Status of Vermont’s Inland Lakes: Phosphorus Trends and Protection

Kellie Merrell, Oliver Pierson

Clean Water Lecture Series

3 June 2021 Virtual
National Lake Assessment (NLA)

2007/2008

2012
Vermont has a higher proportion of natural lakes than the nation and 8 other ecoregions.
Vermont is Stewarding a Higher Proportion of Oligotrophic Lakes than the Nation, 2007 NLA

**Oligotrophic Lakes**
- Low nutrient enrichment = very little plant and algae growth
- Clear water
- Supports coldwater fish species

**Mesotrophic Lakes**
- Moderate nutrient enrichment = some plant and algae growth
- Moderate water clarity
- Supports mostly warmwater fish species

**Eutrophic Lakes**
- High nutrient enrichment = abundant plant and algae growth
- Reduced water clarity
- Only supports warmwater fish species
Vermont is Stewarding a High Proportion of Lakes in Good Condition for Phosphorus, 2007 NLA

Figure 15. Proportion of lakes in Good, Fair, or Poor condition for Total Phosphorus across 9 Ecoregions, the Nation and Vermont.
Vermont is Stewarding Some of the Clearest Lakes in the Nation

Stephens, et al., 2015
Continental-Scale Increase in Lake and Stream Phosphorus: Are Oligotrophic Systems Disappearing in the United States?


![Graph showing percentage of streams and lakes with TP < 10 μg/L from 2004 to 2012.](image)
Estimated trends (slopes) from linear mixed effects model

- Increased TP
- Decreased TP
- Oligotrophic
- Mesotrophic
- Eutrophic
Summer Total Phosphorus

43 Lakes with continuous TP data going back to the late 1980s or 1990s:

15 Eutrophic
19 Mesotrophic
9 Oligotrophic
Summer Total Phosphorus Trends

n = 50

Increased TP

Decreased TP

Lake-Specific Slope (ln(Phos)/year) mean +/- confidence interval

-0.04
-0.02
0.00
0.02
0.04

Lake

Oligotrophic

Mesotrophic

Eutrophic
National Lake Assessment (NLA)

2007/2008

2012
**Total Phosphorus**, Lakes Greater Than 10 Acres
2012 Northern Appalachian Region Thresholds

- **TP concentration (ug/L)**
  - > 22: Poor
  - 14.5 – 22: Fair
  - < 14.5: Good

*Preliminary results, Leslie J Matthews, leslie.matthews@vermont.gov*
**Total Phosphorus**, Lakes Greater Than 10 Acres

2012 Northern Appalachian Region Thresholds

<table>
<thead>
<tr>
<th>Condition Category</th>
<th>2012 Percentage of Lakes</th>
<th>2007-12</th>
<th>Change in % Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Least Disturbed*</td>
<td>10%</td>
<td>-60%</td>
<td>-10%</td>
</tr>
<tr>
<td>Moderately Disturbed</td>
<td>40%</td>
<td>-40%</td>
<td>-10%</td>
</tr>
<tr>
<td>Most Disturbed*</td>
<td>5%</td>
<td>0%</td>
<td>5%</td>
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<tr>
<td>Not Assessed</td>
<td>No Observed Lakes</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*Preliminary results, Leslie J Matthews, leslie.matthews@vermont.gov

U.S. EPA National Lakes Assessment 2012

Percentage of Lakes in Each Condition Category

2012 Estimates and Change from 2007
Phosphorus (Total) | Northern Appalachians


* Reflects a statistically significant change at 95% between 2007 and 2012. Such changes are also indicated using darker colors.
In **2007** HALF of the Nation’s Lakes were Eutrophic or Hypereutrophic

Preliminary results from the **2017** NLA found **$\frac{2}{3}$** of the Nation’s Lakes are Eutrophic or Hypereutrophic

