

Recreational Carrying Capacity in Lakes: How much is too much?

By Sheela Doshi

Indiana's lakes and reservoirs offer a great escape from everyday life. No one wants that escape to include traffic jams at the boat ramp, excess noise, or collisions. As lake use increases, environmental quality, user enjoyment, and safety may decrease. In the long run, less enjoyable, unhealthy lakes can translate to economic losses in the recreation and tourism industries and declining property values. To keep our lakes available for multiple uses, it's helpful to learn about their recreational carrying capacity.

Recreational carrying capacity is "the amount of development and activity a body of water can handle before it starts to deteriorate," as defined by Jacquie Colburn of the New Hampshire Department of Environmental Services. On one hand, it's a simple concept that becomes clear to any recreationist attempting to use an overcrowded lake. However, determining the optimum use level for a lake is a complex process, which may vary from lake to lake. The general steps to determine carrying capacity are: census watercraft use, define goals, develop and apply a carrying capacity formula, and develop a plan to optimize use.

Watercraft Census: Get to Know Your Lake

A watercraft census is a tool for learning about the peak level of recreational use, the types of use in demand, and the mix of public and private access. One way to conduct a census is to make observations at various times during the boating season. Observers should count number of boats on the lake, type of each boat (e.g., fishing, high-speed, personal watercraft), and the boat's approximate speed (stationary, no wake, or wake-producing speed). A census that captures activity at several points in time will provide the most accurate picture of actual usage.

Define Goals: How to Know What "Too Much" Means

No carrying capacity formula is right for every lake. The demand for various activities and the condition of the lake must be considered to set realistic goals and standards. One factor to consider is the ecological or aesthetic value of the lake, which may not be captured in a boater survey. Perceptions of crowding may vary based on the history, remoteness, type of recreation, and public or private nature of the lake. Before evaluating carrying capacity, therefore, it is important to decide which interests must be protected, and what unacceptable consequences should be avoided.

For example, a boat carrying capacity on Marsh Lake, a fishing lake, would have a lower carrying capacity than Lake Tippecanoe, primarily a boating lake.

Boater surveys or questionnaires are tools that can shape these decisions. For example, lake managers on Lake Ripley in Wisconsin learned

that increased safety risks, high chance of user interference, and high probability of environmental harm were areas of concern for lake users, and focused their carrying capacity study on preventing these conditions.

Calculating Carrying Capacity: Putting it all Together

The next step in the process is to combine lake uses and goals with lake characteristics to calculate carrying capacity. The steps to follow include:

1. *Calculate the Usable Surface Area of the lake.* In Indiana, this should exclude areas within 200 feet of the shoreline, which are designated idle zones. Swimming areas, no-wake zones, sensitive habitat, and shallows (less than 5 feet deep) should also be subtracted from the lake's surface area.
2. *Determine the minimum space required for each use.* Space requirements estimated in past studies vary (Table 1), so it is important to look at studies that represent the conditions and type of use on the lake of interest. Multiply the minimum spatial requirement for a use type (e.g., high speed use) by the proportion of boats engaged in this activity. Add up the spatial requirements for each use to estimate the Optimum Boating Density—or average number of acres each boat needs. It's a good idea to build in a safety factor for high-use periods.
3. *Determine the Recreational Carrying Capacity by dividing Usable Lake Area by the Optimum Boating Density* (Table 2).
4. *Compare the Recreational Carrying Capacity to the actual level of use found in the watercraft census.*

Throughout this process, it is important to keep in mind any special conditions that may cause you to adjust your calculations. For example, the Lagrange County and

Table 1. Summary of Reported Figures Related to Optimum Boating Density

Source	Boating Uses	Suggested Density
Ashton (1971)	All uses combined- Cass Lake All uses combined- Orchard Lake All uses combined- Union Lake	5-9 acres/boat 4-9 acres/boat 6-11 acres/boat
Kusler (1972)	Waterskiing & all other uses Waterskiing only	40 acres/boat 15-20 acres/boat
Jackson et al. (1989)	Waterskiing and motorboat cruising Fishing Canoeing, kayaking, sailing All uses combined	20 acres/boat 10 acres/boat 8 acres/boat 10 acres/boat
Wagner (1991)	All boating activities	25 acres/boat
Warbach et al. (1994)	All motorized uses (>5HP)	30 acres/boat

Adapted from Lake Ripley Water Management District, *Lake Ripley Watercraft Census*, 2003.

