TOWN OF HARVARD
Harbor Master
13 Ayer Road
Harvard, Massachusetts 01451
Phone: (978) 456-4100 Fax: (978) 456-4113

Bare Hill Pond Carrying Capacity

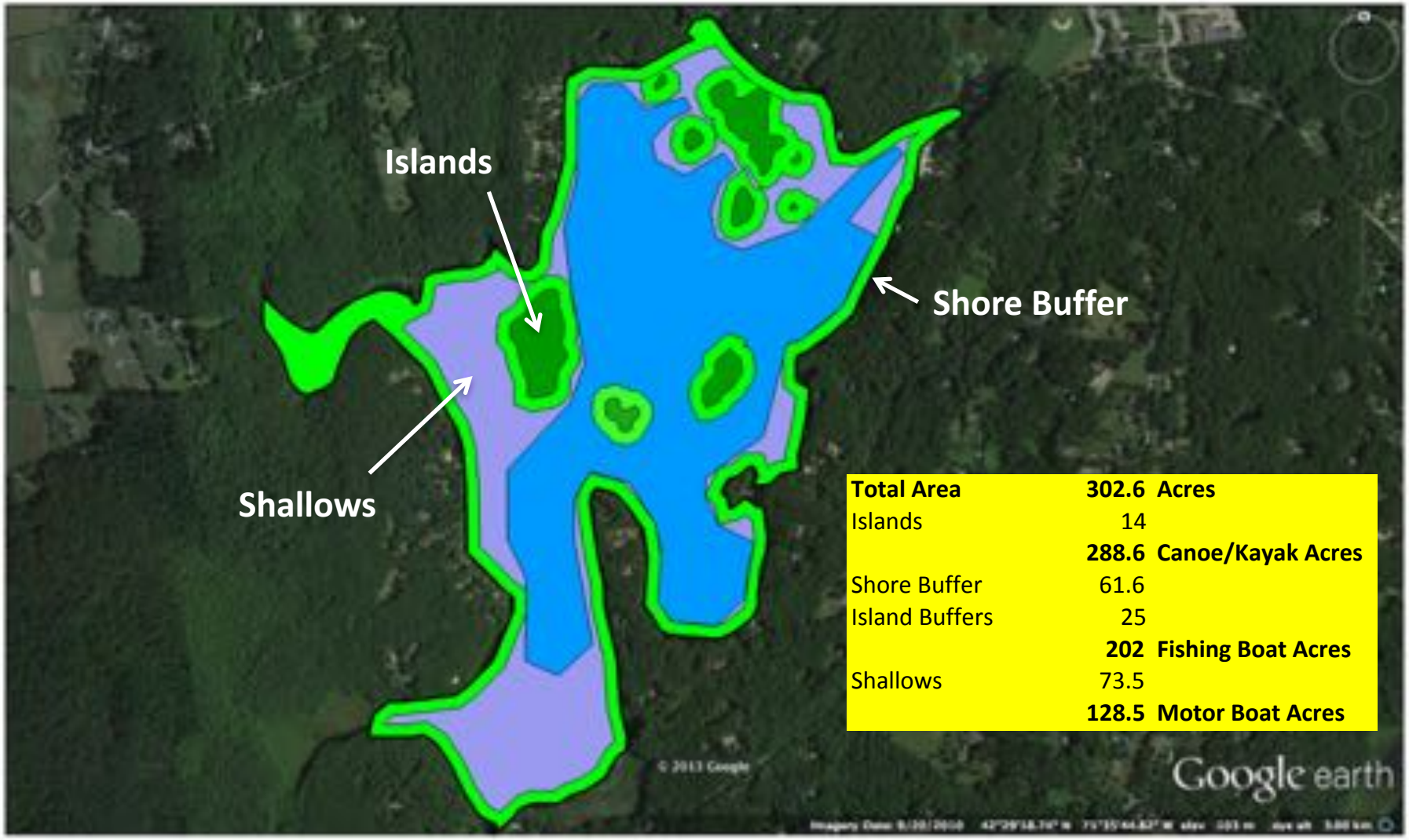
Robert O'Shea

07/01/13

An overcrowded lake.

