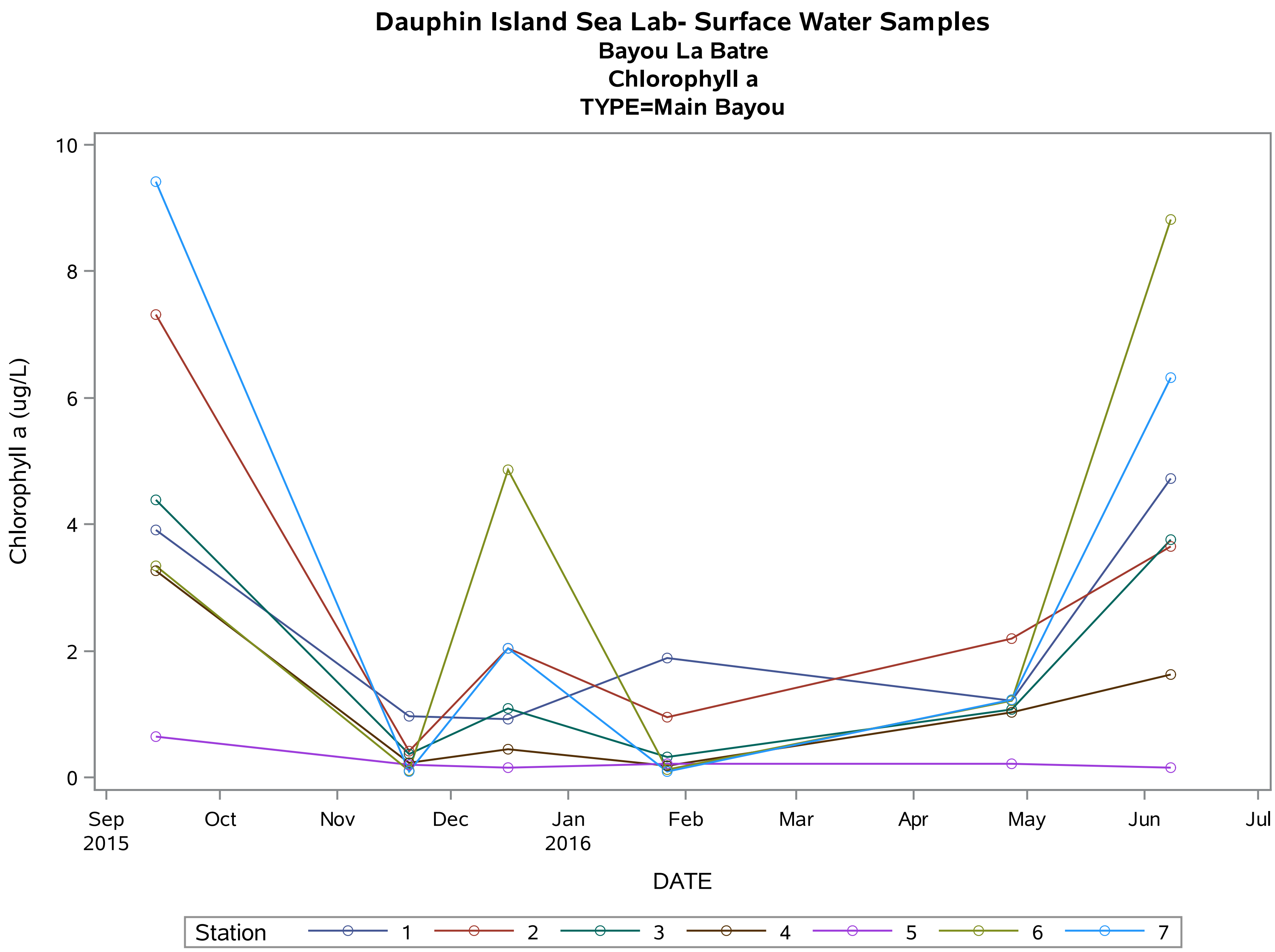
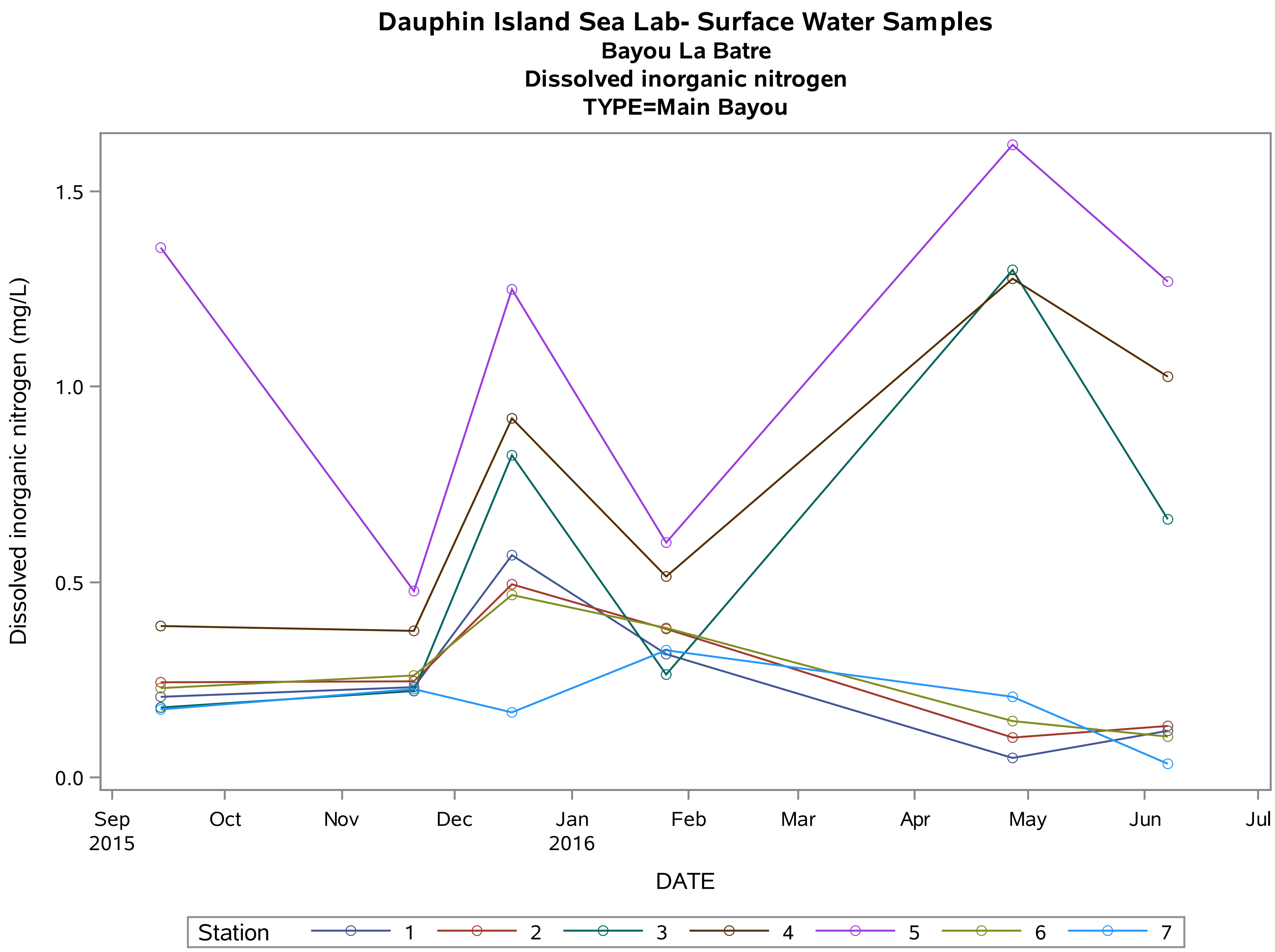
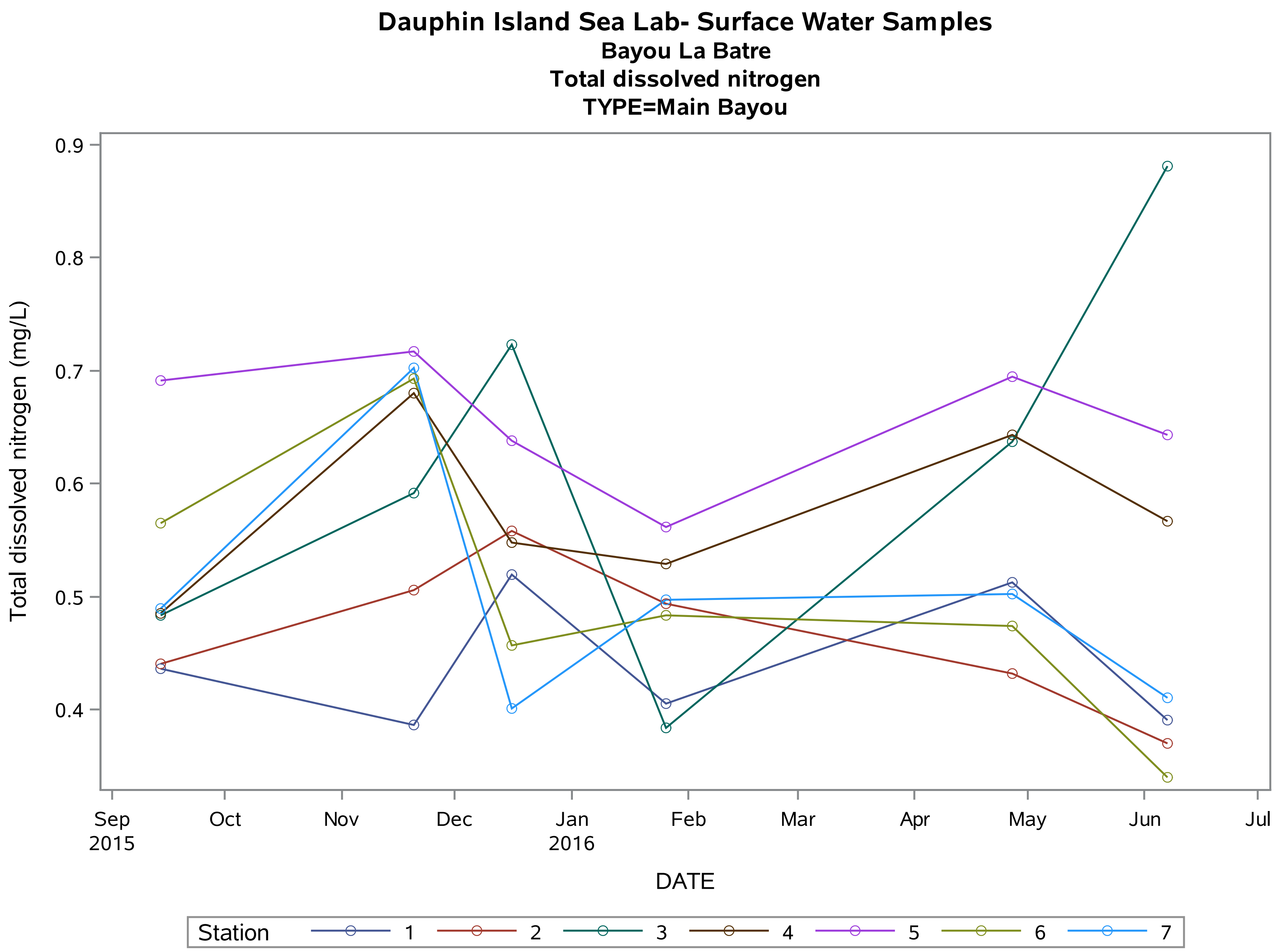
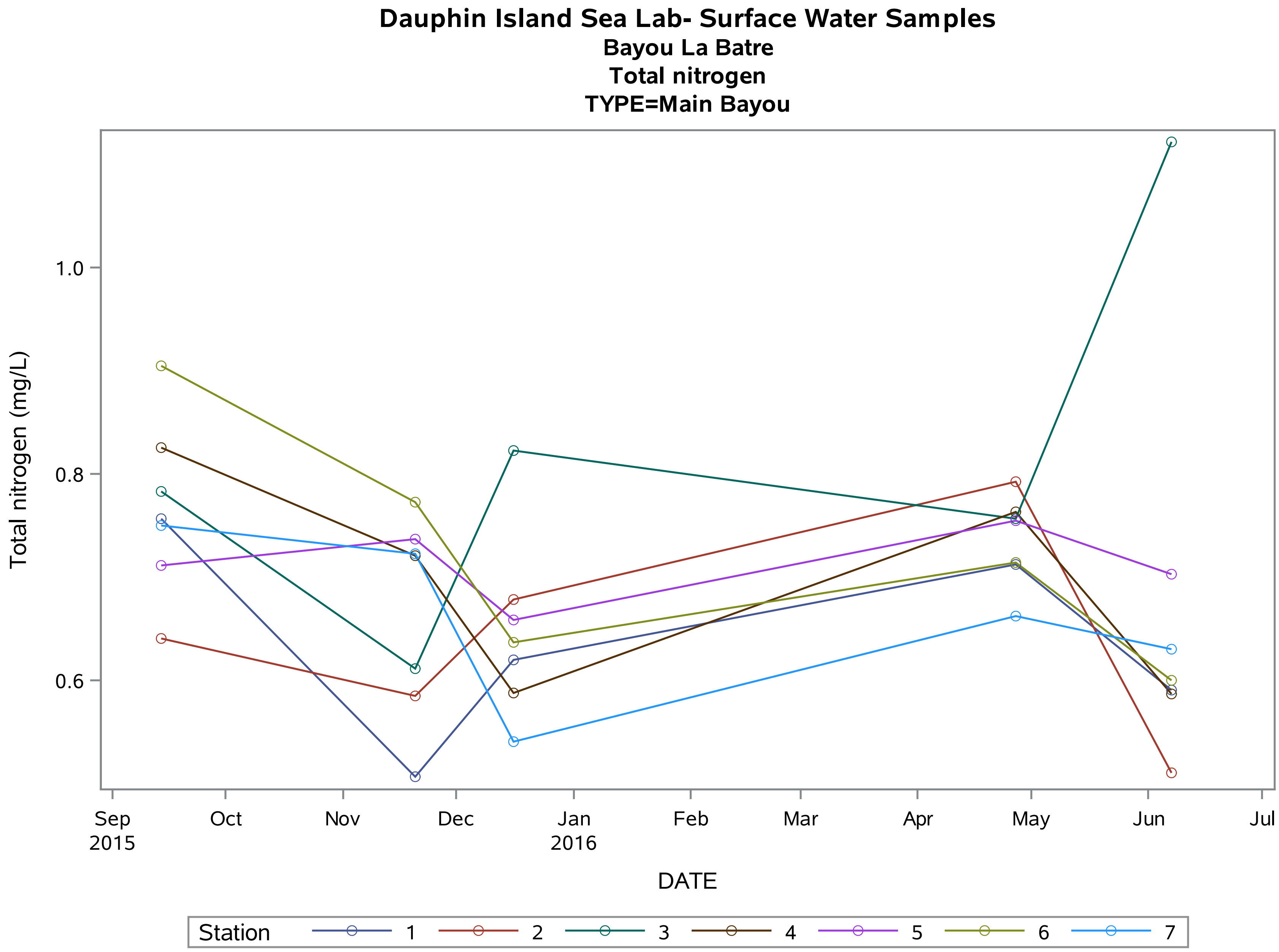
APPENDIX A DISL RAW DATA

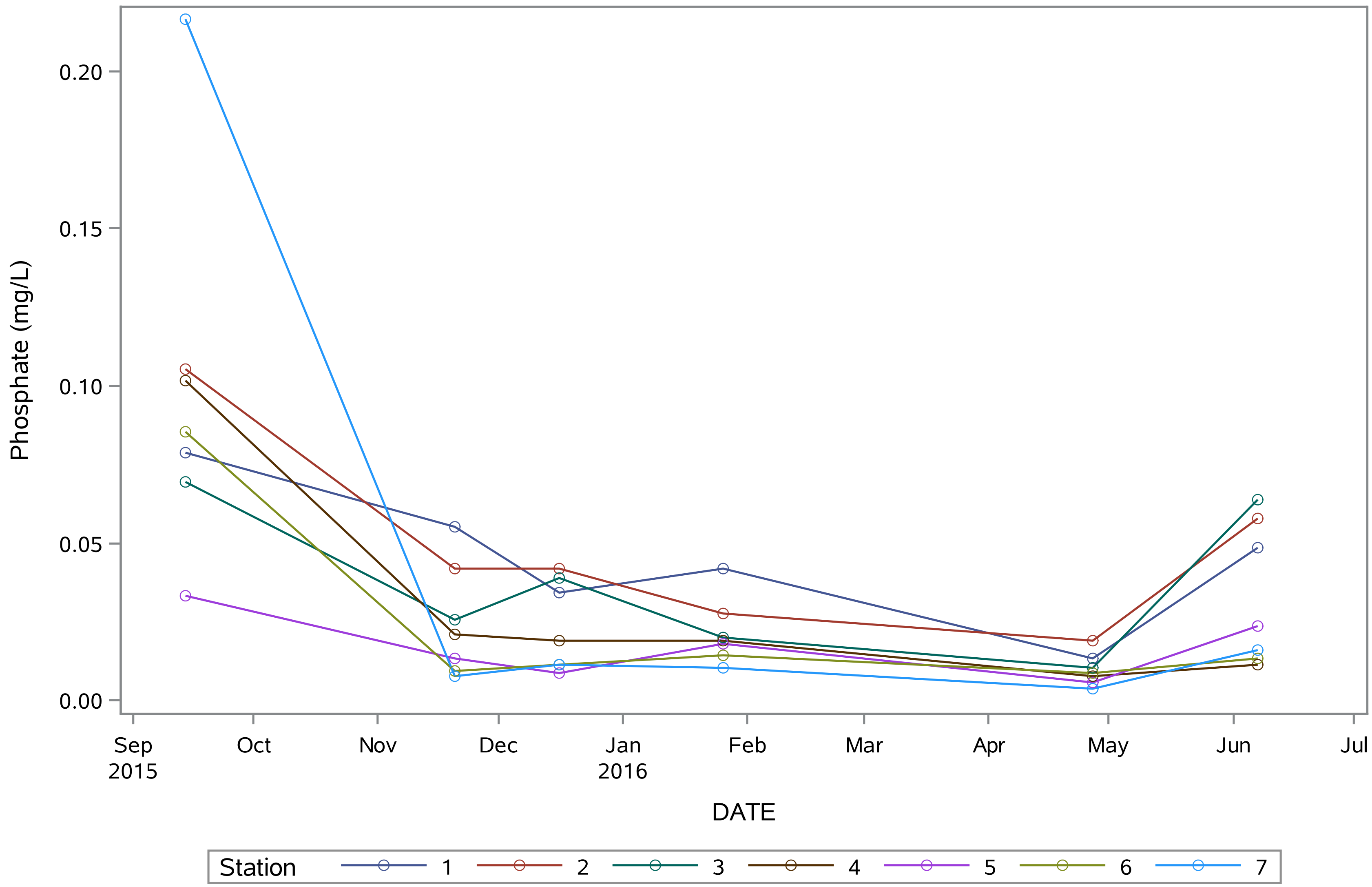

Dauphin Island Sea Lab- Surface Water Samples
Bayou La Batre
Chlorophyll a
TYPE=Main Bayou
Chlorophyll a (ug/L)
0
2
4
6
8
10
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
Station
1
2
3
4
5
6
7

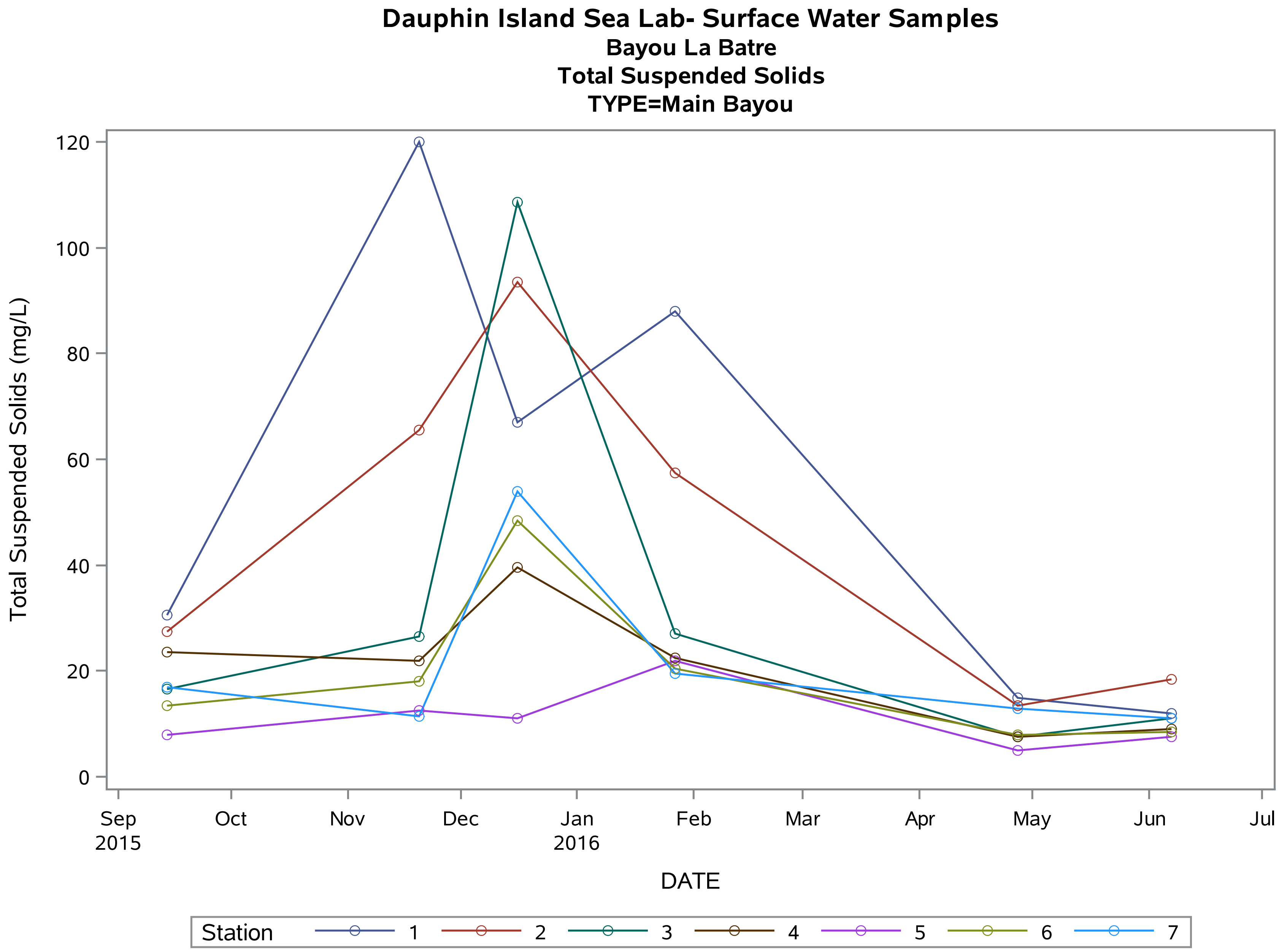

Dauphin Island Sea Lab- Surface Water Samples
Bayou La Batre
Dissolved inorganic nitrogen
TYPE=Main Bayou
Dissolved inorganic nitrogen (mg/L)
1.5
1.0
0.5
0.0
Sep
2015
Oct
Nov
Dec
Jan
2016
Feb
Mar
Apr
May
Jun
Jul
DATE
Station
1
2
3
4
5
6
7

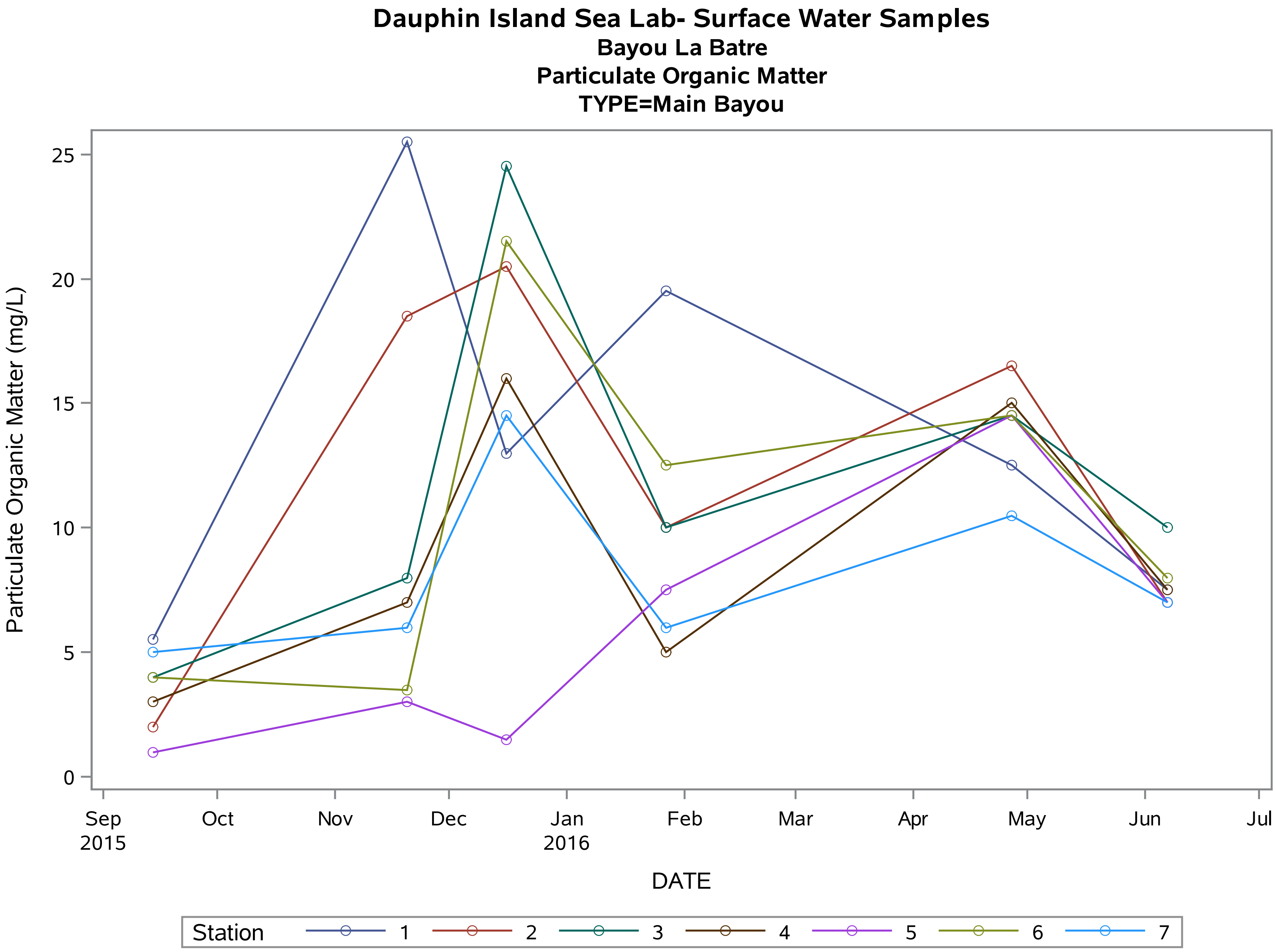

Dauphin Island Sea Lab- Surface Water Samples
Bayou La Batre
Total dissolved nitrogen
TYPE=Main Bayou
Total dissolved nitrogen (mg/L)
0.9
0.8
0.7
0.6
0.5
0.4
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
Station
1
2
3
4
5
6
7


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

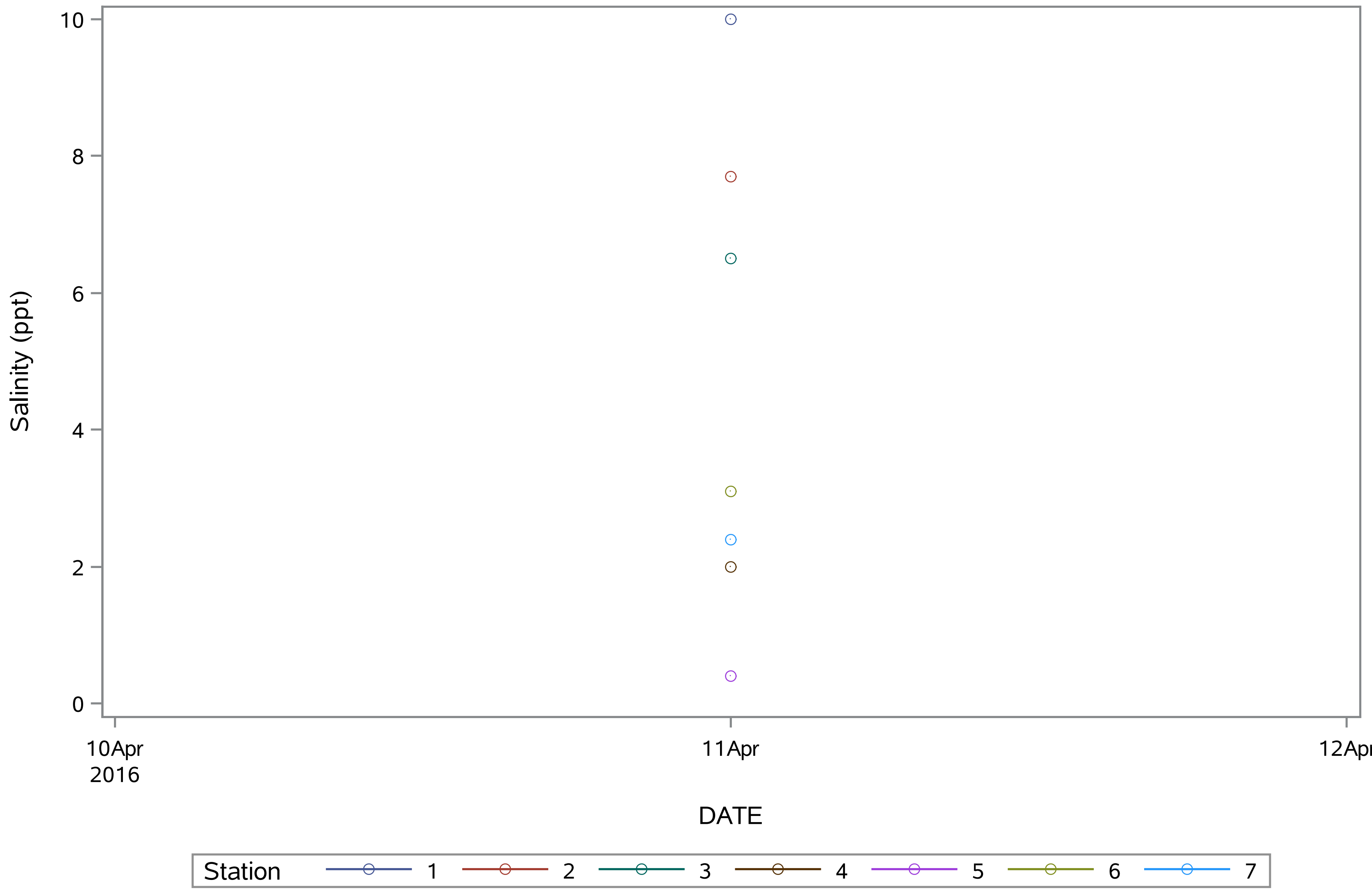
Dauphin Island Sea Lab- Surface Water Samples
Bayou La Batre
Phosphate
TYPE=Main Bayou

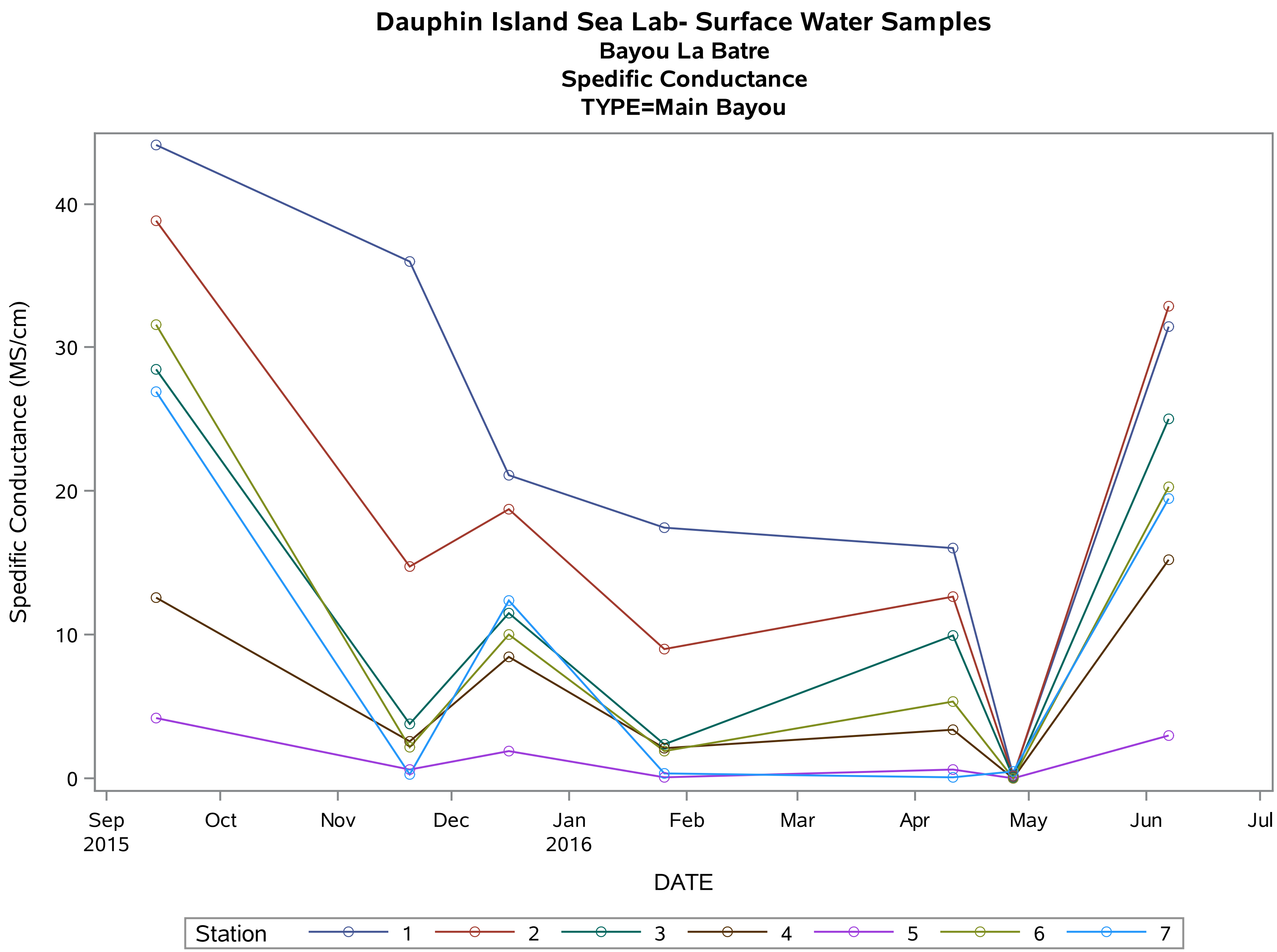


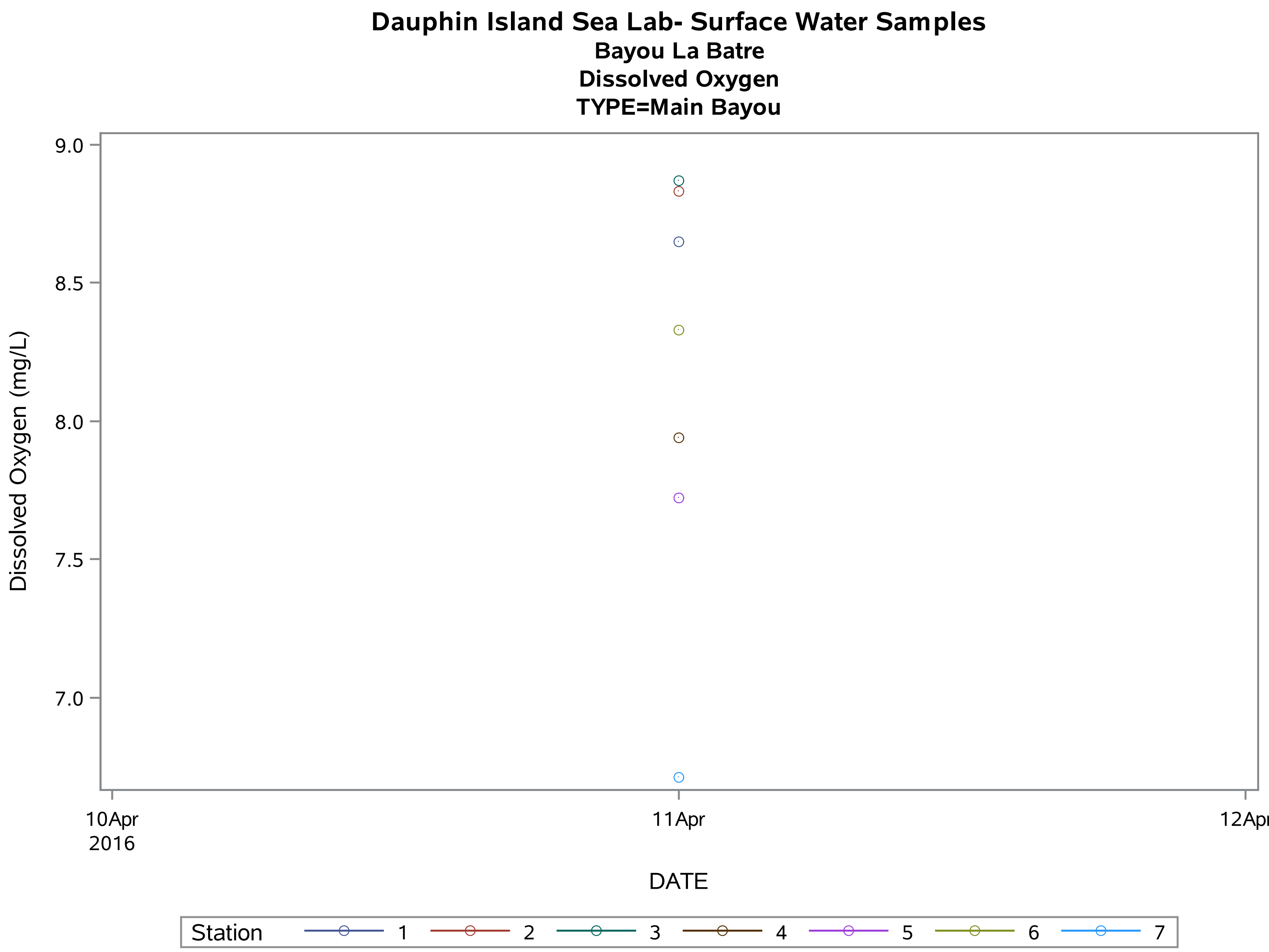

Dauphin Island Sea Lab- Surface Water Samples
Bayou La Batre
Total Suspended Solids
TYPE=Main Bayou
Total Suspended Solids (mg/L)
0
20
40
60
80
100
120
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
Station
1
2
3
4
5
6
7

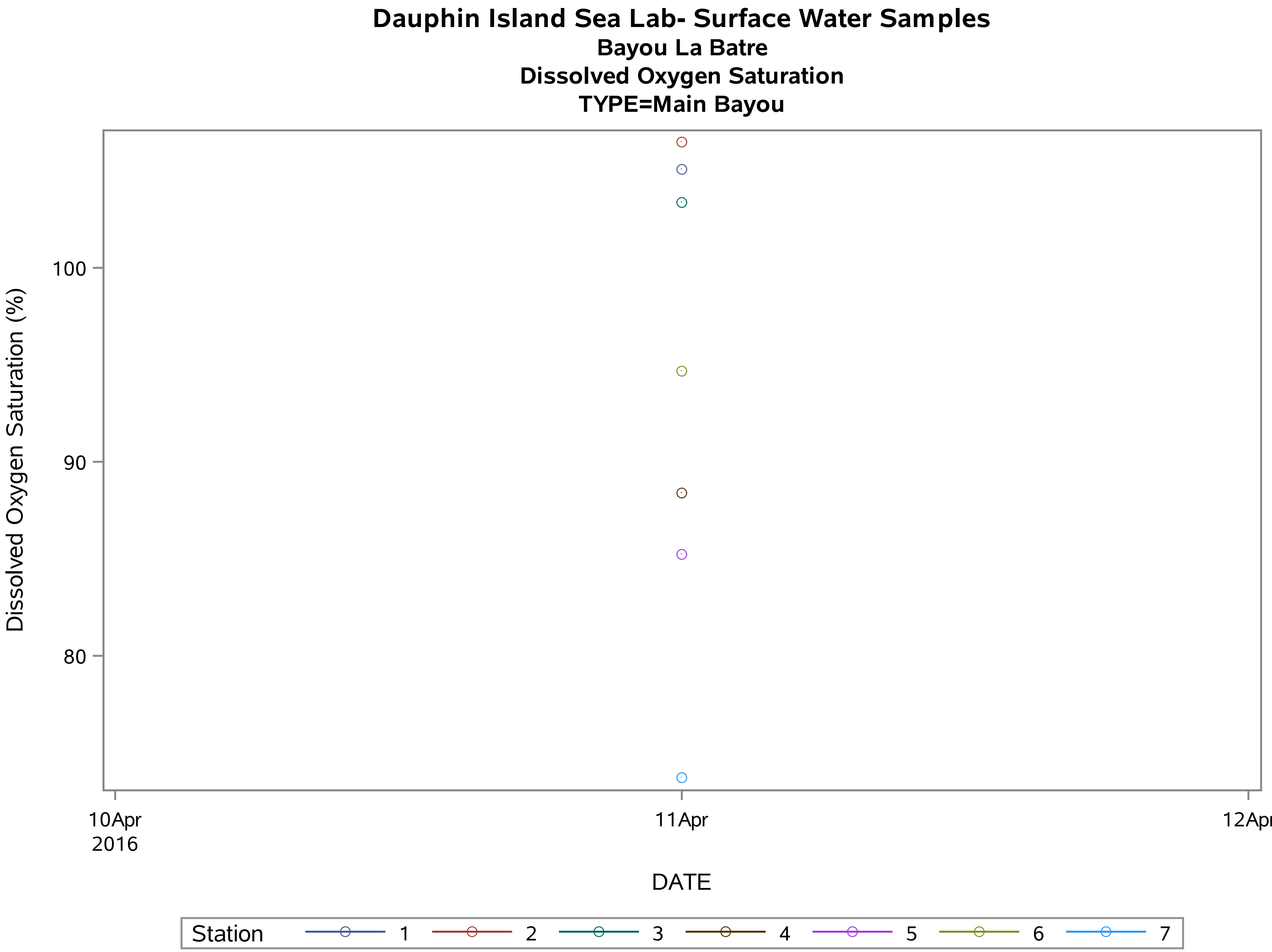

Dauphin Island Sea Lab- Surface Water Samples
Bayou La Batre
Particulate Organic Matter
TYPE=Main Bayou
Particulate Organic Matter (mg/L)
25
20
15
10
5
0
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
Station
1
2
3
4
5
6
7

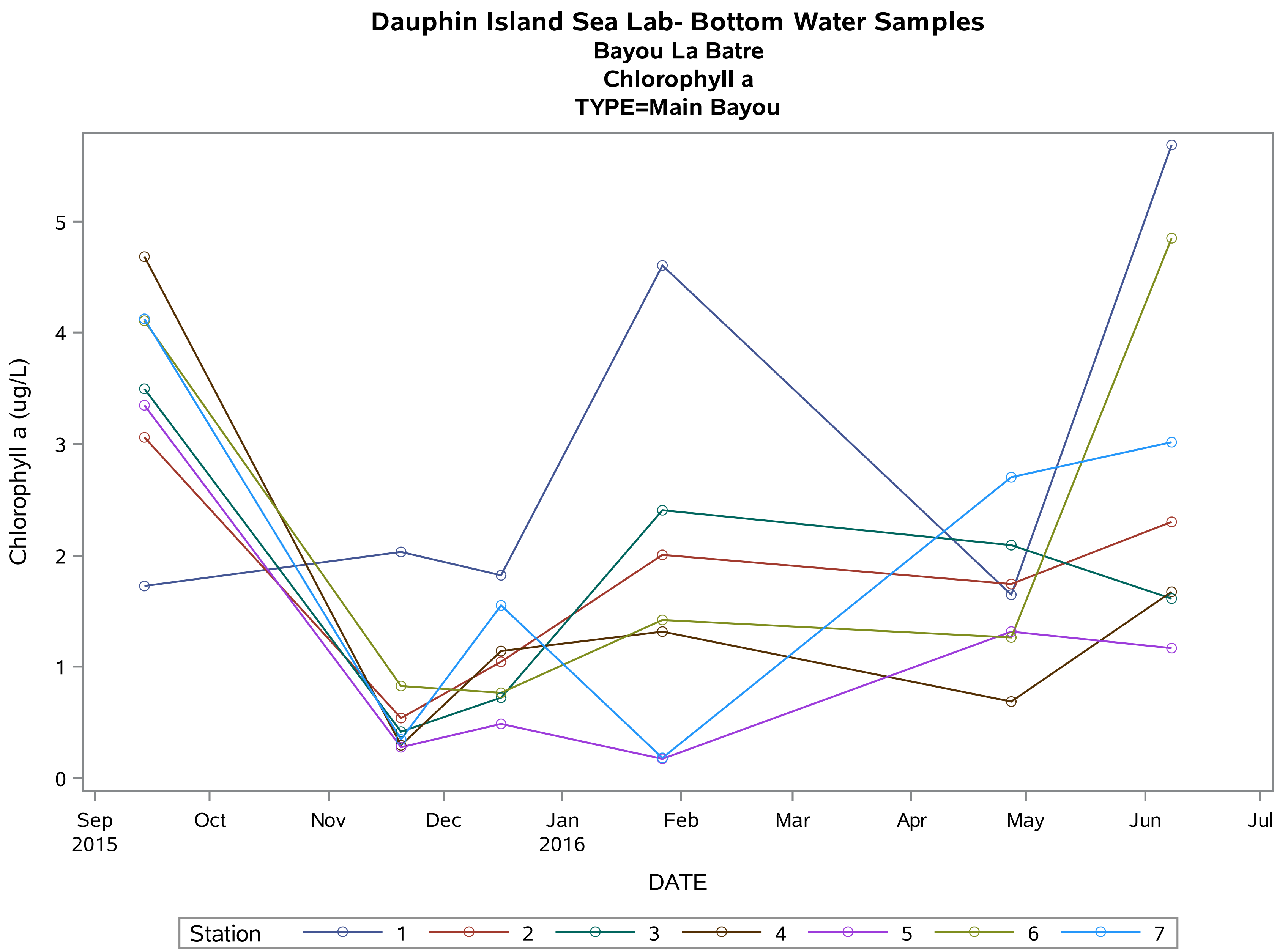
Dauphin Island Sea Lab- Surface Water Samples
Bayou La Batre
Salinity
TYPE=Main Bayou



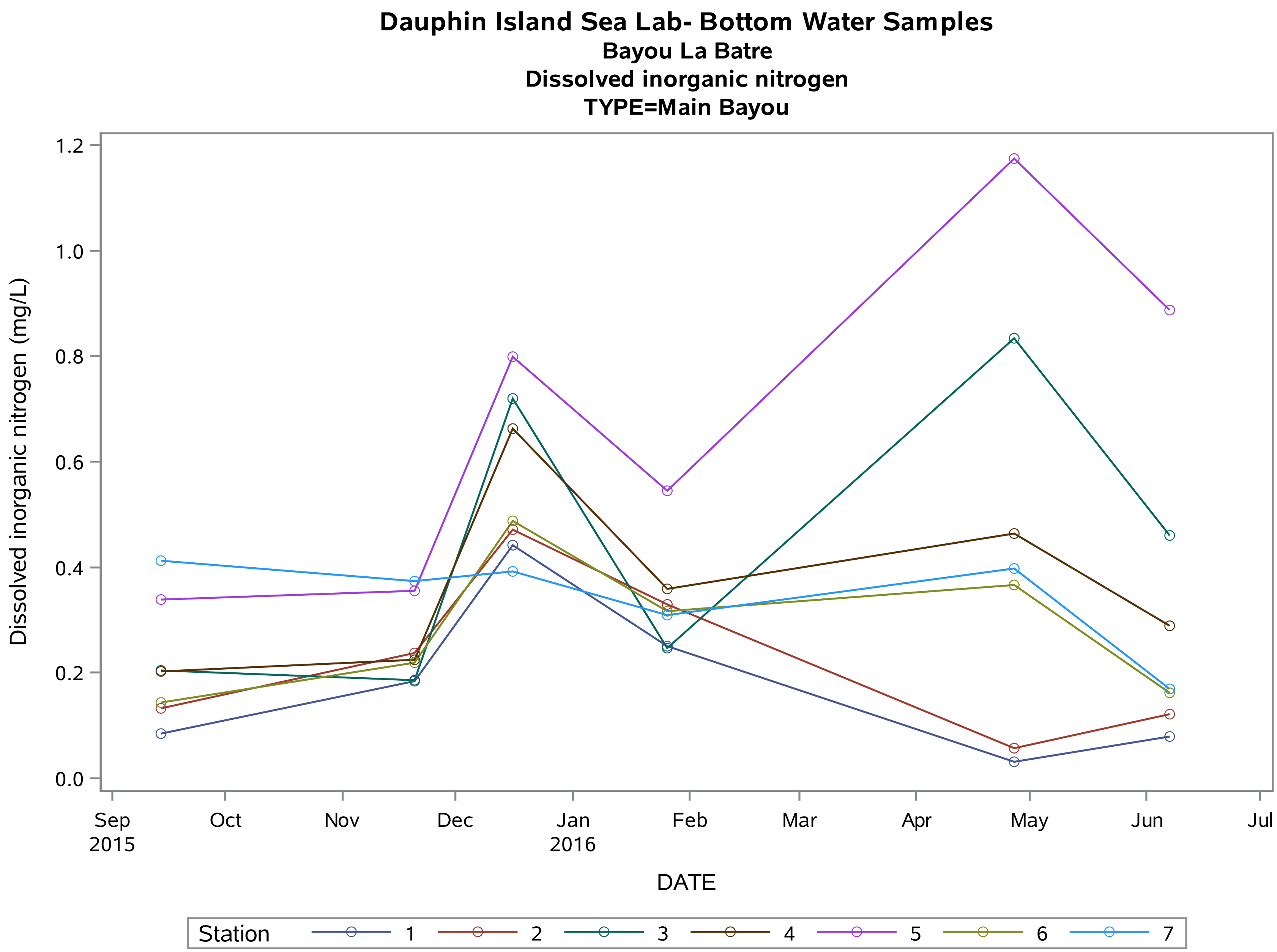

Dauphin Island Sea Lab- Surface Water Samples
Bayou La Batre
Spedific Conductance
TYPE=Main Bayou
Spedific Conductance (MS/cm)
0
10
20
30
40
Sep
2015
Oct
Nov
Dec
Jan
2016
Feb
Mar
Apr
May
Jun
Jul
DATE
Station
1
2
3
4
5
6
7


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

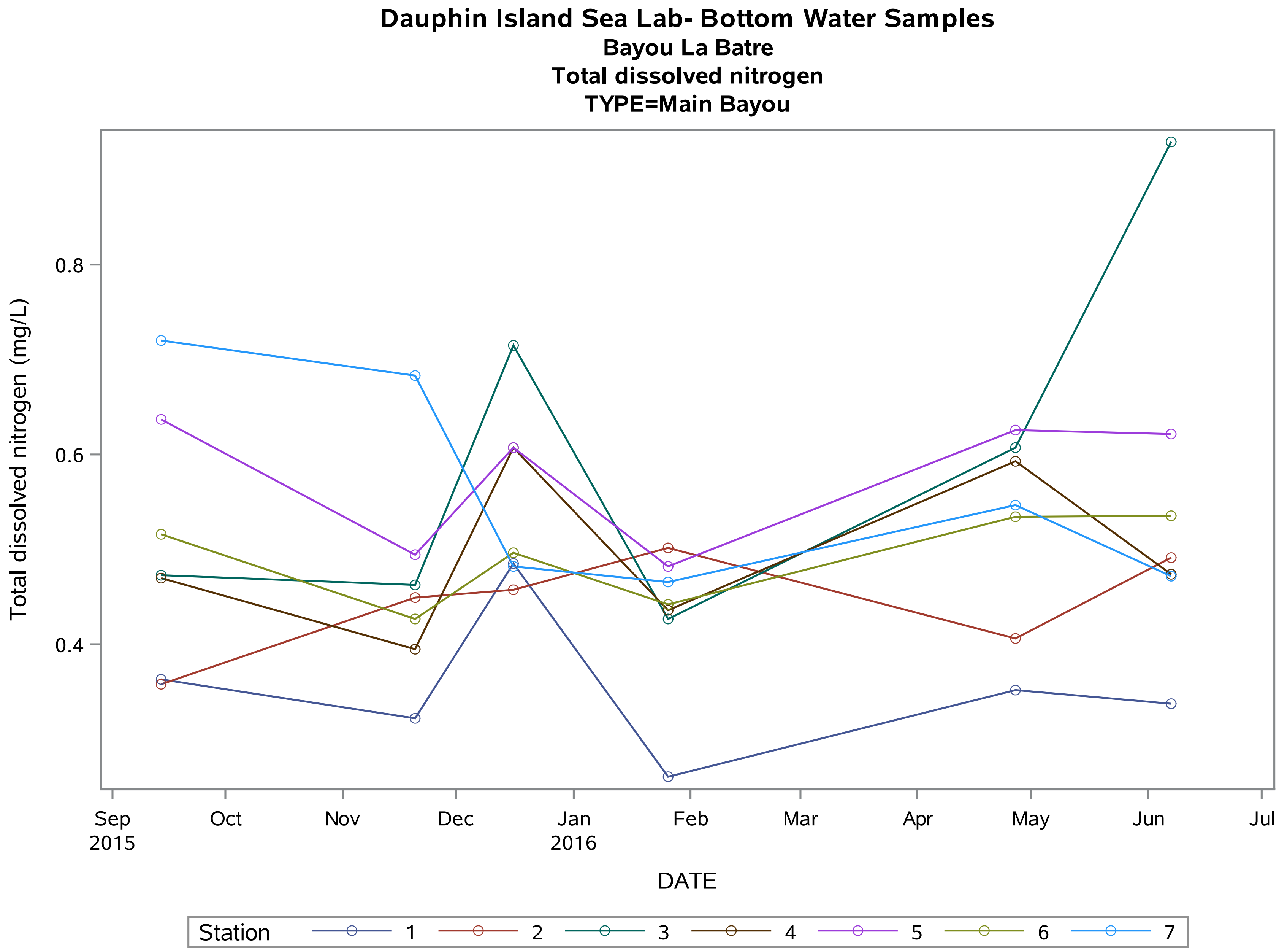

Dauphin Island Sea Lab- Surface Water Samples
Bayou La Batre
Dissolved Oxygen Saturation
TYPE=Main Bayou
Dissolved Oxygen Saturation (%)
100
90
80
10Apr
2016
11Apr
12Apr
DATE
Station
1
2
3
4
5
6
7



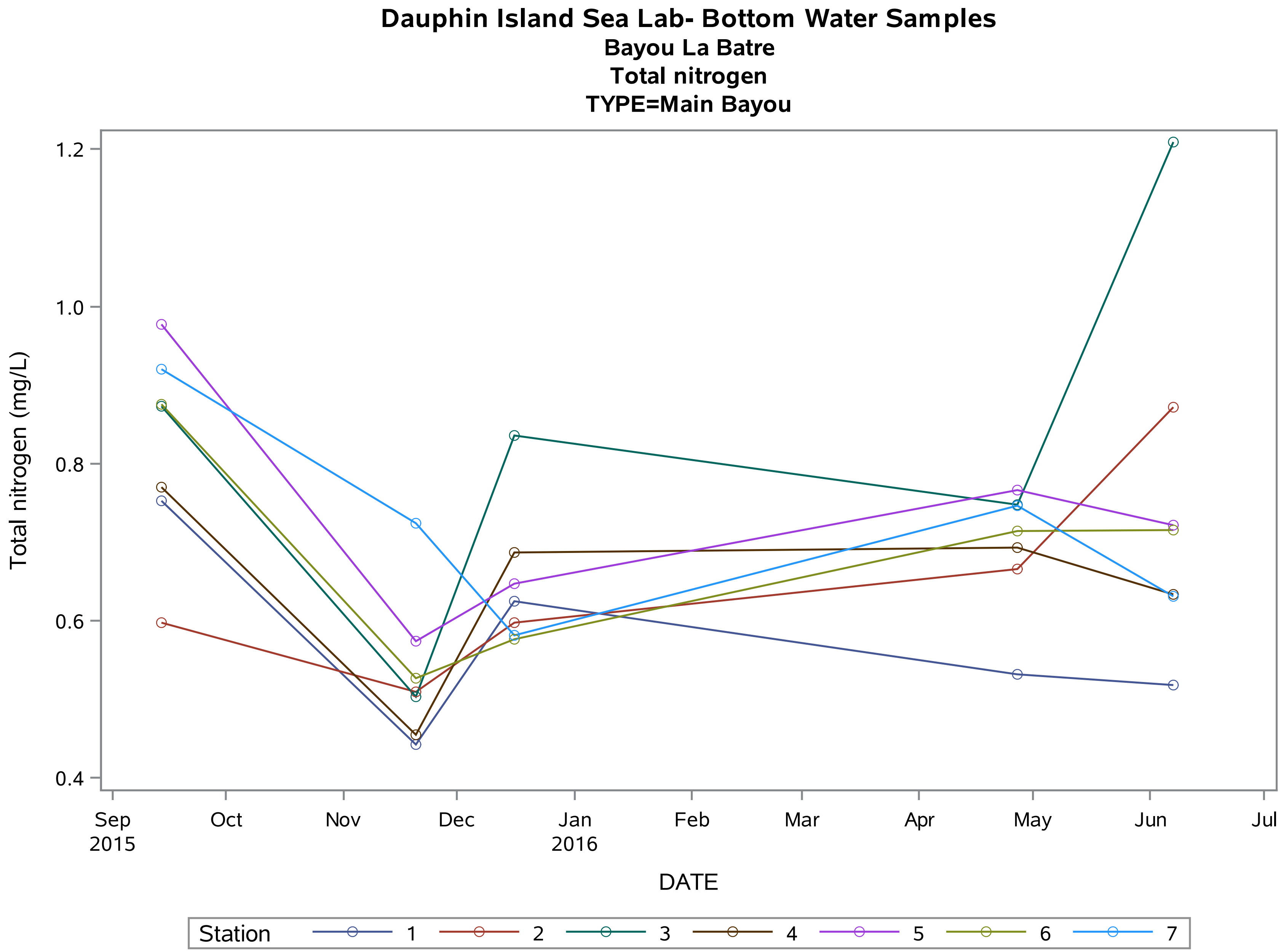
Dauphin Island Sea Lab- Bottom Water Samples
Bayou La Batre
Chlorophyll a
TYPE=Main Bayou
Chlorophyll a (ug/L)
0
1
2
3
4
5
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
Station
1
2
3
4
5
6
7



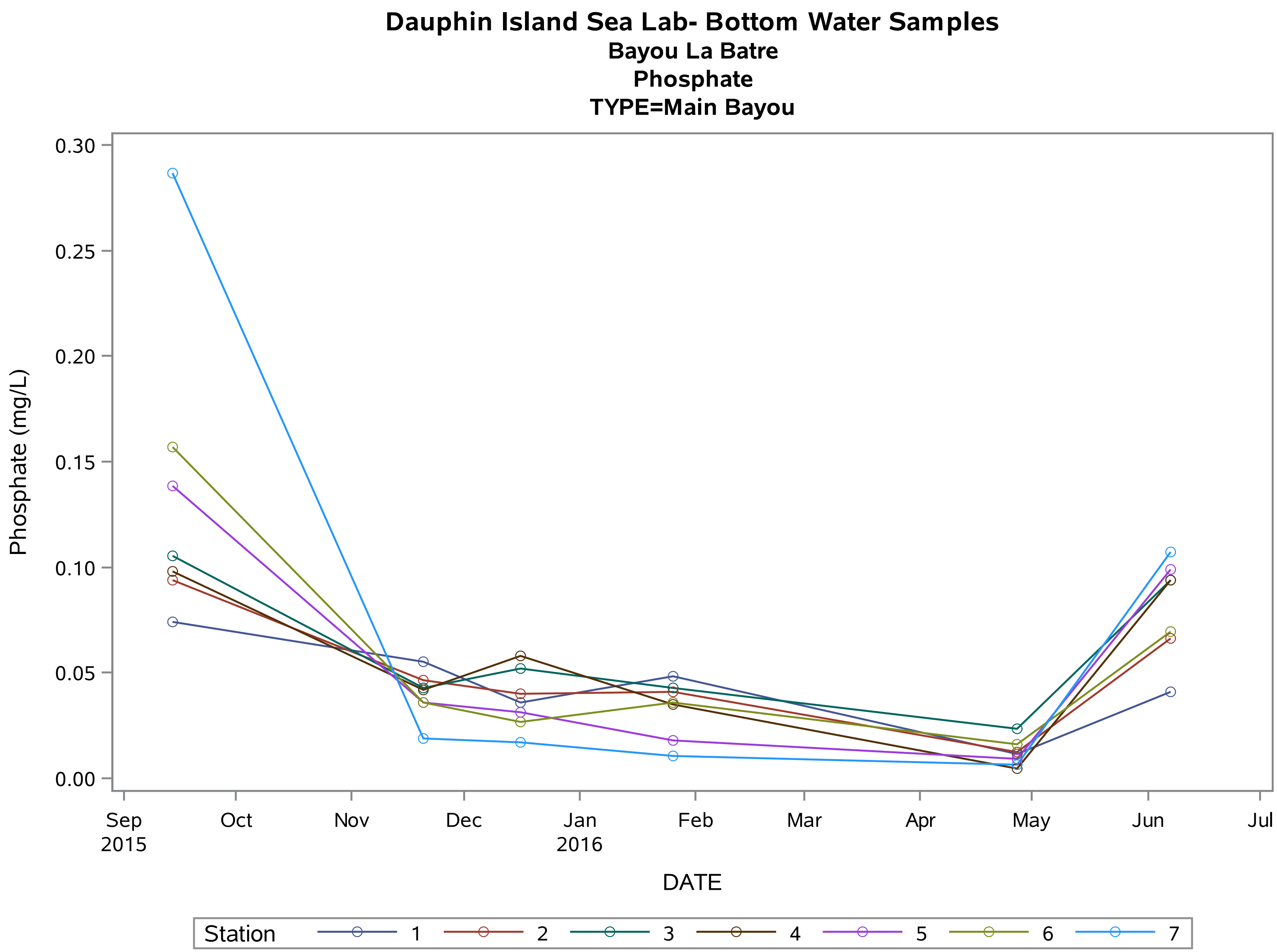
Dauphin Island Sea Lab- Bottom Water Samples
Bayou La Batre
Dissolved inorganic nitrogen
TYPE=Main Bayou
Dissolved inorganic nitrogen (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
Station
1
2
3
4
5
6
7

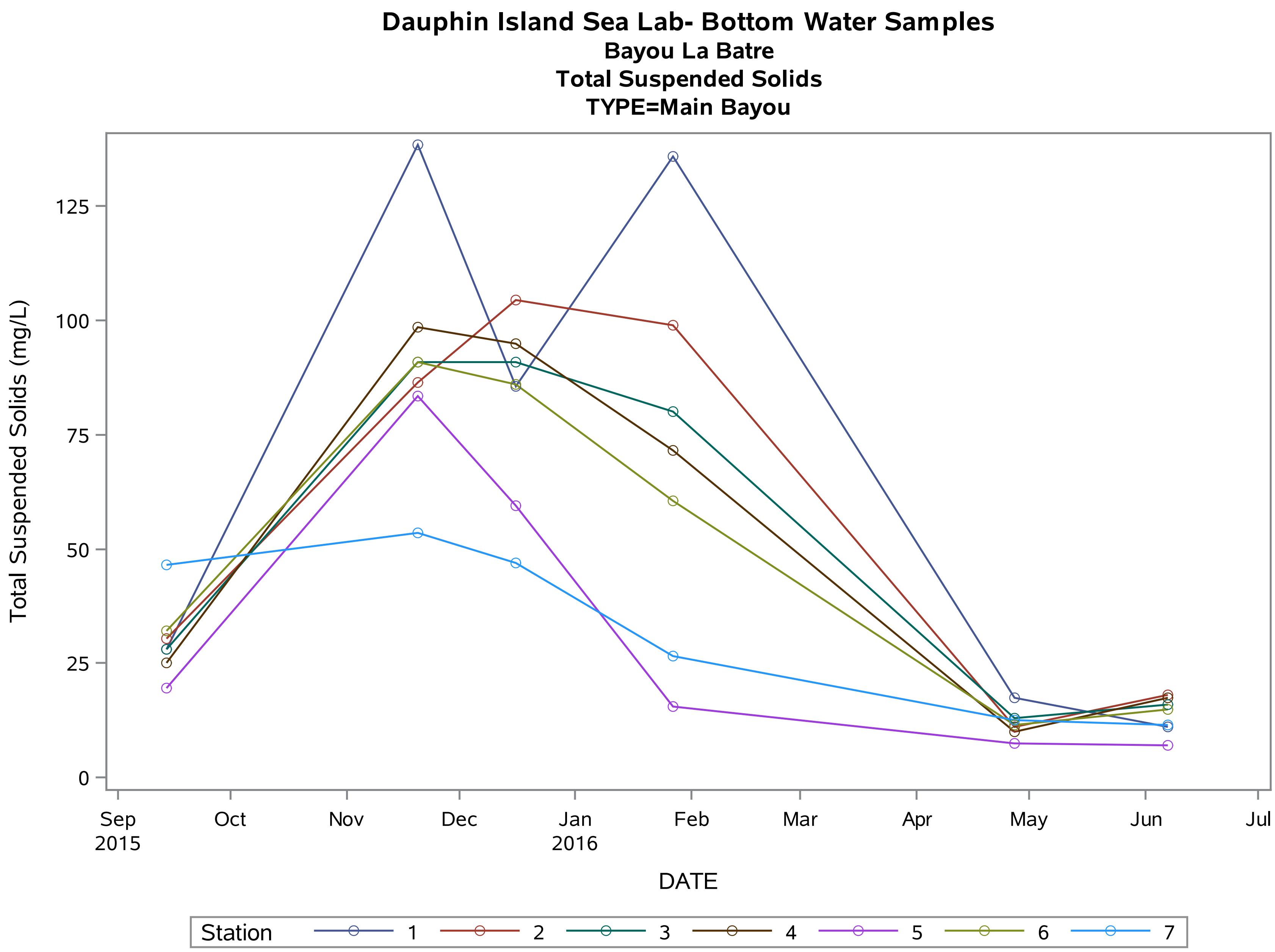


Dauphin Island Sea Lab- Bottom Water Samples
Bayou La Batre
Total dissolved nitrogen
TYPE=Main Bayou
Total dissolved nitrogen (mg/L)
0.8
0.6
0.4
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
Station
1
2
3
4
5
6
7

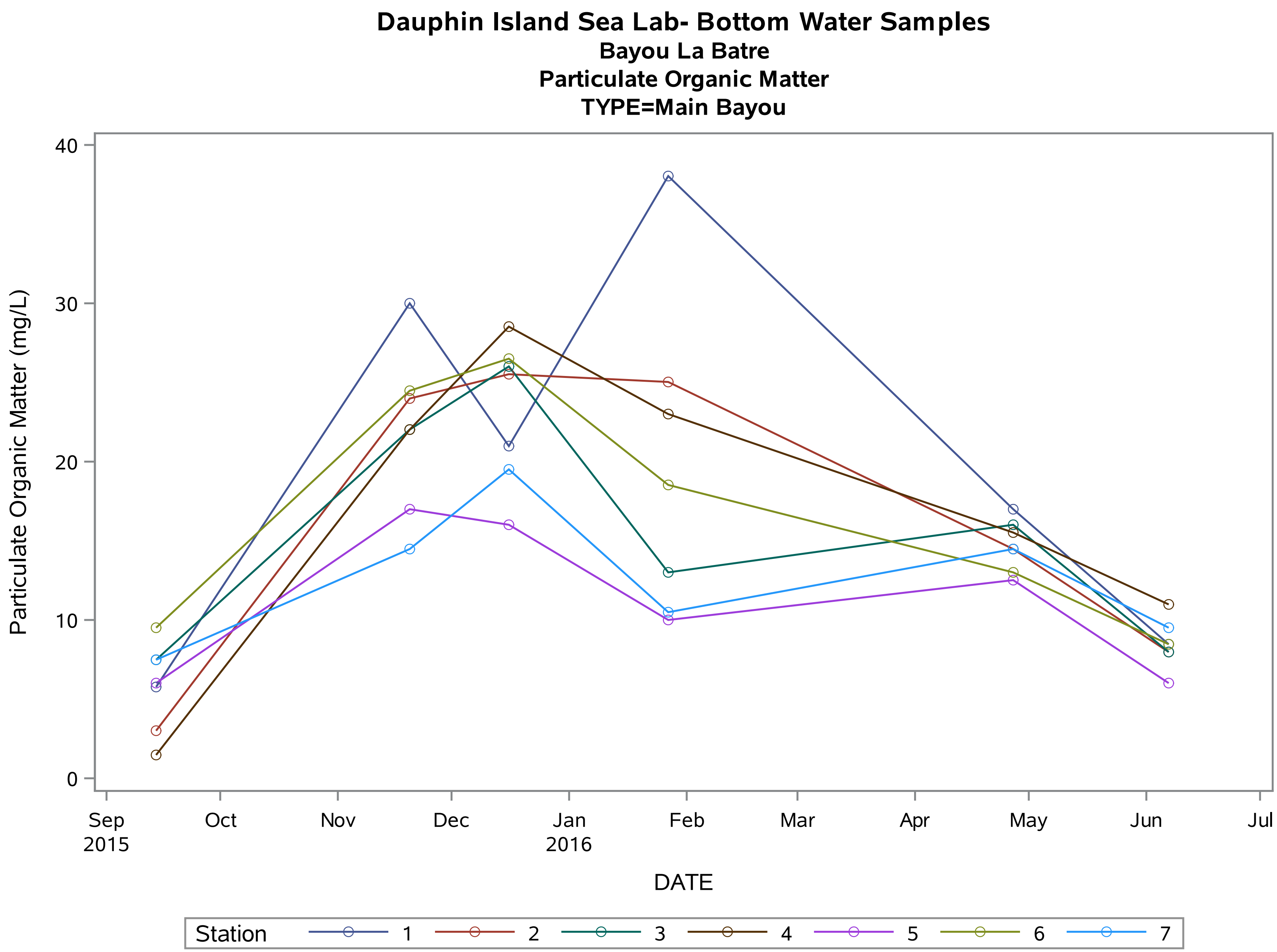


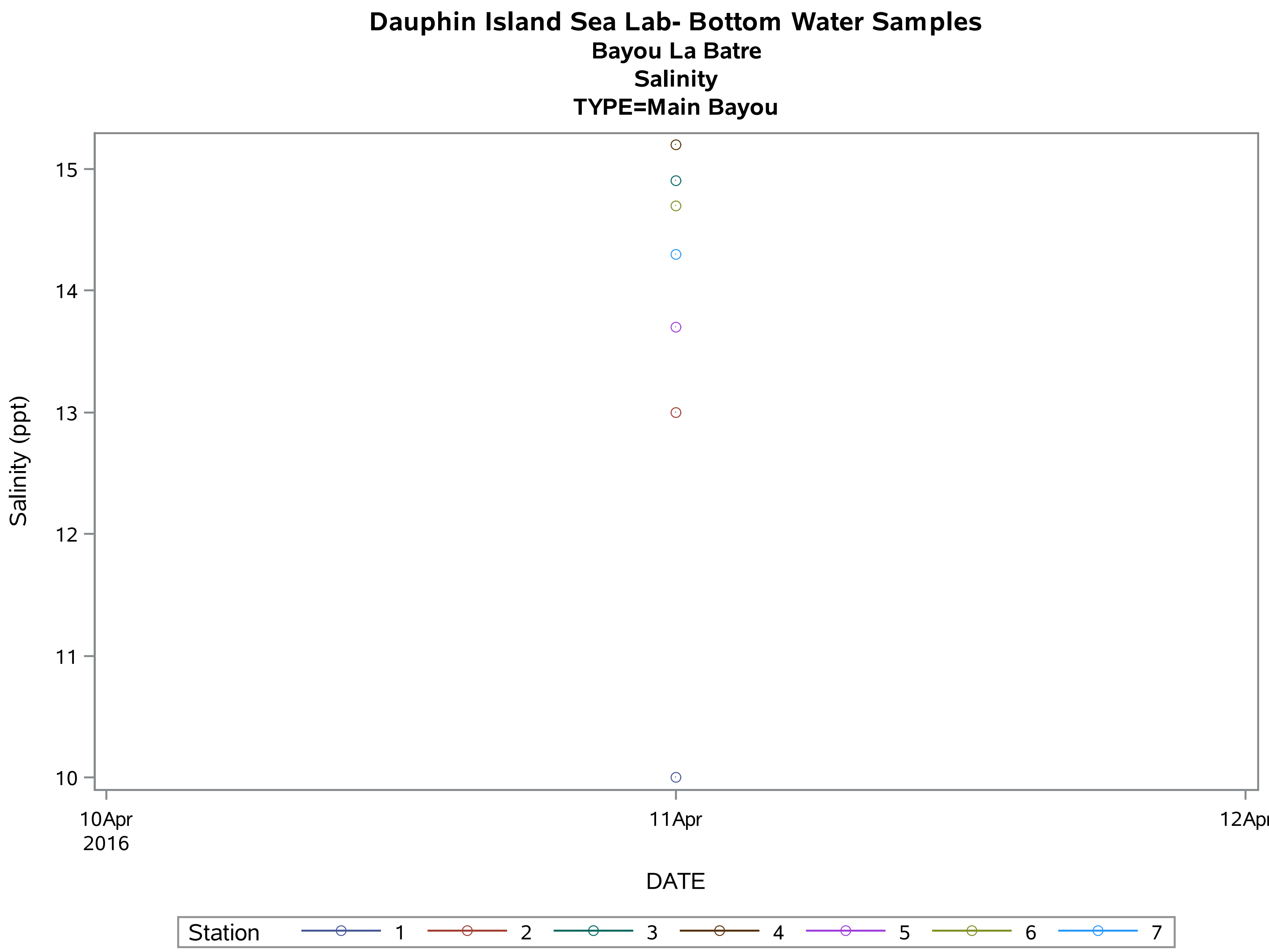
Dauphin Island Sea Lab- Bottom Water Samples
Bayou La Batre
Total nitrogen
TYPE=Main Bayou
Total nitrogen (mg/L)
1.2
1.0
0.8
0.6
0.4
Sep
2015
Oct
Nov
Dec
Jan
2016
Feb
Mar
Apr
May
Jun
Jul
DATE
Station
1
2
3
4
5
6
7

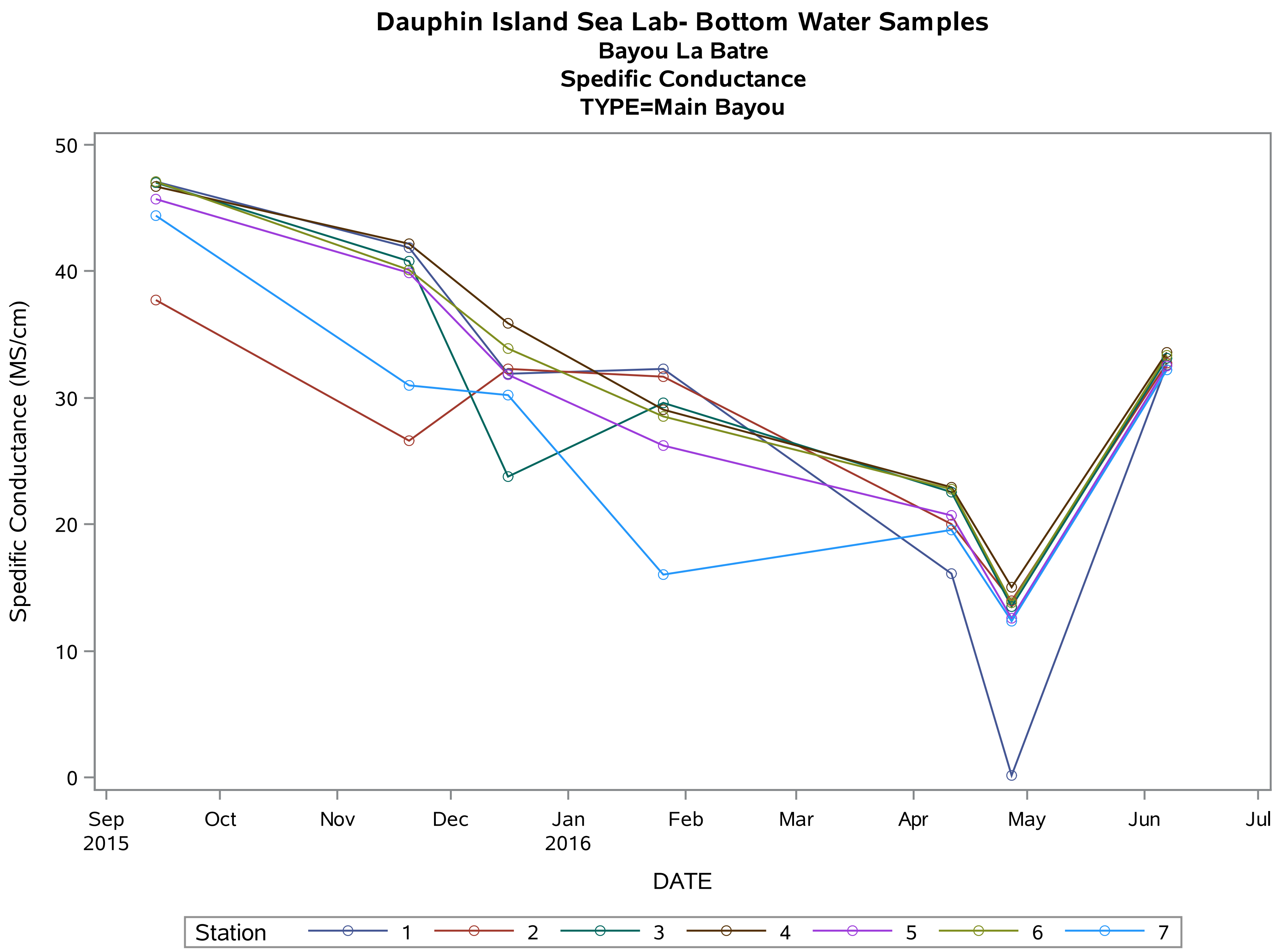

Dauphin Island Sea Lab- Bottom Water Samples
Bayou La Batre
Phosphate
TYPE=Main Bayou
Phosphate (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
Station
1
2
3
4
5
6
7

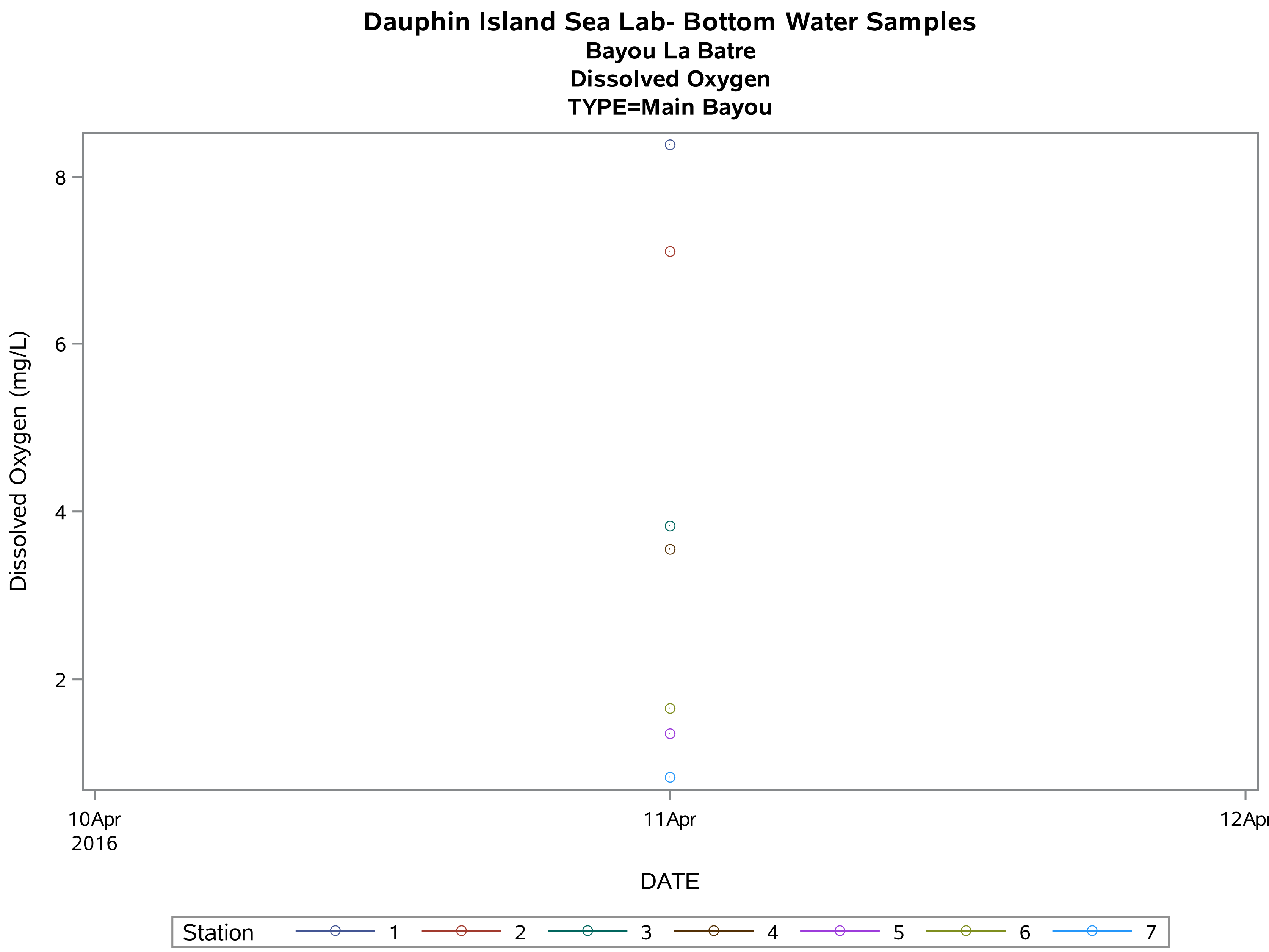


Dauphin Island Sea Lab- Bottom Water Samples
Bayou La Batre
Total Suspended Solids
TYPE=Main Bayou
Total Suspended Solids (mg/L)
0
25
50
75
100
125
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
Station
1
2
3
4
5
6
7

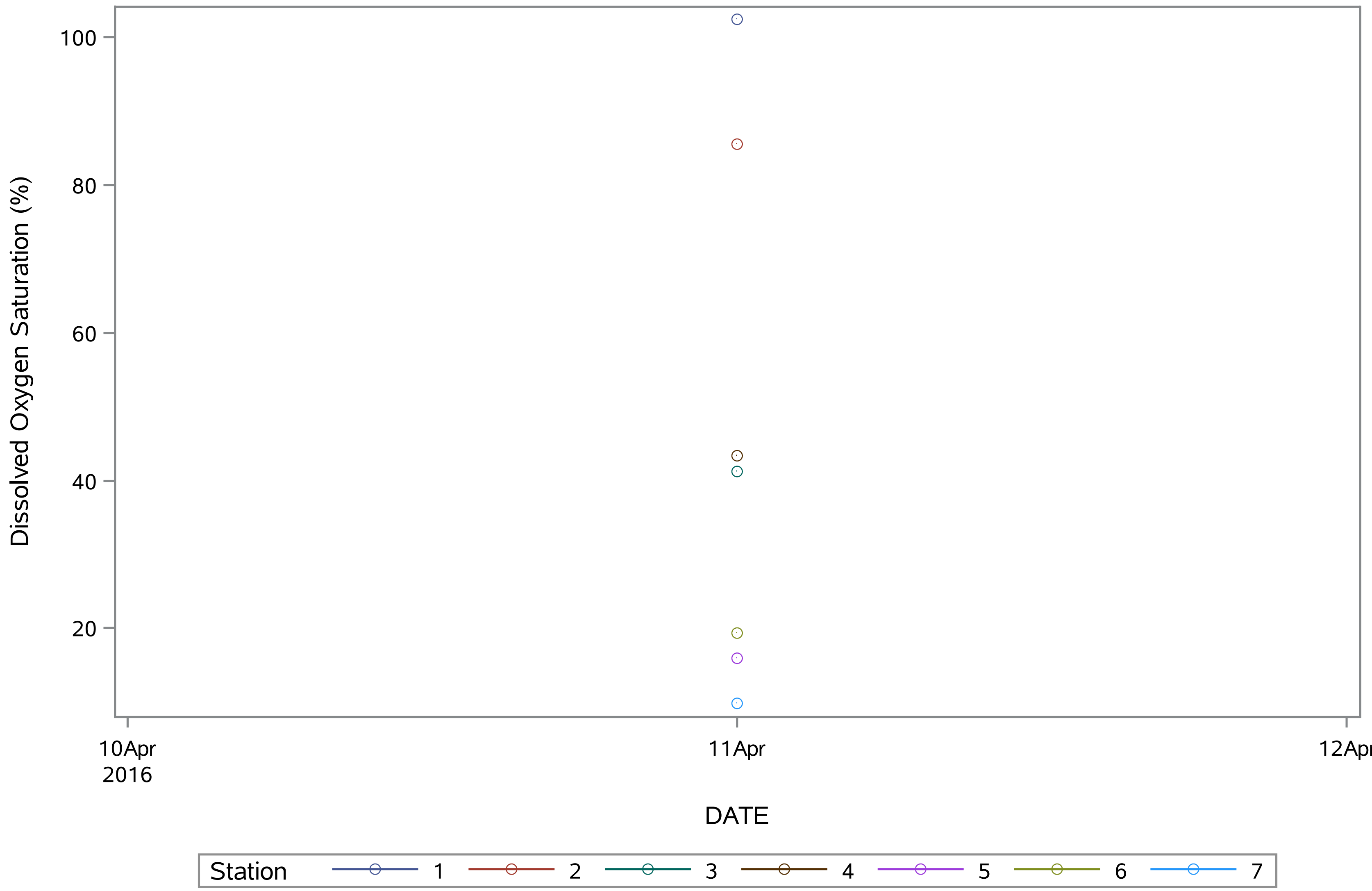

Dauphin Island Sea Lab- Bottom Water Samples
Bayou La Batre
Particulate Organic Matter
TYPE=Main Bayou
Particulate Organic Matter (mg/L)
40
30
20
10
0
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
Station
1
2
3
4
5
6
7

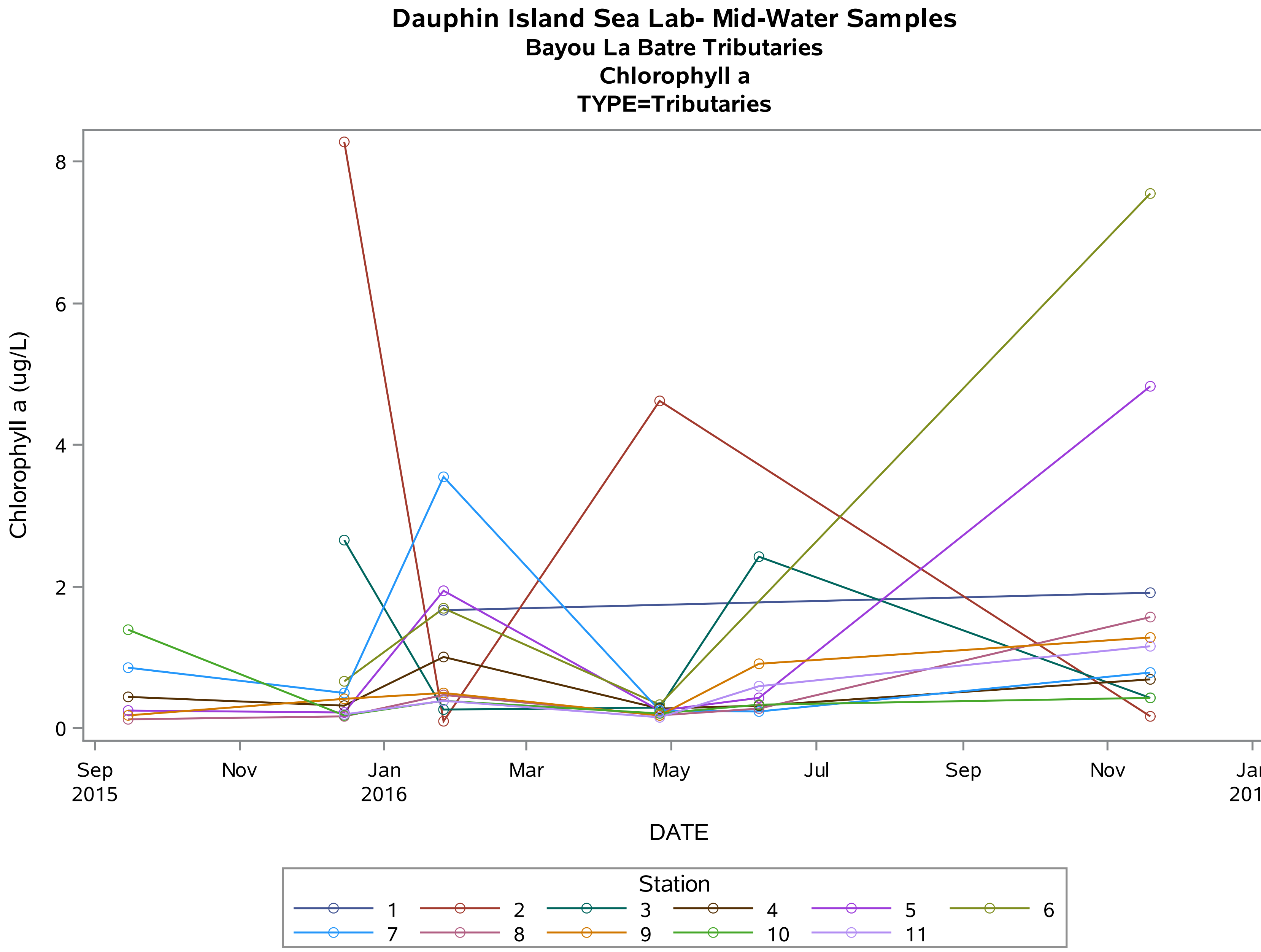

Dauphin Island Sea Lab- Bottom Water Samples
Bayou La Batre
Salinity
TYPE=Main Bayou
Salinity (ppt)
15
14
13
12
11
10
10Apr
2016
11Apr
12Apr
DATE
Station
1
2
3
4
5
6
7

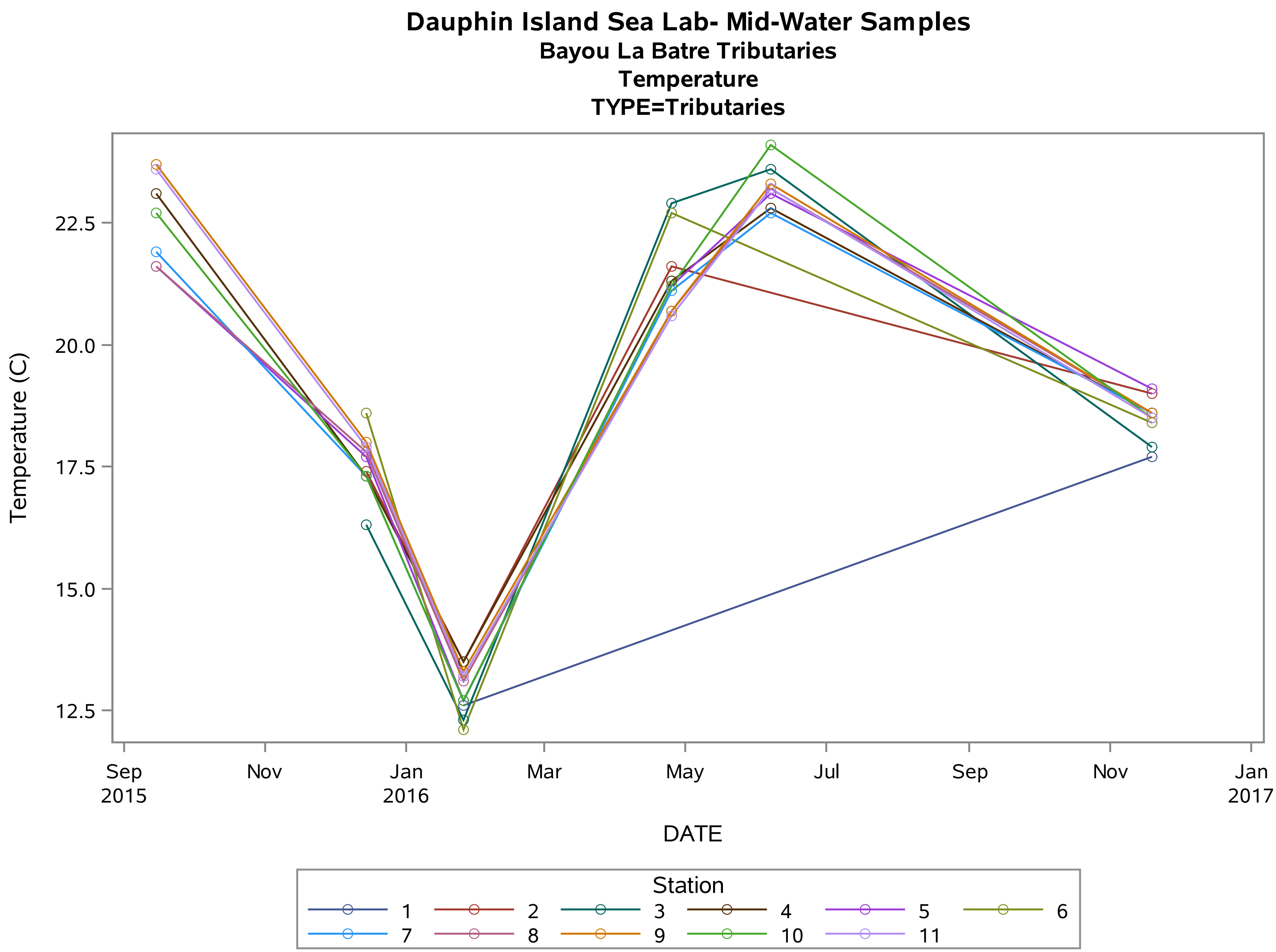

Dauphin Island Sea Lab- Bottom Water Samples
Bayou La Batre
Spedific Conductance
TYPE=Main Bayou
Spedific Conductance (MS/cm)
50
40
30
20
10
0
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
Station
1
2
3
4
5
6
7


Dauphin Island Sea Lab- Bottom Water Samples
Bayou La Batre
Dissolved Oxygen
TYPE=Main Bayou
Dissolved Oxygen (mg/L)
8
6
4
2
10Apr
2016
11Apr
12Apr
DATE
Station
1
2
3
4
5
6
7

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

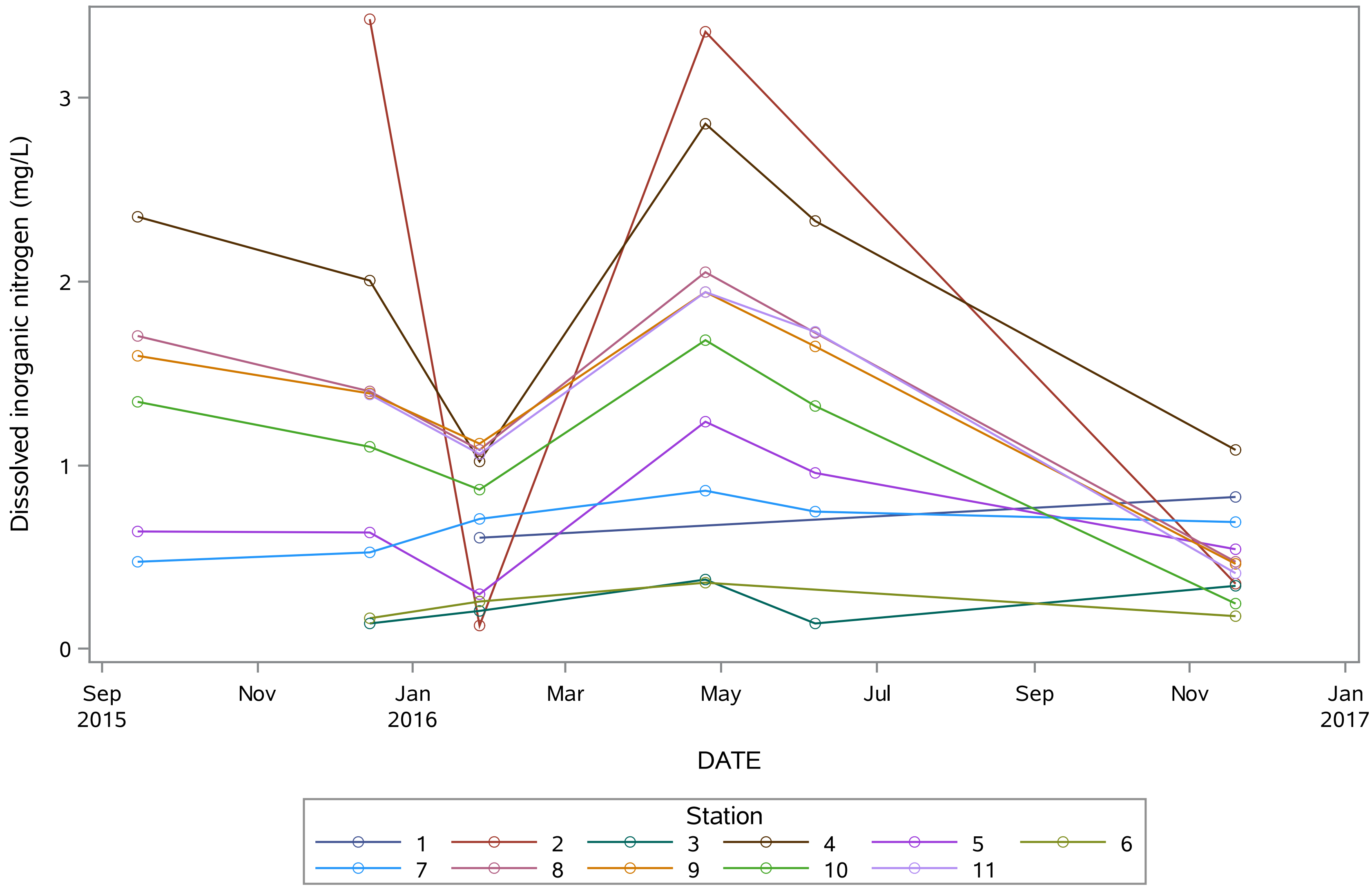


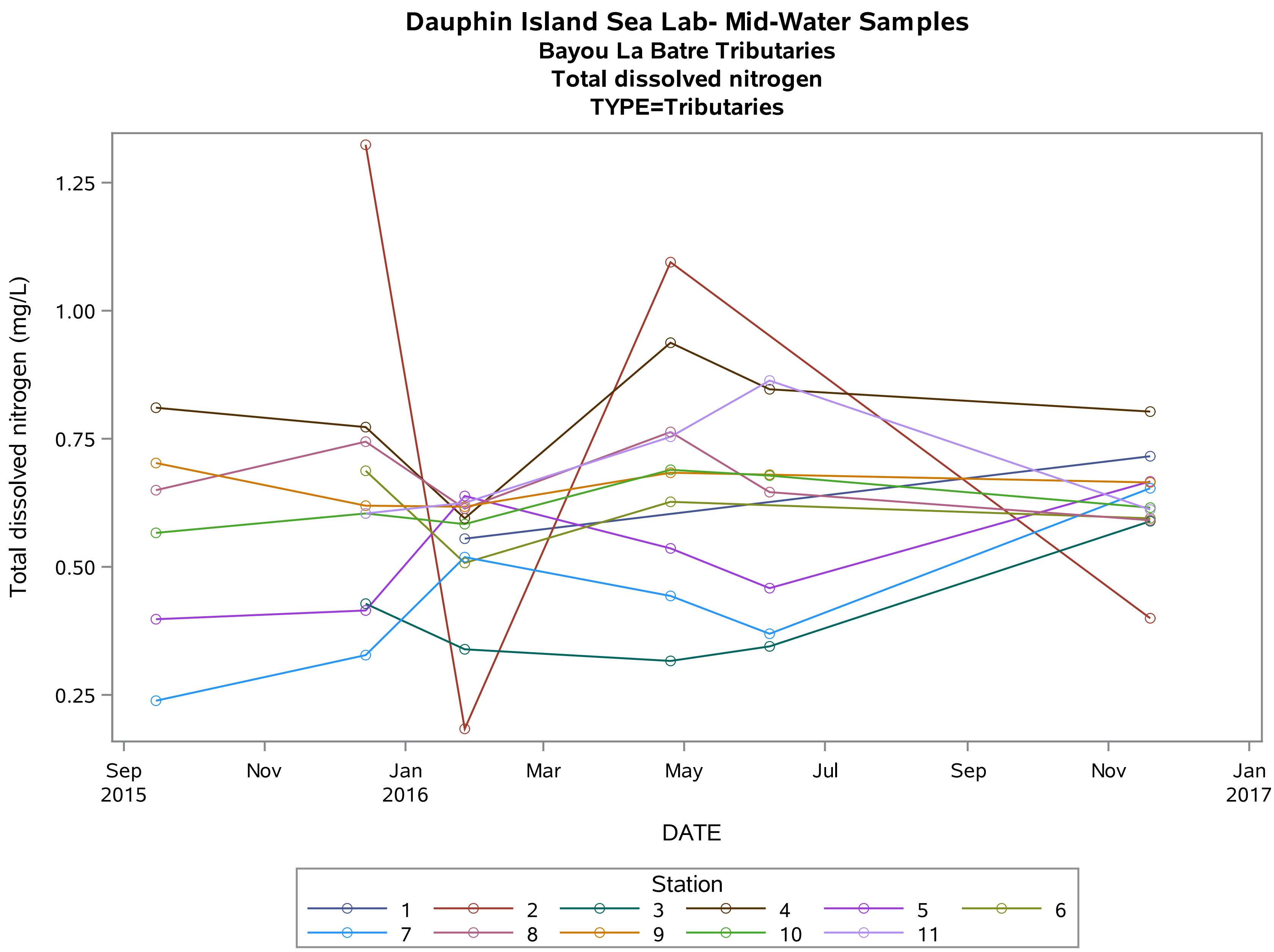

Dauphin Island Sea Lab- Mid-Water Samples
Bayou La Batre Tributaries
Chlorophyll a
TYPE=Tributaries
Chlorophyll a (ug/L)
0
2
4
6
8
Sep 2015
Nov
Jan 2016
Mar
May
Jul
Sep
Nov
Jan 2017
DATE
Station
1
2
3
4
5
6
7
8
9
10
11

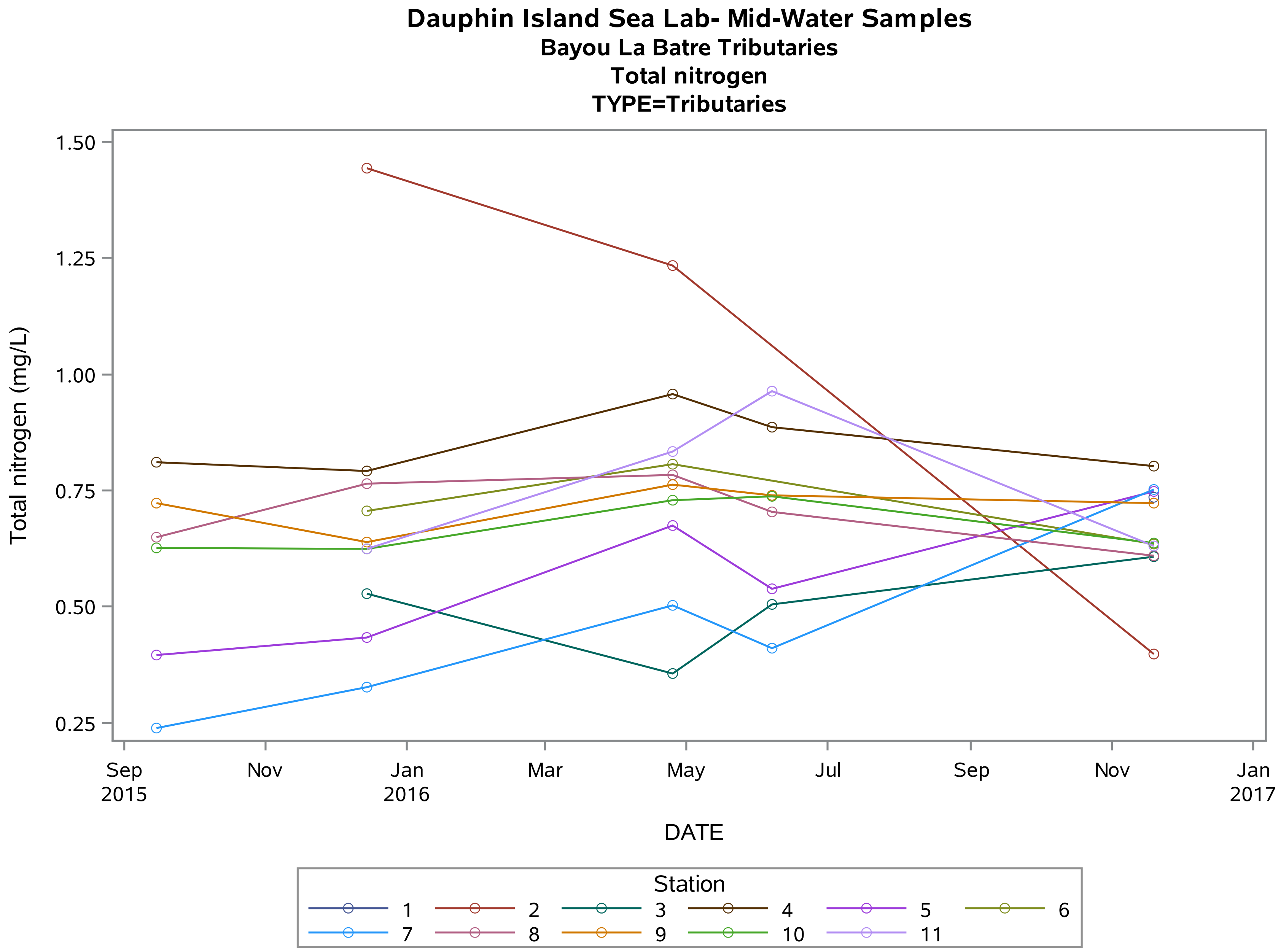


Dauphin Island Sea Lab- Mid-Water Samples
Bayou La Batre Tributaries
Temperature
TYPE=Tributaries
Temperature (C)
22.5
20.0
17.5
15.0
12.5
Sep 2015
Nov
Jan 2016
Mar
May
Jul
Sep
Nov
Jan 2017
DATE
Station
1
2
3
4
5
6
7
8
9
10
11

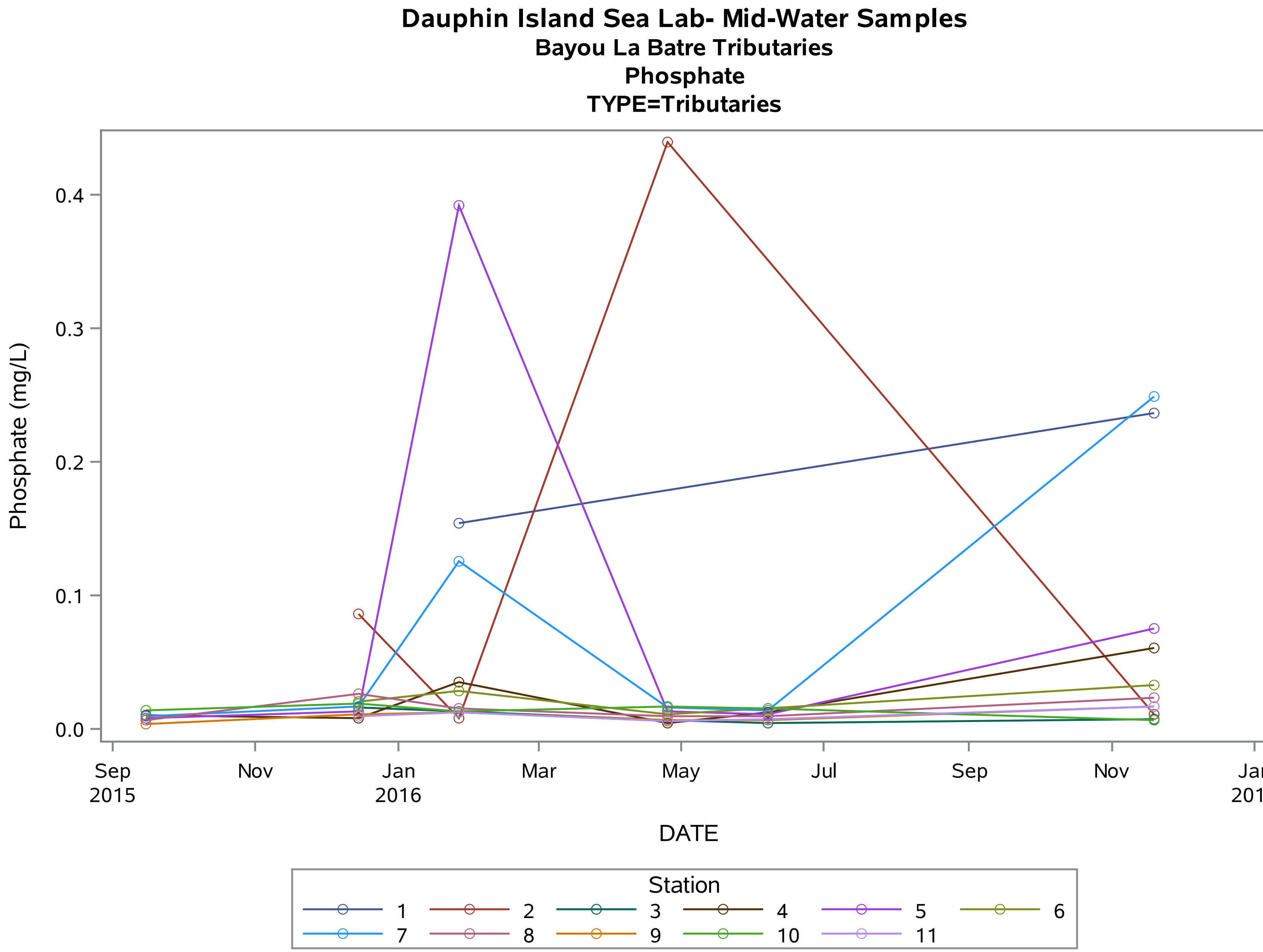
Dauphin Island Sea Lab- Mid-Water Samples
Bayou La Batre Tributaries
Dissolved inorganic nitrogen
TYPE=Tributaries

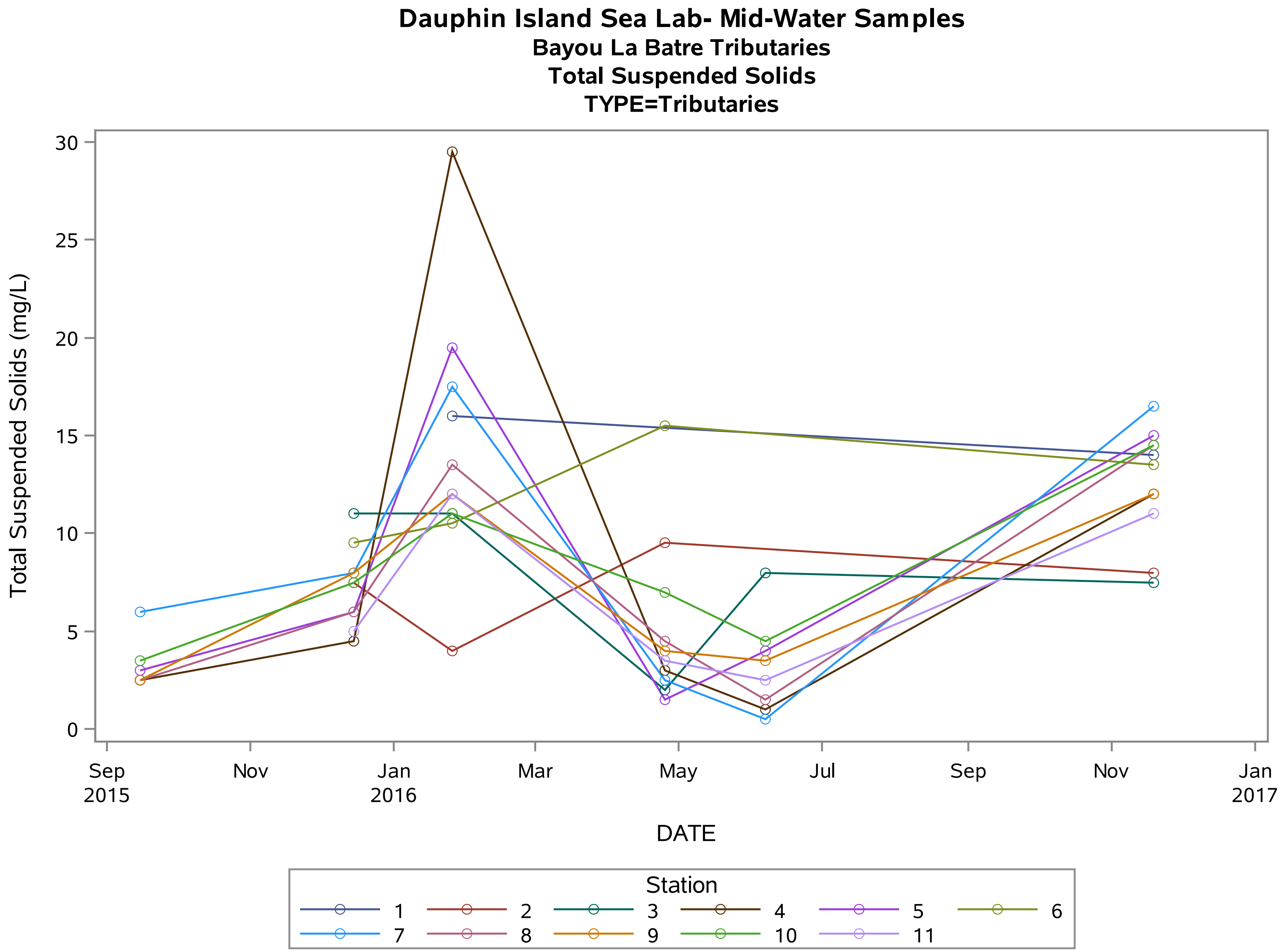


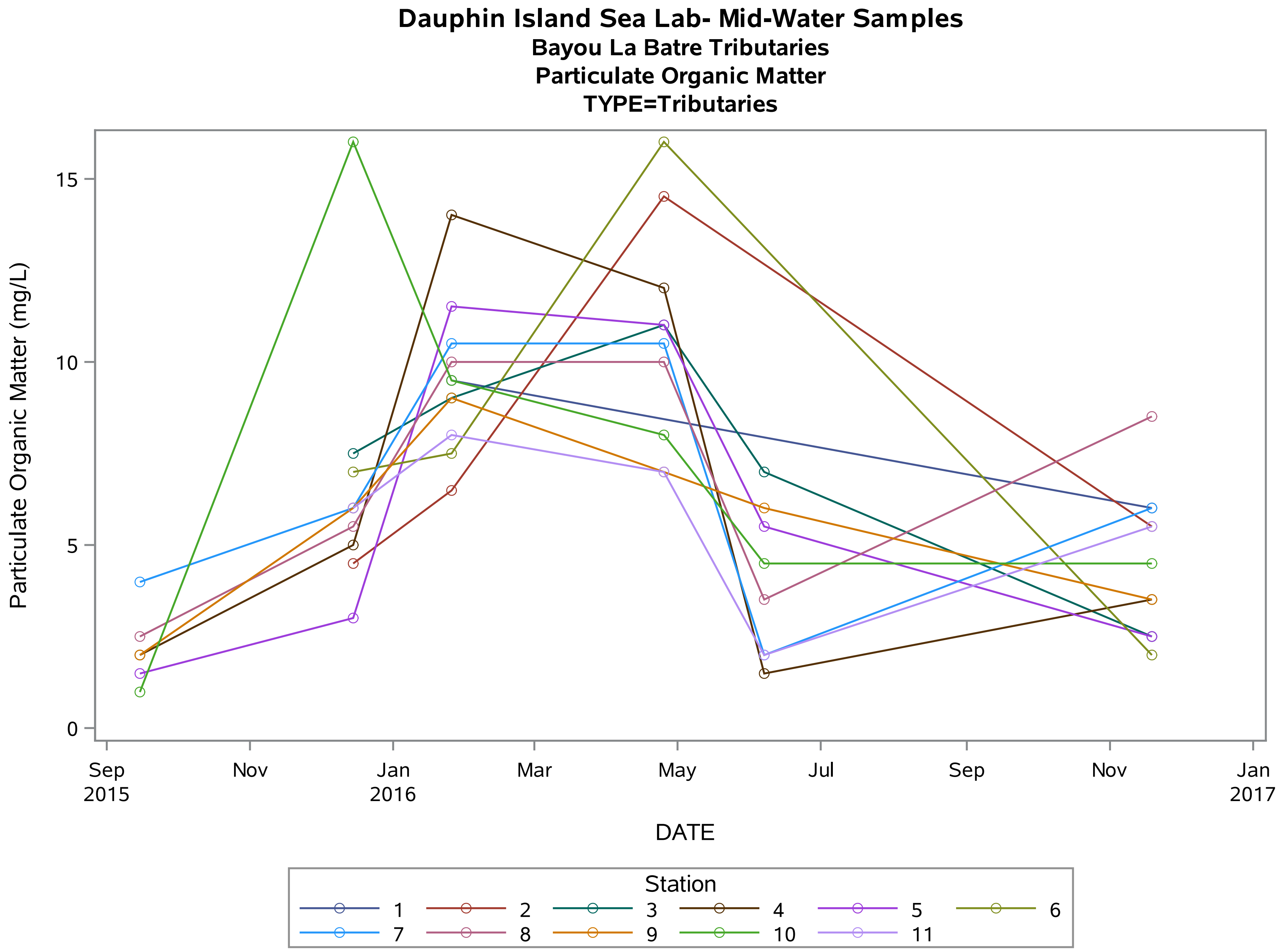

Dauphin Island Sea Lab- Mid-Water Samples
Bayou La Batre Tributaries
Total dissolved nitrogen
TYPE=Tributaries
Total dissolved nitrogen (mg/L)
1.25
1.00
0.75
0.50
0.25
Sep 2015
Nov
Jan 2016
Mar
May
Jul
Sep
Nov
Jan 2017
DATE
Station
1
2
3
4
5
6
7
8
9
10
11



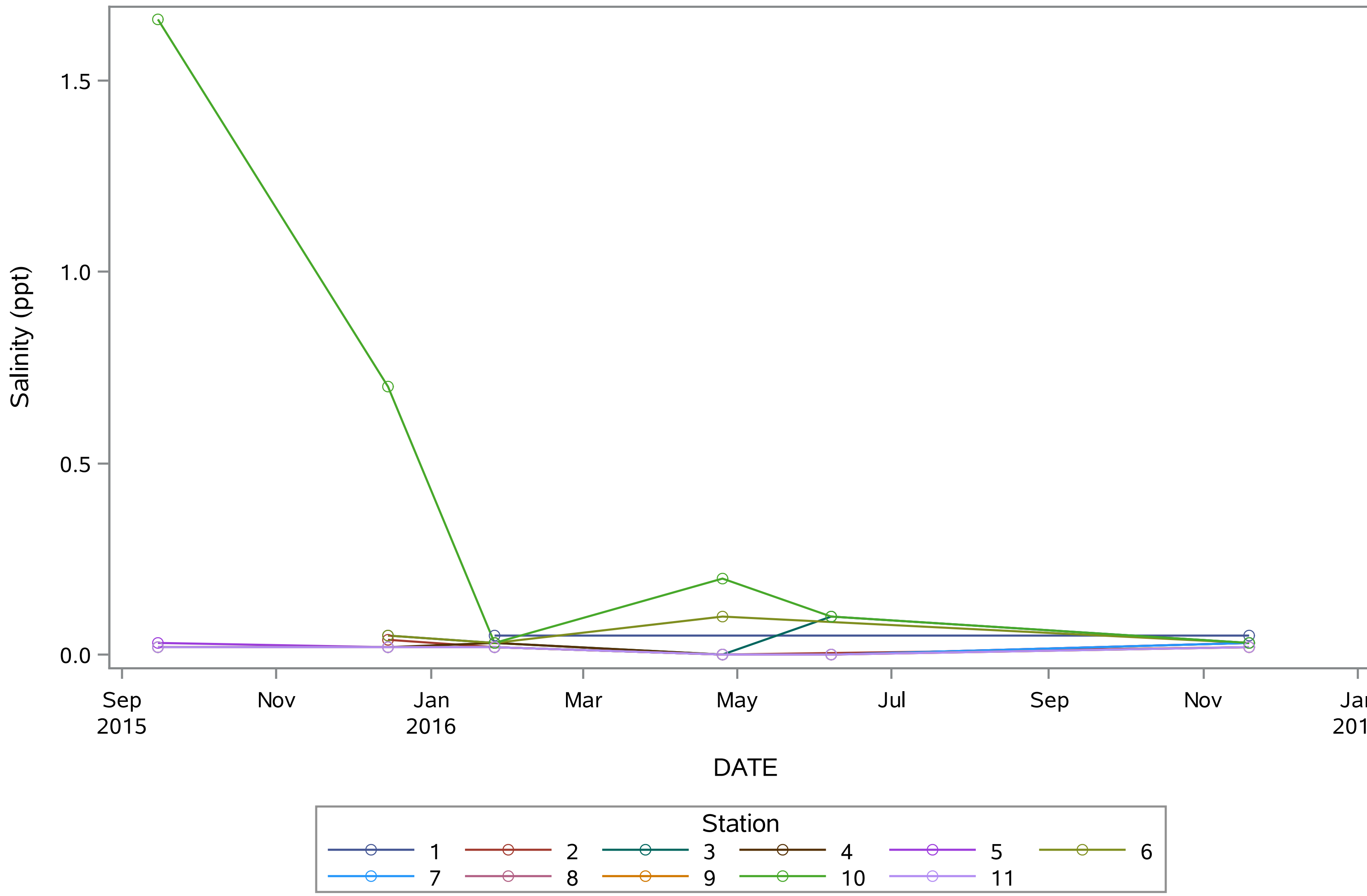
Dauphin Island Sea Lab- Mid-Water Samples
Bayou La Batre Tributaries
Total nitrogen
TYPE=Tributaries
Total nitrogen (mg/L)
1.50
1.25
1.00
0.75
0.50
0.25
Sep 2015
Nov
Jan 2016
Mar
May
Jul
Sep
Nov
Jan 2017
DATE
Station
1
2
3
4
5
6
7
8
9
10
11

