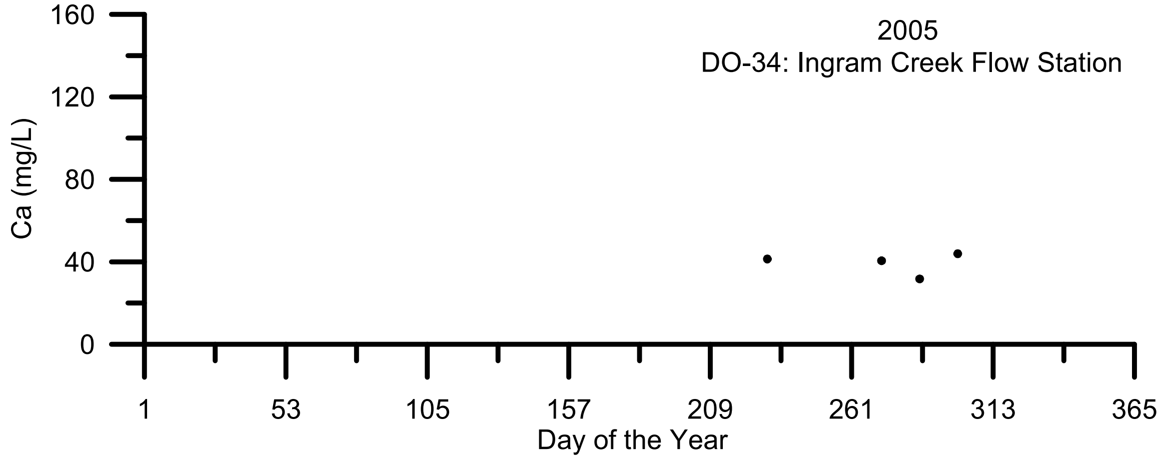
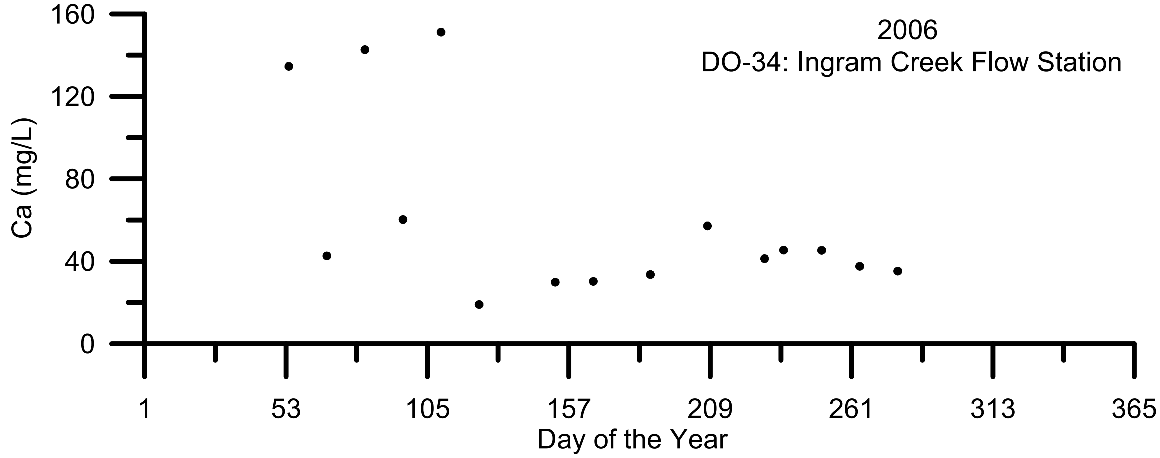
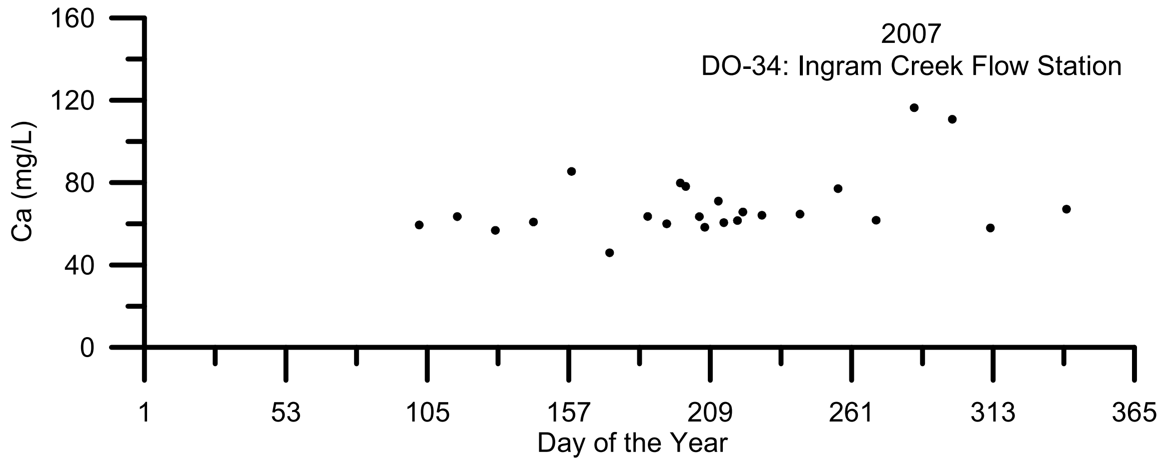
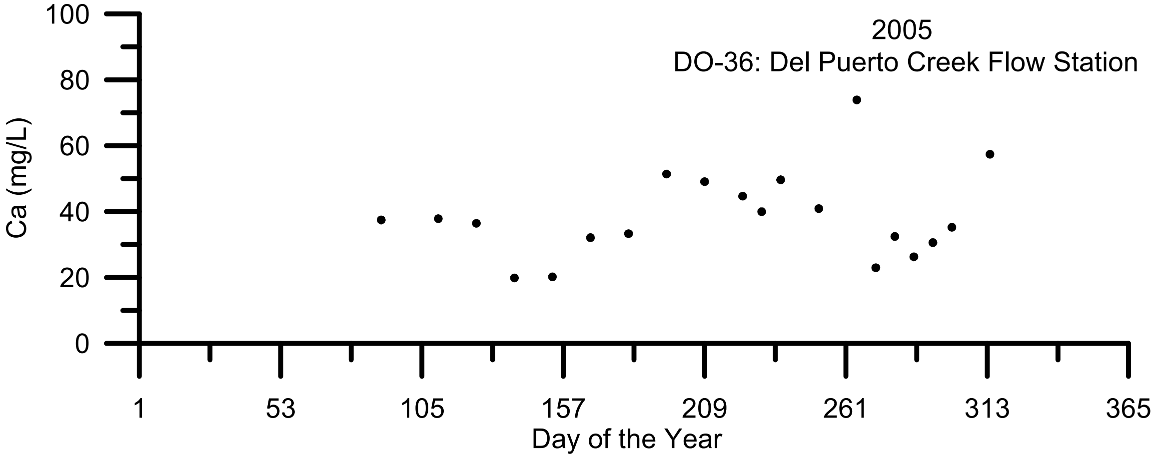
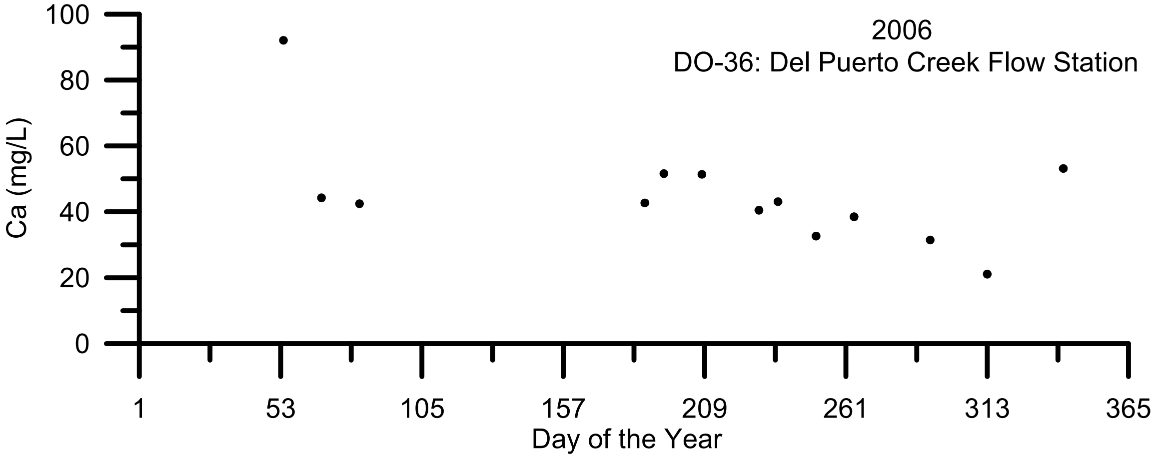
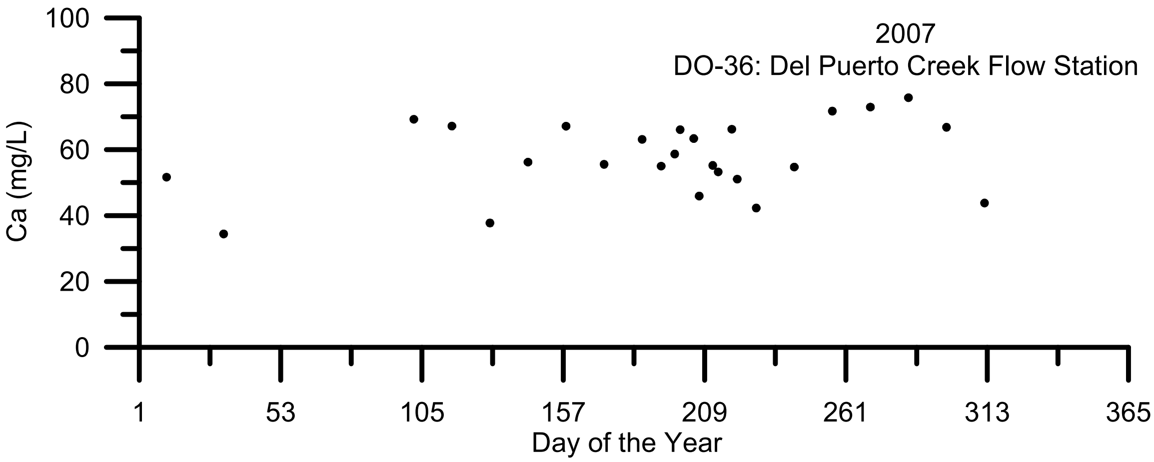

2005
DO-34: Ingram Creek Flow Station
Ca (mg/L)
0
40
80
120
160
1
53
105
157
209
261
313
365
Day of the Year

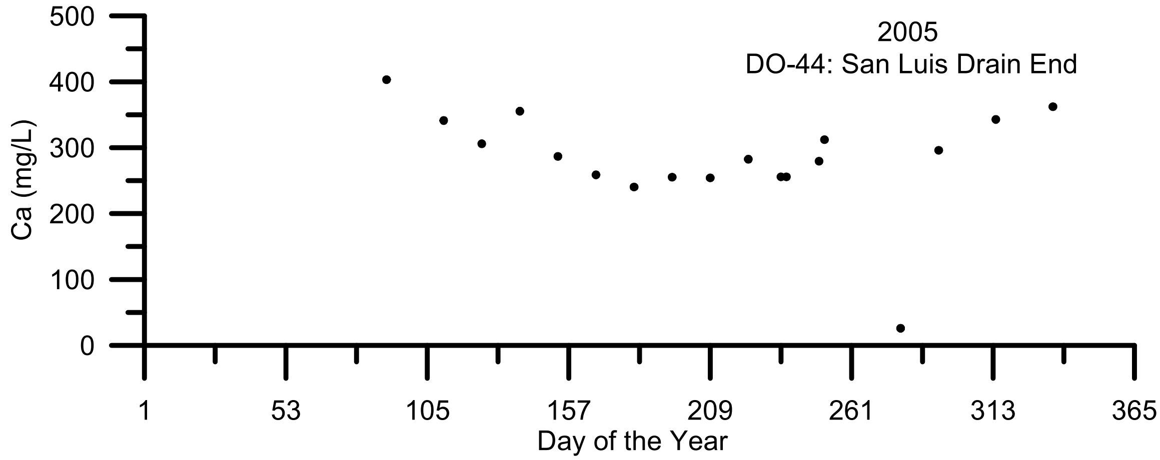

2006
DO-34: Ingram Creek Flow Station
Ca (mg/L)
0
40
80
120
160
1
53
105
157
209
261
313
365
Day of the Year

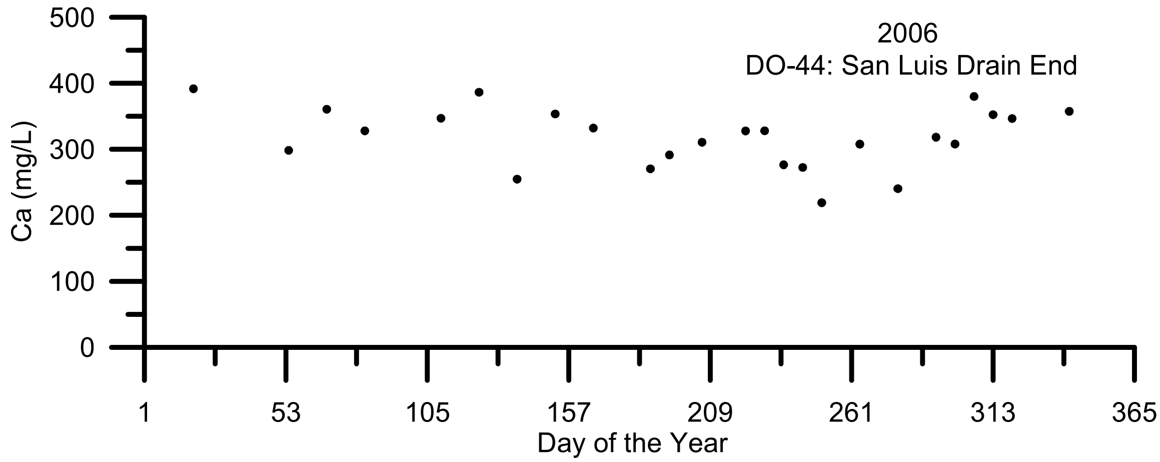

2007
DO-34: Ingram Creek Flow Station
Ca (mg/L)
0
40
80
120
160
1
53
105
157
209
261
313
365
Day of the Year

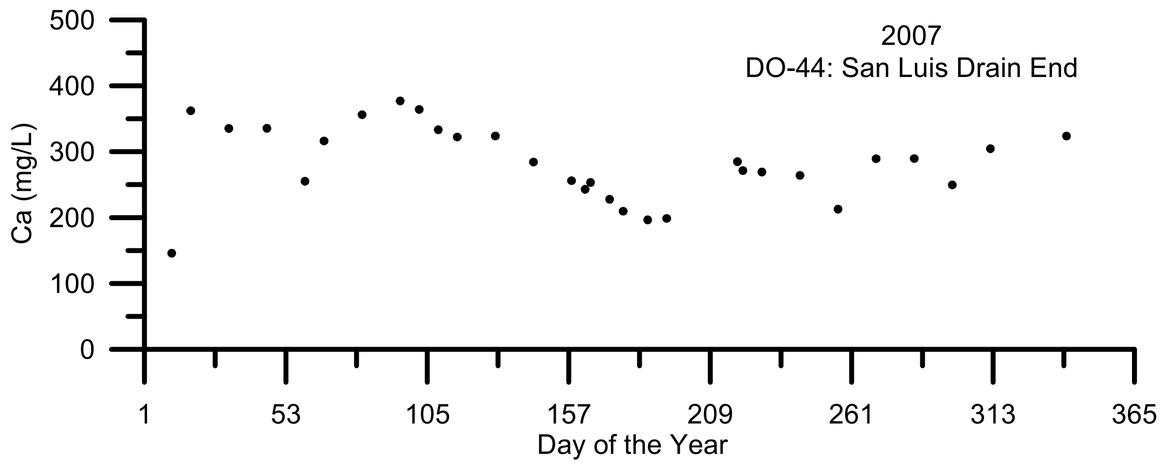

2005
DO-36: Del Puerto Creek Flow Station
Ca (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

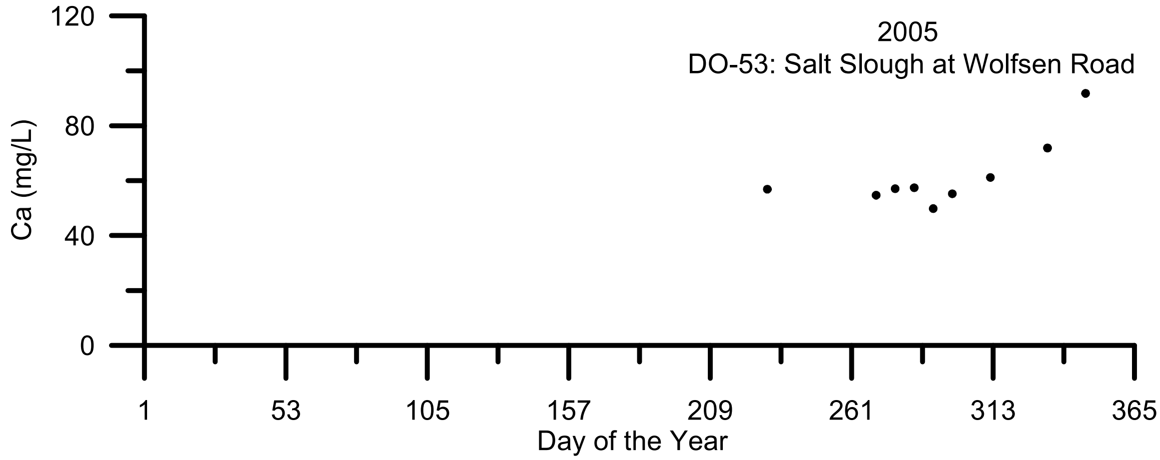

2006
DO-36: Del Puerto Creek Flow Station
Ca (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

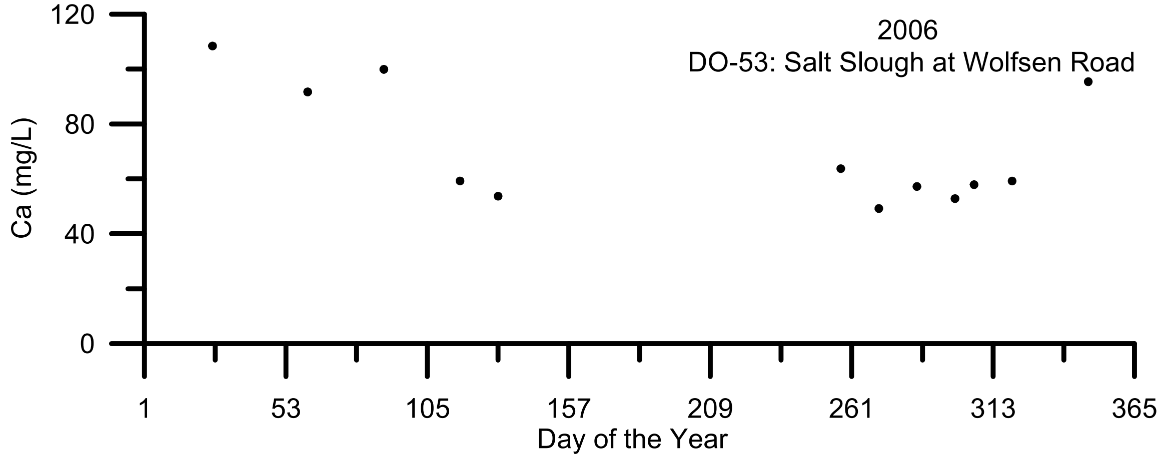

2007
DO-36: Del Puerto Creek Flow Station
Ca (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

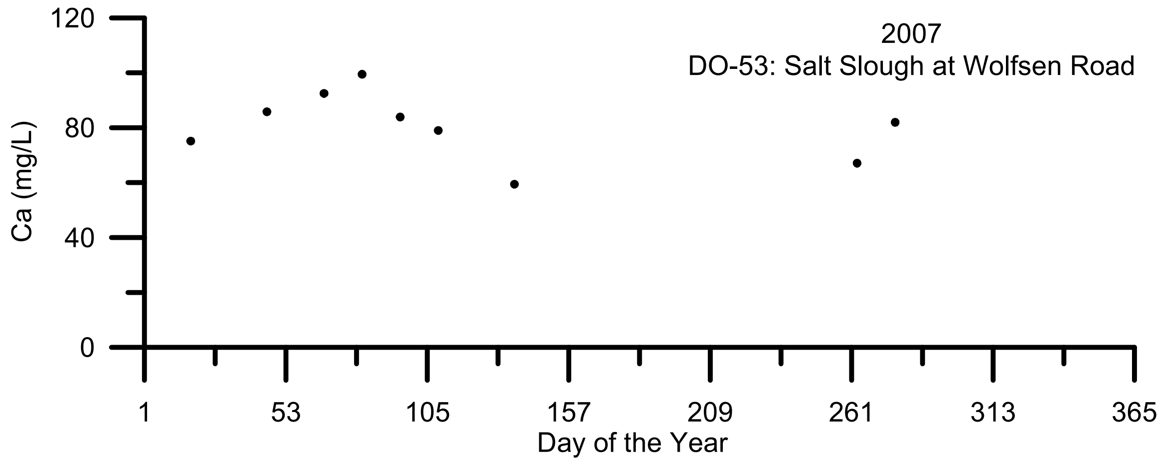

2005
DO-44: San Luis Drain End
Ca (mg/L)
Day of the Year

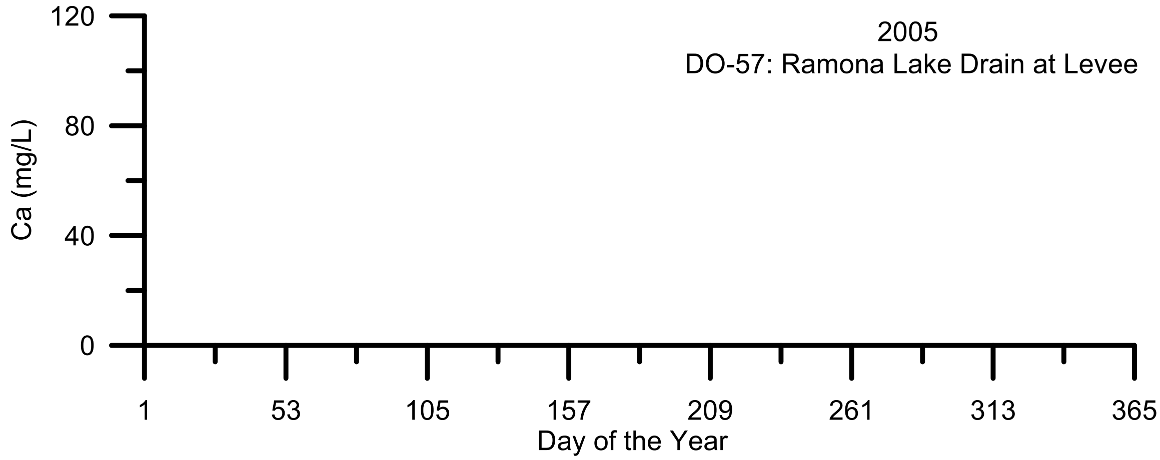

2006
DO-44: San Luis Drain End
Ca (mg/L)
Day of the Year

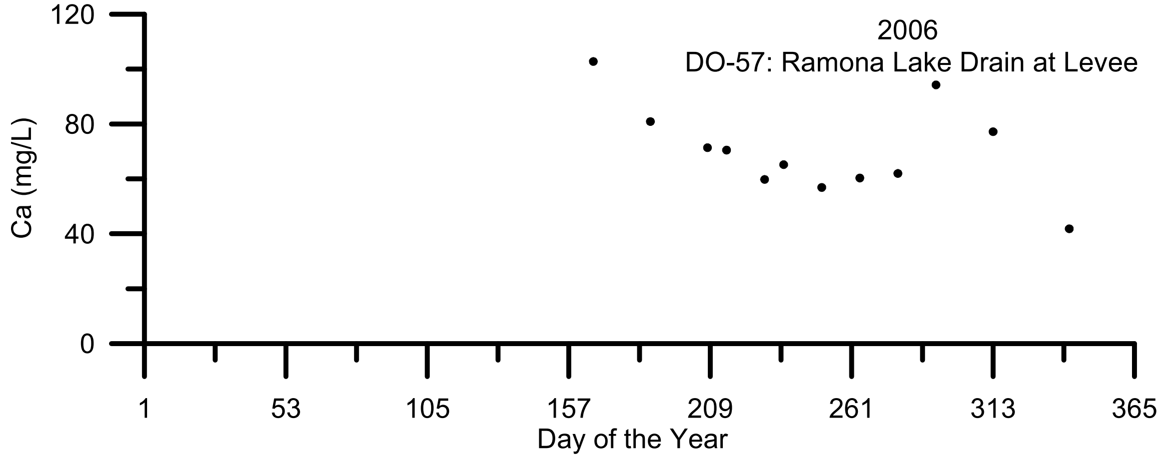

2007
DO-44: San Luis Drain End
Ca (mg/L)
Day of the Year

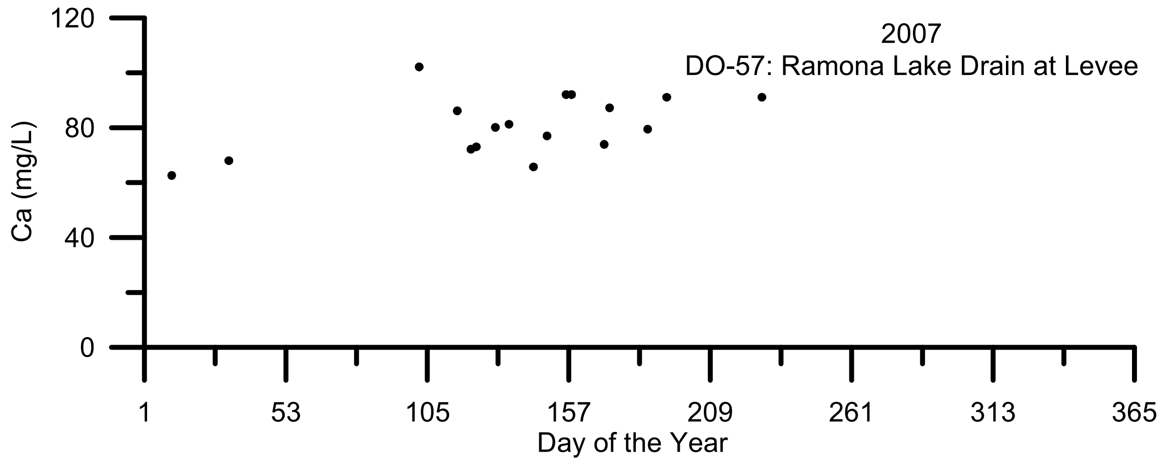

2005
DO-53: Salt Slough at Wolfsen Road
Ca (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

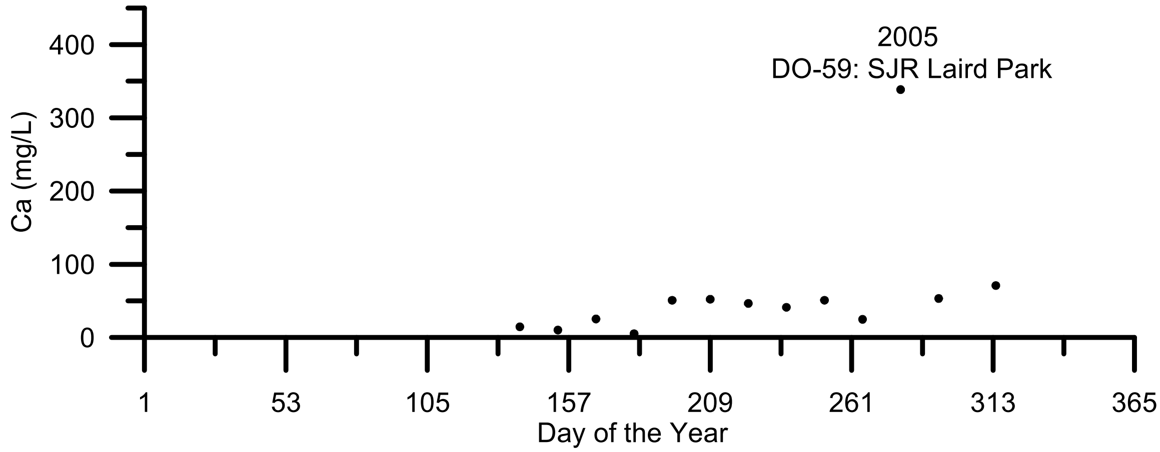

2006
DO-53: Salt Slough at Wolfsen Road
Ca (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

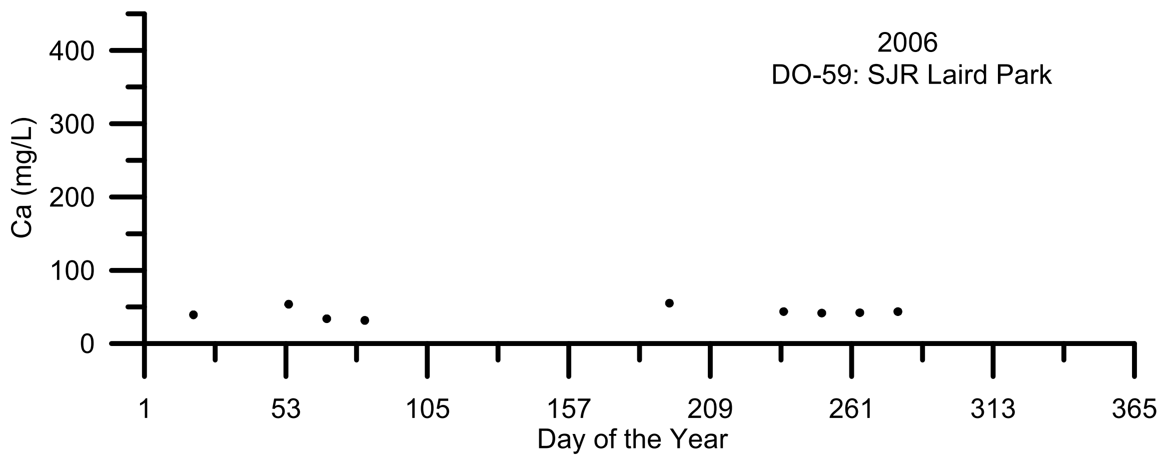

2007
DO-53: Salt Slough at Wolfsen Road
Ca (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

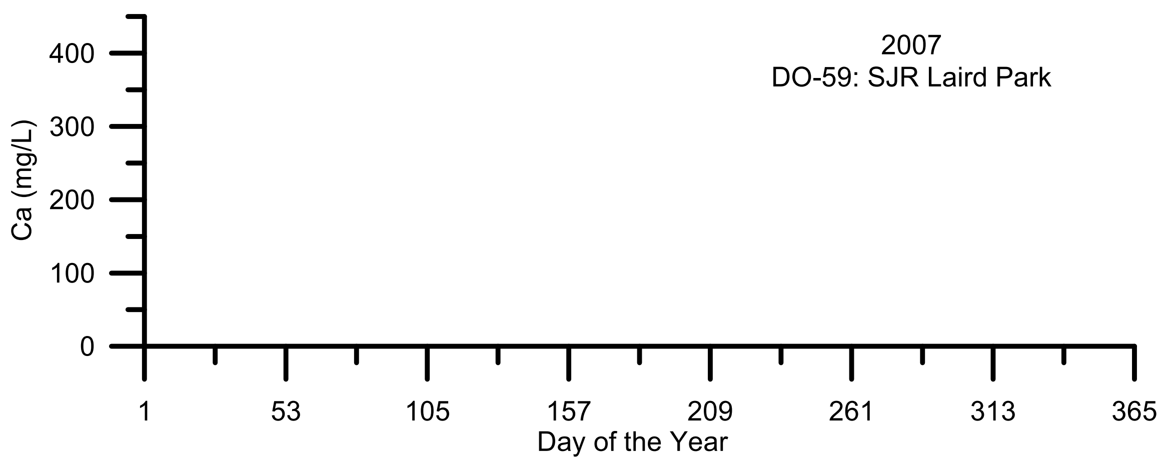

2005
DO-57: Ramona Lake Drain at Levee
Ca (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

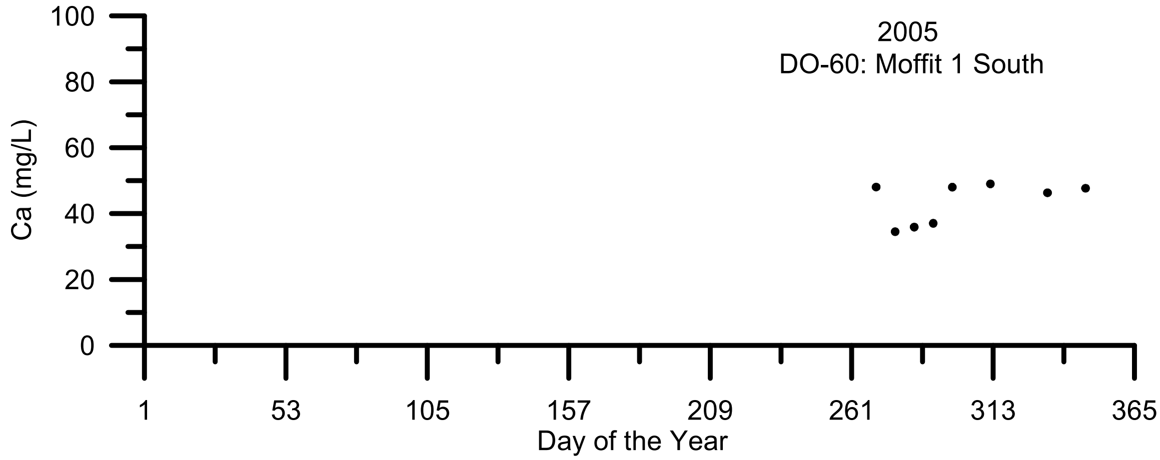

2006
DO-57: Ramona Lake Drain at Levee
Ca (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

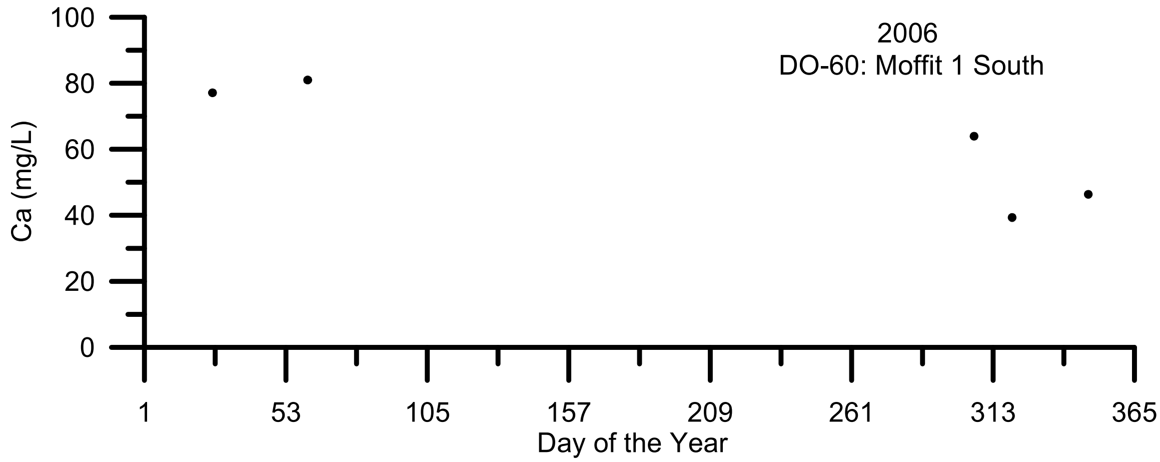

2007
DO-57: Ramona Lake Drain at Levee
Ca (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

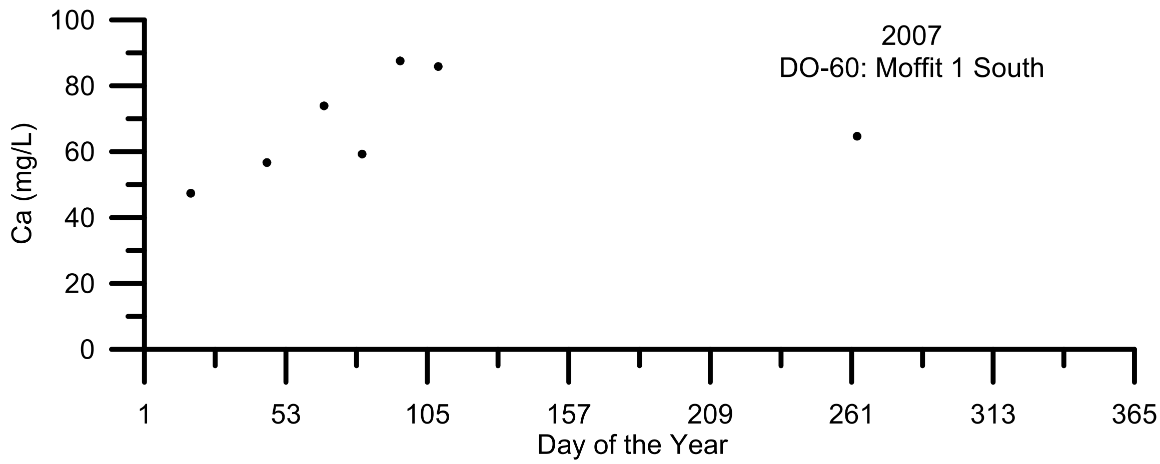

2005
DO-59: SJR Laird Park
Ca (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

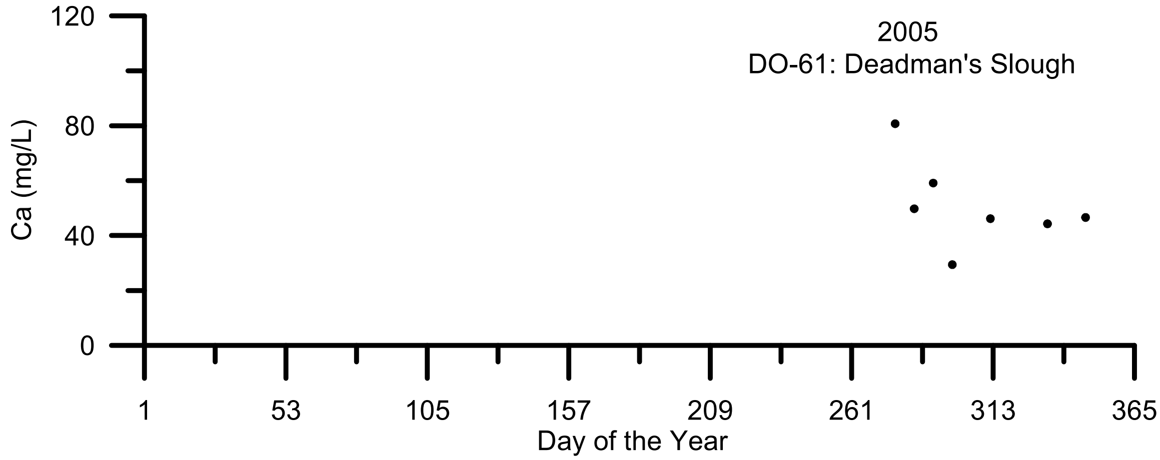

2006
DO-59: SJR Laird Park
Ca (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

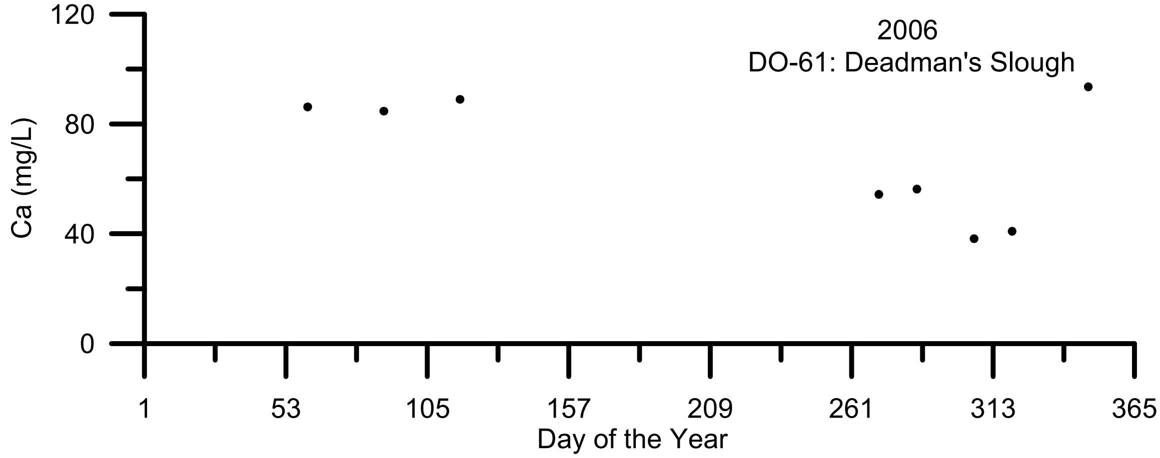

2007
DO-59: SJR Laird Park
Ca (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

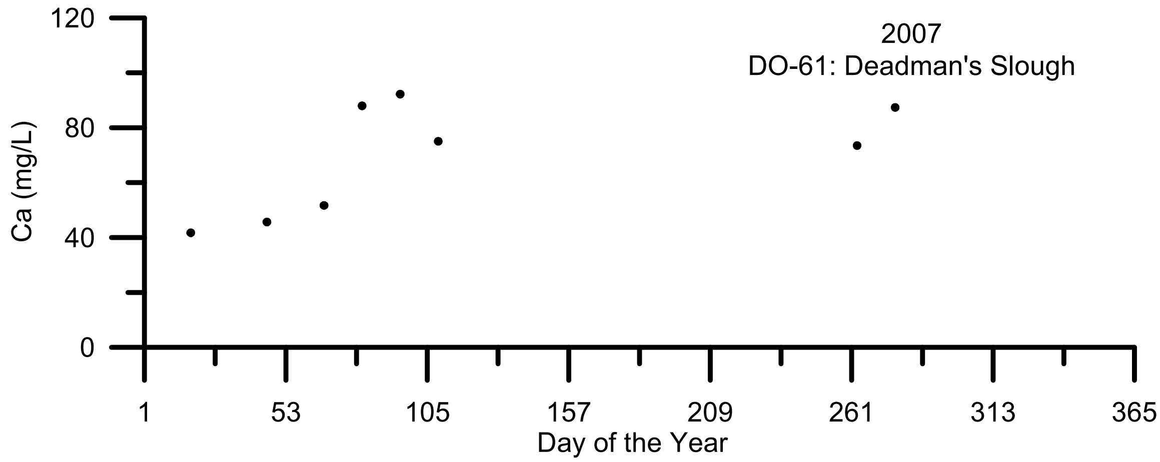

2005
DO-60: Moffit 1 South
Ca (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

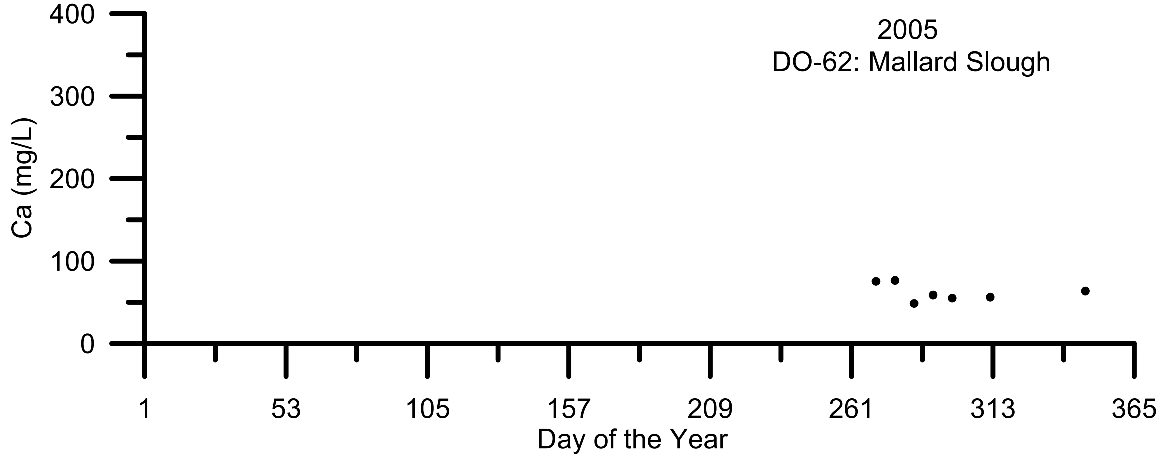

2006
DO-60: Moffit 1 South
Ca (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-60: Moffit 1 South
Ca (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

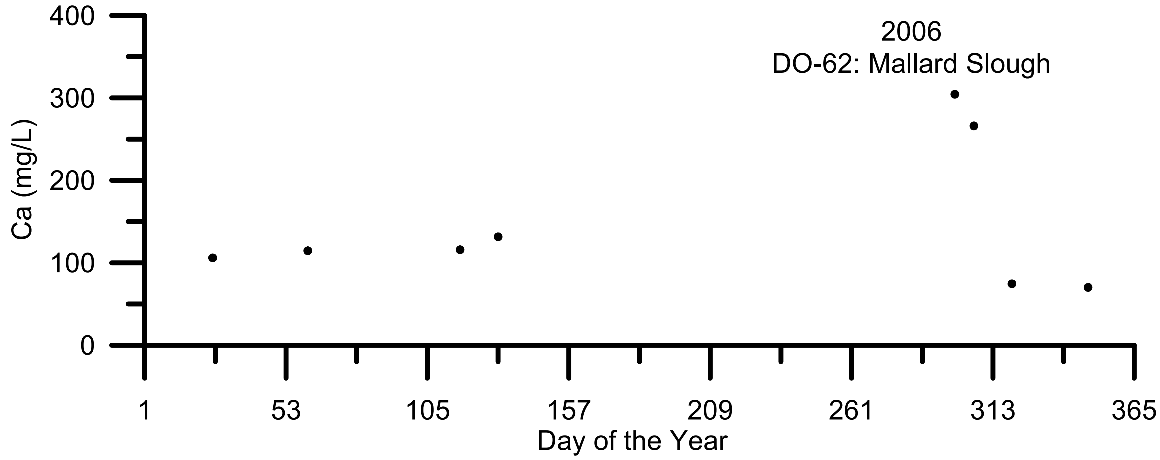

120
80
40
0
Ca (mg/L)
2005
DO-61: Deadman's Slough
1
53
105
157
209
261
313
365
Day of the Year


120
80
40
0
Ca (mg/L)
2006
DO-61: Deadman's Slough
1
53
105
157
209
261
313
365
Day of the Year

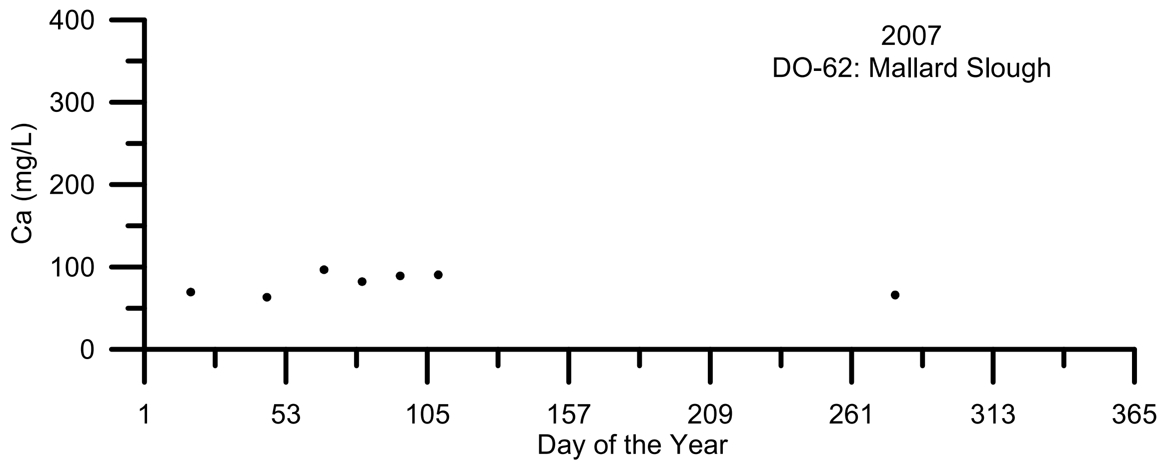

120
80
40
0
Ca (mg/L)
2007
DO-61: Deadman's Slough
1
53
105
157
209
261
313
365
Day of the Year



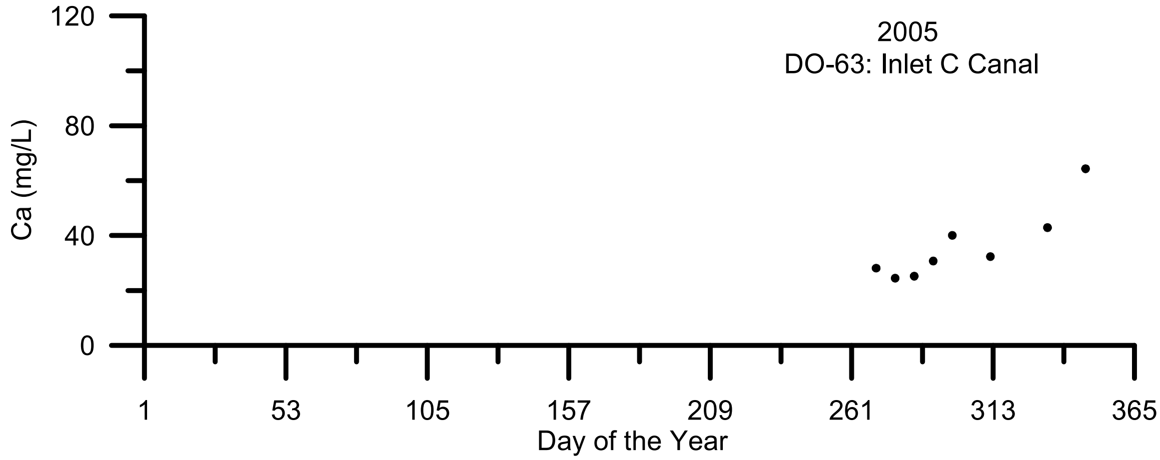
2005
DO-62: Mallard Slough
Ca (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

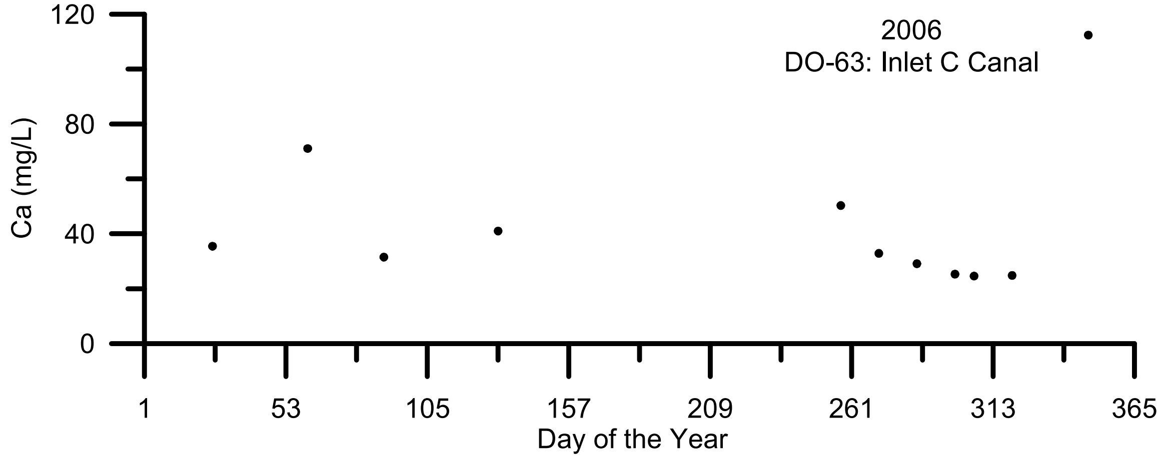


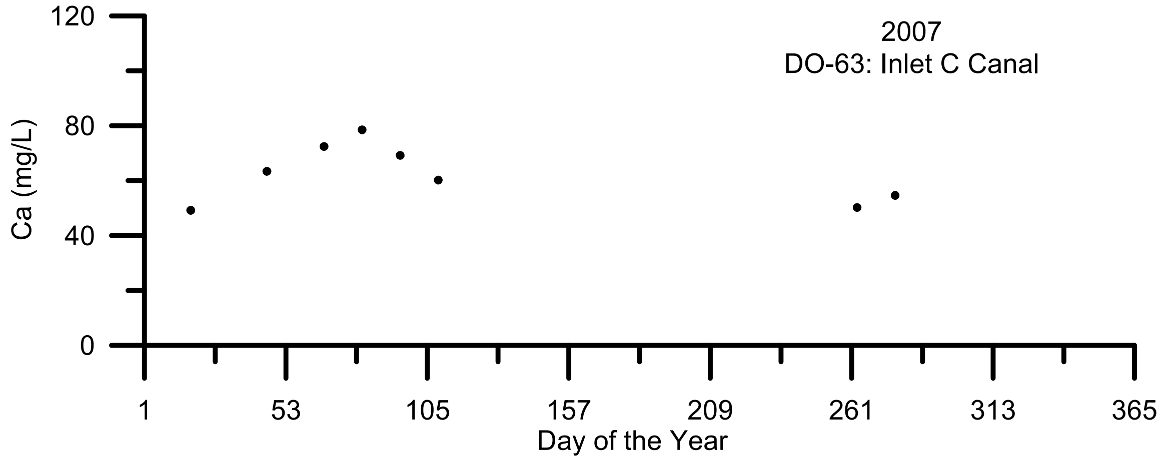
2006
DO-62: Mallard Slough
Ca (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

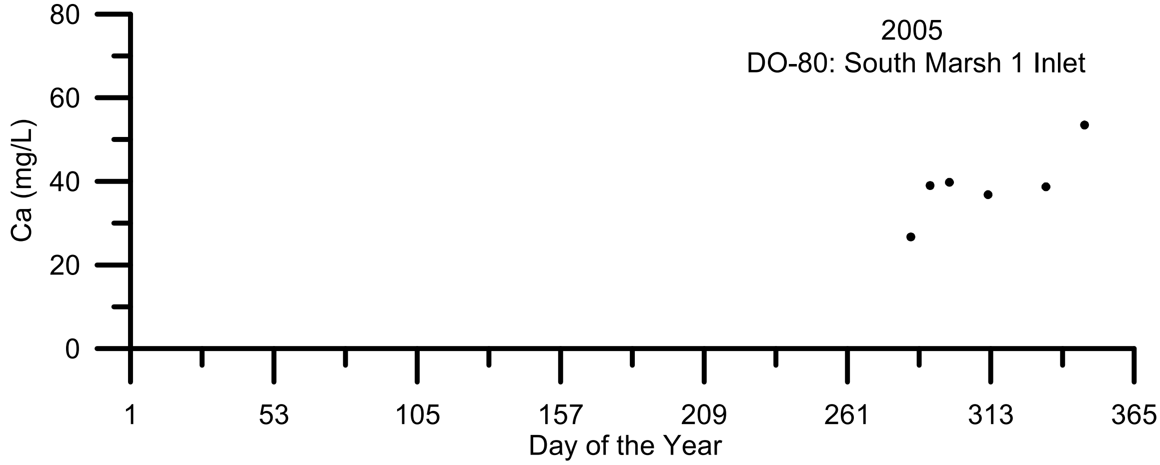


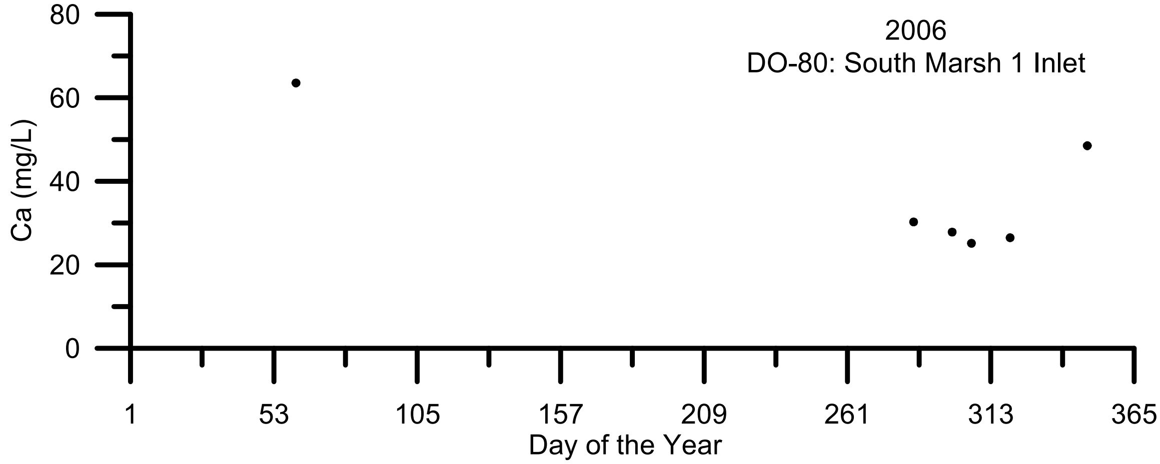
2007
DO-62: Mallard Slough
Ca (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

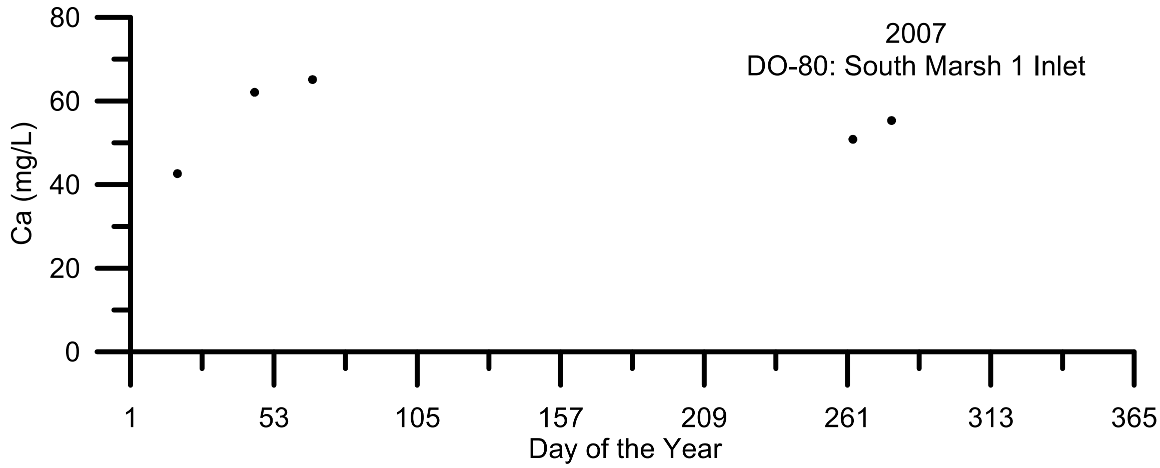

2005
DO-63: Inlet C Canal
Ca (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

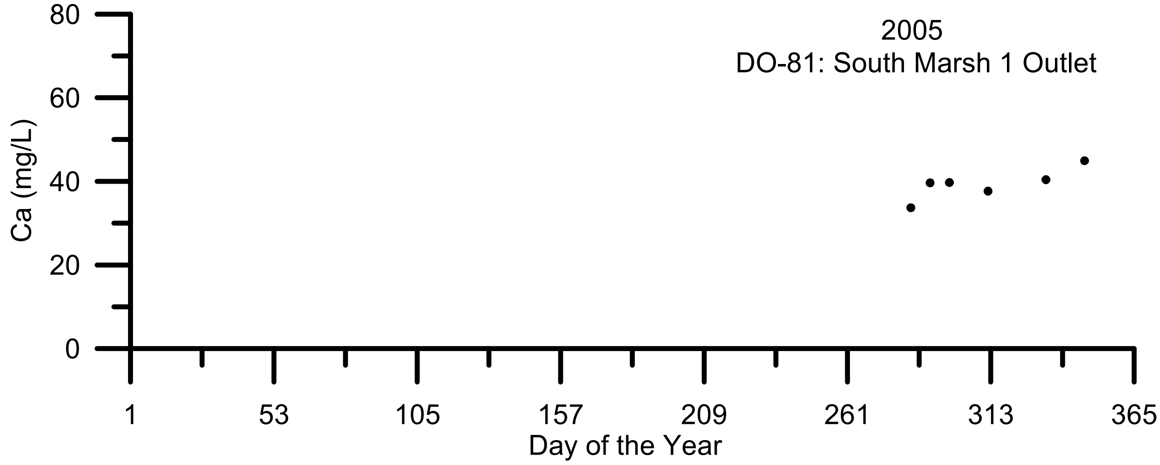

2006
DO-63: Inlet C Canal
Ca (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

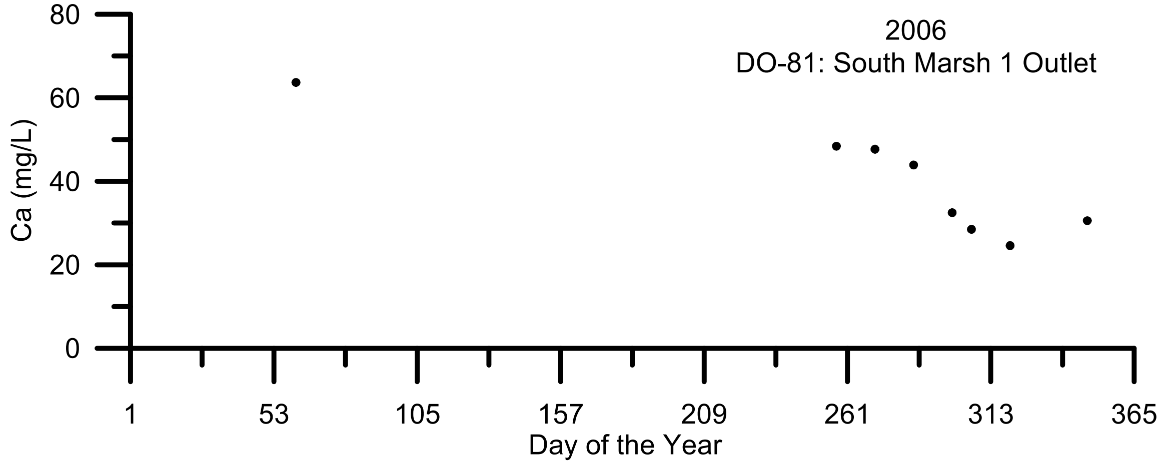

2007
DO-63: Inlet C Canal
Ca (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

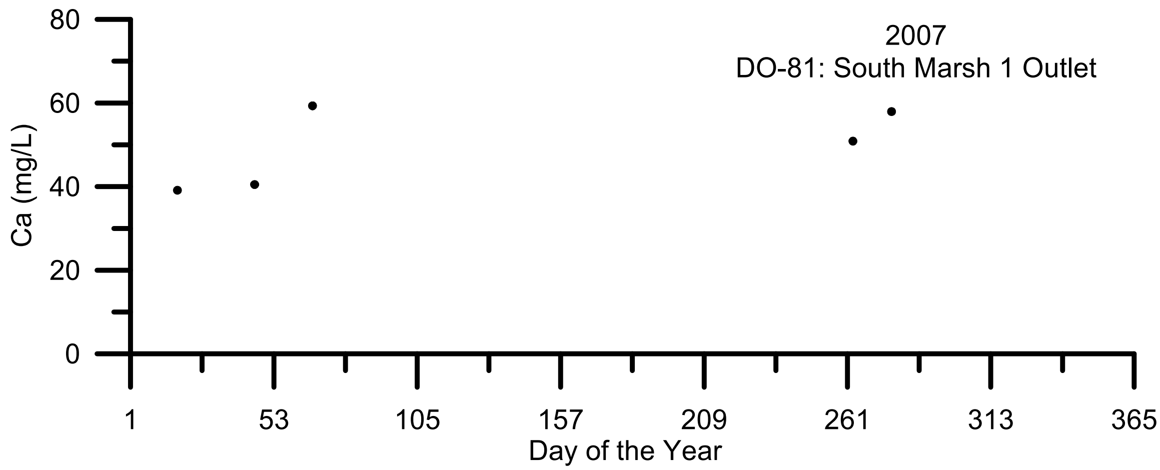

2005
DO-80: South Marsh 1 Inlet
Ca (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

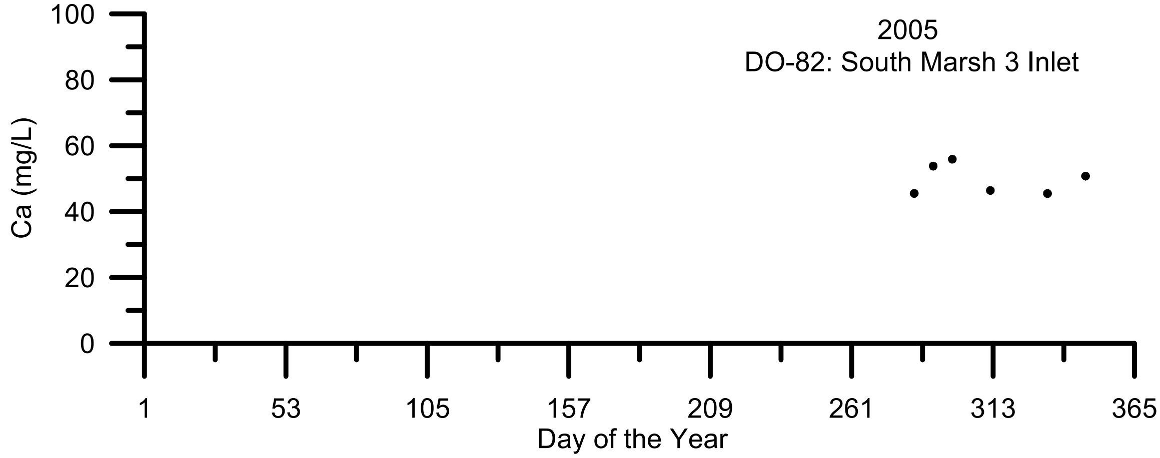

2006
DO-80: South Marsh 1 Inlet
Ca (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-80: South Marsh 1 Inlet
Ca (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

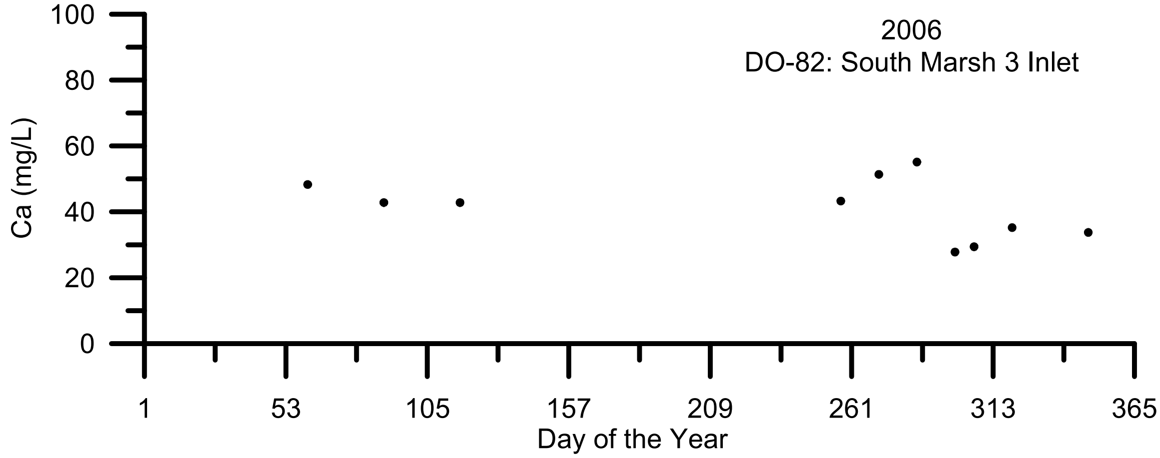

2005
DO-81: South Marsh 1 Outlet
Ca (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-81: South Marsh 1 Outlet
Ca (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

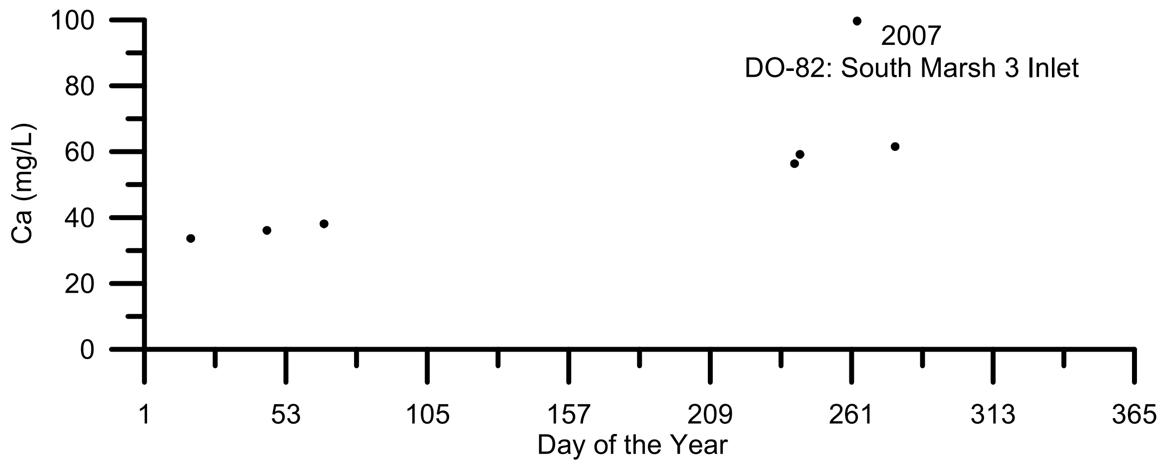

2007
DO-81: South Marsh 1 Outlet
Ca (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year



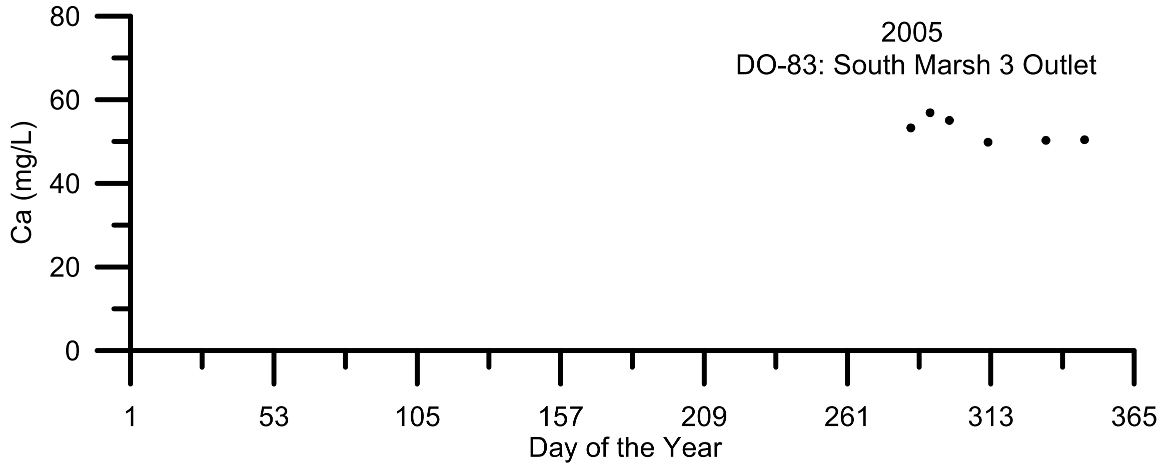
2005
DO-82: South Marsh 3 Inlet
Ca (mg/L)
Day of the Year

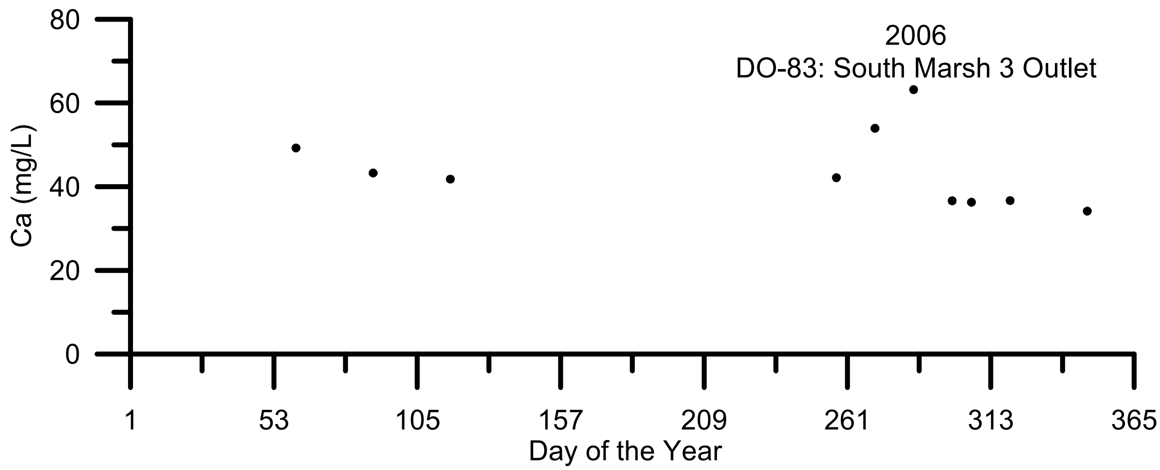


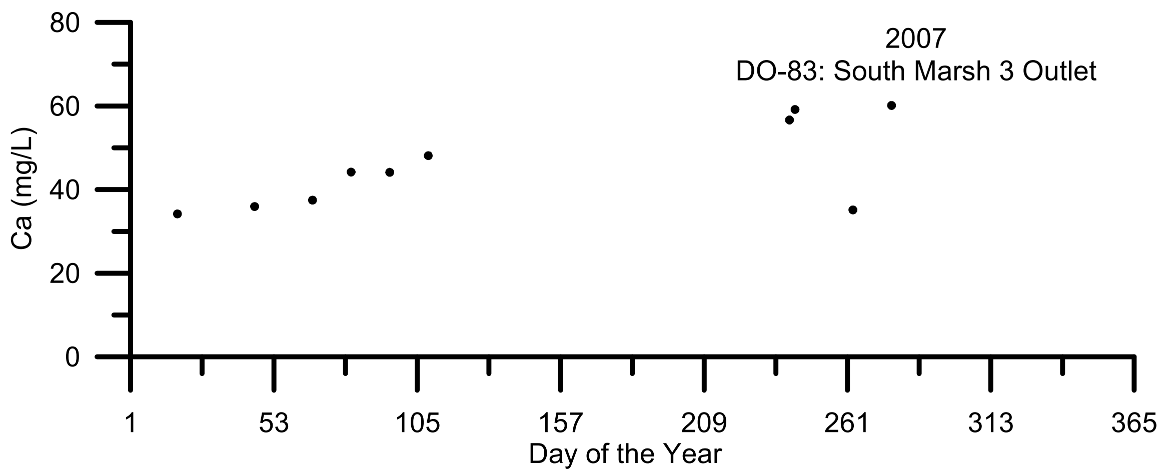
2006
DO-82: South Marsh 3 Inlet
Ca (mg/L)
Day of the Year

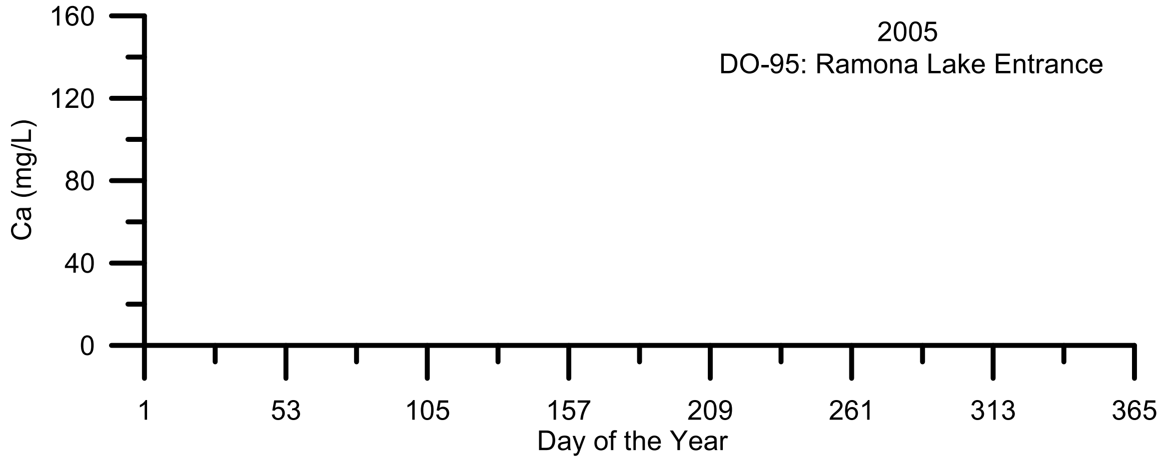


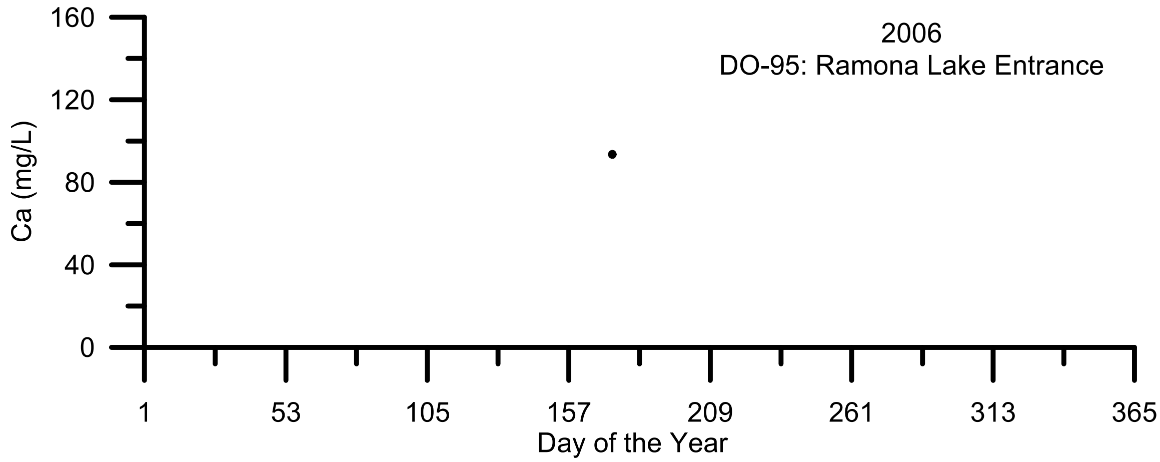
2007
DO-82: South Marsh 3 Inlet
Ca (mg/L)
Day of the Year

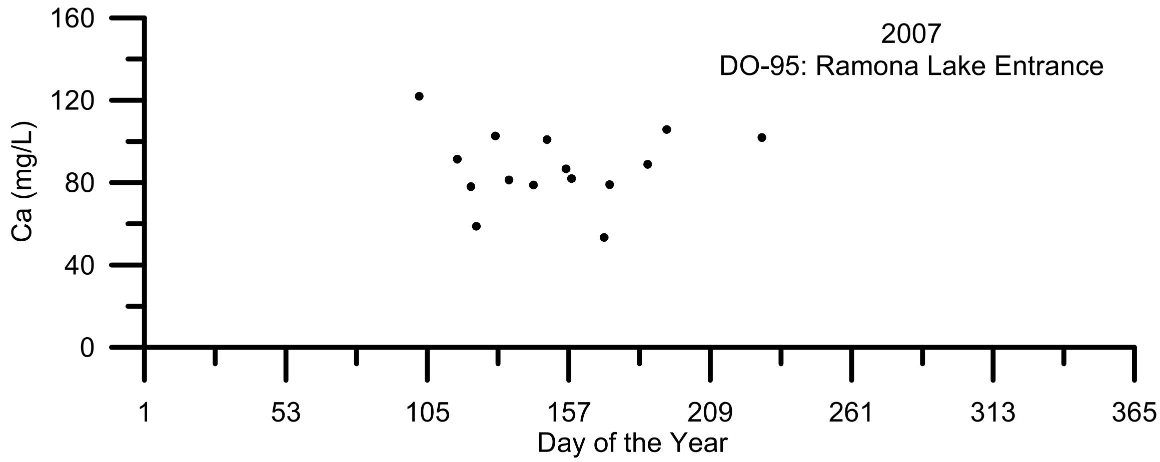

2005
DO-83: South Marsh 3 Outlet
Ca (mg/L)
Day of the Year


2006
DO-83: South Marsh 3 Outlet
Ca (mg/L)
Day of the Year


2007
DO-83: South Marsh 3 Outlet
Ca (mg/L)
Day of the Year


2005
DO-95: Ramona Lake Entrance
Ca (mg/L)
Day of the Year


2006
DO-95: Ramona Lake Entrance
Ca (mg/L)
Day of the Year


2007
DO-95: Ramona Lake Entrance
Ca (mg/L)
Day of the Year

Temporal Plots of 2005-2007 Bromine Data from the Upstream San Joaquin River

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Remie Burks[1]
Sharon Borglin[1]
Randy Dahlgren[2]
Jeremy Hanlon[1]
Justin Graham[1]
William Stringfellow[1]

February 2008

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Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report includes temporal plots of bromine (Br) data analyzed by the UCD Dahlgren laboratory between 2005 and 2007.

Methods

Depth integrated field samples were colleted during 2005-2007 in the upper San Joaquin River in accordance with EERP Field Standard Operating Procedures Protocol Book (Graham 2008). Water samples were colleted in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN). Bottles were labeled with the appropriate sample number, site name and sampling date. All bottles were rinsed with sample water prior to sample collection. Some sites required a bucket to collect sample water because of accessibility from a high bridge or platform. For these sites, the bucket was pre-rinsed with sample water and sample bottles were filled using a rinsed funnel. Care was taken to distribute water simultaneously to all sample bottles (rather than sequentially). Samples were immediately stored at $4^{\circ}C$ after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the EERP lab on the day of sampling.

Within 24 hours of collection samples were transported from the EERP laboratory to the UCD laboratory for analysis, during this time period samples were stored in coolers at $4^{\circ}C$.

Ion chromatography was utilized for measuring bromine (Br^-) using a Dionex ICS-2000 Ion Chromatograph (Dionex Corporation, Sunnyvale, CA) (SM-4110 B).

Results/Discussion

Samples were measured ranging from 0.0-14.69 mg/L Br. The average concentration of Br in samples collected was 1.44 mg/L Br. These temporal plots (Figures 3-104) created an easy visual way to find outliers and double check data entry for possible mistakes.

References

American Public Health Association (APHA). 2005. Standard Methods for the Examination of Water and Wastewater, 21st Edition. American Public Health Association, Washington, DC.

Borglin, S., W. Stringfellow, J. Hanlon. 2005. Standard Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project. LBNL/Pub-937.

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Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008) EERP Field Protocol Book, University of the Pacific, Stockton, CA.

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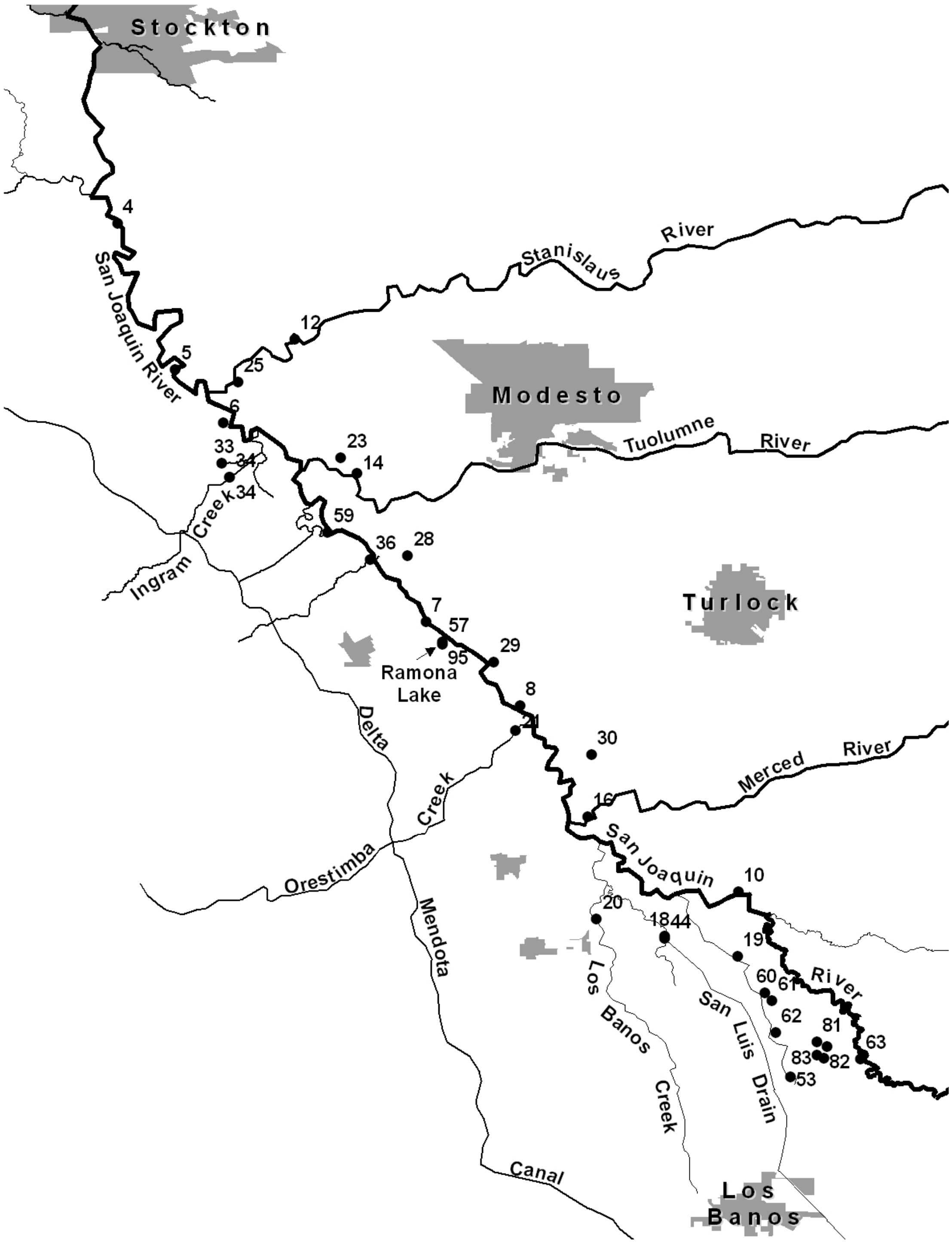
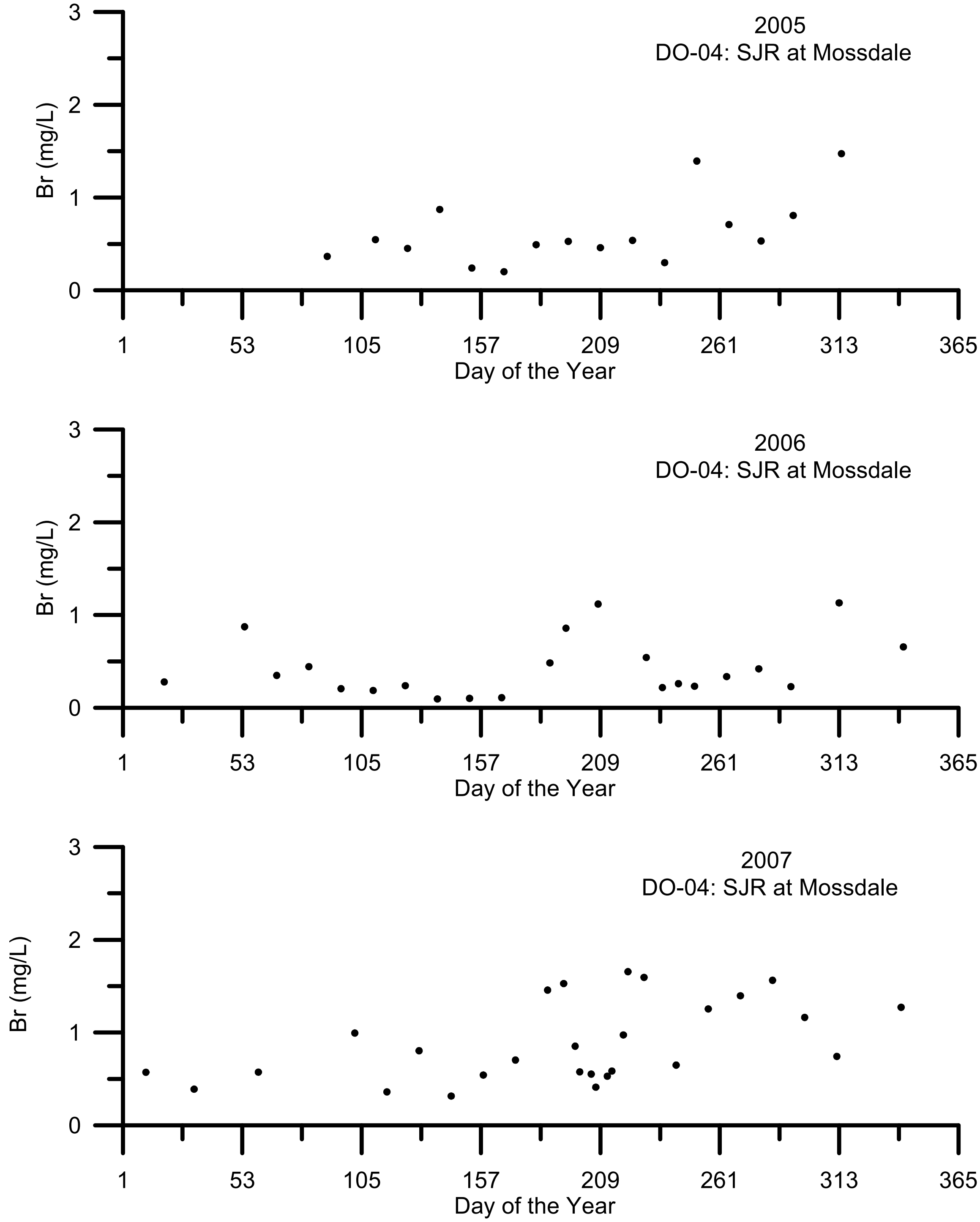
Table 1: EERP Sampling Site List

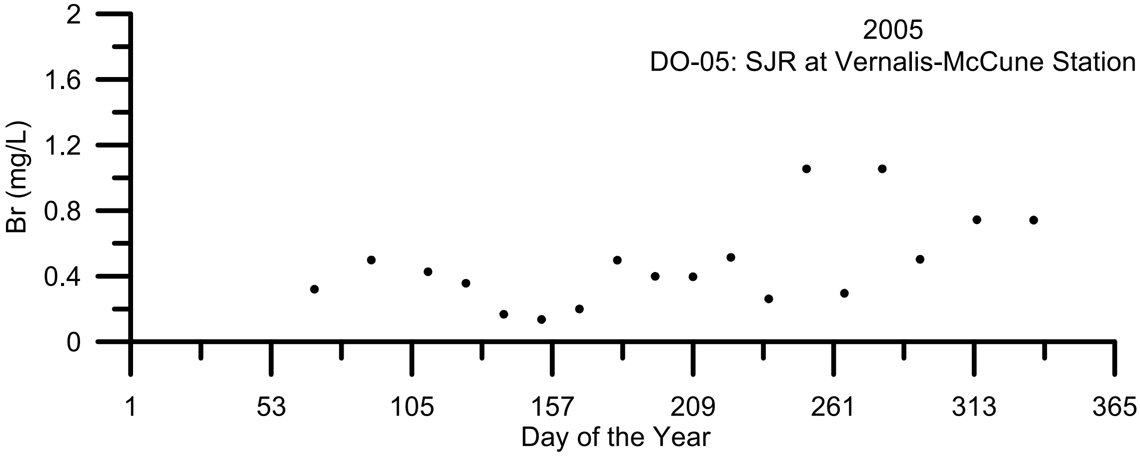
DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
53	**Salt Slough at Wolfsen Road**	Wetland
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
60	**Moffit 1 South**	Wetland
61	**Deadman's Slough**	Wetland
62	**Mallard Slough**	Wetland
63	**Inlet C Canal**	Wetland
80	**South Marsh-1-Inlet**	Wetland
81	**South Marsh-1-Outlet**	Wetland
82	**South Marsh-3-Inlet**	Wetland
83	**South Marsh-3-Outlet**	Wetland
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

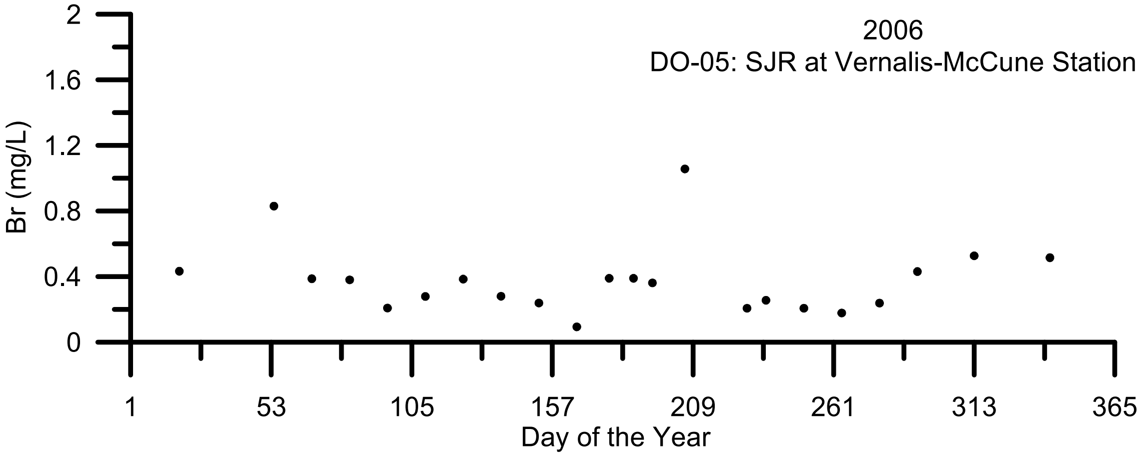
Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

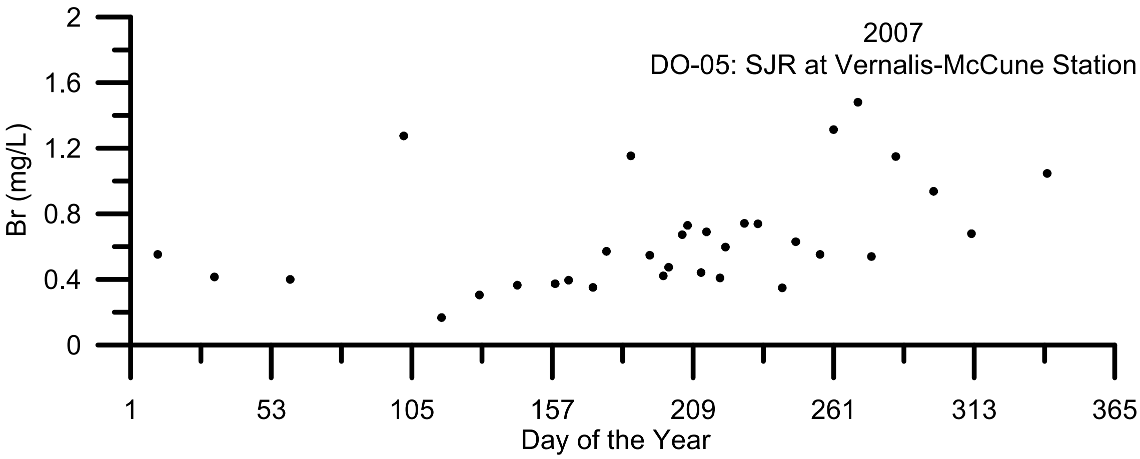


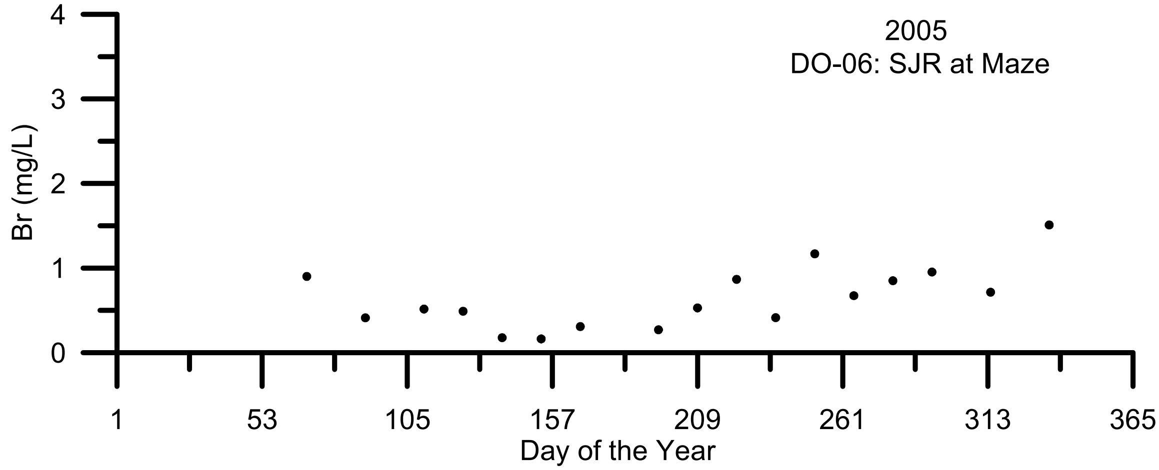
Figures 2 -103: Temporal Plots of Bromine By Site ID




