Lake Champlain Basin Program

State of the Lake

Lake Champlain in 2005—A Snapshot for Citizens

About the Lake Champlain Basin Program

The Lake Champlain Basin Program (LCBP) was created by the Lake Champlain Special Designation Act of 1990. Our mission is implementing the Lake Champlain management plan, *Opportunities for Action*. Program partners include New York, Vermont, and Québec, the US Environmental Protection Agency (US EPA) and other federal agencies, the New England Interstate Water Pollution Control Commission, and local government leaders, businesses, and citizen groups.

The Lake Champlain Steering Committee leads the LCBP. Its members include many of the program partners, and the chairpersons of technical, cultural heritage and recreation, education, and citizen advisory committees. The LCBP's primary annual funding is received through a US EPA appropriation under the Federal Clean Water Act. Visit www.lcbp.org to learn more.

Figure 1 | **THE LAKE CHAMPLAIN BASIN OR WATERSHED**

Cover photos credits (left to right): Voice for the Potash, Dave Capen, Sure Strike Charters, J. Millard/America's Historic Lakes, L. Roy, Boquet River Association. Page 1: W. Howland.

State of the Lake: Lake Champlain in 2005—A Snapshot for Citizens

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J. Millard/America's Historic Lakes

What is the State of the Lake report?

The Lake Champlain Basin Program (LCBP) produced this special report for our most important partners: the hundreds of thousands of citizens who live in the Lake Champlain Basin and whose future is tied to the quality of the Lake itself. It answers important questions frequently asked by the public about the Lake's health. We have included scientific information on trends wherever possible to show changes in the Lake over time.

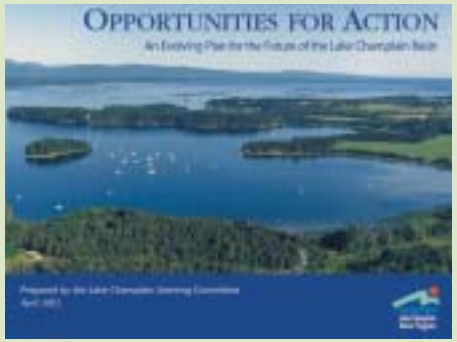
Lake Champlain is a vital lake with many assets, but like many of North America's great waters it has environmental problems. This report is focused on important public interests in water quality, health and safety, fish and wildlife habitat, and aquatic nuisance species. Additional sections highlight cultural heritage, recreation and education. We hope this report will provide readers with a better understanding of the overall state of Lake Champlain and guide them to additional resources.

The report is also a statement to our US Senators and Representatives who have supported Lake Champlain management through authorizations, major appropriations and guidance for more than a decade. It also is an important update for the Governors of New York and Vermont, US Environmental Protection Agency officials and other federal partners, and the Premier of Québec—all of whom have endorsed the implementation of the lake-wide management plan, *Opportunities for Action*. Significant leadership and federal, state and provincial funding for implementation projects have guided stewardship efforts across the boundaries. This public leadership—a collaborative, nonpartisan tradition of solving cross-boundary problems in a large watershed—has emerged as a global model and received high praise from managers struggling with similar challenges worldwide. It is essential that the status of successful efforts to date, and also the serious challenges that lie ahead, be clarified. The *State of the Lake* report advances that goal.

The *State of the Lake* report was assembled with assistance from dozens of scientists and state, provincial, and federal technical experts. Much of the information was gathered at a workshop in March, 2005 that was convened by the LCBP. Addressing a limited number of questions, however, necessarily limits the breadth of the information. Hundreds of additional scientific reports for the Lake Champlain watershed issues have been prepared by university researchers and other professionals. Please refer to the inside back cover for contacts to research groups.

Throughout the report every attempt has been made to present well-established factual information, and to minimize descriptions based on conjecture. The teamwork of many partners has made this possible. We appreciate this broad support for improving the condition of Lake Champlain and assisting the work of the LCBP.

The LCBP Vision: Implementing the Lake Champlain Basin Management Plan



Opportunities for Action (2003) is a management plan endorsed by all the partners of the Lake Champlain Basin Program in New York, Vermont and Québec to implement a vision for a clean lake and a strong economy. The plan envisions a Lake Champlain that supports multiple uses—including a healthy drinking water supply, wildlife habitat, recreation, and commerce. These diverse uses must be balanced to minimize stresses on any part of the Lake system. The LCBP recognizes that maintaining a vital economy which values the preservation of the agricultural sector is an integral part of the balanced management of the Lake Champlain Basin. Implementing a comprehensive management plan will ensure that the Lake and its Basin will be protected, restored and maintained so that future generations will enjoy its full benefits. The plan may be read online at www.lcbp.org.

Can I swim in Lake Champlain?

Yes, the Lake's water quality is usually safe for swimming. Many public beaches are monitored and pathogens like coliform bacteria are usually not high enough to warrant beach closures. When beaches are closed it is often after a heavy rain, which washes pollutants from the landscape into rivers and the Lake. People using unmonitored areas, especially near river mouths and stormwater discharges are advised to avoid swimming after rainstorms.

The most widespread human health risk for swimming is pathogen contamination. Pathogens are disease-causing agents, such as bacteria, viruses and parasites that can create gastrointestinal illnesses when ingested. Sources include human and animal fecal wastes that enter the Lake through rain runoff, failed septic tanks, storm drains, agricultural fields, and combined sewer overflows.

State parks, cities and towns test public swimming areas for pathogens and post warnings at beaches if necessary. Summarizing the total number of Lake-wide beach closures is difficult though because the New York, Vermont, and Québec health departments use different tests to screen for pathogens. All three methods, however, are useful for making decisions on beach closures. The decision about whether to close a beach is usually made by the park or municipality. Swimmers should stay informed about local conditions, especially following rainstorms. Visit www.lcbp.org/swim.htm for links to beach closure information online.

A University of Vermont study of urban stormwater discharges into Burlington Bay found that both pathogens and phosphorus (not a human health threat) were almost always high after rainstorms. Concentrations of other chemicals were more variable. There were generally low levels of heavy metals, such as lead, copper, cadmium, and zinc, and organic contaminants such as polychlorinated biphenyls (PCBs). Pesticides were found more during the summer, reflecting their use on lawns and gardens. For people using the Lake for recreation, this study illustrates that caution should be exercised after rainstorms. More information on this study is online at www.uvm.edu/empact/water/stormwater.php3.

M. Watzin, UVM

Blue-green algae blooms look like green paint slicks on the water.

L. Roy

Do blue-green algae blooms pose a risk?

Yes, especially in Missisquoi Bay, St. Albans Bay and several smaller northeastern bays. Most of Lake Champlain, however, has never had dense blue-green algae blooms or high levels of algae toxins. Dense blooms and shoreline scum may produce toxins that can irritate skin. If ingested, gastrointestinal problems and damage to the liver and nervous system may result. People, especially children (and pets), should avoid water near blooms and scum.

Blue-green algae, or cyanobacteria, have been in Lake Champlain historically and are a normal part of its biology. Dense blooms, however, have increased worldwide in recent years—the Lake is no exception. Nuisance blooms were recognized as a problem in the mid-1990s, when large blooms developed in Missisquoi Bay. Bloom locations vary annually and seasonally and the blooms are blown around by winds.

In August of 1999, the toxins produced by a blue-green algae bloom became a public concern when a dog died from poisoning near Juniper Island in the Main Lake. With funding from the LCBP, the University of Vermont (UVM), in partnership with the VT Department of Environmental Conservation (VTDEC), has monitored blooms and toxicity levels since 2000. They provide their data to health departments in New York, Vermont and

Québec. Several types of toxins are monitored, with microcystin and anatoxin most commonly found. Monitoring locations for Missisquoi Bay are shown on Figure 2.

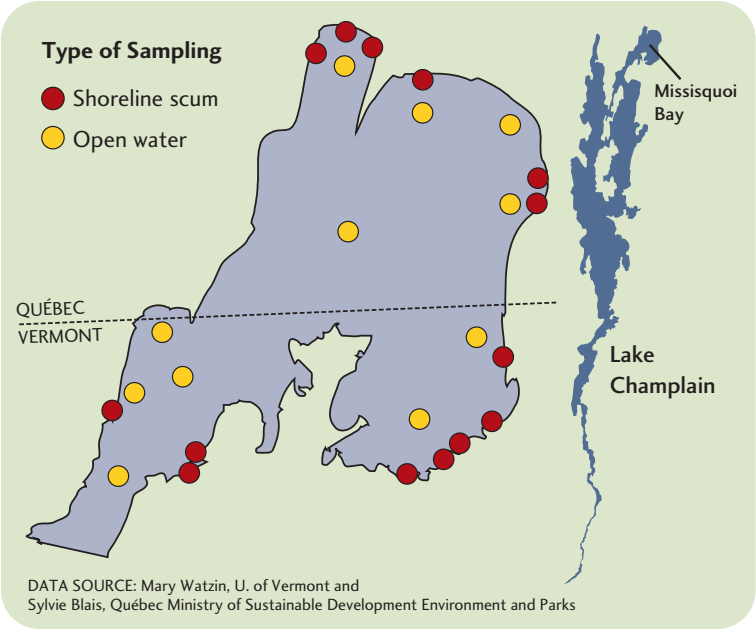
The Québec Ministry of Sustainable Development, Environment and Parks monitors waters in Missisquoi Bay. Much of the United States' shoreline on the Bay is monitored by volunteers identified with help from the non-profit Lake Champlain Committee. The volunteers are trained and coordinated by UVM to collect samples. New York has not experienced the serious blue-green algae problems faced by Vermont and Québec, although two dogs perished after ingesting a large amount of toxins from a small bloom near Point au Roche in 2000.

Although anatoxin caused the 1999 dog death, its levels have been low since 2001. The greater concern is the toxin microcystin. In the South and Main Lake, microcystin levels are well below drinking water and recreational use guidelines. Occasionally concentrations exceed the guidelines in St. Albans Bay and the northern Lake. In Missisquoi Bay, microcystin concentrations regularly exceeded recreational use guidelines from July to September in recent years.

While blue-green algae are known to thrive on excess phosphorus, researchers at the SUNY College of Environmental Science and Forestry, UVM and SUNY Plattsburgh are researching why it has become so dominant over other innocuous algae species in recent years. Another LCBP-funded study at Clarkson University is investigating whether herbicide use contributes to blue-green algal dominance.

A blue-green bloom near Philipsburg, Québec in Missisquoi Bay, July 2003.

Figure 2 | BLUE-GREEN ALGAE SAMPLING LOCATIONS ON MISSISQUOI BAY, 2004



Who notifies the public about blue-green algae risks?

The health departments in Vermont, Québec and New York are responsible for notifying the public about health risks.

