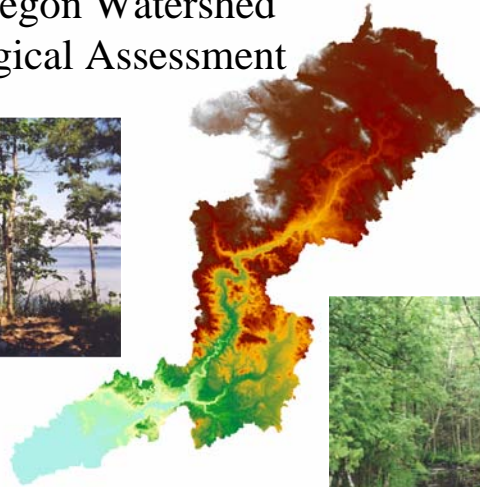
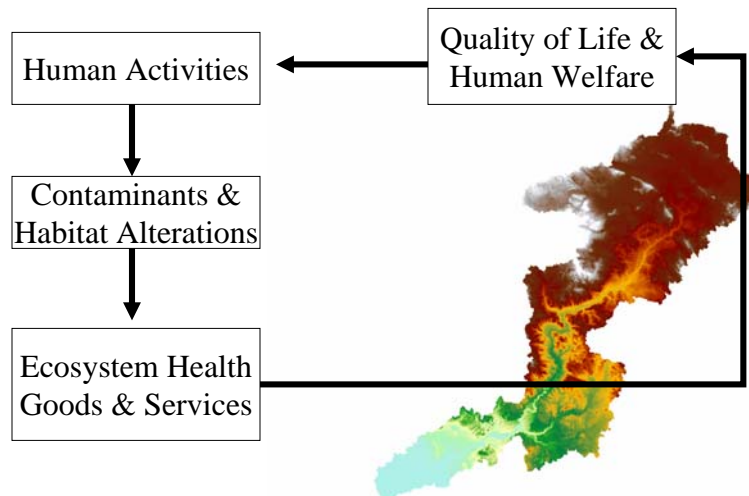


Muskegon Watershed Ecological Assessment



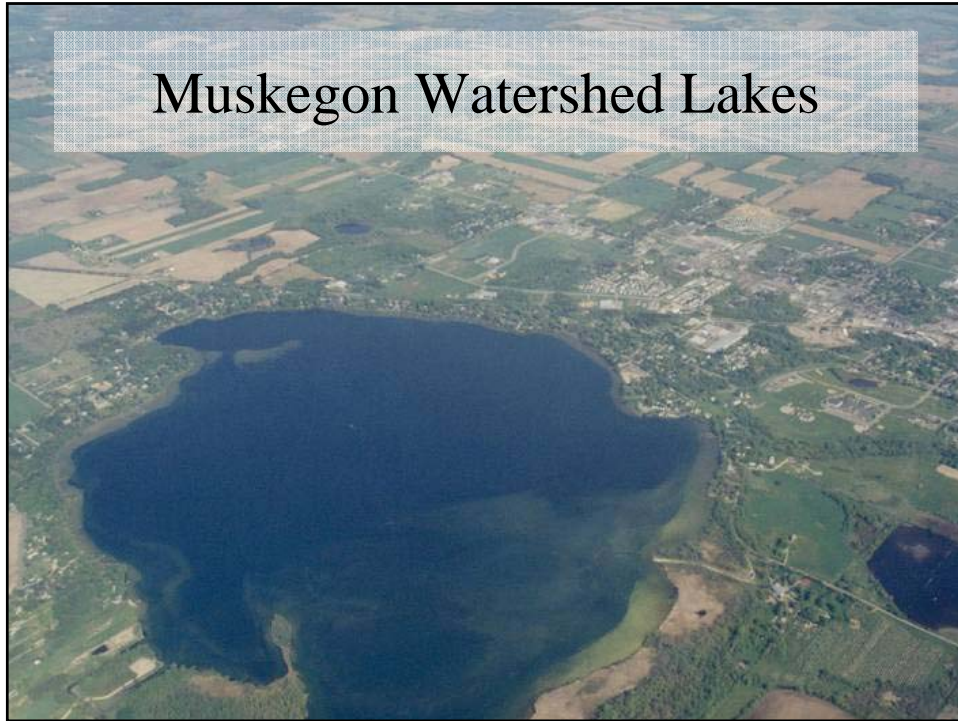
Muskegon Watershed Research Program



“Sustainable use of resources.....”