2005
DO-05: SJR at Vernalis-McCune Station
Br (mg/L)
Day of the Year
0
0.4
0.8
1.2
1.6
2
1
53
105
157
209
261
313
365


2006
DO-05: SJR at Vernalis-McCune Station
Br (mg/L)
Day of the Year
0
0.4
0.8
1.2
1.6
2
1
53
105
157
209
261
313
365


2007
DO-05: SJR at Vernalis-McCune Station
Br (mg/L)
Day of the Year
0
0.4
0.8
1.2
1.6
2
1
53
105
157
209
261
313
365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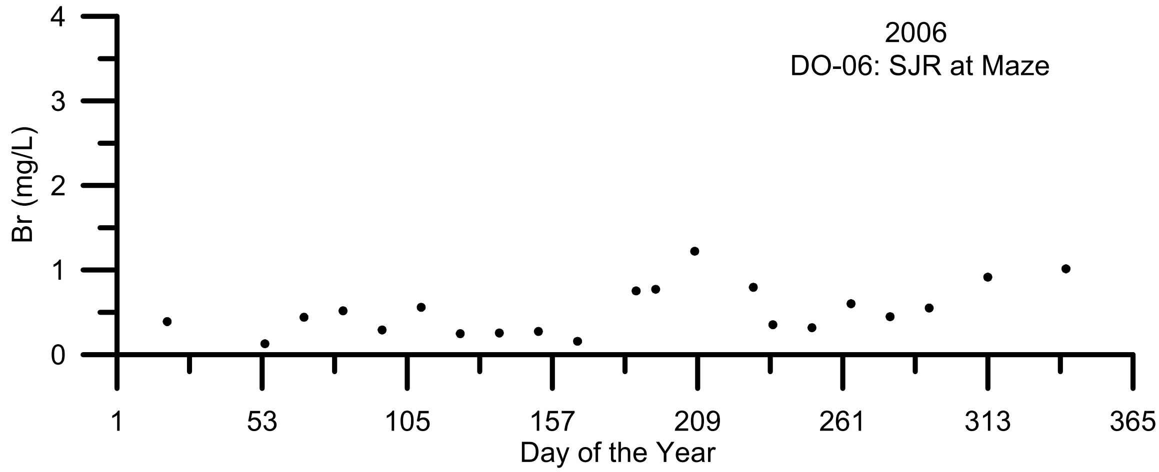
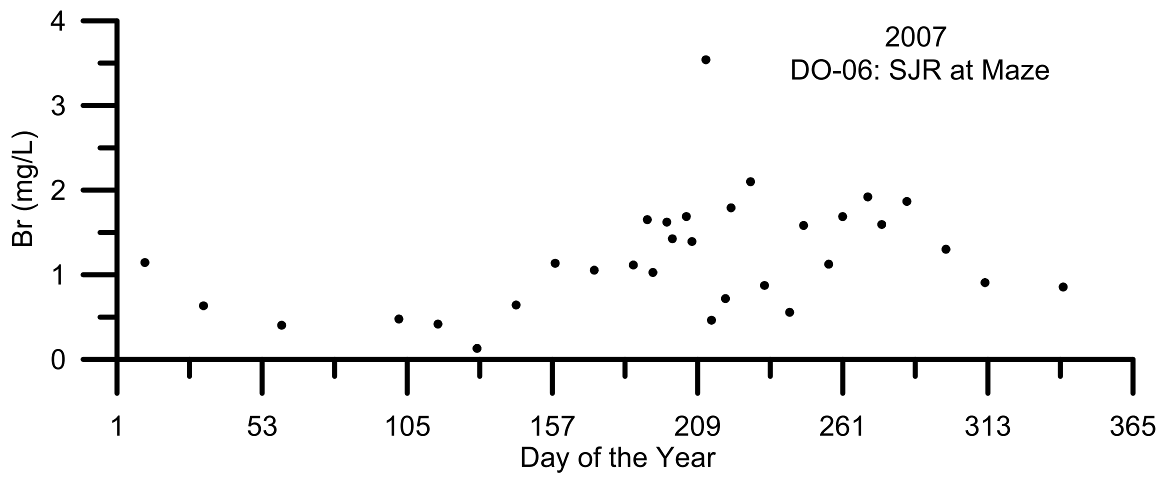
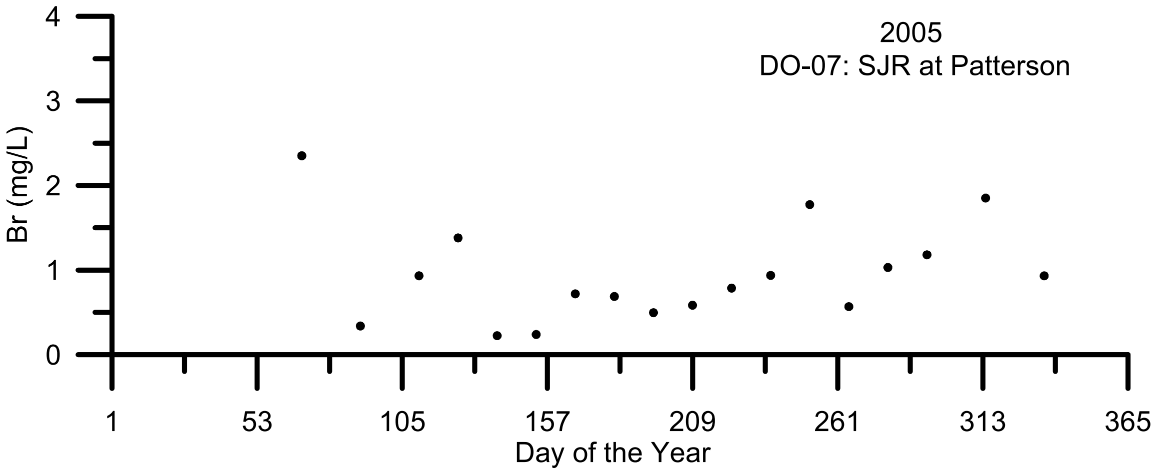
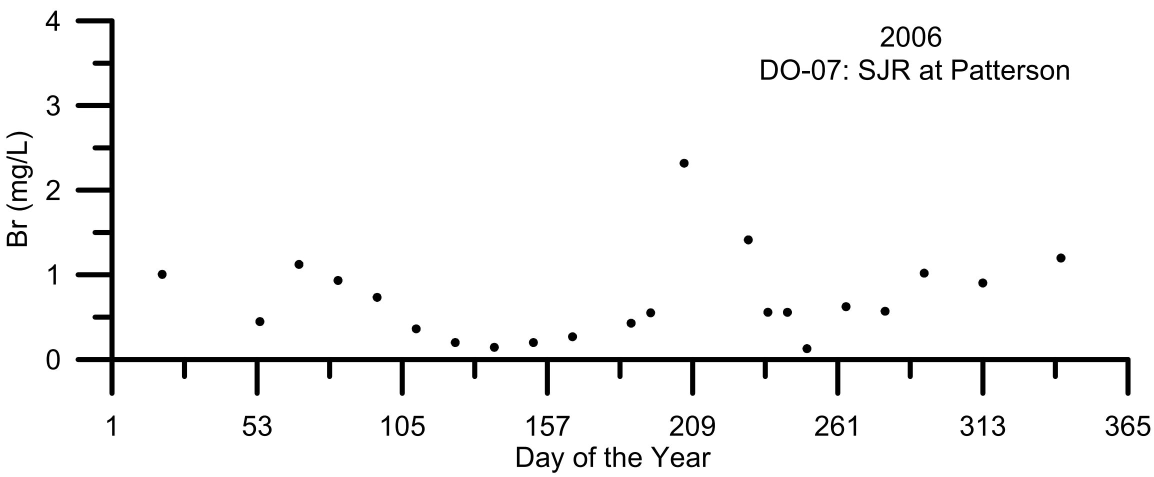
DO-06: SJR at Maze
Br (mg/L)
Day of the Year


2006
DO-06: SJR at Maze
Br (mg/L)
Day of the Year


2007
DO-06: SJR at Maze
Br (mg/L)
Day of the Year


2005
DO-07: SJR at Patterson
Br (mg/L)
Day of the Year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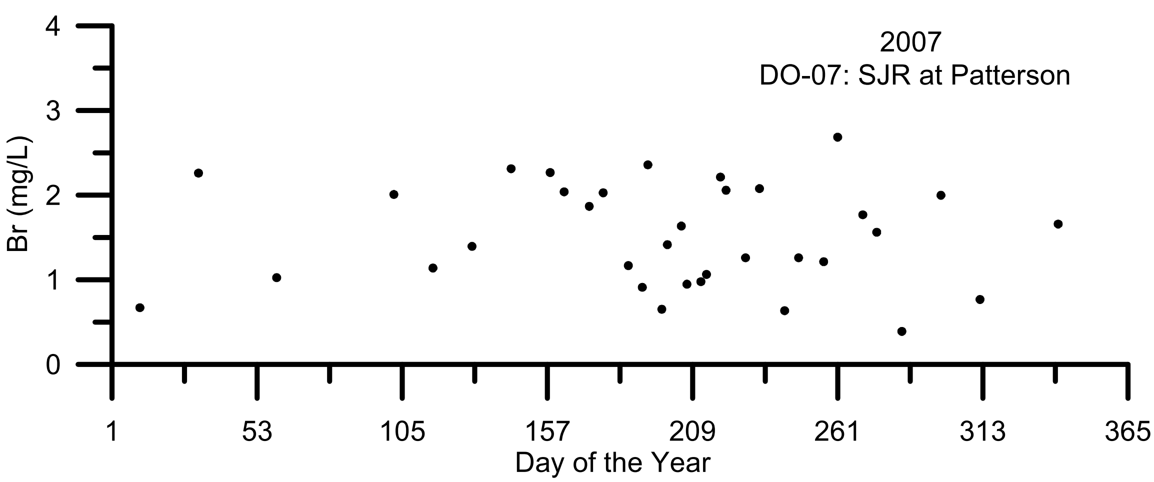
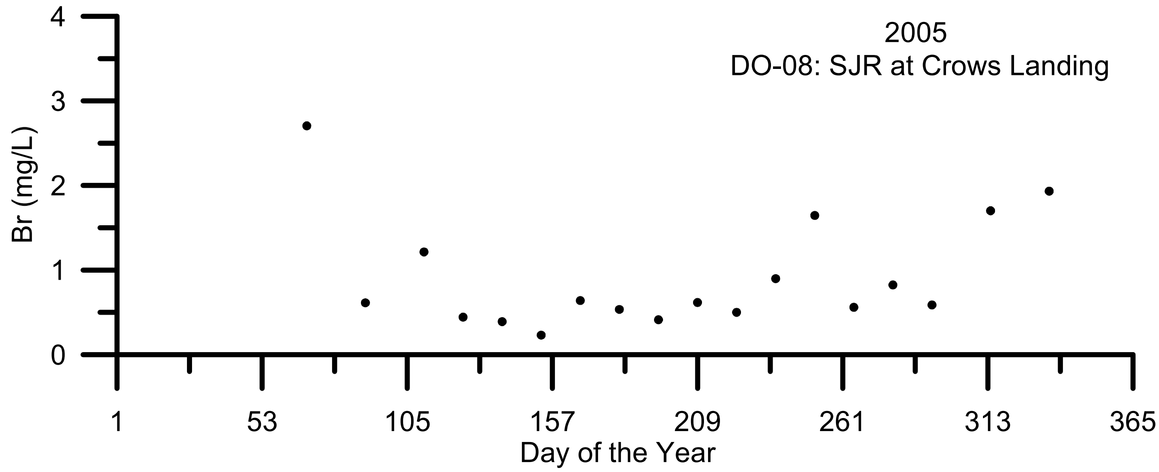
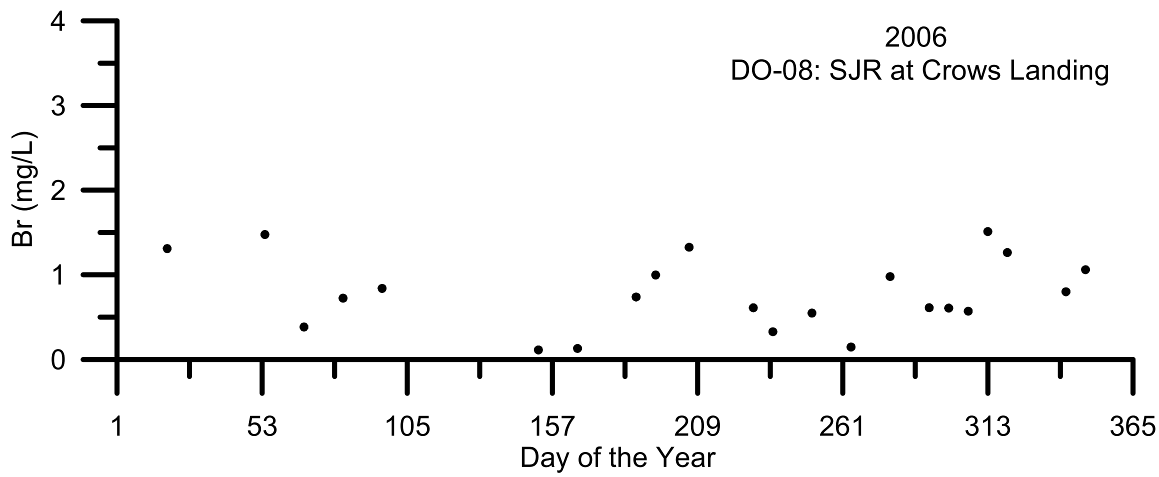
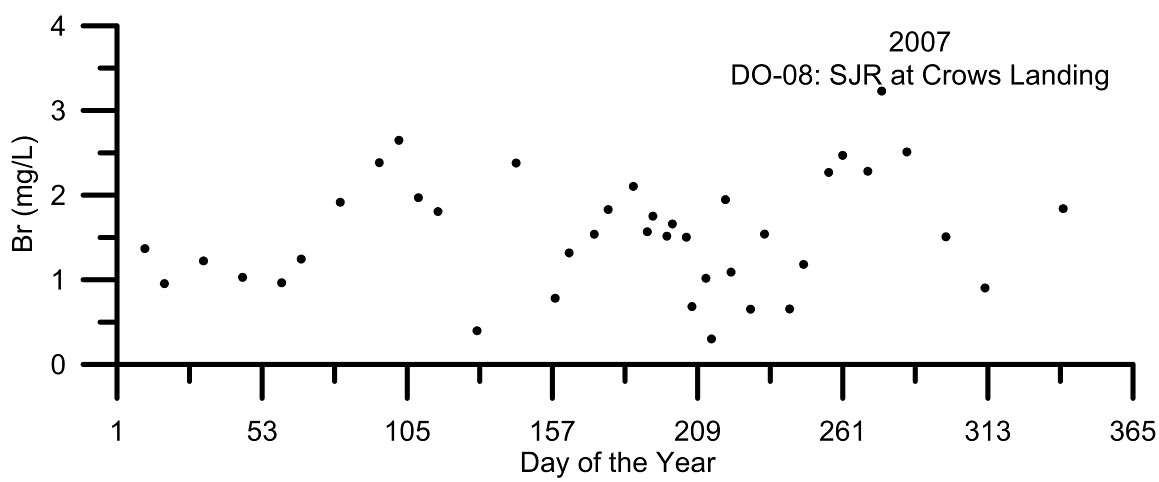
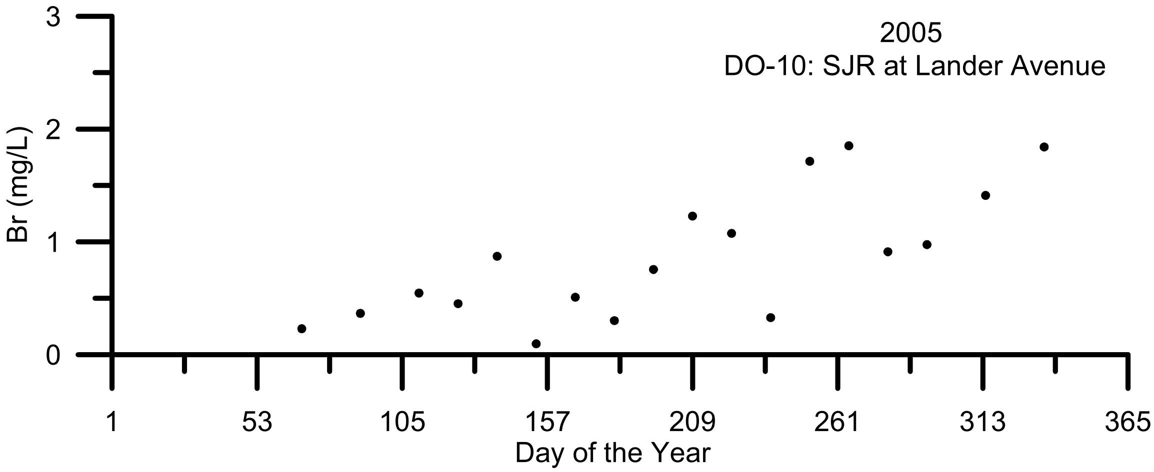
DO-07: SJR at Patterson
Br (mg/L)
Day of the Year

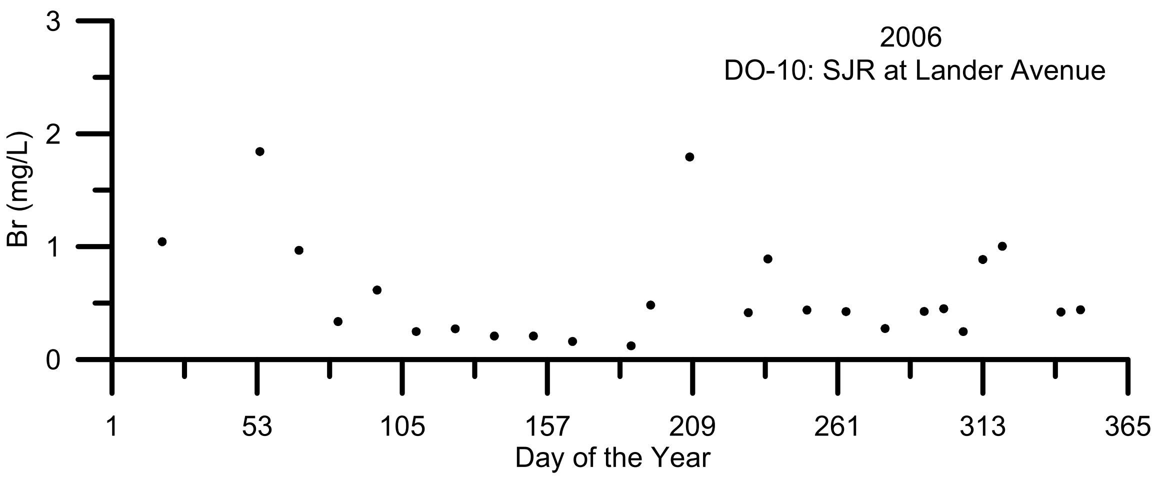

2007
DO-07: SJR at Patterson
Br (mg/L)
Day of the Year

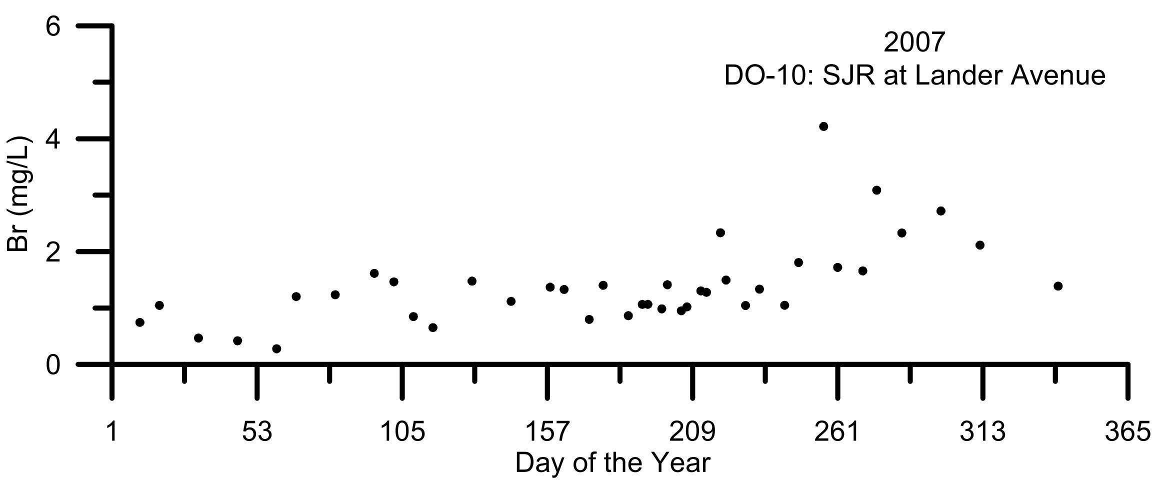

2005
DO-08: SJR at Crows Landing
Br (mg/L)
Day of the Year

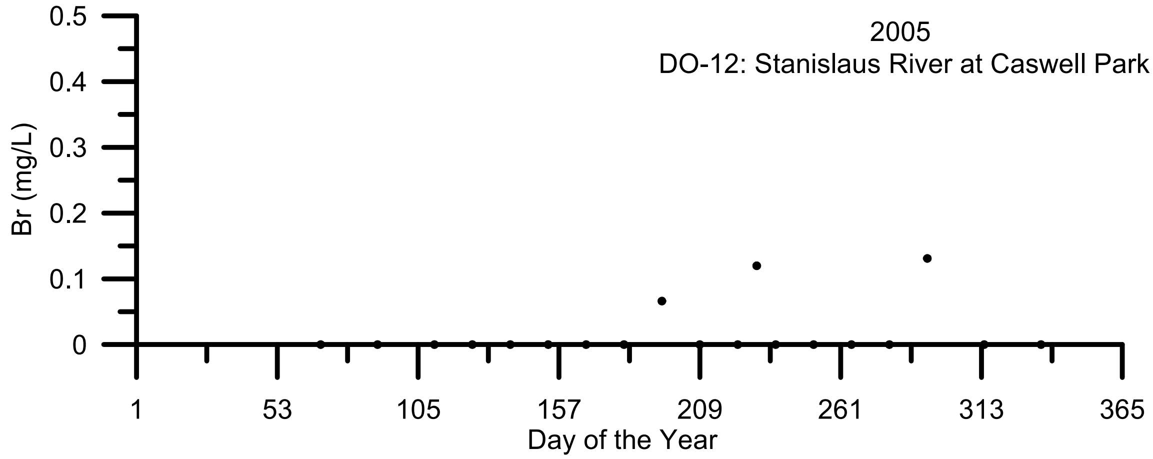

2006
DO-08: SJR at Crows Landing
Br (mg/L)
Day of the Year

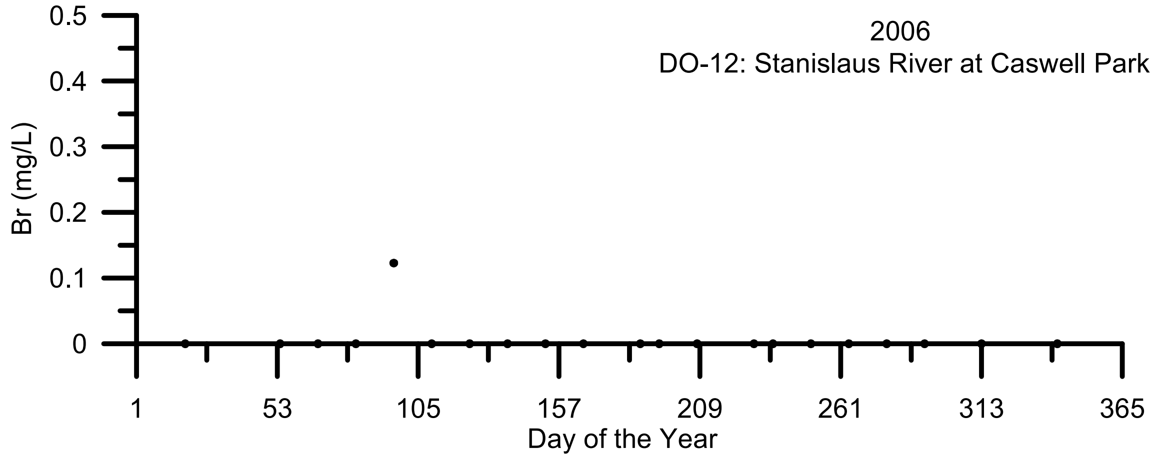

2007
DO-08: SJR at Crows Landing
Br (mg/L)
Day of the Year

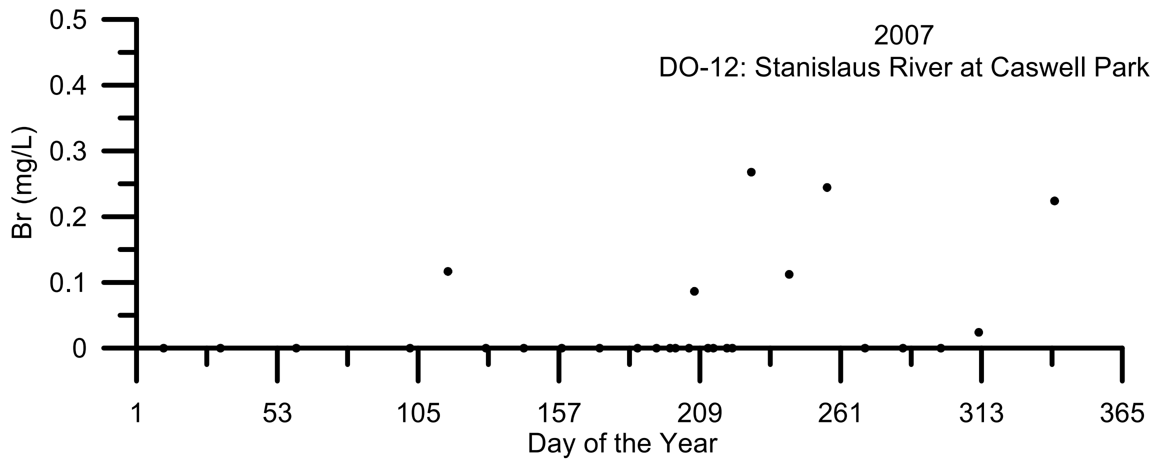

2005
DO-10: SJR at Lander Avenue
Br (mg/L)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

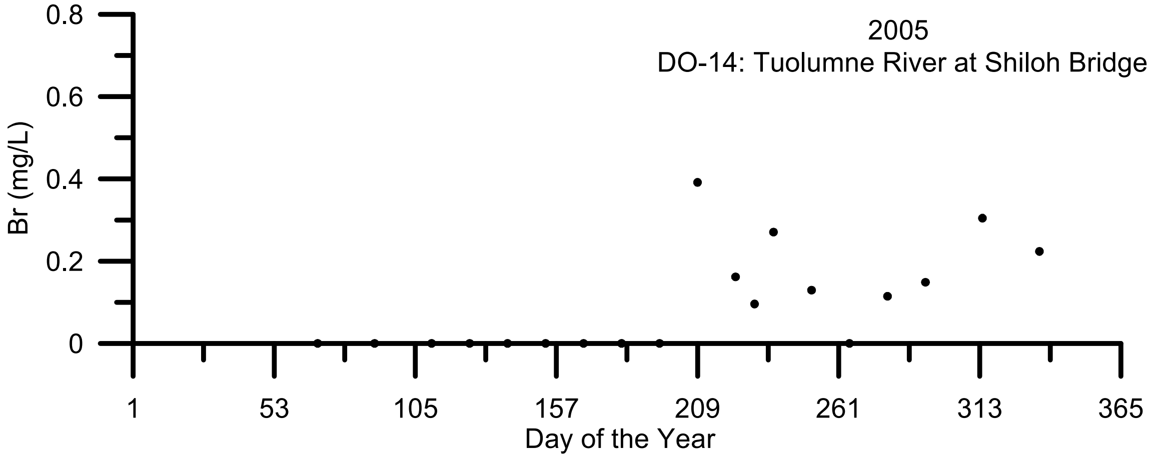

2006
DO-10: SJR at Lander Avenue
Br (mg/L)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

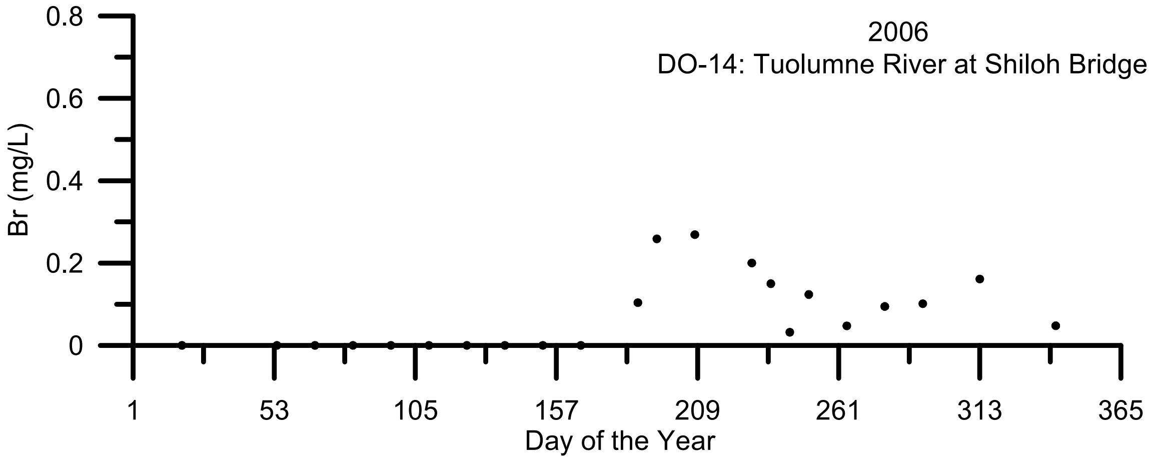

2007
DO-10: SJR at Lander Avenue
Br (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

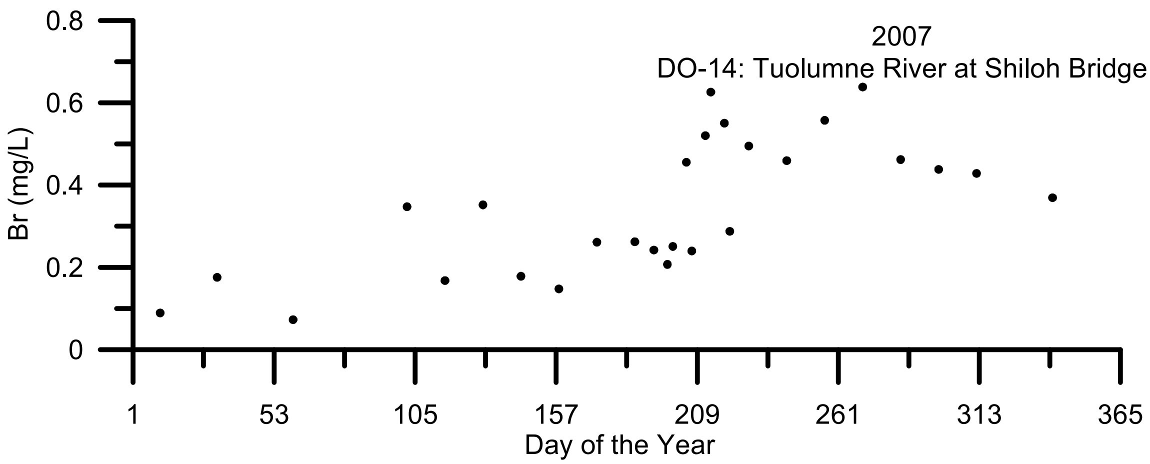

2005
DO-12: Stanislaus River at Caswell Park
Br (mg/L)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

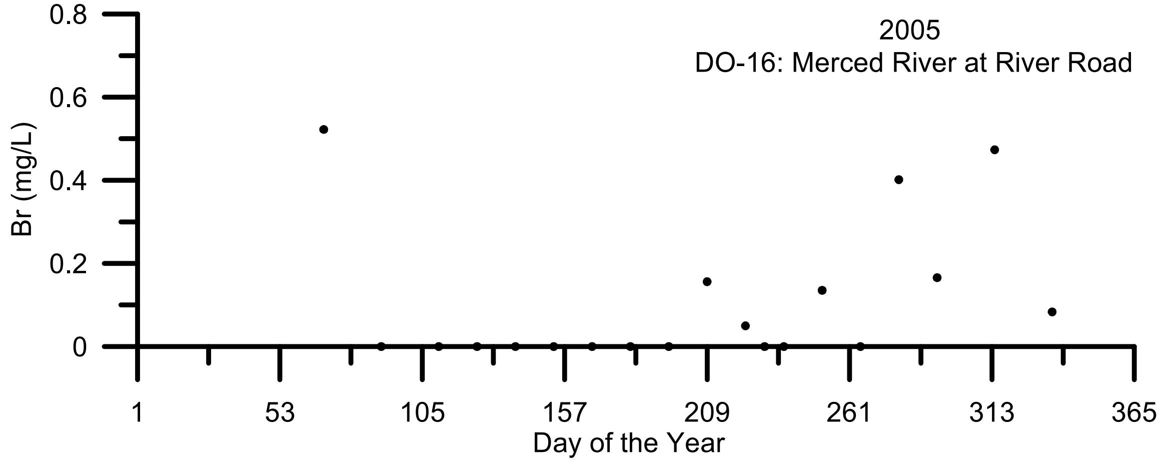

2006
DO-12: Stanislaus River at Caswell Park
Br (mg/L)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

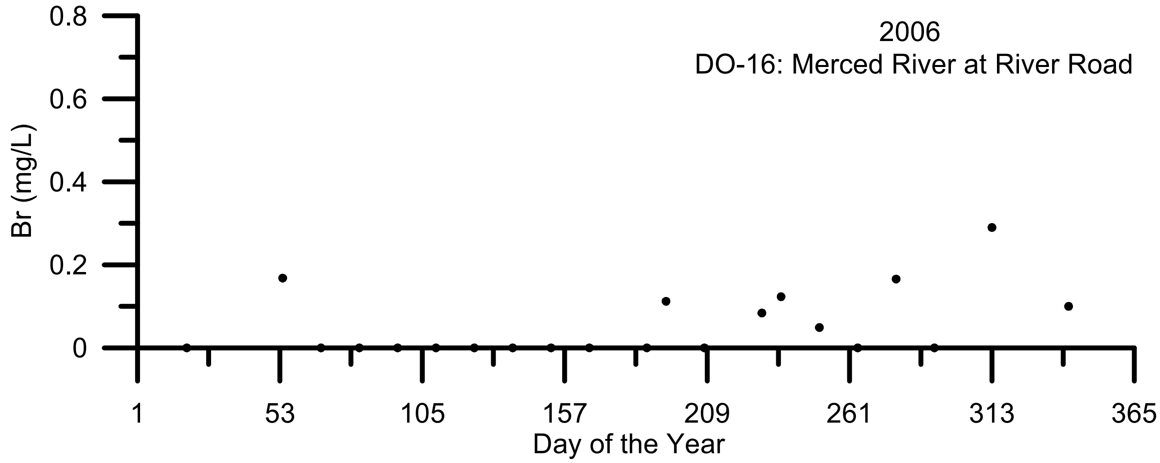

2007
DO-12: Stanislaus River at Caswell Park
Br (mg/L)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

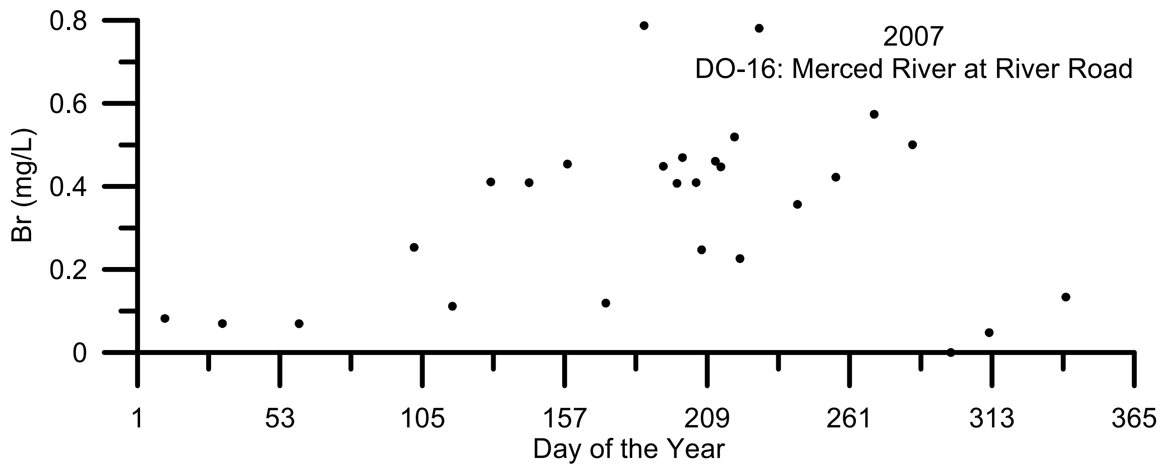

2005
DO-14: Tuolumne River at Shiloh Bridge
Br (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

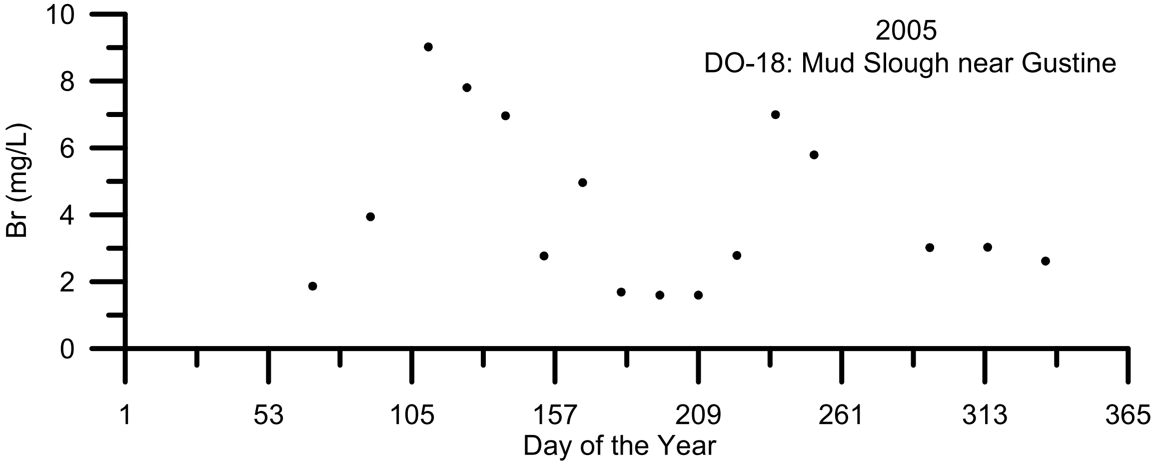

2006
DO-14: Tuolumne River at Shiloh Bridge
Br (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

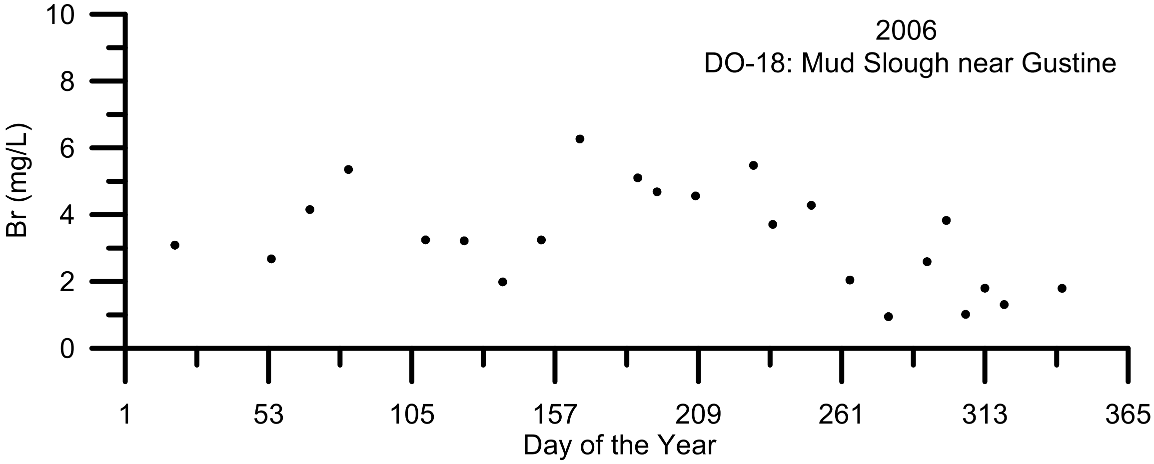

2007
DO-14: Tuolumne River at Shiloh Bridge
Br (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

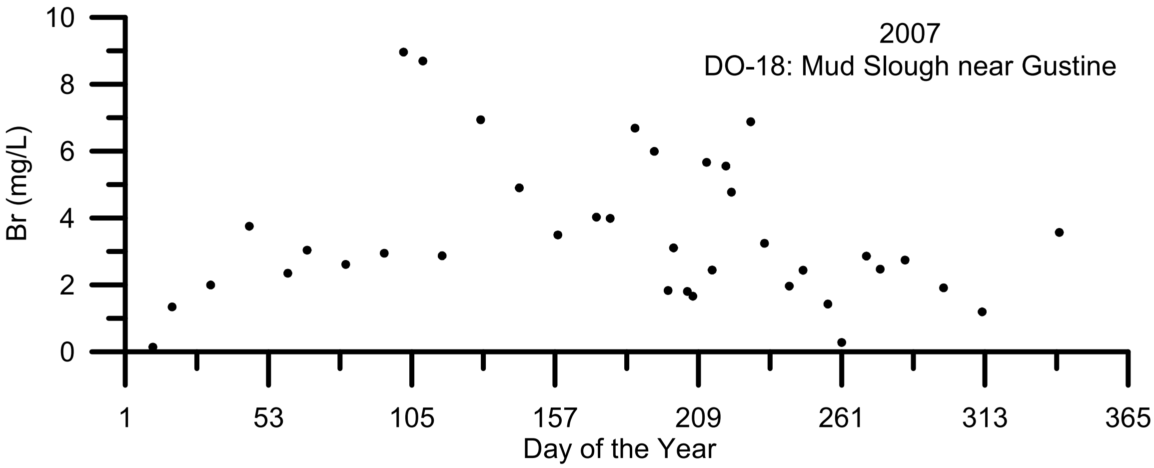

0.8
0.6
0.4
0.2
0
Br (mg/L)
2005
DO-16: Merced River at River Road
1
53
105
157
209
261
313
365
Day of the Year

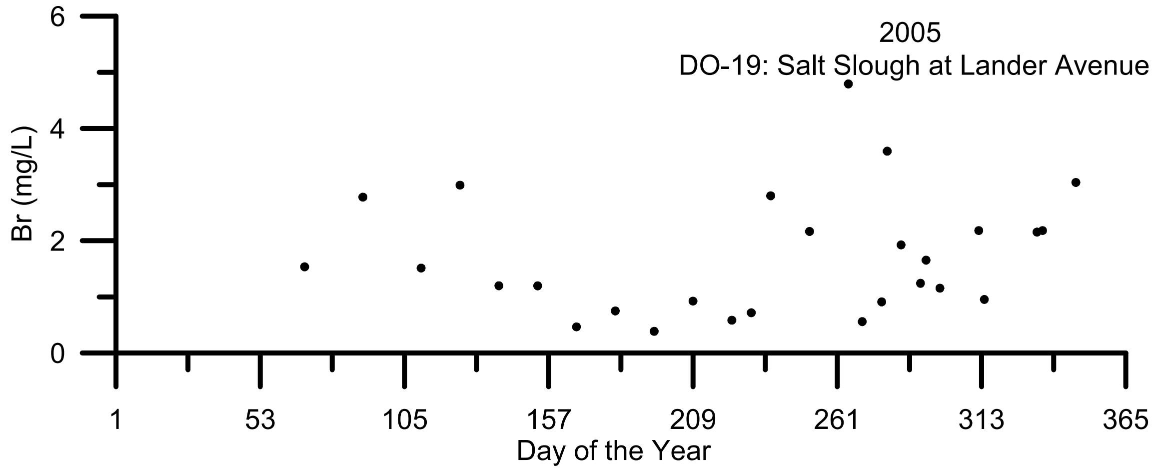

0.8
0.6
0.4
0.2
0
Br (mg/L)
2006
DO-16: Merced River at River Road
1
53
105
157
209
261
313
365
Day of the Year

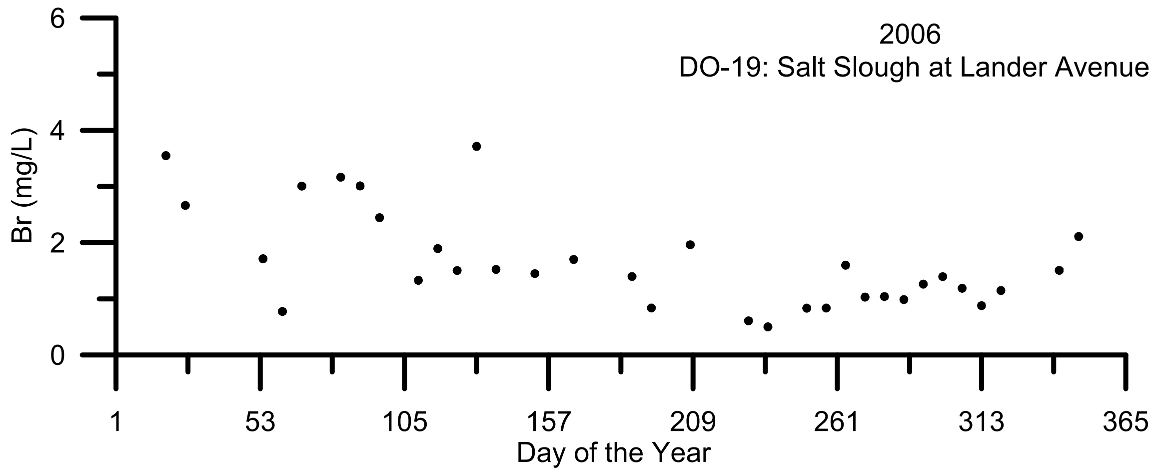

0.8
0.6
0.4
0.2
0
Br (mg/L)
2007
DO-16: Merced River at River Road
1
53
105
157
209
261
313
365
Day of the Year

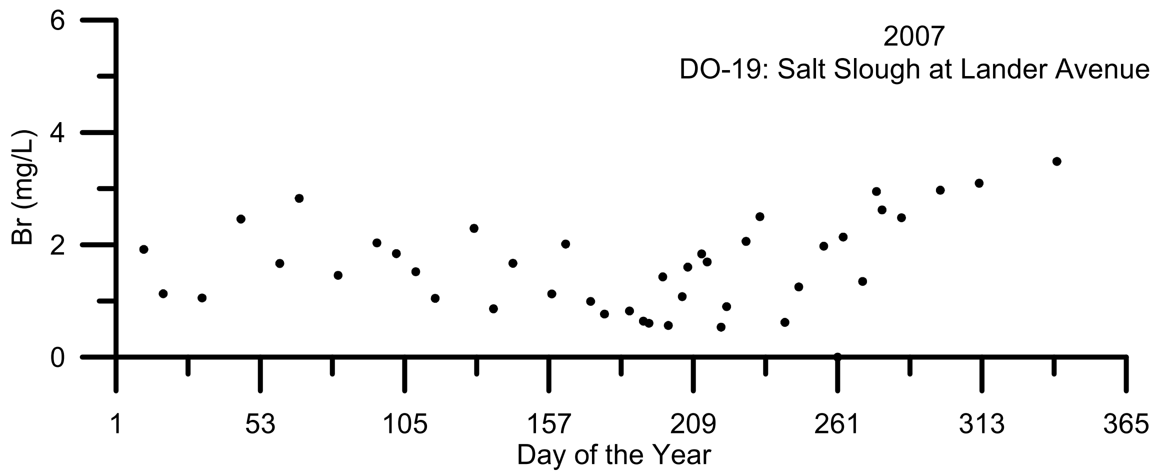

2005
DO-18: Mud Slough near Gustine
Br (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

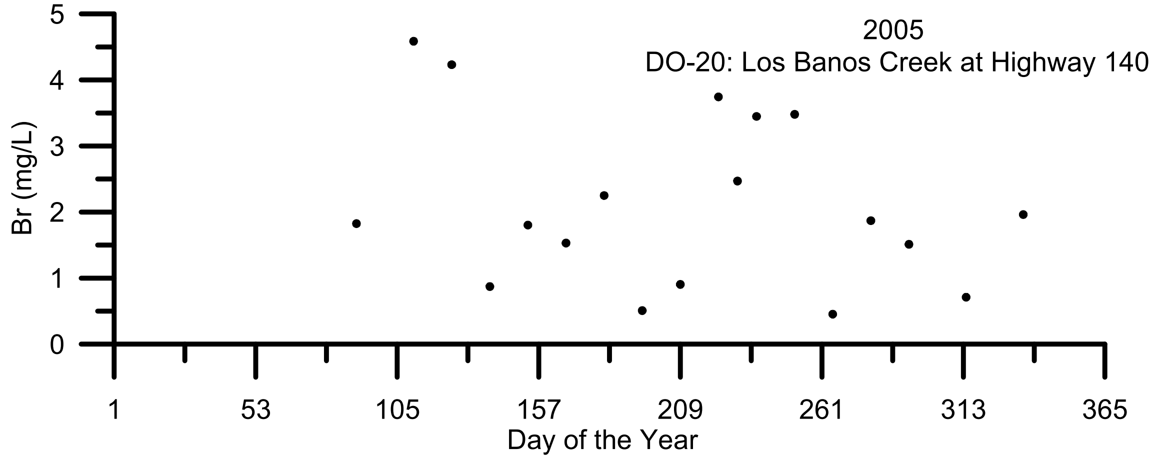

2006
DO-18: Mud Slough near Gustine
Br (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

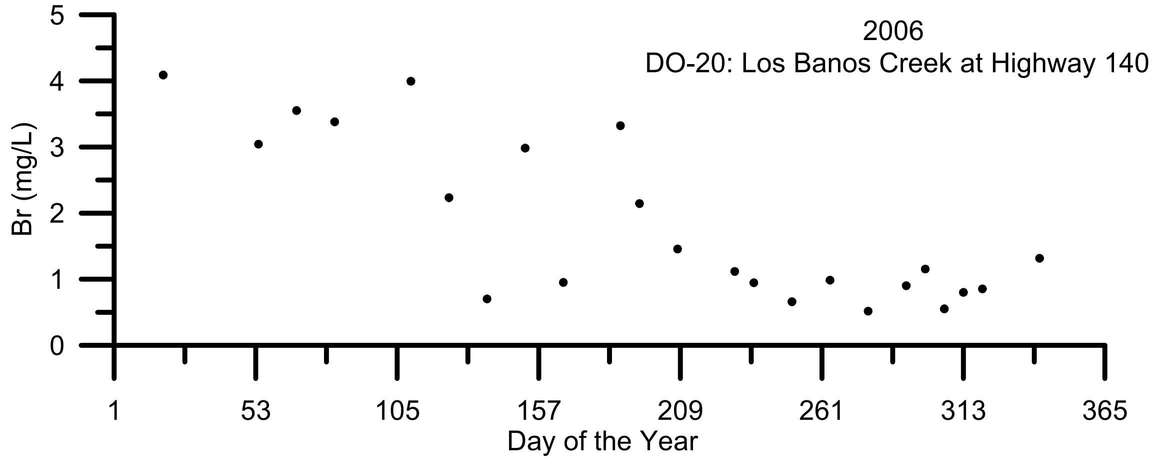

2007
DO-18: Mud Slough near Gustine
Br (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

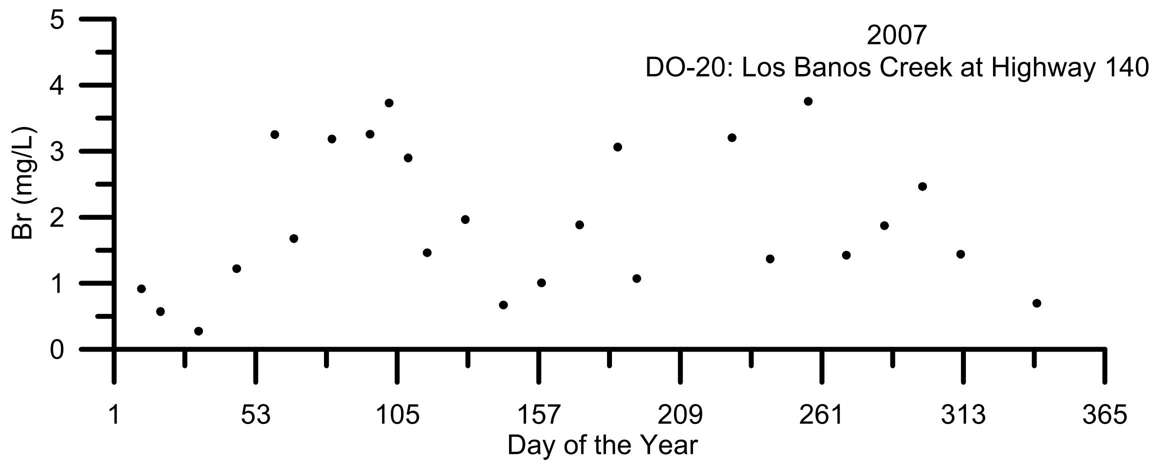

2005
DO-19: Salt Slough at Lander Avenue
Br (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

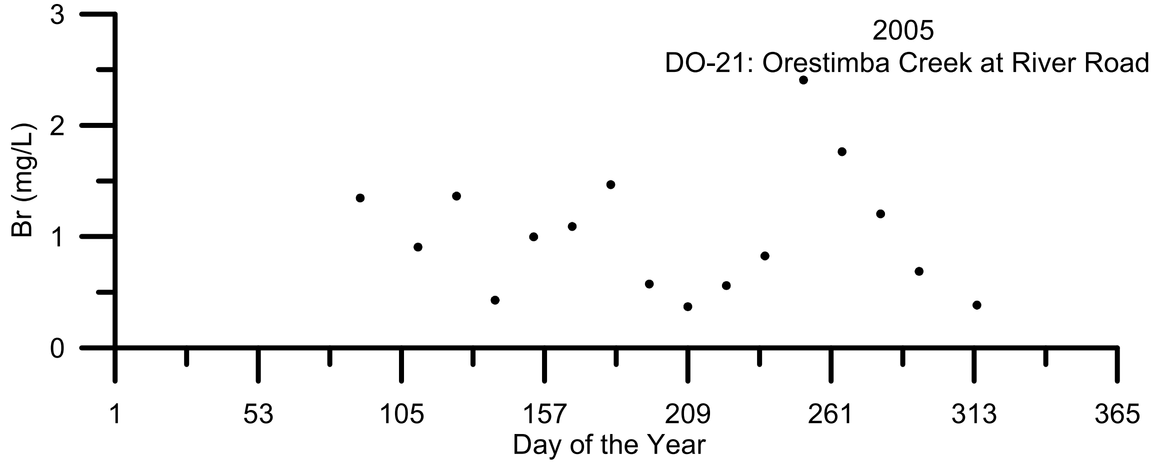

2006
DO-19: Salt Slough at Lander Avenue
Br (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

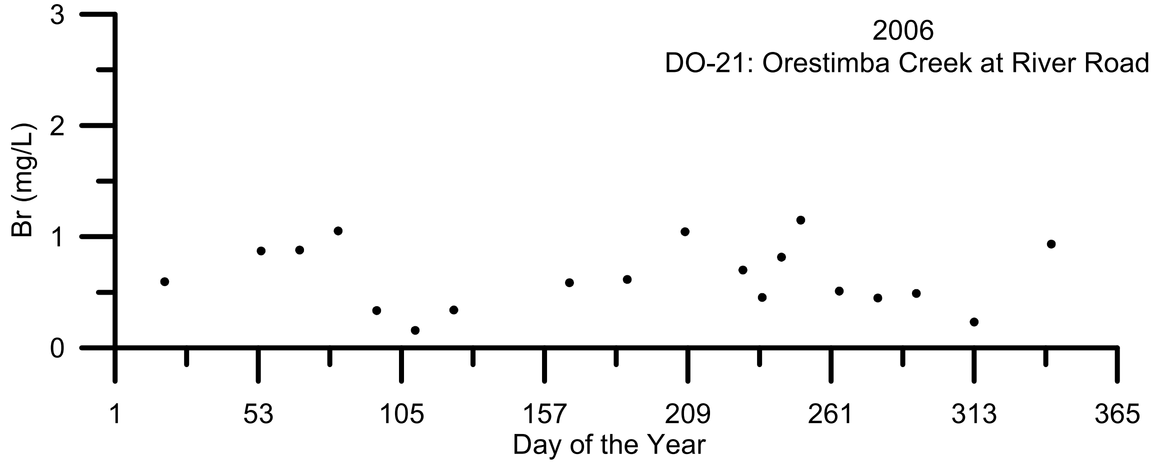

2007
DO-19: Salt Slough at Lander Avenue
Br (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

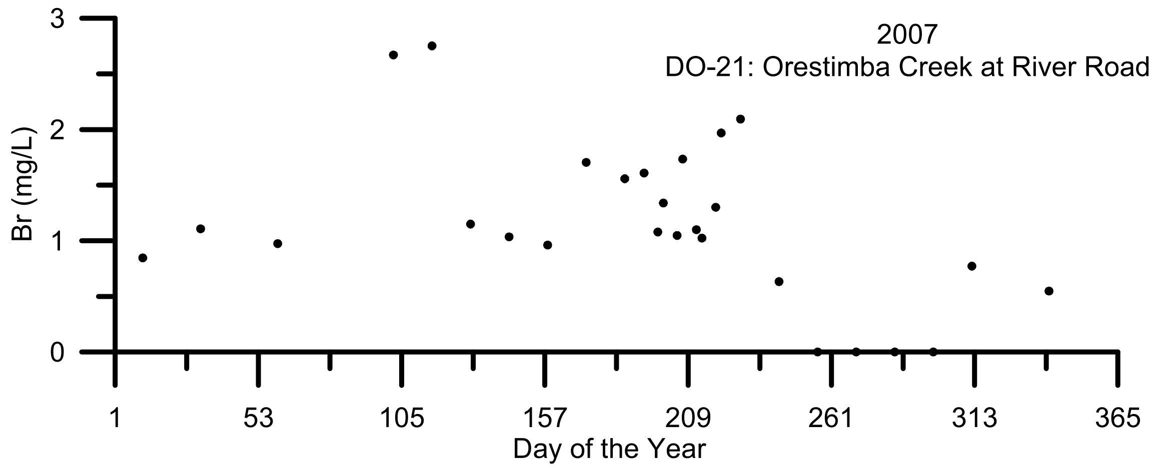

2005
DO-20: Los Banos Creek at Highway 140
Br (mg/L)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

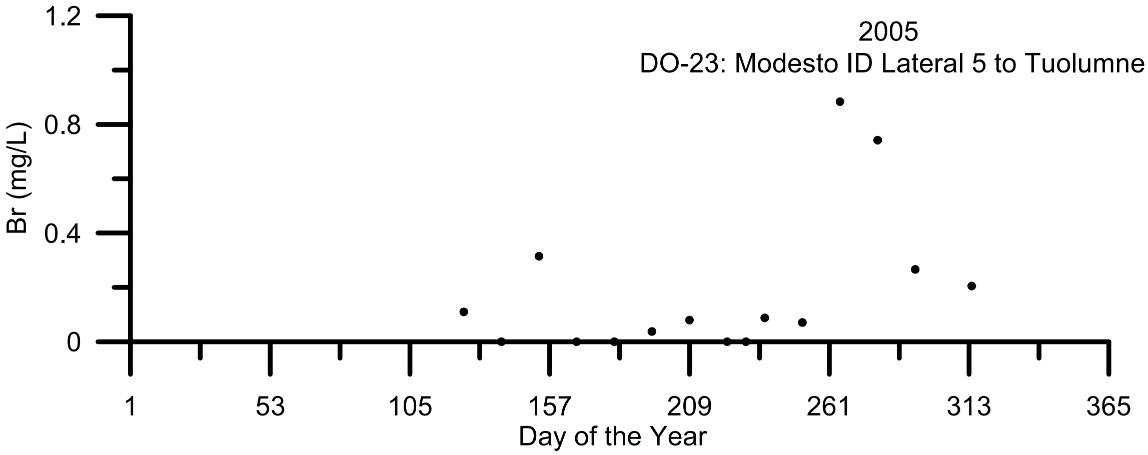

2006
DO-20: Los Banos Creek at Highway 140
Br (mg/L)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

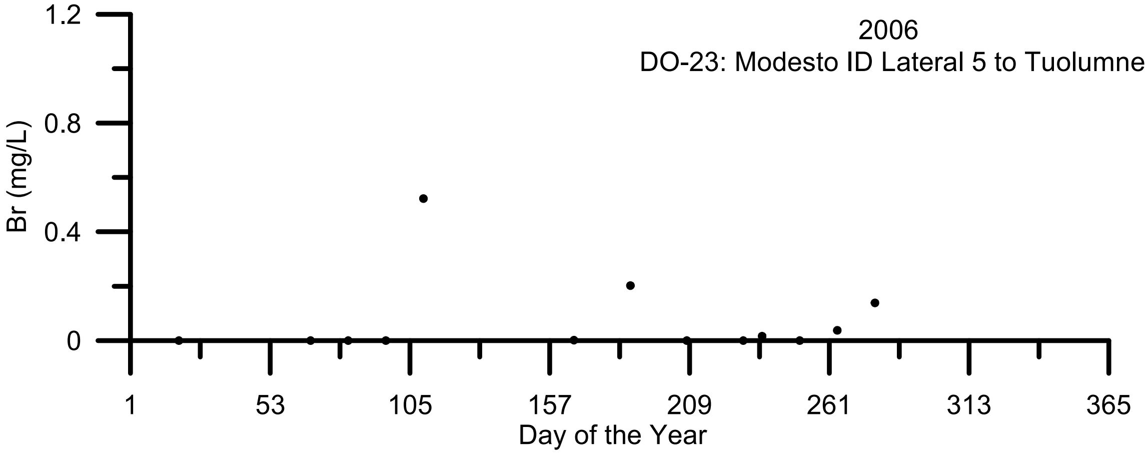

2007
DO-20: Los Banos Creek at Highway 140
Br (mg/L)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

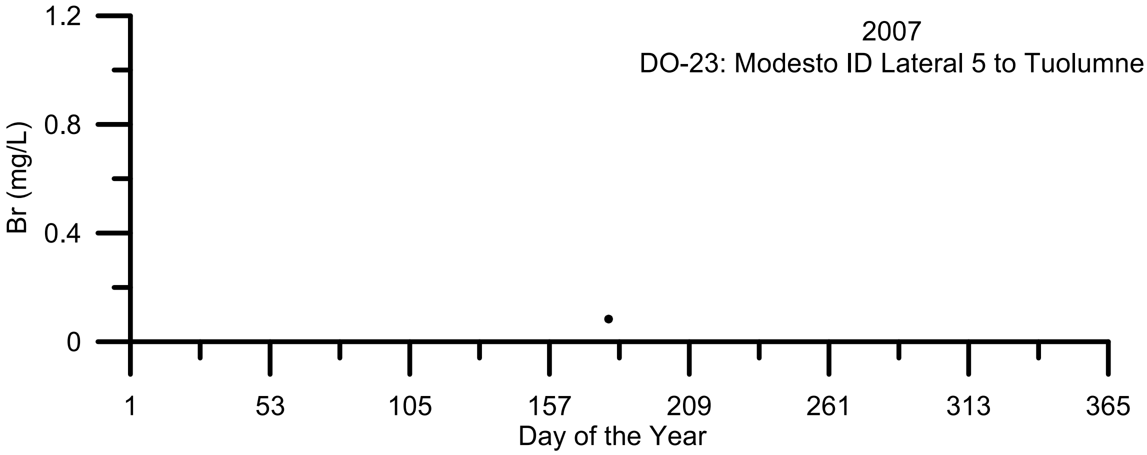

2005
DO-21: Orestimba Creek at River Road
Br (mg/L)
Day of the Year
0
1
2
3
1
53
105
157
209
261
313
365

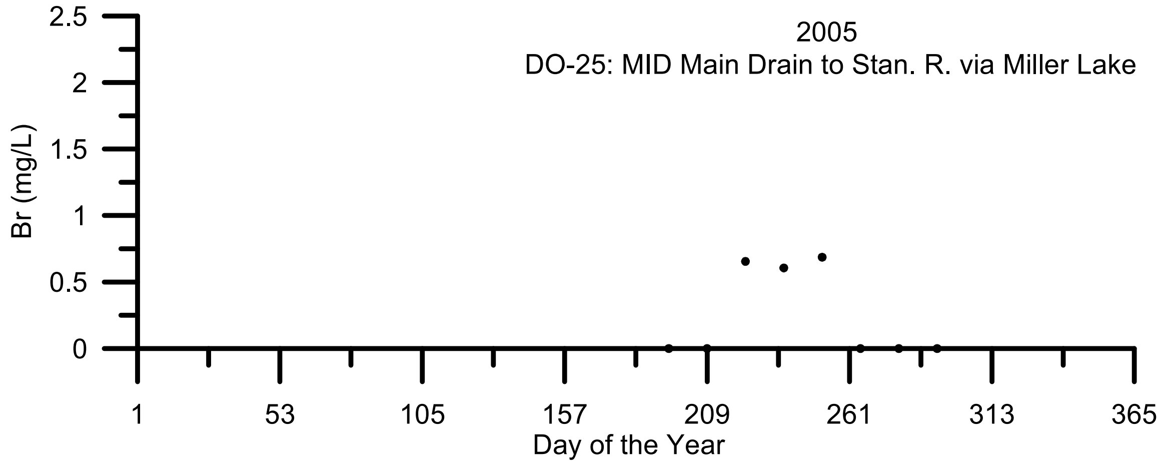

2006
DO-21: Orestimba Creek at River Road
Br (mg/L)
Day of the Year
0
1
2
3
1
53
105
157
209
261
313
365

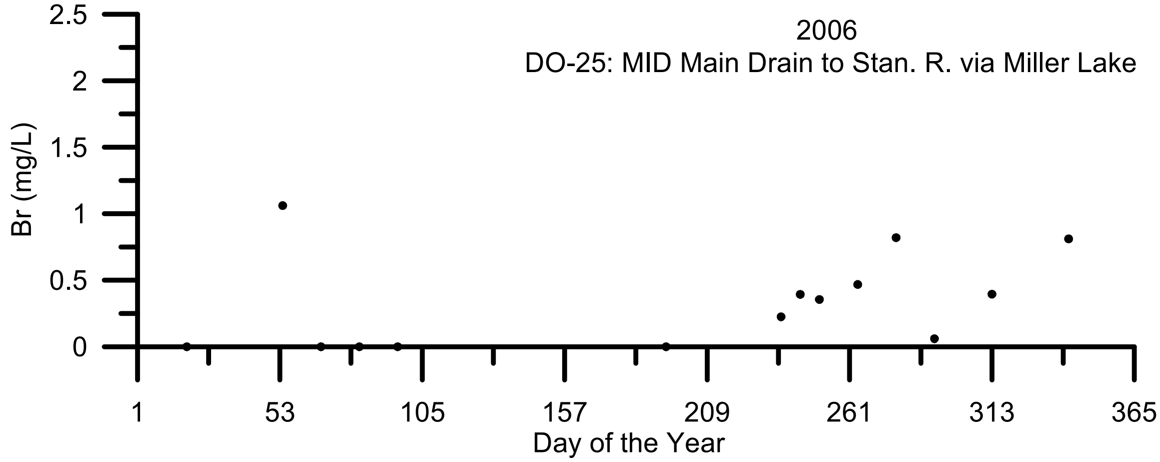

2007
DO-21: Orestimba Creek at River Road
Br (mg/L)
Day of the Year
0
1
2
3
1
53
105
157
209
261
313
365

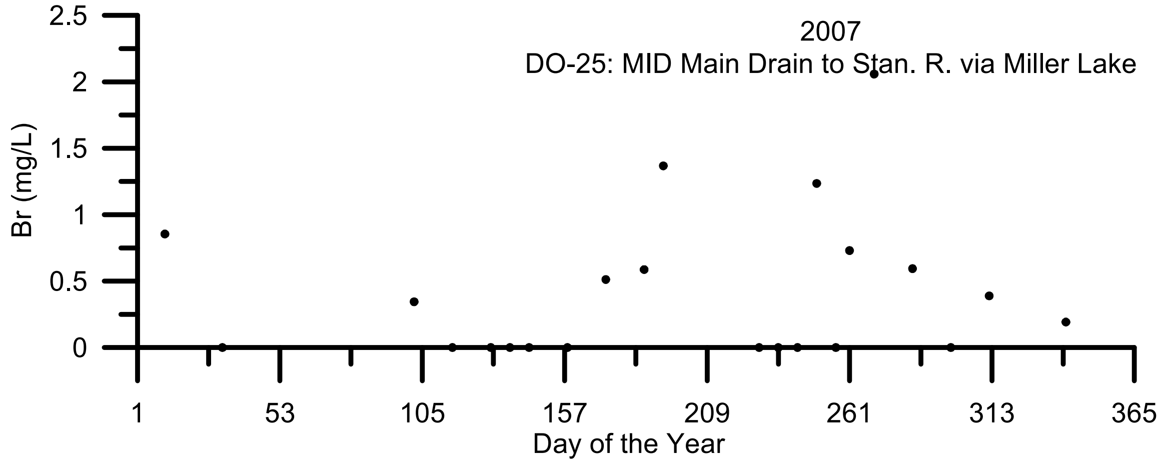

2005
DO-23: Modesto ID Lateral 5 to Tuolumne
Br (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

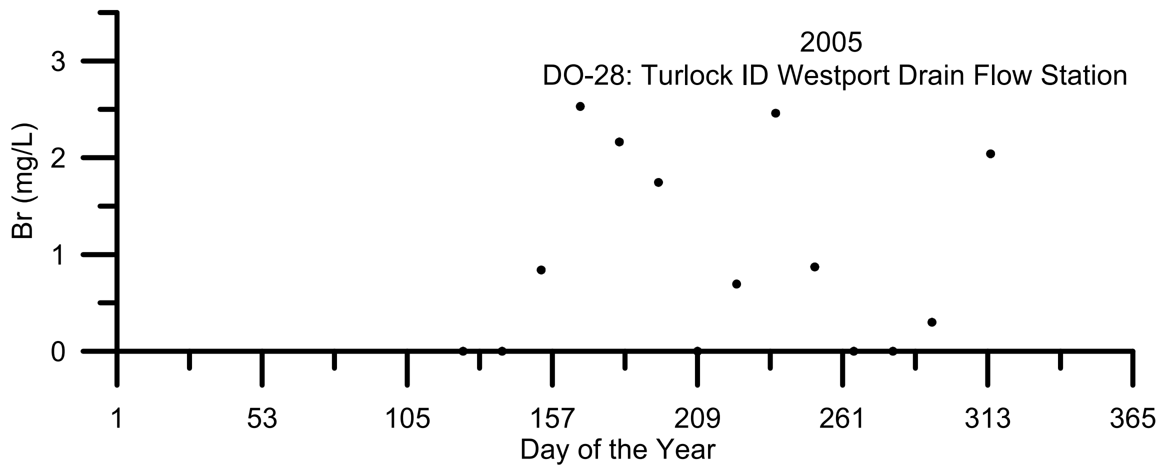

2006
DO-23: Modesto ID Lateral 5 to Tuolumne
Br (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-23: Modesto ID Lateral 5 to Tuolumne
Br (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

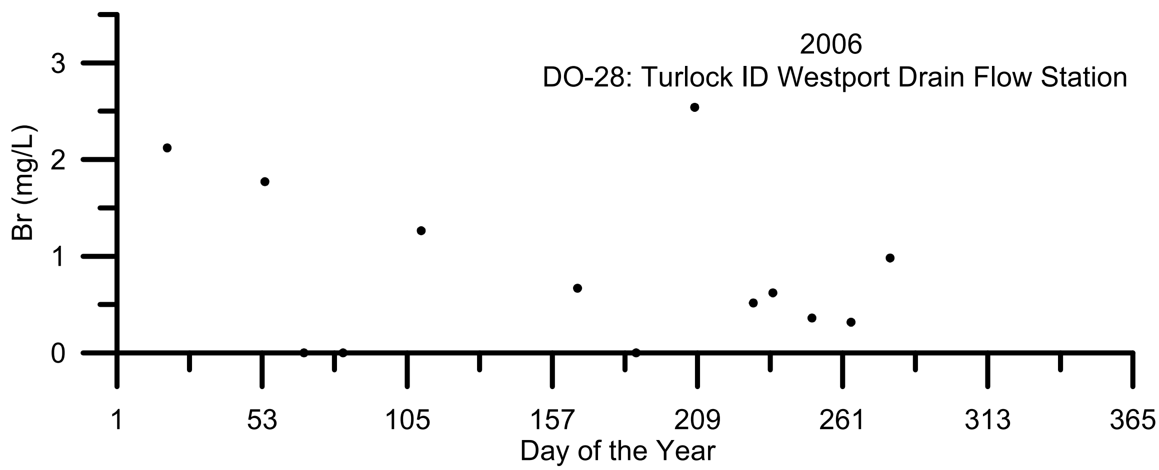

2005
DO-25: MID Main Drain to Stan. R. via Miller Lake
Br (mg/L)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-25: MID Main Drain to Stan. R. via Miller Lake
Br (mg/L)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year

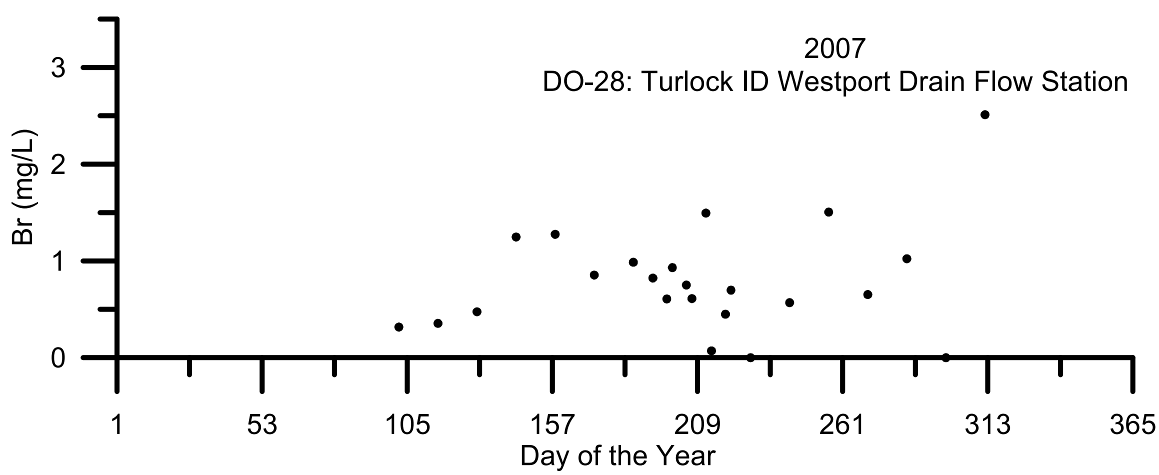

2007
DO-25: MID Main Drain to Stan. R. via Miller Lake
Br (mg/L)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year



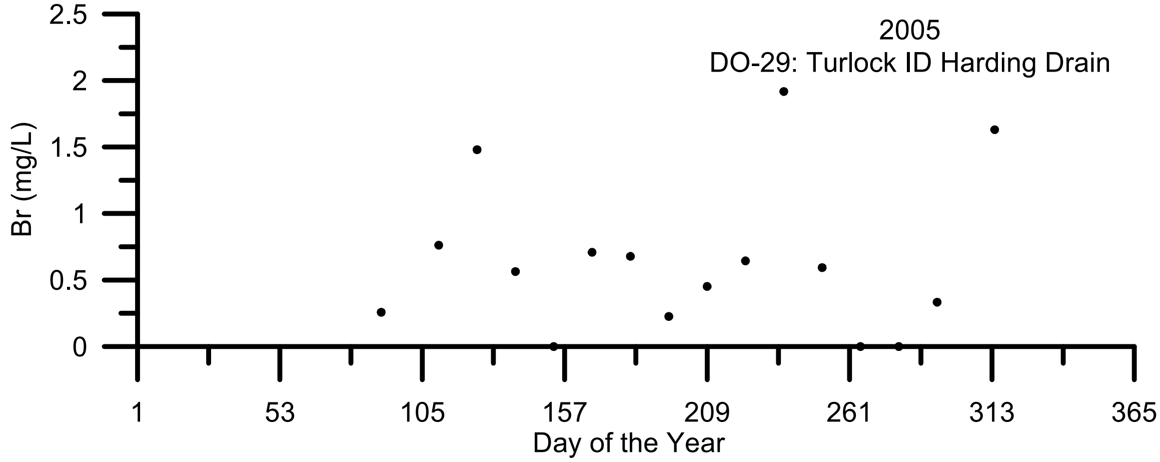
2005
DO-28: Turlock ID Westport Drain Flow Station
Br (mg/L)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

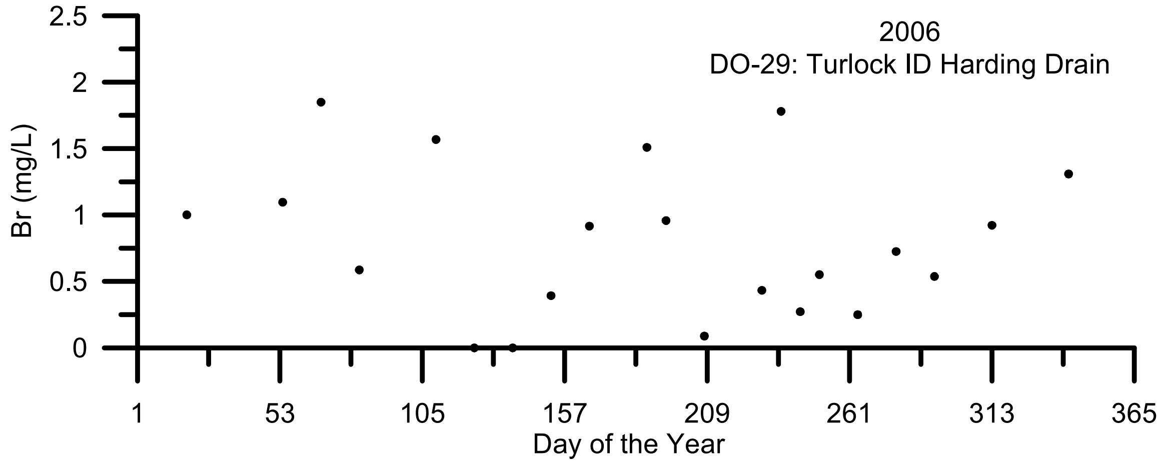


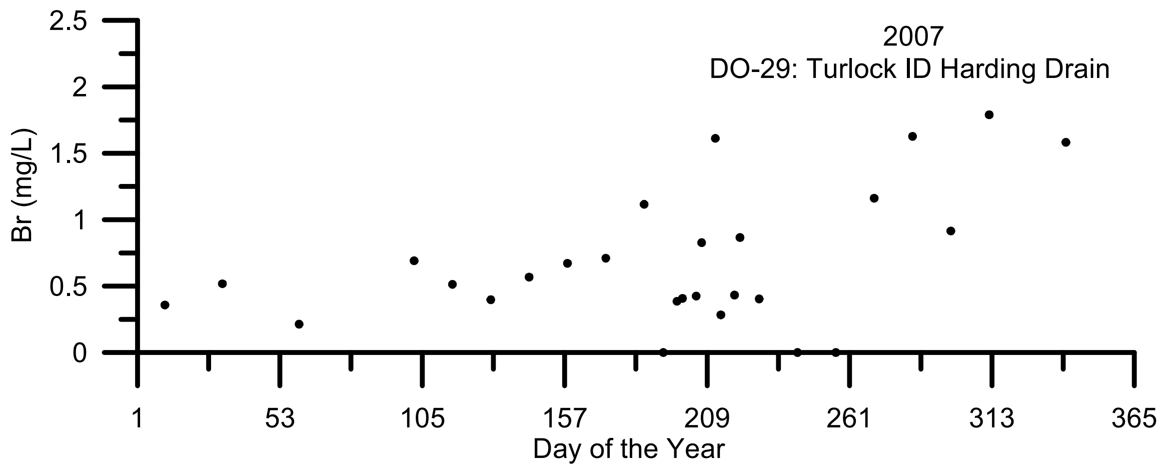
2006
DO-28: Turlock ID Westport Drain Flow Station
Br (mg/L)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

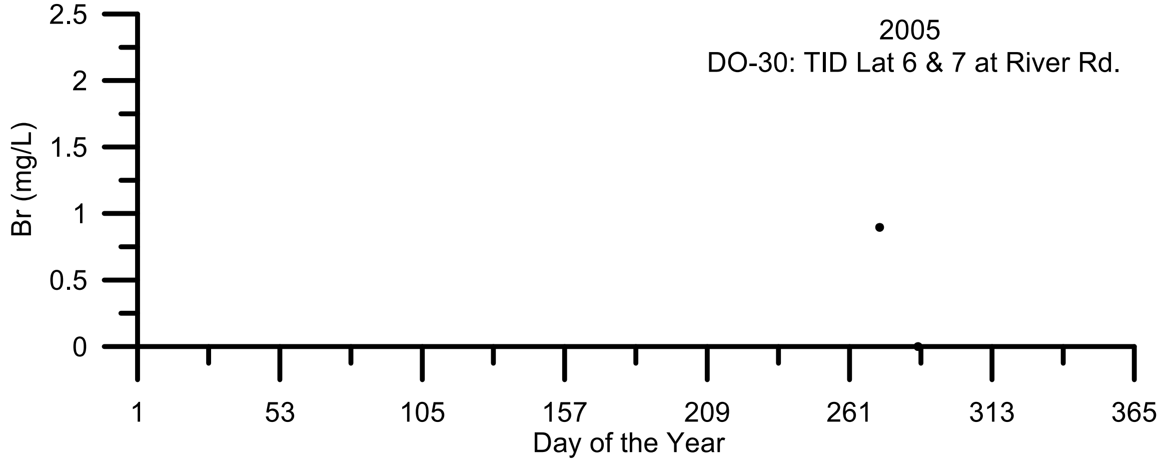


2007
DO-28: Turlock ID Westport Drain Flow Station
Br (mg/L)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

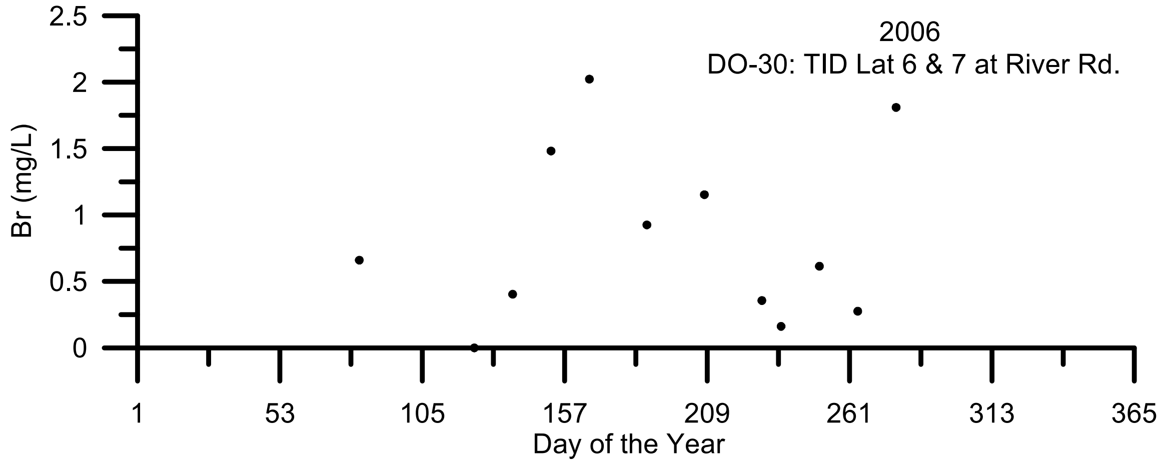

2005
DO-29: Turlock ID Harding Drain
Br (mg/L)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-29: Turlock ID Harding Drain
Br (mg/L)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year

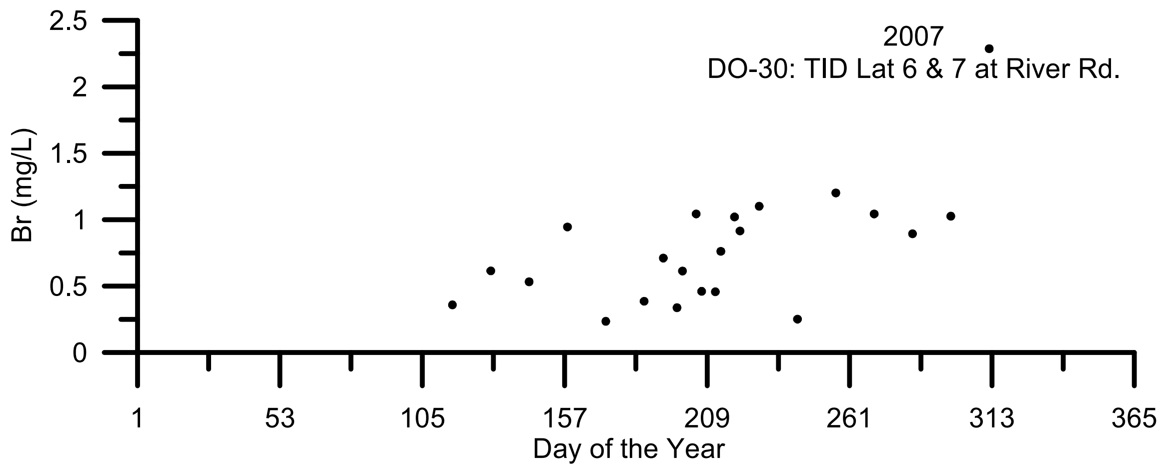

2007
DO-29: Turlock ID Harding Drain
Br (mg/L)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year



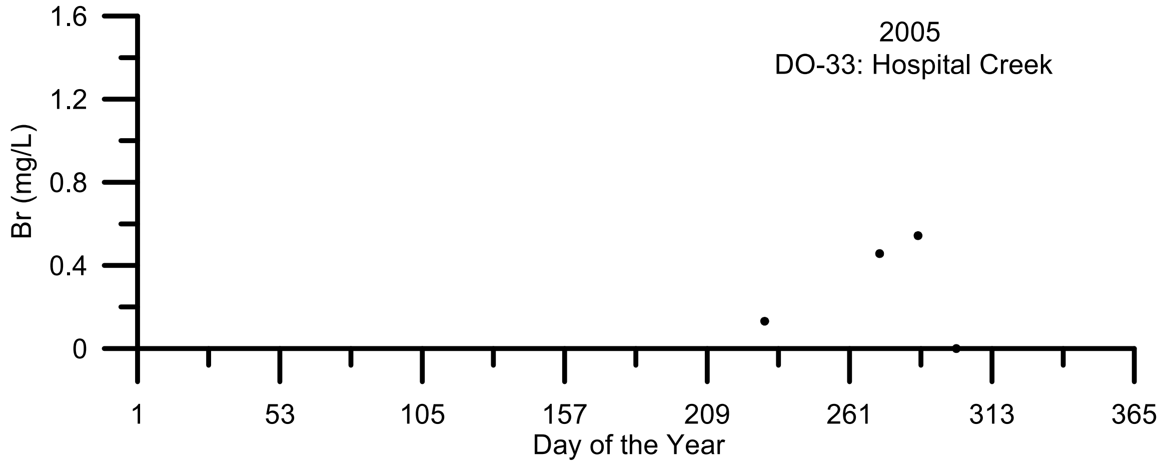
2005
DO-30: TID Lat 6 & 7 at River Rd.
Br (mg/L)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year

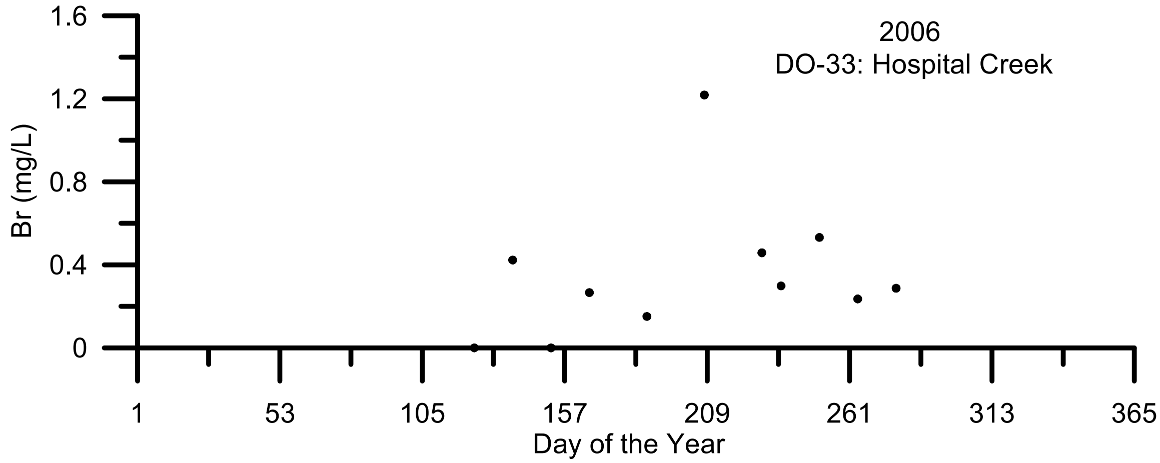


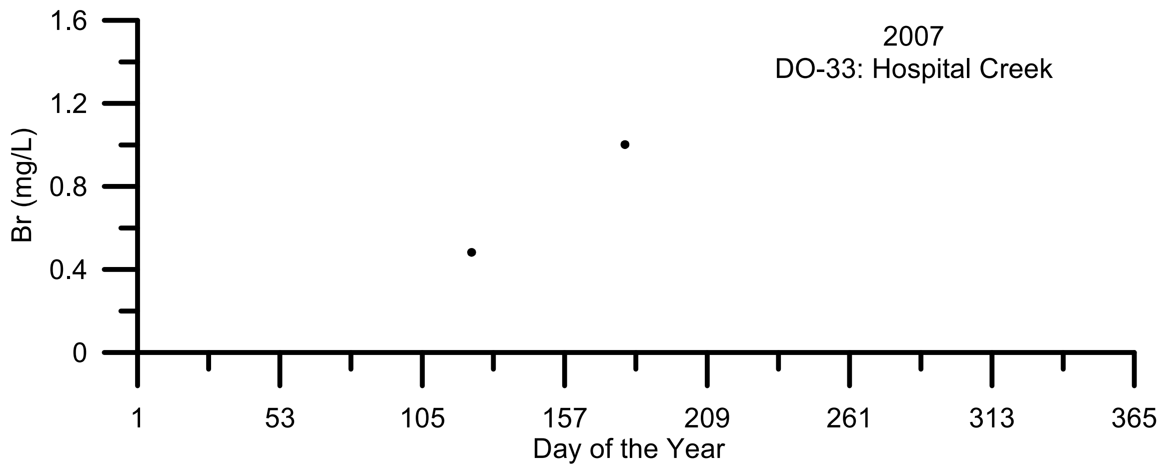
2006
DO-30: TID Lat 6 & 7 at River Rd.
Br (mg/L)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year

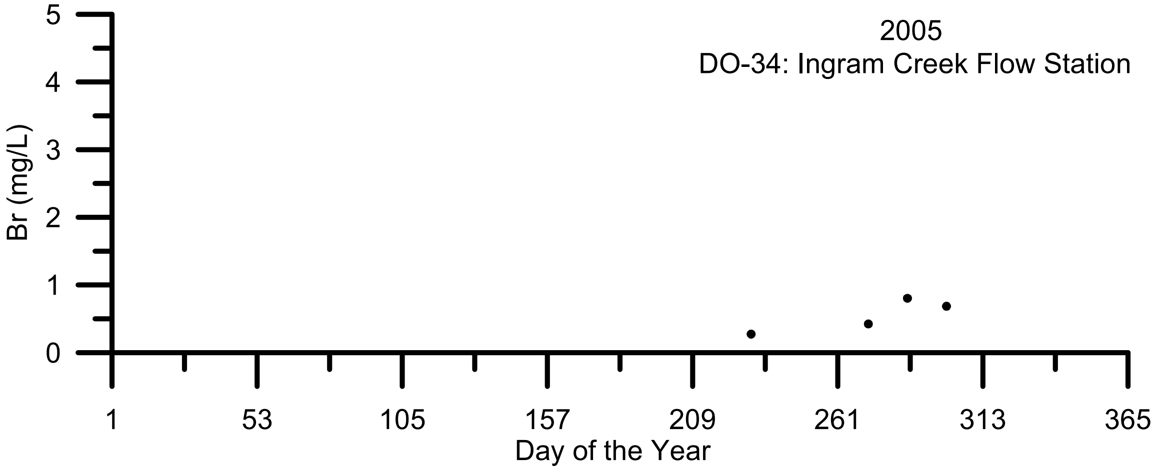


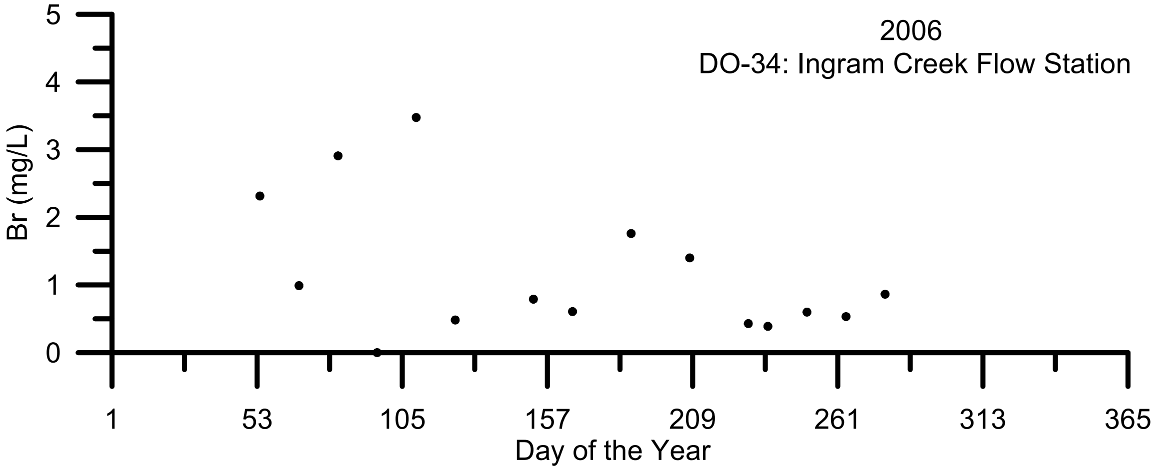
2007
DO-30: TID Lat 6 & 7 at River Rd.
Br (mg/L)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year

