

# Vermont Lake Assessment Program:

**2011 Results for Long Pond in Greensboro**

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# Next Generation Lake Assessment: Report Outline

- Overview of sampling procedures and data collection
- Results for Long Pond
  - Vermont Lake Protection Classification
  - Physical, chemical and biological characteristics
  - Vermont buffer measurements
  - Comparison of results to Vermont Littoral Habitat study
  - Comparison of results to National Lakes Assessment
  - Vermont Lake Report Card
  - Vermont Lake Score Card



# Vermont Lake Assessment Program

- **Purpose**

- To assess the condition of Vermont lakes during the summer, the optimal time for surveying:
  - aquatic plants and macroinvertebrates (aquatic insects, mussels, etc.),
  - shoreline physical habitat,
  - lakeshore vegetative buffers,
  - open water chemical and physical condition, and
  - current and historical sediment diatom communities.



# Vermont Lake Assessment Program

- **Lake Selection**

- Lakes will be selected based on the 5-year basin rotation process.
- Lakes with the oldest data will be priority.
- Reference lakes (lakes with conditions thought to be most natural) within each basin will also be prioritized during basin rotations.



# Vermont Lake Assessment Program

- **2011 Lake Selection**

- Lakes were chosen based on their condition, size class, and applicability for long-term and climate change monitoring.
- Only reference lakes were chosen using a *stratified random design*
  - This was done to make sure the sample was representative based on size class.
- Initial lake generation based on lack of:
  - acid rain impact,
  - water level fluctuations, and
  - development.
- Sentinel sites
  - In order to meet the standards for climate change monitoring, the lakes initially generated were narrowed down based on their conservation status and lack of invasive plants.

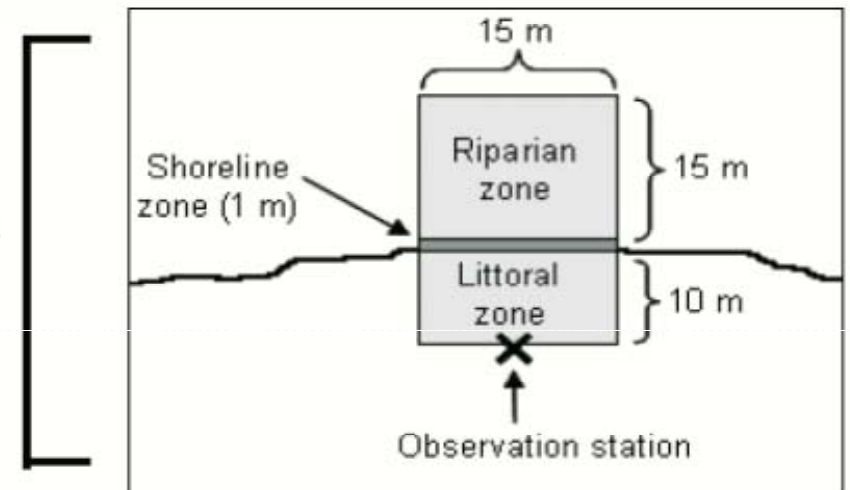
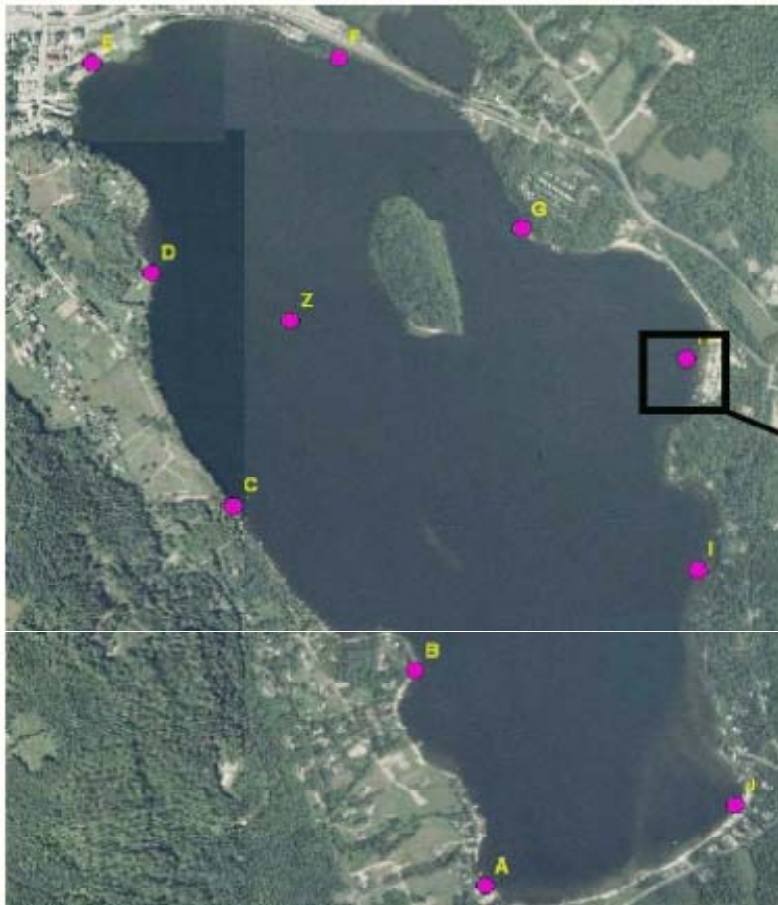


# Vermont Lake Assessment Program

- **Site Selection**

- *Index Site* - deepest point in the lake intended to capture general water quality conditions.
- *Physical Habitat Sites* - 10 randomly selected sites evenly spaced around the shoreline.
- *Inlets and Outlet*

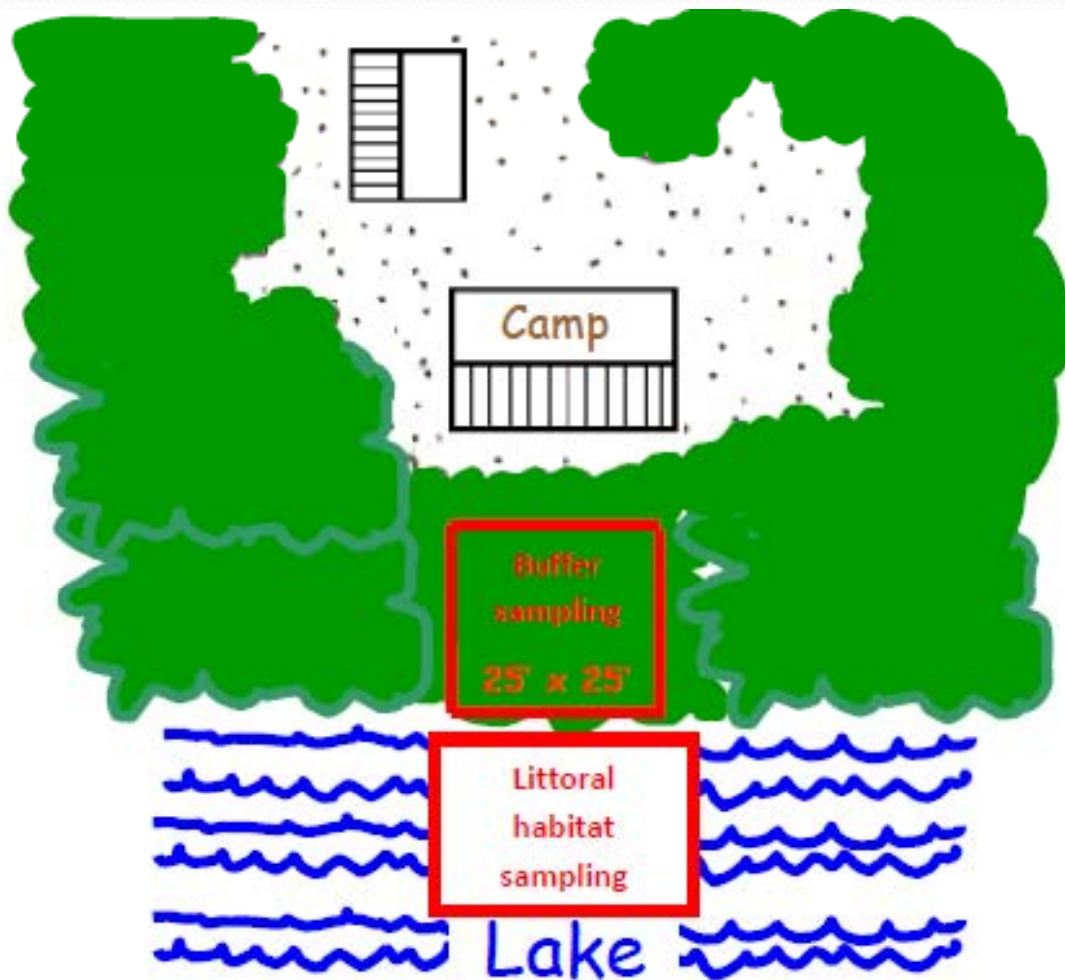
# Vermont Lake Assessment Program



Schematic of a physical habitat and benthic sampling station. The observation station is located on the lake, 10 meters from shore. (Survey of the Nation's Lakes Field Operations Manual)

An example of the 10 randomly selected physical habitat locations and the Index (Z) site, at Island Pond in Brighton, VT.

# Vermont Lake Assessment Program



While snorkelers measure littoral habitat parameters underwater, other personnel take measurements like the diameter of trees at 4.5 ft above ground in the nearshore buffer.







# Vermont Lake Assessment Program

- **Parameters Measured**

- *Water Quality Indicators* - temperature, conductivity, pH, dissolved oxygen, turbidity, chlorophyll-*a*, nutrients (TP/TN), metals, alkalinity, water clarity (Secchi disk depth), and sediment diatoms (from lake bottom).
- *Ecological Integrity Indicators* – shoreline, riparian, and littoral habitat condition; vegetative buffers; inlet sediment characteristics; inlet dominant aquatic plants; crayfish species; and macroinvertebrates.



# Results for Long Pond

# Vermont Lake Protection Classification: Long Pond

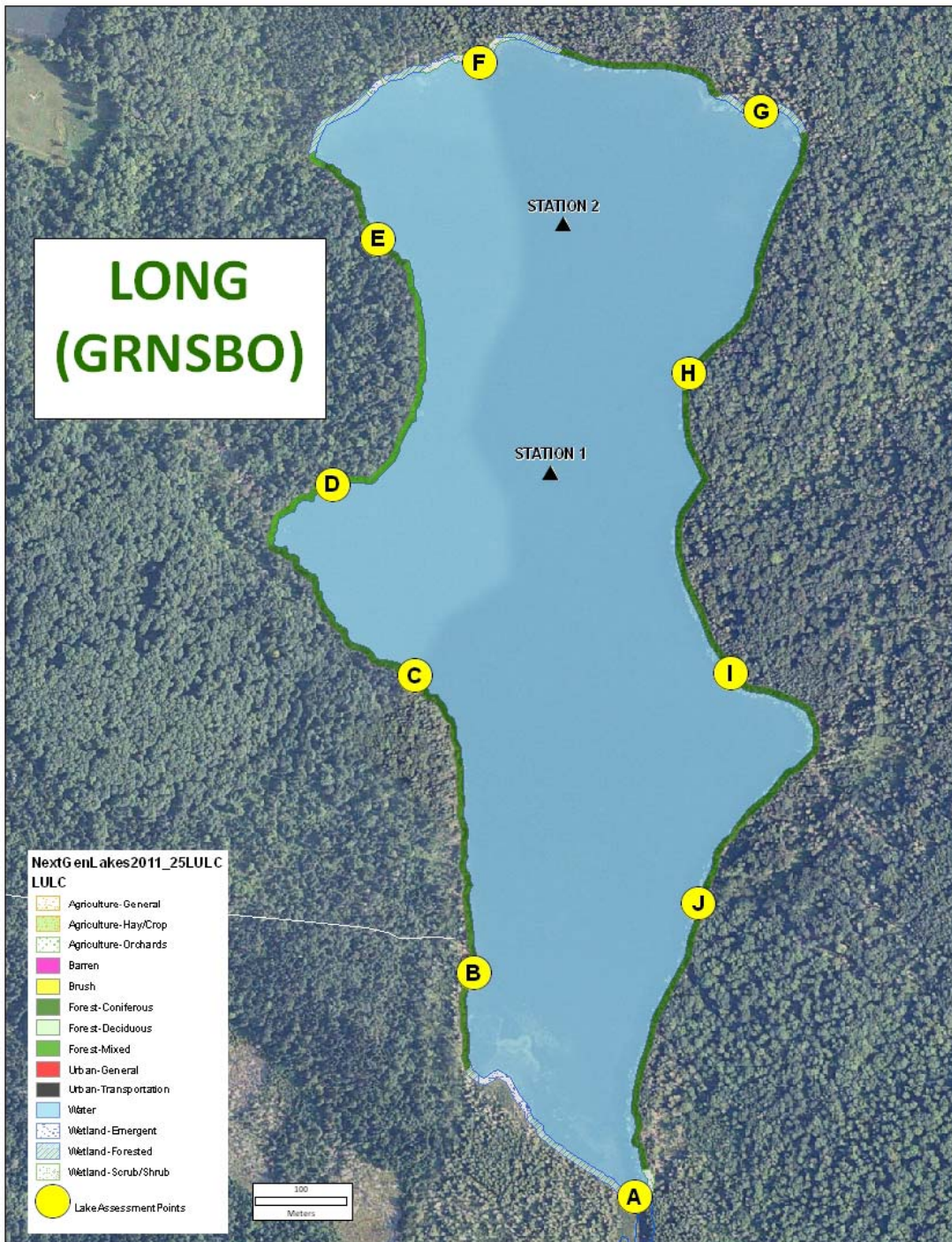
- Wilderness Score: 8 (4WD road, dock, tent platform, wooden shelter)
- Wilderness scoring guidelines:

