

#1

Development of Use-based Chlorophyll Criteria for Recreational Uses of Reservoirs

Presented to
Texas Commission on Environmental Quality

April 13, 2005



Sponsors



Texas Water Conservation Association
with
Association of Metropolitan Sewerage Agencies
and
Members of Texas Association of Metropolitan Sewerage Agencies

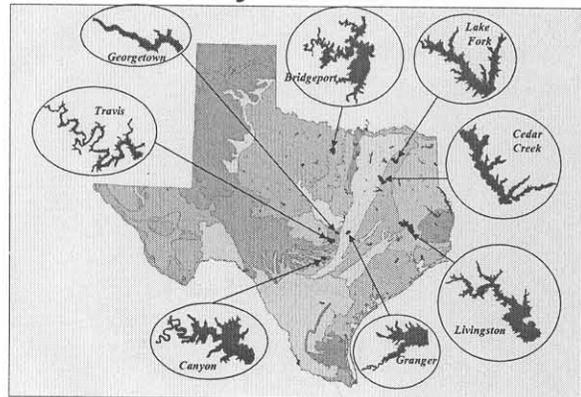


Participants



Brazos River Authority
Guadalupe-Blanco River Authority
Lower Colorado River Authority
Sabine River Authority
San Antonio River Authority
Tarrant Regional Water District
Trinity River Authority
William W. Walker, Jr. Ph.D.
Alan Plummer Associates, Inc.

Study Reservoirs



Description of Study Reservoirs

Reservoir	Level III Ecoregion	Volume (acre-feet)
Cedar Creek Reservoir	Edwards Plateau	637,000
Lake Bridgeport	Central Oklahoma/Texas Plains	366,000
Lake Georgetown	Edwards Plateau	37,000
Lake Travis	Edwards Plateau	1,132,000

Study Approach

- Simultaneous measurements of chlorophyll concentration and survey of users' perceptions of use impairment
- Two locations in each reservoir
 - Main body
 - Headwaters or cove
- Twice per month

Water Quality Sampling



Sample Period and Types

- 2003: June through September
- 2004: April through September
- One depth-composited sample collected at each site (1 ft, 3 ft, 6 ft)
- Field measurements (i.e. profile) recorded at same depths

Parameters Measured

Field

- Dissolved oxygen
- pH
- Secchi disc depth
- Specific conductivity
- Temperature

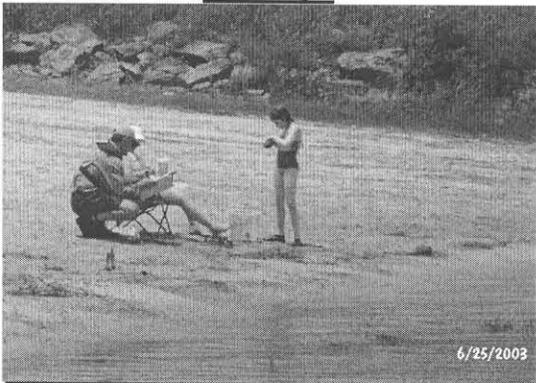
Parameters Measured

Laboratory



Algae	Nutrients	Clarity
Chlorophyll a	Ammonia	Secchi disc
Phytoplankton	NO ₃ -N	Water, Total
	Total Phosphorus	Suspended
		Solids, Turbidity

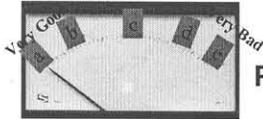
Surveys



Surveys

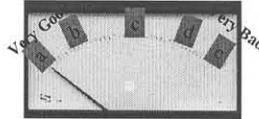
5 Questions:

- 1. How green is the water?
- 2. How is water for recreation?
- 3. If conditions are bad, why?
Algae or mud?
- 4. Primary activity
- 5. Frequency of visitation



Question #1
Perception of Amount of Algae Present

- a. No algae, or crystal clear water
- b. A little algae visible
- c. Definite algae visible
- d. Very green; some scum present and/or mild odor apparent
- e. Pea soup green with one or more of the following: massive floating scums on lake or washed up on shore, strong, foul odor, or fish kill



