

Supporting materials for Little Long Lake Case Study, including various estimates of carrying capacity, WROS Guidelines, and references.

Table 1. Alternative estimates of carrying capacity for various waterways from the literature

Source or location	Conditions or location	Guideline or Standard (acres/boat)	Reference	Find out more at this website
Arizona Outdoor Recreation Coordination Commission	Unstated	10-20	Cited in Bosley (2005a)	http://www.cwrc.info/boatcarryingcapacity.pdf
Ashton (1971)	All uses combined Union Lake	6-11	Cited in Bosley (2005a)	http://www.cwrc.info/boatcarryingcapacity.pdf
Ashton (1971)	All uses combined Cass Lake	5-9	Cited in Bosley (2005a)	http://www.cwrc.info/boatcarryingcapacity.pdf
Ashton (1971)	All uses combined Orchard Lake	4-9	Cited in Bosley (2005a)	http://www.cwrc.info/boatcarryingcapacity.pdf
Bureau of Outdoor Recreation (1977)	Boat fishing	0.5	Cited in SMUD (2005)	http://hydrorelicensing.smud.org/docs/reports/rec_carry_cap/RecCarryCapacity_tts040505.pdf
Bureau of Outdoor Recreation (1977)	Waterskiing	12	Cited in SMUD (2005)	http://hydrorelicensing.smud.org/docs/reports/rec_carry_cap/RecCarryCapacity_tts040505.pdf

Bureau of Outdoor Recreation (1977)	Unlimited power boating	9	Cited in SMUD (2005)	http://hydrorelicensing.smud.org/docs/reports/rec_carry_cap/RecCarryCapacity_tts040505.pdf
Bureau of Outdoor Recreation (1977)	Non-power boating	1.3	Cited in SMUD (2005)	http://hydrorelicensing.smud.org/docs/reports/rec_carry_cap/RecCarryCapacity_tts040505.pdf
Canandaigua Lake	All uses combined	22	Olvany (2008)	http://www.canandaigualake.org/DRAFT%20Current%20Peak%20Boat%20Use%20Inventory%20and%20Carrying%20Capacity%20Analysis%20on%20Canandaigua%20Lake_2.pdf
Comprehensive Outdoor Recreation Plan New York 2003	Water skiing	15-20	Cited in SMUD (2005)	http://hydrorelicensing.smud.org/docs/reports/rec_carry_cap/RecCarryCapacity_tts040505.pdf
Comprehensive Outdoor Recreation Plan New York 2003	Sail boating	6-8	Cited in SMUD (2005)	http://hydrorelicensing.smud.org/docs/reports/rec_carry_cap/RecCarryCapacity_tts040505.pdf
Comprehensive Outdoor Recreation Plan New York 2003	Power boating	6-8	Cited in SMUD (2005)	http://hydrorelicensing.smud.org/docs/reports/rec_carry_cap/RecCarryCapacity_tts040505.pdf
Comprehensive Outdoor Recreation Plan New York 2003	Row boating	1	Cited in SMUD (2005)	http://hydrorelicensing.smud.org/docs/reports/rec_carry_cap/RecCarryCapacity_tts040505.pdf
Connecticut	Small or electric	10		

	motor				
Connecticut	Canoe, Kayak, or rowboat	1			
Connecticut	Sailboat	4			
Connecticut	High speed water skiing	30			
Deep Creek Lake (MD)	All uses combined	6.6	ERM (2004)	Based on usable lake area	http://dnrweb.dnr.state.md.us/download/dclfinalreport.pdf
Florida Division of Recreation and Parks	Water skiing	20-50	State of Florida		http://www.dep.state.fl.us/parks/planning/forms/CarryingCapacityGuidelines.pdf
Florida Division of Recreation and Parks	Unlimited power	10-20	State of Florida		http://www.dep.state.fl.us/parks/planning/forms/CarryingCapacityGuidelines.pdf
Florida Division of Recreation and Parks	No power still water	5-10	State of Florida		http://www.dep.state.fl.us/parks/planning/forms/CarryingCapacityGuidelines.pdf
Florida Division of Recreation and Parks	Sailing	5-10	State of Florida		http://www.dep.state.fl.us/parks/planning/forms/CarryingCapacityGuidelines.pdf
Florida Division of Recreation and Parks	Less than 10 HP	5-10	State of Florida		http://www.dep.state.fl.us/parks/planning/forms/CarryingCapacityGuidelines.pdf
Jaackson et al. (1989), Michigan	Canoing, kayaking, sailing	8	Cited in Bosley (2005a)		http://www.cwrc.info/boatcarryingcapacity.pdf