The VT Department of Health (VTDOH) relies on University of Vermont (UVM) monitoring for information about blue-green algae problems. UVM also shares data with Québec and New York. If a bloom tests positive for harmful toxins, the VTDOH issues press alerts. Québec also tests for toxins regularly and its health department issues advisories and closes public beaches based on dense blooms and algae scum. These somewhat different guidelines may result in the issuance of advisories on different dates in Québec and Vermont.

HEALTH DEPARTMENT CONTACTS

Vermont: (800) 464-4343 (in VT)
www.healthyvermonters.info

New York: (800) 458-1158
www.health.state.ny.us

Québec: (450) 928-6777
www.rrsss16.gouv.qc.ca

Can I drink the water?

Yes. After treatment by public drinking water suppliers, the Lake's water is of high quality and safe for drinking. Untreated water should never be consumed from any surface waters, including Lake Champlain. Only a few Basin residents withdraw Lake water directly for drinking. These residents are advised to contact their local health department to make sure they safely filter or process their drinking water.

People drinking untreated water from Lake Champlain confront the same water quality concerns that pose a risk to swimmers. Intentionally drinking untreated water, rather than accidentally swallowing a mouthful while swimming, exposes people to a significantly higher risk of pathogen contamination from bacteria, viruses and parasites.

Health safety standards are clearly defined and rigorously applied to drinking water. Of the 188,000 people who drink Lake Champlain water, about 98% obtain their water from public supplies that are monitored and regulated by the states or province. In the Basin, Vermont has 73 water supply systems, New York has 26 and Québec has one. The largest water suppliers are the City of Burlington and the Champlain Water District, which serves Chittenden County, Vermont. Plattsburgh uses groundwater and draws from a reservoir in Morrisonville.

About 2% of Basin residents draw water directly from the Lake. This practice may increase exposure to contaminants from stormwater because their intakes are often shallower than those for public drinking water.

Public water suppliers in areas affected by blue-green algae have become increasingly knowledgeable about the problem and effective in treating the water so it is safe to drink. In the summer of 2004, raw (untreated) water was tested for toxins at public water suppliers in North Hero, St. Albans, Swanton, and Alburg Springs. Samples of raw water from Alburg Springs and North Hero contained traces of the toxin microcystin, but at levels well below health guidelines for drinking water. Moreover, following treatment, toxin concentrations in the finished (treated) drinking water were below measurable levels.

The boiling and filtering methods used by most private cottages and camps for drinking water, however, are not effective at removing toxins. Owners are advised to contact their local health departments to determine how to prevent toxin exposure.

Holding tanks for Lake water before treatment at the Champlain Water District.

Safe Drinking Water Act

The Safe Drinking Water Act's 30th anniversary was celebrated in 2004. This act is the main federal law in the United States that ensures the quality of drinking water. It is administered through the US Environmental Protection Agency.

Visit www.epa.gov/safewater to learn more about drinking water quality.

Can I eat the fish from Lake Champlain?

J. Millard/America's Historic Lakes

Ice fishing shanties near the sandbar in South Hero.

Yes, but health advisories for the toxic chemicals PCBs and mercury in certain fish should be considered carefully, especially by women and children. Recent studies show a significant reduction in PCB levels in Cumberland Bay's sediments, as a result of a $35 million cleanup. These findings may allow the PCB-related fish advisories in the Bay to be lifted in the coming years. Mercury and PCBs, however, remain Lake-wide issues.

Mercury and polychlorinated biphenyls (PCBs) are routinely monitored in Lake Champlain fish by the Vermont and New York environmental conservation departments and the Québec Ministry of Sustainable Development, Environment and Parks. Fish may be tested for additional chemicals if spills, contamination or other circumstances warrant investigation.

Health departments use the agency sampling results to determine if fish consumption advisories are needed (Figure 3). Lake Champlain advisories in New York and Vermont are based on statewide and local advisories specific to the Lake. The Québec advisories are specific to Missisquoi Bay.

Special advisories are posted for women of childbearing age and children.

Figure 3 | LAKE CHAMPLAIN FISH CONSUMPTION ADVISORIES IN NUMBER OF MEALS PER MONTH (1 MEAL = 8 OZ OR 230 GRAMS OF FISH)

	VERMONT		NEW YORK		QUÉBEC [C]	
FISH SPECIES	Women/Child [A]	All Others	Women/Child [B]	All Others	Women/Child	All Others
Brown Bullhead	no advisory	no advisory	0	in Cumberland Bay: 0*	8	8
Pumpkinseed	no advisory	no advisory	0	4	no advisory	no advisory
Walleye	0	1	0	> 19" (48cm): 1*	8 <50 cm / 0 >50cm (20")	8 <50cm / 4 >50cm (20")
Lake Trout	1	3	0	4	no advisory	no advisory
Lake Trout >25" (63cm)	0 (incl. child <15)*	1*	0	1*	no advisory	no advisory
Trout: Brook/Brown/Rainbow	3-4	no advisory	0	4	no advisory	no advisory
Chain Pickerel	1	3	0	4	no advisory	no advisory
American Eel	1	3	0	in Cumberland Bay: 1*	no advisory	no advisory
Largemouth Bass	2	6	0	4	no advisory	no advisory
Smallmouth Bass	1	3	0	4	8	8
Northern Pike	2	6	0	4	8 <70cm / 0 >70cm (27")	8 <70cm / 4 >70cm (27")
Yellow Perch	3-4	no advisory	0	in Cumberland Bay: 1*	8	8
All Other Fish	2-3	9	0	4	no advisory	no advisory

NOTES: **A)** Women of childbearing age, particularly pregnant women, women planning to get pregnant and breastfeeding mothers, and children age six or younger. **B)** Women of childbearing age, infants and children under the age of 15. **C)** No meal of any species recomended in Missisquoi Bay during July to January because of blue-green algae (cyanobacteria). New QC guidelines will be issued in summer 2005.
* Advisory specific to Lake Champlain. All other advisories are state-wide in NY and VT. All the QC advisories are specific to Missisquoi Bay.
SOURCES: NY Department of Health, 2004-2005; VT Department of Health, 2000; QC Department of Health, 2005.

Developing fetuses are sensitive to chemical contaminants that the mother consumes, and children are at higher risk because their internal organs are still developing. High concentrations of mercury, PCBs or other toxins can cause birth defects, cancer or other illness. The effects also may include more subtle behavioral and developmental abnormalities.

Mercury is the most common toxic contaminant of concern in the Lake Champlain Basin. Most of the mercury is transported through the atmosphere, having originated in coal-fired power plants and medical and municipal waste incinerators located outside the Basin. There also are sources within the Basin, including improperly disposed old thermometers and thermostats, diesel emissions, and products that use mercury-containing button cell batteries.

When fish advisories mention mercury, they refer to methylmercury. Mercury in the environment can be converted to its more toxic form, methylmercury, and work its way up the food web to accumulate in fish and other animals. Larger predatory fish like walleye, lake trout, smallmouth bass, and northern pike have the highest methylmercury concentrations.

PCBs are persistent industrial chemicals found world-wide that are suspected to cause cancer. Like mercury, they accumulate in larger predatory fish. The two-year $35 million cleanup of Cumberland Bay, New York, completed in 2001 by the NY State Department of Environmental Conservation (NYSDEC), removed PCB-laden sediments that had been left from industrial discharges. Pre- and post-dredging sediment testing shows sharp declines in PCBs (Figure 4). The Bay's fish are sampled annually to determine when the PCB-related advisories on brown bullhead, American eel and yellow perch may be removed. A report on the fish sampling will be available in fall 2005 from the NYSDEC.