**Only 10%** of the Nation’s Lakes are Oligotrophic
Estimated trends (slopes) from linear mixed effects model

- Lake-Specific Slope (lnTP/yr) mean ± 1.96-confidence interval

- Increased TP
- Decreased TP

- Oligotrophic
- Mesotrophic
- Eutrophic

Summer Total Phosphorus Trends

- Lake-Specific Slope (lnTP/yr) mean ± confidence interval

- Increased TP
- Decreased TP

- Oligotrophic
- Mesotrophic
- Eutrophic

TP concentration (ug/L)

- > 22 Poor
- 14.5 – 22 Fair
- < 14.5 Good

Percent of Lakes

Percent Change
SO NOW WHAT

DO WE DO?
The primary goal of the Clean Water Act
“restore and maintain the chemical, physical, and biological integrity of the Nation’s waters”
VT's 4 Inland Lakes that are/had been listed as impaired for phosphorus have stable or decreasing phosphorus trends.
Oligotrophic Lakes

- Low nutrient enrichment = very little plant and algae growth
- Clear water
- Supports coldwater fish species
Deriving nutrient criteria to minimize false positive and false negative water use impairment determinations

<table>
<thead>
<tr>
<th>Water Quality Standard</th>
<th>Lake User Survey Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural condition</td>
<td>The user survey was not used to define natural condition.</td>
</tr>
<tr>
<td>Excellent or very good</td>
<td>(1) Beautiful, could not be any nicer, or</td>
</tr>
<tr>
<td>aesthetic value</td>
<td>(2) Very minor aesthetic problems; excellent for swimming, boating, enjoyment.</td>
</tr>
<tr>
<td>Good aesthetic value</td>
<td>(3) Swimming and aesthetic enjoyment slightly impaired because of algae levels.</td>
</tr>
<tr>
<td>Non-attainment</td>
<td>(4) Desire to swim and level of enjoyment of the lake substantially reduced because of algae levels, or</td>
</tr>
<tr>
<td></td>
<td>(5) Swimming and aesthetic enjoyment of the lake nearly impossible because of algae levels.</td>
</tr>
</tbody>
</table>

![Figure 2. Distributions of individual TP, Chl-a, and Secchi depth observations associated with each lake user survey response choice from Table 1.](image_url)

https://www.tandfonline.com/doi/pdf/10.1080/10402381.2016.1149257

Smeltzer et al, 2016
Table 3. Combined Nutrient Criteria for Aesthetics Uses in Lakes, Ponds, and Reservoirs Except for Lake Champlain and Lake Memphremagog\textsuperscript{1,2}

<table>
<thead>
<tr>
<th>Nutrient Concentrations</th>
<th>Class A(1)</th>
<th>Classes A(2) and B(1)</th>
<th>Class B(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Phosphorus\textsuperscript{3} ((\mu g/L))</td>
<td>12</td>
<td>17</td>
<td>18</td>
</tr>
<tr>
<td>Nutrient Response Conditions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secchi Disk Depth (meters)\textsuperscript{4}</td>
<td>5.0</td>
<td>3.2</td>
<td>2.6</td>
</tr>
<tr>
<td>Chlorophyll-a ((\mu g/L))\textsuperscript{3}</td>
<td>2.6</td>
<td>3.8</td>
<td>7.0</td>
</tr>
<tr>
<td>pH</td>
<td>Not to exceed 8.5 standard units.</td>
<td>\null</td>
<td>\null</td>
</tr>
<tr>
<td>Turbidity</td>
<td>Consistent with the criteria in § 29A-302(4) of these rules.</td>
<td>\null</td>
<td>\null</td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td>Consistent with the criteria in § 29A-302(5) of these rules.</td>
<td>\null</td>
<td>\null</td>
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</tbody>
</table>
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<th>Class A(1)</th>
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<th>Class B(2)</th>
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<tbody>
<tr>
<td><strong>Nutrient Concentrations</strong></td>
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<td></td>
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<tr>
<td>Total Phosphorus\textsuperscript{3} ($\mu g$/L)</td>
<td>12</td>
<td>17</td>
<td>18</td>
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<tr>
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<td></td>
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<tr>
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<th>Class A(1)</th>
<th>Classes A(2) and B(1)</th>
<th>Class B(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Phosphorus³ (µg/L)</td>
<td>12</td>
<td>17</td>
<td>18</td>
</tr>
<tr>
<td>Nutrient Response Conditions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secchi Disk Depth (meters)⁴</td>
<td>5.0</td>
<td>3.2</td>
<td>2.6</td>
</tr>
<tr>
<td>Chlorophyll-a (µg/L)³</td>
<td>2.6</td>
<td>3.8</td>
<td>7.0</td>
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<tr>
<td>pH</td>
<td></td>
<td>Not to exceed 8.5 standard units.</td>
<td></td>
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<tr>
<td>Turbidity</td>
<td></td>
<td>Consistent with the criteria in § 29A-302(4) of these rules.</td>
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<tr>
<td>Dissolved Oxygen</td>
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<td>Consistent with the criteria in § 29A-302(5) of these rules.</td>
<td></td>
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</table>
Monitoring the Health of an Ecosystem Over Time

