Devils Lake
Water Improvement District

Brian Green

Kent Norris

David Skirvin

Kip Ward

Randy Weldon

Lake Manager: Paul Robertson

Water Quality

- HABS – Low to Moderate
- E coli – High – Sand Point, Neotsu, others low
- Lake Level – 8.9’ / 2.7M
- Temp – 64F / 18 C
- Clarity - Good

Regular Meeting: 2014-06-12

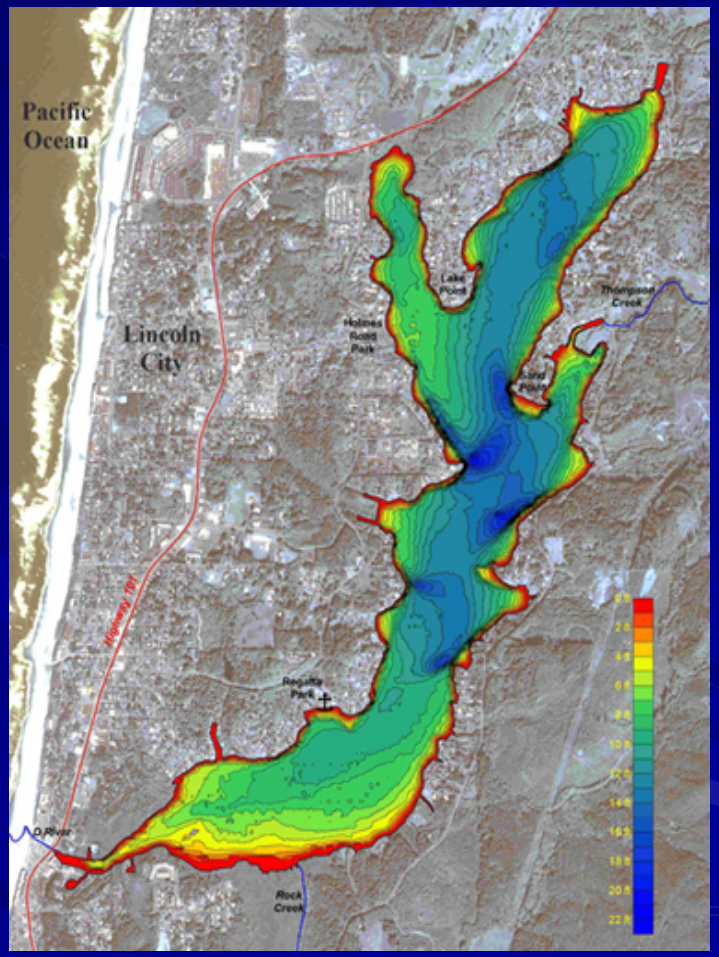
Lake Level Review 2014

www.DLWID.org

By: Paul Robertson, Lake Manager

Devils Lake Facts

- Average Depth
  - 8.4' = 2.6m
- Maximum Depth
  - 21.1' = 6.4m
- Surface Area
  - 685 acres = 277 ha
- Total Volume
  - 5,750 AF = 7.1e6 m3



Eilers, 2005 Bathymetry Data at 8.75' MSL

HABs 2008, 2009, 2010, 2011

Official Bloom Years: 2008, 2009, 2013

Map ID	Station	ID	2008												2009								2010							2011				
A	D River	DR-0								S		N	N		No	No	So	So	No	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
B	Campground	LZ-1					So	N	S	S		N	N	N	So	So	So	So	No	S	S	N	N	N	N	V	V	V	N	N	N	V	V	V
C	Regatta Grounds	LZ-2	4,	2			He	N	N	S		N	S	N	M	So	So	So	No	N	N	N	N	N	N	V	V	V	N	N	N	V	V	V
D	Holmes Road Park	LZ-3					He	N	N		S	S	N	N	So	So	So	So	No	S	M	N	N	N	N	N	N	V	N	N	N	N	N	V
E	Neotsu, K Street	LZ-5																					N	N	N	N	N	V	N	N	N	N	N	V
E	Sand Point	LZ-4	1,	3			So	N	N		S	N	N	N	No	No	So	So	No	N	S	N	N	N	N	N	V	V	N	N	N	N	V	V
F	East D.L. State Park	LZ-6	1				No	N	N		S	S	N	N	No	So	So	So	No	S	N	N	N	N	N	V	V	V	N	N	N	V	V	V
1	Mid Lake	PZ-1					M	N					N		No	No	No	No	No	M	N	N	N	N	N	V	V	V	N	N	N	V	V	V
2	NE Arm	PZ-2					So	N							No	No	No	No	No	N	S	N	N	N	N	V	V	V	N	N	N	V	V	V
3	NW Arm	PZ-3					No	N					N		No	No	No	No	No	N	N	N	N	N	N	V	V	V	N	N	N	V	V	V
4	Southern End	PZ-4					So								No	No	No	No	No	N	N	N	N	N	N	V	V	V	N	N	N	V	V	V
5	East Thumb	PZ-5													No	No	So	So	No	N	N	N	N	N	N	V	V	V	N	N	N	V	V	V
6	Deepest Point	PZ-6											N		No	No	No	No	No	S	S	N	N	N	N				N	N	N			
Microcystin Concentration																																		
A	D River	DR-0								=		<	<						< 0	= 0	= 0						< 0	< 0					< 0	< 0.75
B	Campground	LZ-1				=	=	<	>	>		<	<	=					= 5	= 3	= 2						< 0	< 0					< 0	< 0.75
C	Regatta Grounds	LZ-2	=	>	>		=	<			>	=		=					= 7	= 2	= 2						< 0	< 0					< 0	< 0.75
D	Holmes Road Park	LZ-3			= 0	>	=	=			=	=	<	=					= 7		= 3						< 0	< 0					< 0	< 0.75
E	Neotsu, K Street	LZ-5	=			= 0																					< 0	< 0					< 0	< 0.75
F	Sand Point	LZ-4	=	=	= 7	=	=	<			>	=	<	=					= 3	= 2	= 3						< 0	< 0					< 0	< 0.75
G	East D.L. State Park	LZ-6		=	=	=	=	<			=	=	<	=					= 4	= 2	= 2						< 0	= 0					< 0	= 0.80
1	Mid Lake	PZ-1					=	<					<						= 1	= 2	= 0						< 0	< 0					< 0	< 0.75
2	NE Arm	PZ-2					=	<											= 1	= 4	= 2						< 0	< 0					< 0	< 0.75
3	NW Arm	PZ-3					=	<					<						= 3	= 4	= 2						< 0	< 0					< 0	< 0.75
4	Southern End	PZ-4					=												< 0	= 3	= 2						< 0	< 0					< 0	< 0.75
5	East Thumb	PZ-5																	= 2	= 3	= 3						< 0	< 0					< 0	< 0.75
6	Deepest Point	PZ-6											<						= 1	= 4	= 2													

