# Taste and Odor Relationships in North Texas Reservoirs

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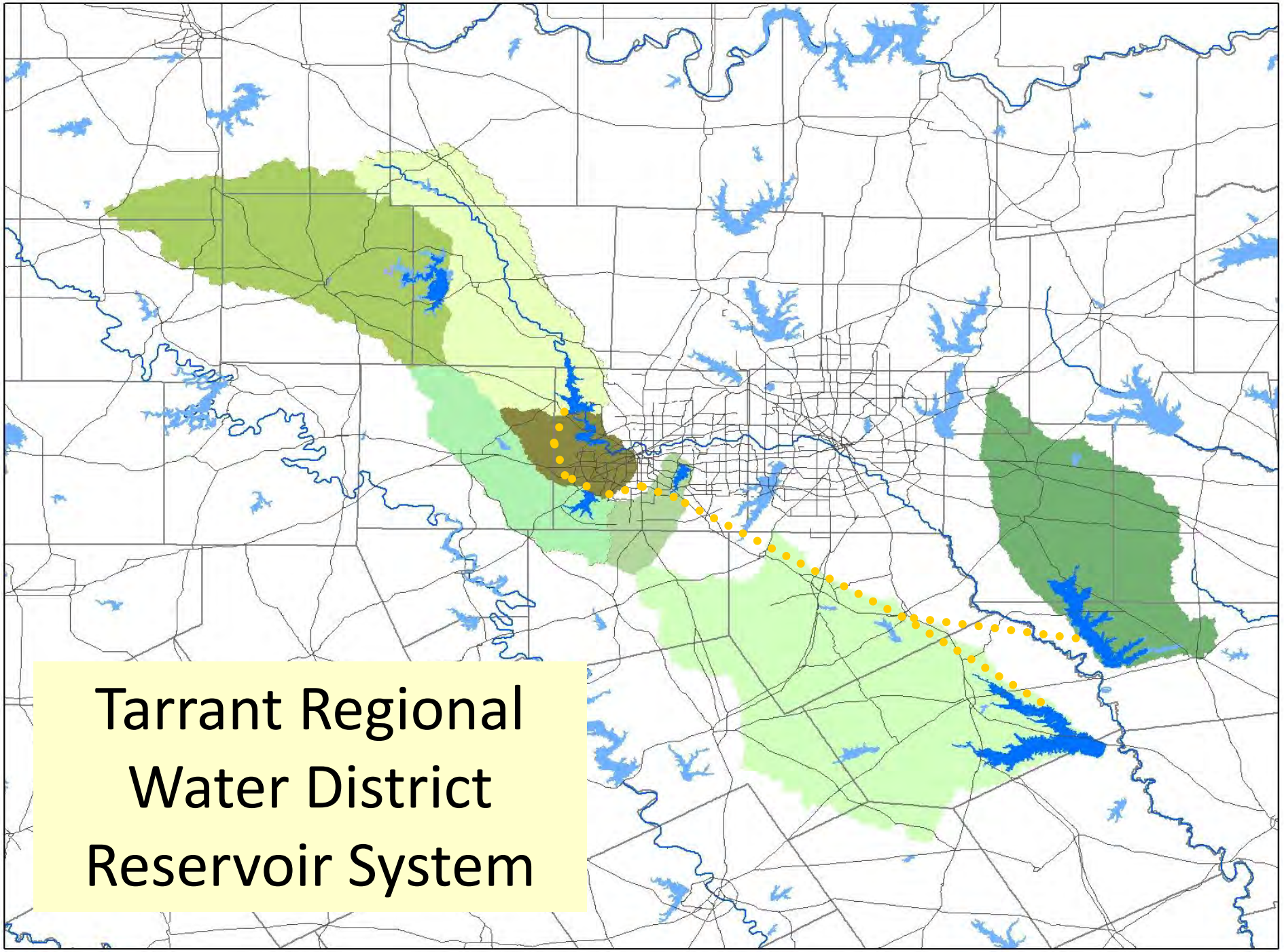
Tarrant Regional Water District


Tarrant Regional
Water District
Reservoir System

# Reservoir Facts

| | Lake Arlington | Benbrook Lake | Cedar Creek Lake | Eagle Mountain Lake | Richland - Chambers Lake | Lake Worth | Lake Palestine |
|---|---|---|---|---|---|---|---|
| **Year Constructed** | 3/31/1957 | 9/29/1952 | 7/2/1965 | 2/24/1934 | 7/17/1987 | 6/1/1914 | 6/13/1962 |
| | | | | | | | |
| **Conservation Pool (ft)** | 550 | 694 | 322 | 649.1 | 315 | 594 | 345 |
| | | | | | | | |
| **Conservation Volume (acre-feet)** | 38,800 | 88,250 | 637,200 | 178,400 | 1,137,000 | 37,070 | 373,202 |
| | | | | | | | |
| **Surface Area (acres)** | 1,939 | 3,635 | 32,623 | 8,738 | 41,356 | 3,458 | 22,656 |
| | | | | | | | |
| **Mean Depth (ft)** | 20 | 24 | 19.5 | 20 | 27.5 | 11 | 16.5 |
| | | | | | | | |
| **Drainage Area ($mi^2$)** | 143 | 429* | 1,007 | 1,970** | 1,957 | 2,064**** | 839 |

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# Study Objectives

- Alert for water treatment plants!
- When does the Geosmin peak?
- Which reservoirs have the highest Geosmin?
- Why do some reservoirs have high Geosmin?
- Is there a way to predict high Geosmin?

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# Sampling Protocol

- 7 Reservoir Intakes weekly from Nov-Mar
- Started in November 2003 (Pal added in 2011). 11 years of data.
- Geosmin, MIB run by CFW Water Lab
- Field data: Temp, DO, pH, SpC, Turb
- Lab Data: Algae Enumeration
- Hydrology: Res Elevation, Pipeline Inflow, Tributary Inflow

