Presentation to Lake Okeechobee Advisory Committee

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August 1, 2000

Response of Net Settling Rate (Knet) to Reductions in External Load

Published Empirical Phosphorus Models

Pre- & Post-Restoration Case Studies

Calibration of Lake Okeechobee Water Quality Model

Preliminary Results for Dynamic P Balance Model *

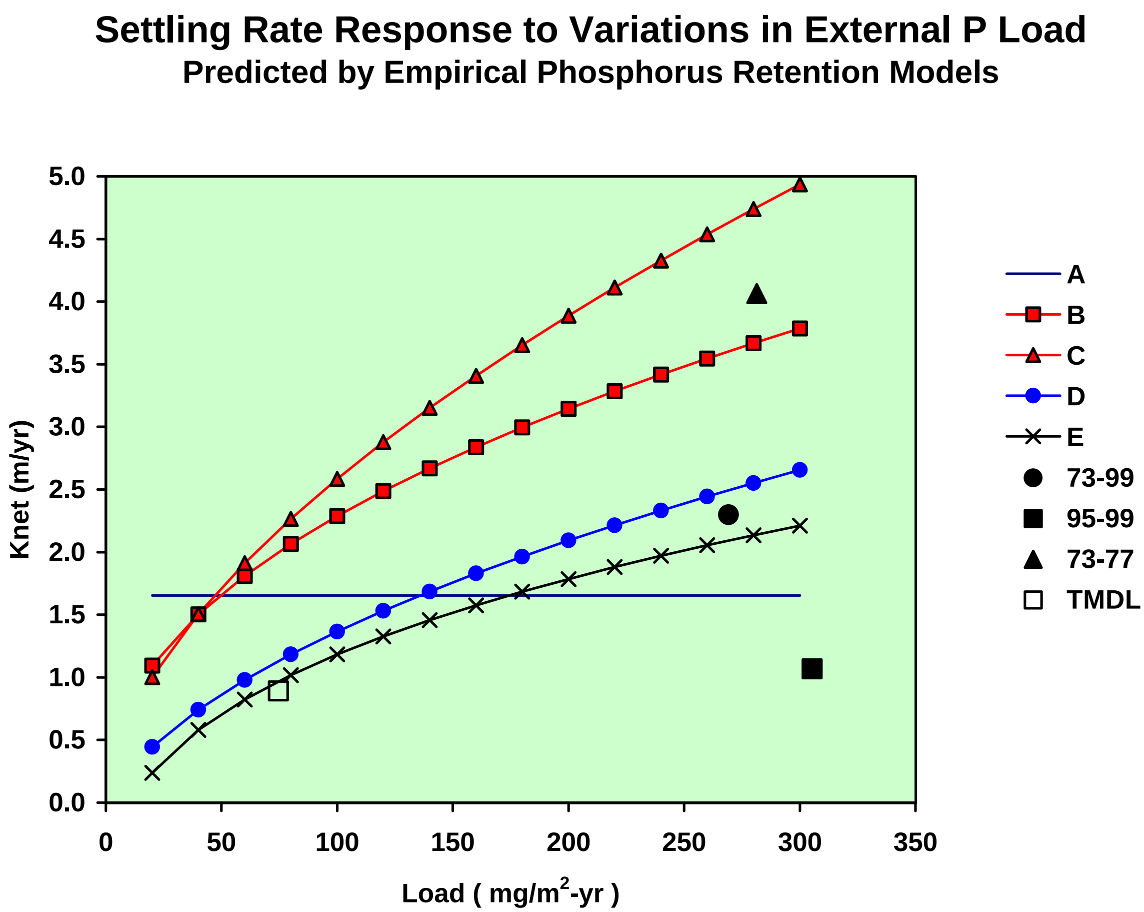
Model Structure & Parameter Estimates

Calibration Plots

Forecasts

TMDL Sensitivity to Depth

* This shows that a two-box model can be calibrated to simulate historical concentration & Knet time series. The apparent quadratic dependence of recycling rate on depth (found by examining residuals plots) indicates sensitivity to water management. This type of model should probably be run with a monthly time step, although a yearly one is used here.   Results yield a steady-state Knet & TMDL similar to those derived from the one-box quasi-steady-state model discussed at previous LOTAC meetings. Results are not definitive. There are five degrees of freedom (calibrated parameters) in the model and alternative sets of parameters may fit the data equally as well. One of the parameters (burial rate) is constrained to match the average sedimentation rate (1 mm/yr) assumed in the LOWQM.