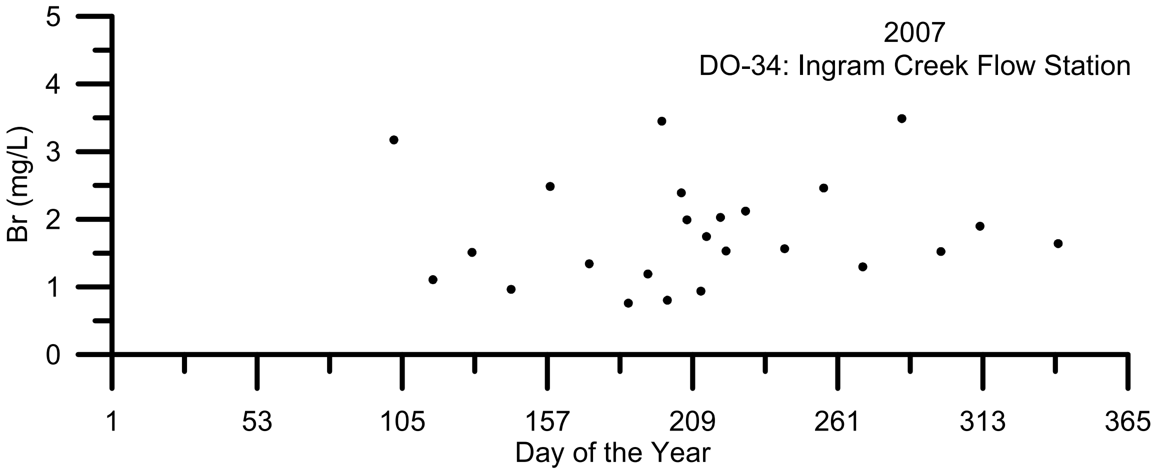

2005
DO-33: Hospital Creek
Br (mg/L)
Day of the Year

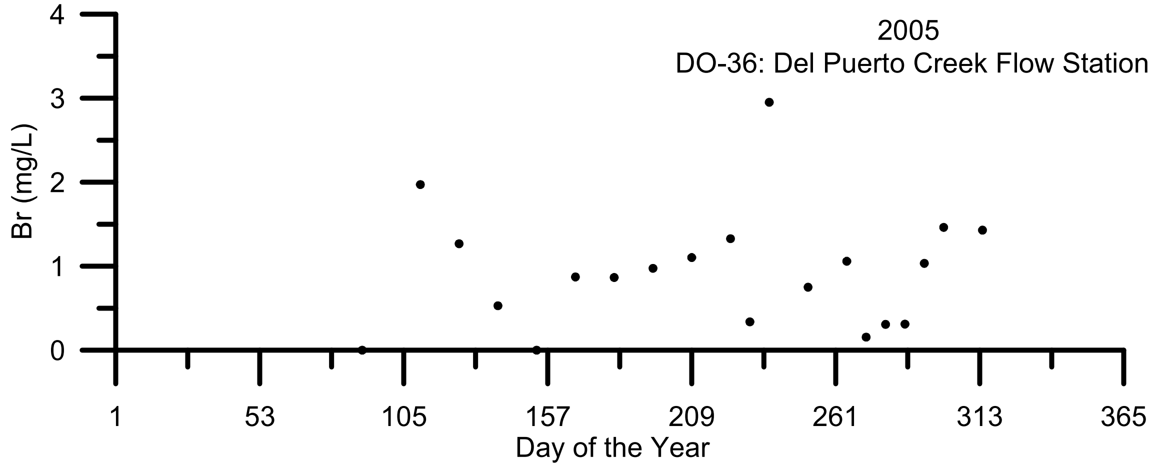

2006
DO-33: Hospital Creek
Br (mg/L)
Day of the Year

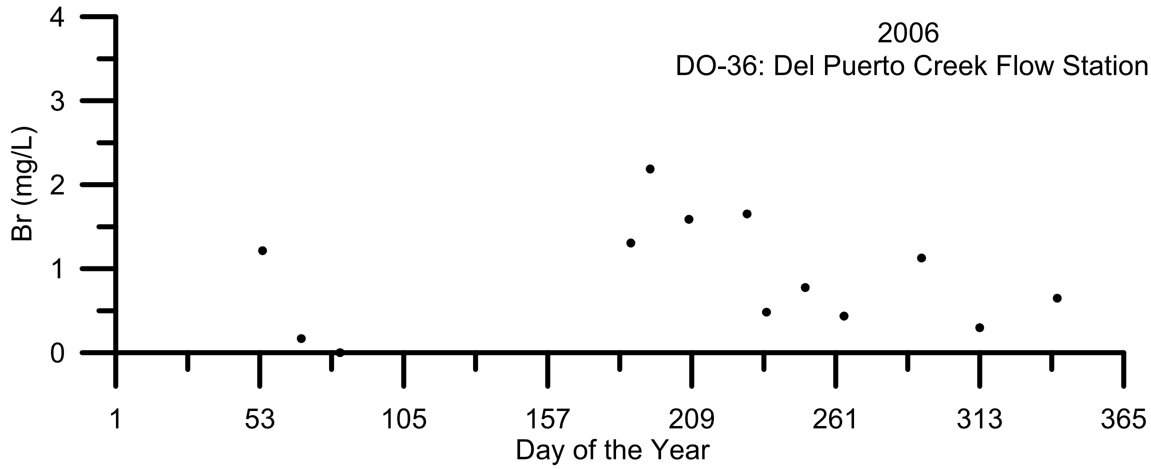

2007
DO-33: Hospital Creek
Br (mg/L)
Day of the Year

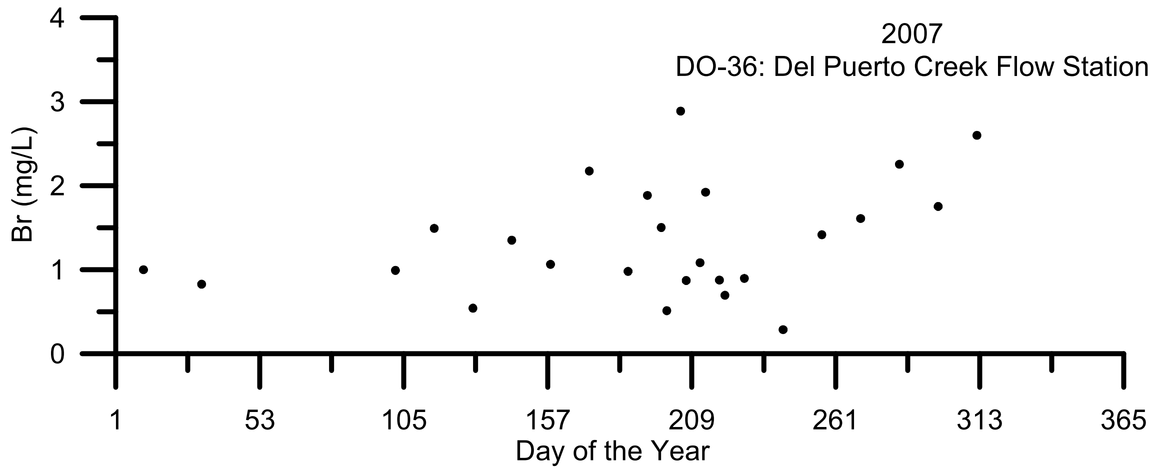

2005
DO-34: Ingram Creek Flow Station
Br (mg/L)
Day of the Year

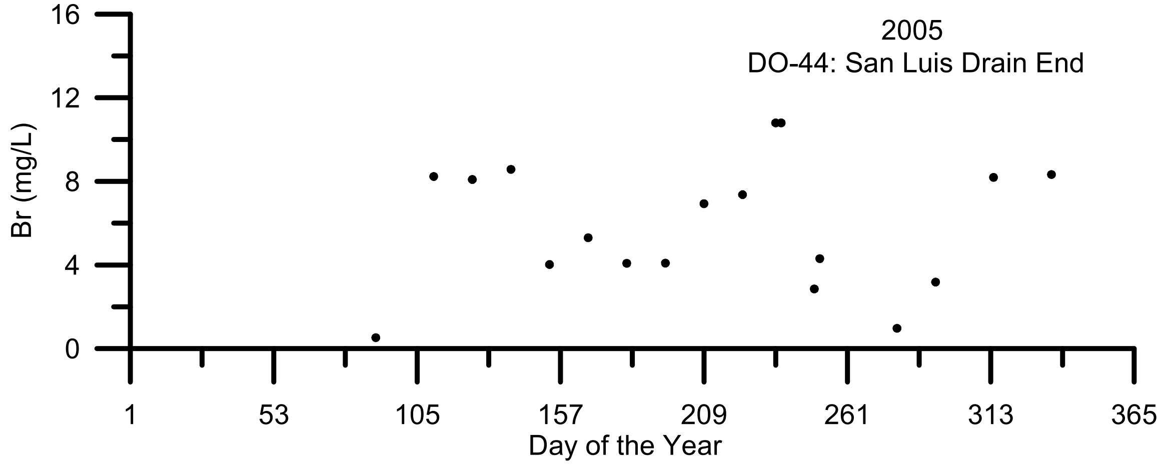

2006
DO-34: Ingram Creek Flow Station
Br (mg/L)
Day of the Year

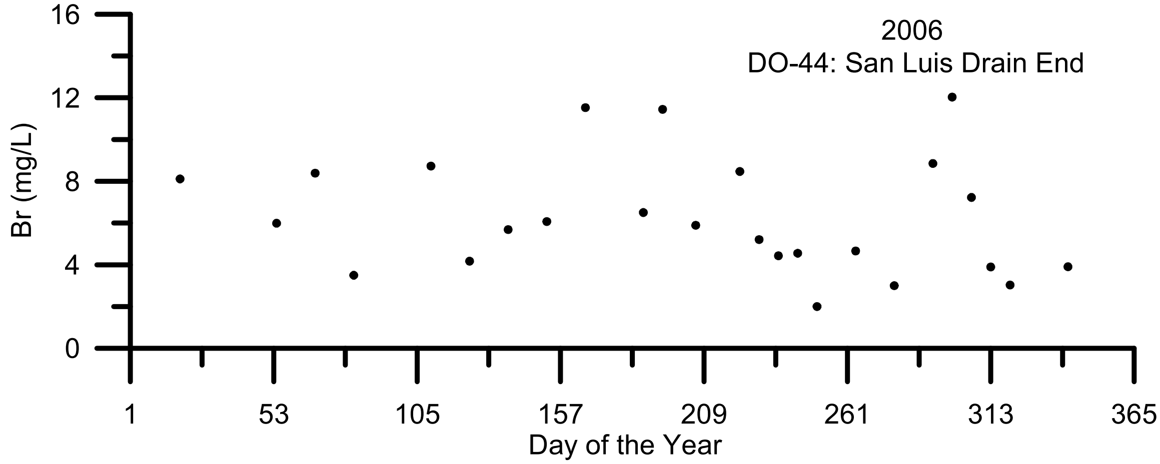

2007
DO-34: Ingram Creek Flow Station
Br (mg/L)
Day of the Year

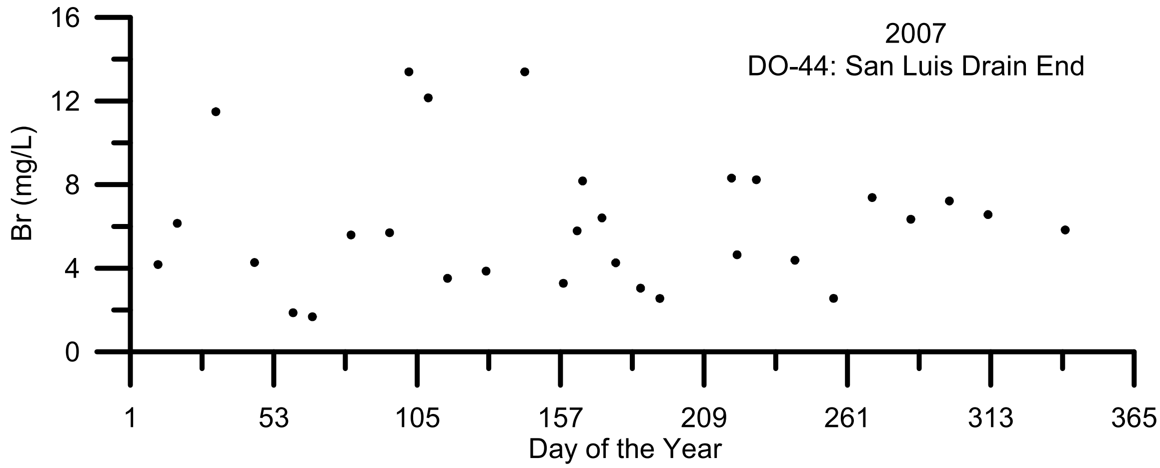

2005
DO-36: Del Puerto Creek Flow Station
Br (mg/L)
Day of the Year
0
1
2
3
4
1
53
105
157
209
261
313
365

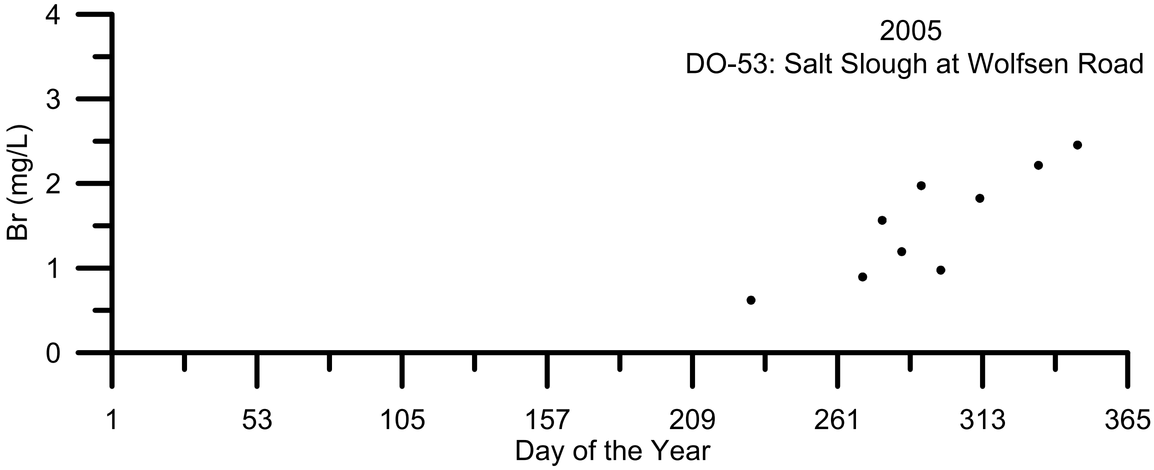

2006
DO-36: Del Puerto Creek Flow Station
Br (mg/L)
Day of the Year
0
1
2
3
4
1
53
105
157
209
261
313
365

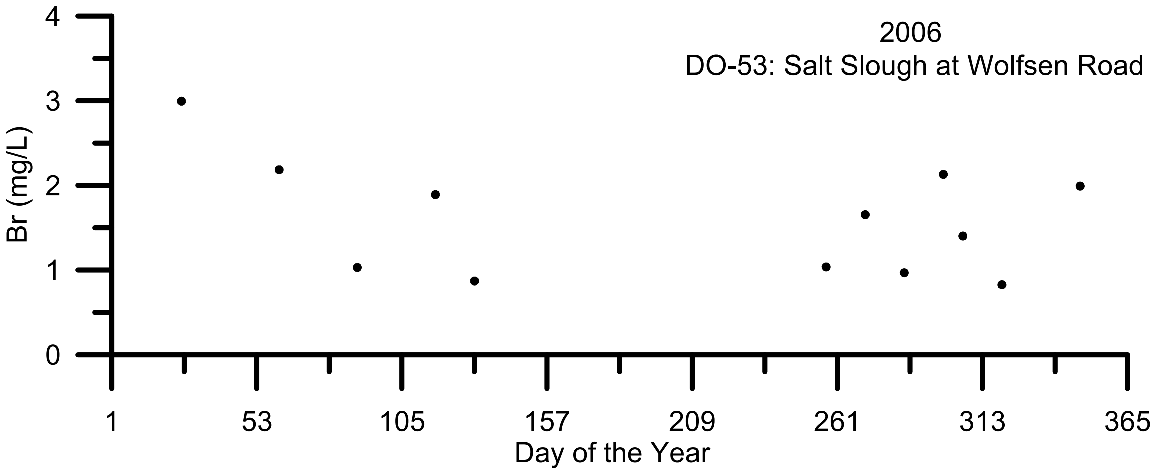

2007
DO-36: Del Puerto Creek Flow Station
Br (mg/L)
Day of the Year
0
1
2
3
4
1
53
105
157
209
261
313
365

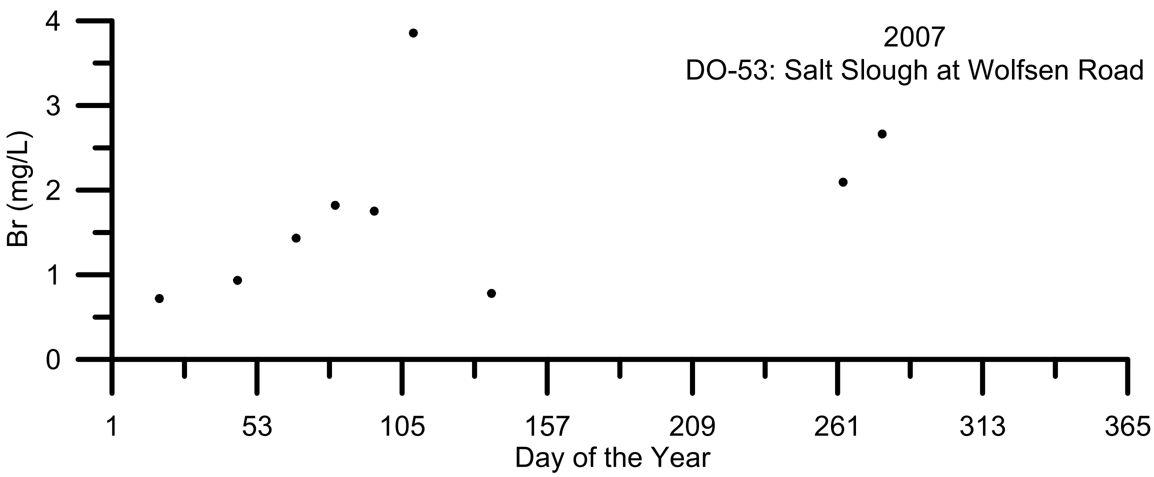

2005
DO-44: San Luis Drain End
Br (mg/L)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year

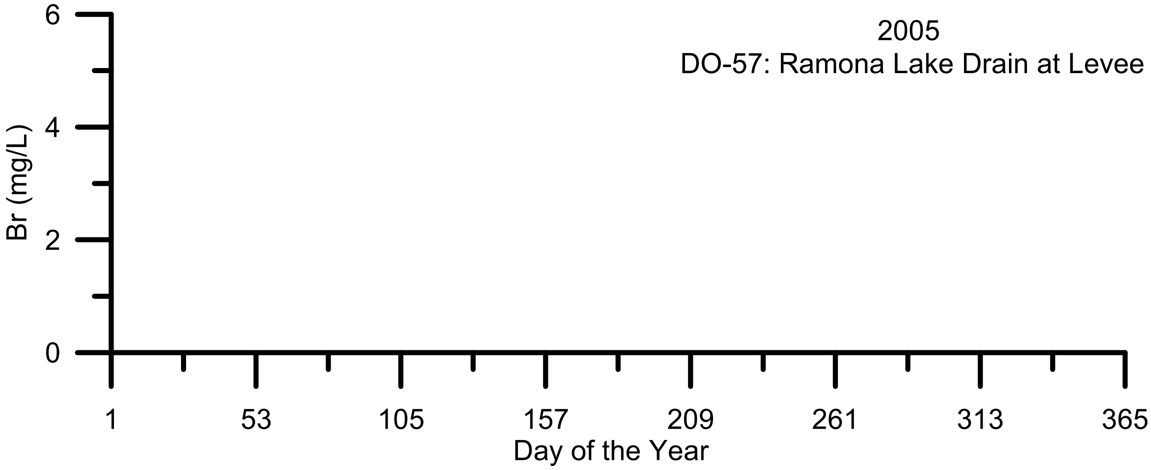

2006
DO-44: San Luis Drain End
Br (mg/L)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year

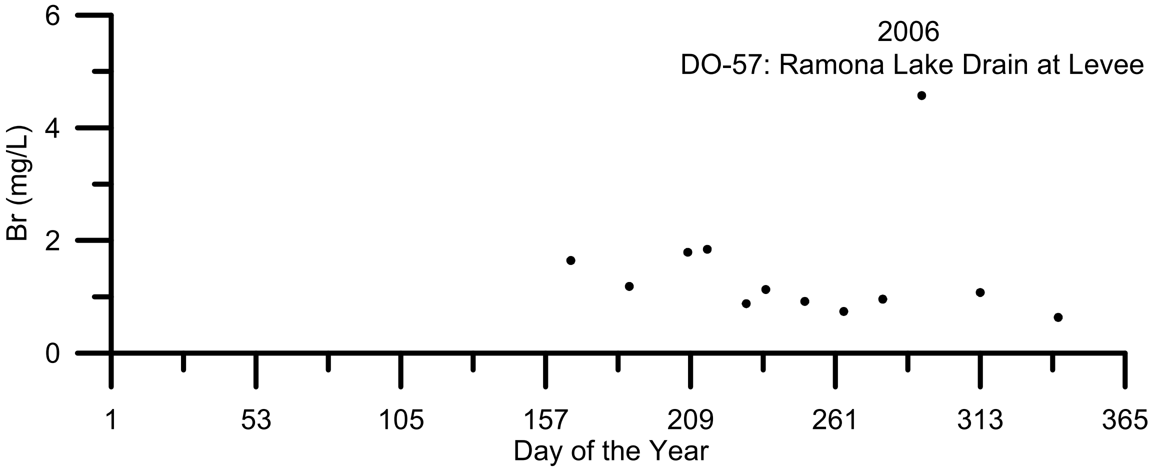

2007
DO-44: San Luis Drain End
Br (mg/L)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year

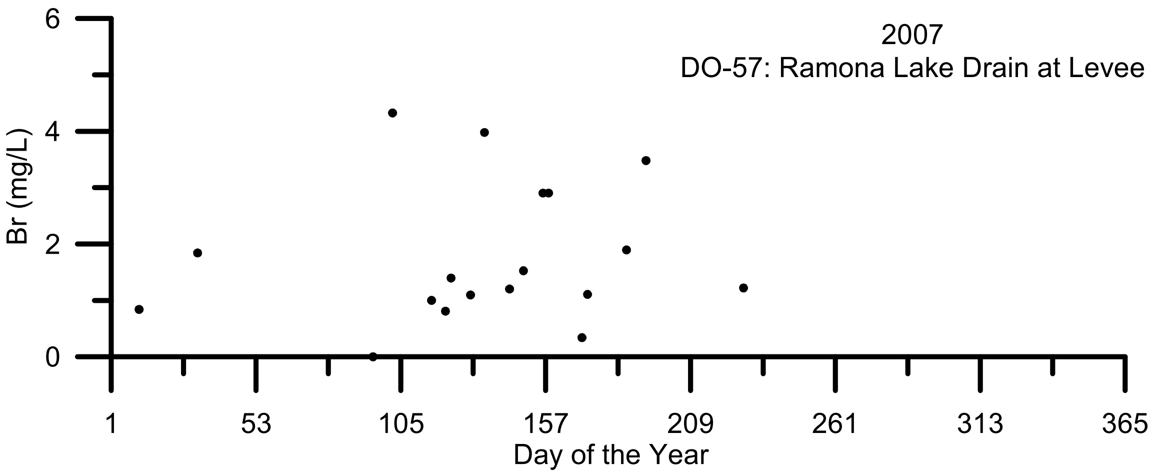

2005
DO-53: Salt Slough at Wolfsen Road
Br (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

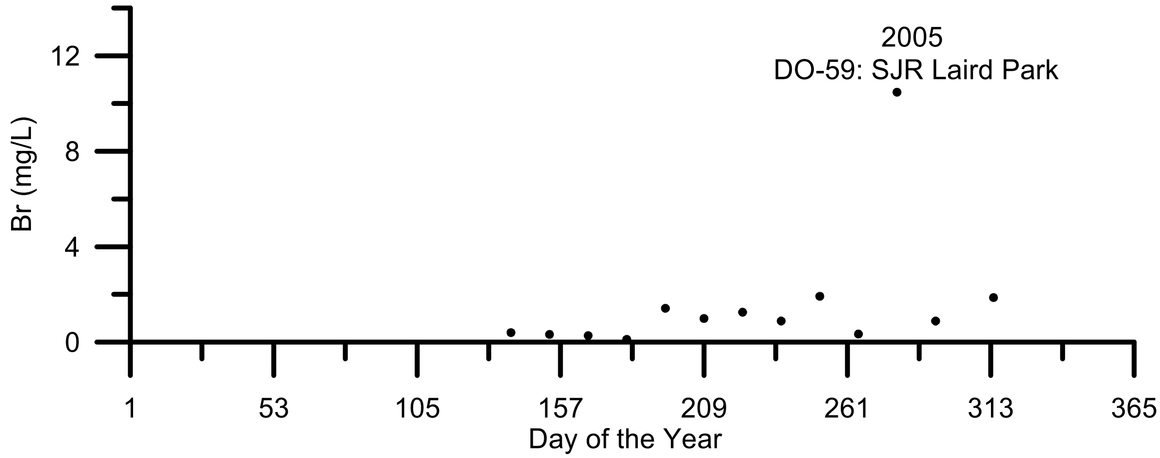

2006
DO-53: Salt Slough at Wolfsen Road
Br (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

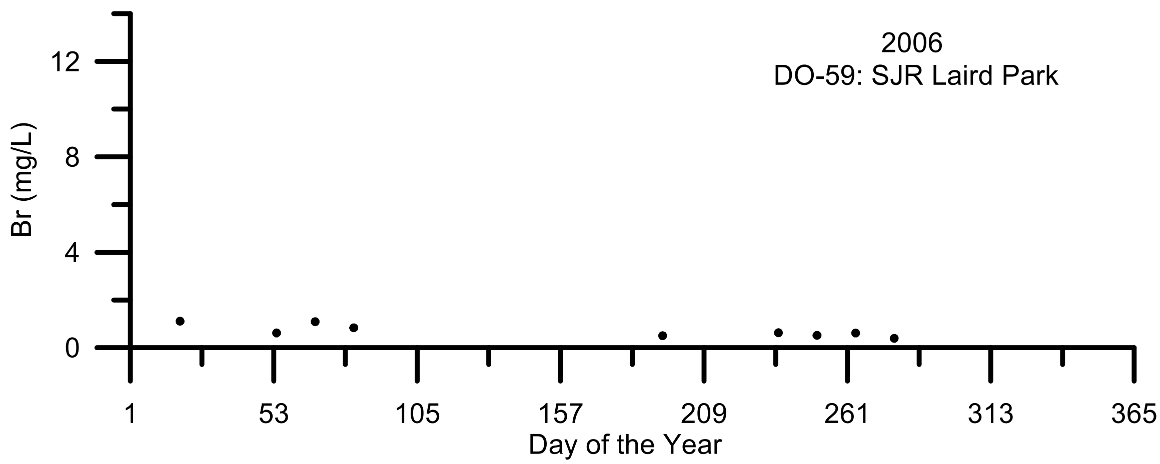

2007
DO-53: Salt Slough at Wolfsen Road
Br (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

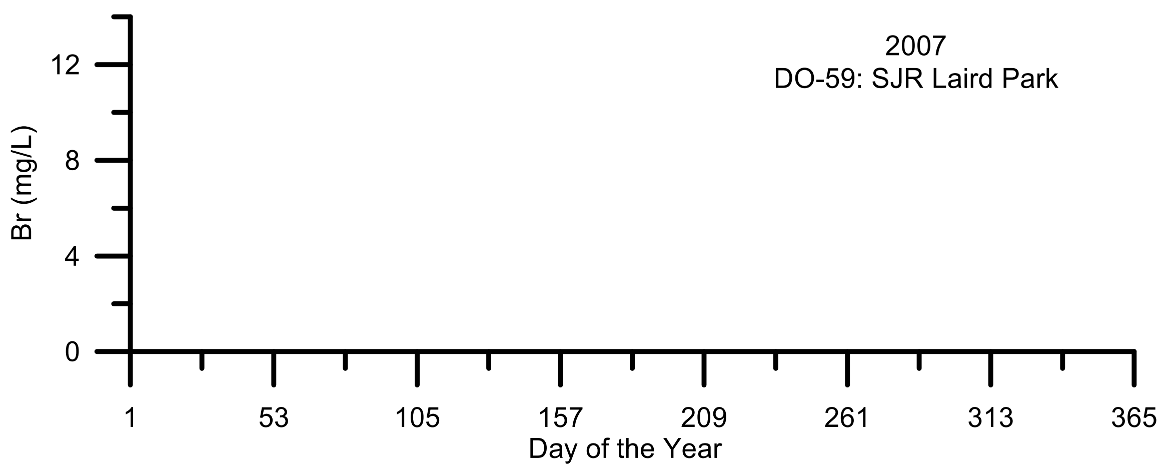

2005
DO-57: Ramona Lake Drain at Levee
Br (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

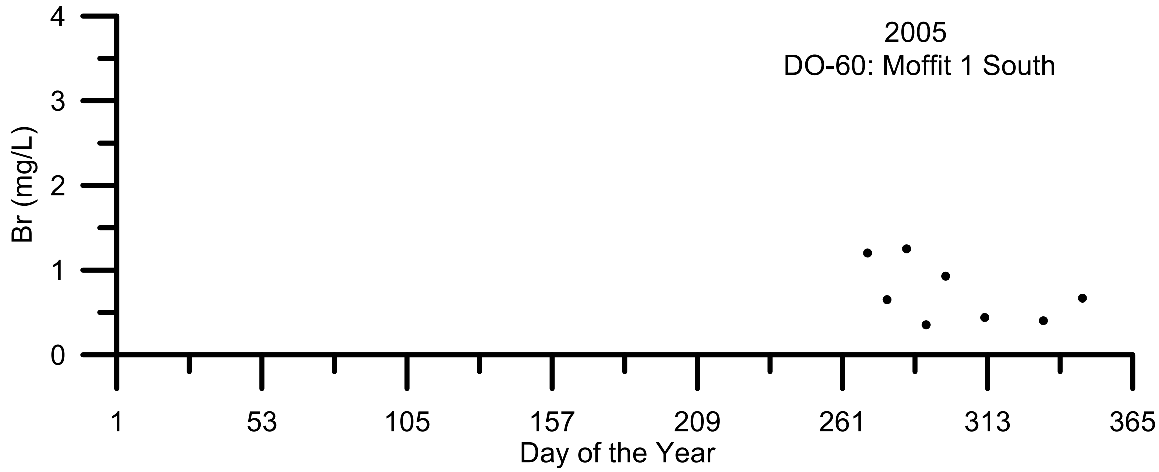

2006
DO-57: Ramona Lake Drain at Levee
Br (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

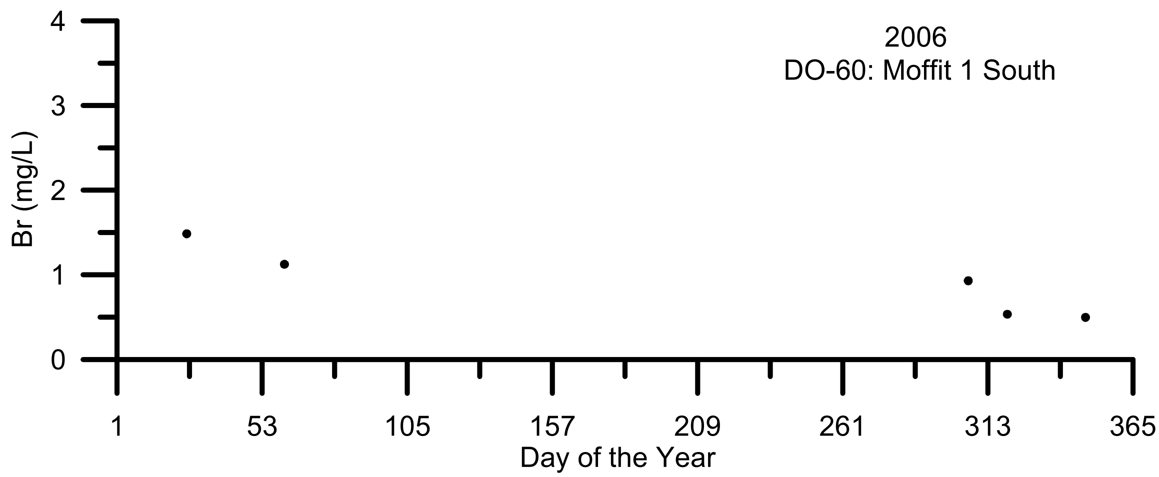

2007
DO-57: Ramona Lake Drain at Levee
Br (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

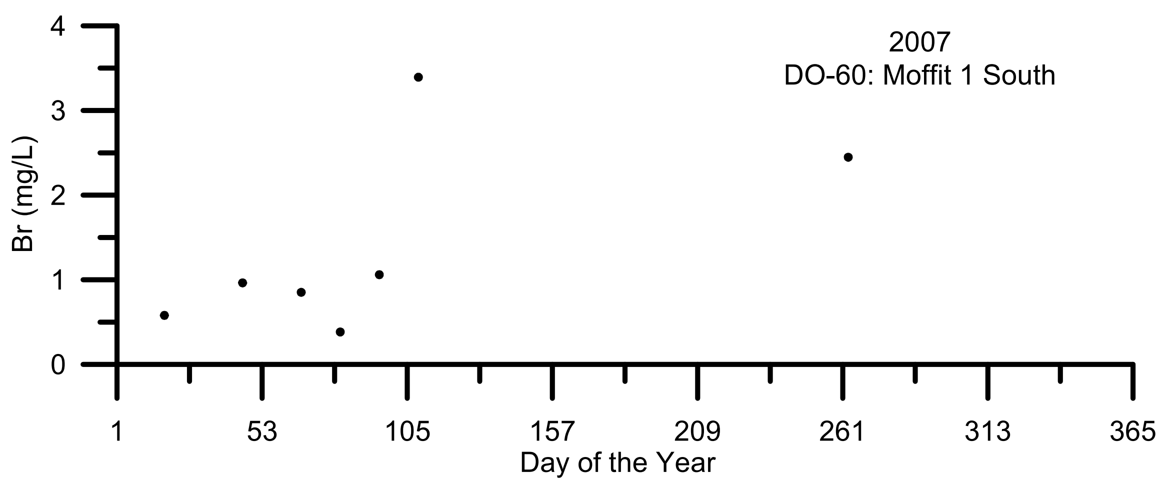

2005
DO-59: SJR Laird Park
Br (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

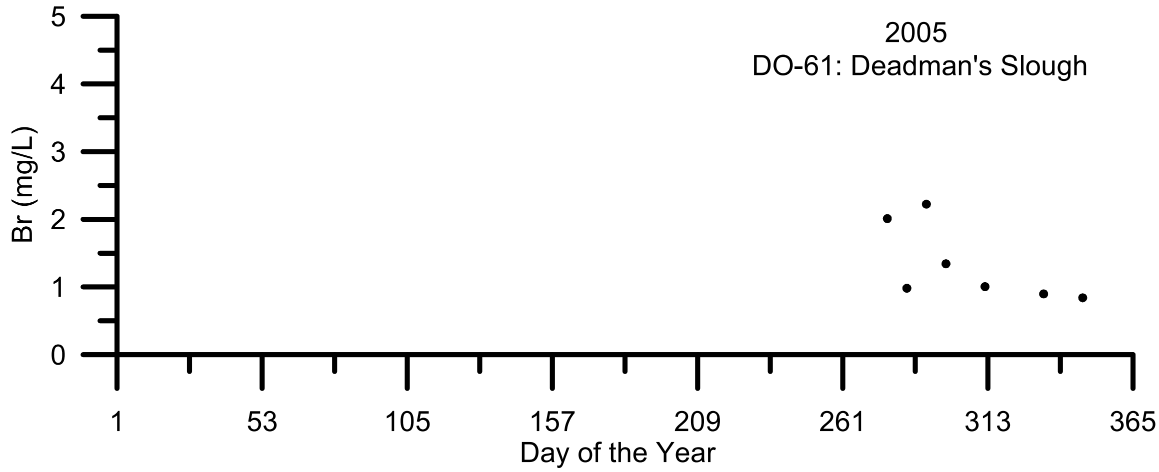

2006
DO-59: SJR Laird Park
Br (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

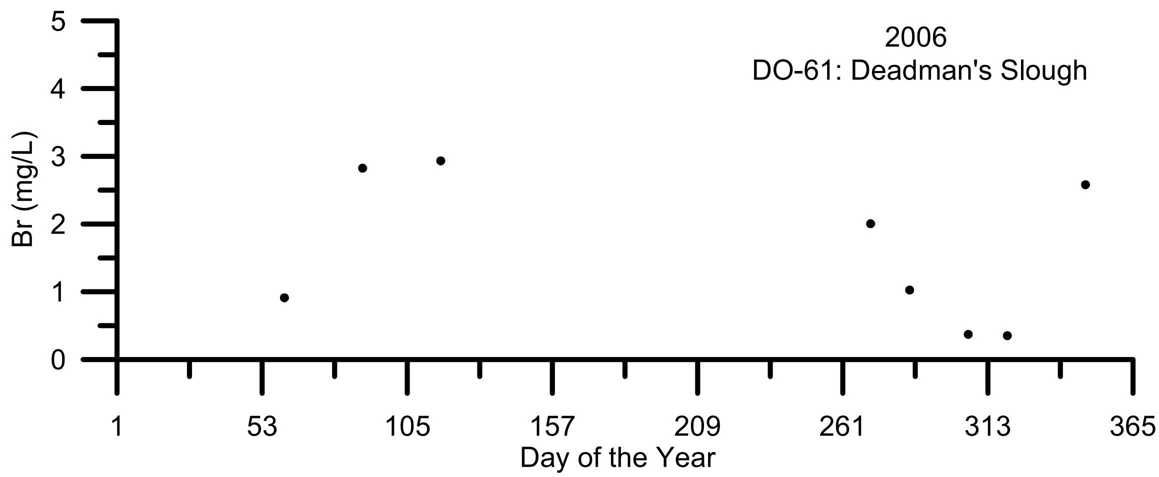

2007
DO-59: SJR Laird Park
Br (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

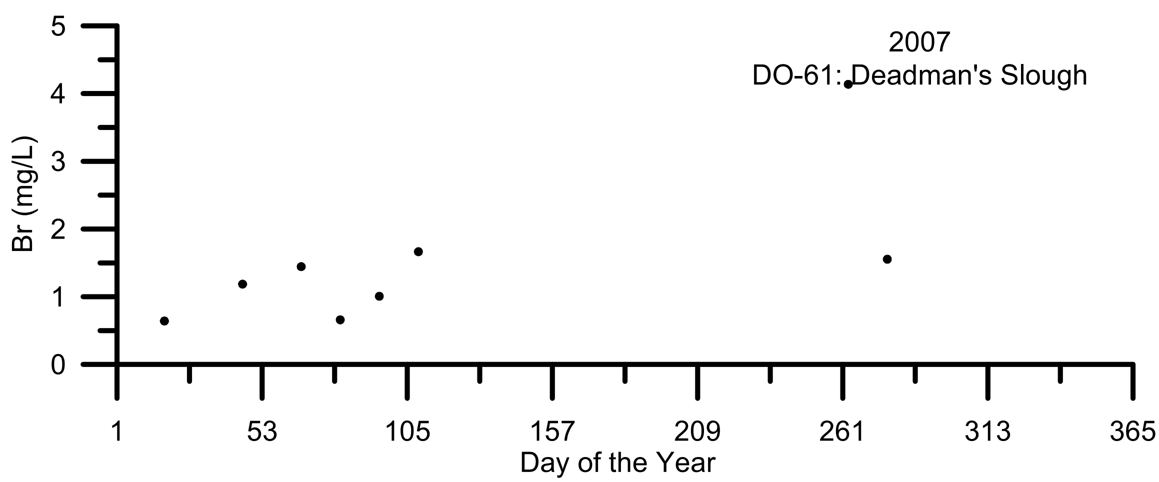

2005
DO-60: Moffit 1 South
Br (mg/L)
Day of the Year

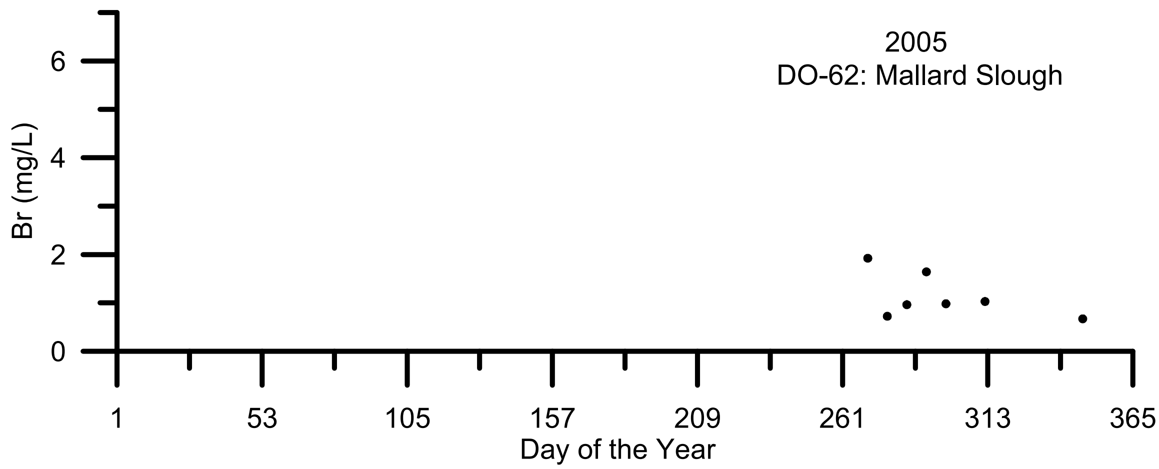

2006
DO-60: Moffit 1 South
Br (mg/L)
Day of the Year

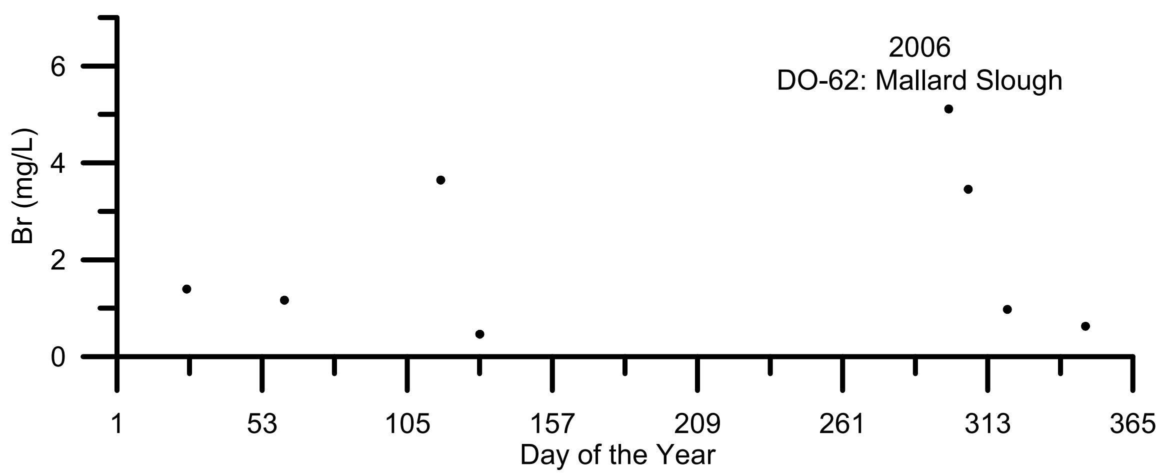

2007
DO-60: Moffit 1 South
Br (mg/L)
Day of the Year

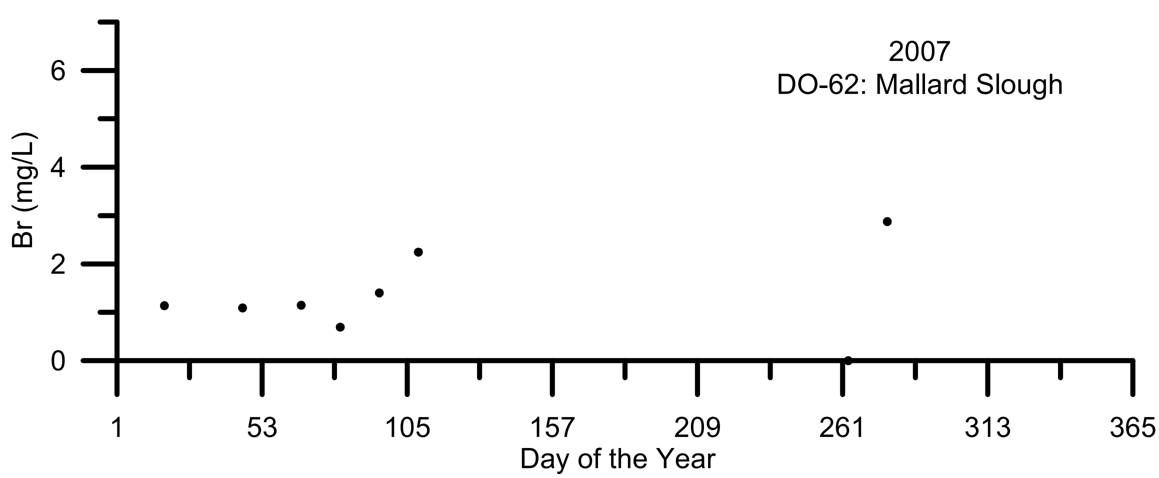

2005
DO-61: Deadman's Slough
Br (mg/L)
Day of the Year

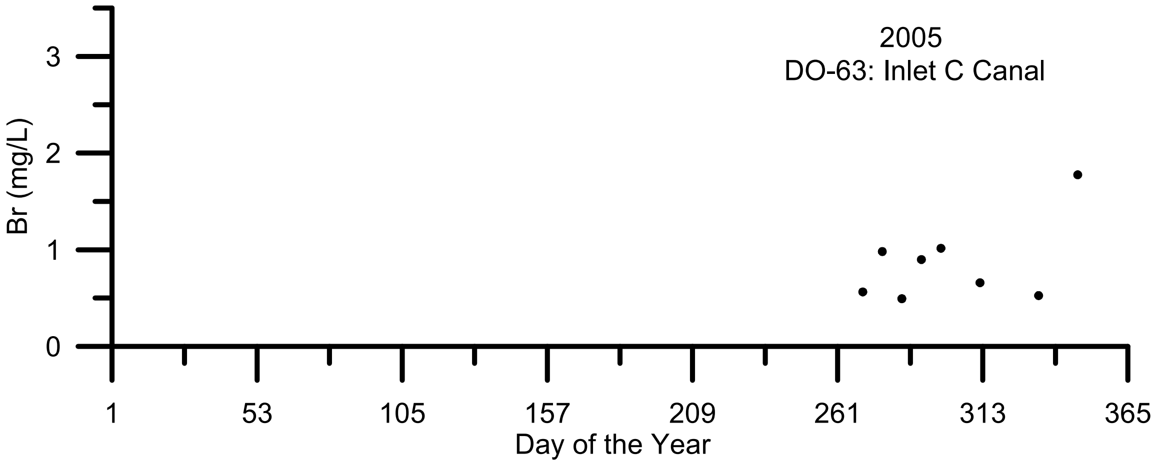

2006
DO-61: Deadman's Slough
Br (mg/L)
Day of the Year

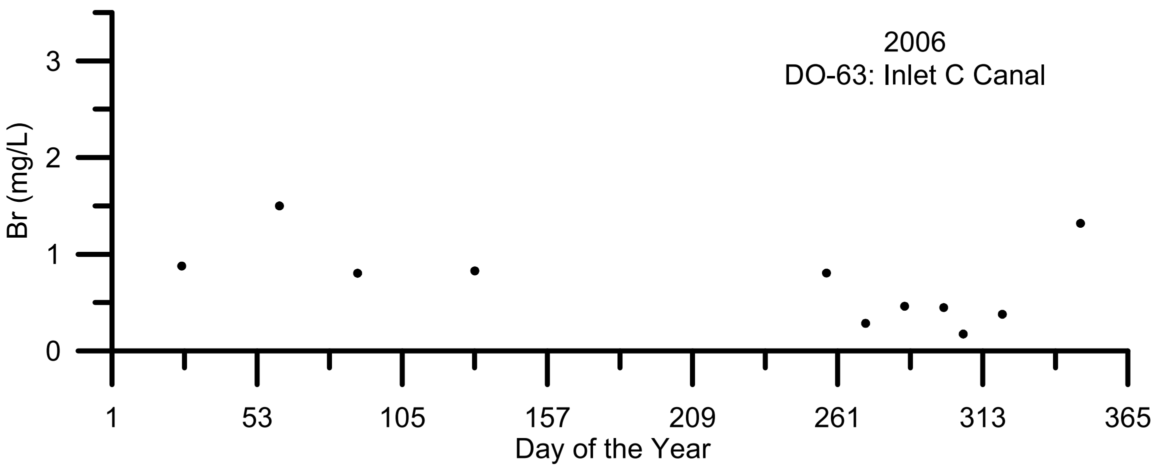

2007
DO-61: Deadman's Slough
Br (mg/L)
Day of the Year

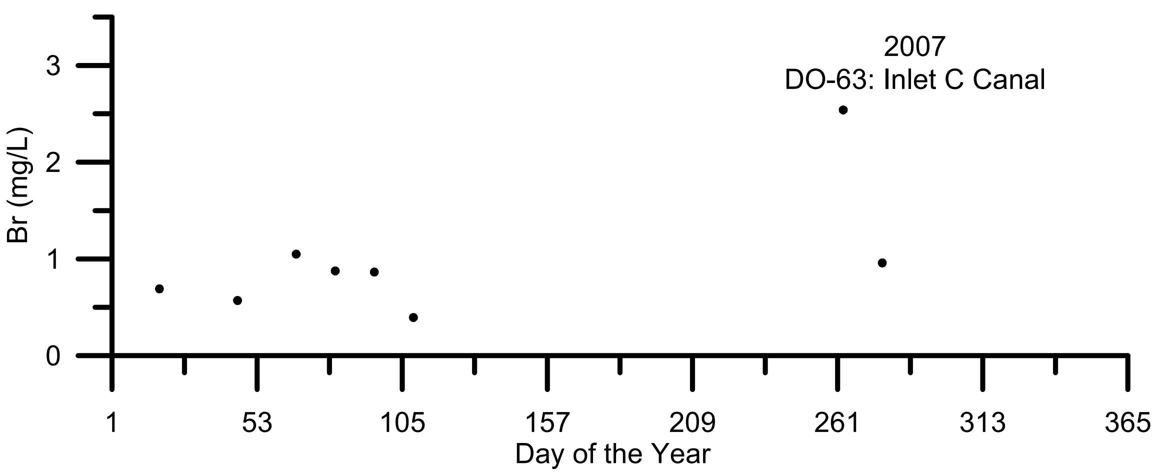

2005
DO-62: Mallard Slough
Br (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

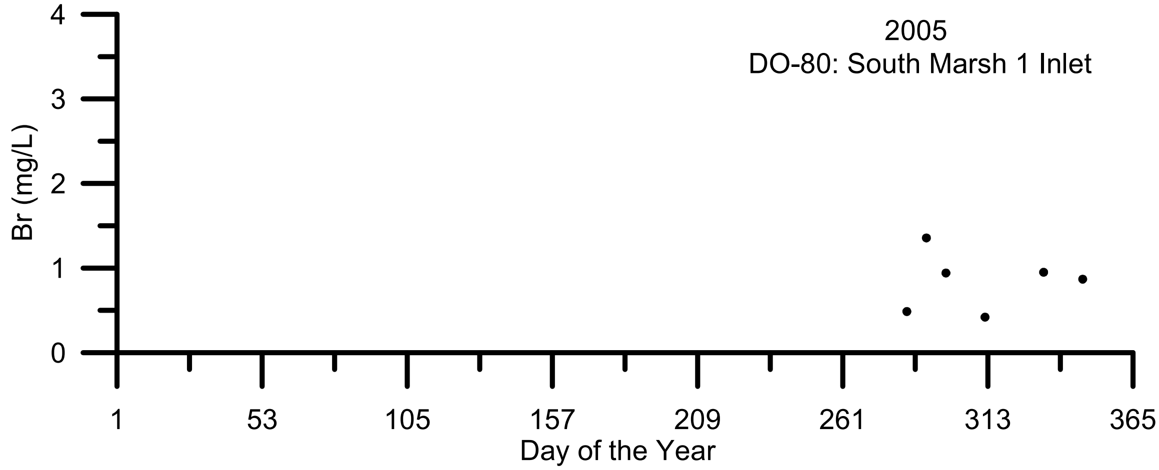

2006
DO-62: Mallard Slough
Br (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

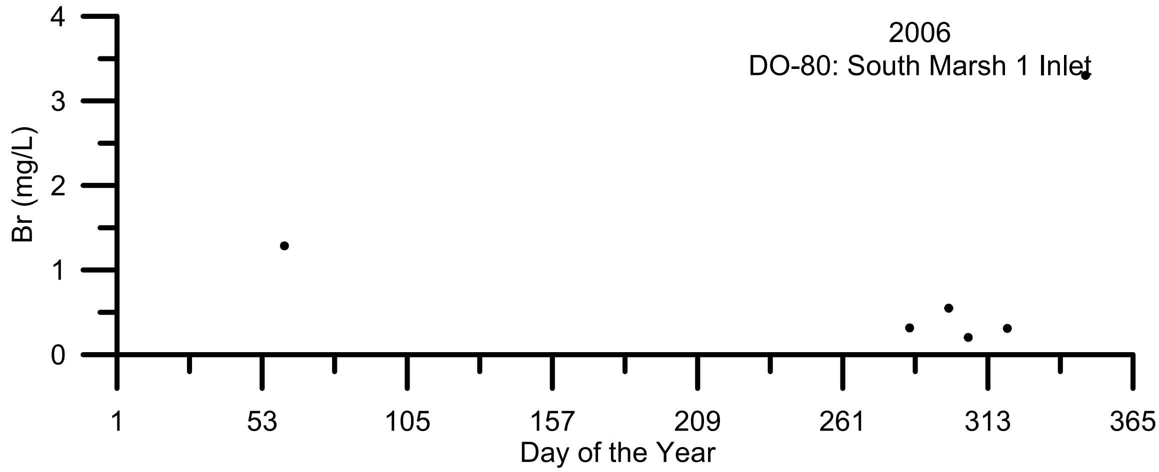

2007
DO-62: Mallard Slough
Br (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

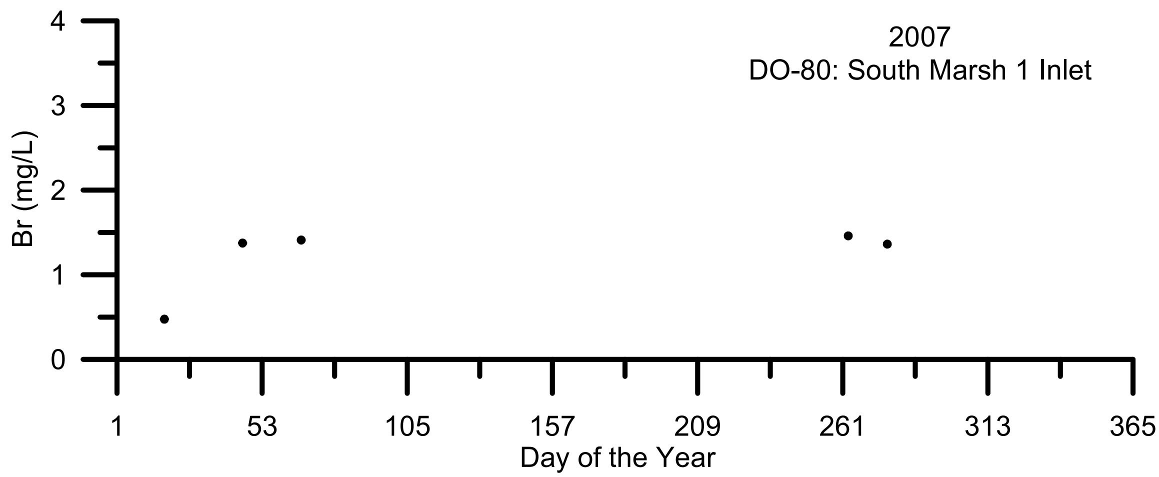

2005
DO-63: Inlet C Canal
Br (mg/L)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

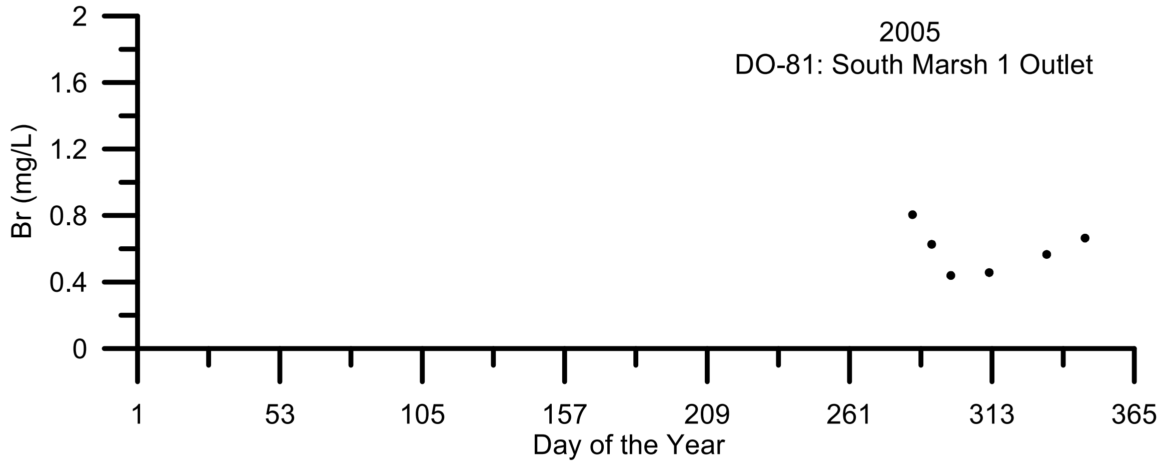

2006
DO-63: Inlet C Canal
Br (mg/L)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

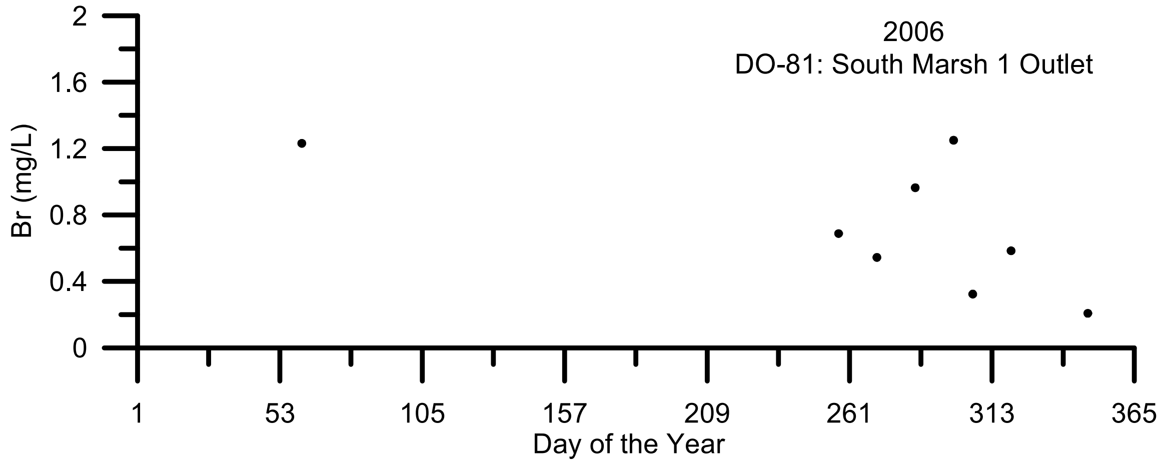

2007
DO-63: Inlet C Canal
Br (mg/L)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

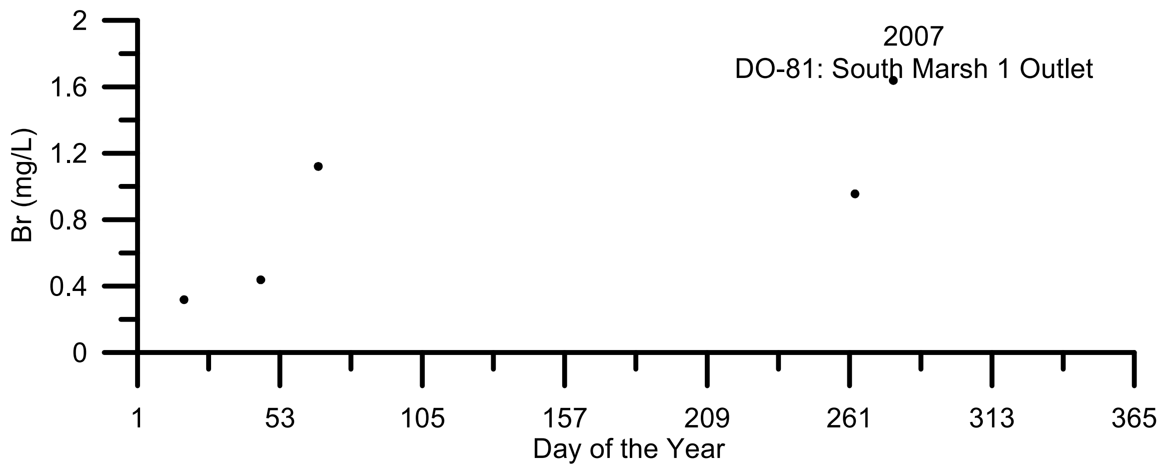

2005
DO-80: South Marsh 1 Inlet
Br (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

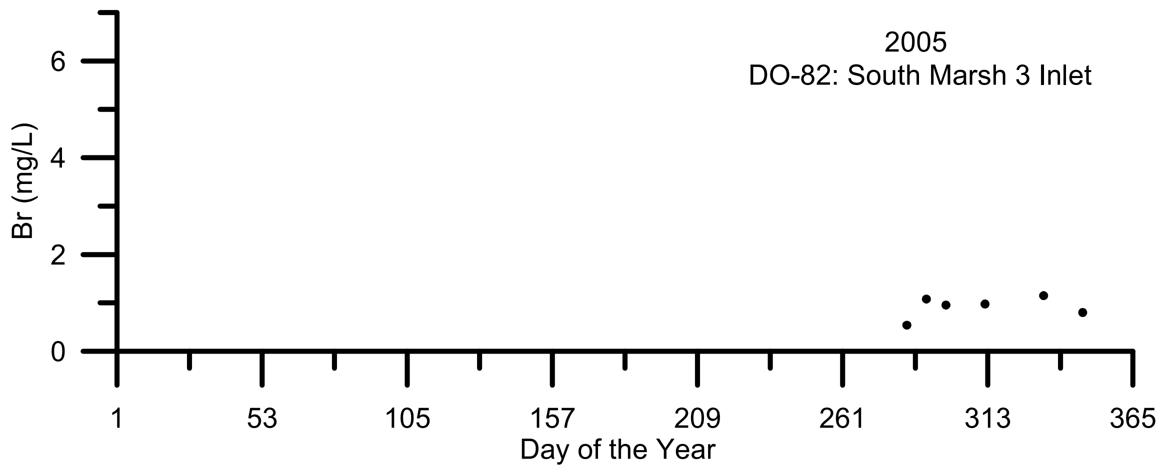

2006
DO-80: South Marsh 1 Inlet
Br (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

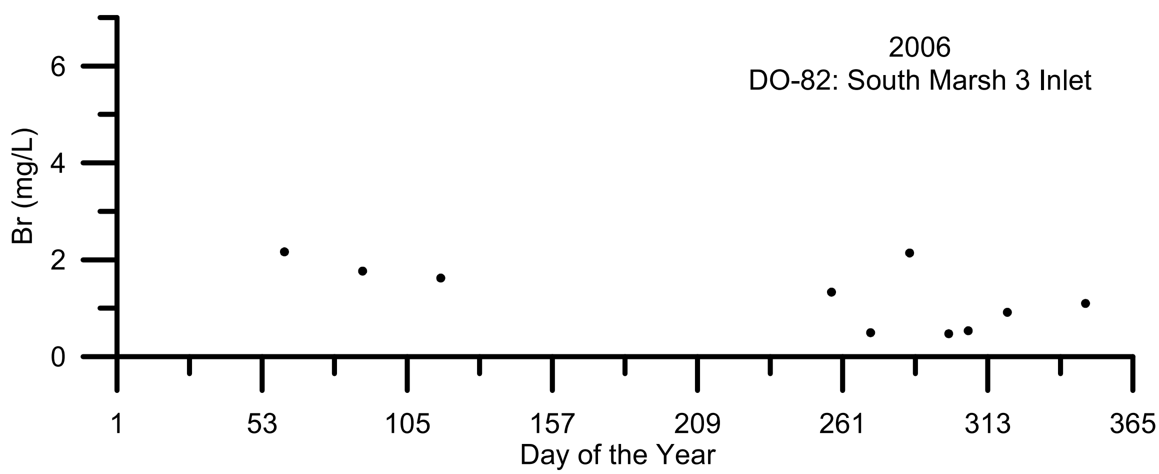

2007
DO-80: South Marsh 1 Inlet
Br (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

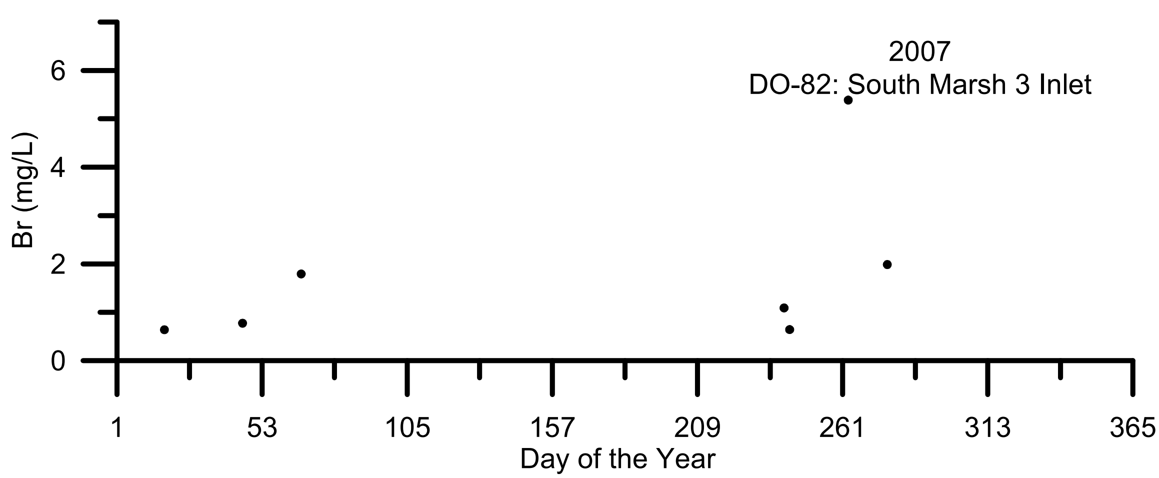

2005
DO-81: South Marsh 1 Outlet
Br (mg/L)
Day of the Year

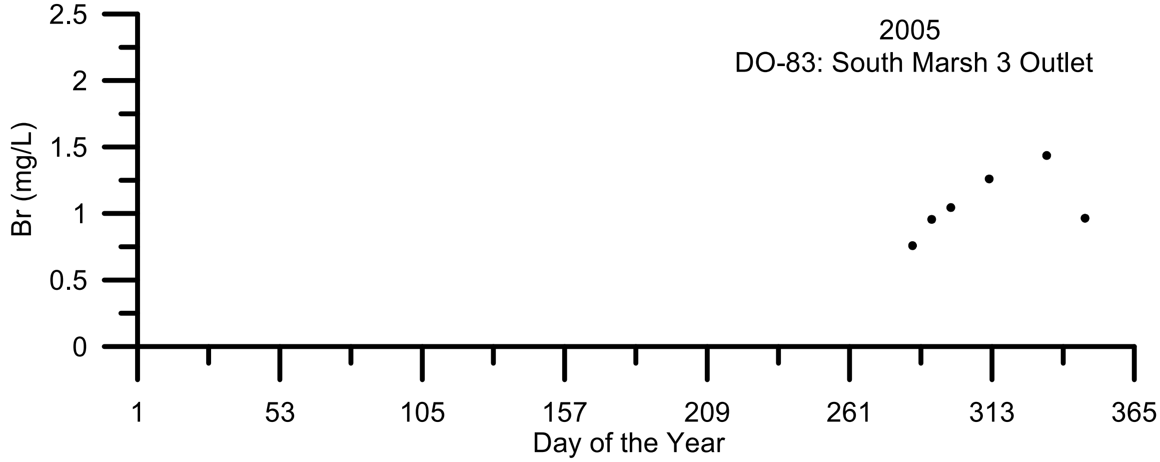

2006
DO-81: South Marsh 1 Outlet
Br (mg/L)
Day of the Year

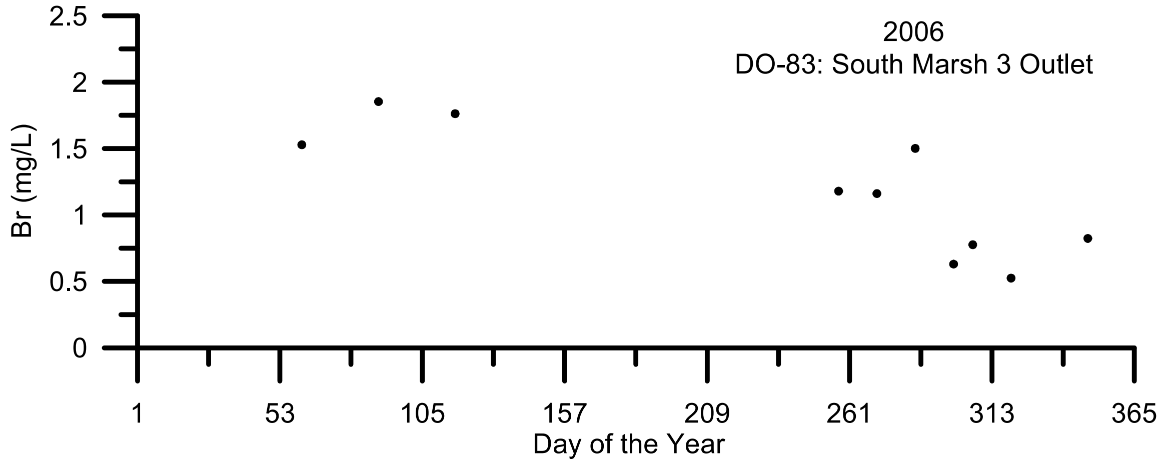

2007
DO-81: South Marsh 1 Outlet
Br (mg/L)
Day of the Year

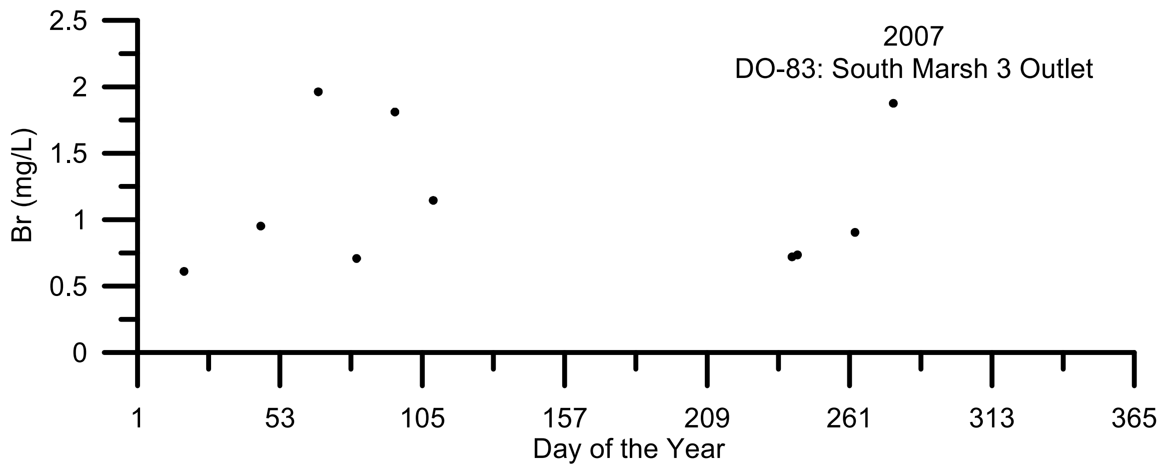

2005
DO-82: South Marsh 3 Inlet
Br (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

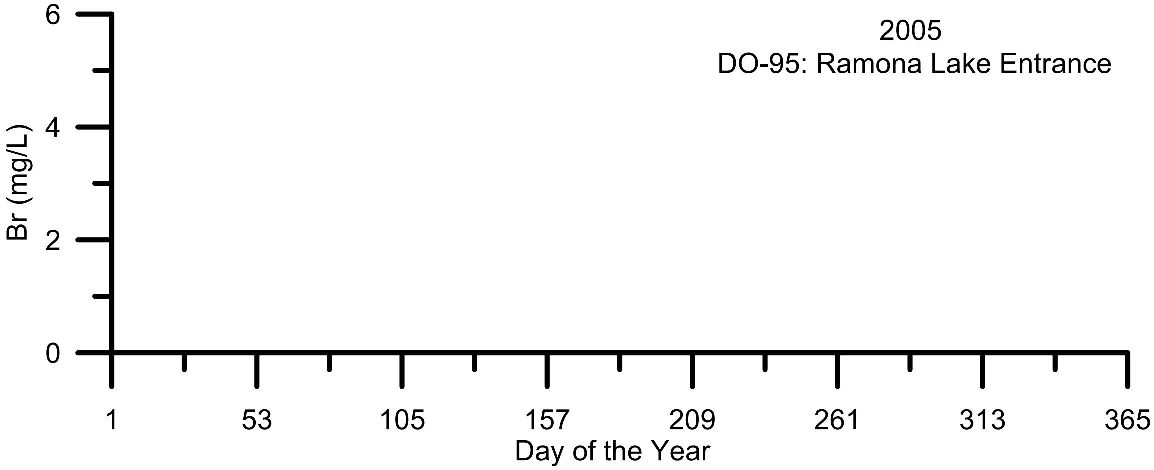

2006
DO-82: South Marsh 3 Inlet
Br (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

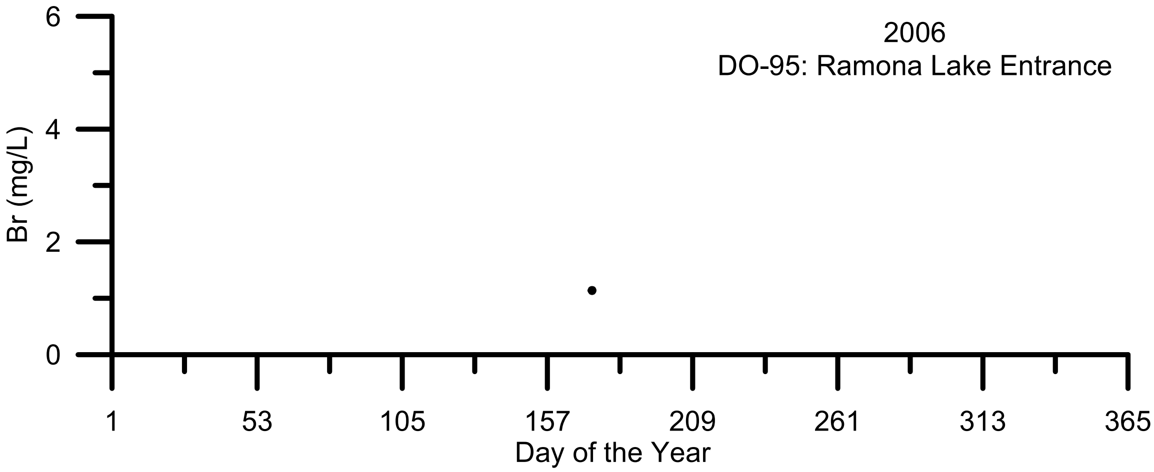

2007
DO-82: South Marsh 3 Inlet
Br (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

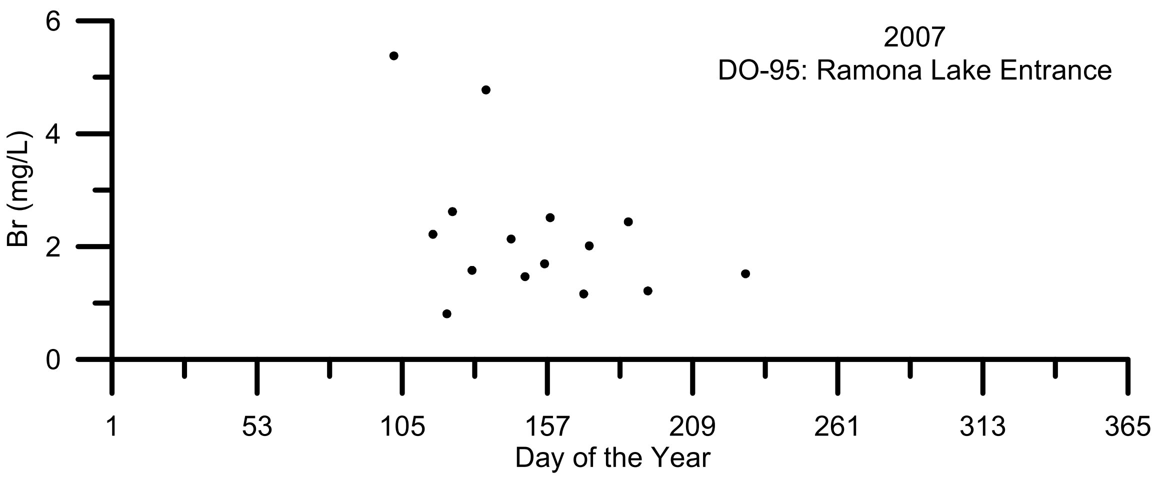

2005
DO-83: South Marsh 3 Outlet
Br (mg/L)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-83: South Marsh 3 Outlet
Br (mg/L)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-83: South Marsh 3 Outlet
Br (mg/L)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-95: Ramona Lake Entrance
Br (mg/L)
Day of the Year
0
2
4
6
1
53
105
157
209
261
313
365


2006
DO-95: Ramona Lake Entrance
Br (mg/L)
Day of the Year
0
2
4
6
1
53
105
157
209
261
313
365


2007
DO-95: Ramona Lake Entrance
Br (mg/L)
Day of the Year
0
2
4
6
1
53
105
157
209
261
313
365

Temporal Plots of 2005-2007 Total Phosphorus Data from the Upstream San Joaquin River

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Remie Burks[1]
Sharon Borglin[1]
Randy Dahlgren[2]
Jeremy Hanlon[1]
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February 2008

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Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report includes temporal plots of total phosphorus (Tot-P) data analyzed by the EERP laboratory starting in late 2006.

Methods

Depth integrated field samples were colleted during 2005-2007 in the upper San Joaquin River in accordance with EERP Field Standard Operating Procedures Protocol Book (Graham 2008). Water samples were colleted in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN). Bottles were labeled with the appropriate sample number, site name and sampling date. All bottles were rinsed with sample water prior to sample collection. Some sites required a bucket to collect sample water because of accessibility from a high bridge or platform. For these sites, the bucket was pre-rinsed with sample water and sample bottles were filled using a rinsed funnel. Care was taken to distribute water simultaneously to all sample bottles (rather than sequentially). Samples were immediately stored at 4°C after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the EERP lab on the day of sampling.

Within 24 hours of collection samples were alquotted and stored at 4°C until Tot-P analysis could be completed.

Tot-P was determined on 5.0 mL of unfiltered sample by persulfate digestion and colorimetric determination by the ascorbic acid method adapted from SM 4500-P B, E (APHA, 2005). To digest samples equal parts of sample and digestion reagent (10 g potassium persulfate, 6 g boric acid, and 3 g NaOH in 1000mL Millipore water) were combined and samples were autoclaved in a Tuttnauer Brinkman autoclave (Westbury, NY). After digestion and sample cooling, the total phosphorus concentrations were determined spectrophotometrically using Hach PhosVer3 packets (Loveland, CO) on a PerkinElmer Lambda 35 UV/VIS Spectrometer (Shelton, CT). The limit of detection for this analysis was 0.06 mg/L Tot-P.

Results/Discussion

With each set of Tot-P field samples analyzed in the EERP laboratory, quality assurance samples including a lab duplicate, field duplicate, matrix spike, matrix spike duplicate, calibration check standards, laboratory control standard, trip blank, and lab blanks were also analyzed. Between 2005 and 2007, 100% of all quality assurance samples were within a passing range (Borglin et al, 2008). Proficiency check samples, standards with unknown concentration to the laboratory analyst, were run approximately twice a year. Two proficiency check samples were analyzed for Tot-P in the EERP laboratory during 2006 and 2007, and both of these samples were found to be within the acceptable range. Samples were measured ranging from 0.0-5.06 mg/L Tot-P. The average concentration of Tot-P in samples collected was 0.32 mg/L Tot-P. Tot-P was also analyzed at UC Davis on all of the same water samples and has a high correlation to values measured by EERP. When all data points measured by the two labs are compared they have r^2=0.951 (Fiugre 2). EERP measured 89.1% as much Tot-P as UCD (Figure 2).

One problem that occurred with this analysis is dissolved ortho-phosphate-phosphorus (PO_4-P) values were sometimes found to be slightly higher then the measured total phosphorus (Total P) values. When this happened one or both of these analyses were re-run. This problem occurred most often in samples with high PO_4-P and Tot-P which required dilutions. Because of this problem all PO_4-P and TP dilutions are now run in triplicate to reduce the potential for dilution errors. These temporal plots (Figures 3-104) as well as plotting EERP data against UCD's data (Figure 2) created an easy visual way to find outliers and double check data entry for possible mistakes. For the purpose of these plots any data points that were slightly negative were changed to 0.

References

American Public Health Association (APHA). 2005. Standard Methods for the Examination of Water and Wastewater, 21st Edition. American Public Health Association, Washington, DC.

Borglin, S., W. Stringfellow, J. Hanlon. 2005. Standard Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project. LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA

Borglin, S.E., Burks, R.D., Hanlon, J.S., Stringfellow, W.T. (2008) EERP Lab Protocol Book, University of the Pacific, Stockton, CA.

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008) EERP Field Protocol Book, University of the Pacific, Stockton, CA.

Stringfellow, W.T., et al., (2008) Evaluation of Vegitated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley, University of the Pacific, Stockton, CA

YSI Environmental Operations Manual (2005) 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

Table 1: EERP Sampling Site List

DO Number	Site Name	Type
4	SJR at Mossdale	Core sites
5	SJR at Vernalis-McCune Station (River Club)	Core sites, BMP
6	SJR at Maze	Core sites, BMP
7	SJR at Patterson	Core sites, BMP
8	SJR at Crows Landing	Core sites, BMP
10	SJR at Lander Avenue	Core sites
12	Stanislaus River at Caswell Park	Core sites
14	Tuolumne River at Shiloh Bridge	Core sites
16	Merced River at River Road	Core sites
18	Mud Slough near Gustine	Core sites, Wetland
19	Salt Slough at Lander Avenue	Core sites, Wetland
20	Los Banos Creek Flow Station	Core sites, Wetland
21	Orestimba Creek at River Road	Core sites, BMP
23	Modesto ID Lateral 5 to Tuolumne	Core sites
25	Modesto ID Main Drain to Stan. R. via Miller Lake	Core sites
28	Turlock ID Westport Drain Flow station	Core sites
29	Turlock ID Harding Drain	Core sites
30	Turlock ID Lateral 6 & 7 at Levee	Core sites
33	Hospital Creek	Intermittent, BMP
34	Ingram Creek	Core sites, BMP
36	Del Puerto Creek Flow Station	Core sites, BMP
44	San Luis Drain End	Core sites
53	Salt Slough at Wolfsen Road	Wetland
57	Ramona Lake Drain	Core sites, BMP
59	SJR Laird Park	Core sites
60	Moffit 1 South	Wetland
61	Deadman's Slough	Wetland
62	Mallard Slough	Wetland
63	Inlet C Canal	Wetland
80	South Marsh-1-Inlet	Wetland
81	South Marsh-1-Outlet	Wetland
82	South Marsh-3-Inlet	Wetland
83	South Marsh-3-Outlet	Wetland
95	Ramona drain at Ramona Lake	BMP, Intermittent

Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

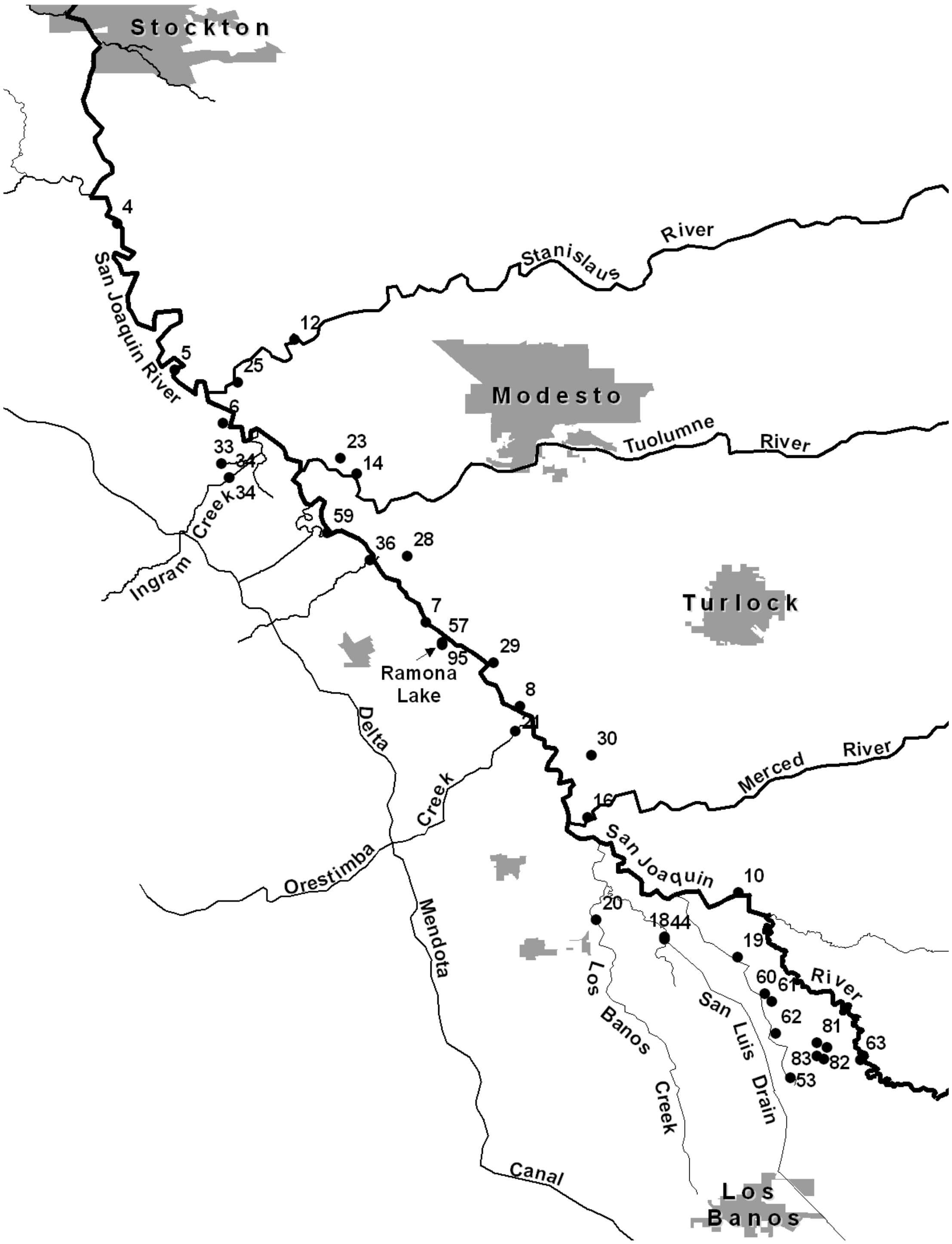
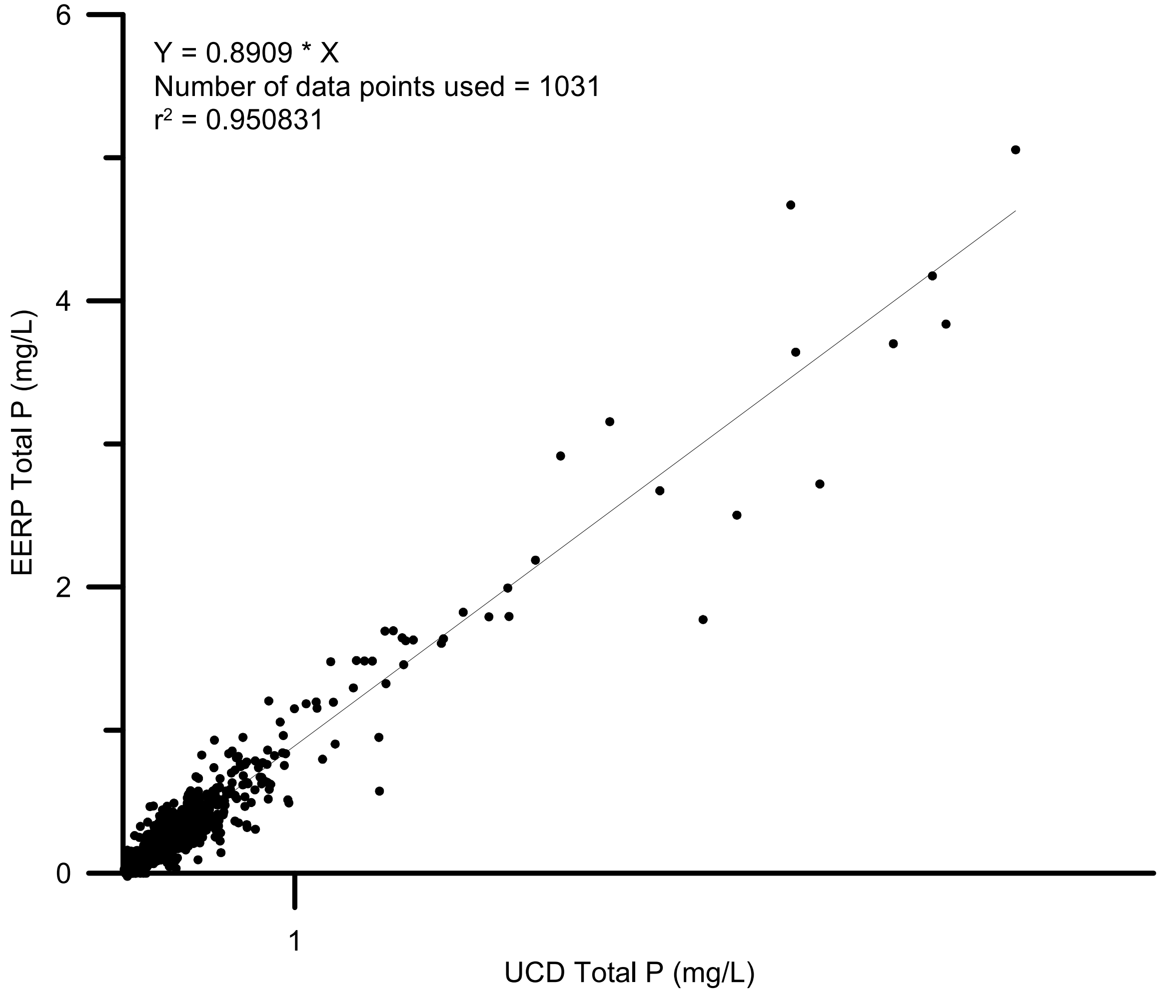
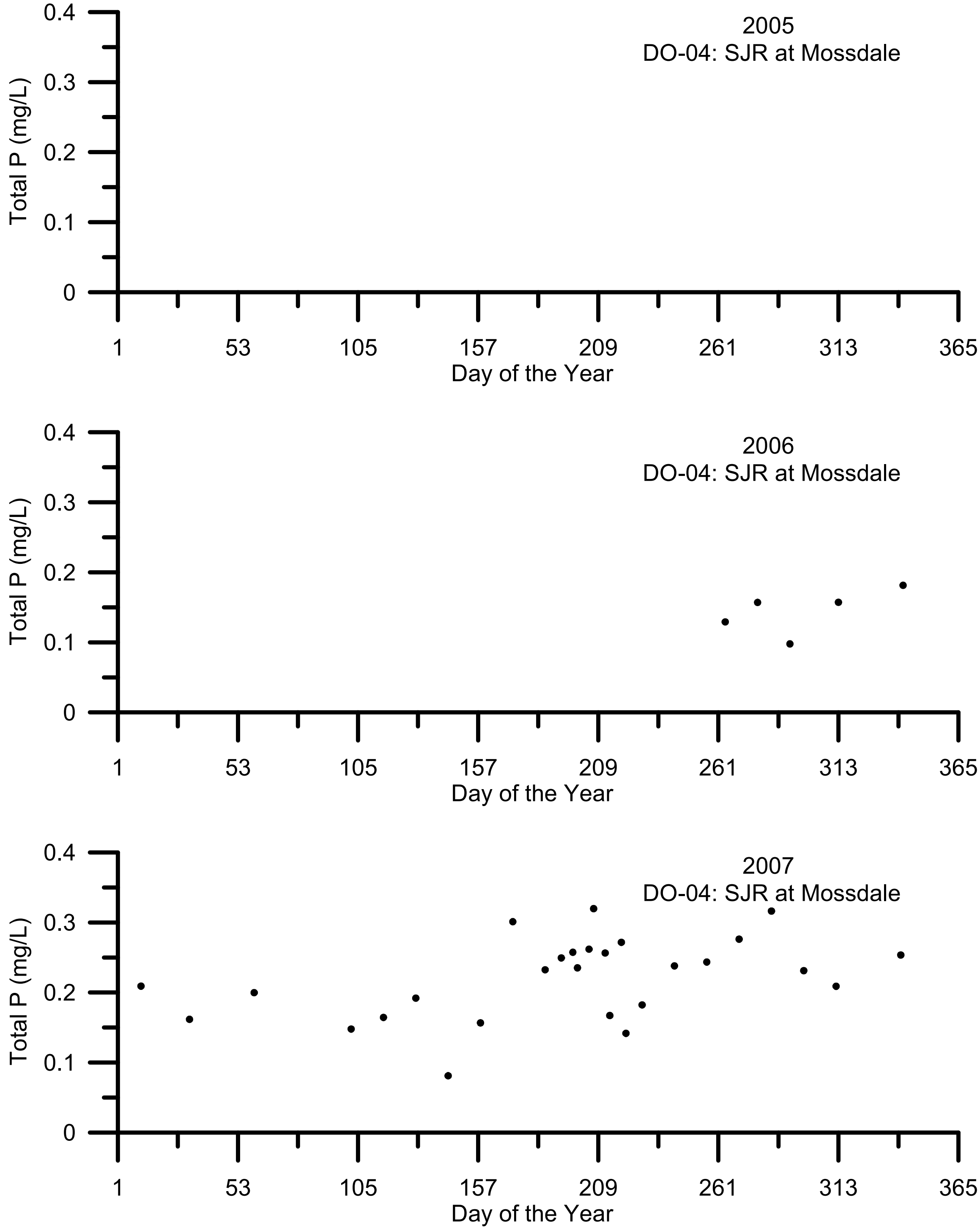
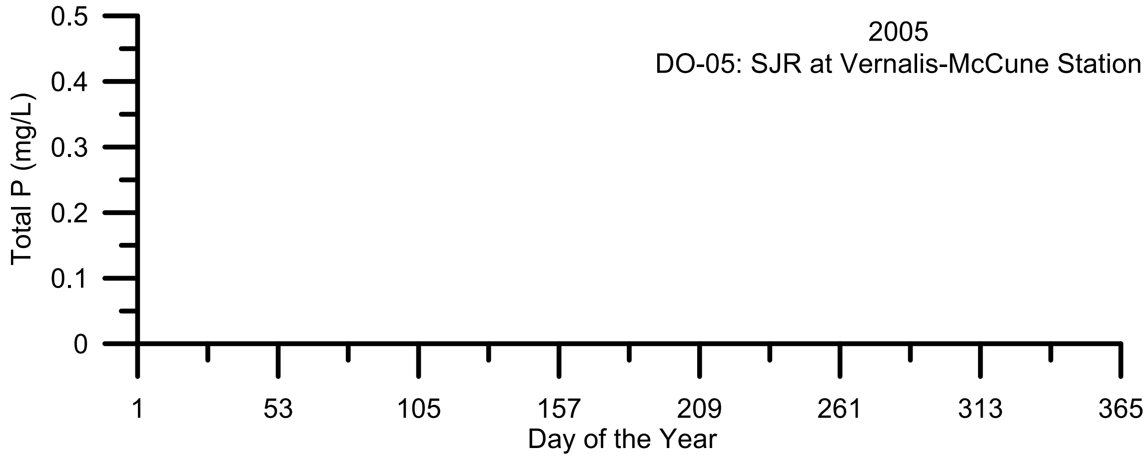


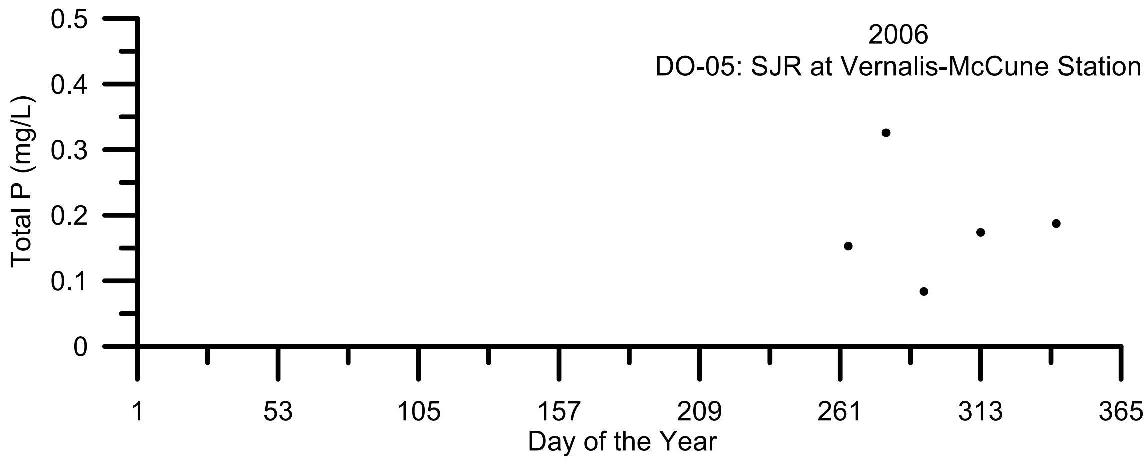
Figure 2: EERP vs UCD Total P Data 2006-2007

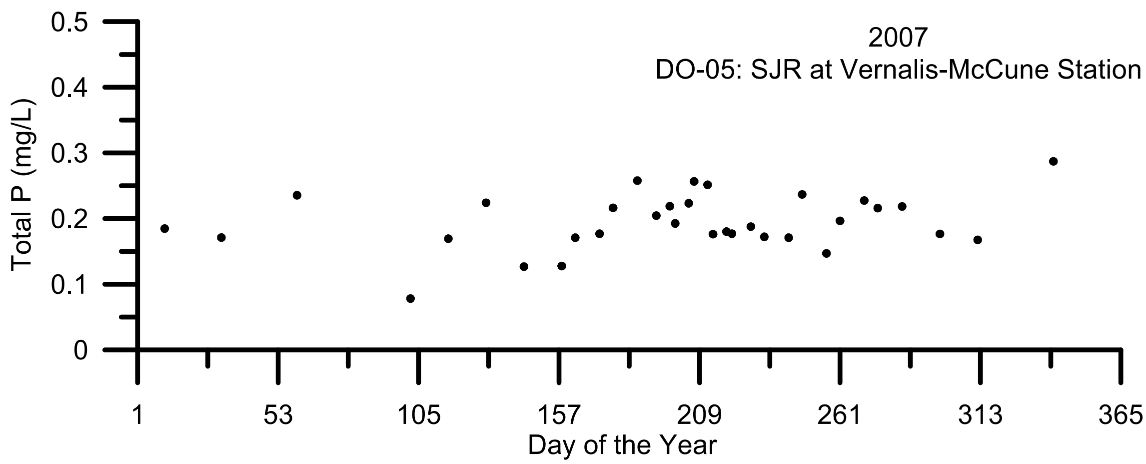


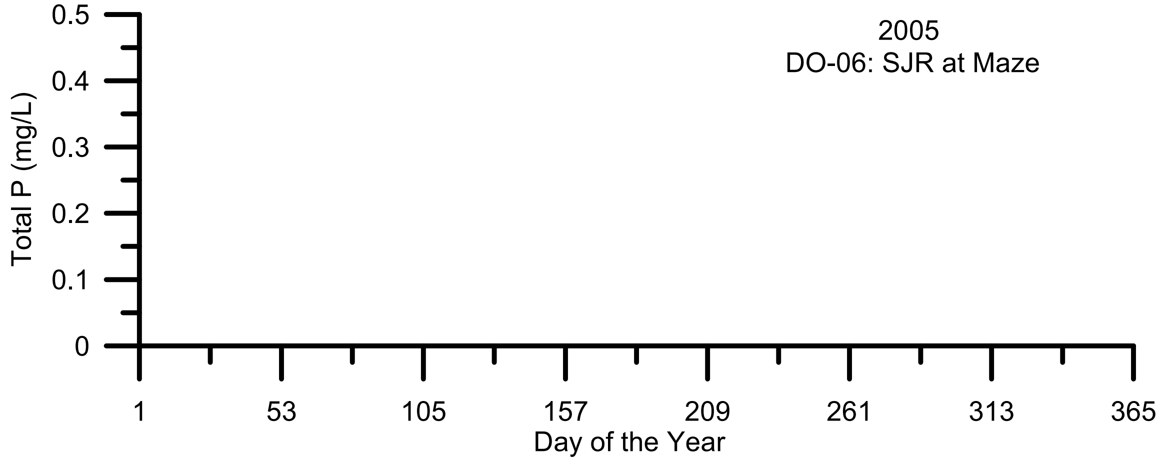
Figures 3 -104: Temporal Plots of Total Phosphorus By Site ID