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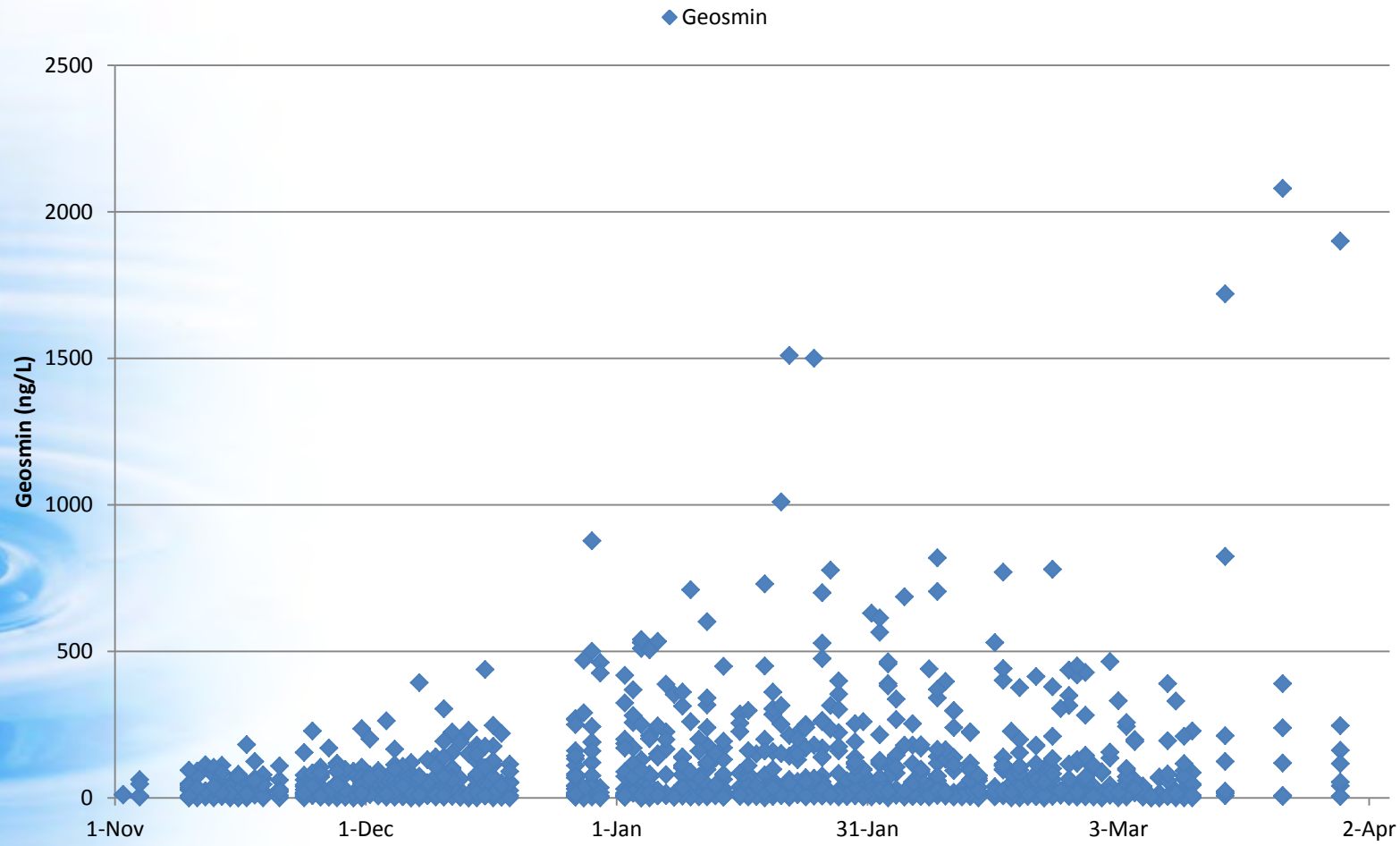
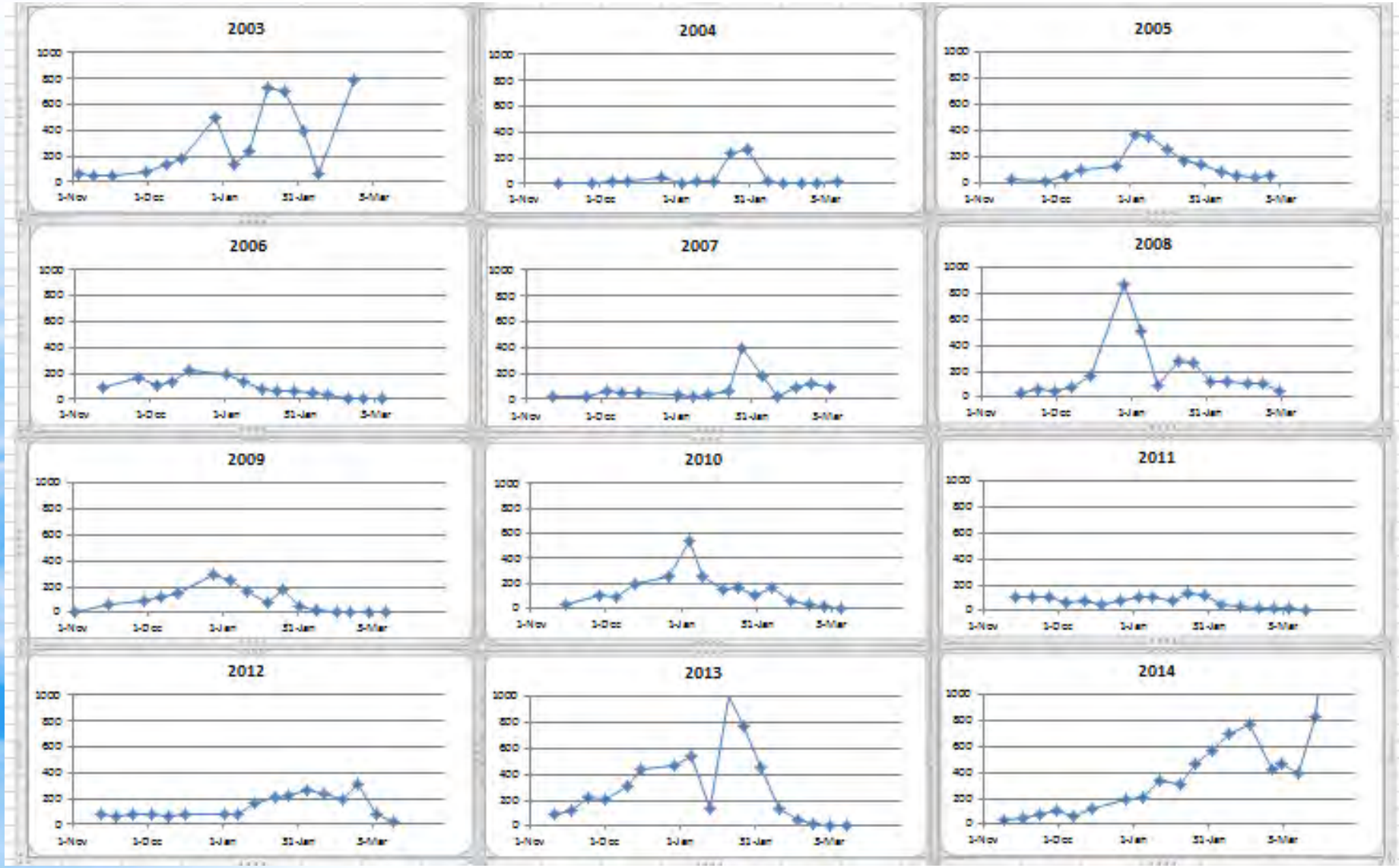
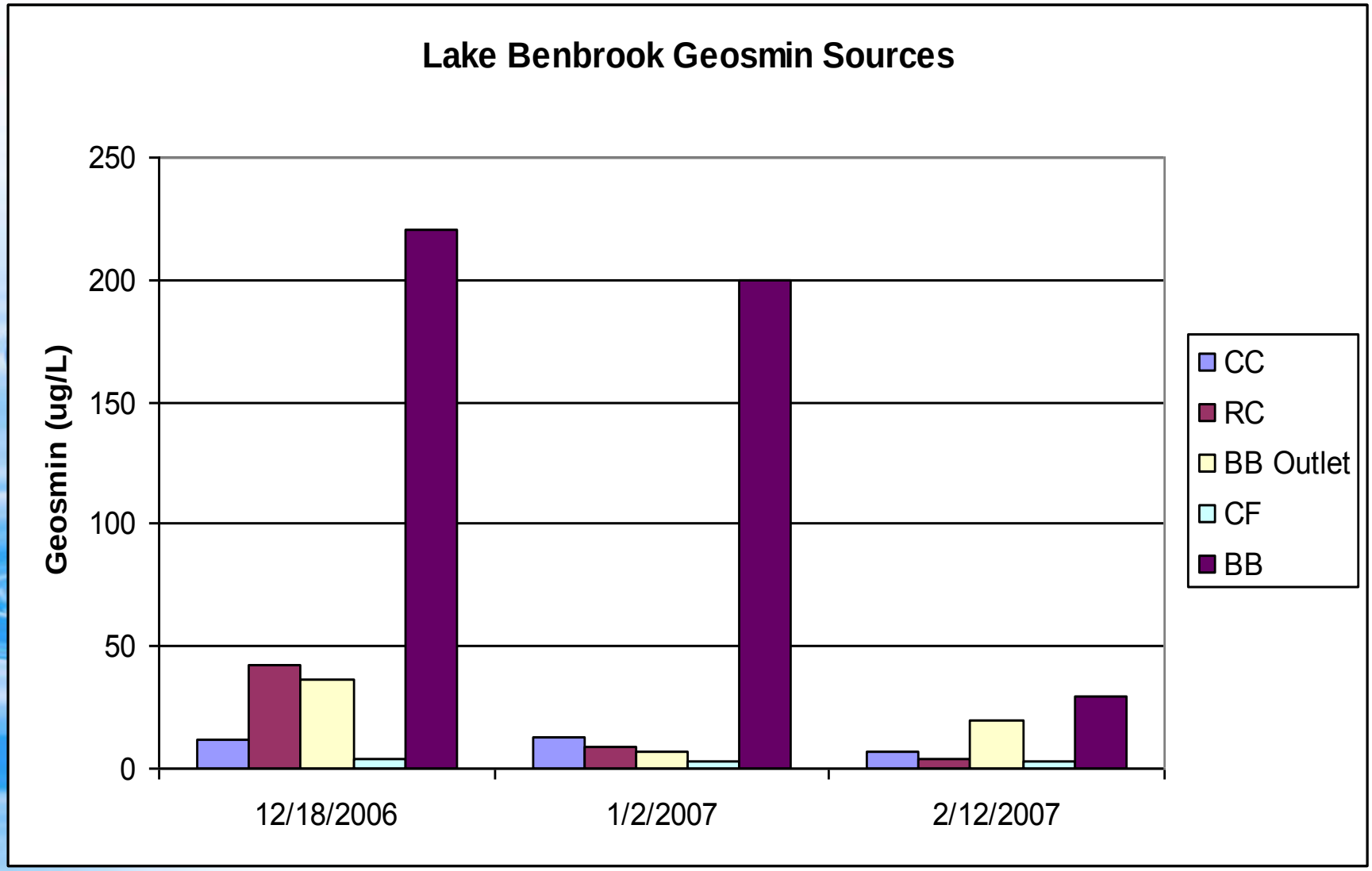
# Historic Geosmin
# 2003-2015



# Lake Benbrook Geosmin by Year




Lake Benbrook Geosmin Sources
Geosmin (ug/L)
250
200
150
100
50
0
12/18/2006
1/2/2007
2/12/2007
CC
RC
BB Outlet
CF
BB

