Lake Spokane Water Quality Project

Project Background

Site Description

From its source at Lake Coeur d'Alene, the Spokane River flows west across the Idaho / Washington state line to the city of Spokane. From Spokane, the river flows northwesterly through the Lake Spokane reservoir, over Long Lake Dam, and through the Spokane Tribe of Indian's reservation to its confluence with the Franklin D. Roosevelt Lake impoundment of the Columbia River (Figure 1).

The river, including the Lake Coeur d'Alene catchment, drains an area of about 6,640 square miles in two states. Approximately 2,295 square miles are within eastern Washington with the remainder of the watershed in Idaho. Most residents in the watershed live in the Spokane metropolitan area. However, the incorporated area of Liberty Lake, east of Spokane, and the cities of Coeur d'Alene and Post Falls in Idaho are experiencing rapid growth.

There are seven wastewater discharges to the mainstem of the Spokane River between Lake Spokane and Lake Coeur d'Alene. These discharge a summer average of approximately 75 million gallons of treated wastewater per day. In Washington, beginning at Spokane and moving upstream, these discharges include the Spokane Wastewater Treatment Plant, Inland Empire Paper, Kaiser Aluminum, and Liberty Lake Sewer and Water District. Dischargers in Idaho include the Post Falls Wastewater Treatment Plant, Hayden Sewer District, and the city of Coeur d'Alene Advanced Wastewater Treatment Plant.

Each discharger has a National Pollutant Discharge Elimination System (NPDES) permit which sets limits on the amount of pollutants that can be discharged to the river. NPDES permits set limits at levels protective of water quality. In Washington State, Ecology issues NPDES permits; in Idaho, EPA issues these permits.

There are seven hydroelectric dams downstream from the outlet of Lake Coeur d'Alene which significantly influence the dynamics of the Spokane River. The six Washington dams are run-of-the river (flow-through) types except for Long Lake Dam, which creates Lake Spokane.

Lake Spokane (also known as Long Lake) is the 24 mile section of the Spokane River between Nine Mile Dam and Long Lake Dam. The lake is part of the Spokane River Water Resource Inventory Area (WRIA) 54. Dissolved oxygen levels in Lake Spokane are seasonally impaired because of excessive nutrient loading; particularly total phosphorus, which facilitates aquatic growth and decay.

There is particular interest in Lake Spokane because as dischargers are spending considerable amounts of money to reduce phosphorus loading to the Spokane River, the question arises "What are Lake Spokane residential areas contributing to the river system?" The Spokane River Watershed Nonpoint Phosphorus Reduction Plan specifically mentions the Suncrest area of Stevens County. The plan advocates aggressive actions to be taken in the areas nearest Lake Spokane. It states that "Connections should be established between specific sources and stakeholders that have the ability to take action". Of particular interest is the need to evaluate the phosphorus load from septic tanks within Suncrest and other densely developed areas.

Water Quality Concerns

While there is historical literature that suggests that septic systems and subsequent treatment in the unsaturated zone provides phosphorus removal from effluent, recent evidence that this may not be the case in all locations. Data indicate that septic systems release significant phosphorus loads into groundwater. Phosphorus loads can increase with time as the wetting front moves through the soil profile. The soils and geology of the Lake Spokane area have relatively little phosphorus removal capacity. The Suncrest area has been targeted as an area where septic system removal and establishment of a sewer system should be seriously considered.

Measurement of optical brighteners to address septic issue

Optical brightener monitoring is a method used to detect septic or sewage discharges to surface water. Optical brighteners are compounds added to laundry detergents to make clothes appear brighter. They are a modern day replacement for bluing, the practice of adding small amounts of blue dye to make clothes appear whiter. The presence of optical brighteners in surface water is a strong indication that household wastewater is reaching a stream or lake. Optical brighteners are relatively slow to decay and are detectable far from the point source. Optical brighteners are only produced by anthropogenic pollution as opposed to other indicators that could have an animal origin. In 1969, over 29 million pounds of optical brighteners went into laundry detergent in the United States.

The goal of the project was to use optical brightener presence as a means of determining the leaching of effluent from septic systems to Lake Spokane from the Suncrest area downstream to TumTum. To achieve this goal, the Stevens County Conservation District (SCCD) developed a water quality monitoring program that established 20 sampling sites, 16 sites on the Stevens County side of the lake and 4 sites on the Spokane County side, to provide a means of identifying possible septic system influence on Lake Spokane. Optical brighteners were measured using a Turner Designs Cyclops-7 Submersible Sensor connected to a DataBank handheld data logger. Fecal coliform bacteria monitoring was conducted during and Secchi depths were recorded during each sampling period at each sampling site. From August 2012 until the end of the project, an InSitu Troll 9500 was used to measure water temperature, dissolved oxygen, pH, and specific conductance. These latter parameters were measured a 3 feet and near the bottom when depths were significantly over 3 feet.

Lake Spokane Water Quality Project

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Figure 1: Spokane River Watershed in Washington

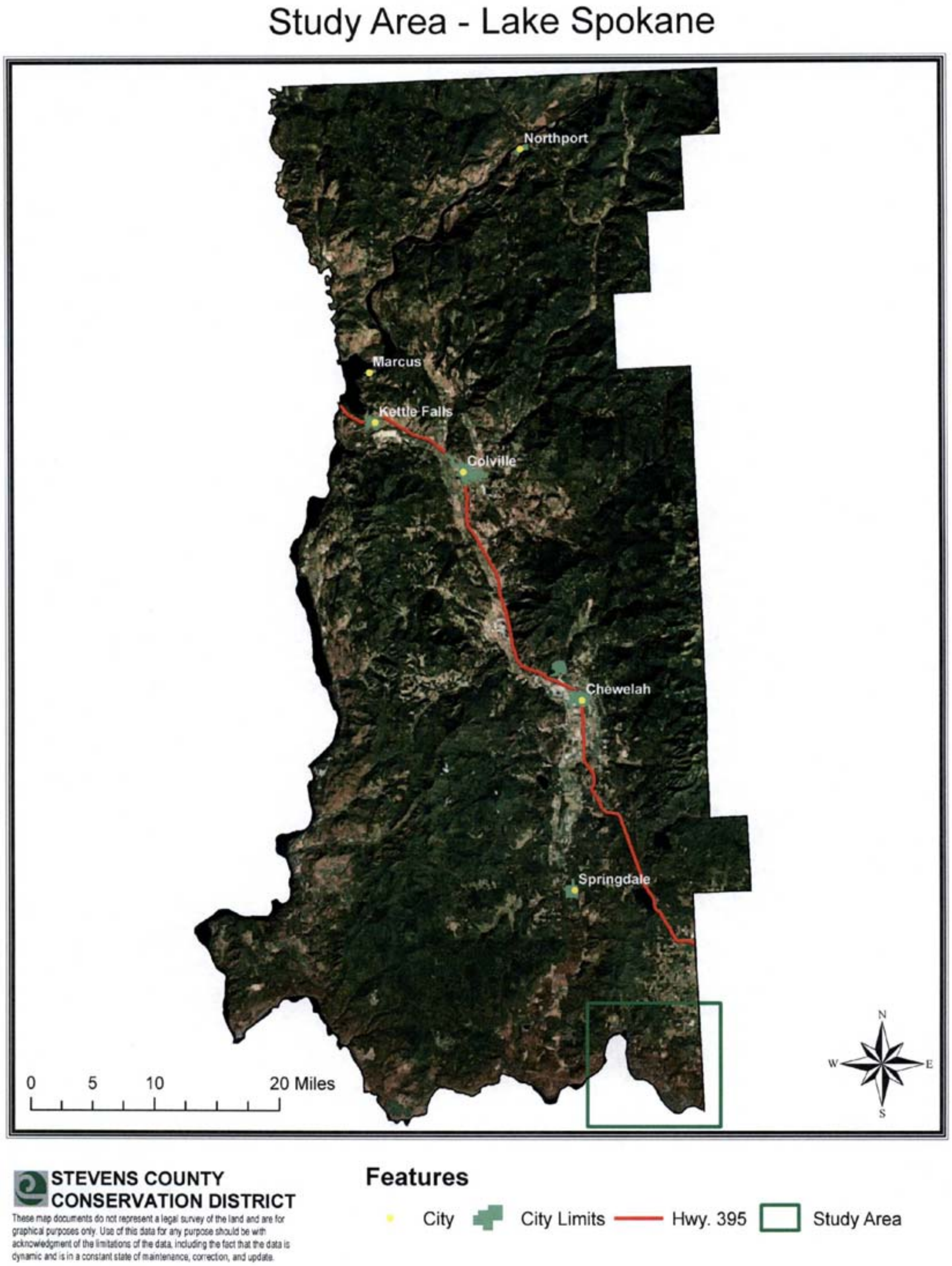


Figure 2: Study area location in Stevens County

Lake Spokane is generally considered the area between Nine Mile Falls Dam and Long Lake Dam. The lake is the reservoir behind Long Lake Dam and is therefore operated to produce power as well as serving as a recreation area. Avista Utilities operates both dams. Avista draws the water level down in the winter months to prepare for high runoff periods and to allow the cold winter temperatures to kill aquatic weeds that are prevalent in the lake.

Lake Spokane Water Quality Project

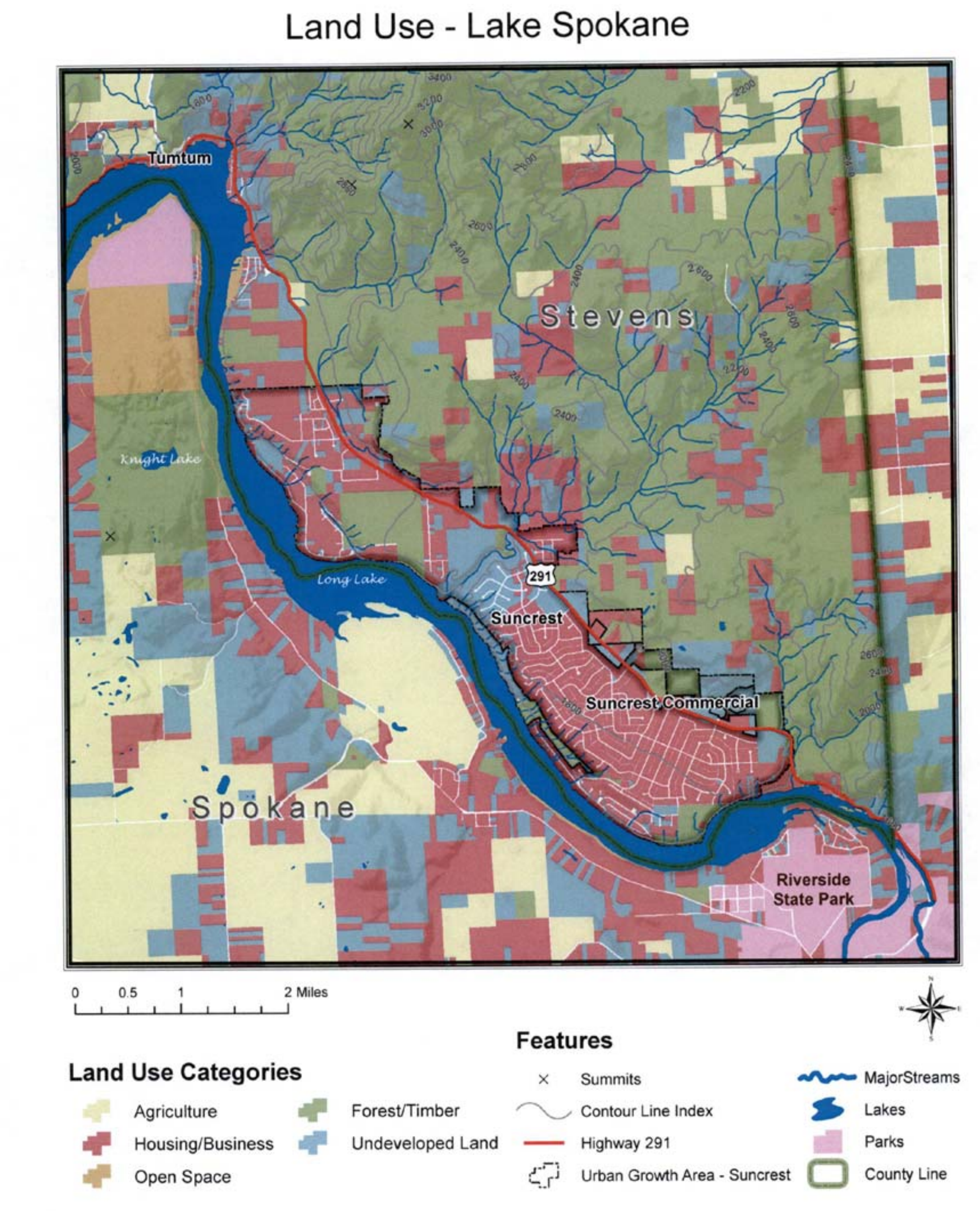


Figure 3: Land use in the study area

Lake Spokane Water Quality Project

Water Quality Sampling

Sampling Station	Latitude	Longitude
LSOPBR 1	N 47.79941	W 117.57126
LSOPBR 2	N 47.79693	W 117.58504
LSOPBR 3	N 47.80007	W 117.59183
LSOPBR 4	N 47.804	W 117.59865
LSOPBR 5	N 47.80793	W 117.60249
LSOPBR 6	N 47.8108	W 117.60576
LSOPBR 7	N 47.81369	W 117.60798
LSOPBR 8	N 47.83152	W 117.62444
LSOPBR 9	N 47.83629	W 117.64246
LSOPBR 10	N 47.84615	W 117.65377
LSOPBR 11	N 47.84894	W 117.65726
LSOPBR 12	N 47.87659	W 117.66069
LSOPBR 13	N 47.88582	W 117.66258
LSOPBR 14	N 47.89339	W 117.66115
LSOPBR 15	N 47.8937	W 117.66705
LSOPBR 16	N 47.89114	W 117.68147
LSOPBR 17	N 47.82668	W 117.64449
LSOPBR 18	N 47.82282	W 117.61984
LSOPBR 19	N 47.81465	W 117.61442
LSOPBR 20	N 47.7967	W 117.55814

Table 1: Location of Lake Spokane optical brightener sampling points

Sampling was conducted April 2012 through October 2012. September 2012 sampling did not occur due to changes in SCCD staffing. Monitoring continued in 2013 after the lake drawdown period. Monitoring events occurred in May and June 2013. Fecal coliform bacteria samples were collected following Washington Department of Ecology Lake monitoring guidelines. Samples were placed on ice and transported to the Tshimakain Creek Laboratory shortly after collection. All samples were collected in the near shore area.

Monitoring results
Monitoring data can be found in Appendix A. The following table provides a summary of data for the 3 major constituents that could be linked to septic discharge in Lake Spokane.

Year	Optical Brightener	Fecal Coliform	Specific Conductance
	ppb	Colonies / 100 ml	µS / cm
2012	0 - 27	<1 – 770	168 - 246
2013	0 - 11	<1 - 170	82 - 154

Lake Spokane Water Quality Project

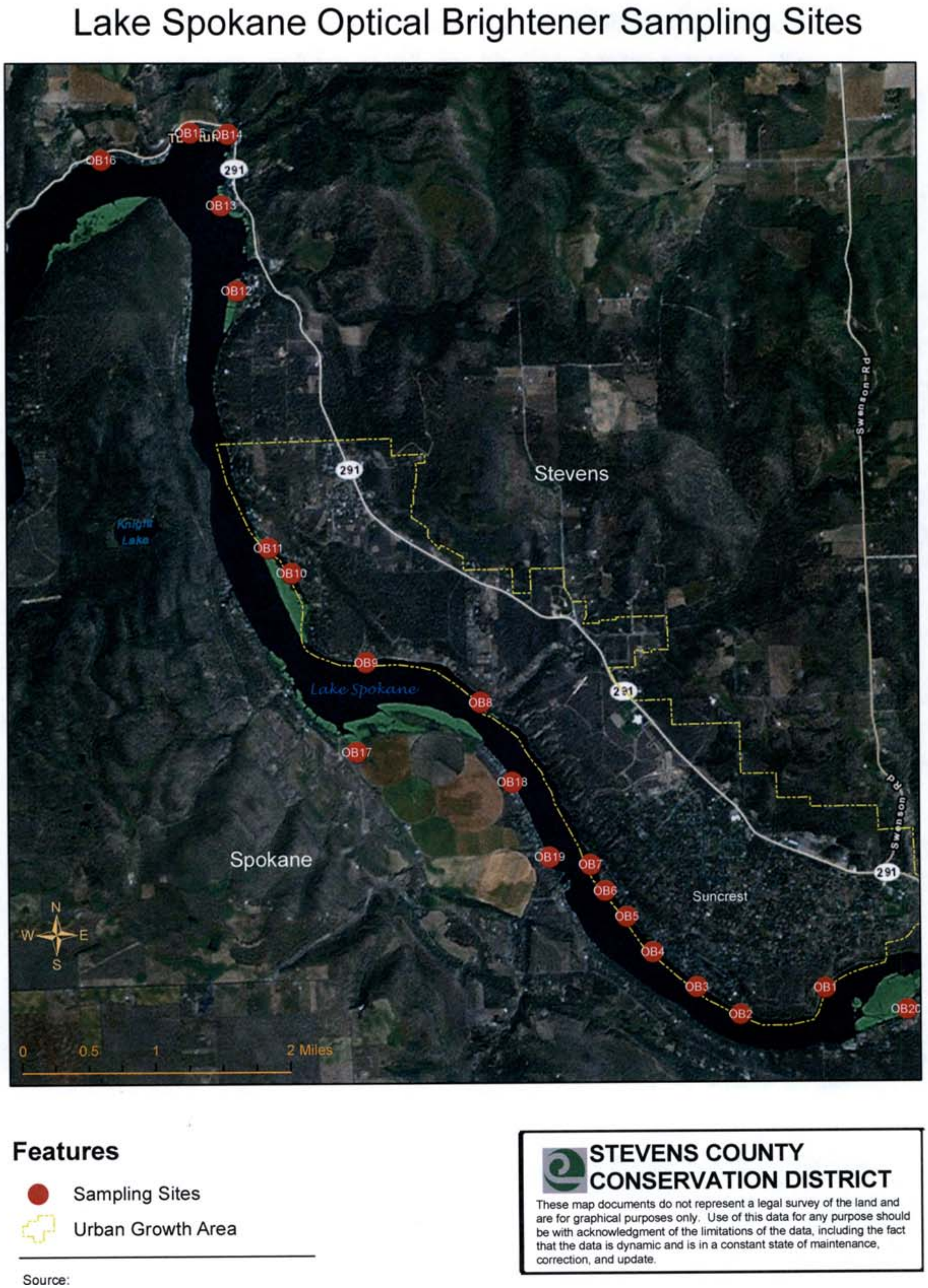


Figure 4: Lake Spokane sampling sites

Discussion of results

There was very little difference in optical brightener concentrations throughout the lake. During some sampling events, there was little to no difference measured between the 20 sampling sites. Often a blank sample of distilled water would read the same as measurements made in the lake. In looking at data generated by a study of rivers in Virginia, it was found that this was not uncommon.

SCCD staff ran tests with 2 types of detergents. One from Costco had no optical brighteners and All Clear contained the brighter disodium distrylbiphenyl disulfonate. The Costco detergent measured the same as a blank solution. The recommended amount of detergent for a heavy load was used to determine the concentration of detergent in a 25 gallon washing machine. This was then used to determine the concentration of detergent in a 1 liter sample. This 1 liter sample was then used to conduct the test. A portion of the 1 liter was poured into an opaque tube that restricted light from above. This tube was used during all calibration events. The All Clear produced the following results.

Time (minutes)	All Clear (ppb)	Probe in the air (ppb)	Tap water (ppb)
Start		3.7	
1	3140		
2	2910		
3	2540		
5	2486		
10	1650		
15	1380		
20	1170		
Finish		0.8	5.5

Most lake readings were made within 5 minutes of the probe being placed in the water and while there was some drift; readings would stabilize enough to determine the level of optical brightener. Looking at the lake data generated from this project, it appears that there is not optical brightener getting into the lake from septic systems.

Possible reasons for optical brightener results include:

- Dilution caused by flow levels through the lake / reservoir
- The area of groundwater / surface water interface for the lake has not been clearly defined
- Perhaps more homes are using optical brightener free detergents
- The sandy soil found throughout the study area may provide more filtration than anticipated

Lake Spokane Water Quality Project

Project Activities

July 2012

- The water quality project was dormant in July because the WRIA 54 Watershed Implementation Team did not finalize funding decisions for 2012-2013. There was talk of allowing Spokane County to provide funds for July sampling and District staff made a request to the lead entity, but funding was not finalized until the July 25th WRIA 54 meeting. Sampling commenced again on August 1st.

August 2012

- Monitoring was conducted 3 times in August. The last monitoring on the 27th coincided with the Landsat pass over the lake. Starting in August, the District added measuring dissolved oxygen, water temperature, pH, and specific conductance at all sites. Matt Scheidt has been using the Troll 9500 to measure these parameters, Eric Staggs of Lake Spokane Association provides the boat and driving skills and collects fecal coliform samples, and Charlie Kessler gets Secchi depths and optical brightener concentrations.

September 2012

- No monitoring was conducted in September due to a staff retirement.

October 2012

- Monitoring was conducted twice in October. The results so far have not identified any real "hot spots". Higher fecal coliform levels have often been tied to the presence of waterfowl in the area just prior to sampling. One of the Spokane County sites has had consistently higher optical brightener readings than other sites. There was a reported septic problem at a neighbor's, so this site is being watched closely. A bulkhead replacement project is scheduled for the home at the sampling site so spring sampling after the project is completed will be interesting.

November 2012

- Monitoring was scheduled to be conducted on November 19th and one of Teri Sardinia's students was scheduled to accompany SCCD staff. The weather forecast was for up to 0.5 inches of rain with 40 mile per hour winds, so the sampling was cancelled. The next sampling period is yet to be determined. Considerations include flow into the lake, water level, usability of the data, and weather.

December 2012

- District staff has been in contact with the Lake Spokane Association representative for the monitoring project. Lake levels have been up and there is a minimum amount of ice.

Monitoring will commence again in the spring, unless it seems appropriate to sample during the winter to get a better picture of conditions within the lake.

January 2013

- No monitoring was conducted, but District staff worked with Avista on planning for planting a stretch of Avista property along the lake. Avista has an obligation to plant trees as a part of the FERC relicensing. Ecology water quality staff is providing local oversight to this effort.

February 2013

- No monitoring was conducted, but District staff reviewed the data collected to date and started planning for the 2013 monitoring season. Lake Spokane was in the drawdown phase and so the near shore sampling areas were dry in February. Information on the monitoring program was included in watershed management presentations made to Mrs. Sardinia's advanced science class at Lakeside High School.

March 2013

- The drawdown of Lake Spokane was terminated late in March. Near shore sampling areas have been dry. As the water level returns to the summertime level, sampling will commence in April.
- Data gathered to date is being graphed to provide a visual representation of how conditions vary throughout the lake.

April 2013

- District staff worked with Eric Staggs to establish a schedule for the remaining 5 sampling periods that must be completed prior to June 30th. Eric provided his schedule and then staff reviewed last year's data to determine if April or May was a better time to start sampling. It was determined that May and June would provide better information so a tentative schedule was established.
- The sampling was discussed with Teri Sardinia of Lakeside High School because she would like some of her students to be able to go on sampling trips. District staff mentioned the issue of liability and Teri is looking into this subject. Eric Staggs was also concerned about the liability he would have as the boat owner.

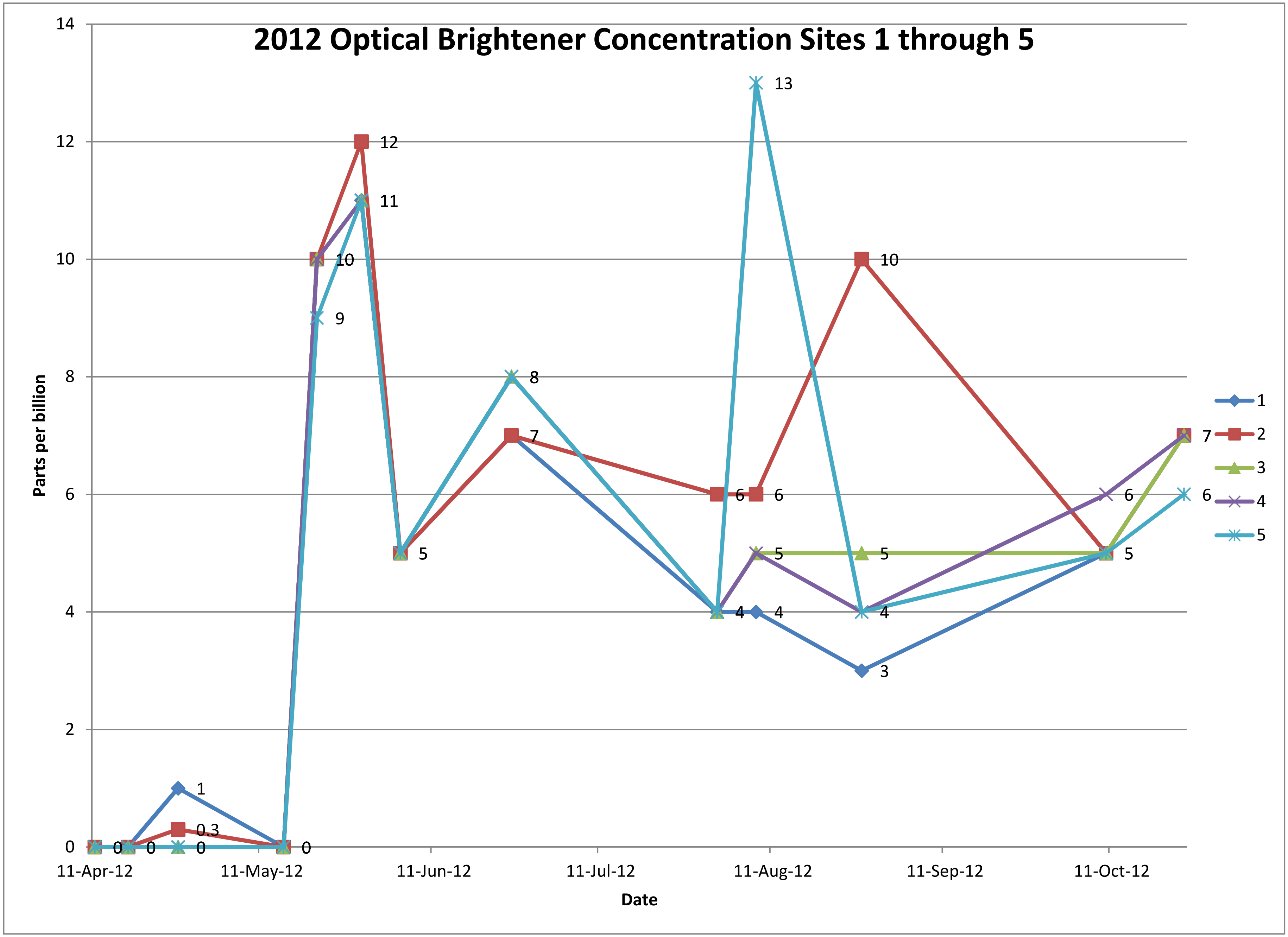
May 2013

- Monitoring was conducted on May 23rd and May 28th.
- District staff made a presentation on the monitoring project to the Spokane River Dissolved Oxygen TMDL Implementation Advisory Committee on May 22nd.

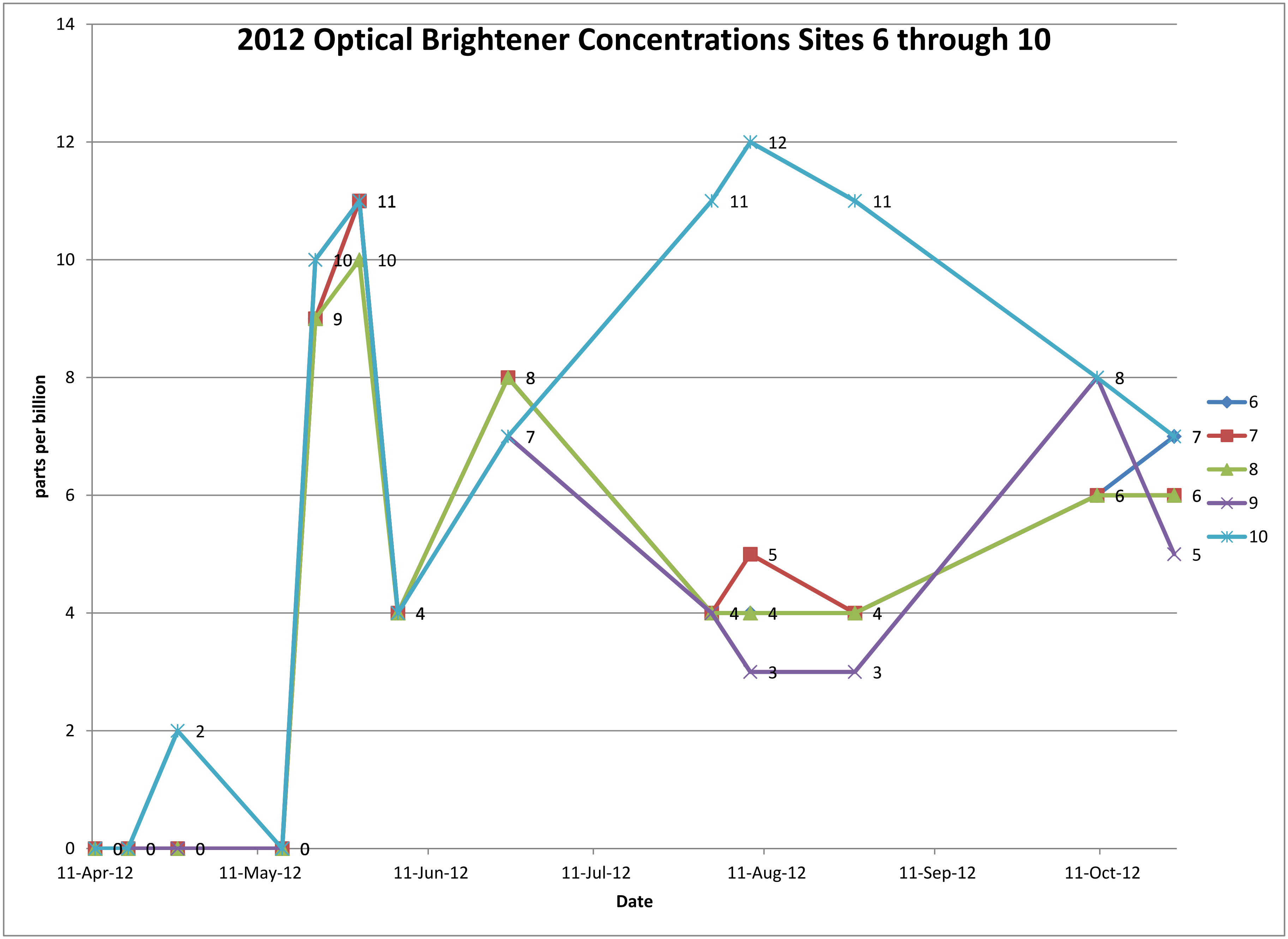
Lake Spokane Water Quality Project

June 2013

- Monitoring was conducted on June 5th and 12th. These were the last two sampling periods. The remaining project funds were expended on writing the project completion report and preparing a presentation for the June WRIA 54 committee meeting.