2010 Estimated, Bloom did occurred after summer season but is not shown

HABs 2012, 2013, 2014

Official Bloom Years: 2008, 2009, 2013

Map ID	Station	ID	2012								2013 Observations - Cell Counts																												2014					
A	D River	DR-0	No	No	No	No	No	V	V	V	No	No	No	No	No	No	No	No	V	V	V	V	Vi	Vi	Vi	Vi	Vi	Vi	Vi	Vi	Vi	V	V	Vi	V	V	Vi	Vi	Vi	Vi	No	No	No	V	V
B	Campground	LZ-1	No	Sli	V	V	Vi	V	V	V	No	No	No	V	V	V	V	No	V	V	V	V	Vi	Vi	V	Vi	Vi	Vi	Vi	Vi	Vi	No	No	Vi	Vi	V	Vi	Vi	Vi	Vi	No	No	No	V	V
C	Regatta Grounds	LZ-2	No	Sli	V	V	Vi	V	V	V	No	No	No	No	V	V	V	V	V	V	V	V	Vi	Vi	Vi	Vi	Vi	Vi	Vi	Vi	Vi	Vi	Vi	Vi	Vi	V	Vi	Vi	Vi	Vi	No	No	No	V	V
D	Holmes Road Park	LZ-3	No	No	No	V	Vi	V	V	V	No	No	No	No	V	No	V	V	V	V	V	V	Vi	Vi	V	Vi	Vi	N	N	Vi	Vi	Vi	Vi	Vi	Vi	V	N	N	N	Vi	V	V	No	V	V
E	Neotsu, K Street	LZ-5	No	No	No	V	Vi	V	V	V	No	No	V	No	No	V	V	V	V	V	V	V	V	Vi	V	Vi	Vi	Vi	Vi	Vi	Vi	Vi	Vi	Vi	Vi	V	Vi	Vi	Vi	Vi	V	No	No	V	V
E	Sand Point	LZ-4	No	No	No	V	Vi	V	V	V	No	No	No	No	No	V	V	V	V	V	V	V	Vi	Vi	Vi	Vi	Vi	Vi	Vi	Vi	Vi	V	V	Vi	Vi	V	Vi	Vi	Vi	Vi	V	No	No	V	V
F	East D.L. State Park	LZ-6	No	Sli	V	V	Vi	V	V	V	No	No	No	No	V	V	V	V	V	V	V	V	42	86	Vi	Vi	Vi	N	N	Vi	Vi	N	Vi	Vi	Vi	V	N	N	N	Vi	No	No	No	V	V
1	Mid Lake	PZ-1	No	No	No	V	Vi	V	V	V	No	No	No	No	No	V	V	V	V	V	V	V	V	18	Vi	Vi	Vi	Vi	Vi	Vi	Vi	Vi	N	Vi	Vi	V	Vi	Vi	Vi	Vi	11	11	11	1	V
2	NE Arm	PZ-2	No	No	No	V	Vi	V	V	V	No	No	No	No	No	V	V	V	V	V	V	V	V	Vi	Vi	Vi	Vi	Vi	Vi	Vi	Vi	N	N	Vi	Vi	V	Vi	Vi	Vi	Vi	V	V	No	V	V
3	NW Arm	PZ-3	No	No	No	V	Vi	V	V	V	No	No	No	No	No	V	V	V	V	V	V	V	V	Vi	Vi	Vi	Vi	N	N	Vi	Vi	N	N	Vi	V	V	N	N	N	Vi	V	V	No	V	V
4	Southern End	PZ-4	No	No	No	V	Vi	V	V	V	No	No	No	No	No	V	V	V	V	V	V	V	V	Vi	Vi	Vi	Vi	N	N	Vi	Vi	N	N	Vi	Vi	V	N	N	N	Vi	No	No	No	V	V
5	East Thumb	PZ-5	No	No	No	V	Vi	V	V	V	No	No	No	No	No	V	V	V	V	V	V	V	26	Vi	Vi	Vi	Vi	N	N	Vi	Vi	N	N	Vi	V	V	N	N	N	Vi	V	V	No	V	V
6	Deepest Point	PZ-6																																										
Microcystin Concentration																																												
A	D River	DR-0				lid	Da	0.7	Da	0.75	Not	Tes	Tes	Tes	Tes	Tes	Tes	Tes	Tes	Tes	< 0	0.7	0.7	25.	11.	2.3	12.	10.	Da	Da	Da	Da	Da	Da	0.7	Data				No	Da	Da	Da	Da	Da
B	Campground	LZ-1				lid	Da	0.7	##	0.75	Not	Tes	Tes	Tes	Tes	Tes	Tes	Tes	Tes	Tes	< 0	0.7	##	##	9.6	5.1	19.	Da	Da	Da	Da	Da	Da	5.7	Data				No	Da	Da	Da	Da	Da
C	Regatta Grounds	LZ-2				lid	Da	0.7	##	##	Not	Tes	Tes	Tes	Tes	Tes	Tes	Tes	Tes	Tes	< 0	##	25.	25.	16.	8.4	6.4	10.	5.0	10.	Da	Da	Da	5.0	3.6	Data				No	Da	1.0	1.0	Da	Da
D	Holmes Road Park	LZ-3				lid	Da	0.7	0.7	0.75	Not	Tes	Tes	Tes	Tes	Tes	Tes	Tes	Tes	Tes	< 0	0.7	25.	##	11.	3.3	20.	10.	Da	Da	Da	5.0	Da	Da	2.6	Data				No	Da	1.0	1.0	Da	Da
E	Neotsu, K Street	LZ-5				lid	Da	0.7	0.7	0.75	Not	Tes	Tes	Tes	Tes	Tes	Tes	Tes	Tes	Tes	< 0	0.7	##	N/A	7.7	2.8	14.	10.	Da	Da	Da	Da	Da	Da	7.0	Data				No	Da	1.0	1.0	Da	Da
F	Sand Point	LZ-4				lid	Da	0.7	0.7	0.75	Not	Tes	Tes	Tes	Tes	Tes	Tes	Tes	Tes	Tested	< 0	##	25.	##	6.3	3.7	3.5	Da	Da	Da	Da	Da	Da	Da	2.1	Data				No	Da	1.0	1.0	Da	Da
G	East D.L. State Park	LZ-6				lid	Da	0.7	##	##	Not	Tes	Tes	Tes	Tes	Tes	Tes	Tes	Tes	Tested	< 0	0.7	25.	##	9.1	1.5	5.7	Da	10.	Da	2.5	Da	2.5	0.7	0.15				No	Da	0.1	0.1	Da	Da
1	Mid Lake	PZ-1				lid	Da	0.7	0.7	0.75	Not	Tes	Tes	Tes	Tes	Tes	Tes	Tes	Tes	Tested	< 0	0.7	##	##	6.0	2.3	3.8	10.	Da	Da	Da	Da	Da	Da	1.1	Data				No	Da	Da	1.0	Da	Da
2	NE Arm	PZ-2				lid	Da	0.7	0.7	0.75	Not	Tes	Tes	Tes	Tes	Tes	Tes	Tes	Tes	Tested	< 0	0.7	##	##	8.2	2.6	16.	Da	Da	Da	Da	Da	Da	Da	1.3	Data				No	Da	Da	1.0	Da	Da
3	NW Arm	PZ-3				lid	Da	0.7	0.7	0.75	Not	Tes	Tes	Tes	Tes	Tes	Tes	Tes	Tes	Tested	< 0	0.7	25.	25.	9.8	0.7	6.9	Da	Da	Da	Da	Da	Da	Da	0.7	Data				No	Da	Da	1.0	Da	Da
4	Southern End	PZ-4				lid	Da	0.7	0.7	0.75	Not	Tes	Tes	Tes	Tes	Tes	Tes	Tes	Tes	Tested	< 0	0.7	25.	##	8.9	6.3	10.	10.	Da	5.0	Da	Da	Da	Da	0.7	Data				No	Da	Da	1.0	Da	Da
5	East Thumb	PZ-5				lid	Da	0.7	0.7	0.75																													No	Data				

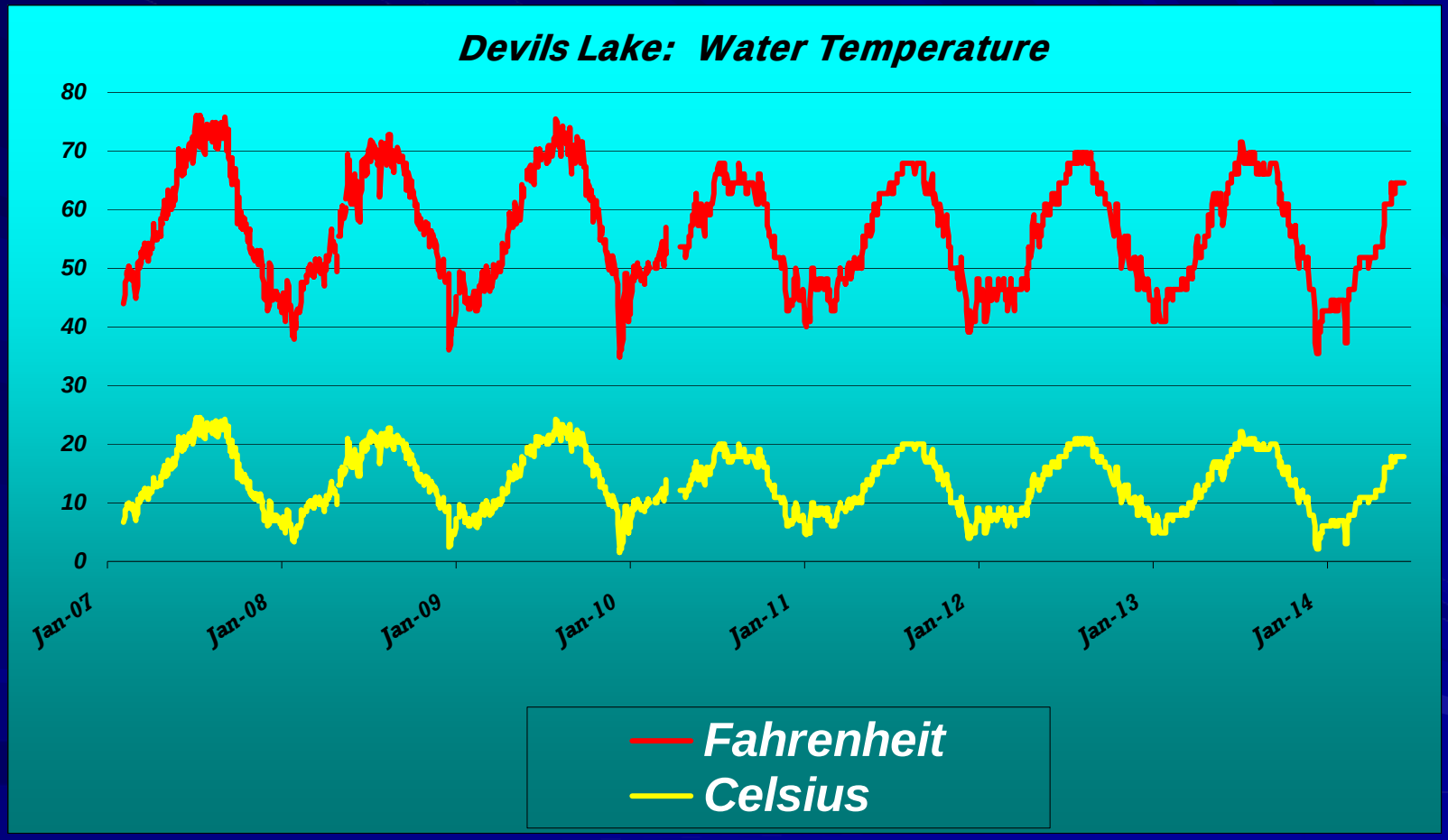
2013 Bloom: Officially Aug 1- Nov 21

2014 Bloom : Mid January as estimated to present

Jan 15, 2014: 45F and 9.52'