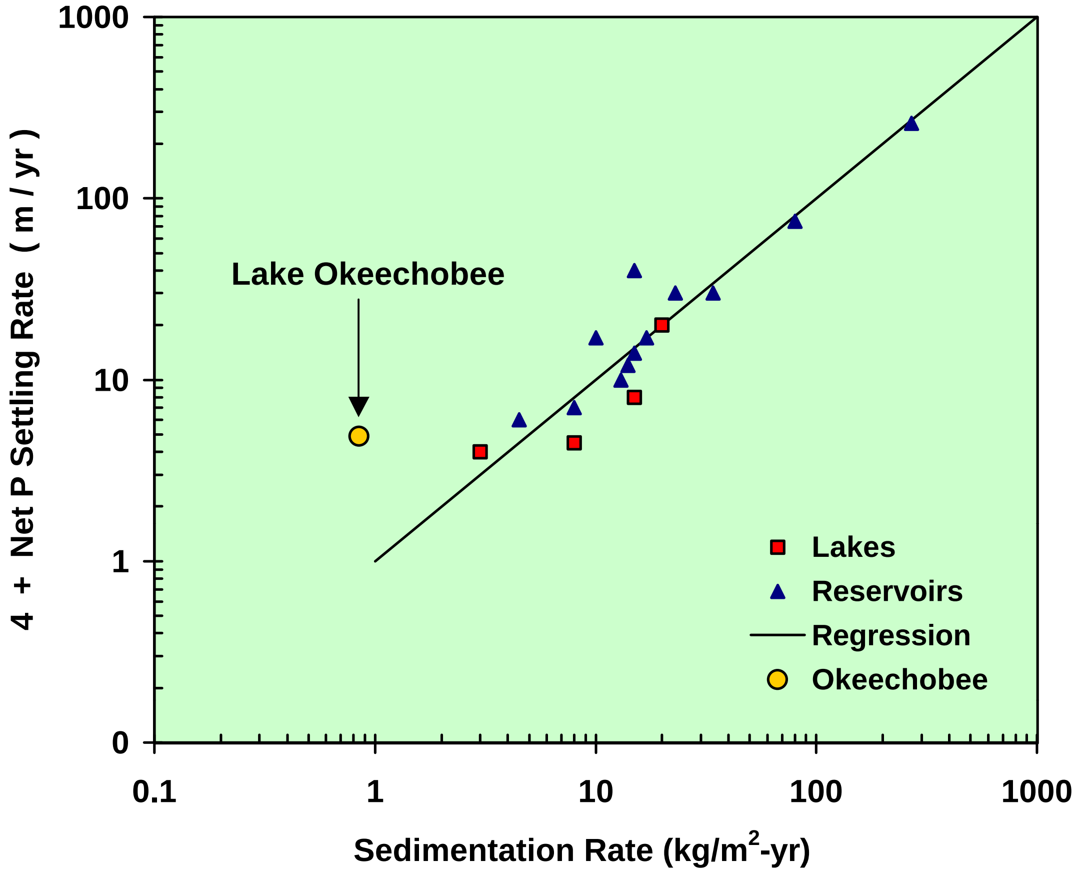


Predictions of Empirical Phosphorus Retention Models		Type of Variation
A	Vollenweider (1976)	across-lakes
B	Canfield & Bachman (1981), Natural Lakes	across-lakes
C	Canfield & Bachman (1981), Reservoirs	across-lakes
D	Walker (1985), Corps of Engineer Reservoirs	across-lakes
E	Ahl (1989)	temporal

Ahl's relationship is derived from pre- & post-restoration data from individual lakes.
The other models are derived from collections of lakes & reservoirs.

Symbols show observed values for Lake Okeechobee in various time intervals
TMDL for Lake Okeechobee derived from state-model discussed at July LOTAC meeting.