Standard	Points Awarded
No evidence of human activity except campsites or foot trail	10
Some evidence of past or temporary human presence, and/or 4WD access	9
Unobtrusive structures near shore, may have 4WD access	8
Not a Wilderness Lake	0
Not Evaluated	n/a



## Unusual or Scenic Natural Features: Long Pond

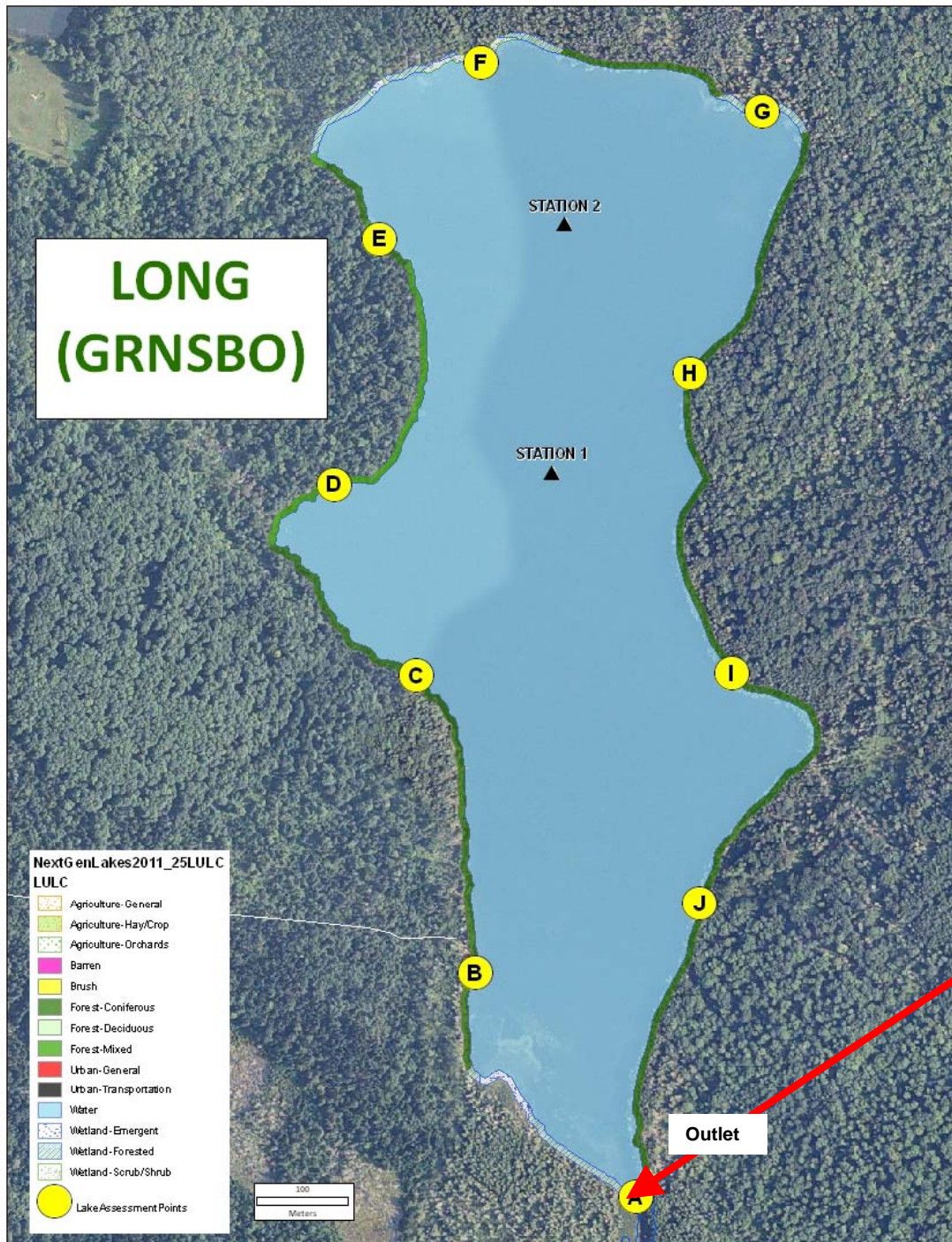
Beach	N
Ledge	Y
Bouldered Shore	Y
Vegetation	Y
Islands	N
Steep Slopes	N
Peaks	N
Scenic Lake Bottom	Y
Cliffs	N
<b>Total # of features</b>	<b>4</b>



# Long Pond Conditions

- Survey date: 8/1/2011
- Reference lake: Yes
- Weather: n/a
- Antecedent precipitation: Dry
- Surficial algae bloom: no
- Significant erosion: no
- Active logging/agriculture: no
- # of camps: 0
- # of recreational areas: 0

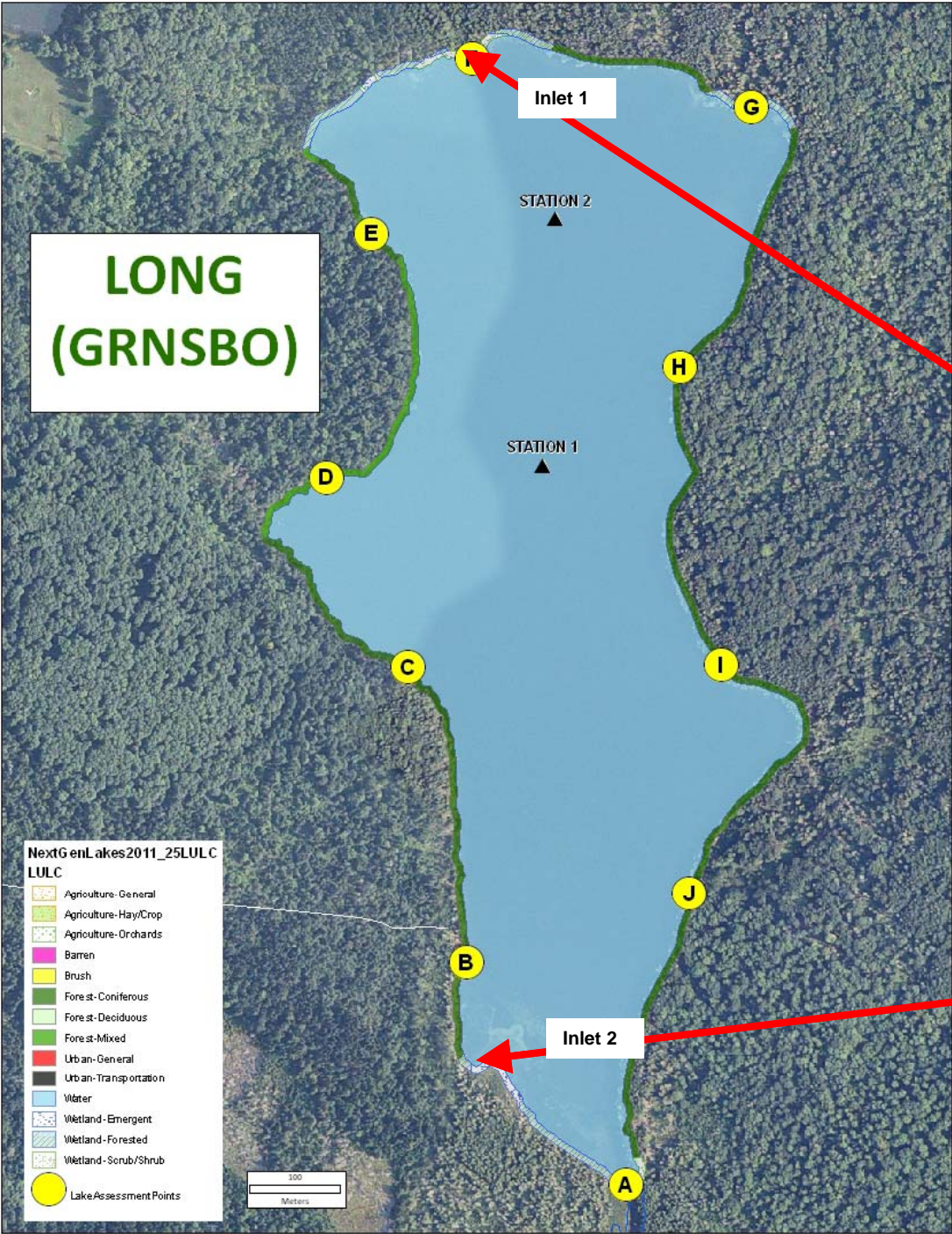
# Long Pond Outlet




- Natural: Wetland with woody debris jam
- % Cover of aquatic plants: N/A
- Temperature (°C): 22.4
- Dissolved oxygen (mg/L): 7.5
- Dissolved oxygen % saturation: 92.9
- Specific conductivity (µS/cm): 110.2
- pH: N/A
- Chlorophyll-*a* (µg/L): 2.7
- Turbidity (NTU): 1.8
- Total phosphorus (µg/L): 16.1
- Total nitrogen (mg/L): 0.241



# Long Pond Inlets






# Long Pond Inlets: Physical Characteristics

Inlet #	Width (m)	Sediment Depth (cm)	Area of Sediment Delta (m <sup>2</sup> )	% Cover of Algae	% Cover of Aquatic Plants	Dominant Macrophyte Species
1	2	37	0	N/A	32	Potamogeton epihydrus, Typha sp., Glyceria borealis
2	1	N/A	0	N/A	50	Nymphaea odorata, Equisetum sp., Sparganium sp.