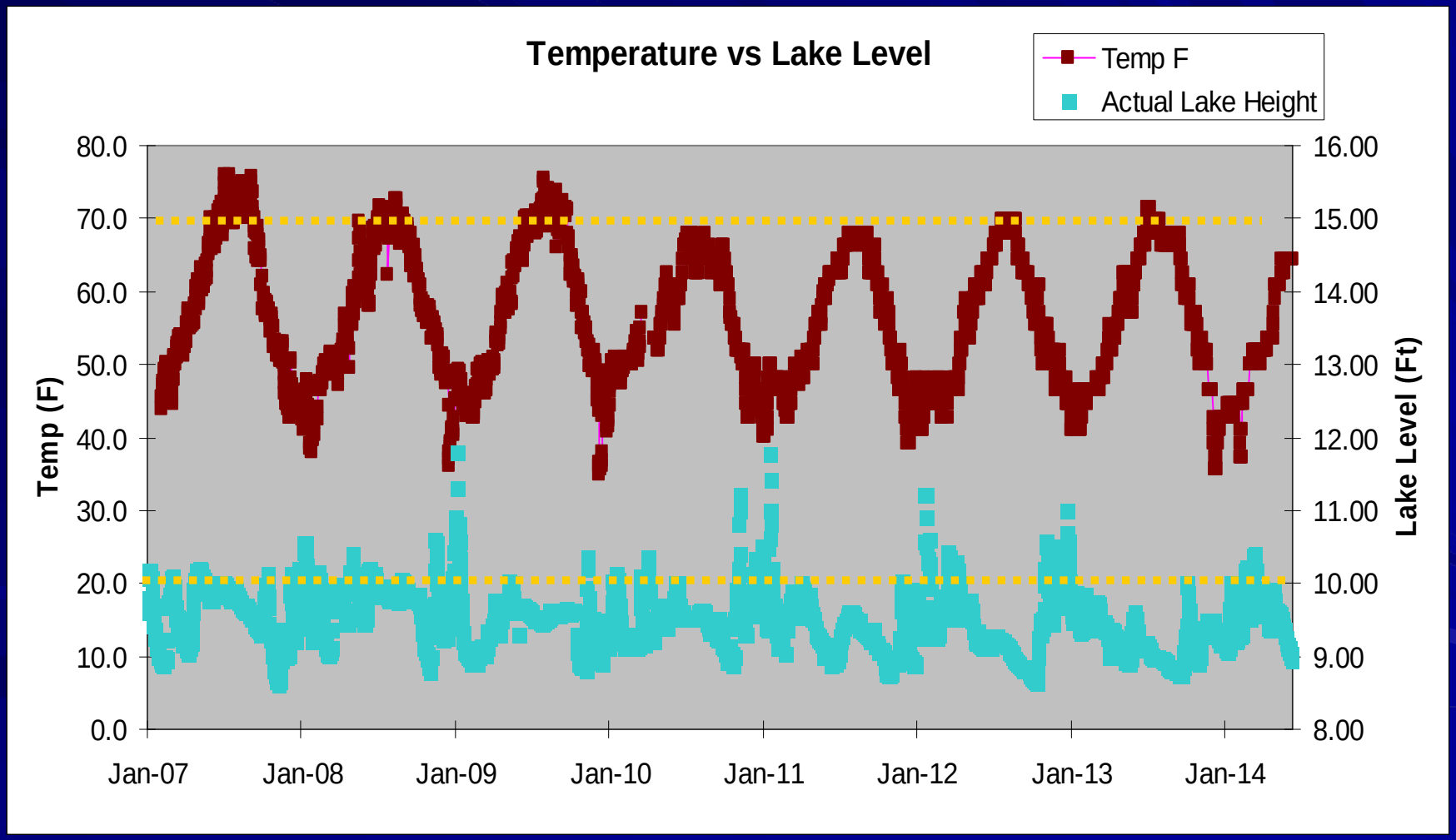
April 9, 2014: 52F and 9.70'