# Geosmin Correlations
# Overall Medians for 6 years
# on 6 reservoirs (n = 6) red = p<0.05

| Variable | Units | r |
|---|---|---|
| Chl'a' | ug/L | 0.71 |
| Bluegreen algae | cells/ml | 0.88 |
| Total Algae | cells/ml | 0.77 |
| Diatoms | cells/ml | 0.47 |
| Temperature | C | -0.06 |
| Weekly Elevation Difference | ft | -0.85 |
| Feet < Conservation Pool | ft | 0.02 |
| Specific Conductance | umhos/cm | -0.09 |
| Turbidity | NTU | 0.38 |
| Variation in Elevation | Stdev | 0.82 |

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# Overall Correlations for each reservoir with 6 years of data

*n ~ 85, Red p<.01, Green p<.05*

| Variable | Units | AR | BB | CC | EM | LW | RC |
|---|---|---|---|---|---|---|---|
| Chl'a' | ug/L | 0.3674 | 0.1439 | 0.1568 | 0.1746 | -0.0500 | 0.2596 |
| Bluegreen algae | cells/ml | -0.1746 | 0.0141 | -0.0707 | 0.0985 | -0.1664 | 0.2085 |
| Total Algae | cells/ml | 0.1360 | 0.0424 | 0.0755 | 0.1431 | -0.1010 | 0.1879 |
| Diatoms | cells/ml | 0.4581 | 0.0632 | -0.1879 | 0.1726 | 0.0500 | 0.0300 |
| Temperature | C | 0.1431 | -0.2339 | 0.1562 | 0.0748 | -0.2377 | 0.0300 |
| Weekly Elevation Difference | ft | 0.2083 | -0.0479 | 0.0387 | 0.0479 | -0.0283 | 0.0557 |
| Feet < Conservation Pool | ft | 0.2749 | 0.1175 | 0.1010 | 0.3793 | 0.0721 | 0.0245 |
| Specific Conductance | umhos/cm | 0.1000 | -0.2093 | 0.1761 | 0.2260 | 0.3226 | 0.0100 |
| Turbidity | NTU | 0.0943 | -0.2715 | -0.1342 | 0.0400 | 0.2431 | 0.2220 |
| Weekly Pump from East TX | ac-ft | 0.0566 | 0.3243 | | | | |
| Daily Pump from East TX | ac-ft | 0.1153 | 0.2689 | | | | |
| Weekly Watershed Inflow | ac-ft | -0.2197 | -0.1565 | | | | |

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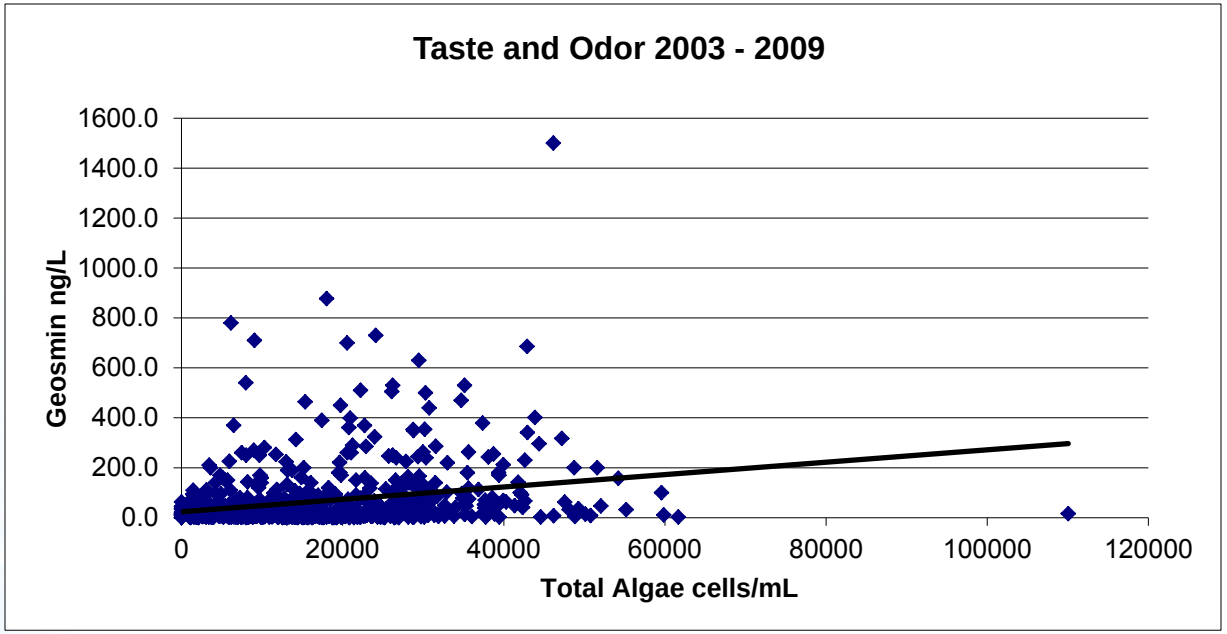
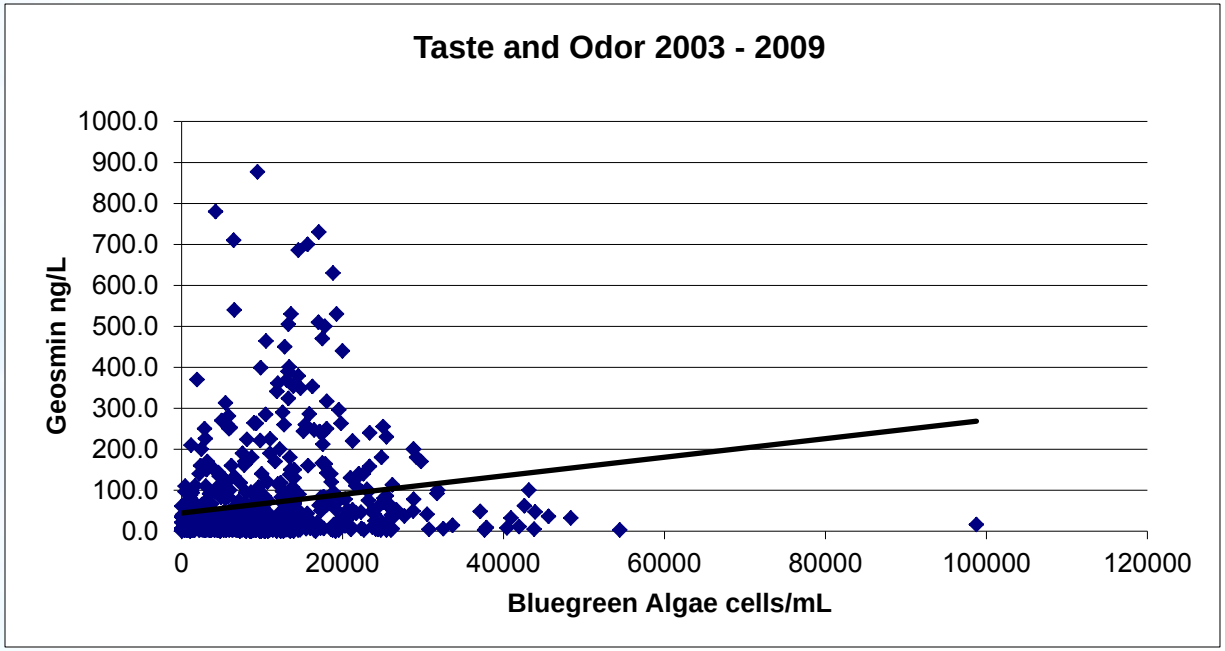

Taste and Odor 2003 - 2009
Geosmin ng/L
1600.0
1400.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
0
20000
40000
60000
80000
100000
120000
Total Algae cells/mL


Taste and Odor 2003 - 2009
Geosmin ng/L
1000.0
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
0
20000
40000
60000
80000
100000
120000
Bluegreen Algae cells/mL

# Conclusions

- Peak Geosmin when reservoir temp ~ 10 $^{o}$C
- BB, AR highest, Median 80 ng/L.  RC distant 3$^{rd}$ at 30 ng/L
- Winter Taste and odor problems are not simply a matter of how much algae or how eutrophic a reservoir is.
- Correlation analysis does not suggest Cause-effect analysis at this point.

