BLUE PAPER

Making Waves

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WHY WAVES MATTER.
The health of shorelines and water in a freshwater lake are inter-related. A stable shoreline holds soil, nurtures plant life, and buffers wave action. Wave action from the lake can cause serious shoreline erosion which, in turn, increases both sediment content and turbidity in water. Understanding and mitigating wave action can protect water quality and produce a more stable shoreline in our lakes.

This Blue Paper reviews the **causes** of wave action and offers **ways to reduce the effects** of waves produced by wind and powerboats in freshwater inland lakes. A major source for this Paper is a presentation at the 2021 Midwest Glacial Lakes Seminar entitled "How Waves Work" by Brian Majka, a restoration ecologist.[1]

WHAT CAUSES WAVES.
Waves are a normal feature of freshwater lakes. The simplest definition of a **wave** is a swell in a body of water, typically with forward motion. Waves originate in three ways: 1) wind driven; 2) gravitational pull (tides); and 3) disturbance-driven events (such as tsunamis, objects thrown into the water, or most often for lakes, motorboats). Gravitational pull is not typically a factor in inland lakes, so this Blue Paper will focus on wind-driven and disturbance-driven waves.

Wind Driven. Energy from the sun drives the wind which transfers some of its energy through friction with the water's surface to create waves. The wind tries to pile the water up. Gravity pulls it back down. The water's up-down motion carries the wave's energy toward the shore. The higher the wave (its **amplitude**), the more energy it carries. It's this energy that damages shorelines. Faster wind speeds drive higher waves, but wind acting over longer distances, the **fetch**, will push water higher as well. When waves come ashore, the waves' energy is transferred to anything it hits. Sand, pebbles, and other objects are put into motion and pulled away by the waves' backwash. Shallow sloping beaches let wave energy be distributed gradually, but on steeply sloping shores, the energy hits with a bang, driving larger objects into motion and creating more erosion.

On Clear Lake, prevailing winds are from the west so the eastern shores of the lake with a long fetch will take the brunt of typical moderate erosion. However, storms drive large, high-energy waves on shore from any direction. Any shoreline with a long fetch in front of it can be damaged.

Disturbance Driven. Boats displace water as they move creating a **wake**. The size and shape of boat-generated wakes are influenced by the boat hull shape and boat speed. Motorboats can **push** or **plow** water to create higher waves than wind-driven waves. Wave height is reduced when motorboats **plane** because less of the boat body is submerged to push or plow water. Many states, including Indiana, establish "no wake zones" requiring that watercraft traveling more than 5 miles per hour (the legal **idle speed**) stay at least 200 feet from shore to reduce the likelihood of damage from boat wakes to people or shorelines.[2]

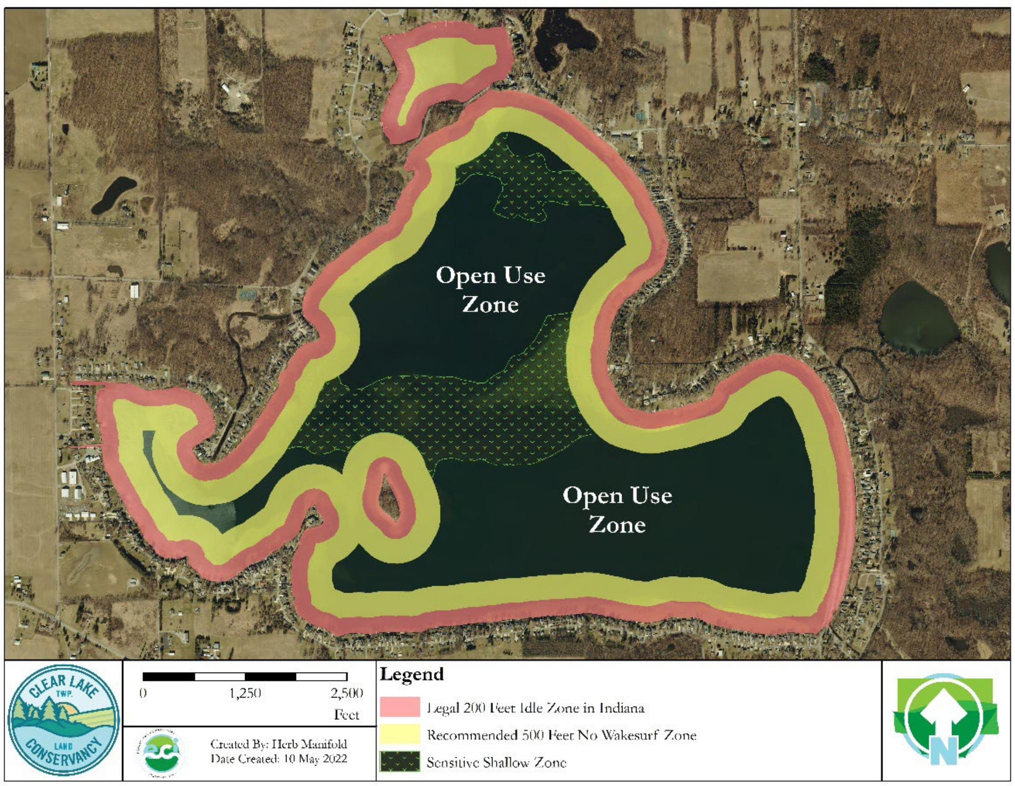
A study released in 2022 by the University of Minnesota is among the first to assess how different types of recreational motorboats produce waves.[3] The study tested wake effects from traditional ski boats and from wakesurf boats (also called wakeboats) when used in a surfing mode. Study leader Jeff Marr described the differences in a February 2022 news interview[4]: "What we learned is when you operate wakesurf boats in a surfing mode, the waves are two to three times larger than a non-wakesurf boat." He added that "waves from wakeboats need to travel a greater distance--more than 500 feet—to decrease to the same height, energy, and power as those from traditional boats."