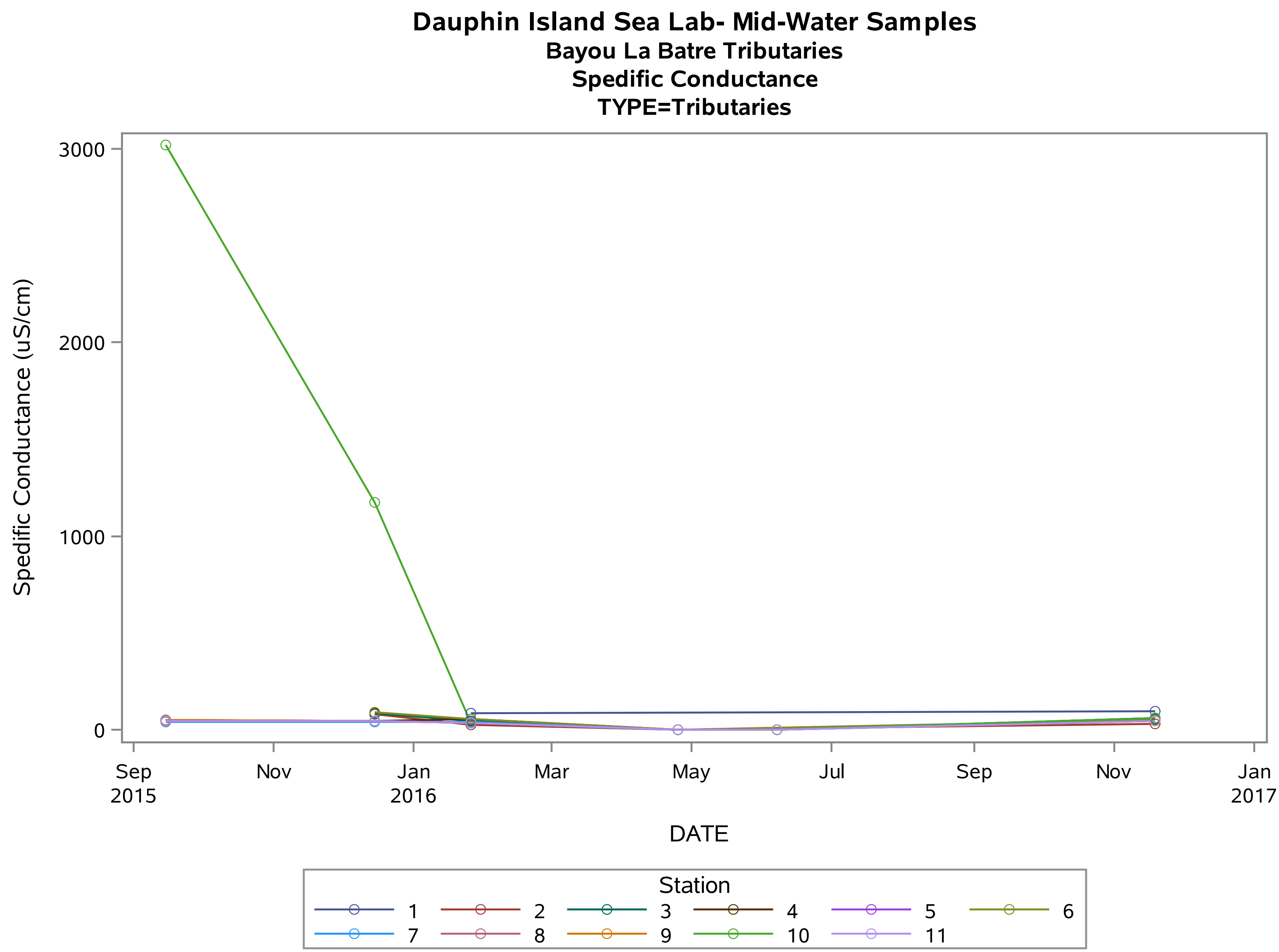

Dauphin Island Sea Lab- Mid-Water Samples
Bayou La Batre Tributaries
Phosphate
TYPE=Tributaries
Phosphate (mg/L)
0.0
0.1
0.2
0.3
0.4
Sep 2015
Nov
Jan 2016
Mar
May
Jul
Sep
Nov
Jan 2017
DATE
Station
1
2
3
4
5
6
7
8
9
10
11


Dauphin Island Sea Lab- Mid-Water Samples
Bayou La Batre Tributaries
Total Suspended Solids
TYPE=Tributaries
Total Suspended Solids (mg/L)
30
25
20
15
10
5
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

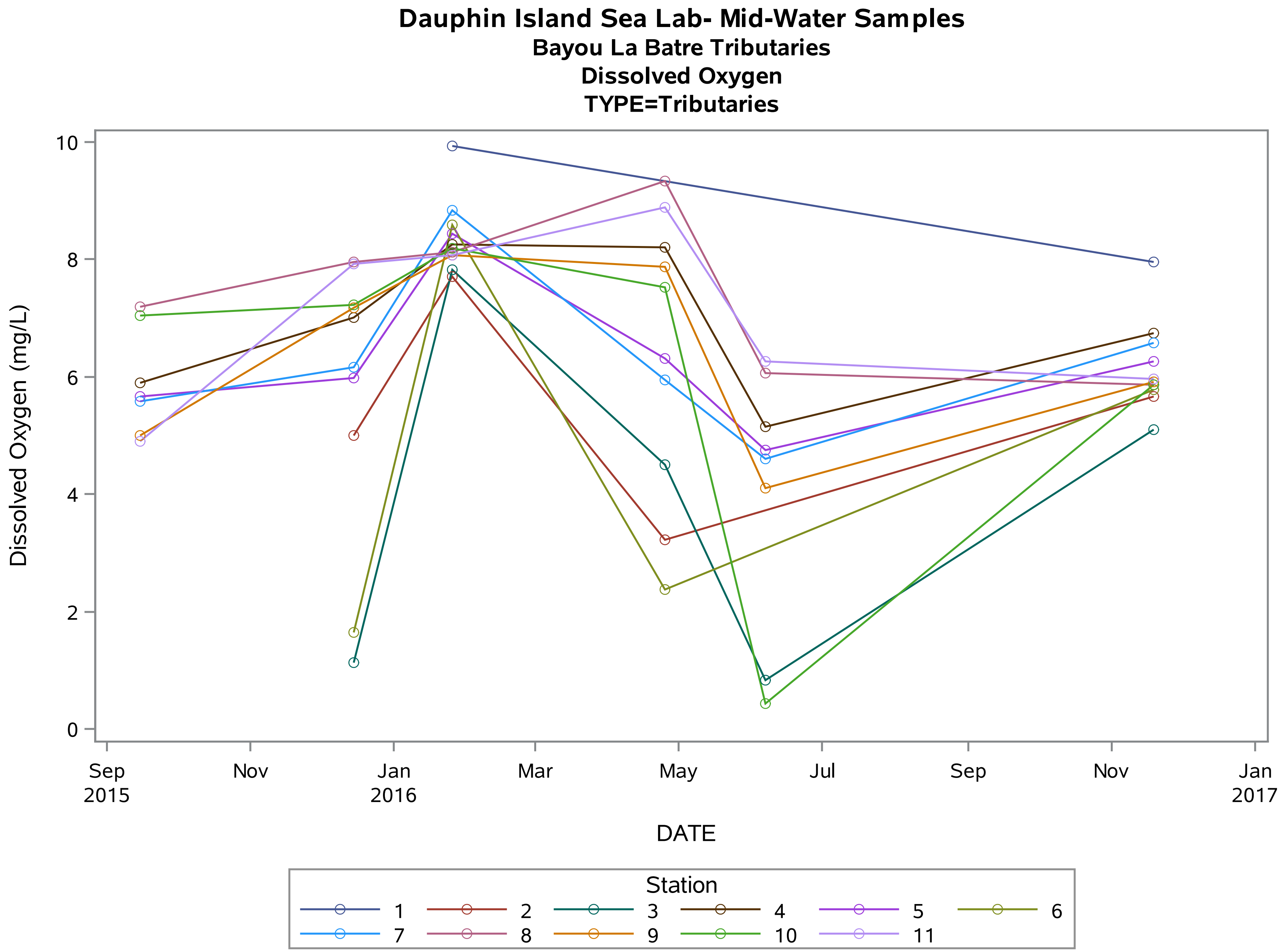

Dauphin Island Sea Lab- Mid-Water Samples
Bayou La Batre Tributaries
Particulate Organic Matter
TYPE=Tributaries
Particulate Organic Matter (mg/L)
0
5
10
15
Sep 2015
Nov
Jan 2016
Mar
May
Jul
Sep
Nov
Jan 2017
DATE
Station
1
2
3
4
5
6
7
8
9
10
11

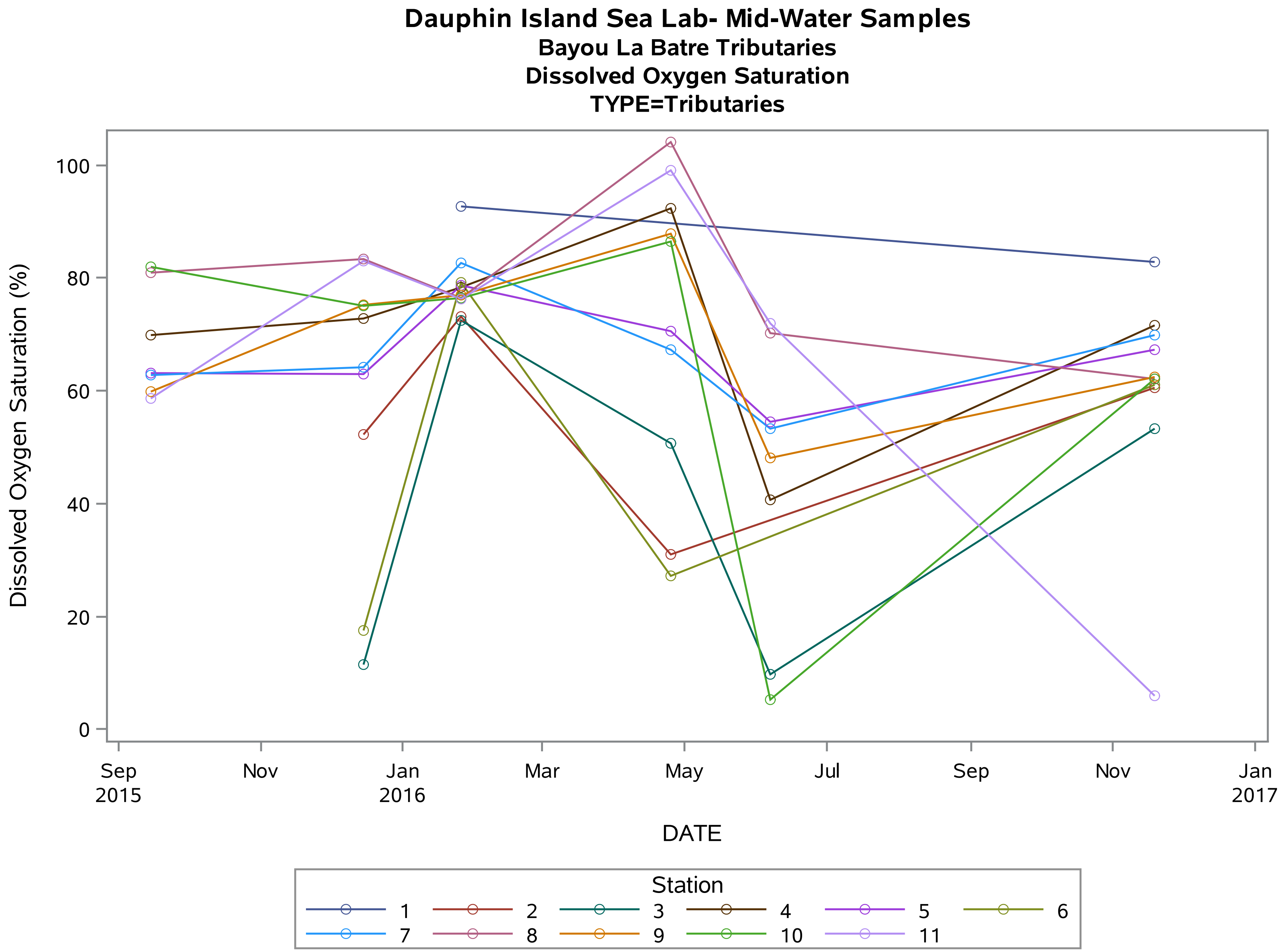
Dauphin Island Sea Lab- Mid-Water Samples
Bayou La Batre Tributaries
Salinity
TYPE=Tributaries



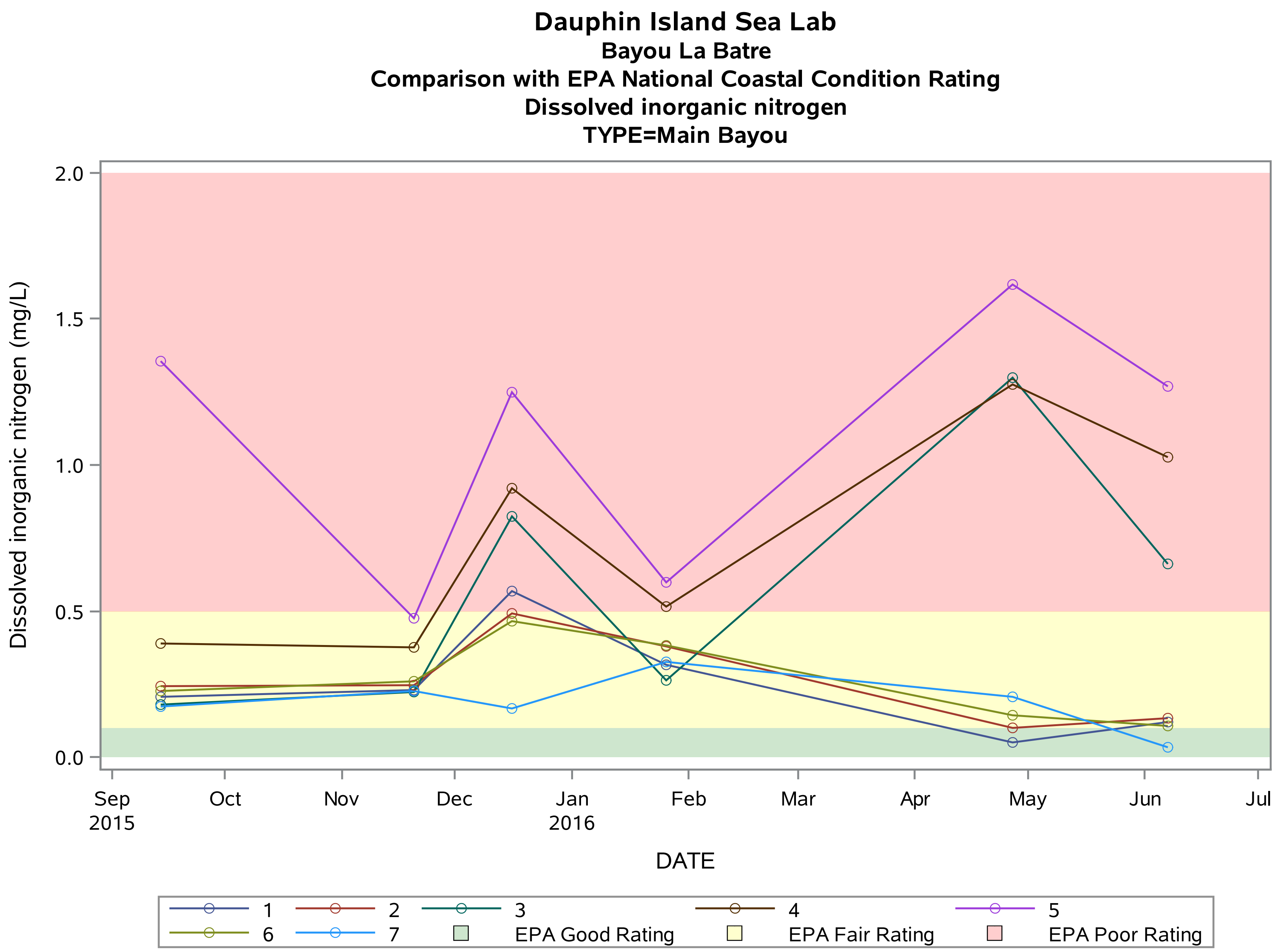


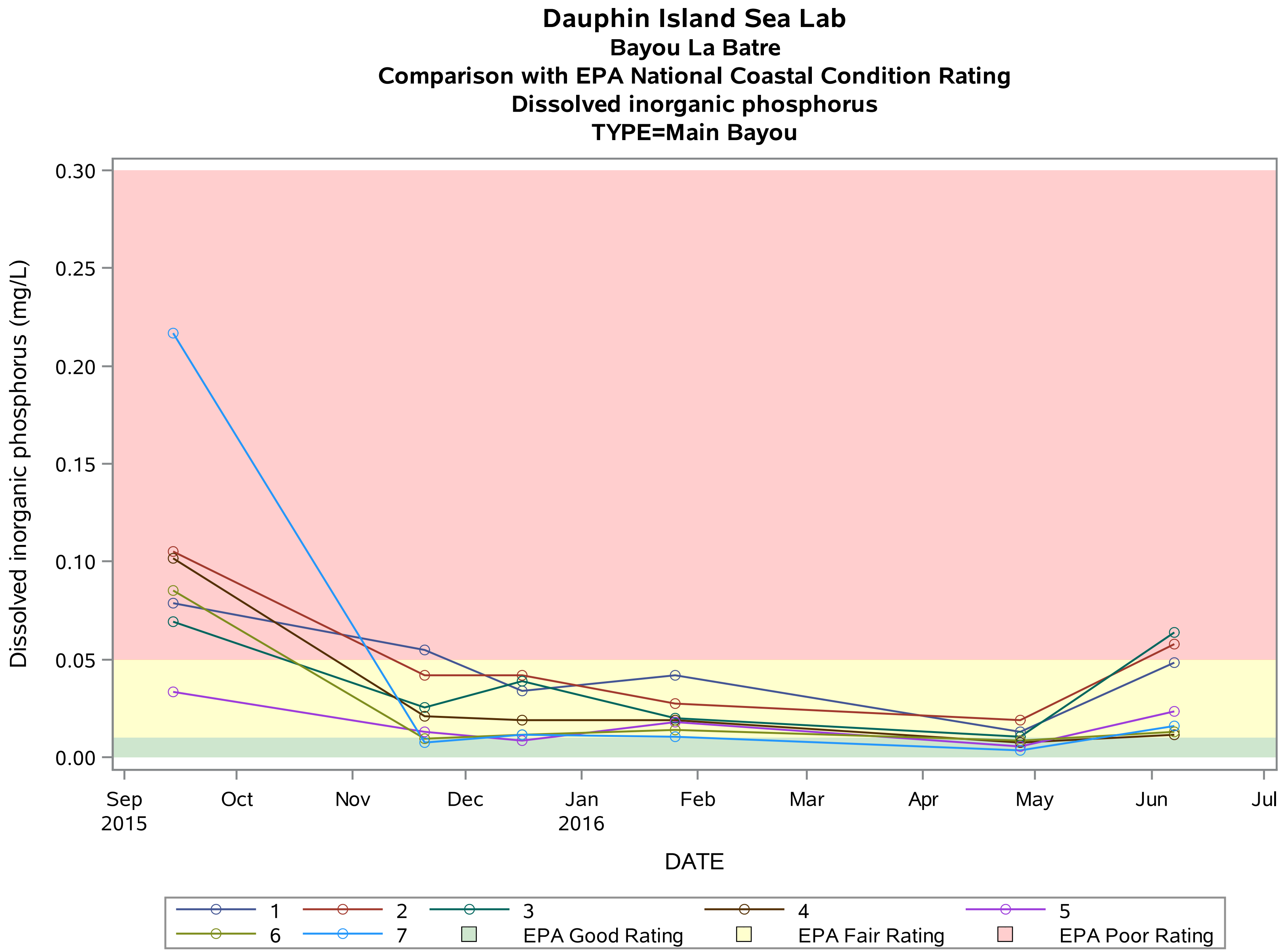
Dauphin Island Sea Lab- Mid-Water Samples
Bayou La Batre Tributaries
Spedific Conductance
TYPE=Tributaries
Spedific Conductance (uS/cm)
3000
2000
1000
0
Sep 2015
Nov
Jan 2016
Mar
May
Jul
Sep
Nov
Jan 2017
DATE
Station
1
2
3
4
5
6
7
8
9
10
11


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

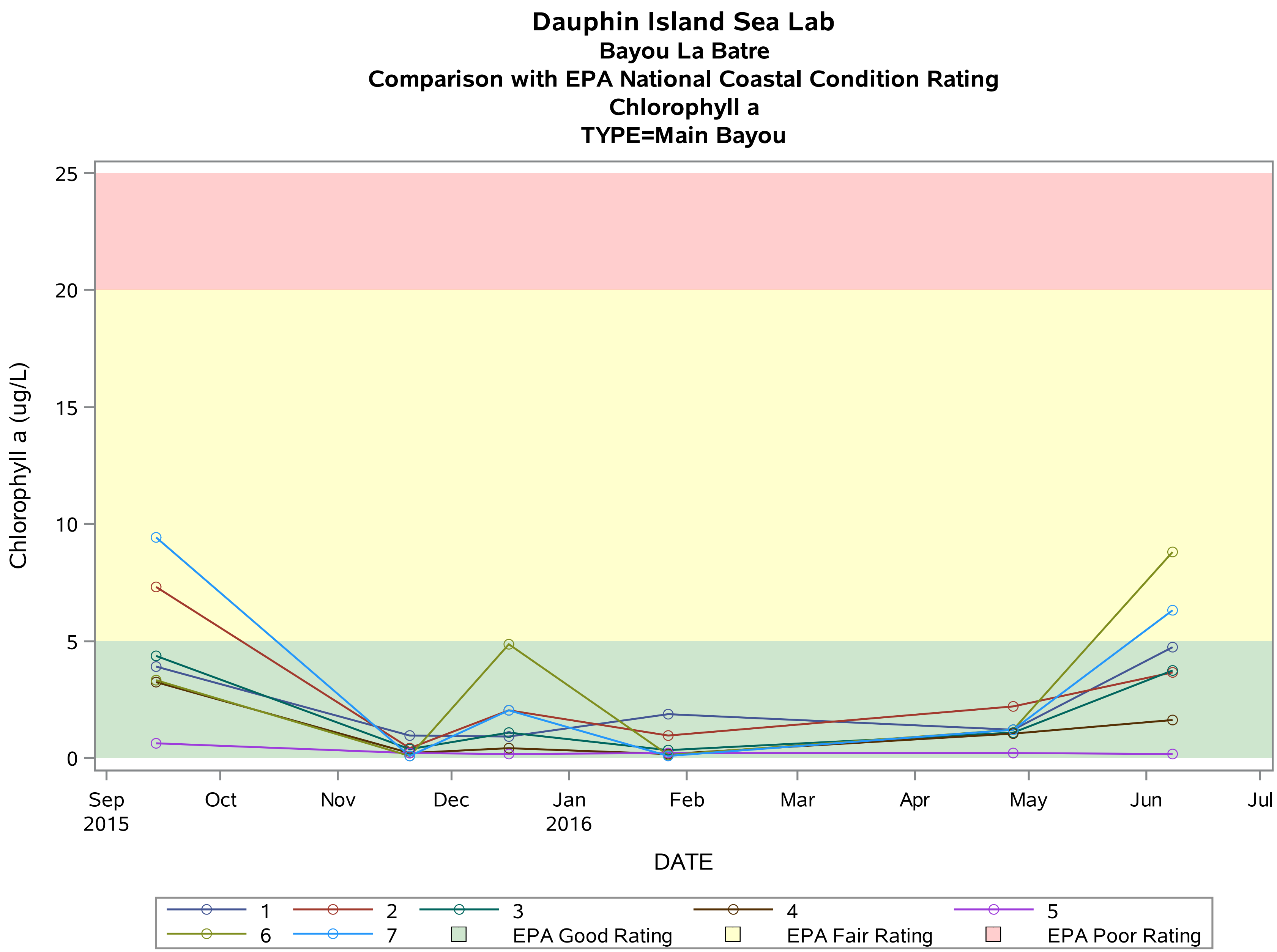


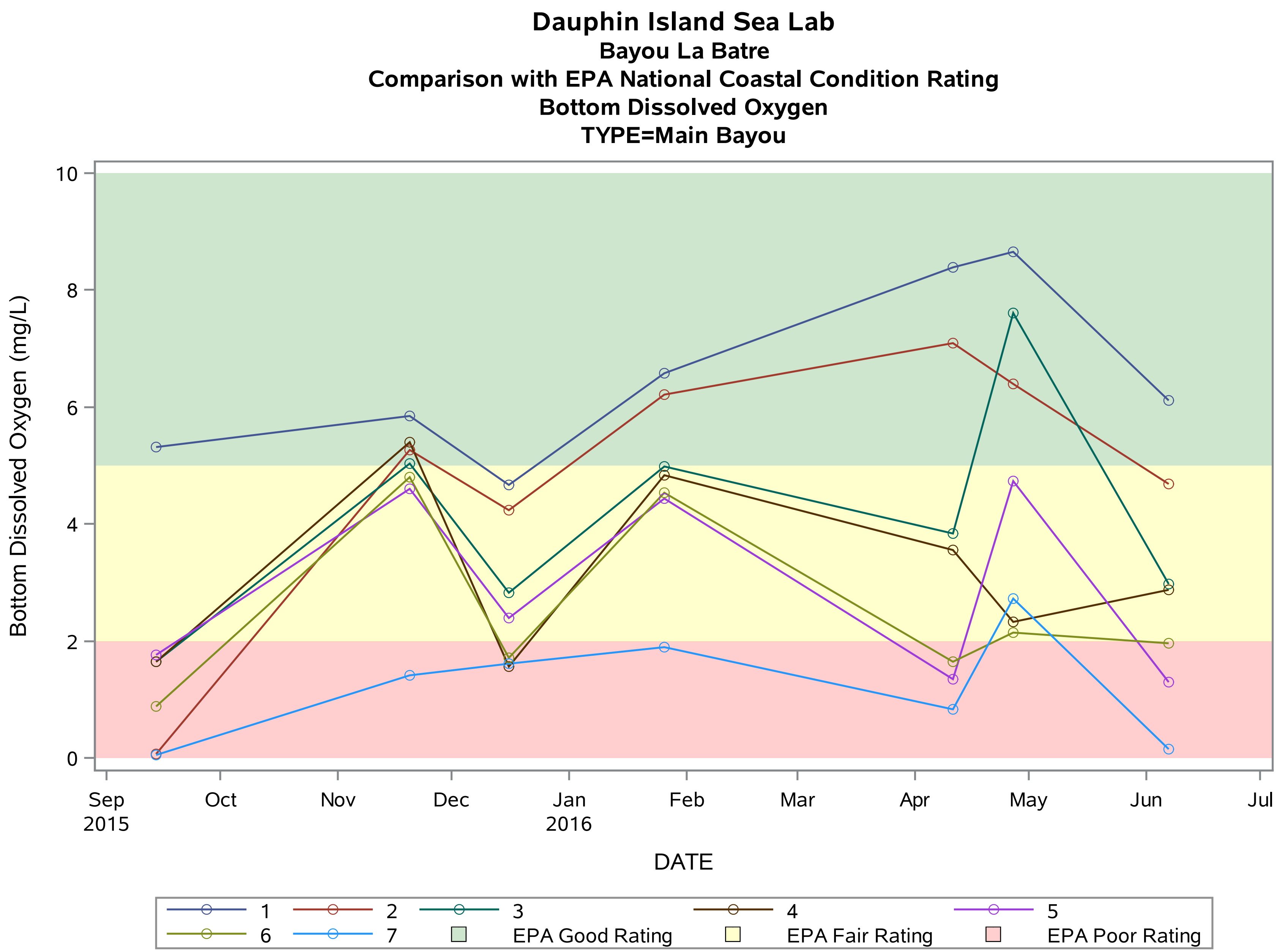
Dauphin Island Sea Lab- Mid-Water Samples
Bayou La Batre Tributaries
Dissolved Oxygen Saturation
TYPE=Tributaries
Dissolved Oxygen Saturation (%)
0
20
40
60
80
100
Sep 2015
Nov
Jan 2016
Mar
May
Jul
Sep
Nov
Jan 2017
DATE
Station
1
2
3
4
5
6
7
8
9
10
11

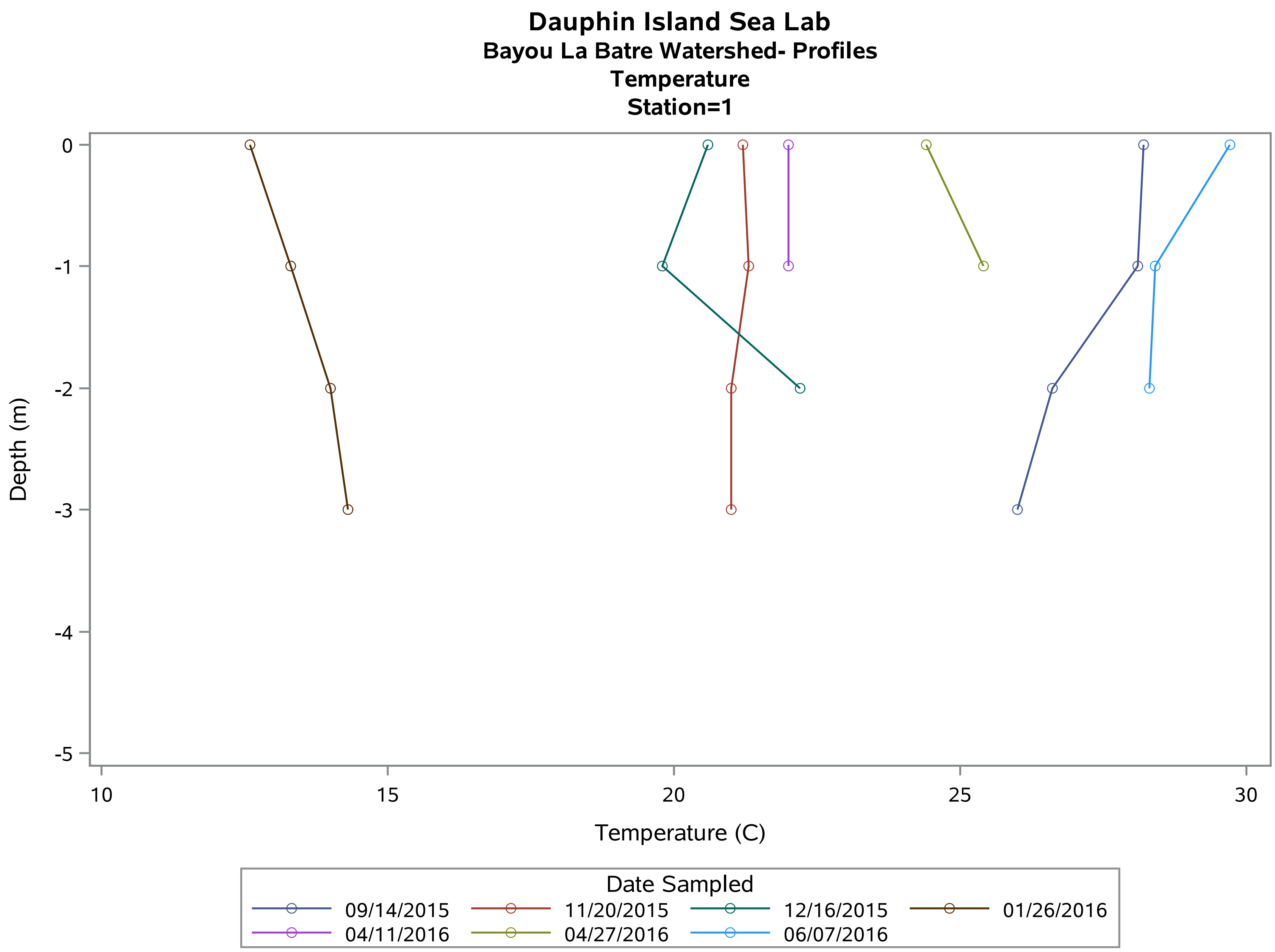

Dauphin Island Sea Lab
Bayou La Batre
Comparison with EPA National Coastal Condition Rating
Dissolved inorganic nitrogen
TYPE=Main Bayou
Dissolved inorganic nitrogen (mg/L)
2.0
1.5
1.0
0.5
0.0
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
1
2
3
4
5
6
7
EPA Good Rating
EPA Fair Rating
EPA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

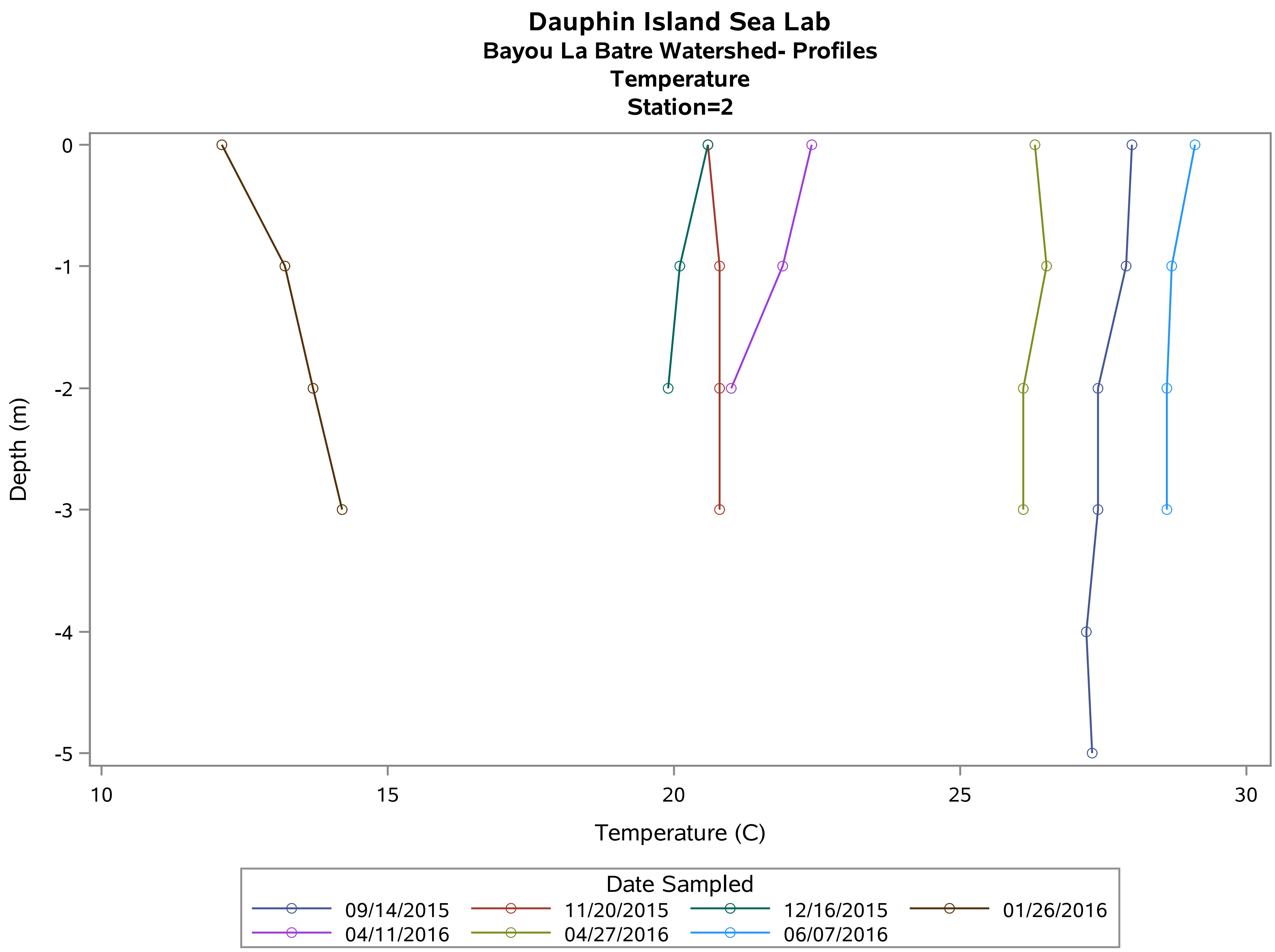


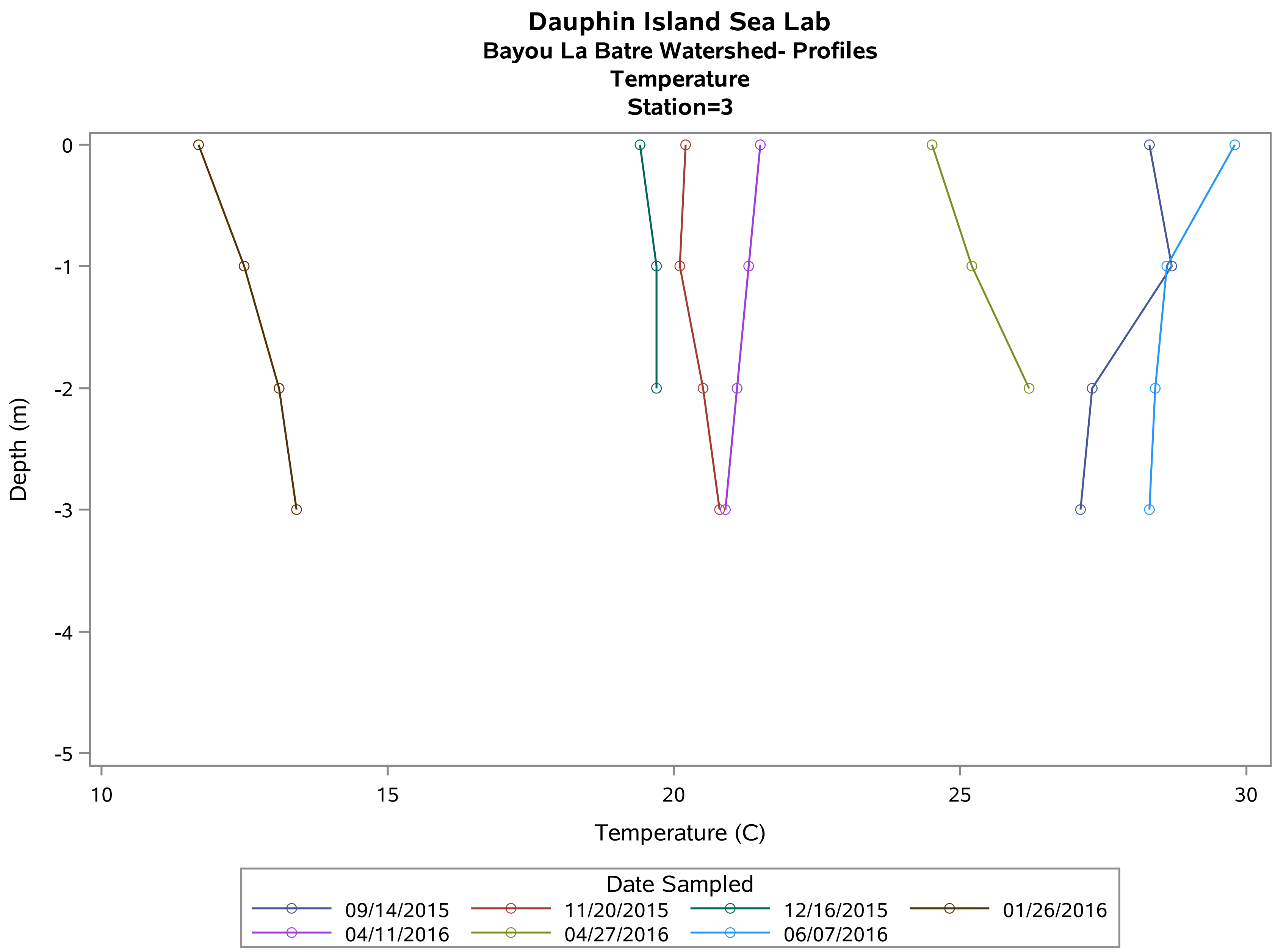
Dauphin Island Sea Lab
Bayou La Batre
Comparison with EPA National Coastal Condition Rating
Dissolved inorganic phosphorus
TYPE=Main Bayou
Dissolved inorganic phosphorus (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
1
2
3
4
5
6
7
EPA Good Rating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

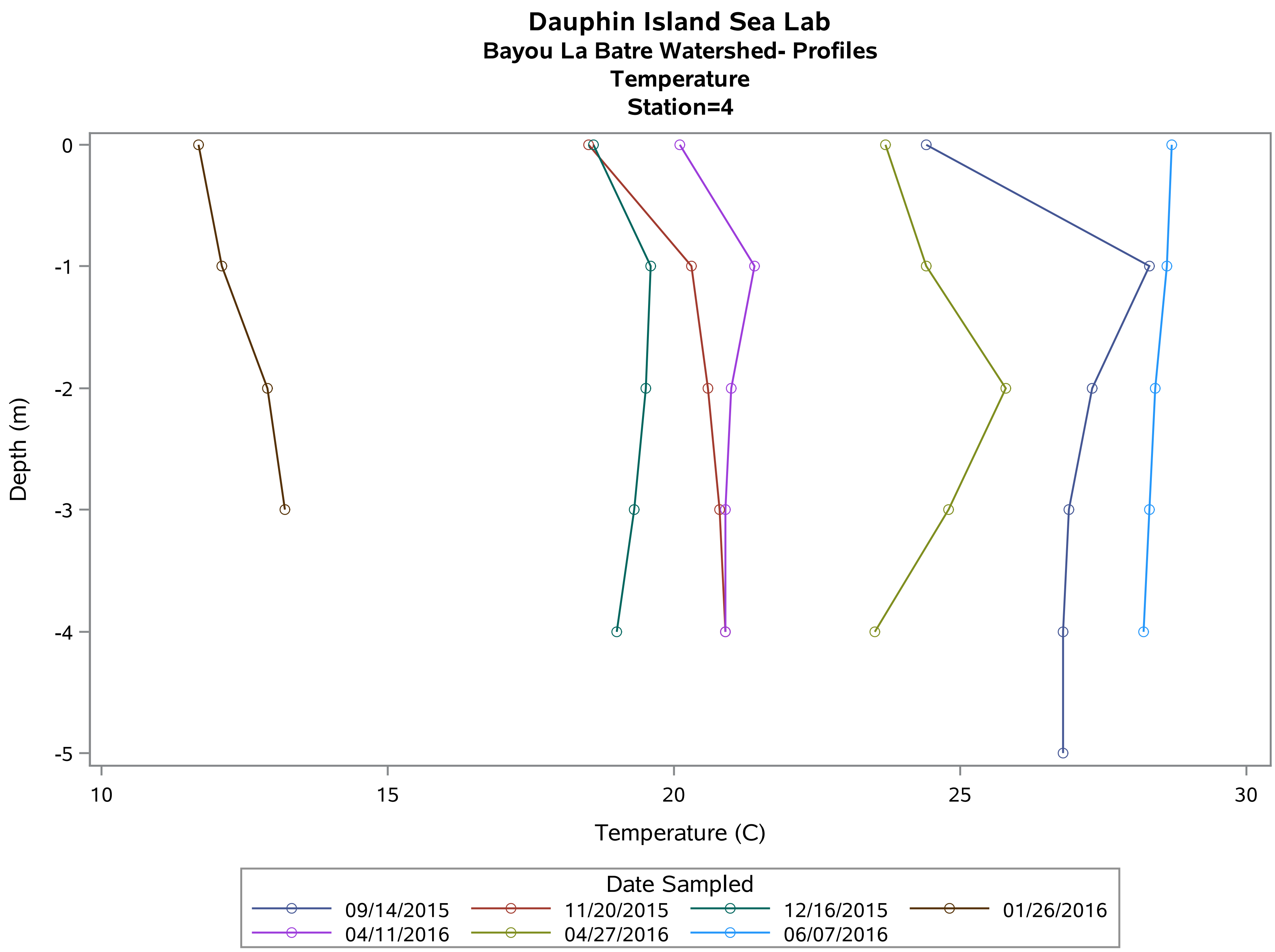

Dauphin Island Sea Lab
Bayou La Batre
Comparison with EPA National Coastal Condition Rating
Chlorophyll a
TYPE=Main Bayou
Chlorophyll a (ug/L)
25
20
15
10
5
0
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
1
2
3
4
5
6
7
EPA Good Rating
EPA Fair Rating
EPA Poor Rating

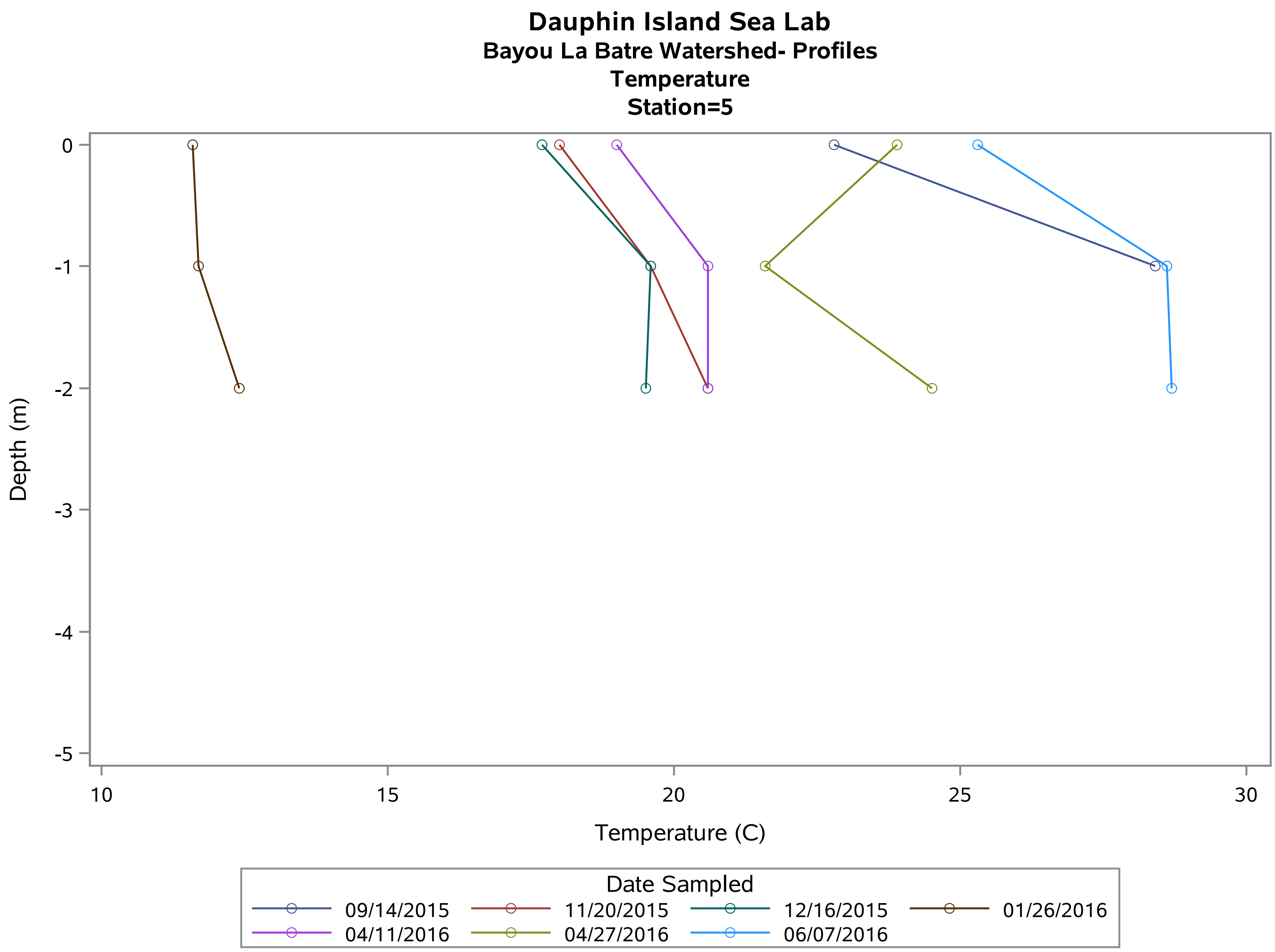

Dauphin Island Sea Lab
Bayou La Batre
Comparison with EPA National Coastal Condition Rating
Bottom Dissolved Oxygen
TYPE=Main Bayou
Bottom Dissolved Oxygen (mg/L)
0
2
4
6
8
10
Sep 2015
Oct
Nov
Dec
Jan 2016
Feb
Mar
Apr
May
Jun
Jul
DATE
1
2
3
4
5
6
7
EPA Good Rating
EPA Fair Rating
EPA Poor Rating

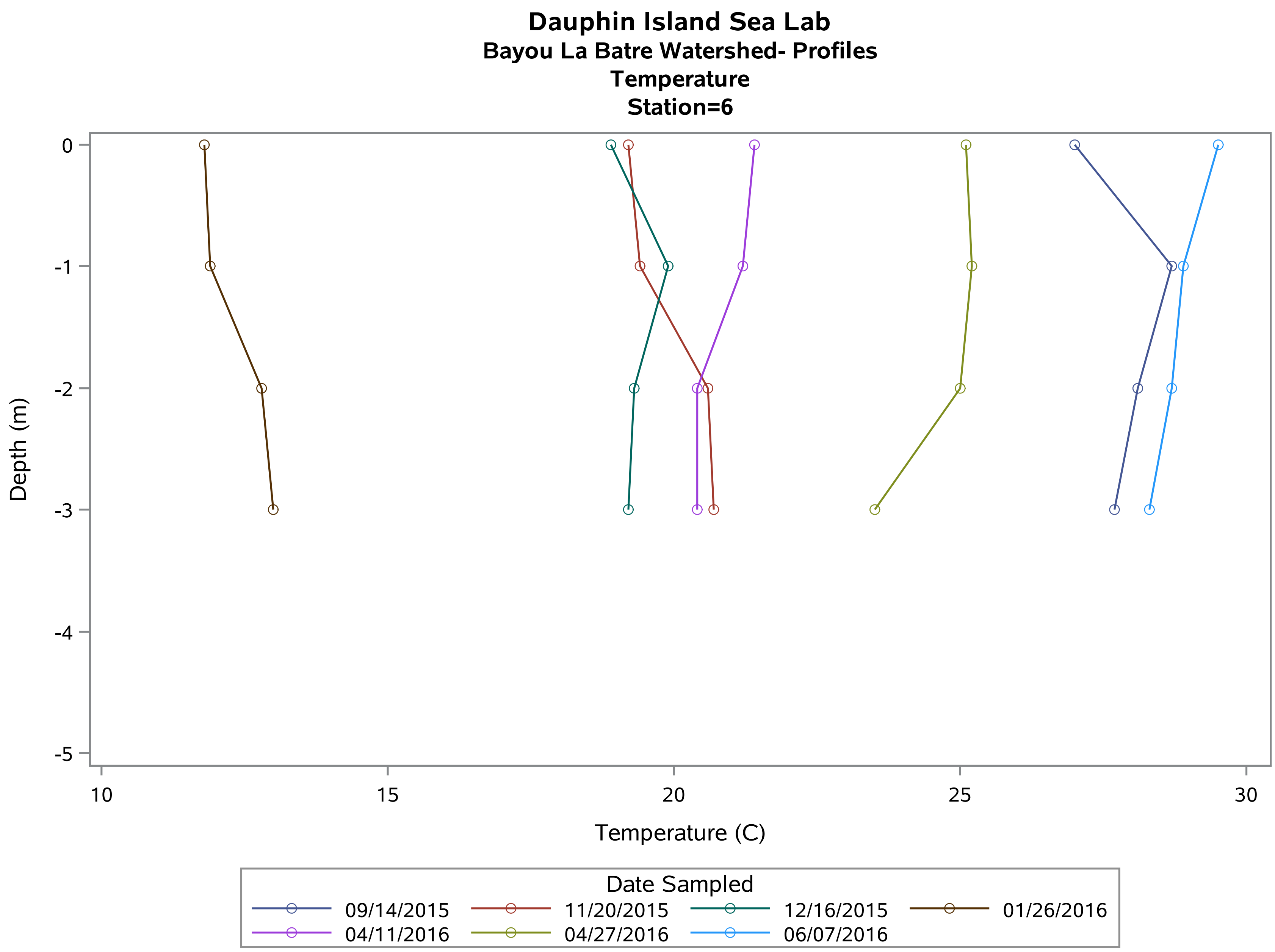

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Temperature
Station=1
Depth (m)
0
-1
-2
-3
-4
-5
10
15
20
25
30
Temperature (C)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016


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

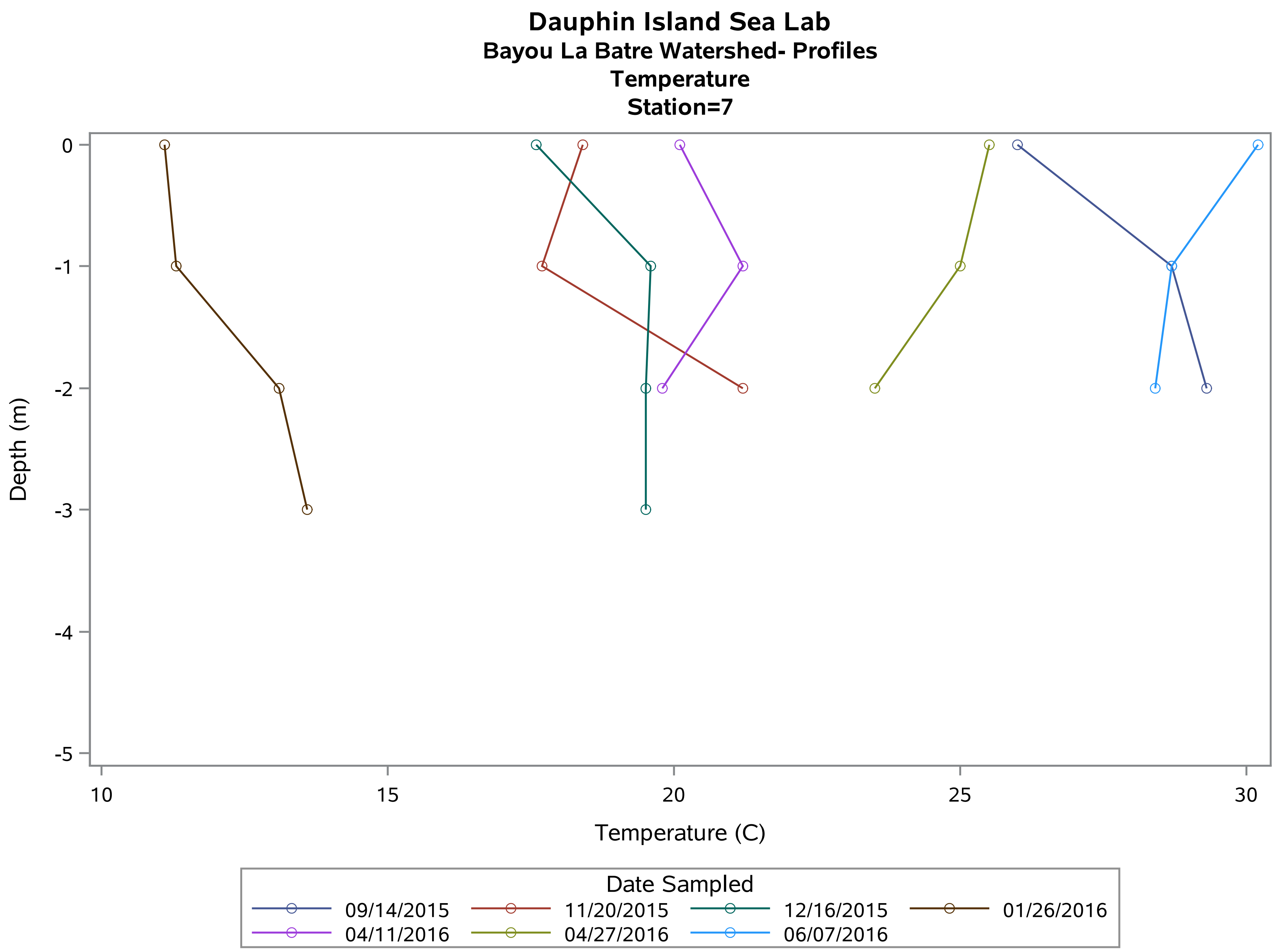

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Temperature
Station=3
Depth (m)
0
-1
-2
-3
-4
-5
10
15
20
25
30
Temperature (C)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016


Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Temperature
Station=4
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

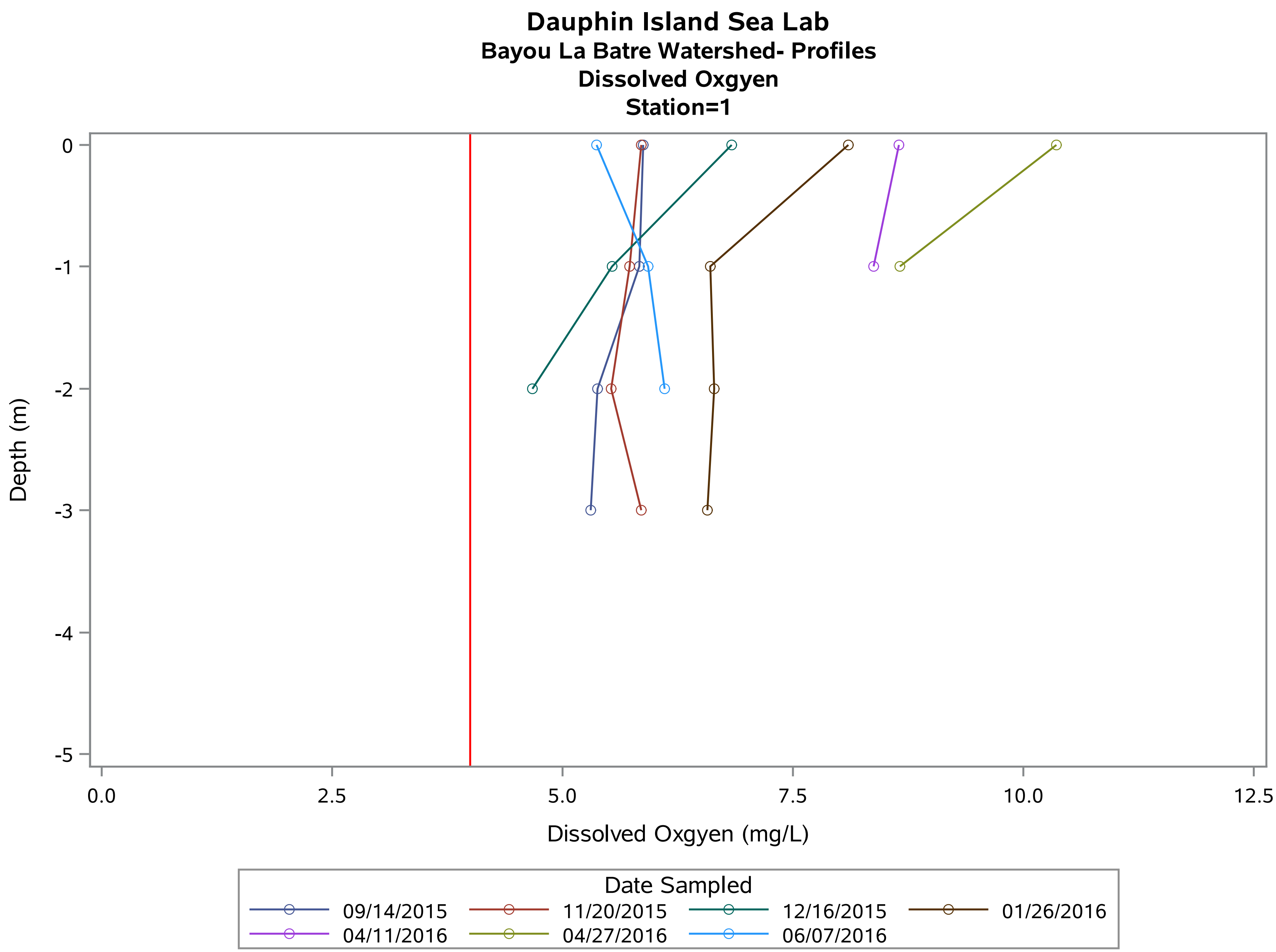

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Temperature
Station=5
Depth (m)
0
-1
-2
-3
-4
-5
10
15
20
25
30
Temperature (C)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

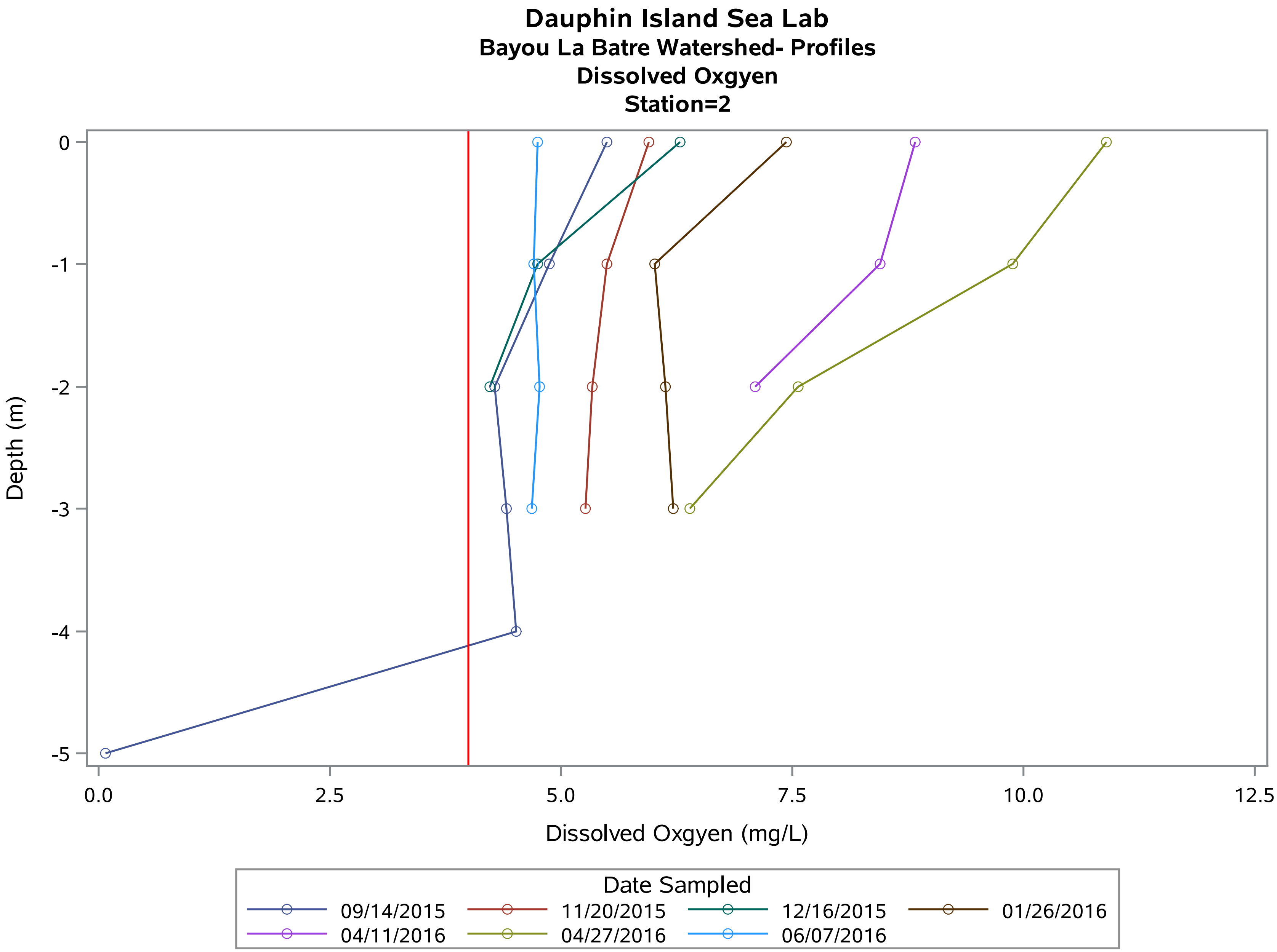


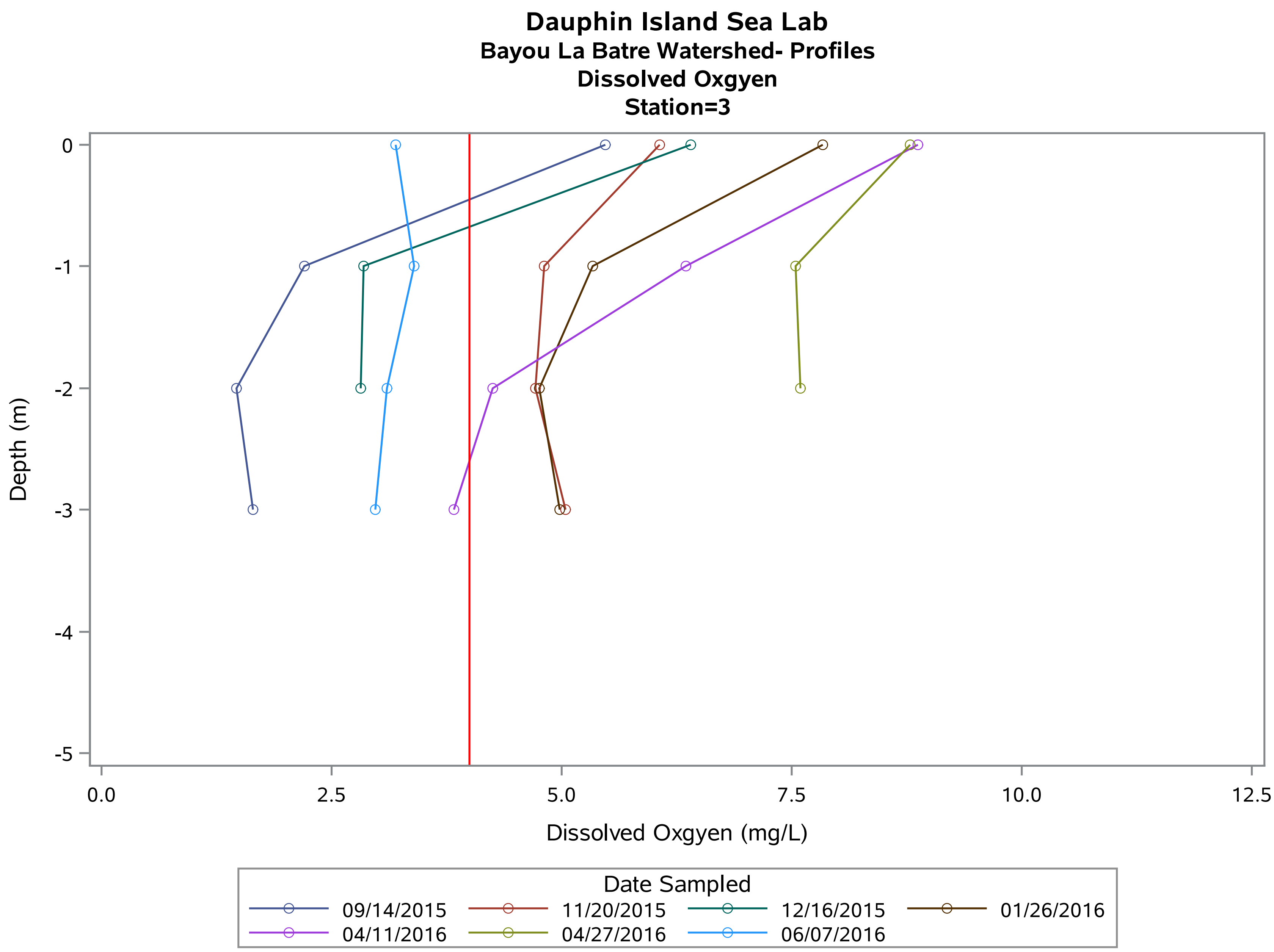
Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Temperature
Station=6
Depth (m)
0
-1
-2
-3
-4
-5
10
15
20
25
30
Temperature (C)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

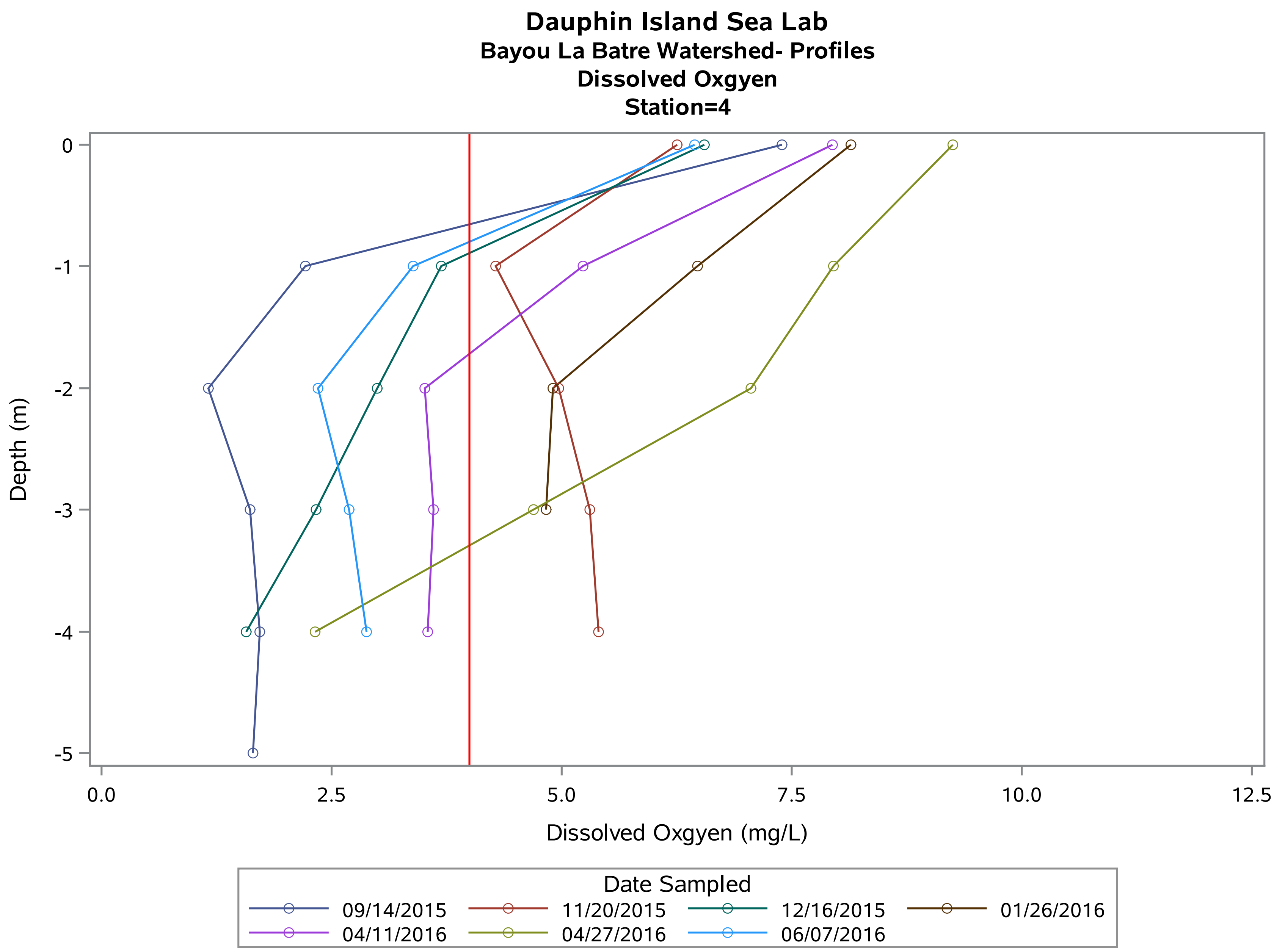


Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Temperature
Station=7
Depth (m)
0
-1
-2
-3
-4
-5
10
15
20
25
30
Temperature (C)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016


Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Dissolved Oxgyen
Station=1
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

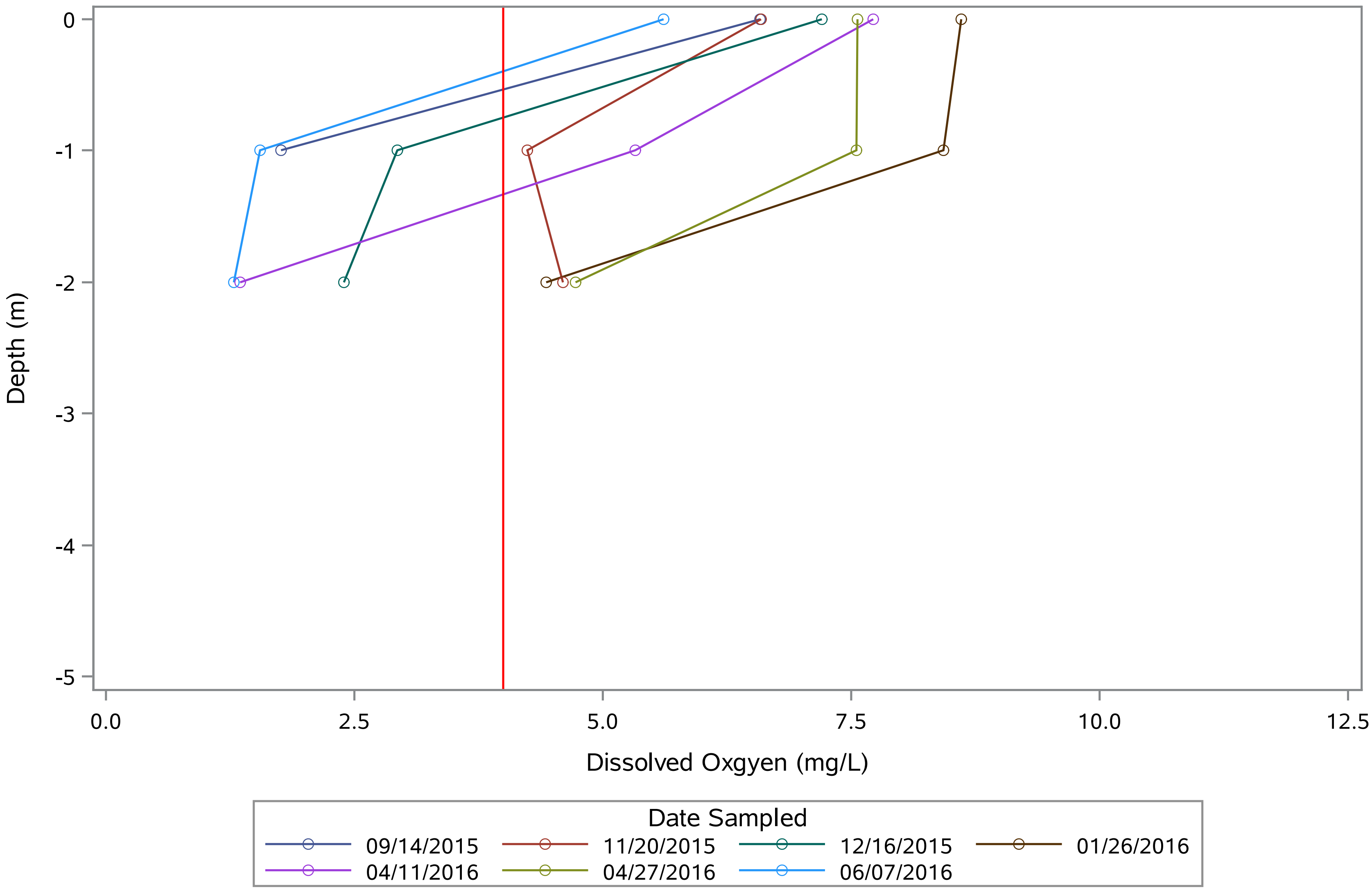

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Dissolved Oxgyen
Station=2
Depth (m)
0
-1
-2
-3
-4
-5
0.0
2.5
5.0
7.5
10.0
12.5
Dissolved Oxgyen (mg/L)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

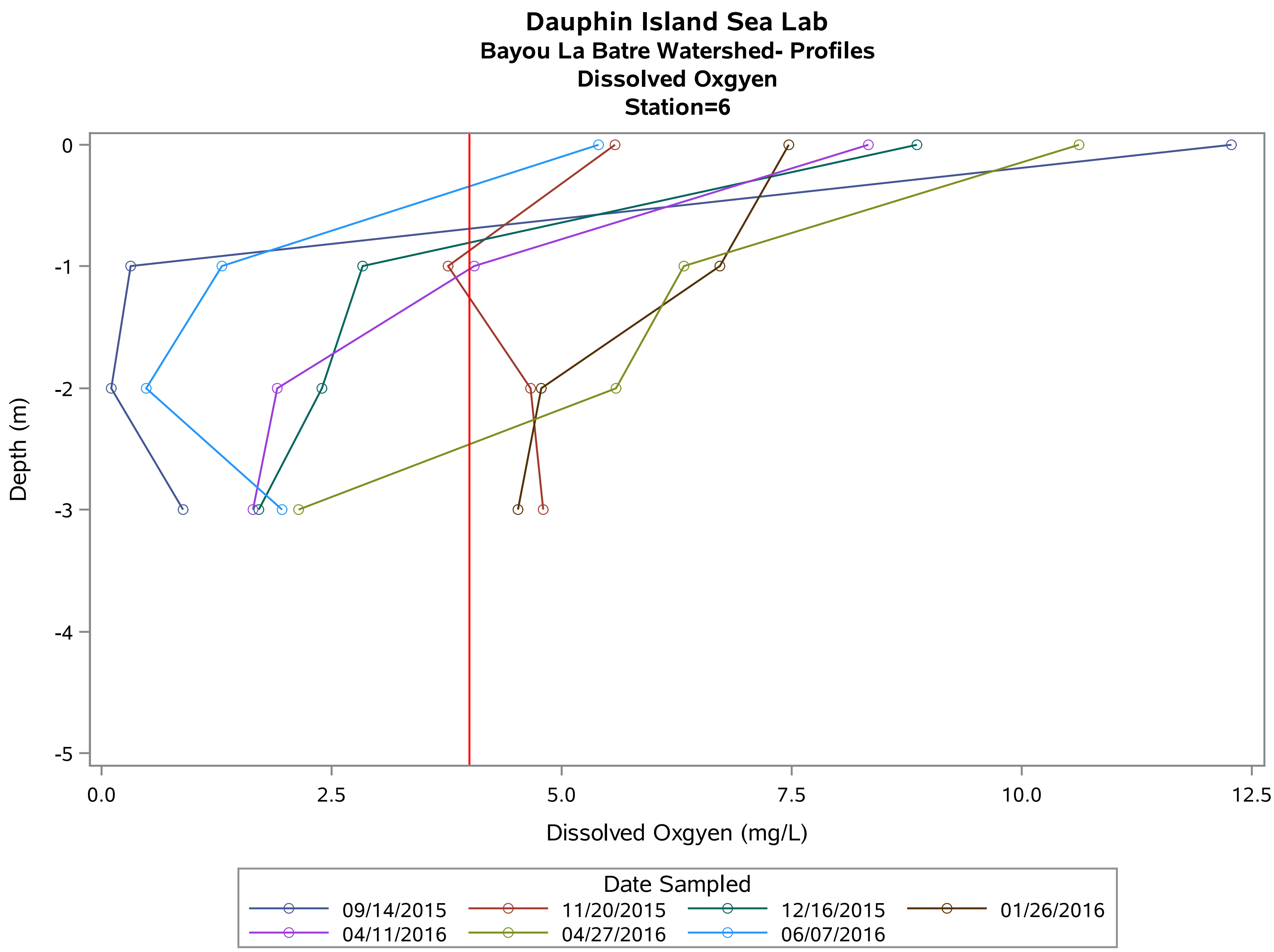

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Dissolved Oxgyen
Station=3
Depth (m)
0
-1
-2
-3
-4
-5
0.0
2.5
5.0
7.5
10.0
12.5
Dissolved Oxgyen (mg/L)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

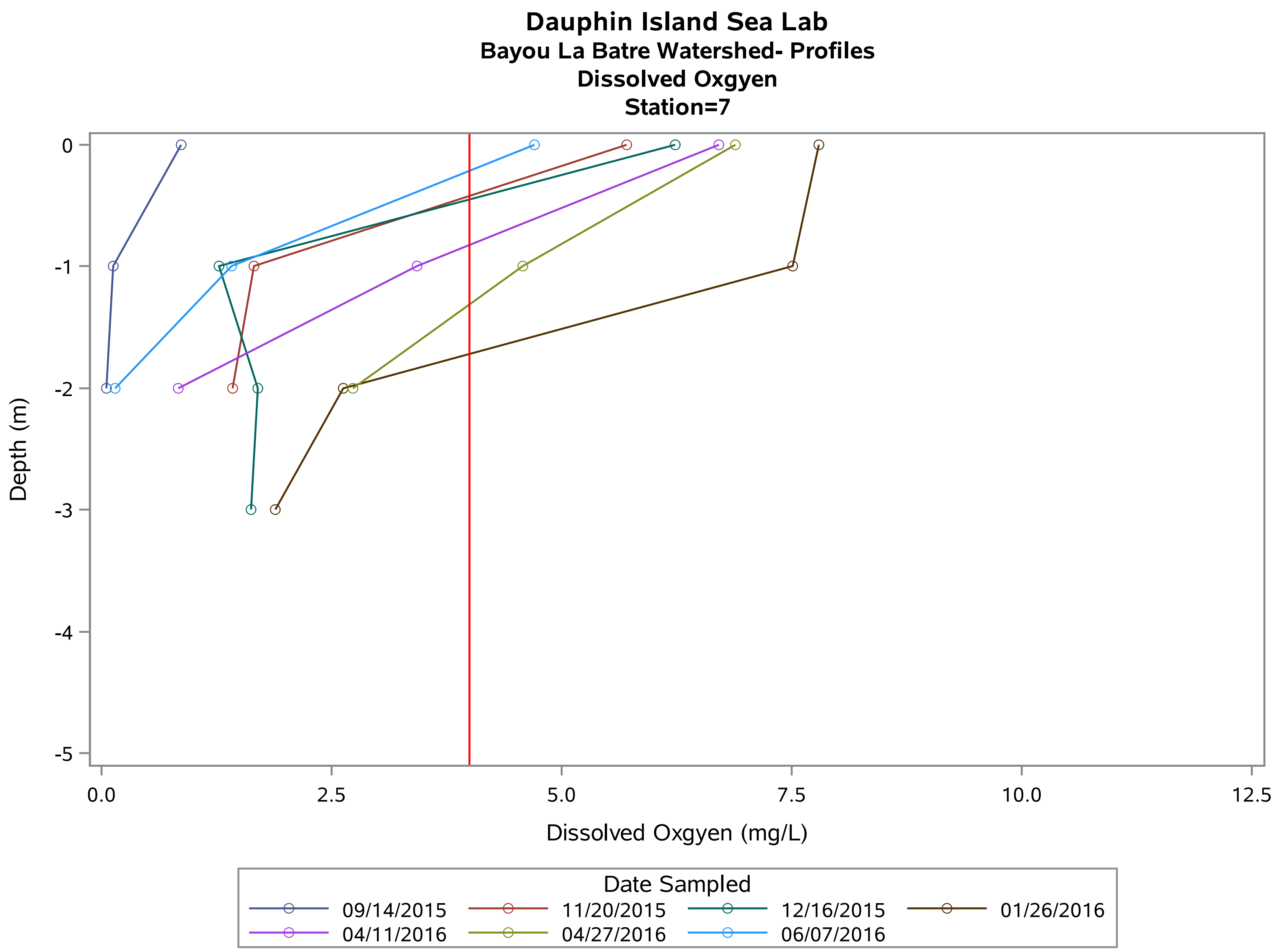


Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Dissolved Oxgyen
Station=4
Depth (m)
0
-1
-2
-3
-4
-5
0.0
2.5
5.0
7.5
10.0
12.5
Dissolved Oxgyen (mg/L)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

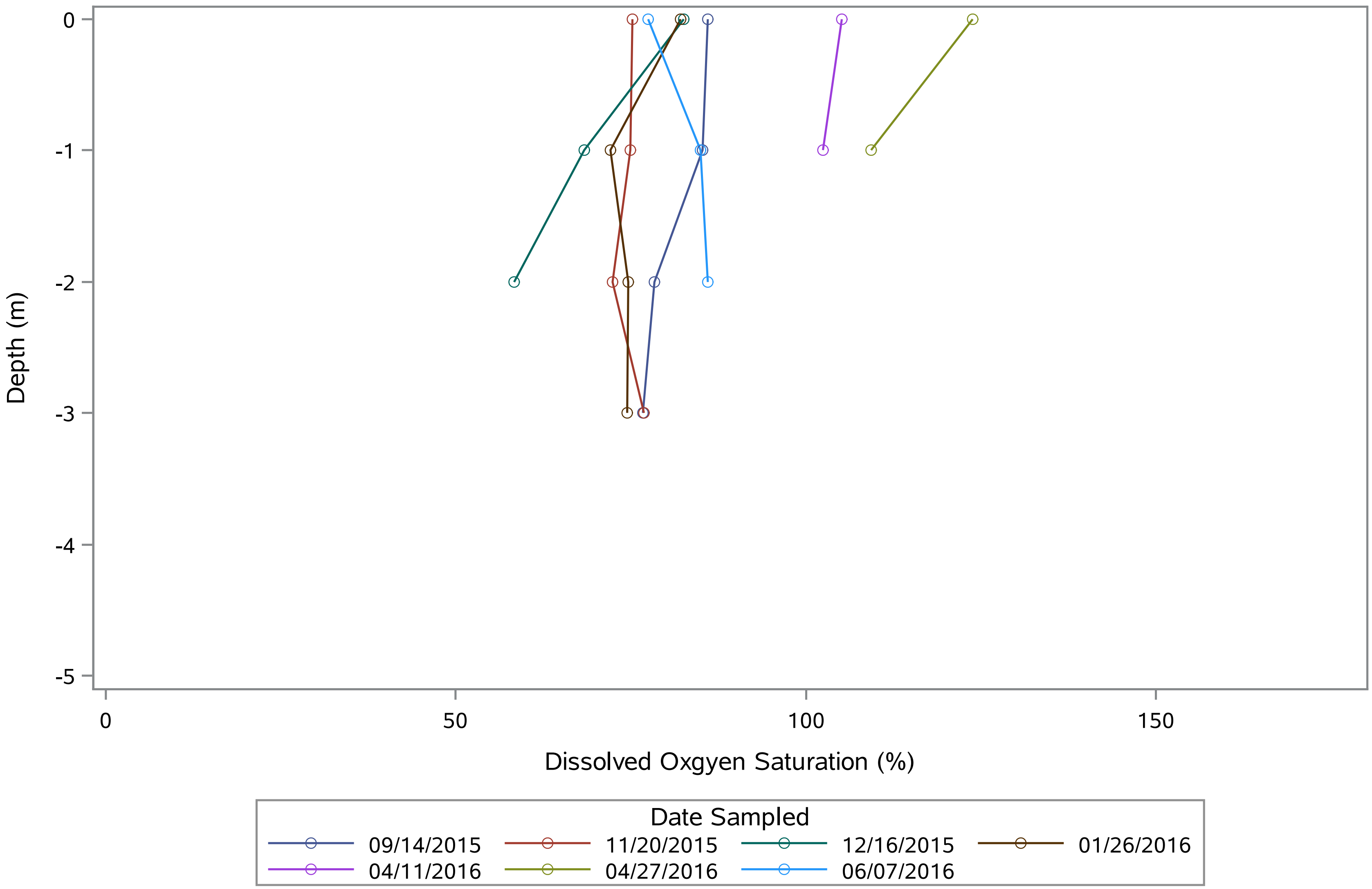
Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Dissolved Oxgyen
Station=5

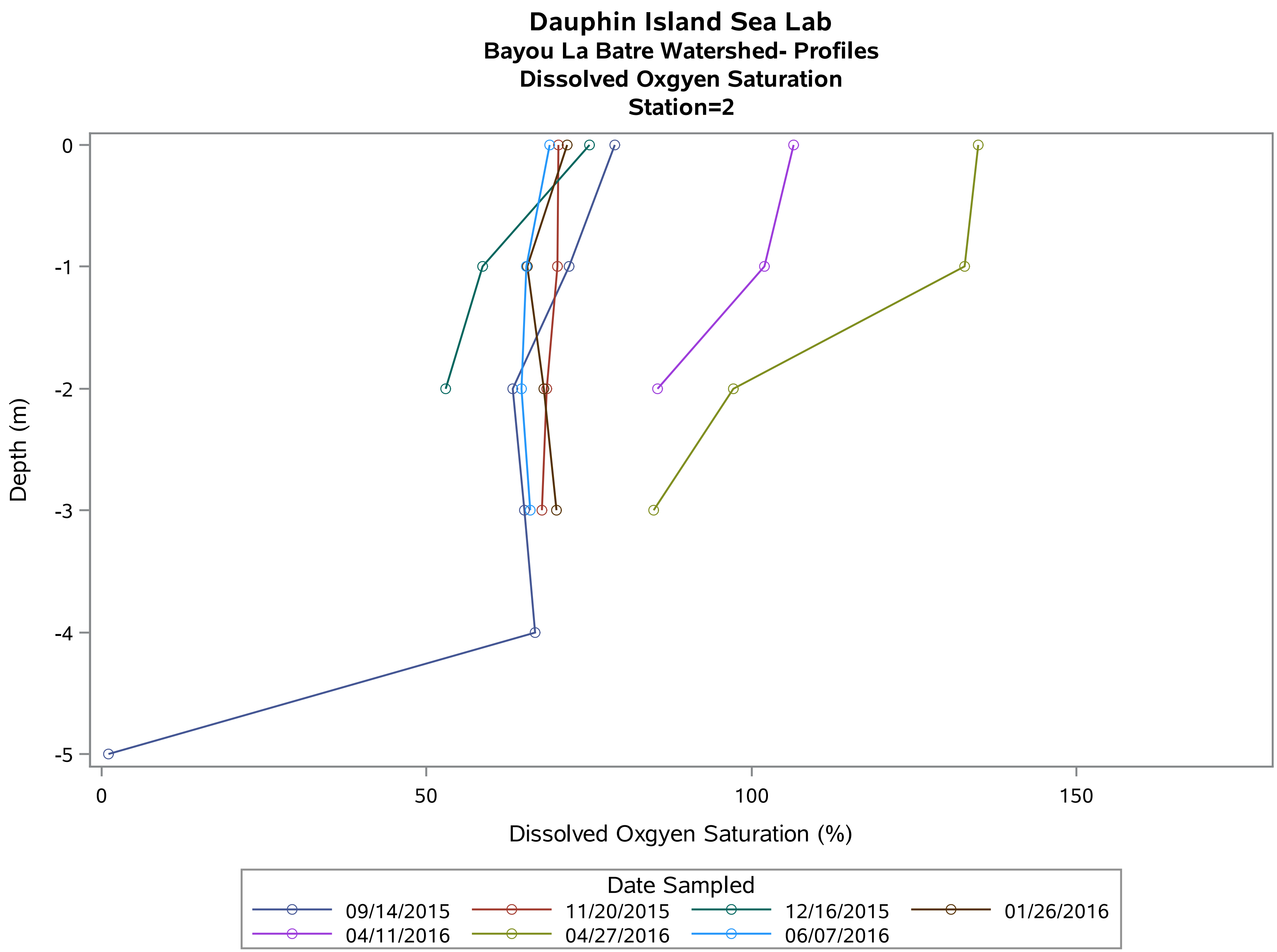


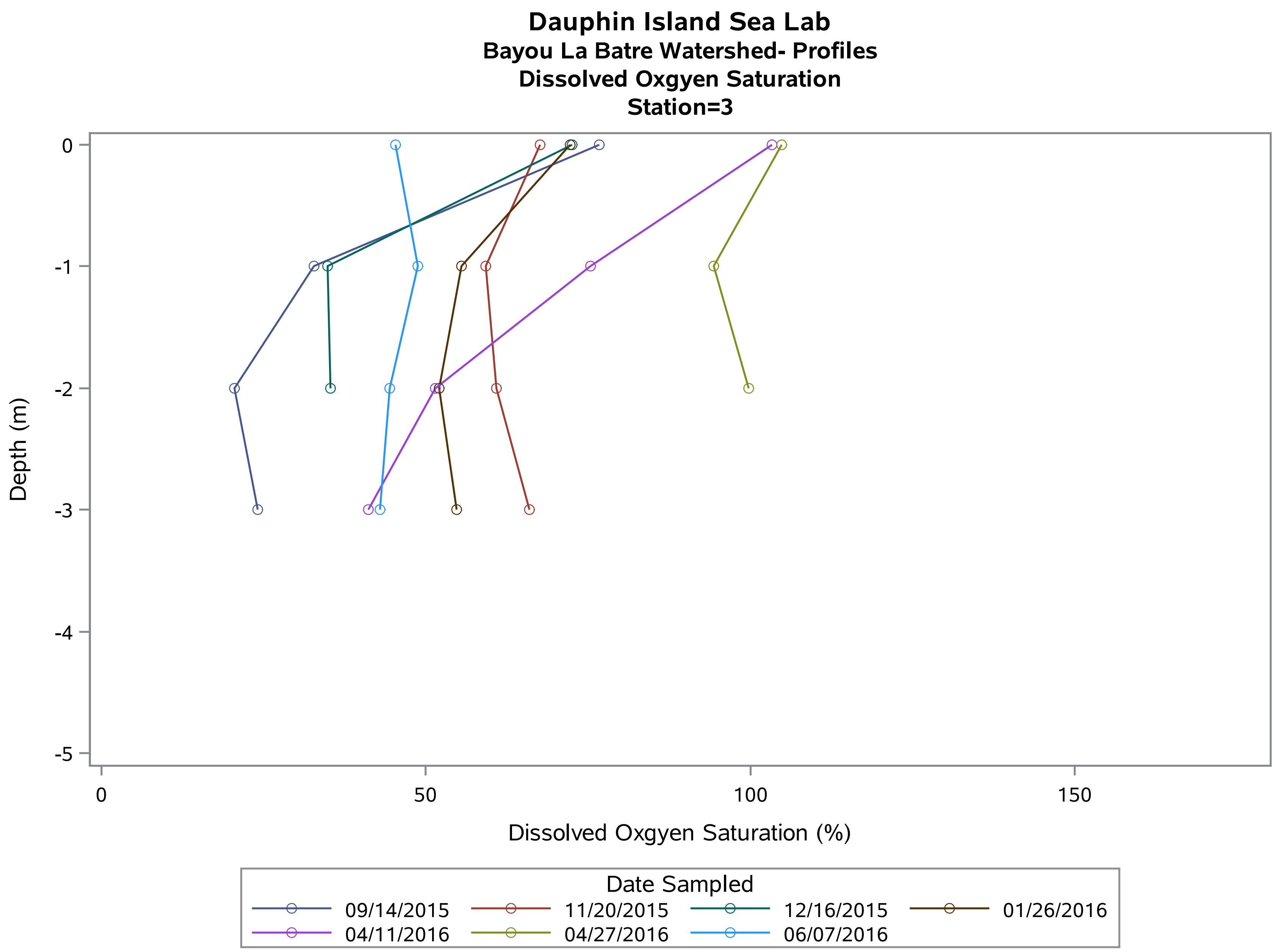

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Dissolved Oxgyen
Station=6
0
-1
-2
-3
-4
-5
Depth (m)
0.0
2.5
5.0
7.5
10.0
12.5
Dissolved Oxgyen (mg/L)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

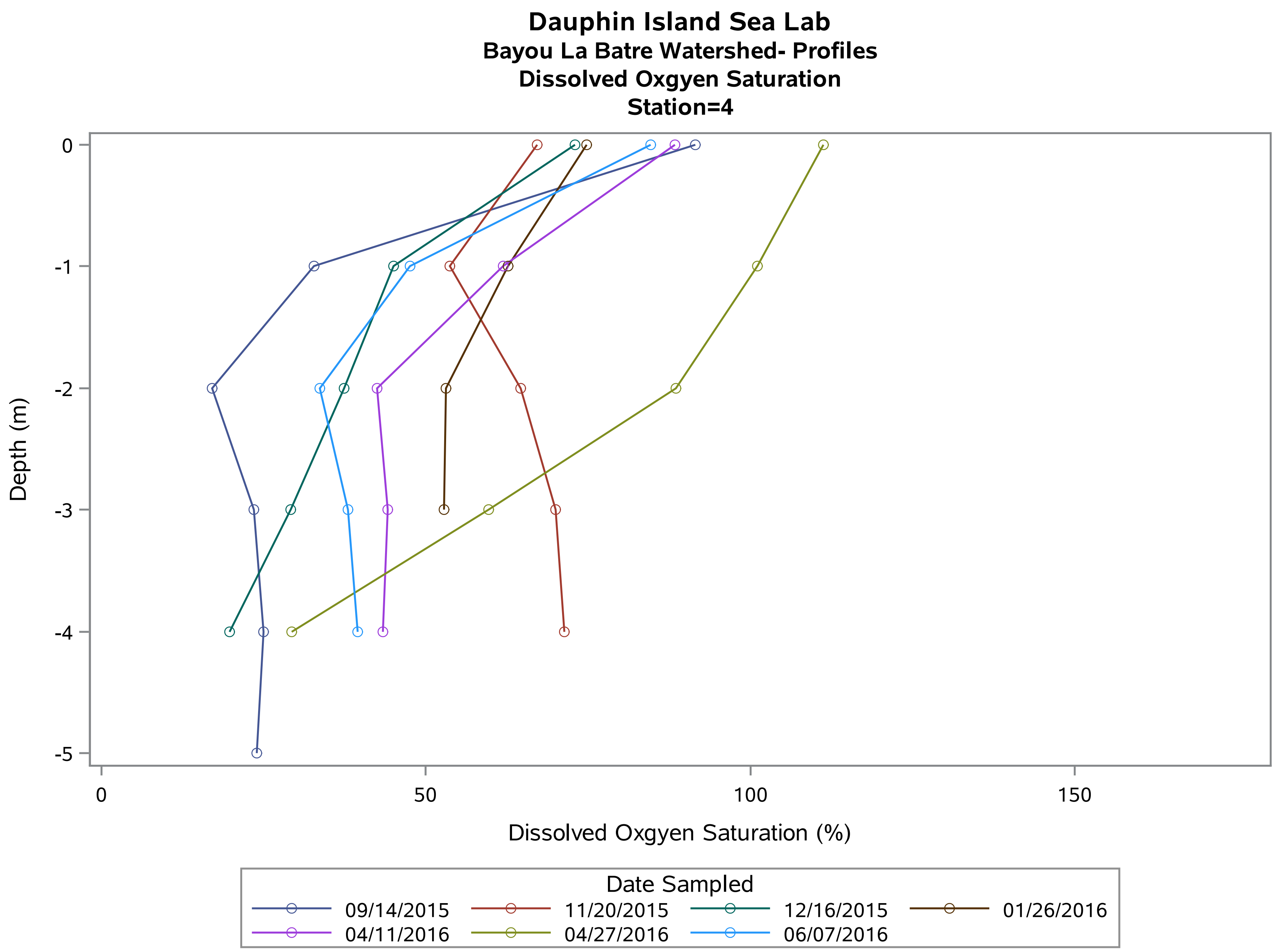

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Dissolved Oxgyen
Station=7
Depth (m)
0
-1
-2
-3
-4
-5
0.0
2.5
5.0
7.5
10.0
12.5
Dissolved Oxgyen (mg/L)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

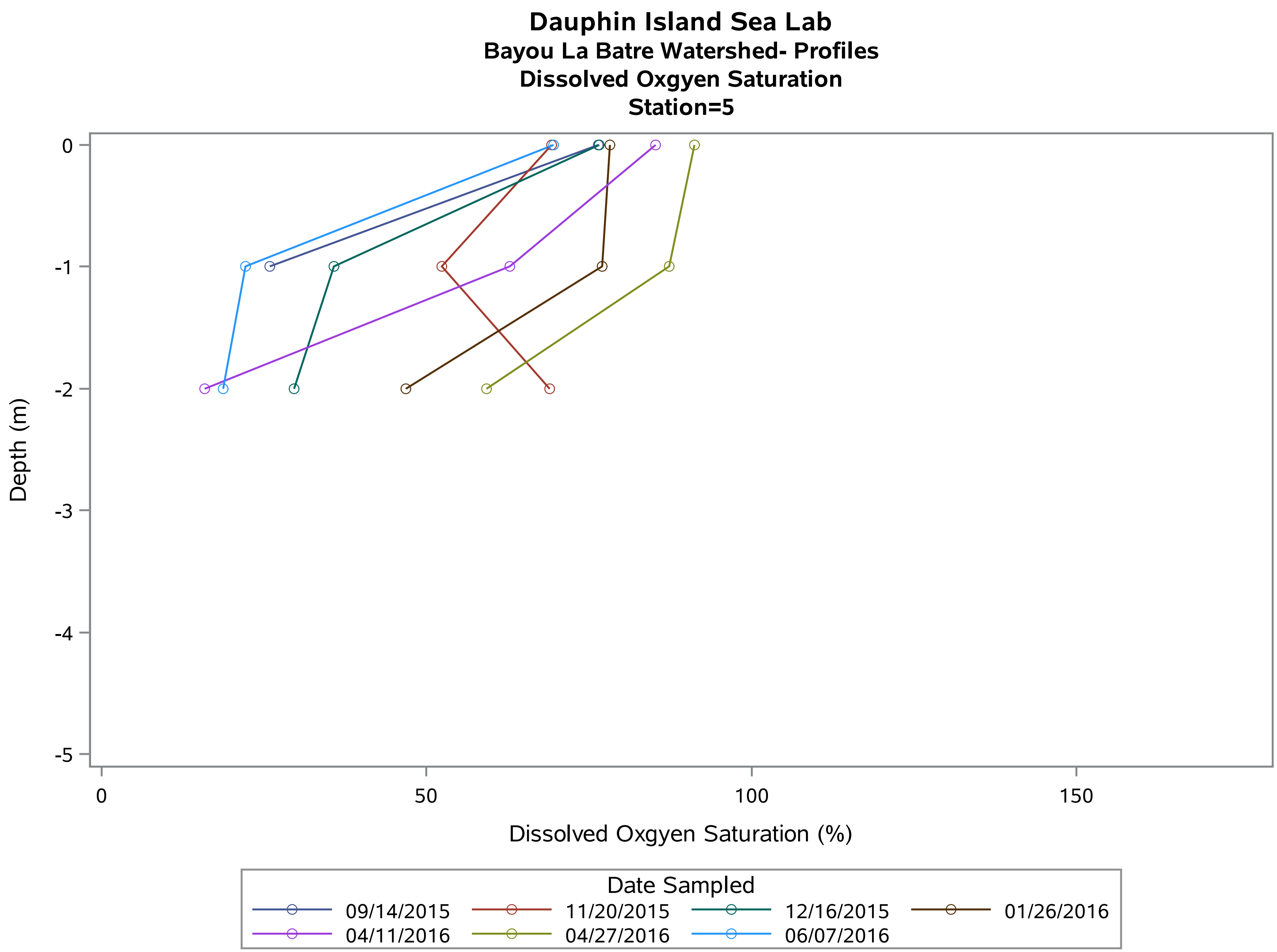
Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Dissolved Oxgyen Saturation
Station=1

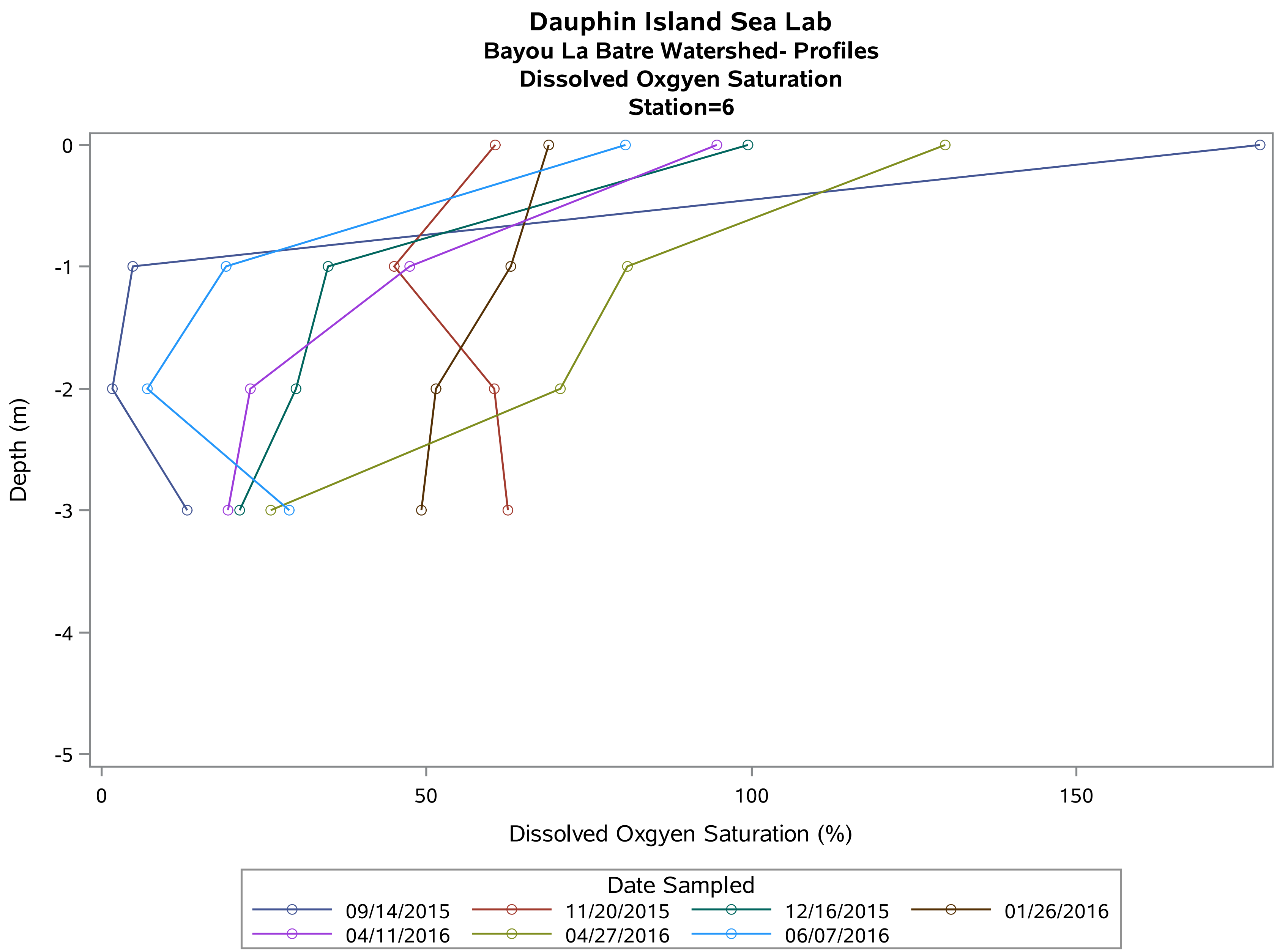


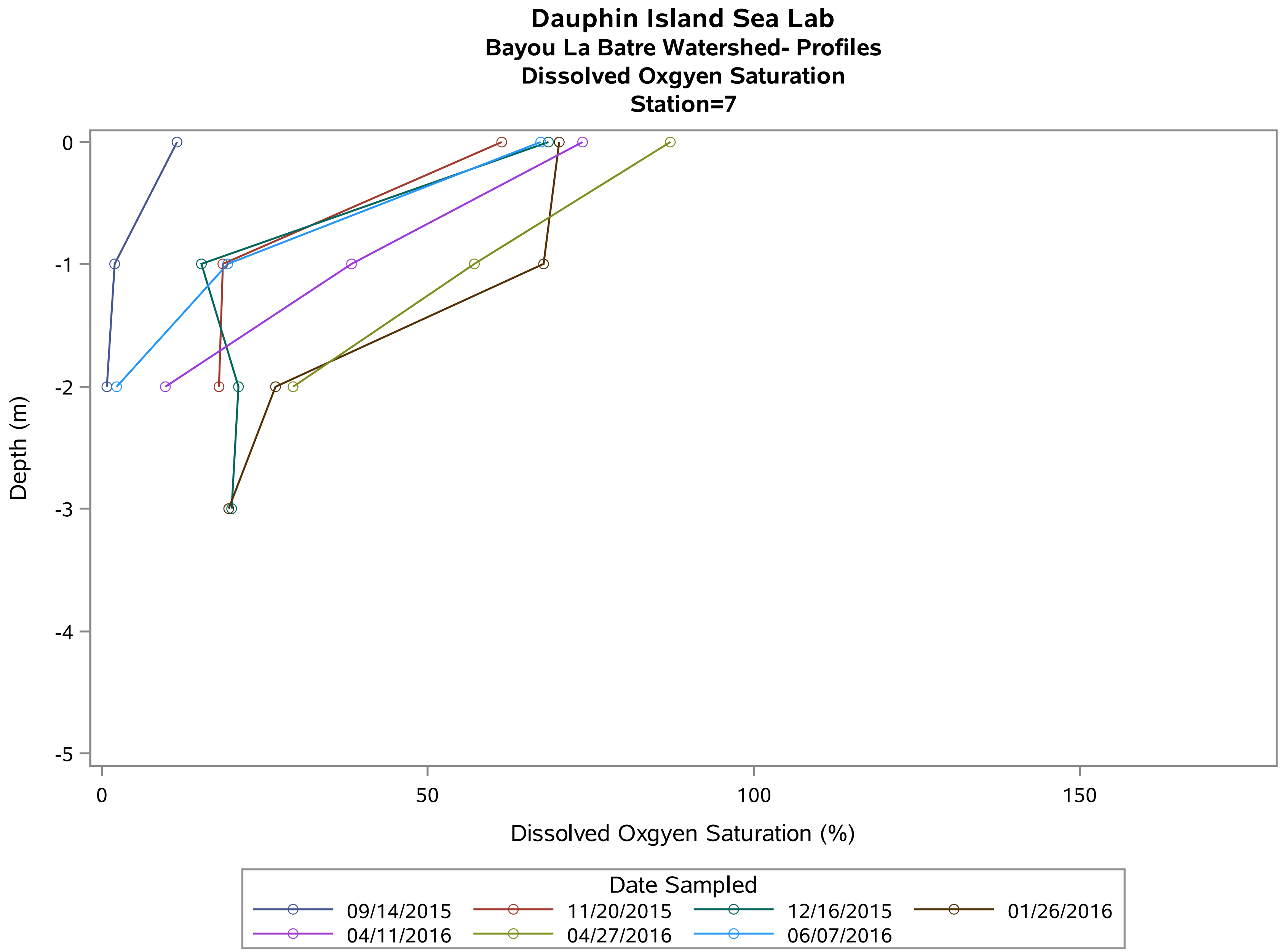

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Dissolved Oxgyen Saturation
Station=2
Depth (m)
0
-1
-2
-3
-4
-5
0
50
100
150
Dissolved Oxgyen Saturation (%)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016


Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Dissolved Oxgyen Saturation
Station=3
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
04/27/2016
06/07/2016


Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Dissolved Oxgyen Saturation
Station=4
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
04/27/2016
06/07/2016

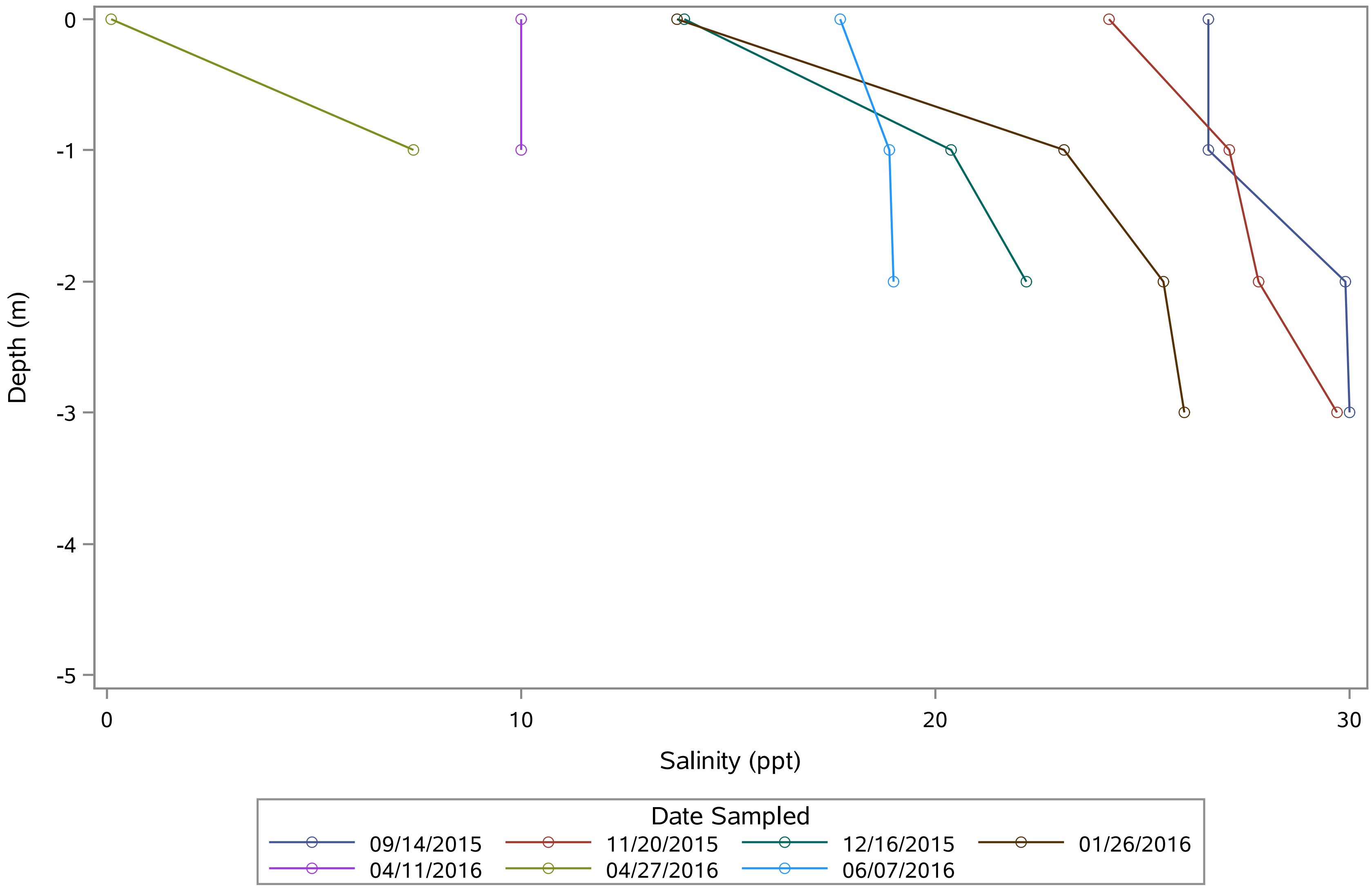

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Dissolved Oxgyen Saturation
Station=5
0
-1
-2
-3
-4
-5
Depth (m)
0
50
100
150
Dissolved Oxgyen Saturation (%)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

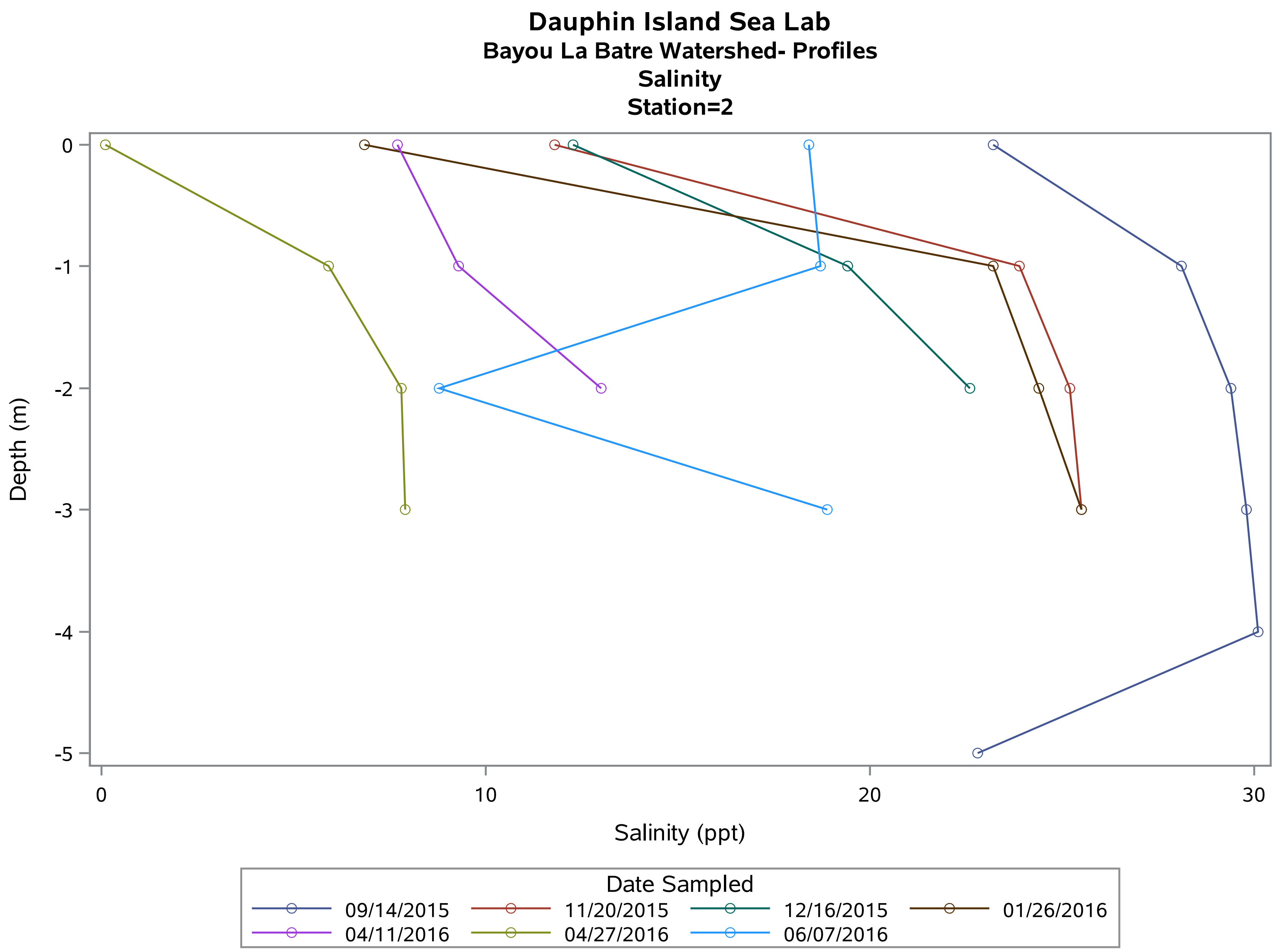

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Dissolved Oxgyen Saturation
Station=6
Depth (m)
0
-1
-2
-3
-4
-5
0
50
100
150
Dissolved Oxgyen Saturation (%)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016



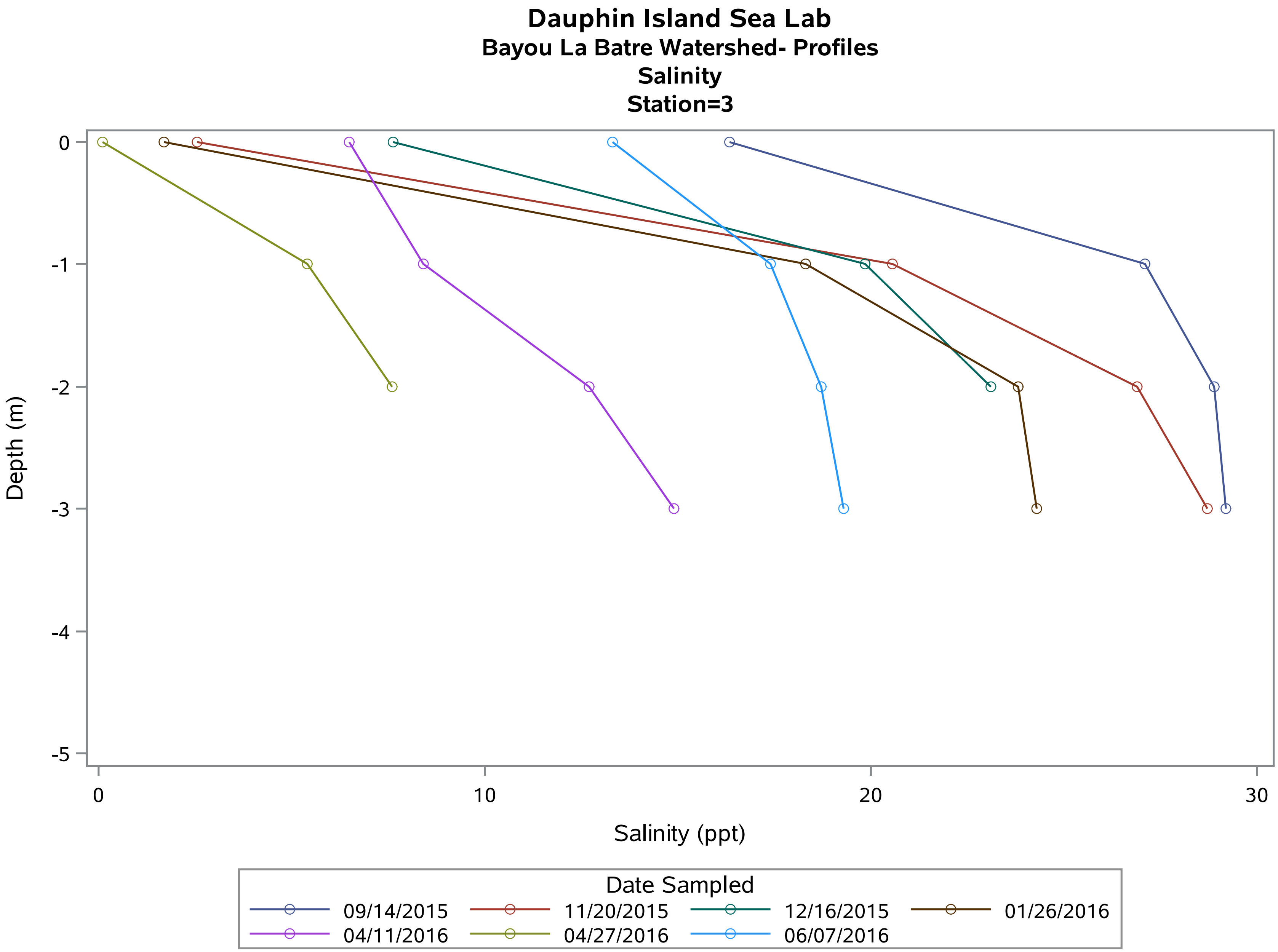
Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Dissolved Oxgyen Saturation
Station=7
Depth (m)
0
-1
-2
-3
-4
-5
0
50
100
150
Dissolved Oxgyen Saturation (%)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