2012 Optical Brightener Concentration Sites 1 through 5
Parts per billion
Date
14
12
10
8
6
4
2
0
11-Apr-12
11-May-12
11-Jun-12
11-Jul-12
11-Aug-12
11-Sep-12
11-Oct-12
1
2
3
4
5



2012 Optical Brightener Concentrations Sites 6 through 10
parts per billion
Date
0
2
4
6
8
10
12
14
11-Apr-12
11-May-12
11-Jun-12
11-Jul-12
11-Aug-12
11-Sep-12
11-Oct-12
6
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9
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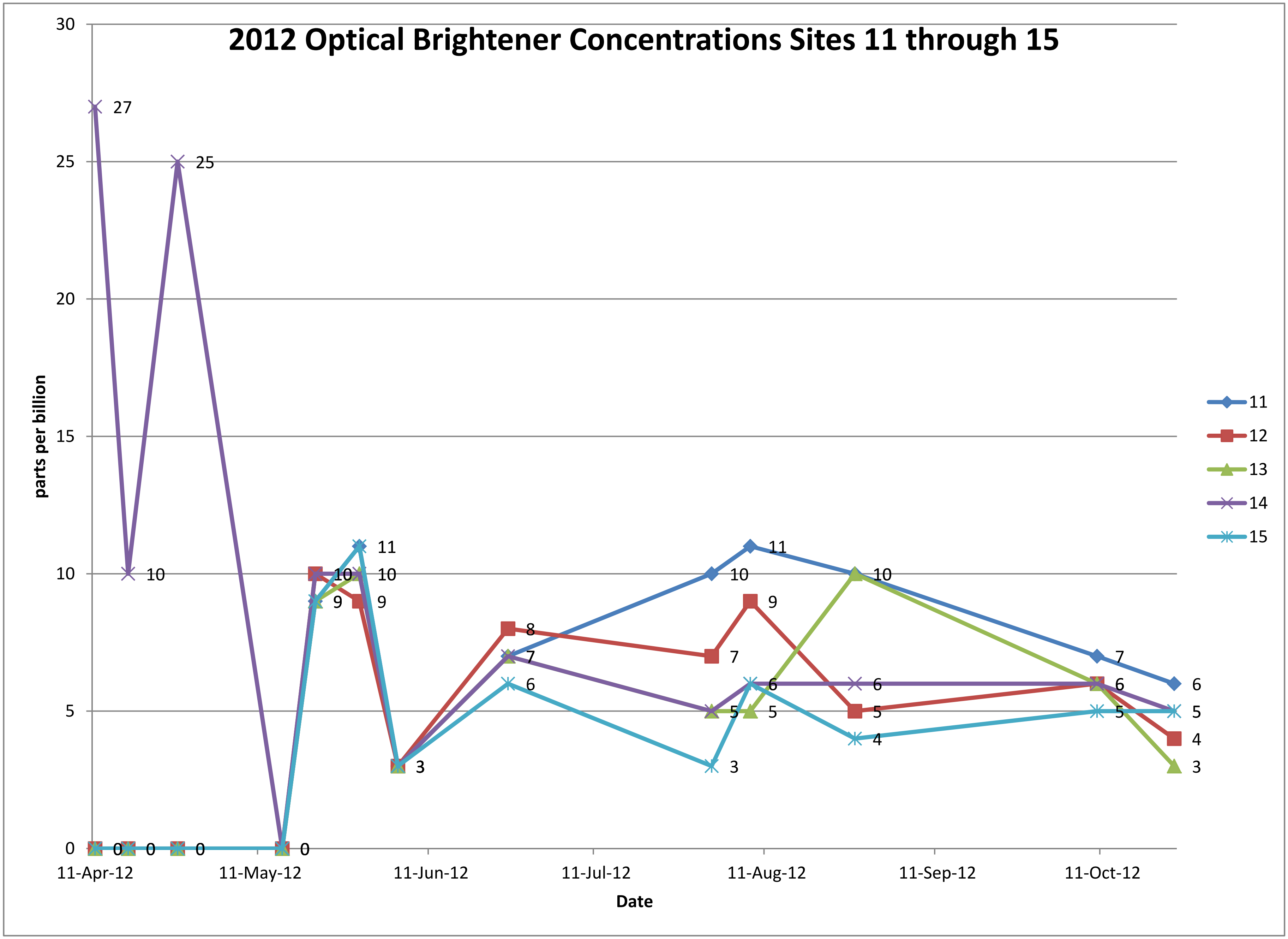
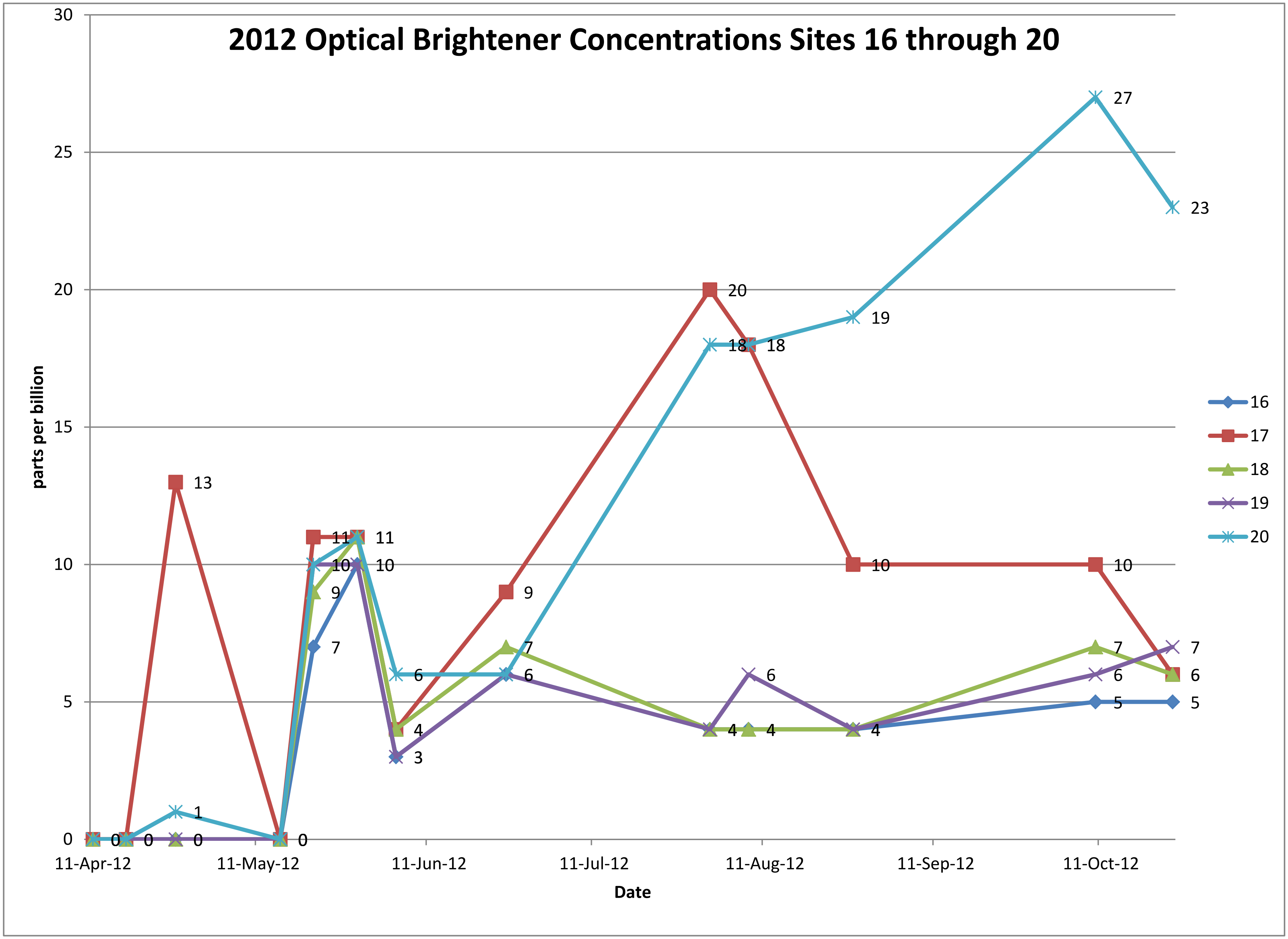
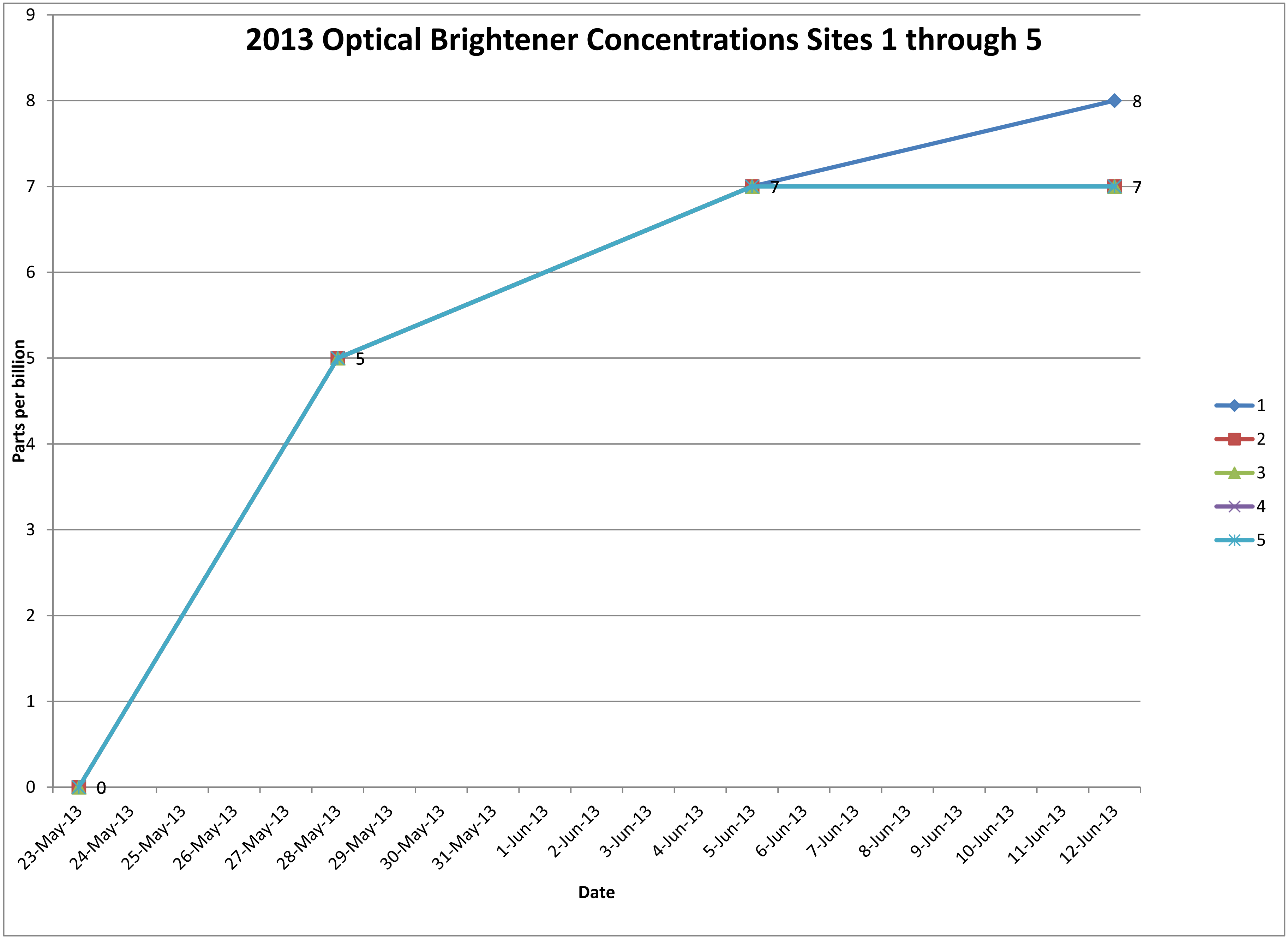

2012 Optical Brightener Concentrations Sites 11 through 15
parts per billion
Date
11-Apr-12
11-May-12
11-Jun-12
11-Jul-12
11-Aug-12
11-Sep-12
11-Oct-12
11
12
13
14
15


2012 Optical Brightener Concentrations Sites 16 through 20
parts per billion
Date
0
5
10
15
20
25
30
11-Apr-12
11-May-12
11-Jun-12
11-Jul-12
11-Aug-12
11-Sep-12
11-Oct-12
16
17
18
19
20



2013 Optical Brightener Concentrations Sites 1 through 5
Parts per billion
Date
0
1
2
3
4
5
6
7
8
9
23-May-13
24-May-13
25-May-13
26-May-13
27-May-13
28-May-13
29-May-13
30-May-13
31-May-13
1-Jun-13
2-Jun-13
3-Jun-13
4-Jun-13
5-Jun-13
6-Jun-13
7-Jun-13
8-Jun-13
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1
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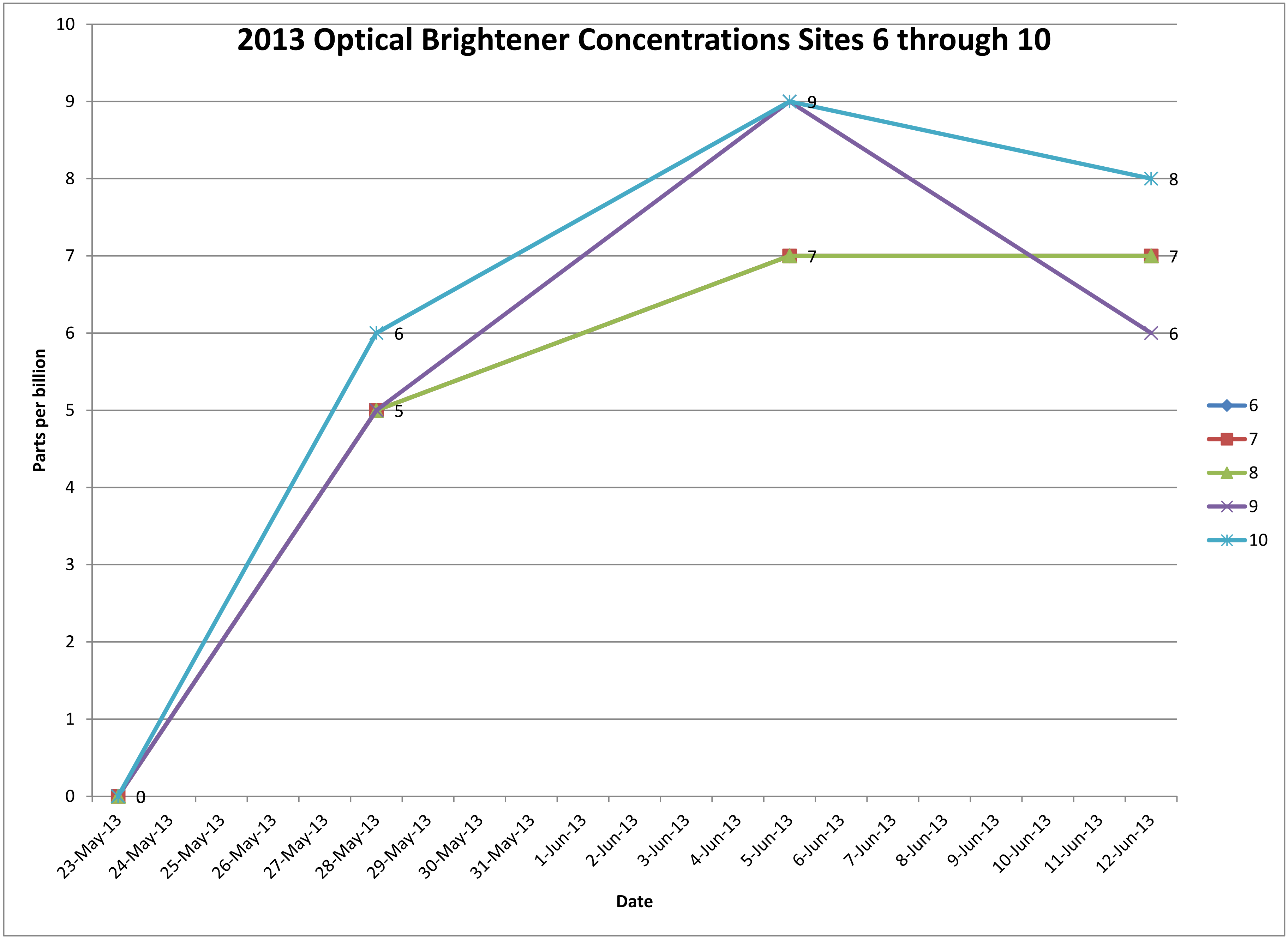

2013 Optical Brightener Concentrations Sites 6 through 10
Parts per billion
Date
10
9
8
7
6
5
4
3
2
1
0
23-May-13
24-May-13
25-May-13
26-May-13
27-May-13
28-May-13
29-May-13
30-May-13
31-May-13
1-Jun-13
2-Jun-13
3-Jun-13
4-Jun-13
5-Jun-13
6-Jun-13
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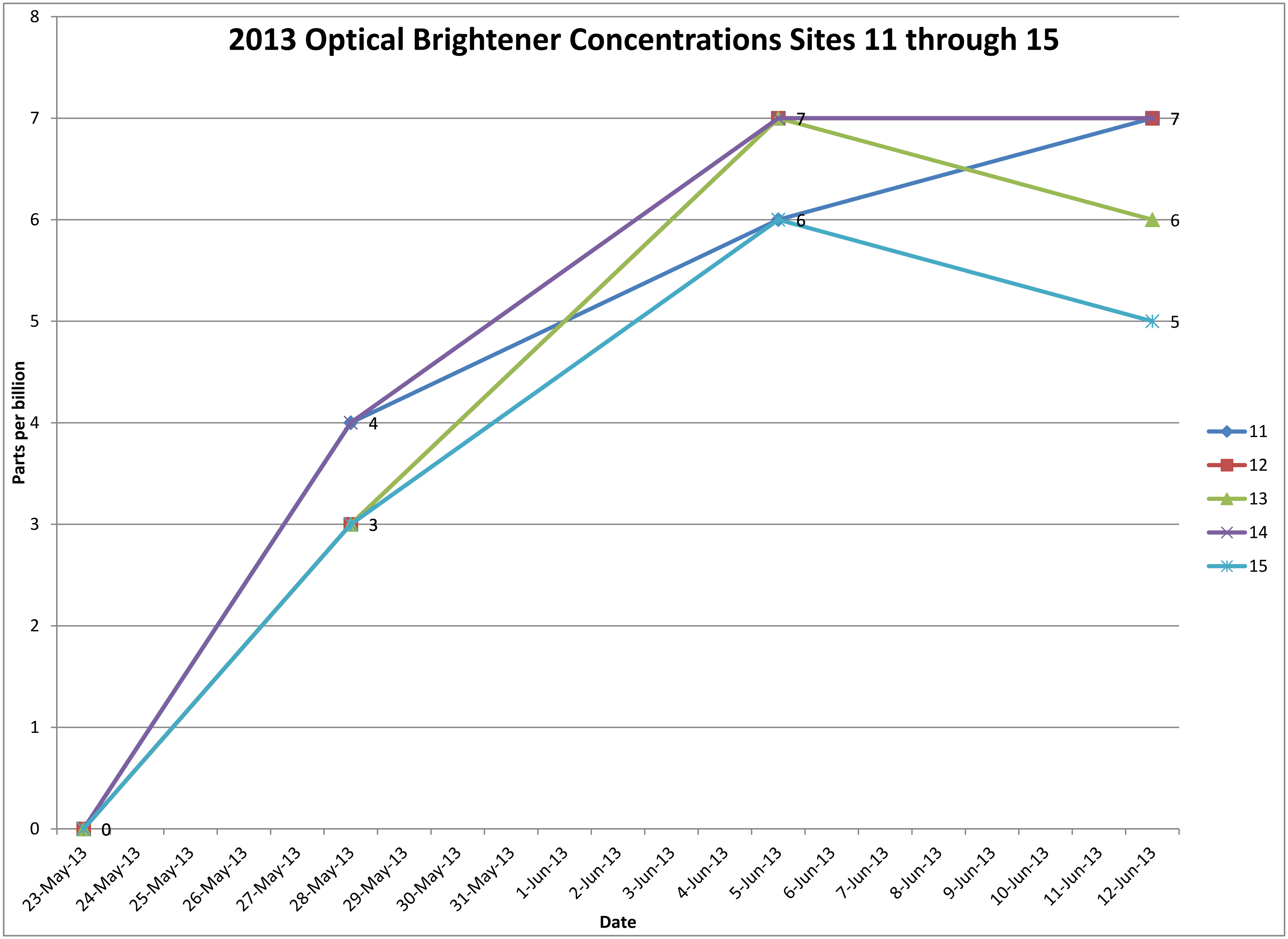
2013 Optical Brightener Concentrations Sites 11 through 15
Parts per billion
Date
0
1
2
3
4
5
6
7
8
23-May-13
24-May-13
25-May-13
26-May-13
27-May-13
28-May-13
29-May-13
30-May-13
31-May-13
1-Jun-13
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4-Jun-13
5-Jun-13
6-Jun-13
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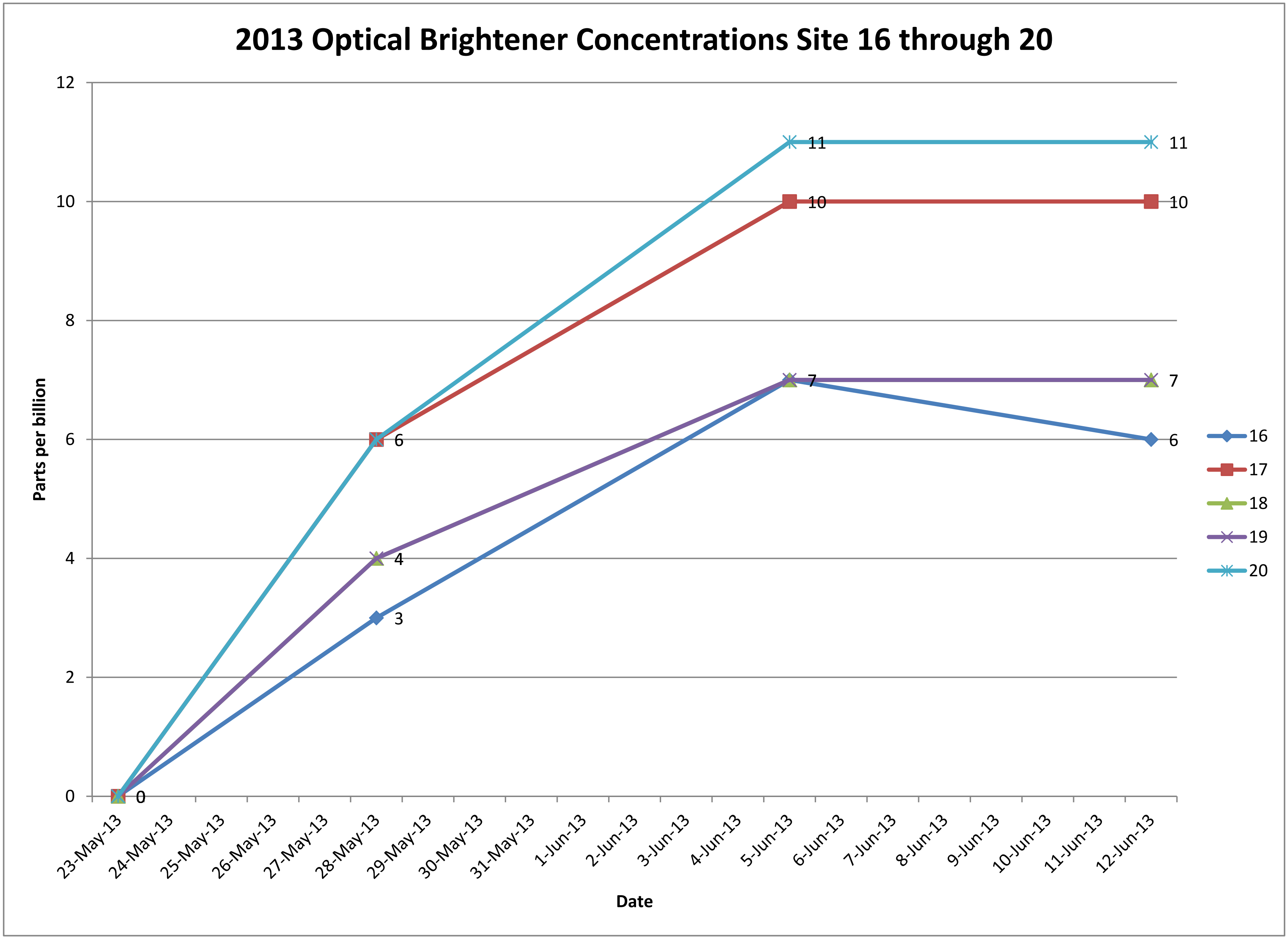

