



*Florida Department of
Environmental Protection*

Lochloosa Lake Nutrient TMDL Development

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Watershed Evaluation and TMDL Section

December 17, 2014

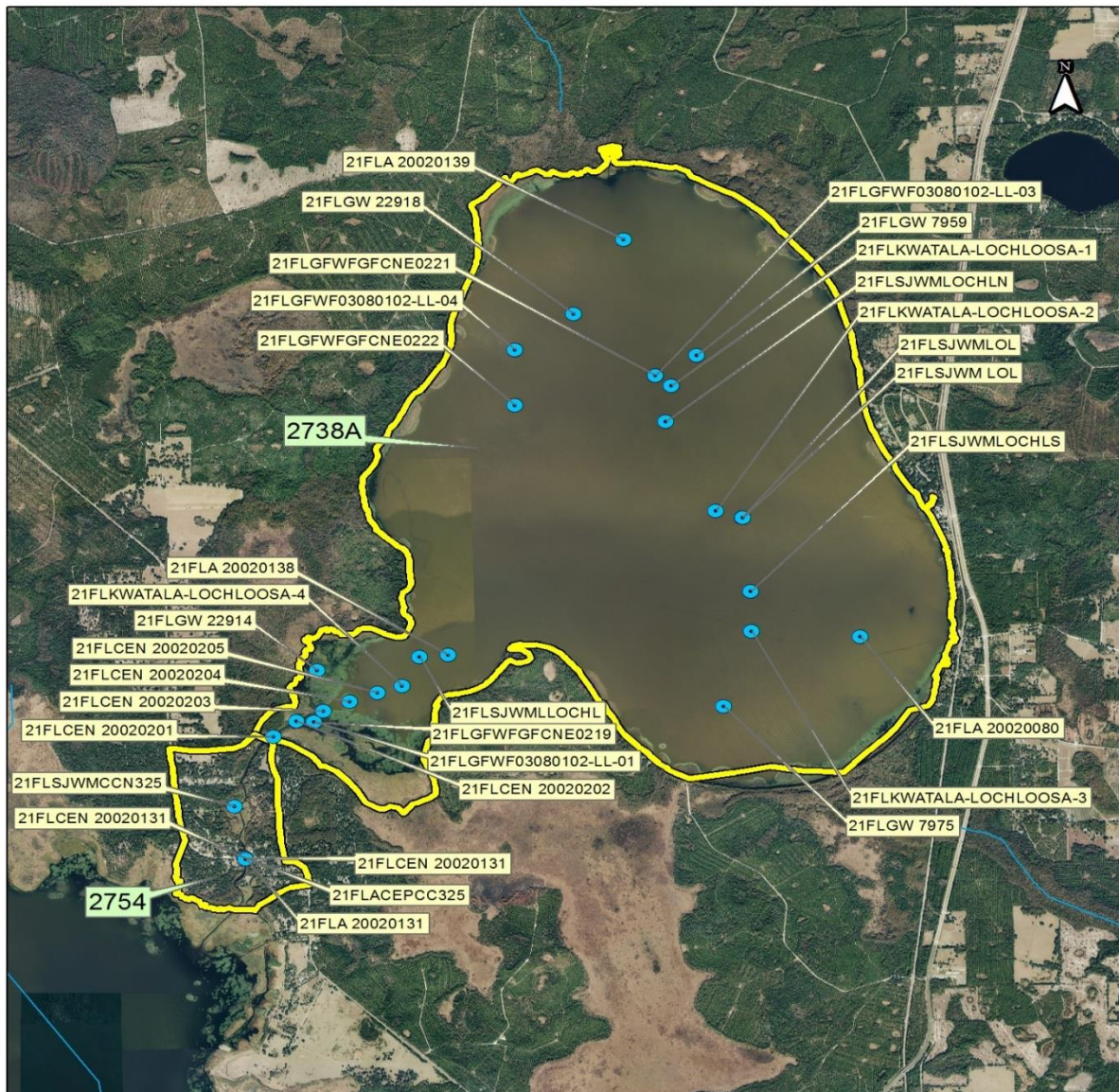


Summary of Presentation

- Lochloosa Lake Impairment Status
- Lochloosa Lake Water Quality Trend
- Process of TMDL Development
 - Target Setting
 - Watershed and Receiving Water Modeling







**Ocklawaha Basin
WBIDs 2738A & 2754
Sampling Stations**



0 0.3 0.6 Miles

Map prepared October 22, 2014 by the Division of Environmental Assessment and Restoration. This map is not for legal decision making purposes. For more information or copies contact: benjamin.mittler@dep.state.fl.us

● IWR Stations

~ Rivers/Streams

📐 WBID Boundaries





Lochloosa Lake (WBID 2738A): Impairment Status

- Identification of Impaired Surface Waters (Chapter 62-303, FAC)
- In assessment Cycles 1 - 3, the IWR methodology used the water quality variables total nitrogen (TN), total phosphorus (TP), and chlorophyll a (a measure of algal mass, corrected and uncorrected) in calculating annual TSI values and in interpreting Florida's narrative nutrient threshold.
 - The WBID was verified for nutrient impairments during the Cycle 1 assessment (January 1, 1995 through June 30, 2002)
 - Adopted Verified List For Cycle 1 on October 1, 2002
 - The nutrient impairment was confirmed in Cycle 2 assessment (January 1, 2000 through June 30, 2007)
 - The nutrient impairment was confirmed in Cycle 3 assessment (January 1, 2005 through June 30, 2012)





Lochloosa Lake Annual TSI Values

Year	Mean Color (PCUs)	Mean TSI	Exceedance
1995		64.6	yes
1996		65.9	yes
1997	66.4	69.7	yes
1998	235	76.7	yes
1999	60	84.7	yes
2000	56.7	88.5	yes
2001	86.3	84.4	yes
2002	45		
2003	121	56.4	
2004	191	61.5	yes
2005	306	56.6	
2006	101	65	yes
2007	36	74	yes
2008	98	84	yes
2009	82	63	yes
2010	39	44	yes
2011	36		





Numeric Nutrient Criteria for Florida Lakes

(62-302.531(2)(b)1, F. A. C)

Long Term Geometric Mean Lake Color and Alkalinity	Minimum calculated numeric interpretation		
	Annual Geometric Mean Chlorophyll a	Annual Geometric Mean Total Phosphorus	Annual Geometric Mean Total Nitrogen
> 40 Platinum Cobalt Units	20 µg/L	0.05 mg/L	1.27 mg/L
≤ 40 Platinum Cobalt Units and > 20 mg/L CaCO ₃	20 µg/L	0.03 mg/L	1.05 mg/L
≤ 40 Platinum Cobalt Units and ≤ 20 mg/L CaCO ₃	6 µg/L	0.01 mg/L	0.51 mg/L