Table 2. Example of Calculating Carrying Capacity for a Hypothetical 400-acre Lake Having 300 Usable Acres

Information	Source	Example
Lake-Use Mix	Watercraft census	50% Idle Speed/Stationary, 50% Fast-Moving uses
Optimum Boating Density	Figures reported in the literature, boating safety rules	$(0.5 * 20 \text{ acres/boat}) + (0.5 * 10 \text{ acres/boat}) = 15 \text{ acres/boat}$
Useable Lake Area	Lake map and goals for preservation	300 acres
Recreational Carrying Capacity	Divide Useable Lake Area by Optimum Boating Density	$300 \text{ acres} / 15 \text{ acres/boat} = 20 \text{ boats}$

Steuben County Lakes Councils recently formed a joint committee to investigate carrying capacity on area lakes. The committee decreased the optimum boating density for Lake James because the presence of multiple uses, irregular shoreline, and lack of open water creates a greater chance of boater interference. This study mentions several other factors that can guide studies of recreational carrying capacity.

Developing a Plan

If actual lake use exceeds the carrying capacity for the lake, or may do so in the future, you will need a plan of action to keep use at

a reasonable level. Lake managers and enthusiasts can work with state and local authorities to set policies that will protect their lakes.

In Indiana, regulations limiting the amount or type of boating activity require the authority of IDNR and state legislators. Speed limits decrease the space required per boat, allowing more boats to safely use the lake. Lake zoning ordinances allot a time or area of the lake for different uses. For example, a no-wake or low-speed period can be established for part of each day or on selected days.

Limiting public access may be necessary to keep recreational use below carrying capacity. Limited parking at landings affects the

number of boats launched at public access sites, if convenient parking is not available elsewhere. Thus, carrying capacity should be considered in decisions to develop public access areas.

Because private access can contribute to overuse, zoning and pier regulations may help limit expansion of lake use to excessive levels. Land-use zoning or other policies can limit high-density shoreline development and “keyhole” or “funnel” development patterns that may push lake use above carrying capacity (see *Water Column*, Spring 2006).

From Problem to Opportunity

No doubt, determining the carrying capacity of a lake and deciding how to prevent overcrowding will inspire some disagreement. However, studying a lake’s recreational carrying capacity can bring lake users and managers together, with the ultimate goal of increasing all users’ enjoyment of the lake. They can be involved through public meetings, surveys, or volunteering to help with the study. Assessing carrying capacity is measure to protect lake users. The more they can be involved in finding ways to do this, the better the solution will be.

For more information, see examples of Recreational Carrying Capacity Studies for:

- Lake James and Lake Gage, Steuben County, IN: <http://www.lagrangecountylakescouncil.org>
- Lake Ripley, WI: www.lakeripley.org
- Pine, Upper Crooked, Gull, & Sherman Lakes, MI: <http://www.kbs.msu.edu/ftwrc/publications/Carryingcapacity.pdf>

References

Ashton, P.G. 1971. Recreational boating carrying capacity: A preliminary study of three heavily used lakes in southeastern Michigan. Doctoral Thesis, Department of Resource Development, Michigan State University.



A carrying capacity plan can prevent overcrowded conditions that are detrimental to lake users. Source: Wisconsin Lakes Partnership.

Dearlove, P. and J. Molinaro. 2004. Assessing a Lake’s Recreational Carrying Capacity. *LakeLine* 24(2):22-26.

Jaakson, R., M.D. Buszynski, and D. Botting. 1990. Carrying capacity and lake recreation planning. *The Michigan Riparian*, November 1989, pp. 11-12, 14.