Source: Wisconsin Lakes Partnership

Bare Hill Pond Acreage



Total Area	**302.6**	**Acres**
Islands	14	
	288.6	**Canoe/Kayak Acres**
Shore Buffer	61.6	
Island Buffers	25	
	202	**Fishing Boat Acres**
Shallows	73.5	
	128.5	**Motor Boat Acres**

Literature on Lake Carrying Capacity

Summary of Optimum Boating Densities

Source	Suggested Density	Boating Uses
Ashton (1971)	5 to 9 acres/boat	All uses combined in Cass Lake
	4 to 9 acres/boat	All uses combined in Orchard Lake
	6 to 11 acres/boat	All uses combined in Union Lake
Kusler (1972)	40 acres/boat	Waterskiing - All uses combined
	20 acres/boat	Waterskiing
	15 acres/boat	Coordinated waterskiing
Jaakson et al. (1989)	20 acres/boat	Waterskiing and motorboat cruising
	10 acres/boat	Fishing
	8 acres/boat	Canoing, kayaking, sailing
	10 acres/boat	All uses combined
Wagner (1991)	25 acres/boat	All recreational activities
Warbach et al. (1994)	30 acres/boat	All motorized (> 5 HP) uses

Boating density adjustment equation (Bosley 2005). Used in controlled situations.

Equation 3
Boating Density Adjustment Equation

Boating density (in acres) = 10 + 5*(proportion of high-speed watercraft)

Conservative Capacity (1) of BHP from Literature

Acres/Boat	Motor/Large Sail Boats	Fishing/ Sunfish Boats	Canoe/Kayaks	All Combined	
Ashton (1971)				11	
Kusler (1972)	15			40	
Jackson et al. (1989)	20	10	8	10	
Wagner (1991)				25	
Warbach et al. (1994)	30	30			
Bare Hill Pond (acres)	128.5	202	288.6	302.6	
Max Boats					
Ashton (1971)				28	
Kusler (1972)	9			8	
Jackson et al. (1989)	6	20	36	30	
Wagner (1991)				12	
Warbach et al. (1994)	4	7			
Selected Standards	25	20	10	Acres/Boat	
Max Boat Limit	**5**	**10**	**29**	Isolated	
					Acres/Boat
Combinations	**5**	4	8	17	17
	4	5	9	18	16
	3	6	9	18	16
	2	8	8	18	16
	1	9	8	18	16
	0	**10**	9	19	15
	0	9	11	20	15
	0	8	13	21	14
	0	7	15	22	13
	0	6	17	23	13
	0	5	19	24	12
	0	4	21	25	12
	0	3	23	26	11
	0	2	25	27	11
	0	1	27	28	10
	0	0	**29**	29	10

Less Restrictive Capacity (2) for BHP

	Motor/Large Sail Boats	Fishing/ Sunfish Boats	Canoe/Kayaks	All Combined
Bare Hill Pond (acres)	128.5	202	288.6	302.6
Selected Standards	25	20	10	Acres/Boat
Calculated Boat Limit	**5**	**10**	**29**	Isolated
Adjusted Standards	15	12	10	Due to req'd counter-clockwise path
Maximum BHP Boats	**9**	**17**	**29**	Isolated

Combinations	**Open Water (OW)**	**Unused OW + Shallows**	**Unused OW +SH + Buffer**	**Total**	**Acres/Boat**
	9	6	8	23	12
	8	7	8	23	12
	7	8	9	24	12
	6	9	9	24	12
	5	11	8	24	12
	4	12	8	24	12
	3	13	9	25	12
	2	14	9	25	12
	1	16	8	25	11
	0	**17**	8	25	11
	0	9	18	27	11
	0	8	19	27	11
	0	7	20	27	11
	0	6	22	28	10
	0	5	23	28	10
	0	4	24	28	10
	0	3	25	28	10
	0	2	26	28	10
	0	1	28	29	10
	0	0	**29**	29	10

Adjustment due to counter clockwise path regulation (if monitored) using Equation 3 of Bosley 2005 Study.