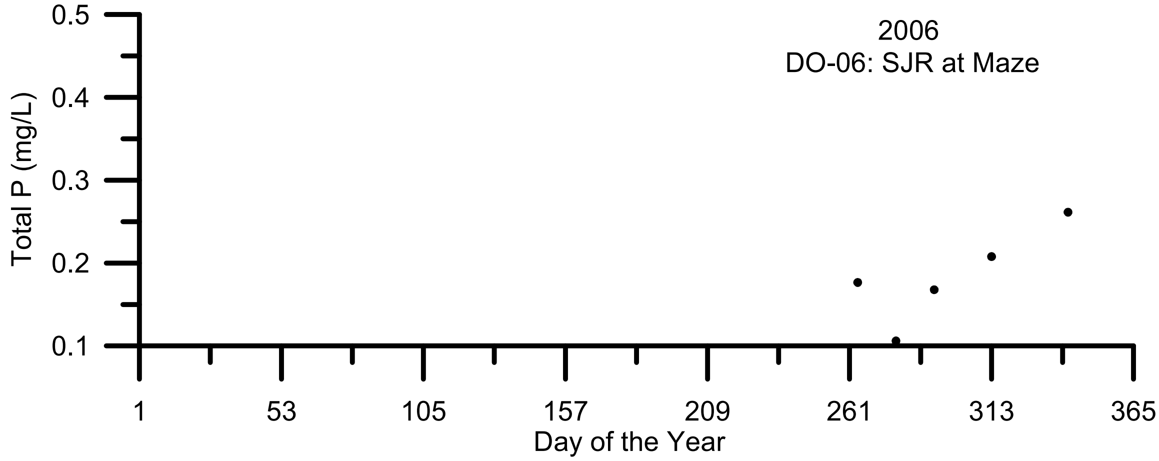


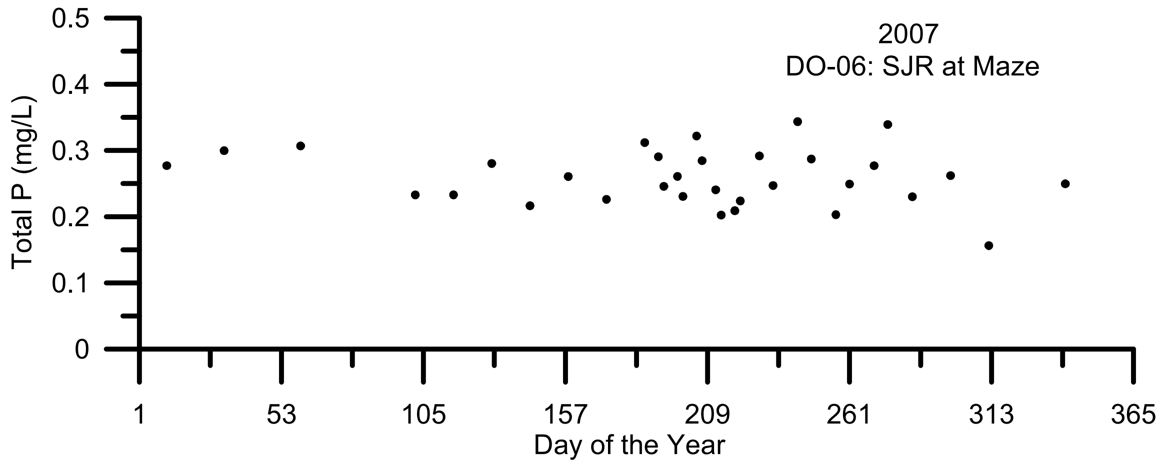

2005
DO-05: SJR at Vernalis-McCune Station
Total P (mg/L)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

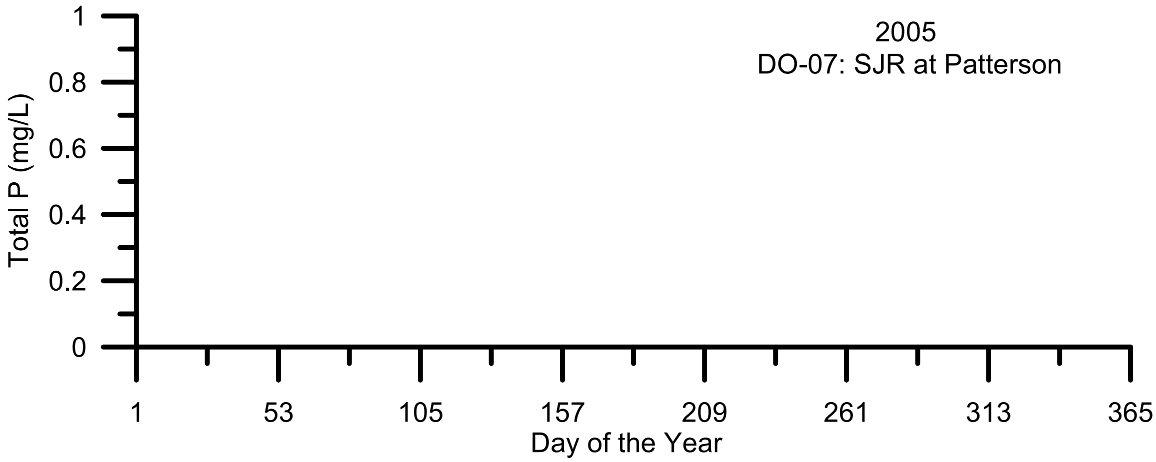

2006
DO-05: SJR at Vernalis-McCune Station
Total P (mg/L)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

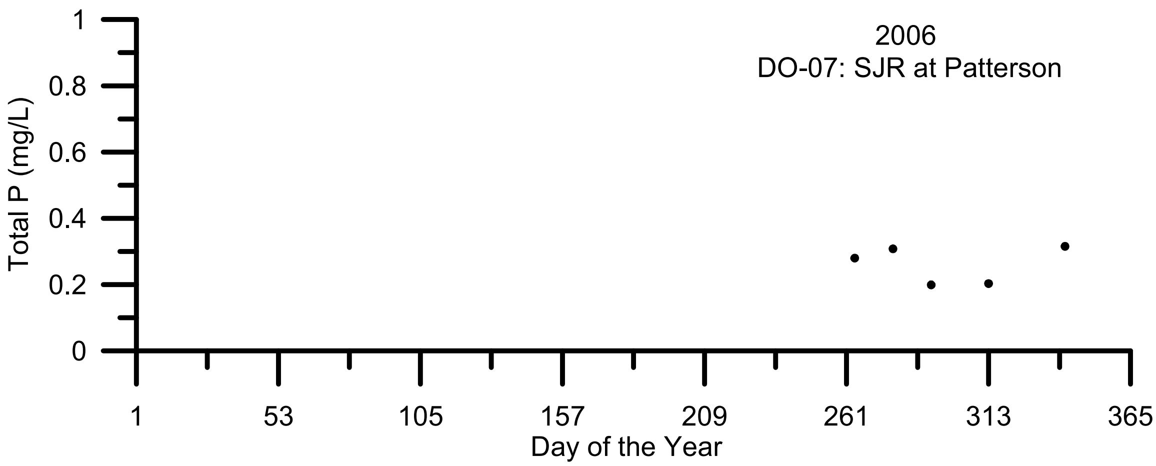

2007
DO-05: SJR at Vernalis-McCune Station
Total P (mg/L)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

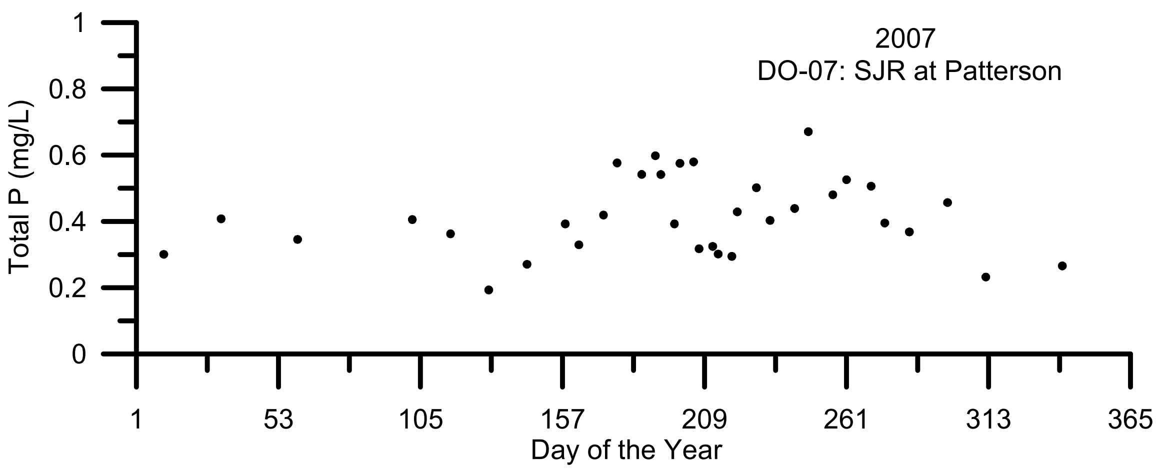

2005
DO-06: SJR at Maze
Total P (mg/L)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

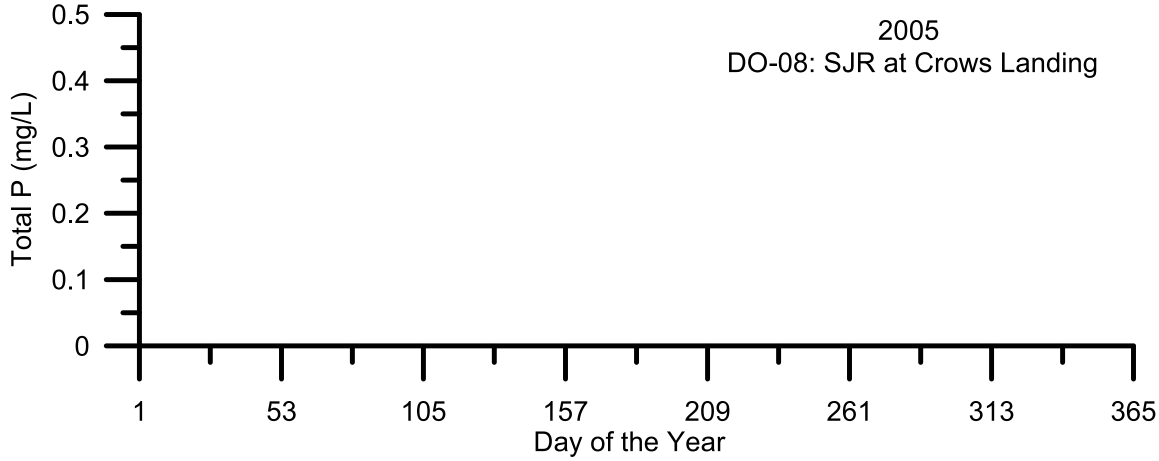

2006
DO-06: SJR at Maze
Total P (mg/L)
0.5
0.4
0.3
0.2
0.1
1
53
105
157
209
261
313
365
Day of the Year

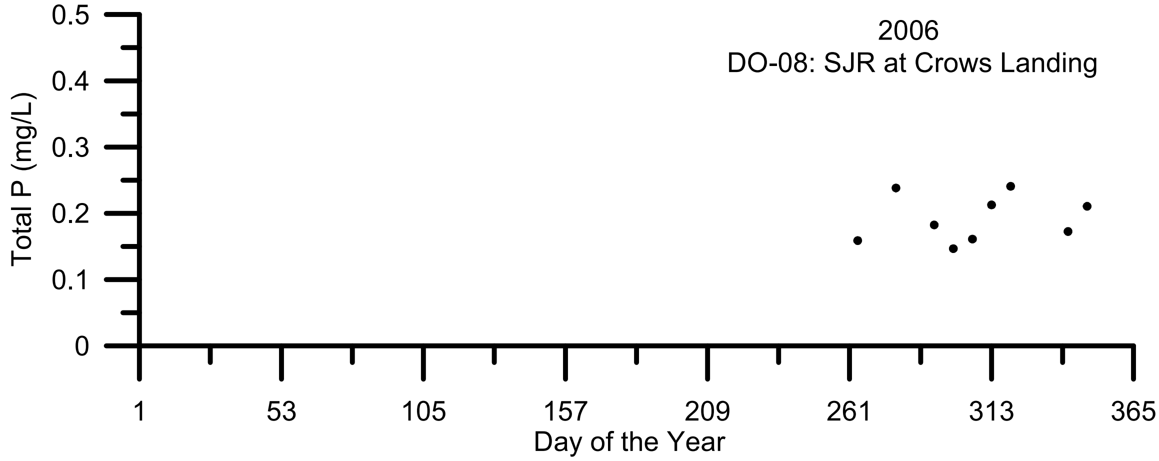

2007
DO-06: SJR at Maze
Total P (mg/L)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

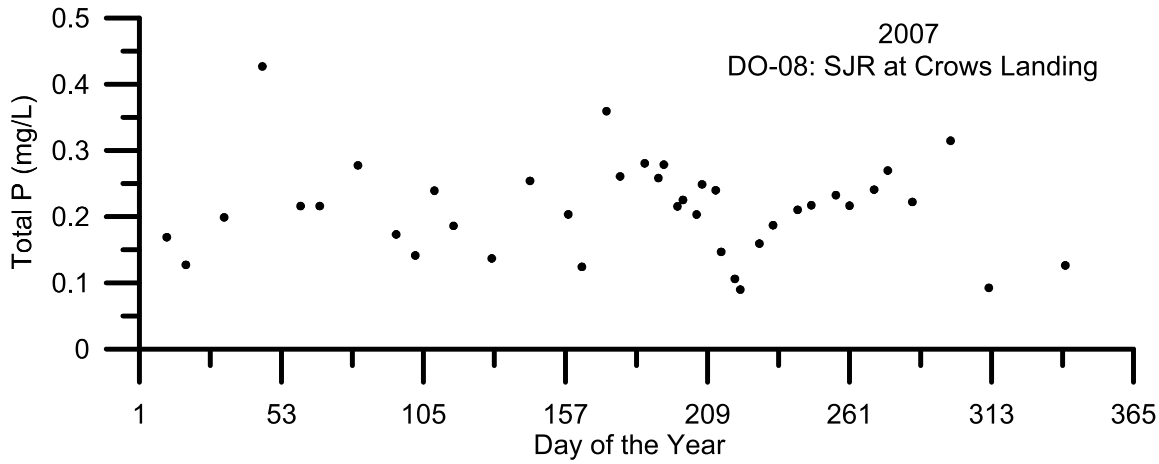

2005
DO-07: SJR at Patterson
Total P (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

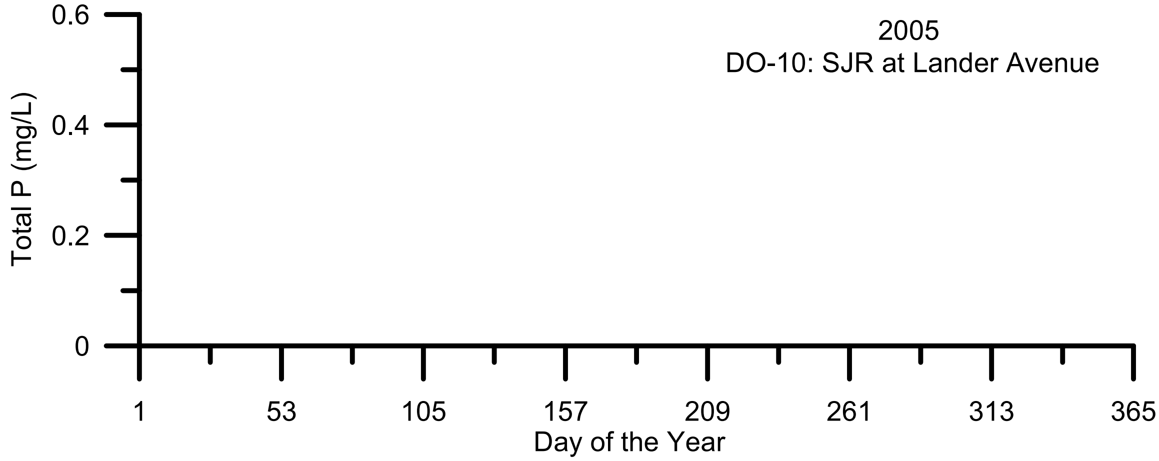

2006
DO-07: SJR at Patterson
Total P (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

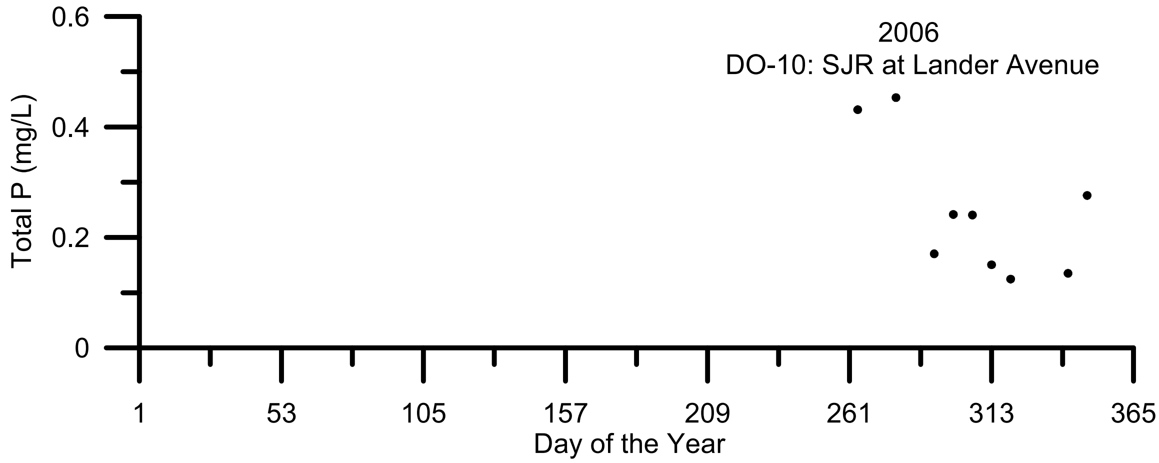

2007
DO-07: SJR at Patterson
Total P (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

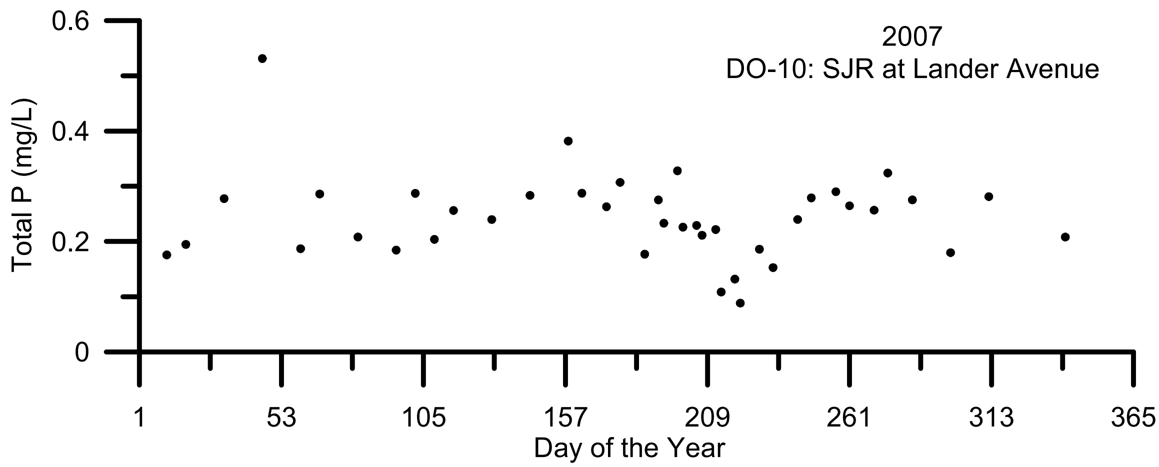

2005
DO-08: SJR at Crows Landing
Total P (mg/L)
Day of the Year

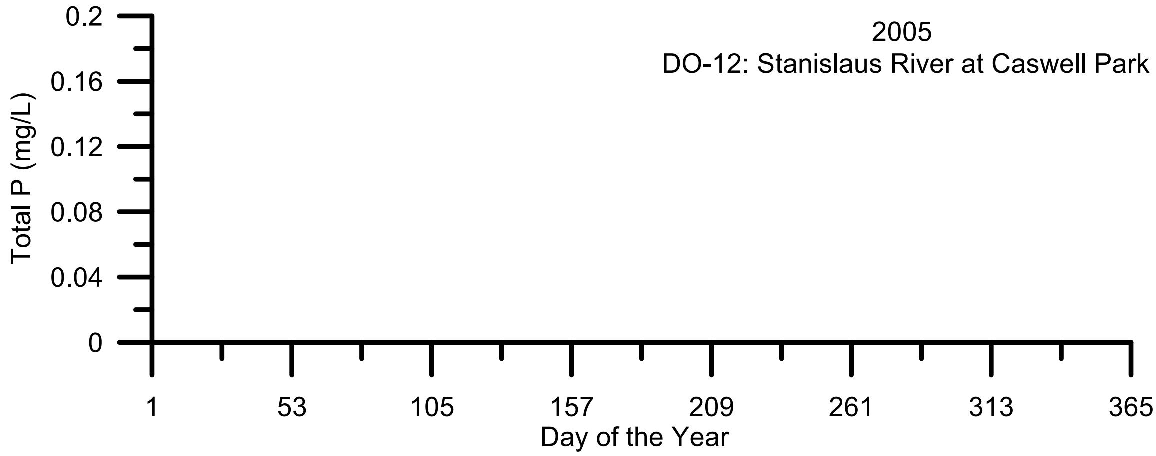

2006
DO-08: SJR at Crows Landing
Total P (mg/L)
Day of the Year

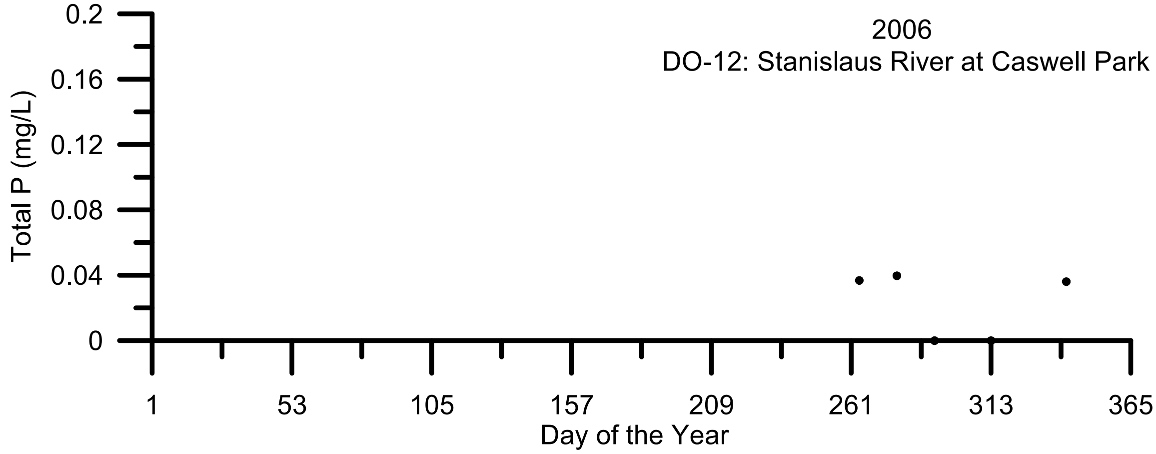

2007
DO-08: SJR at Crows Landing
Total P (mg/L)
Day of the Year

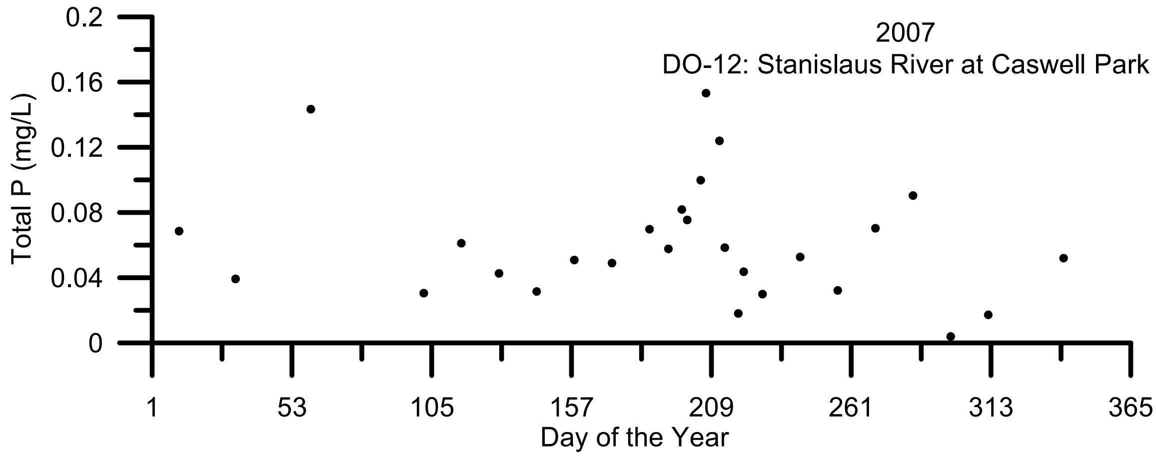

2005
DO-10: SJR at Lander Avenue
Total P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

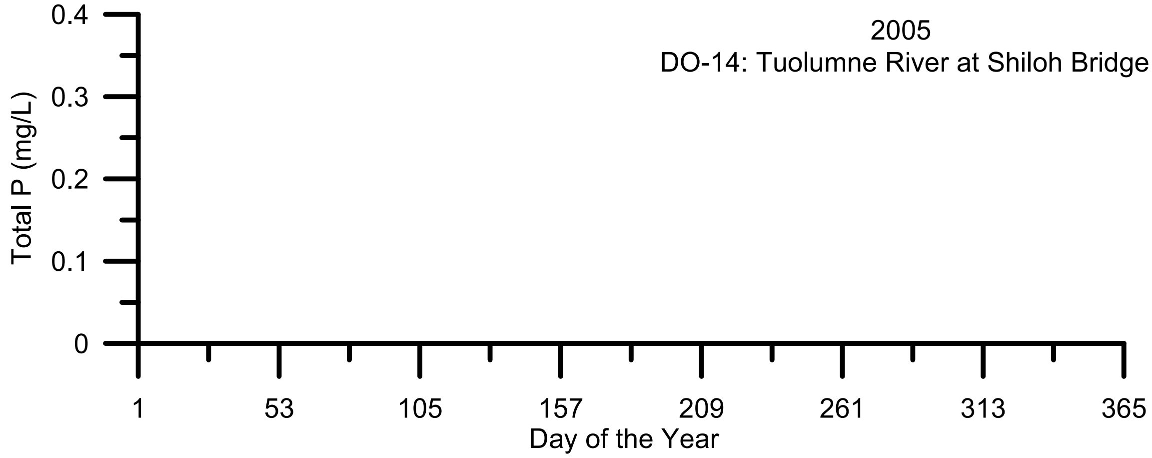

2006
DO-10: SJR at Lander Avenue
Total P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

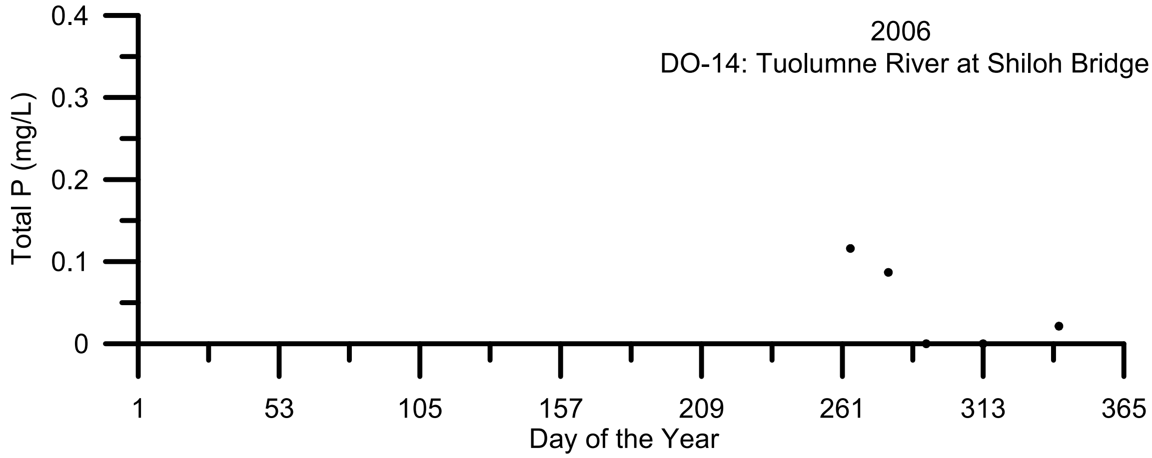

2007
DO-10: SJR at Lander Avenue
Total P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

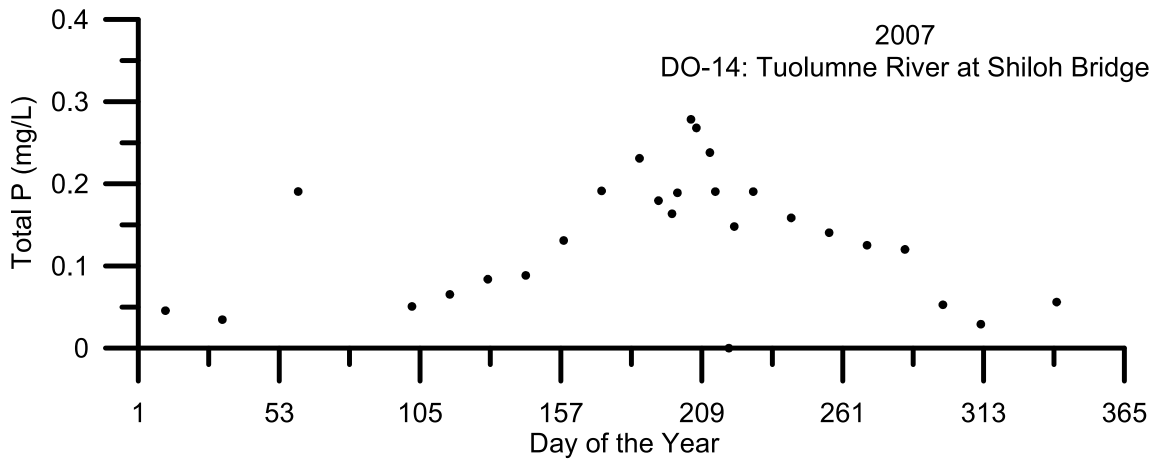

2005
DO-12: Stanislaus River at Caswell Park
Total P (mg/L)
0.2
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

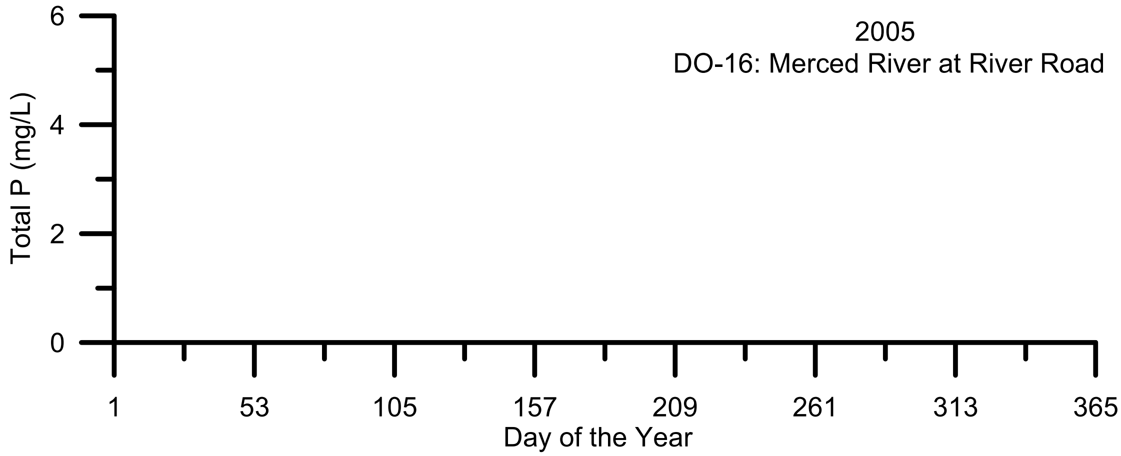

2006
DO-12: Stanislaus River at Caswell Park
Total P (mg/L)
0.2
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

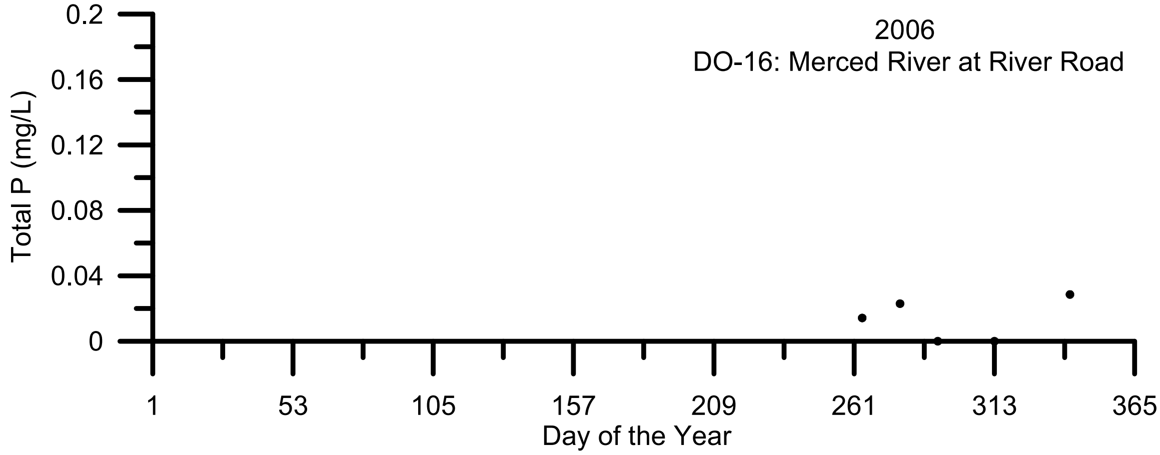

2007
DO-12: Stanislaus River at Caswell Park
Total P (mg/L)
0.2
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

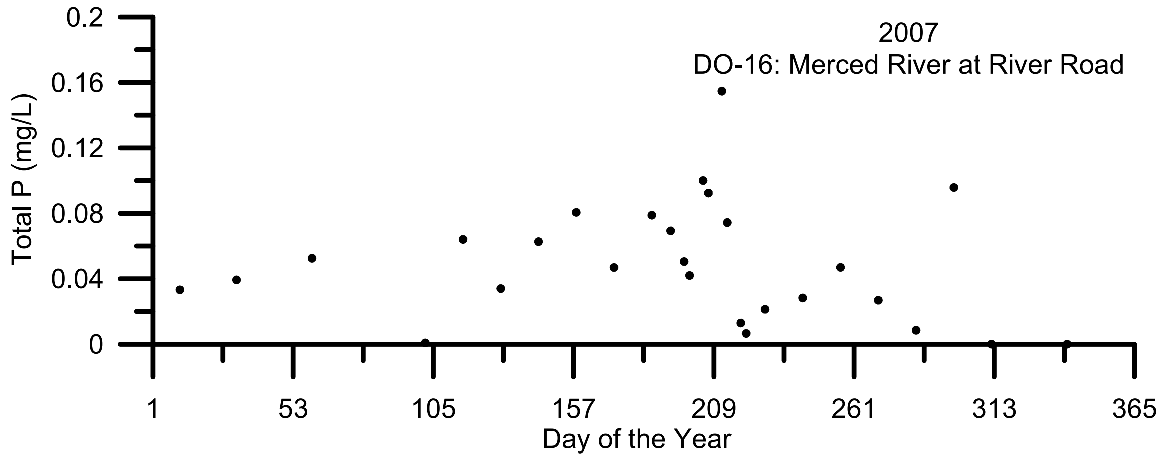

2005
DO-14: Tuolumne River at Shiloh Bridge
Total P (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

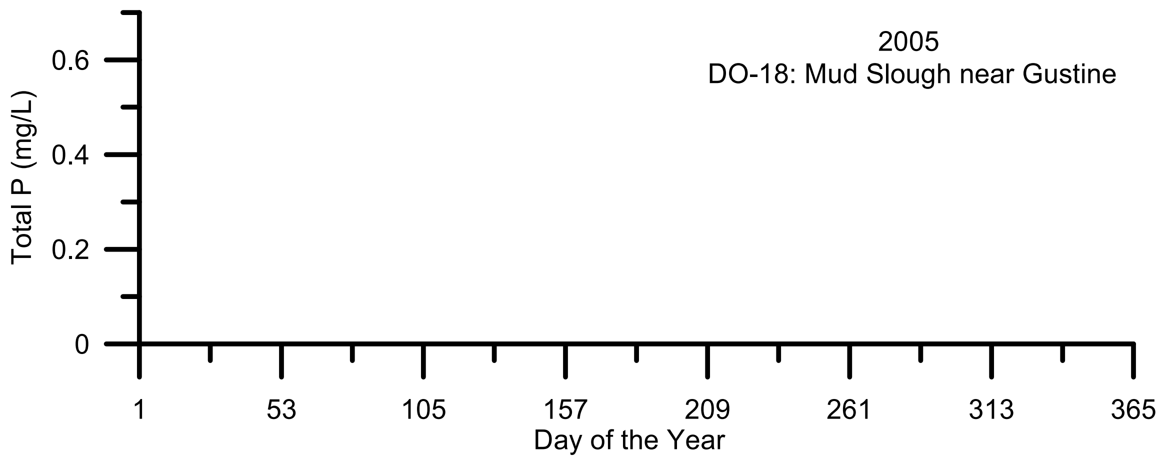

2006
DO-14: Tuolumne River at Shiloh Bridge
Total P (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

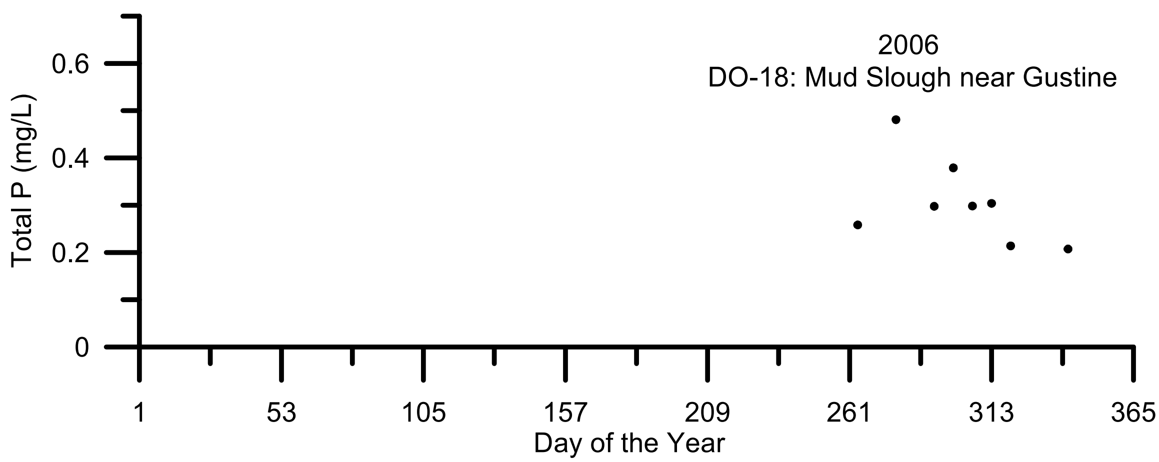

2007
DO-14: Tuolumne River at Shiloh Bridge
Total P (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

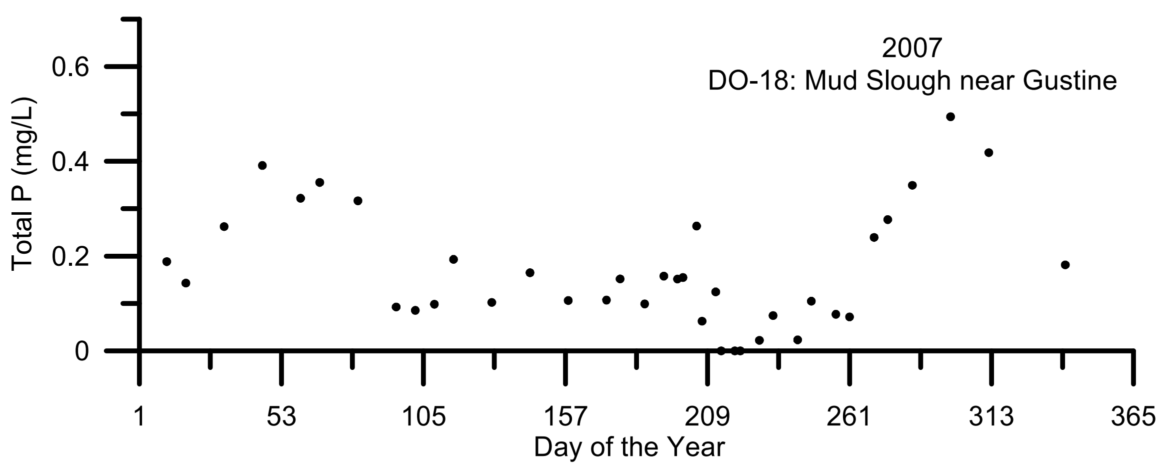

2005
DO-16: Merced River at River Road
Total P (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

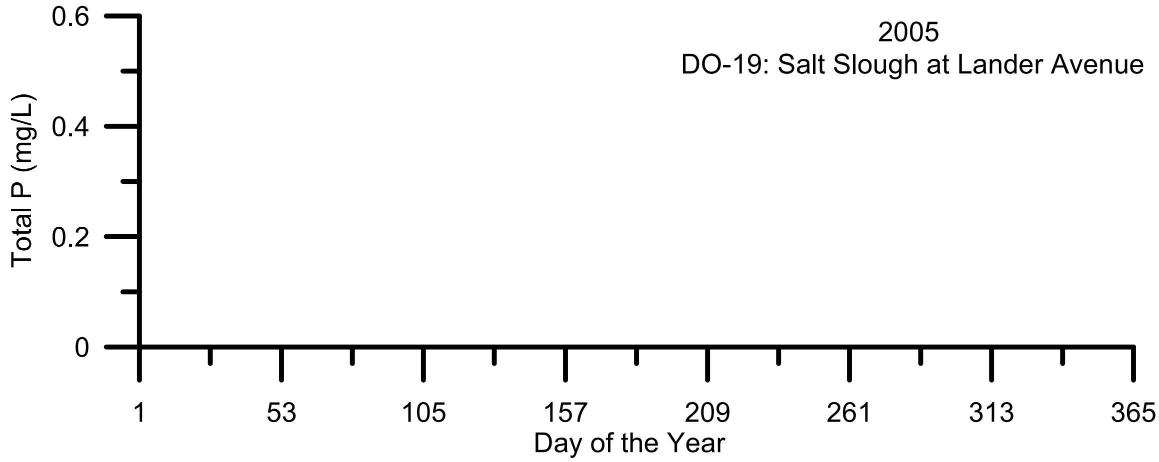

2006
DO-16: Merced River at River Road
Total P (mg/L)
0
0.04
0.08
0.12
0.16
0.2
1
53
105
157
209
261
313
365
Day of the Year

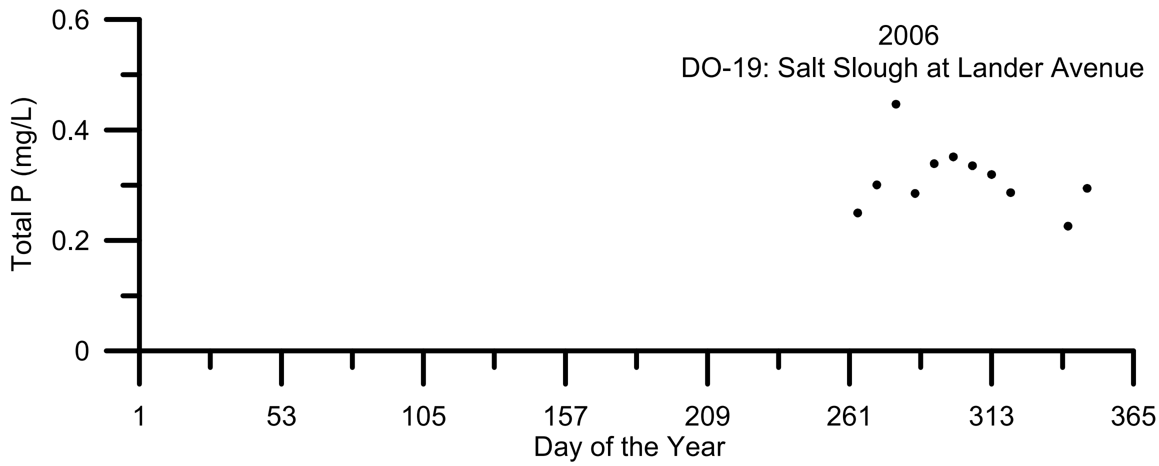

2007
DO-16: Merced River at River Road
Total P (mg/L)
0
0.04
0.08
0.12
0.16
0.2
1
53
105
157
209
261
313
365
Day of the Year

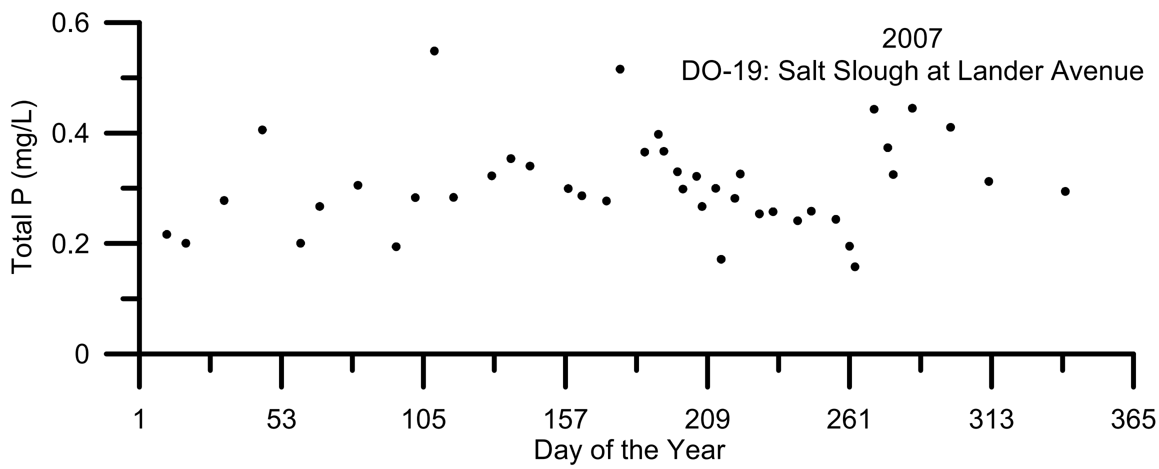

2005
DO-18: Mud Slough near Gustine
Total P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

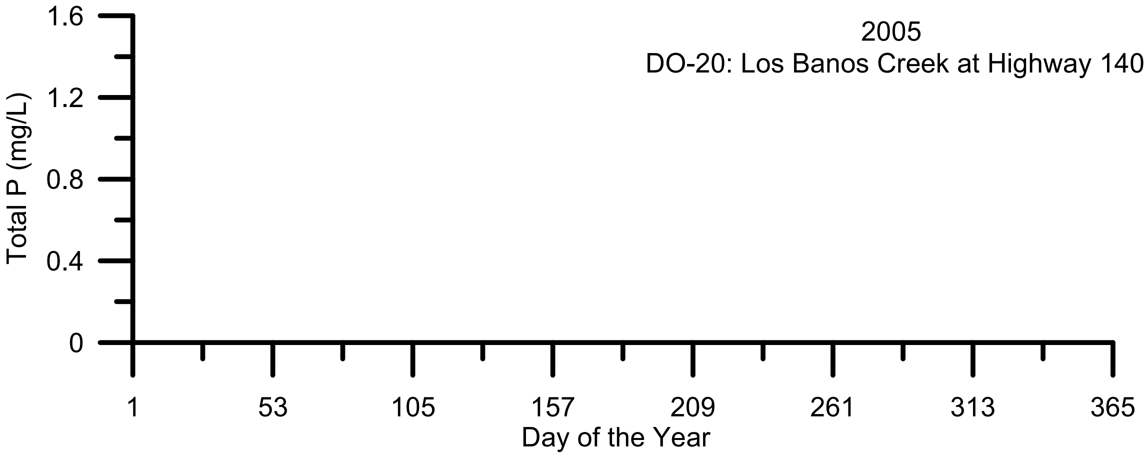

2006
DO-18: Mud Slough near Gustine
Total P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

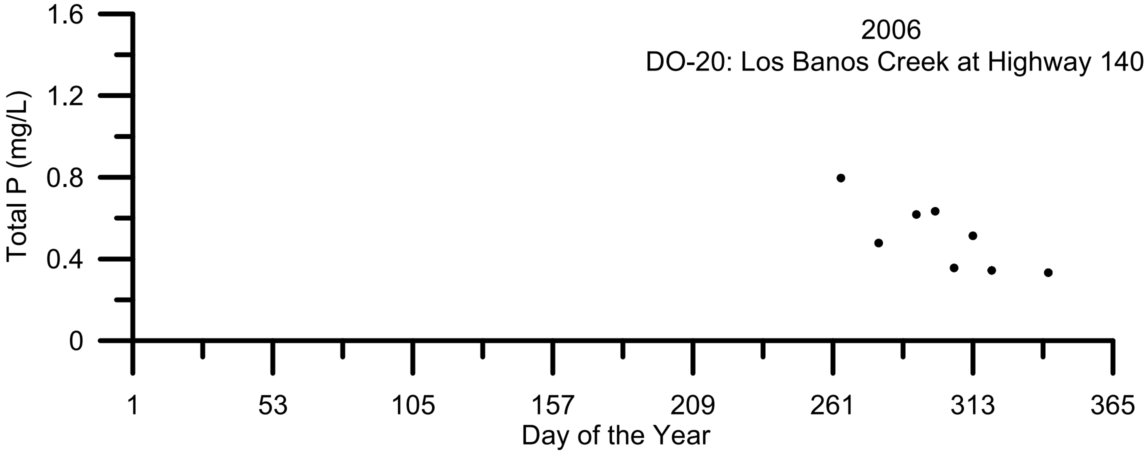

2007
DO-18: Mud Slough near Gustine
Total P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

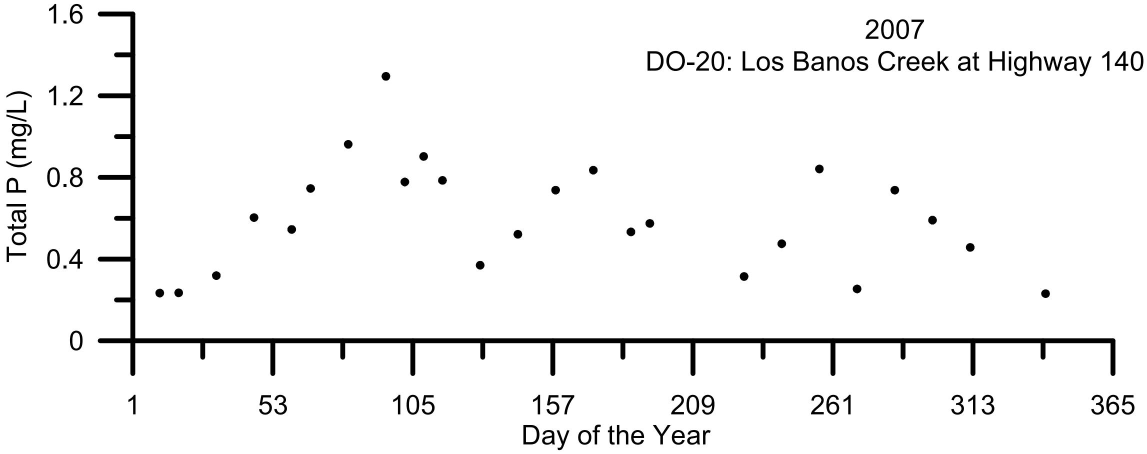

2005
DO-19: Salt Slough at Lander Avenue
Total P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

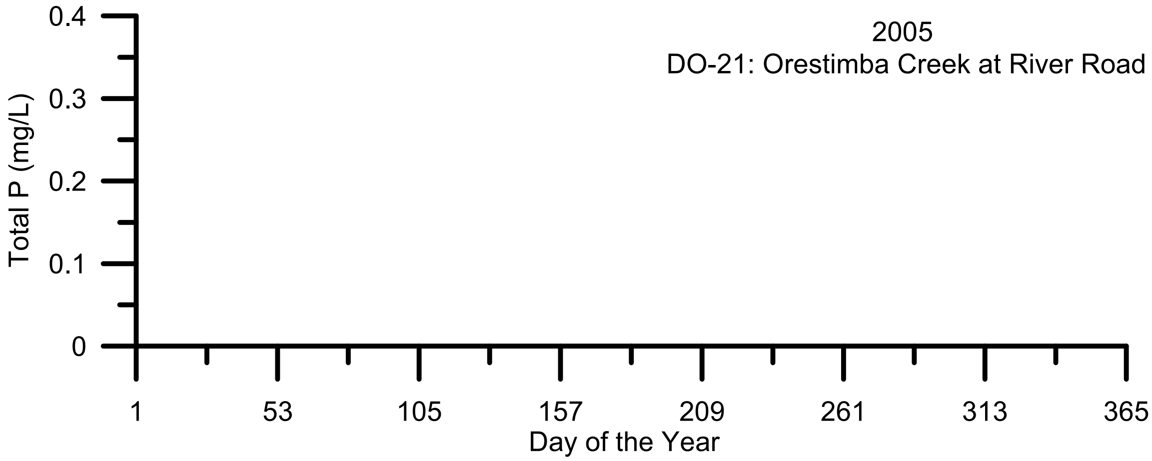

2006
DO-19: Salt Slough at Lander Avenue
Total P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

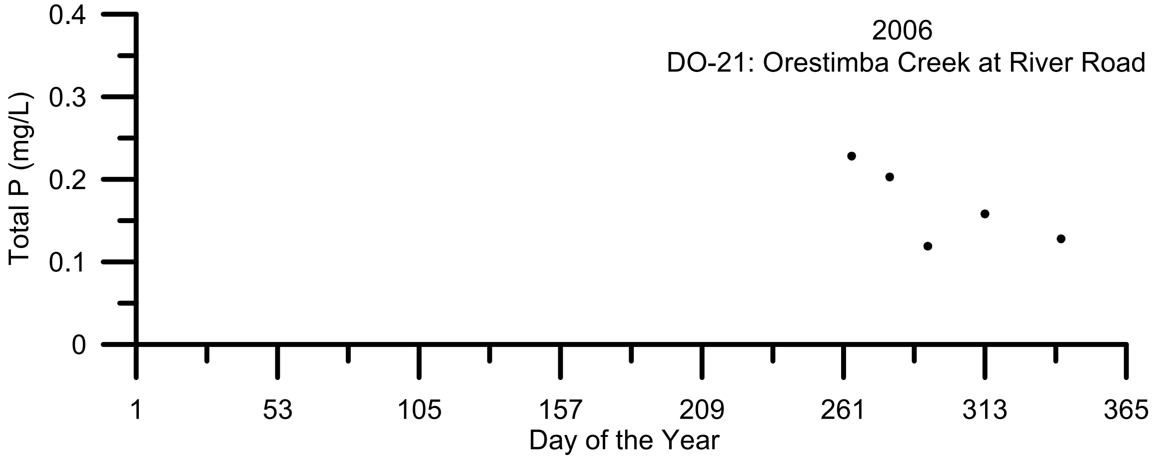

2007
DO-19: Salt Slough at Lander Avenue
Total P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

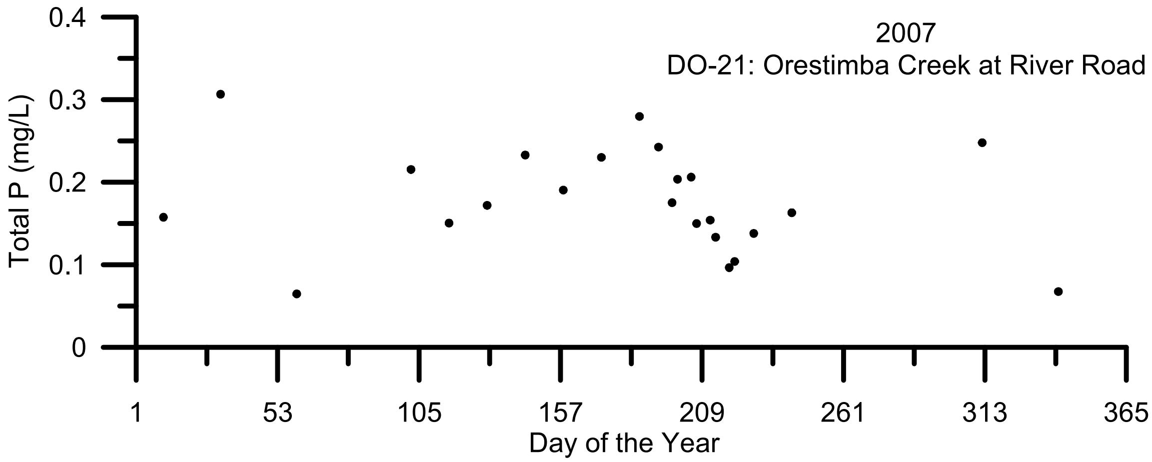

2005
DO-20: Los Banos Creek at Highway 140
Total P (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

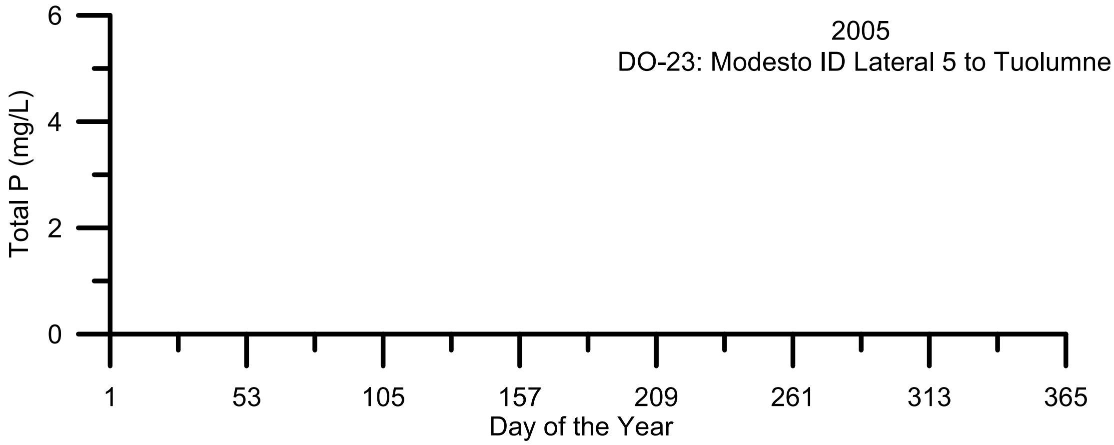

2006
DO-20: Los Banos Creek at Highway 140
Total P (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

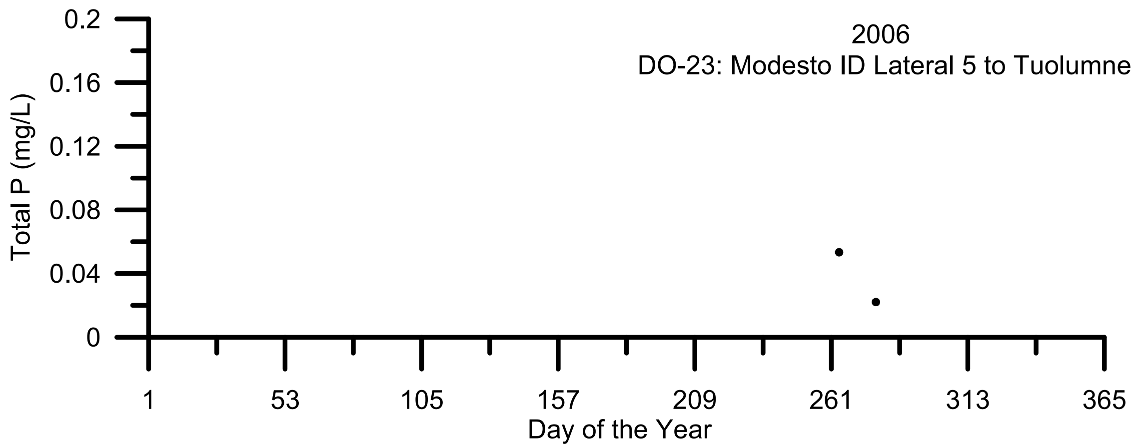

2007
DO-20: Los Banos Creek at Highway 140
Total P (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

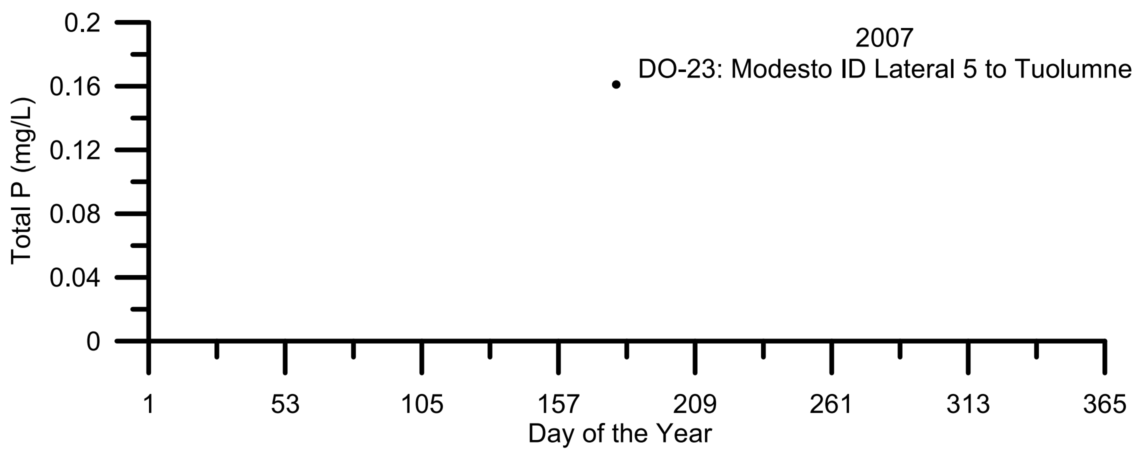

2005
DO-21: Orestimba Creek at River Road
Total P (mg/L)
0
0.1
0.2
0.3
0.4
1
53
105
157
209
261
313
365
Day of the Year

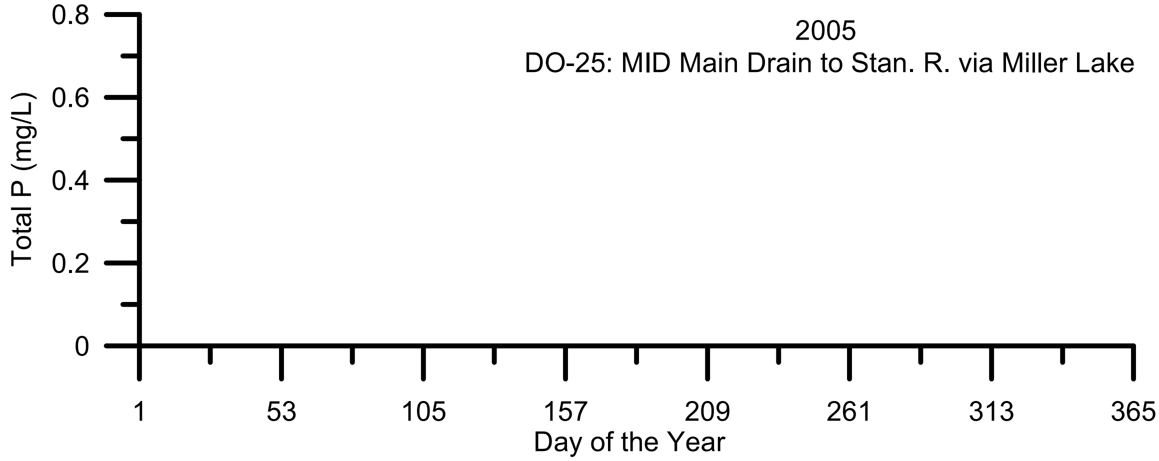

2006
DO-21: Orestimba Creek at River Road
Total P (mg/L)
0
0.1
0.2
0.3
0.4
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-21: Orestimba Creek at River Road
Total P (mg/L)
0
0.1
0.2
0.3
0.4
1
53
105
157
209
261
313
365
Day of the Year

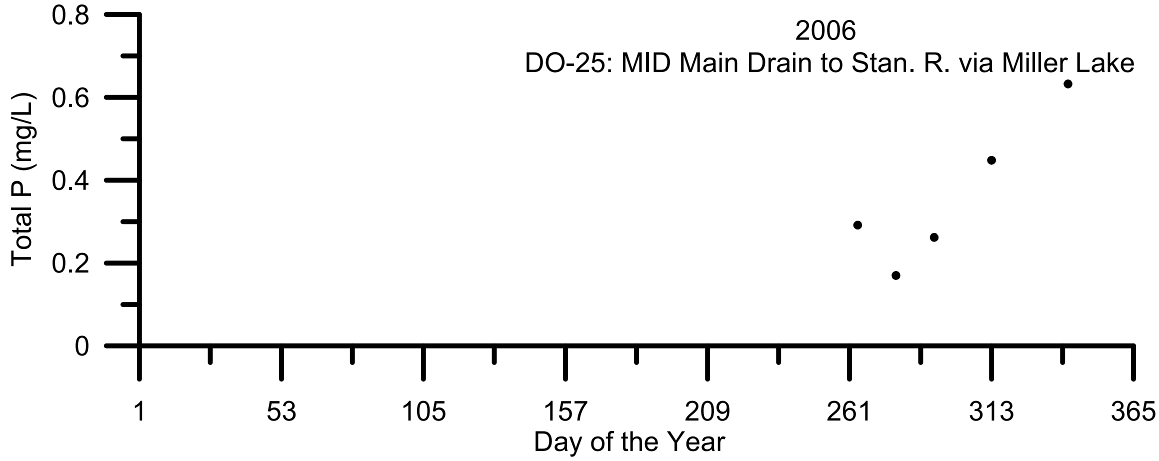

2005
DO-23: Modesto ID Lateral 5 to Tuolumne
Total P (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-23: Modesto ID Lateral 5 to Tuolumne
Total P (mg/L)
0
0.04
0.08
0.12
0.16
0.2
1
53
105
157
209
261
313
365
Day of the Year

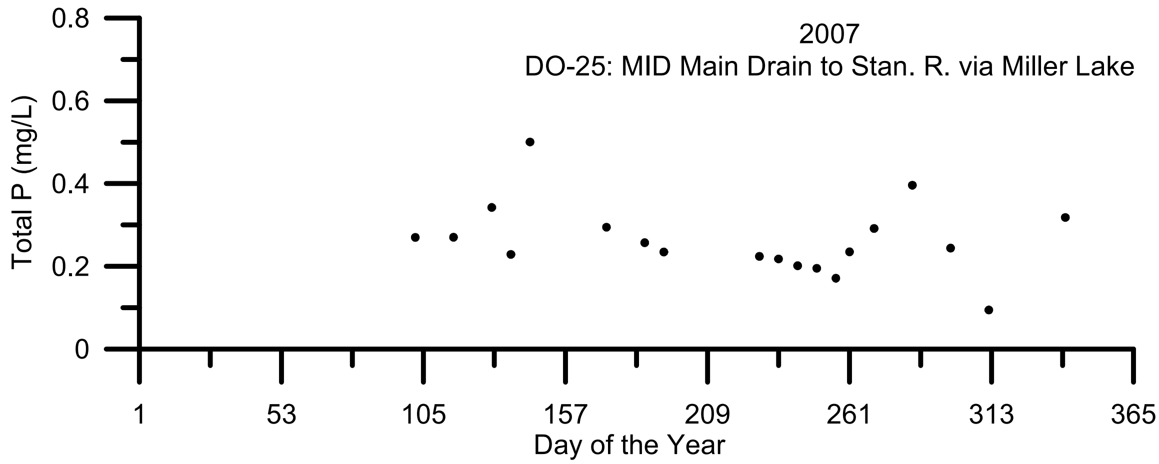

2007
DO-23: Modesto ID Lateral 5 to Tuolumne
Total P (mg/L)
0
0.04
0.08
0.12
0.16
0.2
1
53
105
157
209
261
313
365
Day of the Year



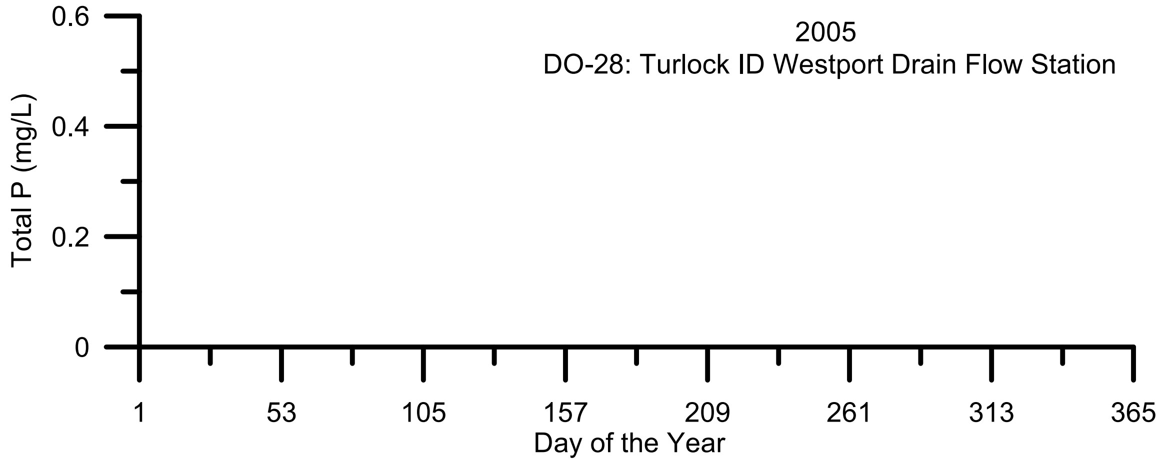
0.8
0.6
0.4
0.2
0
Total P (mg/L)
2005
DO-25: MID Main Drain to Stan. R. via Miller Lake
1
53
105
157
209
261
313
365
Day of the Year

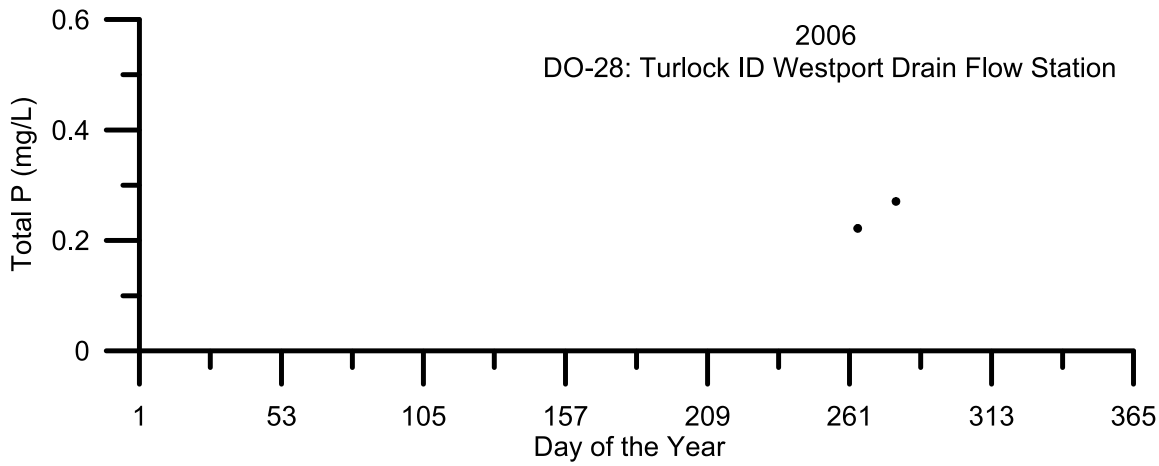


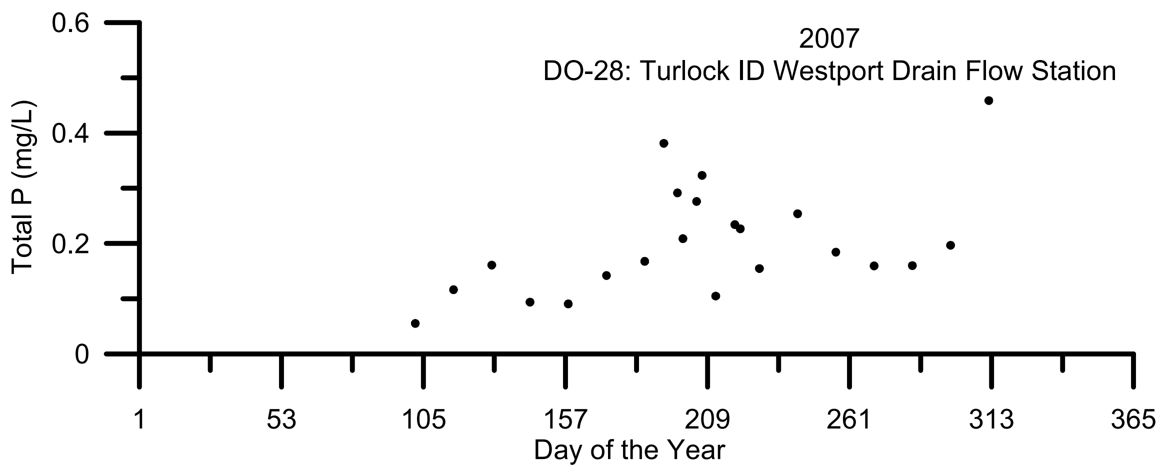
0.8
0.6
0.4
0.2
0
Total P (mg/L)
2006
DO-25: MID Main Drain to Stan. R. via Miller Lake
1
53
105
157
209
261
313
365
Day of the Year

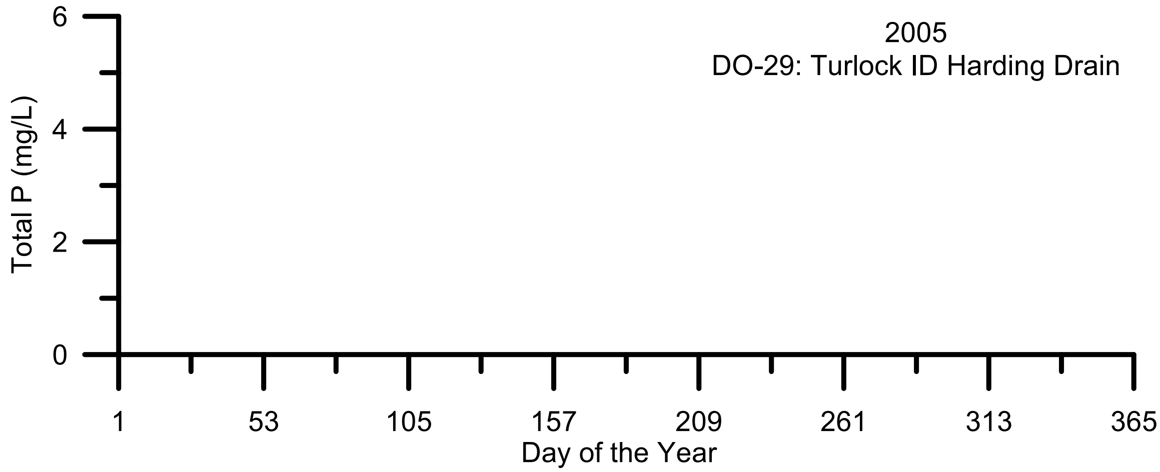


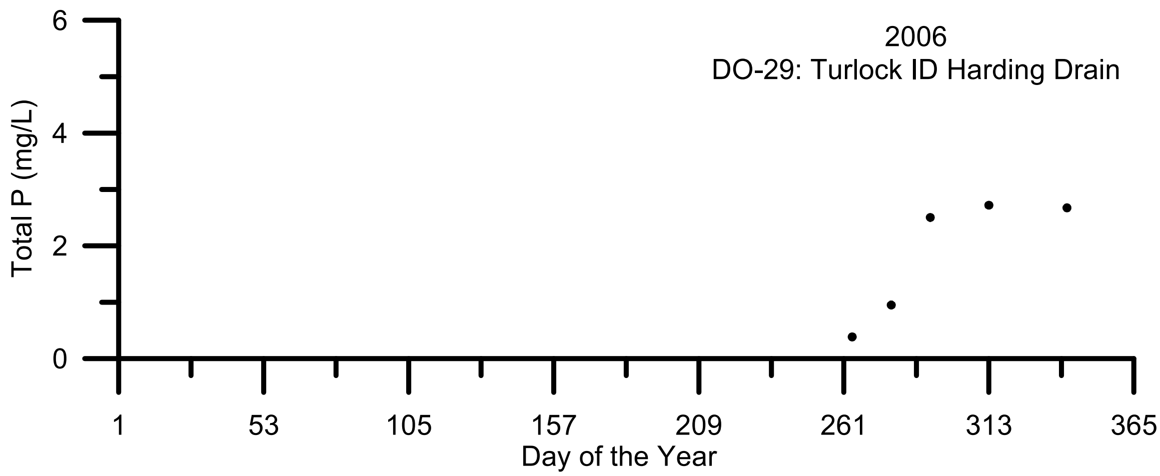
0.8
0.6
0.4
0.2
0
Total P (mg/L)
2007
DO-25: MID Main Drain to Stan. R. via Miller Lake
1
53
105
157
209
261
313
365
Day of the Year

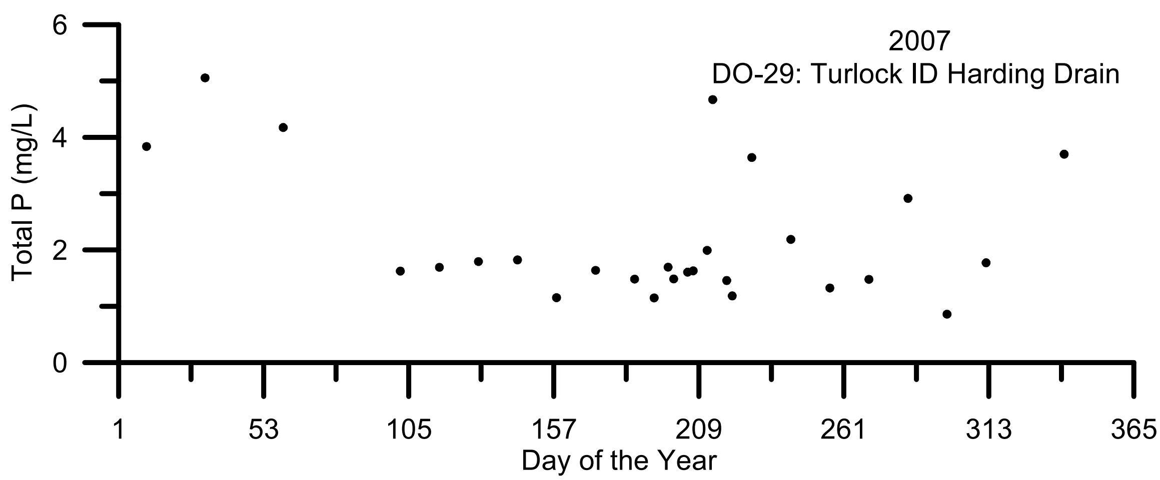

2005
DO-28: Turlock ID Westport Drain Flow Station
Total P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

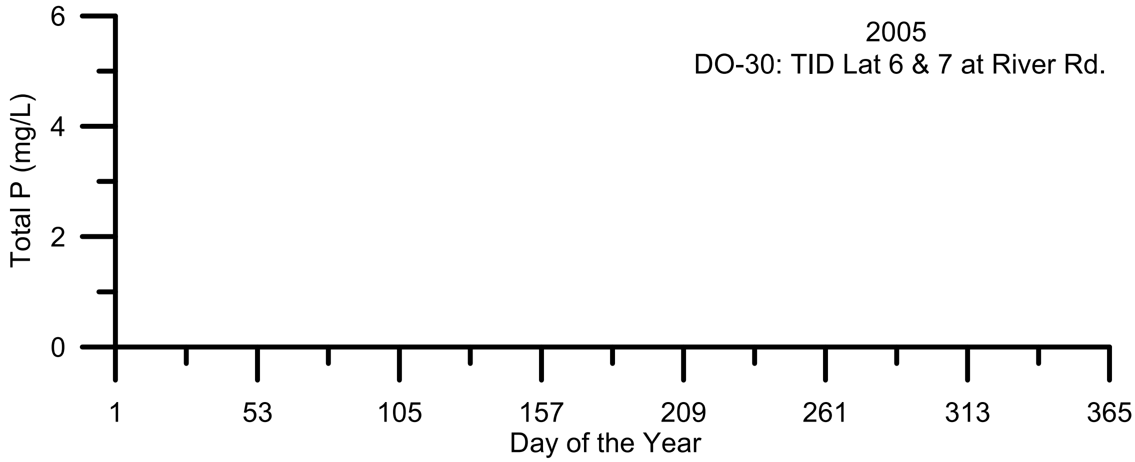

2006
DO-28: Turlock ID Westport Drain Flow Station
Total P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

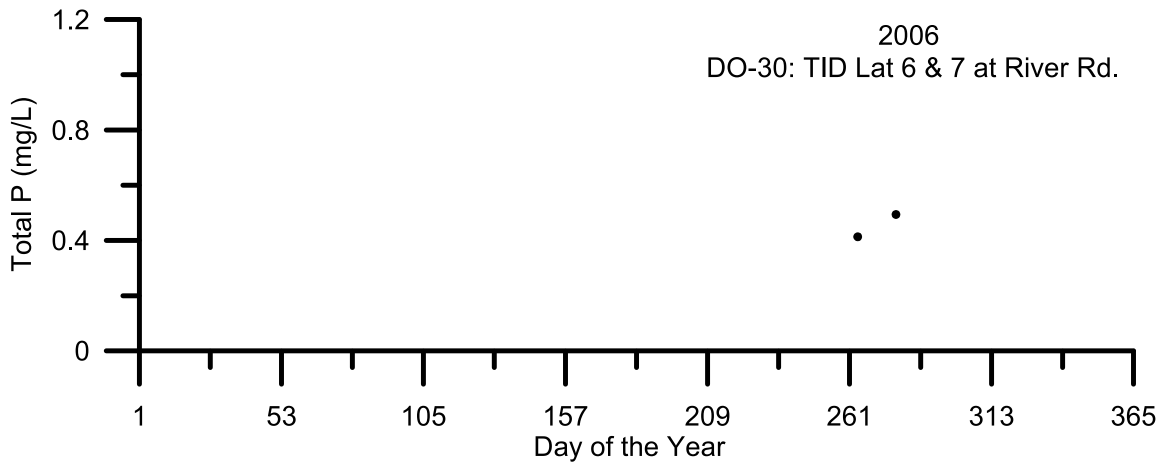

2007
DO-28: Turlock ID Westport Drain Flow Station
Total P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

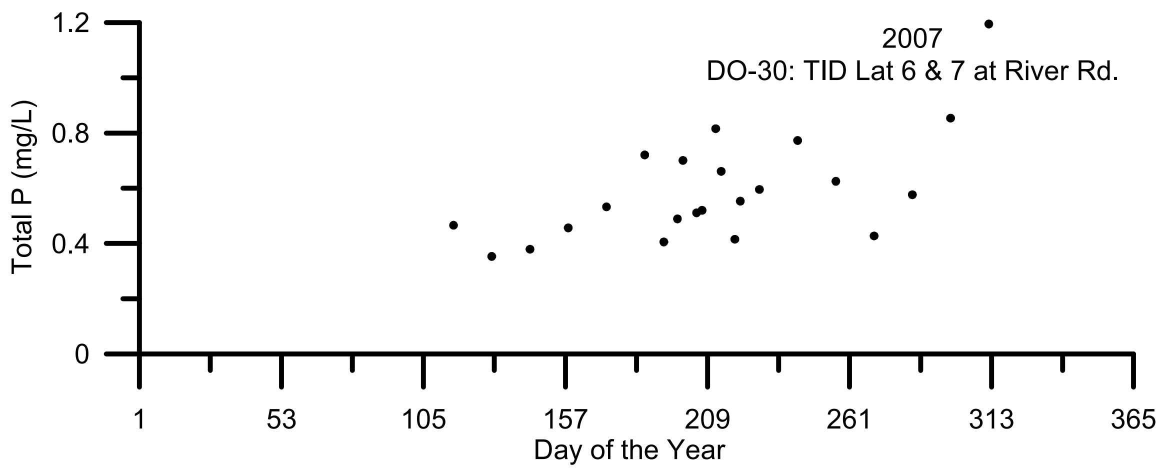

2005
DO-29: Turlock ID Harding Drain
Total P (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

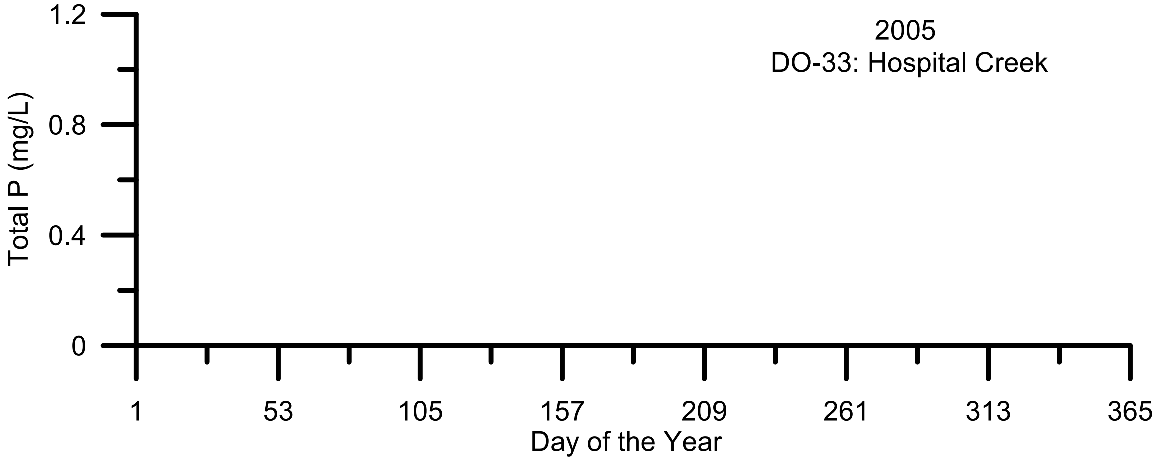

2006
DO-29: Turlock ID Harding Drain
Total P (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

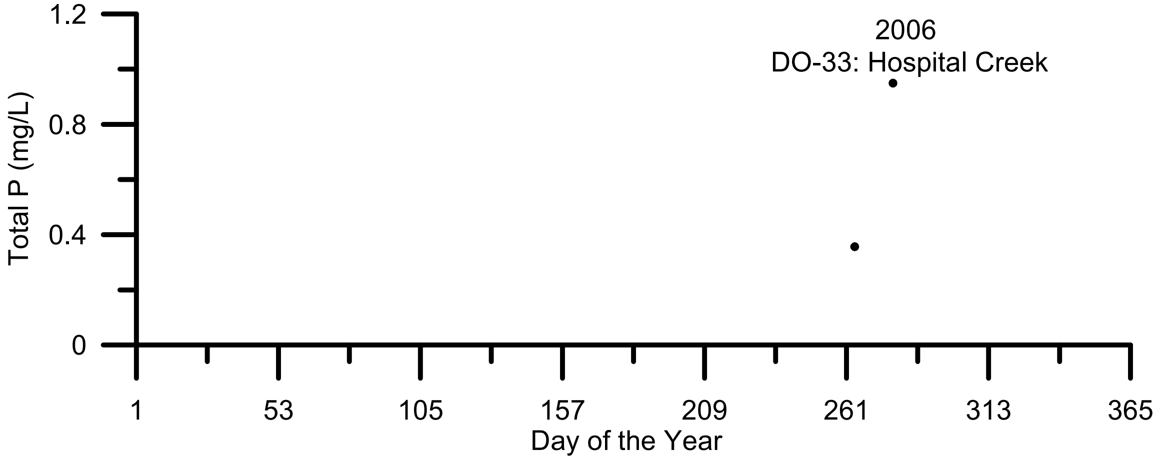

2007
DO-29: Turlock ID Harding Drain
Total P (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

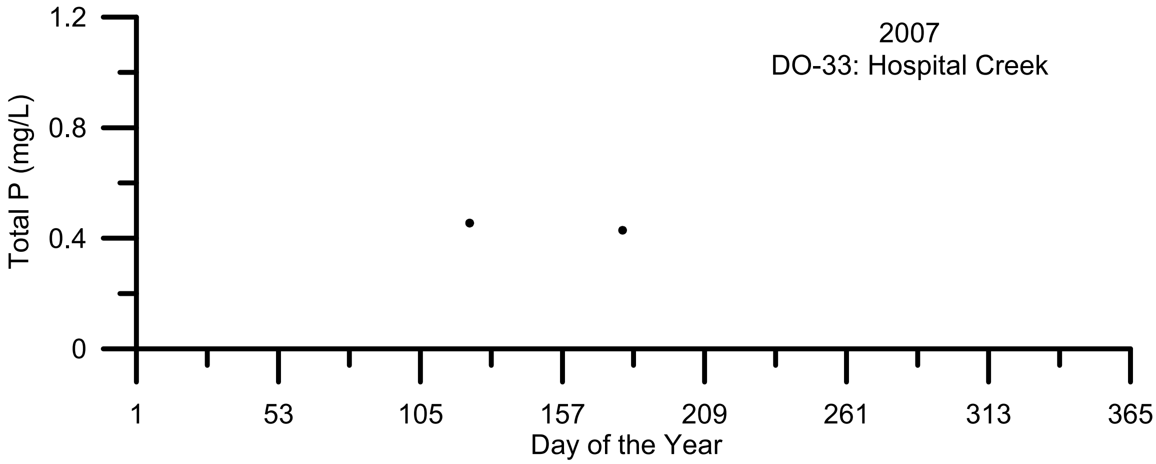

6
4
2
0
Total P (mg/L)
2005
DO-30: TID Lat 6 & 7 at River Rd.
1
53
105
157
209
261
313
365
Day of the Year

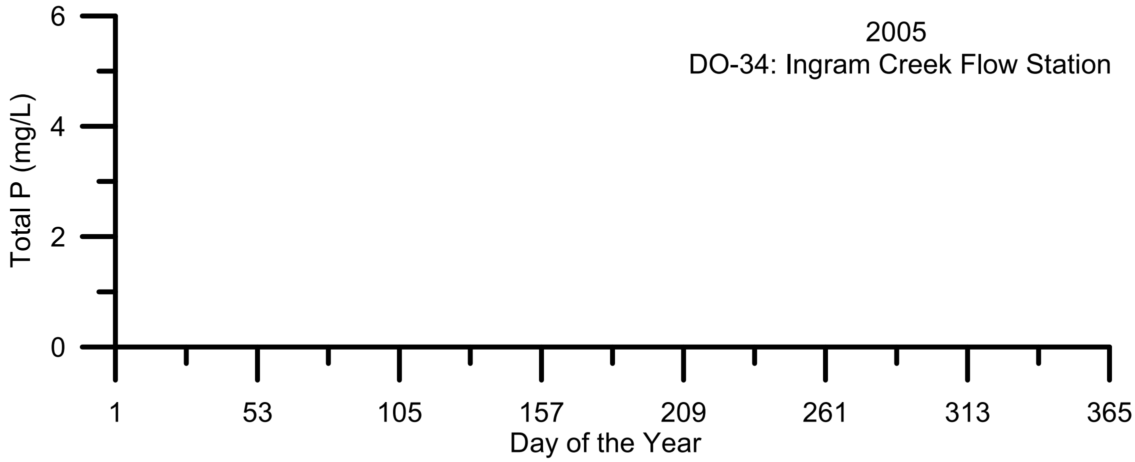

1.2
0.8
0.4
0
Total P (mg/L)
2006
DO-30: TID Lat 6 & 7 at River Rd.
1
53
105
157
209
261
313
365
Day of the Year

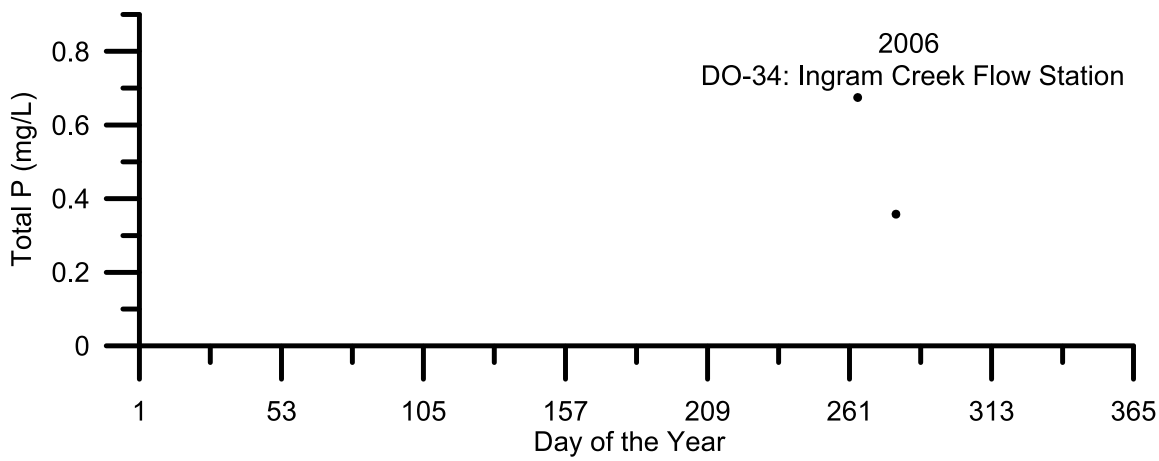

1.2
0.8
0.4
0
Total P (mg/L)
2007
DO-30: TID Lat 6 & 7 at River Rd.
1
53
105
157
209
261
313
365
Day of the Year