Temperature 2007-2014

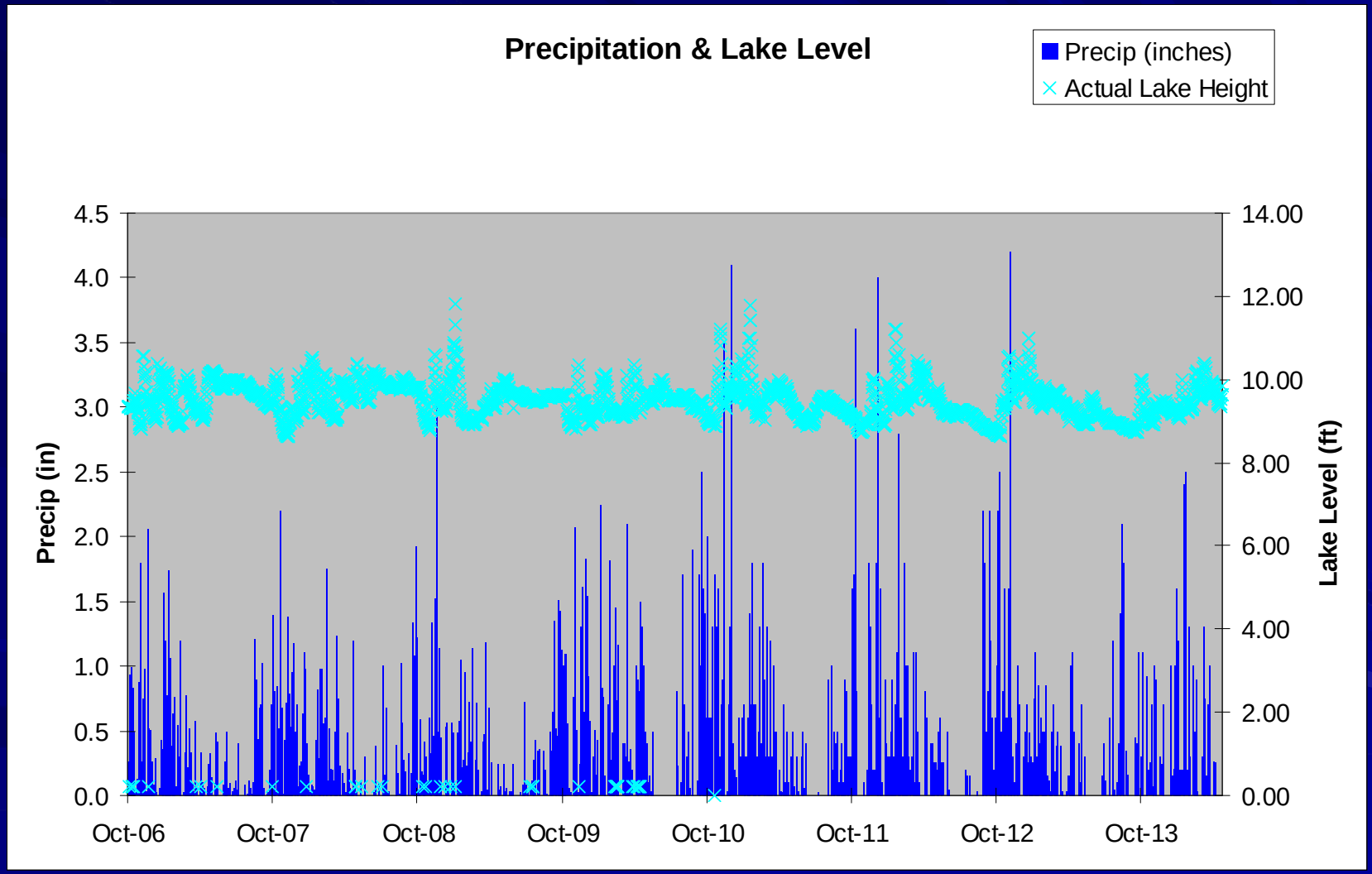


Official Bloom Years: 2008, 2009, 2013

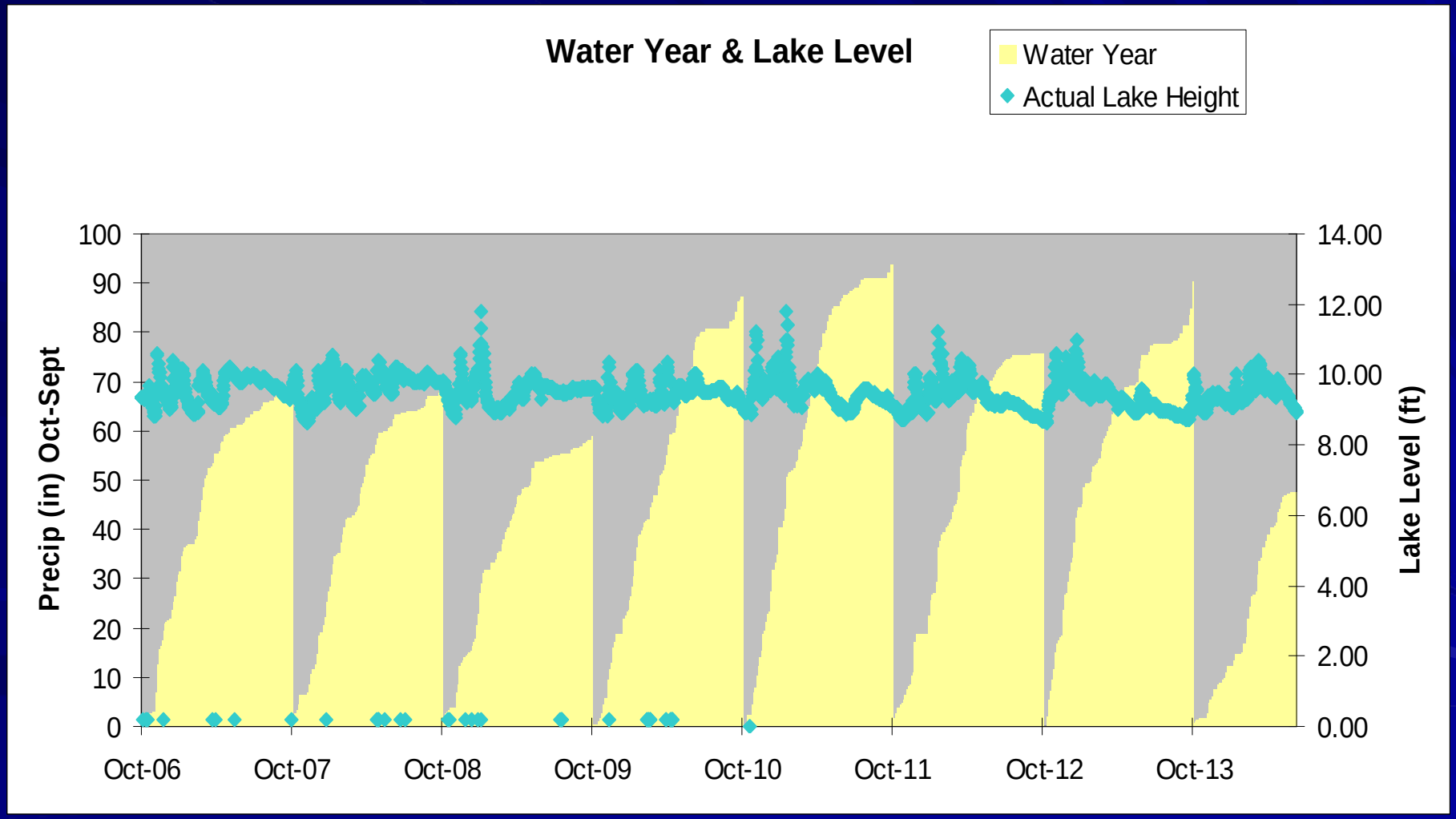
Temperature vs. Lake Level 2007 to 2014



Precipitation & Lake Level

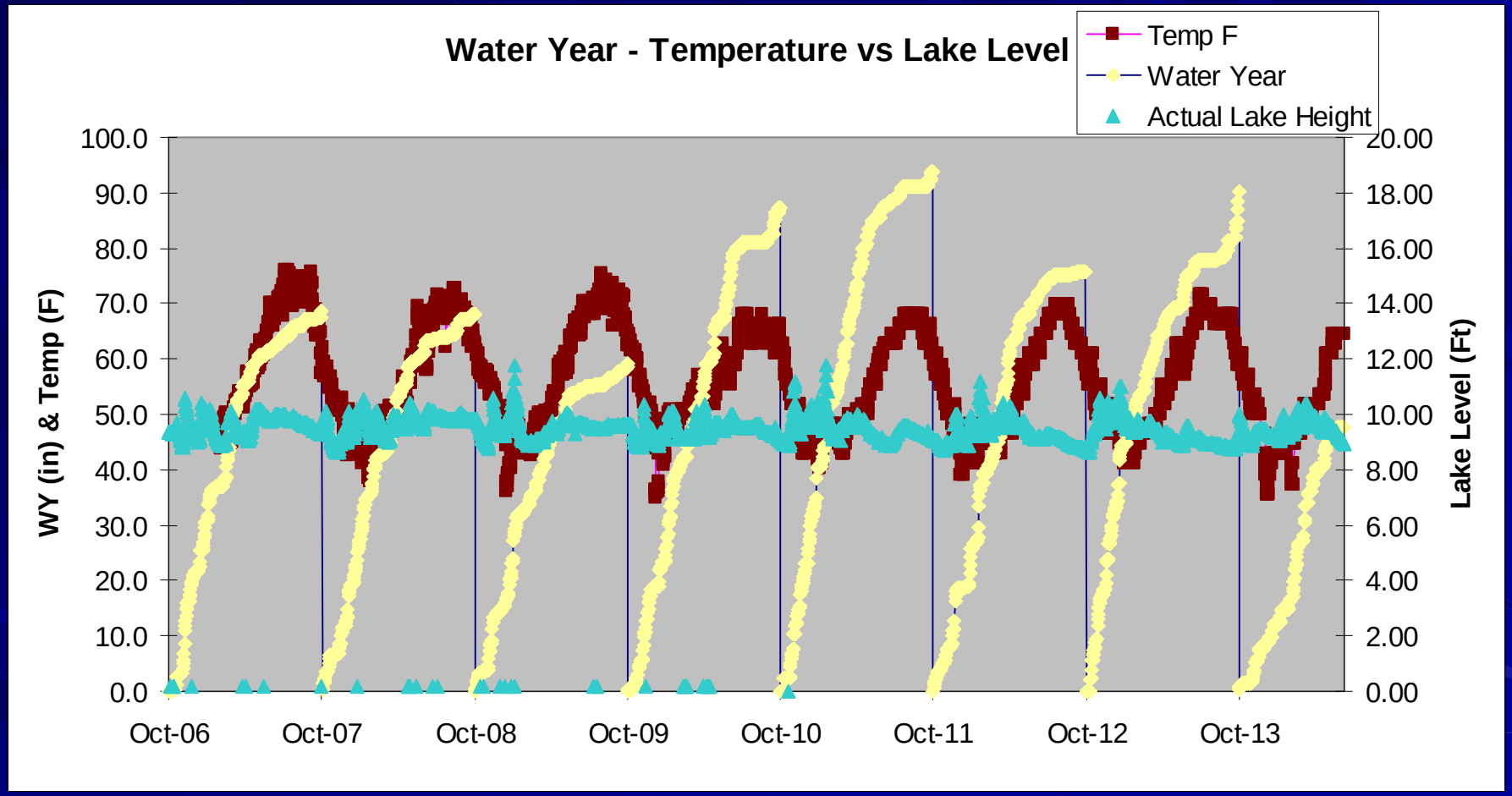


Water Year & Lake Level