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Muskegon Watershed Lakes

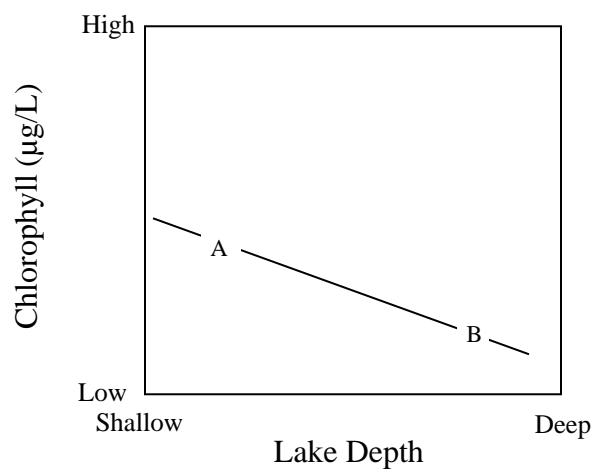


Expected Condition Varies with Natural Factors

- Correct Assessment for Varying Expected Condition
- e.g. Streams, Lakes, & Wetlands
 - Deep lakes are naturally clearer
 - Biota vary with stream size and landscape setting
 - Wetlands vary with water input & connectivity
 - Marshes versus bogs
 - Stream marshes versus lake marshes

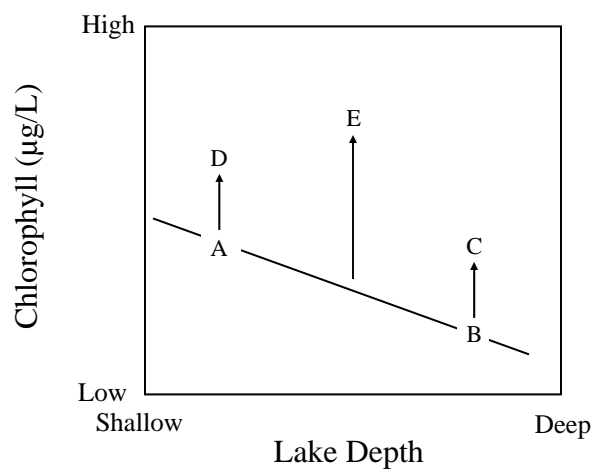
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Expected Condition Varies with Lake Depth



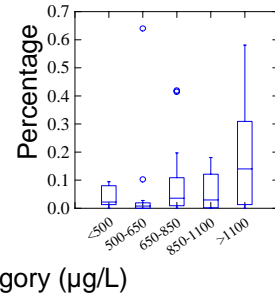
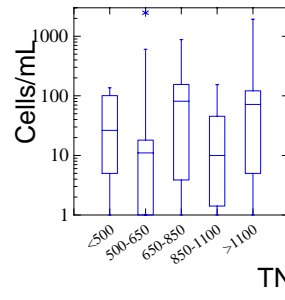
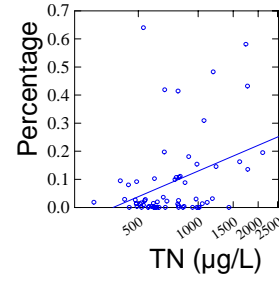
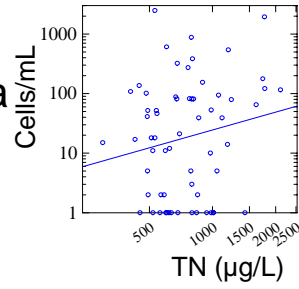
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Deviation from Natural Expected Condition Accounts for Natural Variation Among Habitats



