purposes in 2022. We may deploy the 1636 jon boat and suction harvester on a small pond with a severe Asian Milfoil infestation.

My WC & Aquatic Veggies Resume:

Most of what I've learned about aquatic weed harvesting was re-learning the lessons of tens, hundreds and even thousands of years ago. There is very little new under the sun if you do your homework.

1946-1970: My original involvement with Water Chestnut (WC)(both Trapa bicornis & Trapa natans) was in Asia, Europe & North America as a food; I have a 75 year involvement with WC.

1967-70: WC was regarded as a reliable & nutritious survival food during my time in the US Army Special Forces.

1969: My first involvement with nuisance WC in New England: Nashua, Assabet, Concord & Charles Rivers.

1974-76: BA Literature, BS Biology, MS Analysis, followed by careers in the military, management, academia and consulting.

1990s: My first involvement with WC in Western Mass and on Olde Cape Cod.

2013-14: Developed the Lake Warner PaddleFork; I purchased the parts, assembled & gave them away. I obtained old supermarket hand baskets and adapted them into self-draining weed paniers for kayaks, doubling their capacity. I promoted use of a powered support boat to collect and dispose of harvested weeds. This increased productivity by several fold.

2013-16: Ergonomic WC harvesting & work boat research & development, multiple boat purchases (kayaks, canoes, rafts, boats, jon boats, pontoons) & testing. Several notable learning experiences (aka: failures!).

2014: My first conceptions of multi species harvesting rather than simply pulling WC & of an AVCH. I introduced scientific weighing of WC harvests locally as opposed to bucket or bag counts and WAGs involving dog food. I wrote and introduced a simple "How to Pull WC" handout for volunteers. I had it printed and distributed it. I later turned it over to the Conte folks who subsequently printed and distributed it as a USF&WS product.

2015: I purchased an 18' airboat for WC harvesting on Lake Warner. I purchased a 17' Grumman bob tail canoe for WC harvesting in confined waters.

2014-16: I consolidated USF&WS & other WC records into single format. I undertook an analysis of the relative ineffectiveness of WC harvesting since 1970's; a war we were losing. Studies of WC pulling records led me to a rediscovery of what others had learned many years previously, that the stable work platform of a 1436 jon boat, powered by a small outboard, pulling WC itself, while also collecting from volunteers' overloaded kayaks & canoes & ferrying WC to the shore, could increase yields by 50%. I purchased a small mud motor and added it to the equation to enable access to shallow, heavily weed infested waters. I researched WC literature in a dozen different languages spanning thousands of years. My own WC life cycle research involved: germination rates over time and environment, maturation studies (time-temperature-depth-species interaction) & developed predictive growth models. I conducted research on the effects of draw down on WC: nut desiccation, freezing, insects, rodents, etc. Drawdowns don't work and contribute to algal blooms! I conducted research on the developmental morphology of stem nodes given different stimuli.

2014: I discovered the WeeDoo during an on line search while looking for alternatives & introduced the concept to USF&WS. I later qualified as an operator when the USF&WS/Conte purchased one.

2014-20: Multi-species vegetation management planning.

2015-16: I designed, engineered and completed the first GPS located, specific species inventory of Lake Warner.

2016: I developed the Early & Often WC Harvest Protocol, based on my studies of the WC reproductive cycle & the application of populations biology (a TY to Geof Boetner), & began a campaign to convince river, lakes & pond organizations & the USF&WS to adopt it. The simple objective is to harvest the WC before it can seed as opposed to late & infrequent pulls that allow it to re-seed annually. I wrote & published the first E&O WC Protocol handout card which I handed over to the USF&WS for distribution.