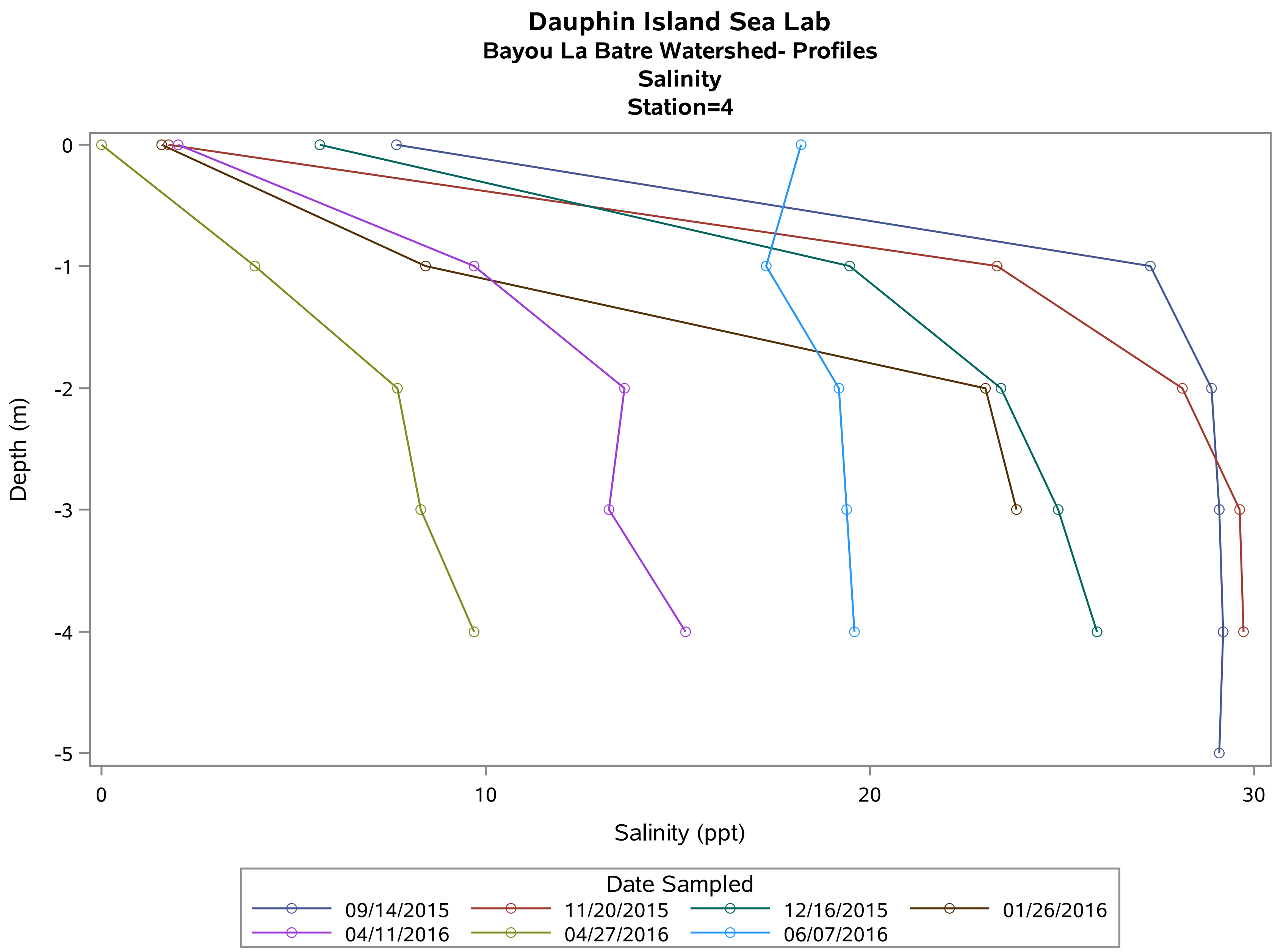
Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Salinity
Station=1

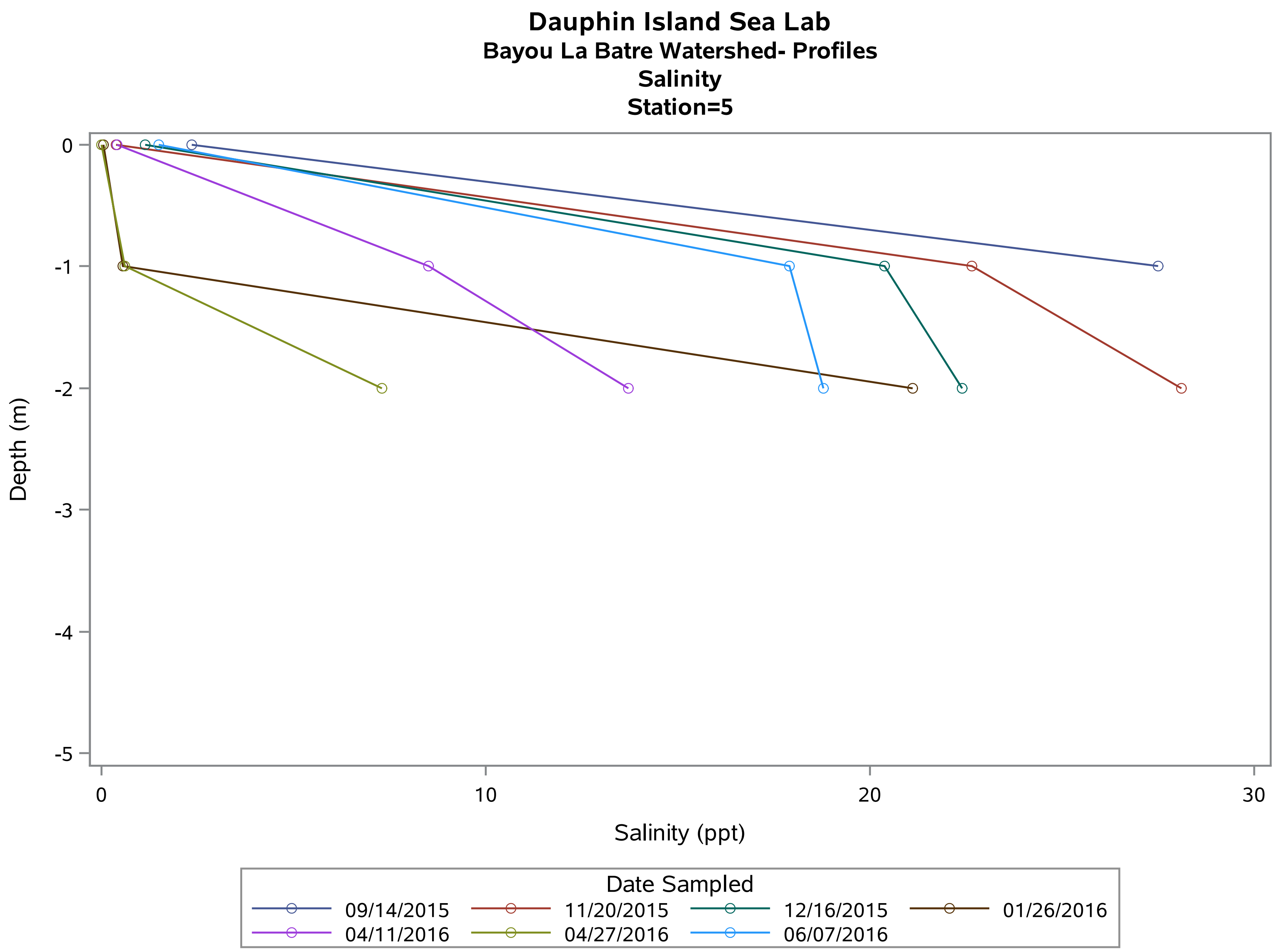


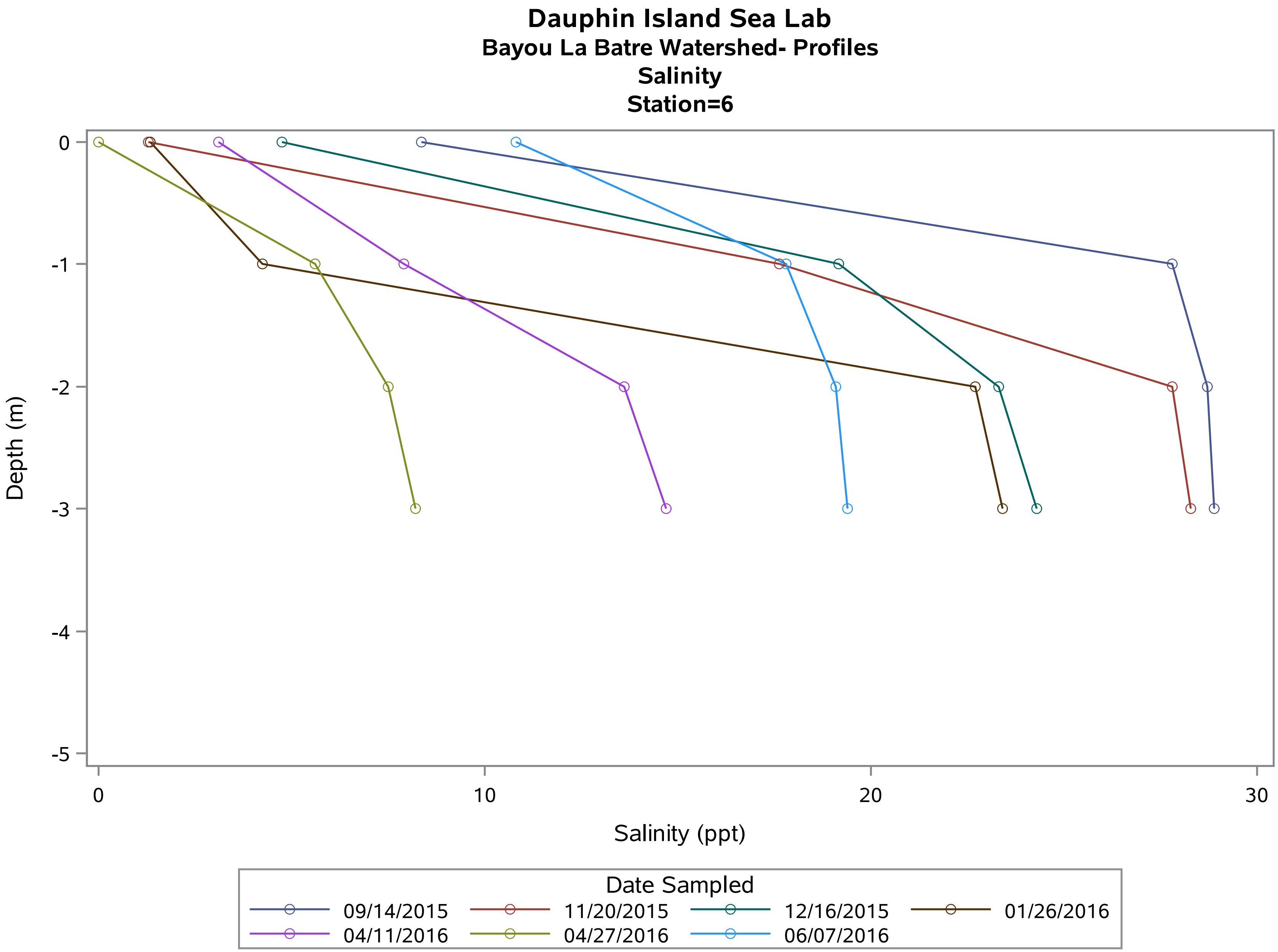


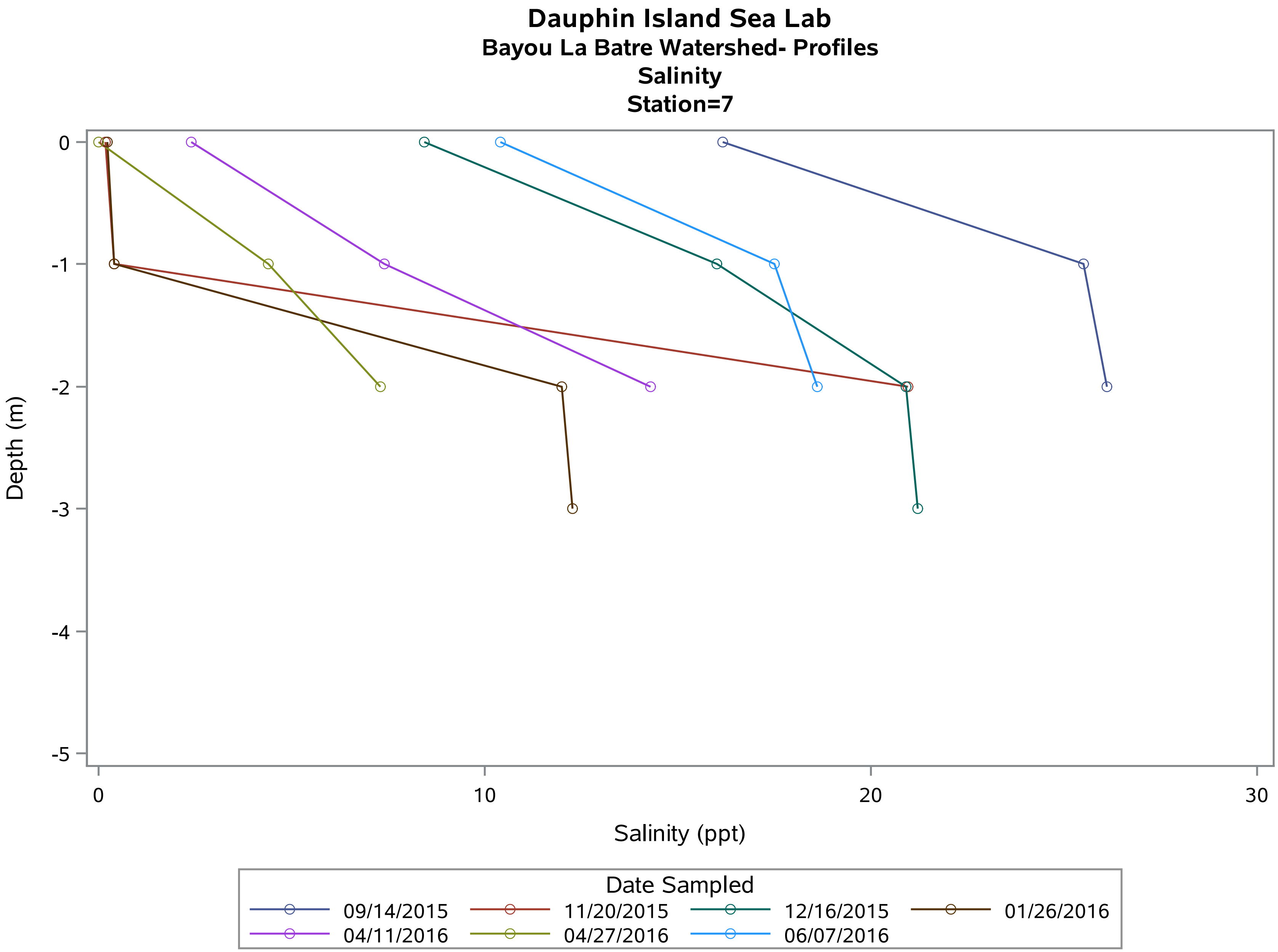
Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Salinity
Station=2
Depth (m)
0
-1
-2
-3
-4
-5
0
10
20
30
Salinity (ppt)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016


Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Salinity
Station=3
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

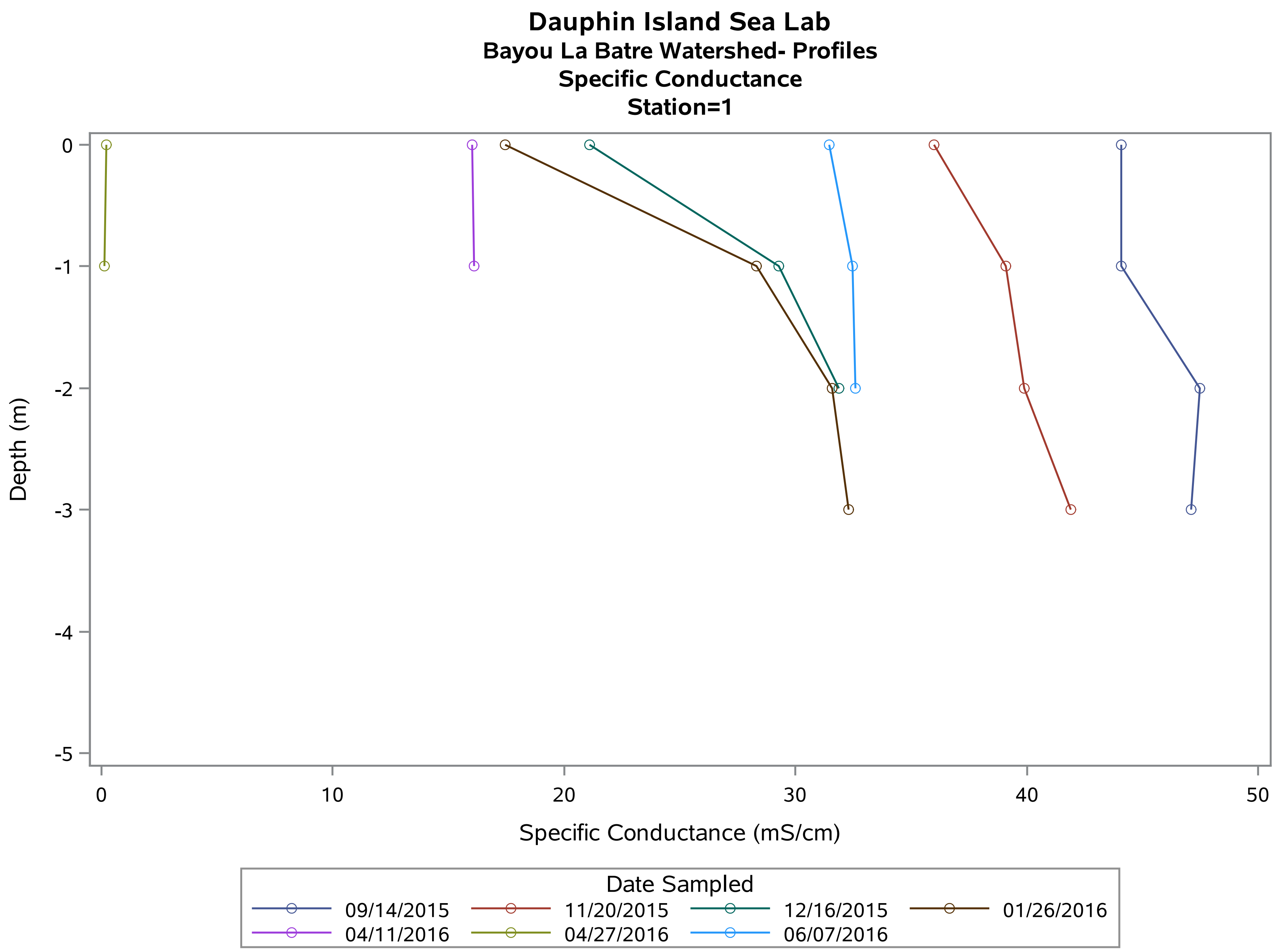

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Salinity
Station=4
Depth (m)
0
-1
-2
-3
-4
-5
0
10
20
30
Salinity (ppt)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

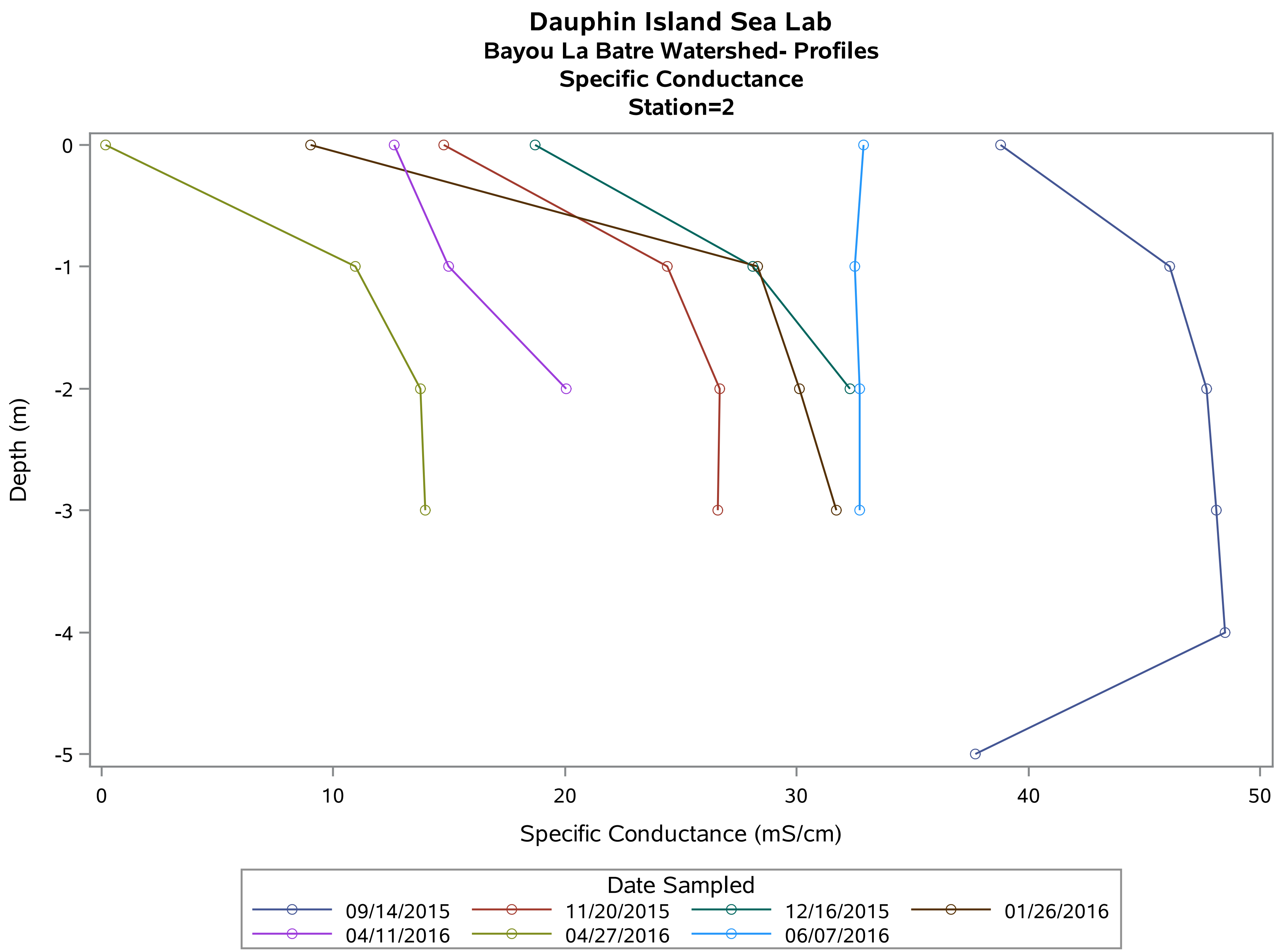

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Salinity
Station=5
0
-1
-2
-3
-4
-5
Depth (m)
0
10
20
30
Salinity (ppt)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

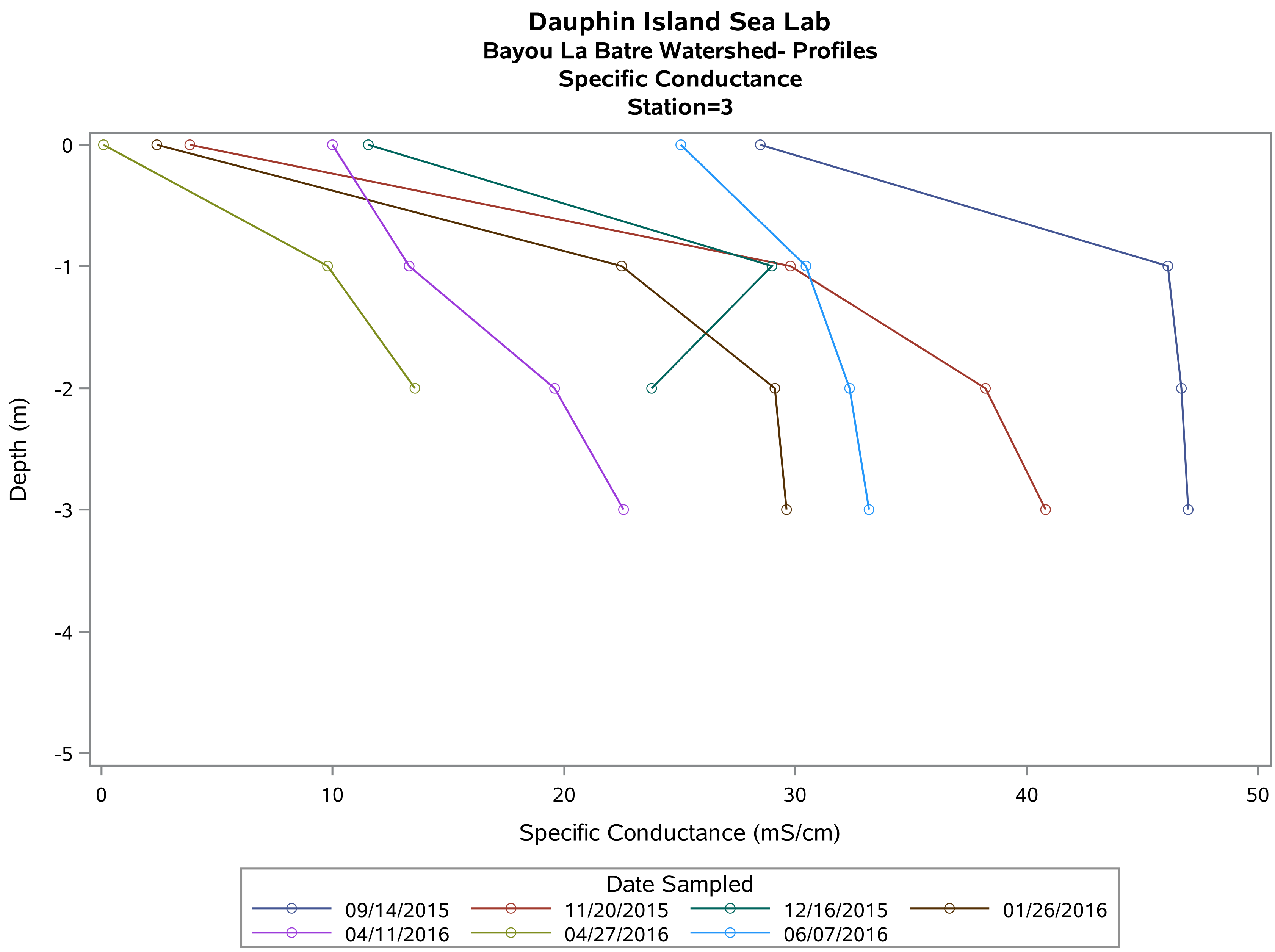

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Salinity
Station=6
Depth (m)
0
-1
-2
-3
-4
-5
0
10
20
30
Salinity (ppt)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

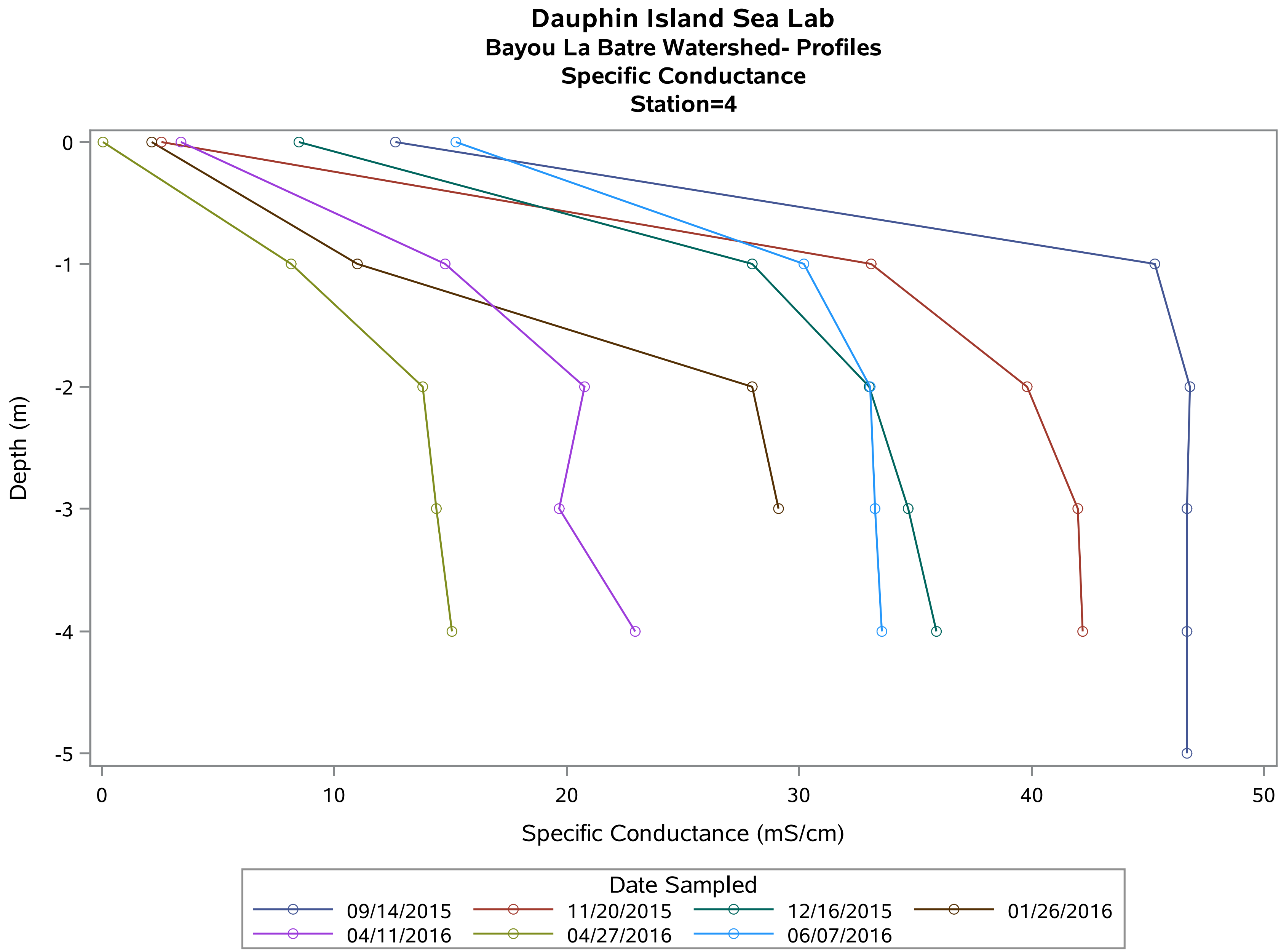


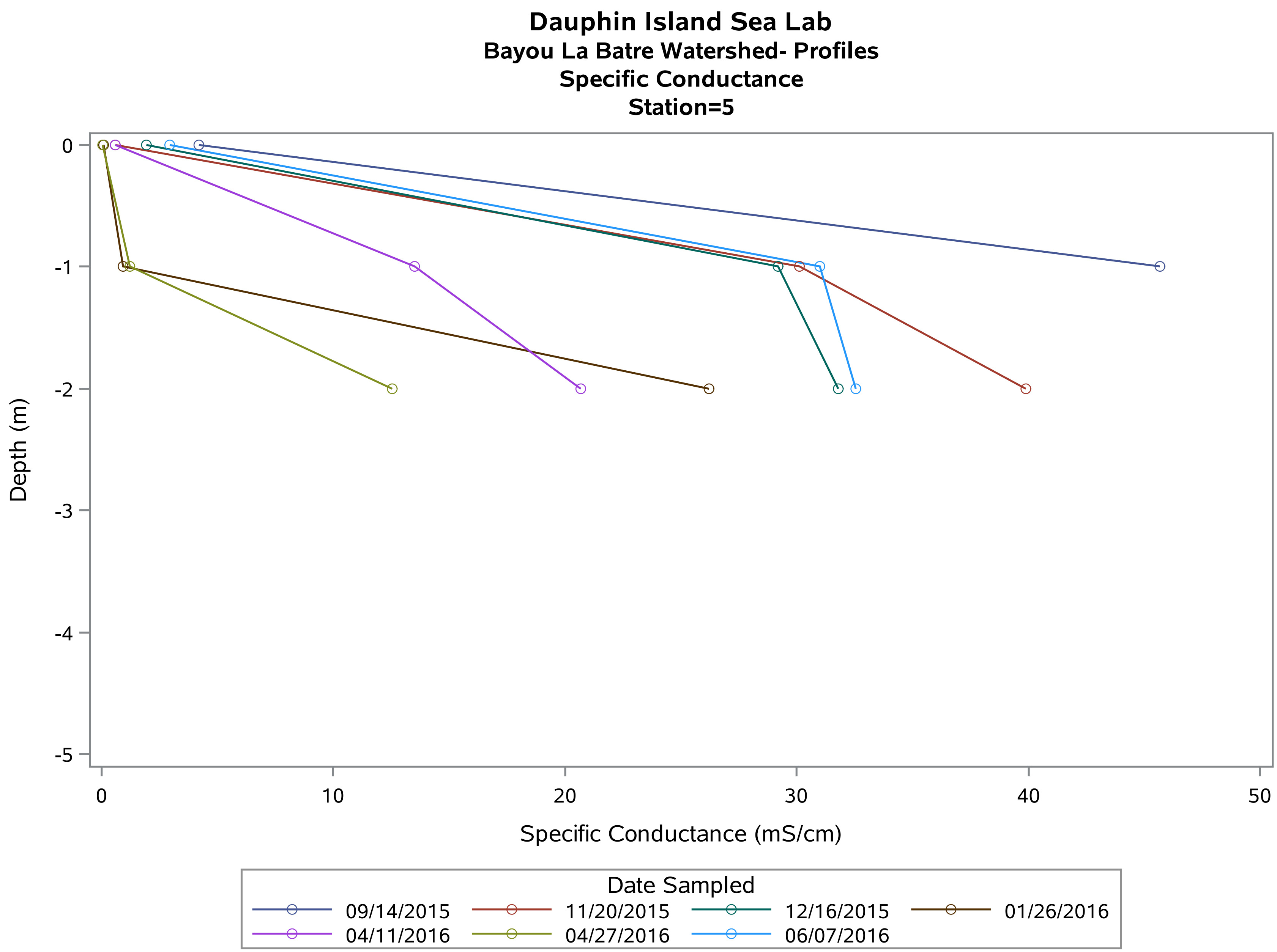
Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Salinity
Station=7
Depth (m)
0
-1
-2
-3
-4
-5
0
10
20
30
Salinity (ppt)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016


Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Specific Conductance
Station=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

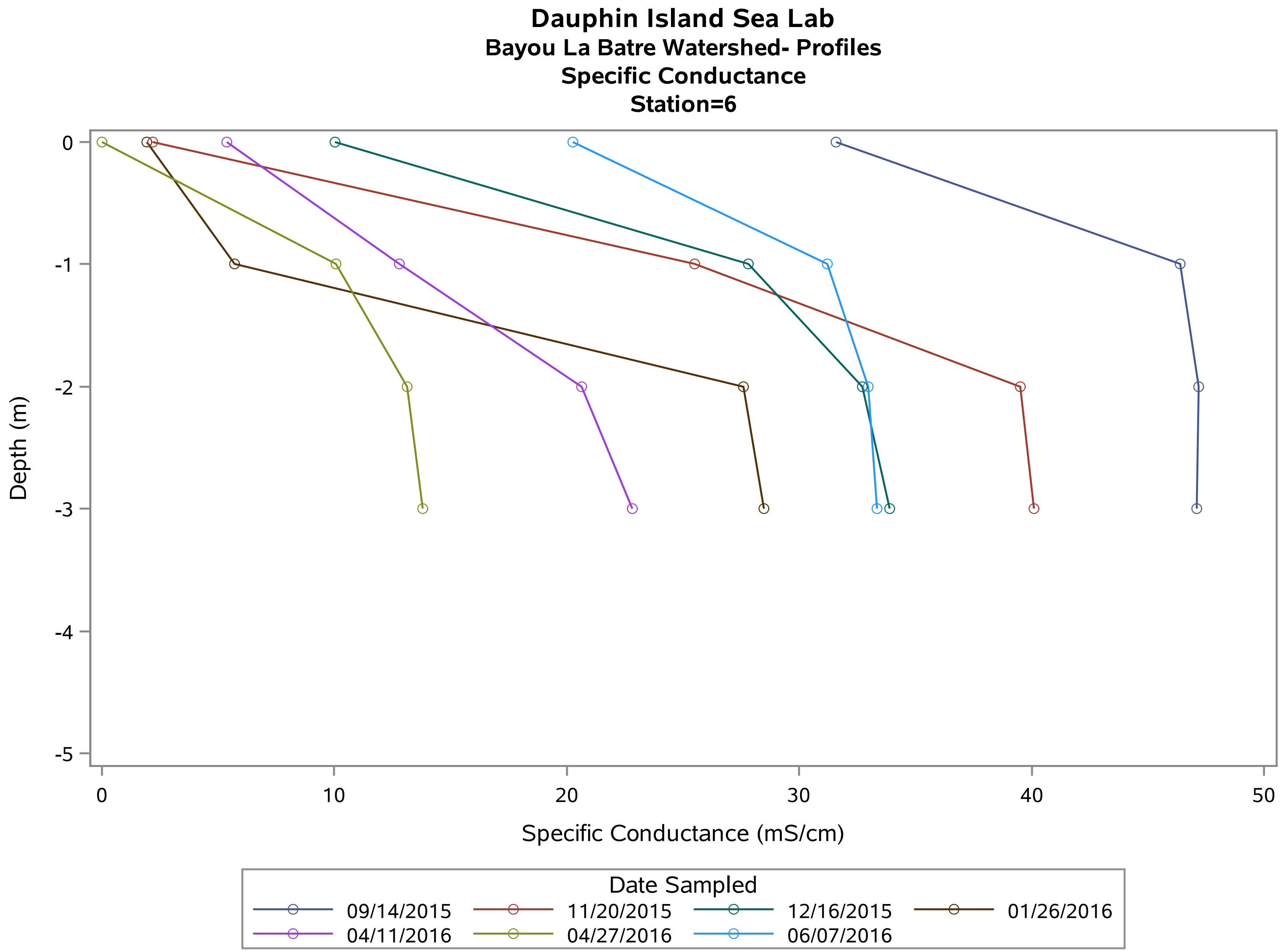

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Specific Conductance
Station=2
Depth (m)
0
-1
-2
-3
-4
-5
0
10
20
30
40
50
Specific Conductance (mS/cm)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

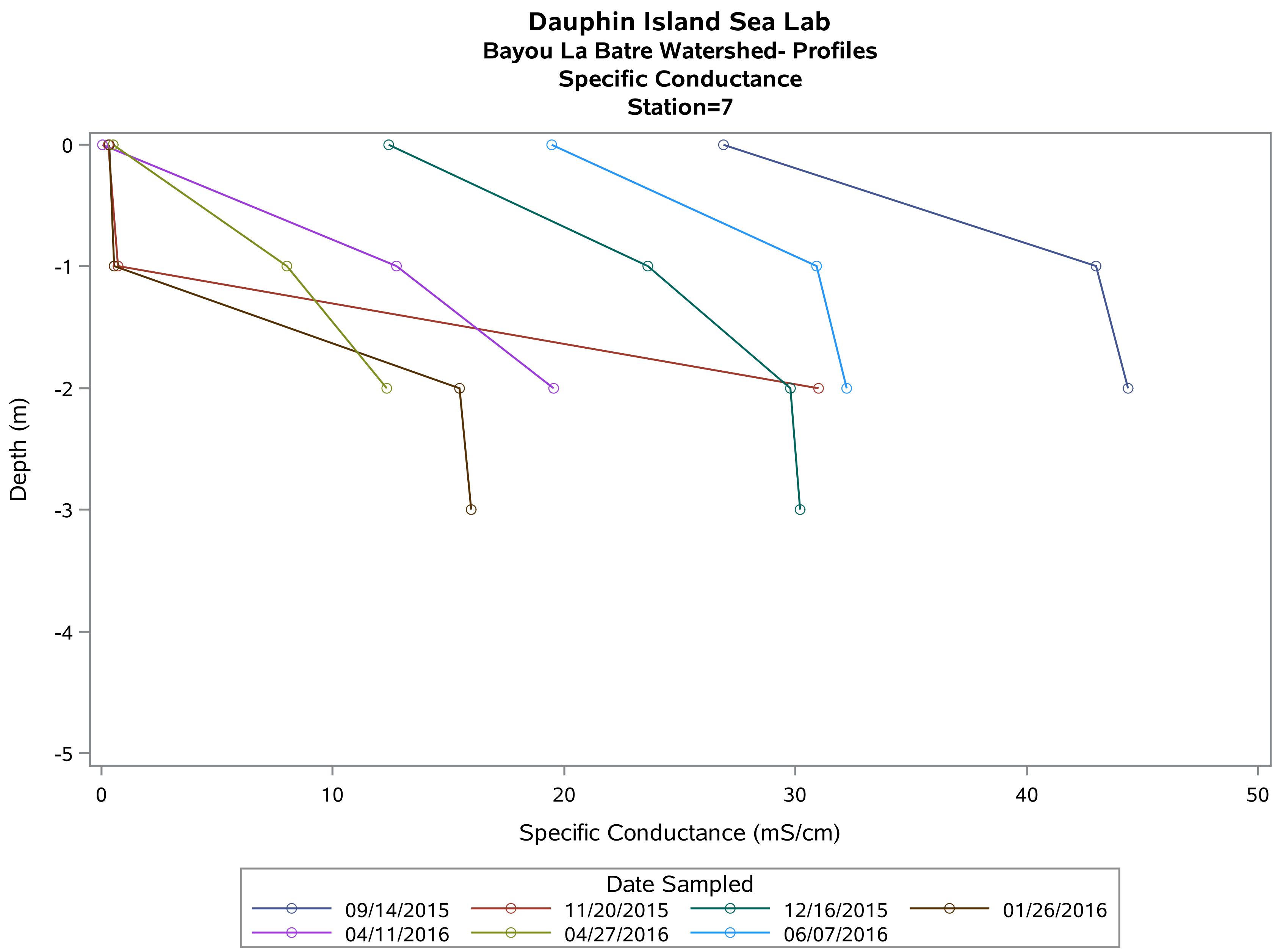

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Specific Conductance
Station=3
Depth (m)
0
-1
-2
-3
-4
-5
0
10
20
30
40
50
Specific Conductance (mS/cm)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016


Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Specific Conductance
Station=4
0
-1
-2
-3
-4
-5
Depth (m)
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

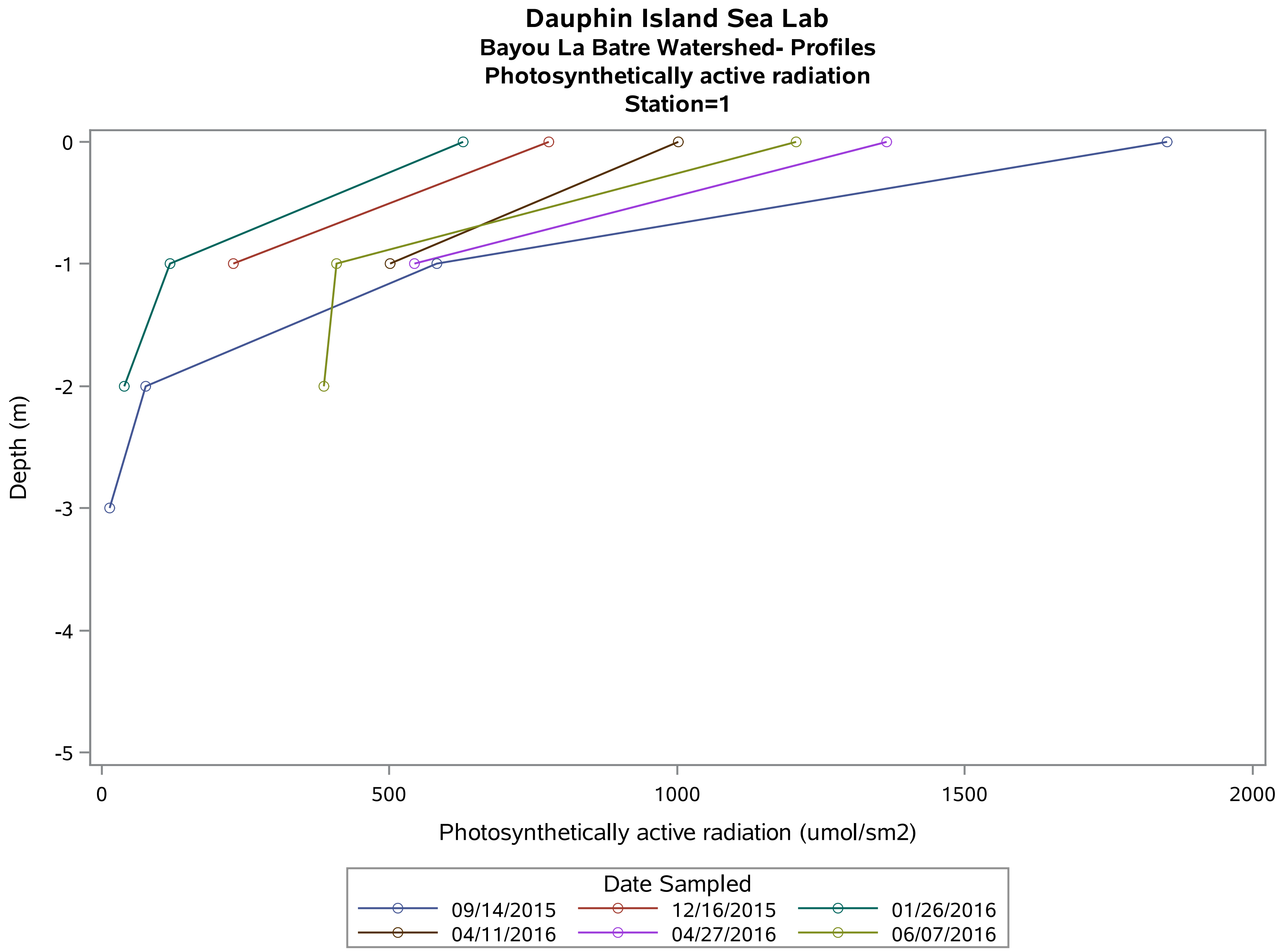


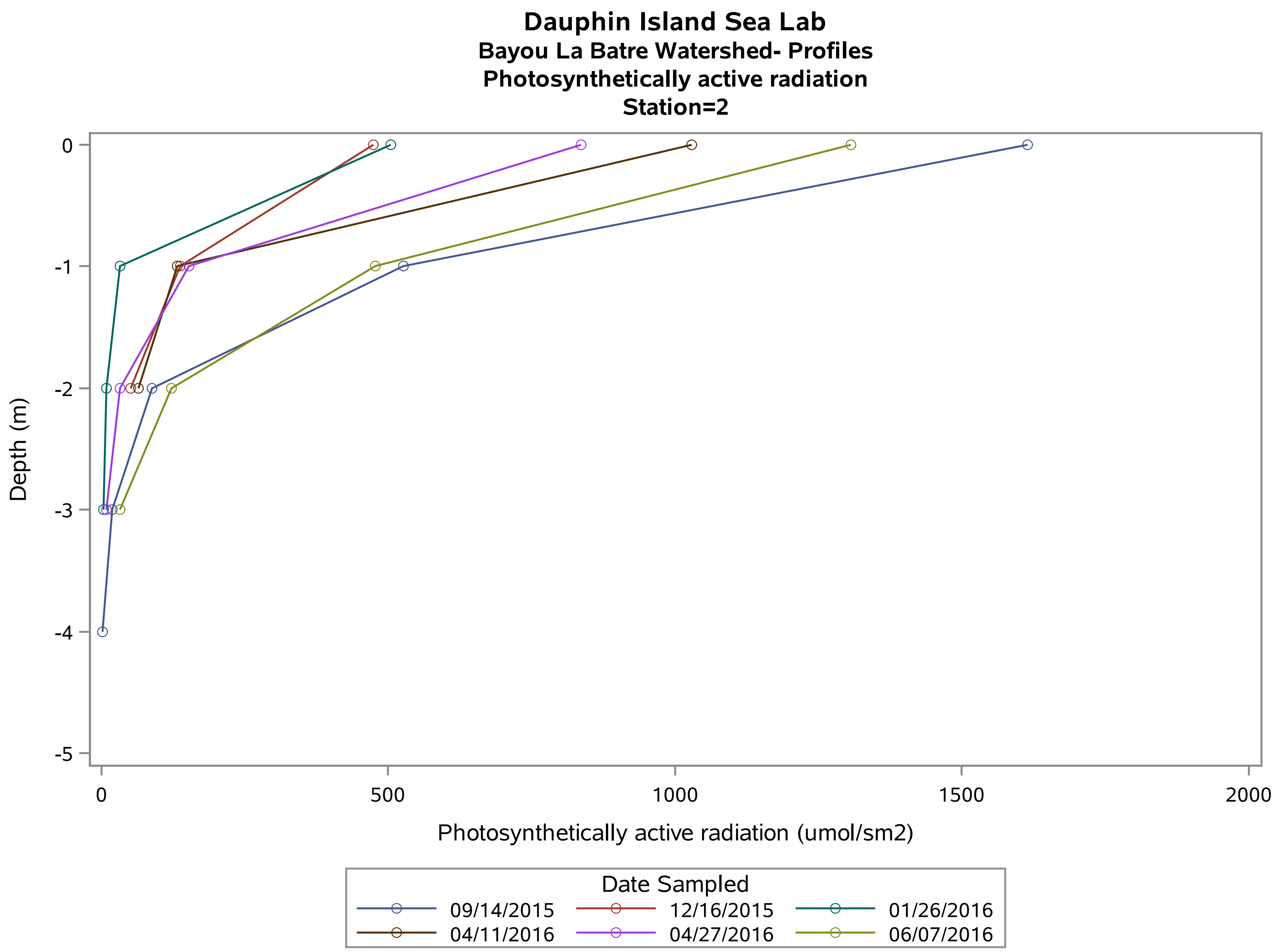
Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Specific Conductance
Station=5
Depth (m)
0
-1
-2
-3
-4
-5
0
10
20
30
40
50
Specific Conductance (mS/cm)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016


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

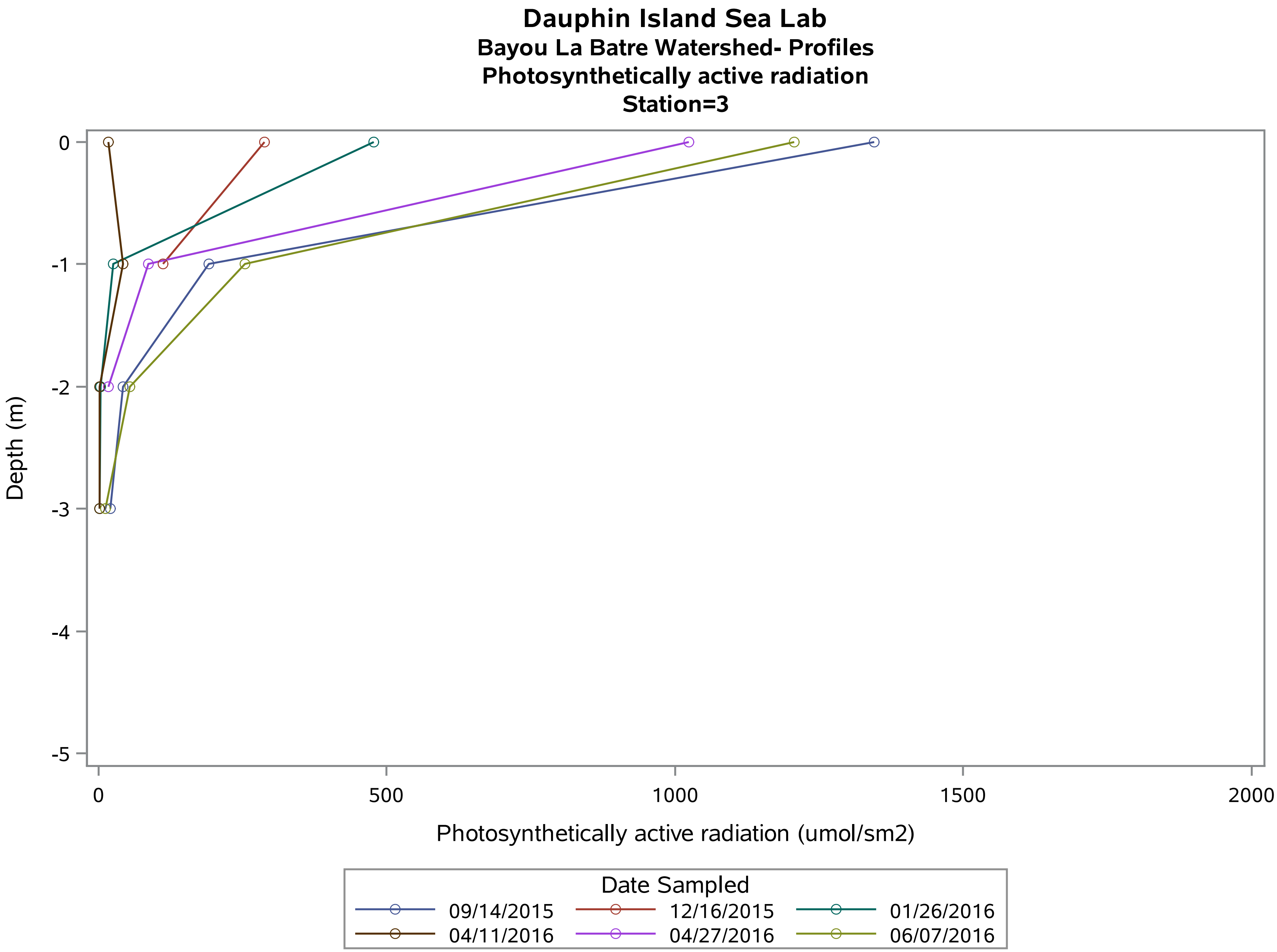


Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Specific Conductance
Station=7
Depth (m)
0
-1
-2
-3
-4
-5
0
10
20
30
40
50
Specific Conductance (mS/cm)
Date Sampled
09/14/2015
11/20/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

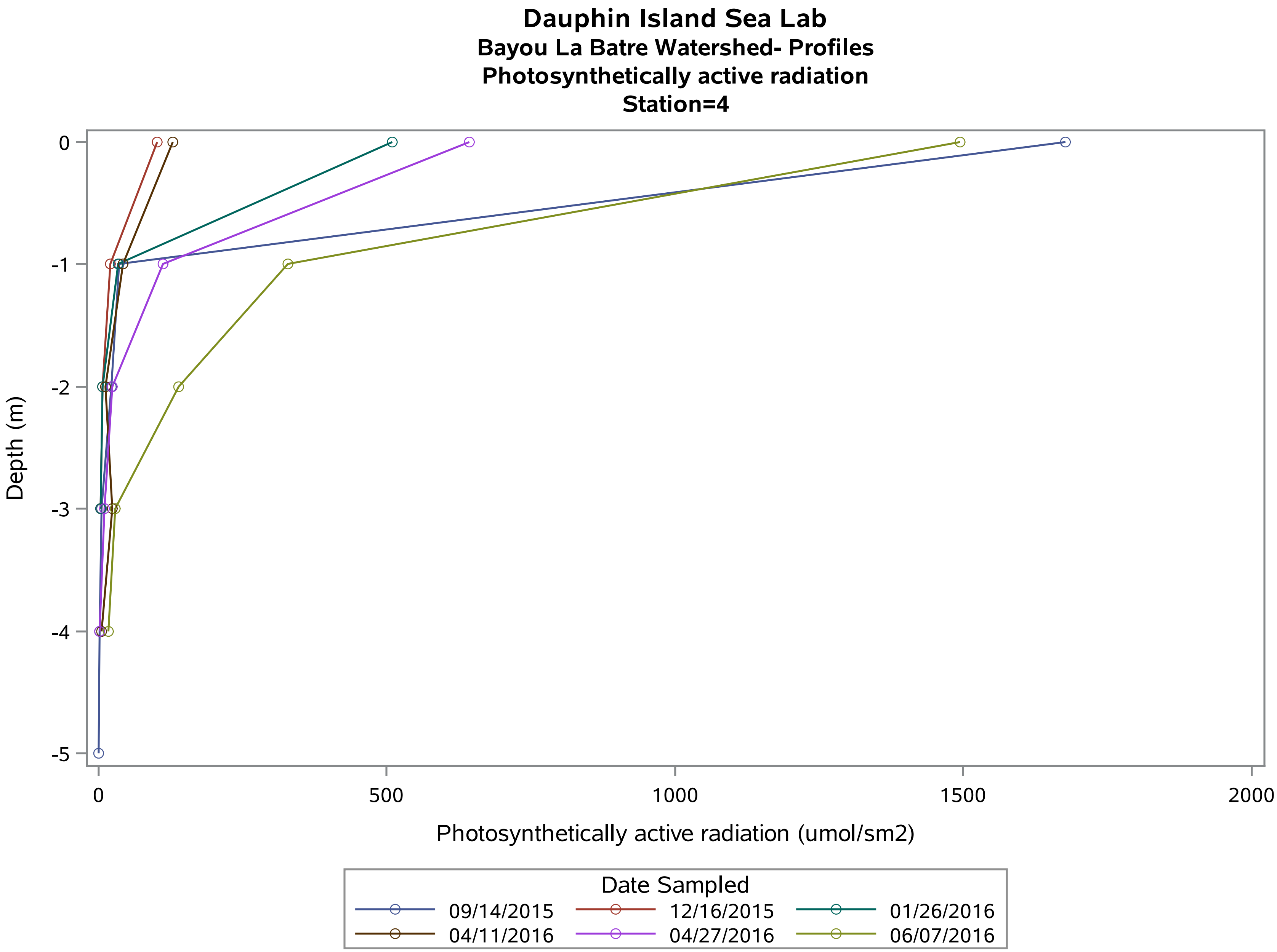

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Photosynthetically active radiation
Station=1
Depth (m)
0
-1
-2
-3
-4
-5
0
500
1000
1500
2000
Photosynthetically active radiation (umol/sm2)
Date Sampled
09/14/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

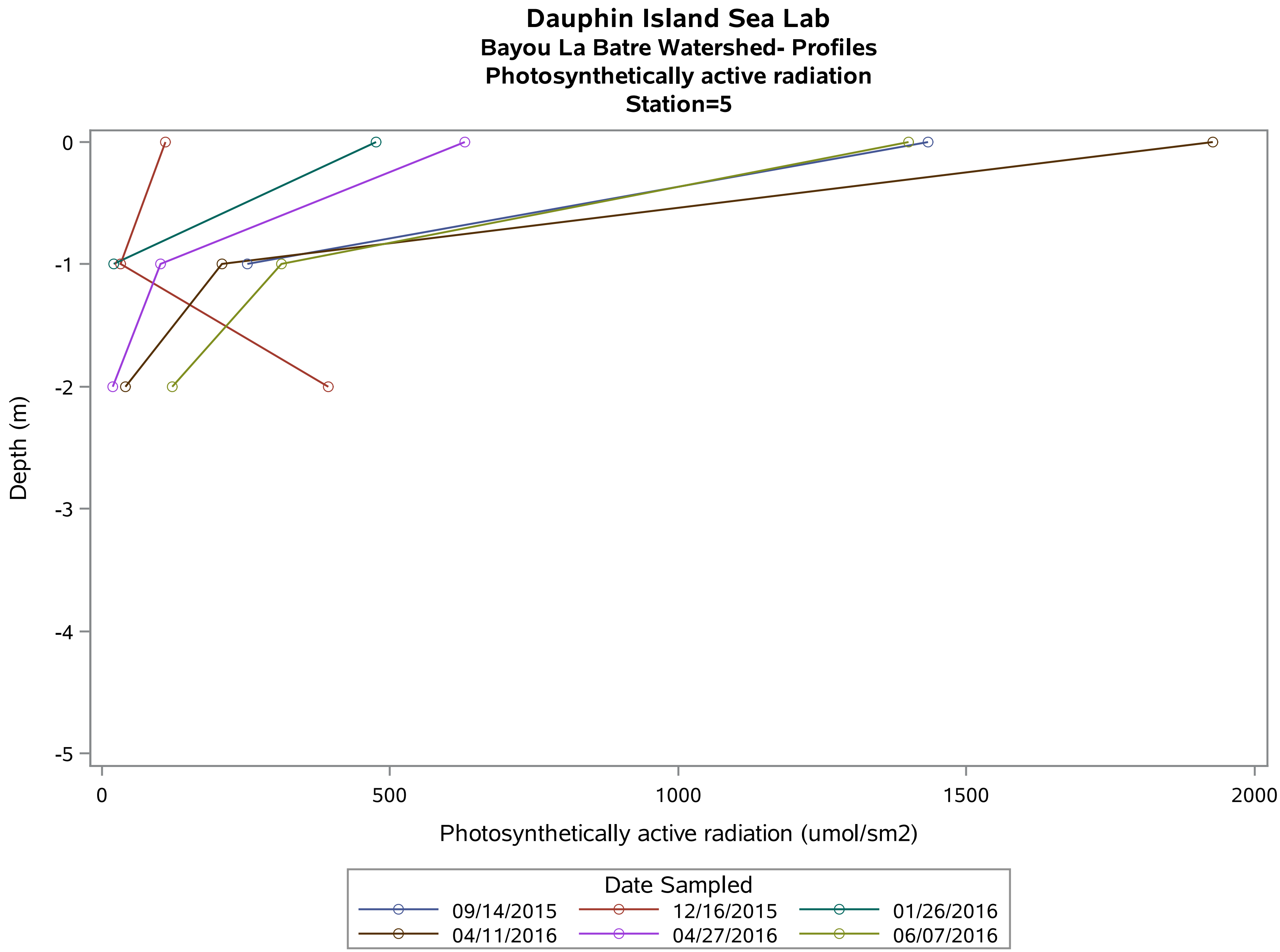


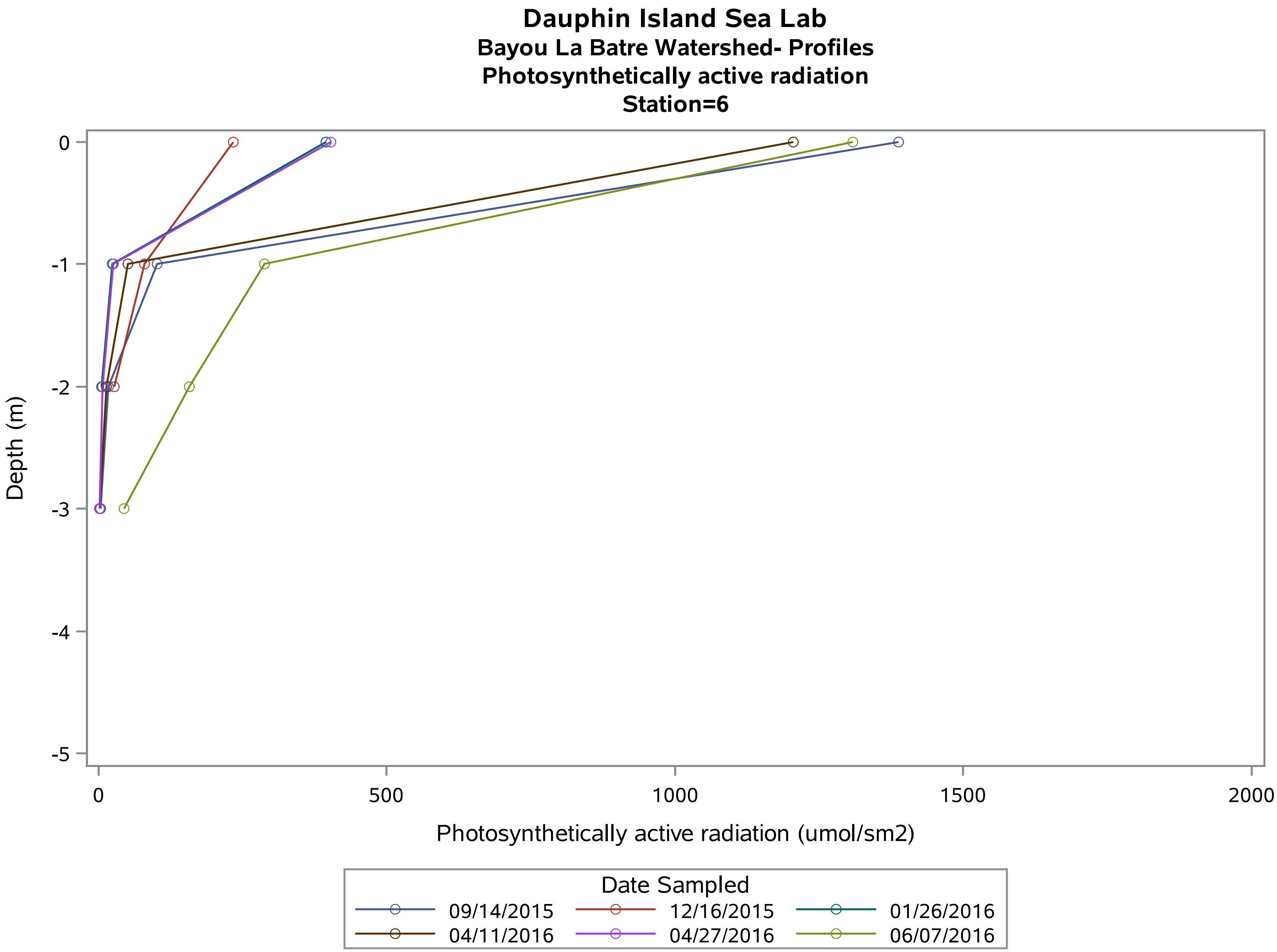
Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Photosynthetically active radiation
Station=2
Depth (m)
0
-1
-2
-3
-4
-5
0
500
1000
1500
2000
Photosynthetically active radiation (umol/sm2)
Date Sampled
09/14/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016



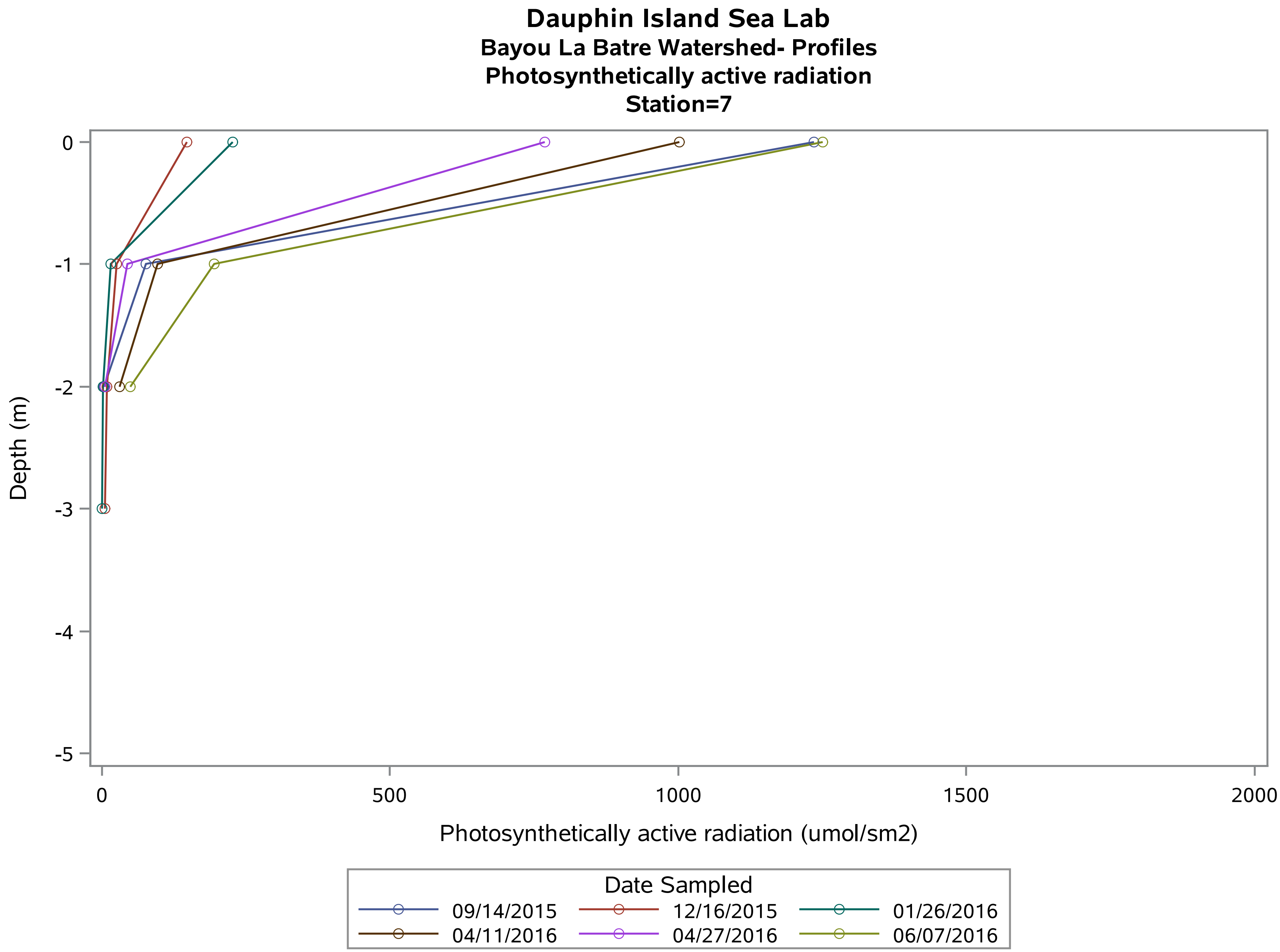
Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Photosynthetically active radiation
Station=3
Depth (m)
0
-1
-2
-3
-4
-5
0
500
1000
1500
2000
Photosynthetically active radiation (umol/sm2)
Date Sampled
09/14/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

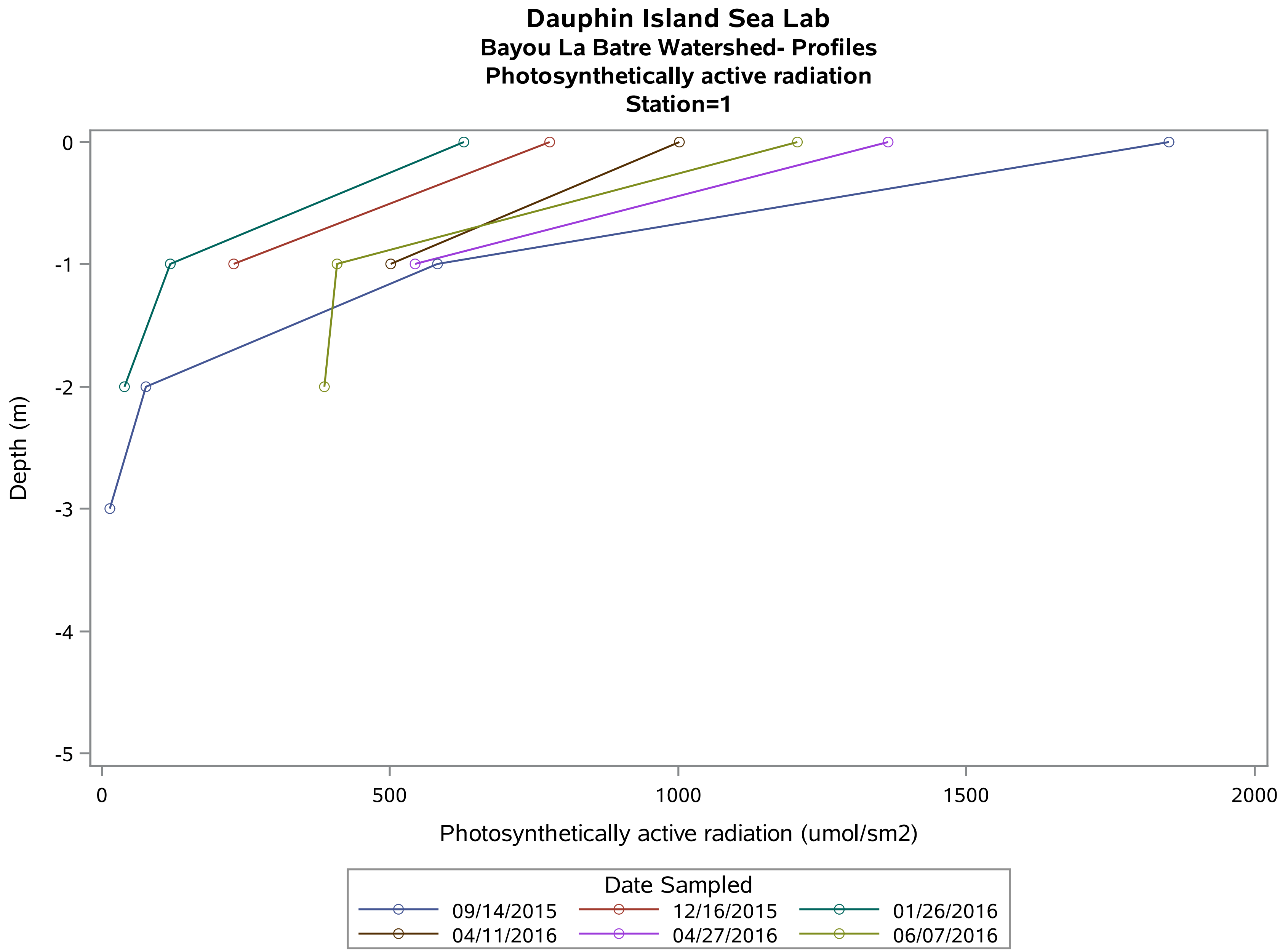

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Photosynthetically active radiation
Station=4
0
-1
-2
-3
-4
-5
Depth (m)
0
500
1000
1500
2000
Photosynthetically active radiation (umol/sm2)
Date Sampled
09/14/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

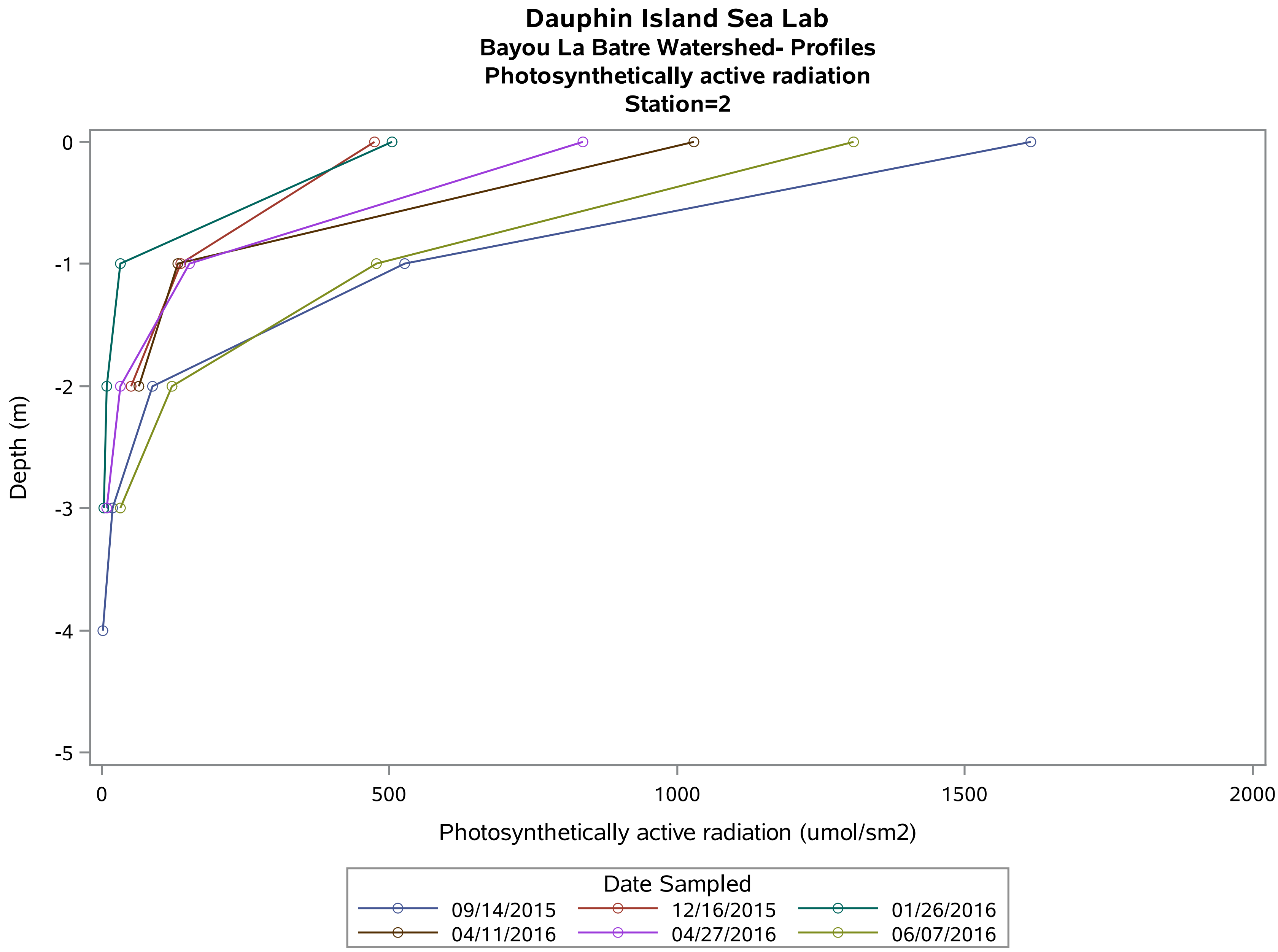

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Photosynthetically active radiation
Station=5
Depth (m)
0
-1
-2
-3
-4
-5
0
500
1000
1500
2000
Photosynthetically active radiation (umol/sm2)
Date Sampled
09/14/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

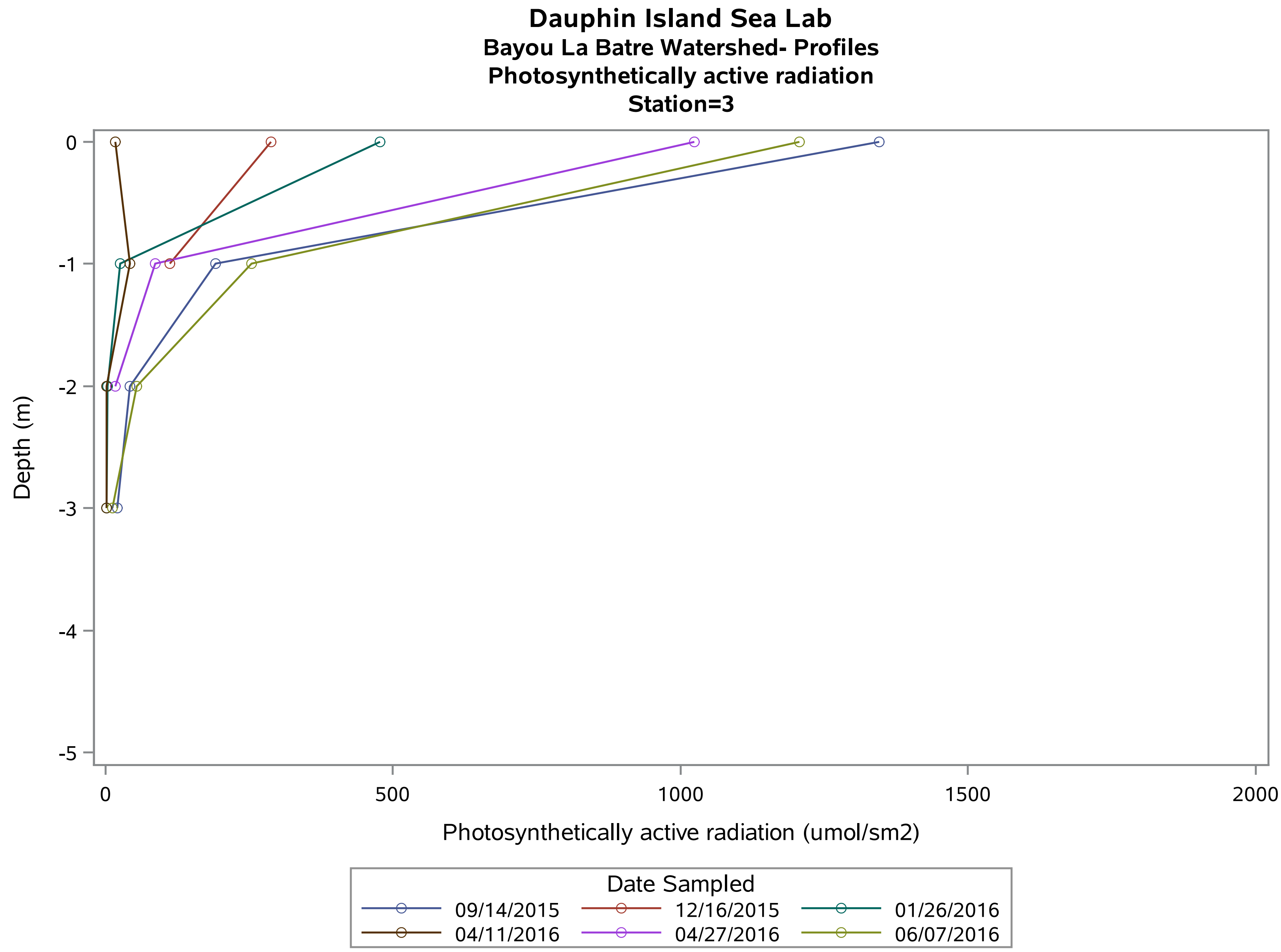


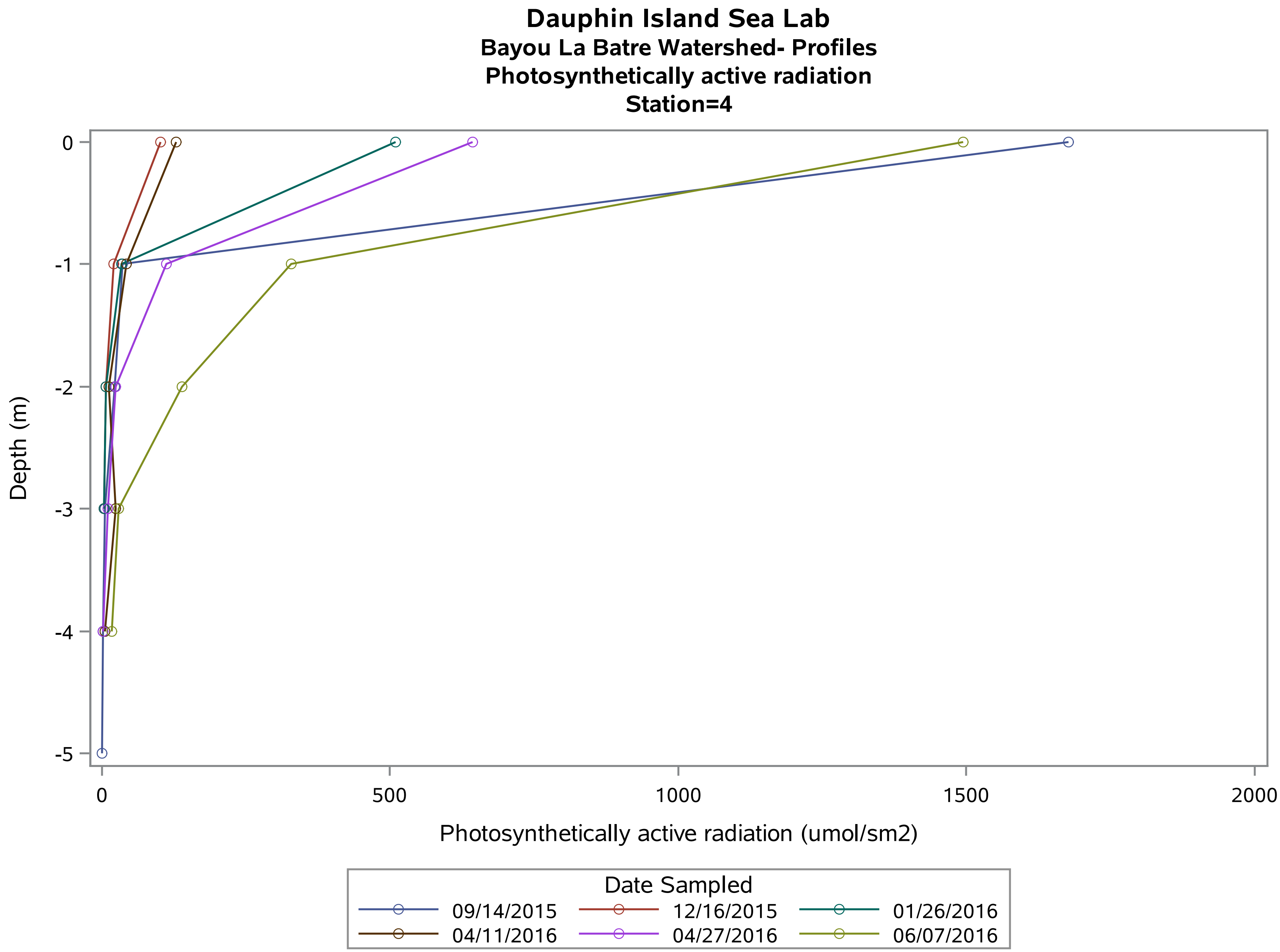
Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Photosynthetically active radiation
Station=6
Depth (m)
0
-1
-2
-3
-4
-5
0
500
1000
1500
2000
Photosynthetically active radiation (umol/sm2)
Date Sampled
09/14/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016


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

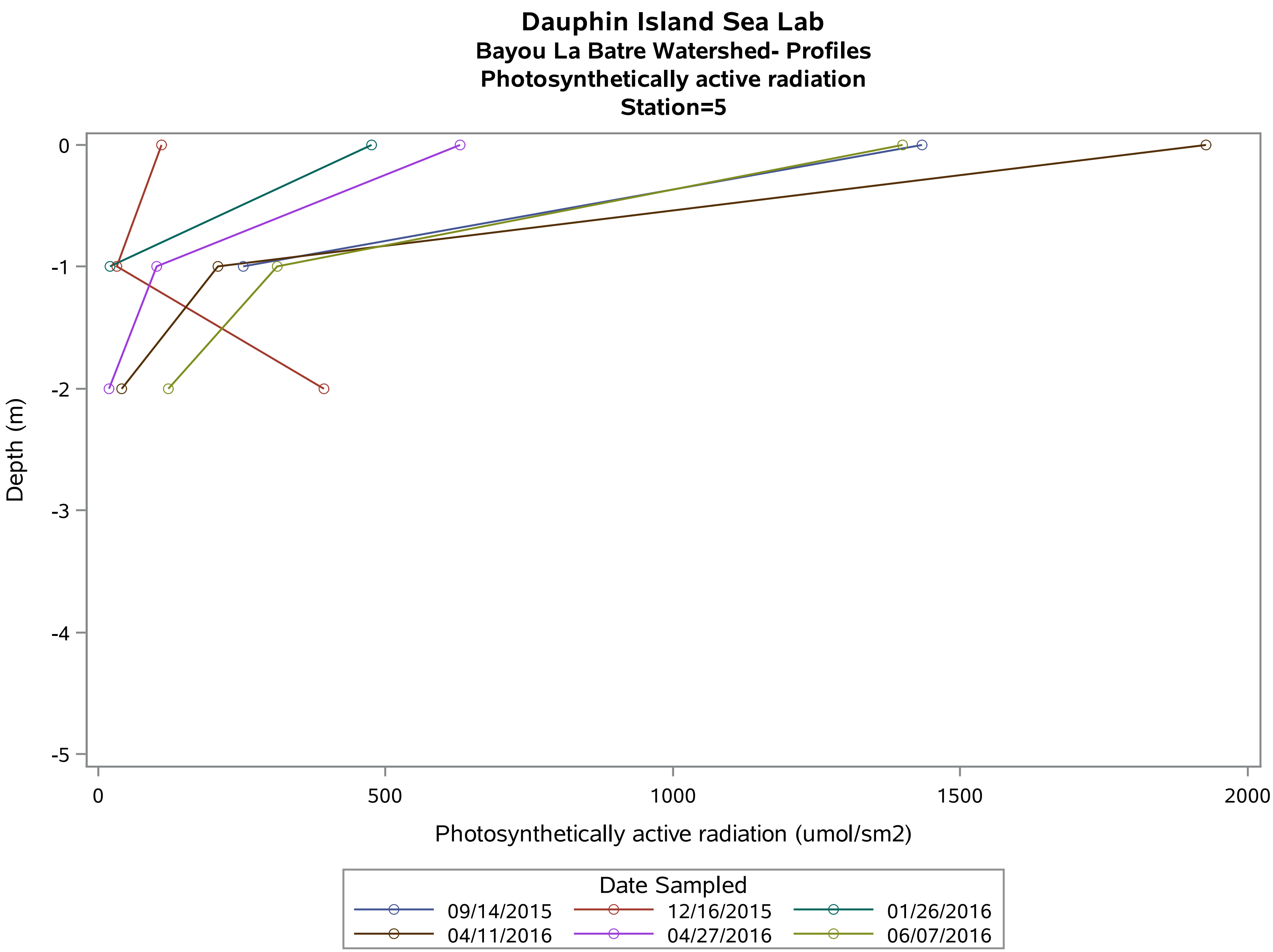

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Photosynthetically active radiation
Station=1
Depth (m)
0
-1
-2
-3
-4
-5
0
500
1000
1500
2000
Photosynthetically active radiation (umol/sm2)
Date Sampled
09/14/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016


Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Photosynthetically active radiation
Station=2
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

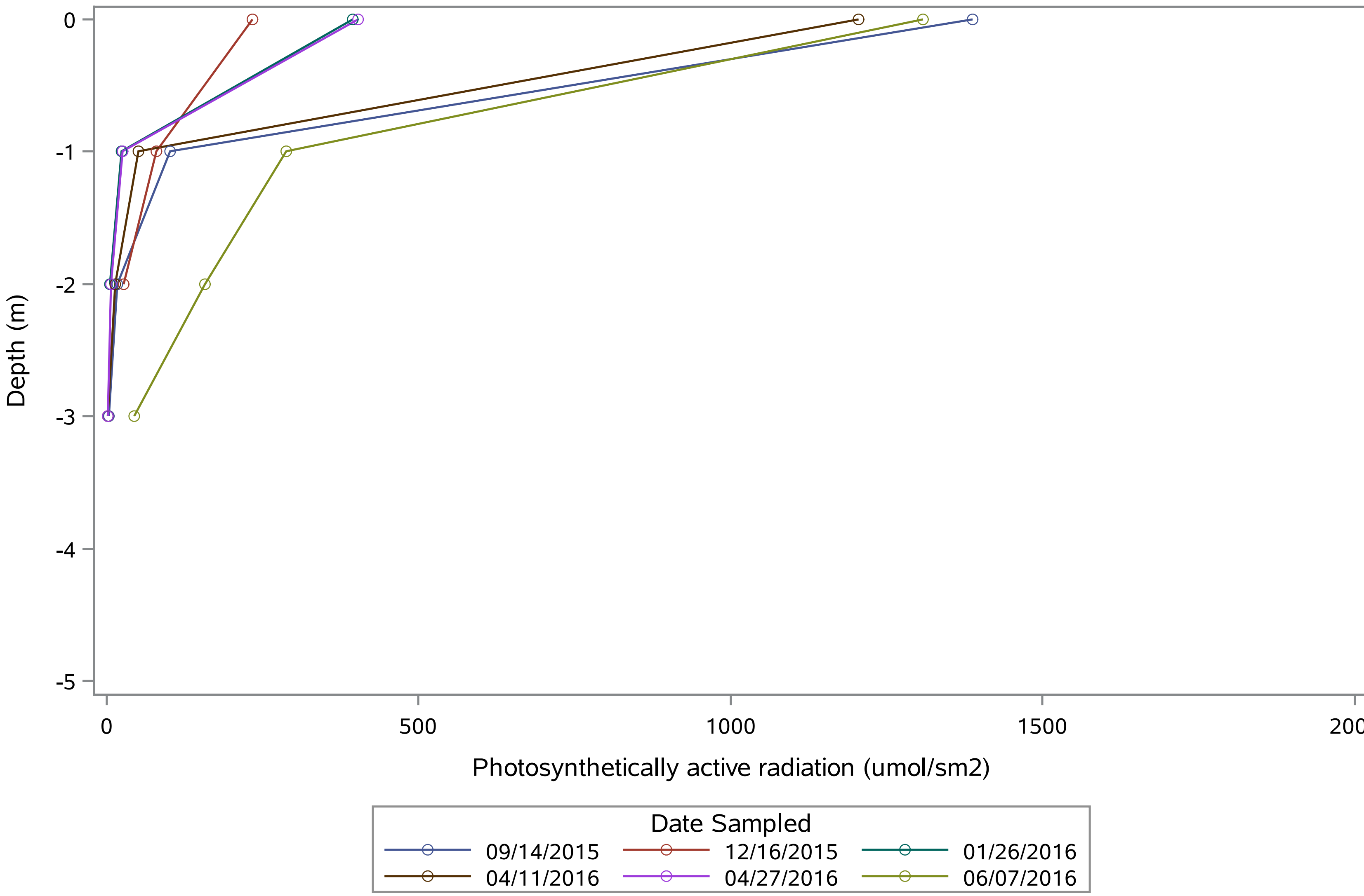

Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Photosynthetically active radiation
Station=3
0
-1
-2
-3
-4
-5
Depth (m)
0
500
1000
1500
2000
Photosynthetically active radiation (umol/sm2)
Date Sampled
09/14/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

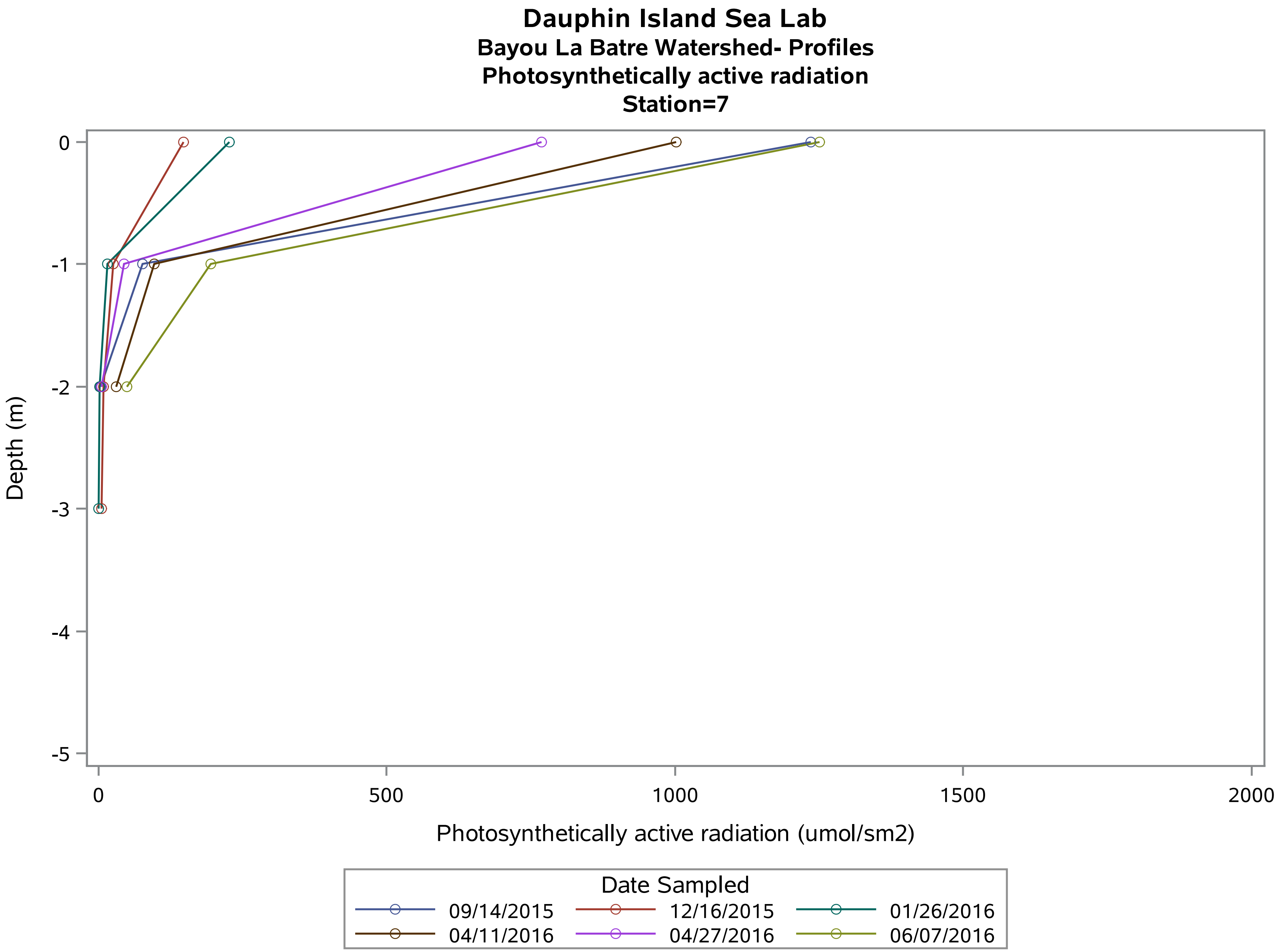


Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Photosynthetically active radiation
Station=4
Depth (m)
0
-1
-2
-3
-4
-5
0
500
1000
1500
2000
Photosynthetically active radiation (umol/sm2)
Date Sampled
09/14/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016


Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Photosynthetically active radiation
Station=5
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

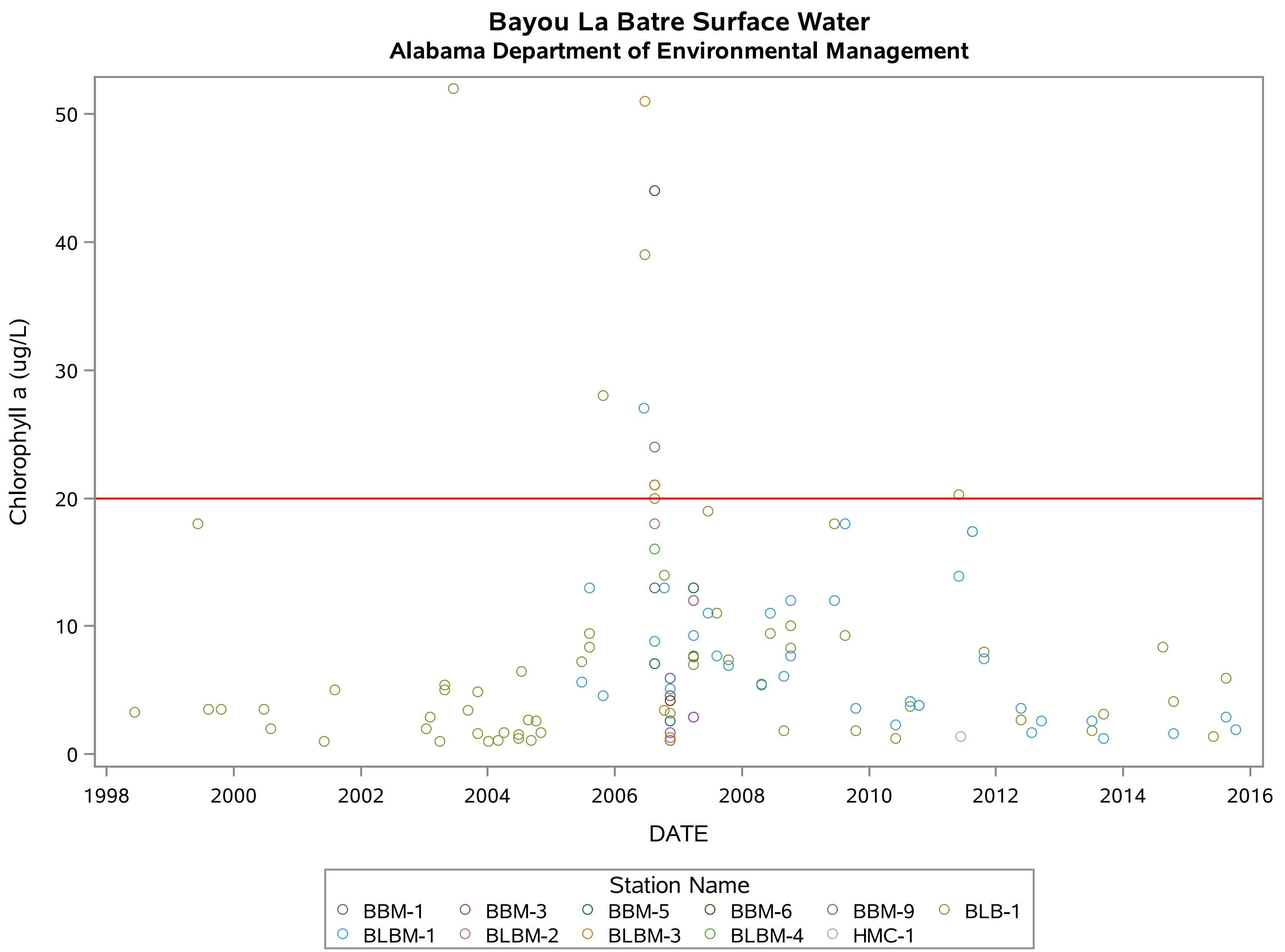
Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Photosynthetically active radiation
Station=6



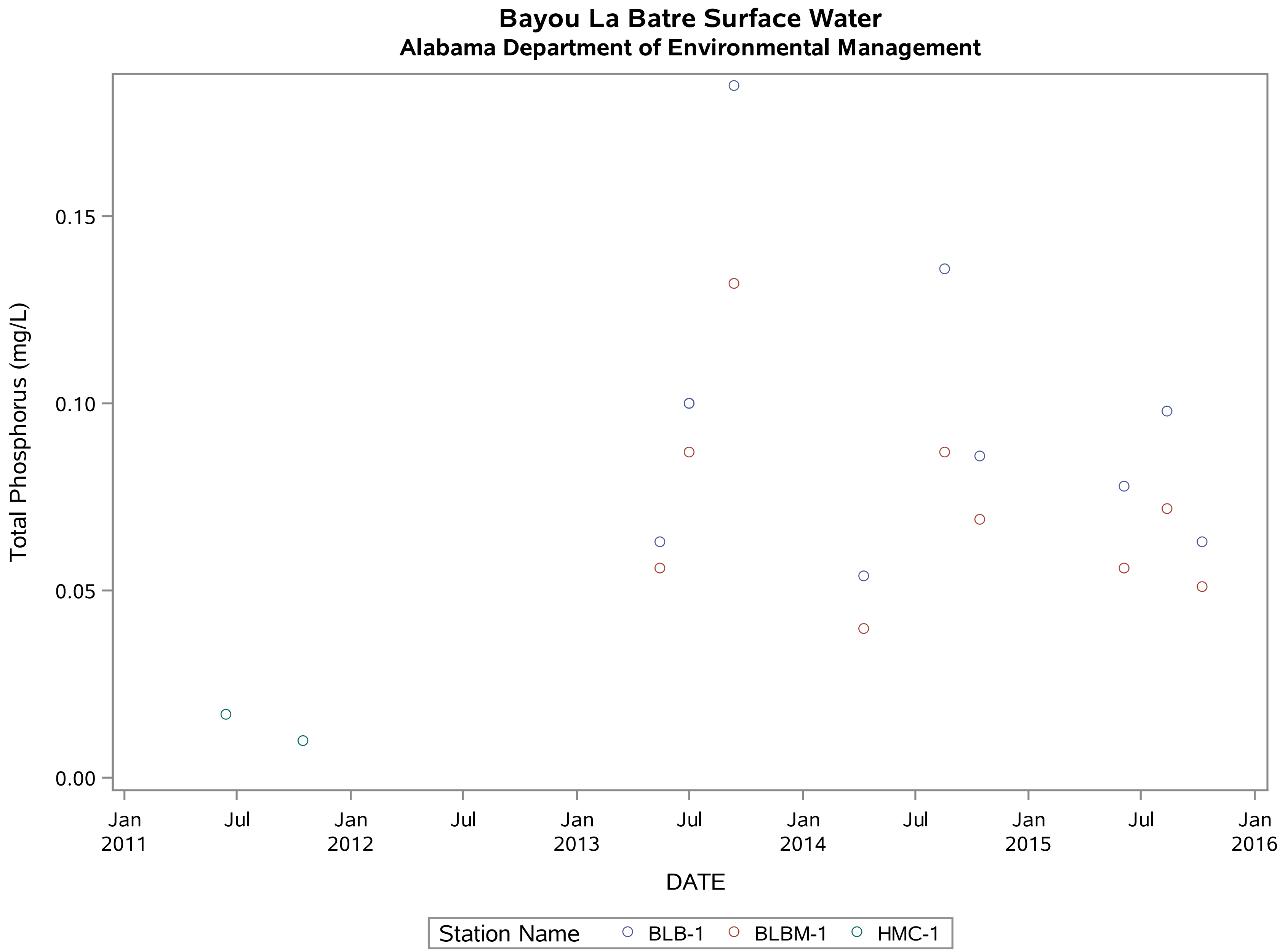


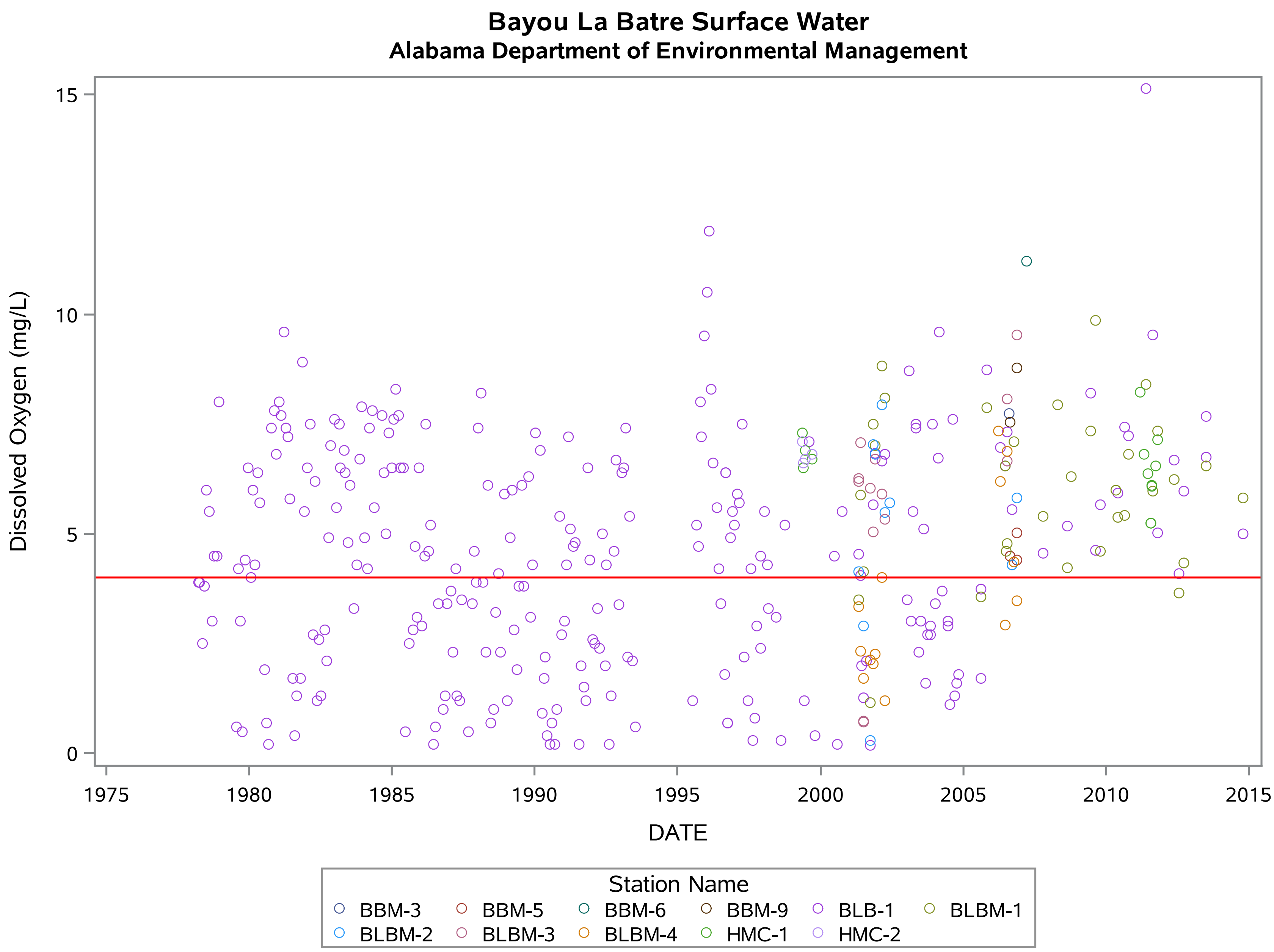
Dauphin Island Sea Lab
Bayou La Batre Watershed- Profiles
Photosynthetically active radiation
Station=7
Depth (m)
0
-1
-2
-3
-4
-5
0
500
1000
1500
2000
Photosynthetically active radiation (umol/sm2)
Date Sampled
09/14/2015
12/16/2015
01/26/2016
04/11/2016
04/27/2016
06/07/2016

APPENDIX A ADEM RAW DATA

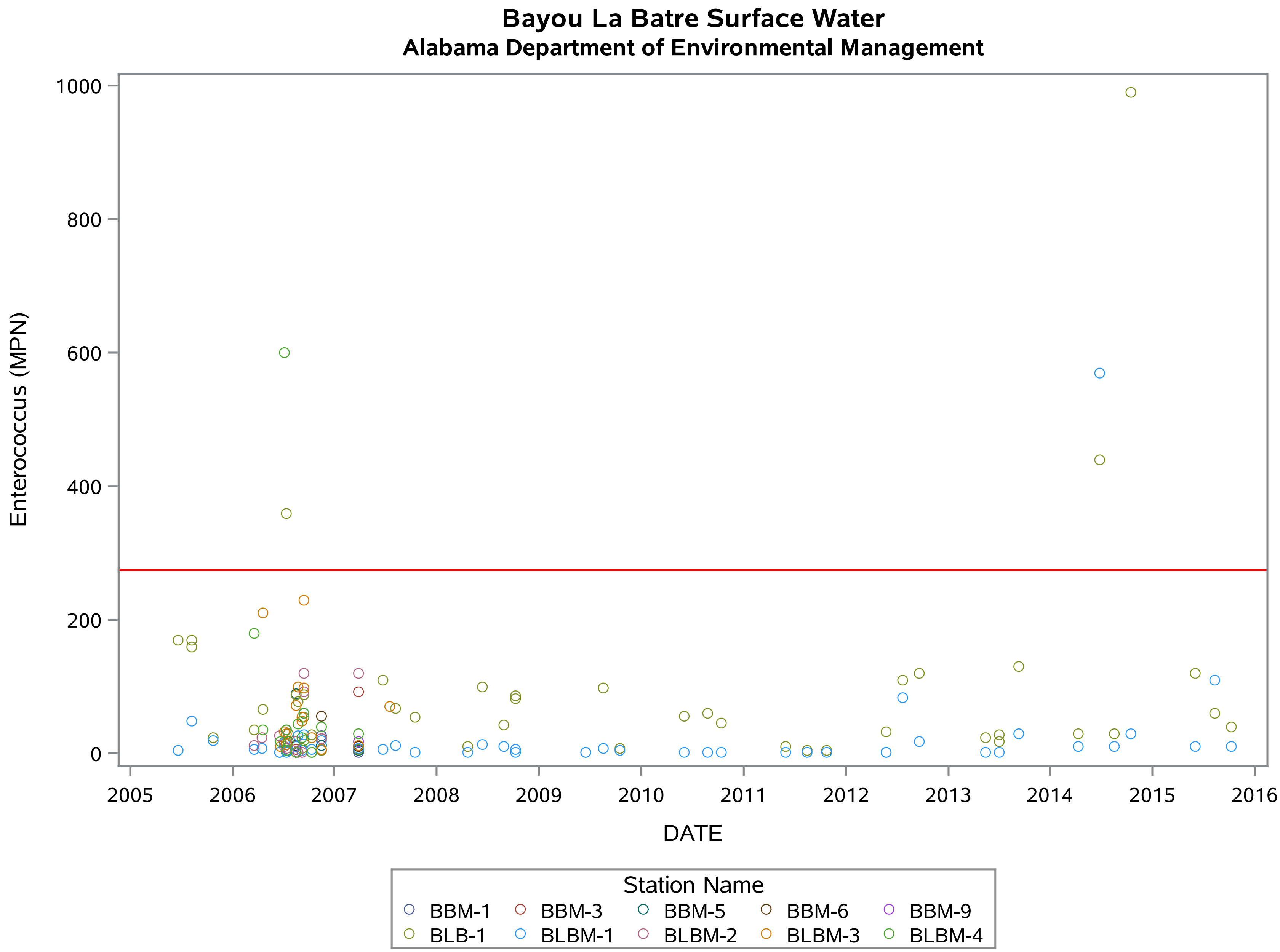

Bayou La Batre Surface Water
Alabama Department of Environmental Management
Chlorophyll a (ug/L)
0
10
20
30
40
50
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
DATE
Station Name
BBM-1
BBM-3
BBM-5
BBM-6
BBM-9
BLB-1
BLBM-1
BLBM-2
BLBM-3
BLBM-4
HMC-1

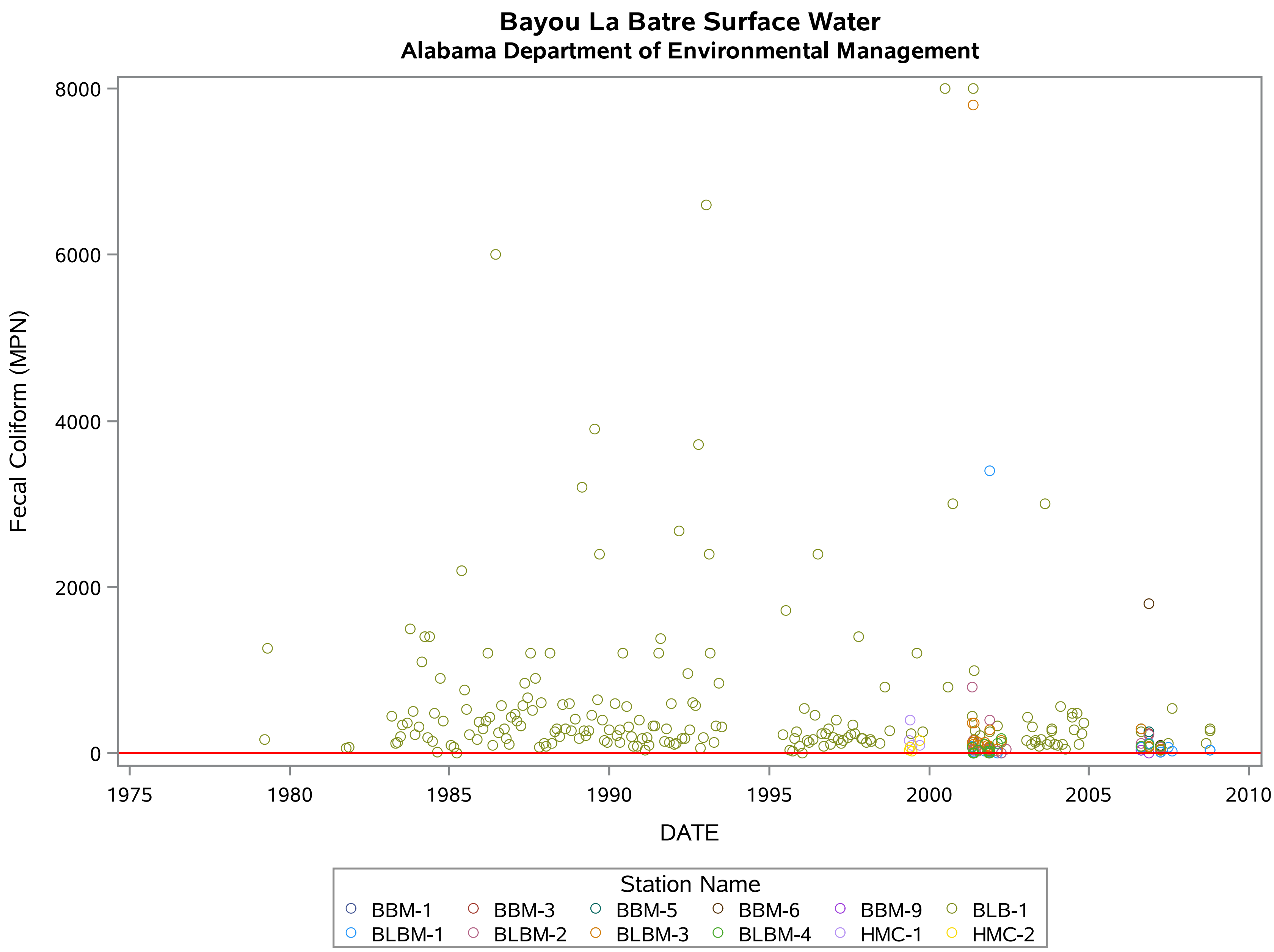

Bayou La Batre Surface Water
Alabama Department of Environmental Management
Total Nitrogen (mg/L)
0
1
2
3
4
5
1985
1990
1995
2000
2005
2010
2015
DATE
Station Name
BBM-1
BBM-3
BBM-5
BBM-6
BBM-9
BLB-1
BLBM-1
BLBM-2
BLBM-3
BLBM-4
HMC-1
HMC-2


Bayou La Batre Surface Water
Alabama Department of Environmental Management
Total Phosphorus (mg/L)
0.00
0.05
0.10
0.15
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