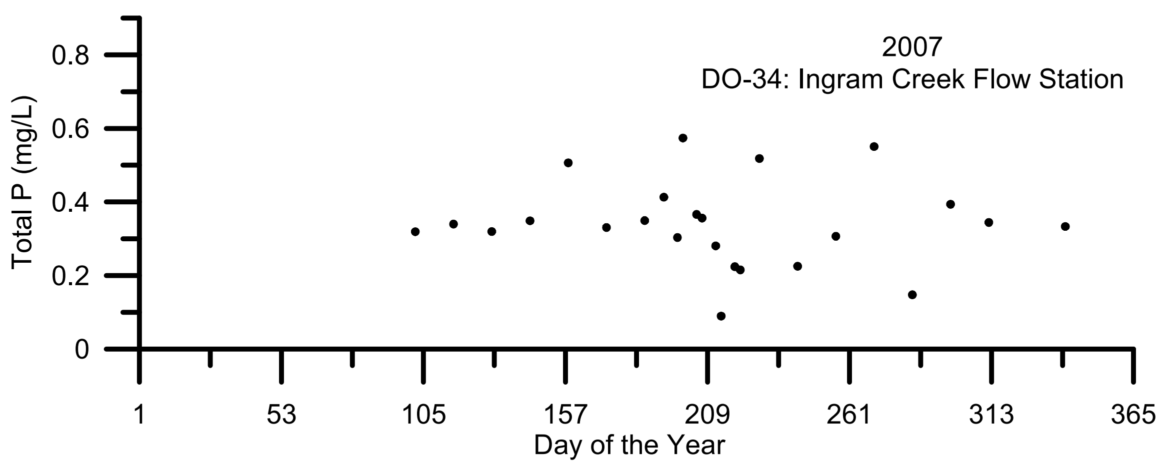

2005
DO-33: Hospital Creek
Total P (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

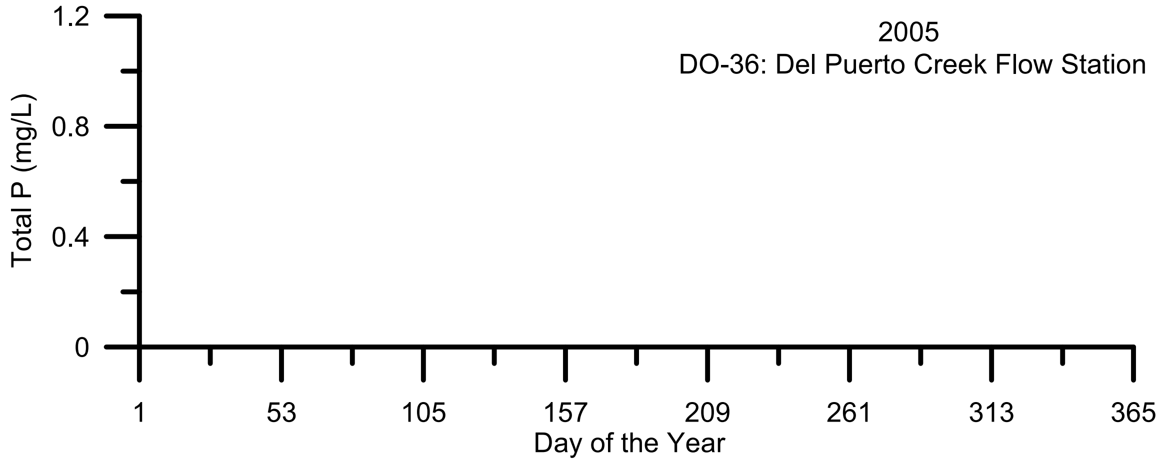

2006
DO-33: Hospital Creek
Total P (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

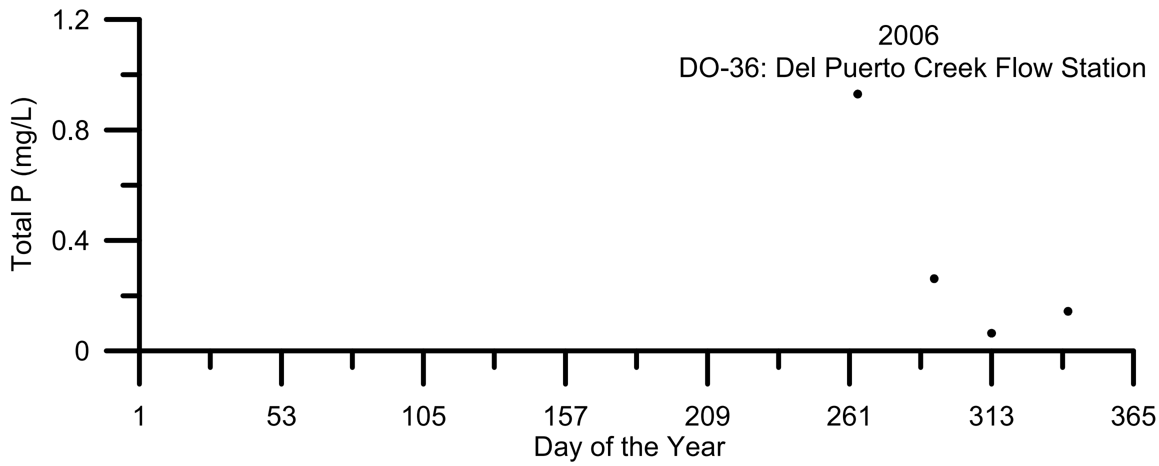

2007
DO-33: Hospital Creek
Total P (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

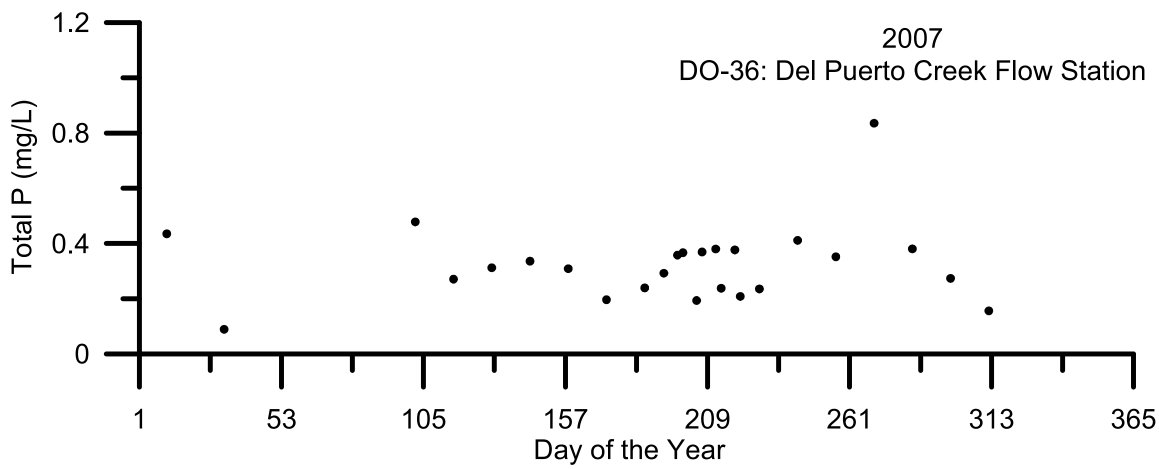

2005
DO-34: Ingram Creek Flow Station
Total P (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

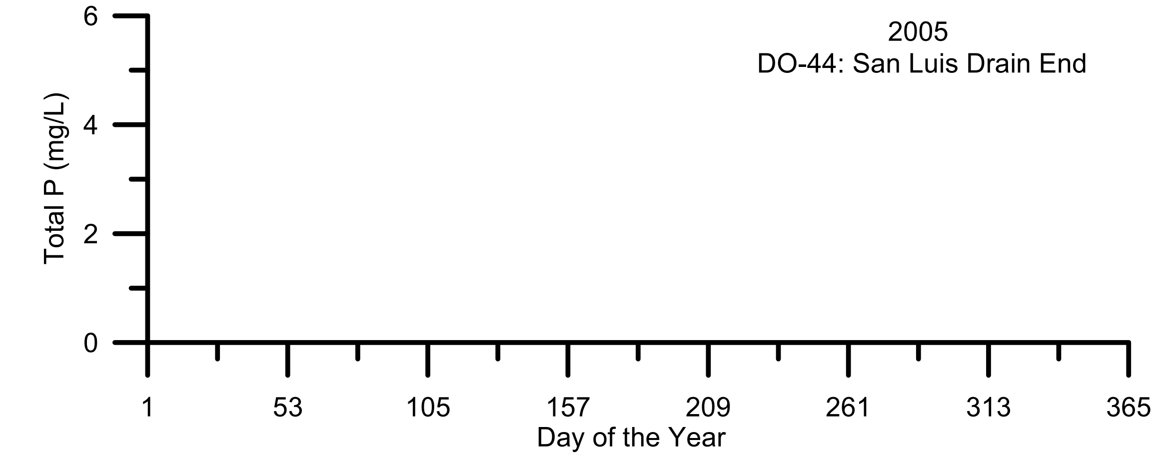

2006
DO-34: Ingram Creek Flow Station
Total P (mg/L)
0
0.2
0.4
0.6
0.8
1
53
105
157
209
261
313
365
Day of the Year

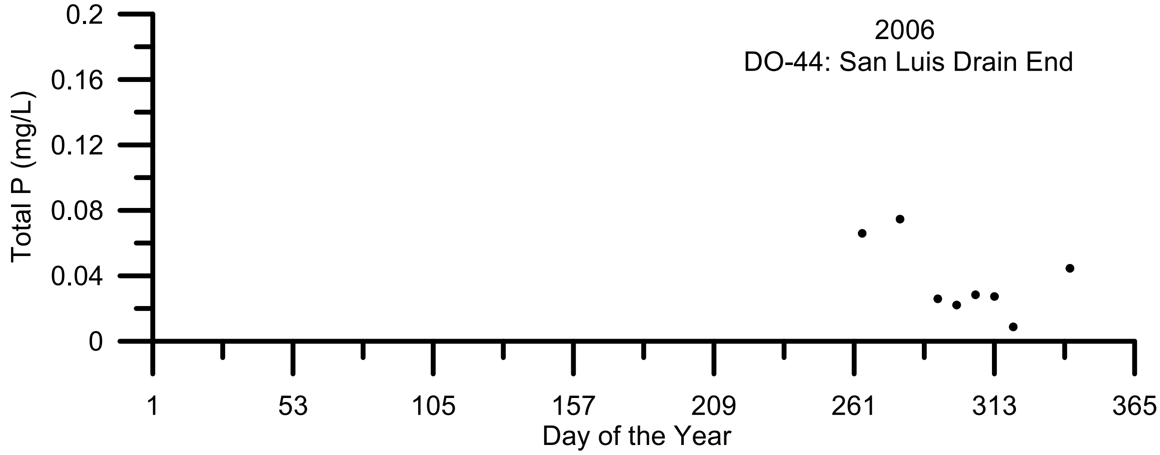

2007
DO-34: Ingram Creek Flow Station
Total P (mg/L)
0
0.2
0.4
0.6
0.8
1
53
105
157
209
261
313
365
Day of the Year

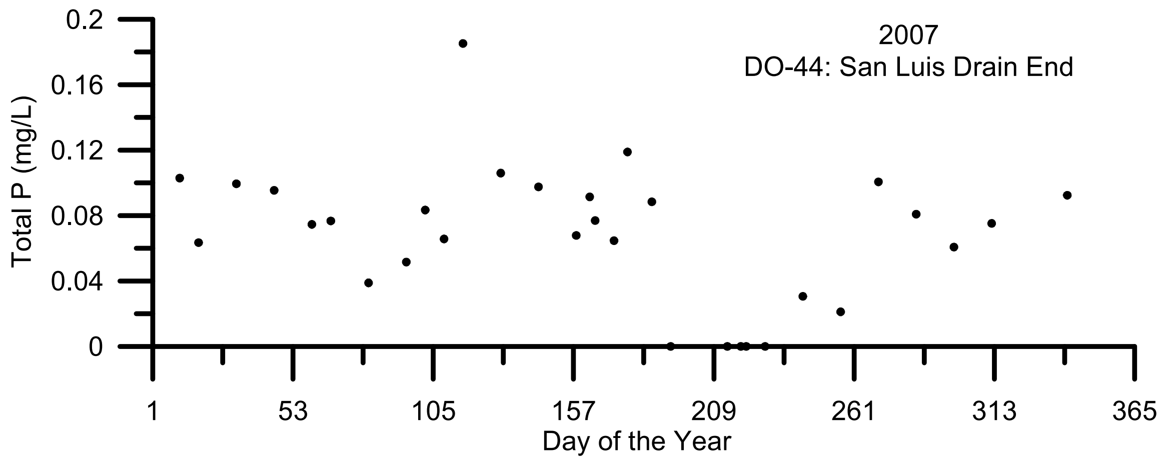

2005
DO-36: Del Puerto Creek Flow Station
Total P (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

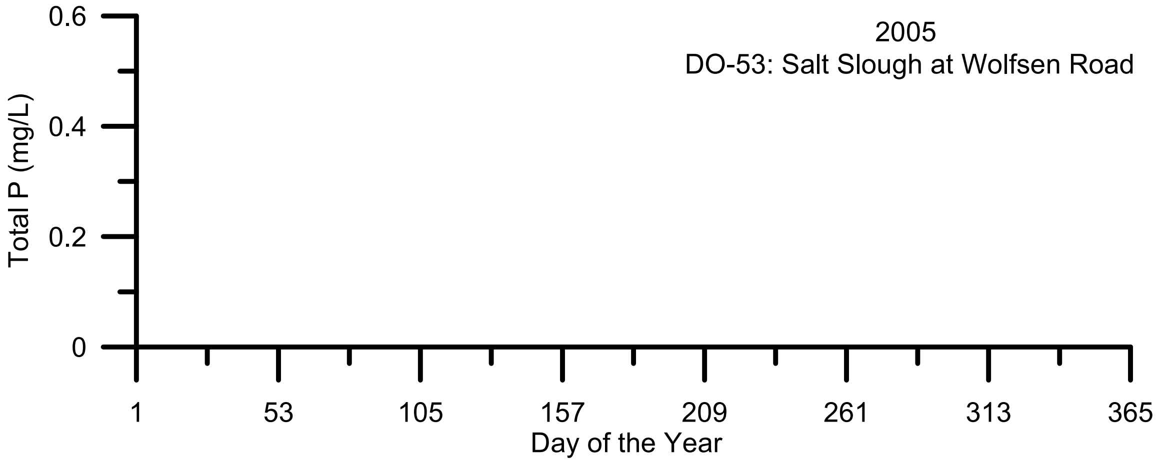

2006
DO-36: Del Puerto Creek Flow Station
Total P (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

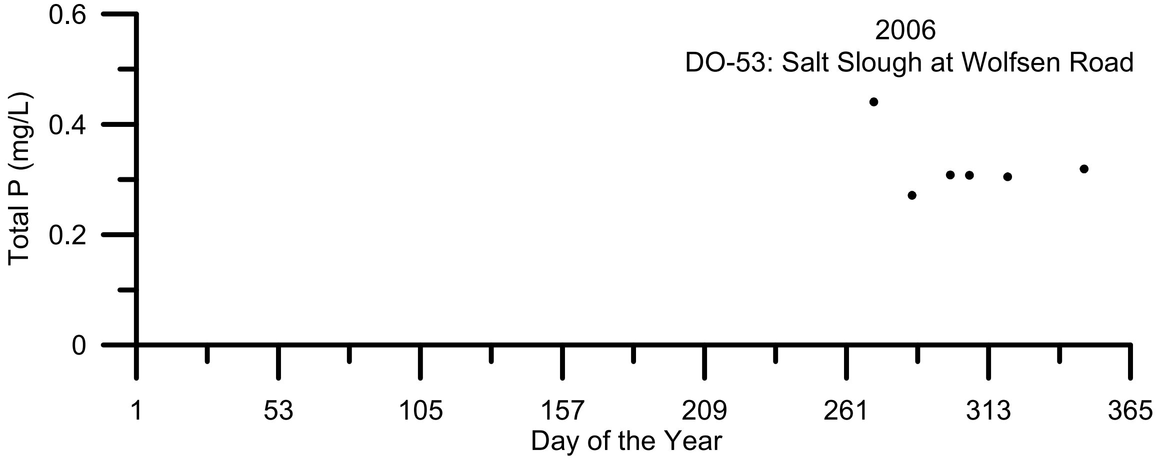

2007
DO-36: Del Puerto Creek Flow Station
Total P (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

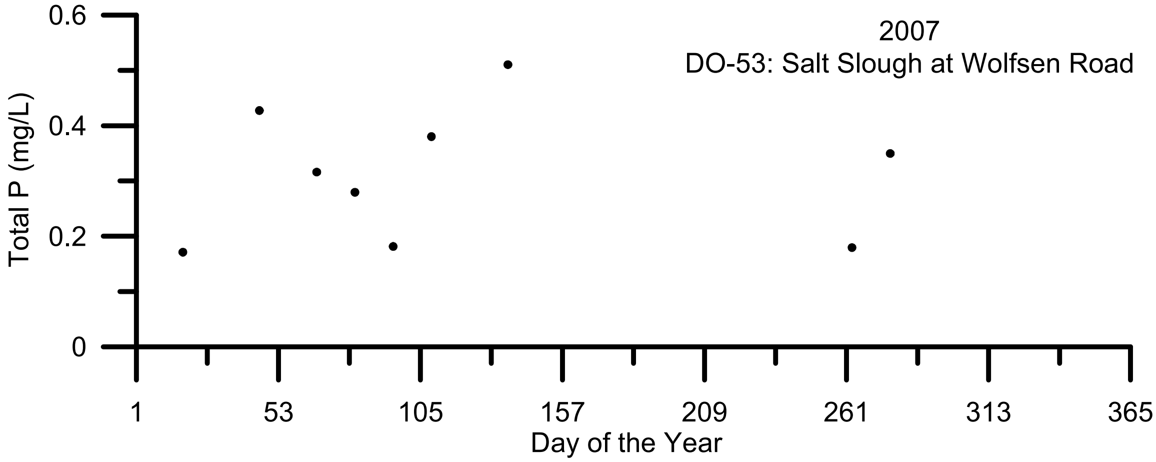

2005
DO-44: San Luis Drain End
Total P (mg/L)
Day of the Year

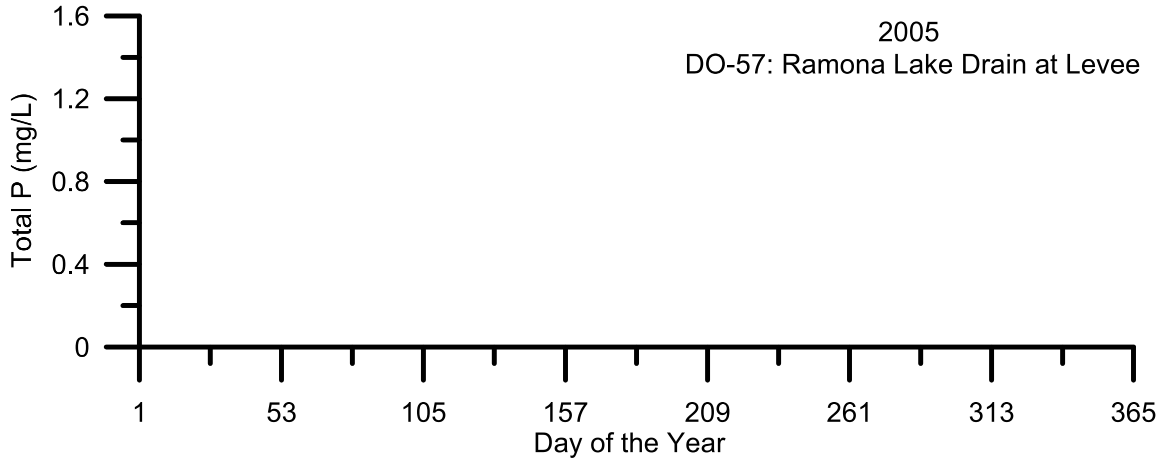

2006
DO-44: San Luis Drain End
Total P (mg/L)
Day of the Year

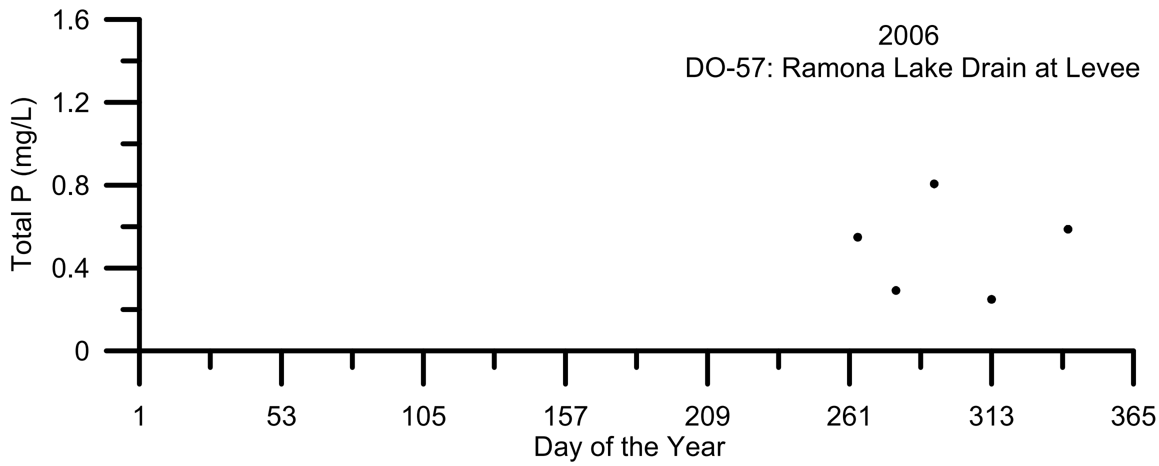

2007
DO-44: San Luis Drain End
Total P (mg/L)
Day of the Year

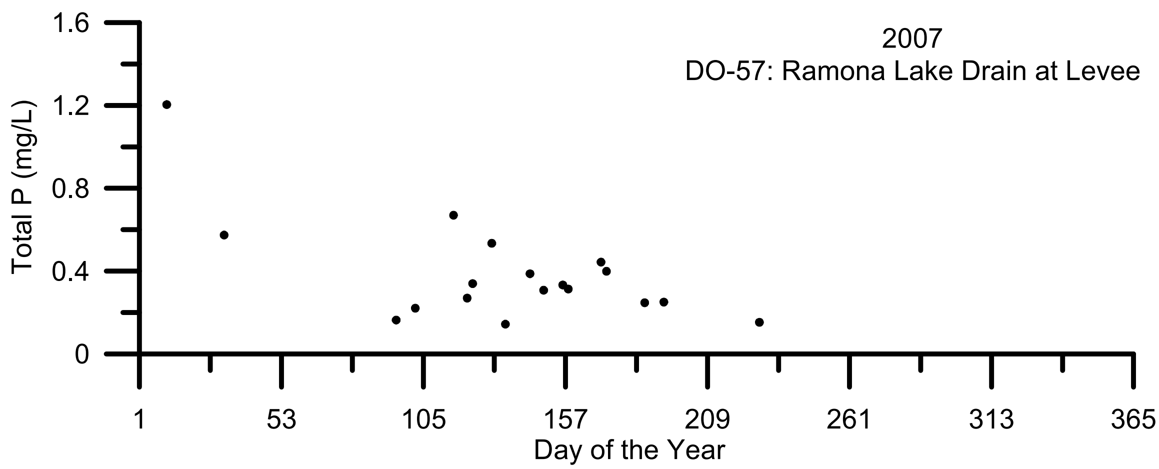

2005
DO-53: Salt Slough at Wolfsen Road
Total P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

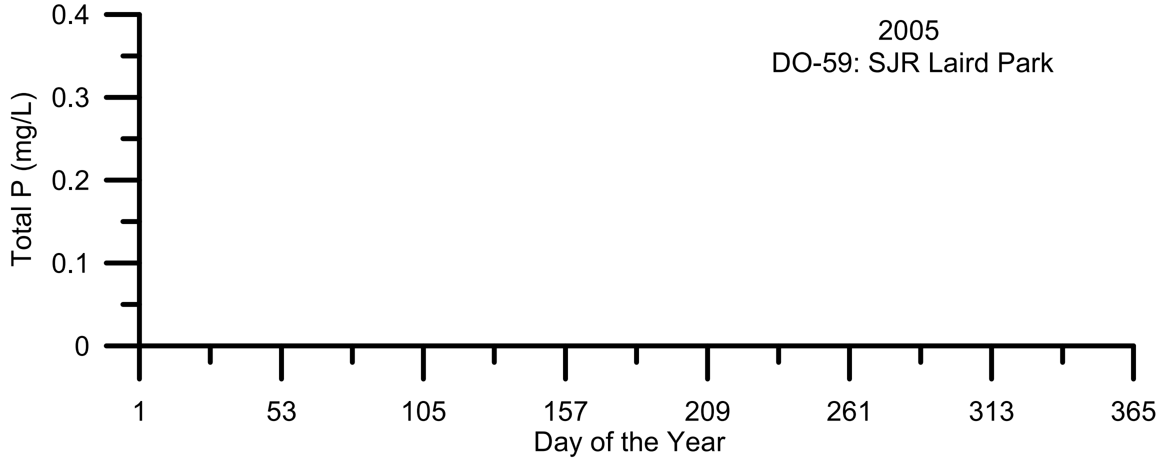

2006
DO-53: Salt Slough at Wolfsen Road
Total P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

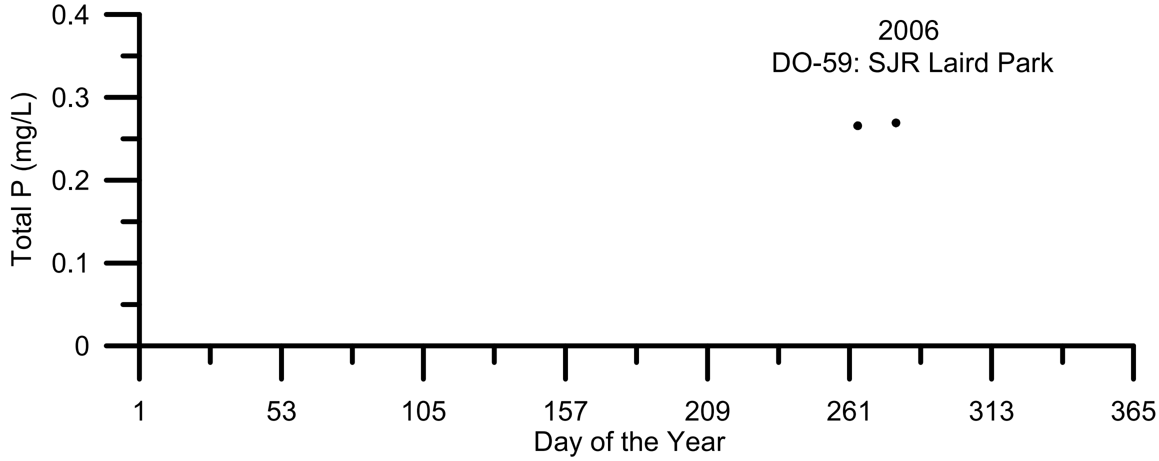

2007
DO-53: Salt Slough at Wolfsen Road
Total P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

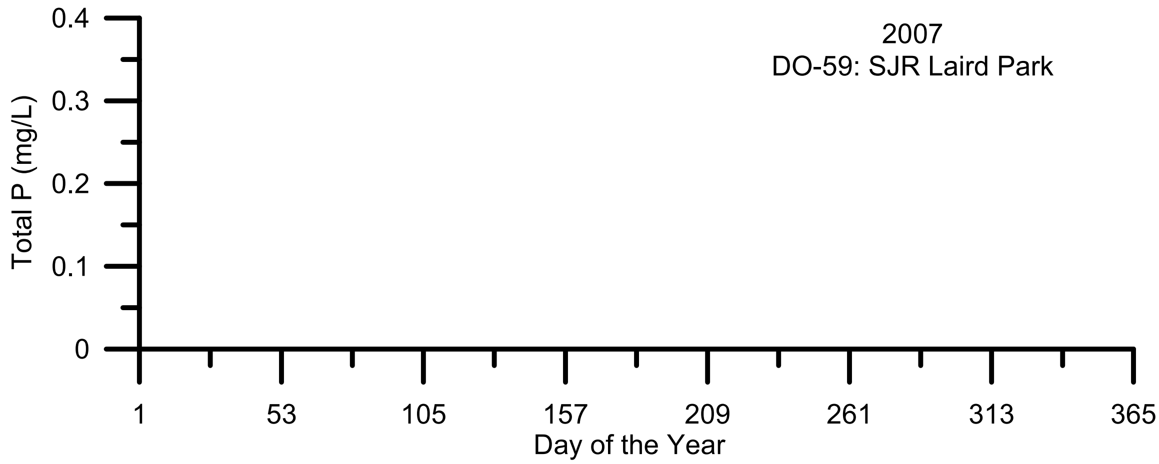

2005
DO-57: Ramona Lake Drain at Levee
Total P (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

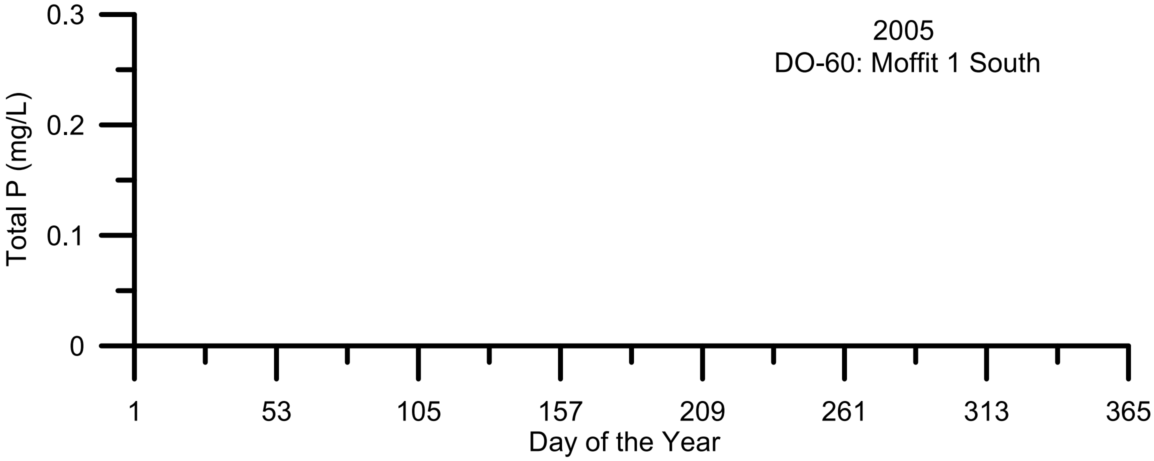

2006
DO-57: Ramona Lake Drain at Levee
Total P (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

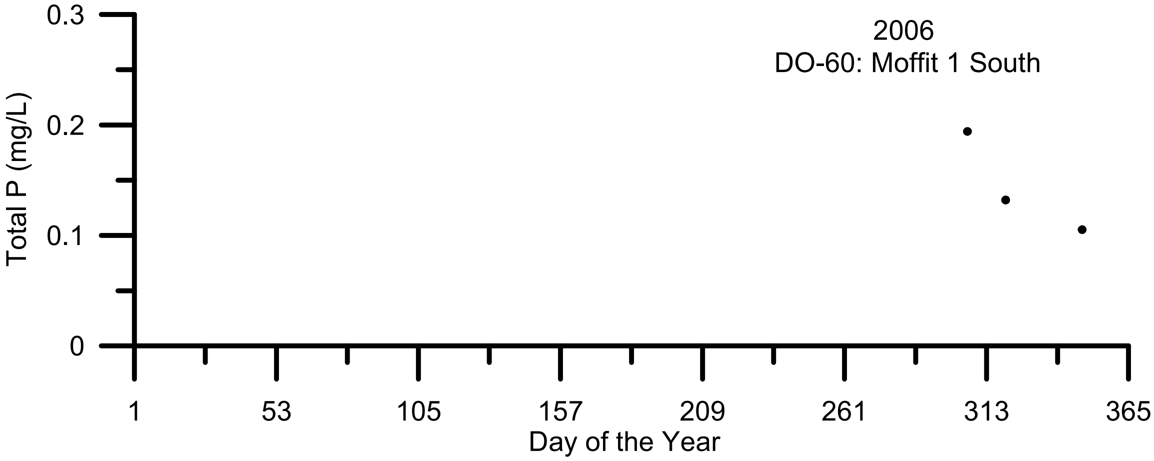

2007
DO-57: Ramona Lake Drain at Levee
Total P (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

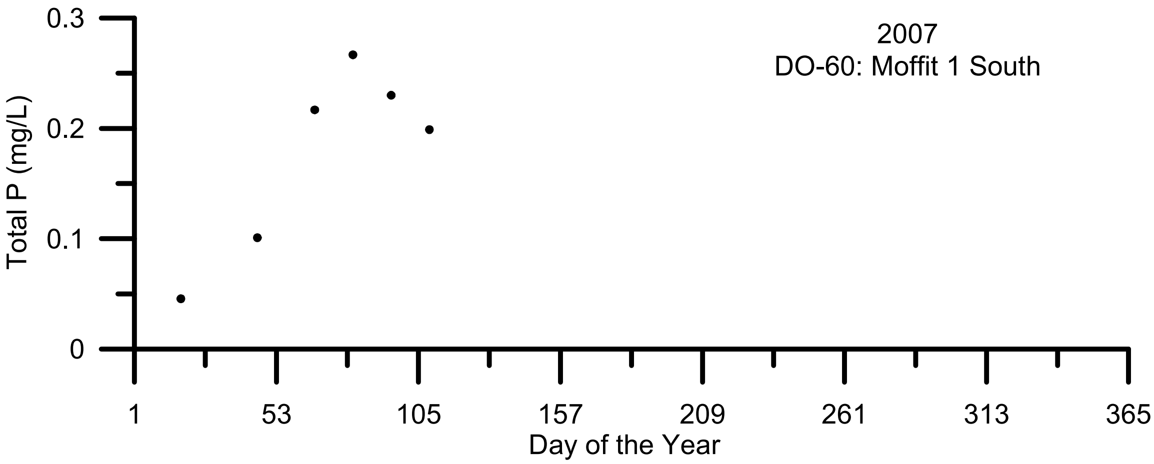

2005
DO-59: SJR Laird Park
Total P (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

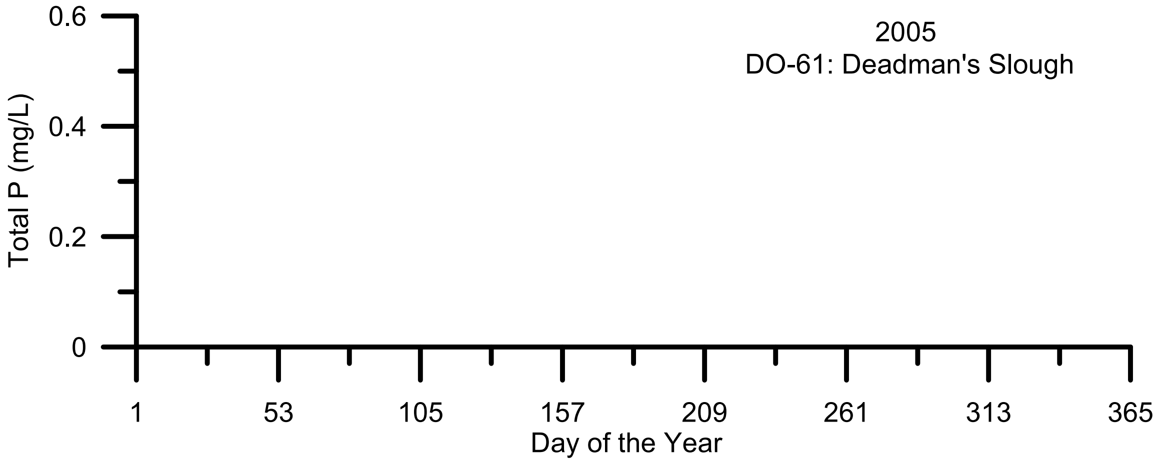

2006
DO-59: SJR Laird Park
Total P (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

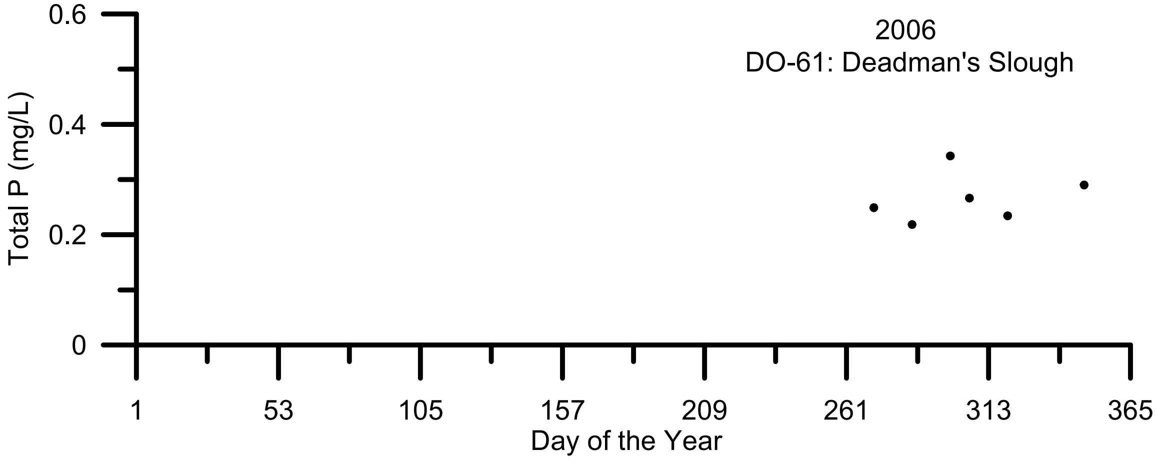

2007
DO-59: SJR Laird Park
Total P (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

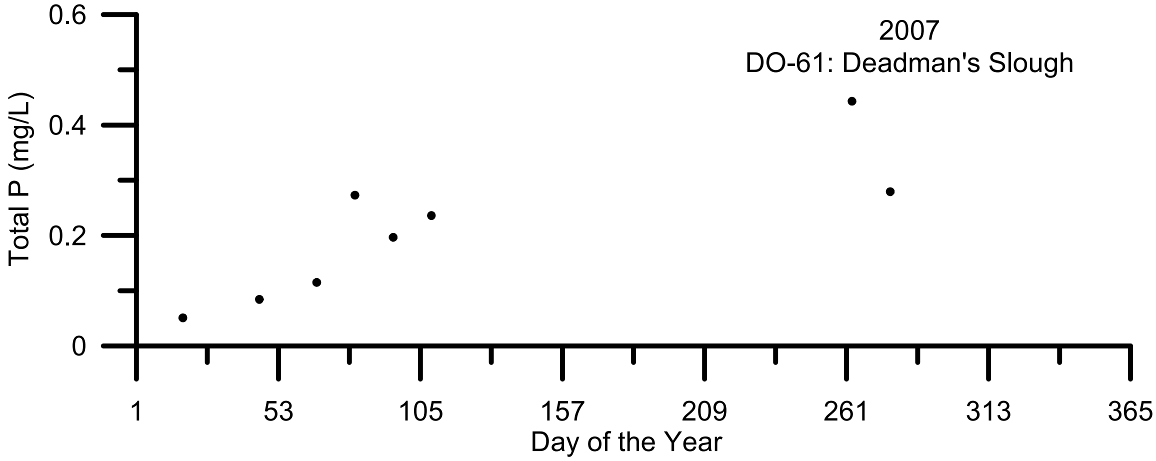

2005
DO-60: Moffit 1 South
Total P (mg/L)
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

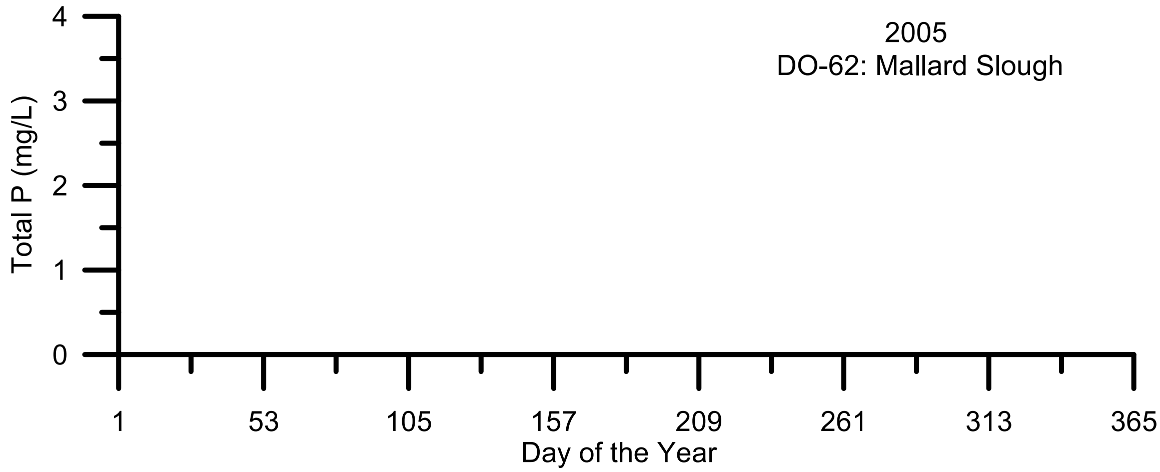

2006
DO-60: Moffit 1 South
Total P (mg/L)
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

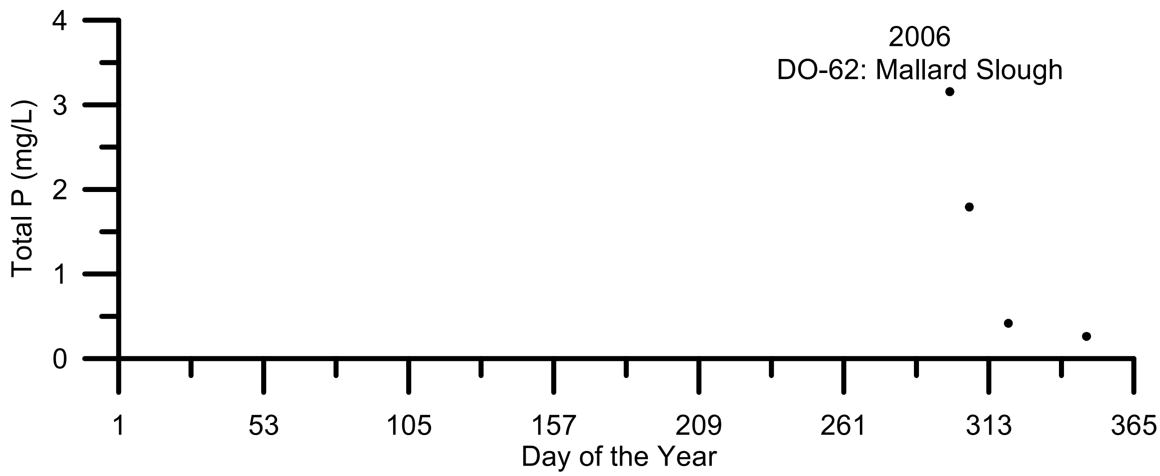

2007
DO-60: Moffit 1 South
Total P (mg/L)
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

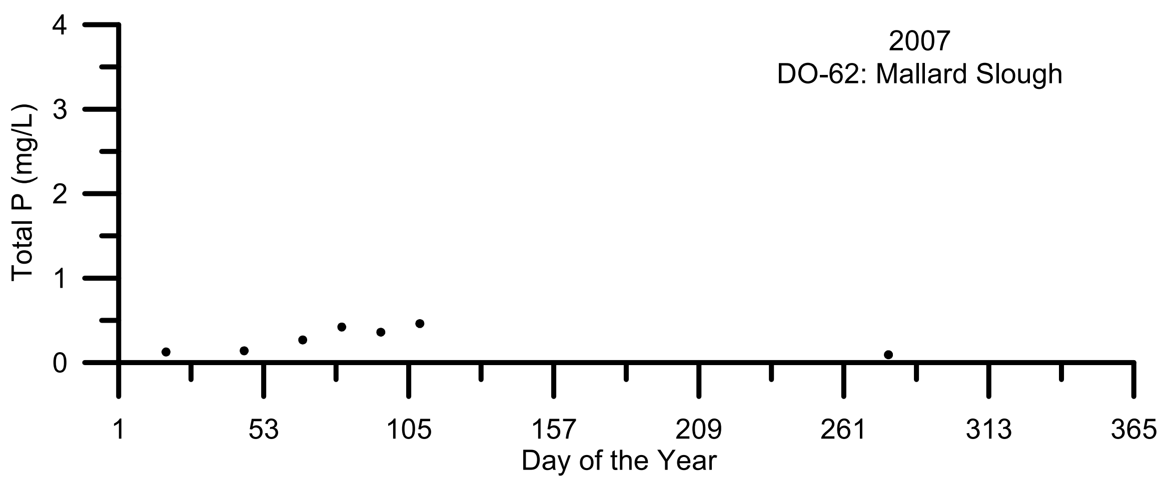

2005
DO-61: Deadman's Slough
Total P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

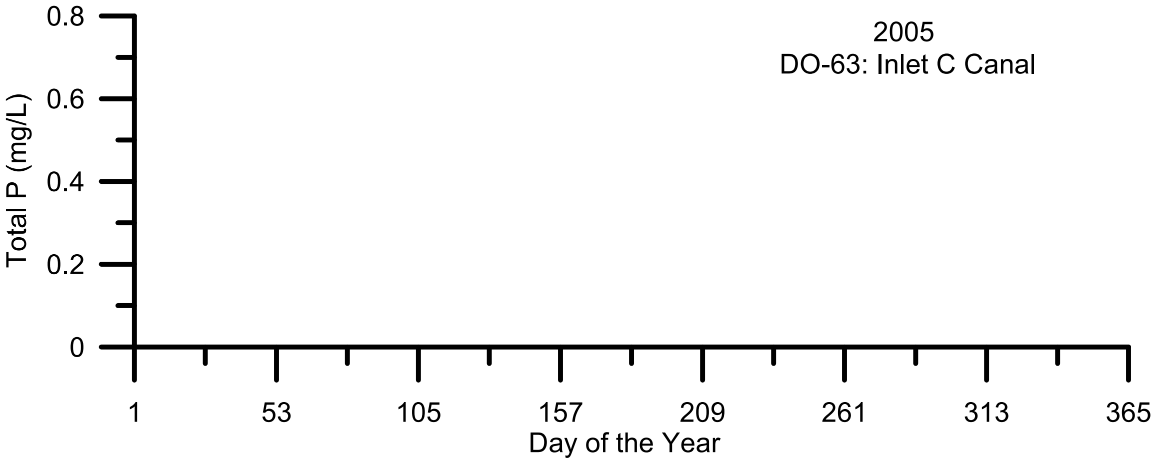

2006
DO-61: Deadman's Slough
Total P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

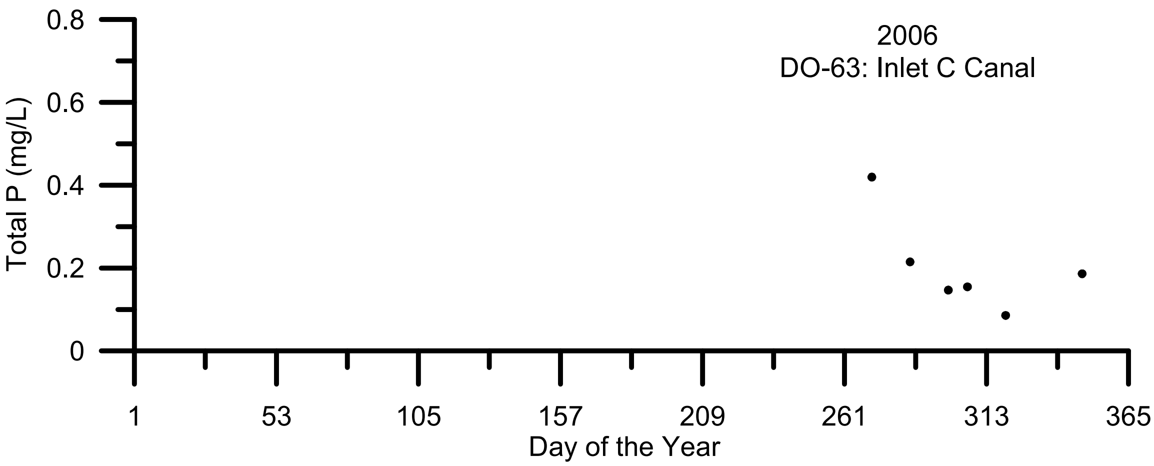

2007
DO-61: Deadman's Slough
Total P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

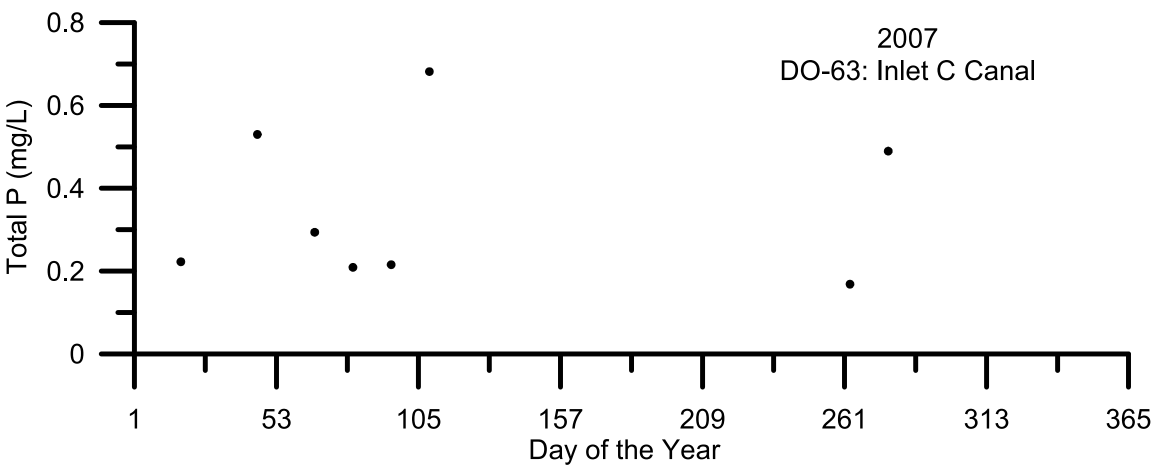

2005
DO-62: Mallard Slough
Total P (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

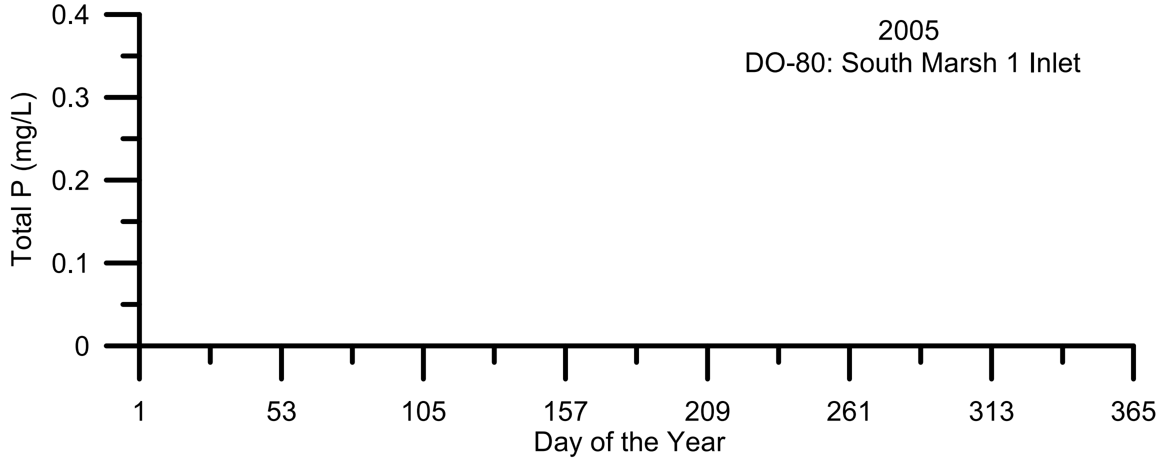

2006
DO-62: Mallard Slough
Total P (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

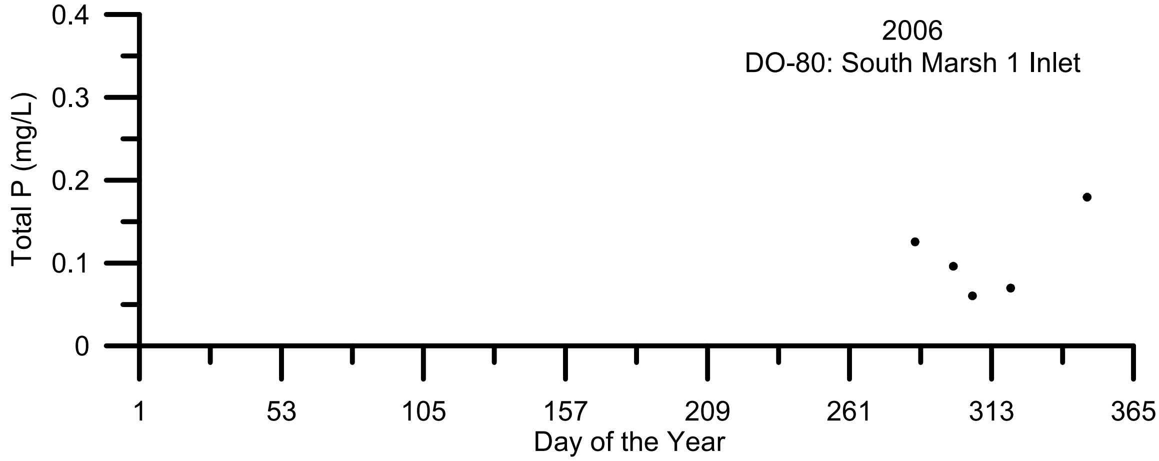

2007
DO-62: Mallard Slough
Total P (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

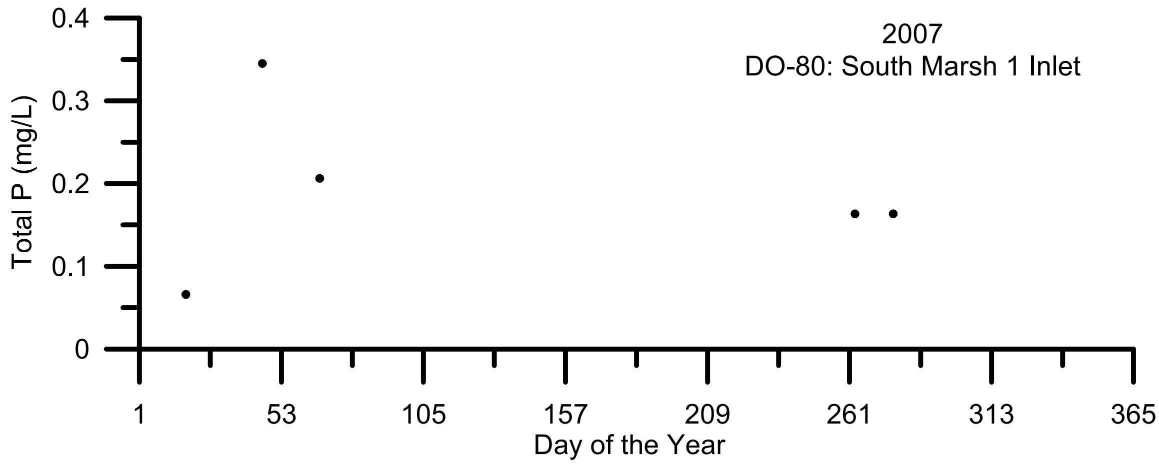

2005
DO-63: Inlet C Canal
Total P (mg/L)
0
0.2
0.4
0.6
0.8
1
53
105
157
209
261
313
365
Day of the Year

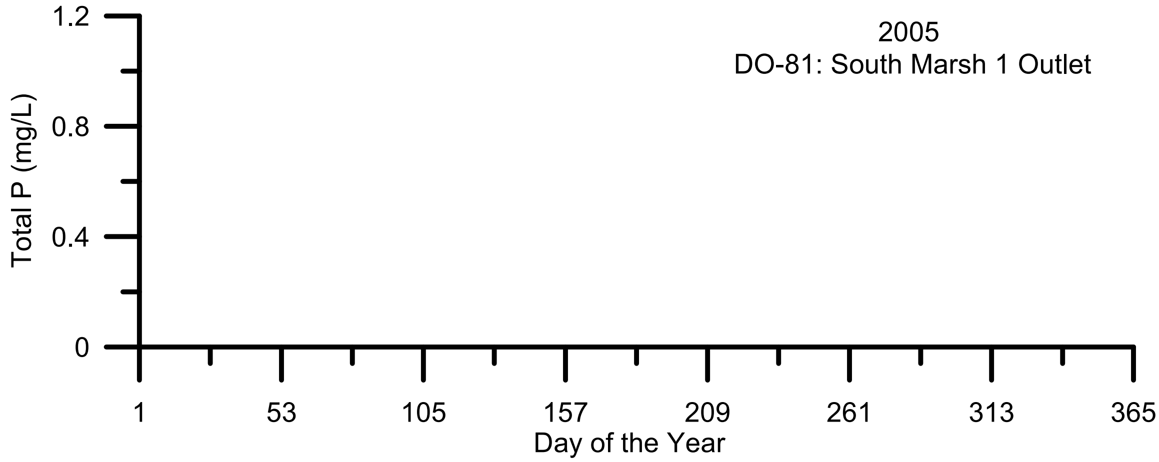

2006
DO-63: Inlet C Canal
Total P (mg/L)
0
0.2
0.4
0.6
0.8
1
53
105
157
209
261
313
365
Day of the Year

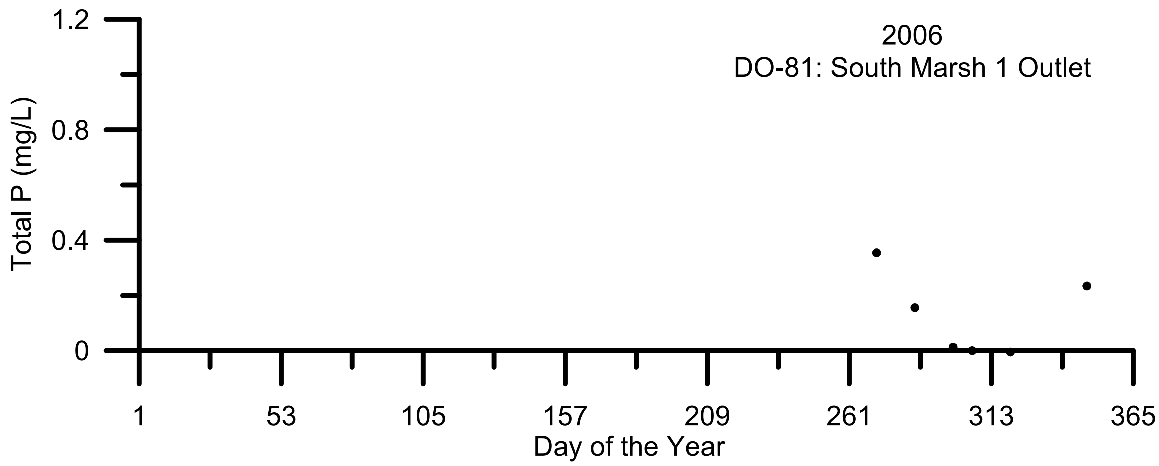

2007
DO-63: Inlet C Canal
Total P (mg/L)
0
0.2
0.4
0.6
0.8
1
53
105
157
209
261
313
365
Day of the Year

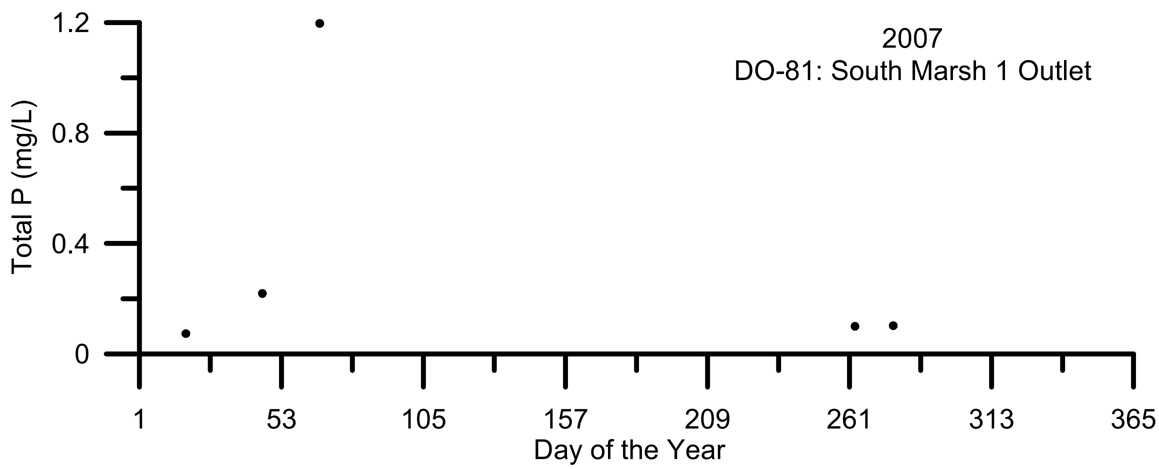

2005
DO-80: South Marsh 1 Inlet
Total P (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

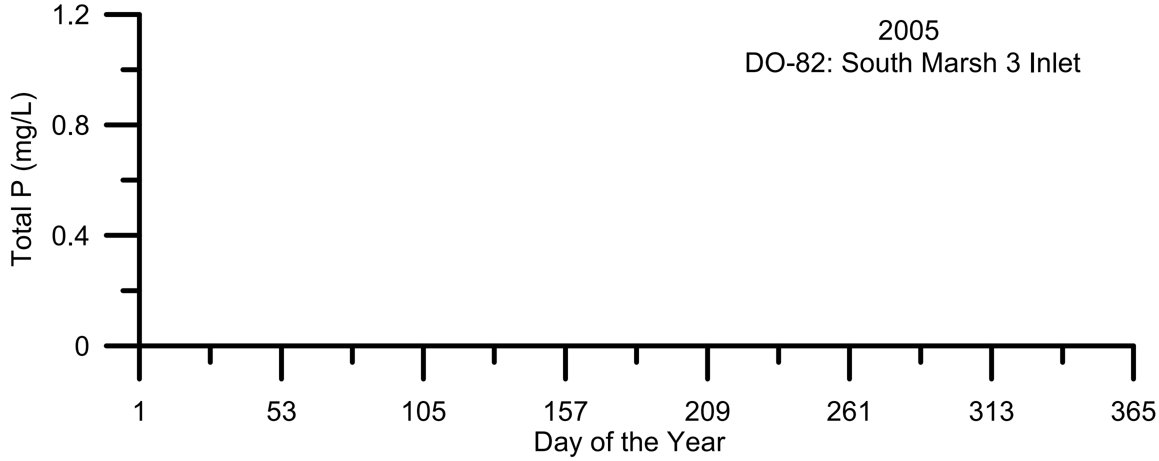

2006
DO-80: South Marsh 1 Inlet
Total P (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

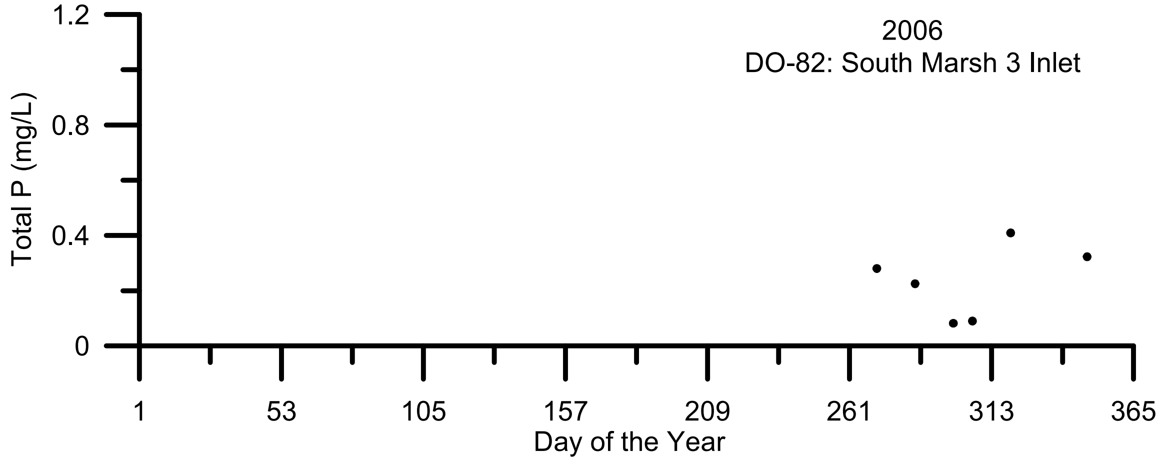

2007
DO-80: South Marsh 1 Inlet
Total P (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

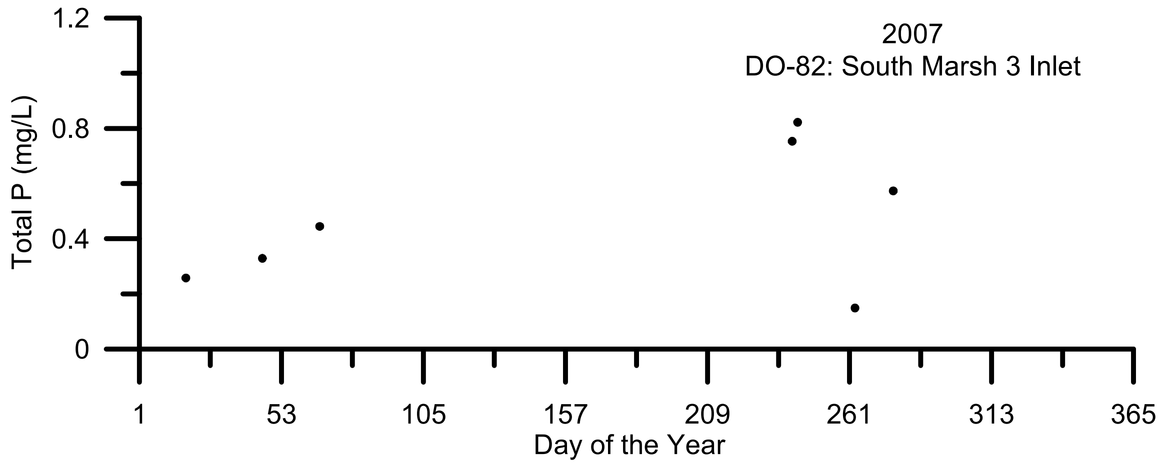

2005
DO-81: South Marsh 1 Outlet
Total P (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

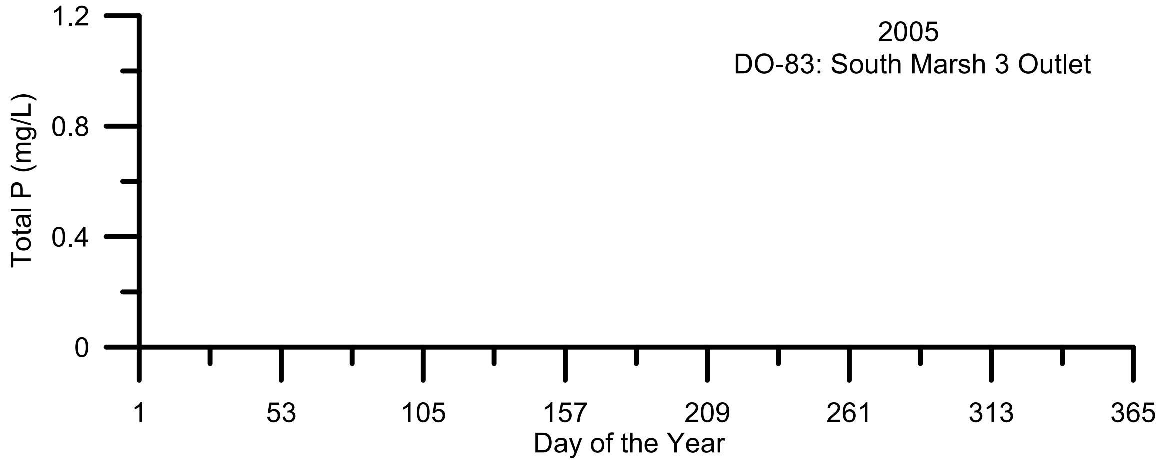

2006
DO-81: South Marsh 1 Outlet
Total P (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-81: South Marsh 1 Outlet
Total P (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

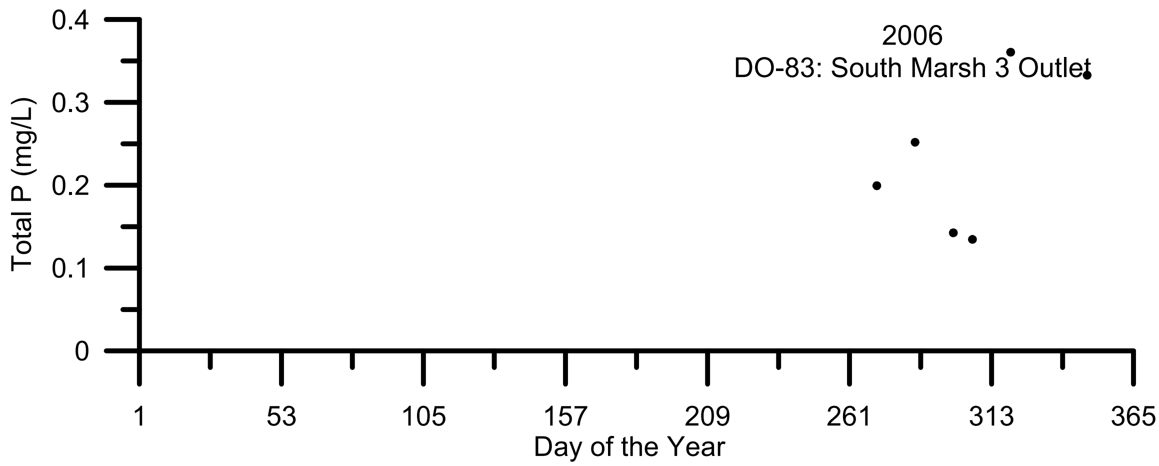

2005
DO-82: South Marsh 3 Inlet
Total P (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-82: South Marsh 3 Inlet
Total P (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

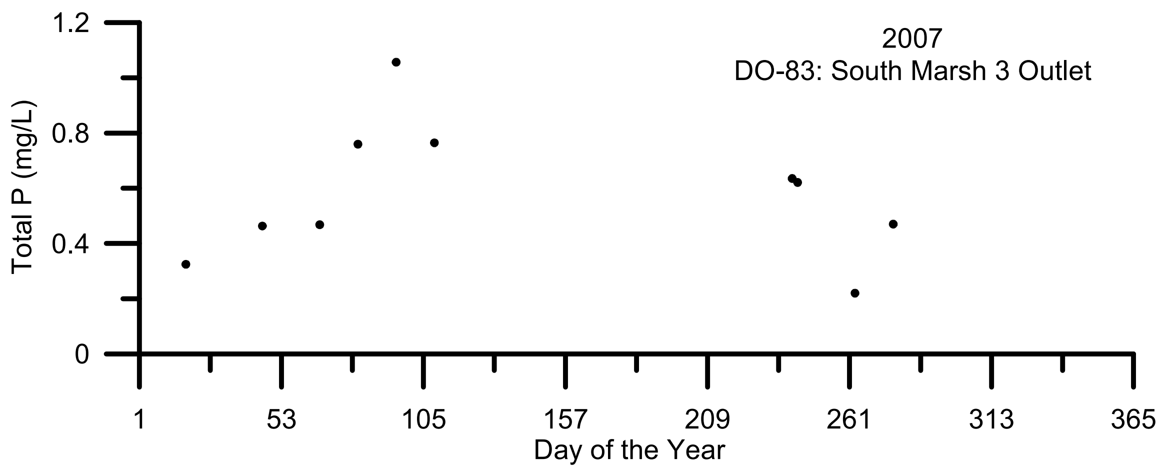

2007
DO-82: South Marsh 3 Inlet
Total P (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year



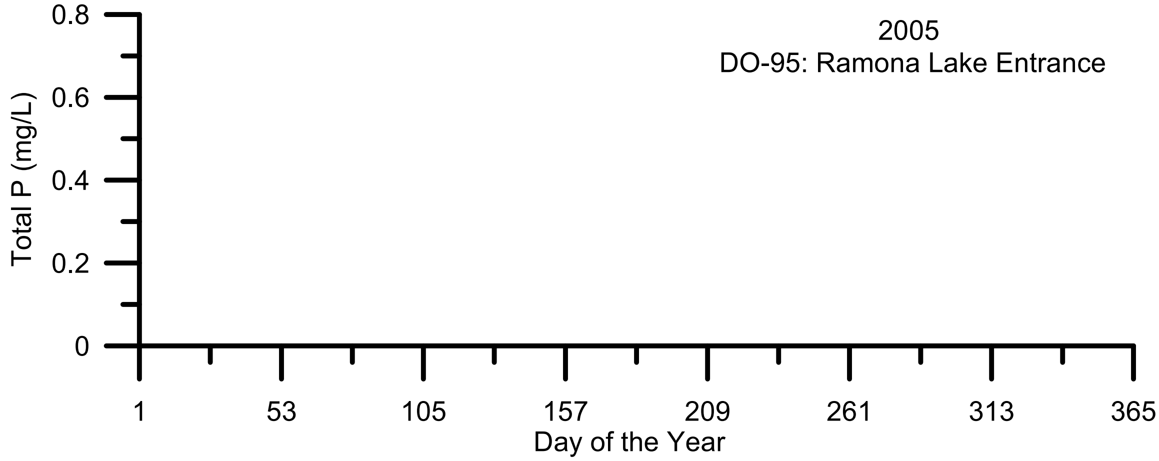
2005
DO-83: South Marsh 3 Outlet
Total P (mg/L)
0
0.4
0.8
1.2
1
53
105
157
209
261
313
365
Day of the Year

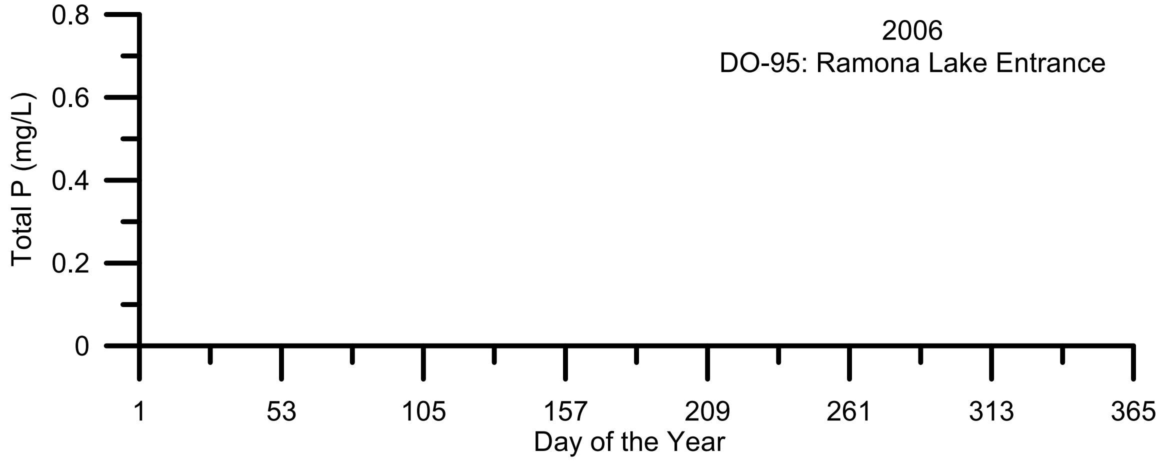


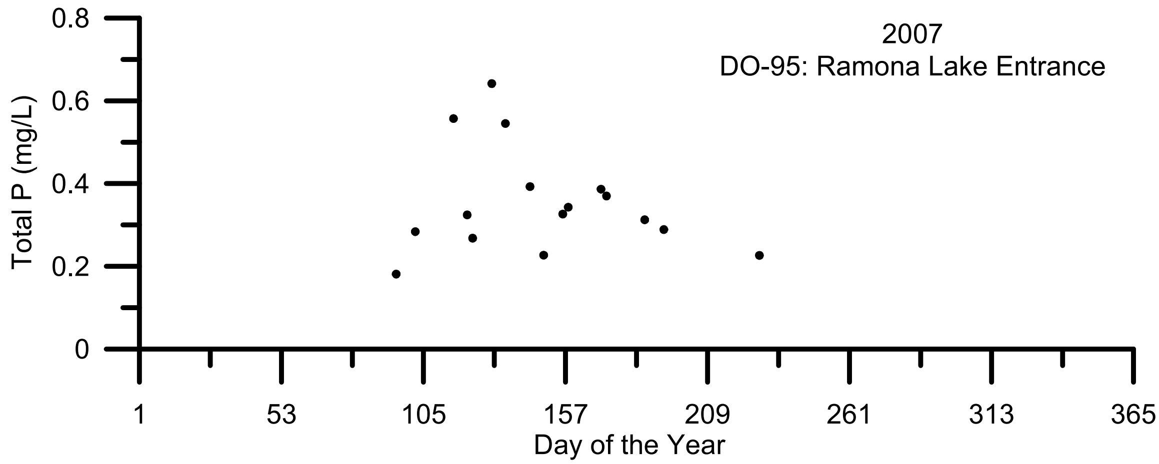
2006
DO-83: South Marsh 3 Outlet
Total P (mg/L)
0
0.1
0.2
0.3
0.4
1
53
105
157
209
261
313
365
Day of the Year



2007
DO-83: South Marsh 3 Outlet
Total P (mg/L)
0
0.4
0.8
1.2
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-95: Ramona Lake Entrance
Total P (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-95: Ramona Lake Entrance
Total P (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-95: Ramona Lake Entrance
Total P (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

Temporal Plots of 2005-2007 Total Nitrogen Data from the Upstream San Joaquin River

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Remie Burks[1]
Sharon Borglin[1]
Randy Dahlgren[2]
Jeremy Hanlon[1]
Justin Graham[1]
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February 2008

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Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report includes temporal plots of total nitrogen (Tot-N) data analyzed by the EERP laboratory starting in the summer of 2007.

Methods

Depth integrated field samples were colleted during 2005-2007 in the upper San Joaquin River in accordance with EERP Field Standard Operating Procedures Protocol Book (Graham 2008). Water samples were colleted in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN). Bottles were labeled with the appropriate sample number, site name and sampling date. All bottles were rinsed with sample water prior to sample collection. Some sites required a bucket to collect sample water because of accessibility from a high bridge or platform. For these sites, the bucket was pre-rinsed with sample water and sample bottles were filled using a rinsed funnel. Care was taken to distribute water simultaneously to all sample bottles (rather than sequentially). Samples were immediately stored at 4°C after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the EERP lab on the day of sampling.

Within 24 hours of collection samples were alquotted and stored at -20°C until Tot-N analysis could be completed.

Starting in 2007 Tot-N was quantified using the TL-2800 ammonia analyzer made by Timberline Instruments (Boulder, CO). All N in a water sample was converted to NO_3-N by the addition of equal parts of unfiltered sample and digestion reagent under high heat and pressure. NO_3-N in the digested sample was mixed with caustic solution (to pH 11-13) and was then passed through a reducing zinc cartridge to convert all NO_3-N to NH_3-N. NH_3 (g) diffused across a gas-permeable membrane and was dissolved in a buffer solution. The dissolution of NH_3 (g) in the buffer causes a change in conductivity which can be correlated to the concentration of NH_3. The Timberline instrument automates the mixing of the caustic solution with the sample, reduction of NO_3 to NH_3 by passing the sample through the zinc cartridge, and pumping of the buffer solution through the gas permeable membrane (Borglin et al, 2008) and (Carlson, 1990). The reportable limit for this method is 0.15 mg/L Tot-N.

Results/Discussion

With each set of Tot-N field samples analyzed in the EERP laboratory, quality assurance samples including a lab duplicate, field duplicate, matrix spike, matrix spike duplicate, calibration check standards, laboratory control standard, trip blank, and lab blanks were also analyzed. 100% of all quality assurance samples were within a passing range (Spier, 2008). Proficiency check samples, standards with unknown concentration to the laboratory analyst, were run approximately twice a year. Four proficiency check samples were analyzed for Tot-N in the EERP laboratory during 2007, and all of these samples were found to be within the acceptable range. Samples were measured ranging from 0.03-42.27 mg/L Tot-N. The average concentration of Tot-N in samples collected was 5.09 mg/L Tot-N. Tot-N was also analyzed at UC Davis on all of the same water samples and has a high correlation to values measured by EERP. When all data points measured by the two labs are compared they have $r^2=0.9896$ (Spier, 2008). Tot-N samples measured by EERP have about 101% as much Tot-N as the same samples measured by UCD (Figure 2).

EERP used to measure Tot-N Using a Tekmar Teledyne Apollo 9000 TOC Combustion Analyzer. It was found that this machine did not measure all forms of N, and had a very low correlation to Tot-N measured at UCD so it is no long used by the EERP laboratory to measure Tot-N. These temporal plots (Figures 3-103) as well as the plot comparing EERP's laboratory data to UCD's data (Fiugre 2) created an easy visual way to find outliers and double check data entry for possible mistakes. For the purpose of these plots any data points that were slightly negative were changed to 0.

References

American Public Health Association (APHA). 2005. Standard Methods for the Examination of Water and Wastewater, 21st Edition. American Public Health Association, Washington, DC.

Borglin, S., W. Stringfellow, J. Hanlon. 2005. Standard Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project. LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA

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Carlson, R.M., R. Cabrera, J. Paul, J. Quick and R.Y. Evans. 1990. Rapid direct determination of ammonium and nitrate in soil and plant tissue extracts. Comm. Soil Sci. Plant Anal. 21:1519-1530.

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008) EERP Field Protocol Book, University of the Pacific, Stockton, CA.

Spier, C., Burks, R., Borglin, S.E. (2008) Comparison of Methods for Analyzing Ammonia, Nitrate and Total Nitrogen, University of the Pacific, Stockton, CA.

Stringfellow, W.T., et al., (2008) Evaluation of Vegitated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley, University of the Pacific, Stockton, CA

YSI Environmental Operations Manual (2005) 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

Table 1: EERP Sampling Site List

DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
53	**Salt Slough at Wolfsen Road**	Wetland
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
60	**Moffit 1 South**	Wetland
61	**Deadman's Slough**	Wetland
62	**Mallard Slough**	Wetland
63	**Inlet C Canal**	Wetland
80	**South Marsh-1-Inlet**	Wetland
81	**South Marsh-1-Outlet**	Wetland
82	**South Marsh-3-Inlet**	Wetland
83	**South Marsh-3-Outlet**	Wetland
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

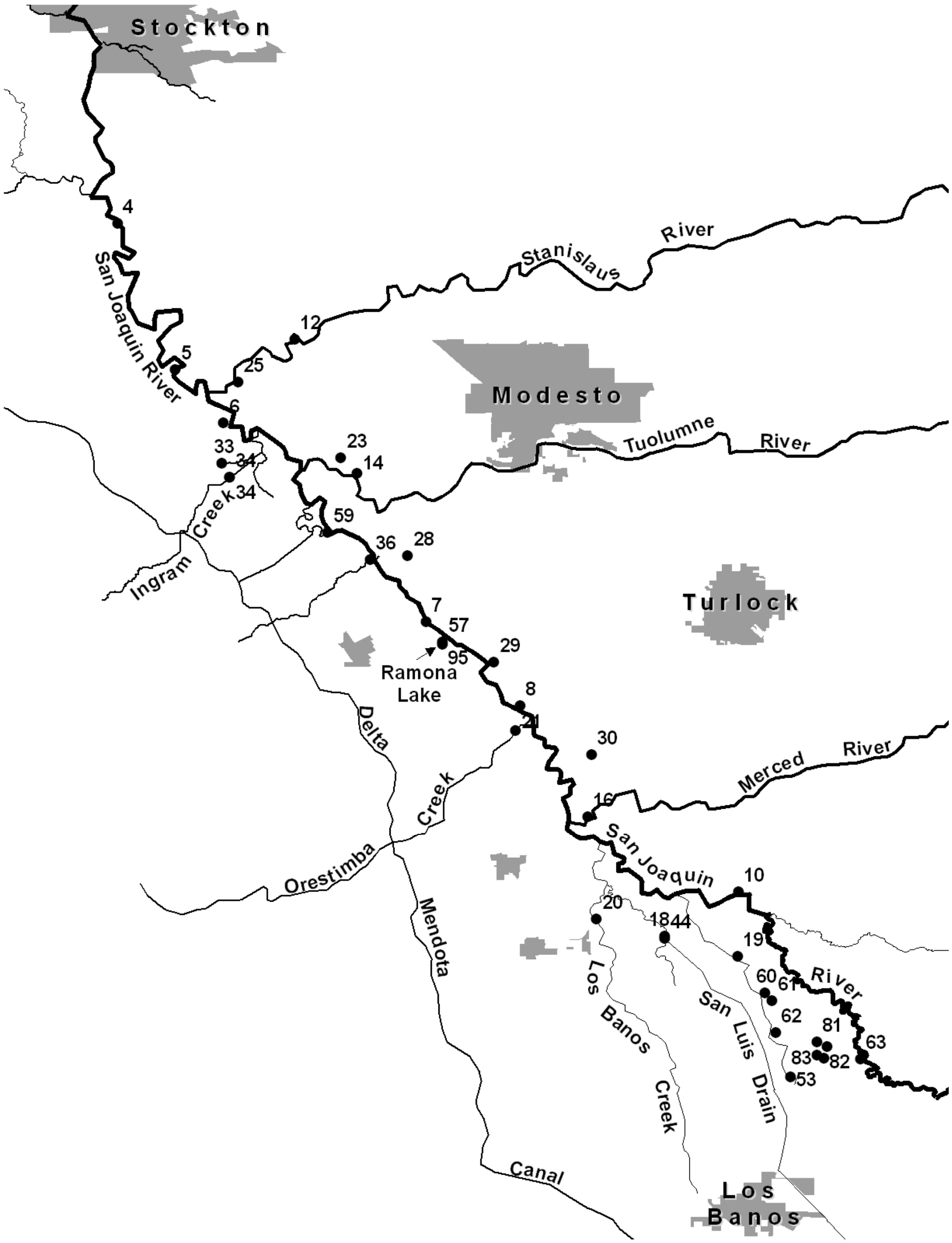
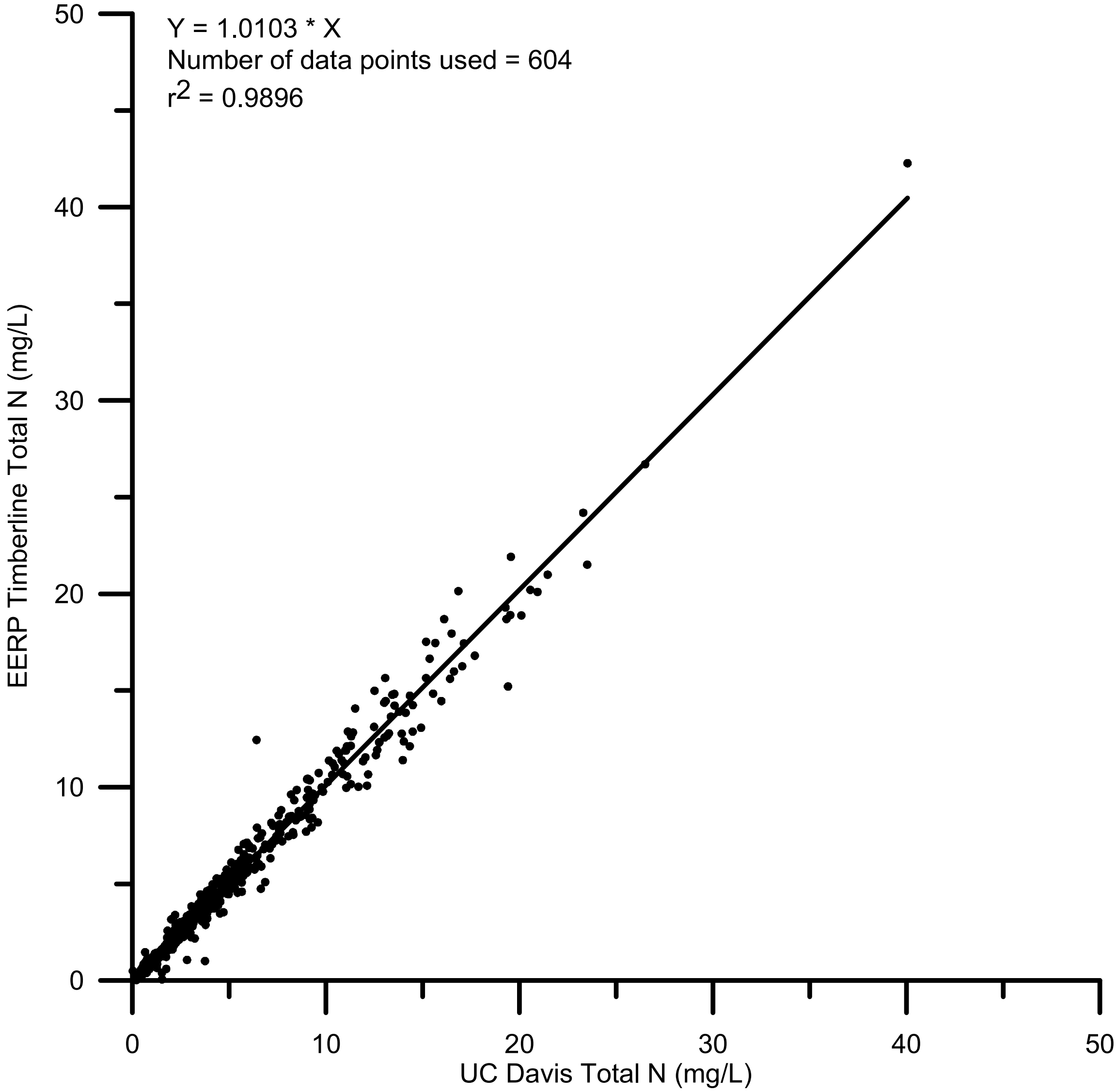
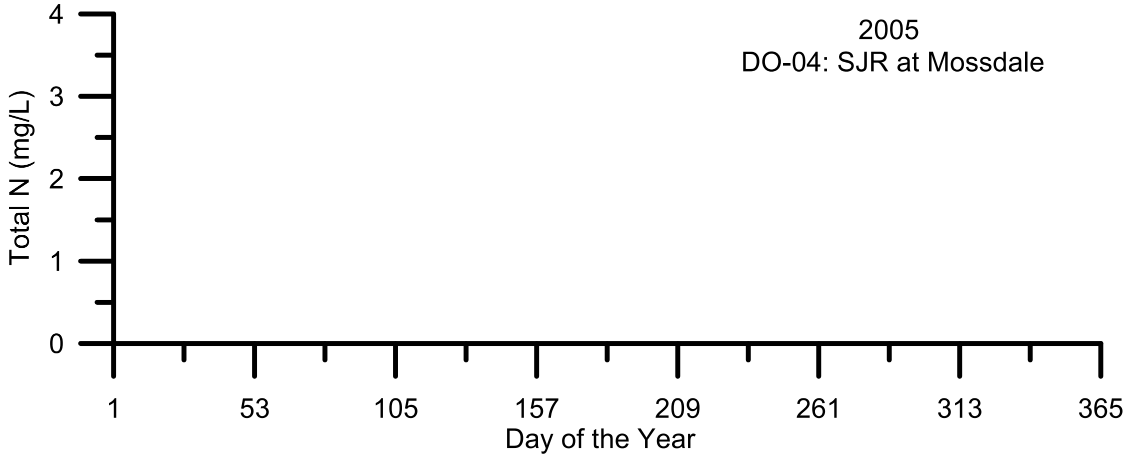
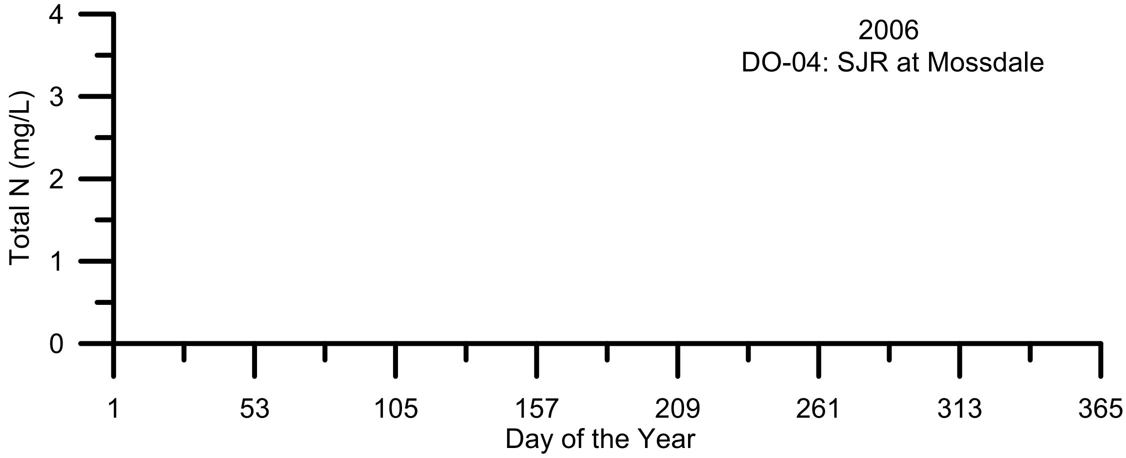


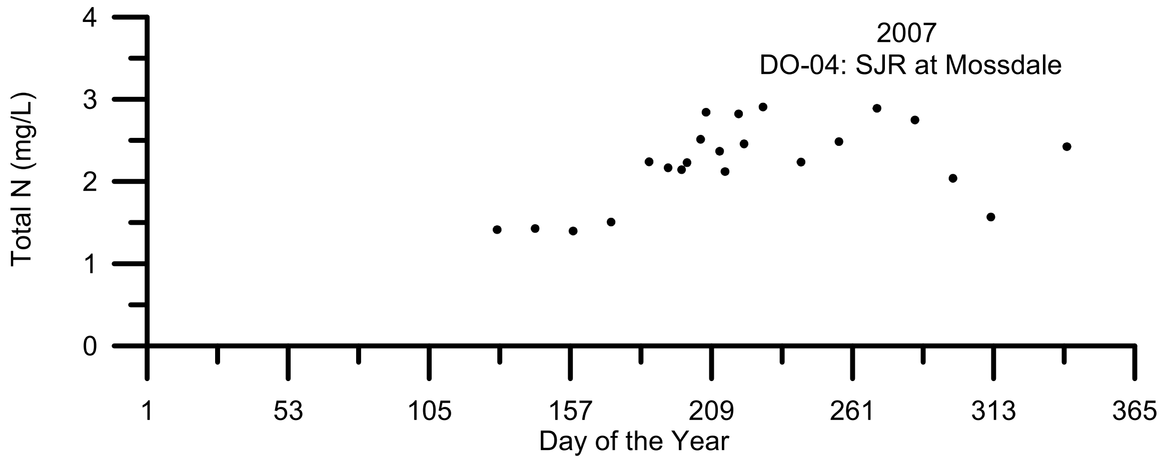
Figure 2: UCD vs EERP Timberline Plot of Tot-N.