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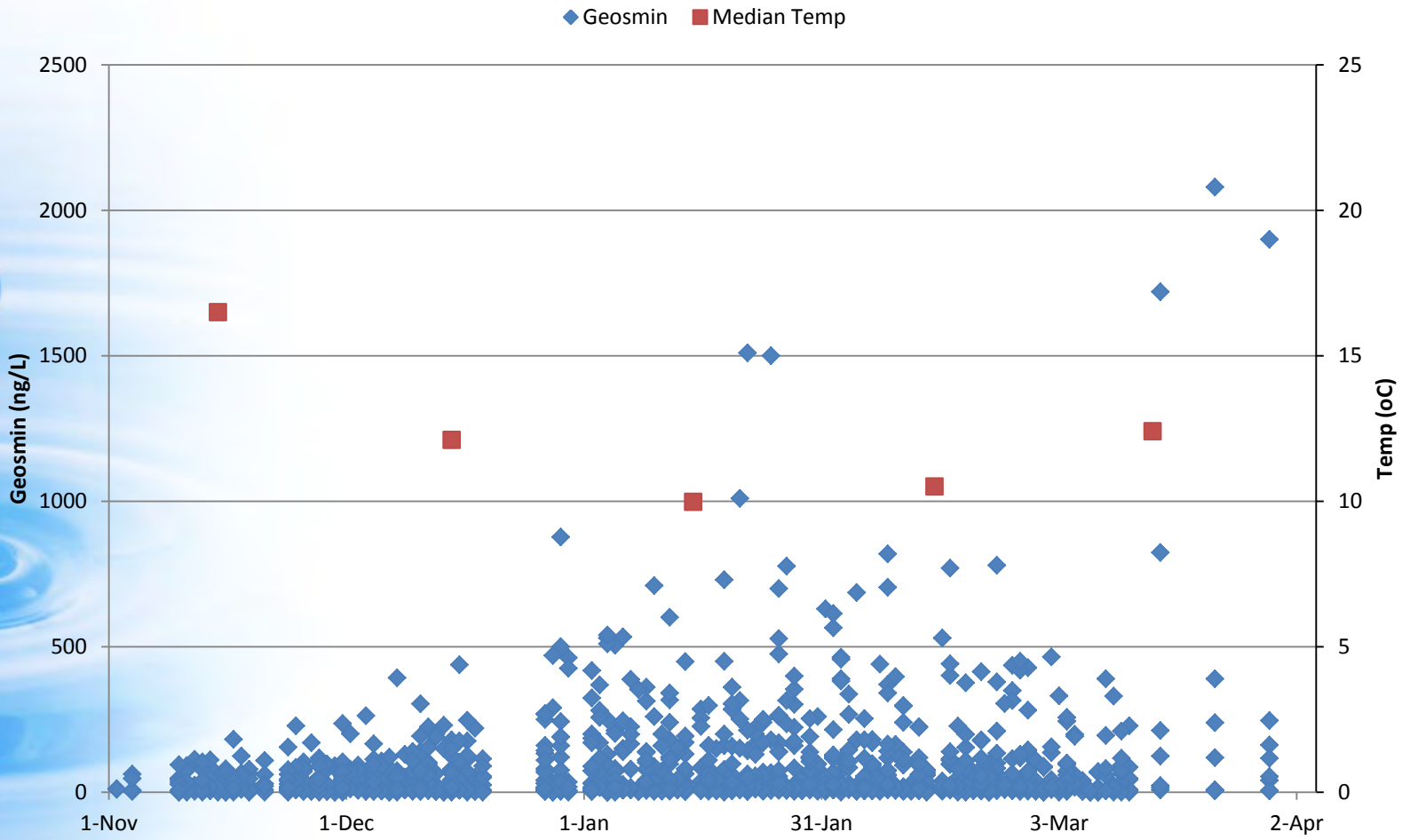
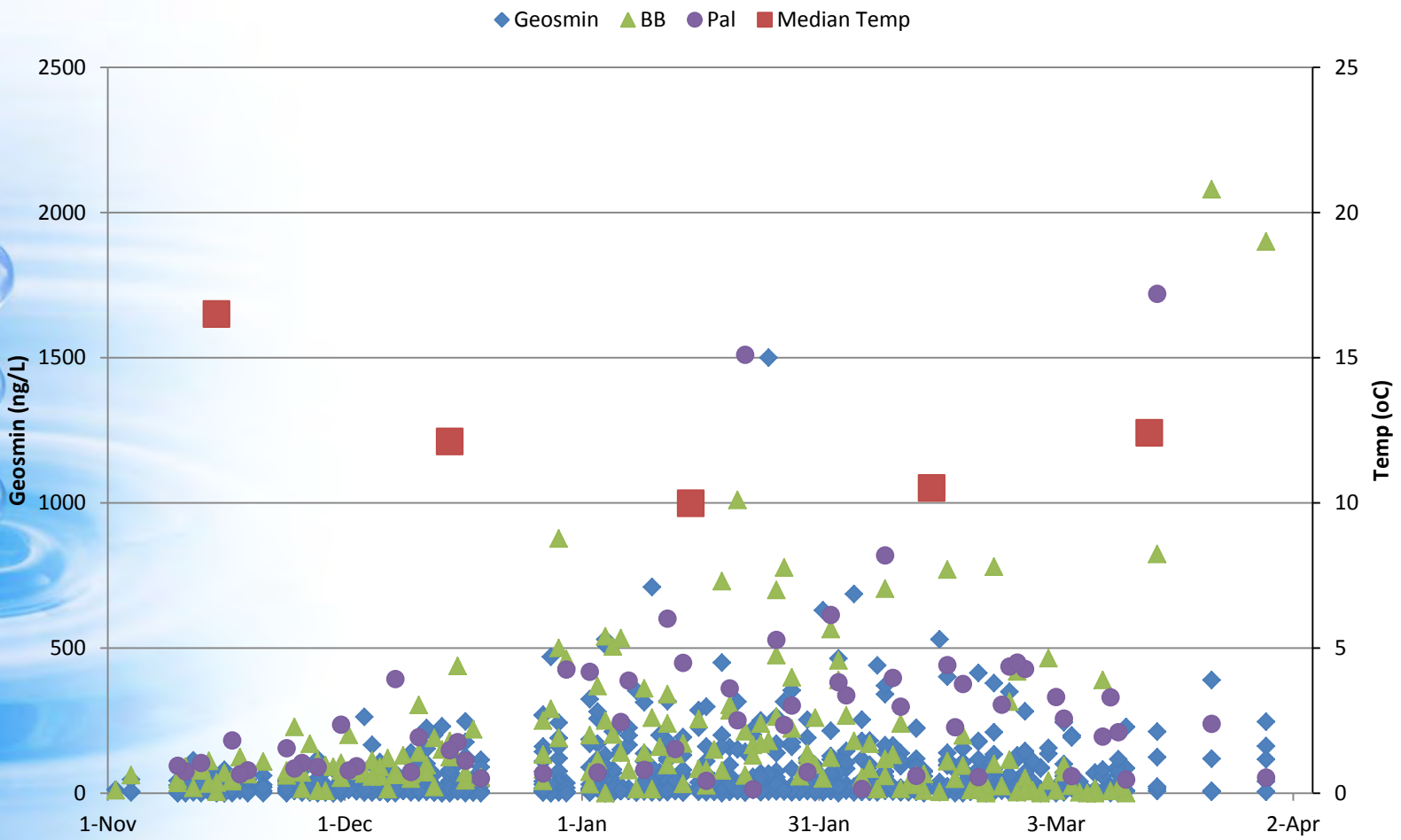
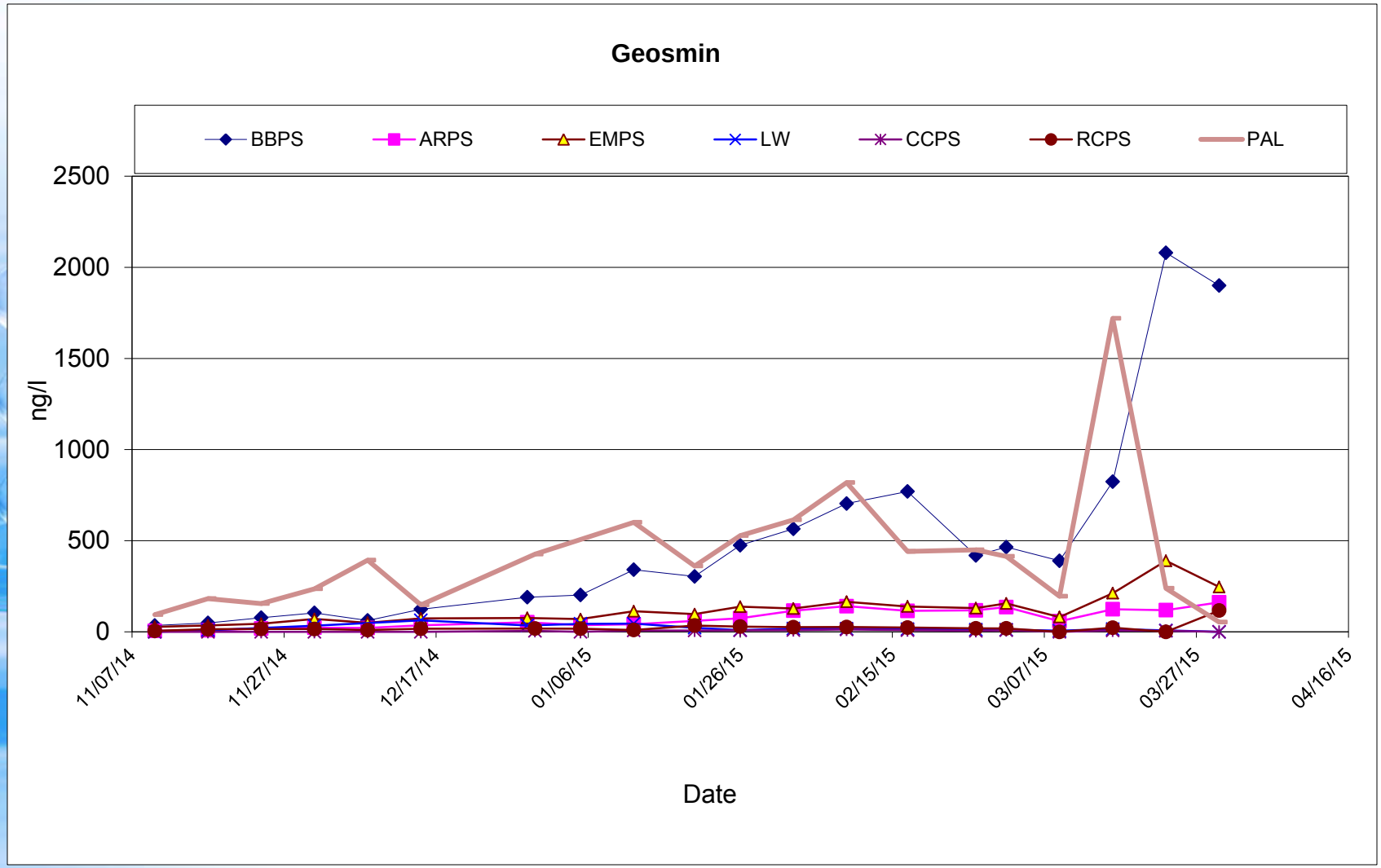
# Historic Geosmin
# 2003-2015