2013 Bare Hill Pond Boat Survey

BHP survey by Kayak (06/29/13)	Houses with Docks	Water Ski Boats	Other Boats	Canoes/kayaks (Avg. 2/House)
Beach to Dam	3	2	2	6
Willow Rd Access	0	1	1	6
4 Acre Island	2	0	2	4
Green Erie	1	0	1	16
Turner Lane	17	7	5	34
Minister's Island	1	0	0	2
South Bay	27	14	5	54
Pennisula Rd	10	2	4	20
Sheep Island	5	1	2	10
Penisula Rd to Beach	16	7	3	32
Park & Rec				
Outer Mooring Field		7/16*	3/0*	0
Slips		7/10*	2/0*	0
Inner Moorings& Canoe/Kayak Racks		0	14/24*	108/130*
Total Riparian Boats	**82**	**48**	**44**	**292**
Avg. Resident Launches		3	1	2
Avg. Non Resident Launches		3	0	0
TOTAL	**82**	**54**	**45**	**294**
Boats @ Peak (6/29/13 survey)		**8**	**5**	**30**
Boat @ Peak (*max capacity @ public access)		**9**	**5**	**32**

Equation 4: Estimated Number of Boats at Peak Use (Bosley 2005)

Total number of boats = 0.10*(# of riparian boats) + 0.50*(max. capacity at public access site)

2013 Bare Hill Pond Carrying Capacity

Equation 6: Percentage at Peak Use (Bosley 2005)

Carrying Capacity = Estimated number of boats at peak use / Optimal number of boats

Before 10am or after 8pm	**Water Ski**	**Other**	**Caonoes/Kayaks**	
Peak	1	7	12	Educated Guess
Optimal # of Boats	5	16	19	Adjusted to Peak
Carrying Capacity	20%	44%	63%	

Summer 10am to 8pm				
	Water Ski	**Other**	**Caonoes/Kayaks**	
Peak	9	5	32	Based on Bosley 2005
Optimal # of Boats (1)	5	4	8	
Optimal # of Boats (2)	9	6	9	Adjusted to Peak
Carring Capacity (1)	180%	125%	400%	
Carrying Capacity (2)	100%	83%	356%	

Spring/Fall 10am to 8pm				
Peak	3	8	20	Educated Guess
Optimal # of Boats	5	13	15	Adjusted to Peak
Carrying Capacity	60%	62%	133%	

Observations

1. The pond has excess capacity except in the summer motoring hours where it is over capacity.
2. Max capacity @ public access site needs to be managed in the Summer but not otherwise.
3. Counter-clockwise rotation needs to be monitored to use capacity (2) in summer.
4. Over capacity of canoes/kayaks is only a danger when combined with motor boating.

References

Ashton, P. G. (1971). Recreational boating capacity: A preliminary study of three heavily used lakes in southeastern Michigan. (Doctoral dissertation, Michigan State University, 1971). *Dissertation Abstracts International, 32*, 03-B (UMI No. AAI7123158).

Bosley, H.E. (Aug. 2005). Techniques for Estimating Boating Carrying Capacity: A Literature Review. North Carolina State University Department of Parks, Recreation & Tourism Management

Jaakson, R., Buszynski, M. D., & Botting, D. (Nov. 1989). Carrying capacity and lake recreation planning (part I). *The Michigan Riparian*, pp. 11-12, 14. Retrieved July 1, 2005 from http://www.mi-riparian.org/RiparianImages/Riparian-800x600/198911-11.jpg, http://www.mi-riparian.org/RiparianImages/Riparian-800x600/198911-12.jpg, http://www.mi-riparian.org/RiparianImages/Riparian-800x600/198911-14.jpg

Jaakson, R., Buszynski, M. D., & Botting, D. (Feb. 1990). Carrying capacity and lake recreation planning (part II). *The Michigan Riparian*, pp. 7-8. Retrieved July 1, 2005 from: http://www.mi-riparian.org/RiparianImages/Riparian-800x600/199002-07.jpg and http://www.mi-riparian.org/RiparianImages/Riparian-800x600/199002-08.jpg

Kusler, J. A. (1972). Carrying capacity controls for recreation water uses. Upper Great Lakes Regional Commission.

Wagner, K. J. (1991). Assessing impacts of motorized watercraft on lakes: Issues and perceptions. In *Proceedings of a National Conference on Enhancing the States' Lake Management Programs*, 77-93.