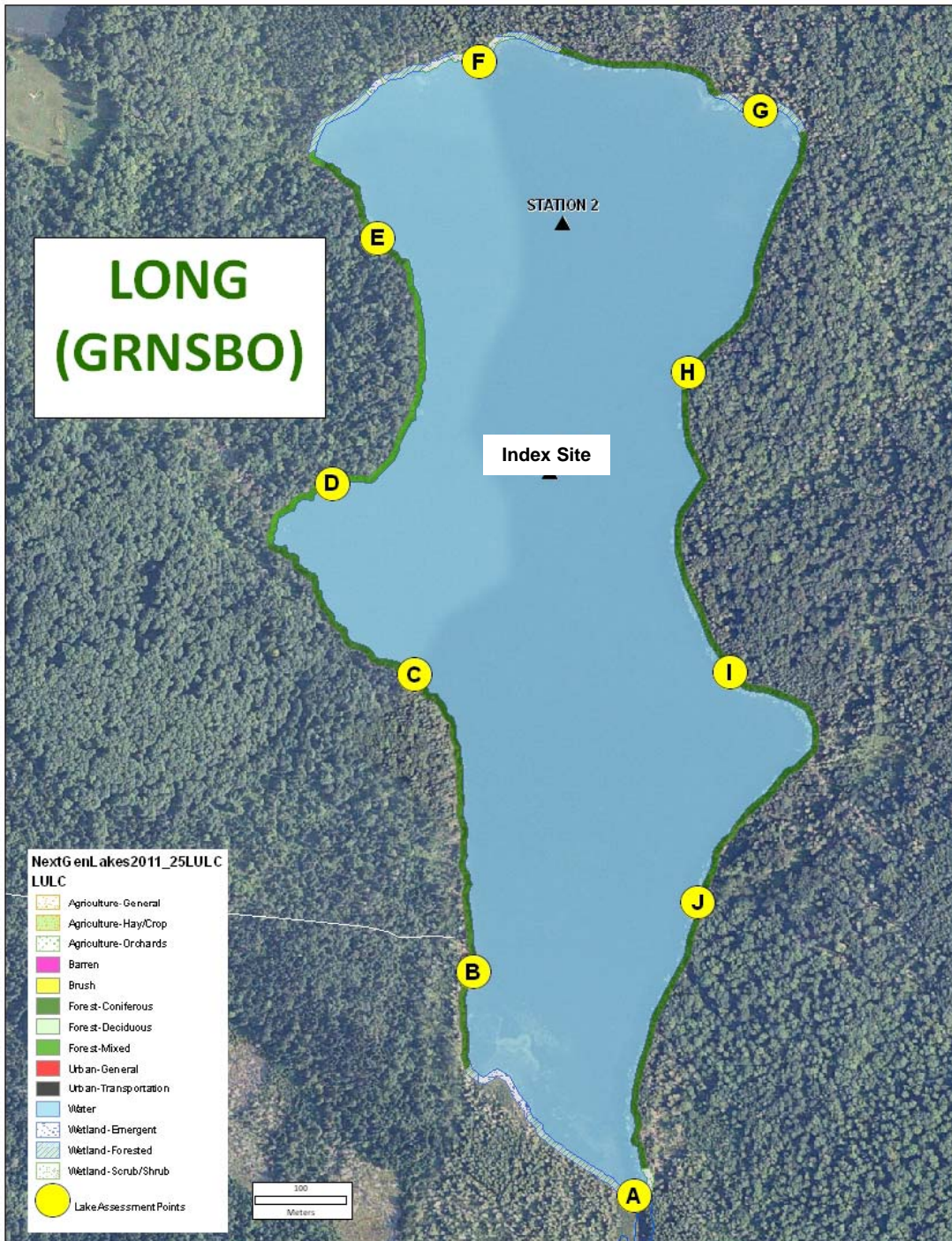




# Long Pond Inlets: Chemical Characteristics

Inlet #	Temperature ( C )	Dissolved Oxygen (mg/L)	Dissolved Oxygen % Saturation	Specific Conductivity (μS/cm)	pH	Chlorophyll- <i>a</i> (μg/L)	Turbidity (NTU)	Total Phosphorus (μg/L)	Total Nitrogen (mg/L)
1	22.6	5.9	72.9	107.7	N/A	2.9	5.7	25	0.337
2	24.5	7.1	90.8	100.6	N/A	5.1	N/A*	45.6	0.501

\* Turbidity sensor failed to receive an accurate reading.



## Long Pond Index Site

- Total depth (m): 9.8
- Secchi depth (m): 3
- Thermocline depth (m): 4.5



# Long Pond Index Site: Sediment Core Diatoms

- **Purpose**

- To compare environmental conditions of pre-colonial times and the present

- **Tests**

- Detrended correspondence analysis (DCA)
  - Used for a comparison of environmental conditions in the top and bottom samples of each lake based on the strongest environmental predictors (nutrients & ANC).
- Inferred Model
  - Used to infer present day and historical concentrations of environmental variables (conductivity, TN, TP, chl-*a*, and Secchi depth) and compare top to bottom.
- Lake Diatom Condition Index (LDCI)
  - Developed as part of the U.S. EPA National Lake Assessment of 2007 using the diatom community found in the surface sediments of the surveyed lakes.
  - Based on 5 metrics that include:
    - Diversity, richness, and percent reference and tolerant taxa
    - Percent epiphytic individuals
    - Percent chain-forming individuals
    - Percent *Achnanthydium*, *Cocconeis*, *Cyclotella* plus *Stephanodiscus* individuals
    - Percents low and high N and P taxa



## Long Pond Index Site: Sediment Core Diatoms

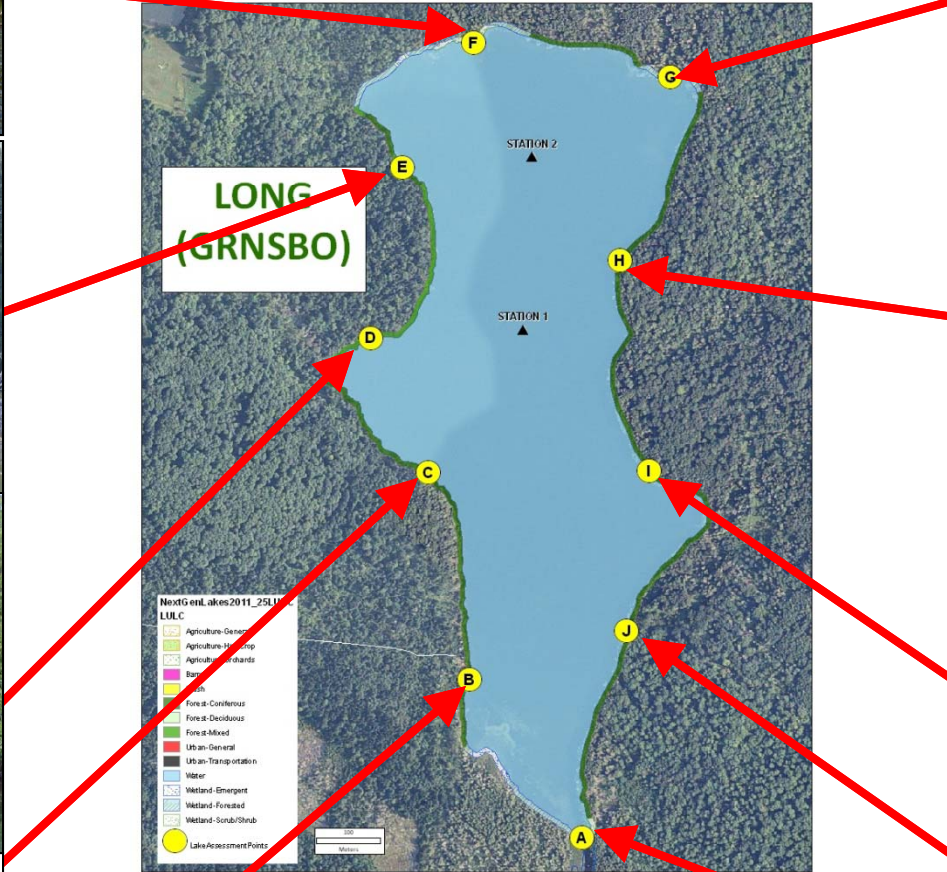
Test	Results	Notes
DCA	Very minimal change in ANC and nitrogen.	
Inferred Model	Very minimal change in all environmental variables.	
LDCI*	9.7	2 <sup>nd</sup> lowest top sample value of the 13 lakes sampled.

\* Based on a 100 point scale. The results are the difference between the scores of the bottom and top samples. Positive numbers indicate worse condition and negative numbers indicate better condition. Low numbers indicate minimal change.

# Long Pond Index Site: Chemical Characteristics

Depth (m)	Temperature ( C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen % Saturation	Specific Conductivity (µS/cm)	pH	Chlorophyll- <i>a</i> (µg/L)	Turbidity (NTU)	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Alkalinity (mg/L)	Total Chloride (mg/L)
0.3	23.9	8.8	111.4	102.5	N/A	2.8	0.4	15.6	0.221	45.5	0.842
1	23.7	8.8	111.5	102	N/A	4.3	1.2				
2	23.4	8.8	111.2	102.1	N/A	5.8	2.8				
3	23.1	8.9	110.6	102	N/A	7.4	2.4	N/A	N/A	N/A	N/A
4	21.7	7.6	92.3	101.3	N/A	6.8	3.2	N/A	N/A	N/A	N/A
5	16.2	7.7	84.3	98.6	N/A	5.8	2.8	N/A	N/A	N/A	N/A
6	12.1	3.2	31.4	100.1	N/A	7	2.3	N/A	N/A	N/A	N/A
7	10.2	1.3	12.1	110.3	N/A	9.6	3.3	44.2	0.363	N/A	N/A
8	9.3	0.5	4.9	119.4	N/A	7.4	7.3	N/A	N/A	N/A	N/A
9	9.1	0.3	2.9	122.9	N/A	7.4	8.6	15.3	0.209	N/A	0.834

# Long Pond Physical Habitat Sites



# Long Pond Physical Habitat Sites: Macrophytes

Site	Dominant Macrophyte Species	% Cover
A	Equisetum sp.	15
	Glyceria borealis	20
	Nymphaea odorata	15
B	Nuphar variegata	30
	Glyceria borealis	25
	Juncus sp.	5
C		0
D	Potamogeton amplifolius	25
E	Potamogeton natans	5
	Iris sp.	5
F	Potamogeton gramineus	2
	Equisetum sp.	2
	Potamogeton richardsonii	5
G	Typha sp.	29
	Equisetum sp.	1
H		0
I		0
J		0

# Long Pond Physical Habitat Sites: Invasive Species

Site	% Littoral Coverage of Invasive Species	% Riparian Coverage of Invasive Species
A	0	0
B	0	0
C	0	0
D	0	0
E	0	0
F	0	0
G	0	0
H	0	0
I	0	0
J	0	0



# Long Pond Physical Habitat Sites: Crayfish

Site	Crayfish Species	Male	Female	Unisex
C	<i>Orconectes virilis</i>	1	0	0
H		0	0	0
I		0	0	0

# Vermont Buffer Measurements

## Maine Standards

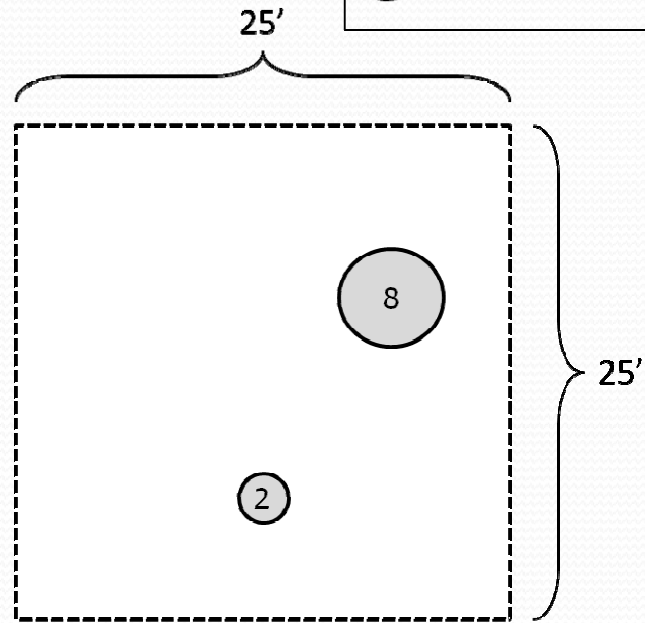
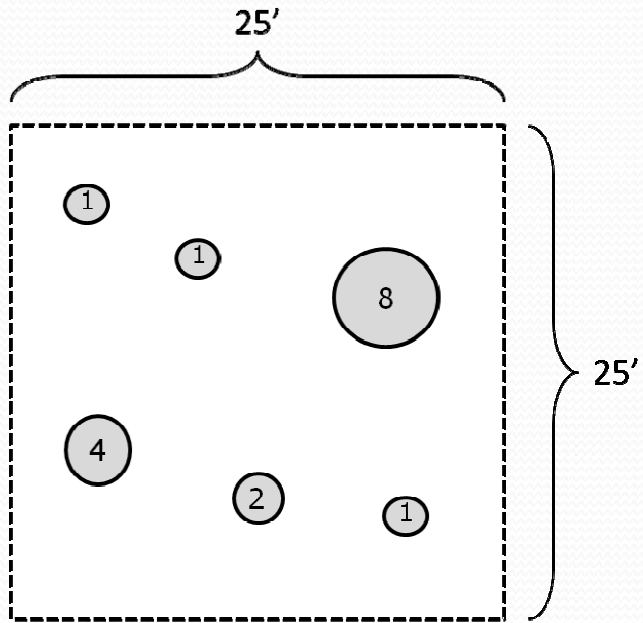
- No openings in tree canopy greater than 15'x15' (canopy intact)
- No vegetation under 3' cut
- Structures set back from water's edge at least 100'
- Minimum of 12 DBH points within each 25'x25' plot *and* at least 3 saplings remain in each plot