2013 Optical Brightener Concentrations Site 16 through 20
Parts per billion
Date
0
2
4
6
8
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12
23-May-13
24-May-13
25-May-13
26-May-13
27-May-13
28-May-13
29-May-13
30-May-13
31-May-13
1-Jun-13
2-Jun-13
3-Jun-13
4-Jun-13
5-Jun-13
6-Jun-13
7-Jun-13
8-Jun-13
9-Jun-13
10-Jun-13
11-Jun-13
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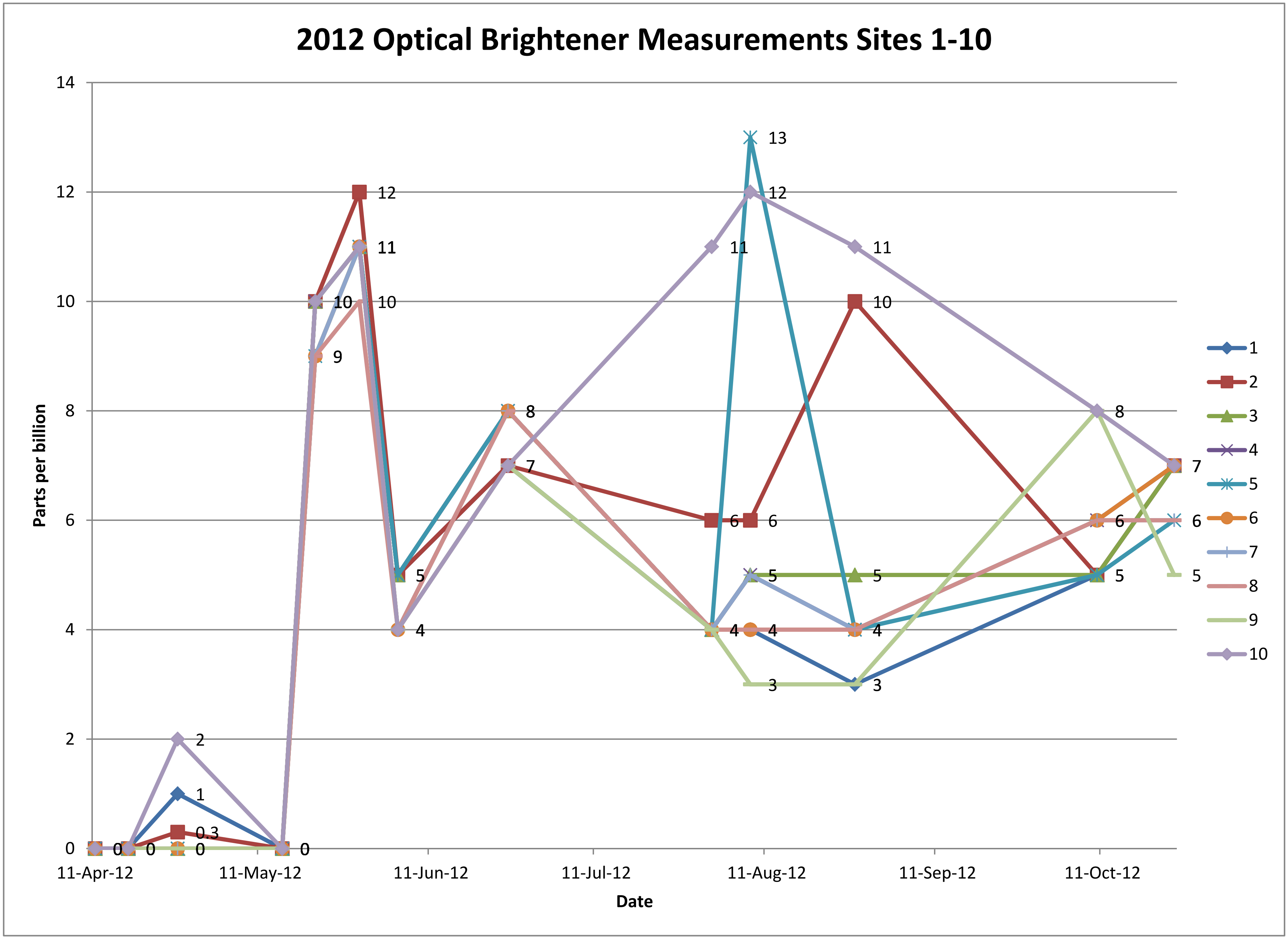
2012 Optical Brightener Measurements Sites 1-10
Parts per billion
Date
0
2
4
6
8
10
12
14
11-Apr-12
11-May-12
11-Jun-12
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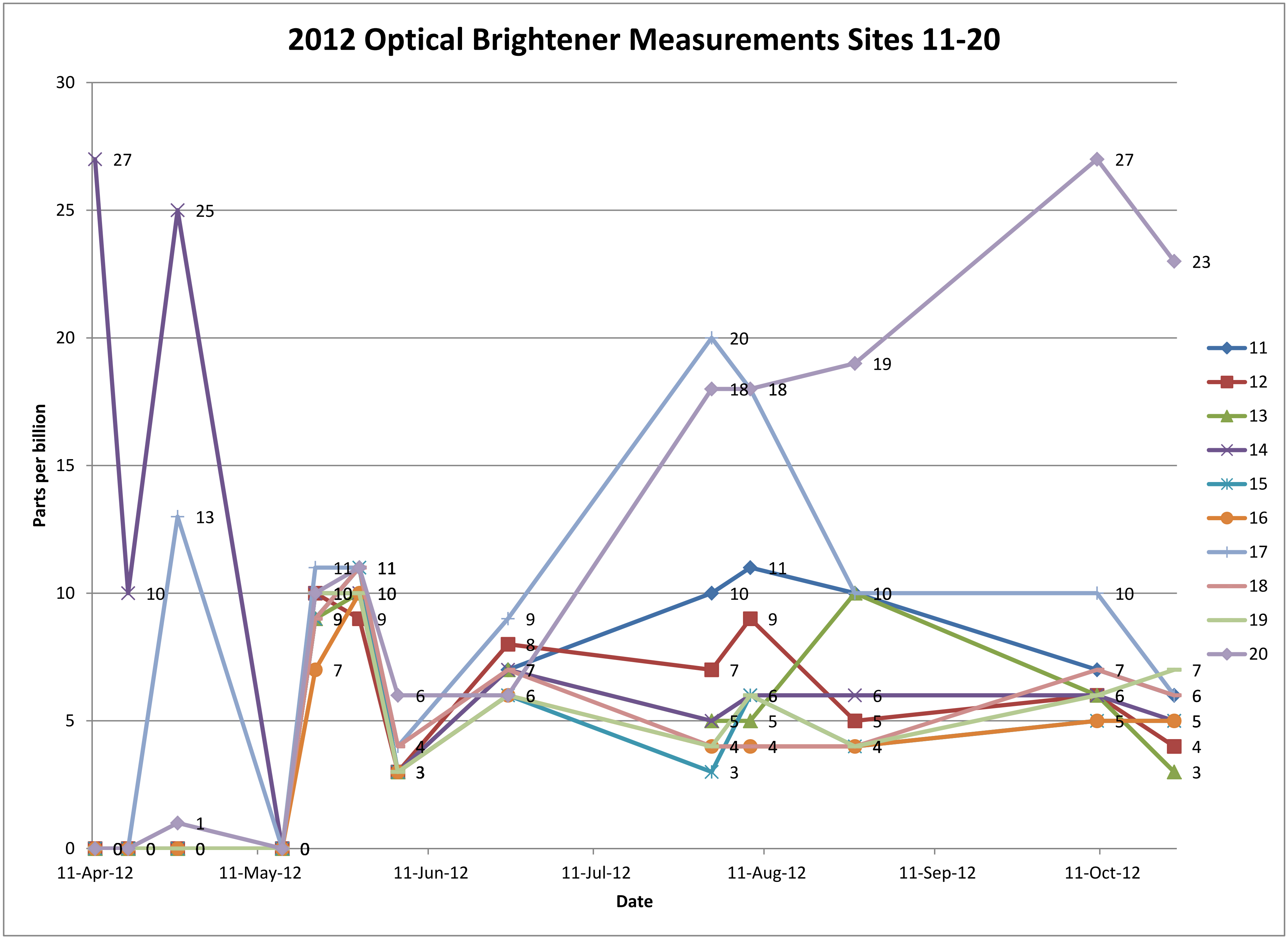
2012 Optical Brightener Measurements Sites 11-20
Parts per billion
Date
0
5
10
15
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25
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11-Apr-12
11-May-12
11-Jun-12
11-Jul-12
11-Aug-12
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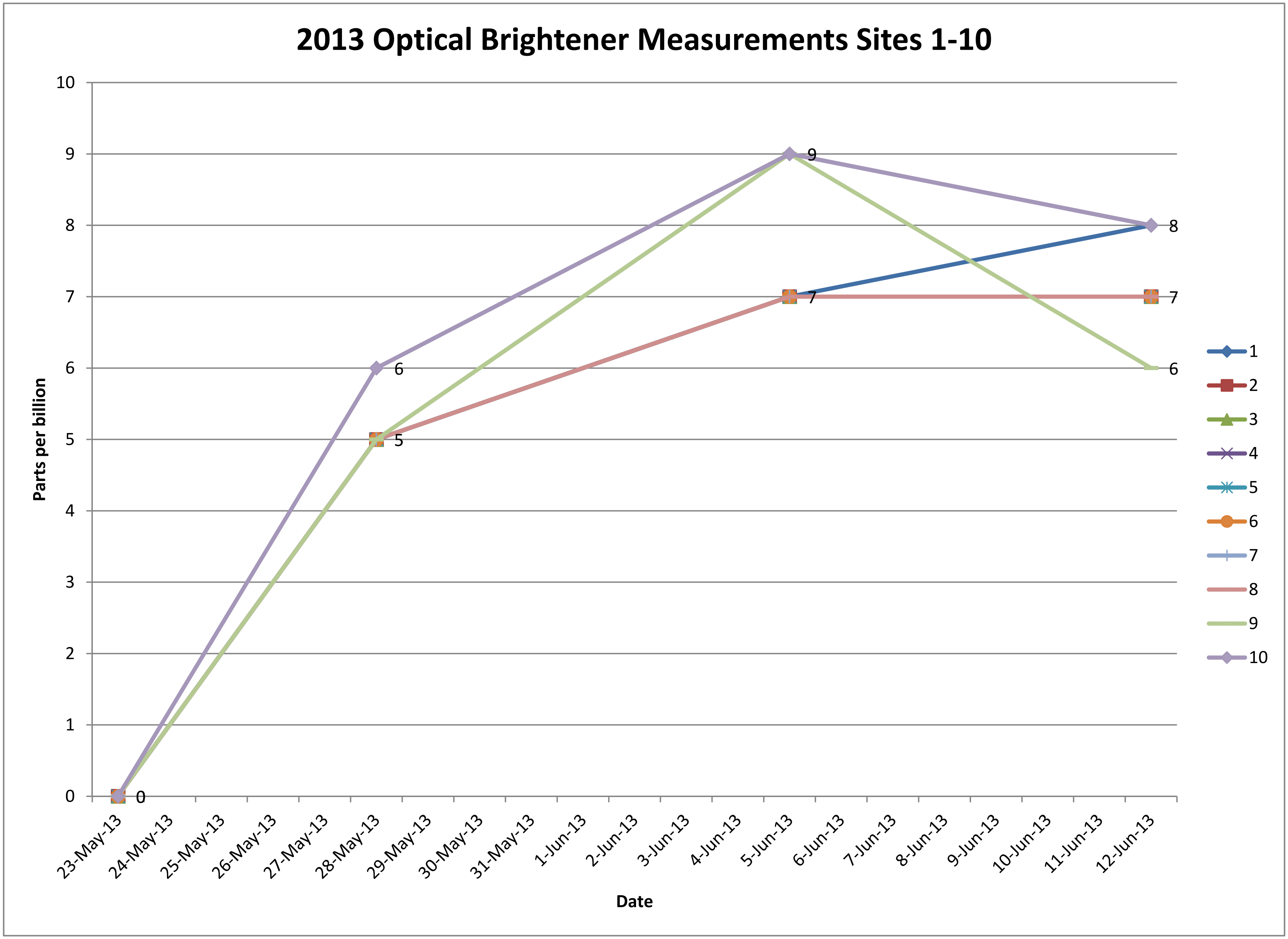

2013 Optical Brightener Measurements Sites 1-10
Parts per billion
Date
0
1
2
3
4
5
6
7
8
9
10
23-May-13
24-May-13
25-May-13
26-May-13
27-May-13
28-May-13
29-May-13
30-May-13
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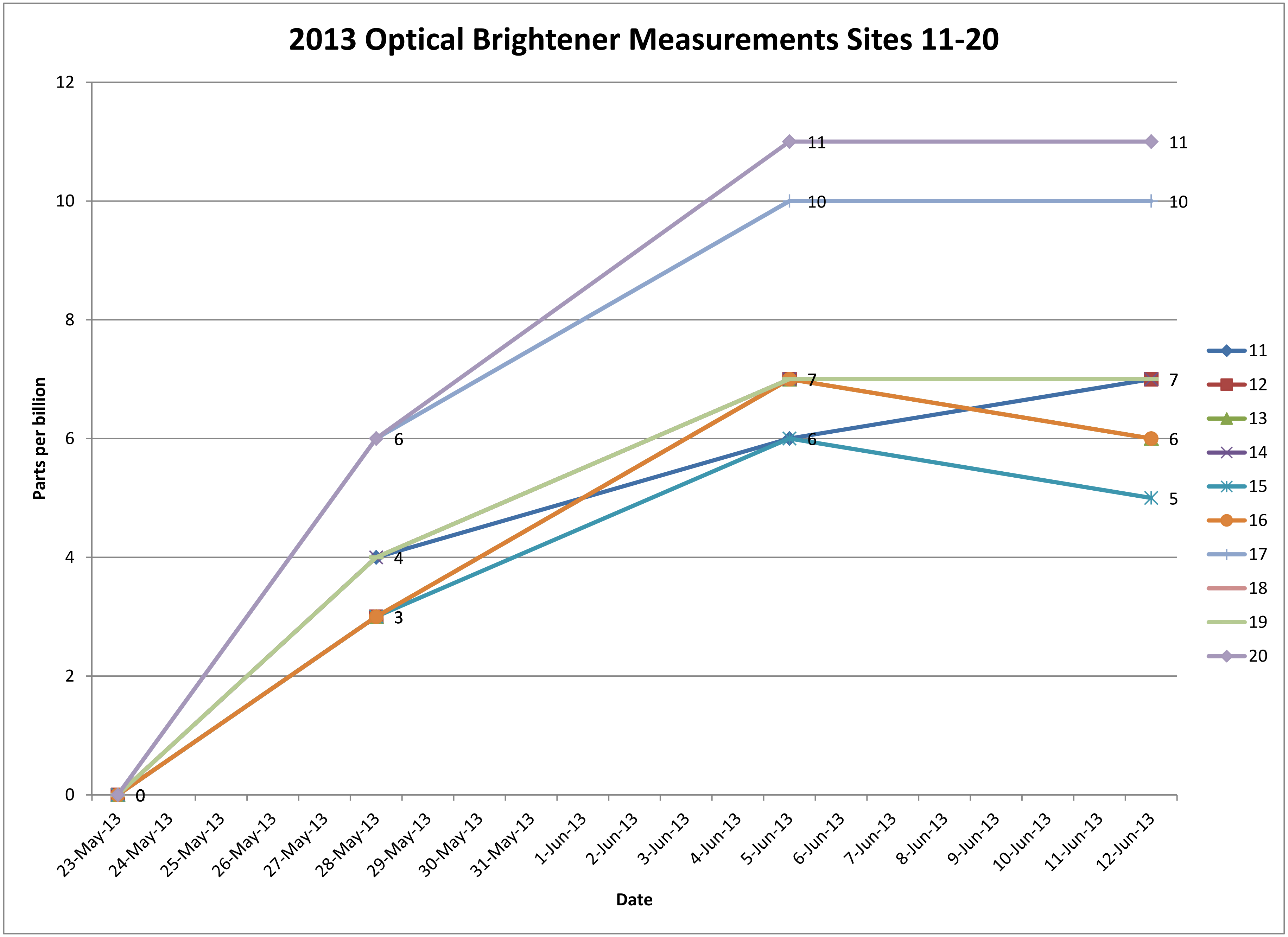
2013 Optical Brightener Measurements Sites 11-20
Parts per billion
Date
0
2
4
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23-May-13
24-May-13
25-May-13
26-May-13
27-May-13
28-May-13
29-May-13
30-May-13
31-May-13
1-Jun-13
2-Jun-13
3-Jun-13
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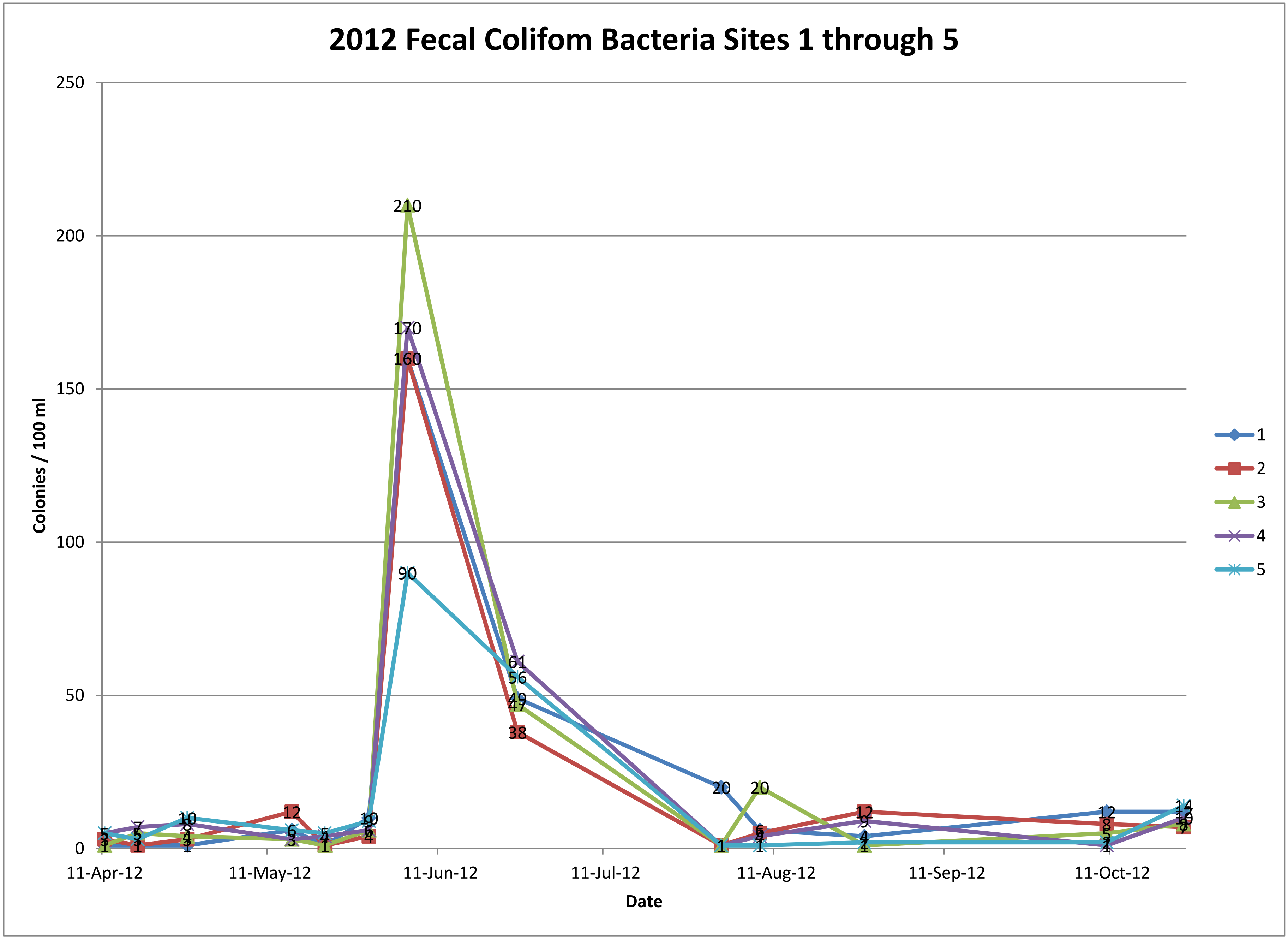
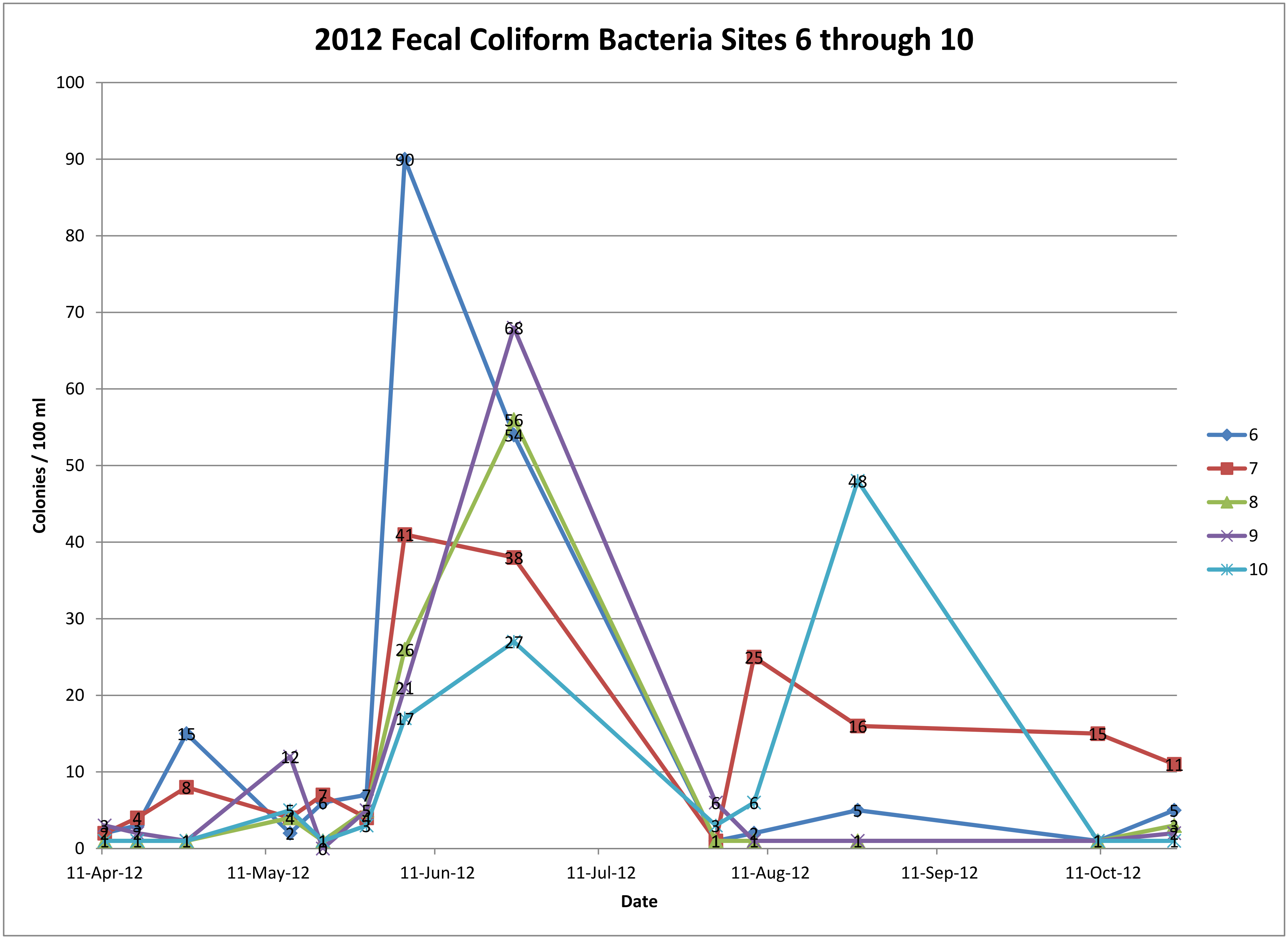

2012 Fecal Colifom Bacteria Sites 1 through 5
Colonies / 100 ml
250
200
150
100
50
0
210
170
160
90
61
56
49
47
38
20
20
12
12
12
11-Apr-12
11-May-12
11-Jun-12
11-Jul-12
11-Aug-12
11-Sep-12
11-Oct-12
Date
1
2
3
4
5


2012 Fecal Coliform Bacteria Sites 6 through 10
Colonies / 100 ml
Date
0
10
20
30
40
50
60
70
80
90
100
11-Apr-12
11-May-12
11-Jun-12
11-Jul-12
11-Aug-12
11-Sep-12
11-Oct-12
6
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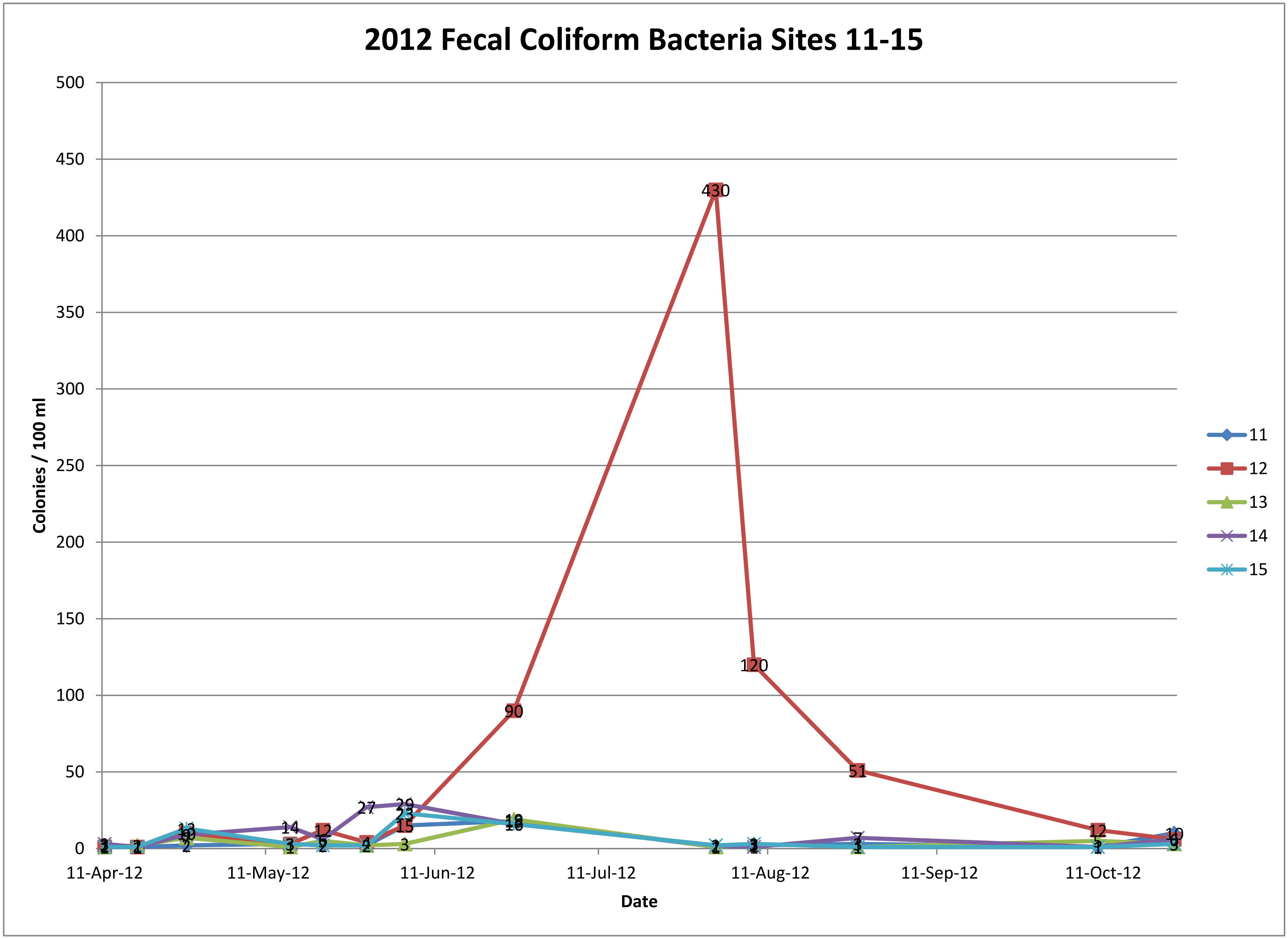

2012 Fecal Coliform Bacteria Sites 11-15
Colonies / 100 ml
500
450
400
350
300
250
200
150
100
50
0
11-Apr-12
11-May-12
11-Jun-12
11-Jul-12
11-Aug-12
11-Sep-12
11-Oct-12
Date
430
120
90
51
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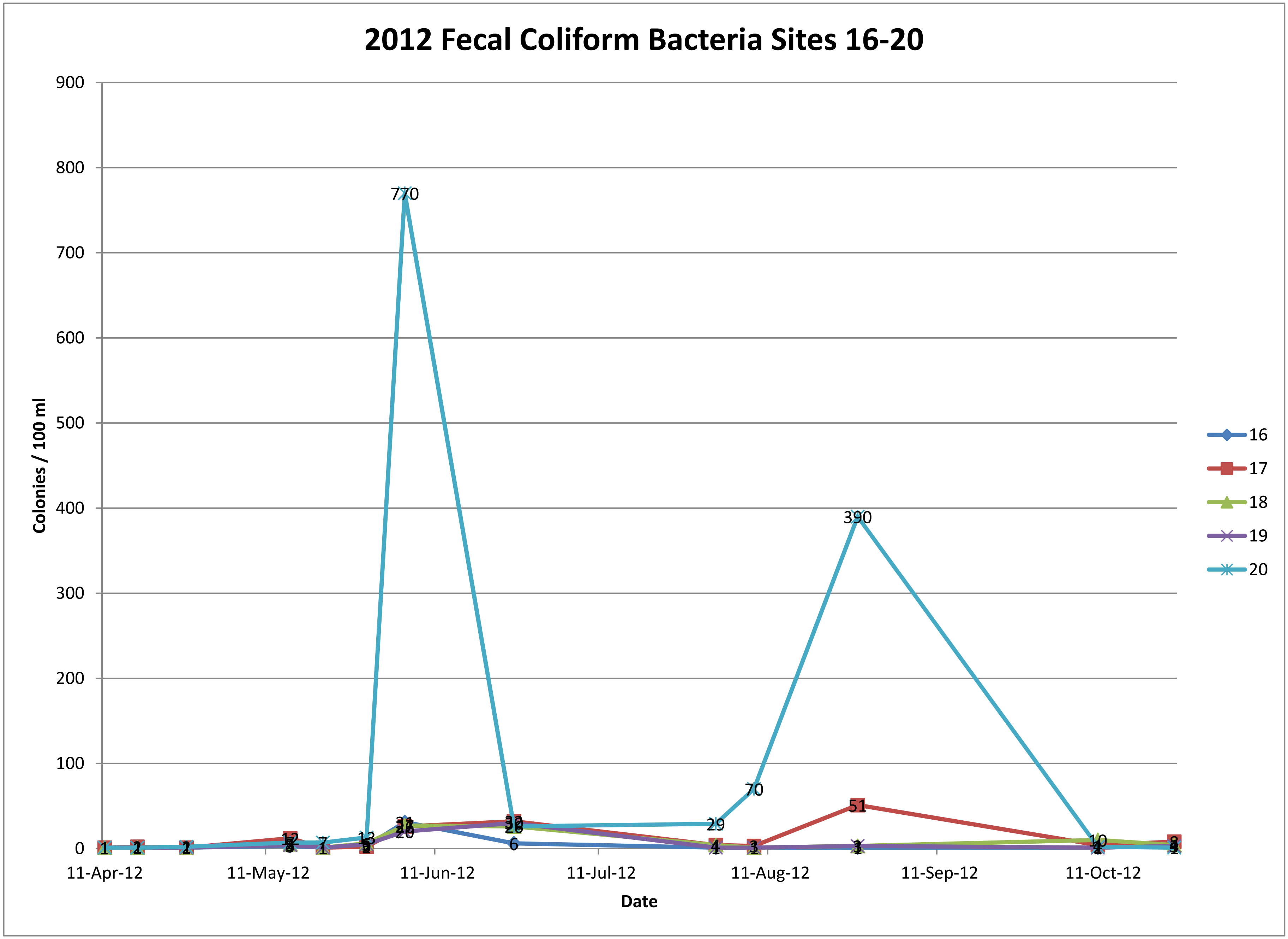
11
12
13
14
15


