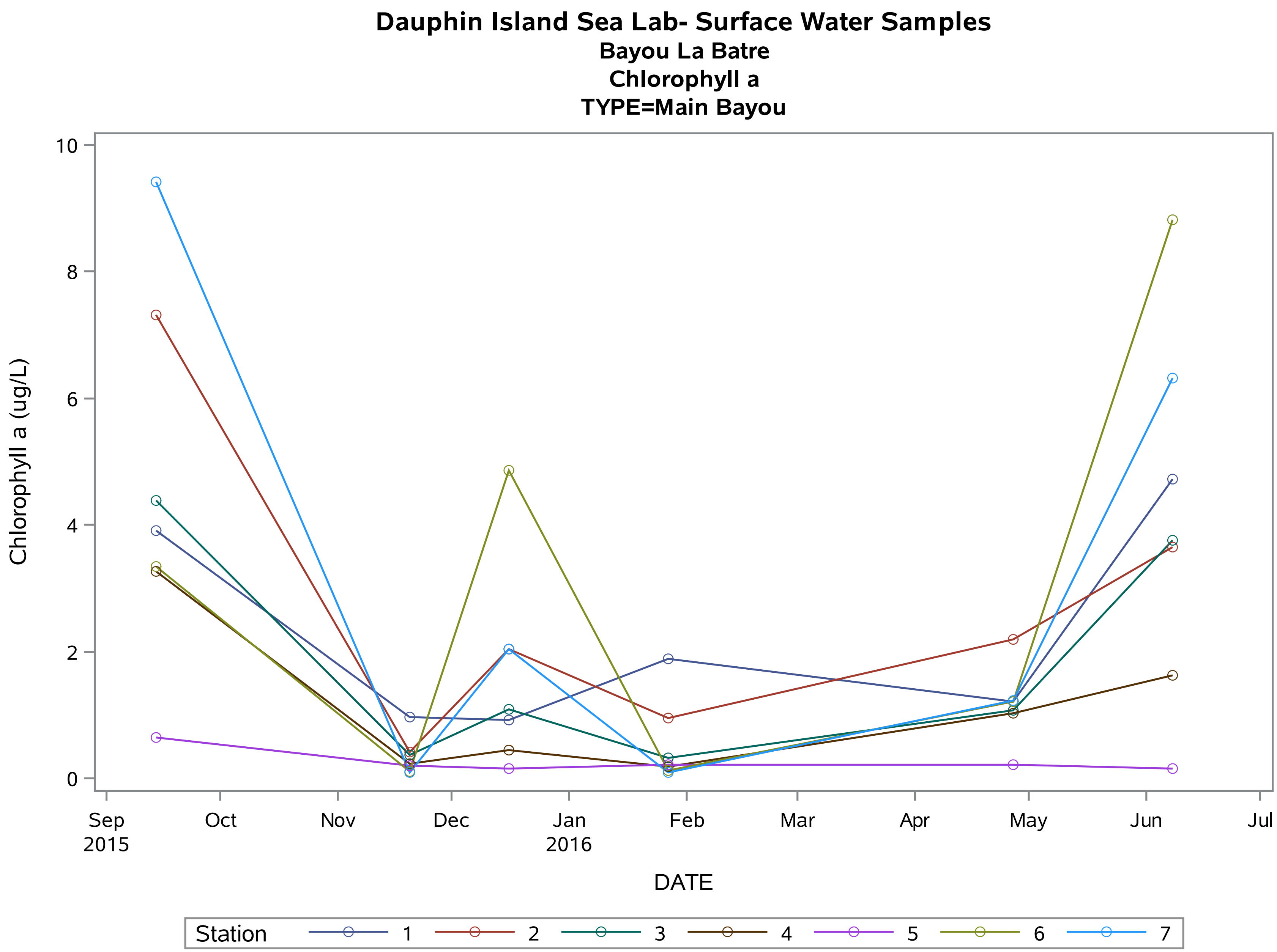
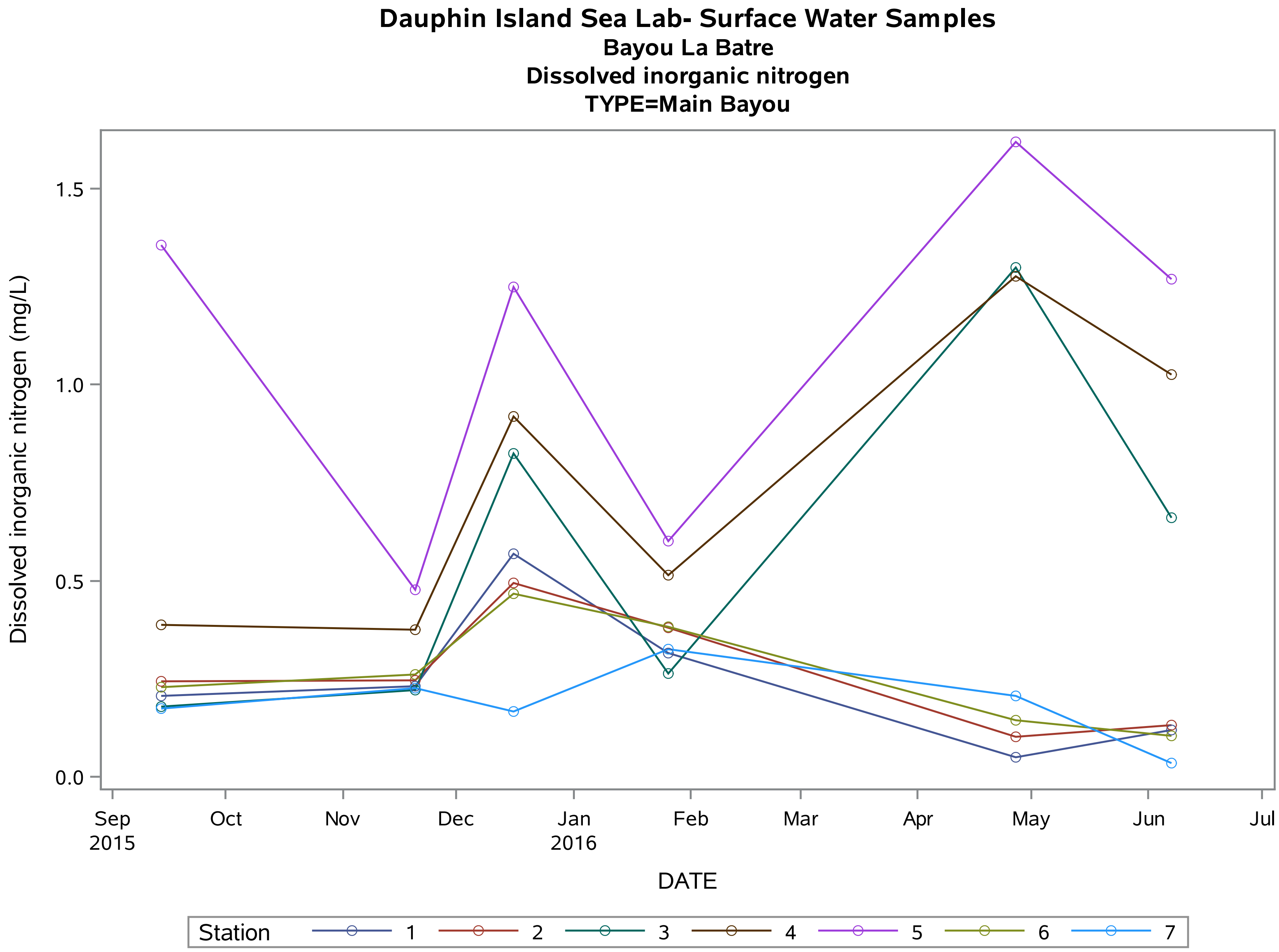
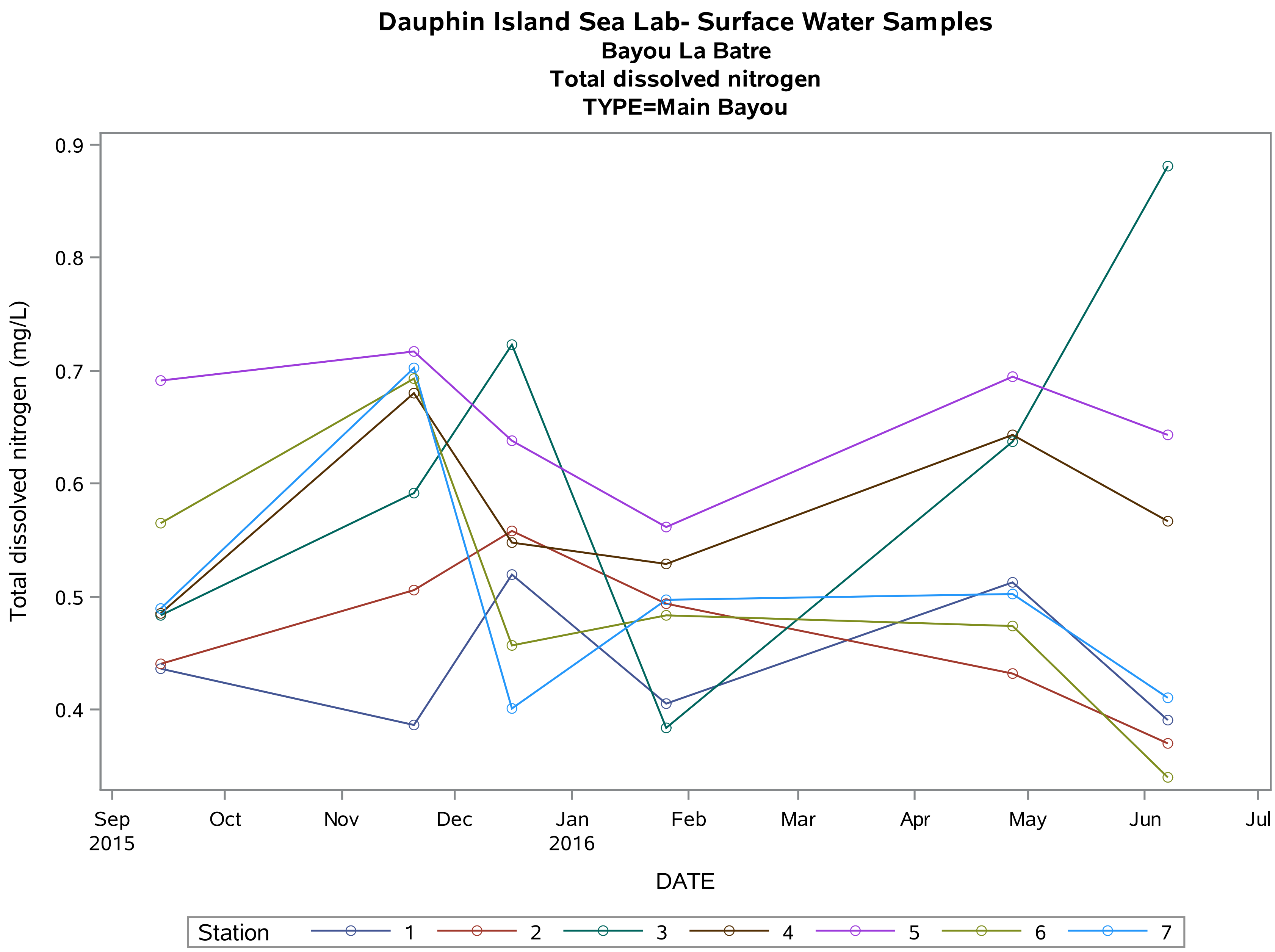
APPENDIX A DISL RAW DATA

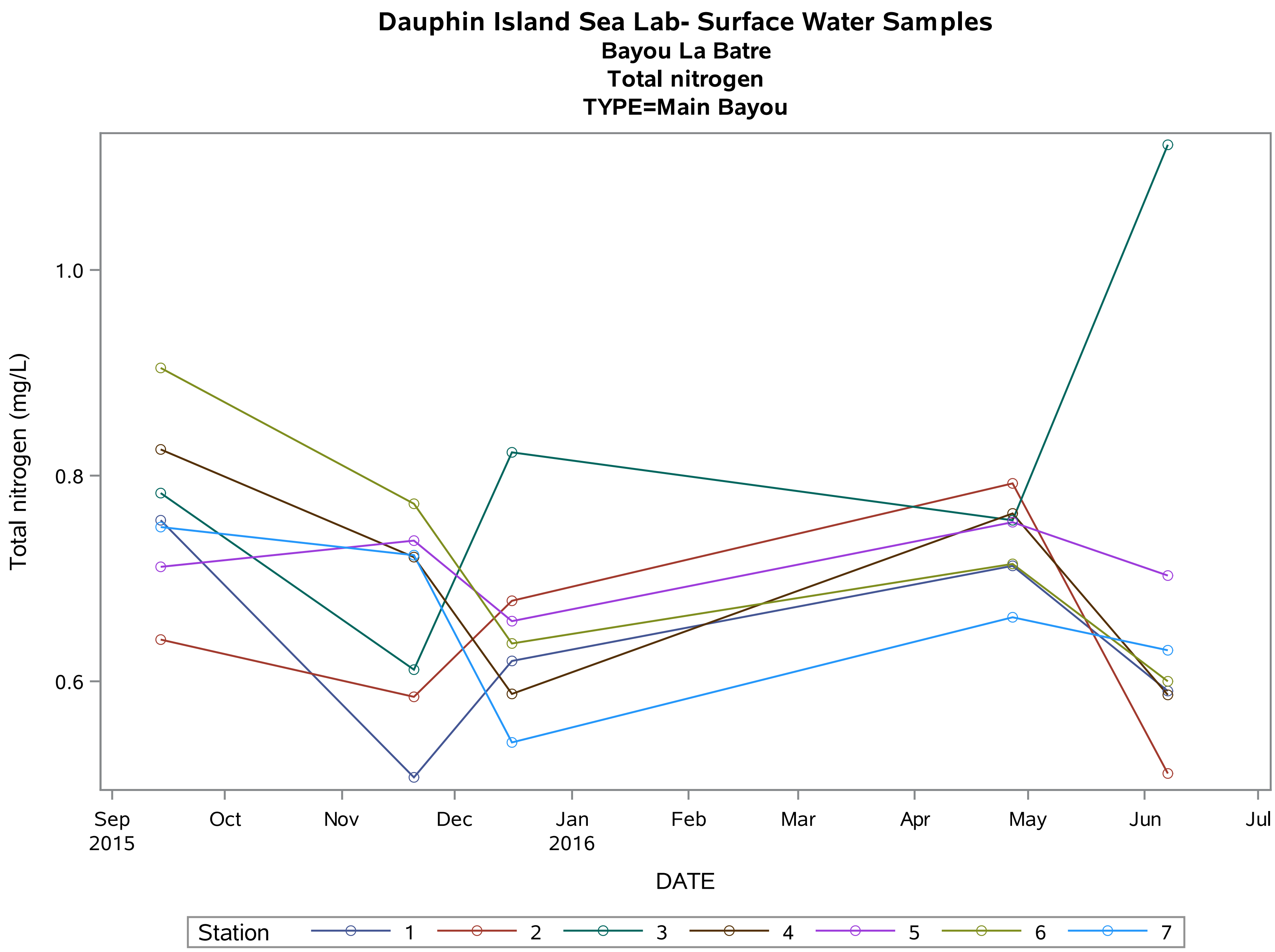

Dauphin Island Sea Lab- Surface Water Samples
Bayou La Batre
Chlorophyll a
TYPE=Main Bayou
Chlorophyll a (ug/L)
0
2
4
6
8
10
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
Station
1
2
3
4
5
6
7

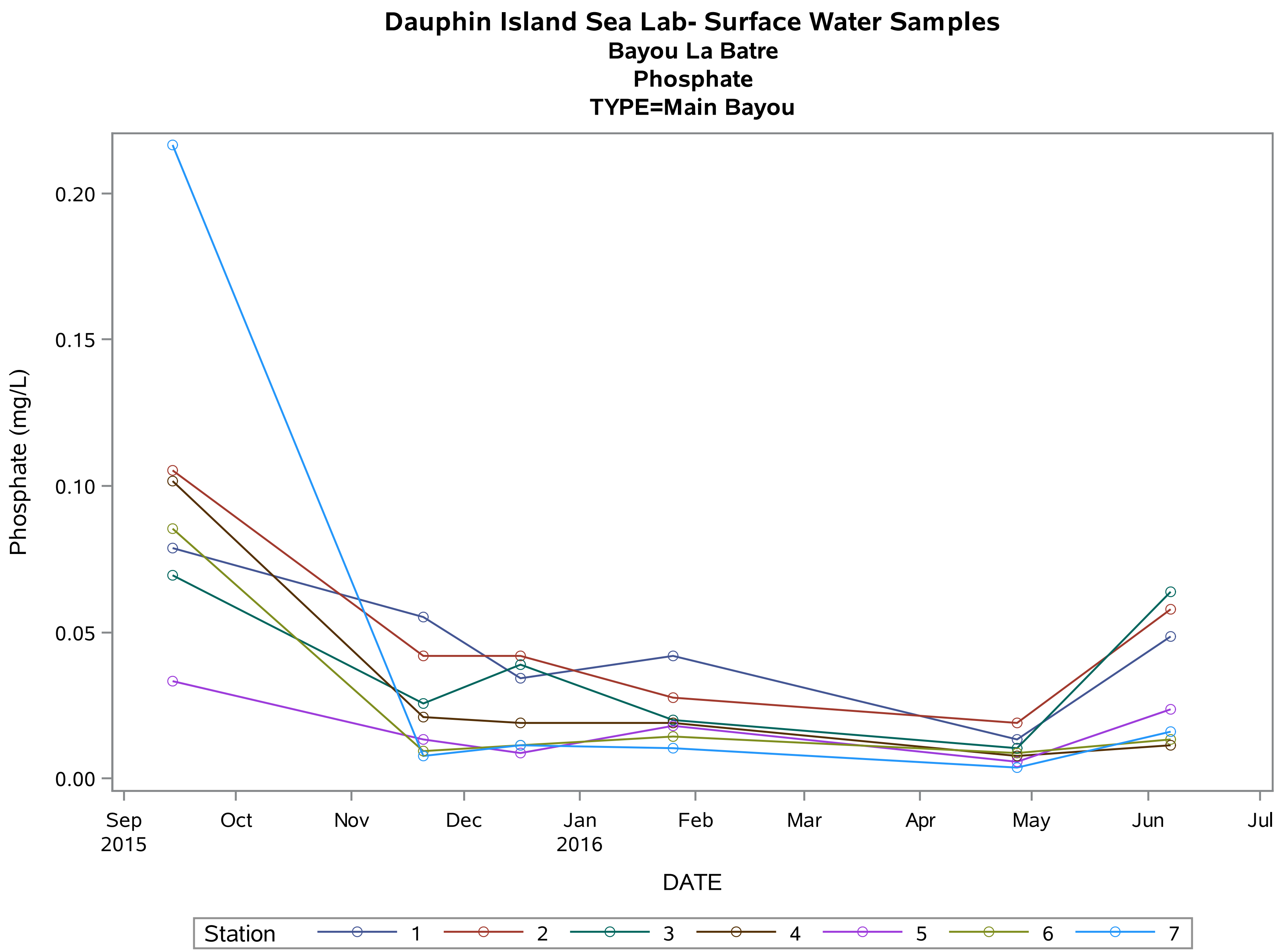


Dauphin Island Sea Lab- Surface Water Samples
Bayou La Batre
Dissolved inorganic nitrogen
TYPE=Main Bayou
Dissolved inorganic nitrogen (mg/L)
1.5
1.0
0.5
0.0
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
Station
1
2
3
4
5
6
7

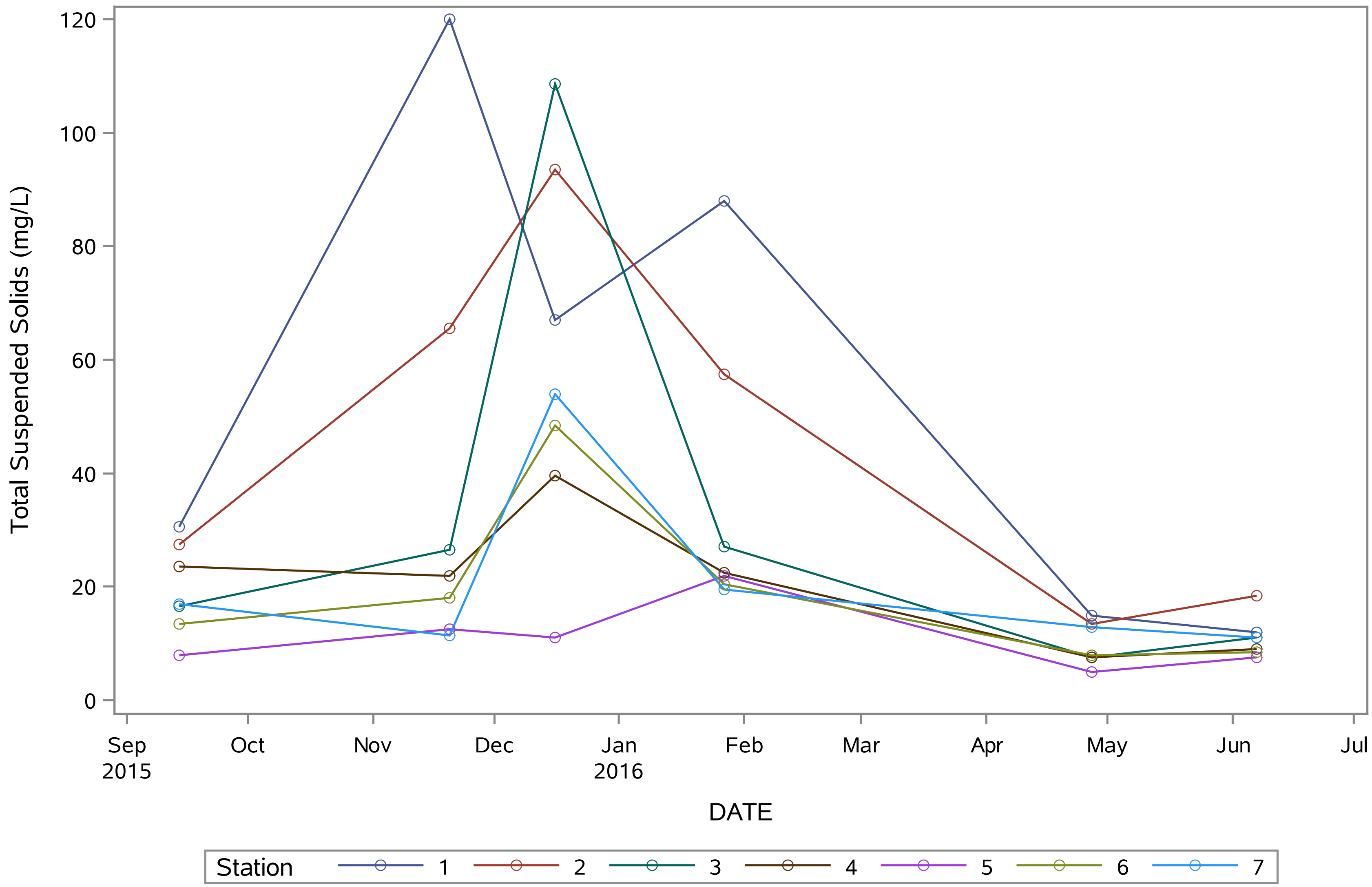


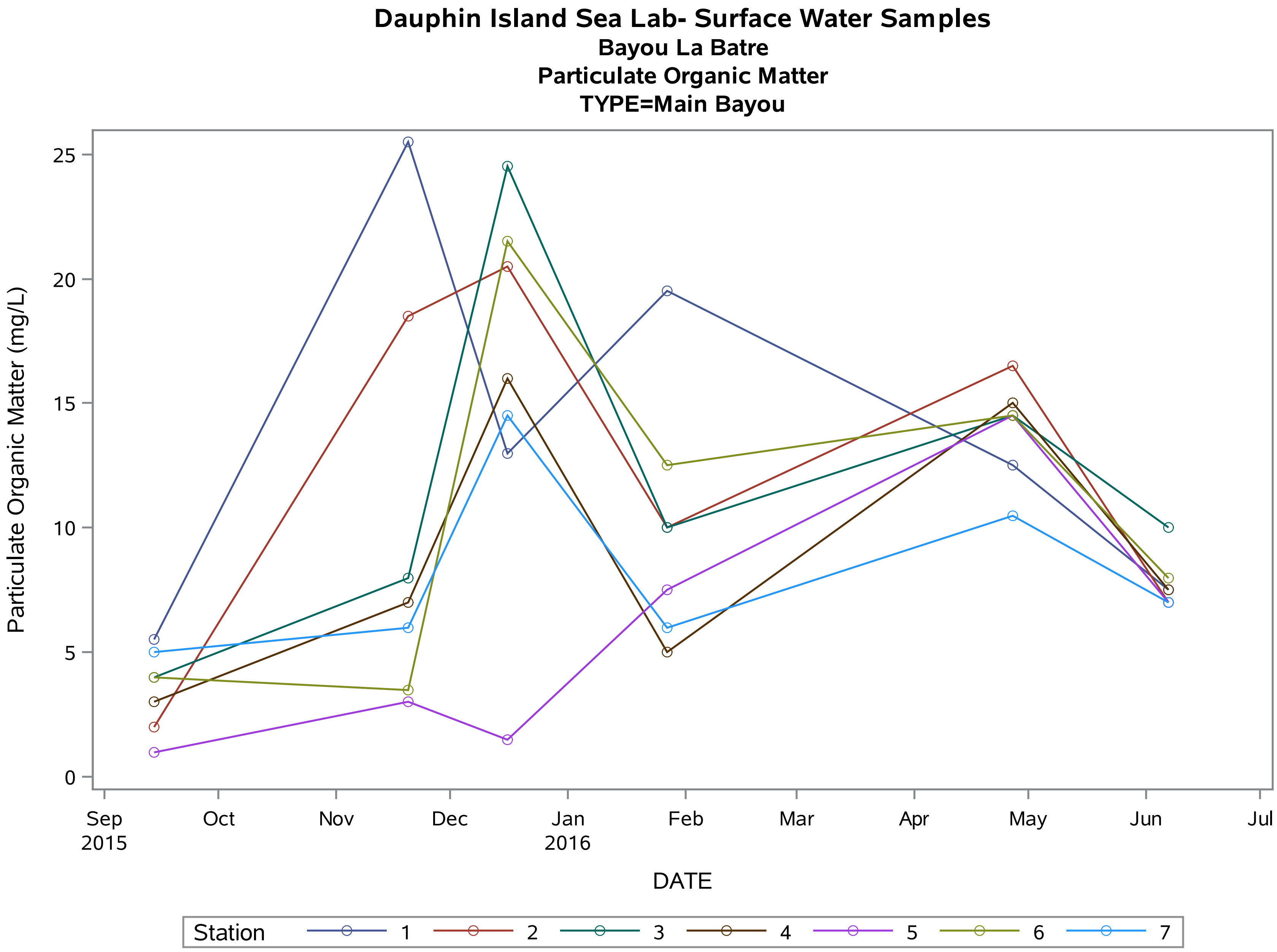
Dauphin Island Sea Lab- Surface Water Samples
Bayou La Batre
Total dissolved nitrogen
TYPE=Main Bayou
Total dissolved nitrogen (mg/L)
0.9
0.8
0.7
0.6
0.5
0.4
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
Station
1
2
3
4
5
6
7

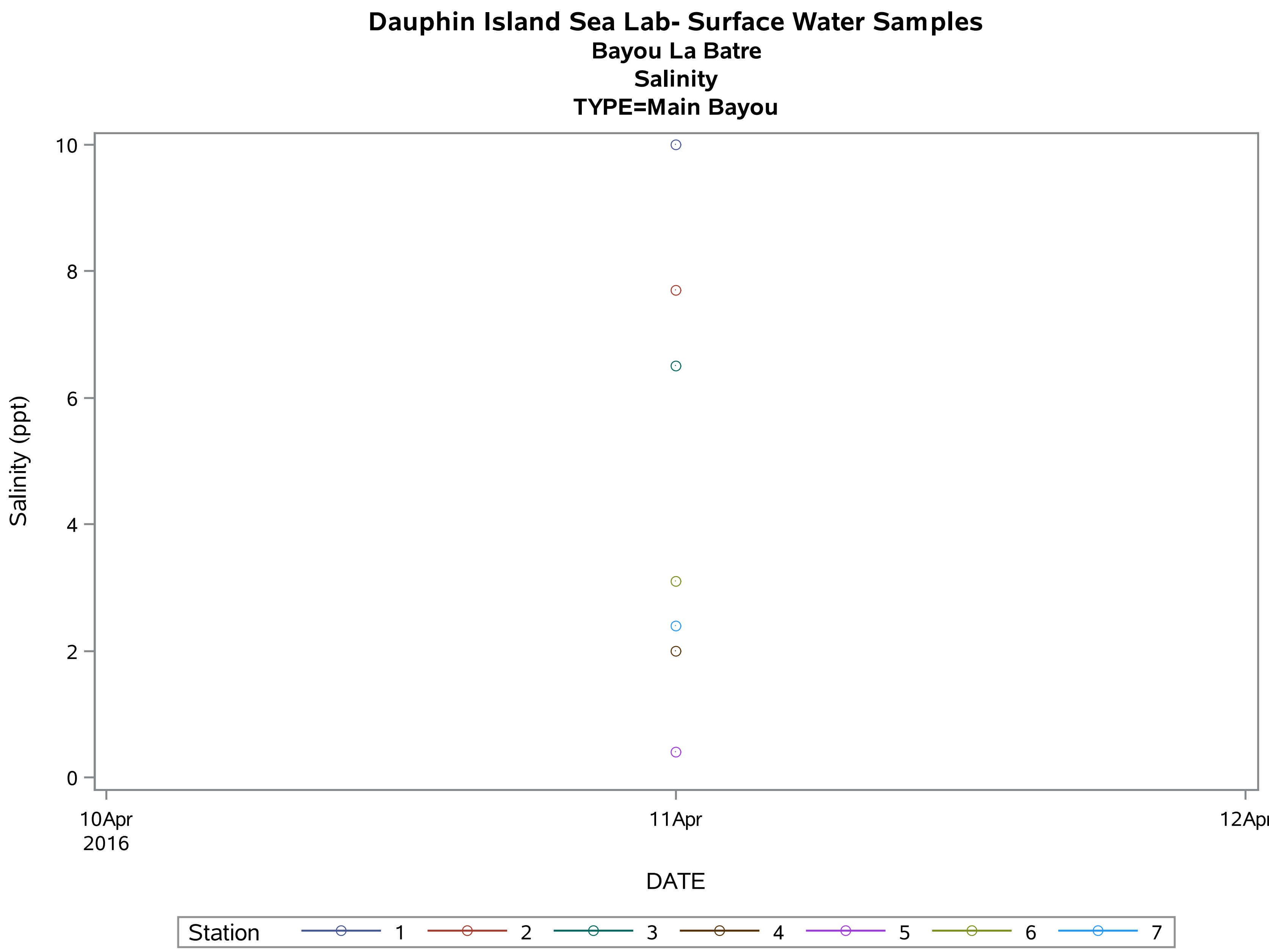

Dauphin Island Sea Lab- Surface Water Samples
Bayou La Batre
Total nitrogen
TYPE=Main Bayou
Total nitrogen (mg/L)
1.0
0.8
0.6
Sep
2015
Oct
Nov
Dec
Jan
2016
Feb
Mar
Apr
May
Jun
Jul
DATE
Station
1
2
3
4
5
6
7


Dauphin Island Sea Lab- Surface Water Samples
Bayou La Batre
Phosphate
TYPE=Main Bayou
Phosphate (mg/L)
0.20
0.15
0.10
0.05
0.00
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
Station
1
2
3
4
5
6
7

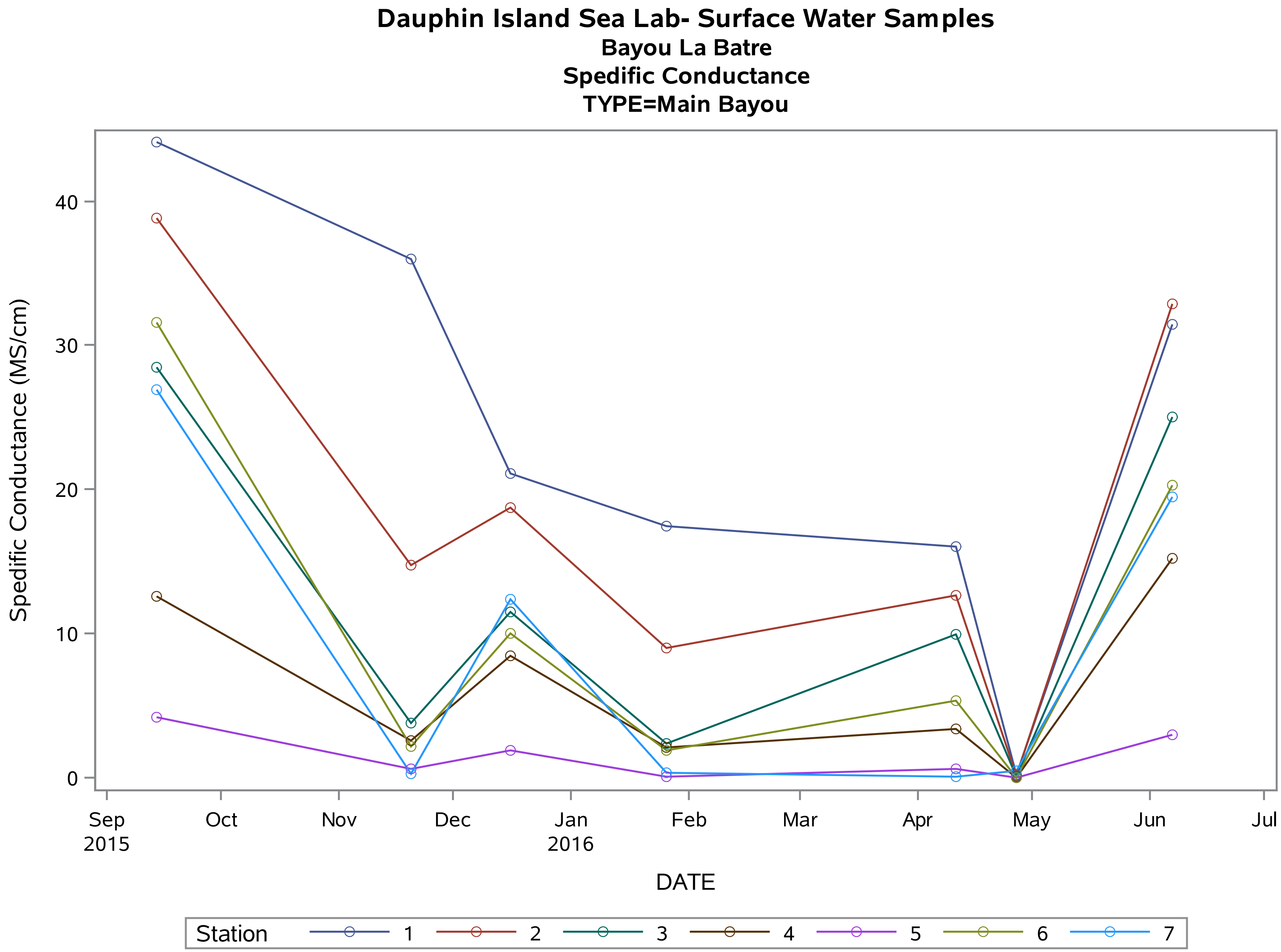
Dauphin Island Sea Lab- Surface Water Samples
Bayou La Batre
Total Suspended Solids
TYPE=Main Bayou



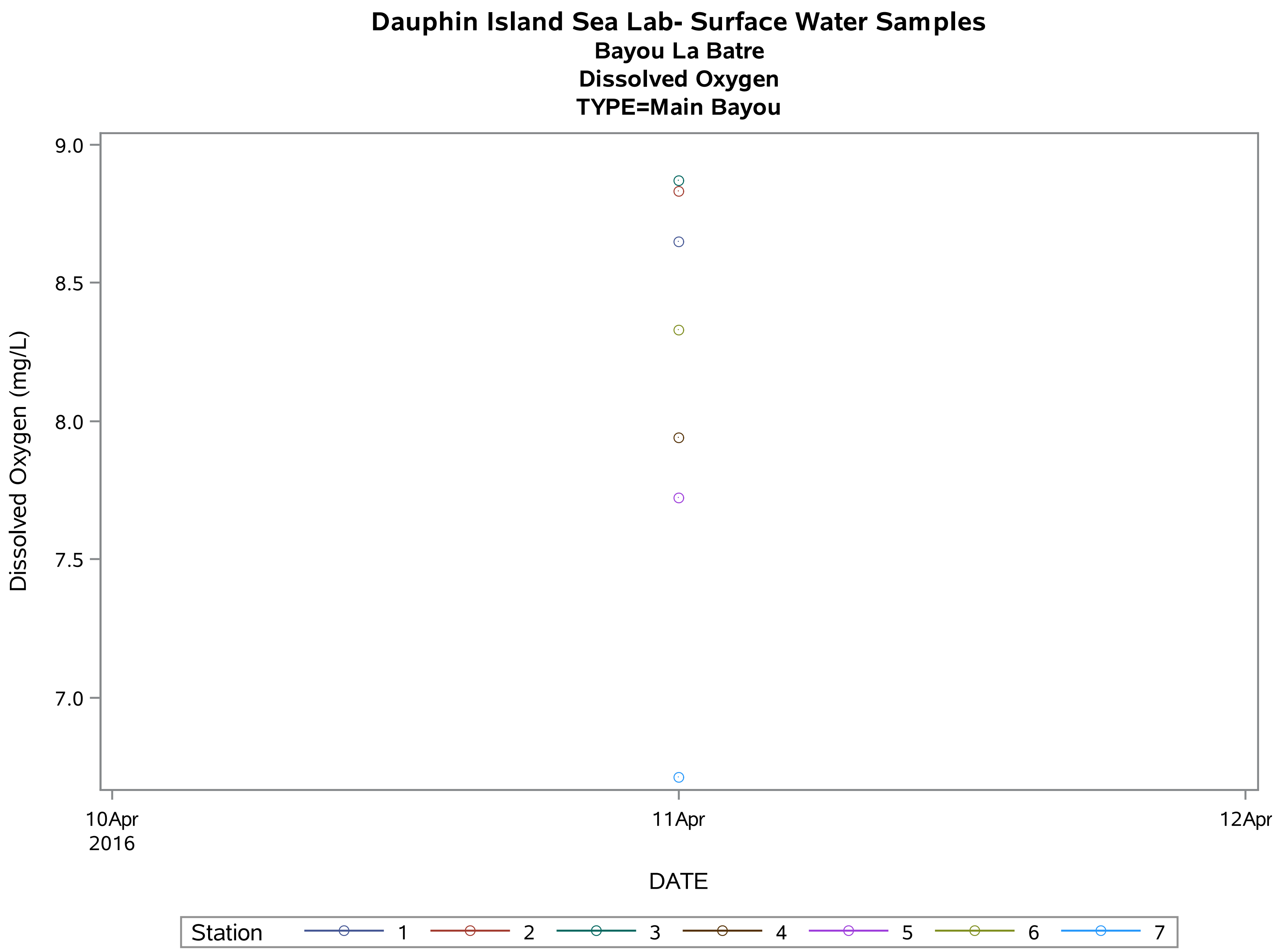

Dauphin Island Sea Lab- Surface Water Samples
Bayou La Batre
Particulate Organic Matter
TYPE=Main Bayou
Particulate Organic Matter (mg/L)
0
5
10
15
20
25
Sep
2015
Oct
Nov
Dec
Jan
2016
Feb
Mar
Apr
May
Jun
Jul
DATE
Station
1
2
3
4
5
6
7



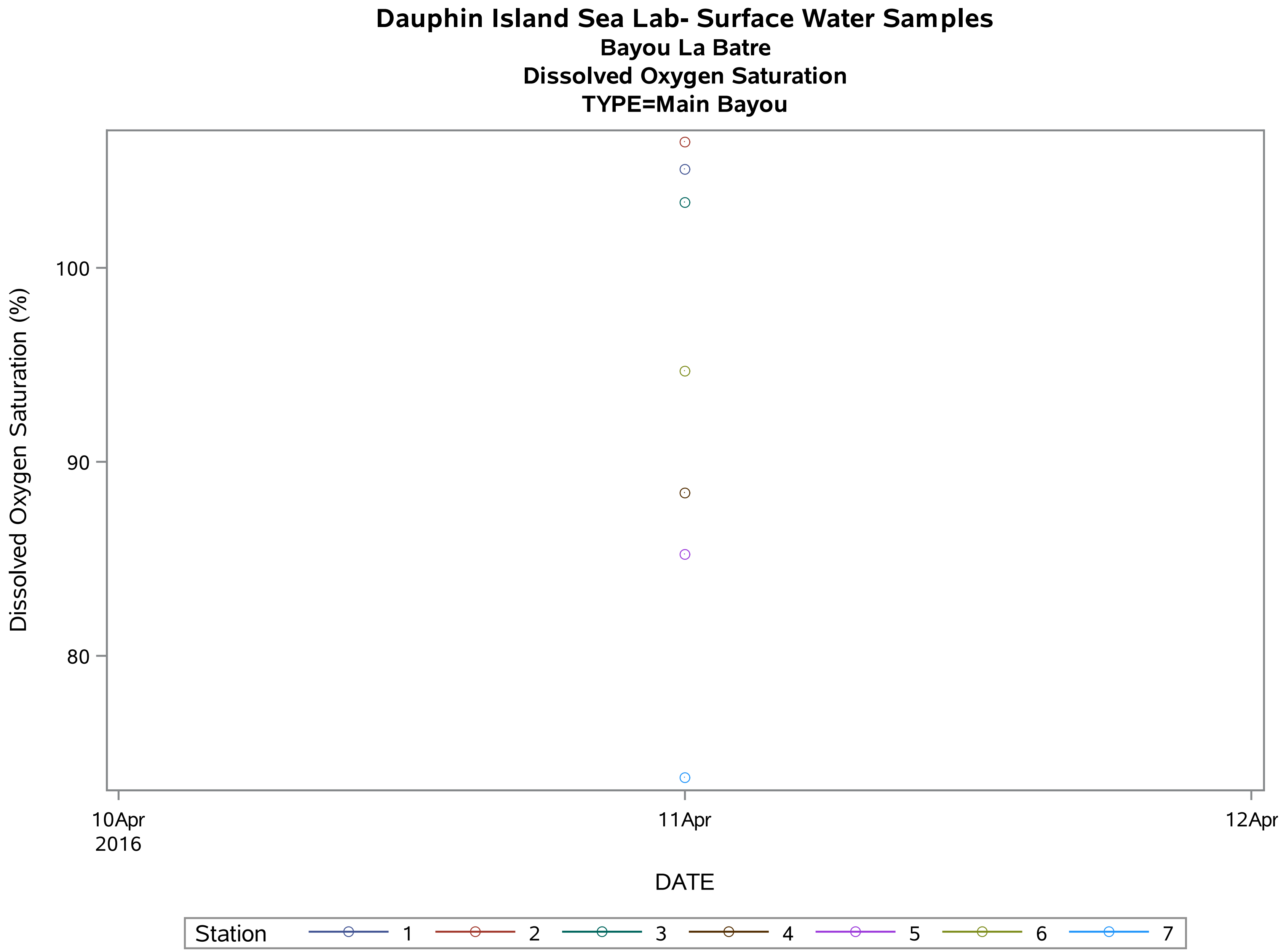
Dauphin Island Sea Lab- Surface Water Samples
Bayou La Batre
Salinity
TYPE=Main Bayou
Salinity (ppt)
10
8
6
4
2
0
10Apr
2016
11Apr
12Apr
DATE
Station
1
2
3
4
5
6
7

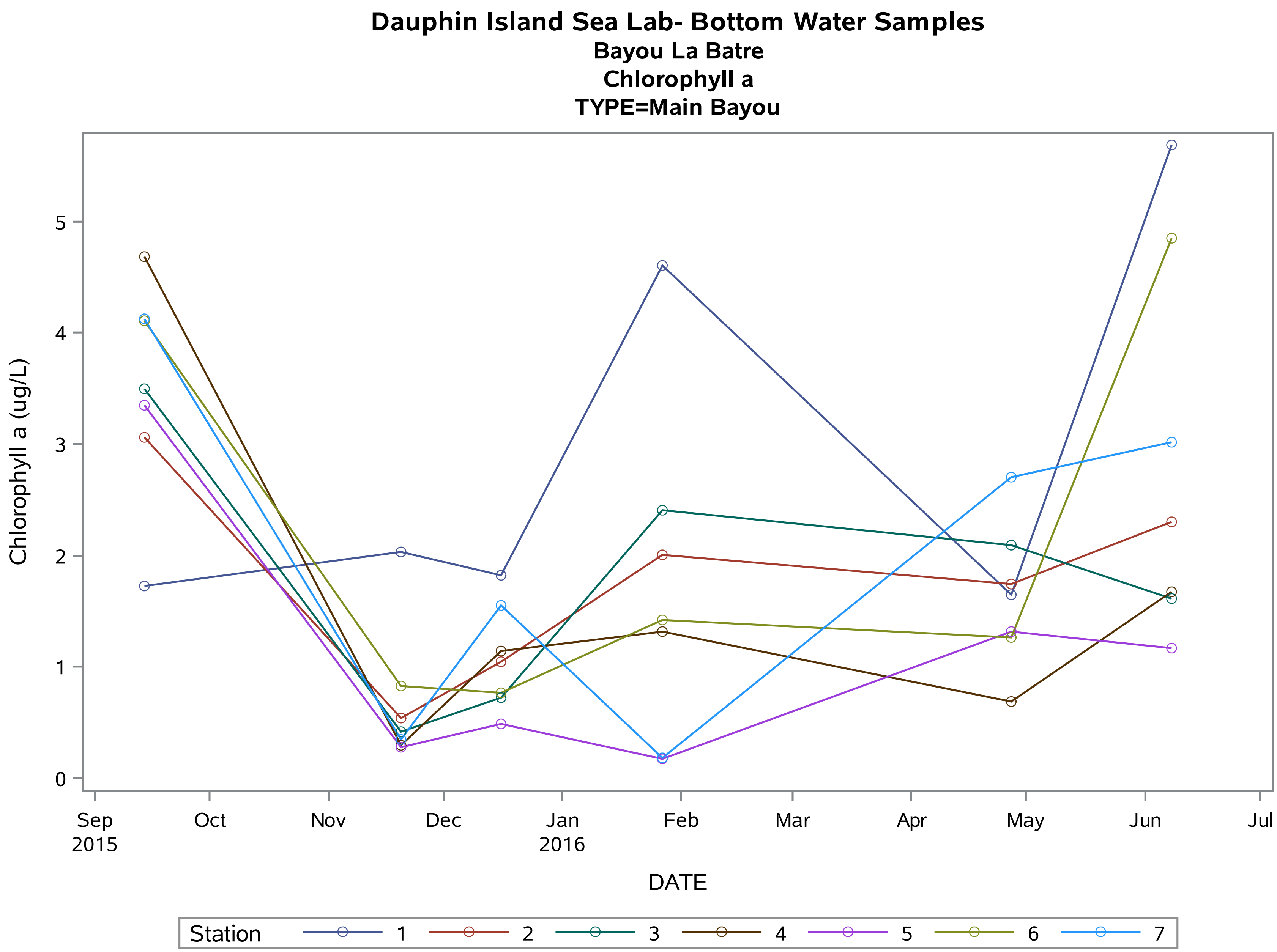


Dauphin Island Sea Lab- Surface Water Samples
Bayou La Batre
Spedific Conductance
TYPE=Main Bayou
Spedific Conductance (MS/cm)
0
10
20
30
40
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
Station
1
2
3
4
5
6
7

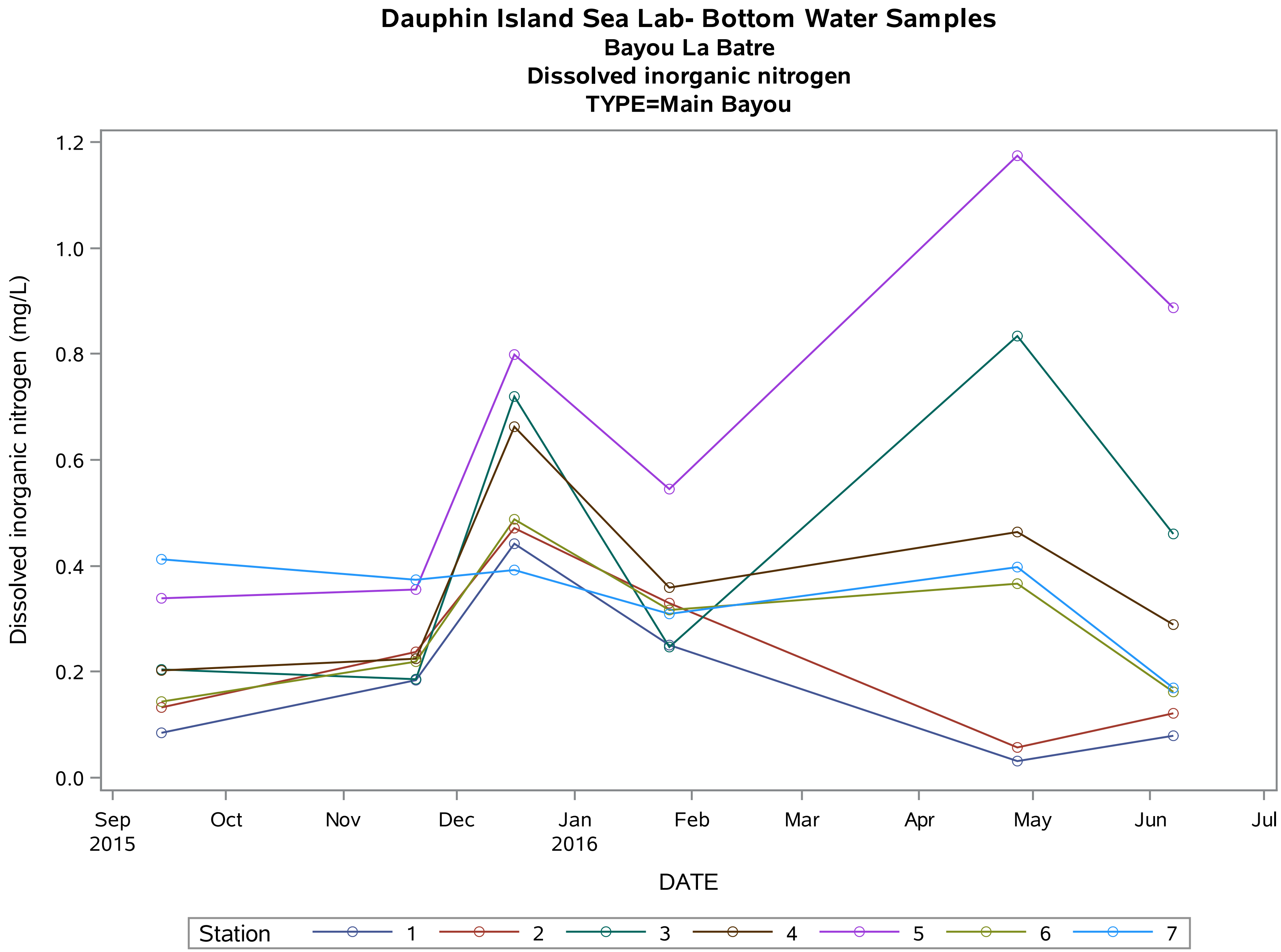


Dauphin Island Sea Lab- Surface Water Samples
Bayou La Batre
Dissolved Oxygen
TYPE=Main Bayou
Dissolved Oxygen (mg/L)
9.0
8.5
8.0
7.5
7.0
10Apr
2016
11Apr
12Apr
DATE
Station
1
2
3
4
5
6
7

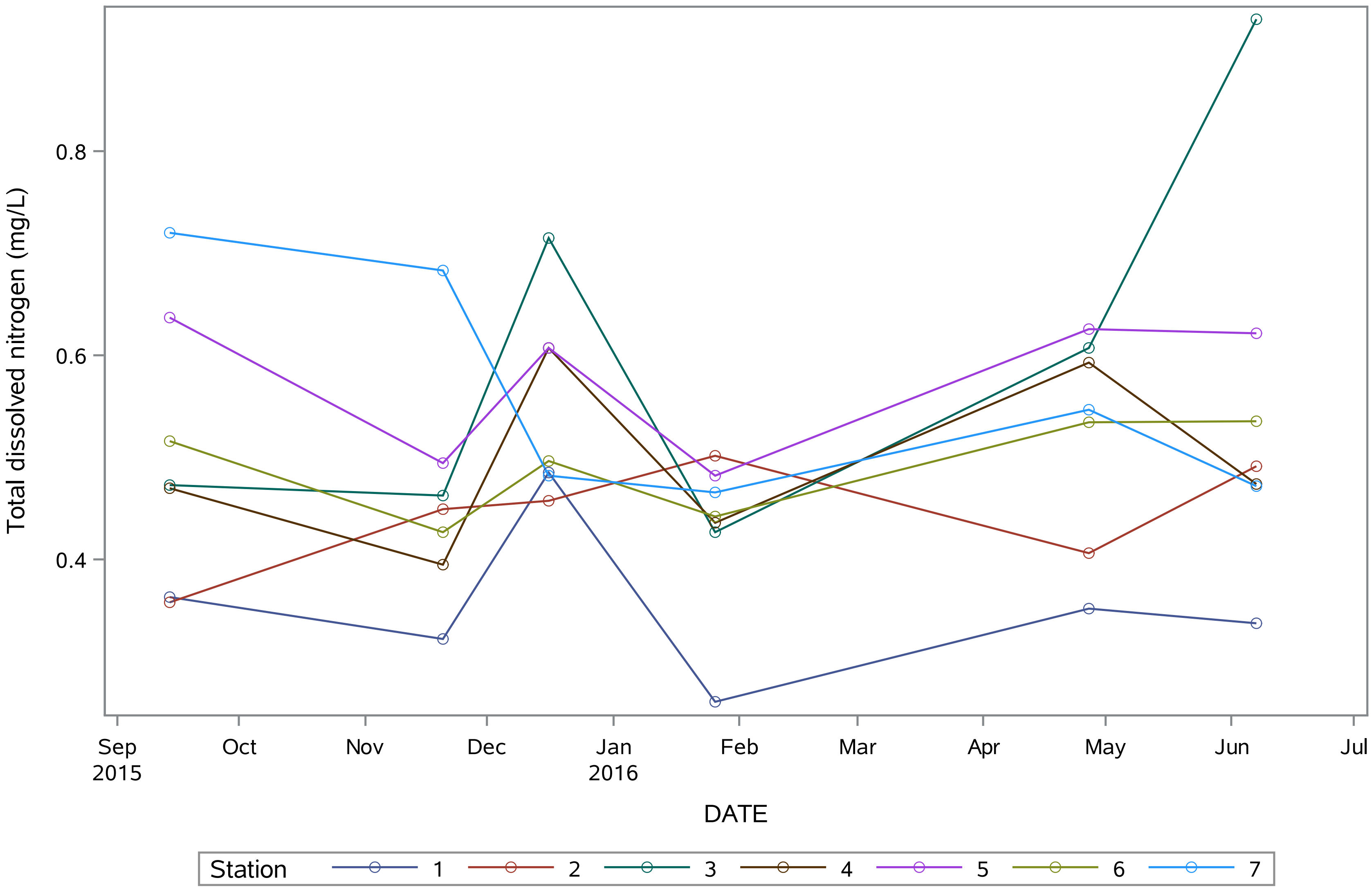

Dauphin Island Sea Lab- Surface Water Samples
Bayou La Batre
Dissolved Oxygen Saturation
TYPE=Main Bayou
Dissolved Oxygen Saturation (%)
100
90
80
10Apr
2016
11Apr
12Apr
DATE
Station
1
2
3
4
5
6
7

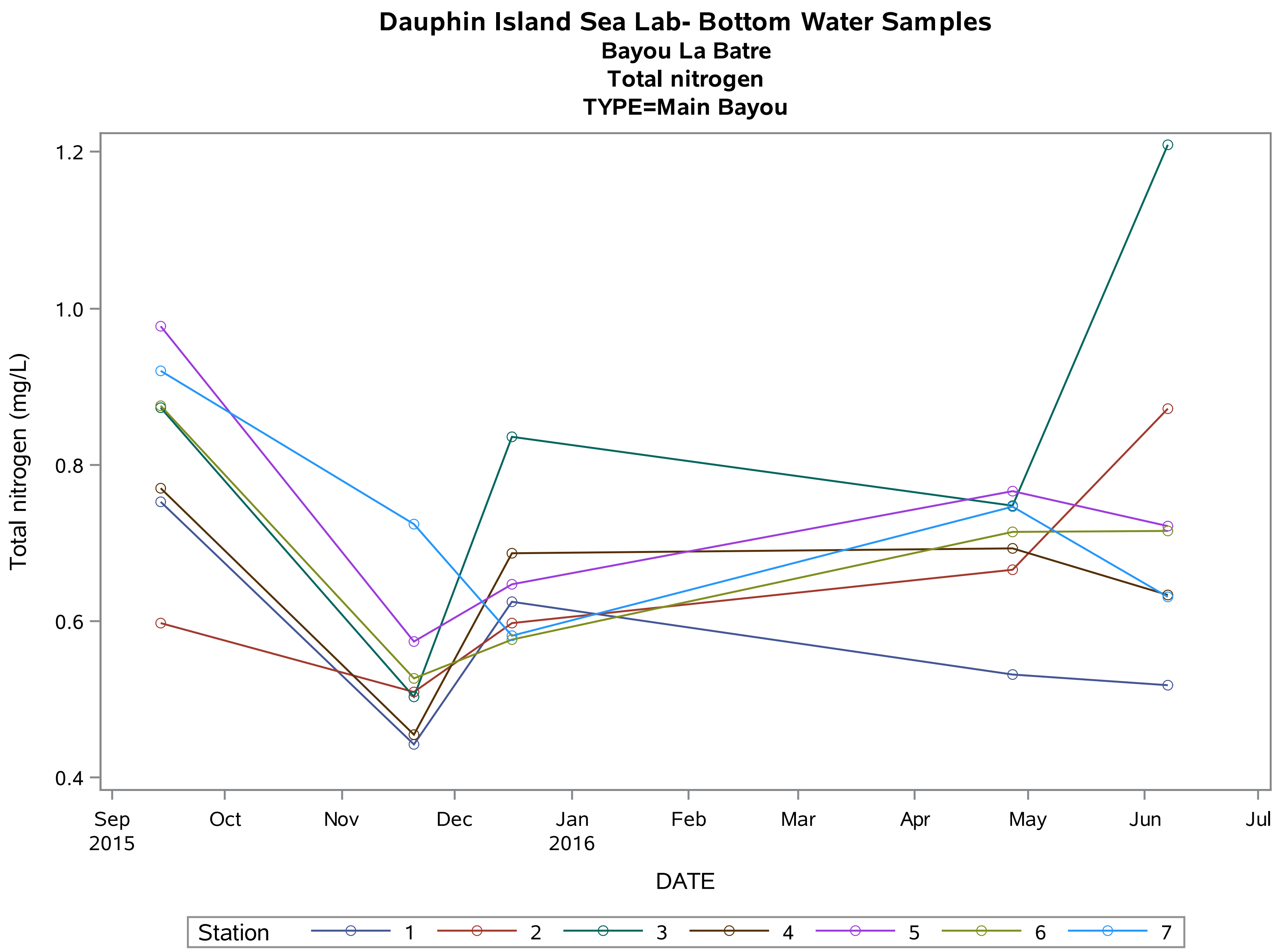


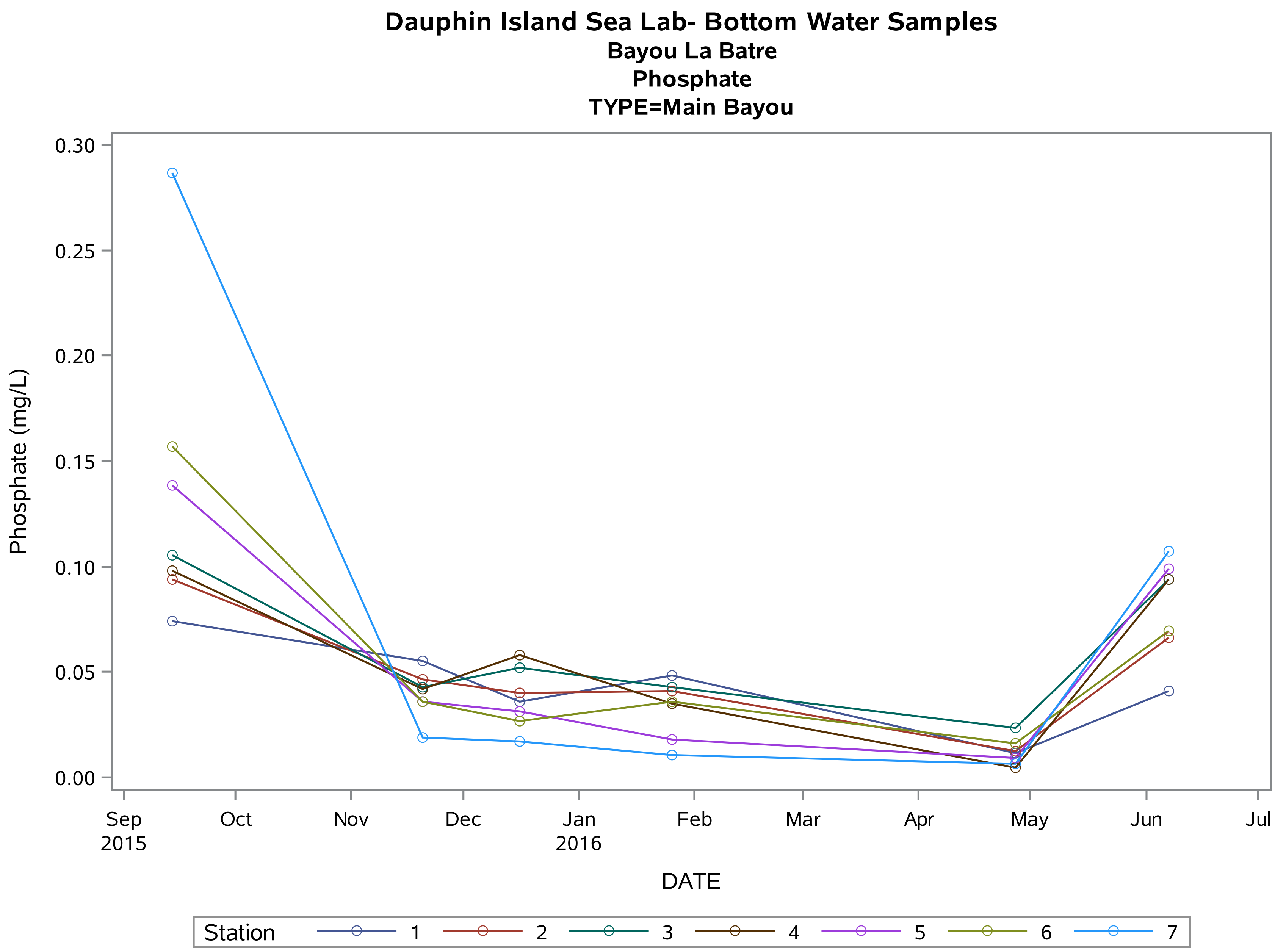
Dauphin Island Sea Lab- Bottom Water Samples
Bayou La Batre
Chlorophyll a
TYPE=Main Bayou
Chlorophyll a (ug/L)
0
1
2
3
4
5
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
Station
1
2
3
4
5
6
7


Dauphin Island Sea Lab- Bottom Water Samples
Bayou La Batre
Dissolved inorganic nitrogen
TYPE=Main Bayou
Dissolved inorganic nitrogen (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
Station
1
2
3
4
5
6
7

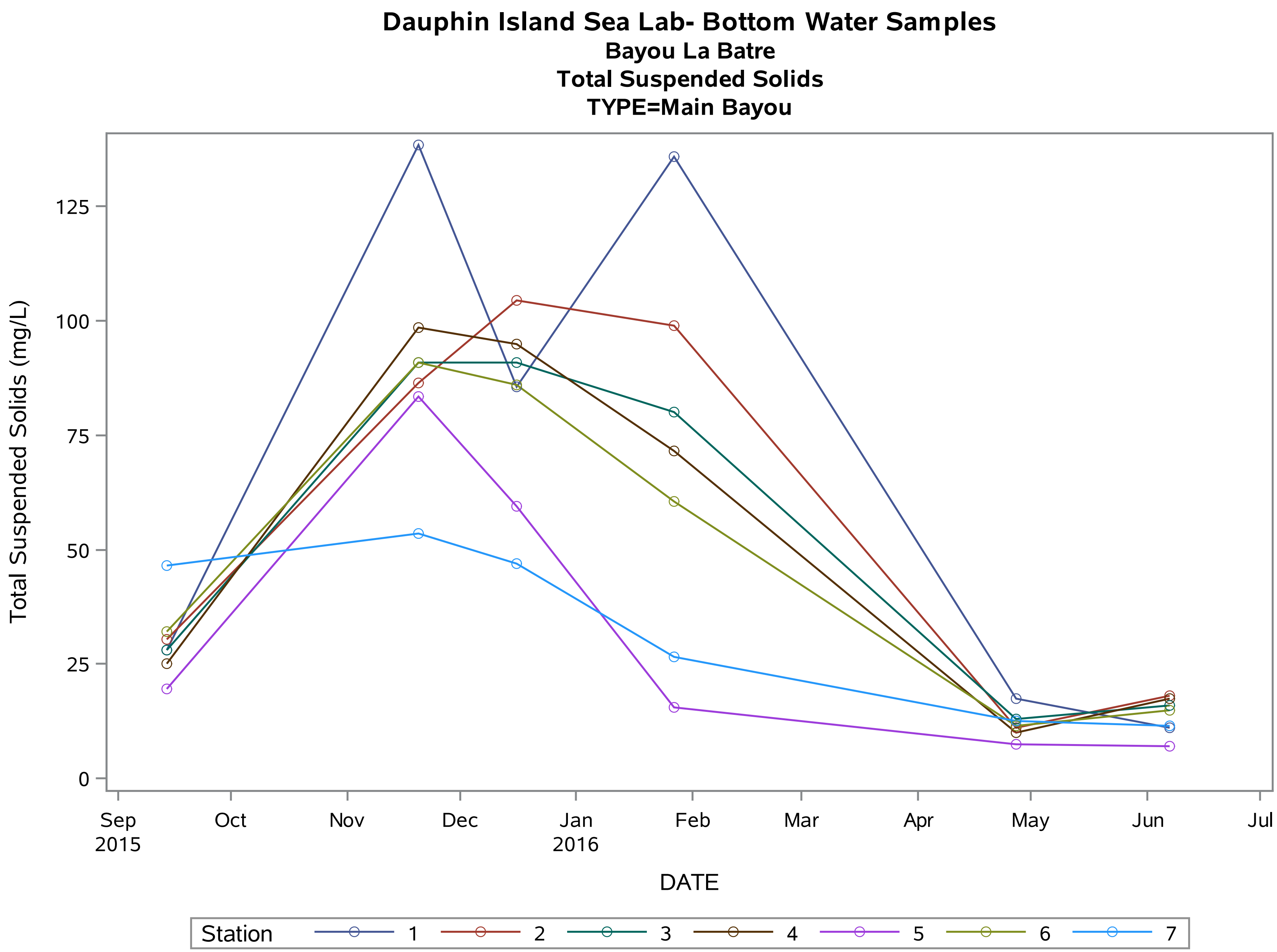
Dauphin Island Sea Lab- Bottom Water Samples
Bayou La Batre
Total dissolved nitrogen
TYPE=Main Bayou

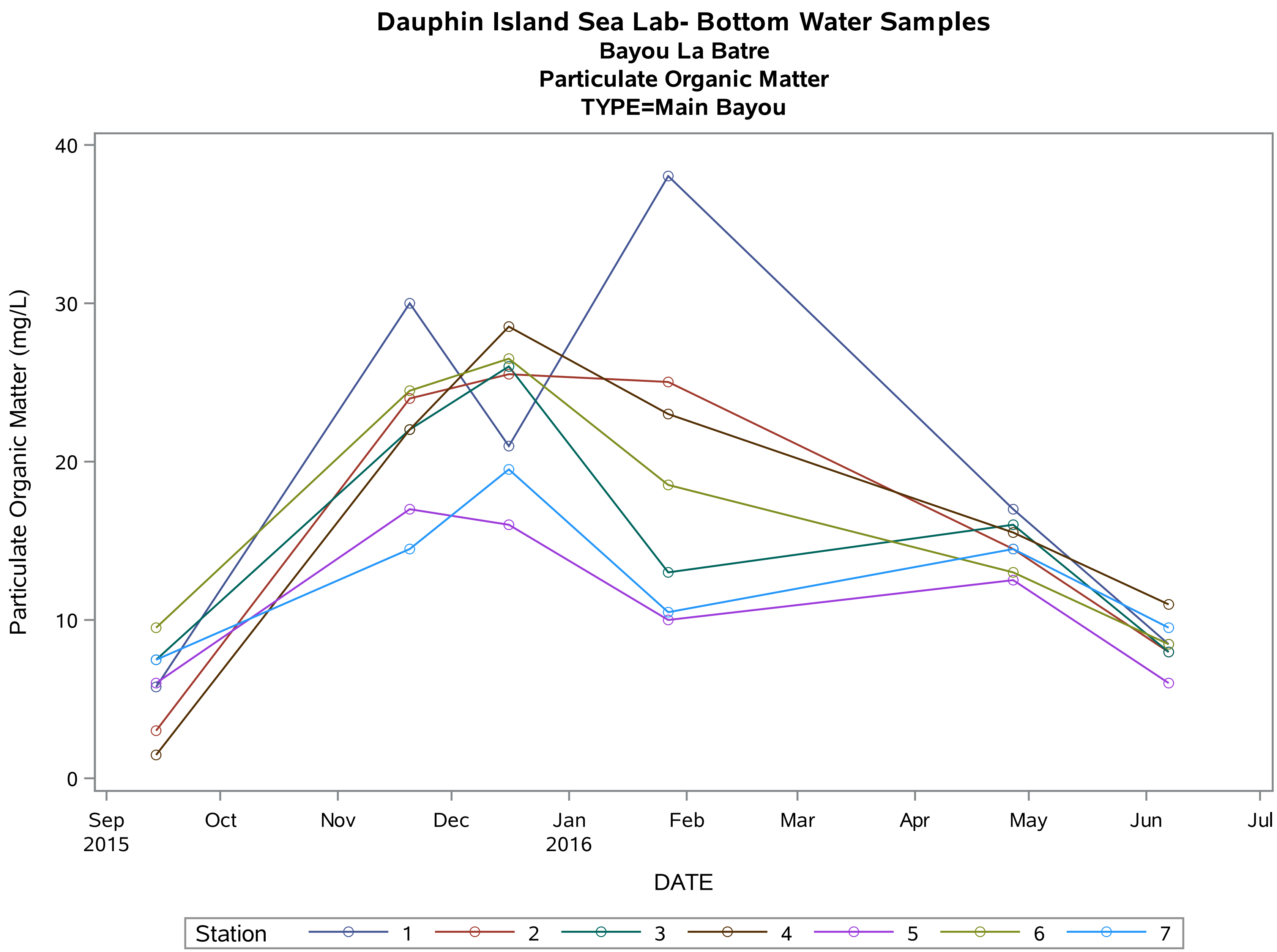



Dauphin Island Sea Lab- Bottom Water Samples
Bayou La Batre
Total nitrogen
TYPE=Main Bayou
Total nitrogen (mg/L)
1.2
1.0
0.8
0.6
0.4
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
Station
1
2
3
4
5
6
7

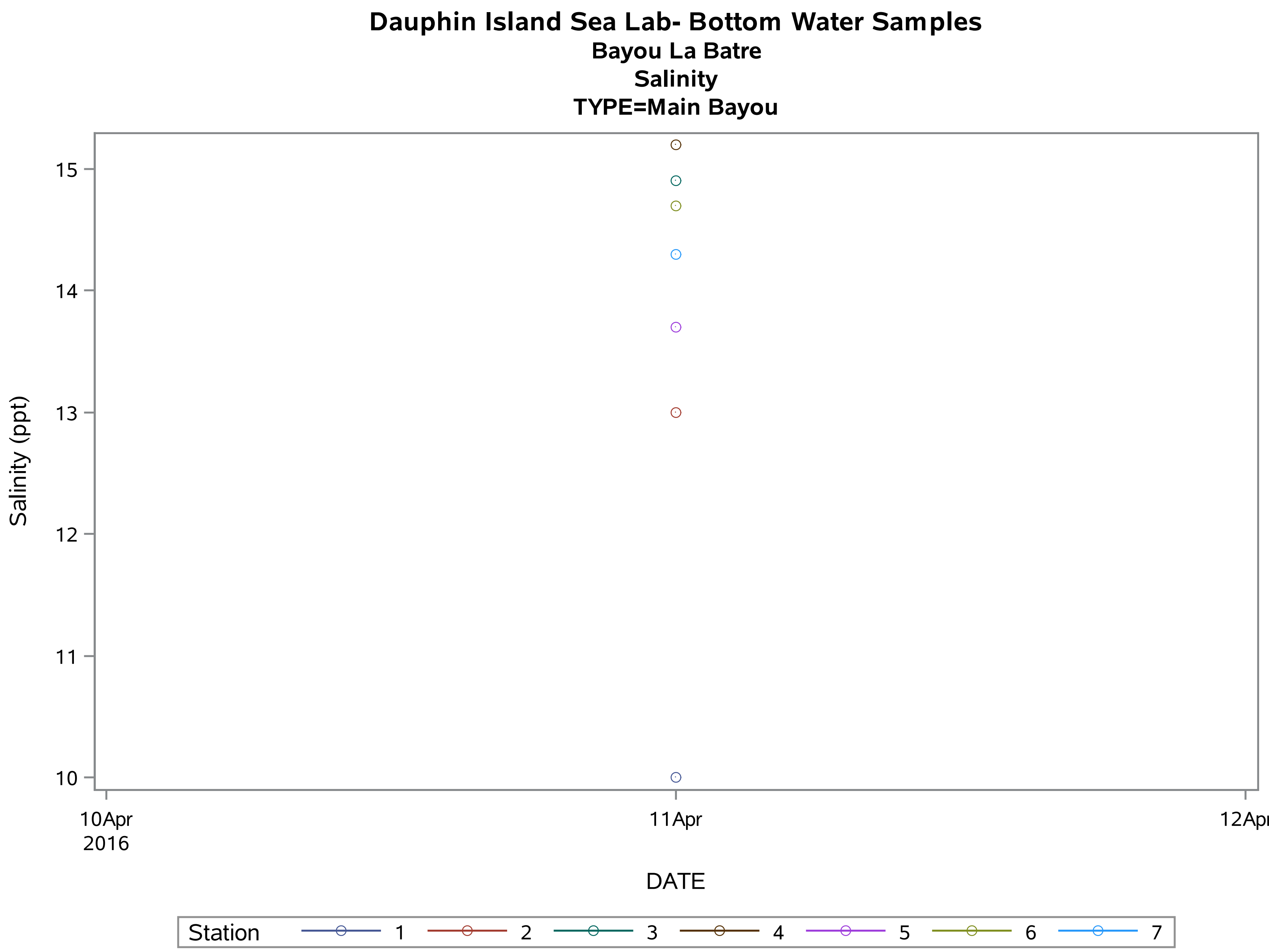


Dauphin Island Sea Lab- Bottom Water Samples
Bayou La Batre
Phosphate
TYPE=Main Bayou
Phosphate (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
Station
1
2
3
4
5
6
7

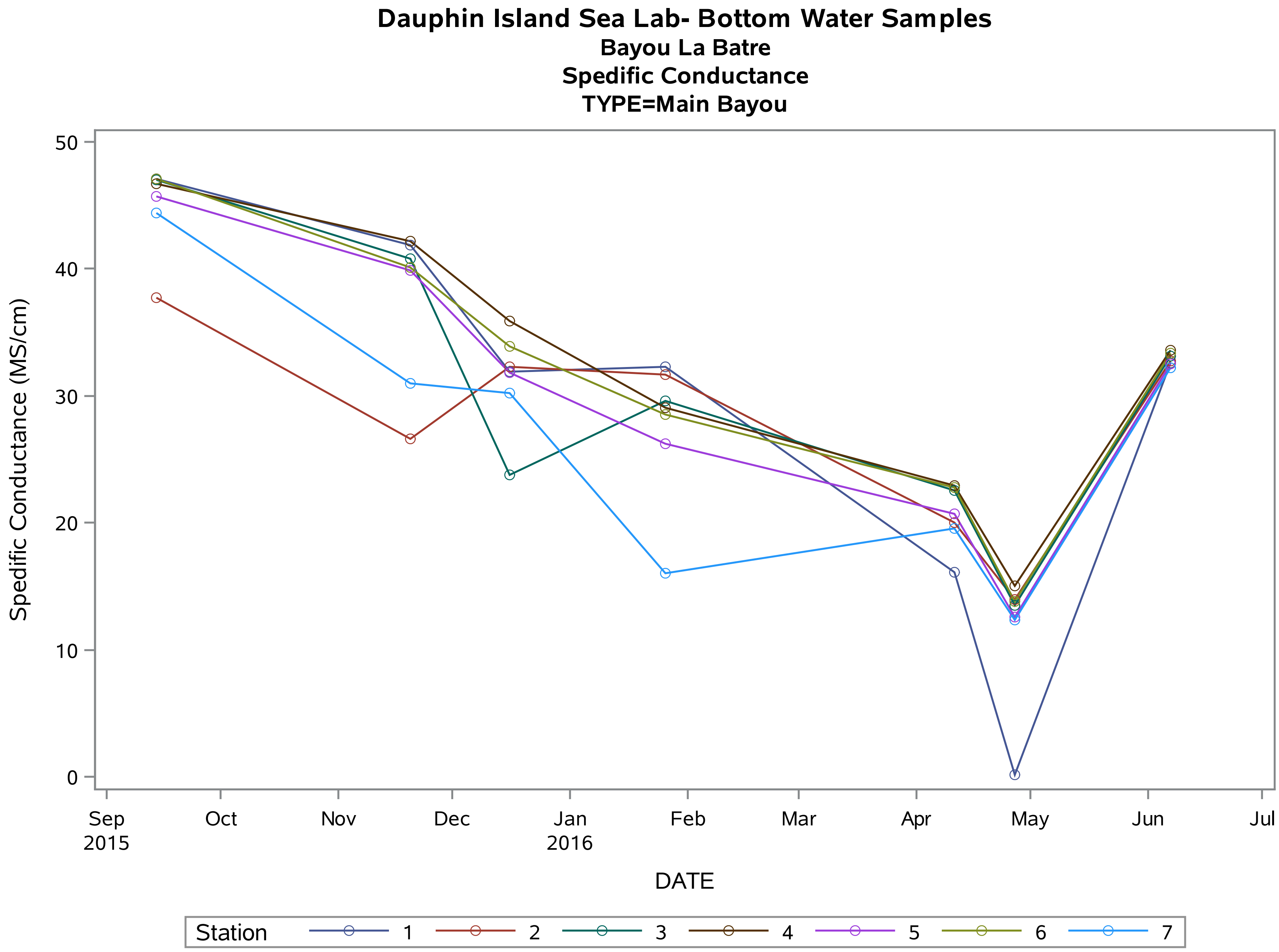

Dauphin Island Sea Lab- Bottom Water Samples
Bayou La Batre
Total Suspended Solids
TYPE=Main Bayou
Total Suspended Solids (mg/L)
0
25
50
75
100
125
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
Station
1
2
3
4
5
6
7



Dauphin Island Sea Lab- Bottom Water Samples
Bayou La Batre
Particulate Organic Matter
TYPE=Main Bayou
Particulate Organic Matter (mg/L)
0
10
20
30
40
Sep
2015
Oct
Nov
Dec
Jan
2016
Feb
Mar
Apr
May
Jun
Jul
DATE
Station
1
2
3
4
5
6
7

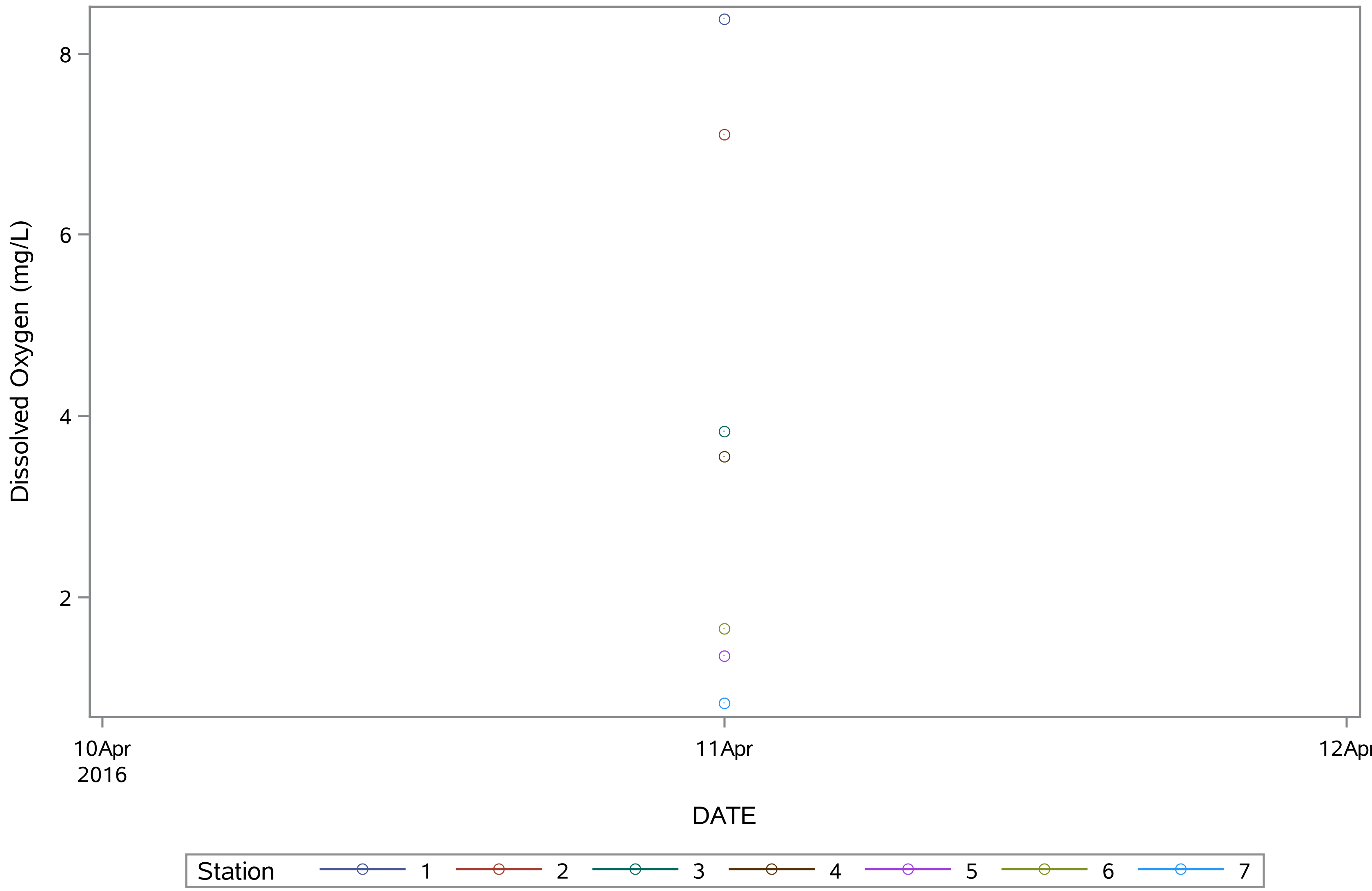


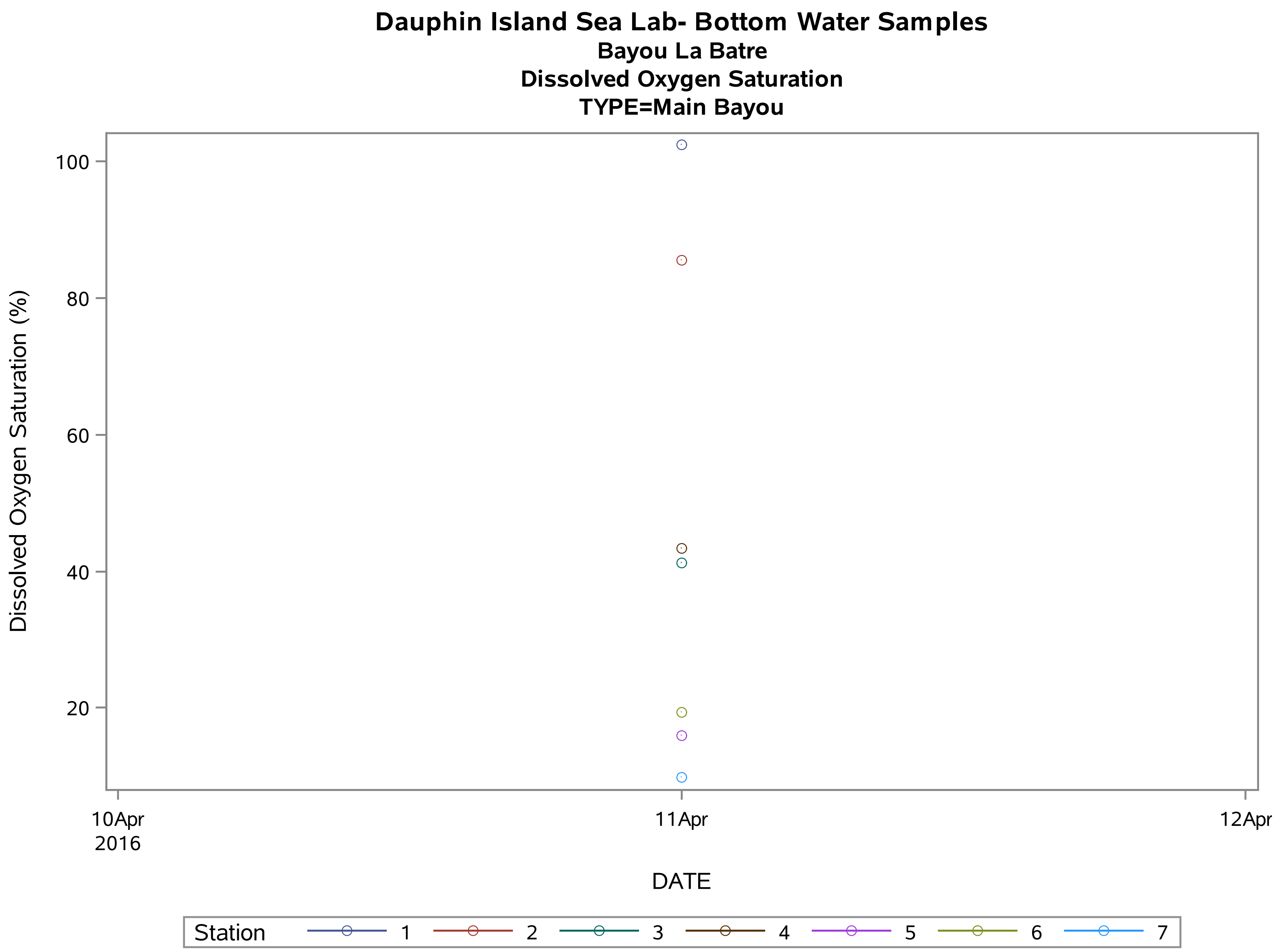
Dauphin Island Sea Lab- Bottom Water Samples
Bayou La Batre
Salinity
TYPE=Main Bayou
Salinity (ppt)
15
14
13
12
11
10
10Apr 2016
11Apr
12Apr
DATE
Station
1
2
3
4
5
6
7



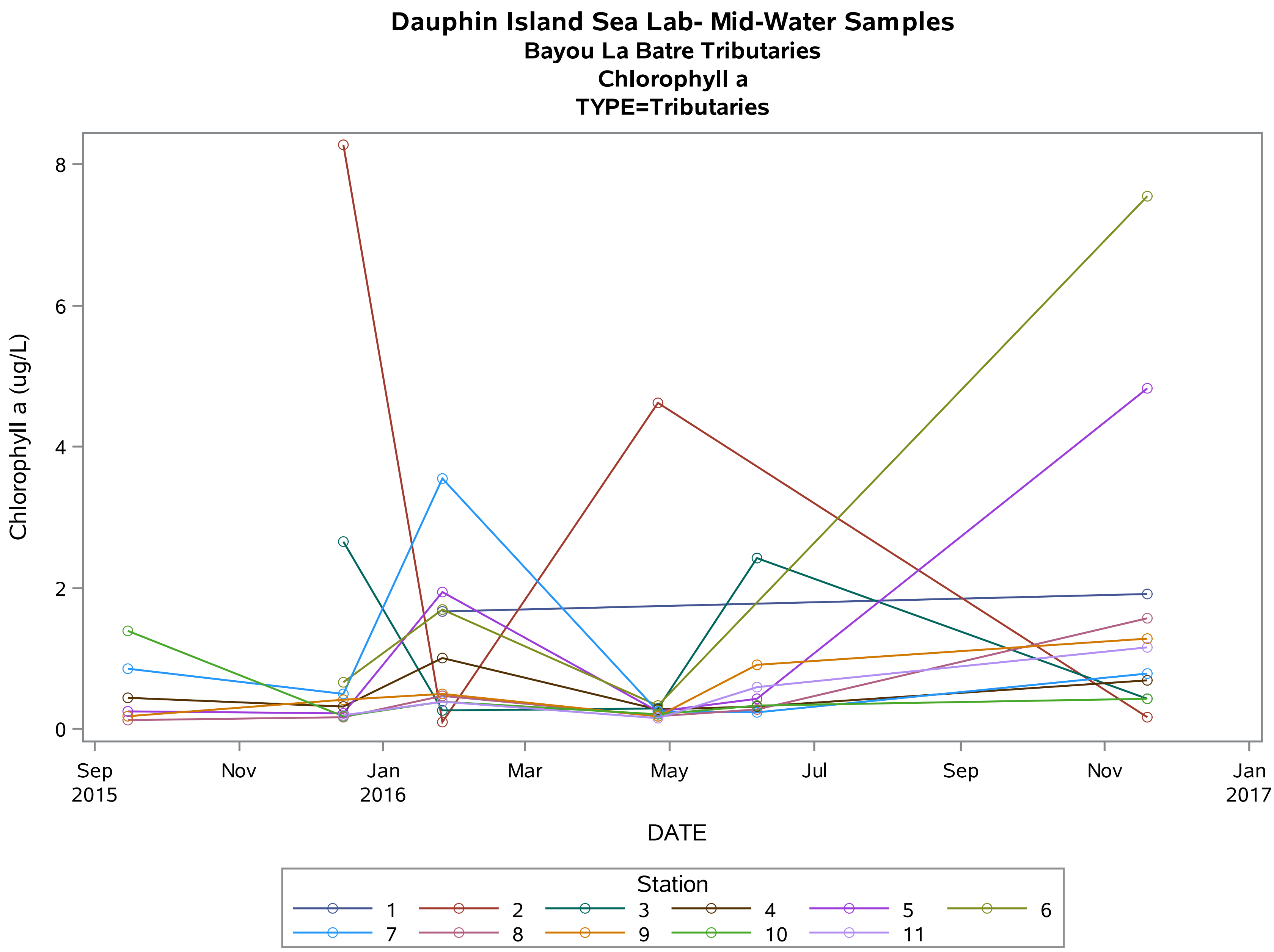
Dauphin Island Sea Lab- Bottom Water Samples
Bayou La Batre
Spedific Conductance
TYPE=Main Bayou
Spedific Conductance (MS/cm)
50
40
30
20
10
0
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
Station
1
2
3
4
5
6
7

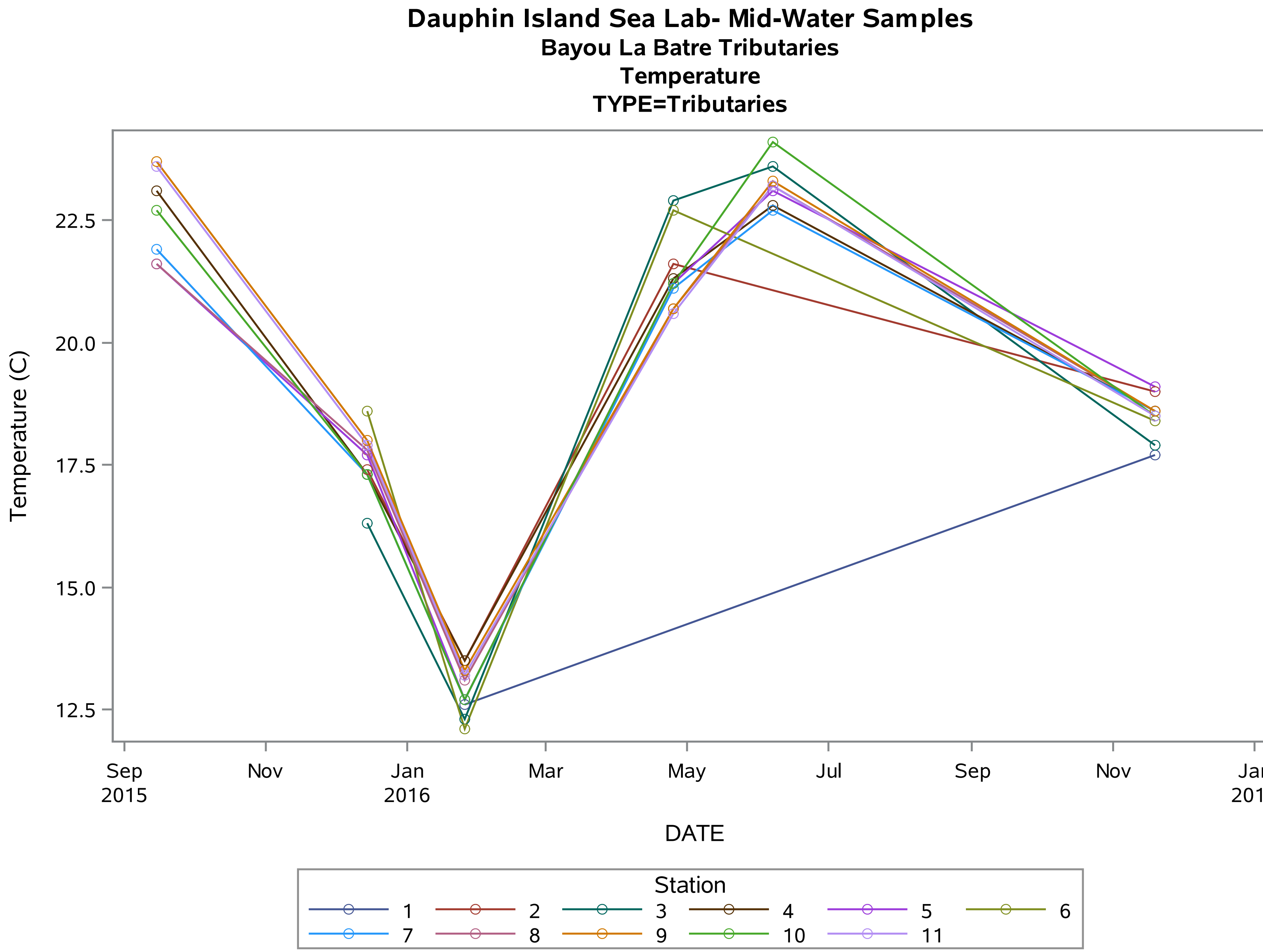
Dauphin Island Sea Lab- Bottom Water Samples
Bayou La Batre
Dissolved Oxygen
TYPE=Main Bayou





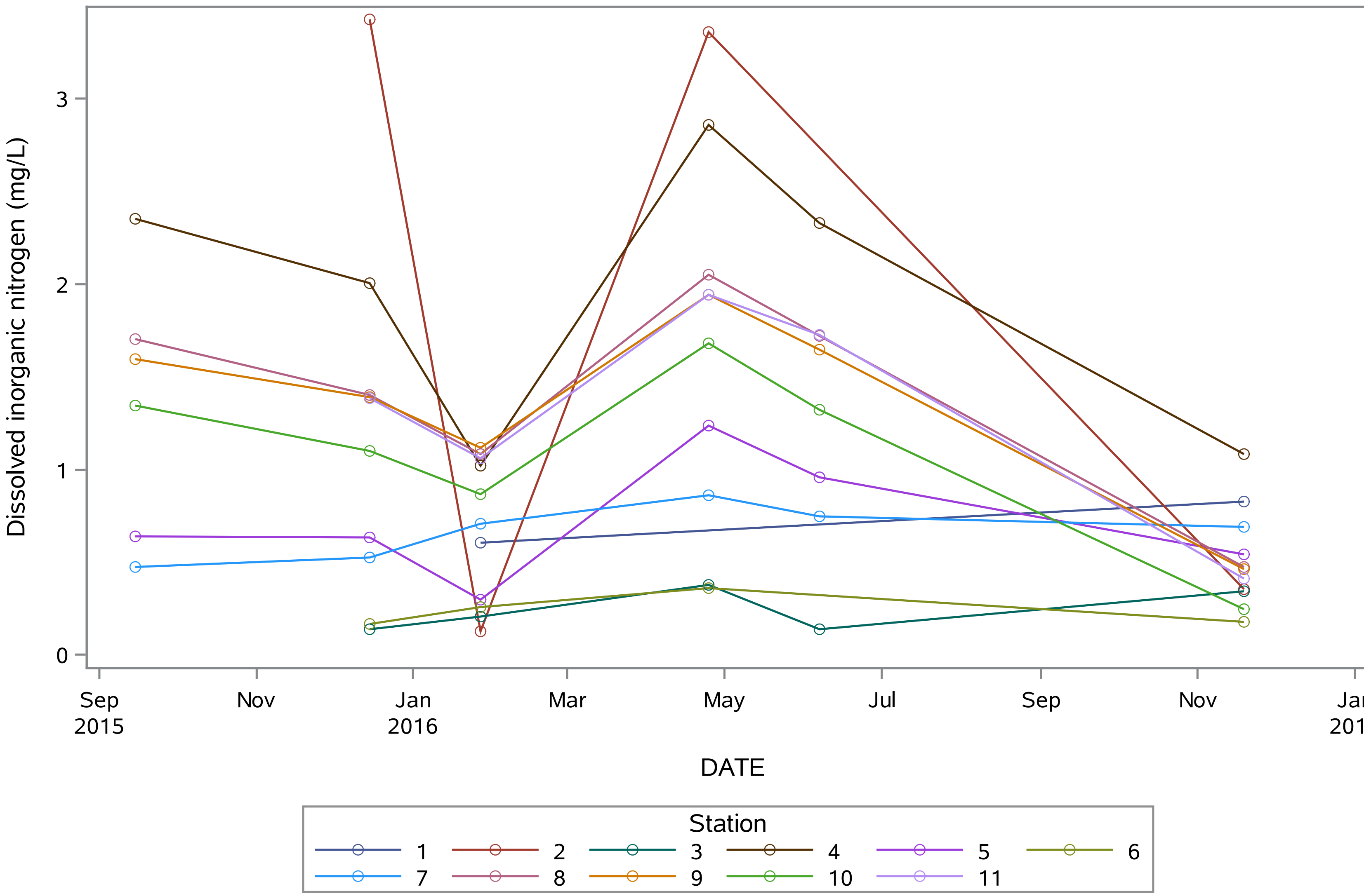
Dauphin Island Sea Lab- Bottom Water Samples
Bayou La Batre
Dissolved Oxygen Saturation
TYPE=Main Bayou
Dissolved Oxygen Saturation (%)
100
80
60
40
20
10Apr
2016
11Apr
12Apr
DATE
Station
1
2
3
4
5
6
7

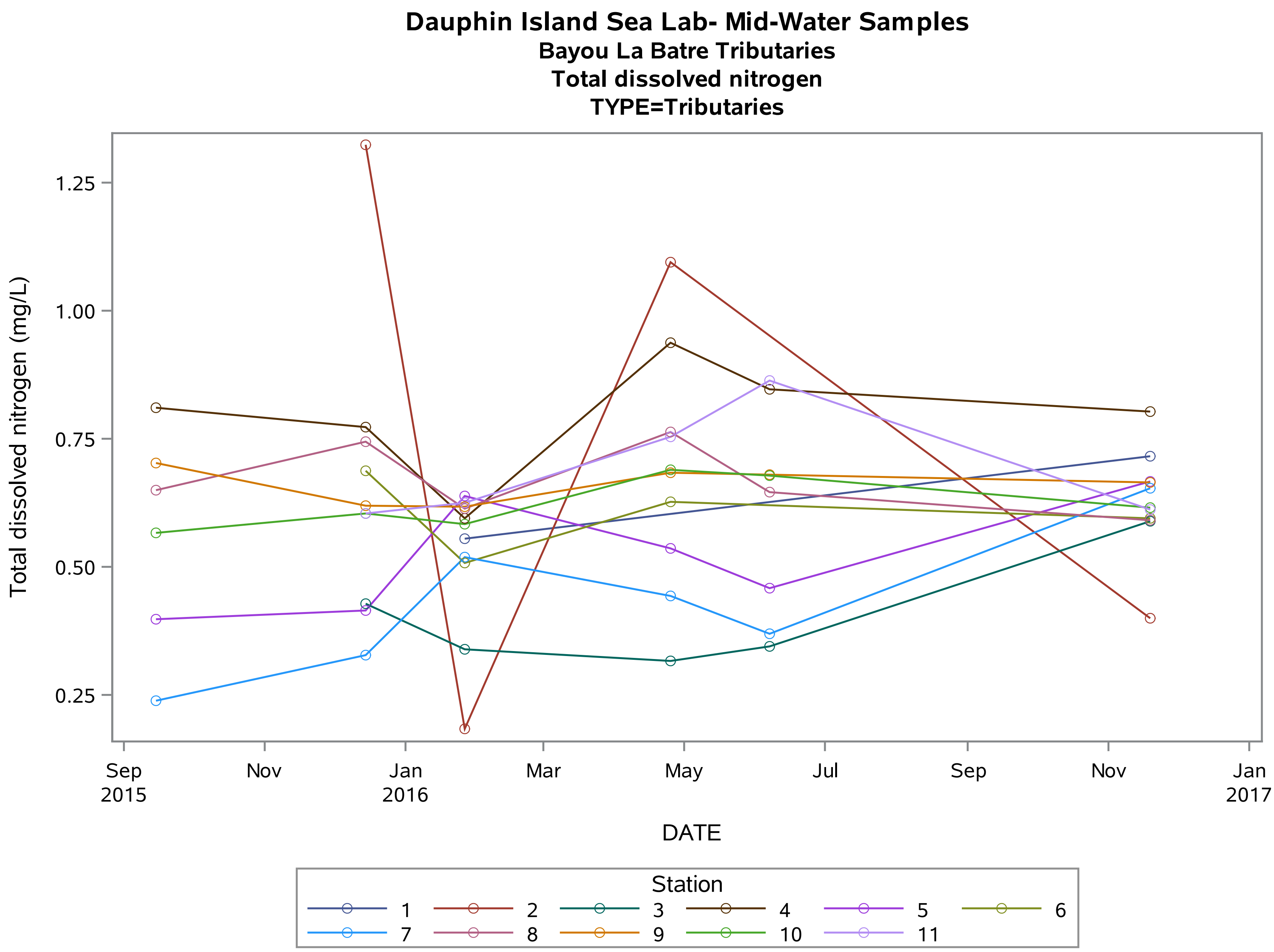

Dauphin Island Sea Lab- Mid-Water Samples
Bayou La Batre Tributaries
Chlorophyll a
TYPE=Tributaries
Chlorophyll a (ug/L)
0
2
4
6
8
Sep 2015
Nov
Jan 2016
Mar
May
Jul
Sep
Nov
Jan 2017
DATE
Station
1
2
3
4
5
6
7
8
9
10
11

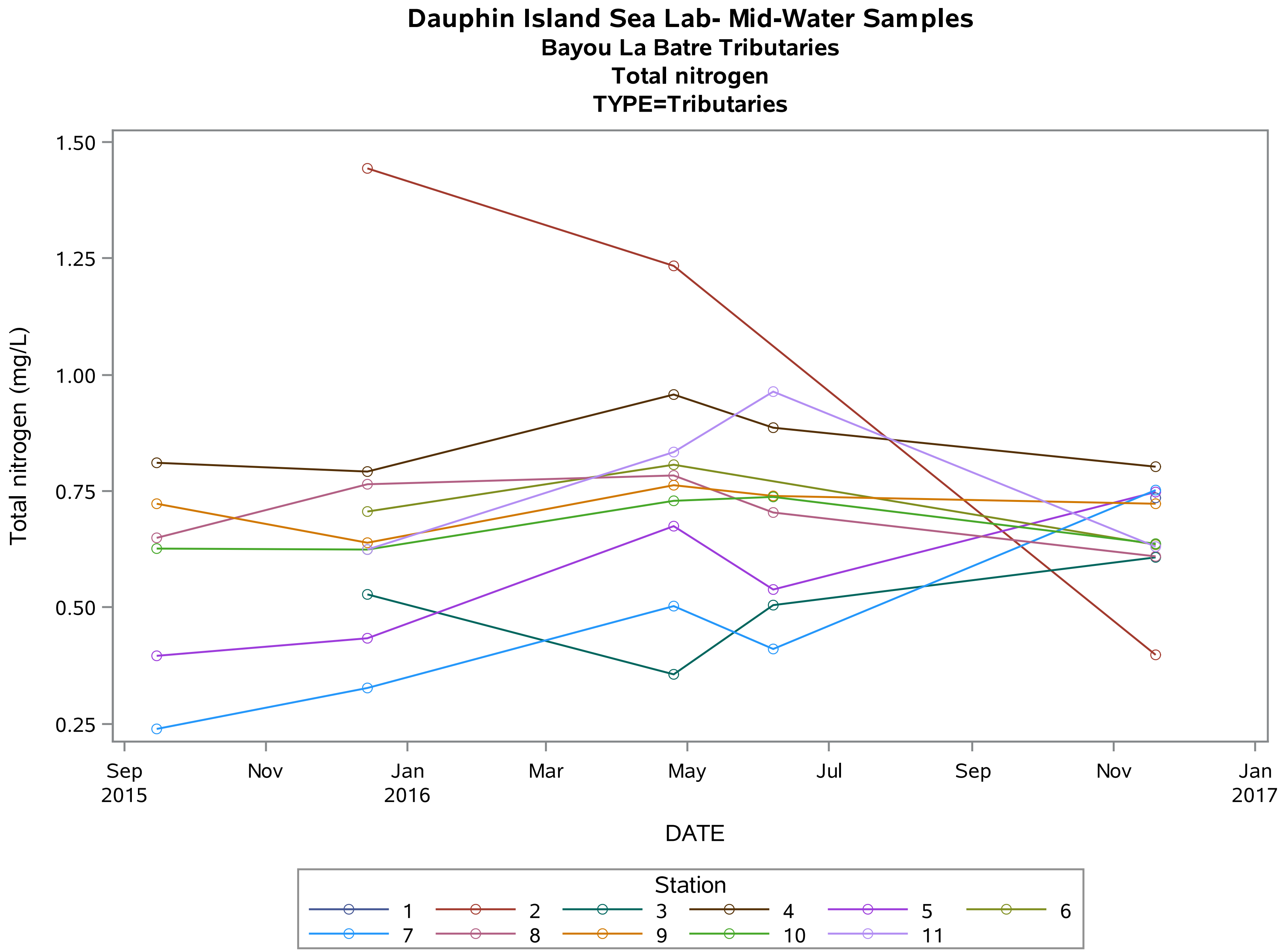


Dauphin Island Sea Lab- Mid-Water Samples
Bayou La Batre Tributaries
Temperature
TYPE=Tributaries
Temperature (C)
22.5
20.0
17.5
15.0
12.5
Sep 2015
Nov
Jan 2016
Mar
May
Jul
Sep
Nov
Jan 2017
DATE
Station
1
2
3
4
5
6
7
8
9
10
11

Dauphin Island Sea Lab- Mid-Water Samples
Bayou La Batre Tributaries
Dissolved inorganic nitrogen
TYPE=Tributaries

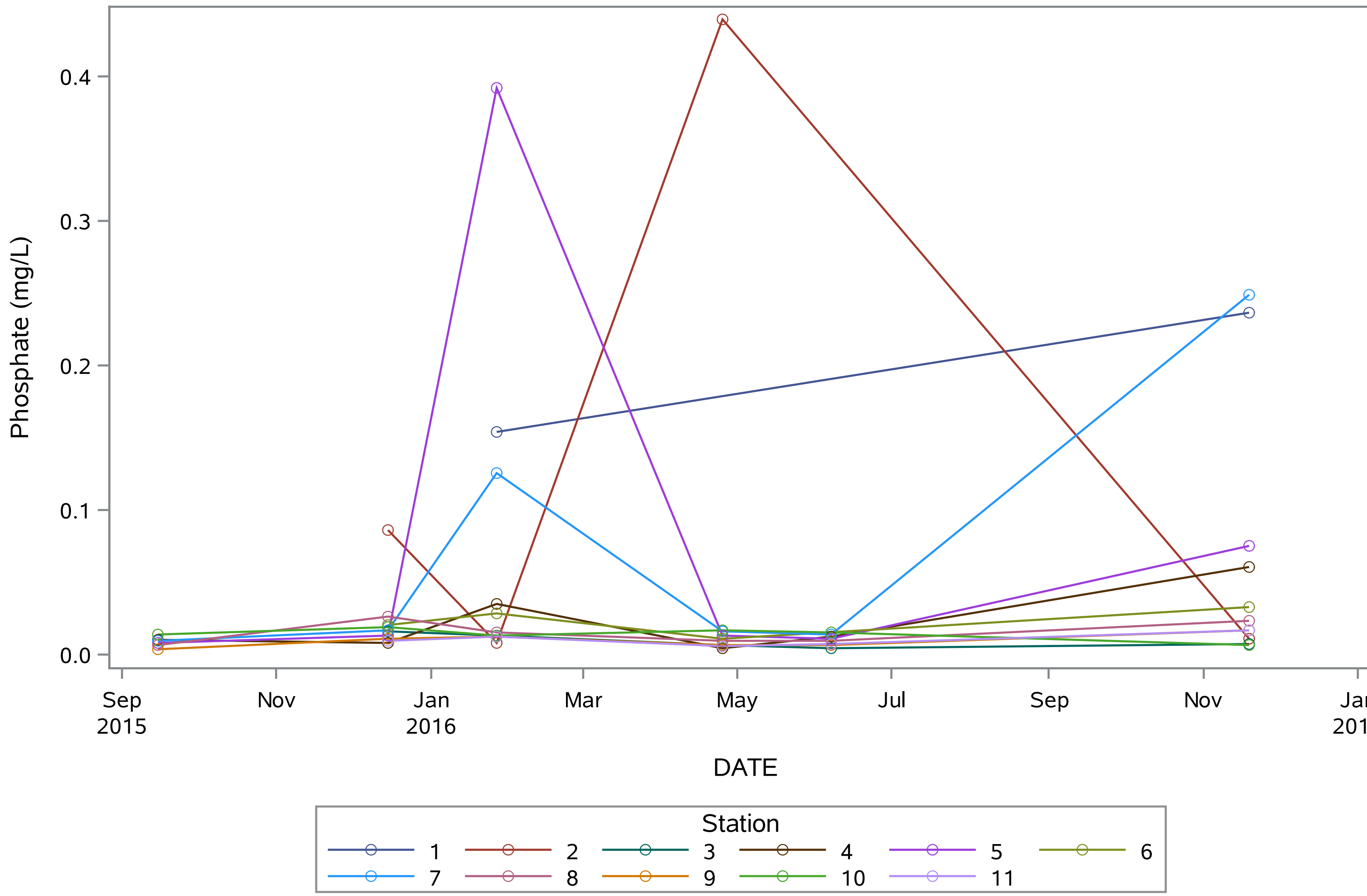



Dauphin Island Sea Lab- Mid-Water Samples
Bayou La Batre Tributaries
Total dissolved nitrogen
TYPE=Tributaries
Total dissolved nitrogen (mg/L)
1.25
1.00
0.75
0.50
0.25
Sep 2015
Nov
Jan 2016
Mar
May
Jul
Sep
Nov
Jan 2017
DATE
Station
1
2
3
4
5
6
7
8
9
10
11

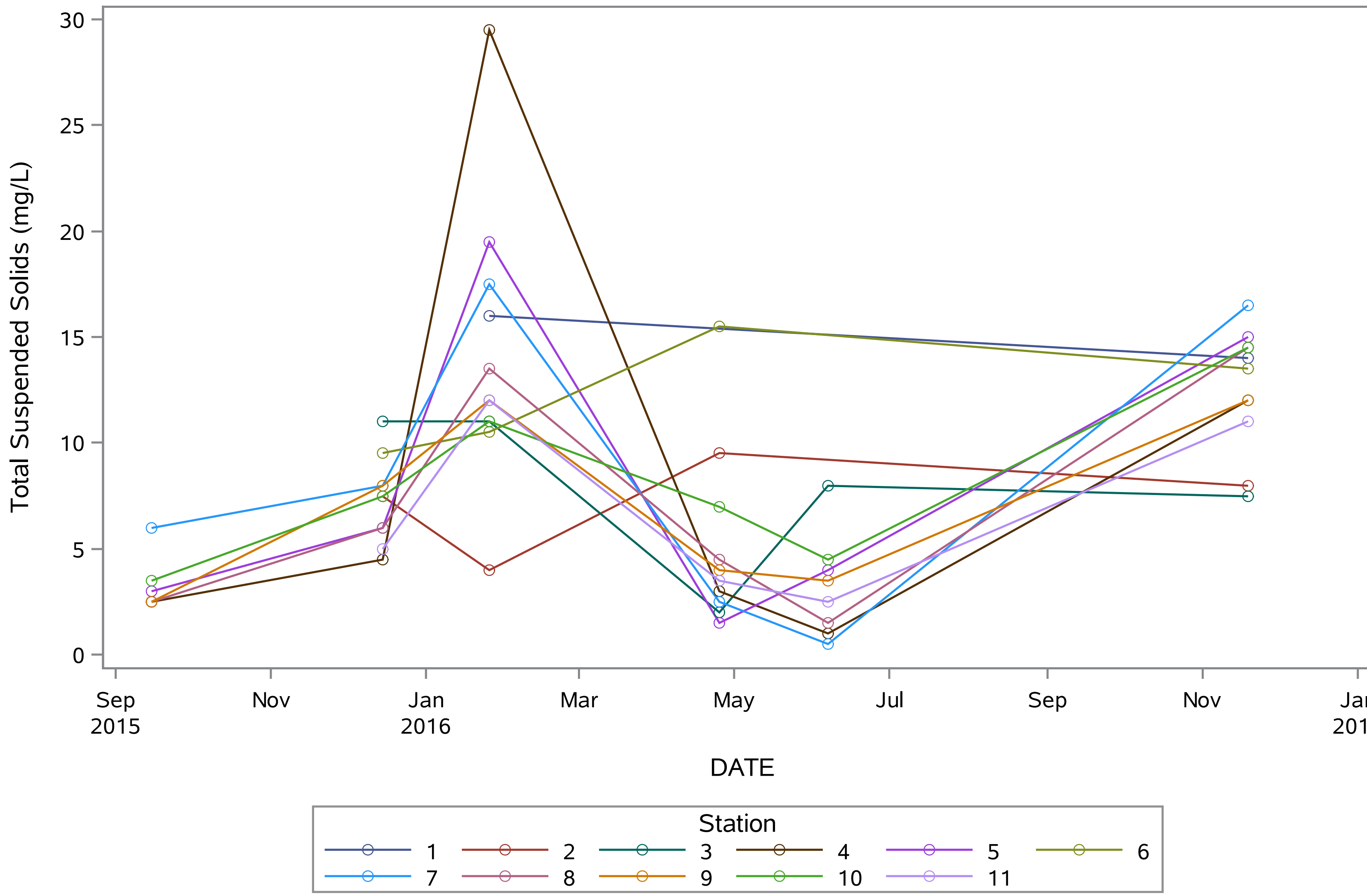


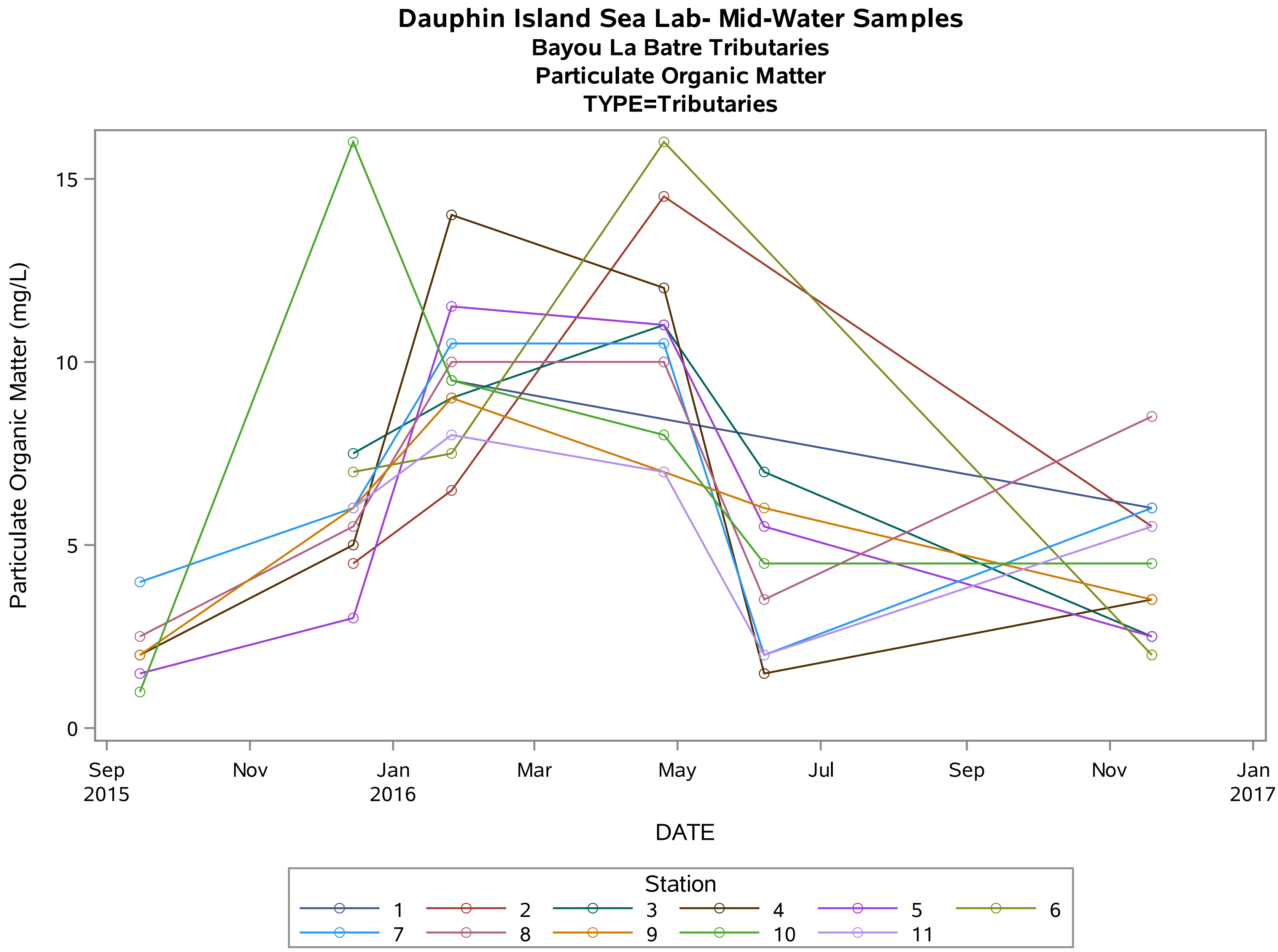
Dauphin Island Sea Lab- Mid-Water Samples
Bayou La Batre Tributaries
Total nitrogen
TYPE=Tributaries
Total nitrogen (mg/L)
1.50
1.25
1.00
0.75
0.50
0.25
Sep 2015
Nov
Jan 2016
Mar
May
Jul
Sep
Nov
Jan 2017
DATE
Station
1
2
3
4
5
6
7
8
9
10
11

Dauphin Island Sea Lab- Mid-Water Samples
Bayou La Batre Tributaries
Phosphate
TYPE=Tributaries



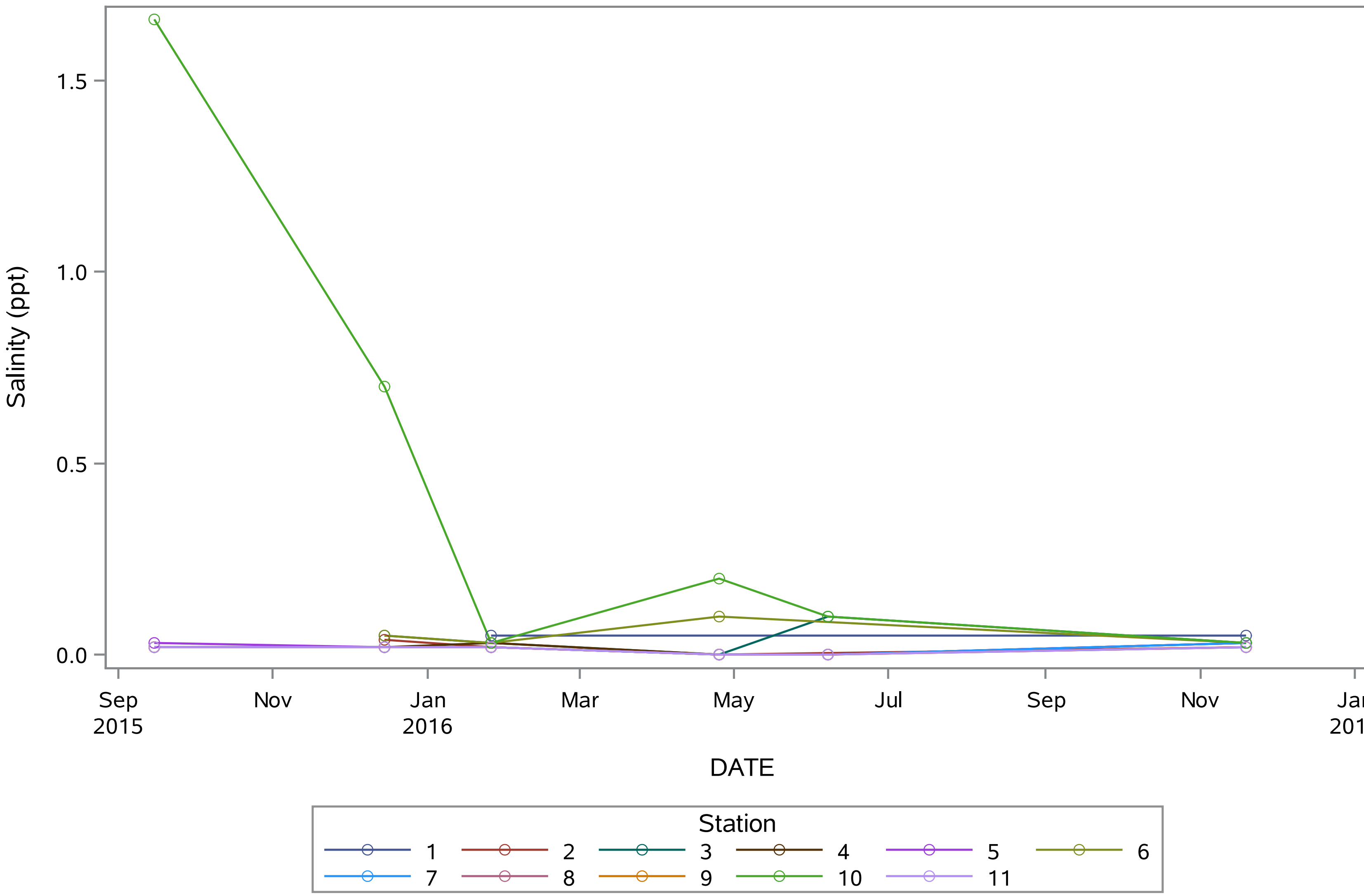
Dauphin Island Sea Lab- Mid-Water Samples
Bayou La Batre Tributaries
Total Suspended Solids
TYPE=Tributaries