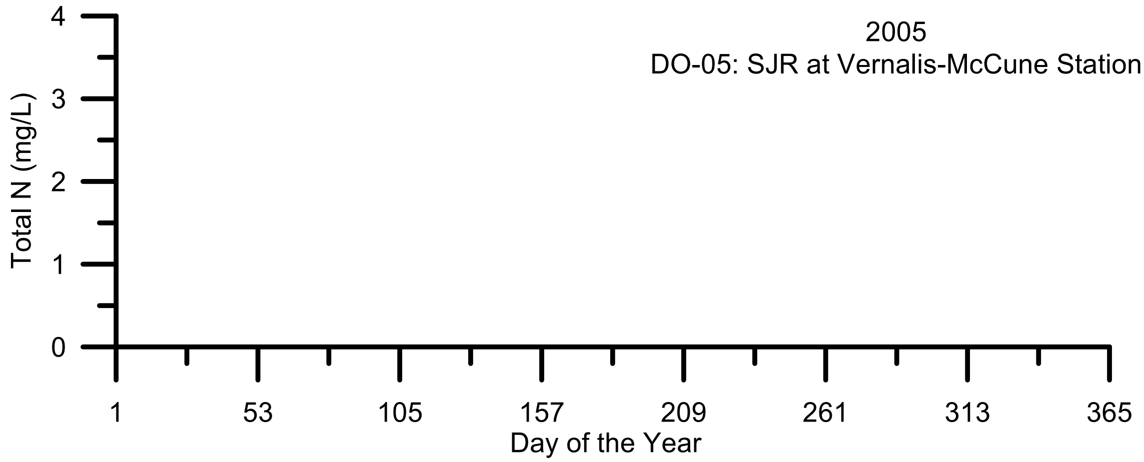


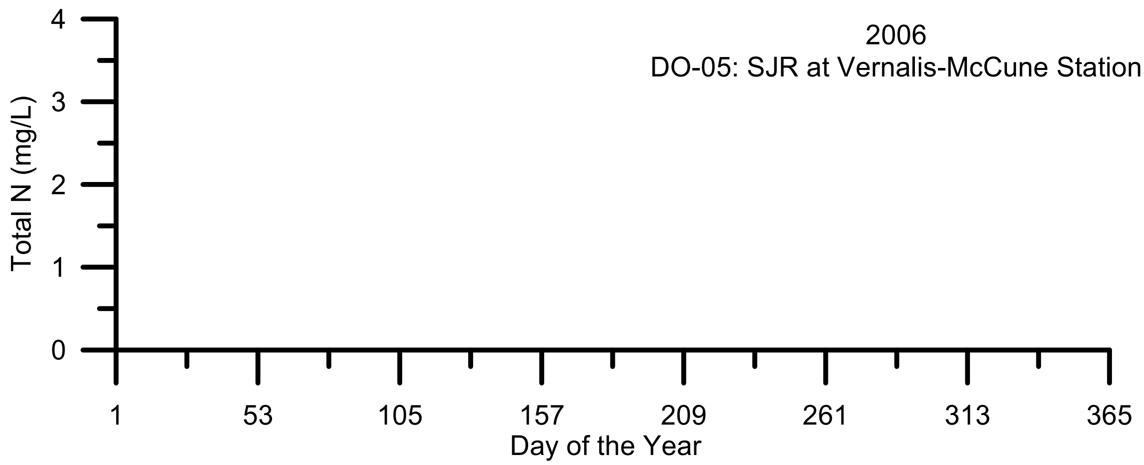
Figures 3 -104: Temporal Plots of Tot-N By Site ID

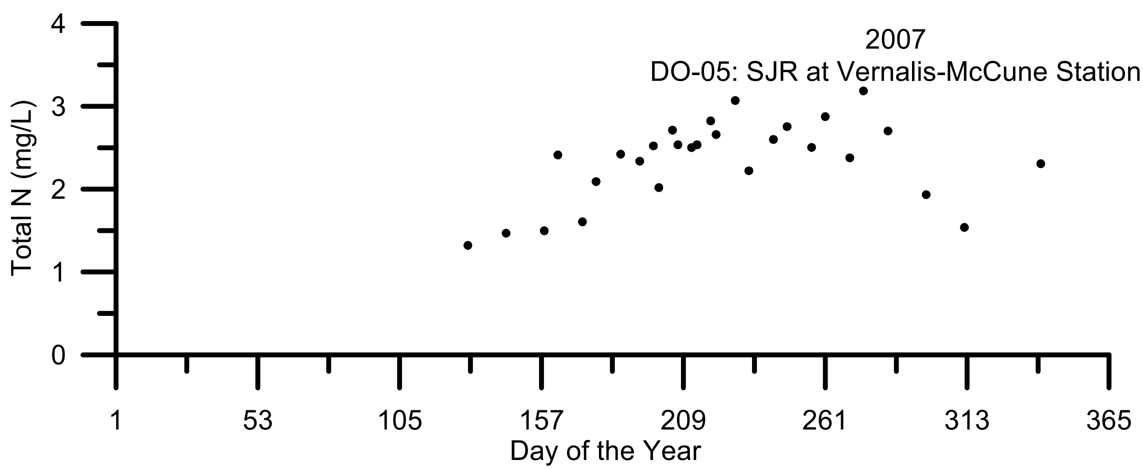


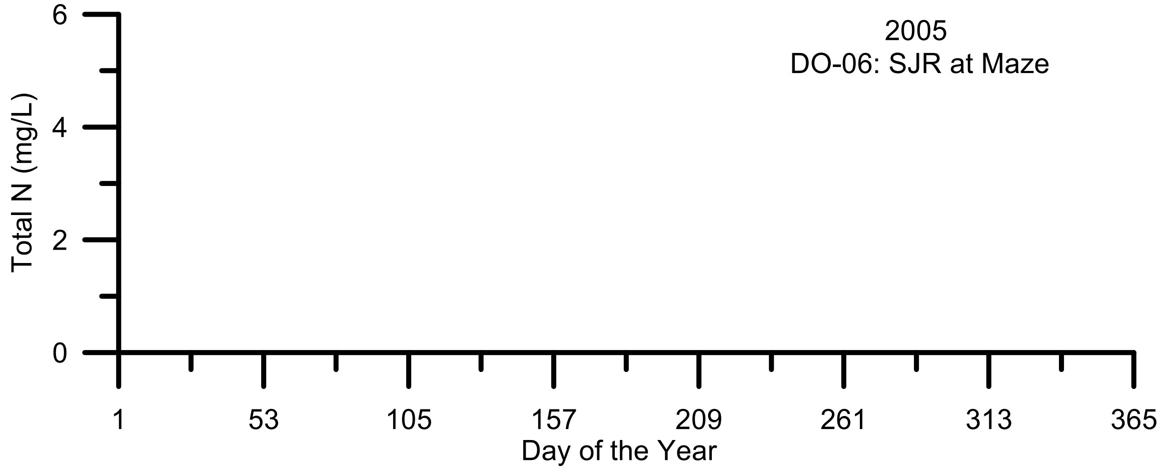


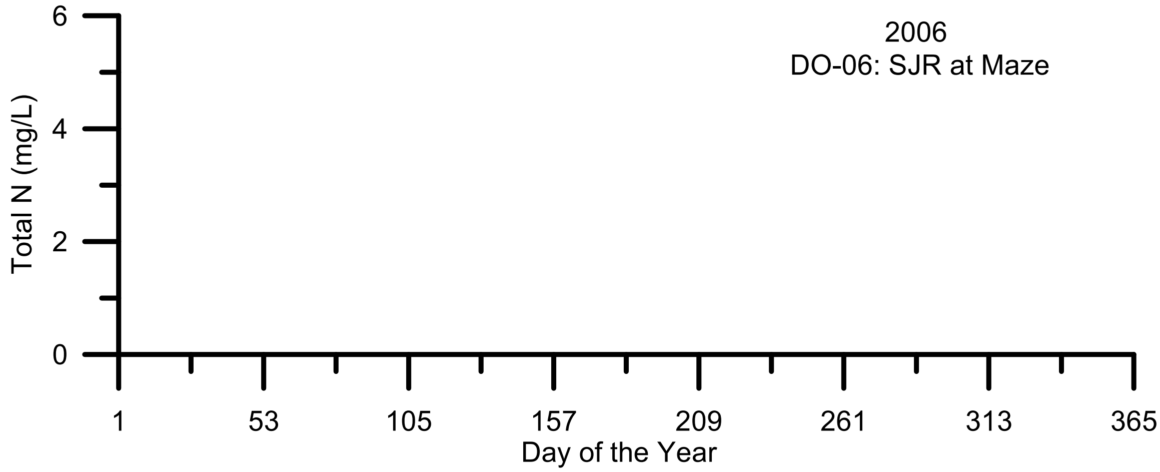


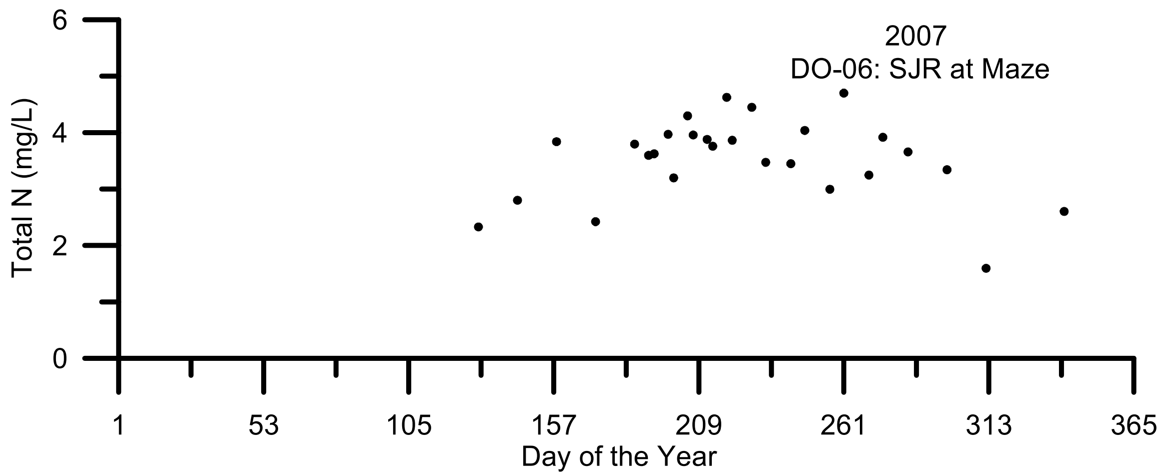

2005
DO-05: SJR at Vernalis-McCune Station
Total N (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

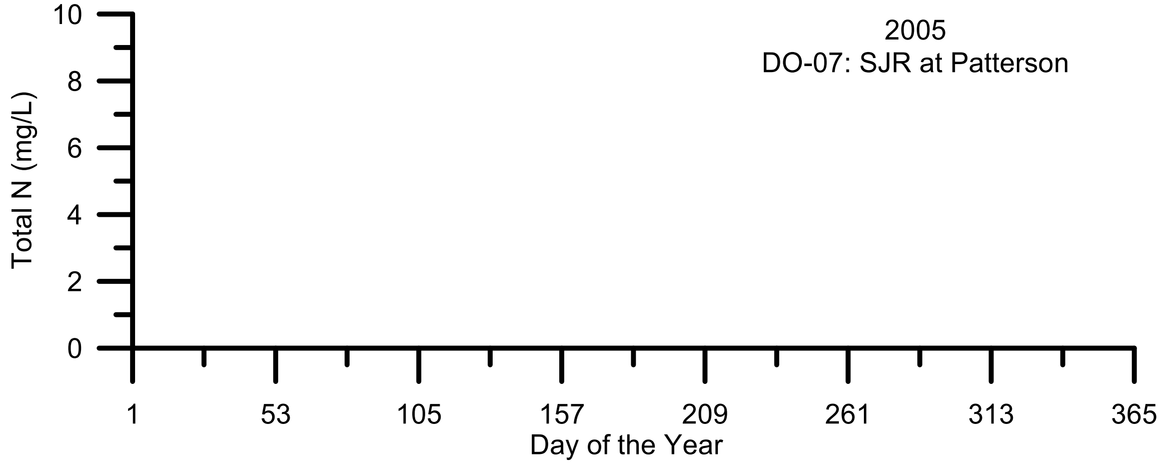

2006
DO-05: SJR at Vernalis-McCune Station
Total N (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

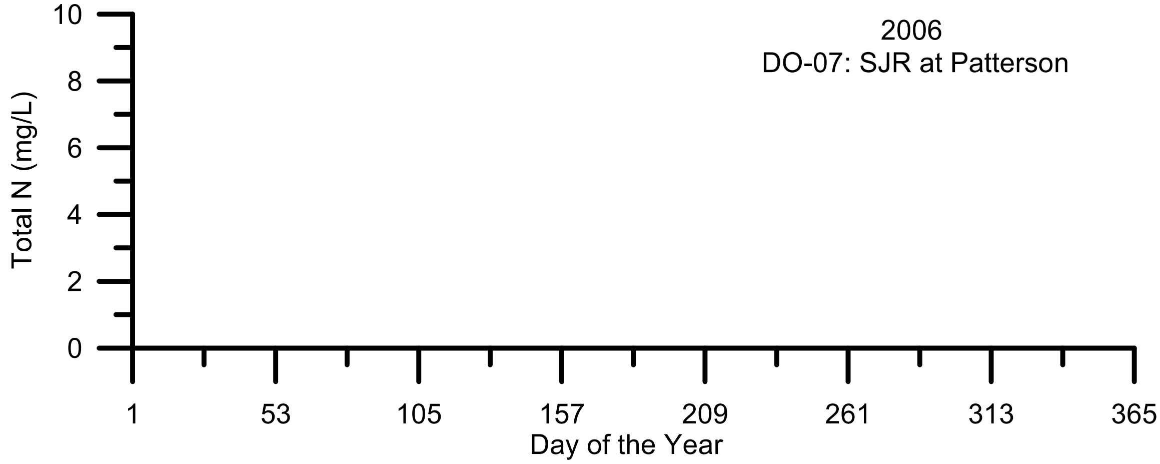

2007
DO-05: SJR at Vernalis-McCune Station
Total N (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

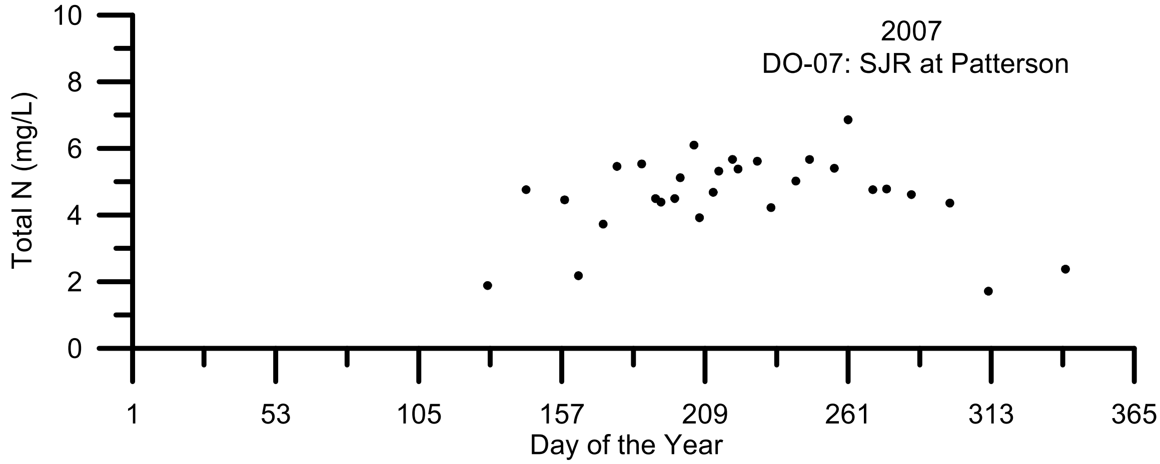

2005
DO-06: SJR at Maze
Total N (mg/L)
Day of the Year

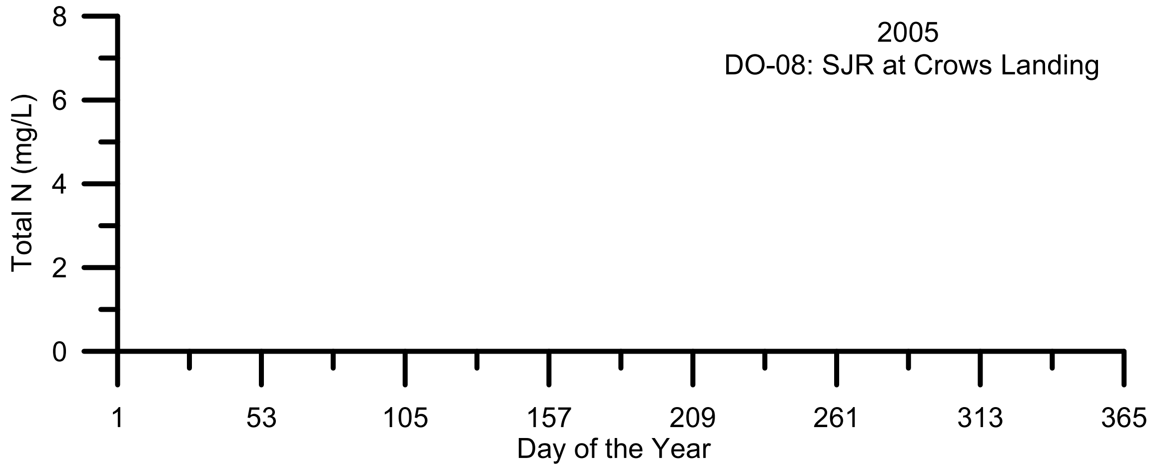

2006
DO-06: SJR at Maze
Total N (mg/L)
Day of the Year

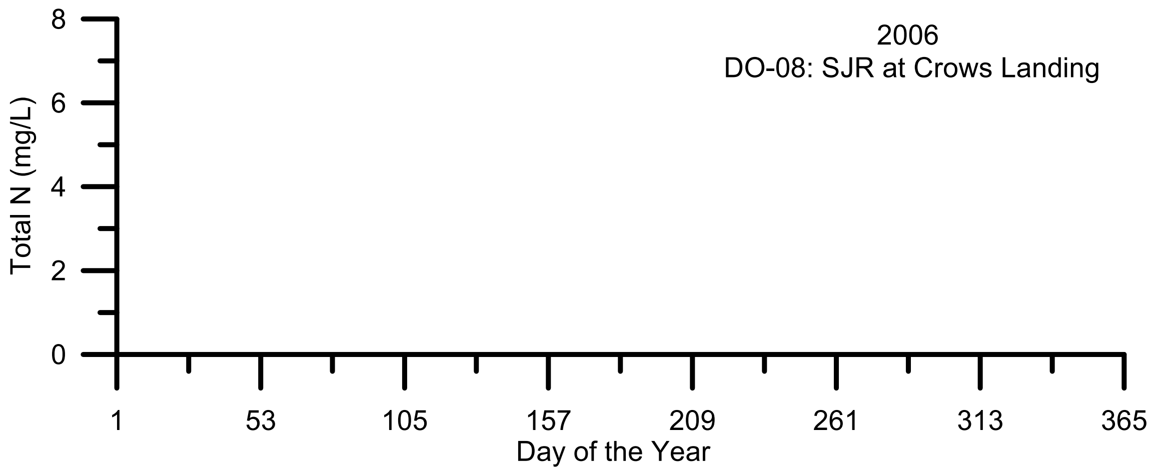

2007
DO-06: SJR at Maze
Total N (mg/L)
Day of the Year

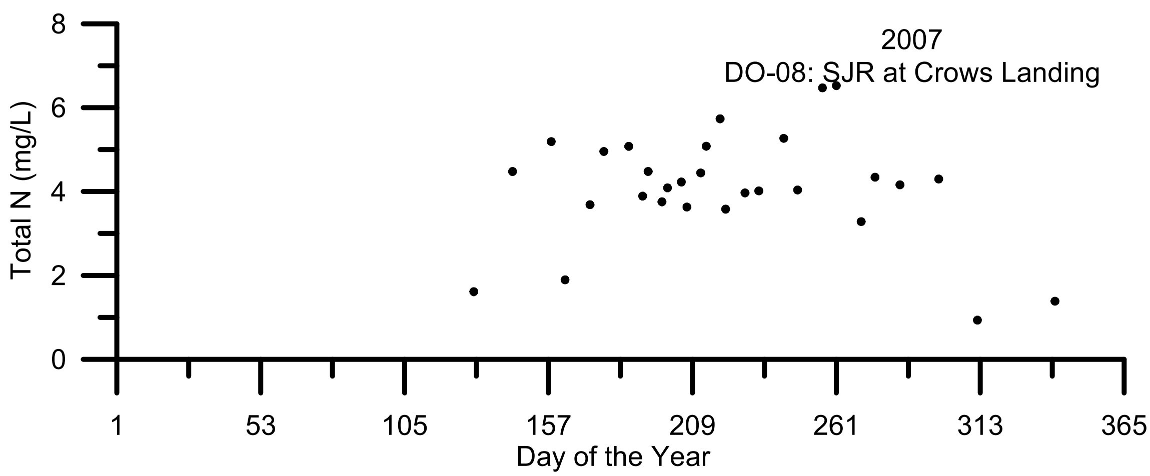

2005
DO-07: SJR at Patterson
Total N (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

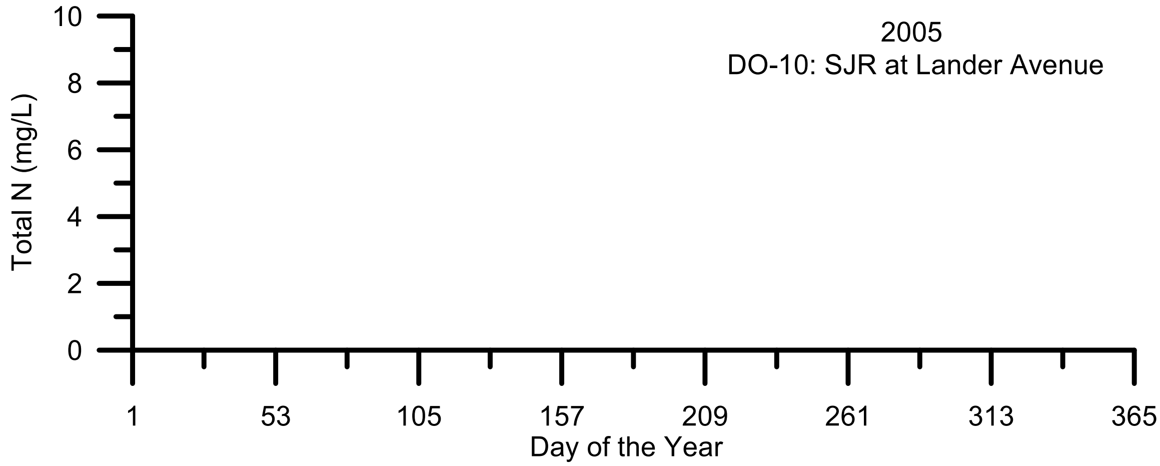

2006
DO-07: SJR at Patterson
Total N (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

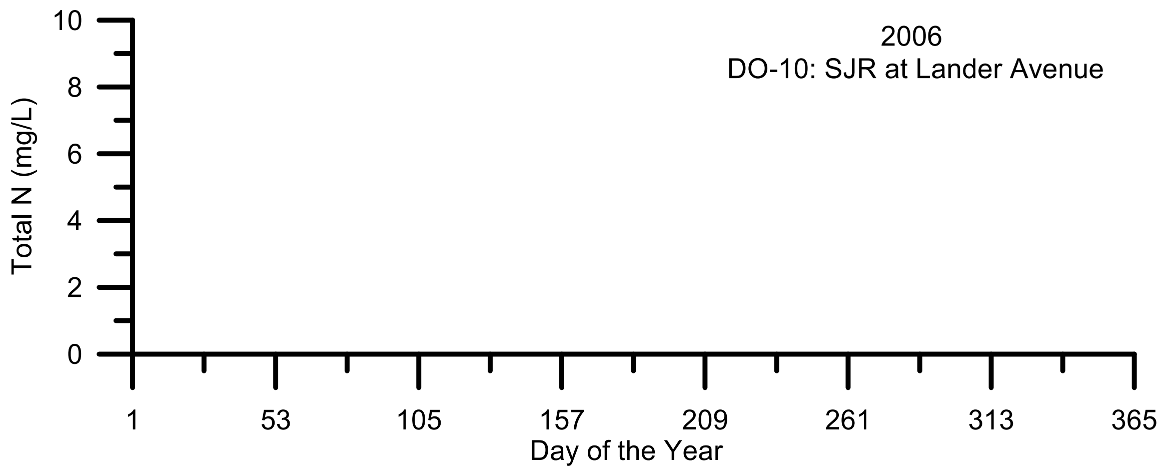

2007
DO-07: SJR at Patterson
Total N (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

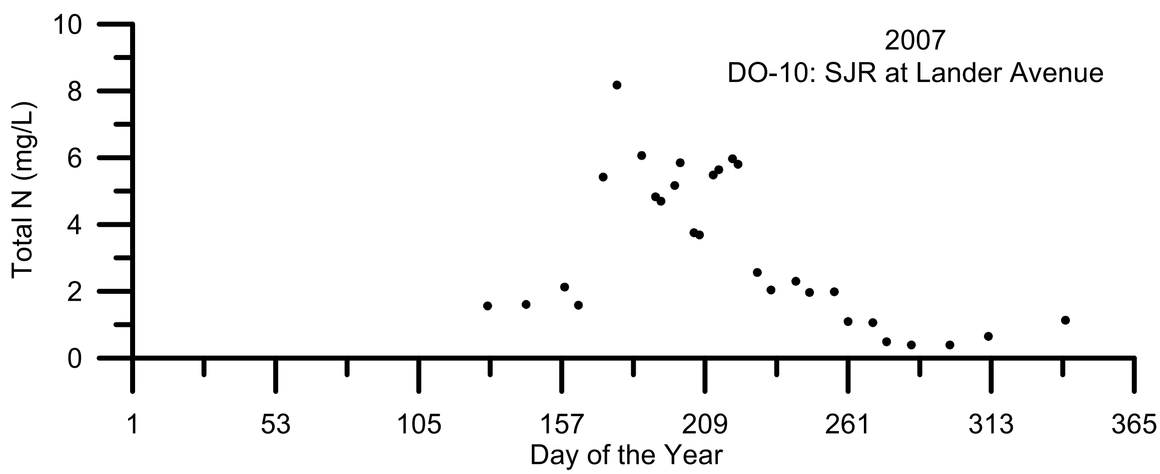

2005
DO-08: SJR at Crows Landing
Total N (mg/L)
8
6
4
2
0
1
53
105
157
209
261
313
365
Day of the Year

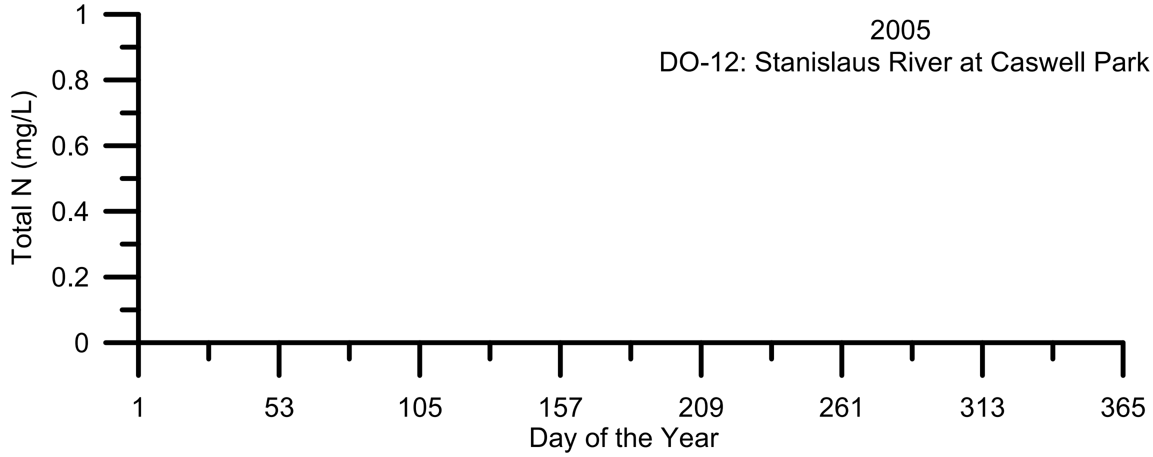

2006
DO-08: SJR at Crows Landing
Total N (mg/L)
8
6
4
2
0
1
53
105
157
209
261
313
365
Day of the Year

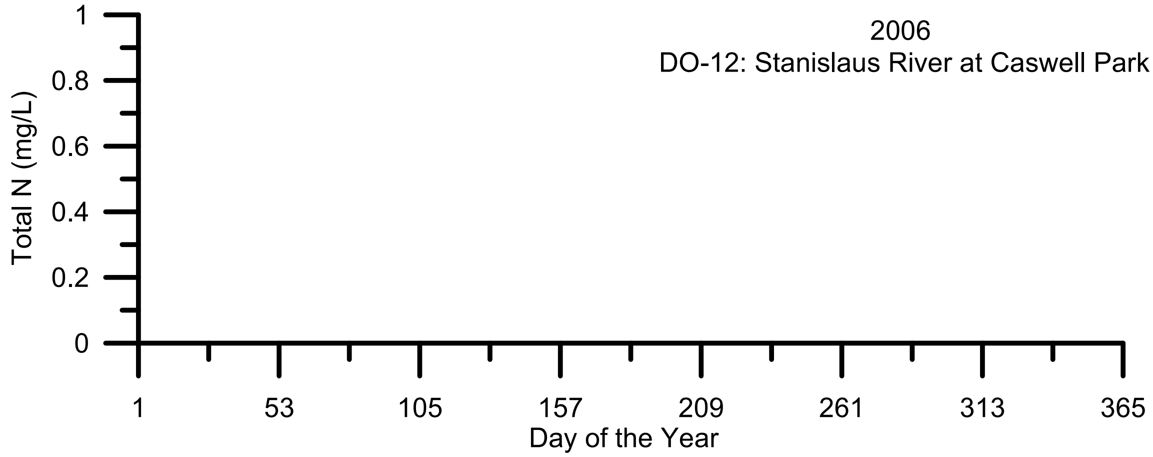

2007
DO-08: SJR at Crows Landing
Total N (mg/L)
8
6
4
2
0
1
53
105
157
209
261
313
365
Day of the Year

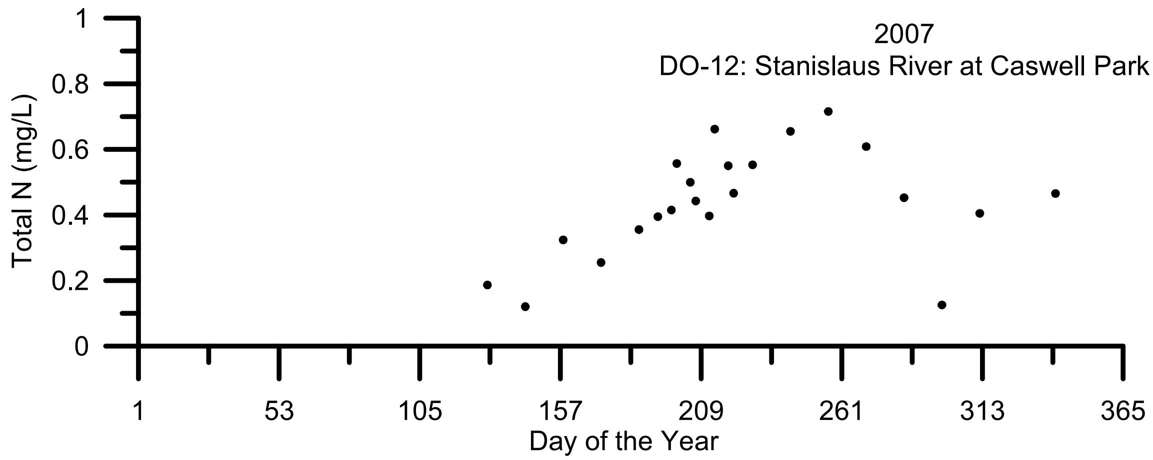

2005
DO-10: SJR at Lander Avenue
Total N (mg/L)
Day of the Year

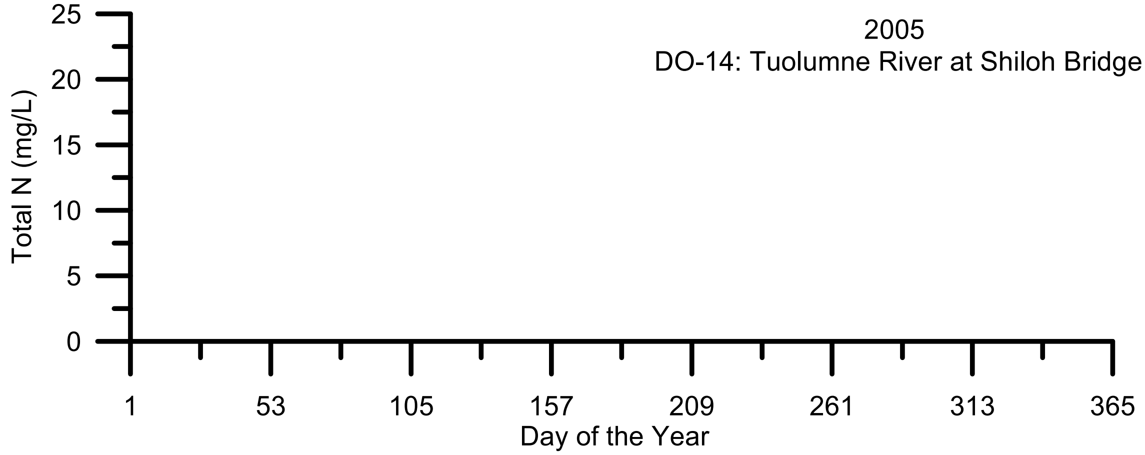

2006
DO-10: SJR at Lander Avenue
Total N (mg/L)
Day of the Year

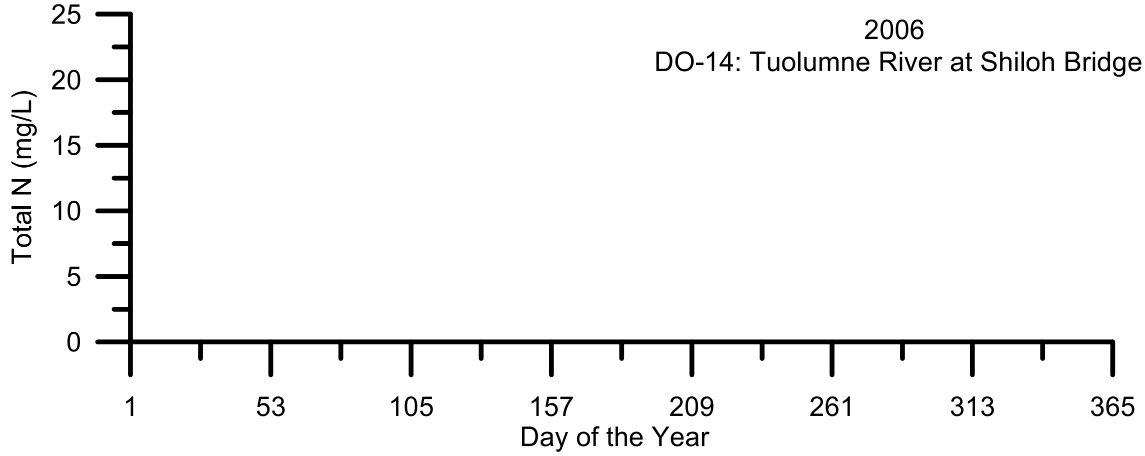

2007
DO-10: SJR at Lander Avenue
Total N (mg/L)
Day of the Year

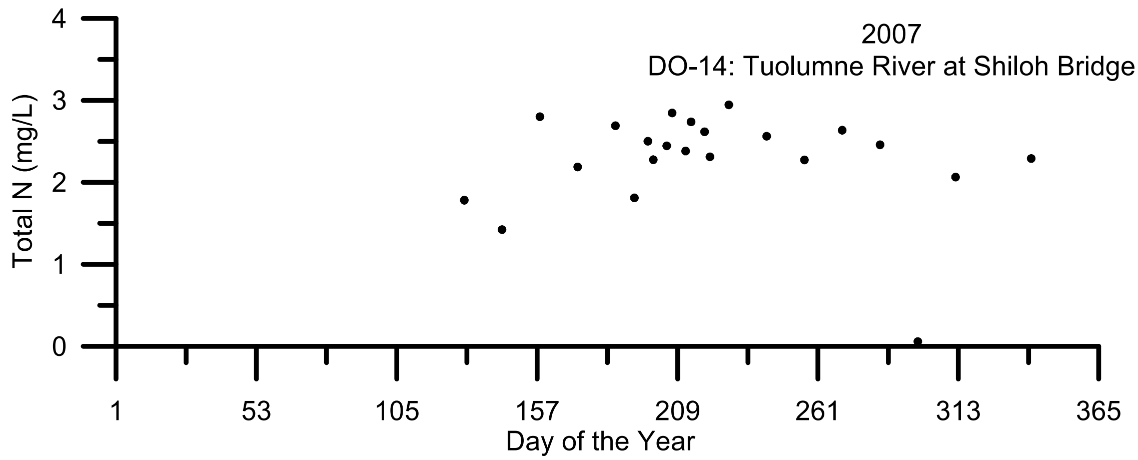

2005
DO-12: Stanislaus River at Caswell Park
Total N (mg/L)
Day of the Year
1
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365

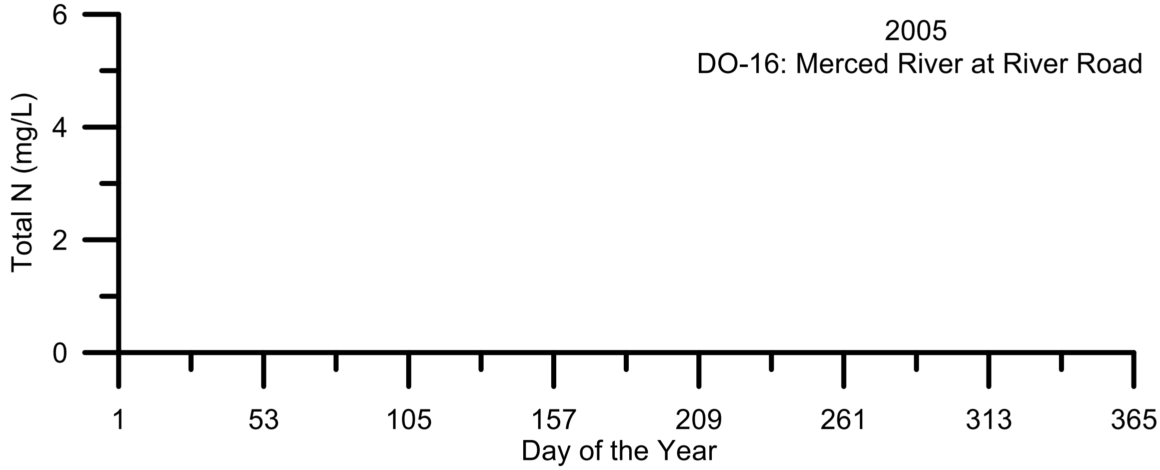

2006
DO-12: Stanislaus River at Caswell Park
Total N (mg/L)
Day of the Year
1
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365

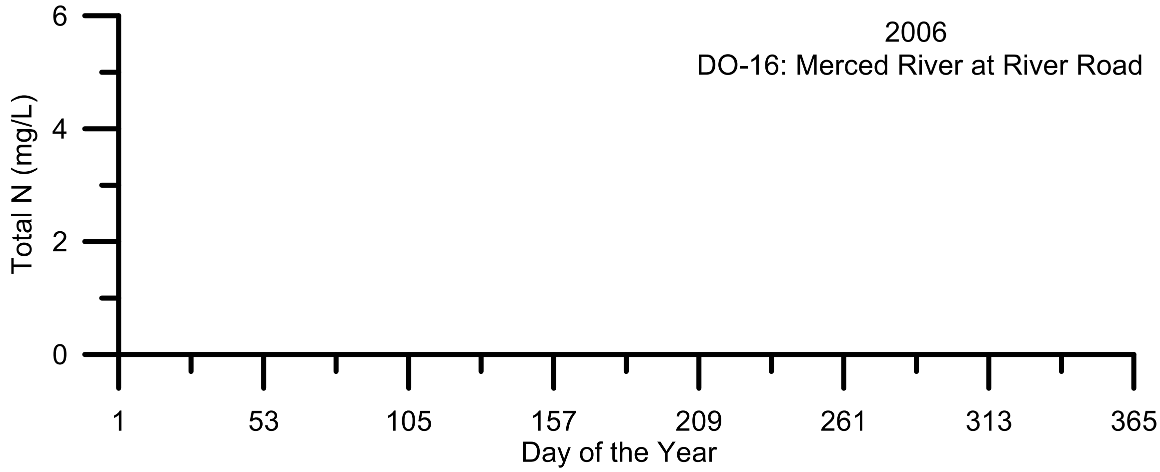

2007
DO-12: Stanislaus River at Caswell Park
Total N (mg/L)
Day of the Year
1
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365

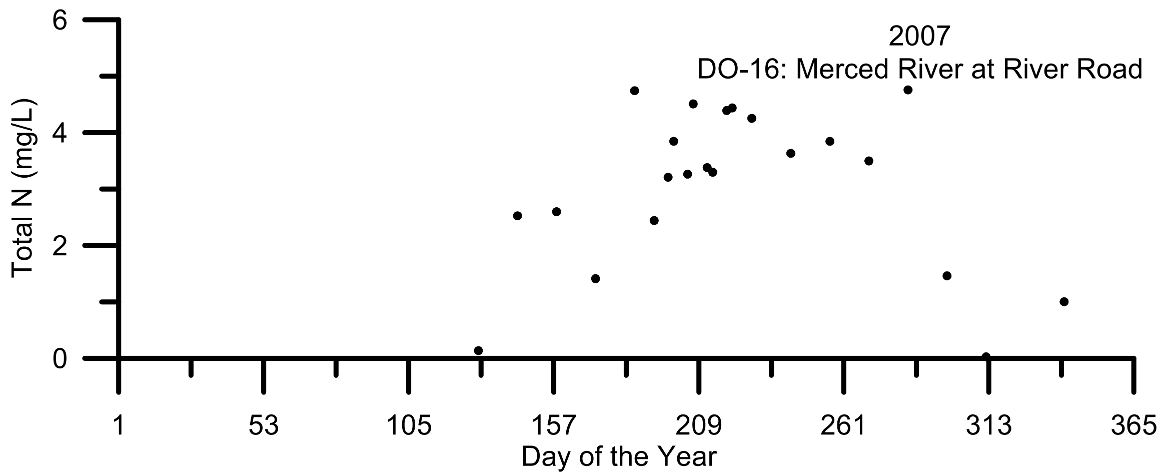

2005
DO-14: Tuolumne River at Shiloh Bridge
Total N (mg/L)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

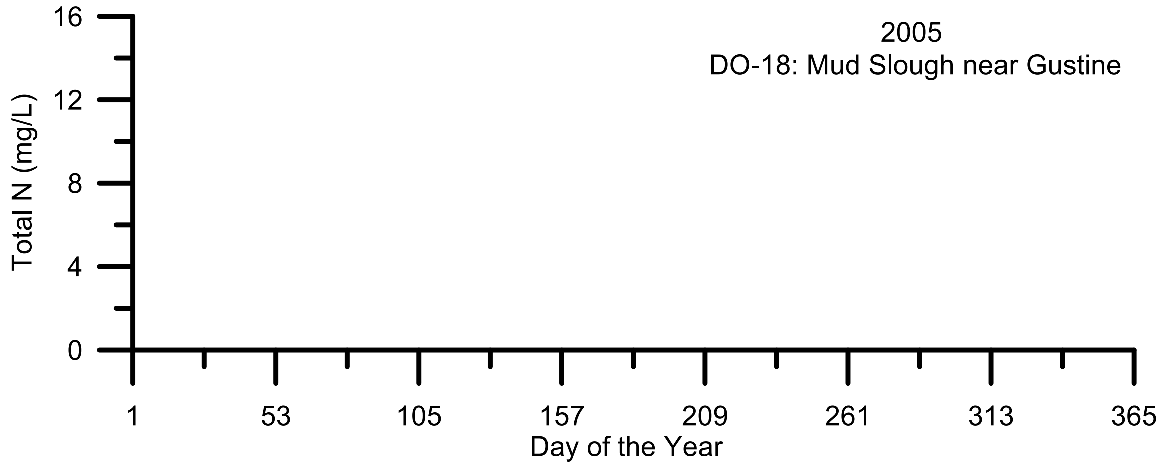

2006
DO-14: Tuolumne River at Shiloh Bridge
Total N (mg/L)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

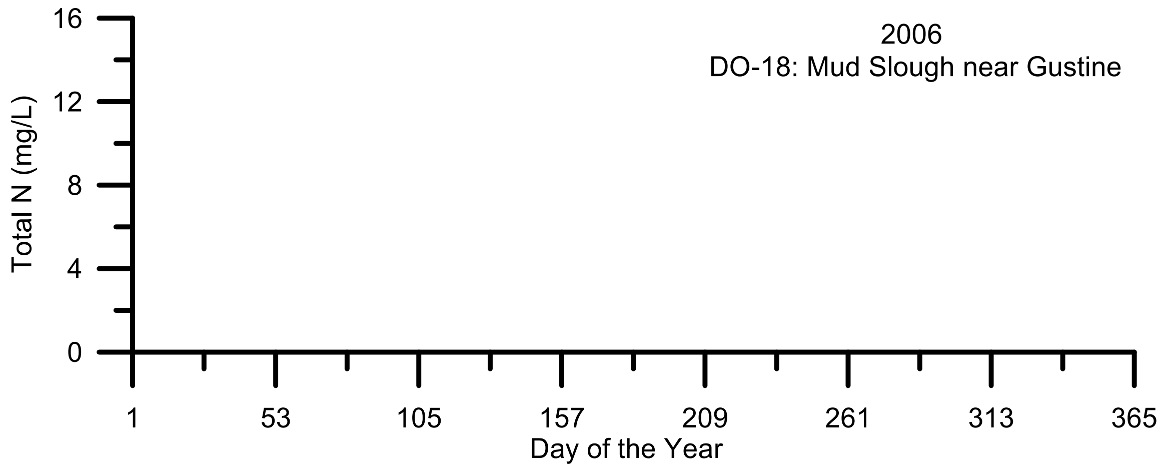

2007
DO-14: Tuolumne River at Shiloh Bridge
Total N (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

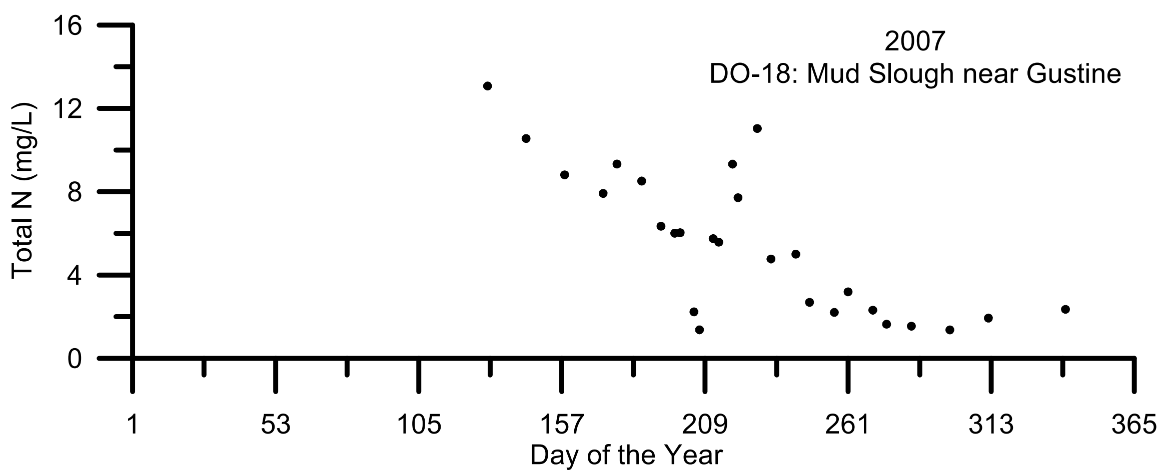

2005
DO-16: Merced River at River Road
Total N (mg/L)
Day of the Year
0
2
4
6
1
53
105
157
209
261
313
365

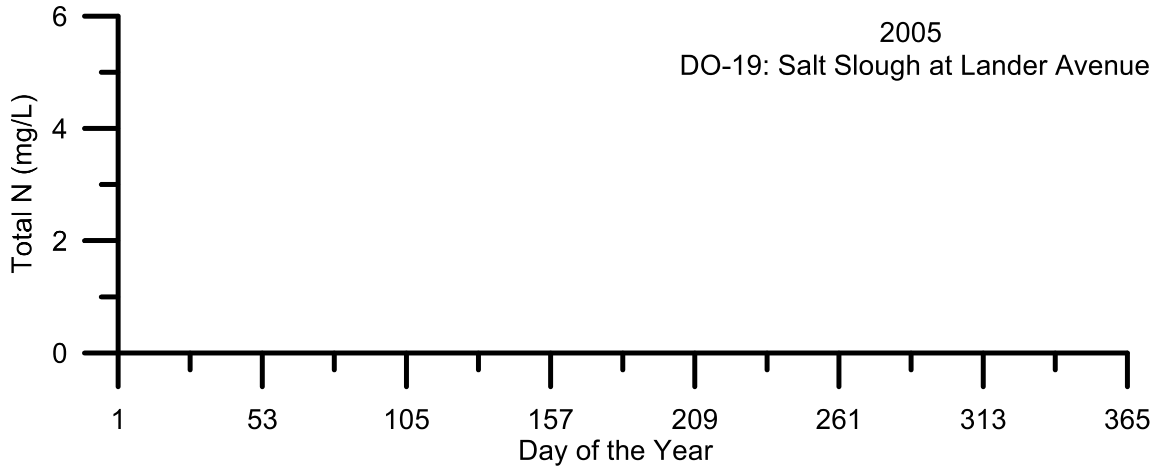

2006
DO-16: Merced River at River Road
Total N (mg/L)
Day of the Year
0
2
4
6
1
53
105
157
209
261
313
365

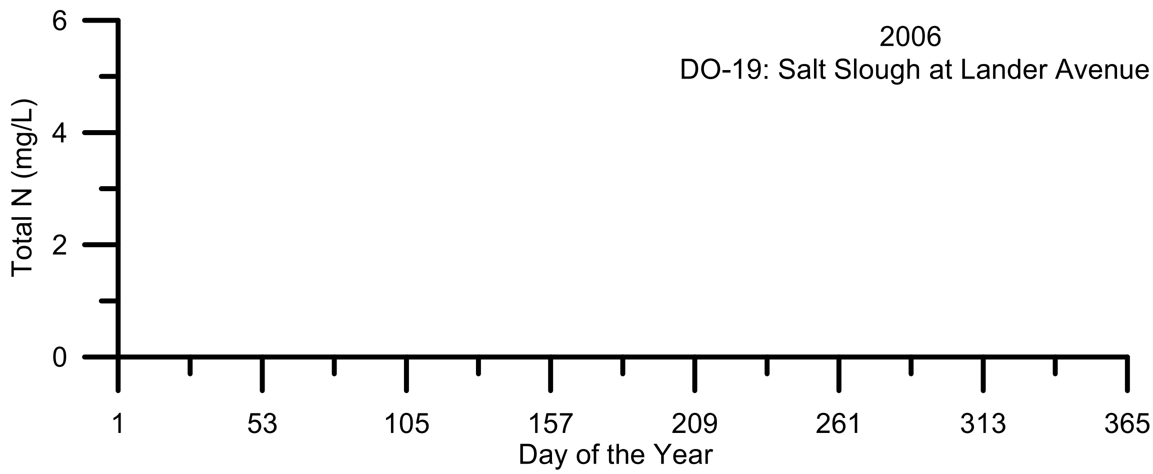

2007
DO-16: Merced River at River Road
Total N (mg/L)
Day of the Year
0
2
4
6
1
53
105
157
209
261
313
365

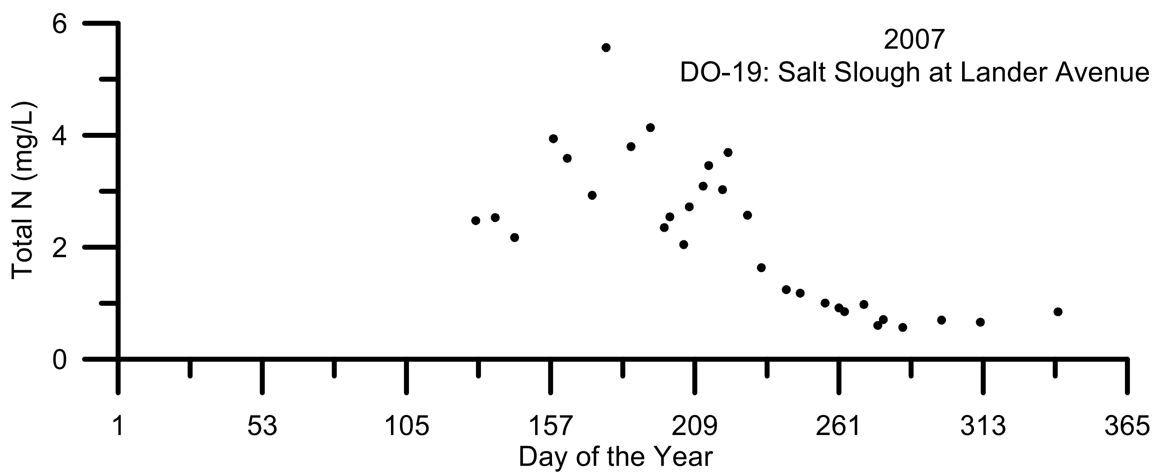

2005
DO-18: Mud Slough near Gustine
Total N (mg/L)
Day of the Year

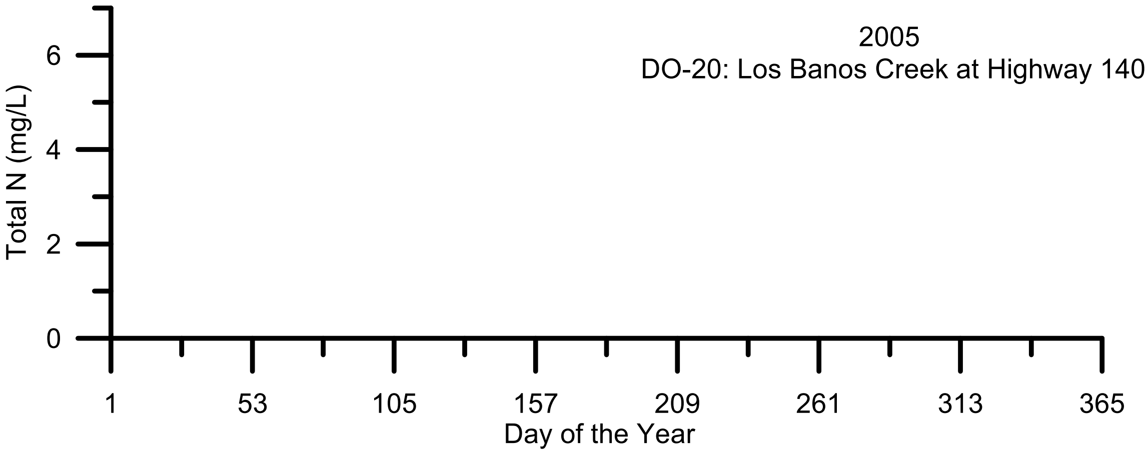

2006
DO-18: Mud Slough near Gustine
Total N (mg/L)
Day of the Year

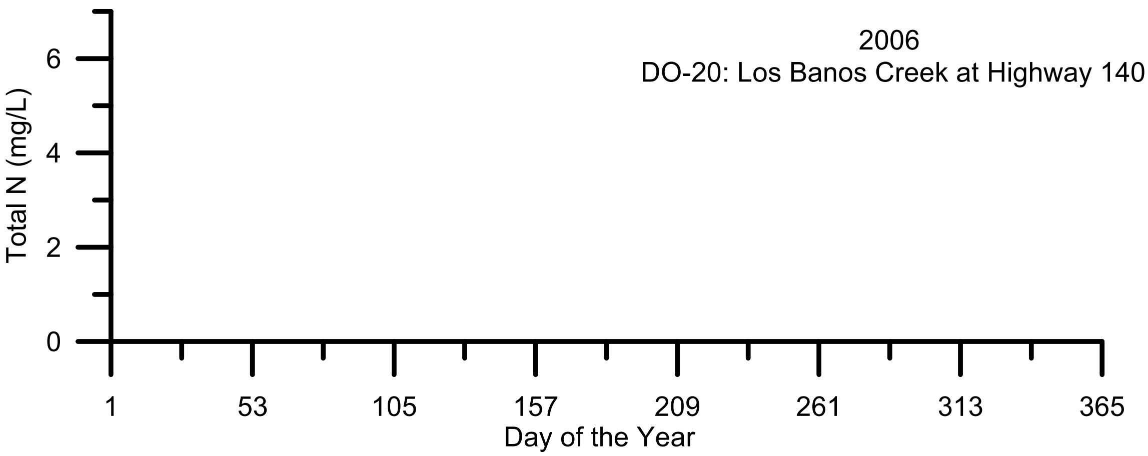

2007
DO-18: Mud Slough near Gustine
Total N (mg/L)
Day of the Year

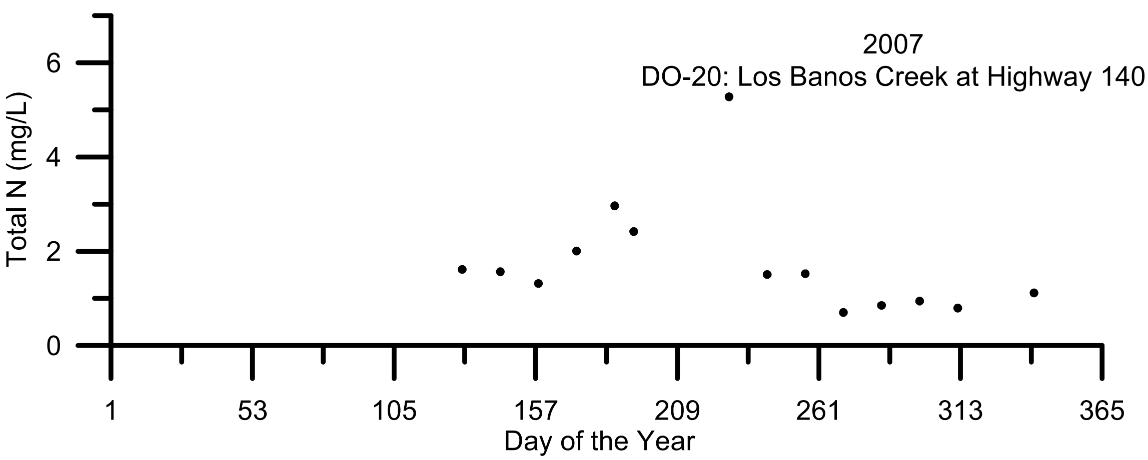

2005
DO-19: Salt Slough at Lander Avenue
Total N (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

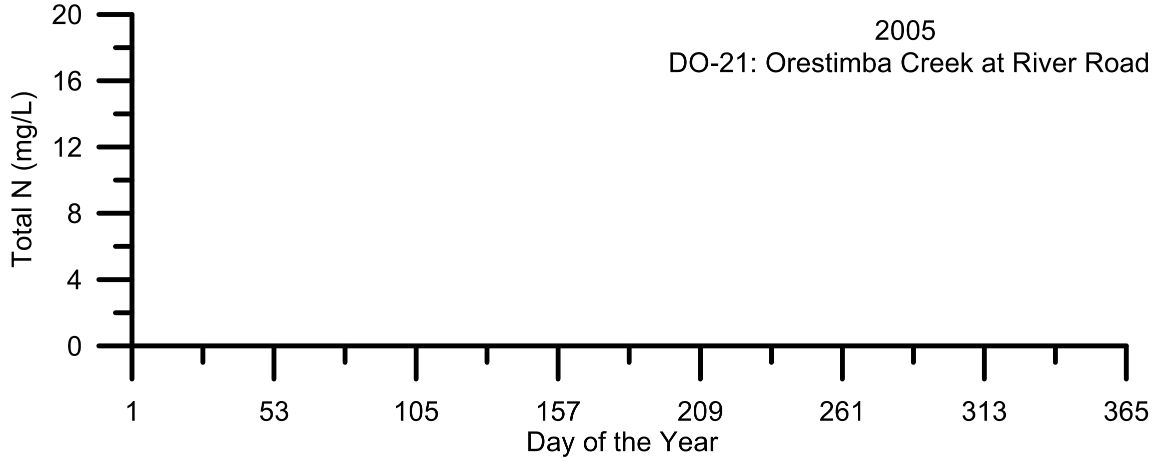

2006
DO-19: Salt Slough at Lander Avenue
Total N (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

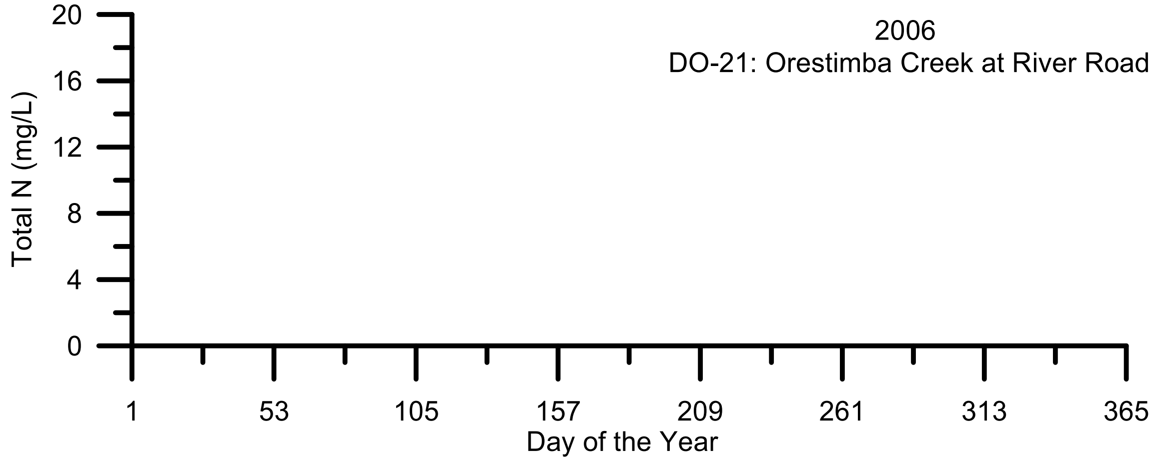

2007
DO-19: Salt Slough at Lander Avenue
Total N (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

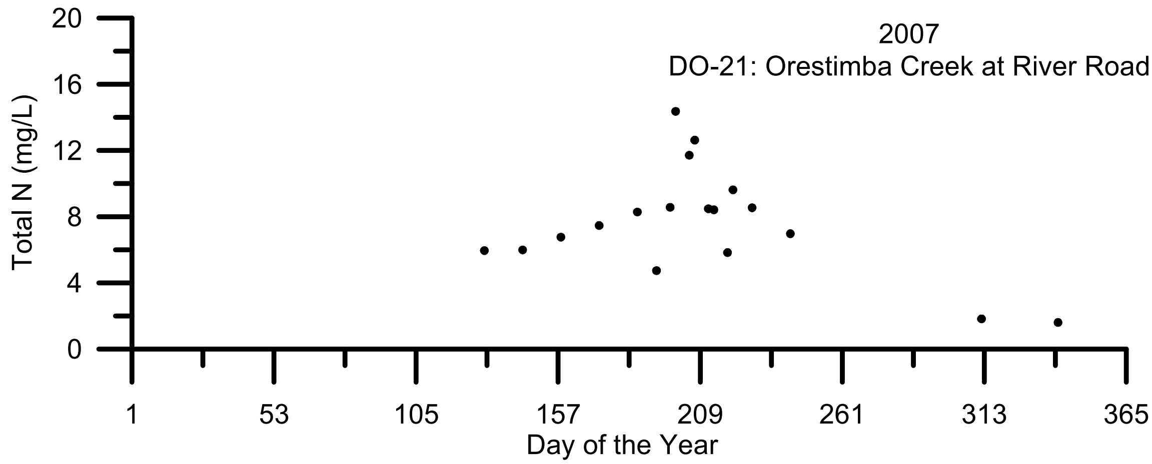

2005
DO-20: Los Banos Creek at Highway 140
Total N (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

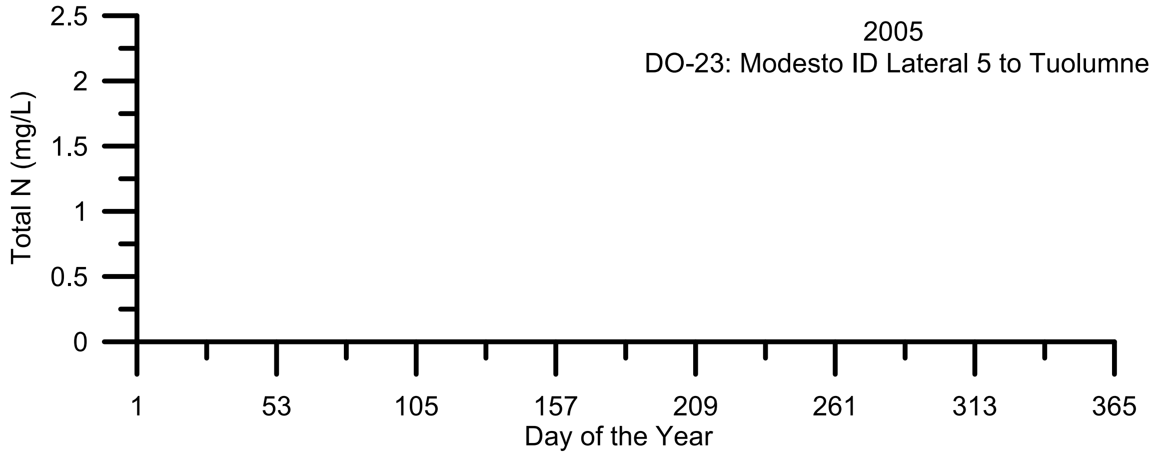

2006
DO-20: Los Banos Creek at Highway 140
Total N (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

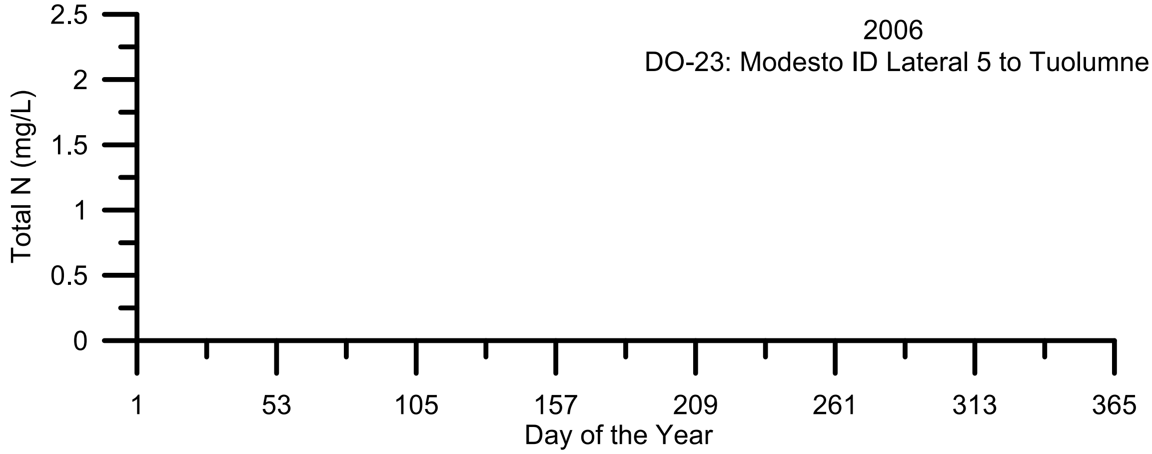

2007
DO-20: Los Banos Creek at Highway 140
Total N (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

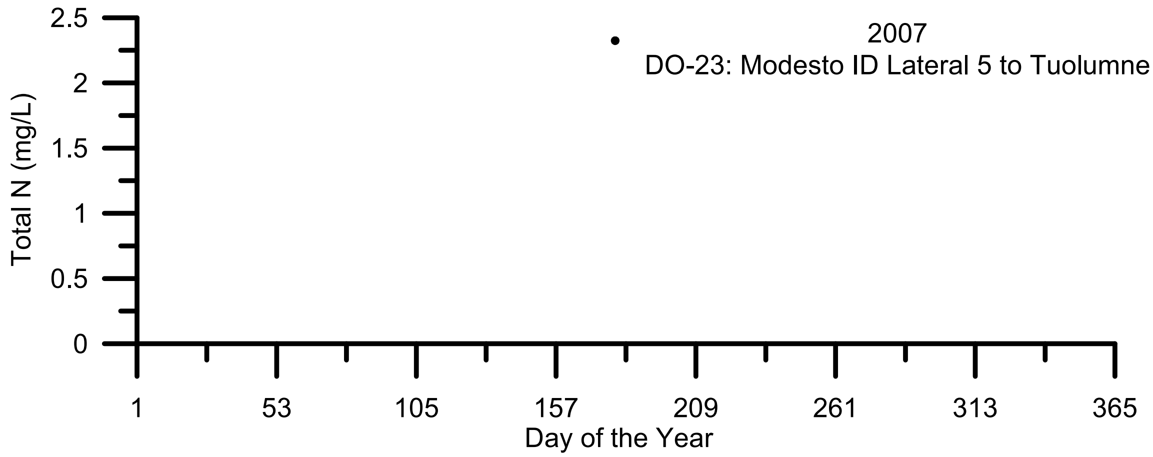

Total N (mg/L)
2005
DO-21: Orestimba Creek at River Road
Day of the Year

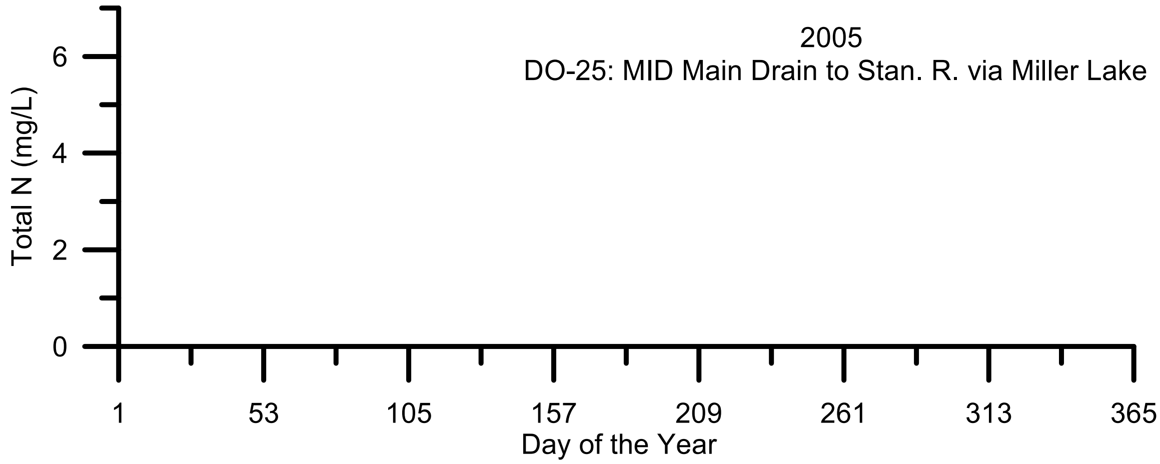

Total N (mg/L)
2006
DO-21: Orestimba Creek at River Road
Day of the Year

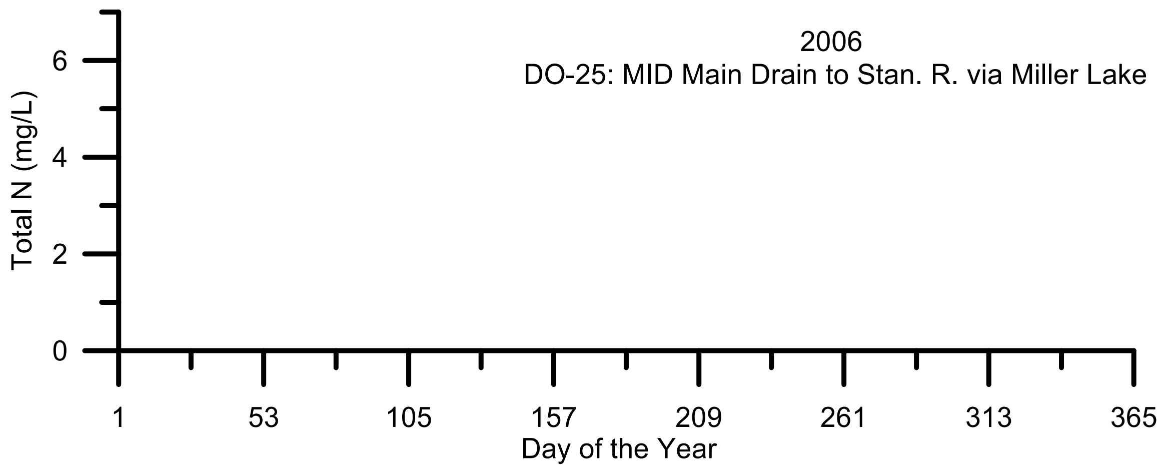

Total N (mg/L)
2007
DO-21: Orestimba Creek at River Road
Day of the Year

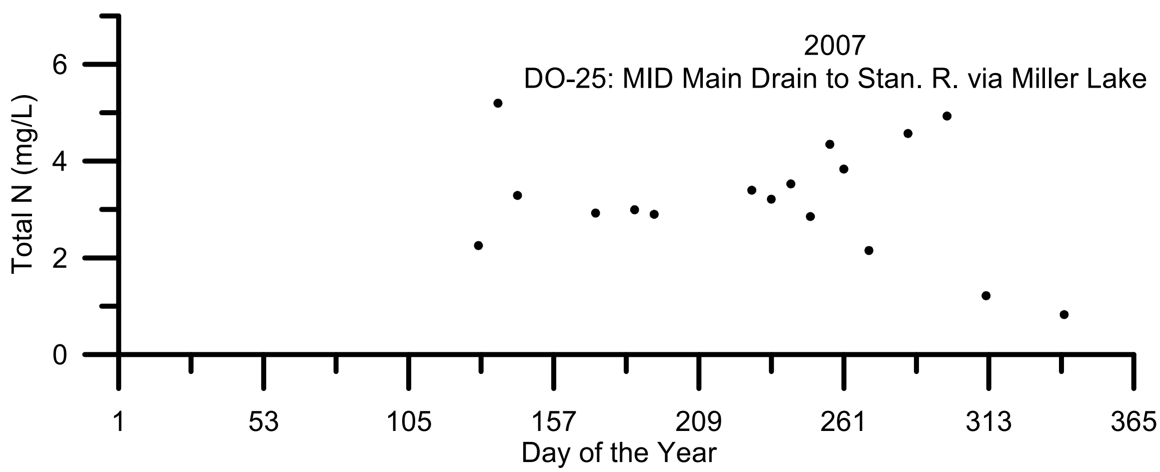

2005
DO-23: Modesto ID Lateral 5 to Tuolumne
Total N (mg/L)
0
0.5
1
1.5
2
2.5
1
53
105
157
209
261
313
365
Day of the Year

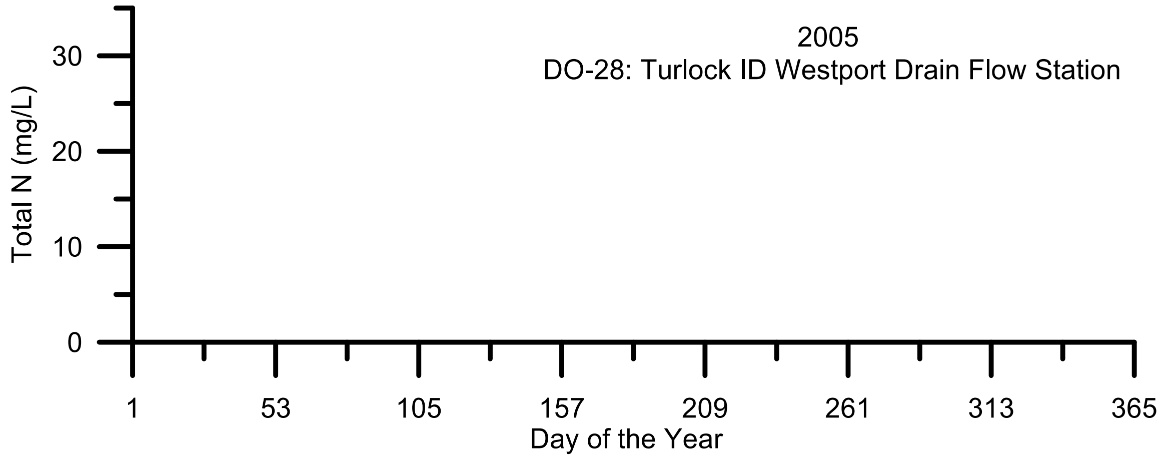

2006
DO-23: Modesto ID Lateral 5 to Tuolumne
Total N (mg/L)
0
0.5
1
1.5
2
2.5
1
53
105
157
209
261
313
365
Day of the Year

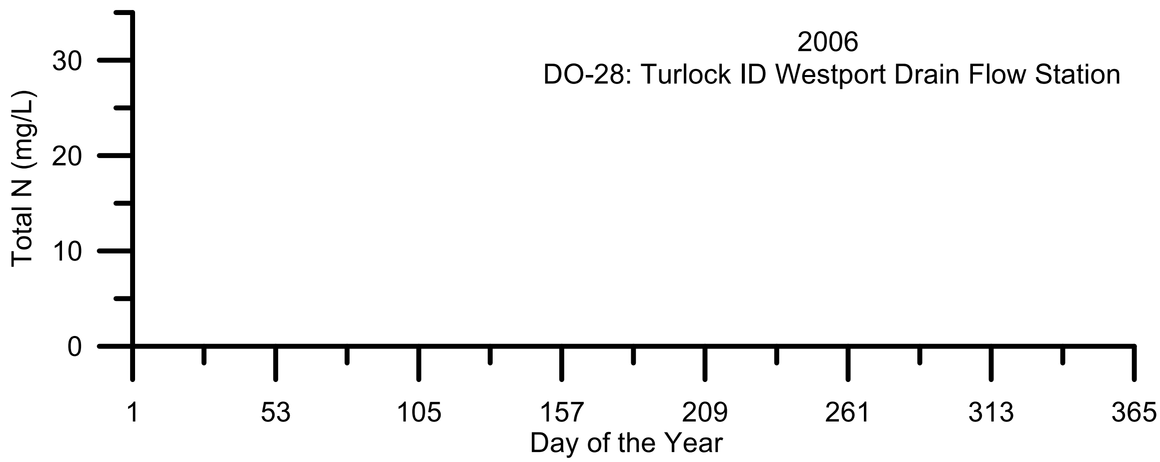

2007
DO-23: Modesto ID Lateral 5 to Tuolumne
Total N (mg/L)
0
0.5
1
1.5
2
2.5
1
53
105
157
209
261
313
365
Day of the Year