2012 Fecal Coliform Bacteria Sites 16-20
Colonies / 100 ml
900
800
700
600
500
400
300
200
100
0
11-Apr-12
11-May-12
11-Jun-12
11-Jul-12
11-Aug-12
11-Sep-12
11-Oct-12
Date
770
390
70
51
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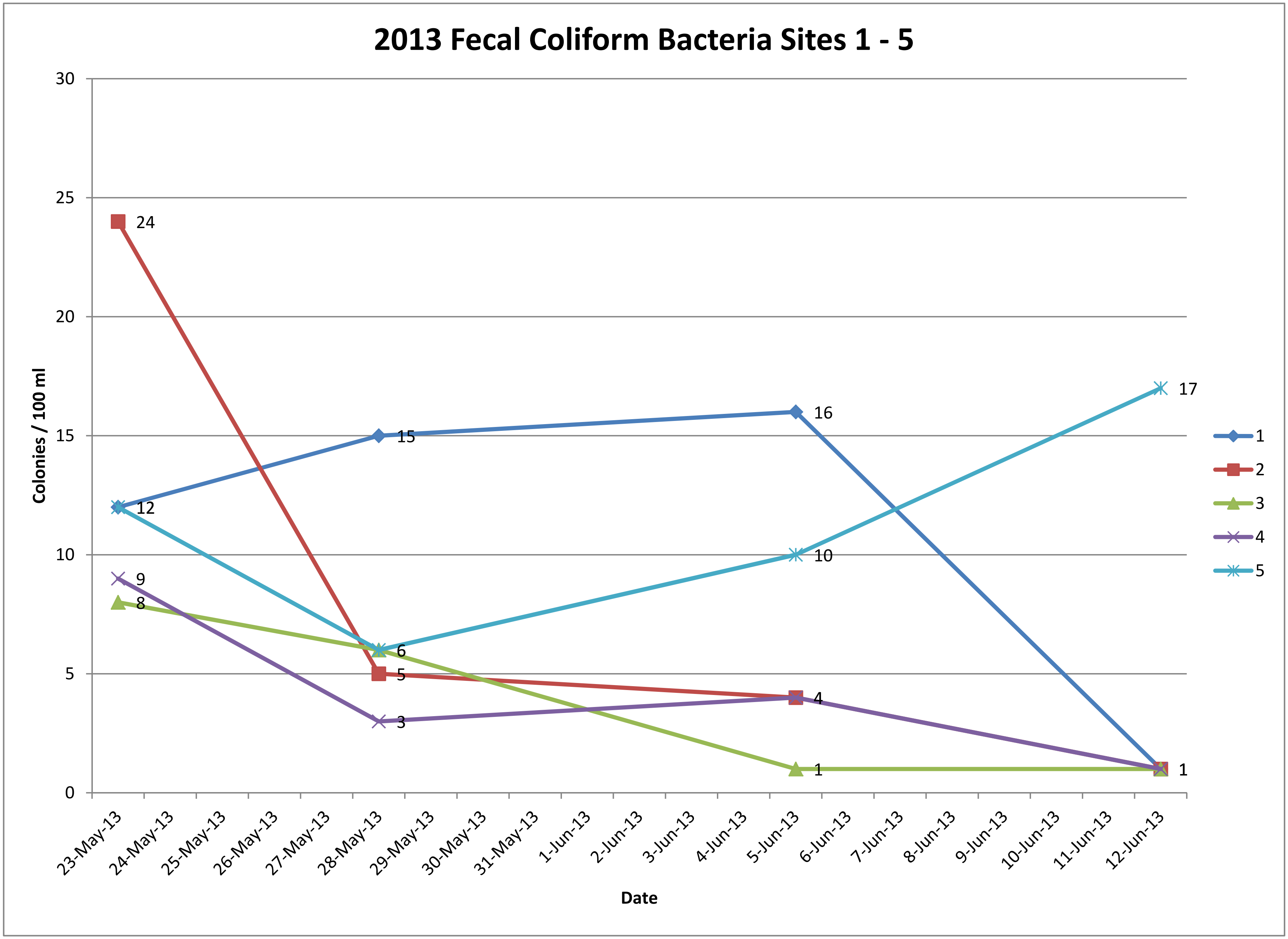
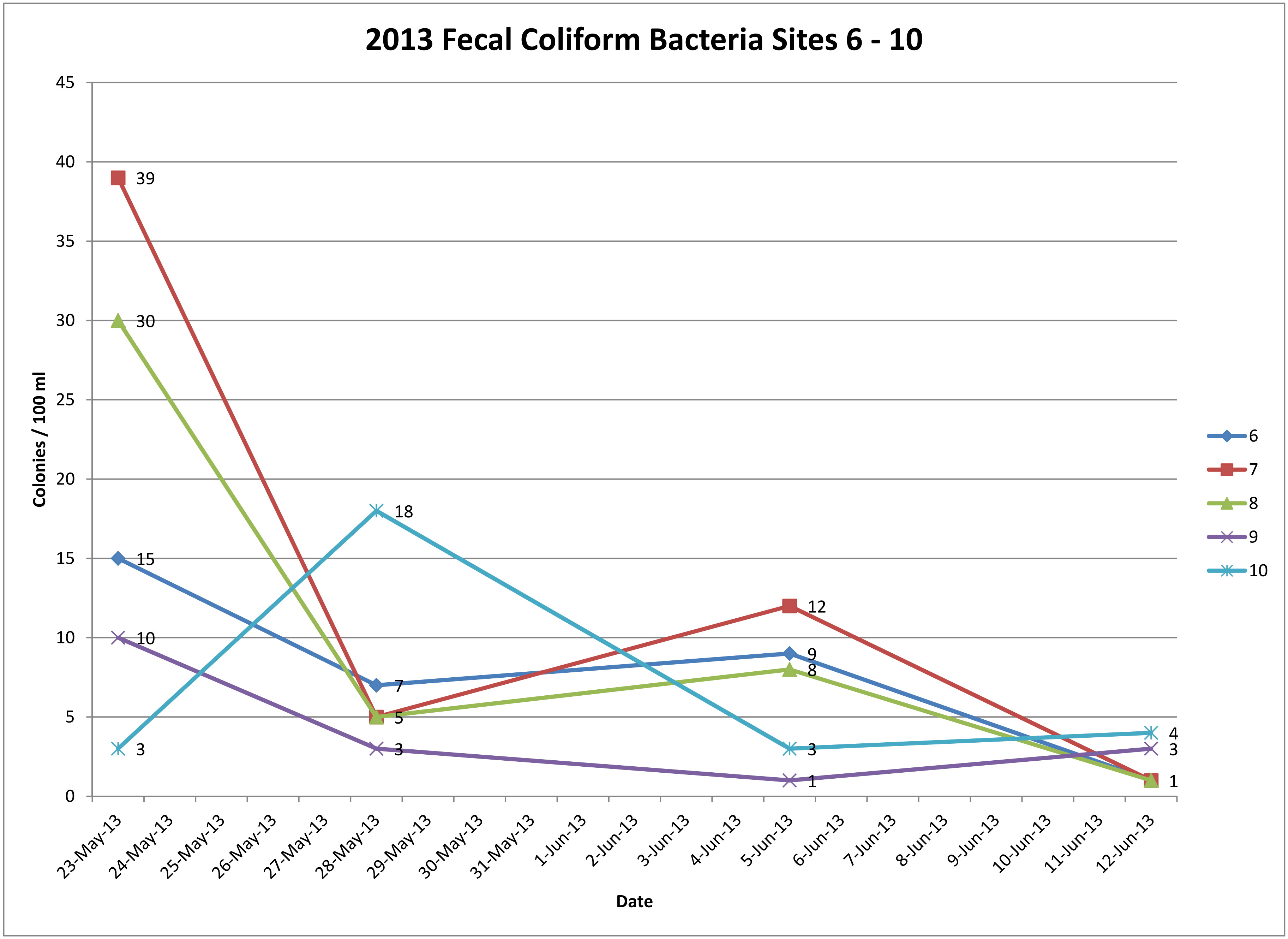
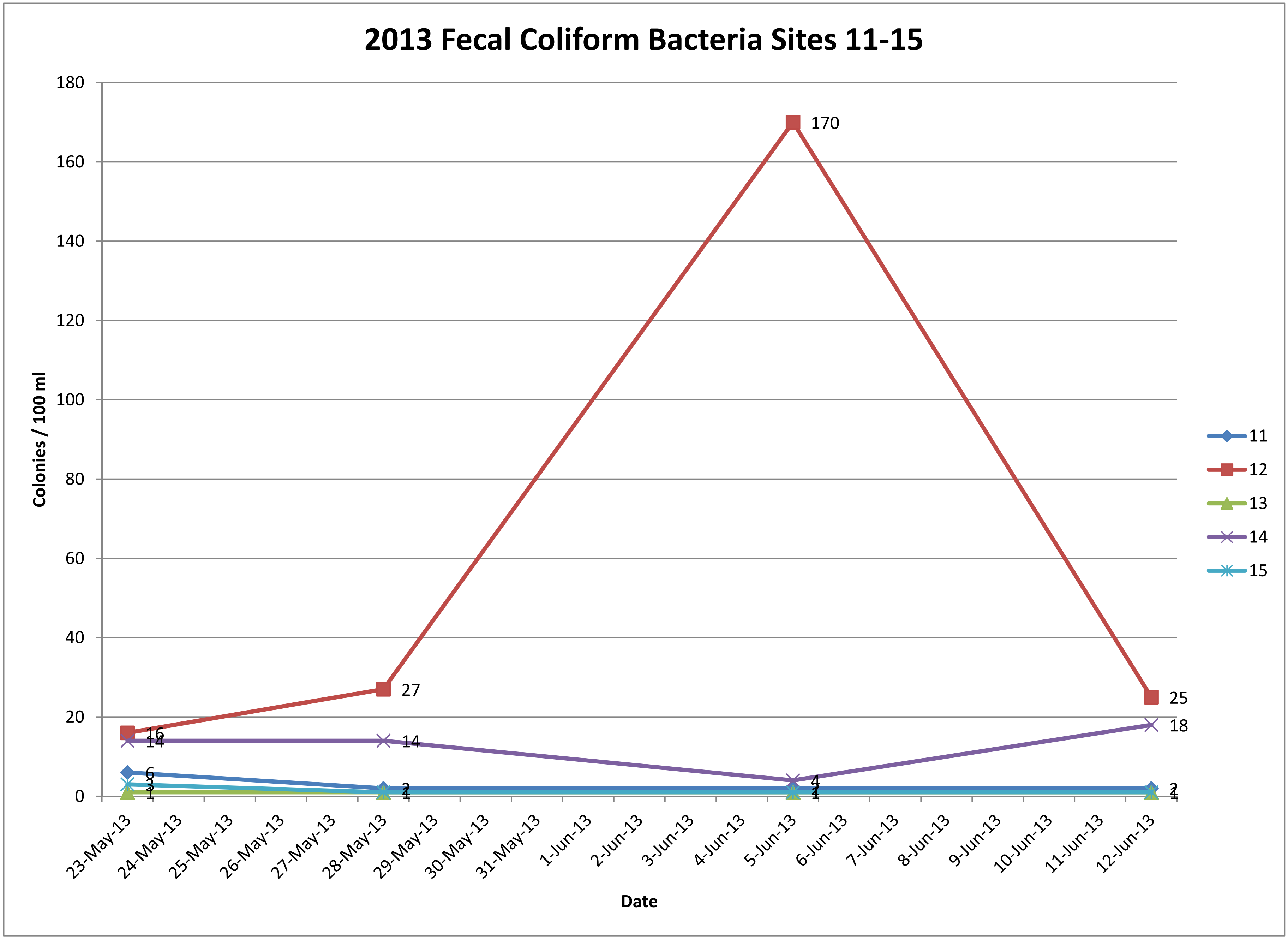
16
17
18
19
20

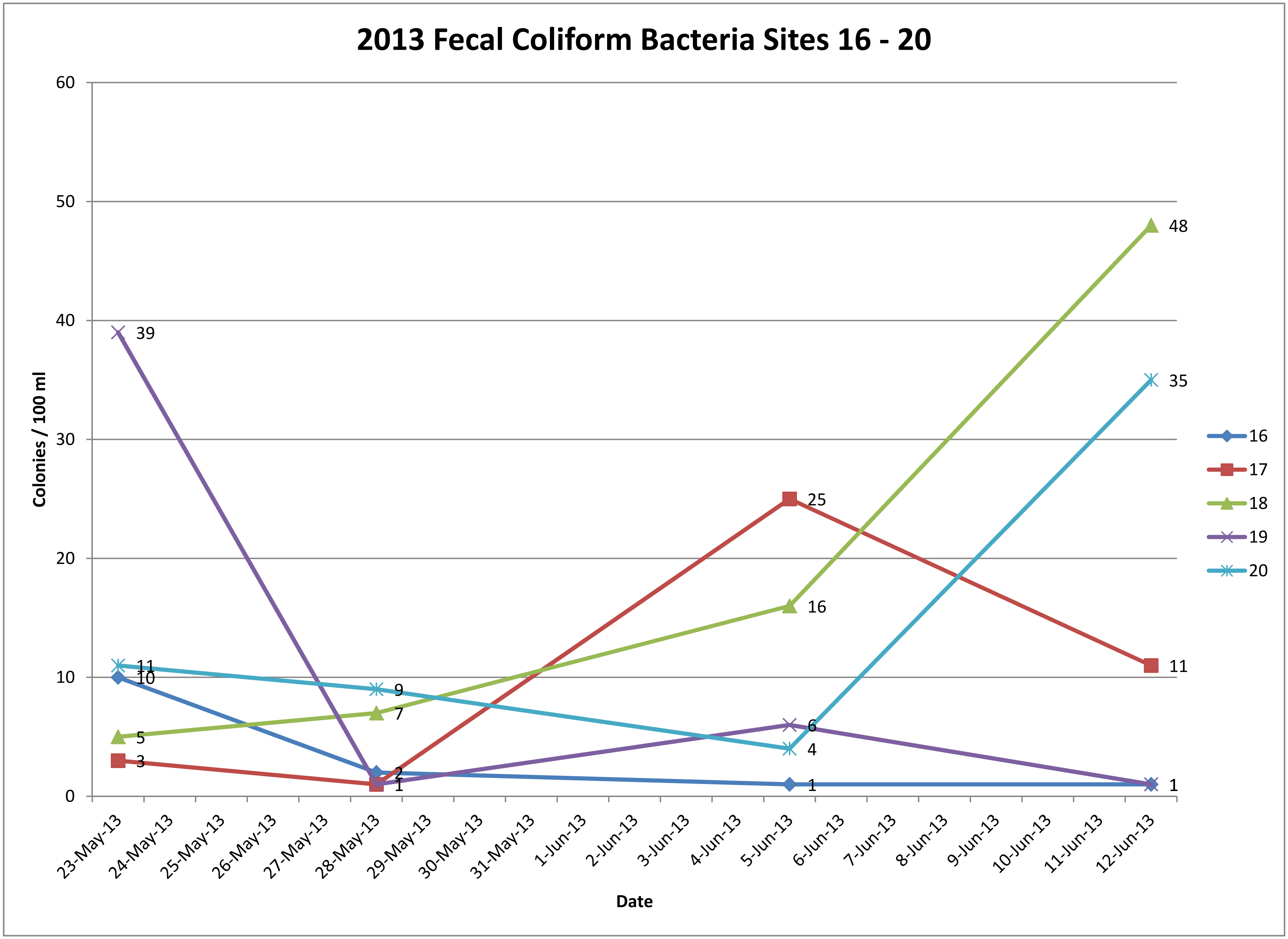


2013 Fecal Coliform Bacteria Sites 1 - 5
Colonies / 100 ml
0
5
10
15
20
25
30
24
15
16
17
12
10
9
8
6
5
4
3
1
1
23-May-13
24-May-13
25-May-13
26-May-13
27-May-13
28-May-13
29-May-13
30-May-13
31-May-13
1-Jun-13
2-Jun-13
3-Jun-13
4-Jun-13
5-Jun-13
6-Jun-13
7-Jun-13
8-Jun-13
9-Jun-13
10-Jun-13
11-Jun-13
12-Jun-13
Date
1
2
3
4
5

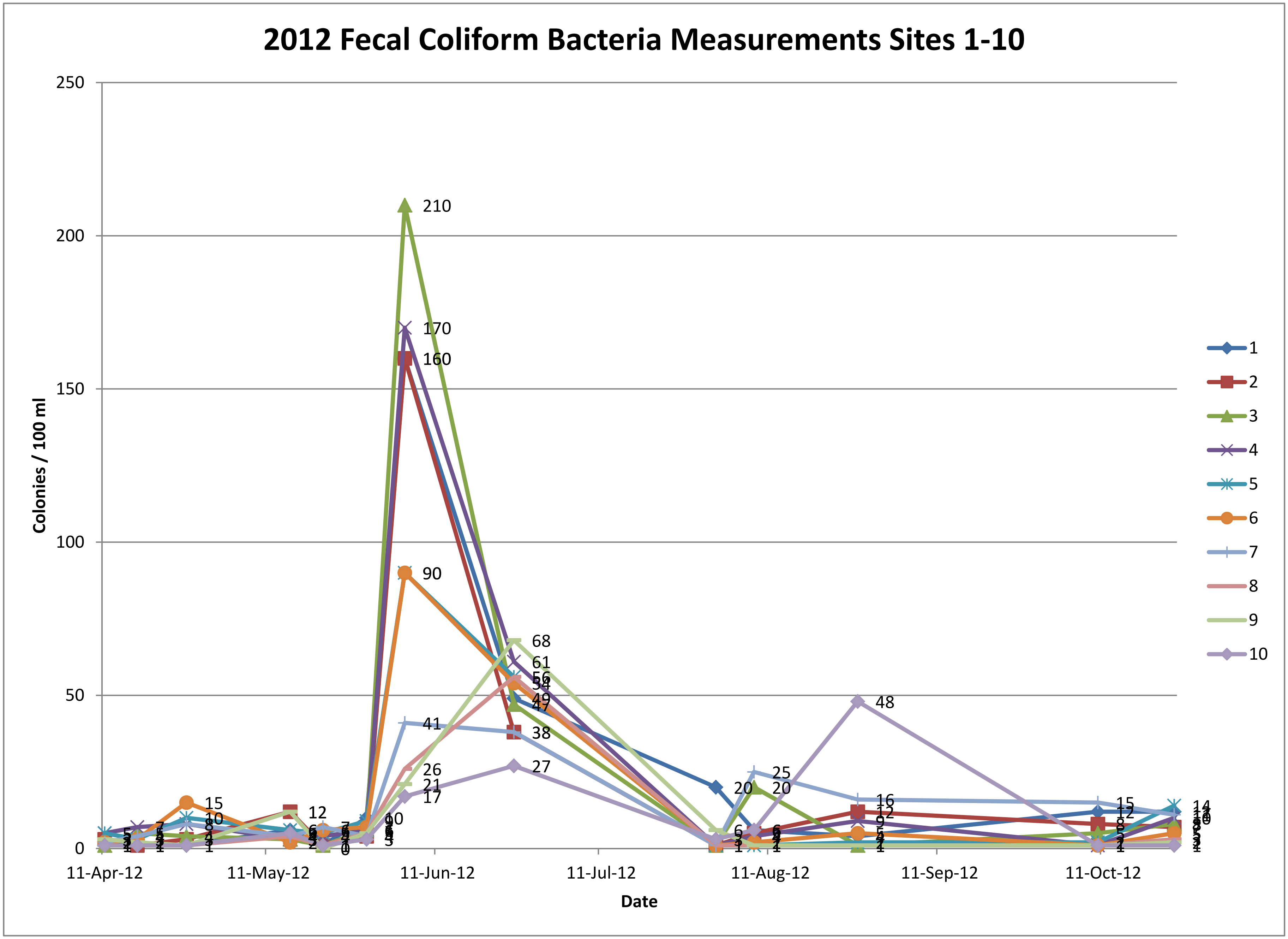

2013 Fecal Coliform Bacteria Sites 6 - 10
Colonies / 100 ml
Date
0
5
10
15
20
25
30
35
40
45
23-May-13
24-May-13
25-May-13
26-May-13
27-May-13
28-May-13
29-May-13
30-May-13
31-May-13
1-Jun-13
2-Jun-13
3-Jun-13
4-Jun-13
5-Jun-13
6-Jun-13
7-Jun-13
8-Jun-13
9-Jun-13
10-Jun-13
11-Jun-13
12-Jun-13
39
30
15
10
3
18
7
5
3
12
9
8
3
1
4
3
1
6
7
8
9
10



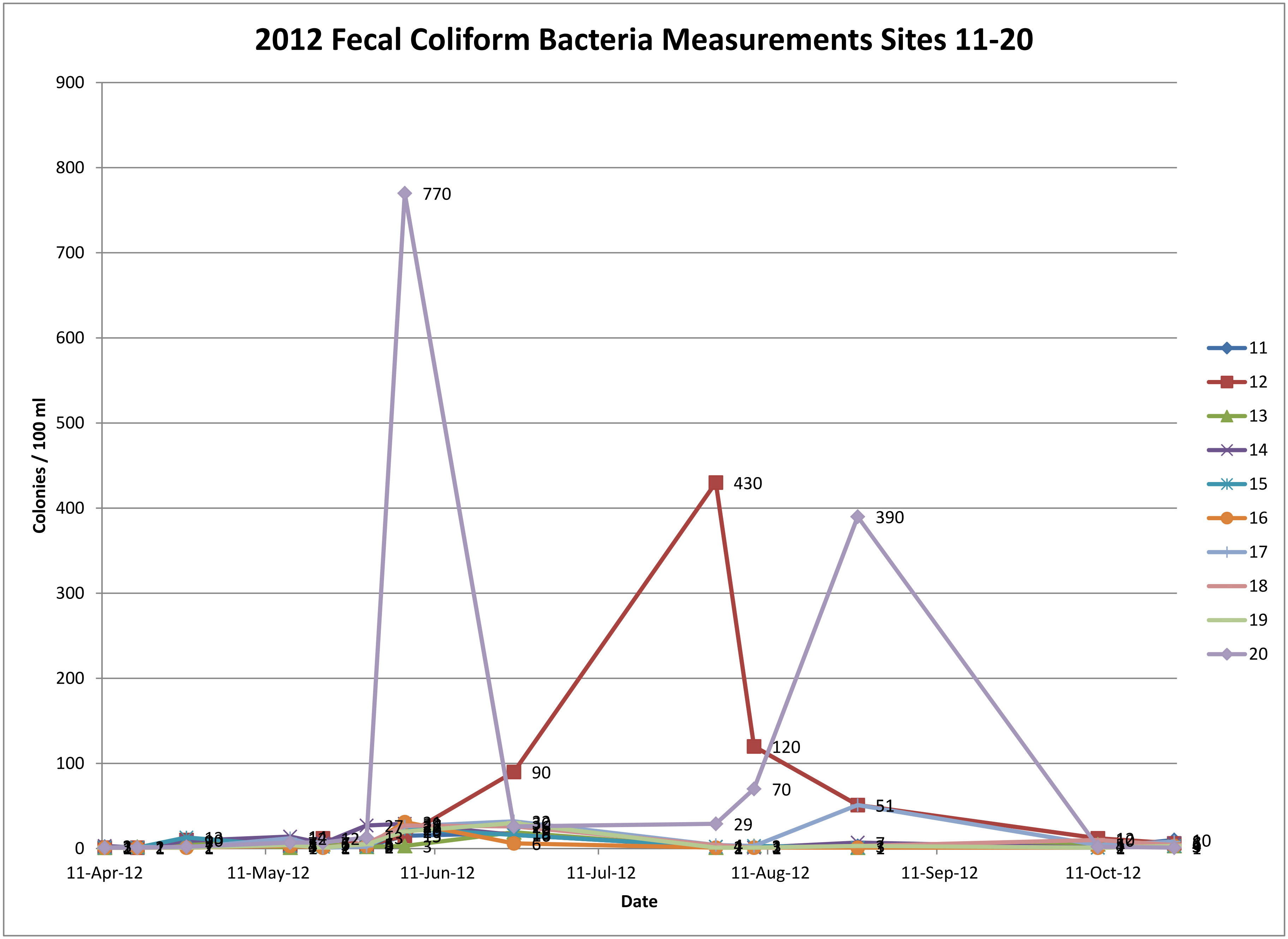
2013 Fecal Coliform Bacteria Sites 11-15
Colonies / 100 ml
180
160
140
120
100
80
60
40
20
0
170
27
25
16
14
14
18
6
4
Date
23-May-13
24-May-13
25-May-13
26-May-13
27-May-13
28-May-13
29-May-13
30-May-13
31-May-13
1-Jun-13
2-Jun-13
3-Jun-13
4-Jun-13
5-Jun-13
6-Jun-13
7-Jun-13
8-Jun-13
9-Jun-13
10-Jun-13
11-Jun-13
12-Jun-13
11
12
13
14
15



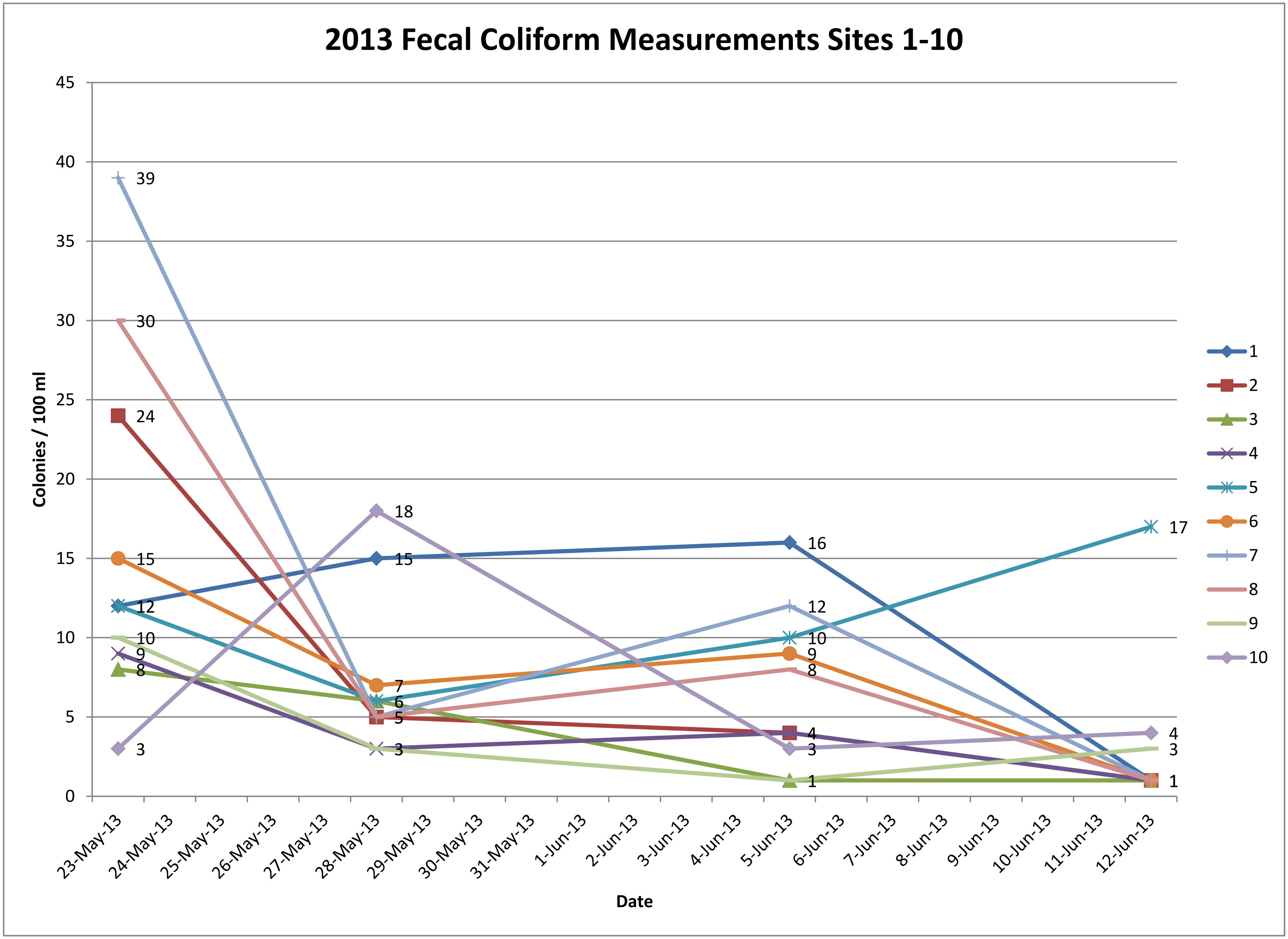
2013 Fecal Coliform Bacteria Sites 16 - 20
Colonies / 100 ml
Date
60
50
40
30
20
10
0
23-May-13
24-May-13
25-May-13
26-May-13
27-May-13
28-May-13
29-May-13
30-May-13
31-May-13
1-Jun-13
2-Jun-13
3-Jun-13
4-Jun-13
5-Jun-13
6-Jun-13
7-Jun-13
8-Jun-13
9-Jun-13
10-Jun-13
11-Jun-13
12-Jun-13
39
11
10
5
3
9
7
2
1
25
16
6
4
1
48
35
11
1
16
17
18
19
20



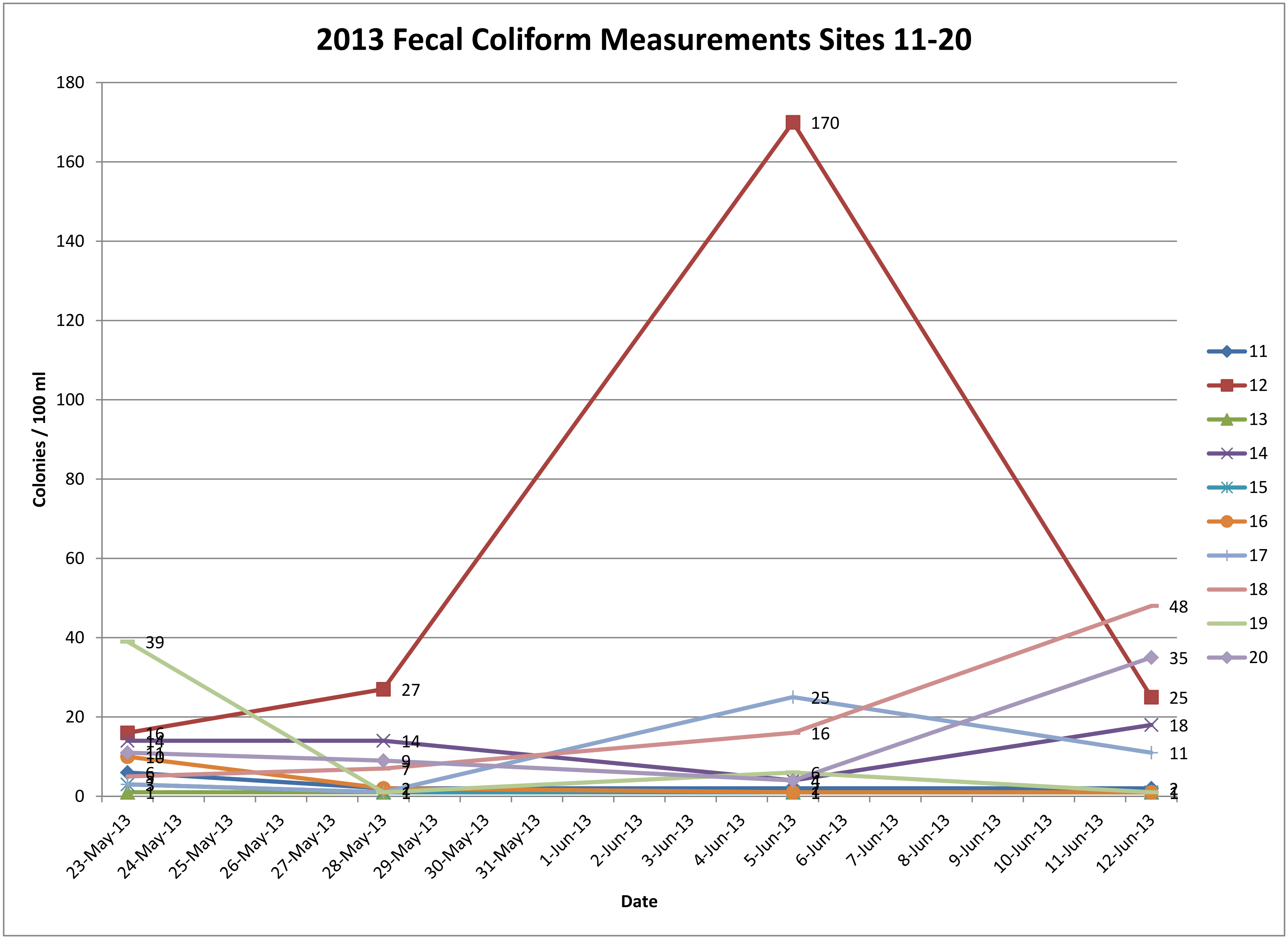
2012 Fecal Coliform Bacteria Measurements Sites 1-10
Colonies / 100 ml
Date
0
50
100
150
200
250
11-Apr-12
11-May-12
11-Jun-12
11-Jul-12
11-Aug-12
11-Sep-12
11-Oct-12
1
2
3
4
5
6
7
8
9
10
210
170
160
90
68
61
56
54
49
47
38
41
27
26
21
17
48
25
20
20
16
15
15
12
12
14