Question #2
Perception of Degree of Use Impairment

- a. Beautiful, could not be nicer
- b. Very minor aesthetic problems; excellent for swimming, boating
- c. Swimming and aesthetic enjoyment slightly impaired
- d. Desire to swim and level of enjoyment substantially reduced
- e. Swimming and aesthetic enjoyment of the lake nearly impossible

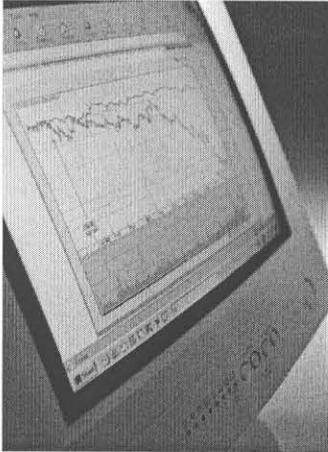
Number of Surveys

7 Surveys per visit, per site

- 2 from sampling crew
- 5 from recreational visitor

Other Study Provisions

- Avoid samples influenced by runoff
- Take water quality samples and user surveys in same area
- Survey persons who have already been on lake or shore
- Avoid locations with significant stands of aquatic vegetation
- Perform all chlorophyll analyses at one laboratory



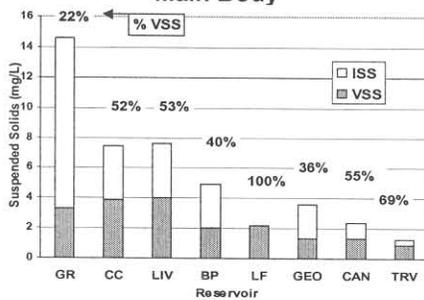
Results

Results

- Over 1,800 surveys
- Over 5,700 water quality measurements
- 95% of surveys can be correlated with water quality data

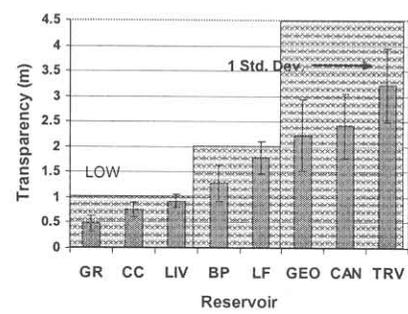
Results

Mean Summer Suspended Solids Concentrations
Main Body



Results

Mean Summer Transparency
Main Body



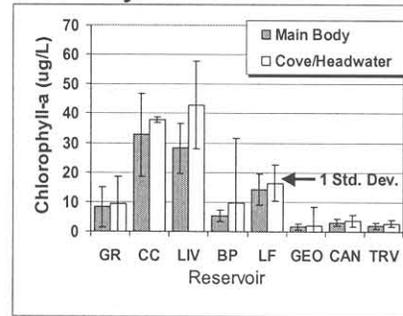
Results

Reservoirs Grouped by Transparency

Clarity Class	Average Main Body Transparency (m)	Reservoirs in Group
Low	<1.0	Cedar Creek Reservoir Granger Lake Lake Livingston
Moderate	1.0 – 2.0	Lake Bridgeport Lake Fork Reservoir
High	>2.0	Canyon Lake Lake Georgetown Lake Travis

Results

Mean Summer Chlorophyll Concentrations Main Body and Cove/Headwaters



Results

Chlorophyll Concentrations Combined Main Body and Cove/Headwaters (ug/L)

Reservoir	Average	Maximum	Minimum
Granger	9	36	1
Cedar Creek	35	64	10
Livingston	37	115	8
Bridgeport	8	32	3
Lake Fork	15	27	5
Georgetown	2	5	1
Canyon	3	7	1
Travis	2	5	1