2016-18: I investigated aerial & satellite photo identification of WC infestations. Yes, you can ID WC on Sat photos. I attempted to refine GPS reporting of WC infestations & standard site reports.
2016-present: I undertook research into substitution propagation & species interaction: Replacing WC (non-native invasive) with Nymphia and Nuphar (both non-native invasives) and Brasenia schreberi (a native invasive). WC fills an ecological niche, what are the consequences of removing it without replacing it? How to harvest WC and simultaneously sow a more desirable replacement species. I built a mud motor for and transferred my 1436 jon boat to The Friends of Lake Warner. I purchased a high sided, heavy gauge 1636 jon boat it had taken me three years to find and converted it into a work boat for myself.
2016-present: Research regarding a hypothesis: Invasive levels of WC shade the water beneath it. It may raise water temperatures in very shallow (<0.5M) water but cools it at greater depths. Eradicating the WC allows more light to penetrate the water, raising, along with climate change, local water temperatures and stimulating local SAV growth. Explosive, localized SAV growth depletes O2 levels. Anoxia fosters the growth of Cyanobacteria. The WC-SAV cycle has been noted by numerous observers but widely ignored. The Mass Guide to Lakes & Ponds warns of unintended consequences of shade removal. Localized anoxia is common in shallow, low flow, nutrient rich waters. A causal link to HAV/HAB conditions has not, to my knowledge, been scientifically demonstrated. In our crusade to eliminate WC, we've ignored the effects on other species.
2016-present: Literature and field studies of co-evolved and antagonistic species: Trapa n./Myriophyllum s., Brasenia s./Elodea c., Trapa n./Nymphaia a./Nuphar l./Brasenia s., Trapa n./Ceratophyllum d./Elodea c. & not surprisingly Trapa n./Eurasian Hydrilla & Connecticut River Hydrilla.
2018-19: I researched & wrote a Cyanobacteria (HAV/HAB) testing protocol for Hadley Board of Health, found, contacted developers & manufacturers of & purchased BlueGreenTest from Finland. NB: this test only identifies hepato toxins in previously identified Cyano Bacteria samples. It does not ID non-specific Cyanobacteria in dilute water samples! There are other tests that do that but they are very expensive. Oddly, they are in use in water purification plants but are not apparently widely used by Boards of Health to test open waters.
2019: Aquatic mower research and purchase. I purchased a 1648 jon boat to increase capability and added 1242 and 1532 jon boats to my quiver.
2019-21 I purchased a 16' Expandacraft pontoon boat for AVCH research. I purchased 3" & 4" hydraulic pumps. I designed a 16' AVCH pontoon boat to be equipped with an aquatic mower and a 3" 6.5hp, 216 gpm or 4" 9hp, 470 gpm harvest pump. I purchased & converted a 24' pontoon boat into an AVCH mounted with dual 4", 9hp, 470 gpm harvest pumps.
2020: Aquatic mower & hydraulic pump WC/SAV harvesting tests. Fragment control tests.
2020: I built inexpensive 12' & 16' 55 gallon drum pontoon AVCH boats.
2021: I launched a first 1272 AVCH pontoon boat in a ConsCom/MassDEP approved multi-species vegetation management plan.
2021: I conducted harvest pump inlet nozzle & water turbulence testing and further experimentation with pump harvesting various species.
2021: I'm currently advising several Lake/Pond organizations in four states (for free). My equipment is still available for demonstration purposes (for free). I am in the research and permitting process of setting up a potential E. coli control experiment with mycelium projected for 2022. I continue to conduct research into interspecies interactions. I plan to construct a third AVCH pontoon this winter for experiments and potential large scale harvesting use in 2022. This may involve a conveyor harvester. I'm involved with a Lake/Pond group looking into salvaging an abandoned aquatic mower. I've recently come up with a simple, vaned, hinged harvest basket that scoops up cuttings and dumps them on deck for draining and bagging.
2021 Throughout my aquatic weed experience I've focused on simple, affordable, easily fielded tools and techniques that I have made available to anyone that wants to use them.
2021-22: It is pretty obvious to me that the current practice of limiting vegetation management to a single species, while ignoring the consequences to other species, and reliance on kayak based, amateur volunteerism, is not just a failure, it is exacerbating the problems. And while I remain interested in the field

and am willing to assist anyone who asks, I basically plan to sell my roughly $20,000 of equipment and abandon the field to those who think they know better. Life's too short for this.

2022: Yes, I'm still involved. Mostly because I think science is fun. And 2021 was, despite Covid and other problems, a resounding success. My AVCH design is evolving with team input; we're learning. Lake groups that have failed to 'control' infestations are increasingly asking me how to 'manage' them. There is a really interesting drone survey being implemented this season in a lake I'm involved with. I hope to write it up at the end of the season. The AVCH pontoon 'beached' in my yard has been the basis of a half dozen experimental mock ups of the "Will this work? Let's try it." variety. Yes, it's frustrating but I've managed to stop caring about the people who are repeating the same bound to fail programs, I'm going to have fun just messing about in boats where we've managed to clean up the water.