YEAR	CHLAC (µg/L)	TN (mg/L)	TP (mg/L)
1988	12.88	1.06	0.069
1989	12.19	1.05	0.052
1990	17.04	0.70	0.052
1991	46.42	1.86	0.072
1992	ID	ID	0.063
1993	13.94	1.90	0.062
1994	39.08	2.02	0.056
1995	28.64	1.43	0.051
1996	40.54	1.55	0.052
1997	45.36	1.76	0.051
1998	77.73	1.97	0.068
1999	144.30	2.57	0.069
2000	187.76	5.41	0.100
2001	150.09	4.26	0.085
2002	26.19	2.83	0.048
2003	13.28	1.55	0.037
2004	15.13	1.65	0.067
2005	7.93	1.58	0.108
2006	24.48	1.35	0.111
2007	55.58	2.13	0.081
2008	133.19	3.38	0.071
2009	47.82	2.07	0.058
2010		2.31	0.054
2011	95.55	3.84	0.090
2012	ID	ID	ID
2013	22.62	1.94	0.052

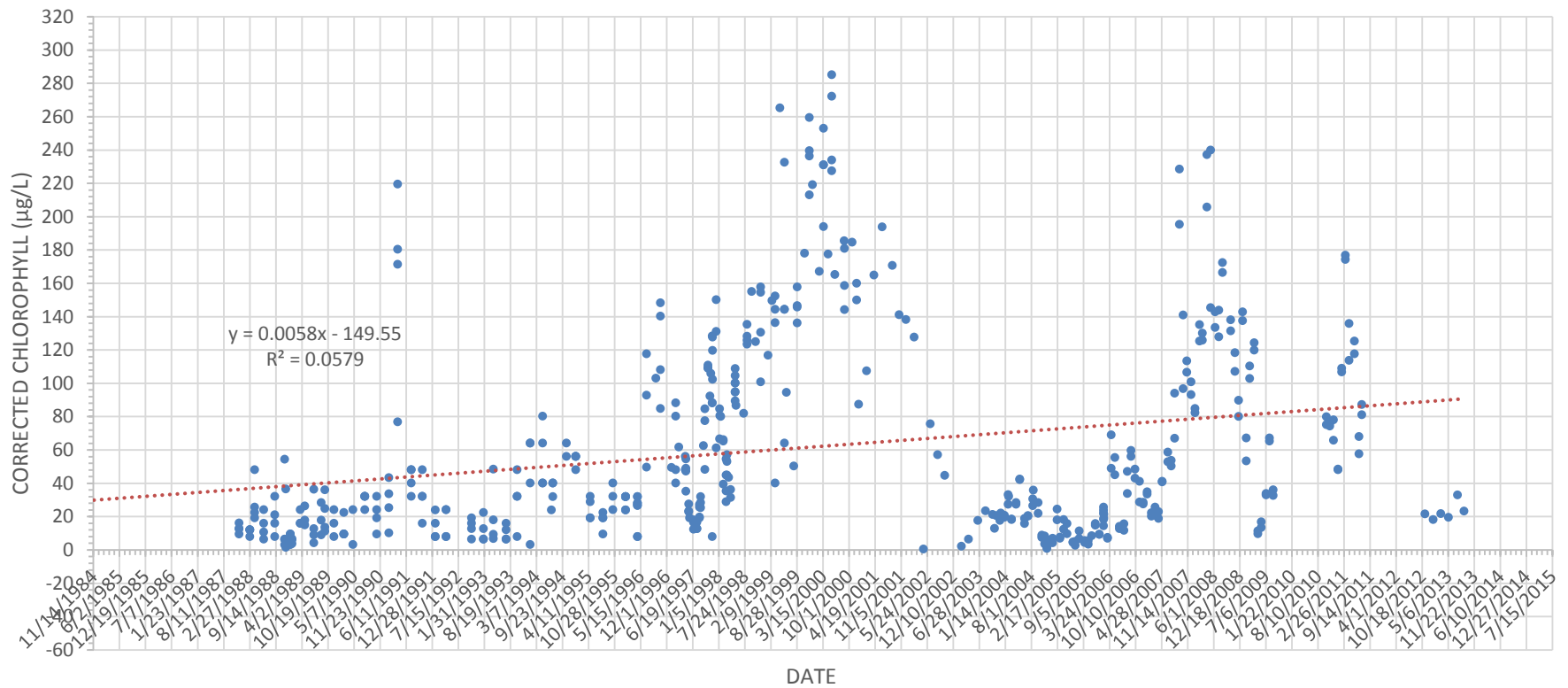
ID - Insufficient Data to Calculate Geometric Means per the Requirements of Rule 62-303.





Corrected Chlorophyll A Time Series

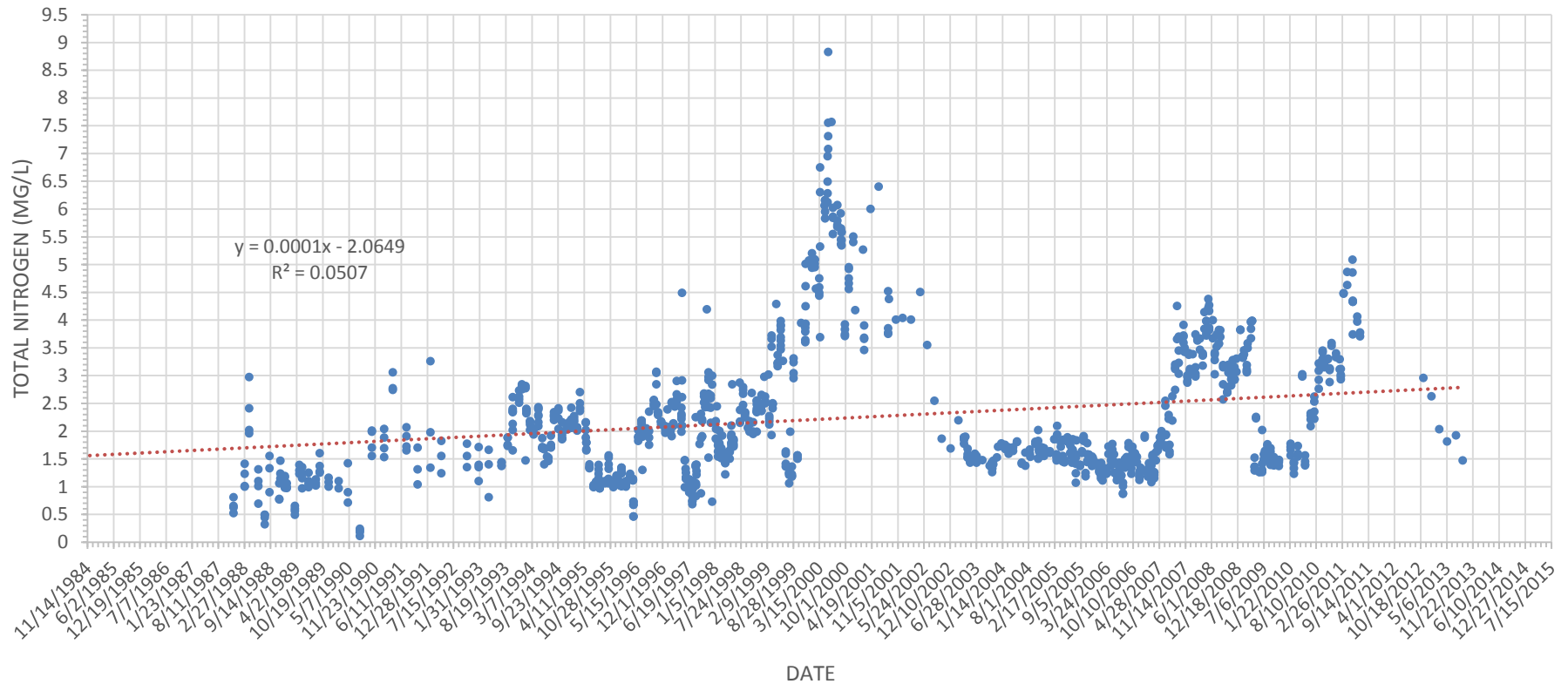
LOCHLOOSA LAKE CORRECTED CHLOROPHYLL TIME SERIES