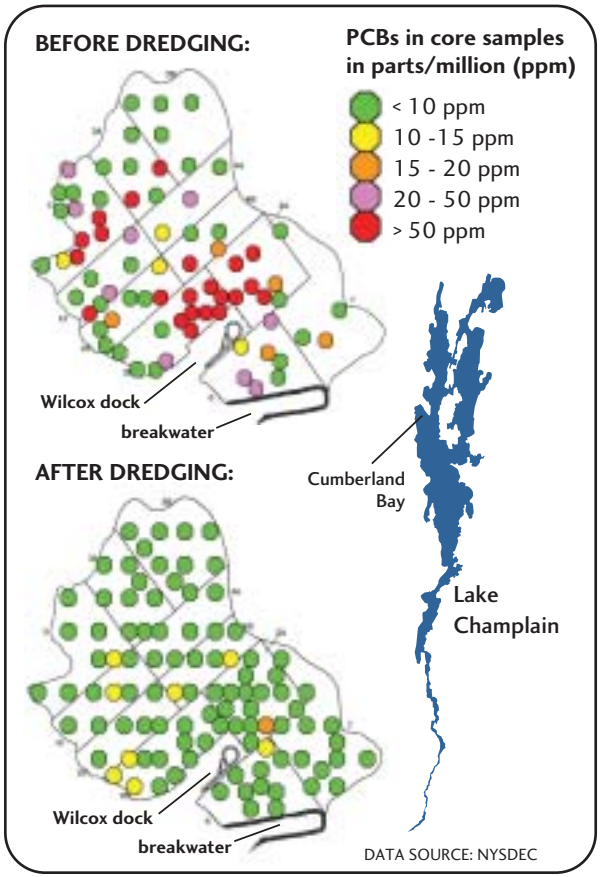


Figure 4 | PCBS IN CUMBERLAND BAY SEDIMENTS BEFORE AND AFTER DREDGING

Mike Dowd, Press Republican

NYSDEC

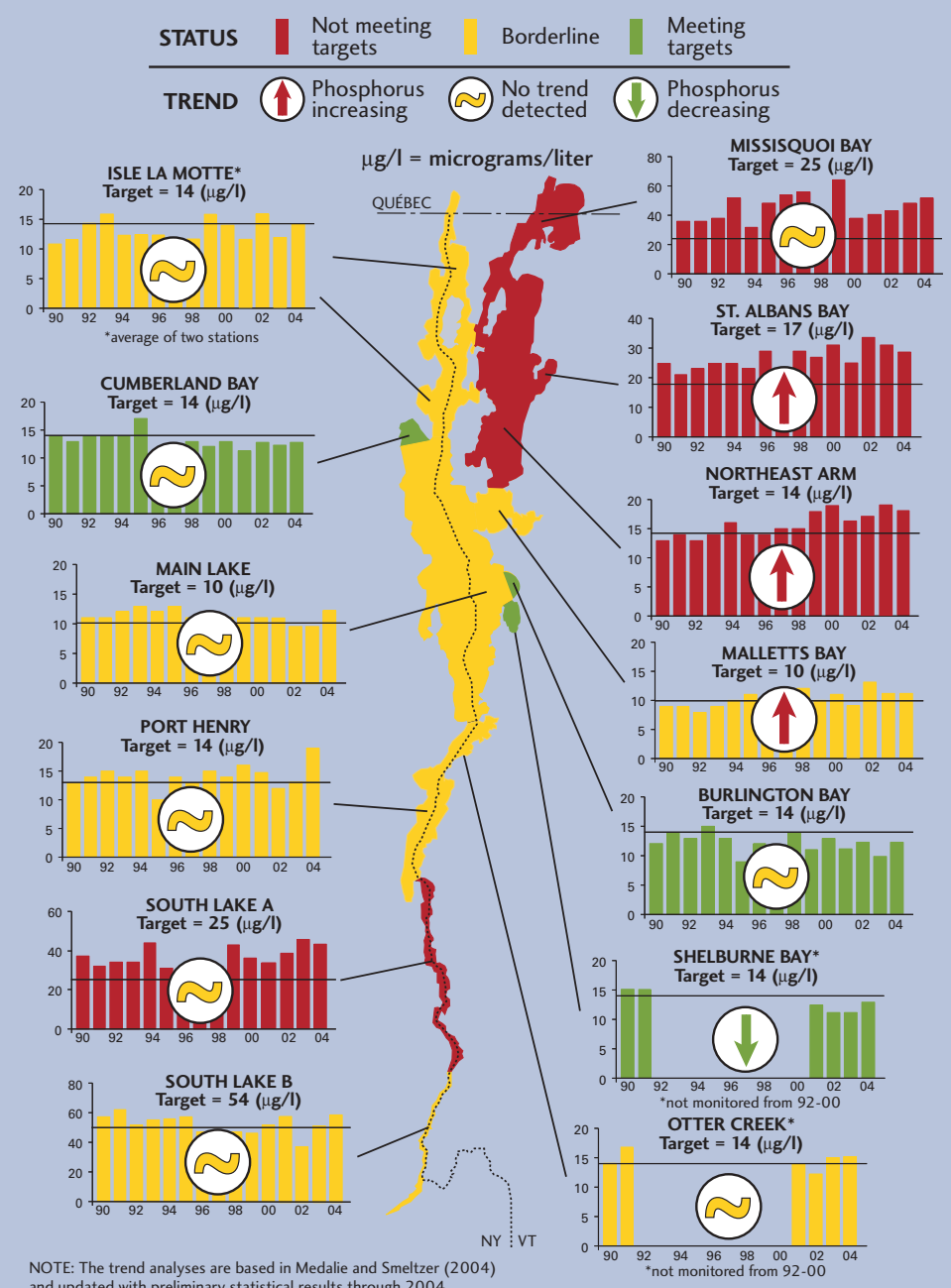
About 140,000 tons of PCB-contaminated sludge was removed from Cumberland Bay in 2001 (top). Below, NYSDEC's "Clean Sweep" is one of many pollution prevention efforts to keep other pollutants from ever getting to the Lake.

Are there any new toxins to be concerned about?

As the ability to detect chemicals in low concentrations improves, researchers in other regions of the United States are finding environmental contamination by "new generation toxins." Pharmaceuticals (primarily drugs passed through the patient), personal care products, caffeine, pesticides, agricultural chemicals, and common fire retardants (PBDEs) are among the contaminants found in other waters.

While these toxins are not a factor in fish advisories, little data exists as to whether these contaminants are a problem in the Lake Champlain ecosystem. In 2005, the LCBP will sponsor a toxins workshop for experts to recommend next steps for these issues in the Basin.

Are phosphorus levels too high in the Lake?



NOTE: The trend analyses are based in Medalie and Smeltzer (2004) and updated with preliminary statistical results through 2004. Based on LCBP/VTDEC Long-Term Monitoring Program data.

Yes, phosphorus levels are too high in most parts of the Lake because of human activities. Missisquoi Bay, the Northeast Arm and parts of the South Lake greatly exceed the phosphorus standards or targets. But the Main Lake and Shelburne, Cumberland, Burlington, and Malletts Bays are near the targets. Large reductions have been gained from sewage treatment improvements, but great challenges remain to reduce phosphorus in nonpoint source runoff.

Human activities such as sewage treatment, farming, lawn care, and urban living produce and concentrate the nutrient phosphorus. Although phosphorus is not harmful to people, too much of it in Lake Champlain is a problem because it promotes algae growth and causes a deterioration of water quality. The increased algae affect many other organisms and interfere with recreational enjoyment.

Tributary rivers carry most of the phosphorus to the Lake. Great progress has been made in reducing phosphorus from point sources, such as sewage treatment and industrial discharges. Today, less than 10% is from these sources. Runoff from nonpoint sources, such as roads, developed land, lawns, riverbanks, and agricultural land, contributes over 90%. Of the nonpoint sources, 56% of the phosphorus comes from agricultural lands, 37% is produced by developed land, and 7% is from forests.

The LCBP has funded water quality monitoring for phosphorus and other indicators since 1992. Monitoring data were examined to see if there have been increasing or decreasing phosphorus trends between 1990 and 2004. The lake segments shown in red (Figure 5) have consistently failed to meet the water quality standards (targets), and the trend (red up arrow) has been an increase in three segments. Segments in yellow sometimes meet water quality standards. Most have no significant trend up or down (yellow wavy line), except for Malletts Bay, which is increasing. Cumberland, Shelburne and Burlington Bays, shown in green, consistently meet water quality standards.

Data from monitoring at the mouths of the Lake's 18 major tributaries indicate that only the La Platte River is close to meeting its target phosphorus load (Figure 6). Seven tributaries, however, show an improving trend (green down arrows) and three show worsening trends for phosphorus (red up arrows). The remaining rivers have no trend (yellow wavy line). It is important to note that each river contributes different percentages of the Lake's total phosphorus load, whatever the trend.

The Total Maximum Daily Load (TMDL) is a plan to reduce phosphorus loads carried to the Lake by the rivers so

Figure 5 | **STATUS AND TRENDS OF LAKE CHAMPLAIN PHOSPHORUS CONCENTRATIONS, 1990-2004**

they do not exceed the pollution standards. It was developed by Vermont and New York in 2002, as required by the US Environmental Protection Agency through the Clean Water Act. The Missisquoi sub-basin carried the highest phosphorus load (167.3 metric tons/year in 1991) of the total 631.3 mt/yr load for the entire Basin. One metric ton (mt) is about 2,205 pounds.

Accordingly, this sub-basin must reduce the most phosphorus—70.1 mt/yr, to achieve the TMDL. In 2002, Vermont and Québec signed an agreement to allocate responsibility for reducing phosphorus in the Missisquoi sub-basin (Vermont 60% and Québec 40%). By comparison, tributaries in the Port Henry and Northeast Arm sub-basins carry very little phosphorus and have targets of 3.5 mt/yr and 1.2 mt/yr, respectively. More information on the TMDL is at: www.vtwaterquality.org/lakes/htm/lp_phosphorus.htm.

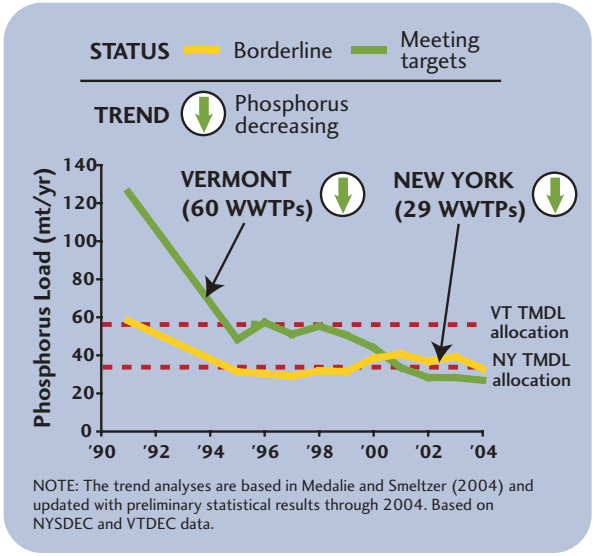
Throughout the Basin, many efforts are reducing both point and nonpoint

Volunteers planting trees on farms in the Missisquoi Bay watershed (top). Below, restoring the banks along Potash Brook to control urban runoff from Route 7 in South Burlington.

NOTE: The trend analyses for all the rivers, except the Pike, are preliminary results from Laura Medalie, USGS, personal communication. Based on LCBP/VTDEC Long-Term Monitoring Program data. The Pike River analysis is from the Québec Ministry of Sustainable Development, Environment and Parks.

Figure 6 | STATUS AND TRENDS OF TRIBUTARY PHOSPHORUS LOADING, 1990-2004

phosphorus sources. Wastewater treatment plant upgrades have greatly reduced point sources and trends show significant improvement (Figure 7). In Vermont, 60 plants have achieved about 100 metric tons/year reduction. New York and Québec have also had substantial reductions since 1990. Best management practices, including manure pits, milk house runoff treatments, and stream buffers, have been implemented on many Basin farms to reduce phosphorus runoff. Vermont's Clean and Clear initiative is implementing the TMDL and the phosphorus reduction actions in *Opportunities for Action*. Much work over many years remains, however, to ensure that a significant phosphorus reduction occurs in Lake Champlain.



NOTE: The trend analyses are based in Medalie and Smeltzer (2004) and updated with preliminary statistical results through 2004. Based on NYSDEC and VTDEC data.

Figure 7

STATUS AND TRENDS IN WASTEWATER TREATMENT PLANT (WWTP) PHOSPHORUS DISCHARGES, 1990-2004

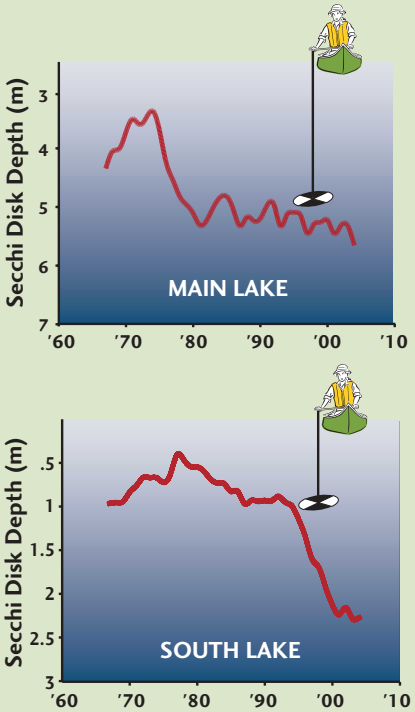
The IJC Missisquoi Bay Causeway Report

Many Missisquoi Bay residents want the Route 78 causeway removed because they believe it restricts water flow and traps phosphorus and algae blooms in the Bay. In March 2005, the International Joint Commission (IJC) affirmed prior research indicating causeway removal would have a negligible impact on the Bay's phosphorus concentration. However, the IJC also felt that since residents believe so strongly that causeway removal would remedy some of Missisquoi Bay's problems, removing it is justified and would shift more public attention to important phosphorus reductions in the watershed. The commission also encouraged dramatically increased phosphorus reduction efforts and recommended habitat protection for the spiny softshell turtle, an endangered species that lives in the Bay. More information is online at www.ijc.org/rel/news/050331_e.htm.