Adapted from Cairns et al, 1993  https://link.springer.com/article/10.1007/BF00006054
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Pristine Condition

Maximum Achievable State

Actual Recorded Condition

Minimum Acceptable State

Chronological Time


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Total Phosphorus ug/L

- Pristine Condition
- Maximum Achievable State?
- Actual Recorded Condition
- Minimum Acceptable State

Chronological Time


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https://link.springer.com/article/10.1007/BF00006084
CASPIAN - data through 2020

Spring TP Trend: p = 0.0182 | CV = 29
Significantly increasing

Summer TP Trend: p = 0.0012 | CV = 21
Highly significantly increasing

Spring TP Annual Means
Summer TP Annual Means

Summer Secchi Trend: p = 0.4832 | CV = 13
Stable

Summer Chla Trend: p = 0.6421 | CV = 31
Stable

Summer Secchi Annual Means
Summer Chla Annual Means

Stresses / Impairments
Stressed -- Flow alteration

Trend Score: Fair
WQ Standards Status: Stressed
Watershed Score: Highly Disturbed

Last 5 yr Mean
Summer TP 11 ug/L

Actual Recorded Condition

11 ug/L

Last 5 yr Mean Summer TP 11 ug/L
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Monitoring the Health of an Ecosystem Over Time

<table>
<thead>
<tr>
<th>Total Phosphorus ug/L</th>
<th>Chronological Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>1981</td>
</tr>
<tr>
<td>16</td>
<td>1991</td>
</tr>
<tr>
<td>21</td>
<td>2001</td>
</tr>
<tr>
<td>12 ug/L</td>
<td>2011</td>
</tr>
<tr>
<td></td>
<td>Present Day</td>
</tr>
<tr>
<td>12 ug/L</td>
<td>2031</td>
</tr>
<tr>
<td>12 ug/L</td>
<td>2041</td>
</tr>
<tr>
<td>12 ug/L</td>
<td>2051</td>
</tr>
<tr>
<td>12 ug/L</td>
<td>2061</td>
</tr>
</tbody>
</table>

Pristine Condition

Maximum Achievable State

Actual Recorded Condition

Minimum Acceptable State for Lake Caspian – Reclassify to A(1) Nutrient Standard 12 ug/L

Minimum Acceptable State

Monitoring the Health of an Ecosystem Over Time

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In 1995, Dr. Daniel Pauly coined the phrase “Shifting Baseline Syndrome.”

“With each new generation, the expectation of various ecological conditions shifts. The result is that standards are lowered almost imperceptibly.”

Vermont is stewarding a higher proportion of oligotrophic lakes than the nation, 2007 NLA

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“With each new generation, the expectation of various ecological conditions shifts. The result is that standards are lowered almost imperceptibly.”

We can shift the baseline by replicating a desired watershed condition. It will take time, commitment and perseverance.