Total Nitrogen Time Series

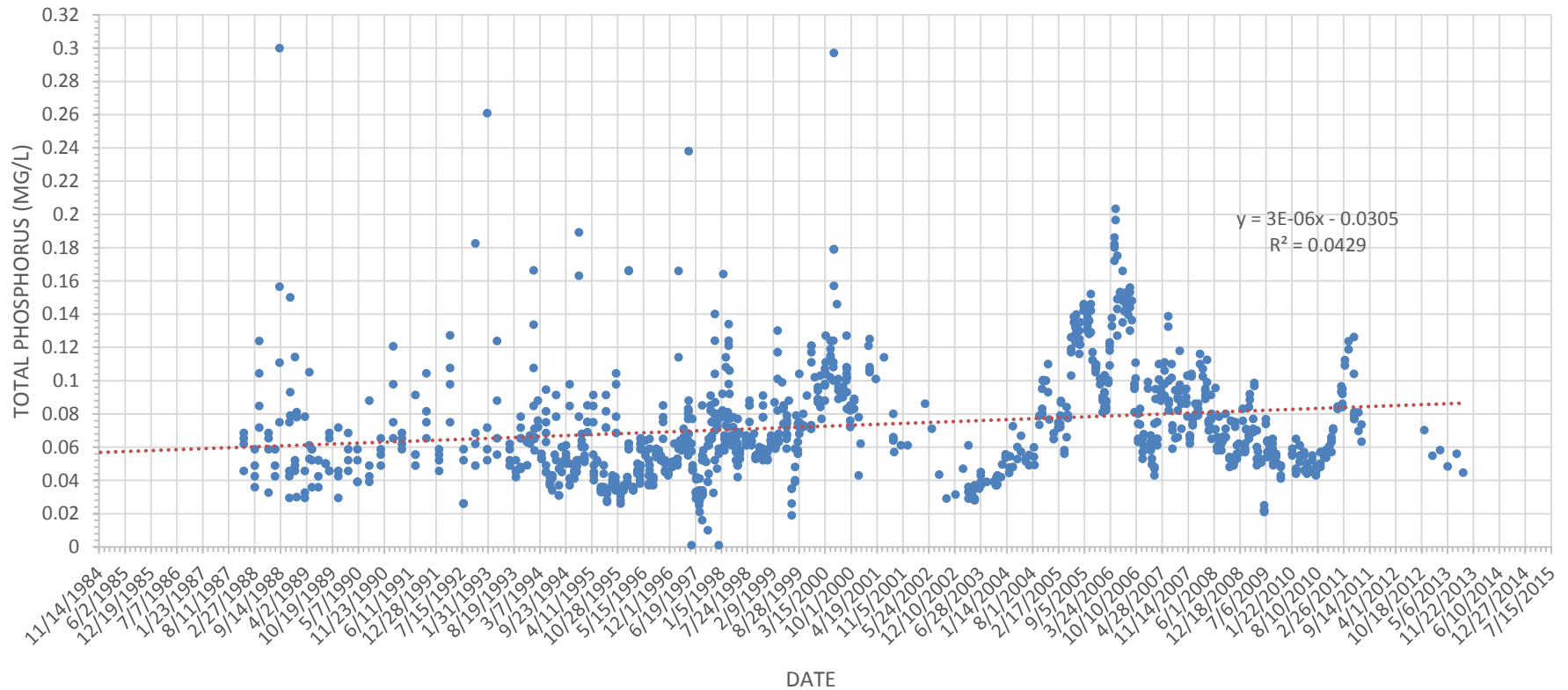
LOCHLOOSA LAKE TOTAL NITROGEN TIME SERIES





Total Phosphorus Time Series

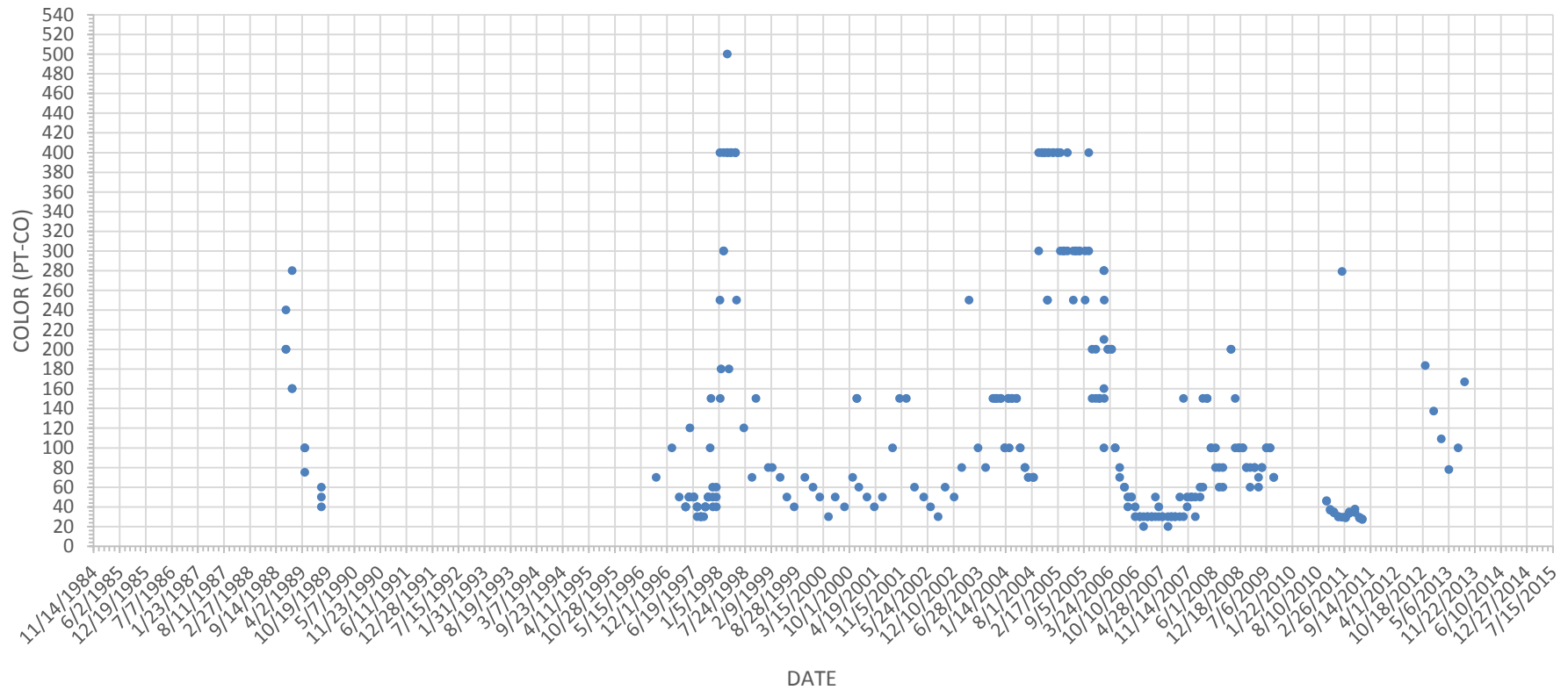
LOCHLOOSA LAKE TOTAL PHOSPHORUS TIME SERIES