Jaackson et al. (1989), Michigan	All uses combined	10	Cited in Bosley (2005a)	http://www.cwrc.info/boatcarryingcapacity.pdf
Jaackson et al. (1989), Michigan	Water skiing and motorboats	20	Cited in Bosley (2005a)	http://www.cwrc.info/boatcarryingcapacity.pdf
Jaackson et al. (1989), Michigan	Fishing	10	Cited in Bosley (2005a)	http://www.cwrc.info/boatcarryingcapacity.pdf
Keuka Lake Management Plan	All uses combined	25	Cited in Olvany (2008)	http://www.canandaigualake.org/DRAFT%20Current%20Peak%20Boat%20Use%20Inventory%20and%20Carrying%20Capacity%20Analysis%20on%20Canandaigua%20Lake_2.pdf
Kusker 1972 Upper Great Lakes	Waterskiing and other	40	Cited in Olvany (2008)	http://www.canandaigualake.org/DRAFT%20Current%20Peak%20Boat%20Use%20Inventory%20and%20Carrying%20Capacity%20Analysis%20on%20Canandaigua%20Lake_2.pdf
Kusler (1972)	Waterskiing	20	Cited in Bosley (2005a)	http://www.cwrc.info/boatcarryingcapacity.pdf
Kusler (1972)	Waterskiing all uses combined	40	Cited in Bosley (2005a)	http://www.cwrc.info/boatcarryingcapacity.pdf
Kusler (1972)	Coordinated waterskiing	15	Cited in Bosley (2005a)	http://www.cwrc.info/boatcarryingcapacity.pdf
Lake Gage and Lake James (Indiana)	Waterskiing corrected for SDF	5.3-12.7	LaGrange and Steuben Lakes Councils (2006)	http://www.lagrangecountylakescouncil.org/LaGrange/Full%20To%20Overflowing%20Final.pdf
Lake Gage and Lake James (Indiana)	Average using several criteria	19.6	LaGrange and Steuben Lakes Councils (2006)	http://www.lagrangecountylakescouncil.org/LaGrange/Full%20To%20Overflowing%20Final.pdf
Lake Gage and Lake James (Indiana)	Manual Pontoon PWC Speed boat	3.0 3.3 3.7 3.9	LaGrange and Steuben Lakes Councils (2006)	See above for website. Calculations shown here give minimum separation based on assumptions given in report. Values are to be multiplied by SDF.

	Water ski	4.6		
Lake Mead Boating Density Standards	Urban park	4.5	Cited in Bosley (2005b)	http://www.cwrc.info/reviewofstandardsandmethodology.pdf
Lake Mead Boating Density Standards	Rural natural	9	Cited in Bosley (2005b)	http://www.cwrc.info/reviewofstandardsandmethodology.pdf
Lake Mead Boating Density Standards	Urban natural	6.75	Cited in Bosley (2005b)	http://www.cwrc.info/reviewofstandardsandmethodology.pdf
Lake Mead Boating Density Standards	Primitive	18	Cited in Bosley (2005b)	http://www.cwrc.info/reviewofstandardsandmethodology.pdf
Lake Mead Boating Density Standards	Semi-primitive	13.5	Cited in Bosley (2005b)	http://www.cwrc.info/reviewofstandardsandmethodology.pdf
Lake Ripley, Wisconsin	All uses combined	20	Cited in Olvany (2008)	http://www.canandaigualake.org/DRAFT%20Current%20Peak%20Boat%20Use%20Inventory%20and%20Carrying%20Capacity%20Analysis%20on%20Canandaigua%20Lake_2.pdf
Lake Ripley, Wisconsin	Sliding scale % idle speed		Lake Ripley Management District (2003)	http://www.lakeripley.org/
	100%	10		
	75%	15		
	50%	20		
	25%	25		
	0%	30		

