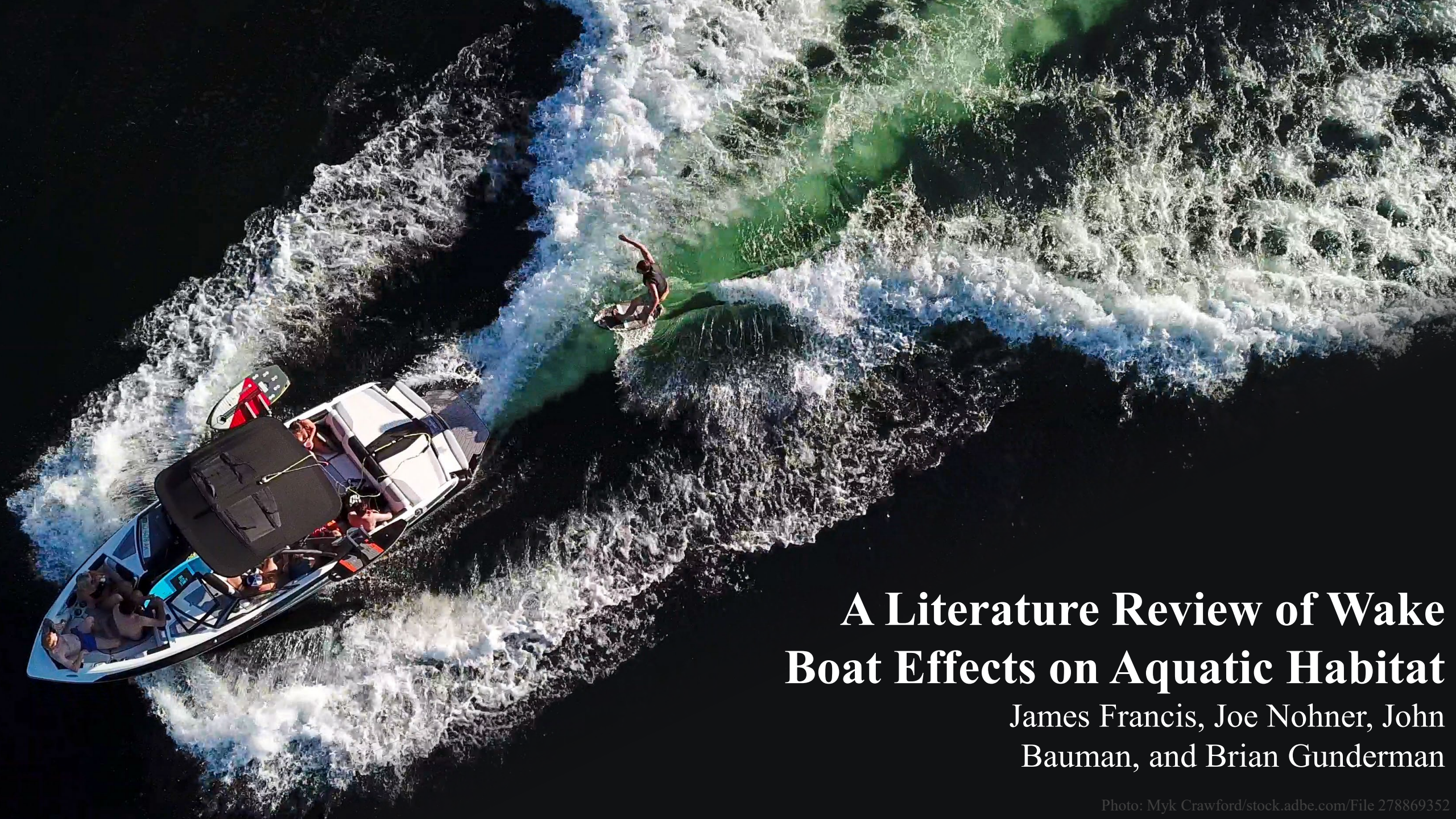


A Literature Review of Wake Boat Effects on Aquatic Habitat

James Francis, Joe Nohner, John Bauman, and Brian Gunderman

Public trust responsibility

- DNR is obligated by the Michigan Constitution to preserve and protect natural resources
- DNR Fisheries' mission: Protect and enhance Michigan's aquatic life and habitats for the benefit of current and future generations.
- DNR Fisheries' strategic plan Goal 1: Ensure healthy aquatic ecosystems and sustainable fisheries
- Shallow water and nearshore areas of lakes are a Wildlife Action Plan key habitat

