

By Marcia Harper: Wake Boat and Wake Surfing Research for CSCD Wake Boat Committee /4 pages in total - to support my proposal and aid us all in educating ourselves on this topic												
Scientific Studies	Study done By and for Who - Year	Date Given to Board	Date Presented to Website	Recommend it to shore structures	Recommend it to other boats	Number of it for wave to dissipate	Power of wave in comparison	Ballast	Affect of Hull Design to Wave Shape Size	Surf Tabs/ Wedge/Flaps	Ecology	Notes
1	SAFL Project Report No. 600 A Field Study of Maximum Wave Height, Total Wave Energy, and Maximum Wave Power Produced by Four Recreational Boats on a Freshwater Lake	August 2022		P 1x- recommends 500' for wake boat, 425' for non wake boat wake surfing. P 87- 100' - 300' from shore/ Michigan- 100' to shore moored or anchored vessel, dock, raft, swimming area, persons in water/ Minnesota-greater than 200' between shore and other structures/ North Dakota- 100' to shore, swimmer, raft, other boats/ Wisconsin- 100' from shore, dock, raft, swimmer. P 94- Study made boat path 225', 325', 425' and 625' from shore.	P 87- Michigan 100'	P 100- We demonstrate how this study can be used to inform operational distances for wake surf boats/ wake surfing based on conditions derived from non-wake surf boat (planning) 200' for waves to attenuate and greater that 500' for wake surf boats (wake surfing).	P 6-The research reported a four-fold increase in wave energy under wake surf conditions. P 84- Maximum wave height, total wave energy, and maximum power in the first 100' and decrease to after approx 200' influenced the added weight of the ballast on the maximum wave height, total energy, and max wave power for the Malibu Walksetters. Note: other areas of the report explain how the impact of hull design, weight of boat, placement of motor and wave shapers play into max waves.	Several comparisons of 4 different boats throughout the study using ballast and not using ballast as well as non-wake surf boats that do not have ballast. P 84- An unexpected finding was the relatively small influence the added ballast weight had on the maximum wave height, total energy, and max wave power for the Malibu Walksetters. Note: other areas of the report explain how the impact of hull design, weight of boat, placement of motor and wave shapers play into max waves.	P 10 - Having the weight of the large engine at the back of the boat creates a greater air trim for the boat, thus creating the bigger wakes needed for water sports like wake surfing. In addition to the type of power train, boat manufacturers and independent businesses have developed methods to manipulate boat-generated wakes (e.g., height, length, shape, direction) that include boat hull design, ballast systems, and surf hydrofoils and wake shapers.)	P 4-Erosion from boat wakes was determined to be significant where wake waves were large and the boats consistently passed within 200 ft or less of the shoreline. P 7- Effects of propeller wash appeared to have penetrated up to 18' deep for the condition associated with 10 mph and biased ballasting (i.e., wake surfing). P 97- A small lake, with short fetches and relatively small wind generated waves, is likely to be more sensitive to boat wakes than a large lake.	P VIII- Operational Distance- distance maintained between the boat and another wakecraft, shoreline, dock, lift, raft, or person(s) in the water. P 1- new designs of wakecraft, specifically, boats engineered to create large wakes for the primary purpose of wake surfing, are elevating concern around impacts to safety, lake and river health, shared-use accessibility, and degradation of property. P 96 - Few data points fall in the 20-100 ft or operational distance, which will generally exceed 100' where the wave height, energy, and power are at their greatest. Note: CSCD docks are generally 30' from buoy (per Nuck at July 2022 board meeting). Other areas are 50' and dams 100' from our buoys. P 84- After market wake shaper resulted in a notable increase in the wave characteristics, not only near the boat (i.e., first 100 ft) but also at all operation distances.	