## Standard Requirements of Developed Sites

Canopy Intact?	Veg < 3' Cut?	Main Structure Setback (m)	Closest Structure Setback (m)	> 3 Saplings?	DBH Points
Yes	No	≥ 30.5	≥ 30.5	Yes	13

# Vermont Buffer Measurements

④ = Trees with DBH Scores



Diameter	Points
Under 2"	0
2" to < 4"	1
4" to < 8"	2
8" to < 12"	4
12" or greater	8

17 Points in 25'x25' area:  
Meets buffer standard  
 for DBH points

10 Points in 25'x25' area:  
Does not meet buffer standard  
 for DBH points

Shoreline

# Vermont Buffer Measurements: Long Pond

Site	Canopy Intact?	Veg < 3' Cut?	Main Setback (m)	Closest Setback (m)	Closest Setback	Narrowest Buffer (m)	Widest Buffer (m)	Avg Buffer (m)	Slope Height (m)	Comments
A	Y	N				7.6	7.6	7.6	0.3	
B	Y	N				7.6	7.6	7.6	0.5	
C	Y	N				7.6	7.6	7.6	0.75	
D	Y	N				7.6	7.6	7.6	0.3	
E	Y	N				7.6	7.6	7.6	0.3	
F	N	N				7.6	7.6	7.6	0.3	Wetland
G	Y	N				7.6	7.6	7.6	0.3	
H	Y	N				7.6	7.6	7.6	3	
I	Y	N				7.6	7.6	7.6	0.75	
J	Y	N				7.6	7.6	7.6	1	

# Vermont Buffer Measurements: Long Pond

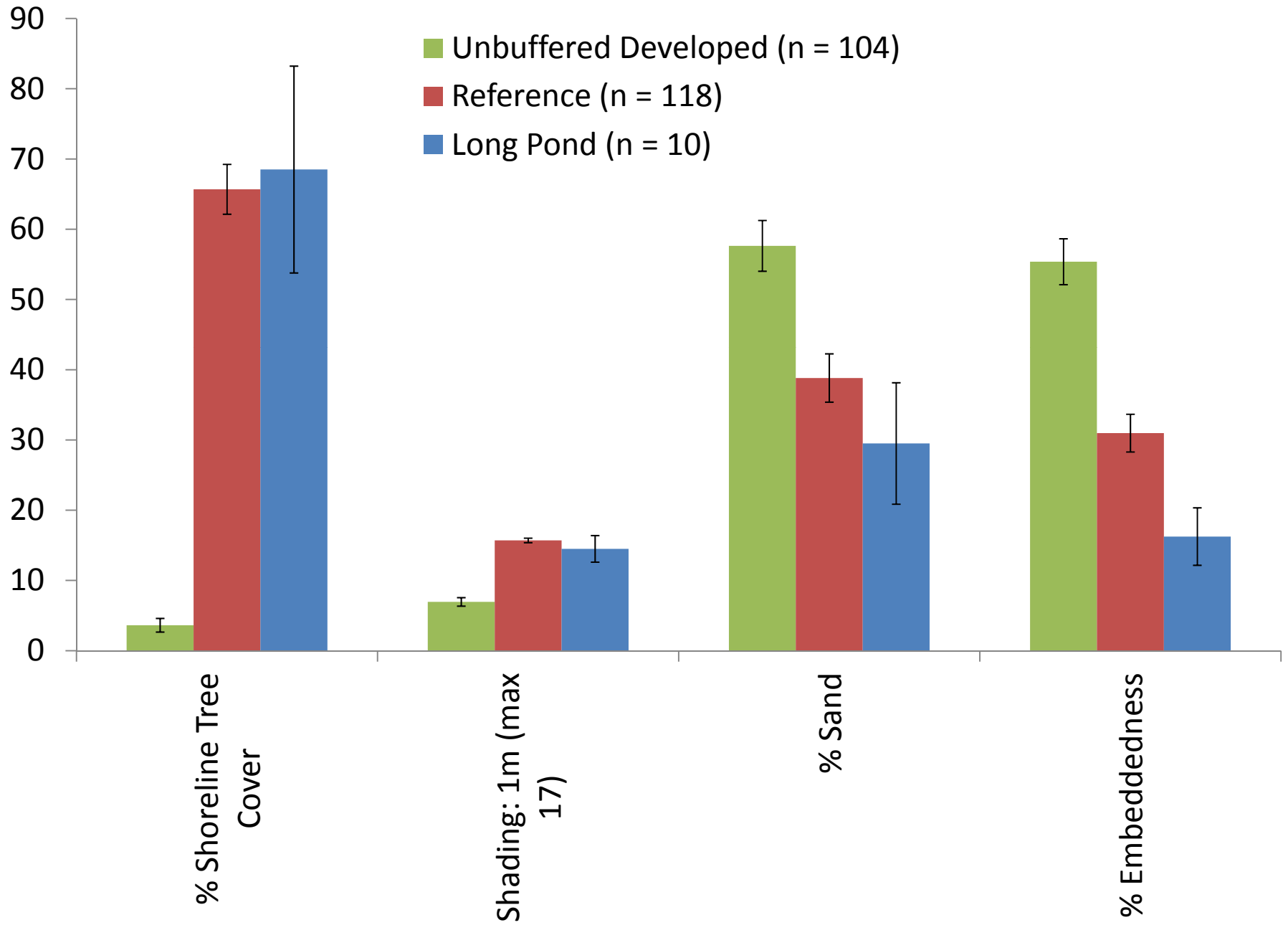
Site	> 3 Saplings?	DBH Points	Developed?	If developed, meets criteria?
A	Y	24	No	
B	Y	72	No	
C	Y	51	No	
D	Y	35	No	
E	Y	56	No	
F	N	0	No	
G	Y	18	No	
H	Y	19	No	
I	Y	61	No	
J	Y	55	No	



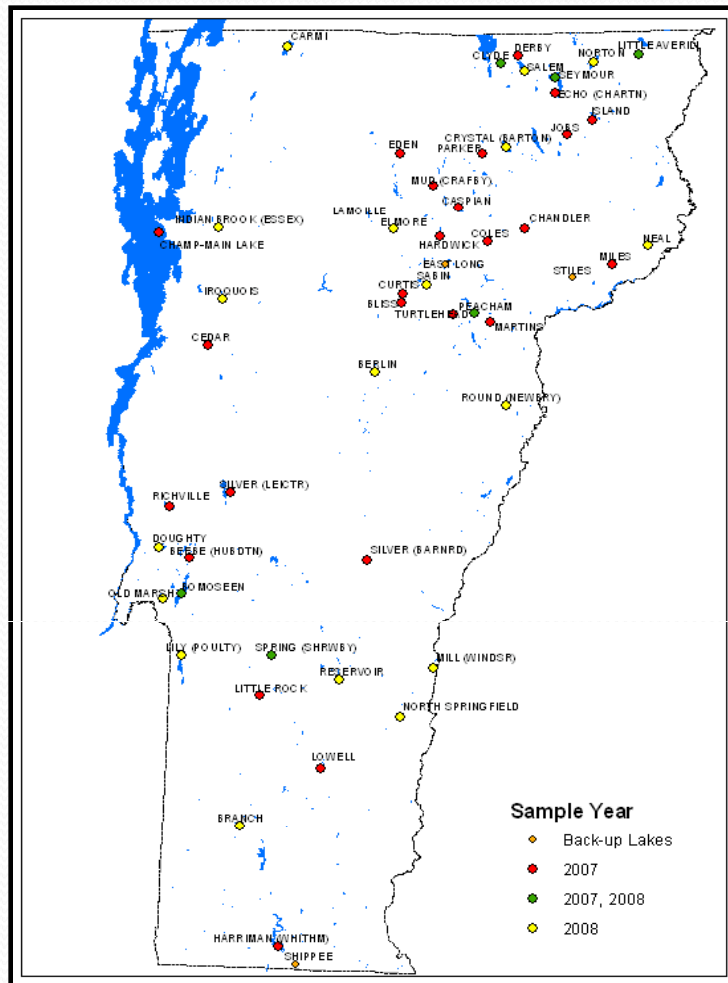
# Vermont Littoral Habitat Assessment (LHA)

- % Shoreline tree cover
- Shading (densiometer: 1m from shore)
- % Sand
- % Embeddedness

## All LHA Lakes and Long Pond in Greensboro



# 2007 and 2008 Vermont participated in the National Lake Assessment



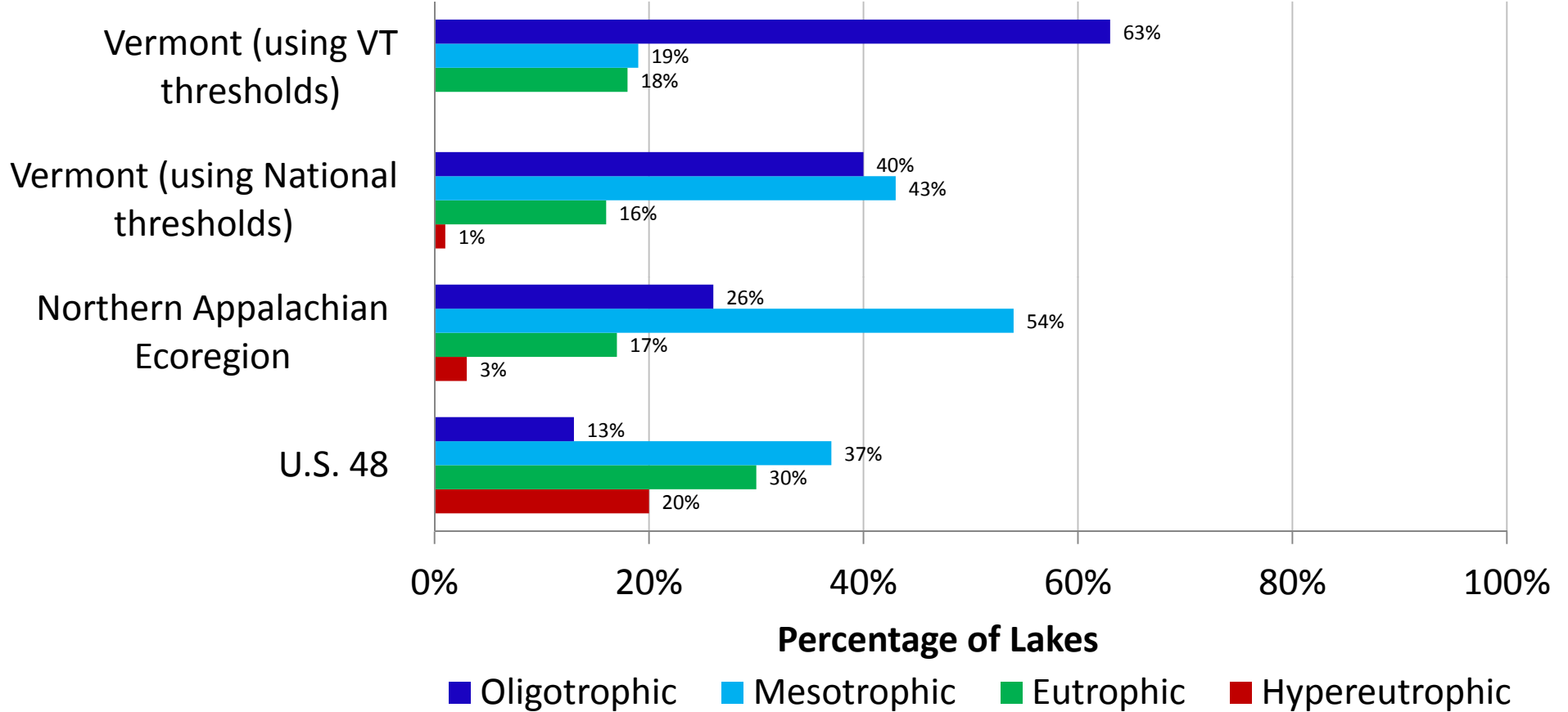
- 11 lakes: NLA draw
- VT asked EPA for an additional 40 draw for statewide assessment