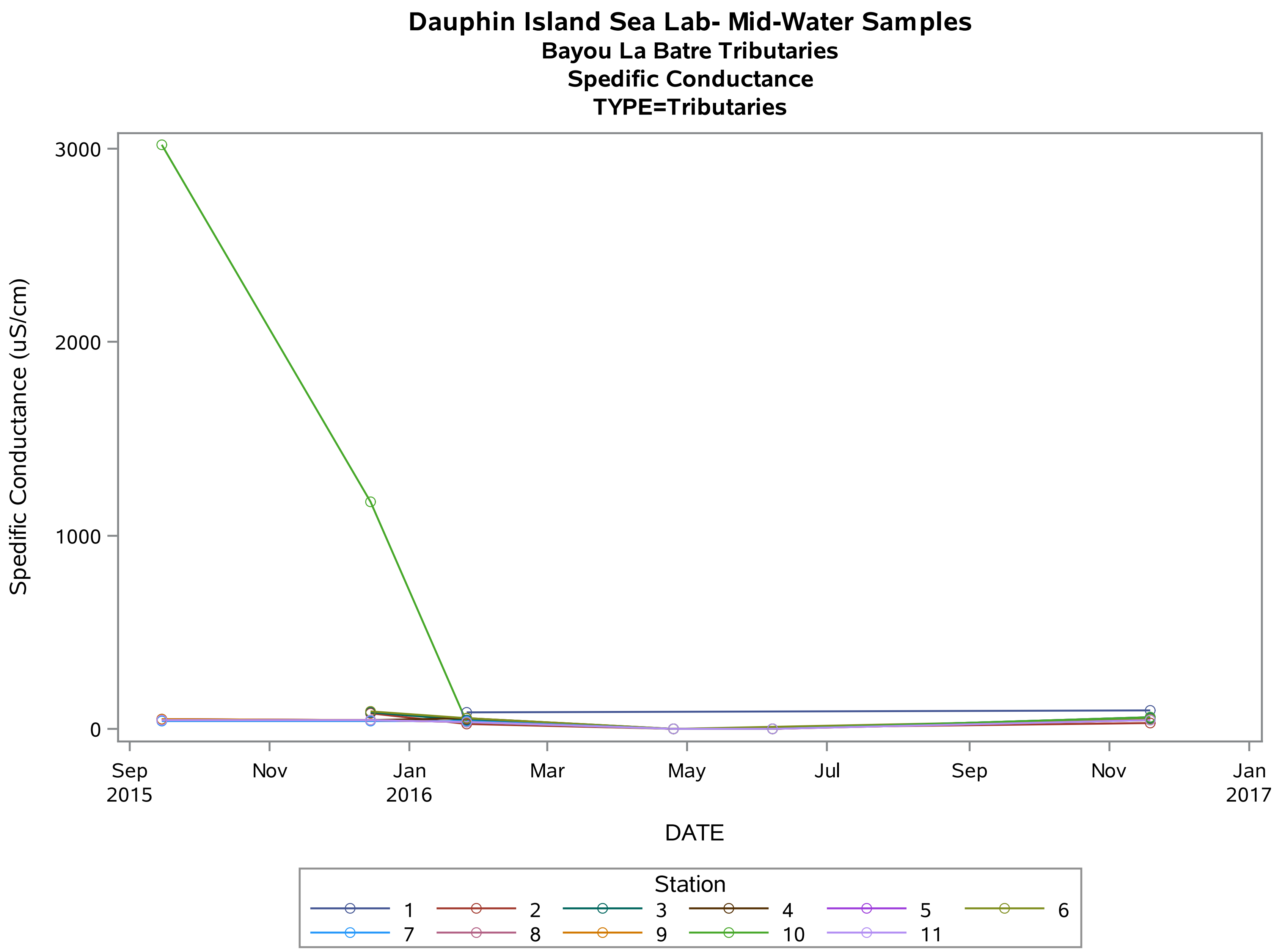




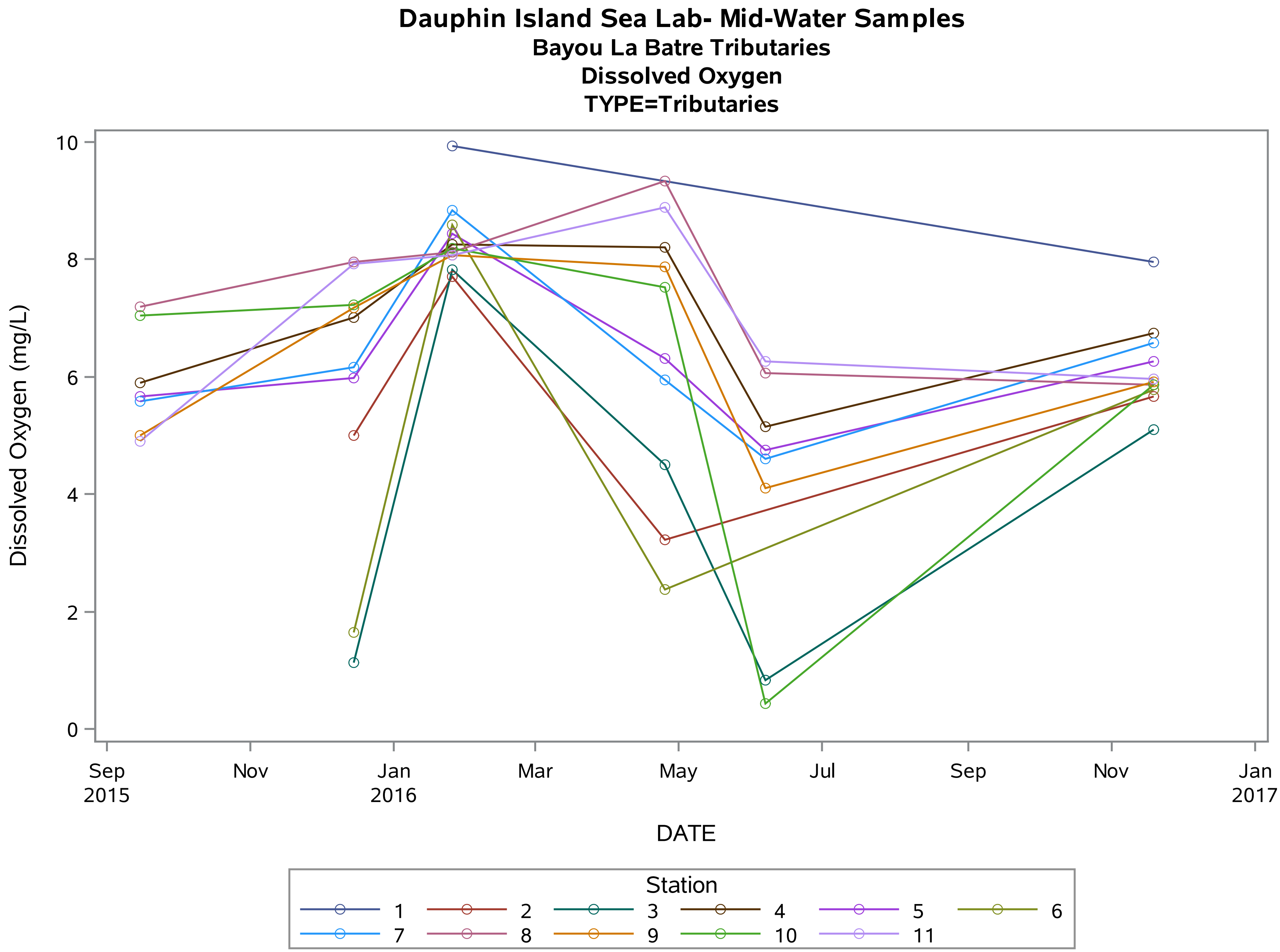
Dauphin Island Sea Lab- Mid-Water Samples
Bayou La Batre Tributaries
Particulate Organic Matter
TYPE=Tributaries
Particulate Organic Matter (mg/L)
0
5
10
15
Sep 2015
Nov
Jan 2016
Mar
May
Jul
Sep
Nov
Jan 2017
DATE
Station
1
2
3
4
5
6
7
8
9
10
11

Dauphin Island Sea Lab- Mid-Water Samples
Bayou La Batre Tributaries
Salinity
TYPE=Tributaries

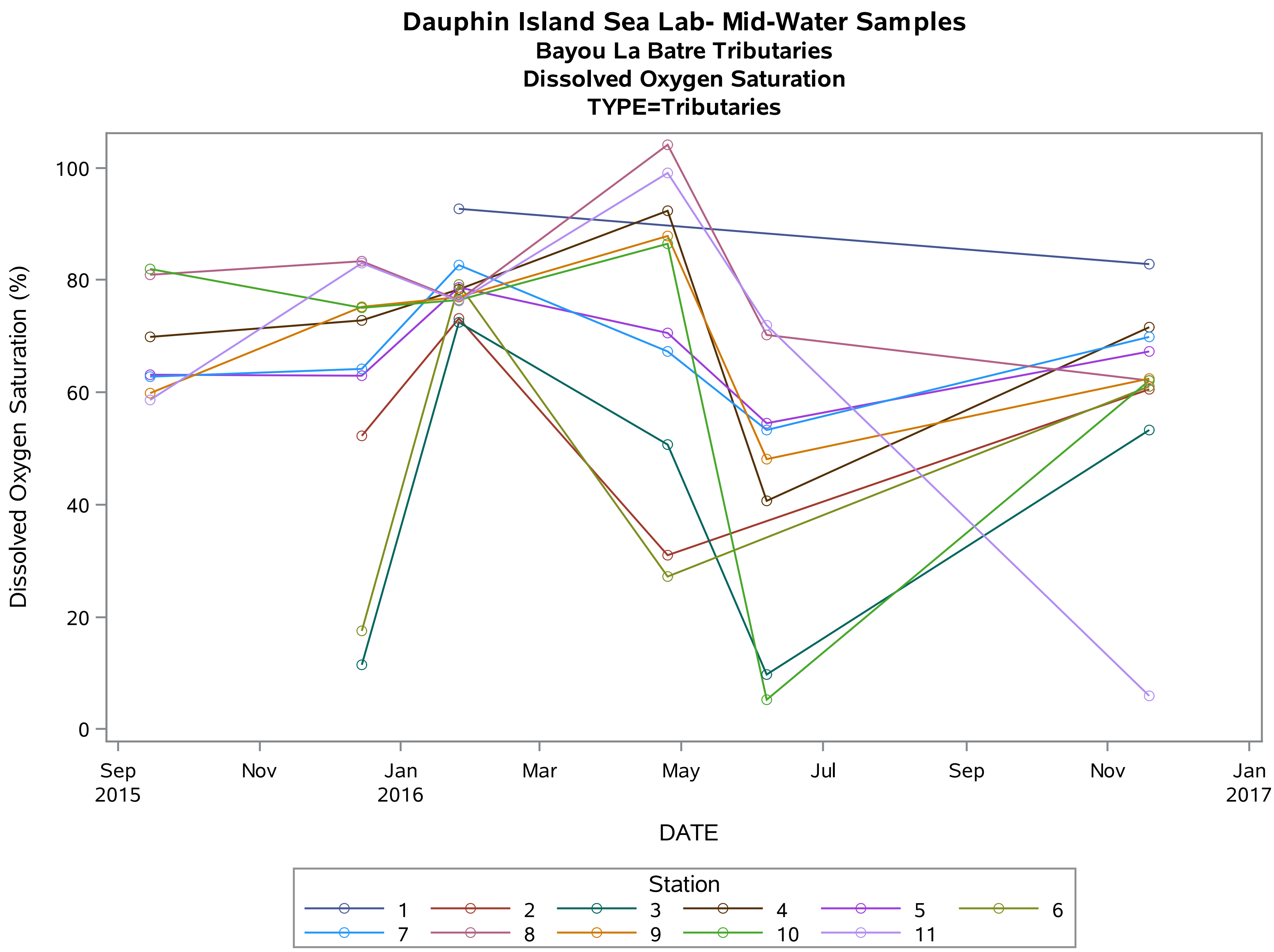




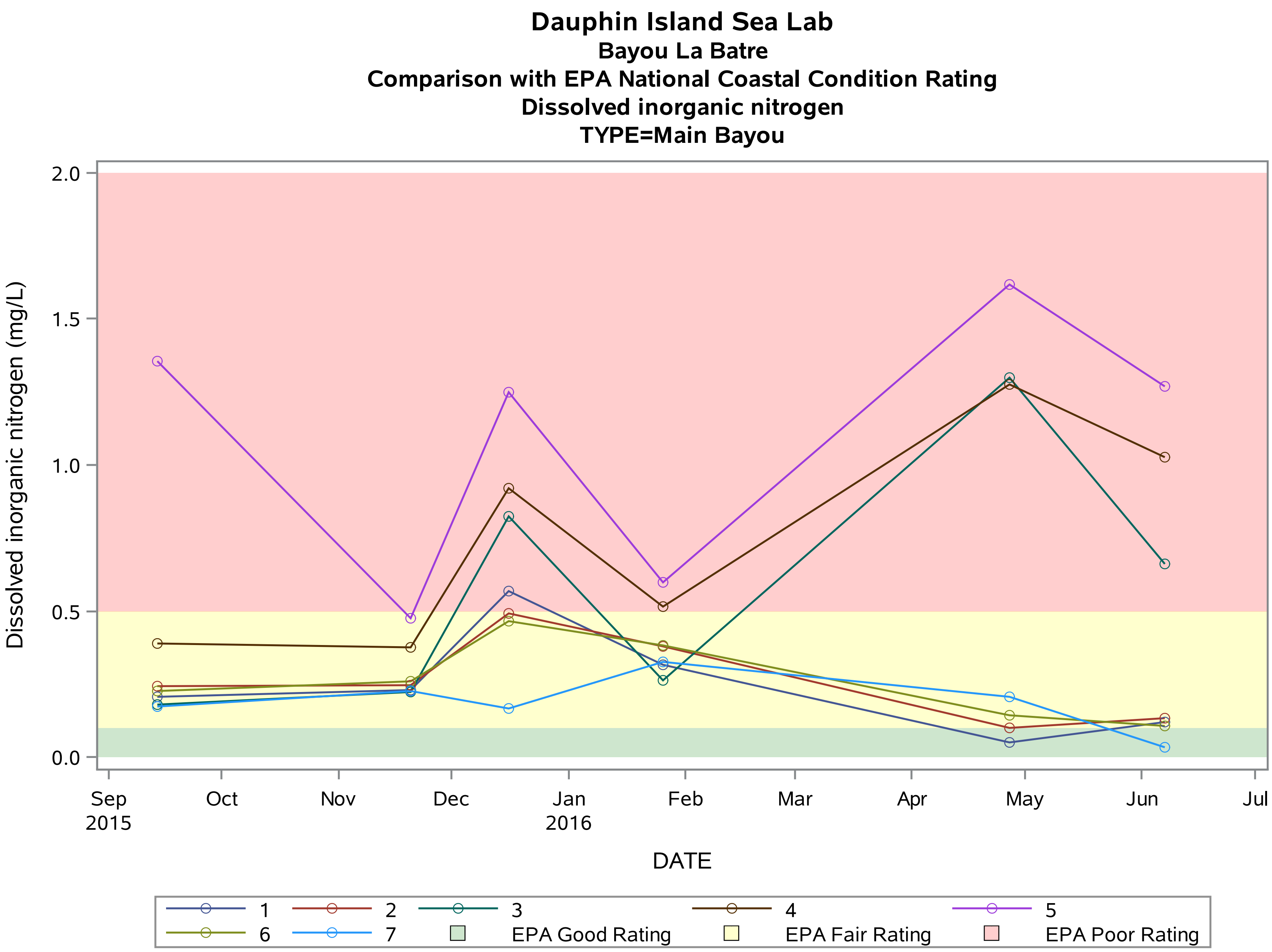
Dauphin Island Sea Lab- Mid-Water Samples
Bayou La Batre Tributaries
Spedific Conductance
TYPE=Tributaries
Spedific Conductance (uS/cm)
3000
2000
1000
0
Sep 2015
Nov
Jan 2016
Mar
May
Jul
Sep
Nov
Jan 2017
DATE
Station
1
2
3
4
5
6
7
8
9
10
11



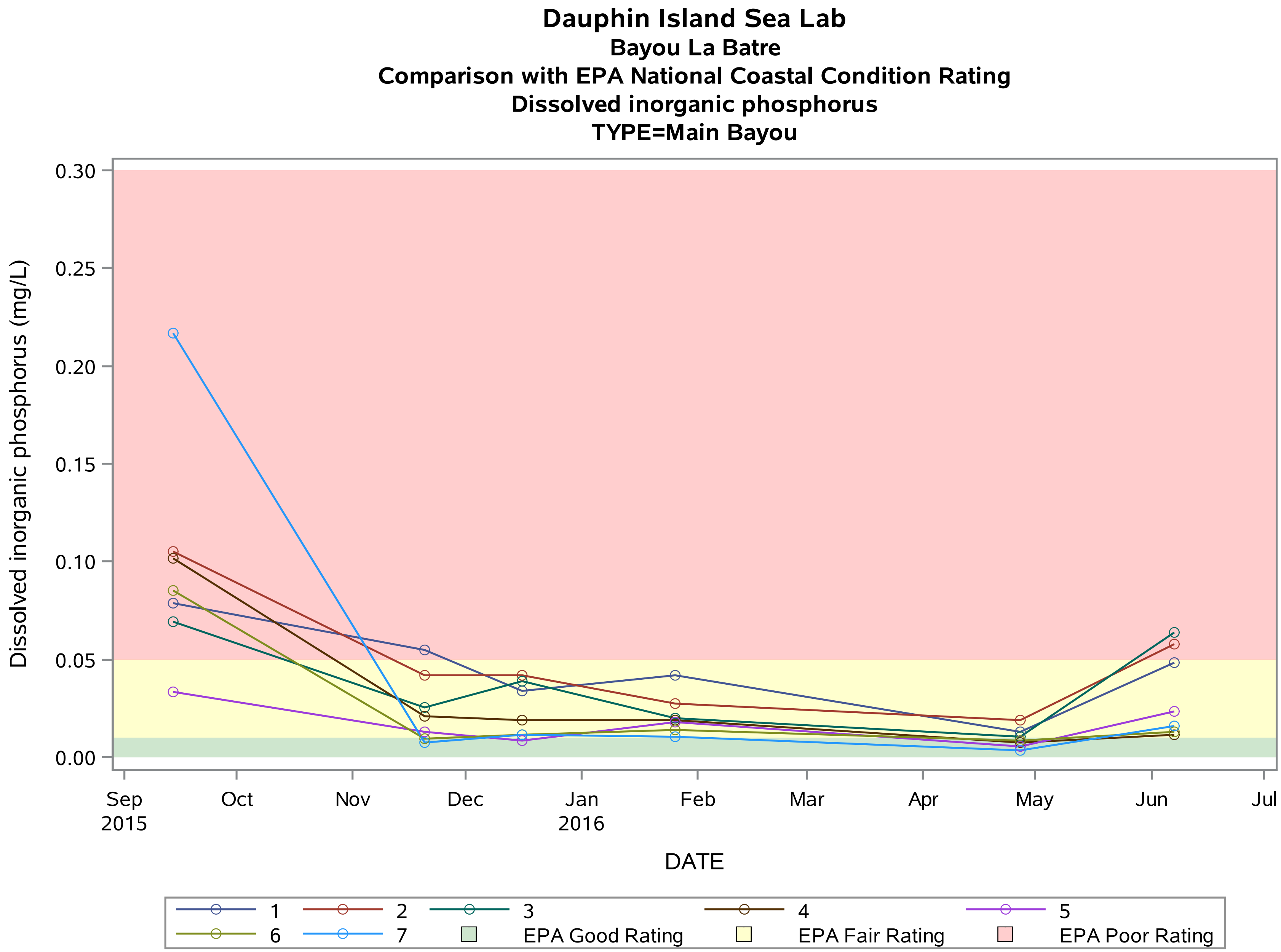
Dauphin Island Sea Lab- Mid-Water Samples
Bayou La Batre Tributaries
Dissolved Oxygen
TYPE=Tributaries
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
Sep 2015
Nov
Jan 2016
Mar
May
Jul
Sep
Nov
Jan 2017
DATE
Station
1
2
3
4
5
6
7
8
9
10
11



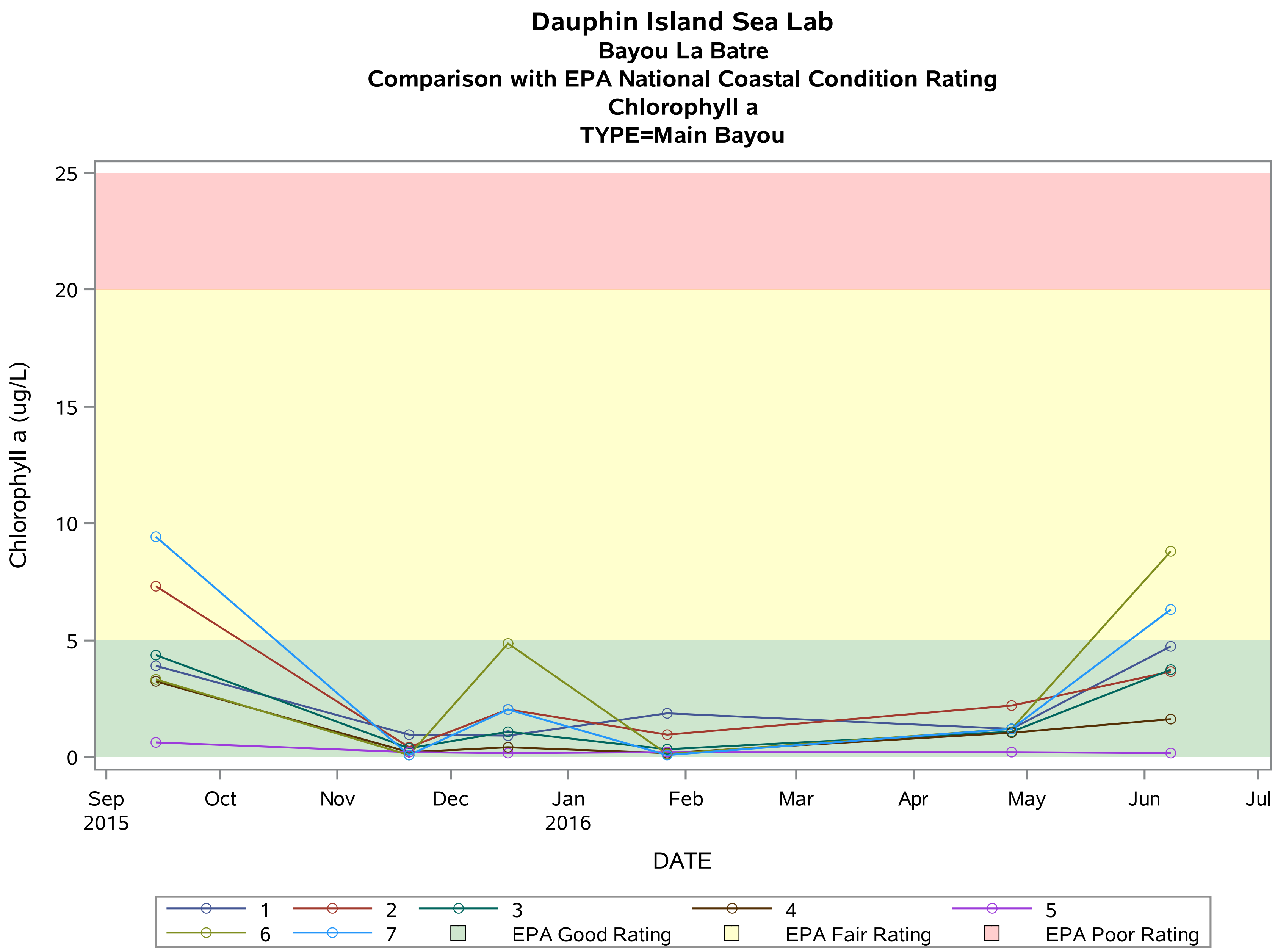
Dauphin Island Sea Lab- Mid-Water Samples
Bayou La Batre Tributaries
Dissolved Oxygen Saturation
TYPE=Tributaries
Dissolved Oxygen Saturation (%)
100
80
60
40
20
0
Sep 2015
Nov
Jan 2016
Mar
May
Jul
Sep
Nov
Jan 2017
DATE
Station
1
2
3
4
5
6
7
8
9
10
11



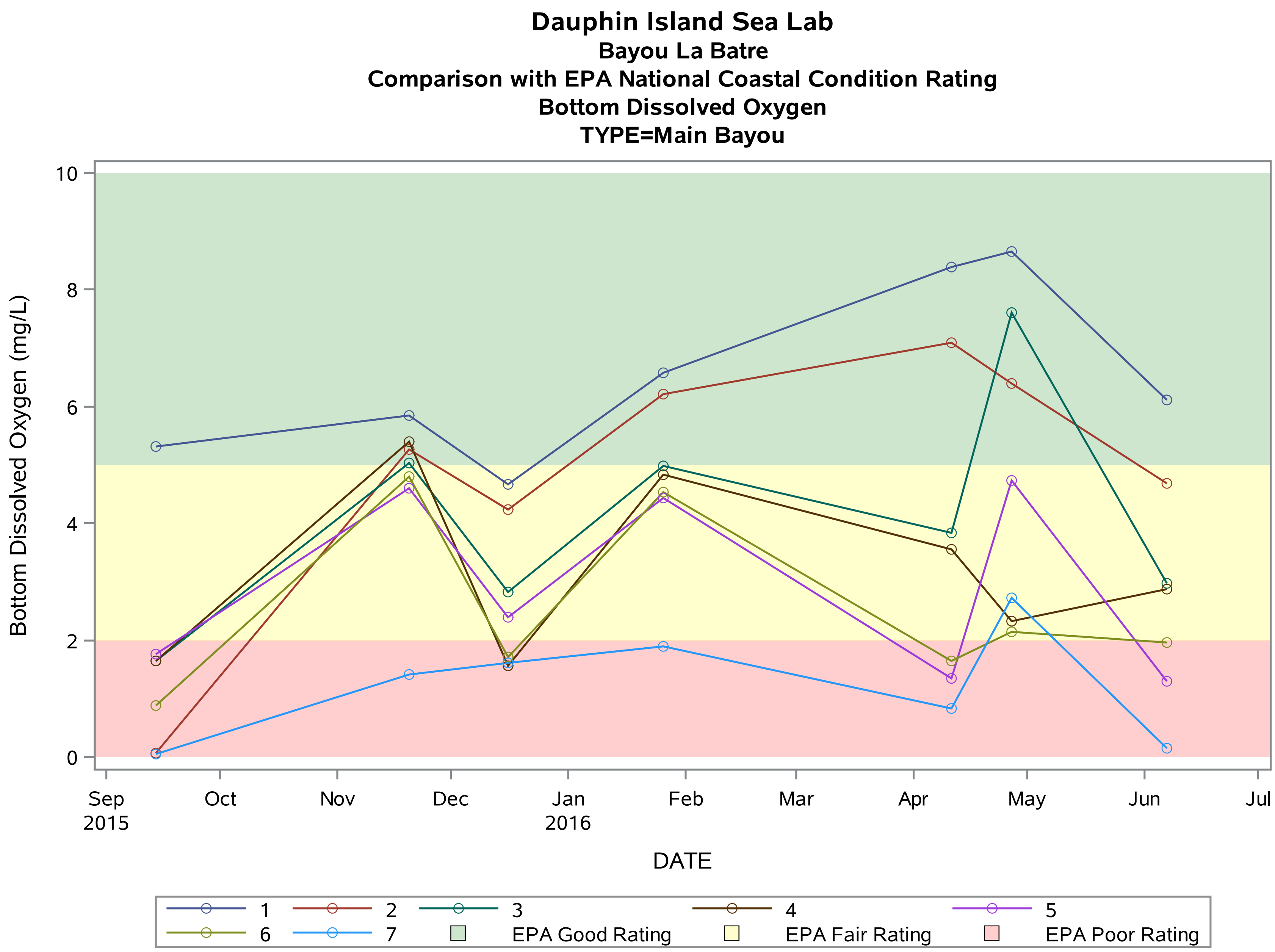
Dauphin Island Sea Lab
Bayou La Batre
Comparison with EPA National Coastal Condition Rating
Dissolved inorganic nitrogen
TYPE=Main Bayou
Dissolved inorganic nitrogen (mg/L)
2.0
1.5
1.0
0.5
0.0
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
1
2
3
4
5
6
7
EPA Good Rating
EPA Fair Rating
EPA Poor Rating

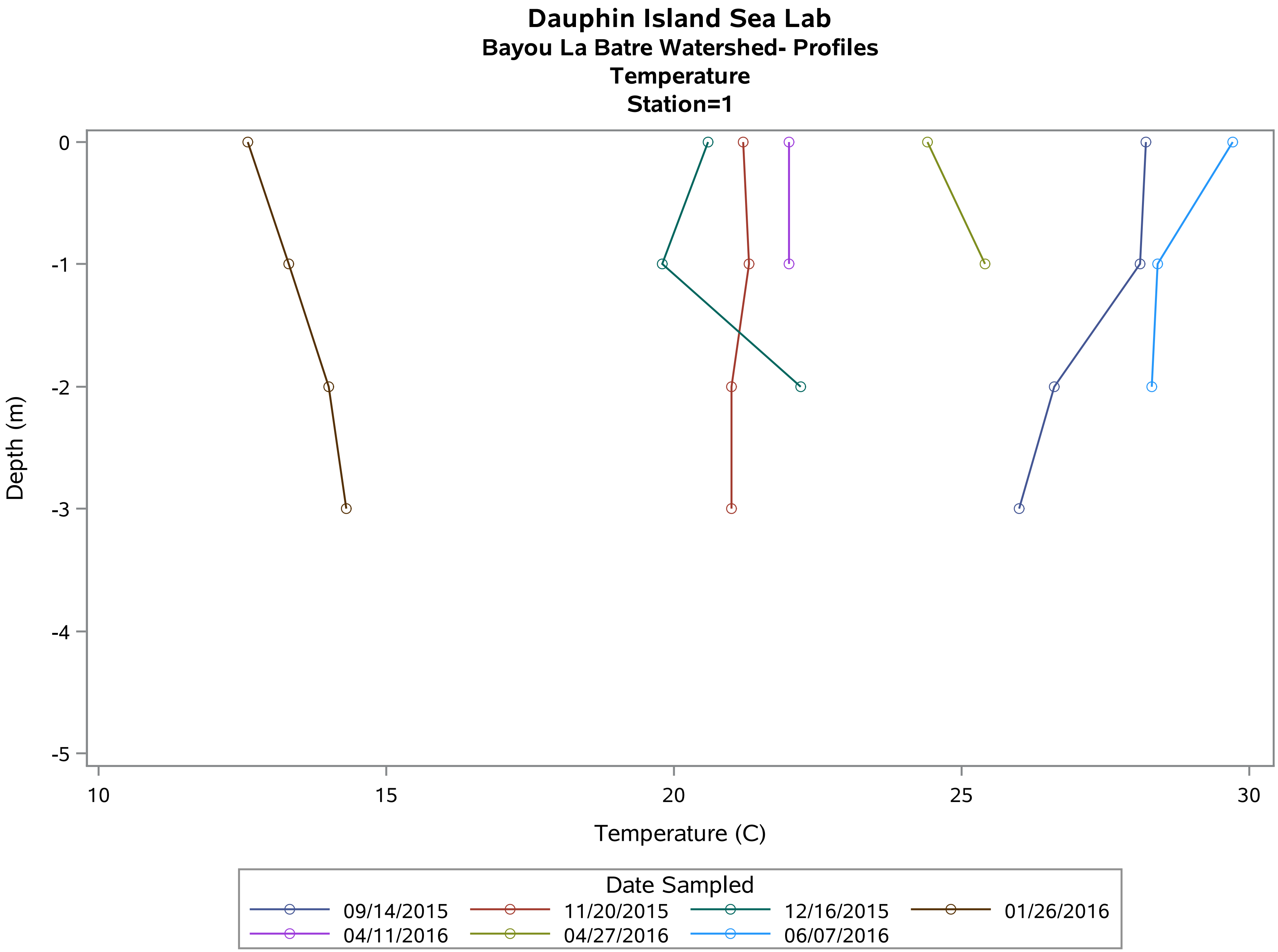


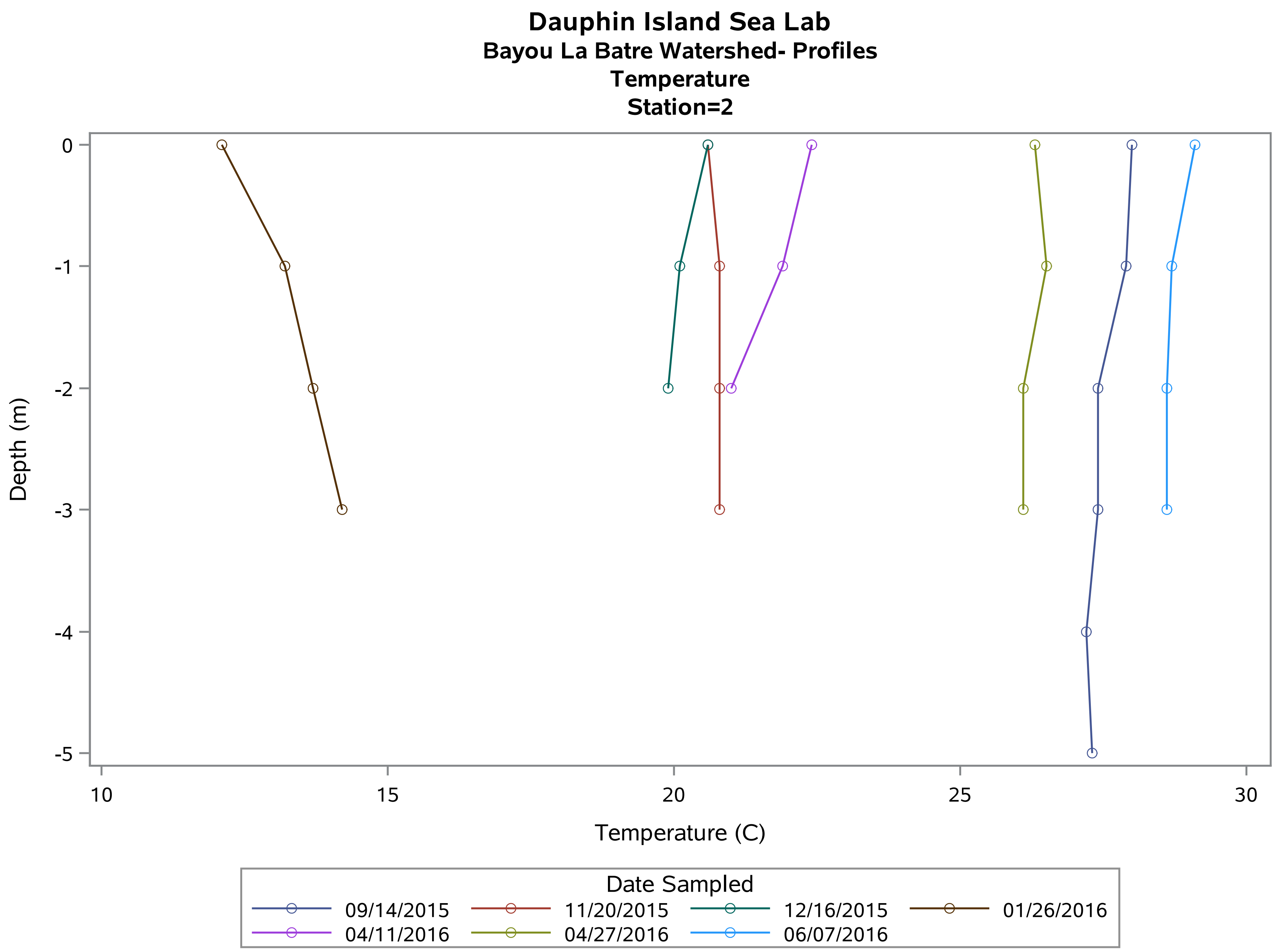
Dauphin Island Sea Lab
Bayou La Batre
Comparison with EPA National Coastal Condition Rating
Dissolved inorganic phosphorus
TYPE=Main Bayou
Dissolved inorganic phosphorus (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
1
2
3
4
5
6
7
EPA Good Rating
EPA Fair Rating
EPA Poor Rating

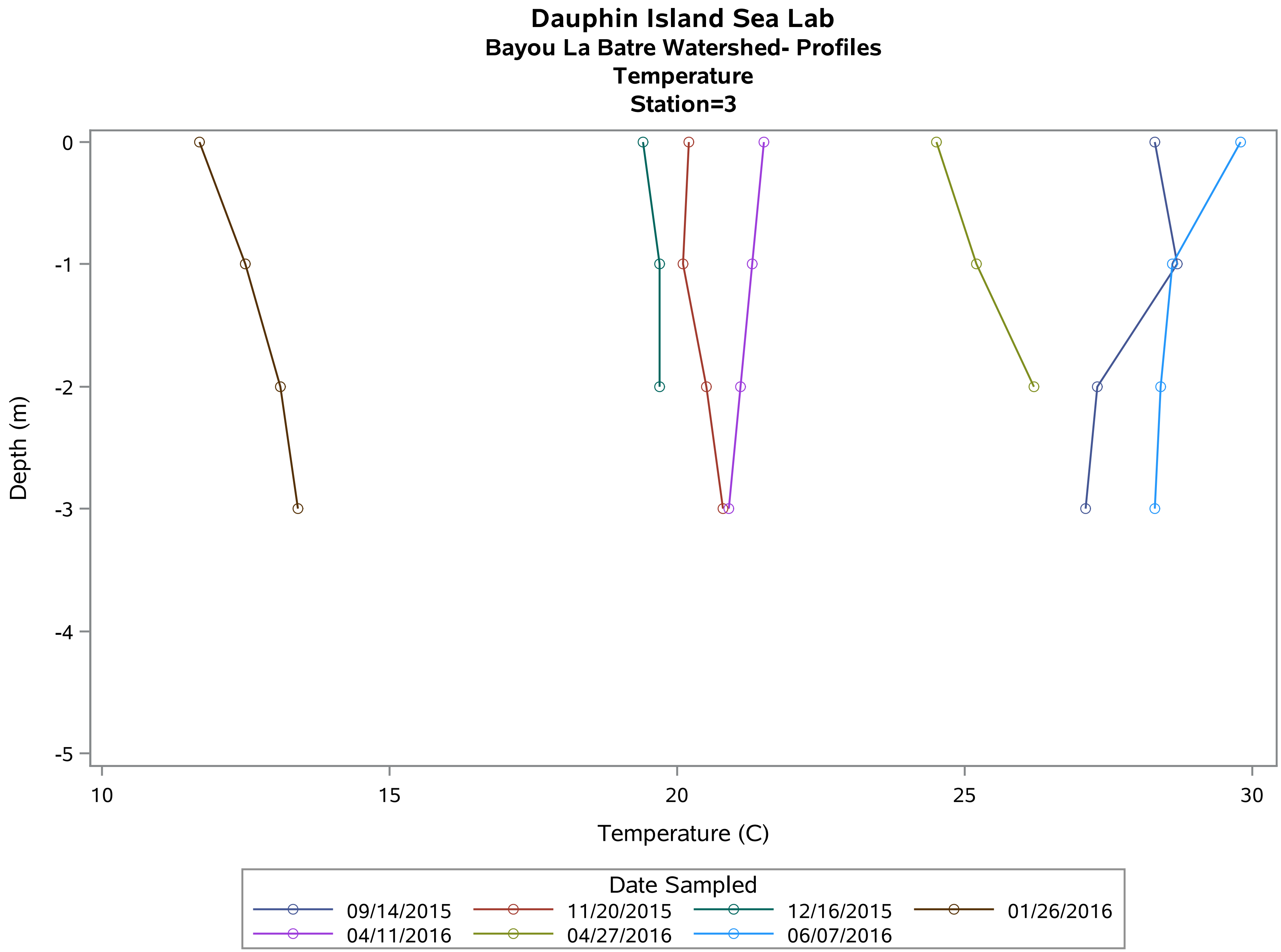


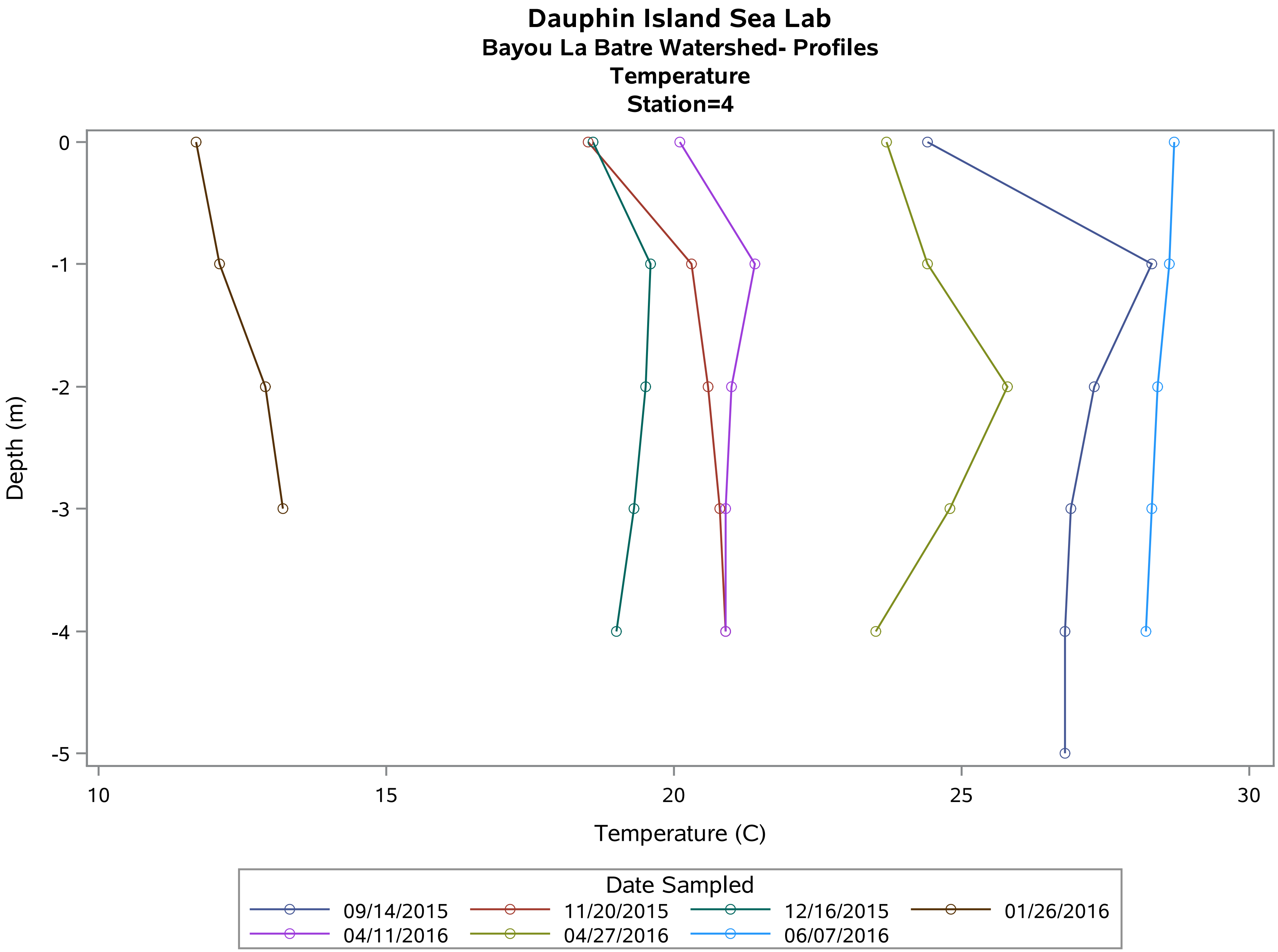
Dauphin Island Sea Lab
Bayou La Batre
Comparison with EPA National Coastal Condition Rating
Chlorophyll a
TYPE=Main Bayou
Chlorophyll a (ug/L)
25
20
15
10
5
0
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
1
2
3
4
5
6
7
EPA Good Rating
EPA Fair Rating
EPA Poor Rating

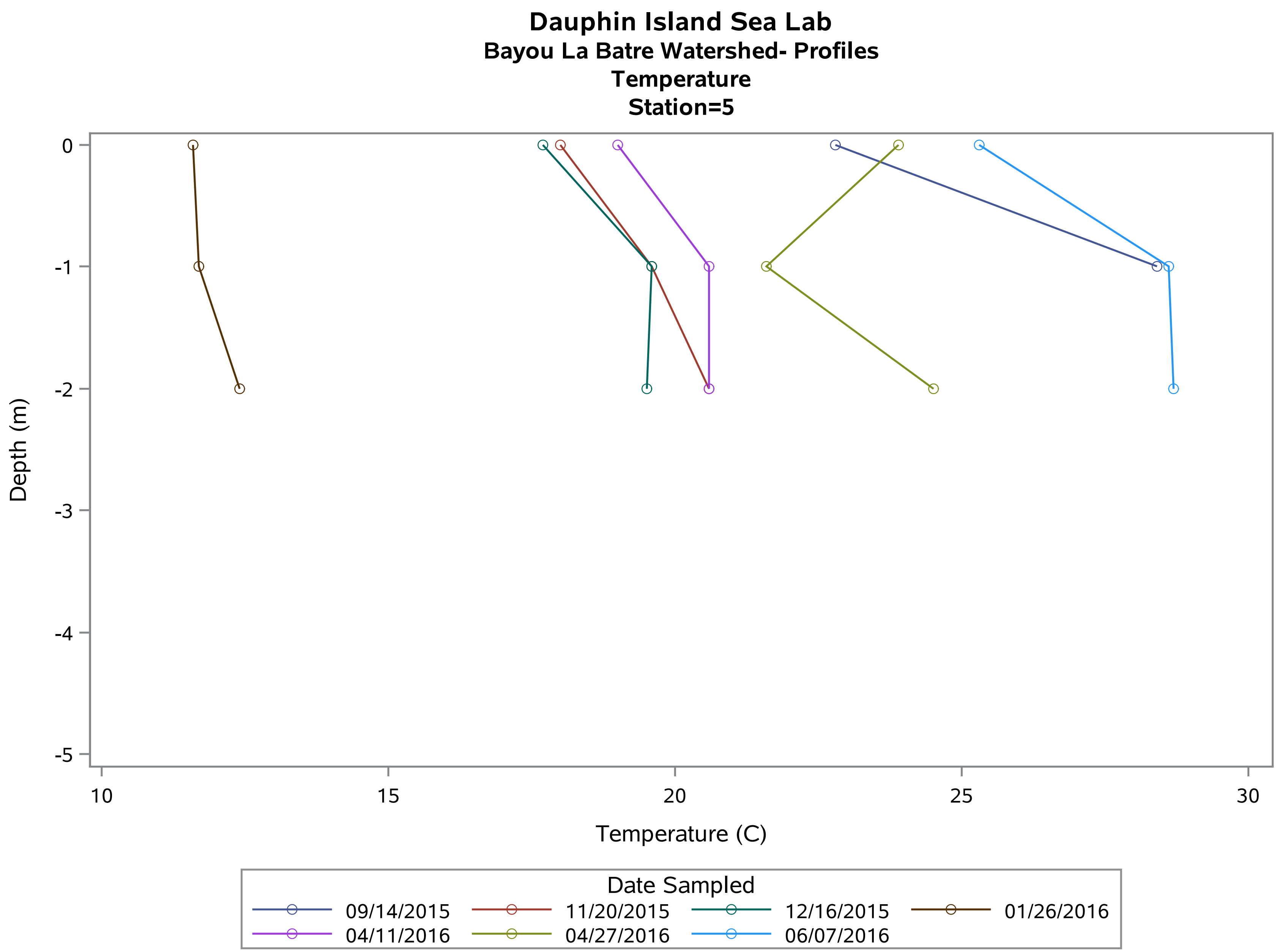

Dauphin Island Sea Lab
Bayou La Batre
Comparison with EPA National Coastal Condition Rating
Bottom Dissolved Oxygen
TYPE=Main Bayou
Bottom Dissolved Oxygen (mg/L)
10
8
6
4
2
0
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
1
2
3
4
5
6
7
EPA Good Rating
EPA Fair Rating
EPA Poor Rating


Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Temperature
Station=1
Depth (m)
0
-1
-2
-3
-4
-5
10
15
20
25
30
Temperature (C)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

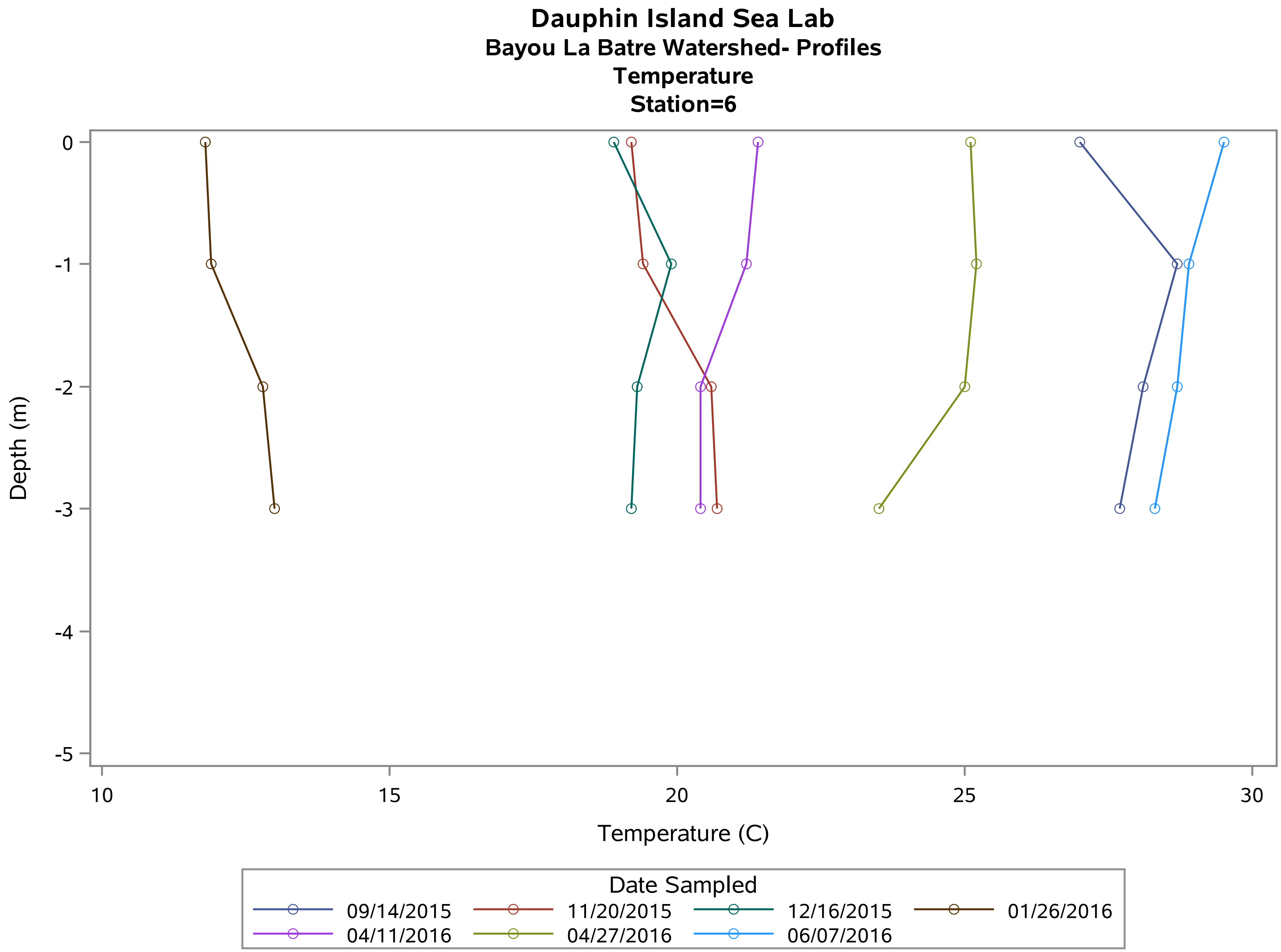

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Temperature
Station=2
Depth (m)
0
-1
-2
-3
-4
-5
10
15
20
25
30
Temperature (C)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016


Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Temperature
Station=3
Depth (m)
0
-1
-2
-3
-4
-5
10
15
20
25
30
Temperature (C)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

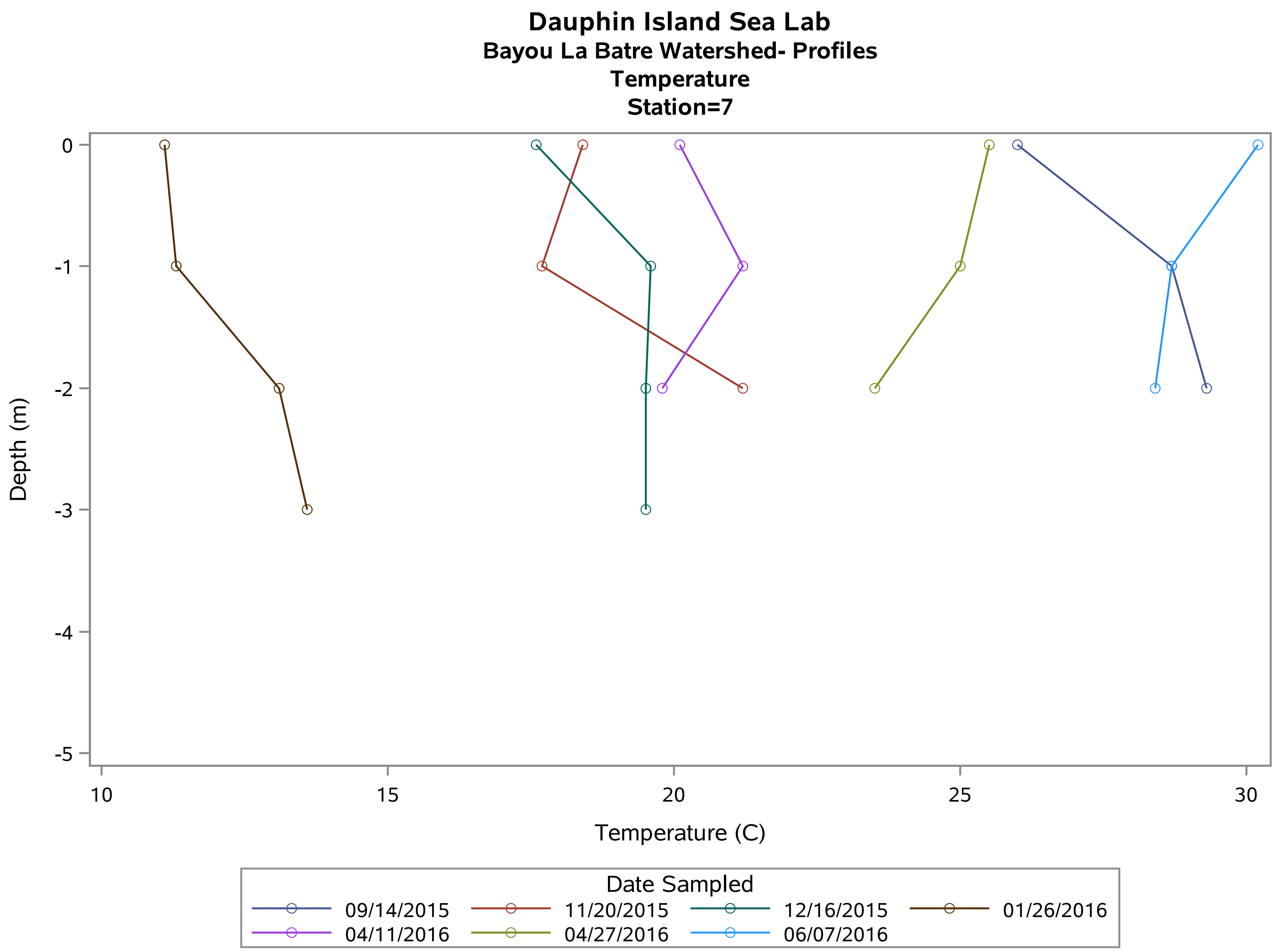

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Temperature
Station=4
0
-1
-2
-3
-4
-5
Depth (m)
10
15
20
25
30
Temperature (C)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016



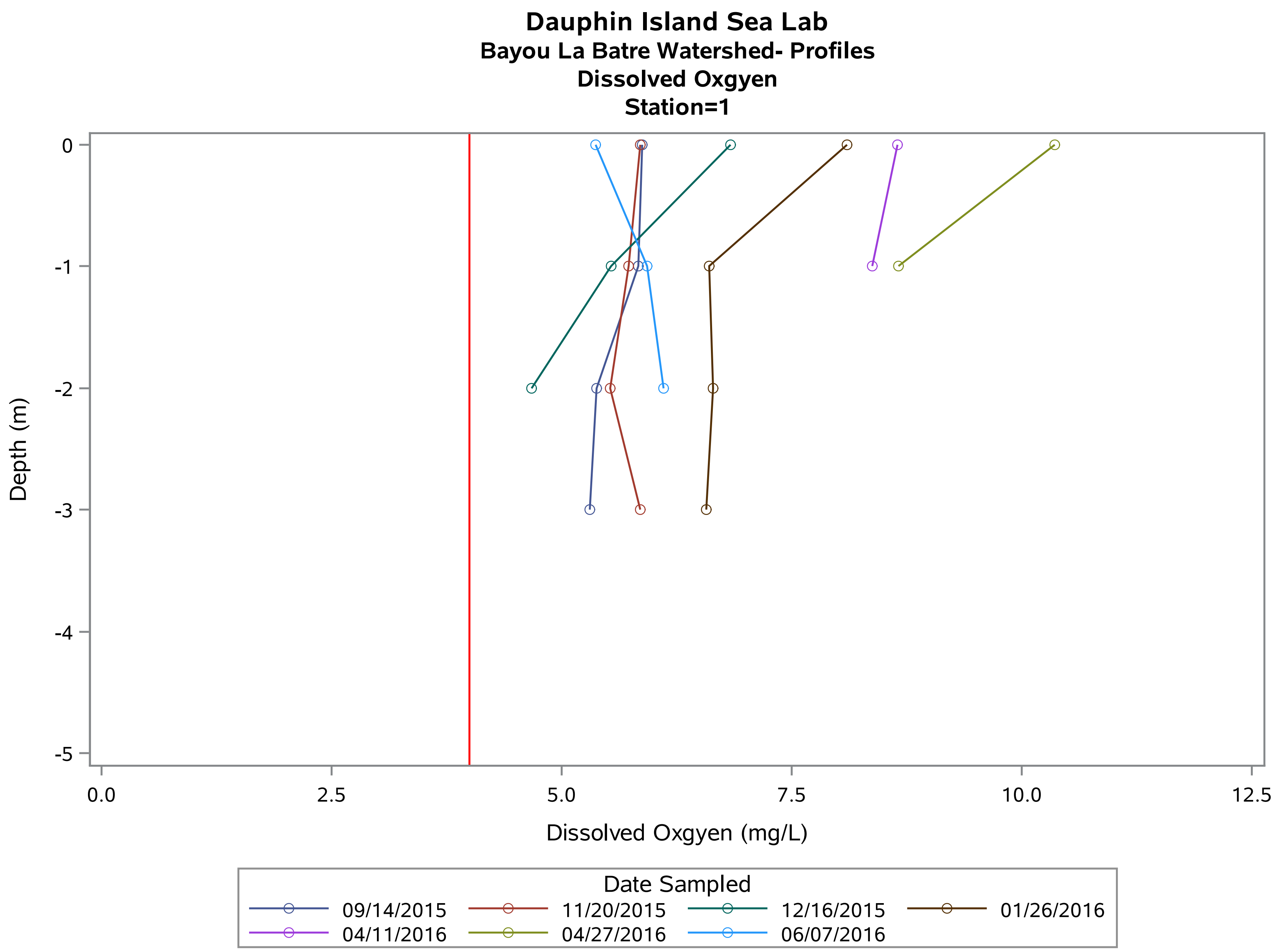
Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Temperature
Station=5
Depth (m)
0
-1
-2
-3
-4
-5
10
15
20
25
30
Temperature (C)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

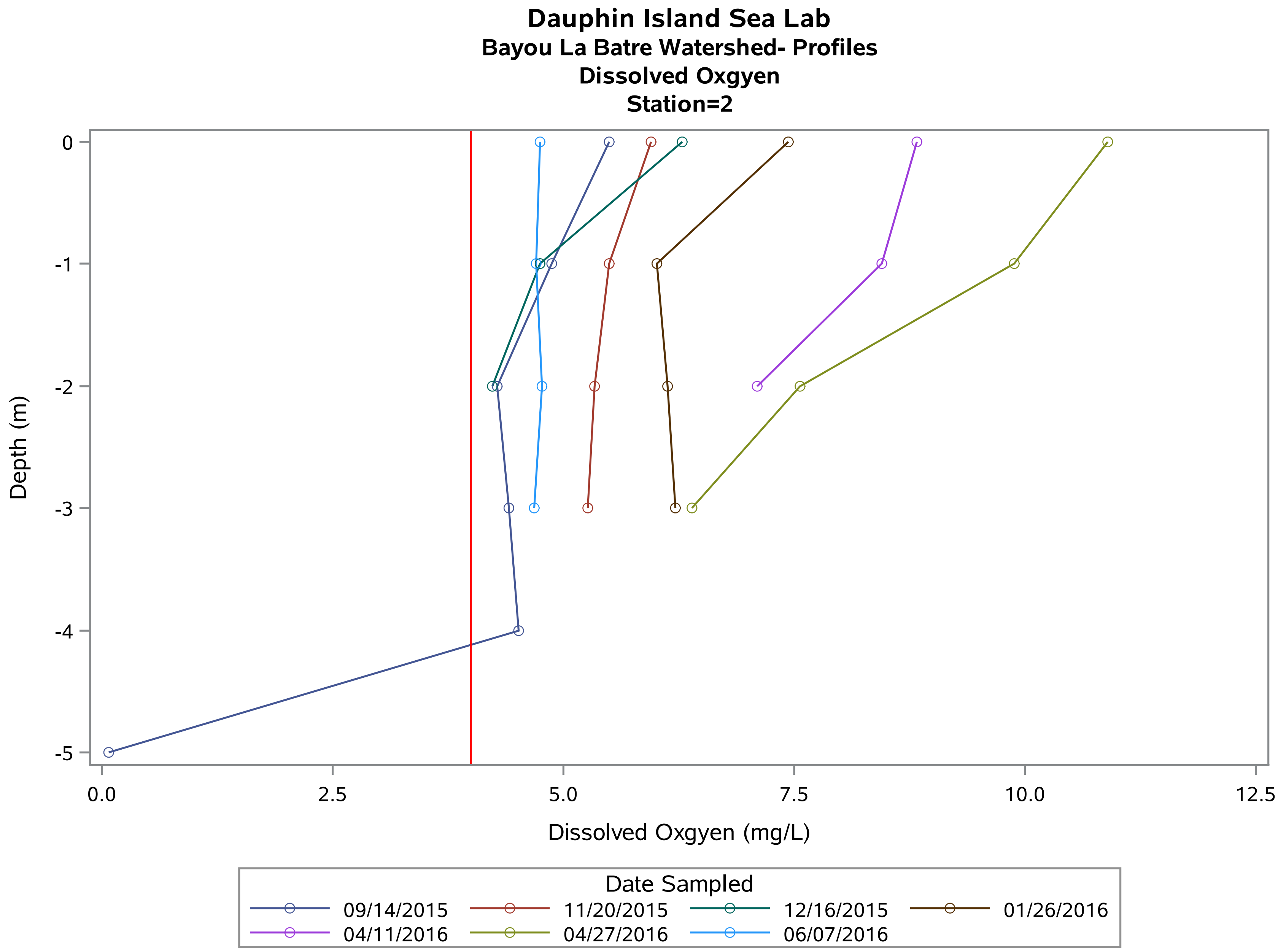


Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Temperature
Station=6
Depth (m)
0
-1
-2
-3
-4
-5
10
15
20
25
30
Temperature (C)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

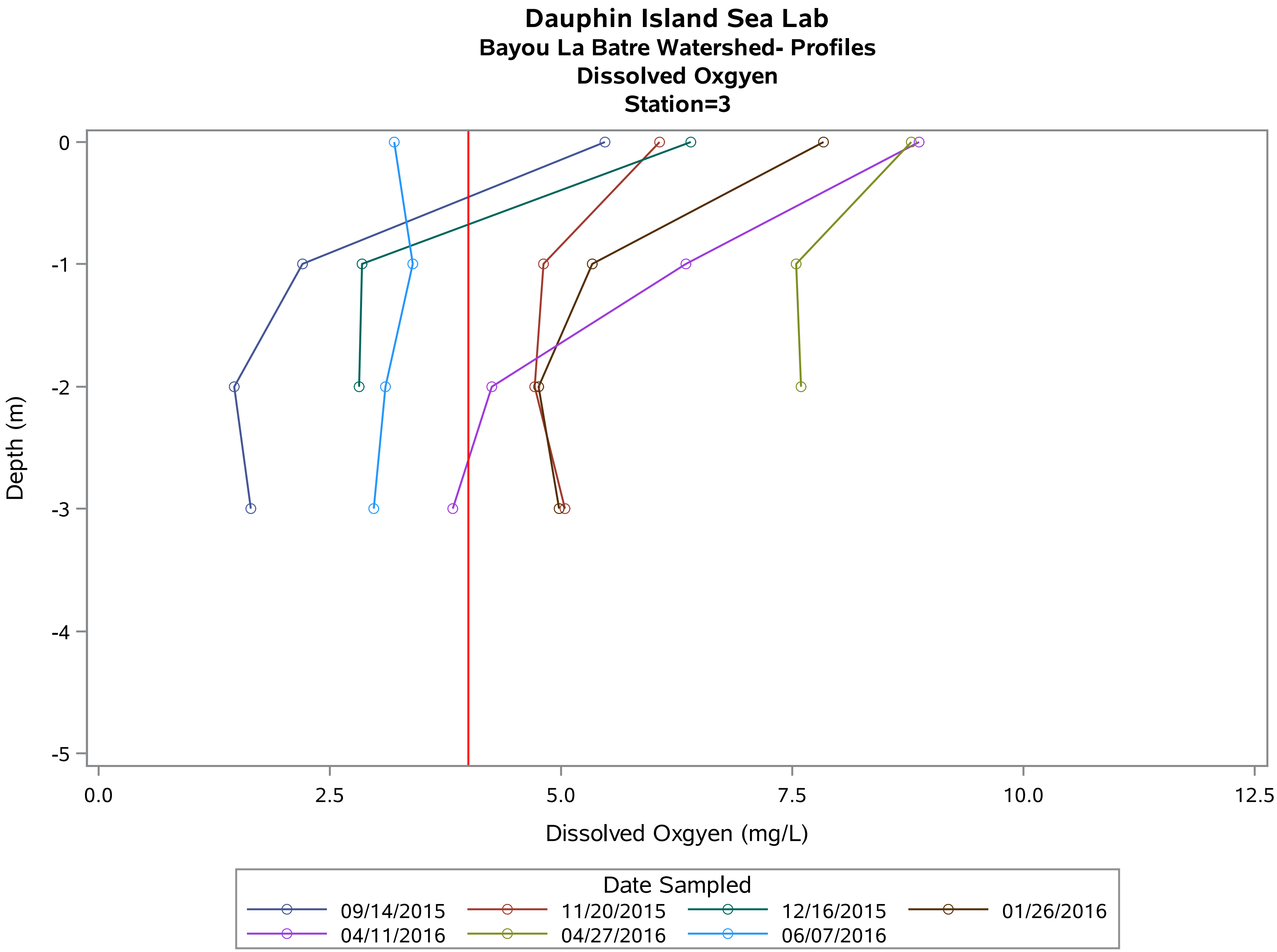


Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Temperature
Station=7
Depth (m)
0
-1
-2
-3
-4
-5
10
15
20
25
30
Temperature (C)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

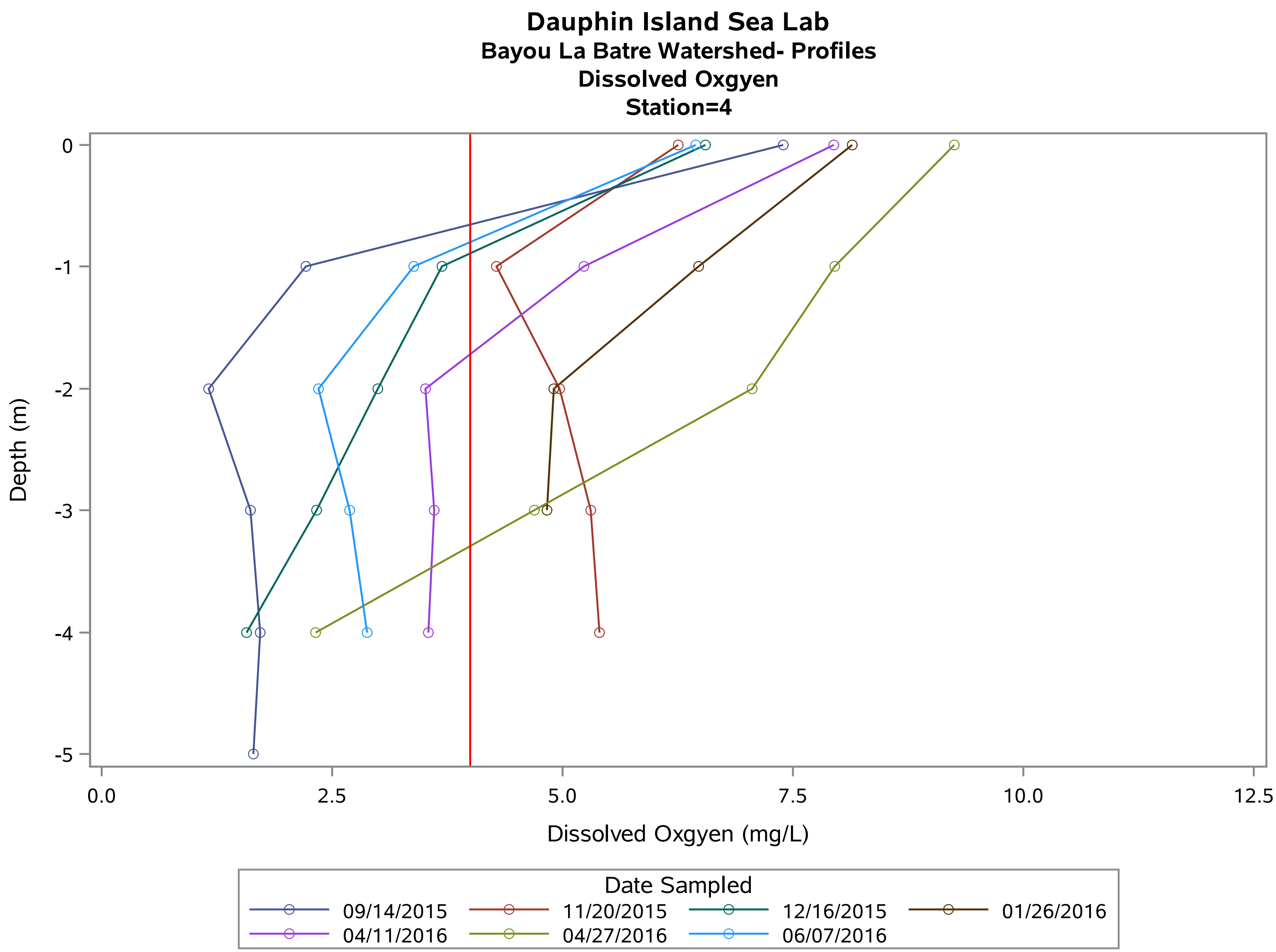

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Dissolved Oxgyen
Station=1
0
-1
-2
-3
-4
-5
Depth (m)
0.0
2.5
5.0
7.5
10.0
12.5
Dissolved Oxgyen (mg/L)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

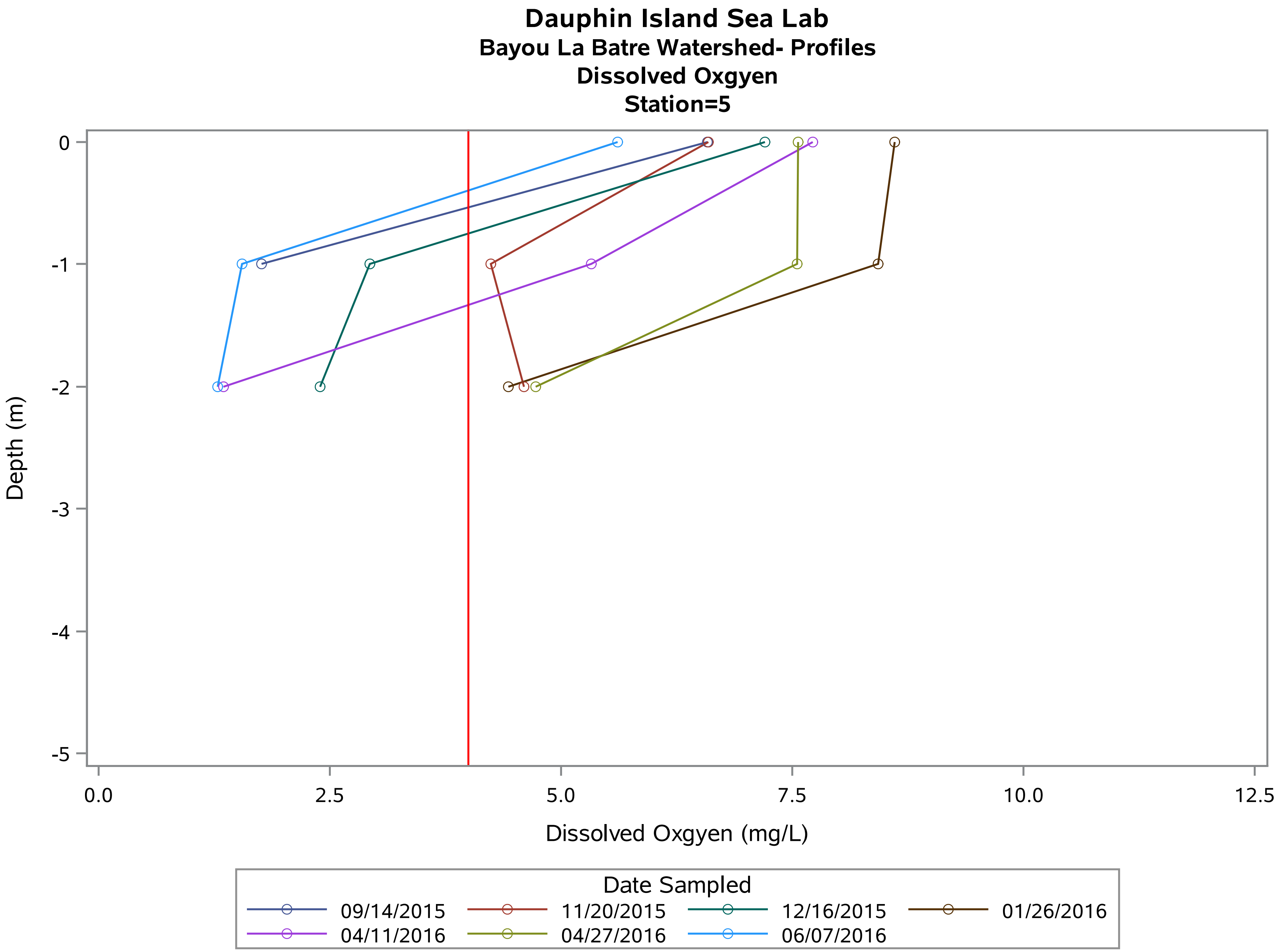


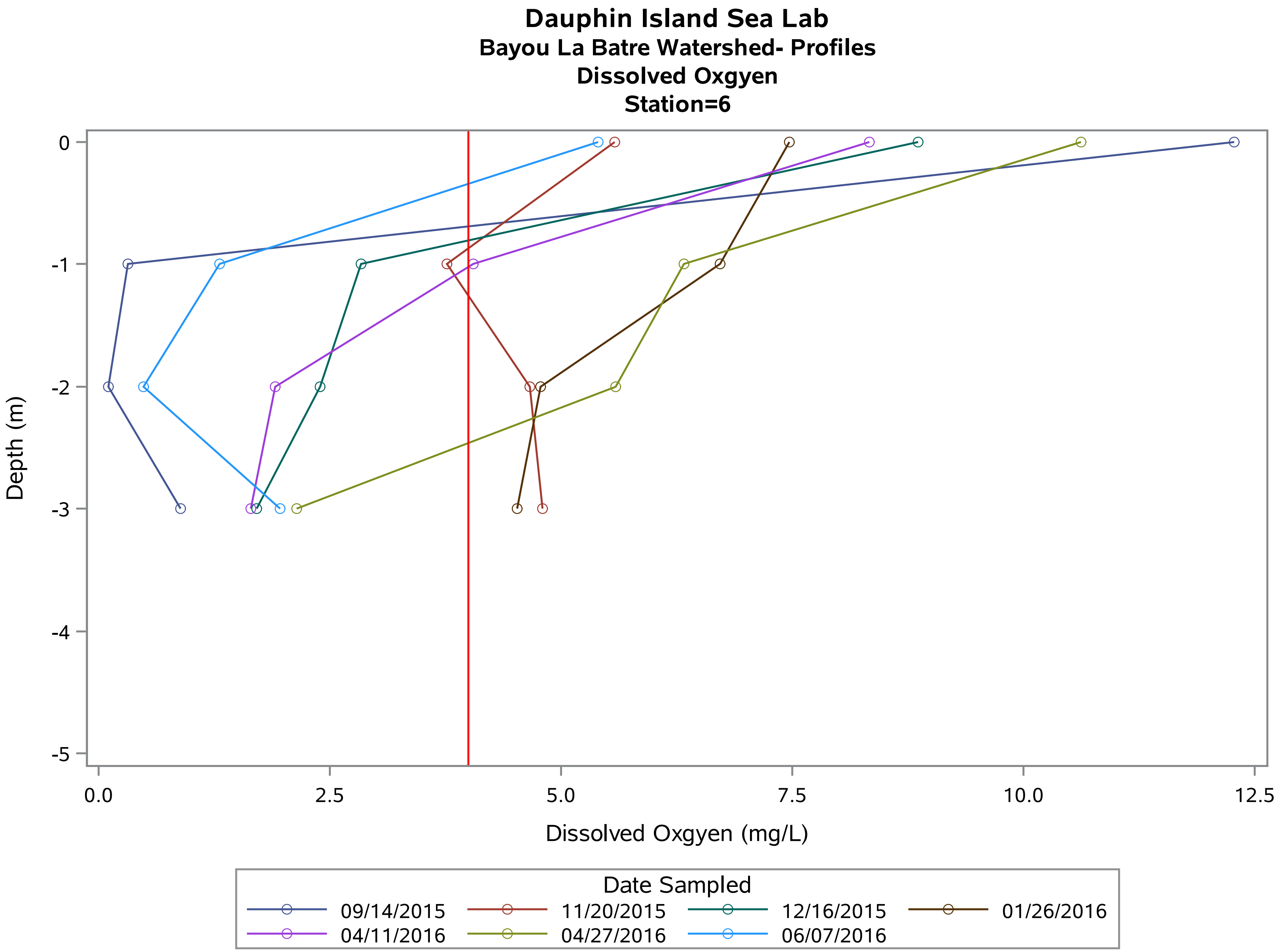
Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Dissolved Oxgyen
Station=2
Depth (m)
0
-1
-2
-3
-4
-5
0.0
2.5
5.0
7.5
10.0
12.5
Dissolved Oxgyen (mg/L)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

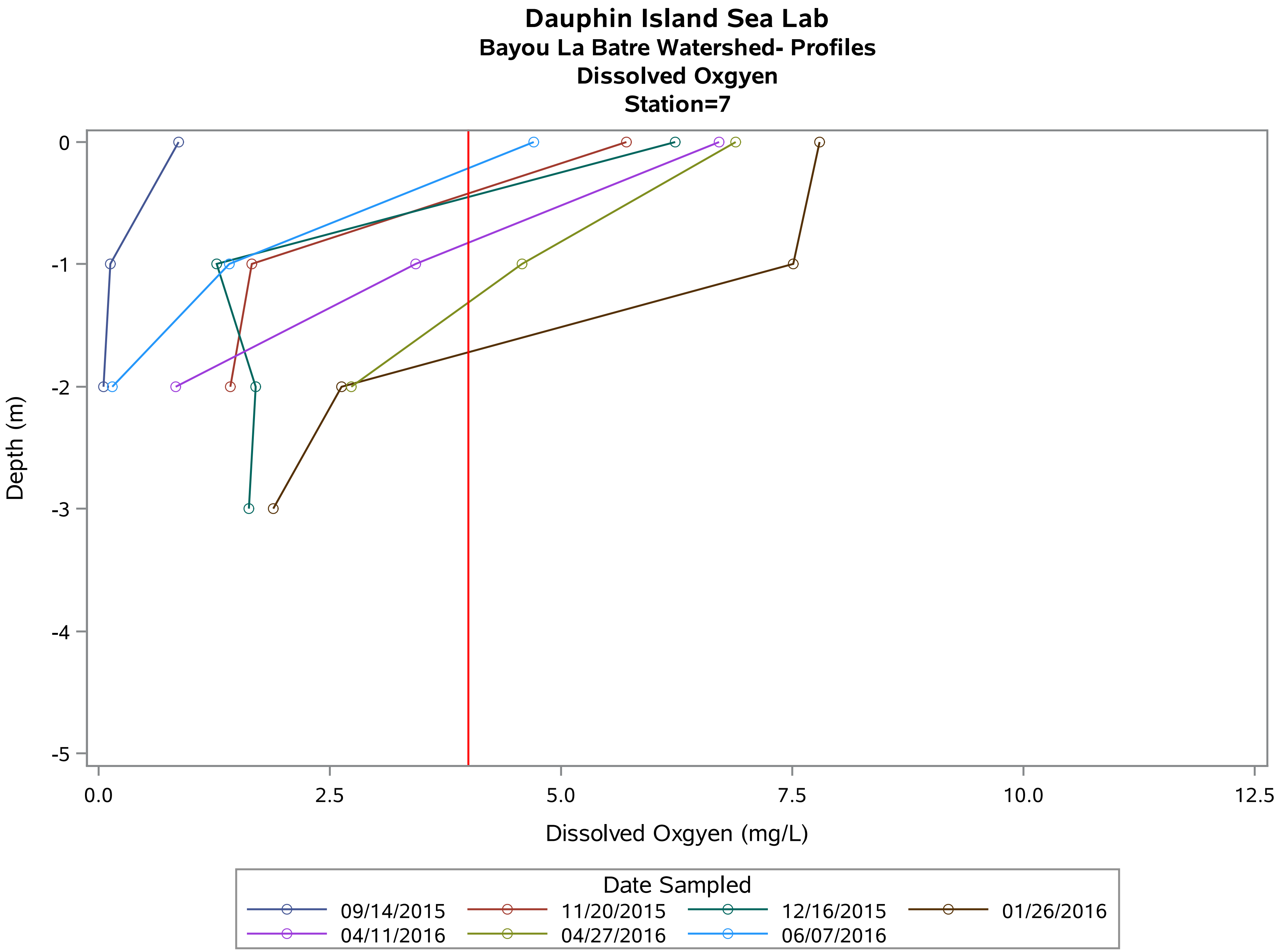


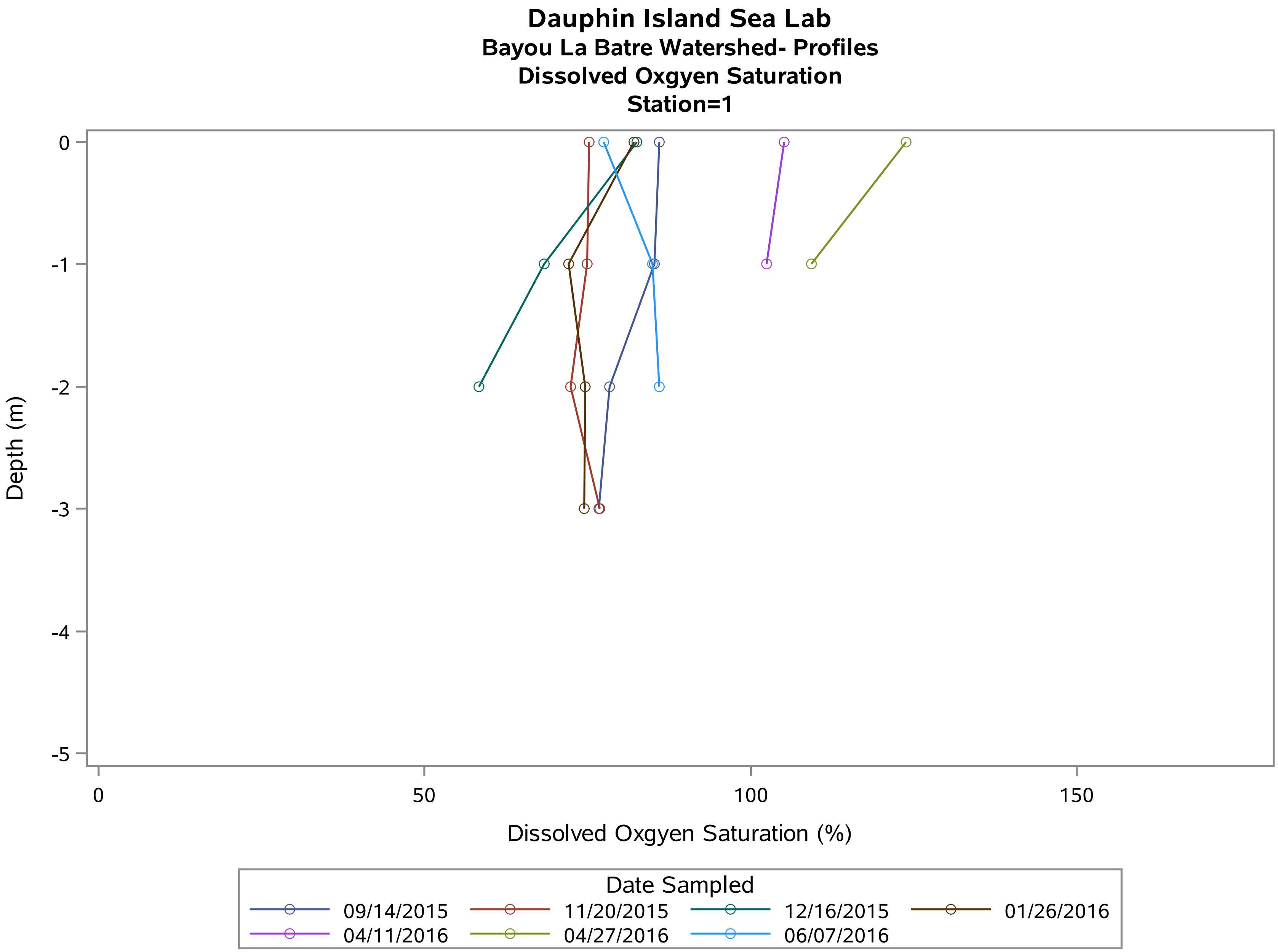
Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Dissolved Oxgyen
Station=3
Depth (m)
0
-1
-2
-3
-4
-5
0.0
2.5
5.0
7.5
10.0
12.5
Dissolved Oxgyen (mg/L)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

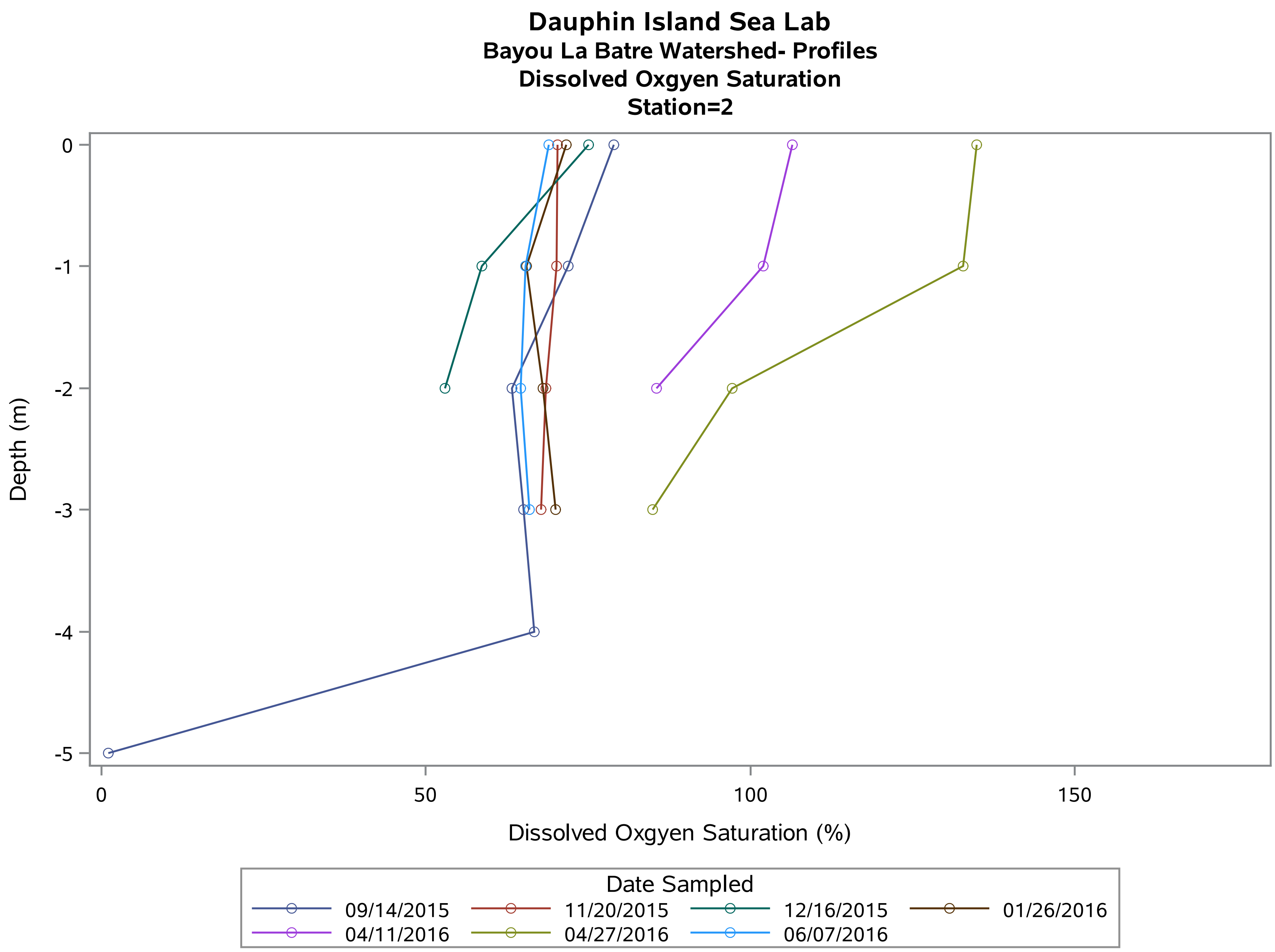

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Dissolved Oxgyen
Station=4
0
-1
-2
-3
-4
-5
Depth (m)
0.0
2.5
5.0
7.5
10.0
12.5
Dissolved Oxgyen (mg/L)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016


Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Dissolved Oxgyen
Station=5
Depth (m)
0
-1
-2
-3
-4
-5
0.0
2.5
5.0
7.5
10.0
12.5
Dissolved Oxgyen (mg/L)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

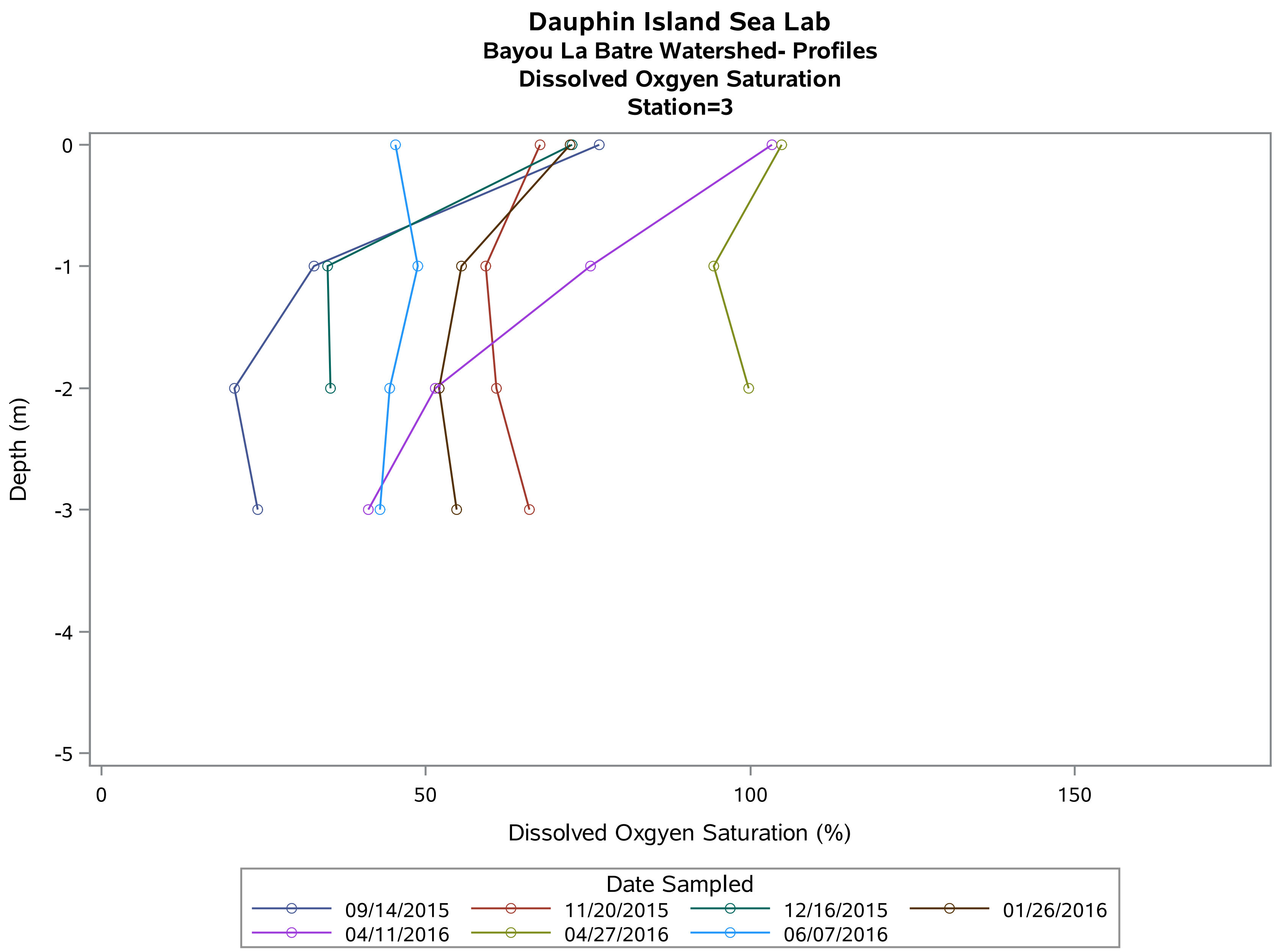

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Dissolved Oxgyen
Station=6
Depth (m)
0
-1
-2
-3
-4
-5
0.0
2.5
5.0
7.5
10.0
12.5
Dissolved Oxgyen (mg/L)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016


Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Dissolved Oxgyen
Station=7
Depth (m)
0
-1
-2
-3
-4
-5
0.0
2.5
5.0
7.5
10.0
12.5
Dissolved Oxgyen (mg/L)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

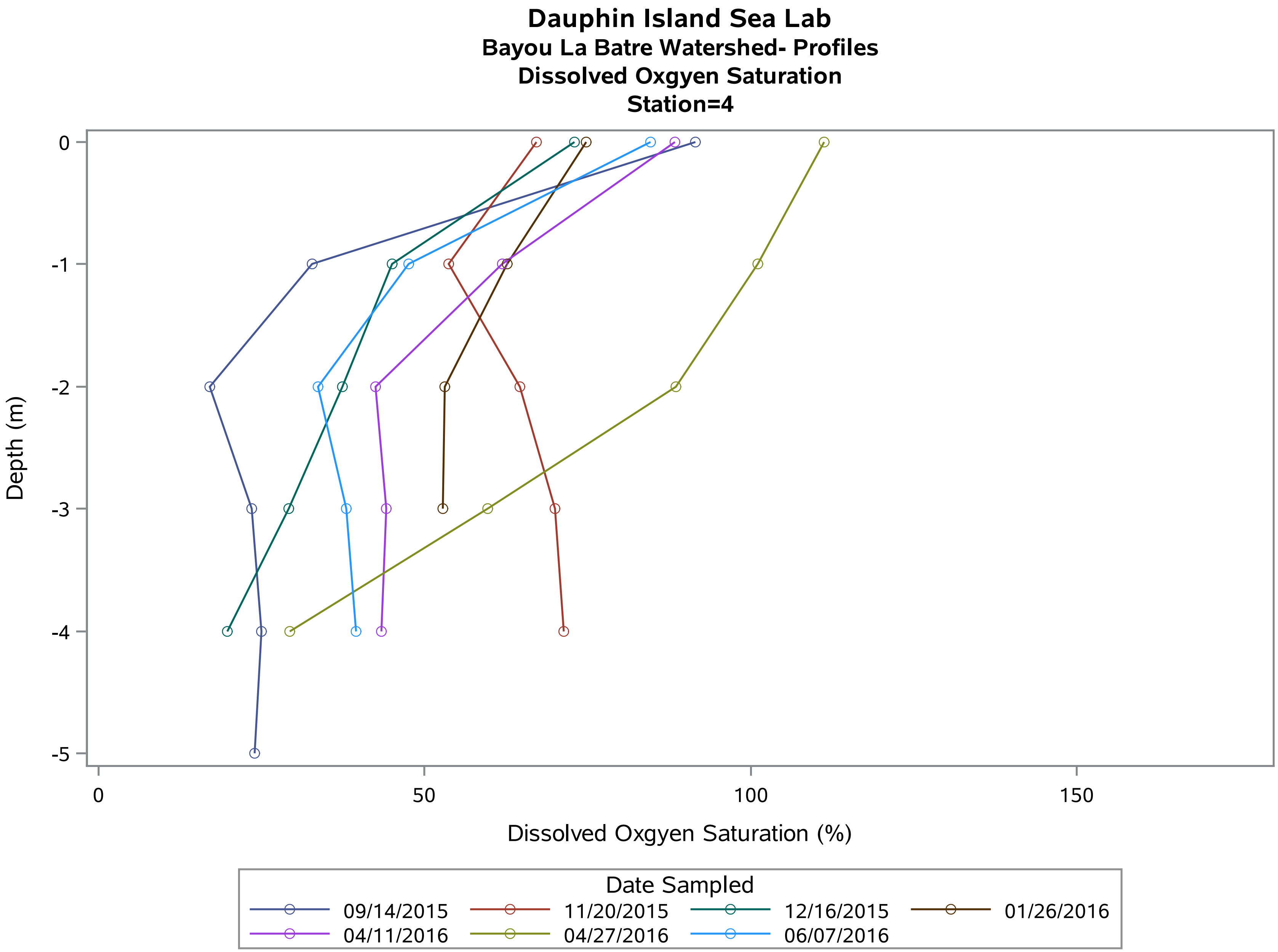

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Dissolved Oxgyen Saturation
Station=1
Depth (m)
0
-1
-2
-3
-4
-5
0
50
100
150
Dissolved Oxgyen Saturation (%)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016



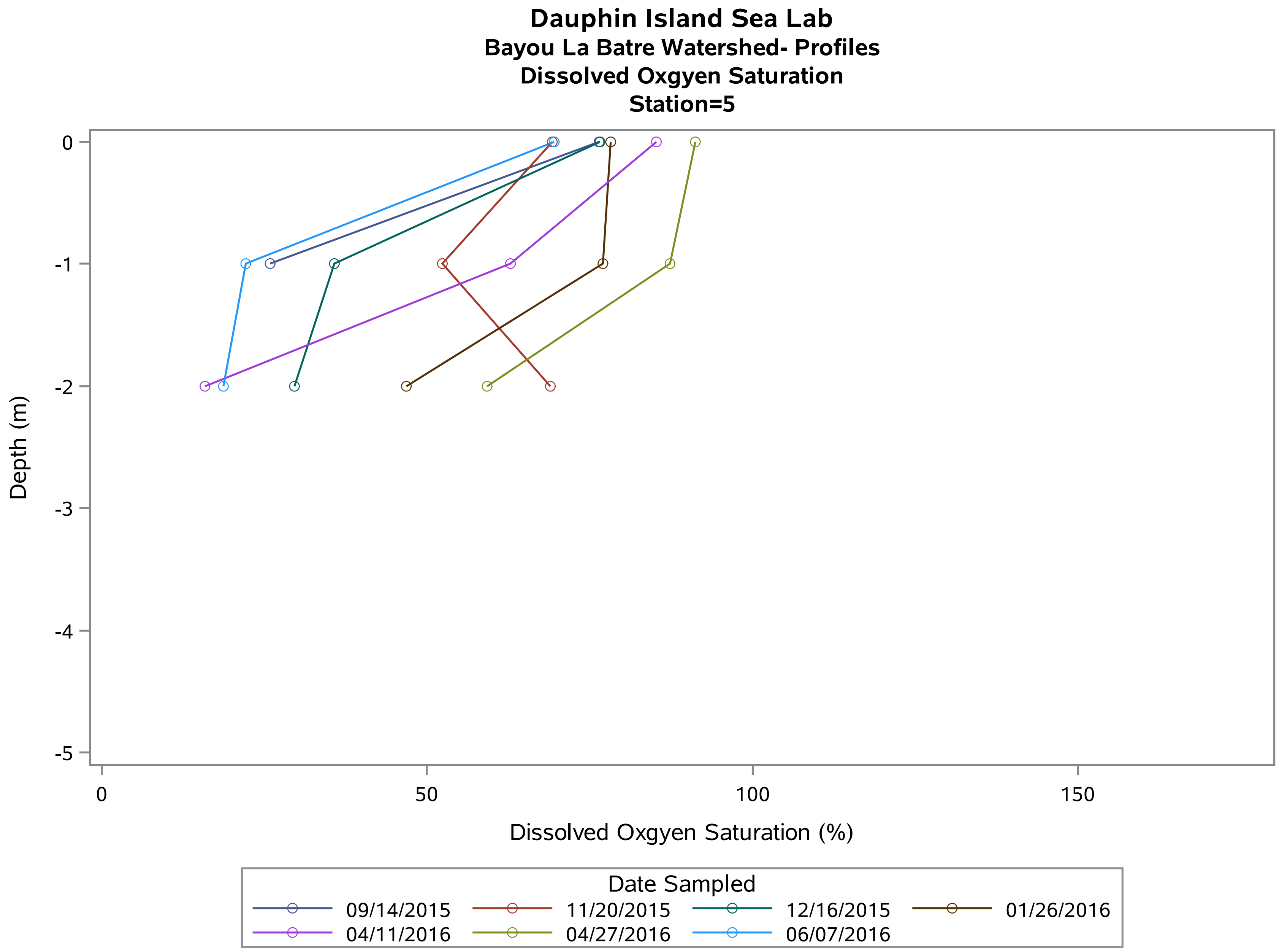
Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Dissolved Oxgyen Saturation
Station=2
Depth (m)
0
-1
-2
-3
-4
-5
0
50
100
150
Dissolved Oxgyen Saturation (%)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016



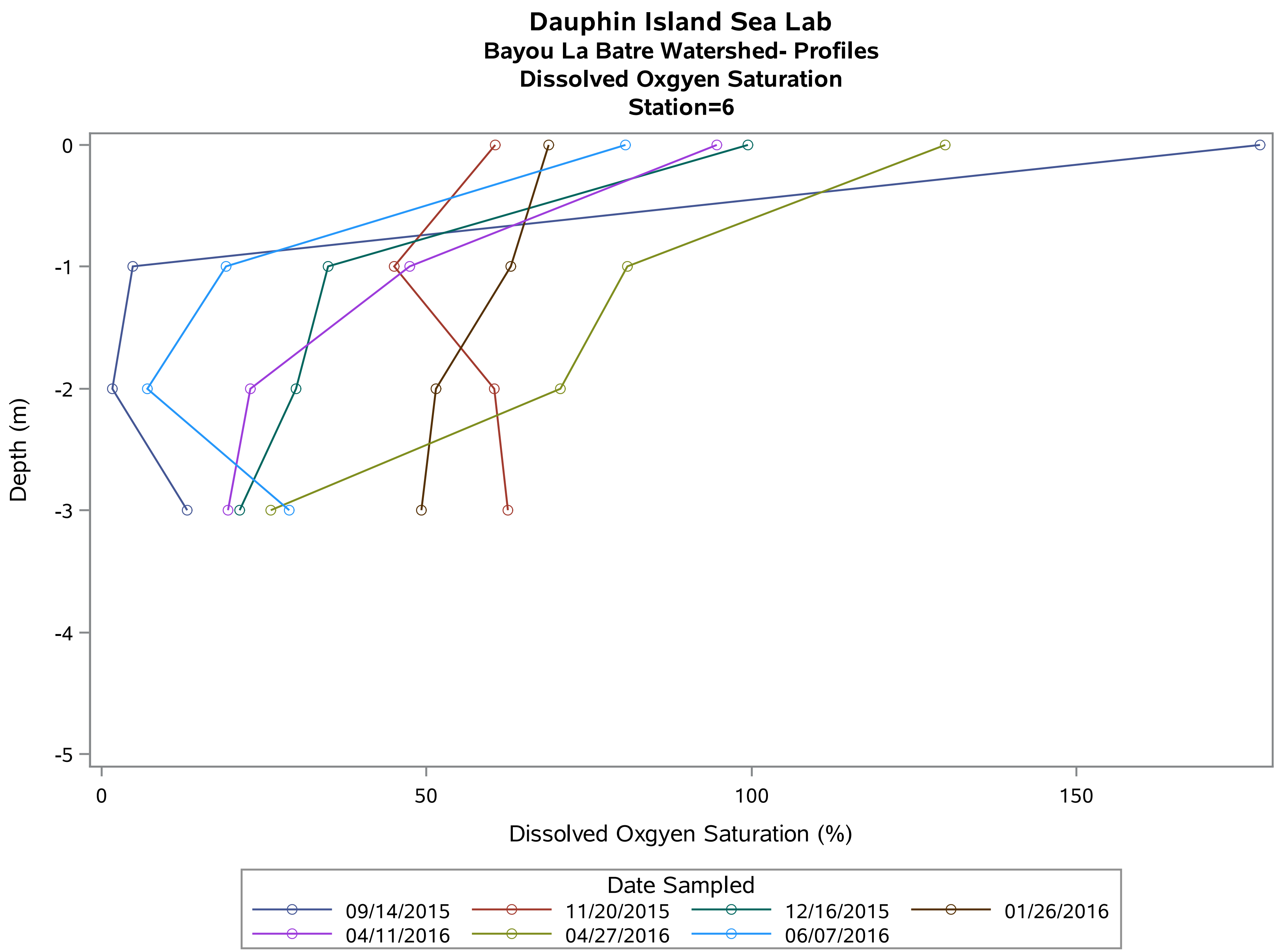
Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Dissolved Oxgyen Saturation
Station=3
Depth (m)
0
-1
-2
-3
-4
-5
0
50
100
150
Dissolved Oxgyen Saturation (%)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016



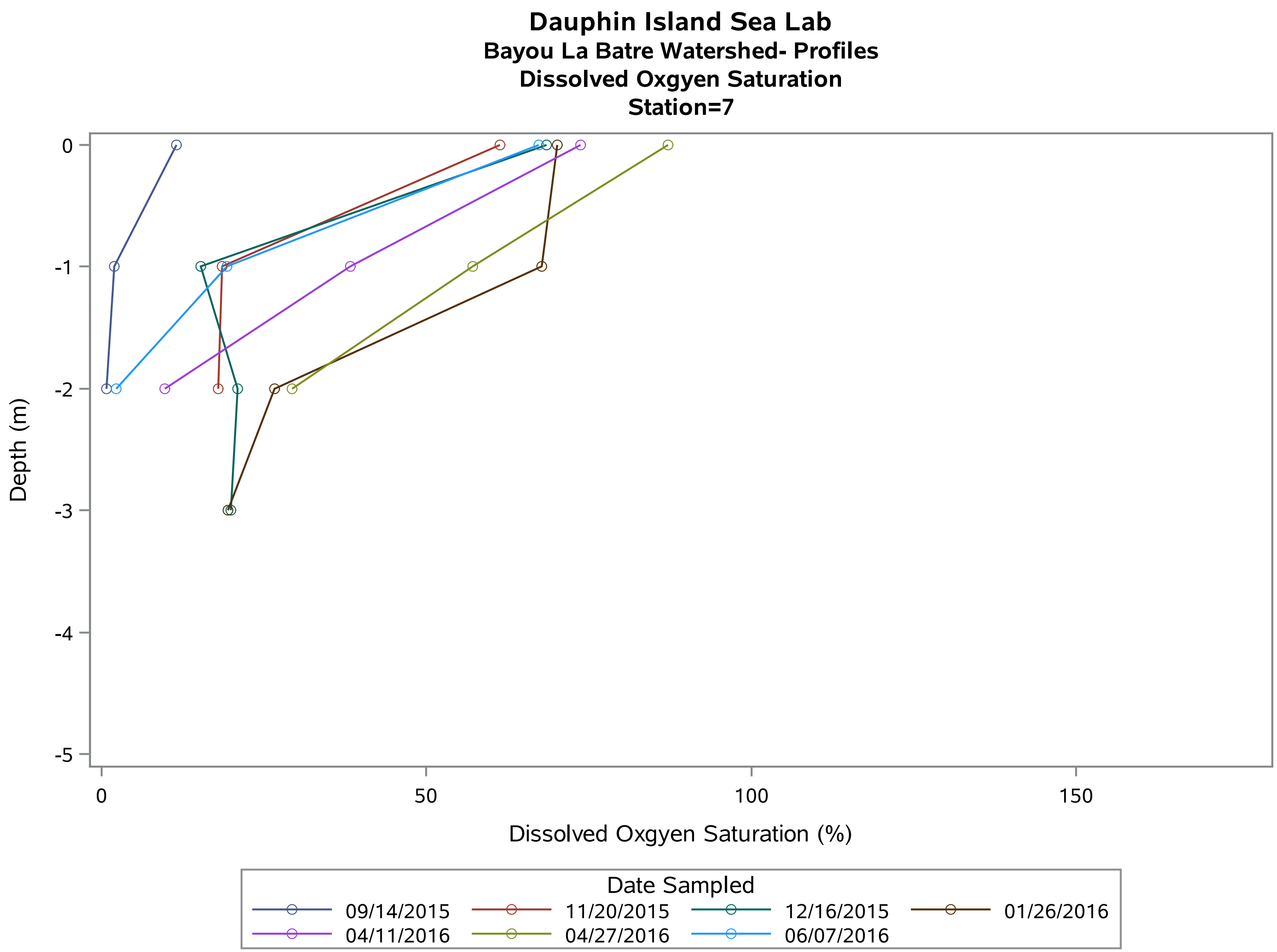
Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Dissolved Oxgyen Saturation
Station=4
Depth (m)
0
-1
-2
-3
-4
-5
0
50
100
150
Dissolved Oxgyen Saturation (%)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016



Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Dissolved Oxgyen Saturation
Station=5
Depth (m)
0
-1
-2
-3
-4
-5
0
50
100
150
Dissolved Oxgyen Saturation (%)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016



Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Dissolved Oxgyen Saturation
Station=6
Depth (m)
0
-1
-2
-3
-4
-5
0
50
100
150
Dissolved Oxgyen Saturation (%)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016


Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Dissolved Oxgyen Saturation
Station=7
0
-1
-2
-3
-4
-5
Depth (m)
0
50
100
150
Dissolved Oxgyen Saturation (%)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
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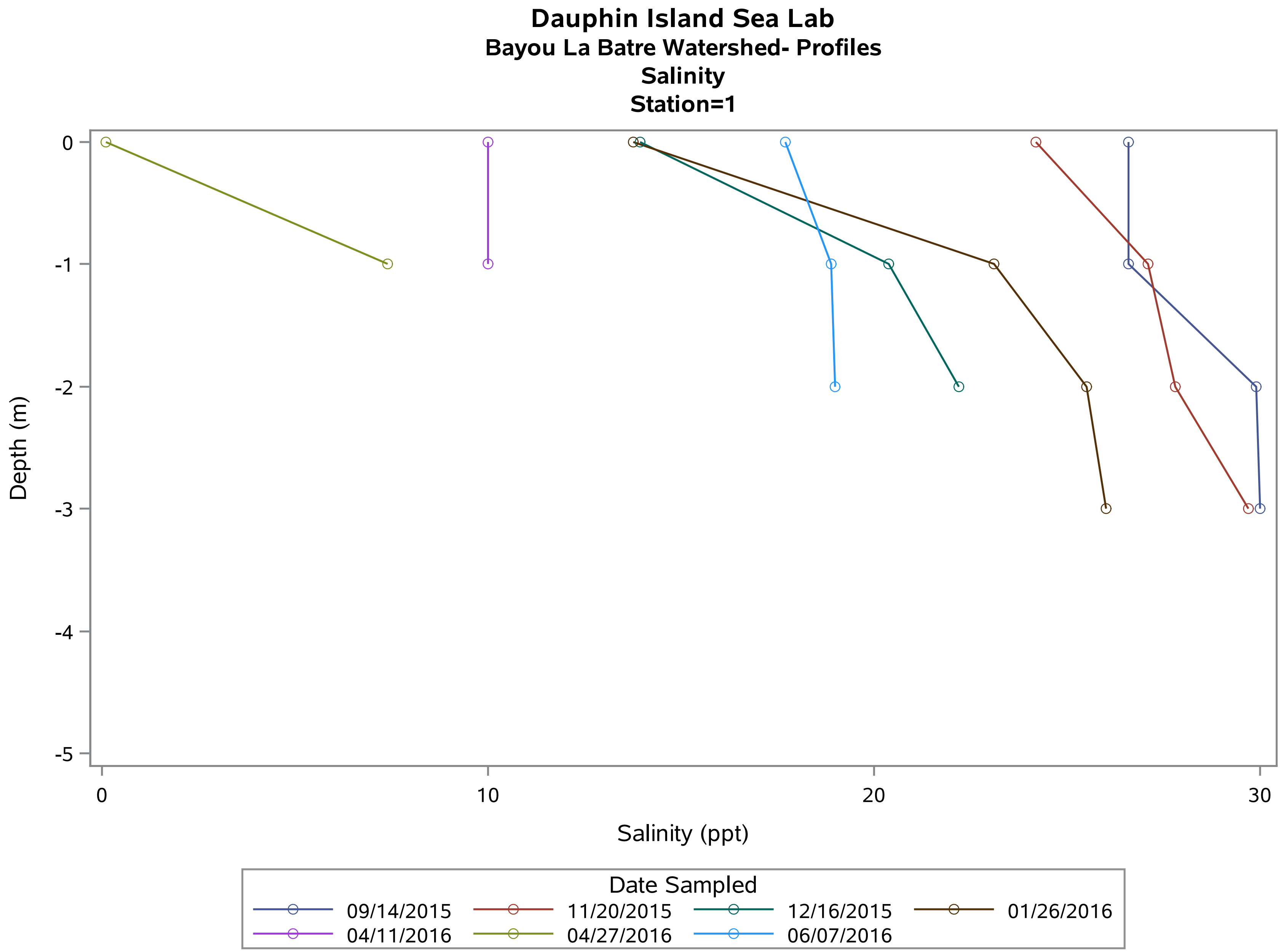
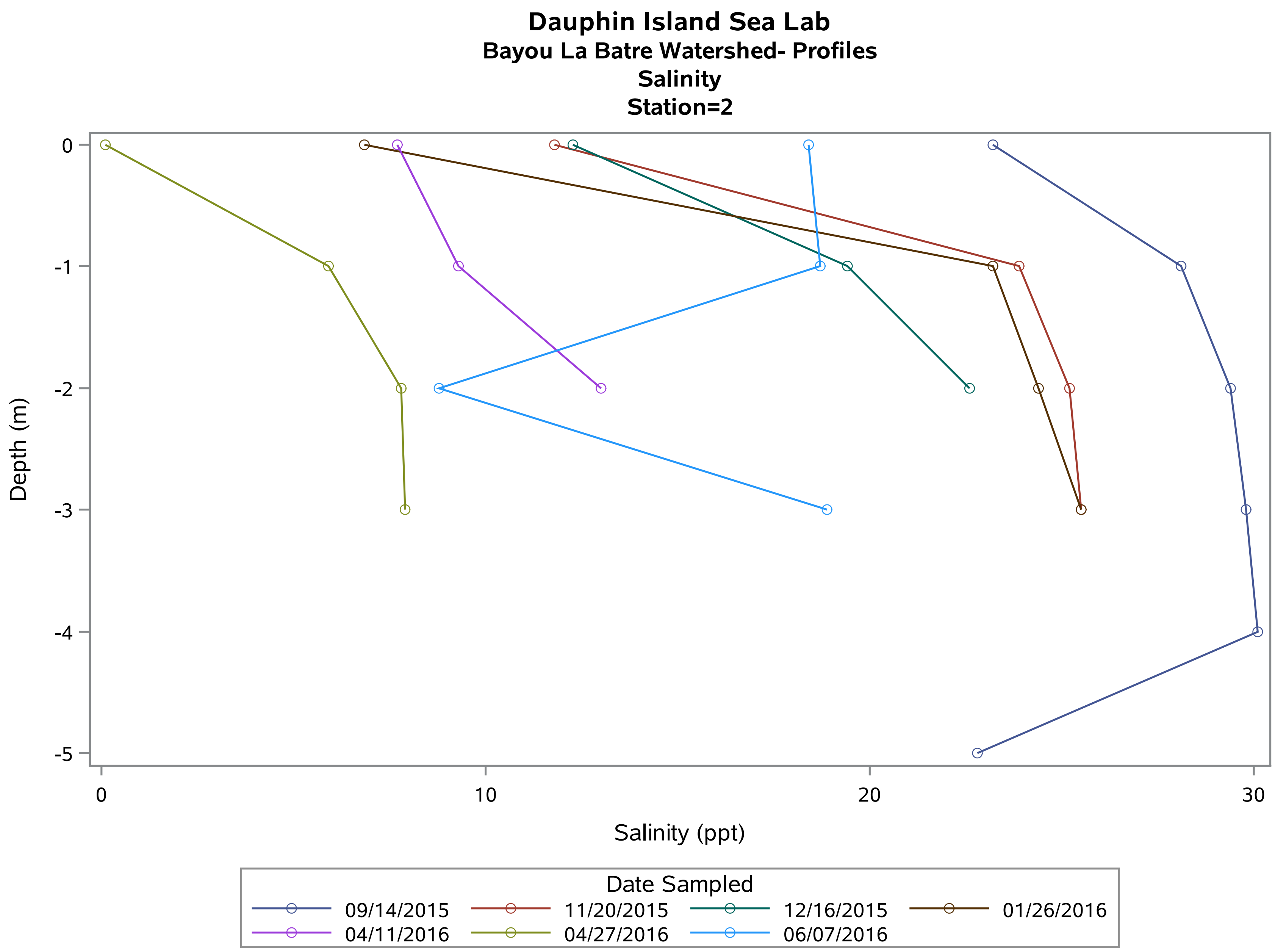

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Salinity
Station=1
Depth (m)
0
-1
-2
-3
-4
-5
0
10
20
30
Salinity (ppt)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016



Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Salinity
Station=2
Depth (m)
0
-1
-2
-3
-4
-5
0
10
20
30
Salinity (ppt)
Date Sampled
09/14/2015
11/20/2015
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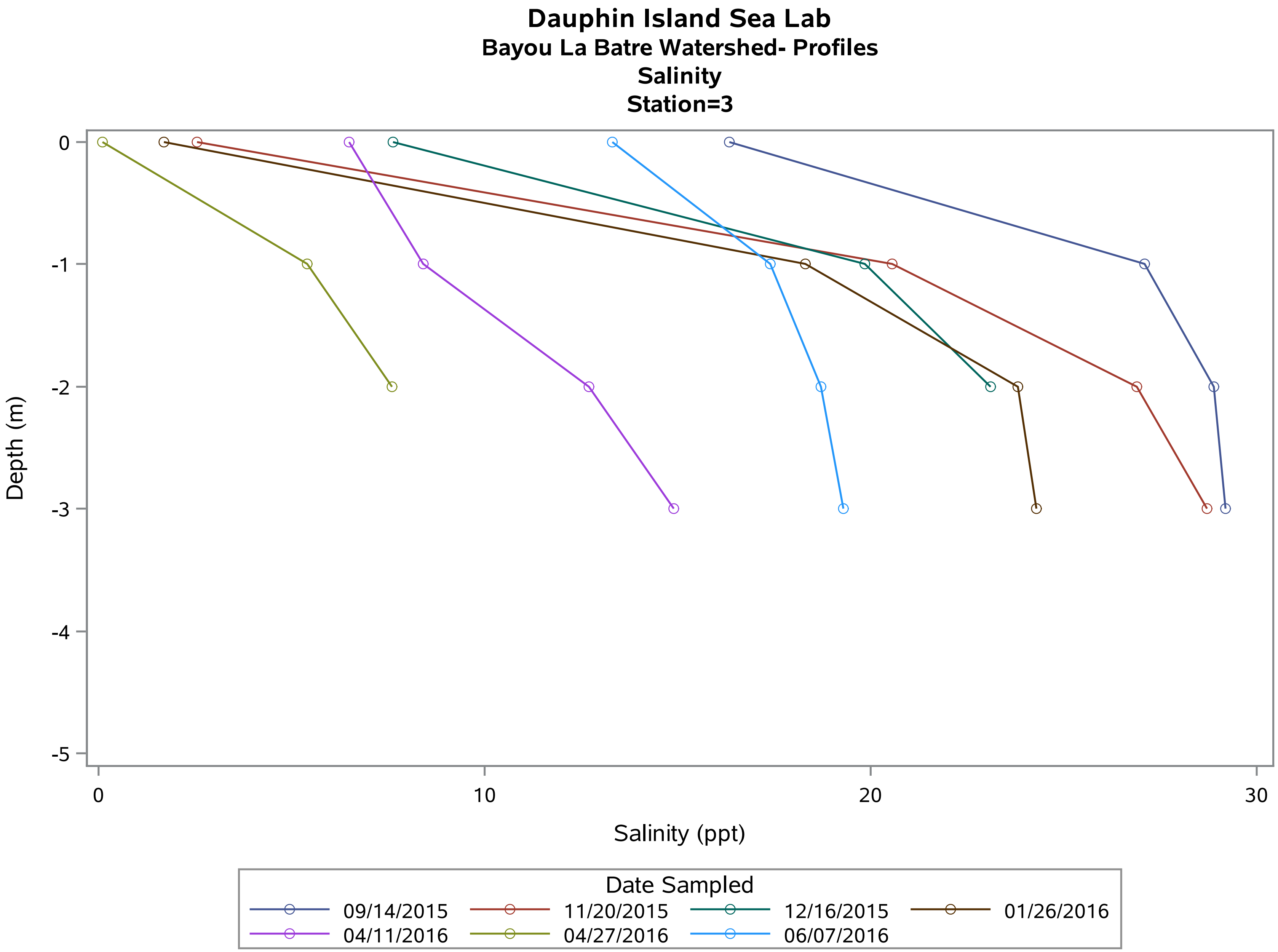
04/27/2016
06/07/2016


Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Salinity
Station=3
0
-1
-2
-3
-4
-5
Depth (m)
0
10
20
30
Salinity (ppt)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
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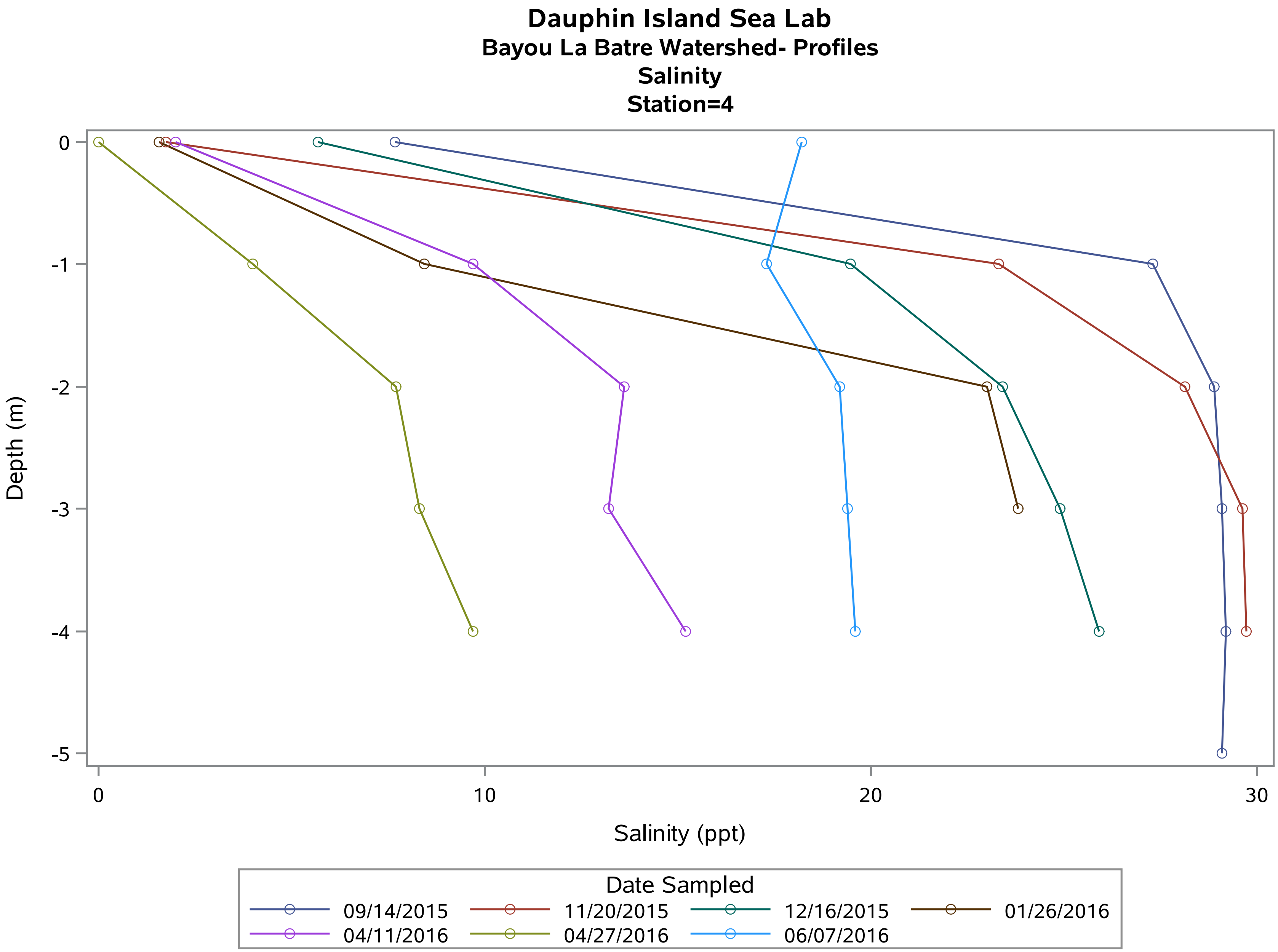
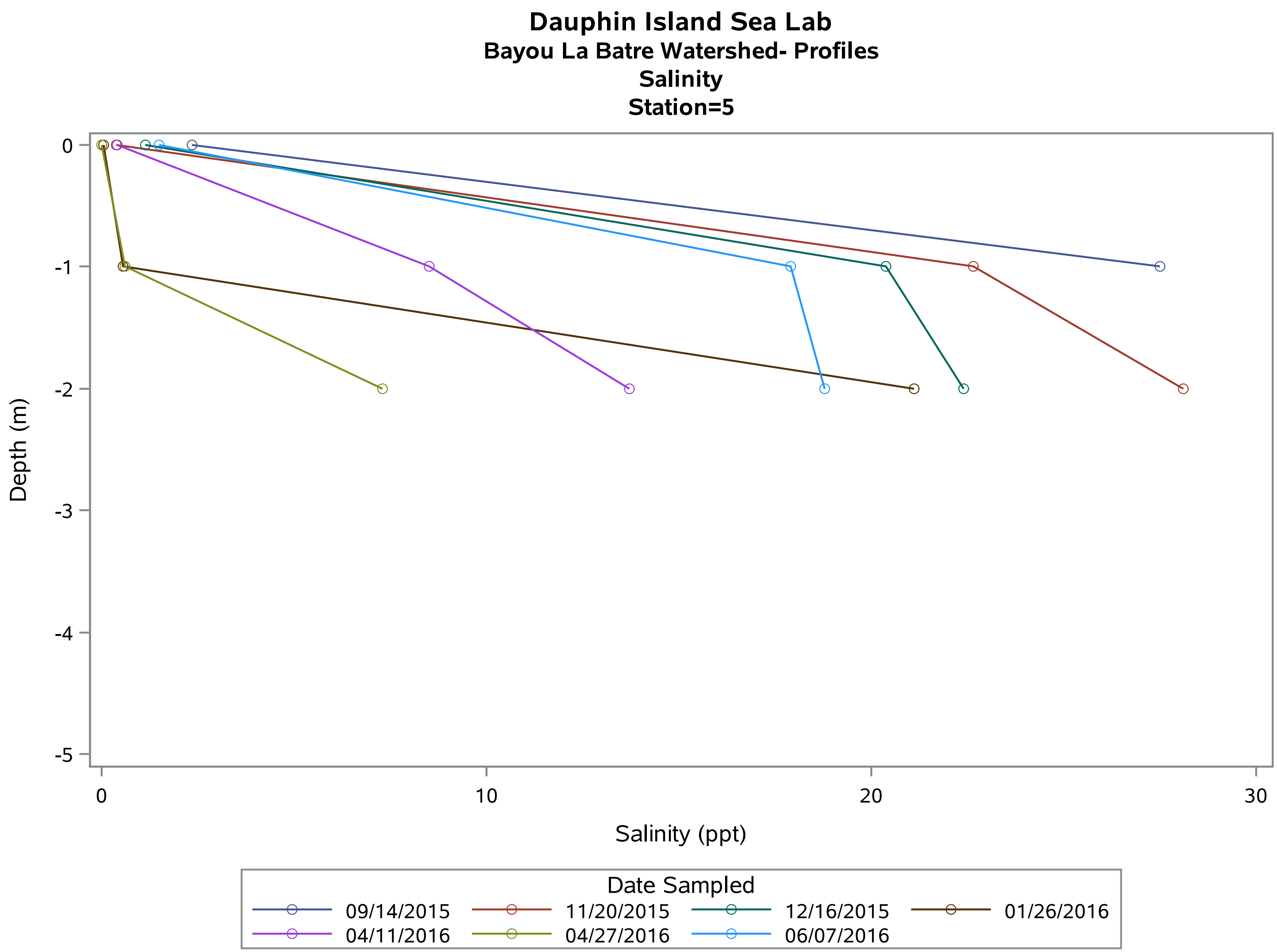
04/27/2016
06/07/2016


Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Salinity
Station=4
0
-1
-2
-3
-4
-5
Depth (m)
0
10
20
30
Salinity (ppt)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016



Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Salinity
Station=5
Depth (m)
0
-1
-2
-3
-4
-5
0
10
20
30
Salinity (ppt)
Date Sampled
09/14/2015
11/20/2015
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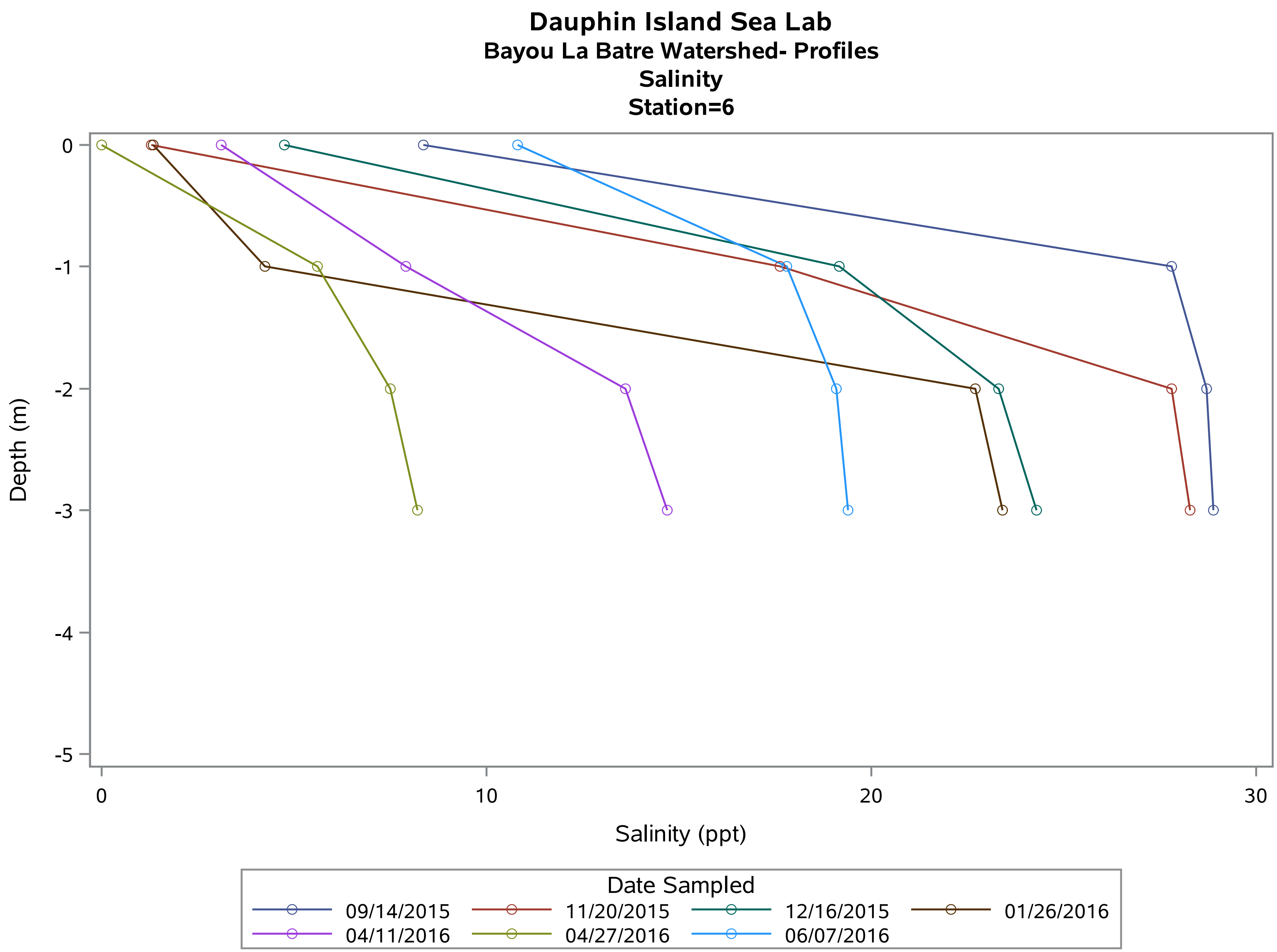
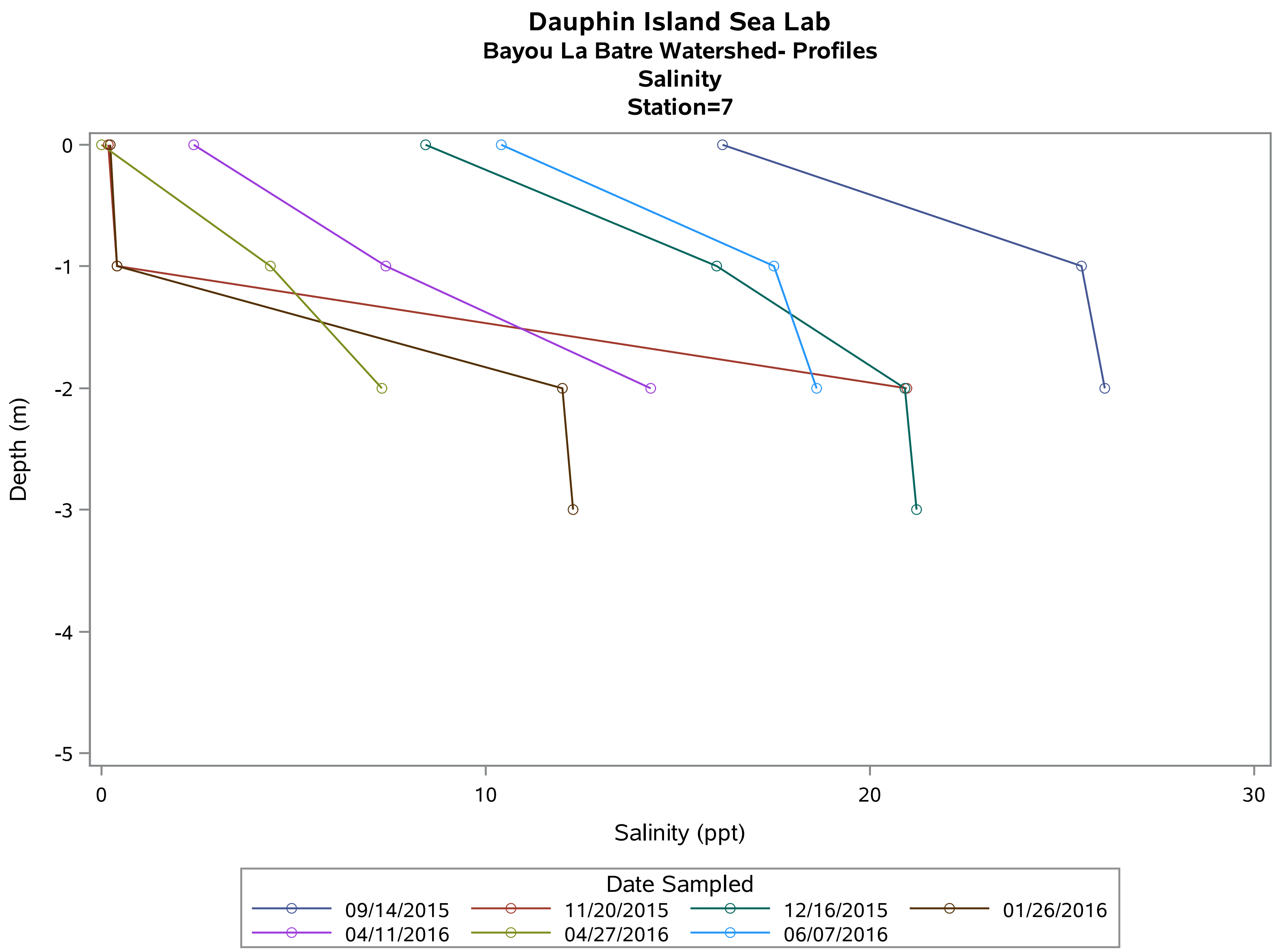
04/27/2016
06/07/2016


Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Salinity
Station=6
Depth (m)
0
-1
-2
-3
-4
-5
0
10
20
30
Salinity (ppt)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016



Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Salinity
Station=7
Depth (m)
0
-1
-2
-3
-4
-5
0
10
20
30
Salinity (ppt)
Date Sampled
09/14/2015
11/20/2015
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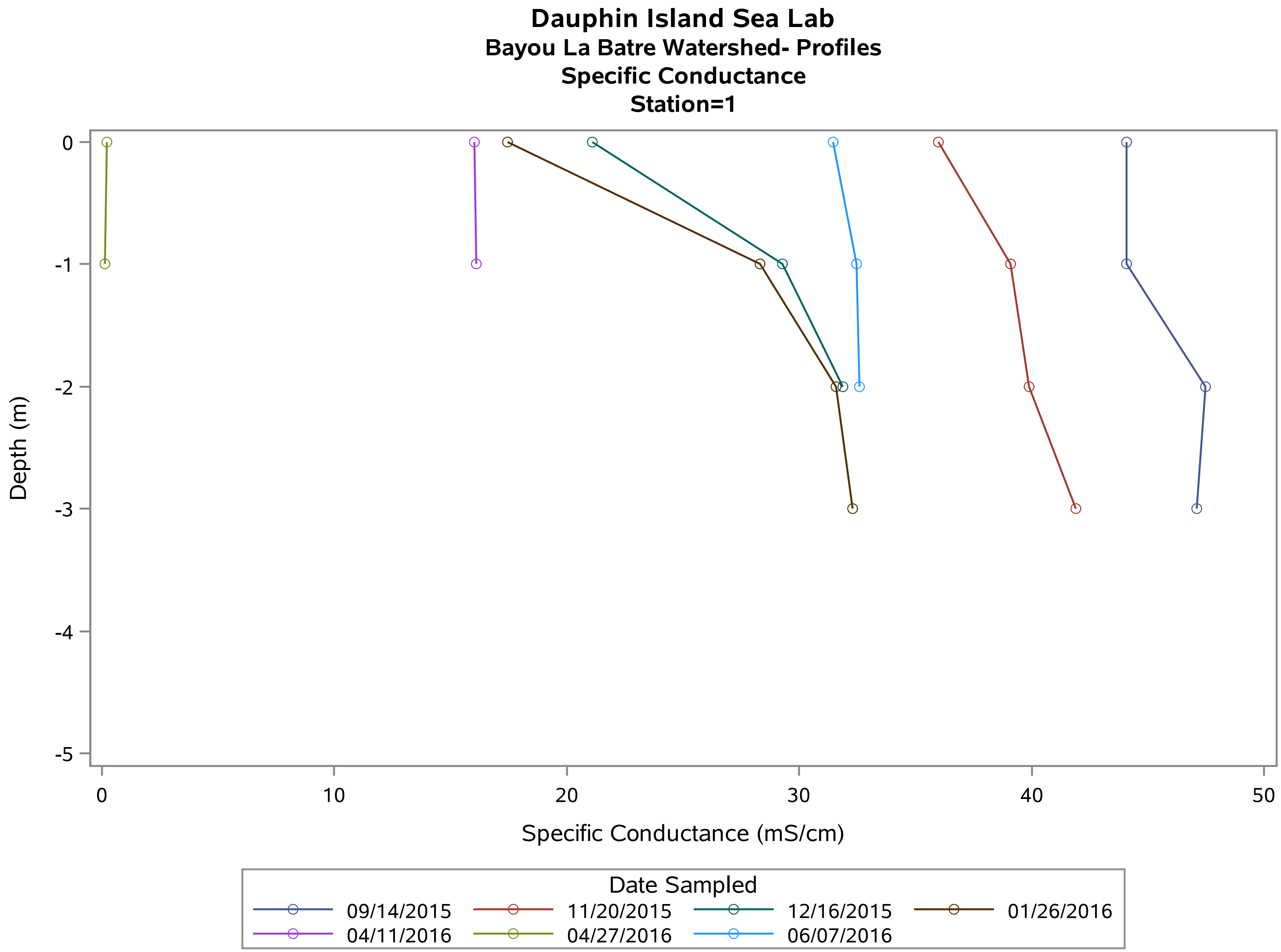
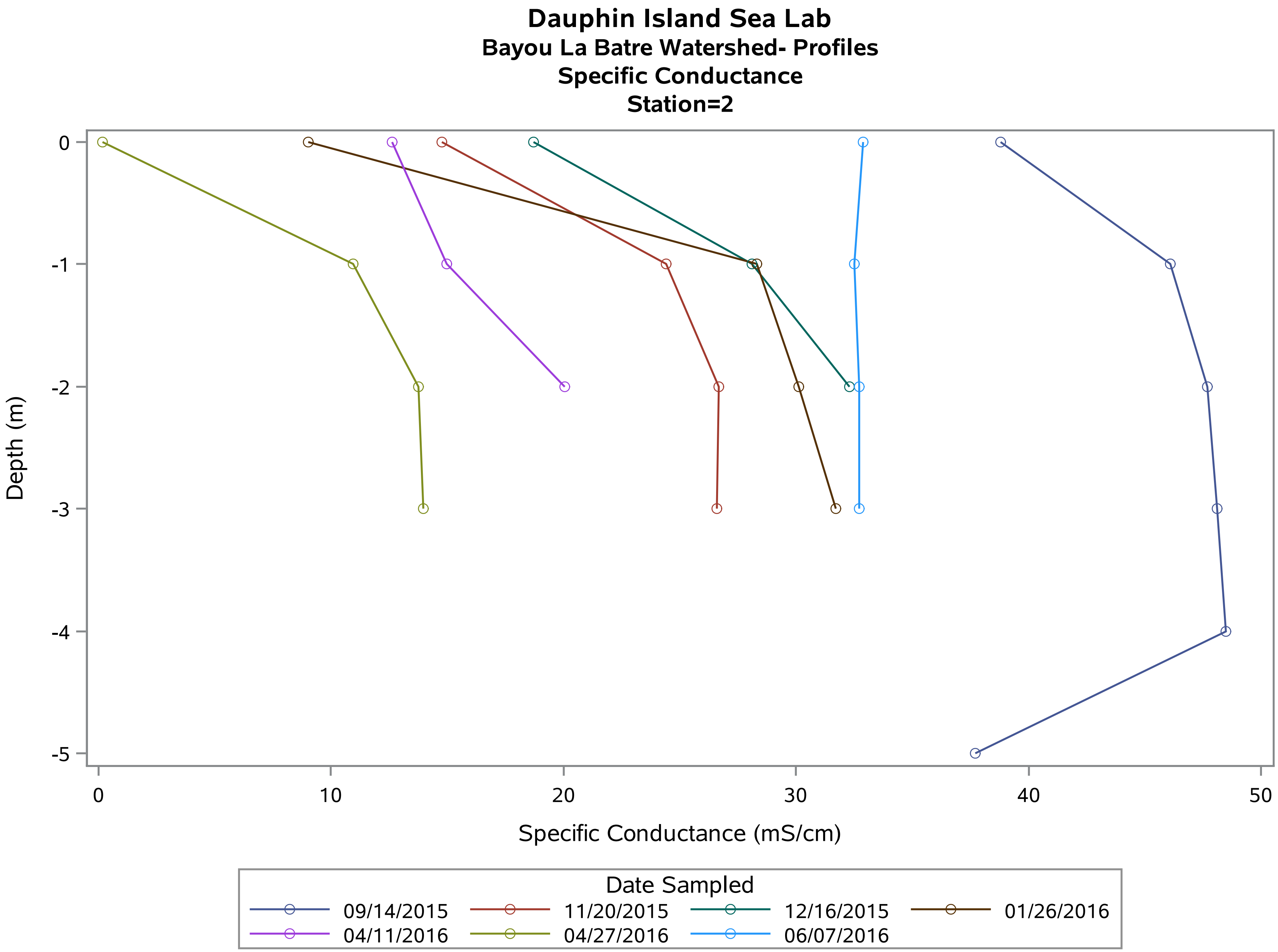
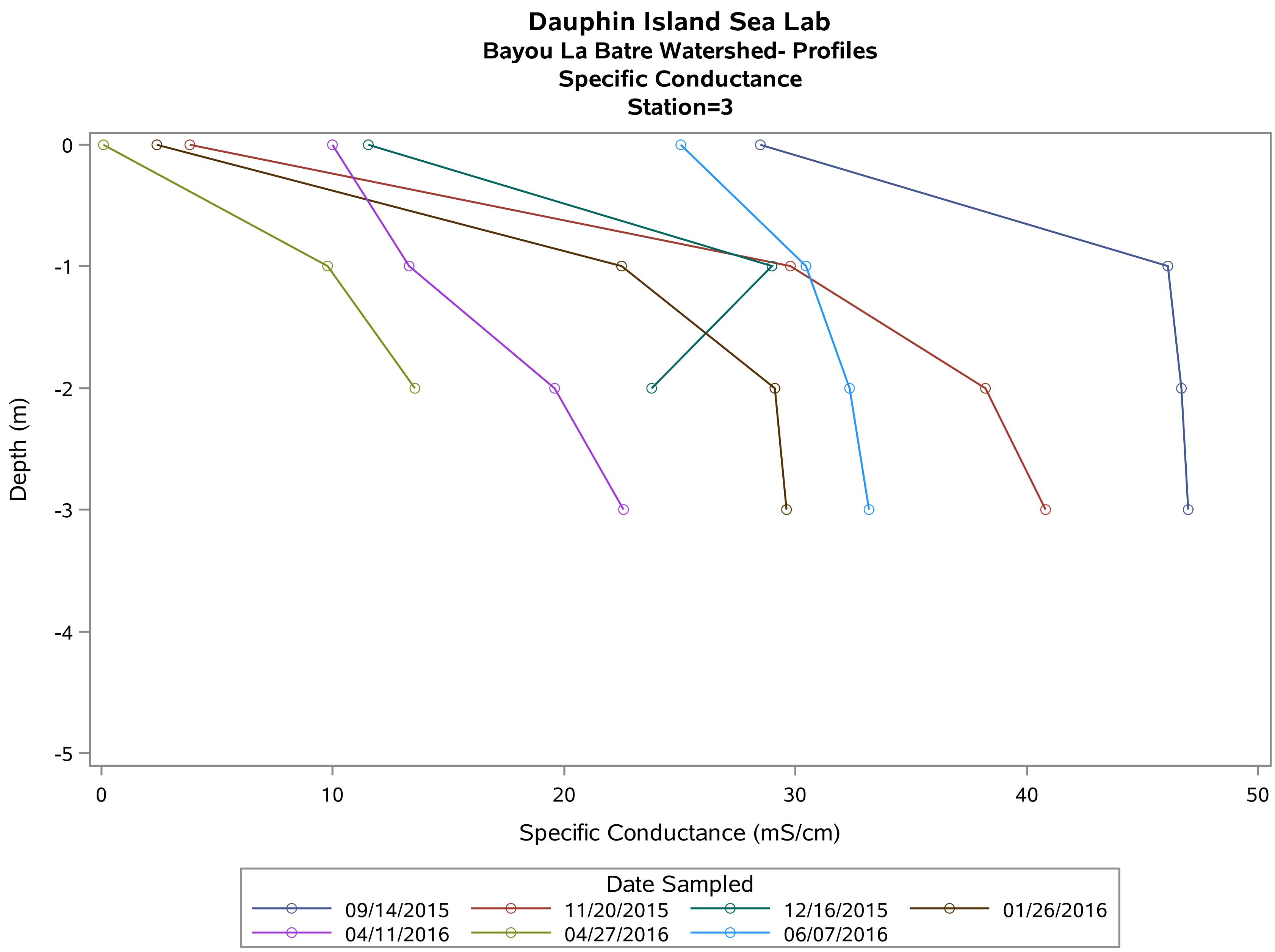
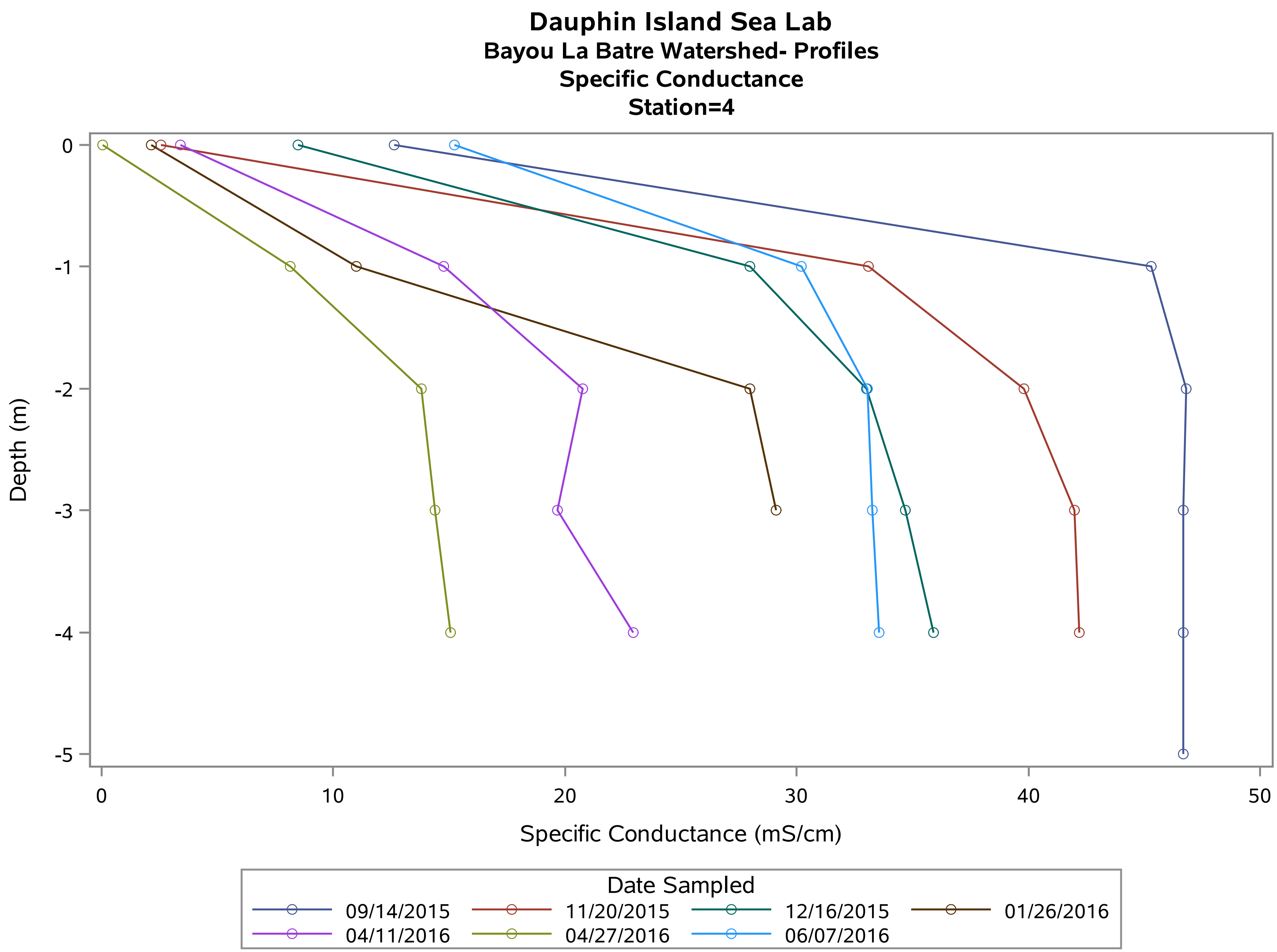
04/27/2016
06/07/2016

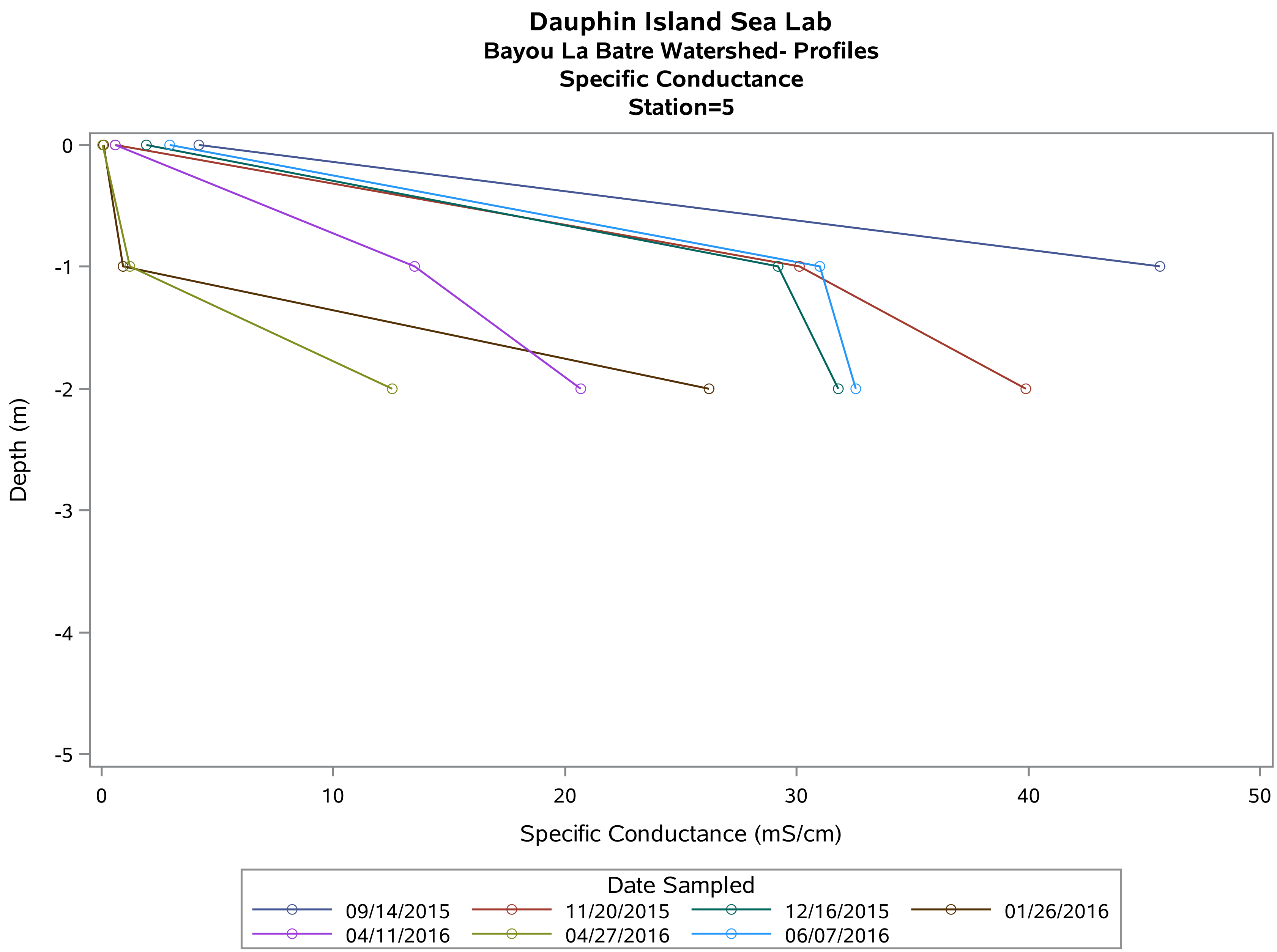

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Specific Conductance
Station=1
Depth (m)
0
-1
-2
-3
-4
-5
0
10
20
30
40
50
Specific Conductance (mS/cm)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

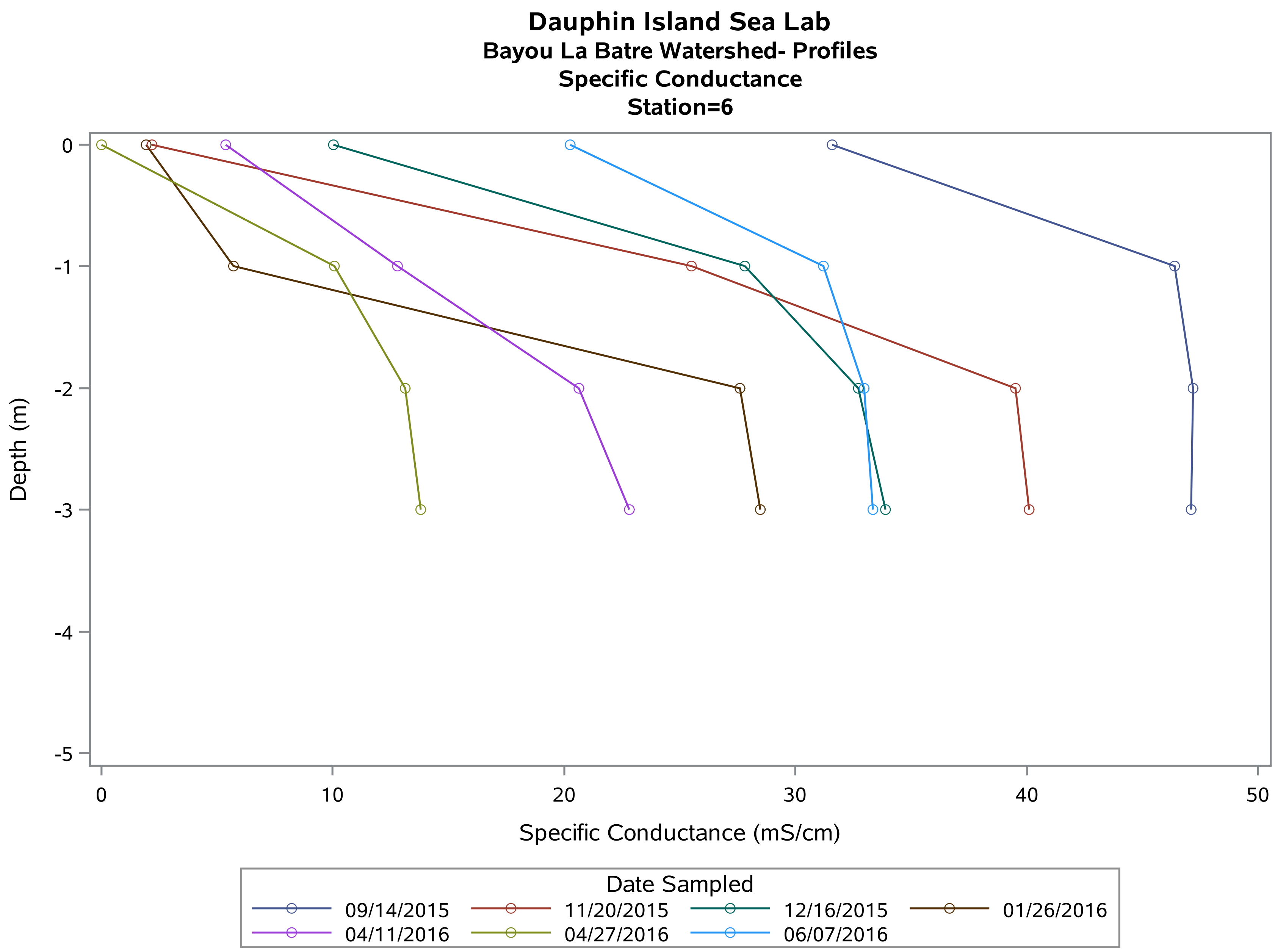


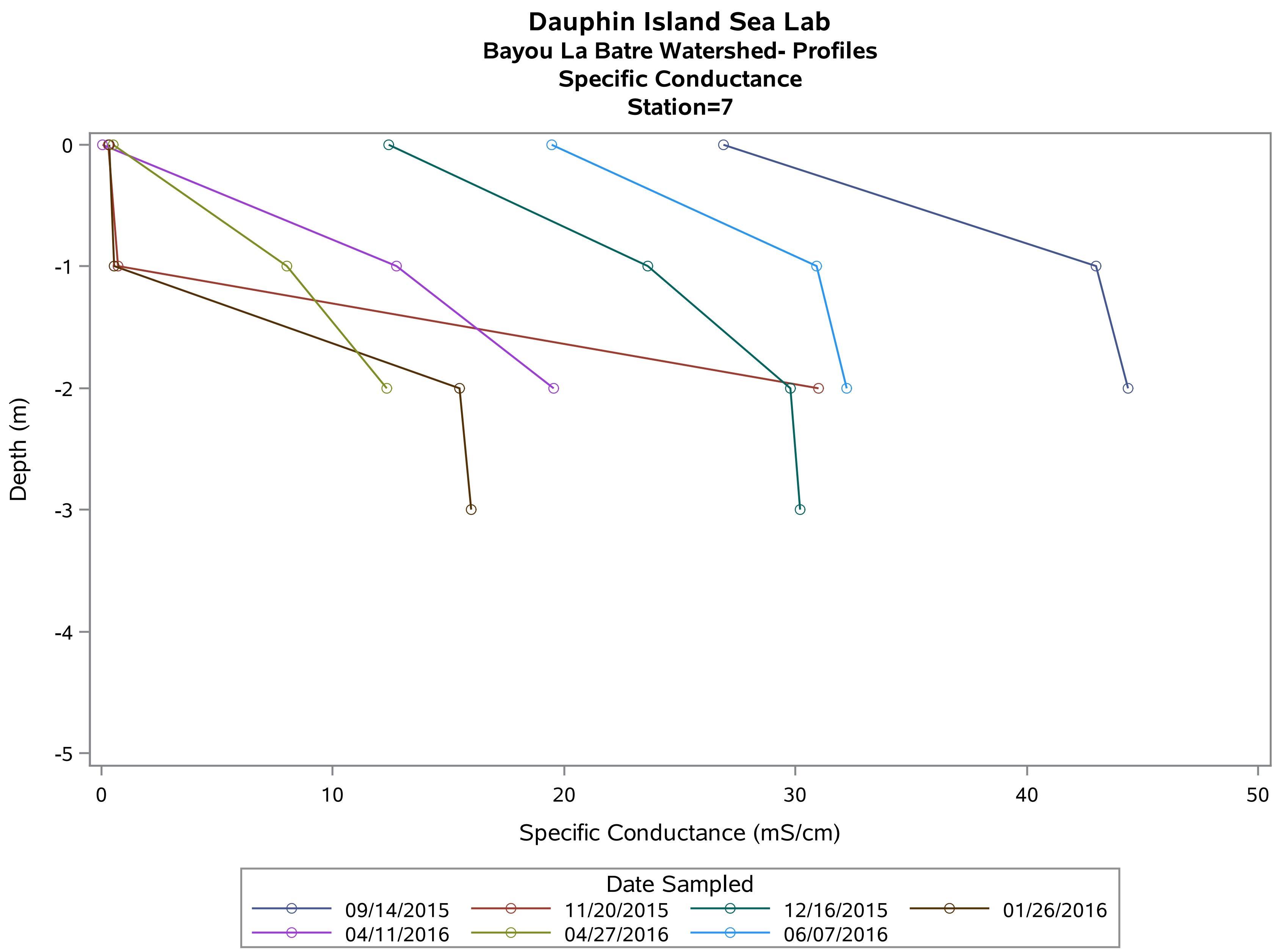
Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Specific Conductance
Station=2
Depth (m)
0
-1
-2
-3
-4
-5
0
10
20
30
40
50
Specific Conductance (mS/cm)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016


Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Specific Conductance
Station=3
Depth (m)
0
-1
-2
-3
-4
-5
0
10
20
30
40
50
Specific Conductance (mS/cm)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

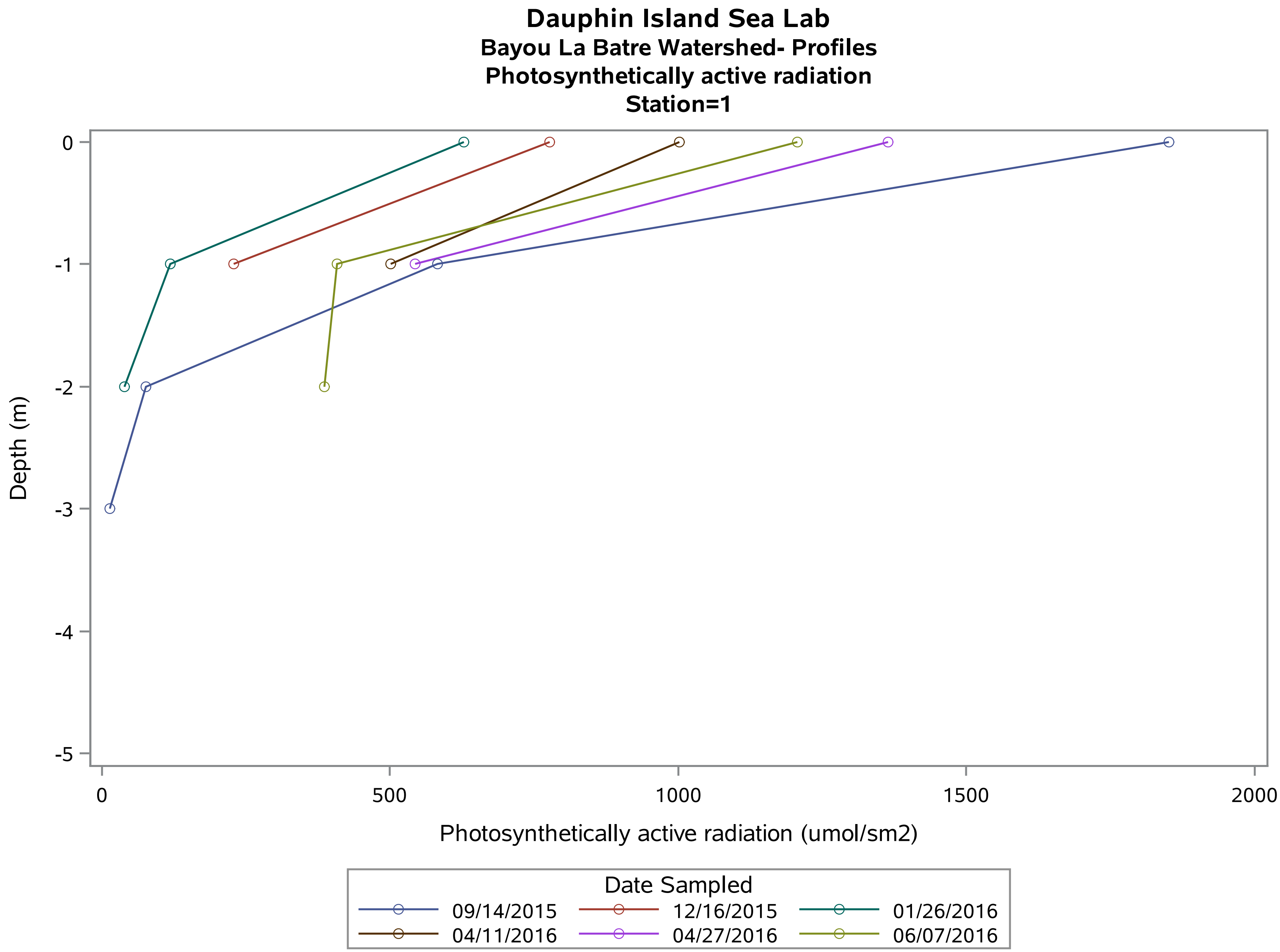

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Specific Conductance
Station=4
Depth (m)
0
-1
-2
-3
-4
-5
0
10
20
30
40
50
Specific Conductance (mS/cm)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

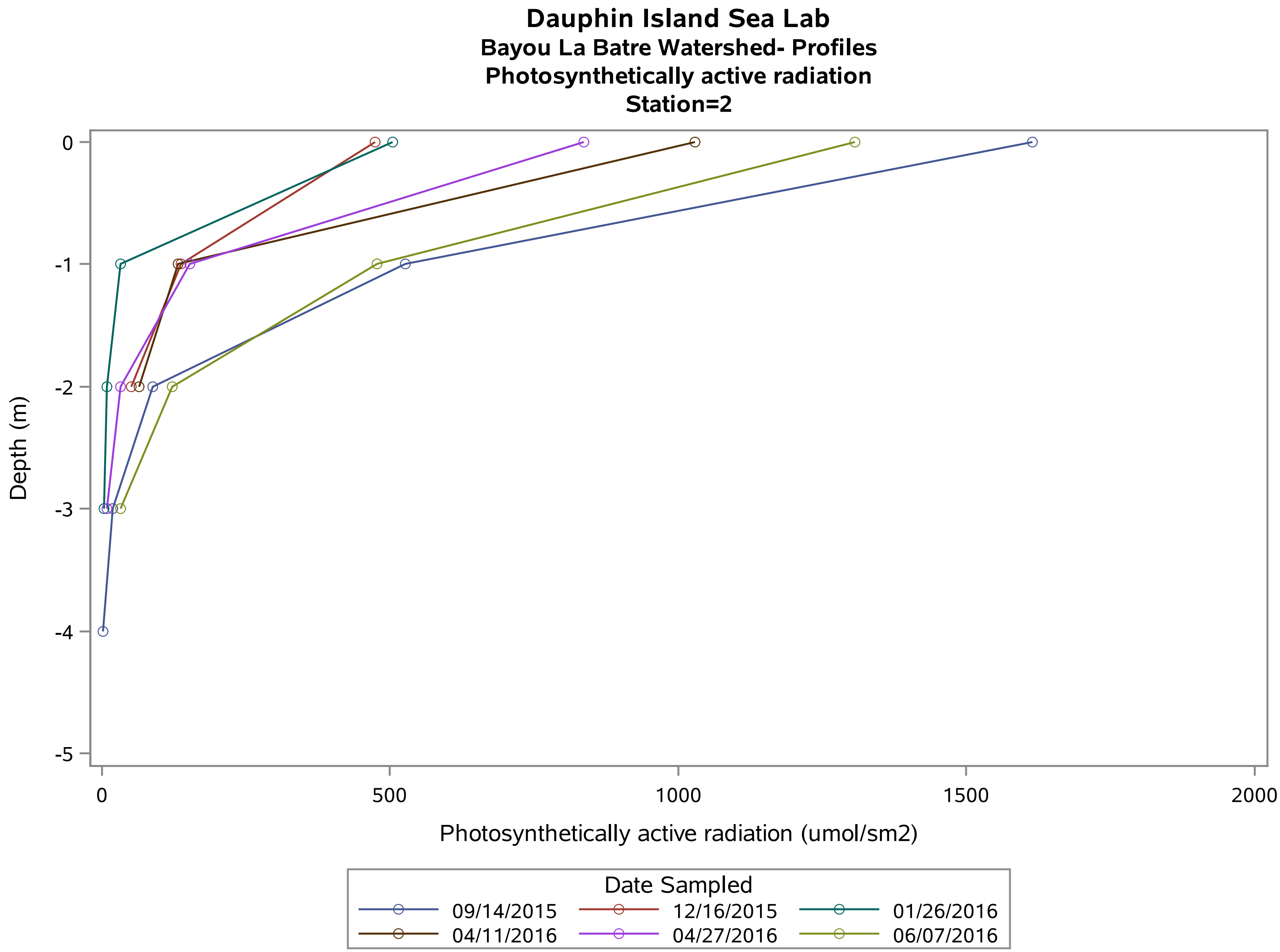

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Specific Conductance
Station=5
Depth (m)
0
-1
-2
-3
-4
-5
0
10
20
30
40
50
Specific Conductance (mS/cm)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

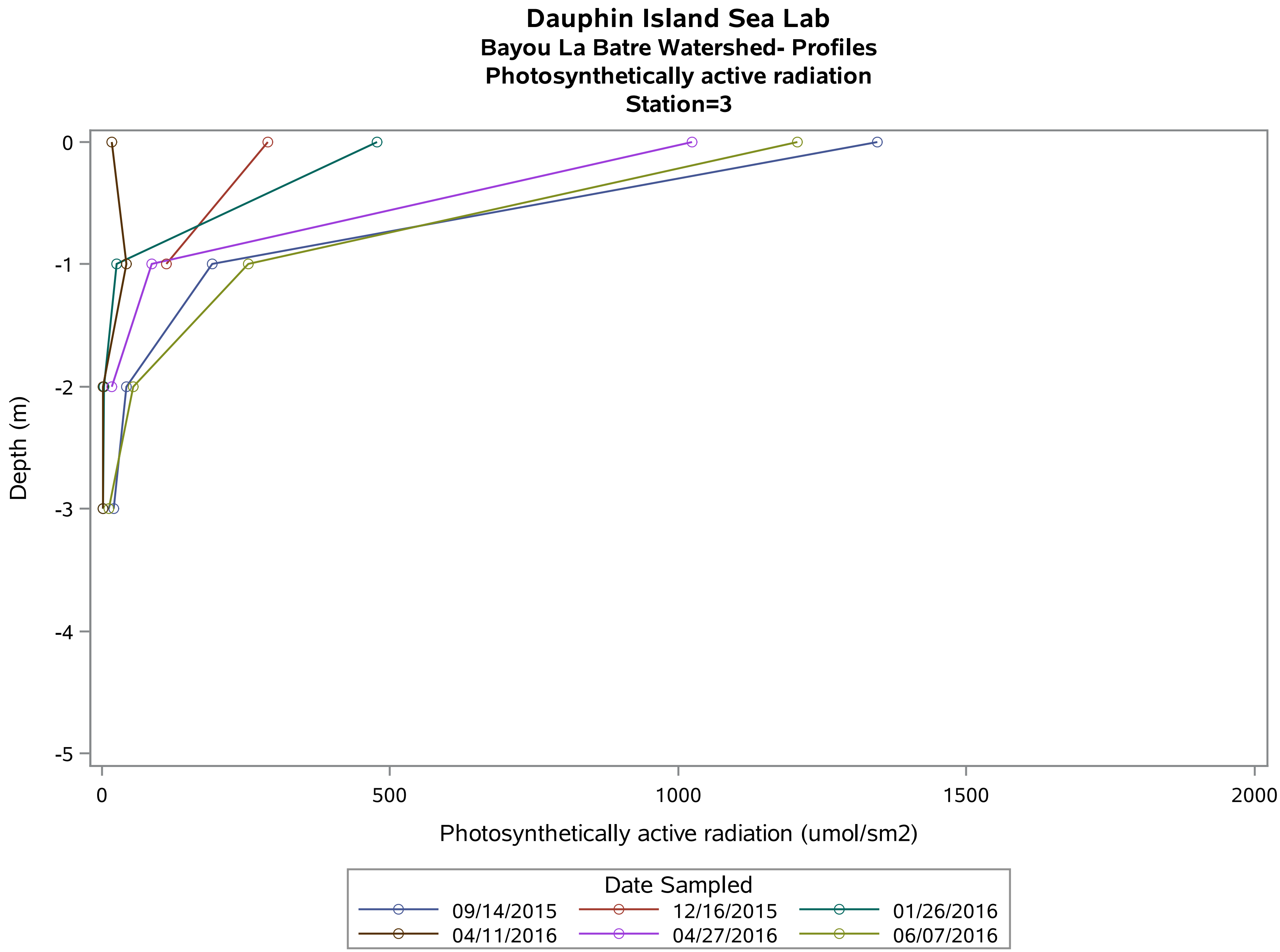

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Specific Conductance
Station=6
Depth (m)
0
-1
-2
-3
-4
-5
0
10
20
30
40
50
Specific Conductance (mS/cm)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016



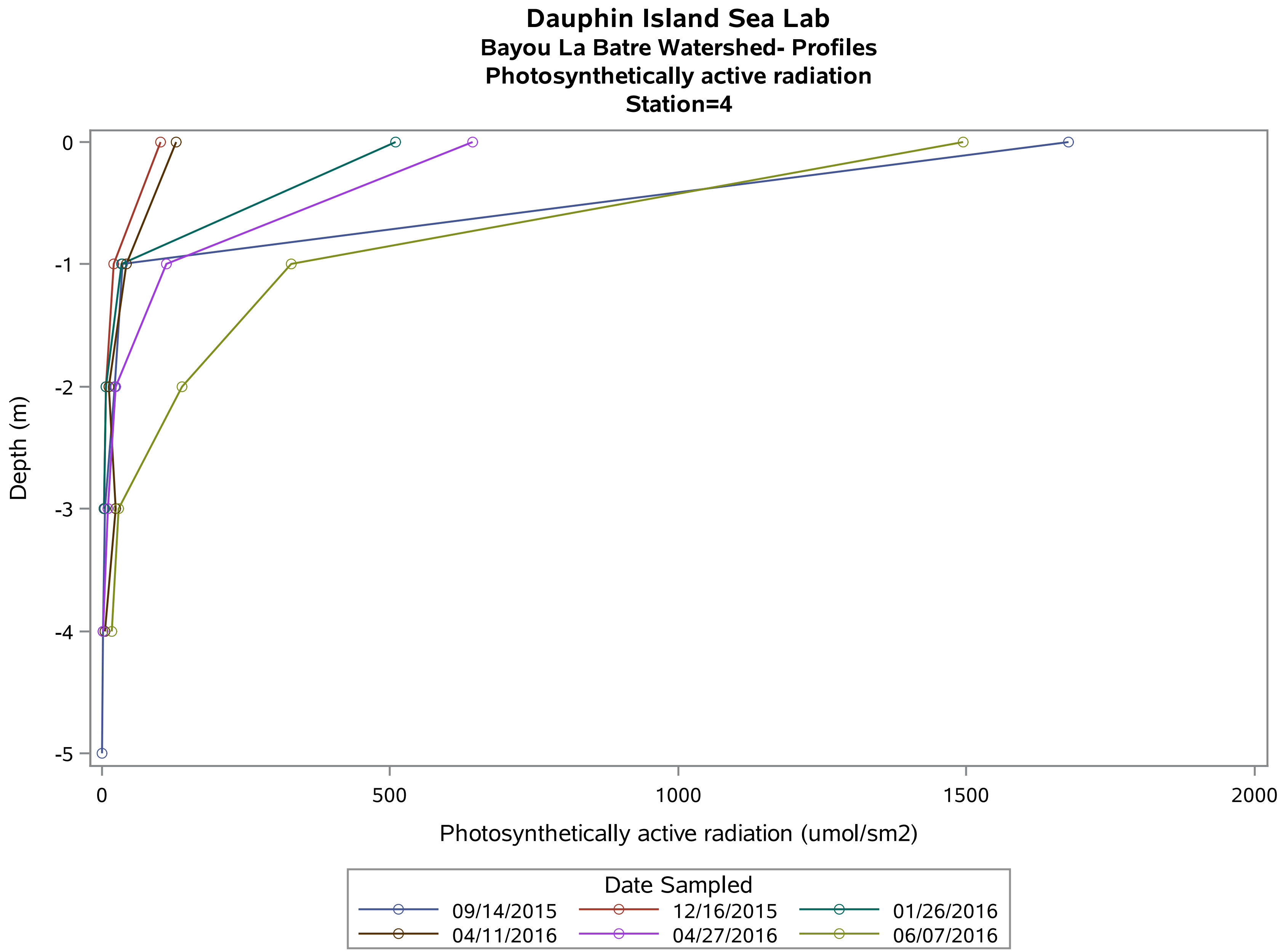
Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Specific Conductance
Station=7
Depth (m)
0
-1
-2
-3
-4
-5
0
10
20
30
40
50
Specific Conductance (mS/cm)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016


Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Photosynthetically active radiation
Station=1
Depth (m)
0
-1
-2
-3
-4
-5
0
500
1000
1500
2000
Photosynthetically active radiation (umol/sm2)
Date Sampled
09/14/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

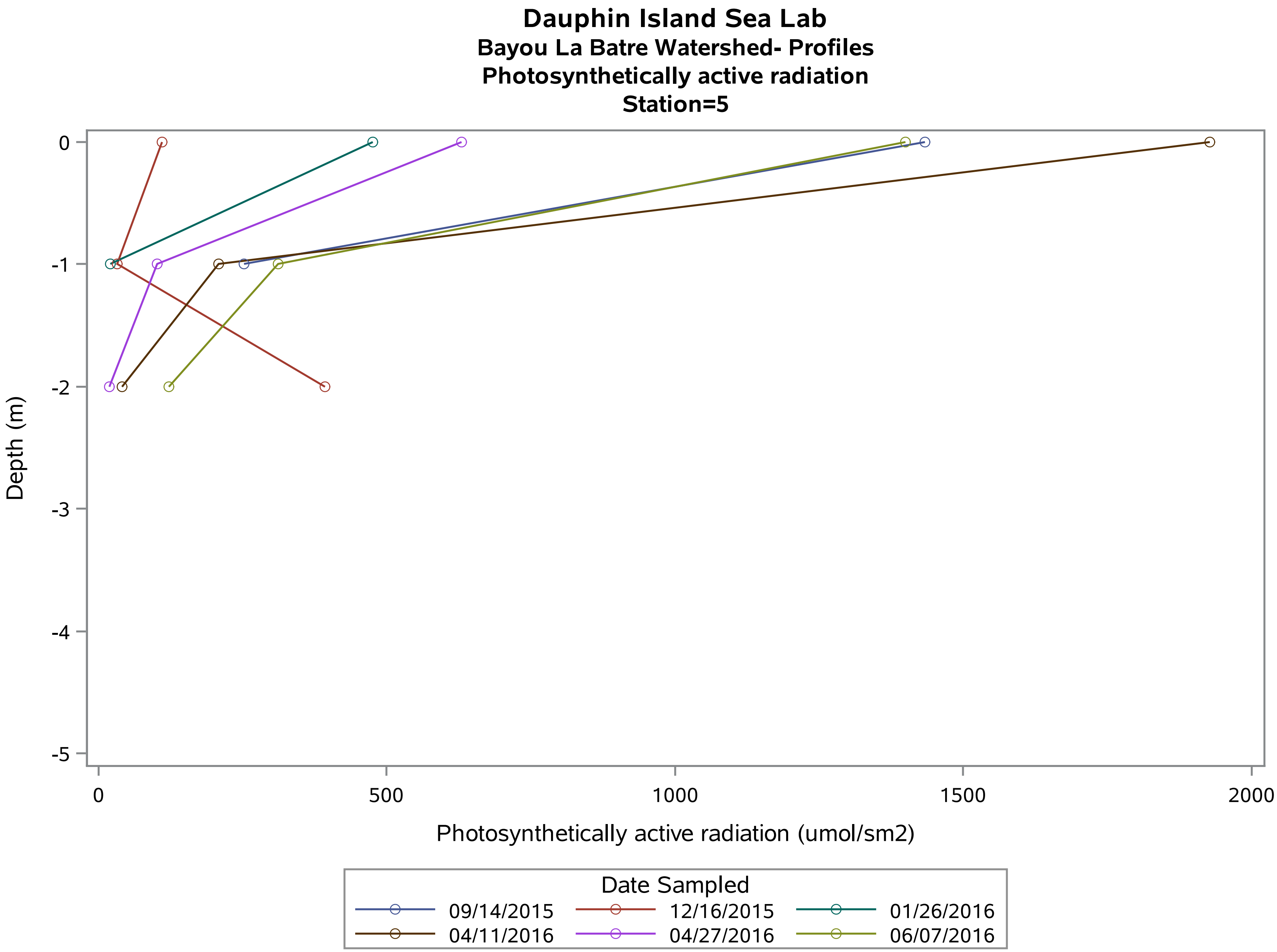

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Photosynthetically active radiation
Station=2
Depth (m)
0
-1
-2
-3
-4
-5
0
500
1000
1500
2000
Photosynthetically active radiation (umol/sm2)
Date Sampled
09/14/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016



Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Photosynthetically active radiation
Station=3
Depth (m)
0
-1
-2
-3
-4
-5
0
500
1000
1500
2000
Photosynthetically active radiation (umol/sm2)
Date Sampled
09/14/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

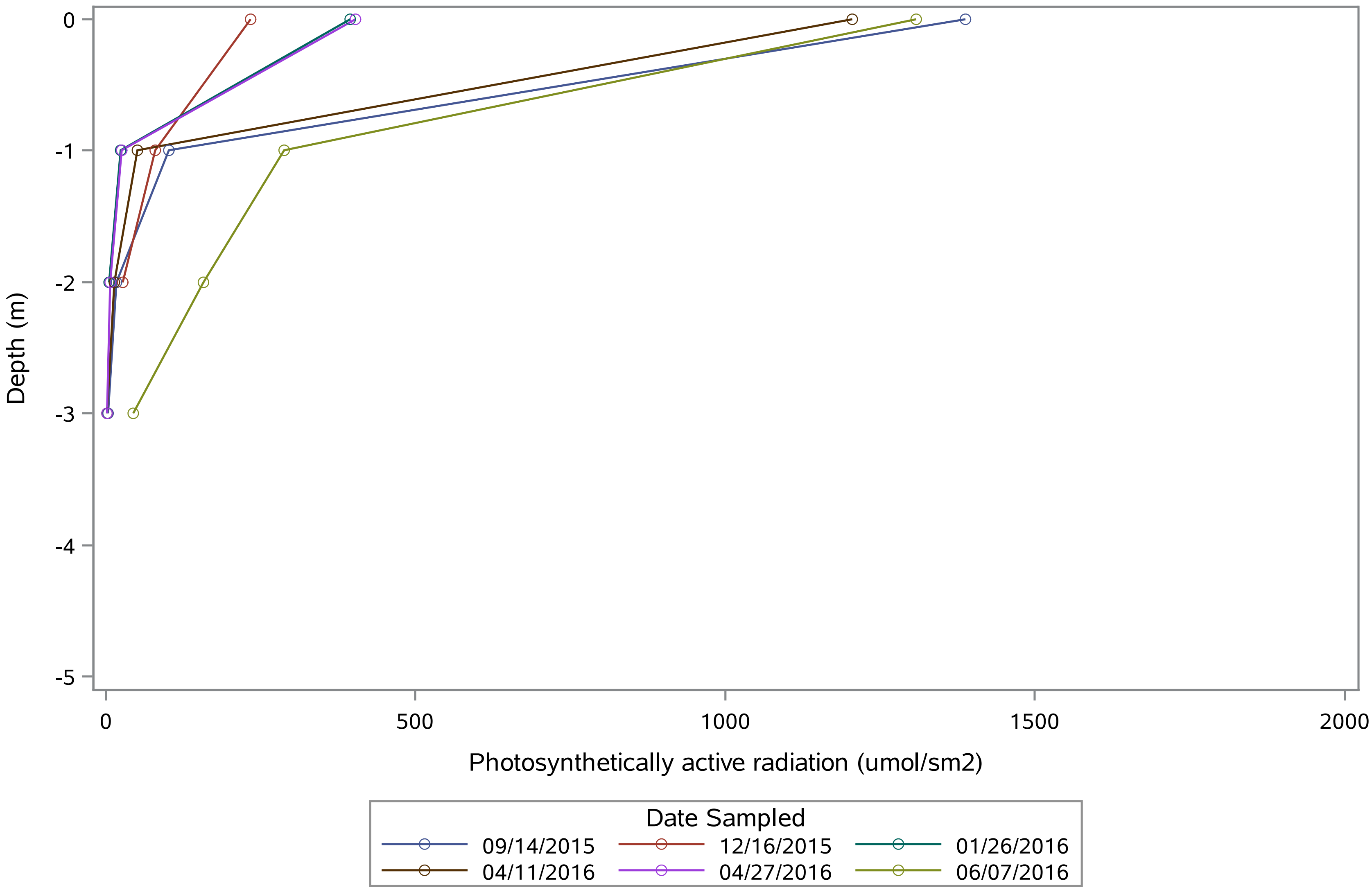


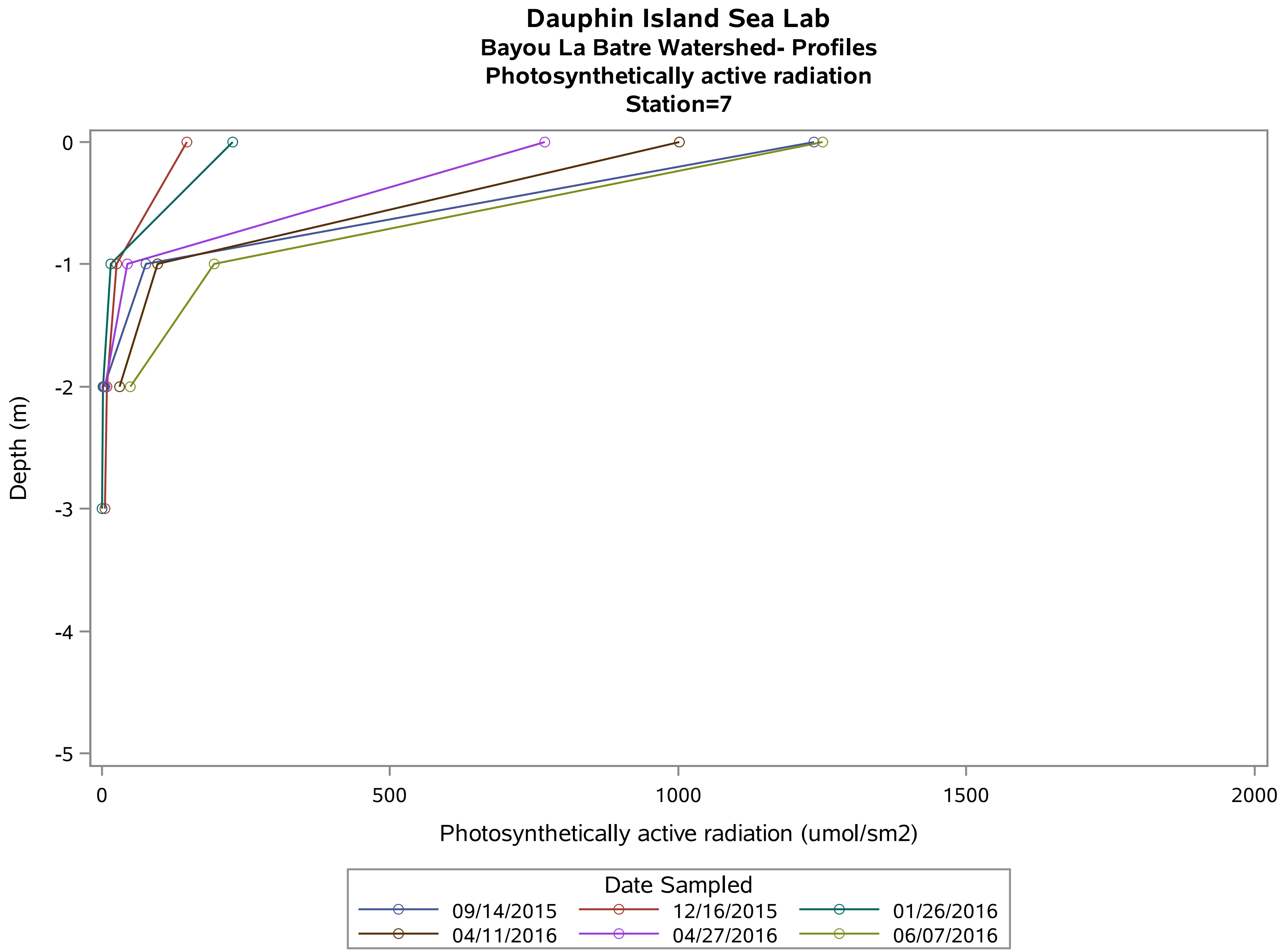
Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Photosynthetically active radiation
Station=4
Depth (m)
0
-1
-2
-3
-4
-5
0
500
1000
1500
2000
Photosynthetically active radiation (umol/sm2)
Date Sampled
09/14/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

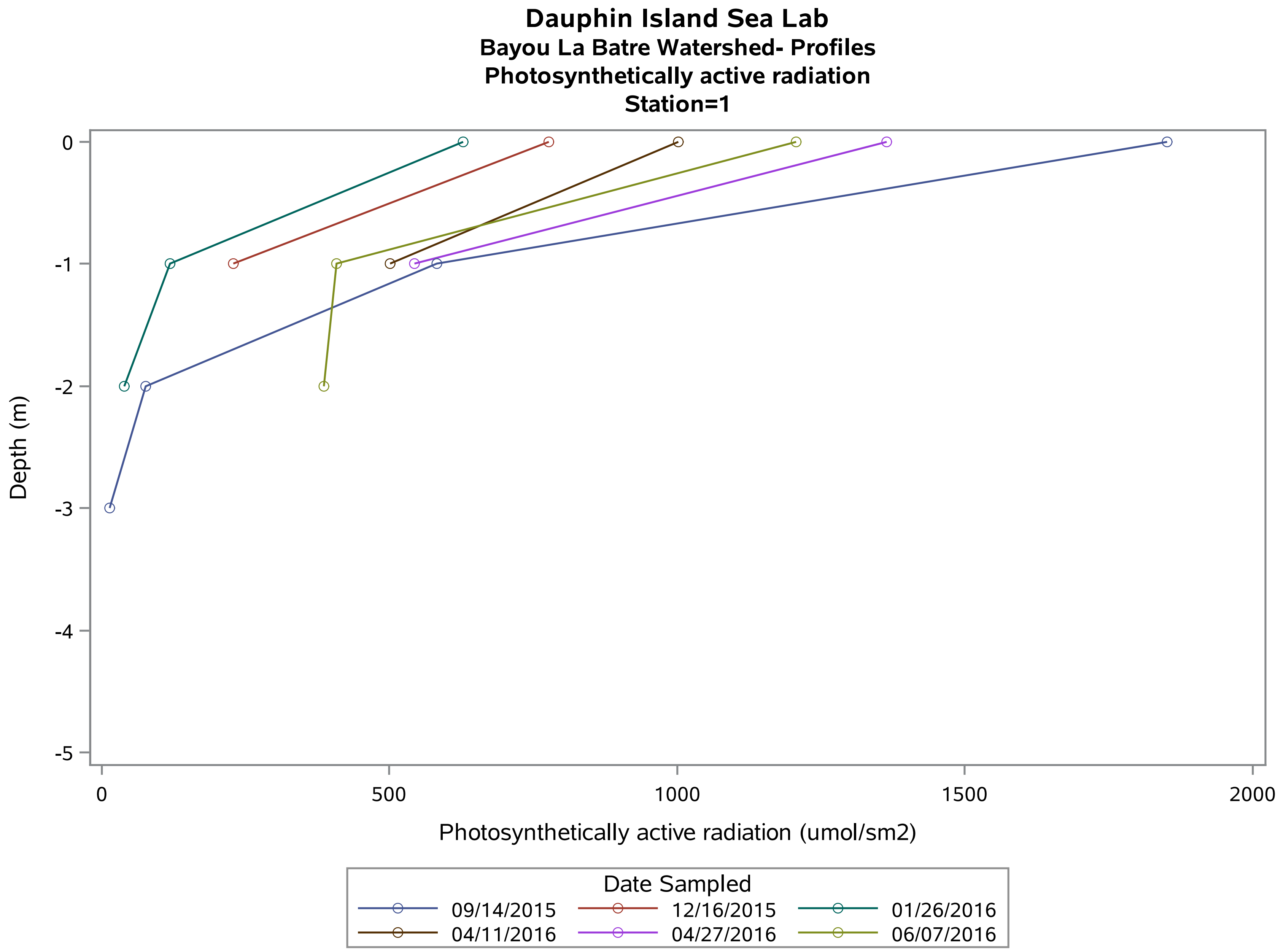


Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Photosynthetically active radiation
Station=5
Depth (m)
0
-1
-2
-3
-4
-5
0
500
1000
1500
2000
Photosynthetically active radiation (umol/sm2)
Date Sampled
09/14/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

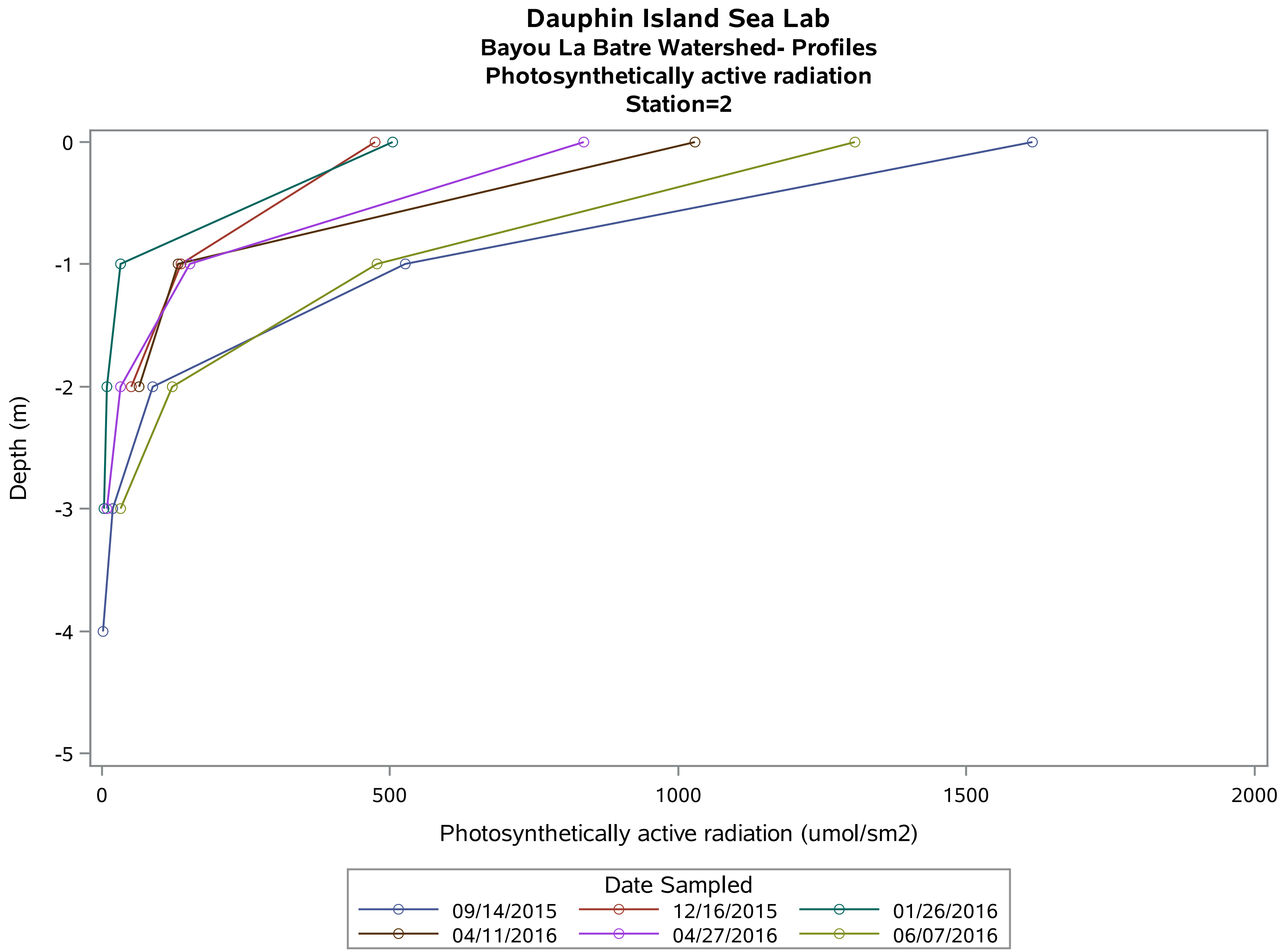
Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Photosynthetically active radiation
Station=6



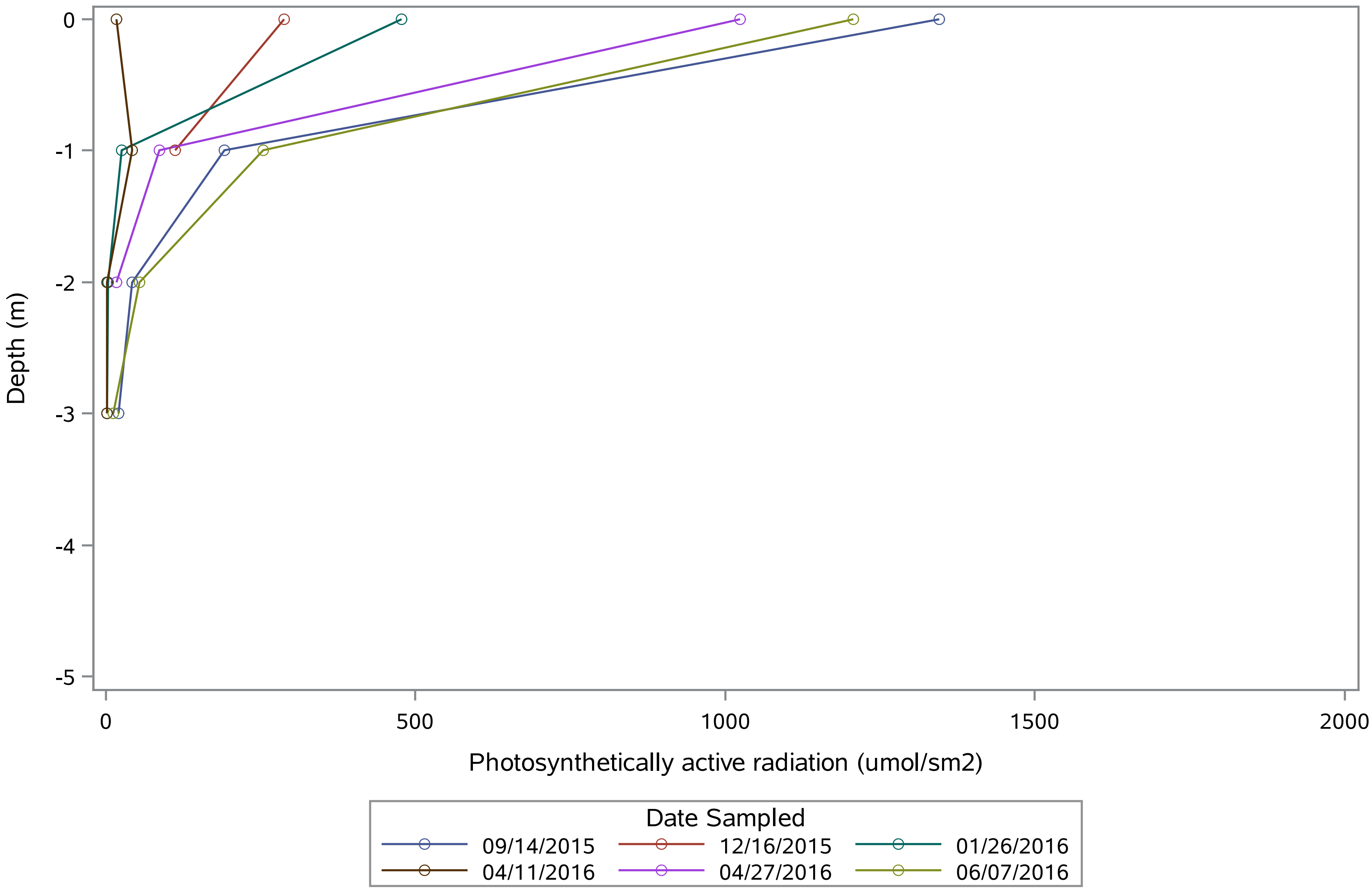

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Photosynthetically active radiation
Station=7
Depth (m)
0
-1
-2
-3
-4
-5
0
500
1000
1500
2000
Photosynthetically active radiation (umol/sm2)
Date Sampled
09/14/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016



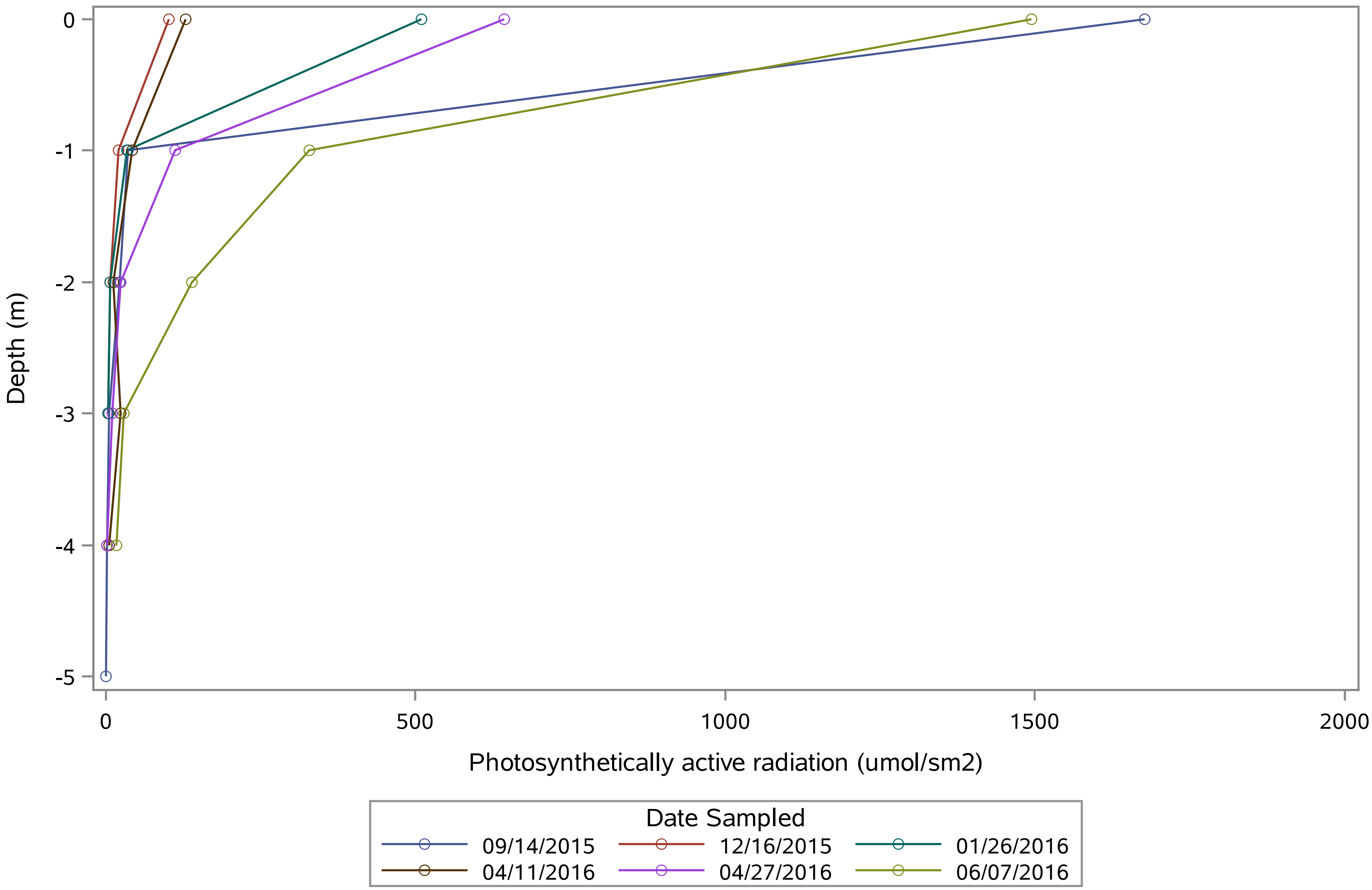
Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Photosynthetically active radiation
Station=1
Depth (m)
0
-1
-2
-3
-4
-5
0
500
1000
1500
2000
Photosynthetically active radiation (umol/sm2)
Date Sampled
09/14/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

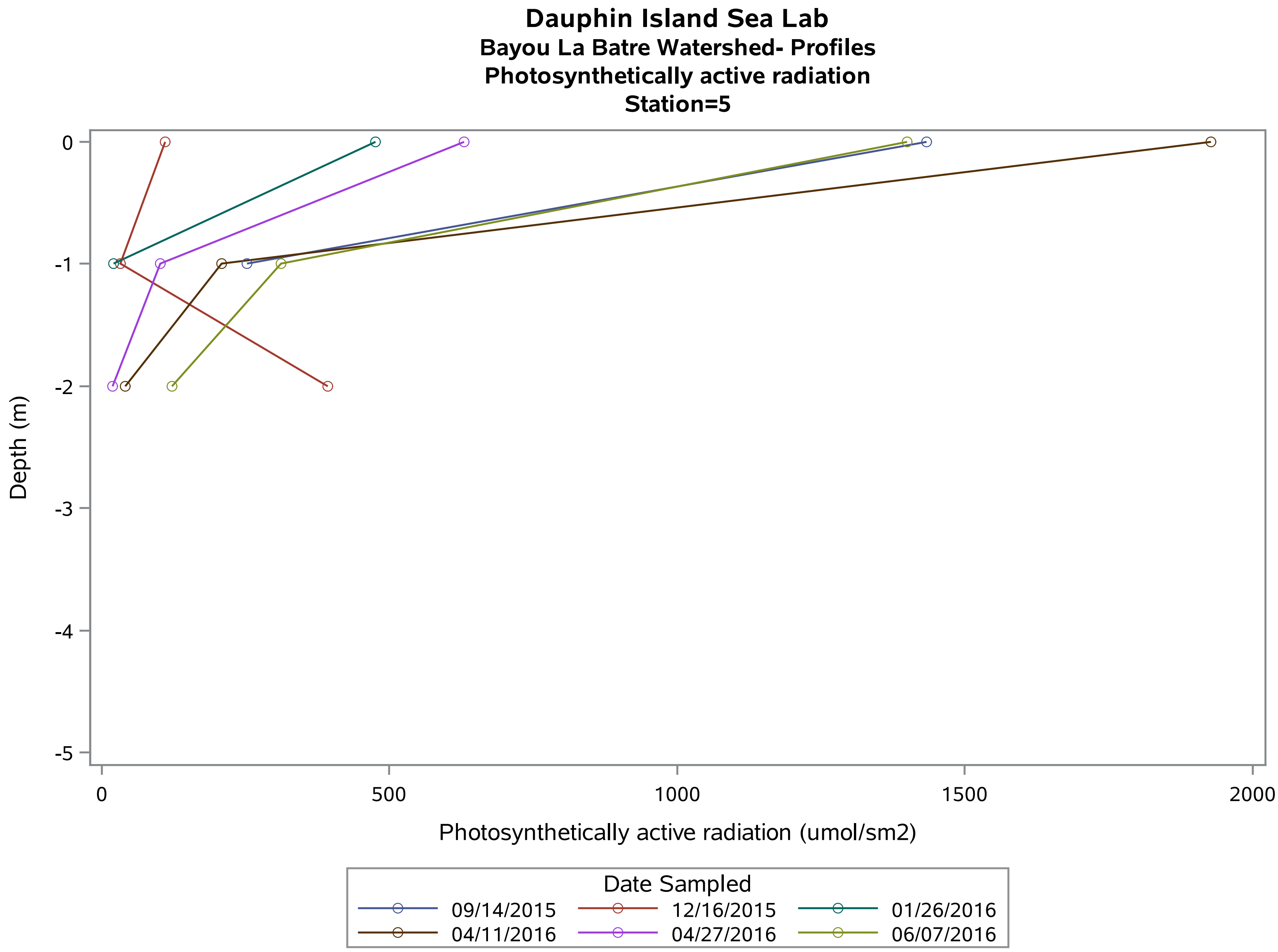

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Photosynthetically active radiation
Station=2
Depth (m)
0
-1
-2
-3
-4
-5
0
500
1000
1500
2000
Photosynthetically active radiation (umol/sm2)
Date Sampled
09/14/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Photosynthetically active radiation
Station=3

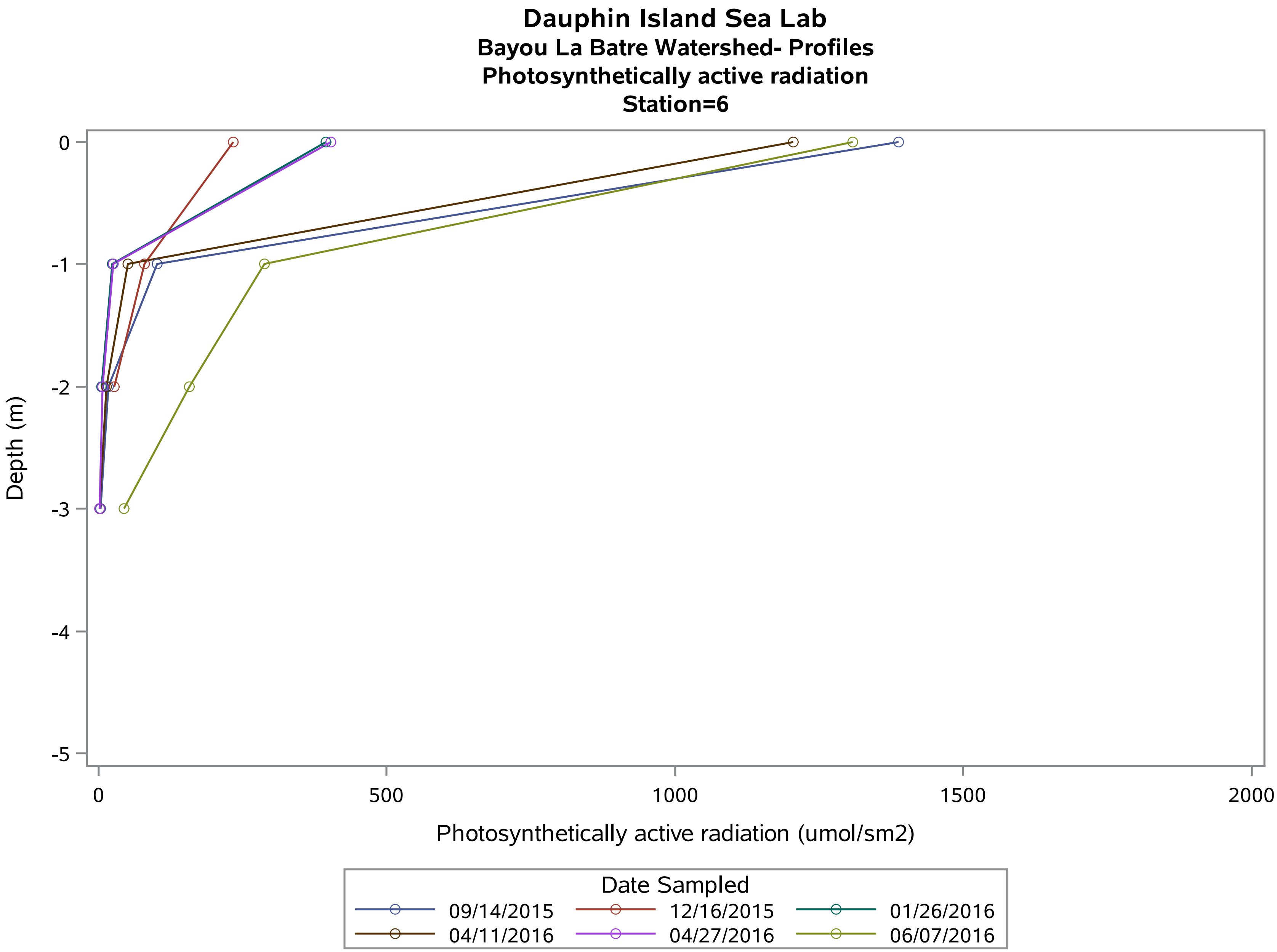


Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Photosynthetically active radiation
Station=4

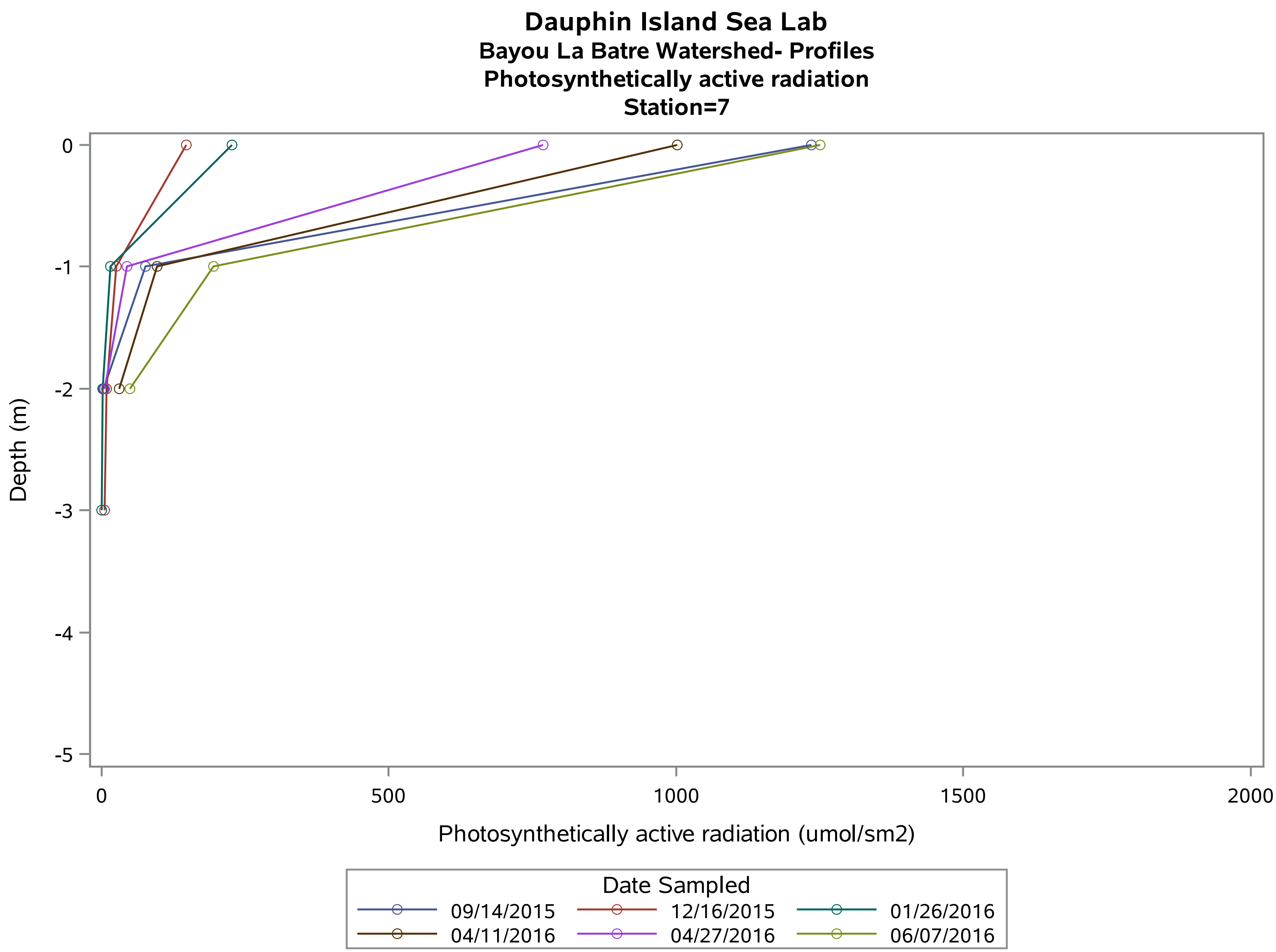




Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Photosynthetically active radiation
Station=5
0
-1
-2
-3
-4
-5
Depth (m)
0
500
1000
1500
2000
Photosynthetically active radiation (umol/sm2)
Date Sampled
09/14/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016



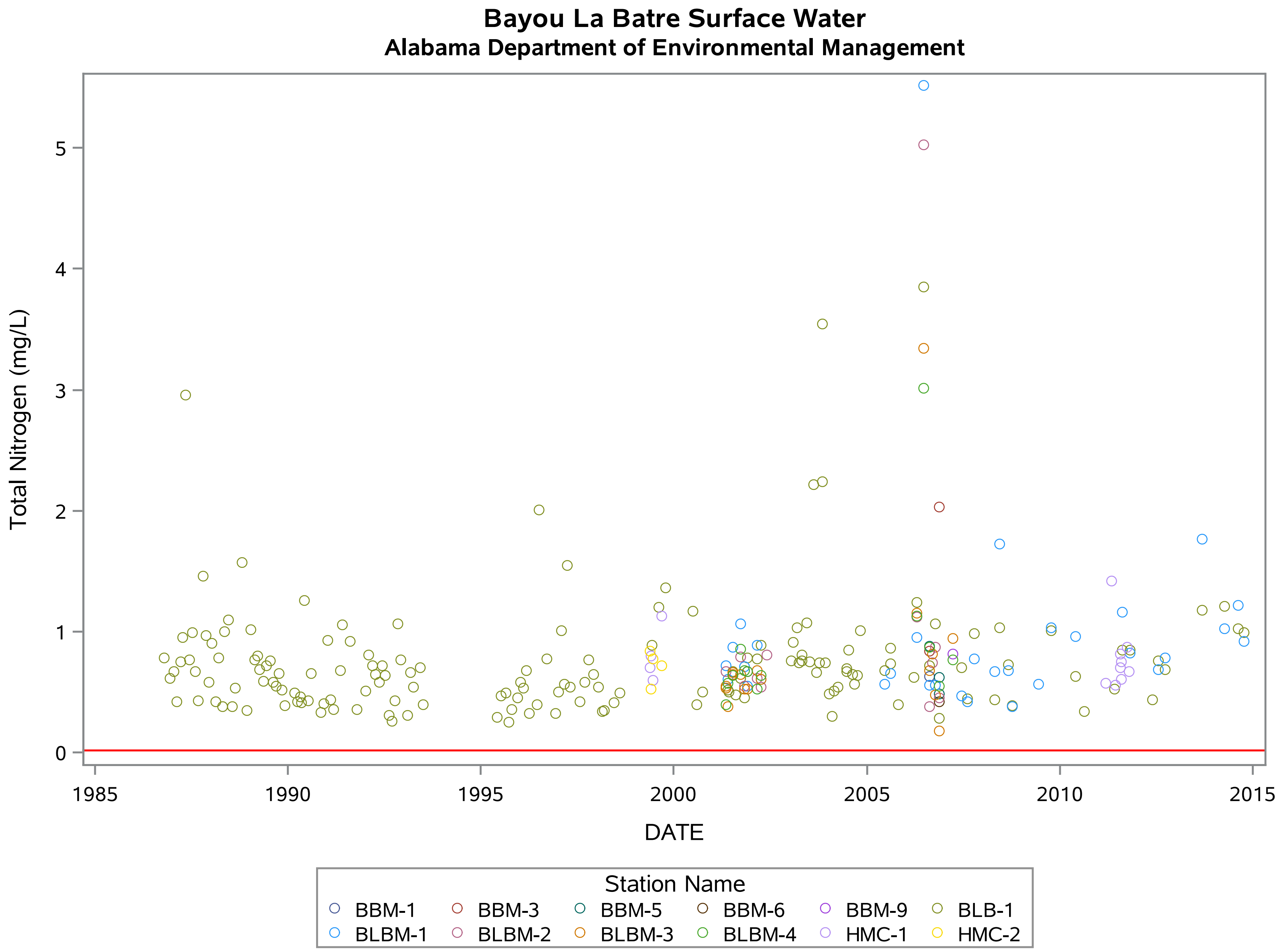
Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Photosynthetically active radiation
Station=6
Depth (m)
0
-1
-2
-3
-4
-5
0
500
1000
1500
2000
Photosynthetically active radiation (umol/sm2)
Date Sampled
09/14/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016



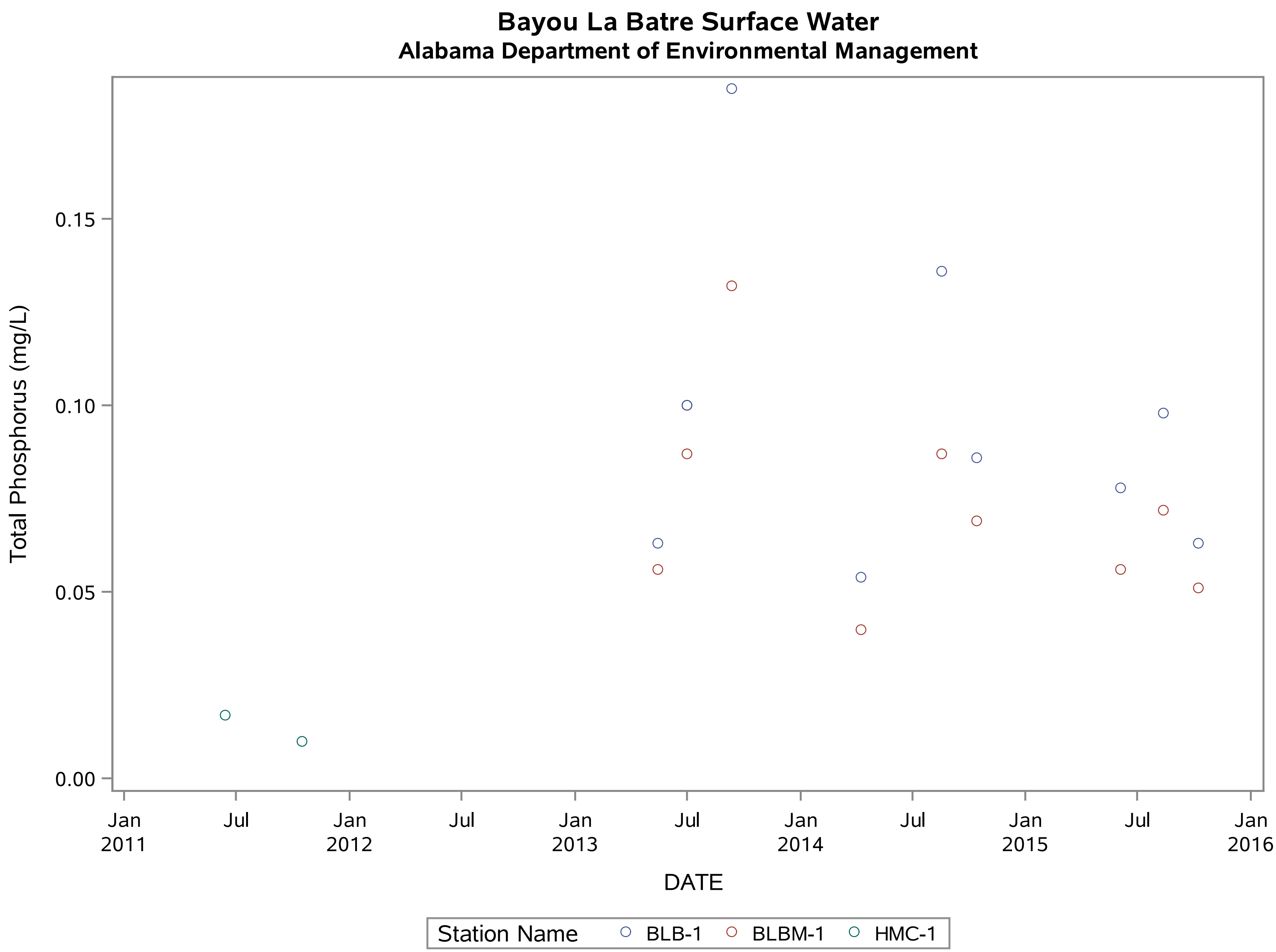
Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Photosynthetically active radiation
Station=7
Depth (m)
0
-1
-2
-3
-4
-5
0
500
1000
1500
2000
Photosynthetically active radiation (umol/sm2)
Date Sampled
09/14/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

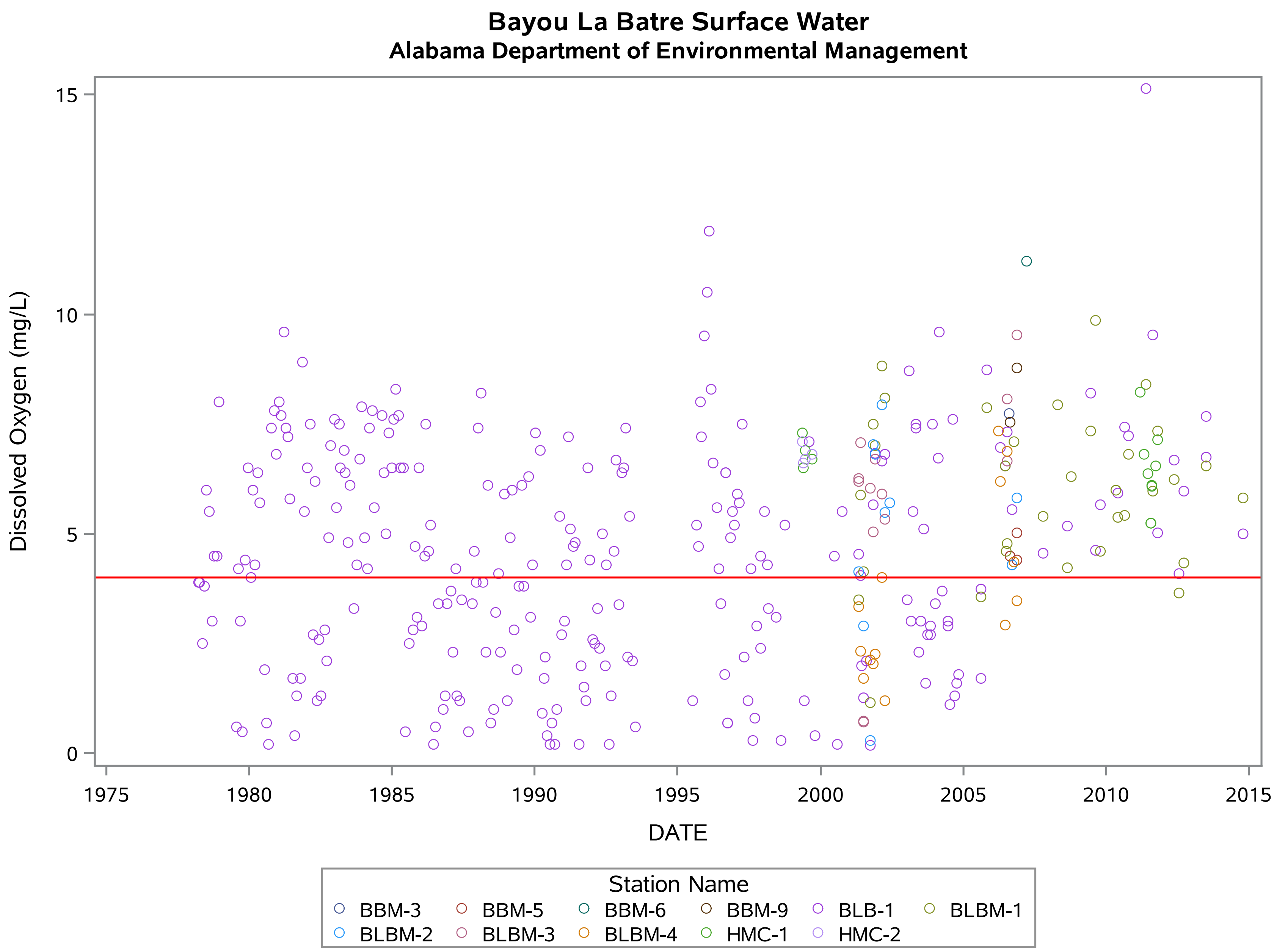
APPENDIX A ADEM RAW DATA

Bayou La Batre Surface Water
Alabama Department of Environmental Management
Chlorophyll a (ug/L)
0
10
20
30
40
50
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
DATE
Station Name
BBM-1
BBM-3
BBM-5
BBM-6
BBM-9
BLB-1
BLBM-1
BLBM-2
BLBM-3
BLBM-4
HMC-1

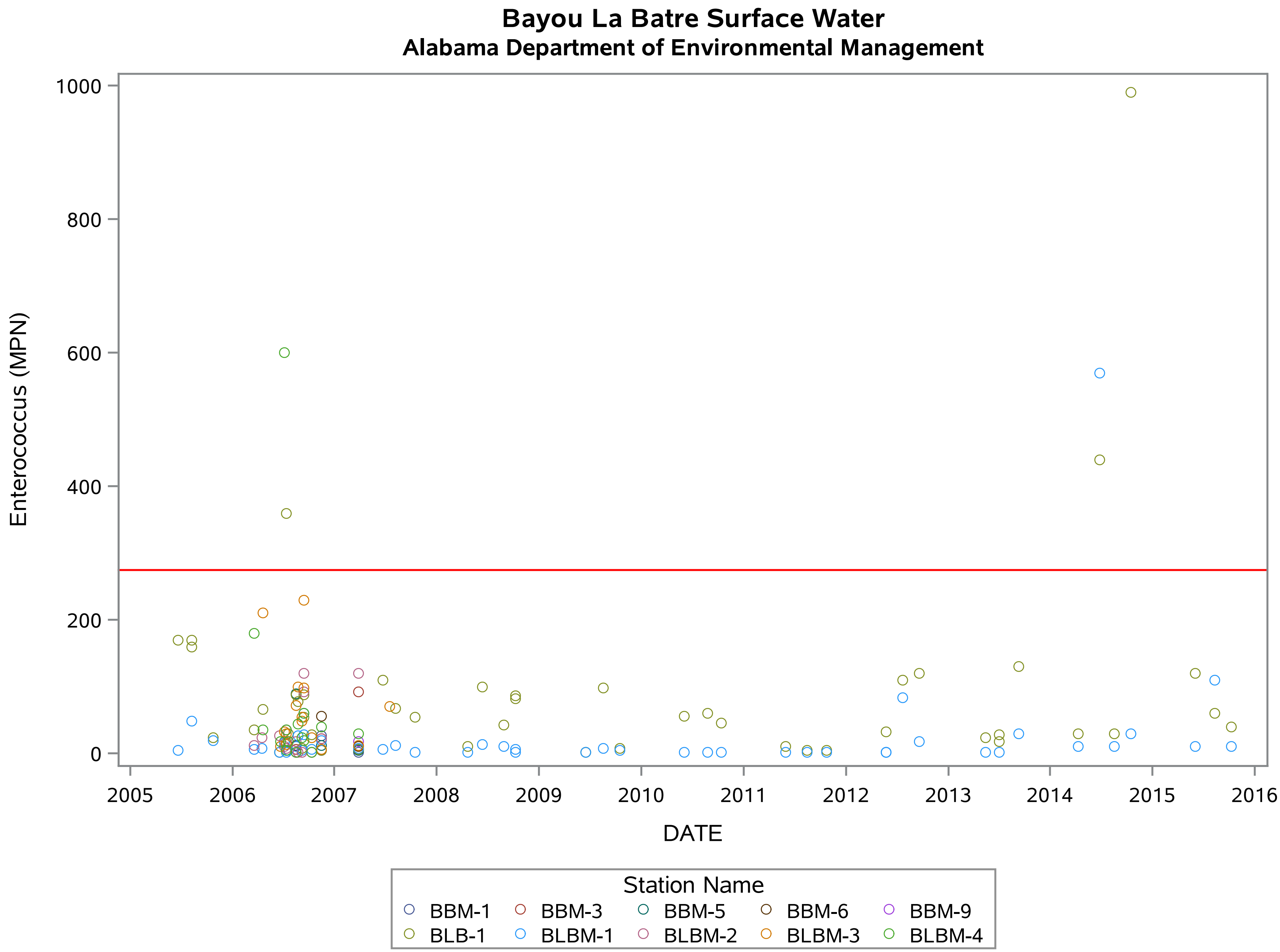


Bayou La Batre Surface Water
Alabama Department of Environmental Management
Total Nitrogen (mg/L)
0
1
2
3
4
5
1985
1990
1995
2000
2005
2010
2015
DATE
Station Name
BBM-1
BBM-3
BBM-5
BBM-6
BBM-9
BLB-1
BLBM-1
BLBM-2
BLBM-3
BLBM-4
HMC-1
HMC-2

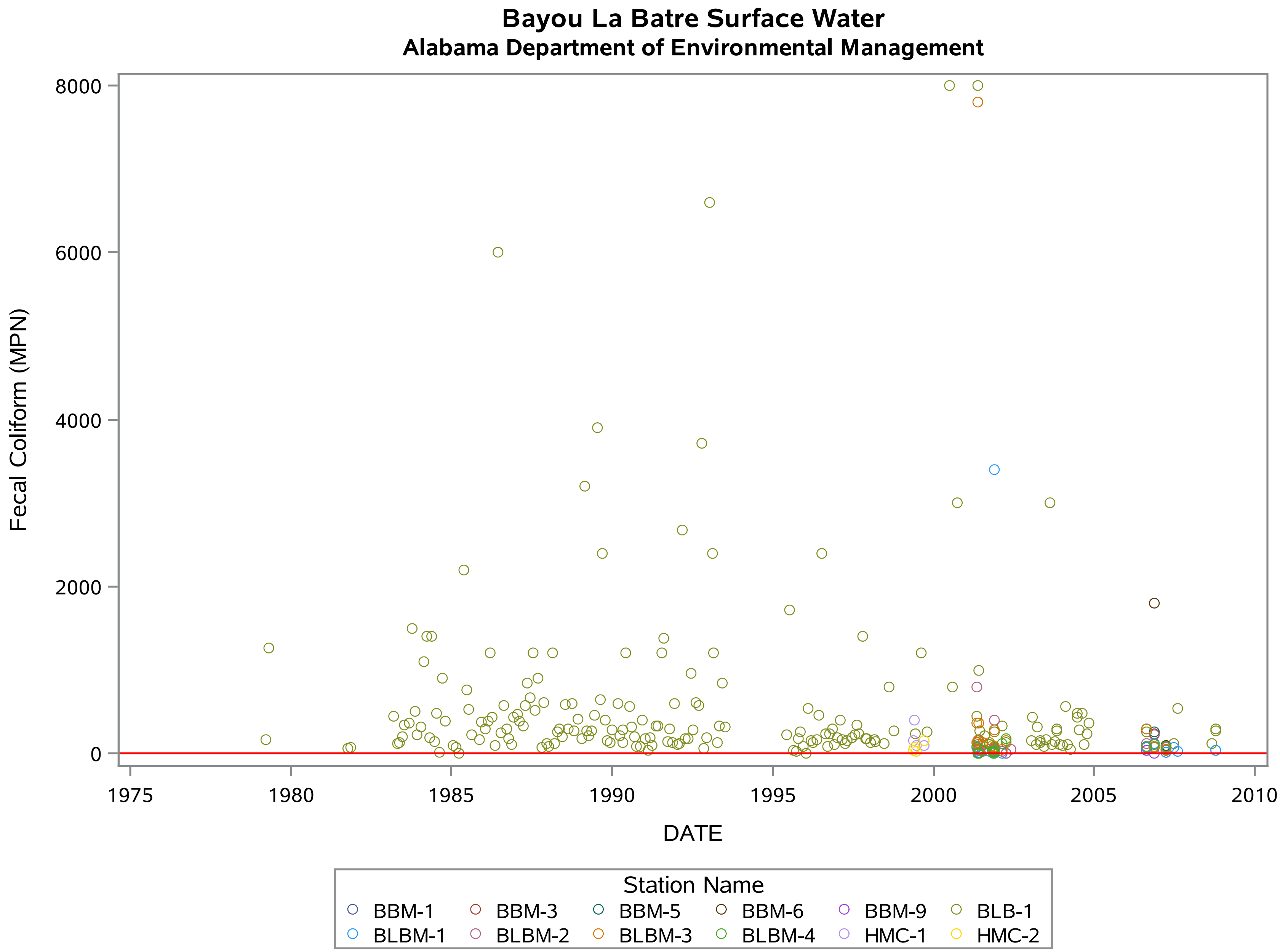

Bayou La Batre Surface Water
Alabama Department of Environmental Management
Total Phosphorus (mg/L)
0.15
0.10
0.05
0.00
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
DATE
Station Name
BLB-1
BLBM-1
HMC-1

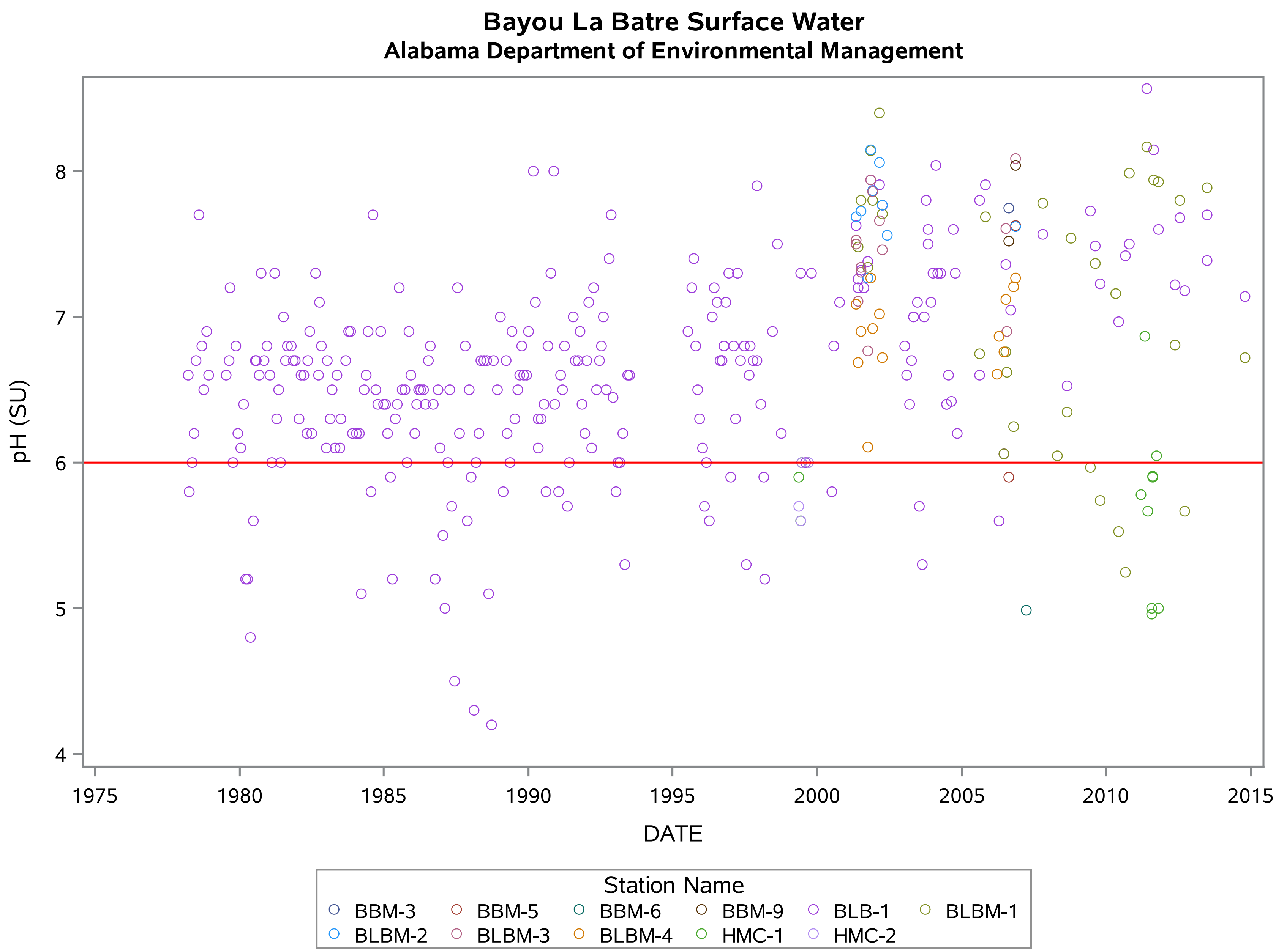


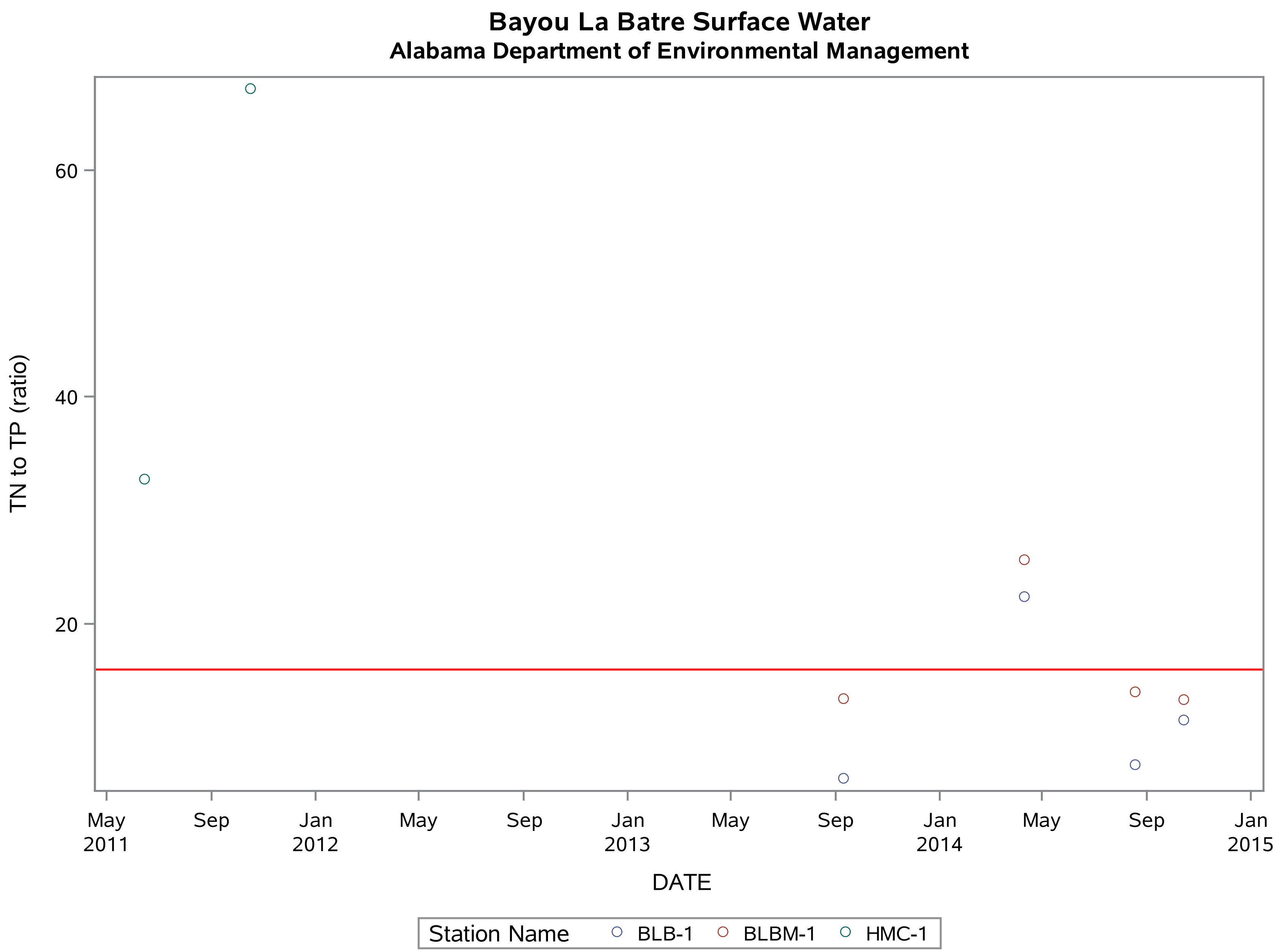
Bayou La Batre Surface Water
Alabama Department of Environmental Management
Dissolved Oxygen (mg/L)
0
5
10
15
1975
1980
1985
1990
1995
2000
2005
2010
2015
DATE
Station Name
BBM-3
BBM-5
BBM-6
BBM-9
BLB-1
BLBM-1
BLBM-2
BLBM-3
BLBM-4
HMC-1
HMC-2



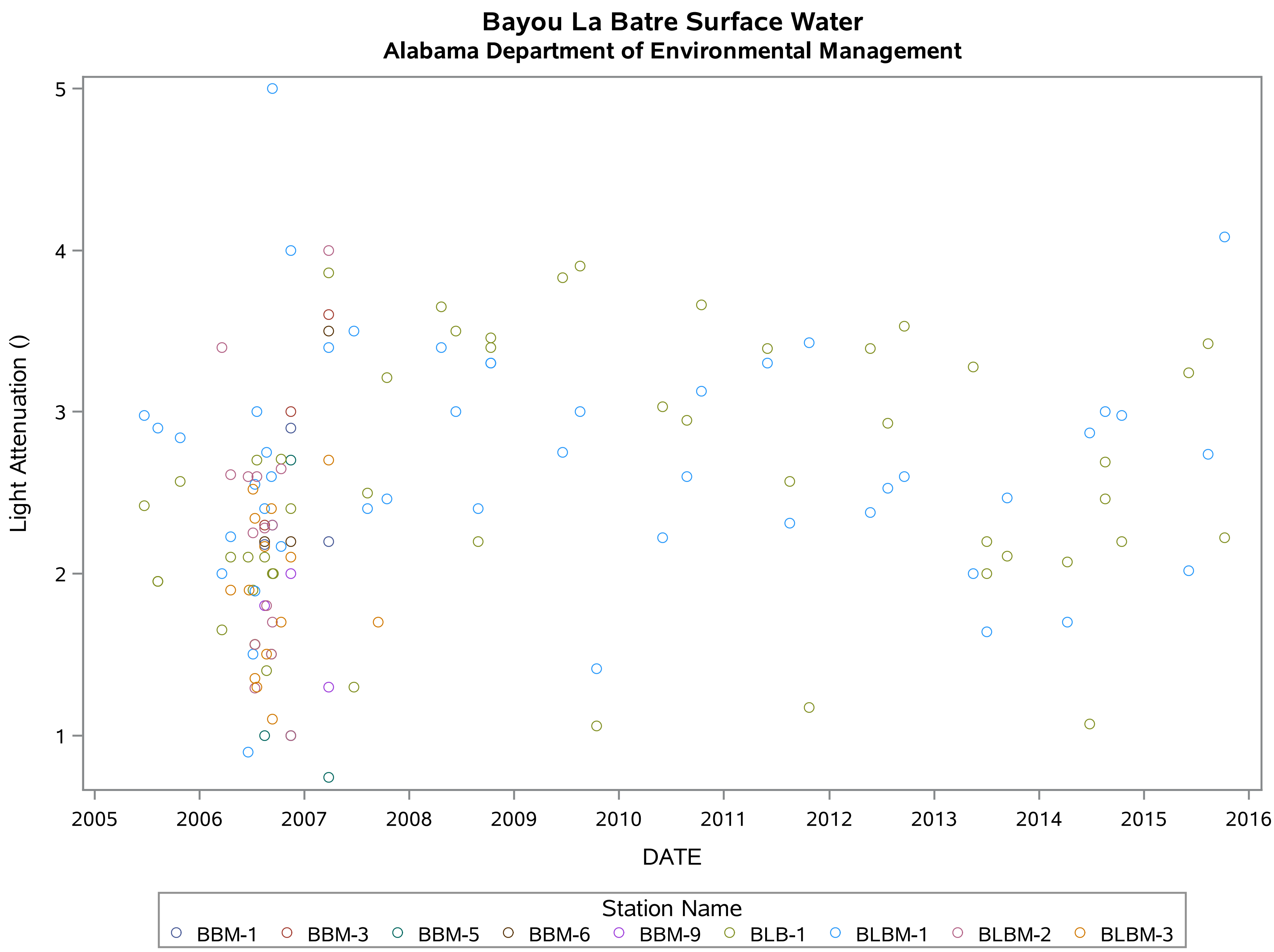
Bayou La Batre Surface Water
Alabama Department of Environmental Management
Enterococcus (MPN)
1000
800
600
400
200
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
DATE
Station Name
BBM-1
BBM-3
BBM-5
BBM-6
BBM-9
BLB-1
BLBM-1
BLBM-2
BLBM-3
BLBM-4


Bayou La Batre Surface Water
Alabama Department of Environmental Management
Fecal Coliform (MPN)
8000
6000
4000
2000
0
1975
1980
1985
1990
1995
2000
2005
2010
DATE
Station Name
BBM-1
BBM-3
BBM-5
BBM-6
BBM-9
BLB-1
BLBM-1
BLBM-2
BLBM-3
BLBM-4
HMC-1
HMC-2

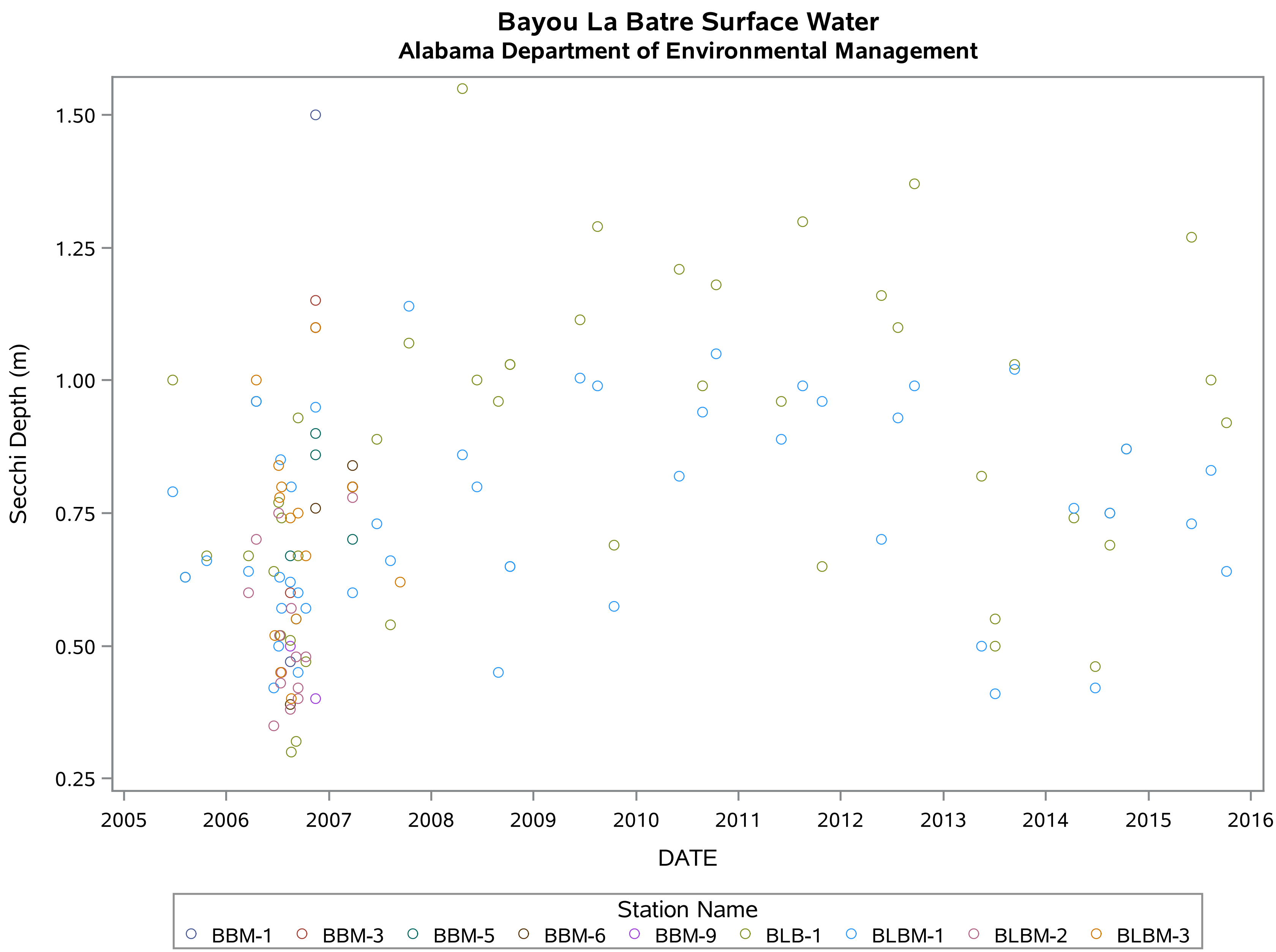

Bayou La Batre Surface Water
Alabama Department of Environmental Management
pH (SU)
8
7
6
5
4
1975
1980
1985
1990
1995
2000
2005
2010
2015
DATE
Station Name
BBM-3
BBM-5
BBM-6
BBM-9
BLB-1
BLBM-1
BLBM-2
BLBM-3
BLBM-4
HMC-1
HMC-2



Bayou La Batre Surface Water
Alabama Department of Environmental Management
TN to TP (ratio)
60
40
20
May 2011
Sep
Jan 2012
May
Sep
Jan 2013
May
Sep
Jan 2014
May
Sep
Jan 2015
DATE
Station Name
BLB-1
BLBM-1
HMC-1