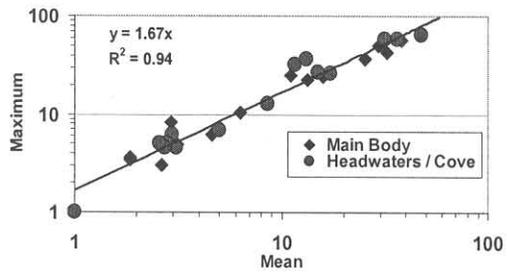
Results

User Groups Surveyed Primary Activity %

Reservoir	Contact Recreation	Fishing	Boating	Sampling Crew	Other
Granger	8	26	11	35	20
Cedar Creek	8	29	24	23	15
Livingston	16	31	12	15	27
Bridgeport	15	35	9	26	15
Lake Fork	5	56	6	24	9
Georgetown	18	11	9	37	25
Canyon	19	11	28	19	22
Travis	26	6	23	32	13

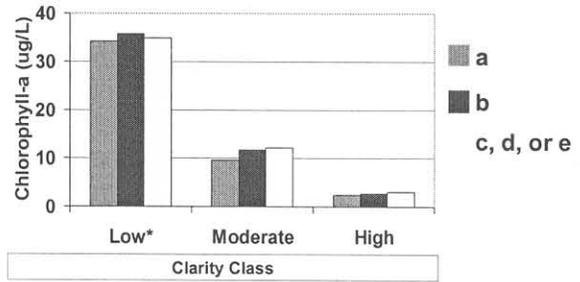
Results

Relationship Between Chlorophyll Seasonal Maximum and Seasonal Mean (ug/L)



Results

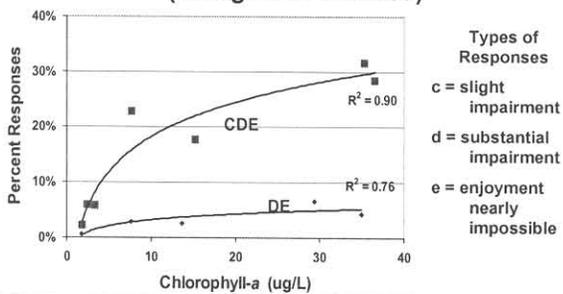
Recreational Suitability Based on Chlorophyll-a Reservoirs Grouped by Clarity



* Granger Not Included

Results

Recreational Suitability Based on Chlorophyll-a All Reservoirs Combined (Granger not Included)



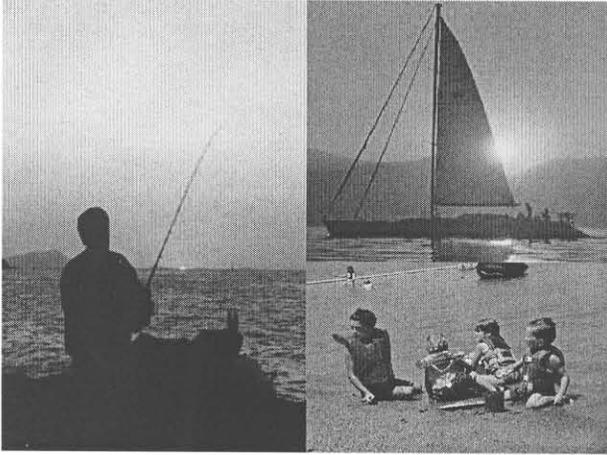
Note: Each data point represents a reservoir

Types of Responses
 c = slight impairment
 d = substantial impairment
 e = enjoyment nearly impossible

Results

Other Conclusions

- Good consistency between TCEQ historical data and these data
- Unnecessary to include pheophytin
- Correlation with degree of use impairment better for chlorophyll than transparency (Secchi disc depth)



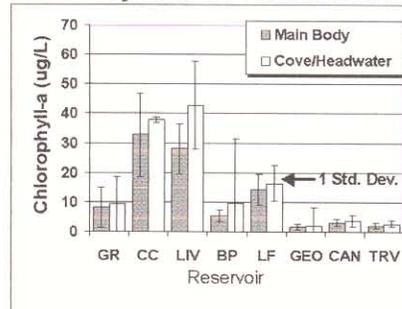
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