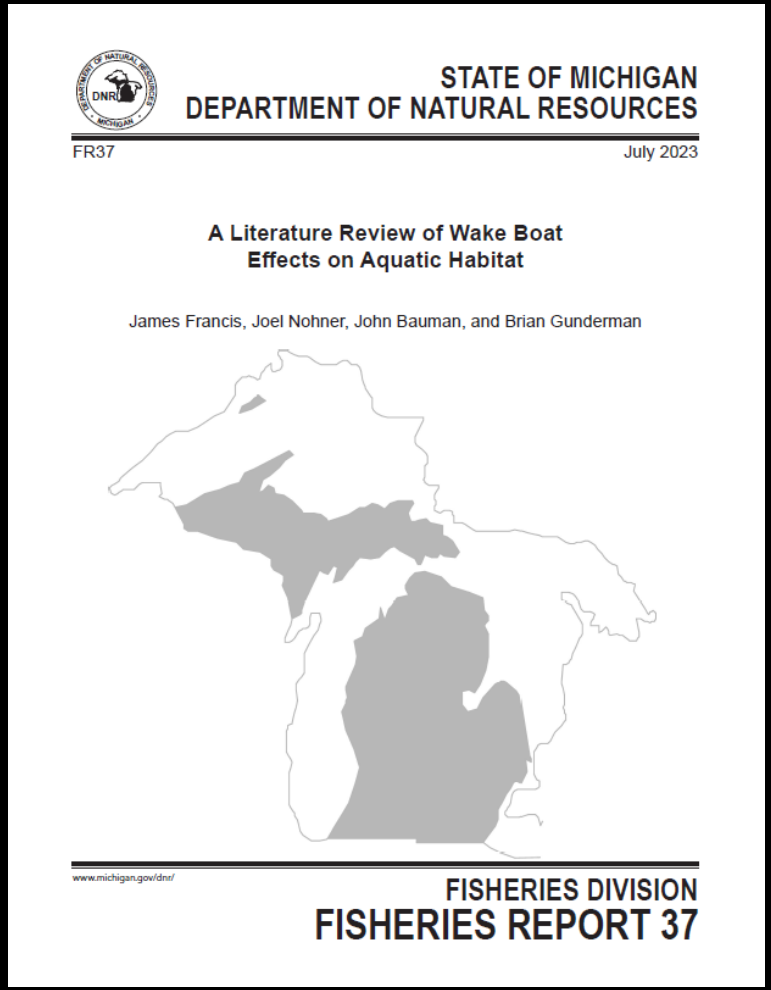
Purpose of the report

DOES

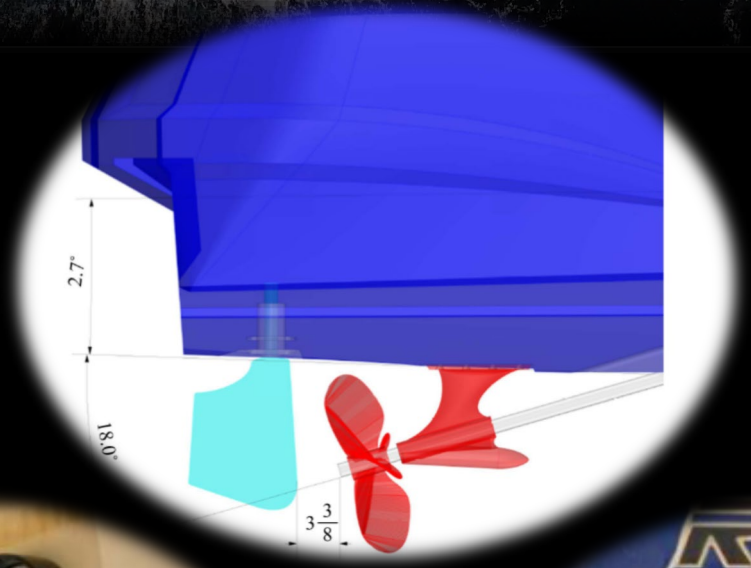
- Review the current state of knowledge
- Provide the Division's position on the operation of wake boats to protect aquatic resources held in public trust.
- Recommend best practices

DOES NOT

- Address public safety or social considerations
- Provide Departmental recommendations for regulation or legislation.



Wake boats 101



Photos: Fay et a;. 2022, Elena/stock.adbe/File 369889798, Marr et al. 2022

Wake boat wave energy

% greater than reference

500 – 1,700% (MacFarlane 2018)

300 – 900% (Marr et al. 2022)

68 - 581%* (Water Environmental Consultants 2021)

400%* (Gouday and Girod 2015 and Ruprecht et al. 2015)

70%* (Mercier-Blais and Prairie 2014)

Wave dissipation

400 ft: Wave height and energy similar to reference motorboats (Macfarlane et al. 2018)

500 – 600+ ft: Dissipation to typical motorboat @ 100 ft. (Marr et al. 2022)

950 ft: Dissipation to typical boat at 100 ft (Water Environment Consultants 2021)

879 – 1,023 ft.: Diss. to normal turbulent kinetic energy (Mercier-Blais and Prairie 2014)

Shoreline erosion

- 61–72% of total wave energy from powerboats on Whitestone Lake (Houser et al. 2021)
- Power boat wakes have accelerated shoreline erosion (Johnson 1994; Nanson et al. 1994; and Bauer et al. 2002)
- Wake boat wave energies 553 – 2,546% higher than wind waves (Water Environment Consultants 2021)

Increased shoreline hardening

- Fisheries comments on shoreline permits
- Applicants frequently list erosion from wake boats as part of their rationale for seawalls and hardening