Phosphorus Settling Rate vs. Sedimentation Rate in Midwestern Lakes & Reservoirs

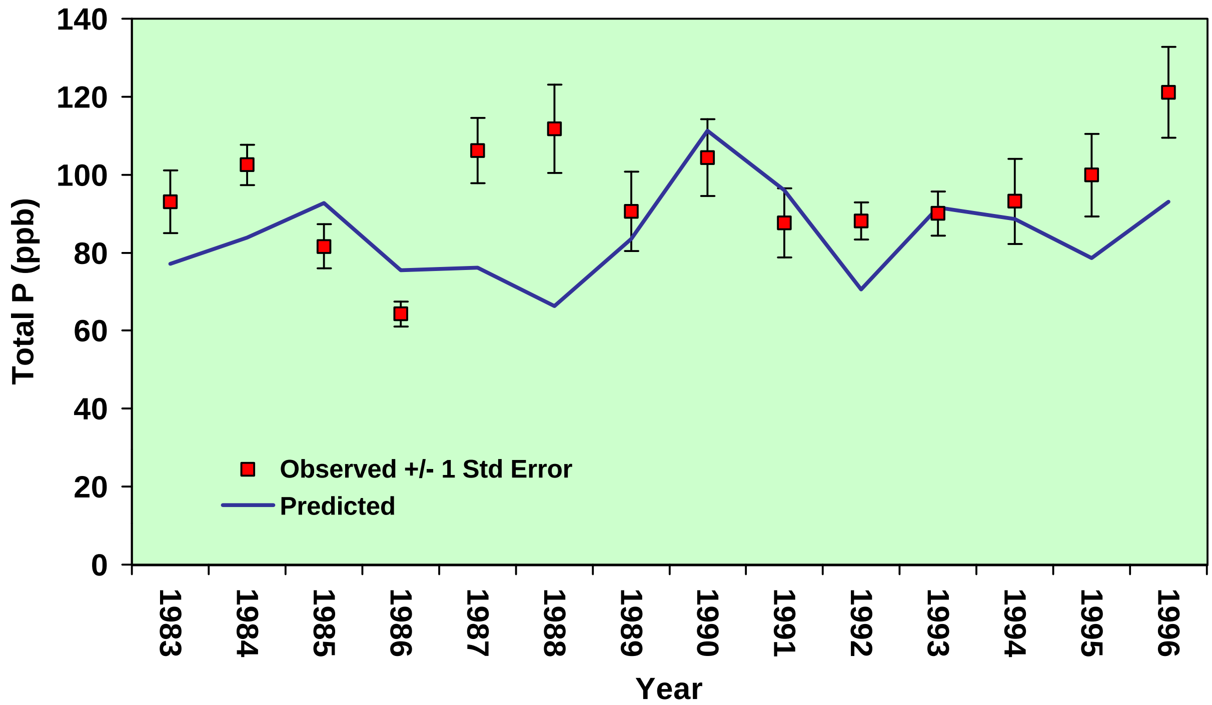


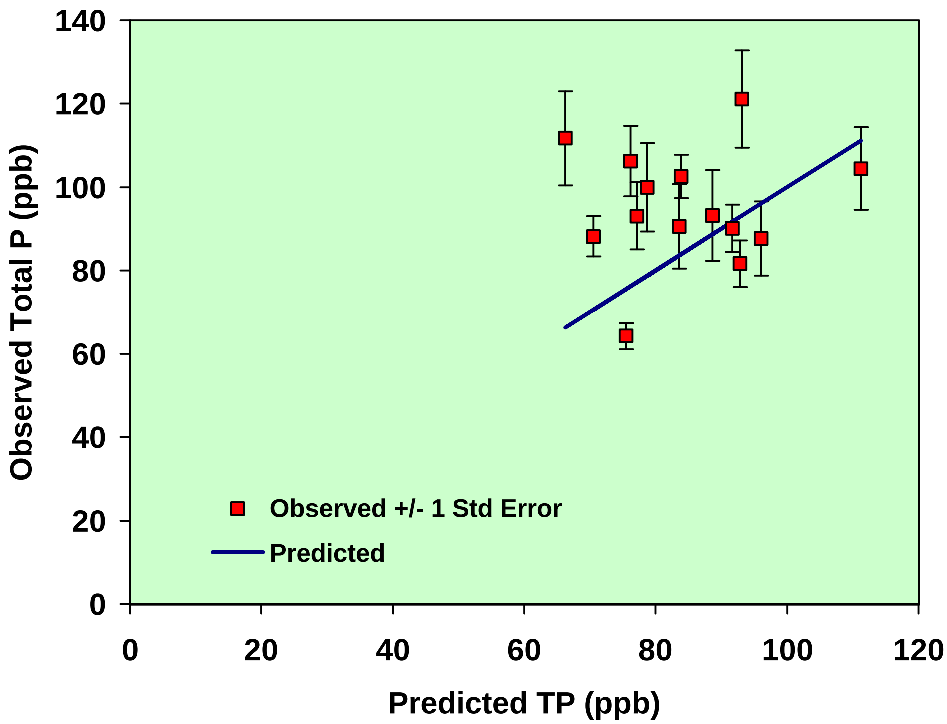
Model: Knet = S - 4

For Lake Okeechobee, mud zone sedimentation rate = 0.85 g/m^2-yr
predicted settling rate = -3.15 m/yr
observed settling rate (from steady state model) = 0.89 m/yr

Reference: Walker, W. & J. Kunher, "An Empirical Analysis fo Factors Controlling Eutrophication in