ENVIRONMENTAL
Fact Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

29 Hazen Drive, Concord, New Hampshire 03301 • (603) 271-3503 • www.des.nh.gov

WD-BB-27 2018

Layman's Guide for Measuring a Lake's Trophic Status

The trophic status of a lake or pond is a general concept that seeks to quantify the productivity of a waterbody. Productivity can be determined by several factors, and consequently multiple methods exist for determining a lake's trophic status. Despite different methodologies, determining trophic status is a useful way to classify and describe individual waterbodies.

Trophic Status of New Hampshire Lakes*		
Class	**Number of Lakes**	**Area of Lakes**
Oligotrophic	25.6%	67.0%
Mesotrophic	50.1%	26.5%
Eutrophic	21.6%	6.0%
Not classified/ Other	2.7%	0.5%

***Only includes waterbodies sampled under NHDES's Lake Trophic Survey Program, 1975 - 2013**

Categories

Oligotrophic: Larger, deeper lakes with clear water, rocky or sandy shorelines, low phosphorus enrichment, limited rooted plant growth, low algal growth, and adequate dissolved oxygen throughout. Low productivity.

Mesotrophic: An intermediate category with characteristics between the other two groups. Medium productivity.

Eutrophic: Smaller, shallower ponds with mucky bottoms, extensive rooted plant growth and depleted dissolved oxygen in the bottom waters; often tea-colored and .sometimes murky from planktonic algal growth. High productivity.

Indicators

Many different indicators have been used by scientists to describe trophic state. A few of the more commonly used indicators are presented below, along with ranges of values that depict the three trophic categories for New Hampshire lakes. Values for the first three indicators are from the lake nutrient criteria first developed for use in the 2010 assessment of lake quality. The values are more restrictive than generally accepted values for lakes world-wide. A given lake may fall into more than one trophic category, depending on the indicator used.

1. **Total Phosphorus**

In New Hampshire lakes, phosphorus is the limiting nutrient that controls aquatic plant growth. Phosphorus values in New Hampshire lakes range from less than 0.001 mg/L to 0.121 mg/L, with a median value of 0.011 mg/L.

Phosphorus (mg/L)	Trophic Category
< 0.008	oligotrophic
0.008 - 0.012	mesotrophic
> 0.012	eutrophic

2. **Water Clarity**

The water clarity or Secchi disk transparency is a measure of the depth one can see into a lake. It ranges from less than a foot to over 40 feet in New Hampshire lakes with a median value of 10 feet.

Water Clarity (ft.)	Trophic Category
> 14	oligotrophic
10 - 14	mesotrophic
< 10	eutrophic

3. Chlorophyll-*a*

Chlorophyll-*a* is a measure of the amount of planktonic algae in the water. Chlorophyll values in New Hampshire lakes range from less than one to over 100 µg/L with a median value of 4.39 µg/L.

Chlorophyll (µg/L)	Trophic Category
< 3.3	oligotrophic
3.3 – 5.0	mesotrophic
> 5	eutrophic

4. **Rooted Plant Growth**

In general, rooted plant growth is more reflective of substrate type, water depth, wind and wave action than it is of in-lake nutrient levels. Most rooted plants obtain most of their nutrient requirements from the sediment and not directly from the water. However, to the extent that shallow, weedy, mucky-bottomed lakes are considered eutrophic, rooted plant growth can be used as a trophic indicator. A subjective evaluation of the amount of plant growth is used for the evaluation below.

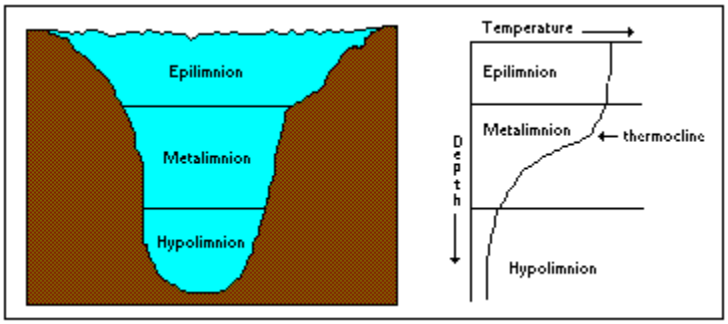
Plant Growth	Trophic Category
Sparse to scattered plant growth around the shore with perhaps a few small patches	oligotrophic
Plants present along most of the shoreline with some	mesotrophic

thick patches	
Floating or emergent plants covering over 1/3 the surface area and/or submerged plants over most of the visible bottom	eutrophic

5. **Dissolved Oxygen**

This criterion is for lakes that are deep enough to develop thermal stratification, which is when a lake forms separate layers of differing temperatures throughout the water column. The top, warm layer is the epilimnion and the bottom, cold layer is the hypolimnion. The middle layer, the metalimnion, is the area of rapid temperature change and contains the thermocline. The extent of dissolved oxygen depletion in the hypolimnion is a measure of decomposing organic matter in the bottom waters and in the sediments, and represents an indirect measure of the biological production in the lake.