Sediment resuspension

- Powerboating increases
  - Sediment resuspension
  - Phosphorus
  - Algae

Sediment resuspension

492 – 656 ft.: Wake waves cause greater sediment resuspension (Mercier-Blais and Prairie 2014)

675 – 938 ft.: Distance for sediment resuspension equivalent to wind waves (Mercier-Blais and Prairie 2014)

Aquatic plants

- 20% reductions in aquatic plant coverage due recreational boating (Asplund and Cook 1997)
- Powerboats reduce aquatic plant biomass, coverage, and shoot height (Asplund and Cook 1997)
- Recreational boating traffic correlated with declines in aquatic plant abundance (Murphy and Eaton 1983)
- Wake boats' larger waves and prop wash likely increase these effects

Source	Distance (ft)	Data type	Notes
Water Environment Consultants (2021)	**100**	Field data	Wake-boarding (553%) and wake-surfing (2,546%) wave energy > max. wind-wave energy.
Water Environment Consultants (2021)	**100**	Field data	Wave energy from wake-boarding (68%) and wake-surfing (581%) greater than cruising vessel
Ray (2020)	**135**	Field data	Wake boat wave 9 inches high.
Fay et al. (2022)	**200**	Model	Claims minimal impacts at this distance.
Water Environment Consultants (2021)	**225**	Model	Wave height attenuation from wake-boarding to wake boat cruising at 100ft.
Water Environment Consultants (2021)	**300**	Field data	Wake-boarding wave energy at 300ft similar to wake boat cruising energy at 100ft.
Goudey and Girod (2015)	**300**	Field data	Large waves during wake-boarding (9.87in) and wake-surfing (12.92in) in deep water.
Ray (2020)	**300**	Field data	Wake boat wave 7.75 inches high.
Mercier-Blais and Prairie (2014)	**328**	Field data	Energy of wake waves decreased significantly, but not assessed relative to typical motorboat.
Macfarlane et al. (2018)	**400**	Field data	Maximum wave height and energy similar to reference motorboats.
Mercier-Blais and Prairie (2014)	**492**	Field data	Sediment resuspension observed from wake-surfing.
Water Environment Consultants (2021)	**500**	Field data	Wake boarding (192%) and wake-surfing (679%) wave energy > max. wind-wave energy
Marr et al. (2022)	**>575**	Field data	Total wave energy similar to reference motorboat at 200 ft.
Marr et al. (2022)	**>600**	Field data	Total wave power similar to reference motorboat at 200 ft.
Mercier-Blais and Prairie (2014)	**656**	Field data	Sediment resuspension observed from wake-boarding.
Mercier-Blais and Prairie (2014)	**675–938**	Model	Wake boat waves equivalent to normal conditions for sediment resuspension
Mercier-Blais and Prairie (2014)	**879–1023**	Model	Wake boat waves equivalent to normal conditions for turbulent kinetic energy
Water Environment Consultants (2021)	**950**	Model	Wake-surfing wave height attenuation to typical boat at 100ft.
Mercier-Blais and Prairie (2014)	**984**	Model	Modeled complete dissipation of wake boat waves.
Ray (2020)	**1,000**	Field data	Wake boat wave 4 inches high.

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Considered for minimal resource impact assessment

Not considered for minimal resource impact assessment

Sediment resuspension

15 ft.: Prop wash can resuspend sand, silt, and organics (Raymond and Galvez-Cloutier 2015)

33 ft.: Modeled sediment resuspension from prop wash (Ray 2020)

Aquatic invasive species

- Wake boat ballast tanks carried 247 zebra mussel veligers (Doll 2018)
- Wake boat ballast tanks rarely ever completely dry, increasing survival
- 5% of zebra mussel veligers remained alive in ballast tanks after 48 hours (Doll 2018)

Current boating law

- No wake … within 100 feet of the shoreline where the water depth is less than 3 feet.(NREPA 1994b)
- Reckless operation that disregards the safety or rights of others or endangers the property of others is illegal;
- Causing damage with a vessel's wake is a specific example of recklessness identified in the most recent Handbook of Michigan Boating Laws and Responsibilities (MDNR 2021)
- Fisheries Division concludes that the current 100-foot buffer is not sufficient to protect public trust aquatic resources

Potential solutions from outside Michigan

- Shoreline Erosion – increased operating distances, prohibition in certain areas, ecozone protection
- Turbulence and scour - minimum depth for wake boat operation
- Invasive Species - Design to allow complete drying or disinfection of ballast tanks
- Education and awareness – outreach through boating safety classes, flyers, etc.

Recommendations

Best operating practices under which the recreational opportunities that wake boats provide can be enjoyed in a manner that minimizes harm to the natural resources and property of Michigan citizens

1. Boats operating in wake-surfing mode or wake-boarding mode, during which boat speed, wave shapers, and/or ballast are used to increase wave height, are recommended to operate at least 500 feet from docks or the shoreline, regardless of water depth.
2. Boats operating in wake-surfing or wake-boarding modes are recommended to operate in water at least 15 feet deep.
3. Ballast tanks should always be drained prior to transporting the watercraft over land.