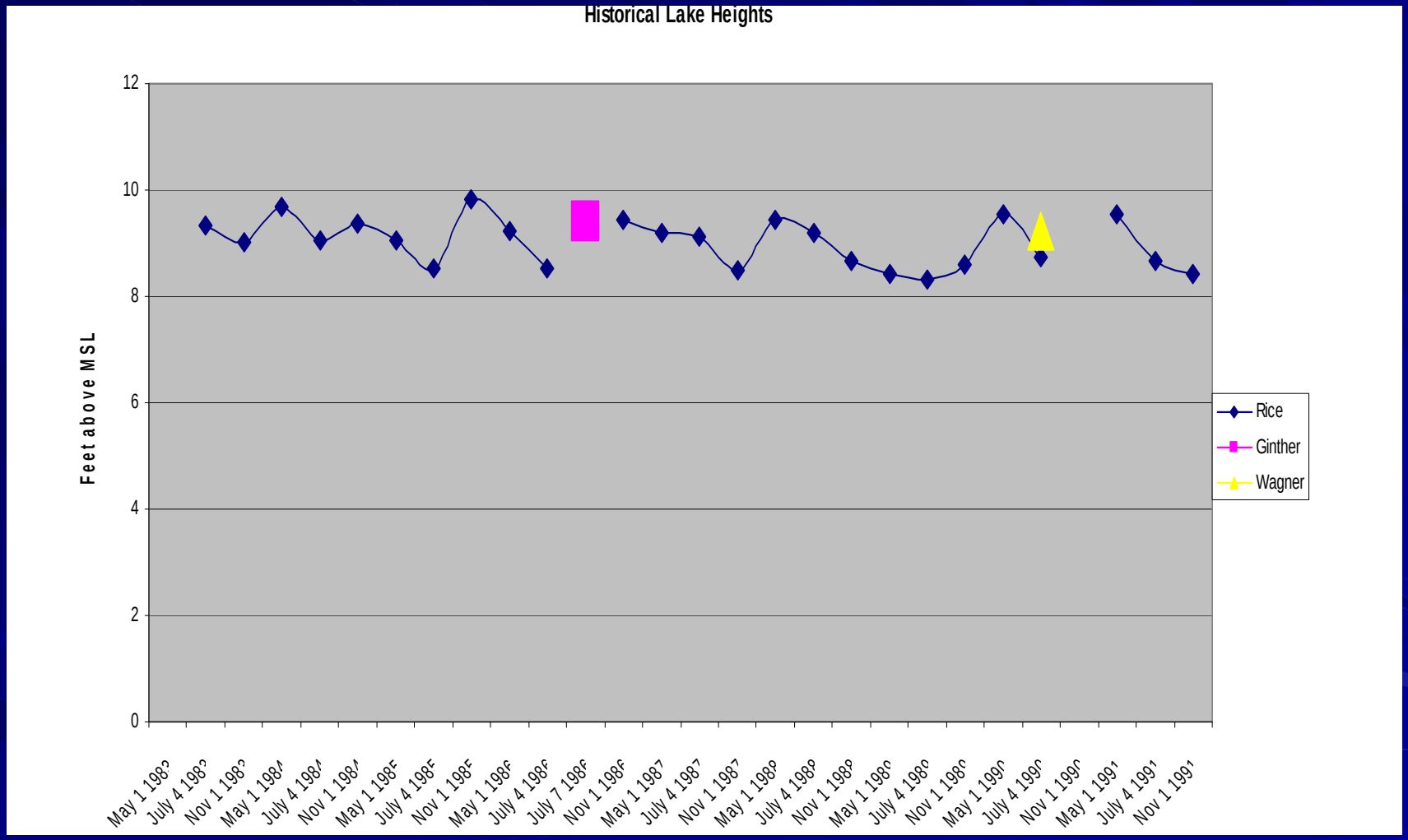
Official Bloom Years: 2008, 2009, 2013

WY –Temp & Lake Level

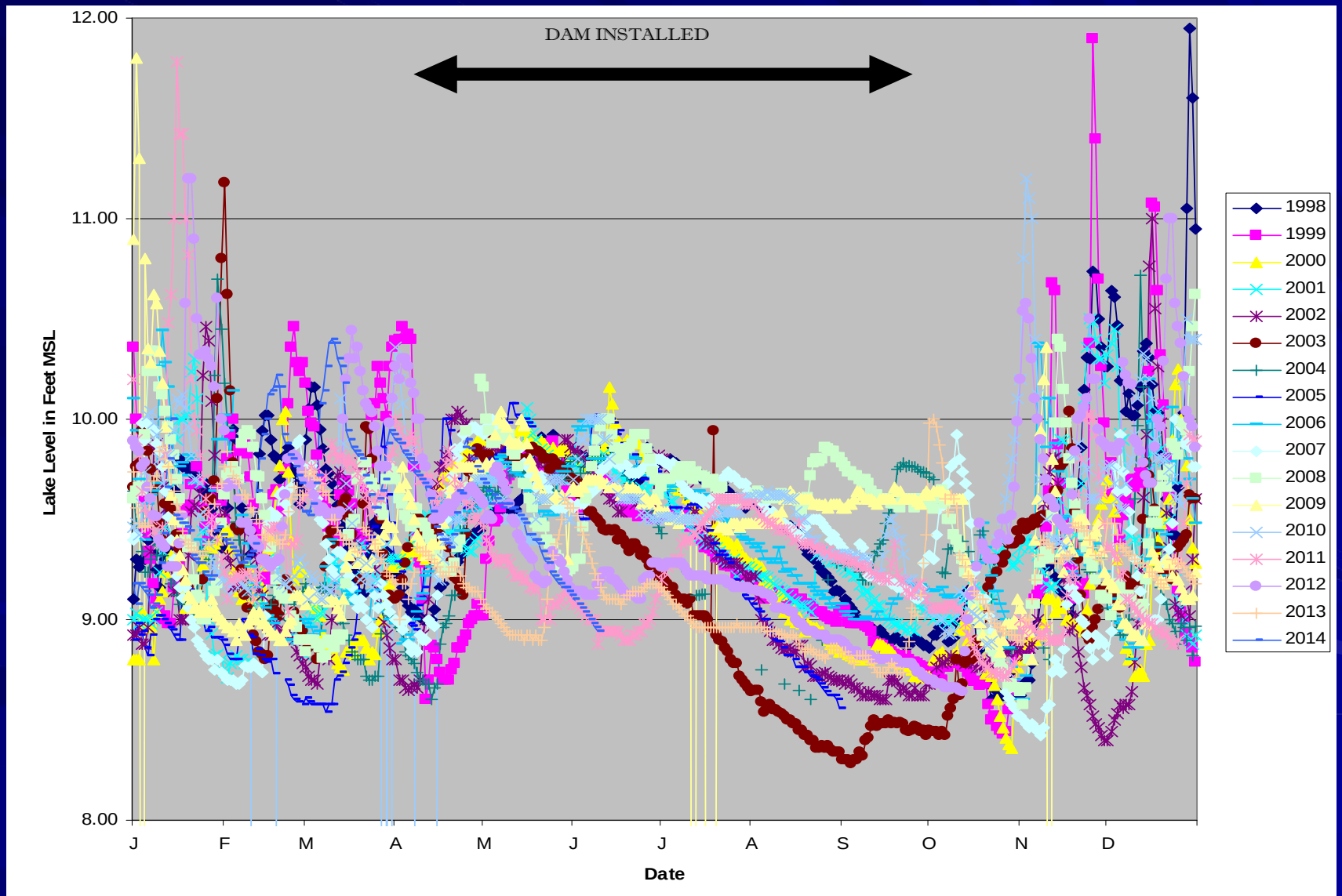


Official Bloom Years: 2008, 2009, 2013

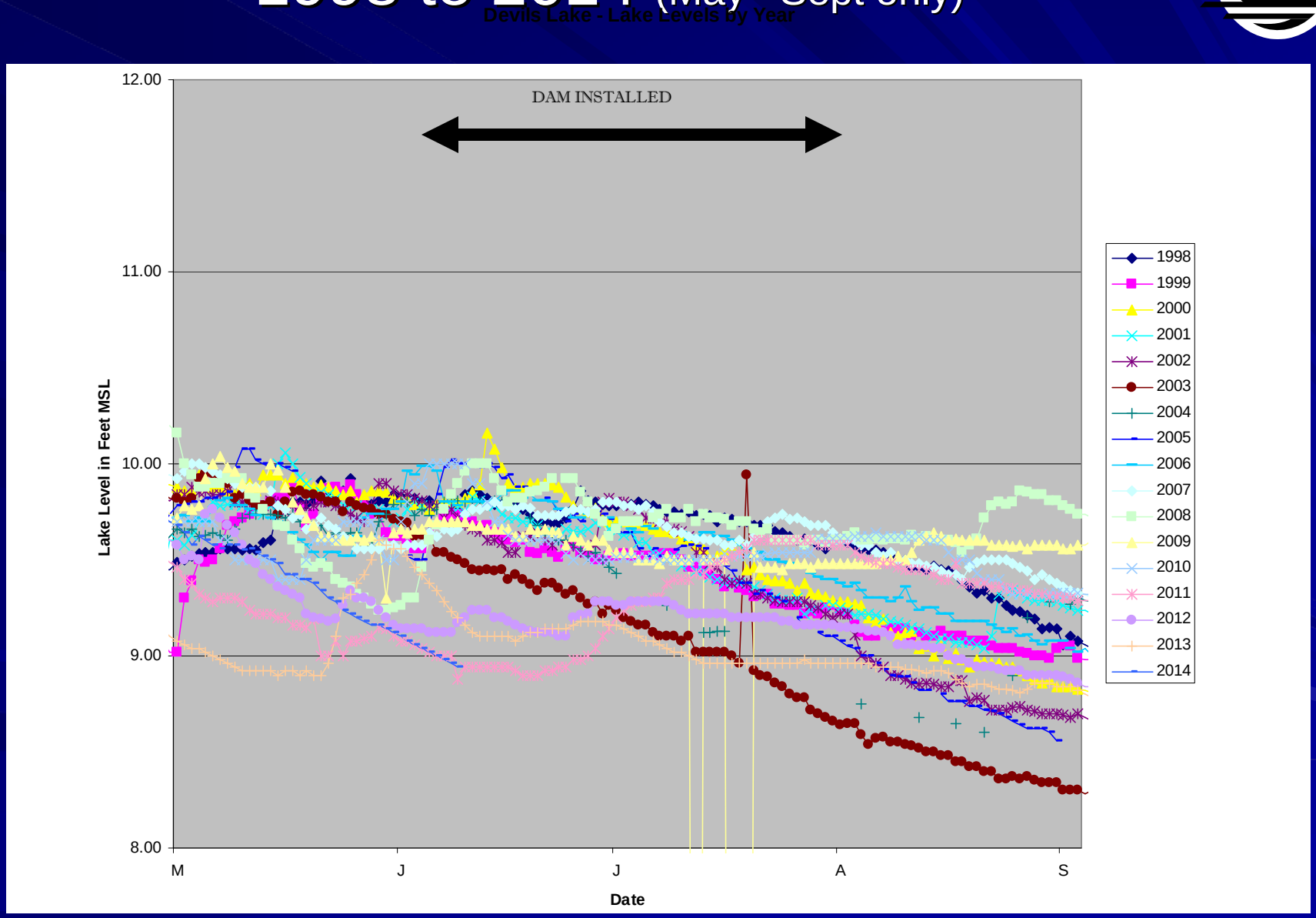
Pre Dam Records of Lake Level 1983-1991: May 1st , July 4th , Nov 1st