Thermal stratification by itself is not a trophic state indicator. However, because it impedes mixing between the surface and bottom waters, it does not allow the hypolimnion to be replenished with dissolved oxygen from the surface. In general, given two hypolimnions of equal size, the one with the least dissolved oxygen is found in the more productive (more eutrophic) lake.



Thermal Stratification of Deep N.H. Lakes in Summer

Changing Trophic State

Lakes generally change trophic state very slowly, gradually becoming more eutrophic over time, where time is measured in thousands of years. This process is called natural eutrophication. Often the process is greatly accelerated due to human activity (called cultural eutrophication). Cultural eutrophication can be controlled by managing human activity within the watershed and on the lake. Watershed controls that reduce phosphorus runoff and erosion into a lake will help protect the lake and slow its movement toward a more eutrophic state. For lake protection tips, see http://des.nh.gov/organization/commissioner/pip/factsheets/bb/documents/bb-9.pdf.

How does NHDES determine trophic status?

NHDES considers dissolved oxygen concentration, water clarity (Secchi disk transparency), aquatic plant abundance, and chlorophyll-*a* concentration when determining trophic status. Each criterion has a list of descriptions that span a range of conditions, and points are under each of the four criteria (see below). Lakes with no hypolimnion are not rated under the bottom dissolved oxygen criterion. The protocol for rating lakes under Secchi disk transparency when the disk is visible on the bottom (V.O.B.) is to select the next higher rating unless field data

sheet comments suggest otherwise. For example, a 2.2 V.O.B. reading would receive two trophic points under the 3 to 5 meter category in the ranking shown below.

This trophic rating system has been used by NHDES since 1989 and was intended to determine a lake's trophic status based off of one summer sample. However, since 2013, NHDES conducts three summer samples over three consecutive years to determine trophic status. While the new methodology better encapsulates year-to-year variation, the rating system needed to be updated. For lake trophic reports written on or after 2013, trophic points were assigned for each annual monitoring trip and summed at the end of the three sample seasons. In other words, each year of sampling received its own trophic points, and the total number of trophic points over three years now determines the final trophic rating. Some waterbodies were stratified in one sample season but not in another, and lakes with no hypolimnion are not rated under the bottom dissolved oxygen criterion. Because whether a waterbody is stratified influences the total number of points used to make a trophic assessment and there can be year-to-year differences in stratification patterns of a single waterbody, a secondary point system was developed to determine the final trophic classification of a waterbody (see below). This secondary point system allows waterbodies with every stratification scenario (e.g. stratified all three years, stratified two out of the three years, etc.) to be given a trophic status that is sensitive to individual stratification patterns.

TROPHIC CLASSIFICATION SYSTEM FOR
NEW HAMPSHIRE LAKES AND PONDS

Trophic Points

1. Summer Bottom Dissolved Oxygen:

a. D.O. >4mg/L 0
b. D.O. = 1 to 4 mg/L & hypolimnion volume ≤10% lake volume.....1
c. D.O. = 1 to 4 mg/L & hypolimnion volume >10% lake volume 2
d. D.O. <1mg/L in <1/3 hypo. volume & hypo. volume ≤10% lake volume.....3
e. D.O. <1mg/L in ≥1/3 hypo. volume & hypo. volume ≤10% lake volume.....4
f. D.O. <1mg/L in <1/3 hypo. volume & hypo. volume >10% lake volume 5
g. D.O. <1mg/L in ≥1/3 hypo. volume & hypo. volume >10% lake volume.....6

2. Summer Secchi Disk Transparency:

a. > 7m.....0
b. > 5m – 7m 1
c. > 3m – 5m.....2
d. >2m – 3m 3
e. >1m – 2m 4
f. >0.5 – 1m 5
g. ≤0.5m 6

3. Aquatic Vascular Plant Abundance:

a. Sparse.....0
b. Scattered.....1
c. Scattered/Common.....2
d. Common.....3
e. Common/Abundant 4

f. Abundant 5
g. Very Abundant 6

4. Summer Epilimnetic Chlorophyll-a (mg/m^3):

a. <4.....0
b. 4 - <8 1
c. 8 - <12.....2
d. 12 - <18 3
e. 18 - <24 4
f. 24 - <32 5
g. ≥32.....6

Trophic Points

Trophic Classification	**Stratified**	***Unstratified**
Oligotrophic	0-6	0-4
Mesotrophic	7-12	5-9
Eutrophic	13-24	10-18

Stratification Scenario *Trophic Rating*	3X Stratified	2X Stratified	1X Stratified	0X Stratified
Oligotrophic	0-18	0-16	0-14	0-12
Mesotrophic	19-36	17-33	15-30	13-27
Eutrophic	37-72	34-66	31-60	28-54

For More Information

For more information about lake water quality, please visit the NHDES web page at http://des.nh.gov/organization/divisions/water/wmb/lakes/lake_water.htm