



The Ins and Outs of Marina-based Boating on Lake Champlain

Lake Champlain is a treasured resource that contributes to the economies of Vermont, New York, and Quebec. Unfortunately, some areas of the lake are challenged by excess phosphorus, which drives cyanobacteria blooms when this nutrient is present in excessive amounts. As these blooms can harbor harmful toxins, the health of recreational users, lakeshore homeowners, and their dogs is at risk.

The Vermont Legislature passed the Vermont Clean Water Act in 2015 and created an associated Clean Water Fund to support implementation of practices identified in a plan (called a Total Maximum Daily Load or TMDL) to minimize phosphorus inputs to the lake. Eligibility for Clean Water Funds is linked to this plan.

One potential source of nutrient inputs to the lake that was not accounted for in the TMDL is sewage produced by recreational boaters on Lake Champlain that may be improperly disposed (e.g., from improperly emptied toilets or over the edge of the boat). While improperly disposed sewage from recreational boaters on Lake Champlain is likely to pale in comparison to the annual volume of combined sewer overflows (CSO) from basin communities, the potential nutrient inputs to the lake from recreational boaters have been overlooked to date. This prohibits the Clean Water Fund from being used to support marinas to operate sewage pumpout facilities, and in turn, directs costs for pumpouts to recreational boaters, which has resulted in reduced use of such facilities in other states.

To begin to address the knowledge gap about recreational boating and sewage production and disposal on Lake Champlain, two surveys were conducted between August 2018 and August 2019: one of marina owners or operators and one of recreational boaters that used marinas. The goals of this research were to: 1) estimate mooring and slip capacity and annual sewage pumpout volume at marinas; 2) estimate the population of boats with toilets that use marinas on Lake Champlain; 3) assess general boater habits and practices related to lake use and sewage production and disposal; 4) estimate annual sewage volume produced by Lake Champlain marina-using boaters; and 5) estimate phosphorus inputs to Lake Champlain from potentially improperly disposed sewage.

Boaters at 16 randomly-selected marinas participated. The survey was offered in both English and French. Thirty-seven of 41 known marinas at the time of the survey participated in the marina survey.

LAKE CHAMPLAIN BOATERS THAT USED MARINAS IN 2018-19

- 273 survey respondents
- 36 homeports
- 5 US states
- 2 Canadian provinces
- 60% operated powerboats



- 39% operated sailboats

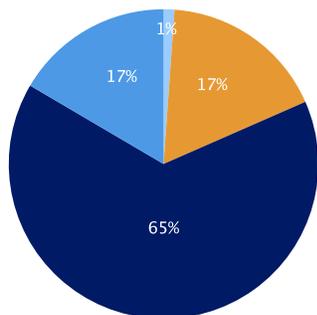


- A few operated pontoon boats and cruisers
- 35% French-speaking
- 65% English-speaking

What Did We Learn?

Vessel Lengths and Number of Boaters Per Boat

■ <16 ft (<4.8 m)
 ■ 16 ft -25 ft (4.8 m - 7.6 m)
 ■ 26 ft -39 ft (7.7 m - 11.9 m)
 ■ 40 ft+ (12 m+)



The majority of boats that used marinas were 26 to 39 feet in length (Figure 1). At the other end of the scale, very few were less than 16 feet long. People reported boating in relatively small groups, with an average of 2.8 people per boat on each trip. In fact, almost half (49%) reported boating with just 1 or 2 people per boat. Another 42% reported boating with a total of 3 to 4 people in the boat at a time.

Figure 1. Length distribution of boats that use marinas on Lake Champlain boats (number of respondents [n] = 266).

Boating Trip Characteristics

In general, on each boating trip, about 58% of people boated for less than 24 hours before returning to shore. Of those, people most commonly spent 4 to 6 hours on the water on each trip (Figure 2). Boaters reported a wide variety of habits, in regard to docking at marinas or offshore when they sleep on their boats (Figure 3).

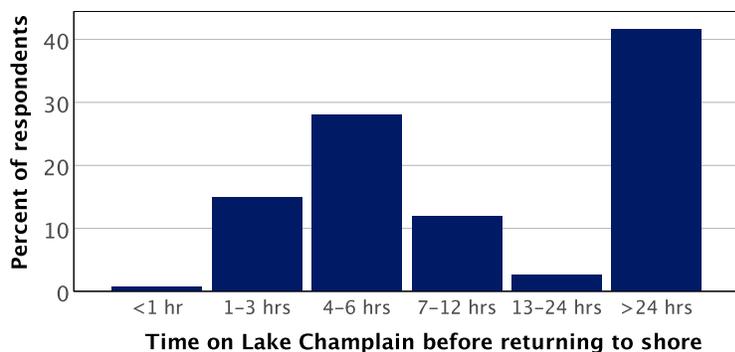
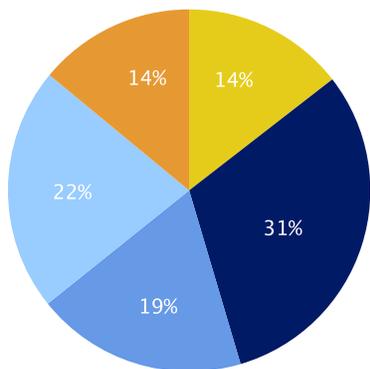


Figure 2. Average time Lake Champlain boaters spent on the water before returning to shore (n = 267).