Color Time Series

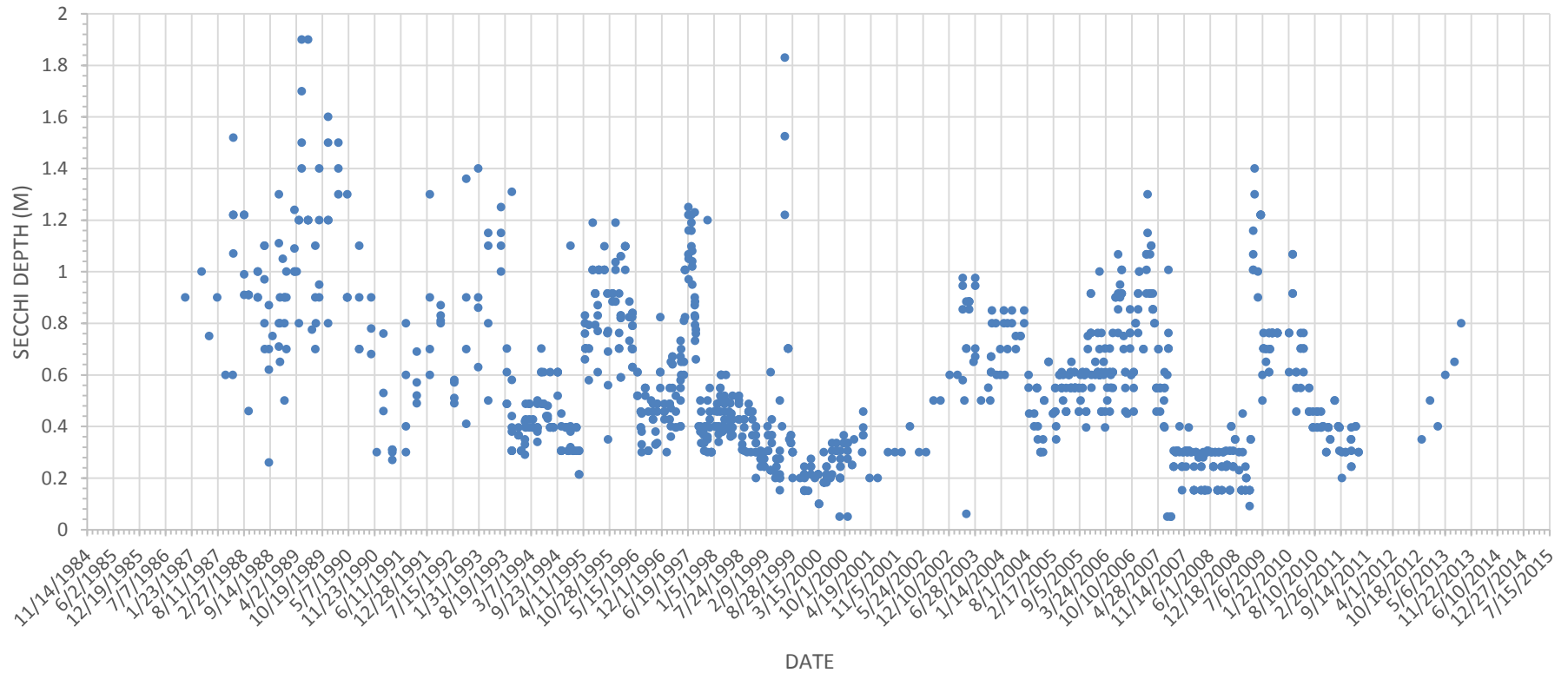
LOCHLOOSA LAKE COLOR TIME SERIES





Secchi Depth Time Series

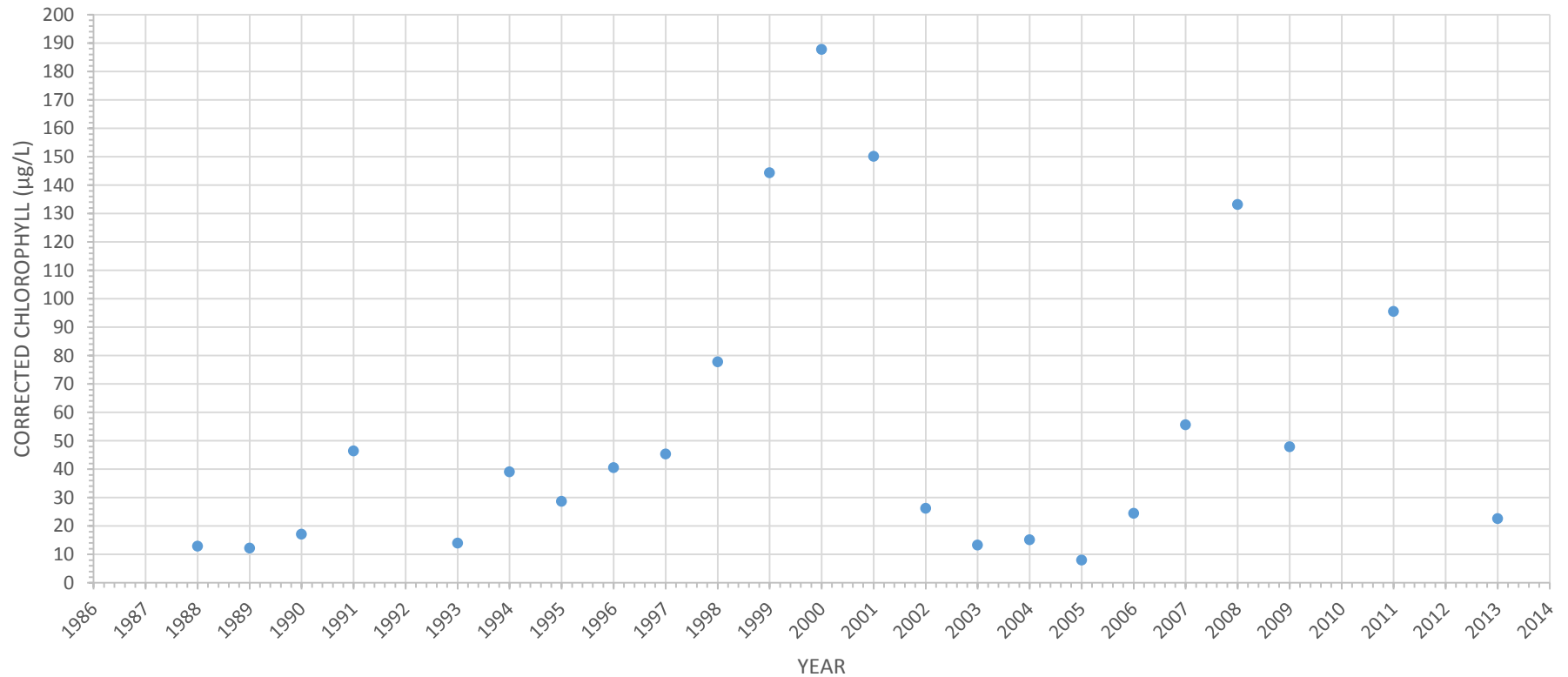
LOCHLOOSA LAKE SECCHI DEPTH TIME SERIES





Annual Chlorophyll A Geomeans

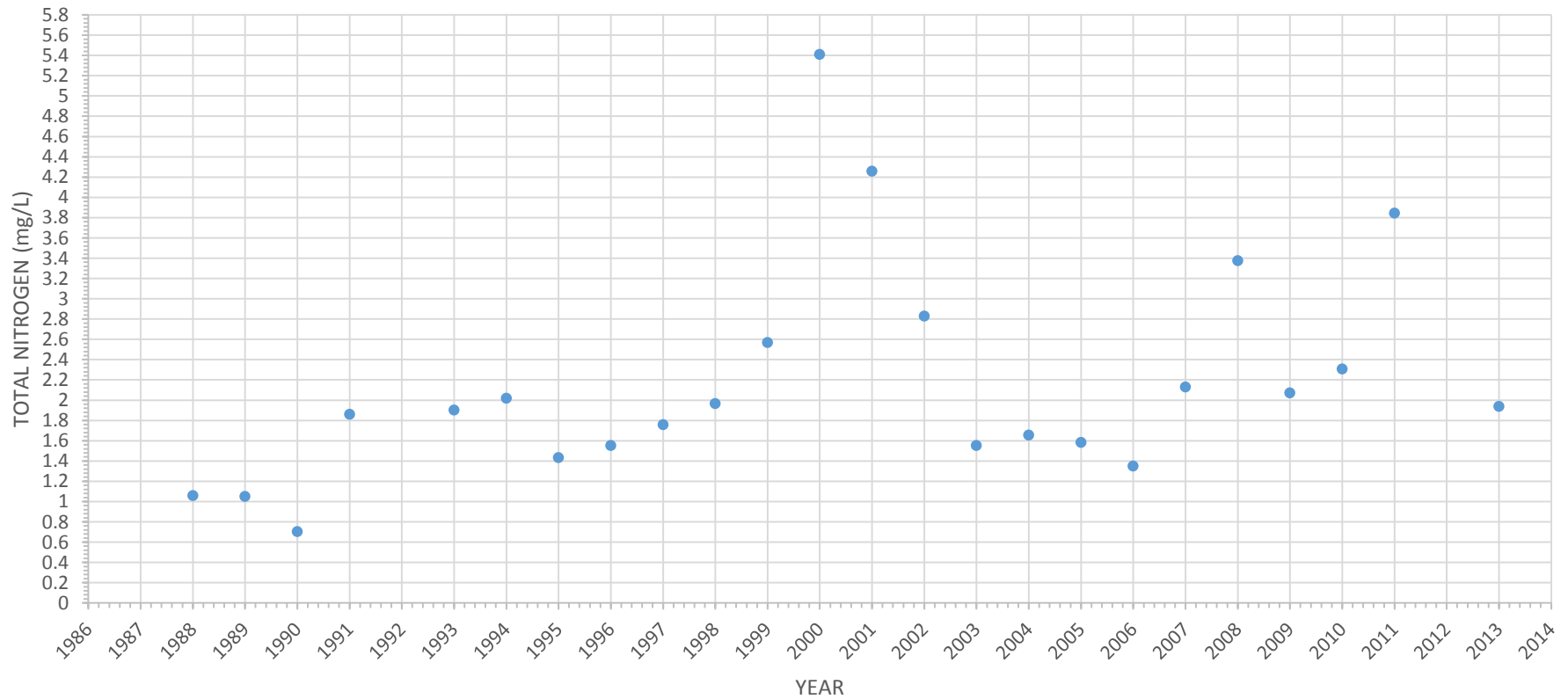
LOCHLOOSA ANNUAL GEOMEAN CHLAC





Annual Total Nitrogen Geomeans

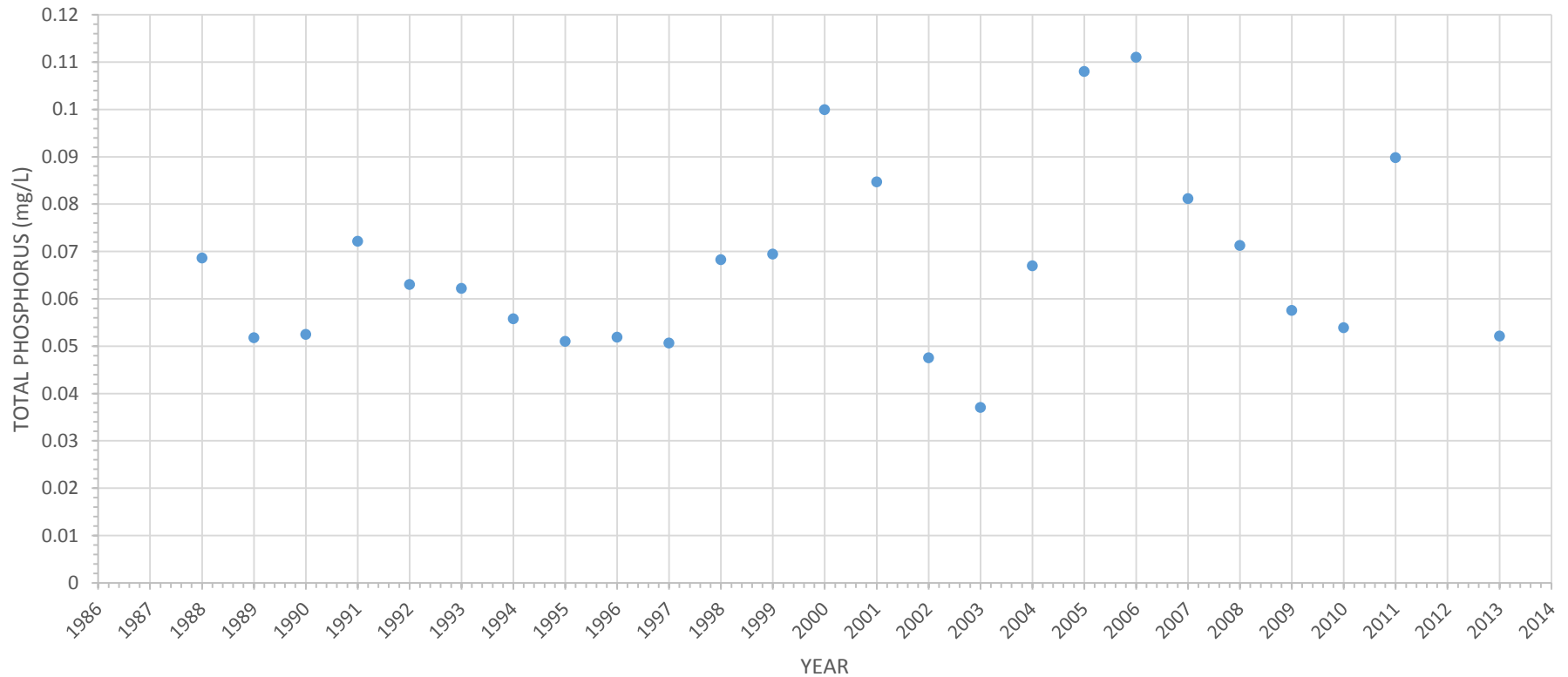
LOCHLOOSA ANNUAL GEOMEAN TOTAL NITROGEN





Annual Total Phosphorus Geomeans

LOCHLOOSA ANNUAL GEOMEAN TOTAL PHOSPHORUS





Process of the TMDL Development

1. Setting up targets
2. Source Identification
3. Modeling Approaches

Current condition

Natural background condition

Target condition

3. TMDL and Percent Reduction





Setting up Target: Multiple Lines of Evidence

1. Numeric Nutrient Criteria
2. Paleolimnological Assessment
3. Central Valley Lake Region Assessment
4. Lake Morphology Approach
5. Empirical Model (Regression Analysis)
6. Watershed/Receiving Water Modeling Approach





Paleolimnological Assessment

- Sediment Accumulation Rate and Past Water Quality in Lochloosa Lake by Brenner *etal.*, 2009 Funded by SJRWMD
 - Five cores were collected for detailed paleolimnological analysis.
 - The diatom inferred limnetic total phosphorus concentration prior to 1900 from the five cores ranged between 47.83 and 58.95 $\mu\text{g/L}$ (median 53.32 $\mu\text{g/L}$). A baseline inference of ~ 40 $\mu\text{g/L}$ TP was consistent with a mean baseline value of 42.9 $\mu\text{g/L}$ obtained from paleolimnological studies of seven other nearby lakes.
 - Diatom inferred limnetic chlorophyll *a* concentrations at the base of the five cores ranged between 8.9 and 43.6 $\mu\text{g/L}$ (median 17.3 $\mu\text{g/L}$). Four of the five chlorophyll *a* concentrations were 20 $\mu\text{g/L}$ or less.





Central Valley Lake Region Assessment