2	Numerical Study of the Impact of Wake Surfing on Inland Bodies of Water			P 238- The energy, type and direction of the boat's wakes are described quantitatively and a table for predicting wind driven waves over varying fetches, depth and wind speeds is provided. The CFD simulation shows that if a wake surf boat is operated 200 ft from shore and is at least in 10 ft of water, the environmental impact is minimal. P 268- (Closest thing to a definition of what they mean by small lake.) Wind generated waves on lakes and small bodies of water are unique that they are generally small but dissipate very quickly. Refers to a fetch of 800 versus very our lakes are much smaller in width making it hard to compare to this example. Note: I'd like to see the actual 2008 study they cite that supports	P 270- In a study, it has been observed that a wake-surf boat wake will dissipate completely in 300 meters (984 ft) from the boat path while operating in deep water.	P 268- The report has shown that the operation of wake boats on a lake has a minor impact on the environmental health of the body of water. Siting and Australian study done in 2008 and not making a distinction on the size or shape of the body of water. P 271- The price of a ticket for a wake that causes damage or injury can be as high as \$720. The law in Oregon reads if a skipper operates a boat in a way that damages or is likely to damage private property or cause injury, ORS 830.305 clearly states it as a citable offense. Note: it does not state how many homeowners have been successful in winning claims or damages. After years of large waves crashing along the shore and dams - how do you isolate the cost of damages to any one skipper.	P 268- The energy, type and direction of the boat's wakes are described quantitatively and a table for predicting wind driven waves over varying fetches, depth and wind speeds is provided. The CFD simulation shows that if a wake surf boat is operated 200 ft from shore and is at least in 10 ft of water, the environmental impact is minimal. P 268- (Closest thing to a definition of what they mean by small lake.) Wind generated waves on lakes and small bodies of water are unique that they are generally small but dissipate very quickly. Refers to a fetch of 800 versus very our lakes are much smaller in width making it hard to compare to this example. Note: I'd like to see the actual 2008 study they cite that supports					
Articles												
1	Dave Jarrett FOR- CSCD Board & Safety Committee. 2021	Feb. 2021										It should be common knowledge to all that the fact of large wakes impacts the safety and enjoyment of boating by all craft and of course the consideration of erosion and water quality or waterfront properties. Also addressed questions/concerns regarding current rules and verbiage as well as enforcement and lake patrol officers.
Personal Notes:												

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2 Wakeboarding in Michigan Impacts & Best Practices	April 2021	BY: Water Policy & Mgmt Michigan State University FOR: Michigan Chapter, North American Lake Mgmt Society. 2015	P. 5 - 340 ft to shore or lakefront residences P. 8 -100 ft from any dock, raft, buoyed area, or vessel moored or anchored	P. 9 -at least 150 ft			P. 1 - Ballast tanks or bags can weigh upwards of 750 lbs			P. 2 - Churn sediment sifting in fish habitat/ vegetation and shoreline damage. Churn up nutrients that could increase algal growth P. 3 - Bathymetric map of water depth around the lake to establish zones and identify areas with no boating/ surfing create a larger water area, as a result create greater demand for shoreline protection and sea walls. Encourage use of glacial stone (fp rap)	P. 5 - Section 60759 of Marine Safety Act holds wake boaters personally responsible for any damage to life or property resulting in excess of the actual dollars. Do not add ballast or extra weight.	
3 Protecting Water Quality & Rejuvenation Caused by Wakeboard Boats	April 2021	BY: Heather Harwood, FOR: Wauvasee Area Conservancy Foundation. 2017. Wauvasee Lake 3500 acres.									P. 3 - Dudciak (2004) suggested that a conservative estimate of lakes motor boat carrying capacity is around 15-20 acres of usable lake area per boat. Their lake is 3500 acres. Note: Cordry 180 acres and Sweetwater 275 acres. They addressed this in relation to how busy over-crowded weekends resulting in some of the wave action and bottom scarring stresses on the lake.	