Has water clarity improved?

Yes, but water clarity, or the clearness of water, can improve for many reasons. The ban on phosphorus in laundry detergents during the mid-1970s reduced phosphorus and algae in Lake Champlain. This ban is most likely why water clarity increased greatly during this same time period in the Main Lake (Figure 8). In the mid-1990s, zebra mussels colonized southern Lake Champlain. Although detrimental in many ways (see page 19), zebra mussels filter algae from the water and may be responsible for the improvements in water clarity in the South Lake near Crown Point.

Lake water clarity is measured with a black and white Secchi disk. The Secchi disk is lowered on a rope into the water until it can no longer be seen, and that depth is recorded as the *Secchi disk transparency depth*. Secchi disk data are available back to the 1960s, thanks to early lake researchers and long term monitoring, including the work of many dedicated volunteer lay monitors.



NOTE: The red line represents a 5-year running average of the June-September annual means. DATA SOURCE: VT DEC

Figure 8

SUMMER SECCHI DISK TRANSPARENCY, 1960-2004

How do increases in population and land use changes influence water quality?

As the Basin's population increases, land is converted from farms and forests to cities and suburbs. One acre of developed land—with roads, parking lots, office parks, and lawns—typically sends three times as much phosphorus to the Lake as one acre of agricultural land. Improved stormwater treatments are essential to accommodate population growth.

Studies from 1993 determined that although only six percent of the Basin was developed land (suburbs and cities), these lands contributed about 37% of the Lake's phosphorus load. Developed land has many impervious surfaces such as parking lots, roads and roofs. When rain falls, impervious surfaces speed up the flow of water over the landscape, washing pollutants into storm drains and nearby streams. These pollutants include lawn fertilizers, pesticides and herbicides, which are used in excess by many homeowners and businesses. Before surfaces were paved, the soil could absorb and store extra surface water and nutrients. Increased water flow can also erode nutrient-rich stream banks and increase both sediment and phosphorus pollution in the Lake.

When the Basin's recent population growth is considered—an increase of 31,000 people between 1990 and 2000—the effect developed land can have on the Lake's phosphorus is startling (Figure 9). Some of the gains made in point source and on-farm phosphorus reduction have been negated by increases in urban and suburban land acreage.

New technology can accommodate growth and treat runoff, but these techniques may seem expensive and may even conflict with current zoning. To address these challenges, the City of South Burlington created the Basin's first-ever stormwater utility in 2005. The utility, which is supported by fees based on impervious surface amounts, will manage runoff from snowmelt and rainstorms.

The LCBP is currently updating the 1993 land use data. This new information will help determine how land uses have changed and improve our understanding of phosphorus loading to Lake Champlain.

VTDEC

Chittenden County Metropolitan Planning Organization

Dense roofs and roads speed up the flow of rain, which washes pollutants into waterways and storm drains (top). Below, a storm drain message sends a reminder that developed areas can affect the Lake's health.

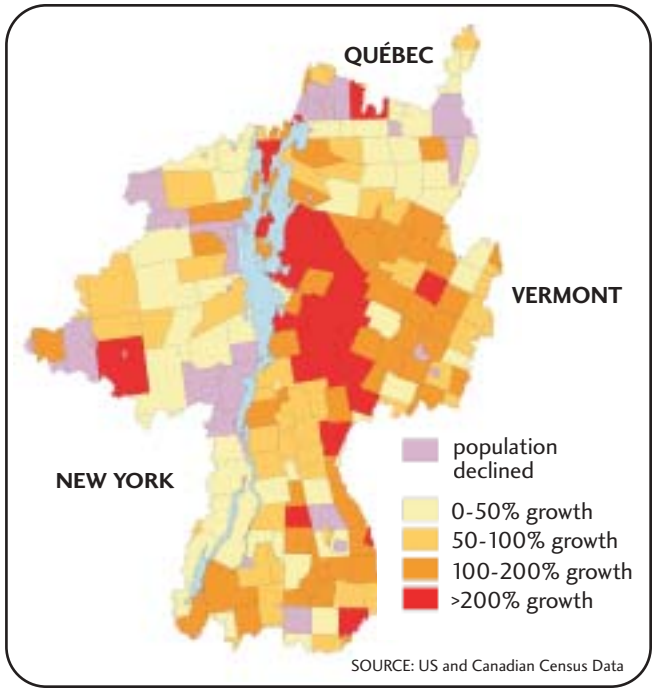


Figure 9 | **LAKE CHAMPLAIN BASIN POPULATION CHANGE BY TOWN, 1960-2000**

State of the Lake by Location

The Lake's size, unique geography and water flow breaks the Lake into five major segments and many smaller bays. Each segment has different physical characteristics and different land uses in its surrounding sub-basin which influence the health of that segment. That is why many concerns for Lake Champlain are location-specific. For example, blue-green algae are a serious problem in Missisquoi Bay, but have never been a problem in the South Lake.

This map describes each segment and shows some of its particular issues. Please refer to the pages listed to learn more about the issue. Lake-wide issues are listed below:

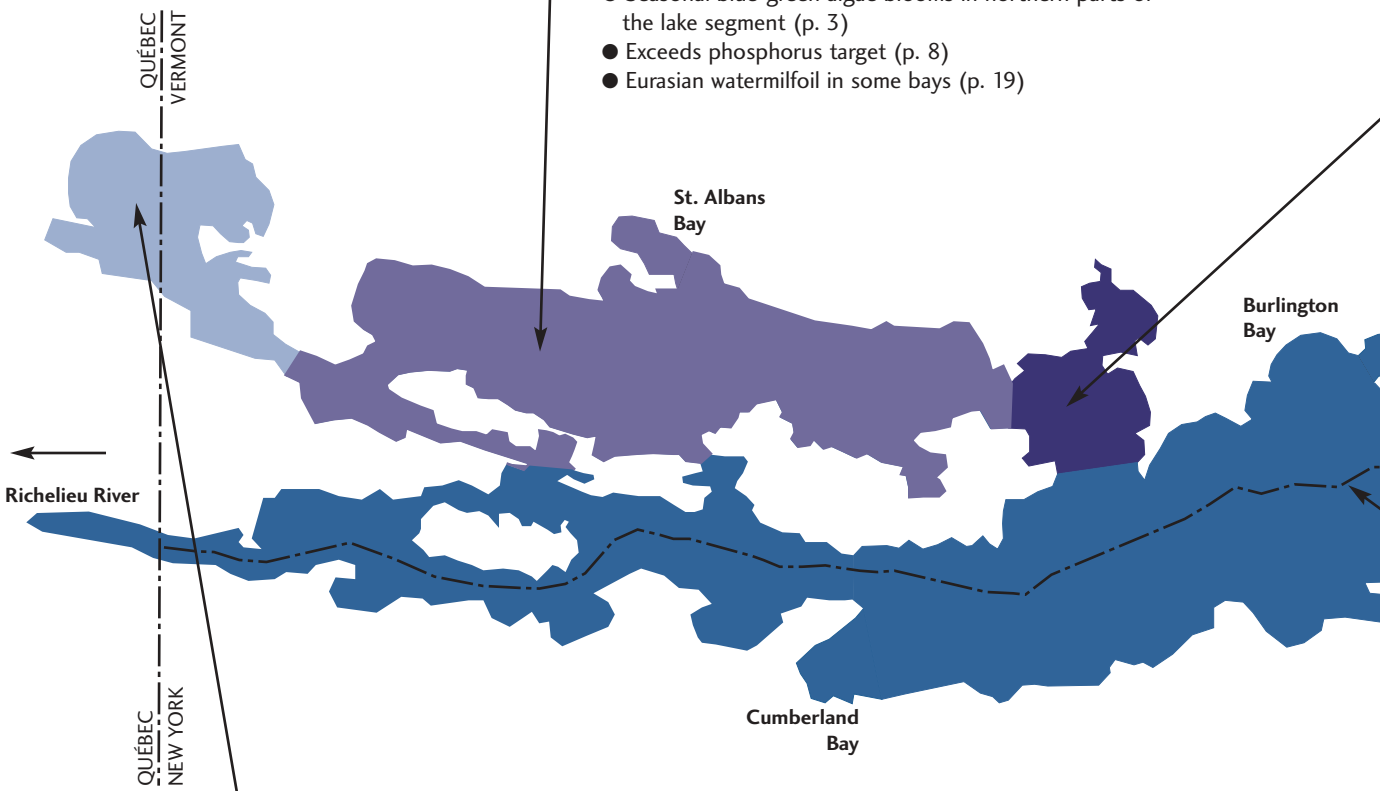
LAKE-WIDE ISSUES:

Alewife (p. 17)
Biodiversity threats (p. 15)
Cormorants (p.16)
Fish advisories (p. 6)
Phosphorus (p. 8)
Sea lamprey (p. 18)
Swimming concerns (p. 3)
Threats from new nonnative species (p. 21)
Wetland and river protection (p. 14)
Zebra mussels (p. 19)

LAKE CHAMPLAIN FACTS:

Length: 120 miles (193 km)
Greatest width: 12 miles (19 km)
Greatest Depth: 400 ft. (122 m)
Average Depth: 64 ft. (19.5 m)
Average Annual Water Level: 95.5 ft. (29 m)
Water Surface Area: 435 sq. miles (1127 sq. km)
Area of the Basin: 8,234 sq. miles (21,326 sq. kms)
Population of Basin: 571,000
Basin Land Distribution: 56% Vermont, 37% New York, and 7% Quebec.

Visit the Lake Champlain Basin Atlas at www.lcbp.org/atlas/index.htm for more facts and maps about the watershed.



INLAND SEA OR NORTHEAST ARM

Physical setting:
Water from both Missisquoi Bay and Malletts Bay mix here. Extensive agricultural land and urbanization results in nonpoint source phosphorus concerns.

Inland Sea Issues:
- Seasonal blue-green algae blooms in northern parts of the lake segment (p. 3)
- Exceeds phosphorus target (p. 8)
- Eurasian watermilfoil in some bays (p. 19)

The sandbar ca

MISSISQUOI BAY

Physical setting:
Shallow, with maximum depth of about 15 ft (5m), and warm water. Extensive agricultural land in sub-basin.