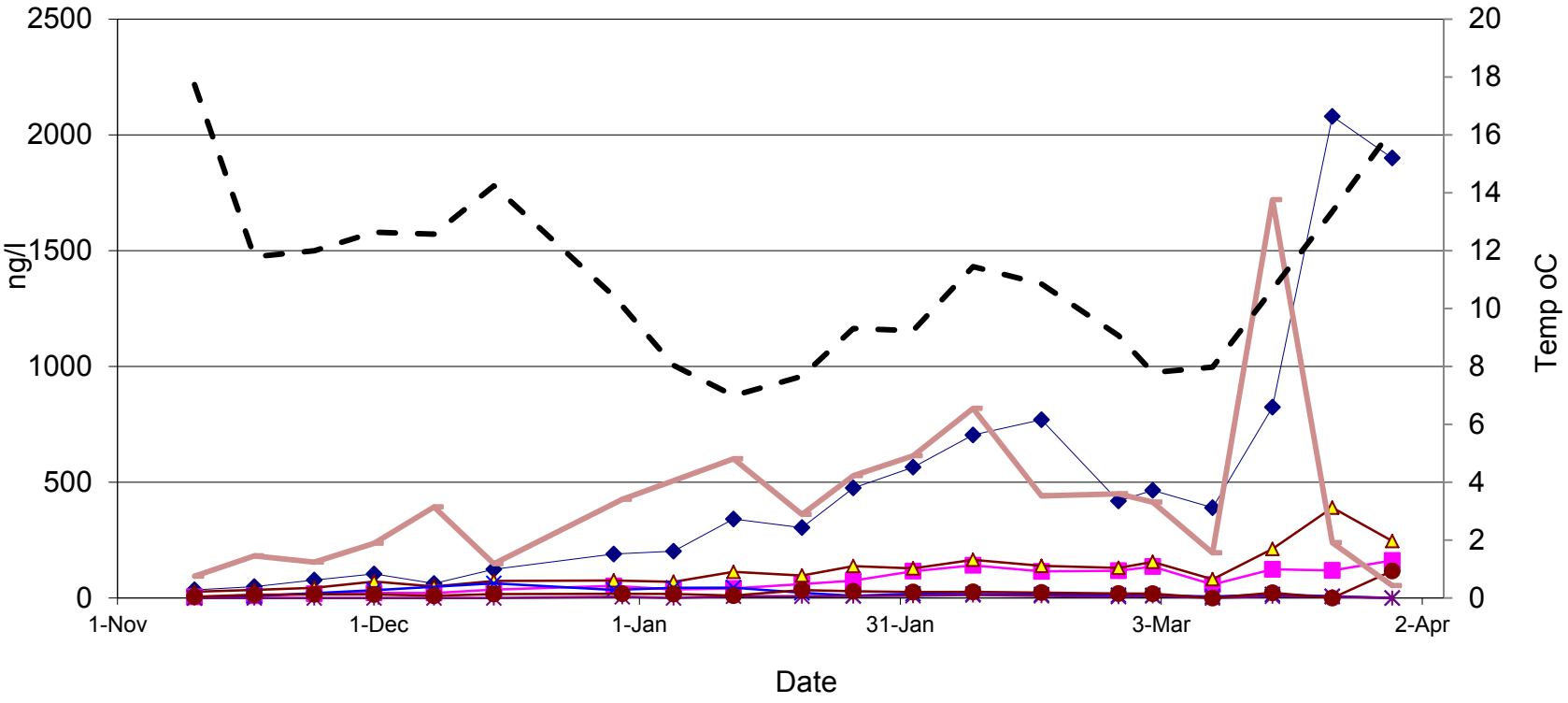


# Historic Geosmin
# 2003-2015

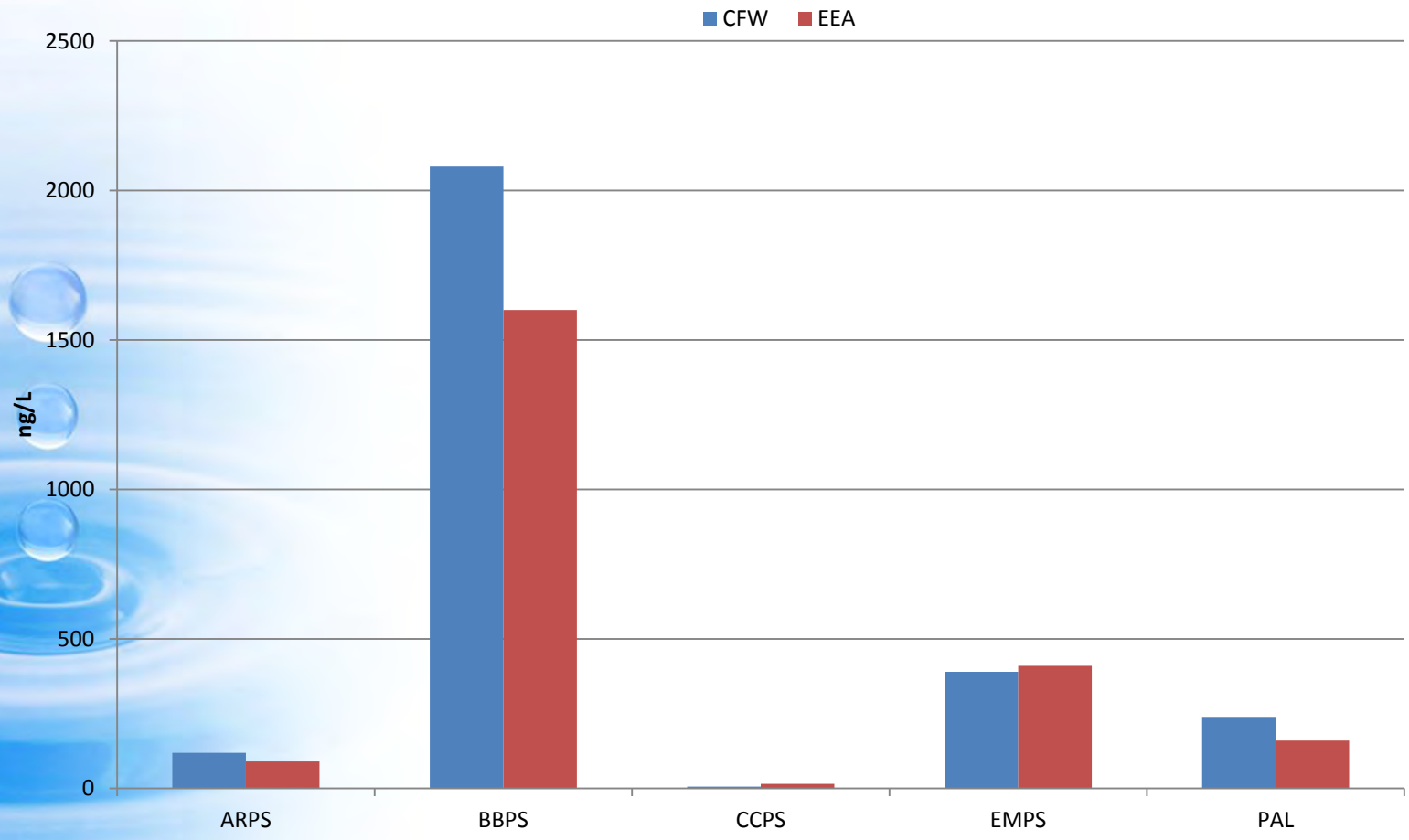


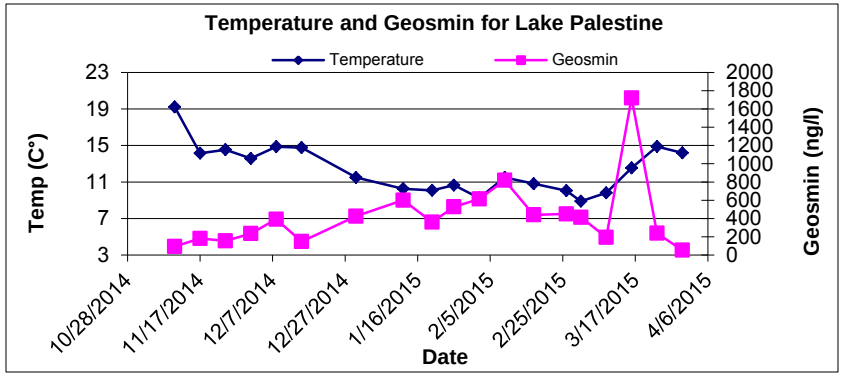

Geosmin
BBPS
ARPS
EMPS
LW
CCPS
RCPS
PAL
2500
2000
1500
1000
500
0
ng/l
11/07/14
11/27/14
12/17/14
01/06/15
01/26/15
02/15/15
03/07/15
03/27/15
04/16/15
Date

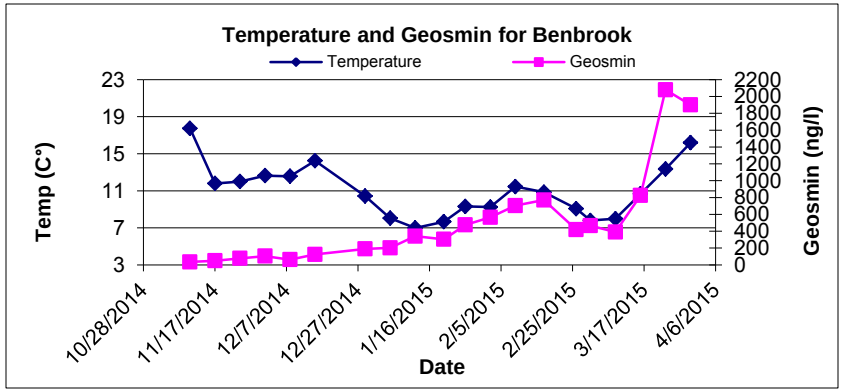
# Geosmin

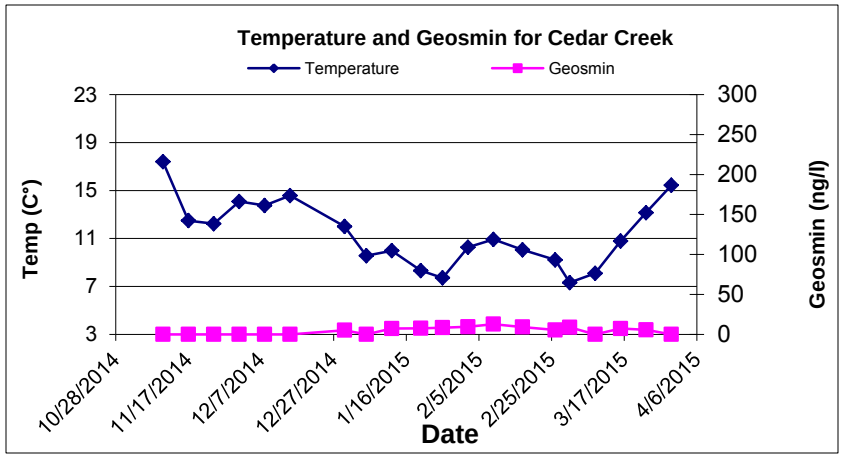

BBPS
ARPS
EMPS
LW
CCPS
RCPS
PAL
Temp
2500
2000
1500
1000
500
0
ng/l
20
18
16
14
12
10
8
6
4
2
0
Temp oC
1-Nov
1-Dec
1-Jan
31-Jan
3-Mar
2-Apr
Date

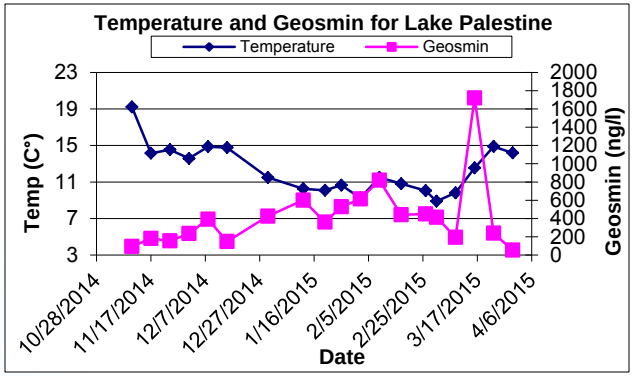
# Geosmin Split Samples
# March 23, 2015



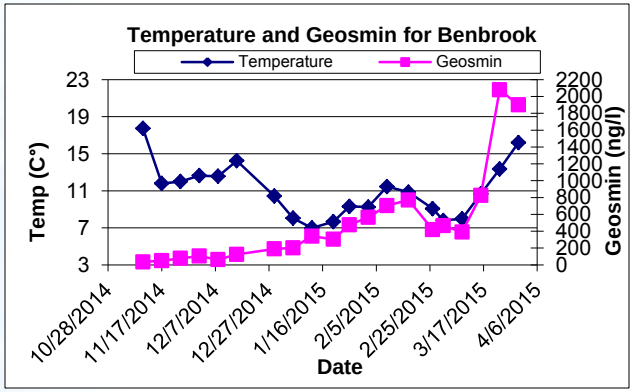

Temperature and Geosmin for Lake Palestine
Temperature
Geosmin
Temp (C°)
Geosmin (ng/l)
23
19
15
11
7
3
2000
1800
1600
1400
1200
1000
800
600
400
200
0
10/28/2014