■ Never
 ■ 1-33% of the time
 ■ 34-66%
 ■ 67-99%
 ■ Always

Dock at marina for the night



Anchor away from shore

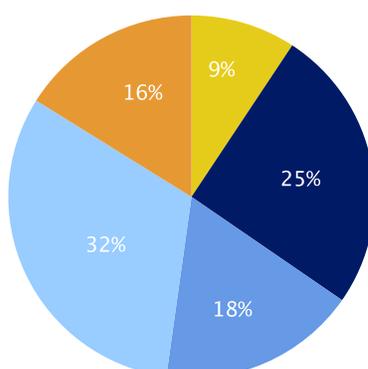


Figure 3. Percent of time Lake Champlain boaters reported being docked at marinas (n = 207) or anchored away from shore (n = 205) when they slept on their boats.

**ON AVERAGE,
EACH YEAR LAKE
CHAMPLAIN BOATERS
SPEND...**



days boating



nights sleeping
on their boats

Use of Boat vs. Land-based Toilets

When docked at a marina for the night, only about 25% of boaters used their boat toilets most of the time. It was much more common for boaters to use marina facilities instead. In fact, almost half (47%) reported using marina facilities more than two-thirds of the time when docked there for the night (Figure 4).

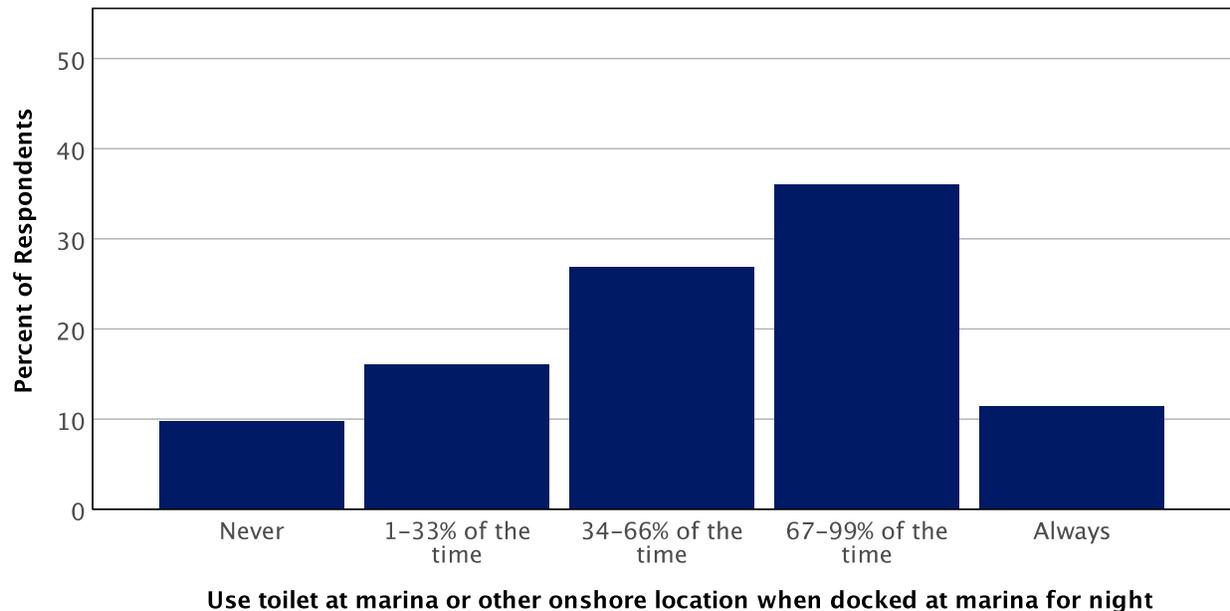


Figure 4. Percent of marina or other land-based toilet use by Lake Champlain boaters when docked at a marina for the night (n = 167).

Boat Toilet Characteristics

Almost a quarter of Lake Champlain boaters that use marinas do not know the size of their toilet's holding tank. Of those that do, there is a wide range of sizes from less than six gallons to more than 72 gallons (Figure 5). The distribution is nearly equal across four categories of size ranges with an average of 12-14% of boats in each.