- ARCGIS was used to identify lake WBIDs in the central valley lake region. Total nitrogen and TP observations for these lakes was extracted from the IWR run 49 database. Annual geomeans for TN and TP were calculated for each lake.
- The geomeans were used if there were a minimum of four sampling events in a year and at least one observation occurred during the May 1 thru September 30 period.
- Statistical approach based on the binomial distribution to calculate the upper 80th percent prediction limit that would be expected with 90 percent confidence not to be exceeded more than once in a three year period. The 80th percent TN and TP concentrations were calculated for each lake with at least 7 annual geomeans.
- There were 35 lakes in the central valley that met the data sufficiency requirements. The lower 25th percentiles for TN and TP were 1.049 mg/L and 0.039 mg/L, respectively and would not be expected to be exceeded more than once in a three year period.





Equation for the 80th percentile annual geometric mean TN and TP Concentrations

$$C = e^{\left(\sum_{1}^n \frac{\text{LnAG}}{n} + (t^* \sqrt{SD^2 - \frac{SD^2}{n}})\right)}$$

- C: the 80th percentile annual geometric mean TN and TP concentrations
- LnAG: the natural log of annual geometric mean of TN and TP concentrations
- n: the number of years
- t: the inverse of the student's t distribution
- SD: the standard deviation of the natural log of the annual geometric mean



Lake Morphology Approach

Water Residence time: the sedimentation of nutrients

* Huber's Lake list (1983)

- About 150 Florida Lakes

- Lake surface area, Lake mean depth,

- Watershed area to lake surface area ratio

- TN and TP Data Collection

1. Surface area of 0.1 to 10 times Lochloosa Lake

2. Mean depth of 0.5 to 2 times Lochloosa Lake

3. Watershed area to lake surface area ratios that are 0.1 to 10 times Lochloosa Lake