BEND THE Trend!
Carmi is not Champlain is not Memphremagog is not Ticklenaked

“You’ve Seen One Lake…..You’ve Seen One Lake”

Terry Rees - Executive Director - Federation of Ontario Cottagers' Associations GLEON Plenary 2019
Similarly, Willoughby is not Raponda is not Maidstone is not Caspian

‘One size fits all’ does not work for those lakes we list as not meeting the aesthetic criteria, nor will it work for lakes we list as meeting Tier 2 aesthetic A1 antidegradation criteria
So, what’s the plan? Use the same approach for reclassification that we do for listing a lake as impaired.

- Reclassify (or list lake) as A1
- Set in motion the requirement that a protection plan be tailored to the lake, similar to our lake watershed action plans and TMDL phosphorus reduction plans.
Example Protection Plan Steps

1. **Determine where the phosphorus is coming from** and develop an action plan for the lake
2. Develop remedial intervention options
3. Implement the preferred options
4. Monitor for compliance and effectiveness
Determining where the phosphorus is coming from

1. Next Generation Lake Assessment Reports
2. High Resolution (0.5m) Mapping
VTDEC Summer Lake Assessment
Inland Lake Monitoring

• Purpose is to monitor status
• 5 – 50 lakes per year
• Semi-Quantitative Assessments since 1989
• Next Generation Quantitative Assessments since 2010, Samples
  • Index Site (Deep Hole)
  • 10 Physical Habitat (PHAB) sites
  • Inlets & Outlets
VTDEC Summer Lake Assessment
Inland Lake Monitoring Index Site (Deep Hole)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Year Started</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gran Alk, Dissolved Oxygen, Secchi,</td>
<td>1989</td>
</tr>
<tr>
<td>Temperature, TP, Conductivity, pH</td>
<td></td>
</tr>
<tr>
<td>Reg Alk</td>
<td>1991</td>
</tr>
<tr>
<td>TFe</td>
<td>1994</td>
</tr>
<tr>
<td>Chlorophyll $a$</td>
<td>1997</td>
</tr>
<tr>
<td>TCa, TMg, TK, TNa</td>
<td>1999</td>
</tr>
<tr>
<td>Color</td>
<td>2000</td>
</tr>
<tr>
<td>TN, DCl, TAl, TSO4</td>
<td>2001</td>
</tr>
<tr>
<td>TotalHardness, TMn</td>
<td>2004</td>
</tr>
<tr>
<td>NTU, DSi</td>
<td>2007</td>
</tr>
<tr>
<td>TCL &amp; Sediment Diatoms</td>
<td>2011</td>
</tr>
<tr>
<td>DOC, DOM and Phytoplankton</td>
<td>2019</td>
</tr>
</tbody>
</table>
VTDEC Summer Lake Assessment
Inland Lake Monitoring (Tribs and PHAB Sites)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Location(s) measured</th>
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</thead>
<tbody>
<tr>
<td>Conductivity, Dissolved Oxygen, DO%, pH, Temperature C, TN, TP, TCl, Chlorophyll a, &amp; DOM</td>
<td>Tributaries and Outlet</td>
</tr>
<tr>
<td>Physical habitat complexity, shallow water habitat, lakeshore habitat, lakeshore disturbance, Embeddedness, % Sand, % trees along shore, and shading</td>
<td>10 random sites around the lake</td>
</tr>
<tr>
<td>Crayfish</td>
<td>3 sites with good crayfish habitat</td>
</tr>
<tr>
<td>Aquatic plants, algae</td>
<td>10 random sites around the lake and tributaries</td>
</tr>
<tr>
<td>Area and depth of deltas</td>
<td>Tributaries and sites of significant erosion</td>
</tr>
</tbody>
</table>
Next Generation Lake Assessment Reports
Next Generation Lake Assessment Reports
Next Generation Lake Assessment Reports