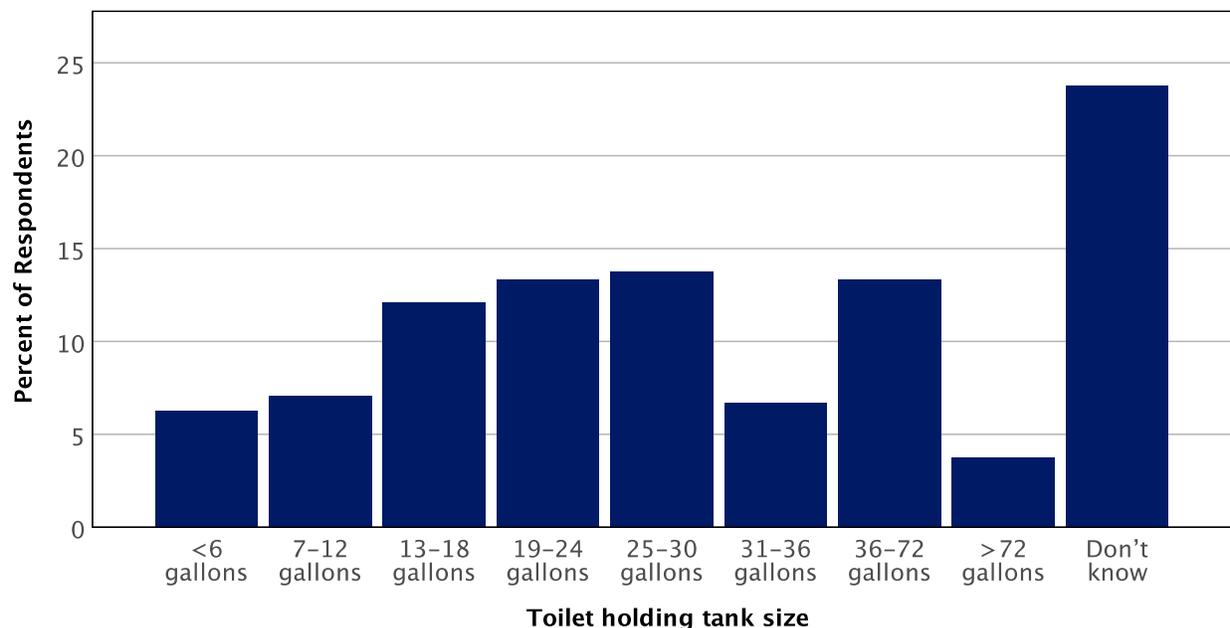


Figure 5. Range of toilet holding tanks sizes on boats that use marinas on Lake Champlain (n = 240).

Pumpout Frequency and Volumes

41% of Lake Champlain boaters pumped out sewage from their toilets between one and five times per year, while 28% pumped out six to ten times per year with a continual decline for the categories of 11-20 times per year (19%), 21-40 times per year (5%), and more than 40 times per year (about 1%). This information aligns with reported percent fill rates, where most people are pumping out sewage when their holding tanks are 75-100% full (Figure 6). Twenty-seven of 37 marinas offered pumpout services, with between 11 to more than 1280 pumpouts offered annually (average 513 pumpouts/year).

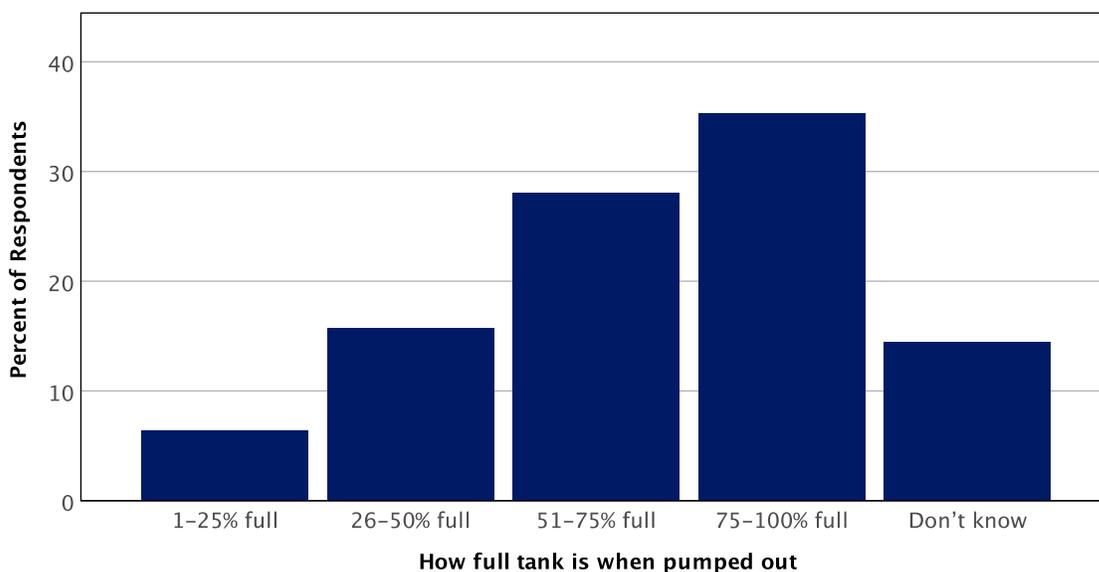


Figure 6. Reported toilet holding tank capacity filled upon sewage pumpout by boats that use marinas on Lake Champlain (n = 235).