11/17/2014
12/7/2014
12/27/2014
1/16/2015
2/5/2015
2/25/2015
3/17/2015
4/6/2015
Date


Temperature and Geosmin for Benbrook
Temperature
Geosmin
Temp (C°)
Geosmin (ng/l)
23
19
15
11
7
3
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
10/28/2014
11/17/2014
12/7/2014
12/27/2014
1/16/2015
2/5/2015
2/25/2015
3/17/2015
4/6/2015
Date

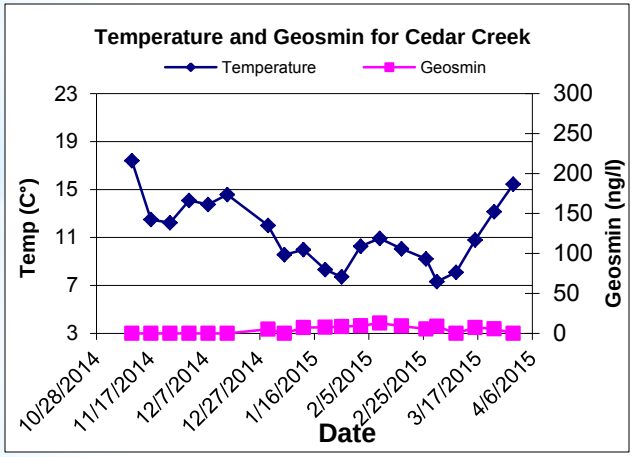

Temperature and Geosmin for Cedar Creek
Temperature
Geosmin
Temp (C°)
Geosmin (ng/l)
23
19
15
11
7
3
300
250
200
150
100
50
0
10/28/2014
11/17/2014
12/7/2014
12/27/2014
1/16/2015
2/5/2015
2/25/2015
3/17/2015
4/6/2015
Date


Temperature and Geosmin for Lake Palestine
Temperature
Geosmin
Temp (C°)
Geosmin (ng/l)
23
19
15
11
7
3
2000
1800
1600
1400
1200
1000
800
600
400
200
0
10/28/2014
11/17/2014
12/7/2014
12/27/2014
1/16/2015
2/5/2015
2/25/2015
3/17/2015
4/6/2015
Date