# Trophic State (chlorophyll-*a*)

Long Pond (using VT DEC thresholds): Mesotrophic, 4.3

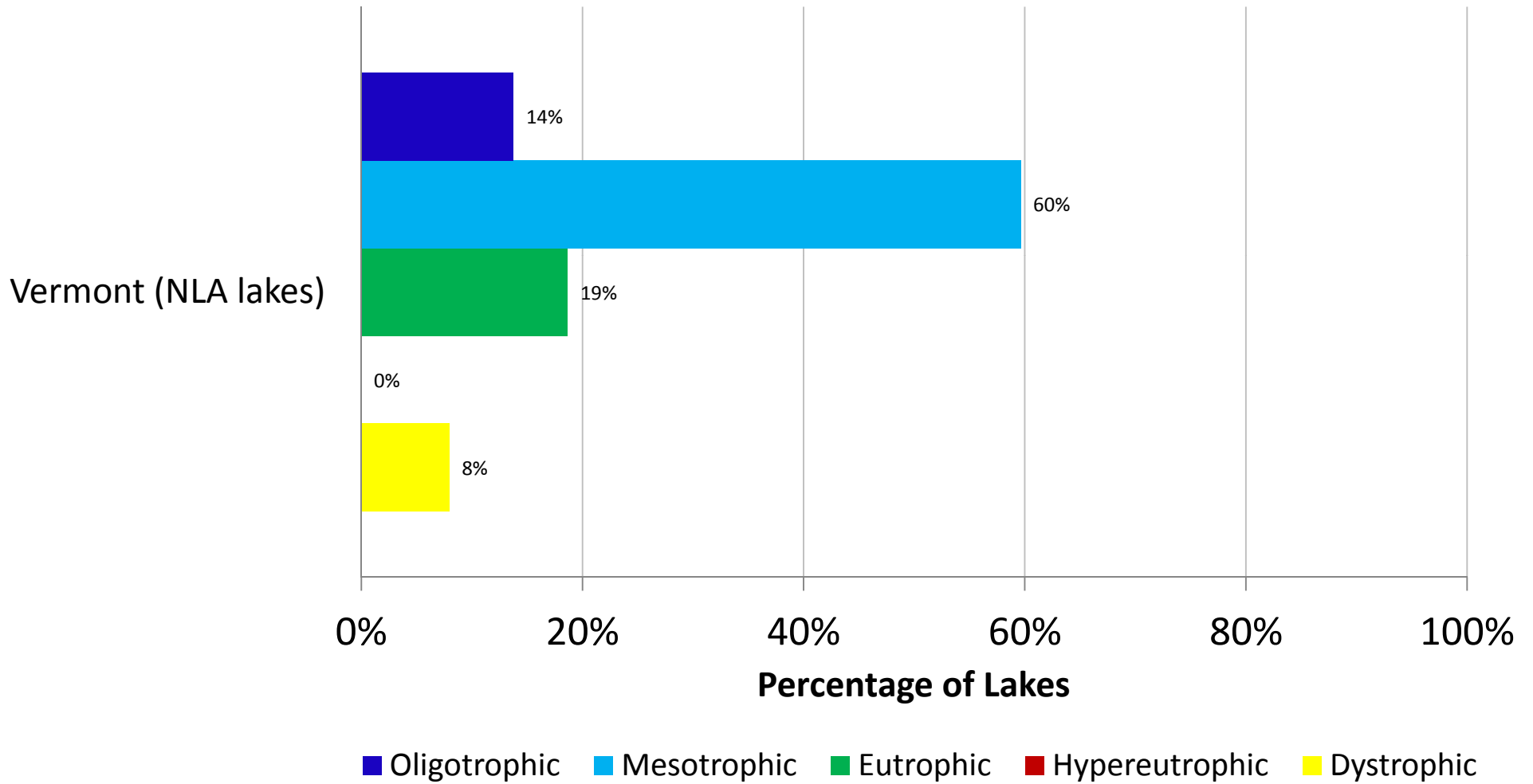
Long Pond (using National thresholds): Mesotrophic



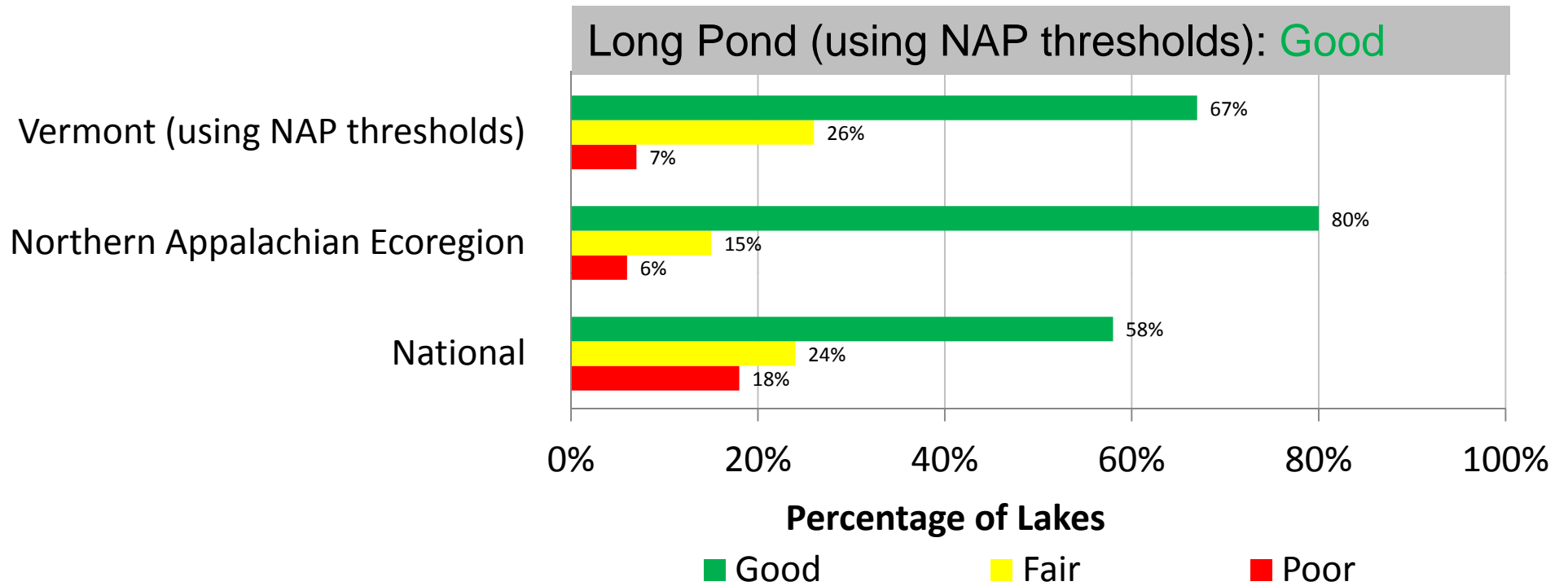
<b>VT DEC thresholds:</b>	Oligotrophic: <3.5 ug/L	Mesotrophic: 3.5 - <7 ug/L	Eutrophic: ≥7 ug/L
<b>National thresholds:</b>	Oligotrophic (< 2 ug/L)	Mesotrophic (>2-7 ug/L)	Eutrophic (>7 - 30 ug/L)
			Hypereutrophic (> 30 ug/L)