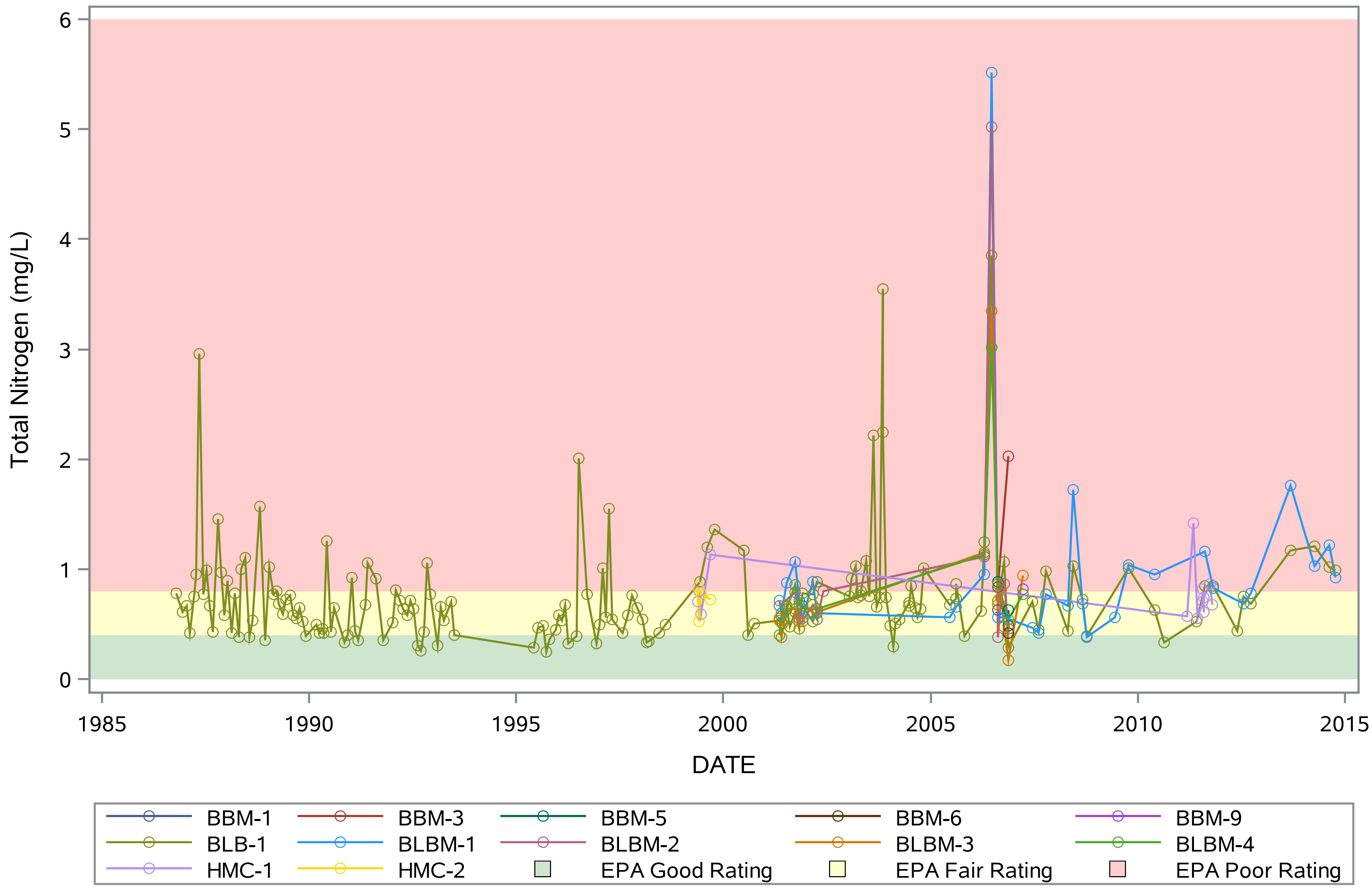


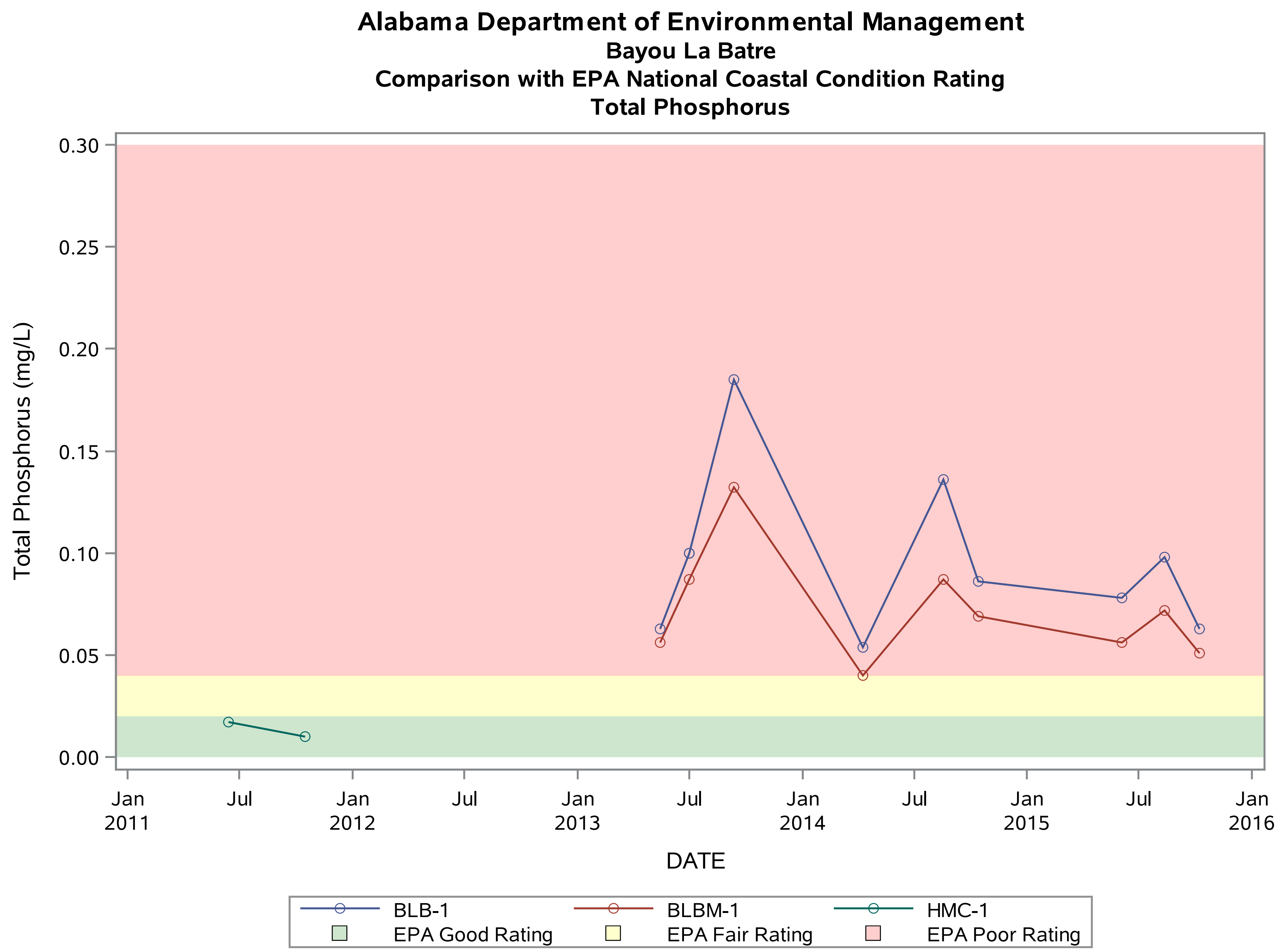
Bayou La Batre Surface Water
Alabama Department of Environmental Management
Light Attenuation ()
5
4
3
2
1
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
DATE
Station Name
BBM-1
BBM-3
BBM-5
BBM-6
BBM-9
BLB-1
BLBM-1
BLBM-2
BLBM-3



Bayou La Batre Surface Water
Alabama Department of Environmental Management
Secchi Depth (m)
1.50
1.25
1.00
0.75
0.50
0.25
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
DATE
Station Name
BBM-1
BBM-3
BBM-5
BBM-6
BBM-9
BLB-1
BLBM-1
BLBM-2
BLBM-3

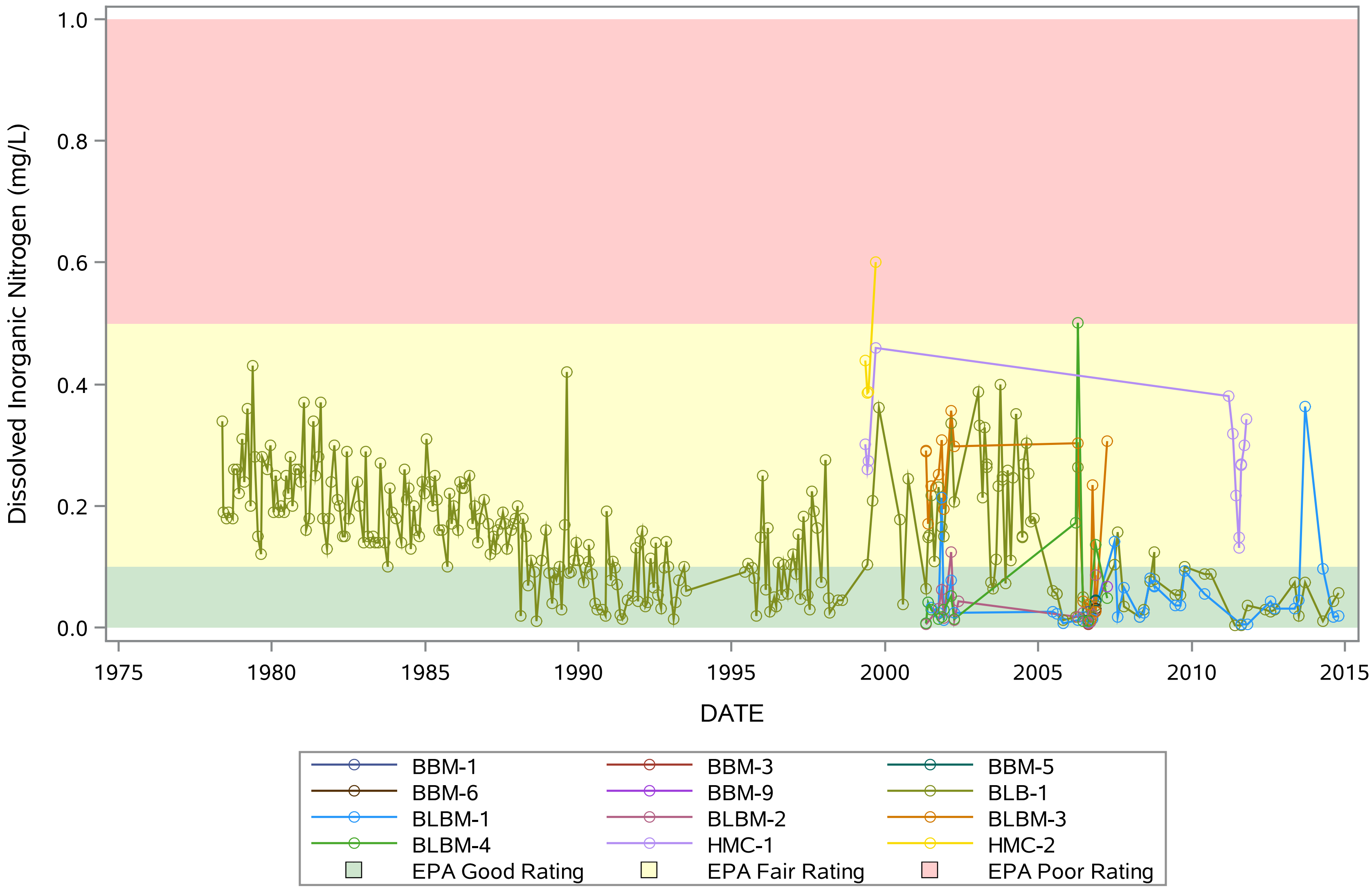
Alabama Department of Environmental Management
Bayou La Batre
Comparison with EPA National Coastal Condition Rating
Total Nitrogen

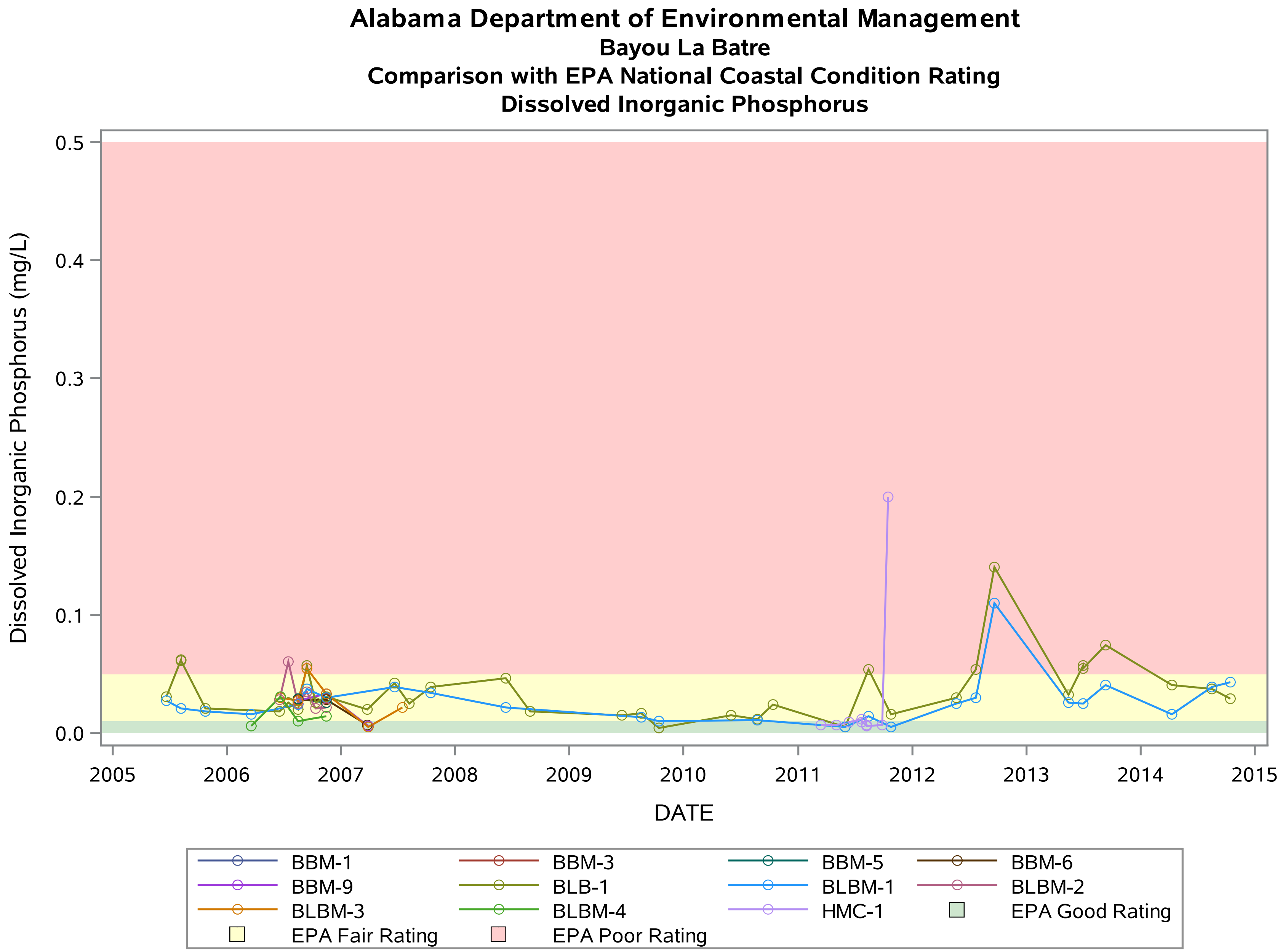




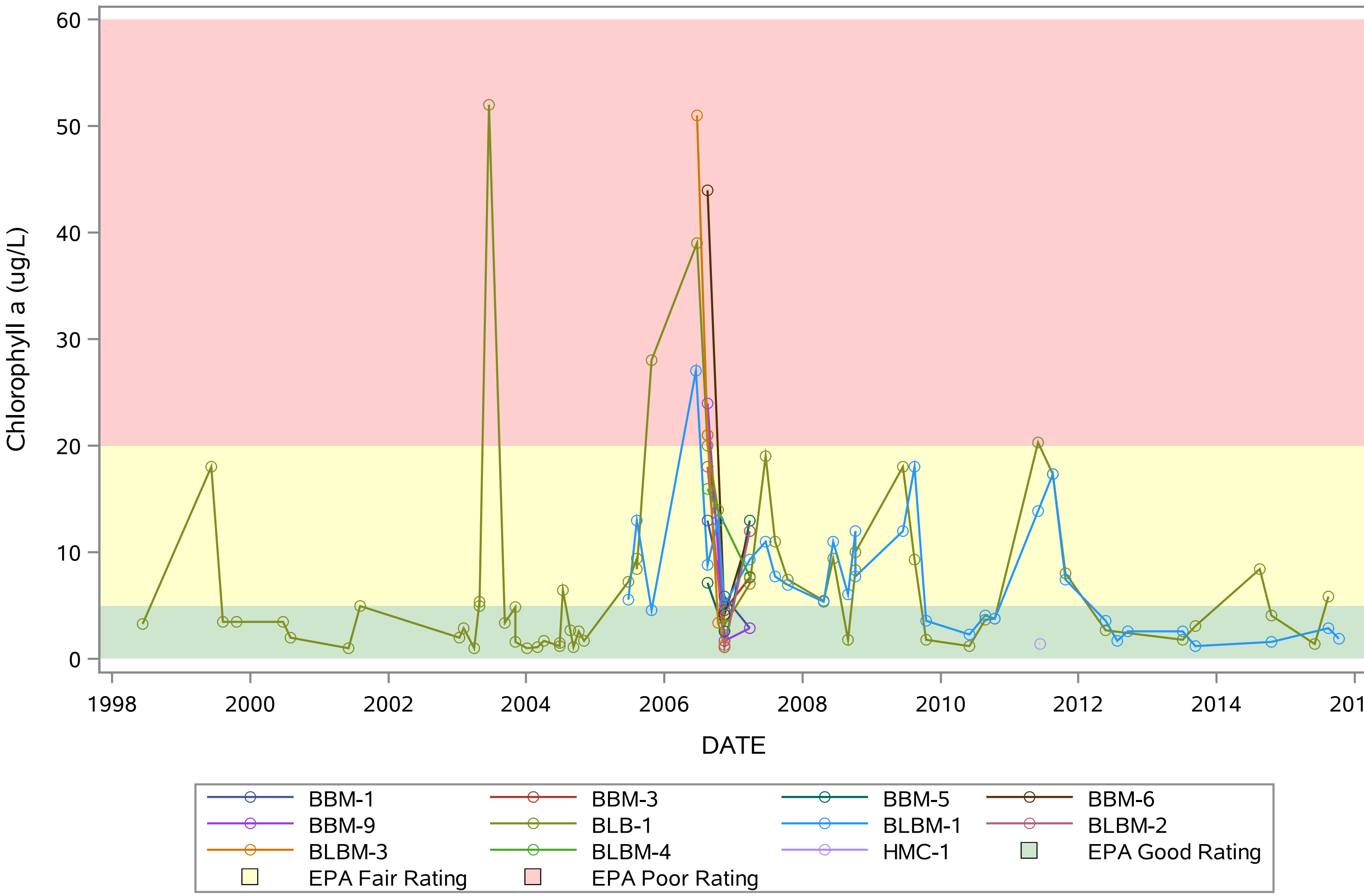
Alabama Department of Environmental Management
Bayou La Batre
Comparison with EPA National Coastal Condition Rating
Total Phosphorus
Total Phosphorus (mg/L)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
DATE
BLB-1
BLBM-1
HMC-1
EPA Good Rating
EPA Fair Rating
EPA Poor Rating

Alabama Department of Environmental Management
Bayou La Batre
Comparison with EPA National Coastal Condition Rating
Dissolved Inorganic Nitrogen

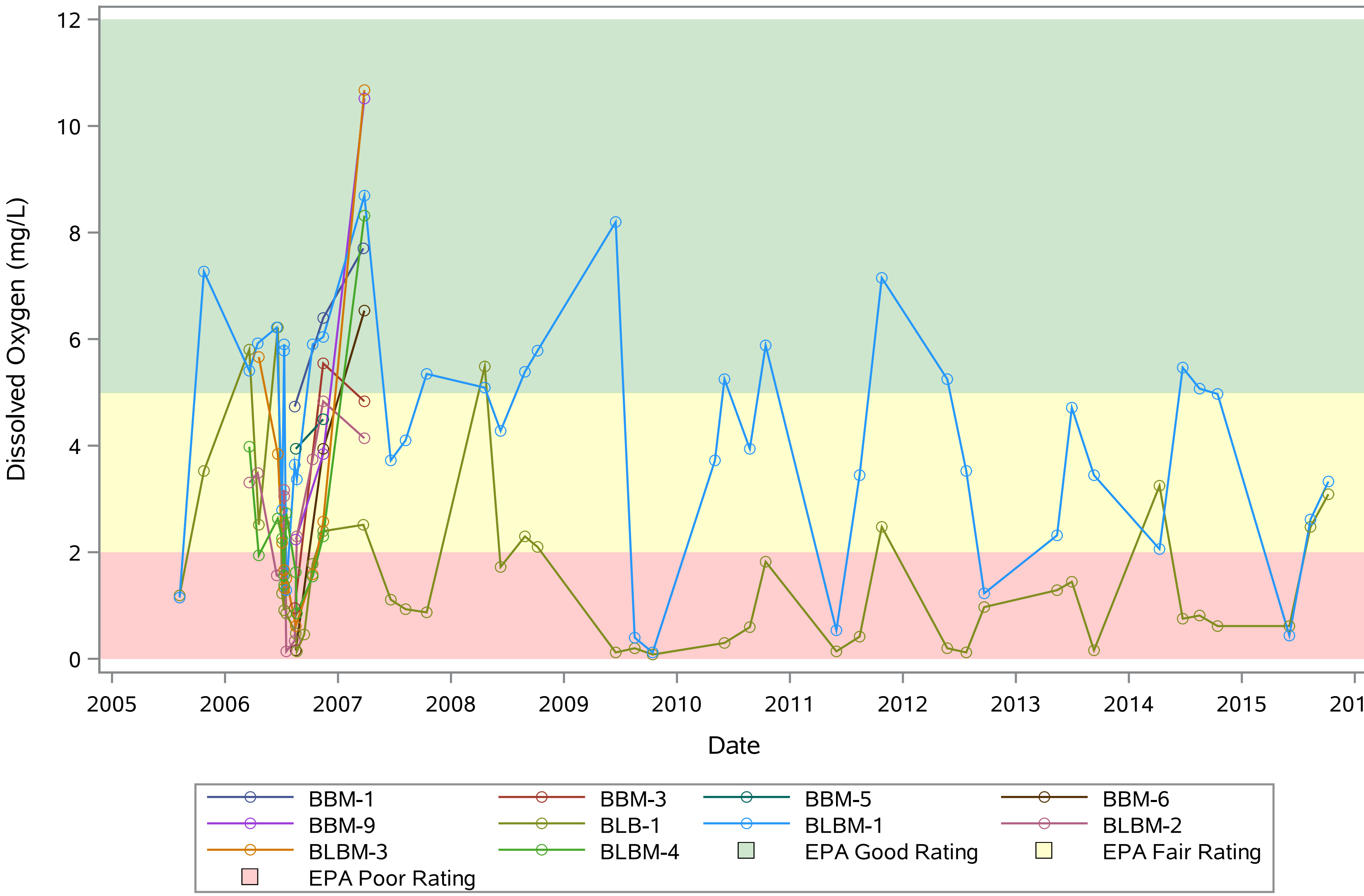


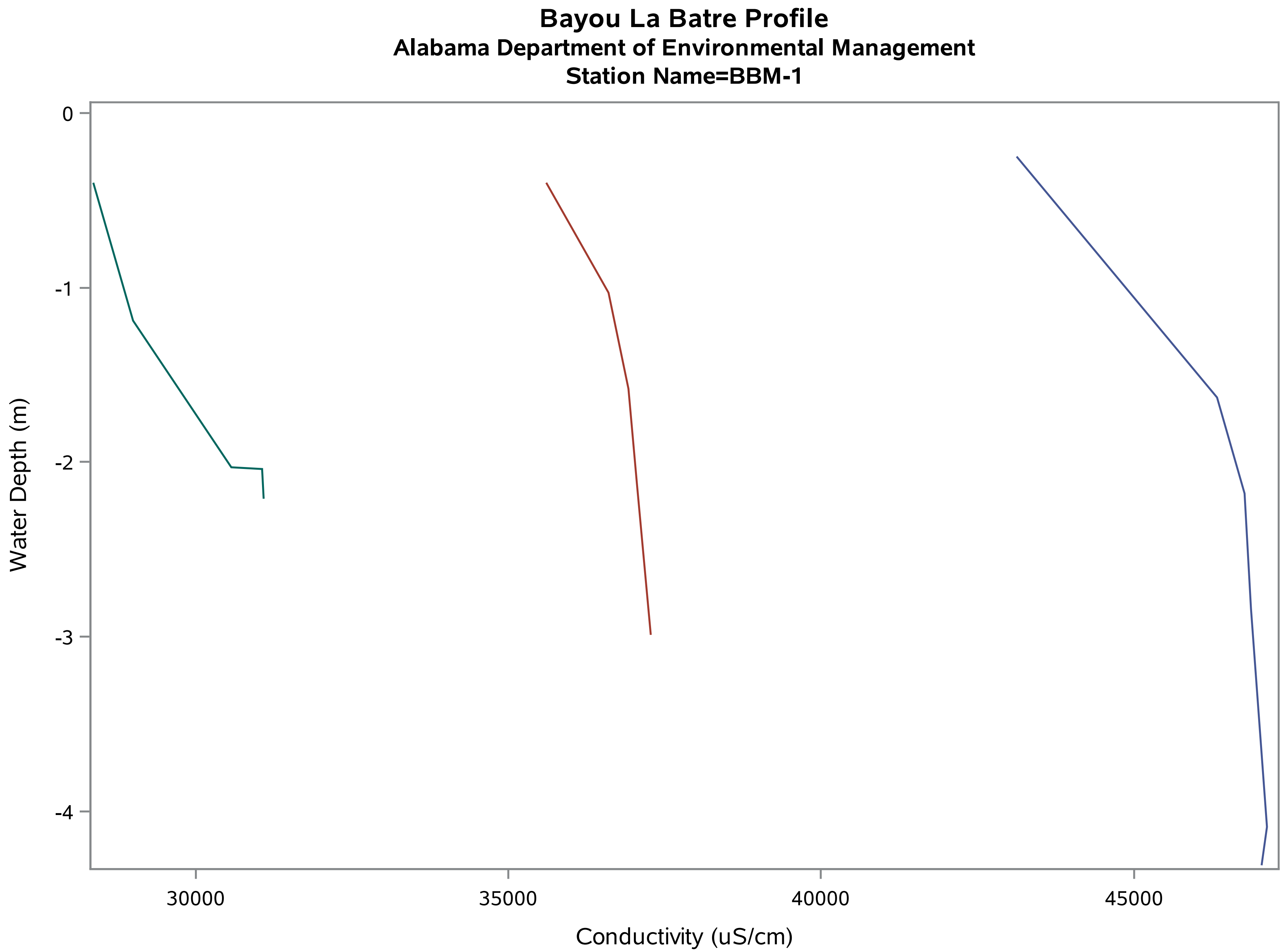

Alabama Department of Environmental Management
Bayou La Batre
Comparison with EPA National Coastal Condition Rating
Dissolved Inorganic Phosphorus
Dissolved Inorganic Phosphorus (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
DATE
BBM-1
BBM-3
BBM-5
BBM-6
BBM-9
BLB-1
BLBM-1
BLBM-2
BLBM-3
BLBM-4
HMC-1
EPA Good Rating
EPA Fair Rating
EPA Poor Rating

Alabama Department of Environmental Management
Bayou La Batre
Comparison with EPA National Coastal Condition Rating
Chlorophyll a

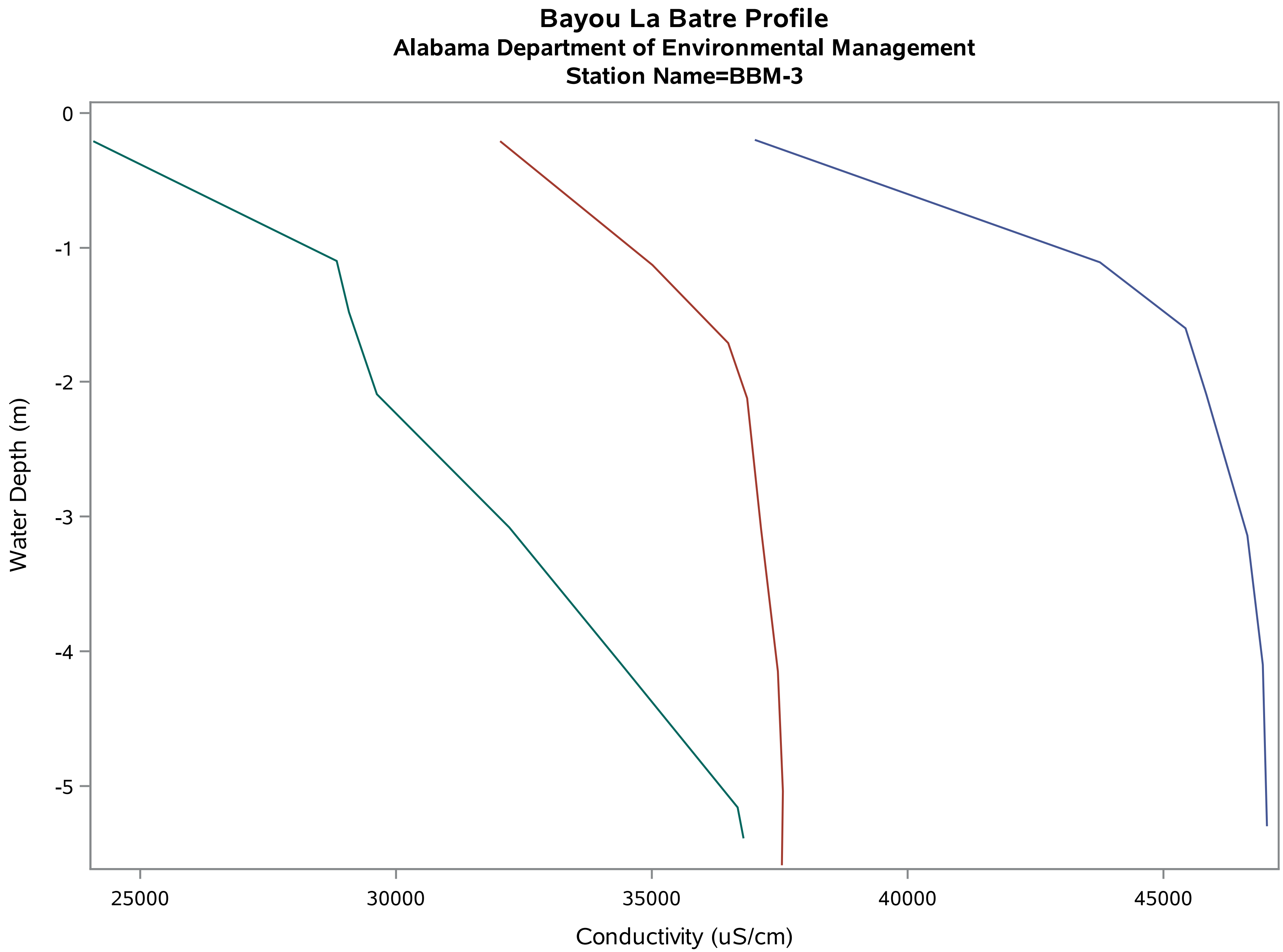


Alabama Department of Environmental Management
Bayou La Batre
Comparison with EPA National Coastal Condition Rating
Bottom Dissolved Oxygen (mg/L)

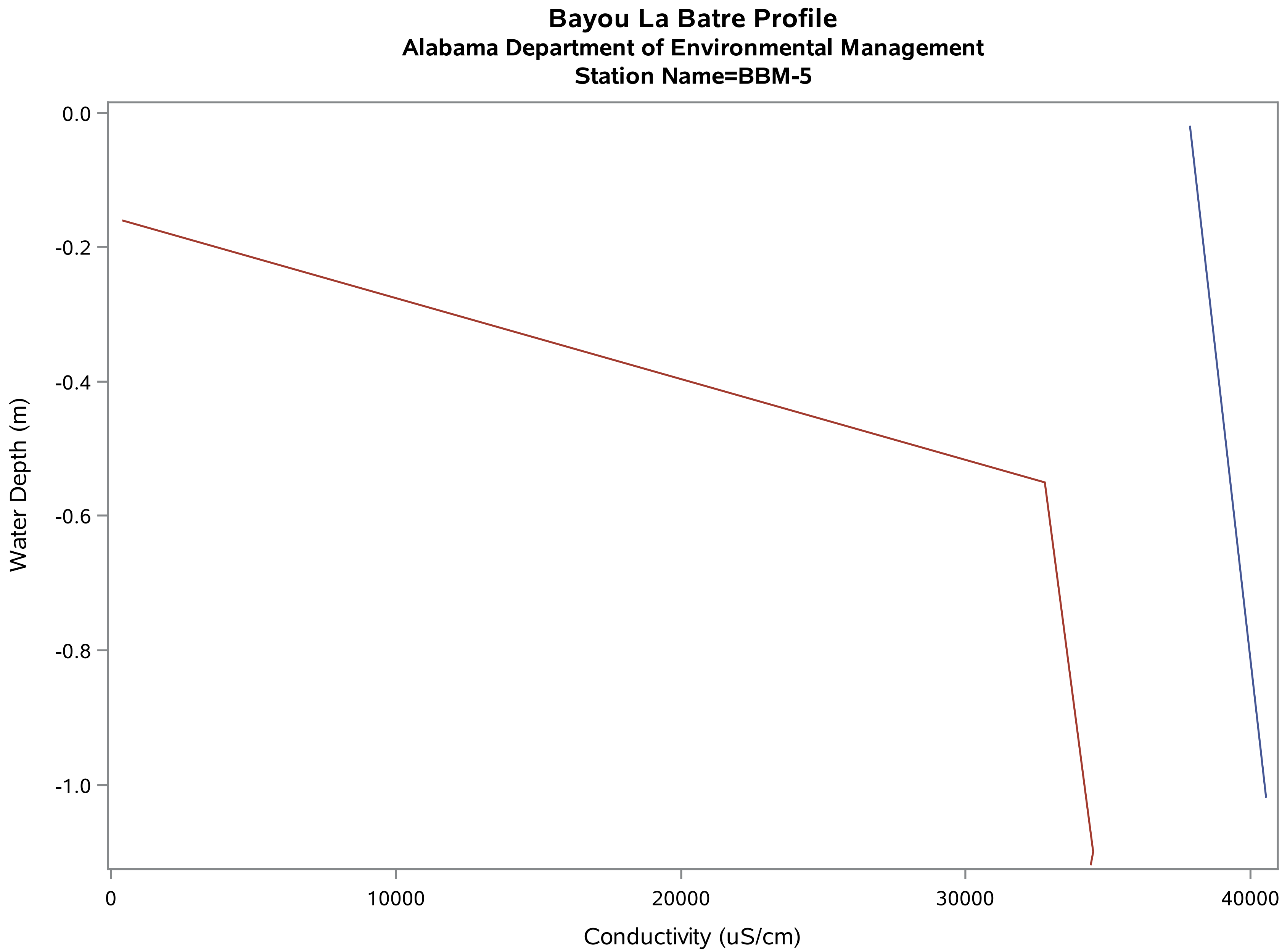


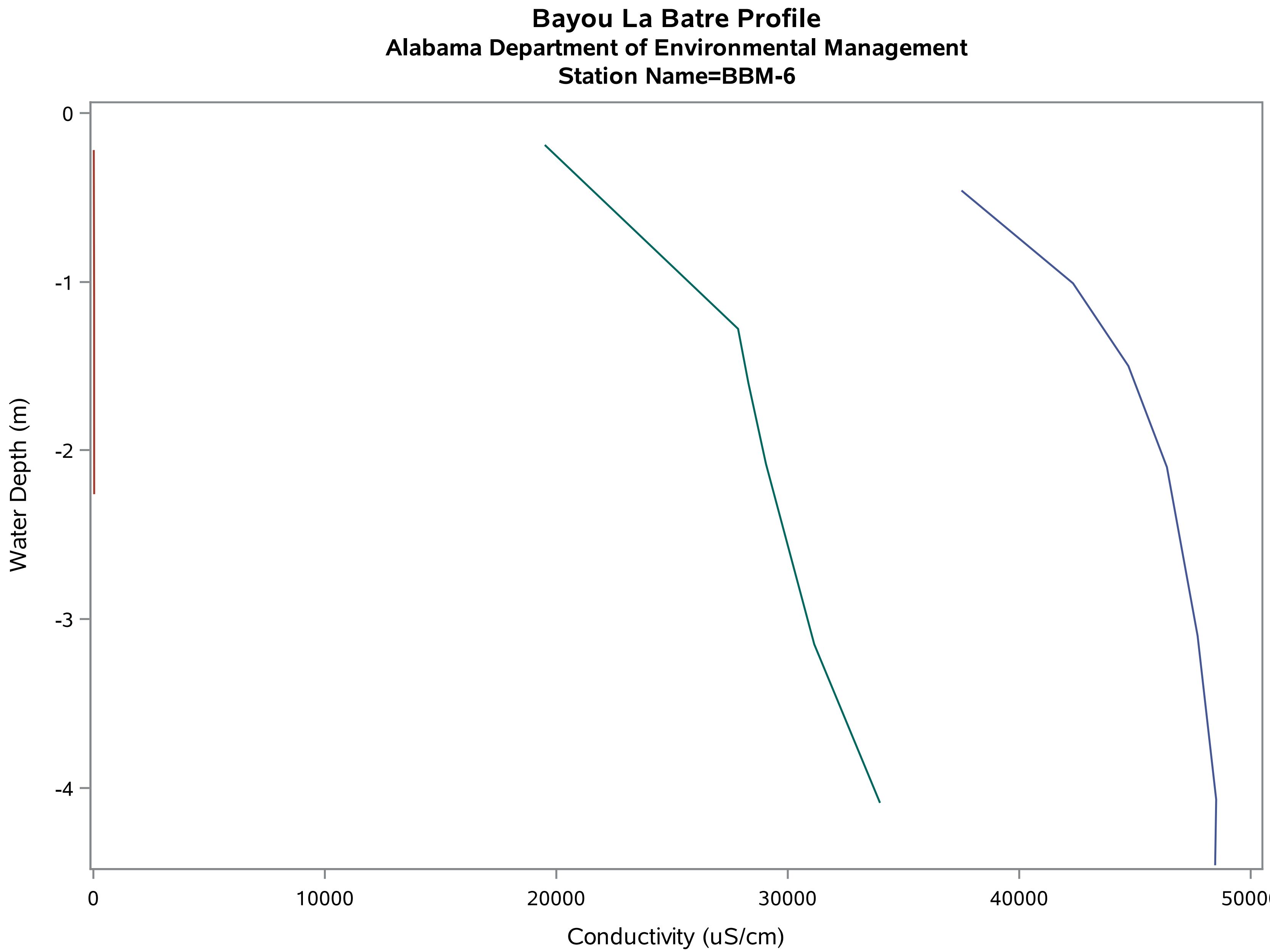


Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-1
0
-1
-2
-3
-4
Water Depth (m)
30000
35000
40000
45000
Conductivity (uS/cm)

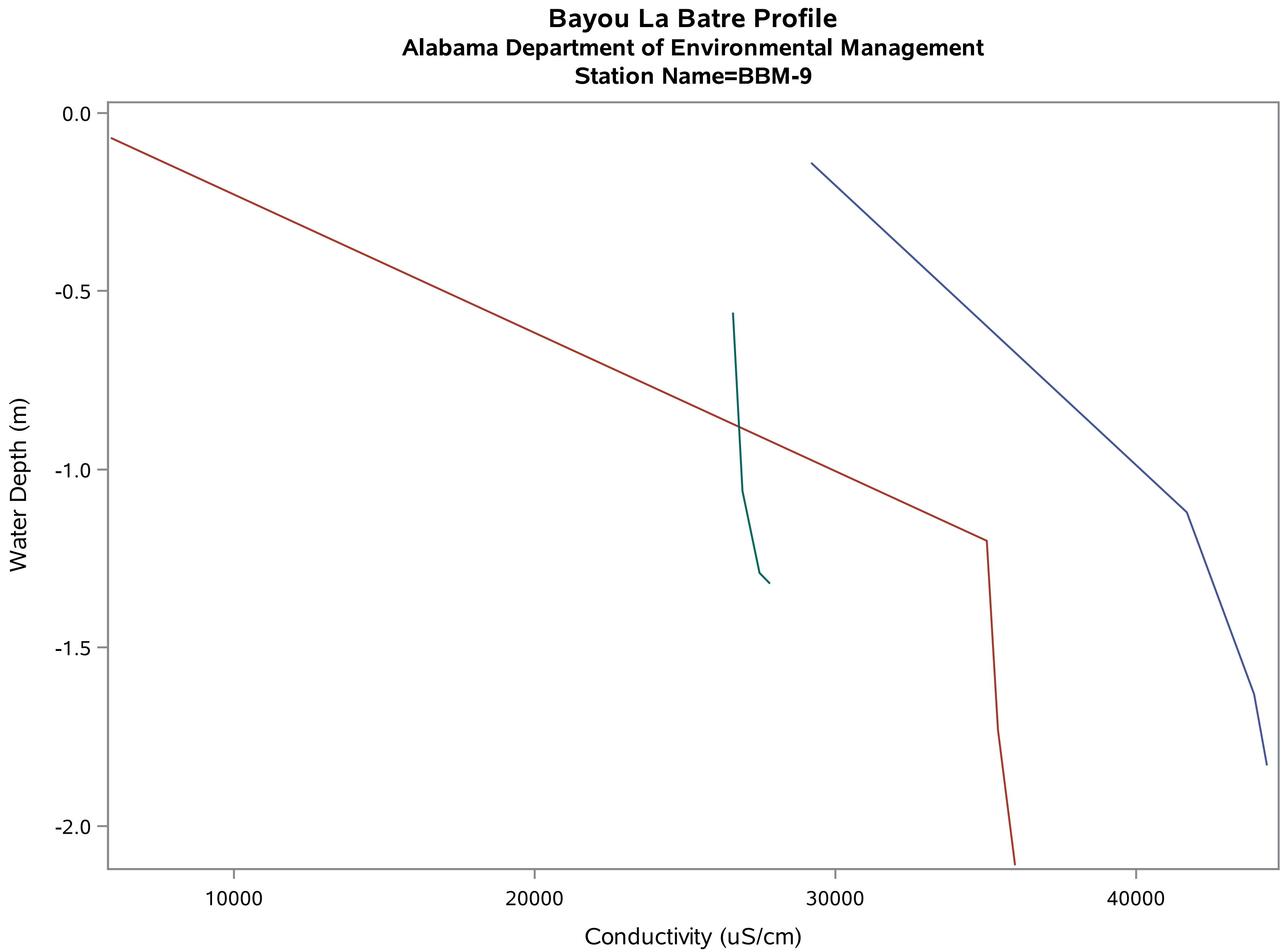


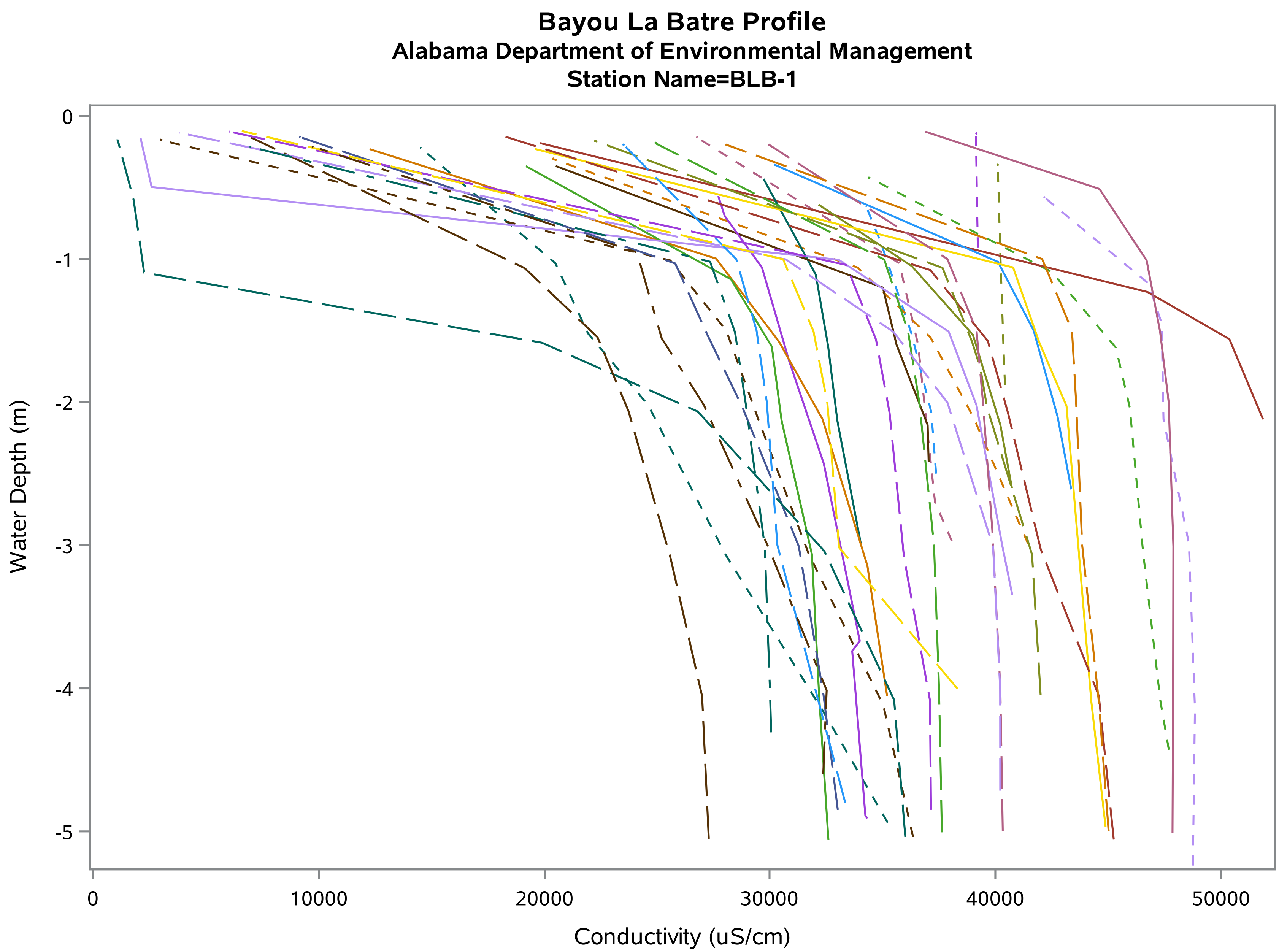
Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-3
0
-1
-2
-3
-4
-5
Water Depth (m)
25000
30000
35000
40000
45000
Conductivity (uS/cm)

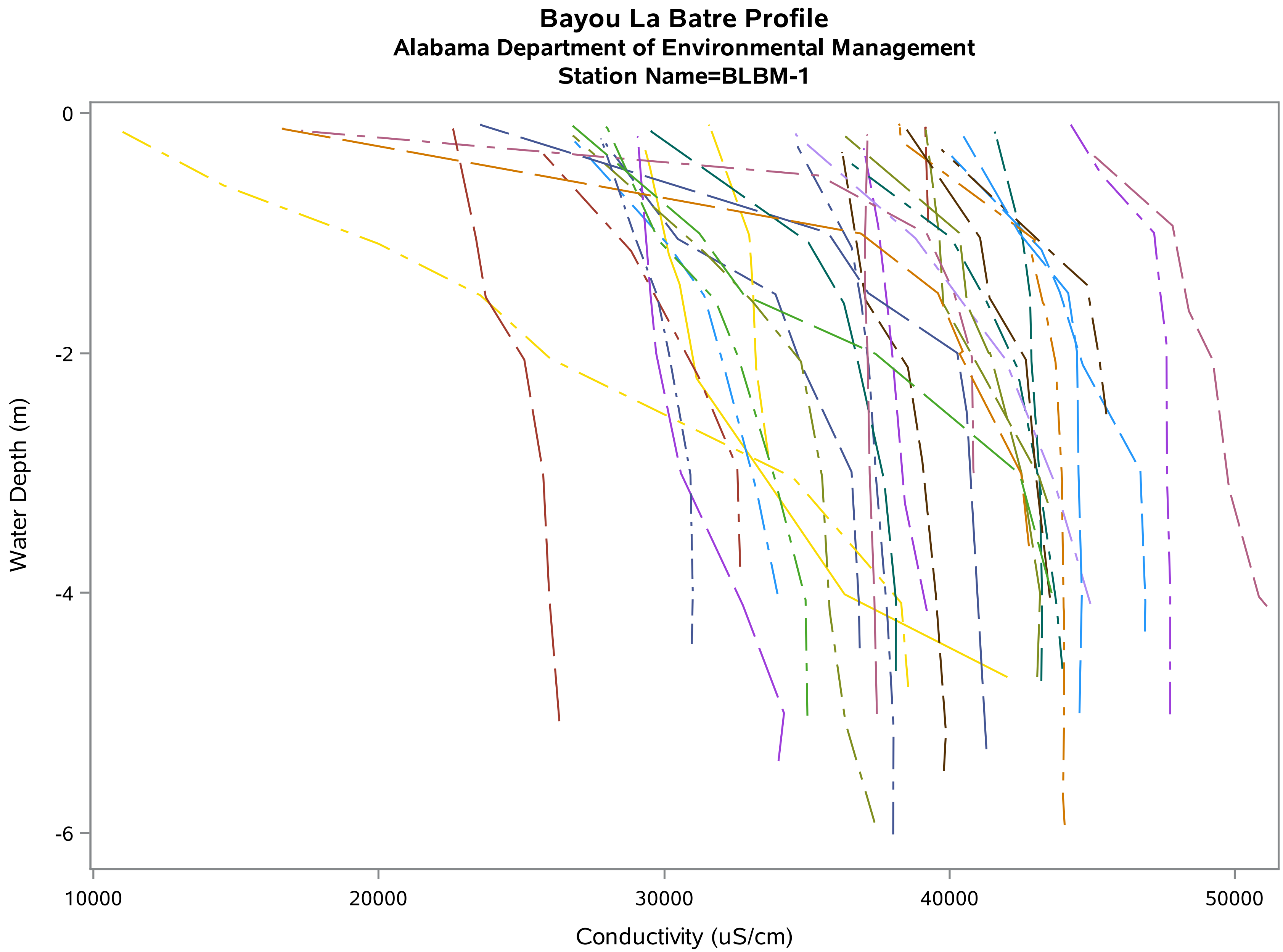

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-5
Water Depth (m)
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
0
10000
20000
30000
40000
Conductivity (uS/cm)



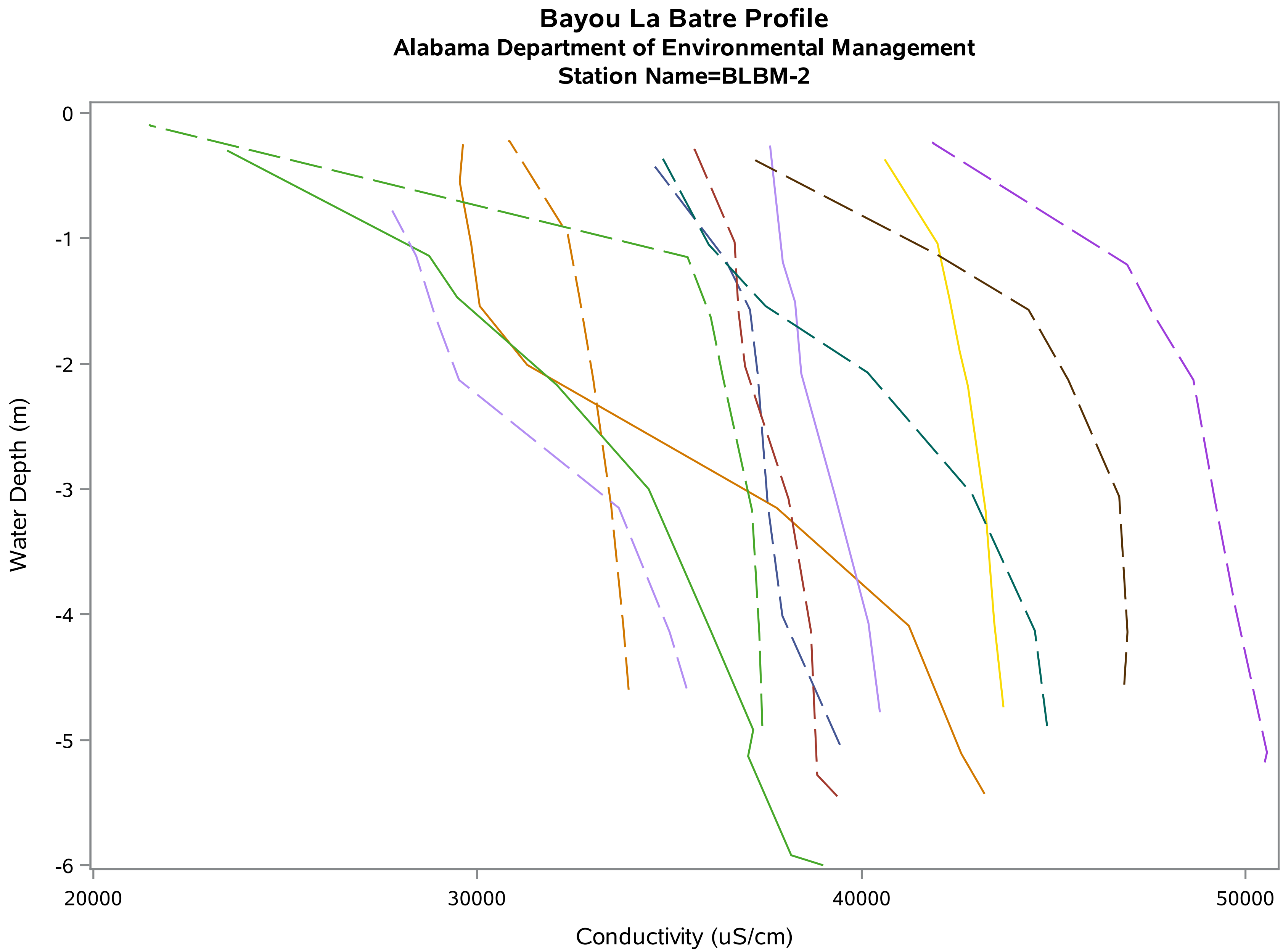
Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-6
0
-1
-2
-3
-4
Water Depth (m)
0
10000
20000
30000
40000
50000
Conductivity (uS/cm)

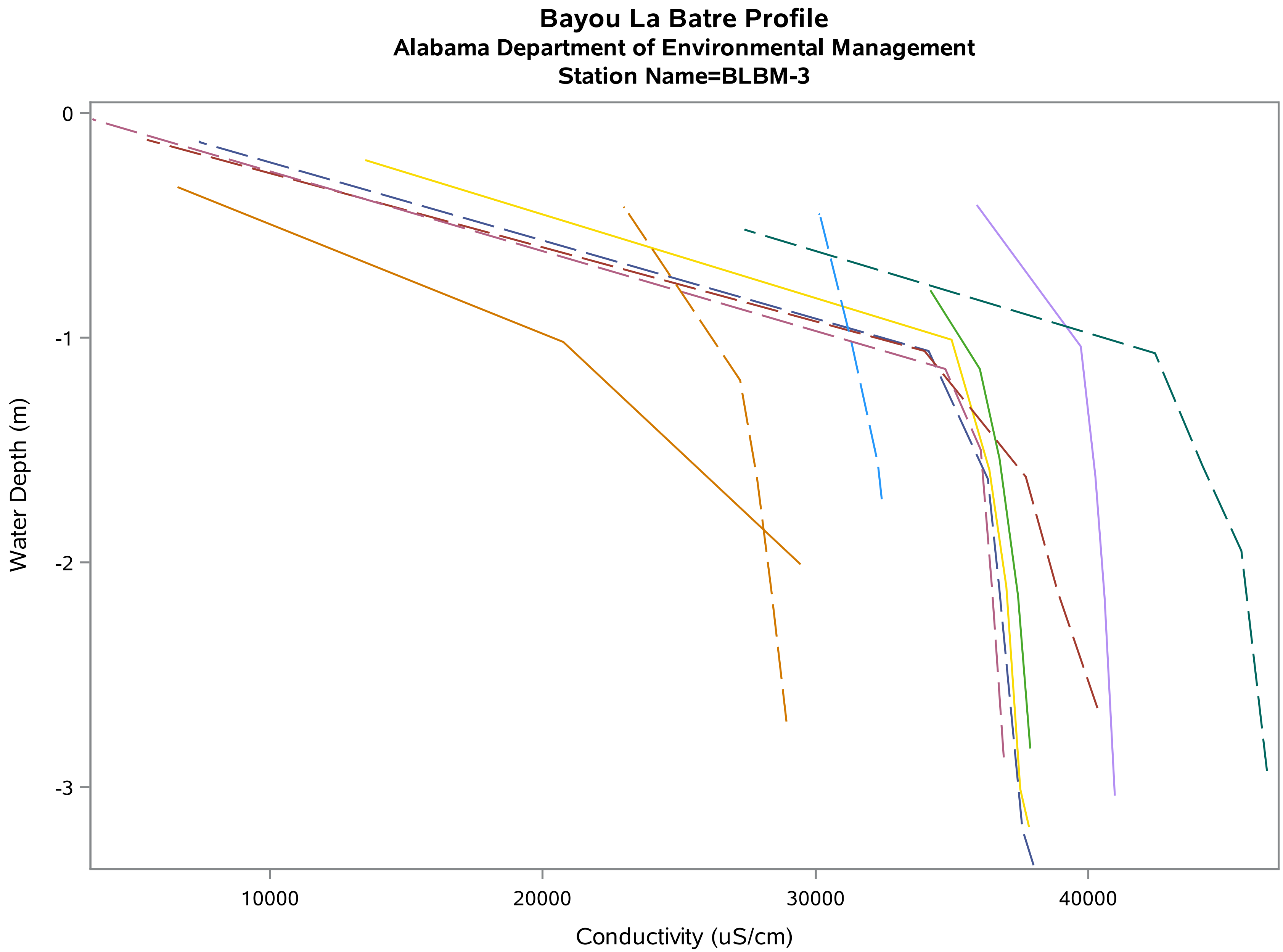

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-9
0.0
-0.5
-1.0
-1.5
-2.0
Water Depth (m)
10000
20000
30000
40000
Conductivity (uS/cm)

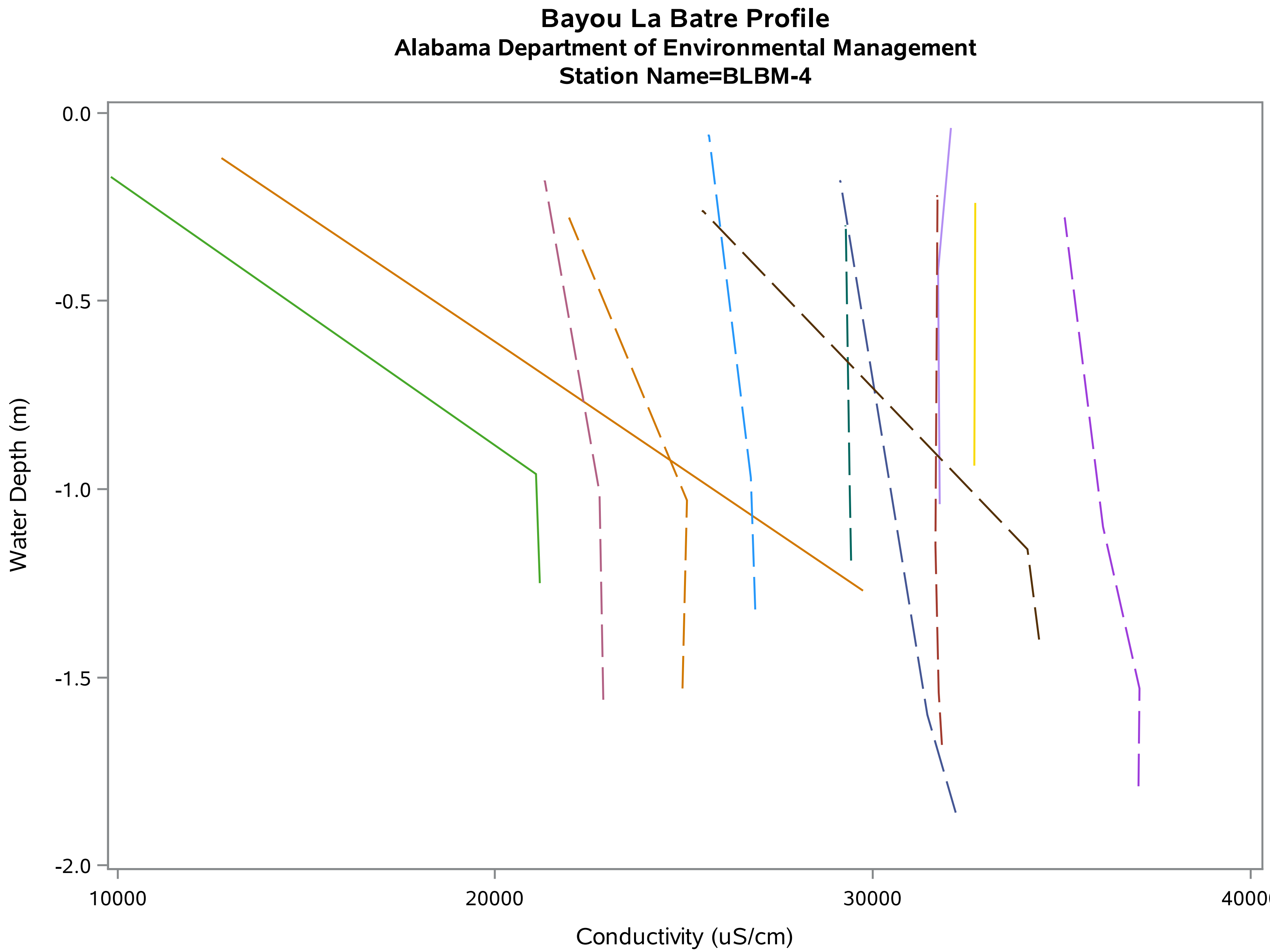

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLB-1
Water Depth (m)
0
-1
-2
-3
-4
-5
0
10000
20000
30000
40000
50000
Conductivity (uS/cm)



Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-1
0
-2
-4
-6
Water Depth (m)
10000
20000
30000
40000
50000
Conductivity (uS/cm)


Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-2
0
-1
-2
-3
-4
-5
-6
Water Depth (m)
20000
30000
40000
50000
Conductivity (uS/cm)

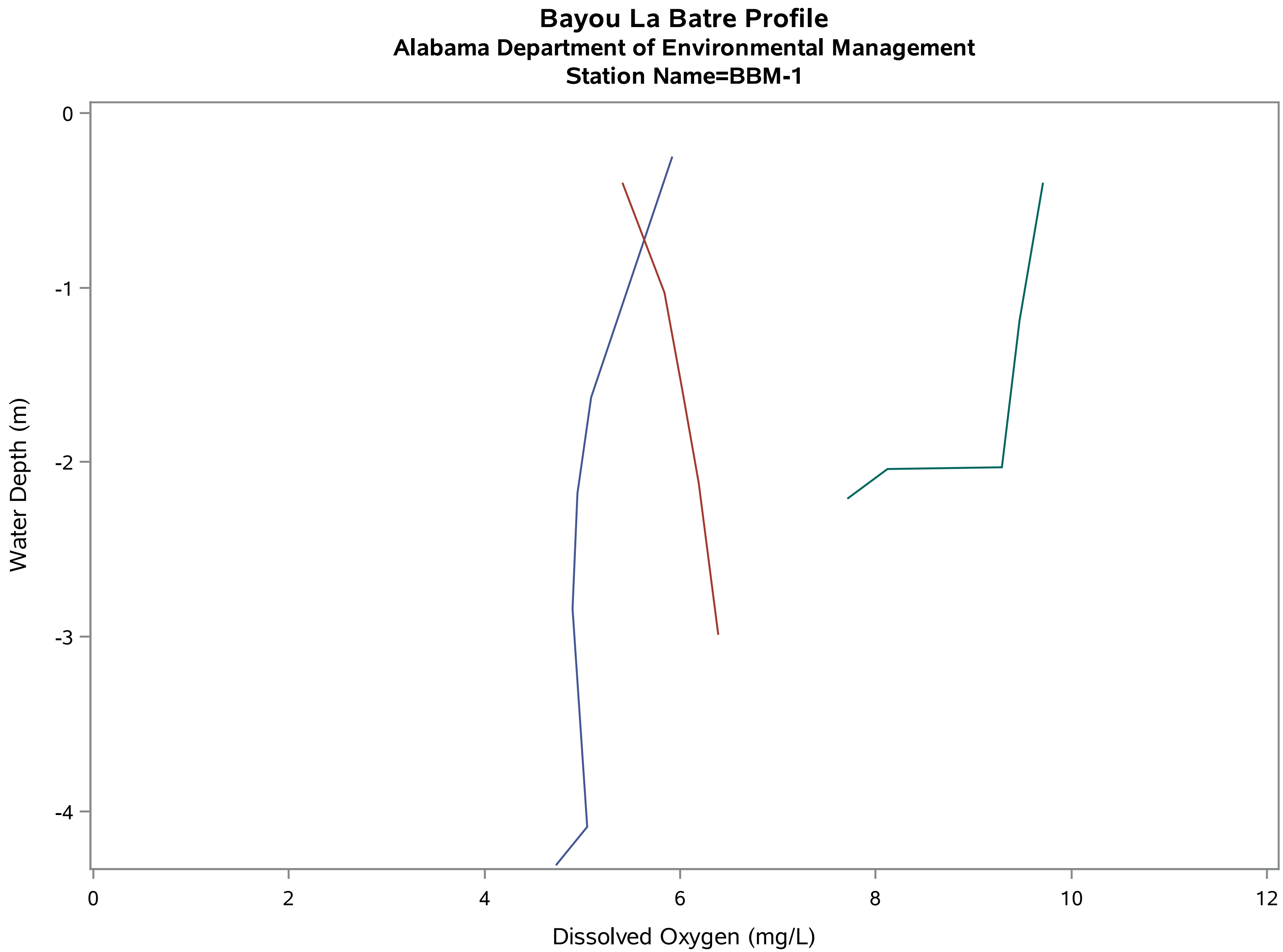

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-3
0
-1
-2
-3
Water Depth (m)
10000
20000
30000
40000
Conductivity (uS/cm)

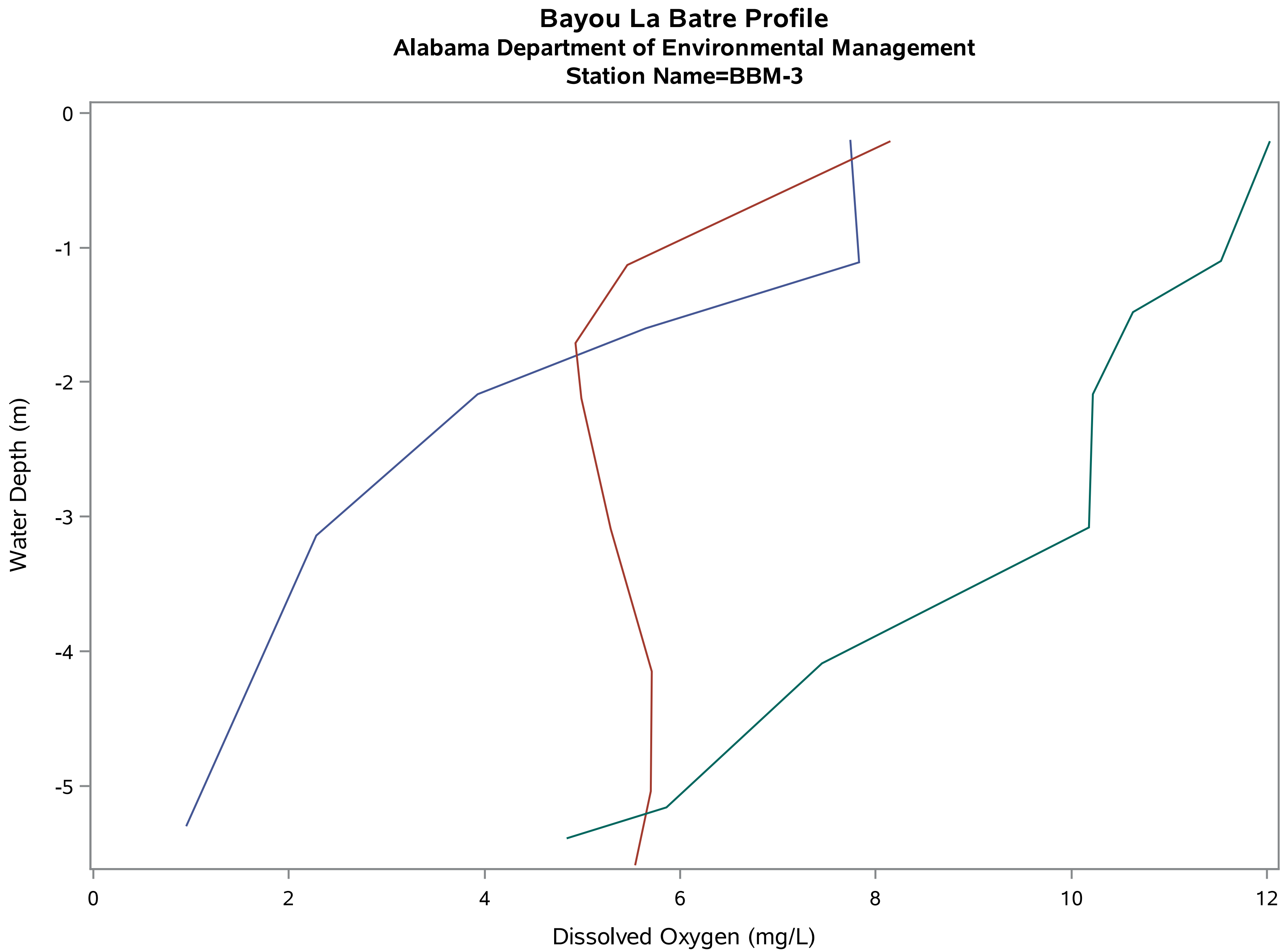


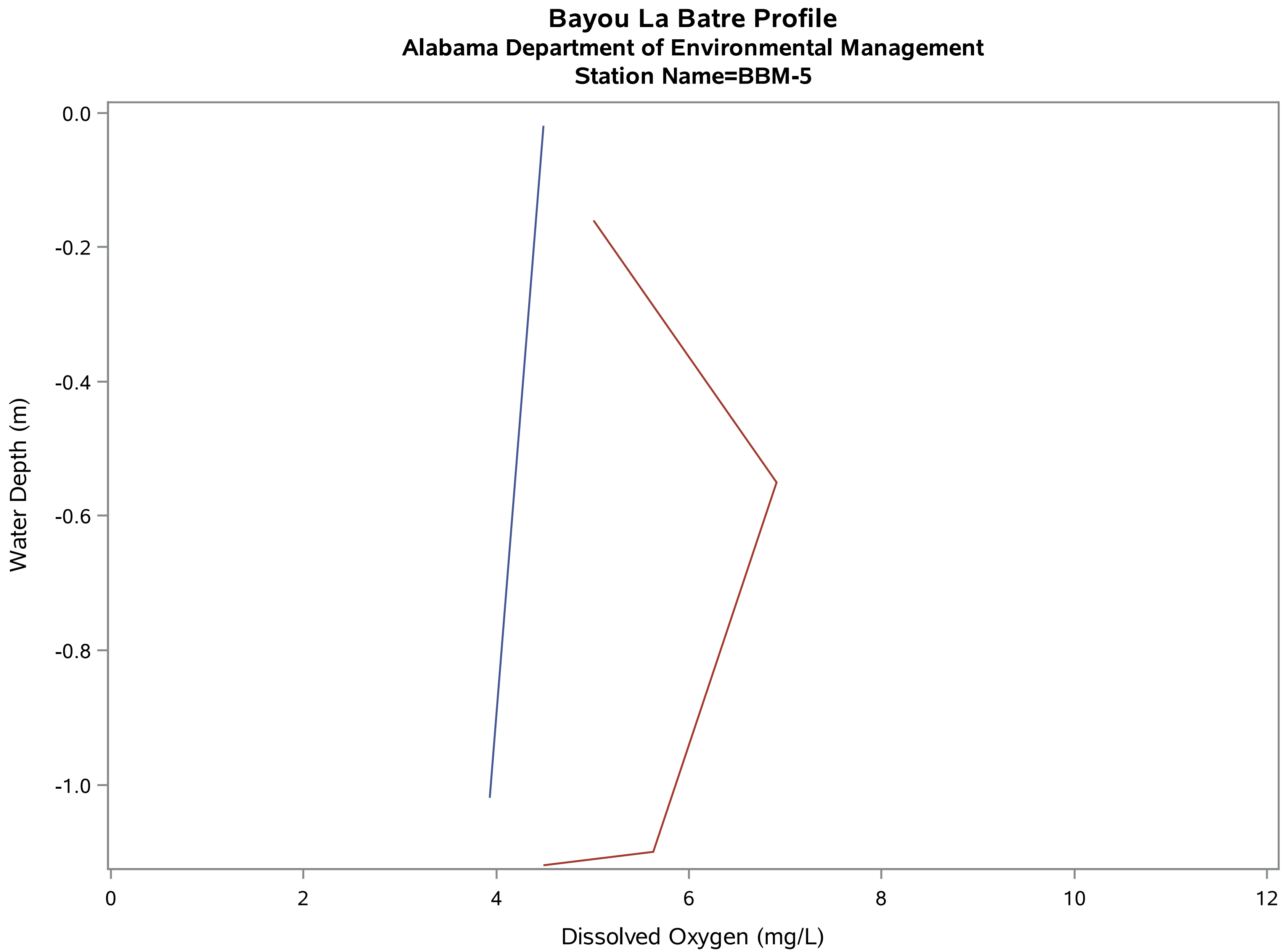
Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-4
0.0
-0.5
-1.0
-1.5
-2.0
Water Depth (m)
10000
20000
30000
40000
Conductivity (uS/cm)

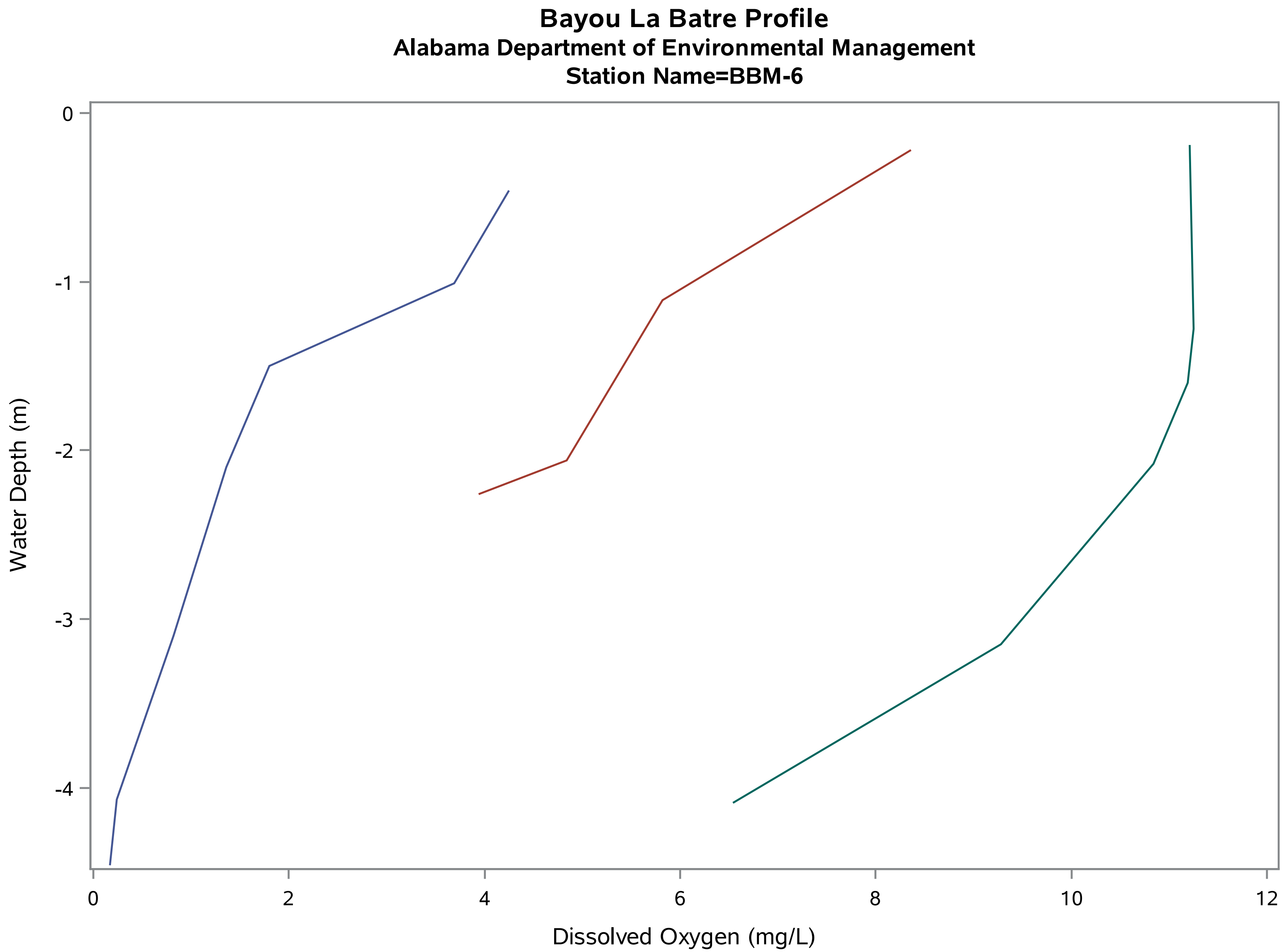

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=HMC-1
Water Depth (m)
-0.6
-0.8
-1.0
-1.2
40
50
60
70
Conductivity (uS/cm)

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=HMC-2

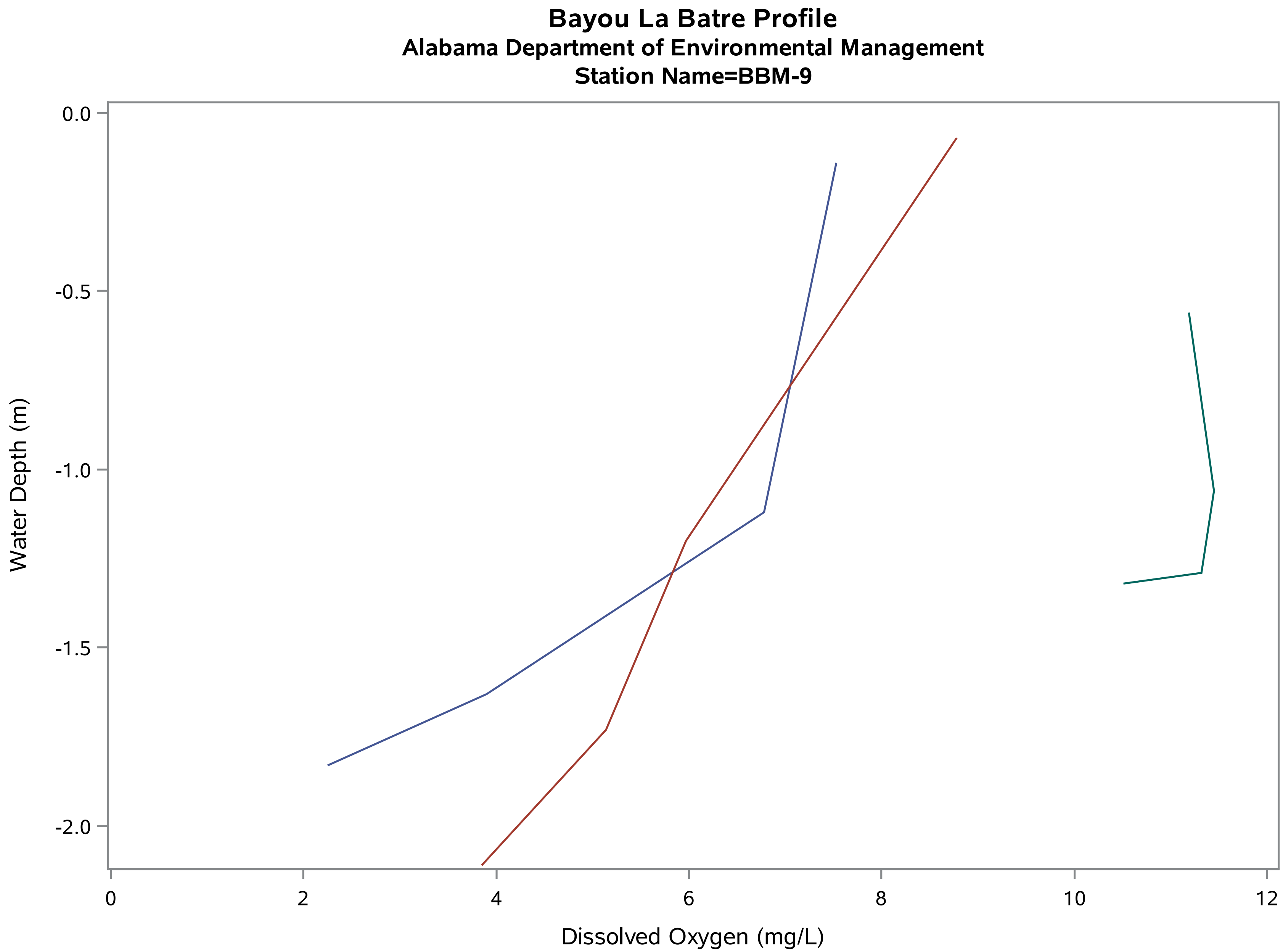

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-1
Water Depth (m)
0
-1
-2
-3
-4
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12

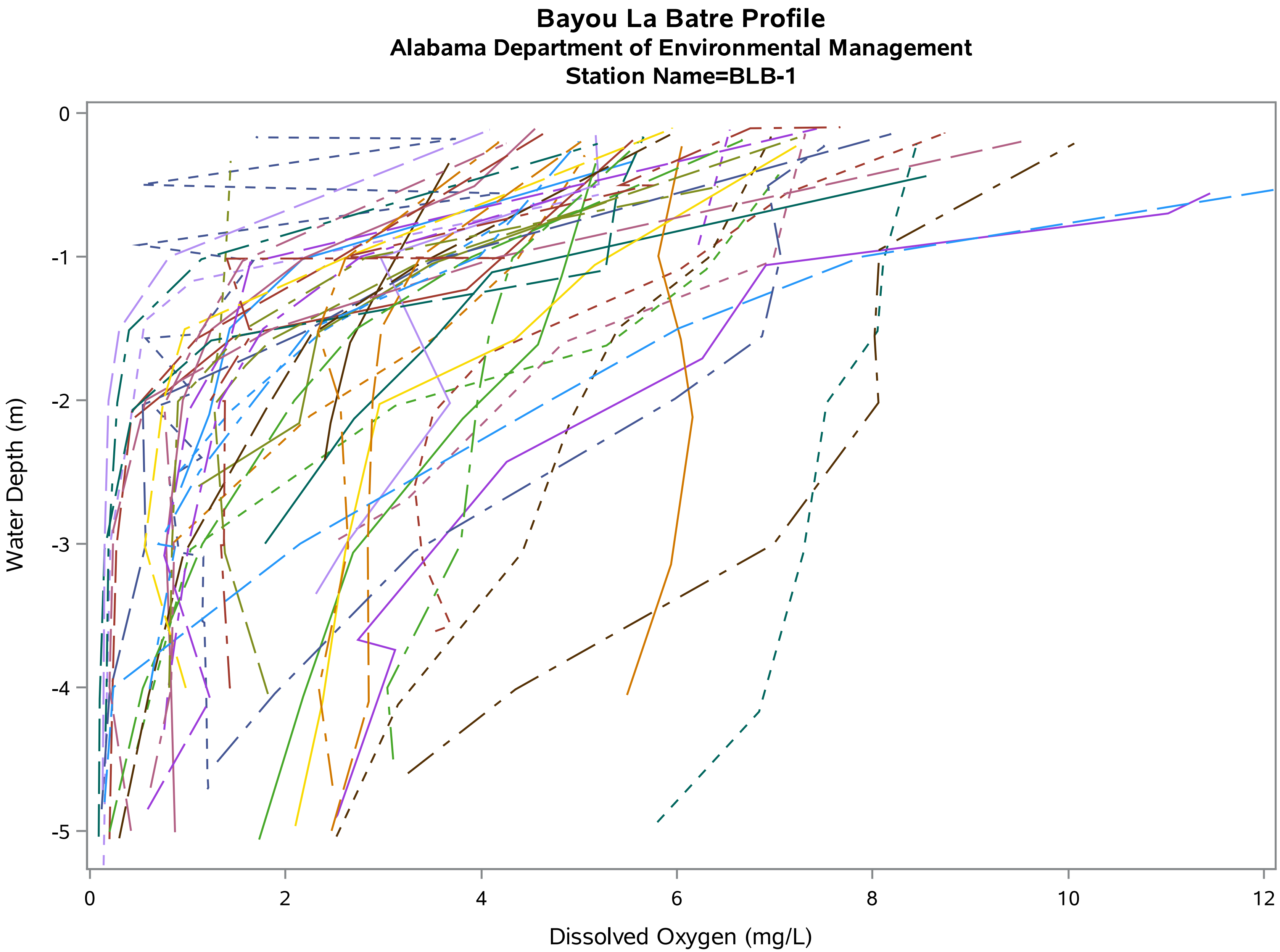

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-3
Water Depth (m)
0
-1
-2
-3
-4
-5
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12

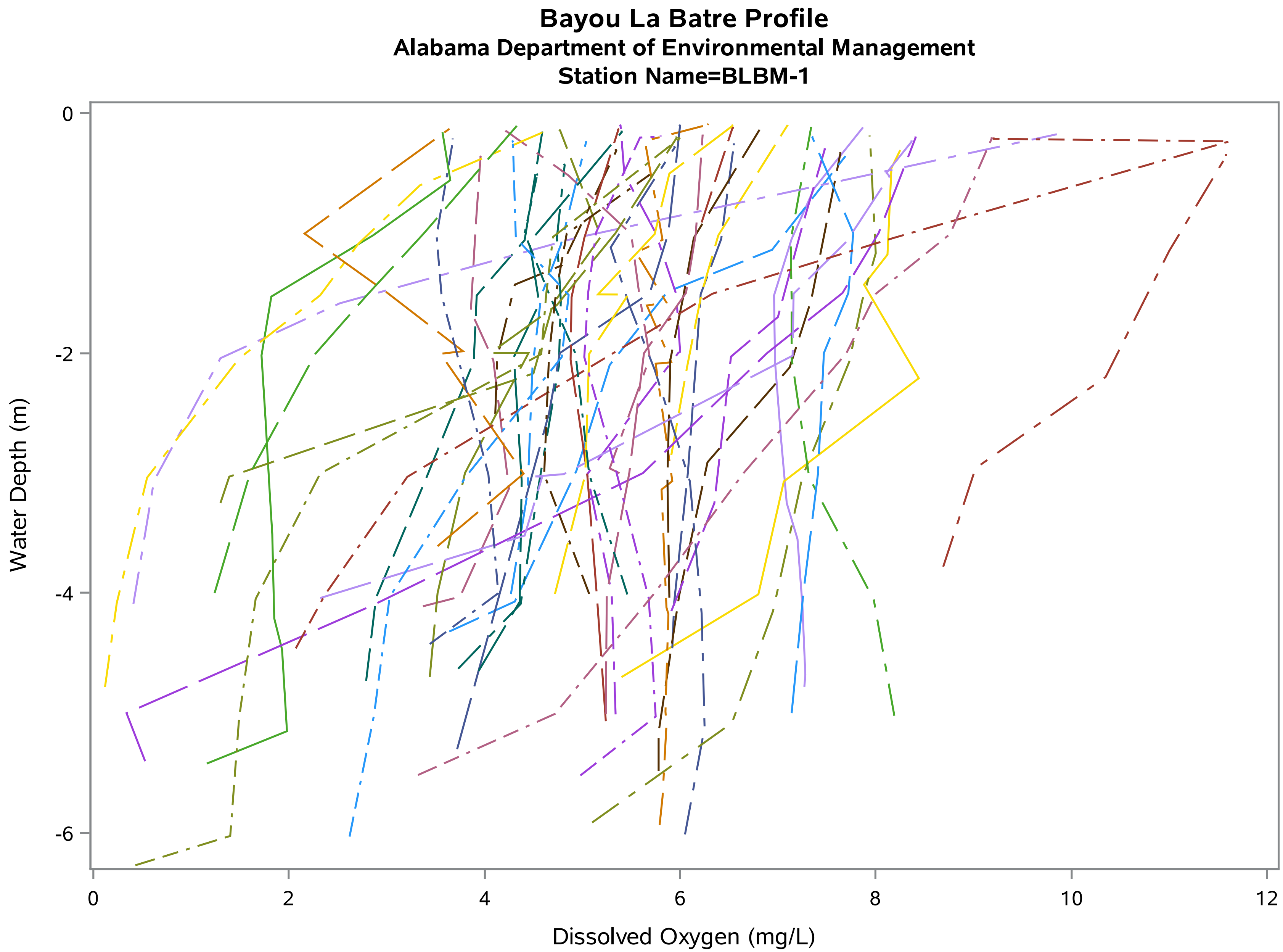

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-5
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
Water Depth (m)
0
2
4
6
8
10
12
Dissolved Oxygen (mg/L)

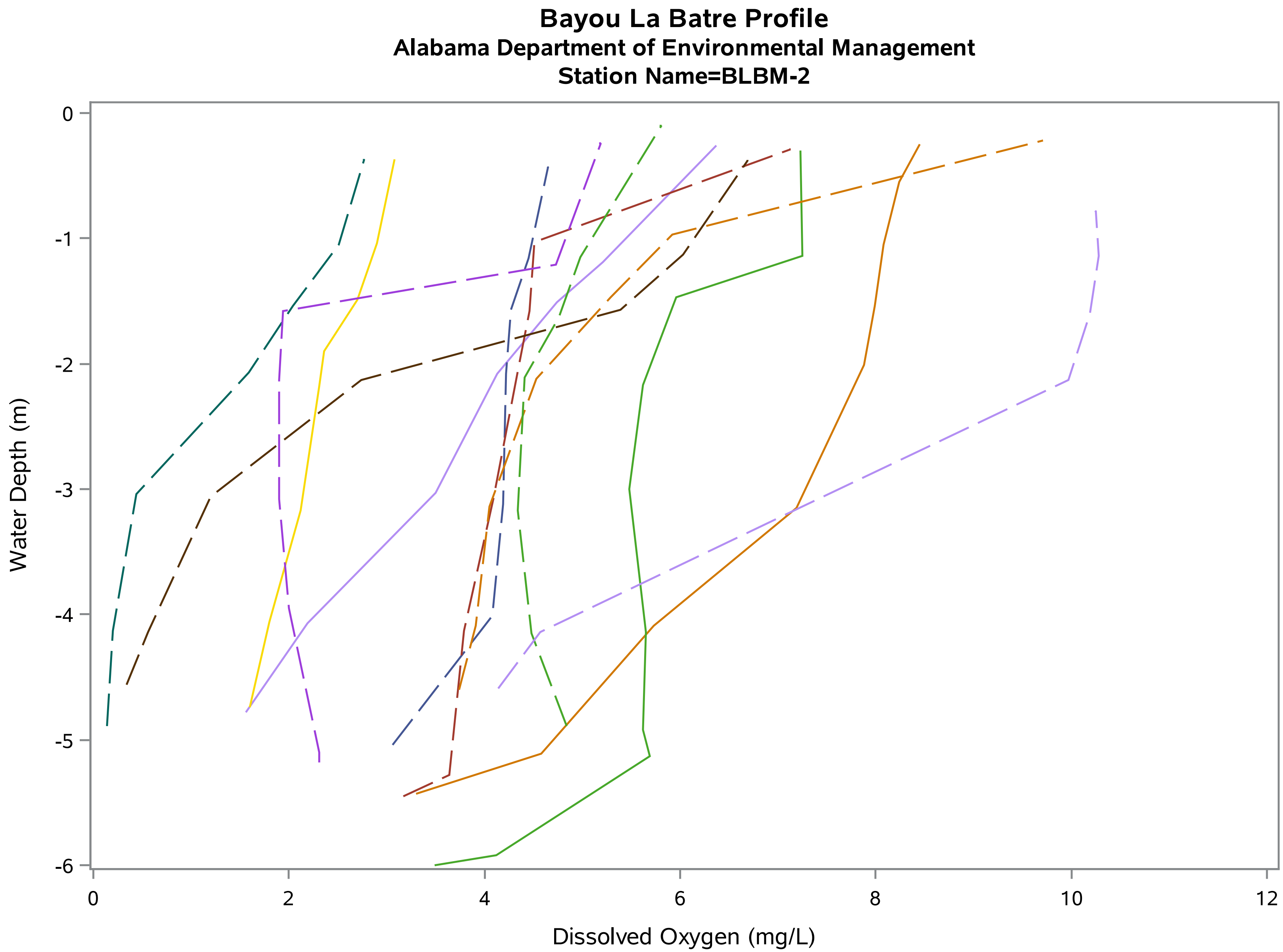


Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-6
Water Depth (m)
0
-1
-2
-3
-4
0
2
4
6
8
10
12
Dissolved Oxygen (mg/L)

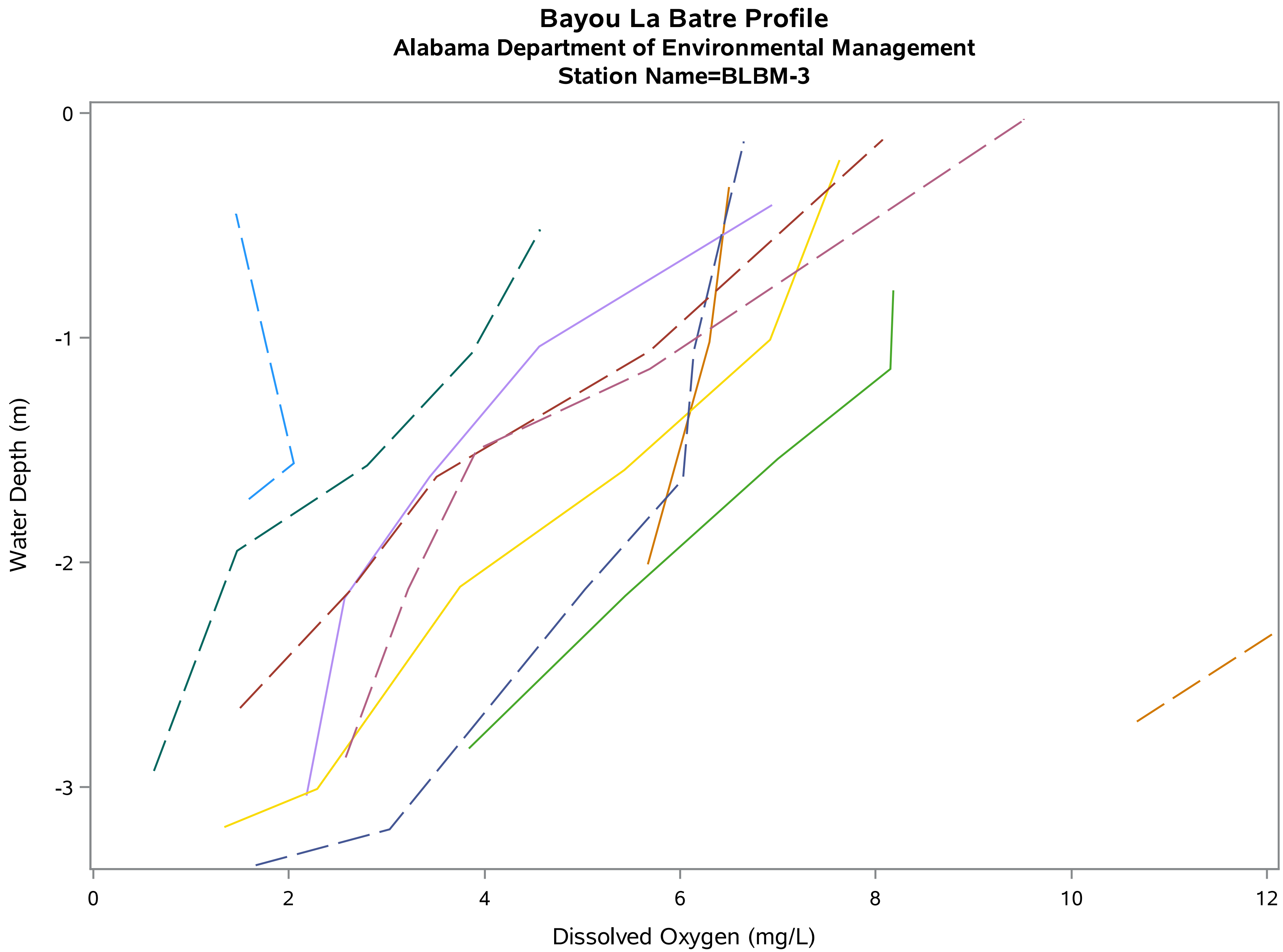

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-9
0.0
-0.5
-1.0
-1.5
-2.0
Water Depth (m)
0
2
4
6
8
10
12
Dissolved Oxygen (mg/L)

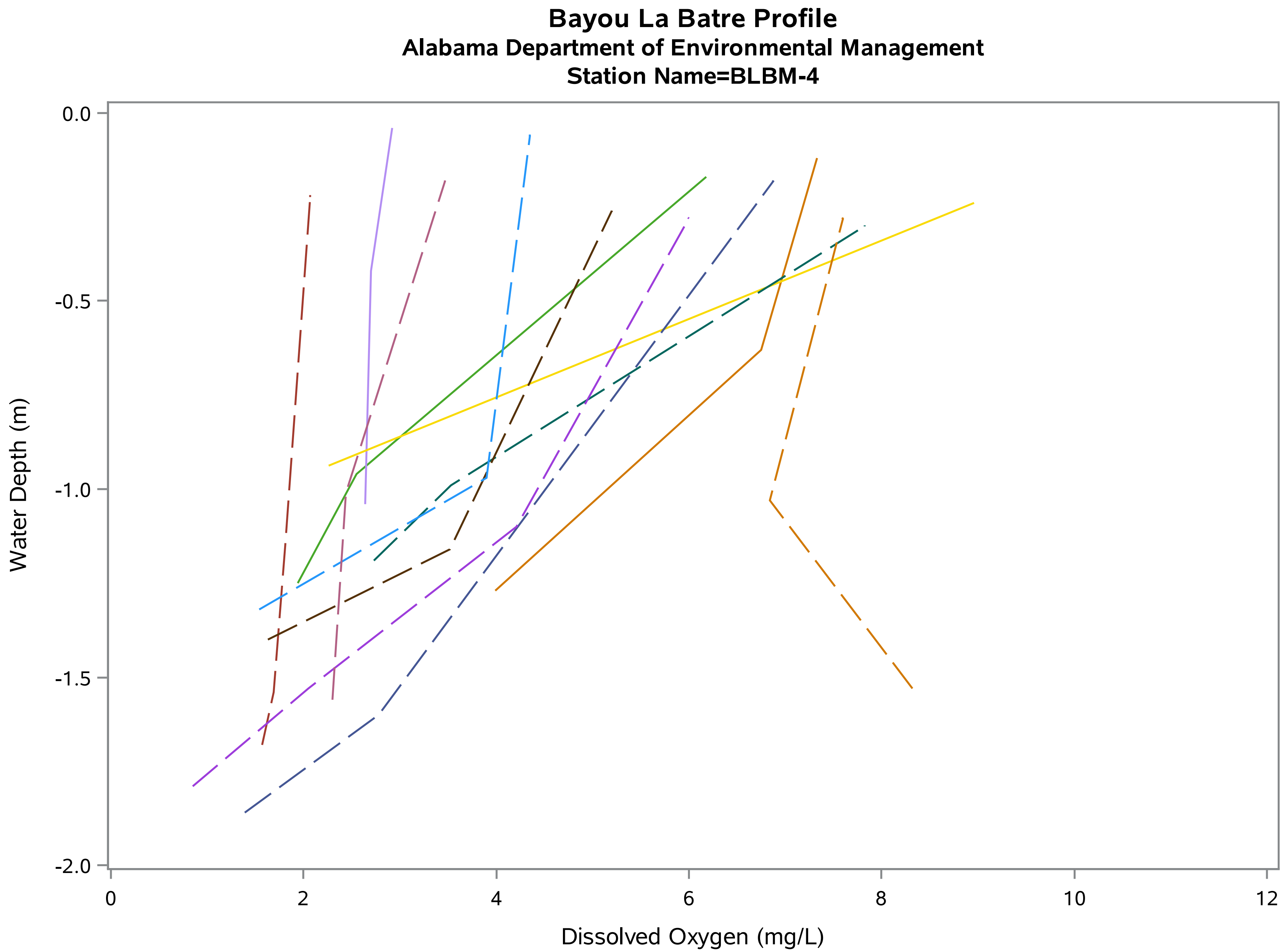

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLB-1
Water Depth (m)
0
-1
-2
-3
-4
-5
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12

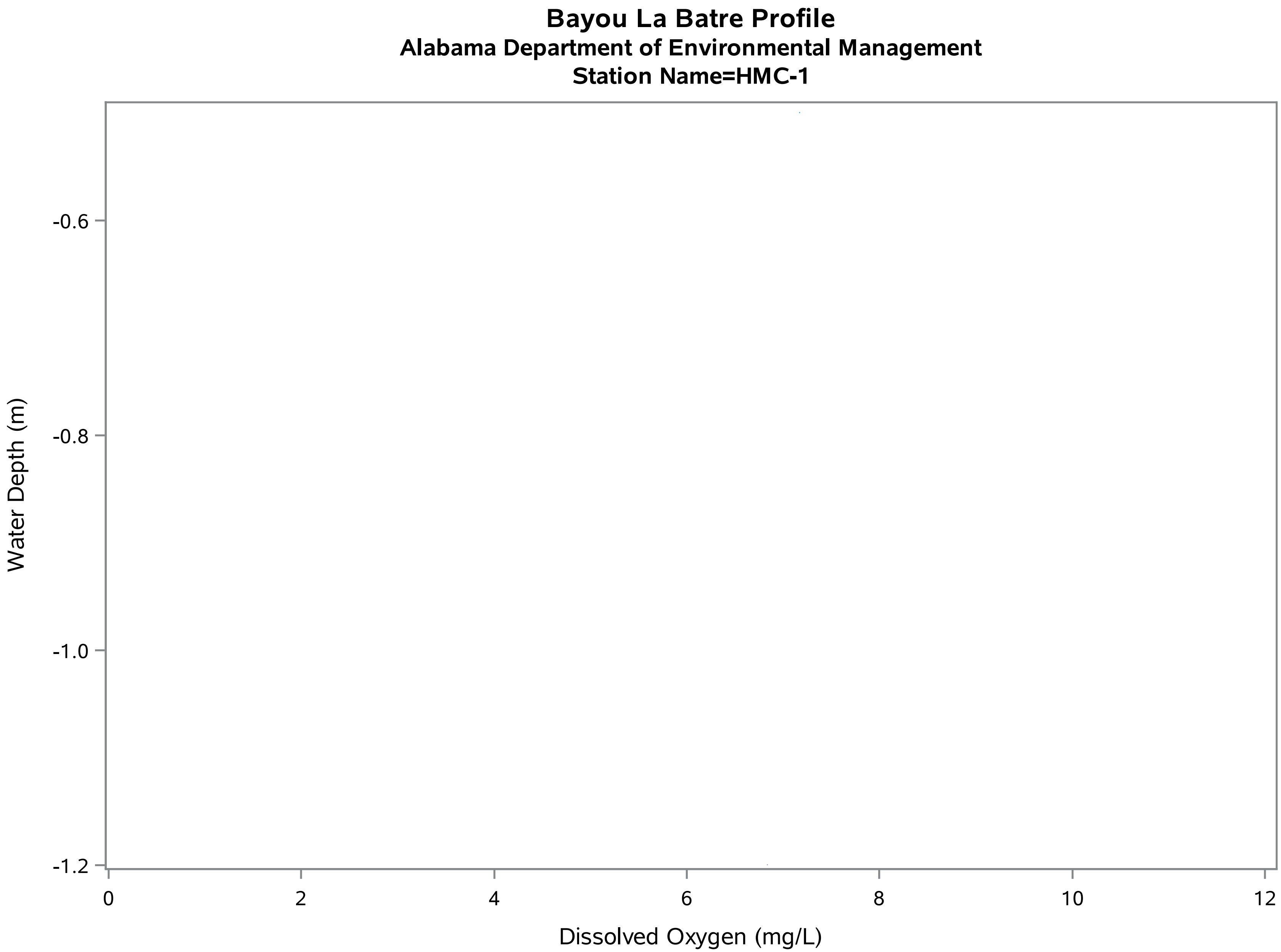

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-1
Water Depth (m)
0
-2
-4
-6
0
2
4
6
8
10
12
Dissolved Oxygen (mg/L)



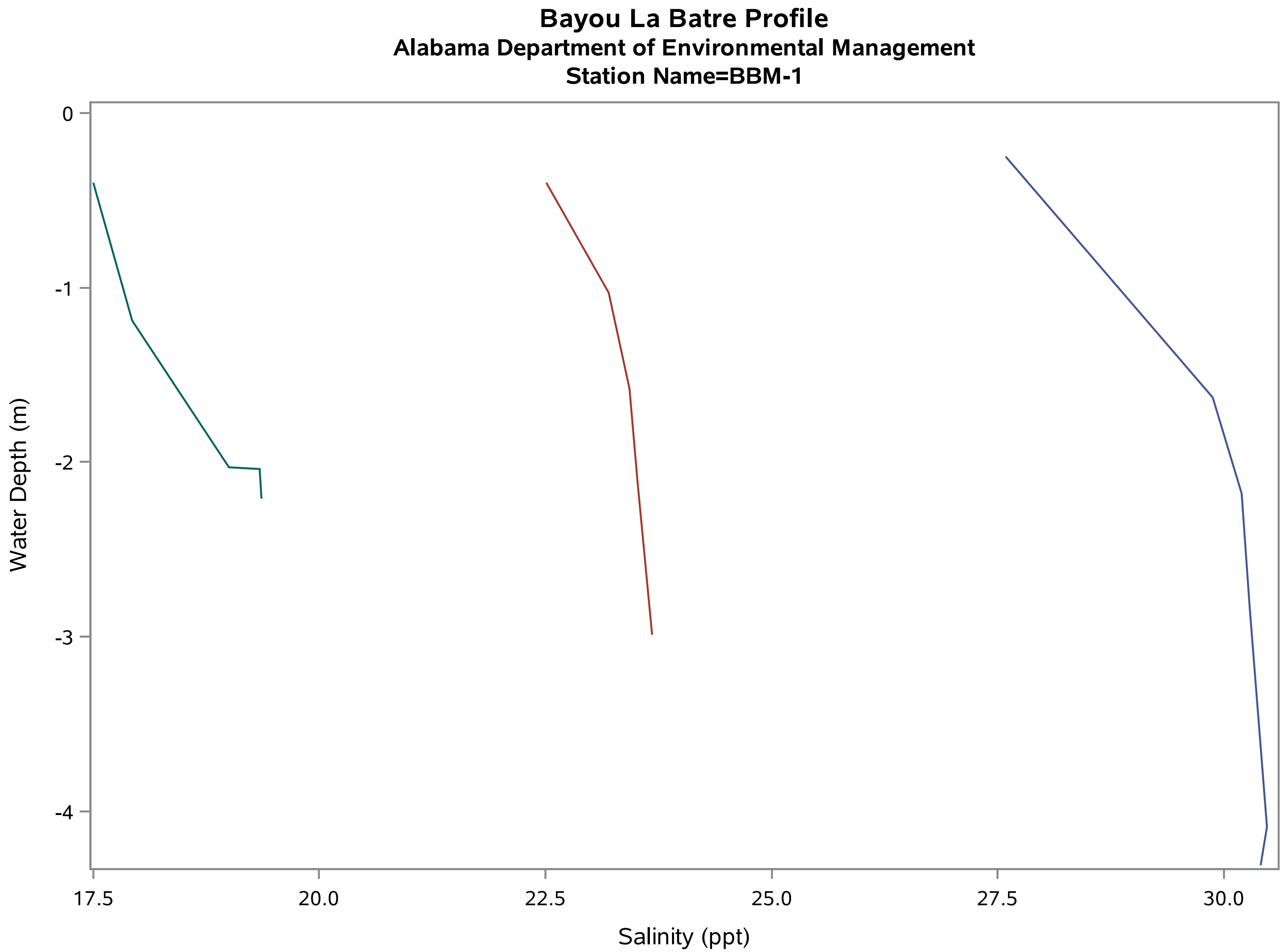
Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-2
Water Depth (m)
0
-1
-2
-3
-4
-5
-6
0
2
4
6
8
10
12
Dissolved Oxygen (mg/L)

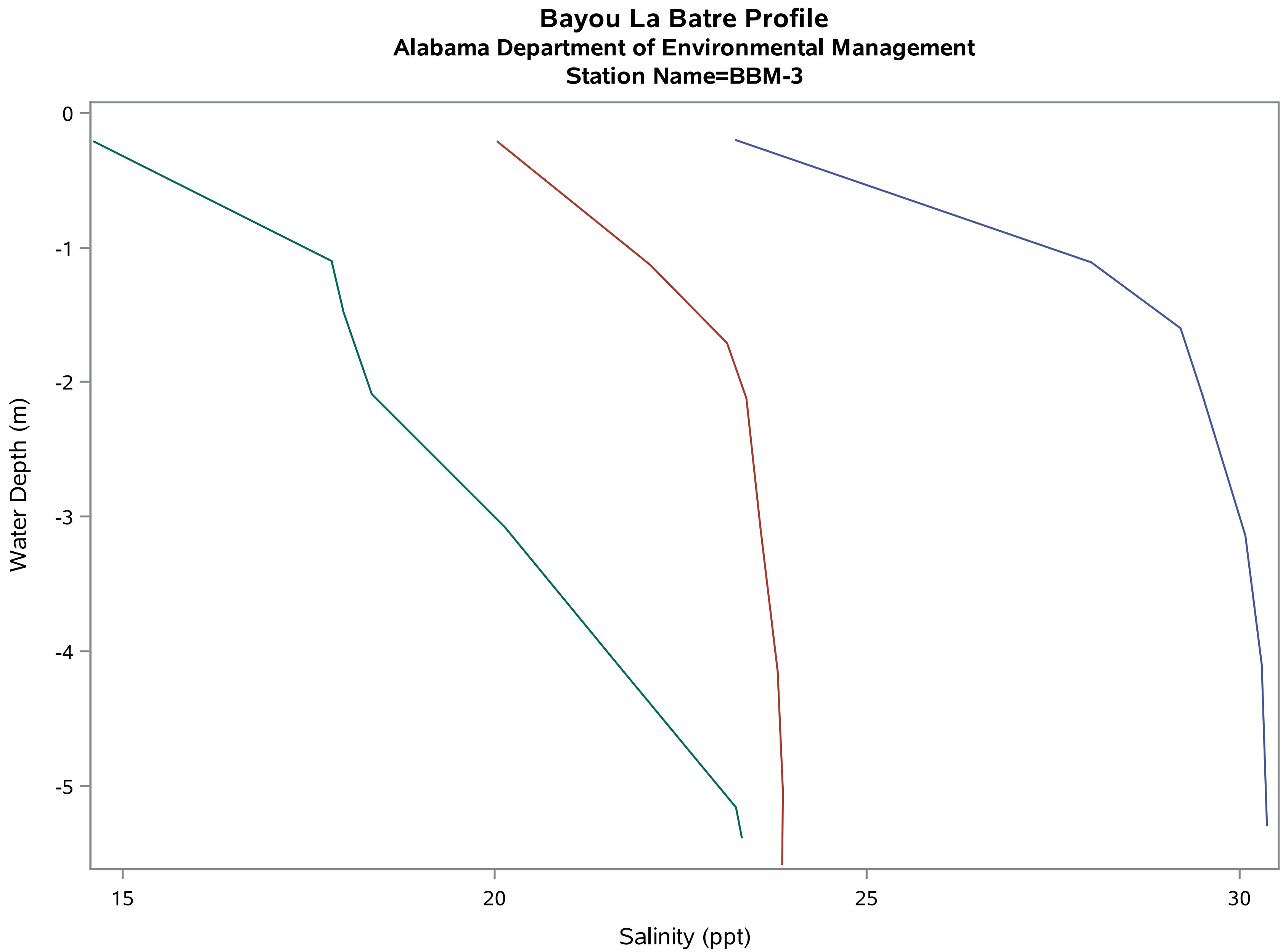

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-3
Water Depth (m)
0
-1
-2
-3
0
2
4
6
8
10
12
Dissolved Oxygen (mg/L)

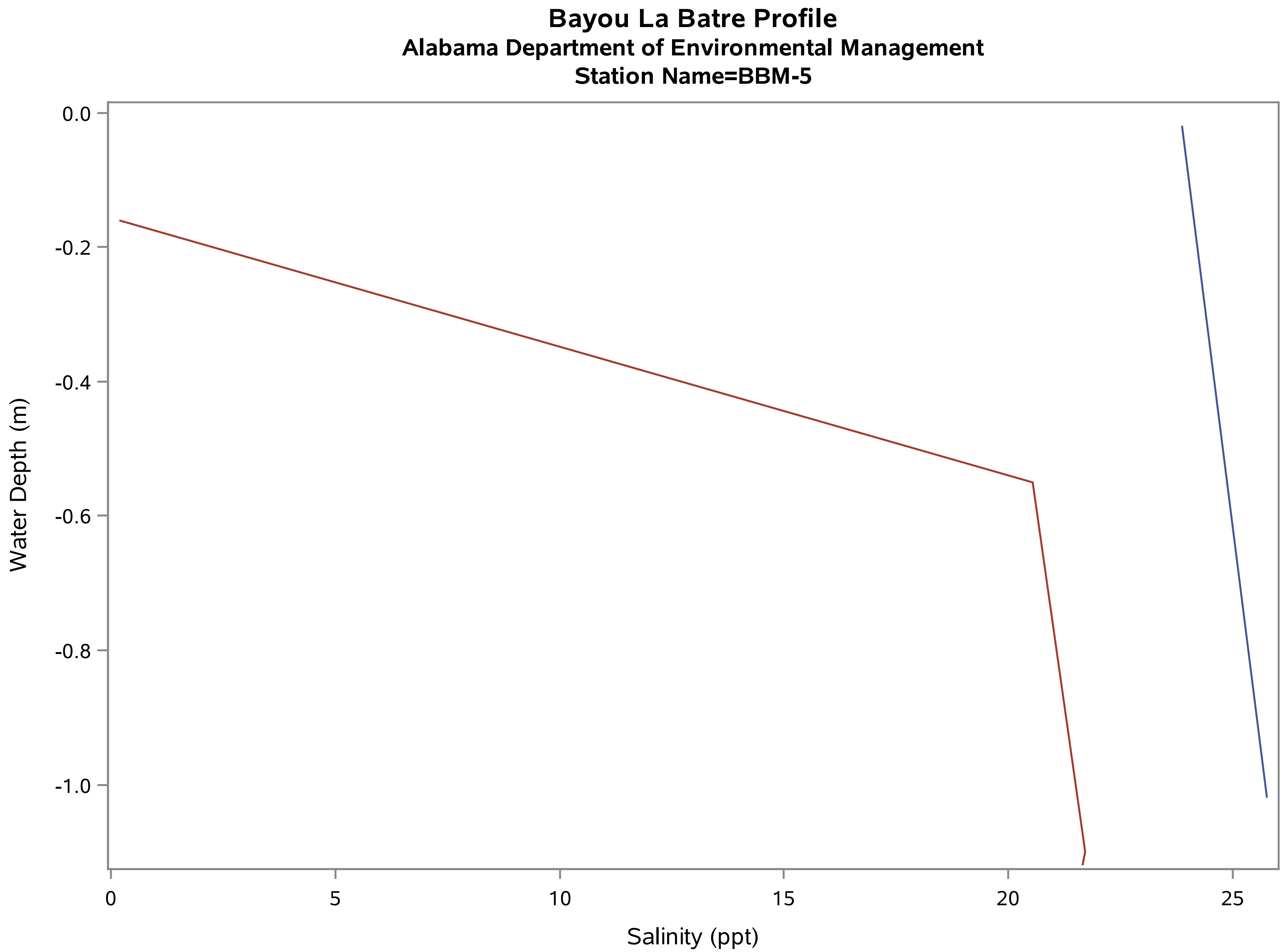

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-4
0.0
-0.5
-1.0
-1.5
-2.0
Water Depth (m)
0
2
4
6
8
10
12
Dissolved Oxygen (mg/L)


Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=HMC-1
-0.6
-0.8
-1.0
-1.2
Water Depth (m)
0
2
4
6
8
10
12
Dissolved Oxygen (mg/L)

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=HMC-2


Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-1
0
-1
-2
-3
-4
Water Depth (m)
17.5
20.0
22.5
25.0
27.5
30.0
Salinity (ppt)

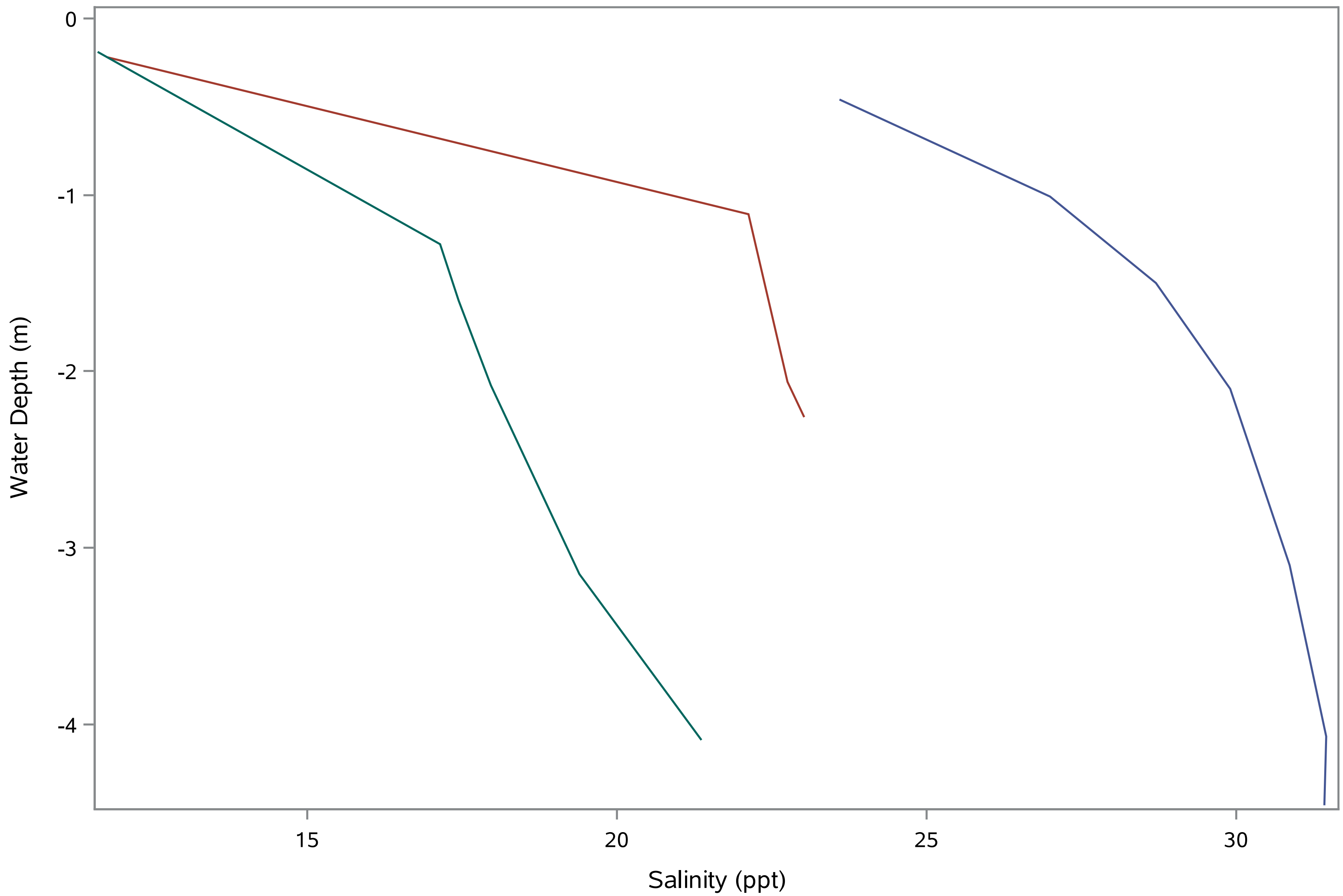

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-3
Water Depth (m)
0
-1
-2
-3
-4
-5
15
20
25
30
Salinity (ppt)

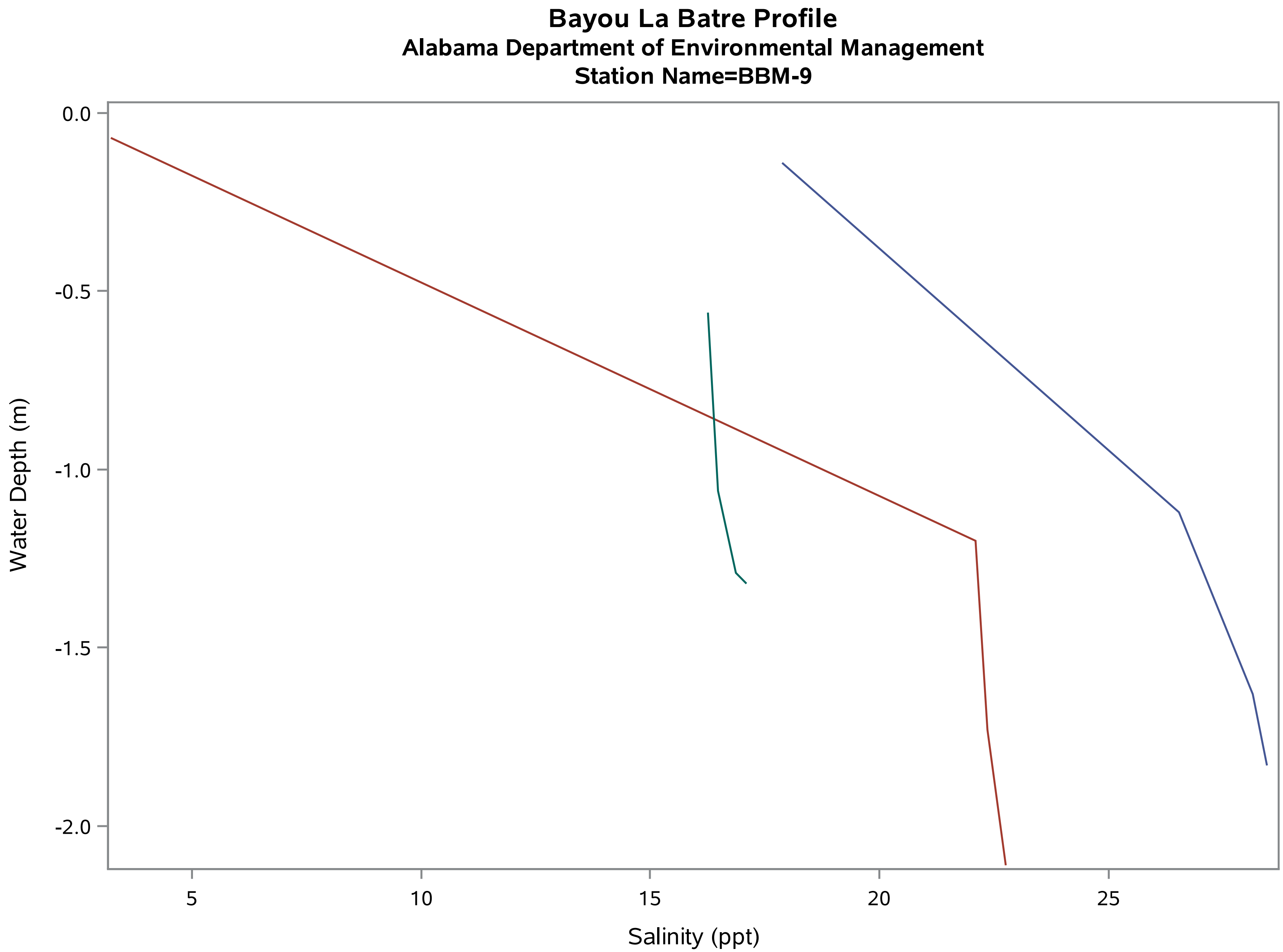

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-5
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
Water Depth (m)
0
5
10
15
20
25
Salinity (ppt)

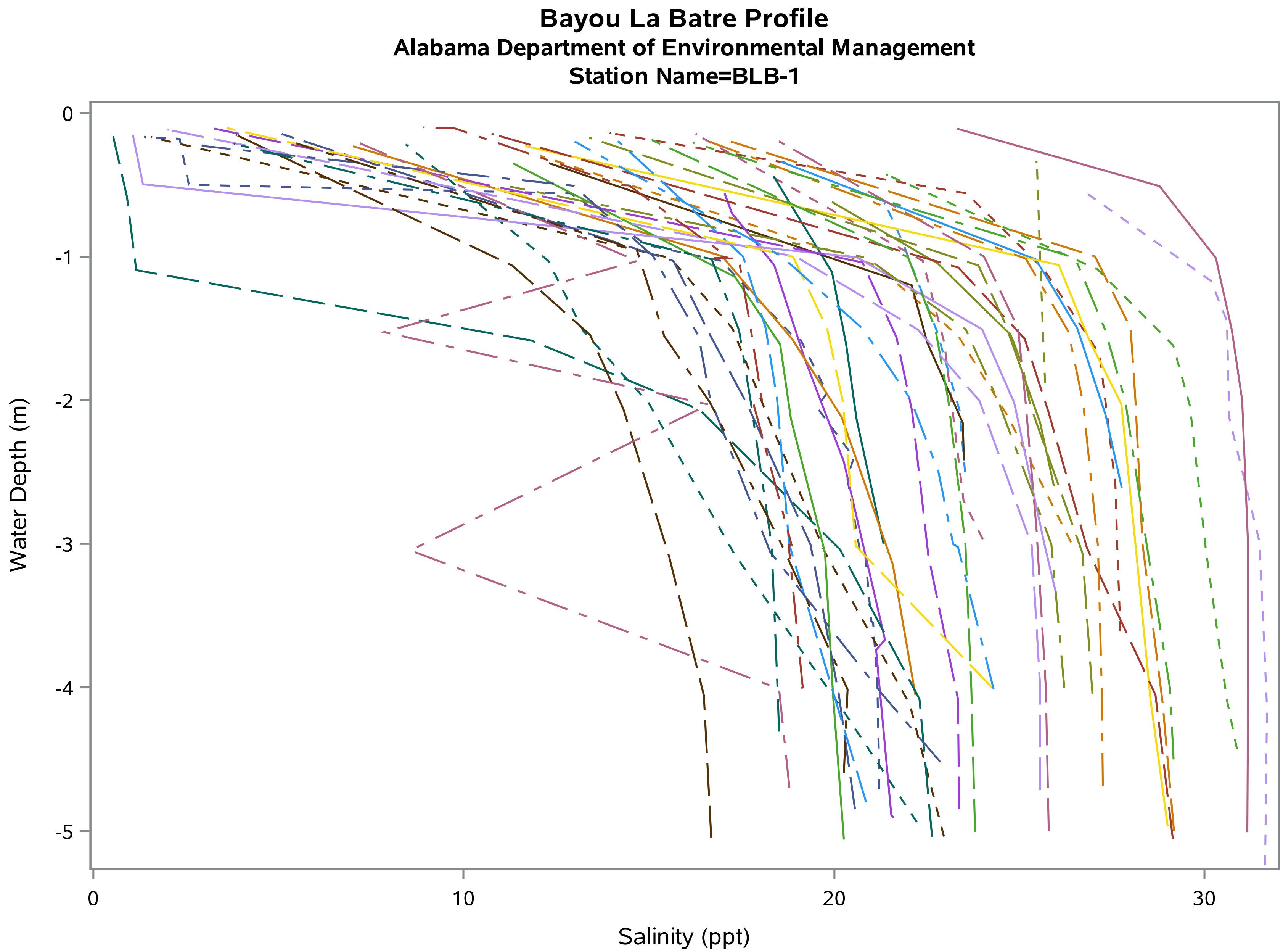
Bayou La Batre Profile

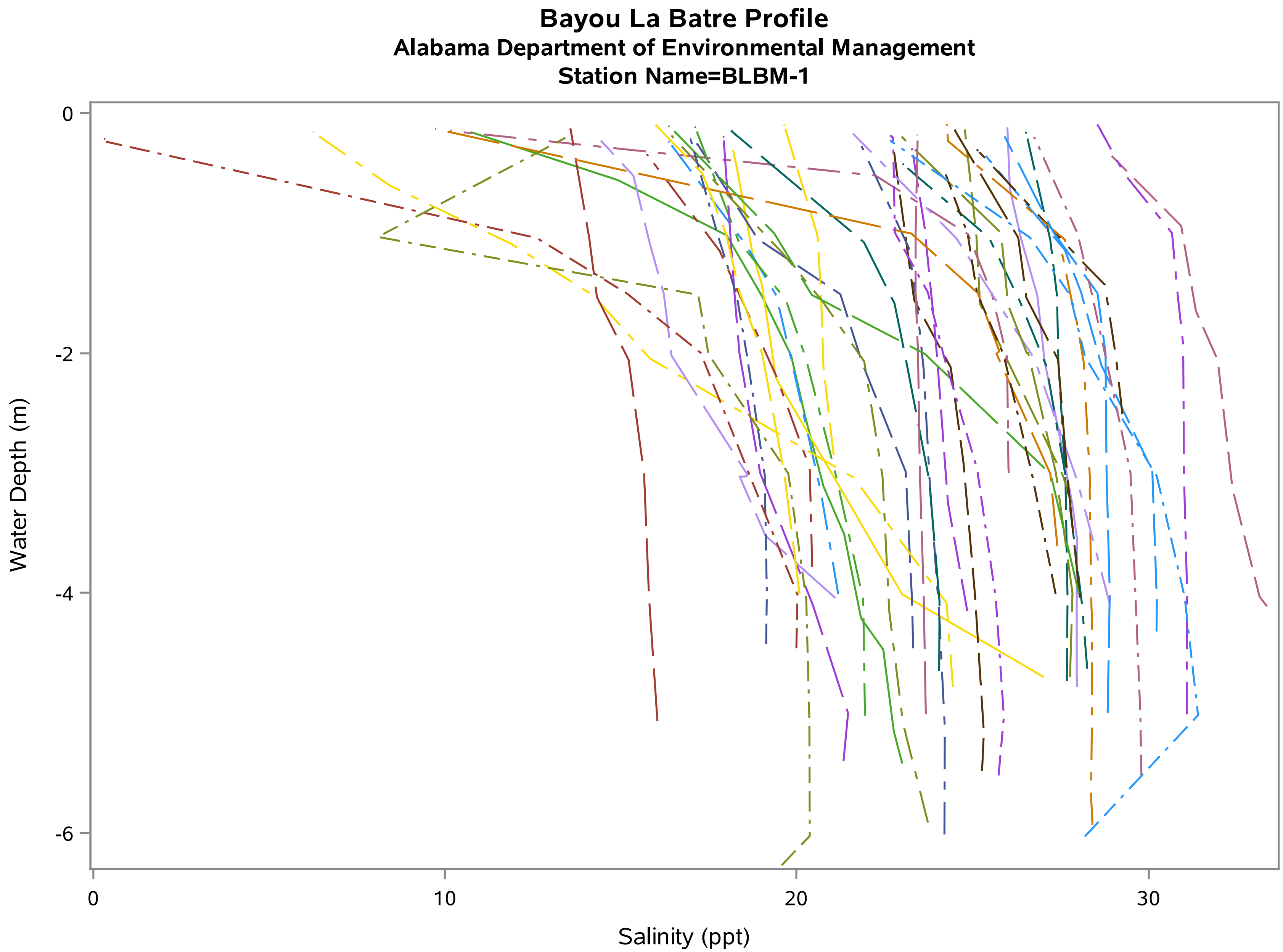
Alabama Department of Environmental Management