Temperature, Dissolved Oxygen, Chlorophyll-a

- **Temp C**
- **DO mg/L**
- **Chla mg/L**
  - Probe
  - Int Sampler
Next Generation Lake Assessment Reports
Next Generation Lake Assessment Reports
Next Generation Lake Assessment Reports
### Analytical Data

<table>
<thead>
<tr>
<th>InletNo</th>
<th>TP (ug/L)</th>
<th>TN (mg/L)</th>
<th>TCI (mg/L)</th>
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<tbody>
<tr>
<td>1</td>
<td>12</td>
<td>0.28</td>
<td>2.00</td>
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<tr>
<td>2</td>
<td>22</td>
<td>0.58</td>
<td>3.12</td>
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<td>3</td>
<td>16</td>
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<td>4</td>
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<tr>
<td>5</td>
<td>28</td>
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### Hydrolab Data

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<tr>
<th>InletNo</th>
<th>Conductivity uS/cm</th>
<th>Turbidity NTU</th>
<th>Temp C</th>
<th>DO mg/L</th>
<th>DO %</th>
<th>pH</th>
<th>Chla (ug/L)</th>
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<tbody>
<tr>
<td>1</td>
<td>164.0</td>
<td>0.37</td>
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<tr>
<td>2</td>
<td>219.1</td>
<td>1.48</td>
<td>19.97</td>
<td>6.01</td>
<td>69.4</td>
<td>7.22</td>
<td>1.07</td>
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<tr>
<td>4</td>
<td>253.5</td>
<td>1.39</td>
<td>22.32</td>
<td>7.45</td>
<td>90.2</td>
<td>7.55</td>
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<td>5</td>
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<td>6</td>
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<td>24.54</td>
<td>7.83</td>
<td>98.8</td>
<td>7.94</td>
<td>3.30</td>
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Next Generation Lake Assessment Reports
Next Generation Lake Assessment Reports
Next Generation Lake Assessment Reports
<table>
<thead>
<tr>
<th>Category</th>
<th>Score</th>
<th>Feature</th>
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<tr>
<td>Wilderness Score</td>
<td>0</td>
<td>Beach</td>
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<tr>
<td>Wilderness-Like Score</td>
<td>0</td>
<td>Ledge</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bouldered Shore</td>
<td>0</td>
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<td></td>
<td></td>
<td>Vegetation</td>
<td>0</td>
</tr>
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<td></td>
<td></td>
<td>Islands</td>
<td>0</td>
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<td></td>
<td></td>
<td>Steep Slopes</td>
<td>0</td>
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<td></td>
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<td>Peaks</td>
<td>0</td>
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<td></td>
<td></td>
<td>Scenic Bottom</td>
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<td></td>
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<td>Cliffs</td>
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<td></td>
<td><strong># Total Features</strong></td>
<td><strong>2</strong></td>
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### Next Generation Lake Assessment Reports