Missisquoi Bay Issues:
- Seasonal blue-green algae blooms (p. 3)
- Greatly exceeds phosphorus target (p. 8)
- White perch invasion (p. 17)

Missisquoi River delta wetlands.

Photo credits (clockwise from top left): N. Ballinger, LocalMotion, G. Randorf, N. Ballinger, Québec MDDEP.

auseway.

MALLETTS BAY

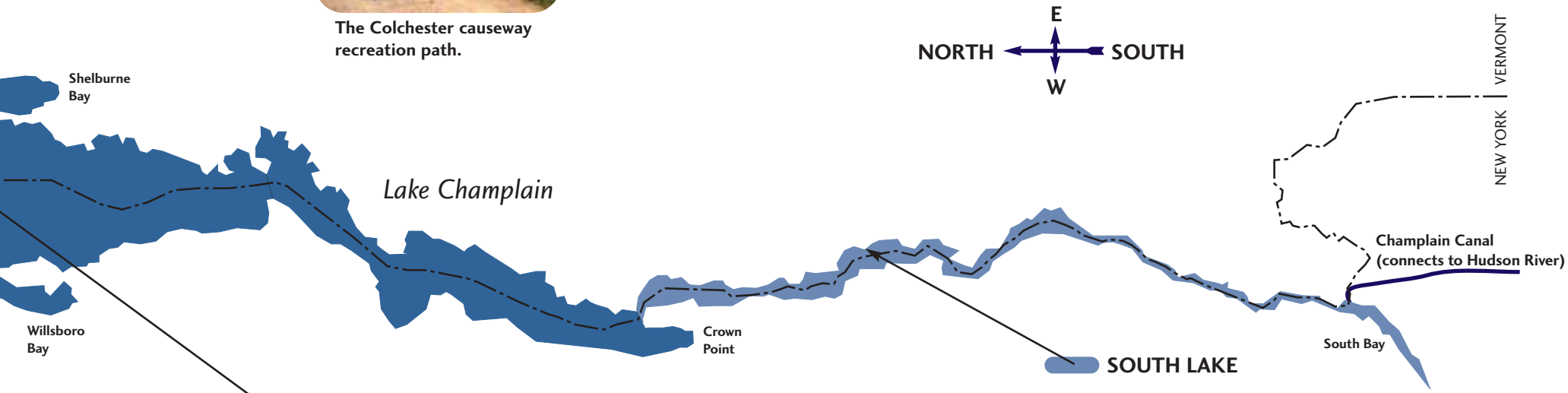
Physical setting:
Deep cold water. Increased population growth in surrounding watershed.

Malletts Bay Issues:
- Has a low phosphorus target that it usually meets, but increased growth in sub-basin is a concern (p. 8-11)

The Colchester causeway recreation path.

Go with the Flow!

Lake Champlain flows from Whitehall, New York north to the US/Canadian border, to its outlet at the Richelieu River in Québec. From there, the water joins the St. Lawrence River, which eventually drains into the Atlantic Ocean at the Gulf of St. Lawrence. Since 1823 the Lake has also been connected to the Hudson River and points south by the Champlain Canal.



SOUTH LAKE

Physical setting:
Narrow and shallow, acting much like a river. Much of the surrounding watershed is intensively farmed.

South Lake Issues:
- Exceeds phosphorus target (p. 8)
- Water chestnut management making progress (p. 20)
- Eurasian watermilfoil dense along shoreline (p. 19)
- Walleye decline in South Bay (p. 17)

The South Lake.

MAIN LAKE OR BROAD LAKE

Physical setting:
Contains 81% of the water in the Lake including the deepest, coldest water. Population growth and mixed land use in the Vermont portion of the sub-basin. The New York portion is more forested.

Main Lake Issues:
- Sometimes meets phosphorus target, but increased nonpoint sources in watershed are a concern (p. 8-11)
- Eurasian watermilfoil in some bays (p. 19)
- Beaches are usually fine for swimming (p. 3)
- Successful PCB cleanup in Cumberland Bay (p. 6)

Winter view of the Main Lake to the Adirondacks.

MAP SCALE:

0	5	10	*Miles*
0	8	16	*Kilometers*

Is it important to protect and restore wetlands and rivers?

VTDEC

Stream banks along the Trout River were restored by the VT Department of Environmental Conservation, using fluvial geomorphology principles. The finished restoration is the top photo; the before (left) and in progress (right) photos are below.

Yes. Wetlands provide important habitat to fish, wildlife and plants. They also slow down the flow of runoff, filter sediments and naturally absorb phosphorus and pollution. Stable river banks and buffers are important in reducing the amount of sediment and pollution to the Lake.

The Basin has more than 300,000 acres (121,400 hectares) of wetlands. About 160 wetlands larger than 50 acres are connected to the Lake. Vermont has lost nearly 35% of its wetlands since colonial times. In New York, 50% of the original wetlands are gone, except in the Adirondack Park where fewer than 10% have been lost. Smaller wetlands are particularly at risk from increasing development.

With support from the LCBP, The Nature Conservancy prioritized wetlands for acquisition from willing landowners, which resulted in over $1.4 million from the federal North American Wetlands Conservation Act. Nearly 8,000 acres (3,237 hectares) of wetlands have been protected to date.

Since 1991, more than 1,300 acres (526 ha) previously drained for agriculture and other uses have been restored to wetlands by the US Fish and Wildlife Service's Partners for Fish and Wildlife Program. Other programs include the Natural Resources Conservation Service's Wildlife Habitat Incentives Program and the Wetlands Reserve Program. Since 2002, Québec has protected more than 1,693 acres (685 ha) of wetlands near Missisquoi Bay with the aid of The Nature Conservancy and other local organizations—at a cost of about $1.2 million (CAD $).

New approaches for restoring rivers use fluvial geomorphology principles to address stream erosion and sediment deposition. River restoration efforts now take into account the entire river system, resulting in more environmentally sensitive and cost-effective work. Trees and vegetation along rivers, called buffers, also help reduce phosphorus and sediment runoff to rivers. Many volunteer watershed groups have played an important role in planting buffers along eroded banks.

USFWS

Wetlands protected by the Missisquoi National Wildlife Refuge support the largest great blue heron rookery on Lake Champlain.

Is the biodiversity of Lake Champlain changing?

Yes, rapidly expanding populations of a few nonnative plants and animals, such as water chestnut, Eurasian watermilfoil and zebra mussel, have displaced many native species. Some native species are on the rebound, such as the common loon, osprey and peregrine falcon. Others, including the black tern and upland sandpiper are not faring well, and the striped chorus frog may already be gone.

Characterizing biodiversity by counting the number of species found in the Basin would be simplistic. Although the total number of species is increasing, biodiversity is not improved. Some of these newcomers rapidly colonize areas of the Lake, displacing and possibly eliminating native species.

Invading zebra mussels have decimated rare native mussel species such as the pink heel splitter and fragile paper shell. Two non-native plants, water chestnut and Eurasian watermilfoil, are displacing less aggressive native plants, such as the endangered water cress. Common reed (*Phragmites*) and purple loosestrife are also displacing native wetland plants. More information about nonnative species is on pages 17-21.

Nearly 30 endangered or threatened mussels, fish, amphibians, reptiles, and birds and about 20 threatened and endangered wetland and aquatic plant species live in the Basin. Visit www.lcbp.org/fwsum.htm for a list of the threatened and endangered animals in the Basin.

Recognizing which species and habitats to protect, manage or control is an integral step in conserving biodiversity. The Nature Conservancy chapters in Vermont and New York are addressing Lake Champlain biodiversity conservation through a new process with scientific experts and organizations throughout the Basin. The results will help resource managers identify primary threats to the Lake's biodiversity and set new conservation priorities.

Osprey have made a terrific comeback in the Lake Champlain watershed. In 2005, osprey, common loon and peregrine falcon were removed from Vermont's endangered and threatened species list.

Phragmites (left) and purple loosestrife (right) aggressively displace native wetland plants. Many groups are controlling some local populations of these species with the help of volunteers.

Do **cormorants** have an affect on fish, birds and habitats?

Dave Capen

Nesting cormorants have defoliated hundreds of trees and destroyed other nesting bird habitat on several Lake Champlain islands.

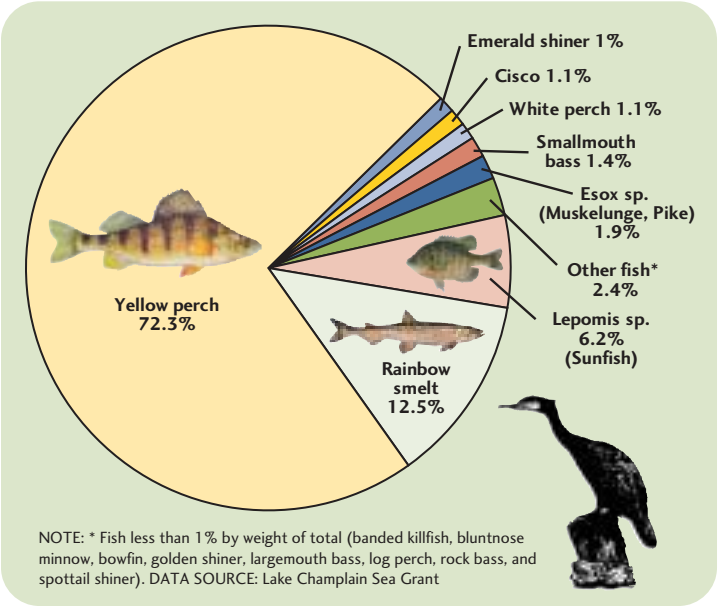
Yes. Double-crested cormorants, native migratory birds, have dramatically changed the biodiversity of several Lake Champlain islands and have displaced some bird species. Diet studies, however, have shown that salmon, trout and bass species are not common foods for the birds on Lake Champlain.

Only two cormorants were found nesting on Lake Champlain in 1981. In dramatic contrast, more than 4,000 nesting pairs were counted in 2004. The summer population is now estimated at 15,000 birds and has been stable since 2001. About 98% nest on Young Island, Vermont and the Four Brothers Islands in New York. Two smaller colonies live at the Missisquoi National Refuge and near Crown Point. Although cormorants were threatened by the pesticide DDT decades ago, today's population is at a historic high due to fewer contaminants and increased food supplies in their southern wintering habitat.

Cormorant guano (bird droppings) has completely defoliated the vegetation on Young Island and parts of the Four Brothers Islands. It has destroyed much of the islands' nesting habitat for birds like the black crowned night heron, cattle egret, great egret, snowy egret, and great blue heron.

Many questions have been raised about the impact of cormorants on fish. Research from 1996 showed that the birds eat about a pound of fish daily. In a 2001-2002 study, the contents of cormorants' stomachs were studied to determine what fish they eat (Figure 10). Yellow perch were the most abundantly eaten (72%) followed by rainbow smelt (12%). Although cormorants may disrupt the local fishing near where they feed, diet studies have shown that salmon, trout and bass species are not common foods for the birds on Lake Champlain.

Cormorants are protected by the Federal Migratory Species Act. In 2003, a US Fish and Wildlife Service ruling let wildlife agencies control cormorants in areas where they damage fisheries, vegetation and other birds. This ruling allowed the VT Fish and Wildlife Department to control cormorants by shooting them on Young Island in 2004. Populations are also managed by oiling eggs to stop the young from hatching. Researchers are currently using radio telemetry to determine if control measures are causing cormorants to relocate to other islands.



NOTE: * Fish less than 1% by weight of total (banded killfish, bluntnose minnow, bowfin, golden shiner, largemouth bass, log perch, rock bass, and spottail shiner). DATA SOURCE: Lake Champlain Sea Grant

Figure 10 | FISH SPECIES FOUND IN STOMACHS OF LAKE CHAMPLAIN CORMORANTS (% BY WEIGHT), 2001-2002

Are fish populations changing?

Yes, fish populations have changed dramatically in Lake Champlain. Lake trout and salmon populations collapsed prior to the 1900s, but stocking and restoration programs have been established to restore these fisheries. Significant future changes are expected to result from nonnative species such as alewife and white perch.

In addition to their ecological importance, sport fish in the Basin's waters lure many anglers to the region and generate many economic benefits. Both New York and Vermont have extensive stocking programs. For example, the NY State Department of Environmental Conservation and the VT Fish and Wildlife Department (VTDFW) stock rainbow, lake and brown trout to Basin waters. The US Fish and Wildlife Service (USFWS) provides landlocked Atlantic salmon smolts (young salmon) to Lake Champlain.

Nonnative nuisance fish have diminished the relative abundance of native fish in Lake Champlain. Of the Lake's 81 fish species, 12 are nonnative. Some nonnative species, like rainbow trout, are intentionally stocked and valued by anglers. Others, however, compete with native fish and have profoundly changed the Lake's food web. Two recent invaders—white perch and alewife—are of great concern based on the experience of other lakes.

Many biologists consider white perch a significant threat to biodiversity in Lake Champlain. In 2003, Québec researchers found that white perch far outnumber native yellow perch in Missisquoi Bay, and are now the Bay's most abundant fish. The white perch may have displaced yellow perch by feeding on their larvae. Also, white perch may compete with yellow perch for zooplankton. In turn, fewer zooplankton are around to eat algae, which may increase algal growth.

Walleye were abundant in Lake Champlain's South Bay in the mid 1980s. Recent surveys in the Bay, however, have shown a significant decline in catches, and few walleye have reached maturity in the last decade. One possible cause is the introduction of white perch and white crappie, which are known to prey on walleye eggs and larvae in other lakes. To help revitalize the population, VTDFW stocks walleye in major Vermont bays and the Lake Champlain Walleye Association stocks South Bay.

Sauger, a close relative of walleye, was caught in many parts of the Lake as late as the 1970s. But unlike its cousin, this species has hardly been found anywhere in the Lake since the mid 1990s.

Six alewife were recently discovered in northern Lake Champlain. Alewife can alter zooplankton communities, compete with other fish for food, and feed on native fish eggs and larvae. Lake trout and Atlantic salmon may also experience reproductive failure by feeding on an alewife diet, which causes a severe vitamin B deficiency. The USFWS and the VTDFW are intensively surveying to determine if a viable alewife population is established in Lake Champlain.

Alewife appeared in the Basin in Lake St. Catherine in Poultney, Vermont in the 1990s, where it is likely that they were introduced by anglers. The alewife in Lake St. Catherine have caused problems, including decreased water clarity and a threatened smelt population.

Although there are no lake-wide assessments of bass populations in Lake Champlain, many anglers consider it one of the best bass fisheries in the country. Bass fishing tournaments are increasingly popular on the Lake.

Sure Strike Charters

Great Lakes National Program

A beautiful lake trout caught from Lake Champlain (top). Below, white perch—a nonnative nuisance species in Lake Champlain.

Alewife

USFWS

Do sea lamprey threaten salmon, trout and other fish?

Photos courtesy of USFWS

Lamprey wounds on an Atlantic salmon (left) and a lamprey trap on the Poultney River (above).

Yes, sea lamprey, a parasitic fish, are a significant threat to Lake Champlain's sport fish populations. They weaken or kill fish by attaching to them and feeding on their body fluids. Studies from the Great Lakes show a mortality rate of 40-60% for fish wounded by sea lamprey. Sea lamprey are actively managed to reduce their impact on the Lake's sport fish and fish restoration programs.

Although almost everyone agrees sea lamprey are a serious nuisance, some biologists believe they are a native species that arrived during the Champlain Sea time period, when the Atlantic Ocean flooded the Champlain Valley after the last Ice Age. Others, however, believe they are a non-native species that entered the Lake via the Champlain Canal.

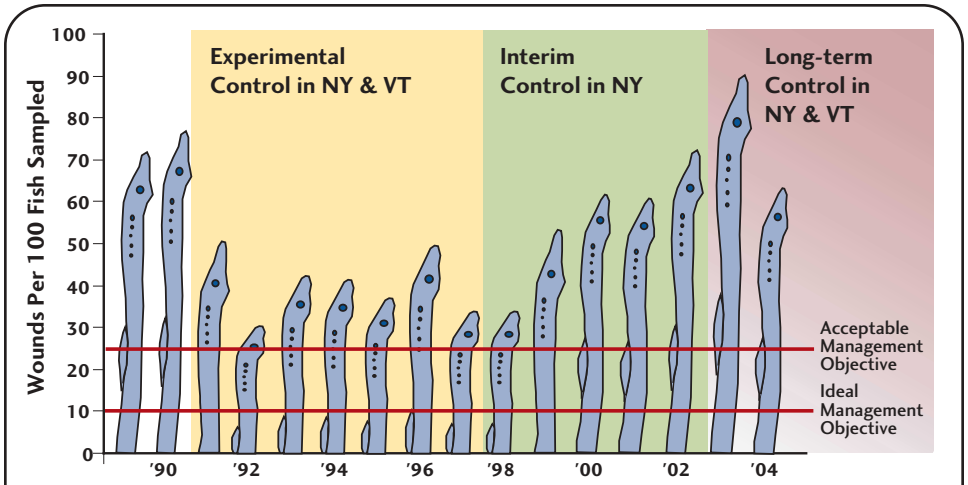
Regardless of their origin, sea lamprey have had a serious impact on lake trout, Atlantic salmon, walleye, northern pike, and other fish species in the Lake. A long-term control program began in 2002 following the evaluation of an eight-year experimental program. Thirteen tributaries to Lake Champlain and five deltas were treated with chemical lampricides during the experimental program. As a result of these efforts, the number of lamprey wounds per 100 fish was reduced (Figure 11). Sea lamprey programs are cooperatively run by the US Fish and Wildlife Service, VT Fish and Wildlife Department and the NY State Department of Environmental Conservation.

The goal of the long-term control is to achieve wounding rates of less than 25 per 100 lake trout, 15 per 100 Atlantic salmon, and 2 per 100 walleye. Wounding rates peaked at approximately 90 wounds per 100 lake trout, but dropped to 62 following the 2003 treatments (Figure 11). Treatments in 2004 targeted several of the highest producing deltas and streams, and wounding rates are expected to drop in 2005. Treatments will continue in 2006.

Several non-chemical alternatives are also used to minimize the impact of sea lamprey management on other species, such as the American brook lamprey. These methods include trapping in seven small streams. In addition, a variety of research and demonstration projects are in progress to maximize control efforts. Enhanced use of physical barriers and research on sea lamprey movement and life history, breeding locations, and trapping lures may lead to greater success.

Dams on the Great Chazy River and Lewis Creek were repaired to block sea lamprey seeking upstream spawning habitat. These and other existing barriers, such as those on the Winooski, Lamoille, Missisquoi, and Saranac, restrict lamprey spawning and larval rearing in the upper reaches of many rivers.

Figure 11 | **SEA LAMPREY WOUNDS PER 100 LAKE TROUT, 1989-2004 AND DATES OF CONTROL PROGRAMS**



NOTE: The lake trout were 533-633mm (21-25 in) in size and were sampled in October-November. The actual number of fish sampled each year ranged from 117 to 377. DATA SOURCE: Lake Champlain Fish and Wildlife Management

Do zebra mussels affect the ecosystem and human use?

Yes, zebra mussels, small freshwater mollusks native to Eastern Europe, are a problem for the Lake's ecosystem, economy, recreational opportunities, and cultural heritage resources. They encrust and kill native mussels, clog water supply intakes, cut the unprotected feet of swimmers, and cover many of the Lake's historic shipwrecks and other cultural artifacts.

Zebra mussels were first discovered in southern Lake Champlain in 1993 and have since spread northward throughout most of the Lake. They likely arrived attached to boats traveling up the Champlain Canal. Zebra mussels colonize nearly all hard surfaces in many areas of the Lake. Preventing colonies from blocking intake pipes is expensive.

Zebra mussels take over spawning habitats for lake trout, smelt and other fish and consume microscopic plants and animals in large quantities, in competition with juvenile fish and native mussels. They also increase water clarity, which has its benefits, but clearer water may promote invasive plant growth in deeper waters (Figure 8 on page 10).

Zebra mussels have caused the decline of entire populations of Lake Champlain's native mussels, particularly south of the Winooski River. By encrusting native mussels, zebra mussels impede their movement, feeding and respiration. This eventually leads to starvation, disease or metabolic problems. Seven mussel species native only to the Basin are now severely threatened. In Missisquoi Bay and in the Northeast Arm, however, where there are few zebra mussels, native mussel populations are relatively intact. Research suggests that cleaning and relocating native mussels can effectively protect remaining populations.

The spread of zebra mussels to other lakes is a threat because there are no environmentally acceptable methods to control them once established. As of 2005, Lake Bomoseen, Vermont; Lake George and Glen Lake, New York; and the upper Richelieu River in Québec have zebra mussels. Lake Champlain boaters have a responsibility to avoid spreading zebra mussels to other water bodies by inspecting, draining and cleaning their equipment before and after launching.

USFWS

Zebra mussels encrust a native mussel (above, right). An Eurasian watermilfoil mat (below).

A. Fox, U. of Florida

Does Eurasian watermilfoil impair the Lake?

Yes, Eurasian watermilfoil, an aquatic plant native to Europe, Asia and Africa, forms dense mats and impairs human uses, such as boating, fishing and swimming. It also out-competes many native plants that provide habitat for native fish and other wildlife. Eurasian watermilfoil infests several thousand near-shore acres of Lake Champlain and 74 other water bodies in the Basin.

Eurasian watermilfoil controls used on Lake Champlain include bottom barriers, hand-pulling and mechanical harvesting. Some technologies used elsewhere in the Basin have not been found appropriate for Lake Champlain, such as lowering the water level, hydro-raking and herbicides. Weevils and moths as biological controls for watermilfoil are currently being studied, but their success has not yet been clearly shown.

Controlling Eurasian watermilfoil is very costly. More than $4.1 million of federal, state and local funds (excluding salaries and administrative costs), and thousands of volunteer hours have been spent on controls in Vermont lakes and ponds since 1982. In Upper Saranac Lake of New York, a three-year control program begun in 2004 will total $1.5 million.

Eurasian watermilfoil was first discovered in New England in 1962 when it was reported in St. Albans Bay. New infestations are discovered nearly every year and likely occur when plant fragments on boats and trailers hitch a ride to new lakes. Boaters can reduce the rate of spread to other water bodies by carefully inspecting and cleaning boats and trailers after each use.

Is water chestnut still a problem?

Hand-pulling water chestnuts.

Yes, water chestnut forms extensive mats in southern Lake Champlain, and can severely restrict boat traffic and other types of recreation. Fortunately, aggressive management is successfully limiting the plant's local range.

Water chestnut, native to Europe, Asia and Africa, displaces native aquatic plants and is of little food value to wildlife. It was first documented in the shallow bays of the southern end of Lake Champlain in the early 1940s. It is generally assumed that its seeds hitchhiked on boats traveling through the Champlain Canal. Because water chestnut is an annual plant, it must be controlled each year—before its seeds drop to the lake bottom—where they can remain viable for up to 12 years.

Water chestnut is managed by mechanical harvesting and hand-pulling. Since the 1960s, its local range has fluctuated in close correspondence with management funding levels. It was nearly eradicated by the early 1970s, but lack of consistent control allowed water chestnut to expand its range. By 1997, it was found 52 miles north of Whitehall. An aggressive management program began in 1998 with an average annual budget of $500,000. Due to the program's success, mechanical harvesting is now needed only as far north as Benson, Vermont. Remaining areas are managed by hand-pulling (Figure 12).

The management program—supported by Army Corps of Engineers, Vermont and New York, the LCBP, the US Fish and Wildlife Service, and others—is implemented by the VT Department of Conservation and The Nature Conservancy with the help of many volunteers. Additional mechanical harvesting is done in the South Lake by the NY State Department of Environmental Conservation and the NY State Canal Corporation.

A northern water chestnut infestation was discovered in 1998 in Québec's South and Richelieu Rivers. While not in the Lake Champlain watershed, these infestations are close to Missisquoi Bay, whose shallow waters would make prime habitat for the plant. The Québec Ministry of Natural Resources and Wildlife rapidly addressed this threat, and areas that once needed intense mechanical harvesting are now controlled with light mechanical equipment and hand-pulling.

Mechanical harvesting on South Bay.

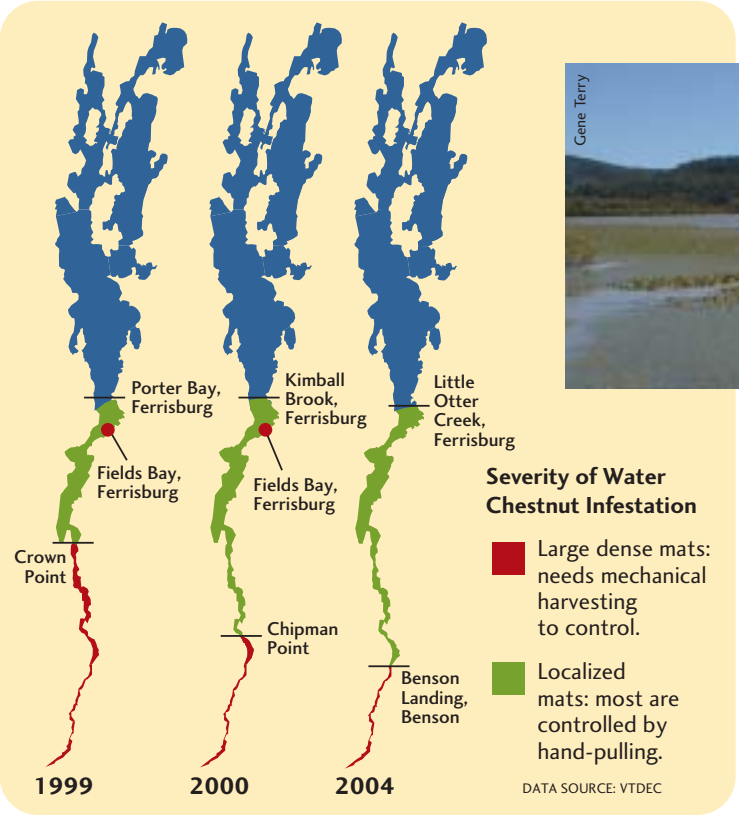


Figure 12 | **WATER CHESTNUT MANAGEMENT, 1999-2004**

What aquatic nuisance species pose future threats?

Many species may invade Lake Champlain in the near future. Of greatest concern are the plant hydrilla, the fish round goby and Eurasian ruffe, and invertebrates such as quagga mussel, spiny water flea and fishhook water flea. If they arrive, their impacts could be devastating.

It is not always easy to predict which nonnative plant or animal could be a nuisance. Observing a species' impact to nearby regions helps managers plan to prevent their arrival.

Hydrilla, for example, was a popular aquarium plant. Introduced to Florida in the 1960s, it now lives throughout the southeastern United States. Hydrilla can completely clog waterways. Already in three New England states, hydrilla will find suitable habitat if it reaches Lake Champlain. Efforts to prevent its arrival include discouraging disposal of aquarium plants into waterways and encouraging boat and trailer washing between launches.

Invasive species are arriving in Lake Champlain ever more frequently. Of the 44 nonnative species in the Basin, the date of arrival or first sighting is known for 34. Four arrived in the 1980s and 13 arrived in the 1990s (Figure 13). Three new species have appeared since 2000.

Preventing the spread of nuisance species in the Basin is the best way to minimize their impact on our ecosystems, economy and recreational pursuits. Managers are also working on rapid response techniques to halt new species that are found. Both approaches will require strong coordination and commitments by all lake users, managers and government leaders to keep the Lake free from future invasions.

Photos courtesy of the U. of Florida, Great Lakes National Program Office and J. E. Marsden.

Watch out for these species that threaten the Lake!
1. Eurasian ruffe
2. Hydrilla
3. Quagga mussels
4. Round goby
5. Fishhook water flea
6. Spiny water flea

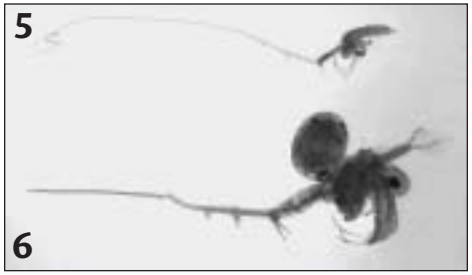
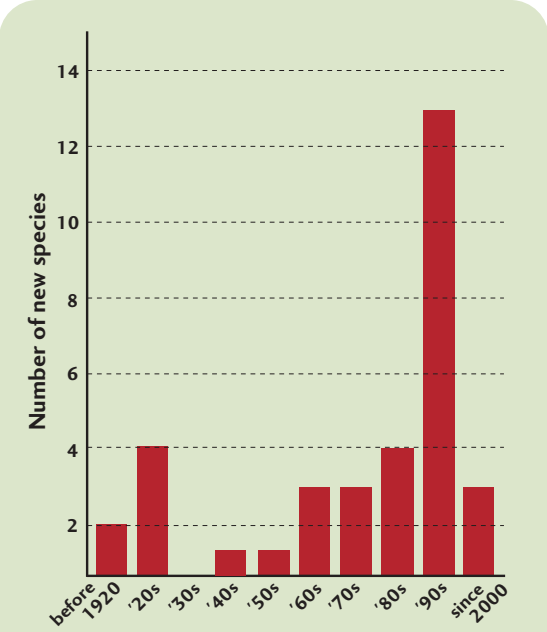


Figure 13 | NONNATIVE SPECIES ARRIVALS TO LAKE CHAMPLAIN BY DECADE



NOTE: Arrival or year of first reported sighting for 34 species, not including alewife. Ten more species have unknown arrival/sighting dates. DATA SOURCE: Ellen Marsden, U. of Vermont.

New Lake Champlain Baitfish Guide Available

Anglers will want to catch the free Lake Champlain baitfish guide by the Vermont Fish and Wildlife Department. It identifies many baitfish and has information about fish that may become invasive and/or are illegal. Sections also cover New York and Québec parts of the Lake. Contact VTDFW for a copy at (802) 241-3700.

What are some cultural heritage and recreation opportunities in the Basin?

G. Randorf/LC Bikeways

Residents and tourists continue to enjoy birding, fishing, scuba diving and boating, as well as visiting a wide array of cultural, historic and archeological sites. As they enjoy these activities, people affect and are affected by the state of the Lake. Recreation and cultural heritage opportunities are growing, and this sector of the economy is thriving in many areas.

In the past 10 years, the Basin has been promoted as a sustainable tourism destination by many organizations, including Lake Champlain Bikeways, the Birding Trail and the Lake Champlain Committee's Paddlers' Trail. The reciprocal fishing license between New York and Vermont, developed in 2004, also increased recreational appeal. Many fishing derbies now provide participants with stewardship materials about the water quality on which their sport depends.

Underwater discoveries have promoted stewardship as well. An underwater survey, completed by the Lake Champlain Maritime Museum (LCMM) in 2004, surveyed 300 square miles of Lake bottom, discovering 75 shipwrecks. The LCMM provides technical support for the Lake Champlain Underwater Historic Preserves System, which includes seven sites in Vermont and one in New York (Figure 14).

Scenic byways in New York and Vermont link a network of recreation and historic sites in shoreline communities. The array of cultural heritage resources in the Basin—including Shelburne Museum's world-class folk art collection, Fort Ticonderoga's exceptional historical interpretation, and the dozens of local and regional historical society museums that tell their own unique stories—is outstanding.

Since 1990, the LCBP has awarded almost $600,000 in grants to cultural heritage, recreation and public access projects throughout the Basin. The LCBP and many partners have developed the Wayside Exhibit Program, which has designed more than 110 interpretive signs since 2001.

In 2009, the 400th anniversary of Samuel de Champlain's 1609 arrival to Lake Champlain will be commemorated and will showcase the region to the world. The Vermont Lake Champlain Quadricentennial Commission and the New York Hudson-Fulton-Champlain Quadricentennial Commission are developing a unified marketing strategy for the anniversary, coordinating their efforts with Québec celebrations scheduled for 2008. The LCMM replica canal schooner *Lois McClure* will promote the upcoming anniversary as it sails to New York City in 2005.

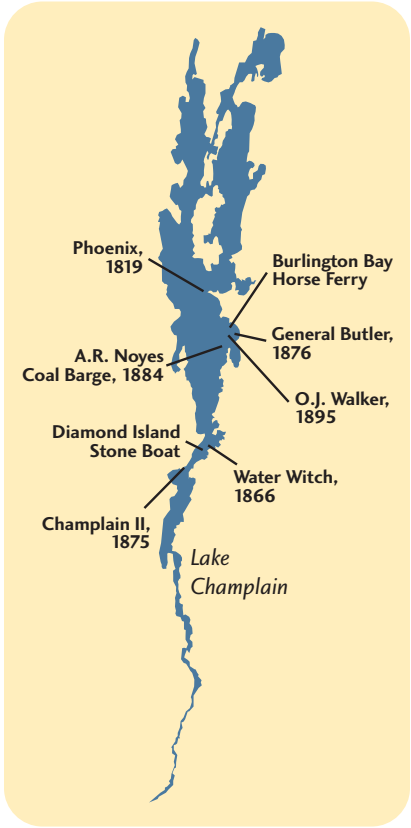


Figure 11
UNDERWATER PRESERVE LOCATIONS AND DATES OF SINKING, IF KNOWN

J. Millard/America's Historic Lakes

Lake Champlain Bikeways promotes sustainable tourism in the Basin (top). Below, many of the Lake's historic lighthouses, such as the Valcour Island Light, have been recently relit.

Are educational efforts making a difference?

Yes. The effectiveness of outreach efforts is reflected by the increasing number of local watershed groups, the growing community involvement through volunteer stewardship projects, and the amount of student/teacher initiatives within the Basin.

Today, more than 30 watershed groups are active in the Champlain Basin. With the help of volunteers, these grassroots groups restore and protect local waterways. Their activities include water quality monitoring, natural resource inventories, river cleanups, habitat restoration, and working with landowners to improve water quality. Many partner with the Vermont Youth Conservation Corps to stabilize streambanks. Most watershed groups rely on annual grants or membership based support. With more sustained funding, these groups could take even greater steps to restore the watershed.

Since 1992, more than 500 educators have participated in LCBP-supported Champlain Basin Education Initiative workshops. These teachers are helping to foster a new generation's broader understanding of Lake issues. Many other institutions also contribute to water science education and promote stewardship concepts, including the Adirondack Visitor Interpretive Centers, the UVM Watershed Alliance and Shelburne Farms.

Stewardship opportunities are abundant and many state and nonprofit organizations seek volunteers. For example, volunteers collect tree seeds from around the region for the Intervale Conservation Nursery. The grown trees later become inexpensive native vegetation for use by watershed groups. Between 1998 and 2003, volunteers spent more than 7,000 hours hand-pulling water chestnut from the Lake. Volunteer lake monitors have collected water quality data for 27 years, providing one of the oldest running data sets in the United States. More than 12,000 volunteer hours were logged building the replica canal schooner, *Lois McClure*—launched by the Lake Champlain Maritime Museum in 2004.

In the past decade, unique partnerships and products have emerged to bring new information to the public, including: media partnerships; ECHO at the Leahy Center for Lake Champlain, which includes the LCBP Resource Room; the curriculum guide *This Lake Alive*; and Lake Champlain Research Consortium publications and workshops. The nonprofit Lake Champlain Committee's initiative, *Lake Protection Pledge*, combines education and personal commitment to reduce pollution.

The LCBP website, www.lcbp.org, includes publications, stewardship efforts, events, partnership projects, and LCBP management goals and actions, as well as, an online version of the *Lake Champlain Basin Atlas*. Many organizations and government agencies also maintain strong websites. The resulting network of linkages makes a vast array of information more accessible than ever.

Just a few of the educational activities in the Basin:
1. **A Vermont Youth Conservation Corps crew works on the Poultney River.**
2. **Students pick up trash as part of a service learning day at Crown Point State Historic Site.**
3. **Educators learn the science of water quality at a Champlain Basin Education Initiative workshop.**
4. **Learning from lake scientists at a Lake Champlain Research Consortium meeting held in Québec.**

Poultney-Mettowee NRCD, LCBP and QC MDDEP.

ECHO at the Leahy Center for Lake Champlain

Opened in 2003, this lake aquarium and science center helps people of all ages learn about the Lake and see many of its famous faces—fish, amphibians and reptiles—up close! Visit www.echovermont.org to learn more about ECHO.

Boquet River Association

Are local communities helping the cleanup?

Yes. Volunteer groups, businesses and municipalities across the Basin are working to improve the health of Lake Champlain. Over 500 local projects have received more than $2.6 million in LCBP grants alone. The diverse array of stewardship activities includes planting riparian buffers on eroding farm fields, cleaning up the lakeshore and local rivers, and removing aquatic nuisance species.

Public appreciation and stewardship of the Lake is increased when community access to the water is improved. Burlington, Vermont has redeveloped its waterfront with a focus on public access and multiple uses. In Plattsburgh, New York, business leaders and state agencies are cooperating on a major waterfront revitalization. Even Basin towns far from the Lake, like Montpelier, Vermont and Saranac Lake, New York, are cleaning up their river fronts in recognition of the importance of Lake Champlain's health.

Improved water quality is important to local economies, and communities are working towards that goal. Towns are implementing many parts of the management plan, *Opportunities for Action* (see page 2). For example, municipalities pay the annual costs for operating and maintaining wastewater treatment plants. As a result of their efforts, the public benefits from a cleaner Lake.

The LCBP supports grassroots efforts through several competitive grant programs. Since 1992, more than $2.6 million has funded projects to reduce phosphorus, prevent the spread of nuisance species, improve public education and outreach, and attain other management goals. New and creative ways to fund these initiatives need to be continually developed to support local efforts to cleanup Lake Champlain.

Landowner education is essential to spread the word about lake-friendly practices. Many local businesses have changed their practices on behalf of the Lake. For example, about 25 marina operators recently attended workshops offered by the US Environmental Protection Agency and Lake Champlain Sea Grant about hazardous material spill prevention.

A grant from the Lake Champlain Basin Program helped volunteers from the Boquet River Association catalogue the rich diversity of species in the river's watershed—281 species were counted in one day!

You can help the Lake!

The state of the Lake depends on our individual actions.
Here are a few things you can do:

Test Your Turf: Test your lawn and garden before you fertilize. You may need less than you think or none at all!

Make a Dish-wash Switch: Most automatic dishwashing detergents still contain phosphorus. Switch to a phosphate-free version.

Look for Leaks: Leaking oil, anti-freeze and gas can pollute the Lake, so keep your engines tuned and recycle your oil.

Leave it on the Lawn: Let your mowed grass clippings serve as mulch on your lawn. This adds nutrients and decreases the need for watering.

Check the Septic: If not properly maintained, your septic system may pollute the Lake with harmful *E. coli* bacteria.

Inspect Your Boat: Remove all mud, plants and animals from your boat and trailer between launches to keep nuisance species from spreading.

Scoop the Poop: Pick up pet waste and throw it in the trash or toilet to keep it from washing into the Lake.

Get Involved: Volunteer with a local watershed group and attend public meetings about water issues—let your love of the Lake be heard!

Lake Champlain Research: Websites and Compilations

Adirondack Research Consortium
www.cedareden.com/arc

America's Historic Lakes
www.historiclakes.org

Lake Champlain Maritime Museum—Maritime Research Insitute
www.lcmm.org

Lake Champlain Research Consortium
cat.middlebury.edu/~lcrc/

Lake Champlain Research Institute
www2.plattsburgh.edu/research/lcri/index.cfm

Lake Champlain Sea Grant
www.uvm.edu/~seagrant/index.html

New England Interstate Water Pollution Control Commission
www.neiwpcc.org

New York State Department of Environmental Conservation
www.dec.state.ny.us

Québec Ministry of Sustainable Development, Environment and Parks
www.mddep.gouv.qc.ca

Québec Ministry of Natural Resources and Wildlife
www.mrnf.gouv.qc.ca

The Rubenstein Ecosystem Science Laboratory (UVM)
www.uvm.edu/~envnr/?Page=rubenstein/default.html

US Fish and Wildlife Service
www.fws.gov/r5lcfwro/complex.htm

Vermont Agency of Natural Resources/Clean and Clear Action Plan
www.anr.state.vt.us

Vermont Cooperative Fish and Wildlife Research Unit
www.uvm.edu/envnr/vtcfwru

Lake Champlain Consortium; Lake Champlain in Transition: From Research Toward Restoration. Water Science and Application Vol 1. American Geophysical Union. 1999.

Lake Champlain Partnership and Research in the New Millennium. Edited by T. Manley et al., Kluwer Academic/Plenum Publishers. 2004.

Visit www.lcbp.org for links to many other organizations involved with Lake Champlain issues and education.

L. Roy

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Lake Champlain Basin Program
54 West Shore Road
Grand Isle, VT 05458
(802) 372-3213 or (800) 468-5227 (NY & VT)
www.lcbp.org
lcbp@lcbp.org

Staff Supporting the Program Call (802) 372-3213, unless otherwise noted
Nicole Ballinger - Communications & Publications Coordinator
Erik Beck - LC Coordinator, US EPA New England, (617) 918-1606
Jim Brangan - Cultural Heritage & Recreation Coordinator
Beckett Grealish - LC Coordinator, US EPA Region 2, (212) 637-3866
Colleen Hickey - Education & Outreach Coordinator
Bill Howland - Basin Program Manager
Kathy Jarvis - Administrative Assistant
Chris Lassell - New York Circuit Rider, (518) 897-1367
Martin Mimeault - Québec MDDEP, (450) 928-7607
Meg Modley - Assistant Technical Coordinator
Art Stemp - NY Coordinator, NYSDEC, (518) 897-1216
Michaela Stickney - VT Coordinator, VTANR/LCBP (802) 241-3619
Lisa Windhausen - Aquatic Nuisance Species Coordinator
Resource Room Staff: Laura Hollowell, Stephanie Larkin, Cynthia Norman (802) 864-1848

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Lake Champlain
Basin Program

54 West Shore Road
Grand Isle, VT 05458

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