Midwestern Impoundments", in Wunderlich, W., ed., Environmental Effects of Hydraulic Engineering Works, Tennessee Valley Authority, Knoxville, September 1978.

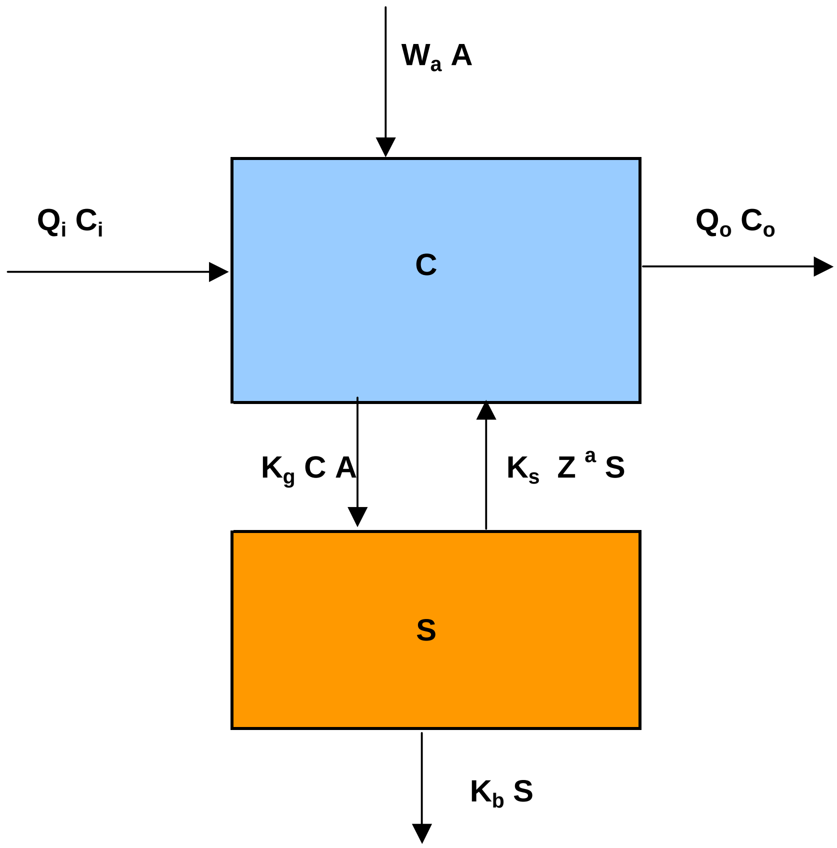
Observed & Predicted Yearly-Mean Lake Total P Concentrations
Lake Okeechobee Water Quality Model Calibration





Data from file 'lowqm.cal.val.xls', June 2000

Lake Okeechobee Dynamic P Balance Model



Parameter Estimates Calibrated to 1983-1999 Data:

K_g	gross settling rate (m/yr)	=	12
K_s	recycle rate (1/yr)	=	0.02
a	depth exponent	=	2
K_b	burial rate (1/yr)	=	0.02 *
S_o	initial ('73) storage (mt)	=	3000

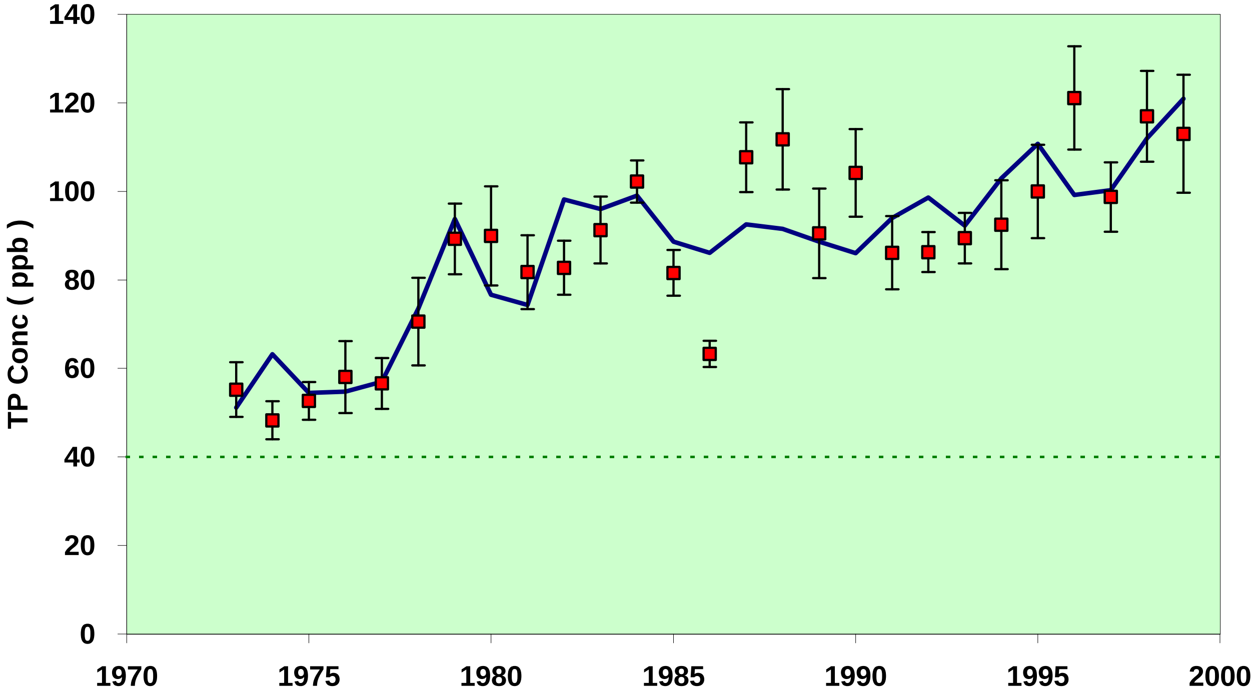
***burial rate computed from:**

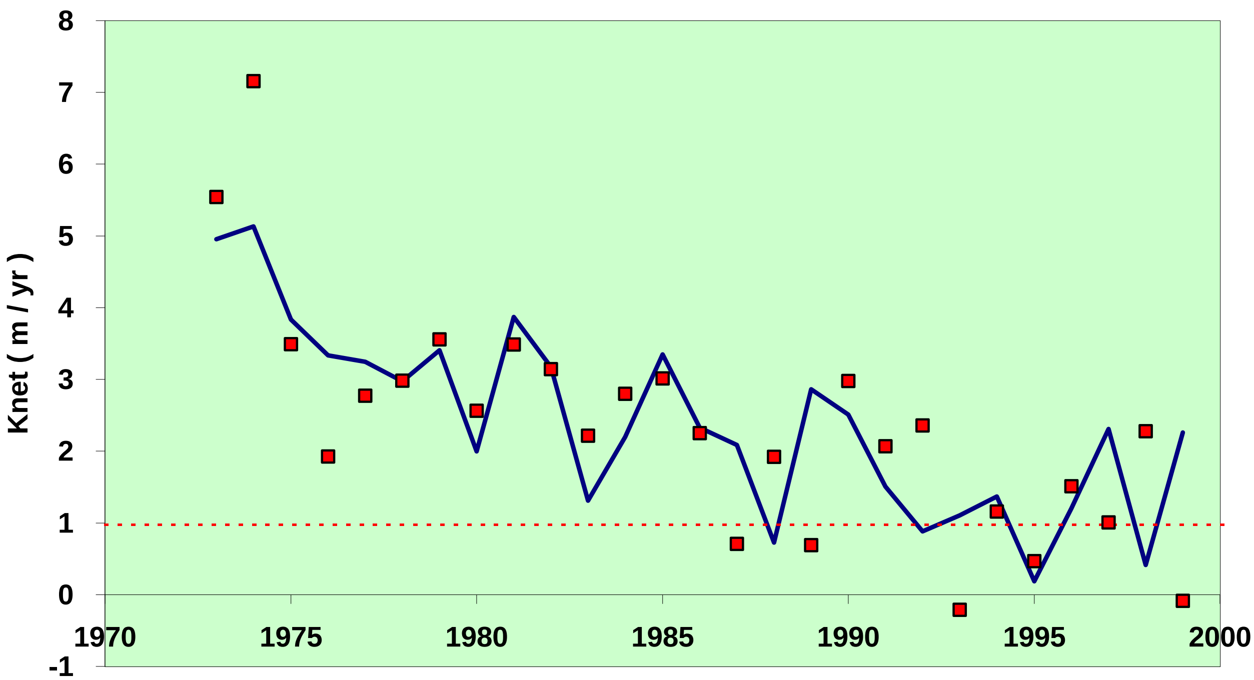