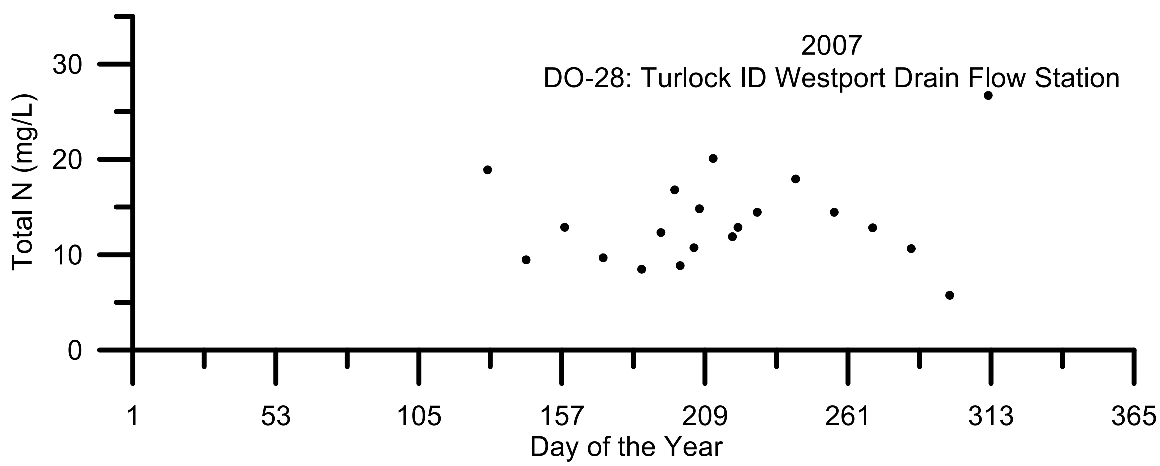

2005
DO-25: MID Main Drain to Stan. R. via Miller Lake
Total N (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

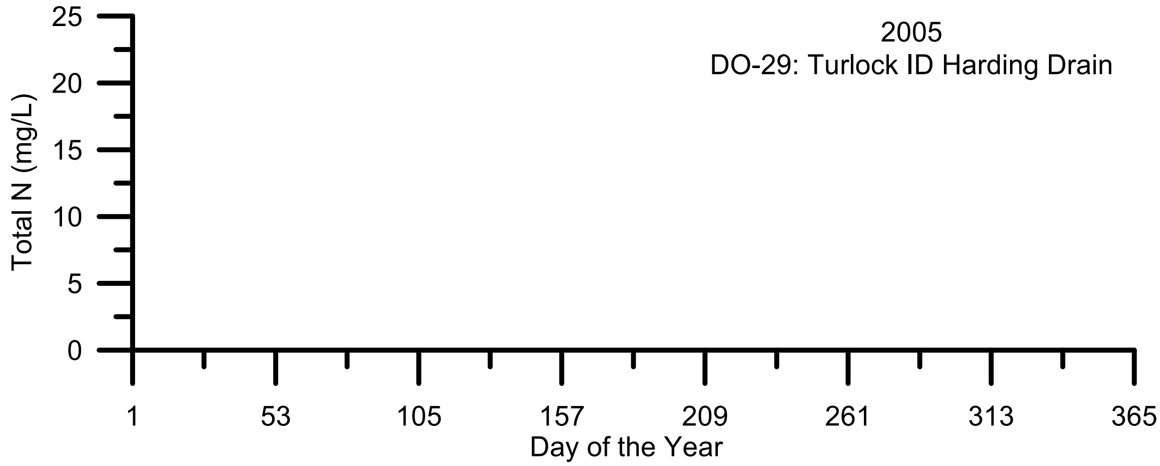

2006
DO-25: MID Main Drain to Stan. R. via Miller Lake
Total N (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

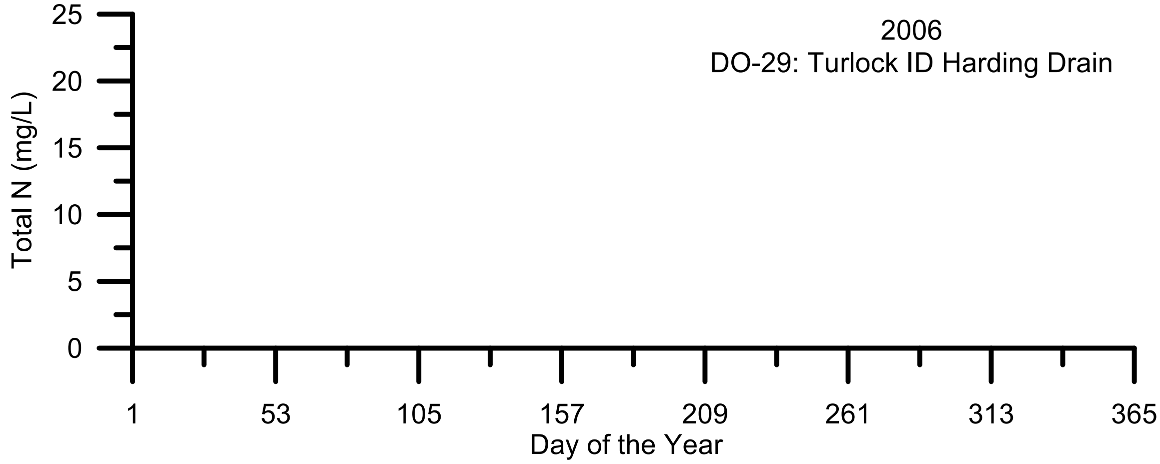

2007
DO-25: MID Main Drain to Stan. R. via Miller Lake
Total N (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

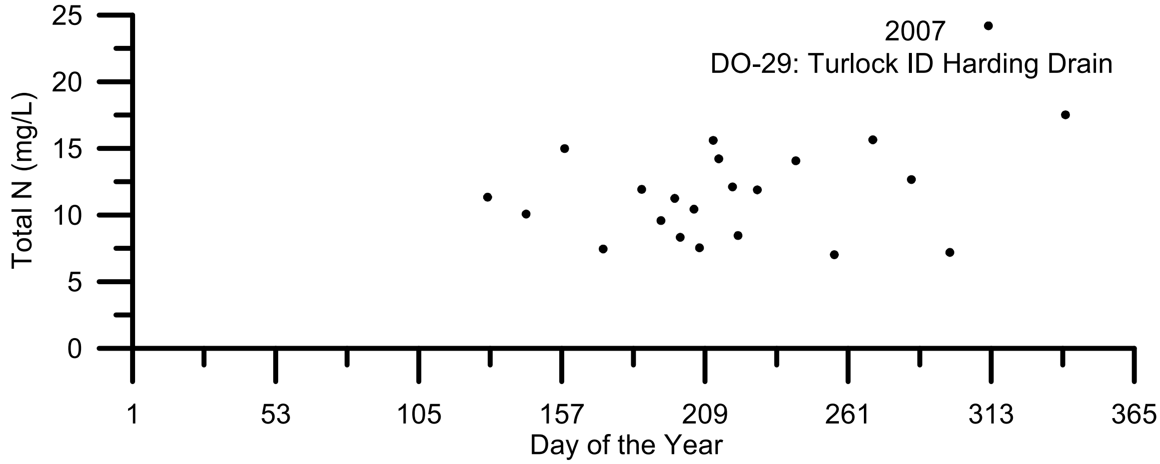

2005
DO-28: Turlock ID Westport Drain Flow Station
Total N (mg/L)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

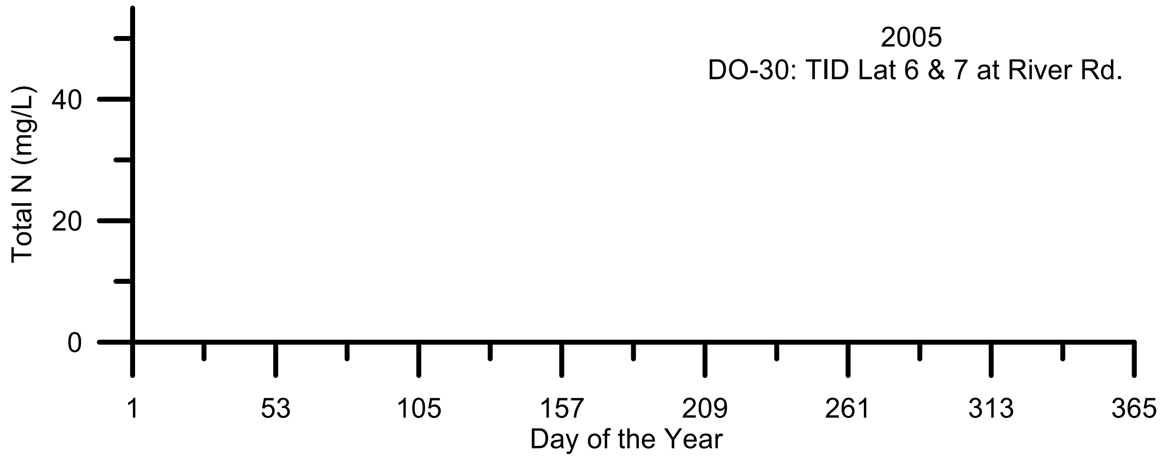

2006
DO-28: Turlock ID Westport Drain Flow Station
Total N (mg/L)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

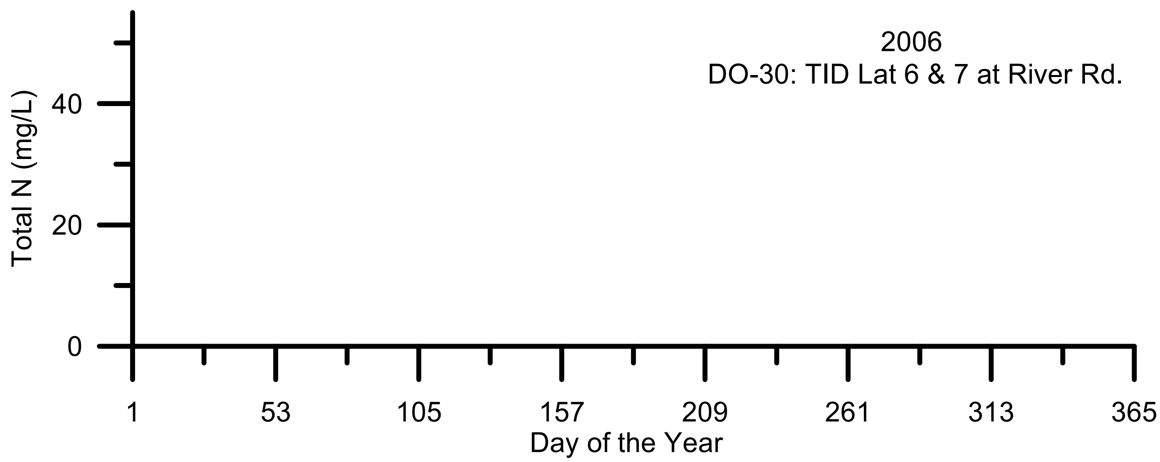

2007
DO-28: Turlock ID Westport Drain Flow Station
Total N (mg/L)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

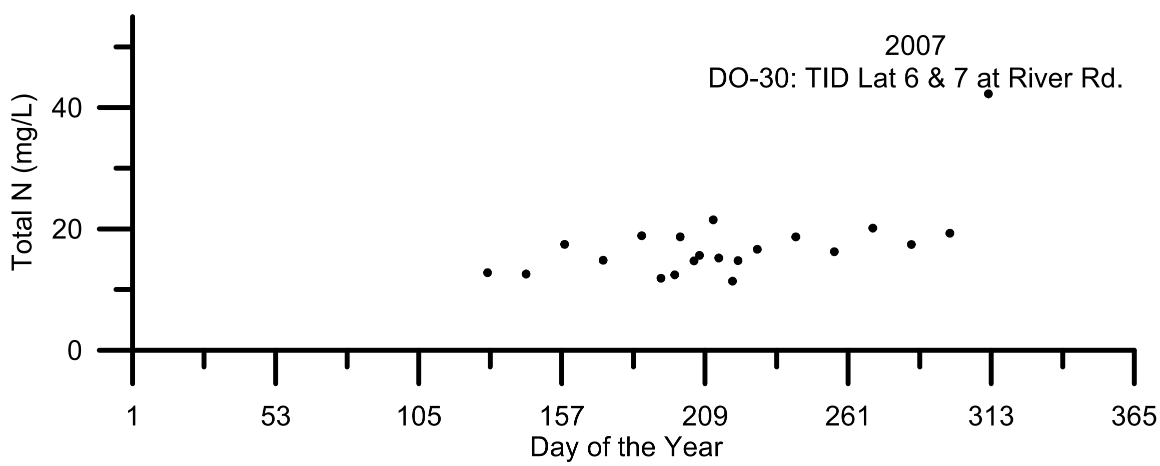

2005
DO-29: Turlock ID Harding Drain
Total N (mg/L)
25
20
15
10
5
0
1
53
105
157
209
261
313
365
Day of the Year

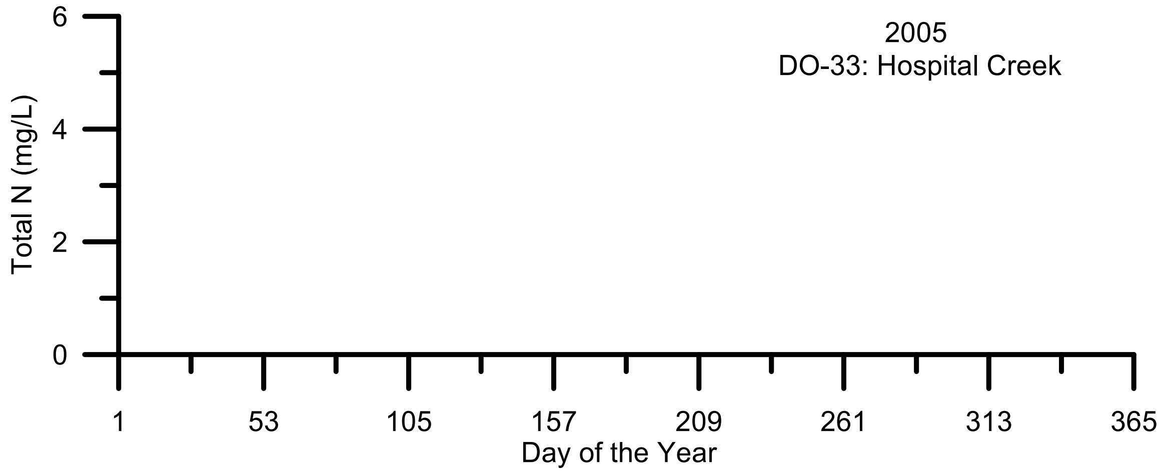

2006
DO-29: Turlock ID Harding Drain
Total N (mg/L)
25
20
15
10
5
0
1
53
105
157
209
261
313
365
Day of the Year

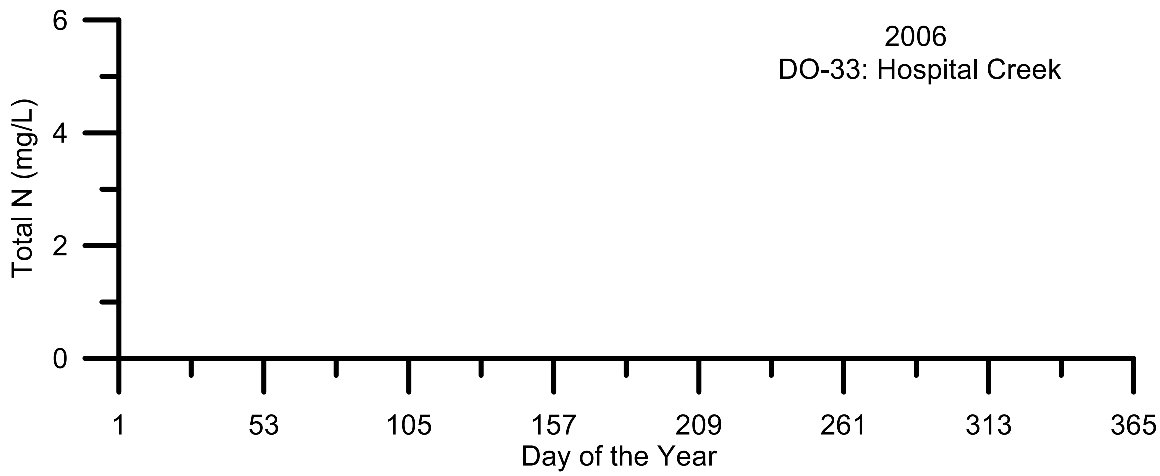

2007
DO-29: Turlock ID Harding Drain
Total N (mg/L)
25
20
15
10
5
0
1
53
105
157
209
261
313
365
Day of the Year

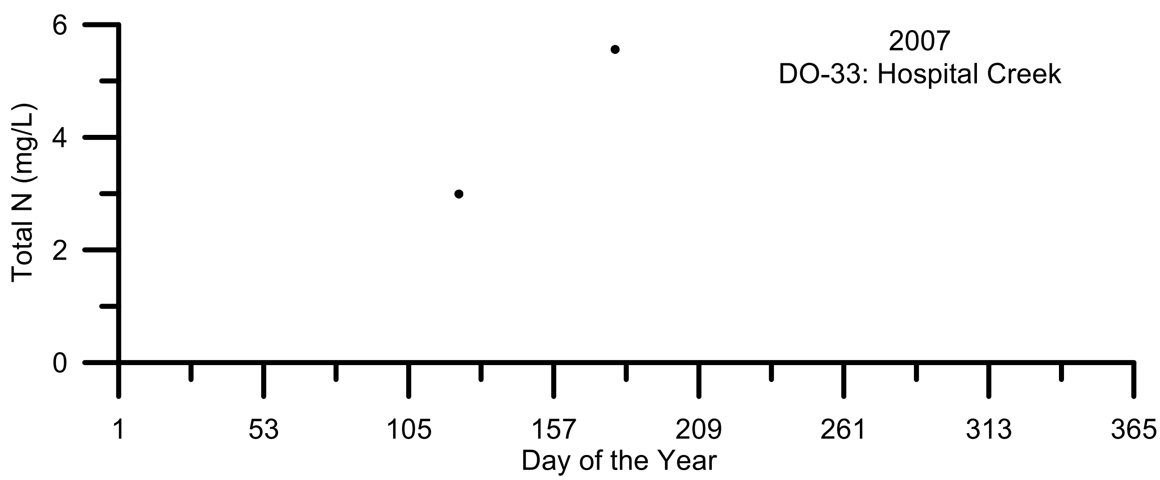

2005
DO-30: TID Lat 6 & 7 at River Rd.
Total N (mg/L)
0
20
40
1
53
105
157
209
261
313
365
Day of the Year

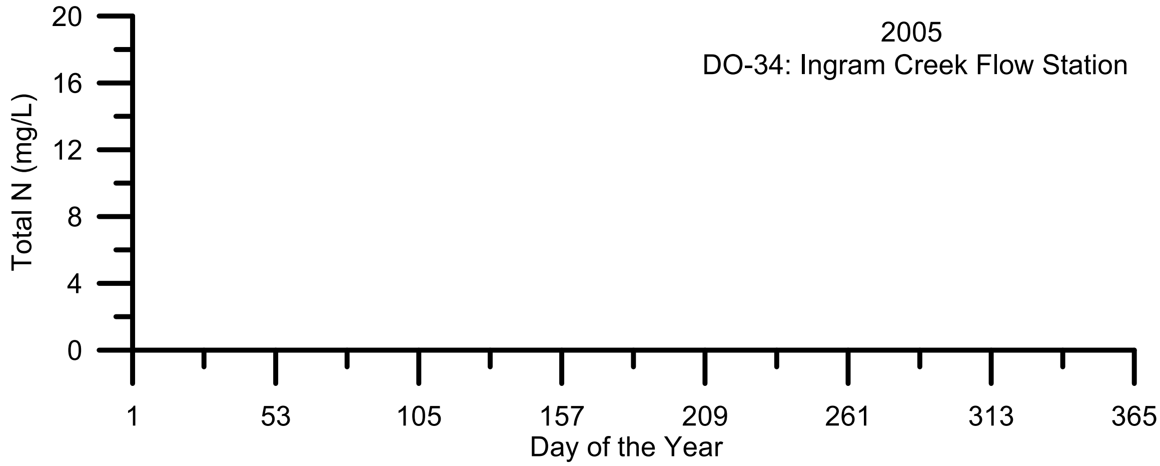

2006
DO-30: TID Lat 6 & 7 at River Rd.
Total N (mg/L)
0
20
40
1
53
105
157
209
261
313
365
Day of the Year

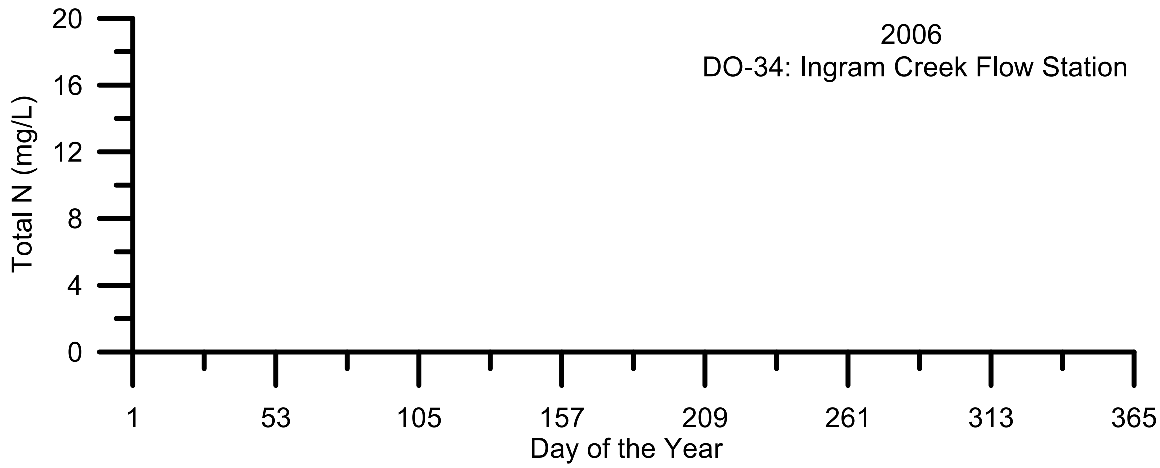

2007
DO-30: TID Lat 6 & 7 at River Rd.
Total N (mg/L)
0
20
40
1
53
105
157
209
261
313
365
Day of the Year

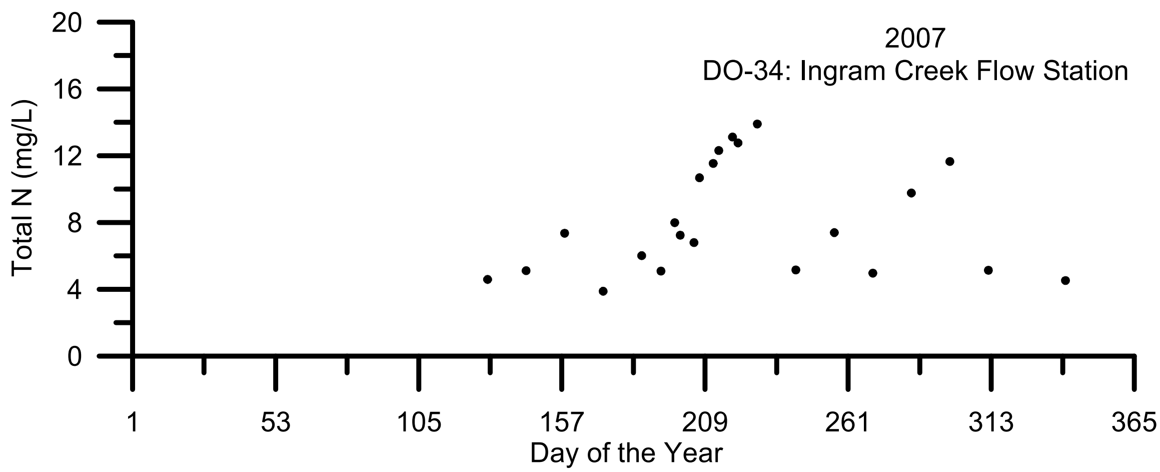

2005
DO-33: Hospital Creek
Total N (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

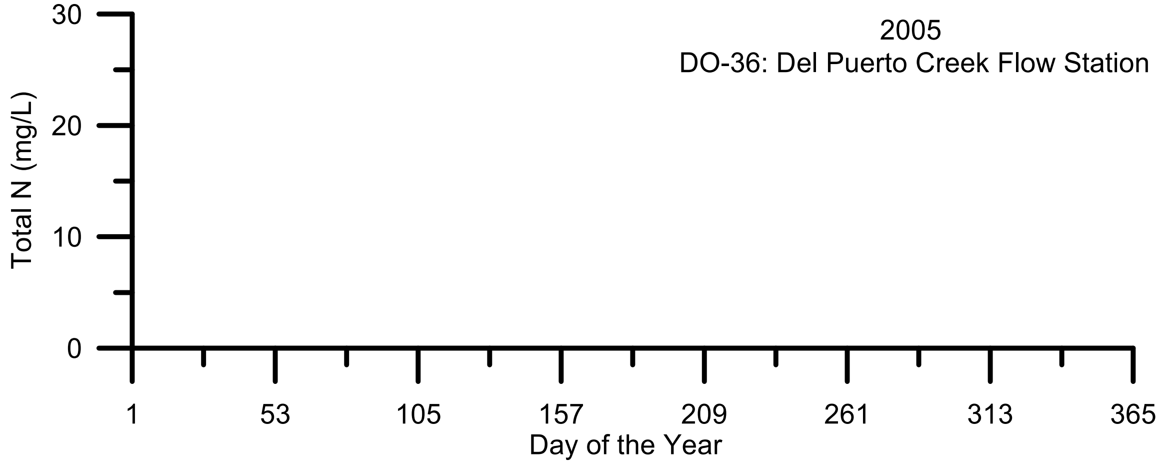

2006
DO-33: Hospital Creek
Total N (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

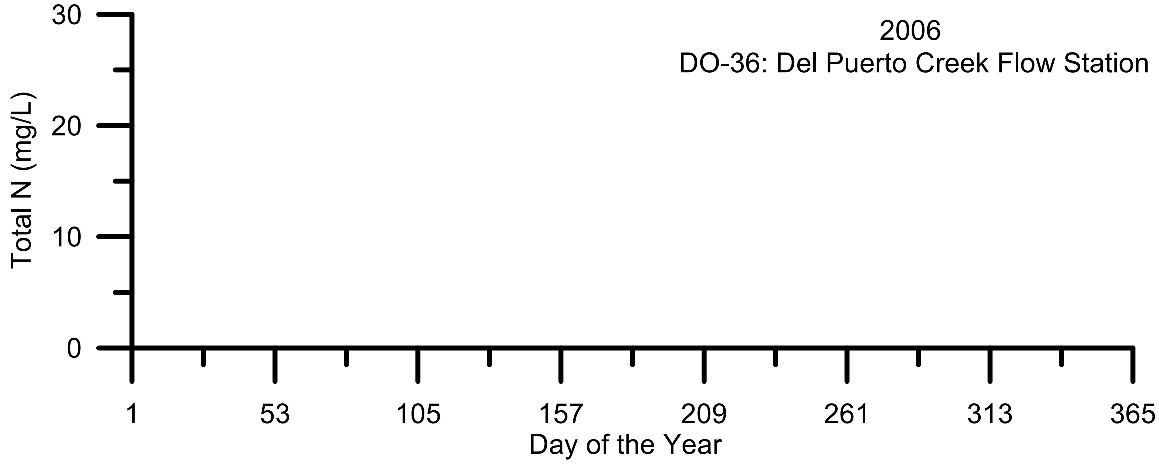

2007
DO-33: Hospital Creek
Total N (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

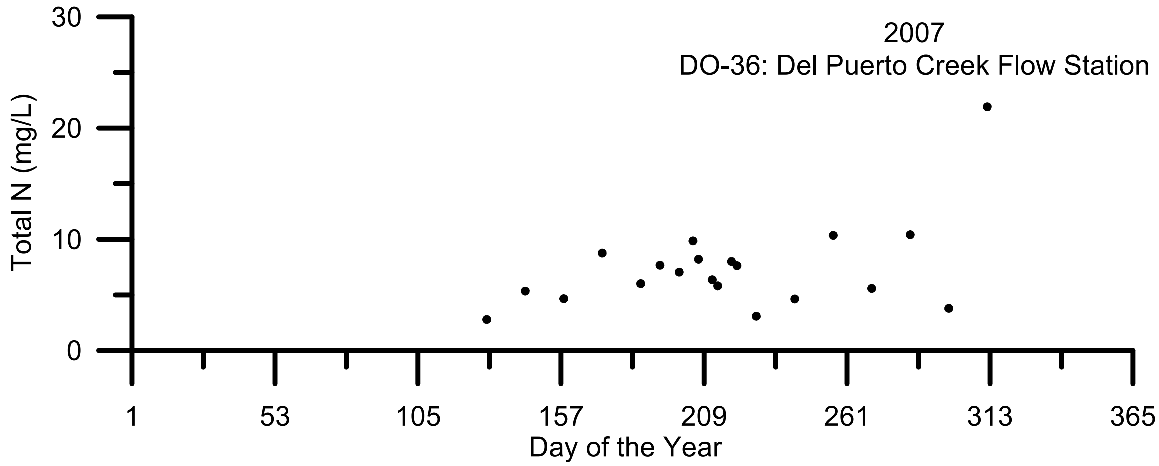

2005
DO-34: Ingram Creek Flow Station
Total N (mg/L)
Day of the Year

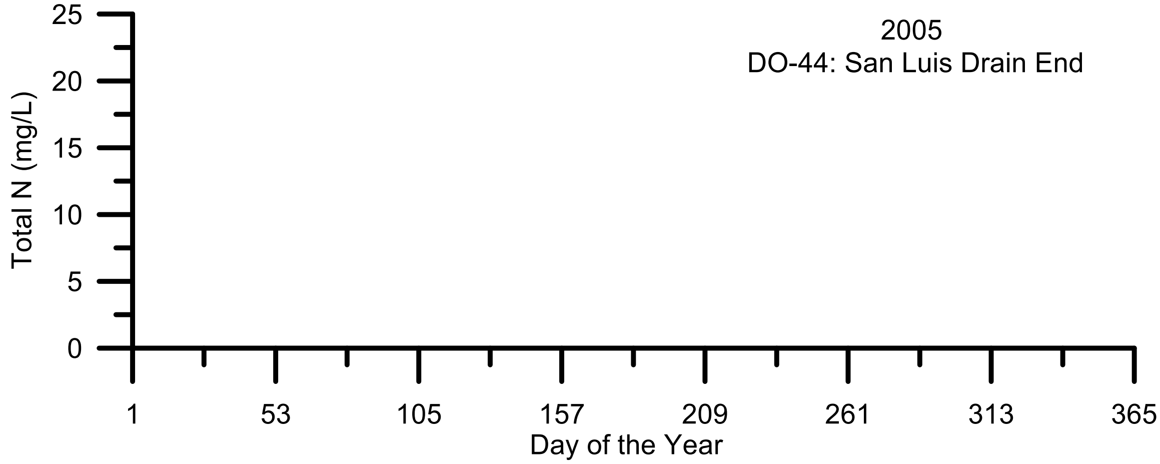

2006
DO-34: Ingram Creek Flow Station
Total N (mg/L)
Day of the Year

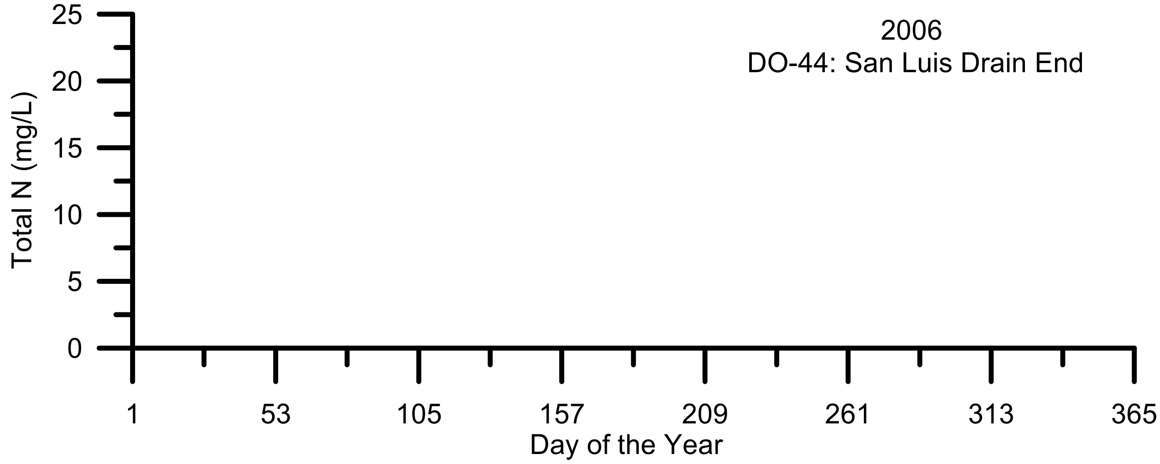

2007
DO-34: Ingram Creek Flow Station
Total N (mg/L)
Day of the Year

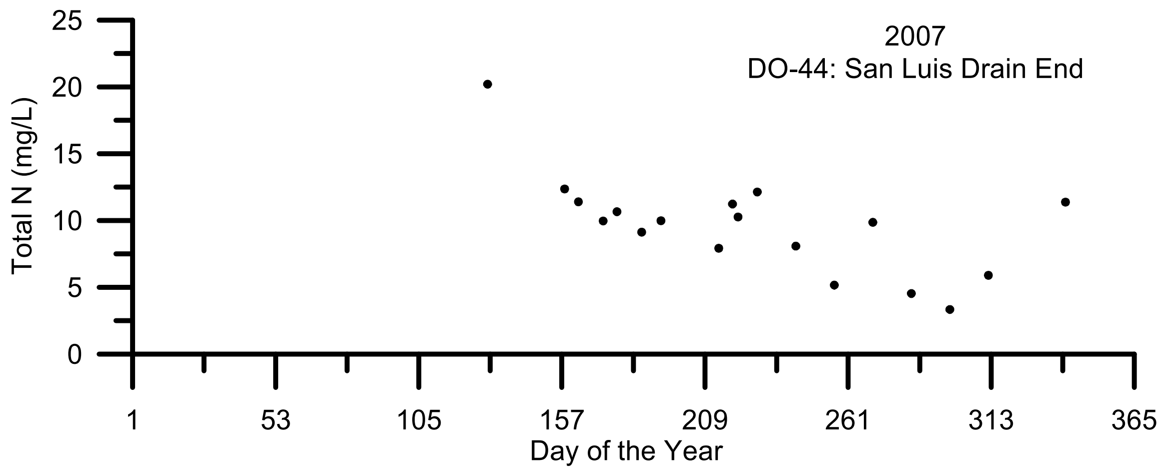

2005
DO-36: Del Puerto Creek Flow Station
Total N (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

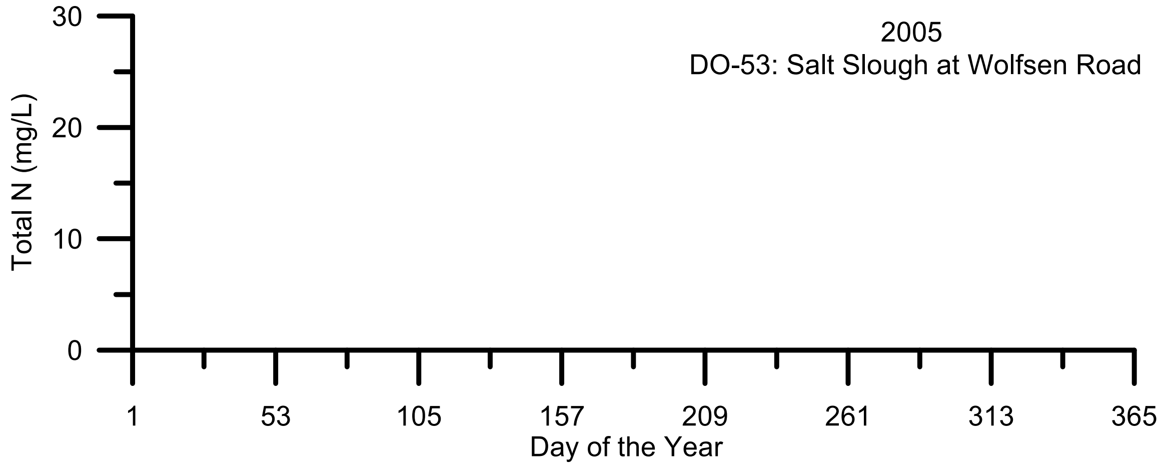

2006
DO-36: Del Puerto Creek Flow Station
Total N (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

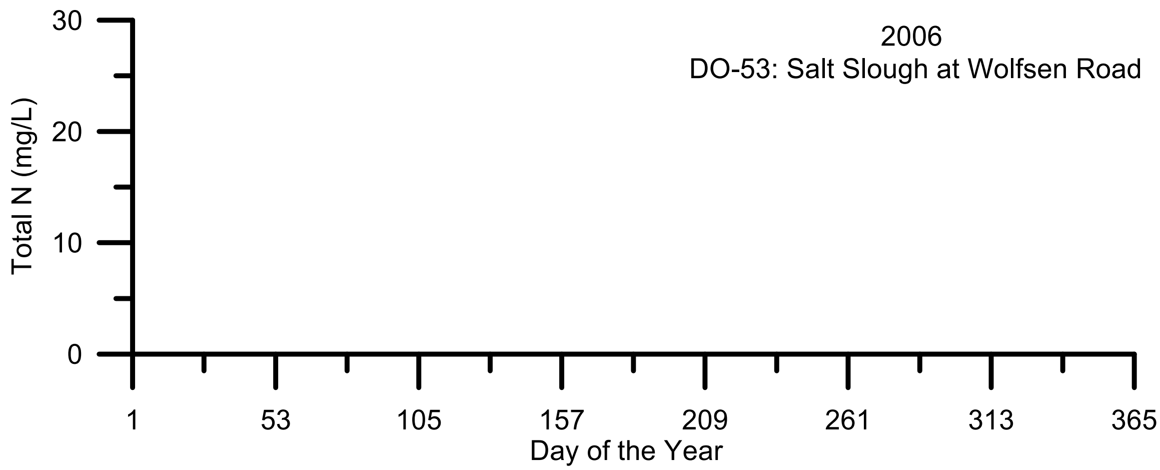

2007
DO-36: Del Puerto Creek Flow Station
Total N (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

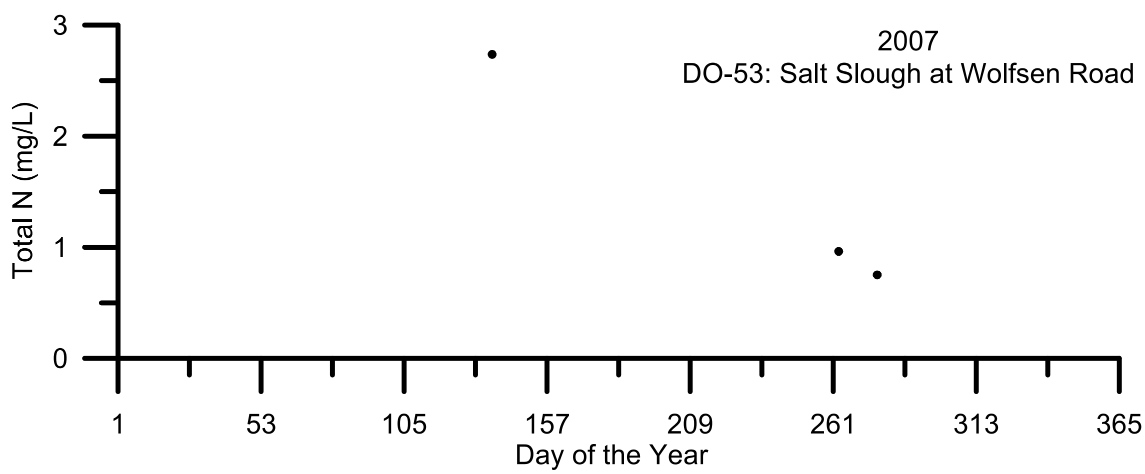

2005
DO-44: San Luis Drain End
Total N (mg/L)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

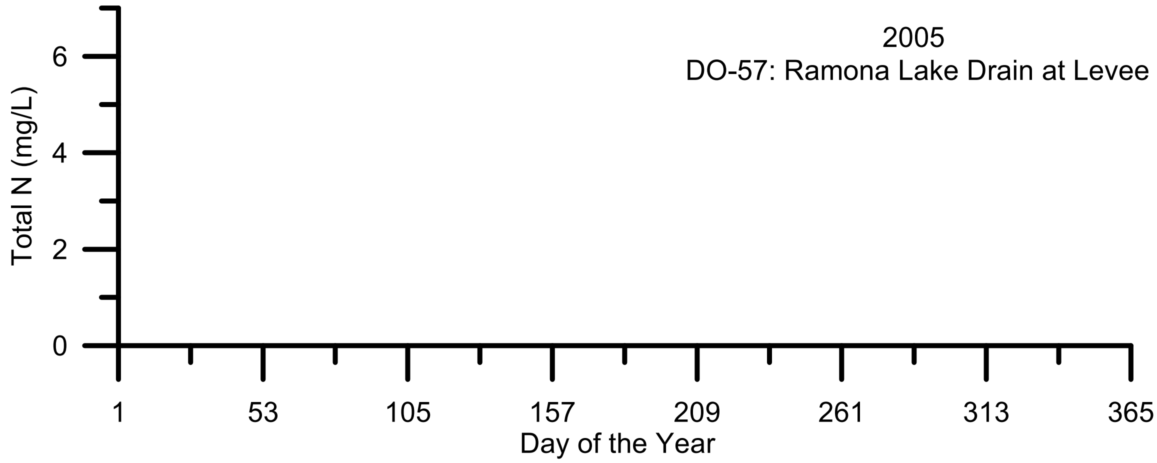

2006
DO-44: San Luis Drain End
Total N (mg/L)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

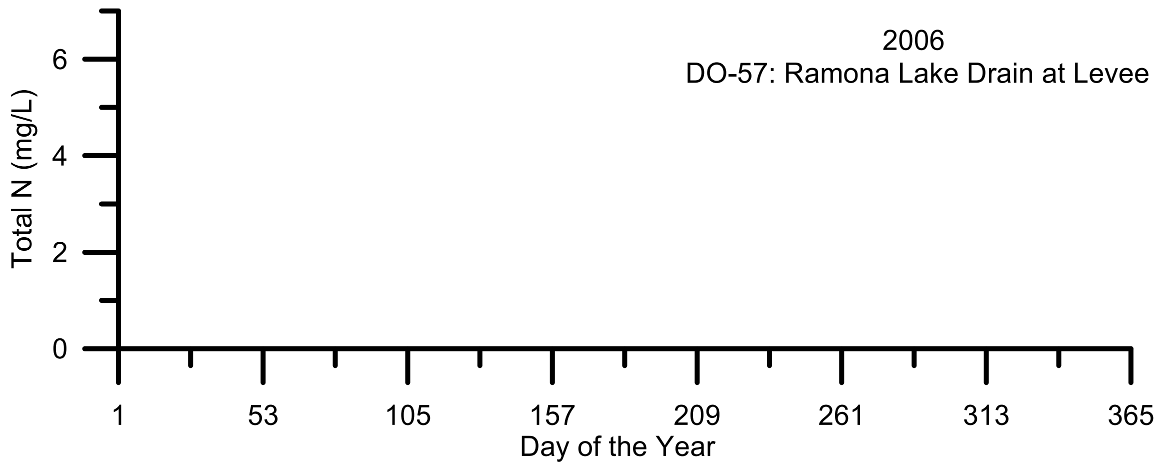

2007
DO-44: San Luis Drain End
Total N (mg/L)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

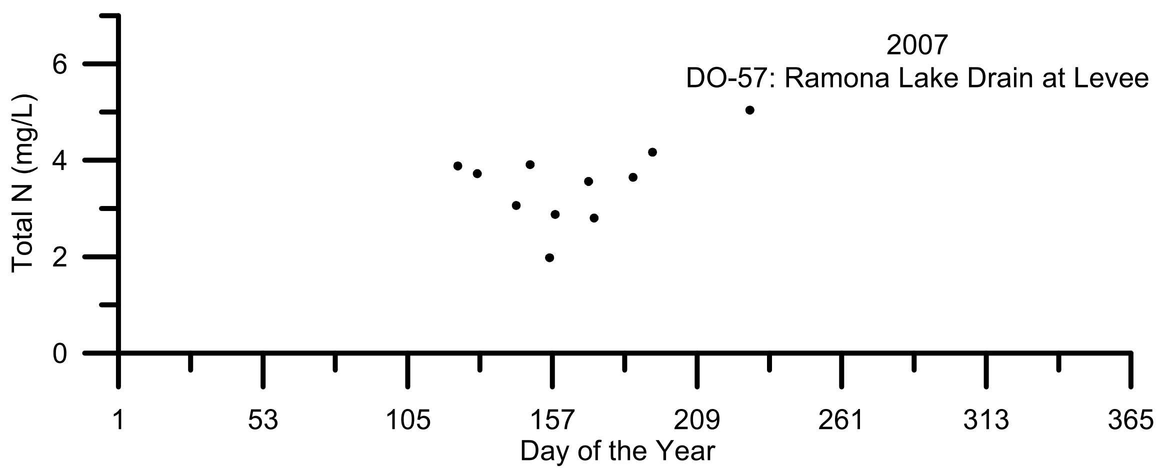

2005
DO-53: Salt Slough at Wolfsen Road
Total N (mg/L)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

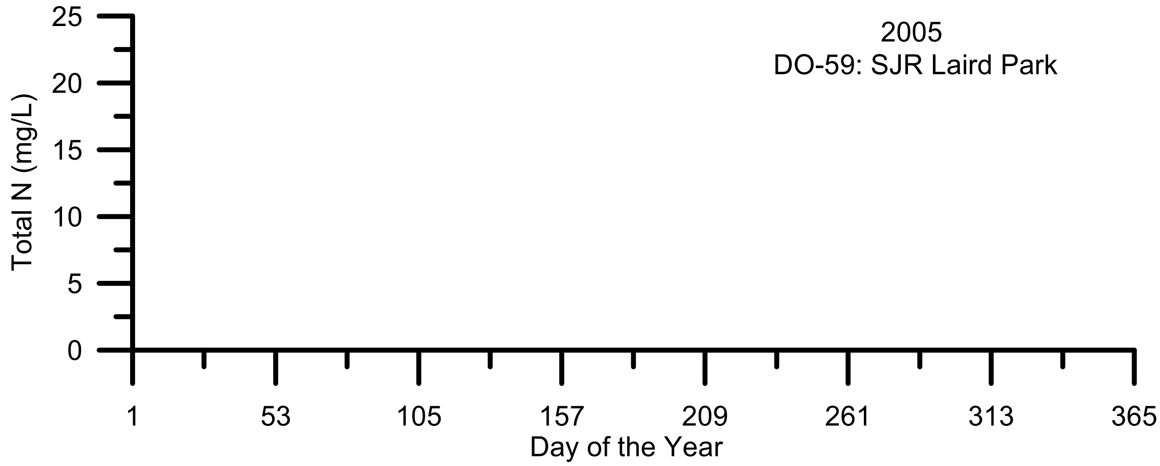

2006
DO-53: Salt Slough at Wolfsen Road
Total N (mg/L)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

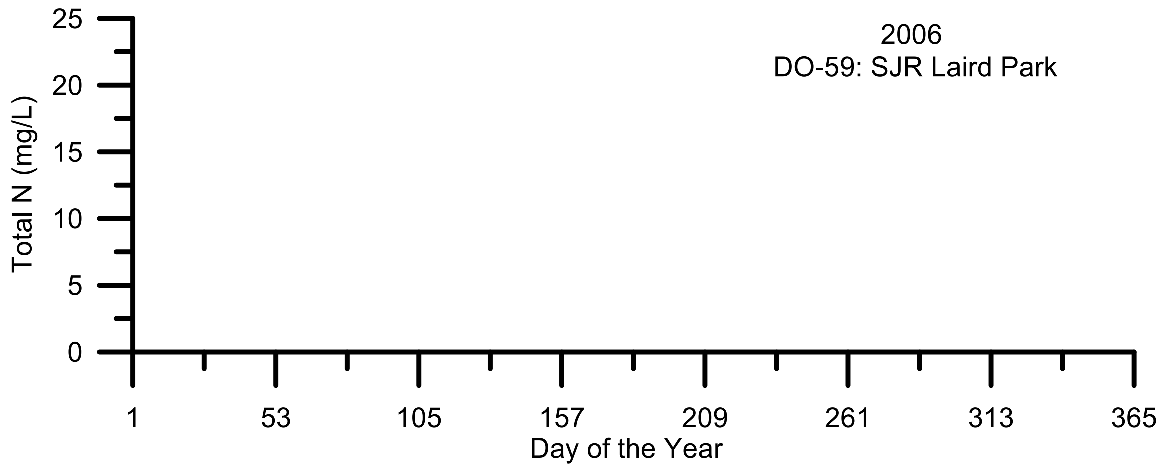

2007
DO-53: Salt Slough at Wolfsen Road
Total N (mg/L)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

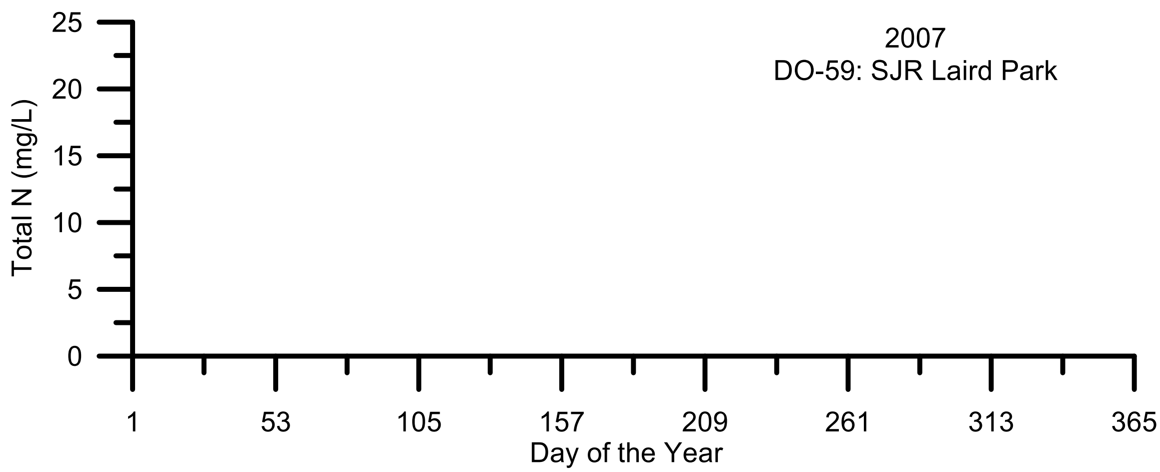

2005
DO-57: Ramona Lake Drain at Levee
Total N (mg/L)
Day of the Year

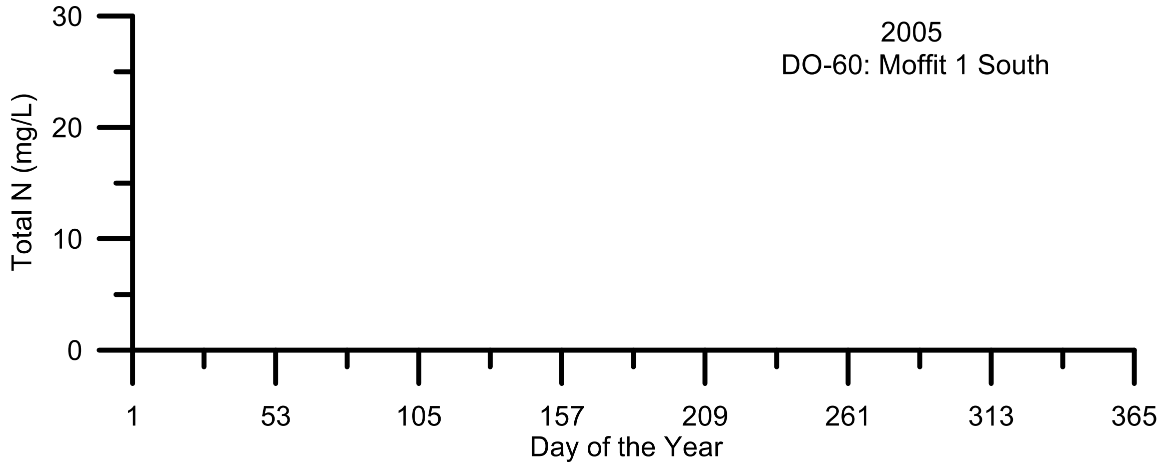

2006
DO-57: Ramona Lake Drain at Levee
Total N (mg/L)
Day of the Year

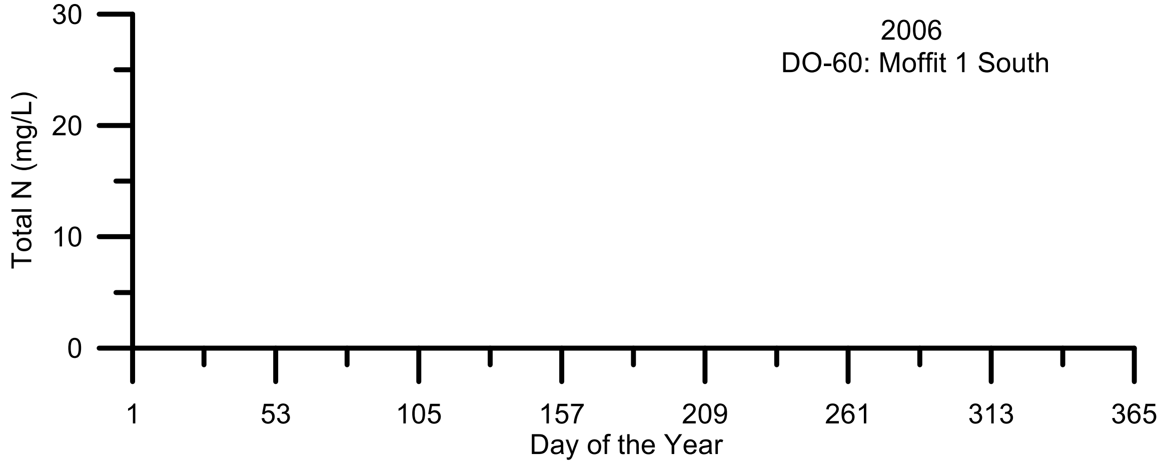

2007
DO-57: Ramona Lake Drain at Levee
Total N (mg/L)
Day of the Year

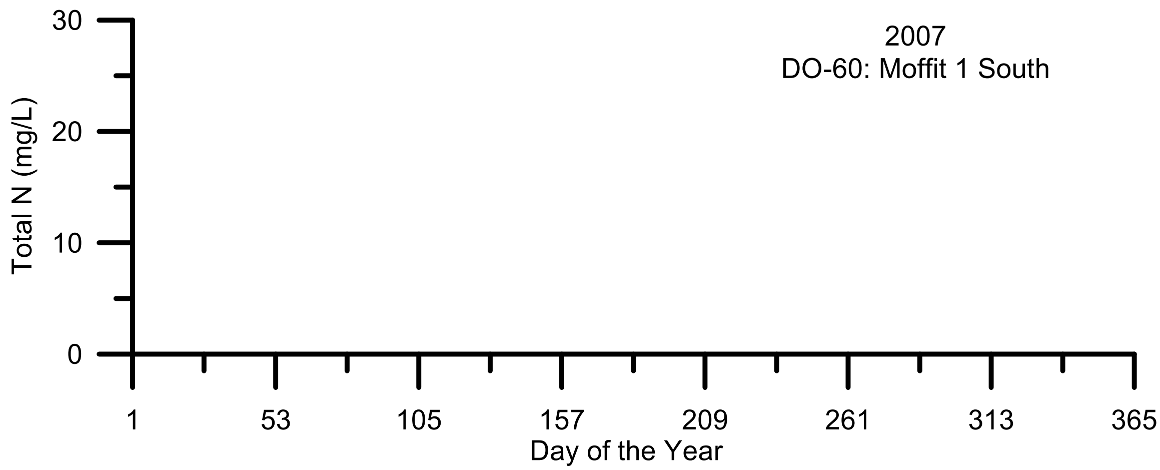

2005
DO-59: SJR Laird Park
Total N (mg/L)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

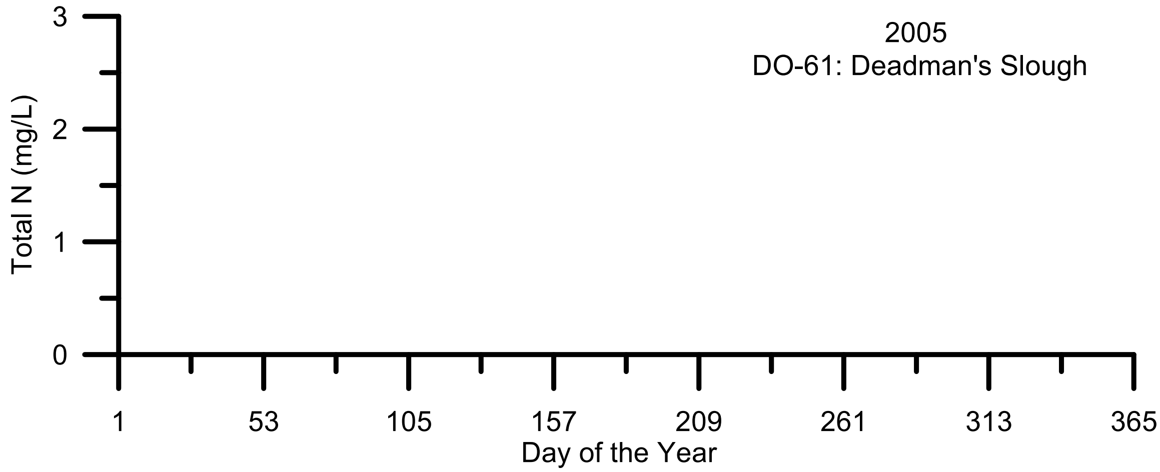

2006
DO-59: SJR Laird Park
Total N (mg/L)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

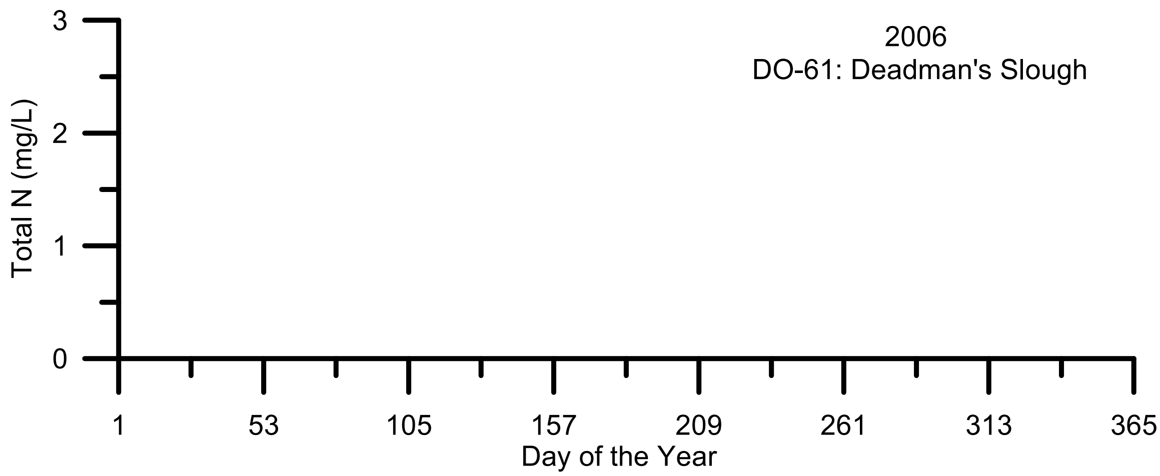

2007
DO-59: SJR Laird Park
Total N (mg/L)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

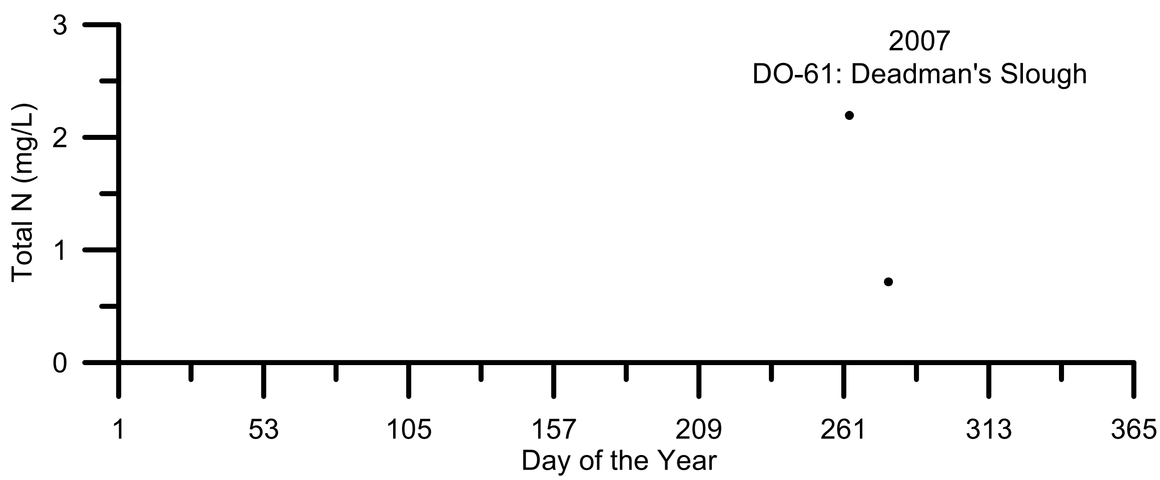

2005
DO-60: Moffit 1 South
Total N (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

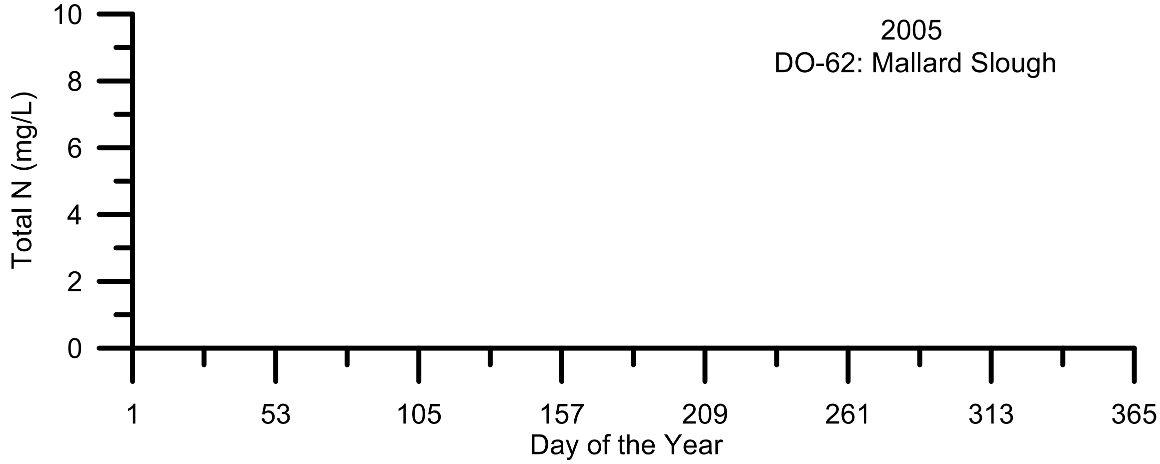

2006
DO-60: Moffit 1 South
Total N (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

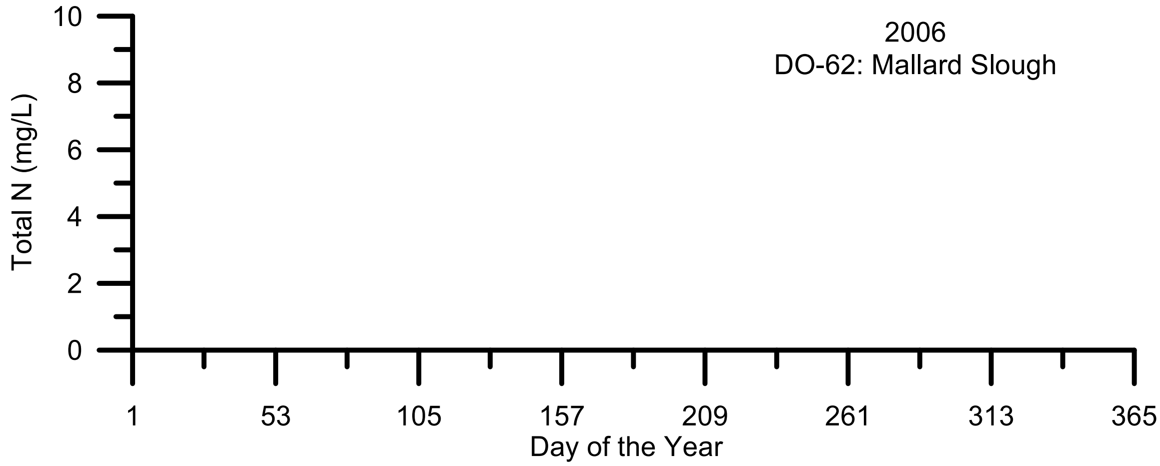

2007
DO-60: Moffit 1 South
Total N (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

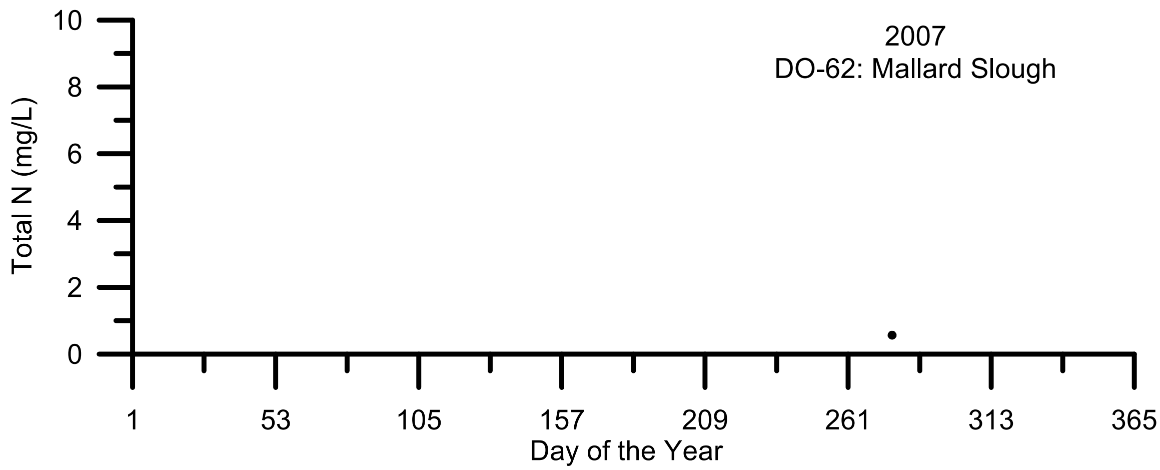

2005
DO-61: Deadman's Slough
Total N (mg/L)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

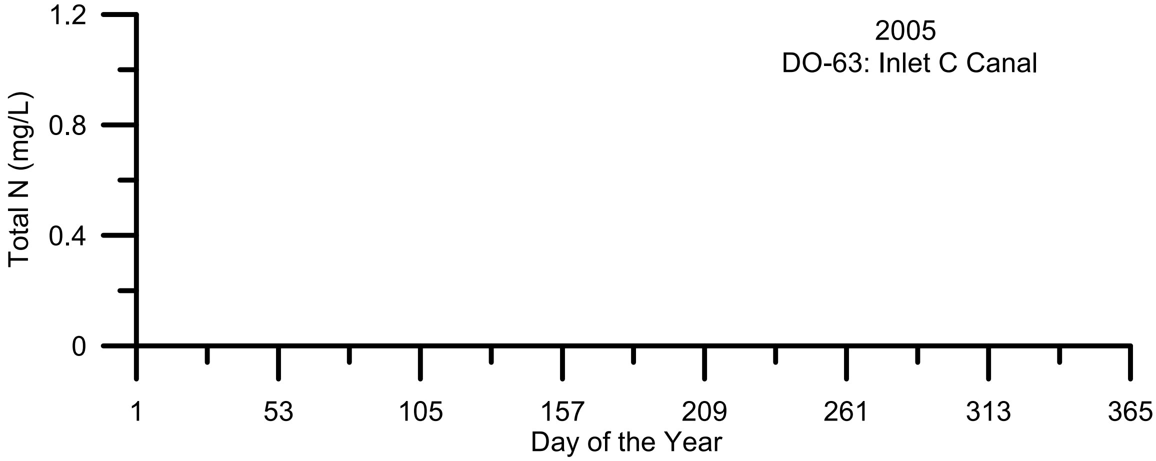

2006
DO-61: Deadman's Slough
Total N (mg/L)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

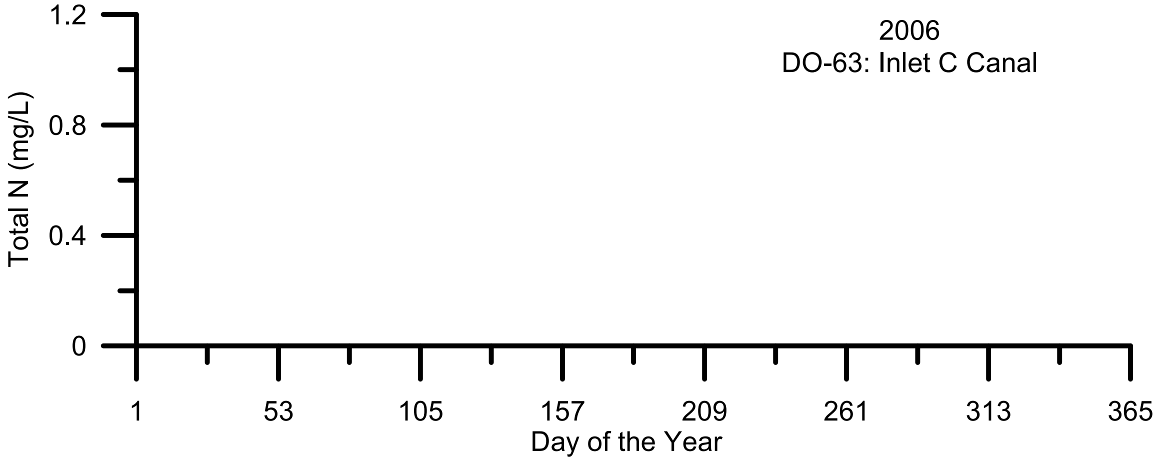

2007
DO-61: Deadman's Slough
Total N (mg/L)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

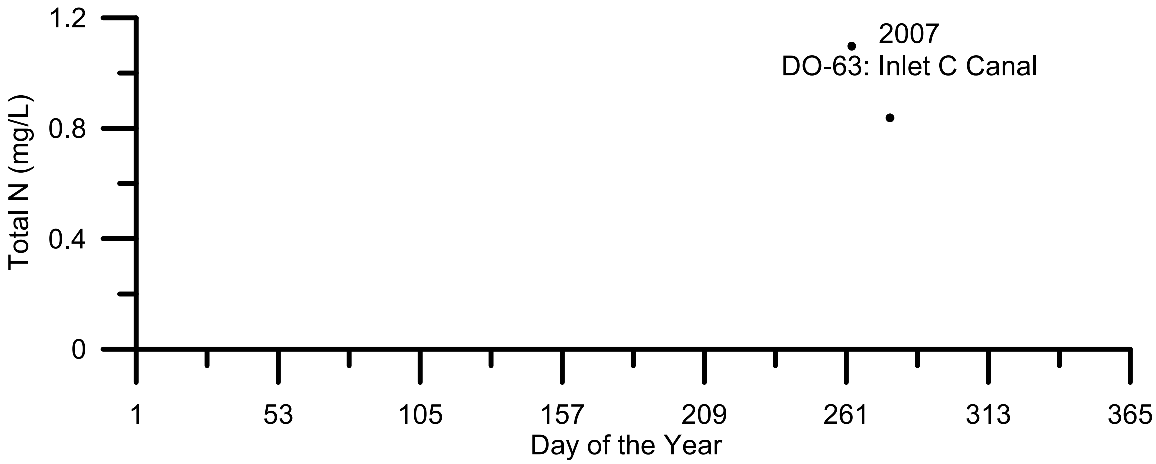

2005
DO-62: Mallard Slough
Total N (mg/L)
10
8
6
4
2
0
1
53
105
157
209
261
313
365
Day of the Year

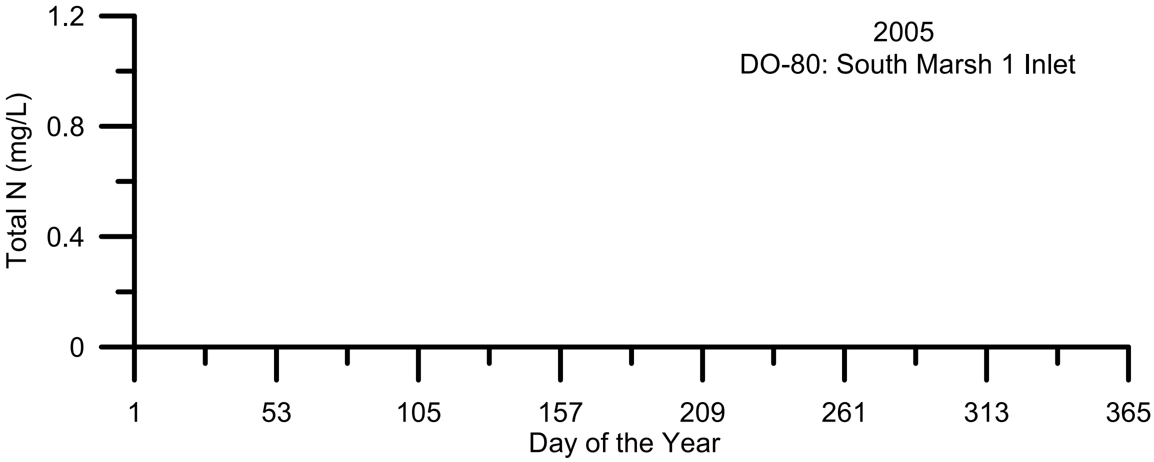

2006
DO-62: Mallard Slough
Total N (mg/L)
10
8
6
4
2
0
1
53
105
157
209
261
313
365
Day of the Year

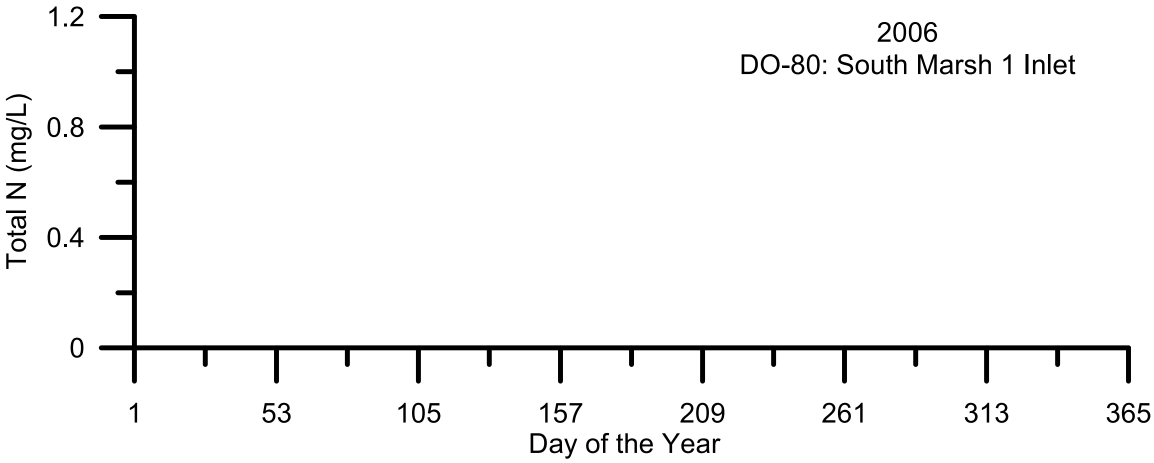

2007
DO-62: Mallard Slough
Total N (mg/L)
10
8
6
4
2
0
1
53
105
157
209
261
313
365
Day of the Year

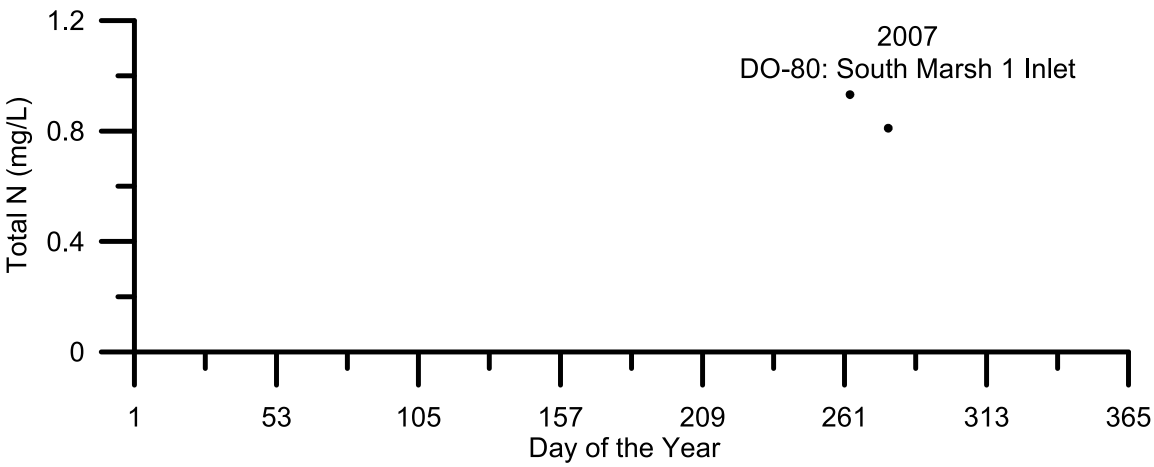

2005
DO-63: Inlet C Canal
Total N (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

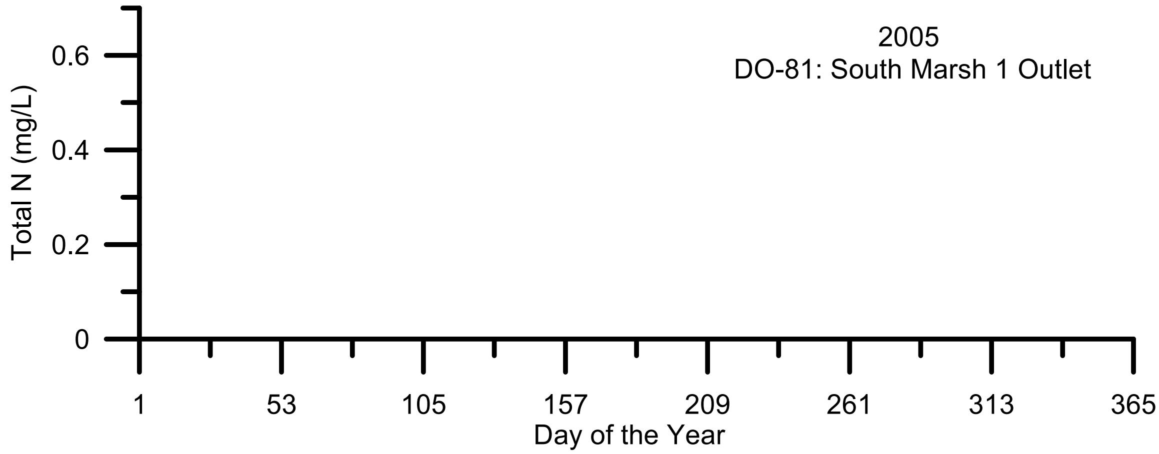

2006
DO-63: Inlet C Canal
Total N (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

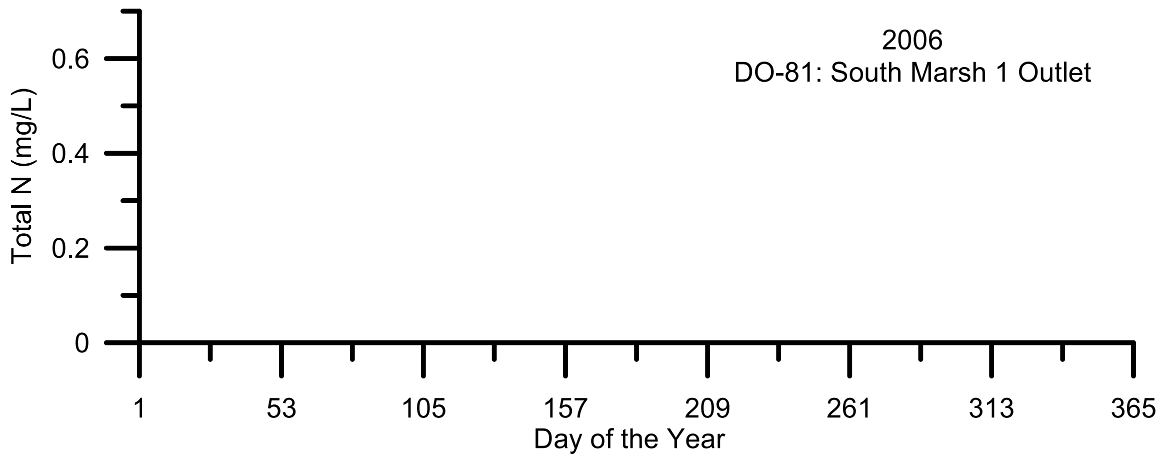

2007
DO-63: Inlet C Canal
Total N (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

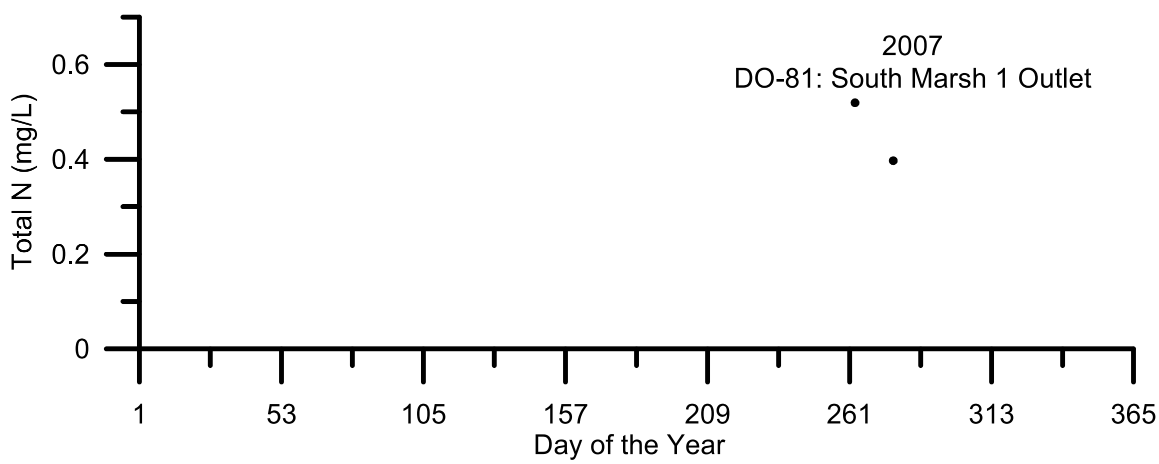

2005
DO-80: South Marsh 1 Inlet
Total N (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

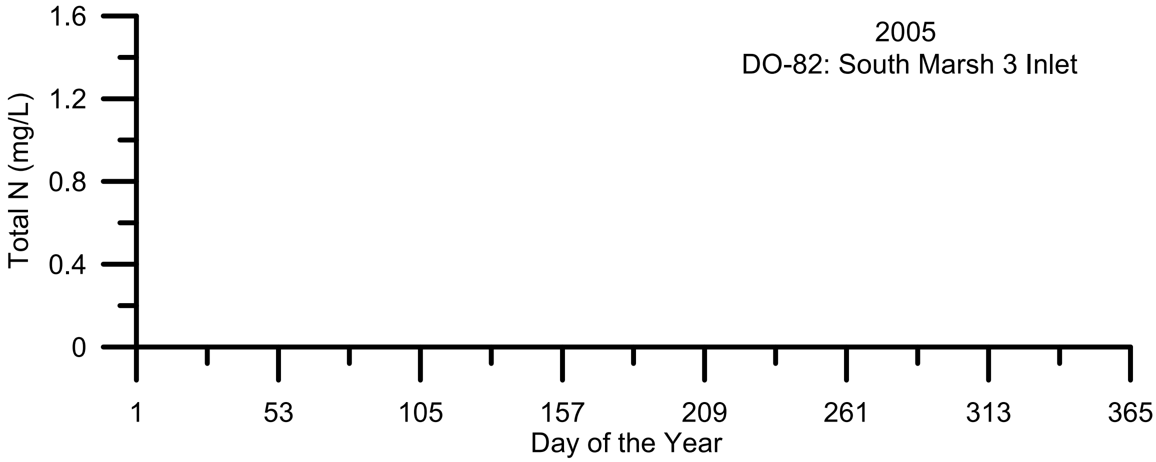

2006
DO-80: South Marsh 1 Inlet
Total N (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

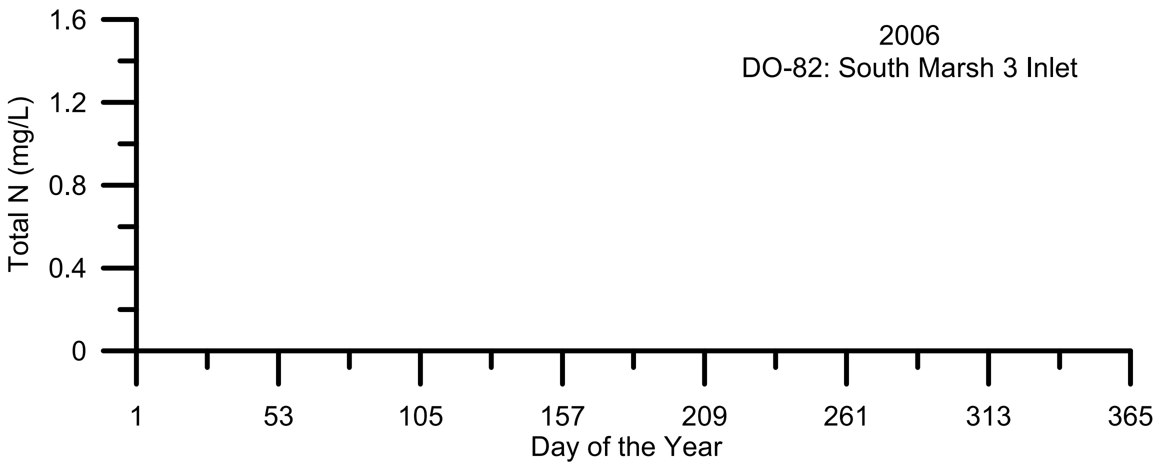

2007
DO-80: South Marsh 1 Inlet
Total N (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

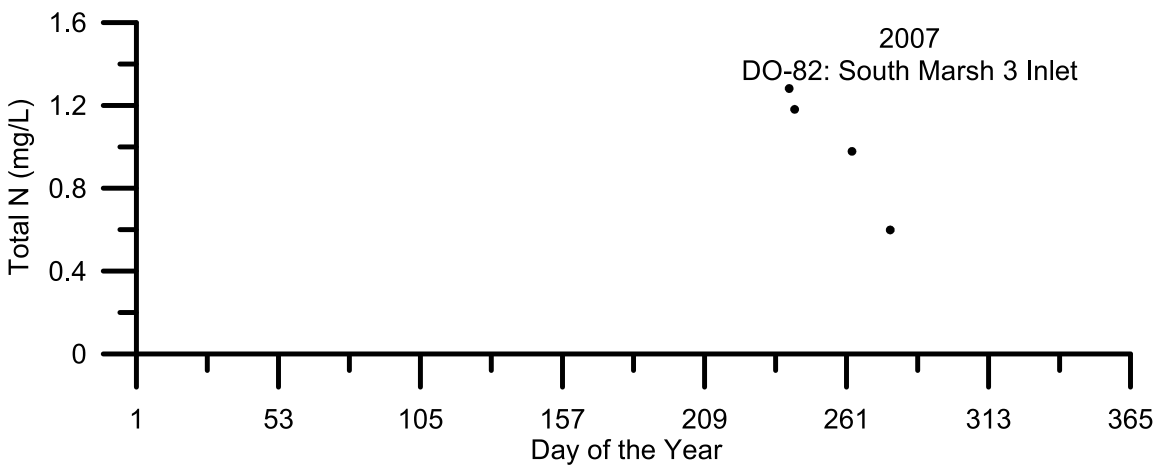

2005
DO-81: South Marsh 1 Outlet
Total N (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

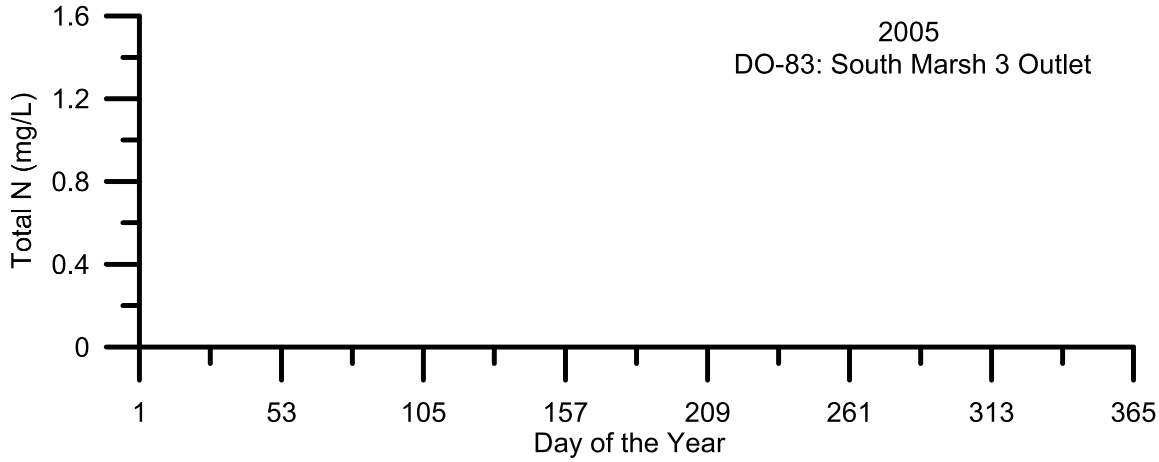

2006
DO-81: South Marsh 1 Outlet
Total N (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

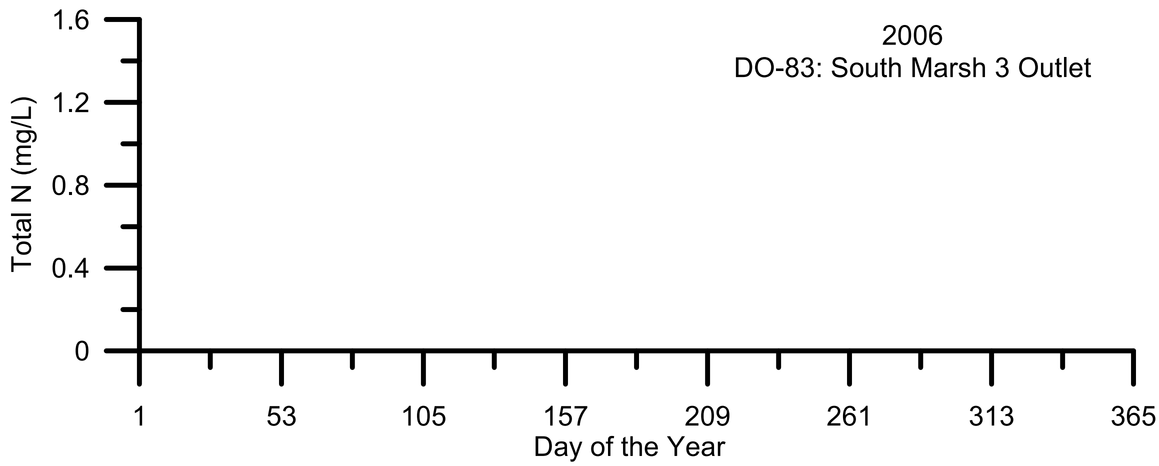

2007
DO-81: South Marsh 1 Outlet
Total N (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

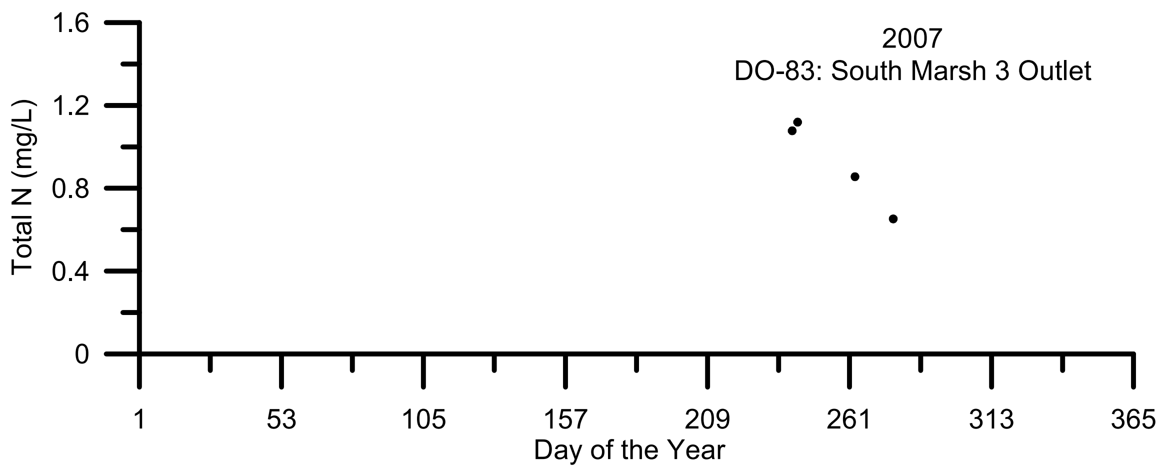

2005
DO-82: South Marsh 3 Inlet
Total N (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

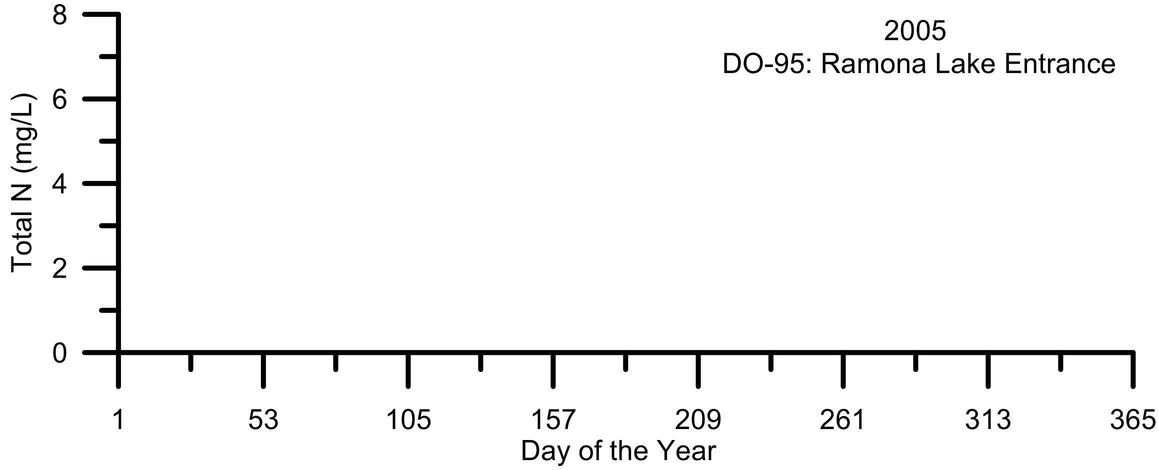

2006
DO-82: South Marsh 3 Inlet
Total N (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

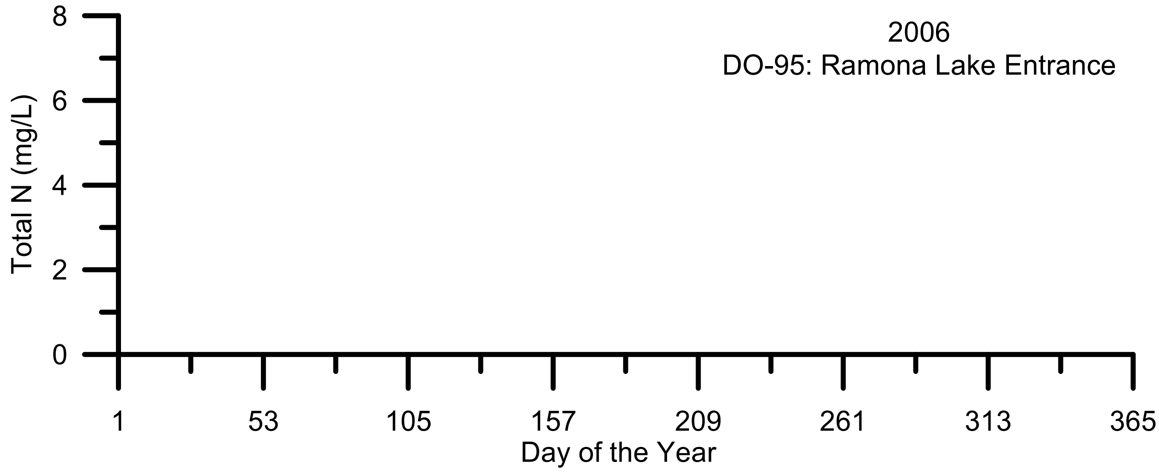

2007
DO-82: South Marsh 3 Inlet
Total N (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

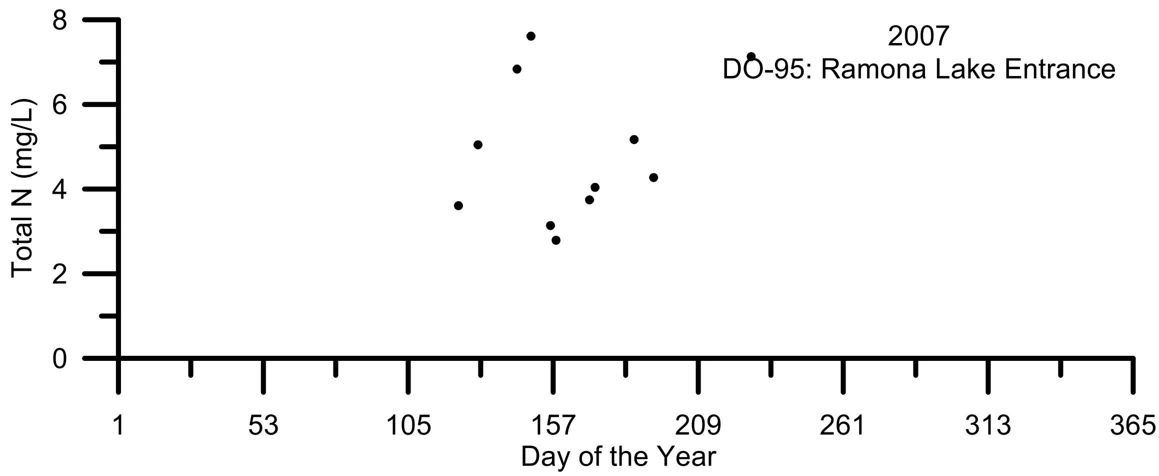

2005
DO-83: South Marsh 3 Outlet
Total N (mg/L)
0
0.4
0.8
1.2
1.6
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-83: South Marsh 3 Outlet
Total N (mg/L)
0
0.4
0.8
1.2
1.6
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-83: South Marsh 3 Outlet
Total N (mg/L)
0
0.4
0.8
1.2
1.6
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-95: Ramona Lake Entrance
Total N (mg/L)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-95: Ramona Lake Entrance
Total N (mg/L)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-95: Ramona Lake Entrance
Total N (mg/L)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

Temporal Plots of 2005-2007 Total Iron Data from the Upstream San Joaquin River

***Chelsea Spier*[1]**
***Remie Burks*[1]**
***Sharon Borglin*[1]**
***Jeremy Hanlon*[1]**
***Justin Graham*[1]**
***William Stringfellow*[1]**

February 2008

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University of the Pacific
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Stockton, CA 95211

Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific. This report includes temporal plots of total iron (Fe) data analyzed by the EERP laboratory between 2005 and 2007.

Methods

Depth integrated field samples were colleted during 2005-2007 in the upper San Joaquin River in accordance with EERP Field Standard Operating Procedures Protocol Book (Graham 2008). Water samples were colleted in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN). Bottles were labeled with the appropriate sample number, site name and sampling date. All bottles were rinsed with sample water prior to sample collection. Some sites required a bucket to collect sample water because of accessibility from a high bridge or platform. For these sites, the bucket was pre-rinsed with sample water and sample bottles were filled using a rinsed funnel. Care was taken to distribute water simultaneously to all sample bottles (rather than sequentially). Samples were immediately stored at 4°C after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the EERP lab on the day of sampling.

Within twenty-four hours of sample collection, 6 mL aliquots of unfiltered sample were placed in 15 mL disposal centrifuge tubes and stored at -20°C for later quantification of Total Fe.

Fe was measured using a reaction with phenanthroline according to SM 3500-Fe B (APHA, 2005) using FerroVer reagents purchased from Hach (Loveland, CO). Prior to analysis, the samples were defrosted and 1 mL of sample was removed and used to measure the background absorbance of the water sample at 510 nm on the PerkinElmer Lambda 35 UV/VIS Spectrometer (Shelton, CT). Total Fe was measured on the remaining 5 mL of unfiltered sample by the addition of pre-made Hach FerroVer phenanthroline reagent and measurement at 510 nm. The background sample absorbance was subtracted from the sample absorbance with reagent added. The limit of detection for this method is 0.02mg/L Fe.

Results/Discussion

With each set of Fe field samples analyzed in the EERP laboratory, quality assurance samples including a lab duplicate, field duplicate, matrix spike, matrix spike duplicate, calibration check standards, laboratory control standard, trip blank, and lab blanks were also analyzed. Between 2005 and 2007, 100% of all quality assurance samples were within a passing range (Borglin et al, 2008). Samples were measured ranging from 0.0-60.3 mg/L Fe. The average concentration of Fe in samples collected was 0.58 mg/L Fe. For many sites Fe peaks towards the end of winter and also in early summer.

These temporal plots (Figures 2-103) created an easy visual way to find outliers and double check data entry for possible mistakes. For the purpose of these plots any data points that were slightly negative were changed to 0.

References

American Public Health Association (APHA). 2005. Standard Methods for the Examination of Water and Wastewater, 21st Edition. American Public Health Association, Washington, DC.

Borglin, S., W. Stringfellow, J. Hanlon. 2005. Standard Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project. LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA

Borglin, S.E., Burks, R.D., Hanlon, J.S., Stringfellow, W.T. (2008) EERP Lab Protocol Book, University of the Pacific, Stockton, CA.

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008) EERP Field Protocol Book, University of the Pacific, Stockton, CA.

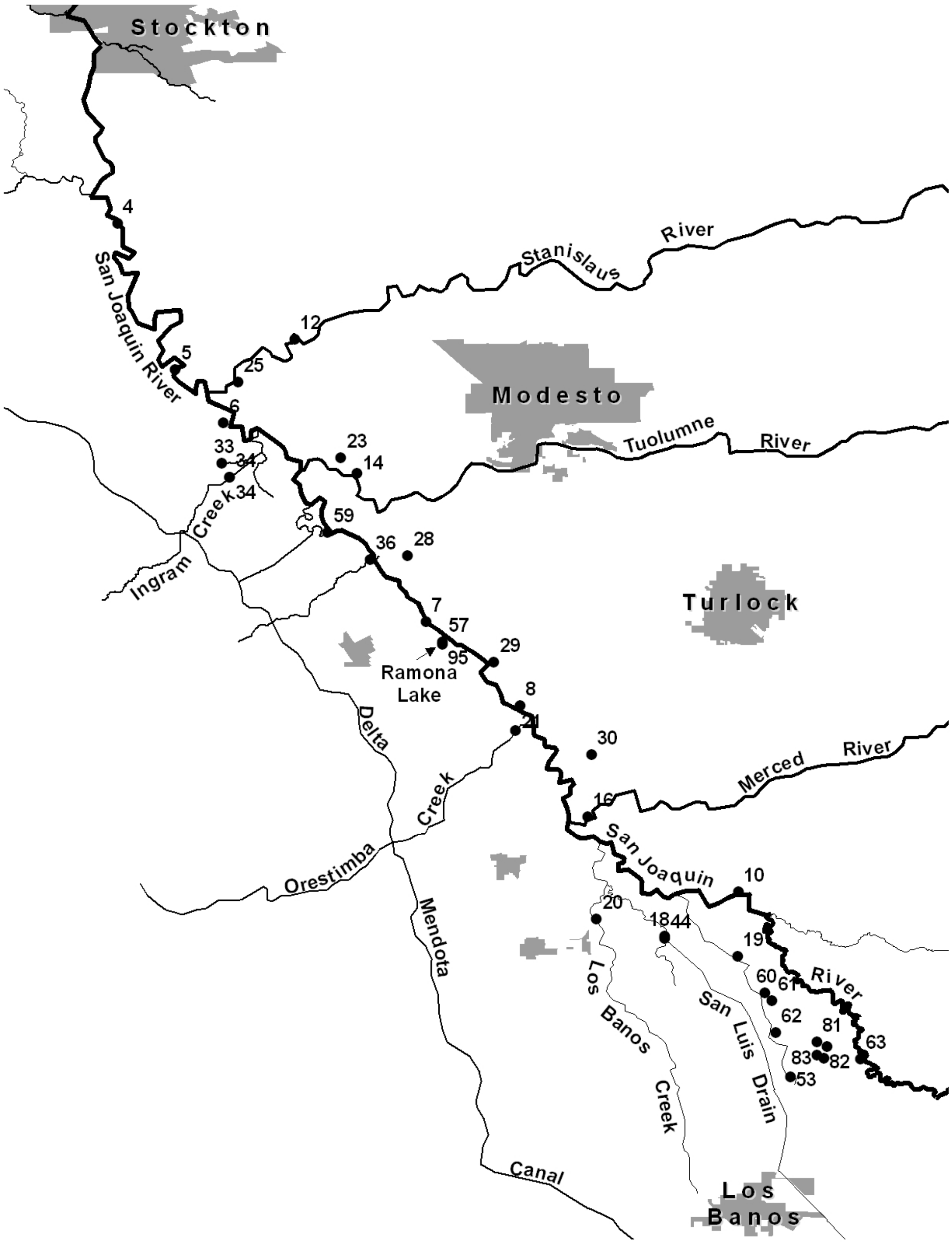
Stringfellow, W.T., et al., (2008) Evaluation of Vegitated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley, University of the Pacific, Stockton, CA

YSI Environmental Operations Manual (2005) 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

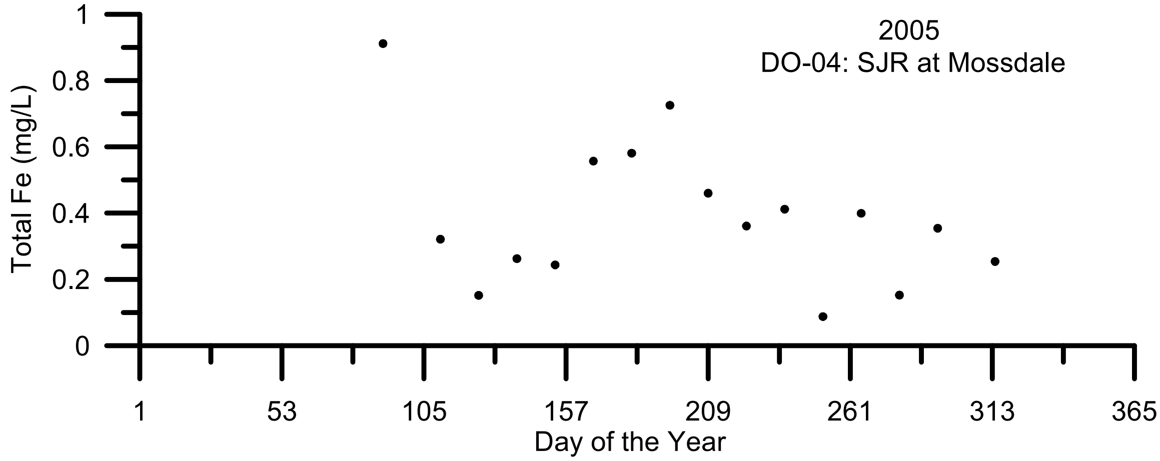
Table 1: EERP Sampling Site List

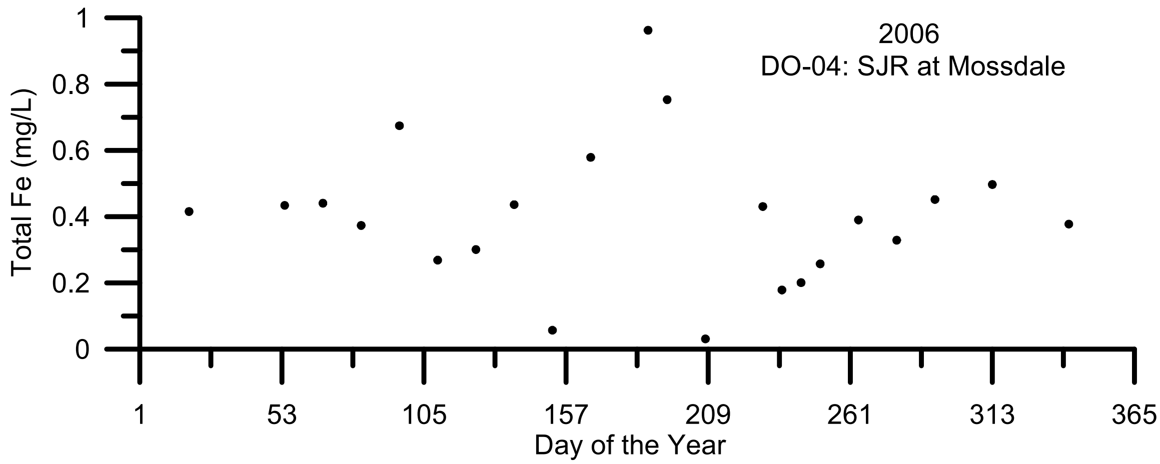
DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
53	**Salt Slough at Wolfsen Road**	Wetland
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
60	**Moffit 1 South**	Wetland
61	**Deadman's Slough**	Wetland
62	**Mallard Slough**	Wetland
63	**Inlet C Canal**	Wetland
80	**South Marsh-1-Inlet**	Wetland
81	**South Marsh-1-Outlet**	Wetland
82	**South Marsh-3-Inlet**	Wetland
83	**South Marsh-3-Outlet**	Wetland
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

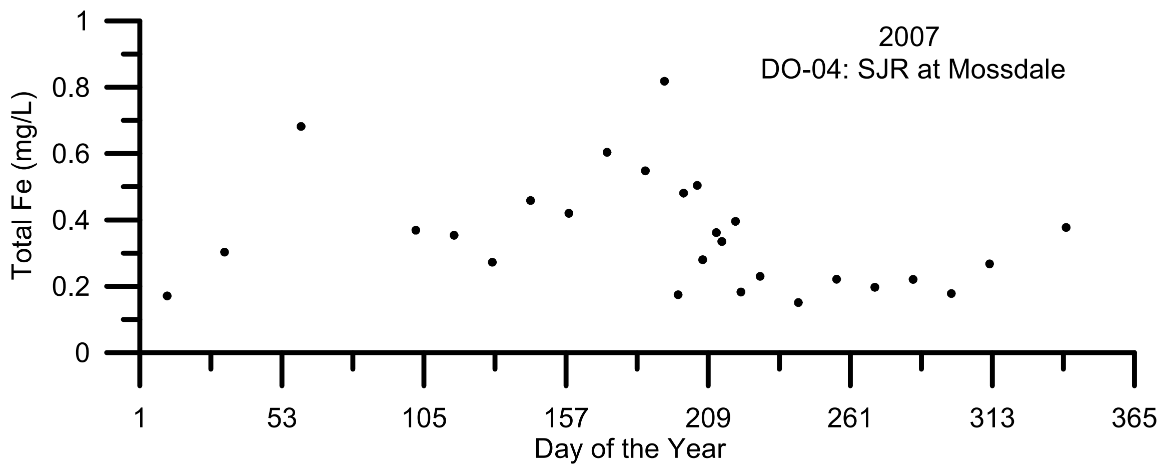
Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

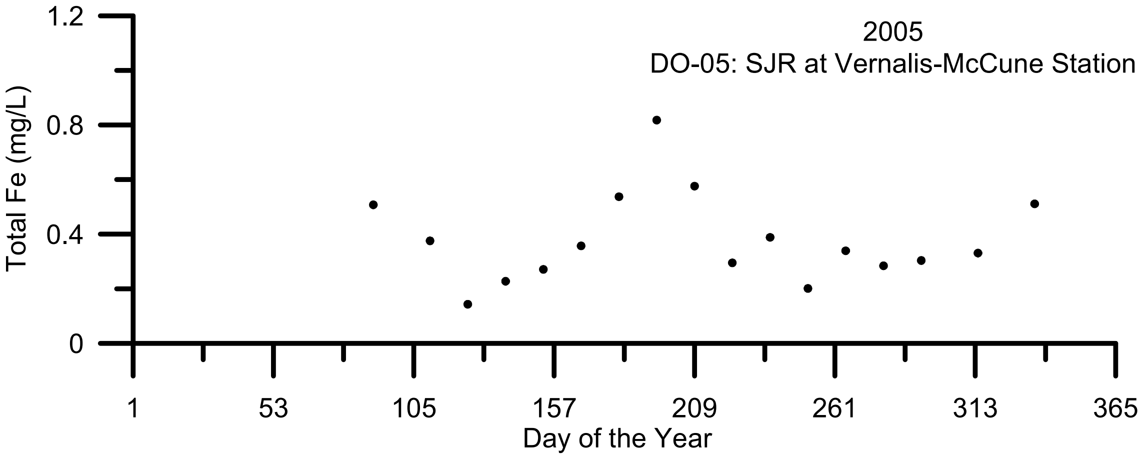


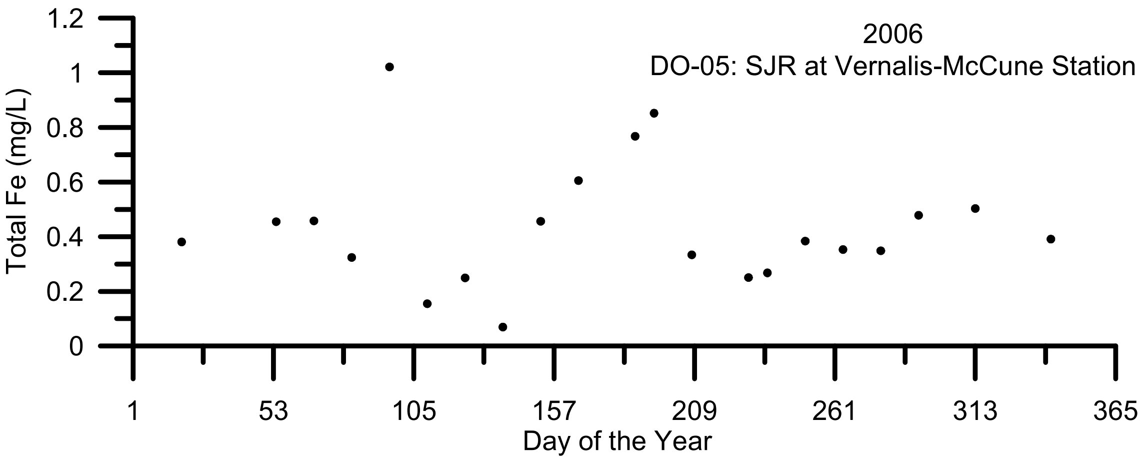
Figures 2 -103: Temporal Plots of Total Fe By Site ID