Station Name=BBM-6

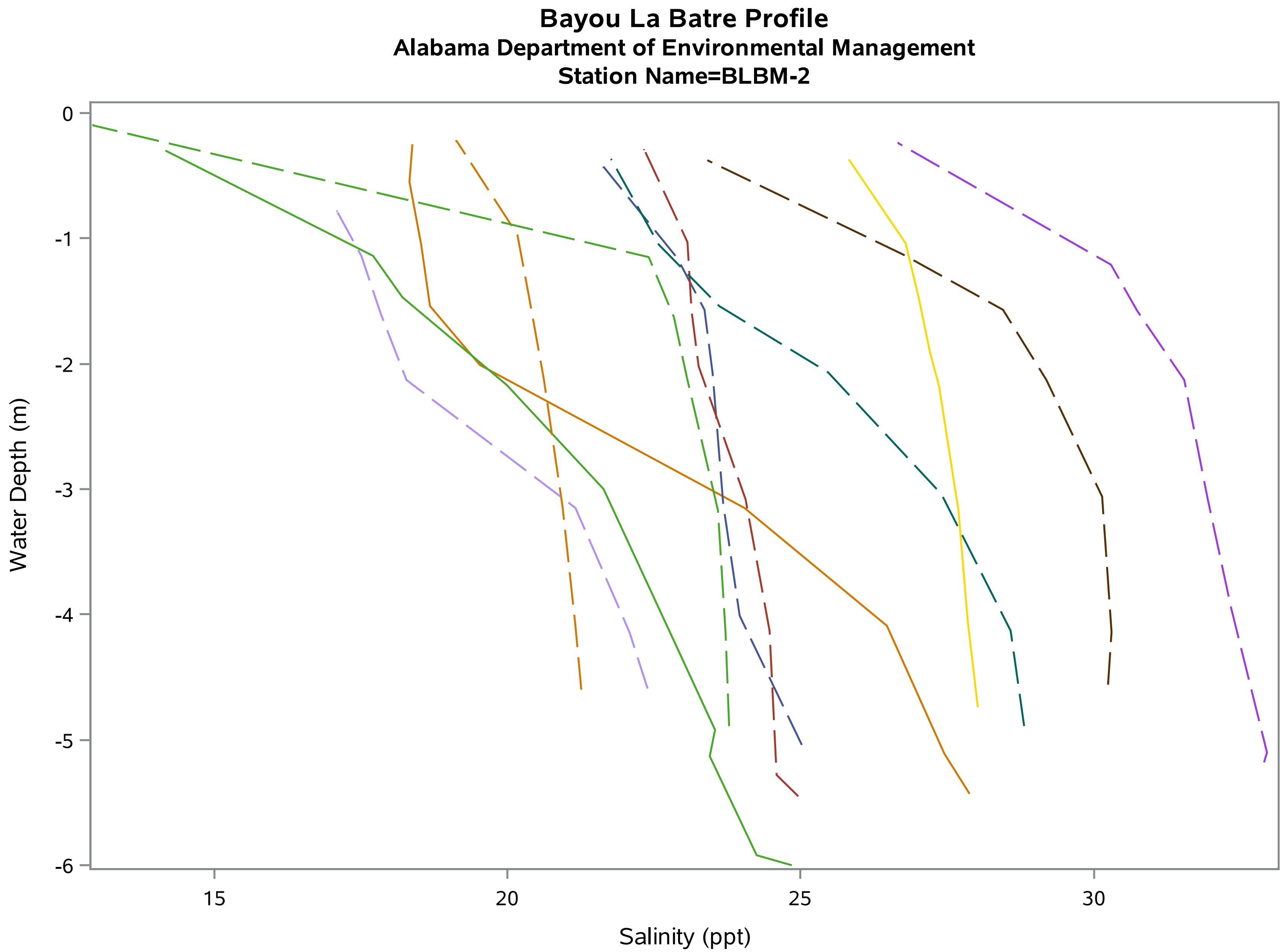



Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-9
0.0
-0.5
-1.0
-1.5
-2.0
Water Depth (m)
5
10
15
20
25
Salinity (ppt)

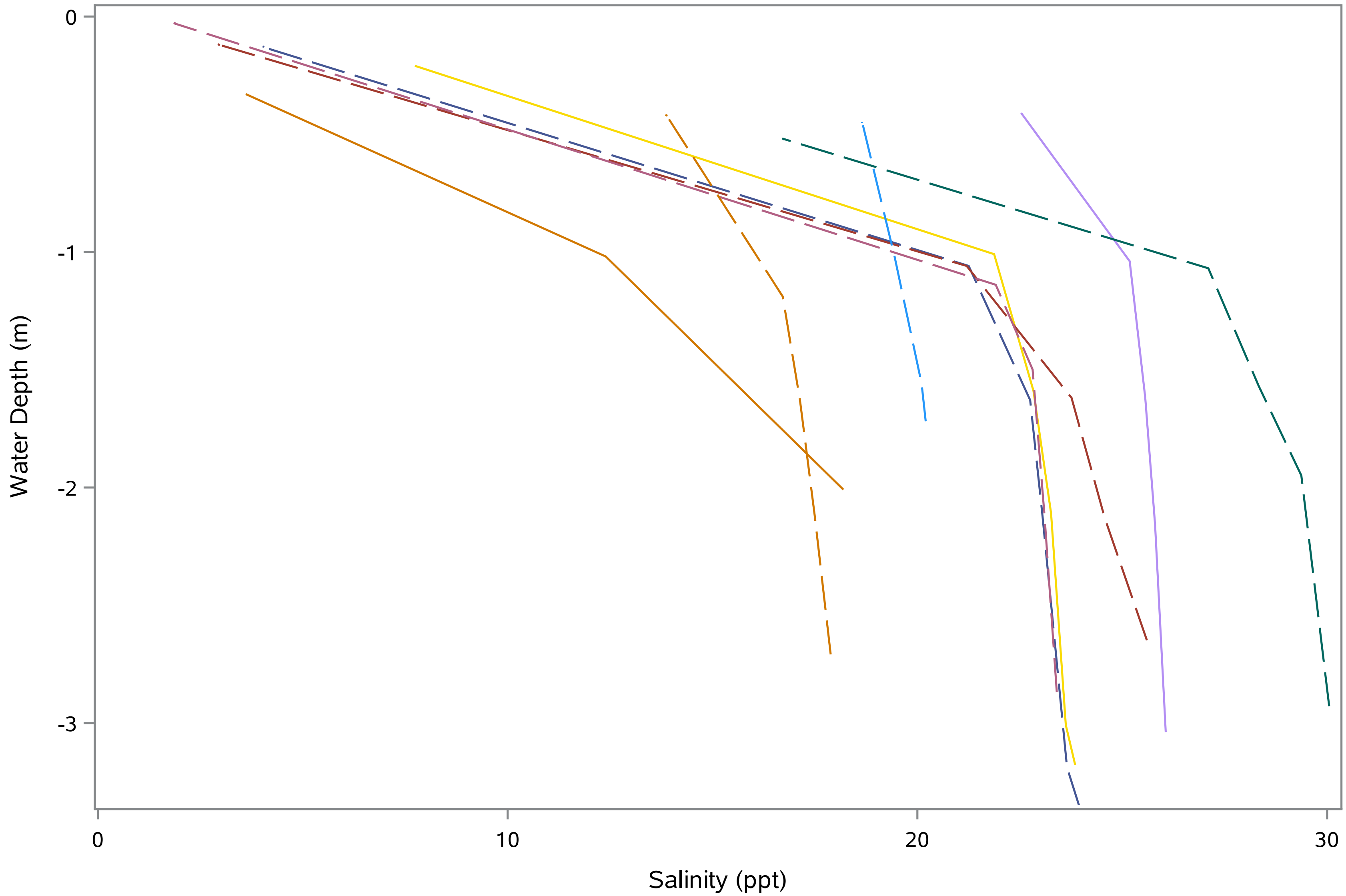

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLB-1
Water Depth (m)
0
-1
-2
-3
-4
-5
0
10
20
30
Salinity (ppt)

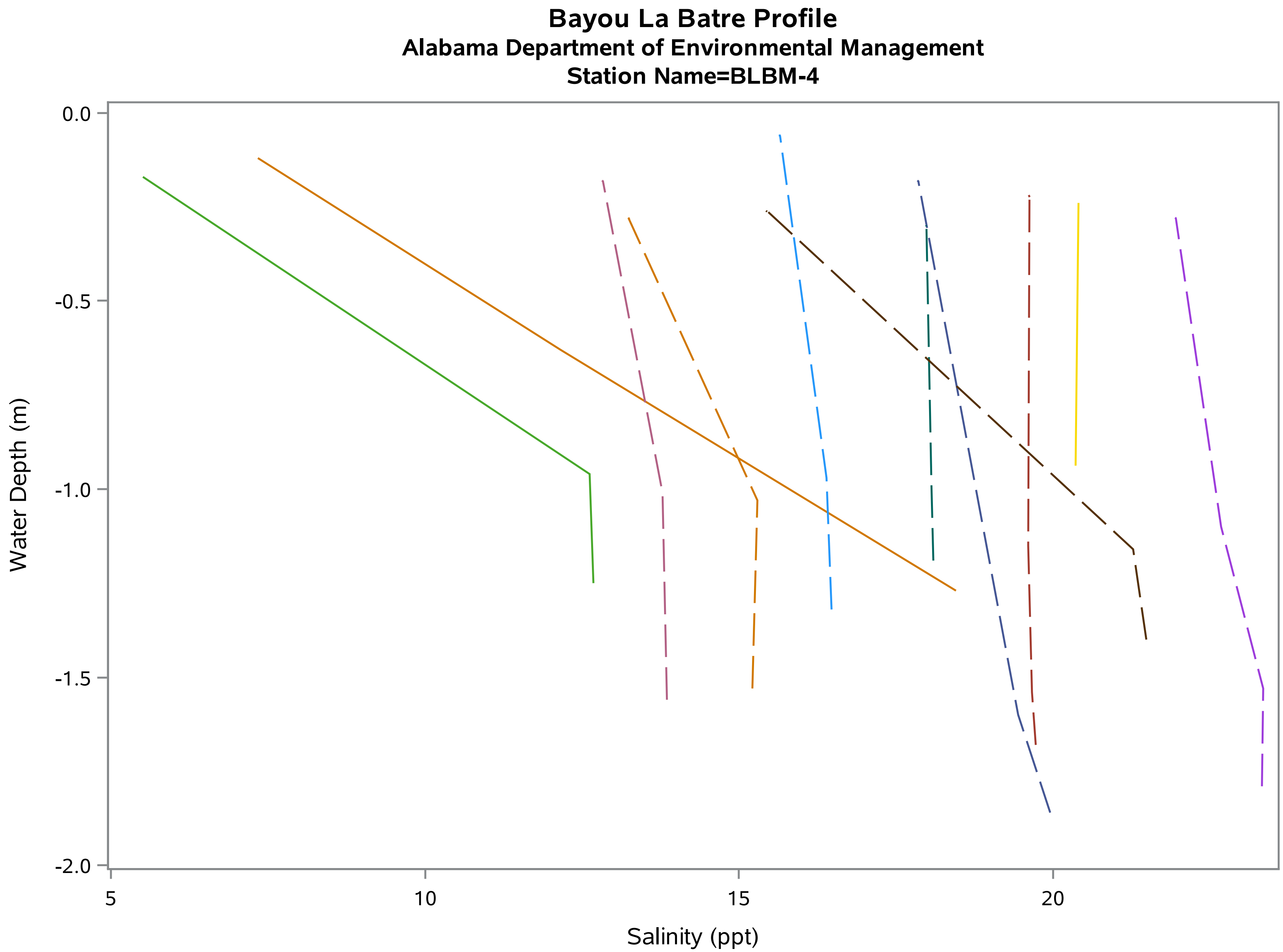


Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-1
0
-2
-4
-6
Water Depth (m)
0
10
20
30
Salinity (ppt)


Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-2
Water Depth (m)
0
-1
-2
-3
-4
-5
-6
15
20
25
30
Salinity (ppt)

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-3



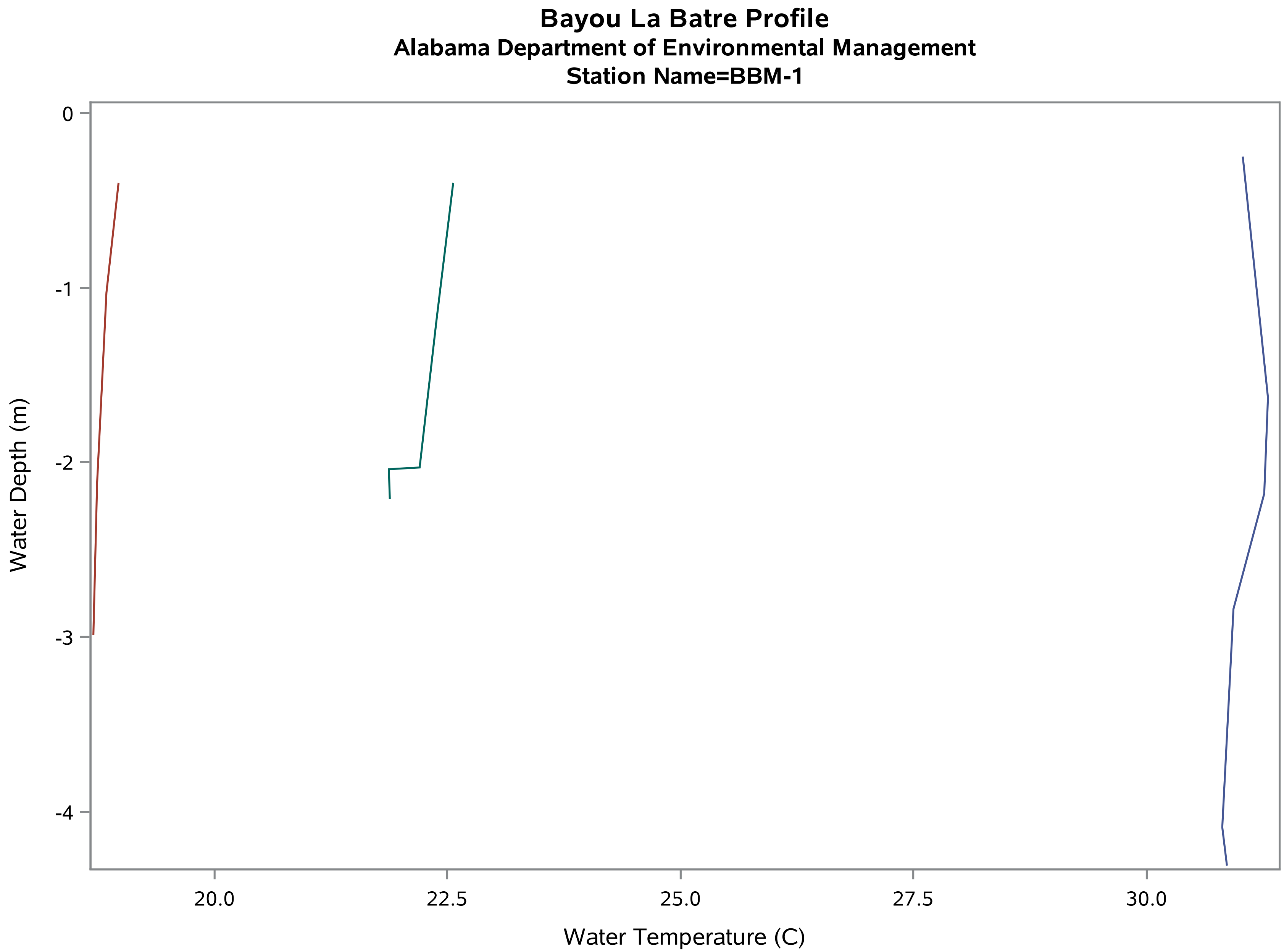

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-4
0.0
-0.5
-1.0
-1.5
-2.0
Water Depth (m)
5
10
15
20
Salinity (ppt)

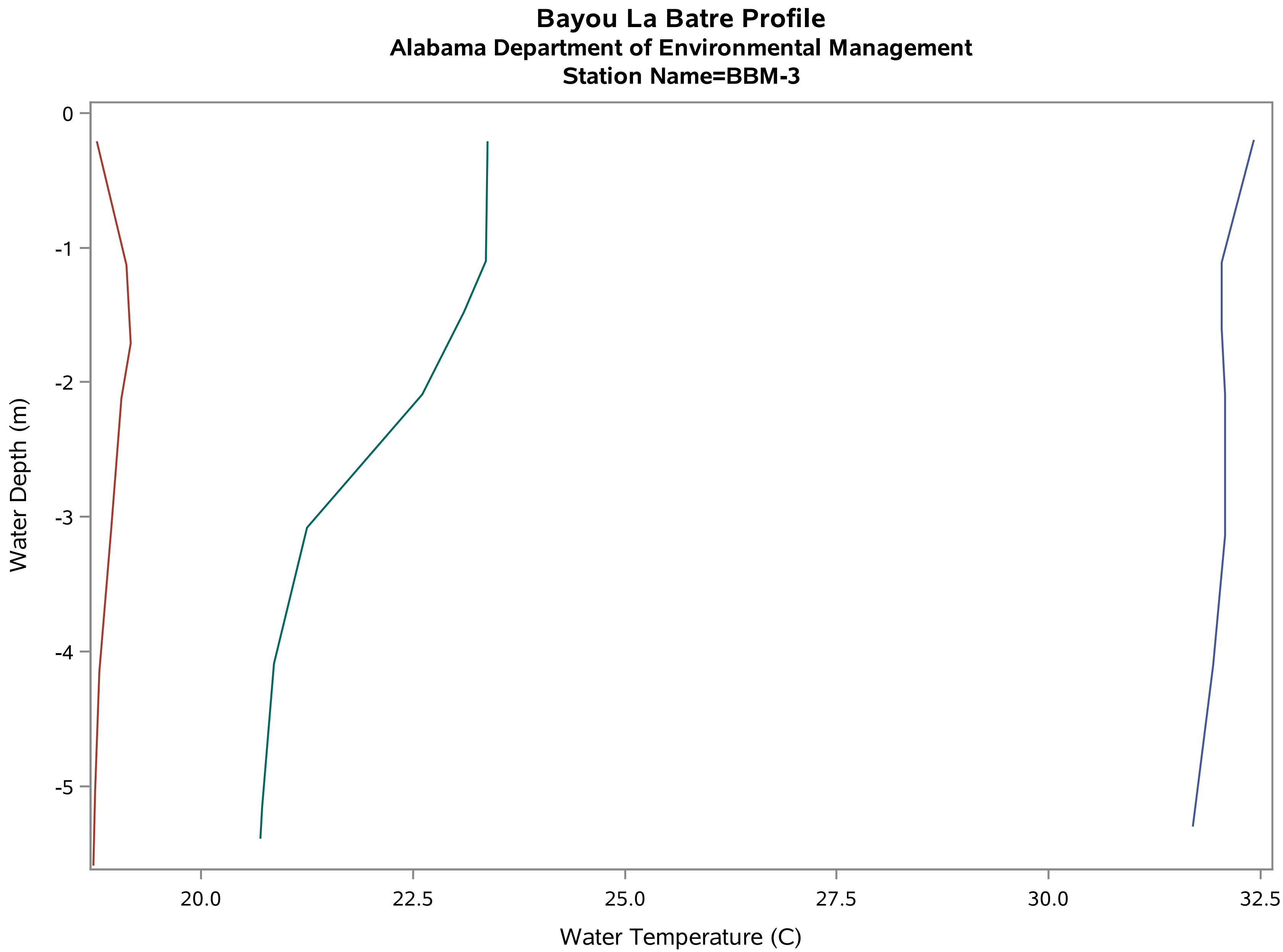
Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=HMC-1
Water Depth (m)
-0.6
-0.8
-1.0
-1.2
0.01
Salinity (ppt)

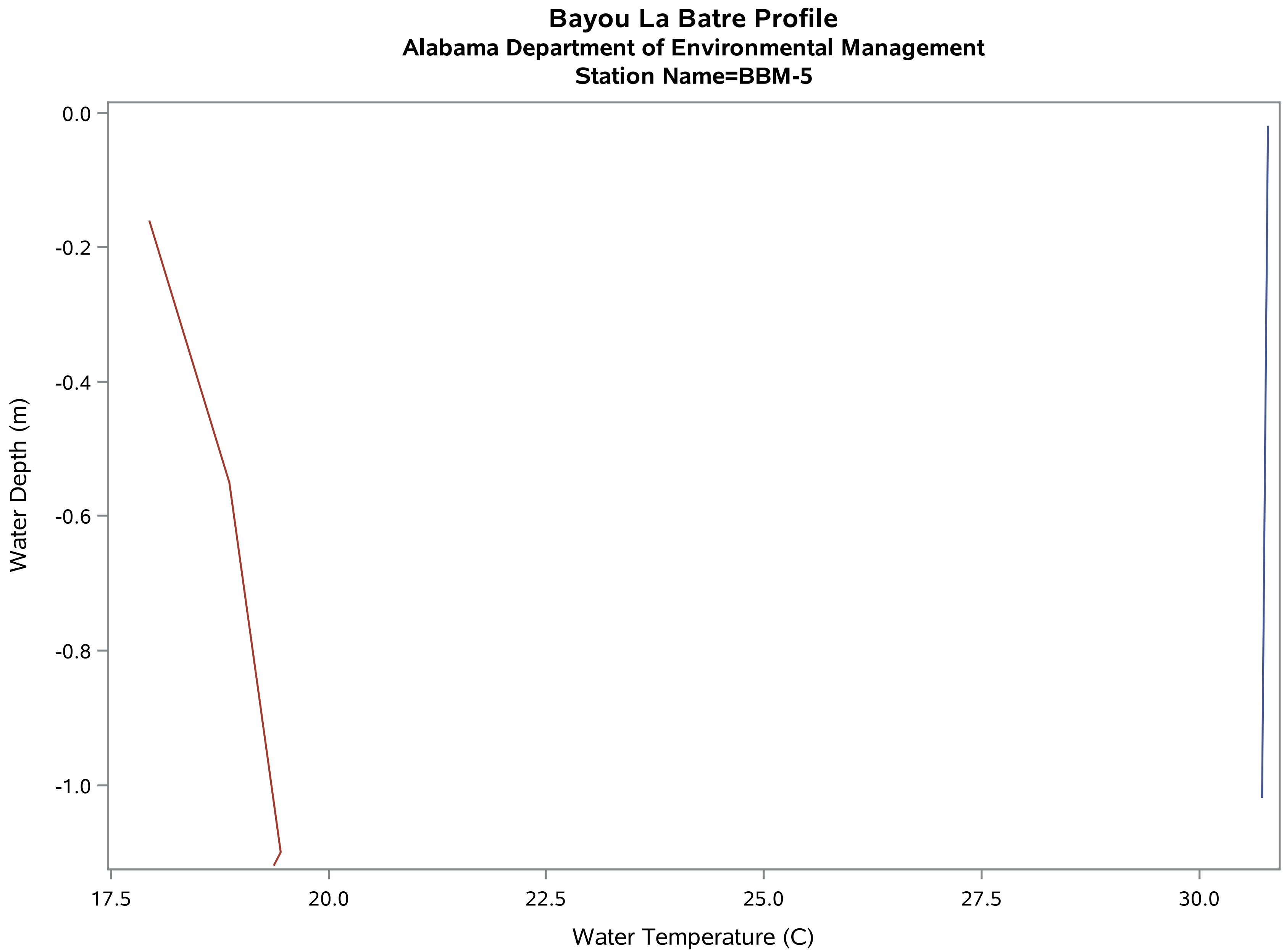
Bayou La Batre Profile

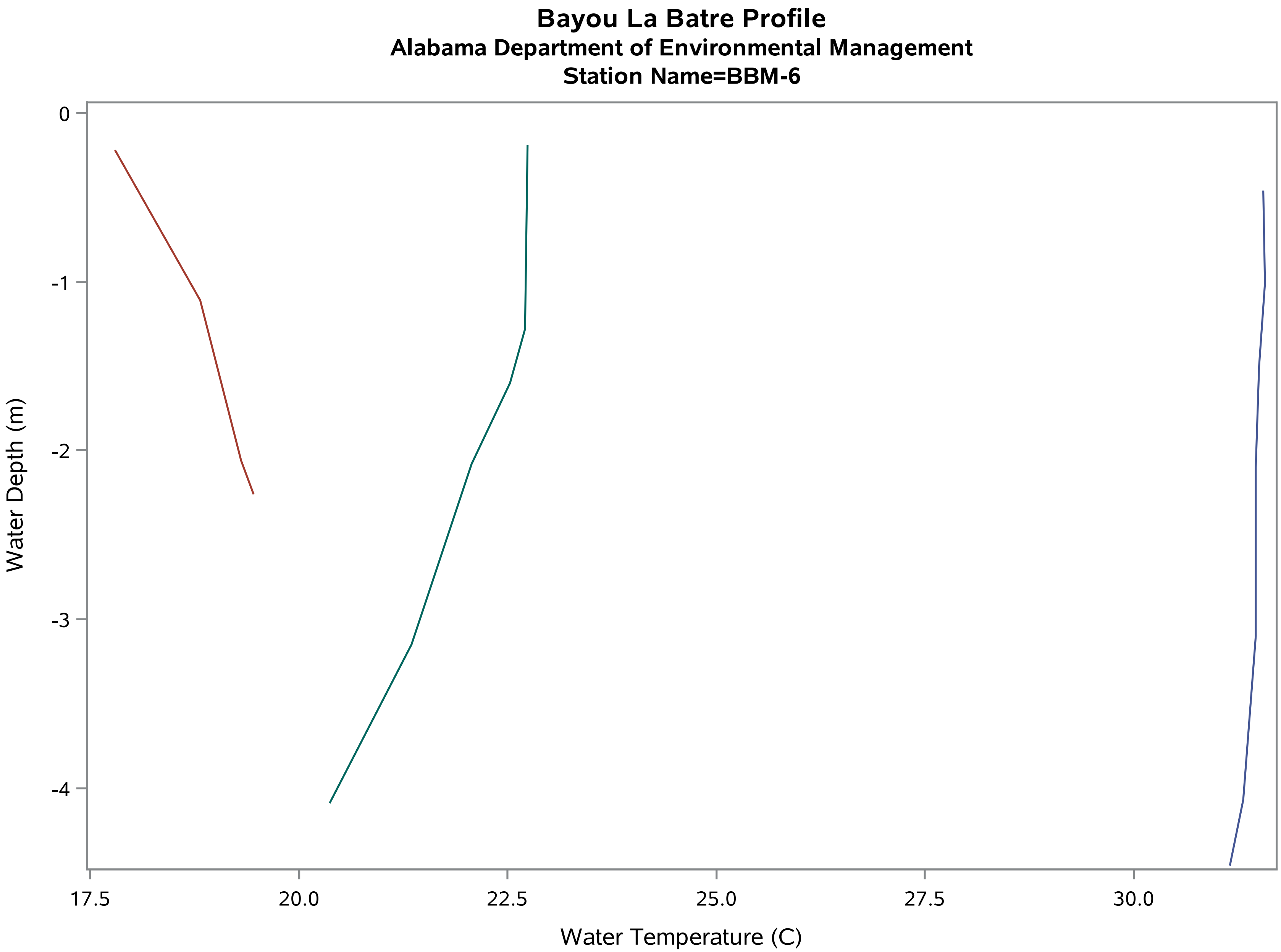
Alabama Department of Environmental Management

Station Name=HMC-2

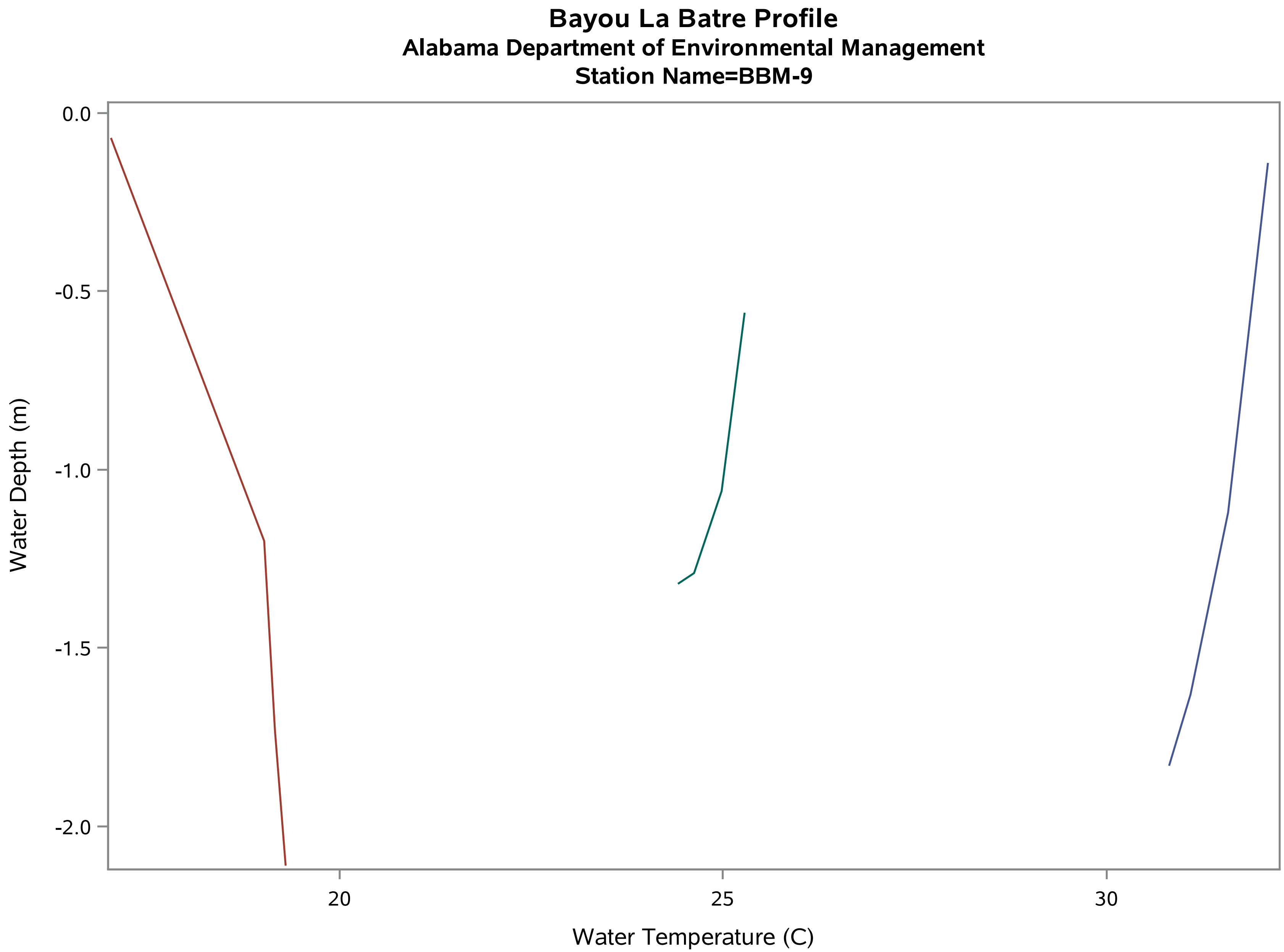

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-1
0
-1
-2
-3
-4
Water Depth (m)
20.0
22.5
25.0
27.5
30.0
Water Temperature (C)

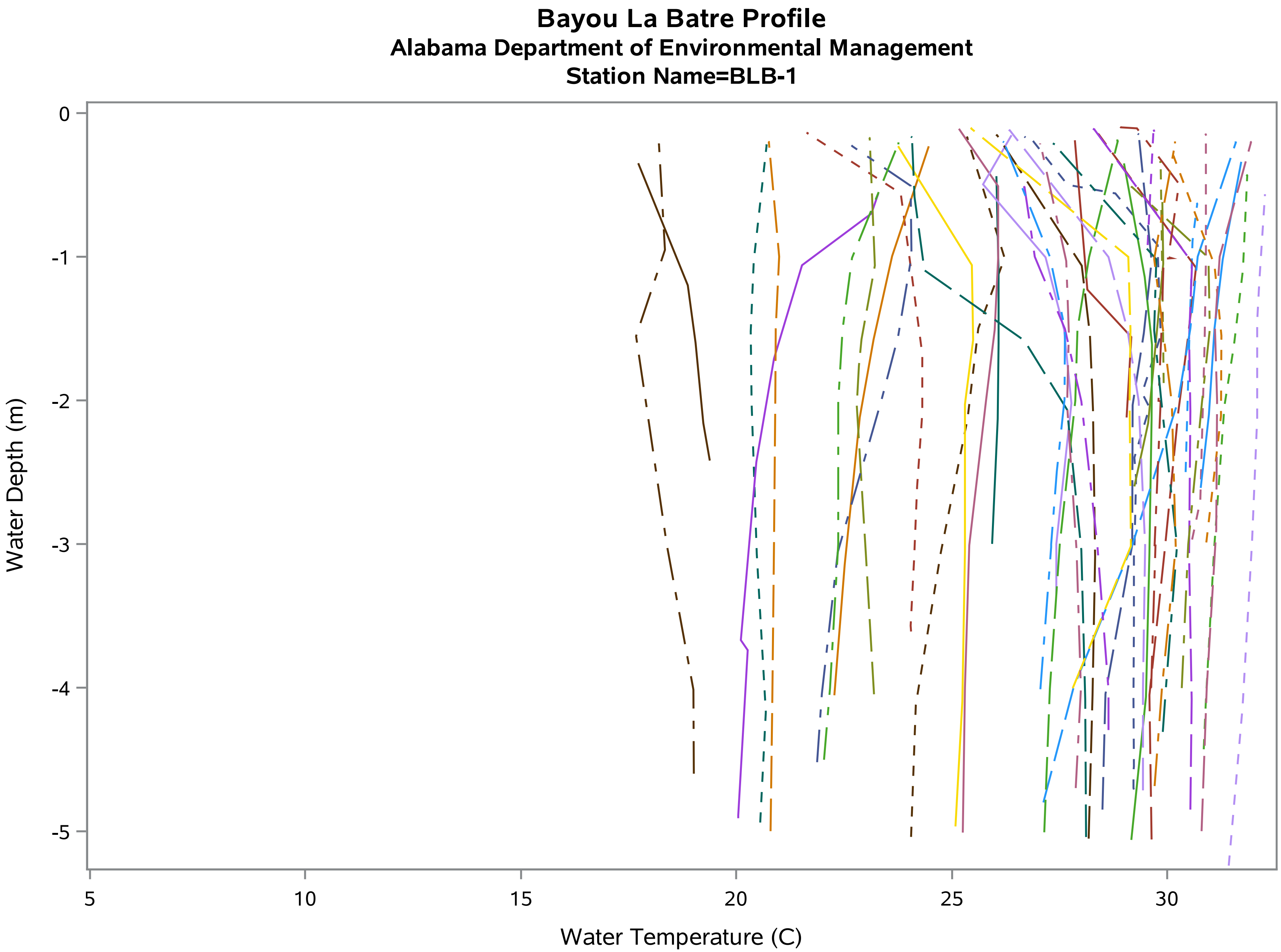

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-3
0
-1
-2
-3
-4
-5
Water Depth (m)
20.0
22.5
25.0
27.5
30.0
32.5
Water Temperature (C)


Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-5
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
Water Depth (m)
17.5
20.0
22.5
25.0
27.5
30.0
Water Temperature (C)

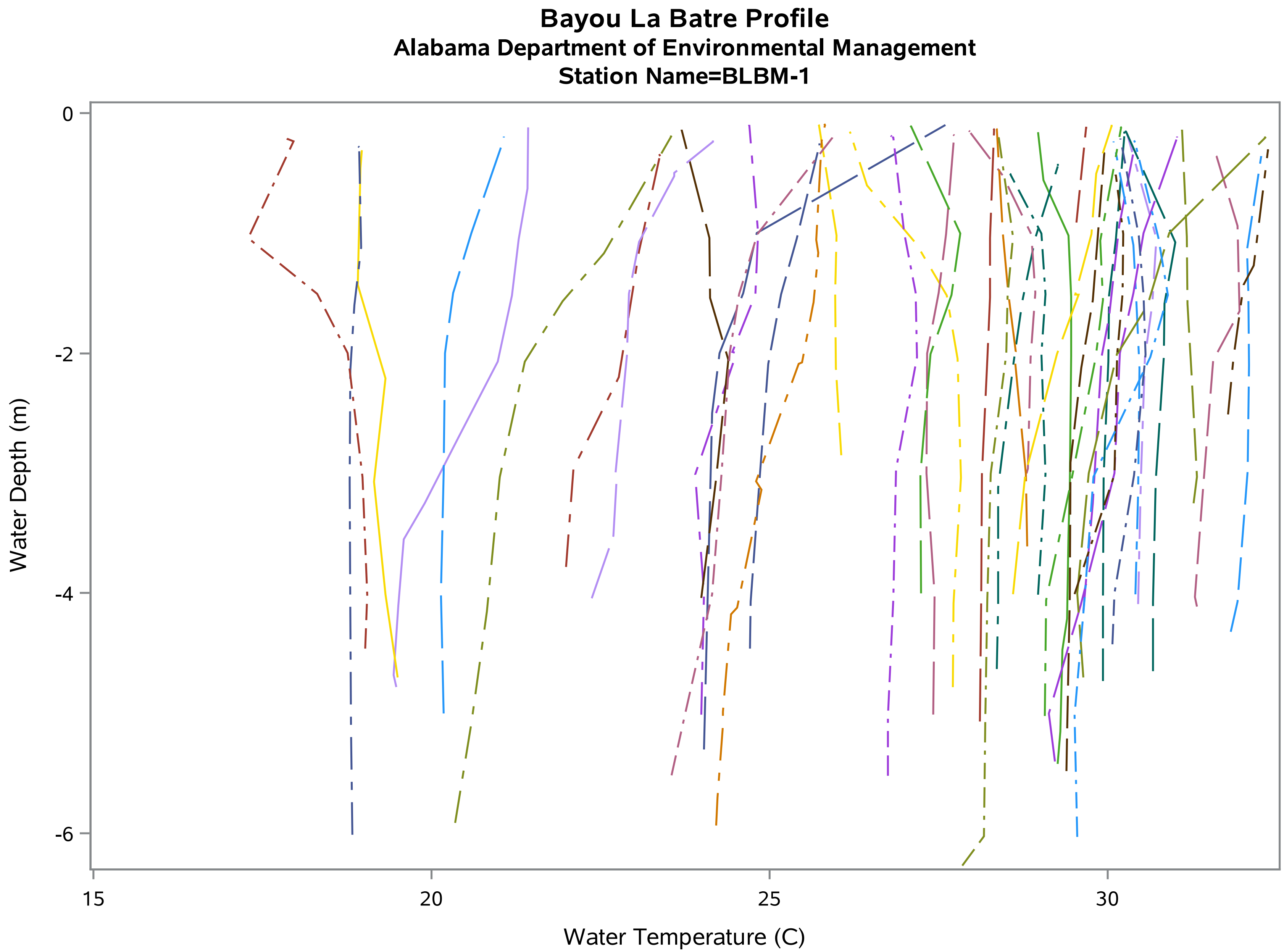


Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-6
0
-1
-2
-3
-4
Water Depth (m)
17.5
20.0
22.5
25.0
27.5
30.0
Water Temperature (C)

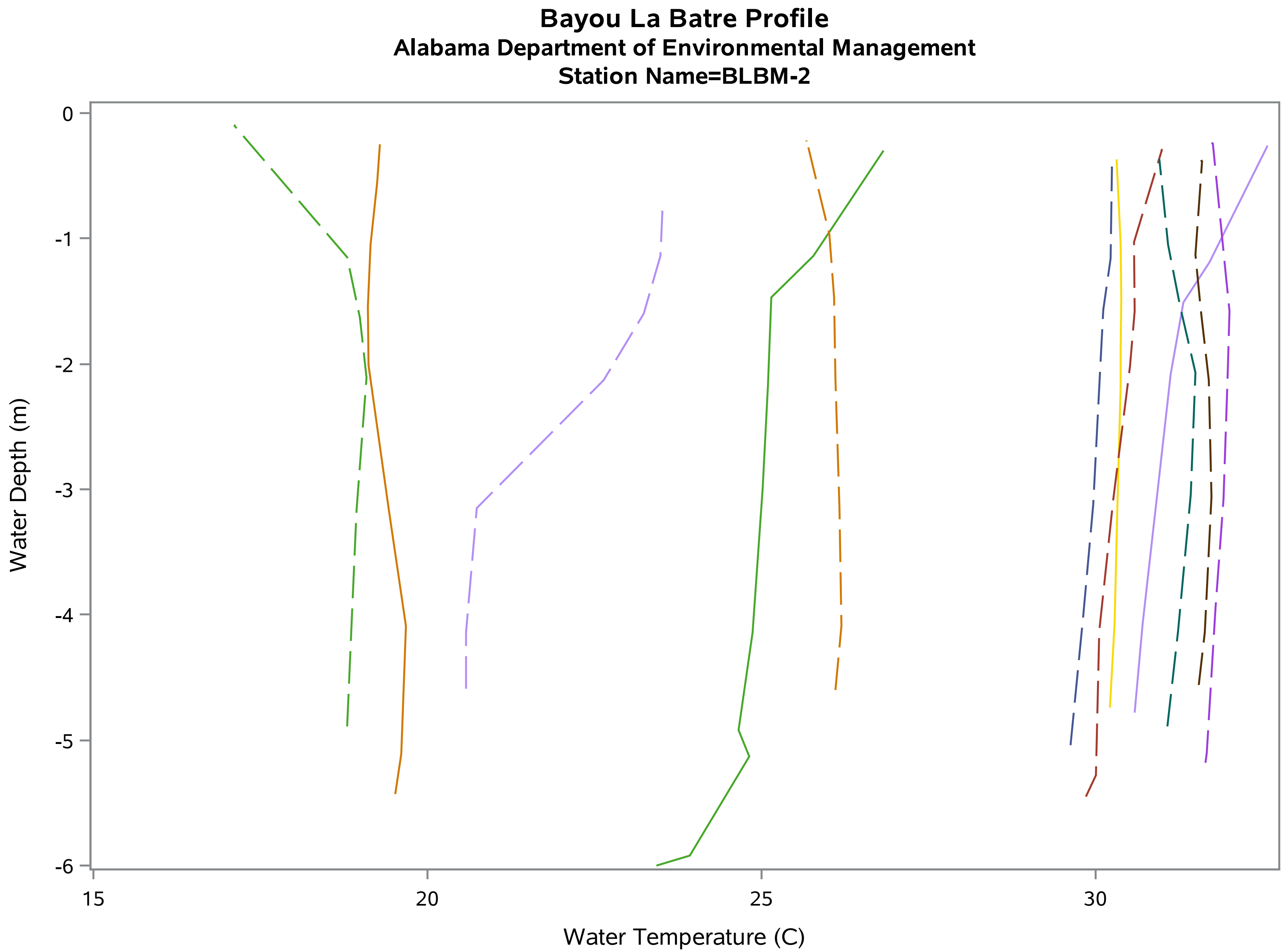

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-9
0.0
-0.5
-1.0
-1.5
-2.0
Water Depth (m)
20
25
30
Water Temperature (C)

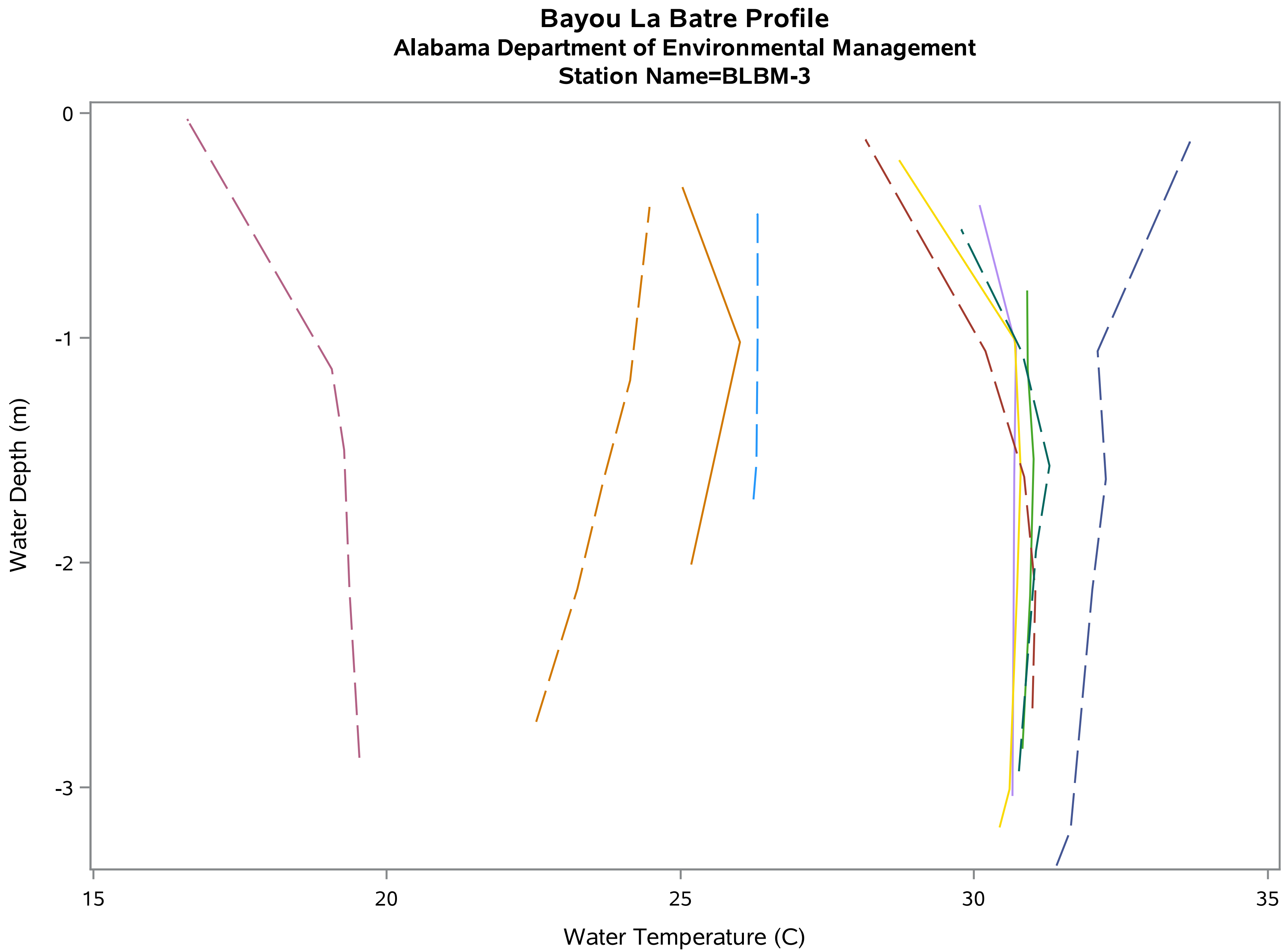


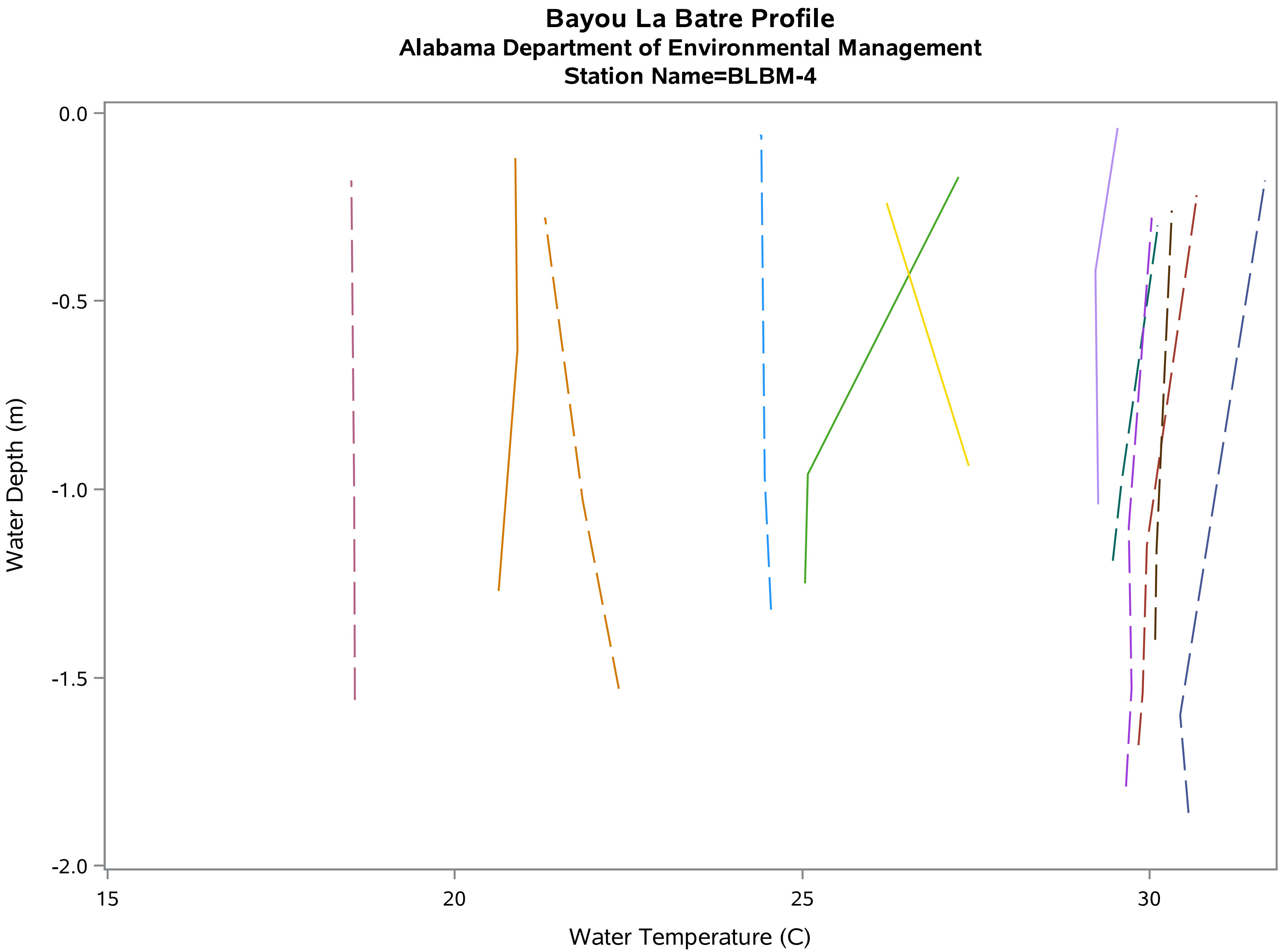
Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLB-1
Water Depth (m)
0
-1
-2
-3
-4
-5
5
10
15
20
25
30
Water Temperature (C)

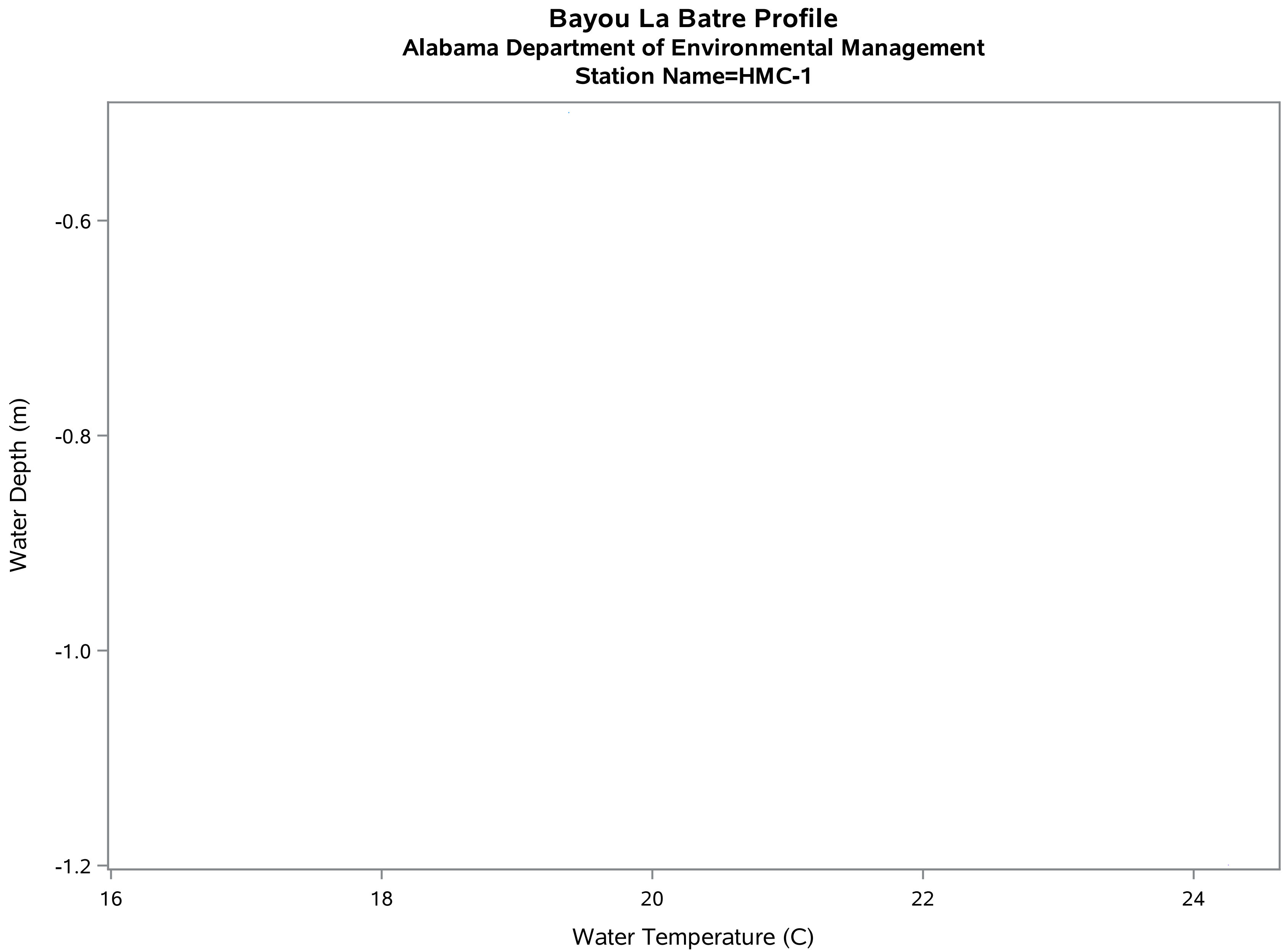


Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-1
0
-2
-4
-6
Water Depth (m)
15
20
25
30
Water Temperature (C)

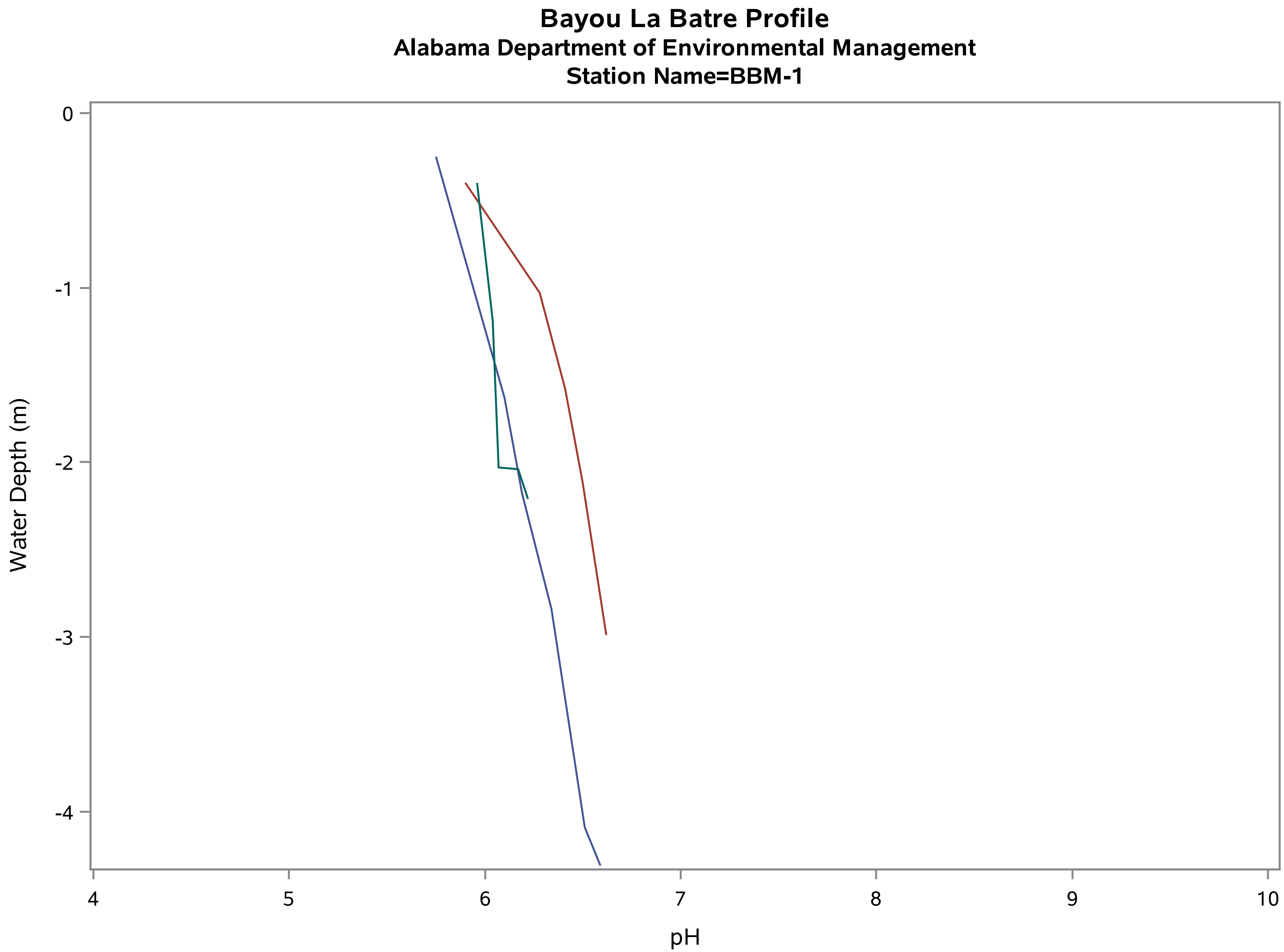

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-2
Water Depth (m)
0
-1
-2
-3
-4
-5
-6
15
20
25
30
Water Temperature (C)

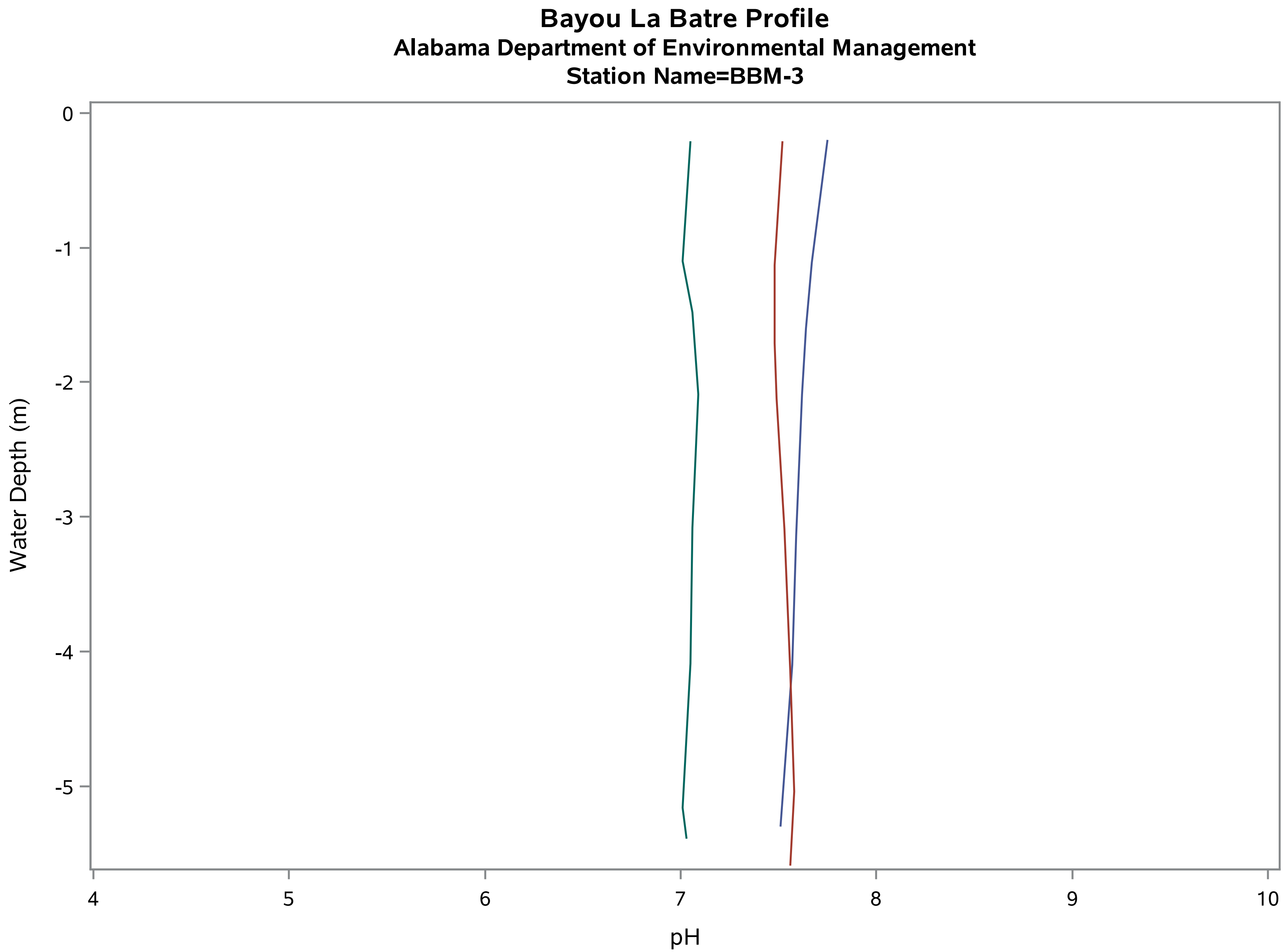

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-3
Water Depth (m)
0
-1
-2
-3
15
20
25
30
35
Water Temperature (C)


Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-4
0.0
-0.5
-1.0
-1.5
-2.0
Water Depth (m)
15
20
25
30
Water Temperature (C)

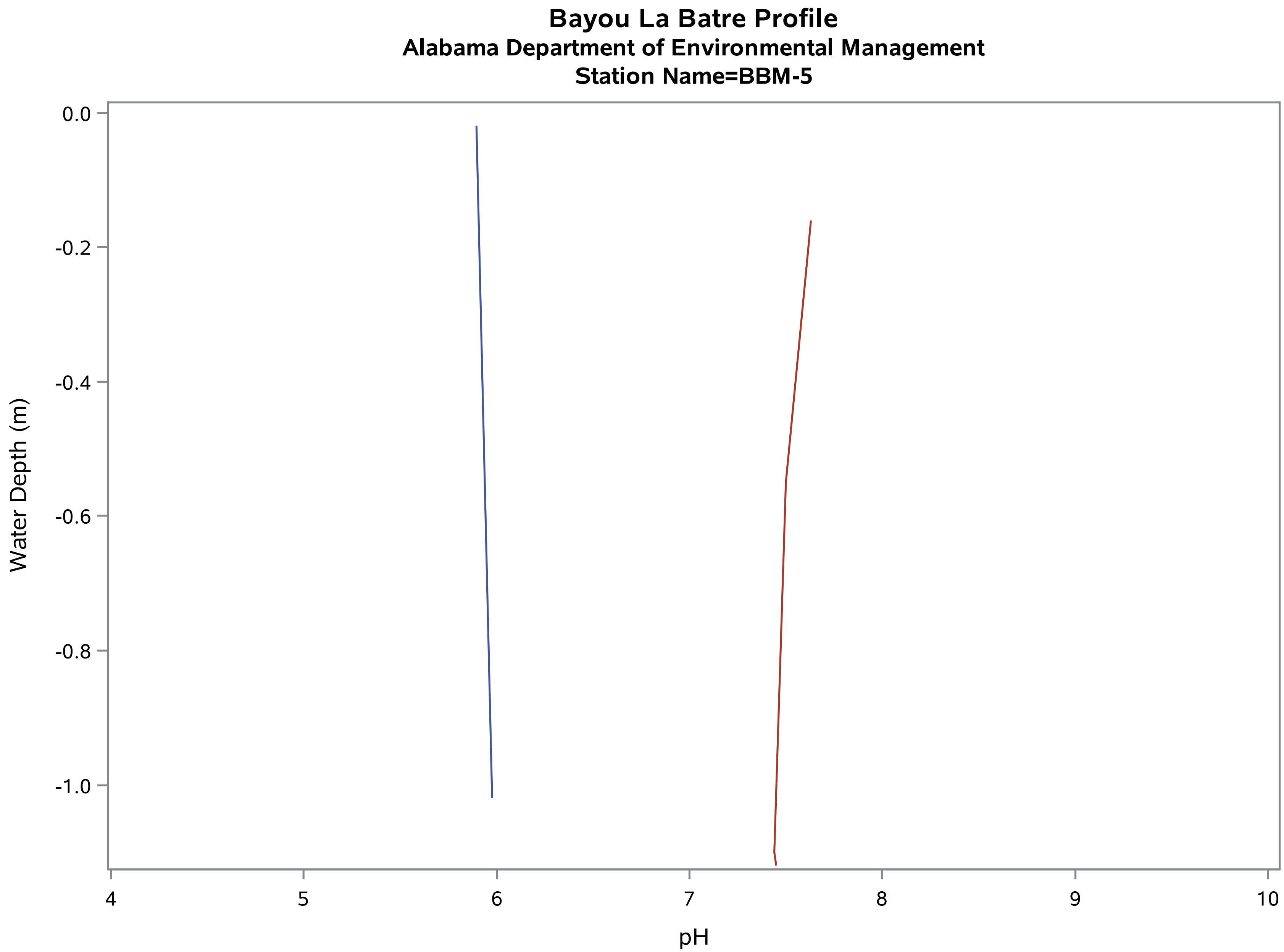

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=HMC-1
Water Depth (m)
-0.6
-0.8
-1.0
-1.2
16
18
20
22
24
Water Temperature (C)

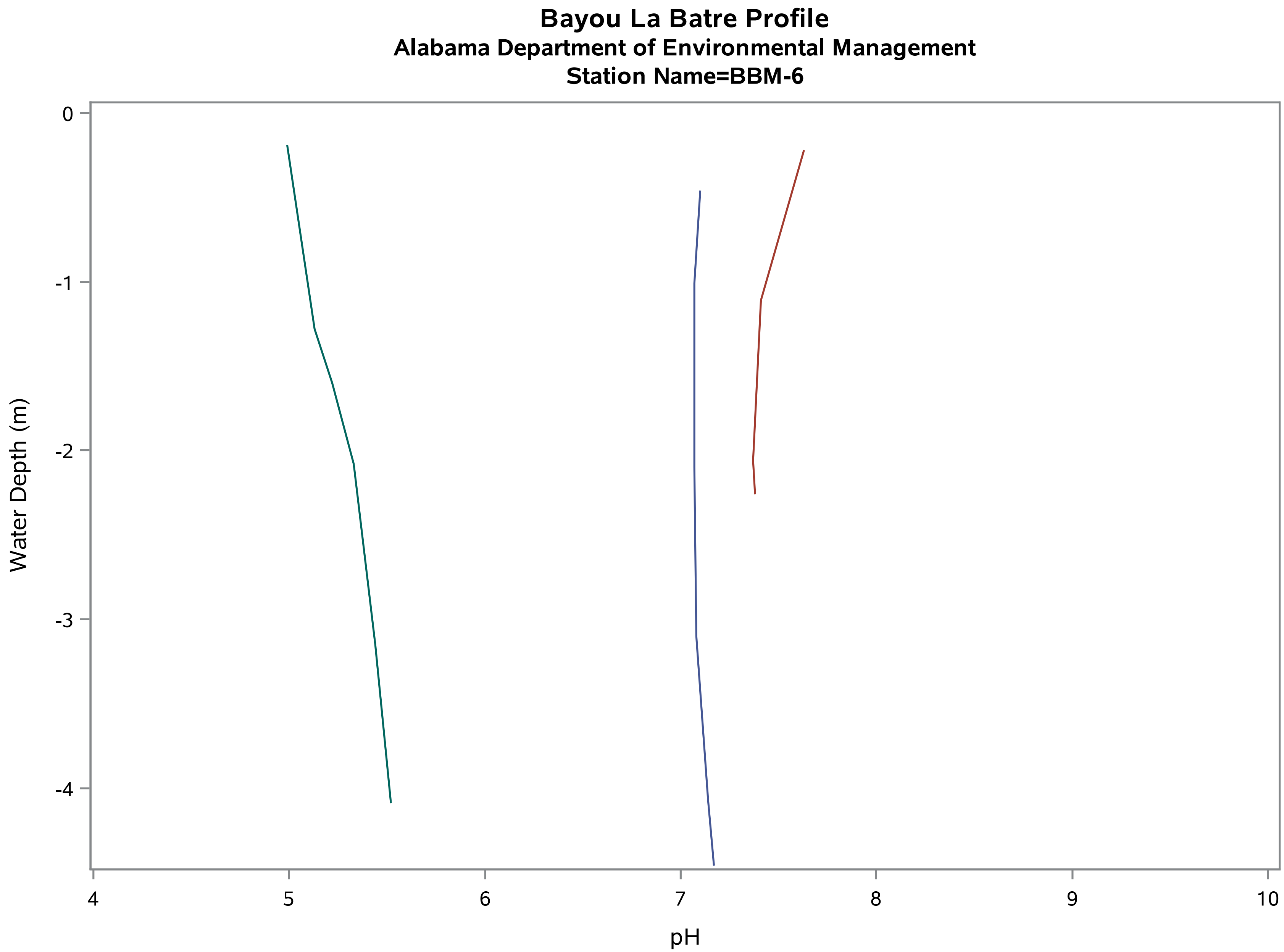
Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=HMC-2


Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-1
Water Depth (m)
0
-1
-2
-3
-4
4
5
6
7
8
9
10
pH

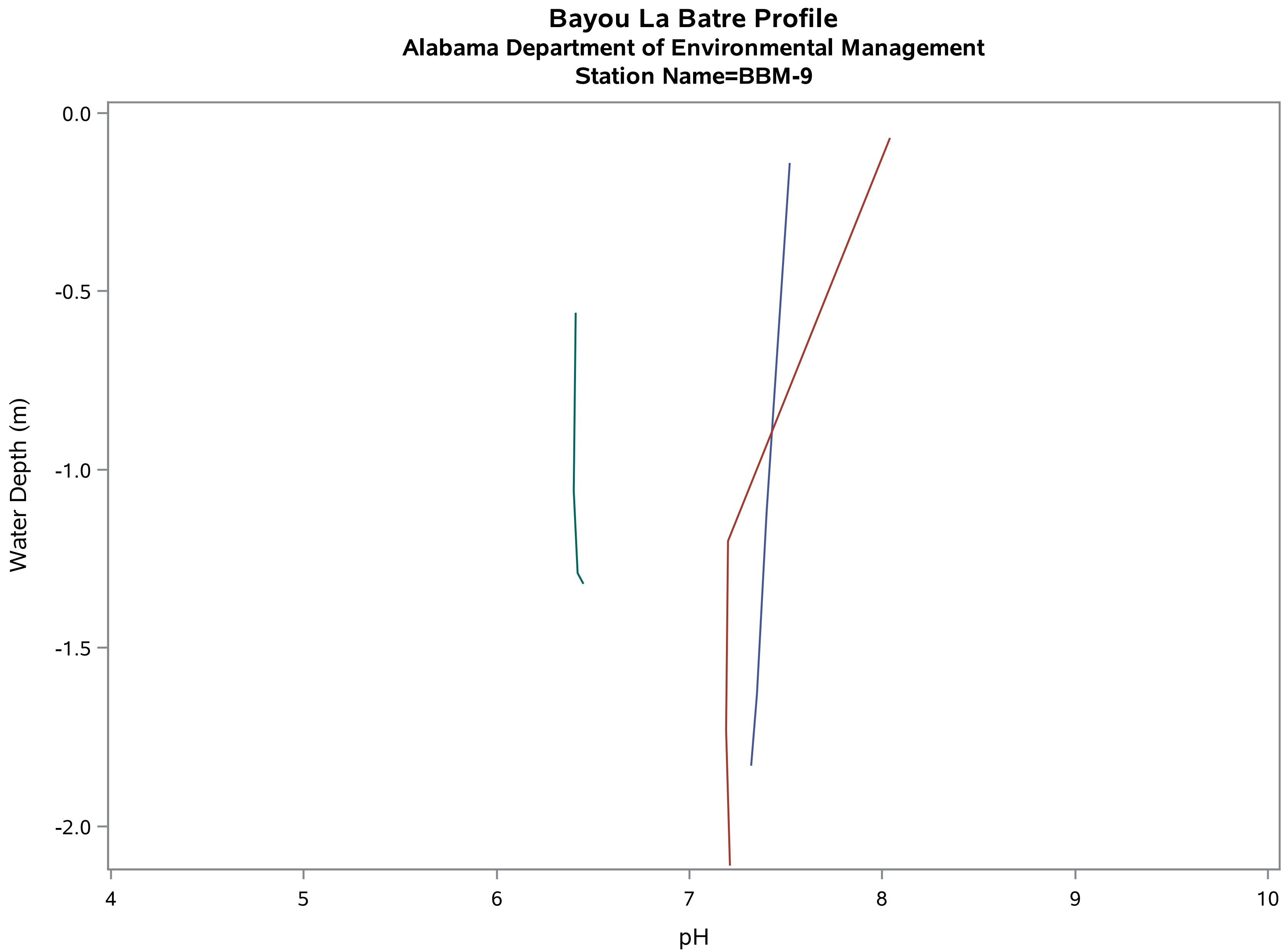


Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-3
0
-1
-2
-3
-4
-5
Water Depth (m)
4
5
6
7
8
9
10
pH

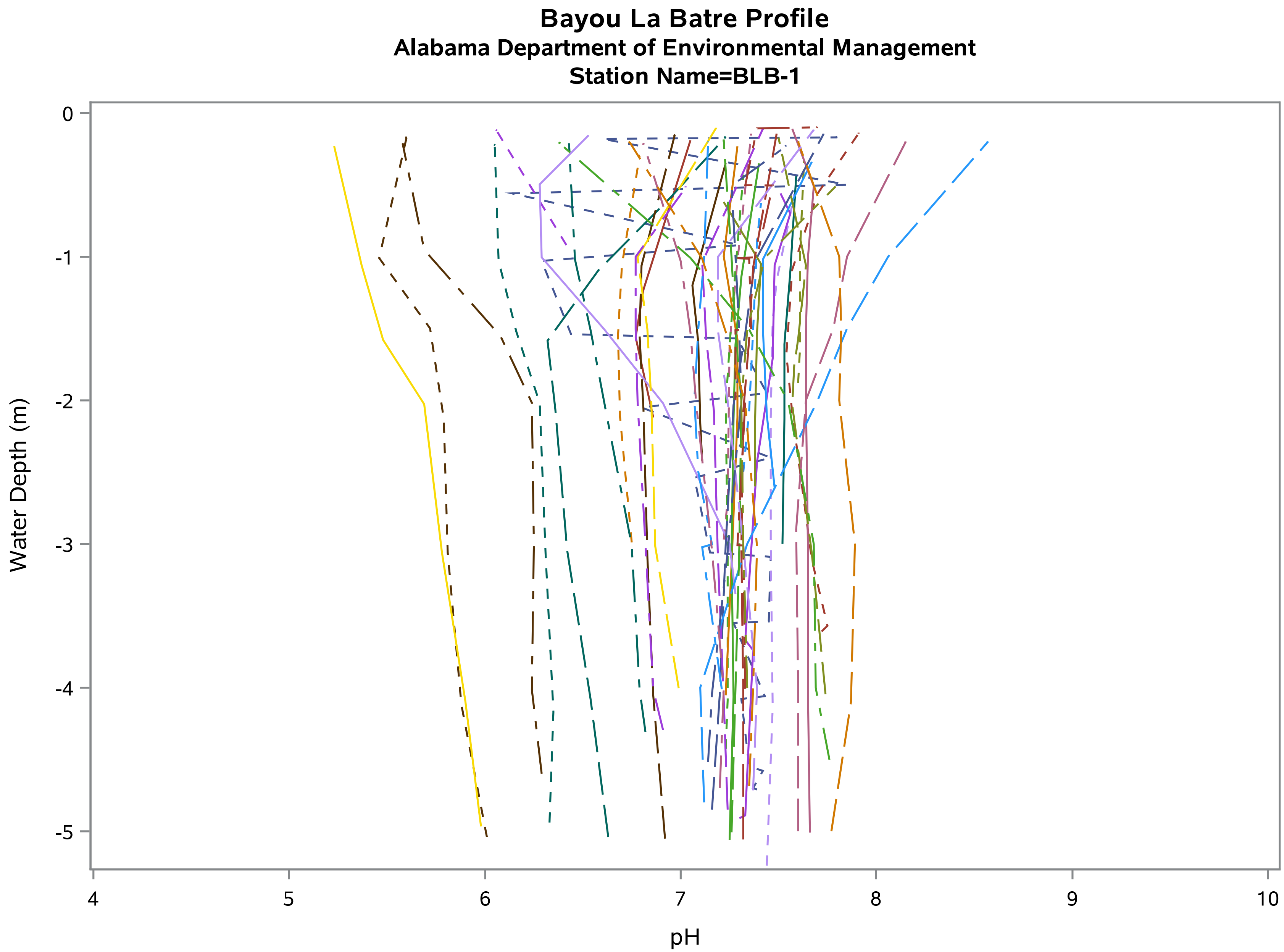

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-5
Water Depth (m)
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
4
5
6
7
8
9
10
pH

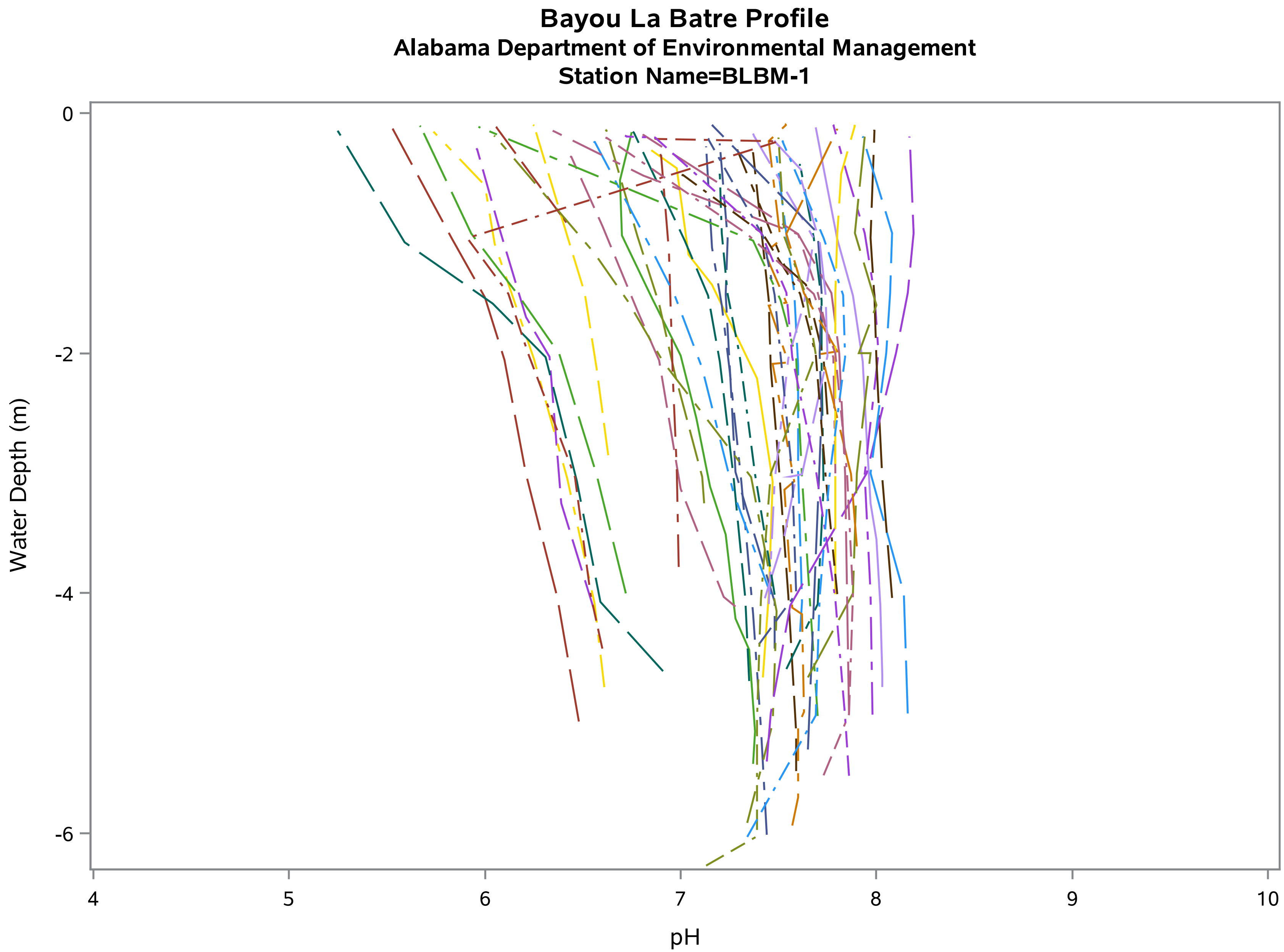


Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-6
Water Depth (m)
0
-1
-2
-3
-4
4
5
6
7
8
9
10
pH

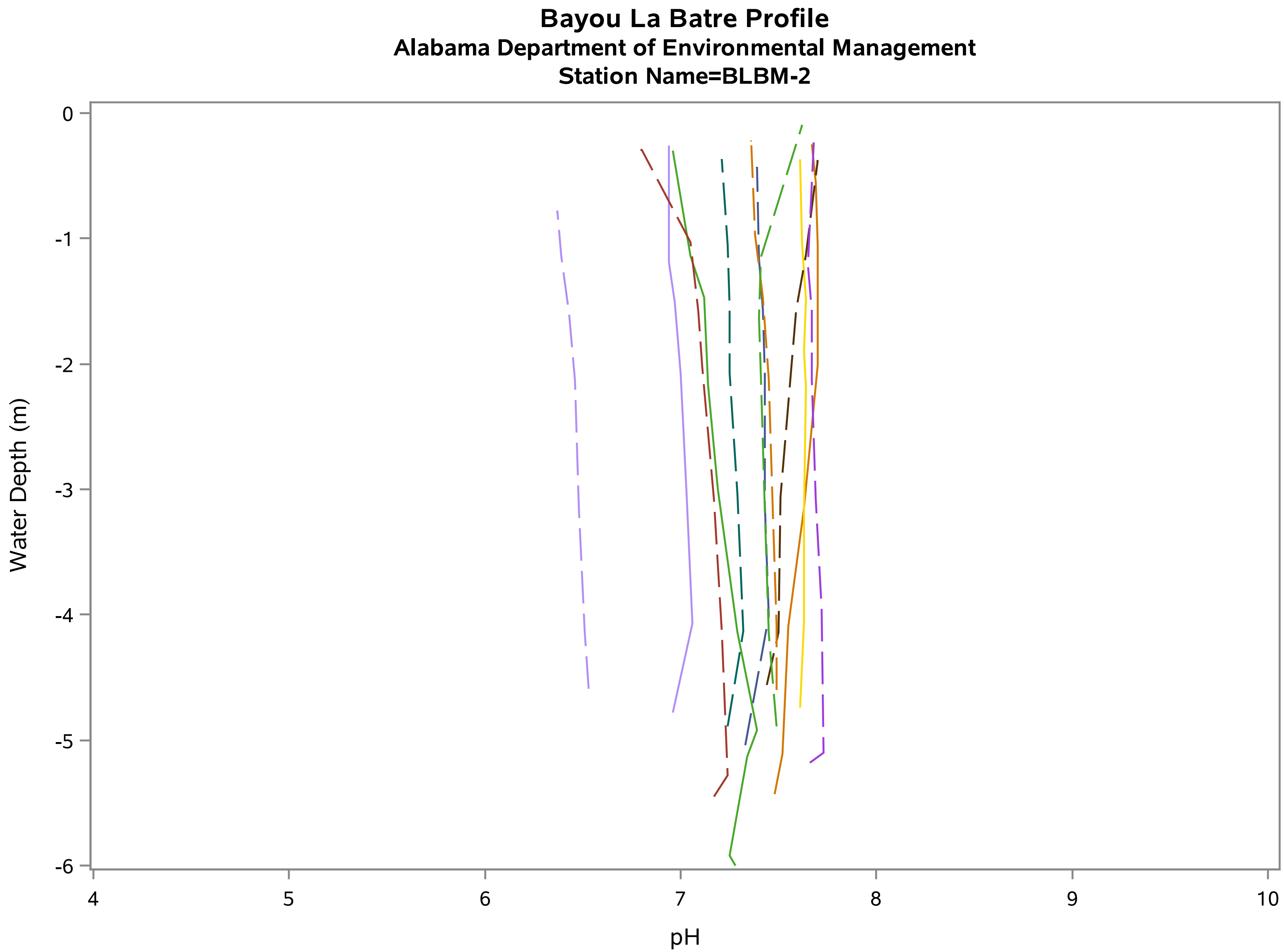


Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-9
0.0
-0.5
-1.0
-1.5
-2.0
Water Depth (m)
4
5
6
7
8
9
10
pH

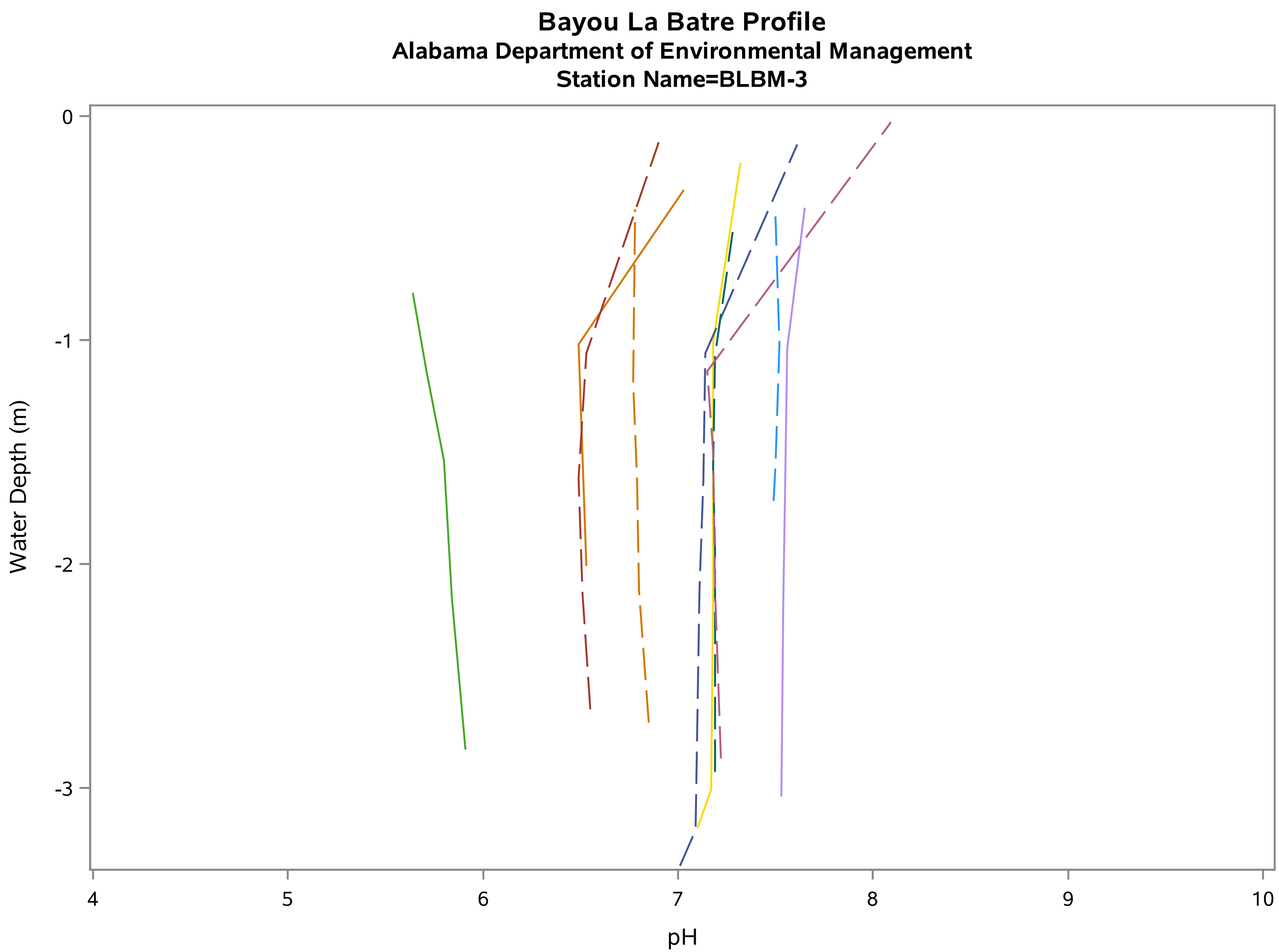

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLB-1
0
-1
-2
-3
-4
-5
Water Depth (m)
4
5
6
7
8
9
10
pH



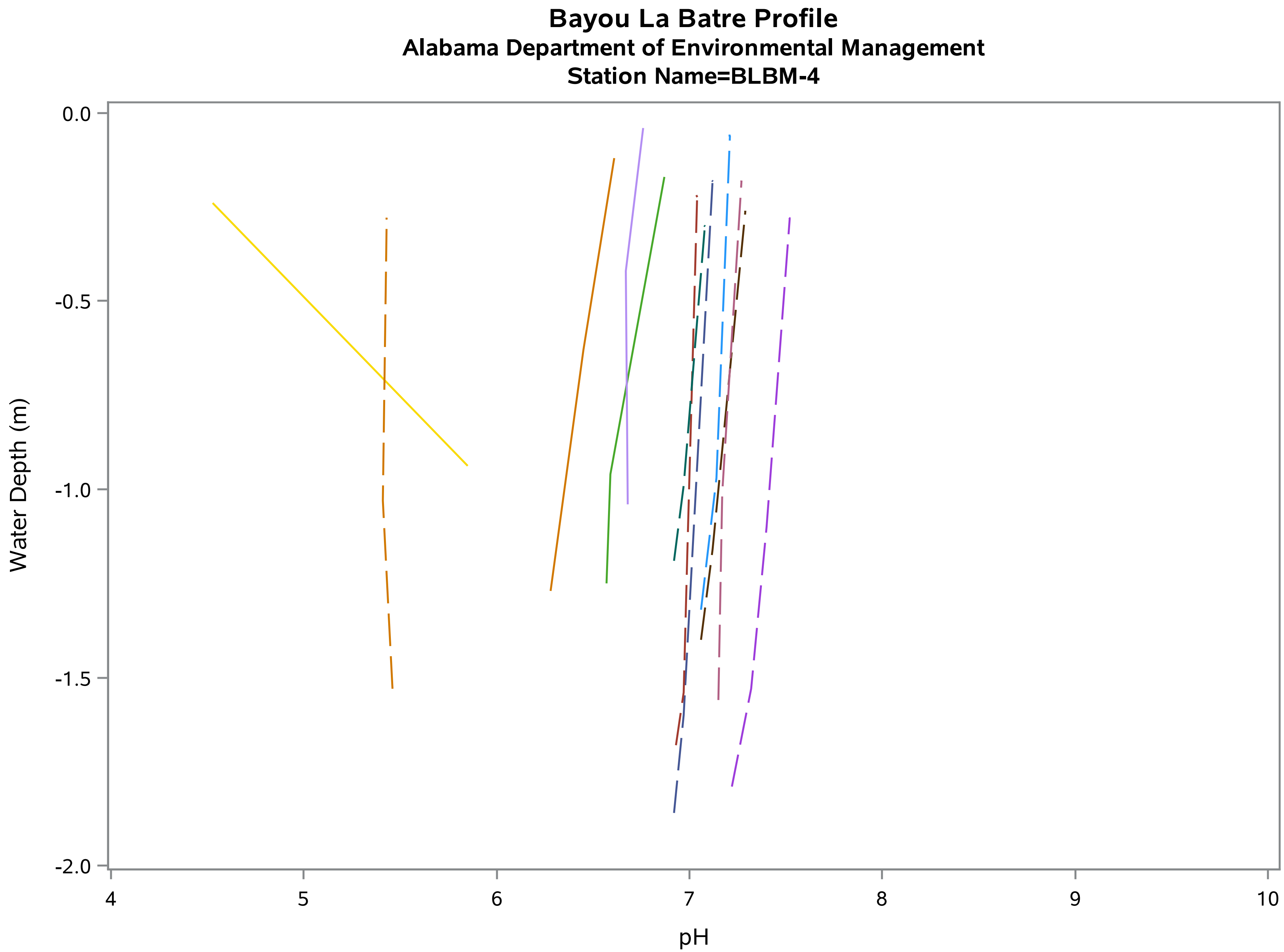
Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-1
0
-2
-4
-6
Water Depth (m)
4
5
6
7
8
9
10
pH



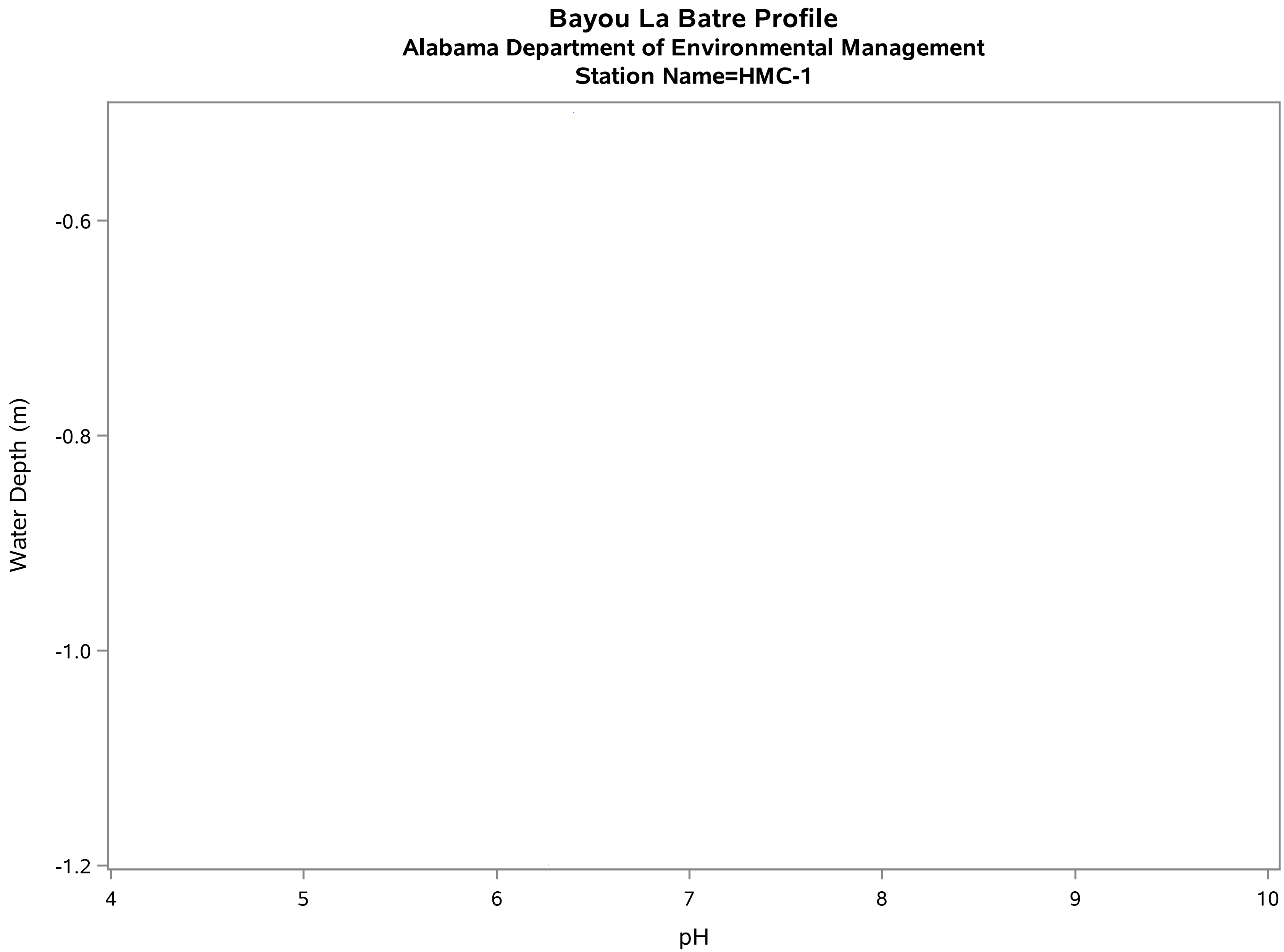
Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-2
Water Depth (m)
0
-1
-2
-3
-4
-5
-6
4
5
6
7
8
9
10
pH



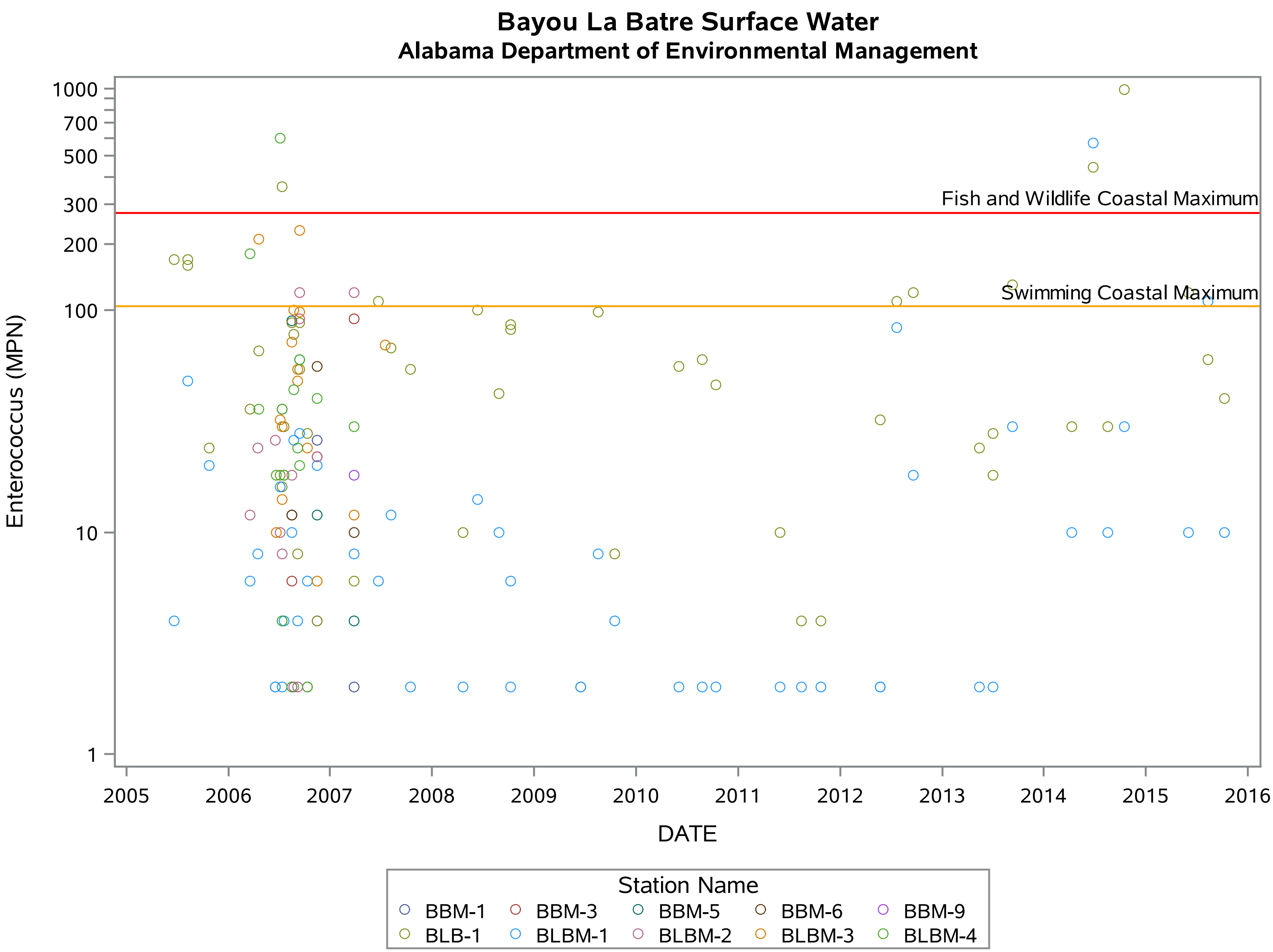
Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-3
Water Depth (m)
0
-1
-2
-3
pH
4
5
6
7
8
9
10



Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-4
0.0
-0.5
-1.0
-1.5
-2.0
Water Depth (m)
4
5
6
7
8
9
10
pH

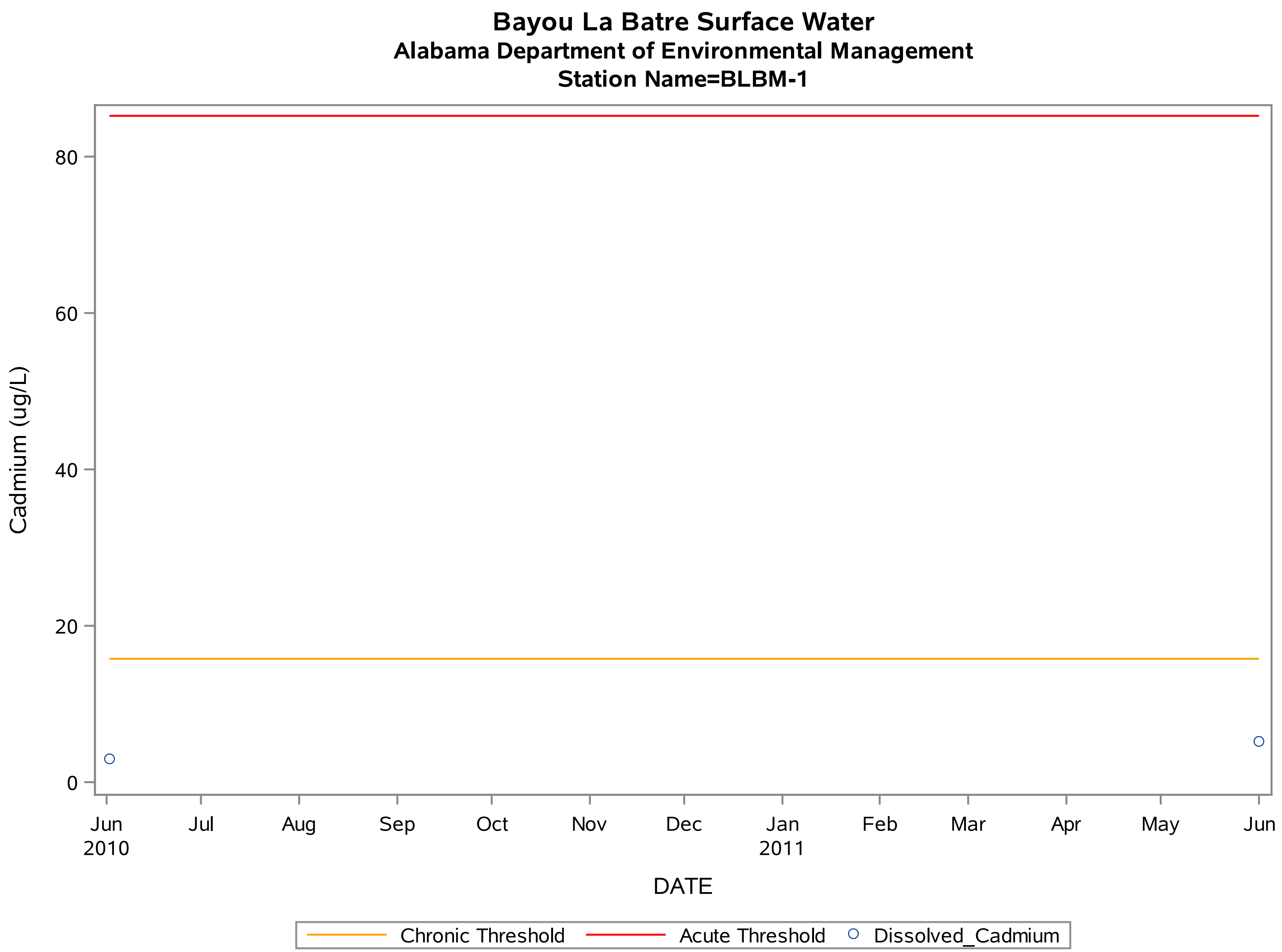

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=HMC-1
Water Depth (m)
-0.6
-0.8
-1.0
-1.2
4
5
6
7
8
9
10
pH

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=HMC-2

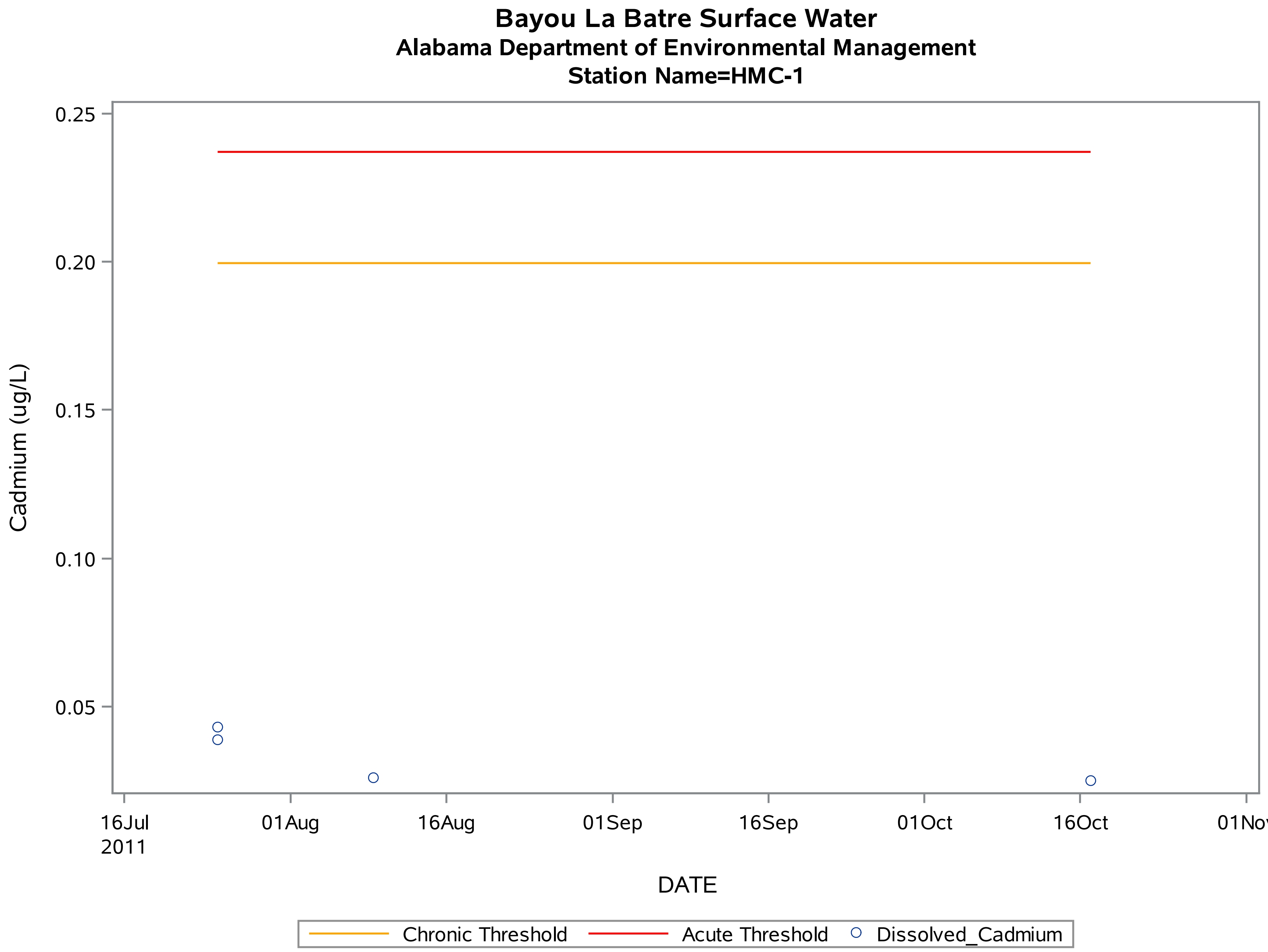


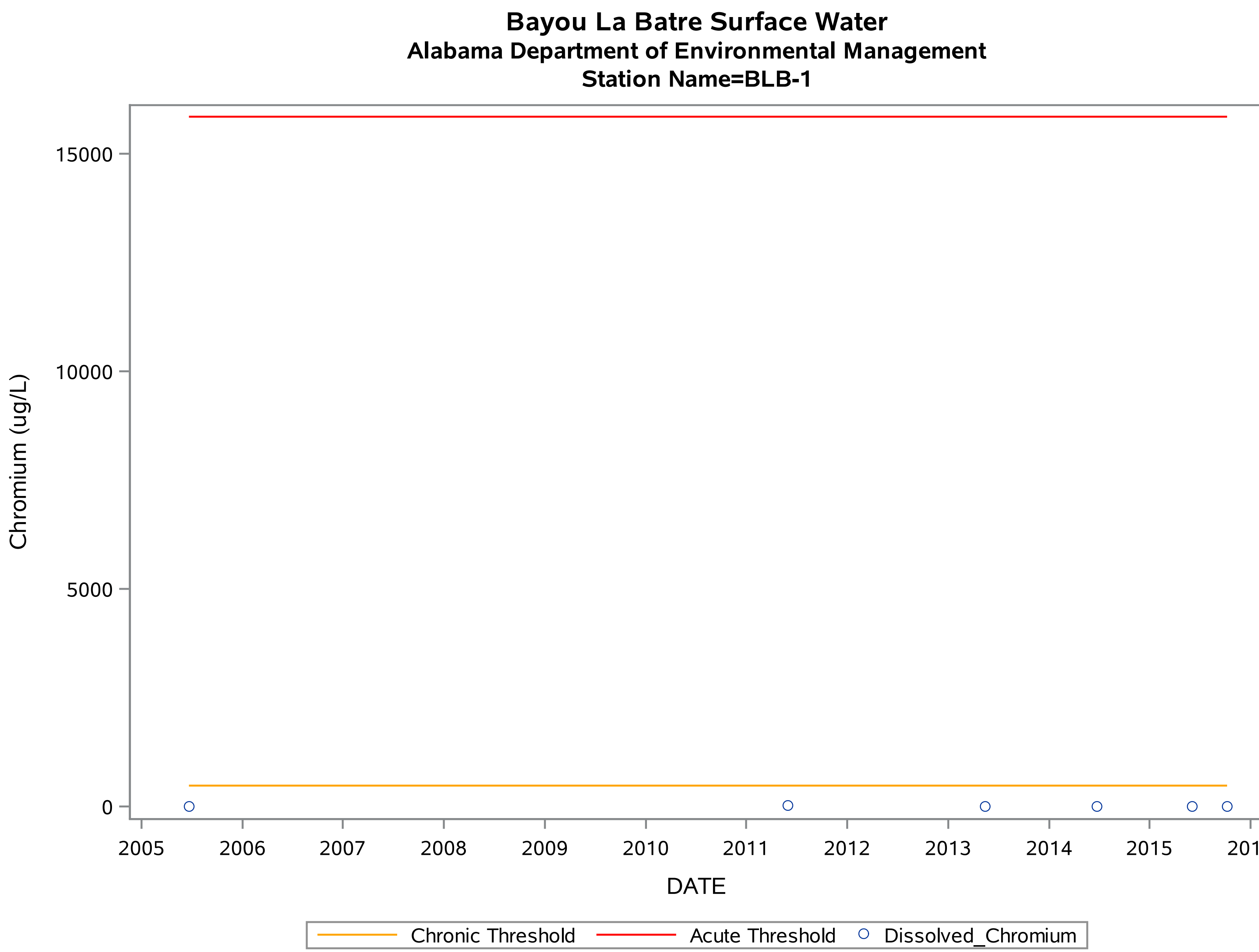
Bayou La Batre Surface Water
Alabama Department of Environmental Management
Fish and Wildlife Coastal Maximum
Swimming Coastal Maximum
Enterococcus (MPN)
1000
700
500
300
200
100
10
1
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
DATE
Station Name
BBM-1
BBM-3
BBM-5
BBM-6
BBM-9
BLB-1
BLBM-1
BLBM-2
BLBM-3
BLBM-4


Bayou La Batre Surface Water
Alabama Department of Environmental Management
Station Name=BLB-1
Cadmium (ug/L)
17.5
15.0
12.5
10.0
7.5
5.0
31May
2011
01Jun
02Jun
DATE
Chronic Threshold
Acute Threshold
Dissolved_Cadmium

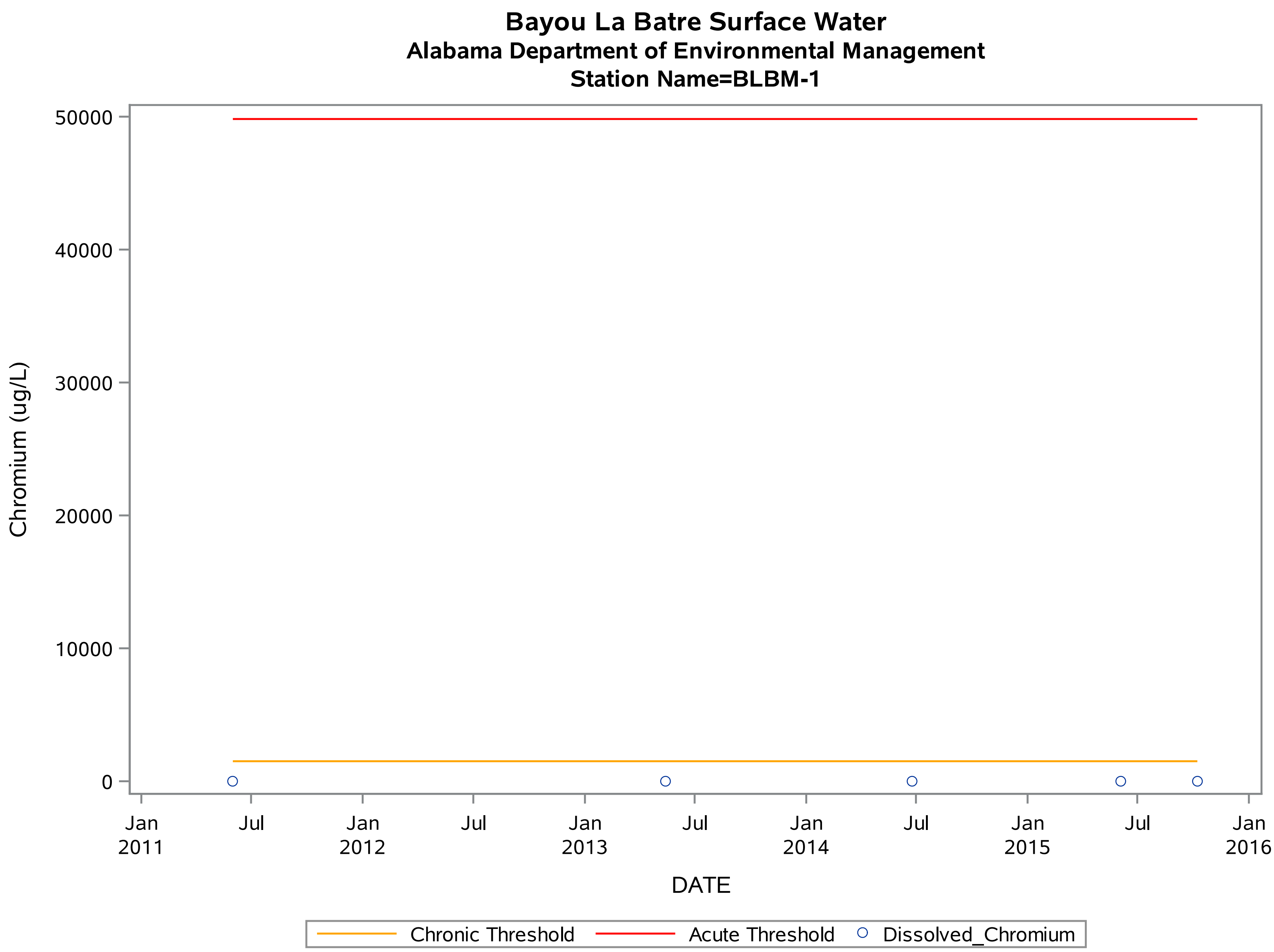


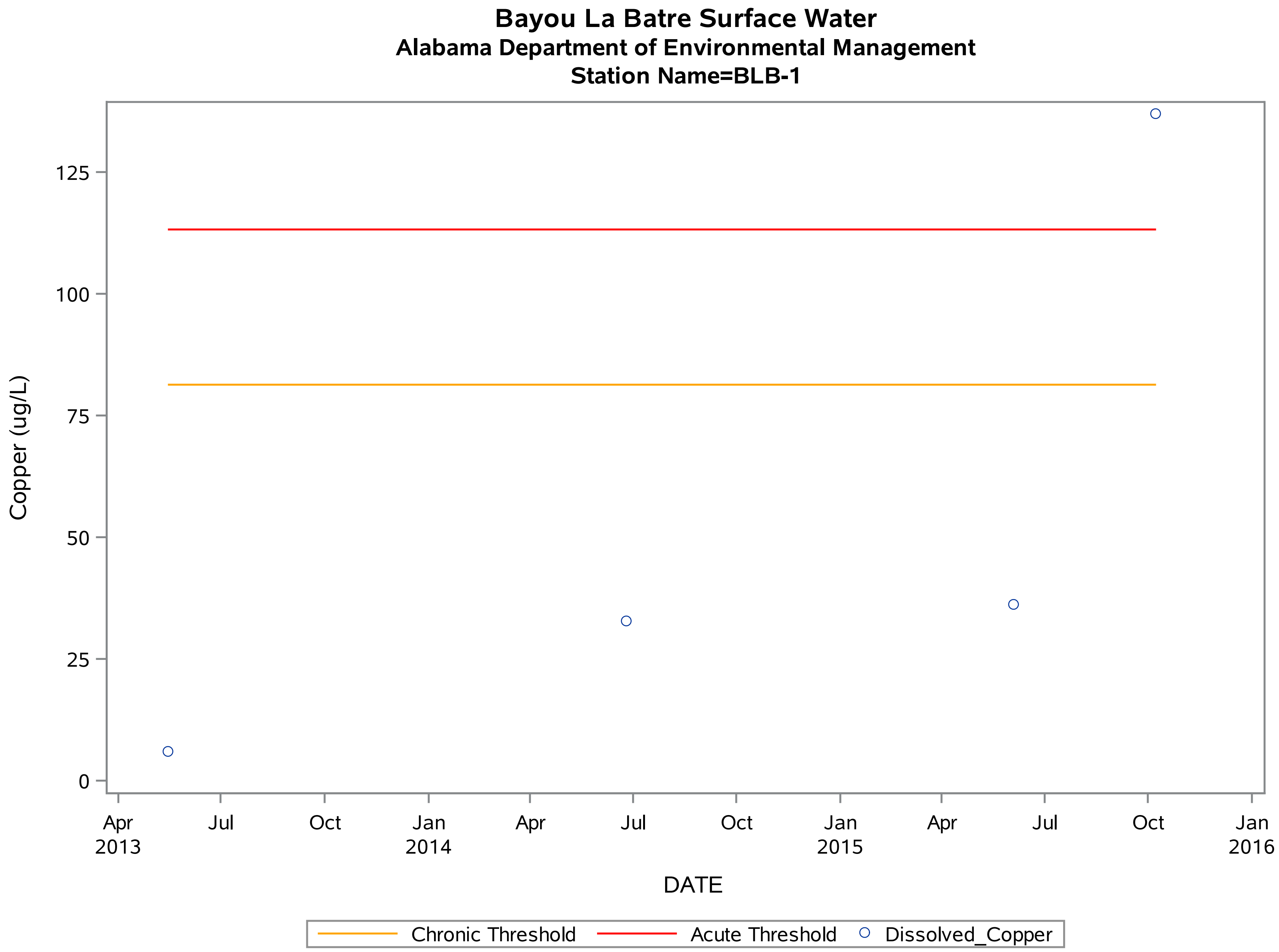
Bayou La Batre Surface Water
Alabama Department of Environmental Management
Station Name=BLBM-1
Cadmium (ug/L)
80
60
40
20
0
Jun 2010
Jul
Aug
Sep
Oct
Nov
Dec
Jan 2011
Feb
Mar
Apr
May
Jun
DATE
Chronic Threshold
Acute Threshold
Dissolved_Cadmium

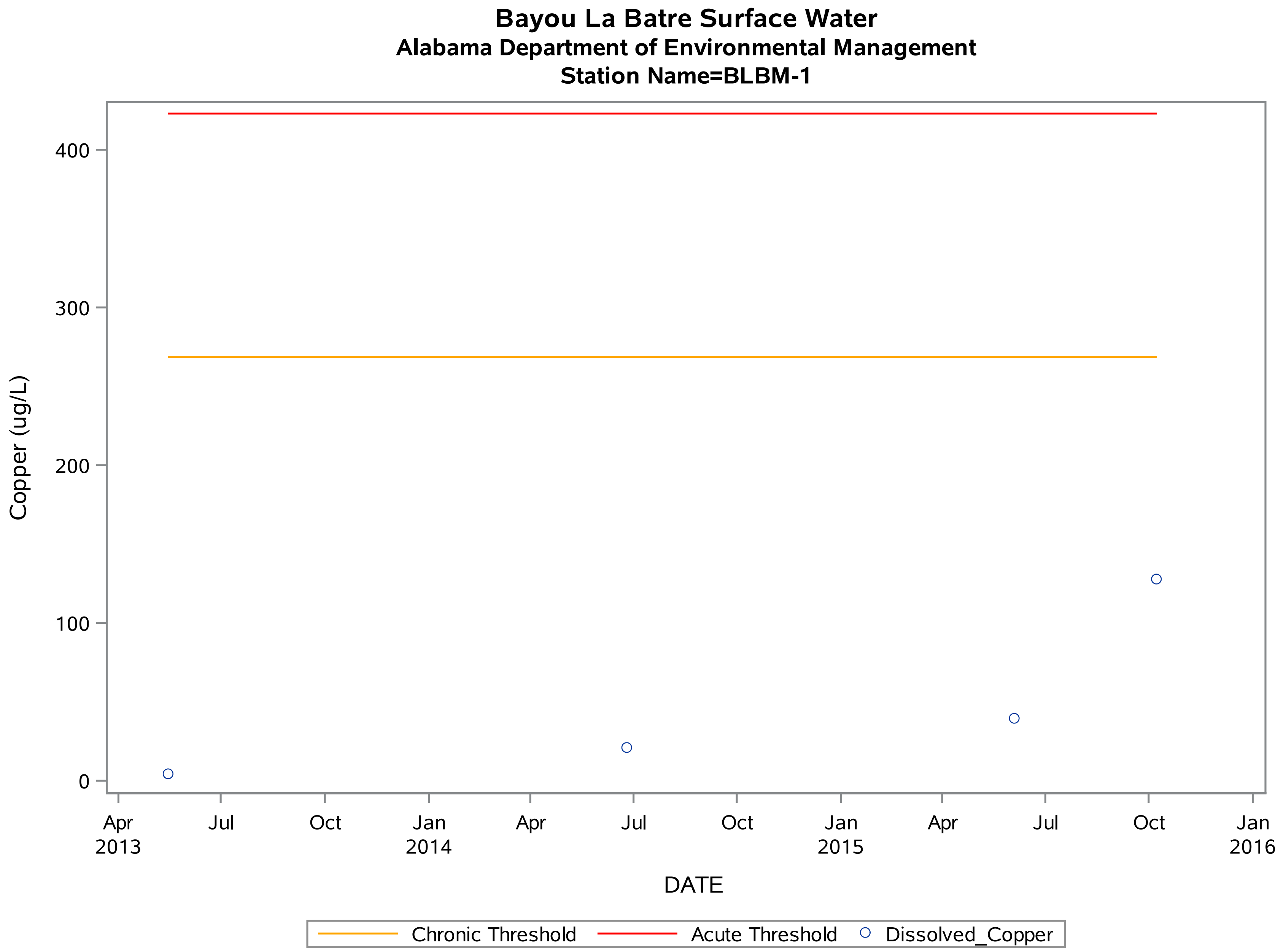

Bayou La Batre Surface Water
Alabama Department of Environmental Management
Station Name=HMC-1
0.25
0.20
0.15
0.10
0.05
Cadmium (ug/L)
16Jul
2011
01Aug
16Aug
01Sep
16Sep
01Oct
16Oct
01Nov
DATE
Chronic Threshold
Acute Threshold
Dissolved_Cadmium