Lewis River Hydroelectric Projects	Baseline	25	Cited in Bosley (2005b)	http://www.cwrc.info/reviewofstandardsandmethodology.pdf
Louisiana Parks and Recreation Commission	Unstated	20-40	Cited in Bosley (2005a)	http://www.cwrc.info/boatcarryingcapacity.pdf
Lucky Peak Master Plan	High power; high density	5	USACE	http://www.nww.usace.army.mil/planning/er/lpeak/sptdata/spt11.htm
Lucky Peak Master Plan	High power; base density	10	USACE	http://www.nww.usace.army.mil/planning/er/lpeak/sptdata/spt11.htm
Lucky Peak Master Plan	Low power; base density	1.3	USACE	http://www.nww.usace.army.mil/planning/er/lpeak/sptdata/spt11.htm
Lucky Peak Master Plan	Low Power; high density	0.5	USACE	http://www.nww.usace.army.mil/planning/er/lpeak/sptdata/spt11.htm
Lucky Peak Master Plan	High power; low density	20	USACE	http://www.nww.usace.army.mil/planning/er/lpeak/sptdata/spt11.htm
Lucky Peak Master Plan	Low power; low density	2.5	USACE	http://www.nww.usace.army.mil/planning/er/lpeak/sptdata/spt11.htm
Michigan Dept of Natural Resources	All uses combined	25 for first 10,000 acres	Cited in Olvany (2008)	http://www.canandaigualake.org/DRAFT%20Current%20Peak%20Boat%20Use%20Inventory%20and%20Carrying%20Capacity%20Analysis%20on%20Canandaigua%20Lake_2.pdf
Minnesota (Radomski and Schultz 2005)	Low-powercraft	9	Minnesota DNR	http://files.dnr.state.mn.us/waters/watermgmt_section/shoreland/Yourlake7.pdf
Minnesota (Radomski and Schultz 2005)	High-speed watercraft	20	Minnesota DNR	http://files.dnr.state.mn.us/waters/watermgmt_section/shoreland/Yourlake7.pdf
National Recreation and Parks Association	Unstated	4	Cited in Bosley (2005a)	http://www.cwrc.info/boatcarryingcapacity.pdf

Nielson (2002)	General depends upon speed	10	Kopke <i>et al.</i> (2007)	http://cmrc.ucc.ie/publications/reports/RecreationCarryingCapacityFinal2.pdf
PAE	All uses combined	10 + 5*fraction of high speed watercraft	Olvany (2008)	http://www.canandaigualake.org/DRAFT%20Current%20Peak%20Boat%20Use%20Inventory%20and%20Carrying%20Capacity%20Analysis%20on%20Canandaigua%20Lake_2.pdf
Various reservoirs/lakes	All uses combined	6-7.6	Fouse (2008)	
Wagner (1991)	All uses combined	25	Cited in Olvany (2008)	http://www.canandaigualake.org/DRAFT%20Current%20Peak%20Boat%20Use%20Inventory%20and%20Carrying%20Capacity%20Analysis%20on%20Canandaigua%20Lake_2.pdf
Warbach and Wyckoff (1994)	All motorized (> 5HP) uses	30	Cited in Olvany (2008)	http://www.canandaigualake.org/DRAFT%20Current%20Peak%20Boat%20Use%20Inventory%20and%20Carrying%20Capacity%20Analysis%20on%20Canandaigua%20Lake_2.pdf
Warbach et al. (1994)	All motorized (> 5 HP) uses	30	Cited in Bosley (2005a)	http://www.cwrc.info/boatcarryingcapacity.pdf
Warren and Rea (1989)	Sailboats	4.3	Cited in Bosley (2005a)	http://www.cwrc.info/boatcarryingcapacity.pdf
Warren and Rea (1989)	Waterskiing boats	12	Cited in Bosley (2005a)	http://www.cwrc.info/boatcarryingcapacity.pdf
Warren and Rea (1989)	Motorboats	9	Cited in Bosley (2005a)	http://www.cwrc.info/boatcarryingcapacity.pdf
Warren and Rea (1989)	Canoes Kayaks	1.3	Cited in Bosley (2005a)	http://www.cwrc.info/boatcarryingcapacity.pdf
Warren and Rea (1989)	Fishing from boat	1.3	Cited in Bosley (2005a)	http://www.cwrc.info/boatcarryingcapacity.pdf