A236 1280x1024 2014/12/04 11:26:10 Unit: um Magnification: 1615.5 x New
20.0 um
LP TQ 11/10/14 50:5 Lugols 200x random

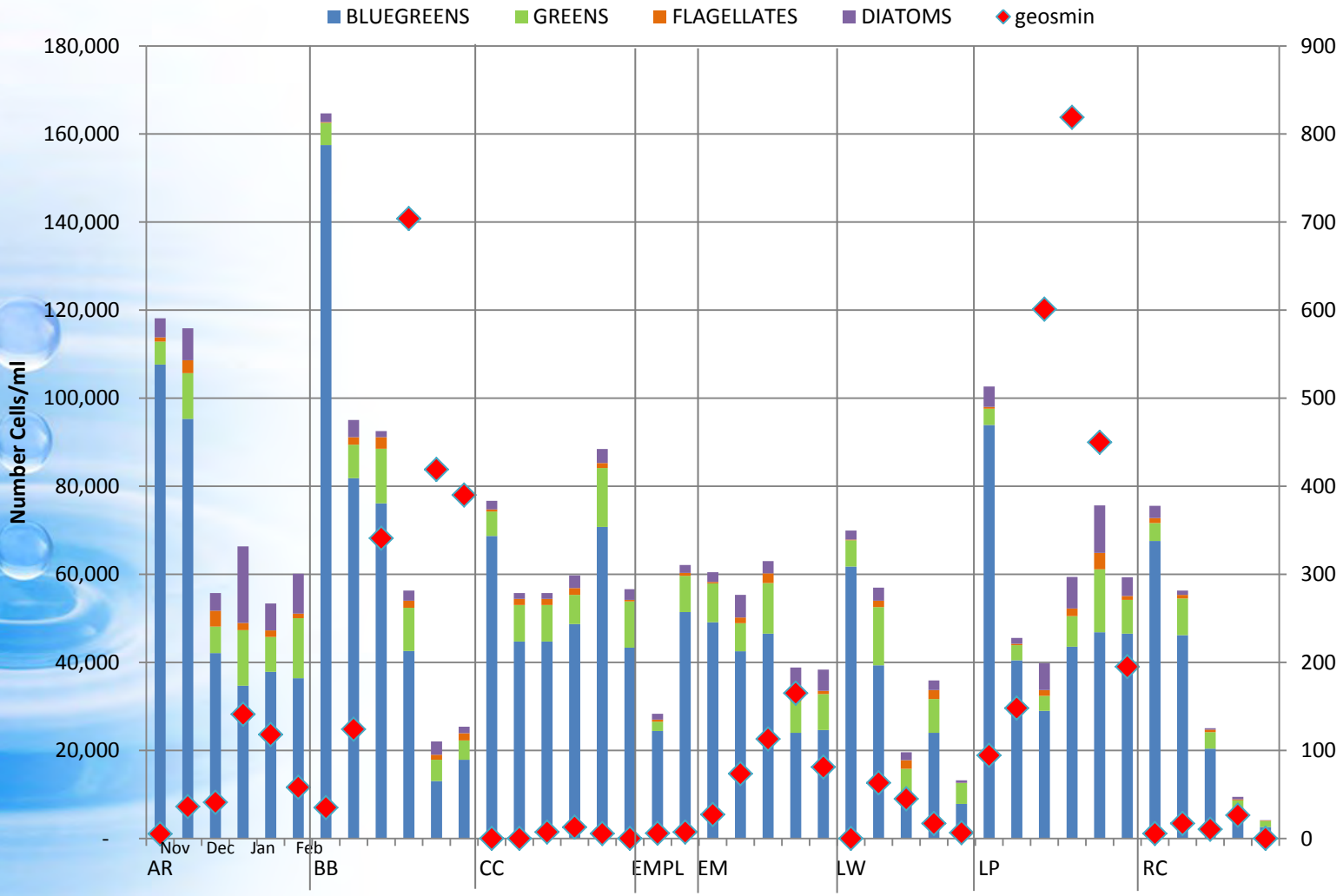

Temperature and Geosmin for Benbrook
Temperature
Geosmin
Temp (C°)
Geosmin (ng/l)
23
19
15
11
7
3
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
10/28/2014
11/17/2014
12/7/2014
12/27/2014
1/16/2015
2/5/2015
2/25/2015
3/17/2015
4/6/2015
Date


A201 1280x1024 2014/12/02 09:55:03 Unit: um Magnification: 1615.5 x New
20.0 um
BBPS TQ 11/10/14 Lugols 200x

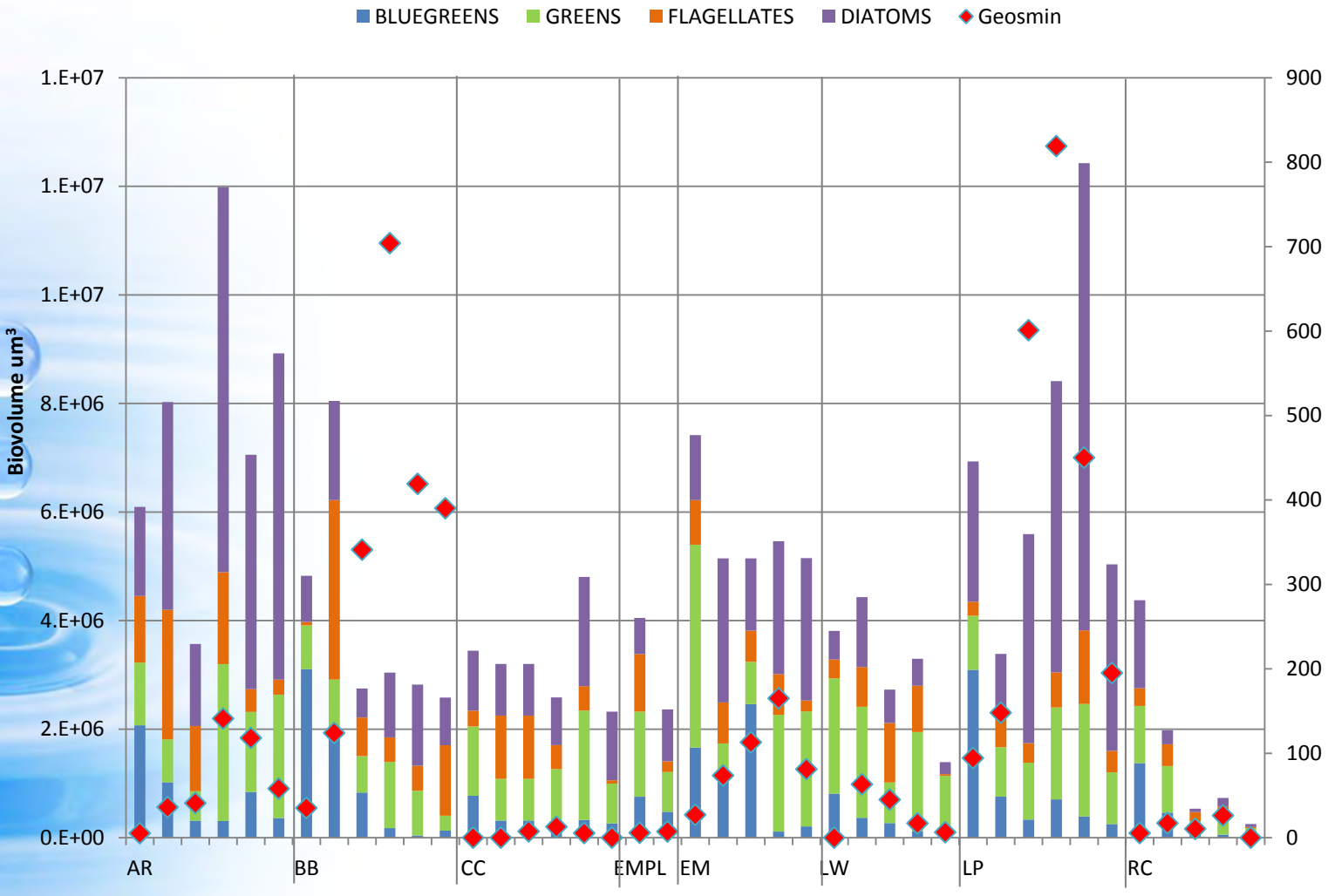

Temperature and Geosmin for Cedar Creek
Temperature
Geosmin
Temp (C°)
Geosmin (ng/l)
23
19
15
11
7
3
300
250
200
150
100
50
0
10/28/2014
11/17/2014
12/7/2014
12/27/2014
1/16/2015
2/5/2015
2/25/2015
3/17/2015
4/6/2015
Date


A140 1280x1024 2014/11/24 15:15:37 Unit: um Magnification: 1615.5 x New
20.0 um
CCPS TQ 11/10/14 Lugols 50:5 200x