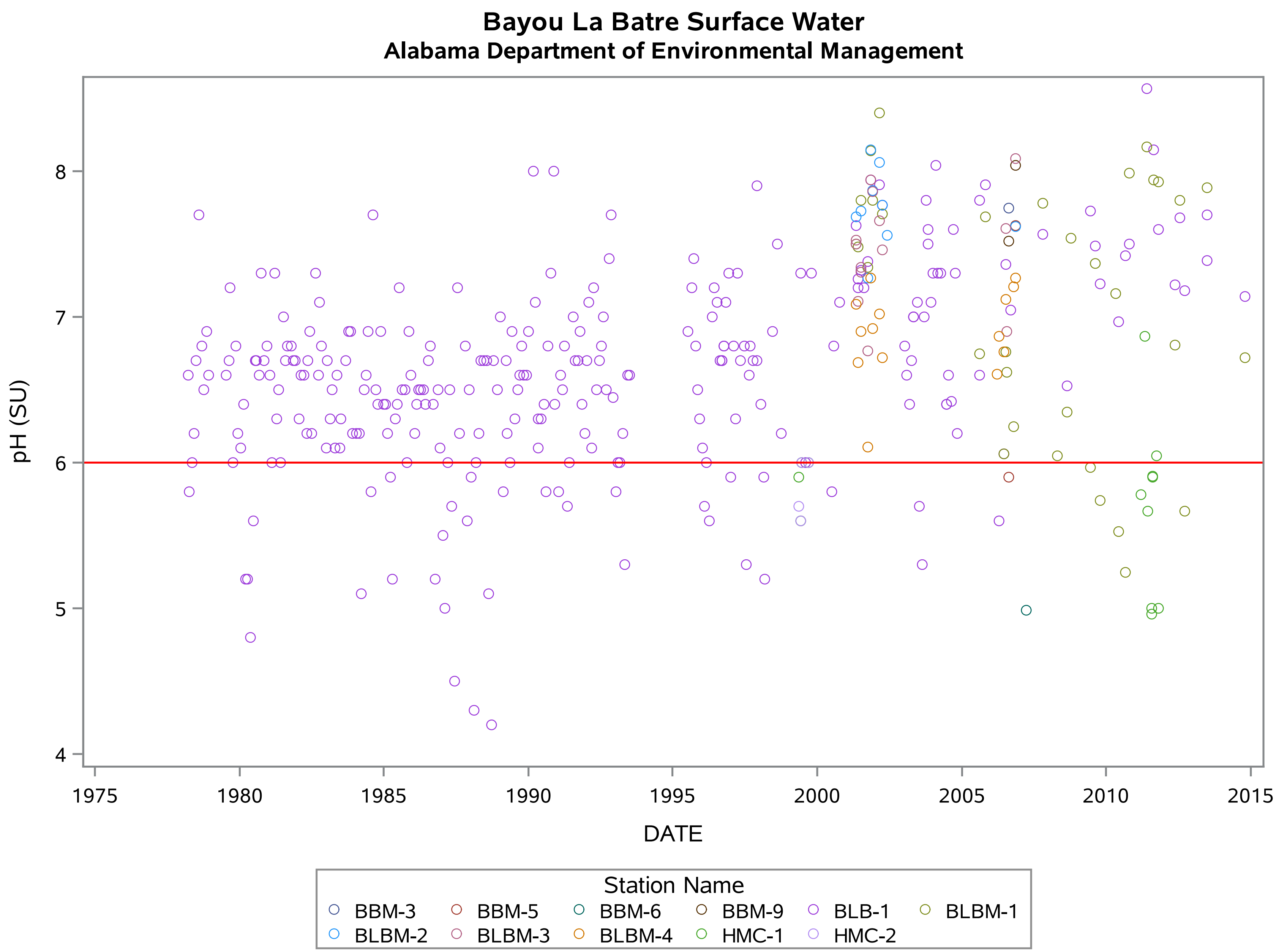


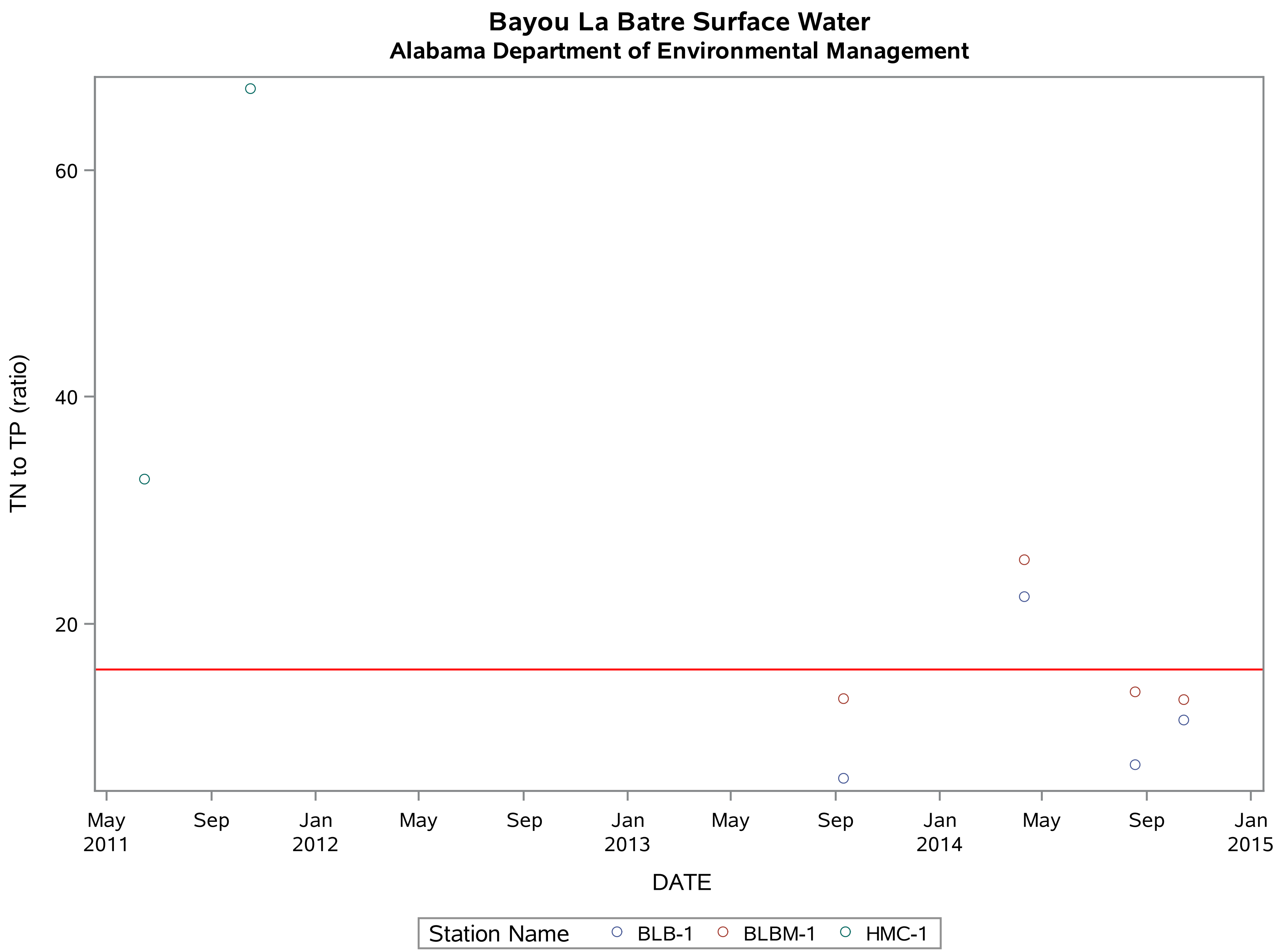
Bayou La Batre Surface Water
Alabama Department of Environmental Management
Dissolved Oxygen (mg/L)
15
10
5
0
1975
1980
1985
1990
1995
2000
2005
2010
2015
DATE
Station Name
BBM-3
BBM-5
BBM-6
BBM-9
BLB-1
BLBM-1
BLBM-2
BLBM-3
BLBM-4
HMC-1
HMC-2

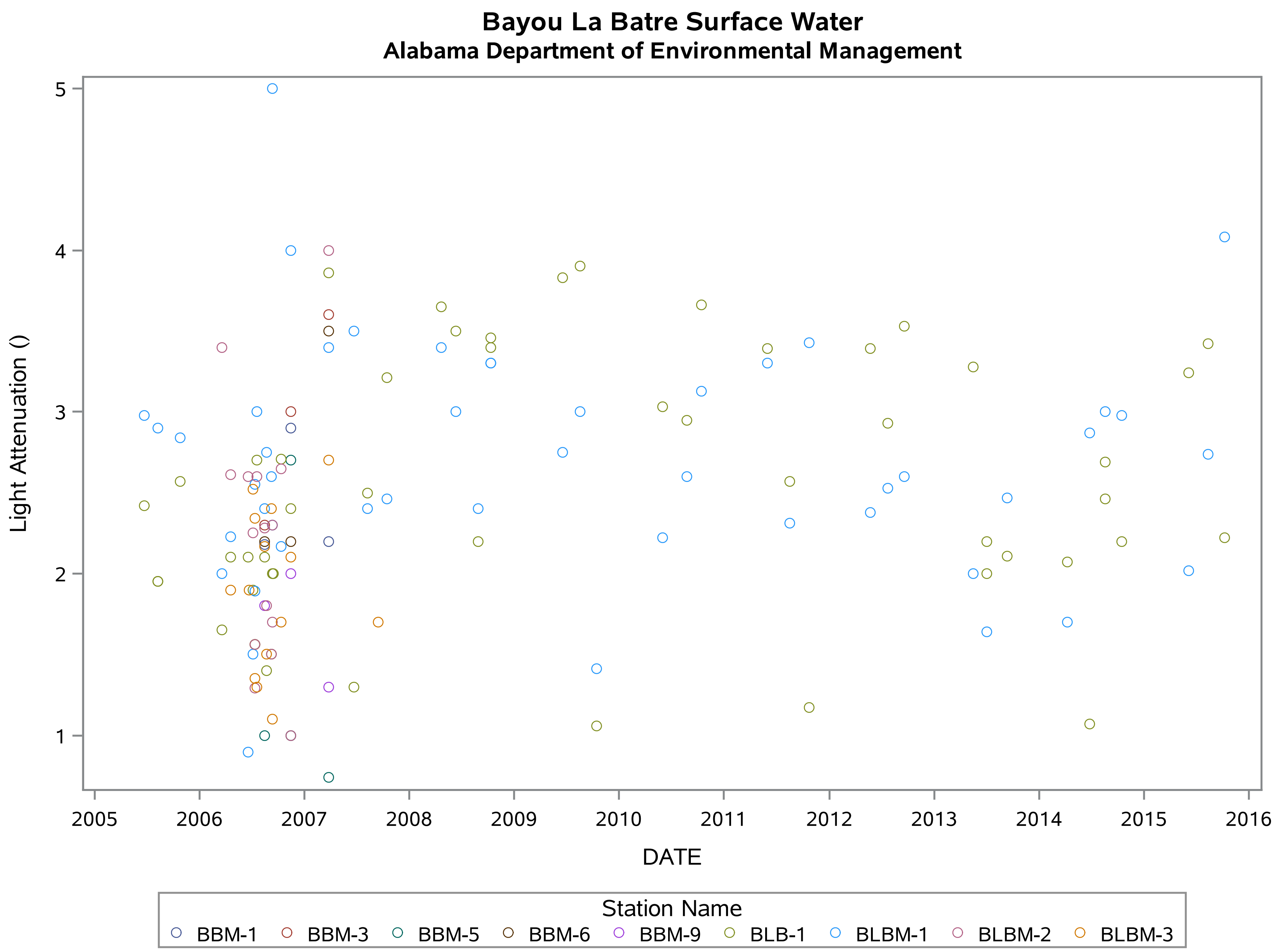

Bayou La Batre Surface Water
Alabama Department of Environmental Management
Enterococcus (MPN)
1000
800
600
400
200
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
DATE
Station Name
BBM-1
BBM-3
BBM-5
BBM-6
BBM-9
BLB-1
BLBM-1
BLBM-2
BLBM-3
BLBM-4

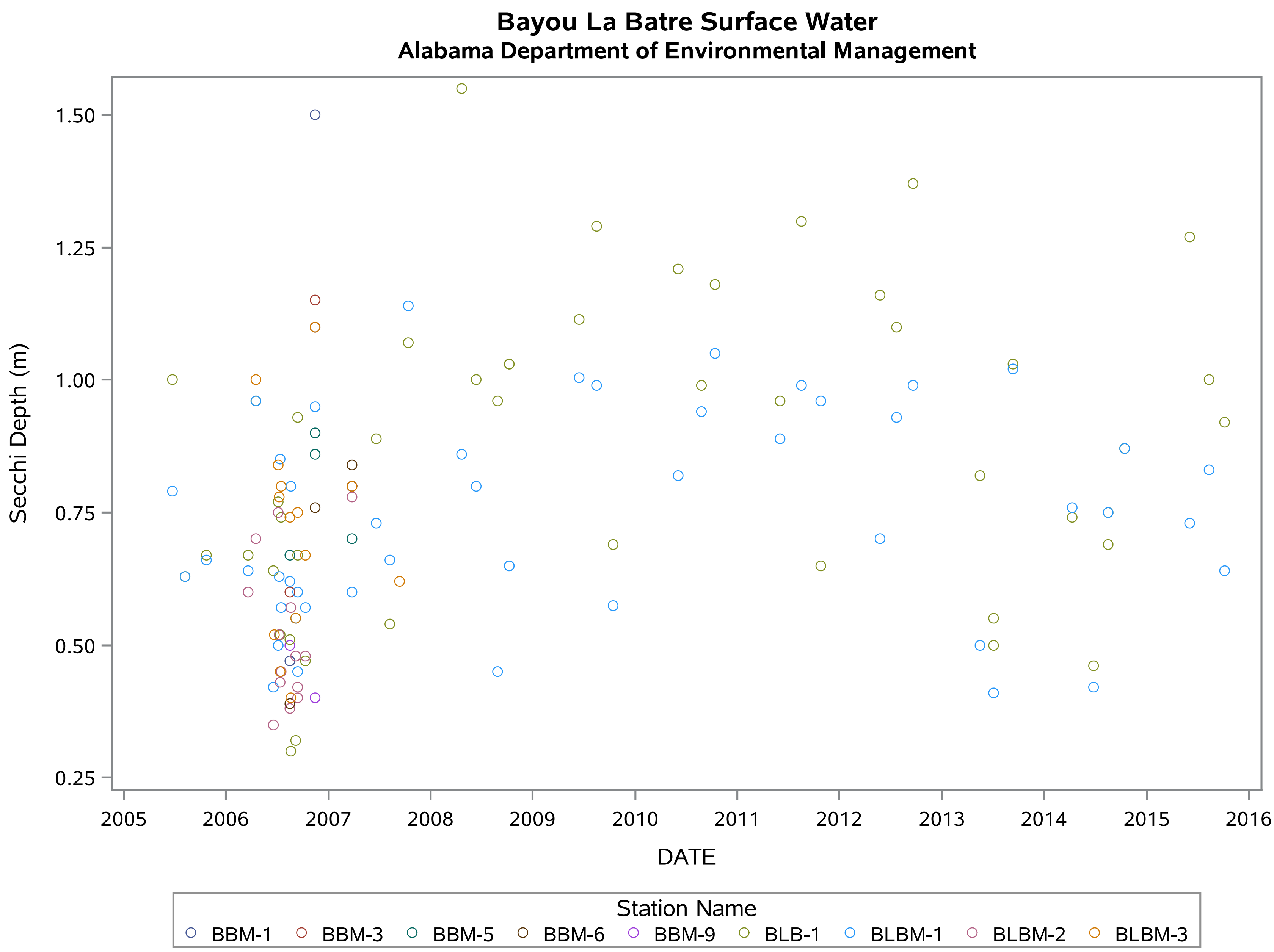


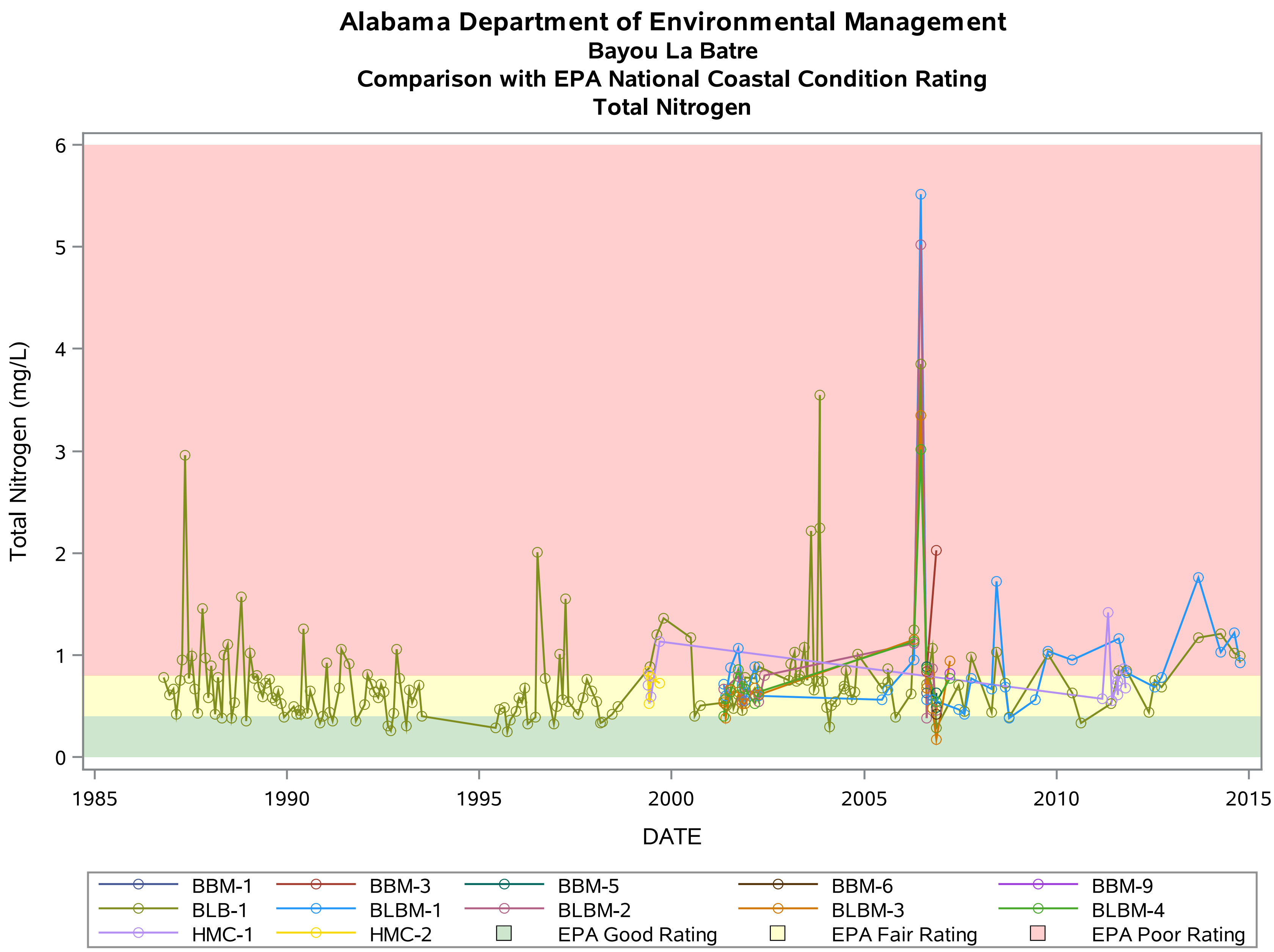
Bayou La Batre Surface Water
Alabama Department of Environmental Management
Fecal Coliform (MPN)
8000
6000
4000
2000
0
1975
1980
1985
1990
1995
2000
2005
2010
DATE
Station Name
BBM-1
BBM-3
BBM-5
BBM-6
BBM-9
BLB-1
BLBM-1
BLBM-2
BLBM-3
BLBM-4
HMC-1
HMC-2


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

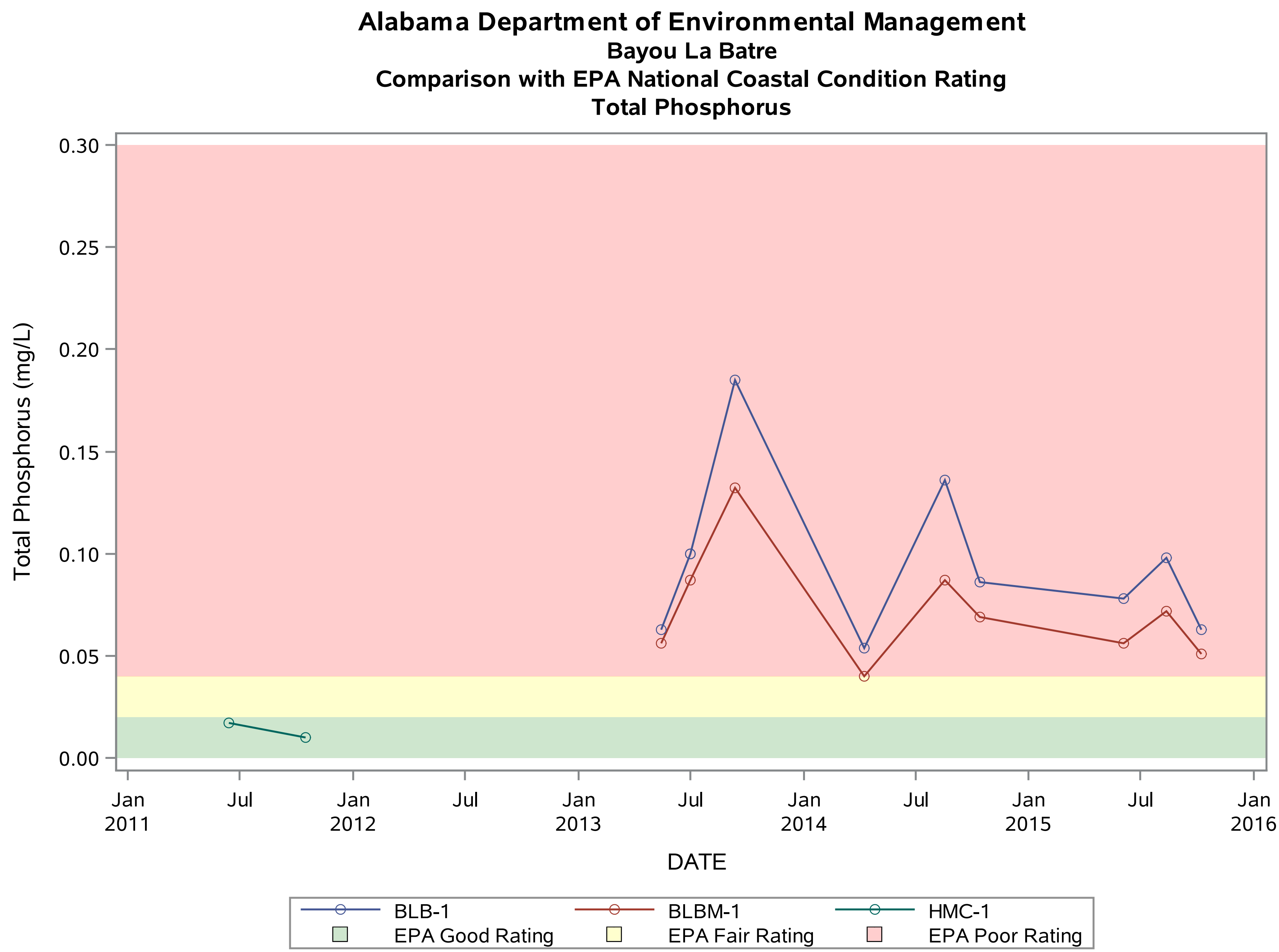

Bayou La Batre Surface Water
Alabama Department of Environmental Management
TN to TP (ratio)
60
40
20
May 2011
Sep
Jan 2012
May
Sep
Jan 2013
May
Sep
Jan 2014
May
Sep
Jan 2015
DATE
Station Name
BLB-1
BLBM-1
HMC-1


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

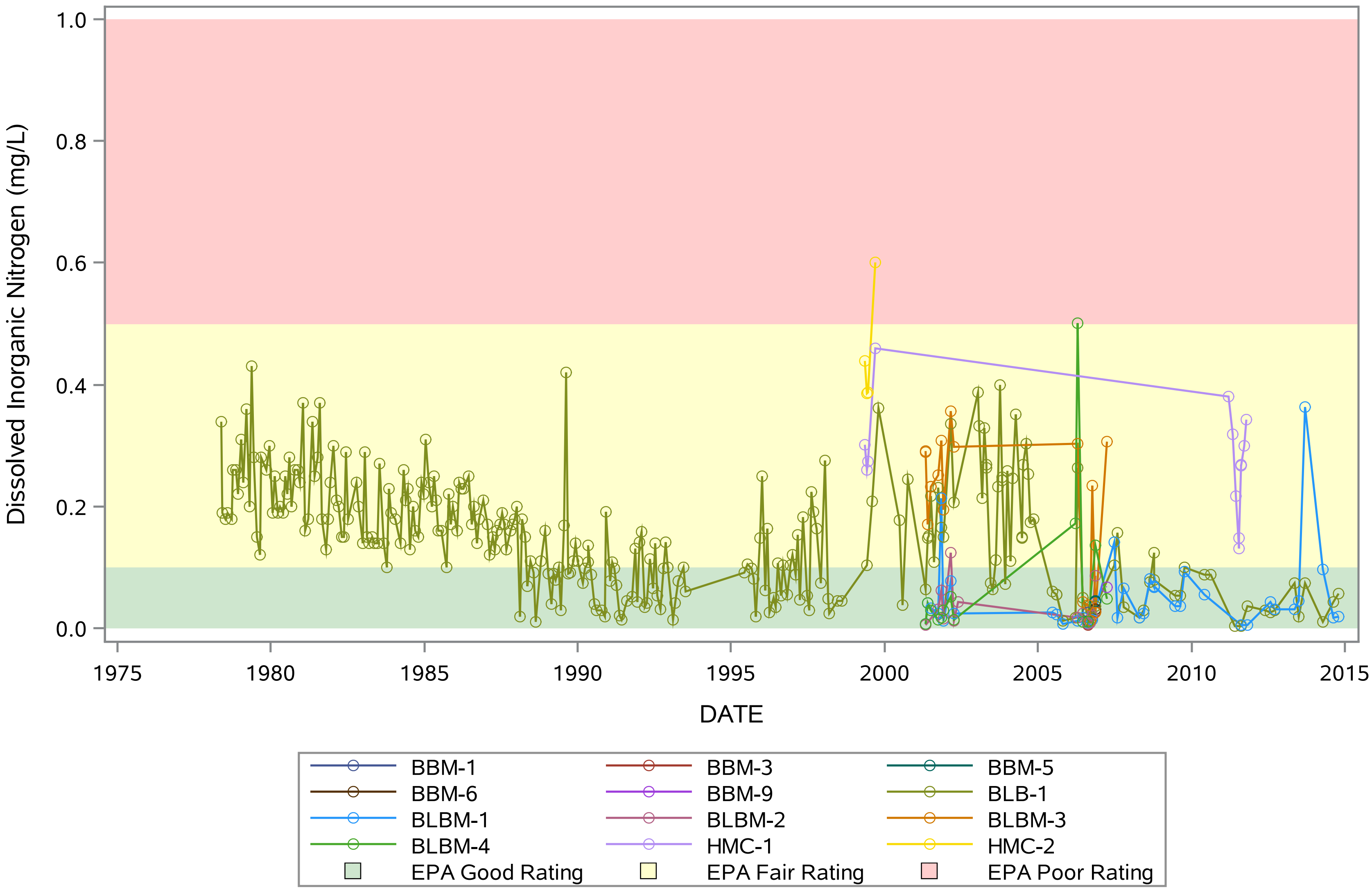

Bayou La Batre Surface Water
Alabama Department of Environmental Management
Secchi Depth (m)
1.50
1.25
1.00
0.75
0.50
0.25
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
DATE
Station Name
BBM-1
BBM-3
BBM-5
BBM-6
BBM-9
BLB-1
BLBM-1
BLBM-2
BLBM-3

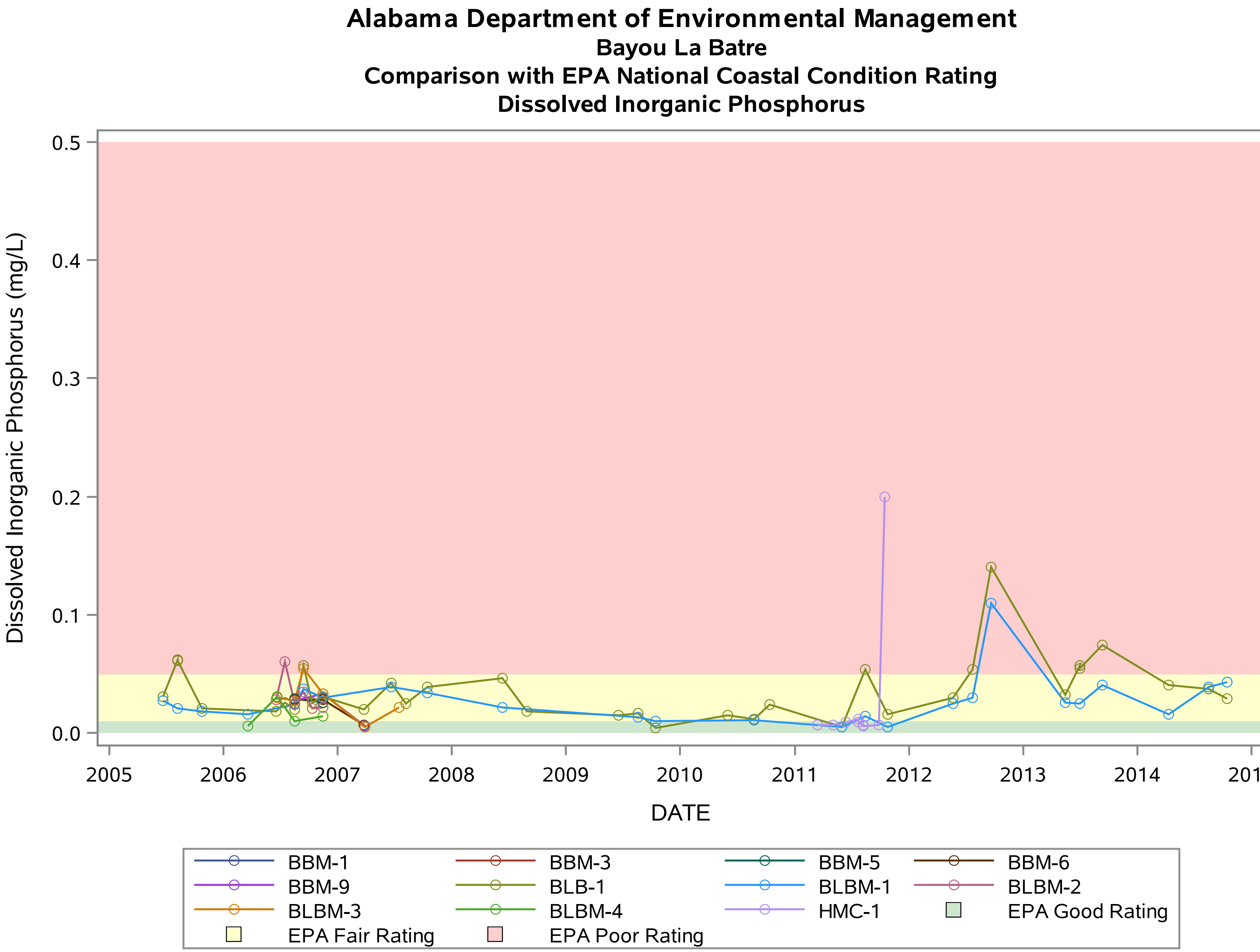


Alabama Department of Environmental Management
Bayou La Batre
Comparison with EPA National Coastal Condition Rating
Total Nitrogen
Total Nitrogen (mg/L)
0
1
2
3
4
5
6
1985
1990
1995
2000
2005
2010
2015
DATE
BBM-1
BBM-3
BBM-5
BBM-6
BBM-9
BLB-1
BLBM-1
BLBM-2
BLBM-3
BLBM-4
HMC-1
HMC-2
EPA Good Rating
EPA Fair Rating
EPA Poor Rating

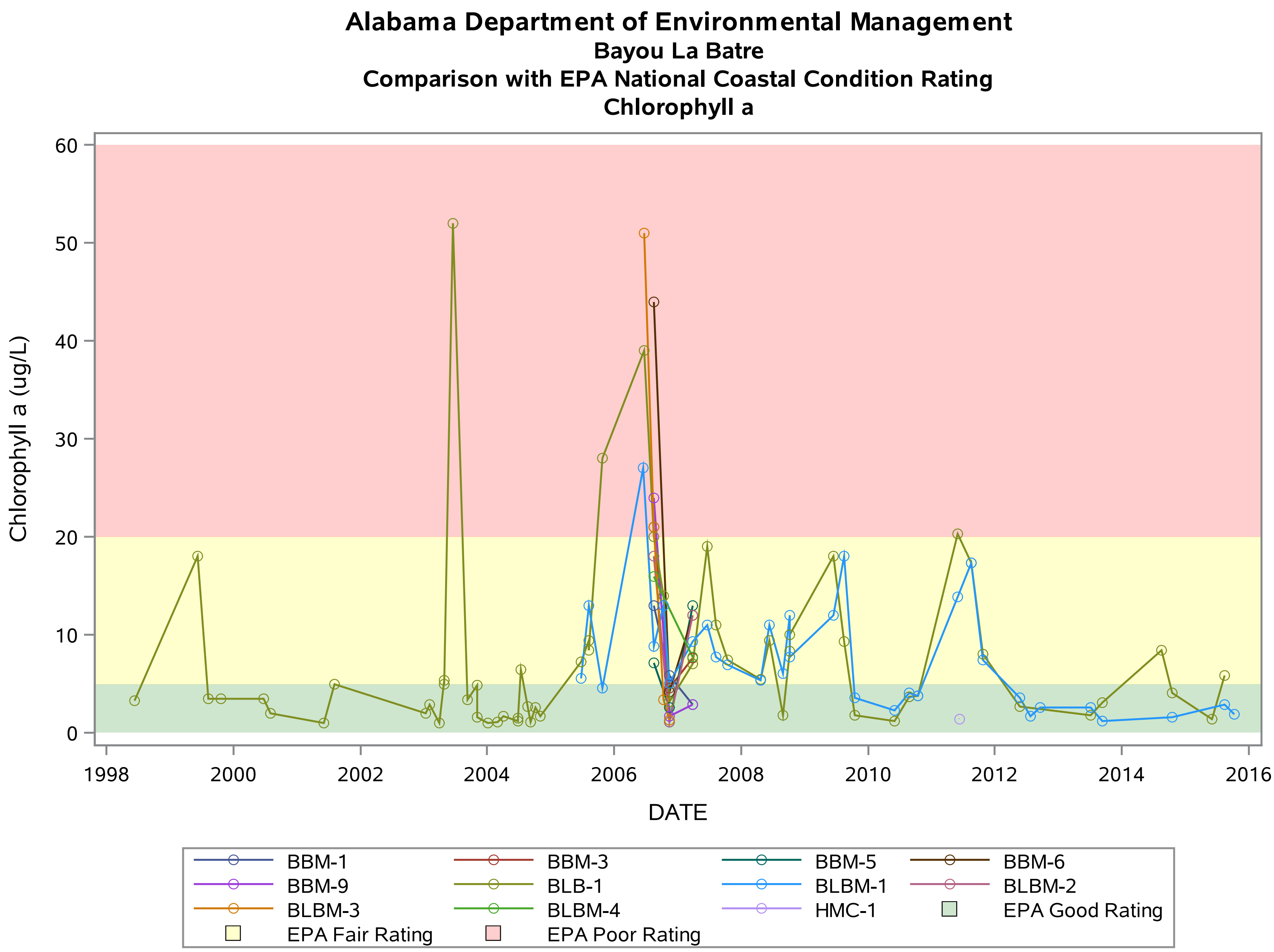

Alabama Department of Environmental Management
Bayou La Batre
Comparison with EPA National Coastal Condition Rating
Total Phosphorus
Total Phosphorus (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
DATE
BLB-1
BLBM-1
HMC-1
EPA Good Rating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

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

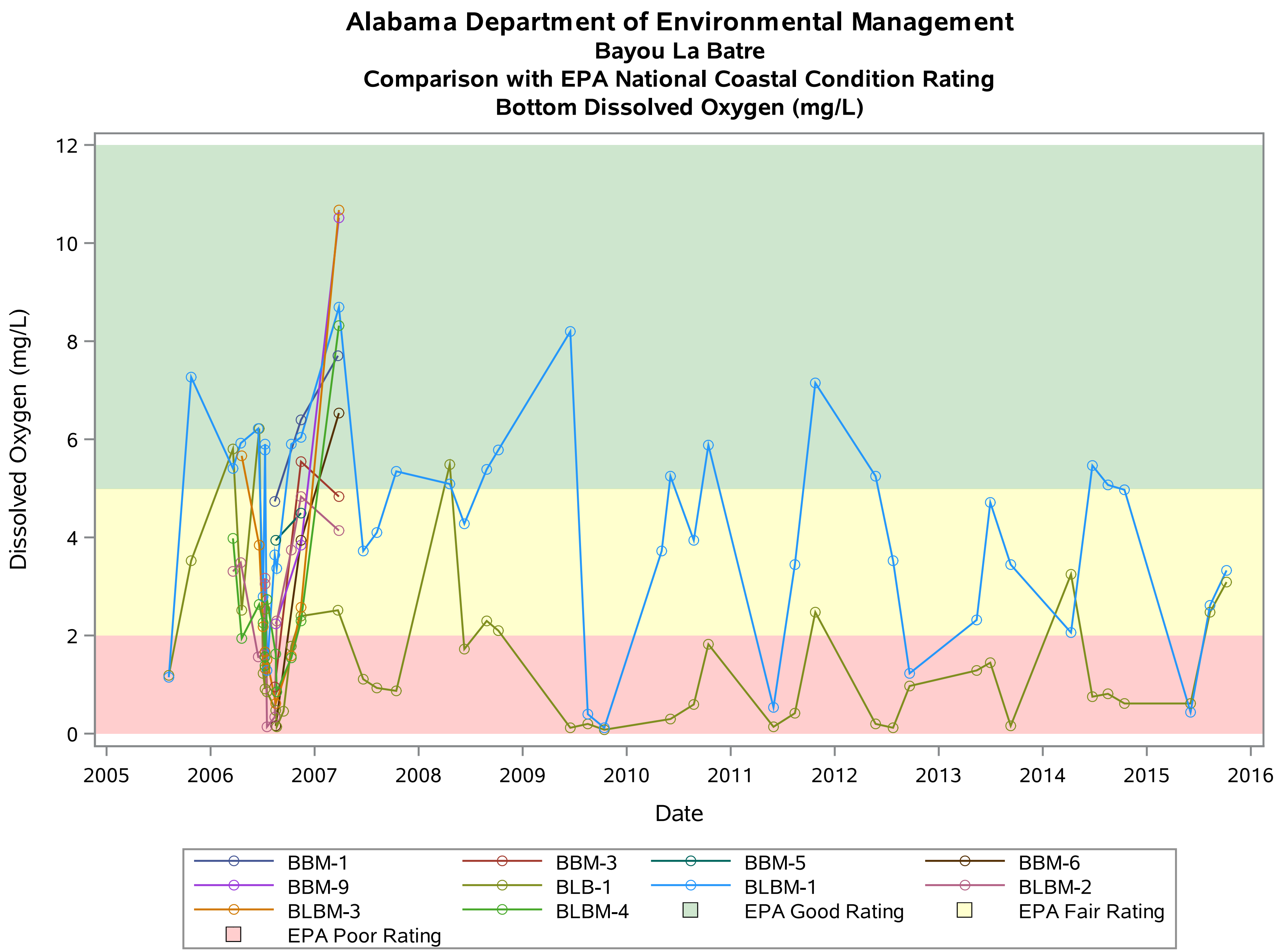




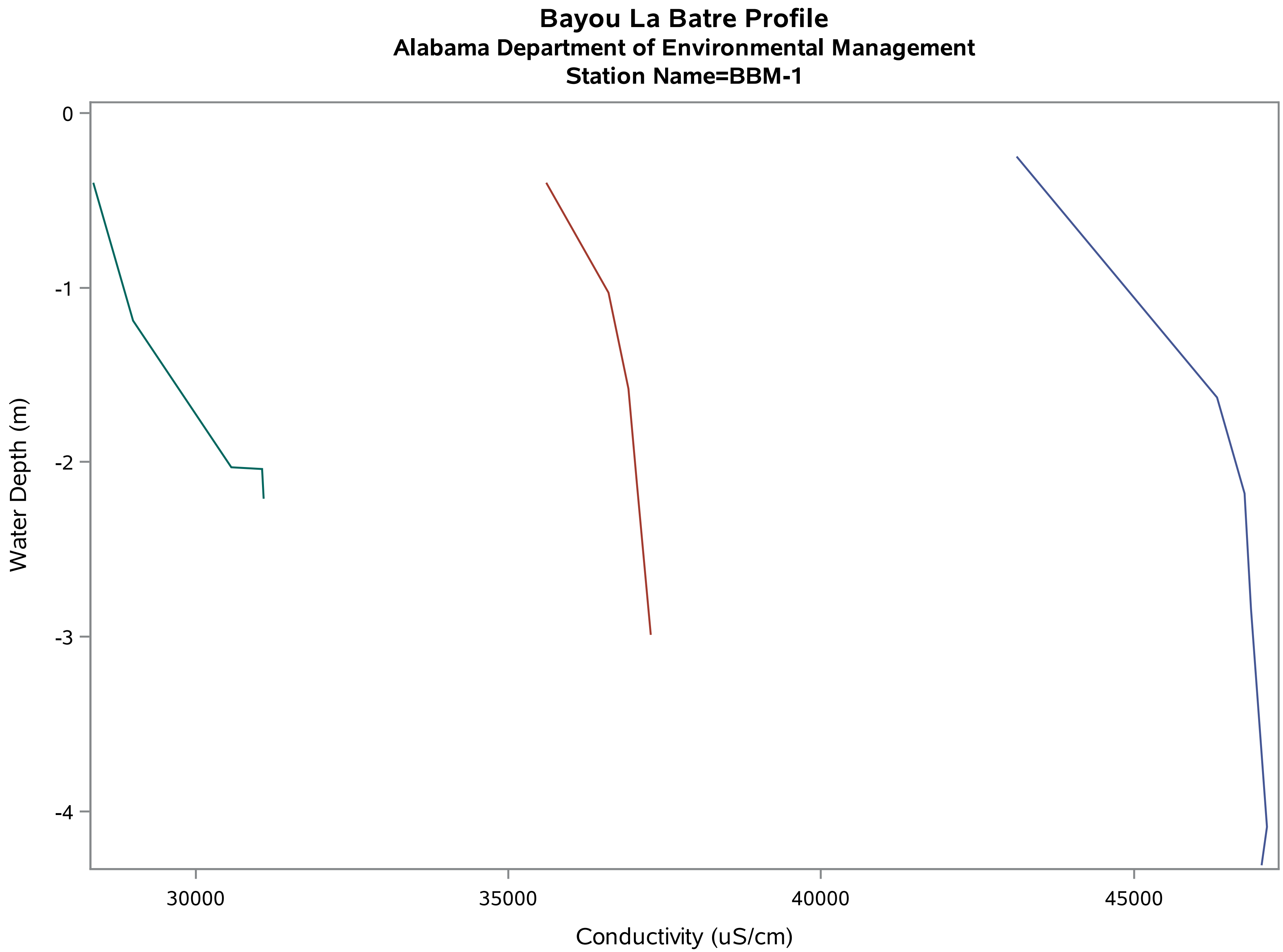
Alabama Department of Environmental Management
Bayou La Batre
Comparison with EPA National Coastal Condition Rating
Dissolved Inorganic Phosphorus
Dissolved Inorganic Phosphorus (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
DATE
BBM-1
BBM-3
BBM-5
BBM-6
BBM-9
BLB-1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

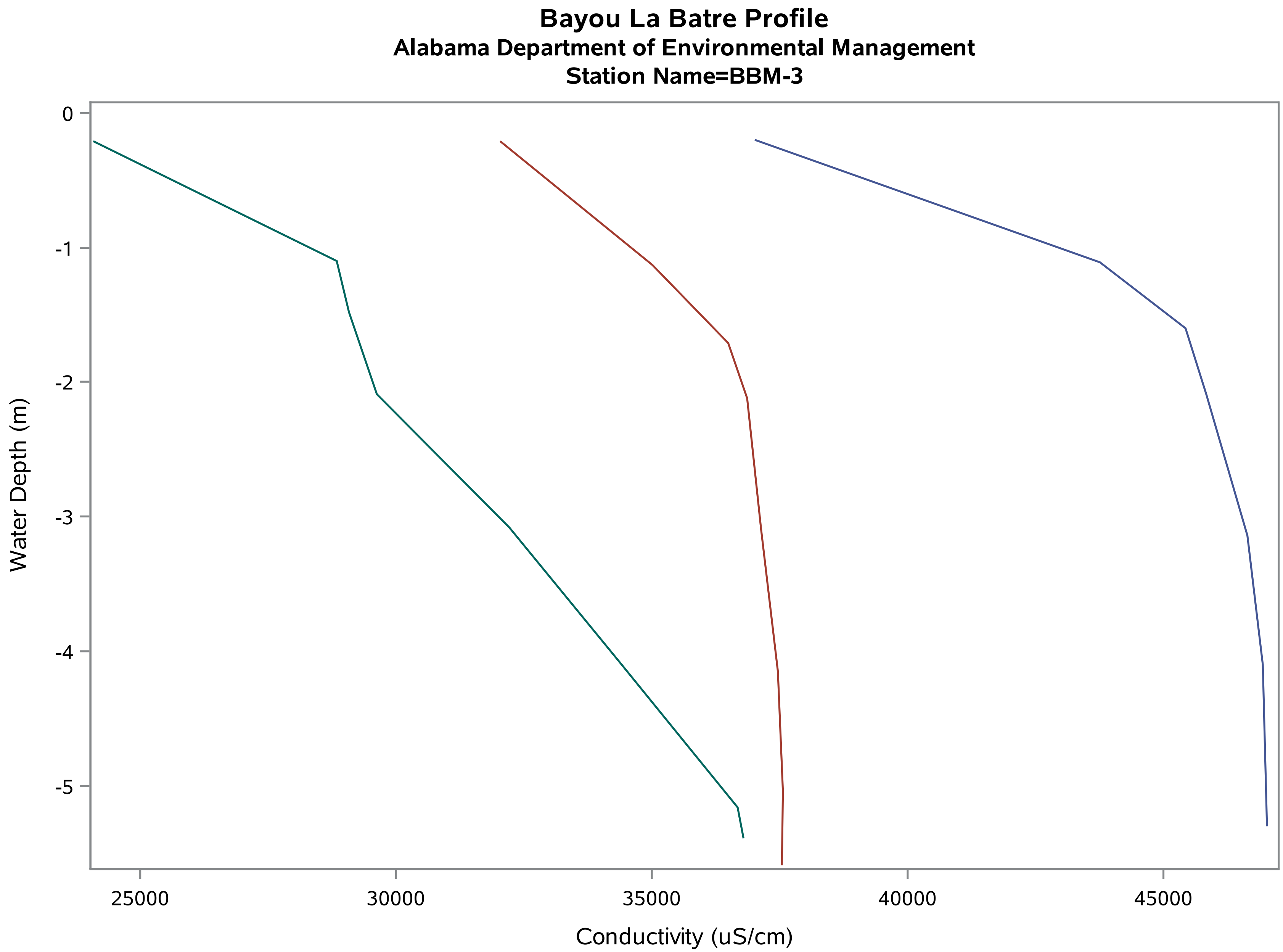


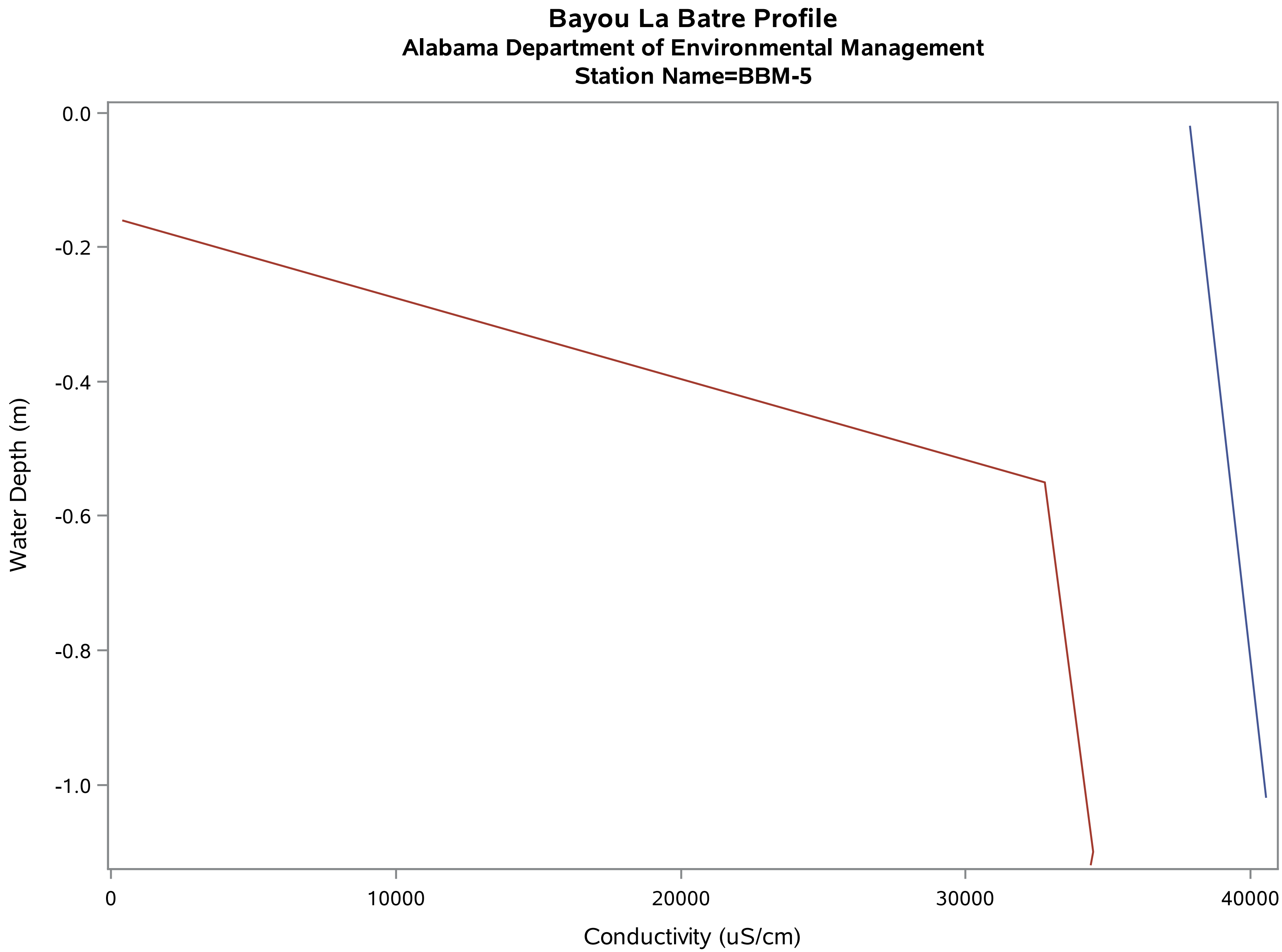
Alabama Department of Environmental Management
Bayou La Batre
Comparison with EPA National Coastal Condition Rating
Chlorophyll a
Chlorophyll a (ug/L)
0
10
20
30
40
50
60
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
DATE
BBM-1
BBM-3
BBM-5
BBM-6
BBM-9
BLB-1
BLBM-1
BLBM-2
BLBM-3
BLBM-4
HMC-1
EPA Good Rating
EPA Fair Rating
EPA Poor Rating



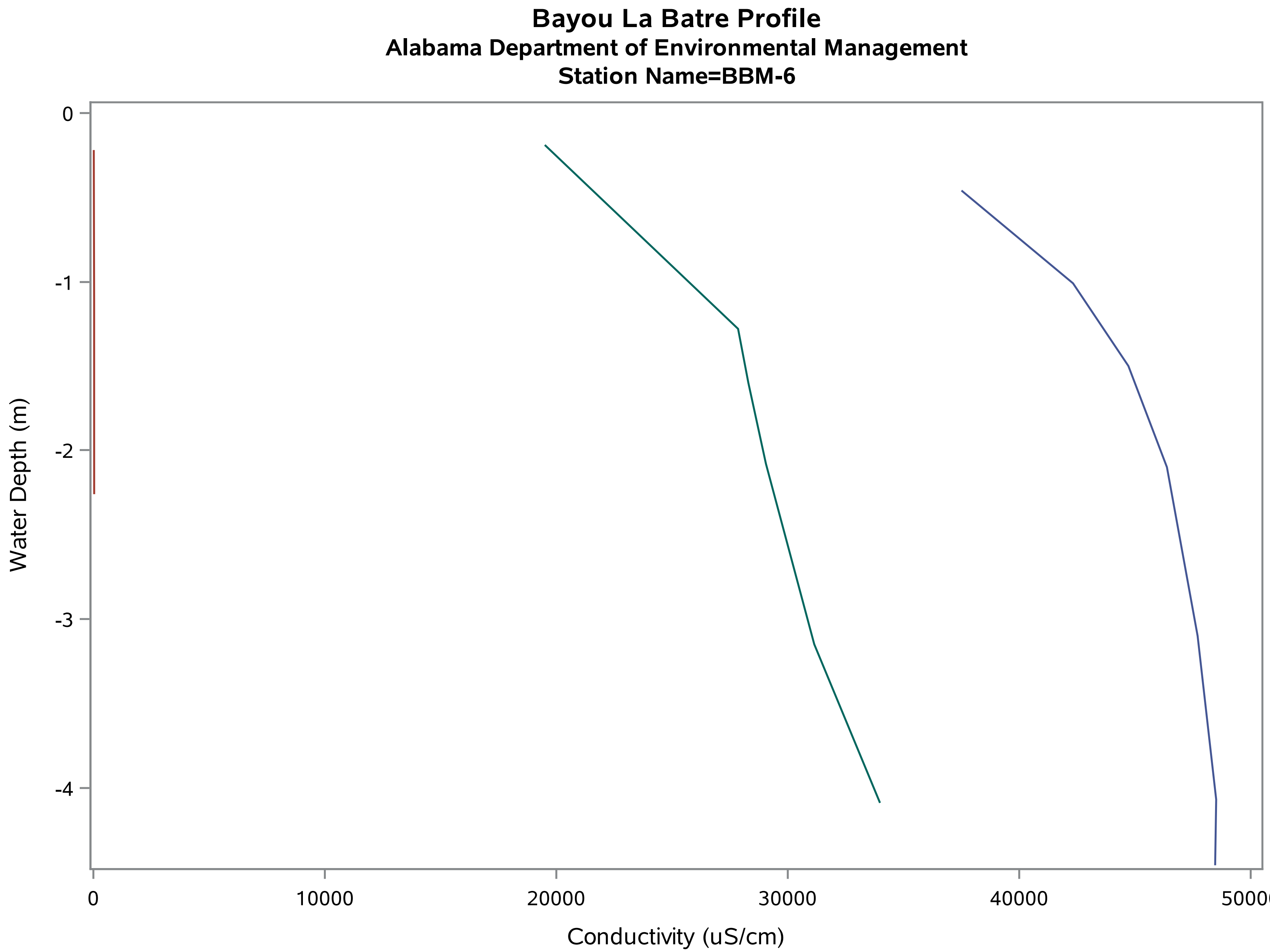
Alabama Department of Environmental Management
Bayou La Batre
Comparison with EPA National Coastal Condition Rating
Bottom Dissolved Oxygen (mg/L)
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
Date
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
BBM-1
BBM-3
BBM-5
BBM-6
BBM-9
BLB-1
BLBM-1
BLBM-2
BLBM-3
BLBM-4
EPA Good Rating
EPA Fair Rating
EPA Poor Rating

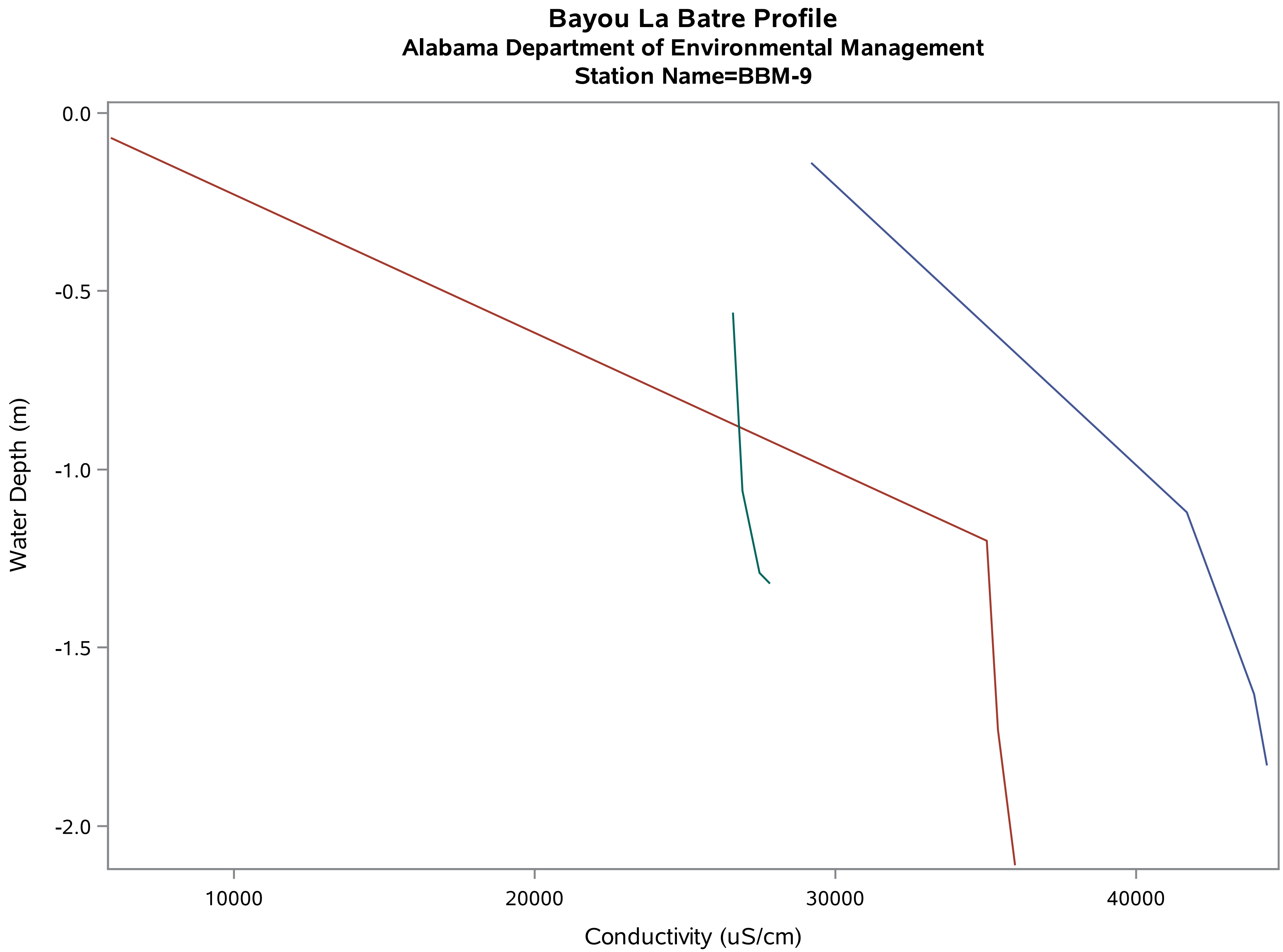

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-1
Water Depth (m)
0
-1
-2
-3
-4
30000
35000
40000
45000
Conductivity (uS/cm)

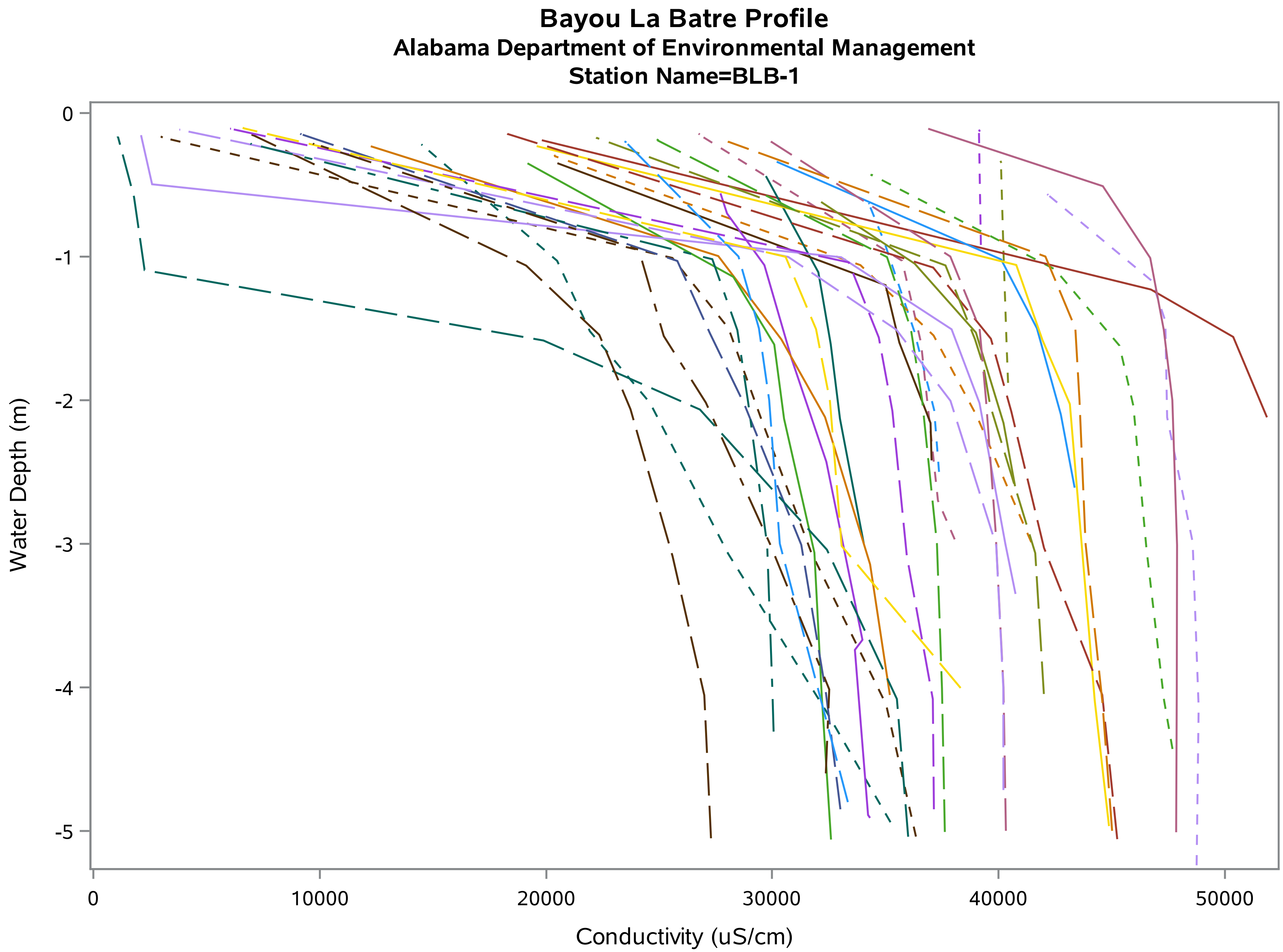

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-3
Water Depth (m)
0
-1
-2
-3
-4
-5
25000
30000
35000
40000
45000
Conductivity (uS/cm)

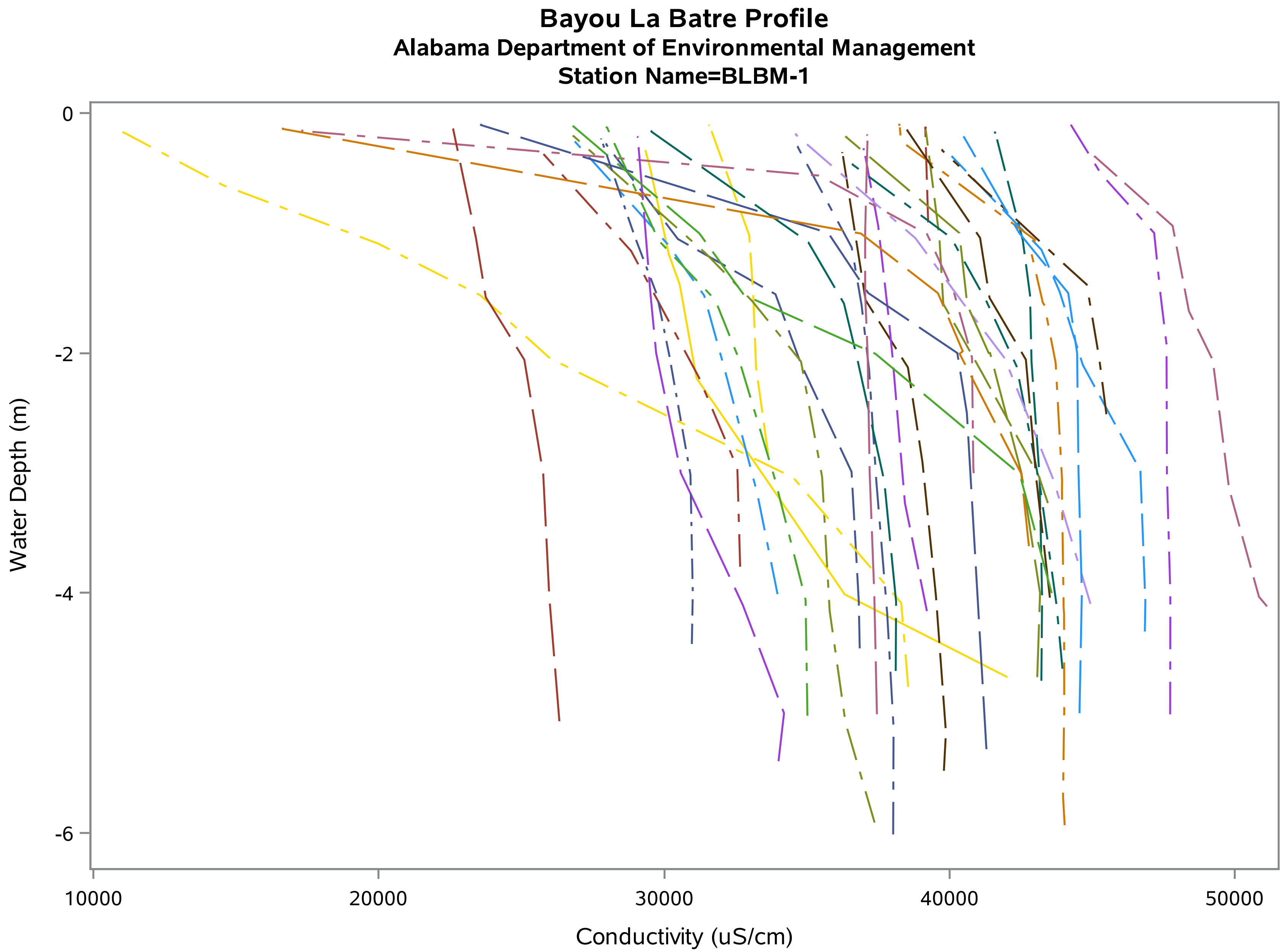


Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-5
Water Depth (m)
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
0
10000
20000
30000
40000
Conductivity (uS/cm)

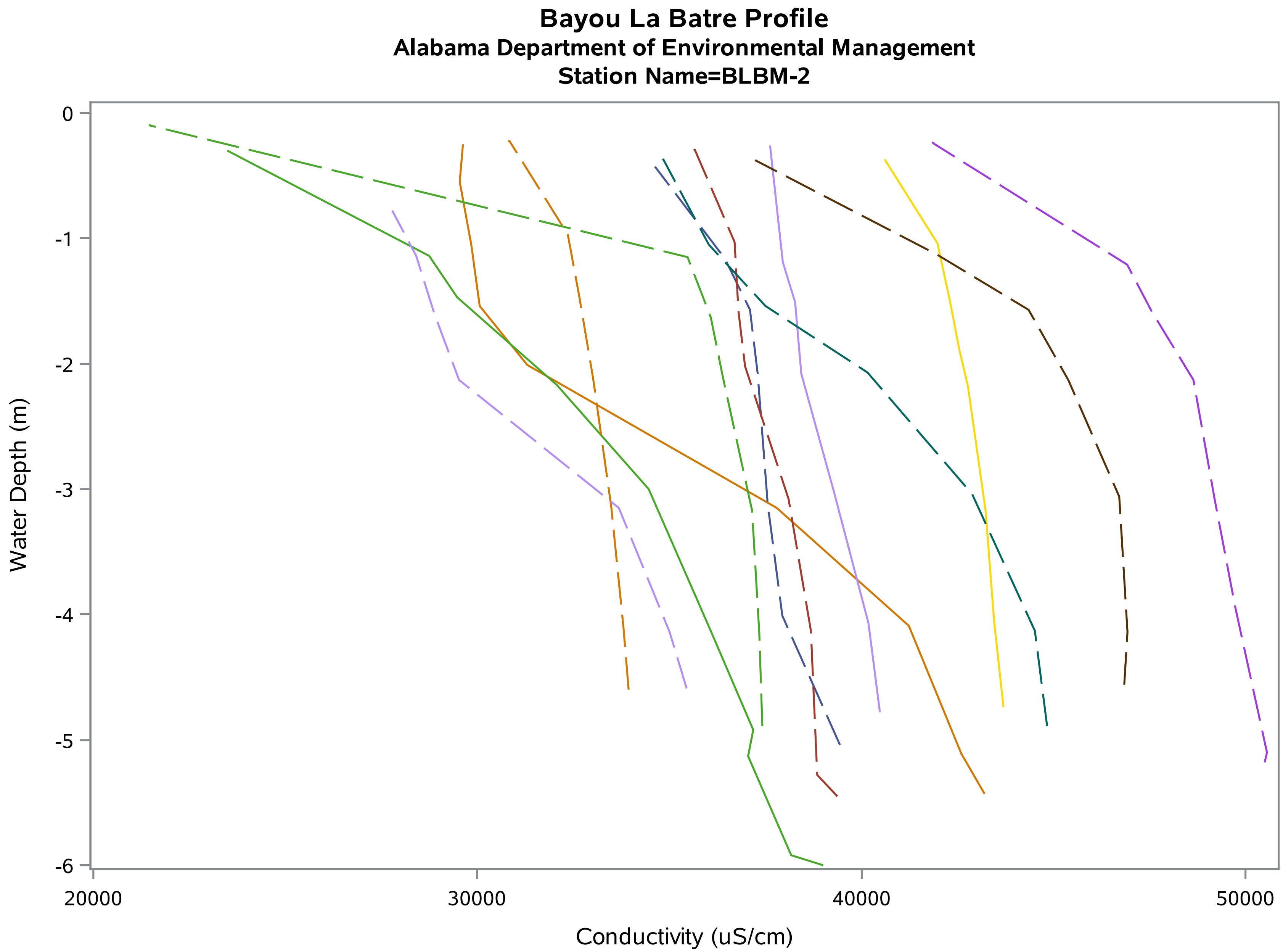

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-6
0
-1
-2
-3
-4
Water Depth (m)
0
10000
20000
30000
40000
50000
Conductivity (uS/cm)

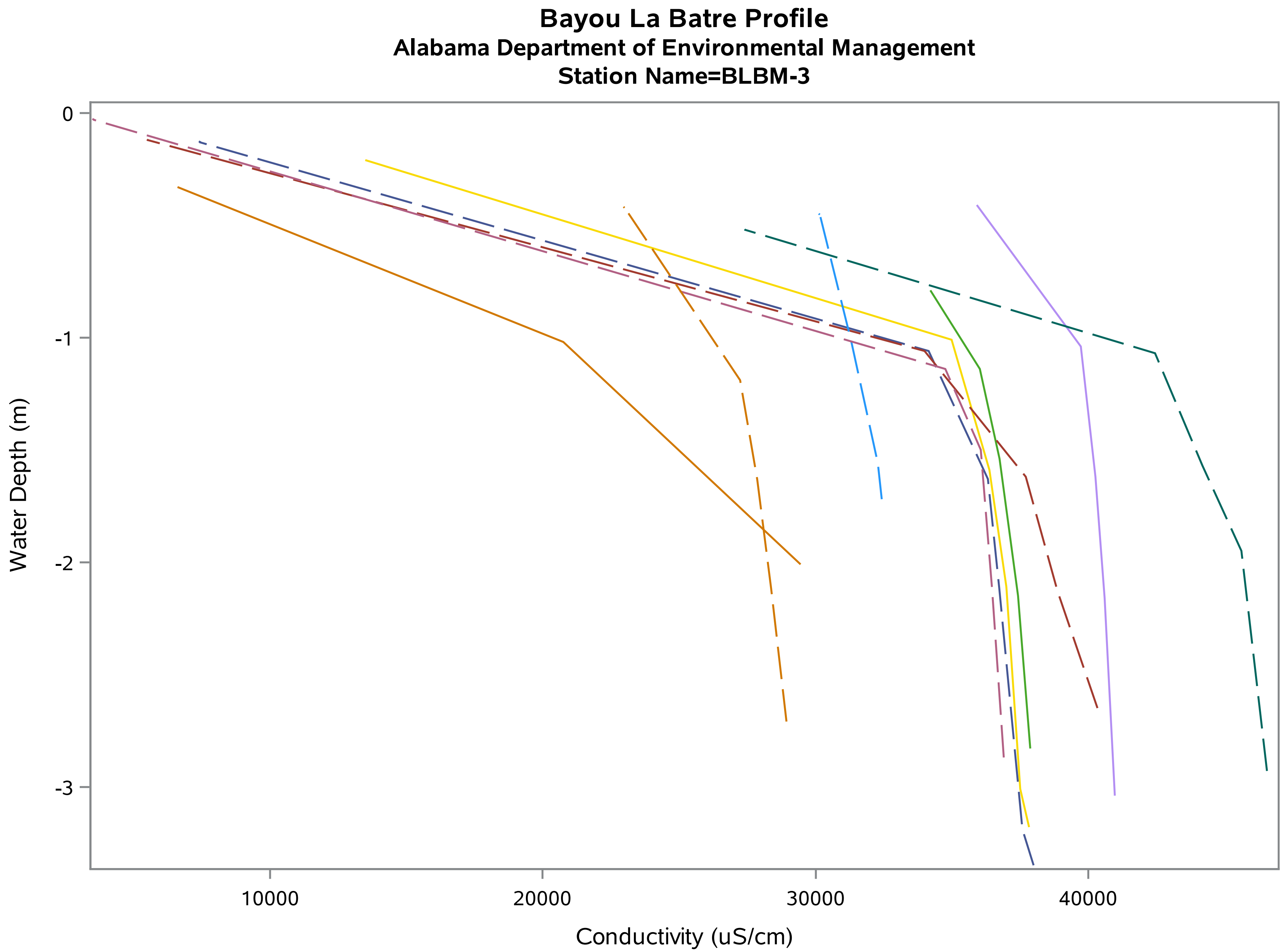

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-9
0.0
-0.5
-1.0
-1.5
-2.0
Water Depth (m)
10000
20000
30000
40000
Conductivity (uS/cm)


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
Water Depth (m)
0
-2
-4
-6
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)

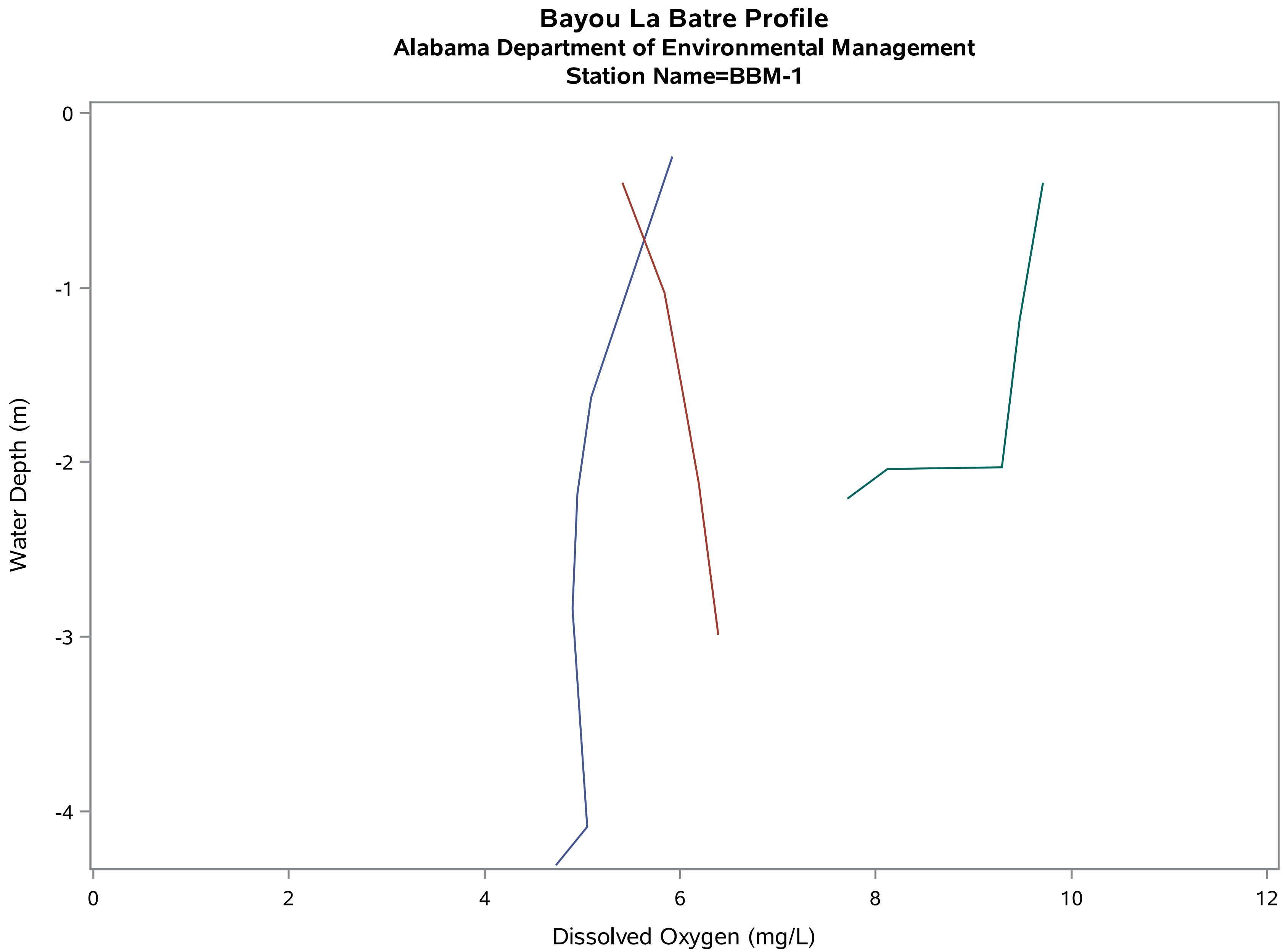


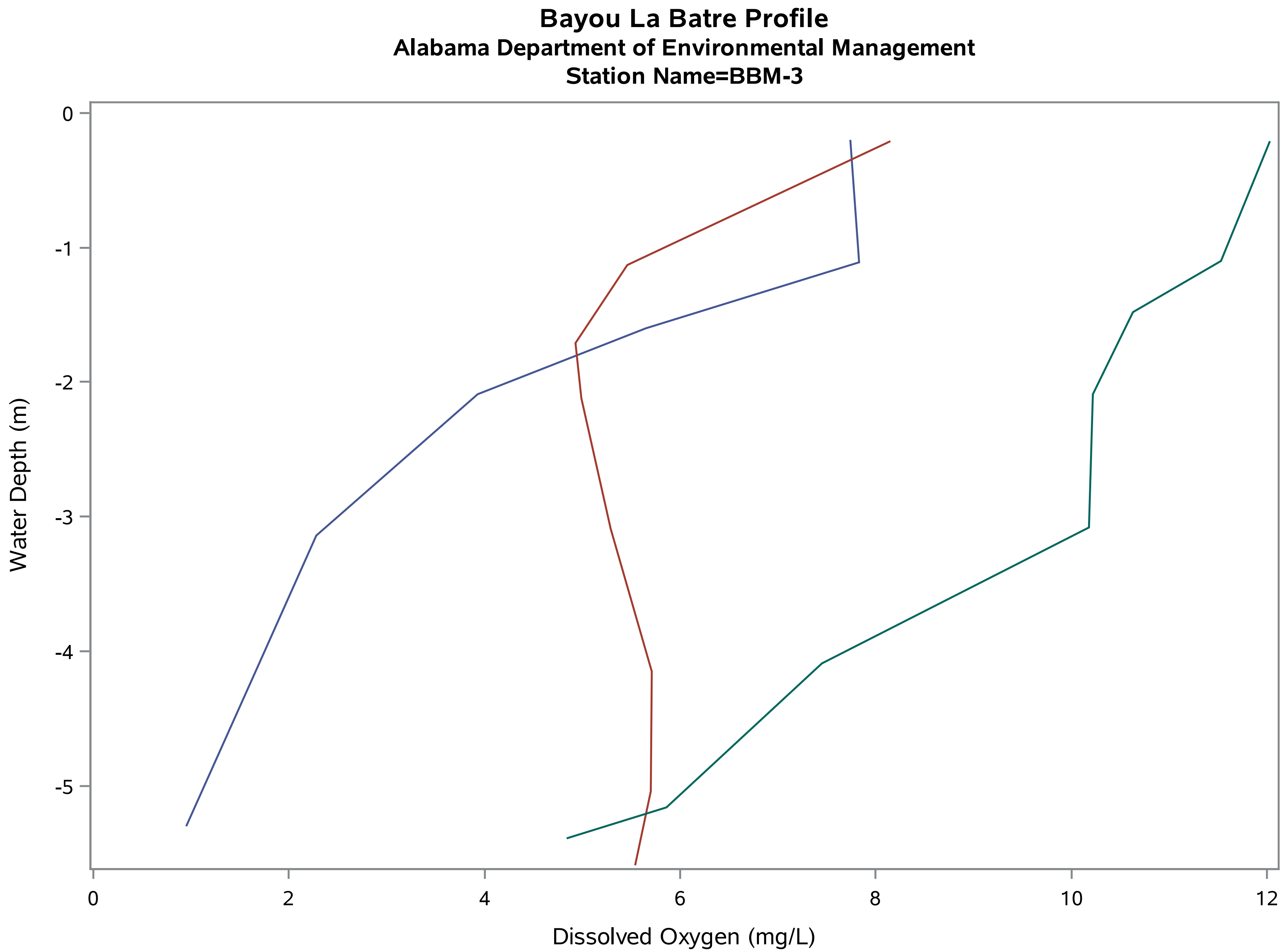
Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-3
Water Depth (m)
0
-1
-2
-3
10000
20000
30000
40000
Conductivity (uS/cm)


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)

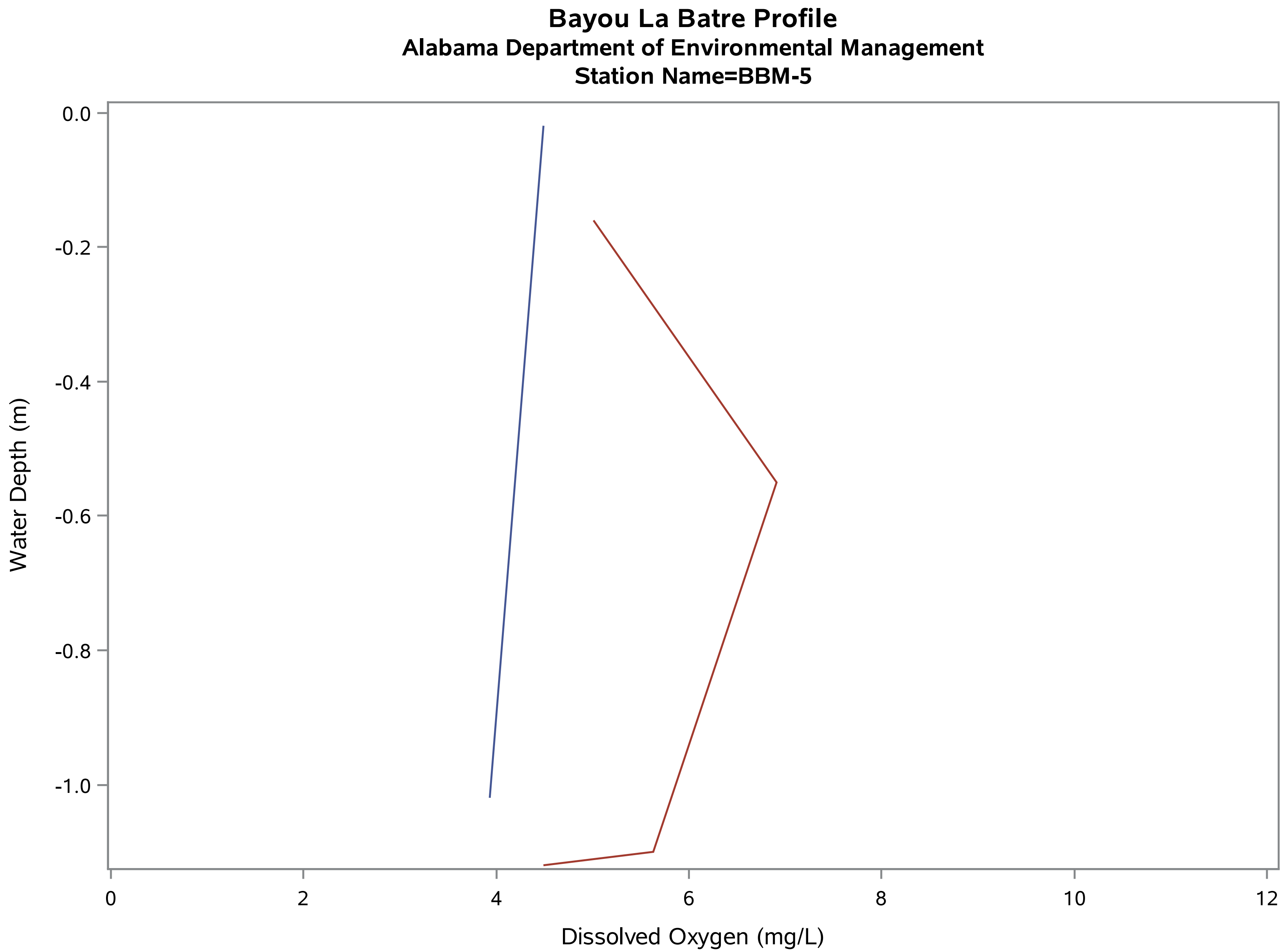
Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=HMC-1
-0.6
-0.8
-1.0
-1.2
Water Depth (m)
40
50
60
70
Conductivity (uS/cm)

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

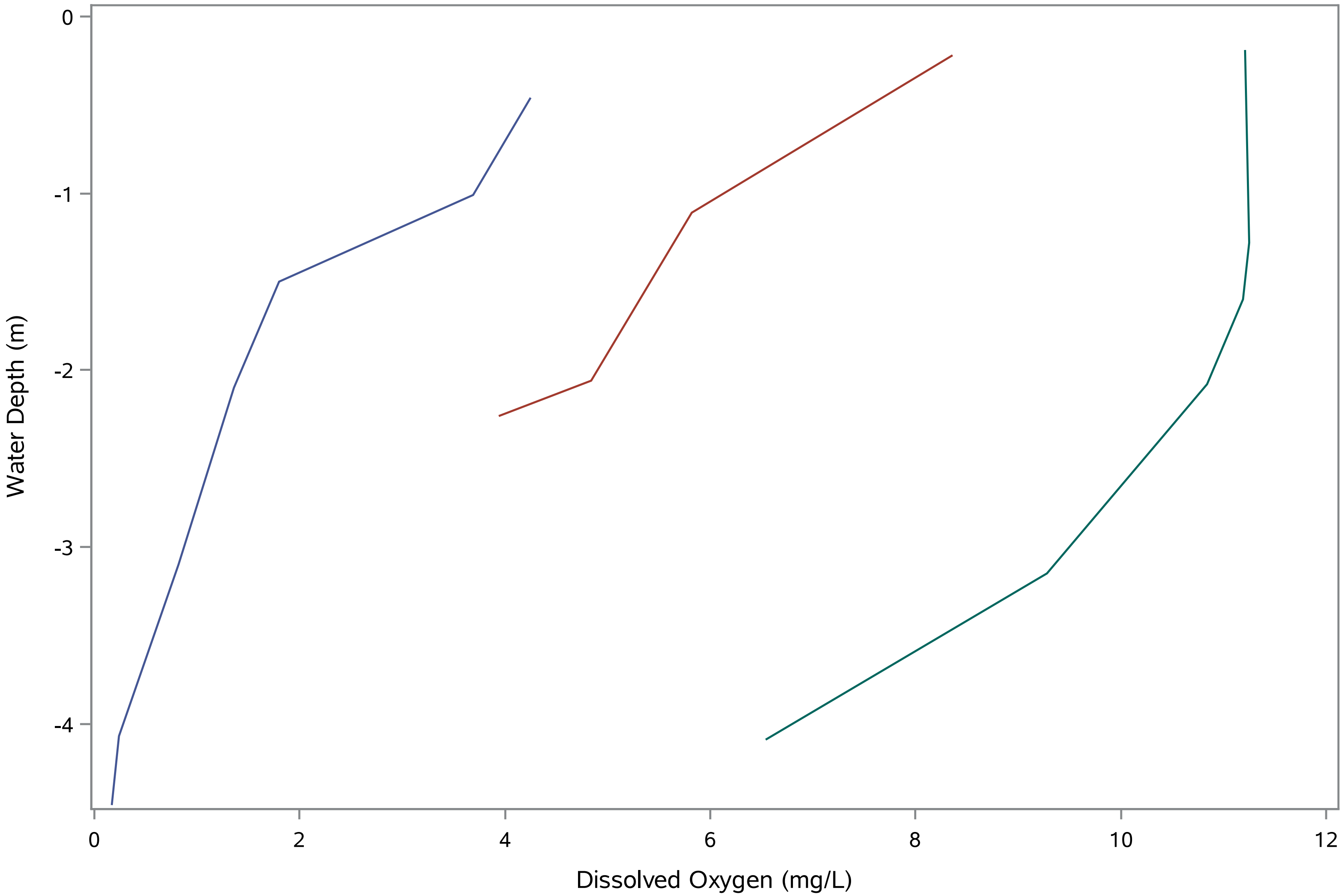

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-1
Water Depth (m)
0
-1
-2
-3
-4
0
2
4
6
8
10
12
Dissolved Oxygen (mg/L)

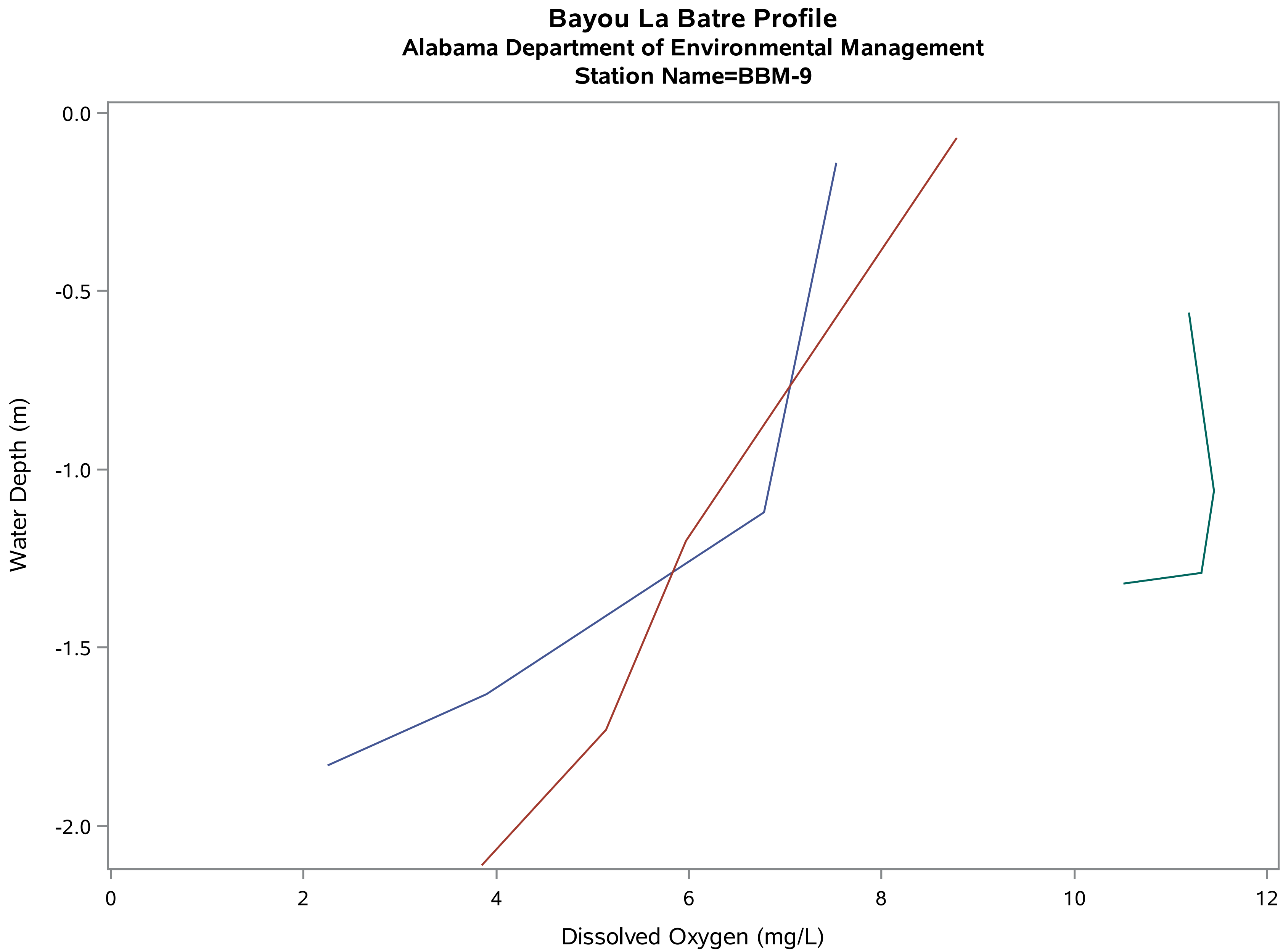


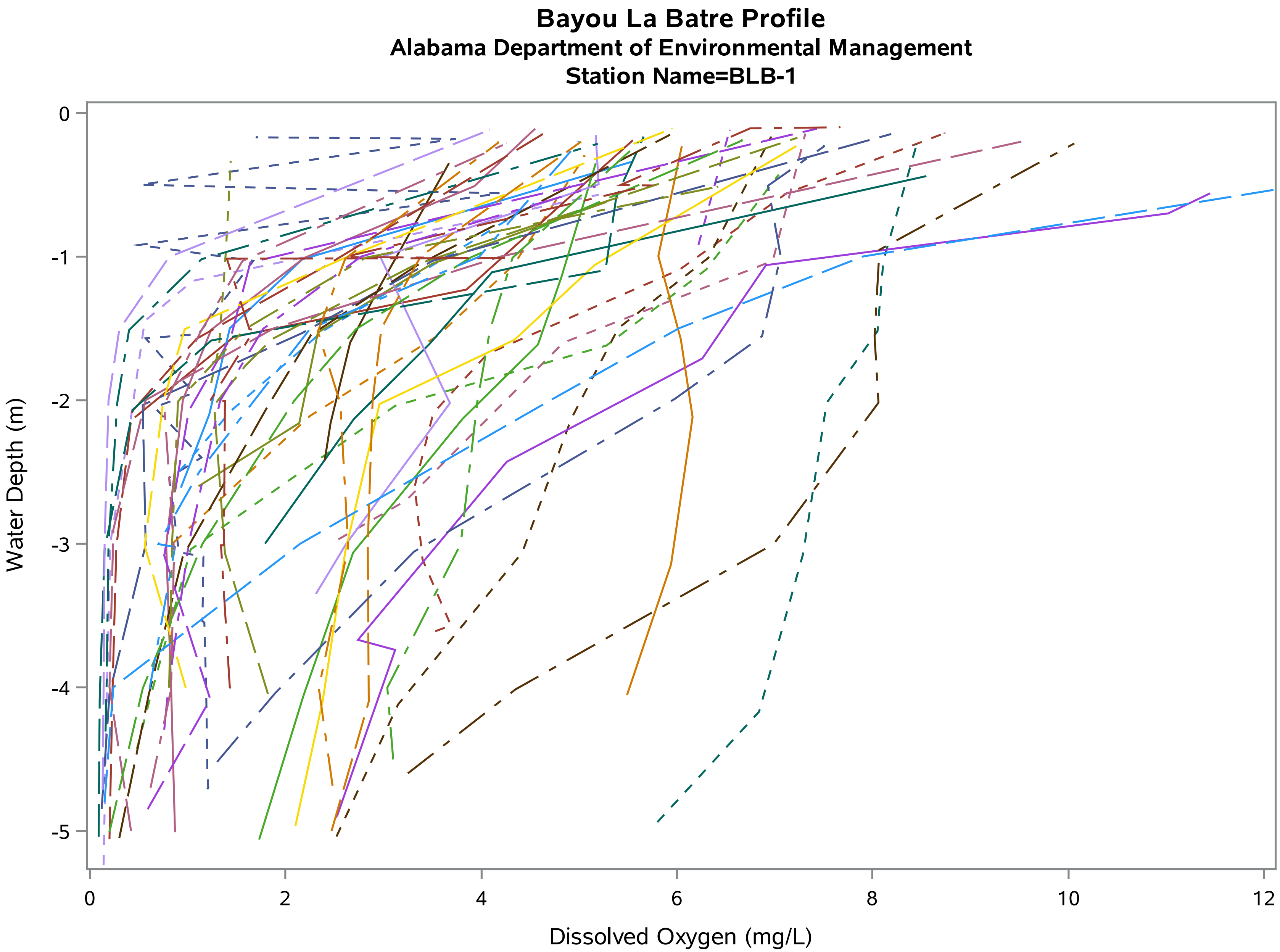
Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-3
Water Depth (m)
0
-1
-2
-3
-4
-5
0
2
4
6
8
10
12
Dissolved Oxygen (mg/L)

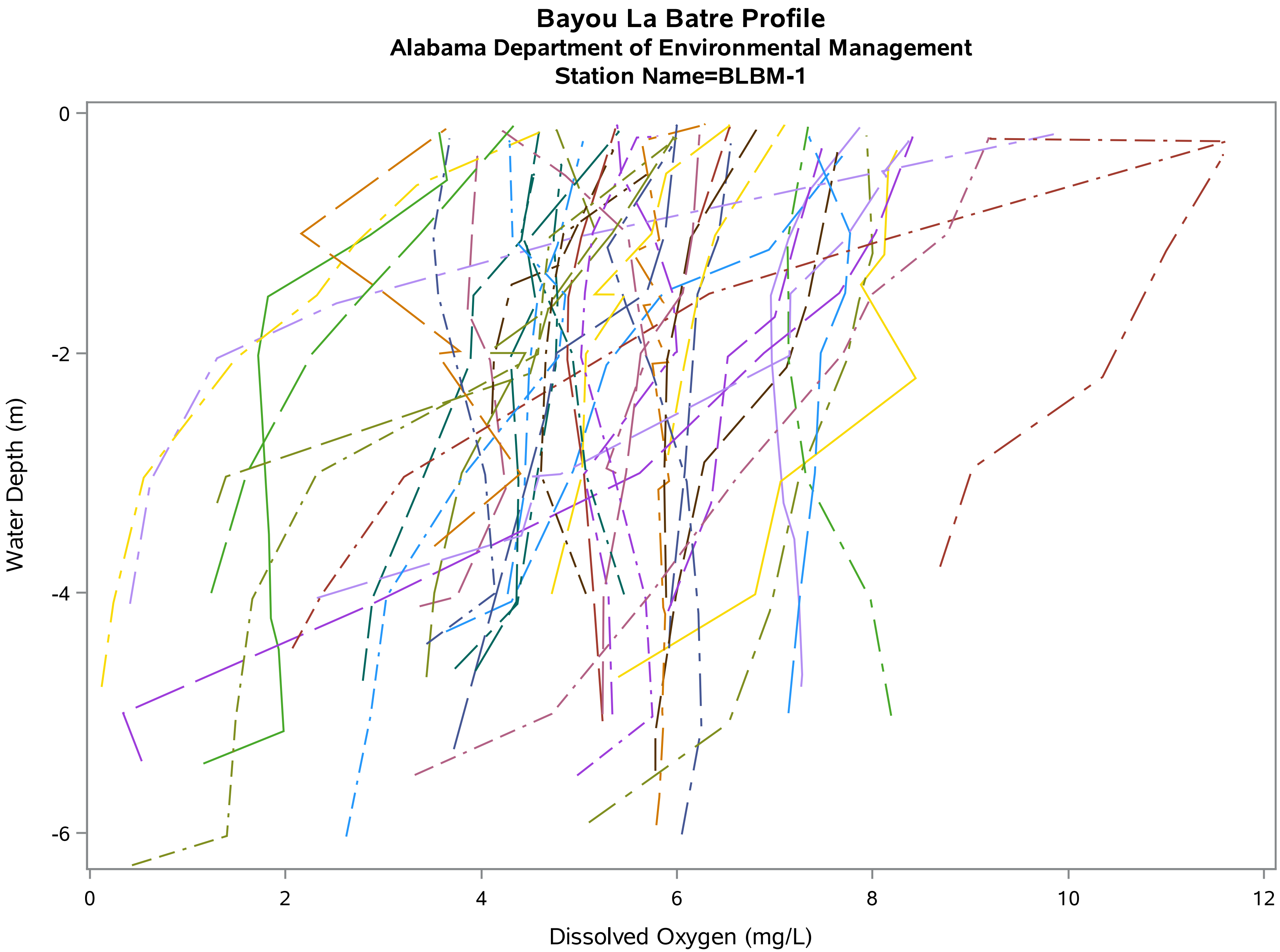

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-5
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
Water Depth (m)
0
2
4
6
8
10
12
Dissolved Oxygen (mg/L)

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-6

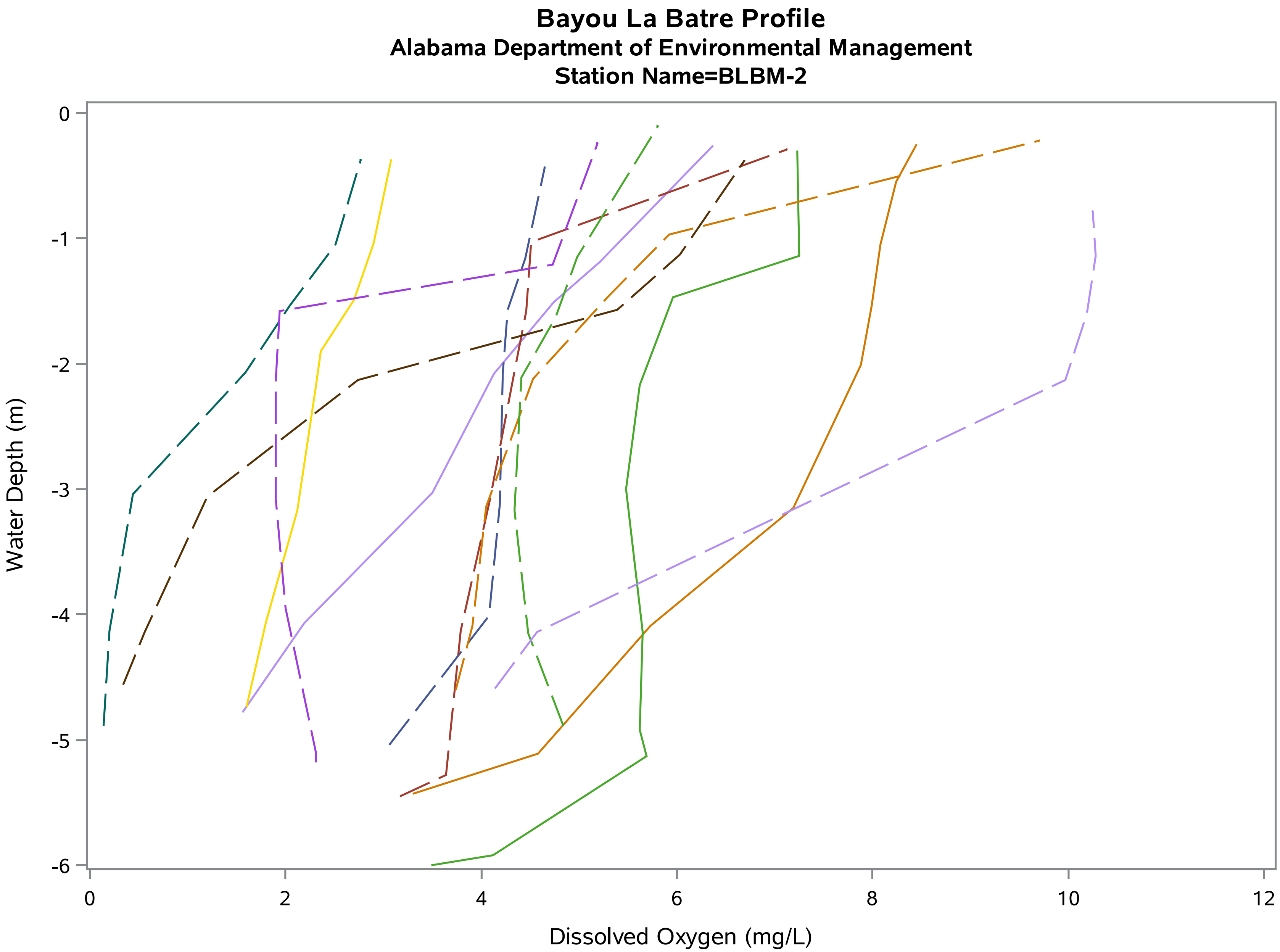


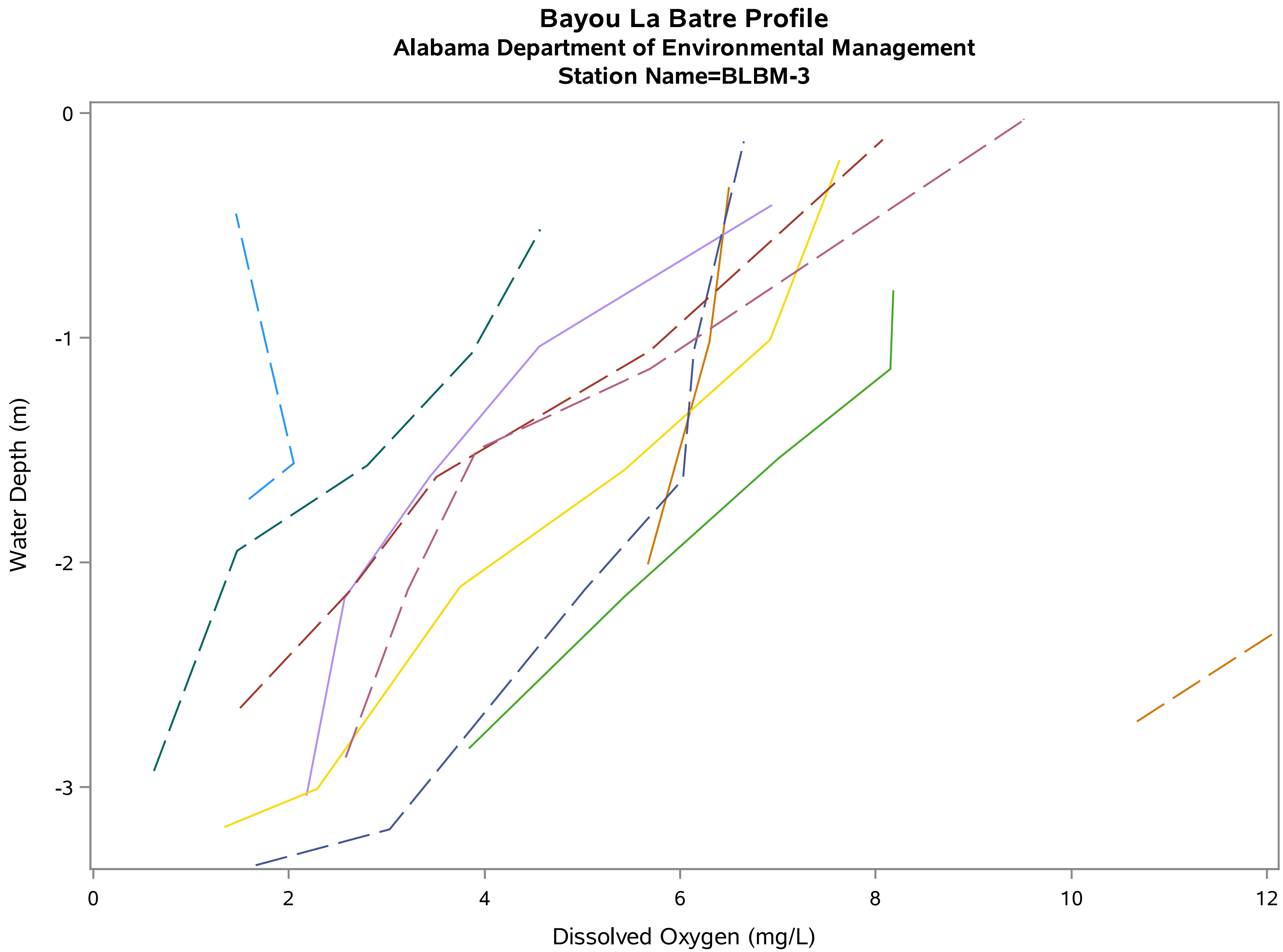

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-9
0.0
-0.5
-1.0
-1.5
-2.0
Water Depth (m)
0
2
4
6
8
10
12
Dissolved Oxygen (mg/L)

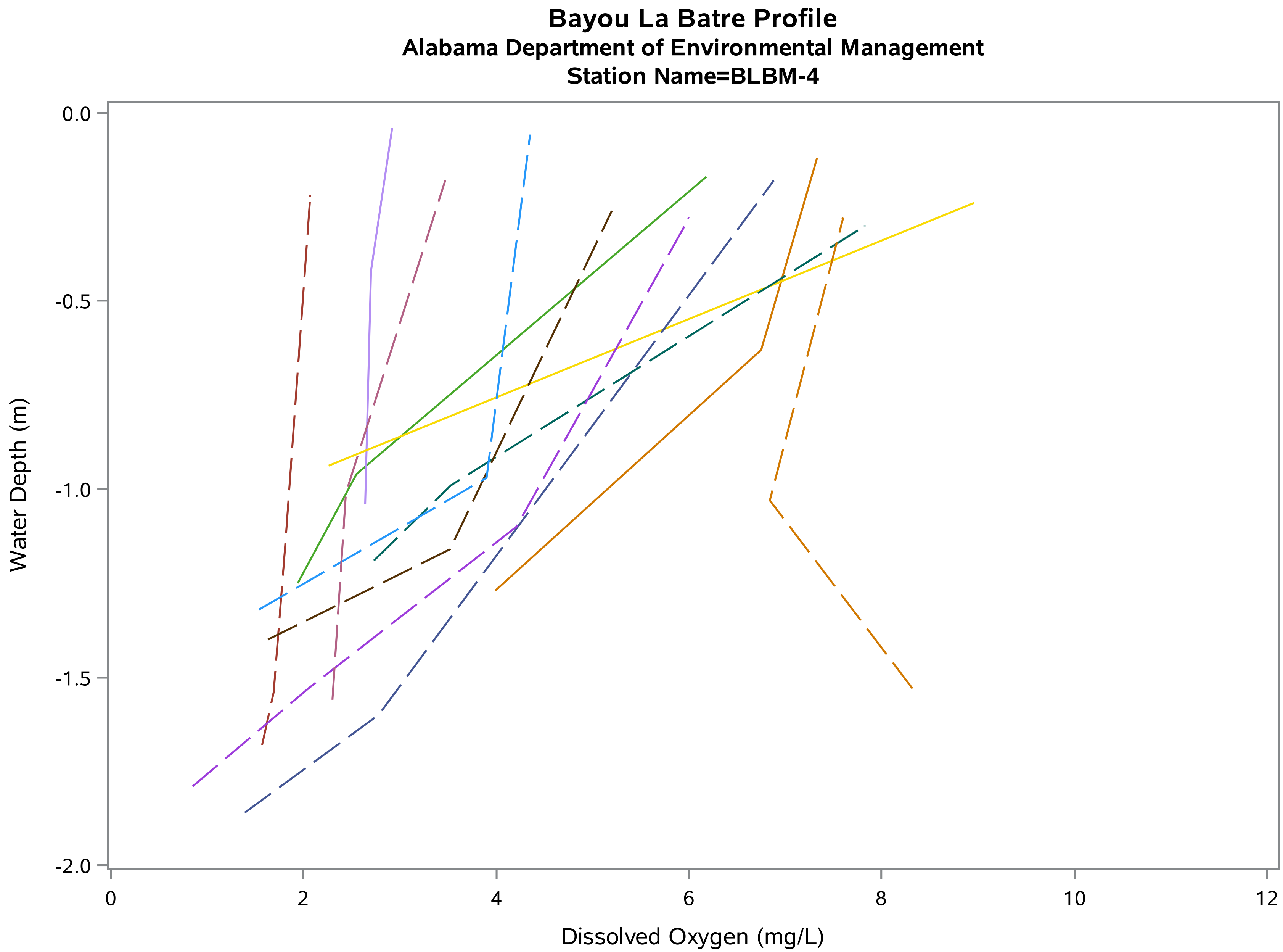

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLB-1
Water Depth (m)
0
-1
-2
-3
-4
-5
0
2
4
6
8
10
12
Dissolved Oxygen (mg/L)

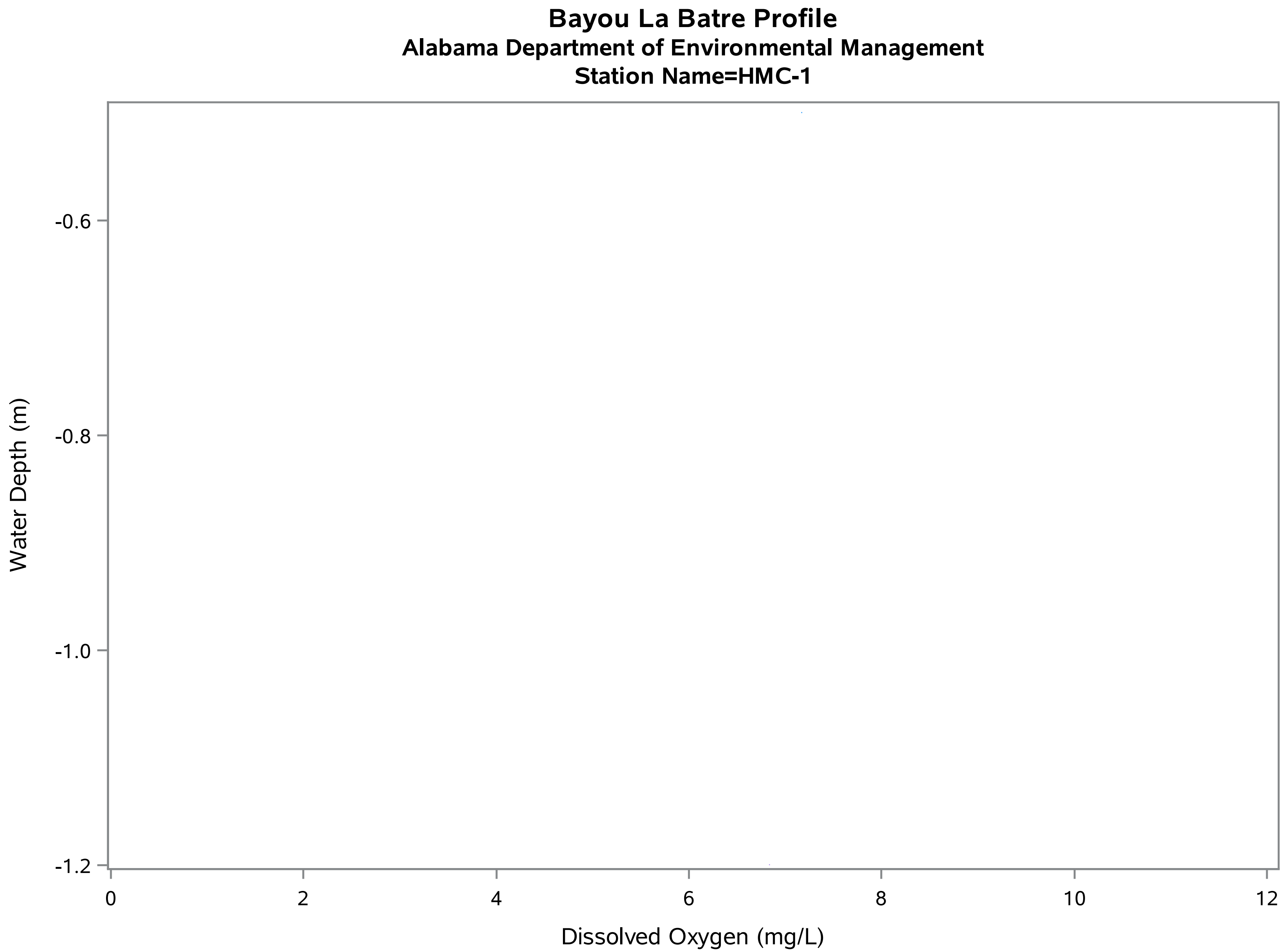


Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-1
Water Depth (m)
0
-2
-4
-6
0
2
4
6
8
10
12
Dissolved Oxygen (mg/L)

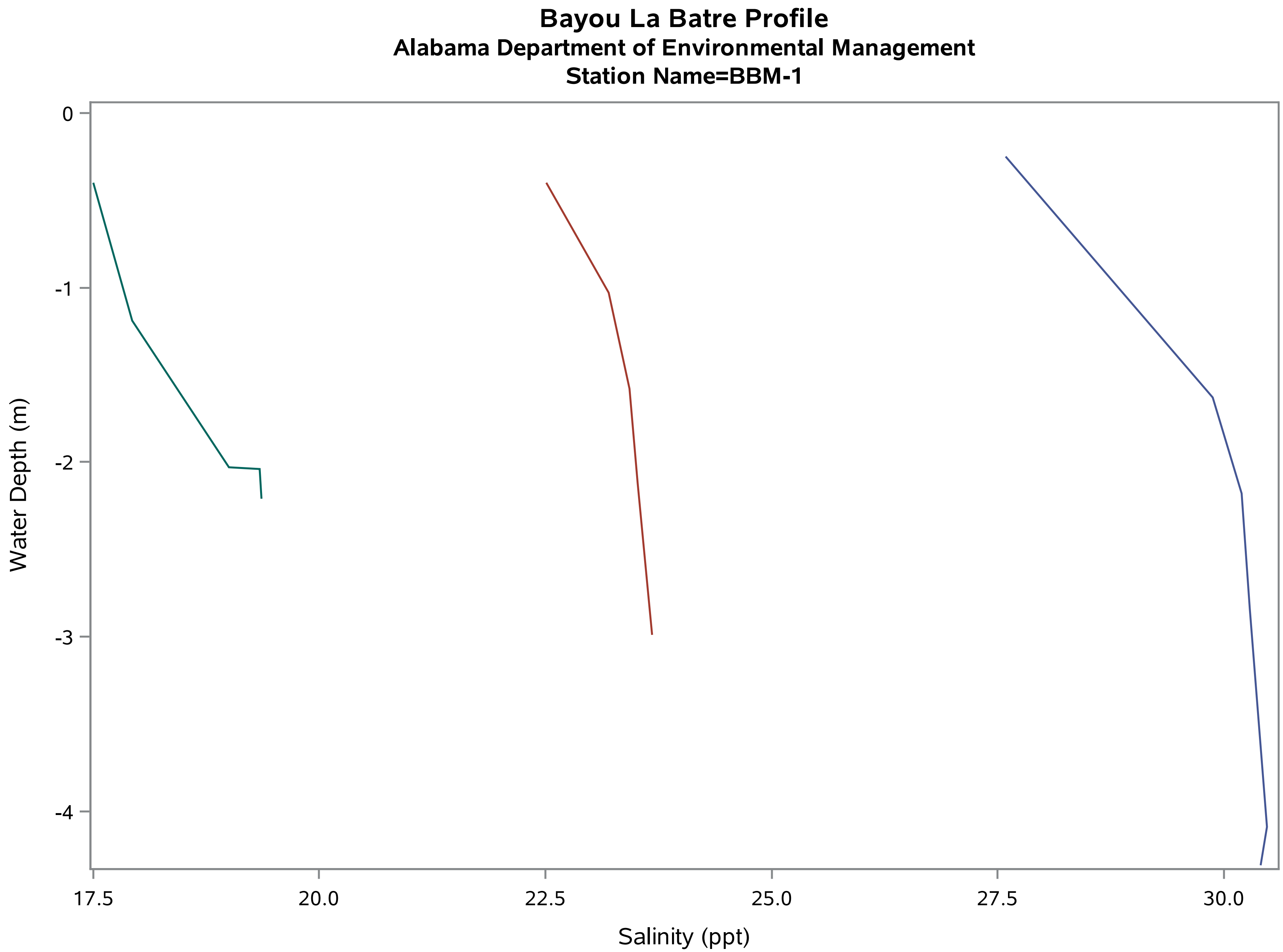

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-2
Water Depth (m)
0
-1
-2
-3
-4
-5
-6
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12

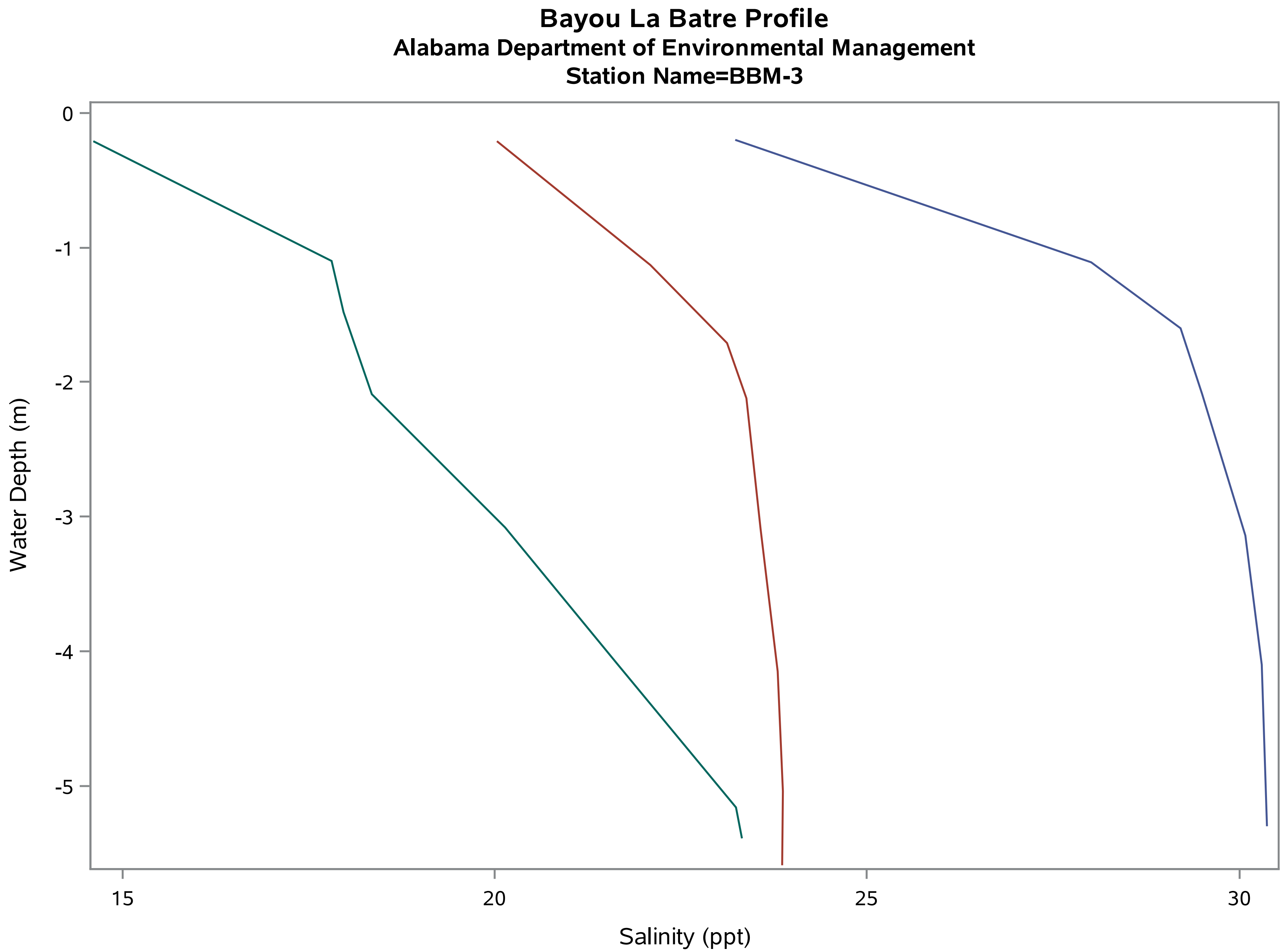

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-3
0
-1
-2
-3
Water Depth (m)
0
2
4
6
8
10
12
Dissolved Oxygen (mg/L)