Warbach, J. D., Wyckoff, M. A., Fisher, G. E., Johnson, P., & Gruenwald, G. (1994). Regulating keyhole development: Carrying capacity analysis and ordinances providing lake access regulations. Planning and Zoning Center, Inc.

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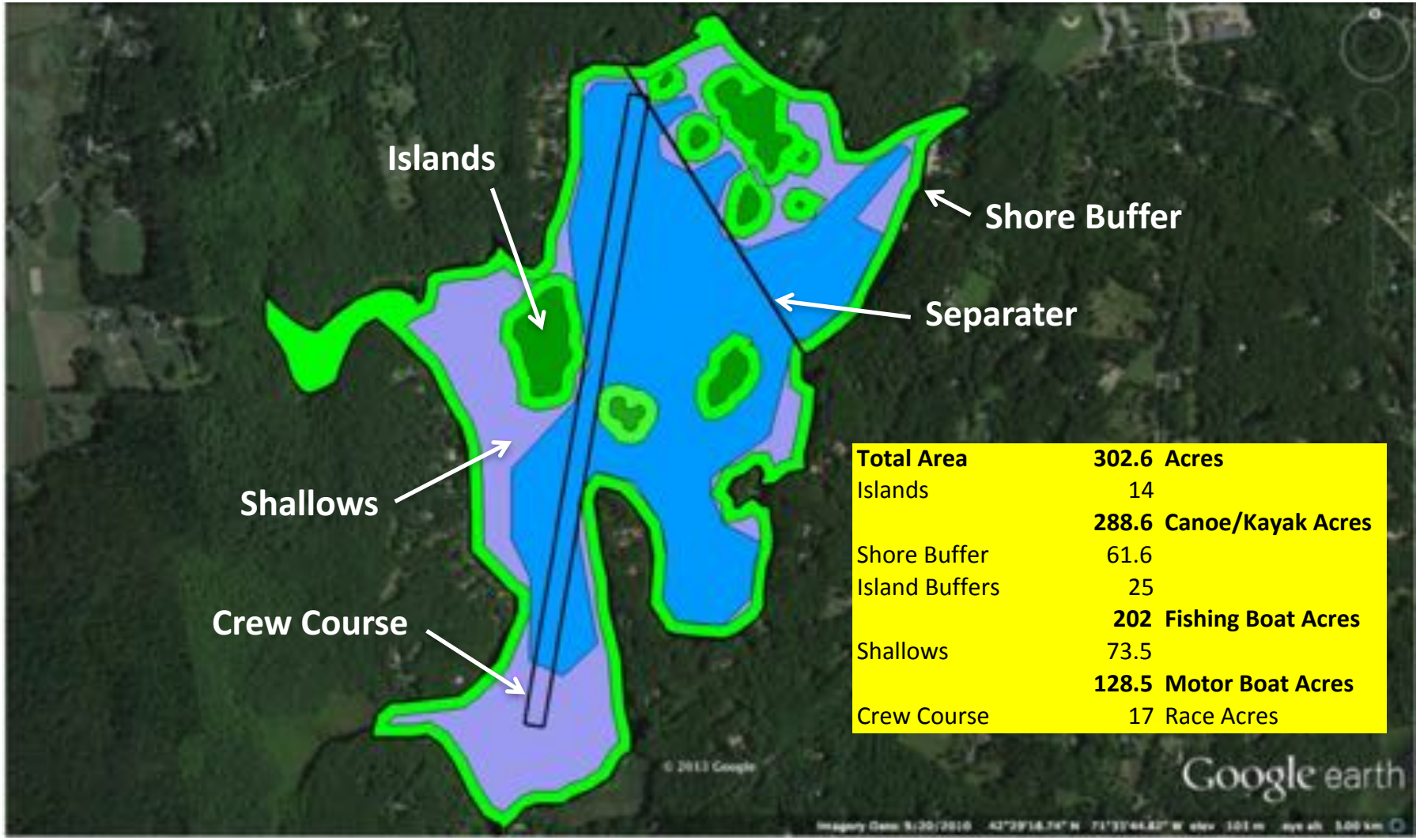

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Shallows	73.5	
	128.5	**Motor Boat Acres**
Crew Course	17	Race Acres