4 Environmental Impacts of Wake Boats on Deep Creek	April 2021	BY: University of Maryland University College. FOR: Garret Cty, Maryland Dept of Environment & MD DNR 2019. Deep Creek Lake 3,600 acres	P. 12/13 -100' to shore all boats. P.14 - Lake Taboa 600' no wake zone to shore. P. 15 - Oregon 200' to shore & boats. P. 17 North Carolina 150' from docks & boats & hope to prohibit wake boats in coves less than 600' wide. P. 18 - Sawyer Cty WI no large waves 700' to shoreline, dock, etc. P. 21 - Michigan 300'	P. 12/13 - Maryland 100'. P. 17 - North Carolina 150'. P. 21 - Michigan 150'. P. 15 - Oregon 200'		P. 8 - Velocity & impact of waves by wake boats believed to be stronger than other recreational boats. P. 15 - Wave energy from wake surfing boat is 4 times as strong as wake boarding wake.		P. 7 - The quality & size of the wake is largely a function of the hull design & ballast weight of the boat. Hull design plays a major role in the size of the wake. P. 10 - Considering the mechanical aspects of the wake boats including the hull design, their impact weight, their impact on water turbidity.		P. 8 - The large waves from wake boats result in an accelerated erosion in the shoreline. P. 31 - Difficult to conclude if wake boats damage the environment more than other boats without more study. Their lake is 3900 acres with a 100' no wake to shoreline rub.	P. 16 - Boat design can mask wake enhancing devices as wake can be shaped by a boat's hull and trim tabs rather than visible wake-enhancing devices such as ballast.	
5 Final Report of the Commission to Study Wake Boats	April 2021	BY - A NH Commission of 15 people representing their House of Representatives, Wake Boat Recreations Community, Senate, Marine Patrol Unit, NH Lakes, USA Water Ski and Wake Sports, NH Campground Assoc., Dept of Environmental Services, NH Marine Trades Assoc., Shorefront property owner lake less than 1,000 acres and Shorefront than 1,000 acres. 2020	P. 12- Wake Responsibility Campaign promotes courteous behavior by boaters to ensure safety and water is safe and enjoyable for all. The 3 pillars are 1) minimize repetitive passes along residential shorelines, 2) play music at reasonable levels, 3) always tow at least 200 feet from shorelines and docks and steer clear of parked boats and smaller watercraft. P. 18- recommendations for 200-300 ft. P. 19 - statues can allow Dept of Safety to prohibit within 300 ft of shore including coves less than 1,000 feet in width	P. 11- 150' from other rafts, floats, swimmers, permitted swimming areas, shore, docks, other vessels. P. 12 - mentions NH 150-500 safe passage law and again on page 10.	P. 11 - "Wake Sport Wave Study" by Gaudy which shows over one-foot waves will be left behind 100 feet from the track of a wake boat configured to make "surf" type waves. The waves are higher closer to the wake boat track, where the surfer rides the wave about 10-15 feet from the transom of the wake boat.	P. 6 - Max wave height wake surfing 30", wake boarding 20", same boat cruising 14". The further away from shore these activities take place, the lower the energy that occurs on the shoreline. 300' from shore still has wave energy equal to (400 J/m) to crashing 150-200' from shore.	P. 8- Recreation boats with ballast (which can be defined as any type of weight from steel shot, or water) ballast system can also be added by a customer using after-market parts. P. 13 - Initiative to drain dry lakes:// <a href="https://www.youtube.com/watch?v=MOgPUCm3HYg">youtube.com/watch?v=MOgPUCm3HYg</a>		P. 5-8 - Shorelines that endure larger and more frequent waves are subjected to higher energetic forces and consequently more erosive power. Shoreline erosion results in two primary negative impacts: loss of property or sediment mobility. P. 6- Aquatic Invasive Species (AIS) viable in ballast compartments can be released into the new waterbody, thereby potentially causing a new AIS infestation.	P. 10/11 - From the Lake Osaipsee Protective Association: "the size of the waves threatens canoes and kayaks with capsizing, even when wake boats maintain the required distance apart. The waves smash watercraft against the docks, creating the potential for damage. Small children playing on the shoreline have been knocked over by waves as wake boats pass." Note: their required distance is 150' from other rafts, floats, swimmers, permitted swimming areas, shore, docks, mooring fields, other vessels. P. 18 - it seems incompatible with all but the center of our largest lakes that such a large swath of water would be taken by one boat and all the rest would have to cope. Some members believe that expanding the safe passage law to 200-300 foot distance from land, swimming areas, beaches, anchored boats and docks would separate wake producing boats from narrow channels, small cove, small cove, beaches, coves, and separate their operation configured to make open-lake wakes, at all, in our smaller lake. P. 19 - Legislation for wake ballast boats would result in a compromise between those who are concerned about the effects of wake boats and the water sports enthusiasts. It would also allow for industry recommendations to become law (no towing within 200 feet of shore) that otherwise would be ignored for lack of consequences.		