The University of Minnesota is continuing work to "study the effects of propeller wash or turbulence caused by boat propellers." Another future aspect of the study is "to understand how waves interact with the lake bottom and aquatic vegetation." Additional Blue Papers will be issued when more research is published.

HOW CAN WAVE ACTION BE REDUCED. The powerful and often harmful effects of waves on shorelines can be mitigated in several ways:

- Encourage natural shorelines rather than **armoring** shores with cement or metal seawalls. With their steeper slopes, seawalls produce harder and higher wave crashes deflecting energy downwards and sideways. The sideways deflection often results in a "domino" effect where adjacent property owners build a seawall to armor their shoreline from neighboring seawalls. The intense wave crashes also **scour** deep holes in the lakebed in front of the seawall.
- Place sloping piles of larger glacial stones at the shoreline or in front of existing seawalls to deflect wave energy and eliminate or reduce scour.

- Plant native aquatic vegetation at the shoreline. These plants buffer waves by absorbing wave energy and keeping sediment in place with their roots. Plants can adapt to changing water levels unlike fixed seawalls.
- Operate motorboats at or near idle speeds when cruising along the shoreline.
- Decelerate gradually when approaching "no-wake" zones in any type of watercraft. Abrupt deceleration can produce large plowing waves close to shorelines.
- Operate motorboats at distances from shore within state limits or guidelines, generally 200 feet or more, and be mindful and respectful of the safety of all boaters, including nearby moored or non-motorized watercraft.
- Operate wakesurf boats in surf mode at distances of 500 feet or more from shorelines to allow wave energy to dissipate before it strikes shore. This means that wakesurf boats should not operate on small lakes or on lakes shaped so that 500 feet distances are not feasible.



Resources & Notes:

1. How Waves Work. Presentation by Brian Majka, Spring 2021 MGLP Lake Conservation Webinars, April 1, 2021. Archived on MGLP Lake Conservation Webinars website: https://youtu.be/w2BqPRpPDus.
2. Under Indiana Code (IC) 14-15-3-17, a person may not operate a watercraft within 200 feet of the shoreline of a lake or channel of the lake at a speed greater than idle speed. IC 14-8-2-129 defines "idle speed" as the slowest possible speed, not exceeding 5 miles per hour, that maintains steerage so that the wake or wash created by the watercraft is minimal.
3. A Field Study of Maximum Wave Height, Total Wave Energy, and Maximum Wave Power Produced by Four Recreational Boats on a Freshwater Lake, by Jeffrey Marr, Andrew Riesgraf, William Herb, Matthew Lueker, Jessica Kozarek, Kimberly Hall, published February 2022, University of Minnesota, St Anthony Falls Laboratory, https://conservancy.umn.edu/bitstream/handle/11299/226190/BoatGeneratedWakeWaveReport_Feb12022_Final.pdf?sequence=1&isAllowed=y
4. "Study: Waves from wakeboats need more distance from shore to reduce size, power", Kirsti Marohn, MPR News (Minnesota Public Radio), February 1, 2022.