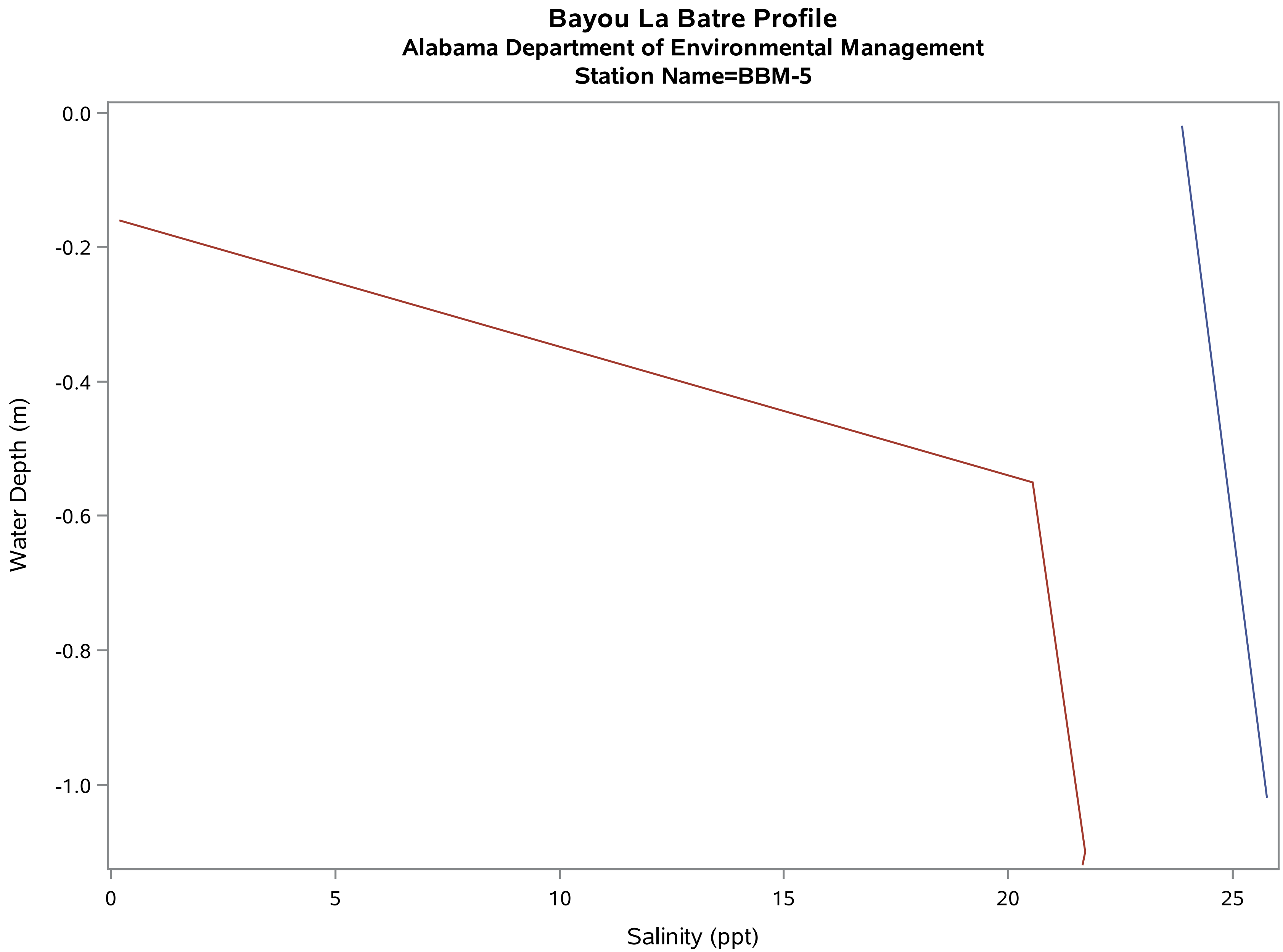

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-4
Water Depth (m)
0.0
-0.5
-1.0
-1.5
-2.0
0
2
4
6
8
10
12
Dissolved Oxygen (mg/L)

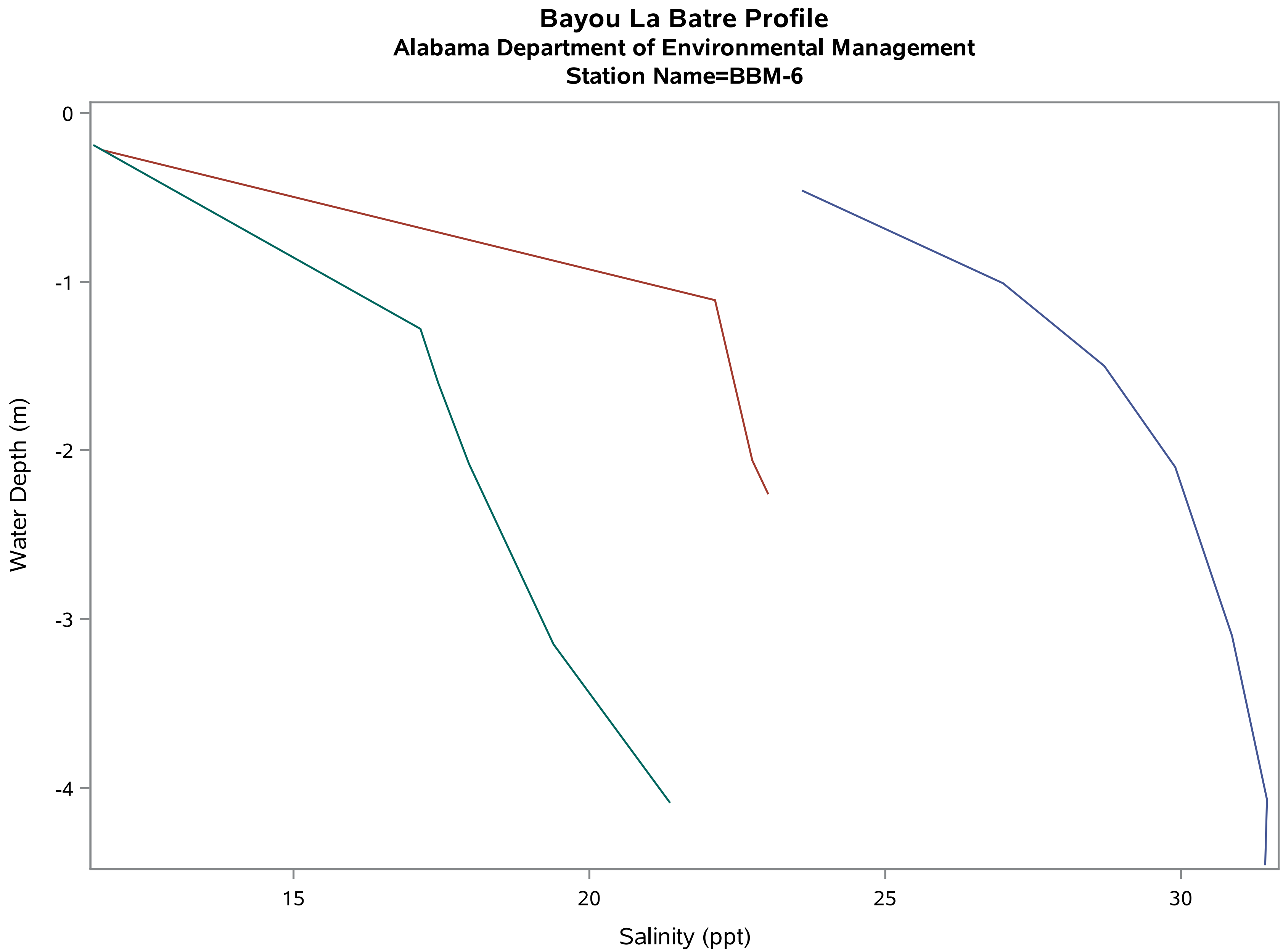

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=HMC-1
-0.6
-0.8
-1.0
-1.2
Water Depth (m)
0
2
4
6
8
10
12
Dissolved Oxygen (mg/L)

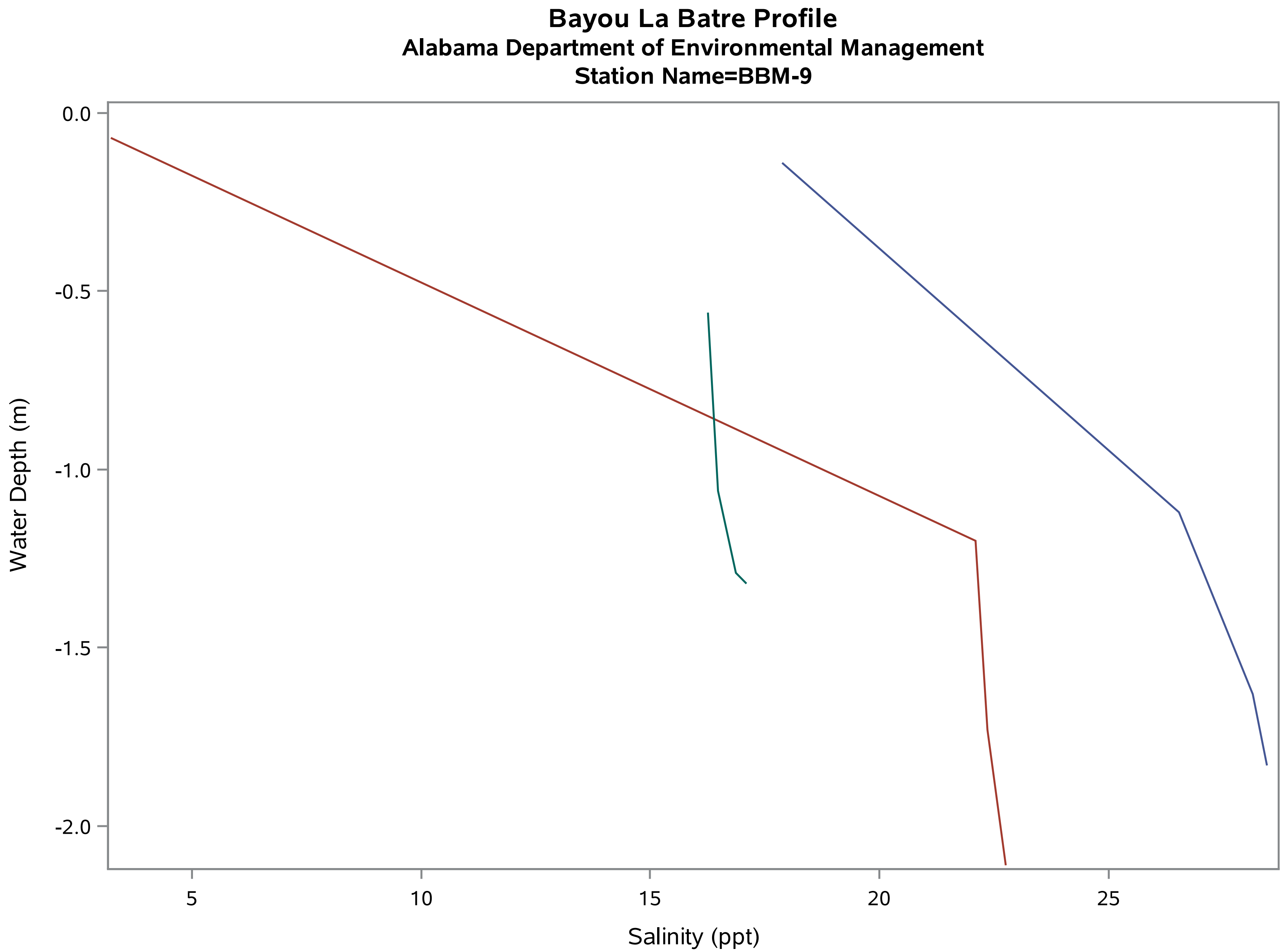
Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=HMC-2

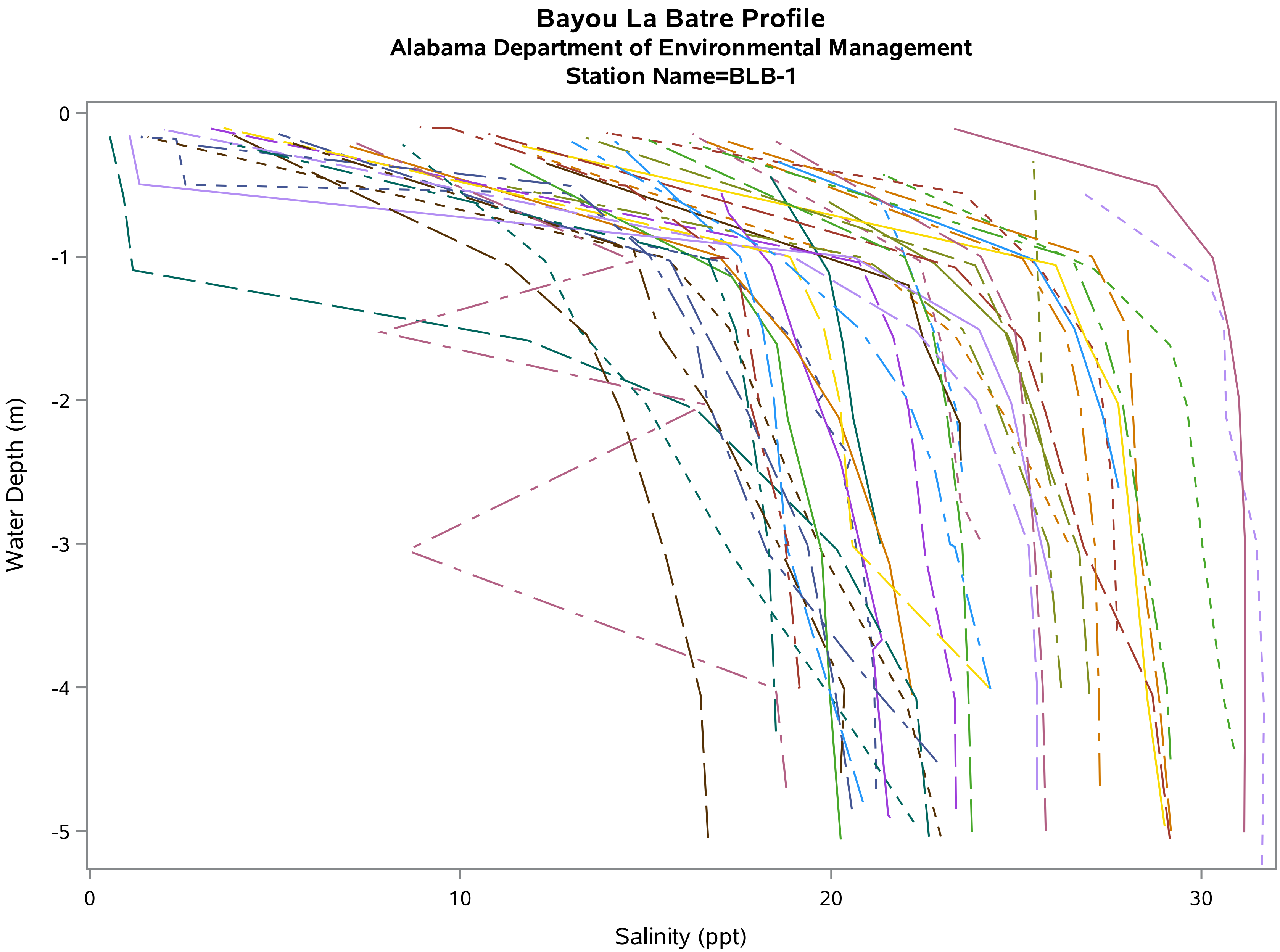

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-1
0
-1
-2
-3
-4
Water Depth (m)
17.5
20.0
22.5
25.0
27.5
30.0
Salinity (ppt)


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
0
-1
-2
-3
-4
Water Depth (m)
15
20
25
30
Salinity (ppt)


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)

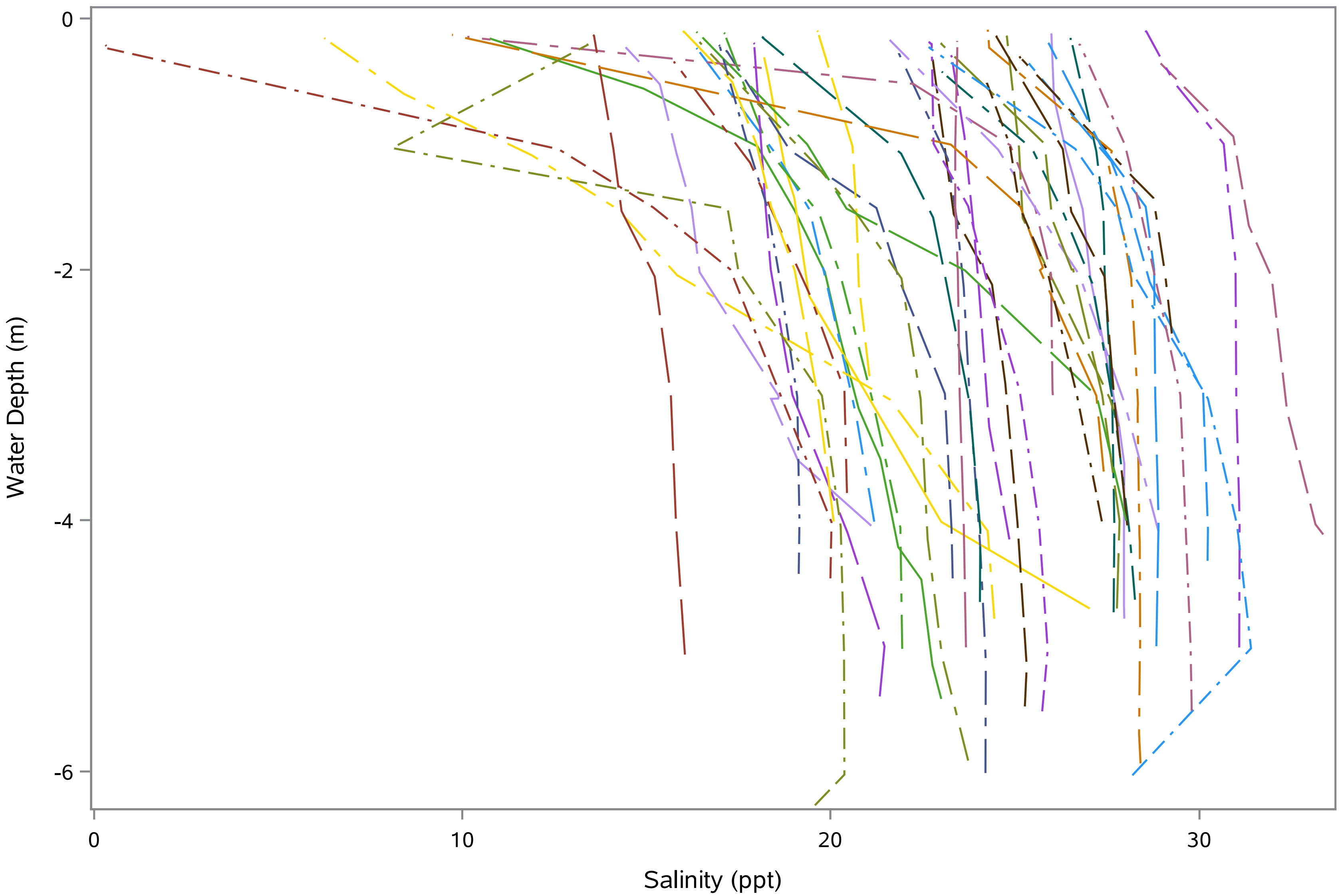


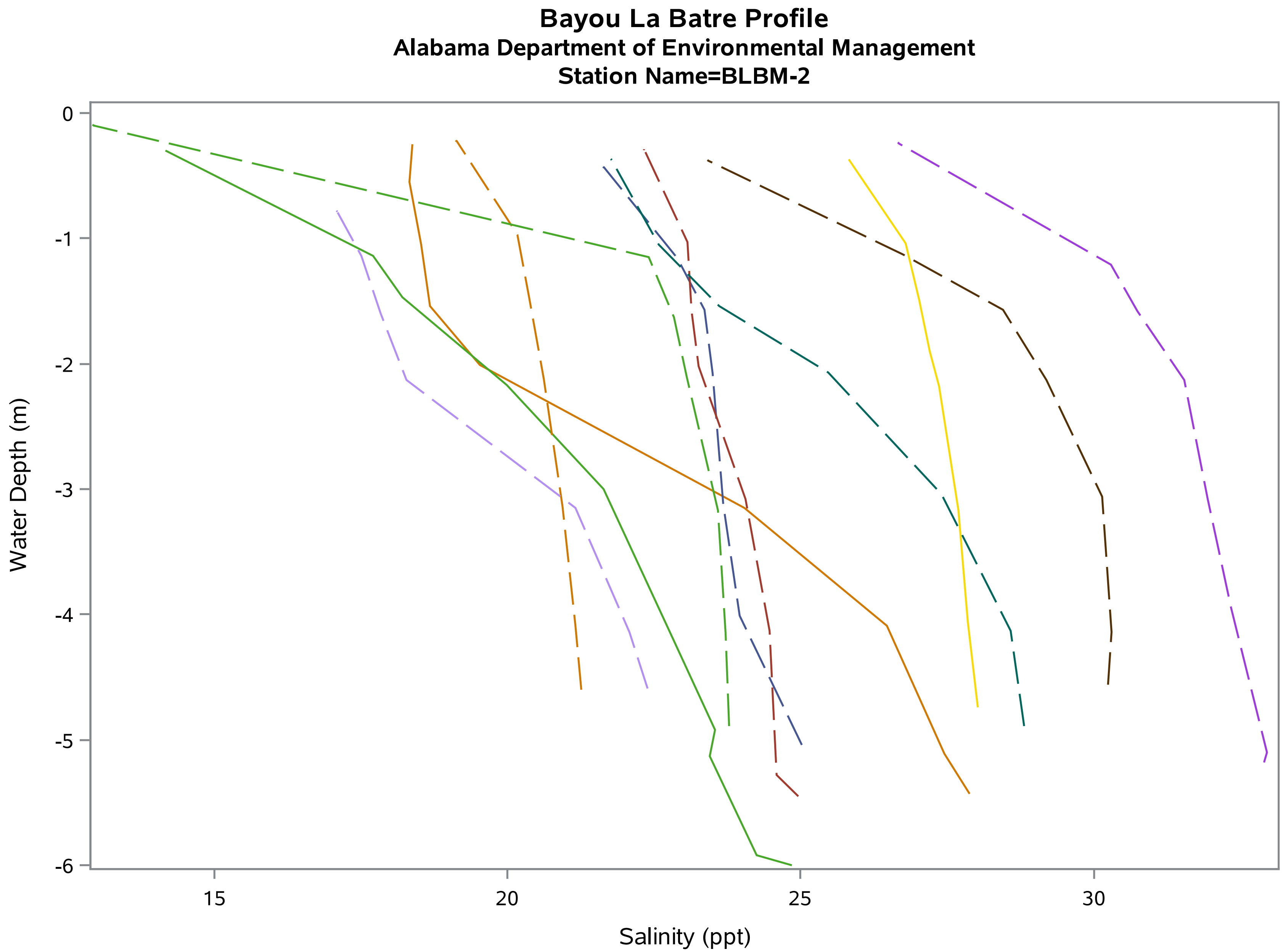
Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLB-1
0
-1
-2
-3
-4
-5
Water Depth (m)
0
10
20
30
Salinity (ppt)

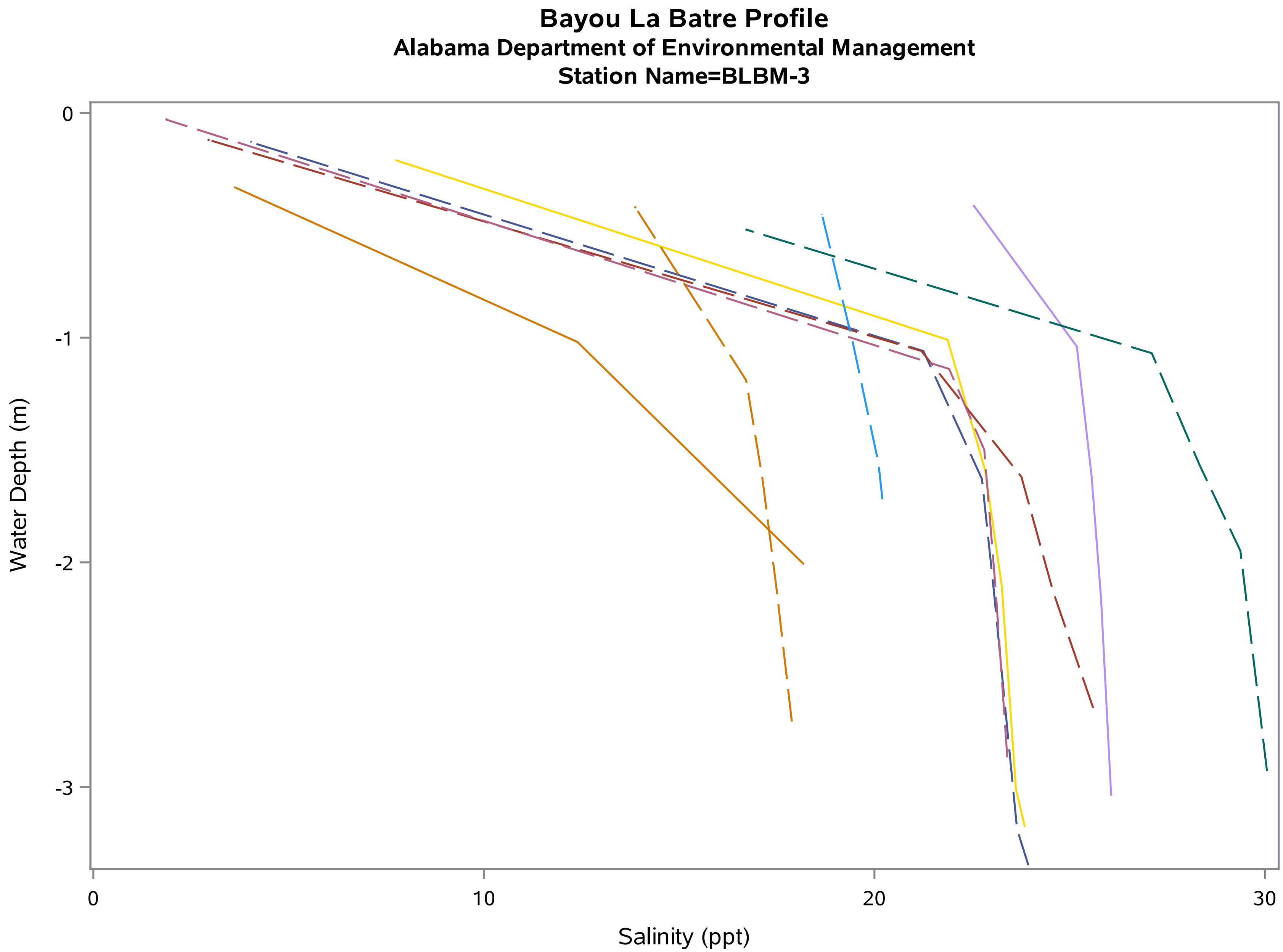
Bayou La Batre Profile

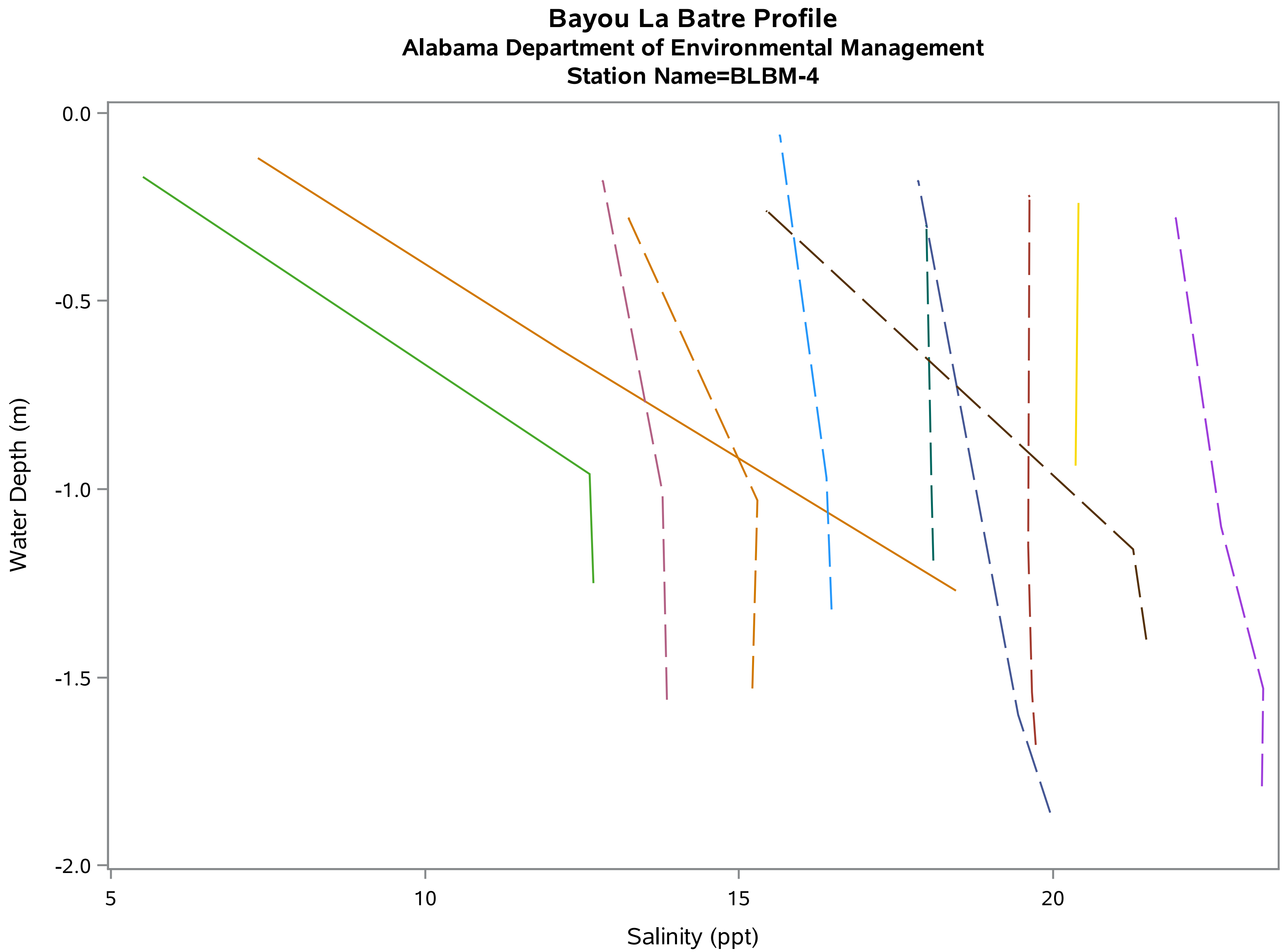
Alabama Department of Environmental Management

Station Name=BLBM-1



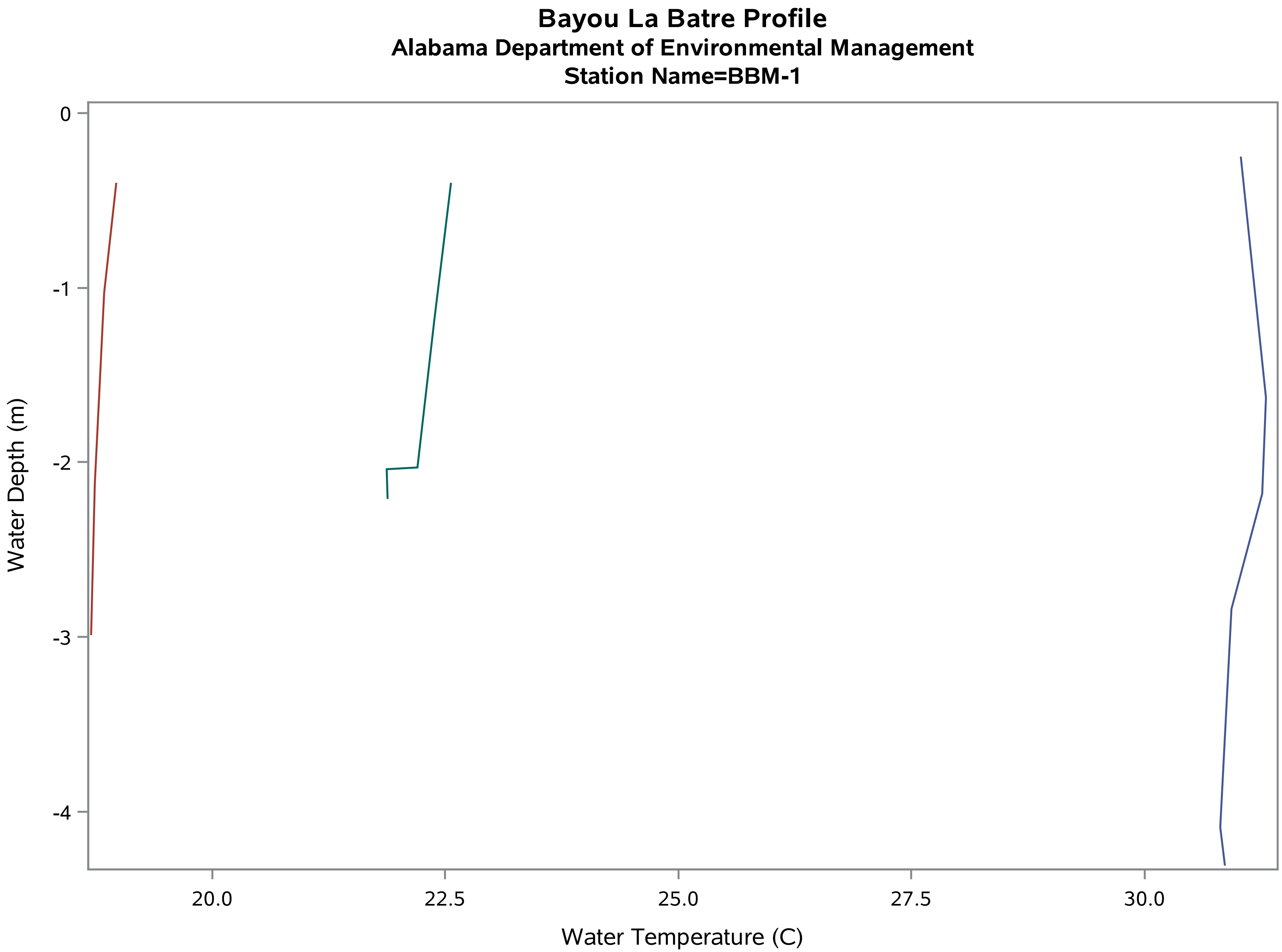

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-2
Water Depth (m)
0
-1
-2
-3
-4
-5
-6
15
20
25
30
Salinity (ppt)

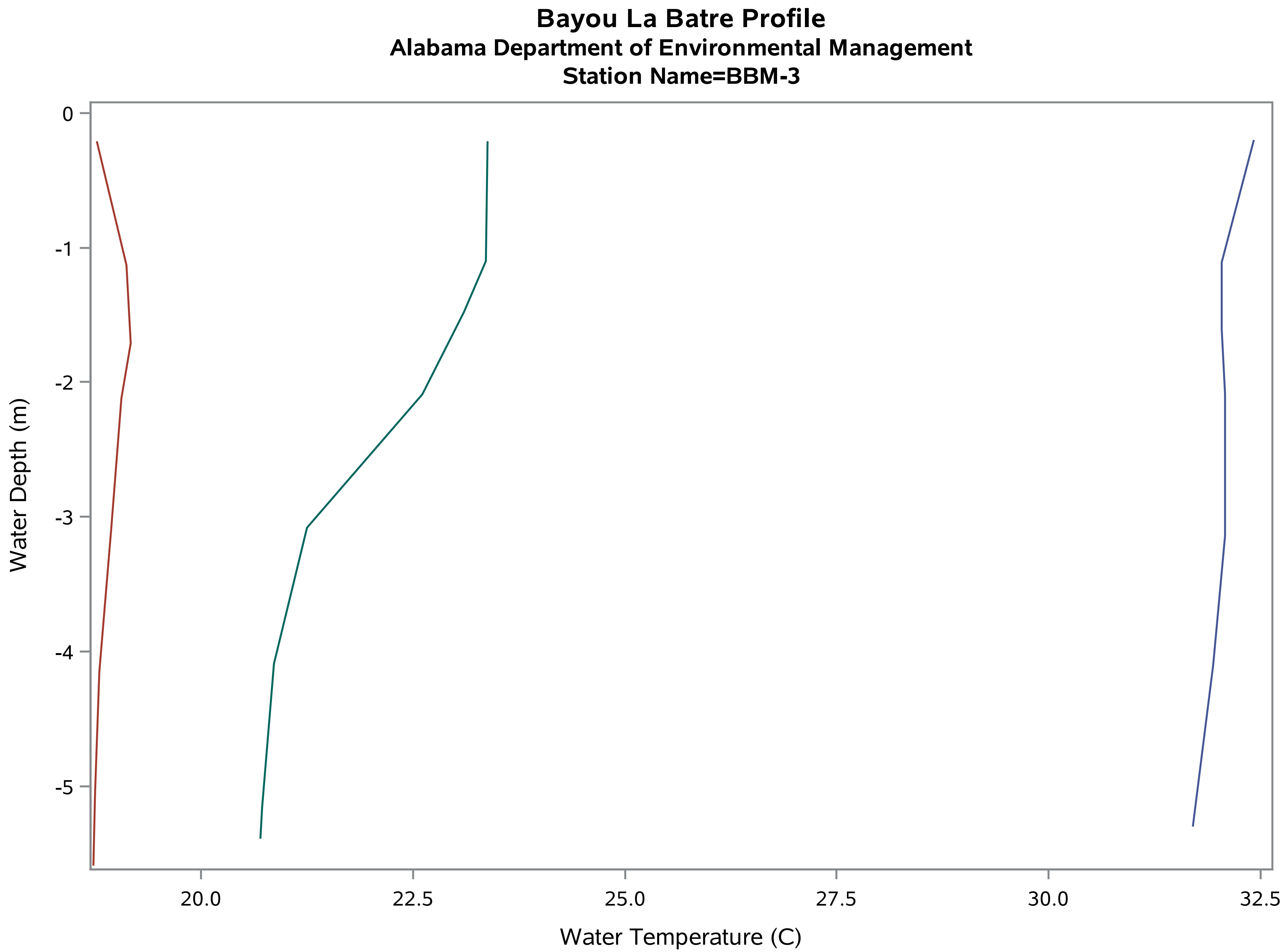

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-3
Water Depth (m)
0
-1
-2
-3
Salinity (ppt)
0
10
20
30

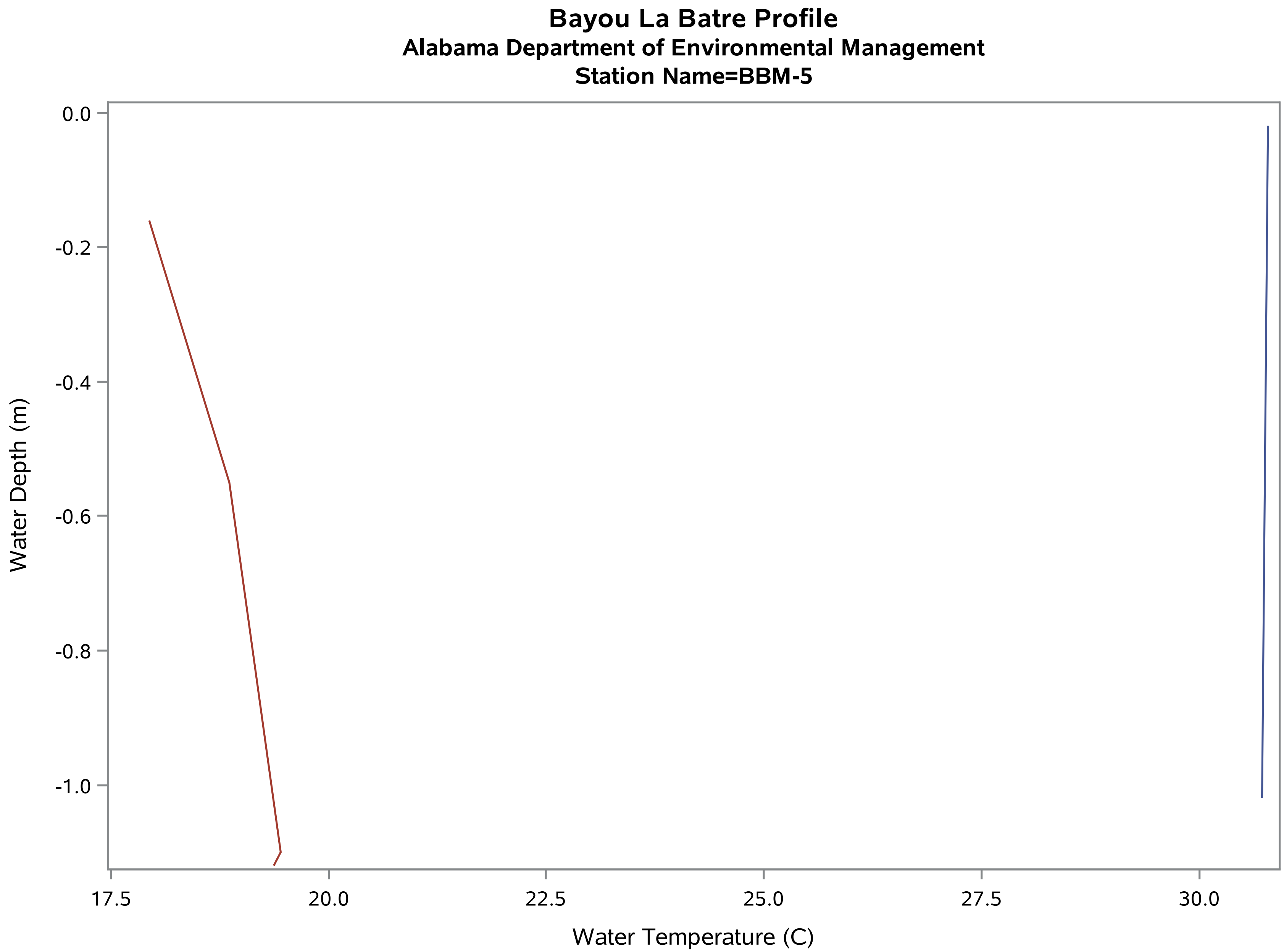

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-4
0.0
-0.5
-1.0
-1.5
-2.0
Water Depth (m)
5
10
15
20
Salinity (ppt)


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)

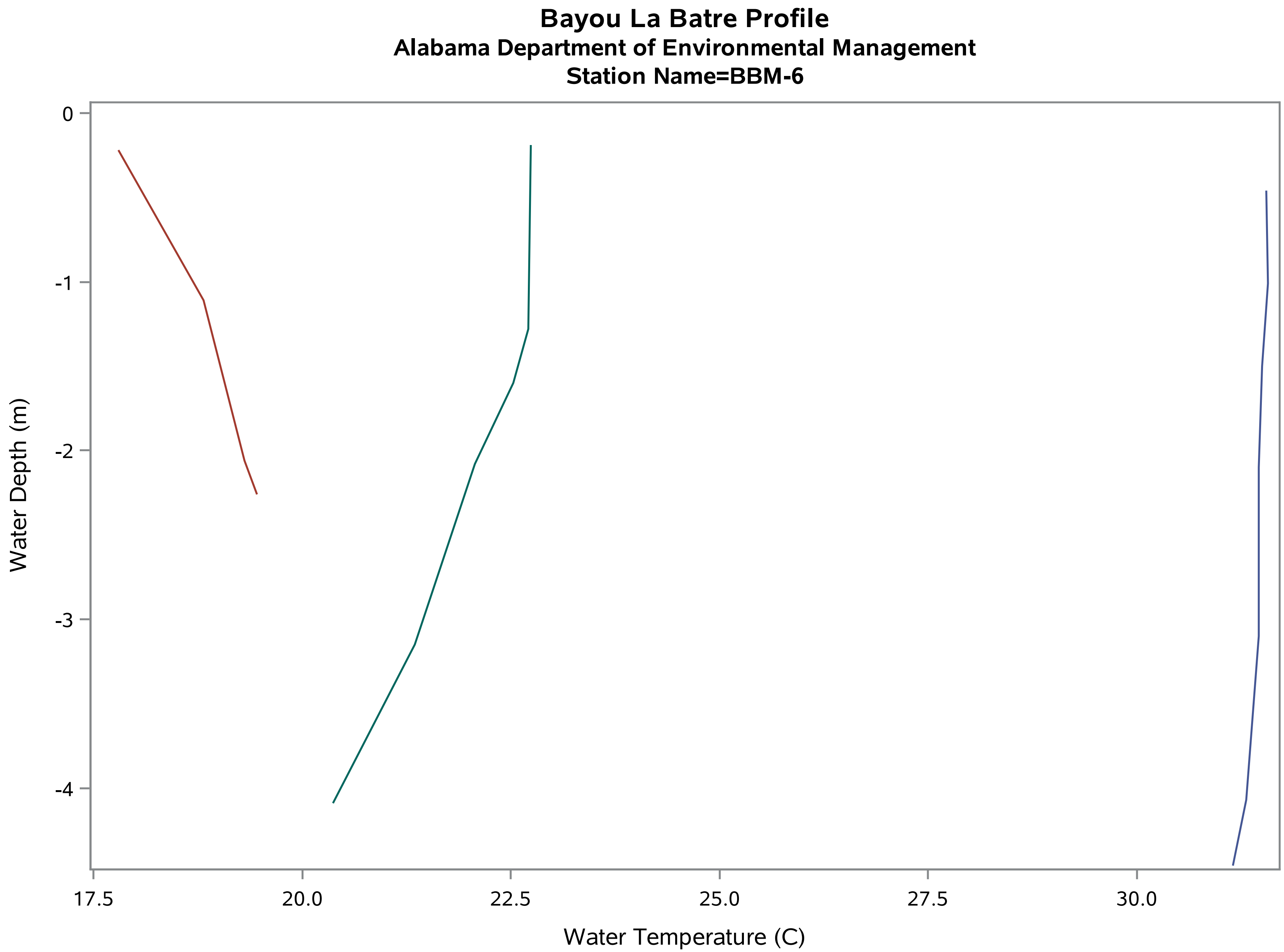
Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=HMC-2

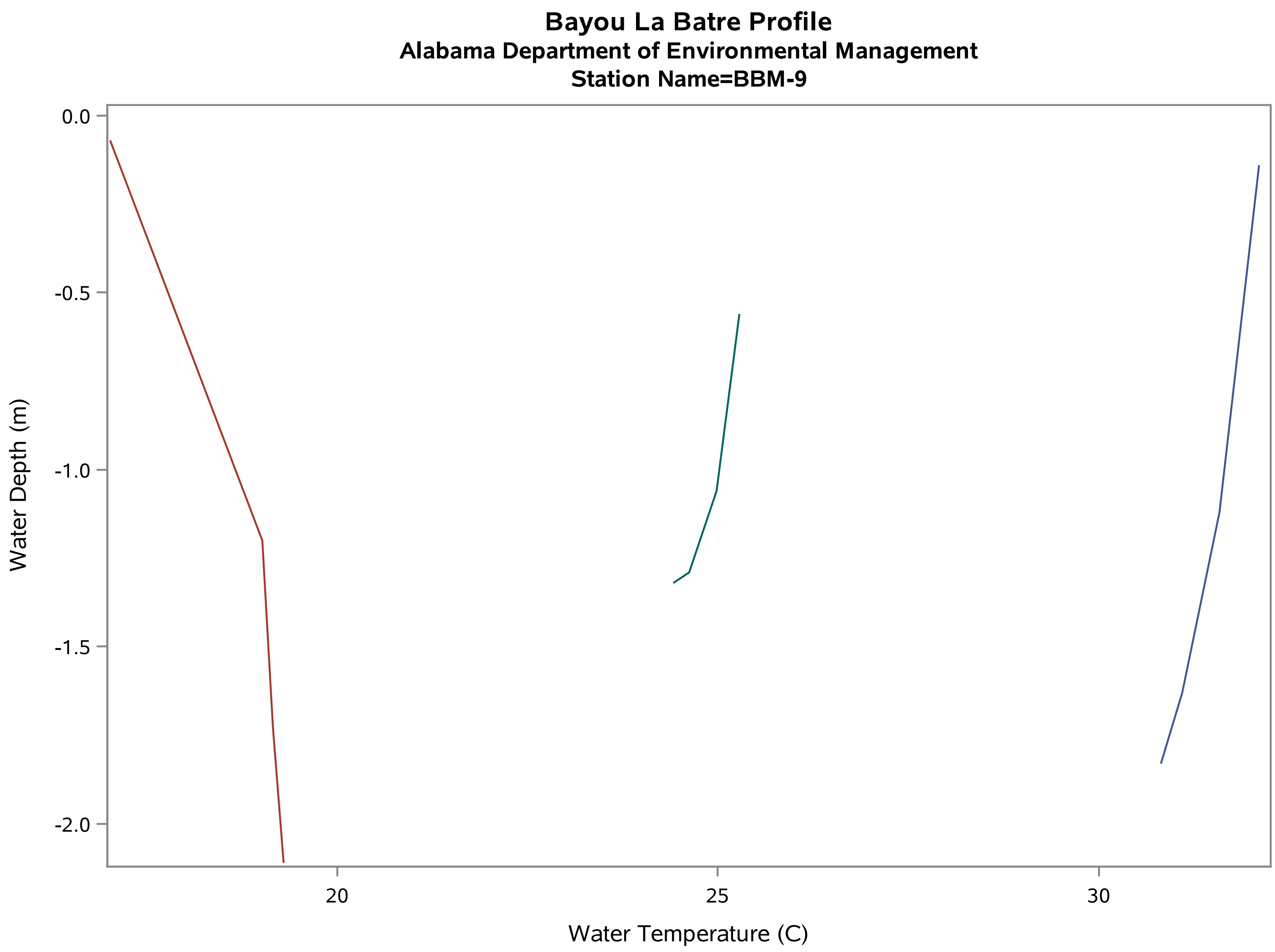

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-1
0
-1
-2
-3
-4
Water Depth (m)
20.0
22.5
25.0
27.5
30.0
Water Temperature (C)

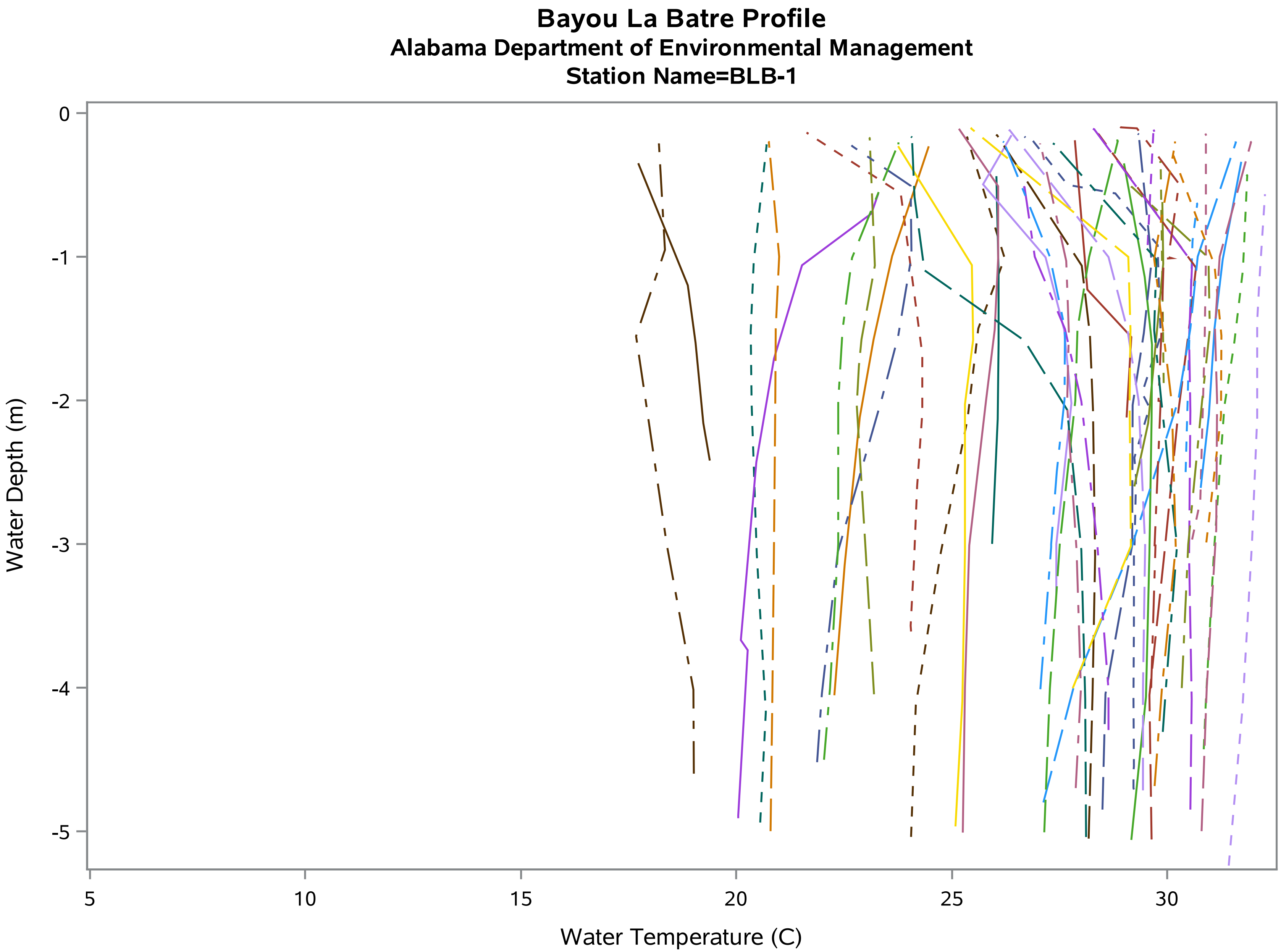

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-3
Water Depth (m)
0
-1
-2
-3
-4
-5
20.0
22.5
25.0
27.5
30.0
32.5
Water Temperature (C)

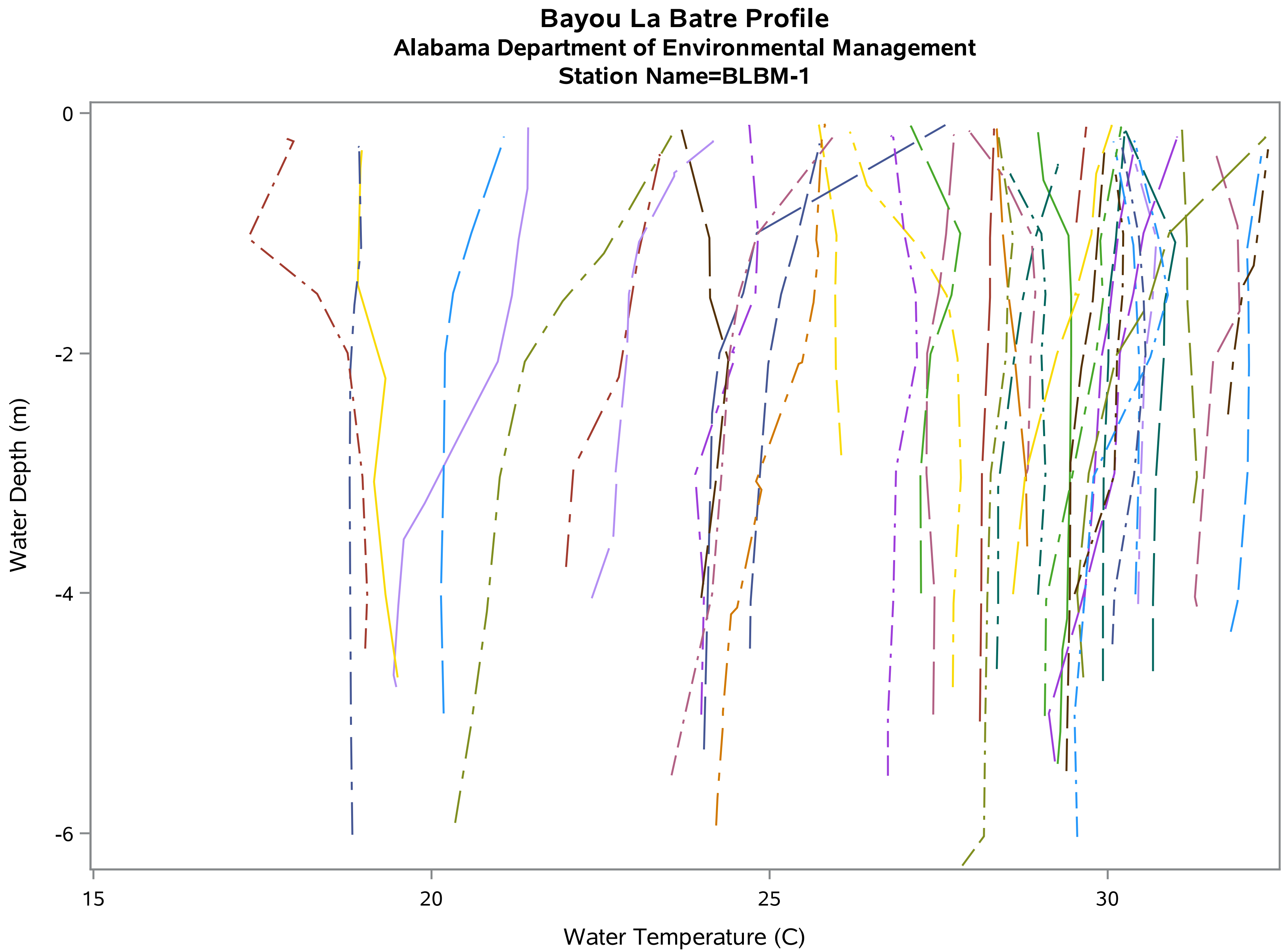


Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-5
Water Depth (m)
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
17.5
20.0
22.5
25.0
27.5
30.0
Water Temperature (C)

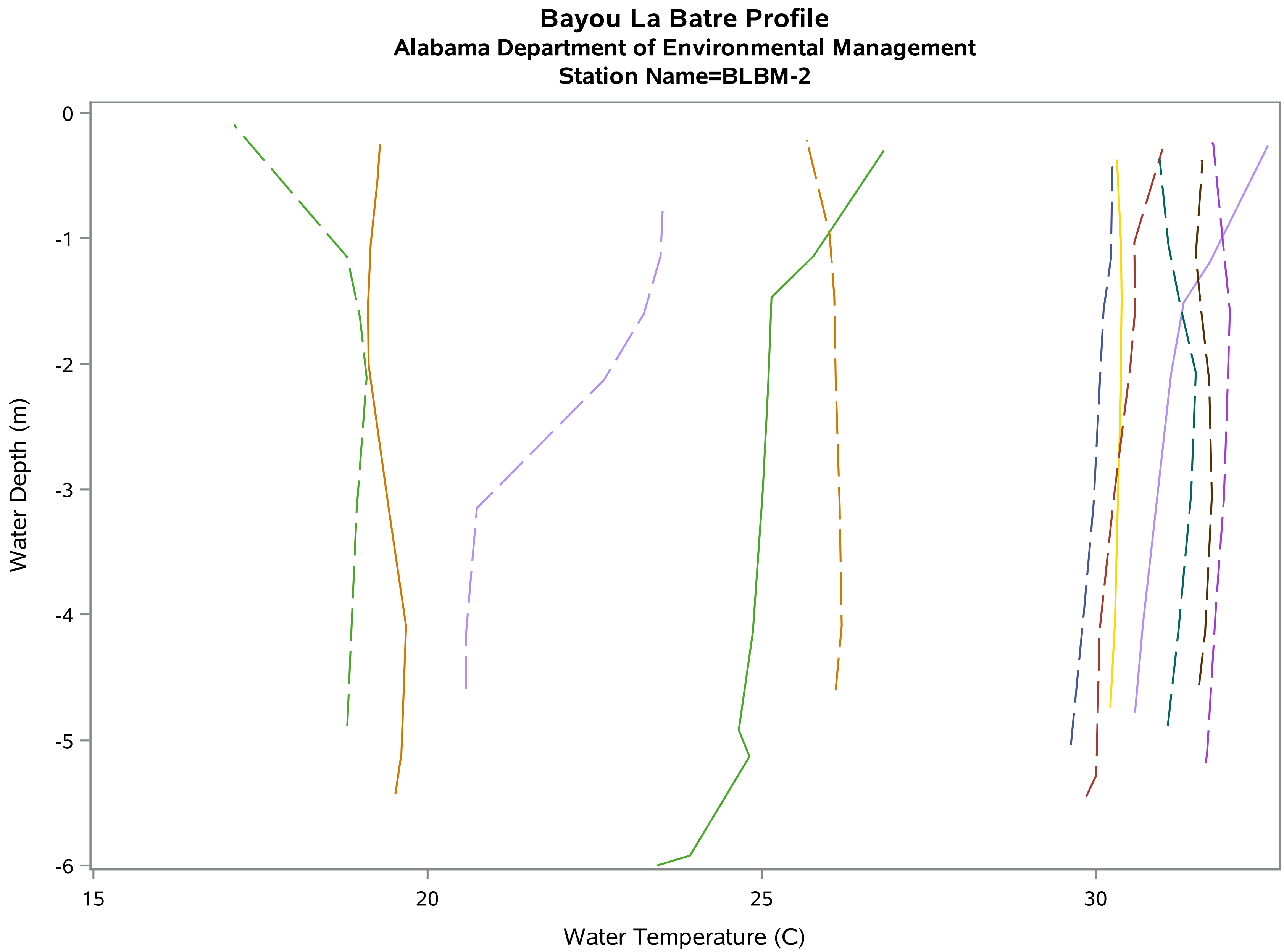

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-6
Water Depth (m)
0
-1
-2
-3
-4
17.5
20.0
22.5
25.0
27.5
30.0
Water Temperature (C)


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)

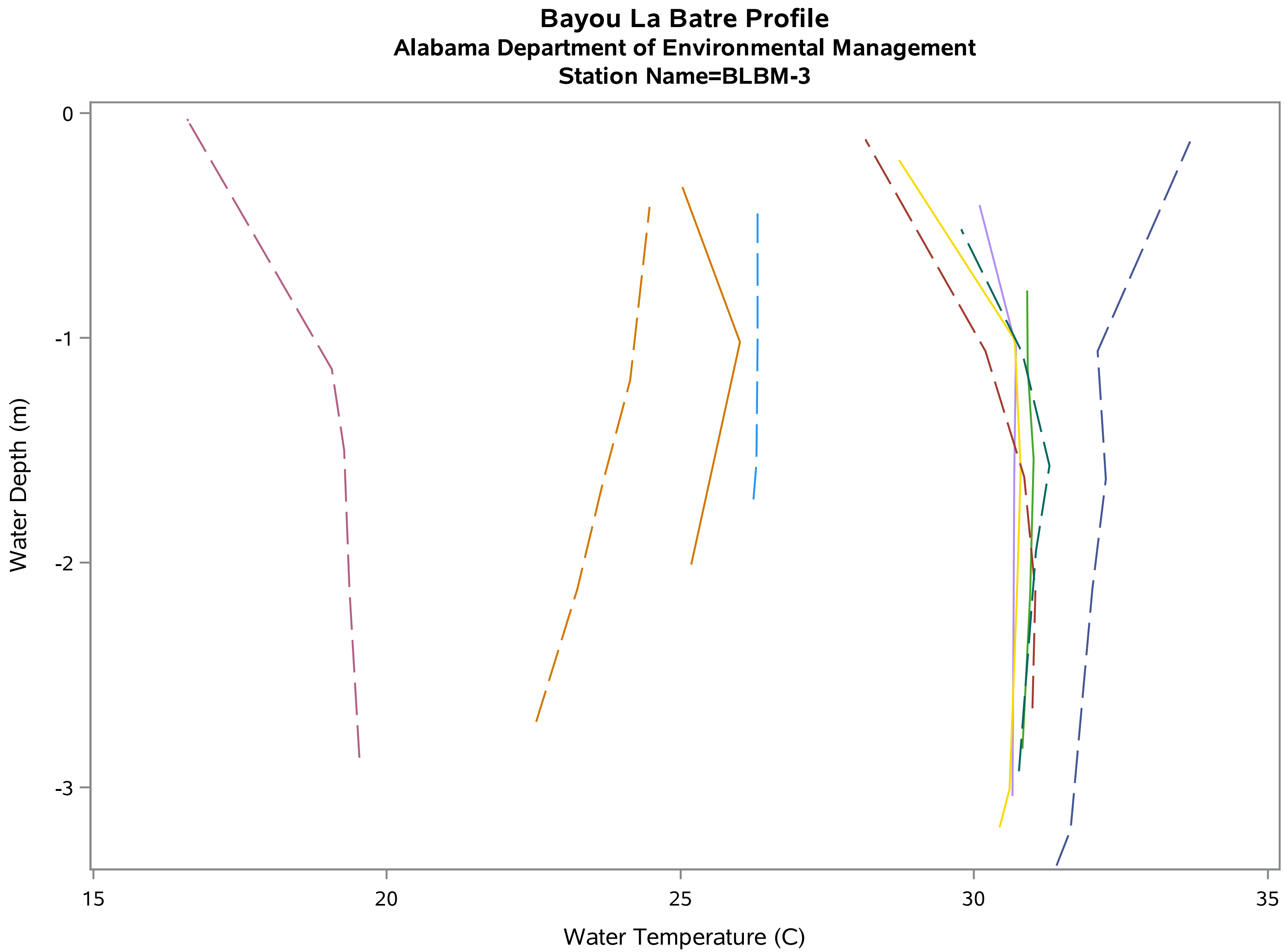

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLB-1
Water Depth (m)
0
-1
-2
-3
-4
-5
5
10
15
20
25
30
Water Temperature (C)

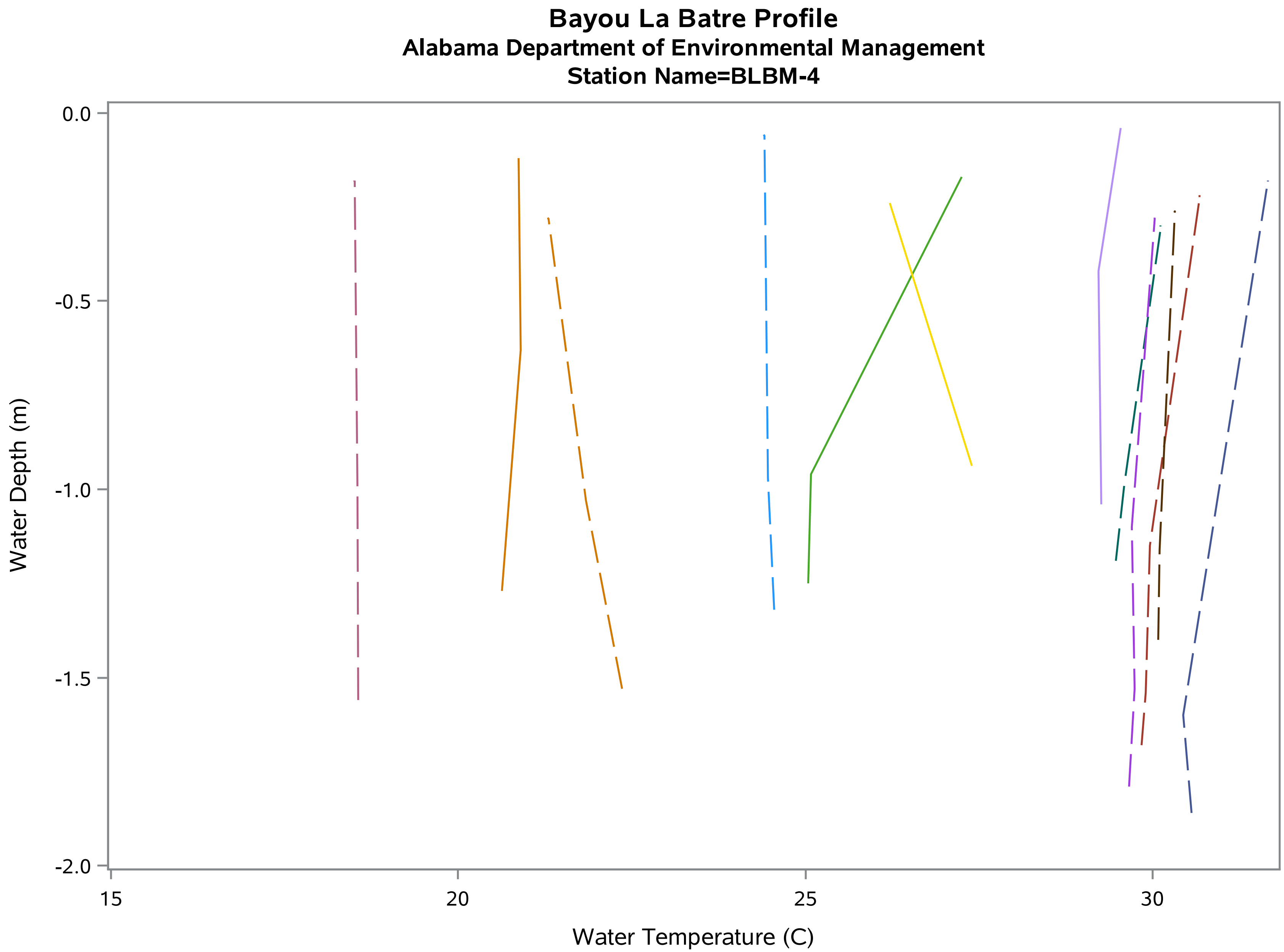


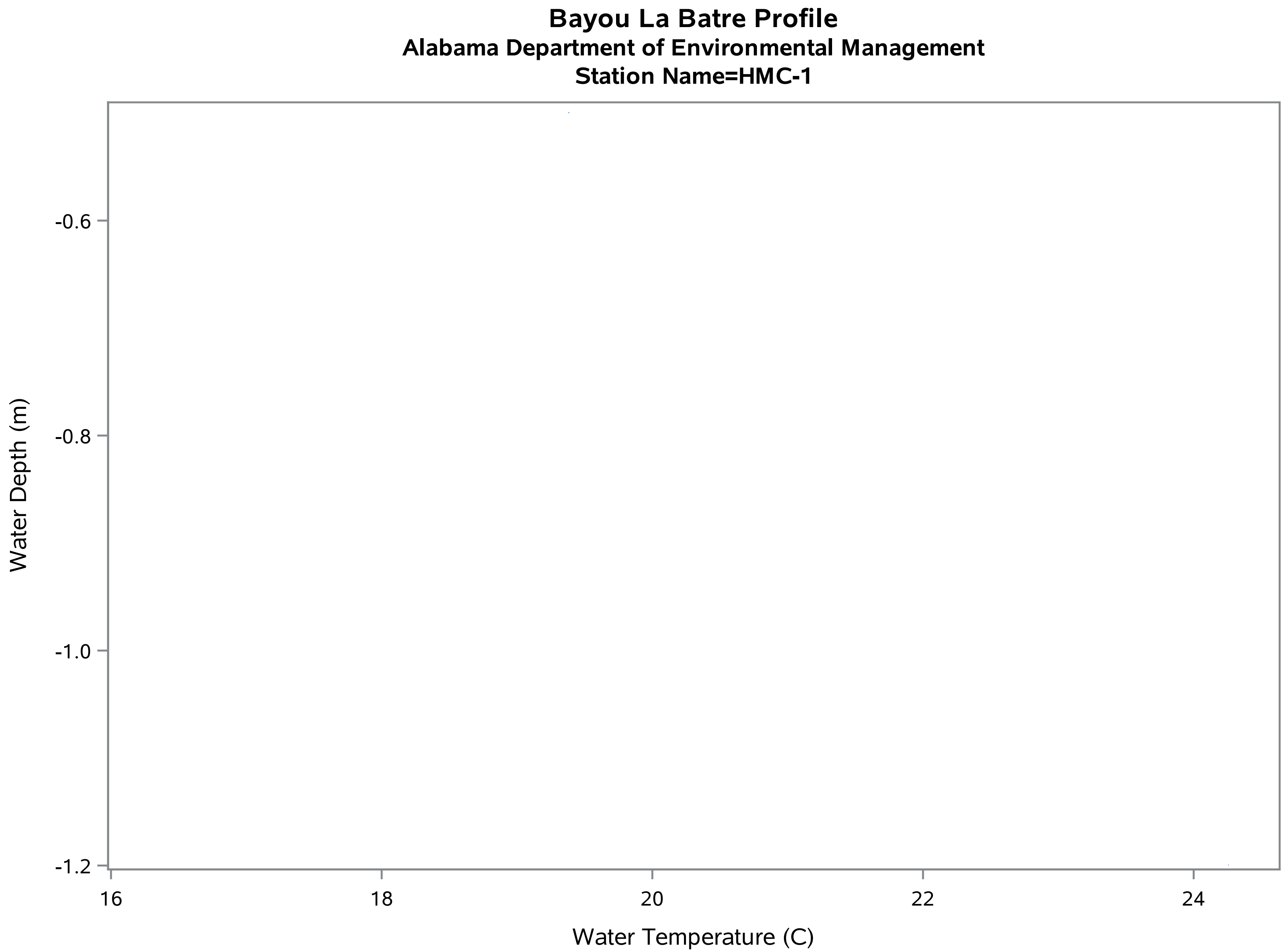
Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-1
0
-2
-4
-6
Water Depth (m)
15
20
25
30
Water Temperature (C)



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

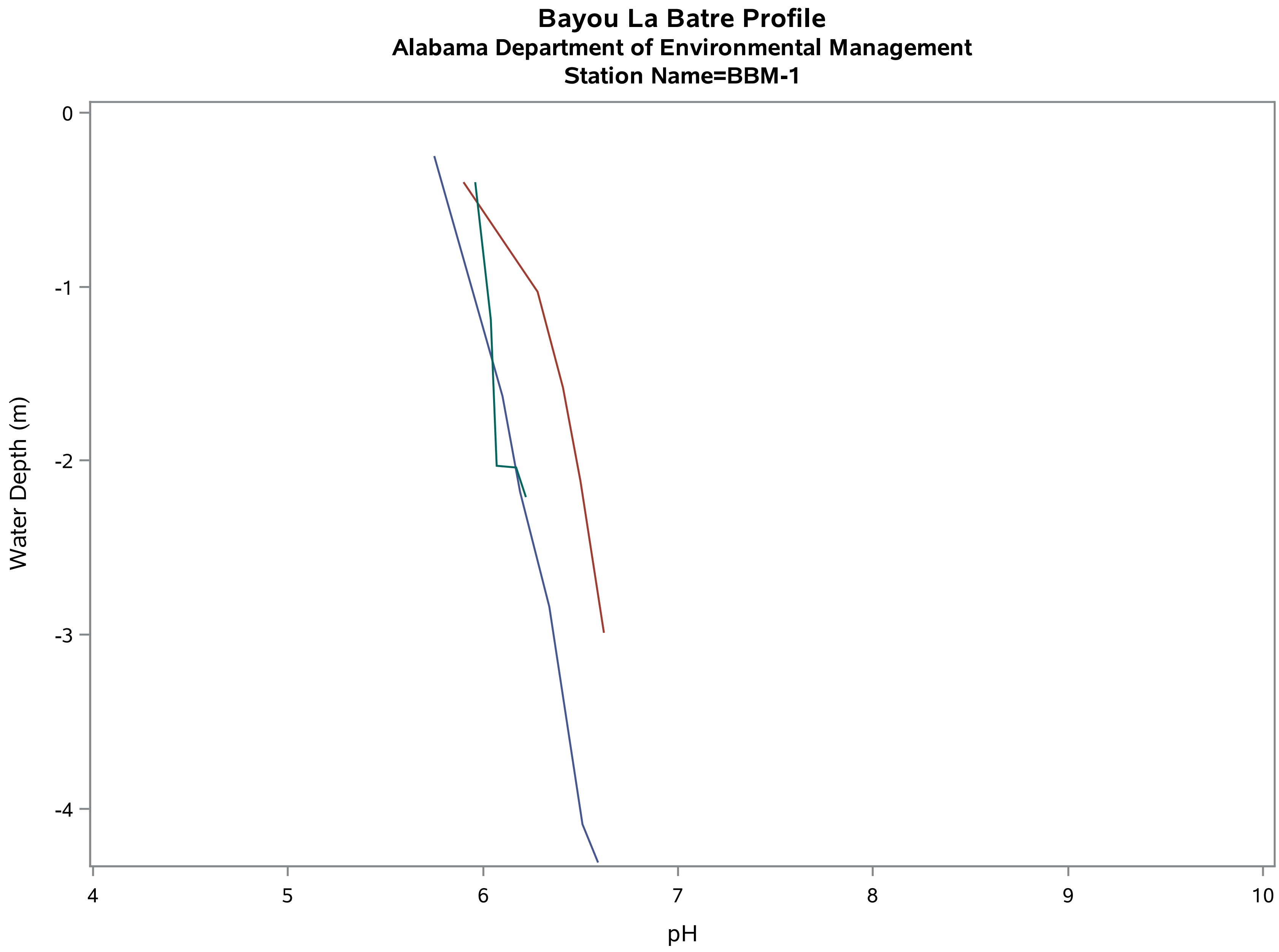

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-4
Water Depth (m)
0.0
-0.5
-1.0
-1.5
-2.0
15
20
25
30
Water Temperature (C)


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)

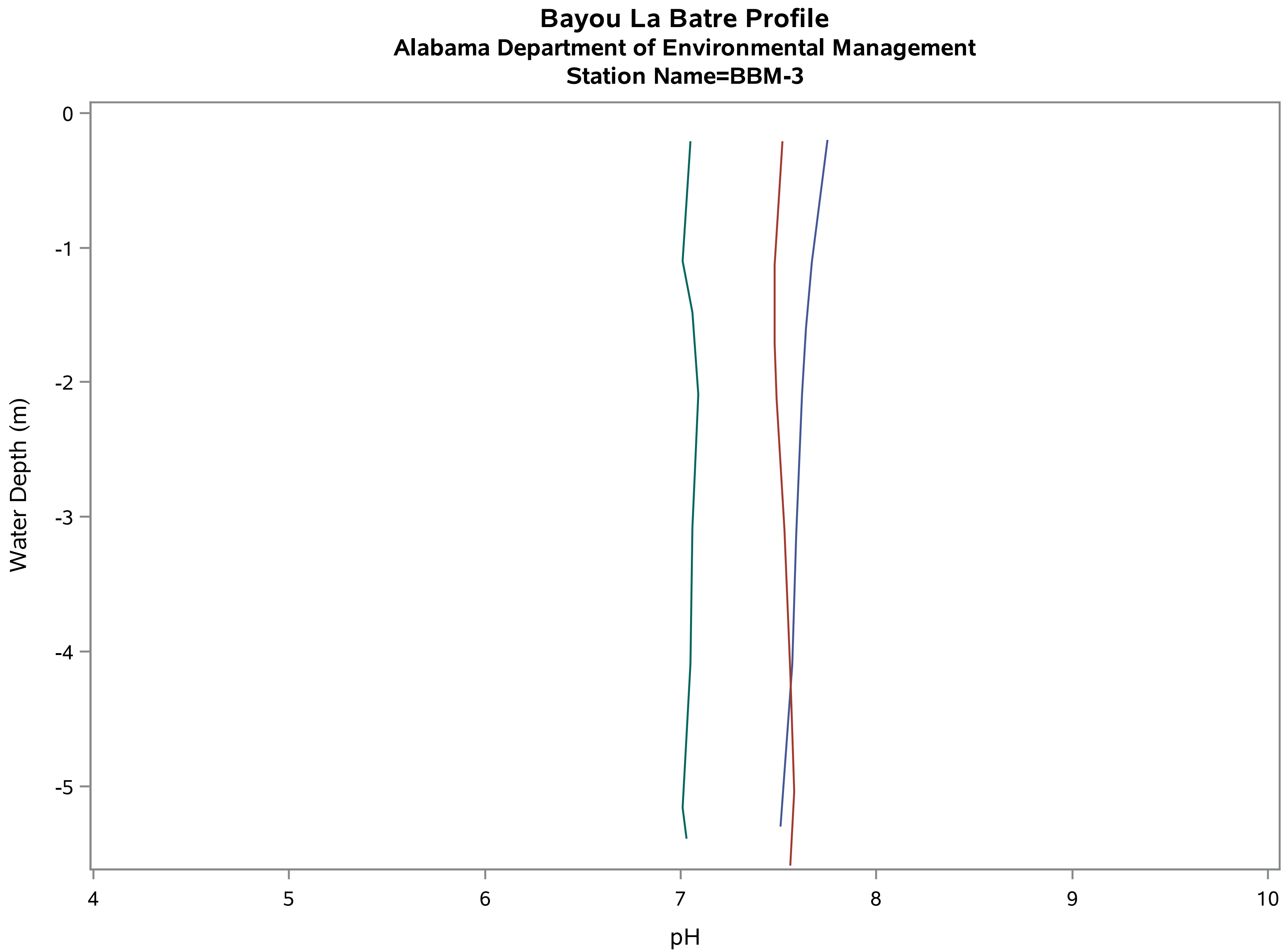
Bayou La Batre Profile

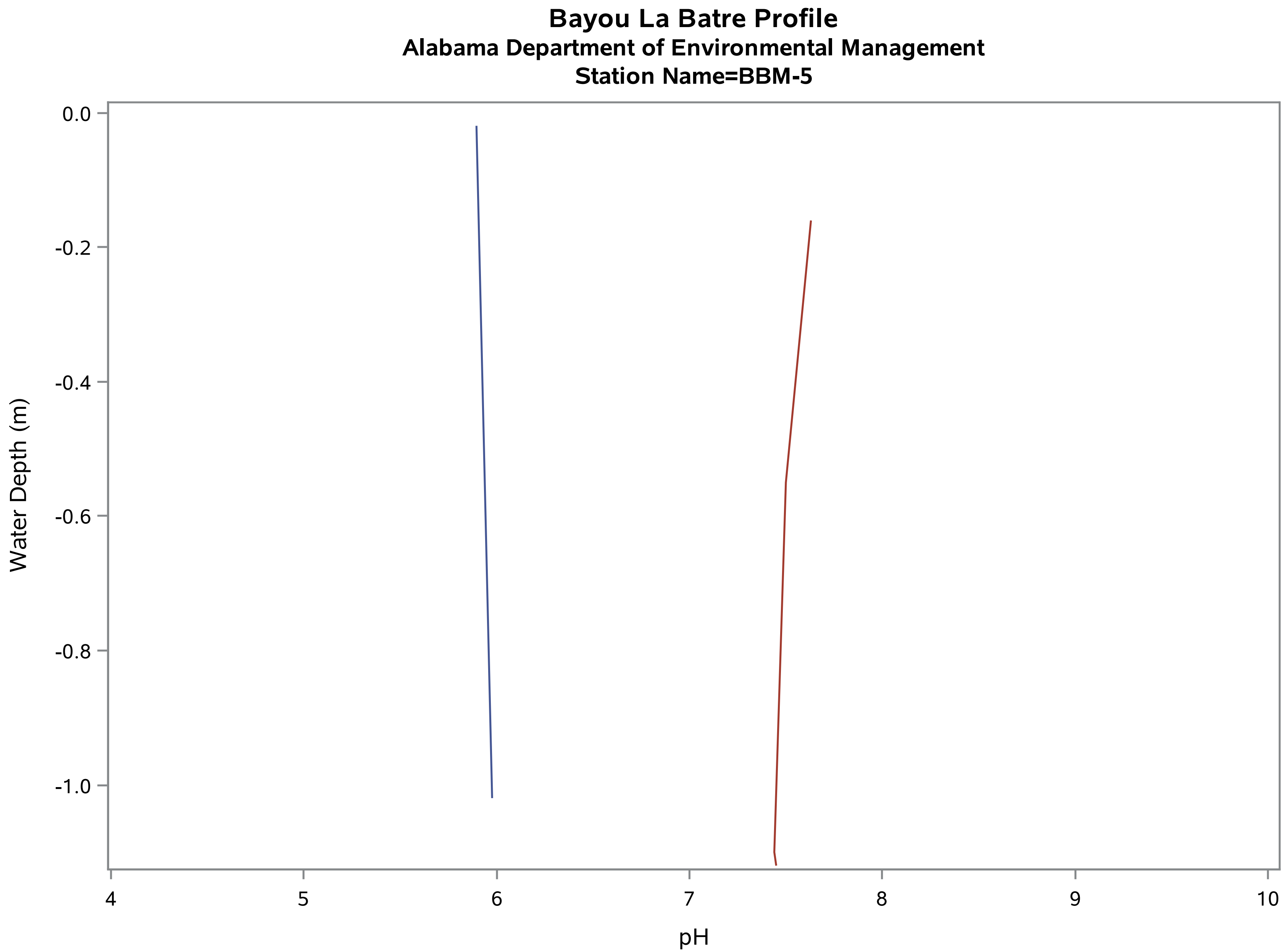
Alabama Department of Environmental Management

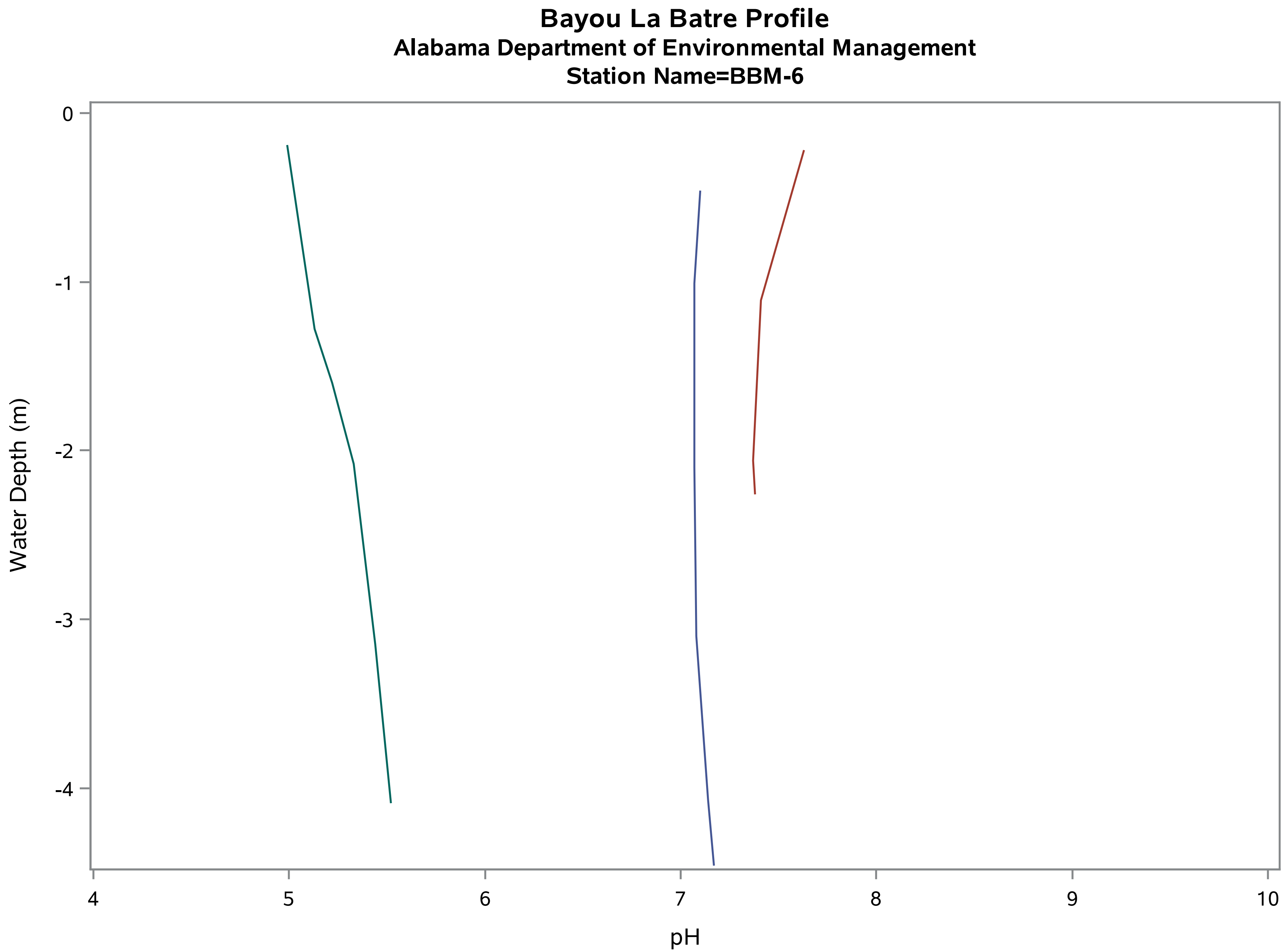
Station Name=HMC-2

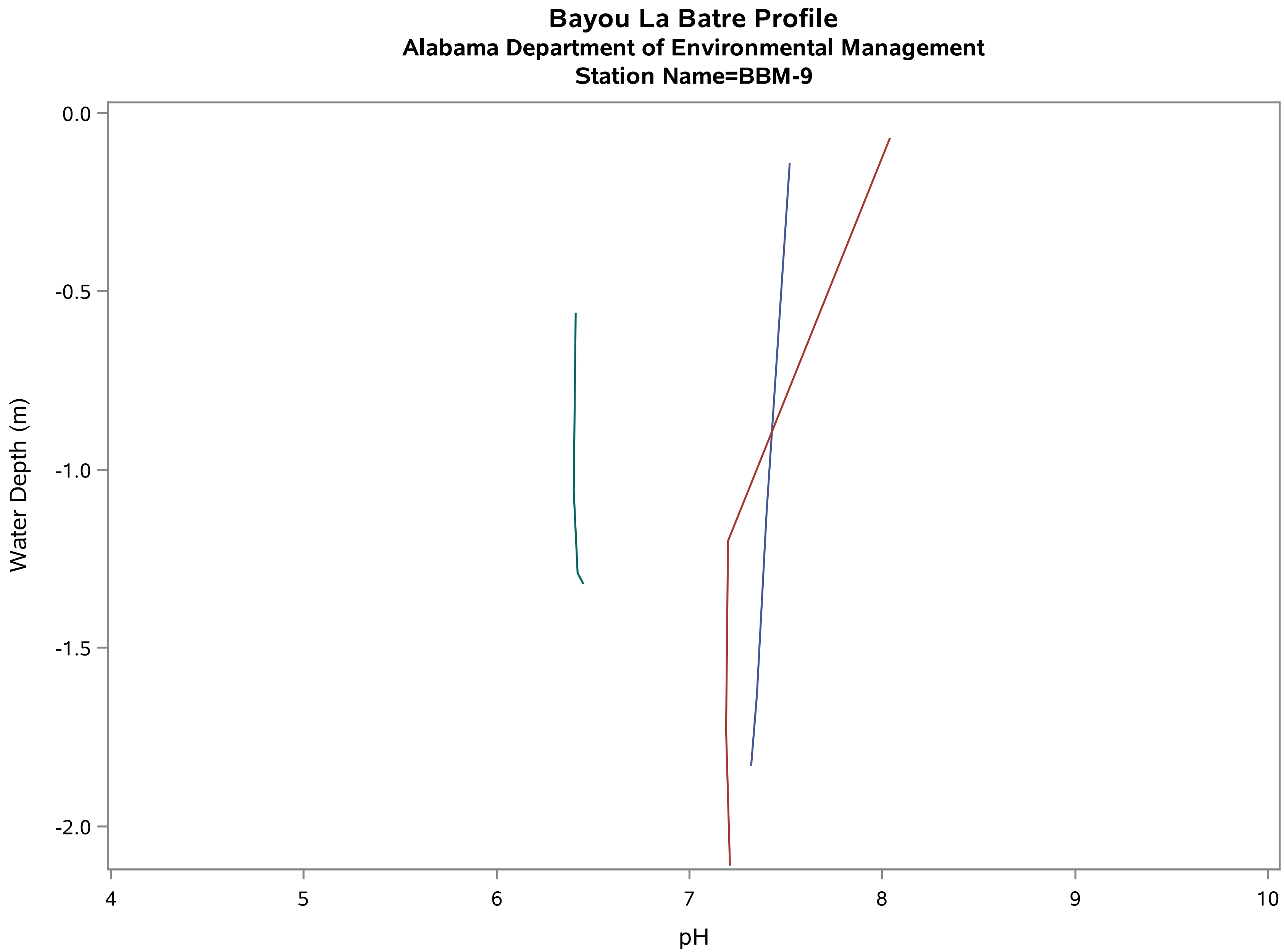


Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-1
0
-1
-2
-3
-4
Water Depth (m)
4
5
6
7
8
9
10
pH

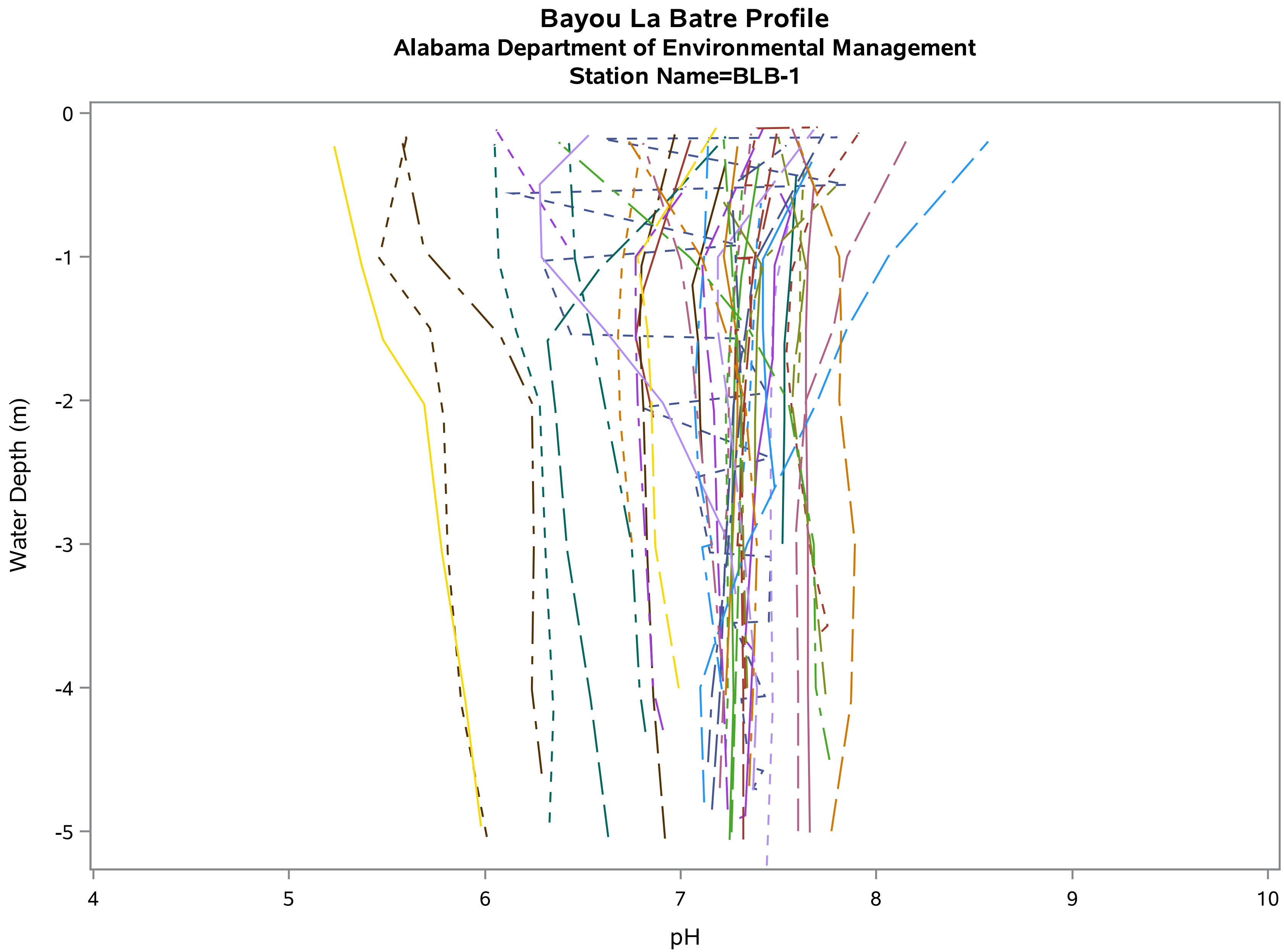

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-3
0
-1
-2
-3
-4
-5
Water Depth (m)
4
5
6
7
8
9
10
pH

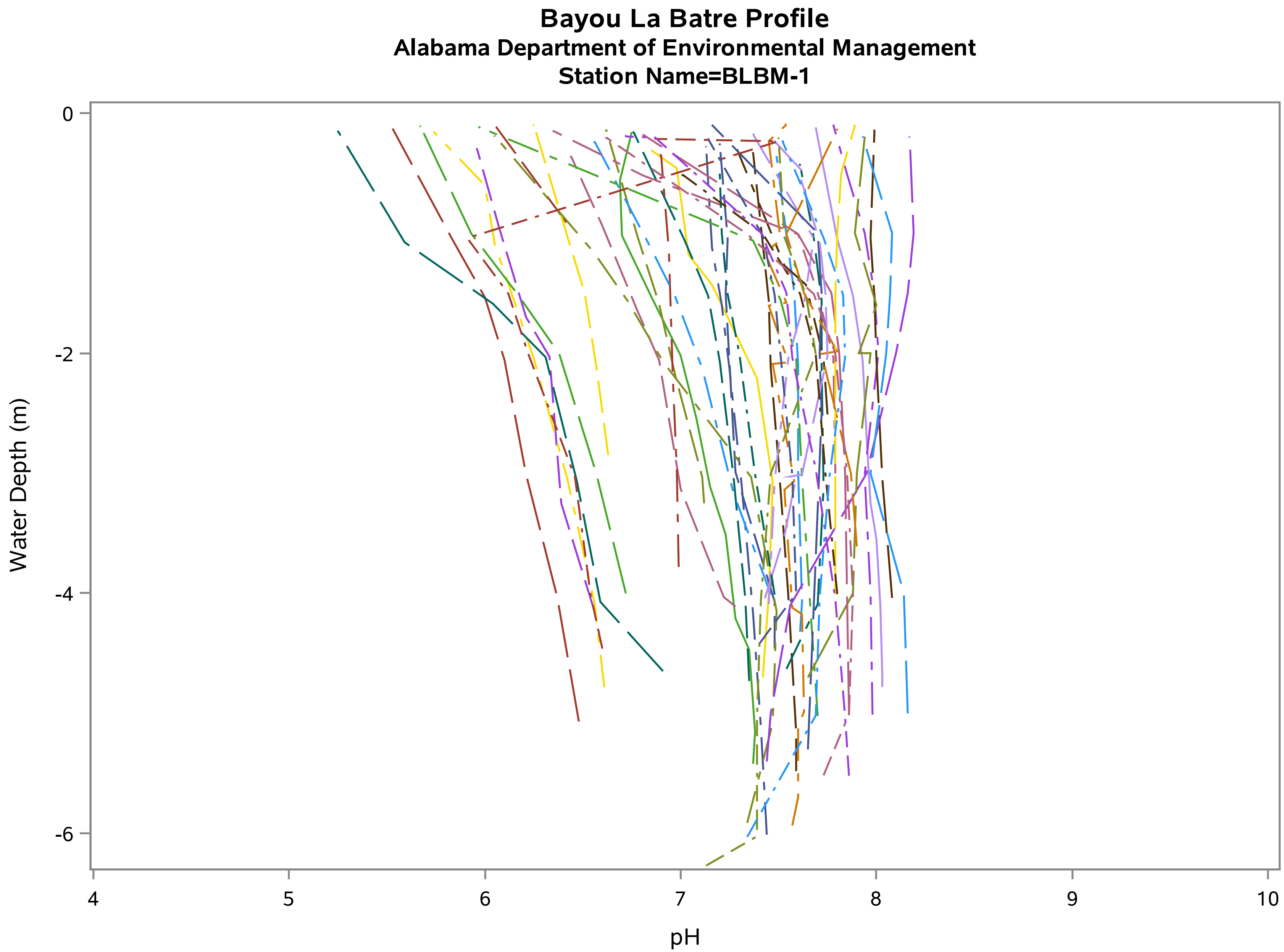

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-5
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
Water Depth (m)
4
5
6
7
8
9
10
pH


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

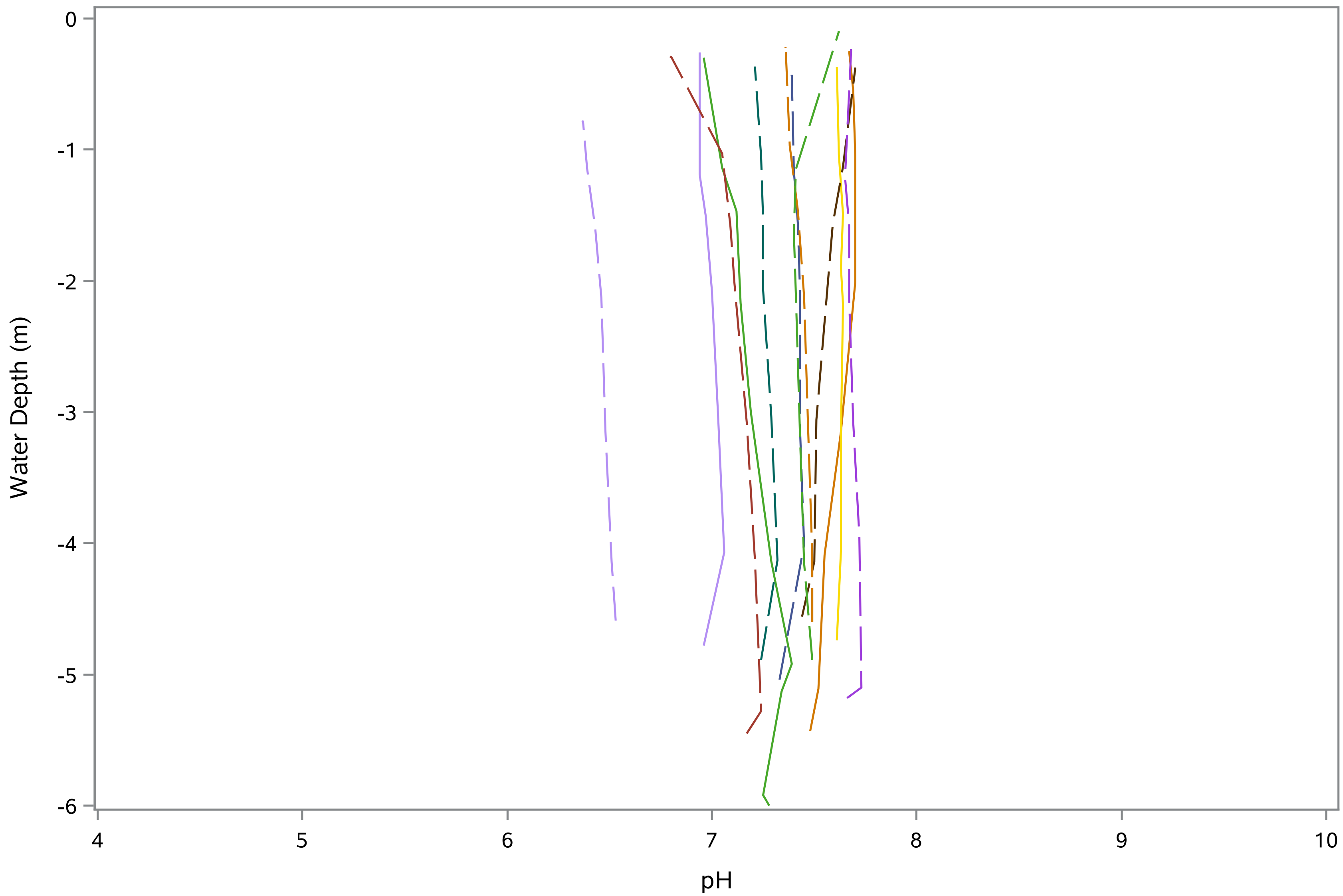


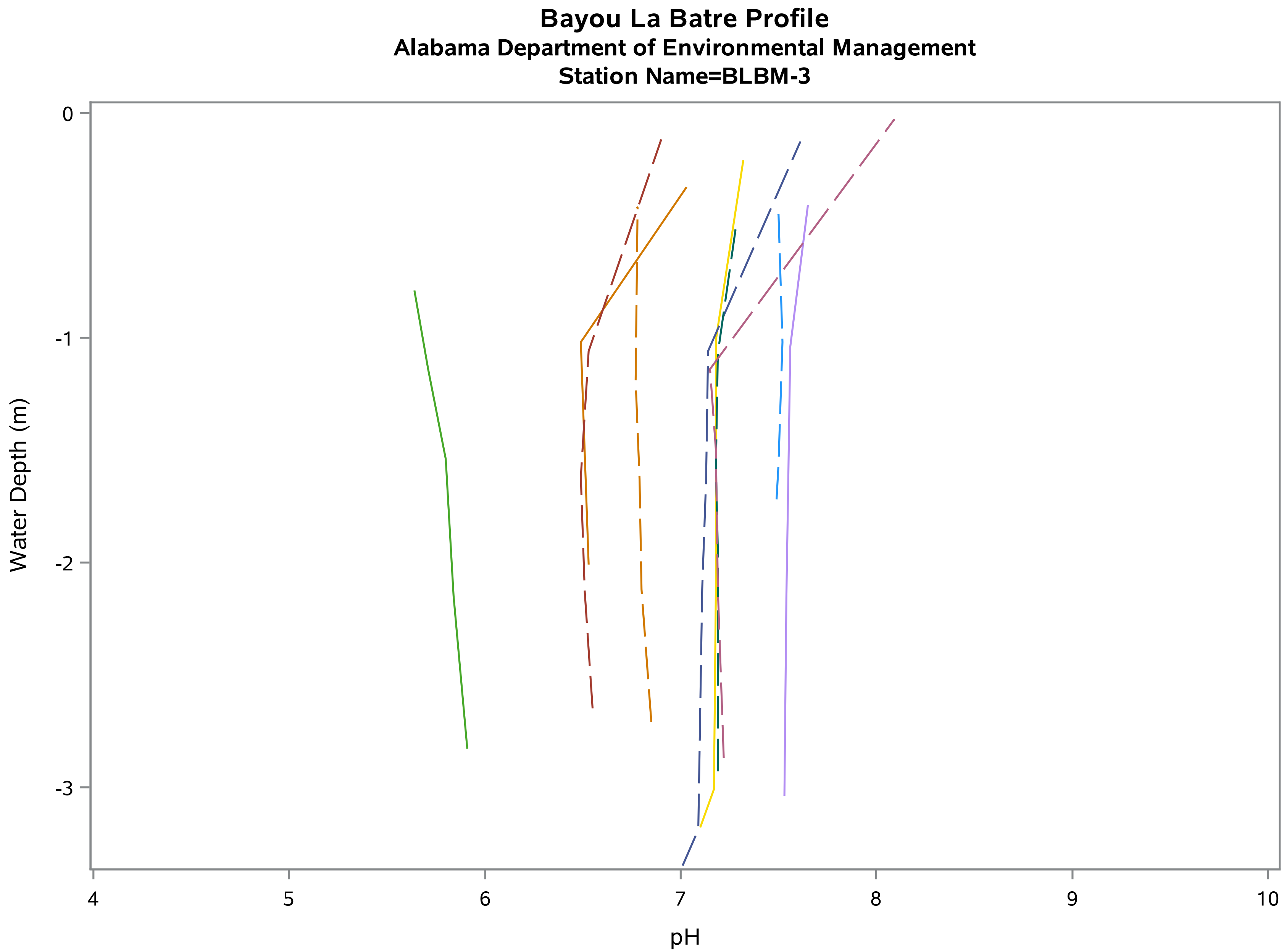
Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BBM-9
0.0
-0.5
-1.0
-1.5
-2.0
Water Depth (m)
4
5
6
7
8
9
10
pH


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

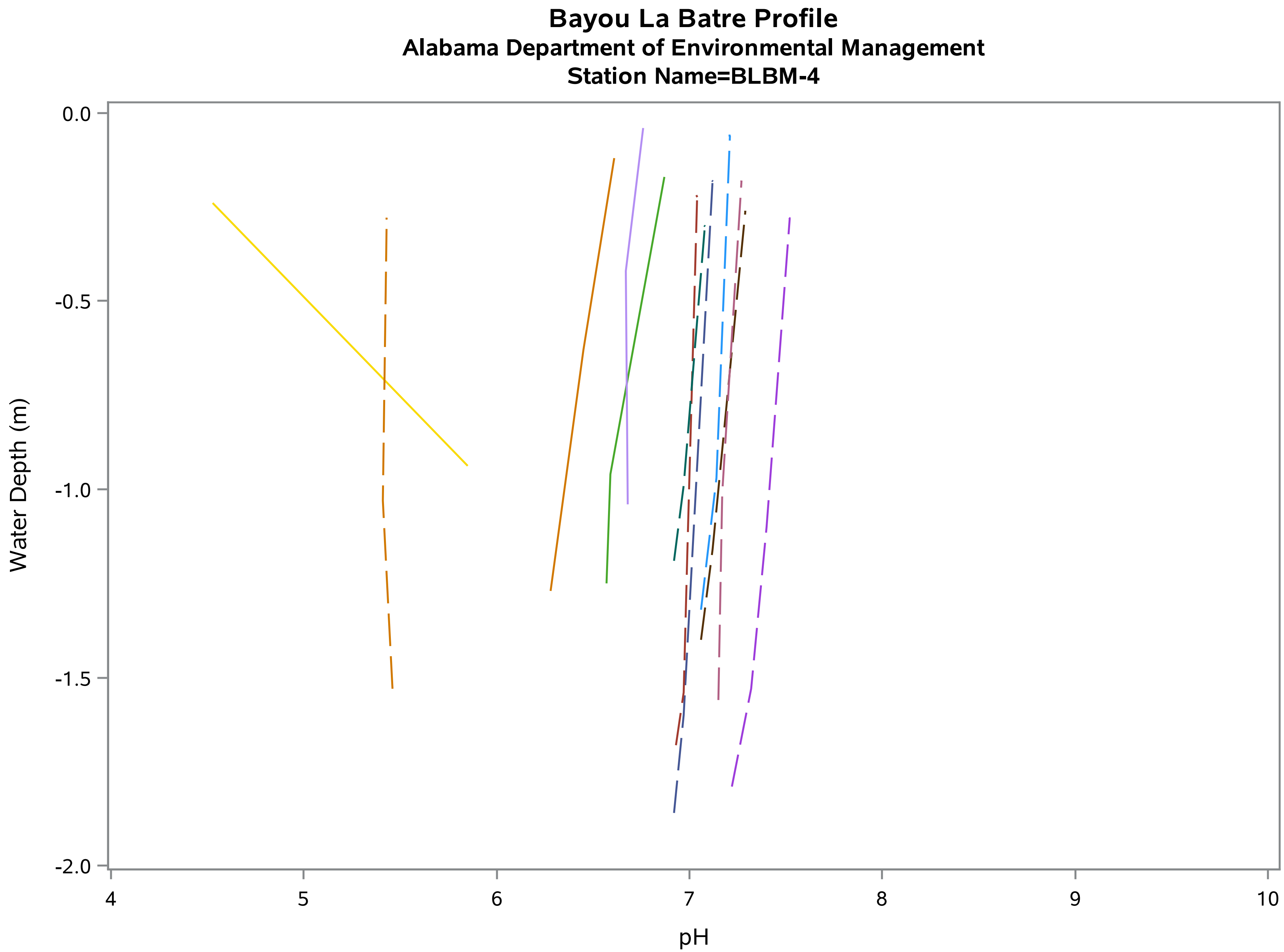

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-1
0
-2
-4
-6
Water Depth (m)
4
5
6
7
8
9
10
pH

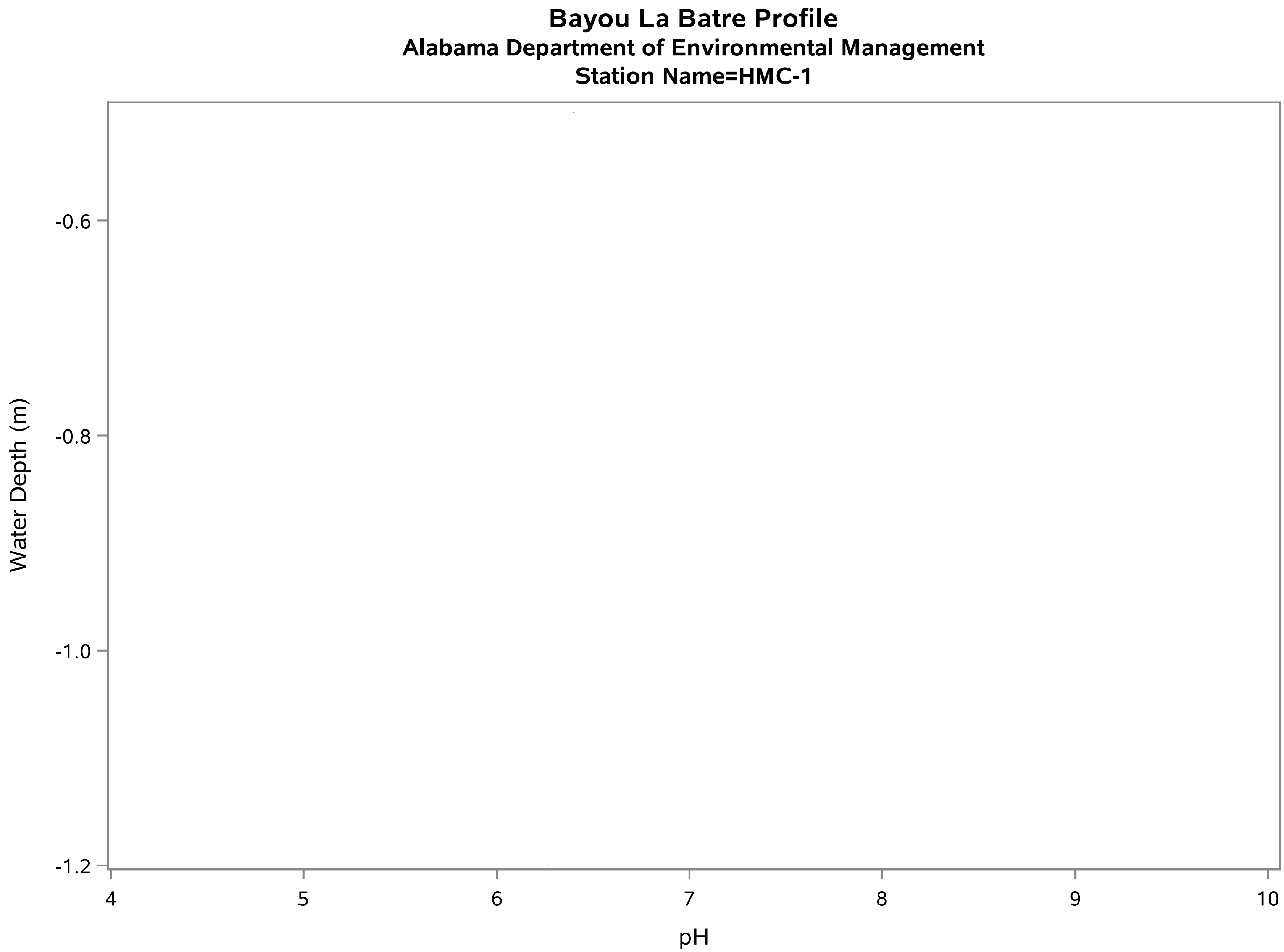
Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-2



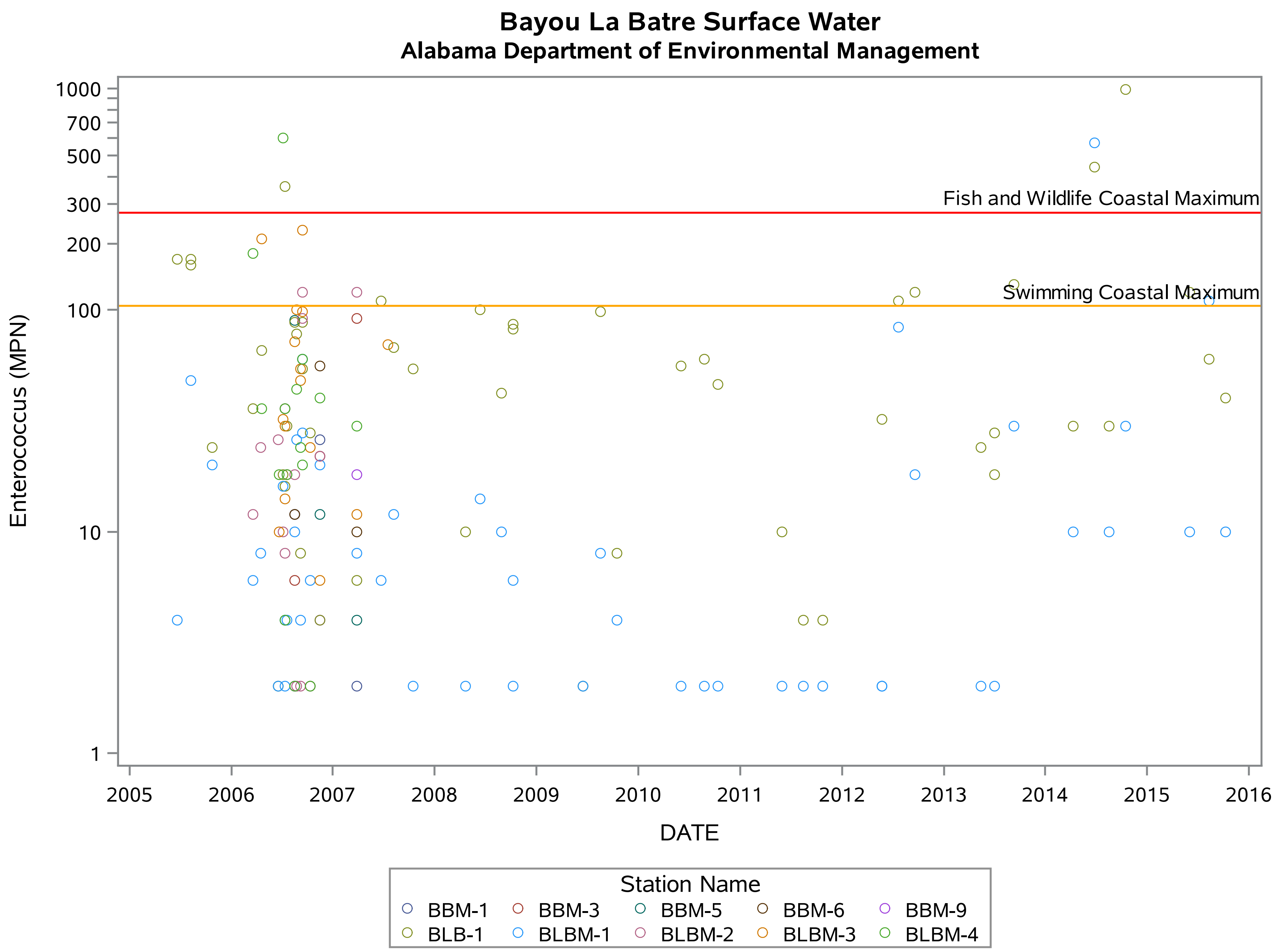


Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-3
Water Depth (m)
0
-1
-2
-3
4
5
6
7
8
9
10
pH