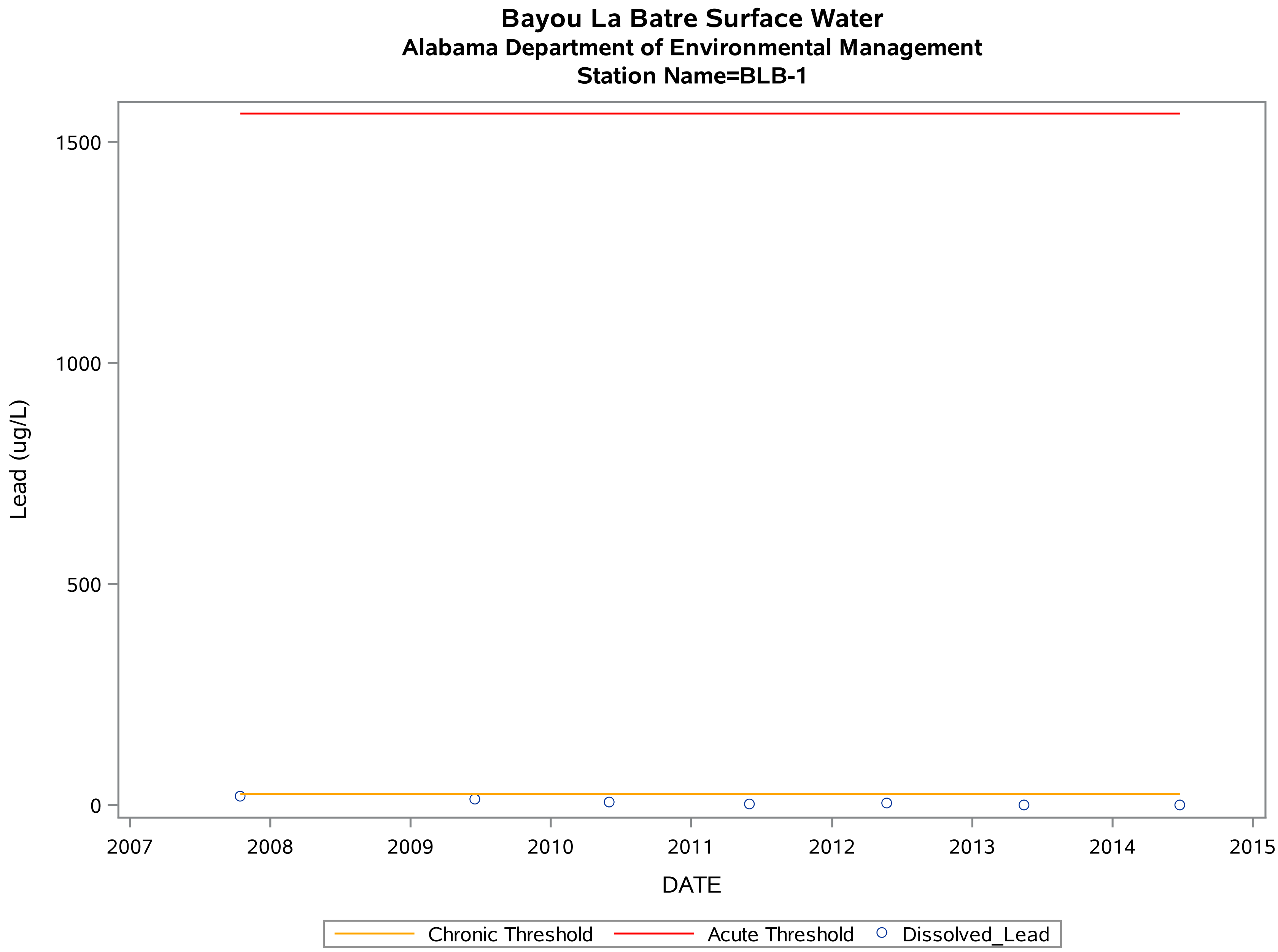


Bayou La Batre Surface Water
Alabama Department of Environmental Management
Station Name=BLB-1
Chromium (ug/L)
15000
10000
5000
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
DATE
Chronic Threshold
Acute Threshold
Dissolved_Chromium

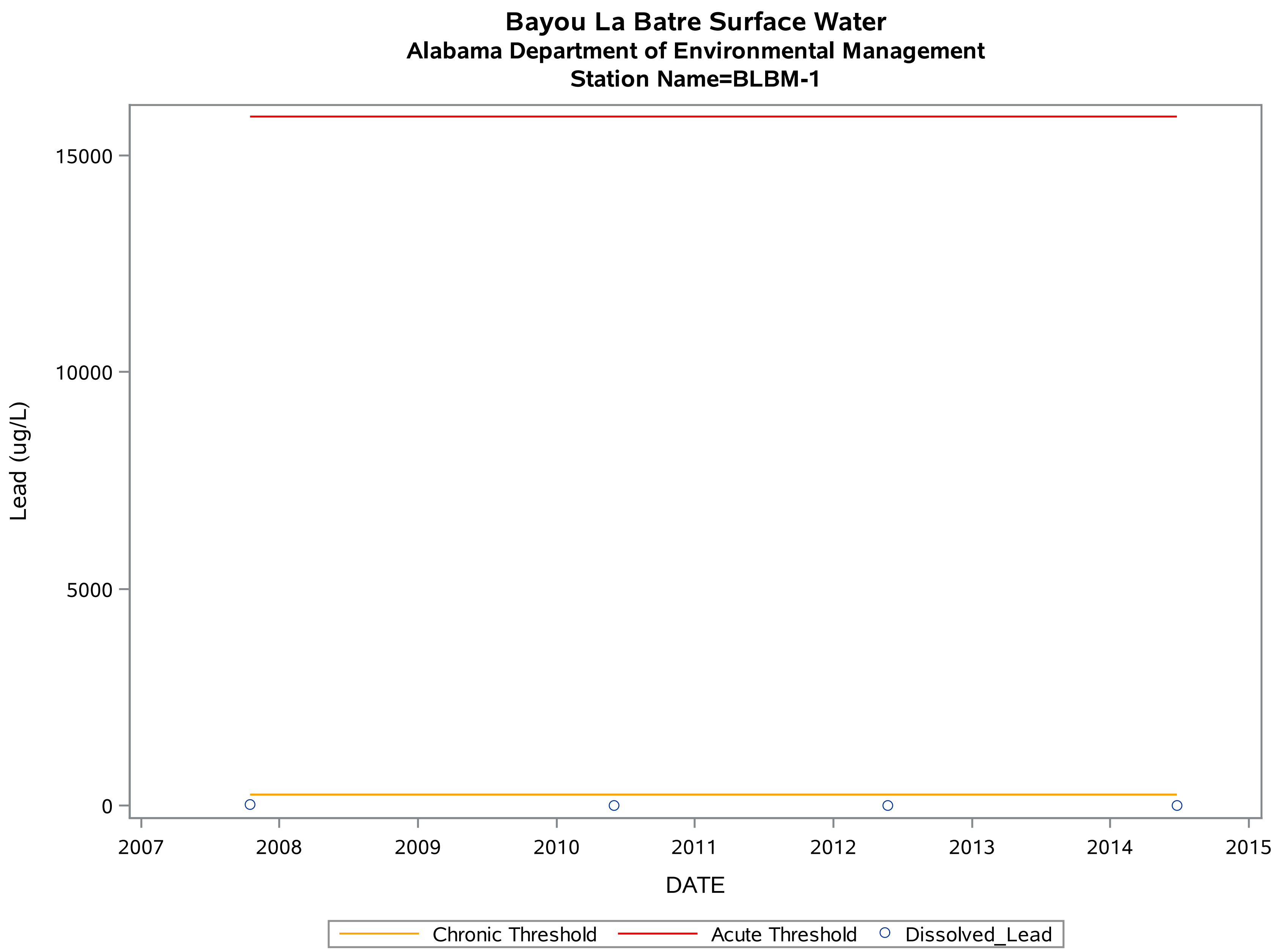

Bayou La Batre Surface Water
Alabama Department of Environmental Management
Station Name=BLBM-1
Chromium (ug/L)
50000
40000
30000
20000
10000
0
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
DATE
Chronic Threshold
Acute Threshold
Dissolved_Chromium

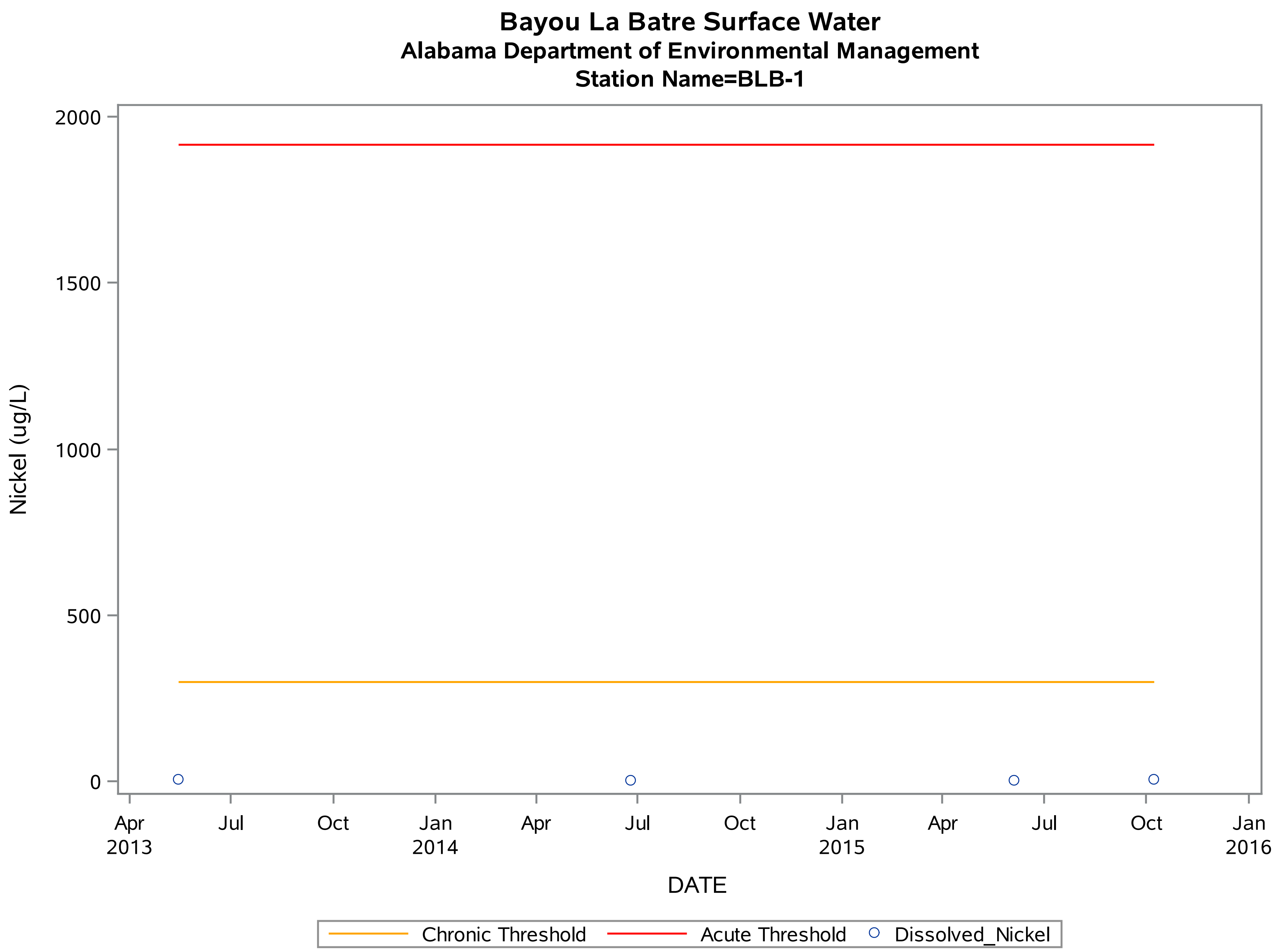

Bayou La Batre Surface Water
Alabama Department of Environmental Management
Station Name=BLB-1
Copper (ug/L)
0
25
50
75
100
125
Apr 2013
Jul
Oct
Jan 2014
Apr
Jul
Oct
Jan 2015
Apr
Jul
Oct
Jan 2016
DATE
Chronic Threshold
Acute Threshold
Dissolved_Copper

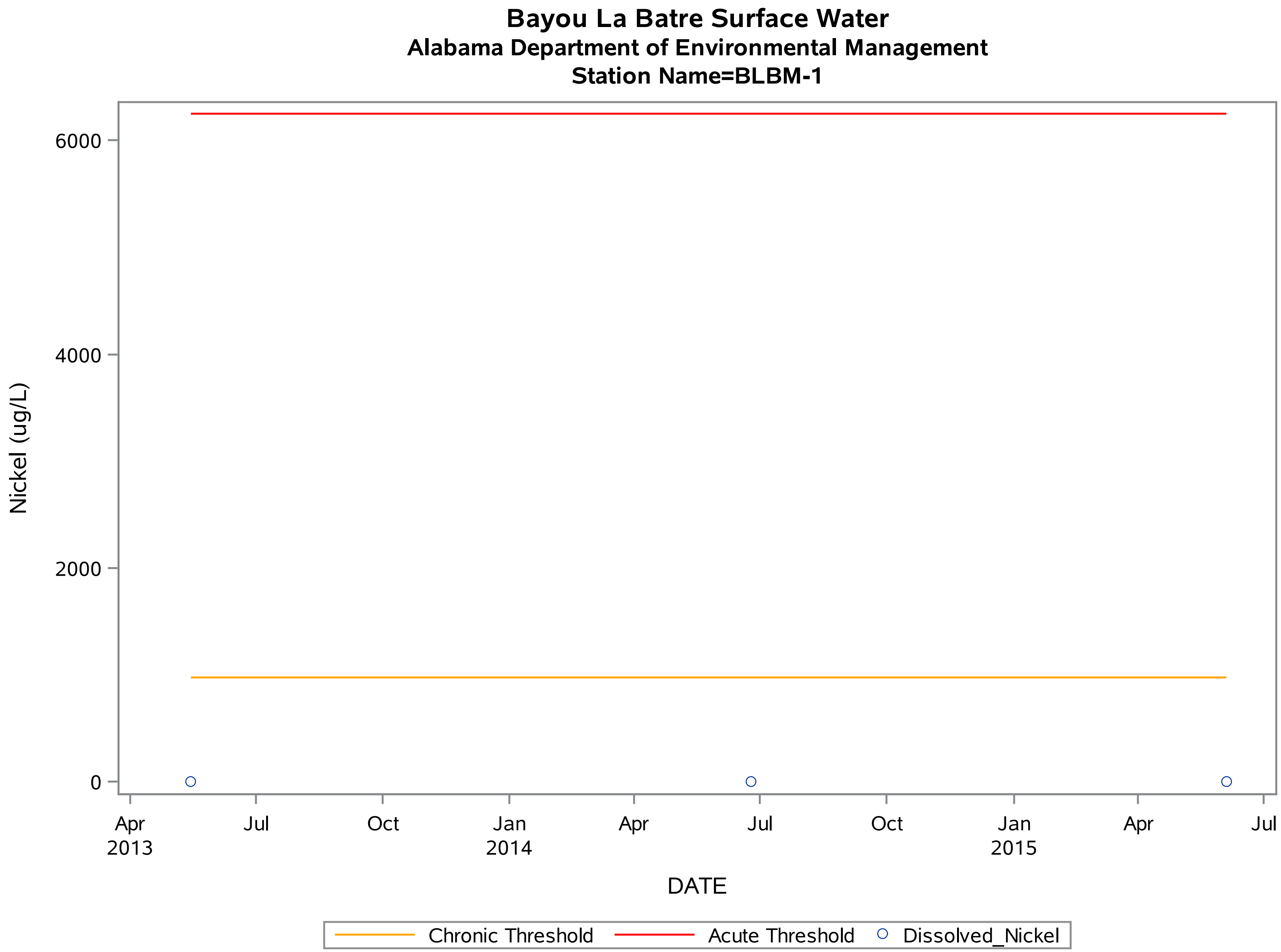

Bayou La Batre Surface Water
Alabama Department of Environmental Management
Station Name=BLBM-1
400
300
200
100
0
Copper (ug/L)
Apr 2013
Jul
Oct
Jan 2014
Apr
Jul
Oct
Jan 2015
Apr
Jul
Oct
Jan 2016
DATE
Chronic Threshold
Acute Threshold
Dissolved_Copper



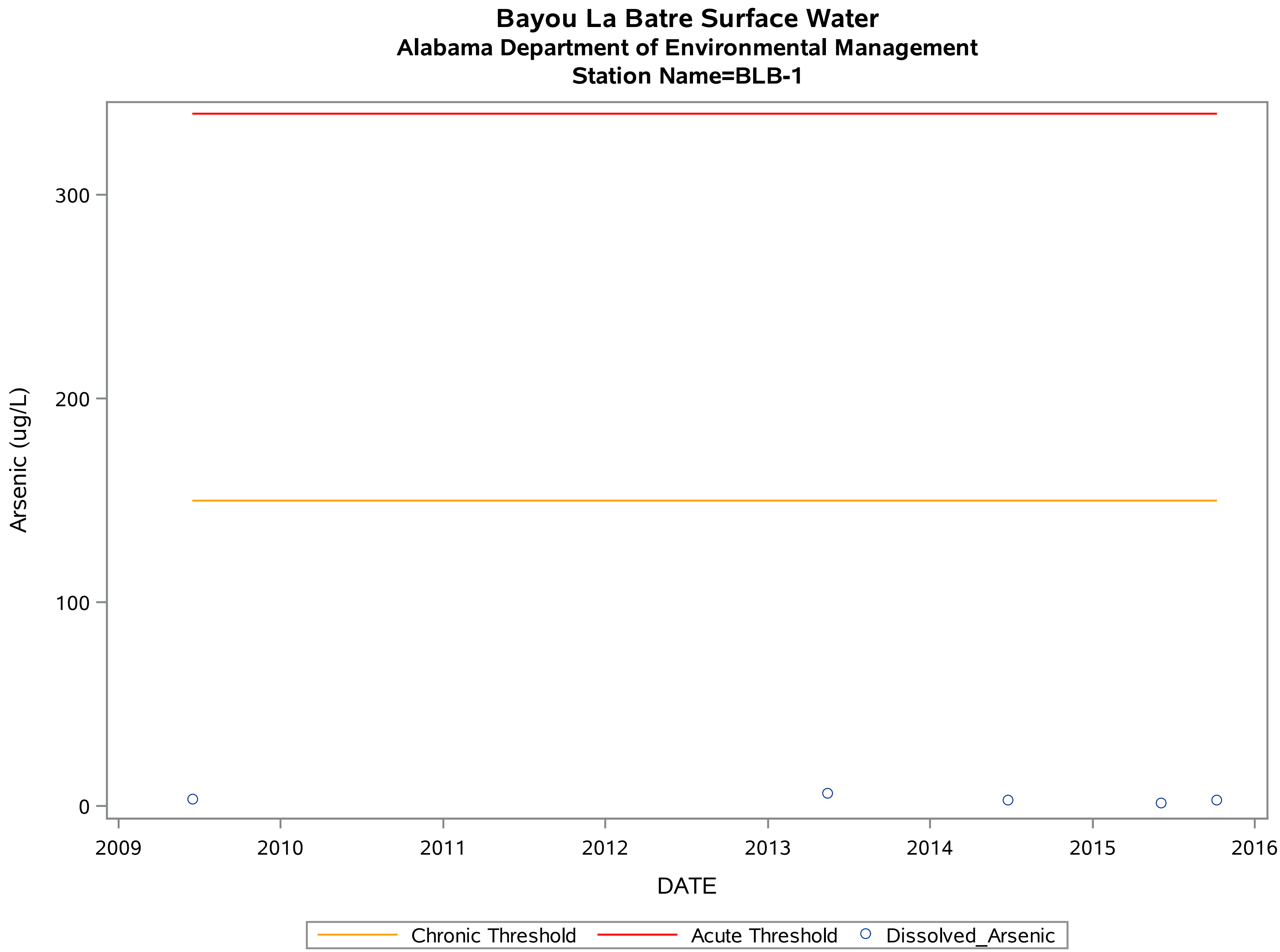
Bayou La Batre Surface Water
Alabama Department of Environmental Management
Station Name=BLB-1
1500
1000
500
0
Lead (ug/L)
2007
2008
2009
2010
2011
2012
2013
2014
2015
DATE
Chronic Threshold
Acute Threshold
Dissolved_Lead

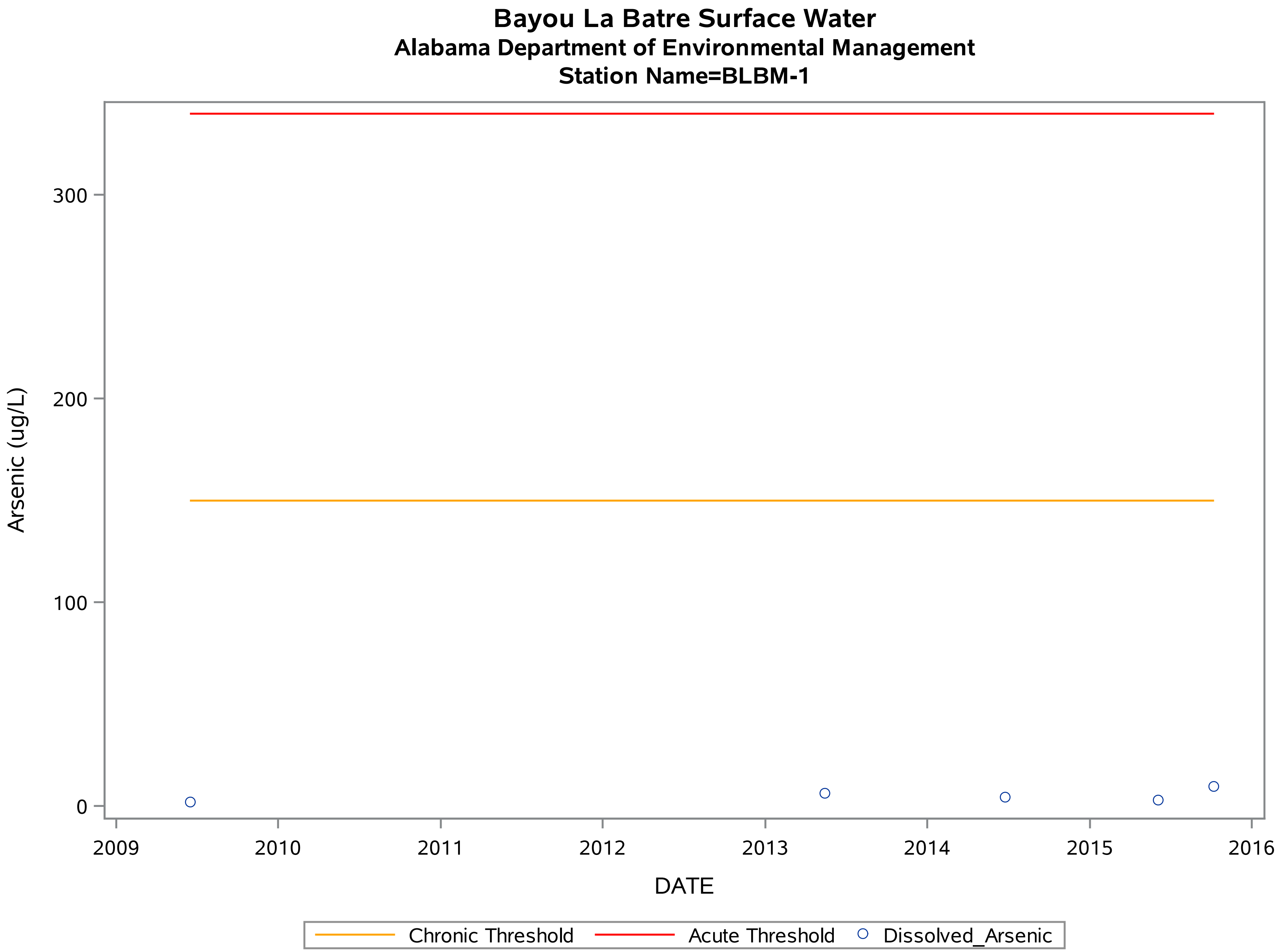

Bayou La Batre Surface Water
Alabama Department of Environmental Management
Station Name=BLBM-1
Lead (ug/L)
15000
10000
5000
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
DATE
Chronic Threshold
Acute Threshold
Dissolved_Lead

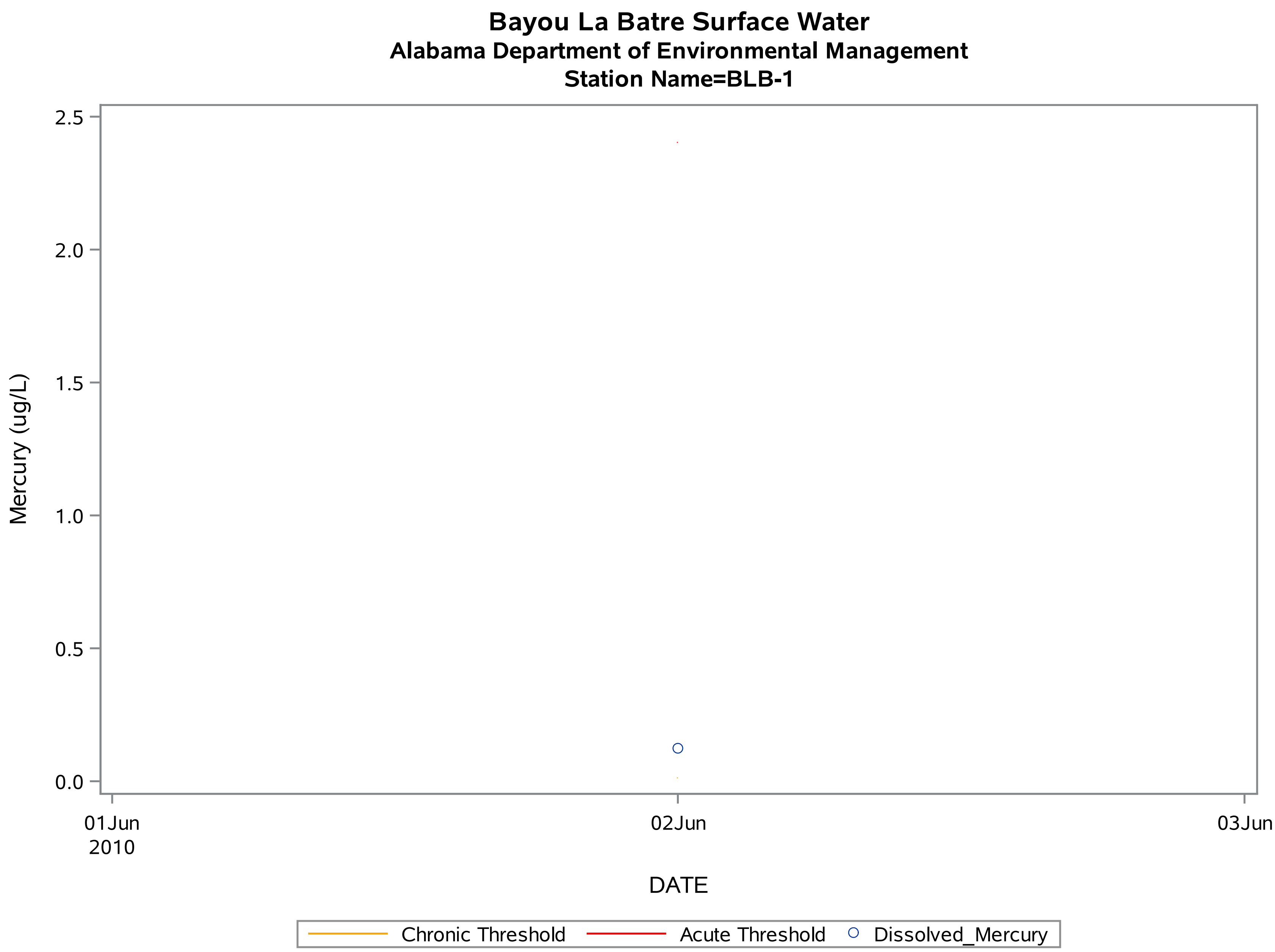

Bayou La Batre Surface Water
Alabama Department of Environmental Management
Station Name=BLB-1
Nickel (ug/L)
2000
1500
1000
500
0
Apr 2013
Jul
Oct
Jan 2014
Apr
Jul
Oct
Jan 2015
Apr
Jul
Oct
Jan 2016
DATE
Chronic Threshold
Acute Threshold
Dissolved_Nickel

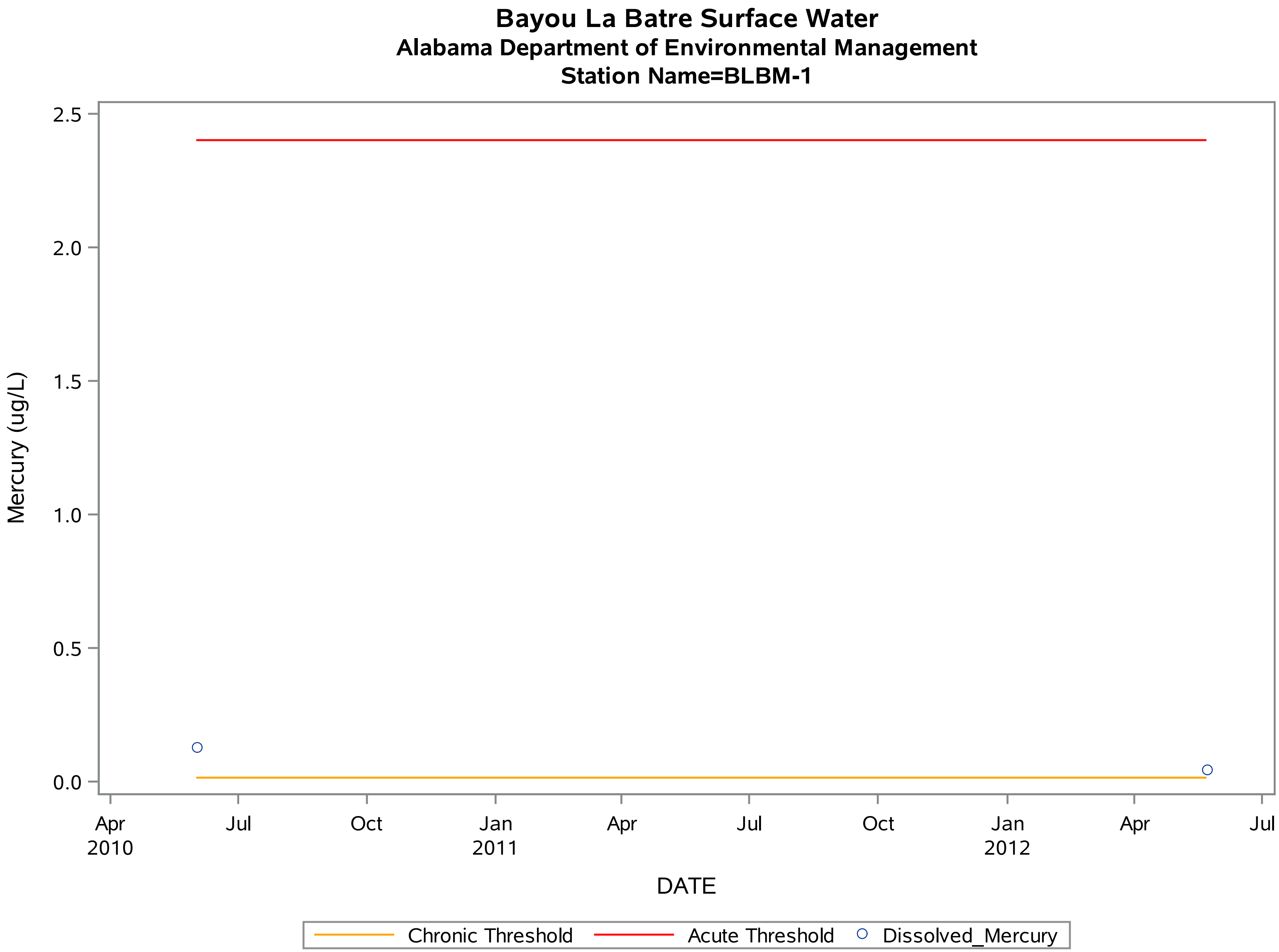


Bayou La Batre Surface Water
Alabama Department of Environmental Management
Station Name=BLBM-1
Nickel (ug/L)
6000
4000
2000
0
Apr 2013
Jul
Oct
Jan 2014
Apr
Jul
Oct
Jan 2015
Apr
Jul
DATE
Chronic Threshold
Acute Threshold
Dissolved_Nickel

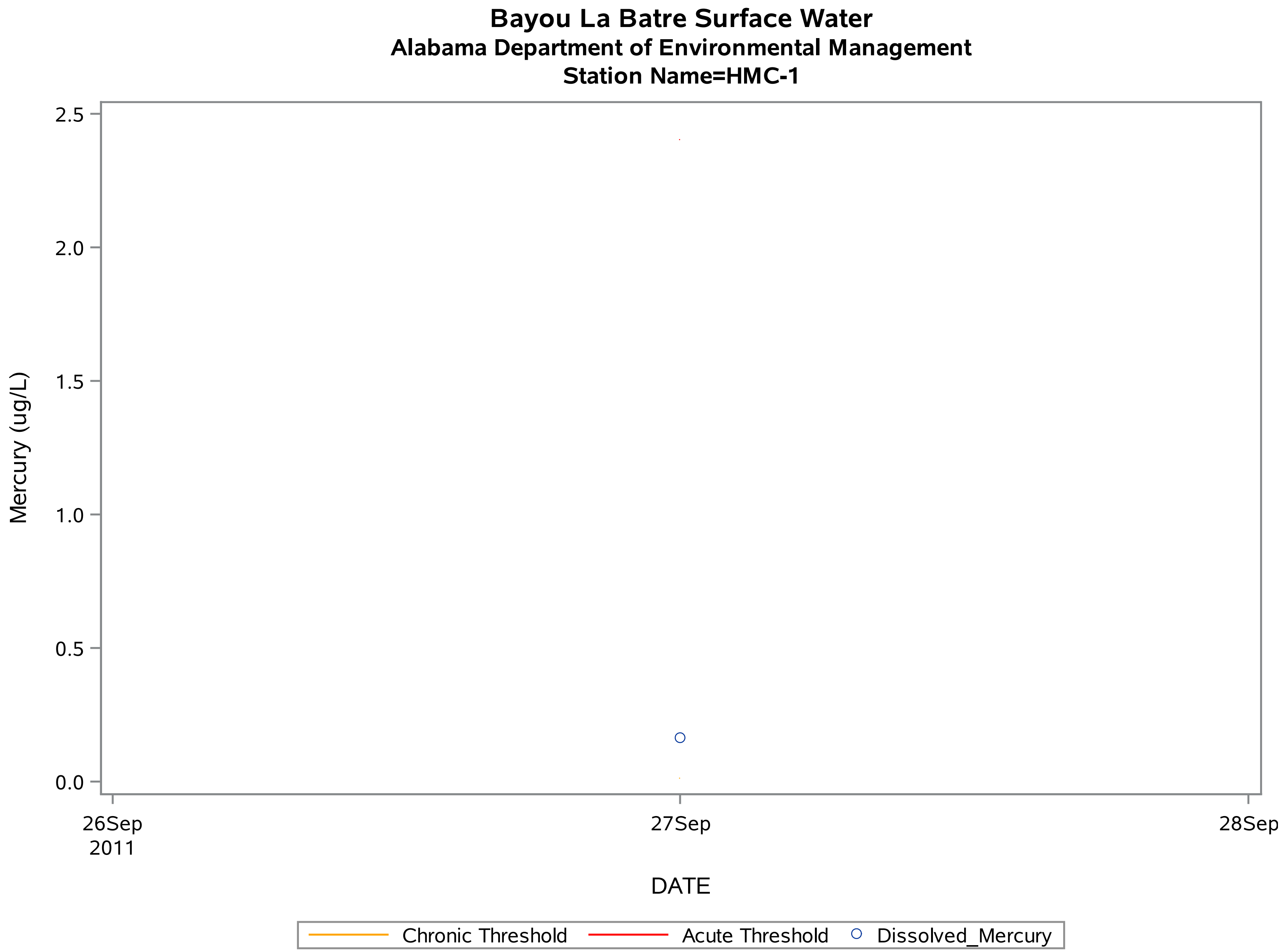

Bayou La Batre Surface Water
Alabama Department of Environmental Management
Station Name=BLB-1
Arsenic (ug/L)
0
100
200
300
2009
2010
2011
2012
2013
2014
2015
2016
DATE
Chronic Threshold
Acute Threshold
Dissolved_Arsenic


Bayou La Batre Surface Water
Alabama Department of Environmental Management
Station Name=BLBM-1
300
200
100
0
Arsenic (ug/L)
2009
2010
2011
2012
2013
2014
2015
2016
DATE
Chronic Threshold
Acute Threshold
Dissolved_Arsenic


Bayou La Batre Surface Water
Alabama Department of Environmental Management
Station Name=BLB-1
Mercury (ug/L)
2.5
2.0
1.5
1.0
0.5
0.0
01Jun
2010
02Jun
03Jun
DATE
Chronic Threshold
Acute Threshold
Dissolved_Mercury



Bayou La Batre Surface Water
Alabama Department of Environmental Management
Station Name=BLBM-1
Mercury (ug/L)
2.5
2.0
1.5
1.0
0.5
0.0
Apr 2010
Jul
Oct
Jan 2011
Apr
Jul
Oct
Jan 2012
Apr
Jul
DATE
Chronic Threshold
Acute Threshold
Dissolved_Mercury


Bayou La Batre Surface Water
Alabama Department of Environmental Management
Station Name=HMC-1
Mercury (ug/L)
2.5
2.0
1.5
1.0
0.5
0.0
26Sep
2011
27Sep
28Sep
DATE
Chronic Threshold
Acute Threshold
Dissolved_Mercury

APPENDIX A BACTERIA RESULTS

CHAIN OF CUSTODY FORM

Energy Technical Services, LLC
Northport Office - 14176 Highway 69 N, Northport, AL 35473 205 330-7994
Mobile Office - 5270 Hamilton Blvd, Theodore, AL 36582 251-288-3766
www.energytechsvc.com Fax 866 594-8920

ETS ID # 15 1216 0001-005

Client: ~~Dewberry~~	ESA
Contact: ~~Kari Servold~~	Susan Shaw
Phone: ~~334-318-1357~~	407-709-9615
Address: ~~169 Dauphin St.~~	5401 South Kollee RD, Suite 405
City, State: ~~Mobile, AL~~	Orlando, FL

Sampled By: Client	ESA - Susan Shaw		
Turnaround: Routine		Rush By:	
*Compositor Start: Date		Time	
*Compositor End: Date		Time	
Comments:			

Project: Bayou La Batre Bacteriological Sampling

Sample ID	Sample Date (2015)	Sample Time	Sample Method: Comp*	Sample Method: Grab			Preservation* / # of Containers	Analysis Requested: Enterococci (NaThio, P-1)	Fecal (NaThio, P-1)	E.Coli								*Preservation Types
BIB1	12/16	9:45am		✓				X	X	X								Ice
BIB2	12/16	10:30		✓				X	X	X								H2SO4
BIB3	12/16	11:15		✓				X	X	X								HNO3
BIB4	12/16	11:35		✓				X	X	X								HCl
BIB5	12/16	12		✓				X	X	X								NaOH
																		NaThio
																		Other
																		None
																		Bottle
																		G-Glass
																		P-Plastic

Relinquished by: Susan Sh (Sign) Date/Time: 12/16/2015 1400 Received by: Dylan Bokke (Sign) Date/Time: 12/16/15 1400

Relinquished by: (Sign) Date/Time: Received by: (Sign) Date/Time:

Relinquished by: (Sign) Date/Time: Received by: (Sign) Date/Time:

Was Shipped Container intact when received? Yes No N/A

Were samples properly preserved? Yes No

Seals Intact: Yes No N/A Initials: DCB

Sample Temp: ICE deg C Initials: DCB

Shipper Tracking Number:

Comments:
Customer Drop off

Page 1 of 1

Revised 02-15

ETS, LLC

fuels - water - environmental
Northport, Alabama 205.330.7994
Mobile, Alabama 251.288.3766

Analytical Report

Customer: Environmental Science Associates
550 Kearny Street, Suite 800
San Francisco, California 94108
US

Project Name: Bayou La Batre Bay Sampling
ETS Sample ID: 151216O001
Location: Misc Test Location

Date/Time collected: 12/16/15 9:45
Sampled by: Sampler, Client
Sample type: Grab
Customer ID: B1B1
PO: n/a

Analyte	Analysis Started Date/Time/Analyst	Result	Units	Det Lim	Dil. Factor	Method
E. coli	12/16/2015 15:30 ew	1414	MPN/100ml	1	1	Idexx Colilert
Enterococci	12/16/2015 15:30 dcb	108	MPN/100ml	1	1	Idexx Enterolert
Fecal Coliform	12/16/2015 15:30 dcb	44	MPN/100ml	1	1	SM 9222 D 1997

Note: Samples were analyzed in general accordance with the following Method References:
-Code of Federal Regulations, Title 40, Part 136
-Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846
-ASTM Annual Standards
-Alabama Department of Environmental Management Lab Certification # 41720

Date: 12/21/2015

report sent via email

ETS, LLC

fuels - water - environmental
Northport, Alabama 205.330.7994
Mobile, Alabama 251.288.3766

Analytical Report

Customer: Environmental Science Associates
550 Kearny Street, Suite 800
San Francisco, California 94108
US

Date/Time collected: 12/16/15 10:30
Sampled by: Sampler, Client
Sample type: Grab
Customer ID: B1B2
PO: n/a

Project Name: Bayou La Batre Bay Sampling
ETS Sample ID: 151216O002
Location: Misc Test Location

Analyte	Analysis Started Date/Time/Analyst	Result	Units	Det Lim	Dil. Factor	Method
E. coli	12/16/2015 15:30 ew	613	MPN/100ml	1	1	Idexx Colilert
Enterococci	12/16/2015 15:30 dcb	142	MPN/100ml	1	1	Idexx Enterolert
Fecal Coliform	12/16/2015 15:30 dcb	42	MPN/100ml	1	1	SM 9222 D 1997

Note: Samples were analyzed in general accordance with the following Method References:
-Code of Federal Regulations, Title 40, Part 136
-Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846
-ASTM Annual Standards
-Alabama Department of Environmental Management Lab Certification # 41720

Date: 12/21/2015

report sent via email

ETS, LLC

fuels - water - environmental
Northport, Alabama 205.330.7994
Mobile, Alabama 251.288.3766

Analytical Report

Customer: Environmental Science Associates
550 Kearny Street, Suite 800
San Francisco, California 94108
US

Project Name: Bayou La Batre Bay Sampling
ETS Sample ID: 151216O003
Location: Misc Test Location

Date/Time collected: 12/16/15 11:15
Sampled by: Sampler, Client
Sample type: Grab
Customer ID: B1B3
PO: n/a

Analyte	Analysis Started Date/Time/Analyst	Result	Units	Det Lim	Dil. Factor	Method
E. coli	12/16/2015 15:30 ew	> 2420	MPN/100ml	1	1	Idexx Colilert
Enterococci	12/16/2015 15:30 dcb	192	MPN/100ml	1	1	Idexx Enterolert
Fecal Coliform	12/16/2015 15:30 dcb	49	MPN/100ml	1	1	SM 9222 D 1997

Note: Samples were analyzed in general accordance with the following Method References:
-Code of Federal Regulations, Title 40, Part 136
-Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846
-ASTM Annual Standards
-Alabama Department of Environmental Management Lab Certification # 41720

Date: 12/21/2015

report sent via email

ETS, LLC

fuels - water - environmental
Northport, Alabama 205.330.7994
Mobile, Alabama 251.288.3766

Analytical Report

Customer: Environmental Science Associates
550 Kearny Street, Suite 800
San Francisco, California 94108
US

Project Name: Bayou La Batre Bay Sampling
ETS Sample ID: 151216O004
Location: Misc Test Location

Date/Time collected: 12/16/15 11:35
Sampled by: Sampler, Client
Sample type: Grab
Customer ID: B1B4
PO: n/a

Analyte	Analysis Started Date/Time/Analyst	Result	Units	Det Lim	Dil. Factor	Method
E. coli	12/16/2015 15:30 ew	> 2420	MPN/100ml	1	1	Idexx Colilert
Enterococci	12/16/2015 15:30 dcb	488	MPN/100ml	1	1	Idexx Enterolert
Fecal Coliform	12/16/2015 15:30 dcb	13	MPN/100ml	1	1	SM 9222 D 1997

Note: Samples were analyzed in general accordance with the following Method References:
-Code of Federal Regulations, Title 40, Part 136
-Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846
-ASTM Annual Standards
-Alabama Department of Environmental Management Lab Certification # 41720

Date: 12/21/2015

report sent via email

ETS, LLC

fuels - water - environmental
Northport, Alabama 205.330.7994
Mobile, Alabama 251.288.3766

Analytical Report

Customer: Environmental Science Associates
550 Kearny Street, Suite 800
San Francisco, California 94108
US

Date/Time collected: 12/16/15 12:00
Sampled by: Sampler, Client
Sample type: Grab
Customer ID: B1B5
PO: n/a

Project Name: Bayou La Batre Bay Sampling
ETS Sample ID: 151216O005
Location: Misc Test Location

Analyte	Analysis Started Date/Time/Analyst	Result	Units	Det Lim	Dil. Factor	Method
E. coli	12/16/2015 15:30 ew	1414	MPN/100ml	1	1	Idexx Colilert
Enterococci	12/16/2015 15:30 dcb	24	MPN/100ml	1	1	Idexx Enterolert
Fecal Coliform	12/16/2015 15:30 dcb	2	MPN/100ml	1	1	SM 9222 D 1997

Note: Samples were analyzed in general accordance with the following Method References:
-Code of Federal Regulations, Title 40, Part 136
-Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846
-ASTM Annual Standards
-Alabama Department of Environmental Management Lab Certification # 41720

Date: 12/21/2015

report sent via email

APPENDIX A MST RESULTS

CHAIN OF CUSTODY FORM

Energy Technical Services, LLC
Northport Office - 14176 Highway 69 N, Northport, AL 35473 205 330-7994
Mobile Office - 5270 Hamilton Blvd, Theodore, AL 36582 251-288-3766
www.energytechsvc.com Fax 866 594-8920

ETS ID #

Client: ~~Dewberry~~	ESA
Contact: ~~Karl Servold~~	Susan Shaw
Phone: ~~334-318-1357~~	407-709-9615
Address: ~~169 Dauphin St.~~	5401 South Kollee RD, Suite 405
City, State: ~~Mobile, AL~~	Orlando, FL

Sampled By: Client	ESA - Susan Shaw		
Turnaround: Routine		Rush By:	
*Compositor Start: Date		Time	
*Compositor End: Date		Time	
Comments:			

Project: Bayou La Batre Bacteriological Sampling

Sample ID	Sample Date (2015)	Sample Time	Comp*	Grab			Preservation* / # of Containers	Enterococci (NaThio, P-1)	Fecal (NaThio, P-1)	E. Coli								*Preservation Types
BB 1	12/16	9:45am		✓				X	X	X								Ice
BIB2	12/16	10:30		✓				X	X	X								H2SO4
BIB3	12/16	11:15		✓				X	X	X								HNO3
BIB4	12/16	11:35		✓				X	X	X								HCl
BiB5	12/16	12		✓				X	X	X								NaOH
																		NaThio
																		Other
																		None
																		Bottle: G-Glass, P-Plastic

Analysis Requested

Relinquished by: [signature] Sign Date/Time: 12/16/2015 1400 Received by: Dylan Bekke Sign Date/Time: 12/16/15 1400

Relinquished by: Sign Date/Time: Received by: Sign Date/Time:

Relinquished by: Sign Date/Time: Received by: Sign Date/Time:

Was Shipped Container intact when received? Yes No N/A — Seals Intact: Yes No N/A — Initials: DCB

Were samples properly preserved? Yes No — Sample Temp: ICE deg C — Initials: DCB

Shipper Tracking Number:

Comments:
Customer Drop off

COPY

Page 1 of 1

Revised 02-15

Chain Of Custody Record

Source Molecular Corporation

SHIPPING ADDRESS:
4985 SW 74th Court, Miami, FL 33155 USA
Tel: (1) 786-220-0379 Fax: (1) 786-513-2733
Email: info@sourcemolecular.com

Company Name:	ESA
Contact Name(s):	Doug Robinson
E-mail Address(es):	DROBINSON@ESASSOC.COM
Phone:	727-430-6712 / 813-207-7206
Address:	4350 W. Cypress St. Suite 950
City/State/Zip:	TAMPA, FL. 33607
Country:	USA

Analysis Requested (see pg. 2)
Mark boxes with "X"

Sample ID	Media	Sample Date (2016)	Sample Time	# of Containers	MST						Quantification (Yes, No, If Positive)	Comments
BIB1		12-16	9:45am	1	X							
BIB2		12-16	10:30am	1	X							
BIB3			11:15am	1	X							
BIB4			11:35am	1	X							
BIB5			12:00pm	1	X							

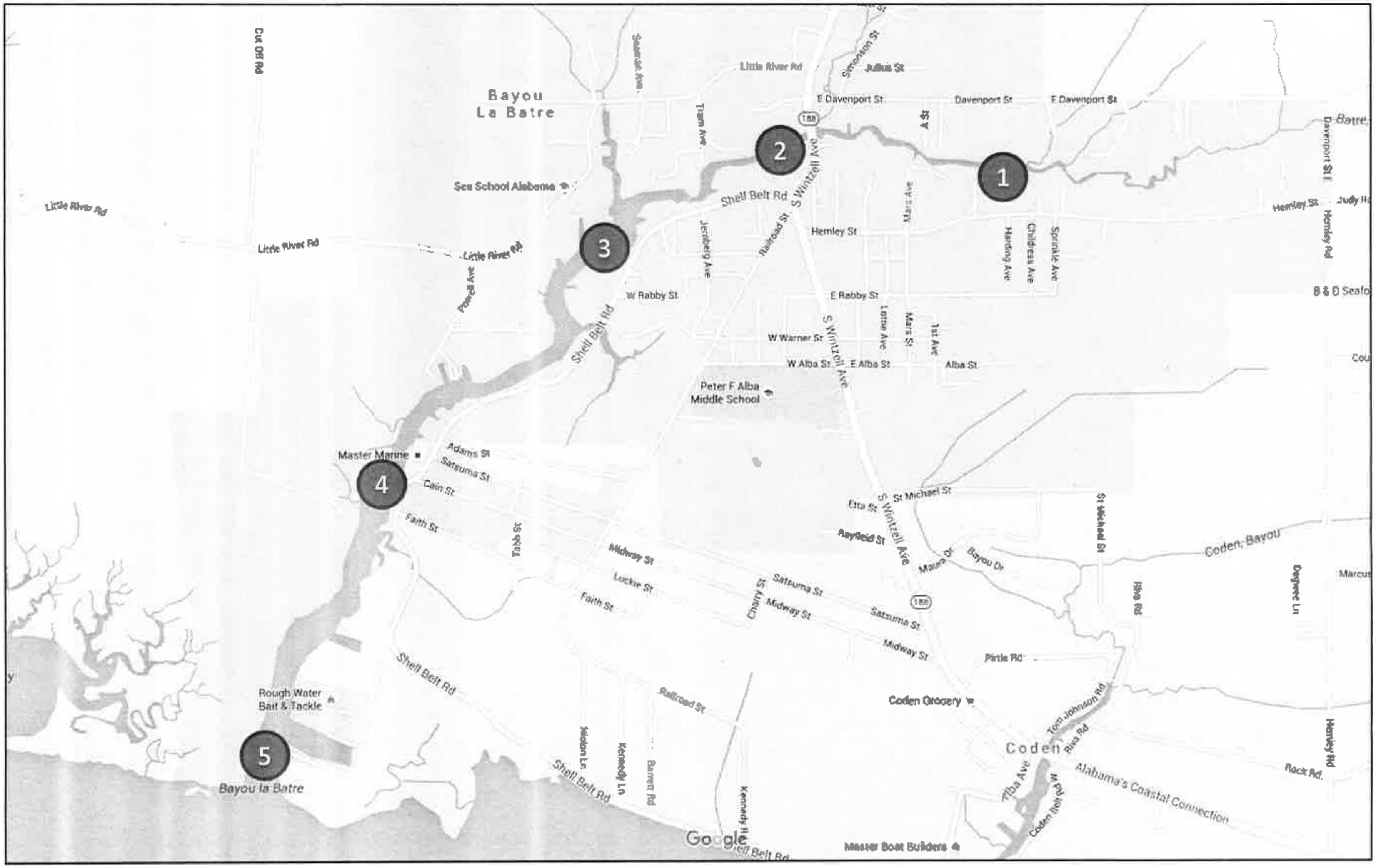
Completed by Client:

SAMPLES DELIVERED BY: Sue Shaw
SAMPLER NAME: [illegible]
SAMPLE SITE: OBLB
SIGNATURE: [illegible]

Completed by Source Molecular:

SAMPLES RECEIVED BY
RECEIVED DATE/TIME
TEMPERATURE
CONDITION
SIGNATURE

Bayou La Batre MST Study Sampling Sites



Source Molecular
Leader in Microbial Source Tracking

4985 SW 74th Court, Miami, FL 33155 USA
Tel: (1) 786-220-0379, Fax: (1) 786-513-2733, Email: info@sourcemolecular.com

Preliminary Interpretation of Human Fecal Pollution ID™ Results

Detection and quantification of the fecal Human gene biomarker for Human fecal contamination by real-time quantitative Polymerase Chain Reaction (qPCR) DNA analytical technology

Submitter: ESA
Date Received: December 17, 2015
Date Reported: January 5, 2016

SM #	Client #	Approximate Contribution of Human Fecal Pollution in Water Sample	Comment
SM-5L17064	BLB1	**Trace**	Trace levels of 1 human fecal biomarker
SM-5L17065	BLB2	**Low Concentration**	Low/Trace levels of 2 human fecal biomarkers
SM-5L17066	BLB3	**Low Concentration**	Low levels of 2 human fecal biomarkers
SM-5L17067	BLB4	**Low Concentration**	Low/Trace levels of 2 human fecal biomarkers
SM-5L17068	BLB5	Not Detected	2 Human fecal biomarkers not detected

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Human Fecal Pollution ID™ Quantification

Detection and quantification of the fecal Human gene biomarker for Human fecal contamination by real-time quantitative Polymerase Chain Reaction (qPCR) DNA analytical technology

Submitter: ESA
Date Received: December 17, 2015
Date Reported: January 5, 2016

SM #	Client #	Analysis Requested	Target	Marker Quantified (copies/100 ml)	DNA Analytical Results
SM-5L17064	BLB1	Human Bacteroidetes ID 1	Dorei	<LOQ	**Present (Trace)**
SM-5L17065	BLB2	Human Bacteroidetes ID 1	Dorei	1.38E+03	**Present**
SM-5L17066	BLB3	Human Bacteroidetes ID 1	Dorei	3.72E+03	**Present**
SM-5L17067	BLB4	Human Bacteroidetes ID 1	Dorei	3.37E+02	**Present**
SM-5L17068	BLB5	Human Bacteroidetes ID 1	Dorei	ND	Absent
SM-5L17069	BLB1	Human Bacteroidetes ID 2	EPA	ND	Absent
SM-5L17070	BLB2	Human Bacteroidetes ID 2	EPA	<LOQ	**Present (Trace)**
SM-5L17071	BLB3	Human Bacteroidetes ID 2	EPA	3.42E+02	**Present**
SM-5L17072	BLB4	Human Bacteroidetes ID 2	EPA	<LOQ	**Present (Trace)**
SM-5L17073	BLB5	Human Bacteroidetes ID 2	EPA	ND	Absent

<LOQ: Below level of quantification
ND: Not Detected

Laboratory Comments

Submitter: ESA

Report Date: January 5, 2016

Negative Results
In sample(s) classified as negative, the human-associated Bacteroidetes gene biomarker(s) was either not detected in test replicates, one replicate was detected at a cycle threshold greater than 35 and the other was not, or one replicate was detected at a cycle threshold less than 35 and the other was not after repeated analysis. It is important to note that a negative result does not mean that the sample does not definitely have human fecal contamination. Only repeated sampling (both during wet and dry sampling events) will enable you to draw more definitive conclusions as to the contributor(s) of fecal pollution.
In order to strengthen the result, a negative sample should be analyzed further for human fecal contamination with other DNA analytical tests. A list of human fecal ID tests can be found at **www.sourcemolecular.com/human**.

Positive Results
In sample(s) classified as positive, the human-associated Bacteroidetes gene biomarker(s) were detected in both test replicates suggesting that human fecal contamination is present in the water sample(s). The biomarker(s) serve as an indicator of the targeted fecal pollution, but the presence of the biomarker does not signify conclusively the presence of that form of fecal pollution. Only repeated sampling (both during wet and dry sampling events) will enable you to draw more definitive conclusions as to the contributor(s) of fecal pollution.

Trace Results
In sample(s) classified as trace, the human-associated Bacteroidetes biomarker was detected in both test replicates but in quantities below the limit of quantification. This result indicates that fecal indicators associated with human were present in the sample(s) but in low concentrations.

Human Fecal Reference Samples
The client is encouraged to submit samples from the surrounding wastewater facilities and/or septic systems in order to gain a better understanding of the concentration of the human-associated fecal Bacteroidetes genetic marker as well as the concentration of the general fecal Bacteroidetes genetic marker in the geographic region of interest. A more precise interpretation would be available to the client with the submittal of such baseline samples.

Result Interpretations
Quantitative results are reported along with interpretations. Interpretations are given as "negative", “trace”, "low concentration", "moderate concentration", or "high concentration" based on the concentration of the genetic markers found in the water samples.

Additional Testing
A portion of all samples has been frozen and will be archived for 3 months. The client is encouraged to perform additional tests on the sample(s) for other hosts suspected of contributing to the fecal contamination. A list of available tests can be found at **www.sourcemolecular.com/tests**

DNA Analytical Method Explanation

All reagents, chemicals and apparatuses were verified and inspected beforehand to ensure that no false negatives or positives could be generated. In that regard, positive and negative controls were run to attest the integrity of the analysis. All inspections and controls tested negative for possible extraneous contaminates, including PCR inhibitors.

Each submitted water sample was filtered through 0.45 micron membrane filters. Each filter was placed in a separate, sterile 2ml disposable tube containing a unique mix of beads and lysis buffer. The sample was homogenized for 1min and the DNA extracted using the Generite DNA-EZ ST1 extraction kit (GeneRite, NJ), as per manufacturer's protocol.

Amplifications were run on an Applied Biosystems StepOnePlus real-time thermal cycler (Applied Biosystems, Foster City, CA) in a final reaction volume of 20ul containing sample extract, forward primer, reverse primer, probe and an optimized buffer. The following thermal cycling parameters were used: 50°C for 2 min, 95°C for 10 min and 40 cycles of 95°C for 15 s and 60°C for 1 min. All assays were run in duplicate. Absolute quantification was achieved by extrapolating genome copy numbers from standard curves generated from serial dilutions of Human specific and generic genomic DNA.

For quality control purposes, a positive control consisting of appropriate genomic DNA and a negative control consisting of PCR-grade water were run alongside the sample(s) to ensure a properly functioning reaction and reveal any false negatives or false positives.

Human Bacteroidetes ID^{TM} Species*: B. dorei*

The **Human Bacteroidetes ID^{TM} Species*: B. dorei*** service targets the species *Bacteroides dorei*. *B. dorei* is an anaerobe that is frequently shed from the gastrointestinal tract and isolated from human feces worldwide. It is a newly discovered species that is widely distributed in the USA.[1,2] The human-associated marker DNA sequence is located on the 16S rRNA gene of *B. dorei*.[3] The marker is the microbial source tracking (MST) marker of choice for detecting human fecal pollution due to its exceptional sensitivity and specificity. Internal validations have been conducted on hundreds of sewage, septage, human and animal host fecal samples collected from throughout the U.S and archived in the Source Molecular fecal bank. The marker has also been evaluated in both inland and coastal waters. A recent, comprehensive, multi-laboratory MST method evaluation study, exploring the performance of current MST methods, concluded the *B. dorei* qPCR assay to be the top performing human-associated assay amongst those tested. The success and consistency of this marker in numerous studies around the world[1,3,4] makes the **Human Bacteroidetes ID^{TM} Species*: B. dorei*** service the primary service for identifying human fecal pollution at Source Molecular.

Fecal *Bacteroidetes* are considered for several reasons an interesting alternative to more traditional indicator organisms such as *E. coli* and *Enterococci*.[5] Since they are strict anaerobes, they are indicative of recent fecal contamination when found in water systems. This is a particularly strong reference point when trying to determine recent outbreaks in fecal pollution. They are also more abundant in feces of warm-blooded animals than *E. coli* and *Enterococci*.

The Human Bacteroidetes ID^{TM} service is designed around the principle that fecal *Bacteroidetes* are found in large quantities in feces of warm-blooded animals.[3,5,6,7,8] Furthermore, certain strains of *Bacteroidetes* have been found to be associated with humans.[3,6] As such, these bacterial strains can be used as indicators of human fecal contamination.

Accuracy of the results is possible because the method amplifies DNA into a large number of small copies of the gene biomarker of interest. This is accomplished with small pieces of DNA called primers that are complementary and specific to the unique *B. dorei* DNA sequence. Through a heating process called thermal cycling, the double stranded DNA is denatured, hybridized to the complementary primers and amplified to create many copies of the DNA fragment desired. If the primers are successful in finding a site on the DNA fragment that is specific to the *B. dorei* DNA sequence, then billions of copies of the DNA fragment will be available and detected in real-time. The accumulation of DNA product is plotted as an amplification curve by the qPCR software. The absence of an amplification curve indicates that the *B. dorei* gene biomarker is not detected in the water sample because it is either not present or present at concentrations below the analytical detection limit.

To strengthen the validity of the results, additional tests targeting other high-ranking, human-associated *Bacteroidetes* species should be performed, such as
Human Bacteroidetes ID^{TM} Species*: B. stercoris*,
Human Bacteroidetes ID^{TM} Species*: B. fragilis,* and
Human Bacteroidetes ID^{TM} Species*: B. thetaiotaomicron*.

[1]Boehm, A., Fuhrman, J., Mrse, R., Grant, S. **Tiered approach for identification of a human fecal pollution source at a recreational beach: case study at Avalon Bay, Catalina Island, California**. Environ Sci Technol. 2003 37**:** 673–680.
[2]Bakir, M., Sakamoto, M., Kitahara, M., Matsumoto, M., Benno, Y. **Bacteroides dorei sp. nov., isolated from human faeces**. Int. J. Syst. Evol. Microbiol. 2006 56: 1639–1641.
[3] Bernhard, A., Field, K. **A PCR assay to discriminate human and ruminant feces on the basis of host differences in Bacteroides-Prevotella genes encoding 16S rRNA.** Appl. Environ. Microbiol. 2000b 66: 4571-4574.
[4]Ahmed, w., Masters, N., Toze, S. **Consistency in the host specificity and host sensitivity of the Bacteroides HF183 marker for sewage pollution tracking. Lett. Appl. Microbiol. 2012 55: 283-289.**
[5] Scott, T., Rose, J., Jenkins, T., Farrah, S., Lukasik, J. **Microbial Source Tracking: Current Methodology and Future Directions.** Appl. Environ. Microbiol. 2002 68: 5796-5803.
[6] Bernhard, A., Field, K. **Identification of nonpoint sources of fecal pollution in coastal waters by using host-specific 16S ribosomal DNA genetic markers from fecal anaerobes.** Appl. Environ. Microbiol. 2000a 66: 1587-1594.
[7] Fogarty, L., Voytek, M. **A Comparison of Bacteroides-Prevotella 16S rRNA Genetic Markers for Fecal Samples from Different Animal Species.** Appl. Environ. Microbiol. 2005 71: 5999-6007.
[8] Dick, L., Bernhard, A., Brodeur, T., Santo Domingo, J., *et al*. **Host Distributions of Uncultivated Fecal Bacteroidales Bacteria Reveal Genetic**

Human Bacteroidetes ID^{TM}: EPA Developed Assay

The **Human Bacteroidetes ID^{TM}: EPA Developed Assay** service targets a functional gene biomarker in *Bacteroidales*-like anaerobic bacteria that is present in high concentrations in the human gut. The U.S Environmental Protection Agency (U.S. EPA) was the first to target the biomarker using quantitative Polymerase Chain Reaction (qPCR) technology in order to detect ground and surface waters impacted by human fecal pollution.[1] Since it's development, the assay has been used succesfully around the U.S to identify fecal pollution originating from human sources, such as sewage and septage wastewaters.

The U.S. EPA Developed assay has been shown to be highly associated with human fecal pollution. It has successfully been validated in multiple nationwide studies using at least 300 individual reference fecal material from 22 different animal species known to commonly contaminate environmental waters.[1,2] A reported 99.2% specificity to human fecal material makes this one of the leading assays to confirm the presence of fecal contamination that is of human origin.[1] The *Bacteroidales*-like bacteria is widely distributed. It was detected in 100% of hundreds of sewage and human reference fecal samples collected from more than 20 human populations, making it highly sensitive. Internal validations have also been conducted on hundreds of wastewater, human and animal host fecal samples archived in the Source Molecular fecal bank.

Fecal anaerobic bacteria are considered for several reasons an interesting alternative to more traditional fecal indicator organisms such as *E. coli* and *Enterococci*.[3] Since they are strict anaerobes, they are indicative of recent fecal contamination when found in water systems.[3] This is a particularly strong reference point when trying to determine recent outbreaks in fecal pollution. They are also more abundant in feces of warm-blooded animals than *E. coli* and *Enterococci*.

The **Human Bacteroidetes ID^{TM}: EPA Developed Assay** service is designed around the principle that fecal *Bacteroidales*-like bacteria are found in large quantities in feces of warm-blooded animals.[4,5] Furthermore, certain strains have been shown to be associated with humans.[4,5] As such, these bacterial strains can be used as indicators of human fecal contamination. An advantage of the Human Bacteroidetes ID^{TM} service is that the entire portion of water sampled is filtered to concentrate bacteria. As such, this method avoids the randomness effect of culturing and selecting bacterial isolates. This is an advantage for highly contaminated water systems with potential multiple sources of fecal contamination.

Accuracy of the results is possible because the method amplifies DNA into a large number of copies of the gene biomarker of interest. This is accomplished with small pieces of DNA called primers that are complementary and specific to the gene biomarker. Through a heating process called thermal cycling, the double stranded DNA is denatured, hybridized to the complementary primers and amplified to create many copies of the DNA fragment. If the primers are successful in finding a site on the DNA fragment that is specific to the human-associated biomarker, billions of copies of the DNA fragment will be available and detected in real-time. The accumulation of DNA product is plotted as an amplification curve by qPCR software. The absence of an amplification curve indicates that the gene biomarker is not detectable in the water sample either because it is not present or present at concentrations below the analytical detection limit.

To strengthen the validity of the results, additional tests targeting other high-ranking, human-associated *Bacteroidetes* species should be performed, such as
Human Bacteroidetes ID^{TM} Species*: B. dorei*,
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Human Bacteroidetes ID^{TM} Species*: B. stercoris*

[1] Shanks, O., Kelty, C., Sivaganesan, M., Varma, M. and Haugland, R. **Quantitative PCR for Genetic Markers of Human Fecal Pollution**. Appl. Environ. Microbiol. 2009 75: 5507-5513.
[2] Layton, B., Cao, Y., Ebentier, D., Hanley, K., Ballesté, E., Brandão, J., *et al*. **Performance of Human Fecal Anaerobe-Associated PCR-Based Assays in a Multi-Laboratory Method Evaluation Study.** Water Research. 2013 In Press.
[3] Scott, T., Rose, J., Jenkins, T., Farrah, S. and Lukasik, J. **Microbial Source Tracking: Current Methodology and Future Directions.** Appl. Environ. Microbiol. 2002 68: 5796-5803.
[4] Bernhard, A., Field, K. **Identification of nonpoint sources of fecal pollution in coastal waters by using host-specific 16S ribosomal DNA genetic markers from fecal anaerobes.** Appl. Environ. Microbiol. 2000a 66: 1587-1594.
[5] Bernhard, A., Field, K. **A PCR assay to discriminate human and ruminant feces on the basis of host differences in Bacteroides-Prevotella genes encoding 16S rRNA.** Appl. Environ. Microbiol. 2000b 66: 4571-4574.

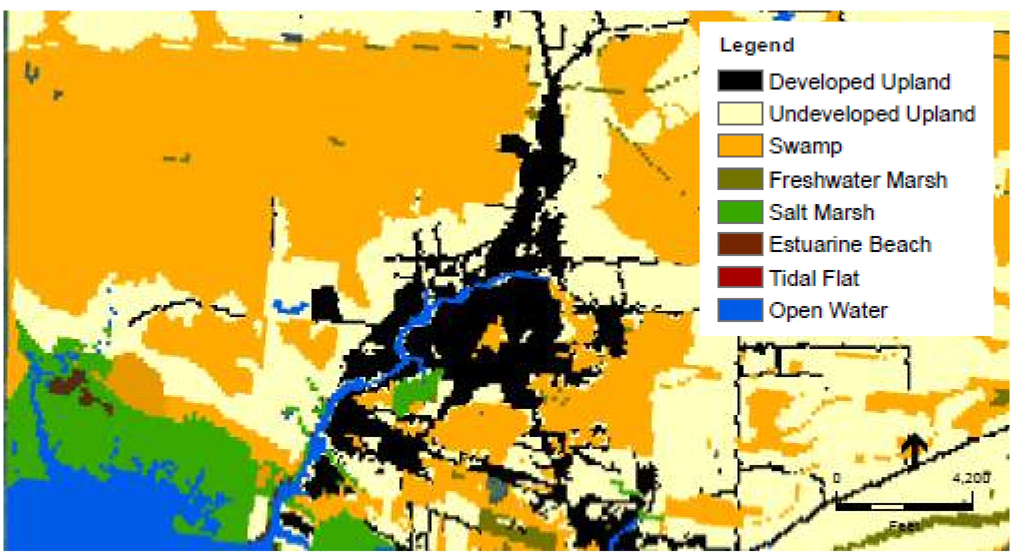
APPENDIX B SLAMM REPORT

FINAL

BAYOU LA BATRE HABITAT PROJECTION MODELING

Prepared for
Dewberry

November 2016



FINAL

BAYOU LA BATRE HABITAT PROJECTION MODELING

Prepared for
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November 2016

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Bayou La Batre Habitat Projection Modeling

1. Bayou La Batre Model Development

SLAMM, the Sea Levels Affecting Marshes Model, was developed by the Environmental Protection Agency (EPA) to evaluate the effects of sea level rise on marsh habitats. The model has been used along the west coast, the gulf coast, and the east coast, since its development in the mid-1980s. The model maps habitat distribution over time in response to sea-level rise, accretion and erosion, and freshwater influence.

SLAMM is based on the conceptual model that Bayou La Batre habitats change over the long-term in response to multiple processes, including tides, accretion, freshwater inflow, ecology, and sea-level rise. These processes are described below and provide the conceptual basis or framework (conceptual model) for the habitat projection model.

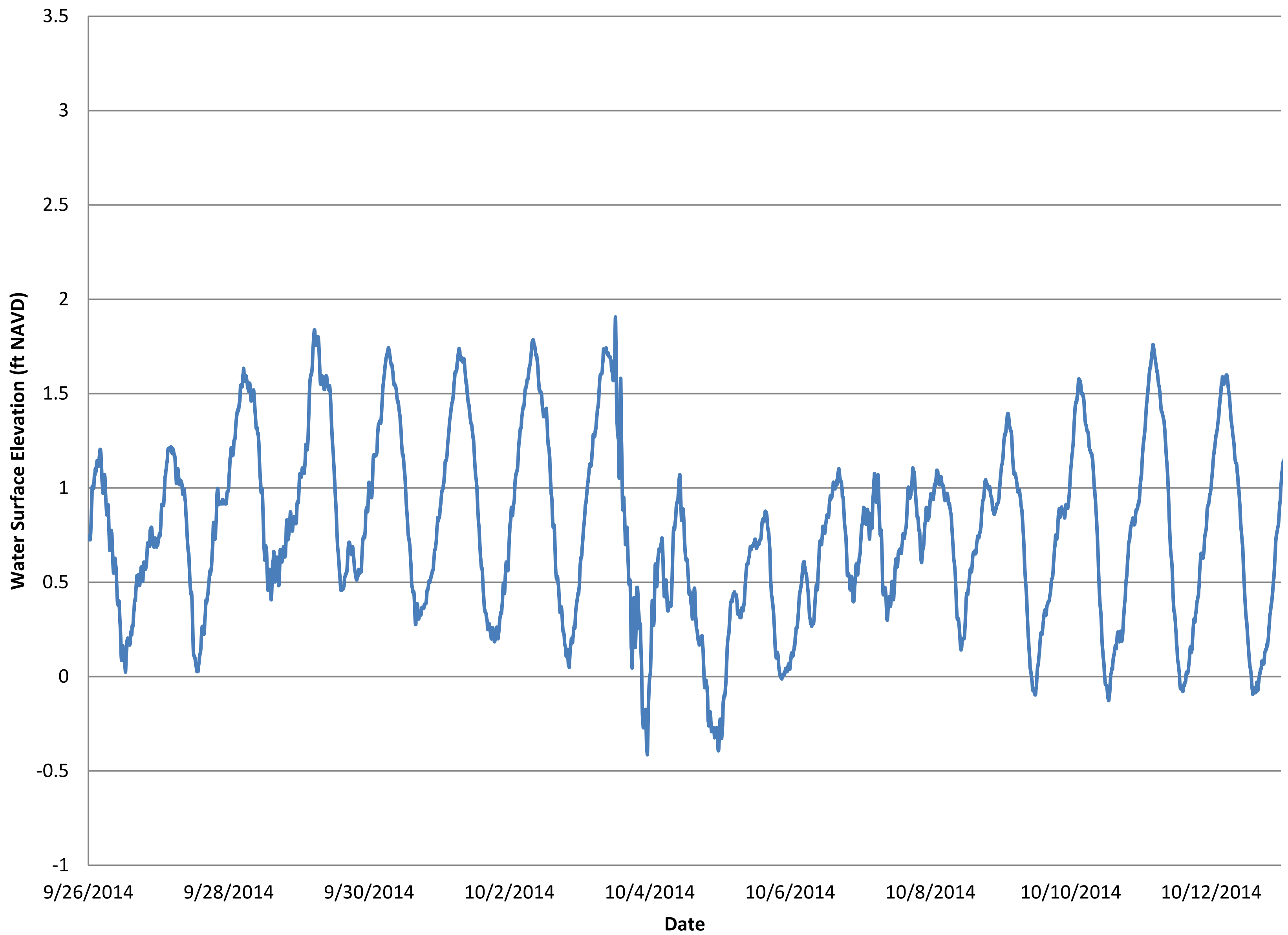
1.1 Tides

Salt marsh and intertidal habitats establish within zones corresponding to tidal inundation. Tides and tidal inundation within the Bayou La Batre estuary are therefore important processes affecting habitats.

The Alabama coast experiences diurnal tides, with one high and one low tide each day (Figure 1). In addition, the tides exhibit strong spring-neap tide variability; spring tides exhibit the greatest difference between high and low tides while neap tides show a smaller than average range. Wind can also greatly affect tidal ranges in this region. The water levels at the tide gage are also affected by the rainfall in the area that causes increases in river flow. Tidal datums for the Bayou La Batre tide gage, which is approximately 2.5 miles upstream of the mouth of the bayou (Figure 2), are summarized in Table 1 (NOAA Tides and Currents).

TABLE 1
NOAA TIDAL DATUMS FOR THE BAYOU LA BATRE BRIDGE TIDE GAGE

Tidal Datum		ft MLLW	ft NAVD
Highest Astronomical Tide	HAT	2.53	1.85
Mean Higher High Water	MHHW	1.61	0.93
Mean High Water	MHW	1.47	0.79
Mean Tide Level	MTL	0.79	0.11
Mean Sea Level	MSL	0.73	0.05
North American Vertical Datum of 1988	NAVD	0.68	0
Mean Low Water	MLW	0.12	-0.56
Mean Lower Low Water	MLLW	0	-0.68

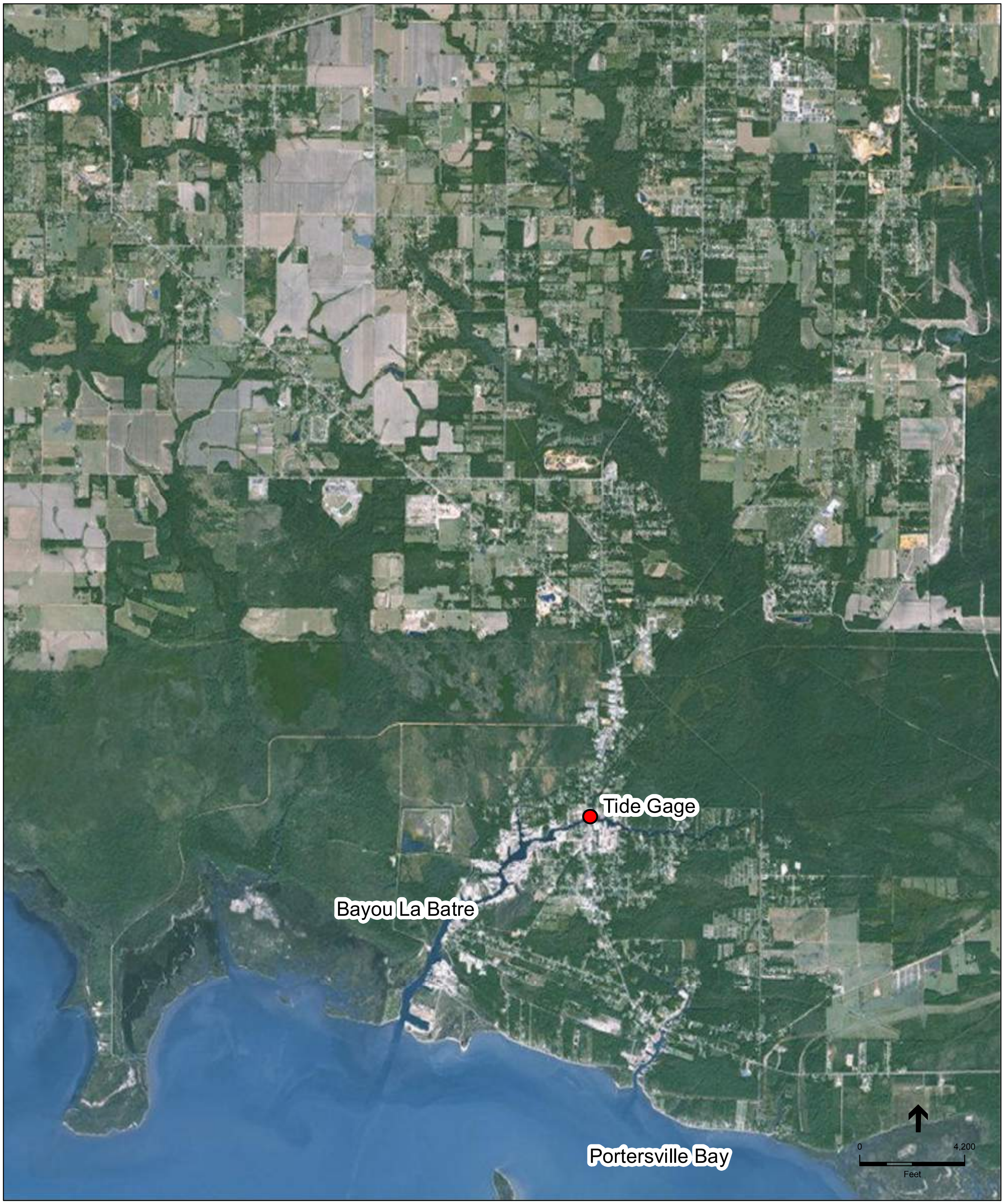


SOURCE: NOAA Bayou La Batre Bridge Gage

Bayou La Batre Watershed Management Plan. D150168

Figure 1

Tide Time Series Sept 26 - Oct12, 2014



SOURCE: ESRI

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Figure 2
Location of Bayou La Batre Bridge Tide Gage

1.2 Topography and Accretion

The elevation of an area determines the frequency of tidal inundation and salinity, which then influences the type of vegetation that will establish. If the topography changes due to accretion (or restoration/grading) the habitat types can change in response.

Bayou La Batre is a low energy tidal creek with relatively low sediment inputs, and fairly low tidal amplitudes and current velocities. Even though the Bayou occasionally receives big freshwater inflows from major rainfall events, the flows and sediment loads are buffered by the large forested wetlands in the headwaters.

1.3 Freshwater Inflow

Freshwater swamp and marsh habitats form in areas influenced by freshwater inflows. These areas of freshwater influence are either inundated solely by freshwater or are characterized by tidal mixing of ocean water and freshwater inflows, creating brackish salinities. The influence of freshwater determines what type of vegetation can establish in that area. If the extent of freshwater influence increases, the extent of freshwater swamp and marsh habitats will increase. Conversely, if the area of freshwater influence is reduced, the extent of freshwater habitats will be reduced. The area or extent of freshwater influence can be inferred from the extent of existing freshwater habitats, correlated to freshwater inflows, and/or quantified through monitoring and modeling of freshwater inflows and salinity gradients.

The Bayou La Batre fluvial system drains 75 square kilometers and the average discharge is 0.4m^3/s (Rodriguez et al, 2008). The study area includes significant amounts of swamp and marsh and the habitats are influence by rainfall and freshwater flow.

1.4 Habitat Zones

Wetland habitat zones can be defined for different areas based on the elevation of the area relative to tidal datums (i.e., as a surrogate for the frequency of tidal inundation) and whether the area is within the zone of freshwater influence. The model uses an additional datum called the “salt elevation,” which is based on the high astronomical tide (1.85 ft NAVD at Bayou La Batre Bridge).

Figure 3 shows the different elevation-based habitat zones used in SLAMM. Upland species establish at the highest elevations, followed by freshwater swamp and marsh, salt marsh, tidal flat, and lastly, open water habitat.

1.5 Sea-level Rise

Sea-level rise is expected to be a major driver of habitat evolution at Bayou La Batre. Since most vegetation establishes in specific areas based on the local tidal inundation and salinity, habitats will evolve when the tides rise.

The Intergovernmental Panel on Climate Change (IPCC; 2013) provides guidance for projects in planning for sea-level rise. These predictions for 2100 are:

- Low Emissions: 14 to 28”
- Medium Emissions: 15 to 29”
- High Emissions: 21 to 39”

With climate change, extreme high water levels may change more than mean sea levels due to alterations in the occurrence of strong winds and low pressures. However, this has not been extensively studied for the project area, so it is not included in this conceptual model.

Relative sea level rise is the sum of global sea level rise and the change in vertical land movement. Thus, if sea level rises and the shoreline rises or subsides, the relative rise in sea level could be lesser or greater than the global sea level rise. Vertical land movement can occur due to tectonics (earthquakes, regional subsidence, or uplift), sediment compaction, isostatic readjustment, and groundwater depletion (USACE 2009).

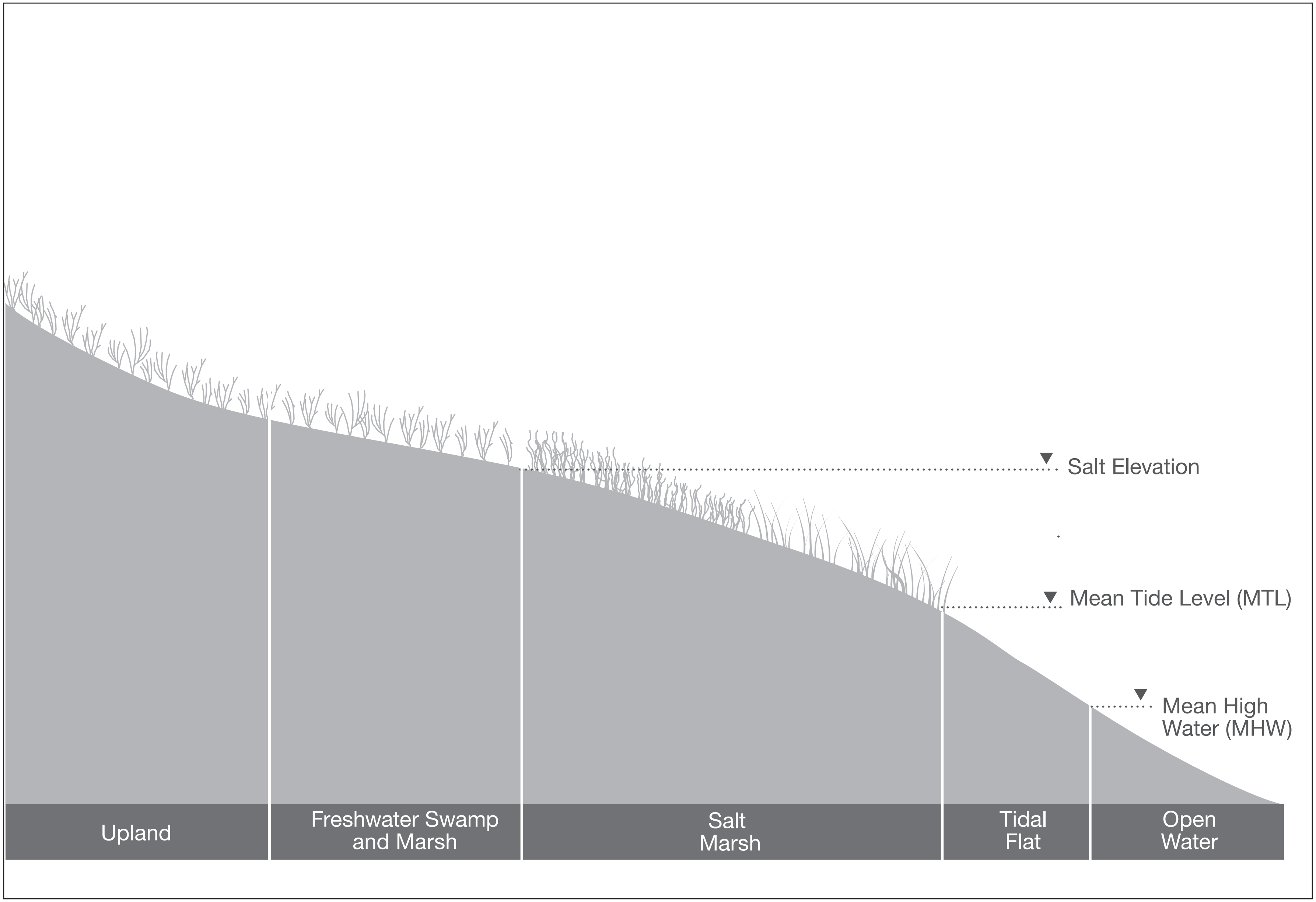

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Figure 3
Conceptual Habitat Elevation Zone Model

2. Model Inputs

SLAMM was run with the following inputs to look at habitat evolution at Bayou La Batre under baseline conditions.

2.1 Topography and Bathymetry

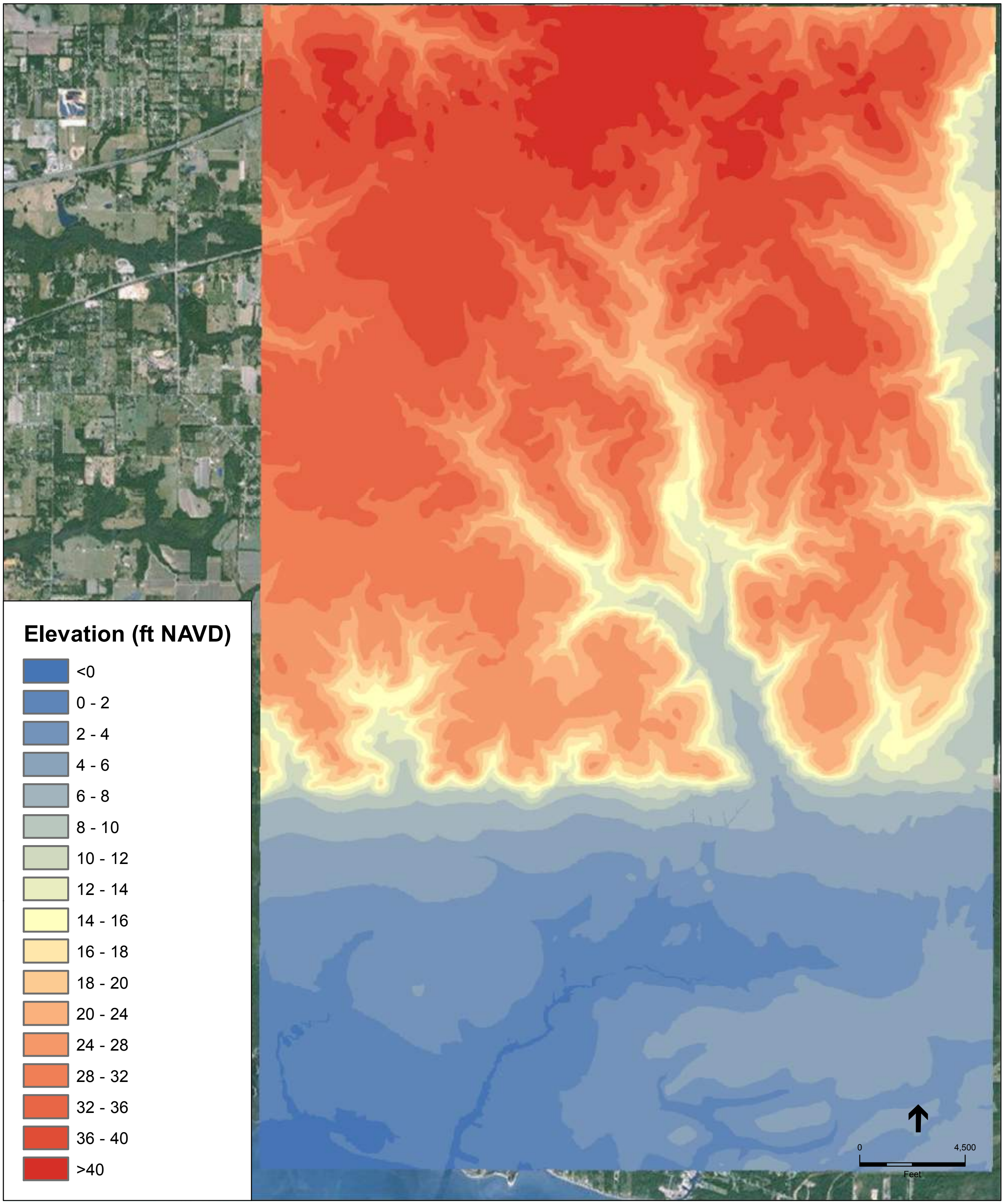
Topography is used in the model as input to the habitat evolution decision tree (see Section 2.2). Figure 4 presents the existing topography of the estuary from the USGS National Elevation Dataset, a 1/3 arc-second resolution DEM dataset from 2013. The resulting topography/bathymetry was converted to 10 m cells to provide a spatial resolution that is consistent with the vegetation mapping (Section 2.2) and maintains reasonable model run times.

Bayou La Batre has a wide, shallowly-sloped basin from the water up to where Highway 188 splits from the Bayou La Batre-Irvington Highway, which is covered largely with swamp (Figure 5). Around where the highways split, there is a much steeper slope up to the heavily developed areas.

2.2 Vegetation Mapping

To evaluate how habitats will evolve over time, existing conditions habitat mapping is needed. A habitat map was created by combining the National Wetlands Inventory (NWI; 2002) data with a map of imperviousness (National Land Cover Database (NLCD) 2011) to delineate between developed and undeveloped upland. The habitat map is shown in Figure 5.

Vegetation was categorized into habitat types according to the SLAMM NWI habitat cross-walk. The SLAMM categories were further simplified to represent the habitat types in the estuary. The brackish rivers of Bayou La Batre have created habitats for shrimp, fish, crab, oysters and more. The small fishing village of Bayou La Batre is described as the “Seafood Capital of Alabama.”

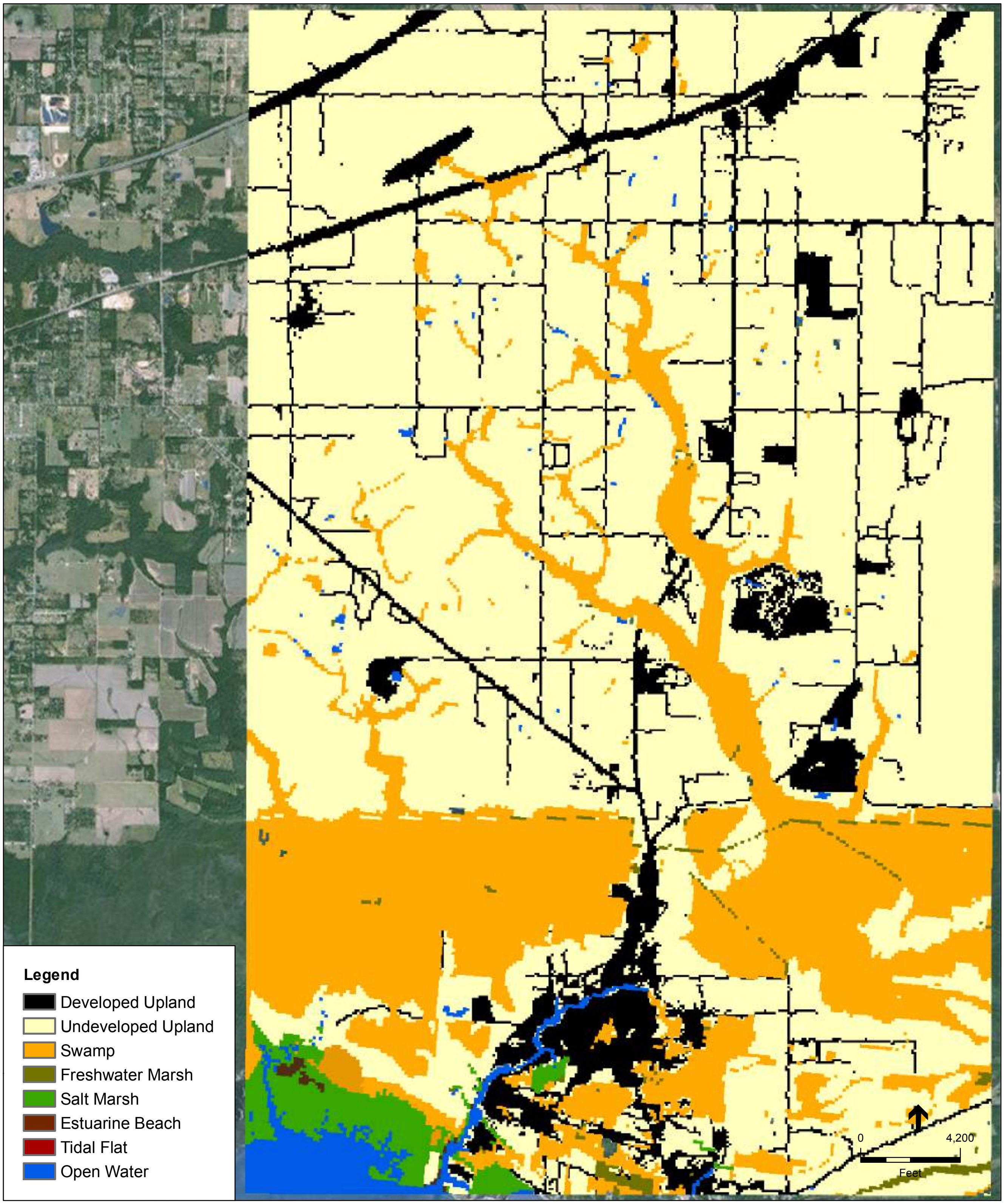


SOURCE: USGS 2013

Bayou La Batre Watershed Management Plan. 150168

Figure 4

Topography and Bathymetry



SOURCE: NWI 2002, NLDC 2011

Bayou La Batre Watershed Management Plan. 150168

Figure 5

Vegetation Map

2.3 Tidal Water Levels

2.3.1 Tidal Datums

Tidal datums are used within the model as an input to the habitat evolution decision tree. For example, MLW is the boundary between open water and tidal flat, because it indicates the elevation at which land is always inundated (during an average day). If land is below MLW, it is assumed to be open water; if land is just above, it is tidal flat.

The model uses tidal datums from the Bayou La Batre Bridge gage as discussed in Section 1.1. An additional "salt elevation" datum is used to set the limit between freshwater habitats. The salt elevation is set to 1.85 ft NAVD at Bayou La Batre Bridge, based on the high astronomical tide elevation (Table 2).

TABLE 2
TIDAL DATUMS USED IN THE MODEL
(values in feet NAVD)

Tidal Datum	Bayou La Batre Bridge[1]
Salt Elevation	1.85
MHHW	0.93
MHW	0.79
MTL	0.11
MSL	0.05
MLW	-0.56
MLLW	-0.68

1. Data from NOAA Tides and Currents

2.3.2 Sea-Level Rise

In the model, sea-level rise is added to each datum over time. To test the sensitivity of the model to sea-level rise predictions, the model was run with low and high rates of sea-level rise from the IPCC 2013 Report. Table 3 provides the different scenarios. The values are averages of the low range and high range values for the low and high emission scenarios (Section 1.5).

TABLE 3
SEA-LEVEL RISE SCENARIOS

	Sea Level Rise by 2100 (inches from 2000)
Low Emissions	21
High Emissions	29

2.4 Accretion and Erosion

Callaway et al (1997) conducted a study of sediment accretion along low-lying sites within the tidal range in the Gulf of Mexico. They took six samples at two sites in Biloxi Bay, Mississippi, about 50 miles west of Bayou La Batre. The samples were taken near the mouth and in upper Biloxi Bay. The average vertical accretion rate was found to be 0.22 in/yr (5.6 mm/yr). One sample from the core at the upper end of the marsh and adjacent to a tidal creek showed accretion rates of 0.24 in/yr (6.1 mm/yr). These rates were assumed to be similar to the sedimentation rates in Bayou La Batre. To test sensitivity to the sedimentation rates, the model was run with both accretion rates.

O'Sullivan and Criss determined linear loss of shoreline in Point au Chenes Bay, about 10 miles west of Bayou La Batre. They observed shoreline change from 1995 to 1997 using reference markers. The two most eastern stations in Middle Bay were averaged to be horizontally eroding 22 in/yr (0.57 m/ yr). This value was used as an estimate of erosion in Bayou La Batre.

2.5 Freshwater Inflow

The model defines the area of year-round freshwater influences based on a freshwater influence polygon. For existing conditions, this polygon was defined by the extent of freshwater marsh in the estuary, which occurred throughout the entire project site. For this analysis, it was assumed that the freshwater influence would remain unchanged in the future.

3. Model Runs

Table 4 presents the scenarios that were run in SLAMM to test the model sensitivity. Low and high rates of sea-level rise were evaluated with low and high accretion rates. The model also evaluates different management scenarios, such as protecting development or "holding the line" versus allowing marsh to migrate into upland areas.

TABLE 4
RUN CATALOG

Run	Sea-Level Rise	Accretion Rates	Protect Development
Run 1	Low (21 in)	Low (0.12 in/yr)	No
Run 2	High (29 in)	Low (0.12 in/yr)	No
Run 3	High (29 in)	High (0.52 in/yr)	No
Run 4	High (29 in)	Low (0.12 in/yr)	Yes

4. Results

The runs in Table 4 allowed for comparisons between different sea-level rise scenarios, accretion rates, and management scenarios. Below, Section 4.1 presents the model "validation" of existing habitat types. Sections 4.2 and 4.3 present the results for sensitivity runs on sea-level rise and accretion rates, and Section 4.4 presents the results for the different management scenarios.

4.1 Model "Validation"

The SLAMM results were compared to existing vegetation to check the model assumptions for the habitat evolution decision tree. Current topography and existing tidal datums were input to the model with no sea-level rise to model the existing conditions (2002) and to validate the model. Table 5 presents habitat acreages from the 2002 mapped vegetation and from the 2002 modeled habitats.

TABLE 5
HABITAT ACREAGES FOR MAPPED VS MODELED

Habitat	2002 Mapped Vegetation[1]	2002 Modeled Vegetation[1]	Difference	
	(ac)	(ac)	(ac)	%
Developed Upland	1,554	1,554	0	0%
Undeveloped Upland	9,468	9,444	-24	0%
Freshwater Swamp	2,914	2,935	21	1%
Freshwater Marsh	72	73	0	1%
Salt Marsh	241	244	3	1%
Tidal Flat	0	0	0	n/a
Estuarine Beach	12	12	0	0%
Open Water	232	232	0	0%

1. Results have been rounded

When the mapped vegetation is input to the model, some habitats change, since actual vegetation does not always follow the rules of the model. For example, SLAMM converts upland to freshwater swamp and salt marsh based on the elevations from the topography. However, these changes are minor, and effect less than 1% of the habitats.

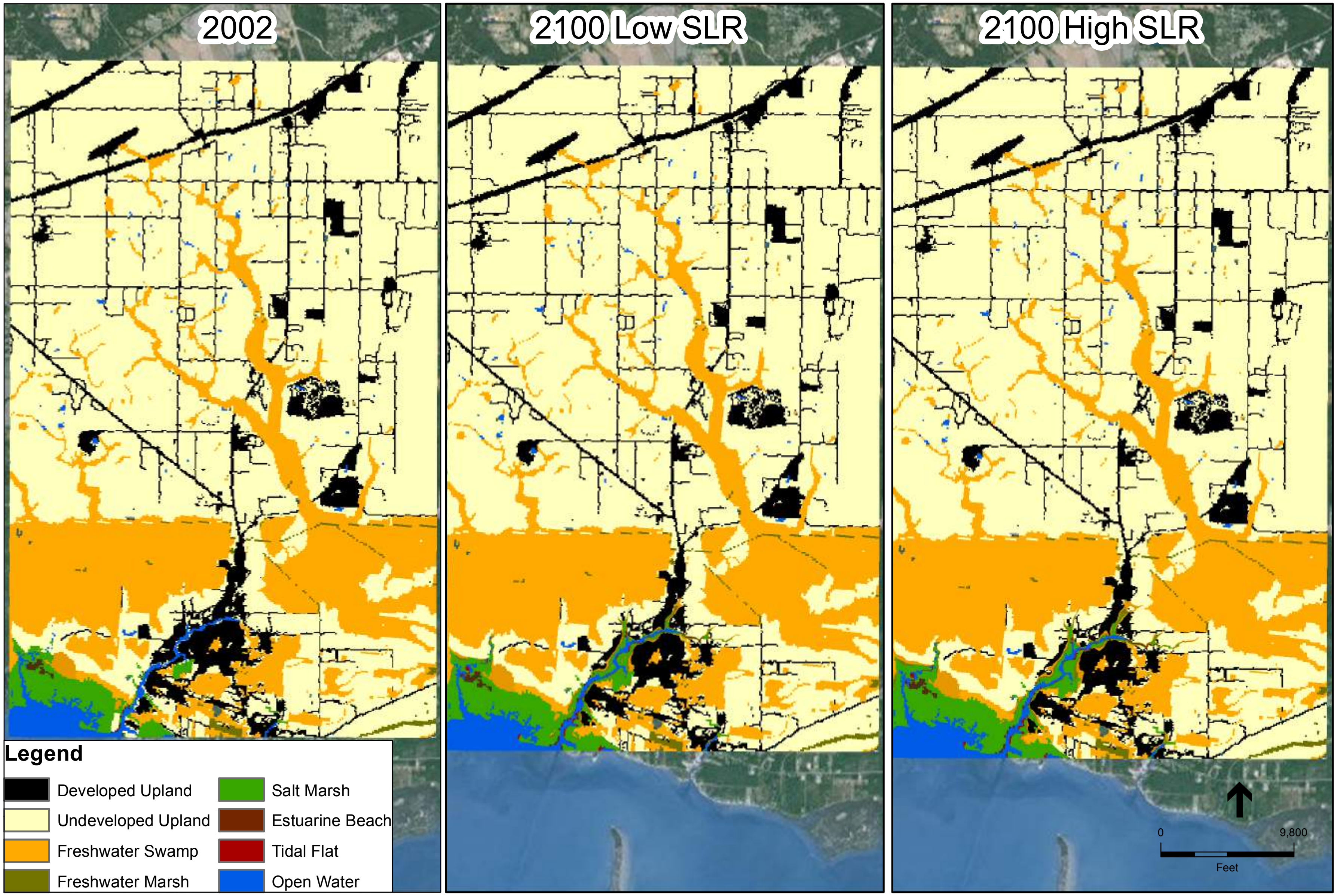
4.2 Sea-Level Rise

Table 6 presents the habitat acreages for low (run 1) and high (run 2) rates of sea-level rise at 2100, as well as the difference between these habitat acreages and the 2002 modeled habitats (See Appendix A for habitat acreages for 2030, 2050, 2070, and 2100). With higher rates of sea-level rise, higher elevation habitats convert to lower habitat types more quickly. For example, under the high sea-level rise scenario, there is a greater loss of upland habitats and a more rapid increase of salt marsh, tidal flat, and open water. Figure 6 shows the 2100 habitat maps for low and high sea-level rise. (See Appendix B for habitat maps at 2030, 2050, 2070, and 2100).

Figure 7 and Figure 8 show the evolution of habitats over time for low and high rates of sea-level rise. In Figures 7,8,10,11,13 and 14 the Freshwater Swamp and Upland sections have been scaled in order for comparison. See table for actual acreage values.

TABLE 6
HABITAT ACREAGES FOR SEA-LEVEL RISE

Habitat	Modeled Acreage in 2002	Acreage in 2100		Acreage difference 2100-2002	
		Low	High	Low	High
Developed Upland	1,554	1,491	1,474	-62	-79
Undeveloped Upland	9,444	9,418	9,397	-27	-48
Freshwater Swamp	2,935	2,933	2,948	-2	13
Freshwater Marsh	73	91	95	19	22
Salt Marsh	244	305	320	61	77
Tidal Flat	0	9	10	9	10
Estuarine Beach	12	12	12	0	0
Open Water	232	234	238	2	6



SOURCE: ESRI, NWI 2002, NLCD 2011

Bayou La Batre Watershed Management Plan. 150168

Figure 6

2002 Modeled Vegetation versus
Low and High Sea-Level Rise

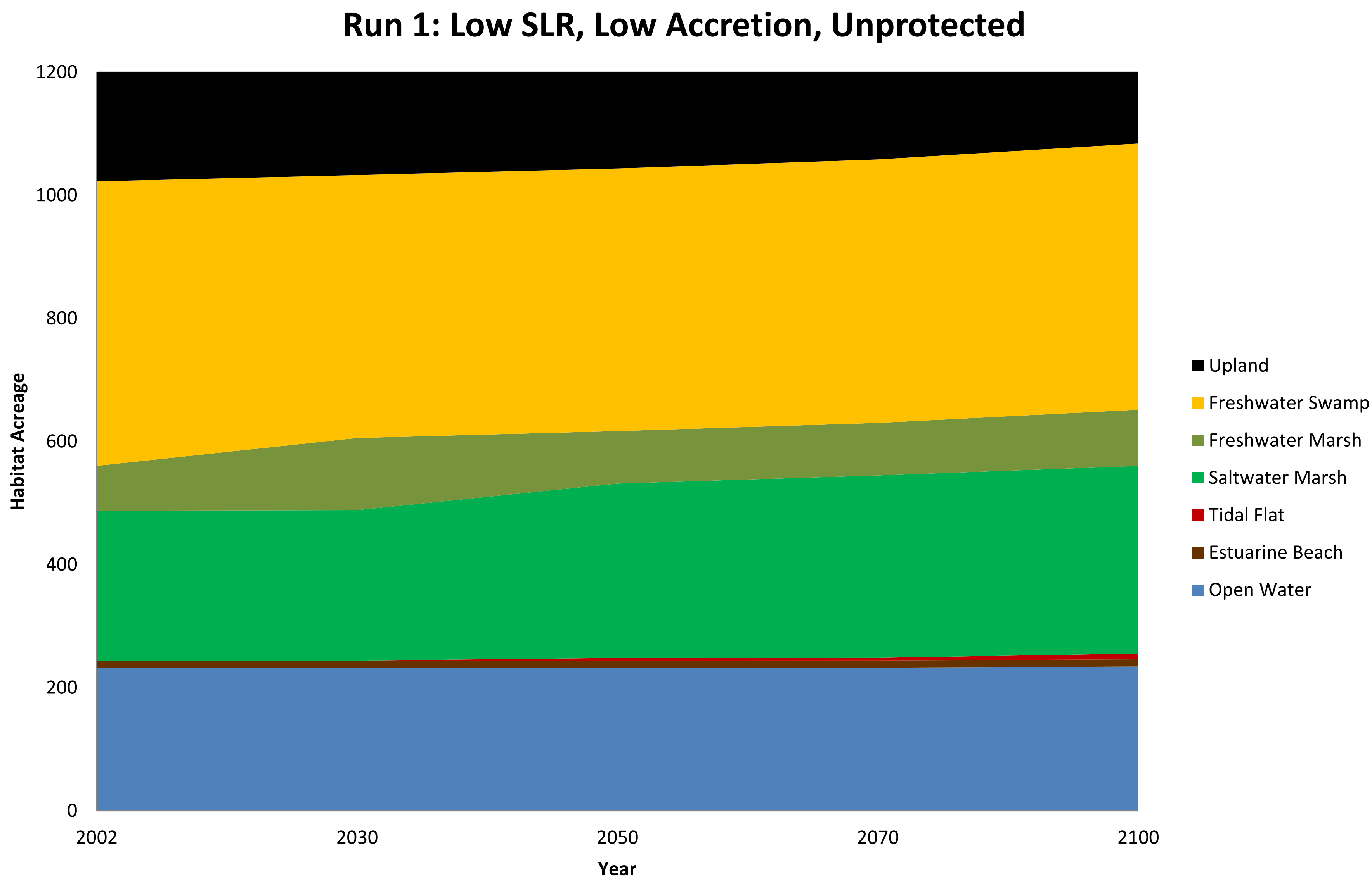


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Figure 7

Run 1 Habitats Over Time

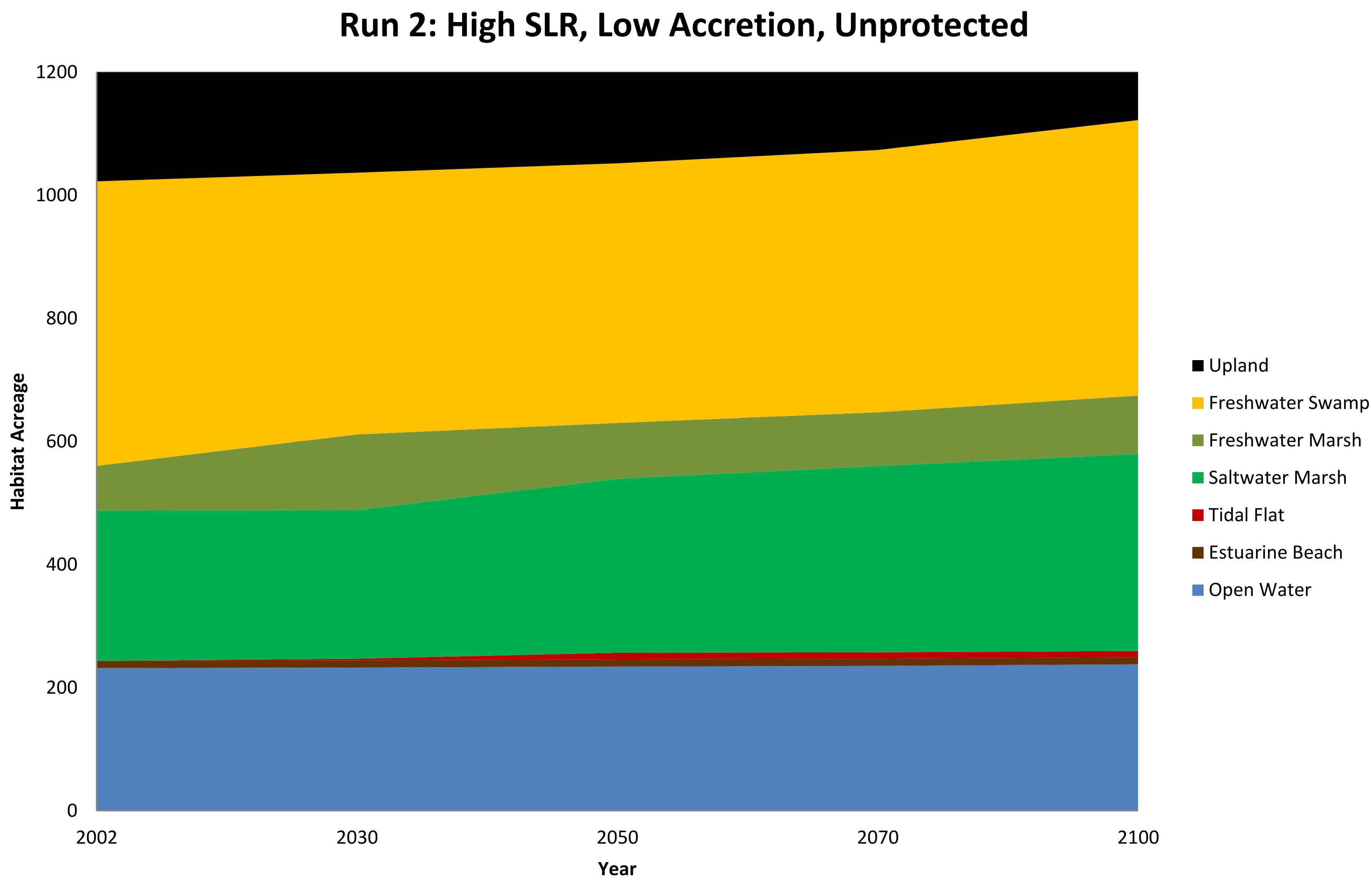

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Figure 8

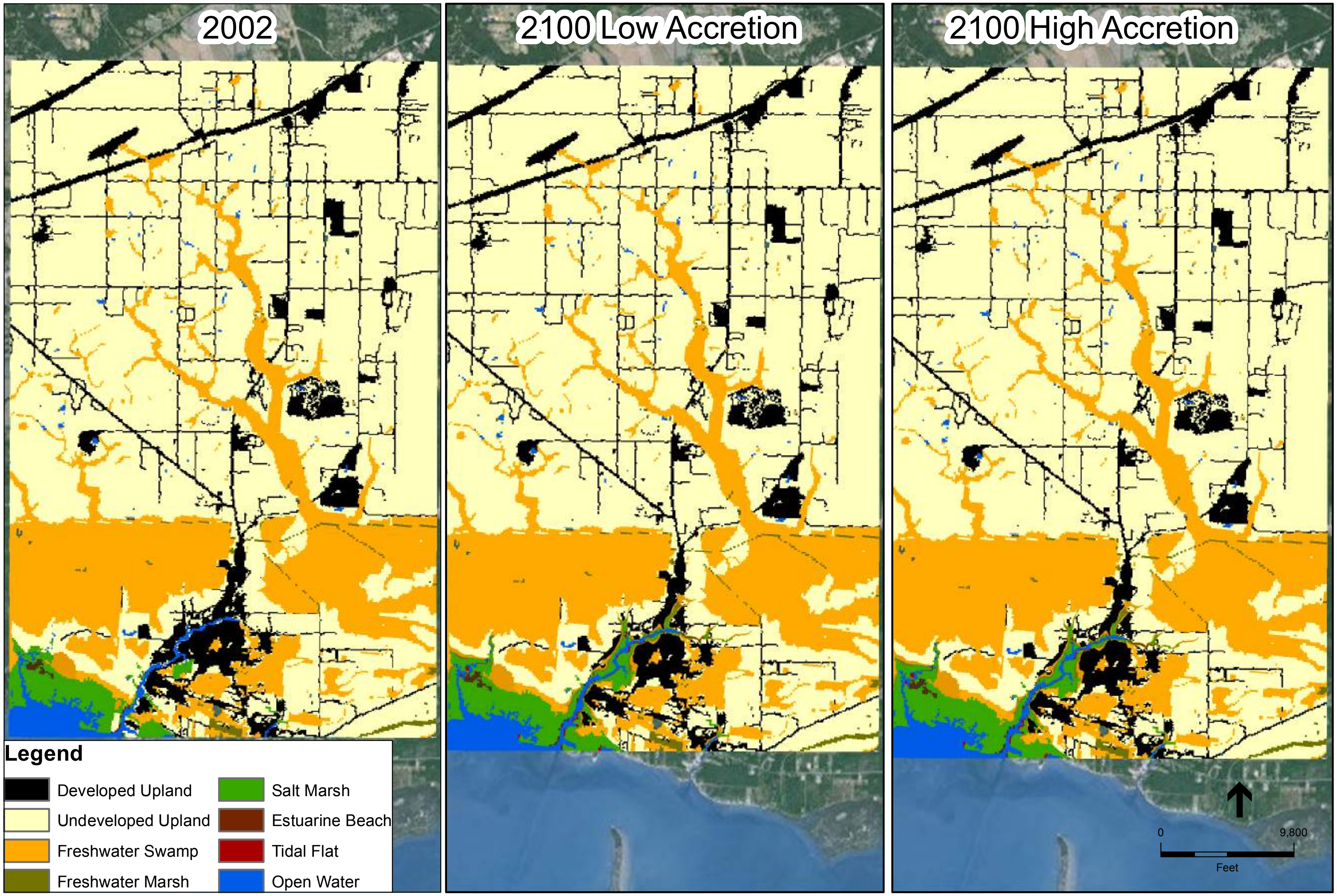
Run 2 Habitats Over Time

4.3 Accretion Rates

Table 7 compares the habitat acreage at 2100 for the modeled low accretion rate (Run 2) and the high accretion rate (Run 3). The accretion rates show only minor differences in habitat acreages, which is not surprising based on the small range of accretion rates found in the literature. Figure 9 shows the 2100 habitat maps with the different accretion rates compared to the 2002 modeled habitats. Figure 10 and Figure 11 show the habitat evolution over time for the Run 2 (low accretion) and Run 3 (high accretion) respectively.

TABLE 7
HABITAT ACREAGES FOR DIFFERENT ACCRETION RATES

Habitat	Modeled Acreage in 2002	Acreage in 2100		Difference
		Run 2 (Low Accretion)	Run 3 (High Accretion)	(Run 3 –Run 2)
Developed Upland	1,554	1,474	1,474	0
Undeveloped Upland	9,444	9,397	9,397	0
Freshwater Swamp	2,935	2,948	2,950	2
Freshwater Marsh	73	95	93	-1
Salt Marsh	244	320	321	1
Tidal Flat	0	10	10	0
Estuarine Beach	12	12	12	0
Open Water	232	238	237	-1



SOURCE: ESRI, NWI 2002, NLCD 2011

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Figure 9

2002 Modeled Vegetation versus Different Accretion Scenarios

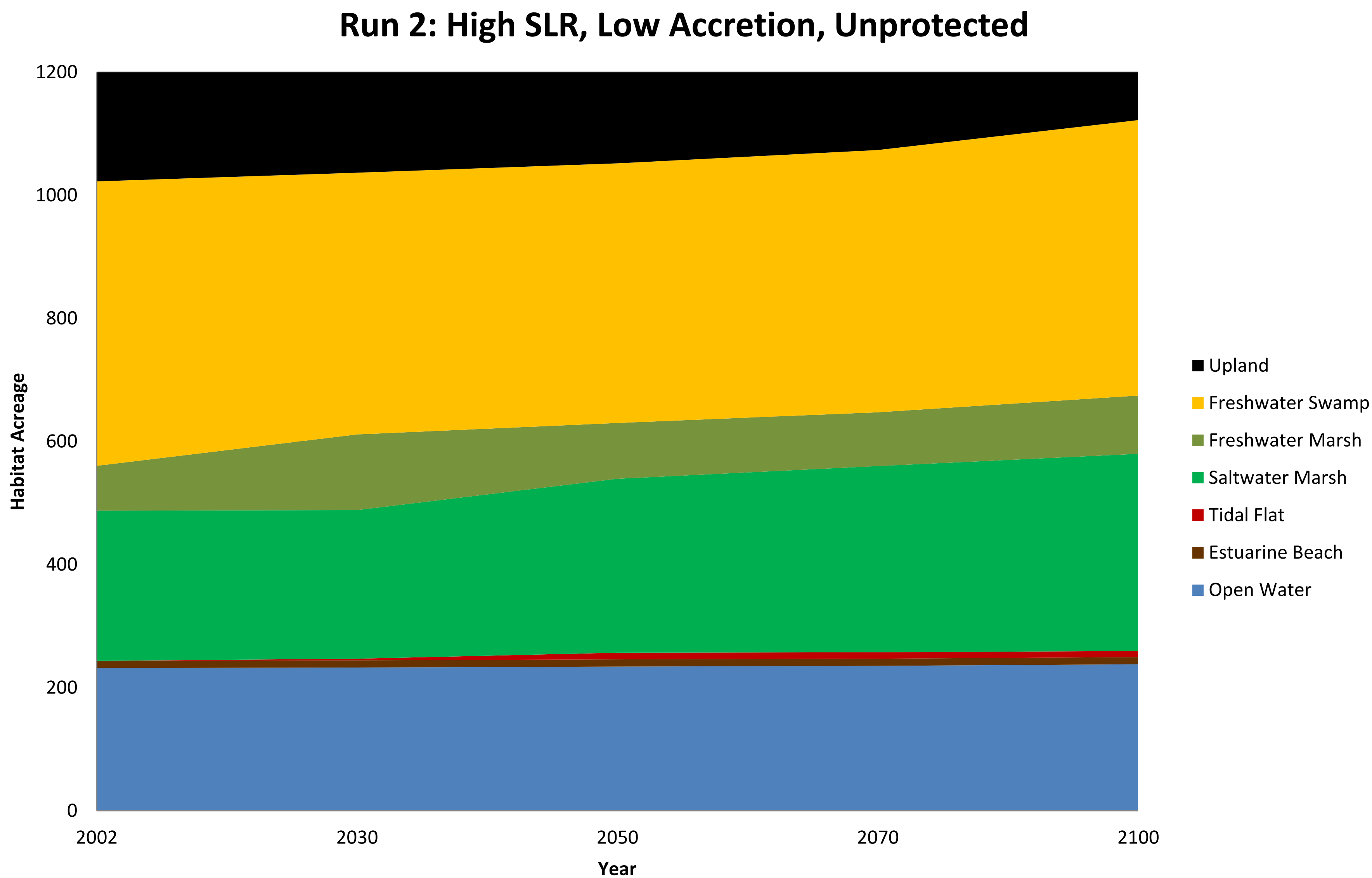

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Figure 10

Run 2 Habitats Over Time

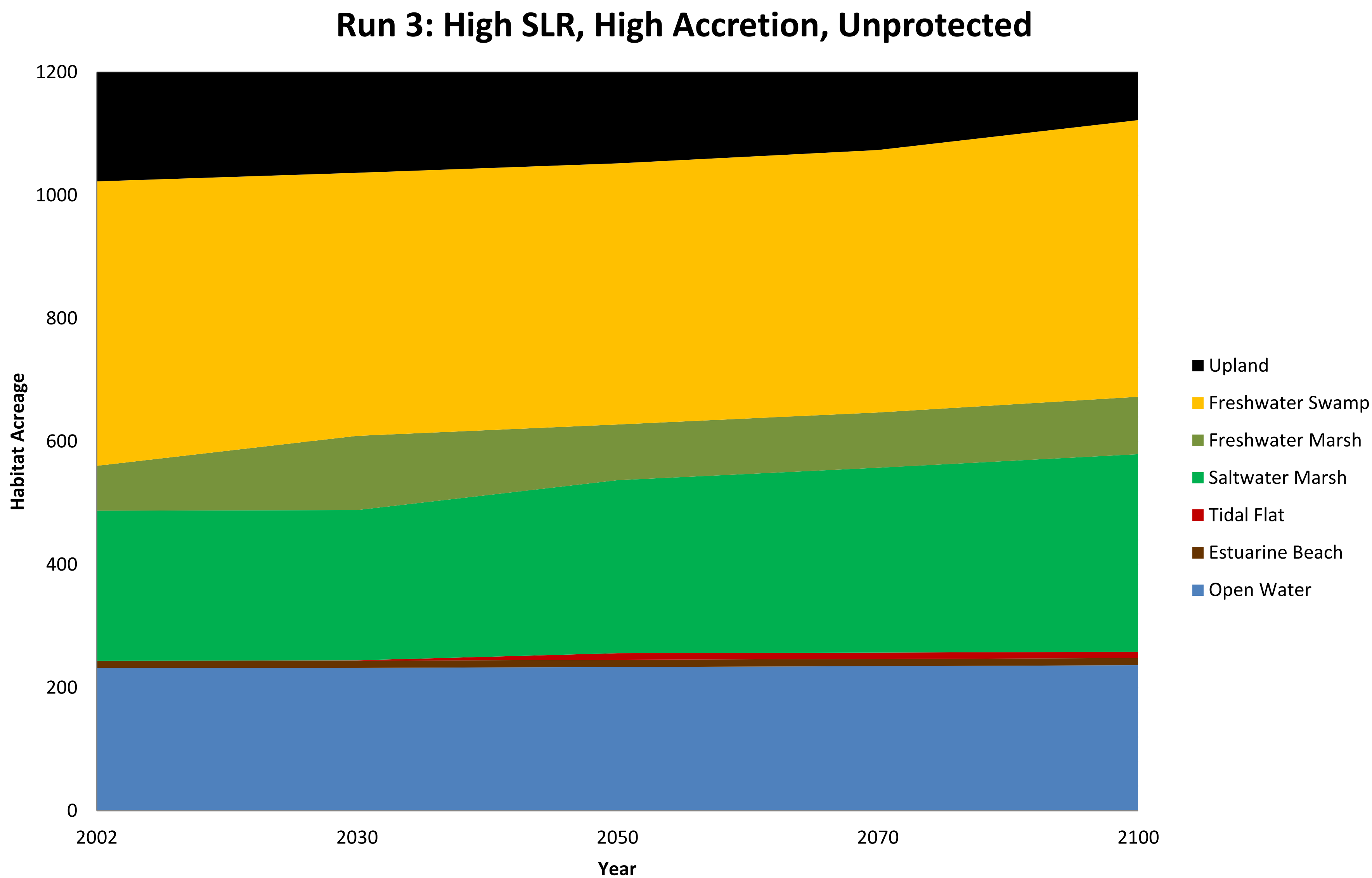

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Figure 11

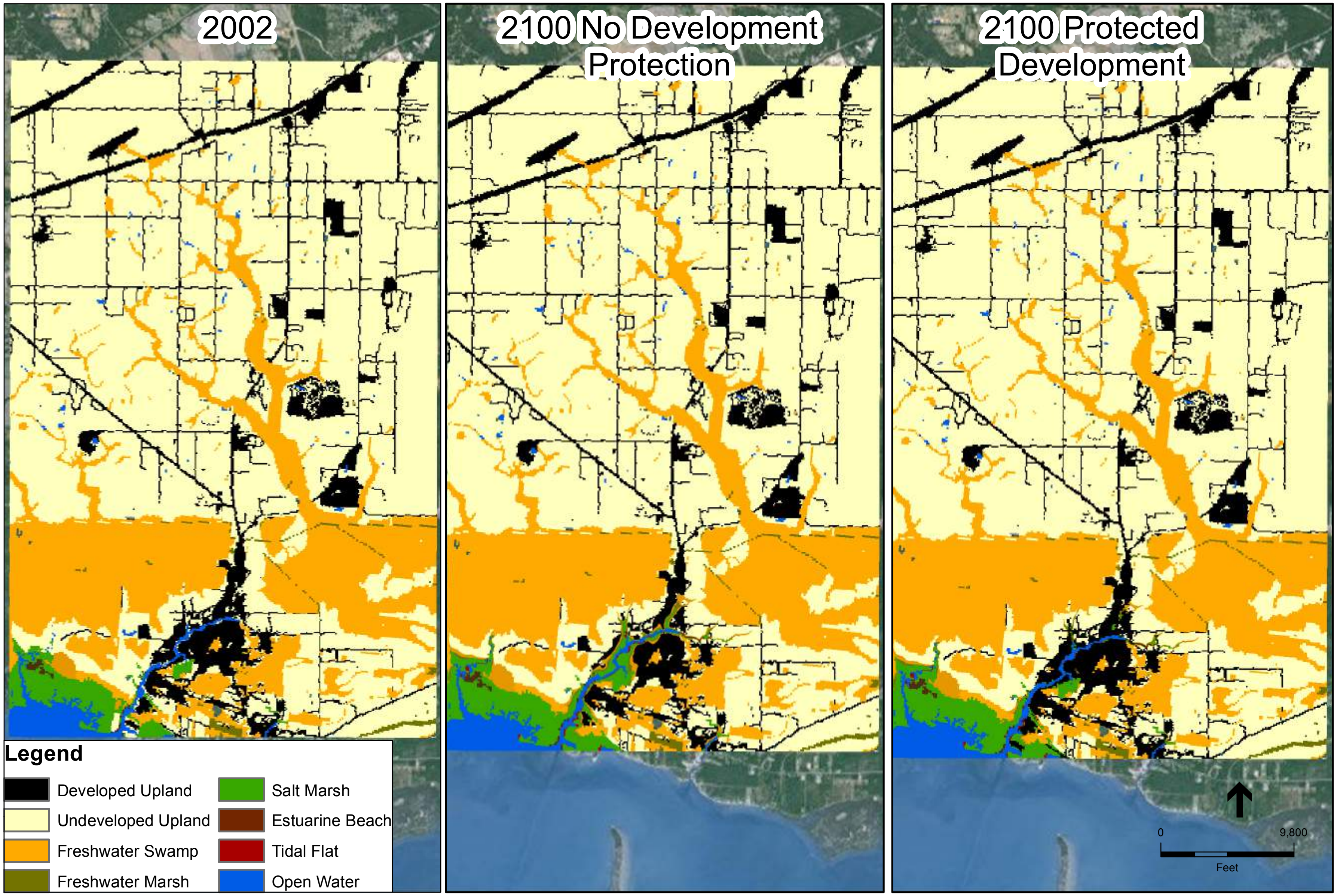
Run 3 Habitats Over Time

4.4 Management Scenarios

Table 8 provides the habitat acreage for Run 2, which allows marsh and freshwater swamp to migrate into developed uplands, and Run 4, which protects the developed uplands ("holding the line" scenario). In Run 2, all of the upland converted to other habitats is developed. When the habitats are allowed to migrate into the developed uplands, 79 acres of developed upland is converted mostly to swamp or marsh. Figure 12 shows the habitat maps with the different management scenarios.