Kusler, Jon A. 1972. *Carrying Capacity Controls for Recreation Water Uses*. Upper Great Lakes Regional Commission.

LaGrange County Lakes Council (LCLC) and Steuben County Lakes Council (SCLC). 2006. *Full to Overflowing: A Study of Lake Carrying Capacity*.

Wagner, Kenneth J. 1991. *Assessing Impacts of Motorized Watercraft on Lakes: Issues and Perceptions. Proceedings of a National Conference on Enhancing States’ Lake Management Programs*. Northeastern Illinois Planning Commission.

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

Making Connections – People, Lakes, Watersheds

Indiana has a long and rich history in limnology and lakes. The last glaciers, some 10,000 years ago, covered the northern third of the state with natural lakes. There are virtually no natural lakes in the southern two-thirds of the state but there are plenty of impoundments. Indiana’s 1,400 lakes over 5 acres in size include eight Corps of Engineers projects (10,700-acre Monroe Reservoir is the largest in the state) and Lake Wawasee, at 2,600 acres, the largest natural lake in the state.

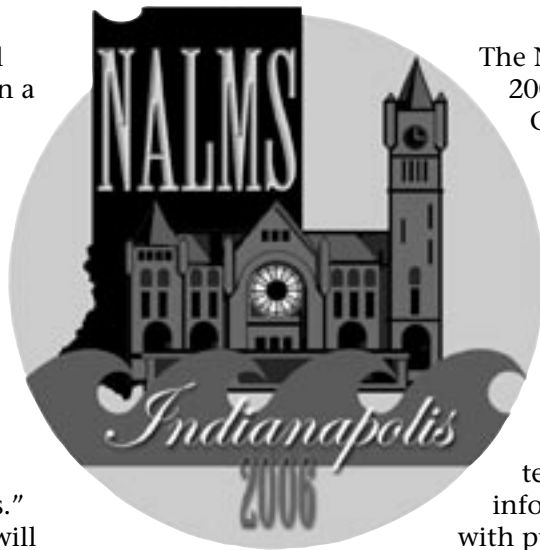
Native Hoosier and IU alum Chancey Juday was stimulated by northern Indiana lakes in his youth and later teamed with E.A. Birge in Wisconsin to pioneer the science of limnology. David Starr Jordan, Carl Eigenmann, Will Scott, Shelby Gerking, and David Frey all made important contributions to the science while in Indiana. In 1895, Eigenmann founded the Indiana University Biological Station on Lake Wawasee, one of

the first biological stations located on a freshwater lake.

It is in recognition of this rich history that the theme of the 2006 NALMS International Symposium is "Making Connections—People, Watersheds, Lakes."

This symposium will emphasize connections between the past and the present; between natural lakes and reservoirs; between watersheds and lakes; and, of course, between people and lakes. People from all over the U.S., Canada, and overseas will travel to Indianapolis to attend this conference.

The conference venue is centrally located in downtown Indianapolis, one of the most visitor-friendly cities in the U.S. In no other U.S. city can you stroll easily between the NBA arena (Conseco Fieldhouse, considered the best professional basketball arena in the U.S.); the NFL stadium (RCA Dome); and the finest Triple A professional baseball park (Victory Field). Hundreds of shops, restaurants, museums, and art galleries are all included in the central city area.



The NALMS 2006 Program Committee is hard at work on a technical program that, like NALMS itself, balances lake management technical information with public policy, education and outreach.

Sessions will focus on issues and research pertinent to lakes and reservoirs throughout North America in addition to sessions focused on Midwest lakes and reservoirs. An all-day session on shoreline management is planned for Friday. Complete registration information for NALMS 2006 may be found on the symposium Web site: www.NALMS.org.

The Indiana Lake Management Society (ILMS) has funds available to financially assist Indiana lake leaders in attending this symposium. Please contact ILMS President, Mark Mongin, via e-mail at: markm@sepro.com for more information.

many as the father of wildlife management and of the United States' wilderness system, Aldo Leopold was a conservationist, forester, philosopher, educator, writer, and outdoor enthusiast. One of Leopold's many legacies was his concept of a "land ethic".