#### Lake Assessment Report

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<th>ProjectID</th>
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<th>CharacteristicID</th>
<th>Depth</th>
<th>CollectionMethodID</th>
<th>Result</th>
<th>UnitCode</th>
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<tr>
<td>1</td>
<td>CASPIAN</td>
<td>LakeAsmt</td>
<td>1</td>
<td>Chla</td>
<td>2</td>
<td>IntSampler</td>
<td>0.8 ugg/l</td>
</tr>
<tr>
<td>2</td>
<td>CASPIAN</td>
<td>LakeAsmt</td>
<td>1</td>
<td>Chla</td>
<td>3</td>
<td>PlasticKemm</td>
<td>1 ugg/l</td>
</tr>
<tr>
<td>3</td>
<td>CASPIAN</td>
<td>LakeAsmt</td>
<td>1</td>
<td>ChlaProbe</td>
<td>0.2</td>
<td>Hydrolab</td>
<td>0.3 ugg/l</td>
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<tr>
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<td>CASPIAN</td>
<td>LakeAsmt</td>
<td>1</td>
<td>ChlaProbe</td>
<td>1</td>
<td>Hydrolab</td>
<td>0.4 ugg/l</td>
</tr>
<tr>
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<td>ChlaProbe</td>
<td>2</td>
<td>Hydrolab</td>
<td>0.4 ugg/l</td>
</tr>
<tr>
<td>6</td>
<td>CASPIAN</td>
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<td>ChlaProbe</td>
<td>3</td>
<td>Hydrolab</td>
<td>0.5 ugg/l</td>
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<td>7</td>
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<td>LakeAsmt</td>
<td>1</td>
<td>ChlaProbe</td>
<td>4</td>
<td>Hydrolab</td>
<td>0.7 ugg/l</td>
</tr>
<tr>
<td>8</td>
<td>CASPIAN</td>
<td>LakeAsmt</td>
<td>1</td>
<td>ChlaProbe</td>
<td>5</td>
<td>Hydrolab</td>
<td>0.7 ugg/l</td>
</tr>
<tr>
<td>9</td>
<td>CASPIAN</td>
<td>LakeAsmt</td>
<td>1</td>
<td>ChlaProbe</td>
<td>6</td>
<td>Hydrolab</td>
<td>0.9 ugg/l</td>
</tr>
<tr>
<td>10</td>
<td>CASPIAN</td>
<td>LakeAsmt</td>
<td>1</td>
<td>ChlaProbe</td>
<td>7</td>
<td>Hydrolab</td>
<td>0.8 ugg/l</td>
</tr>
</tbody>
</table>

Showing 1 to 10 of 630 entries
Determining where the phosphorus is coming from

1. Next Generation Lake Assessment Reports

2. High Resolution (0.5m) Mapping
STATEWIDE HIGH-RESOLUTION VERMONT LAND COVER DATA NOW AVAILABLE

03 SEPTEMBER 2019


- **Supplemental Land Cover**: Vector products that include shrub, agricultural, and wetland land cover types as individual layers. These are standalone delineations of base land cover features.

- **Impervious Surfaces**: Vector product created through a "bottom up" approach to map surfaces obscured by tree canopy. Includes buildings, roads, other paved, bare soil, and railroad classes.

Example of the impervious surfaces land cover layer. Image: UVM Spatial Analysis Lab
At the watershed level, **impervious surfaces** make up only **2.5%** of the land cover or roughly 90 acres.

Whereas, ‘**agriculture’** makes up 781 acres or **22%** of the watershed.
Within the 250’ buffer around the lake, **impervious surface** makes up **10%** of the area equating to roughly 16 acres, while **Agriculture** makes up a lower percentage than in the watershed at **5%** or 9 acres.
Within 100’ of the tributaries draining into the lake, only about **2%** is **impervious surface** (or 5 acres), but **25%** of the tributary buffers are ‘Agriculture’ totaling **70 acres of ‘Ag’ within 100’ of the tributaries** draining into the lake.
Part 2: New approaches for Lake Protection

Applications Received per Year (Hover on bar for Details)

- 2015: 104 Total
- 2016: 218 Total
- 2017: 257 Total
- 2018: 263 Total
- 2019: 217 Total
- 2020: 302 Total
- 2021: 162 Total and counting
Part 2: New approaches for Lake Protection

- Lake Watershed Action Plans

- Reclassification to A(1) Status for Aesthetics Uses under Vermont’s Water Quality Standards using the Combined Nutrient Criteria
A Lake Watershed Action Plan (LWAP) is an assessment to identify the highest nutrient/sediment pollution loading from a lake’s watershed that are resulting in water quality and habitat degradation.

The LWAP results in a prioritized list of projects and strategies to address the sources of pollution and habitat degradation identified in the assessment.

The plan may also contain recommendations to preserve natural features and functions, encourage use of low impact green stormwater infrastructure, and maintain the aesthetic and recreational uses of lakes.