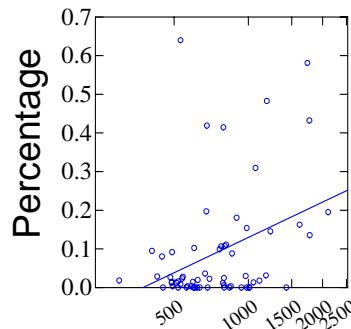
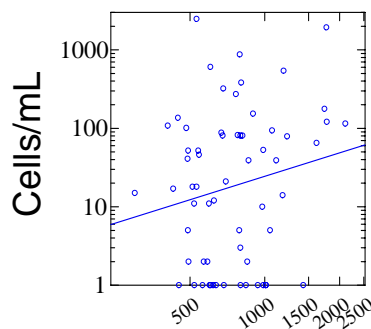
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Problem Cyanobacteria



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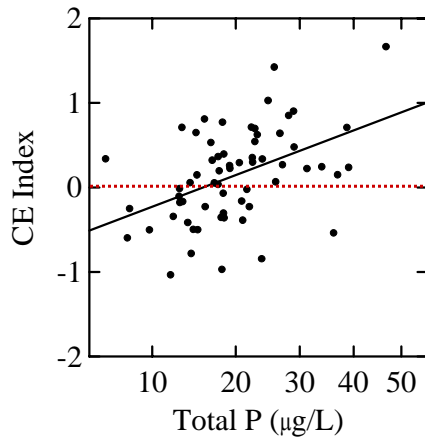
Problem Cyanobacteria (Anabaena, Aphanizomenon, Microcystis)



Summer TN ($\mu\text{g/L}$)

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Multimetric Cultural Eutrophication Index (CEI)

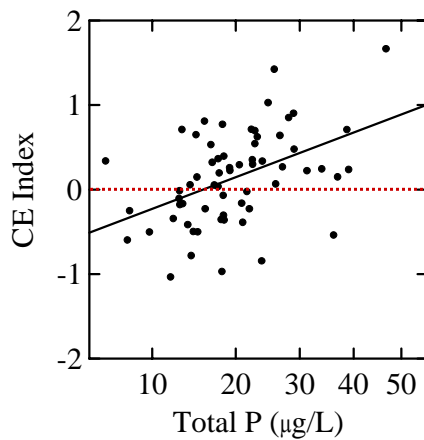


CEI includes deviations from expected:

- 1) Spring Chlorophyll a
- 2) Summer Chlorophyll a
- 3) Spring Secchi Depth
- 4) Summer Secchi Depth

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Multimetric Cultural Eutrophication Index (CEI)



Advantages:

1. Accounts for expected condition varying with lake depth.
2. Multiple indicators compensate for errors in each other.
3. Only includes valued attribute: water clarity indicators.

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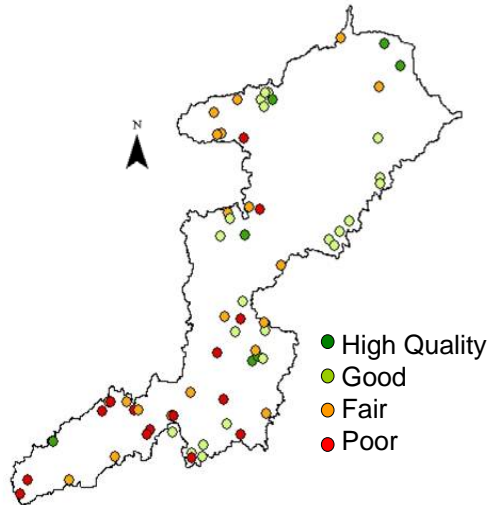
Table of lake Depth, Cultural Enrichment Index (CEI), spring and summer chlorophyll and secchi values, and CEI rank of each MW lake.

