

## USE OF THE INDIANA TROPHIC STATE INDEX (ITSI) TO GUIDE LAKE MANAGEMENT

Eutrophication is a natural process of lake aging, the rate of which can be adversely increased by human activities. Physical, chemical, and biological data gathered on each lake are combined into a standardized multi-metric index known today as the Indiana Trophic State Index (ITSI), a modified version of the BonHomme Index developed for Indiana in 1972. Samples are taken at both the surface (epilimnion) and bottom of the lake (hypolimnion) to identify the effects of stratification on water chemistry. Eutrophy points are assigned to each parameter and totaled to create a final ITSI score ranging from 0 to 75 (Appendix 1). Lower scores indicate lower levels and effects of nutrients on factors related to lake management and use, including water clarity, nutrients available for plant growth and blue green algae dominance.

Over more than three decades, the ITSI score has been calculated regularly during July-August at the deepest point in over 600 boat-accessible public lakes and reservoirs, generally on a five-year rotating basis. Since 1989 the sampling and analytical efforts for this program have been conducted for IDEM by the staff and students of the Indiana University School of Public and Environmental Affairs (IU-SPEA). Values are reported every two years in the *Indiana Integrated Water Monitoring and Assessment Report* ([www.in.gov/idem/4679.htm](http://www.in.gov/idem/4679.htm)) and are available on a more frequent basis from LARE and IDEM lake program staff. Since the beginning of the Lake and River Enhancement (LARE) program in 1987, lake diagnostic studies have required the calculation of the Indiana TSI as a general starting point for lake management strategies.

Lake classifications can be broadly useful in determining general approaches to lake management, including fisheries and aquatic plant control. Updated lake classes were created from data collected during 1971 through 1998 by dividing scores into fourths (~20% of the available score on the Indiana Trophic State Index) (Table 1).

*Table 1. Lake classes used in the IDEM Monitoring and Assessment Report after 1990.*

<b>Indiana TSI Scores</b>	<b>EPA TROPHIC CLASS</b>
0-15	Oligotrophic
16-31	Mesotrophic
32-46	Eutrophic
47-75	Hypereutrophic
Varied productivity, usually due to high humic conditions	Dystrophic

In contrast, Carlson's Trophic State Index is a simpler, but statistically valid means of representing direct linear relationships between three parameters: water clarity (Secchi depth), nutrients (phosphorus) and overall algal biomass (chlorophyll-a). Over a range from 0 to 100, an increase of 10 points in the CTSI represents a doubling of phosphorus and about a 2.8 fold increase in algal biomass. This index is valuable as a way to quickly demonstrate these associations, but does not characterize lake chemistry or algal communities as fully as the ITSI. Because many states have their own more complex indices, the CTSI is also useful for comparing lakes throughout the nation.

A corps of citizen volunteers participates in a complementary monitoring effort; many are trained to provide samples for all three parameters necessary for the calculation of Carlson's TSI. Volunteers are trained to monitor water clarity, as well as collect samples for the analysis of total phosphorus and chlorophyll-a. Volunteers also have access to DO meters and may prepare oxygen profiles. While volunteers do not sample as intensively as the State does during a single sampling event, they do collect data about every 2 weeks from April to August, year after year. Such consistent data gathering can be quite useful in detecting changes in water quality, and has been used by IDEM during 305(b) and 303(d) reporting to EPA.

The parameters collected during most sampling events by the State through IDEM and IDNR lake programs are indicated in Table 2. The current calculation method for each metric in the ITSI is provided in Appendix 1.

*Table 2. Water quality parameters collected by IDEM and IDNR lake programs.*

PHYSICAL	CHEMICAL	BIOLOGICAL
Light Penetration (Secchi disk)	Total Phosphorous	Total Plankton Count
Light Transmission (% at 3 foot depth)	Soluble Reactive Phosphorus	% Blue-green Algae
1% Light Level	Organic Nitrogen	Chlorophyll a
Temperature Profile	Nitrate-Nitrogen	
Alkalinity	Ammonia-Nitrogen	
Conductivity	Dissolved Oxygen: % saturation at 5 foot depth	
Land Use	Dissolved Oxygen: % of water column with at least 0.1ppm	
	Dissolved Oxygen profile	
	pH	

In addition to the efforts listed above, staff with IDEM's Biological Studies Section collect and analyze fish tissue and sediment samples from a handful of Indiana lakes and reservoirs each year. For more information on these programs and water quality monitoring in Indiana lakes, see the IDEM Office of Water Quality website at: [www.in.gov/idem/4114.htm](http://www.in.gov/idem/4114.htm).

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Appendix 1. The Indiana Trophic State Index

<i>Parameter and Range</i>		<i>Eutrophy Points</i>
I.	Total Phosphorus (mg/L)	
	A. Below 0.03	0
	B. 0.03 to 0.039	1
	C. 0.04 to 0.059	2
	D. 0.06 to .199	3
	E. 0.20 to 0.99	4
	F. 1.0 or more	5
II.	Soluble Phosphorus (mg/L)	
	A. Below 0.03	0
	B. 0.03 to 0.039	1
	C. 0.04 to 0.059	2
	D. 0.06 to .199	3
	E. 0.2 to 0.99	4
	F. 1.0 or more	5
III.	Organic Nitrogen (mg/L)	
	A. Below 0.5	0
	B. 0.5 to 0.59	1
	C. 0.6 to 0.89	2
	D. 0.9 to 1.9	3
	E. 2.0 or more	4
IV.	Nitrate (mg/L)	
	A. Below 0.3	0
	B. 0.3 to 0.39	1
	C. 0.4 to 0.89	2
	D. 0.9 to 1.9	3
	E. 2.0 or more	4
V.	Ammonia (mg/L)	
	A. Below 0.3	0
	B. 0.3 to 0.39	1
	C. 0.4 to 0.59	2
	D. 0.6 to 0.99	3
	E. 1.0 or more	4
VI.	Dissolved Oxygen: Percent Saturation at 5 foot Depth	
	A. 114% or less	0
	B. 115% to 119%	1
	C. 120% to 129%	2
	D. 130% to 149%	3

	E.	150% or more	4
VII.		Dissolved Oxygen: Percent of measured water column with at least 0.1 ppm dissolved oxygen	
	A.	28% or less	4
	B.	29 to 49%	3
	C.	50 to 65%	2
	D.	66 to 75%	1
	E.	76 to 100%	0
VIII.		Light Penetration (Secchi disk)	
	A.	Five feet or under	6
	B.	Greater than five feet	0
IX.		Light Transmission (Photocell): Percent of light transmission at a depth of 3 feet	
	A.	0 to 30%	4
	B.	31 to 50%	3
	C.	51 to 70%	2
	D.	71% or more	0
X.		Total Plankton per Liter of Water - sampled from a single vertical tow between the 1% light level and the surface	
	A.	less than 3,000 organisms	0
	B.	3,000 to 6,000 organisms	1
	C.	6,001 to 16,000 organisms	2
	D.	16,001 to 26,000 organisms	3
	E.	26,001 to 36,000 organisms	4
	F.	36,001 to 60,000 organisms	5
	G.	60,001 to 95,000 organisms	10
	H.	95,001 to 150,000 organisms	15
	I.	150,001 to 500,000 organisms	20
	J.	greater than 500,000 organisms	25
	K.	blue-green dominance ( $\geq 50\%$ )	10 additional points