Prioritized list of projects can feed into DEC Watershed Projects Database and be considered for Clean Water Initiative Program Funding.
Lake Watershed Action Plan

- Lake Watershed Action Plans are a relatively new approach in Vermont, completed on 3 lakes: Eden, Elmore and Dunmore
- DEC just awarded a grant to the Essex County Conservation District to develop these plans at Maidstone and Fairlee
- Lake Champlain Basin Program just awarded grants for 4 more plans:
  - Lake Iroquois, Caspian Lake, Lake St Catherine, and Fairfield Pond
- LWAPs: a participatory and consultative process involving a multi sector assessment with 3 core elements: Shoreland, Roads, and Tributaries.
  - Answer what are the greatest threats to lake conditions, water quality and habitat
- Scale is more focused than tactical basin plan but can contribute to broader goals
  - Plans in Champlain Basin can contribute to meeting Phosphorus Reduction Targets in TMDL
Lake Watershed Action Plans: Caspian Example

- Lakeshore AND the watershed should be focus (tribs, roads)
- 10% of the 250’ buffer around the lake is impervious surface
- 25% (70 acres) of the 100’ buffer around the streams draining into lake Caspian are classified as Agriculture
Lake Watershed Action Plan
Remedial Intervention Options for Caspian

1. Enhance support for Lake Wise
2. Incentivize septic upgrades
3. Employ tools within the Shoreland Protection Act and MRGP that reduce existing runoff
4. Reduce runoff to tributaries from roads, agriculture, forestry and development
Lake Reclassification under VT Water Quality Standards

The Vermont Water Quality Standards establish designated uses, management objectives, and minimum criteria for all surface waters; waters are classified independently for each designated use:

- **Aquatic biota and wildlife** that are present in the waters;
- **Aquatic habitat** to support aquatic biota, wildlife, or plant life;
- The use of waters for **swimming, boating, fishing**
- The use of waters for the enjoyment of **aesthetic conditions**;
- The use of the water for **public water source** or for **irrigation** of crops and agricultural uses.
Lake Reclassification under VT Water Quality Standards

There are four possible classifications of Vermont surface waters:

<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A(1)</td>
<td>excellent</td>
</tr>
<tr>
<td>A(2)</td>
<td>public water source;</td>
</tr>
<tr>
<td>B(1)</td>
<td>very good;</td>
</tr>
<tr>
<td>B(2)</td>
<td>good;</td>
</tr>
</tbody>
</table>

- All waters below 2,500 ft are designated Class B(2) for all uses, unless designated via reclassification as Class A(1), A(2), or B(1) for any use.
- All waters above 2,500 ft are designated Class A(1) for all uses.
- All waters must continue to meet their classification criteria, otherwise they are listed as impaired, and a restoration plan must be implemented.
Lay Monitoring Program has trained volunteers since 1979 to conduct lake water quality sampling on more than 100 lakes and 40 stations in Champlain.

- Program leads to summer mean values for Total Phosphorus, Chlorophyll A, Secchi (water clarity) calculated from ≥8 samples.
- This data is used to monitor trends on lakes, for designating lakes as impaired, as the basis to establish policy and statute, and now for reclassification!
VT WQS: Combined Nutrient Criteria

- Combined Nutrient Criteria provides guidelines for lake (re)classification
- Numeric Criteria established for Aesthetics Uses: Total Phosphorus & Response Variables
- Use LMP data to determine what lakes currently meeting or failing B2 criteria, but also which lakes are meeting/exceeding B1 or A1 criteria.
- State can reclassify eligible lakes “upwards” if data shows they exceed A(1) or B(1) requirements
- Consistent w/ VT’s Tier 2 Antideg Program