Water Recreation Opportunity Spectrum	Urban	1-10	Bureau of Reclamation	http://www.usbr.gov/pmts/planning/wros/
Water Recreation Opportunity Spectrum	Suburban	10-20	Bureau of Reclamation	http://www.usbr.gov/pmts/planning/wros/
Water Recreation Opportunity Spectrum	Rural developed	20-50	Bureau of Reclamation	http://www.usbr.gov/pmts/planning/wros/
Water Recreation Opportunity Spectrum	Rural natural	50-110	Bureau of Reclamation	http://www.usbr.gov/pmts/planning/wros/
Water Recreation Opportunity Spectrum	Semi-primitive	110-480	Bureau of Reclamation	http://www.usbr.gov/pmts/planning/wros/
Water Recreation Opportunity Spectrum	Primitive	480-3200	Bureau of Reclamation	http://www.usbr.gov/pmts/planning/wros/
Wisconsin Comprehensive Plan	Unstated	20-40	Cited in Bosley (2005a)	http://www.cwrc.info/boatcarryingcapacity.pdf

Table 2. Various WROS Classes and carrying capacity guidelines

Setting (Classification)	Generalized Description Summary of the Recreation Experiences by WROS Class	Standard (Acres per Boat)
Urban	<p>Limited opportunities to see, hear, or smell the natural resources exist due to the extensive level of development, human activity, and natural resource modification.</p> <p>Meeting other visitors is expected, and socializing with family and friends is important.</p> <p>There is probability for a diverse range of visitors and activities, including groups and special events.</p> <p>Convenience is central and dominant.</p>	1-10
Suburban	<p>Limited or rare opportunities to see, hear, or smell the natural resources exist due to the widespread and prevalent level of development, human activity, and natural resource modification.</p> <p>Meeting other visitors is expected, and socializing with family and friends is important.</p> <p>There is probability for a diverse range of visitors and activities.</p> <p>Convenience is central and dominant.</p>	10-20
Rural Developed	<p>Occasional or periodic opportunities to see, hear, or smell the natural resources exist due to the common and frequent level of development, human activity, and natural resource modification.</p> <p>Brief periods of solitude are likely, although the presence of other visitors is expected.</p> <p>There is probability for a diverse range of visitors and activities.</p> <p>Moderate levels of comfort and convenience are expected.</p>	20-50
Rural Natural	<p>Frequent opportunities exist to see, hear, or smell the natural resources due to an occasional or periodic level of development, human activity, and natural resource modification.</p> <p>Independence and freedom with a moderate level of management presence are important.</p> <p>There is probability for a diverse range of visitors and activities, although experiences tend to be more resource-dependent.</p> <p>Comfort and convenience are not important or expected.</p>	50-110