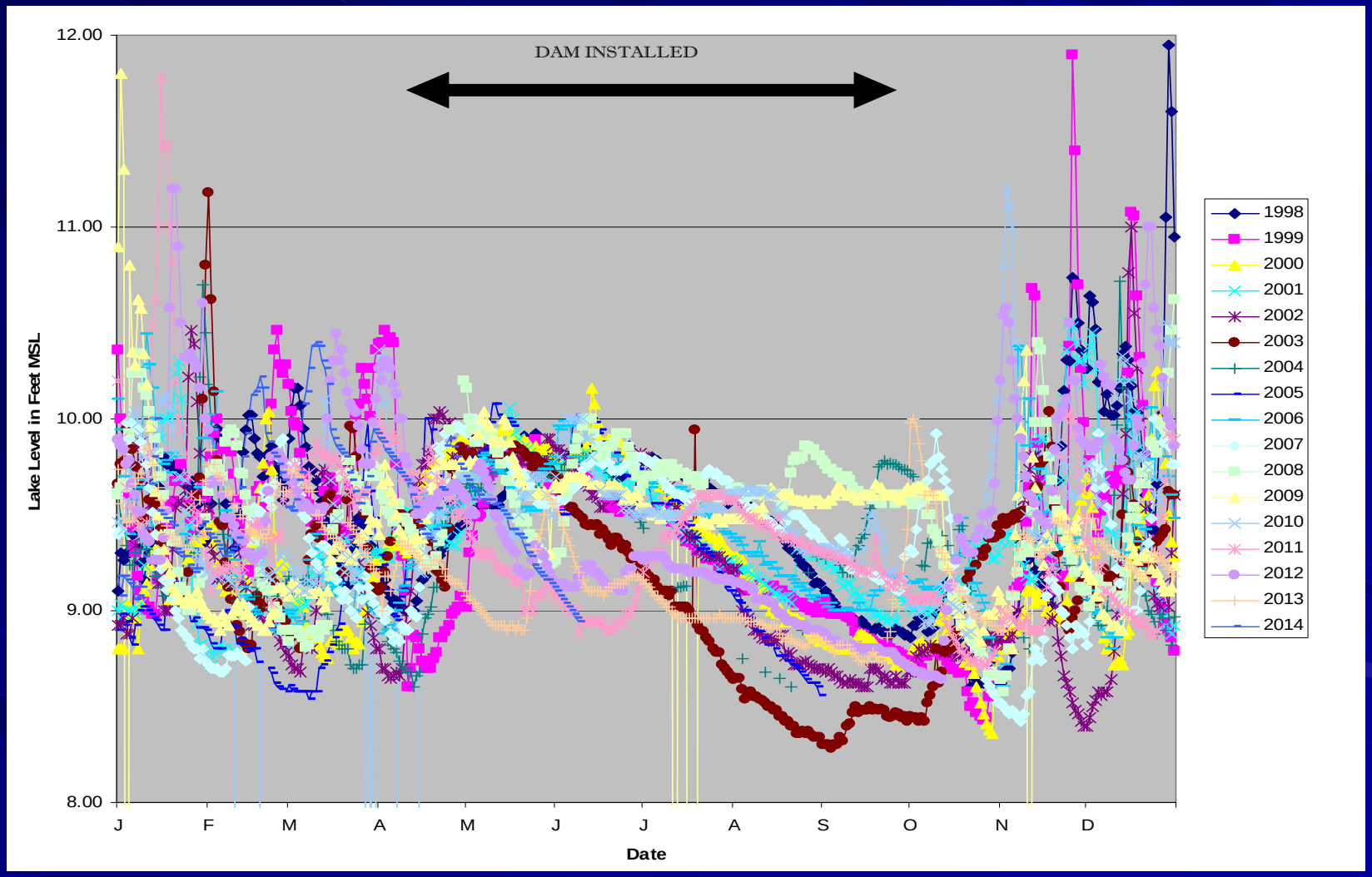
Post Dam Records of Lake Level 1998 to 2014



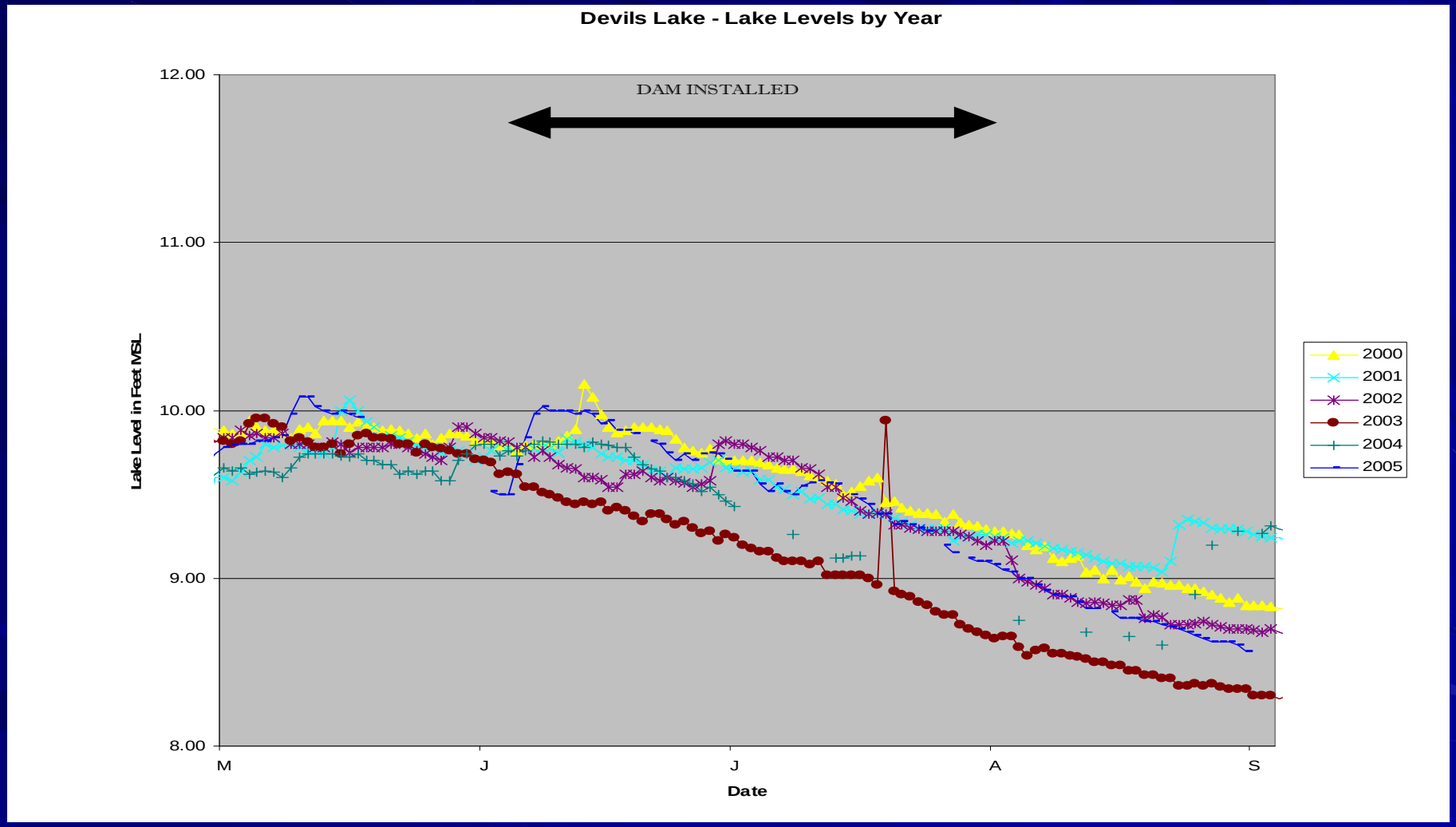
Post Dam Records of Lake Level 1998 to 2014 (May –Sept only)