WBID	Lake Name	Lake Surface Area (acres)	Mean Depth (ft)	Watershed Area to Lake Surface Area Ratio	TN Concentration Exceeded at One in Three Year Frequency (mg/L)	TP Concentration Exceeded at One in Three Year Frequency (mg/L)	Number of Years that TN Annual Geometric Mean Can Be Calculated	Number of Years that TP Annual Geometric Mean Can Be Calculated
1860D	Jackson	3244	9.40	2.76	0.53	0.026	32	35
1521B	Eloise	1172	9.73	3.07	1.64	0.113	30	32
1677C	Buffum	1544	11.30	4.56	0.89	0.073	25	25
2339	Ocean Pond	1793	8.40	4.68	0.71	0.128	14	18
2389	Doctors	3202.4	9.84	5.00	1.45	0.175	30	32
3176	Alligator	3401	7.70	5.01	0.82	0.027	37	40
1476	Mattie	1813	9.80	5.19	1.55	0.168	17	17
3184	Marian	5727	10.80	5.54	2.36	0.157	35	36
1497B	Parker	2291	7.60	6.59	3.67	0.177	22	27
1480	Marion	2968	4.55	7.70	2.03	0.069	33	38
1573E	Weohyakapka	7555	5.24	7.92	0.91	0.053	32	35
2705B	Newnans	7350	6.15	9.93	7.48	0.468	31	33
1532A	Pierce	3736	7.20	10.09	1.85	0.056	33	35
2873C	Johns	2411	8.00	10.64	1.21	0.050	23	23
2807A	Yale	4030	11.73	10.74	1.70	0.038	42	46
1685D	Reedy	3454	10.93	11.28	1.85	0.041	30	32
442	Iamonia	5680	7.00	11.38	0.75	0.029	20	19
3259W	Trafford	1485	5.08	11.46	2.63	0.211	34	37
3008B	South	1103.3	3.62	11.69	1.65	0.062	5	5
2981	Jessup	7792	5.40	12.81	3.92	0.353	44	39
1486A	Tarpon	2534	8.20	15.15	1.15	0.081	42	46
3177	Gentry	1797	7.20	15.88	1.00	0.048	28	29
3598D	Sampson	2071	6.10	18.33	0.91	0.047	21	21
1623L	Hancock	4541	4.70	18.46	8.84	0.785	34	37
2925A	Ashby	1077	6.40	20.20	1.02	0.120	21	21
2839M	Louisa	3660	10.40	21.16	1.45	0.041	38	40
1860B	Josephine	1240	6.46	23.90	1.14	0.085	23	27
791N	Miccosukee	6312	6.70	24.33	0.90	0.038	21	23
1685A	Arbuckle	3787	5.90	28.73	1.41	0.075	35	37
1347	Okahumpka	973	6.50	32.23	2.20	0.063	8	8
2831B	Dora	4437	12.26	34.04	4.20	0.128	42	45
2893V	Blue Cypress	6522	5.10	47.99	1.58	0.124	37	39
1351B	Panasoffkee	4821	6.90	55.76	0.95	0.041	24	27
553A	Deer Point (Deerpoint)	4989.3	9.96	55.80	0.57	0.028	17	25