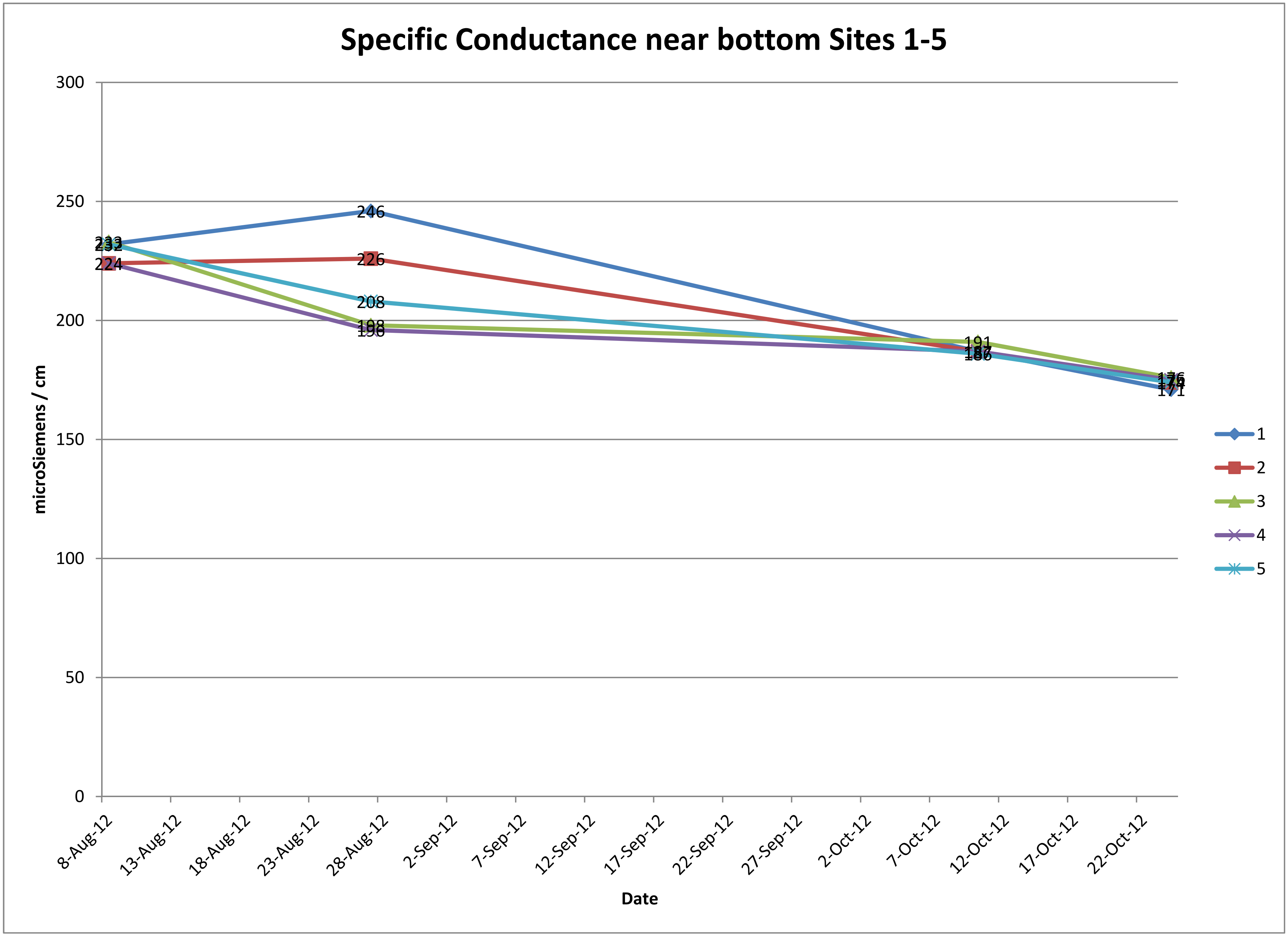
2012 Fecal Coliform Bacteria Measurements Sites 11-20
Colonies / 100 ml
Date
0
100
200
300
400
500
600
700
800
900
11-Apr-12
11-May-12
11-Jun-12
11-Jul-12
11-Aug-12
11-Sep-12
11-Oct-12
770
430
390
120
90
70
51
29
27
11
12
13
14
15
16
17
18
19
20

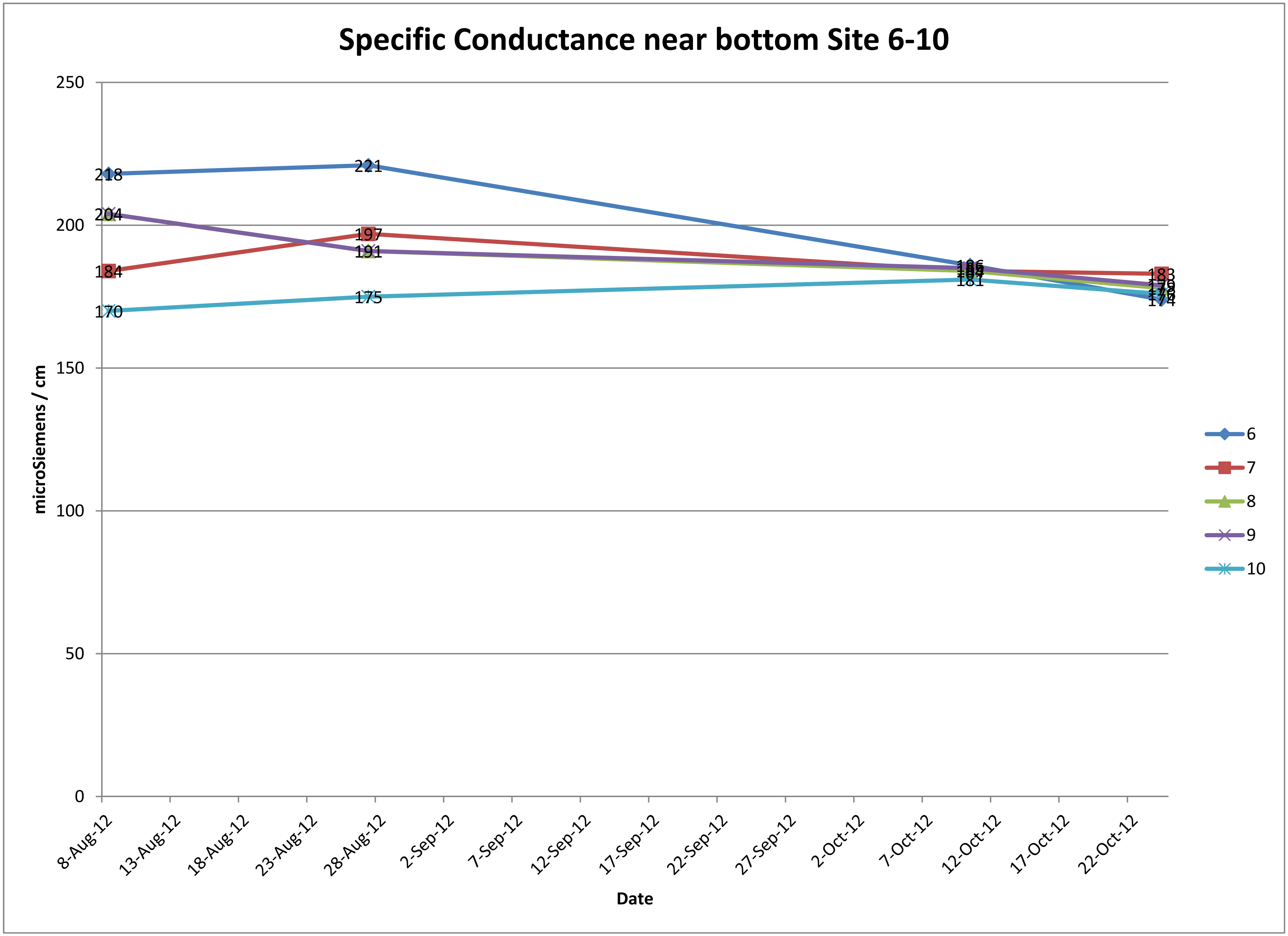


2013 Fecal Coliform Measurements Sites 1-10
Colonies / 100 ml
Date
45
40
35
30
25
20
15
10
5
0
23-May-13
24-May-13
25-May-13
26-May-13
27-May-13
28-May-13
29-May-13
30-May-13
31-May-13
1-Jun-13
2-Jun-13
3-Jun-13
4-Jun-13
5-Jun-13
6-Jun-13
7-Jun-13
8-Jun-13
9-Jun-13
10-Jun-13
11-Jun-13
12-Jun-13
39
30
24
15
12
10
9
8
3
18
15
7
6
5
3
16
12
10
9
8
4
3
1
17
4
3
1
1
2
3
4
5
6
7
8
9
10

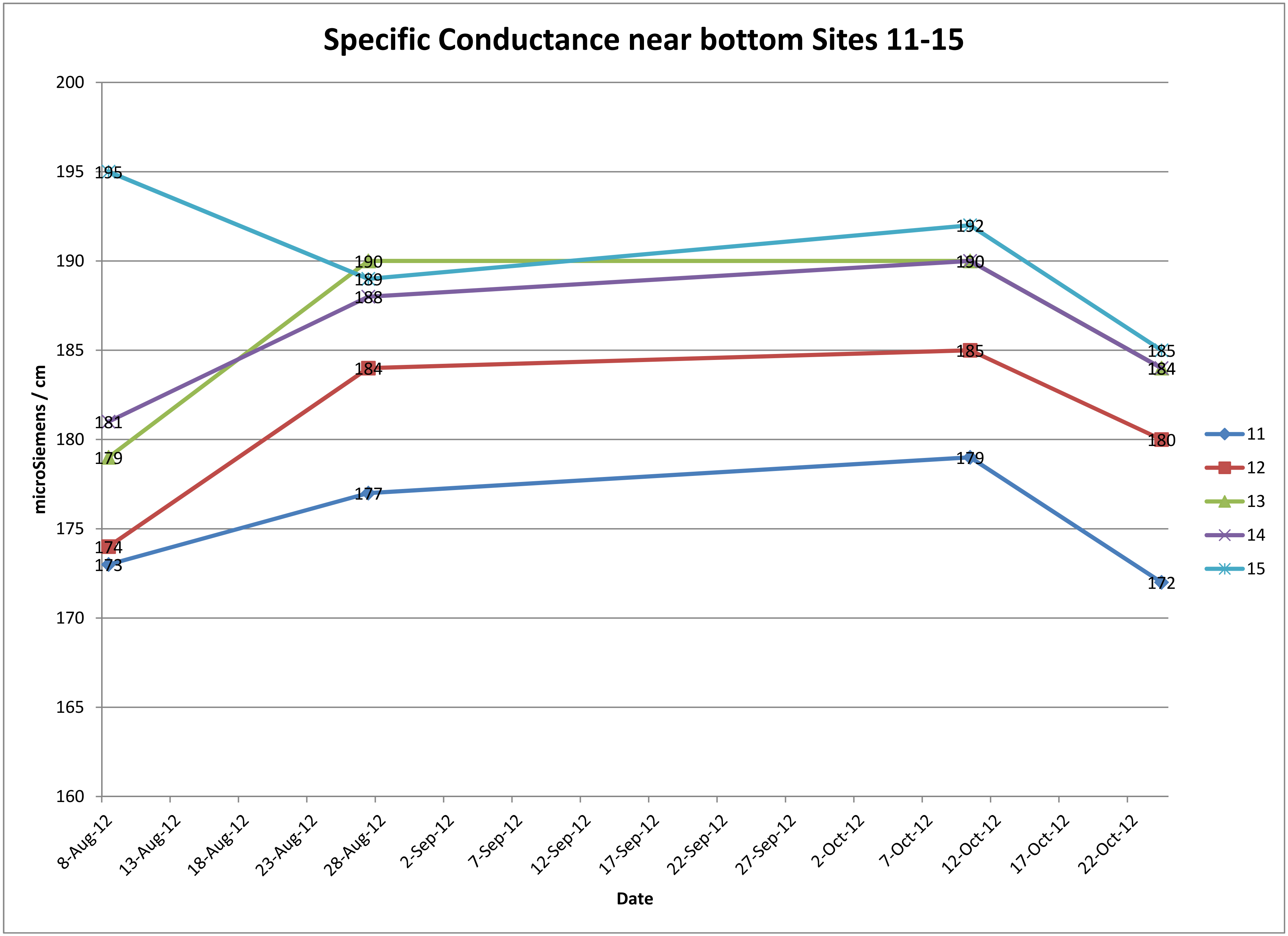


2013 Fecal Coliform Measurements Sites 11-20
Colonies / 100 ml
180
160
140
120
100
80
60
40
20
0
170
48
39
35
27
25
25
16
18
16
14
11
Date
23-May-13
24-May-13
25-May-13
26-May-13
27-May-13
28-May-13
29-May-13
30-May-13
31-May-13
1-Jun-13
2-Jun-13
3-Jun-13
4-Jun-13
5-Jun-13
6-Jun-13
7-Jun-13
8-Jun-13
9-Jun-13
10-Jun-13
11-Jun-13
12-Jun-13
11
12
13
14
15
16
17
18
19
20

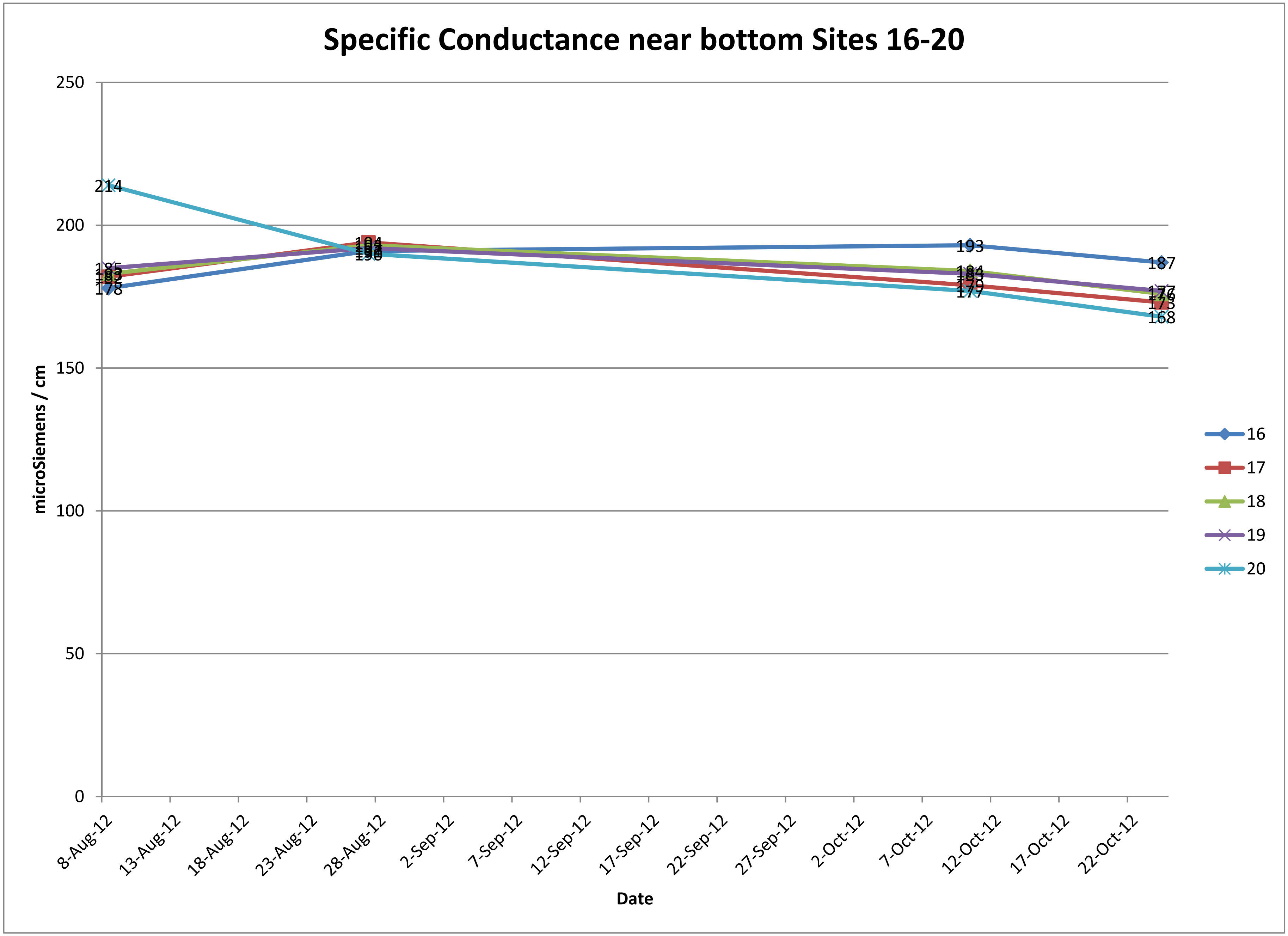

Specific Conductance near bottom Sites 1-5
microSiemens / cm
300
250
200
150
100
50
0
246
233
232
224
226
208
198
196
191
187
186
176
174
171
8-Aug-12
13-Aug-12
18-Aug-12
23-Aug-12
28-Aug-12
2-Sep-12
7-Sep-12
12-Sep-12
17-Sep-12
22-Sep-12
27-Sep-12
2-Oct-12
7-Oct-12
12-Oct-12
17-Oct-12
22-Oct-12
Date
1
2
3
4
5



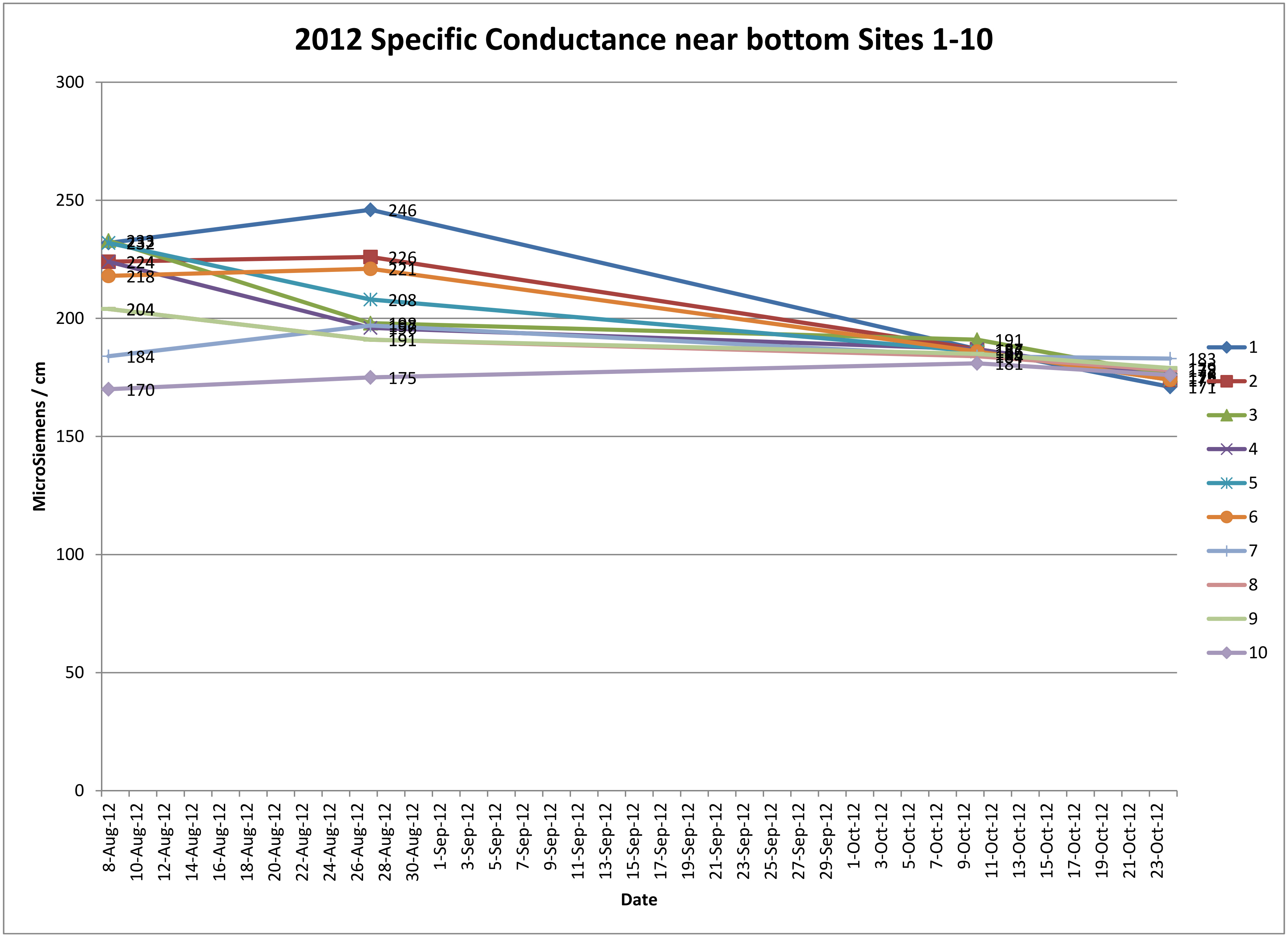
Specific Conductance near bottom Site 6-10
microSiemens / cm
250
200
150
100
50
0
218
221
204
197
191
184
175
170
181
183
174
8-Aug-12
13-Aug-12
18-Aug-12
23-Aug-12
28-Aug-12
2-Sep-12
7-Sep-12
12-Sep-12
17-Sep-12
22-Sep-12
27-Sep-12
2-Oct-12
7-Oct-12
12-Oct-12
17-Oct-12
22-Oct-12
Date
6
7
8
9
10



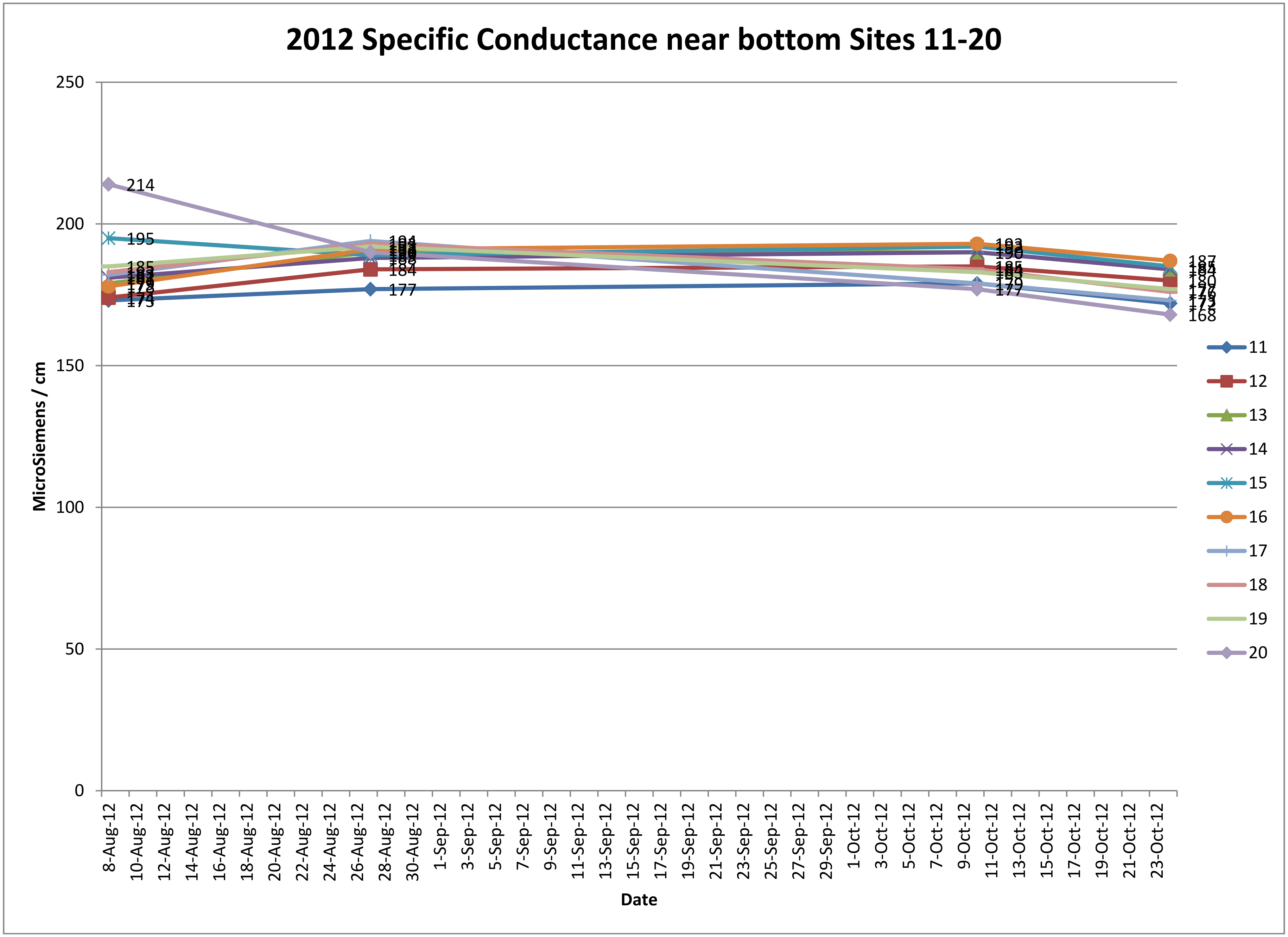
Specific Conductance near bottom Sites 11-15
microSiemens / cm
200
195
190
185
180
175
170
165
160
195
189
192
185
190
190
190
188
184
184
185
180
181
179
174
173
177
179
172
8-Aug-12
13-Aug-12
18-Aug-12
23-Aug-12
28-Aug-12
2-Sep-12
7-Sep-12
12-Sep-12
17-Sep-12
22-Sep-12
27-Sep-12
2-Oct-12
7-Oct-12
12-Oct-12
17-Oct-12
22-Oct-12
Date
11
12
13
14
15



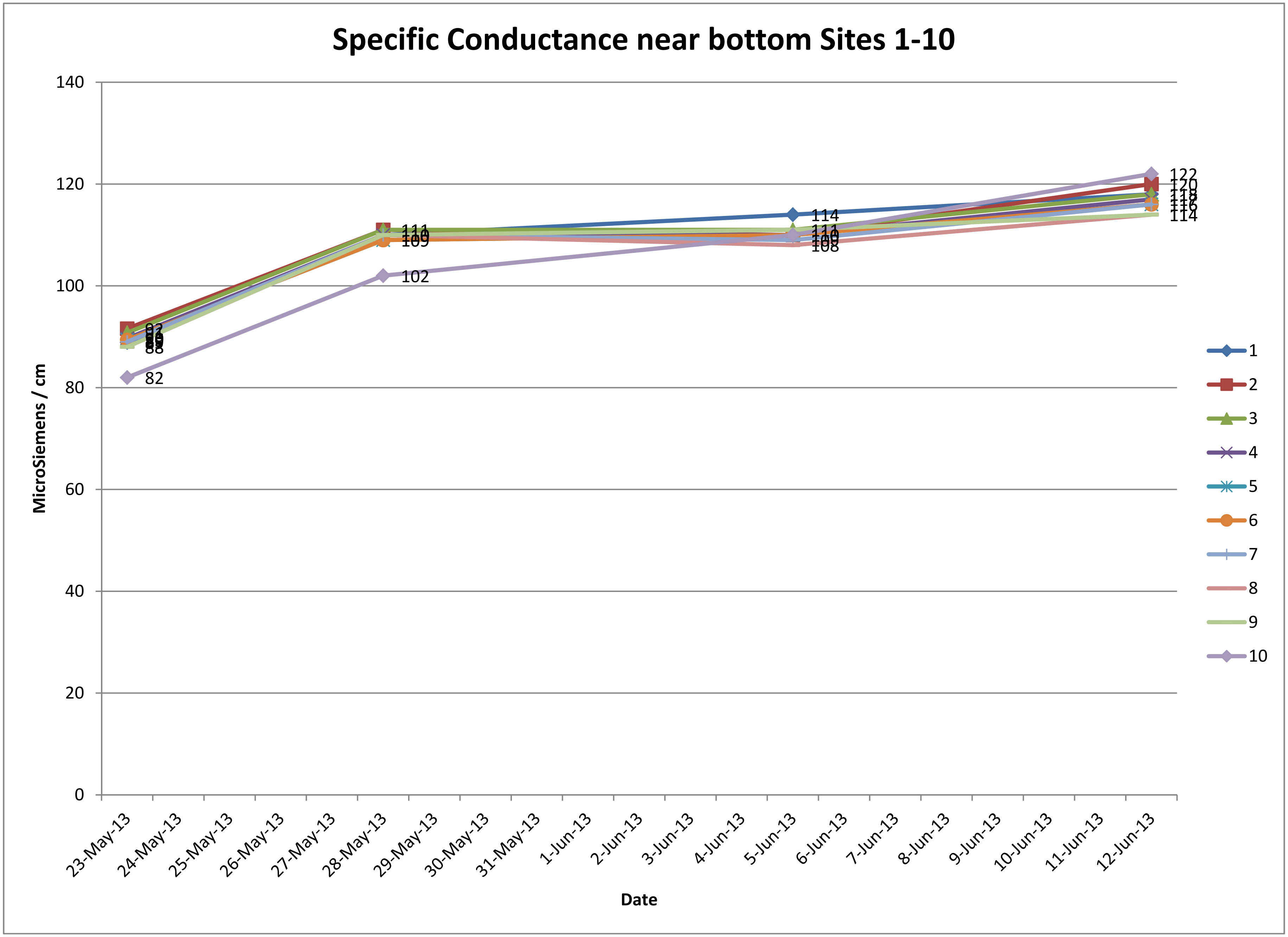
Specific Conductance near bottom Sites 16-20
250
200
150
100
50
0
microSiemens / cm
214
185
178
193
187
168
8-Aug-12
13-Aug-12
18-Aug-12
23-Aug-12
28-Aug-12
2-Sep-12
7-Sep-12
12-Sep-12
17-Sep-12
22-Sep-12
27-Sep-12
2-Oct-12
7-Oct-12
12-Oct-12
17-Oct-12
22-Oct-12
Date
16
17
18
19
20