# T&O Algae Count

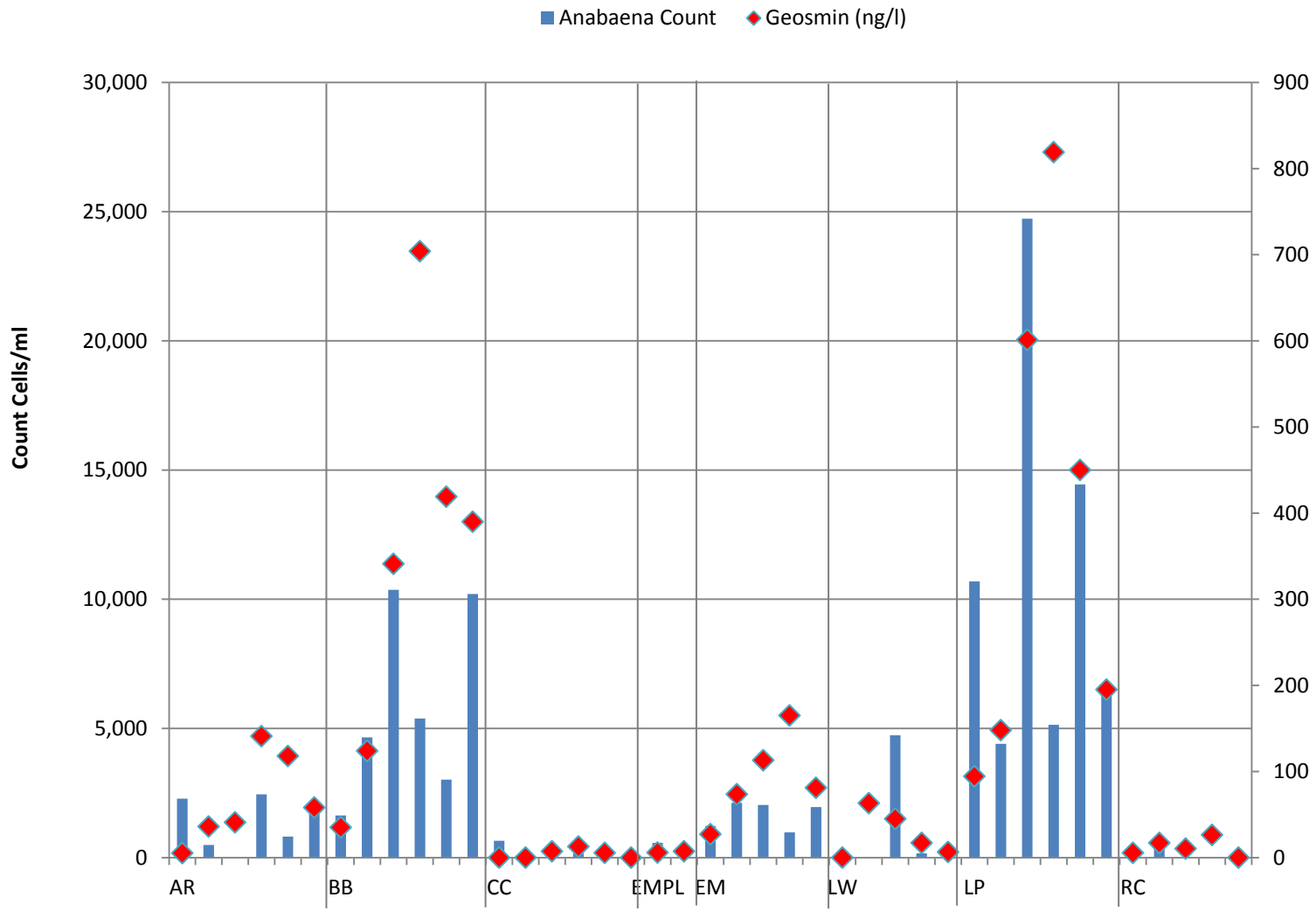


# T&O Algae Biovolume

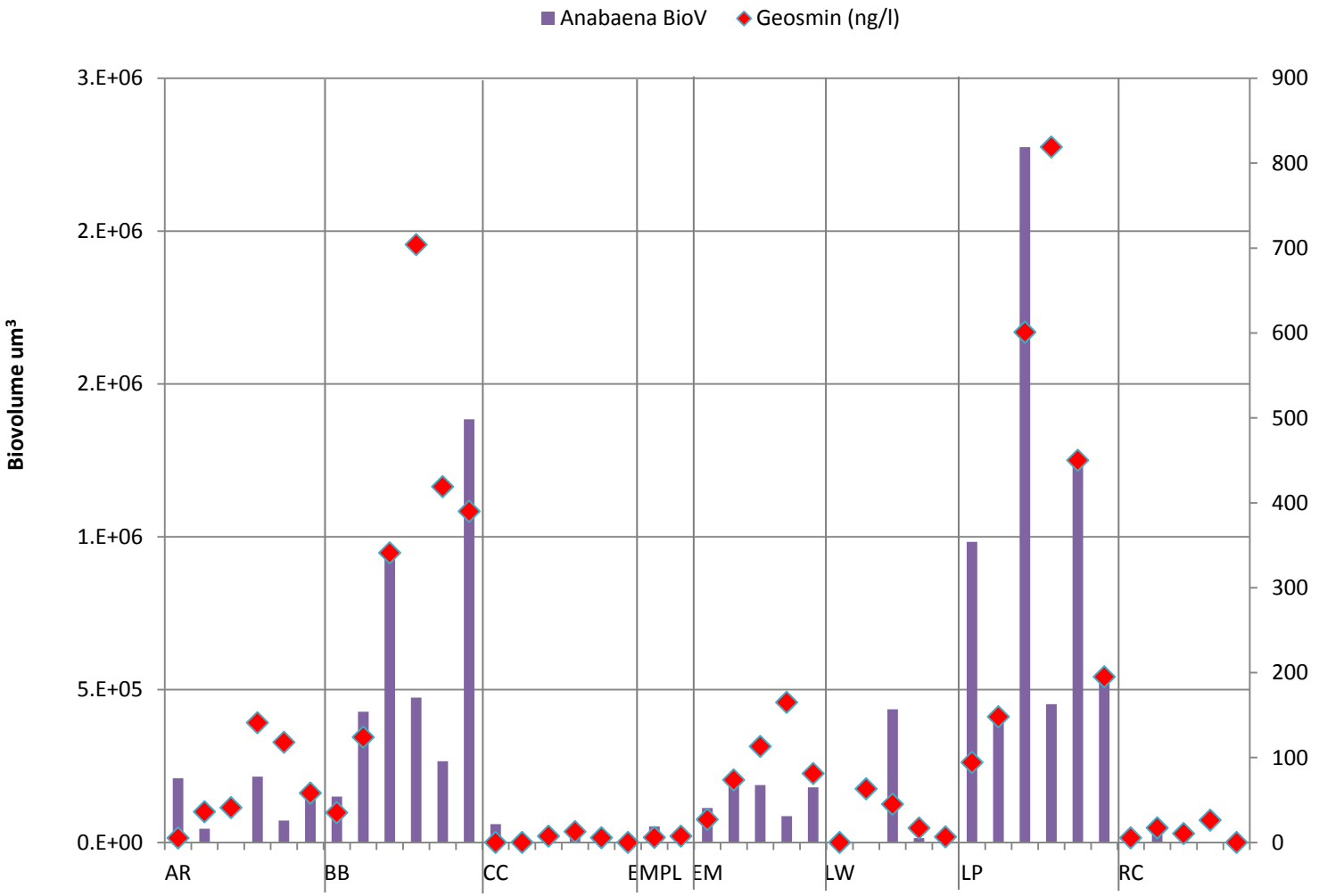



A559 1280x1024 2015/02/18 15:27:43 Unit: um Magnification: 1615.5 x New
DL0
L=6.530 um
DC0
C=16.805 um
A=22.474 um^2
r=2.675 um
DC2
C=20.444 um
A=33.261 um^2
r=3.254 um
Anabaena
DL1
L=6.111 um
DC1
C=19.013 um
A=28.767 um^2
r=3.026 um
DL2
L=6.157 um
DC3
C=16.679 um
A=22.137 um^2
r=2.655 um
DC4
C=16.805 um
A=22.474 um^2
r=2.675 um
20.0 um
LP TO 2/9/15 Lugols SR00x

# T&O Algae Count



# T&O Algae Biovolume



# Conclusions

- Cool water temperature continues to be consistent indicator of geosmin episode in reservoirs with history of geosmin.
- Significant presence of Anabaena is promising although consistency is still being evaluated.
- Lag time and severity of geosmin episode will continue to be explored.
- Continue to evaluate other potential algal or bacterial sources of geosmin to reservoirs.

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# Questions or Comments?

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