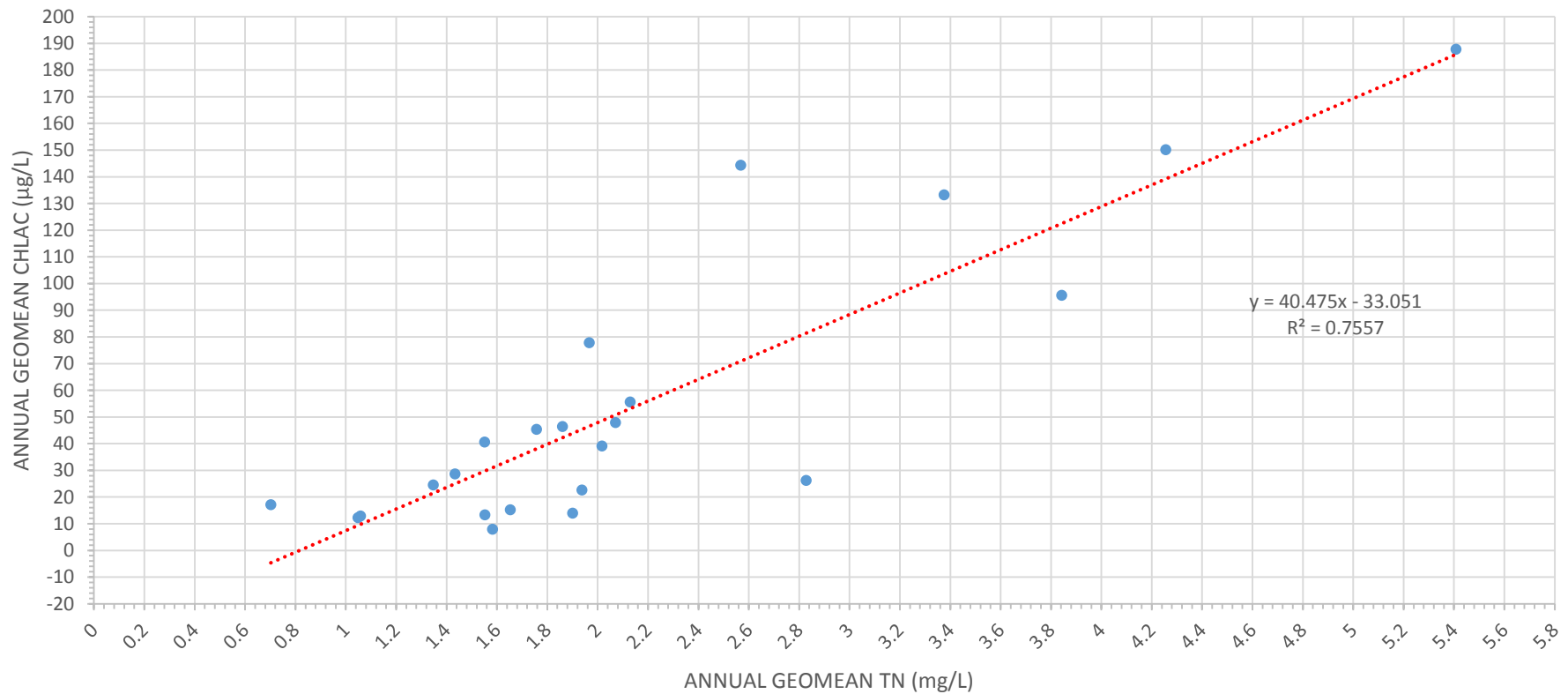
Lake Morphology Assessment

- Thirty-four lakes in the Assessment
- Calculated the 25% percentile of the 1 in 3 year annual geomeans
- TN concentration 0.92 mg/L
- TP concentration 0.043 mg/L



Linear Regression of Geomean CHLAC versus TN

LOCHLOOSA ANNUAL GEOMEAN CHLAC VERSUS ANNUAL GEOMEAN TN





Regression Model

- Based on the regression equation, an annual geomean CHLAC of 20 µg/L corresponds to an annual geomean TN of 1.31 mg/L.
- A general linear model expression based on annual means that included TN and Color explained nearly 82 percent of the variance in CHLAC:

$$\text{CHLAC} = 40.948 + 0.6639 \cdot \text{TN} - 1.1082 \cdot \text{Color} + 0.6147 \cdot \text{Color} \cdot \text{TN}.$$

The average of 15 annual geomeans of Color was 106.75.

Assuming a Color geomeans of 106.75 and a CHLAC geomean of 20 µg/L would yield a TN geomeans of 1.47 mg/L.