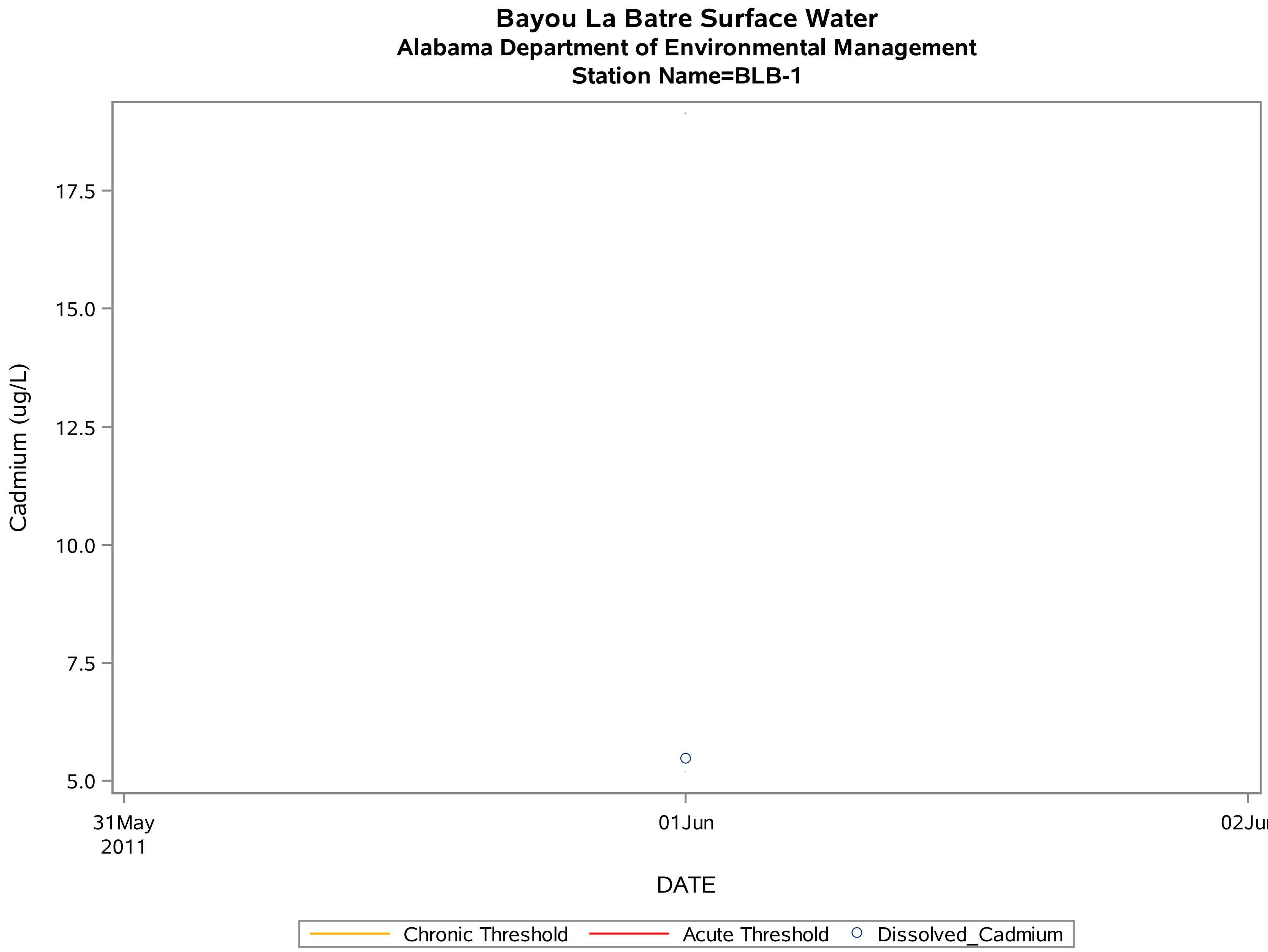

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=BLBM-4
0.0
-0.5
-1.0
-1.5
-2.0
Water Depth (m)
4
5
6
7
8
9
10
pH

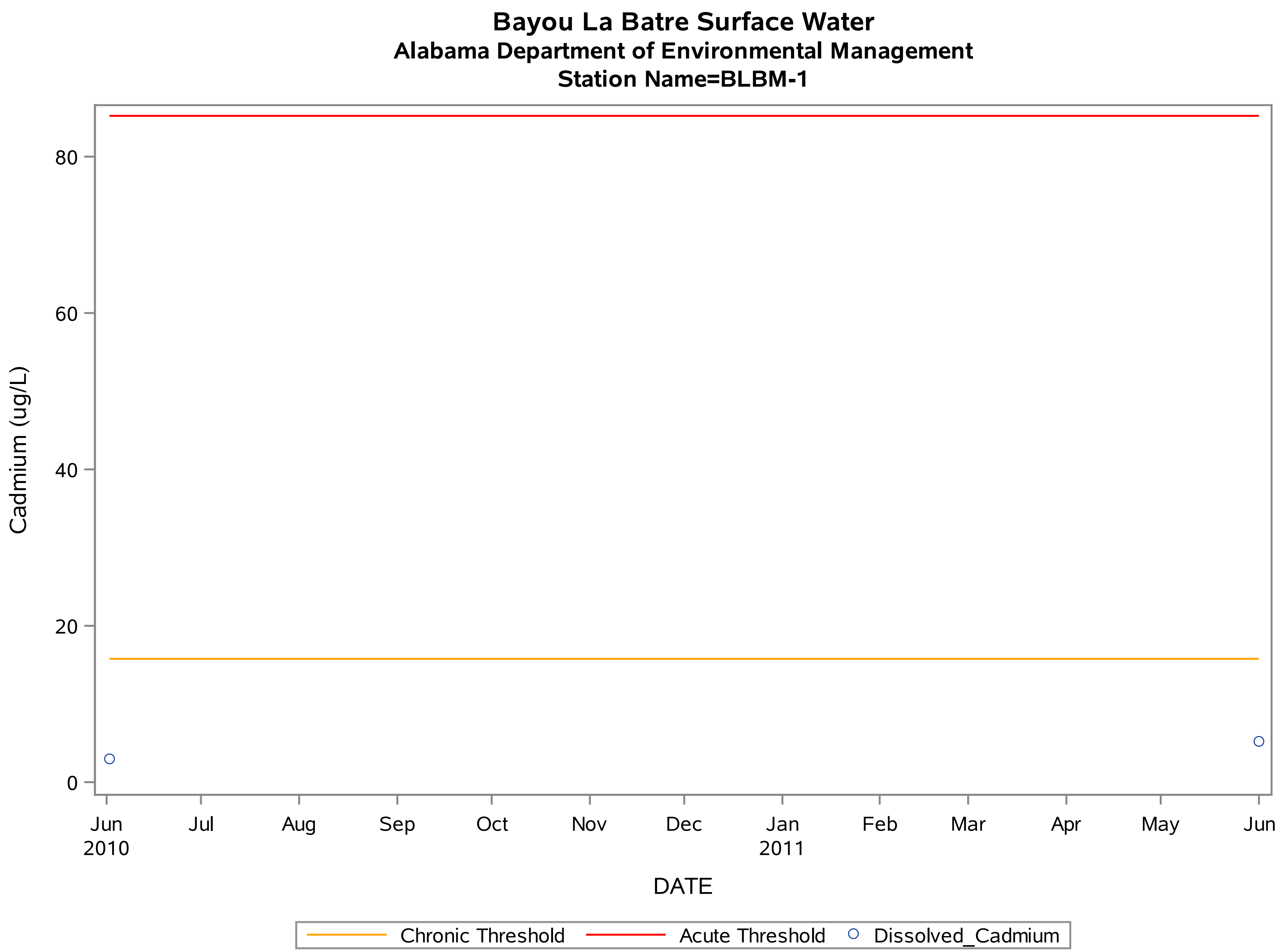

Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=HMC-1
-0.6
-0.8
-1.0
-1.2
Water Depth (m)
4
5
6
7
8
9
10
pH

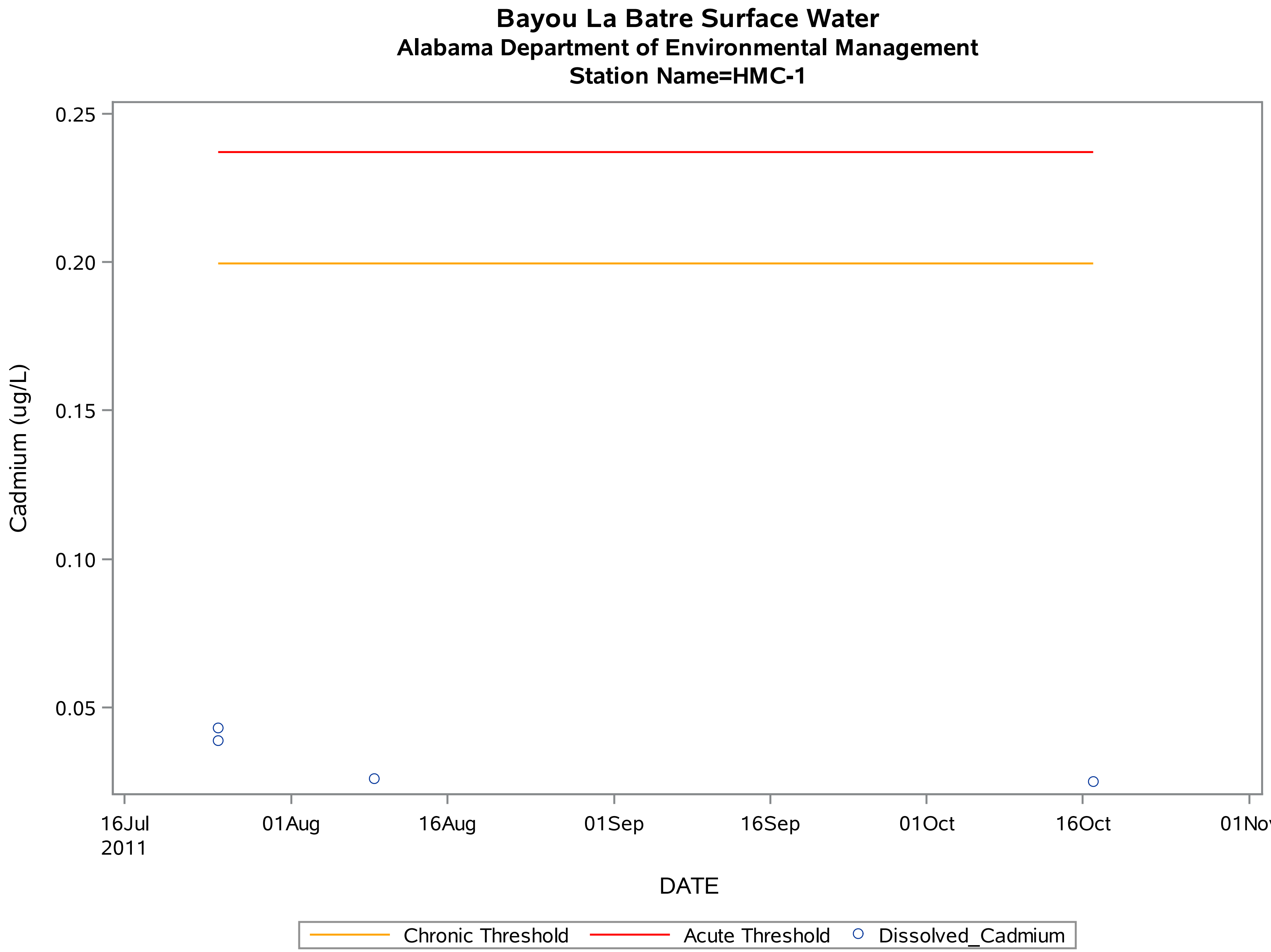
Bayou La Batre Profile
Alabama Department of Environmental Management
Station Name=HMC-2

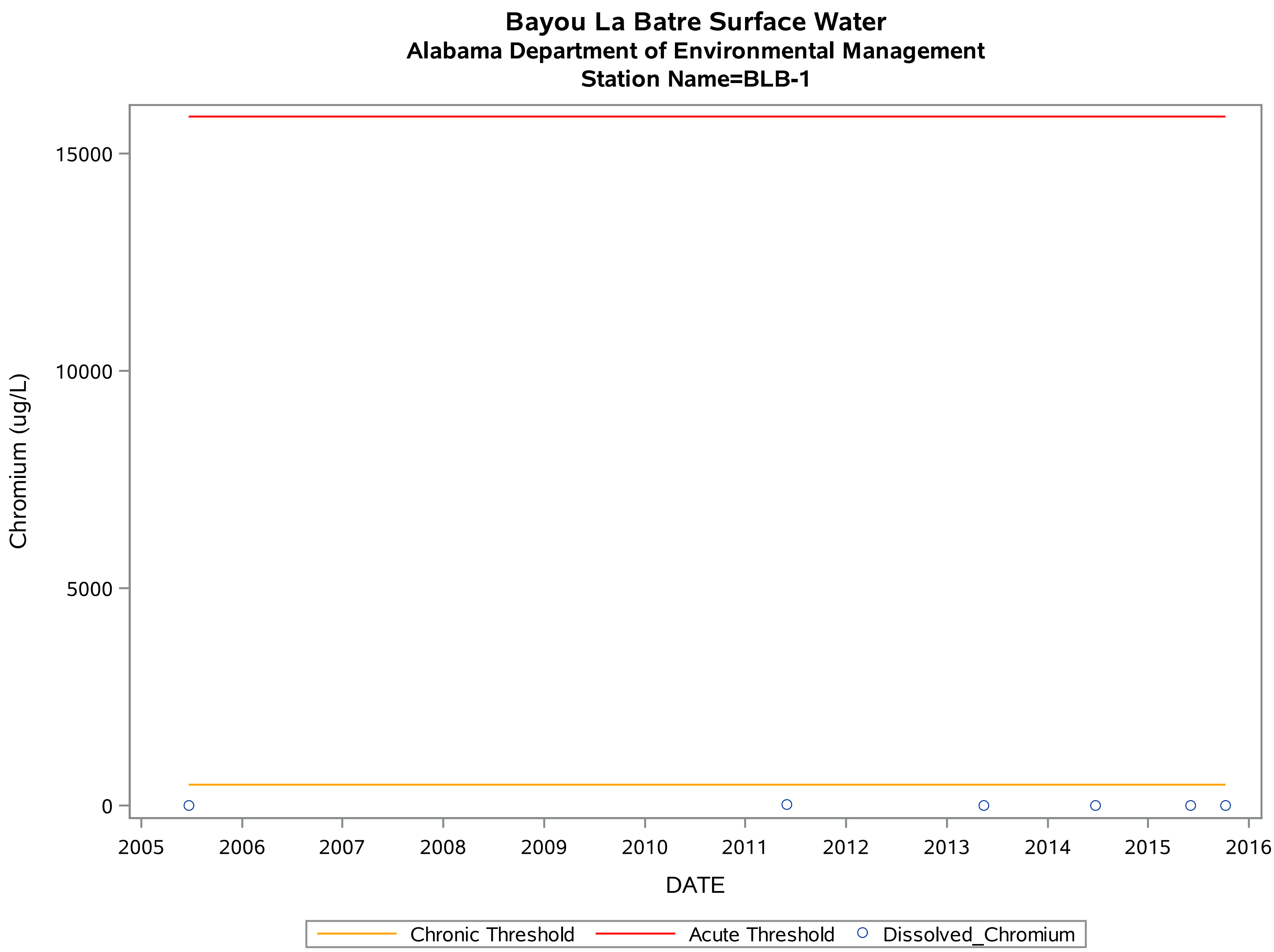


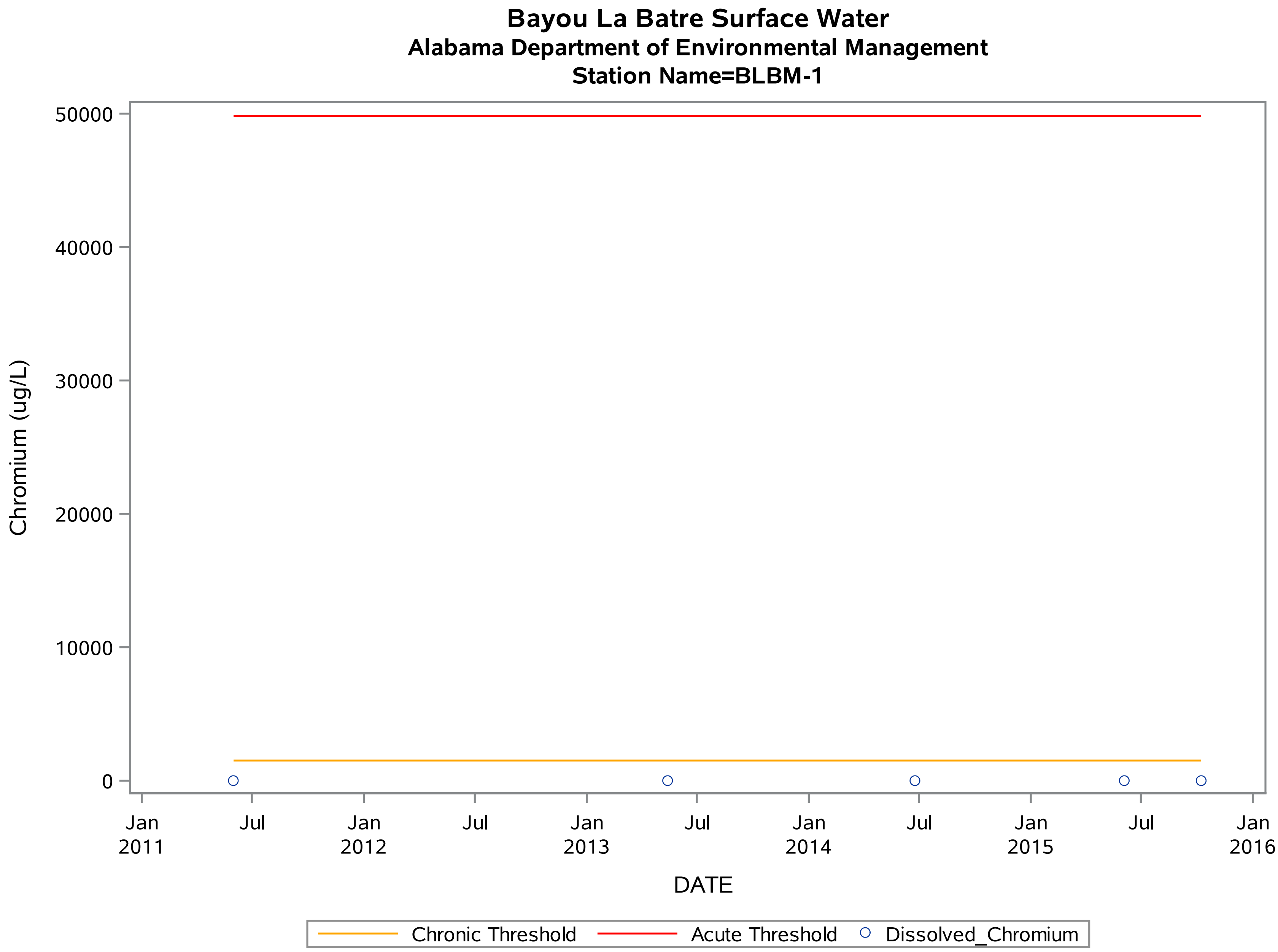
Bayou La Batre Surface Water
Alabama Department of Environmental Management
Enterococcus (MPN)
1000
700
500
300
200
100
10
1
Fish and Wildlife Coastal Maximum
Swimming Coastal Maximum
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
DATE
Station Name
BBM-1
BBM-3
BBM-5
BBM-6
BBM-9
BLB-1
BLBM-1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

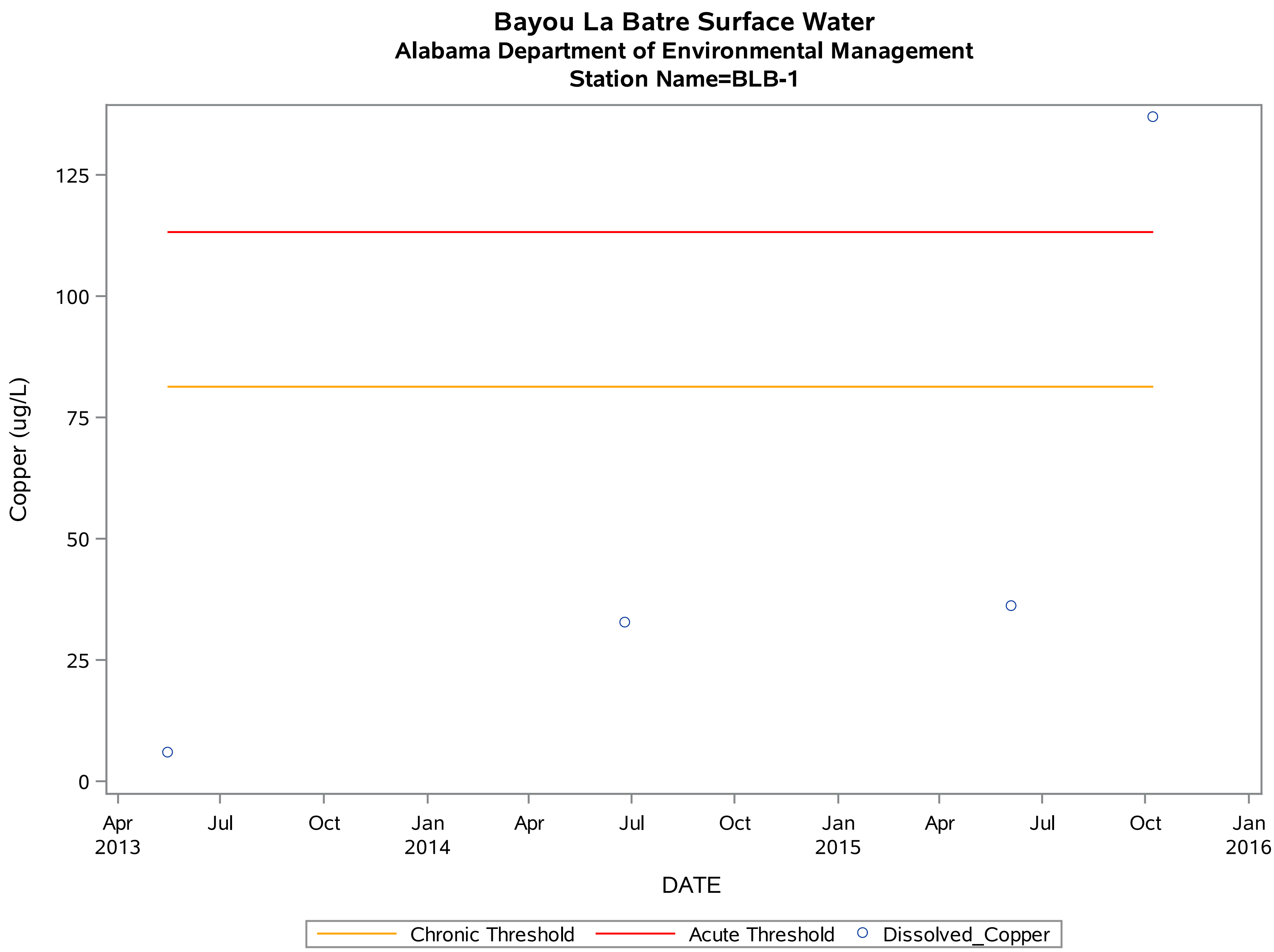

Bayou La Batre Surface Water
Alabama Department of Environmental Management
Station Name=BLB-1
Cadmium (ug/L)
17.5
15.0
12.5
10.0
7.5
5.0
31May
2011
01Jun
02Jun
DATE
Chronic Threshold
Acute Threshold
Dissolved_Cadmium

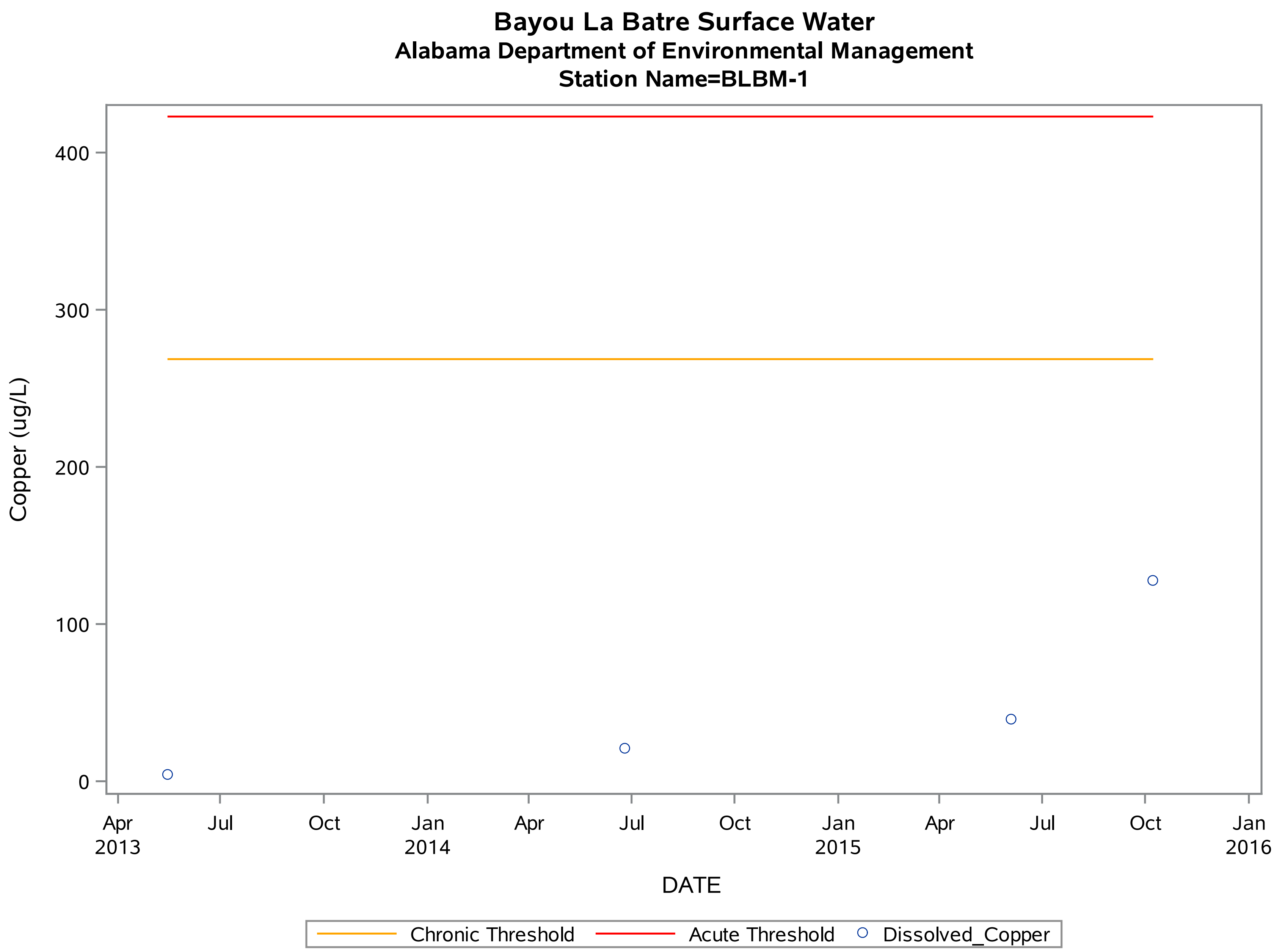

Bayou La Batre Surface Water
Alabama Department of Environmental Management
Station Name=BLBM-1
Cadmium (ug/L)
80
60
40
20
0
Jun
2010
Jul
Aug
Sep
Oct
Nov
Dec
Jan
2011
Feb
Mar
Apr
May
Jun
DATE
Chronic Threshold
Acute Threshold
Dissolved_Cadmium

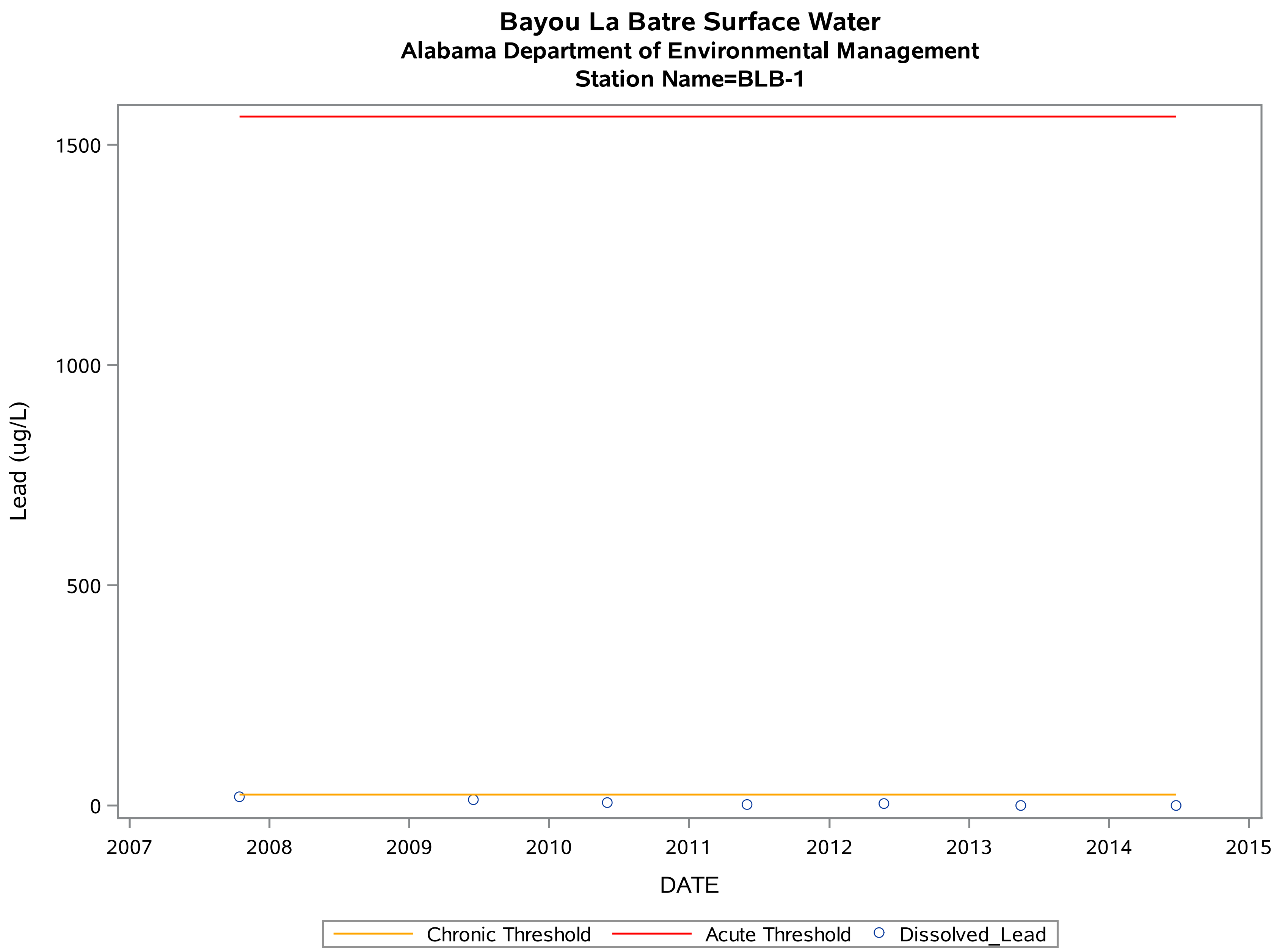

Bayou La Batre Surface Water
Alabama Department of Environmental Management
Station Name=HMC-1
0.25
0.20
0.15
0.10
0.05
Cadmium (ug/L)
16Jul
2011
01Aug
16Aug
01Sep
16Sep
01Oct
16Oct
01Nov
DATE
Chronic Threshold
Acute Threshold
Dissolved_Cadmium


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

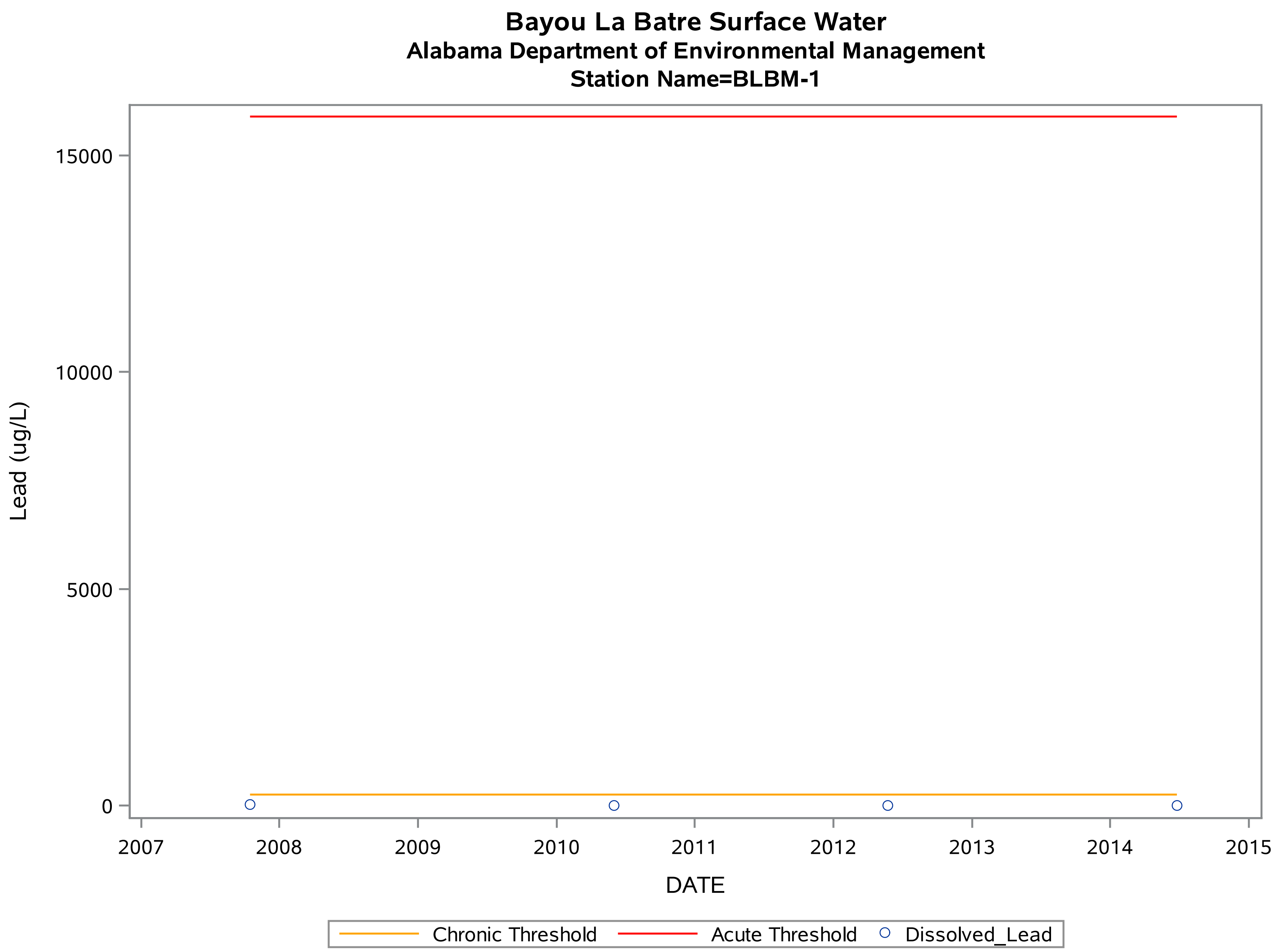

Bayou La Batre Surface Water
Alabama Department of Environmental Management
Station Name=BLBM-1
Chromium (ug/L)
50000
40000
30000
20000
10000
0
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
DATE
Chronic Threshold
Acute Threshold
Dissolved_Chromium


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

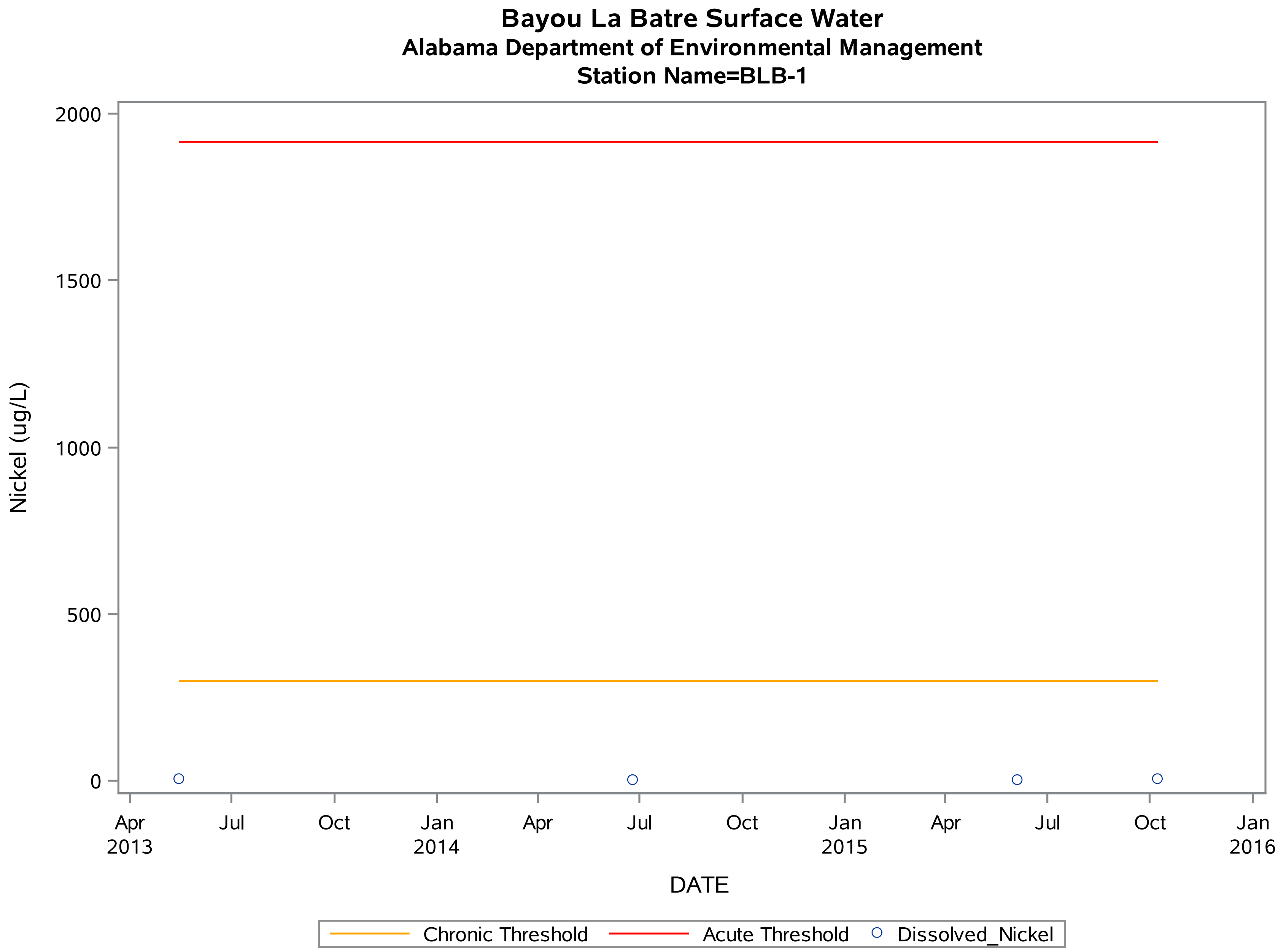

Bayou La Batre Surface Water
Alabama Department of Environmental Management
Station Name=BLBM-1
Copper (ug/L)
400
300
200
100
0
Apr 2013
Jul
Oct
Jan 2014
Apr
Jul
Oct
Jan 2015
Apr
Jul
Oct
Jan 2016
DATE
Chronic Threshold
Acute Threshold
Dissolved_Copper



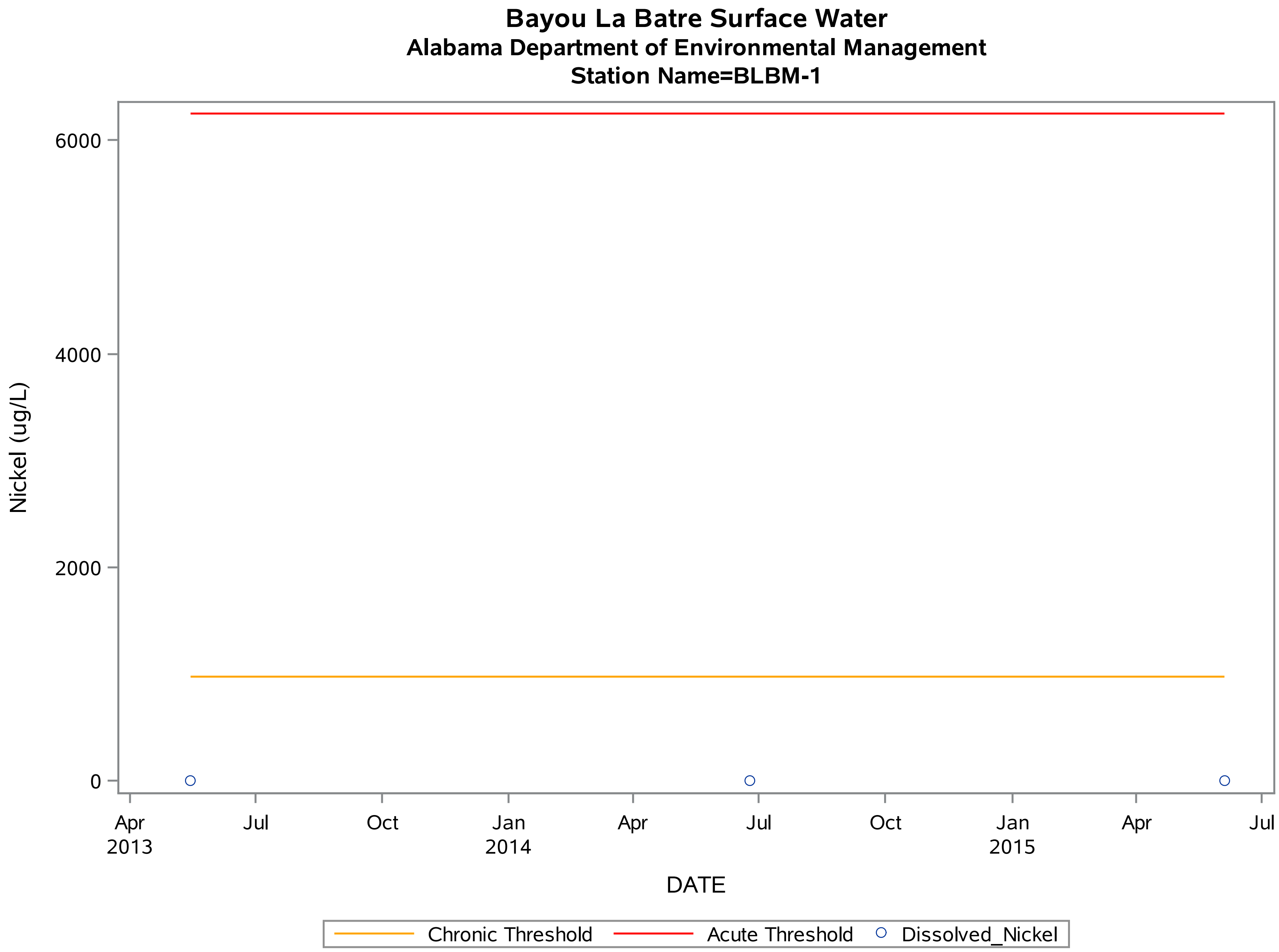
Bayou La Batre Surface Water
Alabama Department of Environmental Management
Station Name=BLB-1
Lead (ug/L)
1500
1000
500
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
DATE
Chronic Threshold
Acute Threshold
Dissolved_Lead

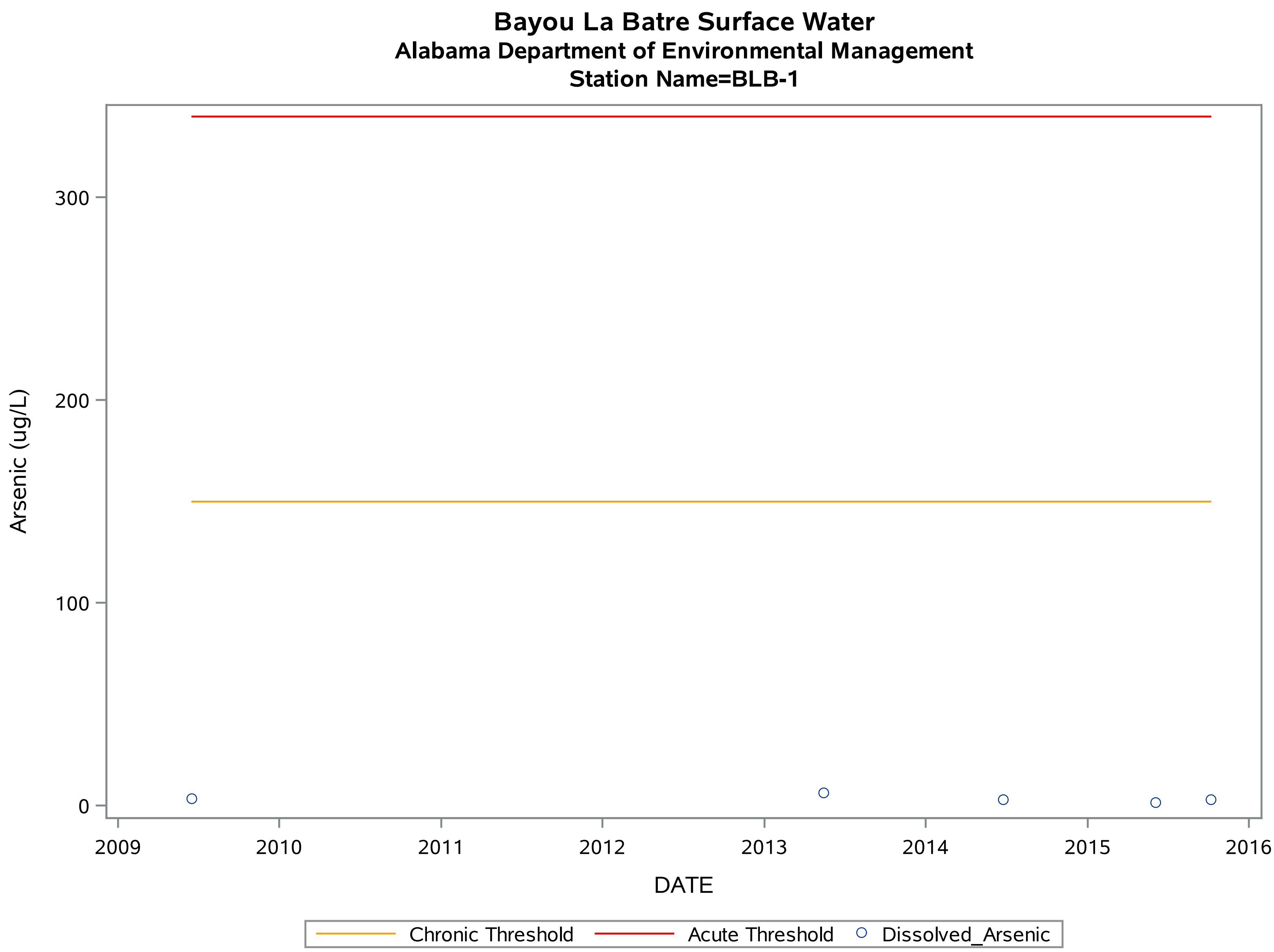


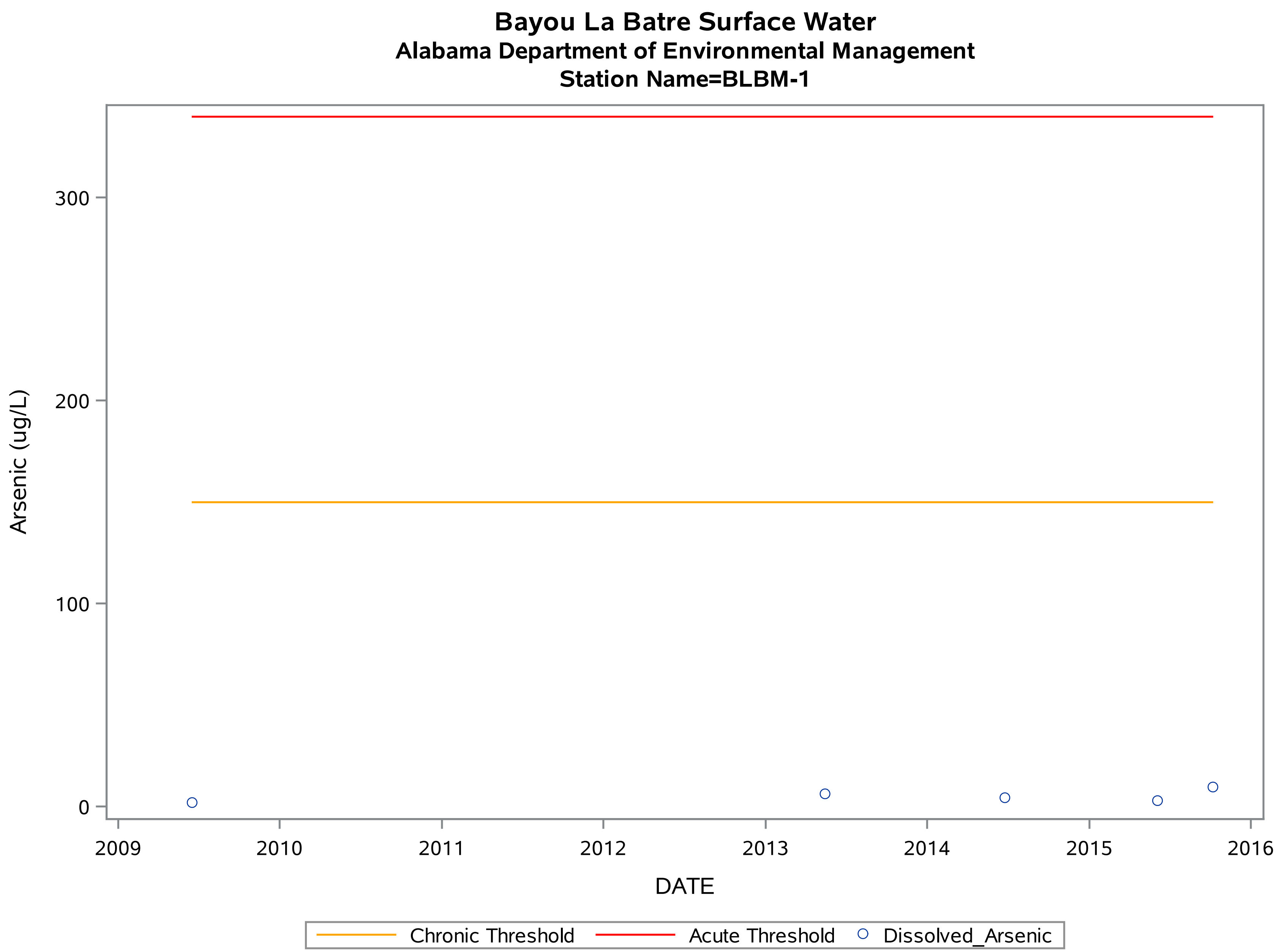
Bayou La Batre Surface Water
Alabama Department of Environmental Management
Station Name=BLBM-1
Lead (ug/L)
15000
10000
5000
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
DATE
Chronic Threshold
Acute Threshold
Dissolved_Lead

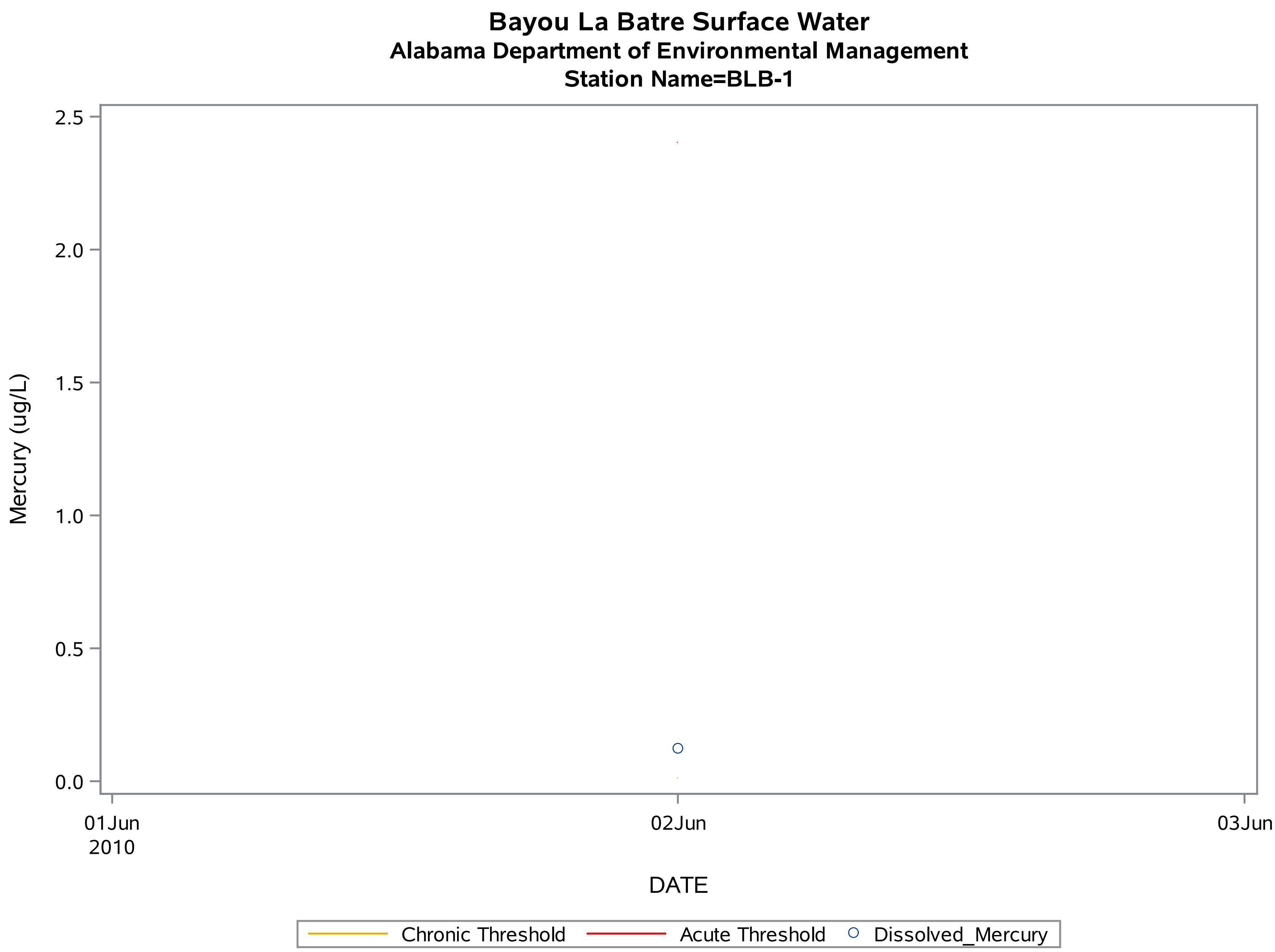


Bayou La Batre Surface Water
Alabama Department of Environmental Management
Station Name=BLB-1
2000
1500
1000
500
0
Nickel (ug/L)
Apr 2013
Jul
Oct
Jan 2014
Apr
Jul
Oct
Jan 2015
Apr
Jul
Oct
Jan 2016
DATE
Chronic Threshold
Acute Threshold
Dissolved_Nickel

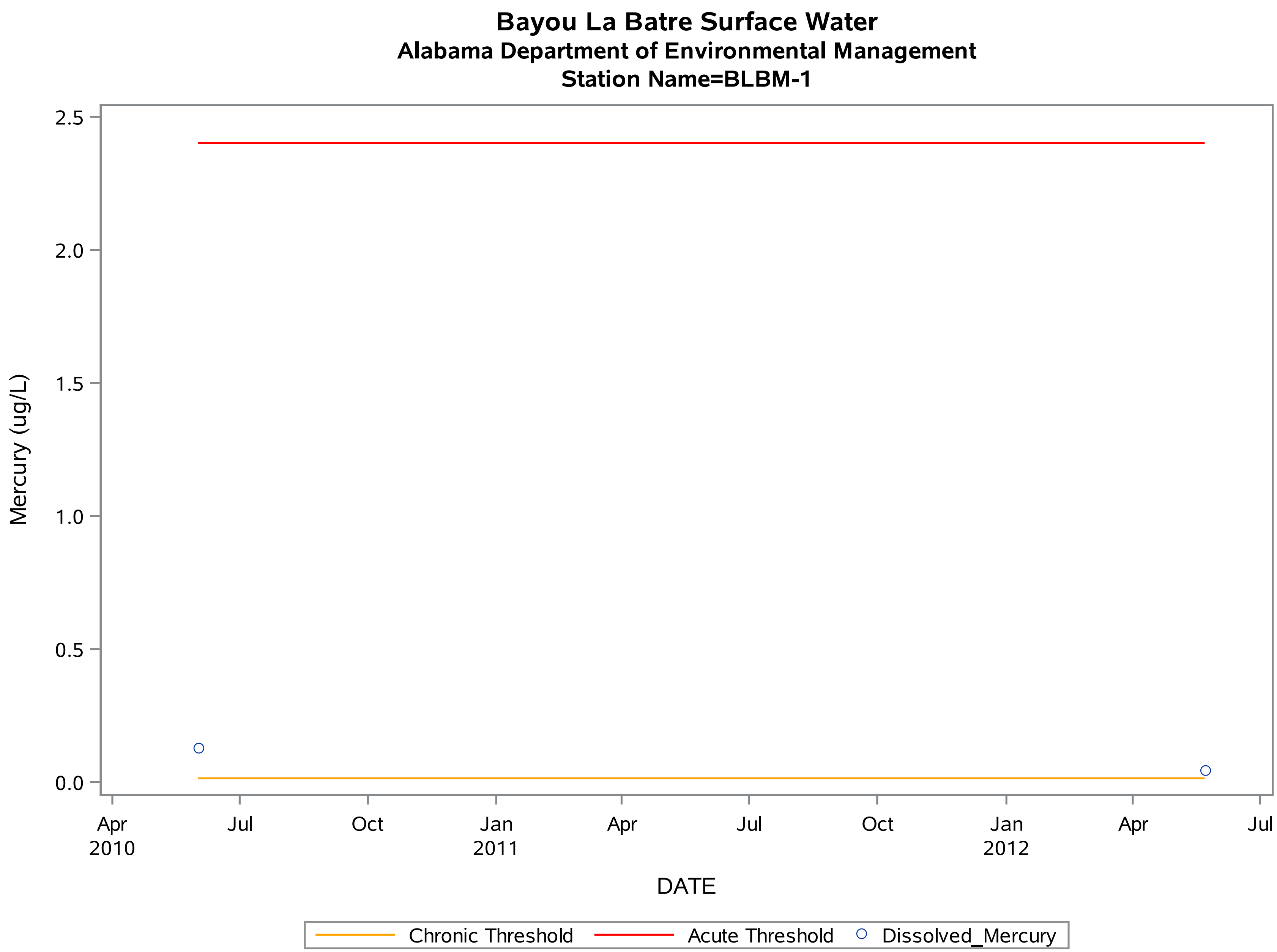

Bayou La Batre Surface Water
Alabama Department of Environmental Management
Station Name=BLBM-1
Nickel (ug/L)
6000
4000
2000
0
Apr 2013
Jul
Oct
Jan 2014
Apr
Jul
Oct
Jan 2015
Apr
Jul
DATE
Chronic Threshold
Acute Threshold
Dissolved_Nickel

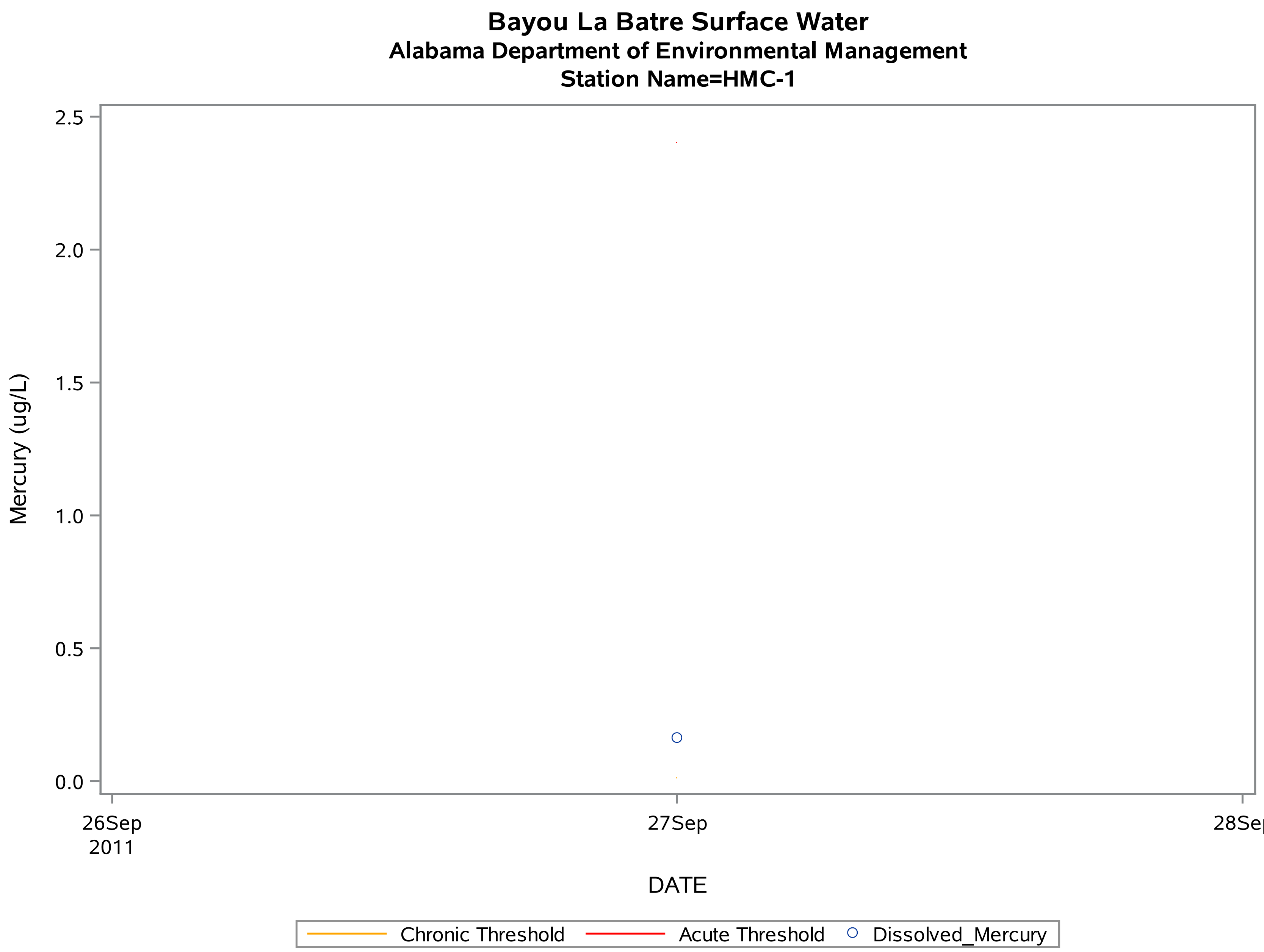

Bayou La Batre Surface Water
Alabama Department of Environmental Management
Station Name=BLB-1
Arsenic (ug/L)
300
200
100
0
2009
2010
2011
2012
2013
2014
2015
2016
DATE
Chronic Threshold
Acute Threshold
Dissolved_Arsenic


Bayou La Batre Surface Water
Alabama Department of Environmental Management
Station Name=BLBM-1
Arsenic (ug/L)
300
200
100
0
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	Comp*	Grab			Preservation* / # of Containers	Enterococci (NaThio P-1)	Fecal (NaThio P-1)	E.Coli							
BLB 1	12/16	9:45am		✓				X	X	X							
BLB 2	12/16	10:30		✓				X	X	X							
BLB 3	12/16	11:15		✓				X	X	X							
BLB 4	12/16	11:35		✓				X	X	X							
BLB 5	12/16	12		✓				X	X	X							

Analysis Requested

*Preservation Types: Ice, H2SO4, HNO3, HCl, NaOH, NaThio, Other, None
Bottle: G-Glass, P-Plastic

Relinquished by: [signature] Sign	Date/Time: 12/16/2015 1400	Received by: Dylan Bakke 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
Shipper Tracking Number:

Seals Intact: Yes No N/A Initials: DCB
Sample Temp: ICE deg C Initials: DCB

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

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

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

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

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

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

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

Project Name: Bayou La Batre Bay Sampling
ETS Sample ID: 151216O004
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	> 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

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

Date/Time collected: 12/16/15 12:00
Sampled by: Sampler, Client
Sample type: Grab
Customer ID: B1B5
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	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							
BIB 1	12/16	9:45am		✓		X	X	X							
BIB2	12/16	10:30		✓		X	X	X							
BIB3	12/16	11:15		✓		X	X	X							
BIB4	12/16	11:35		✓		X	X	X							
BIB5	12/16	12		✓		X	X	X							

Analysis Requested

*Preservation Types: Ice, H2SO4, HNO3, HCl, NaOH, NaThio, Other, None
Bottle: G-Glass, P-Plastic

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
Were samples properly preserved? Yes No
Seals Intact: Yes No N/A Initials: PCB
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

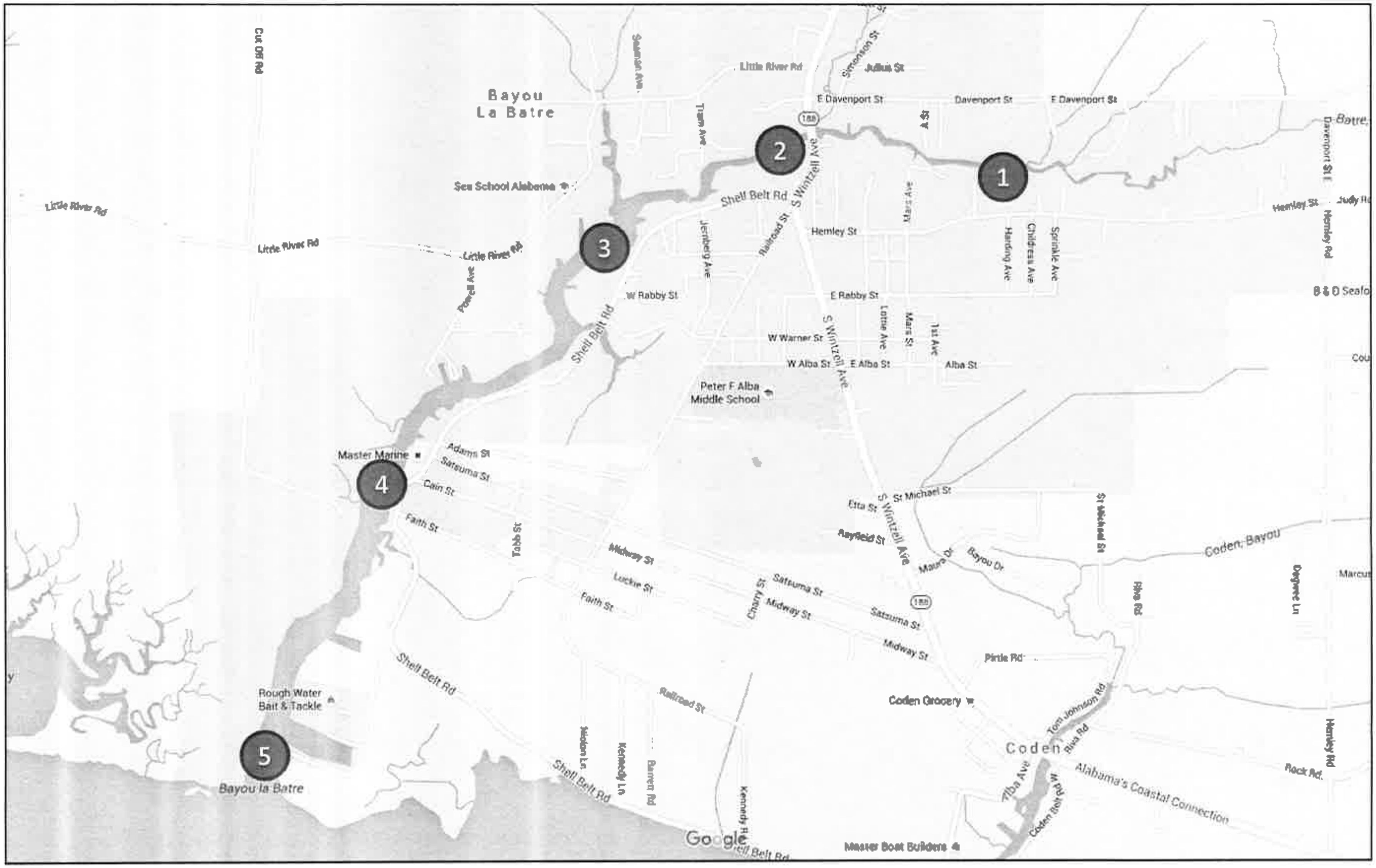
Analysis Requested (see pg. 2)
Mark boxes with "X"

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: "
SAMPLE SITE: BLB
SIGNATURE: [signature]

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™ Species*: B. dorei*

The **Human Bacteroidetes ID™ 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™ 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™ 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™ Species*: B. stercoris*,
Human Bacteroidetes ID™ Species*: B. fragilis,* and
Human Bacteroidetes ID™ 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™: EPA Developed Assay

The **Human Bacteroidetes ID™: 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™: 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™ 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™ Species*: B. dorei*,
Human Bacteroidetes ID™ Species*: B. fragilis,* and
Human Bacteroidetes ID™ 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.

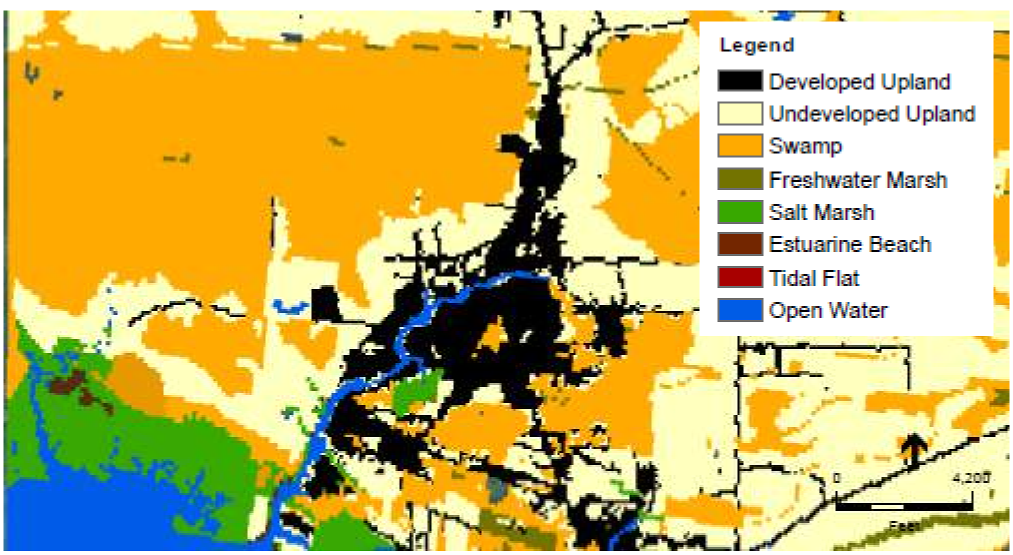
APPENDIX B SLAMM REPORT

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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D150168

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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.

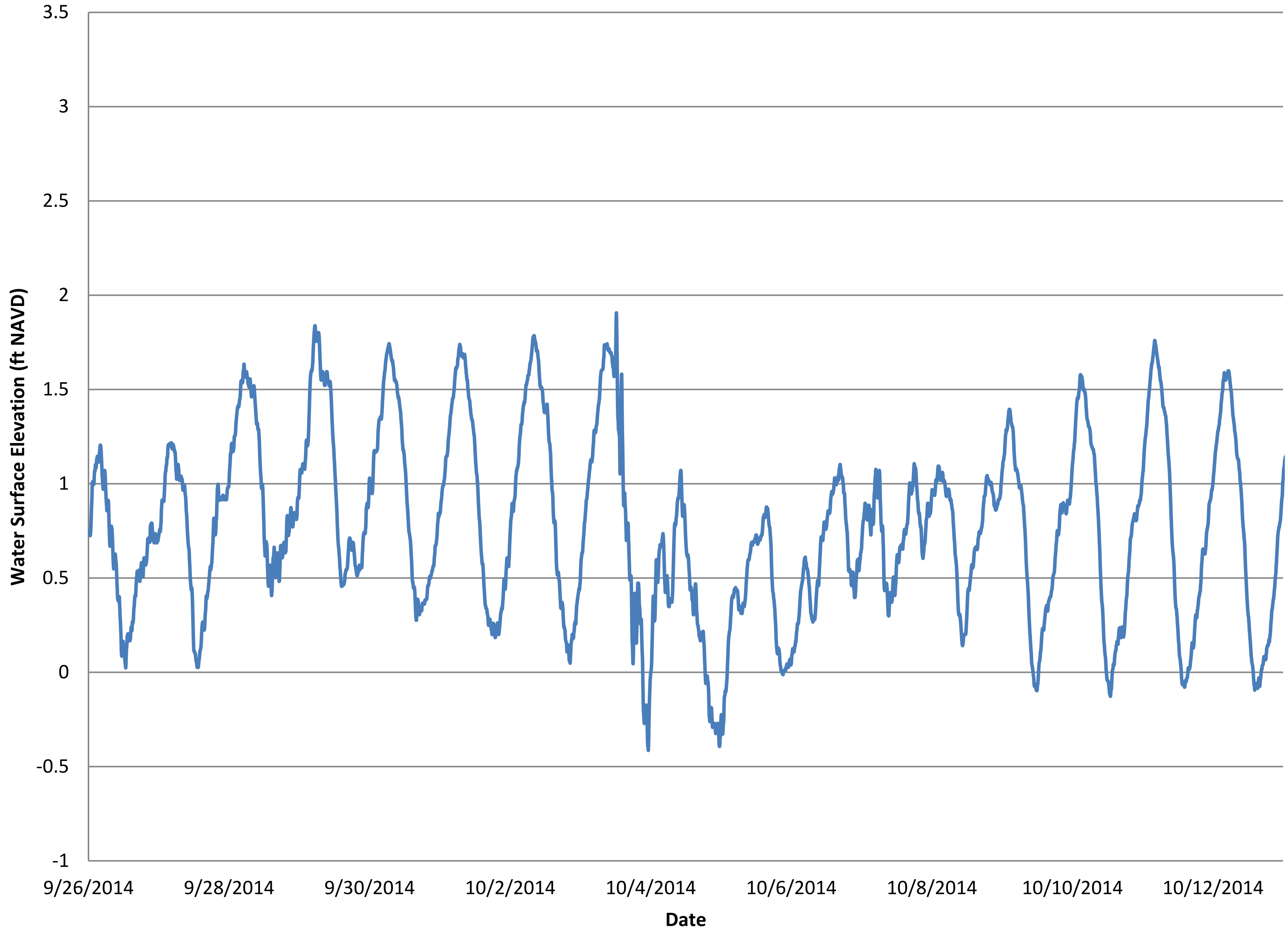
1.1 Tides

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

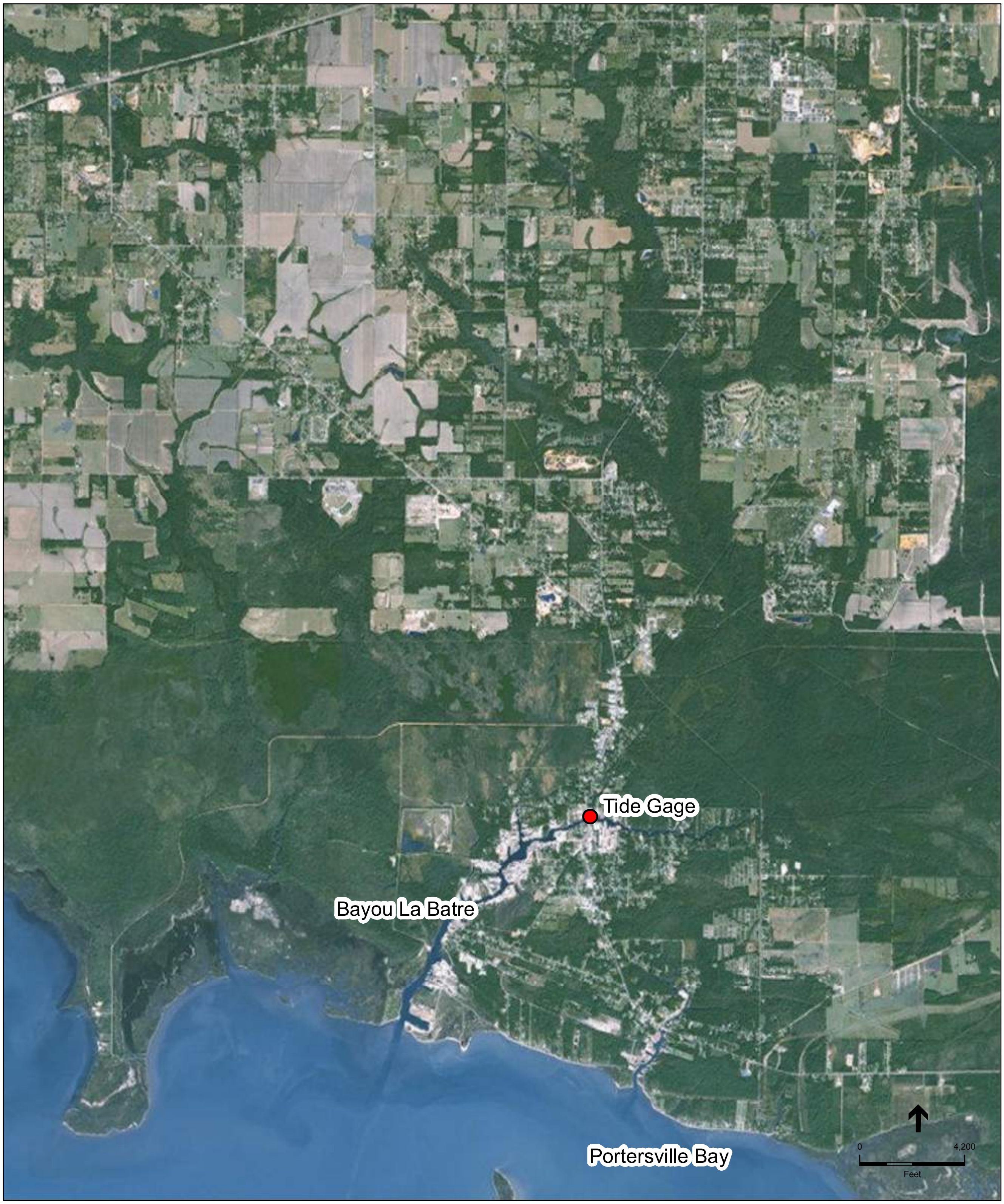


SOURCE: NOAA Bayou La Batre Bridge Gage

Bayou La Batre Watershed Management Plan. D150168

Figure 1

Tide Time Series Sept 26 - Oct12, 2014



SOURCE: ESRI

ESA

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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

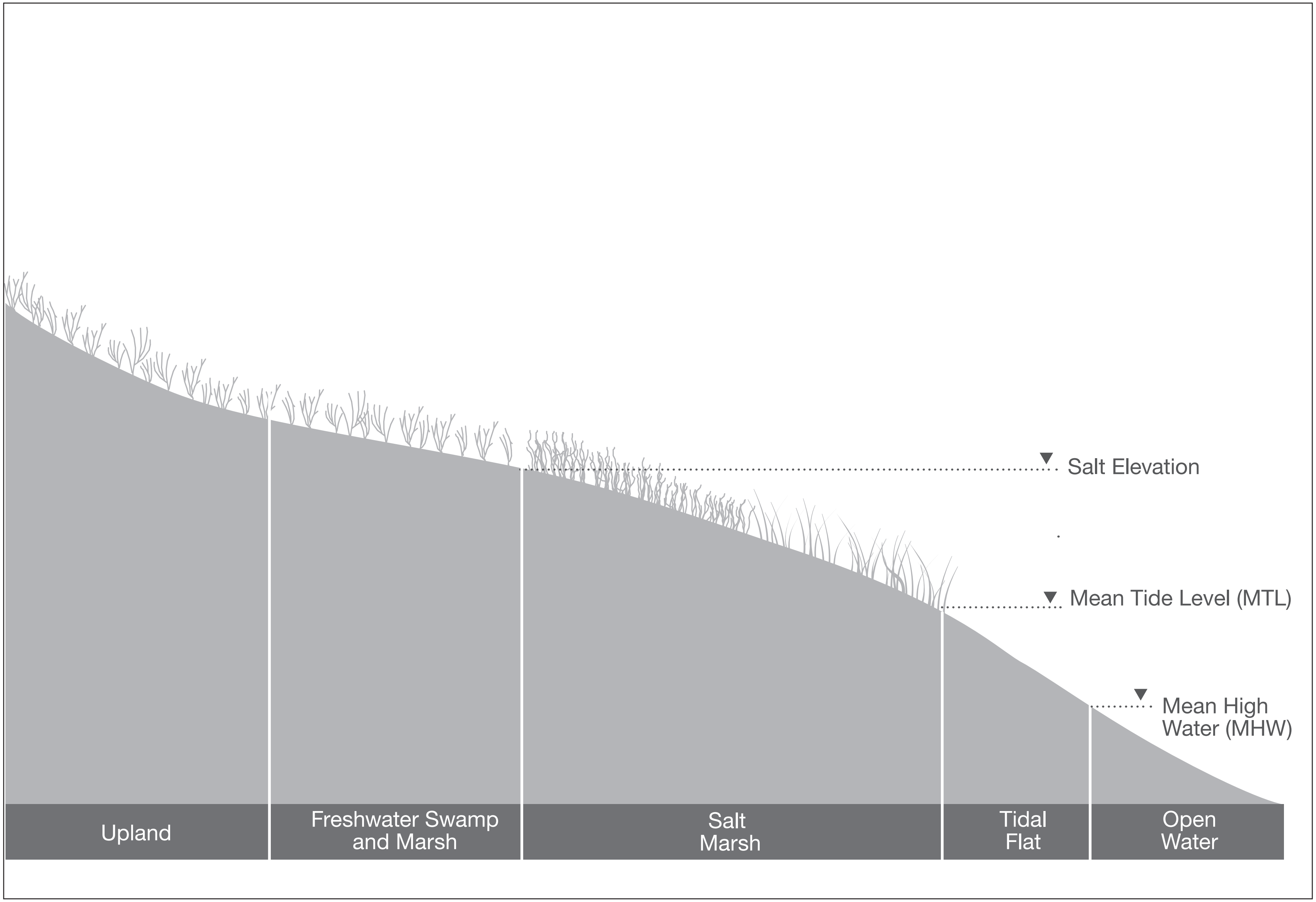
Sea-level rise is expected to be a major driver of habitat evolution at Bayou La Batre. Since most vegetation establishes in specific areas based on the local tidal inundation and salinity, habitats will evolve when the tides rise.

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).



Bayou La Batre Watershed Management Plan . 150168

ESA

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

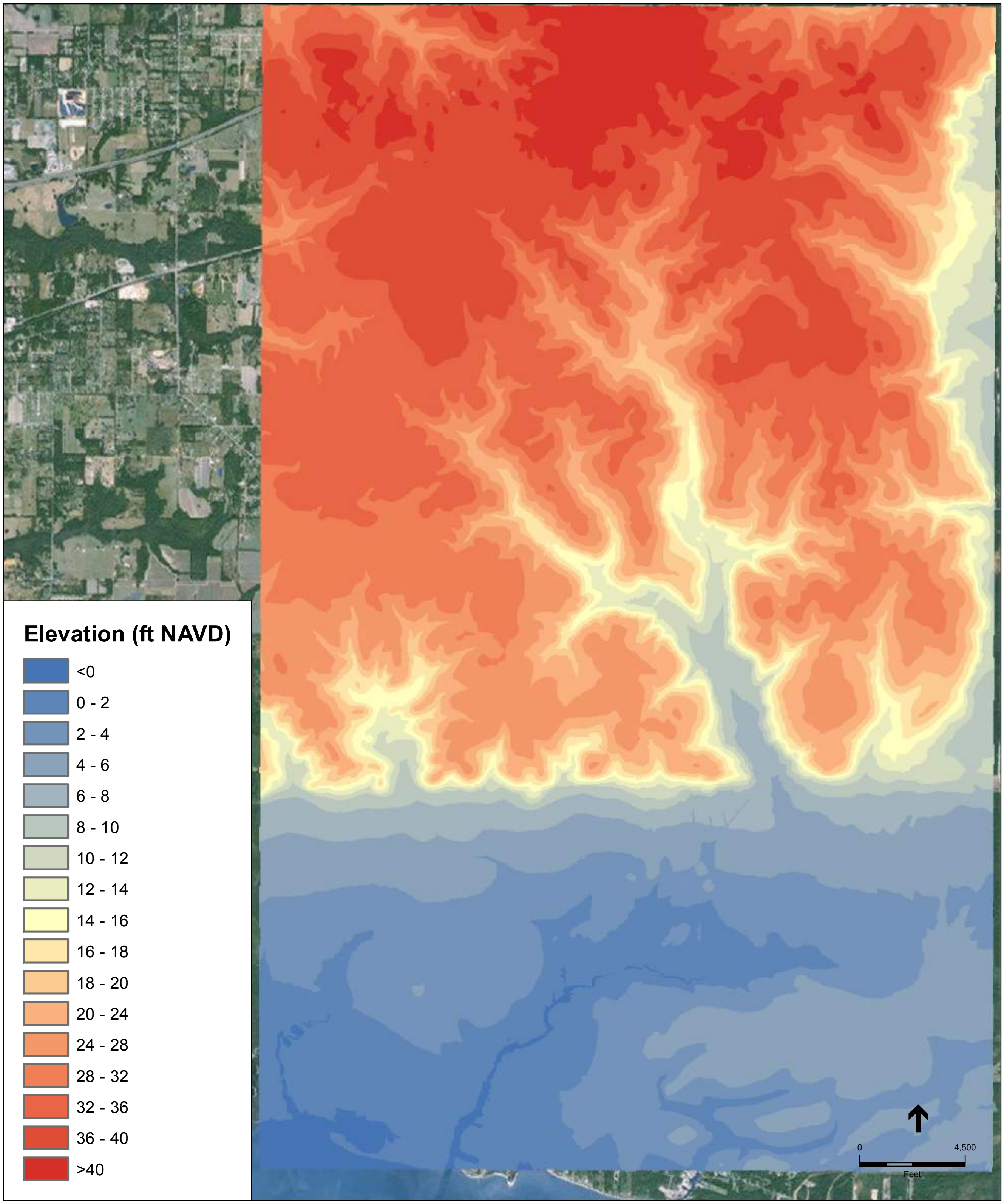
Topography is used in the model as input to the habitat evolution decision tree (see Section 2.2). Figure 4 presents the existing topography of the estuary from the USGS National Elevation Dataset, a 1/3 arc-second resolution DEM dataset from 2013. The resulting topography/bathymetry was converted to 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.”

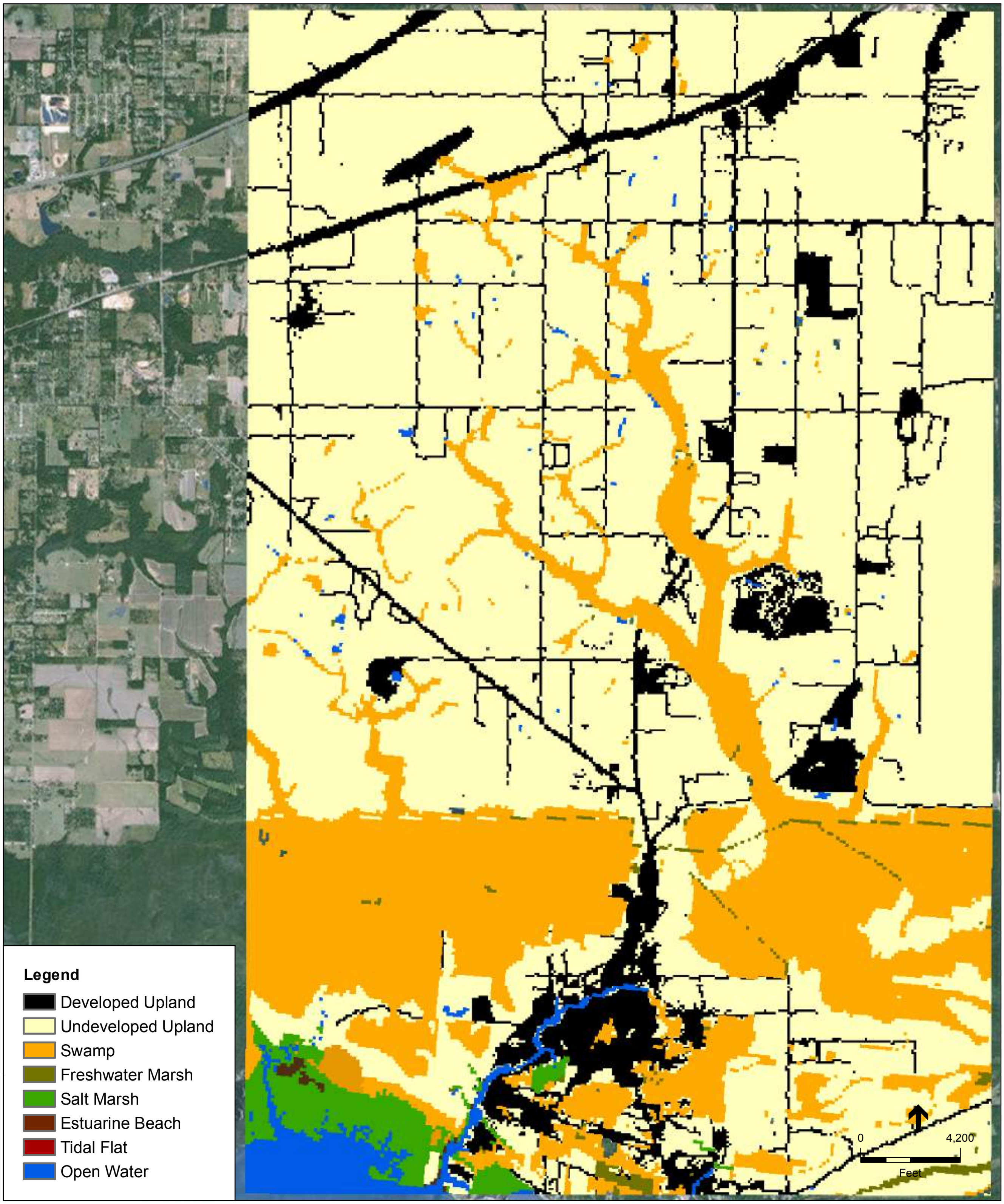


SOURCE: USGS 2013

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] (ac)	2002 Modeled Vegetation[1] (ac)	Difference (ac)	Difference %
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.

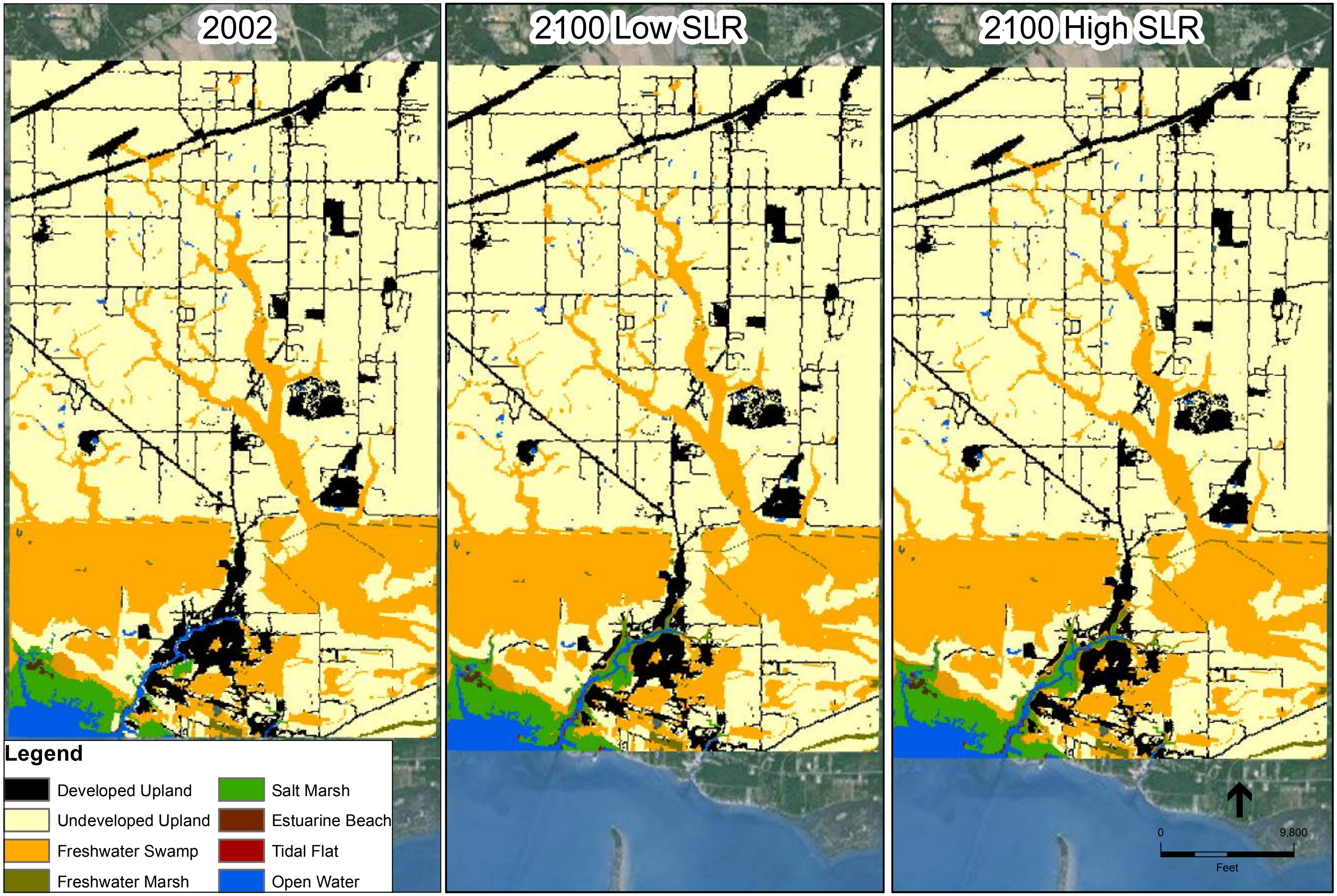
4.2 Sea-Level Rise

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

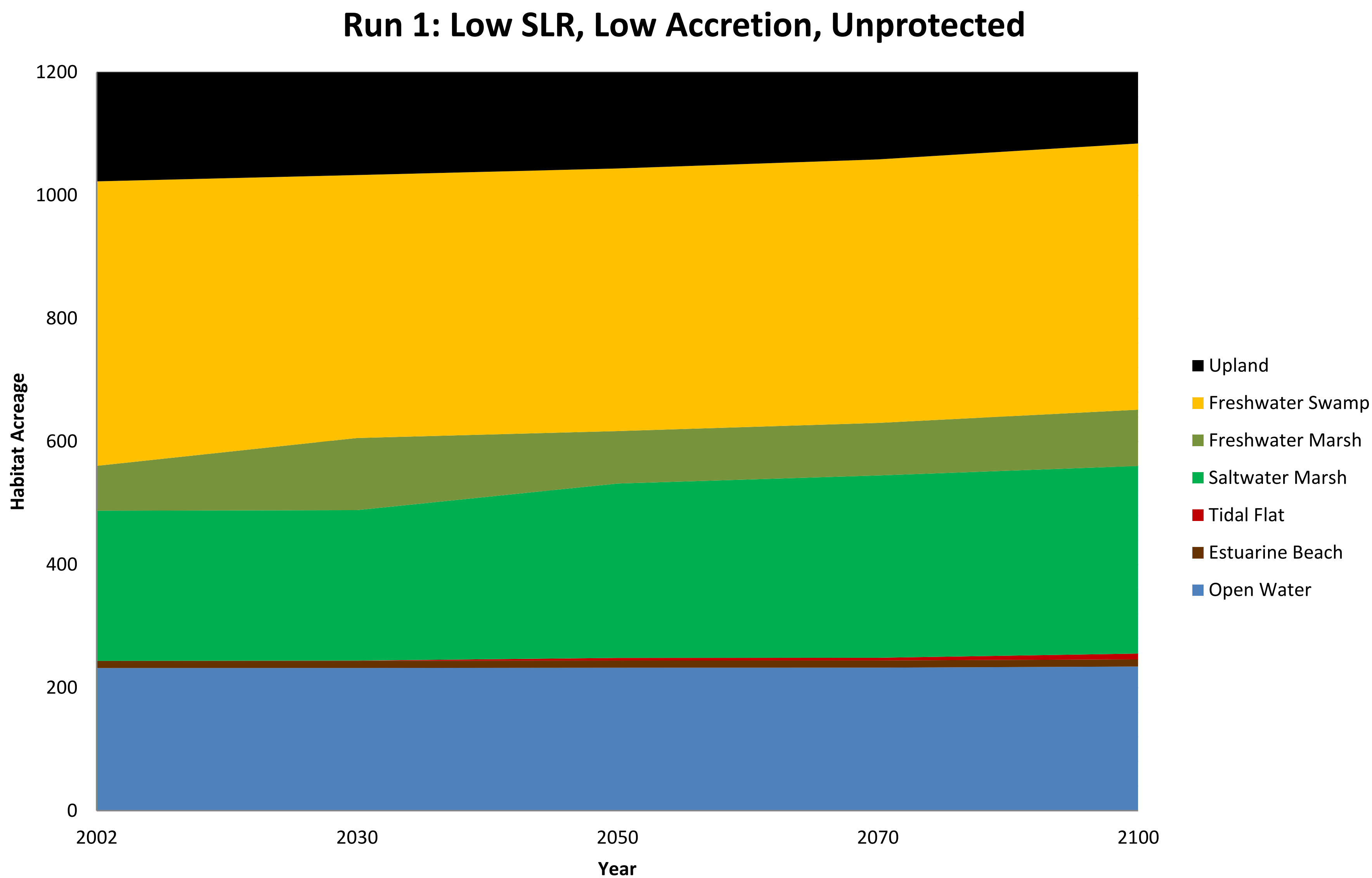


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Figure 7

Run 1 Habitats Over Time

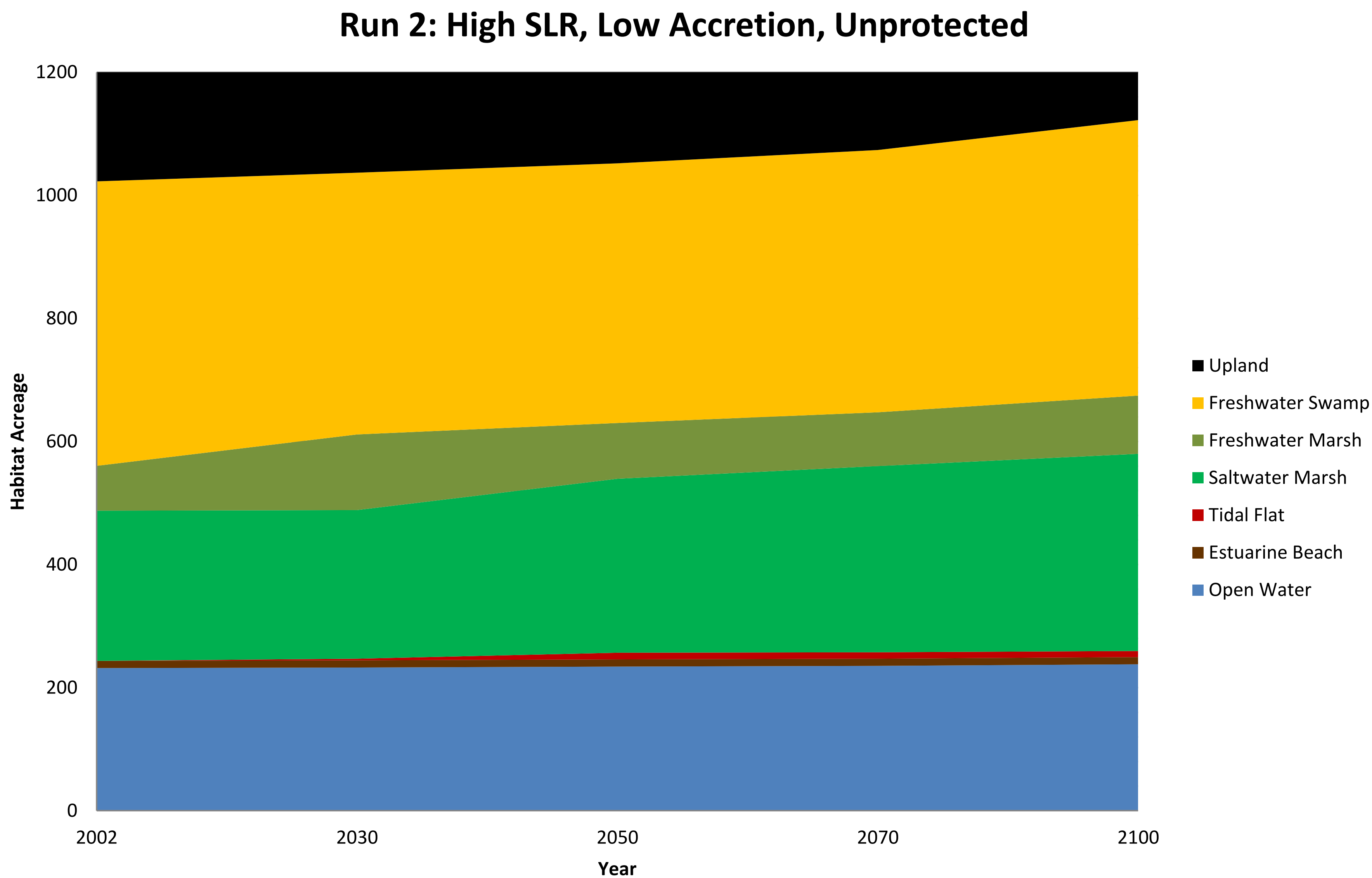

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Figure 8

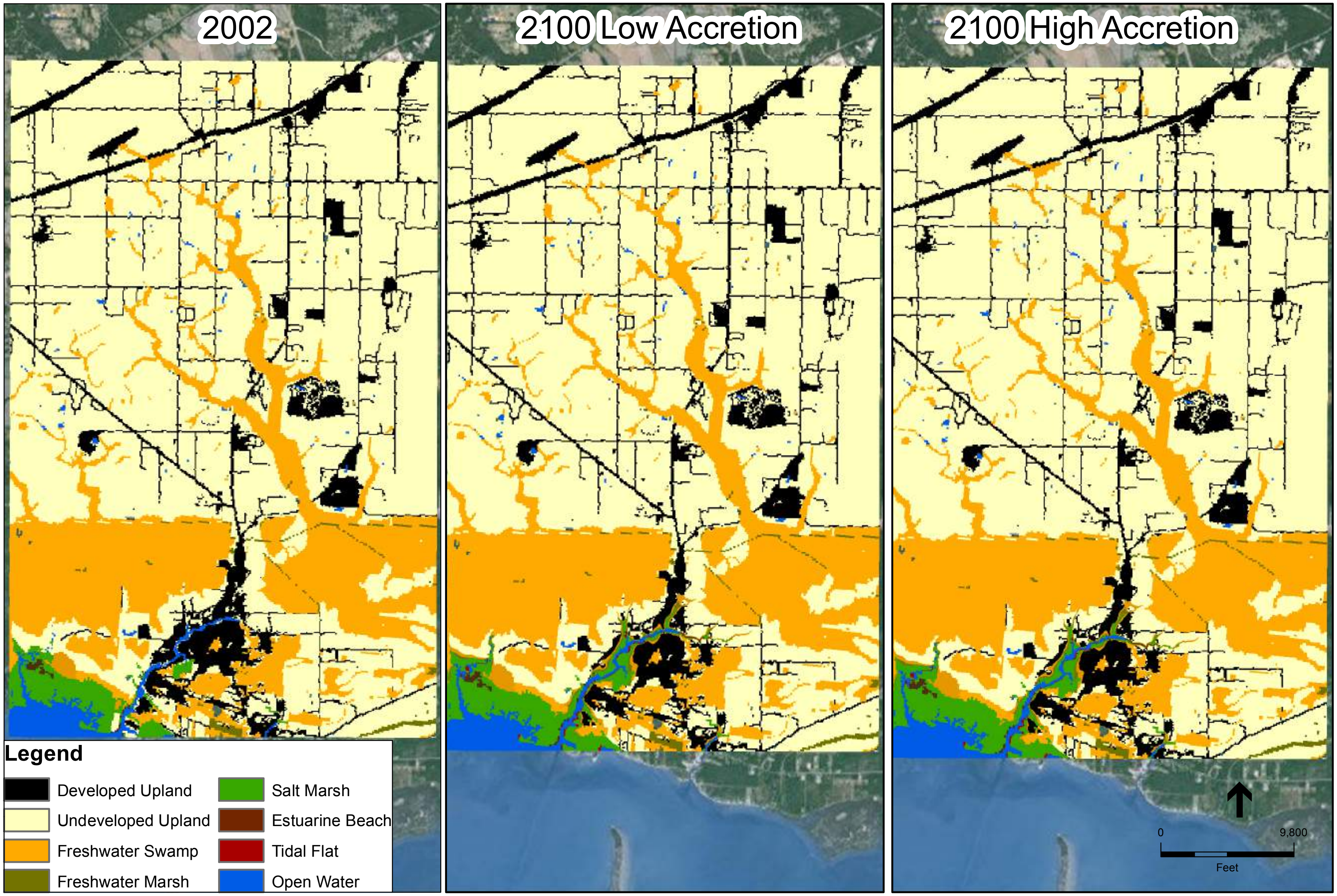
Run 2 Habitats Over Time

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 Run 2 (Low Accretion)	Run 3 (High Accretion)	Difference (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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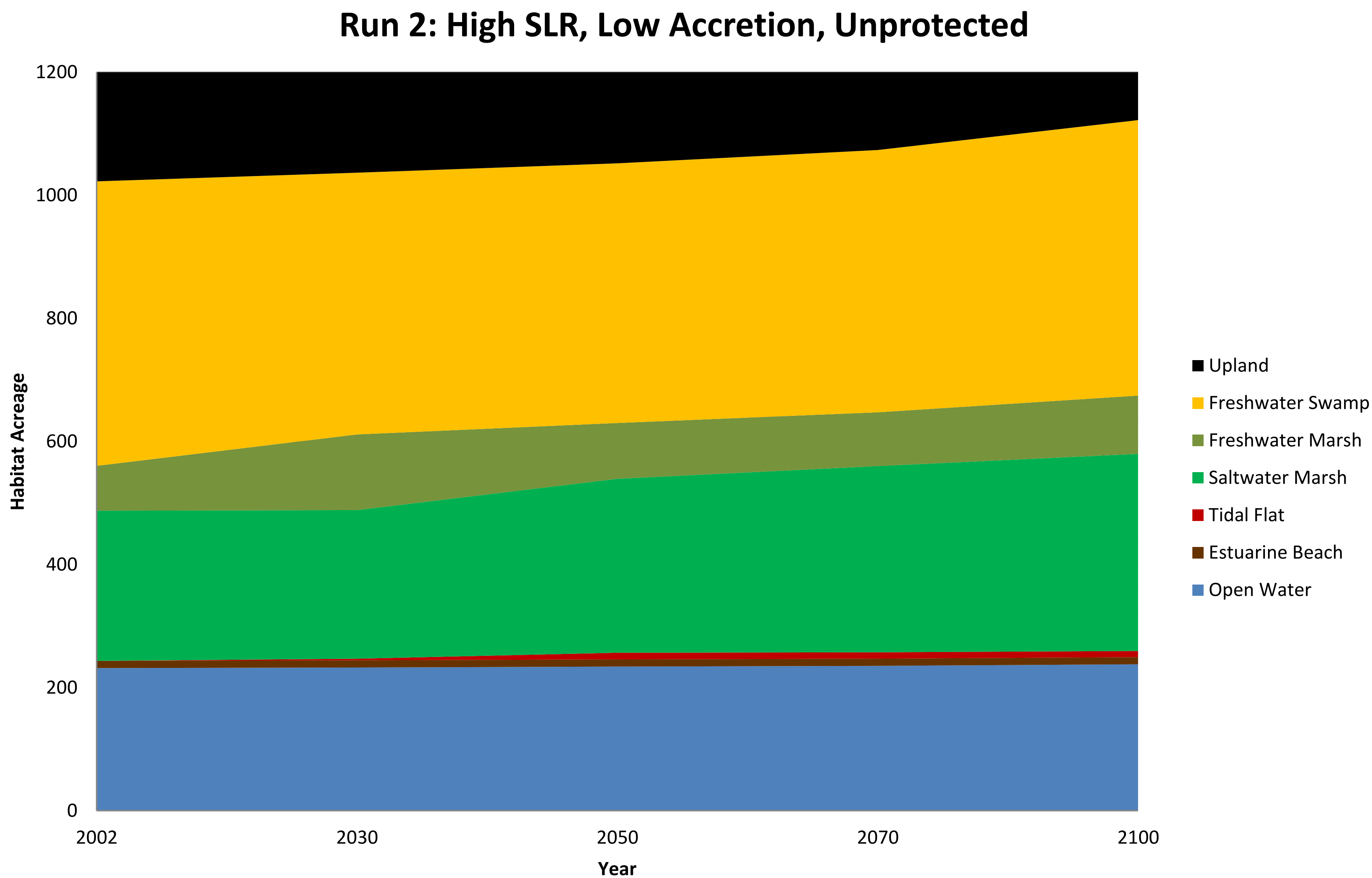
Figure 9

2002 Modeled Vegetation versus Different Accretion Scenarios



Bayou La Batre Watershed Management Plan. 150168

Figure 10

Run 2 Habitats Over Time

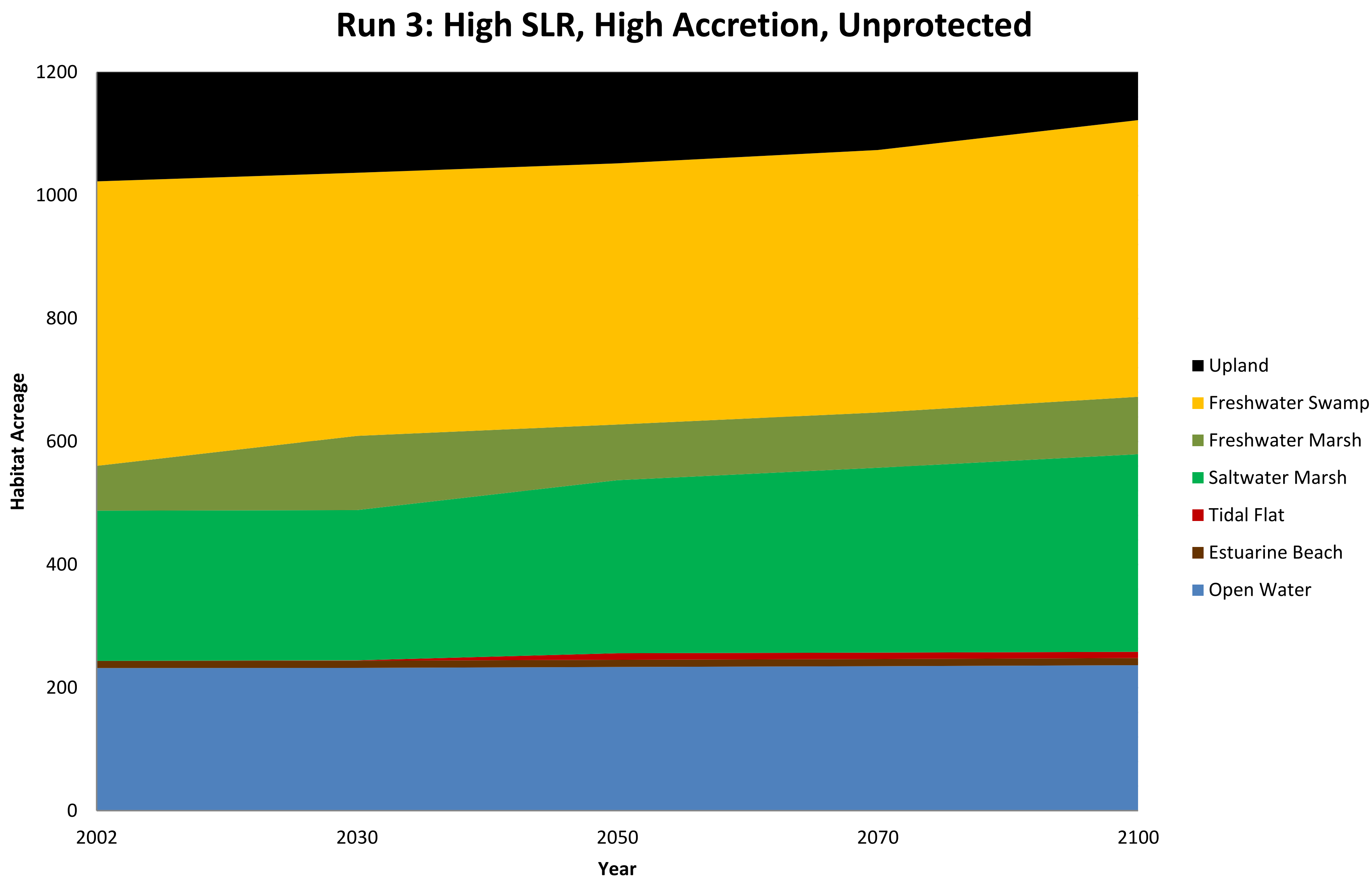


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Figure 11

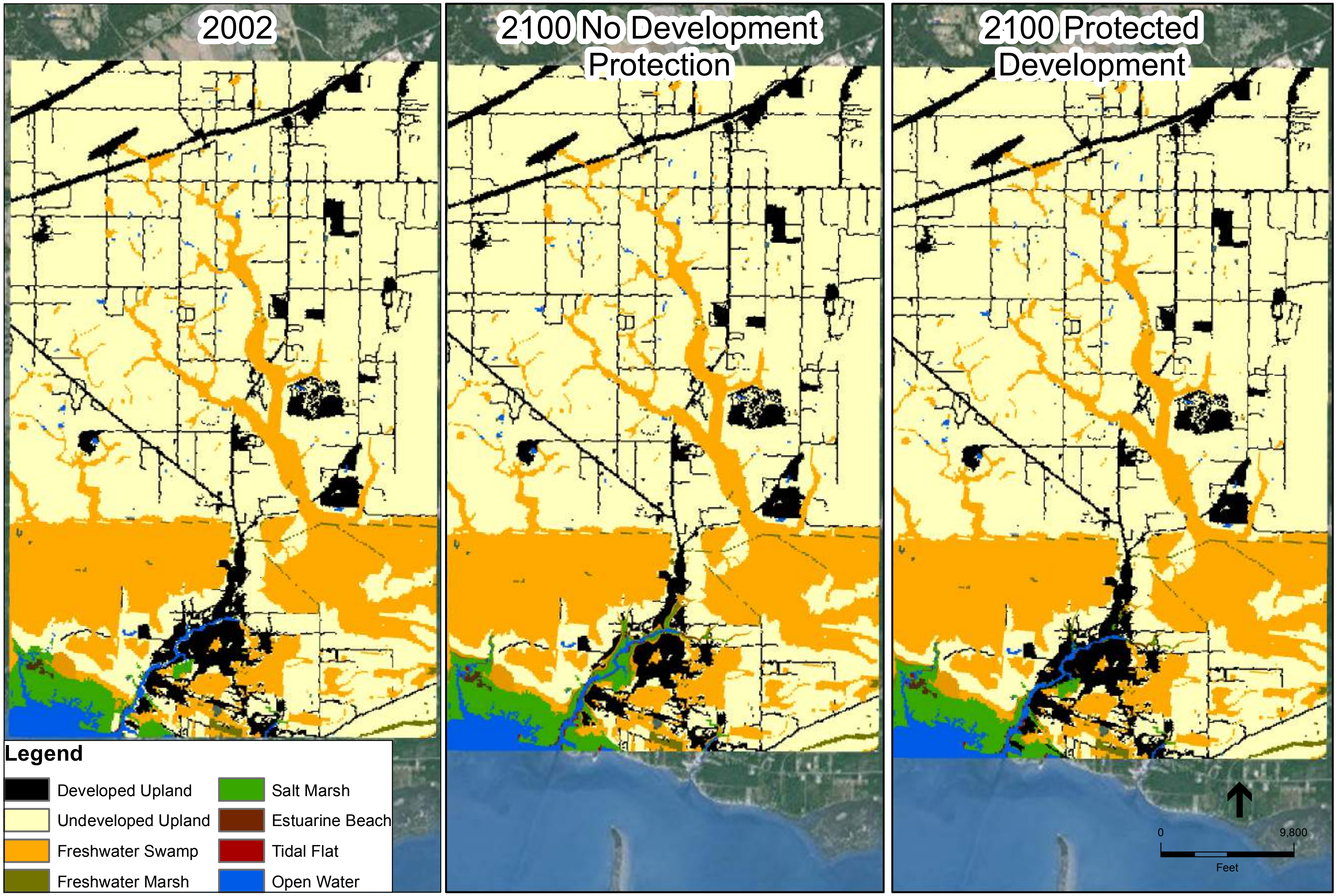
Run 3 Habitats Over Time

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

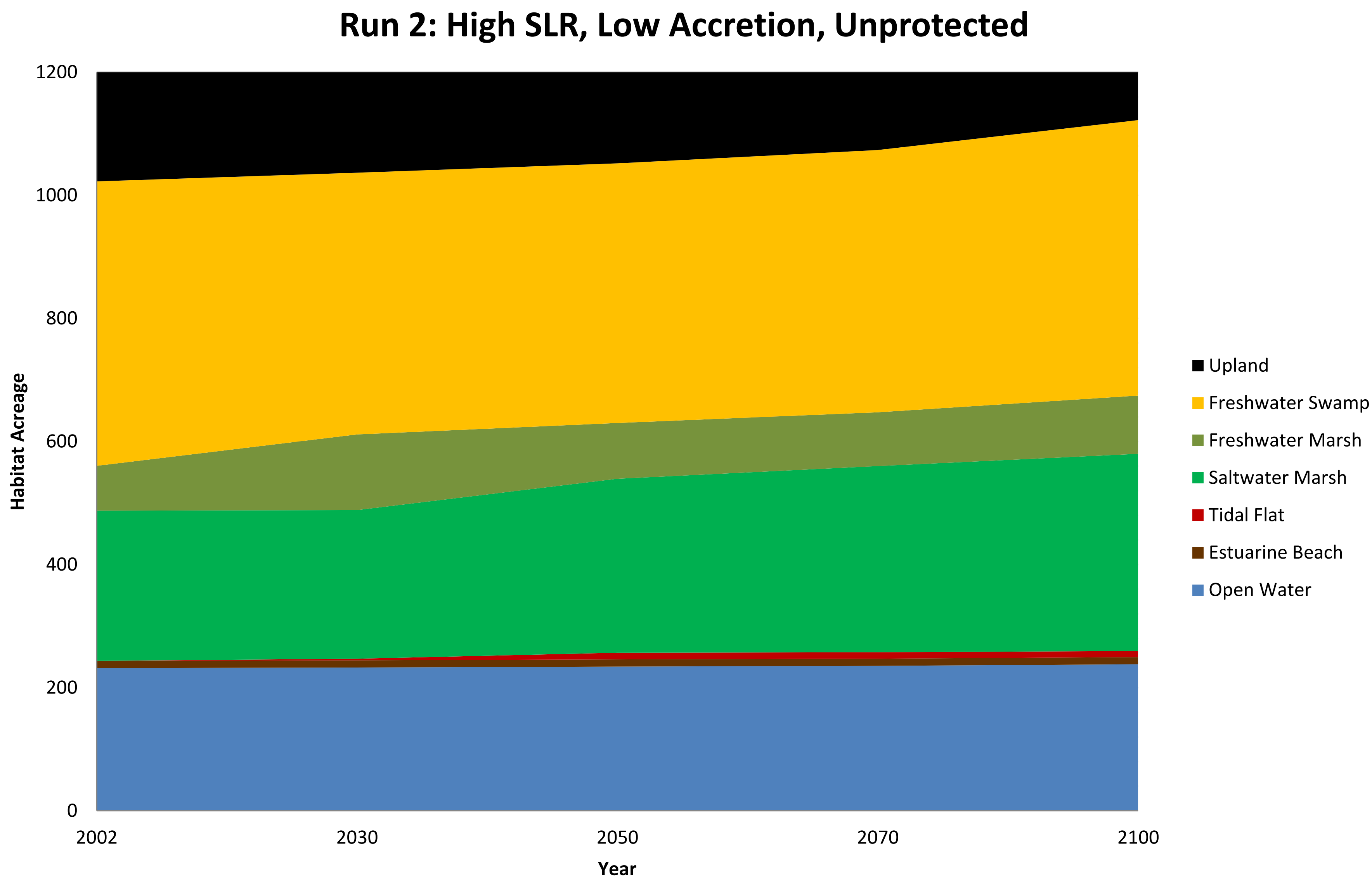


SOURCE: ESRI, NWI 2002, NLCD 2011

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

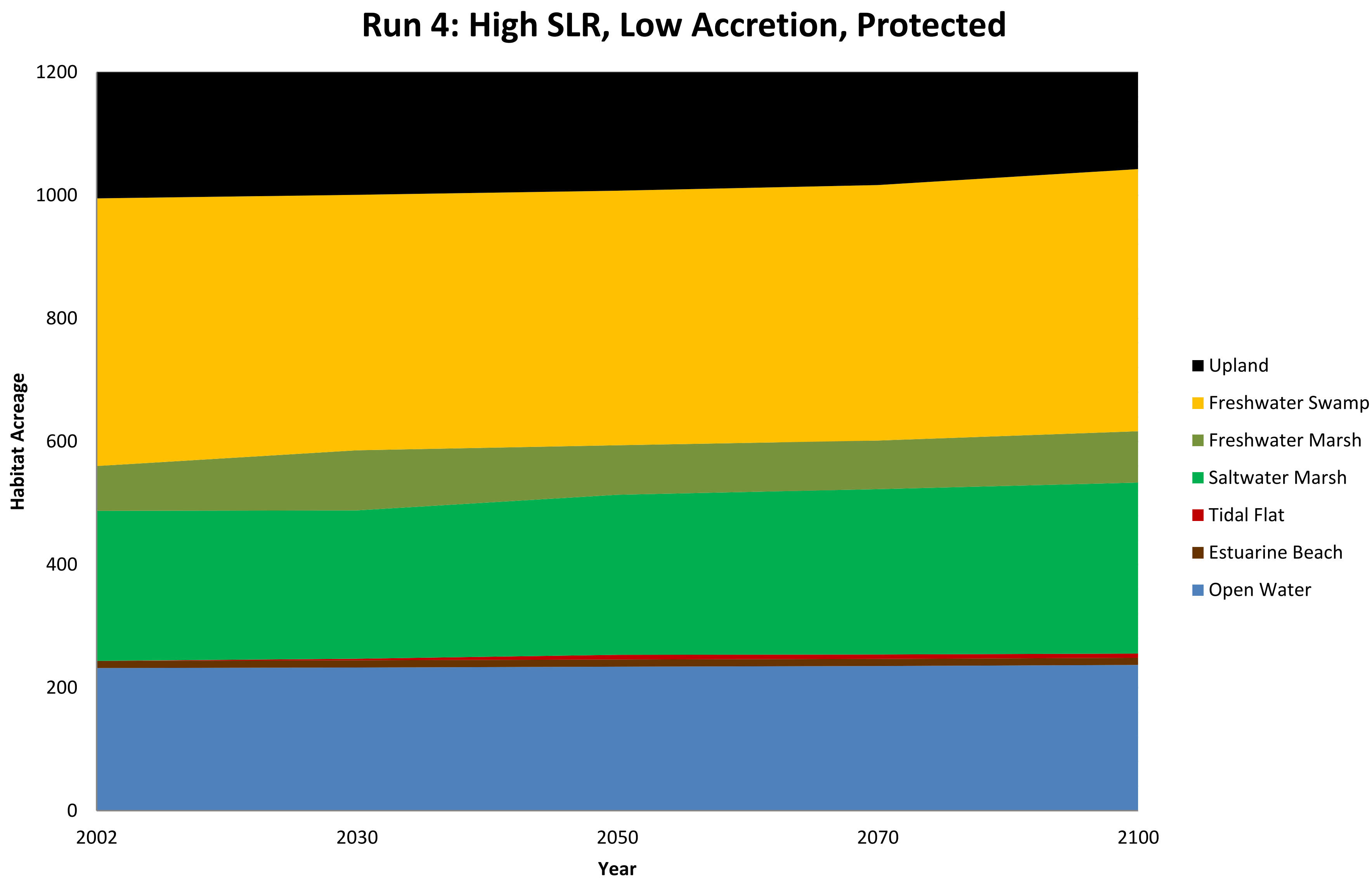


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Figure 14

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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Lindsey Sheehan, P.E.
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