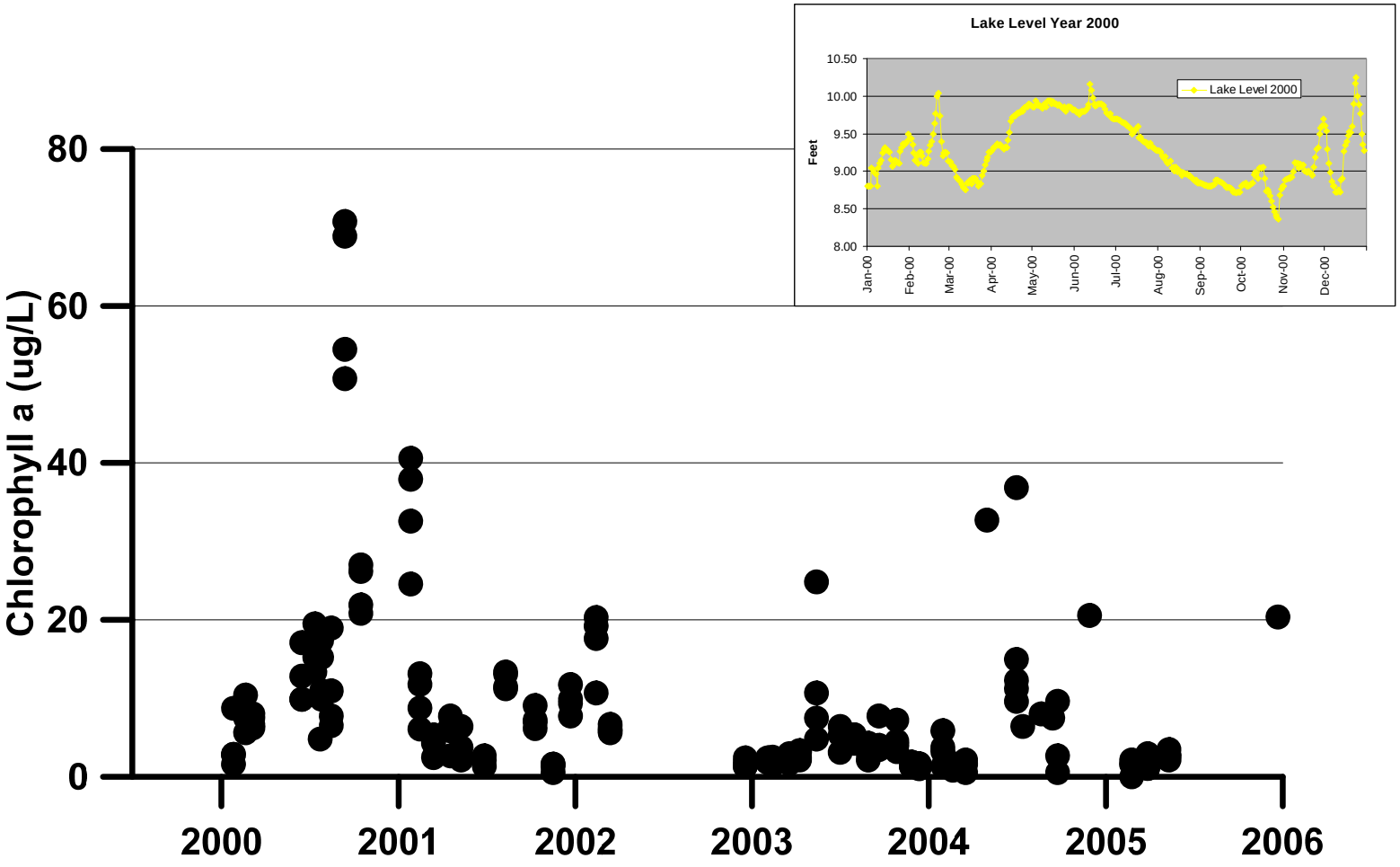
Lake Level 1998 to 2014



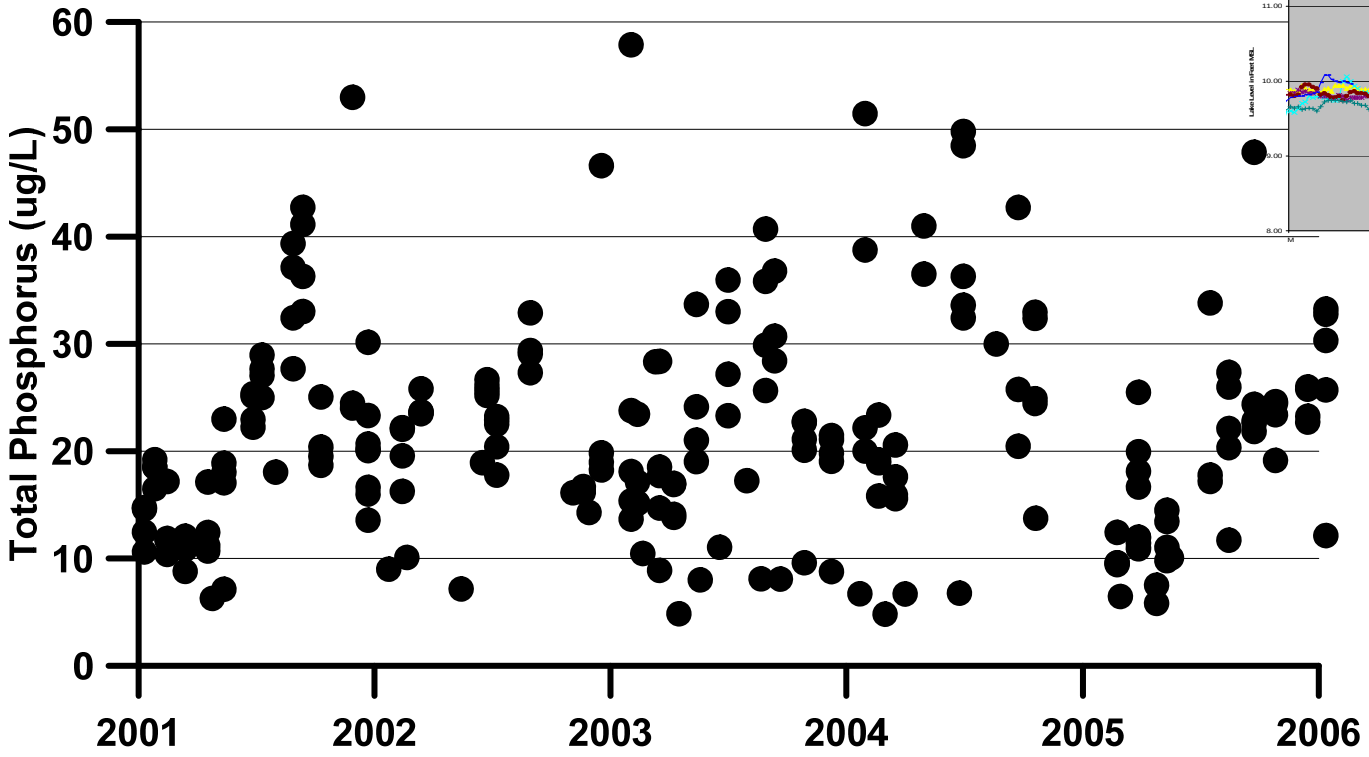
Lake Level 2000-2005 (May-Sept)

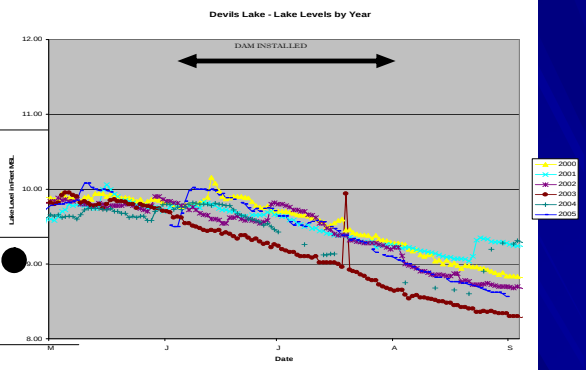


Chlorophyll a & 2000 Lake Level



Phosphorus Lake Level





Modified from Eilers et.al, 2005

Sediment Accumulation Rate

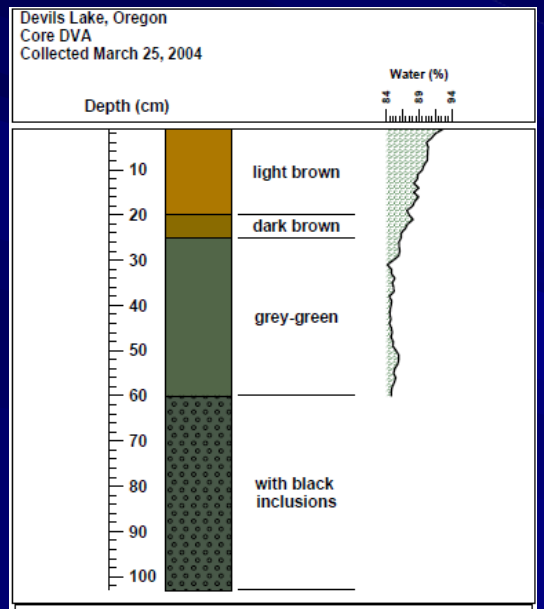


Figure 4. Diagram of major visual demarcations in sediment core DVA from Devils Lake.

Sediment Core from Devils Lake

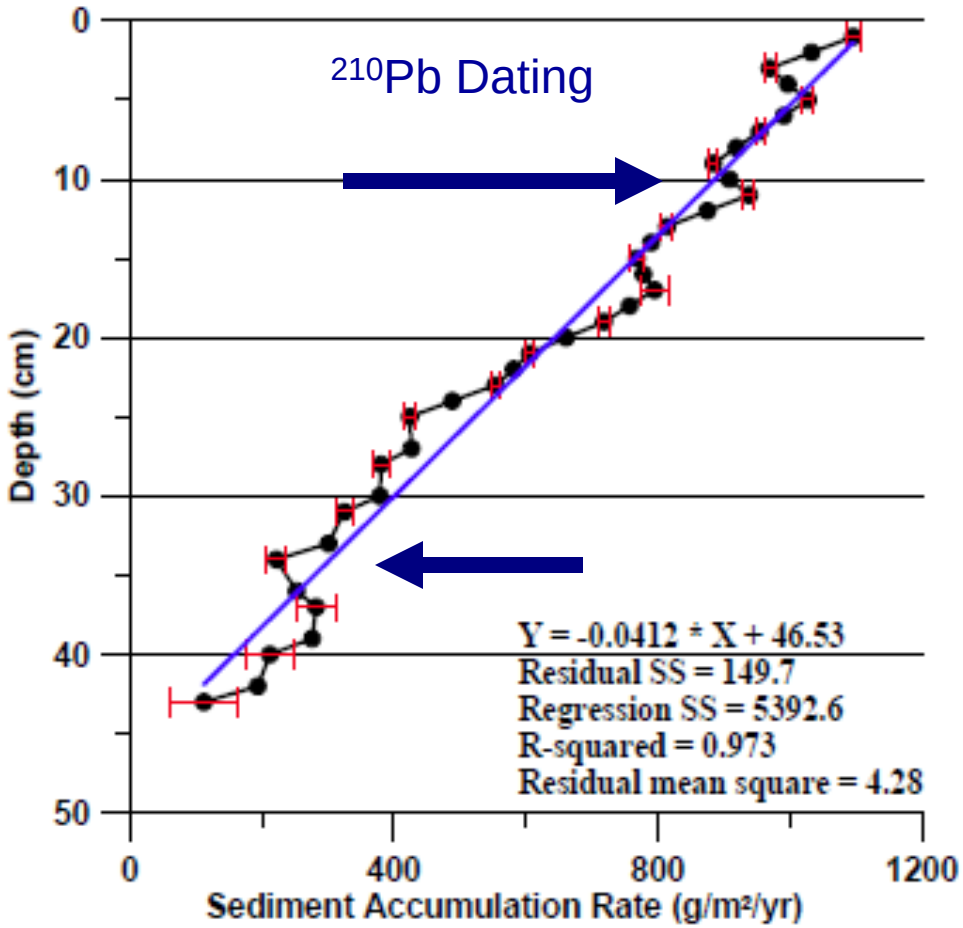


Figure 8. Sediment accumulation rate in Devils Lake based on ^{210}Pb dating. The blue line shows the best-fit linear regression.