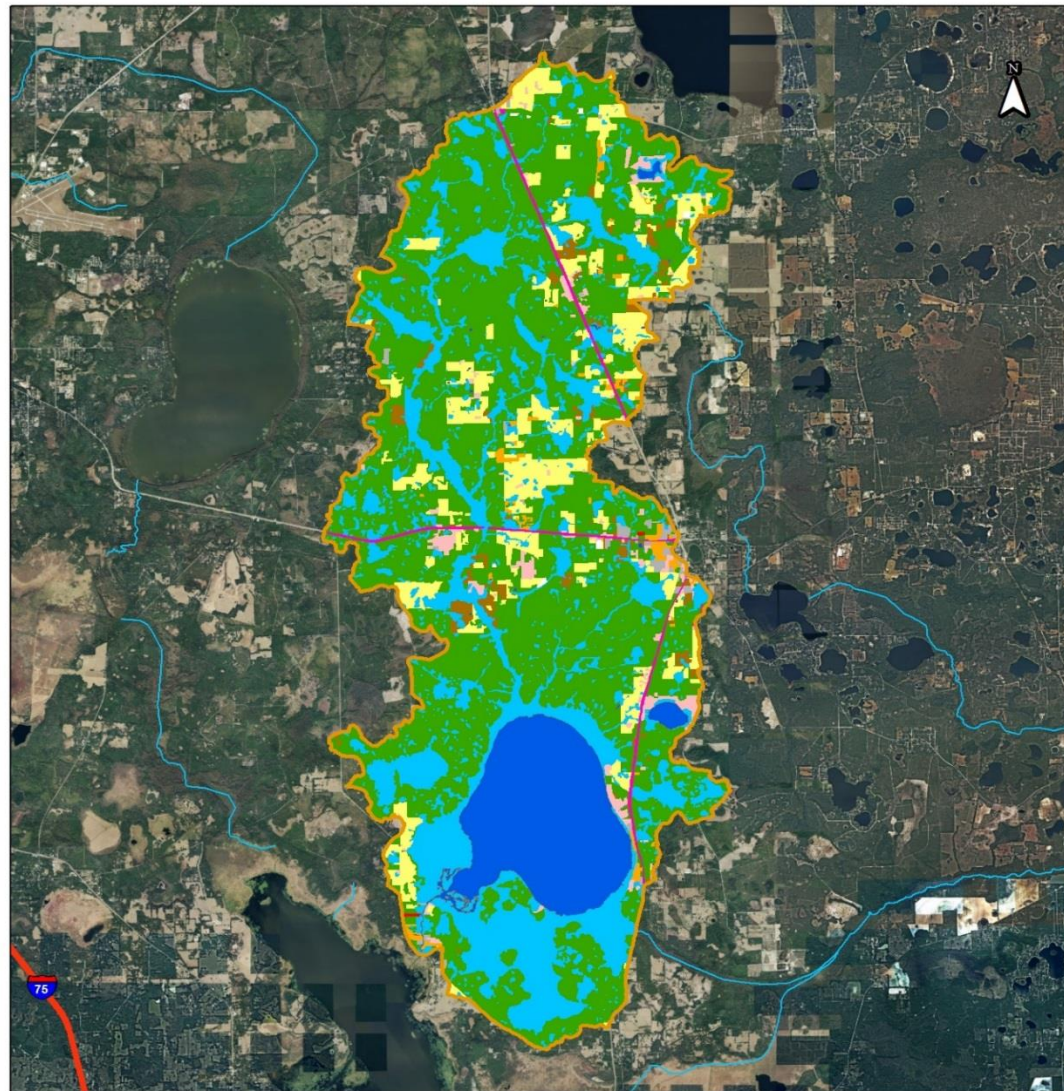




Watershed/Receiving Water Model

- Staff from the SJRWMD, Department of Water Resources, Division of Engineering have used the Hydrological Simulation Program – Fortran (HSPF) model version 12.0 to simulate the hydrology and water quality in the Lake Lochloosa watershed
 - Based on the representation of the Orange Creek Basin in the 2012 Water Supply Impact Study with refinement
 - Simulation period covers October 2003 – December 2012





**Ocklawaha Basin
Lochloosa Basin
WBIDs 2738A & 2754
Landuse**



Map prepared October 22, 2014 by the Division of
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For more information or copies contact:
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0 1 2 Miles

Rivers/Streams
Lochloosa Basin

Low Density Residential
Medium Density Residential
High Density Residential
Urban and Built Up

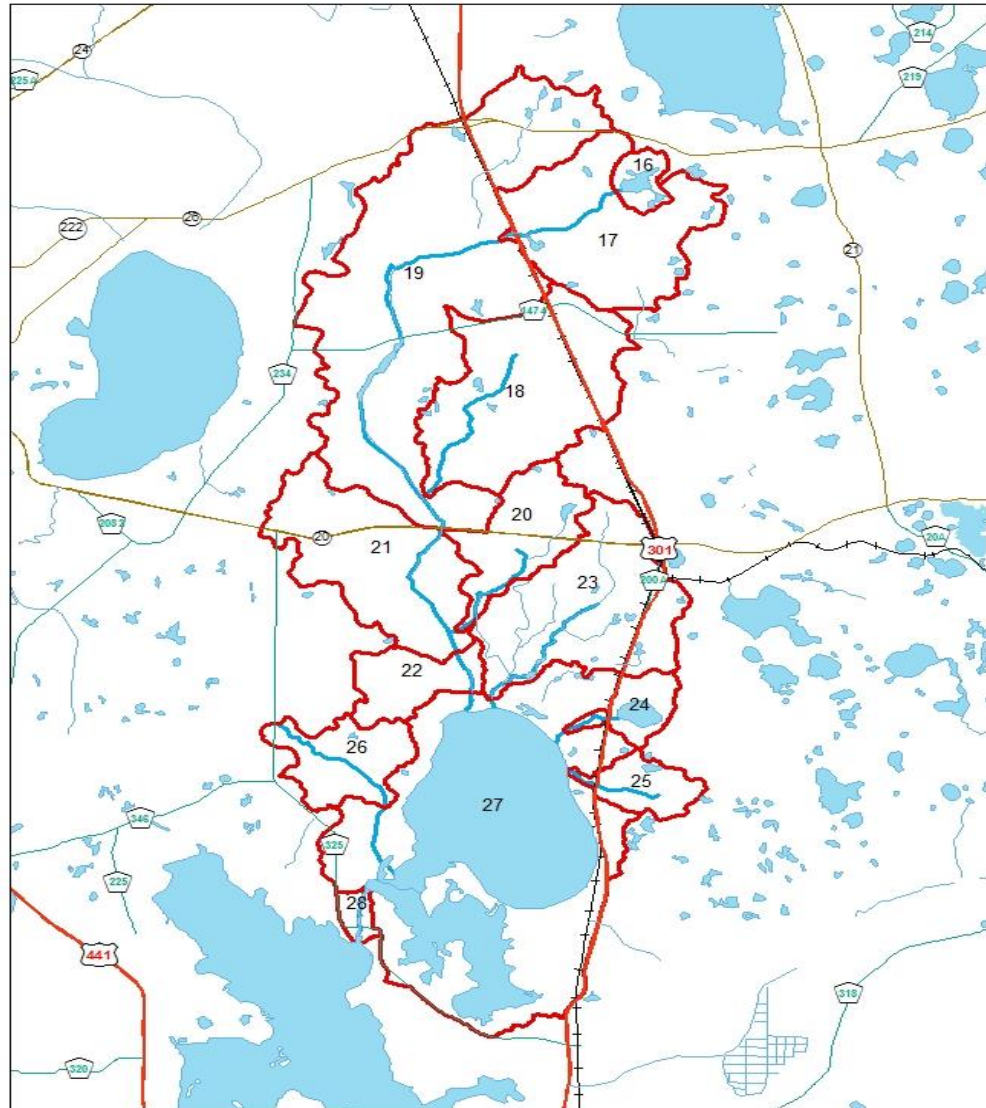
Agriculture
Rangeland
Upland Forest
Water
Wetlands
Barren Land
Trans, Comm, Util





Model Reaches

Reach	Description
16	Lake Elizabeth Creek
17	Morans Prairie
18	Unnamed Slough North
19	Lochloosa Creek SR20
20	Unnamed Slough South
21	Lochloosa Creek South
22	Lochloosa Creek
23	West Hawthorne Branch
24	Lake Jeffords
25	Unnamed Drain
26	Watson Prairie
27	Lochloosa Lake
28	Cross Creek





Model Scenario's

- Current – current (2004 – 2012) conditions
- Pristine – All urban, open, agricultural, pasture, rangeland, and forest regeneration land covers are changed to water and wetland within the watershed



Contact

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Questions ?



Sunrise on Lochloosa By William Garrett