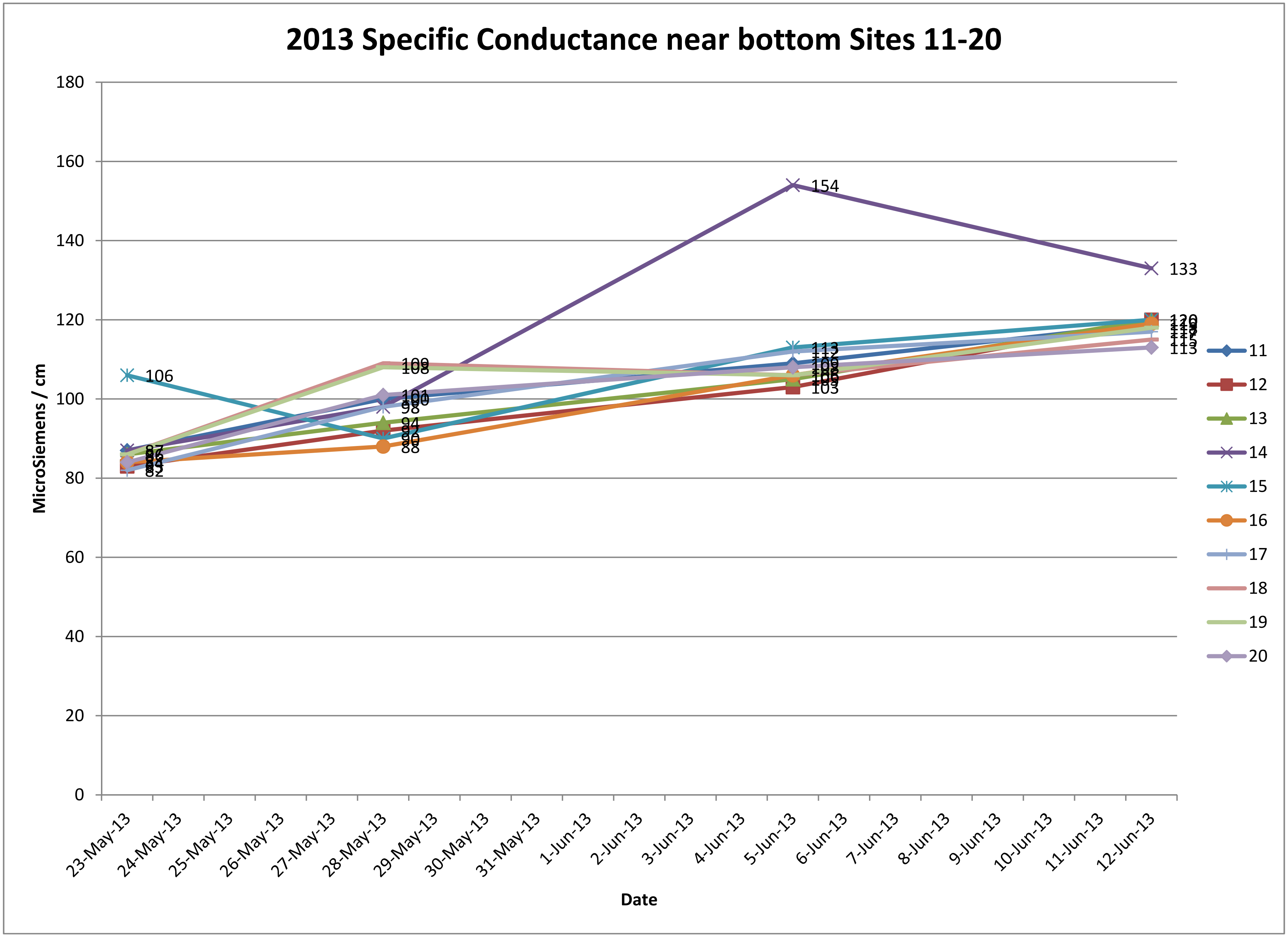
2012 Specific Conductance near bottom Sites 1-10
MicroSiemens / cm
Date
300
250
200
150
100
50
0
8-Aug-12
10-Aug-12
12-Aug-12
14-Aug-12
16-Aug-12
18-Aug-12
20-Aug-12
22-Aug-12
24-Aug-12
26-Aug-12
28-Aug-12
30-Aug-12
1-Sep-12
3-Sep-12
5-Sep-12
7-Sep-12
9-Sep-12
11-Sep-12
13-Sep-12
15-Sep-12
17-Sep-12
19-Sep-12
21-Sep-12
23-Sep-12
25-Sep-12
27-Sep-12
29-Sep-12
1-Oct-12
3-Oct-12
5-Oct-12
7-Oct-12
9-Oct-12
11-Oct-12
13-Oct-12
15-Oct-12
17-Oct-12
19-Oct-12
21-Oct-12
23-Oct-12
246
224
218
204
184
170
226
221
208
191
175
191
181
183
171
1
2
3
4
5
6
7
8
9
10



2012 Specific Conductance near bottom Sites 11-20
MicroSiemens / cm
Date
250
200
150
100
50
0
8-Aug-12
10-Aug-12
12-Aug-12
14-Aug-12
16-Aug-12
18-Aug-12
20-Aug-12
22-Aug-12
24-Aug-12
26-Aug-12
28-Aug-12
30-Aug-12
1-Sep-12
3-Sep-12
5-Sep-12
7-Sep-12
9-Sep-12
11-Sep-12
13-Sep-12
15-Sep-12
17-Sep-12
19-Sep-12
21-Sep-12
23-Sep-12
25-Sep-12
27-Sep-12
29-Sep-12
1-Oct-12
3-Oct-12
5-Oct-12
7-Oct-12
9-Oct-12
11-Oct-12
13-Oct-12
15-Oct-12
17-Oct-12
19-Oct-12
21-Oct-12
23-Oct-12
214
195
185
177
184
177
168
11
12
13
14
15
16
17
18
19
20



Specific Conductance near bottom Sites 1-10
140
120
100
80
60
40
20
0
MicroSiemens / cm
23-May-13
24-May-13
25-May-13
26-May-13
27-May-13
28-May-13
29-May-13
30-May-13
31-May-13
1-Jun-13
2-Jun-13
3-Jun-13
4-Jun-13
5-Jun-13
6-Jun-13
7-Jun-13
8-Jun-13
9-Jun-13
10-Jun-13
11-Jun-13
12-Jun-13
Date
82
102
114
108
122
120
114
1
2
3
4
5
6
7
8
9
10



2013 Specific Conductance near bottom Sites 11-20
MicroSiemens / cm
Date
180
160
140
120
100
80
60
40
20
0
23-May-13
24-May-13
25-May-13
26-May-13
27-May-13
28-May-13
29-May-13
30-May-13
31-May-13
1-Jun-13
2-Jun-13
3-Jun-13
4-Jun-13
5-Jun-13
6-Jun-13
7-Jun-13
8-Jun-13
9-Jun-13
10-Jun-13
11-Jun-13
12-Jun-13
154
133
106
103
113
88
11
12
13
14
15
16
17
18
19
20

Lake Spokane Water Quality Monitoring Results - 2012-13

LSOPBR 1 N 47.79941 W 117.57126										
	04/11/12	**04/17/12**	**04/26/12**	**05/15/12**	**05/21/12**	**05/29/12**	**06/05/12**	**06/25/12**	**08/01/12**	**08/08/12**
Time	9:22	9:37	9:41	9:39	9:26	9:37	9:52	9:34	8:43	10:39
Optical brightener (ppb)	0	0	1	0	10	11	5	7	4	4
Sec chi (FT)		6.5	4.0	5.5	5.5	10.0	10.0	12.0	4.0	16
Fecal coliform (col / 100 ml)	1	<1	<1	6	<1	10	160	49	20	6
Depth 1 (FT)										3
Temperature (^{o}C)										18.0
DO (mg/L)										13.0
pH										8.0
Specific Conductance (µS/cm)										233
Depth 2 (FT)										15
Temperature (^{o}C)										17.4
DO (mg/L)										13.1
pH										8.0
Specific Conductance (µS/cm)										232
	08/27/12	**10/10/12**	**10/24/12**	**5/23/13**	**5/28/13**	**6/5/13**	**6/12/13**			
Time	9:29	9:40	9:29	8:46	8:30	8:32	8:39			
Optical brightener (ppb)	3	5	7	0	5	7	8			
Sec chi (FT)	14	15	13	12	10	17	18			
Fecal coliform (col / 100 ml)	4	12	12	12	15	16	1			
Depth 1 (FT)	3	3	3	3	3	3	3			
Temperature (^{o}C)	19.6	11.4	9.4	12.8	13.7	14.99	16.06			
DO (mg/L)	14.4	9.0	10.4	10.9	9.9	9.67	9.39			
pH	8.5	6.4	6.3	7	6.9	5.94	6.01			
Specific Conductance (µS/cm)	208	188	173	89	111	114	118			
Depth 2 (FT)	15	15	15	15	15	15	15			
Temperature (^{o}C)	15.1	11.3	9.5	12.8	13.7	14.88	16.04			
DO (mg/L)	12.6	9.4	9.5	10.8	10.5	9.7	9.6			
pH	8.2	7.1	7.6	7.1	7.1	6.54	6.85			
Specific Conductance (µS/cm)	246	187	171	89	110	114	118			

Lake Spokane Water Quality Monitoring Results - 2012-13

LSOPBR 2	N 47.79693	W 117.58504								
	04/11/12	04/17/12	04/26/12	05/15/12	05/21/12	05/29/12	06/05/12	06/25/12	08/01/12	08/08/12
Time	9:28	9:43	9:52	9:45	9:30	9:42	9:57	9:41	8:52	10:51
Optical brightener (ppb)	0	0	0.3	0	10	12	5	7	6	6
Sec chi (FT)		6.0	3.5	4.5	4.5	7.0	6.5	8.0	5	8
Fecal coliform (col / 100 ml)	3	<1	3	12	<1	4	160	38	<1	5
Depth 1 (FT)										3
Temperature (^{o}C)										24.4
DO (mg/L)										15.3
pH										8.4
Specific Conductance (μS/cm)										197
Depth 2 (FT)										8
Temperature (^{o}C)										22.9
DO (mg/L)										11.2
pH										7.9
Specific Conductance (μS/cm)										224

	08/27/12	10/10/12	10/24/12	5/23/13	5/28/13	6/5/13	6/12/13
Time	9:36	9:48	9:52	8:46	8:37	8:39	8:44
Optical brightener (ppb)	10	5	7	0	5	7	7
Sec chi (FT)	6	7	7	7	7	8	7
Fecal coliform (col / 100 ml)	12	8	7	24	5	4	<1
Depth 1 (FT)	3	3	3	3	3	3	3
Temperature (^{o}C)	20.8	11.4	9.1	12.8	13.9	15.27	16.67
DO (mg/L)	15.7	9.0	9.5	10.9	10.5	10.8	10.46
pH	8.6	6.4	7.7	7.2	7.3	7.65	7.86
Specific Conductance (μS/cm)	203	188	174	91	111	112	120
Depth 2 (FT)	8	9	8	8	7	11	8
Temperature (^{o}C)	20.6	11.0	9.2	12.8	13.9	15.2	16.6
DO (mg/L)	9.5	10.1	9.2	10.9	10.6	11.1	11.3
pH	7.8	8.3	7.7	7.2	7.3	7.7	8.3
Specific Conductance (μS/cm)	226	187	174	92	111	110	120

Lake Spokane Water Quality Monitoring Results - 2012-13

LSOPBR 3 N 47.80007 W 117.59183										
	04/11/12	**04/17/12**	**04/26/12**	**05/15/12**	**05/21/12**	**05/29/12**	**06/05/12**	**06/25/12**	**08/01/12**	**08/08/12**
Time	9:32	9:48	9:57	9:48	9:34	9:45	9:59	9:46	8:57	10:57
Optical brightener (ppb)	0	0	0	0	10	11	5	8	4	5
Sec chi (FT)		5.5	3.5	4.5	4.5	6.5	6.0	7.5	10	9
Fecal coliform (col / 100 ml)	<1	5	4	3	<1	6	210	47	<1	20
Depth 1 (FT)										3
Temperature (^oC)										24.5
DO (mg/L)										14.2
pH										8.4
Specific Conductance (µS/cm)										185
Depth 2 (FT)										12
Temperature (^oC)										18.6
DO (mg/L)										13.7
pH										8.1
Specific Conductance (µS/cm)										233
	08/27/12	**10/10/12**	**10/24/12**	**5/23/13**	**5/28/13**	**6/5/13**	**6/12/13**			
Time	9:40	9:59	9:58	8:58	8:41	8:46	8:47			
Optical brightener (ppb)	5	5	7	0	5	7	7			
Sec chi (FT)	7	weeds	5	9	7	9	10			
Fecal coliform (col / 100 ml)	1	5	8	8	6	1	<1			
Depth 1 (FT)	3	3	3	3	3	3				
Temperature (^oC)	21.4	11.2	8.9	14	15.3	17.0				
DO (mg/L)	15.4	10.7	10.0	10.7	11.3	10.7				
pH	8.6	8.2	7.8	7.4	7.8	8.1				
Specific Conductance (µS/cm)	197	191	174	111	110	117				
Depth 2 (FT)	8.5	10	11	10	10	11				
Temperature (^oC)	21.3	11.2	8.9	14	15.2	16.8				
DO (mg/L)	15.2	11.4	9.5	10.8	11.5	10.4				
pH	8.6	8.3	7.8	7.5	7.8	8.0				
Specific Conductance (µS/cm)	198	191	176	111	111	118				

Lake Spokane Water Quality Monitoring Results - 2012-13

LSOPBR 4 **N 47.80400** **W 117.59865**										
	04/11/12	**04/17/12**	**04/26/12**	**05/15/12**	**05/21/12**	**05/29/12**	**06/05/12**	**06/25/12**	**08/01/12**	**08/08/12**
Time	9:35	9:54	10:00	9:52	9:37	9:49	10:02	9:49	9:00	11:02
Optical brightener (ppb)	0	0	0	0	10	11	5	8	4	5
Sec chi (FT)		6.0	3.0	4.5	5.0	6.0	5.5	8.5	weeds	9
Fecal coliform (col / 100 ml)	5	7	8	3	4	6	170	61	<1	4
Depth 1 (FT)										3
Temperature (^{o}C)										24.7
DO (mg/L)										14.3
pH										8.4
Specific Conductance (μS/cm)										184
Depth 2 (FT)										10
Temperature (^{o}C)										21.7
DO (mg/L)										10.1
pH										7.7
Specific Conductance (μS/cm)										224
	08/27/12	**10/10/12**	**10/24/12**	**5/23/13**	**5/28/13**	**6/5/13**	**6/12/13**			
Time	9:44	10:03	10:02	9:01	8:45	8:49	8:51			
Optical brightener (ppb)	4	6	7	0	5	7	7			
Sec chi (FT)	7	weeds	7	9	7	9	9			
Fecal coliform (col / 100 ml)	9	1	10	9	3	4	1			
Depth 1 (FT)	3	3	3	3	3	3	3			
Temperature (^{o}C)	21.8	11.4	9.4	12.8	14.1	15.4	16.9			
DO (mg/L)	15.5	9.8	9.8	11.2	10.7	11.5	10.3			
pH	8.7	8.1	7.9	7.3	7.5	7.9	8.0			
Specific Conductance (μS/cm)	196	184	174	90	110	110	117			
Depth 2 (FT)	8	10	11	10	10	9	9			
Temperature (^{o}C)	21.7	11.5	9.4	12.8	13.9	15.3	16.9			
DO (mg/L)	15.5	10.0	9.7	11.4	10.8	11.8	10.8			
pH	8.6	8.2	7.9	7.3	7.5	7.9	8.1			
Specific Conductance (μS/cm)	196	187	175	90	110	110	117			

Lake Spokane Water Quality Monitoring Results - 2012-13

LSOPBR 5	**N 47.80793**	**W 117.60249**								
	04/11/12	**04/17/12**	**04/26/12**	**05/15/12**	**05/21/12**	**05/29/12**	**06/05/12**	**06/25/12**	**08/01/12**	**08/08/12**
Time	9:40	9:56	10:04	9:55	9:40	9:52	10:05	9:52	9:05	11:06
Optical brightener (ppb)	0	0	0	0	9	11	5	8	4	13
Sec chi (FT)		6.0	3.0	3.0	5.0	6.5	6.0	8.0	4	14.7
Fecal coliform (col / 100 ml)	5	3	10	6	5	9	90	56	1	1
Depth 1 (FT)										3
Temperature (^oC)										24.7
DO (mg/L)										14.2
pH										8.4
Specific Conductance (μS/cm)										184
Depth 2 (FT)										14.5
Temperature (^oC)										18.2
DO (mg/L)										13.5
pH										8.2
Specific Conductance (μS/cm)										232
	08/27/12	**10/10/12**	**10/24/12**	**5/23/13**	**5/28/13**	**6/5/13**	**6/12/13**			
Time	9:49	10:07	10:07	9:05	8:48	8:52	8:54			
Optical brightener (ppb)	4	5	6	0	5	7	7			
Sec chi (FT)	7.5	13	10	10	8	14	11			
Fecal coliform (col / 100 ml)	2	2	14	12	6	10	17			
Depth 1 (FT)	3	3	3	3	3	3				
Temperature (^oC)	21.9	13.1	9.5	14.1	15.3	16.9				
DO (mg/L)	15.2	9.8	10.0	10.8	10.9	10.3				
pH	8.6	8.2	7.9	7.5	7.8	8.0				
Specific Conductance (μS/cm)	196	184	174	110	110	117				
Depth 2 (FT)	12.5	15	15	12	15	13				
Temperature (^oC)	21.6	11.3	9.5	13.9	15.3	16.8				
DO (mg/L)	15.2	9.6	9.7	11.3	11.4	10.3				
pH	8.6	8.1	7.9	7.6	7.8	7.9				
Specific Conductance (μS/cm)	208	186	174	109	110	116				

Lake Spokane Water Quality Monitoring Results - 2012-13

LSOPBR 6	N 47.8108	W 117.60576								
	04/11/12	**04/17/12**	**04/26/12**	**05/15/12**	**05/21/12**	**05/29/12**	**06/05/12**	**06/25/12**	**08/01/12**	**08/08/12**
Time	9:44	9:58	10:08	9:57	9:44	9:55	10:08	9:56	9:10	11:10
Optical brightener (ppb)	0	0	0	0	9	11	4	8	4	4
Sec chi (FT)		5.5	3.5	5.0	5.0	7.0	6.5	8.5	14.8	14.8
Fecal coliform (col / 100 ml)	2	3	15	2	6	7	90	54	<1	2
Depth 1 (FT)										3
Temperature (^oC)										24.6
DO (mg/L)										14.4
pH										8.4
Specific Conductance (μS/cm)										185
Depth 2 (FT)										14
Temperature (^oC)										21.1
DO (mg/L)										14.2
pH										8.3
Specific Conductance (μS/cm)										218
	08/27/12	**10/10/12**	**10/24/12**	**5/23/13**	**5/28/13**	**6/5/13**	**6/12/13**			
Time	9:52	10:12	10:10	9:08	8:52	8:55	8:58			
Optical brightener (ppb)	4	6	7	0	5	7	7			
Sec chi (FT)	14.8	13	11	11	9	14	12			
Fecal coliform (col / 100 ml)	5	<1	5	15	7	9	<1			
Depth 1 (FT)	3	3	3	3	3	3	3			
Temperature (^oC)	22.0	13.5	9.5	12.9	14.1	15.4	17.0			
DO (mg/L)	15.3	9.6	9.9	11.2	10.8	10.9	10.4			
pH	8.7	8.3	7.9	7.4	7.6	7.8	8.0			
Specific Conductance (μS/cm)	193	183	174	89.5	110	110	116			
Depth 2 (FT)	15	15	15	14	13	14	14			
Temperature (^oC)	19.3	12.3	9.5	12.9	14	15.3	16.9			
DO (mg/L)	15.1	9.5	9.6	11.5	11	11.4	10.4			
pH	8.5	8.2	7.9	7.4	7.6	7.8	8.0			
Specific Conductance (μS/cm)	221	186	174	89	109	110	116			

Lake Spokane Water Quality Monitoring Results - 2012-13

LSOPBR 7 N 47.81369 W 117.60798										
	04/11/12	**04/17/12**	**04/26/12**	**05/15/12**	**05/21/12**	**05/29/12**	**06/05/12**	**06/25/12**	**08/01/12**	**08/08/12**
Time	9:47	10:01	10:12	10:01	9:47	9:57	10:10	9:59	9:13	11:15
Optical brightener (ppb)	0	0	0	0	9	11	4	8	4	5
Sec chi (FT)		*4.0*	3.0	4.5	*3.5*	*4.5*	*4.5*	*4.5*	*5.0*	*5.0*
Fecal coliform (col / 100 ml)	2	4	8	4	7	4	41	38	1	25
Depth 1 (FT)										5
Temperature (^oC)										24.6
DO (mg/L)										14.7
pH										8.4
Specific Conductance (µS/cm)										184
Depth 2 (FT)										
Temperature (^oC)										
DO (mg/L)										
pH										
Specific Conductance (µS/cm)										
	08/27/12	**10/10/12**	**10/24/12**	**5/23/13**	**5/28/13**	**6/5/13**	**6/12/13**			
Time	9:56	10:17	10:16	9:12	8:55	8:59	9:01			
Optical brightener (ppb)	4	6	6	0	5	7	7			
Sec chi (FT)	4	4	5	4	4	6	4			
Fecal coliform (col / 100 ml)	16	15	11	39	5	12	1			
Depth 1 (FT)	4	3	6	3	3	3	3			
Temperature (^oC)	21.7	13.5	9.2	12.7	14.2	15.3	16.8			
DO (mg/L)	15.4	9.6	9.9	11.4	11.0	11.1	10.5			
pH	8.6	8.2	7.9	7.4	7.6	7.9	8.0			
Specific Conductance (µS/cm)	197	184	183	89	110	109	116			
Depth 2 (FT)		5								
Temperature (^oC)		13.5								
DO (mg/L)		9.7								
pH		8.3								
Specific Conductance (µS/cm)		184								

Lake Spokane Water Quality Monitoring Results - 2012-13

LSOPBR 8	N 47.83152	W 117.62444							
	04/11/12	**04/17/12**	**04/26/12**	**05/15/12**	**05/21/12**	**05/29/12**	**06/05/12**	**06/25/12**	**08/01/12**	**08/08/12**
Time	9:56	10:07	10:22	10:10	10:06	10:19	10:15	10:07	9:18	11:20
Optical brightener (ppb)	0	0	0	0	9	10	4	8	4	4
Sec chi (FT)		5.0	3.0	4.0	5.5	7.0	5.5	7.0	8	14.8
Fecal coliform (col / 100 ml)	1	<1	<1	4	<1	5	26	56	1	<1
Depth 1 (FT)										3
Temperature (^{o}C)										25.2
DO (mg/L)										15.0
pH										8.6
Specific Conductance (μS/cm)										181
Depth 2 (FT)										14
Temperature (^{o}C)										22.7
DO (mg/L)										14.4
pH										8.4
Specific Conductance (μS/cm)										204
	08/27/12	**10/10/12**	**10/24/12**	**5/23/13**	**5/28/13**	**6/5/13**	**6/12/13**			
Time	10:28	10:25	10:22	9:18	9:01	9:06	9:08			
Optical brightener (ppb)	4	6	6	0	5	7	7			
Sec chi (FT)	8	7	7	7	6	7	7			
Fecal coliform (col / 100 ml)	1	<1	3	30	5	8	1			
Depth 1 (FT)	3	3	3	3	3	3	3			
Temperature (^{o}C)	22.1	14.4	9.7	13.1	14.4	15.8	17.1			
DO (mg/L)	15.3	9.6	9.9	11.3	11	11.1	10.3			
pH	8.8	8.3	8.0	7.4	7.6	7.8	7.9			
Specific Conductance (μS/cm)	192	185	179	89	110	109	115			
Depth 2 (FT)	12	9	9	8	9	8	9			
Temperature (^{o}C)	22.0	14.3	9.6	13	14.3	15.6	16.9			
DO (mg/L)	15.2	9.8	9.6	7.4	11.2	11.4	10.7			
pH	8.7	8.4	8.0	11.5	7.6	7.8	8.0			
Specific Conductance (μS/cm)	191	184	178	88	110	108	114			

Lake Spokane Water Quality Monitoring Results - 2012-13

LSOPBR 9	N 47.83629	W 117.64246							
	04/11/12	**04/17/12**	**04/26/12**	**05/15/12**	**05/21/12**	**05/29/12**	**06/05/12**	**06/25/12**	**08/01/12**	**08/08/12**
Time	10:04	10:16	10:27	10:15	10:10	10:22	10:20	10:16	9:23	11:27
Optical brightener (ppb)	0	0	0	0	10	11	4	7	4	3
Sec chi (FT)		6.0	3.0	5.0	6.0	6.0	6.5	7.0	16.4	14.8
Fecal coliform (col / 100 ml)	3	2	<1	12	<1	5	21	68	6	<1
Depth 1 (FT)										3
Temperature (^{o}C)										25.2
DO (mg/L)										15.0
pH										8.6
Specific Conductance (μS/cm)										181
Depth 2 (FT)										14
Temperature (^{o}C)										22.7
DO (mg/L)										14.4
pH										8.4
Specific Conductance (μS/cm)										204
	08/27/12	**10/10/12**	**10/24/12**	**5/23/13**	**5/28/13**	**6/5/13**	**6/12/13**			
Time	10:34	10:40	10:30	9:24	9:06	9:11	9:12			
Optical brightener (ppb)	3	8	5	0	5	9	6			
Sec chi (FT)	8	5	16	10	11	6	11			
Fecal coliform (col / 100 ml)	1	<1	2	10	3	<1	3			
Depth 1 (FT)	3	3	3	3	3	3	3			
Temperature (^{o}C)	22.2	14.5	11.2	13.36	14.3	17.9	17.8			
DO (mg/L)	15.1	9.5	8.9	11.5	10.9	11.4	10.6			
pH	8.8	8.3	8.0	7.5	7.6	8.1	8.1			
Specific Conductance (μS/cm)	191	186	181	89	110	109	116			
Depth 2 (FT)	15	15	15	15	14	12	15			
Temperature (^{o}C)	21.6	14.5	10.3	13.1	14.3	15.4	17.0			
DO (mg/L)	14.7	9.1	8.9	11.6	11.1	11.5	10.6			
pH	8.6	8.3	7.9	7.5	7.6	7.9	7.9			
Specific Conductance (μS/cm)	191	185	179	88	110	111	114			

Lake Spokane Water Quality Monitoring Results - 2012-13

LSOPBR 10	**N 47.84615**	**W 117.65377**								
	04/11/12	**04/17/12**	**04/26/12**	**05/15/12**	**05/21/12**	**05/29/12**	**06/05/12**	**06/25/12**	**08/01/12**	**08/08/12**
Time	10:11	10:22	10:34	10:22	10:15	10:29	10:24	10:25	9:30	11:34
Optical brightener (ppb)	0	0	2	0	10	11	4	7	11	12
Sec chi (FT)		6.0	3.5	5.0	6.0	5.5	6.0	5.5	6	7
Fecal coliform (col / 100 ml)	1	<1	<1	5	<1	3	17	27	3	6
Depth 1 (FT)										3
Temperature (°C)										24.9
DO (mg/L)										12.8
pH										7.6
Specific Conductance (µS/cm)										171
Depth 2 (FT)										6.5
Temperature (°C)										24.7
DO (mg/L)										12.9
pH										7.6
Specific Conductance (µS/cm)										170
	08/27/12	**10/10/12**	**10/24/12**	**5/23/13**	**5/28/13**	**6/5/13**	**6/12/13**			
Time	10:42	10:48	10:37	9:34	9:12	9:18	9:18			
Optical brightener (ppb)	11	8	7	0	6	9	8			
Sec chi (FT)	6	5	6	5	5	6	5			
Fecal coliform (col / 100 ml)	48	<1	1	3	18	3	4			
Depth 1 (FT)	3	3	3	3	3	3	3			
Temperature (°C)	21.2	13.3	10.3	13.8	14.9	18.0	19.1			
DO (mg/L)	12.0	9.1	10.2	11.6	12.3	11.9	11.3			
pH	7.6	8.0	7.9	7.5	8	8.2	8.2			
Specific Conductance (µS/cm)	175	181	176	83	97	114	123			
Depth 2 (FT)	7		7	6	7	7	7			
Temperature (°C)	21.1		10.3	13.7	14.5	17.0	19.0			
DO (mg/L)	11.7		9.1	11.7	12.4	14.1	11.3			
pH	7.5		7.8	7.5	8	8.6	8.2			
Specific Conductance (µS/cm)	174		175	82	102	110	122			