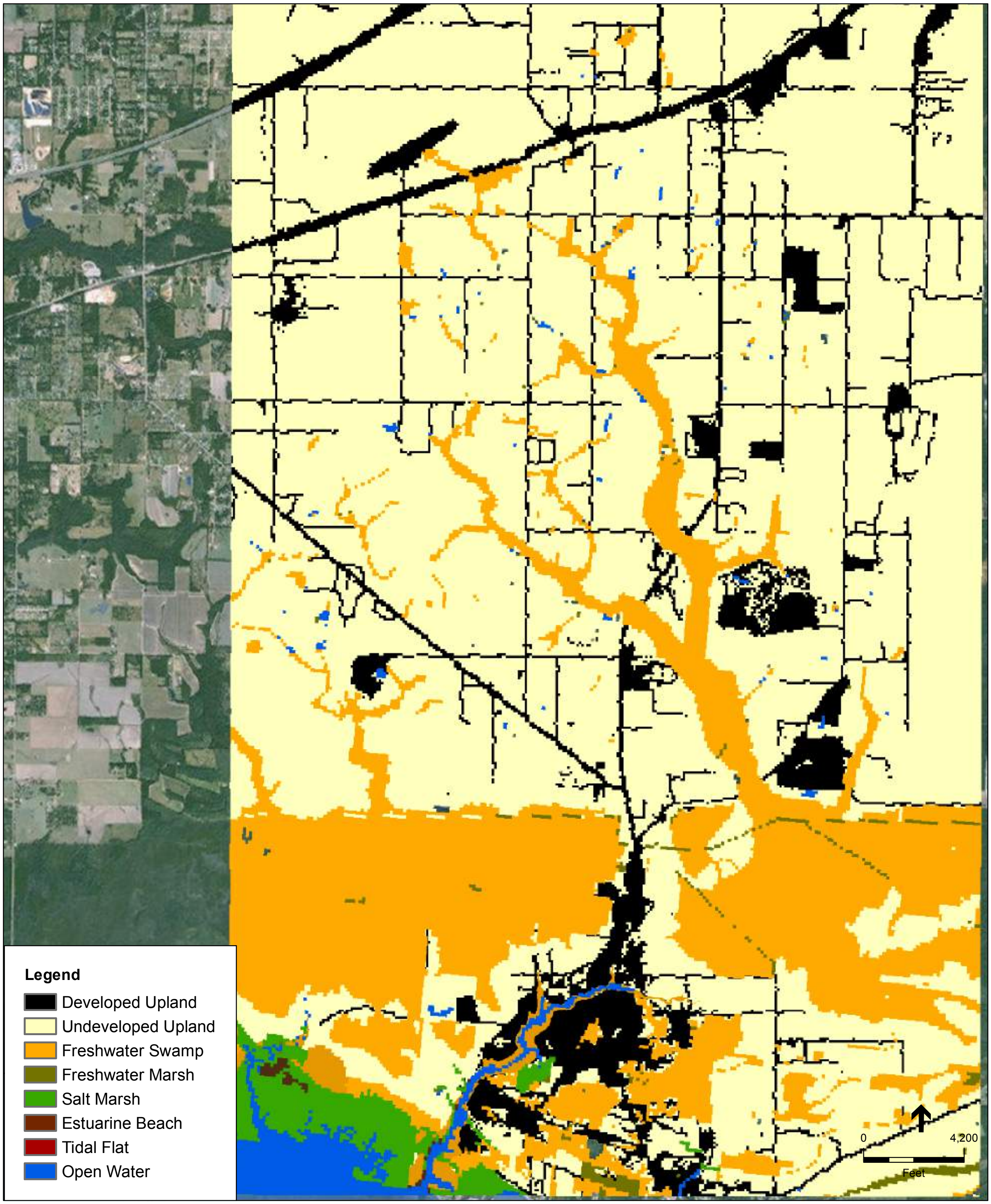

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Figure B-1
Run 1, 2002

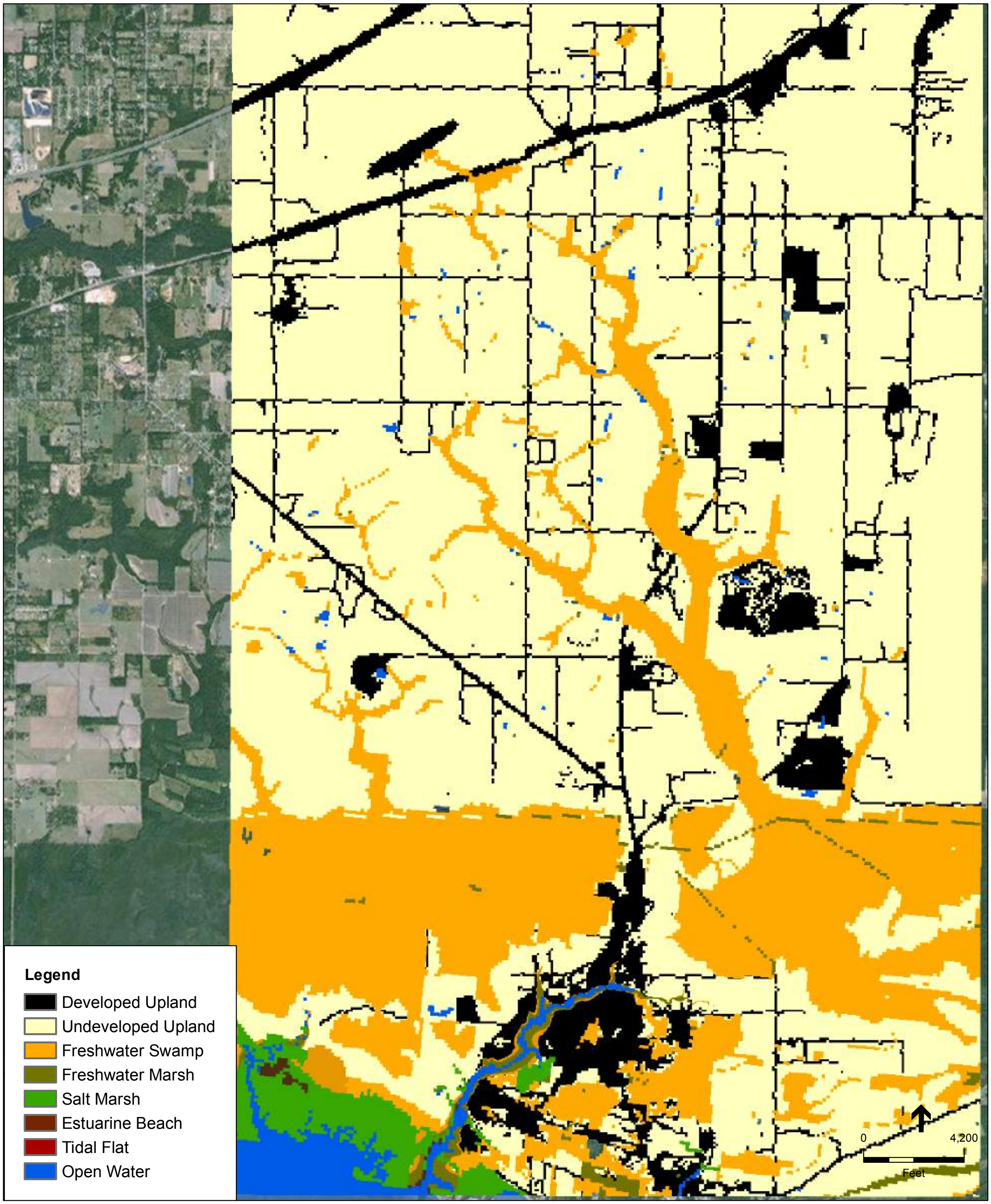

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Figure B-2
Run 1, 2030

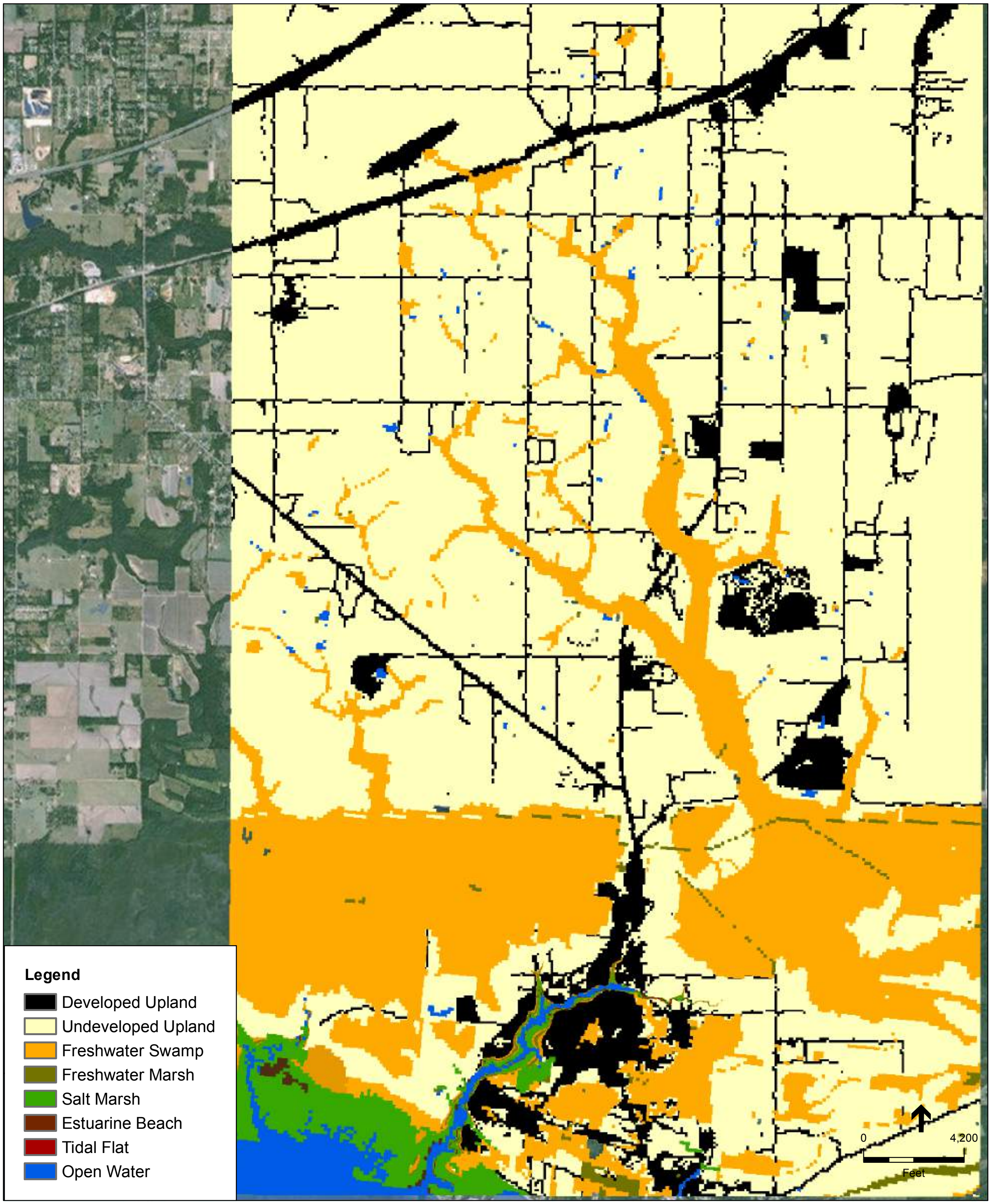

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Figure B-3
Run 1, 2050

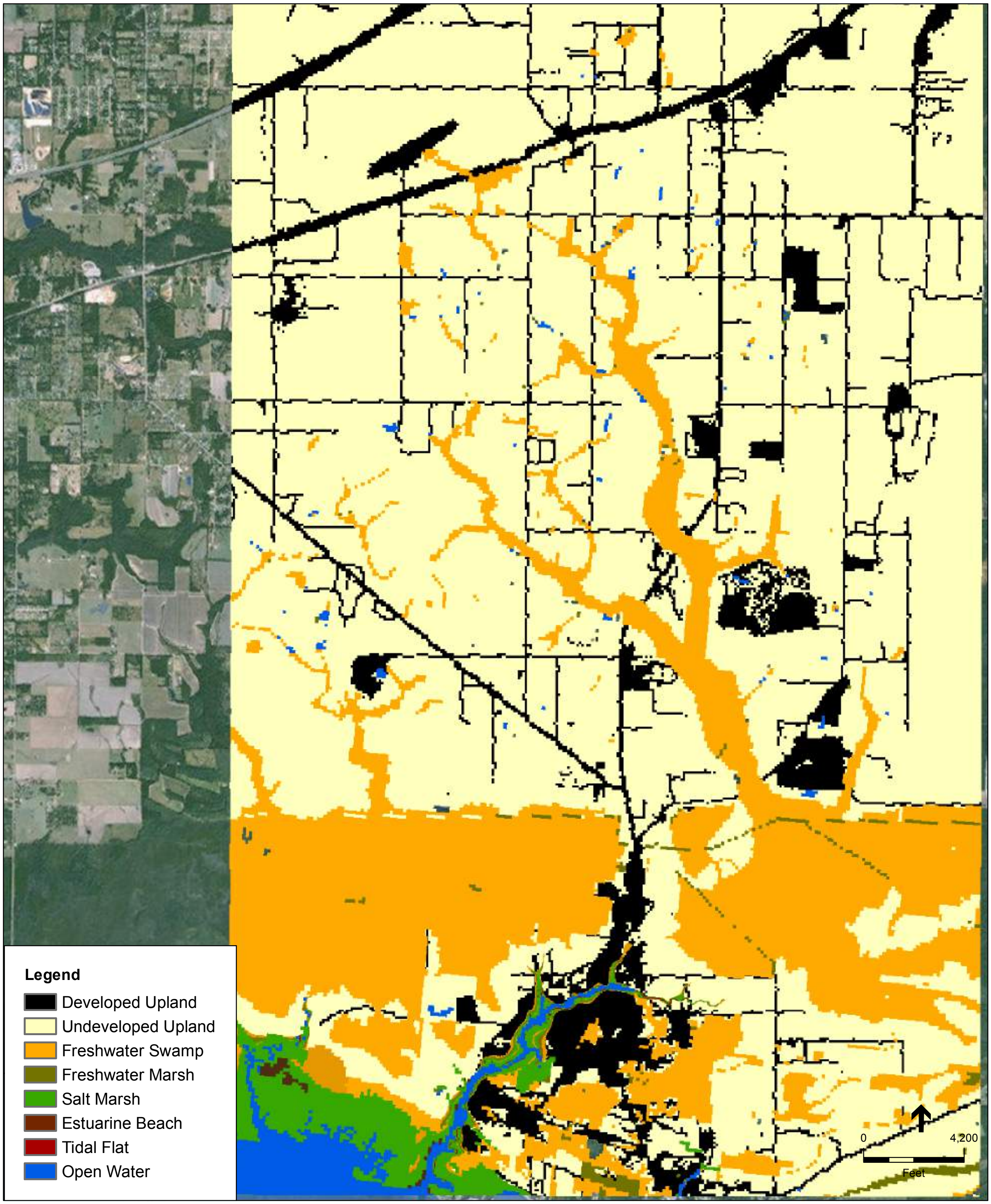

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Figure B-4

Run 1, 2070

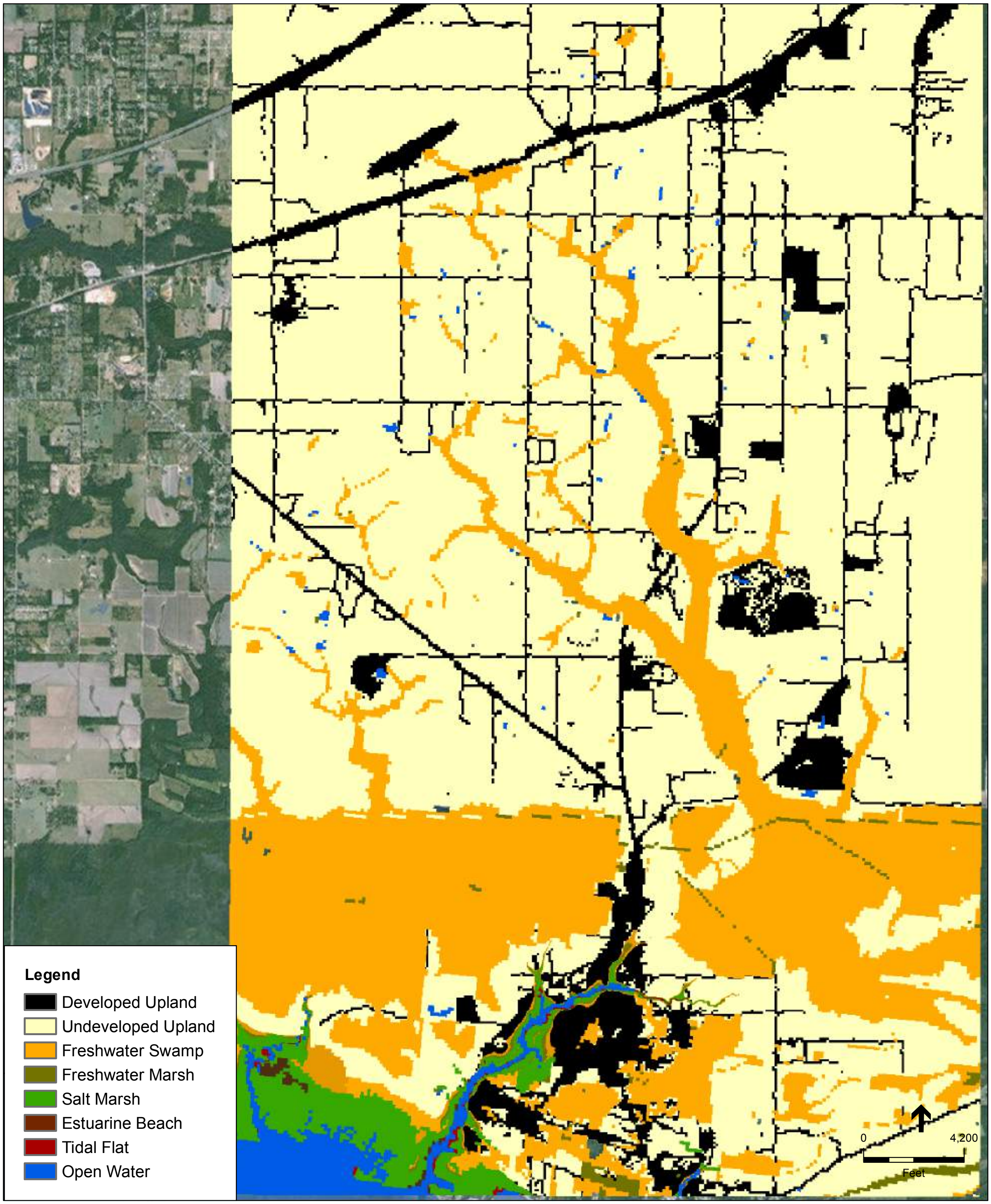

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Figure B-5
Run 1, 2100

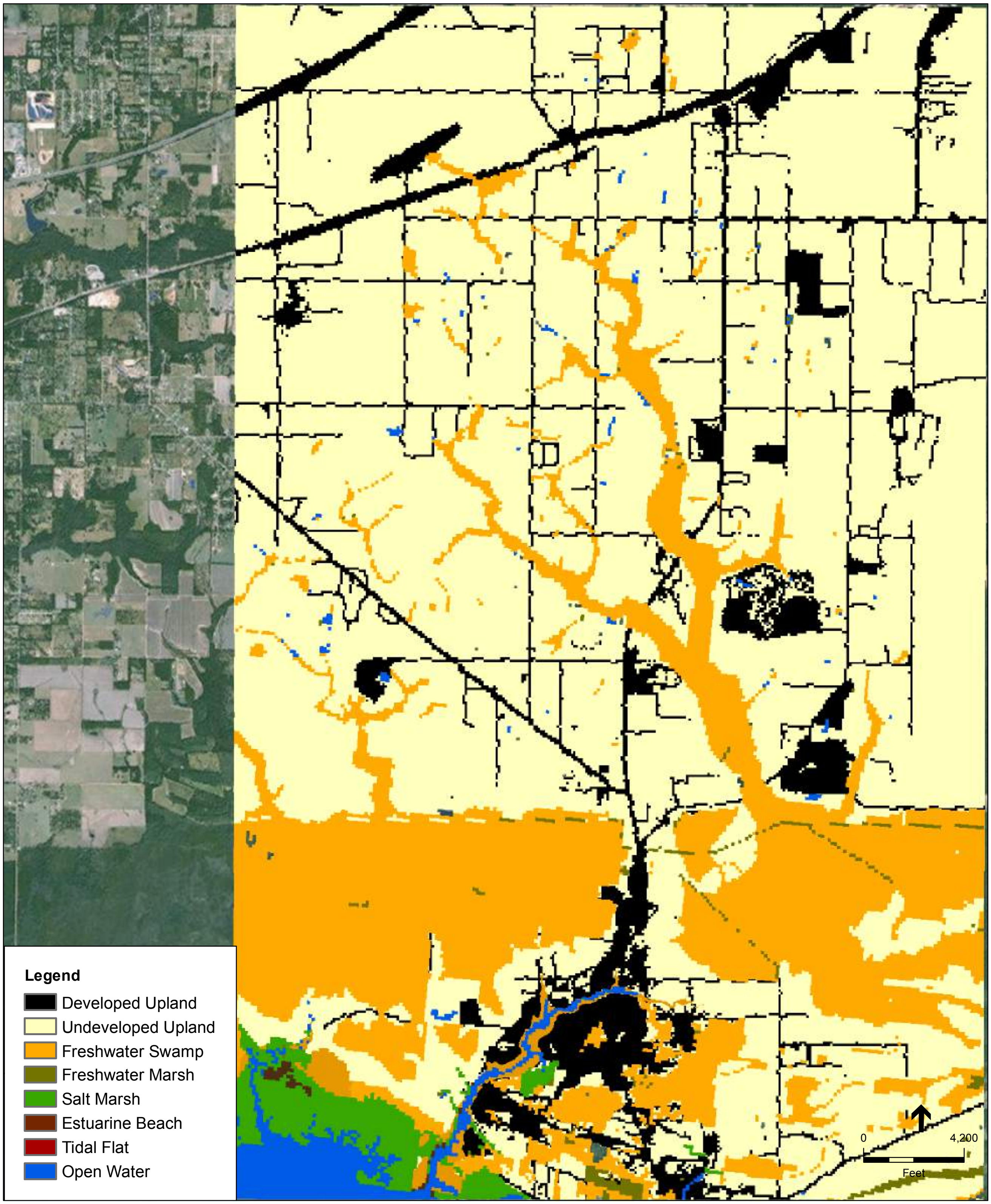

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Figure B-6
Run 2, 2002

ESA

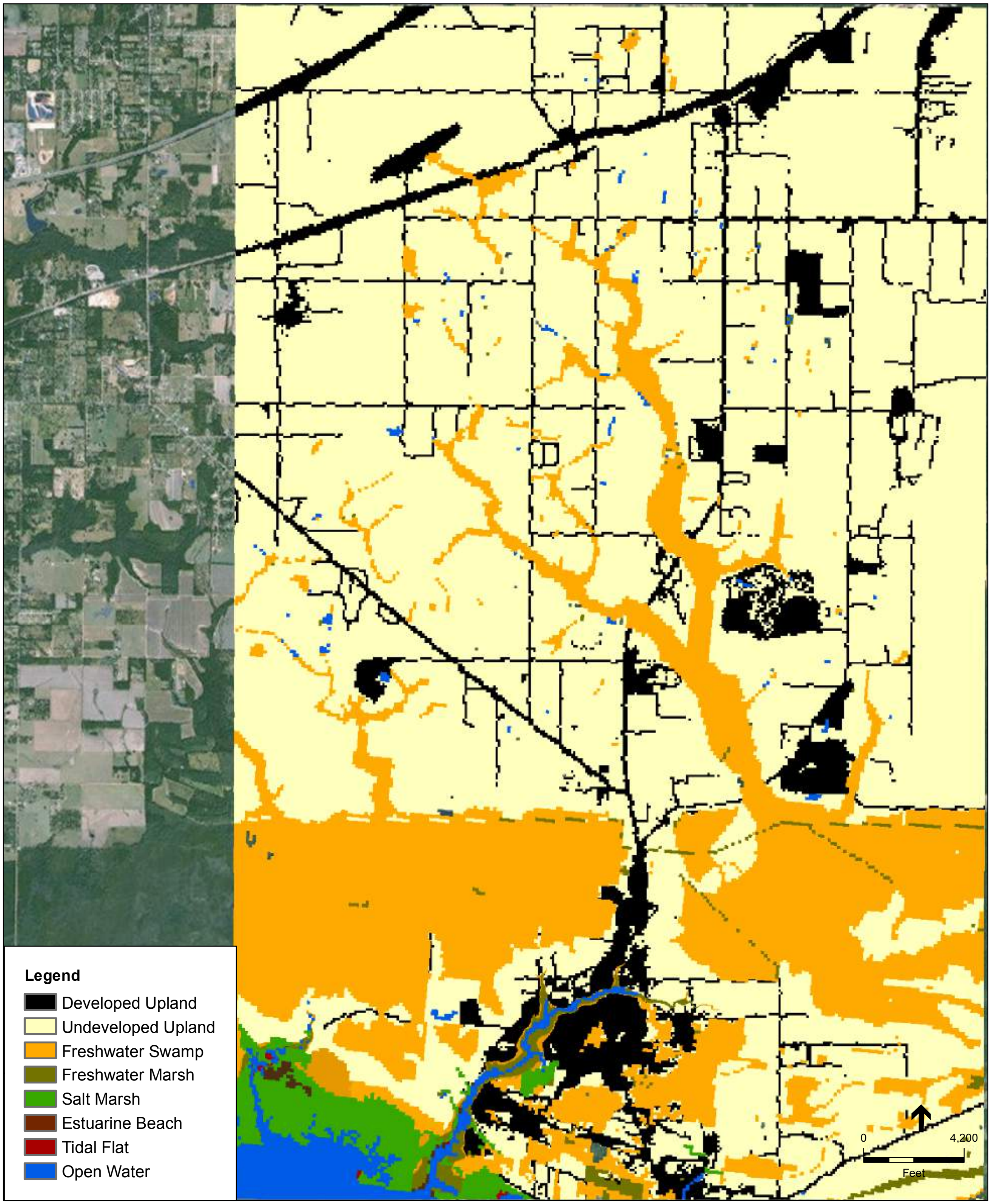

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Figure B-7
Run 2, 2030

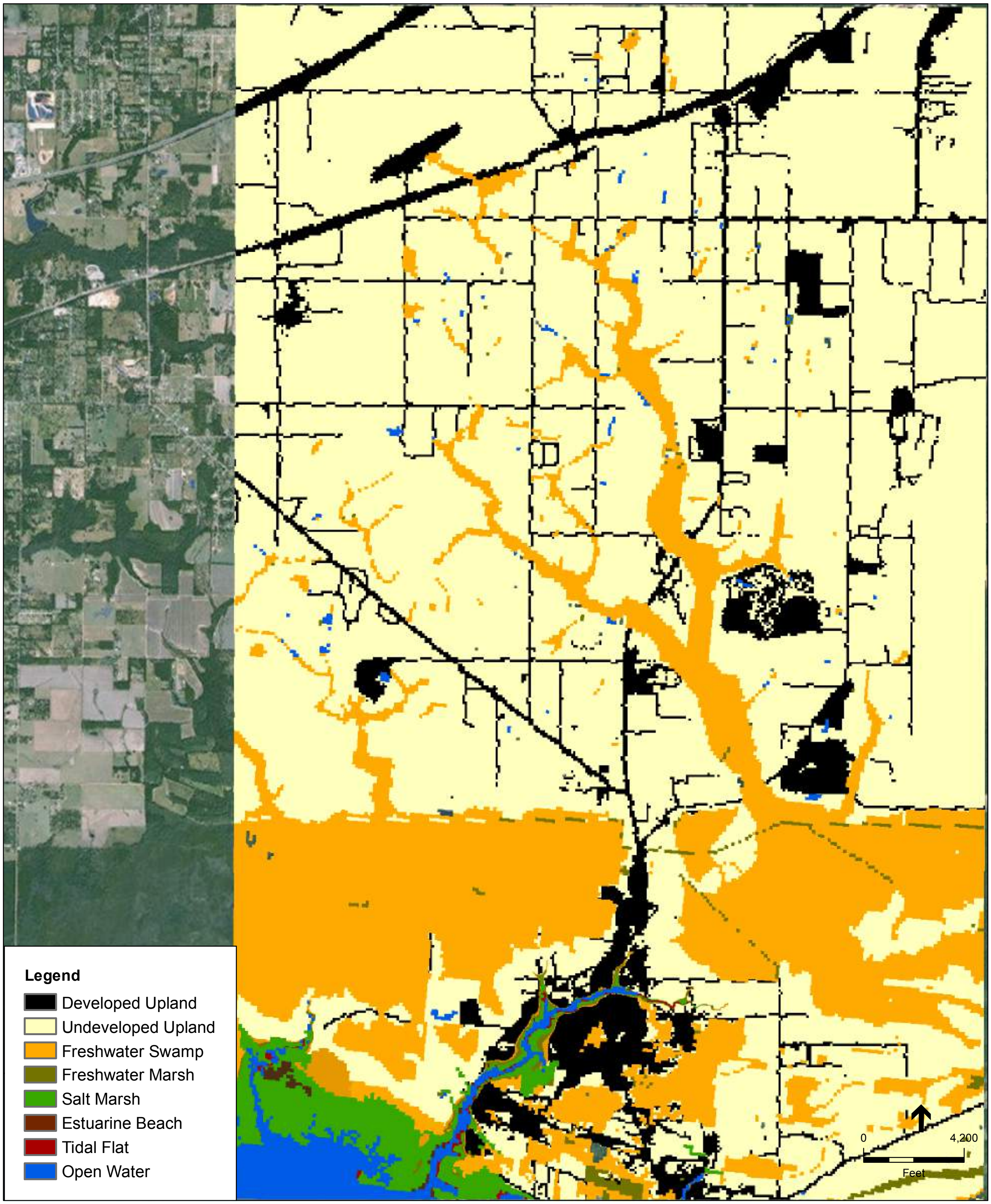

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Figure B-8
Run 2, 2050

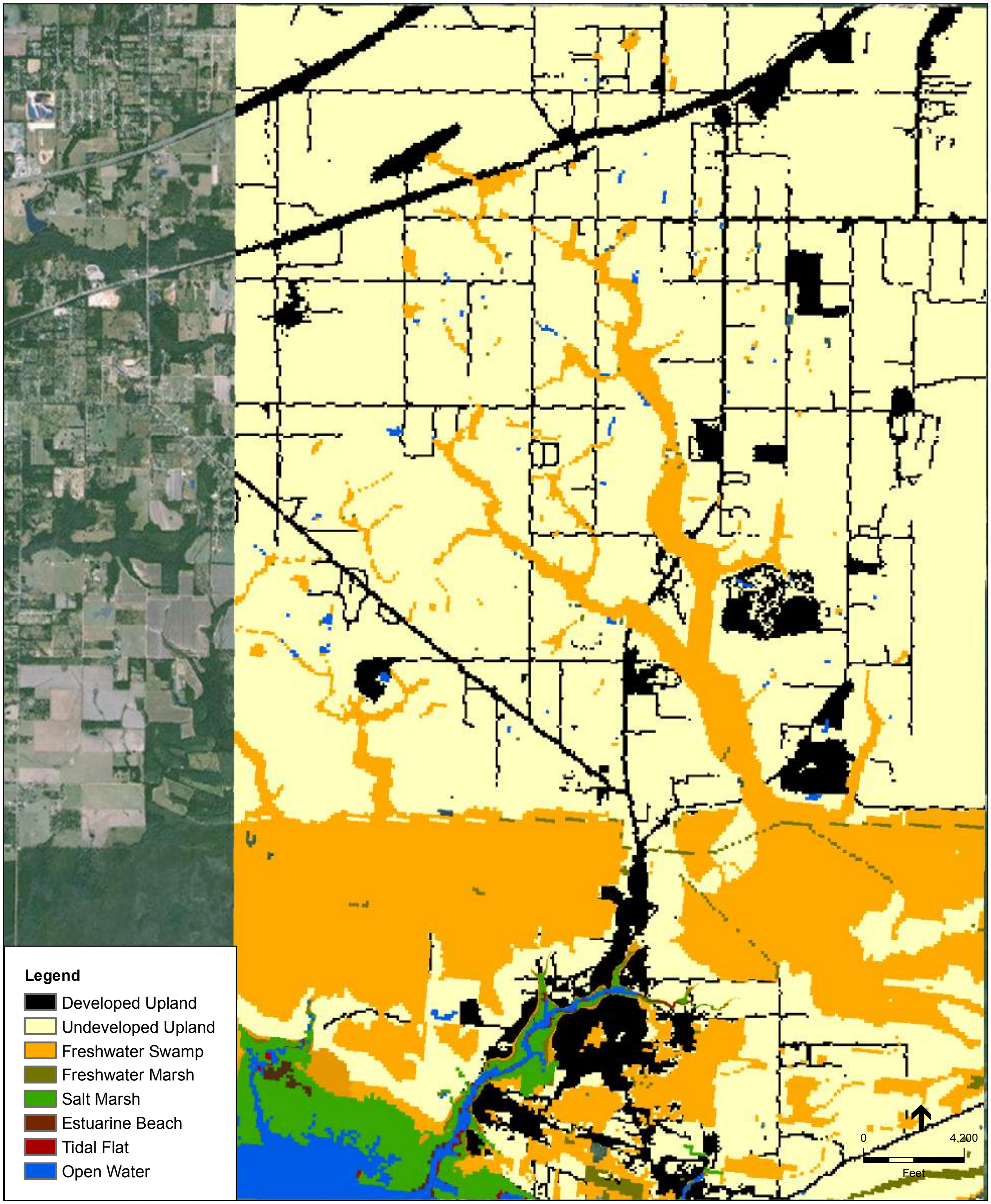

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Figure B-9
Run 2, 2070

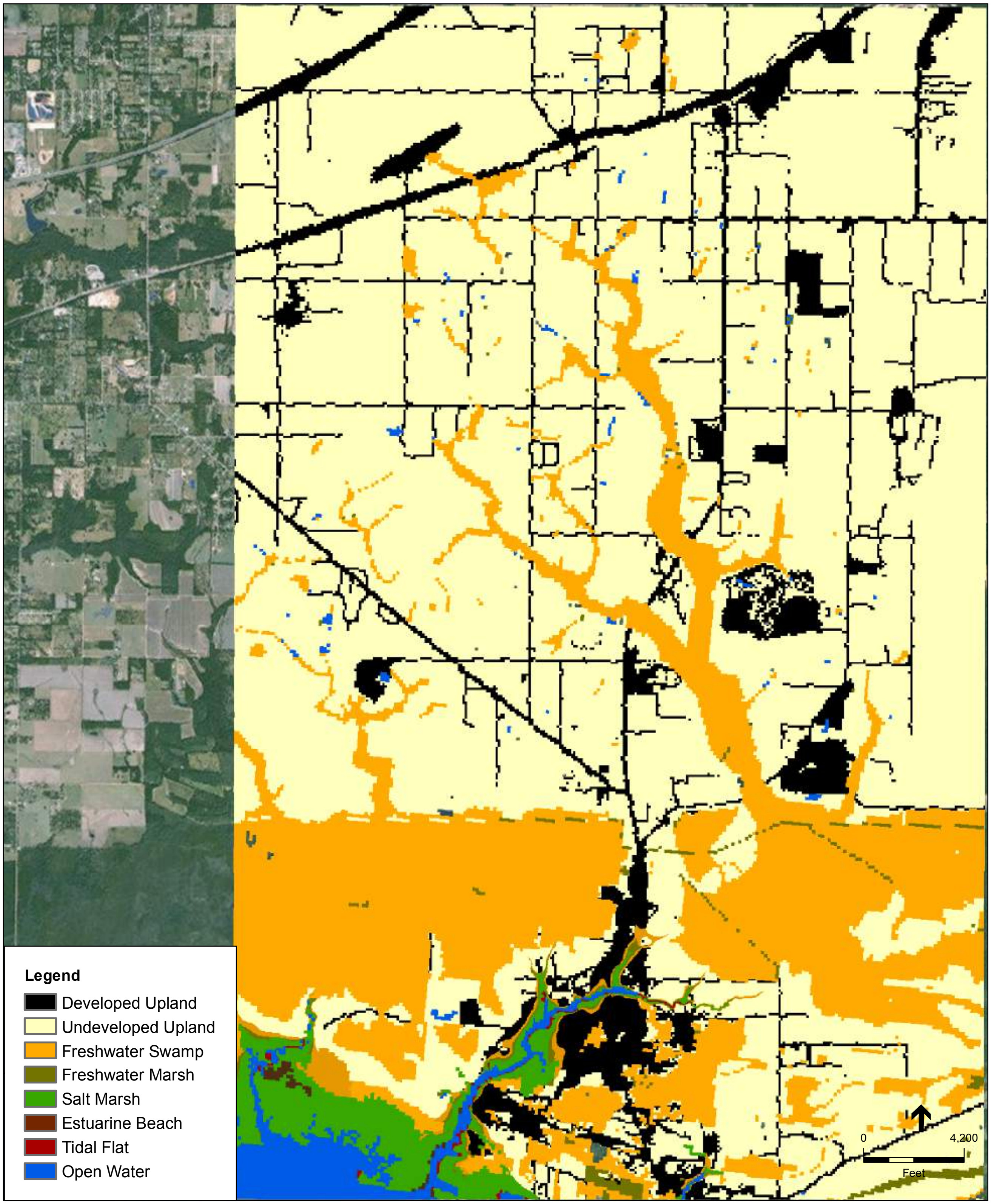

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Figure B-10
Run 2, 2100

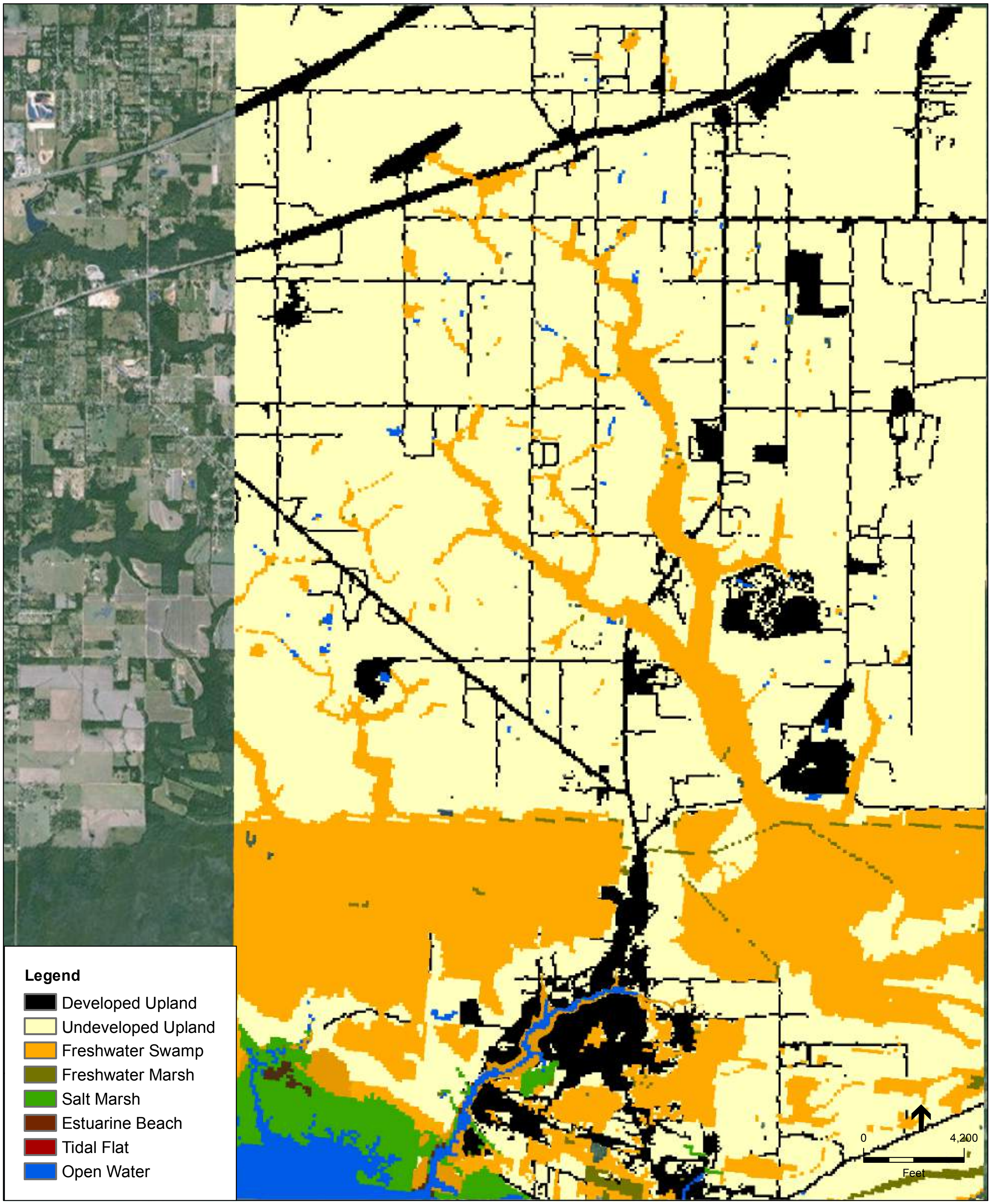

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Figure B-11
Run 3, 2002

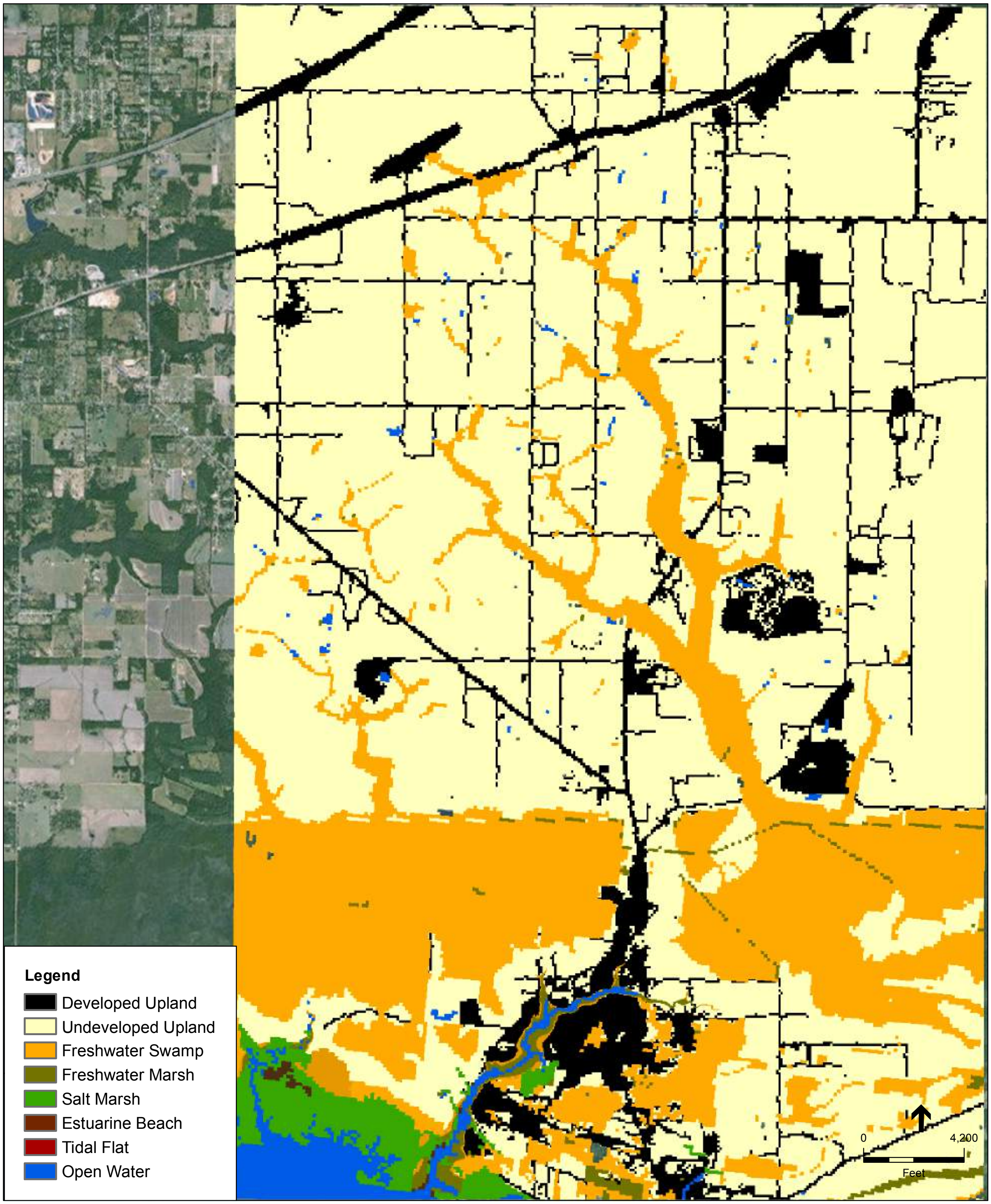

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Figure B-12
Run 3, 2030

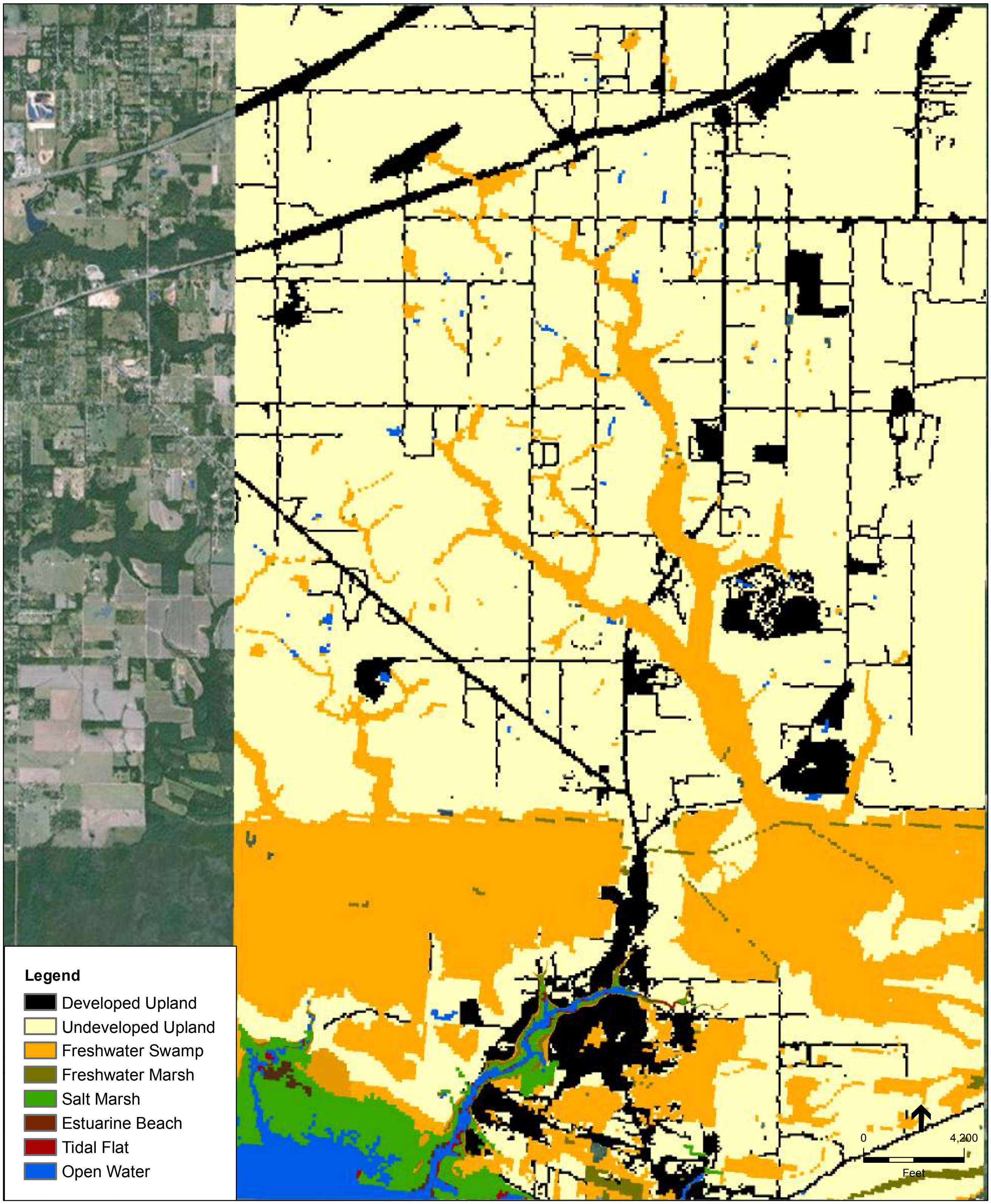

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Figure B-13
Run 3, 2050

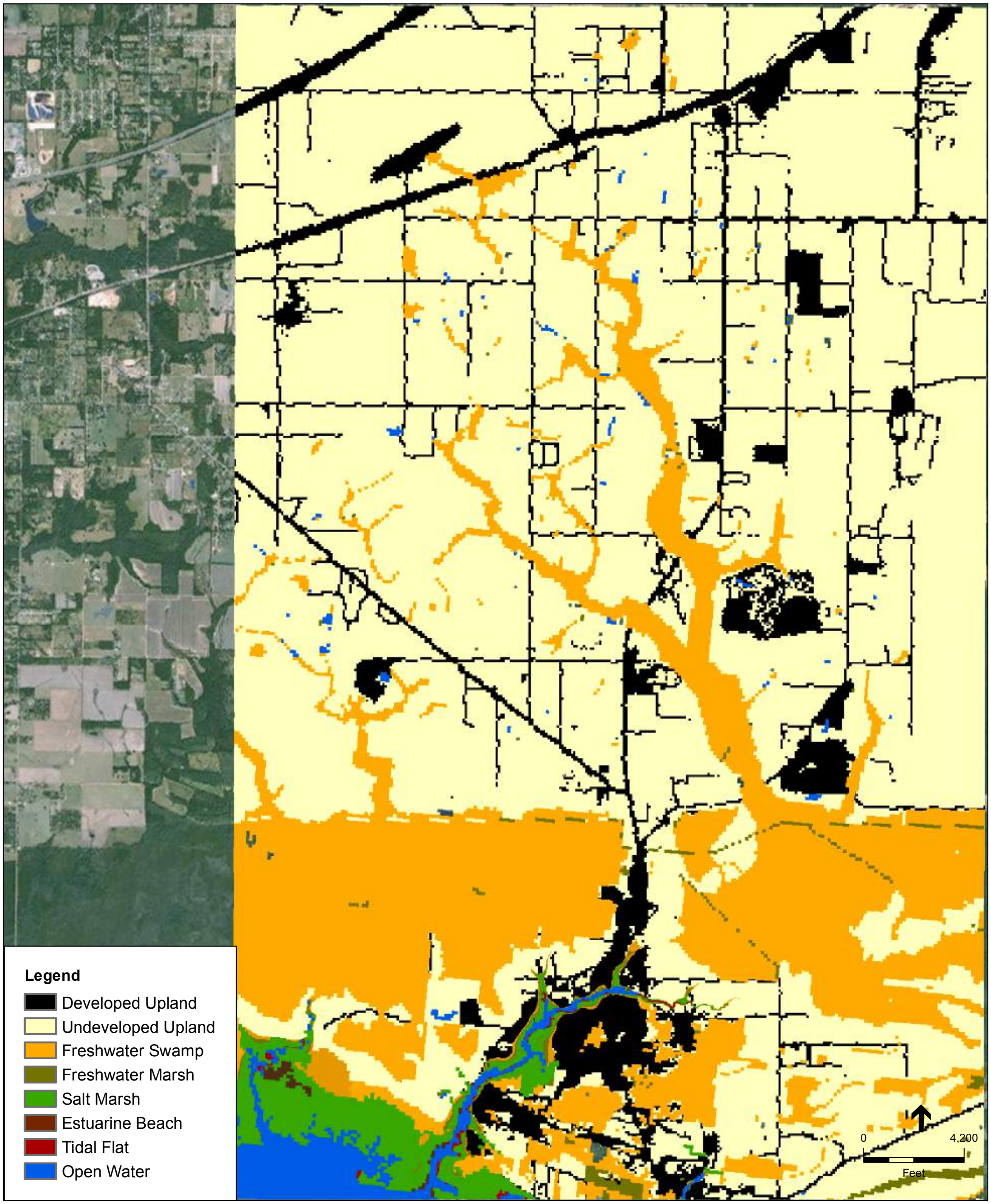

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Figure B-14
Run 3, 2070

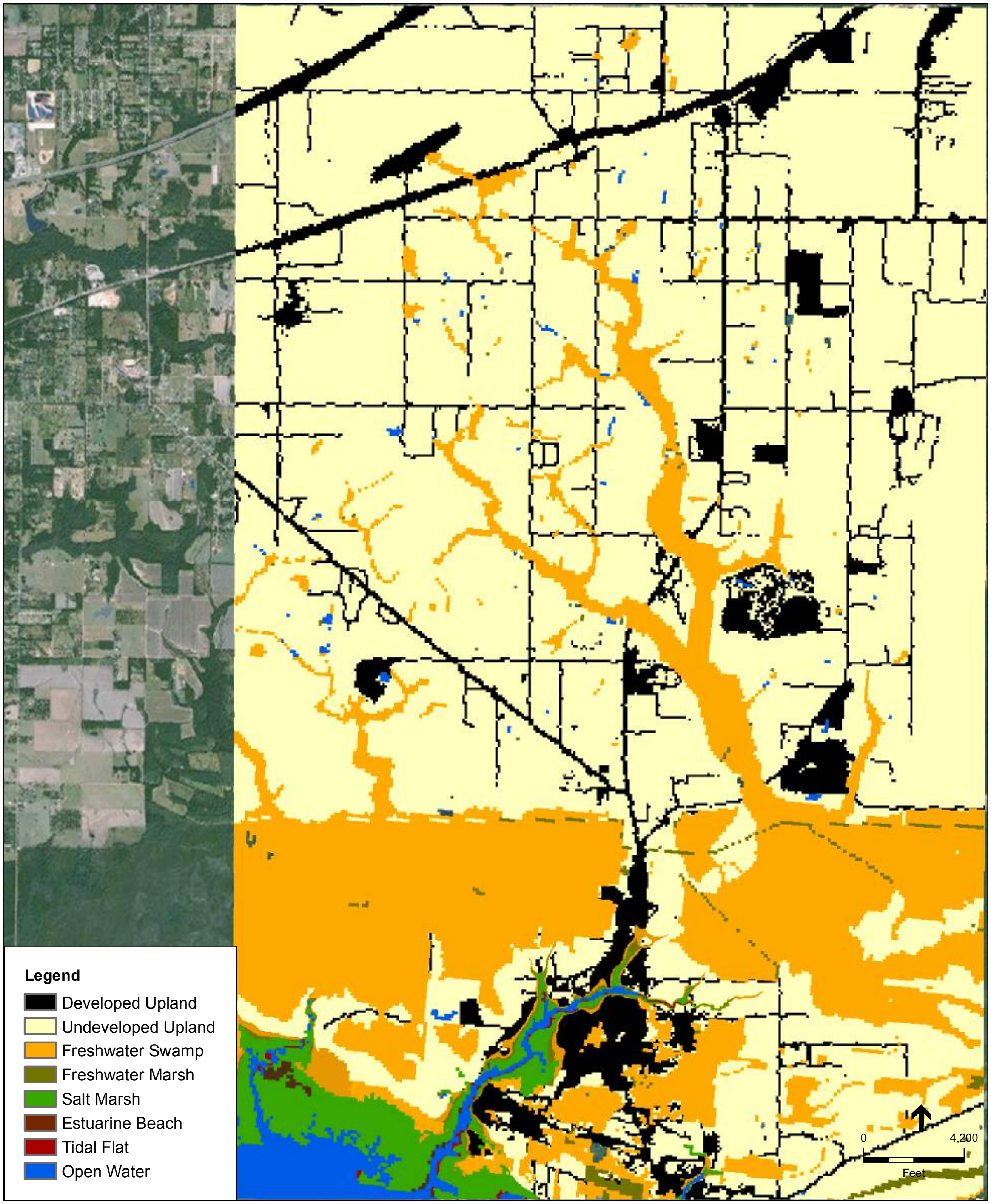

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Figure B-15
Run 3, 2100

ESA

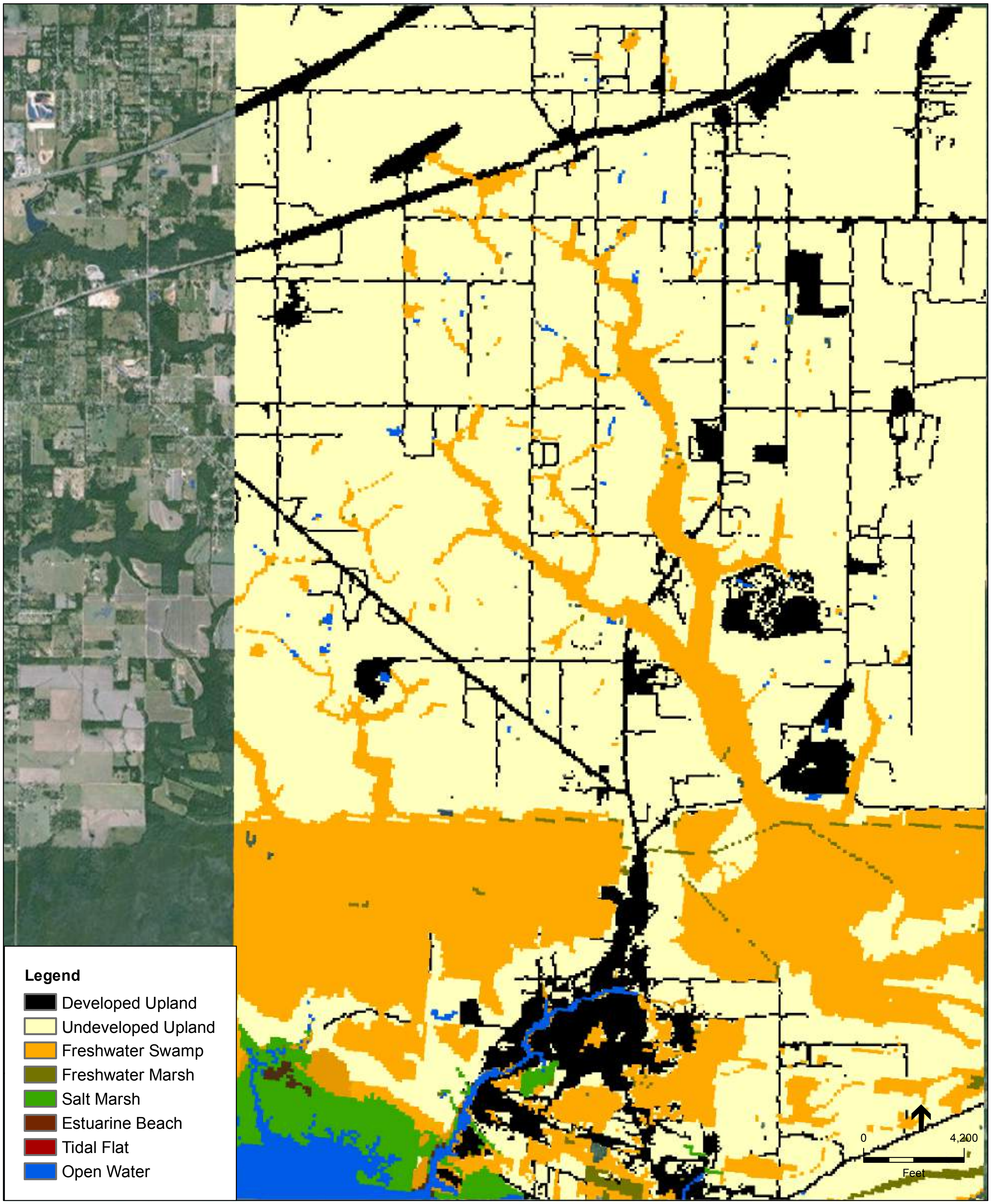

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Figure B-16
Run 4, 2002

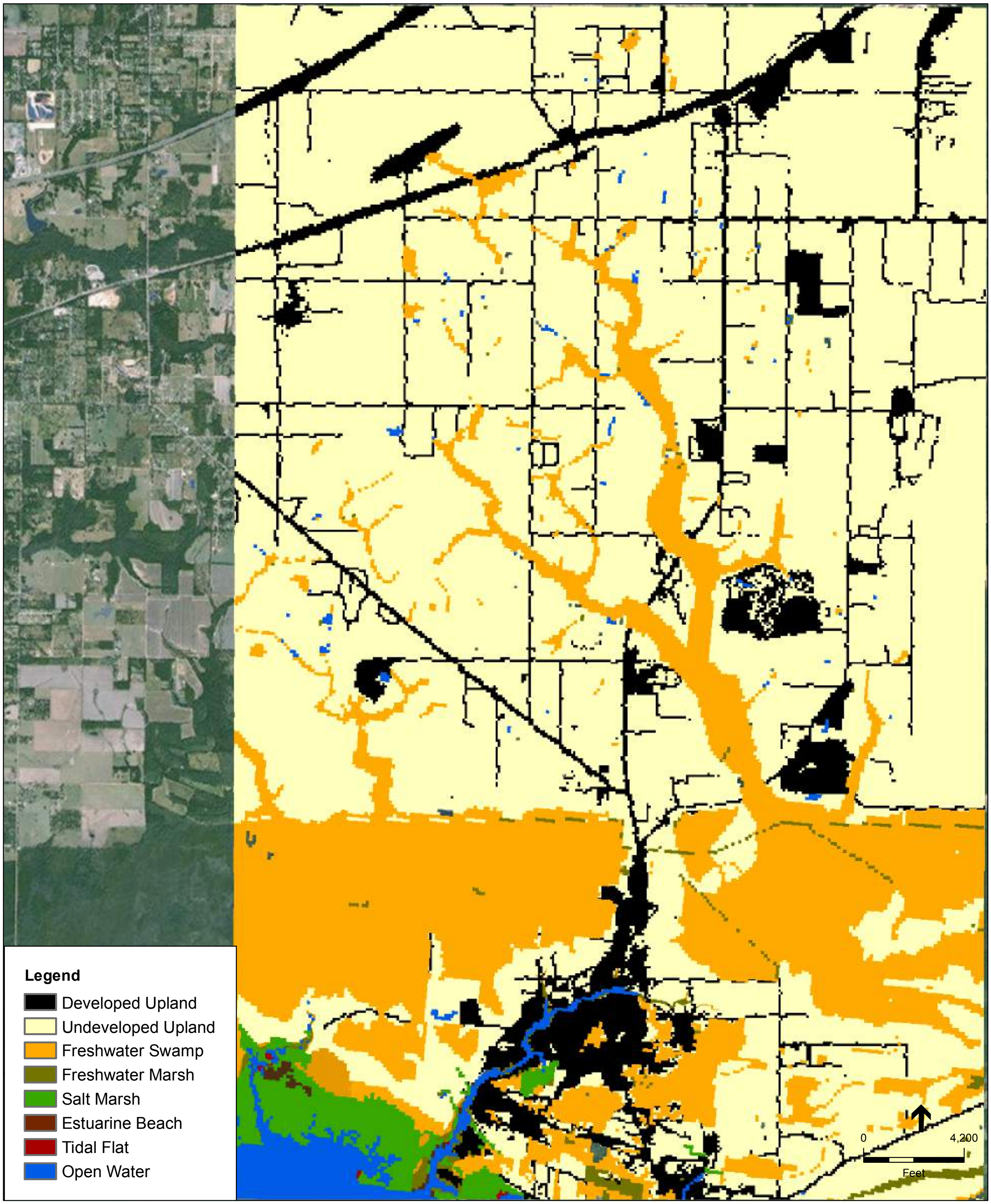

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Figure B-17

Run 4, 2030

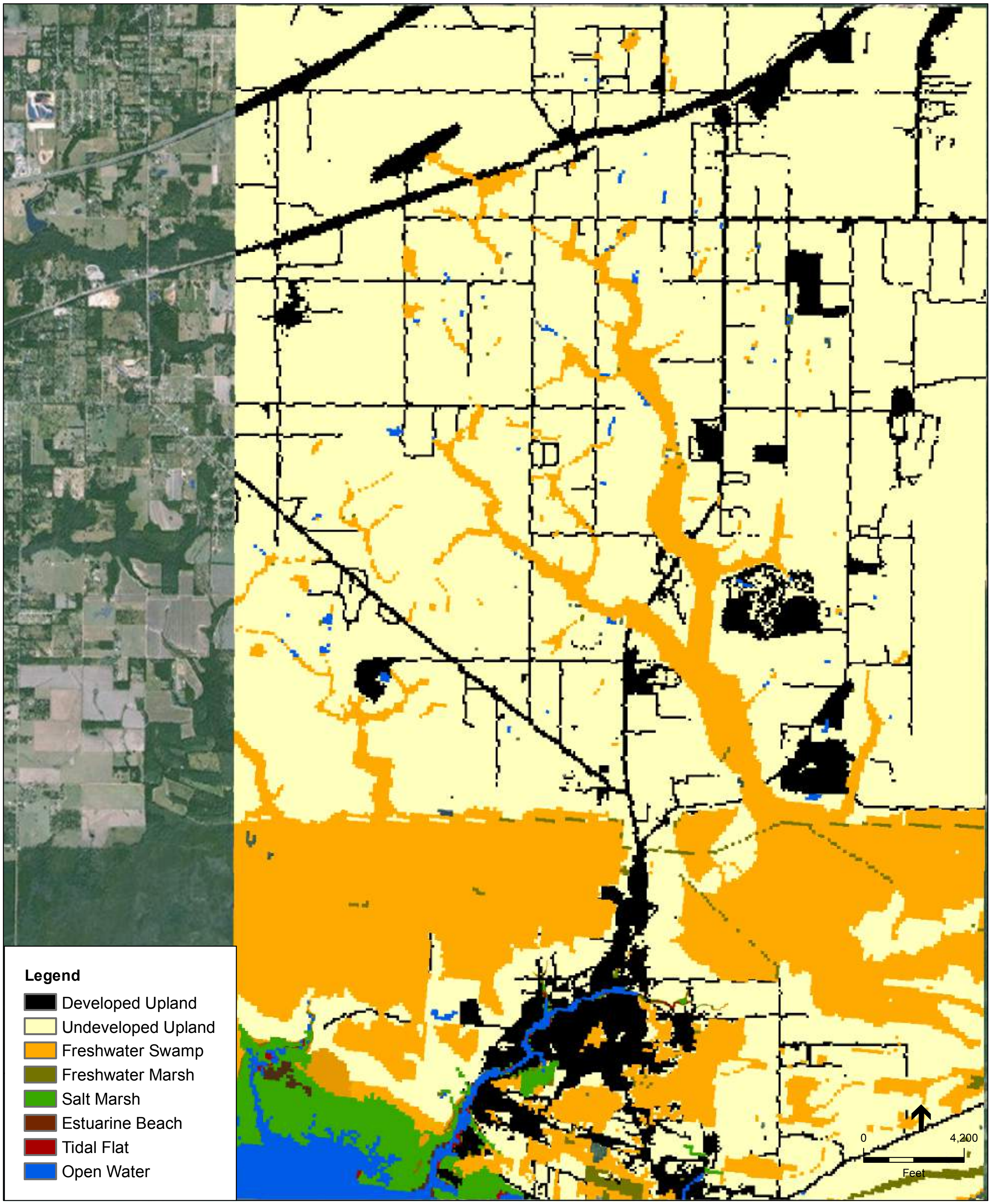

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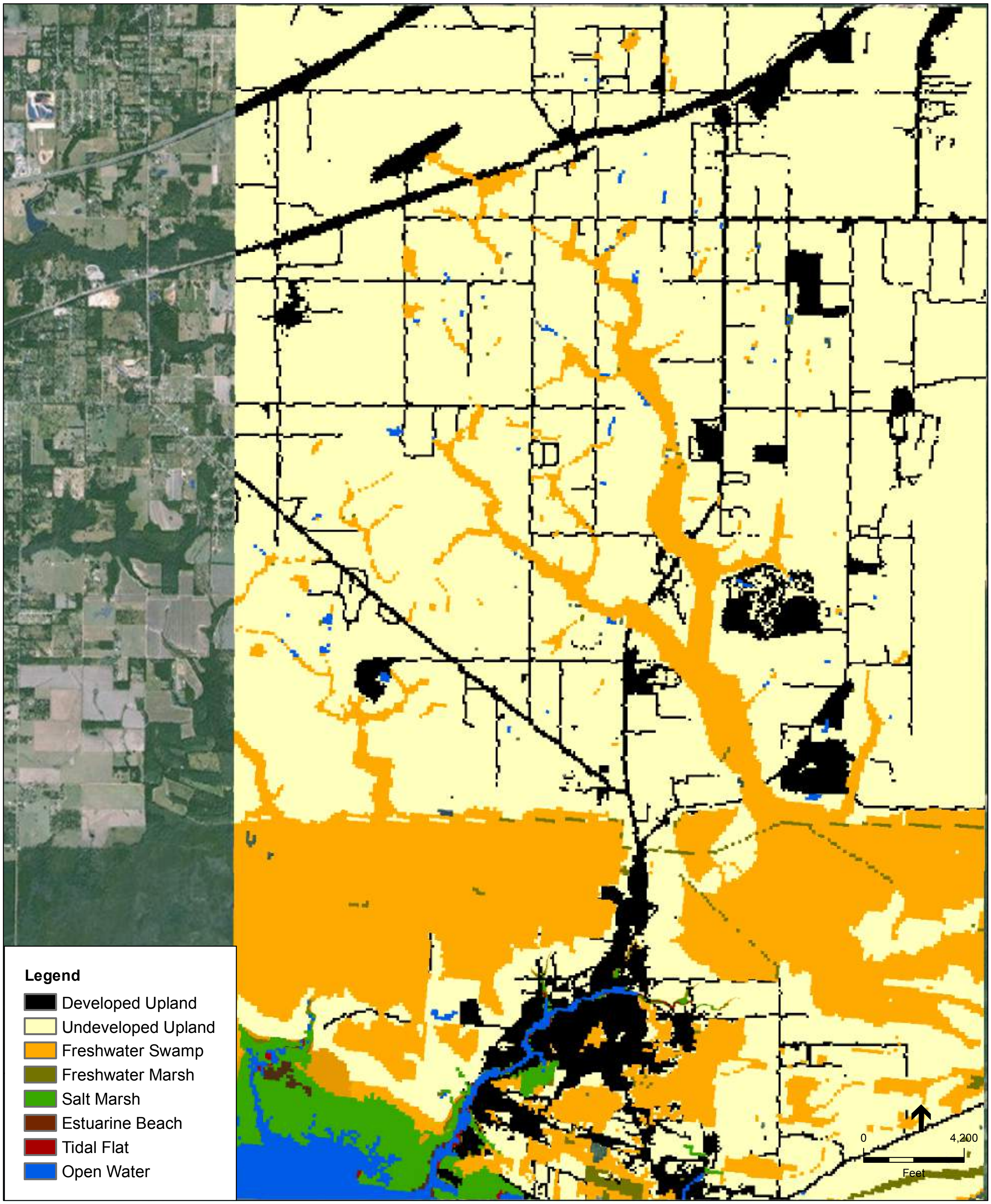
Figure B-18
Run 4, 2050



Bayou La Batre Watershed Management Plan. 150168

Figure B-19

Run 4, 2070

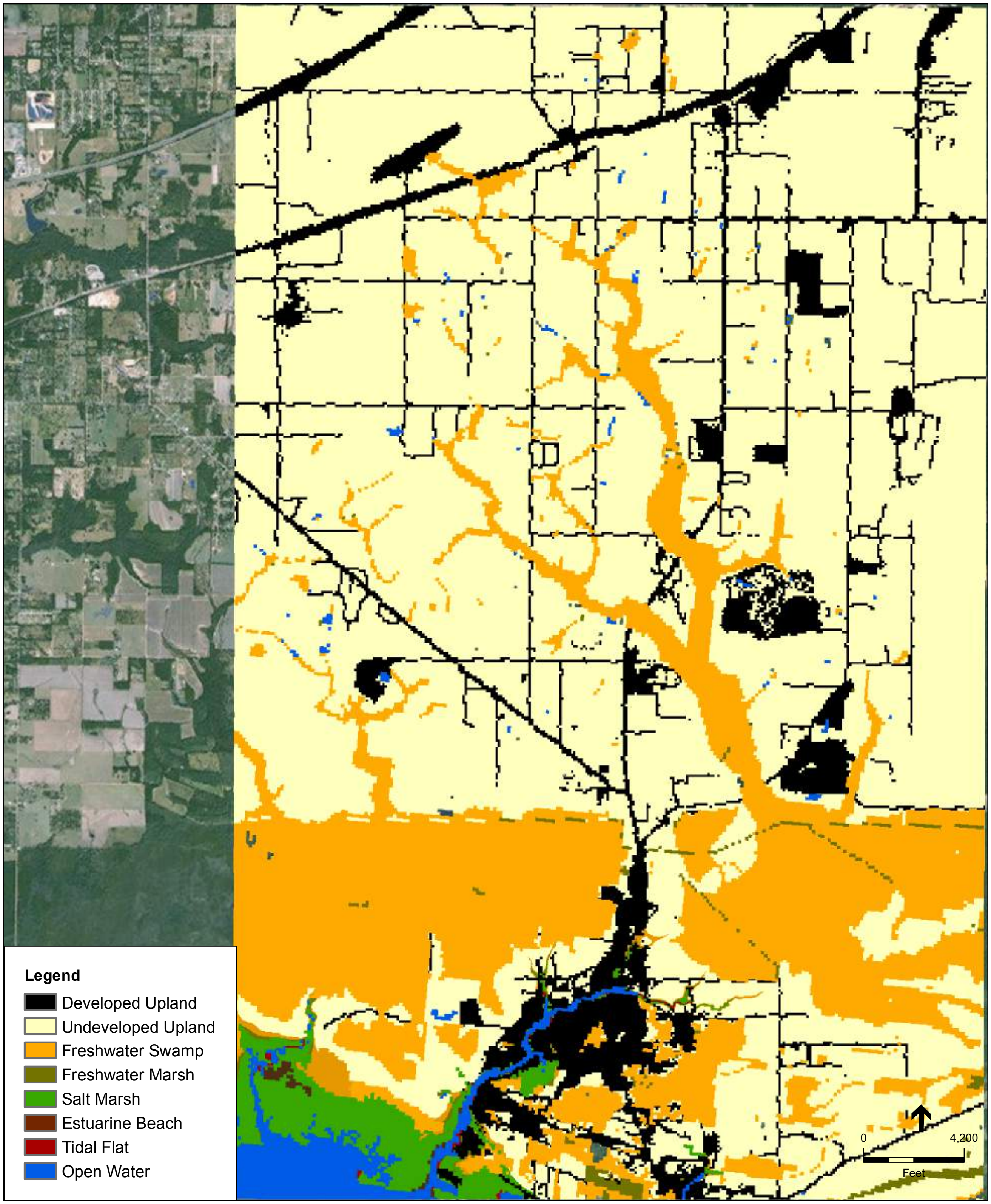


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Figure B-20
Run 4, 2100

APPENDIX C SSO REPORTS

NEWS RELEASE

mobile county health department
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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-

mobile county health department
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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-

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NEWS RELEASE

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-

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NEWS RELEASE

Office of Media Relations
MediaRelations@mchd.org | 251.690.8818

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-

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NEWS RELEASE

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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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NEWS RELEASE

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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

Office of Media Relations
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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.

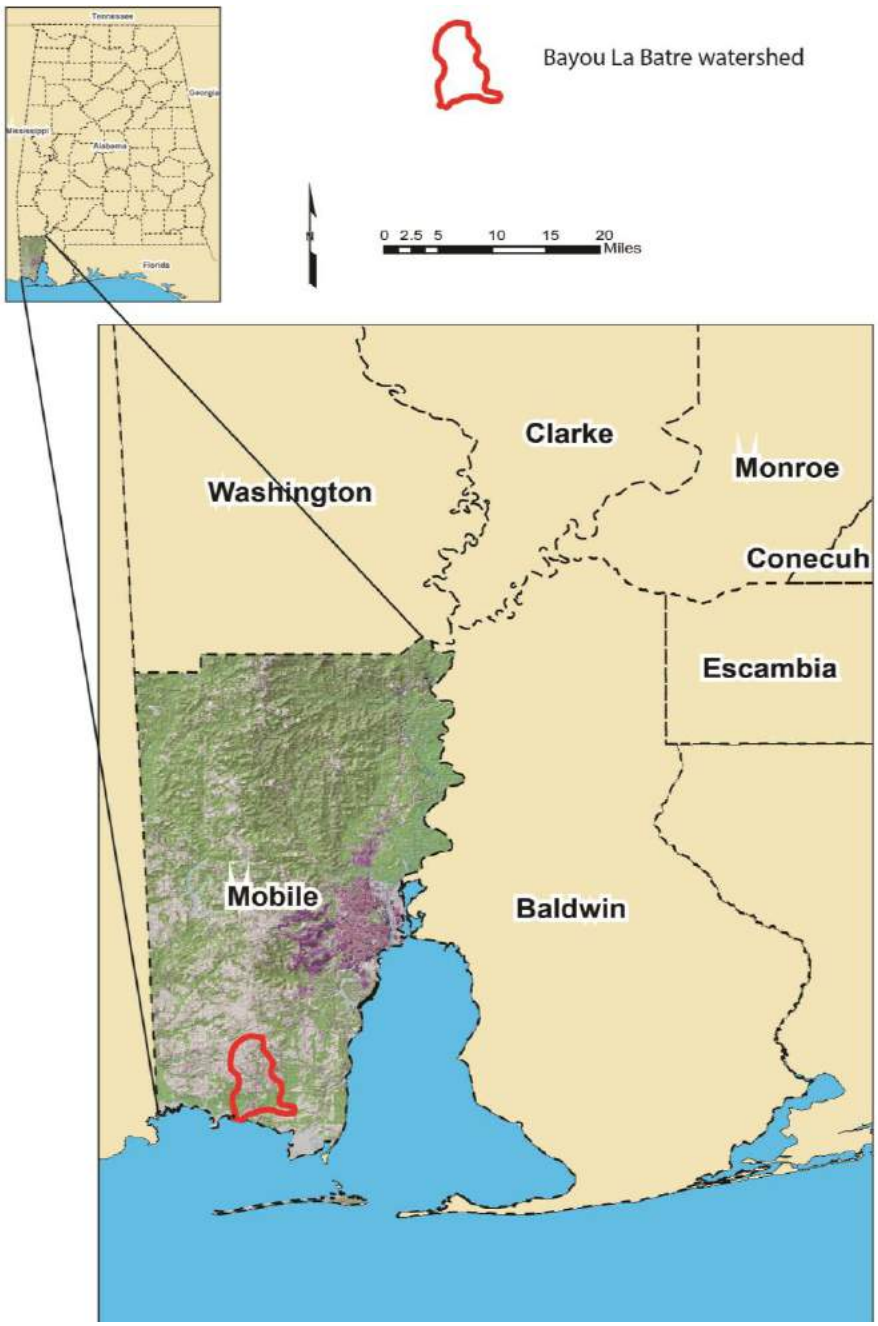

Figure 1.— Bayou La Batre project area.

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

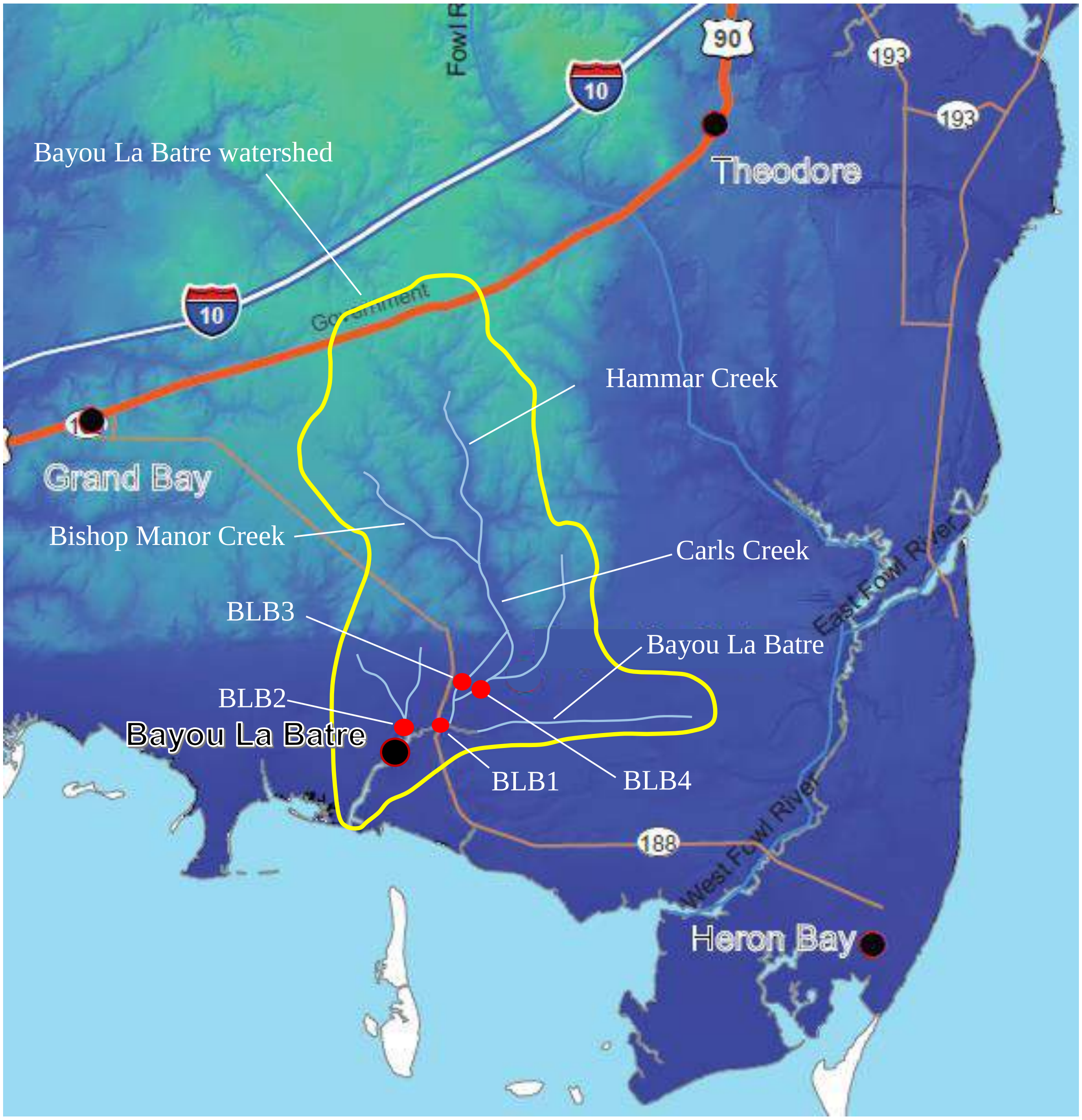

Figure 2.—Bayou La Batre watershed, streams, and monitored sites.

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).

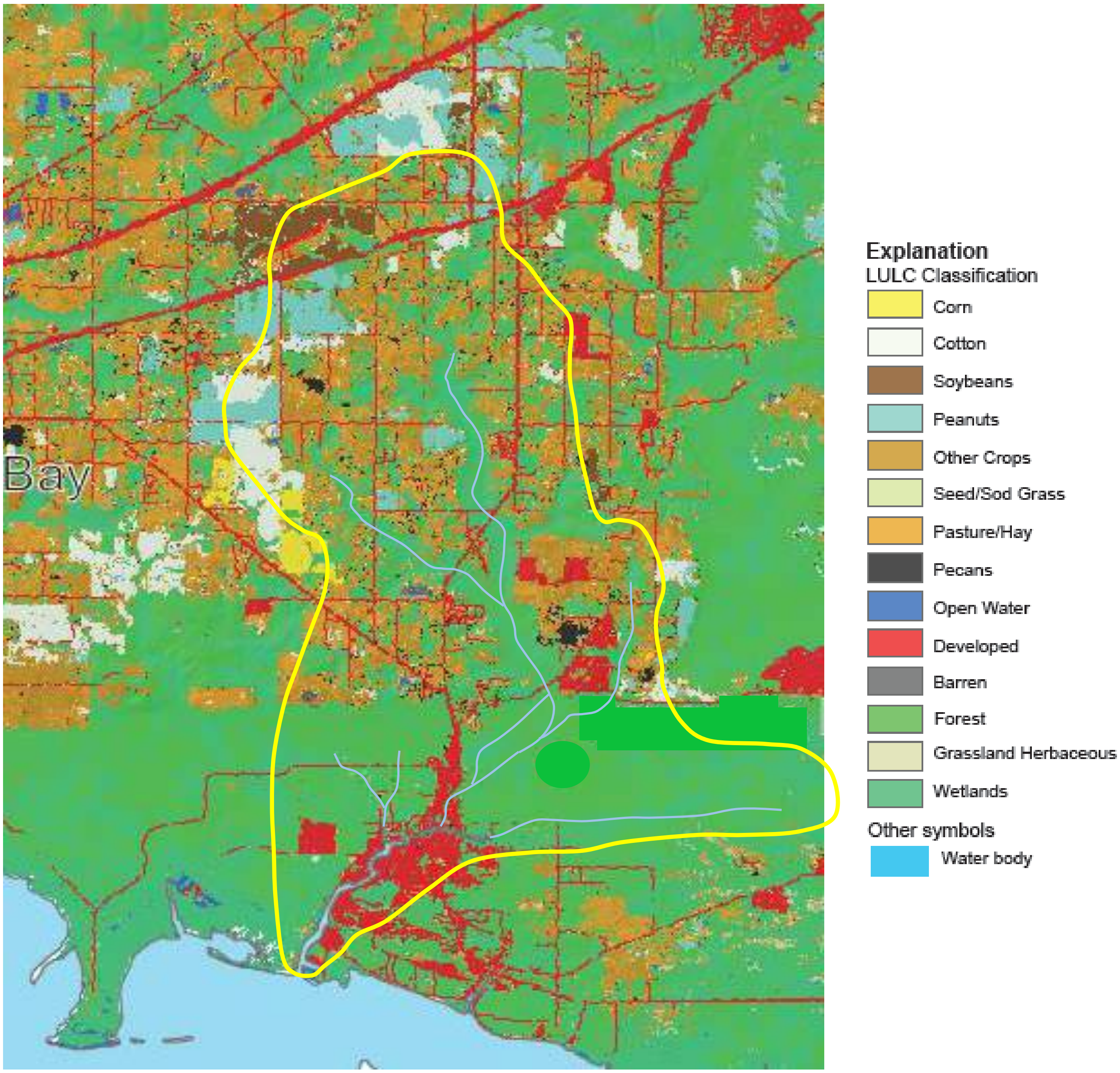

Figure 3.-Land use classifications for the Bayou La Batre area.

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.

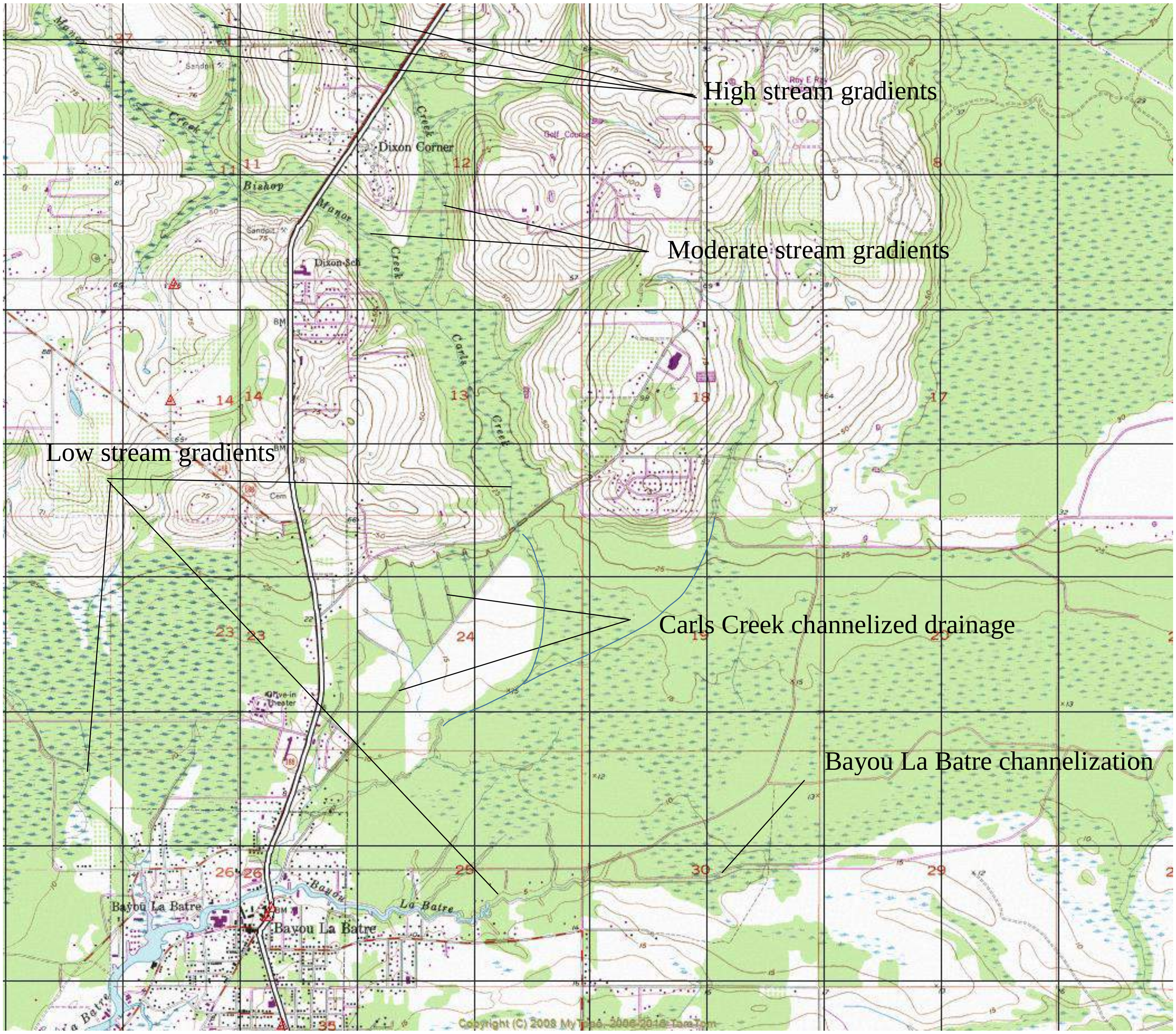

Figure 4.—USGS 7.5-minute topographic map of a selected area of the Bayou La Batre watershed, showing stream gradients and anthropogenic features.

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

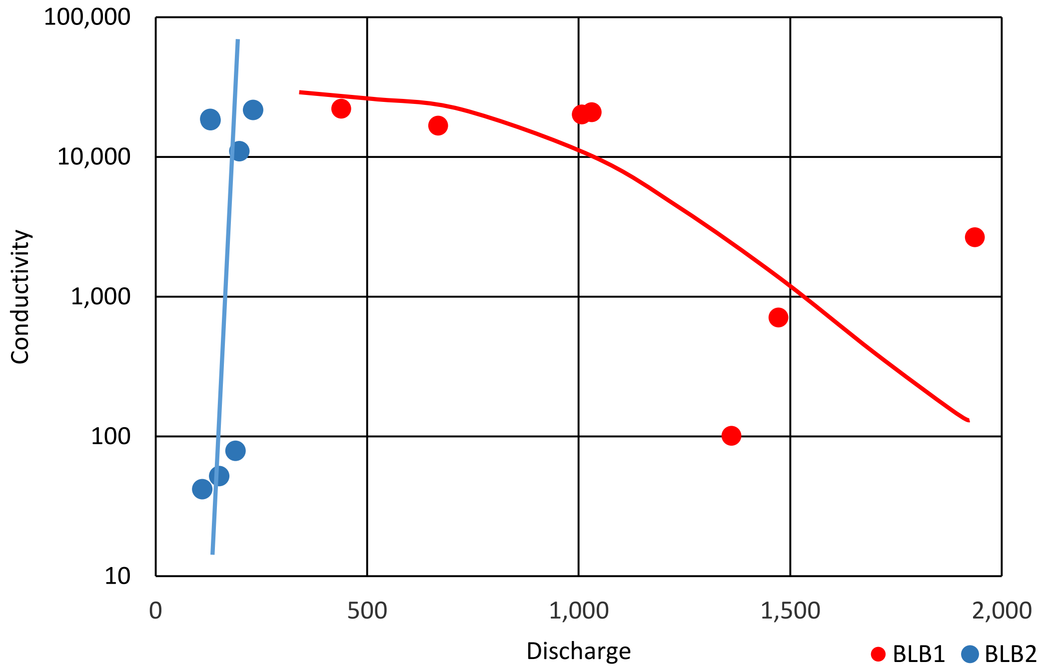

Figure 5.—Conductivity and discharge relationships for samples collected at sites BLB1 and BLB2.

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.

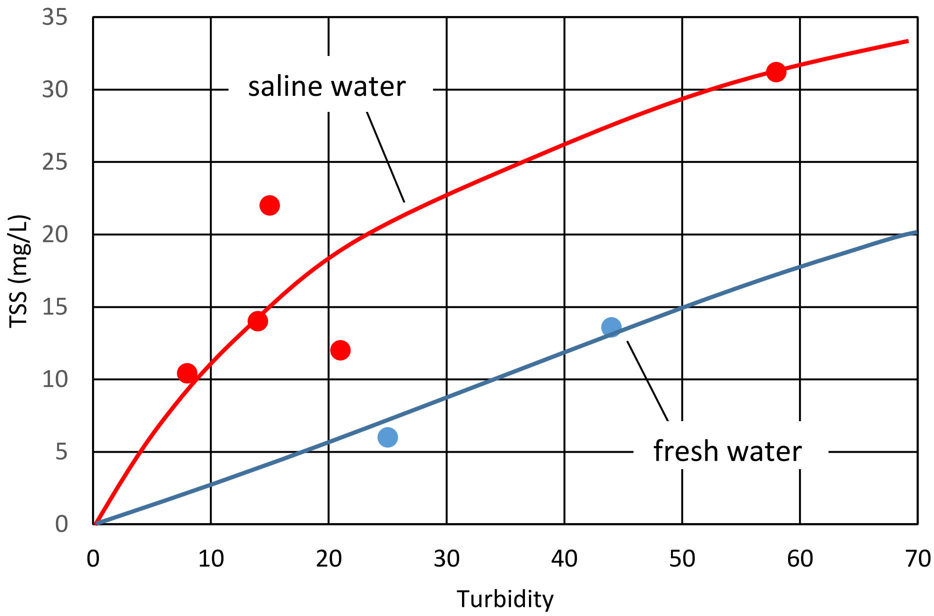

Figure 6.—Turbidity and TSS relationship showing difference between fresh- and saline-water samples at site BLB1.

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),

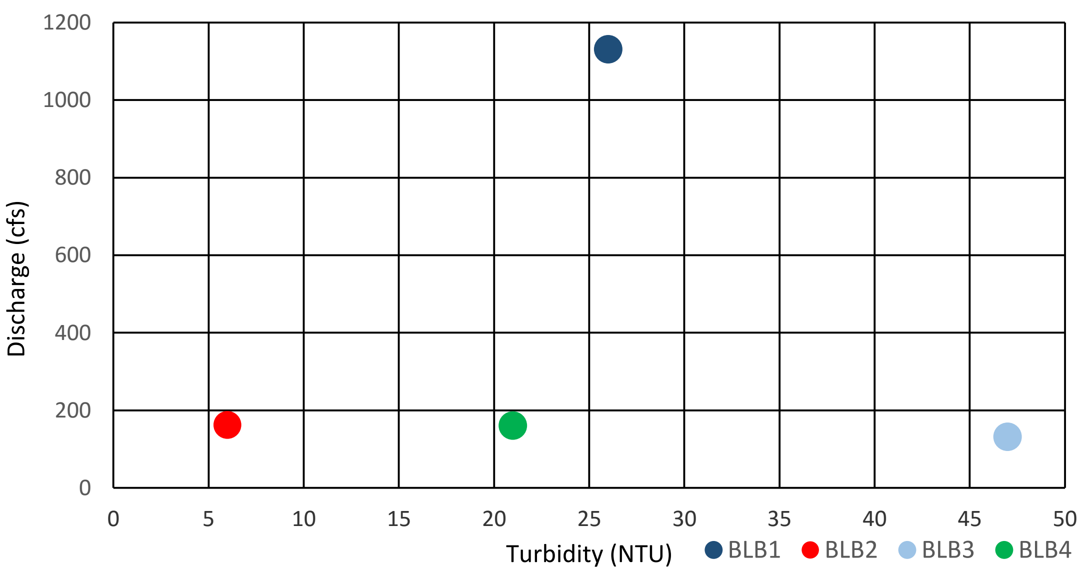

Figure 7.—Average turbidity and discharge relationships for Bayou La Batre monitored sites.

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.

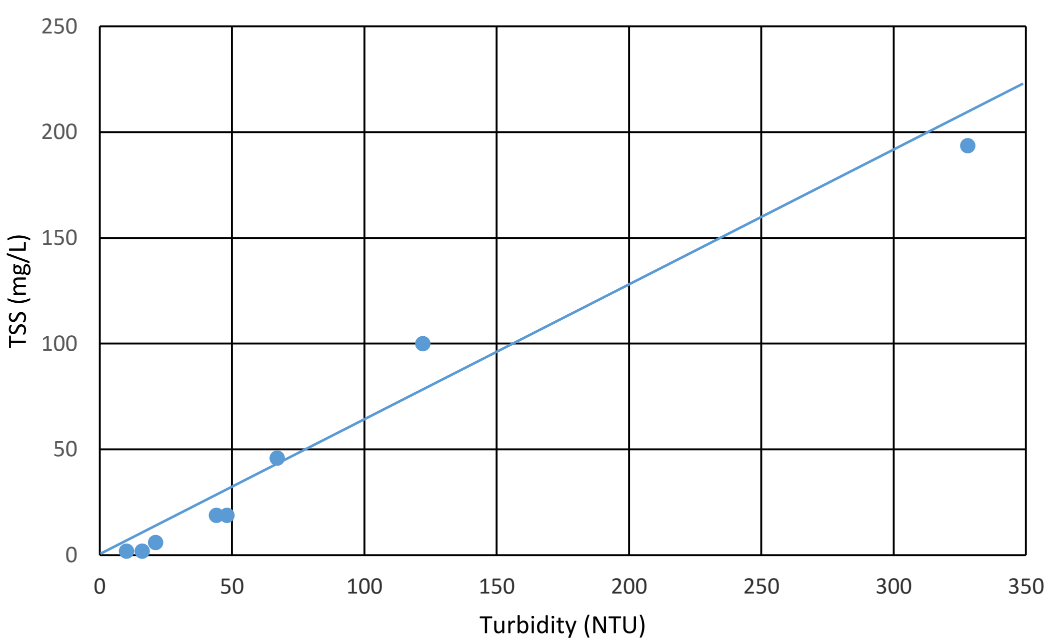

Figure 8.—Turbidity and TSS relationship for fresh-water samples from Carls Creek site BLB3.

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

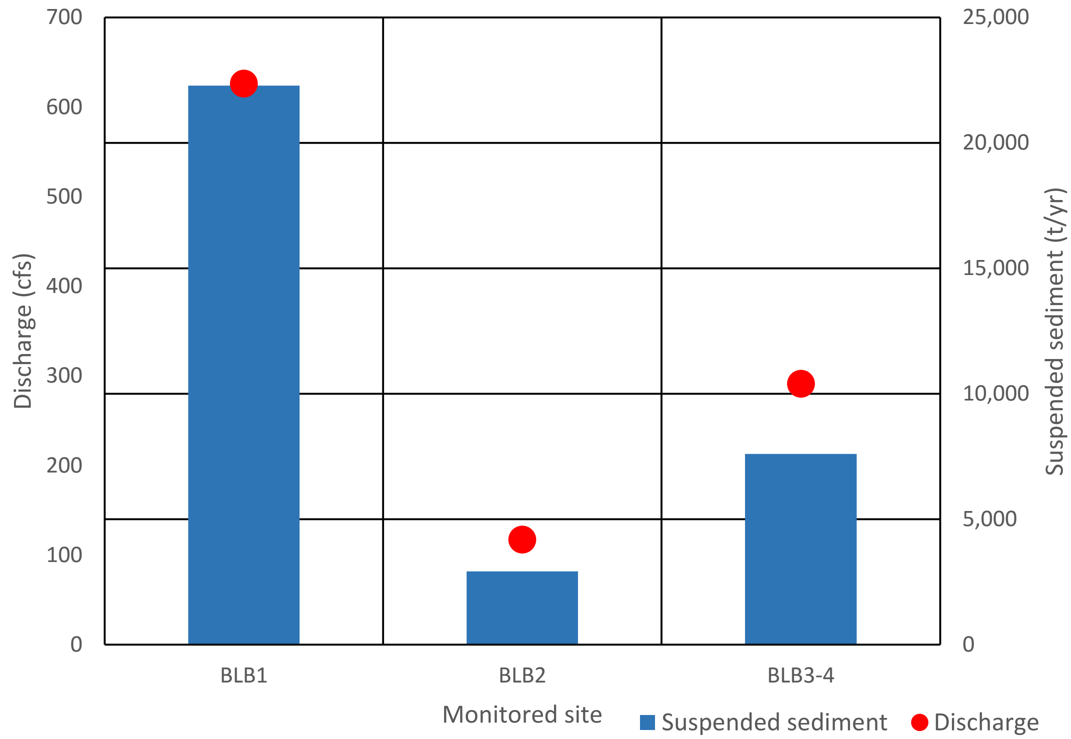

Figure 9.—Average annual daily discharge and suspended sediment loads for Bayou La Batre monitored sites.

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.

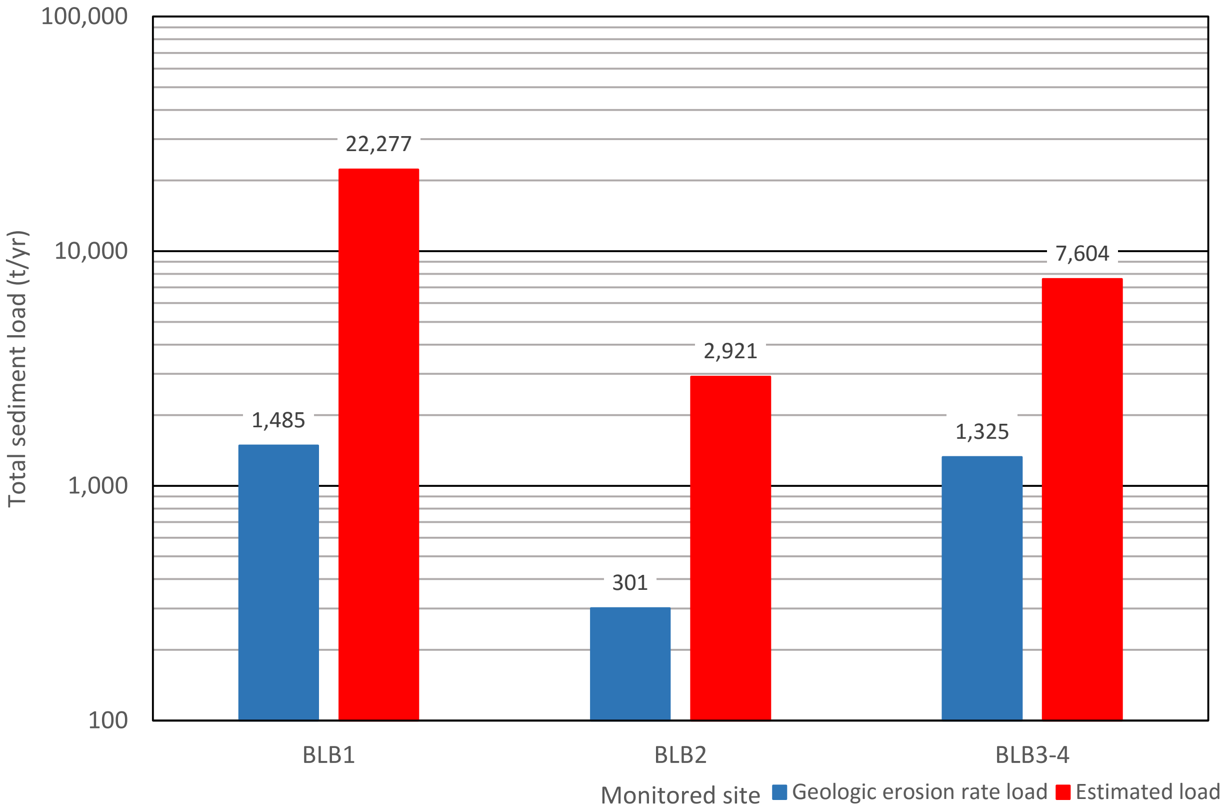

Figure 10.—Comparisons of total sediment geologic erosion rate loads with estimated total sediment loads for monitored Bayou La Batre watersheds.

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).

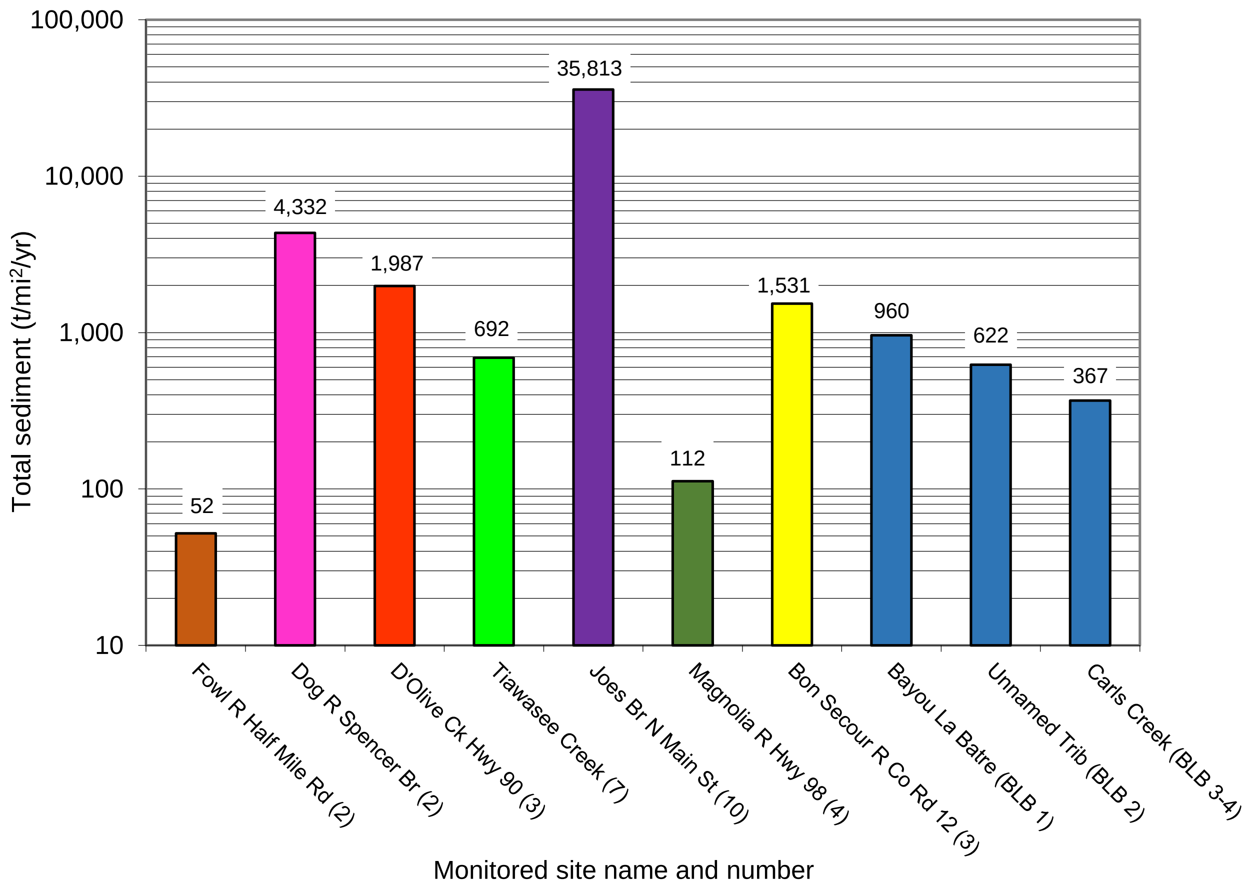

Figure 11.—Comparison of total sediment loads for streams in Baldwin and Mobile Counties.

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

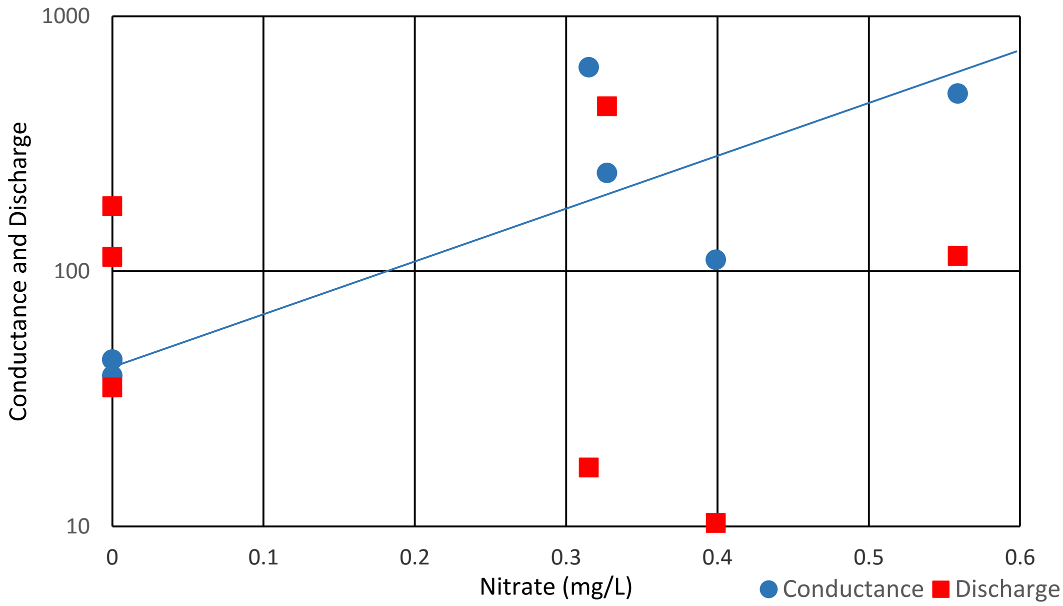

Figure 12.—Relationships of measured nitrate with measured conductance and discharge at site BLB3 (Carls Creek man-made channel at Arnette Street).

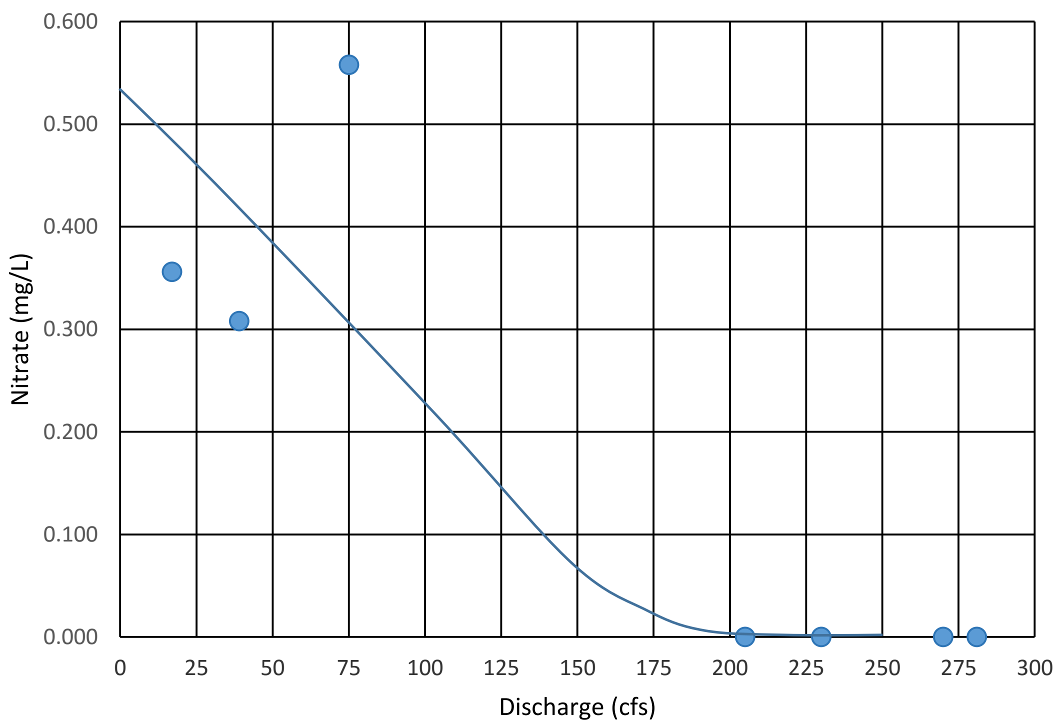

Figure 13.—Relationship of nitrate and discharge at site BLB4 (Carls Creek natural channel at Arnette Street).

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.

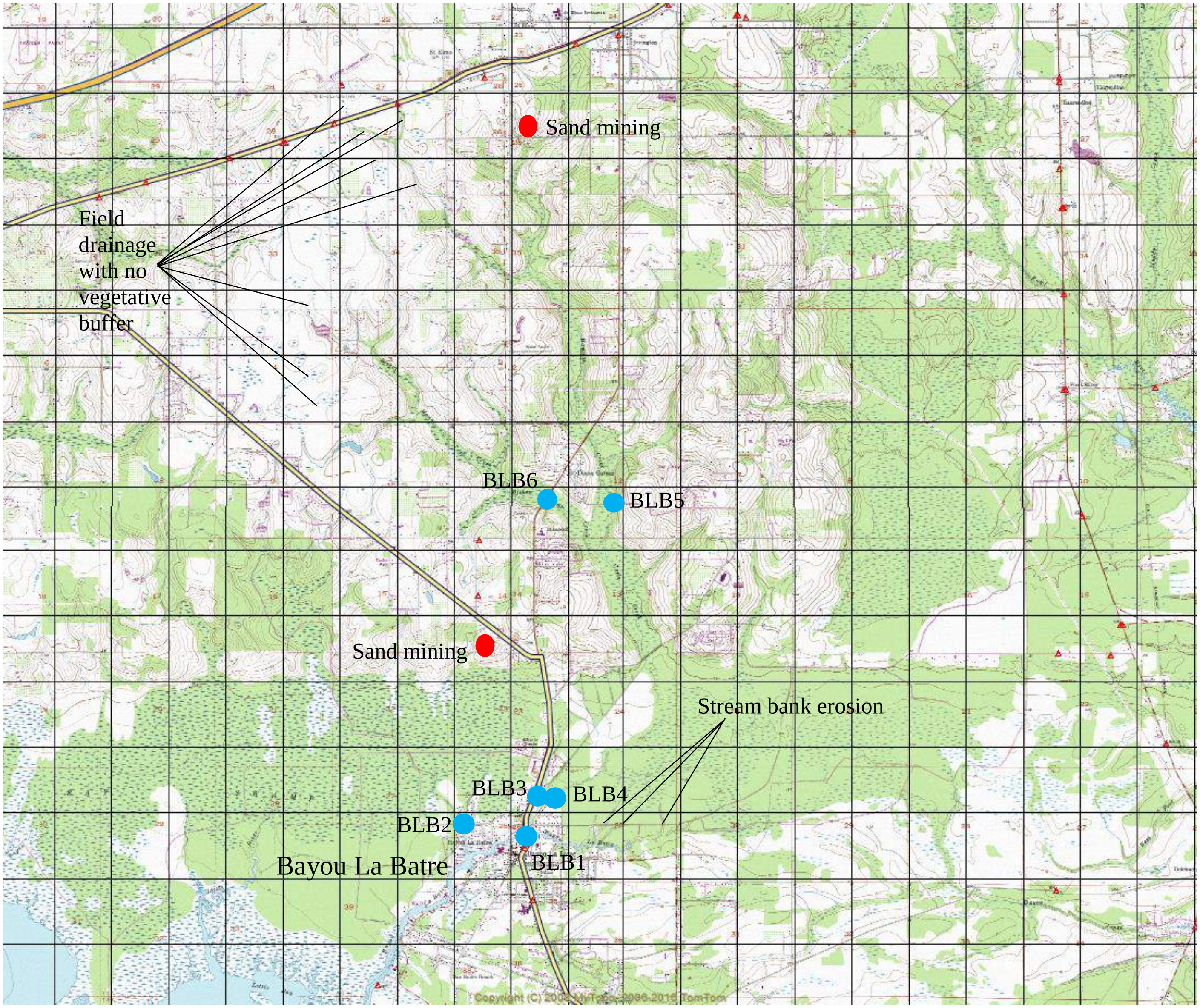

Figure 15.—Sources of water quality impacts identified by field observations.

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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E-mail: publications@gsa.state.al.us

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 AGRICULTURE AND FORESTRY BEST MANAGEMENT PRACTICES

1. Alabama NRCS Conservation Practice Catalog
2. Alabama's Best Management Practices for Forestry

USDA
United States Department of Agriculture
Natural Resources
Conservation Service

ALABAMA

Natural Resources Conservation Service

CONSERVATION PRACTICE CATALOG

As a landowner or farm operator, you face many decisions when managing your natural resources. When you evaluate options for your operation, consider installing conservation practices listed in this handout to help improve your resource management and cropping system. A conservation plan can be developed to improve management for additional resource concerns. NRCS staff and your local soil and water conservation district (SWCD) are available to help you make the right choices to protect your operation and resources.

Helping People Help the Land

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October 2016

This document is not to be used as technical guidance or policy. All NRCS practices shall be applied according to current Conservation Practice Standards available in the Field Office Technical Guide, Section IV (http://efotg.sc.egov.usda.gov/efotg_locator.aspx?map=).

For information on the USDA Natural Resources Conservation Service in Alabama, visit www.al.nrcs.usda.gov or follow us on Twitter at http://twitter.com/NRCS_AL

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Access Control - 472

Practice Description
The temporary or permanent exclusion of animals, people, vehicles, and/or equipment from an area

Purpose
Acheive and maintain by monitoring and managing animals people, vehicles, coordination with the practices, measures conservation plan

Access Road - 560

Practice Description
A travel-way for equipment and vehicles constructed to provide a fixed route for vehicular travel for resource activities involving the management of timber, livestock, agriculture, wildlife habitat, and other conservation enterprises while protecting the soil, water, air, fish, wildlife, and other adjacent natural resources

Purpose
This practice is planned where access is needed from a private or public road or highway to a land use enterprise or conservation measure, or where travel ways are needed in a planned land use area. Access roads range from seasonal use roads, designed for low speed and rough driving conditions, to all-weather roads heavily used by the public and designed with safety as a high priority. Some roads are only constructed for a single purpose; i.e. control of forest fires, logging and forest management activities, access to remote recreation areas, or access for maintenance of facilities.

Agrichemical Handling Facility - 309

Practice Description
A facility with an impervious surface to provide an environmentally safe area for on-farm agrichemicals. Provides a safe environment to store, mix, load and cleanup agrichemicals, retain incidental spillage, retain leakage, and reduce surface water, groundwater, air, and/or soil pollution

Purpose
Practice applies where:

- The handling of agrichemicals creates significant potential for pollution of surface water, groundwater, air or soil and a facility is needed to properly manage and handle the chemical operation;
- An adequate water supply is available for filling application equipment tanks, rinsing application equipment and chemical containers as needed;
- Soils and topography are suitable for construction.

NOTE: This practice does not apply to the handling or storage of fuels, or to commercial or multi-landowner agrichemical handling operations.