<p>Semiprimitive</p>	<p>Widespread and prevalent opportunities exist to see, hear, or smell the natural resources due to a rare or minor level of development, human activity, and natural resource modification.</p> <p>Solitude through the lack of contact with other visitors and managers is important.</p> <p>Opportunities exist for more adventure-based enthusiasts and overnight visitors.</p> <p>Sensations of challenge, adventure, risk, and self-reliance are important.</p>	<p>110-480</p>
<p>Primitive</p>	<p>Extensive opportunities abound to see, hear, or smell the natural resources due to the rare and very minor level of development, human activity, and natural resource modification.</p> <p>Solitude and lack of the site, sound, and smells of others are important.</p> <p>Opportunities are plentiful for human-powered activities (e.g., canoeing, fly-fishing, backpacking, etc.).</p> <p>Sensations of solitude, peacefulness, tranquility, challenge, adventure, risk, testing skills, orienteering, and self-reliance are important.</p>	<p>480-3,200</p>

References

Note: All web references accessed on 19 May 2009.

- 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).
- Aukerman, R., G. Haas, V. Lovejoy, and D. Welch. 2004. *Water Recreation Opportunity Spectrum (WROS) User's Guide*. U.S. Department of the Interior, Bureau of Reclamation.
- Bosley, H., (2005a). Techniques for estimating boating carrying capacity: A literature review. Prepared for Catawba-Wateree Relicensing Coalition. Available electronically at <http://www.cwrc.info/boatcarryingcapacity.pdf>.
- Bosley, H., (2005b). Review of standards and methodology in FERC relicensing studies. Prepared for Catawba-Wateree Relicensing Coalition. Available electronically at <http://www.cwrc.info/reviewofstandardsandmethodology.pdf>.
- Bureau of Outdoor Recreation, (1977). *Guidelines for Understanding and Determining Optimum Recreation Carrying Capacity*. Department of Interior, Washington, D.C.
- Connecticut; Personal communication Eleanor Mariani.
- Devine, Tarbell & Associates, Inc. and The Louis Berger Group (2005). Sacramento Municipal Utility District Upper American River Project (FERC # 2101) Recreation Carrying Capacity Technical Report. Available electronically at http://hydrorelicensing.smud.org/docs/reports/rec_carry_cap/RecCarryCapacity_tts040505.pdf.
- Doshi, S., (2006). Recreational carrying capacity in lakes: how much is too much? Column Clean Lakes Program, Office of Water Quality, Indiana Dept. of Environmental Management. Available electronically at <http://www.indiana.edu/~clp/documents/WATER%20COL%20V18,%20N2.pdf>.
- EDAW (2004a). *Reservoir boating, Final R-7, Oroville Facilities Relicensing FERC Project No.2100*. The State of California, Department of Water Resources.