# Trophic State (VT DEC long-term TP, chlorophyll-*a*, and Secchi data)

Long Pond: **Mesotrophic**



# Total Phosphorus

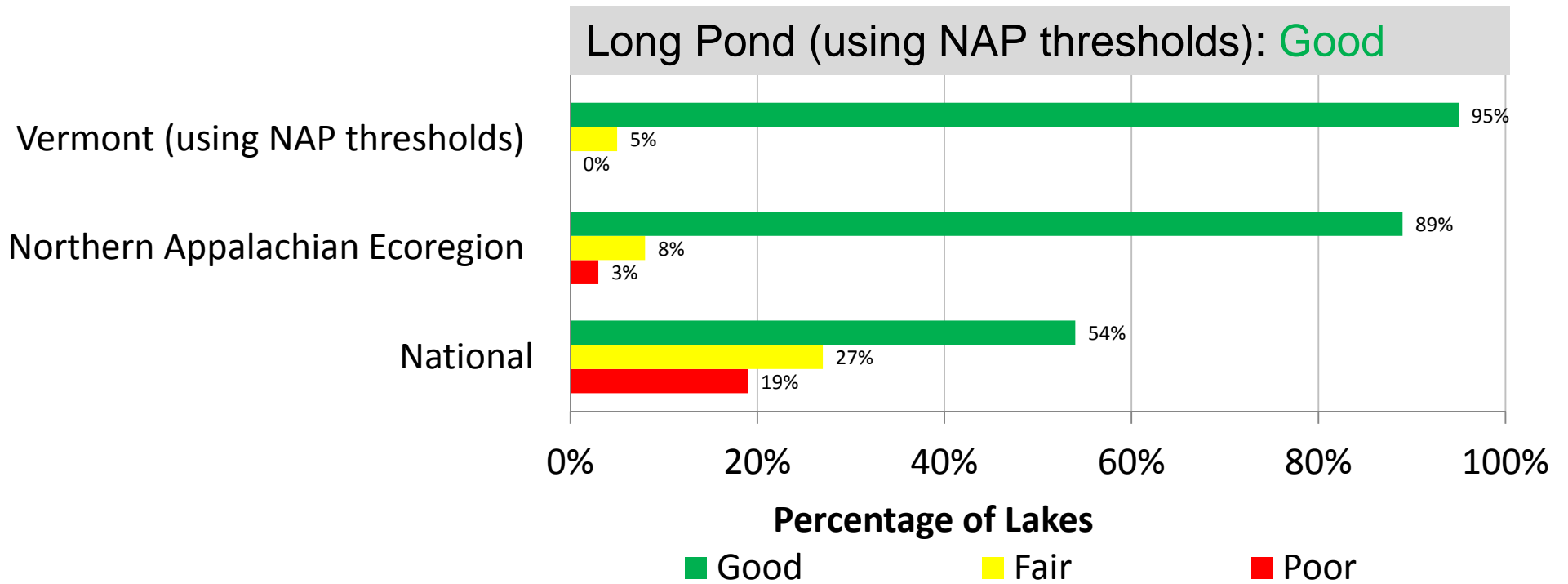


**NAP thresholds (Nutrient Ecoregion VIII):** Good: <16.5 ug/L

Fair: 16.5 - <36 ug/L

Poor: ≥36 ug/L

# Total Nitrogen

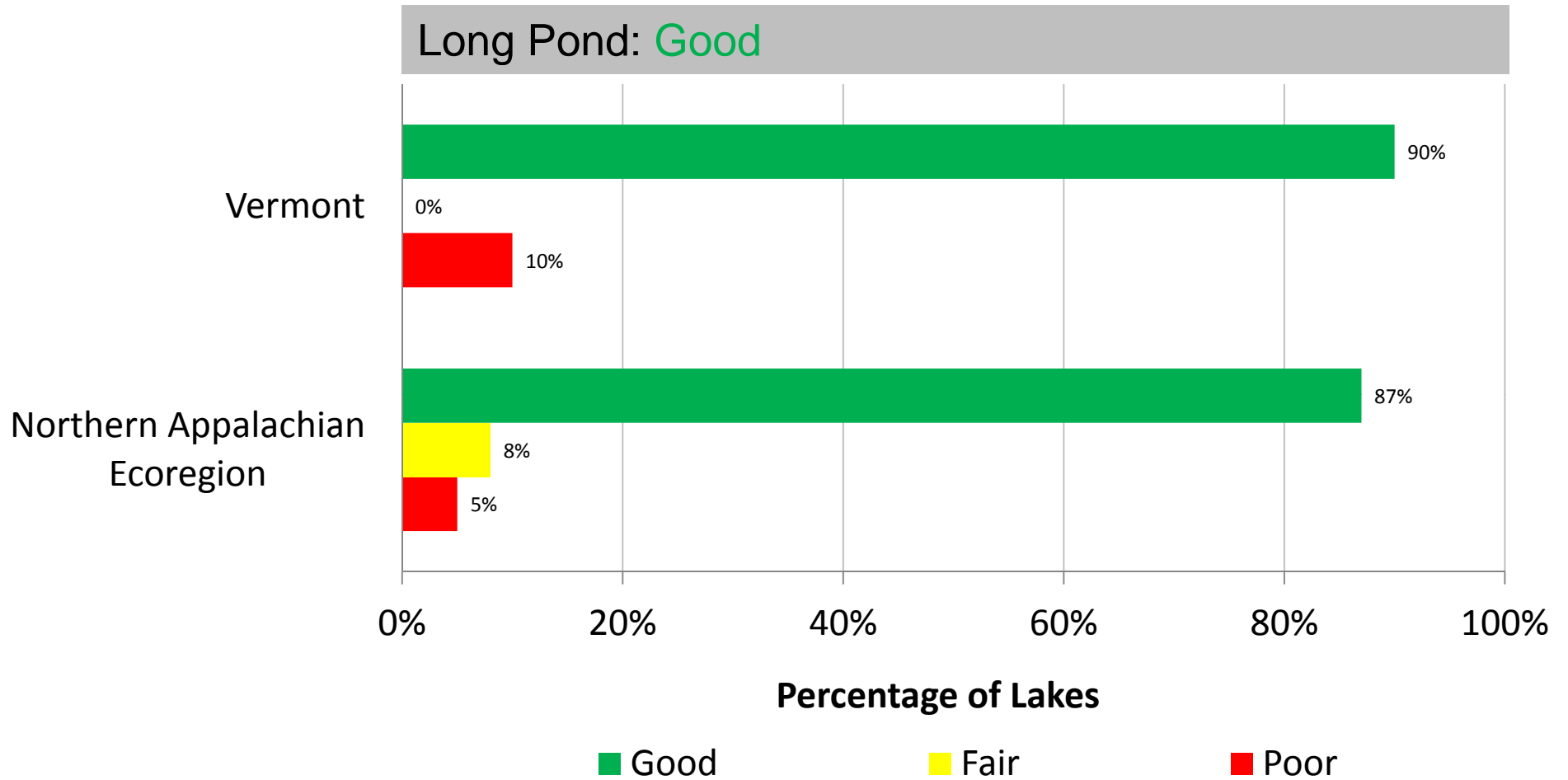


**NAP thresholds (Nutrient Ecoregion VIII):** Good: <674 ug/L

Fair: 674 - <1174 ug/L

Poor: ≥1174 ug/L

# Chlorophyll-*a*



## NAP thresholds (Nutrient Ecoregion VIII):

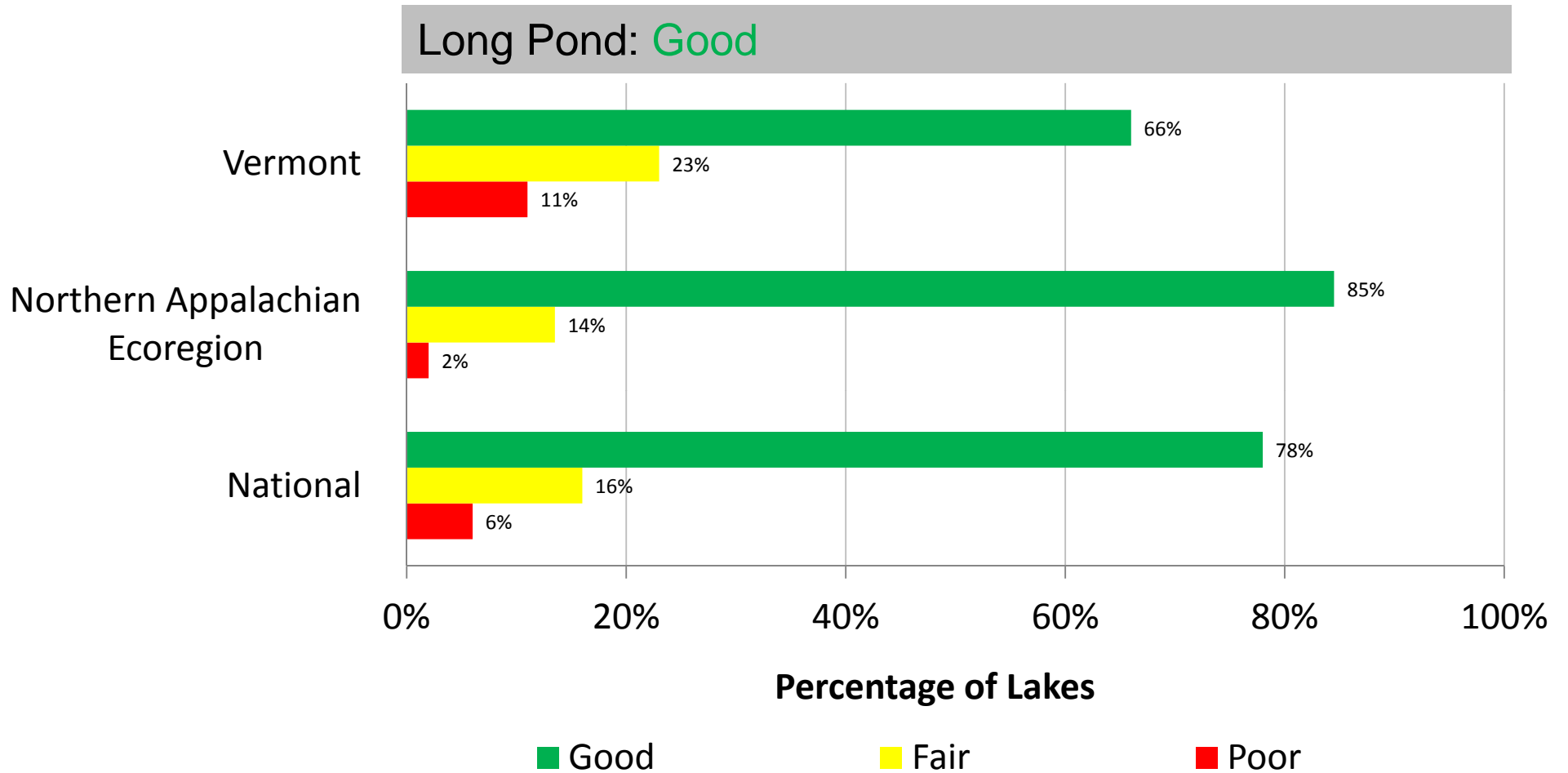
Good: <7.56 ug/L

Fair: 7.56 - <12.5 ug/L

Poor: ≥12.5 ug/L

# Turbidity

Long Pond: **Good**



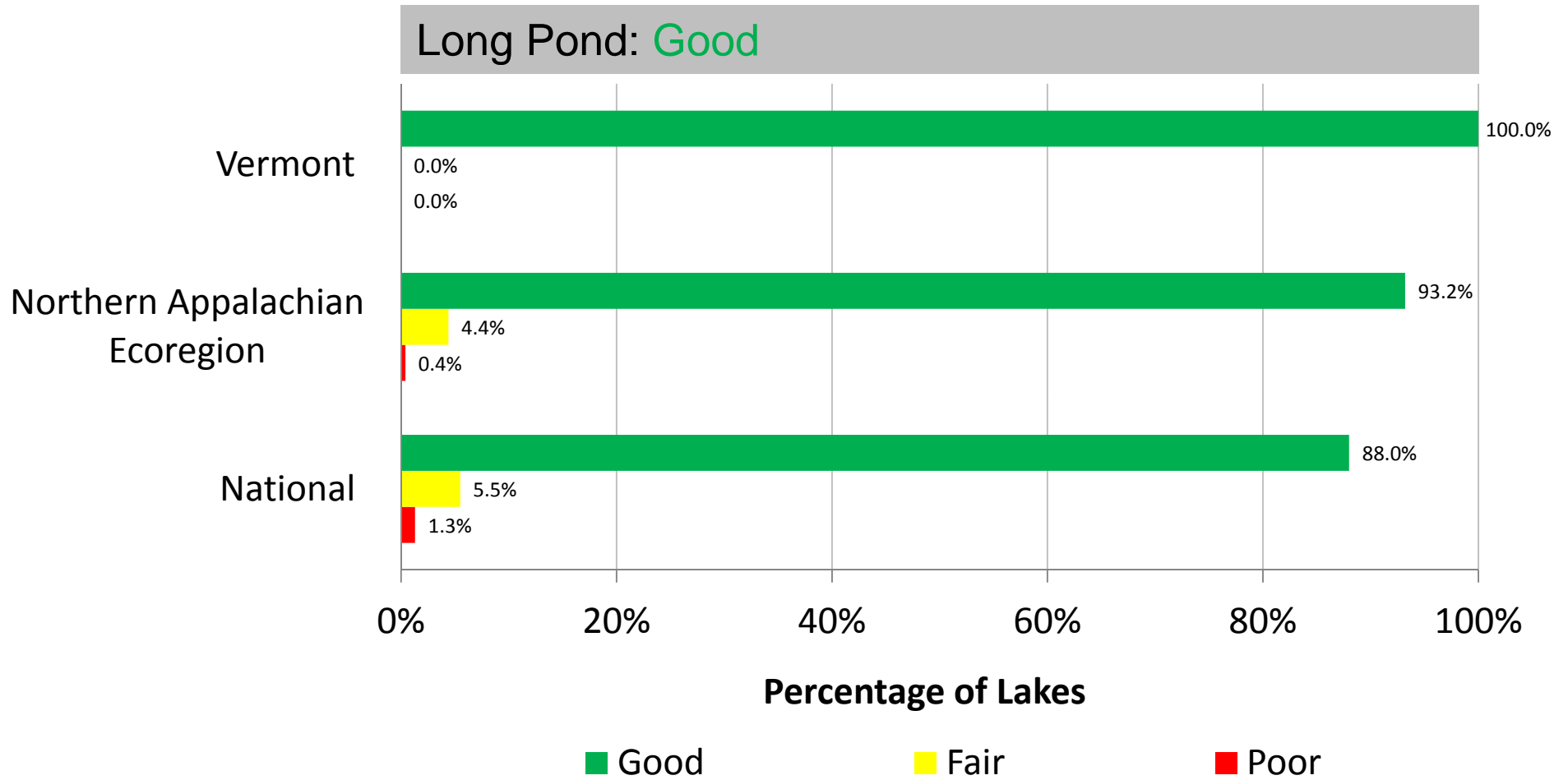
## NAP thresholds (Nutrient Ecoregion VIII):

Good: <2.75 NTU

Fair: 2.75 - <5.41 NTU

Poor:  $\geq 5.41$  NTU

# Dissolved Oxygen



## National thresholds:

Good:  $\geq 5$  mg/L

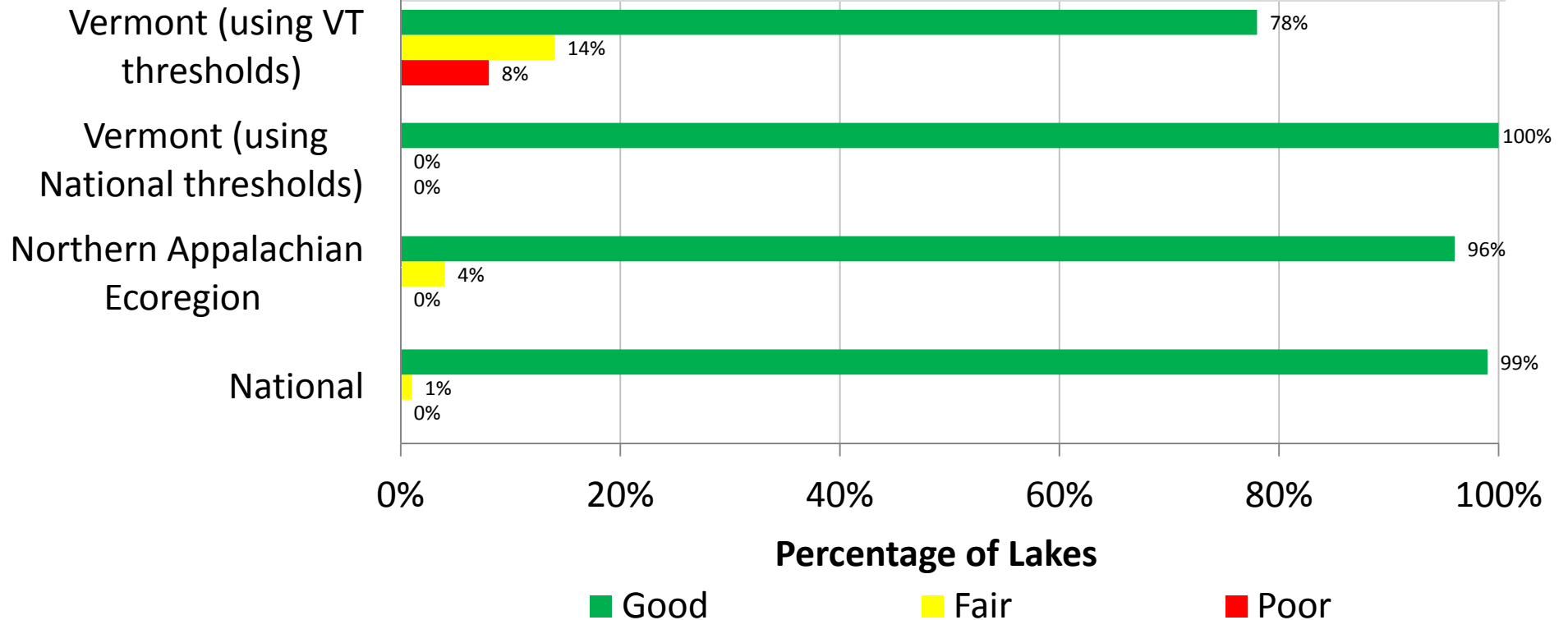
Fair:  $< 5 - 3$  mg/L

Poor:  $< 3$  mg/L

# Acid Neutralizing Capacity

Long Pond (using VT DEC thresholds): **Good**

Long Pond (using National thresholds): **Good**



**VT DEC thresholds:** Good: Alkalinity >12.5 mg CaCO<sub>3</sub>/L  
 Fair: Alkalinity 2.5 - 12.5 mg CaCO<sub>3</sub>/L  
 Poor: Alkalinity <2.5 mg CaCO<sub>3</sub>/L