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6 Colorado Division of Wildlife Ballast tanks							P. 1 - Many ballast tanks can't be visually checked, and many cannot be fully drained. This presents a risk of introducing zebra or quagga mussels to your favorite lake. P. 2 - list Colorado options for decontamination in the Clean, Drain, Dry, Dispose Protocol			P. 1 - Risk of zebra mussels and other Aquatic Invasive Species transferring from one body of water to another through contaminated water in a ballast tank.	P. 1 - The only tool we currently have to decontaminate enclosed ballast tanks is to flush them out with very hot water that will kill any mussels present. The problem is that there are numerous models of boats with ballast tanks. Some require extremely sophisticated and technical processes to get the hot water in all the necessary places. Wakeboard boats are particularly technical, difficult, and time consuming to decontaminate. Also, some wakeboard boats may have ballast tank pumps which are only rated for 130 degree F water, the standard for killing zebra mussels is 140 to 170 degrees F, which is hotter than these pumps can tolerate. Boats with these low temperature rated pumps will be difficult to decontaminate and decontamination may need to be performed by a certified dealer.
7 Wake boats; concerns and recommendations related to natural resources in Michigan waters			P. 2 - DNR fisheries recommend wake boats operate 500' from docks or shorelines.		P. 3 - An existing 100-foot shoreline buffer rule for boating wakes on most inland waters in Michigan is insufficient to manage wake boat waves, which take up to 1,000 feet to dissipate. That and other laws were developed prior to the popularization of wake boats, the report says.	P. 2 - According to studies cited in the DNR report, wake boats can produce waves with up to 17 times the energy of other comparable-sized powerboats and their propellers can generate enough turbulence to resuspend lake bottom sediments in water up to 33-feet deep.	P. 1 - Beyond ballast tanks filled with lake water may be a vector for transporting other comparable-invasive species.	P. 2 - Wake boats are generally shaped with special hulls and propellers beneath the boat, rather than behind, and a stern weighted with ballast tanks. The lowered stern helps displace more water and maximize the following wave size.		P. 2 - Recommend wake boats not operate 500' from docks or shorelines and in at least 15' of water to prevent lake bottom scouring, shoreline erosion, and dock damage from heavy waves. P. 3 - Underside propulsion can also disturb lake sediments, re-suspending nutrients such as phosphorus, which is the primary fuel for harmful algae blooms.	P. 3/4 - DNR report cites restrictions enacted in other states, such as shoreline buffer rules and restricted areas in Oregon's Willamette River and restrictions on boat size and speed in inland lakes in Indiana, which also has established "eco zones" on some lakes to protect wildlife habitat. "A minimum lake size is considered for wake boats." The report says. P. 4 - Pine Lake in Bloomfield, Michigan is the "biggest motor" in 2020 for wake boats in the deep water center of lake. Notes this lake is a private oval type shape with no concrete lining on its size in acres as our lake do. Wikipedia list is as 396 acres, lake.com lists as 660 acres. Ambruster said his dock has been hit by 2' waves a few times with adequate tender should handle the wake. Other nearby Lake Lansing is 461 acres and S 249. Note: our lakes of 180 and 275 acres are a fraction of the width experience docks being jostled with large waves multiple times a day - not just a couple times.
Video Links											
1 <a href="https://youtu.be/9TzGQD5508">https://youtu.be/9TzGQD5508</a>								Shape of wave defined by 3 things 1)Hull design 2)Ballast amount/ location 3) Speed			Adding turbulence to the opposite side of the boat from the surfer, cleans up the wave coming from under the hull.