Lake Name (County)	Maximum Depth (m)	CEI	Total Chlorophyll (ug/L)		Correct Chlorophyll (ug/L)		Secchi Transparency (m)		Rank
			Spr	Sum	Spr	Sum	Spr	Sum	
Baptist Lake	20	-0.42	11.8	2.5	14.0	2.0	5.5	6.3	11
Bear Lake	3.5	1.66	65.3	53.5	56.0	57.0	0.5	0.6	64
Berry Lake	6	0.85	7.9	58.2	7.0	64.0	2.5	0.5	60
Big Lake (Oceola)	27	0.34	5.2	10.6	5.0	10.0	4.1	2.3	43
Bills Lake	16.8	0.34	7.4	6.3	.	.	2.7	2.8	44
Brooks Lake	4.5	1.03	25.9	27.0	.	.	1.1	0.8	62
Cadillac Lake	3.8	0.71	16.7	42.6	.	.	2.1	1.1	57
Canadian Lakes	2.4	-0.36	9.4	5.0	9.0	4.0	2.7	2.9	13
Clear Lake (Mecosta)	7.5	-0.50	5.3	4.8	4.0	5.0	3.5	4.5	10
Crooked Lake	3	-0.39	9.1	4.7	8.0	5.0	2.6	3.8	12
Croton Dam Pond	10	0.23	7.4	16.1	5.0	15.0	2.5	3.6	35
Doc & Tom (Lake of the Pines)	8	0.04	9.8	5.7	5.0	5.0	2.5	2.5	27
East Twin Lake	5.75	-0.78	8.5	10.6	10.0	10.0	4.5	3.9	5
Englewright Lake	20	0.24	3.8	4.3	4.0	3.0	4.2	4.3	37
Fremont Lake	24	0.62	10.8	13.4	12.0	13.0	4.6	2.2	51
Goose Lake	5	0.06	4.6	20.3	5.0	19.0	2.9	2.2	29
Grass Lake	0.5	0.24	10.5	2.9	14.0	3.0	1.9	1.9	36
Halfmoon Lake	11.5	-0.84	8.6	103.5	7.0	.	1.0	.	4
Hardy Dam Pond	24	0.65	2.8	3.8	2.0	4.0	5.0	4.5	53
Haymarsh Lake	9	0.05	9.6	13.0	7.0	16.0	2.4	3.3	28
Hess Lake	4.1	1.42	10.4	7.0	7.0	6.0	2.9	3.5	63
Hicks Lake	9.5	0.81	56.1	45.0	.	.	0.9	0.4	59
Higgins Lake	22	-2.18	11.0	35.4	.	.	2.8	1.3	1

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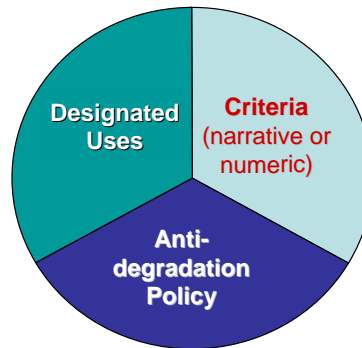
Lakes Assessment

Map of Muskegon River Watershed indicating location of lakes sampled between 2001 and 2003, and the quality of those wetlands as determined from a multimetric index of cultural enrichment (CE)



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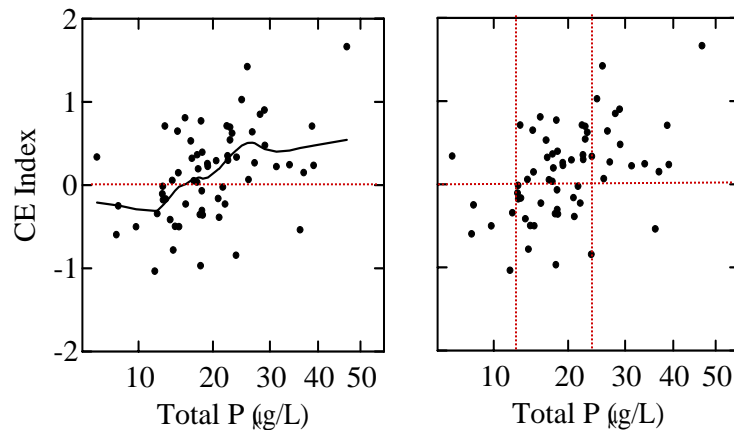
Water Quality Standards



- 3 Parts
 1. Designated Uses
 2. Criteria that Support of those Uses
 3. Antidegradation Rule
 - Prevents gradual degradation of condition
- Standards violations que management actions
 - listing a water body on an non-attainment list
 - regulating contaminant loading

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Multimetric Cultural Eutrophication Index & Nutrient Criteria



Thresholds in responses of Value Ecological Attributes help justify specific concentrations for designation nutrient criteria.

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