	sediment depth (cm)	=	5
	bulk density (g/cm^3)	=	0.15
	sed. rate (mm/y)	=	1

TMDL Calculation:

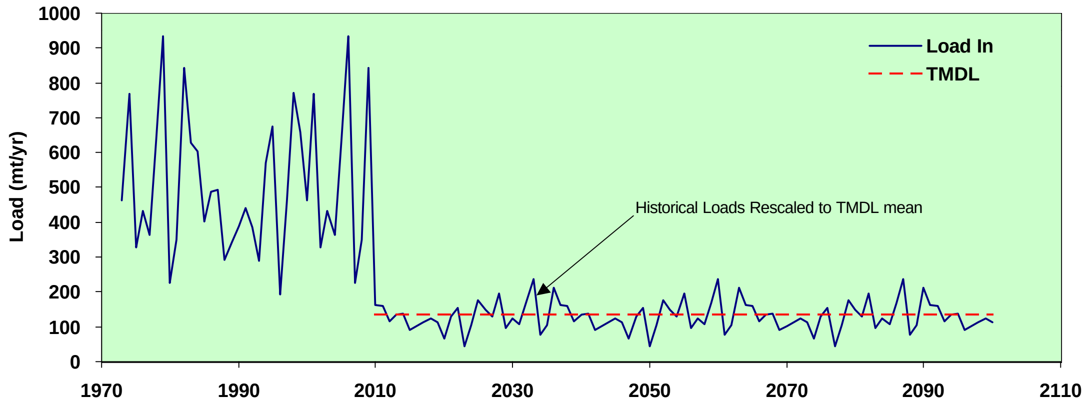
Z	mean depth (m)	=	2.7
Knet	steady-state K_{net} (m/yr)	=	0.97
TMDL	40 ppb TMDL (mtons/y)	=	135
C_i	lake inflow conc (ppb)	=	41