Amendments for Treatment of Ag Waste - 591

Practice Description
The treatment of manure, wastewater, storm water runoff from high use areas, and other wastes, with chemical or biological additives

Purpose
This practice applies where the use of a chemical or biological amendments will alter the physical and chemical characteristics of animal waste as a part of a planned waste management system to:

• Improve or protect air quality
• Improve or protect water quality
• Improve or protect animal health
• Alter the consistency of the waste stream of facilitates implementation of a waste management system

Anerobic Digester - 366

Practice Description
A component of a waste management system that provides biological treatment in the absence of oxygen

Purpose
This practice is applied for the treatment of manure and other byproducts of animal agricultural operations for one or more of the following reasons:

• Capture biogas for energy production
• Manage odors
• Reduce the net effect of greenhouse gas emissions
• Reduce pathogens

Animal Mortality Facility - 316

Practice Description
An on-farm facility for the treatment or disposal of livestock and poultry carcasses for routine and catastrophic mortality events

Purpose
This practice is applied for one or more of the following purposes:

• Reduce impacts to surface and groundwater resources
• Reduce the impact of odors
• Decrease the spread of pathogens

Animal Trails and Walkways - 575

Practice Description
Established lanes or travel ways that facilitate animal movement

Purpose
This practice is applied to achieve one or more of the following:

• Provide or improve access to forage, water, working/handling facilities, and/or shelter
• Improve grazing efficiency and distribution, and/or
• Protect ecologically sensitive, erosive and/or potentially erosive sites

Anionic Polyacrylamide Erosion Control - 450

Practice Description
Application of water-soluble Anionic Polyacrylamide (PAM) to meet a resource concern

Purpose
This practice is applied as part of a conservation system to support one or more of the following:

• Reduce soil erosion by water or wind
• Improve water quality
• Improve air quality by reducing dust emissions

Aquaculture Ponds - 397

Practice Description
A water impoundment constructed and managed for commercial production of fish and other aquaculture products

Purpose
This practice applies to all types of ponds installed or modified for commercial production of fish and other animals and plants. The purpose of the practice is to provide a favorable water environment for producing, growing, harvesting, and marketing commercial aquaculture crops.

Brush Management - 314

Practice Description
The management or removal of woody (non-herbaceous or succulent) plants including those that are invasive and noxious

Purpose
This practice is applied to achieve one or more of the following:

• Create the desired plant community consistent with the ecological site
• Restore or release desired vegetative cover to protect soils, control erosion, reduce sediment, improve water quality or enhance stream flow
• Maintain, modify, or enhance fish and wildlife habitat
• Improve forage accessibility, quality and quantity for livestock and wildlife
• Manage fuel loads to achieve desired conditions

Channel Bed Stabilization - 584

Practice Description
Measure(s) used to stabilize the bed or bottom of a channel. This practice applies to the beds of existing or newly constructed alluvial or threshold channels that are undergoing damaging aggradation or degradation and that cannot be feasibly controlled by clearing or snagging, by the establishment of vegetative protection, by the installation of bank protection, or by the installation of upstream water control measures

Purpose
This practice may be applied as part of a conservation management system to support one or more of the following:

• Maintain or alter channel bed elevation or gradient
• Modify sediment transport or deposition
• Manage surface water and groundwater levels in floodplains, riparian areas, and wetlands

Clearing and Snagging - 326

Practice Description
Removal of vegetation along the bank (clearing) and/or selective removal of snags, drifts, or other obstructions (snagging) from natural or improved channels and streams

Purpose
Reduce risks to agricultural resources or civil infrastructure by removing obstructions that hinder channel flow or sediment transport in order to accomplish one or more of the following:

• Restore flow capacity and direction
• Prevent excessive bank erosion by eddies or redirection of flow
• Reduce the undesirable formation of bars; and/or;
• Minimize blockages by debris and ice

Combustion System Improvement - 372

Practice Description
Installing, replacing, or retrofitting agricultural combustion systems and/or related components or devices for air quality and energy efficiency improvement

Purpose
This practice is applied to achieve one or more of the following:

- To improve air quality by addressing the air quality resource concerns for particulate matter and ozone precursors by mitigating actual or potential emissions of oxides of nitrogen and/or fine particulate matter
- To improve the energy efficiency of agricultural combustion systems

Composting Facility - 317

Practice Description
A facility to process raw organic by-products such as, animal mortality and manure into biologically stable organic material

Purpose
This practice is applied to reduce the pollution potential of organic agricultural wastes to surface and groundwater by one or more of the following:

- Reduces volume by 25 to 50 percent
- Improves fertilizing capabilities by converting nitrogen to less soluble form
- Aids in nutrient management

Conservation Cover - 327

Practice Description
Establishing and maintaining permanent vegetative cover

Purpose
This practice may be applied to accomplish one or more of the following:

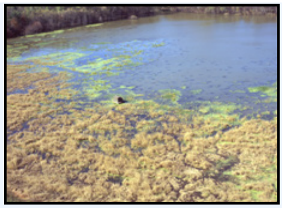
- Reduce soil erosion and sedimentation
- Improve water quality
- Enhance wildlife habitat

Conservation Crop Rotation - 328

Practice Description
Growing crops in a recurring sequence on the same field

Purpose
This practice may be applied as part of a conservation management system to support one or more of the following:

• Reduce sheet and rill erosion
• Reduce soil erosion from wind
• Maintain or improve soil organic matter content
• Manage the balance of plant nutrients
• Improve water use efficiency
• Manage plant pests (weeds, insects, and diseases)
• Provide food for domestic livestock
• Provide food and cover for wildlife



Constructed Wetland - 656

Practice Description
An artificial ecosystem with hydrophytic vegetation for water treatment

Purpose
For treatment of wastewater and contaminated runoff from agricultural processing, livestock, and aquaculture facilities, or for improving the quality of storm water runoff or other water flows lacking specific water quality discharge criteria

Contour Buffer Strips - 332

Practice Description
Narrow strips of permanent, herbaceous vegetative cover established around the hill slope, and alternated down the slope with wider cropped strips that are farmed on the contour

Purpose
This practice is applied to achieve one or more of the following:

• Reduce sheet and rill erosion
• Reduce transport of sediment and other water-borne contaminants downslope
• Increase water infiltration

Contour Farming - 330

Practice Description
Using ridges and furrows formed by tillage, planting and other farming operations to change the direction of runoff from directly downslope to around the hillslope

Purpose
This practice is applied to achieve one or more of the following:

• Reduce sheet and rill erosion
• Reduce transport of sediment, other solids and the contaminants attached to them
• Increase water infiltration

Contour Orchard and Other Perennial Crops - 331

Practice Description
Planting orchards, vineyards, or small fruits so that all cultural operations are done on the countour

Purpose
• Reduce soil erosion
• Reduce water loss

Cover Crop - 340

Practice Description
Crops including grasses, legumes and forbs for seasonal cover and other conservation purposes

Purpose
This practice is applied to achieve one or more of the following:

• Reduce erosion from wind and water
• Increase soil organic matter content
• Promote biological nitrogen fixation
• Increase biodiversity
• Weed suppression
• Provide supplemental forage
• Soil moisture management
• Minimize and reduce soil compaction

Critical Area Planting - 342

Practice Description
Establishing permanent vegetation on sites that have or are expected to have high erosion rates, and on sites that have physical, chemical or biological conditions that prevent the establishment of vegetation with normal practices

Purpose

- Stabilize areas with existing or expected high rates of soil erosion by water.
- Stabilize areas with existing or expected high rates of soil erosion by wind
- Rehabilitate and re-vegetate degraded sites that cannot be stabilized through normal farming practices.
- Stabilize coastal areas, such as sand dunes and riparian areas.

Dam - 402

Practice Description
An artificial barrier that can impound water for one or more beneficial purposes

Purpose
This practice is applied to achieve one or more of the following:

- Reduce downstream flood damage
- Provide permanent water storage for one or more beneficial uses such as irrigation or livestock supply, fire control, municipal or industrial uses, or recreational uses
- Create or improve habitat for fish and wildlife

Deep Tillage - 324

Practice Description
Performing tillage operations below the normal tillage depth to modify adverse physical or chemical properties of a soil

Purpose
This practice is applied to achieve one or more of the following:

- Bury or mix soil deposits from wind or water erosion or flood overwash
- Reduce concentration of soil contaminants, which inhibit plant growth
- Fracture restrictive soil layers

Dike - 356

Practice Description
A berm or ridge, or ridge and channel combination of compacted soil to channel water to a desired location or away from an undesired location

Purpose
This practice is applied to achieve one or more of the following:

• Protect people and property from floods
• Control water level in connection with crop production, fish and wildlife management; or wetland maintenance, improvement, restoration, or construction
• Direct water to stable outlets or traps
• Direct clean water away from disturbed or polluted areas

Diversion - 362

Practice Description
A channel constructed across the slope with a supporting ridge on the lower side

Purpose
This practice may be applied as part of a resource management system to support one or more of the following purposes:

• Break up concentrations of water on long slopes, on undulating land surfaces, and on land that is generally considered too flat or irregular for terracing
• Increase or decrease the drainage area above ponds
• Protect terrace systems by diverting water from the top terrace where topography, land use, or land ownership prevents terracing the land above
• Intercept surface and shallow subsurface flow
• Reduce runoff damages from upland runoff

Drainage Water Management - 554

Practice Description
The use of structures for water control in the process of managing water discharges from surface and/or subsurface agricultural drainage systems

Purpose
The purpose of this practice is:

• Reduce nutrient, pathogen, and/or pesticide loading from drainage systems into downstream receiving waters
• Improve productivity, health, and vigor of plants
• Reduce oxidation of organic matter in soils
• Reduce wind erosion or particulate matter (dust) emissions
• Provide seasonal wildlife habitat

Dry Hydrant - 432

Practice Description
A non-pressurized permanent pipe assembly system installed into water source that permits the withdrawal of water by suction. To provide all weather access to an available water source for fire suppression

Purpose
Where a dependable source of water is available, where transport vehicles can access the site, and where a source of water is needed for fire suppression.

Early Successional Habitat Development / Management - 647

Practice Description
Manage plant succession to develop and maintain early successional habitat to benefit desired wildlife and/or natural communities. To provide habitat for species requiring early successional habitat for all or part of their life cycle

Purpose
This practice is applied on all lands that are suitable for the kinds of desired wildlife and plant species. Management will be designed to achieve the desired plant community structure (e.g., density, vertical and horizontal cover) and plant species diversity.

Farmstead Energy Improvement - 374

Practice Description
Installing, replacing, or retrofitting agricultural equipment systems and/or related components or devices which results in an on-farm and/or off-site reduction in actual or potential emissions of greenhouse gases

Purpose
This practice is applied to achieve the following:

• Reduce net greenhouse gas emissions (on farm and/or off-site) from agricultural systems or components by implementing the recommendations from on-site energy audits

Fence - 382

Practice Description
A constructed barrier to animals or people

Purpose
This practice facilitates the accomplishment of conservation objectives by providing a means to control movement of animals, people, and vehicles.

Feral Swine Management Conservation Activity - 297

Practice Description
Feral swine management is a component of an area wide effort of assessment, planning, exclusion, scouting, control, and monitoring to document and reduce resource damage caused by
feral swine and focus interagency management efforts to reduce adverse resource impacts and health concerns for other animals and humans.

Purpose
• Determine locations and intensity of feral swine impacts upon resource conditions and potential means to reduce or eliminate these impacts
• Develop a management plan to address feral-swine-impacted resources of concern using a conservation practice or system of conservation practices
• Evaluate the effectiveness of a practice or system of practices in reducing resource impacts from feral swine

Field Border - 386

Practice Description
A strip of permanent vegetation established at the edge or around the perimeter of a field

Purpose
This practice may be applied to accomplish one or more of the following:

• Reduce soil erosion
• Provide turn rows for farm machinery
• Soil and water quality protection
• Management of harmful insect populations
• Provide wildlife food and cover
• Increase carbon storage in biomass and soils
• Improve air quality

Filter Strip - 393

Practice Description
A strip or area of herbaceous vegetation that removes contaminants from overland flow

Purpose
This practice is applied to achieve one or more of the following:

- Reduce suspended solids and associated contaminants in runoff
- Reduce dissolved contaminant loadings in runoff
- Reduce suspended solids and associated contaminants in irrigation tailwater

Firebreak - 394

Practice Description
A permanent or temporary strip of bare or vegetated land planned to retard fire

Purpose
This practice applies on all land uses where protection from wildfire is needed or prescribed burning is applied to accomplish one or more of the following:

- Reduce the spread of wildfire
- Contain prescribed burns

Fishpond Management - 399

Practice Description
Managing impounded water for the production of fish or other aquatic organisms

Purpose
This practice is applied in warm and cold water ponds, lakes, and reservoirs not managed for commercial aquaculture purposes to accomplish one or more of the following:

- To provide favorable habitat for fish and other aquatic organisms.
- To develop and maintain a desired species composition and ratio.
- To develop and maintain a desired level of production

Forage and Biomass Planting - 512

Practice Description
Establishing adapted and/or compatible species, varieties, or cultivars of herbaceous species suitable for pasture, hay, or biomass production

Purpose
This practice is applied to achieve one or more of the following:

•Improve or maintain livestock nutrition and/or health
•Provide or increase forage supply during periods of low forage production
• Reduce soil erosion
• Improve soil quality and water quality
• Produce feedstock for biofuel or energy production

Forage Harvest Management - 511

Practice Description
The timely cutting and removal of forages from the field as hay, green-chop or ensilage

Purpose
• Optimize yield and quality of forage at the desired levels
• Promote vigorous plant re-growth
• Manage for the desired species composition
• Use forage plant bio-mass as a soil nutrient uptake tool
• Control insects, dis-eases and weeds
• Maintain and/or im-prove wildlife habitat

Forest Stand Improvement - 666

Practice Description
The manipulation of spe-cies composition, stand structure and stocking by cutting or killing selected trees and understory vegetation

Purpose
This practice may be ap-plied to accomplish one or more of the following:

• Increase the quan-tity and quality of forest products by manipulat-ing stand density and structure
• Harvest forest products
• Initiate forest stand regeneration
• Reduce wildfire hazard
• Improve forest health reducing the potential of damage from pests and moisture stress
• Restore natural plant communities
• Achieve or maintain a desired native understory plant community for special forest products, grazing, and browsing
• Improve aesthetic and recreation, values
• Improve wildlife habitat
• Alter water yield
• Increase carbon storage in selected trees

Forest Trails and Landings - 655

Practice Description
A temporary or infrequently used route, path or cleared area. Trails and landings including skid trails are applicable on forest land. They typically connect to an Access Road (560)

Purpose
This practice may be applied to accomplish one or more of the following:

- Provide routes for temporary or infrequent travel by people or equipment for management activities
- Provide periodic access for removal and collection of forest products

Fuel Break - 383

Practice Description
A strip or block of land on which the vegetation, debris and detritus have been reduced and/or modified to control or diminish the risk of the spread of fire crossing the strip or block of land

Purpose
This practice applies on all land where protection from wildfire is needed to control and reduce the risk of the spread of fire by treating, removing or modifying vegetation, debris and detritus.

Grade Stabilization Structure - 410

Practice Description
A structure used to control the grade and head cutting in natural or artificial channels

Purpose
The purpose of this practice is to stabilize the grade and control erosion in natural or artificial channels, to prevent the formation or advance of gullies, and to enhance environmental quality and reduce pollution hazards.

Grassed Waterways - 412

Practice Description
A shaped or graded channel that is established with suitable vegetation to carry surface water at a non-erosive velocity to a stable outlet

Purpose
This practice is applied to achieve one or more of the following:

• Convey runoff from terraces, diversions, or other water concentrations without causing erosion or flooding
• Reduce gully erosion
• Protect/improve water quality

Heavy Use Area Protection - 561

Practice Description
The stabilization of areas frequently and intensively used by people, animals or vehicles by establishing vegetative cover, by surfacing with suitable materials, and/or by installing needed structures

Purpose
This practice is applied to achieve one or more of the following:

• Reduce soil erosion
• Improve water quantity and quality
• Improve air quality
• Improve aesthetics
• Improve livestock health

Hedgerow Planting - 422

Practice Description
Establishment of dense vegetation in a linear design to achieve a natural resource conservation purpose

Purpose
This practice may be installed to accomplish one or more of the following:

• Habitat, including food, cover, and corridors for terrestrial wildlife
• To enhance pollen, nectar, and nesting habitat for pollinators
• Food, cover, and shade for aquatic organisms that live in adjacent streams or watercourses
• To provide substrate for predaceous and beneficial invertebrates as a component of integrated pest management
• To intercept airborne particulate matter
• To reduce chemical drift and odor movement
• Screens and barriers to noise and dust
• To increase carbon storage in biomass and soils
• Living fences
• Boundary delineation and contour guidelines

Herbaceous Weed Control - 315

Practice Description
The removal or control of herbaceous weeds including invasive, noxious and prohibited plants

Purpose
• Enhance accesibility, quantity, and quality of forage and/or browse.
• Restore or release native ore create desired plant communities and wildlife habitats consistent with the ecological site.
• Protect soils and control erosion
• Reduce fine-fuels fire hazard and improve air quality

Integrated Pest Management - 595

Practice Description
A site-specific combination of pest prevention, pest avoidance, pest monitoring, and pest suppression strategies

Purpose
This practice is applied on all lands where pests will be managed to accomplish one or more of the following:

• Prevent or mitigate off-site pesticide risks to water quality from leaching, solution runoff and adsorbed runoff losses
• Prevent or mitigate off-site pesticide risks to soil, water, air, plants, animals and humans from drift and volatilization losses
• Prevent or mitigate on-site pesticide risks to pollinators and other beneficial species through direct contact
• Prevent or mitigate cultural, mechanical and biological pest suppression risks to soil, water, air, plants, animals and humans

Irrigation Canal or Lateral - 320

Practice Description
A permanent channel constructed to convey irrigation water from the source of supply to one or more irrigated areas

Purpose
Apply this practice to facilitate the efficient distribution and use of water on irrigated land to accomplish one or more of the following:

• Where a canal or lateral and related structures are needed as an integral part of an irrigation water conveyance system
• Where water supplies for the area served are sufficient to make irrigation practical for the crops to be grown and the irrigation water application methods to be used

Conservation Practice Standard Irrigation Field Ditch (388) should be used for on-farm irrigation water conveyance and/or distribution of less than 25 cubic feet per second

Irrigation Field Ditch - 388

Practice Description
A permanent irrigation ditch constructed in or with earth materials, to convey water from the source of supply to a field or fields in an irrigation system

Purpose
This practice may be applied as part of an irrigation water management system to efficiently convey and distribute irrigation waters. This standard is limited to open channels and elevated ditches of 25 cubic feet per second or less in capacity and constructed of earth materials. The practice applies where field ditches are needed as an integral part of an irrigation water distribution system design to facilitate the conservation use of soil and water resources.

Irrigation Land Leveling - 464

Practice Description
Reshaping the surface of land to be irrigated, to planned lines and grades

Purpose
This practice applies to the leveling of land irrigated by surface or subsurface irrigation systems. The leveling is based on a detailed engineering survey, design, and layout. Land to be leveled shall be suitable for irrigation and for the proposed methods of water application. Soils shall be deep enough that, after leveling, an adequate usable root zone remains that will permit satisfactory crop production with proper conservation measures. Limited areas of shallow soils may be leveled to provide adequate irrigation grades or an improved field alignment. The finished leveling work must not result in exposed areas of highly permeable soil materials that would inhibit proper distribution of water over the field.

Irrigation Pipeline - 430

Practice Description
A pipeline and appurtenances installed in an irrigation system to convey water

Purpose
This practice is applied to convey water from a source of supply to an irrigation system or storage reservoir.

Irrigation Reservoir - 436

Practice Description
An irrigation water storage structure made by constructing a dam, embankment, pit, or tank

Purpose
This practice may be applied as part of a resource conservation system to achieve one or more of the following:

- Store water to provide a reliable irrigation water supply or regulate available irrigation flows
- Improve water use efficiency on irrigated land
- Provide storage for tailwater recovery and reuse
- Provide irrigation runoff retention time to increase breakdown of chemical contaminants
- Reduce energy consumption

Irrigation System, Microirrigation - 441

Practice Description
An irrigation system for frequent application of small quantities of water on or below the soil surface: as drops, tiny streams or miniature spray through emitters or applicators placed along a water delivery line

Purpose
This practice may be applied as part of a conservation management system to support one or more of the following purposes:

- To efficiently and uniformly apply irrigation water and maintain soil moisture for plant growth
- Prevent contamination of ground and surface water by efficiently and uniformly applying chemicals
- Establish desired vegetation

Irrigation System, Sprinkler - 442

Practice Description
An irrigation system in which all necessary equipment and facilities are installed for efficiently applying water by means of nozzles operated under pressure

Purpose
This practice may be applied as part of a conservation management system to achieve one or more of the following:

- Efficiently and uniformly apply irrigation water to maintain adequate soil water for the desired level of plant growth and production without causing excessive water loss, erosion, or water quality impairment
- Climate control and/or modification
- Applying chemicals, nutrients, and/or waste water
- Leaching for control or reclamation of saline or sodic soils
- Reduction in particulate matter emissions to improve air quality

Irrigation System, Surface and Subsurface - 443

Practice Description
A system in which all necessary earthwork, multi-outlet pipelines, and water-control structures have been installed for distribution of water by surface means, such as furrows, borders, and contour levees, or by subsurface means through water table control

Purpose
Applied as part of a resource conservation system to achieve one or more of the following:

• Efficiently convey and distribute irrigation water to the surface point of application without causing excessive water loss, erosion, or water quality impairment
• Efficiently convey and distribute irrigation water to the subsurface point of application without causing excessive water loss or water quality impairment
• Apply chemicals and/or nutrients as part of a surface irrigation system in a manner which protects water quality
• Improve energy use efficiency

Irrigation Tailwater Recovery - 447

Practice Description
A planned irrigation system in which all facilities utilized for the collection, storage, and transportation of irrigation tailwater and/or rainfall runoff for reuse have been installed

Purpose
This practice shall be applied as part of a conservation management system to support one or more of the following:

• Conserve irrigation water supplies
• Improve off-site water quality

Irrigation Water Management - 449

Practice Description
The process of determining and controlling the volume, frequency and application rate of irrigation water in a planned, efficient manner

Purpose
This practice is applied to achieve one or more of the following:

• Manage soil moisture to promote desired crop response
• Optimize use of available water supplies
• Minimize irrigation induced soil erosion
• Decrease non-point source pollution of surface and groundwater resources
• Manage salts in the crop root zone
• Manage air, soil, or plant micro-climate
• Proper and safe chemigation or fertigation
• Improve air quality by managing soil moisture to reduce particulate matter movement

Karst Sinkhole Treatment - 527

Practice Description
The treatment of sinkholes in karst areas to reduce contamination of groundwater resources, and/or to improve farm safety

Purpose
This practice may be applied as part of a conservation management system in karst topography, which is an area underlain by solutioned carbonate bedrock with sinkholes and caverns. The practice supports one or more of the following purposes:

- Improve water quality
- Improve farm safety

Land Clearing - 460

Practice Description
Removing trees, stumps, and other vegetation to achieve a conservation objective

Purpose
This practice applies to wooded areas where the removal of trees, stumps, brush, and other vegetation is needed in carrying out a conservation plan to allow needed land use adjustments and improvements in the interest of conservation.

Land Reclamation, Abandoned Mined Land - 543

Practice Description
Reclamation of land and water areas adversely affected by past mining activities

Purpose
Apply this practice to abandoned mined land that degrades the quality of the environment and prevents or interferes with the beneficial uses of soil, water, air, plant or animal resources, or endangers human health and safety to accomplish one or more of the following:

- Stabilize abandoned mined areas to decrease erosion and sedimentation, support desirable vegetation and improve off-site water quality and or quantity
- Maintain or improve landscape visual and functional quality
- Protect public health, safety and general welfare

Land Reclamation, Landslide Treatment - 453

Practice Description
Managing natural materials, mine spoil (excavated over-burden), mine waste or overburden to reduce down-slope movement.

Purpose
Apply where in-place material, mine spoil, waste, or overburden, or rock cut road banks are unstable, moving, or judged to have potential of moving down slope in a manner that will cause damage to life, property, or the environment to accomplish one or more of the following:

• Repair unstable slopes caused by slope failure, and reduce the chance of enlargement or movement of slope surfaces
• Protect life and property
• Prevent excessive erosion and sedimentation
• Improve water quality and landscape resource quality
• Create a condition conducive to establishing surface protection and beneficial land use

This practice does not apply to constructed embankment surfaces (road fills, dams, dikes, levees and terraces.

Land Smoothing - 466

Practice Description
Removing irregularities on the land surface. To improve surface drainage, provide for more uniform cultivation, and improve equipment operation and efficiency.

Purpose
This practice applies on areas where depressions, mounds, old terraces, turn-rows, and other surface irregularities interfere with the application of needed soil and water conservation and management practices. It is limited to areas having adequate soil depth or where topsoil can be salvaged and replaced. This practice does not apply to the regular maintenance on irrigated land or on land that has been modified using practice standards Precision Land Forming (462) or Irrigation Land Leveling (464).

Lighting System Improvement - 670

Practice Description
Complete replacement or retrofitting of one or more components of an existing agricultural lighting system.

Purpose
This practice may be applied as part of a conservation management system to reduce energy use.

Livestock Shelter Structure - 576

Practice Description
A permanent or portable structure with less than four walls and/or a roof to provide for improved utilization of pastureland and rangeland and to shelter livestock from negative environmental factors. This structure is not to be construed to be a building

Purpose
• To provide protection for livestock from excessive heat, wind, cold, or snow.
• Protect surface waters from nutrient and pathogen loading.
• Protect wooded areas from accelerated erosion and excessive nutrient deposition by providing alternative livestock shelter/shade location.
• Improve the distribution of grazing livestock to enhance wildlife habitat, reduce overused areas, or correct other resource concerns resulting from improper livestock distribution

Mulching - 484

Practice Description
Applying plant residues or other suitable materials produced off site, to the land surface

Purpose
This practice is applied to achieve one or more of the following:

• Conserve soil moisture
• Moderate soil temperature
• Provide erosion control
• Suppress weed growth
• Establish vegetative cover
• Improve soil condition and increase soil fertility

Nutrient Management - 590

Practice Description
Managing the amount, source, placement, form and timing of the application of plant nutrients and soil amendments

Purpose
This practice is applied to achieve one or more of the following:

• Budget and supply nutrients for plant production
• Properly utilize manure or organic by-products as a plant nutrient source
• Minimize agricultural non-point source pollution of surface and groundwater resources
• Protect air quality by reducing nitrogen emissions (ammonia and NO2 compounds) and the formation of atmospheric particulates
• Maintain or improve the physical, chemical and biological condition of soil

Obstruction Removal - 500

Practice Description
Removal and disposal of buildings, structures, other works of improvement, vegetation, debris or other materials

Purpose
To safely remove and dispose of unwanted obstructions in order to apply conservation practices or facilitate the planned land use.

CONDITIONS WHERE PRACTICE APPLIES
On any land where existing obstructions interfere with planned land use development, public safety or infrastructure. This standard is not intended for the removal of obstructions from aquatic environments

Open Channel - 582

Practice Description
Pipeline having an inside diameter of 4 inches or less where conveyance of water is desirable or necessary to conserve the supply, or maintain the quality of water

Purpose
This practice is applied to improve water quantity and quality by conveying water from a source of supply to points of use for livestock or wildlife; make practical the exclusion of livestock from ponds and streams.

Pipeline (Livestock Pipeline) - 516

Practice Description
A pipeline and appurtenances installed to convey water for livestock and wildlife

Purpose
This practice may be applied as part of a resource management system to achieve one or more of the following purposes:
• Convey water to the points of use for livestock or wildlife
• Reduce energy use
• Develop renewable energy systems

Pond - 378

Practice Description
A water impoundment made by constructing an embankment or by excavating a pit or dugout. Ponds constructed by the first method are referred to as embankment ponds, and those constructed by the second method are referred to as excavated ponds. Ponds constructed by both the excavation and the embankment methods are classified as embankment ponds if the depth of water impounded against the embankment at the auxiliary spillway elevation is 3 feet or more

Purpose
This practice is applied to provide water for livestock, fish and wildlife, recreation, fire control, and other related uses, and to maintain or improve water quality.

Pond Sealing or Lining, Bentonite Sealant - 521c

Practice Description
A liner for a pond or waste storage impoundment consisting of a compacted soil-bentonite mixture.

Purpose
This practice is applied to reduce seepage losses from ponds or waste impoundments for water conservation and environmental protection to accomplish one or more of the following:

• Soils are suitable for treatment with bentonite
• Ponds or waste storage impoundments require treatment to reduce seepage rates and to impede the migration of contaminants to within acceptable limits

Pond Sealing or Lining, Compacted Clay Treatment - 521d

Practice Description
A liner for a pond or waste storage impoundment constructed using compacted soil without soil amendments

Purpose
Apply this practice to reduce seepage losses from ponds or waste storage impoundments constructed for water conservation and environmental protection to accomplish one or more of the following:

• In-place soils at the site would exhibit seepage rates in excess of acceptable limits or would allow an unacceptable migration of contaminants from the impoundment
• An adequate quantity of soil suitable for constructing a clay liner without amendments is available at an economical haul distance

Pond Sealing or Lining, Flexible Membrane - 521a

Practice Description
Pond sealing with a flexible membrane is installing a liner made of impervious flexible material to reduce seepage to an acceptable level

Purpose
This practice is used to improve the functionality of a pond, and prevent damage to the natural resources including unacceptable loss of water from seepage. This method of pond sealing is relatively expensive, but often necessary for sandy textured sites and projects that require a very effective sealant. Ponds to be lined may include Irrigation Storage Reservoirs, Irrigation Pits, Waste Treatment Lagoons, Waste Treatment Ponds, and Ponds For Livestock/Wildlife.

Pond Sealing or Lining, Soil Dispersant - 521b

Practice Description
A liner for a pond or waste storage impoundment consisting of a compacted soil-dispersant mixture

Purpose
Apply this practice to reduce seepage losses from ponds or waste impoundments for water conservation and environmental protection to accomplish one or more of the following:

• Soils are suitable for treatment with dispersants
• Ponds or waste storage impoundments require treatment to reduce seepage rates and to impede the migration of contaminants to within acceptable limits

Precision Land Forming - 462

Practice Description
Reshaping the surface of land to planned grades

Purpose
All precision land forming shall be planned as an integral part of an overall system to facilitate the conservative use to improve surface drainage and control erosion.

Prescribed Burning - 338

Practice Description
Controlled fire applied to a predetermined area

Purpose
This practice is applied to achieve one or more of the following:

• Control undesirable vegetation
• Prepare sites for harvesting, planting or seeding.
• Control plant disease.
• Reduce wildfire hazards
• Improve wildlife habitat
• Improve plant production quantity and/or quality
• Remove slash and debris
• Enhance seed and seedling production
• Facilitate distribution of grazing and browsing animals
• Restore and maintain ecological sites

Prescribed Grazing - 528

Practice Description
Managing the harvest of vegetation with grazing and/or browsing animals

Purpose
This practice may be applied as a part of conservation management system to achieve one or more of the following:

• Improve or maintain desired species composition and vigor of plant communities
• Improve or maintain quantity and quality of forage for grazing
• Improve or maintain surface and/or subsurface water quality and quantity
• Improve or maintain riparian and watershed function
• Reduce accelerated soil erosion, and maintain or improve soil condition
• Improve or maintain the quantity and quality of food and/or cover available for wildlife
• Manage fine fuel loads to achieve desired conditions

Pumping Plant - 533

Practice Description
A facility that delivers water at a designed pressure and flow rate. Includes the required pump, associated power unit(s), plumbing, appurtenances, and may include on-site fuel or energy sources, and protective structures.

Purpose
This practice may be applied as a part of a resource management system to achieve one or more of the following:

• Delivery of water irrigation, water facilities
• Removal of excessive surface water
• Provide efficient use of water on irrigated land
• Transfer of animal waste as part of a manure transfer system
• Improve energy use efficiency
• Improve air quality

Residue & Tillage Management, Reduce Till - 345

Practice Description
Managing the amount, orientation and distribution of crop and other plant residue on the soil surface year round while limiting the soil-disturbing activities used to grow crops in systems where the entire field surface is tilled prior to planting.

Purpose
This practice is applied as part of a conservation management system to support one or more of the following purposes:

• Reduce sheet and rill erosion
• Reduce tillage-induced particulate emissions
• Maintain or increase soil quality and organic matter content
• Reduce energy use
• Increase plant-available moisture

Residue Management, No-Till, and Strip Till - 329

Practice Description
Managing the amount, orientation and distribution of crop and other plant residue on the soil surface year round while limiting soil-disturbing activities to only those necessary to place nutrients, condition residue and plant crops.

Purpose
This practice is applied to achieve one or more of the following:

• Reduce sheet and rill erosion
• Reduce wind erosion
• Improve soil organic matter content
• Reduce CO2 losses from soil
• Increase plant-available moisture
• Provide food and escape cover for wildlife

Restoration and Management of Rare and Declining Habitats - 643

Practice Description
Restoring and managing rare and declining habitats and their associated wildlife species to conserve biodiversity.

Purpose
This practice may be installed to provide habitat for rare and declining species.

Riparian Forest Buffer - 391

Practice Description
An area predominantly trees and/or shrubs located adjacent to and up-gradient from watercourses or water bodies

Purpose
This practice is applied to achieve one or more of the following:

- Create shade to lower or maintain water temperatures to improve habitat for aquatic organisms
- Create or improve riparian habitat and provide a source of detritus and large woody debris
- Reduce excess amounts of sediment, organic material, nutrients and pesticides in surface runoff and reduce excess nutrients and other chemicals in shallow groundwater flow
- Reduce pesticide drift entering the water body
- Restore riparian plant communities
- Increase carbon storage in plant biomass and soils

Road / Trail / Landing Closure - Treatment - 654

Practice Description
The closure, decommissioning, or abandonment of roads, trails, and/or landings and associated treatment to achieve conservation objectives.

Purpose
To minimize various resource concerns associated with existing roads, trails, and/or landings by closing them and treating to a level where one or more the following objectives are achieved:

- Controlling erosion (road, sheet and rill, gully, wind), chemical residues and off-site movement, sediment deposition and damage, accentuated storm runoff, and particulate matter generation;
- Restoring land to a productive state by reestablishing adapted plants and habitat (wildlife food, cover, and shelter), reconnecting wildlife habitat and migration corridors including streams and riparian areas, and controlling noxious and invasive species;
- Reestablishing drainage patterns that existed prior to construction of the road, trail, or landing to restore the form and integrity of associated hill slopes, channels and floodplains and their related hydrologic and geomorphic processes;
- Minimizing human impacts to the closure area to meet safety, aesthetic, sensitive area protection, or wildlife habitat requirements

Roof Runoff Structure - 558

Practice Description
Structures that collect, control, and transport precipitation from roofs

Purpose
This practice may be installed to improve water quality, reduce soil erosion, increase infiltration, protect structures, improve animal health, and/or increase water quantity.

Roofs and Covers - 367

Practice Description
A rigid, semi-rigid, or flexible manufactured membrane, composite material, or roof structure placed over a waste management facility

Purpose
This practice is applied to achieve one or more of the following:

• Water quality improvement
• Diversion of clean water from animal management areas (i.e. barnyard, feedlot or exercise area) and/or waste storage facilities
• Capture of biogas for energy production
• Reducing net effect of greenhouse gas emissions
• Air quality improvement and odor reduction

High Tunnel System - 325

Practice Description
An enclosed polyethylene, polycarbonate, plastic, or fabric covered structure that is used to cover and protect crops from sun, wind, execessive rainfall, or cold to extend the growing season in an envrionmentally safe manner

Purpose
Improve plant health and vigor.

Sediment Basin - 350

Practice Description
A basin constructed to collect and store debris or sediment

Purpose
This practice is applied to achieve one or more of the following:

• Preserve the capacity of reservoirs, wetlands, ditches, canals, diversion, waterways, and streams
• Prevent undesirable deposition on bottom lands and developed areas
• Trap sediment originating from construction sites or other disturbed areas
• Reduce or abate pollution by providing basins for deposition and storage of silt, sand, gravel, stone, agricultural waste solids, and other detritus

Shallow Water Development and Management - 646

Practice Description
The inundation of lands to provide habitat for fish and/or wildlife

Purpose
To provide habitat for wildlife such as shore-birds, waterfowl, wading birds, mammals, fish, reptiles, amphibians and other species that require shallow water for at least a part of their life cycle.

Silvopasture Establishment - 381

Practice Description
An application establishing a combination of trees or shrubs and compatible forages on the same acreage

Purpose
This practice is applied to achieve one or more of the following:

• Provide forage for livestock and the production of wood products
• Increase carbon sequestration
• Improve water quality
• Reduce erosion
• Enhance wildlife habitat
• Reduce fire hazard
• Provide shade for livestock
• Develop renewable energy systems

Solid/Liquid Waste Separation Facility - 632

Practice Description
A filtration or screening device, settling tank, settling basin, or settling channel used to separate a portion of solids from a liquid waste stream

Purpose
This practice is applied to partition solids, liquids and their associated nutrients as part of a conservation management system to achieve one or more of the following:

• Improve or protect air quality
• Improve or protect water quality
• Improve or protect animal health
• Meet management objectives

Spoil Spreading - 572

Practice Description
Disposal of surplus excavated materials

Purpose
This practice applies to sites where spoil material is available from the excavation of open channels, ponds or other construction sites to dispose of excess soil from construction activities in an environmentally sound manner that minimizes soil erosion, protects water quality and fits with the land use and landscape

Spring Development - 574

Practice Description
Collection of water from springs or seeps to provide water for a conservation need

Purpose
In areas where a spring or seep will provide a dependable supply of suitable water to improve the quantity and/or quality of water for livestock, wildlife or other agricultural uses

Stream Crossing - 578

Practice Description
Controlling the quantity and quality of stormwater runoff

Purpose
To control stormwater runoff to achieve one or more of the following:
- Minimize erosion and sedimentation during and following construction activities.
- Reduce the quantity of stormwater leaving developing or developed sites.
- Improve the quality of stormwater leaving developing or developed sites

Storm Water Runoff Control - 570

Practice Description
A stabilized area or structure constructed across a stream to provide a travel way for people, livestock,equipment, or vehicles

Purpose
This practice may be applied to achieve improved water quality by the following:

• Reduce sediment, nutrient, organic, and inorganic loading of the stream
• Reduce stream bank and streambed erosion
• Provide crossing for access to another land unit
• Provide limited access for livestock water use

Stream Habitat Improvement and Management - 395

Practice Description
Maintain, improve or restore physical, chemical and biological functions of a stream, and its associated riparian zone, necessary for meeting the life history requirements of desired aquatic species.

Purpose
This practice is applied to achieve one or more of the following:

• Provide suitable habitat for desired fish and other aquatic species
• Provide stream channel and associated riparian conditions that maintain stream corridor ecological processes and hydrological connections of diverse stream habitat types important to aquatic species

Streambank and Shoreline Protection - 580

Practice Description
Treatment(s) used to stabilize and protect banks of streams or constructed channels, and shorelines of lakes, reservoirs, or estuaries

Purpose
This practice is applied to achieve one or more of the following:

• To prevent the loss of land or damage to land uses, or facilities adjacent to the banks of streams or constructed channels, shoreline of lakes, reservoirs, or estuaries including the protection of known historical, archeological, and traditional cultural properties
• To maintain the flow capacity of streams or channels
• Reduce the off-site or downstream effects of sediment resulting from bank erosion
• To improve or enhance the stream corridor for fish and wildlife habitat, aesthetics, and recreation

Stripcropping - 585

Practice Description
Growing planned rotations of row crops, forages, small grains, or fallow in a systematic arrangement of equal width strips across a field

Purpose
This practice may be applied to achieve one or more of the following:

• Reduce soil erosion from water and transport of sediment and other water-borne contaminants
• Reduce soil erosion from wind
• Protect growing crops from damage by wind-borne soil particles

Structure For Water Control - 587

Practice Description
A structure in a water management system that conveys water, controls the direction or rate of flow, maintains a desired water surface elevation or measures water

Purpose
The practice may be applied as a management component of a water management system to control the stage, discharge, distribution, delivery or direction of water flow.

Structure for Wildlife - 649

Practice Description
A structure installed to replace or modify a missing or deficient wildlife habitat component.
PURPOSE
To provide structures, in proper amounts, locations and seasons to:

Purpose
A structure installed to replace or modify a missing or deficient wildlife habitat component.
PURPOSE
To provide structures, in proper amounts, locations and seasons to:
• Enhance or sustain non-domesticated wildlife; or
• Modify existing structures that pose a hazard to wildlife

Surface Drain Field Ditch - 607

Practice Description
A graded ditch for collecting excess water in a field

Purpose
This practice may be applied as part of a resource conservation system to achieve one or more of the following:

• Interception of excess subsurface water and conveyance to an outlet
• Collection or interception of excess surface water, such as sheet flow from natural and graded land surfaces or channel flow from furrows, and conveyance to an outlet
• Drainage of surface depressions

Surface Drain, Main or Lateral - 608

Practice Description
An open drainage constructed to a designed cross section alignment and grade

Purpose
This practice is applied as part of a water management system (tailwater recovery) to collect and convey excess irrigation water to storage area for reuse through out the growing season.

Terrace - 600

Practice Description
An earthen embankment, or a combination ridge and channel, constructed across the field slope

Purpose
This practice is applied as a part of a resource management system for one or more of the following purposes:

• Reduce erosion by reducing slope length
• Retain runoff for moisture conservation

Tree/Shrub Establishment - 612

Practice Description
Establishing woody plants by planting seedlings or cuttings, direct seeding, or natural regeneration

Purpose
This practice is applied to establish woody plants for:

• Forest products such as timber, pulpwood, and energy biomass
• Wildlife habitat
• Long-term erosion control and improvement of water quality
• Treating waste
• Storing carbon in biomass
• Energy conservation
• Improving or restoring natural diversity
• Enhancing aesthetics

Tree/Shrub Pruning - 660

Practice Description
The removal of all or part of selected branches, leaders or roots from trees and shrubs

Purpose
This practice when applied may achieve one or more of the following:

• Improve the appearance of trees or shrubs, e.g., ornamental plants and Christmas trees
• Improve the quality of wood products
• Improve the production of plant products, e.g., nuts, fruits, boughs and tips
• Reduce fire and/or safety hazards
• Improve the growth and vigor of understory plants
• Adjust the foliage and branching density or rooting length for other specific intents, such as wind and snow control, noise abatement, access control, and visual screens and managing competition
• Improve health and vigor of woody plants e.g. disease, insect and injury management

Tree/Shrub Site Preparation - 490

Practice Description
Treatment of areas to improve site conditions for establishing trees and/or shrubs

Purpose
This practice when applied may achieve one or more of the following:

• Encourage natural regeneration of desirable woody plants
• Permit artificial establishment of woody plants

Underground Outlet - 620

Practice Description
A conduit or system of conduits installed beneath the surface of the ground to convey surface water to a suitable outlet.

Purpose
This practice is applied to carry water to a suitable outlet from terraces, water and sediment control basins, diversions, waterways, surface drains or other similar practices without causing damage by erosion or flooding.

Upland Wildlife Habitat Management - 645

Practice Description
Provide and manage upland habitats and connectivity within the landscape for wildlife.

Purpose
Treating upland wildlife habitat concerns identified during the conservation planning process that enable movement, or provide shelter, cover, food in proper amounts, locations and times to sustain wild animals that inhabit uplands during a portion of their life cycle.

Vegetated Treatment Area - 635

Practice Description
An area of permanent vegetation used for agricultural wastewater treatment.

Purpose
To improve water quality by reducing loading of nutrients, organics, pathogens, and other contaminants associated with livestock, poultry, and other agricultural operations.

Waste Facility Closure - 360

Practice Description
The closure of waste impoundments (treatment lagoons and liquid storage facilities), that are no longer used for their intended purpose, in an environmentally safe manner

Purpose
This practice is applied to achieve one or more of the following:

• Protect the quality of surface water and groundwater resources
• Eliminate a safety hazard for humans and livestock
• Safeguard the public health

Waste Recycling - 633

Practice Description
Using agricultural wastes such as manure and wastewater or other organic residues

Purpose
This practice is applied to achieve one or more of the following:

• Protect water quality
• Protect air quality
• Provide fertility for crop, forage, fiber production and forest products
• Improve or maintain soil structure
• Provide feedstock for livestock
• Provide a source of energy

Waste Storage Facility - 313

Practice Description
A waste storage impoundment made by constructing an embankment and/or excavating a pit or dugout, or by building a structure

Purpose
This practice is installed to temporarily store wastes such as manure, to protect from runoff as a component of an agricultural waste management system.

Waste Transfer - 634

Practice Description
A system using structures, conduits or equipment to convey by-products (wastes) from agricultural operations to points of usage

Purpose
To transfer agricultural material associated with production, processing, and/or harvesting through a hopper or reception pit, a pump (if applicable), a conduit, and/or hauling equipment to:

• A storage/treatment facility
• A loading area, and/or
• Agricultural land for final utilization as a resource

Waste Treatment - 629

Practice Description
The mechanical, chemical or biological treatment of agricultural waste

Purpose
To use mechanical, chemical, or biological treatment facilities and/processes as part of an agricultural waste management system:

• Improve ground and surface water quality by reducing the nutrient content, organic strength, and/or pathogen levels of agricultural waste
• Improve air quality by reducing odors and gaseous emissions
• Produce value added by-products
• Facilitate desirable waste handling, storage, or land application alternatives

Waste Treatment Lagoon - 359

Practice Description
A waste treatment impoundment made by constructing an embankment and/or excavating a pit or dugout

Purpose
To biologically treat waste, such as manure and wastewater, and thereby reduce pollution potential by serving as a treatment component of a waste management system.

• Where the lagoon is a component of a planned agricultural waste management system
• Where treatment is needed for organic wastes generated by agricultural production or processing
• On any site where the lagoon can be constructed, operated and maintained without polluting air or water resources
• To lagoons utilizing embankments with an effective height of 35 feet or less where damage resulting from failure would be limited to damage of farm buildings, agricultural land, or township and country roads

Water Harvesting Catchment - 636

Practice Description
The closure of waste impoundments (treatment lagoons and liquid storage facilities), that are no longer used for their intended purpose, in an environmentally safe manner

Purpose
This practice is applied to achieve one or more of the following:

• Protect the quality of surface water and groundwater resources
• Eliminate a safety hazard for humans and livestock
• Safeguard the public health

Water and Sediment Control Basin - 638

Practice Description
An earthen embankment or a combination ridge and channel constructed across the slope of minor watercourses to form a sediment trap and water detention basin with a stable outlet

Purpose
This practice may be applied as part of a resource management system for one or more of the following purposes:

• Reduce watercourse and gully erosion
• Trap sediment
• Reduce and manage on-site and downstream runoff

Watering Facility - 614

Practice Description
A permanent or portable device to provide an adequate amount and quality of drinking water for livestock and or wildlife

Purpose
To provide access to drinking water for livestock and/or wildlife in order to:

• Meet daily water requirements
• Improve animal distribution

Water Well - 642

Practice Description
A hole drilled, dug, driven, bored, jetted or otherwise constructed to an aquifer for water supply

Purpose
This practice is applied to achieve one or more of the following:

• Provide water for livestock, wildlife, irrigation, and other agricultural uses
• Facilitate proper use of vegetation, such as keeping animals on rangeland and pastures and away from streams, and providing water for wildlife

Water Well Decommissioning - 351

Practice Description
The sealing and permanent closure of an inactive, abandoned, or unusable water well

Purpose
This practice is applied to achieve one or more of the following:

• Eliminate physical hazard to people, animals, and farm machinery; and to prevent entry of animals, debris, or other foreign substances
• Prevent contamination of groundwater by surface water inflow
• Restore the natural hydrogeologic conditions, to the extent possible, by preventing vertical cross-contamination or commingling of groundwaters between separate water bearing zones
• Eliminate the possibility of the water well being used for any other purpose
• Allow future alternative use or management of the site

Wetland Creation - 658

Practice Description
The creation of a wetland on a site that was historically non-wetland

Purpose
This practice may be applied as part of a resource management system to create wetland functions and values.

Wetland Enhancement - 659

Practice Description
The rehabilitation of a degraded wetland or the re-establishment of a former wetland so that soils, hydrology, vegetative community, and habitat are a close approximation of the original natural condition and boundary that existed prior to the modification

Purpose
To provide specific wetland conditions to favor specific wetland functions and targeted species by:

- Hydrologic enhancement (depth duration and season of inundation, and/or duration and season of soil saturation)
- Vegetative enhancement (including the removal of undesired species, and/or seeding or planting of desired species)

Wetland Restoration - 657

Practice Description
The rehabilitation of a degraded wetland or the reestablishment of a wetland so that soils, hydrology, vegetative community, and habitat are a close approximation of the original natural condition that existed prior to modification to the extent practicable

Purpose
To restore wetland function, value, habitat, diversity, and capacity to a close approximation of the pre-disturbance by:

- Restoring hydric soil
- Restoring hydrology (depth duration and season of inundation, and/or duration and season of soil saturation)
- Restoring native vegetation (including the removal of undesired species, and/or seeding or planting of desired species

Wetland Wildlife Habitat Management - 644

Practice Description
Retaining, developing or managing wetland habitat for wetland wildlife

Purpose
To maintain, develop, or improve wetland habitat for waterfowl, shorebirds, fur-bearers, or other wetland dependent or associated flora and fauna on or adjacent to wetlands, rivers, lakes and other water bodies where wetland associated wildlife habitat can be managed. This practice applies to natural wetlands and/or water bodies as well as wetlands that may have been previously restored (657), enhanced (659), and created (658).

Woody Residue Treatment - 384

Practice Description
Treating woody plant residues created during forestry, agroforestry and horticultural activities to achieve management objectives

Purpose
This practice is applied to achieve one or more of the following:

- Reduce hazardous fuels
- Reduce the risk of harmful insects and disease
- Protect/maintain air quality by reducing the risk of wildfire
- Improve access to forage for grazing and browsing animals
- Enhance aesthetics
- Reduce the risk of harm to humans and livestock
- Improve the soil organic matter
- Improve the site for natural or artificial regeneration

County/Field Service Center Index

County	Field Service Center	Phone
Autauga	Autaugaville	(334) 365-5532
Baldwin	Bay Minette	(251) 937-3297
Barbour	Clayton	(334) 775-3266
*Bibb	Centerville	(334) 926-4360
Blount	Oneonta	(205) 274-2363
*Bullock	Union Springs	(334) 738-2079
Butler	Greenville	(334) 382-8538
Calhoun	Anniston	(256) 835-7821
*Chambers	LaFayette	(334) 864-9983
Cherokee	Centre	(256) 927-8732
*Chilton	Clanton	(205) 646-0277
*Choctaw	Butler	(205) 459-2496
Clarke	Jackson	(251) 246-0245
*Clay	Ashland	(256) 354-7512
*Cleburne	Heflin	(256) 463-2877
Coffee	New Brockton	(334) 894-5581
Colbert	Tuscumbia	(256) 383-4323
Conecuh	Evergreen	(251) 578-1520
*Coosa	Rockford	(256) 377-4750
Covington	Andalusia	(334) 222-3519
Crenshaw	Luverne	(334) 335-3613
Cullman	Cullman	(256) 734-6471
Dale	Ozark	(334) 774-4749
Dallas	Selma	(334) 872-2611
Dekalb	Rainsville	(256) 638-6398
Elmore	Wetumpka	(334) 567-2264
Escambia	Brewton	(251) 867-3185
Poarch Band of Creek Indians		(251) 368-0826
Etowah	Gadsden	(256) 546-2336
Fayette	Fayette	(205) 932-8959
Franklin	Russellville	(256) 332-0274
Geneva	Geneva	(334) 684-2235
Greene	Eutaw	(205) 372-3271
Hale	Greensboro	(334) 624-3856
Henry	Abbeville	(334) 585-2284
Houston	Dothan	(334) 793-2310
Jackson	Scottsboro	(256) 574-1005
Jefferson	Bessemer	(205) 424-9990
Lamar	Vernon	(205) 695-7622

*Note | Offices with an asterisk (*) are Soil and Water Conservation District Offices.

County/Field Service Center Index

County	Field Office	Phone
Laurderdale	Florence	(256) 764-5833
Lawrence	Moulton	(256) 974-1174
Lee	Opelika	(334) 745-4791
Limestone	Athens	(256) 232-4025
Lowndes	Haynesville	(334) 548-2767
Macon	Tuskegee	(334) 725-3321
Madison	Huntsville	(256) 532-1677
Marengo	Linden	(334) 295-8724
Marion	Hamilton	(205) 921-3103
Marshall	Guntersville	(256) 582-3923
Mobile	Mobile	(251) 441-6505
Monroe	Monroeville	(251) 743-2587
Montgomery	Montgomery	(334) 279-3579
Morgan	Hartselle	(256) 773-6541
Perry	Marion	(334) 683-9017
Pickens	Carrollton	(205) 367-8168
Pike	Troy	(334) 566-2300
Randolph	Wedowee	(256) 357-4561
Russell	Phenix City	(334) 297-6692
Shelby	Columbiana	(205) 669-5121
*St. Clair	Pell City	(205) 338-7215
Sumter	Livingston	(205) 652-5105
Talladega	Talladega	(256) 362-8210
Tallapoosa	Alexander City	(256) 329-3084
Tuscaloosa	Tuscaloosa	(205) 553-1733
Walker	Jasper	(205) 387-1879
*Washington	Chatom	(251) 847-6041
Wilcox	Camden	(334) 682-4117
*Winston	Double Springs	(205) 489-5227

*Note | Offices with an asterisk (*) are Soil and Water Conservation District Offices.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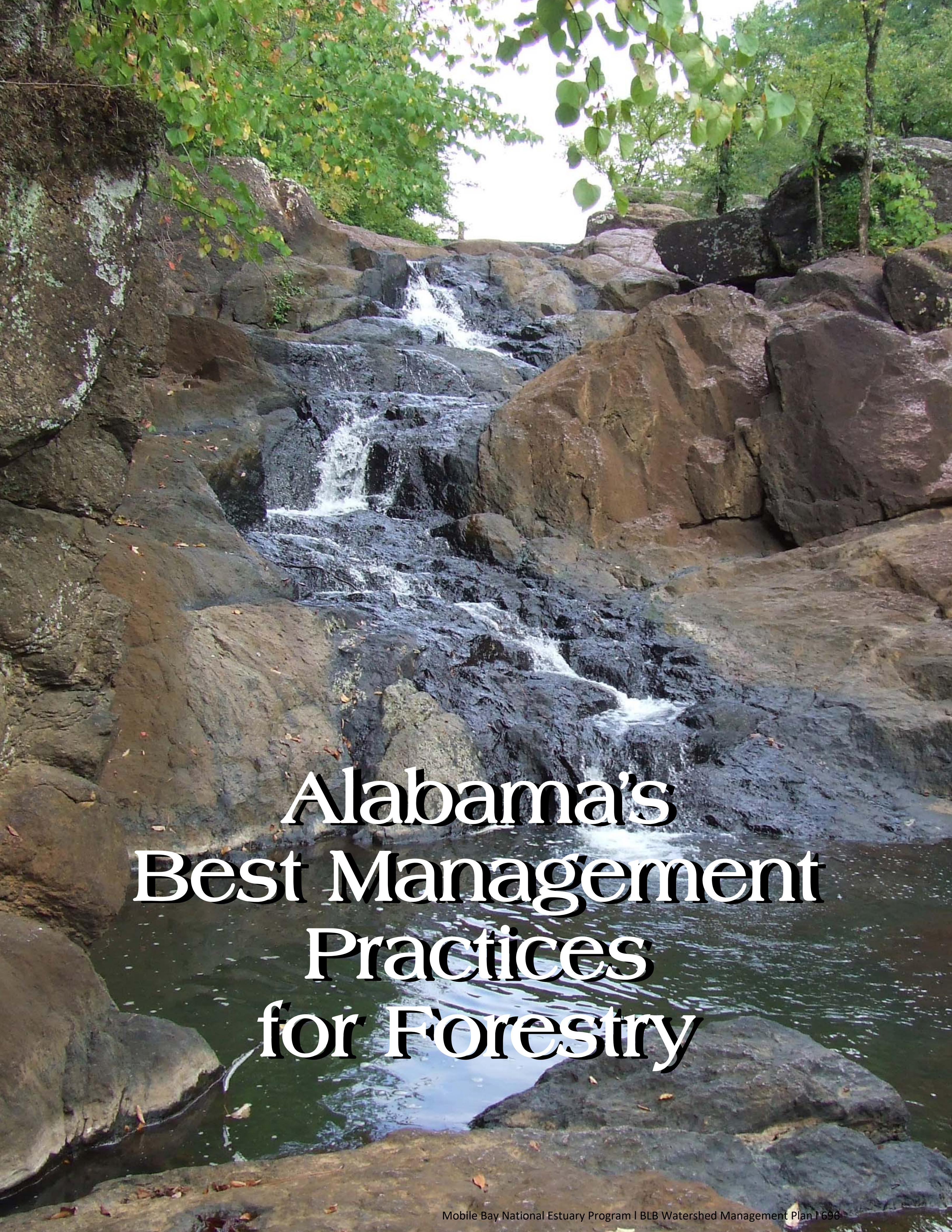

Alabama's Best Management Practices for Forestry

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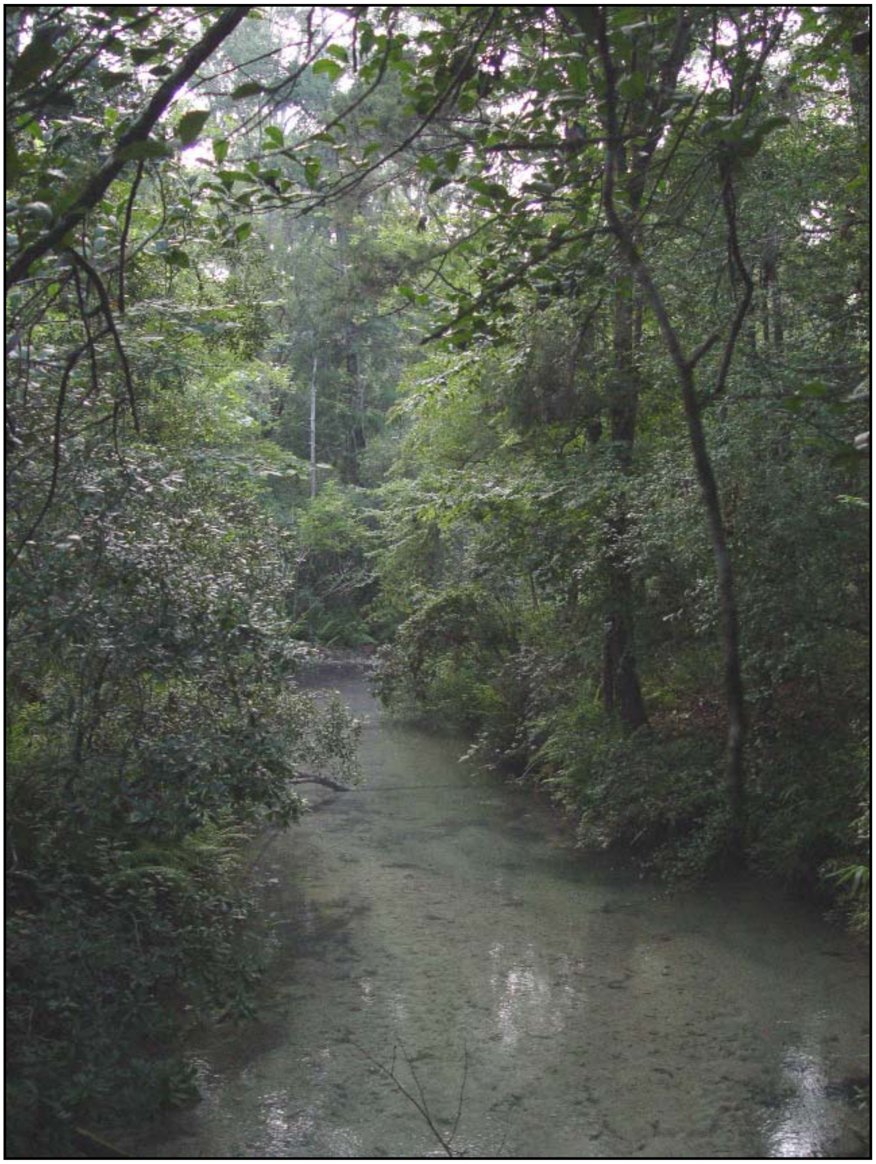
FOREWORD

Water Quality Management in Alabama

The Alabama Environmental Management Act authorizes the Alabama Department of Environmental Management (ADEM) to establish and enforce water quality standards, regulations and penalties in order to carry out the provisions of state and federal water quality laws. From that authorization, ADEM Administrative Code prohibits the deposition of pollutants into or the degradation of the physical, chemical, or biological integrity of waters of the state (see glossary for definitions). With regard to silviculture, nonpoint source pollutants include, but are not limited to, sediment, organic materials, temperature, trash, pesticides and nutrients (see glossary for definitions and impacts) that are man induced.

In addition, the Alabama Water Pollution Control Act states that ADEM shall have the authority to propose remedial measures necessary to clean up waters that have been determined to be polluted. ADEM advocates, however, that avoiding environmental problems through voluntary application of preventative techniques is much less expensive, more cost effective and practical than restoration after the fact.



The Alabama Forestry Commission's Role in Best Management Practices

The Alabama Forestry Commission was established and is mandated by Code of Alabama, 1975, Section 9-3-4 (1), to protect, conserve, and increase the timber and forest resources of the state. All citizens of Alabama are our valued customers. However, as the lead agency for forestry in the state, we seek to strike a balance between serving Alabama forest owners' needs and enhancing the benefits flowing to society from their forests. Our mission is to promote environmentally and economically sound forestry practices, and we are committed to optimizing available resources to achieve this mission.

The Alabama Forestry Commission is not an environmental regulatory or enforcement agency, but it does accept the responsibility to maintain and update *Alabama's Best Management Practices (BMPs) for Forestry* whenever necessary to help Alabama's forestry community meet state water quality needs. The Commission will work in a cooperative manner with all state and federal agencies concerned, and is determined to utilize technical expertise from within and without the forestry community in any BMP revision process.

The Alabama Forestry Commission also accepts responsibility to provide education and technical assistance to landowners, loggers, foresters, vendors and the general public to ensure that good stewardship principles are understood and used.

Purpose of Best Management Practices

Alabama's Best Management Practices for Forestry are **non-regulatory guidelines** (except for the U.S. Army Corps of Engineer's baseline BMPs on pages 16 and 17 which are mandatory) suggested to help Alabama's forestry community maintain and protect the physical, chemical and biological integrity of waters of the state as required by the Federal Water Pollution Control Act, the Alabama Water Pollution Control Act, the Clean Water Act, the Water Quality Act, and the Coastal Zone Management Act.

The BMPs in this booklet lay out a framework of sound stewardship practices that, when consistently applied, will contribute positively to maintaining a high degree of water quality flowing from a forest. These BMPs are not intended to be all inclusive. Rational and objective on-site judgement must be applied to ensure that water quality standards are maintained.

The most important guidance that these BMPs can offer the forestry community is to **think and plan before you act**. Adequate forethought will pay off in two ways: to avoid unnecessary site disturbance or damage in the first place and to minimize the expense of stabilizing or restoring unavoidable disturbances when the operation is finished.

The enclosed BMPs are directed only toward the maintenance of water quality.

However, these BMPs will have an indirect, positive impact on other forest resource values. Sound stewardship principles that enhance wildlife habitat, clean air, aesthetics and general environmental quality are compatible with water quality BMPs and the Alabama Forestry Commission encourages their use when applicable to the landowner's objectives.

Following sound stewardship principles in carrying out forestry practices will ensure that our forests continue to meet the needs of their owners, provide jobs, forest products, clean water and a healthy environment without costly regulations. Only through sound stewardship principles will all of these needs be met.

Responsibility

Responsibility for maintaining water quality standards during a forestry operation has been broadly interpreted to include all parties involved in the authorization, planning or implementation of the operation. **The responsible parties may include professional forestry practitioner(s) such as forest resource managers, timber purchasers, loggers, vendors, forest engineers or others.**

Due to this inherent responsibility it is in the best interest of all those involved in silvicultural operations to make every effort to prevent and correct violations of state and federal water quality laws, regulations and standards by consistently implementing BMPs.

SPECIFICATIONS FOR INDIVIDUAL BMPs

1. STREAMSIDE MANAGEMENT ZONES

Landowners should have adequate streamside management zones marked before negotiating bids for timber sales.

A streamside management zone (SMZ) is a strip of land immediately adjacent to a water of the state where soils, organic matter and vegetation are managed to protect the physical, chemical and biological integrity of surface water adjacent to and downstream from forestry operations. Table 1 provides guidelines for protecting the critical area within a SMZ.

Harvesting in streamside management zones should be done so as to protect the forest floor and under story vegetation from damage. Do not remove (harvest) trees from banks, beds, or steep slopes if it will destabilize the soil and cause degradation of the water. Trees on the south and west banks provide the most critical shading of water. Fell and skid trees directly away from waters of the state. According to Alabama Department of Environmental Management (ADEM) regulations, any tops or other logging debris dropped into the water or channel must be removed; **however, organic debris in the water prior to harvest should not be removed from the stream.** Stabilize wheel ruts if they could carry sediment into waters of the state. Locate log decks and roads outside of SMZs (except at proper stream crossings and access points or unless steep topography/wetland conditions necessitate location within the SMZ).

Courtesy of the South Carolina Forestry Commission

Table 1: SMZ Minimum Standards[1]

Purpose:	Protect banks, bed, and floodplains from erosion; control direct deposition of pollutants; provide shade, food, and cover for aquatic ecosystems; filter out pollutants from uplands.	
Management	**Perennial Stream**	**Intermittent Stream**
Minimum width on each side of channel	In no cases should SMZs be less than 35 feet from a definable bank.[2] A landowner's personal management objectives, on-site condition or stream sensitivity may require wider SMZs and more stringent control of forestry operations within the SMZ. For example, width should be extended to account for erodibility of soil, steepness of slopes and activities to be performed outside of the SMZ.[3] SMZs must always be wide enough to maintain water quality standards.	
Delineation	Outside boundaries should be well marked before operations begin.	
Roads	Follow state and federal BMPs (see Sections 2, 3, and 6) for roads and stream crossings.	
Harvesting Method	Partial cut only within minimum of 35 feet; partial cut or regeneration cut can take place beyond 35 feet.	Partial cut or regeneration cut when water quality degradation can be avoided.
Minimum Residual Cover	50% Crown cover	Vegetative[4]
Reforestation	Natural regeneration, hand planting, direct seeding.	
Mechanical Site Preparation	No	
Herbicide	If herbicide is used, adhere strictly to label restrictions. Direct application is preferred over broadcast spraying.	
Fertilizer	No	

1 In cases where the stream channel is significantly braided, the forest should be managed under wetland BMP management recommendations (Section 6).

2 If wildlife is a major objective, a minimum SMZ of 50 feet is recommended.

3 USDA Natural Resources Conservation Service can provide information on soil erodibility.

4 Permanent residual tree cover is not required along intermittent streams as long as other vegetation and organic debris are left to protect the forest floor during regeneration.

2. STREAM CROSSINGS

The crossing of streams by roads, skid trails, or firebreaks should be avoided. Stream crossings cause a break in the canopy and filtration strip provided by an SMZ. It may take a large amount of time and effort to stabilize water quality impairment from excessive stream crossings. If stream crossings are unavoidable, use the fewest number, cross the stream/SMZ by the least disruptive manner possible, and control sediment and other pollutants.

In general, stream crossings should be located where the bank and SMZ will be least disturbed. They should be installed at right angles to the stream where the stream channel is straight, and should have gentle slopes and straight paths in and out of the SMZ. Water diversions should divert upland runoff so that sediment and other pollutants can be filtered out on the forest floor before reaching the stream. At no time should a perennial or intermittent stream be crossed without providing a way for normal passage of water or aquatic animals within the channel. **Follow mandatory federal BMPs listed on pages 19 and 20 when roads cross streams or any other wetlands.**

Log crossings involve placing hollow or solid logs into shallow channels. Green and/or small diameter tops, limbs and brush should not be used for this purpose. The surface can be improved by use of secured decking or portable logging mats; do not use fill dirt. All log crossings must be removed when the logging operation is complete.

Fords can be used where the stream bed is firm, banks are low and stream is shallow. Banks should be back bladed away from water and used to improve the approaches. Rock may be brought in to stabilize the approaches and stream bottom.

Culverts, properly sized and installed, should be used to reduce road washouts and impoundments of water. Culvert sizes in Table II are best estimates for normal rainfall but may not handle the largest storm events. One large pipe is better than several smaller pipes. Culverts should be long enough to extend at least one foot beyond the fill on either end. Fill material upstream and down must be stabilized. Possible techniques include use of sand bags, concrete, rip-rap, hay bales, mulch, and vegetation. Culverts should be cleaned out regularly.

Proper culvert installation.

After an operation or phase of an operation has been completed or is going into a period of inactivity, all temporary crossings must be removed and the site stabilized; all permanent crossings must be stabilized and maintained.

Table II

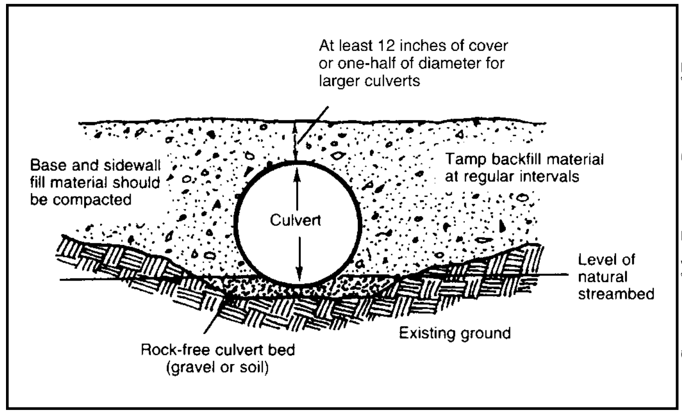
Recommended Diameters for Culverts

Drain Area (acres)	Lower Coastal Plain	Upper Coastal Plain	Piedmont	Mountains
10	12”	12”	12”	18”
50	30”	18”	30”	36”
100	48’’	30”	42”	48”
200	60”	42”	54”	two 48” pipes

Cleared stream crossing, stabilized with hay.

Culvert Installation

- Place culvert on stream bottom; do not dig below natural stream level to bury pipe.
- Culvert should have 2-3% pitch down-stream for self-cleaning.
- Compact lower half of fill during installation.
- Earth cover over pipe should be a minimum of 12” or half the culvert’s diameter, whichever is greater. Make fill over a culvert the high spot in the stream crossing.
- Provide for stream overflow away from culvert fill to prevent blowouts.



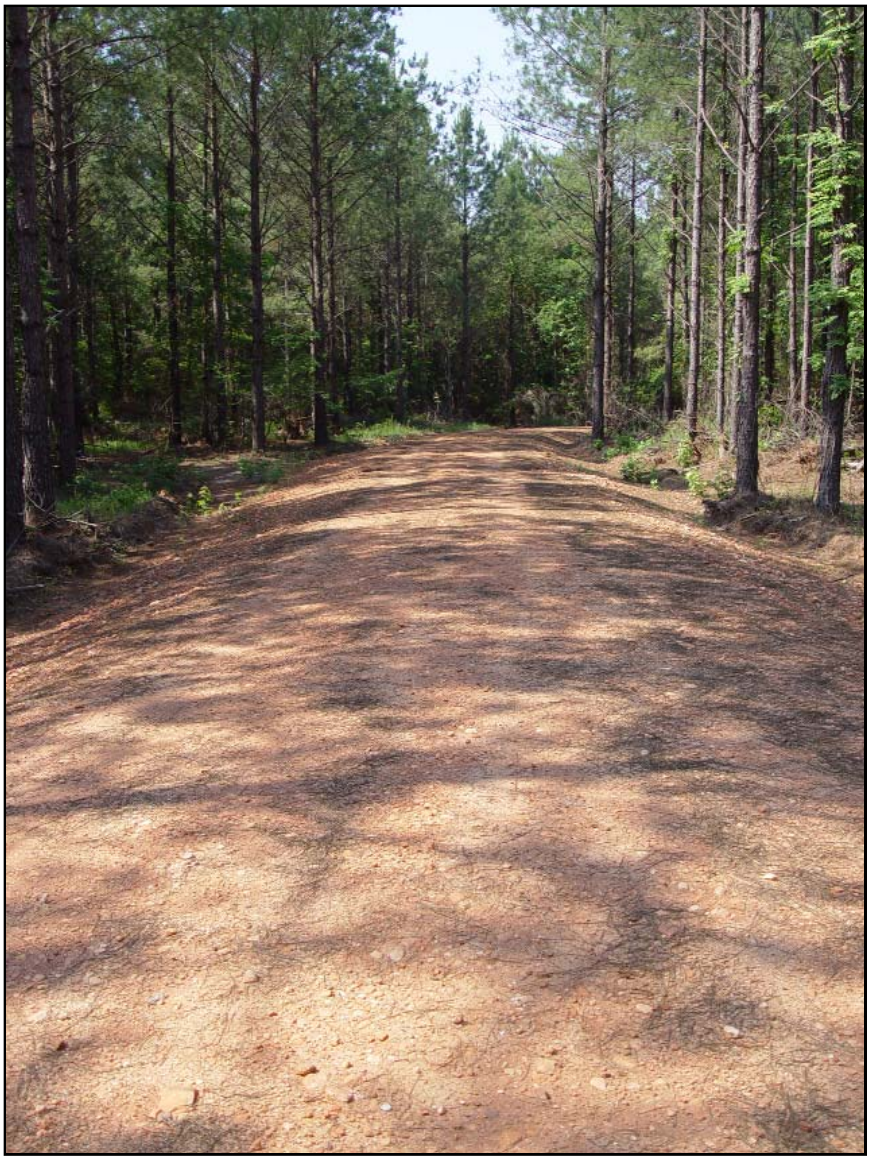
Courtesy of the Tennessee Division of Forestry

Proper installation prevents culverts from being crushed by heavy roads.

***Bridges** create the least disruption to stream flow. According to the Alabama Department of Environmental Management (ADEM) and Corps of Engineer regulations, banks and fill material must be stabilized and protected from erosion. Spans must be installed to permit passage of all expected high flow.*

Portable bridges can be used in a way that protects water quality and reduces effort and expense in the long run.

3. FOREST ROADS



Crowned forest road.

Proper planning and location of roads will minimize the potential for deposition of pollutants into waters of the state, future maintenance and expense, and the amount of land taken out of production. Old roads should be reopened only if they are properly located and drainage devices will function properly. New roads must avoid streamside management zones (except at proper stream crossings and access points or unless steep topography/wetland conditions necessitate location within the SMZ), troublesome or sensitive moisture-laden soils, eroded gullies, etc. Road grades should also be minimized where soils are highly erodible and/or topography is steep. Dredge and fill operations which may alter the flow, circulation or reach of waters of the state, especially wetlands, may require a permit from the Corps of Engineers.

Adequate drainage is the most important factor in controlling soil erosion and keeping roads in a serviceable condition. Construction techniques such as crowned roads, turnout ditches, out-sloping and in-sloping should be used to provide some slope to flat roads which would hold water.

Crowned roads are designed to quickly drain road surfaces from the center of the road to side ditches. This technique helps to prevent water from soaking into the road and making it soft and muddy.

Turnout ditches should be installed at appropriate intervals to disperse water collected in roadside ditches away from the road base into surrounding vegetation.

Outsloped roads in hilly or mountainous terrain are graded at a 2-4% pitch to the downhill side of the road to drain off water as quickly as possible. Avoid berms of dirt along the outer edge of outsloped roads because they hold water in the road.

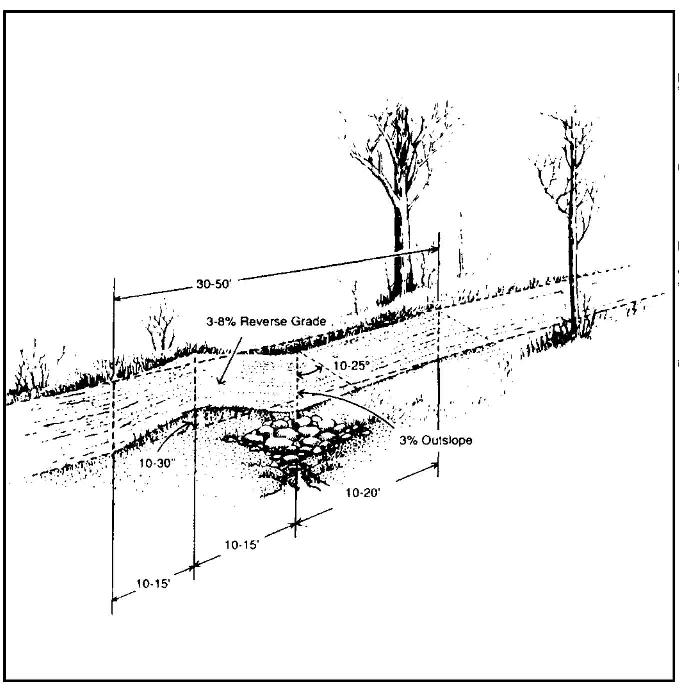
Insloped roads may be preferable when roads are built on side slopes with slippery soils and/or in steep terrain. Water collecting in the inside ditch, however, will have to be drained under the roads through culverts and be dispersed into vegetation on the outside of the road.

Construction of permanent roads should take place with the following considerations:

- Use at least the minimum design standard consistent with anticipated traffic and reasonable safety.
- Merchantable timber should be cleared from the right of way before the arrival of grubbing equipment.
- Stumps, logs, slash and other organic debris should not be covered with fill material and incorporated into road beds.
- Minimize the amount of soil on the road banks or roadsides that is exposed to soil erosion. Balancing cuts and fills whenever practical is one means of minimizing soil exposure. Stabilize these areas as they are created to minimize any problems.
- Functional water diversion techniques or devices should be installed at the same time that roads are constructed. Drainage water should be dispersed onto the undisturbed forest floor whenever possible.

Excessive road steepness, on the other hand, may allow surface water to build up velocity and cause erosion. A variety of water diversion devices can be used to direct water from roads and ditches into vegetated areas upslope from streams in order to slow water down and filter out sediment.

Broad-based dips are an effective means of diverting water off a permanent road without interfering with truck or skidder traffic. They hold up well and remain effective under traffic as long as the outfall remains below the dip in the road grade. Gravel in the bottom of the dip may be necessary on some soils to hold up vehicles operating in wet conditions.



Courtesy of the Tennessee Division of Forestry

Broad-based dips are designed to move water off roads and facilitate the ease of vehicle use.

Water bars (and turnouts) installed at 30-45 degree angles are best used to stabilize temporary roads and skid trails that will no longer be used. Water bars may not hold up well or maintain their effectiveness when they are packed down or rutted by truck, skidder or four-wheeler traffic. A series of small water bars, well anchored into the hillside, can be constructed by a skidder or bulldozer.

Maintenance of permanent roads should take place with the following considerations:

- Regular periodic inspection should start immediately after construction to determine maintenance requirements that prevent excessive erosion, impairment of natural drainage, or water quality problems.
- After an operation is completed, rutted or channeled roads should be reshaped and stabilized with functional water diversion devices to allow good drainage and control erosion.
- Seeding and mulching may be necessary to stabilize roadsides and closed temporary roads.
- Special soil stabilizing materials are available for particularly vulnerable areas (see USDA Natural Resources Conservation Service for dealers).

Outfall protection should be provided to prevent erosion by absorbing the energy of water falling from the outlet end of water diversion devices. Use rocks, concrete, mulch, woody debris or dense vegetation. Outfalls must never be installed where runoff can be discharged or flushed directly into waters of the state.

Table III

Diversion devices can generally be installed using the following spacing guide. However, soil erodibility and natural drainage opportunities should also be considered for determining appropriate spacings. The USDA Natural Resources Conservation Service can provide information about the erodibility of soils.

% Slope	Distance between water bars	Distance between broad-base dips and turnouts
3%	200’	235’
5%	135’	180’
10%	80’	140’
15%	60’	125’
20%	45’	
30%	35’	
40%	30’	

Control non-essential traffic during wet weather on roads which have a high potential for erosion; particularly immediately following construction.

A single large water bar constructed by a bulldozer can be used to close temporary roads to any further two-wheel drive traffic.

4. TIMBER HARVESTING

Harvesting activities should be conducted to ensure long-term maintenance of water quality. The following suggestions will help timber harvesters achieve this objective.

Temporary access roads (logging roads) and landing locations should be planned before operations begin to minimize soil disturbance. Road construction should be kept to a minimum, consistent with reasonable skidding distance. Spring heads, natural drainages and gullies should be avoided. Landings should also be kept as small as possible, consistent with safe and efficient operation. Logging roads and landings must be located on firm ground, outside of Streamside Management Zones and above the ordinary high water mark of streams.

Landings must be located to prevent the adverse impact of skidding on water quality. Locating logging decks uphill and skidding up to them results in a cone-shaped pattern of skid trails which disperses water running downhill. If the logging deck is on the lower slope, the V-shaped pattern of skid trails could concentrate runoff and erode the logging deck areas. If the trees must be skidded downhill, erosion can be minimized by using several, smaller logging decks with fewer, smaller skid trails leading to any one.

When operations are completed, landings and temporary roads should be stabilized with water diversion devices and/or vegetation where there is a possibility of significant erosion and/or water quality degradation.

Felling should be done carefully to minimize the impact of subsequent phases of logging operations on water quality. Timber cut in Streamside Management Zones should be harvested in accordance with recommended guidelines on pages 4 and 5.

Skidding should be done to avoid disrupting natural drainages, prevent excessive soil displacement, and minimize impacts of rutting, compaction, and puddling on water quality and soil stability.

Stream channels and natural drainages must not be used as skid trails. They should be crossed following guidelines in Section 2.

Where slopes are steep but short in duration, trees can be felled uphill and winched to the skidder. Skid trails on steep slopes should have occasional breaks in grade and upon completion of use, must be water barred. Erosion in skid trails can sometimes be reduced by covering them with logging slash. Logging slash can also be scattered over temporary landings to help stabilize them.

When wet and/or soft ground conditions cannot be avoided, it is better to concentrate soil compaction from skidder traffic on a few trails that can be stabilized rather than disperse the effects over many trails.

Cut-to-length harvesting systems offer state-of-the-art equipment and best available technology to maximize timber production and protect water quality and other forest resources at the same time.

Primary benefits of this system are from forwarders (or prehaulers) which can haul wood off the ground for long distances and need only minimum skid trails or landings. Less soil is displaced, rutted, and compacted. The on-board loader can be used to place logs for stream crossings and easily remove them when the crossing is no longer needed. In addition to high initial costs, however, this equipment is also limited by very steep terrain.

Trash disposal must be properly handled throughout the operation in accordance with all applicable laws. Fuel, lubricants and other toxic chemicals must never be drained into the soil. Food and drink containers, discarded equipment parts, and used fluids must be properly removed and disposed of. Trash must not be burned or buried on site.

5. REFORESTATION / STAND MANAGEMENT


Bedding on a contour.

Mechanical site preparation treatments must be used in such a manner as to minimize displacement of forest litter and topsoil, soil compaction and erosion, stream sedimentation and the deposition of debris into waters of the state. The degree of mechanical site preparation should be limited to the amount that is needed to get a well stocked stand of desirable trees. In general, mechanical site preparation should be excluded from soils with slopes exceeding 25%. No mechanical site preparation should be used in SMZs.

Drum chopping is one of the most desirable methods of mechanical site preparation for the protection of soil and water quality. When chopping is done on steep slopes it should always be done up and down hill so that sediment can be trapped in the slits created by the chopper blades.

Bedding on slopes exceeding 2% should follow the contour. On slopes 2% or less, beds should follow the natural drainage of the land. *Ripping and/or sub-soiling* should be done on the contour.

Disking should be done on the contour and restricted to areas with slopes 10% or less.

Shearing requires that the operator keep the blade out of the soil to minimize soil disturbance. Avoid overraking the area. The retention of small limbs, twigs, bark and rock on the ground surface helps reduce soil erosion.

Windrows should be laid out on the contour of the land 100 to 300 feet apart depending upon the slope of the land and erodibility of the soil. Topsoil should not be pushed into windrows. Debris may not be piled into any water of the state.

Straight blade bulldozing is the least desirable method of mechanical site preparation.


Windrows.

Chemical site preparation, with or without the use of fire, can duplicate or surpass mechanical site preparation results with less water quality impact.

Herbicide applications must follow the manufacturer's label instructions, EPA guidelines and Alabama State Law. Herbicides should not be aerially or broadcast applied in SMZs. Under no circumstances should herbicides be applied directly onto or allowed to drift or wash into surface waters unless labeled for such applications. Do not mix or clean equipment or herbicide containers in or near streams or water bodies. Frequent inspection of equipment is recommended.

Prescribed burning should be designed and managed to minimize adverse environmental effects. Avoid intense spray and burns on steep slopes and highly erodible soils if water quality would be impacted.

Constructed firebreaks can be tied into existing natural barriers to minimize the need for fresh soil disturbances. Firebreaks should be stabilized with water diversion devices to minimize erosion and conveyance of sediment laden runoff into waters of the state. Vegetating firebreaks can further reduce erosion and the movement of sediment and other pollutants into waters of the state.

Wildfires demand that the primary objective of firebreak construction is to bring the fire under control.

Tree planting with a furrow type machine should be done on the contour.

Planting on a contour.

Constructed firebreak.

6. FORESTED WETLAND MANAGEMENT

Wetlands are those areas that are inundated or saturated by surface or groundwater at a frequency or duration sufficient to support (and under normal circumstances do support) a prevalence of vegetation typically adapted for life in saturated soil conditions.

The U.S. Army Corps of Engineers, using the *Federal Manual for Delineating Jurisdictional Wetlands*, determines under which conditions hydrophytic vegetation, hydric soils, and wetland hydrology must be present on the same site, under normal circumstances, for an area to be classified as a wetland. Jurisdictional wetlands may be found in the following

- Coves and lower slopes
- Branch bottoms
- Creek bottoms
- River bottoms
- Muck swamps
- Peat swamps and cypress/gum ponds
- Wet flats

Section 404 of the Clean Water Act usually requires that a permit be obtained from the Corps of Engineers before a discharge of dredged or fill materials can be made into waters of the United States (U.S.), including wetlands. A regulated discharge occurs when fill or dredged material is deposited into wetlands.

Exemptions for forestry activities from having to obtain an individual Section 404 permit from the Corps of Engineers may apply if the activities meet the following conditions:

1. It is not part of an activity whose purpose is to convert a wetland into an upland, where the flow or circulation of the waters of the U.S. may be impaired or the reach of water reduced; and

2. It is part of an established (i.e. ongoing) silvicultural, farming or ranching operation and not a new use to which the wetland was not previously subject; and

3. It uses "normal" silvicultural, farming or ranching activities which are in compliance with federal BMPs (listed under "Roads and Stream Crossings . . ." on, pages 19 and 20); and

4. It has not lain idle for so long that hydrological modifications will be necessary to resume operations; and

5. It does not contain any toxic pollutant listed under Section 307 of the Clean Water Act.

What is an established silvicultural operation? Established or ongoing operations are included in a management system (not necessarily written) which is planned over conventional rotation cycles for a property or are introduced as part of an ongoing operation.

Evidence of use of the property may be used to determine whether an operation is ongoing. Such evidence includes the following:

1) a history of harvesting with either natural or artificial regeneration; 2) a history of fire, insect, and disease control to protect the maturing timber; and 3) the presence of stumps, logging roads, landings, or other indications of established silvicultural operations that will continue on the site.

While past management may have been relatively non-intensive, intensification of management involving artificial regeneration and other practices can occur as part of a conventional rotation and be considered an established operation.

Although wetland regulations do not require a written forest management plan, it is in a landowner's best interest to have one to document that operations are established, that BMPs are implemented and effective, and that all activities are consistent with other Section 404 exemption criteria.

A change in ownership between landowners (both of which manage forested wetlands for silvicultural purposes) has no bearing on whether a forestry operation is part of an established ongoing activity. Continuation or strict adherence to a management plan written for the previous owner is not required by Section 404 silvicultural exemptions.

"Normal" silvicultural activities (such as road construction, timber harvesting, mechanical or chemical site preparation, reforestation, timber stand improvement, and minor drainage) conducted as part of established ongoing silvicultural operations are exempt from Section 404 Corps of Engineers permit requirements as long as the appropriate measures are implemented. Those measures are listed under "Roads and Stream Crossings. . ." on pages 19-20. *Alabama's Best Management Practices for Forestry* are not required for exemption from Section 404 Corps of Engineer permit requirements; they are, however, **strongly** recommended to minimize nonpoint source pollution of waters of the state and/or waters of the U.S.

A forestry activity or operation WILL require a 404 permit from the Corps of Engineers when the following applies:

1. The activity results in the immediate or gradual conversion of a wetland to an upland as a consequence of altering the flow and circulation or reducing the reach of waters of the U.S.

   Changes in flow, circulation or reach of waters can be affected by permanent major drainage such as channelization or by placement of fill material. A discharge which changes the bottom elevation of waters of the U.S., without converting it to dry land, does not reduce the reach of waters but may alter flow or circulation and therefore may be subject to permitting requirements.

   The criteria that are used to determine if a wetland has been converted include a change in hydrology, soils and vegetation to such an extent that the area no longer qualifies as a jurisdictional wetland according to the *Federal Manual for Delineating Jurisdictional Wetlands.*

2. A new activity results in a change from the past, historical use of the wetland into a different use to which it was not previously subject where the flow or circulation of waters is impaired or the reach of the water is reduced. Such a change does not meet the established, ongoing requirement and causes the activity or operation to lose its exemption.

   Examples of this situation are areas where tree harvesting has been the established use and the landowner wishes to convert the site for use as pasture, green tree reservoir, agriculture, real estate or aquaculture. In such cases the landowner must first obtain a 404 permit before proceeding with the change. (Changes of use to farm stock ponds may be exempt under a nationwide Corps of Engineers permit).

3. Roads and stream crossings are constructed in a wetland without following the mandatory, federal BMPs listed under the wetland road regulations.

4. The area has lain idle for so long that hydrologic modifications are necessary to resume operations. This does not refer to temporary water management techniques such as minor drainage, plowing, bedding and seeding which exempt, normal silvicultural activities as long as they don't result in the conversion of wetlands to uplands. However, it does apply to reopening ditches which were once established as permanent wetland drainage structures but have lost their effectiveness for this purpose as they filled in with soil and vegetation.

BMPs for wetlands are not intended to make up for uncontrolled negative impacts on uplands but are part of the overall management of the full landscape to protect water quality.

Streamside management zones should be established and managed around the perimeter of all major drainages and open bodies of water (i.e., main stream courses, oxbow lakes, sloughs) contained within wetlands.

Minor drainage refers to installation of ditches or other water control facilities for temporary dewatering of an area. Minor drainage is considered a normal silvicultural activity in wetlands to temporarily lower the water level and minimize adverse impacts on a wetland site during road construction, timber harvesting and reforestation activities. Minor drainage does not include construction of a canal, dike or any other structure which continuously drains or significantly modifies a wetland or other aquatic area.

Minor drainage is exempt from needing an individual 404 permit if it is part of an ongoing silvicultural operation and does not result in the immediate or gradual conversion of a wetland to an upland or other uses. Artificial drainage must be managed. Once silvicultural activity has been completed the hydrology that existed prior to the activity should be restored by closing drainage channels.

Roads and stream crossings within wetlands and other waters of the U.S. *must* be constructed and maintained in accordance with the following U.S. Army Corps of Engineer baseline BMPs (from Section 404, Corps of Engineers Permit Requirements, 40 CFR Part 233.22) in order to retain exemption status for the road operation:

1. Permanent roads, temporary access roads and skid trails (all for forestry) in waters of the U.S. shall be held to the minimum feasible number, width, and total length consistent with the purpose of specific silvicultural operations, and local topographic and climatic conditions;

2. All roads, temporary or permanent, shall be located sufficiently far from streams or other water bodies (except for portions of such roads which must cross water bodies) to minimize discharges of dredged or fill material into waters of the U.S.;

3. The road fill shall be bridged, culverted or otherwise designed to prevent the restriction of expected flood flows;

4. The fill shall be properly stabilized and maintained during and following construction to prevent erosion;

5. Discharges of dredged or fill material into waters of the U.S. to construct a road fill shall be made in a manner that minimizes the encroachment of trucks, tractors, bulldozers, or other heavy equipment within waters of the U.S. (including adjacent wetlands) that lie outside the lateral boundaries of the fill itself;

6. In designing, constructing and maintaining roads, vegetative disturbance in the waters of the U.S. shall be kept to a minimum;

7. The design, construction and maintenance of the road crossing shall not disrupt the migration or other movement of those species of aquatic life inhabiting the water body;

8. Borrow material shall be taken from upland sources whenever feasible;

9. The discharge shall not take, or jeopardize the continued existence of a threatened or endangered species as defined under the Endangered Species Act, or adversely modify or destroy the critical habitat of such species;

10. Discharges into breeding and nesting areas for water fowl, spawning, and wetlands shall be avoided if less harmful alternatives exist;

11. The discharge shall not be located in the proximity of a public water supply intake;

12. The discharge shall not occur in areas of concentrated shellfish production;

13. The discharge shall not occur in a component of the National Wild and Scenic River System;

14. The discharge of material shall consist of suitable material free from toxic pollutants in toxic amounts; and

15. All temporary fills shall be removed in their entirety and the area restored to its original elevation.

Timber harvesting using normal methods and equipment may be appropriate if harvesting is timed during dry periods.

Harvesting during wet periods or sites that remain wet require special precautions and harvesting systems to minimize water quality hazards and other negative site impacts. Site damaging effects from harvesting equipment such as rutting, puddling and compaction should be controlled and minimized. For example, concentrate skidder traffic on a few trails rather than over the entire area. Do not harvest sites during periods of flowing water whether from overbank flooding or other water accumulation.

Roads must be constructed and maintained in accordance with BMPs to assure that flow and circulation pattern and chemical and biological characteristics of waters of the U.S. are not impaired, that the reach of the waters of the U.S. is not reduced and that any adverse effect on the aquatic environment will be otherwise minimized.

Minor drainage is allowed (i.e., to maintain a dry road bed) unless it becomes obvious that BMPs have not been followed or that the road is serving some function other than conveyance of vehicles (i.e., a continuous roadside barrow ditch may not be used to drain adjacent wetlands.

Reforestation in wetlands is not much different from regenerating uplands in regards to water quality; the main factors to consider are the site's potential for erosion/sedimentation and hydrology.

Land clearing is an exempt silvicultural activity if it is associated with timber harvesting or reforestation operations. However, land clearing using mechanical equipment for purpose of removing vegetation in preparation for converting the site to a different land use is not part of an established silvicultural operation and is not exempt from having to go through the Corps of Engineer permitting process.

Herbicides bearing the "wetlands" warning on the label can be applied to vegetation on dry soils of jurisdictional wetland areas but must not be applied directly to surface water or to inter-tidal areas below the main high water mark.

Bedding is the construction of earthen mounds from surrounding soil resulting in adjacent and alternating "beds" and furrows. Seedling beds create temporary elevated soil conditions which allow seedlings to escape saturated soil conditions and have a greater opportunity to survive and grow.

Bedding is considered a normal silvicultural activity that is exempt from Section 404 permitting requirements if the following conditions exist:

- The bedding does not result in the gradual or immediate conversion of a wetland to upland as a consequence of impairing the flow or circulation or reducing the reach of waters of the U.S.; and
- It is performed as part of an established, on-going silvicultural operation.

However, if bedding were to significantly alter the flow, circulation, or reach of waters of the U.S. and consequently result in conversion of a wetland to an upland, the exemption would no longer apply.

Species composition change (i.e., bottomland hardwood to pine plantation) resulting from intensification of management is considered a normal, silvicultural activity that is exempt from 404 permitting if the property is in silvicultural usage before and after the harvesting and planting.

However, a species composition change is not exempt if the activities used to clear, prepare or plant the site would result in a change in use that is accompanied by an impairment of the flow or circulation or the reduction of the reach of waters. An example of such a new use situation would be where the change in species composition would cause a conversion of wetlands to uplands.

Removal of beaver dams and other blockages to remove impounded surface water is considered exempt from 404 permitting as long as the process does not include enlarging or extending the dimension or changing the bottom elevation of the affected drainage way as it existed prior to the formation of the blockage, or without changing the use of the land in question.

Beaver dams can be dismantled by hand without any problems. Dynamite and heavy equipment can also be used to destroy dams as long as they are not used to construct drainage channels that will result in conversion of wetlands to uplands. However, when dynamite or heavy equipment is to be used to remove beaver dams or other blockages, the Corps of Engineers should be contacted for possible permit requirements.

***Before and After**: Top photo shows blockage caused by beaver dam. Bottom photo illustrates flow restored.*

7. Revegetation/Stabilization

Skid trail stabilized with logging slash.

As already pointed out in previous sections, some temporary haul roads, skid trails, log landings, firebreaks and other forestry related soil disturbing activities require the establishment of a vegetative cover to stabilize mineral soil surfaces so as to reduce erosion and runoff of sediment into state waters. The USDA Natural Resources Conservation Service can provide a detailed plan for establishing vegetation on these disturbed sites.

Site preparation, such as smoothing or reshaping rutted roads and landings, may be required before conventional equipment can be used for seedbed preparation, seeding, mulching and drainage improvement. Heavily compacted areas may require ripping and/or disking to allow water infiltration and provide a suitable seedbed for root growth.

Agricultural limestone and fertilizer may be needed to ensure success in establishing a vegetative cover. Soil tests are recommended. Incorporate lime and fertilizer into the top 2-4" of soil on slopes less than 6%; into the top 2"of soil on slopes of 6-10%; and onto the surface only on slopes greater than 10%.

Plant species recommendations can be obtained from the local county office of the USDA Natural Resources Conservation Service or Cooperative Extension Service. Areas treated by temporary seeding or mulch should be reseeded with permanent vegetative species as soon as possible during the correct growing season to ensure stabilization of disturbed areas. Disking or mowing of temporary cover is recommended before application of permanent seed and fertilizer.

Mulch is recommended for critical situations to hold seed, lime and fertilizer in place, maintain moisture and prevent extreme temperatures on the soil surface. Mulch needs to be applied immediately after seeding to provide best benefits.

Vegetative establishment for control of erosion and sedimentation can be considered successful once a 75% cover has been obtained. Within one

Vegetated forest road.

year of establishment, a second broadcast application of fertilizer at half the original rate is recommended to ensure plant survival and growth.

Silt screen and hay bales can be used to filter runoff water from closed roads and skid trails to prevent or stop sediment from flowing downslope into waters of the state. When using silt screen, 5-6 foot-long posts should be staked 5-10 feet apart across the problem area. The porous material is stapled 3 feet high on the post and excess material at the bottom of the screen is folded uphill and anchored down with rocks or fill material. Hog wire can be stapled to the stakes before the material is attached to give strength to the silt screen as intercepted sediment builds up.

Square hay bales can be used for the same purpose by lining them up across the road, end to end and one to two bales high. Stake the bales in place on their sides with the strings off the ground to prevent rotting.

Gully stabilization should receive high priority during all land management activities. The most effective way to reduce sediment production and/or reduce the change of reactivating the erosion process in healed gully systems is to avoid operating in them and maintain all existing vegetation. Site preparation, including herbicide and burning, should be excluded.

Actively eroding gully systems need to be stabilized. The USDA Natural Resources Conservation Service can provide technical assistance in planning and installing gully stabilization measures.

APPENDICES

Glossary

ADEM – The state regulatory agency (Alabama Department of Environmental Management) which administers and enforces the Alabama Water Pollution Control Act.

Approaches – The entry and exit of a road or skid trail through a stream crossing.

Aquatic ecosystem – An interacting community of plants and animals (i.e., insects, crayfish, fish and amphibians) requiring an abundance of water during some part of their life cycle.

Backblade – To pull dirt by dropping a dozer blade into the soil and operating the tractor in reverse.

Back slope – The soil profile in the side of a hill that is exposed from cut and fill type road construction.

Banks – The sides of a channel which holds or carries water.

Bed – The bottom of a stream.

Bedding – A mechanical site preparation technique where top soil is mounded into rows. Trees planted on top of the row will be well drained and will benefit from a concentration of nutrients and organic matter during initial stages of growth.

Biological integrity of waters of the state – The ability of a body of water to support the natural level of diverse plants and animals that would normally occur without man-made disturbance or manipulation of the landscape.

Broad based dip – An alteration of a road grade to intercept water from the surface and dispel it to the side without seriously interfering with vehicular traffic.

Canopy – The upper leafy branches of dominant and codominant trees and shrubs which intercept sunlight and shade the ground.

Chemical integrity of waters of the state – The natural range of nutrient and pH levels which would normally occur in waters passing through an undisturbed site.

Compaction – The result of all air and moisture holding spaces being squeezed out from between soil particles by operation of heavy equipment during unfavorable ground conditions. All soils are generally more easily compacted when wet. Compacted soil is less productive and more erodible.

Contour – An imaginary line on the surface of the earth connecting points of the same elevation.

Corps of Engineers – The federal regulatory agency, a branch of the U.S. Army, which administers and enforces the Section 404 permitting program of the Clean Water Act.

Critical shading of water – Shading when water receives the greatest protection from overheating and ultraviolet exposure caused by solar radiation.

Cross drain – A pipe, ditch or channel which safely conveys water from one side of the road to the other.

Crown – The top of a tree consisting of trunk and expanding branches.

Culverts – Usually metal or plastic pipe but can be a constructed wooden trough.

Cut and fill – Earthen material which is dug out of a hill and placed down slope to provide a relatively level road bed.

Deck – An area cleared to provide a site for loading logs onto a transport vehicle.

Decking – Rough or unfinished lumber used to provide a stable surface for roads, stream crossings or landings.

Definable bank – The bounds of a water body at or below its normal flow level which is usually devoid of terrestrial plants and accumulations of light organic debris.

Deposition – The act of depositing or putting into.

Destabilize (the soil) – To expose and/or loosen soil thus making it more susceptible to erosion.

Direct seeding – Artificially placing seed by hand, land machine or aircraft onto a germination surface.

Disking – Breaking up plants (above and below ground portions), organic matter and soil in preparation to improve the ground for replanting and to reduce plant competition.

Diversion device – A structure to intercept and re-route water from a road surface.

Drainage device – Same as diversion device.

Dredge – Earthen material that is dug from a channel or removed from the bottom of a water body, often to improve drainage.

Ephemeral streams – Low places in the landscape that only flow shortly after significant rainfall. Does not have a well defined channel.

EPA – The U.S. Environmental Protection Agency. The federal agency created and mandated by the U.S. Congress to administer and enforce the Clean Water Act upon waters of the United States.

Erosion – The dislodging and carrying away of soil particles by wind or water.

Fell – To cut or knock down standing trees or other vegetation.

Fill – To raise the elevation of a surface by depositing dredged or excavated material onto it.

Filtration strip – A strip of land where vegetation, mulch, or fabric is maintained or placed to intercept and prevent upland sediment and other pollutants from flowing into water.

Firebreaks – Natural or artificially constructed barriers to the spread of fire.

Floodplain – Areas adjacent to bodies of water that are most prone to flooding when the water overflows its banks.

Forest floor – Accumulations of organic debris and low vegetation on the ground beneath a stand of trees.

Forest resource managers – This group includes foresters, wildlife biologists, recreational planners and other developers.

Fragile area – Areas that are easily altered physically, biologically, or chemically, and are difficult or slow to recover.

Grade – The steepness of rise or fall of a road surface.

Ground cover – Low growing vegetation such as grass, forbs, vines, or shrubs.

Ground water – Water stored and/or flowing out of sight under the surface of the ground.

Hand planting – Re-establishing vegetation by planting seed or seedlings into prepared planting holes in the ground.

Harvests – Gathering merchantable portions of trees for commercial or domestic use.

Herbicide – a natural or synthetic chemical pesticide applied specifically to control competition from undesirable plant species.

High flow – The increased volume and speed of water that exceeds a stream's normal rate of flow.

High water mark – Physical evidence of past flooding such as discoloration of the lower portions of vegetation or debris suspended in branches off the ground.

Implementation – The carrying out of instructions contained in a management plan, harvest plan or reforestation plan (written or verbal).

Impoundments – An accumulation of water into pools or ponds formed by blocking the natural drainage.

Inslope – Sloping of a road surface so drainage is toward a ditch between the road and hill.

Intermittent bodies of water – Contain water within well defined channels during part of the year.

Label restrictions – Explicit instructions from the manufacturer with approval from federal and state authorities on when, where, and how a particular pesticide may be applied. Instructions also usually include worker and environmental safety precautions.

Landing - A site where logs are sorted and loaded onto trucks for hauling to handling or processing facilities.

Litter Layer – The natural buildup of dead leaves, branches and stems of dead trees and other forest vegetation which accumulate on the ground and then decay with time.

Log decks – Same as landings.

Mechanical planter – A tree planting machine pulled by a tractor and manned by a person who places trees into the ground.

Mechanical site preparation – Use of heavy machinery such as bulldozers with special attachments that clear debris or incorporate it into the soil to improve planting, sprouting, growth and or survival conditions for new forest trees.

Minimum residual cover - The fewest number of trees necessary to provide shade, natural recruitment of organic material, and soil holding capability for protection of the biological integrity of aquatic ecosystems.

Mulch – A coarse material used to protect soil from rainfall impact and erosion and to improve germination and growth of vegetation. Examples are hay, straw, bark and geotextile fabric.

Natural barrier – Areas that are devoid of fuel or food to support a spreading fire or insect or disease epidemic.

Natural drainage – Perennial, intermittent and ephemeral stream courses in a watershed that collect and expel runoff water.

Natural regeneration – Young trees that originate from seed or sprouts of trees that do or did grow on the site.

Nonpoint source – Water pollution which is not traceable to any discrete or identifiable facility but comes from a broad treatment area.

Normal passage of water and/or aquatic animals – Movement of water or animals which has not been obstructed or inhibited as the result of man-made activity.

Nutrients – Substances that nourish such as nitrogen, potassium and phosphorus in fertilizer. Excess nutrients can destabilize aquatic ecosystems.

Organic debris – Refuse such as tree tops, limbs or severely damaged tree stems which are left following road construction, logging, or site preparation.

Organic matter – Dead plant parts or animals. While natural recruitment of organic matter is part of the energy and nutrient cycles of an aquatic ecosystem, decay of excess amounts in water depletes oxygen needed by fish and other aquatic animals. Tops and other debris can sometimes block and divert the flow of streams causing additional erosion.

Partial cut – A selective timber harvest method where particular trees are usually designated to remain in the stand and the rest are removed in a thinning harvest.

Perennial bodies of water – Contain water within well defined channels virtually year round under normal climate conditions.

Permanent road – A road constructed, used and maintained beyond the time period of a single operation such as a timber sale.

Pesticide - See herbicide for specific application.

Physical integrity of waters of the state – The retention of water in its natural condition without alteration of stream course, depth, clarity or freedom of obstructions that might occur as the direct result of man-made activity.

Plowed fire control line – A man-made fire break constructed by a heavy piece of equipment such as a small bulldozer pushing or pulling a heavy duty plow designed for cutting through the forest floor and root mat to clear combustible material and expose mineral soil.

Pollutants – Man-induced elements such as sediment, organic debris, increased temperature, nutrients, chemicals, trash and soil degradation which exceed a water's natural ability to neutralize before changes in the physical, chemical or biological integrity of waters of the state occur.

Portable bridge – a stream crossing device that is preassembled, installed across a channel and removed following completion of an activity with minimum adverse impact to water quality.

Portable logging mats – Temporary road or stream crossing surface constructed of rough cut lumber nailed or bolted together. These are usually expected to be removed and reused following completion of a particular operation.

Prescribed burning – Preplanned fire that is deliberately set in a time and manner when prescribed conditions will allow accomplishment of specific objectives and is under control until it burns out or is extinguished.

Puddling – The destruction of root systems and soil structure by the tearing and churning action of heavy equipment operating in saturated soils. Puddled soils are more susceptible to erosion than undisturbed soils.

Reforestation – The restocking of a forest stand through natural regeneration or artificially planted seed or seedlings.

Regeneration – A young stand of a forest.

Regeneration cut – Either partial harvests where selected trees are left to provide adequate seed or silvicultural clearcuts where all merchantable and non-merchantable tree stems are removed or felled to encourage sprouting of desirable tree species.

Riprap – Large stones which are arranged over loose soil to protect it from erosion.

Rutting – Impression left in the ground after soil is compacted by the wheels or tracks of heavy equipment operating in soft earth. Deep rutting can disrupt surface and subsurface hydrology on flat lands and cause soil erosion on steep lands by concentrating surface runoff.

Sediment – Accumulations of loose soil particles. Excessive amounts of sediment can pollute water needed for aquatic ecosystems, drinking, wildlife, outdoor recreation, and industrial use.

Shearing and raking – A site preparation technique that uses a large tractor equipped with a special cutting blade to cut down trees just above the ground surface and a second tractor equipped with a specialized raking blade that pushes the felled trees and other debris into piles or windrows.

Side bank – Same as back slope.

Silviculture – The care and cultivation of forest trees; forestry.

Site preparation – Use of machines, herbicides, fire or combinations thereof to dispose of slash, improve planting conditions and provide initial control of competing vegetation.

Skid – To drag logs with a specialized tractor to a landing.

Skid trails – Paths where logs have been dragged.

Slash – Unmerchantable debris such as brush or tree stems, tops, branches or leaves that are left following a commercial timber harvest operation.

Slough – An open water inlet from a larger body of water.

Soil stabilizing materials – Silt fencing, straw blankets, geotextile fabric, geoweb, etc., applied to protect soil from erosion.

Soil type – Consistent characteristics of an identifiable soil such as particle sizes, moisture holding capacity, plasticity and ease of compaction.

Span – A structural beam designed to hold other bridge components and traffic above a stream or channel.

Steep gradient – A high rate of ascent or descent on a road.

Stringent – Tightly regulated or controlled.

Surface water – Exposed water above the ground surface.

Temperature – The degree of hotness or coldness of an environment. Removal of vegetative shade from banks of streams and shores will directly raise water temperature and indirectly result in lower dissolved oxygen levels. These influences place some fish and other organisms under stress.

Temporary access roads – Roads not expected to be maintained much longer than the activity for which they were installed to support.

Timber purchasers – Agents who locate commercial stands of timber and negotiate terms of purchase on either their own behalf or on the behalf of timber brokerage or forest product companies.

Topography – The lay of the land.

Tops – The upper (usually referring to unmerchantable) portions of trees.

Trash – Unnaturally occurring, man-made refuse or discarded substances. Openly discarded trash and petroleum wastes may be carried into waters of the state by storm runoff and is unsightly.

Understory vegetation – Small trees, shrubs or other plants which grow beneath the canopy of more dominant trees.

Upland runoff – Surface drainage water which flows from higher elevations of a landscape into the natural drainage system of a watershed.

Vendors – Contractors who provide tree harvesting, site preparation, tree planting or other forestry services for a fee.

Washouts – Clearing of natural or man made obstructions of drainage systems during high stream flows.

Water bar – A long mound of dirt constructed to prevent soil erosion and water pollution by diverting drainage from a road or skid trail into a filter strip.

Water bodies – Branches, creeks, rivers, ponds, lakes, bays, etc.

Water diversions – Structures or devices which change the direction of drainage flow.

Water quality impairment – The reduction of water quality below established water quality standards.

Waters of the State – Include every watercourse, stream, river, wetland, pond, lake, coastal, ground or surface water, wholly or partially in the state, natural or artificial which is not entirely confined and retained on the property of a single landowner.

Waters of the United States (U.S.) – Include all waters such as lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands and sloughs which are susceptible to use in interstate or foreign commerce, recreation, fish and shellfish production and industrial use; impoundments of waters just described; tributaries of waters just described (other than waters that are themselves wetlands).

Wildfire – Fires burning without the control of a responsible person.

Windrows – Long piles of accumulated debris.

Wing ditch – A secondary "turn out" ditch that diverts drainage water from primary roadside ditches, to be filtered out into the surrounding area.

Additional Resources

Additional information pertaining to silvicultural BMPs and water quality is available from the following publications and sources of assistance:

Streamside Management Zones

Comerford, N.B., D.G. Neary and R.S Mansel. *The Utility of Buffer Strips to Protect Forested Wetlands from Impacts Due to Forest Silvicultural Operations,* Gainesville, FL, National Council of the Paper Industry for Air and Stream Improvement, In Press.

Dickson, J.G. and J.C. Huntley. "Riparian Zones and Wildlife in Southern Forests," *Managing Southern Forests for Wildlife and Fish*, Ed. J. Dickson and O. Maughan, USDA Forest Service General Technical Report 50-65, (1987), 37-39.

Helfrich, L.A. et al. *Landowner's Guide to Managing Streams in the Eastern United States,* Virginia Cooperative Extension Service Publication 420-141, 1986.

James, B.R. "Riparian Vegetation Effects on Nitrate Removal from Groundwater," *Journal of Environmental Quality*, University of Maryland, In Press.

Kundt, J.F. et al. *Streamside Forests: The Vital Beneficial Resource*, Maryland Cooperative Extension Service, 1988.

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Practical Approaches to Riparian Resource Management: An Educational Workshop, Billings, MT, US Bureau of Land Management BLM-MT-PT-89-001-4351, 1989.

Rudolph, D.G and J.G. Dickinson. "Streamside Zone Width and Amphibian and Reptile Abundance," *The Southwestern Naturalist,* 35, (1990), 472-476.

Schilling, Erik B. and B. Graeme Lockaby. *Streamside Management Zones in Alabama: Functions and Management,* Auburn University Center for Forest Sustainability.

Swift, L.W. "Filter Strip Widths for Forest Roads in Southern Appalachians," *Southern Journal of Applied Forestry*, 10 (1984), 27-34.

Warmwater Streams Symposium: A National Symposium on Fisheries Aspects of Warmwater Streams, Southern Division American Fisheries Society, (1980).

Stream Crossings

Baker, C.O. and F.E. Votapka. "Fish Passage Through Culverts," *USDA Forest Service Technology and Development Center Report No. FHWA-FL-90-006*, 1990.

Mason, L. *Portable Wetland Area and Stream Crossings*, USDA Forest Service Technology and Development Center, 1990.

Forest Roads

Kochenderfer, J.N. *Cost of and Soil Loss in "Minimum-Standard" Forest Truck Roads Constructed in the Central Appalachians,* USDA Forest Service Research Paper NE-544, 1984.

Swift, L.W. "Soil Losses from Roadbeds and Cut and Fill Slopes in the Slopes in the Southern Appalachian Mountains," *Southern Journal of Applied Forestry,* 8, (1984), 209-215.

Swift, L.W. "Gravel and Grass Surfacing Reduces Soil Loss from Mountain Roads," *Forest Science,* 30, (1984), 656-670.

The Layman's Guide to Private Access Road Construction in the Southern Appalachian Mountains, Tennessee Valley Authority, Waynesville, N. C.: Haywood Press, Inc. 1985.

Wallbridge, T.A., Jr. *The Paper Location of Forest Roads*, Blackburge, AA, Virginia Polytechnical Institute and State University, 1989.

Wallbridge, T.A., Jr. *The Direct Location of Forest Roads*, Blacksburg, VA, Virginia Polytechnical Institute State University, 1990.

Timber Harvesting

Brinker, R.W. *Best Management Practices for Timber Harvesters*, Alabama Cooperative Extension Service Circular ANR-539, 1989.

Simmons, F.C. *Handbook for Eastern Timber Harvesting,* USDA Forest Service Northeastern Area State and Private Forestry, 1979.

Swindel, B.F. "Multi-Resource Effects of Harvest, Site Preparation and Planting in Flatwoods," *Southern Journal of Applied Forestry*, 7, (1983), 6-15.

Reforestation/Stand Management

Beasley, R.S., and A. Granillo, "Water Yields and Sediment Losses from Chemical and Mechnical Site Preparation in Southwest Arkansas," *Forestry and Water Quality. A Mid-South Symposium*, Arkansas Cooperative Extension Service, 1985.

Wetlands

Gosselink, J.G. and L.C. Lee. *Cumulative Impact Assessment in Bottomland Hardwood Forest*, Baton Rouge, LA, Center for Wetlands Resources, Louisiana State University LSU-CEI-86-09, 1987.

Federal Manual for Identifying and Delineating Jurisdictional Wetlands, Federal Interagency Committee for Wetland Delineation, 1989.

Forested Wetlands of the Southeast: Review of Major Characteristics and Role in Maintaining Water Quality, USDI Fish and Wildlife Service Publication 163, 1986.

Forested Wetlands of the United States: Proceedings of the Symposium, USDA Forest Service Southeastern Forest Experiment Station General Technical Report SE-50, 1988.

Good, R.E., D.F. Whigham and R. L. Simpson. *Freshwater Wetlands: Ecological Processes and Management Potential*, New York, Academic Press, 1978.

Kellison, R.C. et al. *Regenerating and Managing Natural Stands of Bottomland Hardwoods,* American Pulpwood Association, 88-A-6, 1988.

Kibby, H.V. "Effects of Wetlands on Water Quality," *Proceedings of the Symposium on Strategies for Protection and Management of Floodplain Wetlands and Other Riparian Ecosystems,* USDA Forest Service Publication GTR-WO-12, 1978.

Larson, J.S. "Wetland Value Assessment: State of the Art," *National Wetlands Newsletter*, Vol. 3, No. 2, Mar-Apr 1981.

National List of Plant Species That Occur in Wetlands: Southeast (Region 2), U.S. Fish and Wildlife Service, Biological Report 88 (26.2), 1988.

National Wetlands Policy Forum, The Conservation Foundation, 1989.

Wharton, C. H. et al. *Forested Wetlands of Florida, Their Management and Use,* Gainesville, FL, Center for Wetlands, University of Florida, 1977.

General BMPs

Alabama Nonpoint Source Management Program, Montgomery, Alabama. Alabama Department of Environmental Management. October 2000. http://www.adem.state.al.us/Education%20Div/Nonpoint%20Program/ManagePlan/partIIsi.pdf

Best Management Practices for Silvicultural Activities on TVA Lands, Norris, TN, Division of Land Resources, Tennessee Valley Authority, 1990.

Burns, R.G., and J.D. Hewlett. “A Decision Model to Predict Sediment Yield from Forest Practices,” *Water Resources Bulletin 19*, (1983), 9-14.

Dissmeyer, G.E. and G.R. Foster. *A Guide for Predicting Sheet and Rill Erosion on Forest Land,* USDA Forest Service State and Private Forestry Southeastern Area, Technical Publication SA-TP 11, 1980.

Dissmeyer, G.E. and N.D. Kidd. “Multiresource Inventories: Watershed Condition of Commercial Forest Land in South Carolina,” *USDA Forest Service Research Paper SE-247*, 1984.

Erosion Control on Forest Land in Georgia, Georgia Cooperative Extension Service, 1979.

Forestry and Water Quality: A mid-south symposium, Arkansas Cooperative Extension Service, 1985.

Glasser, S.P. *Summary of Water Quality Effects from Forest Practices in the South*, Atlanta, GA, USDA Forest Service Southern Region, 1982.

Golden, M.S. et al. *Forestry Activities and Water Quality in Alabama: Effects, Recommended Practices, and an Erosion Classification System,* Alabama Agricultural Experimental Station Auburn University, Bulletin 555, 1984.

Golden, M.S. et al. *Guidelines for Refinement of Best Management Practices in Alabama*, Auburn University, AL, Department of Forestry, 1984.

National Management Measures to Control Nonpoint Source Pollution from Forestry, U.S. Environmental Protection Agency, Office of Water, Washington DC 20460 (4503F) EPA-841-B-05-001 April 2005. http://www.epa.gov/owow/nps/forestrymgmt/ (May 2005).

Sources of Technical Assistance

Technical assistance and/or additional information may be available from the following agencies and organizations to help you plan forestry operations that may affect water quality.

Alabama Department of Conservation and Natural Resources
64 North Union Street, Suite 468
Montgomery, AL 36130
(334) 242-3465
www.outdooralabama.com

Alabama Department of Environmental Management (ADEM)
1400 Coliseum Boulevard
Montgomery, AL 36110-2059
or
P. O. Box 301463
Montgomery, AL 36130-1463
(334) 271-7700
http://www.adem.alabama.gov

Alabama Cooperative Extension System
109-D Duncan Hall
Auburn University, AL 36849
(334) 844-4444
www.aces.edu

Alabama Forestry Association
555 Alabama Street
Montgomery, AL 36104
(334) 265-8733
www.alaforestry.org

Alabama Forestry Commission
513 Madison Avenue
Montgomery, AL 36130
(334) 240-9365 or 240-9332
www.forestry.state.al.us

American Forest and Paper Association
1111 19th St. NW, Suite 800
Washington, DC 20036
(800) 878-8878
www.afandpa.org

U.S. Army Corps of Engineers
Mobile District
P.O. Box 2288
Mobile, AL 36628
(251) 471-5966
www.sam.usace.army.mil

Nashville District
P.O. Box 1070
Nashville, TN 37202
(615) 736-7161
www.orn.usace.army.mil

U.S. Environmental Protection Agency (EPA)
Region 4
Sam Nunn Atlanta Federal Center
61 Forsyth Street SW
Atlanta, GA 30303-8960
(404) 562-9900 or 1-800-241-1754
http://www.epa.gov/region04/about/index.html

USDA Forest Service
2946 Chestnut Street
Montgomery, AL 36107
(334) 832-4470
www.fs.fed.us

USDA Natural Resources Conservation Service
P.O. Box 311
Auburn, AL 36830
(334) 887-4560
www.nrcs.usda.gov/programs

U.S. Fish and Wildlife Service
1208-B Main Street
Daphne, AL 36526-4419
(251) 441-5181
www.fws.gov


Alabama Forestry Commission
2007

APPENDIX G 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:

<u>Submerged Aquatic Vegetation</u>

	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*

<u>Wetlands</u>

	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.

<u>Streams and Riparian Buffers</u>

	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 H 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.) <u>Comments</u>: 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.) <u>Comments</u>: 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.) <u>Comments</u>: 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.) <u>Comments:</u> 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

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.) <u>Comments</u>:	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.) <u>Comments</u>:	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.) <u>Comments:</u>	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.) <u>Comments</u>:	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.) <u>Comments:</u>	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.) <u>Comments</u>: (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