- EDAW (2004b). *Ririe Reservoir recreation carrying capacity study*. Prepared for U.S. Department of the Interior, Bureau of Reclamation, Pacific Northwest Region, Snake River Area Office, Boise, Idaho. Available electronically at http://parksandrecreation.idaho.gov/assets/content/docs/2004_Ririe_RCC_Complete_Final.pdf.
- ERM, (2004). Deep Creek Lake Boating and Commercial Use Carrying Capacity Study. ERM, Annapolis, MD. Available at <http://dnrweb.dnr.state.md.us/download/dclfinalreport.pdf>.
- Florida Department of Environmental Protection, Division of Recreation and Parks (n.d.). *Visitor carrying capacity guidelines*. Available electronically at <http://www.dep.state.fl.us/parks/planning/forms/CarryingCapacityGuidelines.pdf>.
- Fouse, J., (2008). Technical Report: Boating density analysis-a comparison among Tennessee Valley Authority and other Federal, State, and Investor-Owned Utilities. Tennessee Valley Authority, Office of Environment and Research.
- Holmes, T., Connelly, N., Brown, T. L., Drury, J., and Bonney, B., (2006). *Lake George Recreation Study Plan, 2005 for the Lake George Park Commission. An assessment of recreational use on Lake George, including identification of priority issues and locations, and a framework for the monitoring and evaluation of future use*. Available electronically at http://adironackresearch.com/projects/lakegeorge/LG_Final_Rec_Plan.pdf.
- Jaakson, R., Buszynski, M. D., & Botting, D. (Nov. 1989). Carrying capacity and lake recreation planning (part I). *The Michigan Riparian*, pp. 11-12, 14. Available electronically at <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>.
- Kopke, K., O'Mahony, C., Cummins, V., and Gault, J., (2007). *Assessment of Coastal Recreational Activity and Capacity for Increased Boating in Cork Harbour*. Coastal and Marine Resources Centre, ERI, University College Cork. Available electronically at <http://cmrc.ucc.ie/publications/reports/RecreationCarryingCapacityFinal2.pdf>.
- Kusler, J. A. (1972). Carrying capacity controls for recreation water uses. Upper Great Lakes Regional Commission.
- LaGrange County Lakes Council, Inc., and Steuben County Lakes Council Inc., (2006). Full to overflowing: A study of Lake carrying Capacity. Available electronically at <http://www.lagrangecountylakescouncil.org/LaGrange/Full%20To%20Overflowing%20Final.pdf>.

- Lake Ripley Management District (2003) Lake Ripley watercraft census and recreational carrying capacity analysis.
- National Park Service 2002. Final Environmental Impact Statement for the Lake Mead National Recreation Area. Lake Mead National Recreation Area. December 2002.
- New, J. F., (2007). *Wawasee Carrying Capacity Report, Elkhart, Kosciusko, and Noble Counties, Indiana*. JFNew, Walkerton, Indiana. Available electronically at <http://www.lagrangecountylakescouncil.org/WawaseeStudy.pdf>.
- New York, (2003). Statewide Comprehensive Outdoor Recreation Plan. New York State Office of Parks, Recreation and Historic Preservation, Albany, New York. January 2003.
- Nielsen, M., (2002). Township of Minden Hills - Official Plan Program - Lake Capacity and Shoreline Development Standards. Issues Paper.
- Olvany, K., (2008). Peak boat use inventory and carrying capacity analysis: Canandaigua Lake. Canandaigua Lake Watershed Council, Canandaigua, NY. Available electronically at, http://www.canandaigualake.org/DRAFT%20Current%20Peak%20Boat%20Use%20Inventory%20and%20Carrying%20Capacity%20Analysis%20on%20Canandaigua%20Lake_2.pdf.
- Progressive AE. (2001) Four Township Recreational Carrying Capacity Study. Available electronically at <http://www.ftwrc.org/publications/littlelonglakerecc.pdf>.
- Radomski, P., and Schultz, R., (2005). Governor's Clean Water Initiative: Shoreland Rules Update Project. Article Number 7, DNR News. Available electronically at http://files.dnr.state.mn.us/waters/watermgmt_section/shoreland/Yourlake7.pdf.
- Threinen, W.,W., (1964). An analysis of space demands for water and shore. Wildlife Management Institute, Transactions of the twenty-ninth North American Wildlife and Natural Resources Conference, March 1964, Washington D.C.
- US Army Corps of Engineers, Walla Walla District (Undated). Lucky Peak Master Plan Technical Report, Volume II. Available electronically at <http://www.nww.usace.army.mil/planning/er/lpeak/sptdata/spt11.htm>.

- 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., and Gruenwald, G. (1994). Regulating keyhole development: Carrying capacity analysis and ordinances providing lake access regulations. Planning and Zoning Center, Inc.
- Warbach JD and Wyckoff MA. (1994) Carrying capacity analysis & ordinances providing lake access regulations, a report for the Michigan Department of Natural Resources.
- Warren, R. and Rea, P., (1989). *Management of Aquatic Recreation Resources*. North Carolina State University. Publishing Horizons, Inc. Columbus, Ohio.