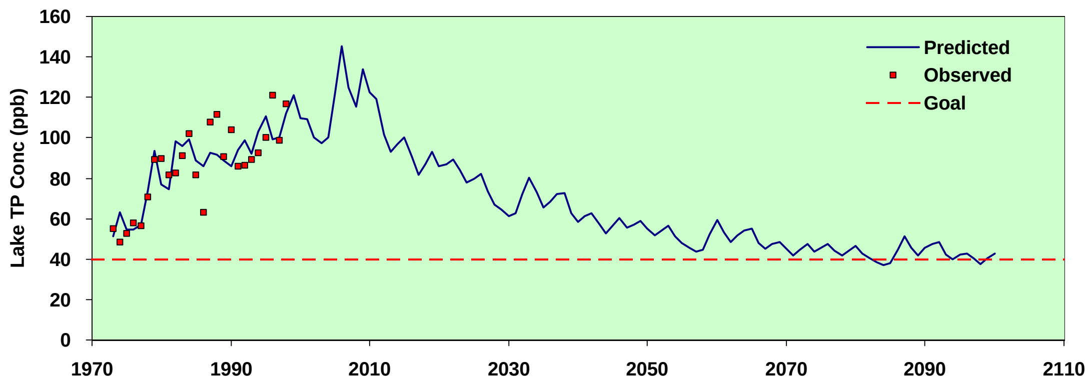
Calibration Plots

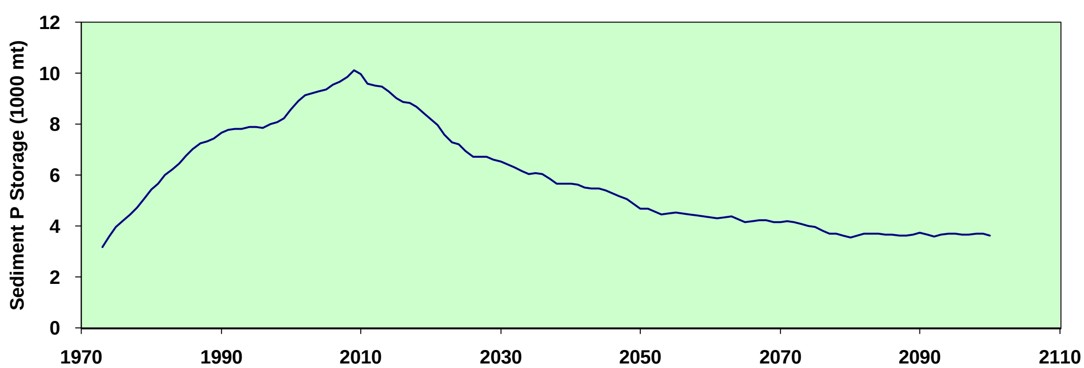


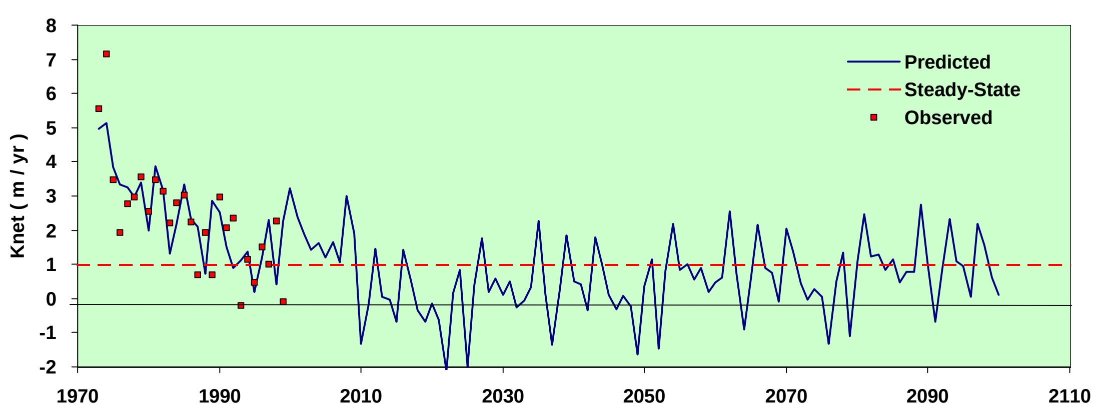


Forecasts **TMDL = 135 mtons/yr starting in 2010**

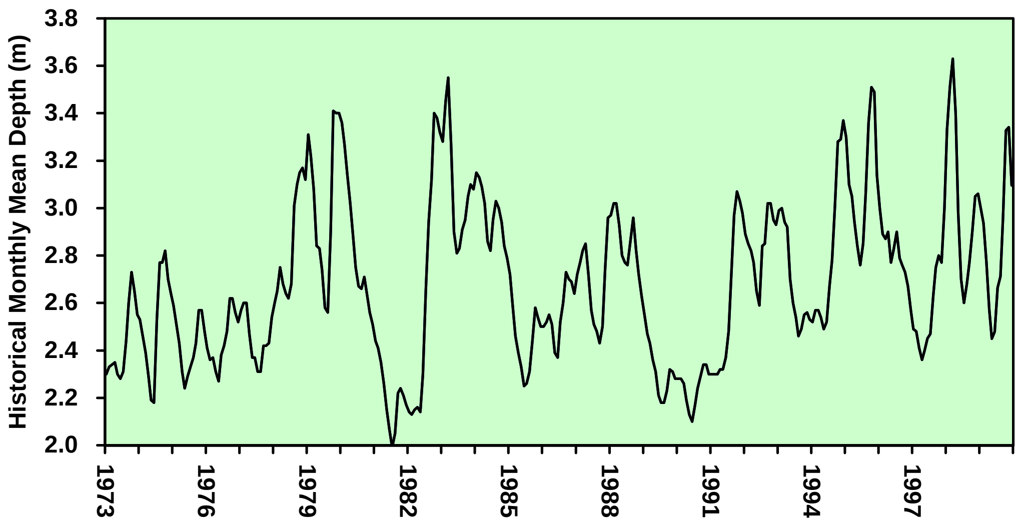








TMDL Sensitivity to Depth



Simulations are run using the above historical depth time series, constraining the maximum monthly depths to values ranging from 2.0 to 3.8 m. The table shows the corresponding average depth for the entire simulation period, Knet, TMDL, and inflow concentration resulting in an average lake concentration of 40 ppb.