Leopold's land ethic simply enlarged the boundaries of the community to include the land (its soils, waters, plants, and animals) as well as its people and their buildings. Published in 1949 as the finale to *A Sand County Almanac*, Leopold's land ethic defined a new relationship between people and nature and set the stage for the modern conservation movement. Leopold understood that ethics direct individuals to cooperate with each other for the mutual benefit of all. One of his philosophical achievements was the idea that this "community" should be enlarged to include non-human elements such as soils, waters, plants, and animals, "or collectively: the land." He stated, "That a basic concept of ecology is that the land is a community", but he also added, "that land is to be loved and respected and that is an extension of ethics." This recognition, according to Leopold, implies individuals play an important role

Do You Have a "Land Ethic"?

The July 4th Independence holiday causes many of us to think about the many sacrifices people have made in the past to help provide us a great country. Paula Baldwin, Chair of the Marion County Soil and Water Conservation District (SWCD) would like to remind people that part of our country is our great countryside. One early conservation pioneer that helped Americans focus on the many benefits of that countryside was a person from the Midwest, Aldo Leopold. Considered by



Aldo Leopold was an early conservation pioneer who encouraged people to recognize the need for a "land ethic" and then to use it to help guide land owners and communities to take better care of the land.

WATER COLUMN

Published quarterly by the Indiana Clean Lakes Program as a medium for open exchange of information regarding lake and watershed management in Indiana

Address all correspondence to:
William W. Jones, Editor
SPEA 347, 1315 E. Tenth Street
Indiana University
Bloomington, IN 47405-1701

E-mail: joneswi@indiana.edu
Phone: (812) 855-4556
FAX: (812) 855-7802

in protecting and preserving the health of this expanded definition of a community. "A land ethic, then, reflects the existence of an ecological conscience, and this in turn reflects a conviction of individual responsibility for the health of land."

Central to Leopold's philosophy is the assertion to "quit thinking about decent land use as solely an economic problem." While recognizing the influence economics have on decisions, Leopold understood that ultimately, our economic well-being could not be separated from the well-being of our environment. Therefore, he believed it was critical that people have a close personal connection to the land. He said, "We can be ethical only in relation to something we can see, feel, understand, love, or otherwise have faith in." Do *you* have a land ethic?

Born in 1887 and raised in Burlington, Iowa, Aldo Leopold developed an interest in the natural world at an early age, spending hours observing, journaling, and sketching his surroundings. Graduating from the Yale Forest School in 1909, he eagerly pursued a career with the newly established U.S. Forest Service in Arizona and New Mexico. By the age of 24, he had been promoted to the post of Supervisor for the Carson National Forest in New Mexico. In 1922, he was instrumental in developing the proposal to manage the Gila National Forest as a wilderness area, which became the first such official designation in 1924.

Following a transfer to Madison, Wisconsin in 1924, Leopold continued his investigations into ecology and the philosophy of conservation and in 1933 published the first textbook in the field of wildlife management. Later that year he accepted a new chair in game management—a first for the University of Wisconsin and the nation. In 1935, he and his family initiated their own ecological restoration experiment on a worn-out farm along the

Wisconsin River outside of Baraboo, Wisconsin. Planting thousands of pine trees, restoring prairies, and documenting the ensuing changes in the flora and fauna further informed and inspired Leopold.

If you *have* a land ethic, are you using it? The country currently has need for more individuals who have a love for the land to come forward and work in their local communities. People from all walks of life with a conviction of individual responsibility for the health of land are needed to assist their communities as members of soil and water conservation district boards, park boards, resource conservation and development (RC&D) councils, land trusts, and the many other community conservation organizations. Your local SWCD has several sub-committees of its own that have volunteer needs for a variety of tasks

For more information about Aldo Leopold, visit the Aldo Leopold Foundation Web site at <http://www.aldoleopold.org/>. *A Sand County Almanac* should be required reading for everyone wanting to learn more about land ethics and environmental protection. Leopold's writing style is non-scientific and almost poetic. Most local libraries would have this and other books by Leopold available. Most local bookstores would also have copies of *A Sand County Almanac* available for around \$6.00, as well as several other Leopold books about conservation. If they are not available, the bookstores would be happy to assist in ordering copies.