Nutrients in Sediment

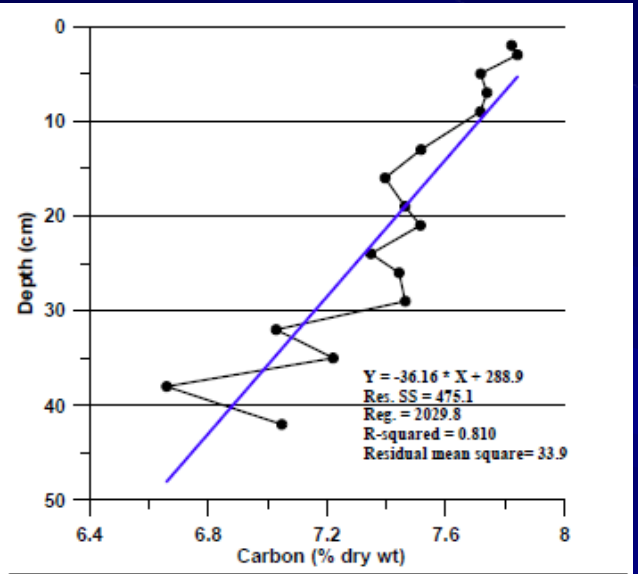


Figure 9. Carbon content in the sediments of Devils Lake. The blue line is the best-fit linear regression.

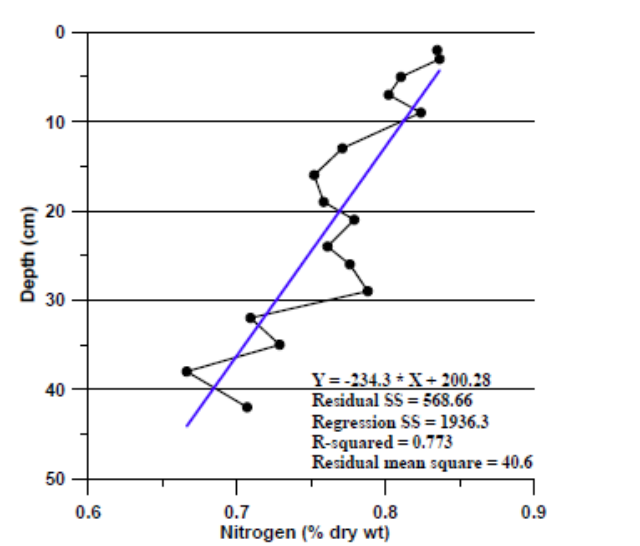


Figure 10. Nitrogen content in the sediments of Devils Lake. The blue line is the best-fit linear regression.

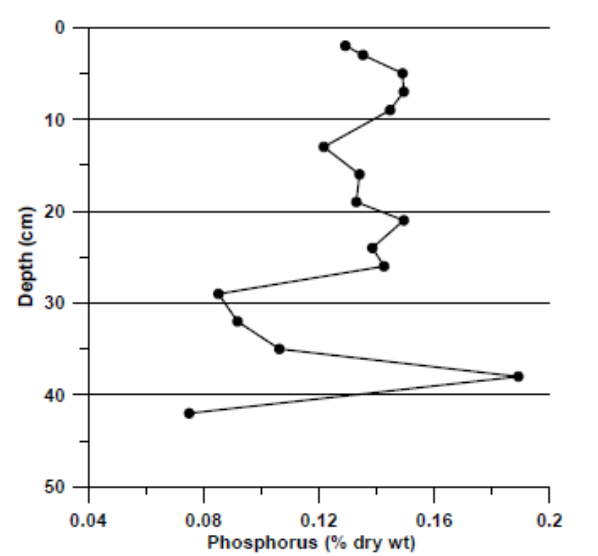
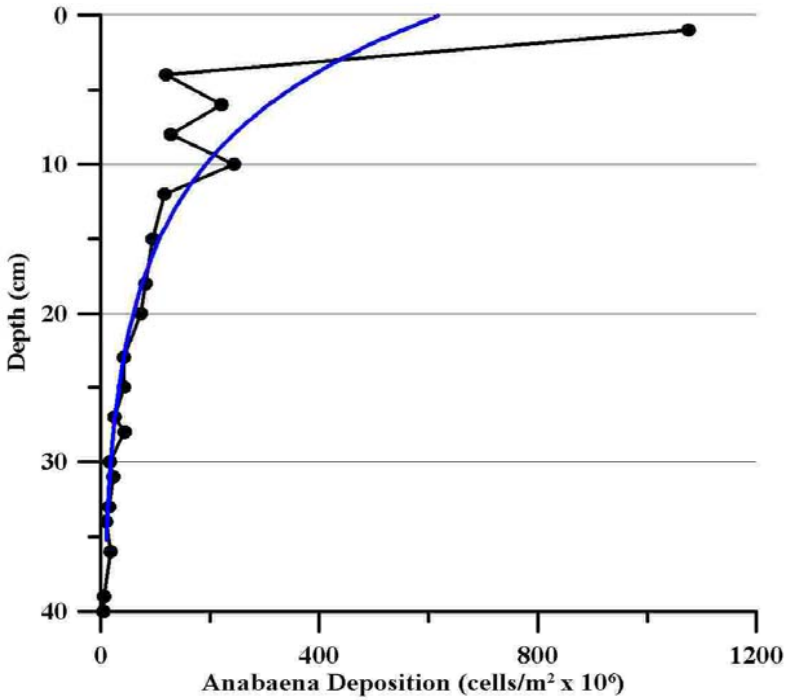


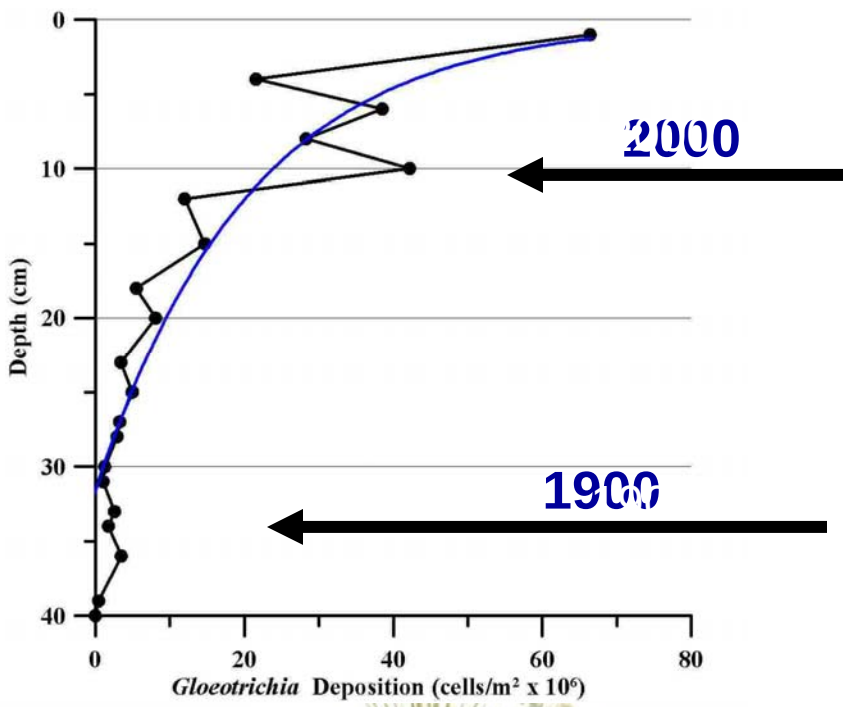
Figure 11. Phosphorus content in the sediments of Devils Lake.

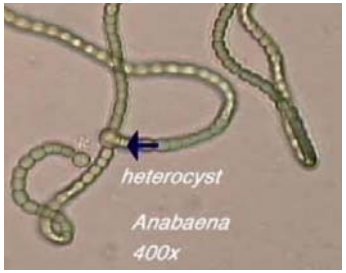
Carbon Nitrogen Phosphorus

Modified from Eilers et.al, 2005

Blue-Green Algae
(Exponential Growth)







^{210}Pb Dating

Modified from Eilers et.al, 2005

How To Reduce Algae (Cyanobacteria)?

Short Term

- Let grass carp die out
- Inactivate P with alum
- Increase flushing (steal water from Salmon River – just kidding!)
- Decrease residence time by keeping lake at minimum stage
- Increase shading with dyes
- Apply oxidants (sodium percarbonate)
- Aeration (for circulation)
- Introduce silver carp

Long Term

- Sewer lakeshore homes
- Increase wetlands
- Divert storm sewers/Detention basins
- Eliminate yard/lawn use of fertilizer applications in watershed (use lake water instead)
- Restore shoreline

Devils Lake
Water Improvement District

Brian Green

Kent Norris

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Kip Ward

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Lake Manager: Paul Robertson

Water Quality

- HABS – Low
- Lake Level – 8.9’ / 2.7M
- Temp – 64F / 18 C
- Clarity - Good

Regular Meeting: 2014-06-12