**National thresholds:** Good: Alkalinity >2.5 mg CaCO<sub>3</sub>/L  
 Fair: Alkalinity ≤2.5 - >0 mg CaCO<sub>3</sub>/L and Dissolved Organic Carbon ≤5 mg/L  
 Poor: Alkalinity ≤0 mg CaCO<sub>3</sub>/L and Dissolved Organic Carbon <5 mg/L





# SHORELINE HUMAN DISTURBANCE INDEX (Lakeshore Disturbance)

$$RDis\_IX = \frac{1 - \{1 / [1 + hiiNonAg + (5 \times hiiAg)]\} + hifpAnyCirca}{2}$$

**hiiAg** = sum of individual weighted presence of agricultural influences  
(hipwCrops+hipwOrchard+hipwPasture)

**hiiNonAg** = sum of individual weighted presence of nonagricultural influences  
(hipwBuildings+hipwCommercial+hipwDocks+hipwLandfill+hipwLawn+hipw  
Park+hipwPowerlines+hipwRoads+hipwWalls)

**hifpAnyCirca** = fractional presence of any influence occurring in station plots

## Condition Criteria for RDis\_IX:

Low Disturbance  $RDis\_IX \leq 0.20$

Medium Disturbance  $RDis\_IX > 0.20$  but  $\leq 0.75$

High Disturbance  $RDis\_IX > 0.75$

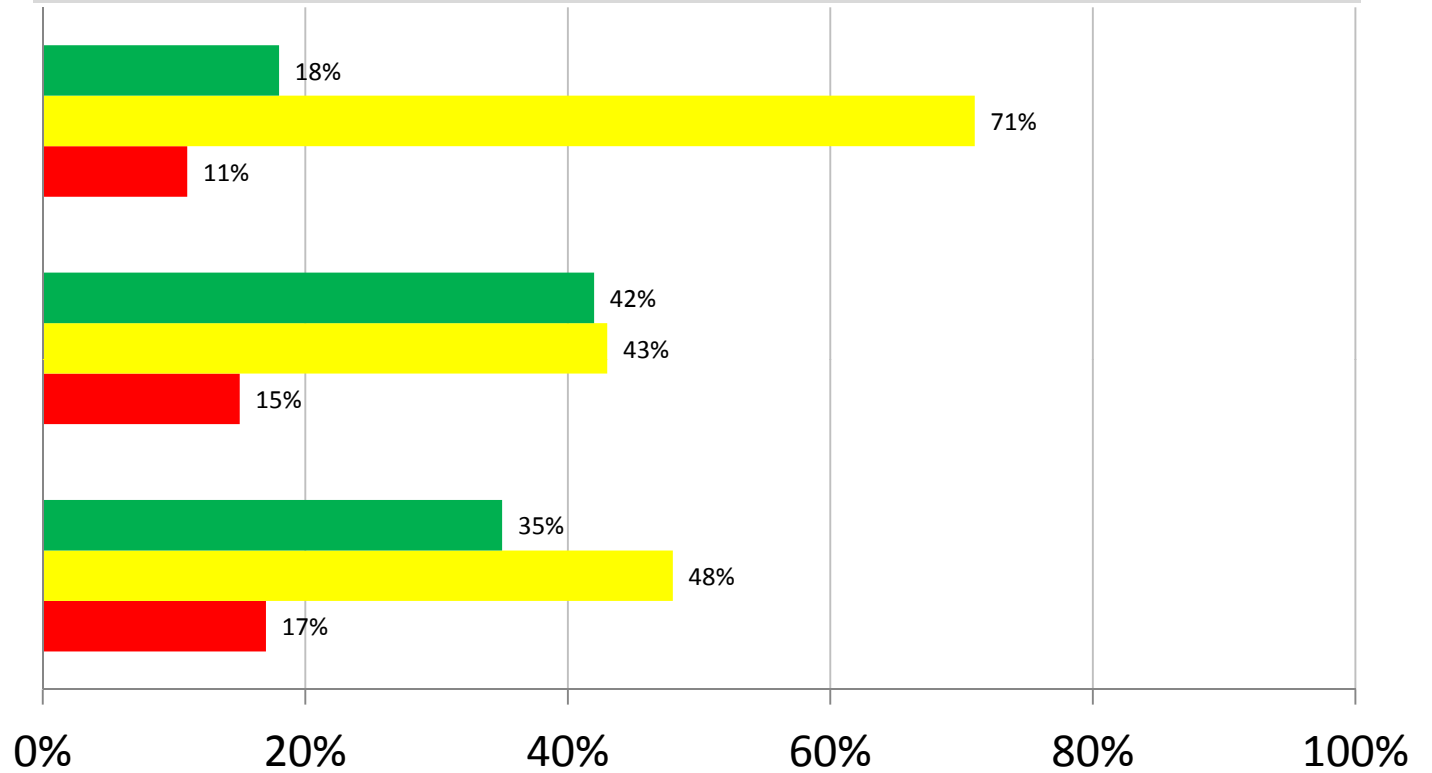
# Lakeshore Disturbance

Long Pond: **Low Disturbance**

Vermont (Excluding Lake Champlain)

Northern Appalachian Ecoregion

National



Percentage of Lakes

■ Low Disturbance

■ Medium Disturbance

■ High Disturbance



## RIPARIAN VEGETATION COVER-COMPLEXITY INDEX (Lakeshore Habitat)

$$RVegQ_2 = \frac{\{( rviwoody / 2.5) + rvfcGndInundated \}}{2}$$

**rvfcGndInundated** = riparian zone and vegetation fraction of ground cover by inundation

**rviWoody** = index of total woody vegetation cover (rvfcCanBig + rvfcCanSmall + rvfcUndWoody + rvfcGndWoody)

**Observed/Expected (O/E) index value:**  $Rveg\_OE = RVegQ_2 / 0.268$

**Condition Criteria for Rveg\_OE:**

Good-Fair: 0.821438398

Fair-Poor: 0.616062821

# Lakeshore Habitat

Long Pond: **Good**

Vermont (excluding Lake Champlain)

Northern Appalachian Ecoregion

National

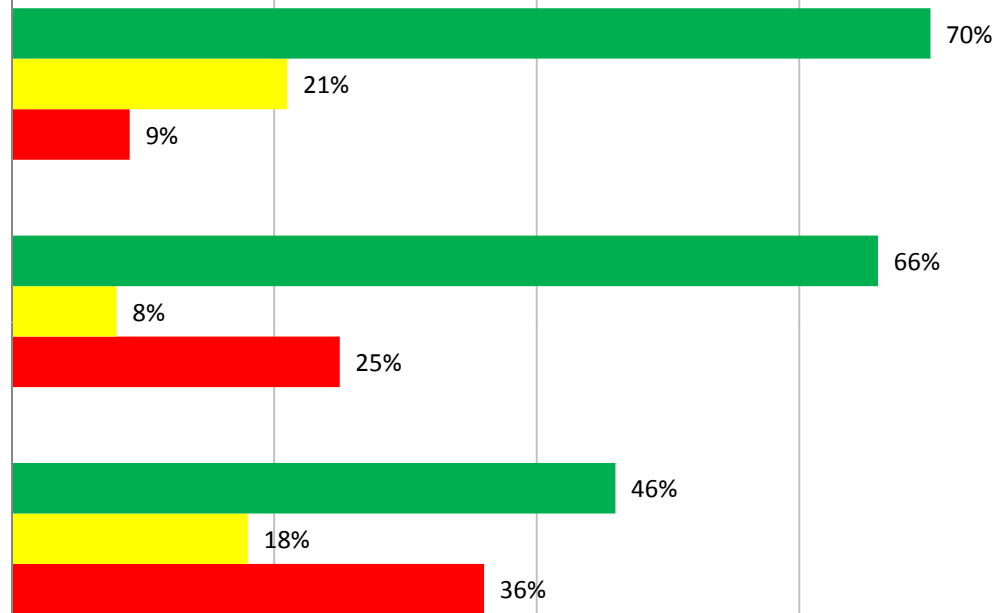
0% 20% 40% 60% 80% 100%

Percentage of Lakes

■ Good

■ Fair

■ Poor



# LITTORAL COVER-COMPLEXITY INDEX (Shallow Water Habitat)

$$LitCvr\_D = \frac{(SomeNatCvr / 1.5) + (fcfcSnag / 0.2875) + \{(amfcFltEmg) / 1.515\}}{3}$$

**amfcFltEmg** = aquatic macrophytes fractional cover of emergent and floating macrophytes (*amfcEmergent* + *amfcFloating*)

**fcfcSnag** = fish cover fractional cover of snags

**SomeNatCvr** = (fcfcBoulders + fcfcBrush + fcfcLedges + fcfcLivetrees + fcfcOverhang)

**Observed/Expected (O/E) index value:**  $LitCvr\_OE = LitCvr\_D / 0.147$

**Condition Criteria for LitCvr\_OE:**

Good-Fair: 0.735420954

Fair-Poor: 0.469158944

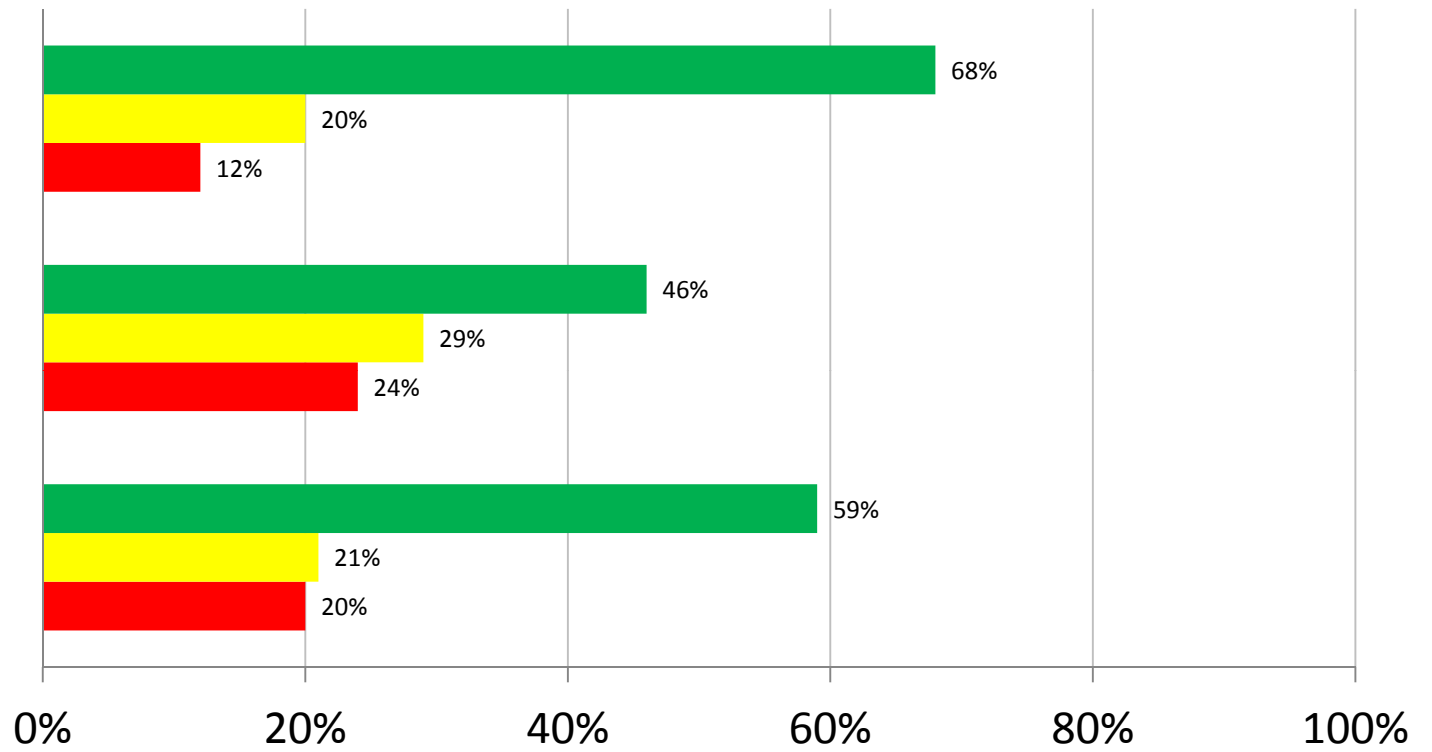
# Shallow Water Habitat

Long Pond: **Good**

Vermont (Excluding Lake Champlain)