(Article adapted from a news release from the Marion County Soil and Water Conservation District.)

Got a question about your lake? Or lakes in general? Or about something you've read? Write to us at the WaterColumn and we will do our best to answer it.

Critics: Fish Warnings Fail to Hook Those Most at Risk

Alerts are now only on the Internet, where anglers most likely to eat what they catch may not see them

Joe King has been fishing streams and rivers in the Indianapolis area since he was a boy selling carp in his neighborhood near Dr. Martin Luther King Jr. and 21st streets.

But in all those years, the 71-year-old has never seen state advisories warning that some fish caught in Indiana might contain levels of toxins that could be harmful. "I don't think most people are aware of any advisory," said King, co-founder of the Dirty Dozen Hunting and Fishing Club, which each year teaches more than 150 people to fish. "Most of the people I know eat what they catch. We need to know about this."

An annual statewide advisory on which fish to avoid eating, once available in a printed document, is now available only on the Internet. The bottom line, community advocates say, is that the people who most need the information—poor and minority residents who often eat what they catch—are now those least likely to see it.

"It seems like the state is moving backward, not forward, in better informing people," said Brian Wright of the Hoosier Environmental Council. "We don't want to see people stop fishing, but we want to make sure they're aware that some fish may have (toxin) levels high enough to be harmful to children."

Experts say the health benefits of eating fish generally outweigh the risks, but people must know which fish and waterways to avoid.

The annual advisory identifies which Indiana waterways and fish species have high levels of mercury and polychlorinated biphenyls, or PCBs—both accumulate in the body—and how many meals a person, especially women and children,

can safely eat. For example, people should avoid eating large carp and catfish, because they generally have higher levels of toxins.

High mercury levels can be passed from a mother to her fetus. In children, mercury can cause brain damage and nervous-system problems. PCBs can affect children's motor skills and short-term memory and may damage the immune system.

LaNetta Alexander, the Indiana State Department of Health's director of environmental epidemiology, said the agency in the past printed about 10,000 of the 50-plus-page advisories annually. It stopped doing so last year after determining it wasn't practical or cost-effective to continue.

The advisories mainly were sent to those who requested them, including local health departments and some fishing groups. Fishing supply stores and businesses that

sold licenses were not required to carry them. The booklets, which covered advisories for the entire state, were bulky and confusing for many people, Alexander said.

You can view the 2006 Indiana Fish Consumption Advisory at: <http://www.in.gov/isdh/dataandstats/fish/2006/index.htm>.

Adapted from an article by: Tammy Webber, www.IndyStar.com

Fuel for Thought



The gas you buy this season at the fuel dock or gas station may not be the same as the gas you bought last year. Gasoline refineries are phasing out the use of MTBE, a toxic additive, and replacing it with ethanol (E10).

Your car or truck will never know the change but your boat may be a different story.

Ethanol use in marine engines has been linked to:

- Weakened fiberglass gas tanks
- Clogged fuel filters and carburetors
- Increased corrosion of metal gas tanks
- Inadequate lubrication in two-stroke marine engines

Preventive maintenance can alleviate some of these potential problems—if you know that you are burning E10 gasoline. To be safe, check at your local fuel retailer to find out whether E10 is being pumped.

You can read a complete report from *Boat U.S. Magazine* about problems associated with E10 gas in marine engines at: http://www.boatus.com/news/e10_0706.htm.

**Have you checked out the Indiana Clean Lakes Program Web page lately?
Take a look at <http://www.spea.indiana.edu/clp/>
and see what's new and happening with the Program and with Indiana lakes!**

NONPROFIT ORG.
U.S. POSTAGE
PAID
Bloomington, IN
Permit No. 2

WATER COLUMN
School of Public and Environmental Affairs
Room 347
1315 E. Tenth Street
Indiana University
Bloomington, IN 47405-1701