Lake Spokane Water Quality Monitoring Results - 2012-13

LSOPBR 11 **N 47.84894** **W 117.65726**										
	04/11/12	**04/17/12**	**04/26/12**	**05/15/12**	**05/21/12**	**05/29/12**	**06/05/12**	**06/25/12**	**08/01/12**	**08/08/12**
Time	10:16	10:25	10:39	10:26	10:33	10:31	10:27	10:28	9:35	11:40
Optical brightener (ppb)	0	0	0	0	9	11	3	7	10	11
Sec chi (FT)		5.5	3.0	4.5	6.0	5.5	6.5	7.0	9	9
Fecal coliform (col / 100 ml)	2	1	2	3	2	2	15	18	1	2
Depth 1 (FT)										3
Temperature (^oC)										24.9
DO (mg/L)										13.5
pH										7.6
Specific Conductance (μS/cm)										172
Depth 2 (FT)										10
Temperature (^oC)										24.0
DO (mg/L)										10.0
pH										7.2
Specific Conductance (μS/cm)										173
	08/27/12	**10/10/12**	**10/24/12**	**5/23/13**	**5/28/13**	**6/5/13**	**6/12/13**			
Time	10:46	10:53	10:42	9:37	9:16	9:22	9:23			
Optical brightener (ppb)	10	7	6	0	4	6	7			
Sec chi (FT)	6	9	10	6	8	7	6			
Fecal coliform (col / 100 ml)	3	1	10	6	2	2	2			
Depth 1 (FT)	3	3	3	3	3	3	3			
Temperature (^oC)	21.8	13.8	11.0	13.7	14.7	17.9	18.9			
DO (mg/L)	13.7	8.8	8.9	11.2	12.0	11.6	10.7			
pH	7.8	8.0	7.9	7.5	8.0	8.3	8.3			
Specific Conductance (μS/cm)	181	183	179	87	99.0	112	122			
Depth 2 (FT)	10	11.5	11	10	11	10	10			
Temperature (^oC)	21.2	13.5	10.0	13.5	14.2	16.1	18.3			
DO (mg/L)	10.7	8.2	7.9	11.2	11.6	13.6	10.6			
pH	7.5	7.7	7.7	7.5	7.8	8.7	8.2			
Specific Conductance (μS/cm)	177	179	172	87	100	109	119			

Lake Spokane Water Quality Monitoring Results - 2012-13

LSOPBR 12 **N 47.87659** **W 117.66069**										
	04/11/12	**04/17/12**	**04/26/12**	**05/15/12**	**05/21/12**	**05/29/12**	**06/05/12**	**06/25/12**	**08/01/12**	**08/08/12**
Time	10:26	10:32	10:46	10:37	10:40	10:42	10:34	10:37	9:46	11:52
Optical brightener (ppb)	0	0	0	0	10	9	3	8	7	9
Sec chi (FT)		*4.5*	*4.0*	*4.0*	*3.5*	*4.0*	*4.0*	*4.0*	3	4
Fecal coliform (col / 100 ml)	<1	1	10	3	12	4	15	90	430	120
Depth 1 (FT)										4
Temperature (^oC)										24.6
DO (mg/L)										14.9
pH										8.1
Specific Conductance (μS/cm)										174
Depth 2 (FT)										
Temperature (^oC)										
DO (mg/L)										
pH										
Specific Conductance (μS/cm)										
	08/27/12	**10/10/12**	**10/24/12**	**5/23/13**	**5/28/13**	**6/5/13**	**6/12/13**			
Time	10:57	11:04	10:52	9:46	9:25	9:31	9:31			
Optical brightener (ppb)	5	6	4	0	3	7	7			
Sec chi (FT)	weeds	3	4	3	3	4	3			
Fecal coliform (col / 100 ml)	51	12	6	16	27	170	25			
Depth 1 (FT)	3	4	3	3	3	3	3			
Temperature (^oC)	20.9	13.4	11.2	13.6	15.6	17.5	18.9			
DO (mg/L)	14.1	9.4	9.7	11.4	12.2	12.7	10.6			
pH	8.3	8.1	8.0	7.6	8.2	8.7	8.3			
Specific Conductance (μS/cm)	184	185	180	83	92	103	120			
Depth 2 (FT)										
Temperature (^oC)										
DO (mg/L)										
pH										
Specific Conductance (μS/cm)										

Lake Spokane Water Quality Monitoring Results - 2012-13

LSOPBR 13 N 47.88582 W 117.66258										
	04/11/12	**04/17/12**	**04/26/12**	**05/15/12**	**05/21/12**	**05/29/12**	**06/05/12**	**06/25/12**	**08/01/12**	**08/08/12**
Time	10:35	10:37	10:51	10:42	10:45	10:45	10:40	10:43	9:58	11:56
Optical brightener (ppb)	0	0	0	0	9	10	3	7	5	5
Sec chi (FT)		6.0	3.5	3.5	*5.5*	5.5	6.5	5.5	5.5	4
Fecal coliform (col / 100 ml)	1	2	7	1	5	2	3	19	1	3
Depth 1 (FT)										4
Temperature (^{o}C)										24.2
DO (mg/L)										17.3
pH										8.6
Specific Conductance (μS/cm)										179
Depth 2 (FT)										
Temperature (^{o}C)										
DO (mg/L)										
pH										
Specific Conductance (μS/cm)										
	08/27/12	**10/10/12**	**10/24/12**	**5/23/13**	**5/28/13**	**6/5/13**	**6/12/13**			
Time	11:06	11:10	11:00	9:50	9:29	9:35	9:35			
Optical brightener (ppb)	10	6	3	0	3	7	6			
Sec chi (FT)	6	5	5	5	5	4	5			
Fecal coliform (col / 100 ml)	<1	5	3	<1	1	<1	<1			
Depth 1 (FT)	3	6	5	3	3	3	3			
Temperature (^{o}C)	22.1	15.1	12.0	14	15.6	17.1	19.2			
DO (mg/L)	14.2	9.8	9.6	11.4	11.9	11.7	10.6			
pH	8.6	8.4	8.1	7.5	8.2	8.3	8.3			
Specific Conductance (μS/cm)	190	190	184	86	94	105	120			
Depth 2 (FT)	7			6	5		6			
Temperature (^{o}C)	21.8			13.9	15.6		19.1			
DO (mg/L)	14.4			11.6	12.5		10.8			
pH	8.6			7.6	8.3		8.4			
Specific Conductance (μS/cm)	188			84	95		119			

Lake Spokane Water Quality Monitoring Results - 2012-13

LSOPBR 14	**N 47.89339**		**W 117.66115**							
	04/11/12	**04/17/12**	**04/26/12**	**05/15/12**	**05/21/12**	**05/29/12**	**06/05/12**	**06/25/12**	**08/01/12**	**08/08/12**
Time	10:40	10:43	10:55	11:12	10:48	10:59	10:42	10:50	10:02	12:01
Optical brightener (ppb)	27	10	25	0	10	10	3	7	5	6
Sec chi (FT)		5.0	3.5	4.5	5.0	6.0	6.0	6.0	9	8
Fecal coliform (col / 100 ml)	3	1	9	14	6	27	29	16	2	<1
Depth 1 (FT)										3
Temperature (°C)										24.3
DO (mg/L)										14.5
pH										8.4
Specific Conductance (µS/cm)										180
Depth 2 (FT)										9
Temperature (°C)										23.2
DO (mg/L)										13.9
pH										8.1
Specific Conductance (µS/cm)										181
	08/27/12	**10/10/12**	**10/24/12**	**5/23/13**	**5/28/13**	**6/5/13**	**6/12/13**			
Time	11:10	11:16	11:04	9:54	9:33	9:41	9:41			
Optical brightener (ppb)	6	6	5	0	4	7	7			
Sec chi (FT)	7.5	8	8	5	6	8	5			
Fecal coliform (col / 100 ml)	7	<1	6	14	14	4	18			
Depth 1 (FT)	3	3	3	3	3	3	3			
Temperature (°C)	21.5	14.7	11.5	14	16	16.5	19.2			
DO (mg/L)	14.7	8.8	9.6	11	11.8	11.3	10.7			
pH	8.7	8.2	8.0	7.5	8.4	8.3	8.2			
Specific Conductance (µS/cm)	189	191	184	84	91	109	121			
Depth 2 (FT)	9	9	9	8	9	9	9			
Temperature (°C)	20.7	13.8	11.4	13.9	14.8	15.2	18.9			
DO (mg/L)	14.6	7.1	9.3	11.3	12.8	13.6	10.5			
pH	8.3	7.7	8.1	7.4	8.2	8.3	8.1			
Specific Conductance (µS/cm)	188	190	184	87	98	154	133			

Lake Spokane Water Quality Monitoring Results - 2012-13

LSOPBR 15	**N 47.8937**	**W 117.66705**								
	04/11/12	**04/17/12**	**04/26/12**	**05/15/12**	**05/21/12**	**05/29/12**	**06/05/12**	**06/25/12**	**08/01/12**	**08/08/12**
Time	10:48	10:48	11:00	11:16	10:53	11:05	10:45	10:56	10:05	12:04
Optical brightener (ppb)	0	0	0	0	9	11	3	6	3	6
Sec chi (FT)		6.0	3.5	5.5	6.0	6.0	6.5	8.0	9	9
Fecal coliform (col / 100 ml)	<1	<1	13	3	2	2	23	16	2	3
Depth 1 (FT)										24.3
Temperature (^{o}C)										15.1
DO (mg/L)										8.6
pH										179
Specific Conductance (µS/cm)										10
Depth 2 (FT)										23.4
Temperature (^{o}C)										16.7
DO (mg/L)										8.6
pH										195
Specific Conductance (µS/cm)										
	08/27/12	**10/10/12**	**10/24/12**	**5/23/13**	**5/28/13**	**6/5/13**	**6/12/13**			
Time	11:17	11:22	11:09	10:00	9:37	9:44	9:44			
Optical brightener (ppb)	4	5	5	0	3	6	5			
Sec chi (FT)	10	8	9	5	7	9	9			
Fecal coliform (col / 100 ml)	1	1	3	3	<1	<1	<1			
Depth 1 (FT)	3	3	3	3	3	3	3			
Temperature (^{o}C)	22.0	15.3	12.2	14.4	16.3	16.9	19.7			
DO (mg/L)	14.3	9.0	8.9	11.4	12.6	11.3	10.9			
pH	8.7	8.3	8.0	75	8.5	8.4	8.4			
Specific Conductance (µS/cm)	192	192	186.0	84	88	104	120			
Depth 2 (FT)	11	10	9.0	10	10	12	9			
Temperature (^{o}C)	21.7	15.1	12.1	14.1	15.9	16.2	19.4			
DO (mg/L)	15.0	9.6	9.4	11.9	12.9	12.9	11.2			
pH	8.9	8.4	8.2	7.7	8.4	8.6	8.5			
Specific Conductance (µS/cm)	189	192	185	106	90	113	120			

Lake Spokane Water Quality Monitoring Results - 2012-13

LSOPBR 16	**N 47.89114**	**W 117.68147**								
	04/11/12	**04/17/12**	**04/26/12**	**05/15/12**	**05/21/12**	**05/29/12**	**06/05/12**	**06/25/12**	**08/01/12**	**08/08/12**
Time	10:53	10:51	11:05	11:20	10:57	11:10	10:48	11:01	10:09	12:09
Optical brightener (ppb)	0	0	0	0	7	10	3	6	4	4
Sec chi (FT)		5.5	3.5	*5.0*	5.5	5.5	6.0	*6.0*	5	4.5
Fecal coliform (col / 100 ml)	<1	<1	<1	3	<1	3	31	6	1	1
Depth 1 (FT)										5
Temperature (^oC)										24.4
DO (mg/L)										15.8
pH										8.7
Specific Conductance ($\mu S/cm$)										178
Depth 2 (FT)										
Temperature (^oC)										
DO (mg/L)										
pH										
Specific Conductance ($\mu S/cm$)										
	08/27/12	**10/10/12**	**10/24/12**	**5/23/13**	**5/28/13**	**6/5/13**	**6/12/13**			
Time	11:22	11:27	11:15	10:06	9:42	9:49	9:49			
Optical brightener (ppb)	4	5	5	0	3	7	6			
Sec chi (FT)	weeds	6	9	4	5	5	5			
Fecal coliform (col / 100 ml)	<1	<1	3	10	2	1	<1			
Depth 1 (FT)	5	3	6	3	3	3	3			
Temperature (^oC)	22.0	15.3	12.3	14.7	16.3	17.0	19.8			
DO (mg/L)	16.8	9.2	9.4	11.8	12.5	12.4	10.6			
pH	9.0	8.3	8.1	7.7	8.5	8.5	8.3			
Specific Conductance ($\mu S/cm$)	191	193	187	84	88	103	119			
Depth 2 (FT)				5	8	6				
Temperature (^oC)				14.6	16.3	16.7				
DO (mg/L)				12.1	13	13.1				
pH				7.7	8.5	8.6				
Specific Conductance ($\mu S/cm$)				84	88	106				

Lake Spokane Water Quality Monitoring Results - 2012-13

LSOPBR 17	**N 47.82668**	**W 117.64449**								
	04/11/12	**04/17/12**	**04/26/12**	**05/15/12**	**05/21/12**	**05/29/12**	**06/05/12**	**06/25/12**	**08/01/12**	**08/08/12**
Time	11:18	11:12	11:21	11:40	11:14	11:29	11:05	11:48	10:29	12:31
Optical brightener (ppb)	0	0	13	0	11	11	4	9	20	18
Sec chi (FT)		4.0	3.0	*4.0*	*4.5*	*4.5*	*5.0*	2.0	4	5
Fecal coliform (col / 100 ml)	<1	2	<1	12	<1	2	26	32	4	3
Depth 1 (FT)										3
Temperature (°C)										25.2
DO (mg/L)										7.4
pH										7.2
Specific Conductance (µS/cm)										182
Depth 2 (FT)										5
Temperature (°C)										24.9
DO (mg/L)										5.8
pH										7.0
Specific Conductance (µS/cm)										182
	08/27/12	**10/10/12**	**10/24/12**	**5/23/13**	**5/28/13**	**6/5/13**	**6/12/13**			
Time	11:38	11:49	11:34	10:23	9:58	10:05	10:05			
Optical brightener (ppb)	10	10	6	0	6	10	10			
Sec chi (FT)	5	3.5	4	4	4	3	3			
Fecal coliform (col / 100 ml)	51	4	8	3	1	25	11			
Depth 1 (FT)	3	4	3	3	3	3	3			
Temperature (°C)	22.3	12.7	9.2	13.4	14.4	18.1	17.5			
DO (mg/L)	14.2	10.7	10.4	11.8	12.4	11.0	12.5			
pH	8.6	7.9	8.1	7.8	8.2	8.1	8.6			
Specific Conductance (µS/cm)	194	179	173	82	97.7	112	117			
Depth 2 (FT)	9				5					
Temperature (°C)	22.1				14.4					
DO (mg/L)	14.4				13.4					
pH	8.6				8.3					
Specific Conductance (µS/cm)	193				98					

Lake Spokane Water Quality Monitoring Results - 2012-13

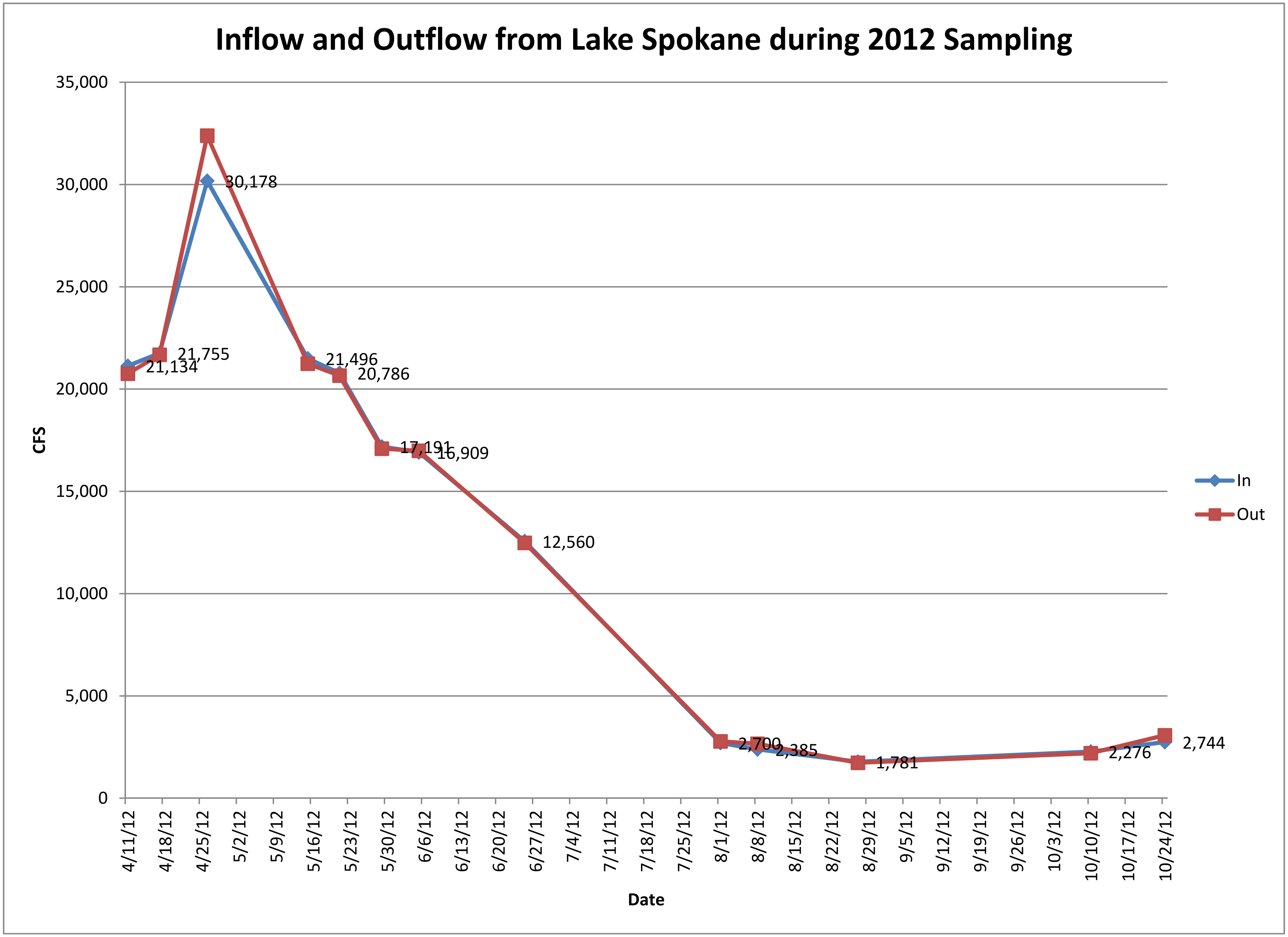
LSOPBR 18	N 47.82282	W 117.61984								
	04/11/12	**04/17/12**	**04/26/12**	**05/15/12**	**05/21/12**	**05/29/12**	**06/05/12**	**06/25/12**	**08/01/12**	**08/08/12**
Time	11:28	11:22	11:31	11:49	11:21	11:37	11:12	12:02	10:38	12:42
Optical brightener (ppb)	0	0	0	0	9	11	4	7	4	4
Sec chi (FT)		6.0	3.5	5.0	4.5	6.0	5.0	8.0	4	11.5
Fecal coliform (col / 100 ml)	<1	1	<1	5	<1	6	27	26	4	1
Depth 1 (FT)										3
Temperature (^oC)										24.9
DO (mg/L)										14.5
pH										8.4
Specific Conductance (μS/cm)										183
Depth 2 (FT)										12
Temperature (^oC)										24.5
DO (mg/L)										14.2
pH										8.4
Specific Conductance (μS/cm)										183
	08/27/12	**10/10/12**	**10/24/12**	**5/23/13**	**5/28/13**	**6/5/13**	**6/12/13**			
Time	11:45	11:59	11:45	10:30	10:06	10:12	10:14			
Optical brightener (ppb)	4	7	6	0	4	7	7			
Sec chi (FT)	6	8	5	6	6	4	6			
Fecal coliform (col / 100 ml)	3	10	4	5	7	16	48			
Depth 1 (FT)	3	3	3	3	3	3	3			
Temperature (^oC)	22.3	14.4	9.3	13.4	14.5	15.6	17.4			
DO (mg/L)	14.2	9.3	10.7	11.4	11.2	11.1	109.0			
pH	8.6	8.3	8.2	7.7	7.9	8.0	8.2			
Specific Conductance (μS/cm)	194	184	176	82	109	107	116			
Depth 2 (FT)	9	7	10	8	8	8	8			
Temperature (^oC)	22.1	14.2	9.3	13.1	14.4	15.4	17.2			
DO (mg/L)	14.4	9.1	10.0	11.7	11.3	12.1	11.3			
pH	8.6	8.3	8.1	7.6	7.8	8.2	8.3			
Specific Conductance (μS/cm)	193	184	176	86	109	106	115			

Lake Spokane Water Quality Monitoring Results - 2012-13

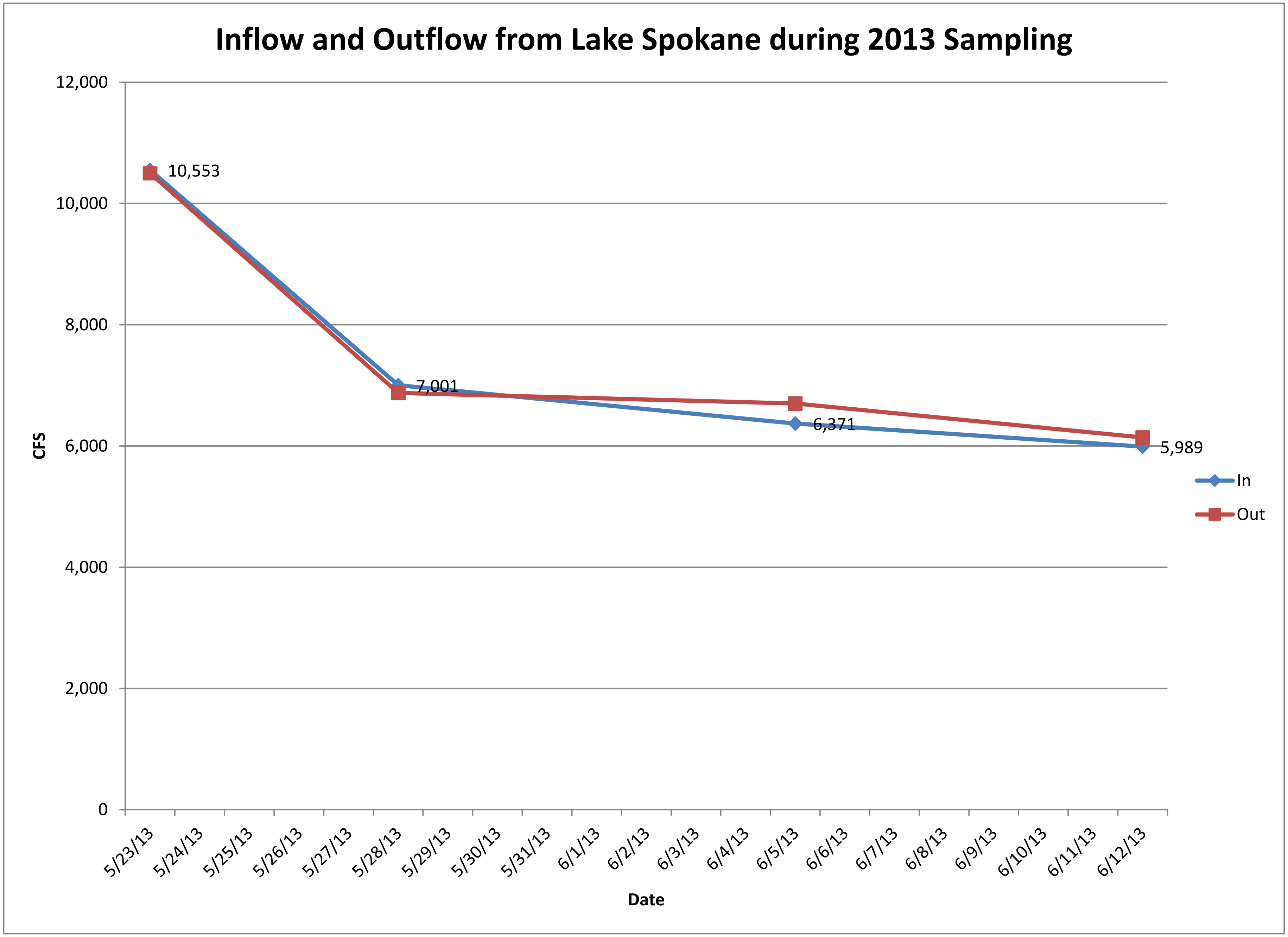
LSOPBR 19	N 47.81465	W 117.61442							
	04/11/12	**04/17/12**	**04/26/12**	**05/15/12**	**05/21/12**	**05/29/12**	**06/05/12**	**06/25/12**	**08/01/12**	**08/08/12**
Time	11:31	11:26	11:36	11:53	11:25	12:07	11:15	12:12	10:43	12:50
Optical brightener (ppb)	0	0	0	0	10	10	3	6	4	6
Sec chi (FT)		6.5	3.5	5.0	5.5	5.5	6.0	8.5	9	8
Fecal coliform (col / 100 ml)	<1	1	<1	4	<1	5	20	30	1	<1
Depth 1 (FT)										3
Temperature (°C)										24.9
DO (mg/L)										13.2
pH										8.3
Specific Conductance (µS/cm)										187
Depth 2 (FT)										9
Temperature (°C)										24.5
DO (mg/L)										14.1
pH										8.5
Specific Conductance (µS/cm)										185
	08/27/12	**10/10/12**	**10/24/12**	**5/23/13**	**5/28/13**	**6/5/13**	**6/12/13**			
Time	11:50	12:04	11:51	10:36	10:10	10:18	10:19			
Optical brightener (ppb)	4	6	7	0	4	7	7			
Sec chi (FT)	6.5	8	7	5	6	8	9			
Fecal coliform (col / 100 ml)	3	<1	3	39	<1	6	<1			
Depth 1 (FT)	3	3	3	3	3	3	3			
Temperature (°C)	22.5	14.2	9.1	13.3	14.4	15.5	17.4			
DO (mg/L)	15.6	9.1	10.5	11	11.3	11.6	104.5			
pH	8.8	8.3	8.2	7.6	7.8	8.2	8.1			
Specific Conductance (µS/cm)	195	185	178	87	108	106	116			
Depth 2 (FT)	9.5	9	8	9	9	8	9			
Temperature (°C)	22.0	14.0	9.1	12.9	14.2	15.4	17.1			
DO (mg/L)	16.3	10.2	10.9	11.2	11.3	12.1	11.8			
pH	8.8	8.5	8.3	7.6	7.8	8.2	8.4			
Specific Conductance (µS/cm)	192	183	177	86	108	106	114			

Lake Spokane Water Quality Monitoring Results - 2012-13

LSOPBR 20	N 47.7967	W 117.55814								
	04/11/12	**04/17/12**	**04/26/12**	**05/15/12**	**05/21/12**	**05/29/12**	**06/05/12**	**06/25/12**	**08/01/12**	**08/08/12**
Time	12:09	11:41	11:47	12:08	11:39	12:19	11:29	13:25	11:00	13:05
Optical brightener (ppb)	0	0	1	0	10	11	6	6	18	18
Sec chi (FT)		*4.0*	2.0	*4.0*	*4.0*	*4.5*	*3.5*	*4.5*	3	4
Fecal coliform (col / 100 ml)	<1	<1	2	7	7	13	770	26	29	70
Depth 1 (FT)										5
Temperature (^oC)										22.4
DO (mg/L)										12.0
pH										7.4
Specific Conductance (µS/cm)										214
Depth 2 (FT)										
Temperature (^oC)										
DO (mg/L)										
pH										
Specific Conductance (µS/cm)										
	08/27/12	**10/10/12**	**10/24/12**	**5/23/13**	**5/28/13**	**6/5/13**	**6/12/13**			
Time	12:06	12:18	12:05	10:48	10:21	10:30	10:30			
Optical brightener (ppb)	19	27	23	0	6	11	11			
Sec chi (FT)	2	3	3	3	3	3	3			
Fecal coliform (col / 100 ml)	390	2	<1	11	9	4	35			
Depth 1 (FT)	5	3	3	3	3	3	3			
Temperature (^oC)	17.8	8.0	6.2	13.4	14.1	18.5	18.9			
DO (mg/L)	8.8	8.5	8.5	11.4	10.3	10.9	8.9			
pH	7.3	7.9	7.8	7.5	7.7	8.0	7.7			
Specific Conductance (µS/cm)	190	177	168	84	101	108	113			
Depth 2 (FT)					5	5				
Temperature (^oC)					14.1	17.7				
DO (mg/L)					10.2	12.0				
pH					7.5	8.2				
Specific Conductance (µS/cm)					102	108				



Inflow and Outflow from Lake Spokane during 2012 Sampling
CFS
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
30,178
21,755
21,134
21,496
20,786
17,191
16,909
12,560
2,700
2,385
1,781
2,276
2,744
4/11/12
4/18/12
4/25/12
5/2/12
5/9/12
5/16/12
5/23/12
5/30/12
6/6/12
6/13/12
6/20/12
6/27/12
7/4/12
7/11/12
7/18/12
7/25/12
8/1/12
8/8/12
8/15/12
8/22/12
8/29/12
9/5/12
9/12/12
9/19/12
9/26/12
10/3/12
10/10/12
10/17/12
10/24/12
Date
In
Out


Inflow and Outflow from Lake Spokane during 2013 Sampling
12,000
10,000
8,000
6,000
4,000
2,000
0
CFS
10,553
7,001
6,371
5,989
In
Out
5/23/13
5/24/13
5/25/13
5/26/13
5/27/13
5/28/13
5/29/13
5/30/13
5/31/13
6/1/13
6/2/13
6/3/13
6/4/13
6/5/13
6/6/13
6/7/13
6/8/13
6/9/13
6/10/13
6/11/13
6/12/13
Date

Lake Spokane Water Quality Project

QUALITY ASSURANCE AND WATER QUALITY MONITORING PLAN

Prepared By:

Charlie Kessler, Water Quality Coordinator
Stevens County Conservation District

June 2012
Revised October 2012

Lead Agency:
Stevens County Conservation District
232 Williams Lake Road
Colville WA 99114

______________________________ ________________
Dean Hellie, District Administrator Date

Funding Agency:
Spokane County Utilities
Spokane WA 99205

______________________________ ________________
Robert Lindsay, Project Manager Date

Table of Contents

List of Tables and Figures

BACKGROUND

Site Description

From its source at Lake Coeur d'Alene, the Spokane River flows west across the Idaho / Washington state line to the city of Spokane. From Spokane, the river flows northwesterly through the Lake Spokane reservoir, over Long Lake Dam, and through the Spokane Tribe of Indian's reservation to its confluence with the Franklin D. Roosevelt Lake impoundment of the Columbia River (Figure 1).

The river, including the Lake Coeur d'Alene catchment, drains an area of about 6,640 square miles in two states. Approximately 2,295 square miles are within eastern Washington with the remainder of the watershed in Idaho. Most residents in the watershed live in the Spokane metropolitan area. However, the incorporated area of Liberty Lake, east of Spokane, and the cities of Coeur d'Alene and Post Falls in Idaho are experiencing rapid growth.

There are seven wastewater discharges to the mainstem of the Spokane River between Lake Spokane and Lake Coeur d'Alene. These discharge a summer average of approximately 75 million gallons of treated wastewater per day. In Washington, beginning at Spokane and moving upstream, these discharges include the Spokane Wastewater Treatment Plant, Inland Empire Paper, Kaiser Aluminum, and Liberty Lake Sewer and Water District. Discharges in Idaho include the Post Falls Wastewater Treatment Plant, Hayden Sewer District, and the city of Coeur d'Alene Advanced Wastewater Treatment Plant.

Each discharger has a National Pollutant Discharge Elimination System (NPDES) permit which sets limits on the amount of pollutants that can be discharged to the river. NPDES permits set limits at levels protective of water quality. In Washington State, Ecology issues NPDES permits; in Idaho, EPA issues these permits.

There are seven hydroelectric dams downstream from the outlet of Lake Coeur d'Alene which significantly influence the dynamics of the Spokane River. The six Washington dams are run-of-the river (flow-through) types except for Long Lake Dam, which creates Lake Spokane.

Lake Spokane (also known as Long Lake) is the 24 mile section of the Spokane River between Nine Mile Dam and Long Lake Dam. The lake is part of the Spokane River Water Resource Inventory Area (WRIA) 54. Dissolved oxygen levels in Lake Spokane are seasonally impaired because of excessive nutrient loading; particularly total phosphorus, which facilitates aquatic growth and decay.

There is particular interest in Lake Spokane because as dischargers are spending considerable amounts of money to reduce phosphorus loading to the Spokane River, the question arises "What are Lake Spokane residential areas contributing to the river system?" The Spokane River Watershed Nonpoint Phosphorus Reduction Plan specifically mentions the Suncrest area of Stevens County. The plan advocates aggressive actions to be taken in the areas nearest Lake Spokane. It states that "Connections should be established between specific sources and stakeholders that have the ability to take action". Of particular interest is the need to evaluate the phosphorus load from septic tanks within Suncrest and other densely developed areas.

Water Quality Concerns

While there is historical literature that suggests that septic systems and subsequent treatment in the unsaturated zone provides phosphorus removal from effluent, recent evidence that this may not be the case in all locations. Data indicate that septic systems release significant phosphorus loads into groundwater. Phosphorus loads can increase with time as the wetting front moves through the soil profile. The soils and geology of the Lake Spokane area have relatively little phosphorus removal capacity. The Suncrest area has been targeted as an area where septic system removal and establishment of a sewer system should be seriously considered.

Optical brighteners are primarily added to laundry soaps, detergents, and cleaning agents for the purpose of brightening fabrics. Optical brighteners are dyes that are added to essentially all laundry detergents. These brighteners are absorbed by fabric and brighten clothes.

Laundry wastewater is the largest contributor of optical brighteners to wastewater systems because it retains a large portion of dissolved brighteners. Laundry effluent is predominantly associated with sanitary wastewater. Toilet paper contains fluorescent whitening agents. As toilet paper breaks down, fluorescent whitening agents are released into the water column. Since optical brighteners decompose relatively slowly except through photo degradation, they serve as ideal indicators of discharges from septic systems.

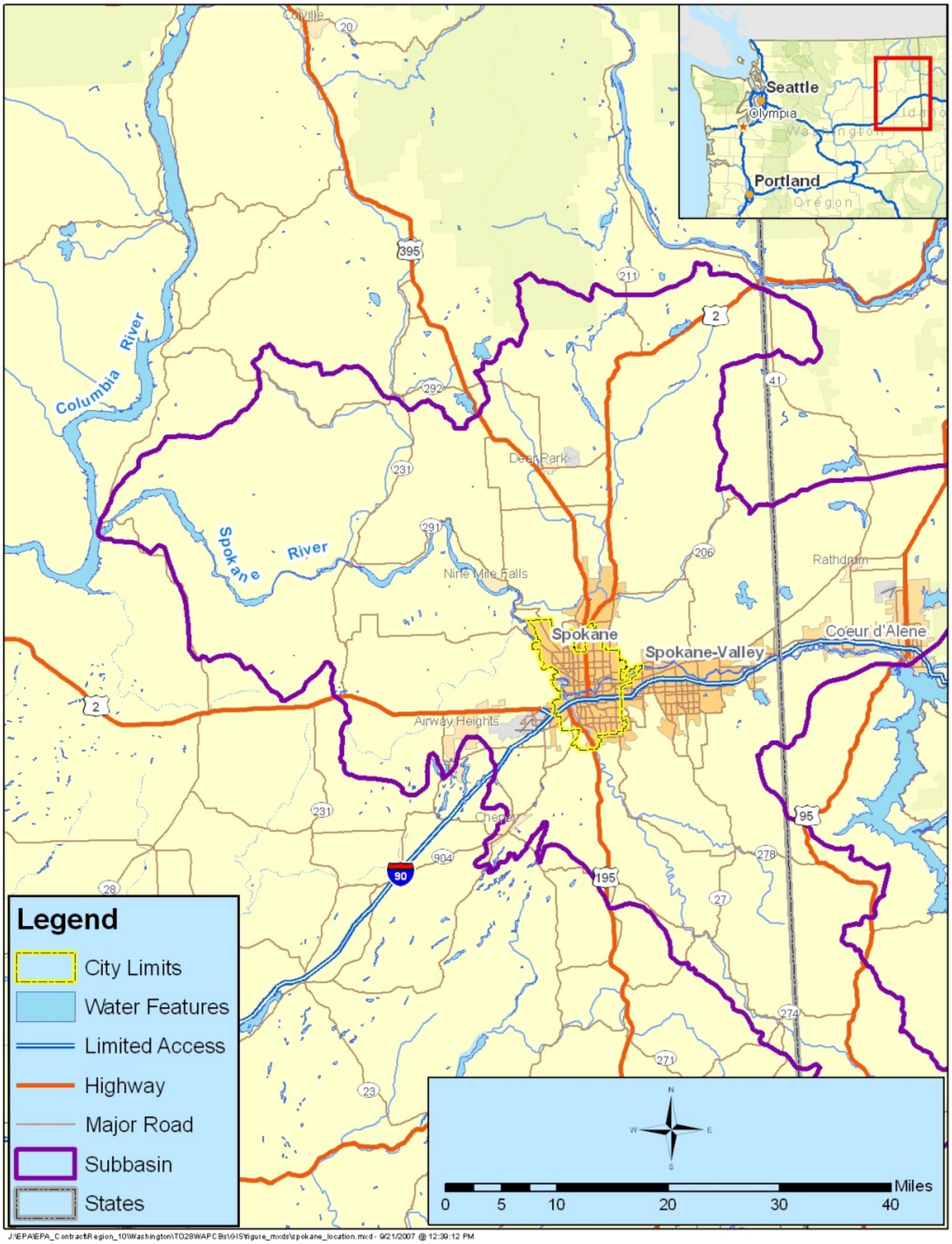


Figure 1 Spokane River Basin

PROJECT DESCRIPTION

The goal of the project:

- To use optical brightener presence as a means of determining the leaching of effluent from septic systems to Lake Spokane from the Suncrest area downstream to Tum Tum.

The desired water quality outcomes of this project include:

- The District will develop a water quality monitoring program that will establish 20 sampling sites to provide a means of identifying possible septic system influence on Lake Spokane. .
- The results of the monitoring effort will be compared with septic system studies conducted in the Suncrest area and with the results of satellite data for total phosphorus levels in the lake.

Routine monitoring conducted under this project will enlarge the database for water quality within Lake Spokane.

Data Needs

The following data needs should be addressed by this monitoring project.

1. Data are needed to assess potential contribution of nutrients from septic systems to Lake Spokane.
2. Data are needed to help identify "hot spots" along the lake shoreline

Project Objectives

1. Characterize the existing levels of optical brighteners and fecal coliform bacteria at selected sites along the shoreline of Lake Spokane from the Suncrest area to the Tum Tum area
2. Locate the majority of the sampling sites on the Stevens County side of the lake, but have representative samples on the Spokane County side also

Study Design

The monitoring is designed to evaluate spatial and temporal patterns in optical brightener and fecal coliform bacteria, within the study reach of Lake Spokane. Optical brighteners will be measured using a Turner Designs Cyclops-7 Submersible Sensor connected to a DataBank handheld data logger.

Fecal coliform bacteria monitoring will be conducted during each sampling period at each sampling site.

Secchi depths will be recorded at each sampling site.

Project Organization and Responsibility

Lead Agency

The Stevens County Conservation District is the lead agency for this project. The lead agency will be responsible for maintaining communications with the funding agency for the entire project. The lead agency will also be responsible for ensuring compliance with grant agreement terms and conditions.

Table 1: Key District personnel involved in the monitoring project

Name	Title	Responsibility	Phone number
Dean Hellie	District Manager	District oversight	(509) 685-0937 x110
Charlie Kessler	Water Quality Coordinator	Sampling design, sample collection, data analysis	(509) 685-0937 x111

The District will be responsible for properly collecting the water samples, transporting samples to the laboratories, storing all data, interpreting the data, and submitting the monitoring data in an appropriate format. District staff will conduct field measurements and sample collection. Once the Chain-of-Custody form(s) has been completed, and the cooler(s) containing the sample containers secured, samples will be transported to the Tshimakain Creek Laboratory.

Funding Agency

The Spokane County Department of Utilities is the funding agency under the WRIA 54 Watershed Implementation Process. The responsibility of the funding agency is to ensure that all grant requirements are met. It is also the responsibility of the funding agency to ensure that the monitoring program, as outlined, complies with grant requirements. Robert Lindsay, of Spokane County Department of Utilities, is the project manager for this grant. He may be reached at (509) 477-3604.

Laboratory

The Stevens County Conservation District has developed an excellent working relationship with the Tshimakain Creek Laboratory on previous projects. The laboratory is accredited by Ecology for Chemistry I and microbiology. Darren Lantzer, Manager Tshimakain Creek Laboratory, will be responsible for sample analysis, laboratory QA/QC, and data reporting to SCCD. He may be reached at (509) 928-3577.

Tentative Schedule

Sampling will be conducted in coordination with Lake Spokane Association personnel availability and flow levels through and water levels in Lake Spokane.

QUALITY OBJECTIVES

Precision and Bias

Precision: A qualitative term used to denote the scatter of results. Precision is said to improve as the scatter among results becomes smaller.

Bias: That part of inaccuracy of analytical results caused by systematic error. Systematic errors are indicated by a tendency of results to consistently be greater or smaller than the true value. Bias can usually be considered to be equivalent to systematic error

Precision is defined as the degree of agreement between independent, similar or repeated measures. Precision is expressed in terms of analytical variability. For this project, analytical variability will be measured as the relative standard deviation (RSD) between the duplicate samples obtained in the field and between the laboratory duplicates. RSD is widely used in analytical chemistry to express the precision and repeatability of results. The field duplicates incorporate both monitoring and laboratory variability while the laboratory duplicates isolate analytical variability.

Precision will be calculated as follows:

$$RSD = \{(|x_1 - x_2| / \sqrt{2}) / \text{Ave.}\} \times 100$$

Where:
RSD = Relative standard deviation
$|x_1 - x_2|$ = absolute value of field measurement (x_1) minus duplicate measurement (x_2)
$\sqrt{2}$ = the square root of 2
Ave. = the average of the field measurement and the duplicate measurement

The RSD for each sampling period will be calculated and reviewed by the District Water Quality Coordinator and the District Manager. If the RSD is not in compliance with data quality objectives, the laboratory will be notified. The RSD of laboratory duplicates will be reviewed to see if there are similar trends in laboratory results. The field procedures for obtain duplicate samples will also be reviewed.

District staff will follow the District's updated *Standard Operating Procedures for Water Quality Monitoring* and other established procedures for field measurements, sample collection, and sample storage in a manner that optimizes precision and reduces bias. Data quality objectives for this project are based on the objectives of and experience from water quality monitoring associated with previous watershed projects conducted by the District.

Table 3 provides information about the project data objectives. For the measurements made using these field instruments, accuracy depends primarily on instrument capabilities and proper instrument calibration

Table 3 Data Quality Objectives for water quality samples

Laboratory Parameter	Method	Reference	Detection Limit	Predicted Accuracy	Precision (RSD)
Fecal Coliform Bacteria	9222D Membrane filter	Standard Method 19	1 cfu / 100 ml	NA	20%

Field Parameters	Instrument	Resolution	Expected Range	Accuracy	Precision (RSD)
Temperature	In-Situ Troll 9500	0.1 °C	0°C - 26°C	± 0.1 °C	20%
pH	In-Situ Troll 9500	0.01 unit	6.5 – 9.0	± 0.1 unit	20%
Dissolved Oxygen	In-Situ Troll 9500	0.01 mg/L	4 – 14 mg/L	± 0.1 mg/L @0-10 mg/L ± 0.2 mg/L @10-20 mg/L	20%
Specific Conductance	In-Situ Troll 9500	0.1 µS/cm	100 – 400 µS/cm	± 2 µS/cm	20%
Optical brightener	Cyclops-7 sensor	0.6 ppb	0 – 400 ppb		

*Accuracy: The degree of agreement of an analytical result with the true value. The accuracy of a result is affected by both systematic errors, i.e. bias, and random errors, i.e. imprecision

Completeness and Representativeness

Completeness is defined as the percentage of usable data obtained from the total amount of data generated. Completeness will be determined by dividing the number of valid samples collected by the number of samples scheduled for collection. The goal is to correctly collect and analyze 100% of the samples for each parameter at each site. However, unexpected problems can occur. Therefore, SCCD will consider the project successful if 80% of the samples for each parameter at each sampling site are collected and deemed valid.

Efforts will be made to ensure that data is representative of surface water quality in the watershed and that collection and analysis of all samples is completed. Sampling sites have been established in locations that will spatially characterize water quality in the watershed.

Water samples will be collected during daylight hours on scheduled sampling days; the time of all collections will be recorded in the field notebook.

The District will coordinate the sampling schedule with the Lake Spokane Association representative who will be providing the boat from which samples will be obtained and the Tshimakain Creek Laboratory to ensure timely analysis of all samples.

Comparability

Comparability: The ability to compare different test groups using common factors

Data generated during this project may be comparable to bacteria data collected form the lake by Avista and Ecology during previous sampling projects.

Analytical Procedures

The analytical methods and sensitivity or reporting for laboratory and field measurements of conventional and biological parameters for the study are listed in Tables 4.

Table 4 Tshimakain Creek Laboratory Analytical Methods

Parameter name	Method	Reference	MDL	RPD
Fecal Coliform - count	9222 D	SM	1.0 cfu/100 ml	50

SAMPLING PROCESS DESIGN

Sampling Site Locations

Twenty (20) water quality sampling sites have been established for this monitoring effort. Sites were selected during a boat tour of the lake. Each site is considered representative of the various conditions within the lake. Effort was made to collect samples form uninhabited sections as well as densely populated portions of the lake.

Sampling sites are designated using an alphanumeric code. Lake Spokane OPtical BRightener or LSOPBR is the letter designator used for the sample sites. Each site was also given a number with LSOPBR 1 being the eastern most site on the Stevens County side of the lake. LSOPBR 16 is the western most site on the Stevens County side of the lake and sites 17-20 are spaced out on the Spokane County side of the lake. Sampling sites were recorded on a hand-held GPS unit so that each site could be revisited during subsequent monitoring efforts.

Table 5: Potential Water Quality Monitoring Stations

Sampling Station	Latitude	Longitude
LSOPBR 1	N 47.79941	W 117.57126
LSOPBR 2	N 47.79693	W 117.58504
LSOPBR 3	N 47.80007	W 117.59183
LSOPBR 4	N 47.804	W 117.59865
LSOPBR 5	N 47.80793	W 117.60249
LSOPBR 6	N 47.8108	W 117.60576
LSOPBR 7	N 47.81369	W 117.60798
LSOPBR 8	N 47.83152	W 117.62444
LSOPBR 9	N 47.83629	W 117.64246
LSOPBR 10	N 47.84615	W 117.65377
LSOPBR 11	N 47.84894	W 117.65726
LSOPBR 12	N 47.87659	W 117.66069
LSOPBR 13	N 47.88582	W 117.66258
LSOPBR 14	N 47.89339	W 117.66115
LSOPBR 15	N 47.8937	W 117.66705
LSOPBR 16	N 47.89114	W 117.68147
LSOPBR 17	N 47.82668	W 117.64449
LSOPBR 18	N 47.82282	W 117.61984
LSOPBR 19	N 47.81465	W 117.61442
LSOPBR 20	N 47.7967	W 117.55814

Sampling Schedule and Frequency

Sampling will be contingent on conditions in Lake Spokane. Since the lake is the reservoir behind Long Lake Dam, the winter time levels of the lake and the amount of water passing through the lake can vary greatly. Sampling will only be conducted when the water level is such that there is not considerable amount of exposed shoreline. The objective of the sampling is to determine the possible effects of septic systems so the nearshore areas are the areas of importance.

Sampling Parameters

A list of routine field parameters that will be measured by Stevens County Conservation District staff at each of the designated stations is presented in Table 6. District staff will collect water samples from these same sites and submit them to the Tshimakain Creek Laboratory, an Ecology accredited laboratory, for analysis of the parameters listed in Table 4.

Table 6 List of routine water quality parameters measured in the field by District staff.

Parameter	Analyst	Instrument
Water clarity	District	Secchi disk
Temperature	District	Troll 9500
Dissolved oxygen	District	Troll 9500
pH	District	Troll 9500
Specific conductance	District	Troll 9500
Optical brightener	District	Turner Designs Cyclops-7

Fecal coliform bacteria and total suspended solids will be measured by the Tshimakain Creek Laboratory.

Field Sampling Procedures

The Stevens County Conservation District will follow Washington Department of Ecology water quality monitoring standard operating procedures.

Table 7: Relevant Ecology Water Quality Monitoring Standard Operating Procedures

Ecology Index Number	Standard Operating Procedures Title
EAP010	Field Measurements of Conductivity / Salinity
EAP011	Instantaneous Measurement of Temperature in Water
EAP015	Grab Sampling - Freshwater
EAP030	Fecal Coliform Sampling
EAP031	Collection and Analysis of pH Samples
EAP035	Measurement of Dissolved Oxygen in Surface Water

Table 8: Sample container, preservation, and holding times for samples sent to the Tshimakain Creek Laboratory

Parameter	Matrix	Minimum Quantity Needed	Container	Preservative	Holding Time
Fecal coliform bacteria	Surface water	500 ml	500 ml wide-mouth sterilized polyethylene	Cool to 4^{o} C	24 hours

Fecal coliform sample bottles will be labeled with tape and indelible marker prior to going to the field. The label information will include the site identification. A bottle will be attached to a metal sampling pole and inserted into the water upside down so as not to gather any of the sample from the surface. After the bottle has reached approximately 4 feet in depth, it will be brought upright by means of an attached rod and the sample bottle filled. The full bottle will be brought to the surface and capped and then place in a cooler full of ice.

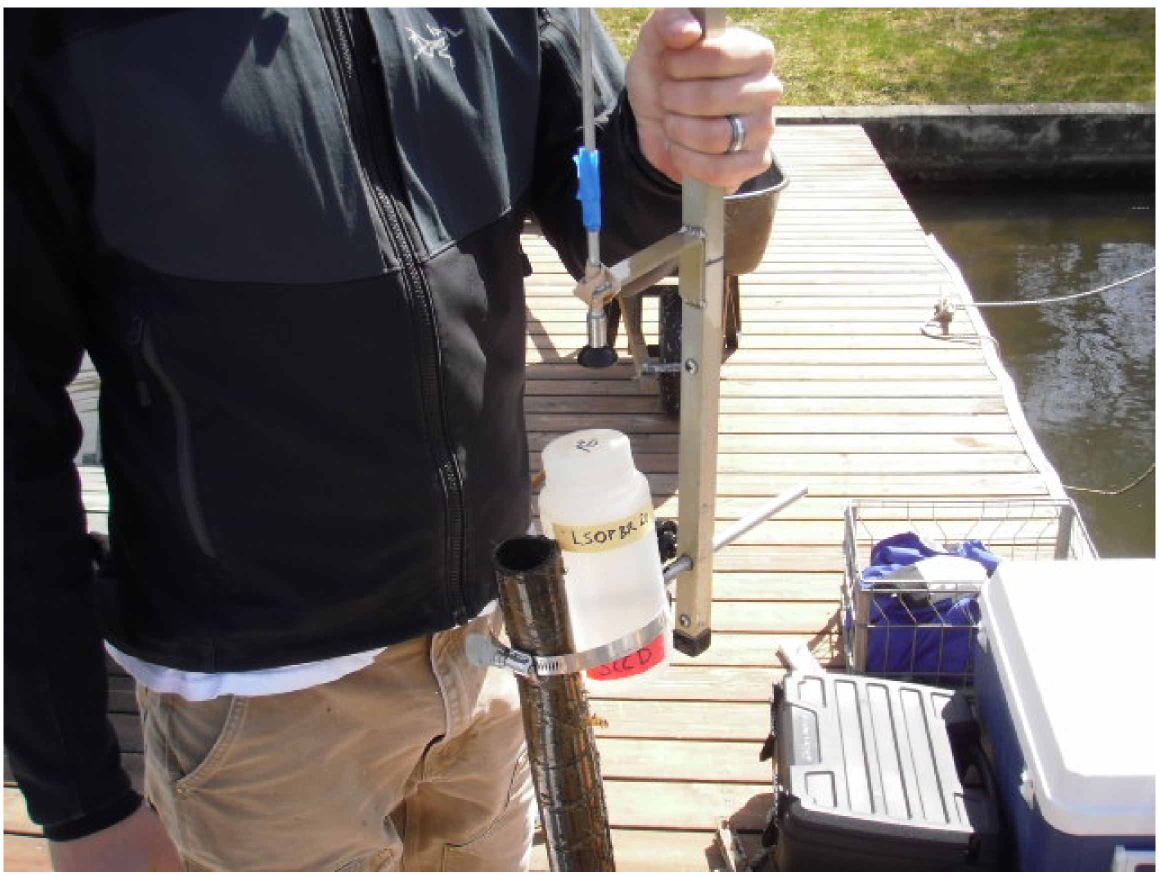


Figure2 – Fecal coliform sampling device

The Turner Designs Cyclops-7 attached to the DataBank Handheld Datalogger will be used to obtain optical brightener concentrations in parts per billion (ppb). The instrument will be calibrated using a Turner Designs standard of 400 ppb prior to each sampling session. At each site, the probe will be lowered into the water to a depth of 10 feet or less depending upon the depth of water the particular site. Since the ppb readout tends to fluctuate over a 1 ppb range, the sampler will record the reading to the nearest whole ppb.

The Troll 9500 will be used to obtain water temperature, dissolved oxygen, pH, and specific conductance readings from 1 or 2 depths, depending upon depth at each site. An upper reading will be made at 3 feet below the surface and an additional reading will be made at 15 feet or just above the bottom in shallower sites. When the depth is less than 5 feet, only one reading will be made at the deeper depth.

Water clarity will be measured using a Secchi disk. The disk will be lowered into the water until it is no longer visible and then will be brought up until it reappears. Light penetration is estimated as the average of the depths at which the disk disappears and at which it reappears.

A chain-of-custody form will be used for all samples sent to the laboratory. The chain of custody form is used to document sample handling during transfer from the field to the laboratory. The record of the physical sample, location and time of collection, will be linked with the analytical results to insure proper reporting of results. The form will contain the following:

1. Site identification
2. Date and time of collection
3. Sample matrix
4. Number of containers from each site
5. Preservatives used if any
6. Analysis required
7. Name(s) of collector(s)
8. Custody transfer signatures and dates and times of transfer
9. Name of laboratory receiving the sample

As samples are taken from the field and prepared for transport to the laboratory, the following procedures will be employed:

1. The chain of custody is checked for completeness and a copy is made for the SCCD records,
2. Sample containers are checked for tight and sealed caps and that the labels are secure on the bottle,
3. Each cooler is checked to insure that there is sufficient ice in the cooler to preserve the samples until they are turned over to laboratory personnel, and
4. Each cooler will be handled in such a way so that the temperature requirements of the sample holding time will be met.

Field data books will consist of "All-Weather Rite in the Rain" spiral notebooks. Data will be uniformly entered at each site. The sample date will appear on each page of the book used for that sampling period. Site identification and time of sampling will be recorded.

- For field measurements, the parameter will be identified and the various readings taken at the site will be recorded. Care must be taken in the recording of data to make it plain to anyone picking up the field book what is being recorded.

Quality Control

Field Quality Control

Equipment manuals and standard operating procedures for field instruments will be followed closely regarding suggested routine and preventive maintenance. Equipment will be checked upon return to the office after every sampling event and will be stored in such a way to avoid damage between sampling events.

At least 10% of the fecal coliform samples collected in the field will be randomly selected duplicates. A field duplicate is defined as a second sample from the same location, collected in immediate succession, using identical techniques. Duplicate samples are preserved, sealed, handled, stored, shipped, and analyzed in the same manner as the primary sample. The laboratory staff will not be informed as to the identity of duplicate samples until after the analysis of samples for the sampling event is completed. Results from these collections are used to estimate total precision for each parameter.

Fecal coliform samples will be collected in compliance with the Ecology's sampling SOPs. Bottles will be handled carefully to avoid contamination from the sampler's hands. Since the bottle has been sterilized, it will only be submerged into the flow once.

Laboratory Quality Control

The Tshimakain Creek Laboratory shall employ standard quality control procedures. This will include, but not be limited to, samples being analyzed in duplicate, use of laboratory spikes to indicate bias that may be caused by interference from the sample matrix, and use of external standards. The Tshimakain Creek Laboratory has been accredited by the Washington Department of Ecology and will provide a current copy of their Quality Assurance Plans to the District.

Performance and Systems Audits

The Tshimakain Creek Laboratory is expected to routinely participate in performance and systems audits of their laboratory procedures. The laboratory will make the results of these audits available to both the Stevens County Conservation District (lead agency) and the Department of Ecology (funding agency) upon request.

DATA MANAGEMENT PROCEDURES

Data Reduction, Review and Reporting

Laboratory and field results will be organized by sampling site for each parameter, measurement, and sampling event. The Tshimakain Creek Laboratory will review the analytical results from each sampling event as they become available, for completeness, precision, and bias. The laboratory will provide the results from each sample event in a spreadsheet format. Spreadsheets will be sent to the District electronically and later in a paper copy accompanying the invoice for billing.

The Stevens County Conservation District Water Quality Coordinator will be responsible for the collection of field data. The Water Quality Coordinator and the District Manager will be reviewing these data, and the procedures used to obtain them, throughout the duration of the monitoring program. Field data will also be kept in a spreadsheet format.

Data will be kept in a spreadsheet and will be available for Department of Ecology review. The final project report will include a quality assurance section that will summarize QC results and the procedures used to insure data quality during the monitoring project.

Progress will be summarized in monthly project reports developed by the Water Quality Coordinator and presented to the District Board of Supervisors. All monitoring data collected will be managed in order to be available to secondary users and to meet the ten-year rule for collected data.

Throughout the sampling season, District staff will be communicating with the Laboratory manager on the review of the data. Outlier results from any site will be discussed with the laboratory to determine possible causes. Field duplicate sample results will be used to assess the entire sampling process, including environmental variability, and field duplicate samples will be compared with laboratory duplicates. Professional judgment will be relied upon in evaluating results. Rejecting results based on significant variability is a possibility.

At the end of each sampling month, District staff will review the data. Field books will be compared to the spreadsheet data to determine if there are any transposition errors or errors of omission of data. Spreadsheet equations will be checked to make sure that the formulas used are correct. All errors found will be corrected.

Fecal coliform measurements may be below the detection limit of the laboratory, 1 colony forming unit (cfu) per 100 milliliters of water. In these cases, the results will be reported as less than the detection limit (< 1 cfu / 100ml). For statistical purposes, the actual detection limit will be used in calculating the geometric mean of all the data points for that given time period.

Data Management

The management of data will include all mathematical operations and analyses performed on the data. Data management guidelines include:

1. Ensuring that data encoding and entry into databases is correct,

2. Appropriately converting data into related values such as loading,
3. Transmitting data electronically or as hard copy without error,
4. Analyzing data by applying the appropriate statistics,
5. Tracking the flow of data through the data processing system,
6. Ensuring proper storage of data at the District level, and
7. Entry of data into the Ecology EIM system in a timely manner if required.

Corrective Action

The Tshimakain Creek Laboratory has specific quality control procedures that include criteria for initiating corrective action based on QC results. These criteria and the proposed corrective action will be specified to the Stevens County Conservation District's Water Quality Coordinator at the initiation of sample analysis. The Water Quality Coordinator will be contacted when the laboratory has to initiate any corrective action.

The Water Quality Coordinator will deal with any problems associated with field data collection. Sample acquisition, storage, and transfer will all be monitored and documented to assure that QC standards are being met. Sampling procedures and sample handling will be documented and corrected if needed during changing sampling conditions in order to comply with the QC standards. Errors detected in data reporting will be corrected when they are found.

References Used in the Creation of this Document

Ecology Publications

1. Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies; 2004, S. Lombard and C. Kirchmer, Ecology Publication Number 04-03-030

2. Field Sampling and Measurement Protocols for the Watershed Assessment Section; 1993, B. Cusimano, Ecology Publication Number 93-e04

3. Ecology Standard Operating Procedures Manuals for obtaining watershed data
   - EAP015 - Grab Sampling – Freshwater; Joy
   - EAP030 - Fecal Coliform Sampling; Ward

4. Tshimakain Creek Laboratory Guide for Sample Handling, Method of Analysis, and Cost per Parameter