TABLE 8
HABITAT ACREAGES FOR DIFFERENT MANAGEMENT SCENARIOS

Habitat	Modeled Acreage in 2002	Acreage in 2100		Difference
		Unprotected Development	Protected Development	(Protected-Unprotected)
Developed Upland	1,554	1,474	1,554	79
Undeveloped Upland	9,444	9,397	9,397	0
Freshwater Swamp	2,935	2,948	2,926	-22
Freshwater Marsh	73	95	83	-11
Salt Marsh	244	320	278	-43
Tidal Flat	0	10	7	-3
Estuarine Beach	12	12	12	0
Open Water	232	238	237	-1

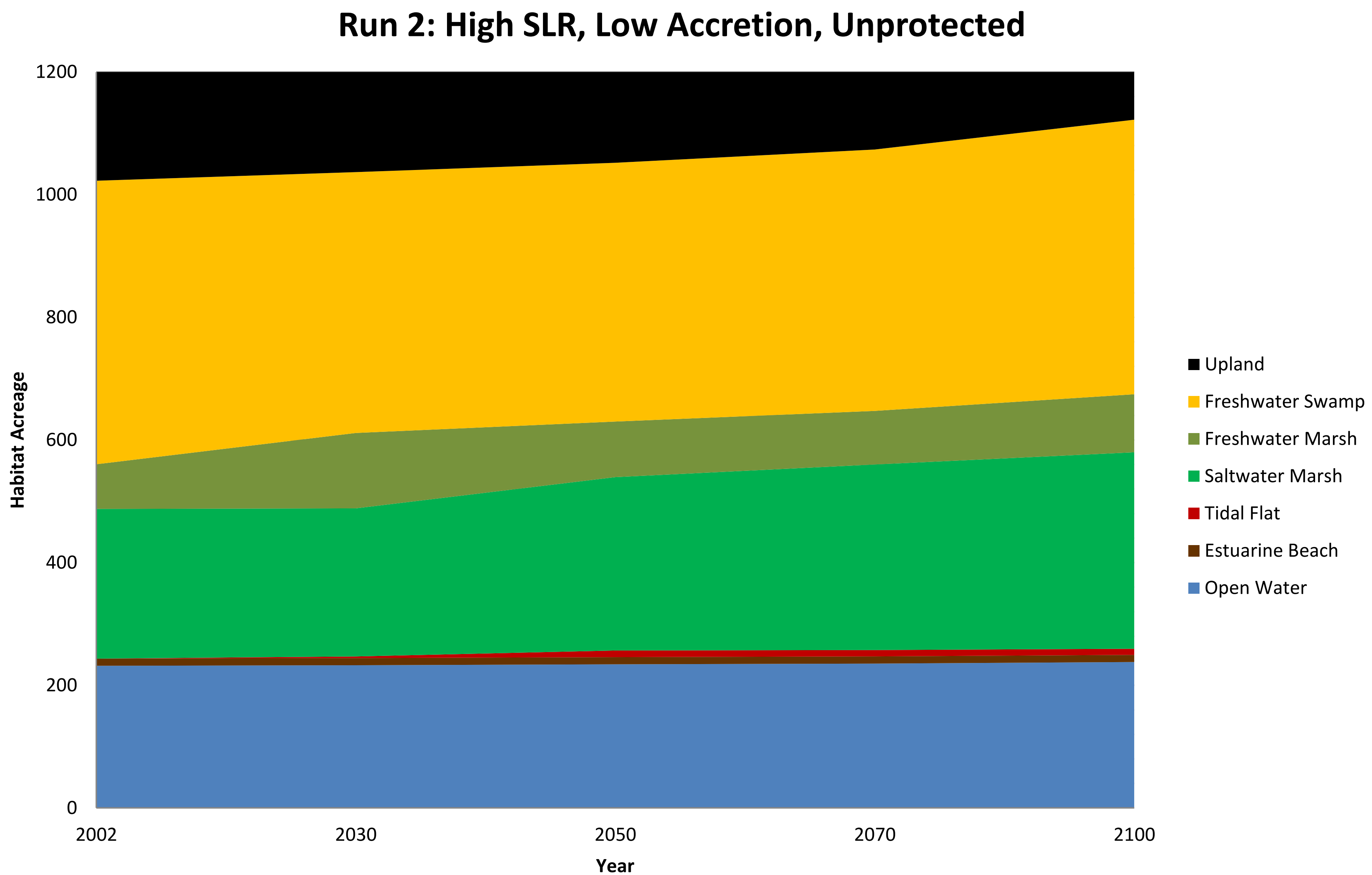


SOURCE: ESRI, NWI 2002, NLCD 2011

Bayou La Batre Watershed Management Plan. 150168

Figure 12

2002 Modeled Vegetation versus
Different Management Scenarios



Bayou La Batre Watershed Management Plan. 150168

Figure 13

Run 2 Habitats Over Time

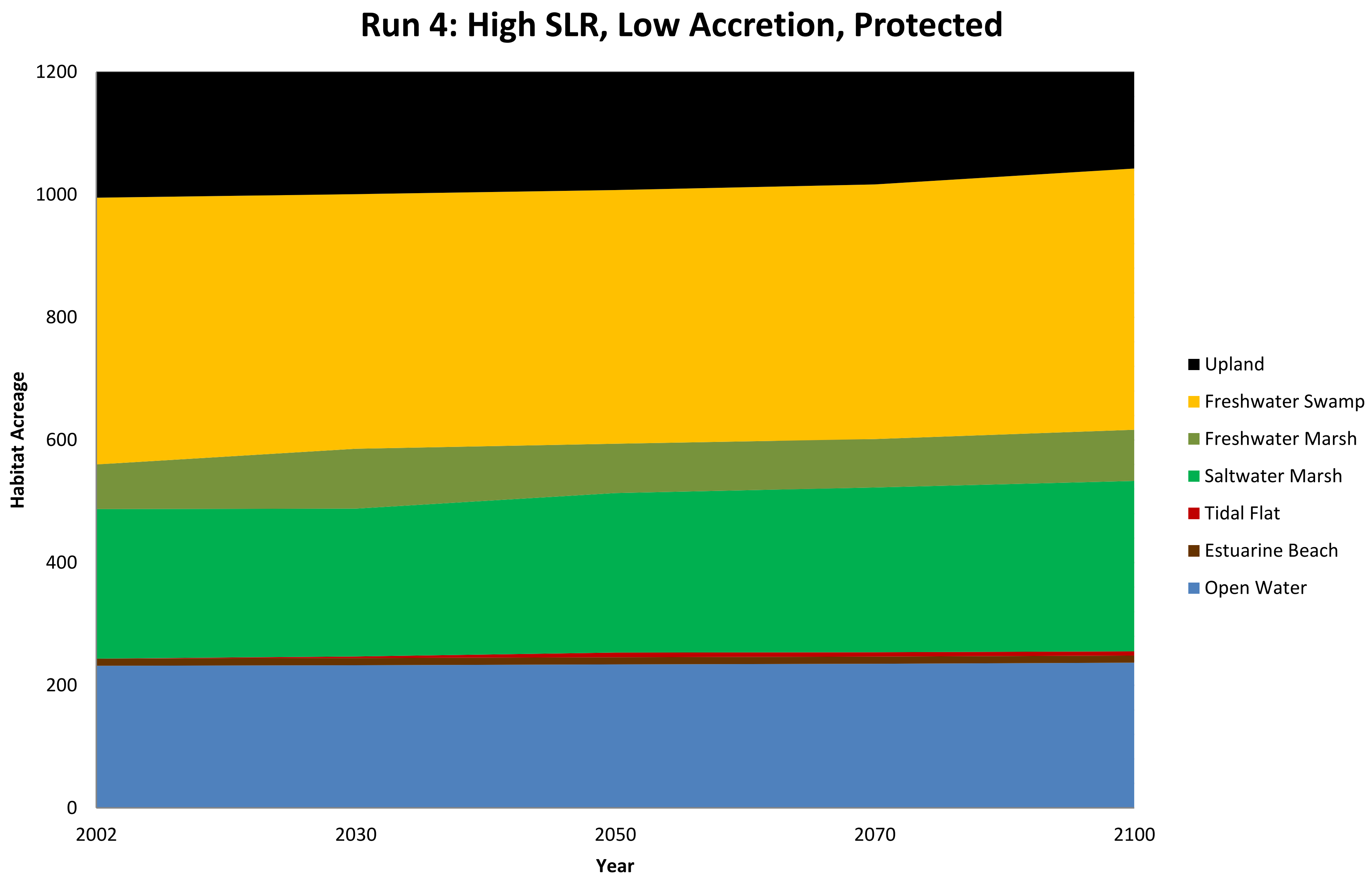


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Figure 14

Run 4 Habitats Over Time

5. Discussion

SLAMM provides graphical and tabular projections of potential future habitat changes in the Bayou La Batre. It can model different levels of sea-level rise, accretion rates, and management scenarios. The results presented here look at the base conditions and predict or project future conditions in the estuary.

5.1 Model Calibration

The current model setup captures the habitat categories very well with less than 1% of the total site changing due to the model assumptions. This indicates the model's elevation/vegetation assumptions are representative of the Bayou La Batre system.

5.2 Sea-Level Rise

In both sea-level rise scenarios some upland and freshwater swamp habitats are converted to saltmarsh and open water habitats. Under low sea-level rise, salt marsh acreage increases as upland and freshwater swamp habitat fall lower in the tidal frame. Under high sea-level rise, even more land is converted to salt marsh. In the high sea-level rise scenario, tidal swamps encroach on the uplands resulting in an increase of freshwater swamps by 2100. There is a net decrease in freshwater swamps in the low SLR scenario.

5.3 Accretion Rates

The accretion rates that were selected for this study (0.22 in/year and 0.24 in/yr), do not produce significantly different results. The only noticeable change between runs occurred within the salt marsh category, as the frequency of inundation at the mouth of the Bayou increased, converting brackish marsh to salt marsh.

5.4 Management Scenarios

The results suggest that the model is most sensitive to protection scenarios. The land near the bayou is developed into commercial land to support the prolific fishing industry. If habitats are allowed to migrate, this area would eventually convert into marsh and swamp land. The model predicts a total of 79 acres of developed upland could be converted to marsh and swamp habitat if the habitats are allowed to migrate.

6. Conclusions

The Bayou La Batre SLAMM model was used to simulate macro-level habitat conversions in response to sea level rise and related geomorphologic processes. With sea level rise, much of the developed lands surrounding the bayou will be at risk for frequent flooding. If these areas are abandoned over time through managed retreat, the model predicts these areas could convert to swamp and marsh habitat.

Accretion rates only affect a few habitats near the bayou. Lower accretion rates result in more inundation compared to higher accretion rates, since the topography sinks compared to the tide levels. The small difference in accretion rates could determine whether land is below or above the salt elevation and hence a saltwater or freshwater habitat. Further analysis of erosion and accretion in the area is recommended in order to validate the sedimentation assumptions.

7. References

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8. List of Preparers

This report was prepared by the following ESA staff:

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Doug Robison

Appendix A

Habitat Acreage Tables

Run 1: Low Sea-Level Rise, Low Accretion, No Development Protection

	2002	2030	2050	2070	2100
Developed Dry Land	1526	1520	1514	1506	1491
Undeveloped Dry Land	9444	9440	9436	9429	9418
Freshwater Swamp	2962	2927	2927	2928	2933
Freshwater Marsh	73	117	85	85	91
Saltwater Marsh	244	245	283	296	305
Tidal Flat	0	0	4	4	9
Estuarine Beach	12	12	12	12	12
Open Water	232	232	232	233	234

Run 2: High Sea-Level Rise, Low Accretion, No Development Protection

	2002	2030	2050	2070	2100
Developed Dry Land	1526	1518	1509	1497	1474
Undeveloped Dry Land	9444	9439	9432	9423	9397
Freshwater Swamp	2962	2925	2922	2926	2948
Freshwater Marsh	73	123	91	87	95
Saltwater Marsh	244	242	283	303	320
Tidal Flat	0	3	11	10	10
Estuarine Beach	12	12	12	12	12
Open Water	232	233	234	235	238

Run 3: High Sea-Level Rise, High Accretion, No Development Protection

	2002	2030	2050	2070	2100
Developed Dry Land	1526	1518	1509	1497	1474
Undeveloped Dry Land	9444	9439	9432	9423	9397
Freshwater Swamp	2962	2928	2924	2927	2950
Freshwater Marsh	73	121	90	90	93
Saltwater Marsh	244	244	281	300	321
Tidal Flat	0	1	11	10	10
Estuarine Beach	12	12	12	12	12
Open Water	232	232	234	235	237

Run 4: High Sea-Level Rise, Low Accretion, Protect Development

	2002	2030	2050	2070	2100
Developed Dry Land	1554	1554	1554	1554	1554
Undeveloped Dry Land	9444	9439	9432	9423	9397
Freshwater Swamp	2935	2915	2914	2915	2926
Freshwater Marsh	73	98	80	79	83
Saltwater Marsh	244	241	260	269	278
Tidal Flat	0	3	8	7	7
Estuarine Beach	12	12	12	12	12
Open Water	232	233	234	235	237

Appendix B
Habitat Maps

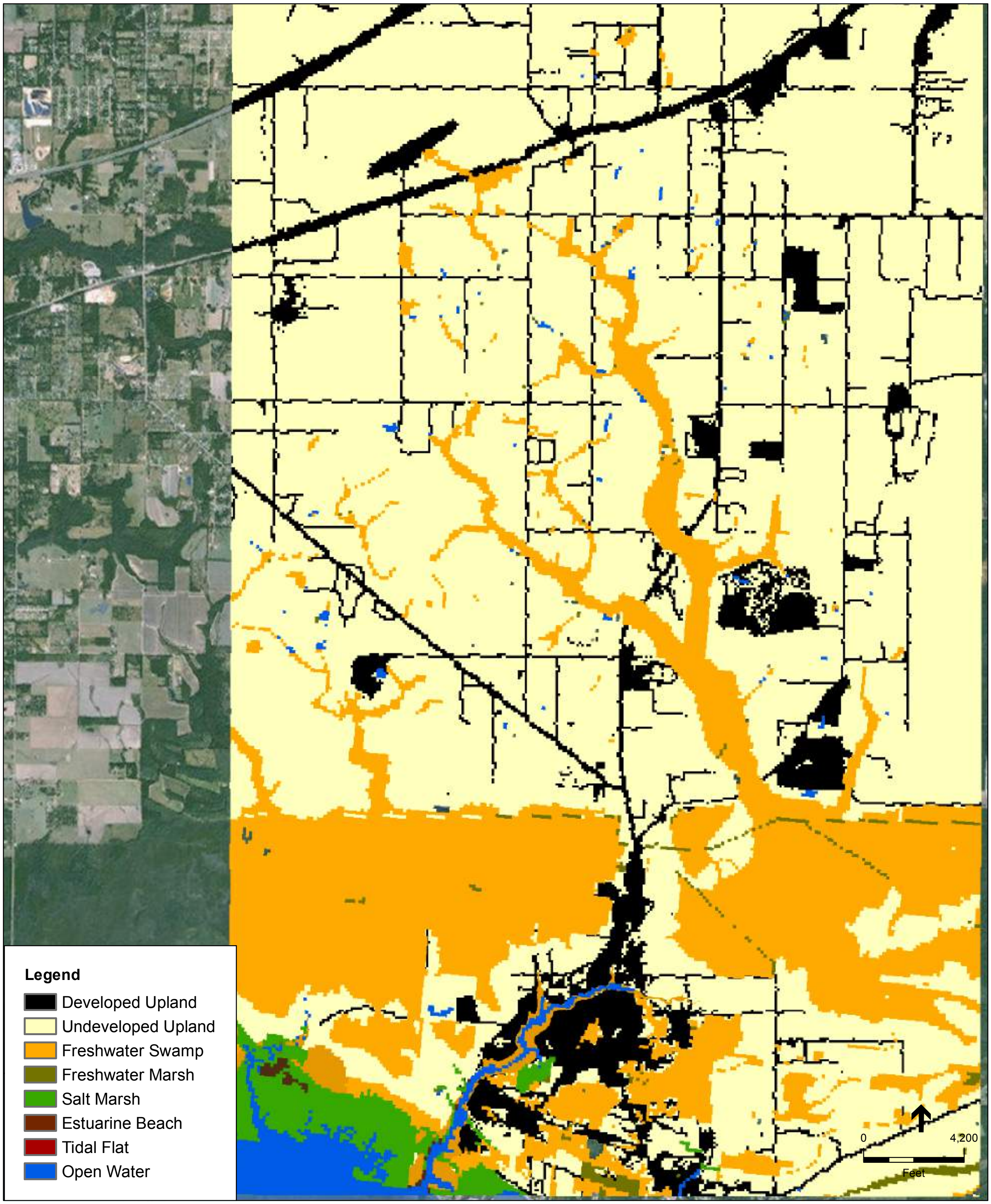

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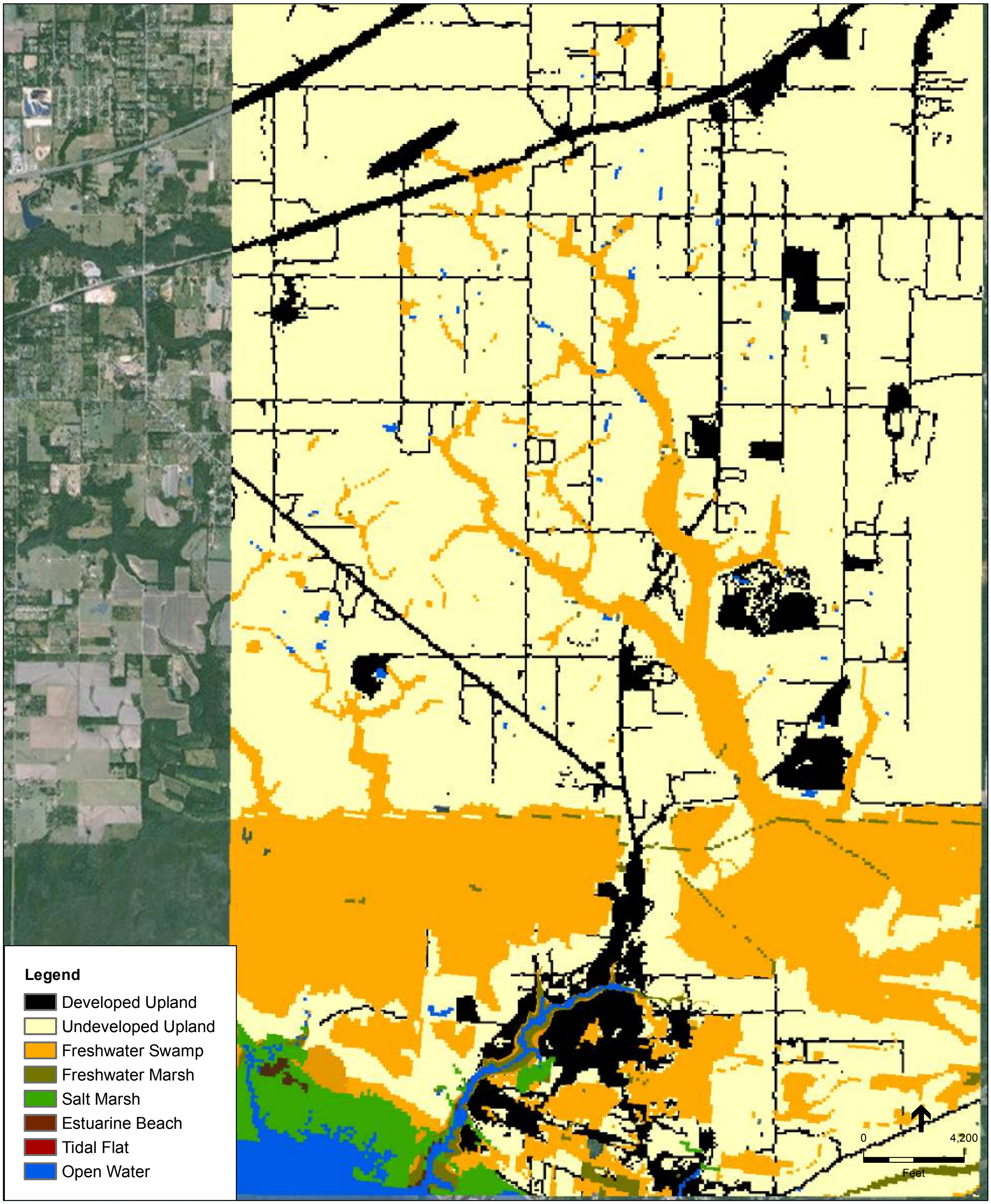
Figure B-1
Run 1, 2002



Bayou La Batre Watershed Management Plan. 150168

ESA

Figure B-2
Run 1, 2030

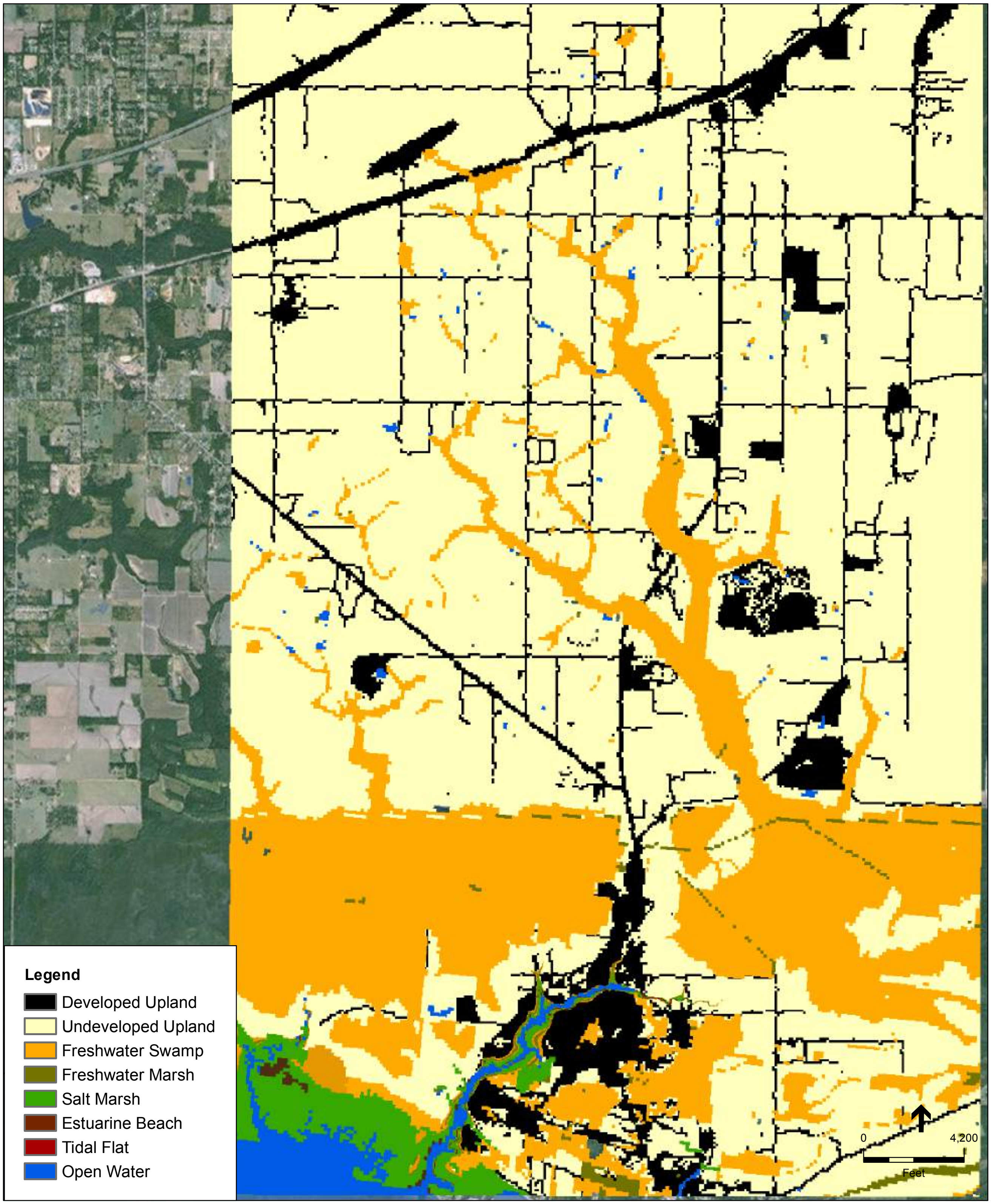


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Figure B-3

Run 1, 2050

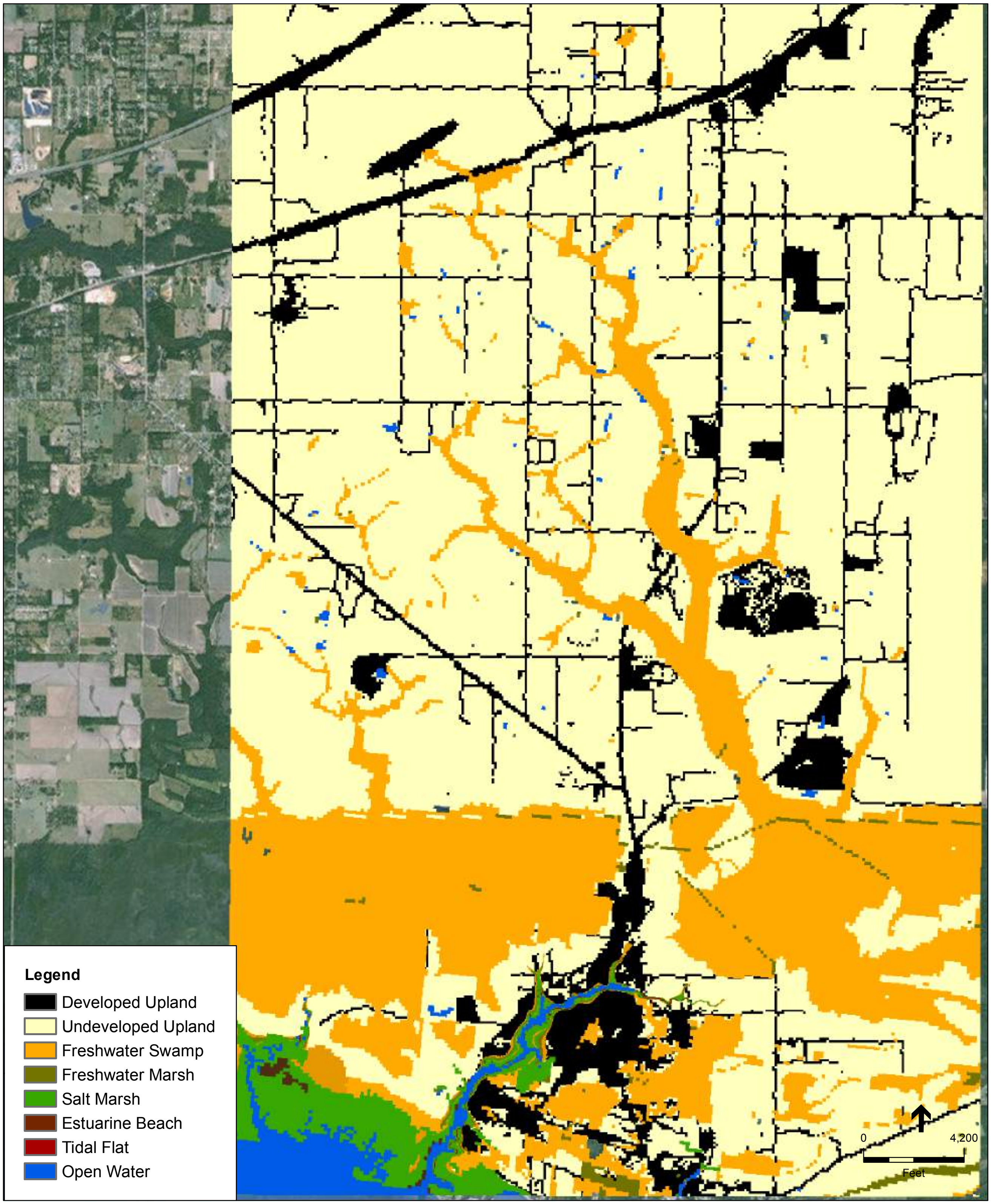

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Figure B-4
Run 1, 2070

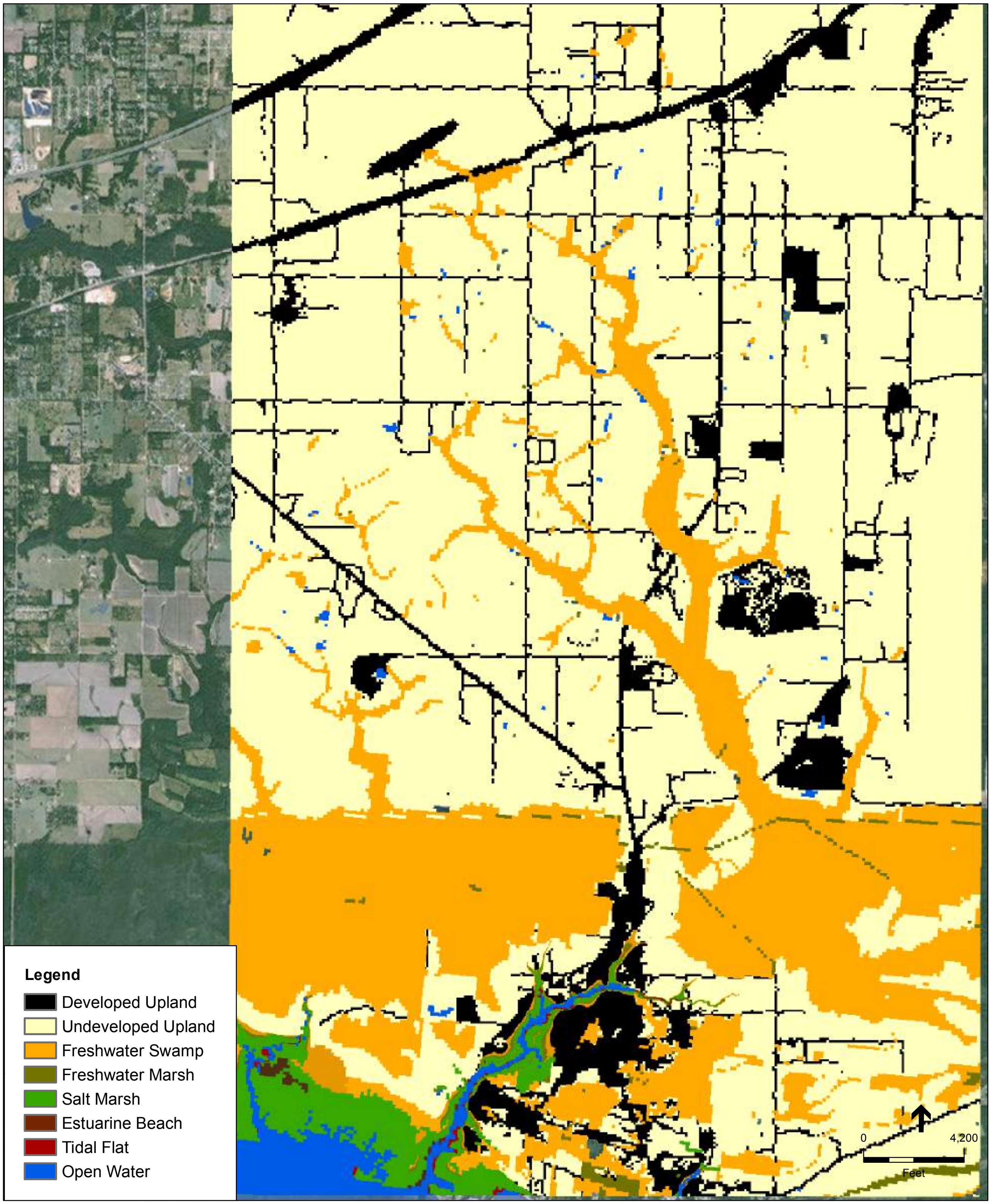

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Figure B-5
Run 1, 2100

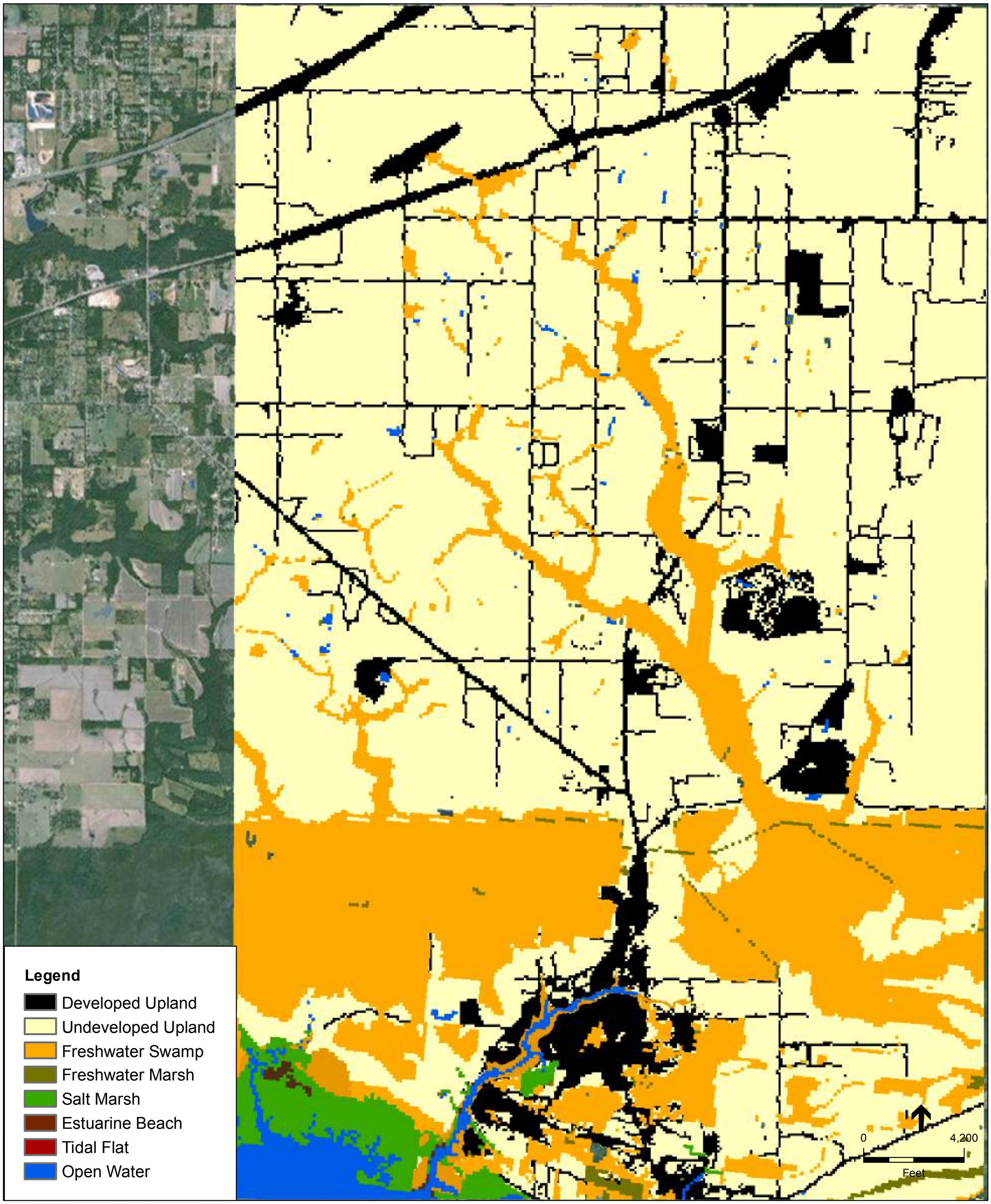

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Figure B-6
Run 2, 2002

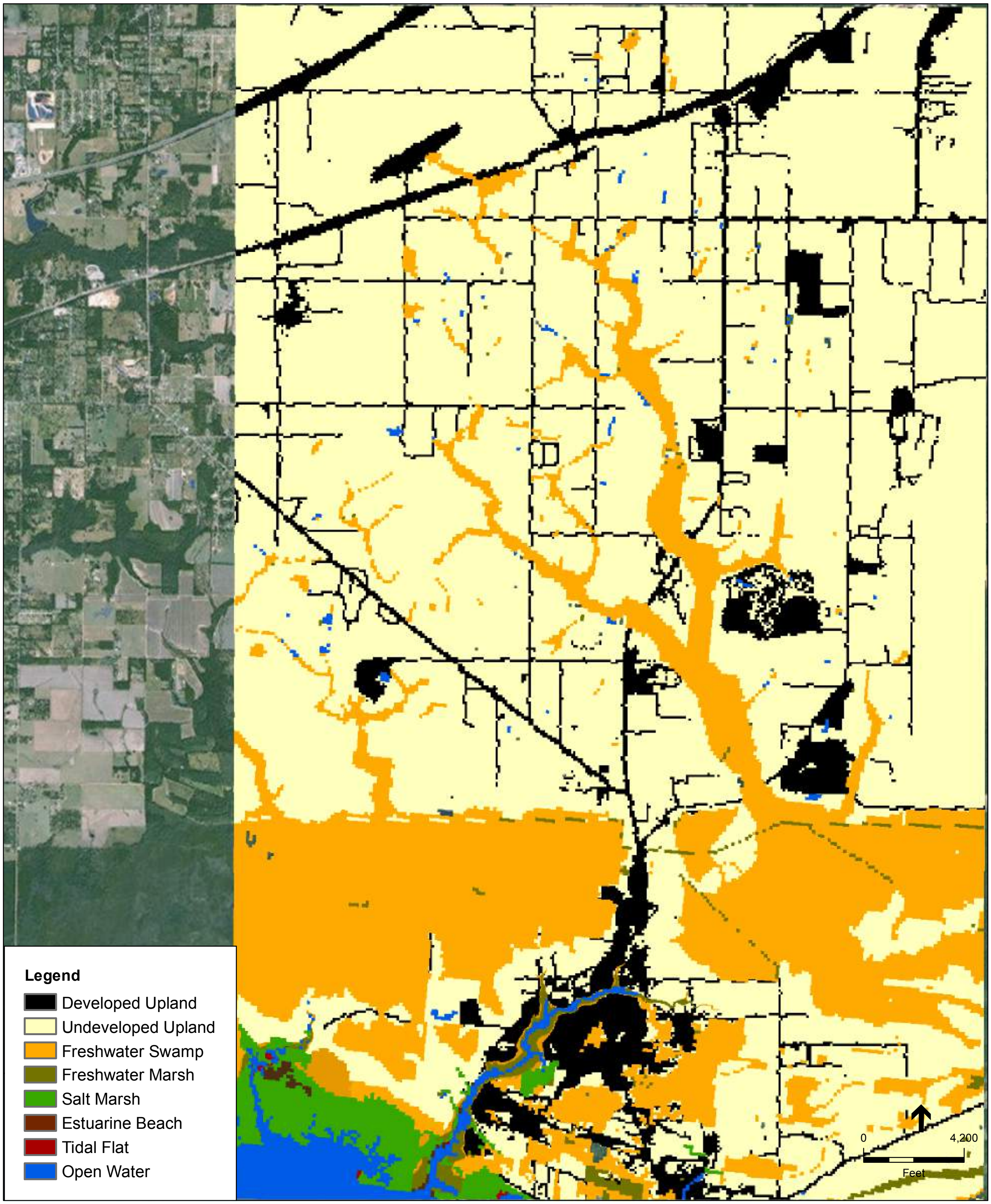

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Figure B-7
Run 2, 2030

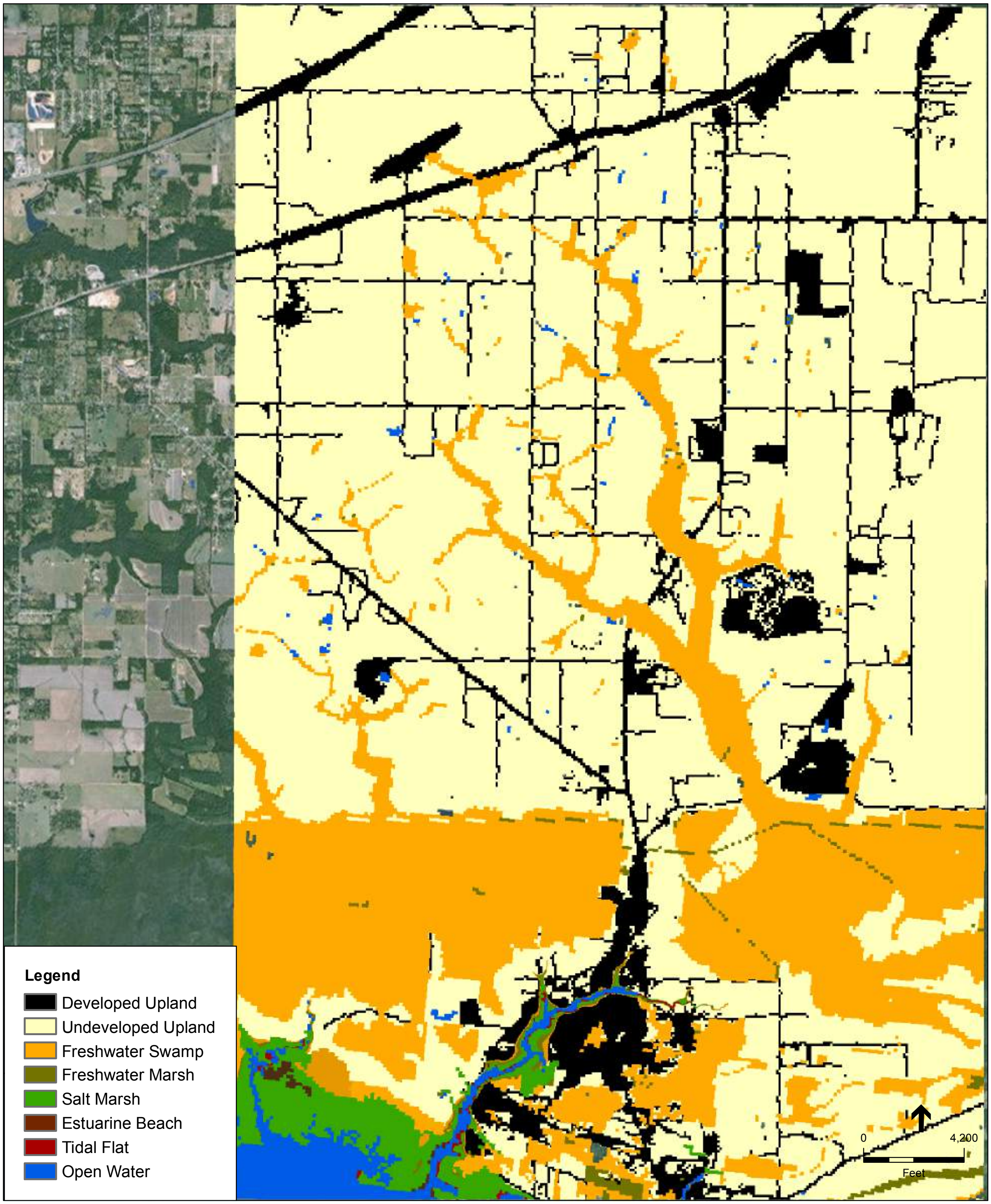

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Figure B-8
Run 2, 2050

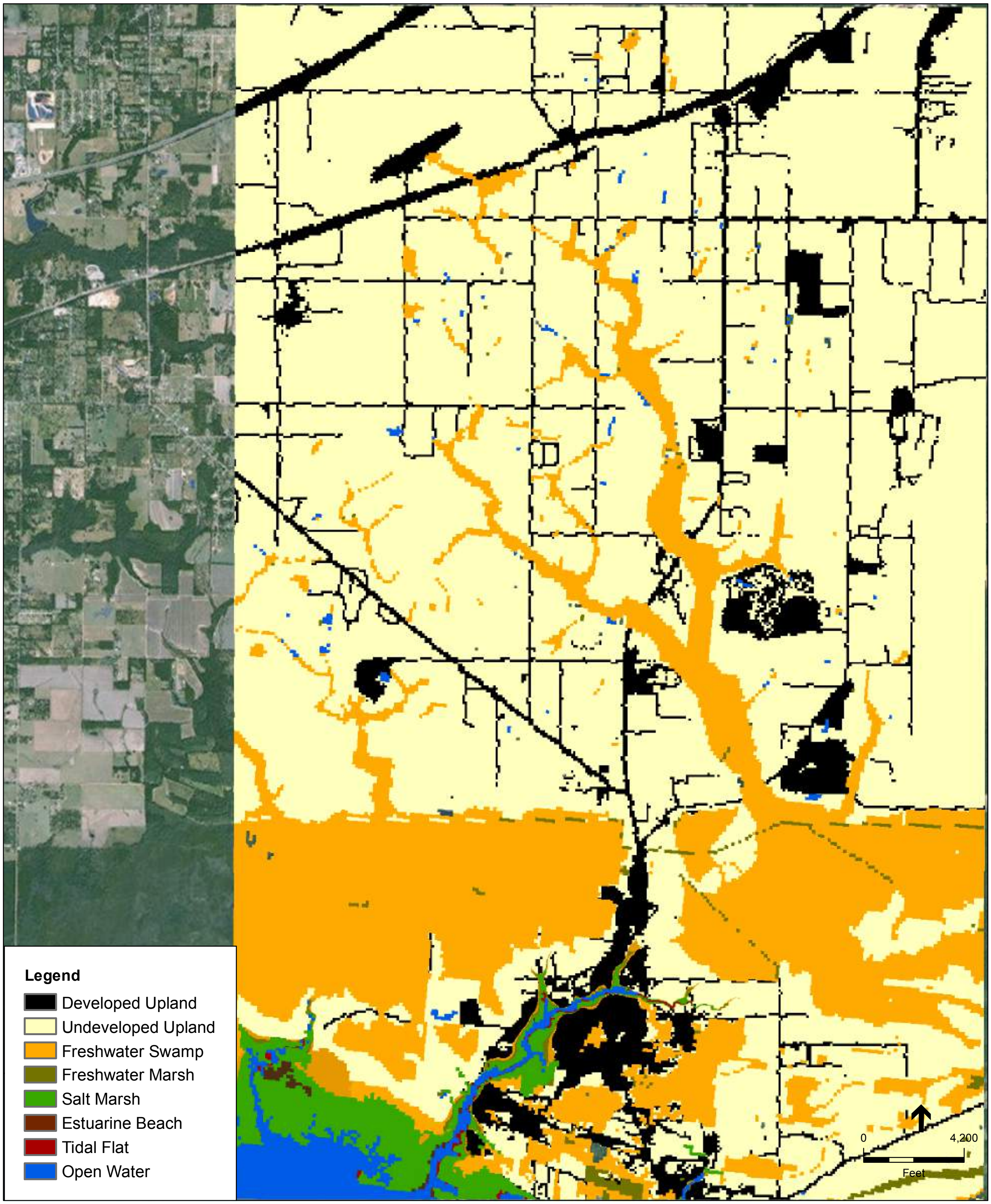

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Figure B-9

Run 2, 2070

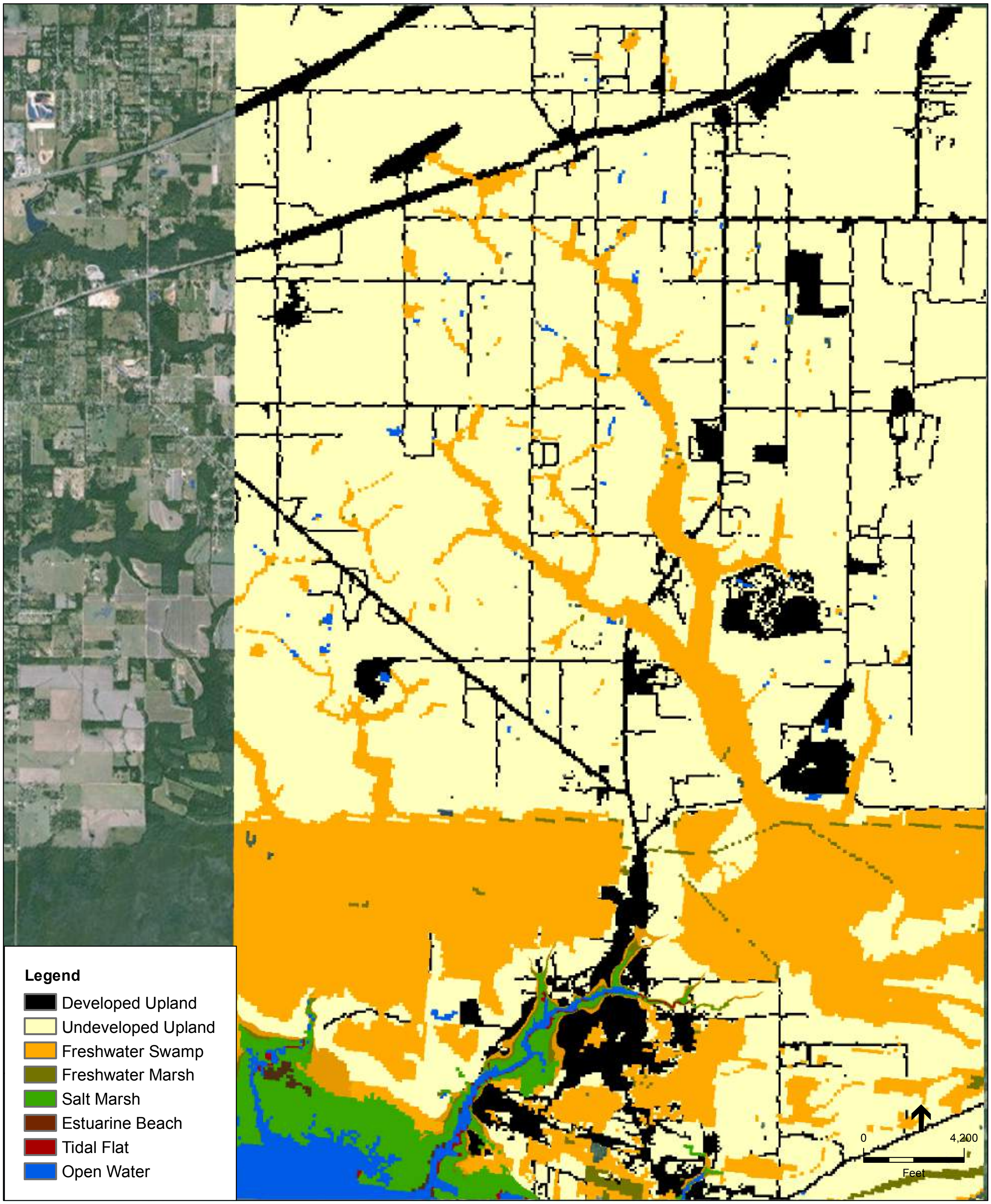

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Figure B-10
Run 2, 2100

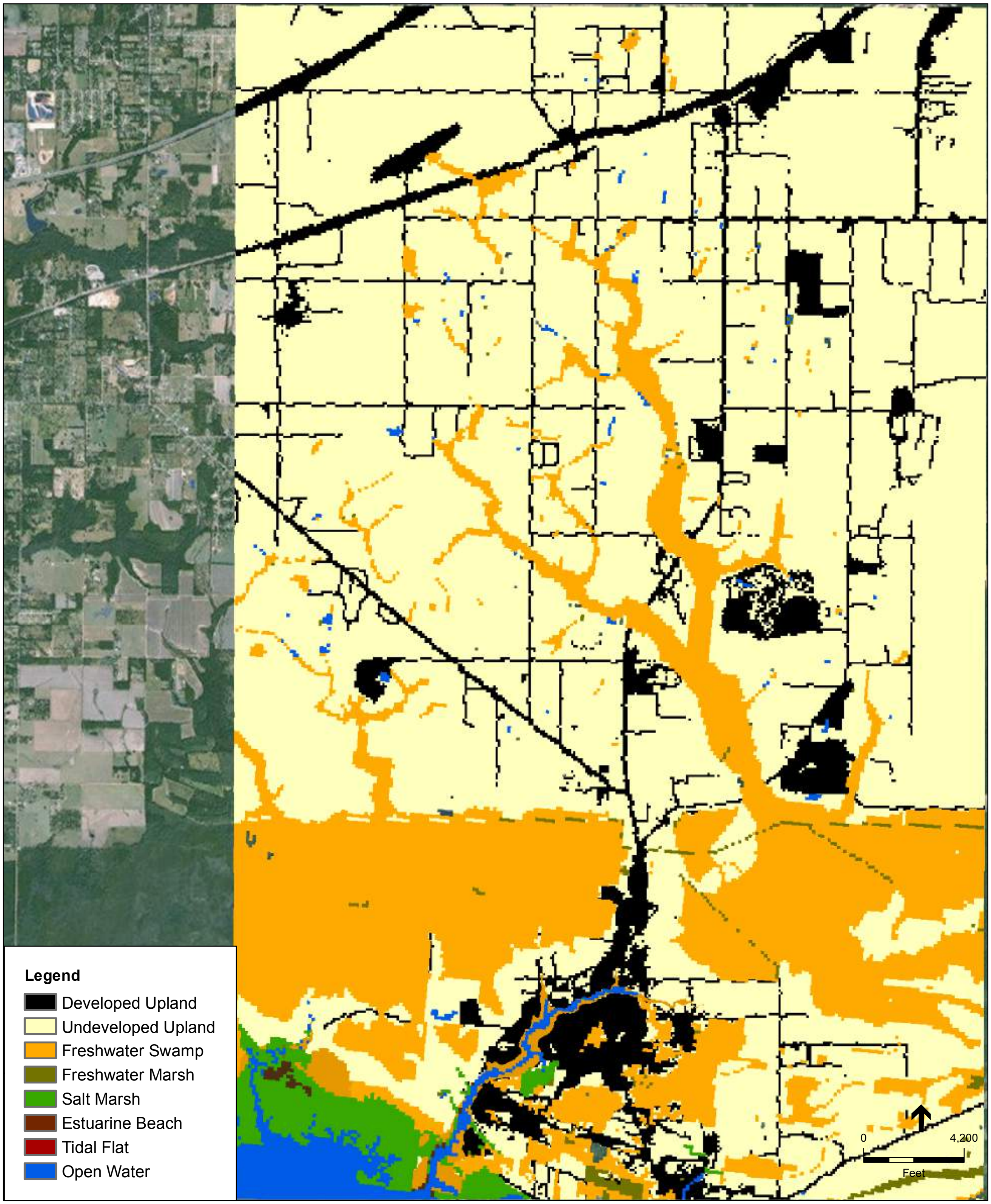

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Figure B-11

Run 3, 2002

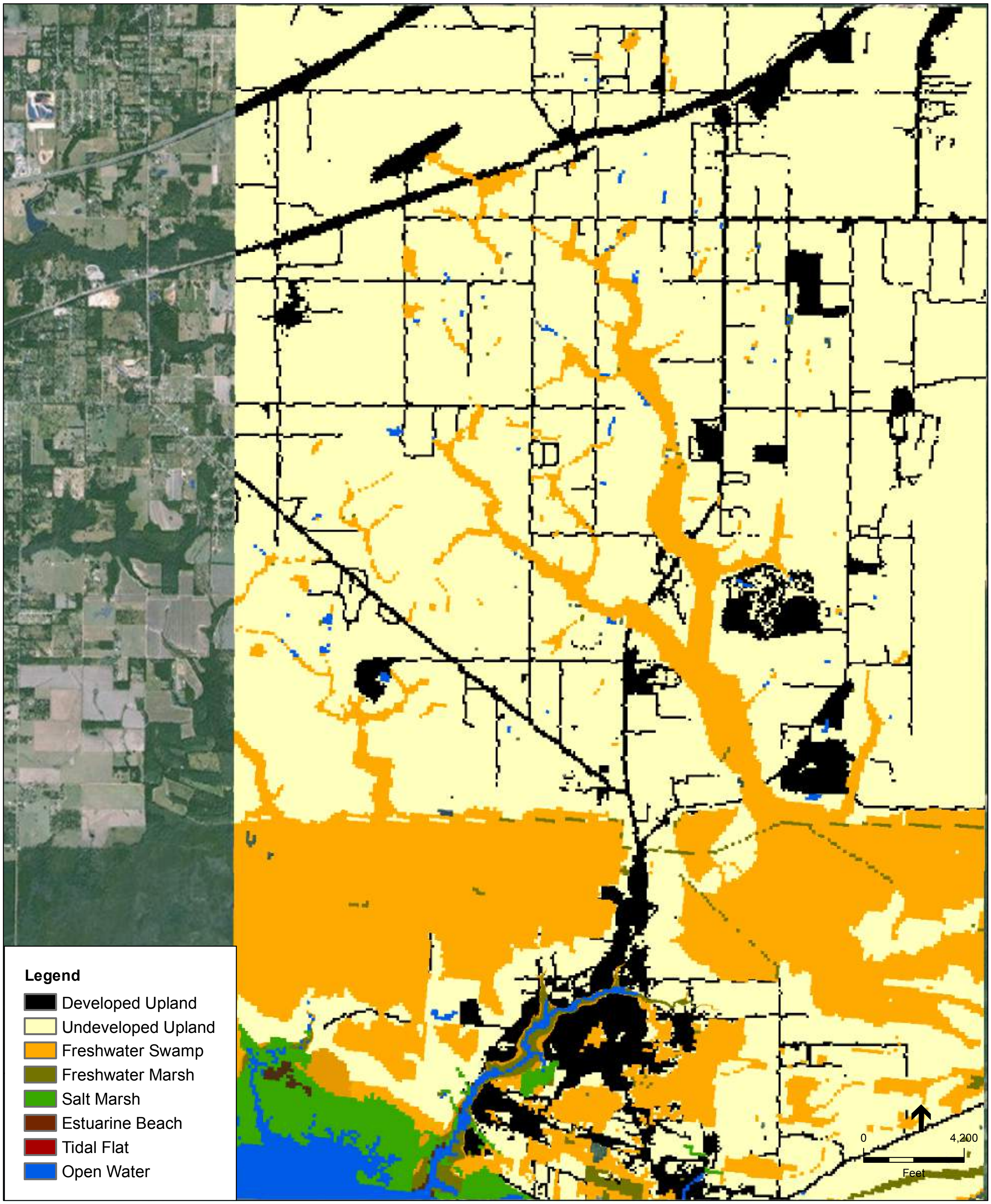

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Figure B-12
Run 3, 2030

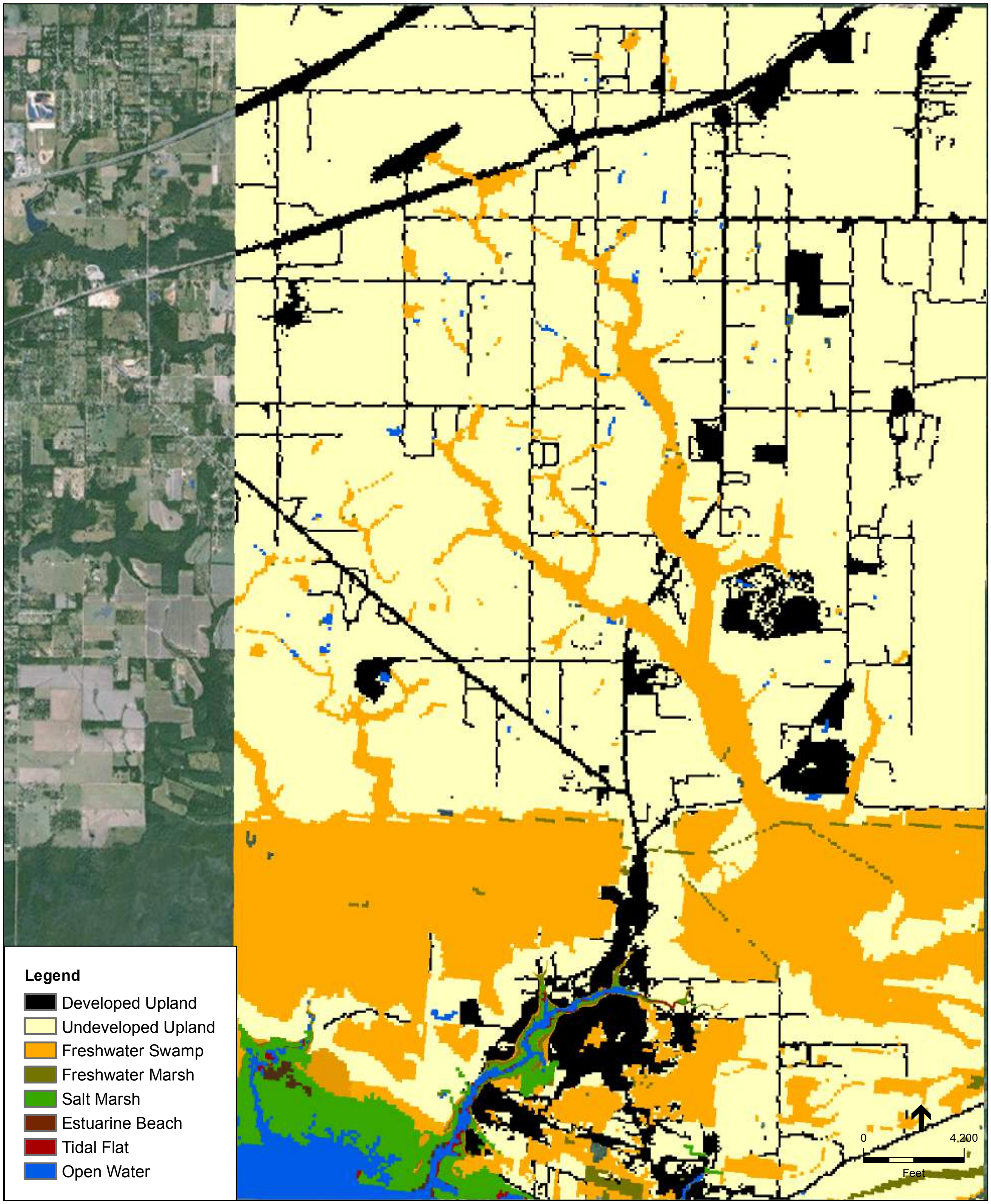

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Figure B-13

Run 3, 2050

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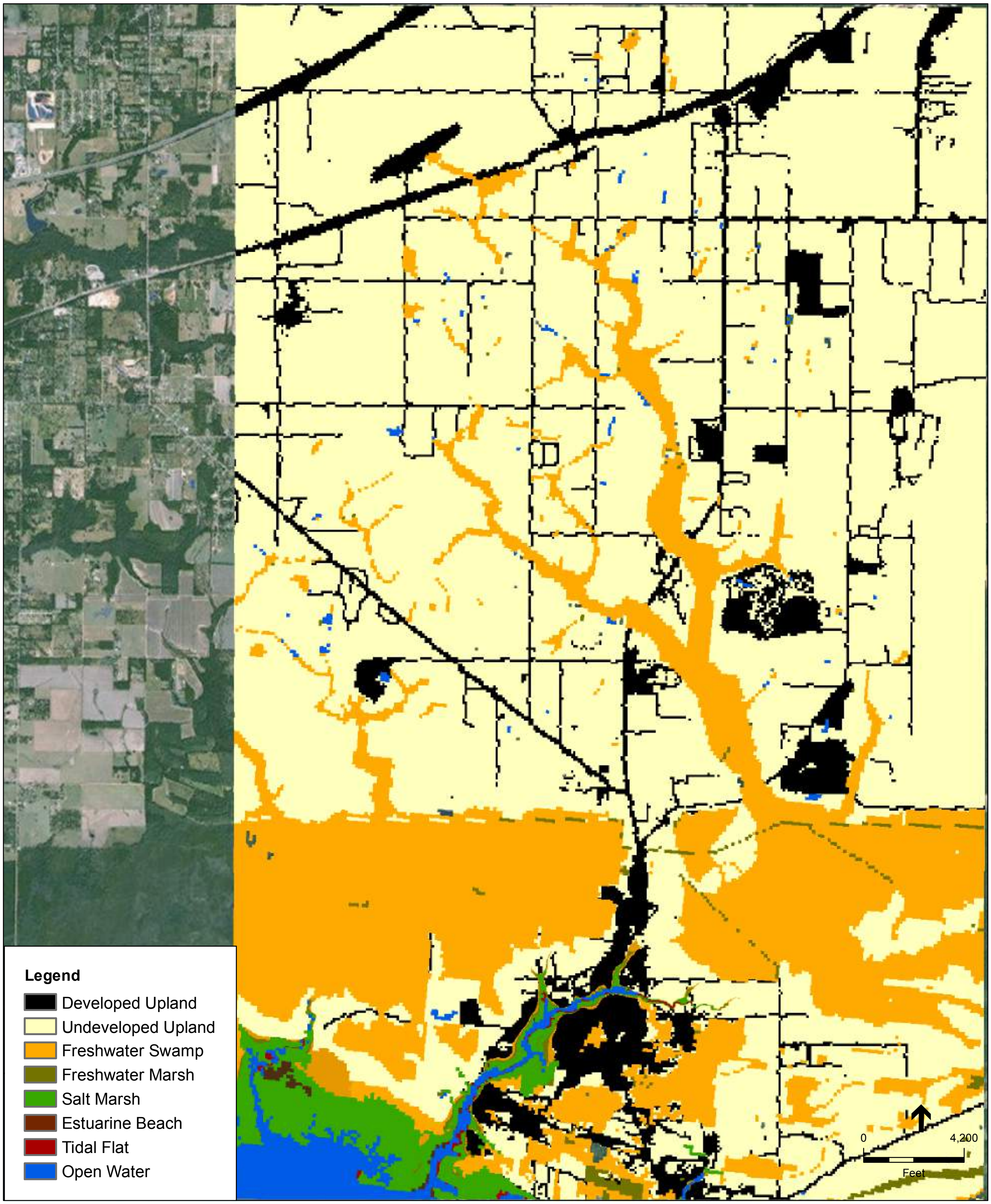

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Figure B-14
Run 3, 2070

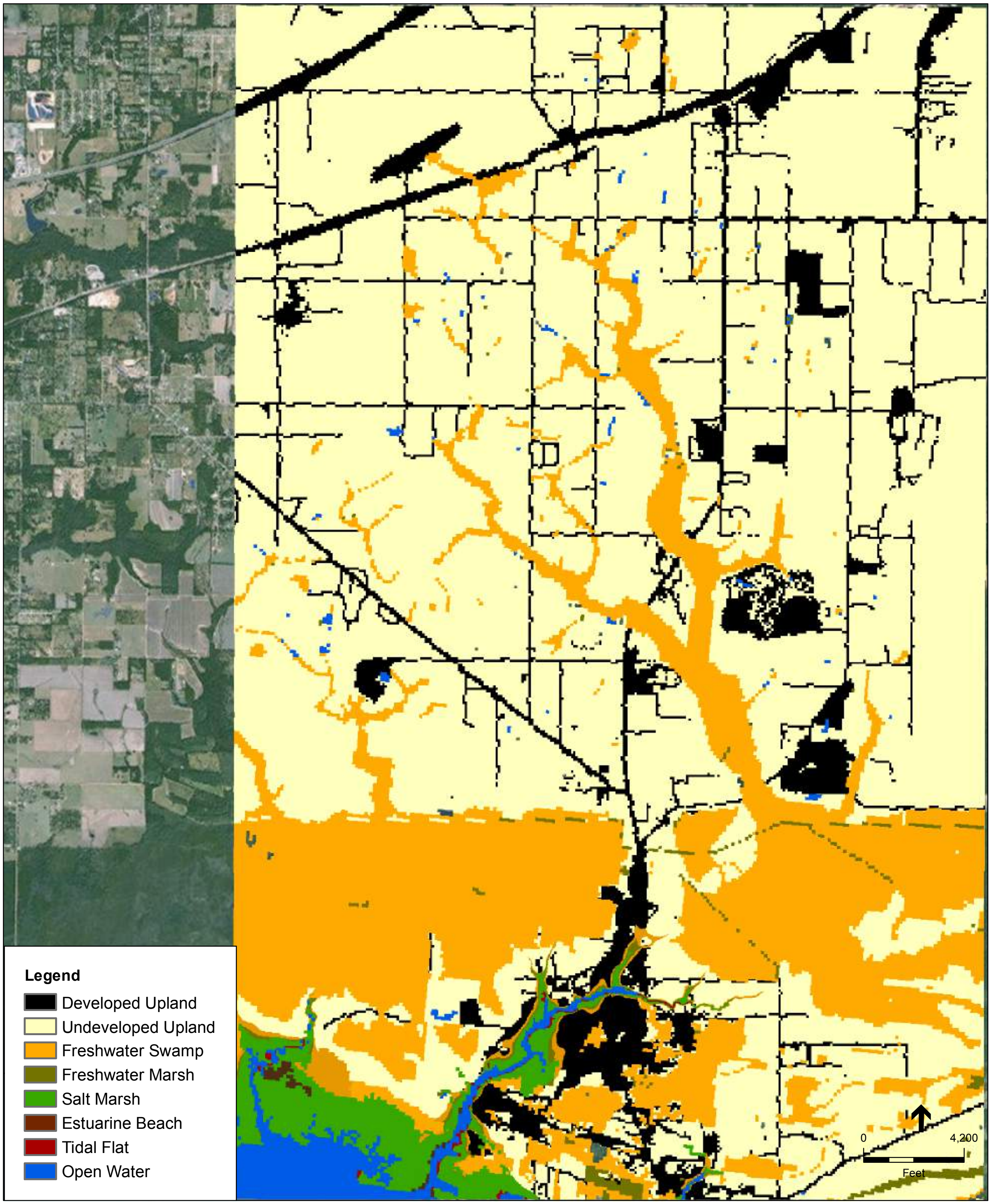

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Figure B-15
Run 3, 2100

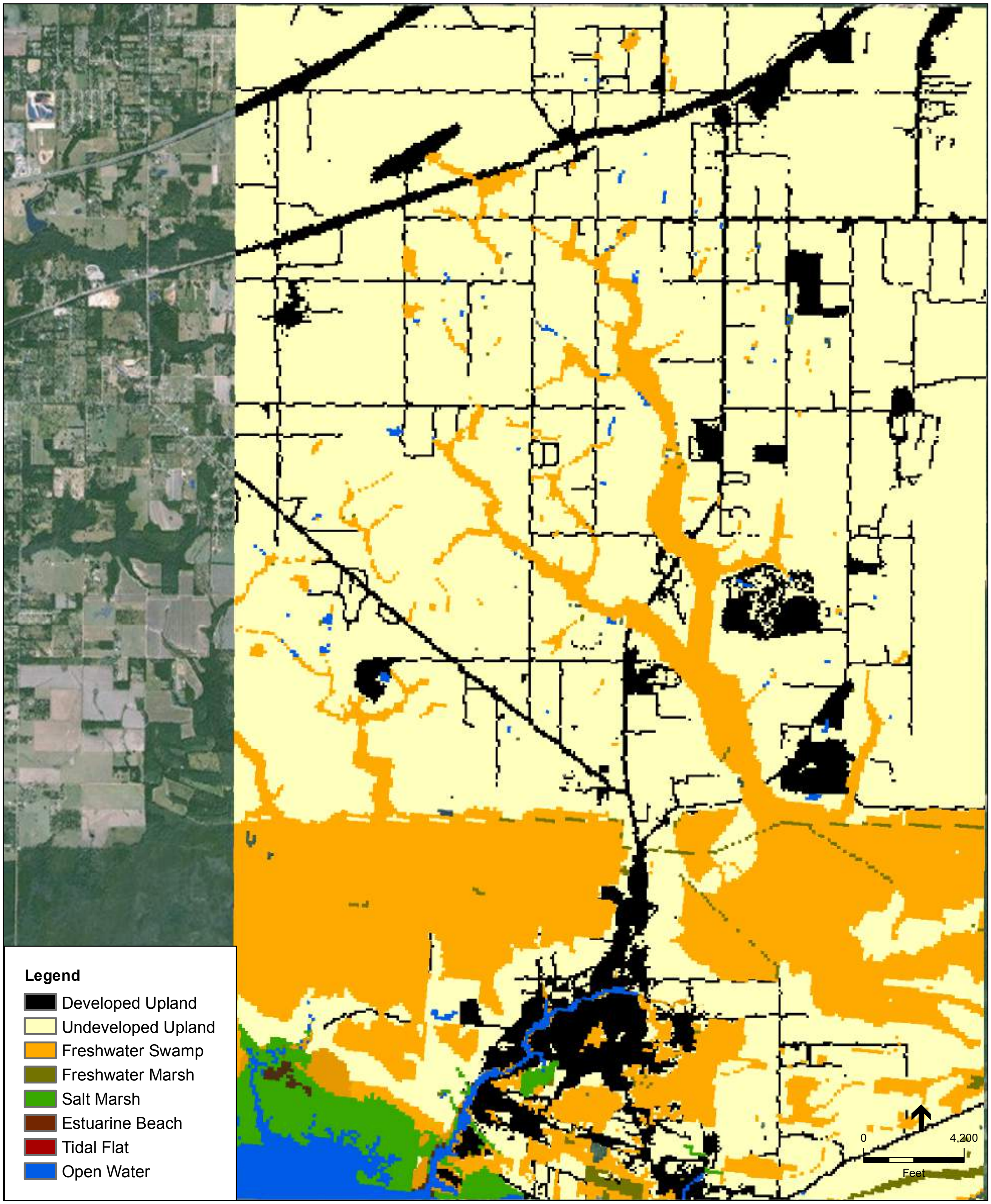

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Figure B-16
Run 4, 2002

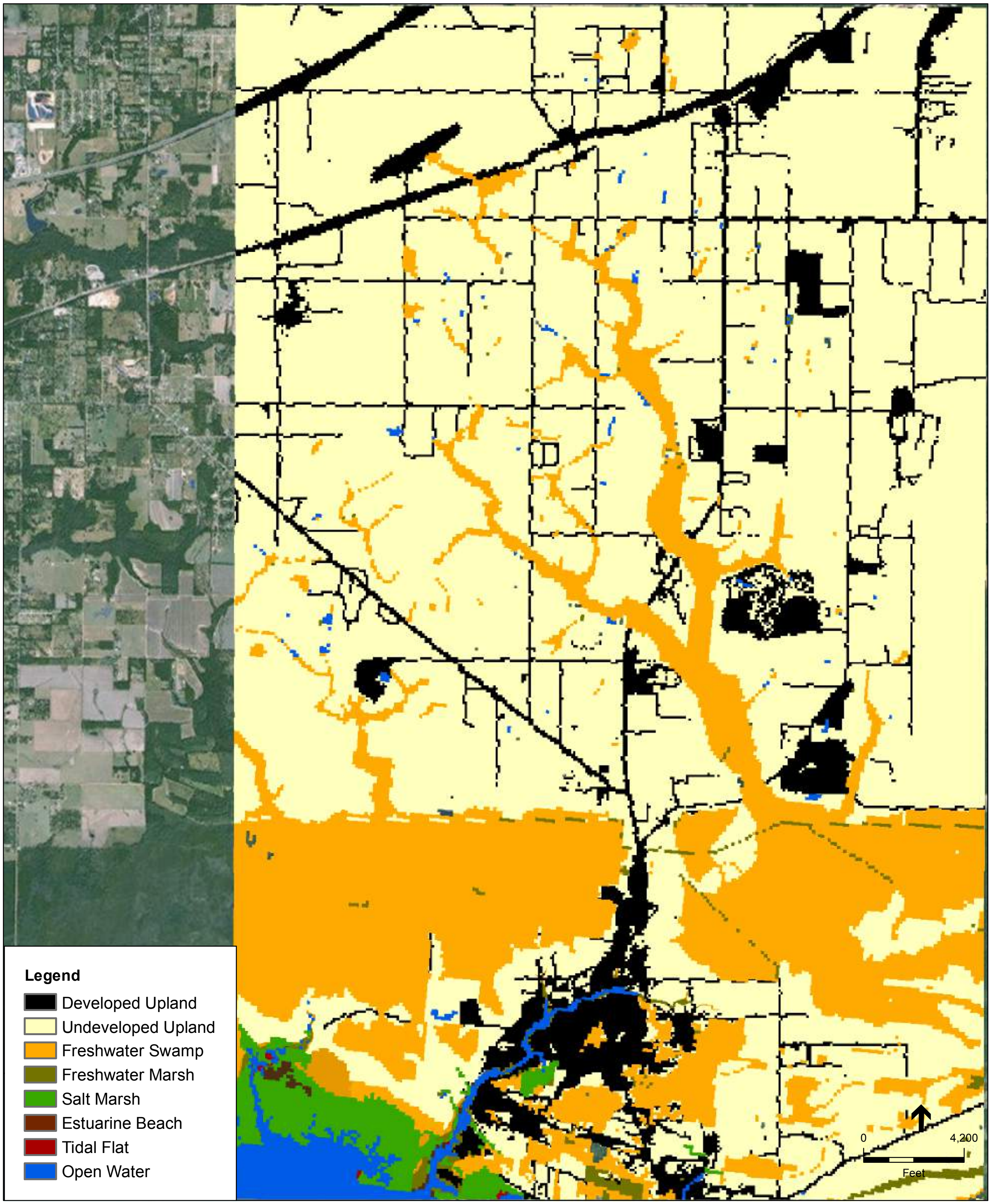

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Figure B-17
Run 4, 2030

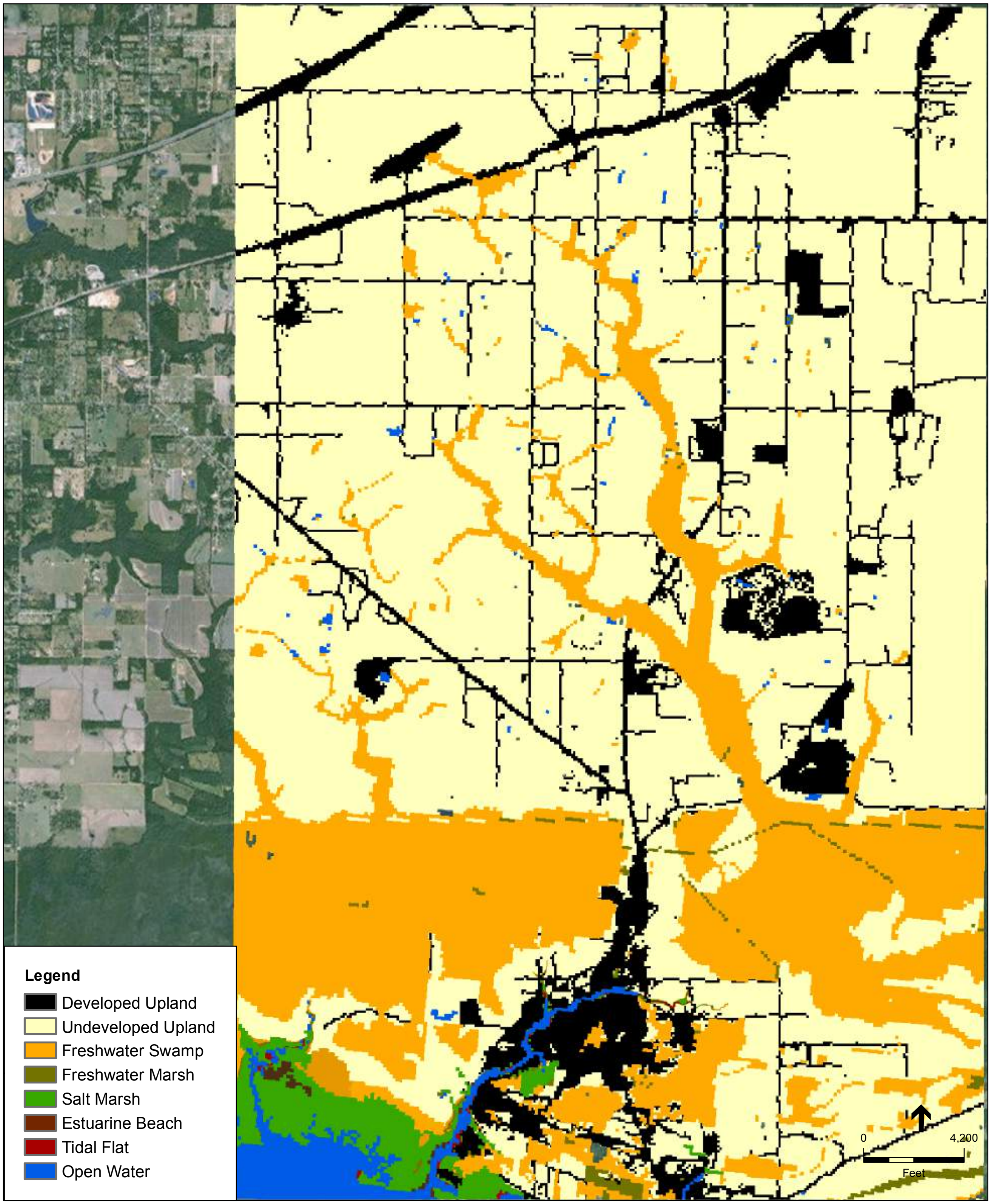

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Figure B-18

Run 4, 2050

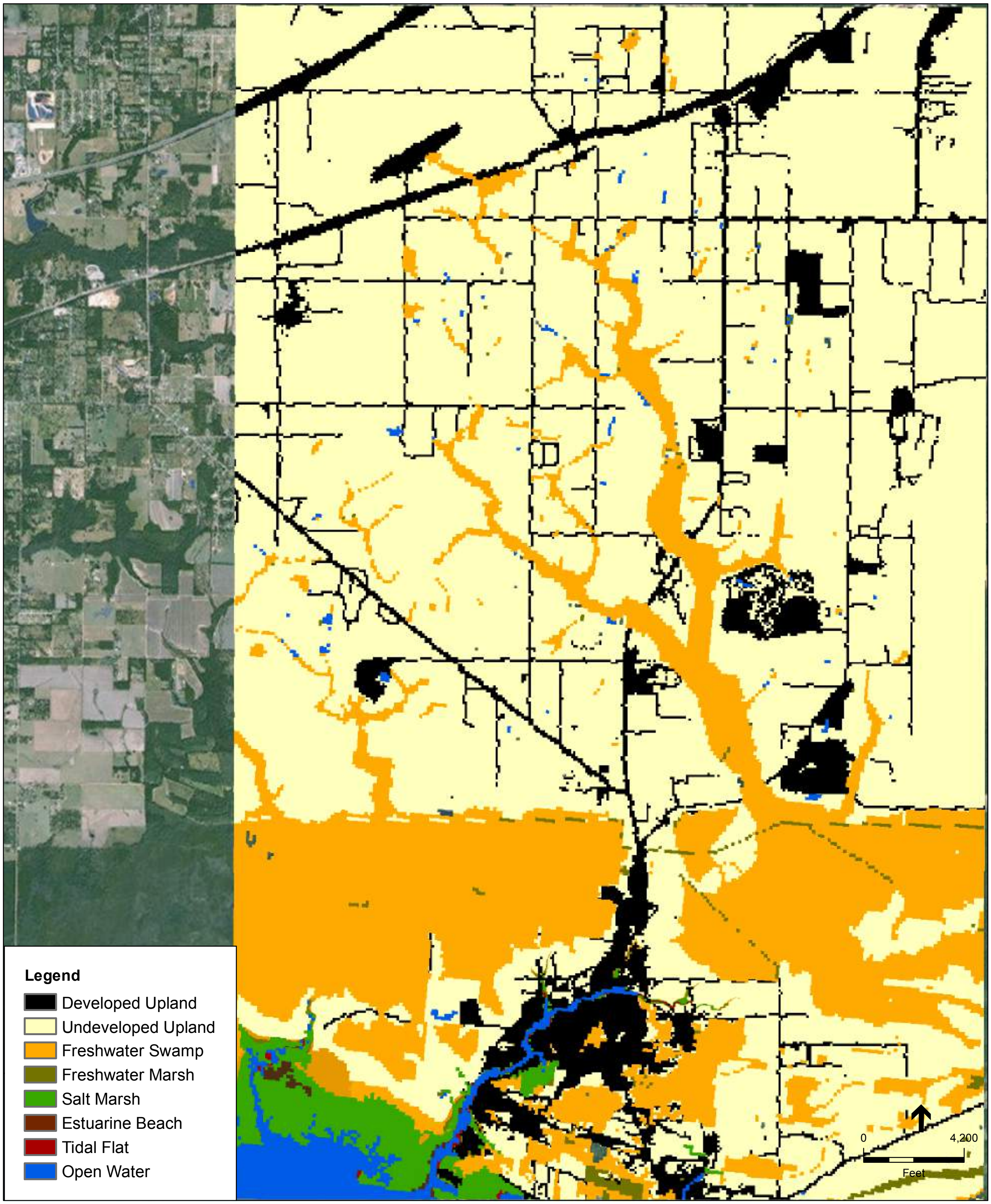

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Figure B-19
Run 4, 2070

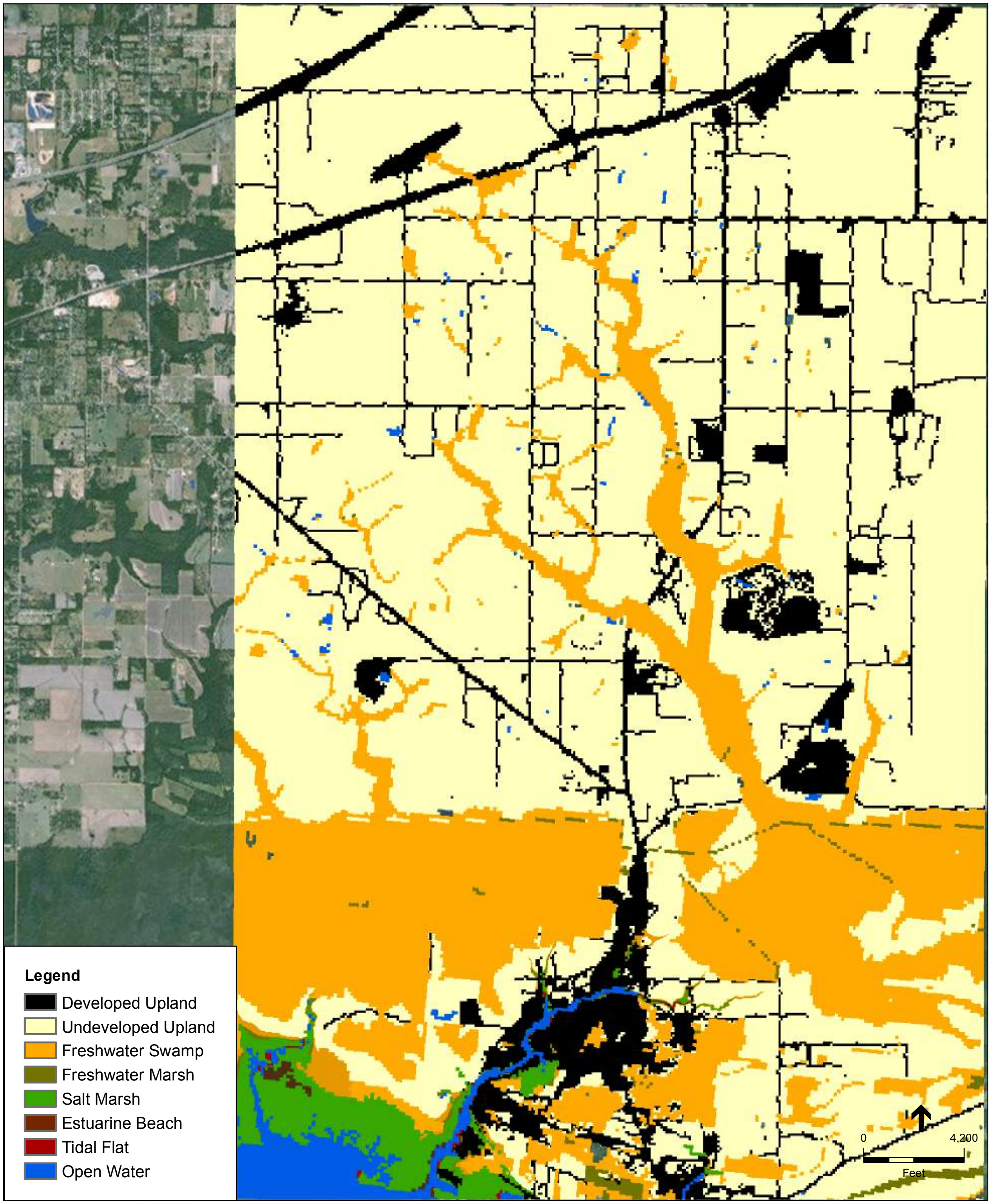

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Figure B-20
Run 4, 2100

APPENDIX C SSO REPORTS

MCHD
mobile county health department
A legacy of excellence since 1816

NEWS RELEASE

Office of Public Information Officer
sstonge@mchd.org 251.690.8818

June 25, 2015

Sanitary sewer overflow

The Utilities Board of the City of Bayou La Batre has notified the Mobile County Health Department that a loss of power due to severe weather caused a sanitary sewage overflow on June 24 from a manhole at the following location:

Location	Approximate Gallons	Receiving Water
Little River Road @ Seafood House Road	1,000 Gallons	Portersville Bay

Dr. Bernard Eichold, Health Officer for the Mobile County Health Department, advises area residents to take precautions when coming into contact with any standing water that may have accumulated as a result of these overflows. Those who have come into direct contact with untreated sewage are advised to wash their hands and clothing thoroughly.

Area residents also should take precautions if using Portersville Bay for recreational purposes. All seafood harvested in affected areas should be thoroughly cooked before consumption. People should wash their hands after cleaning any fish or other seafood and also before preparing food.

-30-

NEWS RELEASE

Office of Media Relations
MediaRelations@mchd.org | 251.690.8818

August 6, 2015

Sanitary sewer overflows

The Utilities Board of the City of Bayou La Batre has notified the Mobile County Health Department that heavy rainfall caused several sanitary sewage overflows on Wednesday, August 5 from manholes at the following locations:

Location	Approximate Gallons	Receiving Water
Warner Street @ Dana's Seafood	300 Gallons	Portersville Bay
Mars Road @ Hemley Avenue	250 Gallons	Portersville Bay
Little River Road @ Bryant Street	1,000 Gallons	Portersville Bay
Little River Road @ Seafood House Road	1,000 Gallons	Portersville Bay
Shell Belt Road @ Marshall Marine	1,200 Gallons	Portersville Bay
Shell Belt Road @ Olympic Shellfish	1,000 Gallons	Portersville Bay
Little River Road @ Seafood House Road	1,000 Gallons	Portersville Bay

Dr. Bernard Eichold, Health Officer for the Mobile County Health Department, advises area residents to take precautions when coming into contact with any standing water that may have accumulated as a result of these overflows. Those who have come into direct contact with untreated sewage are advised to wash their hands and clothing thoroughly.

Area residents also should take precautions if using Portersville Bay for recreational purposes. All seafood harvested in affected areas should be thoroughly cooked before consumption. People should wash their hands after cleaning any fish or other seafood and also before preparing food.

-30-

NEWS RELEASE

mobile county health department
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Office of Media Relations
MediaRelations@mchd.org | 251.690.8818

November 9, 2015

Sanitary sewer overflow

The Utilities Board of the City of Bayou La Batre has notified the Mobile County Health Department that heavy rainfall caused a several sanitary sewage overflow on Sunday, November 8. An estimated 1,500 gallons of sanitary sewer water overflowed from a manhole at Shell Belt Road between Marshall Marine & Olympic Shellfish. The ultimate destination of the discharge was the waters of Bayou La Batre, the utility reported.

Dr. Bernard Eichold, Health Officer for the Mobile County Health Department, advises area residents to take precautions when coming into contact with any standing water that may have accumulated as a result of this overflow. Those who have come into direct contact with untreated sewage are advised to wash their hands and clothing thoroughly.

Area residents also should take precautions when using Bayou La Batre waters for recreational purposes because of the overflows. All seafood harvested in this general area should be thoroughly cooked before eating. People should wash hands after cleaning seafood and before preparing food.

-30-

December 23, 2015

Sanitary sewer overflows

The Utilities Board of the City of Bayou La Batre has notified the Mobile County Health Department that heavy rainfall caused several sanitary sewage overflows on Wednesday, December 23 from manholes at the following locations:

Location	Approximate Gallons	Receiving Water
9300 Little River Road	200 Gallons	Bayou La Batre Bayou/Portersville Bay
Little River Road @ Bryant Street	200 Gallons	Bayou La Batre Bayou/Portersville Bay
Shell Belt Road @ Jones Street	6,300 Gallons	Bayou La Batre Bayou/Portersville Bay
Shell Belt Road @ Mallet Street	1,260 Gallons	Bayou La Batre Bayou/Portersville Bay
Alba Street @ Fifth Avenue	2,500 Gallons	Bayou La Batre Bayou/Portersville Bay

Dr. Bernard Eichold, Health Officer for the Mobile County Health Department, advises area residents to take precautions when coming into contact with any standing water that may have accumulated as a result of these overflows. Those who have come into direct contact with untreated sewage are advised to wash their hands and clothing thoroughly.

Area residents also should take precautions if using Bayou La Batre Bayou and Portersville Bay for recreational purposes. All seafood harvested in affected areas should be thoroughly cooked before consumption. People should wash their hands after cleaning any fish or other seafood and also before preparing food.

-30-

NEWS RELEASE

Office of Media Relations
MediaRelations@mchd.org | 251.690.8818

December 30, 2015

Sanitary sewer overflow reported in Bayou La Batre

The Utilities Board of the City of Bayou La Batre has notified the Mobile County Health Department that heavy rainfall caused several sanitary sewage overflows on Wednesday, December 30. An estimated 2,430 gallons of sanitary sewer water overflowed from a manhole at Shell Belt Road and Jones Street and at another manhole at Alba Street and Fifth Street. The ultimate destination of the discharge was the Portersville Bay, the utility reported.

Dr. Bernard Eichold, Health Officer for the Mobile County Health Department, advises area residents to take precautions when coming into contact with any standing water that may have accumulated as a result of this overflow. Those who have come into direct contact with untreated sewage are advised to wash their hands and clothing thoroughly.

Area residents also should take precautions when using Portersville Bay for recreational purposes because of the overflows. All seafood harvested in this general area should be thoroughly cooked before eating. People should wash hands after cleaning seafood and before preparing food.

-30-

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March 14, 2016

Sanitary sewer overflows

The Utilities Board of the City of Bayou La Batre has notified the Mobile County Health Department that heavy rainfall caused several sanitary sewage overflows that began and stopped on Friday, March 11, from manholes at the following locations:

Location	Approximate Gallons	Receiving Water
Shell Belt and Mallette Street	2,000 Gallons	Bayou La Batre Bayou
Shell Belt and Jones Street	2,000 Gallons	Bayou La Batre Bayou
9315 Little River Road	2,000 Gallons	Bayou La Batre Bayou

Dr. Bernard Eichold, Health Officer for the Mobile County Health Department, advises area residents to take precautions when coming into contact with any standing water that may have accumulated as a result of these overflows. Those who have come into direct contact with untreated sewage are advised to wash their hands and clothing thoroughly.

Area residents also should take precautions if using Bayou La Batre Bayou for recreational purposes. All seafood harvested in affected areas should be thoroughly cooked before consumption. People should wash their hands after cleaning any fish or other seafood and also before preparing food.

-30-

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NEWS RELEASE

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March 28, 2016

Bayou La Batre reports sanitary sewer overflows

The Utilities Board of the City of Bayou La Batre has notified the Mobile County Health Department that heavy rainfall caused a sanitary sewage overflow that began and stopped on Sunday, March 27, from a manhole at the following location:

Location	Approximate Gallons	Receiving Water
Shell Belt Road and Jones Street	1,260 Gallons	Bayou La Batre Bayou

Dr. Bernard H. Eichold II, Health Officer for the Mobile County Health Department, advises area residents to take precautions when coming into contact with any standing water that may have accumulated as a result of these overflows. Those who have come into direct contact with untreated sewage are advised to wash their hands and clothing thoroughly.

Area residents also should take precautions if using Bayou La Batre Bayou for recreational purposes. All seafood harvested in affected areas should be thoroughly cooked before consumption. People should wash their hands after cleaning any fish or other seafood and also before preparing food.

-30-

NEWS RELEASE

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August 11, 2016

Bayou La Batre reports sanitary sewer overflow

The Utilities Board of the City of Bayou La Batre has notified the Mobile County Health Department that heavy rainfall caused a sanitary sewage overflow that began and ended on Thursday, August 11, from a manhole at the following location:

Location	Approximate Gallons	Receiving Water
Shell Belt Road and Jones Street	500 Gallons	Bayou La Batre Bayou

Dr. Bernard H. Eichold II, Health Officer for the Mobile County Health Department, advises area residents to take precautions when coming into contact with any standing water that may have accumulated as a result of this overflow. Those who have come into direct contact with untreated sewage are advised to wash their hands and clothing thoroughly.

Area residents also should take precautions if using Bayou La Batre Bayou for recreational purposes. All seafood harvested in affected areas should be thoroughly cooked before consumption. People should wash their hands after cleaning any fish or other seafood and also before preparing food.

-30-

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NEWS RELEASE

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January 22, 2016

Sanitary sewer overflows

The Utilities Board of the City of Bayou La Batre has notified the Mobile County Health Department that heavy rainfall caused several sanitary sewage overflows that began on Thursday, January 21 and stopped on Friday, January 22 from manholes at the following locations:

Location	Approximate Gallons	Receiving Water
Shell Belt Road @ Jones Street	1,800 Gallons	Bayou La Batre Bayou/Portersville Bay
Seafood House Road and Powell Street	420 Gallons	Bayou La Batre Bayou/Portersville Bay
Alba Street and Fifth Avenue	480 Gallons	Bayou La Batre Bayou/Portersville Bay

Dr. Bernard Eichold, Health Officer for the Mobile County Health Department, advises area residents to take precautions when coming into contact with any standing water that may have accumulated as a result of these overflows. Those who have come into direct contact with untreated sewage are advised to wash their hands and clothing thoroughly.

Area residents also should take precautions if using Bayou La Batre Bayou/Portersville Bay for recreational purposes. All seafood harvested in affected areas should be thoroughly cooked before consumption. People should wash their hands after cleaning any fish or other seafood and also before preparing food.

-30-

APPENDIX D COOK REPORT

PRE-RESTORATION ANALYSIS OF DISCHARGE, SEDIMENT TRANSPORT RATES, WATER QUALITY, AND LAND-USE IMPACTS IN THE BAYOU LA BATRE WATERSHED, MOBILE COUNTY, ALABAMA

Mobile Bay National Estuary Program

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PRE-RESTORATION ANALYSIS OF DISCHARGE, SEDIMENT TRANSPORT RATES, WATER QUALITY, AND LAND-USE IMPACTS IN THE BAYOU LA BATRE WATERSHED, MOBILE COUNTY, ALABAMA

By

Marlon R. Cook,
Polyengineering, Inc.

Funding for this project was provided by the
Mobile Bay National Estuary Program

August 2016

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INTRODUCTION

Commonly, land-use and climate are major contributors to non-point source contaminants that impact surface-water quality. In parts of Baldwin and Mobile Counties, population growth and economic development are critical issues leading to land-use change. When combined with highly erodible soils and Alabama's coastal climate, characterized by cyclonic storms that produce high intensity rainfall events, deleterious water-quality and biological habitat impacts can be severe. Previous investigations of sediment transport and general water quality have shown dramatic increases in sediment loading and loss of biological habitat in streams downstream from areas affected by rapid runoff and resulting erosion from particular types of land uses. Other areas are virtually unimpacted by land-use change and are characterized by natural landscapes dominated by forests and wetlands. Results of these investigations are valuable in quantifying impacts so that limited regulatory and remedial resources may be focused to remediate problem areas or to preserve relatively pristine watersheds.

The purpose of this investigation is to assess general hydrogeologic and water quality conditions and to estimate sediment loads for Bayou La Batre and its tributaries. These data will be used to quantify water quality impacts and to support development of a watershed management plan, designed to preserve, protect, and restore the Bayou La Batre watershed.

ACKNOWLEDGMENTS

Ms. Roberta Swann, Director; Ms. Amy Newbold, Deputy Director; and Mr. Tom Herder, Watershed Protection Coordinator, Mobile Bay National Estuary Program, provided administrative and coordination assistance for the project; Mr. Bruce Bradley, President, Polyengineering, Inc., provided administrative and technical assistance; Mr. Christopher Warn, Senior Project Manager, Dewberry, provided coordination for the watershed management plan.

PROJECT AREA

The Bayou La Batre watershed covers 19,584 acres (30.6 square miles (mi^2) (US Geological Survey (USGS), 2016) in southern Mobile County (fig. 1). The project area includes monitoring sites on three tributaries and the main stem of Bayou La Batre. Bayou La Batre flows southwestward from its headwaters about one and three quarters miles northeast of the town of Bayou La Batre to its mouth in Portersville Bay in the

Mississippi Sound (fig 2). Elevations in the project area vary from about 15 feet above mean sea level (ft MSL) at the headwaters to sea level at the mouth. The three monitored tributaries include two unnamed streams, and Carls Creek. Carls Creek is the largest subwatershed, containing 13,248 acres (20.7 mi^2) (USGS, 2016) and two tributaries; Hammar Creek and Bishops Manor Creek with maximum elevations of about 140 ft MSL.

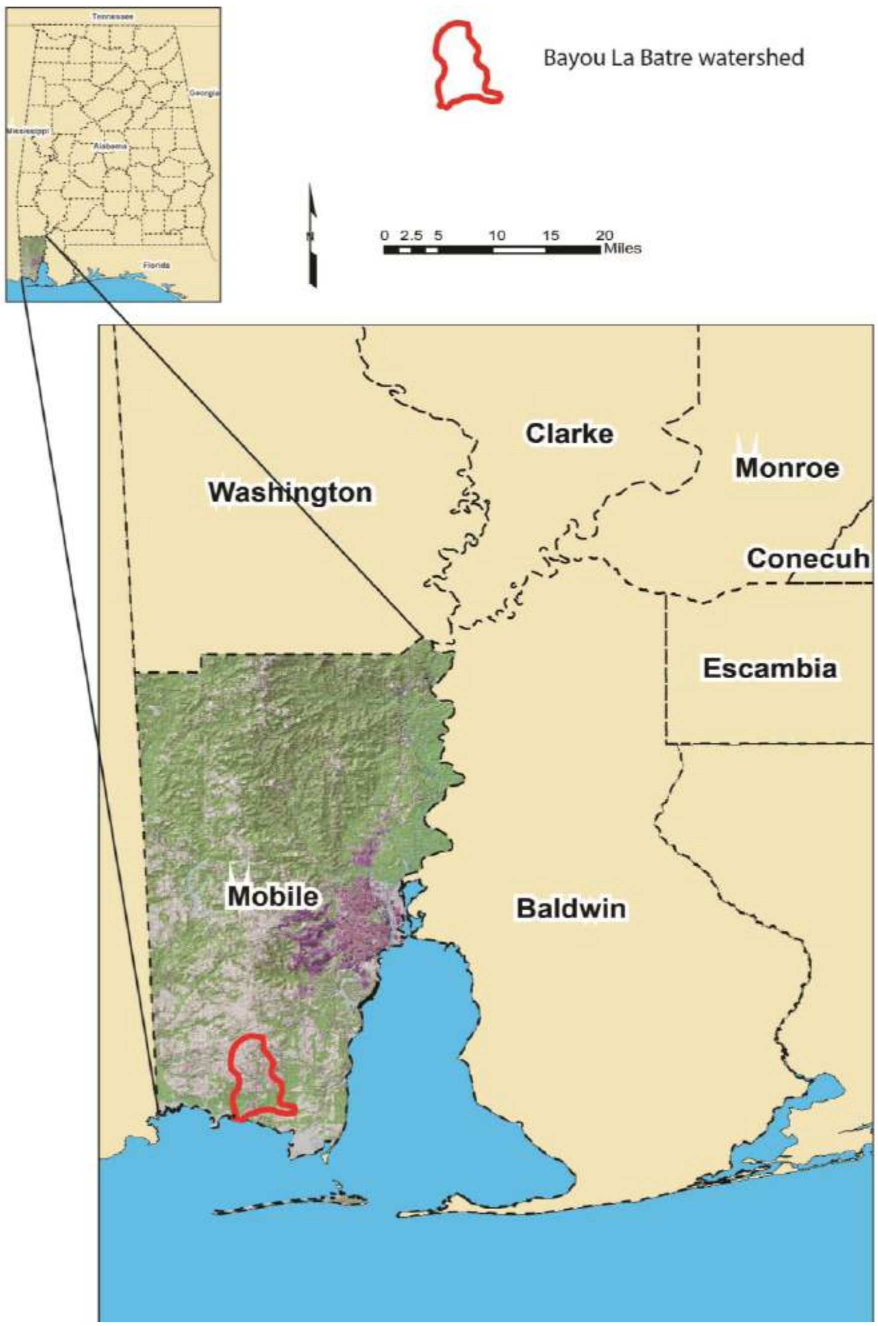

Figure 1.— Bayou La Batre project area.

PROJECT MONITORING STRATEGY AND SITE CHARACTERISTICS

The monitoring strategy employed for the Bayou La Batre project was to collect water samples at each site over a wide range of discharge from base flow to high flow for analyses of total suspended solids, nitrate, and total phosphorus, and constituent load estimation. A number of factors, including site accessibility in a rural, wetlands dominated setting, extensive wetlands and tidal influence that constrains stream flow and impacts water chemical character, and selection of sites as far downstream as possible, were considered during selection of monitoring sites.

Site BLB1 is on the main stem of Bayou La Batre at Wintzell Avenue, the most downstream access point, flowing southwestward, 2.5 mi from the mouth (latitude (lat) 30.40572, longitude (long) -88.24798). The watershed upstream from site BLB1 covers 14,848 acres (23.2 mi^2) (USGS, 2016) (fig. 2).

Site BLB2 is on an unnamed tributary on the northwest side of the town of Bayou La Batre at the Little River Road crossing (lat 30.40706, long -88.25691). The watershed upstream from site BLB2 covers 3,200 acres (5.0 mi^2) (USGS, 2016) (fig. 2).

Sites BLB3 and BLB4 are on Carls Creek, which is formed by two tributaries, Hammar Creek and Bishops Manor Creek, that join to form Carls Creek 2.5 miles upstream from Site BLB3 (fig. 2). One mile downstream from the tributary confluence, the Carls Creek channel splits (fig. 2). Site BLB3 is on a man-made channel at the Arnette Street crossing, about 1.5 miles downstream from the split (lat 30.41066, long -88.24566) (fig. 2). The man-made channel rejoins the natural channel 400 ft downstream from site BLB3 and flows into Bayou La Batre 2,600 ft downstream from the site (fig.2).

Site BLB4 is on a natural channel at the Arnette Street crossing (lat 30.41060, long -88.24496), 150 ft east of the BLB3 site and 1.5 mi downstream from the Carls Creek channel split. The watershed upstream from sites BLB3 and BLB4 contains 13,248 acres (20.7 mi^2) (USGS, 2016) (fig. 2).

LAND USE

Land use is directly correlated with water quality, hydrologic function, ecosystem health, biodiversity, and the integrity of streams and wetlands. Land-use classification for the project area was calculated from the USDA National Agricultural Statistics Service 2013 Alabama Cropland Data Layer (NASS CDL) raster dataset. The CDL is produced using satellite imagery from the Landsat 5 TM sensor, Landsat 7 ETM+ sensor, the

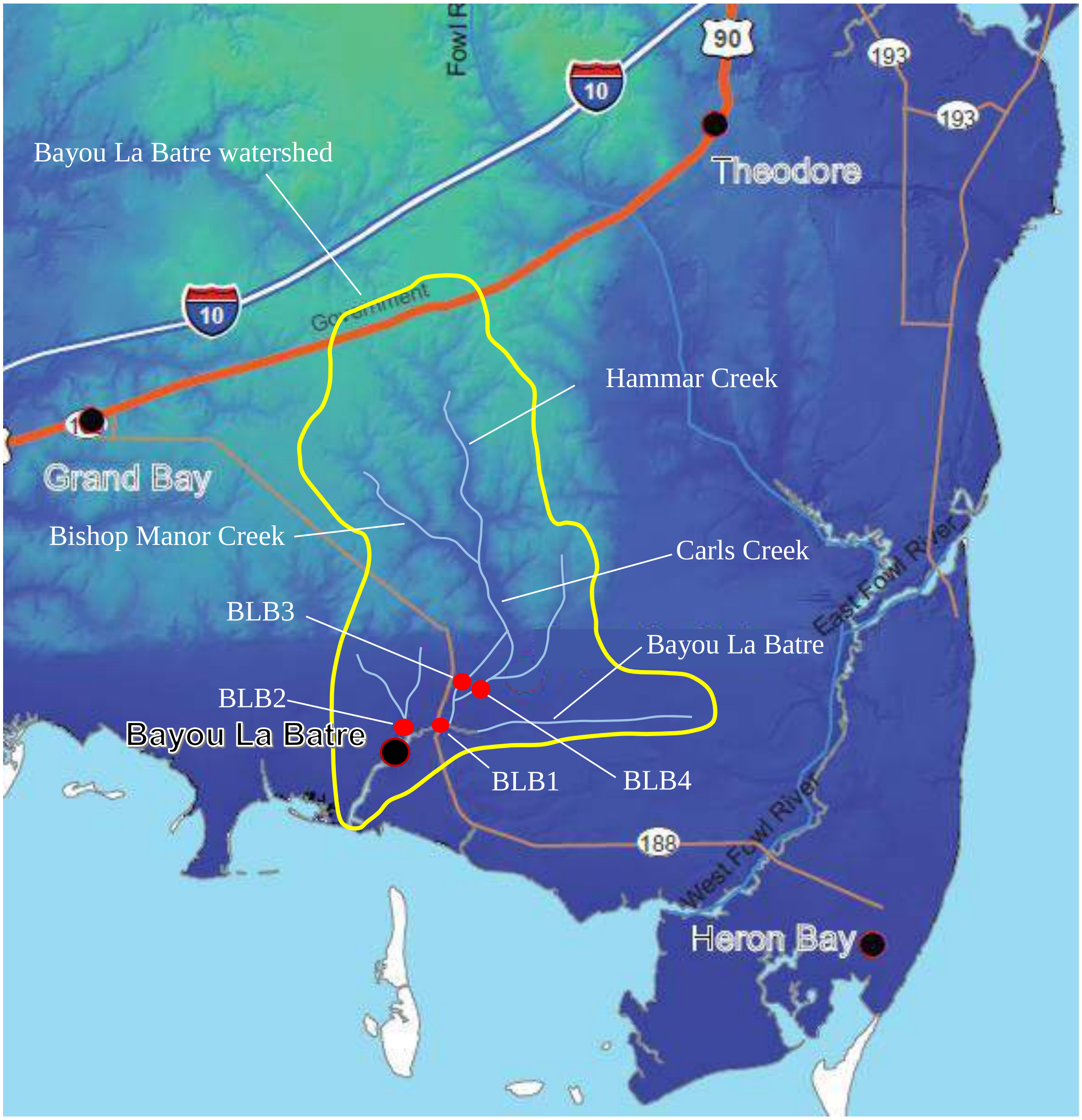

Figure 2.—Bayou La Batre watershed, streams, and monitored sites.

Spanish DEIMOS-1 sensor, the British UK-DMC 2 sensor, and the Indian Remote Sensing RESOURCESAT-1 (IRS-P6) Advanced Wide Field Sensor (AWiFS) collected during recent growing seasons (USDA, 2013). Figure 3 shows land use, subdivided into 17 classified types defined as developed, forested, grassland, wetlands, barren areas, open water, and agriculture, subdivided into eight specific crops (fig. 3).

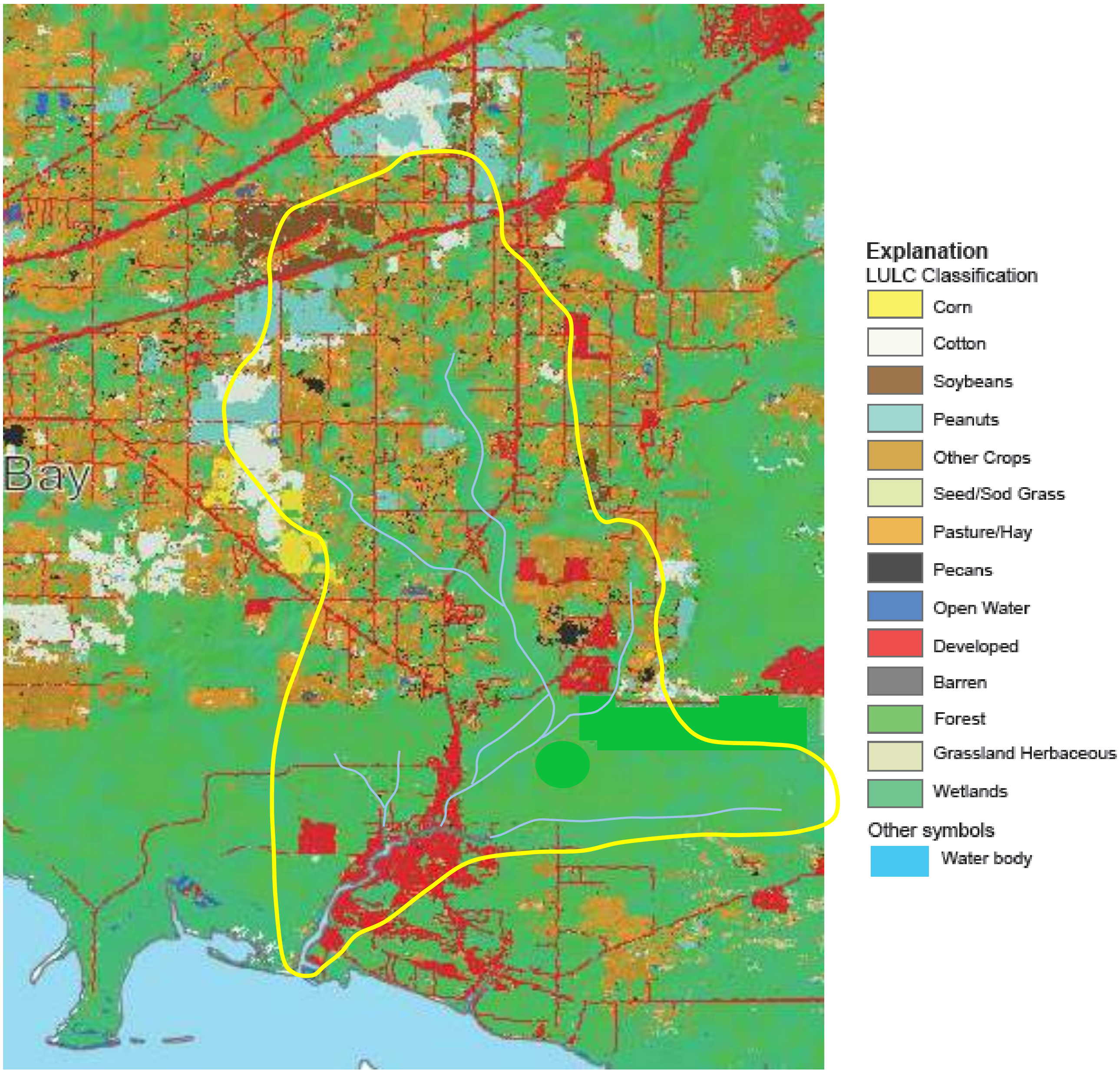

Figure 3.-Land use classifications for the Bayou La Batre area.

The dominant land use category in the Bayou La Batre watershed is pasture/hay and wetlands (fig. 3). Wetlands are important because they provide water quality improvement and management services such as: flood abatement, storm water management, water purification, shoreline stabilization, groundwater recharge, and streamflow maintenance. The next largest land use categories are evergreen and mixed forest and surprisingly, developed land (fig. 3). Developed land in the northern part of the watershed (Carls Creek and tributaries) is dominated by residential development, primarily along roadways (fig. 3). Developed land in the southern part of the watershed is primarily related to the town of Bayou La Batre (fig. 3). Agriculture is a dominant land use in the headwaters of Carls Creek tributaries (fig. 3). Crops consist of peanuts, soybeans, corn, cotton, and pecans. Land uses and their specific impacts are discussed in detail in the Conclusions and Sources of Water-Quality Impacts section of the report.

STREAM FLOW CONDITIONS

Numerous streams in Baldwin County exhibit flashy discharge due to relatively high topographic relief and land-use change. Most streams in the Dog River watershed, in and near the city of Mobile, are also flashy, with relatively high velocities and an average stream gradient of 48 ft/mi, due to channelization and urbanization. However, the character of stream flows in the Bayou La Batre watershed are quite different and influenced by a number of natural and anthropogenic factors. Stream channels in the northern part of the watershed, consisting of Carls Creek tributaries (Bishop Manor and Hammar Creeks) are characterized by relatively high elevation (maximum 140 ft MSL, average 48 ft MSL), with topography that decreases in relief from north (upstream) to south (downstream). The tributary flood plains are dominated by wetlands, channels that are in part, anastomosing, and stream gradients that decrease from upstream to downstream in three zones from 33 to 21 to 10 ft/mi (fig. 4). Prior to 1956, anthropogenic impacts influencing stream discharge in the downstream part of Carls Creek, include a relief channel 1.6 miles long along Padgett Switch Road and eight man-made channels constructed to drain a 300-acre low area between the Carls Creek relief channel and Padgett Switch Road (fig. 4). After 1985, much of the drained area was filled to construct Lucille Zirlott Park, a number of businesses, and a medical center along Padgett Switch Road. However, one of the drainage ditches and the Carls Creek relief channel remain. Other anthropogenic impacts to stream flow include a 6,800-foot-long constructed channel in the headwaters of Bayou La Batre, east of the town of Bayou La Batre (fig. 4). The Carls Creek natural channel, monitored unnamed tributary, and Bayou La Batre are in the Alabama Coastal Zone, where they flow through the eastern extent of Grand Bay Swamp, and have an average gradient of 7 ft/mi. The Carls Creek man-made channel has a gradient of 11 ft/mi. Conductance values for a number of monitoring events indicate tidal influence on volume and quality of stream flow.

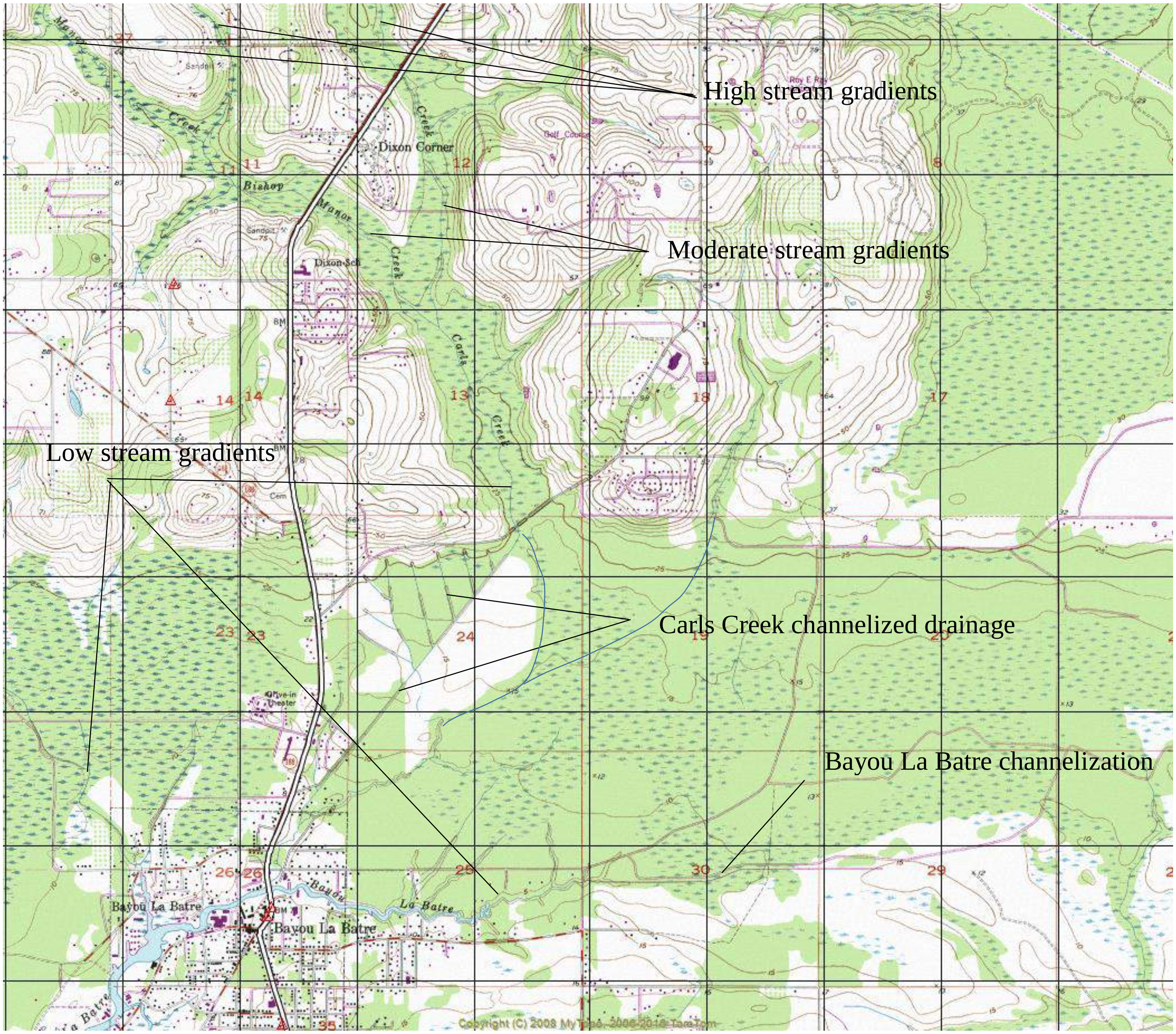

Figure 4.—USGS 7.5-minute topographic map of a selected area of the Bayou La Batre watershed, showing stream gradients and anthropogenic features.

A wide range of discharge events are required to adequately evaluate hydrologic conditions in Bayou La Batre. Table 1 shows that sampling occurred in the Bayou La Batre watershed during discharge conditions from base flow to flood. For example, minimum discharge measured for Carls Creek at Arnette Street (site 3) was 10.3 cfs (January 13, 2016) and the maximum was 444 cfs, measured on January 21, 2016 . Average daily discharge for each monitored stream is also required to adequately estimate constituent loading. Discharge data collected at the USGS stream gaging site 02471078, Fowl River at Half Mile Road, near Laurendine, Alabama was used as a basis for average daily discharge estimation for each monitored stream.

Table 1.—Stream-flow characteristics for monitored sites in the Bayou La Batre watershed.

Monitored site	Average discharge (cfs)	Maximum discharge (cfs)	Minimum discharge (cfs)	Average discharge per unit area (cfs/mi)	Average stream flow velocity (ft/s)	Stream gradient (ft/mi)
1	1,131	1,937[1]	439[1]	49	0.6	3.2
2	162	230[1]	110	35	0.5	8.6
3	131	444	10		1.1	
4	160	281[1]	17		0.9	
3 and 4	291	725	27	14	1.0	16.3

[1]TI- tidal influence

SPECIFIC CONDUCTANCE

Surface water in each project watershed is characterized by a unique specific conductance (SC) (microseimens/centimeter (μS/cm)) profile based on physical and chemical properties. The variability of SC is influenced by differences in stream temperature, discharge, total dissolved solids, local geology and soil conditions, and ionic influxes from nonpoint sources of pollution or from seawater in reaches of streams with tidal influence. Streams without significant contaminant sources exhibit increased SC values with decreasing discharge due to increasing volumes of relatively high SC groundwater inflow and decreased SC with increasing discharge due to increasing volumes of relatively low SC runoff. The opposite SC character is exhibited for streams with significant contaminant sources where relatively high conductance runoff causes increasing SC with increasing discharge. Fluctuations of SC in streams with tidal influence correspond to tidal cycles with relatively high SC (salt water) at high tide and relatively low SC (fresh water) at low tide. However, the relationship between runoff, discharge, tidal cycles, and conductivity can be extremely complex, as was observed in data collected at sites BLB1 and BLB2. Table 2 shows SC in monitored streams in the Bayou La Batre watershed. Figure 5 shows the relationship between discharge and conductivity for samples collected at sites BLB 1 and 2. BLB1 samples are grouped by relatively high discharge and low conductivity and relatively low discharge and high conductivity. BLB2 samples are grouped by relatively high and low conductivity, but discharge does not appear to have an influence. This is most likely due to the dominance of wetlands and marsh upstream from site BLB2 that limits surface-water runoff and maximizes groundwater contributions to flow. However, it is clear that tidal cyclicity is a major influence on the chemical character of these waters.

Table 2.—Measured specific conductance values for the Bayou La Batre monitoring sites.