Northern Appalachian Ecoregion

National



Percentage of Lakes

■ Good

■ Fair

■ Poor



## LITTORAL-RIPARIAN COVER-COMPLEXITY INDEX (Physical Habitat Complexity)

$$\text{LitRipCvQ} = \frac{(\text{RVegQ} + \text{LitCvrQ})}{2}$$

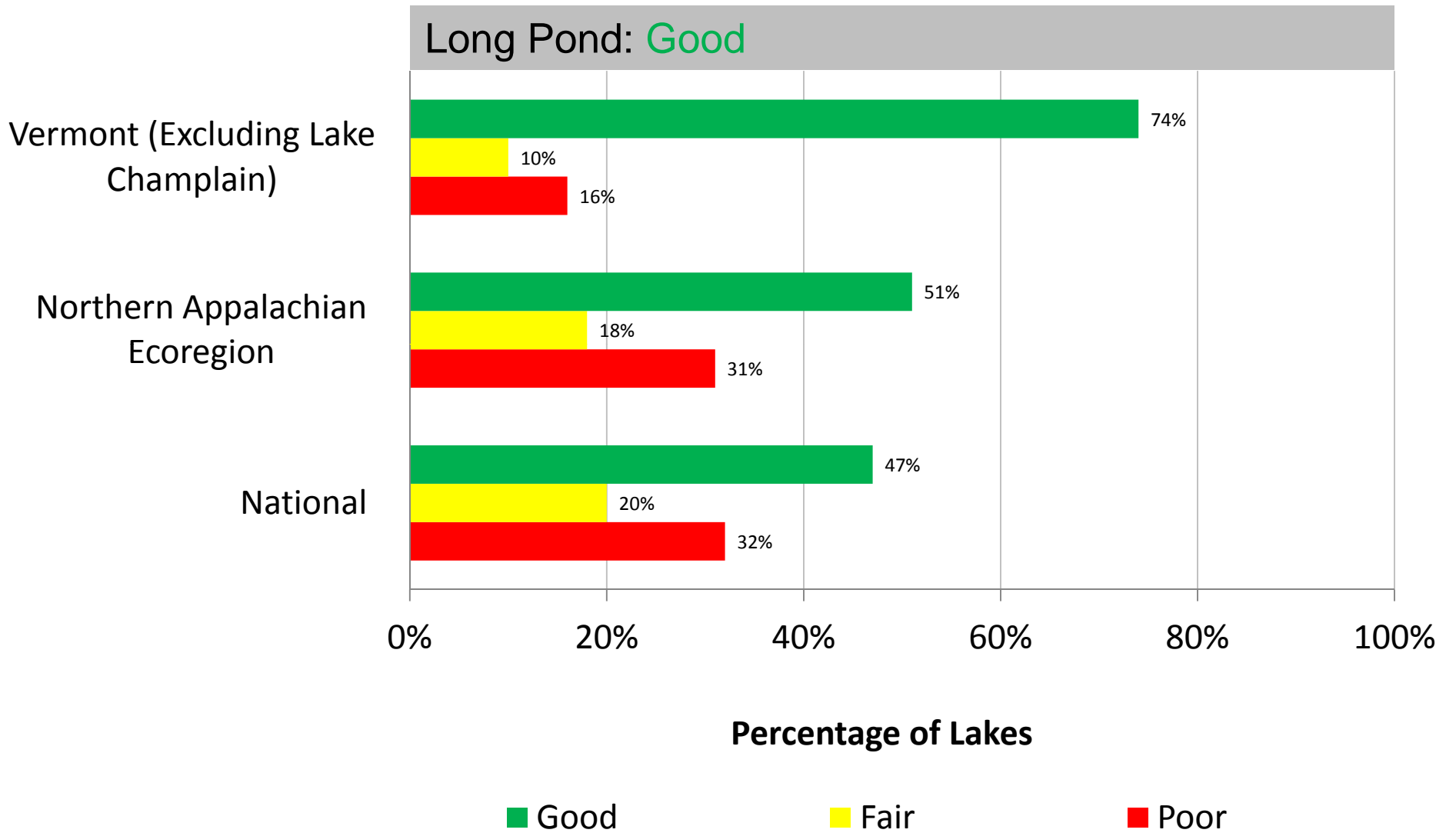
**Observed/Expected (O/E) index values:**  $\text{LitRipCvr\_OE} = \text{LitRipCvQ}/0.214$

**Condition Criteria for LitRipCvr\_OE:**

Good-Fair: 0.84901038

Fair-Poor: 0.668243895

# Physical Habitat Complexity





# Long Pond Report Card

Meso-	Trophic State (NLA)
Meso-	Trophic State (VTDEC)
	Total Phosphorus (NLA)
	Total Phosphorus (VTDEC)
	Total Nitrogen (NLA)
	Total Nitrogen (VTDEC)
	Chlorophyll <i>a</i> (NLA)
	Turbidity (NLA)
	Dissolved Oxygen (NLA)
	Acid Neutralizing Capacity (NLA)
	Acid Neutralizing Capacity (VTDEC)
	Lakeshore Disturbance (NLA)
	Lakeshore Habitat (NLA)
	Shallow Water Habitat (NLA)
	Physical Habitat Complexity (NLA)

# Vermont Lake Score Card

*Answers to the Question "How are Vermont lakes doing?"*



Water Quality

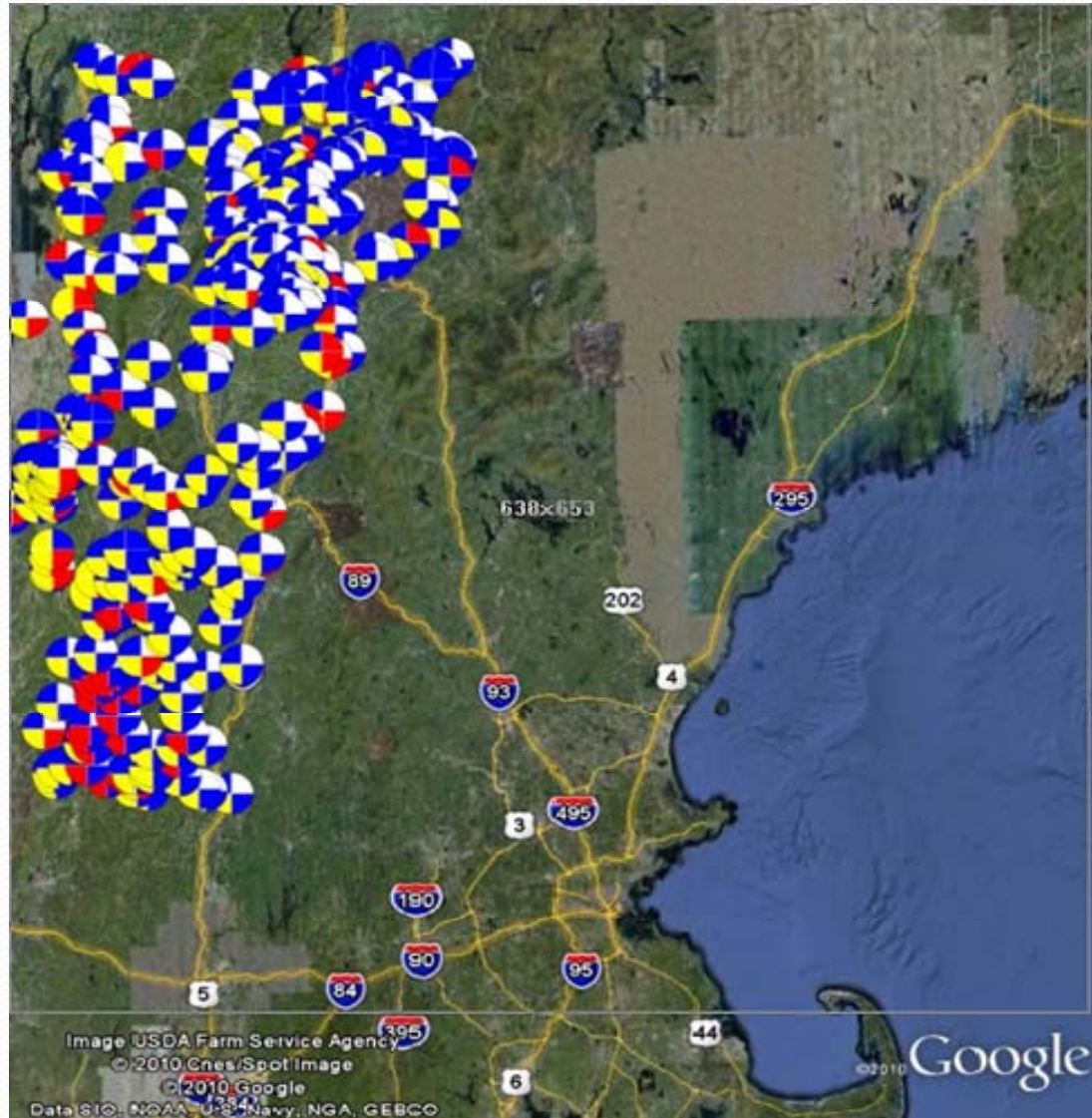
Shoreland and  
Lake Habitat

Atmospheric  
Pollution

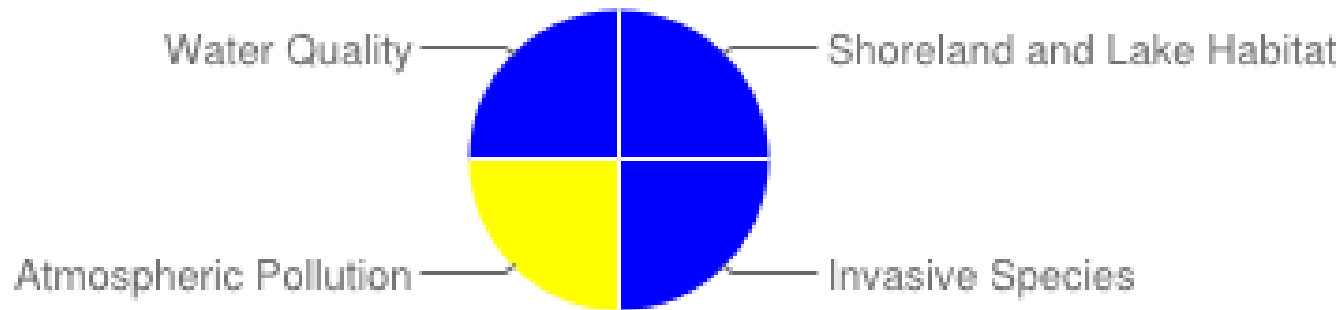
Aquatic Invasive  
Species



# Vermont Lake Score Card



# Vermont Lake Score Card\*: Long Pond in Greensboro



 Good Conditions

 Fair Conditions

 Reduced Conditions

 No data available

\* Based on current standing. Because of mercury contamination all Vermont lakes, but two, get a yellow score for atmospheric pollution. Acid precipitation has resulted in the acidification of some of the high elevation lakes, but this trend is improving for acid-sensitive lakes.