Boat Population and Marina Capacity

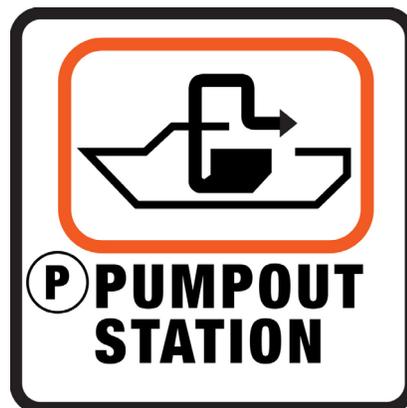
About 81% of 4200 slips and 82% of 820 moorings were rented for the season (with about 90% of marinas reporting). The estimated average boat population with toilets that used marinas on Lake Champlain in 2018-19 was 3470 (+/- 91) boats.

Reasonable Price for a Pumpout

45% of boaters felt a reasonable price for a sewage pumpout on Lake Champlain was \$10. Another 20% felt pumpouts should be free (Figure 7). As of 2020, 34 marinas offered pumpout services on Lake Champlain (Epical, 2020). Twelve of those offered free pumpouts, and prices for others ranged from \$5 to \$25, with 10 charging between \$12 and \$25 per pumpout (Epical, 2020). The average cost per pumpout was \$8.29.



Figure 7. Price per pumpout that Lake Champlain boaters felt was reasonable to pay (n = 236).



Sewage Produced by Lake Champlain Boaters Annually

Annual sewage production in boats by boaters that use Lake Champlain marinas was estimated using a variety of methods as a way to check and compare results (Table 1). Across the four methods used, the estimated volume of sewage produced in boat toilets by boaters that used marinas on Lake Champlain ranged from about 650,000 to 1.4 million gallons per year.

Table 1. Four methods were used to estimate annual sewage production (gallons) in boat toilets of boats that use Lake Champlain marinas. To make an estimate using average number of boater days and boater nights on Lake Champlain per year, 10 gallons/boat/day was used as an estimated volume of sewage produced (NC, 2018).

Method to Estimate Annual Sewage Production	Estimated Sewage Produced Annually (Gallons)
Pumpouts reported by boaters	770,340 (+/- 124,320)
Pumpout volume reported by marinas	792,692 (+/-102,704)
Reported boater days	1,388,000
Reported boater nights	1,075,700

Possible Phosphorus Contributions to Lake Champlain

A 1998 study surveyed boaters in the US about their habits (Baasel-Tillis and Tucker-Carver, 1998). Boaters in that study reported between a 6 and 15% direct overboard discharge rate of urine/feces and a 4 to 10% overboard discharge rate of holding tanks. Using those rates combined with the boat population, the average number of people per boat, and the average number of nights spent on boats, total pounds of phosphorus (P) that may enter Lake Champlain annually from improperly disposed boater sewage was estimated (Table 2).

Pounds of phosphorus were then converted to metric tons of phosphorus per year, and those values were compared to the 921 metric tons (MT) of phosphorus per year that enter Lake Champlain from all measured sources (LCBP, 2018). If reported overboard discharges from the 1998 study are valid, the resulting estimates suggest that contributions of phosphorus from overboard discharge of urine/feces into Lake Champlain make up, at most, a hundredth of a percent of the lake's annual phosphorus load (Table 2).

Table 2. Estimated annual potential phosphorus inputs to Lake Champlain from improperly-disposed urine/feces. 1.6 grams of phosphorus per person per day was used for calculations (USEPA, 2002) and later converted to lbs and metric tons.

Lower estimates of potential phosphorus inputs			Upper estimates of potential phosphorus inputs		
Phosphorus (Lbs/yr)	Phosphorus (MT/yr)	Percent of annual P loading to Lake Champlain	Phosphorus (Lbs/yr)	Phosphorus (MT/yr)	Percent of annual P loading to Lake Champlain
74	0.03	0.004	223	0.10	0.01

Acknowledgments

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- Dr. Eric Roy for information to calculate annual estimated phosphorus loads

References and Credits

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Notes

This document was prepared by Dr. Kris Stepenuck to share high level results with Lake Champlain marina owners and operators and local study partners. The information has yet to be peer-reviewed, and so is subject to revision.



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