Monitoring site	Maximum conductivity (µS/cm)	Minimum conductivity (µS/cm)	Average conductivity (µS/cm)
1	22,100	101	11,880
2	21,700	42	9,982
3	630	39	230
4	1,690	37	388

TURBIDITY

Turbidity in water is caused by suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter, and plankton and other microscopic organisms (Eaton, 1995). Turbidity is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted with no change in direction or flux level through the stream (Eaton, 1995). Turbidity values measured in nephlametric turbidity units (NTU) from water samples may be utilized to formulate a rough estimate of long-term trends of total suspended solids (TSS) and therefore may be used to observe trends in suspended sediment transport in streams. This relationship is more complex in estuaries and streams with tidal influence, as is the case for streams in the Bayou La Batre watershed. Turbidity and TSS in marine settings originate from organic and

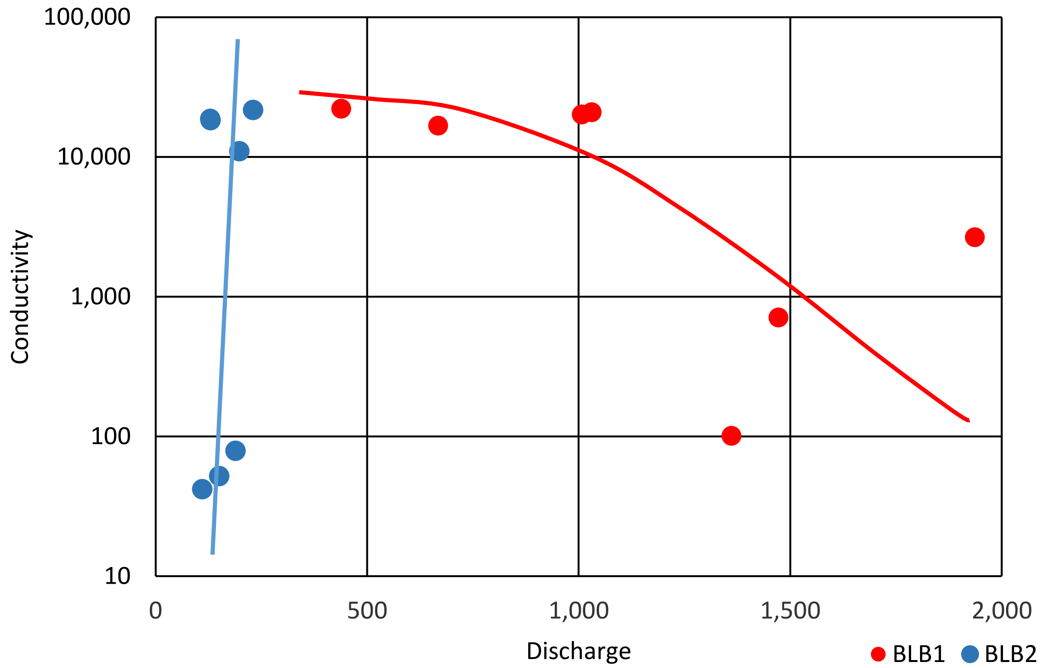

Figure 5.—Conductivity and discharge relationships for samples collected at sites BLB1 and BLB2.

inorganic material. Salinity of the ocean or estuary will cause suspended solids to aggregate, or combine. As the aggregate weight increases, the solids begin to sink and will settle on the seafloor or estuary bottom. This effect causes greater water clarity than is observed in most lakes and rivers. The higher the salinity, the greater the effect. In estuaries and tidal streams, turbidity values may be consistently high, due to the constant resuspension of settled solids as tides move in and out (Fondriest Environmental, Inc., 2014). However, turbidity and TSS in tidally influenced streams in the Bayou La Batre watershed correlate differently, depending on whether the samples are fresh or saline (fig. 6). Samples from Bayou La Batre streams with elevated conductivity (saline water) resulting from tidal influence, on average, have 43 percent higher TSS concentrations than fresh-water samples with the same turbidity values. Figure 6 shows fresh-water and saline-water turbidity and TSS correlations.

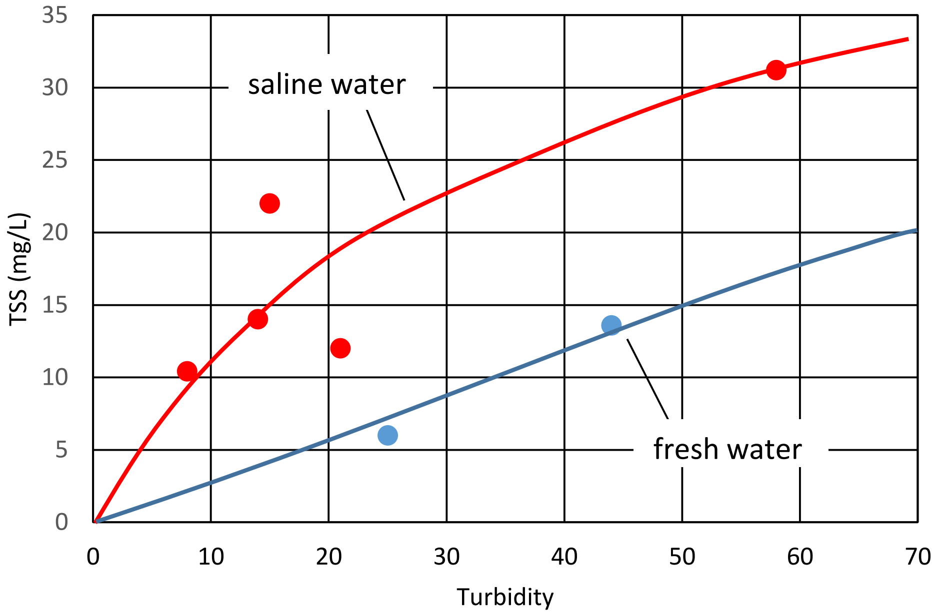

Figure 6.—Turbidity and TSS relationship showing difference between fresh- and saline-water samples at site BLB1.

Analyses of turbidity and stream discharge provide insights into hydrologic, land-use, and general water-quality characteristics of a watershed. Average measured turbidity and discharge, shown in figure 7, illustrates that generally, site BLB3 (channelized part of Carls Creek at Arnette Street) has the highest turbidity to discharge ratio (0.4 NTU/cfs),

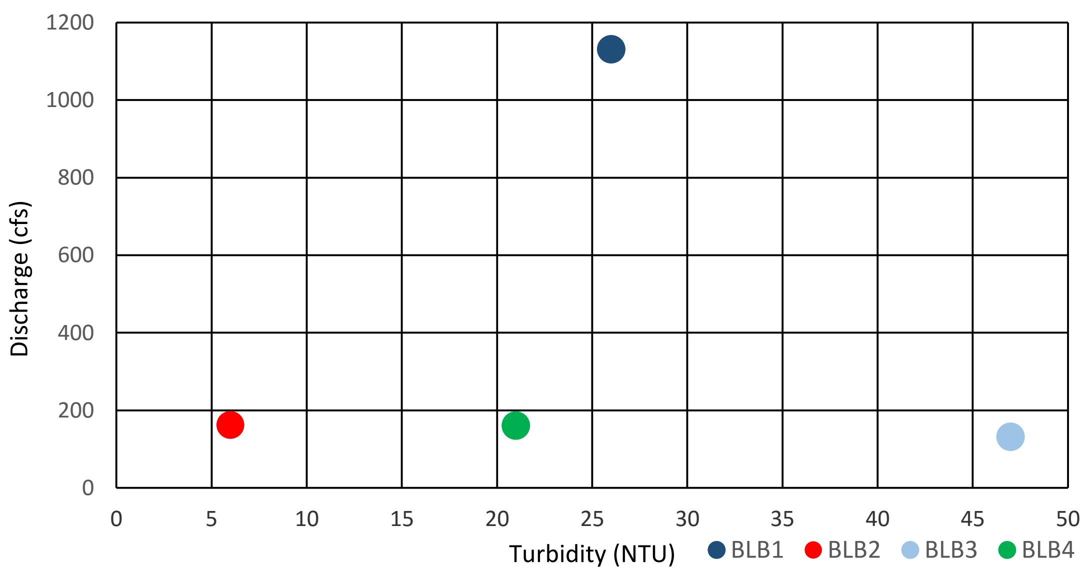

Figure 7.—Average turbidity and discharge relationships for Bayou La Batre monitored sites.

site BLB 4 (natural channel of Carls Creek at Arnette Street) is 0.1 NTU/cfs, site BLB2 (unnamed tributary at Little River Road) is 0.04 NTU/cfs, and site BLB1 (BLB at Wintzel Avenue) has the lowest (0.02 NTU/cfs).

Commonly, excessive turbidity is closely tied to land uses that cause land disturbances that lead to erosion or to land uses that cause excessive runoff. Field observation indicate that a number of row crop fields in the headwaters of Bishop Manor Creek have intermittent drainage channels with no vegetative buffers. Although a majority of the monitoring data for Carls Creek (the largest tributary watershed in the Bayou La Batre system) was collected in the downstream part of the watershed in order to estimate constituent loading, additional data were collected at upstream sites to determine tributary and headwaters contributions to downstream water quality. Storm impacted flows were monitored in early August 2016 in the Bishop Manor and Hammar Creeks watershed. Turbidity for Bishop Manor Creek, 1.8 mi upstream from the confluence with Hammar Creek (Bishop Manor Creek at Argyle Road) was 114 NTU and for Hammar Creek, 1.2 mi upstream from the confluence with Bishop Manor Creek (Hammar Creek at 3 Mile Road) was 44 NTU. The highest turbidity measured during the project period was 375 NTU at an unnamed tributary to Hammar Creek at Tom Weller Road. This is a headwaters tributary, where part of the stream flows through row crop fields with no vegetative buffer.

SEDIMENTATION

Sedimentation is a process by which eroded particles of rock are transported primarily by moving water from areas of relatively high elevation to areas of relatively low elevation, where the particles are deposited. Upland sediment transport is primarily accomplished by overland flow and rill and gully development. Lowland or flood plain transport occurs in streams of varying order, where upland sediment joins sediment eroded from flood plains, stream banks, and stream beds. Erosion rates are accelerated by human activity related to agriculture, construction, timber harvesting, unimproved roadways, or any activity where soils or geologic units are exposed or disturbed. Excessive sedimentation is detrimental to water quality, destroys biological habitat, reduces storage volume of water impoundments, impedes the usability of aquatic recreational areas, and causes damage to structures.

Precipitation, stream gradient, geology and soils, and land use are all important factors that influence sediment transport characteristics of streams. Sediment transport conditions in the Bayou La Batre watershed are evaluated and quantified by tributary, in order to evaluate factors impacting erosion and sediment transport at a localized scale. In addition to commonly observed factors above, wetlands, vegetation, and tidal effects also play prominent roles in sediment transport and overall water quality in the Bayou La Batre watershed. Estimates of sediment loads for this assessment are based on measured sediment and stream discharge. Therefore, a stream flow dataset composed of values ranging from base flow to flood is desirable. Observed stream flow conditions are shown in table 1.

Sediment loads in streams are composed of relatively small particles suspended in the water column (suspended solids) and larger particles that move on or periodically near the streambed (bed load). A pre-monitoring assessment of sediment characteristics indicated that due to low elevation and topographic relief and extensive wetlands, relatively little bed sediment was present in the streams at selected Fowl River monitoring sites. Therefore, total sediment loads for all monitored sites were assumed to be suspended.

SEDIMENT LOADS TRANSPORTED BY PROJECT STREAMS

The rate of transport of sediment is a complex process controlled by a number of factors primarily related to land use, precipitation runoff, erosion, stream discharge and flow velocity, stream base level, and physical properties of the transported sediment. Deterrents to excessive erosion and sediment transport include wetlands, forests, vegetative cover and field buffers for croplands, limitations on impervious surfaces, and a number of constructed features to promote infiltration of precipitation and to store and slow runoff. Currently, the Bayou La Batre watershed maintains a relatively healthy hydrologic environment, characterized by a relatively rural setting, minimal row crop agriculture, low topographic relief, abundant wetlands, anastomosing stream channels, and forested flood plains. However, a number of anthropogenic impacts to stream flow and water quality were identified in the Bayou La Batre watershed that require evaluation and possible remediation (see Conclusions and Sources of Water-Quality Impacts section of the report).

SUSPENDED SEDIMENT

The basic concept of constituent loads in a river or stream is simple. However, the mathematics of determining a constituent load may be quite complex. The constituent load is the mass or weight of a constituent that passes a cross-section of a stream in a specific amount of time. Loads are expressed in mass units (tons or kilograms) and are measured for time intervals that are relative to the type of pollutant and the watershed area for which the loads are calculated. Loads are calculated from concentrations of constituents obtained from analyses of water samples and stream discharge, which is the volume of water that passes a cross-section of the river in a specific amount of time.

Suspended sediment is defined as that portion of a water sample that is separated from the water by filtering. This solid material may be composed of organic and inorganic particles that include algae, industrial and municipal wastes, urban and agricultural runoff, and eroded material from geologic formations. These materials are transported to stream channels by overland flow related to storm-water runoff and cause varying degrees of turbidity. Figure 8 shows that turbidity and suspended sediment are closely related in Carls Creek (site BLB3), where water is primarily fresh. Turbidity, TSS, suspended sediment loads, and discharge values for all monitoring sites are shown in table 2.

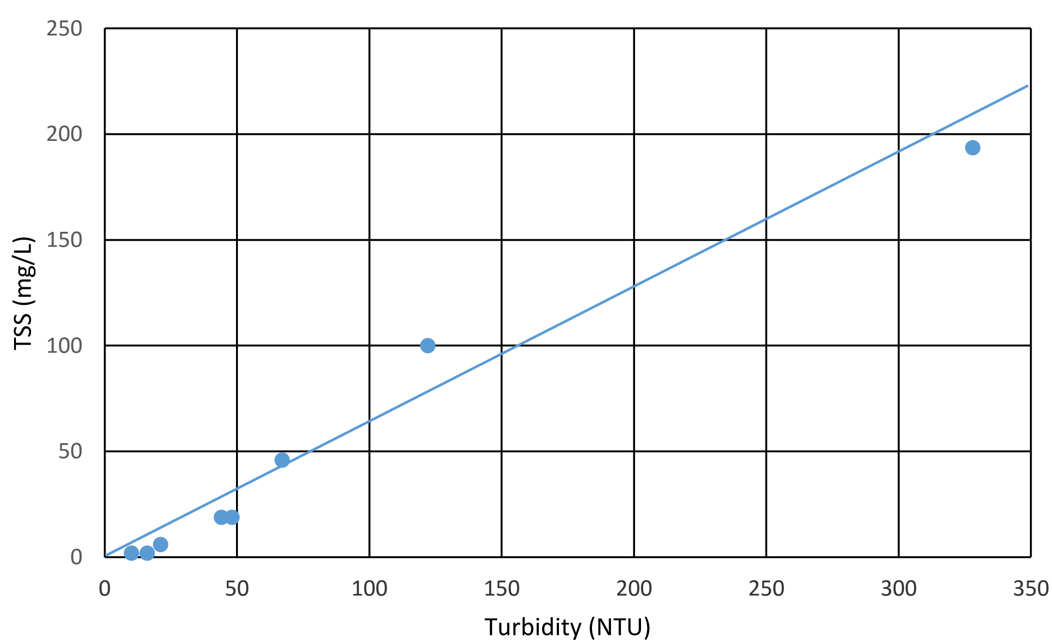

Figure 8.—Turbidity and TSS relationship for fresh-water samples from Carls Creek site BLB3.

Annual suspended sediment loads were estimated for Bayou La Batre monitored streams using the computer regression model Regr_Cntr.xls (*Regression with Centering*) (Richards, 1999). The program is an Excel adaptation of the U.S. Geological Survey (USGS) seven-parameter regression model for load estimation in perennial streams (Cohn and others, 1992). The regression with centering program requires total suspended solids (TSS) concentrations and average daily stream discharge to estimate annual loads. Although average daily discharge for project streams was not available from direct measurement for the monitored sites, it was estimated by establishing a ratio between periodic measured discharge in project streams and discharge values for the same times obtained from USGS stream gaging site (02471078, Fowl River at Half Mile Road, near Laurendine, Alabama). The USGS gaging site is 7.4 mi northeast of Bayou La Batre and has similar hydrogeologic and hydrologic characteristics (Cook, 2014).

Concentrations of TSS in mg/L were determined by laboratory analysis of periodic water grab samples. These results were used to estimate the mass of TSS for the period of stream flow (July 2015 to July 2016). Site BLB1 (Bayou La Batre at Wintzell Avenue), had a suspended sediment load of 22,277 tons per year (t/yr) (table 3). Site BLB2 (unnamed tributary at Little River Road) and the combined load for sites BLB3 and BLB4 (Carls Creek at Arnette Street) had suspended sediment loads of 2,921 and 7,604 t/yr, respectively. Figure 9 shows estimated average annual daily discharge and suspended sediment loads, which shows that generally, increased discharge results in increased suspended sediment loads for Bayou La Batre monitored sites.

Table 3.—Measured discharge, turbidity, and TSS and estimated suspended sediment loads in monitored streams in the Bayou La Batre watershed.

Monitored site	Average Discharge (cfs)	Average turbidity (NTU)	Maximum turbidity (NTU)	Average TSS (mg/L)	Maximum TSS (mg/L)	Estimated suspended sediment load (t/yr)	Estimated normalized suspended sediment load (t/mi^2/yr)
1	1,131	26	58	16	31	22,277	960
2	162	20	35	12	17	2,921	622
3	131	47	122	28	100		
4	160	21	42	9	26		
3&4 combined	291	34	122	37	106	7,604	367

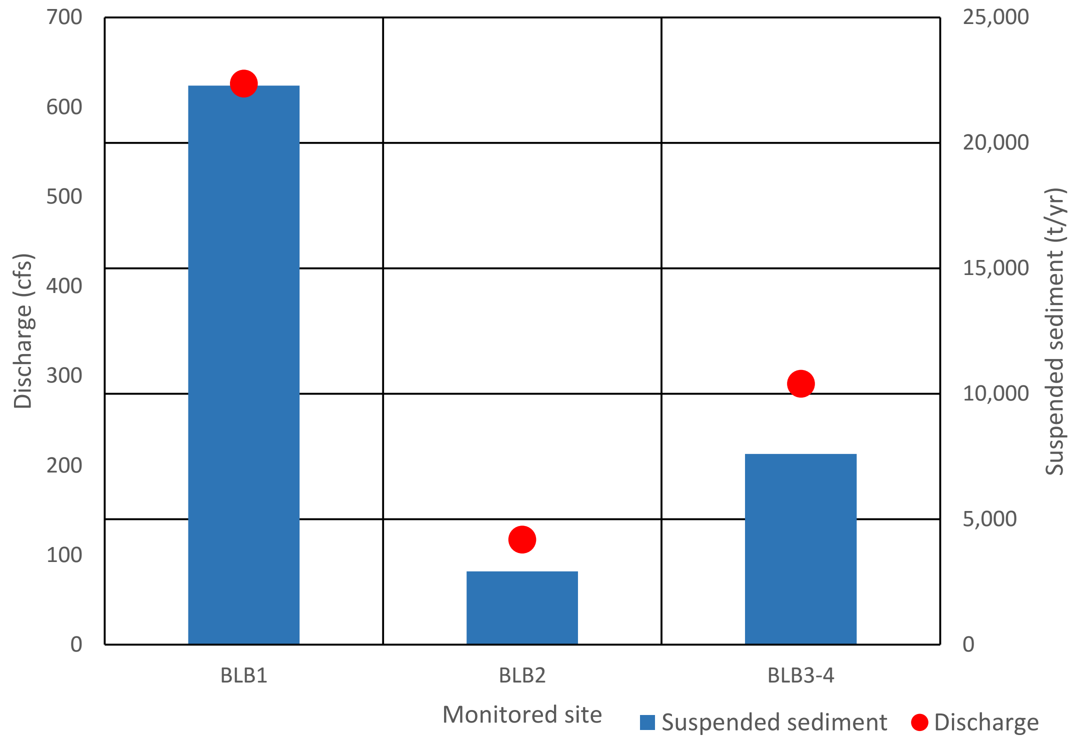

Figure 9.—Average annual daily discharge and suspended sediment loads for Bayou La Batre monitored sites.

For comparison with other watersheds in Mobile County, the largest suspended sediment loads in the Dog River watershed were urban streams, Eslave Creek, Spencer Branch, and Spring Creek with 10,803, 5,970, and 5,198 tons per year (t/yr), respectively (Cook, 2012) and Fowl River watershed streams, Dykes Creek and Fowl River with 1,139 and 795 t/yr, respectively (Cook, 2014). Discharge and watershed area are two of the primary factors that influence sediment transport rates in the Bayou La Batre watershed.

Normalizing suspended loads to unit watershed area permits comparison of monitored watersheds and negates the influence of drainage area size and discharge on sediment loads. Normalized loads in the Bayou La Batre watershed are 960 t/mi^2/yr for Bayou La Batre site BLB1 (Bayou La Batre at Wintzell Avenue), 622 t/mi^2/yr for site BLB2 (unnamed tributary at Little River Road), and 367 t/mi^2/yr for combined sites BLB3 and BLB4 (Carls Creek at Arnette Street). These loads can be compared to the largest normalized loads in Dog River streams, Spencer Branch, Spring Creek, and Eslava Creek with 4,332 and 2,985, and 1,662 t/mi^2/yr, respectively (Cook, 2012). The largest normalized loads in Fowl River streams were, unnamed tributary at Half Mile Road, Dykes Creek, and unnamed tributary at Bellingrath Road with normalized loads of 303 and 271, and 128 t/mi^2/yr, respectively. When the contribution of Carls Creek is removed, the suspended sediment load upstream from site BLB1 (Bayou La Batre at Wintzell Avenue) is 14,673 t/yr (5,869 t/mi^2/yr). This is a substantial sediment load and normally indicates significant upstream sources of sediment. However, it is suspected that a significant part of the suspended sediment is related to the tidal resuspension of sediment discussed previously.

BED SEDIMENT

Transport of streambed material is controlled by a number of factors including stream discharge and flow velocity, erosion and sediment supply, stream base level, and physical properties of the streambed material. Most streambeds are in a state of constant flux in order to maintain a stable base level elevation. The energy of flowing water in a stream is constantly changing to supply the required power for erosion or deposition of bed load to maintain equilibrium with the local water table and regional or global sea level. Stream base level may be affected by regional or global events including fluctuations of sea level or tectonic movement. Local factors affecting base level include fluctuations in the water table elevation, changes in the supply of sediment to the stream caused by changing precipitation rates, and/or land use practices that promote excessive erosion in the floodplain or upland areas of the watershed.

Bed load sediment is composed of particles that are too large or too dense to be carried in suspension by stream flow. These particles roll, tumble, or are periodically suspended as they move downstream. Traditionally, bed load sediment has been difficult to quantify due to deficiencies in monitoring methodology or inaccuracies of estimating volumes of sediment being transported along the streambed. This is particularly true in streams that flow at high velocity or in streams with excessive sediment loads.

Due to a number of factors including relatively small areas of development or land disturbance, limited sources of coarse-grained sediment, relatively low stream gradients and stream flow velocities, and extensive wetlands that slow stream flow velocities and detain sediment, no bed sediment was observed in Bayou La Batre streams except the man-made channel upstream from site BLB3, which was too small to measure. Therefore, all sediment loads are assumed to be suspended.

TOTAL SEDIMENT LOADS

Without human impact, erosion rates in the watershed, called the geologic erosion rate, would be 64 t/mi^2/yr (Maidment, 1993). Normalized sediment loads for all three monitored watersheds were at least five times greater than the geologic erosion rate. Calculated non-normalized geologic erosion rate loads are compared to total estimated loads in figure 10.

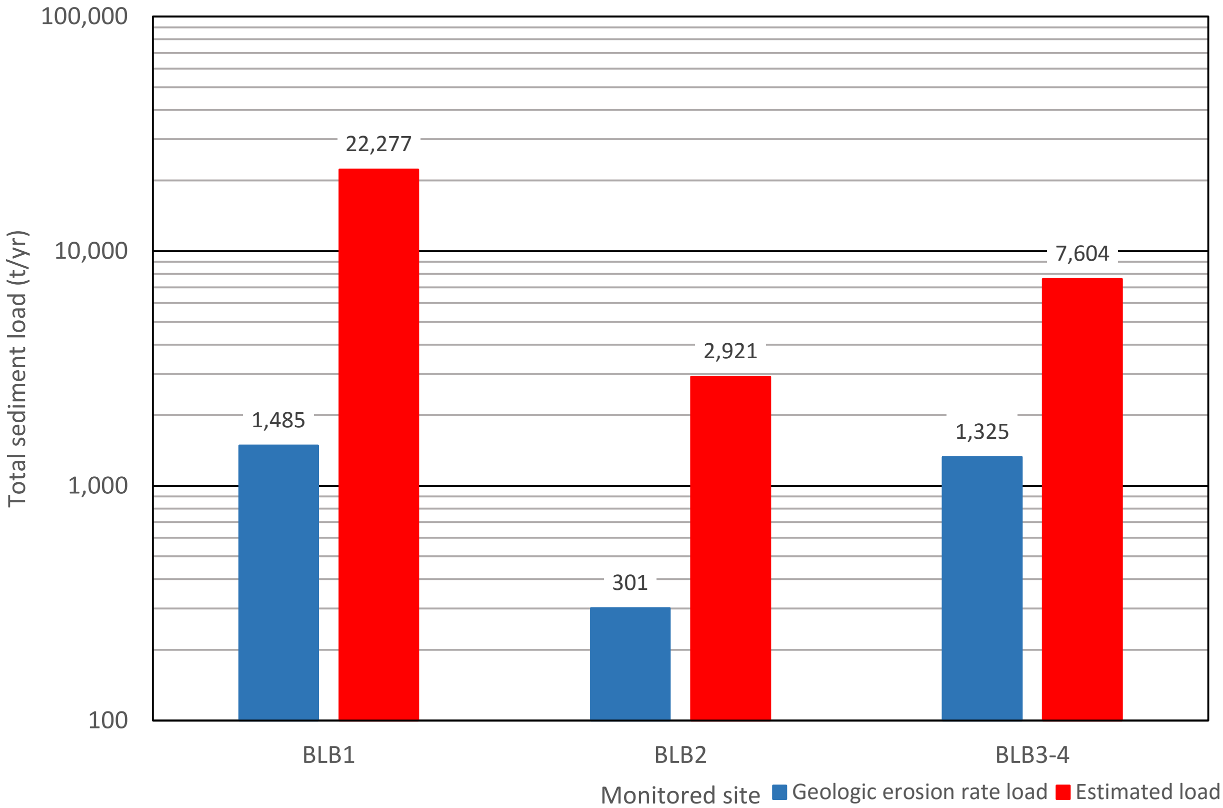

Figure 10.—Comparisons of total sediment geologic erosion rate loads with estimated total sediment loads for monitored Bayou La Batre watersheds.

Comparisons of sediment loads from other watersheds are helpful in determining the severity of erosion problems in a watershed of interest. Estimates of total sediment loads from Dog River site 2 (Spencer Branch at Cottage Hill Road in the city of Mobile) (Cook, 2012), D'Olive Creek site 3 (D'Olive Creek at U.S. Highway 90 in Daphne) (Cook, 2008), Tiawasee Creek site 7 (Tiawasee Creek upstream from Lake Forest) (Cook, 2008), in Baldwin County, Joes Branch site 10 (at North Main Street in Daphne)

(Cook, 2008), Magnolia River site 4 (at U.S. Highway 98) (Cook, 2009), and Bon Secour River site 3 (County Road 12 in Foley) (Cook, 2013) are compared to Bayou La Batre monitored sites in figure 11. GSA estimated sediment loads for more than 60 streams in Alabama. Fowl River at Half Mile Road (site FR2), three miles northeast of the Bayou La Batre watershed, is an excellent reference site for streams in south Mobile County. Fowl River, upstream from site FR2 is characterized by geology, topography, soils, wetlands, and land use is similar to other streams in the region. The estimated sediment load at site FR2 was 53 t/mi^2/yr (20 percent lower than the geologic erosion rate).

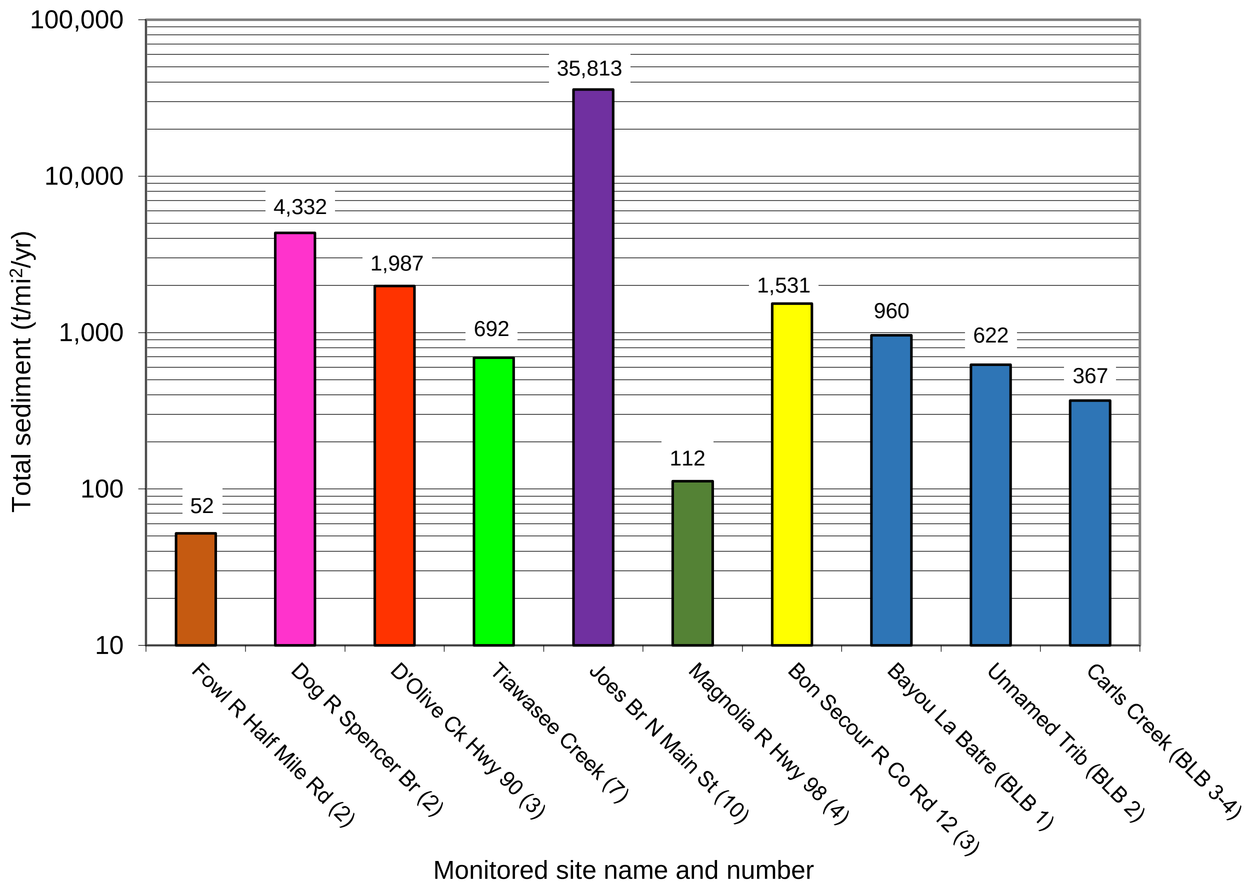

Figure 11.—Comparison of total sediment loads for streams in Baldwin and Mobile Counties.

NUTRIENTS

Excessive nutrient enrichment is a major cause of water-quality impairment. Excessive concentrations of nutrients, primarily nitrogen and phosphorus, in the aquatic environment can lead to increased biological activity, increased algal growth, decreased dissolved oxygen concentrations at times, and decreased numbers of species (Mays, 1996). Nutrient-impaired waters are characterized by numerous problems related to growth of algae, other aquatic vegetation, and associated bacterial strains. Blooms of algae and associated bacteria can cause taste and odor problems in drinking water and decrease oxygen concentrations to eutrophic levels. Toxins also can be produced during blooms of particular algal species. Nutrient-impaired water can dramatically increase treatment costs required to meet drinking water standards. Nutrients discussed in this report are nitrate (NO_3-N) and phosphorus (P-total).

NITRATE

The U.S. Environmental Protection Agency (USEPA) Maximum Contaminant Level (MCL) for nitrate in drinking water is 10 mg/L. Typical nitrate (NO_3 as N) concentrations in streams vary from 0.5 to 3.0 mg/L. Concentrations of nitrate in streams without significant nonpoint sources of pollution vary from 0.1 to 0.5 mg/L. Streams fed by shallow groundwater draining agricultural areas may approach 10 mg/L (Maidment, 1993). Nitrate concentrations in streams without significant nonpoint sources of pollution generally do not exceed 0.5 mg/L (Maidment, 1993).

Water samples were collected from January through May 2016 at Bayou La Batre monitoring sites for discharge events from base flow to bank full. Samples were analyzed for nitrate. The critical nitrate concentration in surface water for excessive algae growth is 0.5 mg/L (Maidment, 1993). All samples analyzed for nitrate at site BLB1 (Bayou La Batre at Wintzell Avenue) were below detection limit of 0.3 mg/L. All samples analyzed for nitrate from site BLB2 (unnamed tributary to Bayou La Batre at Little River Road) were below detection limit or below the 0.5 mg/L nitrate criterion. Forty-three percent of analytical results from samples collected at site BLB3 (man-made channel of Carls Creek at Arnette Street) were below the detection limit, 43 percent were below the 0.5 mg/L nitrate criterion, and 14 percent exceeded the 0.5 mg/L criterion. Analytical results for samples collected at site BLB4 (natural channel of Carls Creek at Arnette Street) indicate that 57 percent are below the detection limit and 29 percent are below the 0.5 mg/L nitrate criterion, and 14 percent exceeded the 0.5 mg/L criterion. Lower concentrations of nitrate are common in most streams during high flows due to dilution, resulting in negative regressions when nitrate is plotted with discharge. However, nitrate and discharge are not well correlated for streams in the Bayou La Batre watershed. Extremely small nitrate concentrations at sites BLB1 (Bayou La Batre at Wintzell Avenue) and BLB2 (unnamed tributary to Bayou La Batre at Little River Road) are likely caused by dilution of runoff from the urban area of Bayou La Batre. Nitrate is poorly correlated with discharge at site BLB3 but is relatively well correlated with conductivity (fig. 12). Nitrate/conductivity correlations were the subject of an investigation by Iowa State University researchers (Gali and others, 2012). The Iowa State University researchers showed that in fresh water, conductivity and nitrate form positive regression correlations and in some cases, conductivity could be used as a surrogate for nitrate. Nitrate has a much better correlation with discharge at site BLB4, forming an expected negative regression (fig. 13). These relationships indicate that dilution is a primary control of nitrate concentrations in fresh-water streams.

Although concentrations are relatively small throughout the monitoring period, elevated concentrations of nitrate in Carls Creek are expected, due to row crop agriculture, cattle, and residential development in the headwaters of Bishop Manor Creek and Hammar Creek (tributaries to Carls Creek) (fig. 3).

PHOSPHORUS

Phosphorus in streams originates from the mineralization of phosphates from soil and rocks or runoff and effluent containing fertilizer or other industrial products. The principal components of the phosphorus cycle involve organic phosphorus and inorganic phosphorus in the form of orthophosphate (PO_4) (Maidment, 1993). Orthophosphate is soluble and is the only biologically available form of phosphorus. Since phosphorus strongly associates with solid particles and is a significant part of organic material, sediments influence water column concentrations and are an important component of the phosphorus cycle in streams.

The natural background concentration of total dissolved phosphorus is approximately 0.025 mg/L. Phosphorus concentrations as low as 0.005 to 0.01 mg/L may cause algae growth, but the critical level of phosphorus necessary for excessive algae is around 0.05 mg/L (Maidment, 1993). Although no official water-quality criterion for

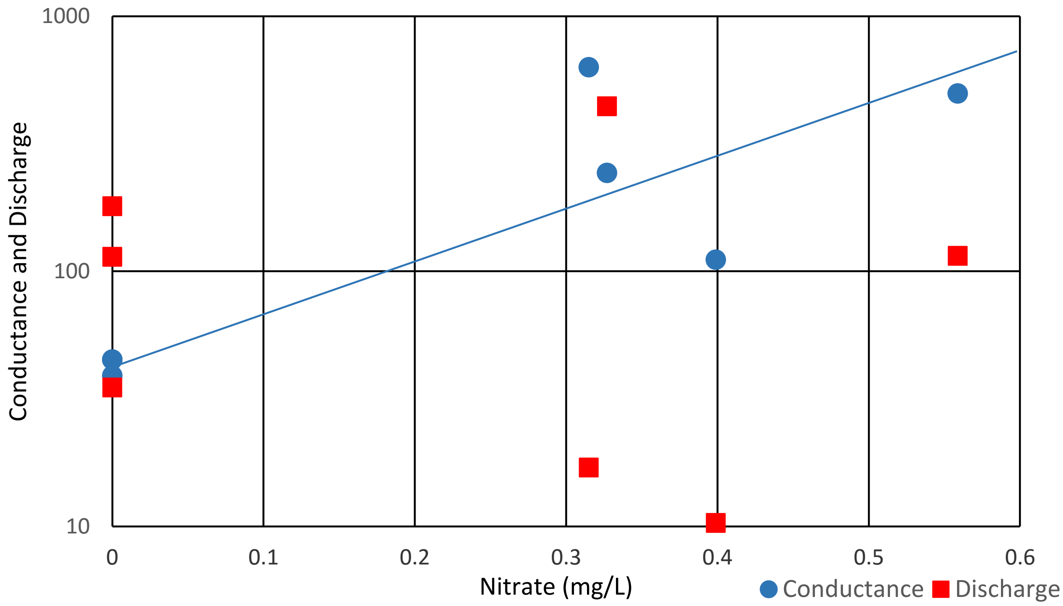

Figure 12.—Relationships of measured nitrate with measured conductance and discharge at site BLB3 (Carls Creek man-made channel at Arnette Street).

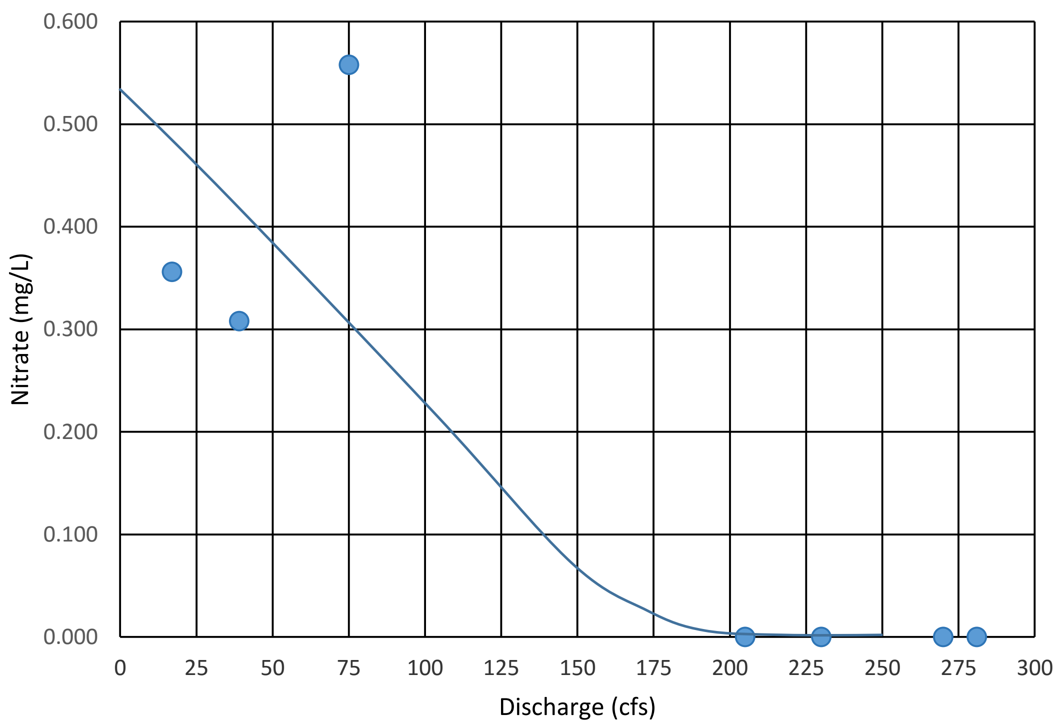

Figure 13.—Relationship of nitrate and discharge at site BLB4 (Carls Creek natural channel at Arnette Street).

phosphorus has been established in the United States, total phosphorus should not exceed 0.05 mg/L in any stream or 0.025 mg/L within a lake or reservoir in order to prevent the development of biological nuisances (Maidment, 1993). In many streams phosphorus is the primary nutrient that influences excessive biological activity. These streams are termed “phosphorus limited.” All samples analyzed for total phosphorus at site BLB1 (Bayou La Batre at Wintzell Avenue) were below detection limit of 0.05 mg/L. All samples but one analyzed for total phosphorus from site BLB2 (unnamed tributary to Bayou La Batre at Little River Road) were below detection limit. One saline water sample collected in April 2016 had a total phosphorus concentration of 0.063 mg/L. All samples but one analyzed for total phosphorus from site BLB3 (man-made channel of Carls Creek at Arnette Street) were below detection limit. The sample collected during the largest discharge event for the monitoring period had a total phosphorus concentration of 0.398, which exceeded the 0.05 mg/L criterion. All samples analyzed for total phosphorus at site BLB4 (natural channel of Carls Creek at Arnette Street) were below detection limit of 0.05 mg/L.

DISSOLVED OXYGEN

Dissolved oxygen (DO) concentration is an essential constituent that affects the biological health and the chemical composition of surface waters. Biological processes, oxidation, and sediment loads all contribute to depletion of DO in surface water. The ADEM standard for DO in surface water classified as Fish and Wildlife is 5.0 mg/L except under extreme conditions when it may be as low as 4.0 mg/L. The effects of an impoundment on DO in the impounded waters and in the downstream release from the impoundment must be carefully considered in the planning and design stage of a reservoir project. The equilibrium concentration of DO in water that is in contact with air is primarily related to water temperature and barometric pressure and secondarily related to concentrations of other solutes (Hem, 1985). Equilibrium DO in water at 10° C and 25° C is 11.27 mg/L and 8.24 mg/L, respectively. DO concentrations in the project watersheds are significantly affected by water temperature, stream discharge, concentrations of organic material in the water, and oxygen-consuming pollutants. These factors are represented in table 4 where observed DO is compared to the 100 percent dissolved oxygen saturation for the observed stream temperature for each of the monitoring periods. Additional DO measurements were made on August 3, 2016 in Carls Creek tributaries, dominated by wetlands and anastomosing stream channels. Hammar Creek at 3 Mile Road and Bishop Manor Creek at Argyle Road had DO concentrations of 4.7 and 5.2 mg/L, respectively.

Table 4.—Dissolved oxygen measured in monitored streams in the Bayou La Batre watershed.

Site	Dissolved oxygen (mg/L)			Average DO saturation (% atmospheric saturation)
	Maximum	Minimum	Average	
BLB1	8.3	6.9	7.5	84
BLB2	8.2	6.4	7.3	83
BLB3	9.8	6.4	7.4	80
BLB4	8.3	7.1	7.6	84

CONCLUSIONS AND SOURCES OF WATER-QUALITY IMPACTS

Evaluations of sediment loads, water-quality analyses, land-use data, and aerial imagery led to conclusions of probable sources of water quality and habitat impairments in the Bayou La Batre watershed. Stream flow conditions are an important factor that influences erosion, sediment transport, and attenuation of nutrients and other contaminants that impact water quality in a watershed. Streams in the Bayou La Batre watershed are characterized by relatively low gradients, anastomosing channels, forested flood plains, extensive wetlands, and tidal impacts in the downstream part of the watershed. The topography of the watershed can be divided into two zones; an upland headwaters zone and a downstream coastal zone. The upland headwaters zone has elevations of about 140 ft MSL, 80 ft of relief, and three percent slopes. The average stream gradient in the upland zone is about 20 ft/mi. The downstream coastal zone part of the watershed is in the Alabama Coastal Zone and is characterized by extensive wetlands and marsh, maximum elevation of 25 ft MSL, and an average stream gradient of 7 ft/mi.

Carls Creek splits into two channels just south of Padgett Switch Road (fig. 14). Site BLB3 is on the man-made relief channel of Carls Creek at Arnette Street. This site had the highest average turbidity (47 NTUs) and the highest turbidity to discharge ratio (0.4 NTU/cfs).

Site BLB1 (Bayou La Batre at Wintzell Avenue), had a suspended sediment load of 22,277 tons per year (t/yr). Site BLB2 (unnamed tributary at Little River Road) and the combined load for sites BLB3 and BLB4 (Carls Creek at Arnette Street) had suspended sediment loads of 2,921 and 7,604 t/yr, respectively. Sediment loads normalized to unit drainage area in the Bayou La Batre watershed are 960 t/mi^2/yr for Bayou La Batre site

Figure 14.—Carls Creek channel bifurcation just south of Padgett Switch Road.

BLB1, 622 t/mi^2/yr for site BLB2, and 367 t/mi^2/yr for combined sites BLB3 and BLB4.

When the Carls Creek load is subtracted from the load at Bayou La Batre site BLB1, the remaining load for Bayou La Batre upstream from site BLB1 is 14,673 t/yr (5,869 t/mi^2/yr). Field reconnaissance and research review led to the conclusion that this surprisingly large suspended sediment load results from three primary sources. The first, as discussed previously, are estuary streams with tidal influence that have constantly elevated turbidity and suspended sediment due to movement of water upstream and downstream in response to tidal cyclicity that mobilizes fine-grained sediment that settled out in the low gradient estuary zone. Secondly, part of the town of Bayou La Batre storm water runoff enters Bayou La Batre immediately upstream from the BLB1 site. The third source is from three upstream, unnamed tributaries to Bayou La Batre that have relatively severe bank erosion (fig. 15).

Comparisons of sediment transport rates and water-quality data in watersheds in Baldwin and Mobile Counties indicate that streams in the Bayou La Batre watershed have moderate-sized sediment loads and generally good water quality. This is attributed to the relatively rural setting, extensive wetlands and forests, and use of winter cover crops on agricultural fields. However, water quality and habitats could be improved and protected for the future by employing best management practices that prevent destruction of wetlands, prevent erosion and sediment transport from areas of timber harvesting and row crop agriculture, and control runoff from urban areas including construction sites and areas with significant bare and impervious surfaces. Sources of sediment in the Bayou La Batre watershed include runoff from headwaters row crop agriculture, sand mining operations, and runoff from urban areas in the town of Bayou La Batre (fig. 15). Observations recorded during monitoring included at least seven fields used for row crop agriculture in the headwaters of Bishop Manor and Hammar Creeks have streams or drainage ditches running through them with no vegetative buffer or sediment detention (Google Earth, 2016) (fig. 15). One of these streams (unnamed tributary to Hammar Creek at Tom Waller Road, site BLB8), had the highest turbidity (375 NTU) recorded during during a storm event in early August 2016 (figs. 15, 16). Other potential sediment sources are two sand mining operations (fig. 15).

Water samples collected from January through May 2016 at Bayou La Batre monitoring sites were analyzed for nitrate. The critical nitrate concentration in surface water for excessive algae growth is 0.5 mg/L. All samples analyzed for nitrate at site BLB1 (Bayou La Batre at Wintzell Avenue) were below detection limit of 0.3 mg/L. All samples analyzed for nitrate from site BLB2 (unnamed tributary to Bayou La Batre at Little River Road) were below detection limit or below the 0.5 mg/L nitrate criterion. Forty-three percent of analytical results from samples collected at site BLB3 (man-made channel of Carls Creek at Arnette Street) were below the detection limit, 43 percent were below the 0.5 mg/L nitrate criterion, and 14 percent exceeded the 0.5 mg/L criterion. Analytical results for samples collected at site BLB4 (natural channel of Carls Creek at Arnette Street) indicate that 57 percent are below the detection limit and 29 percent are below the 0.5 mg/L nitrate criterion, and 14 percent exceeded the 0.5 mg/L criterion.

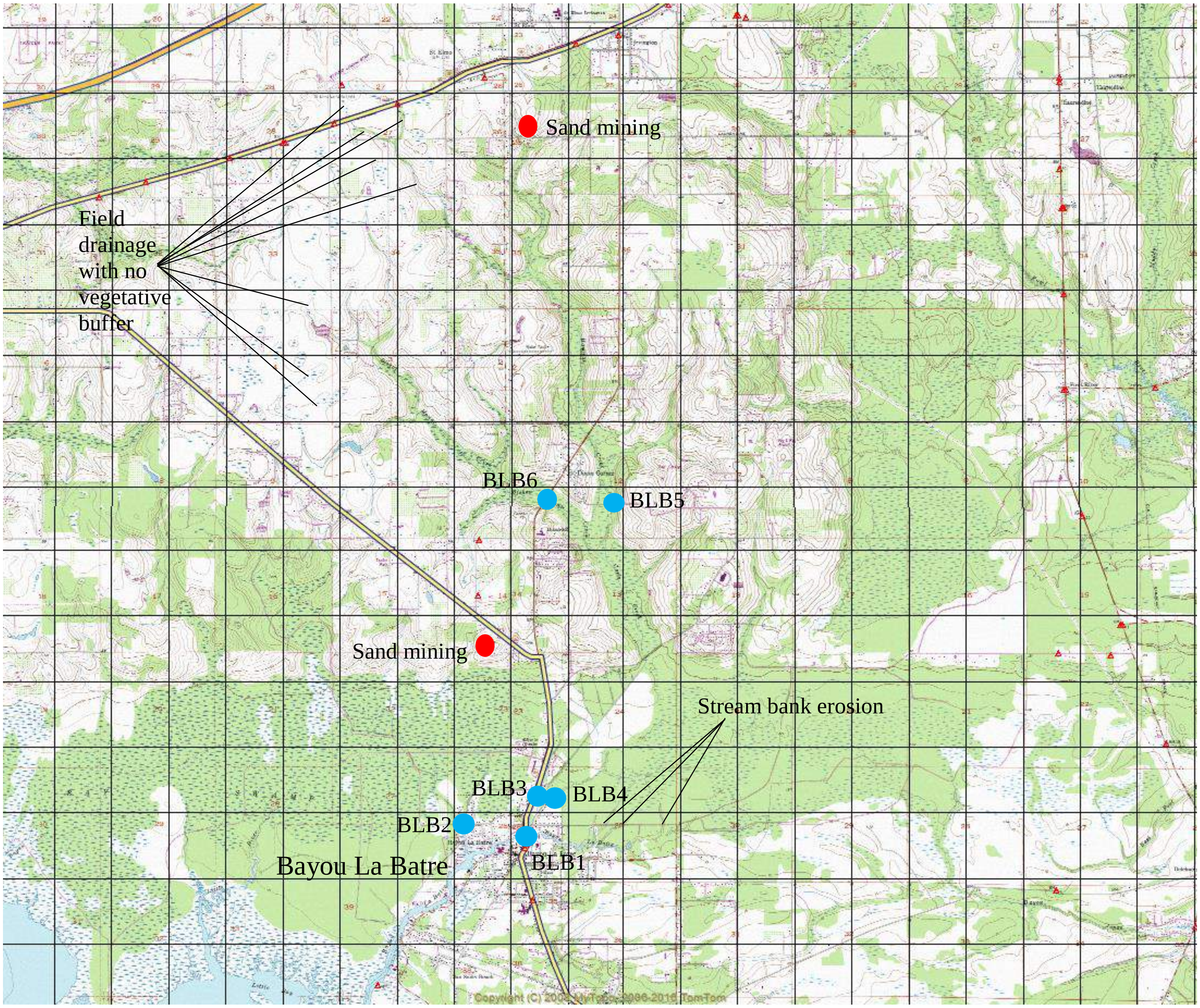

Figure 15.—Sources of water quality impacts identified by field observations.

Figure 16.—Turbid runoff from row-crop fields in unnamed tributary to Hammar Creek at Tom Waller Road immediately after a rain event.

Water samples collected at Bayou La Batre monitoring sites were also analyzed for total phosphorus. All samples collected at site BLB1 (Bayou La Batre at Wintzell Avenue) were below detection limit of 0.05 mg/L. All samples but one analyzed for total phosphorus from site BLB2 (unnamed tributary to Bayou La Batre at Little River Road) were below detection limit. One saline water sample collected in April 2016 had a total phosphorus concentration of 0.063 mg/L. All samples but one analyzed for total phosphorus from site BLB3 (man-made channel of Carls Creek at Arnette Street) were below detection limit. The sample collected during the largest discharge event for the monitoring period had a total phosphorus concentration of 0.398, which exceeded the 0.05 mg/L criterion. All samples analyzed for total phosphorus at site BLB4 (natural channel of Carls Creek at Arnette Street) were below detection limit of 0.05 mg/L.

This assessment indicates that the water quality in the Bayou La Batre watershed is relatively good, due primarily to the rural character of the watershed and land cover dominated by forest and wetlands. However, sediment loads are significantly larger than the geologic erosion rate. Therefore, steps should be taken to correct current impairments and to protect the watershed from future negative impacts that are common in streams in Alabama's coastal region, including urban expansion, timber cutting, poorly maintained agricultural fields, and conversion of agricultural and forest land to residential development. One of the primary targets of watershed protection should be preservation of wetlands and marsh in the Bayou La Batre watershed.

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APPENDIX A

FIELD AND ANALYTICAL DATA

Bayou La Batre at North Wintzel Avenue — Drainage area=23.2 square miles

Site	Date	Time	Discharge	Temp	Conductance	Turbidity	pH	DO	Salinity	TSS	Nitrate	Total Phosphorus
			cfs	°C	mS/cm	NTU		mg/L		mg/L	mg/L	mg/L
BLB1	01/13/16	9:05	439		22,100	8	6.4		13.2	10.4	<0.3	<.05
BLB1	01/21/16	22:40	668		16,700	15	6.0		10	22.0	<0.3	<.05
BLB1	02/15/16	20:45	1,031	15.1	20,800	21	7.3	8.3	12.4	12.0	<0.3	<.05
BLB1	03/11/16	14:10	1,937	19.7	2,650	58	6.9	7.1	1.4	31.2	<0.3	<.05
BLB1	03/28/16	11:15	1,362	21.0	101	25	5.9	7.5	0	6.0	<0.3	<.05
BLB1	04/01/16	14:45	1,473	21.2	709	44	6.5	6.9	0.3	13.6	<0.3	<.05
BLB1	05/31/16	18:10	1,008	28.1	20,100	14	6.9	7.8	12.0	14.0	<0.3	<.05

Unnamed Tributary to Bayou La Batre at Little River Road — Drainage area=4.7 square miles

Site	Date	Time	Discharge	Temp	Conductance	Turbidity	pH	DO	Salinity	TSS	Nitrate	Total Phosphorus
			cfs	°C	mS/cm	NTU		mg/L		mg/L	mg/L	mg/L
BLB2	01/13/16	8:45	130		18,300	8	6.0		11	10.0	<.3	<.05
BLB2	01/21/16	22:55	198		11,000	16	6.0		6.6	13.6	0.424	<.05
BLB2	02/15/16	21:00	230	15.1	21,700	35	7.0	8.2	13.0	16.8	<.3	<.05
BLB2	03/11/16	14:25	189	19.2	79	30	5.3	7.4	0.0	11.6	<.3	<.05
BLB2	03/28/16	11:30	110	20.9	42	13	4.6	7.5	0.0	7.0	<.3	<.05
BLB2	04/01/16	14:55	150	20.8	52	22	5.5	6.4	0.0	8.4	<.3	<.05
BLB2	05/31/16	18:30	129	29.1	18,700	16	6.7	7.0	11.1	15.2	<.3	0.063

Carls Creek at Arnette Street (man-made channel) — Drainage area=17.8

Site	Date	Time	Discharge	Temp	Conductance	Turbidity	pH	DO	Salinity	TSS	Nitrate	Total Phosphorus
			cfs	°C	mS/cm	NTU		mg/L		mg/L	mg/L	mg/L
BLB3	01/13/16	8:20	10.3		111	16	5.5		0.07	2	0.399	<.05
BLB3	01/21/16	23:10	444		243	122	6.8		0.1	100.0	0.327	0.398
BLB3	02/15/16	21:15	115	14.9	498	44	6.4	7.4	0.2	18.8	0.559	<.05
BLB3	03/11/16	14:30	180	19.3	39	67	6.4	7.1	0	46.0	<.3	<.05
BLB3	03/28/16	11:40	35	21.0	45	21	6.0	9.8	0	6.0	<.3	<.05
BLB3	04/01/16	15:05	114	20.8	45	48	6.3	6.5	0	18.8	<.3	<.05
BLB3	05/31/16	18:45	17	25.6	630	10	4.3	6.4	0.2	2.0	0.315	<.05

Unnamed Tributary to Bayou La Batre at Arnette Street (natural channel) — Drainage area=2.9 square miles

Site	Date	Time	Discharge	Temp	Conductance	Turbidity	pH	DO	Salinity	TSS	Nitrate	Total Phosphorus
			cfs	°C	mS/cm	NTU		mg/L		mg/L	mg/L	mg/L
BLB4	01/13/16	8:30	17		112	6	5.6		0.07	2	0.356	<.05
BLB4	01/21/16	23:20	281		1,690	10	5.6		1	6.4	<.3	<.05
BLB4	02/15/16	21:20	75	14.7	110	20	6.4	7.5	0.1	5.6	0.558	<.05
BLB4	03/11/16	14:35	270	19.2	37	42	6.1	7.3	0	26.4	<.3	<.05
BLB4	03/28/16	11:50	205	20.9	42	32	6.3	7.6	0	8.4	<.3	<.05
BLB4	04/01/16	15:15	230	20.9	45	35	6.4	7.1	0	10.8	<.3	<.05
BLB4	05/31/16	18:55	39	25.2	680	5	4.6	8.3	0.3	2.0	0.308	<.05

BLB 5 Hammar Creek at 3 mile road

Site	Date	Time	Discharge	Temp	Conductance	Turbidity	pH	DO	Salinity	TSS	Nitrate	Total Phosphorus
			cfs	°C	mS/cm	NTU		mg/L		mg/L	mg/L	mg/L
BLB5	8/3/2016	1630	55	25.1	79	44	5.6	4.7	0	24.0	0.509	<.05

Bishop Manor Creek at Argyle Road

Site	Date	Time	Discharge	Temp	Conductance	Turbidity	pH	DO	Salinity	TSS	Nitrate	Total Phosphorus
			cfs	°C	mS/cm	NTU		mg/L		mg/L	mg/L	mg/L
BLB6	8/3/2016	1650	28	25.2	46	114	6.0	5.2	0	50.0	<.3	0.116

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APPENDIX E GRANT INFORMATION

Federal/State			
Clearinghouse for Federal Grant Opportunities (Grants.gov)	Grants.gov Contact Center Phone: 1-800-518-4726 24 hours/day,7days/week	Administered by the U.S. Department of Health and Human Services, Grants.gov is a central storehouse for information on over 1,000 grant programs and provides access to approximately $500 billion in annual awards. This site also includes information about project funding that is available under the American Recovery and Reinvestment Act. www.grants.gov,	
EPA Catalog of Federal Funding Sources for Watershed Protection	N/A	The Catalog of Federal Funding Sources for Watershed Protection Web site is a searchable database of financial assistance sources (grants, loans, and cost-sharing) available to fund a variety of watershed protection projects. https://ofmpub.epa.gov/apex/watershedfunding/f?p=fedfund:1	
EPA Clean Water and Drinking State Revolving Loan/Grants Funds	James Dailey ADEM P.O. Box 301463 Montgomery, AL 36130 1-334-271-7805 Email: jwd@adem.state.al.us http://water.epa.gov/grants_funding /cwsrf /cwsrf_index.cfm	The Clean Water State Revolving Fund and the Drinking Water State Revolving Funds (SRF) are low-interest loan programs intended to finance public water and wastewater infrastructure improvements in Alabama. ADEM administers these funds for EPA, performs the required technical/environmental reviews of projects, and disburses funds to recipients. States establish limits for project awards; there is no statutory limit. www.adem.state.al.us/ www.adem.state.al.us/programs/water/srf.cnt	August - December
EPA Five-Star Restoration Program Grants	Lindsay Vacek lindsay.vacek@nfwf.org Coordinator, Eastern Partnership Office Add phone number	This program provides challenge grants, technical support and opportunities for information exchange to enable community-based projects that restore wetlands and streams. Grant awards typically range from $5,000 to $20,000. www.epa.gov/wetlands/restore/5star and www.epa.gov/water/funding.html (List of funding and financing resources)	November – February

Funding Program	Contact	Description	Grant Application Date
EPA Non-Point Source Grant Program (Clean Water Act Section 319)	Susan Dingman, Chief Nonpoint Source Unit Office of External Affairs Alabama Department of Environmental Management Telephone (334) 394-4354 E-mail: sdingman@adem.state.al.us	Through its 319 program, EPA provides formula grants to the states and tribes to implement nonpoint source projects and programs in accordance with Section 319 of the Clean Water Act (CWA). Nonpoint source pollution reduction projects can be used to protect source water areas and the general quality of water resources in a watershed. Examples of previously funded projects include the design and implementation of BMP systems for stream, lake and estuary watersheds. Grant awards vary by State. http://adem.alabama.gov/programs/water/nps/319grant.cnt	April-May
EPA Wetlands Program Development Grants (State-Tribal-Local Governments and State Universities only)	Contact Region 4 EPA office Phone: 404-562-9393 E-mail: Geryl Ricks (ricks.geryl@epa.gov)	The EPA Wetland Program Development Grants are intended to encourage comprehensive wetlands program development by promoting the coordination and acceleration of research, investigations, experiments, training, demonstrations, surveys, and studies relating to the causes, effects, extent, prevention, reduction, and elimination of water pollution. Projects build the capacity of states, tribes, and local governments to effectively protect wetland and riparian resources. Projects funded under this program support the initial development of a wetlands protection, restoration or management program or support the enhancement/refinement of an existing program. www.epa.gov/owow/wetlands/grantguidelines/	Deadlines are determined annually and vary from region to region.
Mitigation Grant Program	Mitigation Officer and local government official(s) for specific details	The Federal Emergency Management Agency Hazard Mitigation Grant Program (HMGP) provides states and communities with resources to invest in long-term actions that help to reduce the toll from potential natural and manmade hazards. The program also supports the implementation of mitigation measures during the immediate recovery from a disaster. The HMGP funds projects to protect either public or private property, as long as the project fits within the overall mitigation strategy of the state and/or local government and complies with program guidelines. In response to flood hazards, eligible projects include the elevation, relocation or acquisition and demolition of flood-prone structures, stormwater management projects and certain types of minor flood control projects. The state is responsible for setting priorities for funding and administering the HMGP. http://www.fema.gov/hazard-mitigation-assistance	
NOAA Coastal Services Center Cooperative Agreements	James L. Free U.S. Department of Commerce National Oceanic and Atmospheric Administration Services Center 2234 South Hobson Avenue Charleston, SC 29405-2413 843-740-1185	The National Oceanic and Atmospheric Administration (NOAA) guides the conservation and management of coastal resources through a variety of mechanisms, including collaboration with the coastal resource management programs of the nation's states and territories. The mission of the NOAA Coastal Services Center is to support the environmental, social, and economic well-being of the coast by linking people, information, and technology. The vision of the NOAA Coastal Services Center is to be the most useful government organization to those who manage and care for our nation's coasts. $4.65 Million (est.) http://www.noaa.gov/	Varies by state. Consolidated state CZMA program applications are provided to NOAA in March through May.
NOAA Coastal Zone Management Administration Awards	U.S. Department of Commerce National Oceanic and Atmospheric Administration	The program assists states in implementing and enhancing Coastal Zone Management programs that have been approved by the Secretary of Commerce. Funds are available for projects in areas such as coastal wetlands management and protection, natural hazards management, public access	Varies depending on opportunity.

	National Ocean Service, Office for Coastal Management 2234 South Hobson Ave. Charleston, SC 29405-2413 (301) 713-3155 Joelle.gore @noaa.gov www.coast.noaa.gov or www.coast.noaa.gov/czm/	improvements, reduction of marine debris, assessment of impacts of coastal growth and development, special area management planning, regional management issues, and demonstration projects with potential to improve coastal zone management.www.coastalmanagement.noaa.gov	
Coastal and Marine Habitat Restoration Grants	Melanie Gange U.S. Department of Commerce National Oceanic and Atmospheric Administration Office of Habitat Conservation, HC-3 1315 East-West Highway Silver Spring, MD 20910 301-713-01714 Melanie.Gange@noaa.gov http://www.habitat.noaa.gov/funding/index.html	The principal objective of the National Marine Fisheries Service's (NMFS) Coastal and Marine Habitat Restoration Project solicitation is to identify and support proactive restoration project(s), which use a habitat-based approach to foster species recovery and increase fish production. Proposals submitted under this solicitation will be selected based on their ability to demonstrate how the proposed habitat restoration actions will help recover threatened and endangered species listed under the Endangered Species Act, sustain or help rebuild fish stocks managed under the Magnuson-Stevens Fishery Conservation and Management Act, or benefit other coastal and marine species with a nexus to NMFS management. Successful proposals will 1) identify a habitat-based issue/concern limiting the recovery or sustainability of one or more target species (e.g. fish marine mammals, sea turtles); 2) identify the project(s)' goal(s) and describe in detail the actions and on-the-ground habitat restoration project(s) to be undertaken to resolve the issue/concern and; 3) describe the measurable impact on the target species, including evaluation techniques.	Every three years. Anticipated in fall 2015.
NOAA Estuary Habitat Restoration Project Funding	http://www.era.noaa.gov/information/funding.html	The Estuary Restoration Act (ERA) Council seeks projects that achieve cost effective restoration while promoting partnerships among agencies and between public and private sectors. Eligible habitat restoration activities may include (but are not limited to) improvement of estuarine wetland tidal exchange or re-establishment of historic hydrology; dam or berm removal; improvement or reestablishment of fish passage; appropriate reef/substrate/habitat creation; planting of native estuarine wetland and submerged aquatic vegetation; reintroduction of native species; control of invasive species; and establishment of riparian buffer zones in the estuary. Projects will be evaluated for their support of the Estuary Habitat Restoration Strategy. Awarded proposal may be funded by any of the five ERA agencies, depending on annual appropriated ERA funds. http://noaa.gov	No Funding could come at a later date
Engineers Aquatic Ecosystem Restoration (CAP Section 206)	Todd Boatman Mobile District Office 216-694-4101 Go to www.usace.army.mil; look for your state and district to find your local contact person.	Work done under this authority may carry out aquatic ecosystem restoration projects that will improve the quality of the environment, are in the public interest, and are cost-effective. There is no requirement that an existing Corps project be involved. The median grant awarded under this program is $300,000. A ceiling of $5,000,000 is established for each project. http://www.usace.army.mil/	None
U.S. Army Corps of Engineers Emergency Streambank and Shoreline Protection (Section 14)	Todd Boatman Mobile District Office 251-694-4101	Section 14 of the 1946 Flood Control Act provides authority for the Corps of Engineers to develop and construct emergency streambank and shoreline protection projects to prevent erosion damages to endangered highways, highway bridge approaches, public work facilities such as water and sewer lines,	Check with your local US Army Corp of Engineers for funding information

		churches, public and private non- profit schools and hospitals, and other non-profit public facilities. Each project is limited to a Federal cost of $1,000,000. http://www.sam.usace.army.mil/pd/custguide/custguide.htm	
U.S. Army Corps of Engineers Environmental Infrastructure Program (Section 219)	Todd Boatman Mobile District Office 251-694-4101	Section 219 of the Water Resources Development Act of 1992 provides authority for the Corps of Engineers to assist non-Federal interests carry out water-related environmental infrastructure and resource protection and development projects. Such assistance may be in the form of technical planning, design assistance, and construction assistance. http://www.sam.usace.army.mil	Check with your local US Army Corp of Engineers for funding information
U.S. Army Corps of Engineers General Investigation Study	Todd Boatman Mobile District Office 251-694-4101	Authority for the study must be provided by a specific Congressional resolution or identified in a Water Resources Development Act. The Congressional authority determines the purpose and scope of the study. Funds to conduct the study must be specifically identified for that purpose in an Appropriations Act. Studies could lead to recommendations for construction of a Corps construction project. http://www.sam.usace.army.mil	
Engineers Planning Assistance to the States (Section 22)	Todd Boatman Mobile District Office 251-694-4101	Section 22 of the Water Resources Development Act of 1974 provides authority for the Corps of Engineers to assist the States, local governments, and other non-Federal entities in the preparation of comprehensive plans for the development, utilization, and conservation of water and related land. Federal allotments for each State are limited to 500,000 annually, but are typically much less. Typical cost of an individual study is $25,000 to $75,000. The studies generally involve the analysis of existing data for planning purposes using standard engineering techniques, although some data collection is often necessary. Most studies become the basis for State and local planning decisions and can lead to a project under Section 206 or a congressionally authorized project in a future Water Resources Development Act. http://www.sam.usace.army.mil	
U.S. Army Corps of Engineers Small Flood Damage Reduction Projects (CAP Section 205)	Todd Boatman Mobile district Office 251-694-4101 U.S. Army Corps of Engineers 202-761-7763 internet www.usace.army.mil	Work under this authority provides for local protection from flooding by the construction or improvements of structural flood damage reduction features such as levees, channels and dams. Non-structural alternatives are also considered and may include measures such as installation of flood warning systems, raising and/or flood proofing of structures, and relocation of flood prone facilities. http://www.sam.usace.army.mil/pd/custguide/custguide.htm	none
USDA Forest Service Urban and Community Forestry Challenge Cost-Share Grants	Nancy Stremple Urban and Community Forestry Staff, Mail Stop 1151 USDA Forestry Service 1400 Independence Avenue, S.W. Washington, DC 20250-1151 202-205-7829	The U.S. Forest Service Urban and Community Forestry Grant Program seeks to establish sustainable urban and community forests by encouraging communities to manage and protect their natural resources. The program works to achieve a number of goals, including (1) effectively communicating information about the social, economic, and ecological values of urban forests; (2) involving diverse resource professionals in urban and community forestry issues; and (3)	Pre-proposals must be posted to Grants.gov or courier hard copies received by 11:59 PM Eastern, November 23 Pre-proposals selected for full proposals will be (tentatively) due by

	nstremple@fs.fed.us	supporting a holistic view of urban and community forestry. In particular, the program supports an ecosystem approach to managing urban forests for their benefits to air quality, stormwater runoff, wildlife and fish habitat, and other related ecosystem concerns. The Forest Service awards these grants based on recommendations made by the National Urban and Community Forestry Advisory Council, a 15-member advisory council created by the 1990 Farm Bill to provide advice to the Secretary of Agriculture on urban and community forestry. http://www.fs.fed.us/ucf/nucfac.shtml	11:59 PM Eastern, March 15 The U.S. Forest Service anticipates that the statutory authority (Sub Title 9 of the Cooperative Forestry Assistance Act) for the Fiscal Year 2016 Urban and Community Forestry (U&CF) Program may provide, approximately $900,000 ($300,000 per category) in grant funds to be awarded through the 2016 National Urban and Community Forestry Challenge Cost-Share Grant Program. Funds are to support national urban and community forestry projects on nonfederal public land that have a national or multi-state impact and application. All awards are based on the availability of funding, which may be subject to change. Eligible Applicants: Any U.S. non-Federal organization and Tribal agencies, operating within the United States or its territories, may apply for the Challenge Cost-Share grant. While collaboration with Federal agencies is encouraged, a Federal agency may not receive funding or be used as match to the Federal funds being requested. Individuals and private land are not eligible. The Forest Service will address any conflicts of interest. Not Eligible: If an entity has a local/State tree-planting projects, capital improvements to property of any ownership, and/or projects that have only a local impact and applicability are not eligible and they
USDA Natural Resources Conservation Service (NRCS) Emergency Watershed Protection Program	Contact your local USDA Service Center. For a list, see www.usda.gov/offices.html. Click on the County Office Locator	The USDA NRCS Emergency Watershed Protection (EWP) program helps protect lives and property threatened by natural disasters such as floods, hurricanes, tornadoes, droughts, and wildfires. EWP provides funding for such work as clearing debris from clogged waterways, restoring vegetation, and stabilizing river banks. The measures that are taken must be environmentally and economically sound and generally benefit more than one property owner. EWP also provides funds to purchase floodplain easements as an emergency measure. Floodplain easements restore, protect, maintain, and enhance the functions of the floodplain; conserve natural values including fish and wildlife habitat, water quality, flood water retention, ground water recharge, and open space; reduce long-term federal disaster assistance; and safeguard lives and property from floods drought and the products of erosion. EWP can provide up to 90 percent cost share in limited resource areas as determined by the U.S. Census. www.nrcs.usda.gov/programs/ewp	Funds are issued on an emergency basis only. The sponsor has 60 days to request assistance from the time of an emergency declaration

USDA Natural Resources Conservation Service (NRCS) Watershed Rehabilitation Program	National Watershed Rehabilitation Contact: Lorenzo Henderson Watershed Rehabilitation Specialist USDA Natural Resources Conservation Service 14th and Independence Ave. SW, Room 6021-S Washington D.C. 20250 Telephone: 202-205-4098 Lorenzo.henderson@wdc.usda.gov	This program provides Federal cost-share funding for the rehabilitation of aging dams that were installed primarily through the Watershed Protection and Flood Prevention Program over the past 55 years. The purpose for rehabilitation is to extend the service life of dams and bring them into compliance with applicable safety and performance standards or to decommission the dams so they no longer pose a threat to life and property. As of January 2013, there are 202 approved rehabilitation projects in 25 states. One hundred and twenty-one of these projects in 20 states have been completed; 50 projects in 12 states are being implemented (either in design or construction phase0; and 31 projects in 12 states are in the planning stage. It also includes case studies of rehabilitation projects in Georgia, Oklahoma, Texas, and Virginia www.nrcs.usda.gov/programs/WSRehab	Applications may be submitted anytime during the year
U.S. Department of Transportation Federal Highway Administration National Scenic Byways Discretionary Grant program	Collette E. Boehm Special Projects Director Alabama's Coastal Connection P.O. Drawer 457, 900 Commerce loop (36542)Gulf Shores, AL 36547 251-974-4632 cboehm@gulfshores.com Cindi Ptak National Scenic Byways Program Manager 202-366-1586	To implement projects on roads designated as national Scenic Byways or All American Roads, State scenic byways, or Indian tribe scenic byways. Eligible projects must be from one of the following eight eligible activities: State or Indian tribe Scenic Byway Programs, Corridor Management Plans, Safety Improvements, Byways Facilities, Access to Recreation, Resource Protection, Interpretive Information or marketing. Alabama's Coastal Connection is a designated Scenic Byway. http://www.bywaysonline.org/grants	Check Website for funding.
U.S. Fish and Wildlife Service Coastal Program	Patric Harper Northern Gulf Coastal Program Coordinator Phone: 228-475-0765 x 105 E-mail: Patric_Harper@fws.gov	The U.S. Fish and Wildlife Service Coastal Program works to conserve healthy Coastal habitats on public or private land for the benefit of fish, wildlife, and people in 22 specific coastal areas. The program forms cooperative partnerships designed to (1) protect coastal habitats by providing technical assistance for conservation easements and acquisitions: (2) restore coastal wetlands, uplands, and riparian areas: and (3) remove barriers to fish passage in coastal watersheds and estuaries. Program biologists provide restoration expertise and financial assistance to federal and state agencies, local and tribal governments, businesses, private landowners and conservation organizations such as local land trusts and watershed councils. http://www.fws.gov/coastal/ : http://www.fws.gov/daphne	Check with the individual Coastal Program location
U.S. Fish and Wildlife Service Landowner Incentive Program	Contact the state Fish and Wildlife office directly. See web site link at right.	The U.S. Fish and Wildlife Service Landowner Incentive Program (LIP) grant program provides competitive matching grants to states to establish or supplement landowner incentive programs. These programs provide technical and financial assistance to private landowners for projects that protect and	

		restore habitats of listed species or species determined to be at-risk. LIP projects involve activities such as the restoration of marginal farmlands to wetlands, the removal of exotic plants to restore natural prairies, a change in grazing practices and fencing to enhance important riparian habitats, instream structural improvements to benefit aquatic species, road closures to protect habitats and reduce harassment of wildlife, and acquisition of conservation easements. Although not directly eligible for these funds, third parties such as nonprofit organizations may benefit from these funds by working directly with their states to see if either grants or partnering opportunities are available. http://wsfrprograms.fws.gov/Subpages/GrantPrograms/LIP/LIP.htm	
U.S. Fish and Wildlife Service North American Wetlands Conservation Act Grants Program	http://www.fws.gov/birds/grants/north-american-wetland-conservation-act.php U.S. Department of the Interior U.S. Fish and Wildlife Service North American Waterfowl and Wetlands Office (NAWWO) 4401 North Fairfax Drive, Room 110, Arlington, VA 22203 (703) 358-1784 Email dbhc@fws.gov Internet http://birdhabitat.fws.gov	The U.S. Fish and Wildlife Service Division of Bird Habitat Conservation administers this matching grants program to carry out wetlands and associated uplands conservation projects in the United States, Canada, and Mexico. Grant requests must be matched by a partnership with nonfederal funds at a minimum 1:1 ratio. Conservation activities supported by the Act in the United States and Canada include habitat protection, restoration, and enhancement. Project proposals must meet certain biological criteria established under the Act. http://birdhabitat.fws.gov; www.cfda.gov	July
U.S. Fish and Wildlife Service Partners for Fish and Wildlife Program	U.S. Fish and Wildlife Service Branch of Habitat Restoration Division of Fish and Wildlife management and Habitat Restoration 4401 North Fairfax Drive Room 400 Arlington, VA 22203 703-358-2031	The Partners for Fish and Wildlife Program provides technical and financial assistance to private landowners to restore fish and wildlife habitats on their lands. Since 1987, the program has partnered with more than 37,700 landowners to restore 765,400 acres of wetlands; over 1.9 million acres of grasslands and other upland habitats: and 6,560 miles of in-stream and streamside habitat. In addition, the program has reopened stream habitat for fish and other aquatic species by removing barriers to passage. www.fws.gov/partners	No deadline. Check Website for funding
U.S. Housing and Urban Development Community Development Block Grants (CDBG)	Community Development Block Grants/Entitlement Grants Contact your state's CDBG grantees)	The objective of this program is to develop viable urban communities, by providing decent housing and a suitable living environment, and by expanding economic opportunities, principally for persons of low and moderate income. Recipients may undertake a wide range of activities directed toward neighborhood revitalization, economic development and provision of improved community facilities and services. http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/communitydevelopment/programs	For formula grants, no earlier than November 15 or no later than August 16 of the fiscal year for which the funds are allocated
Environmental Solutions for Communities	National Fish and Wildlife Fouwww.nfwf.org National Fish and Wildlife Foundation	In 2012, Wells Fargo and the National Fish and Wildlife Foundation launched the Environmental Solutions for Communities initiative, designed to support projects that link economic development and community well-being to the stewardship and health of the environment. This 5-year initiative is supported	December

	1133 15th Street NW, Suite 1100 Washington, DC 20005 Primary Telephone 202-595-2471 Primary Email Carrie.Clingan@nfwf.org	through a $15 million contribution from Wells Fargo that will be used to leverage other public and private investments with an expected total impact of over $37.5 million. Funding priorities for this program include: (1) supporting sustainable agricultural practices and private lands stewardship; (2) conserving critical land and water resources and improving local water quality (3) restoring and managing natural habitat species and ecosystems that are important to community livelihoods; (4) facilitating investments in green infrastructure, renewable energy and energy efficiency; and (5) encouraging broad-based citizen participation in project implementation. www.nfwf.org	
Conservation Partners	U.S. Department of Agriculture's natural Resources Conservation Service National Fish and Wildlife Foundation Other regional/specific partners	Conservation Partners is a partnership between the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) (www.nrcs.usda.gov), the National Fish and Wildlife Foundation (NFWF) (www.nfwf.ortg), and other regional/initiative specific partners. The purpose of this program is to provide grants on a competitive basis to support field biologist and other habitat conservation professionals (ecologists, foresters, range cons, etc.) working with NRCS field offices in providing technical assistance to farmers, ranchers, foresters and other private landowners to optimize wildlife habitat conservation on private lands. Conservation Partners aims to better focus and increase the effectiveness of Farm Bill assistance funded through programs such as Wildlife Habitat Incentives Program (WHIP), Environmental Quality Incentives Program (EQIP), Conservation Reserve Program (CRP) and others. In addition, Conservation Partners will consider funding capacity and outreach for organizations whose mission matches the goals of this program. www.nfwf.org/ConservationPartners	Multiple funding opportunities are available Throughout the year. All applications must be submitted online through the Easygrants application system.
Marine Debris Fishing for Energy Fund	National Fish and Wildlife Foundation	The Fishing for Energy Fund is a partnership between the NOAA Marine Debris Program, Covanta Energy Corporation and National Fish and Wildlife Foundation to provide grants on a variety of proposal topics to support public outreach and prevention strategies to reduce the impacts of derelict fishing gear to the marine and coastal environments. The Program supports projects that proactively engage the fishing community and state managers in developing prevention strategies to address derelict fishing gear. www.nfwf.org www.nfwf.org/fishingforenergy	Application Deadline: October

National Wildlife Refuge Friends Group Grant Program	National Fish and Wildlife Foundation National Fish and Wildlife Foundation 1133 15th Street, NW Suite 1100 Washington, DC 20005 Telephone (202) 857-0166 teal.edelen@nfwf.org www.nfwf.org	The National Fish and Wildlife Foundation provides grants for projects that help organizations to be effective co-stewards of our nation's important natural resources within the national Wildlife Refuge System. This program provides competitive seed grants to help increase the number and effectiveness of organizations interested in assisting the refuge system nationwide. The program will fund: (1) Start-up Grants to assist starting refuge support groups with formative and/or initial operational support (membership drives, training, postage, etc.); (2) Capacity Building Grants to strengthen existing refuge support groups' capacity to be more effective (outreach efforts, strategic planning, membership development) and (3) Project Specific Grants to support a specific project (conservation education programs for local schools, outreach programs for private landowners, habitat restoration projects, etc.) www.nfwf.org	See Website
Pulling Together Initiative	National Fish and Wildlife www.nfwf.org National Fish and Wildlife Foundation, 1133 15th Street, NW, Suite 1100, Washington, DC 20005 teal.edelen@nfwf.org	The National Fish and Wildlife Foundation's Pulling Together Initiative (PTI) provides a means for federal agencies to partner with state and local agencies, private landowners, and other interested parties to develop long-term weed management projects within the scope of an integrated pest management strategy. The goals of PTI are: (1) to prevent, manage, or eradicate invasive and noxious plants through a coordinated program of public/private partnerships; and (2) to increase public awareness of the adverse impacts of invasive and noxious plants. PTI provides support on a competitive basis for the formation of local weed management area (WMA) partnerships, allowing them to demonstrate successful collaborative efforts and develop permanent funding sources for the maintenance of WMAs from the involved parties. Successful projects will serve to increase public awareness and interest in future partnership projects. www.nfwf.org	Pre Proposal Due August 3 Full Proposal Due Sept. 30
Shell Marine Habitat Program	National Fish and Wildlife Foundation National Fish and Wildlife Foundation 1133 15th Street, NW, Suite 1100 Washington, DC 20005 Telephone 202-857-0166 lSuzanne.Sessine@nfwf.org	The Shell marine Habitat Program is a partnership between the Shell Oil Company and the National Fish and Wildlife Foundation (NFWF). The purpose of this partnership is to provide grants for projects that benefit marine and coastal habitats in and around the Gulf of Mexico, as well as the North Aleutian Basin, North Slope Borough, and Northwest Arctic Borough areas of Alaska. The National Oceanic and the Atmospheric Administration recently joined Shell and NFWF in their efforts to support projects that benefit the habitat for living marine resources in the Gulf of Mexico. www.nfwf.org	April or May annually; Full proposals invited forward are due June-July; only electronic preproposals submitted through the on-line application system will be considered
Southern Company Power of Flight Program	National Fish and Wildlife Foundation National Fish and Wildlife Foundation 1133 15th Street, NW, Suite 1100 Washington, DC 20005 202-857-0166 x2479 heather.fox@nfwf.org	Through the Southern Company Power of Flight program, a minimum of $600,000 is available annually to fund bird conservation projects within the Southern Company service area of Georgia, Alabama, northwestern Florida, and southeastern Mississippi. www.nfwf.org	March

National Sea Grant College Program	National Oceanic and Atmospheric Administration U.S. Department of Commerce National Oceanic and Atmospheric Administration National Sea Grant College Program, ATTN:Dorn Carlson, Research Director 1315 East-West Highway Silver Spring, MD 20910 (301) 734-1080 dorn.carlson@noaa.gov	The National Sea Grant College Program encourages the wise use and stewardship of marine and coastal environmental resources through research, education, outreach and technology transfer. Sea Grant works in partnership between the nation's universities and the National Oceanic and Atmospheric Administration. There are 33 Sea Grant Programs in every coastal and Great Lakes state, Puerto Rico, Lake Champlain and Guam. Sea Grant serves as a bridge between government academia, industry, scientists and private citizens to promote the sustainable use of Great Lakes and ocean waters for long-term economic growth. Funding opportunities are available through national-and state-level competitions. (Click on the program name and refer to the link listed under "primary Internet" for information on national-level competitions and links to all state Sea Grant Program offices) http://seagrant.oarhq.noaa.gov/Home.aspx	Full proposals due June 8 Notification of funding decisions September 7 Meetings with funded PIs to develop outreach plans Mid-Sept. Project initiation February 1
Community-based Marine Debris Prevention and Removal Grants	National Oceanic and Atmospheric Administration marinedebris.web@noaa.gov Asma Mahdi asma.mahdi@noaa.gov Nancy Wallace, Director nancy.wallace@noaa.gov	The NOAA Marine Debris Program (MDP) provides funding to catalyze the implementation of locally driven, community-based marine debris prevention, assessment, and removal projects that benefit coastal habitat, waterways, and NOAA trust resources. The primary priorities for removal are large-scale debris, derelict fishing gear, derelict vessels, tsunami debris clean-ups and targeted shoreline and watershed projects. Projects funded through the MDP have strong on-the-ground habitat components and provide long-term ecological habitat improvements for NOAA trust resources, and provide educational and social benefits for people and their communities. http://marinedebris.noaa.gov/funding/funding-opportunities	NOW OPEN: The NOAA Marine Debris Program is proud to announce the FY2016 Community-based Marine Debris Removal Federal Funding Opportunity. This application is open until Nov 2, 2015. To apply and for the complete details, visit Grants.gov (link is external).
Beneficial Uses of Dredged Material (CAP Section 204)	U.S. Army Corps of Engineers Go to www.usace.army.mil Look for your state and district to find your local contact.	Work under this authority provides for the use of dredged material from new or existing Federal projects to protect, restore, or create aquatic and ecologically related habitats, including wetlands. www.usace.army.mil	None
Project Modifications for Improvement of the Environment (CAP Section 1135)	U.S. Army Corps of Engineers See www.usace.army.mil; find your state and district to identify your local contact person U.S. Army Corps of Engineers Telephone 202-761-7763	Work under this authority provides for modifications in the structures and operations of water resources projects constructed by the Corps of Engineers to improve the quality of the environment. Additionally, the Corps may undertake restoration projects at locations where an existing Corps project has contributed to the degradation. The primary goal of these projects is ecosystem restoration with an emphasis on projects benefiting fish and wildlife. The project must be consistent with the authorized purposes of the project being modified, environmentally acceptable, and complete within itself.	None
Sustainable Agriculture Research and Education	U.S. Department of Agriculture 1400 Independenc Ave., SW, Stop 2240	The Sustainable Agriculture Research and Education (SARE) program of the U.S. Department of Agriculture National Institute of Food and Agriculture (NIFA) works to advance farming systems that are productive, profitable,	Research and Education Grant March: Call for Pre-proposal released June: Pre-proposals due

	Washington, DC 20250 (202) 720-5384 Email: rhedberg@nifa.usda.gov www.sare.org	environmentally sound and good for communities through a regional grants program. SARE funds research and extension activities to reduce the use of chemical pesticides, fertilizers, and toxic materials in agricultural production; to improve management of on-farm resources to enhance productivity, profitability, and competitiveness; to promote crop, livestock, and enterprise diversification and to facilitate the research of agricultural production systems in areas that possess various soil, climatic, and physical characteristics; to study farms that are managed using farm practices that optimize on-farm resources and conservation practices; and to promote partnerships among farmers, nonprofit organizations, agribusiness, and public and private research and extension institutions. Click on program name and check the link in the Primary Internet box for more information about grant opportunities and program results. http://www.southernsare.org/Grants/Apply-for-a-Grant www.sare.org	August: Selected pre-proposals invited to submit full proposals November: Full proposals due February: Grants awarded Large Systems Research Grant September: Call for Proposal released November: Proposals due February: Grants awarded Professional Development Program Grant March: Call for Pre-proposal released June: Pre-proposal due August: Selected pre-proposals invited to submit full proposals November: Full proposals due February: Grants awarded On-Farm Research Grant September: Call for Proposal released November: Proposal due March: Grants awarded Producer Grant September: Call for Proposal released November: Proposal due March: Grants awarded Sustainable Community Innovation Grant March: Call for Proposal released May: Proposal due July: Grants awarded Graduate Student Grant February: Call for Proposal released May: Proposal due September: Grants awarded
Land and Water Conservation Fund (Outdoor Recreation, Acquisition, Development and Planning Grants)	U S Department of Interior Alabama Director Department of Economic & Community Affairs 401 Adams Street, P.O. Box 5690 Montgomery, AL 36103-5690 Tel: 334-242-5090	To provide financial assistance to the States and their political subdivisions for the preparation of Statewide Comprehensive Outdoor recreation Plans (SCORPs) and acquisition and development of outdoor recreation areas and facilities for the general public, to meet current and future needs. www.nps.gov/lwcf http://www.adeca.alabama.gov/Divisions/ced/Recreation/Pages/Programs.aspx	Contact State Director

Pollution Prevention Grant Program	U.S. Environmental Protection Agency U.S. Environmental Protection Agency Office of Pollution Prevention and Toxic Substances Pollution Prevention Division (7409 M) 1200 Pennsylvania Ave., NW Washington, DC 20460 Telephone 202-564-8857 Email: amhaz.michele@epa.gov www.epa.gov/p2/pubs/grants/index.htm	The Pollution Prevention Grant program provides grants and cooperative agreements to state agencies, instrumentalities of a state and federally recognized tribes to implement pollution prevention projects that provide technical assistance to businesses. The program requires applicants to work towards reducing pollution, conserving energy and water, and saving dollars through P2 efforts; as identified in EPA's Strategic Plan under Goal 4: Ensuring Safety of Chemicals and Preventing Pollution, Objective 4.2: Promote Pollution Prevention http://www2.epa.gov/p2	May 14
Urban Waters Small Grants	U.S. Environmental Protection Agency Environmental Protection Agency Office of Water 1200 Pennsylvania Ave, NW 4101M Washington, DC 20460 202-566-0730 urbanwaters@epa.gov	EPA's Urban Waters Program protects and restores America's urban waterways. EPA's funding priority is to achieve the goals and commitments established in the Agency's Urban Waters Strategic Framework (www.epa.gov/urbanwaters/urban-waters-strategic-framework). This program has an emphasis on engaging communities with environmental justice concerns. The objective of the Urban Waters Small Grants is to fund projects that will foster a comprehensive understanding of local urban water issues, identify and address these issues at the local level, and educate and empower the community. In particular, the Urban Waters Small Grants seek to help restore and protect urban water quality and revitalize adjacent neighborhoods by engaging communities in activities that increase their connection to, understanding of, and stewardship of local urban waterways.	Grants are awarded every other year. Next awards will be funded FY 2016. The total anticipated award amount (combining funding years 2015/2016) is $1.6 million, with each individual award amount of up to $60K. CFDA Program 66.440
State Wildlife Grant Program (Non-Tribal and Non-Competitive)	U S Fish and Wildlife Service paul_vanryzin@fws.gov 404-679-4124	The U.S. Fish and Wildlife Service's (USFWS) State Wildlife Grant (SWG) program provides grants to states, territories, and the District of Columbia for wildlife conservation. The SWG program provides funds to help develop and implement programs that benefit wildlife and their habitat, including species that are not hunted or fished. Although not directly eligible for these grants, third parties such as nonprofit organizations may benefit from these funds by working directly with their states to see if either grants or partnering opportunities are available. http://wsfrprograms.fws.gov/Subpages/GrantPrograms/SWG/SWG_Funding.htm http://www.fws.gov/offices/Directory/ListOffices.cfm?statecode=1	No deadline. State fish and wildlife agencies may submit applications until all funds are obligated.
Cooperative Endangered Species Conservation Fund	U S Fish and Wildlife Service Region 4 - Southeast Chief, Endangered Species U.S. Fish and Wildlife Service 1875 Century Blvd., Suite 200 Atlanta, GA 30345 http://www.fws.gov/southeast/es/	The U.S. Fish and Wildlife Service's (USFWS) Cooperative Endangered Species Conservation Fund provides financial assistance to states and territories that have entered into cooperative agreements with the USFWS to assist in the development of programs for the conservation of endangered and threatened species. The assistance provided to the state or territorial wildlife agency can include animal, plant, and habitat surveys; research; planning; monitoring; habitat protection, restoration, management, and acquisition; and public education. The Fund is dispersed to the states and territories through four	Late Fall

		programs: Conservation Grants, Habitat Conservation Planning Assistance Grants, Habitat Conservation Plan Land Acquisition Grants, and Recovery Land Acquisition Grants. Although not directly eligible for these grants, third parties such as nonprofit organizations and local governments may work with their state or territorial wildlife agency to apply for these funds. http://www.fws.gov/endangered/grants/index.html	
North American Wetlands Conservation Act Grants Program	U.S. Fish and Wildlife Service U.S. Department of the Interior U.S. Fish and Wildlife Service North American Waterfowl and Wetlands Office (NAWWO) 4401 North Fairfax Drive, Room 110, Arlington, VA 22203 (703) 358-1784 dbhc@fws.gov	The U.S. Fish and Wildlife Service's Division of Bird Habitat conservation administers this matching grants program to carry out wetlands and associated uplands conservation projects in the United States, Canada, and Mexico. Grant requests must be matched by a partnership with nonfederal funds at a minimum 1:1 ratio. Conservation activities supported by the Act in the United States and Canada include habitat protection, restoration, and enhancement. Mexican partnerships may also develop training, educational, and management programs and conduct sustainable-use studies. Project proposals must meet certain biological criteria established under the Act. Visit the program web site for more information. http://birdhabitat.fws.gov	March 7 and August 27
U.S. Department of Interior Gulf of Mexico Energy Security Act (GOMESA)	Office of Minerals Management Services	The Gulf of Mexico Energy Security Act of 2006 (GOMESA) shares leasing revenues for the four Gulf oil and gas producing states of Alabama, Louisiana, Mississippi, and Texas, and to their coastal political subdivisions. GOMESA funds are to be used for coastal conservation, restoration, and hurricane protection. http://www.mms.gov/offshore/GOMESARevenueSharing.htm	
Bring Back the Natives Grant Program	Cara Rose National Fish and Wildlife Foundation Western Partnership Office 421 SW 6th Avenue Suite 950 Portland, OR 97204 Telephone 503-417-8700 x 6008 Cara.Rose@nfwf.org	The Bring Back the Natives initiative (BBN) funds on-the-ground efforts to restore native aquatic species to their historic range. Projects should involve partnerships between communities, agencies, private landowners, and organizations that seek to rehabilitate streamside and watershed habitats. Projects should focus on habitat needs of species such as fish, invertebrates, and amphibians that originally inhabited the waterways across the country. Funding for the BBN program is administered through NFWF from federal agencies cooperating to support this program. Cooperating agencies and organizations include the US Fish and Wildlife Service (FWS), Bureau of Land Management (BLM), USDA Forest Service (FS), and Trout Unlimited (TU). www.nfwf.org/bbn	Pre-proposal Due Date: January of each year; Full Proposal Due Date: March of each year
Forest Legacy Program	Southern Region -- Region 8 (AL, AR, FL, GA, KY, LA, MS, NC, OK, Mike Murphy U.S. Forest Service 1720 Peachtree Rd., N.W. Suite 700B North Atlanta, GA 30309 404-347-5214 (phone) mwmurphy@fs.fed.us	The 2014 Omnibus funds the Forest Legacy Program (FLP). The USDA Forest Service supports state efforts to protect environmentally important forest lands from the conversion to non-forest uses through the use of conservation easements and fee-simple purchase. Designed to encourage the protection of privately owned forest lands, FLP is an entirely voluntary program. The program enables landowners to retain ownership of their land and continue to earn income from it while keeping drinking water safe and clean, conserving valuable open space as well as protecting critical wildlife habitats and outdoor recreation opportunities. The program promotes professional forest management and requires forest management plans. The program emphasizes strategic conservation - working in partnership with States, local communities and non-	Applications are submitted to the State Lead Agency in each participating State. While some States have discrete open seasons others accept applications year-round. There are currently 53 participating States and Territories in FLP. A list of State and regional Forest Service contacts can be viewed at

		governmental organizations to make a difference on the land and for communities by conserving areas of unbroken forest, watershed or river corridor forests or by complimenting existing land conservation efforts. FLP conservation easements restrict development, protect a range of public values and many require public access for recreation. http://www.fs.fed.us/spf/coop/programs/loa/flp.shtml	
Non-Governmental Organization and Other Private Funding			
Chronicle of Philanthropy Guide to Grants	The Chronicle of Philanthropy 1255 Twenty-Third Street, N.W. Seventh Floor Washington, D.C. 20037 PHONE: 202-466-1200 FAX: 202-466-2078	The Guide to Grants is an electronic database of all foundation and corporate grants listed in The Chronicle since 1995. To search this database, users must purchase a subscription; subscription rates are available for terms ranging from one week to one year. http://philanthropy.com/section/Guide-to-Grants/270	
Community of Science Database (COS)	1 North Charles Street Suite 2305 Baltimore, MD 21201 PHONE: 410-563-2378 FAX: 410-563-5389	COS is the leading global resource for hard-to-find information critical to scientific research and other projects across all disciplines. The COS Funding Opportunities web site allows users to search more than 23,000 records, representing over 400,000 funding opportunities, worth over $33 billion. A subscription fee may be required, depending on the type of organization conducting a search. http://www.cos.com	
The Foundation Center	Contact may be made through the web site address shown in the column to the right.	The Foundation Center Foundation Finder allows users to search for basic information (contact information, web site address, and IRS 990 form) on 70,000 private and community foundations in the United States (free service). They also offer two subscription-based online searchable databases, the Foundation Director and Foundation Grants to Individuals. http://foundationcenter.org	
The Kodak American Greenways Program	The Conservation Fund 703-908-5809	Eastman Kodak Company, the National Geographic Society, and The Conservation Fund are the partners in the Kodak American Greenways Program, an annual program that recognizes outstanding individuals and organizations for exemplary leadership in the enhancement of our nation's outdoor heritage. The program was established in response to the recommendation from the President's Commission on Americans Outdoors that a national network of greenways be created. Since the program's inception in 1989, more than $800,000 has been granted to nearly 700 organizations in all 50 states. The program also provides small grants to land trusts, watershed organizations, local governments and others seeking to create or enhance greenways in communities throughout America. www.conservationfund.org/kodak_awards	
RBC Bank Blue Water Project Gran	Contact may be made through the web site address shown in the column to the right.	In 2013-2014, the RBC Blue Water Project will focus on supporting initiatives that help protect and preserve water in towns, cities and urbanized areas with populations of more than 10,000 people that focus on: Improved control and management of urban storm or rain water, Efficient and innovative use (or capture and reuse) of water in towns and cities, Protection and restoration of urban waterways ,Improved urban water quality http://www.rbc.com/donations/blue-water-apply.html	

Surdna Foundation Substainable Environments Grants	Surdna Foundation 330 Madison Avenue 30th Floor New York, NY 10017 212-557-0010 questions@surdna.org	The Surdna Foundation seeks to create just and sustainable communities where consumption and conservation are balanced and innovative solutions to environmental problems improve people's lives. The Foundation works from a sustainable development perspective to demonstrate that a healthy environment is the backbone of a healthy economy and a democratic society. They fund three key related priority areas-Climate Change, Green Economy, and Transportation and Smart Growth-that aim to transform how Americans work, consume and move. Grants are approved in February, May and September. www.surdna.org	
Water Environmental Research Foundation Werf Cooperative Agreement	Carrie Capuco Communications Director ccapuco@werf.org 571-384-2097	Funding for the research is through EPA's Aging Water Infrastructure Research Program, a research agenda that supports efforts to put the nation's aging infrastructure on a pathway toward sustainability. Research efforts will include treatment technologies for wastewater, stormwater, water reuse, and drinking water. The innovative tools and cost-effective solutions that will be developed through this research should provide assistance to municipalities in their ongoing efforts to serve the public and improve water quality. www.werf.org	
KaBOOM	http://kaboom.org/about_kaboom/pr o grams/grants	The Build It with KaBOOM! Playground Grant provides eligible communities with the majority of funds, tools and resources they need to build a custom-made playground – all in one day! Through this grant program, the majority of the playground funding for the project is provided by one of our generous Funding Partners. Selected groups, referred to as Community Partners, will work closely with a KaBOOM! Project Manager who will lead Design Day and Build Day activities as well as coordinate the equipment and material purchases for the project. Community members will take the lead in recruiting volunteers, securing food and tool donations and completing any necessary site preparation.	
The W.K. Kellogg Foundation	http://www.wkkf.org/who-we-are/overview	Over the years, the Kellogg Foundation's programming has continued to evolve, striving to remain innovative and responsive to the ever-changing needs of society. Today, the organization ranks among the world's largest private foundations, awarding grants in the United States, Mexico, Haiti, northeastern Brazil and southern Africa.	

APPENDIX F MOBILE BAY SUBWATERSHED RESTORATION MONITORING FRAMEWORK

Mobile Bay Subwatershed Restoration Monitoring Framework

Science Advisory Committee: Monitoring Working Group, 2015

Mobile Bay Subwatershed Restoration Monitoring Framework

Vision: Comprehensive restoration monitoring that enables quantitative assessment of restoration success and assessment of overall ecosystem function

Goals: To answer three questions:

1. What, if any, changes are there in the water quality, sedimentation, flow, biology, and habitat quantity and quality as a result of restoration efforts and management plan implementation?
2. How are potential ecosystem health indicators related to stressors and ecosystem functions/services?
3. What is the long-term status of the biological condition in the Mobile Bay watershed?

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COMMENTS ON THE PROCESS AND RECOMMENDATIONS

This framework outlines recommended monitoring procedures in relation to watershed restoration and watershed management plan implementation to understand ensuing impacts on the entire subwatershed. Development and implementation of a standardized monitoring protocol across the larger Mobile Bay watershed in all subwatersheds is critical for understanding the current health and function of the Mobile Bay Estuary and any shifts due to restoration. Recognizing the existing gap and need for such a plan in Mobile and Baldwin Counties the Mobile Bay National Estuary Program (MBNEP) tasked their Science Advisory Committee with the development of a comprehensive monitoring framework. This plan contributes to the MBNEP's Five Year Comprehensive Conservation Management Plan and can be integrated with larger monitoring networks being developed by the Gulf of Mexico Alliance, the Gulf of Mexico Coastal Ocean Observing System, and other partners.

This plan was developed by a working group of the Mobile Bay National Estuary Program Science Advisory Committee (SAC) and then approved by the rest of the SAC. These are thought to be the best available practices necessary to answer the questions laid forth in our goals. Recommendations of best practices reflect the group’s professional opinion.

Desired Outcomes:

The recommended protocols will result in standardized data collection for restoration efforts throughout Mobile and Baldwin Counties, allowing comparisons both temporally and spatially, improved decision making, and data preservation for future use. We recommend the monitoring program outlined within this framework be incorporated into all watershed management plans and restoration proposals and contracts. Ensuring utilization of this framework uniformly across all restorations and watersheds in Mobile and Baldwin counties will allow an interconnected network of data that can improve understanding of the processes of Mobile Bay as a whole. This will also serve as a model for future efforts across the Gulf Coast in developing larger, regional networks, including those envisioned by the Gulf of Mexico Alliance, the National Oceanic and Atmospheric Administration, and the Gulf of Mexico Coastal Ocean Observing System. To achieve these goals we recommend:

1) The adoption of this framework in every restoration request for proposals (RFP) and restoration contracts for Mobile and Baldwin County
2) Long-term monitoring based on this framework in every watershed management plan for all watersheds in Mobile and Baldwin County
3) Data synthesis to develop tools and products for assessment of restoration success, adaptive resource management, and baseline establishment
4) Active engagement with county and municipality planners, resource managers, agencies working within the watershed, and other stakeholders to encourage implementation of monitoring and broad application of tools developed from data synthesis.

Efficiency:

These recommendations are not all inexpensive or new. Prior to design and implementation in specific watersheds we highly encourage an inventory of required and ongoing monitoring within the watershed to assess what resources are available and what can be leveraged. For example municipalities, businesses, and state and local agencies frequently must monitor to some degree to meet Clean Water Act MS4 requirements. Interagency cooperation will avoid redundancy and provide maximum success for the minimum investment for all partners.

Data Utilization and Storage:

In addition to the monitoring scheme laid forth here, we highly recommend implementation of a feedback mechanism in both developing and existing watershed management plans (WMP). Collection of data is not enough; synthesis and analysis is required to determine if restoration and management practices are successful. While this implementation will be different for each watershed, a set of essential minimum requirements need to be met. It is critical that a committee be composed of representatives from:

- The drafter of the WMP – to navigate any changes necessary to the plan
- The municipalities and counties within the watershed – to ensure buy in to the adaptive management process and to supplement their efforts
- Agencies that will derive use from these data – to encourage focus on the watershed and implementation of necessary regulation or status change (i.e. EPA or FDA)
- Those performing the restoration – to evaluate progress of the restoration and give context to observed outcomes

- The Mobile Bay National Estuary Program – to coordinate effort and outcomes between surrounding watersheds and leverage existing partnerships
- Expert researchers – to perform analyses and interpret results

It is imperative that this committee be afforded the power needed to influence or direct the actions in the WMP based on monitoring results. Suggestions include: annual review and restructuring of the WMP based on monitoring data, review of the effectiveness of the restoration, a mechanism to address, edit, or introduce local policy based on baseline and restoration results, and implement adaptive management measures.

We also recommend that these data be housed within a regional partner to facilitate consistency, development of metadata, and promote public access to the data. Establishing a regional data repository will encourage integration within larger monitoring programs, expanding the context of the restoration effort and subsequent monitoring. This will also promote more research and data analysis, thereby improving our understanding of system function and management capabilities. As part of these recommendations metadata should be in ISO 19115-2 standard format. Utilizing a nationally recognized metadata standard will encourage data utilization across Mobile Bay and within larger regional data analyses and inventories.

Incorporating historical datasets to obtain a longer time series for analysis of system status and trends is encouraged; however, such datasets should be utilized in context and not applied beyond the scope of the original sampling.

Final Remarks

This document was developed as a framework to guide individual subwatersheds in the Mobile Bay watershed in standardizing their restoration monitoring. This standardization encourages integration of data and assessment of health of the entire Mobile Bay Estuary. Commitment to these protocols ensures relevance of data and increases the capacity of our region to better manage our resources. This sampling regime will develop an understanding of what drives the successes and failures of restoration efforts. Applying this understanding to adaptive watershed management is critical to utilizing our scarce financial and ecological resources efficiently.

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SAMPLING PROTOCOLS

We recommend that all of these monitoring efforts begin at least one year prior to implementation of restoration efforts to establish baselines. Monitoring should continue after restoration to track both short-term and long-term impacts. The minimum length of monitoring post restoration should be 3-5 years. We strongly recommend, if at all possible, transition of this monitoring into a sustained, long-term program for each subwatershed to continue tracking response to restoration and overall shifts in subwatershed health and function.

Sedimentation and Flow

Reducing sedimentation and flow are often at the core of restoration aims. If the primary goal of the restoration is to reduce sedimentation and flow, we recommend development of performance metrics specific to each restoration project for assessing success. We recommend the following monitoring metrics:

	Timing and Frequency	**Location**	**Methodology**
Erosion Rates	• Begin in Nov/Dec • After every rainfall event ≥ 1 inch • Post catastrophic events related to flow but not precipitation (e.g., dam failure)	• Upstream of restoration • Downstream of restoration • At restoration	*Staley et al., 2006*
Continuous Monitoring - Sondes	Every 15 minutes	• Mouth of all 2nd order streams or strategically important locations • Receiving sub-basin • Prior to and after in-stream retention water bodies (e.g. small lakes or large retention ponds)	• Flow • Turbidity: *EPA, 2012*
Continuous Monitoring – Automatic Water Grabs	• Any rainfall event ≥ 0.1 inch preceded by 72 dry hours • Continue every 15 min there has been no precipitation for 72 hours *Citation: EPA, 1992*	• Mouth of all 2nd order streams or strategically important locations • Receiving sub-basin • Prior to and after in-stream retention water bodies (e.g. small lakes or larger retention ponds)	• Total Suspended Solids • Suspended Sediment Annual Loading: *Cook & Moss, 2008*
Soil/sediment characterization	• Annually, beginning prior to restoration.	• Upstream of restoration • At restoration site • Downstream	• Grain size • Fraction distribution • TOC

		depositional site	
Manual Monitoring – Develop Sediment Transport Model	• After any rainfall event ≥ 1 inch for 12 months	• Upstream of restoration • Downstream of restoration • Mouth of all 2nd order streams or strategically important locations	• *Cohn et al., 1992*
Manual Monitoring – Maintain Sediment Transport Model	• Two rainfall events annually: ○ Moderate flow event ○ High flow event	• Upstream of restoration • Downstream of restoration • Mouth of all 2nd order streams or strategically important locations	• Bed Sediment Transport Rates • Bed Sediment Annual Loading: *Cook & Moss, 2008*

The Geological Survey of Alabama (GSA) has extensive experience and historical data regarding sediment and flow in many of the subwatersheds around Mobile Bay. It is highly recommended to coordinate effort and standard methods with this agency to improve efficiency and standardization.

Water Quality

Improved water quality is desired outcome from all restoration efforts. Given that water quality is a direct link to biological condition and ecosystem health, impacts must be quantified. It is critical to the evaluation of a restoration project to measure baselines and changes of water quality over time. For accurate assessment of water quality baselines and quantified changes in response to restoration we recommend monitoring:

	Timing and Frequency	**Location**	**Method**
Continuous Monitoring – Sondes	Every 15 minutes (to sample first flush)	• Reference site • Upstream from restoration • Downstream from restoration ○ Combine with sediment and flow continuous monitoring • Receiving Sub-basin • In-stream retention water bodies	• Temperature • Dissolved Oxygen • pH • Conductivity • Photosythetically Active Radiation ○ Only in receiving sub-basin • NO3 • CDOM • Turbidity
Continuous Monitoring – Automatic Water	• Any rainfall event ≥ 1 inch • Continue every	• Reference Site • Upstream from restoration • Downstream from	• Nutrients ○ NO3 ○ NH4

Grabs	15 min until it has been dry for 3 days: *EPA, 1992*	restoration ○ Combine with sediment and flow continuous monitoring • Receiving sub-basin • In-stream retention water bodies	○ DON ○ PN ○ PO4 ○ DOP ○ POP ○ *Lehrter et al., 2013* • Total Suspended Solids • Dissolved Organic Carbon • Particulate Organic Carbon *Welschmeyer, 1994*
Manual Sampling – Monthly Water Grabs	Sample based on turnover in the receiving sub-basin	Receiving sub-basin • Determine sampling locations within the sub-basin based on size and dynamics of the system	• Nutrients ○ NO3 ○ NH4 ○ DON ○ PN ○ PO4 ○ DOP ○ POP • Chlorophyll-a • Dissolved Organic Carbon • Particulate Organic Carbon *Welschmeyer, 1994*
Other	• Consider additional 303d issues based on initial screening sampling with subsequent periodic reevaluations for both continuous and manual sampling • Any additional issues specific to a subwatershed should be addressed with a detailed monitoring protocol ▪ Protocols used should be submitted to the MBNEP SAC for integration into this framework to ensure consistency and standardization across the Mobile Bay Watershed		

Habitats

Habitats are the foundation of an ecosystem; shifts in habitat health and function directly impact the ecological and economic benefits of the watershed. To accurately assess the health of individual habitats we recommend the following monitoring for each habitat:

Submerged Aquatic Vegetation

	Timing and Frequency	Location	Method

Bed Boundaries	Annually at peak biomass	Receiving sub-basins	Aerial Photography; Tier 1, *Neckles et al., 2012*
Species Composition and Density	Annually at peak biomass	Receiving sub-basins – determine sampling locations depending on the size and dynamics of the system and the SAV beds	Percent Cover & Cores; Tier 2,3, *Neckles et al., 2012*

Wetlands

	Timing and Frequency	Location	Methods
Acreage*	Annually at peak biomass	• Reference Site • Restoration Site • Downstream of restoration site	Aerial imagery and existing spatial data with field verification. *USACE, 2010*
Floristic Quality Index (FQI)	Annually at peak biomass	• Reference Site • Restoration Site • Downstream of restoration (if applicable)	*Lopez & Fennessy, 2002*
Wetlands Rapid Assessment Protocol (WRAP)	Annually at peak biomass	• Same locations as the FQI	*Miller and Gunsalus, 1999*
Hydrogeomorphic (HGM) Model	Annually at peak biomass	• Receiving sub-basins	*Shafer et al., 2007*

* Mobile and Baldwin Counties will have detailed mapping of critical habitat including wetlands conducted in 2015. It is the recommendation of this team that such mapping occur annually as part of a comprehensive watershed management plan for each sub-watershed. If complete watershed mapping is not scheduled in the year prior to and at least 3 years after restoration then follow this recommendation.

Streams and Riparian Buffers

	Timing and Frequency	Location	Method
Rapid Stream Assessment for Riparian Buffers	Annually at peak biomass	Entire watershed	• *Barbour et al., 1999* • *Look to leverage effort with ADEM: ADEM conducts these around the state*
Stream Quality Score	Annually, during early spring, prior to adult insect emergence	• 100 m reach segments • Upstream from	• *Barbour et al., 1999* • *Be aware of agriculture, golf*

		restoration or a reference site • At restoration • Downstream from restoration	*courses, and other potential sources of insecticide that could artificially skew results*

Oyster Reefs

	Timing and Frequency	Location	Method
Reef Areal Dimension	Annually and after events that impact oyster survival (i.e. hurricanes)	Receiving sub-basins	*Bagget et al, 2014*
Reef Height *	Annually and after events that impact oyster survival (i.e. hurricanes)	Reference sites within receiving sub-basins	*Bagget et al, 2014*
Oyster Density	Annually after peak growing season	Receiving sub-basins	*Bagget et al, 2014*
Oyster Size-Frequency Distribution	Annually after peak growing season	Receiving sub-basins	*Bagget et al, 2014*
Other	Coordination with Alabama Department of Conservation and Natural Resources Marine Resources Division (ADCNR MRD) is highly recommended as ADCNR MRD have a long-term oyster data set and expertise in oyster sampling methodologies. Any additional concerns such as HABs or fecal coliforms should be considered and coordination with the Alabama Department of Public Health (ADPH) is highly recommended to reduce redundancy and incorporate experts in sampling and analysis of results. (*National Shellfish Sanitation Program*)		

*Monitoring oyster reef height provides understanding of how upstream or adjacent land-based activities that change rates of sedimentation, dissolved oxygen, or other water column attributes may, in turn, impact the overall function and productivity of reefs (which can change based on vertical distribution). Low height oyster reefs are naturally occurring in and around Mobile Bay, and a low reef height alone is not to be considered a sign of a poorly functioning reef.

Other Foundational Habitats

There are other habitats that may be critical within individual subwatersheds. For each of these habitats we recommend following a protocol based on published and standardized methods that details frequency and location. Protocols used should be submitted to the MBNEP SAC for integration into this framework to ensure consistency and standardization across the Mobile Bay Watershed

Biological Communities

Biological communities are a critical component of both ecological function and services including fisheries. Many of the native species are captured in the stream and marsh indices; however, specific species and their associated habitats should be considered. Targeted species differ for individual subwatershed. To ensure that no critical species are overlooked the following should be considered in detail for each subwatershed monitoring program:

- Sensitive habitats
    - Determine if there are any habitats (e.g. marine mammal feeding, resting, breeding habitats, nesting bird habitat etc.)
    - Develop a protocol based on published or standardized methods that details frequency and location
        - Developed protocol should be submitted to the MBNEP SAC for integration into this framework to ensure consistency and standardization across the Mobile Bay Watershed
- Invasive Species
    - Develop a protocol based on published and standardized methods that details frequency and location
- Endangered and Threatened Species
    - Determine if there are any endangered or threatened species
    - Develop a protocol based on published methods or standardized methods that details frequency and location

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APPENDIX G WATERSHED MANAGEMENT PLAN COMPONENT CHECKLIST

Watershed Management Plan Component Checklist
Watershed Management Plan Title: Bayou La Batre Watershed Management Plan
Waterbody ID, Hydrologic Unit Code, Watershed Boundary Data Set, or Hydrologic Response Unit: U.S. Geological Survey (USGS) 12-digit hydrologic unit code (HUC) HUC 031700090102 (USGS 2013). TMDL Assessment Unit ID# AL03170009-01-2-100 (ADEM 2009)
River Basin: Escatawpa River Basin
County(ies): Mobile County
Title of TMDL: a) A TMDL for This Watershed is (“X” as applicable): (X) Approved ( ) In Draft b) No TMDL Has Been Developed to Date: ( ) c) The Watershed Plan Addresses a Non-Impaired or Threatened Waterbody: (X) Yes ( ) No
Comments: Approved TMDL for Bayou La Batre; Addresses Degraded Stream & Wetlands (Section 4.2.1)

Component (A) Watershed Conditions	Yes	No	N/A	Chapter, Section, Table, List, etc.	Page No.(s)
I. The plan assesses the conditions of shorelines, wetlands, and riparian areas. (If “No” or “N/A” provide comments below.) <u>Comments</u>:	X			Chapters: 2, 3, 4, 6 Section 2.2 Section 3.5 Section 4.4 Section 6.2; Table 2.5 Table 2.8 Table 2.10 Table 3.6 Table 3.8 Figure 2.7 Figure 2.8 Figure 3.22 Figure 3.25 Figure 3.26 Figure 6.25	 42- 73 111-117 161-162 172- 202 44 51 57 106 113 43 45 110 115 116 200
II. The plan characterizes watershed biological resources, including fauna, flora, invasive species, and threatened and endangered species. (If “No” or “N/A” provide comments below.) <u>Comments</u>:	X			Chapters 2, 3, 4; Section 2.1 Section 2.2 Section 3.3 Section 4.2 Table 2.3 Table 2.4	 29-42 42-73 99-101 147-153 40 41
III. The plan characterizes customary uses of biological resources. (If “No” or “N/A” provide comments below.) <u>Comments</u>:	X			Chapter 2; Section 2.2 Table 2.5 Table 2.7 Figure 2.5 Figure 2.6 Figure 2.7 Figure 2.8 Figure 2.9	 42-73 44 46 35 38 43 45 48
IV. The plan identifies vulnerabilities on the watershed from increased sea level rise, storm surge, temperature increases, and precipitation. (If “No” or “N/A” provide comments below.) <u>Comments</u>:	X			Chapters 2,3,4; Section 2.1 Section 3.4 Section 3.5 Section 4.3 Table 2.1 Table 3.7 Table 4.5 Table 4.6 Table 4.7 Figure 2.4 Figure 3.19-24 Figure 4.12	 29-42 101-111 111-117 153-161 31 111 154 159 160 34 104-113 148
V. The plan characterizes existing opportunities for public access, recreation, and ecotourism. (If “No” or “N/A” provide comments below.) <u>Comments</u>:	X			Chapters 2, 3, 4, 5; Section 2.2 Section 3.6 Section 3.7	 42-73 117-125 125-126

				Section 4.5 Section 4.6 Section 6.3 Section 6.4 Section 6.7 Figure 3.27	162-163 163-165 202- 220 220-221 231-234 116

Component (B) Identification of Pollutant Causes and Sources	**Yes**	**No**	**N/A**	**Chapter, Section, Table, List, etc.**	**Page No.(s)**
I. The plan identifies the pollutant *causes* and *sources* <u>or</u> groups of similar sources that will need to be managed to achieve the load reductions identified in a TMDL, or elsewhere in this plan. (If "No" or "N/A" provide comments below.) <u>Comments</u>:	X			Chapters 3, 4, 6 Section 3.1 Section 4.1 Section 6.2 Section 6.3 Table 3.1 Table 4.1 Table 4.2 Table 4.3 Figure 4.1-10 Figure 6.17 Figure 6.18 Figure 6.26	 79-98 127-147 172- 202 202- 220 82- 84 133 141 146 128-144 192 193 205
II. The plan addresses *other* watershed/natural resource/stakeholder issues and concerns that *may be* problematic, but are *not* addressed by a TMDL. (If "No" or "N/A" provide comments below.) <u>Comments</u>:	X			Chapters 1, 3, 4, 5, 6, 10 Section 1.3 Section 3.6 Section 3.7 Section 4.6 Section 5.1 Section 6.5 Section 10.4 Section 10.5 Table 10.2 Table 10.4 Figure 6.28 Figure 6.29 Figure 10.1 Figure 10.2 Figure 10.10	 24-25 117-125 125-126 163- 165 166-167 221- 226 295-300 300-301 295 298 206 209 288 289 300

Component (C) **Pollutant Load Reduction Estimates**	**Yes**	**No**	**N/A**	**Chapter, Section, Table, List, etc.**	**Page No.(s)**
I. The plan provides estimates of load reductions needed to achieve a TMDL. (If "No" or "N/A" provide comments below.) Comments: The September 2009 TMDL for Bayou La Batre has resulted in the removal of Bayou La Batre and its tributaries from the Section 303(d) list of impaired waters.			X		
II. The plan provides *estimates* of potential load reductions for each pollutant cause or source, or groups of similar sources that need to be managed. (If "No" or "N/A" provide comments below.) Comments: The September 2009 TMDL for Bayou La Batre has resulted in the removal of Bayou La Batre and its tributaries from the Section 303(d) list of impaired waters.			X		
III. The plan provides locations where *potential* BMPs may be implemented. (If "No" or "N/A" provide comments below.) Comments: The September 2009 TMDL for Bayou La Batre has resulted in the removal of Bayou La Batre and its tributaries from the Section 303(d) list of impaired waters.			X		
IV. A reasonable approach is used to *estimate* pollutant load reductions (assumptions and limitations should be stated). (If "No" or "N/A" provide comments below.) Comments: The September 2009 TMDL for Bayou La Batre has resulted in the removal of Bayou La Batre and its tributaries from the Section 303(d) list of impaired waters.			X		

Component (D) Best Management Practices	Yes	No	N/A	Chapter, Section, Table, List, etc.	Page No.(s)
I. The plan identifies *potential* BMPs to be installed in "critical" areas. <u>Comments;</u> (If "No" or "N/A" provide comments below.)	X			Chapter 6; Section 6.2 Section 6.3 Table 6.3 Table 6.4 Table 6.5 Figure 6.10 Figure 6.12-16 Figure 6.19 Figure 6.21 Figure 6.25 Figure 6.26	 172-202 202-220 185 185 190 183 187-191 194 196 200 205
II. The plan identifies actions to improve habitats necessary to support healthy populations of fish and shellfish. (If "No" or "N/A" provide comments below.) <u>Comments</u>:	X			Chapters 6, 7; Section 6.3 Section 6.6 Section 7.1 Table 7.1 Table 7.2	 202-220 226-231 236-262 239 248
III. The plan identifies actions to reduce the incidence and impacts of invasive flora and fauna. (If "No" or "N/A" provide comments below.) <u>Comments</u>:	X			Chapters 6, 7; Section 6.3 Section 7.1 Table 7.1 Table 7.2	 202-220 236-262 239-247 248-253
IV. The plan identifies actions to preserve culture, heritage, and traditional ecological knowledge of the watershed. (If "No" or "N/A" provide comments below.) <u>Comments</u>:	X			Chapters 6, 7; Section 6.5 Section 7.1 Table 7.1 Table 7.2	 221-226 236-262 239-247 248-253
V. The plan recommends strategies to remediate effects of environmental degradation. (If "No" or "N/A" provide comments below.) <u>Comments</u>:	X			Chapters 6, 7; Section 6.2 Section 6.3 Section 7.1; Table 7.1 Table 7.2	 172-202 202-220 236-262 239-247 248-253
VII. The plan identifies strategic areas for shoreline stabilization, wetland and stream restoration/conservation, and fishery enhancements. (If "No" or "N/A" provide comments below.) <u>Comments</u>:	X			Chapters 6, 7; Section 6.3 Section 6.6 Section 7.1 Table 7.1 Table 7.2	 202-220 226-231 236-262 239-247 248 -253
VIII. The plan provides recommendations to improve watershed resiliency through adaptation strategies. (If "No" or "N/A" provide comments below.) <u>Comments</u>:	X			Chapters 6, 7; Section 6.7 Section 7.1 Table 7.1 Table 7.2	 231-235 236-262 239-247 248-253
IX. The plan identifies potential sites to expand access to open spaces and waters within the watershed. (If "No" or "N/A" provide comments below.) <u>Comments</u>:	X			Chapters 6, 7; Section 6.4 Section 7.1 Table 7.1 Table 7.2	 220-221 236-262 239-247 248-253

	Yes	No	N/A	Chapter, Section, Table, List, etc.	Page No.(s)
X. The plan incorporates established programs in implementation strategies (Clean Marina, Alabama Water Watch, Community Ratings System, Smart Yards, etc) . (If "No" or "N/A" provide comments below.) Comments:	X			Chapters 6; Section 6.5 Section 7.1 Section 10.6 Section 11.5 Table 7.1 Figure 6.19 Figure 6.23 Figure 6.26	 221-226 236-262 301-308 317 239-247 194 198 205

Component (E) **Financial and Technical Assistance**	**Yes**	**No**	**N/A**	**Chapter, Section, Table, List, etc.**	**Page No.(s)**
I: The plan provides estimates of the financial and technical assistance that will be needed to implement the plan. (If "No" or "N/A" provide comments below.) Comments:	X			Chapters 6. 7, 9; Section 6.3 Section 6.6 Section 7.1 Section 9.2 Table 6.8 Table 7.3 Table 9.1	 202-220 226-231 236-262 279-286 214 255 286
II: The plan identifies sources and authorities that will be relied upon to implement the plan. (If "No" or "N/A" provide comments below.) Comments:	X			Chapter 7; Section 7.1	 236-262
III. The plan contains a strategy for driving regulatory change. (If "No" or "N/A" provide comments below.) Comments:	X			Chapters 5, 6, 7, 8 Section 5.2 Section 6.2 Section 6.6 Section 7.1 Section 8.6 Section 8.7	 169-170 172-202 226-231 236-262 274-277 277

Component (F) **Education and Outreach**	**Yes**	**No**	**N/A**	**Chapter, Section, Table, List, etc.**	**Page No.(s)**
I. The plan provides an information/education component that will enhance public understanding of the plan and encourage their early and continued participation in project development. (If "No" or "N/A" provide comments below.) Comments:	X			Chapters 1, 6, 7, 10 Section 1.5 Section 6.2 Section 7.1 Section 10.6 Table 7.1 Table 7.2	 26-27 172-202 236-262 301-307 239-247 248-253

Component (G) **Plan Implementation Schedule**	**Yes**	**No**	**N/A**	**Chapter, Section, Table, List, etc.**	**Page No.(s)**
I. The plan provides a reasonably expeditious schedule for implementing management measures. (Should base implementation timetable on BMPs in "C" above.) Comments: (If "No" or "N/A" provide comments below.)	X			Chapters 7, 11 Section 7.1 Section 11.4 Table 7.1	 236-262 317 239-247

				Table 7.2	248-253

Component (H) Interim Milestones	**Yes**	**No**	**N/A**	**Chapter, Section, Table, List, etc.**	**Page No.(s)**
I. The plan provides a list or description of interim milestones for determining whether NPS management measures are being implemented. (If "No" or "N/A" provide comments below.) Comments:	X			Chapter 7 Section 7.1	 236-262

Component (I) Monitoring and Assessment	**Yes**	**No**	**N/A**	**Chapter, Section, Table, List, etc.**	**Page No.(s)**
I. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards, and if not, the criteria for determining whether the watershed plan needs to be revised - or if a NPS TMDL has been established - whether the NPS TMDL needs to be revised. (If "No" or "N/A" provide comments below.) Comments:	X			Chapter 11 Section 11.2	 310-313
The plan identifies key locations for volunteer water monitoring. (If "No" or "N/A" provide comments below.) Comments:	X			Chapter 11 Section 11.3 Table 11.1 Figure 11.2	 313-317 314 316

Component (J) Plan Implementation Effectiveness	**Yes**	**No**	**N/A**	**Chapter, Section, Table, List, etc.**	**Page No.(s)**
I. A monitoring component to evaluate the effectiveness of the implementation efforts over time measured against the criteria established under item (I). (If "No" or "N/A" provide comments below.) Comments:	X			Chapter 11 Section 11.6 Section 11.7 Figure 11.3	 317-325 325 319