2 <a href="https://youtu.be/698E1Y2Xqto">https://youtu.be/698E1Y2Xqto</a>	Mission Boat Gear - How Do WakeSurf Shapers Work on Inboard Boats? May 18, 2017								Video clearly shows how these "surf tabs" make the wave larger and shape it specifically for wake surfing as an enhancing device.		Some call these devices "trim tabs" this video calls them "surf tabs" for how they enhance the wake for surfing. Video #7 goes into great detail the difference between a "trim tab" which is recessed when too much ballast is present - which is not supposed to be used on our lakes anyway. And also goes into on our lakes anyway. And also goes into enhance a wake.
3 <a href="https://youtu.be/GXEVJTCQW0Y">https://youtu.be/GXEVJTCQW0Y</a>	Bert Krages - 200 Feet is Not Responsible - Wake Surfing, April 28, 2022		Boating industry counting on education instead of regulation will somehow protect shorelines and other boaters. Industry promoting wake surfing wakes do not carry enough energy to have a significant impact to shorelines when wake boats operate 200 ft from shore.	He points out the "Wake Responsibly" campaign does not address a safe distance to other boaters.	Sites why the #2 study above has a faulty analysis that boat wakes are inconsequential compared to waves caused by wind. Explains why comparing the two are meaningless and sites the #1 study above stating needed to greater than 500' needed to attenuate waves to shore.				This video exposes how the boating industry even promotes wake surfing in water as shallow as 10' with no damage. The video tells a different story regarding prop wash, sediment and scouring lake bottoms damaging habitats.	"Wake Responsibly" campaign that uses a false premise of wake surfing 200' from shore creates no damage to shoreline when presenting to legislators and state boating industries/ general public. The actual study they reference does not site that 200' is a protective distance. Their own data sites "wake 210 ft away from boat wake surfing has 2.5 to 2.7 times the energy as a wake only 10' from the same boat when in cruising mode." This critically important fact seems to be ignored over in their summary report and glossed over in their summary report and characterization of the study. Only way to mitigate impact of huge wakes is to maintain distances of much greater than 200' to shorelines and other watercraft.	

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4 <a href="https://youtu.be/ELzK6RD_KYQ">https://youtu.be/ELzK6RD_KYQ</a>							Makes recommendations of where to add ballast to your boat. Educational for lake patrol in knowing where to look for ballast when inspecting.		Describes how weight, wave displacement and speed create the desired wake.		Warns against breathing in carbon dioxide from the exhaust as well as the danger of surfing behind an unpowered inboard/ outboard. You are taking on a risk if you do. These shapes allow you to displace the water by equally weighting the boat which allows you to sink deeper into the water, creating a better wave.
5 <a href="https://youtu.be/4VYNnsxw4">https://youtu.be/4VYNnsxw4</a>									No Audio. Demonstrates how wake is shaped after installing 6 trim tabs.		If we allow these after market devices that can easily be applied with a suction cup, this shows how "if one is good 6 must be better" philosophy. This would need to be considered regarding any rule recommendations.
6 <a href="https://youtu.be/CSS60LlZcA">https://youtu.be/CSS60LlZcA</a>									Describes how surf tabs under the boat create larger waves than tabs on the sides.		In depth look at wake enhancing devices from suction cup applied shapers to factory ready devices and in between. His opinion from a perspective is "trim tabs / surf tabs" that go down into the water under the boat are always better than producing a bigger wave for lake patrol to notice because it's under water and easily flipped off as you get pulled over. There is no suction these tabs are wake enhancing devices. (The affidavit of 2015 states #2 is this best equipped with a wave enhancing device?) (Any device that is used to create drag against the water to pull the back of the boat lower thus creating a large wake.) (Just because these tabs may not have been as prevalent in 2015 to be named alongside wedges and ballast does not make them any less of a wake enhancing device)
7 <a href="https://youtu.be/Z5c5dF2H1Vc">https://youtu.be/Z5c5dF2H1Vc</a>							Explains how surf tabs assist in getting boat to plane when ballast tanks are filled then disengages when speed accelerates over 14 mph. is not a trim tab.		Thoroughly educates on trim tabs vs surf tab for wake surfing and regular boating.		He's describing how their equipment works. This is still useful information based on other research that shows how these tabs are used on many boat models as well as after market products that can be added to boats.
											Personal Notes: