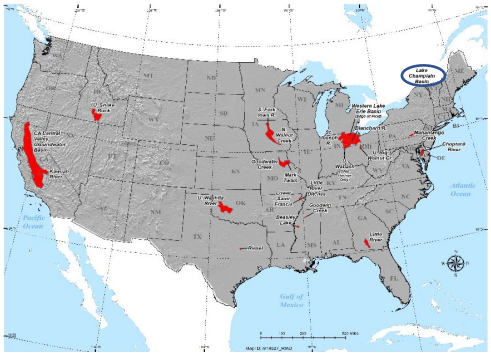
Lake Champlain Basin

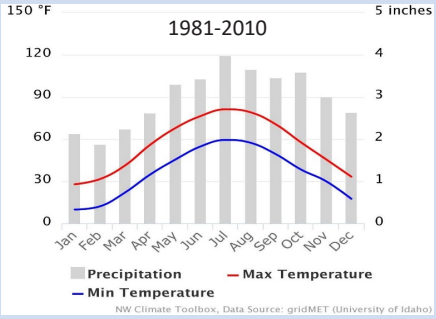


A Conservation Effects Assessment Project (CEAP) Watershed Assessment Study: A collaboration between the University of Vermont, the Natural Resources Conservation Service, and the Agricultural Research Service

Location

The Lake Champlain Basin (LCB) is 8,170 mi^2 and drains portions of Vermont, New York, and the province of Quebec. The surface area of Lake Champlain itself is 435 mi^2 and is regionally important as a water supply and for recreation.

Temperature and Precipitation



Major land uses

Cropland: Corn silage, Soybean
Grassland: Pasture and Hay

Data collection

This study started recently, so data collection just began in late 2019. A 'control' (Dead Creek) and 'treatment' (Headwaters Little Otter Creek) watershed were both selected within the LCB and instrumented with stream gages and automated water sampling stations. Discharge is measured every 15 minutes, and samples are collected during storms and every two weeks during baseflow. Water is analyzed for phosphorus, nitrogen, and sediment to be used as key indicators of water quality and conservation practice effectiveness.

Concerns

Many farmed soils in the study area are heavy clay. These soils often have poor drainage and high runoff, transporting nutrients to surface waters and increasing sheet and rill erosion. Increased frequency of heavy storms and more overall annual precipitation exacerbate these issues.

As a result of poor drainage and wetter conditions, artificial subsurface drainage (i.e., tile) is being implemented on many farms to maintain productivity. It is not clear how this increased drainage and altered field hydrology affects the overall transport of nutrients, especially phosphorus to surface waters.

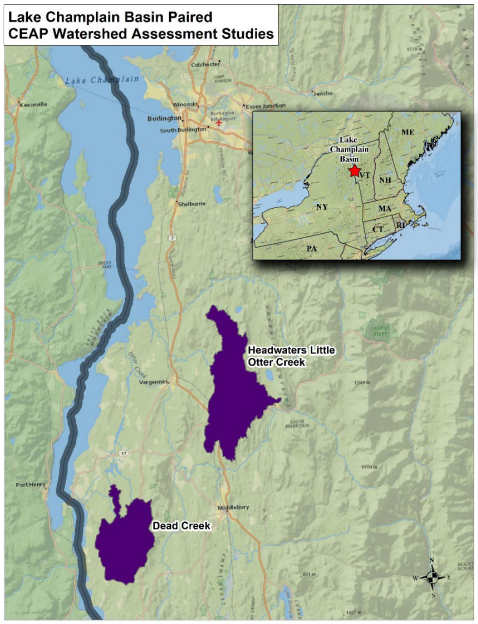
The heavy clay soils also affect crop production. Wet conditions can delay planting and lead to deep soil compaction that reduces yields and is difficult to remediate.

Efforts to reduce nutrient transport to the lake have accelerated significantly in the LCB after a new Total Maximum Daily Load (TMDL) was issued in 2016, focused on phosphorus loading for the lake.

Main conservation practices used

A number of conservation practices are regularly used in the watershed. These practices include no-till, winter cover crops, manure incorporation, and crop rotation. Adoption of manure injection in both corn fields and hayland is increasing rapidly.

Newer conservation practices to be studied include manure phosphorus removal systems and tile outlet phosphorus removal filters.



Lake Champlain Basin

Planned Research

Plot and field scale

- Evaluate the cumulative effect of using multiple conservation practices for reducing phosphorus loss and delivery to surface waters. This study will align with NRCS's Avoid-Control-Trap (ACT) framework, and will evaluate phosphorus sources vulnerable to loss, in-field practices for controlling export, and edge-of-field practices for trapping any phosphorus that does leave the field.
- Evaluate innovative edge-of-field practices for treating phosphorus inside tile drains. Project personnel are collaborating closely with ARS scientists to design, implement, and test at least one type of phosphorus removal structure for tile drainage water treatment. If conducive site conditions exist, a phosphorus removal structure will also be evaluated for treatment of surface runoff.
- Evaluate edge-of-field field-scale hydrology and total phosphorus loss in surface and subsurface runoff from tile-drained fields following manure injection to the field. A field-scale paired-watershed study will compare injection to surface application of manure in heavy clay soils typical of the LCB.
- Evaluate soil health, water quality, and crop yield implications following application of a low-phosphorus fertilizer source. Low-phosphorus effluent from a manure phosphorus removal system will be applied at a rate to meet the crop nitrogen requirements, but without adding meaningful amounts of phosphorus to the soils. This fertility source will be evaluated in large plots in the treatment watershed.

Clockwise from top left: Tile drainage monitoring station on Dead Creek, edge-of-field surface runoff monitoring flume, flow measurement instrumentation on a monitored tile outlet, newly installed USGS flow gage on East Branch of Dead Creek.

Watershed scale

- A paired watershed study will evaluate the effectiveness of conservation practices at the watershed-scale. This will include a 1- to 2-year calibration period before an accelerated implementation of conservation practices occurs in the treatment watershed.
- Practices targeted for accelerated implementation will be determined through consultation with a stakeholder advisory committee, but will likely include manure injection, no-till, cover cropping, and changes in timing of manure application to avoid high runoff time periods.
- Phosphorus removal performance of two innovative systems designed to extract phosphorus from liquid dairy manure will be compared. Low-phosphorus effluents will be evaluated in the treatment watershed.
- Collaboration with NRCS and ARS scientists to evaluate the Agricultural Conservation Planning Framework (ACPF) planning tool within the LCB.
- Evaluation of watershed water quality outcomes of various future conservation scenarios using 1) the APEX model with NRCS scientists, and 2) the SWAT model in collaboration with Virginia Tech scientists.

Collaborators and Stakeholders

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VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION
USGS science for a changing world
COLLEGE OF ENGINEERING
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