<table>
<thead>
<tr>
<th>Nutrient Concentrations</th>
<th>Class A(1)</th>
<th>Classes A(2) and B(1)</th>
<th>Class B(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Phosphorus (µg/L)</td>
<td>12</td>
<td>17</td>
<td>18</td>
</tr>
<tr>
<td>Nutrient Response Conditions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secchi Disk Depth (meters)</td>
<td>5.0</td>
<td>3.2</td>
<td>2.6</td>
</tr>
<tr>
<td>Chlorophyll-a (µg/L)</td>
<td>2.6</td>
<td>3.8</td>
<td>7.0</td>
</tr>
<tr>
<td>pH</td>
<td>Not to exceed 8.5 standard units.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turbidity</td>
<td>Consistent with the criteria in § 29A-302(4) of these rules.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td>Consistent with the criteria in § 29A-302(5) of these rules.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Rationale for Reclassification of Lake Caspian

- Does A(1) classification better match expectations for Caspian’s Aesthetic Use?
- Is 12 ug/L TP a more appropriate threshold for impairment?

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean Value (since ‘79)</th>
<th>A(1) Threshold</th>
<th>B(2) Threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer TP mean</td>
<td>9.4 ug/L</td>
<td>&lt;12 ug/L</td>
<td>&lt;18 ug/L</td>
</tr>
<tr>
<td></td>
<td>Significantly increasing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secchi</td>
<td>7.7 m</td>
<td>&gt;5.0 m</td>
<td>&gt;2.6 m</td>
</tr>
<tr>
<td>Chlorophyll A</td>
<td>2.1 ug/L</td>
<td>&lt;2.6 ug/L</td>
<td>&lt; 7.0 ug/L</td>
</tr>
</tbody>
</table>
So, how does reclassification increase lake protections?

• While reclassification does not guarantee that the total phosphorus levels (early detection indicator) will not be exceeded, it puts into place a mechanism for action sooner, when more likelihood of restoration success could be achieved at much lower cost.

• Reclassification gets Caspian the tool of legal requirements that come with listing a water as impaired and in particular helps make funds available sooner for restoration work.

• This ‘increased protection’ is afforded the lake even if no other legal protections are afforded the lake.
Management Implications

Management Implications – Existing Prohibitions in Class A waters:

• A direct discharge of any wastes that contained organisms pathogenic to human beings.
• Indirect discharge systems (septic systems) with a design flow greater than 1,000 gallons per day
• Solid waste management facilities and application of biosolids or septage

Possible New Management Implications for A(1) Waters?:

• In lakes w/ increasing TP due to external nutrient loading, require riparian buffers on all lake tribus?
• Other ideas? Incentives for use of AMPs / BMPs?
• No exemptions to ban on winter manure spreading?
• When listing a lake as impaired, we list the lake based on the evidence that the lake is failing our water quality standards.

• We don’t articulate what will and won’t be allowed activities in the watershed; not germane to the finding that the lake is not meeting the water quality standards.

• Listing then established process for TMDL development, which is tailored to lake ‘s unique characteristics and sources of phosphorus.

• We propose a similar approach for reclassification: develop a lake specific approach to establish A(1) protections, enshrine through rule-making process.
What will reclassification offer to a lake (that isn’t already possible?)

Lake Specific Protections, possibly a Lake Watershed Action Plan

Projects & Funding
- Act 76 (Water Quality Enhancement Grants)
- CWIP
- LCBP
Next Steps: Engagement w/ Towns & Lake Associations

- Reclassification can be initiated by Vermont DEC or via petitions from the public.
- Increasing lake protections via reclassification, while not a new idea, has only been used once in VT.
- VT DEC: outreach to interested / eligible lake communities and towns about lake reclassification.
- Identified seven eligible lakes w/ increasing TP and active lake associations:
  - Maidstone, Caspian, Raponda, Willoughby, Shadow (Glover), Seymour, Echo (Charleston)
- Substantial local interest, some concerns over management restrictions.
- Exploring reclassifying same lakes for fishing uses to generate additional support.
- Expect first petitions to reclassify high-quality lakes later this year.
- Petitions kick off a rulemaking process, involving public hearings, legislative review, & decision.
Thanks for your attention!

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Kellie.Merrell@vermont.gov