	Max Monthly Depth m	Max Monthly Elevation ft	Mean Depth m	Steady-State Knet m/yr	TMDL mt/yr	Inflow Conc ppb
	2.0	9.9	2.0	1.64	181	58
	2.2	11.3	2.2	1.40	164	52
	2.4	13.3	2.4	1.22	152	47
	2.6	14.5	2.5	1.11	144	44
	2.8	15.4	2.6	1.04	140	42
	3.0	16.1	2.6	1.00	137	41
	3.2	16.7	2.7	0.98	136	41
historical	3.4	17.5	2.7	0.98	135	41
	3.6	18.0	2.7	0.97	135	41
	3.8	18.3	2.7	0.97	135	41

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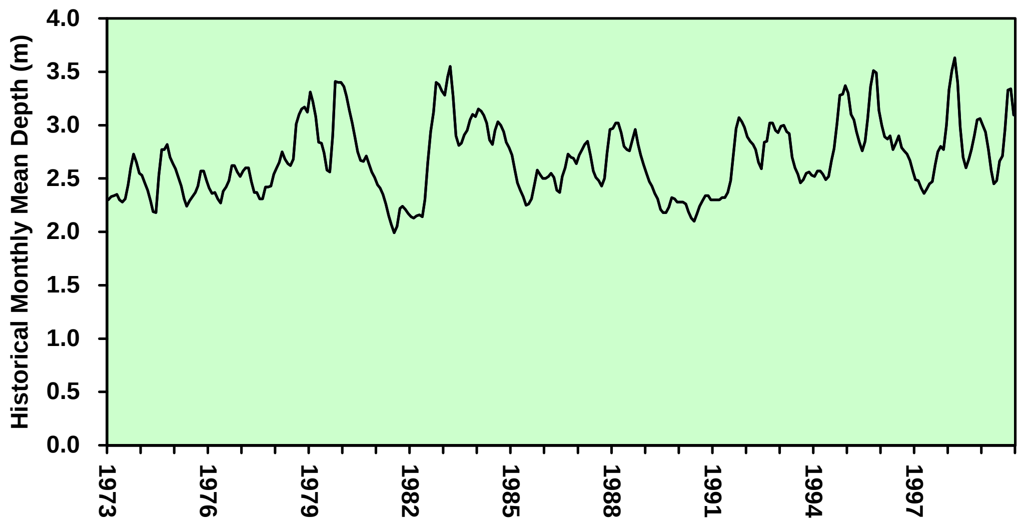

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