2005
DO-05: SJR at Vernalis-McCune Station
Total Fe (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-05: SJR at Vernalis-McCune Station
Total Fe (mg/L)
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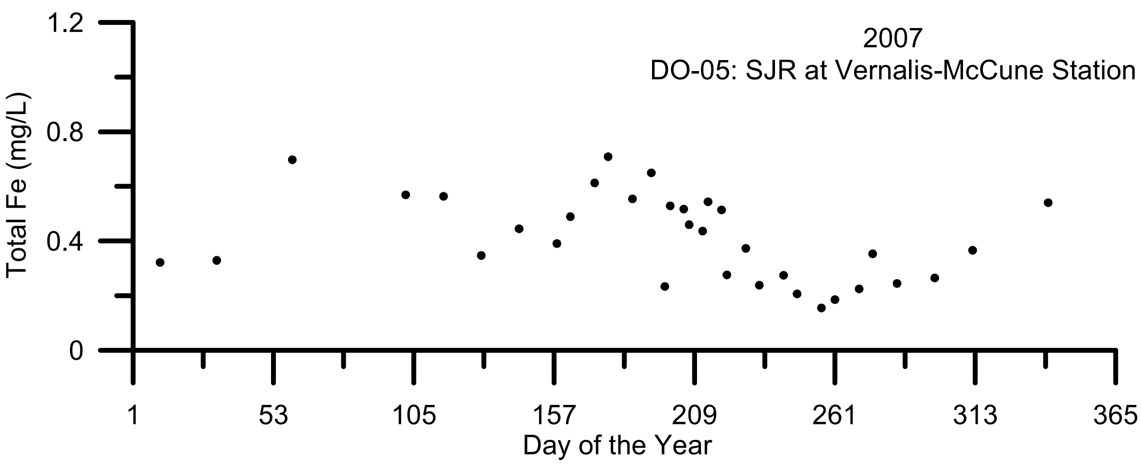
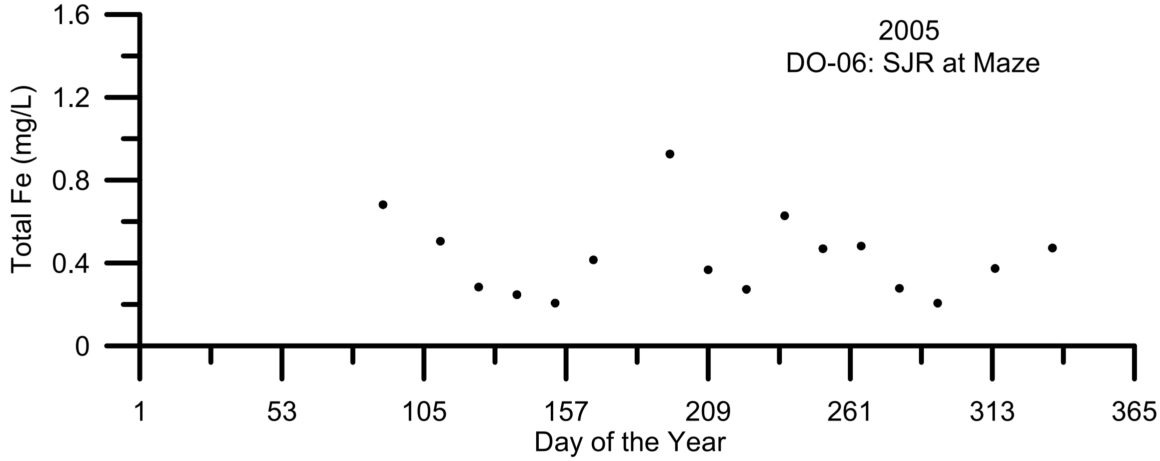
1
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-05: SJR at Vernalis-McCune Station
Total Fe (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-06: SJR at Maze
Total Fe (mg/L)
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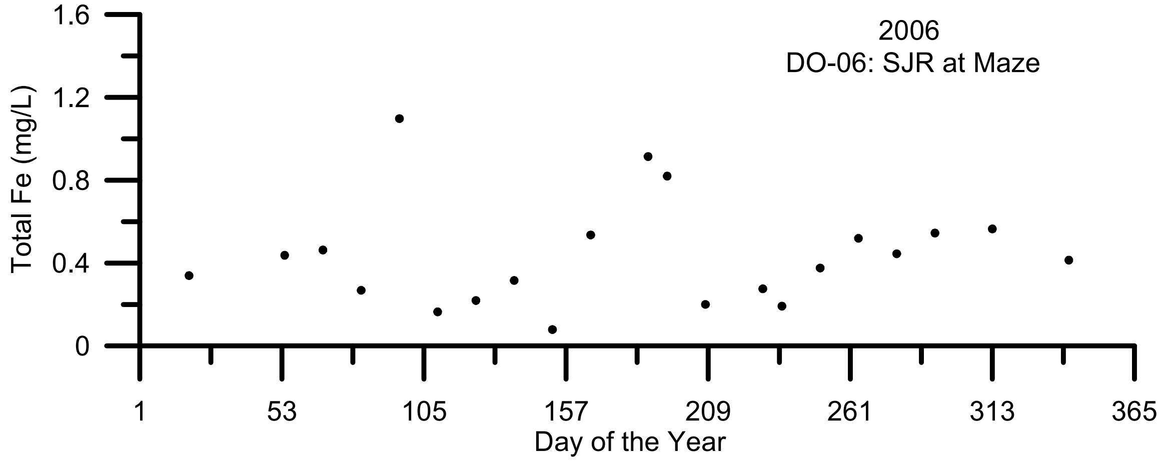
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-06: SJR at Maze
Total Fe (mg/L)
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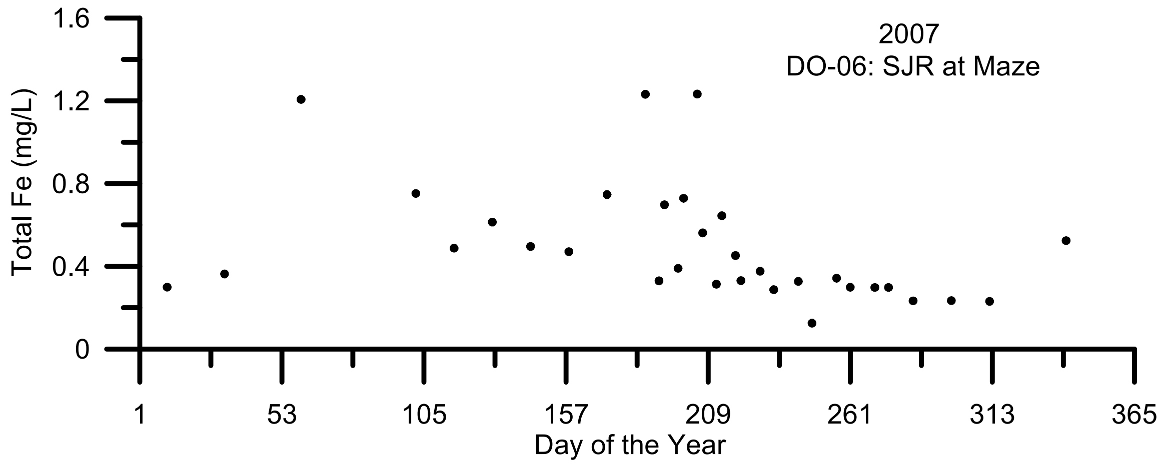
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year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DO-06: SJR at Maze
Total Fe (mg/L)
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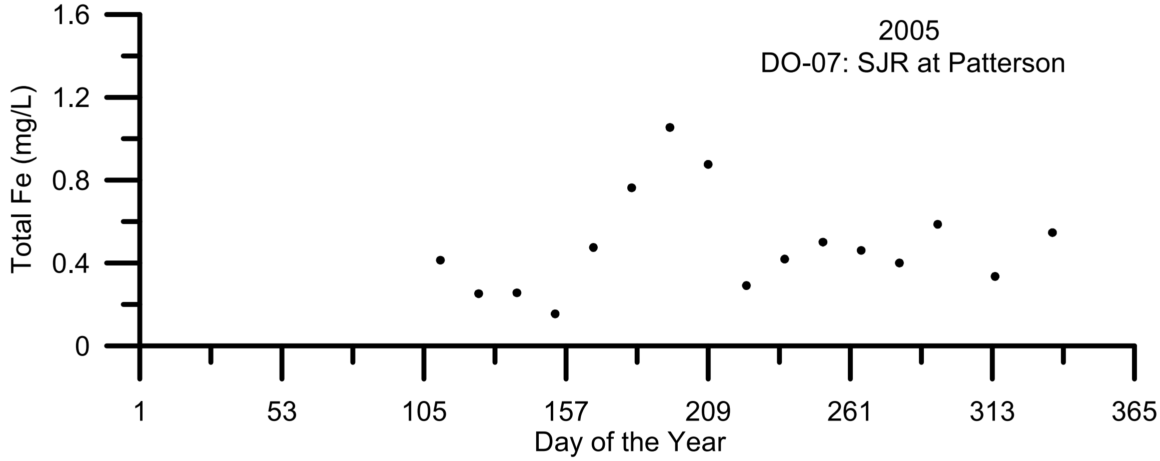
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year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DO-07: SJR at Patterson
Total Fe (mg/L)
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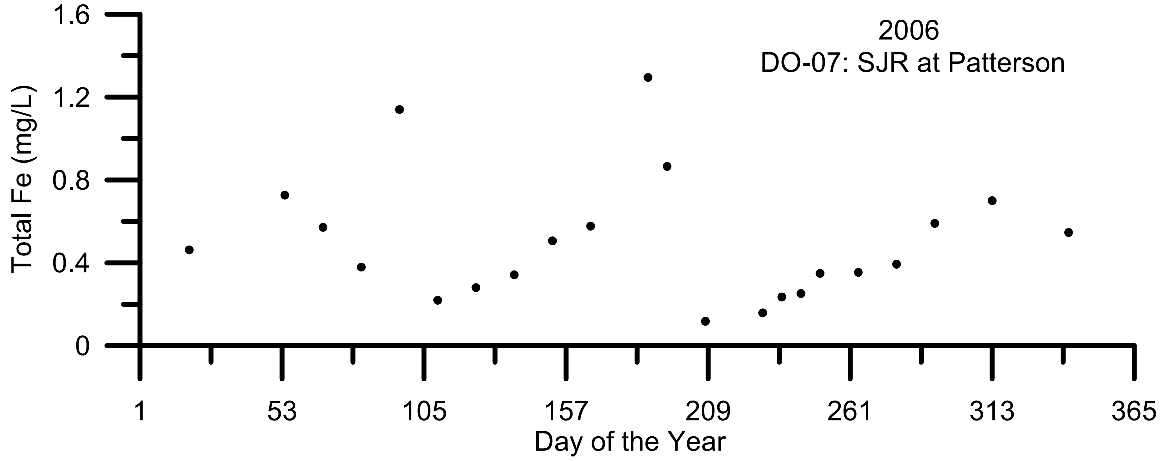
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year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DO-07: SJR at Patterson
Total Fe (mg/L)
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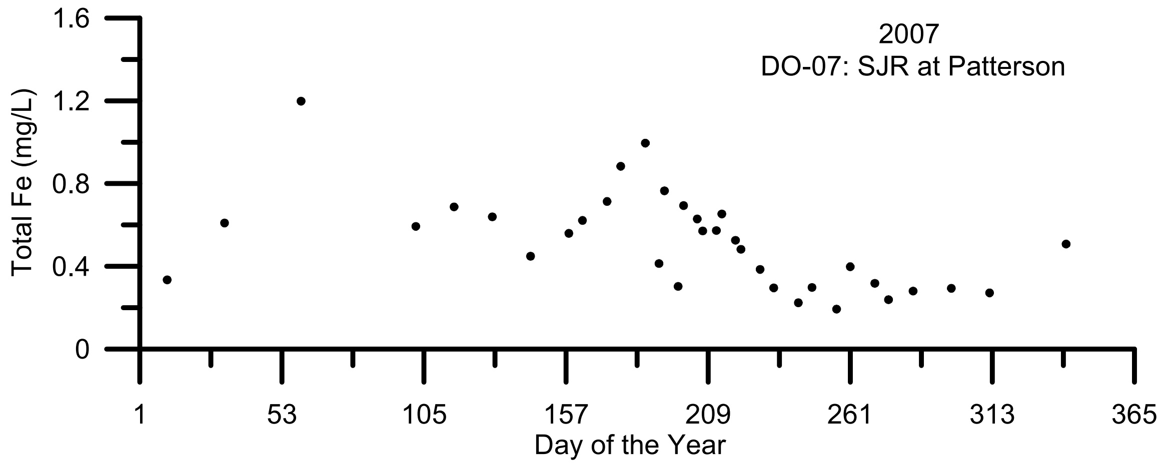
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-07: SJR at Patterson
Total Fe (mg/L)
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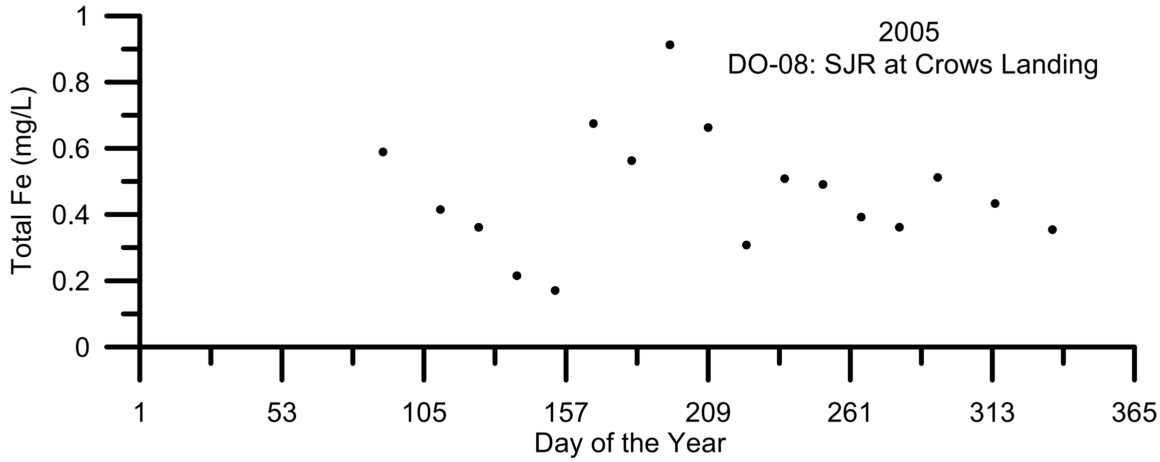
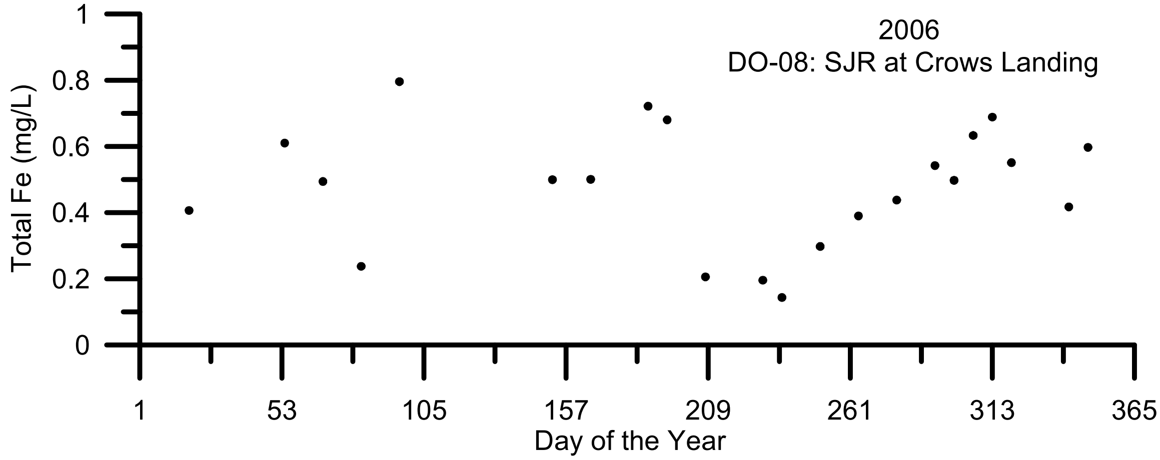
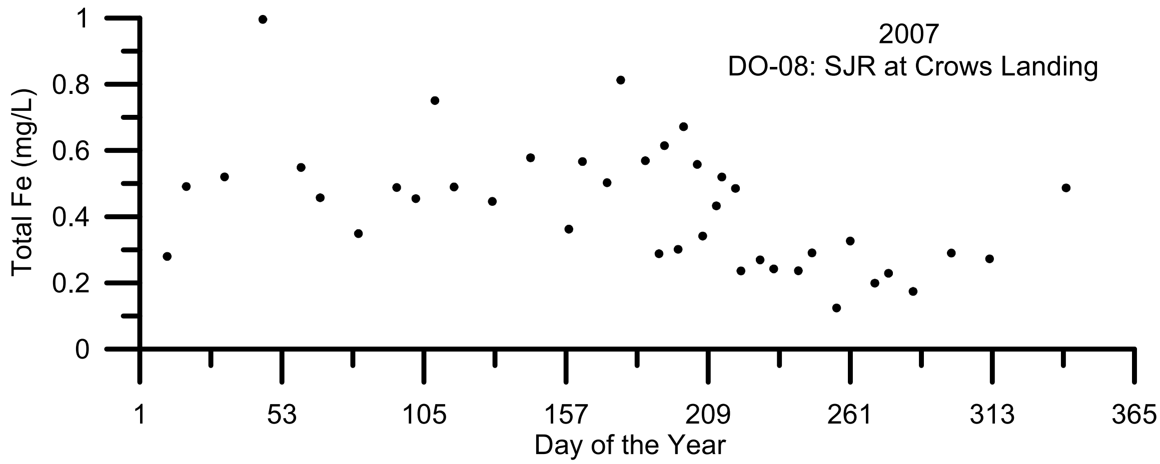
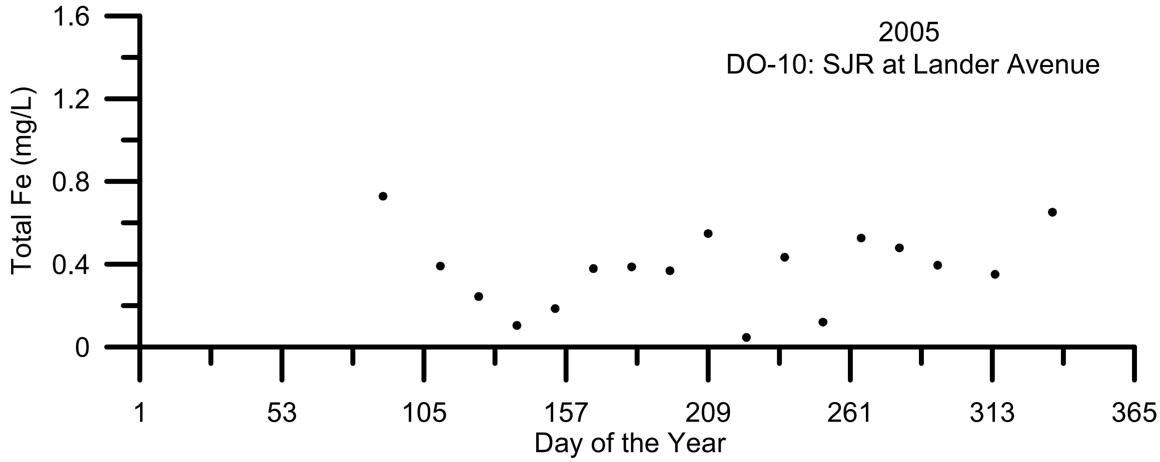
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-08: SJR at Crows Landing
Total Fe (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-08: SJR at Crows Landing
Total Fe (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-08: SJR at Crows Landing
Total Fe (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-10: SJR at Lander Avenue
Total Fe (mg/L)
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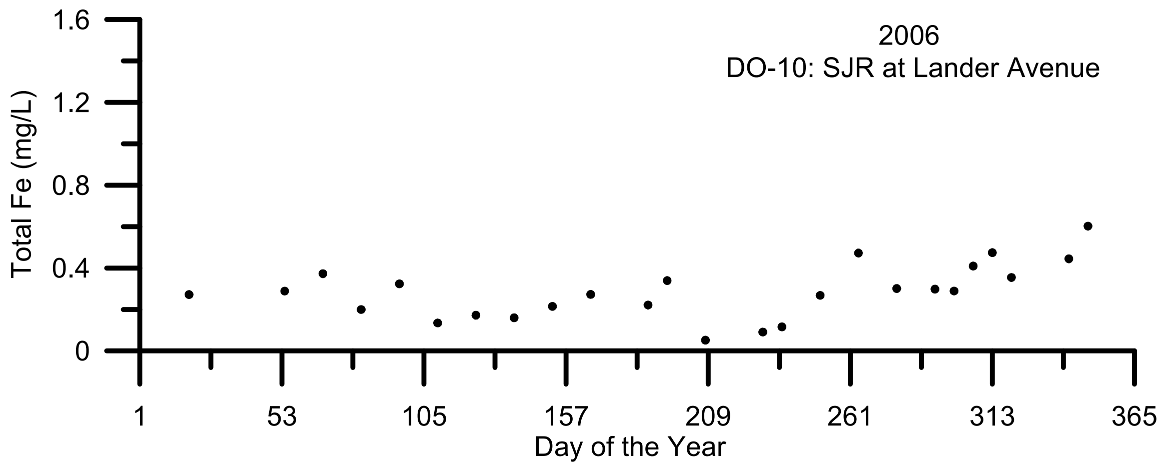
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-10: SJR at Lander Avenue
Total Fe (mg/L)
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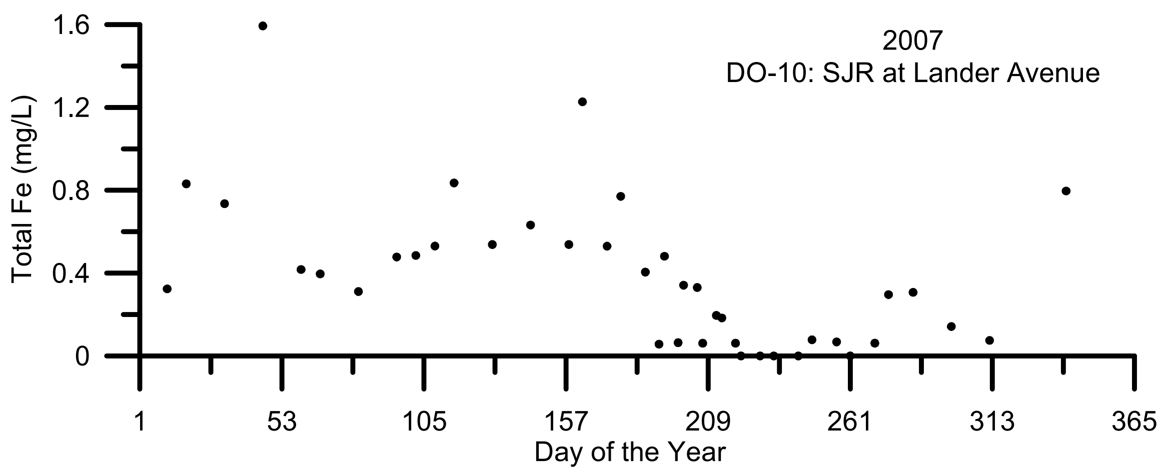
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-10: SJR at Lander Avenue
Total Fe (mg/L)
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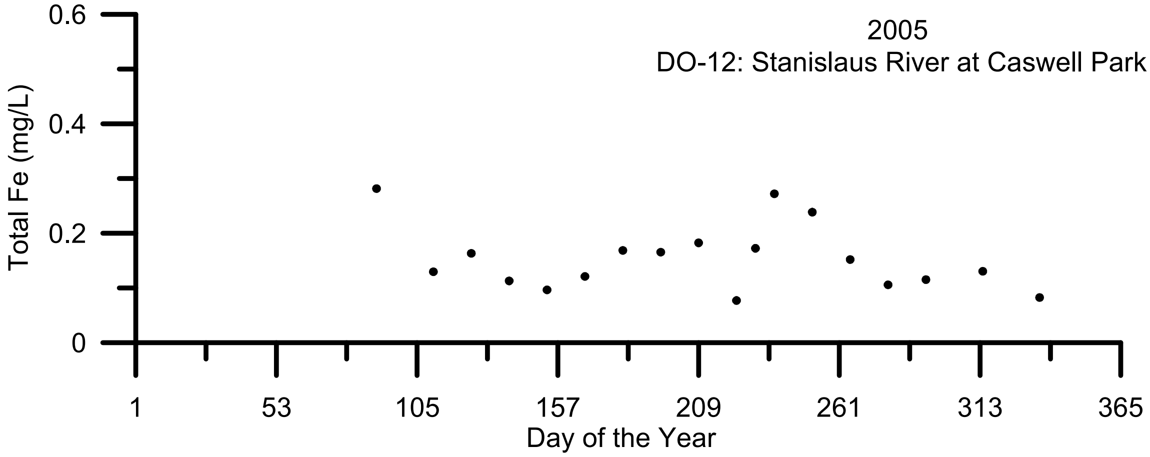
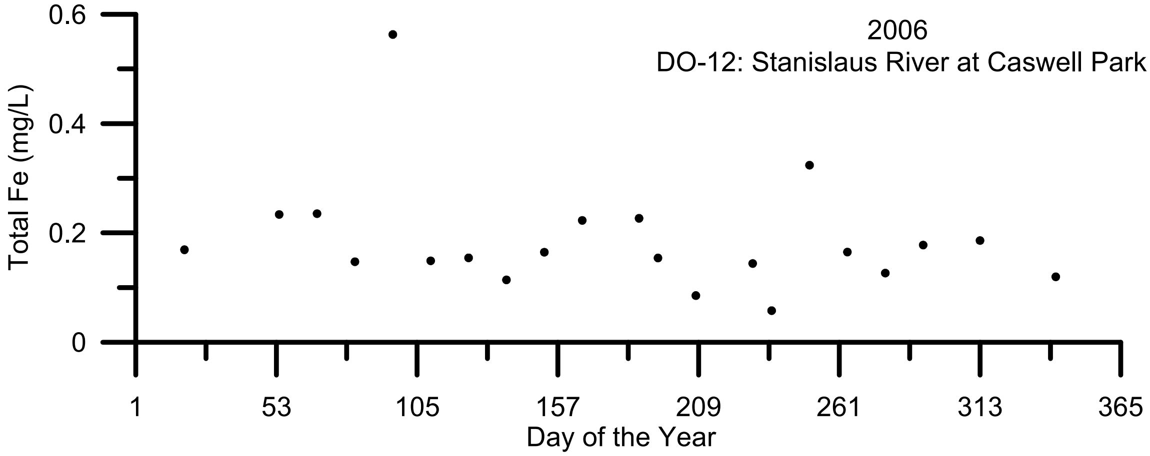
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-12: Stanislaus River at Caswell Park
Total Fe (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-12: Stanislaus River at Caswell Park
Total Fe (mg/L)
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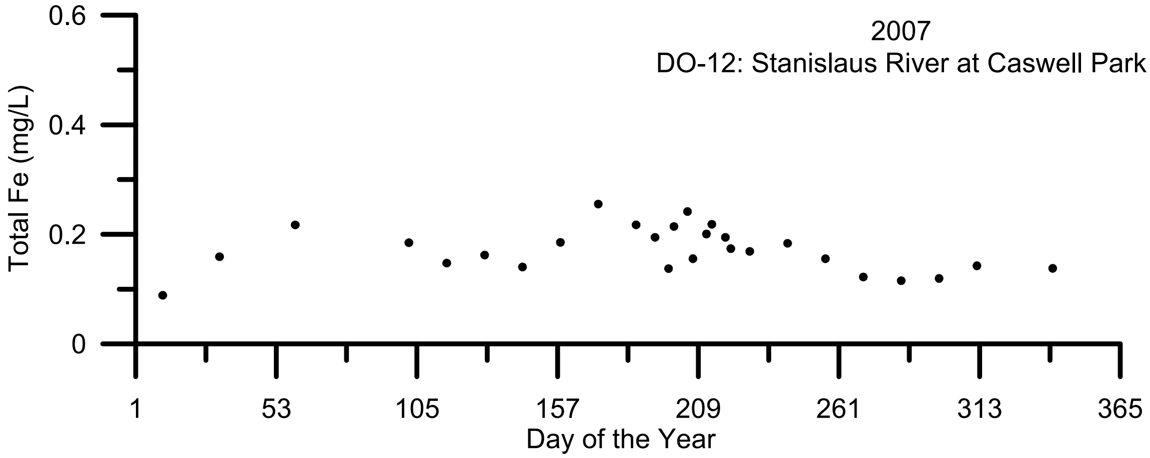
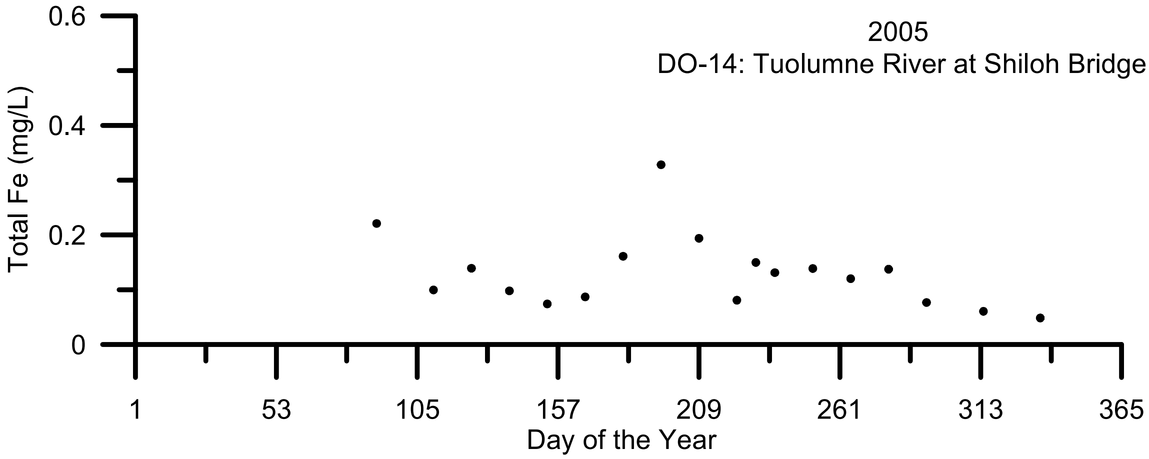
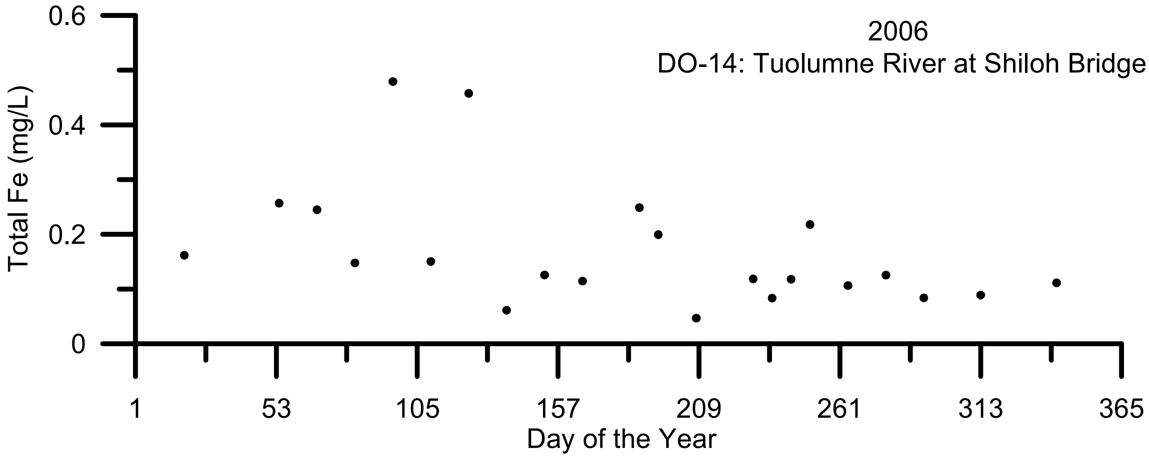
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

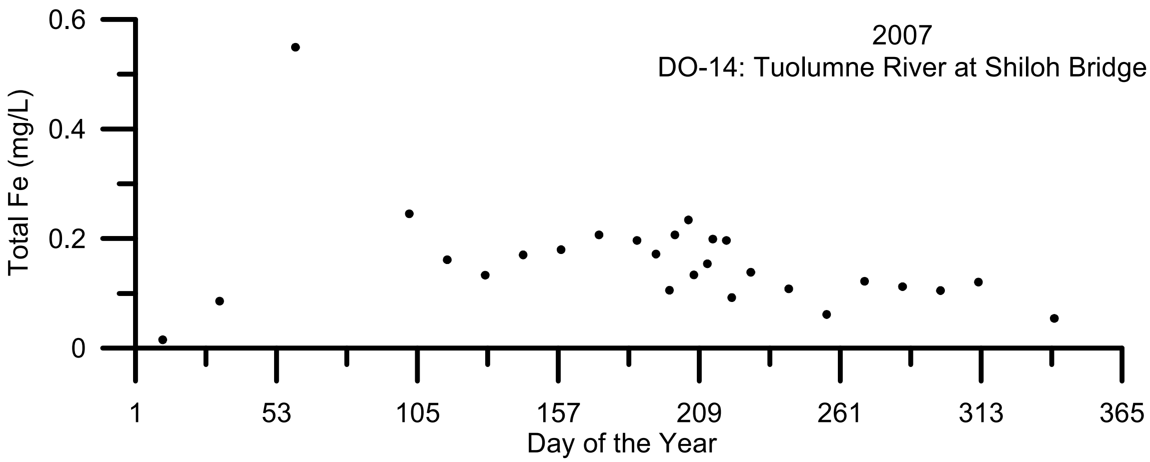

2007
DO-12: Stanislaus River at Caswell Park
Total Fe (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year



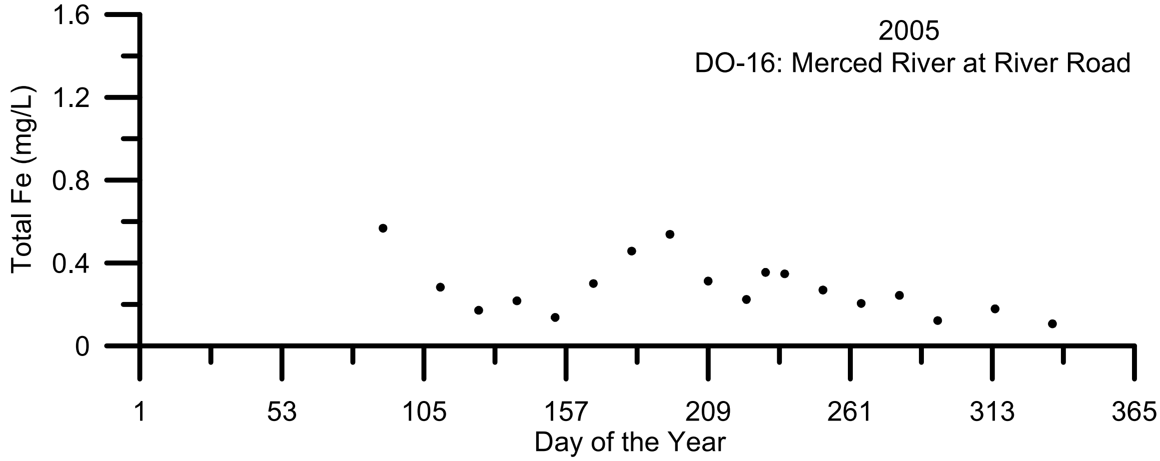
2005
DO-14: Tuolumne River at Shiloh Bridge
Total Fe (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year



2006
DO-14: Tuolumne River at Shiloh Bridge
Total Fe (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year



2007
DO-14: Tuolumne River at Shiloh Bridge
Total Fe (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-16: Merced River at River Road
Total Fe (mg/L)
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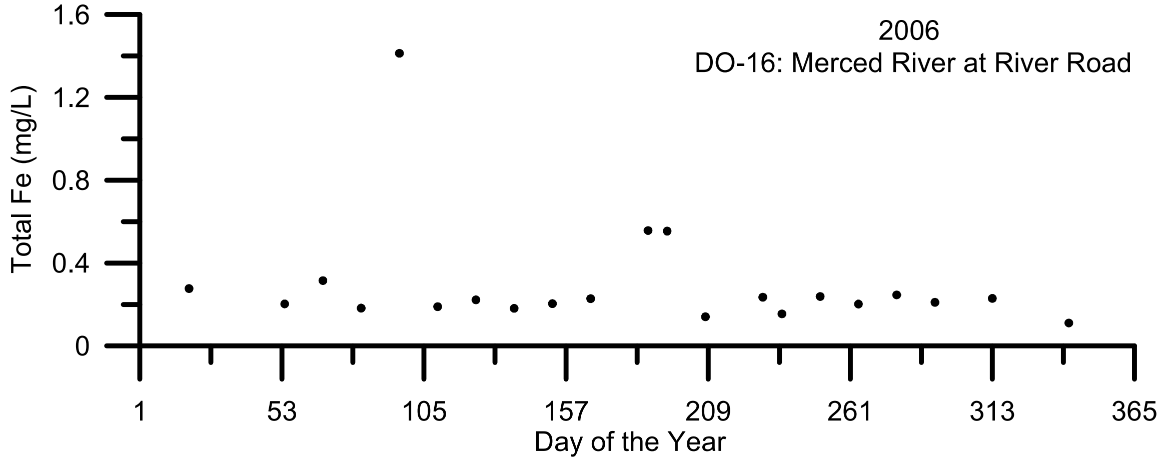
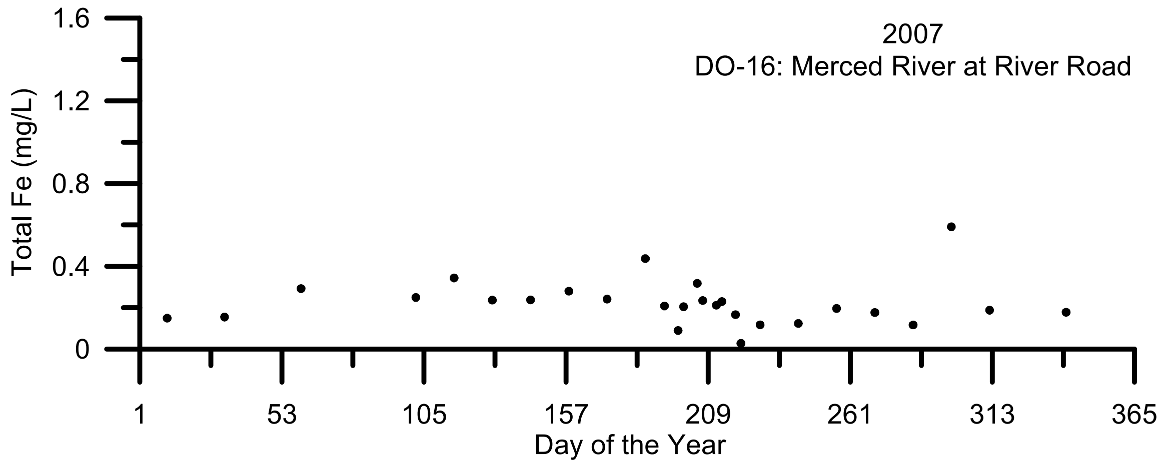
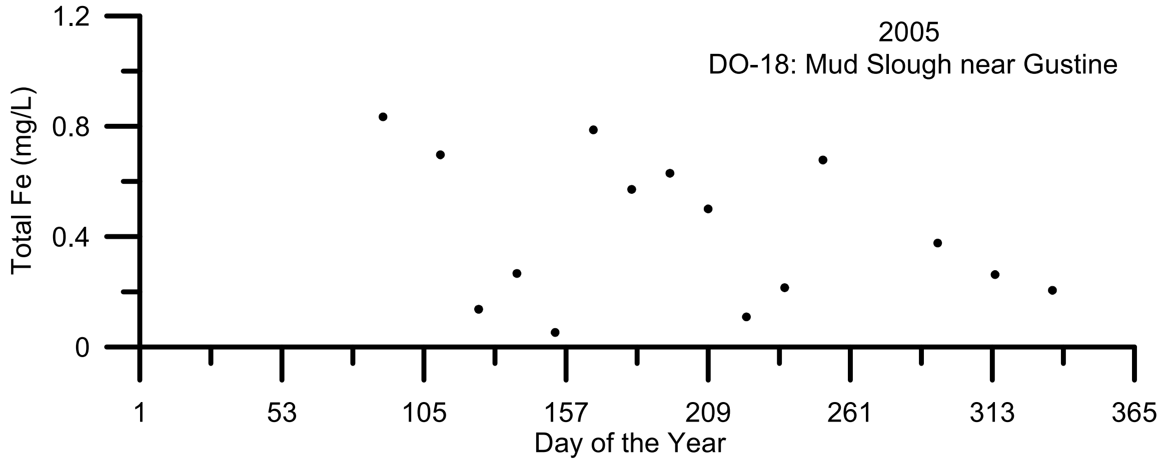
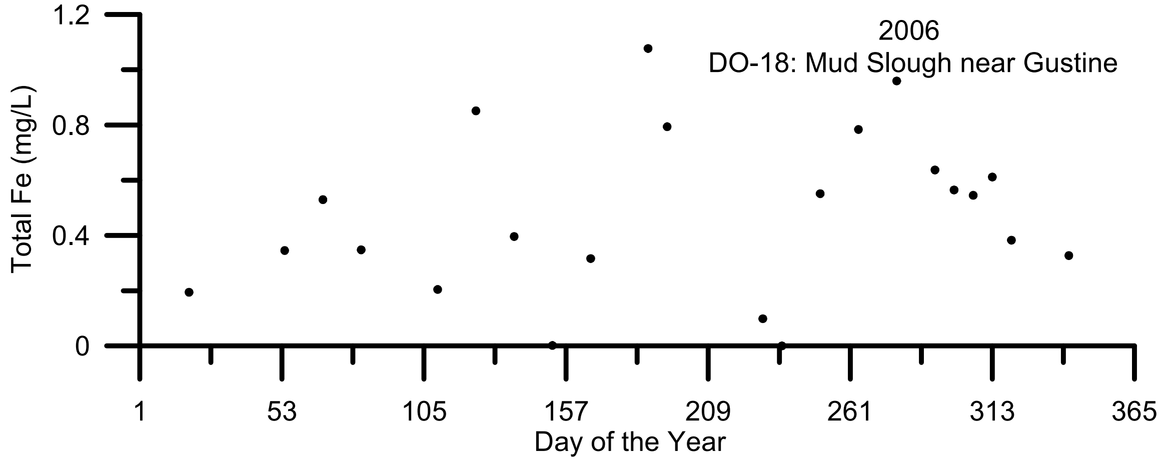
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-16: Merced River at River Road
Total Fe (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

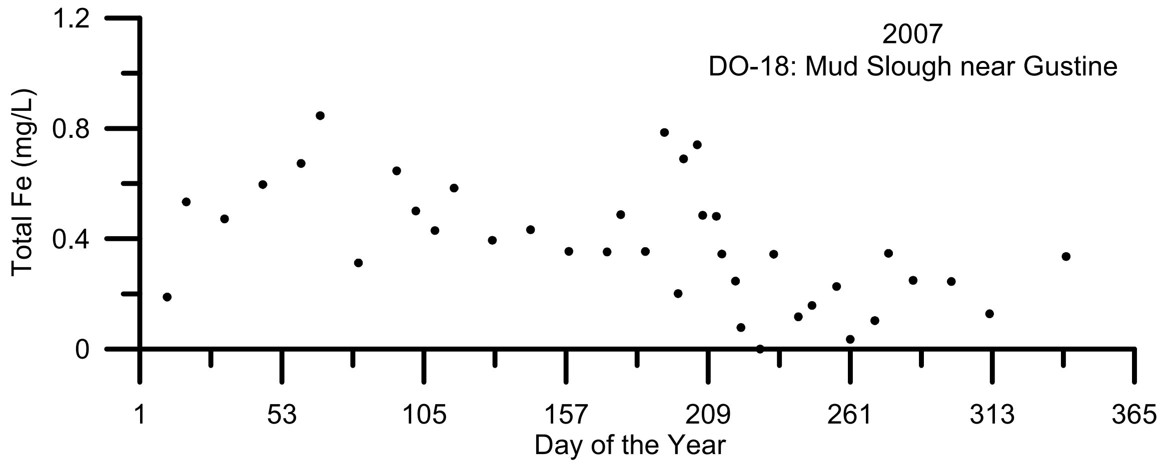

2007
DO-16: Merced River at River Road
Total Fe (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year



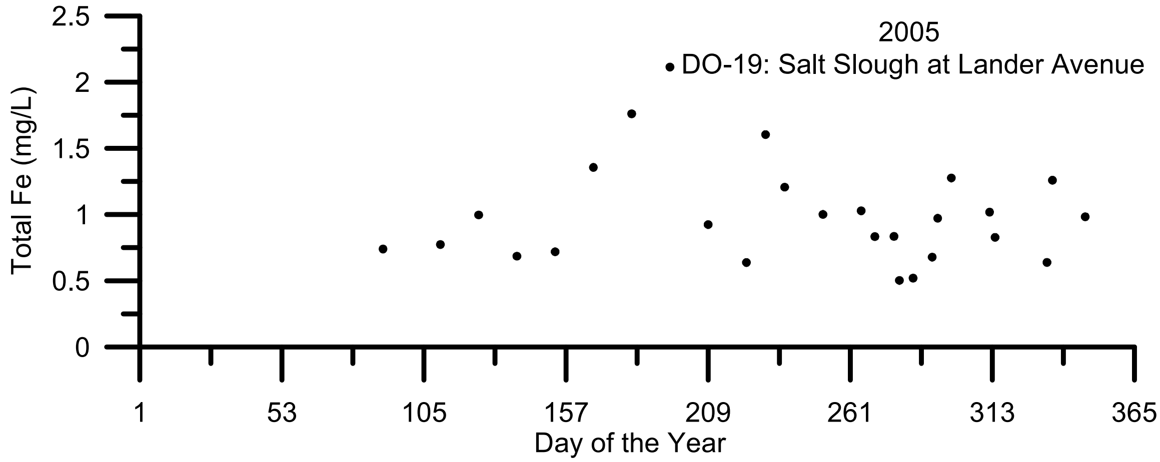
2005
DO-18: Mud Slough near Gustine
Total Fe (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year



2006
DO-18: Mud Slough near Gustine
Total Fe (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year



2007
DO-18: Mud Slough near Gustine
Total Fe (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-19: Salt Slough at Lander Avenue
Total Fe (mg/L)
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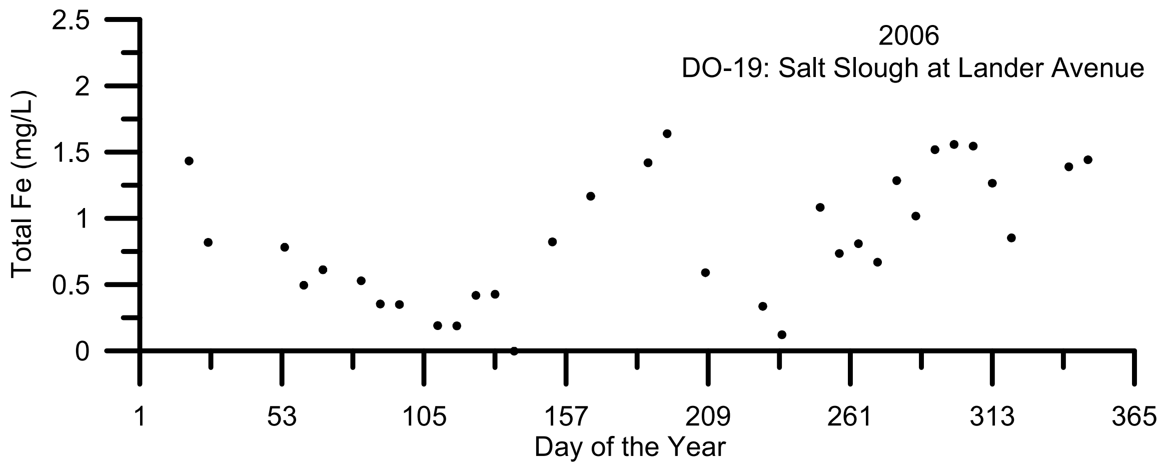
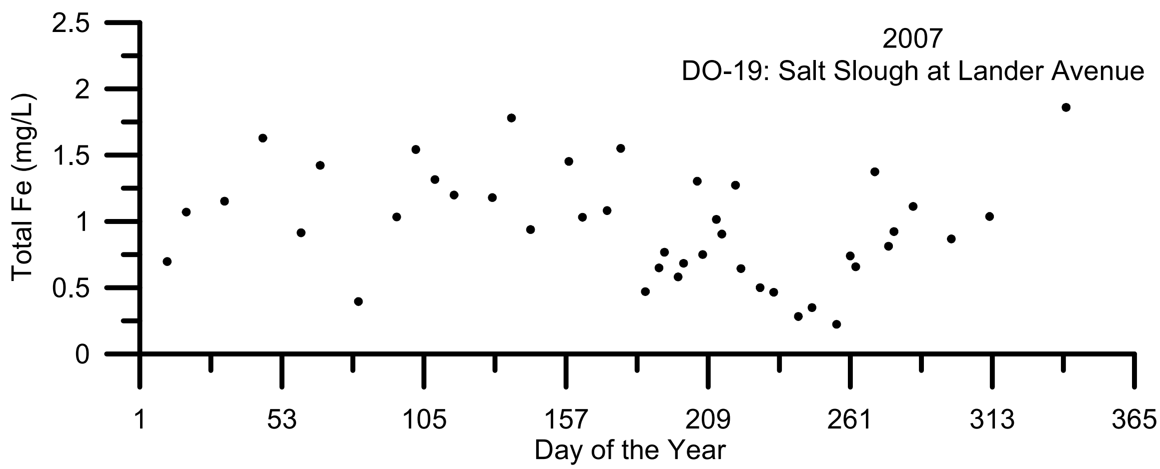
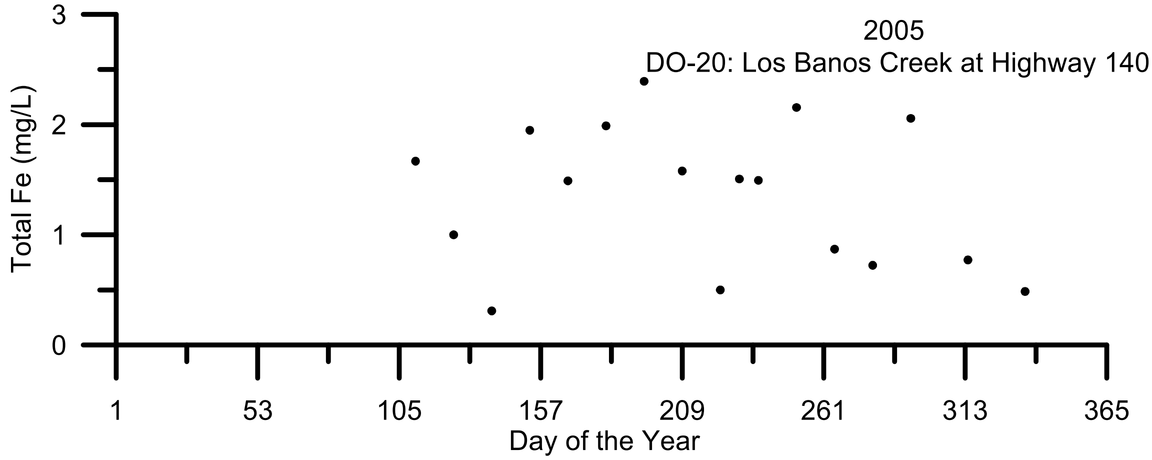
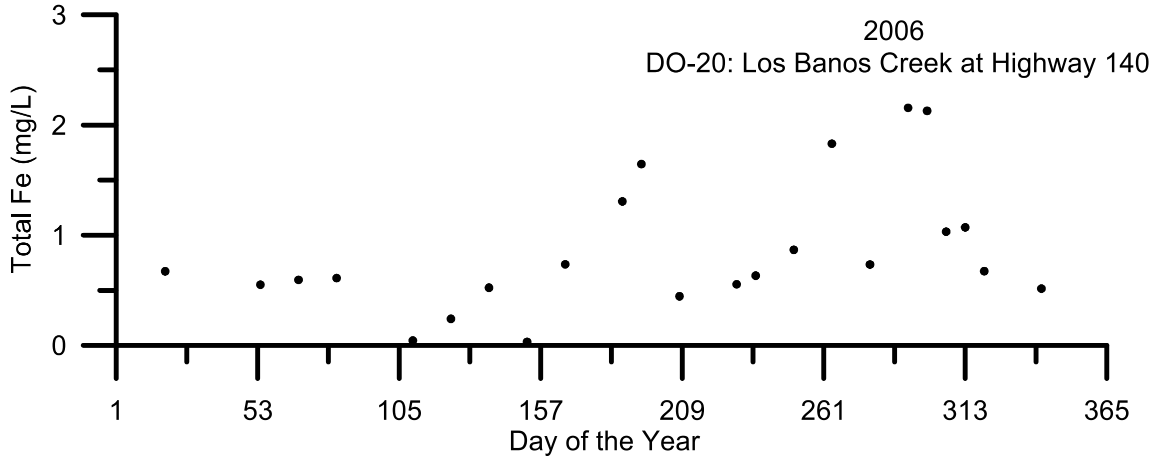
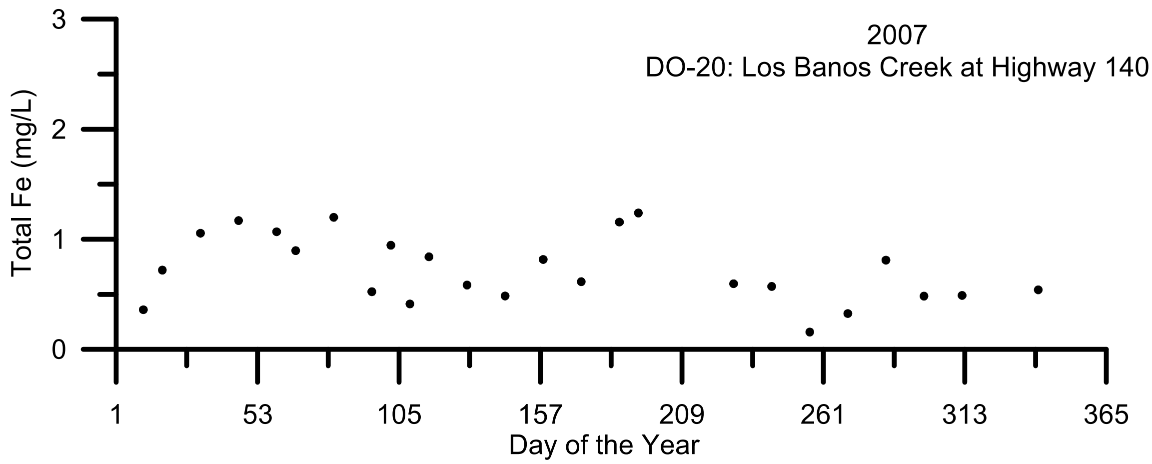
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year

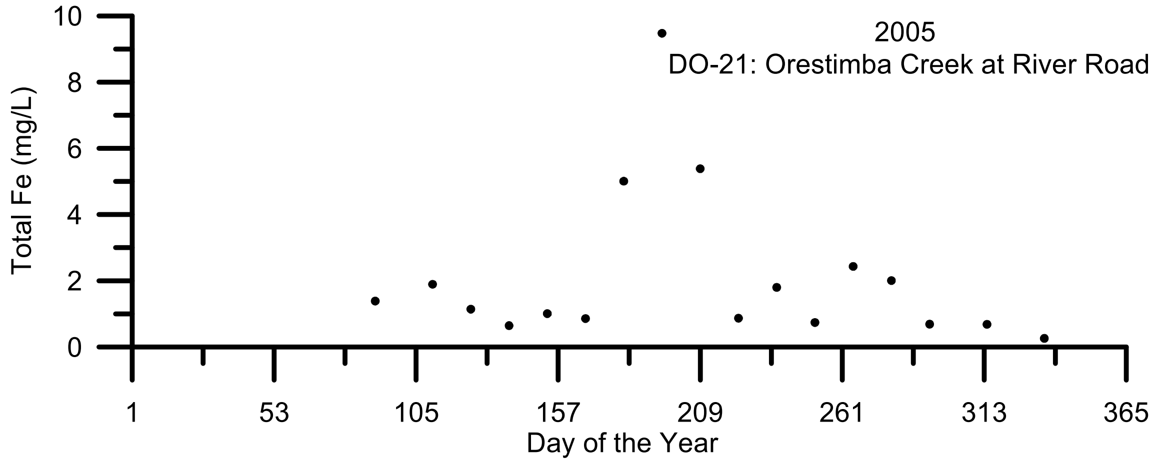

2006
DO-19: Salt Slough at Lander Avenue
Total Fe (mg/L)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year

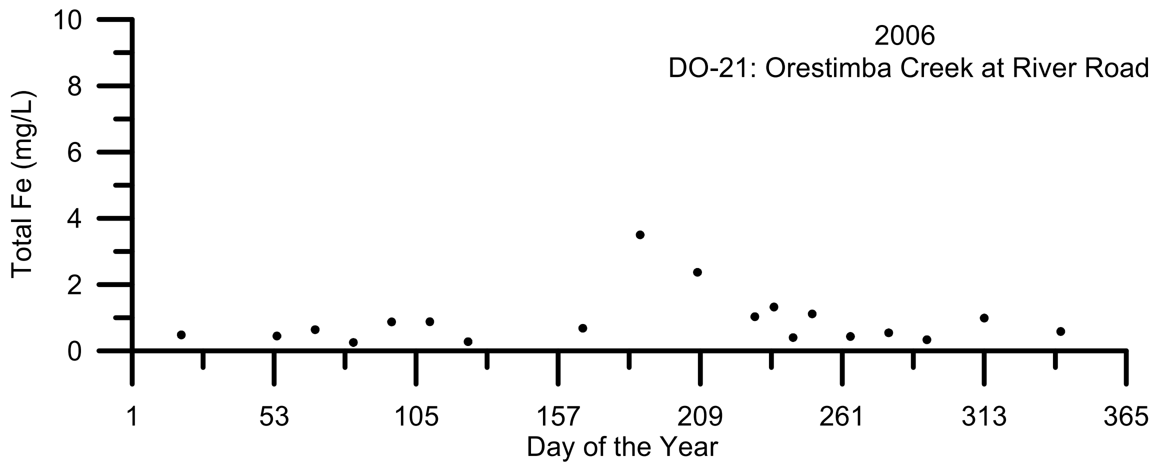

2007
DO-19: Salt Slough at Lander Avenue
Total Fe (mg/L)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year

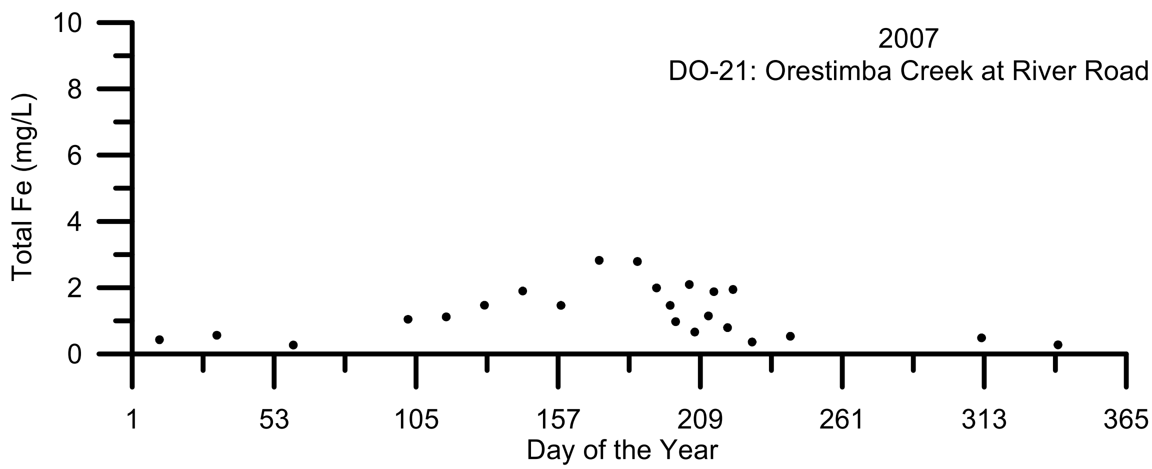

2005
DO-20: Los Banos Creek at Highway 140
Total Fe (mg/L)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

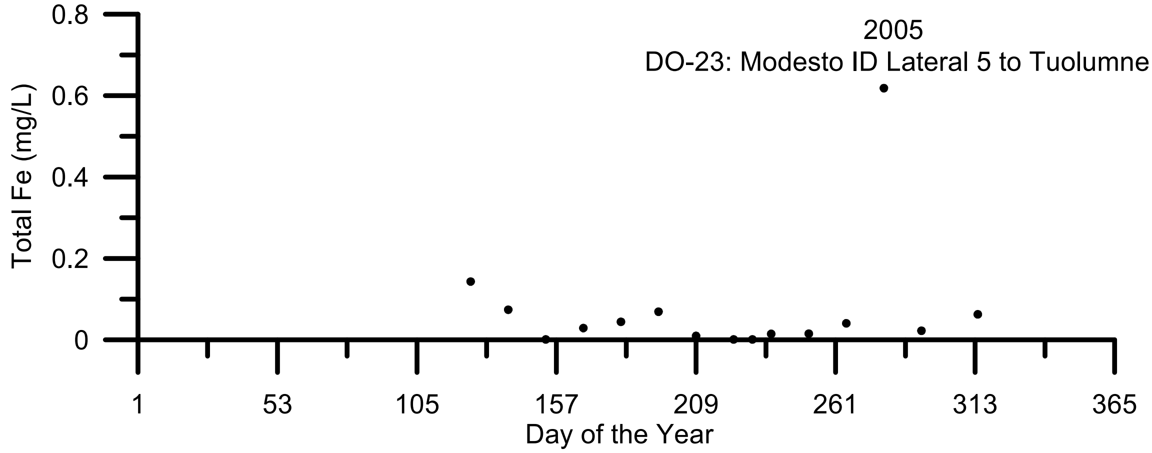

2006
DO-20: Los Banos Creek at Highway 140
Total Fe (mg/L)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

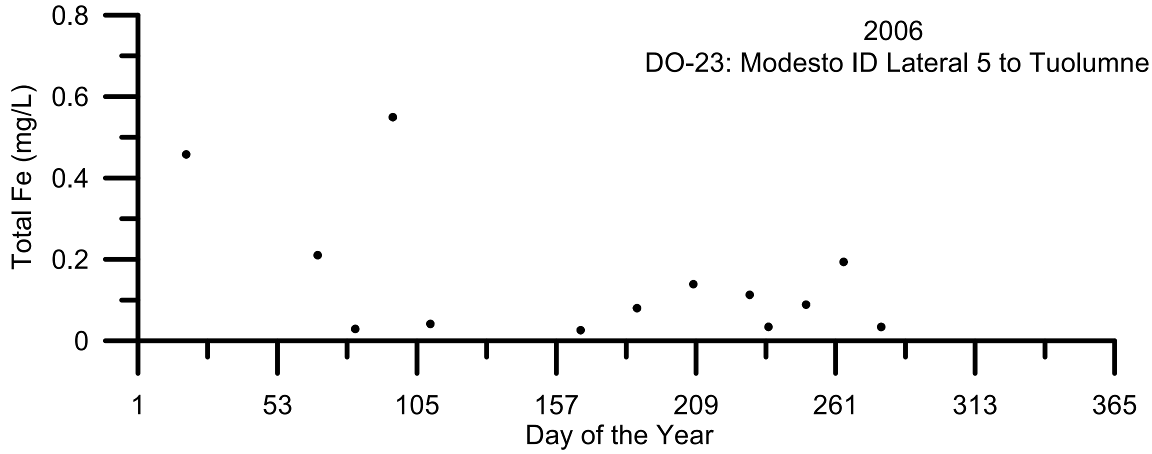

2007
DO-20: Los Banos Creek at Highway 140
Total Fe (mg/L)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

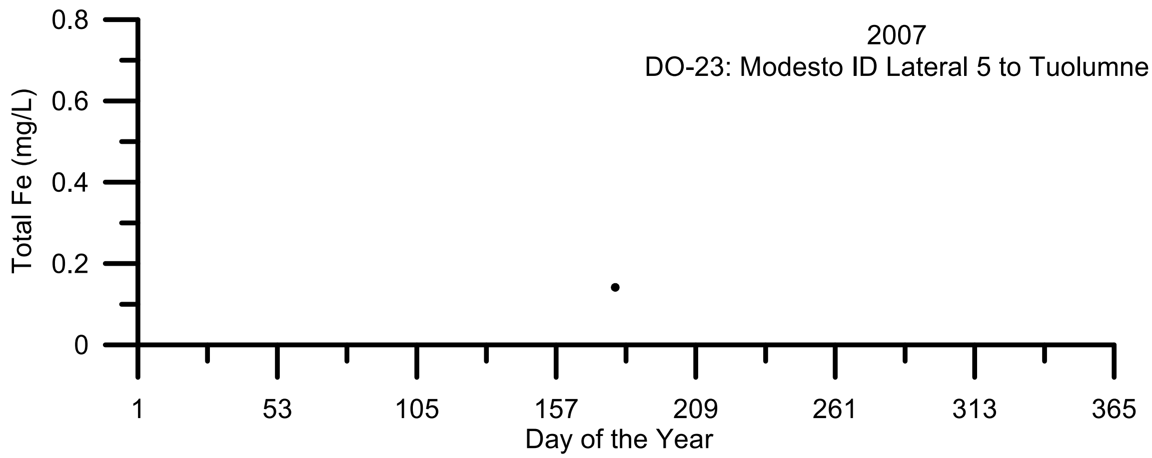

2005
DO-21: Orestimba Creek at River Road
Total Fe (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

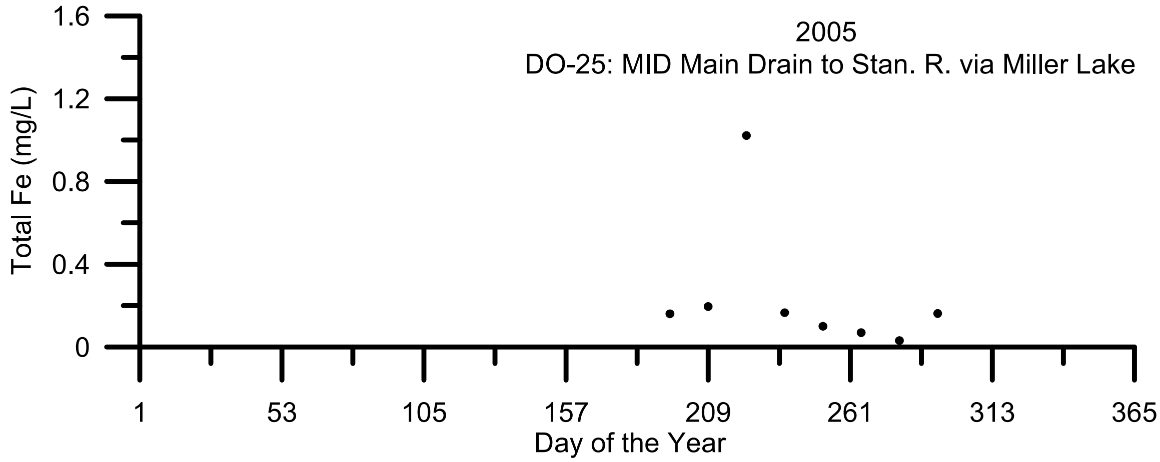

2006
DO-21: Orestimba Creek at River Road
Total Fe (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

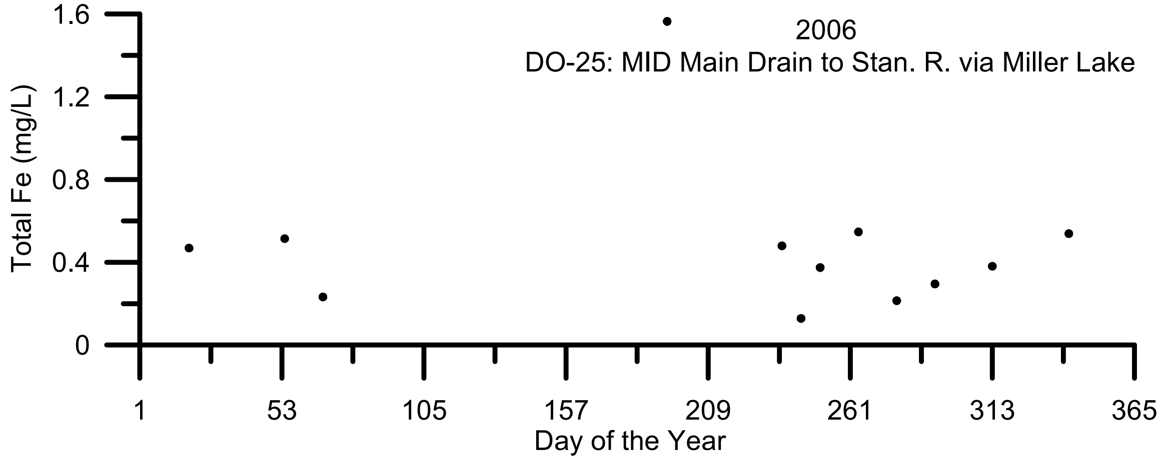

2007
DO-21: Orestimba Creek at River Road
Total Fe (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

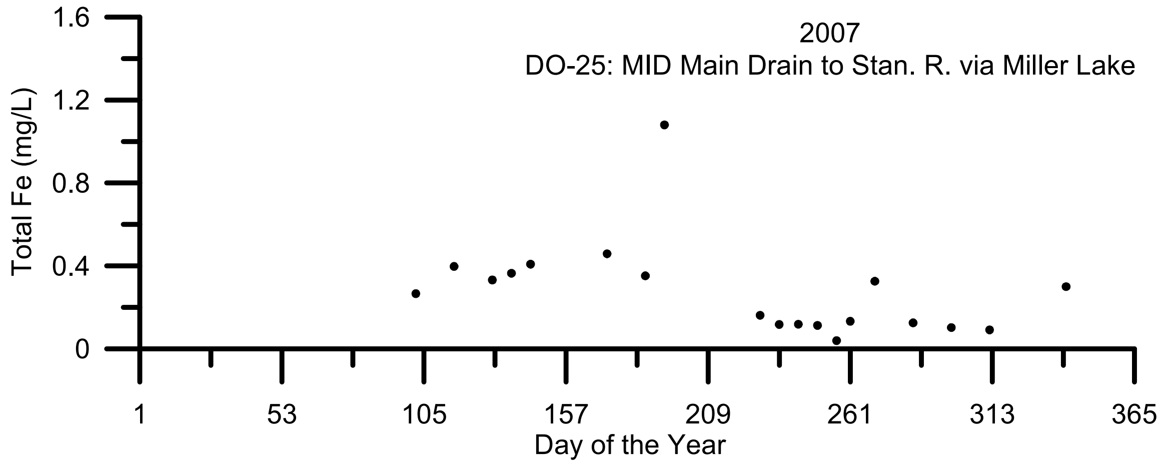

2005
DO-23: Modesto ID Lateral 5 to Tuolumne
Total Fe (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

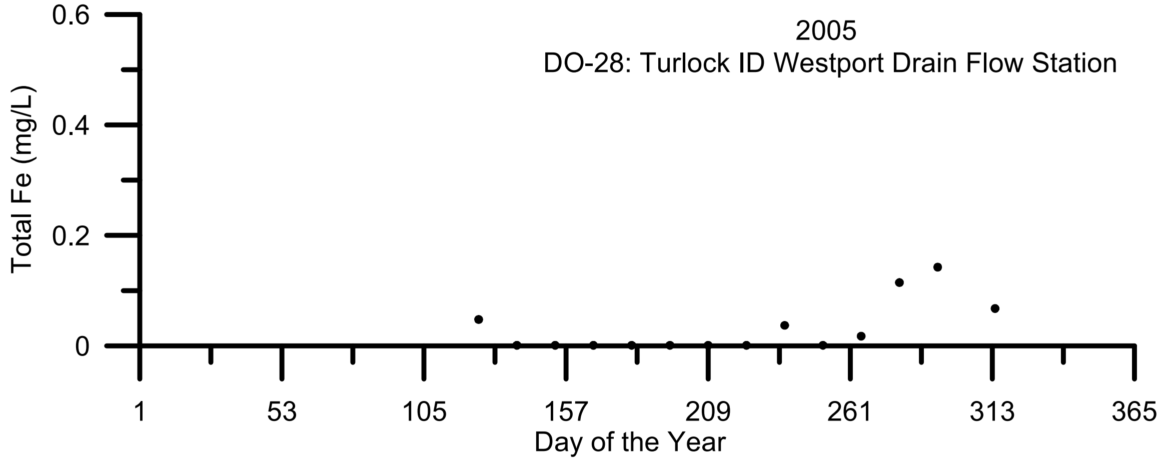

2006
DO-23: Modesto ID Lateral 5 to Tuolumne
Total Fe (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

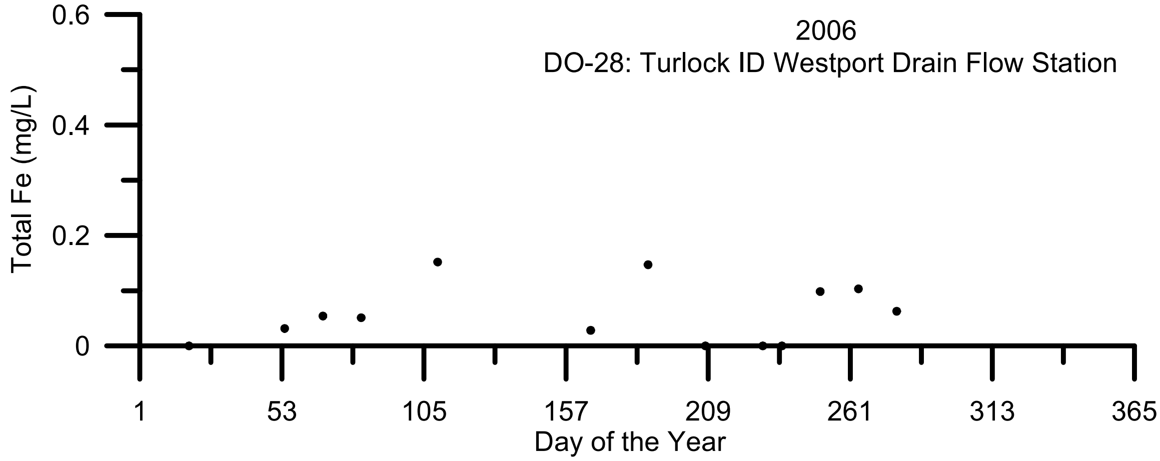

2007
DO-23: Modesto ID Lateral 5 to Tuolumne
Total Fe (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

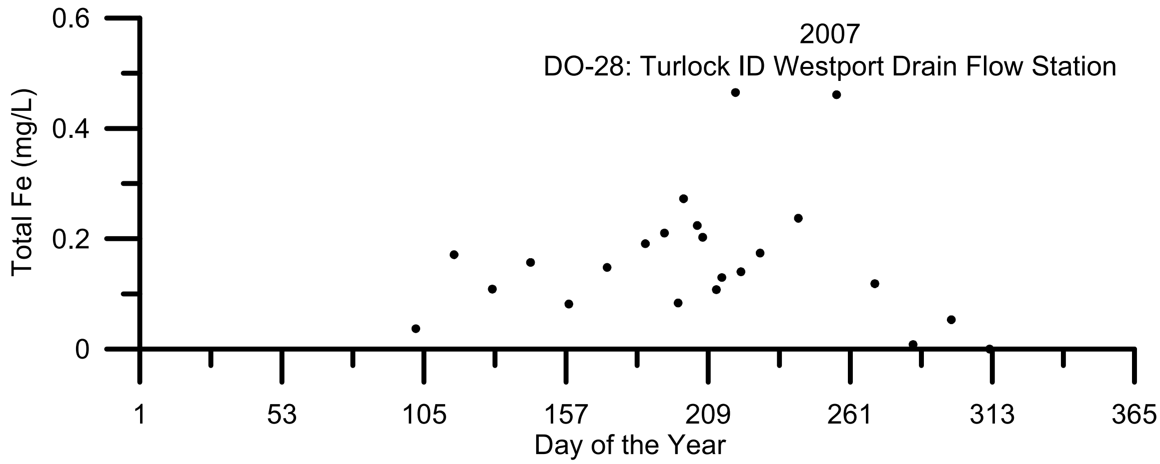

2005
DO-25: MID Main Drain to Stan. R. via Miller Lake
Total Fe (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

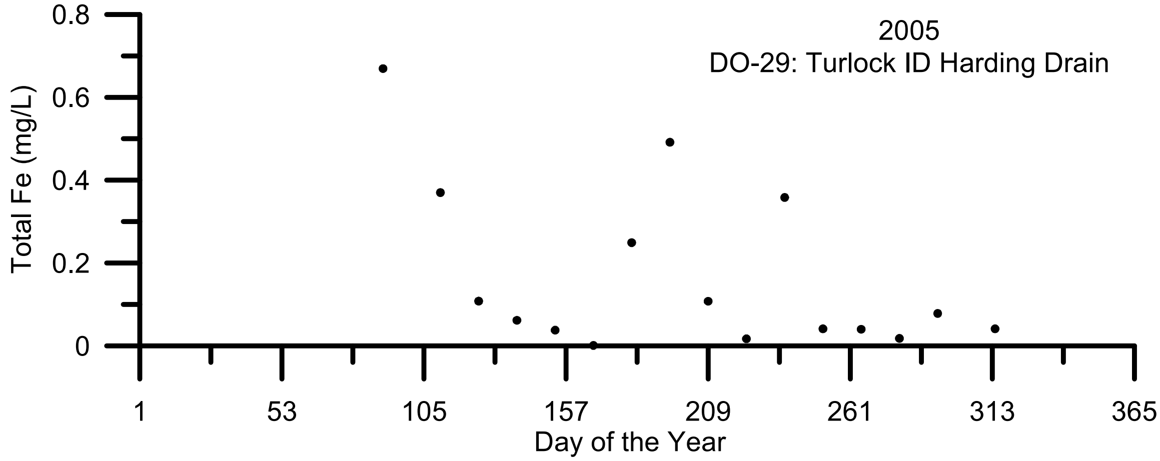

2006
DO-25: MID Main Drain to Stan. R. via Miller Lake
Total Fe (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

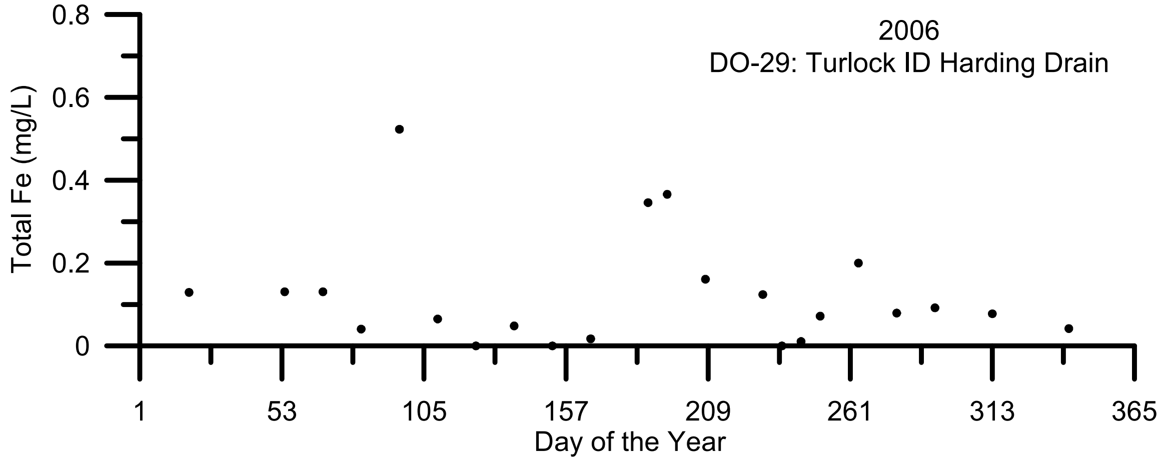

2007
DO-25: MID Main Drain to Stan. R. via Miller Lake
Total Fe (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

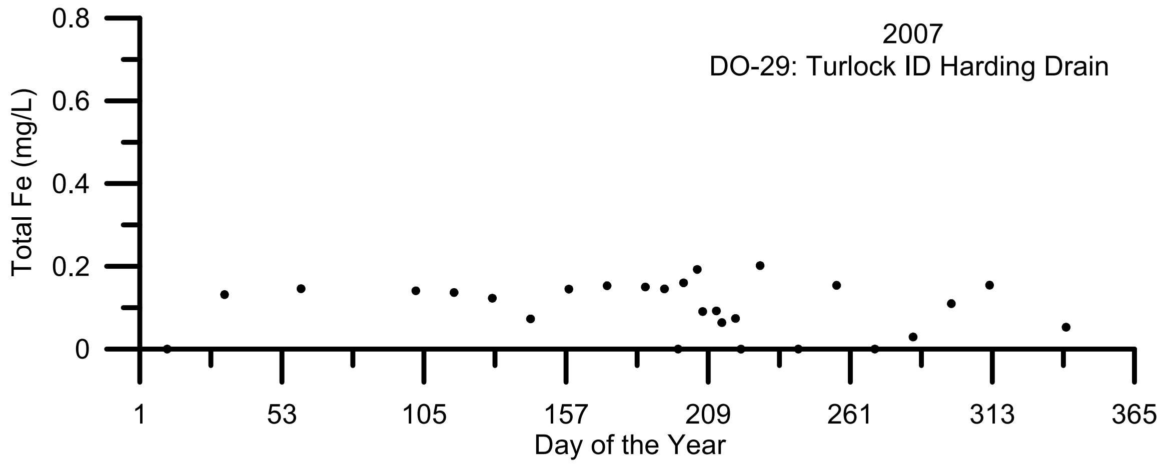

2005
DO-28: Turlock ID Westport Drain Flow Station
Total Fe (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

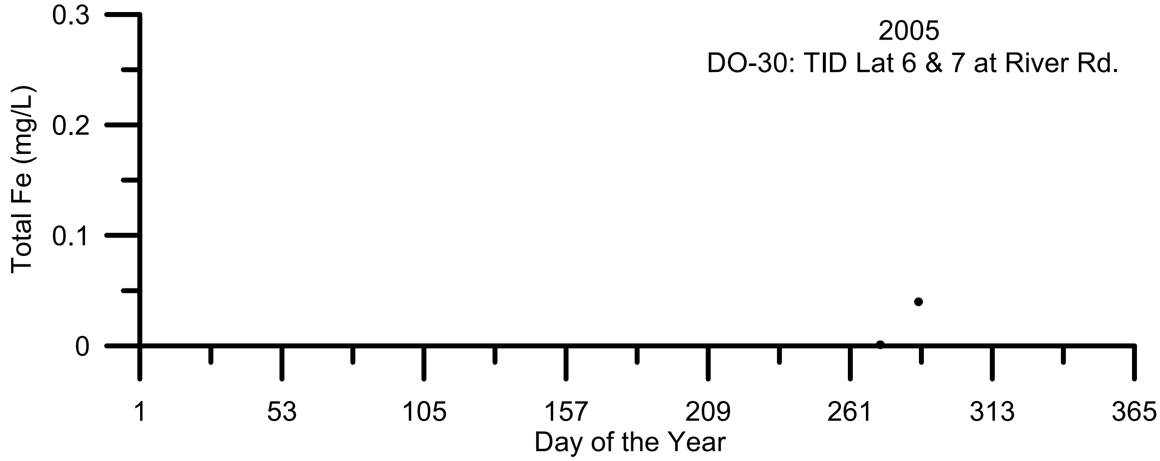

2006
DO-28: Turlock ID Westport Drain Flow Station
Total Fe (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

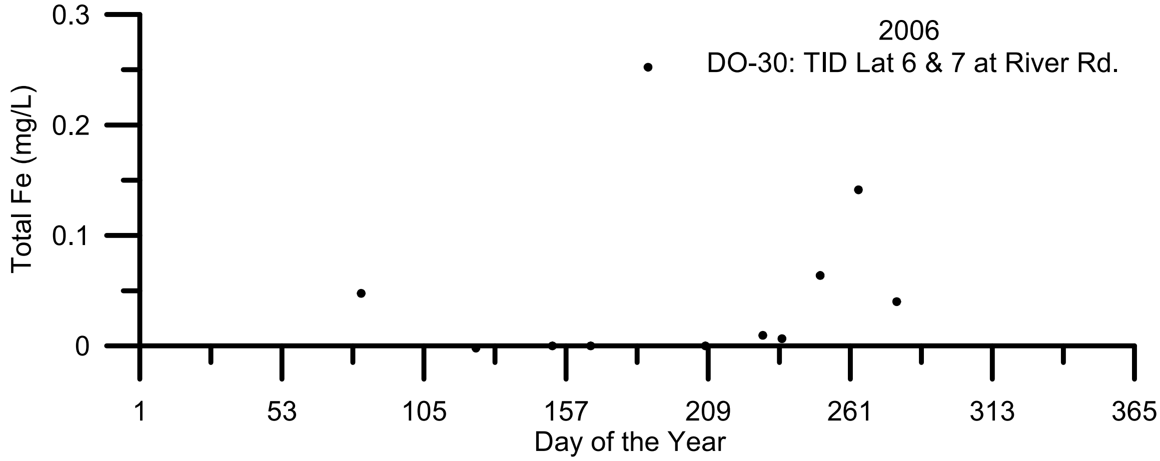

2007
DO-28: Turlock ID Westport Drain Flow Station
Total Fe (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

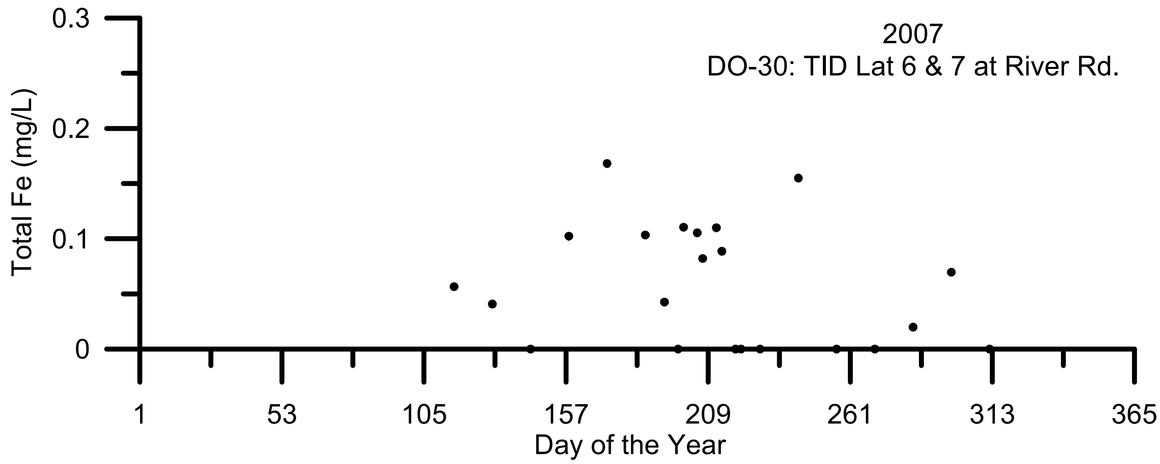

2005
DO-29: Turlock ID Harding Drain
Total Fe (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

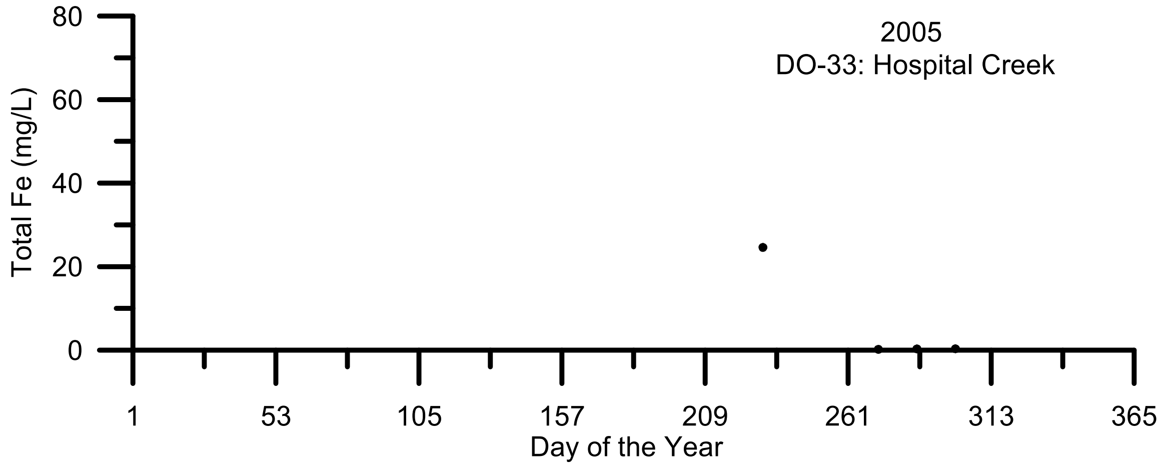

2006
DO-29: Turlock ID Harding Drain
Total Fe (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

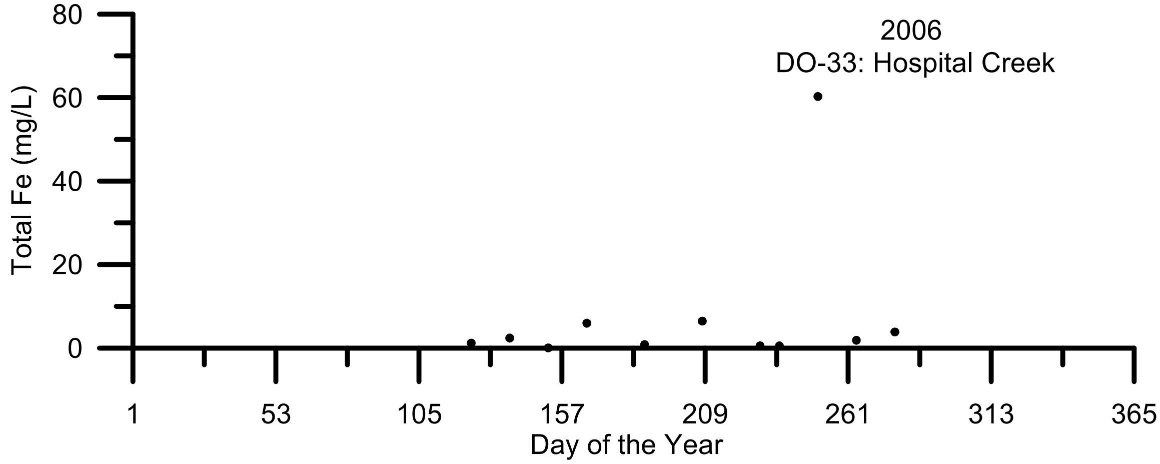

2007
DO-29: Turlock ID Harding Drain
Total Fe (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

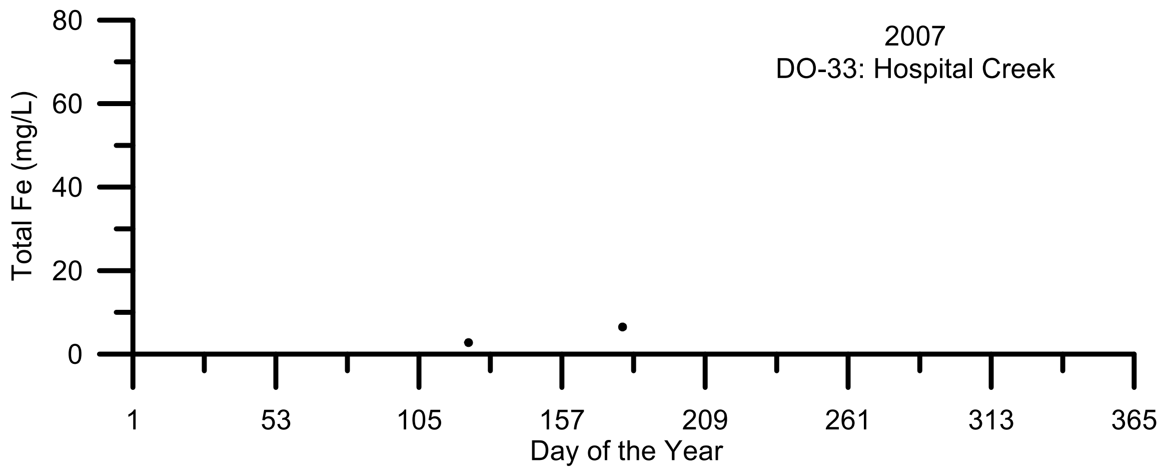

2005
DO-30: TID Lat 6 & 7 at River Rd.
Total Fe (mg/L)
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

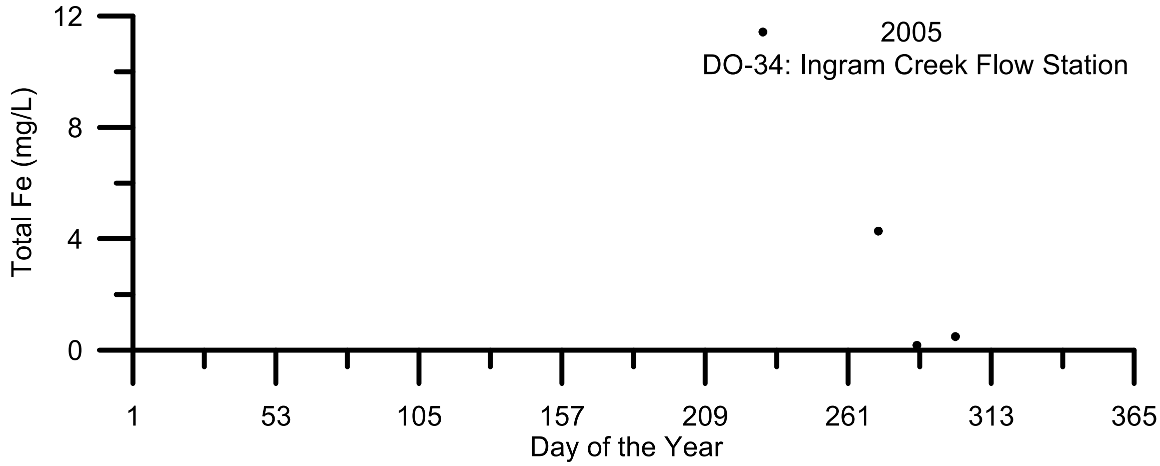

2006
DO-30: TID Lat 6 & 7 at River Rd.
Total Fe (mg/L)
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

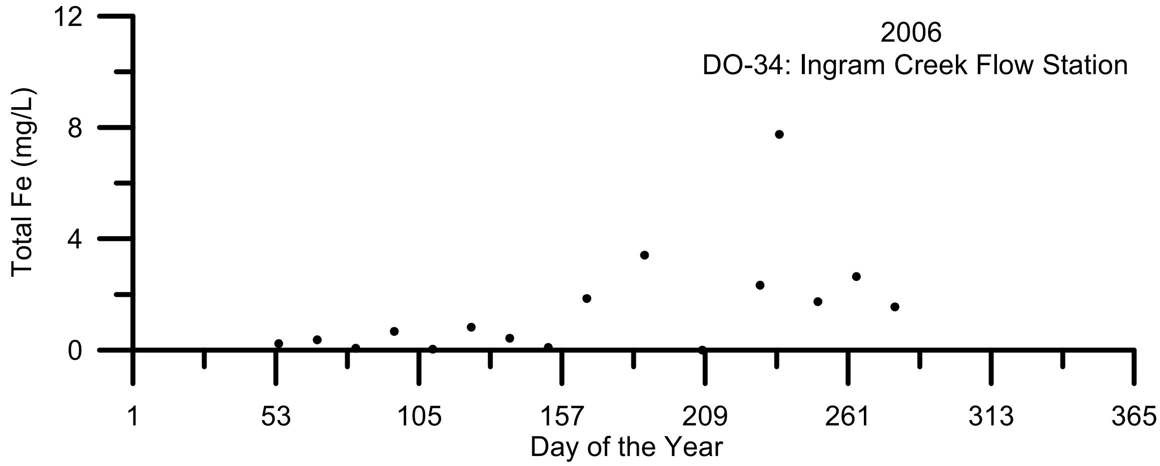

2007
DO-30: TID Lat 6 & 7 at River Rd.
Total Fe (mg/L)
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

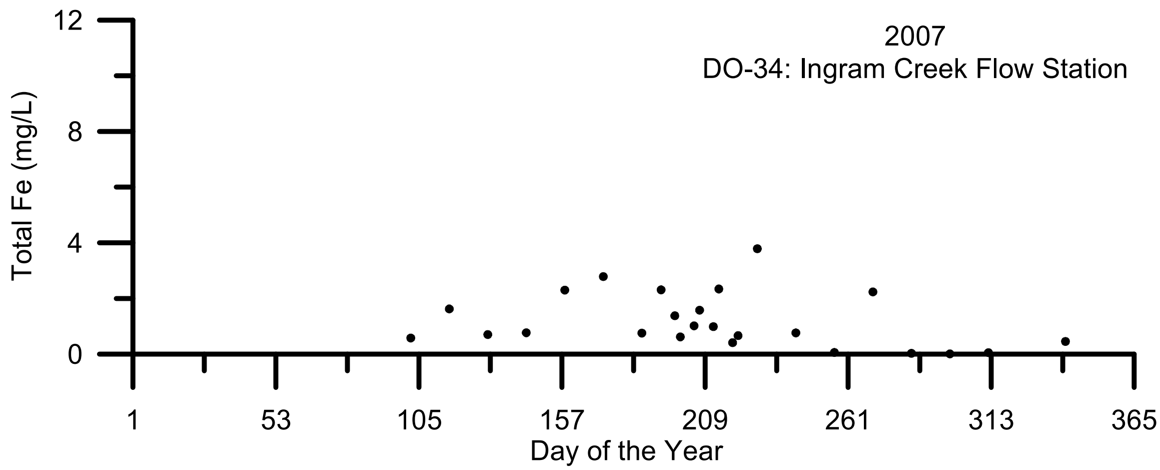

2005
DO-33: Hospital Creek
Total Fe (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

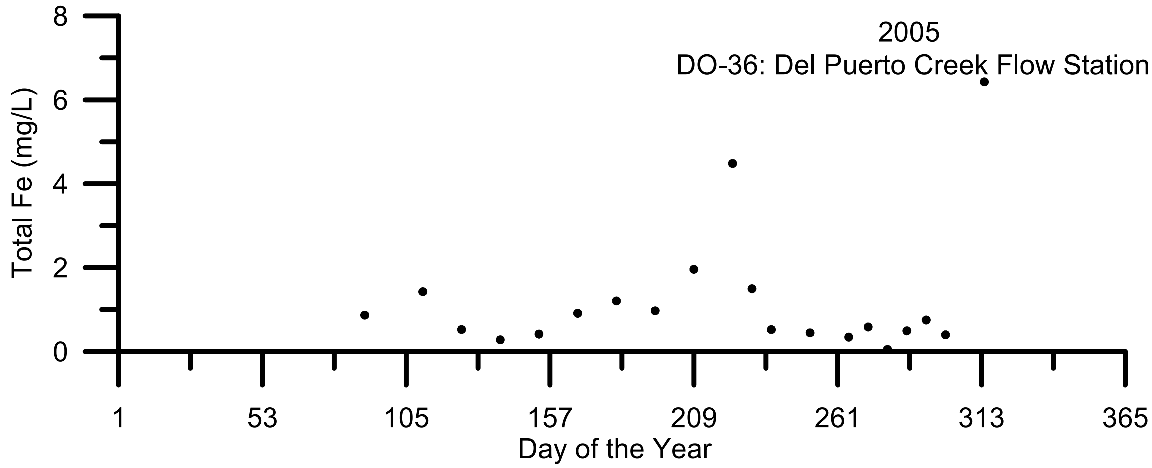

2006
DO-33: Hospital Creek
Total Fe (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

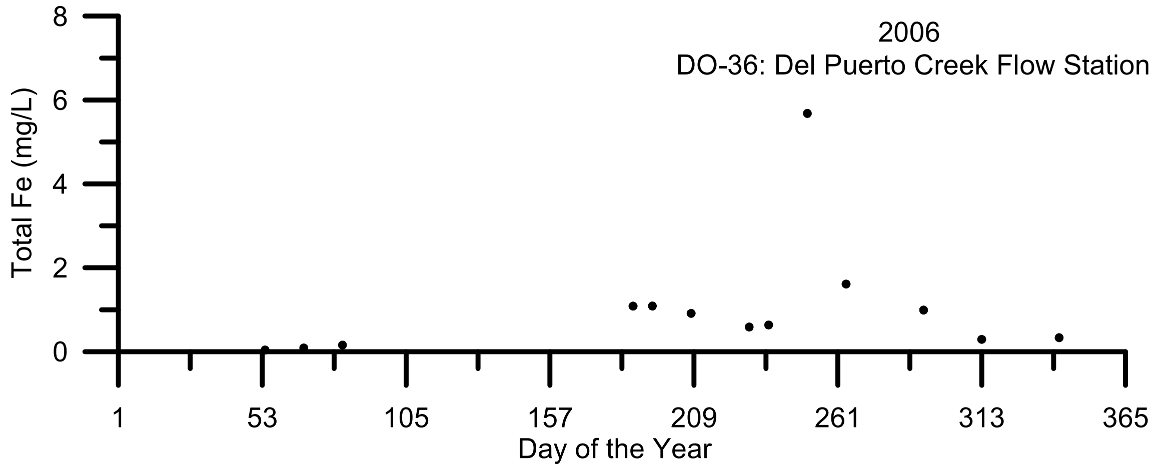

2007
DO-33: Hospital Creek
Total Fe (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

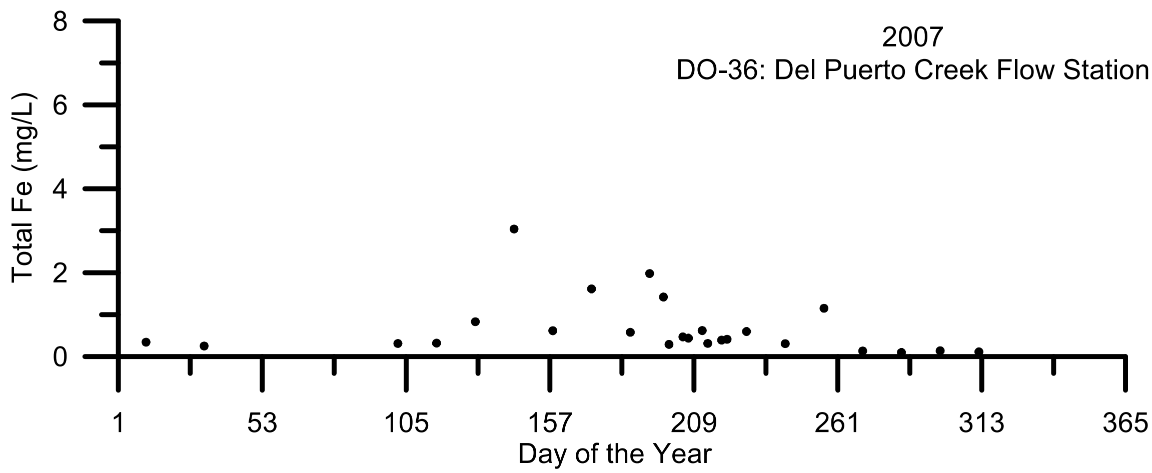

2005
DO-34: Ingram Creek Flow Station
Total Fe (mg/L)
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

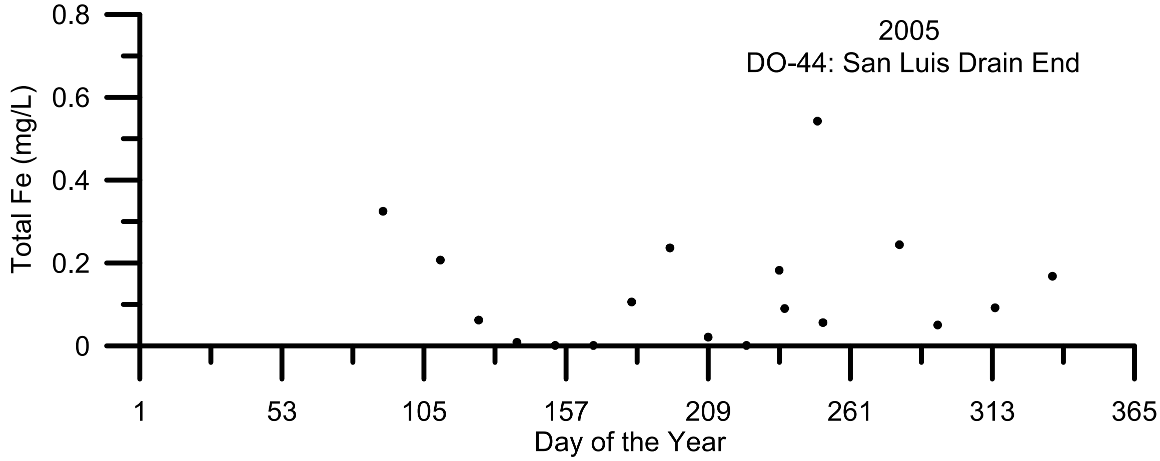

2006
DO-34: Ingram Creek Flow Station
Total Fe (mg/L)
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

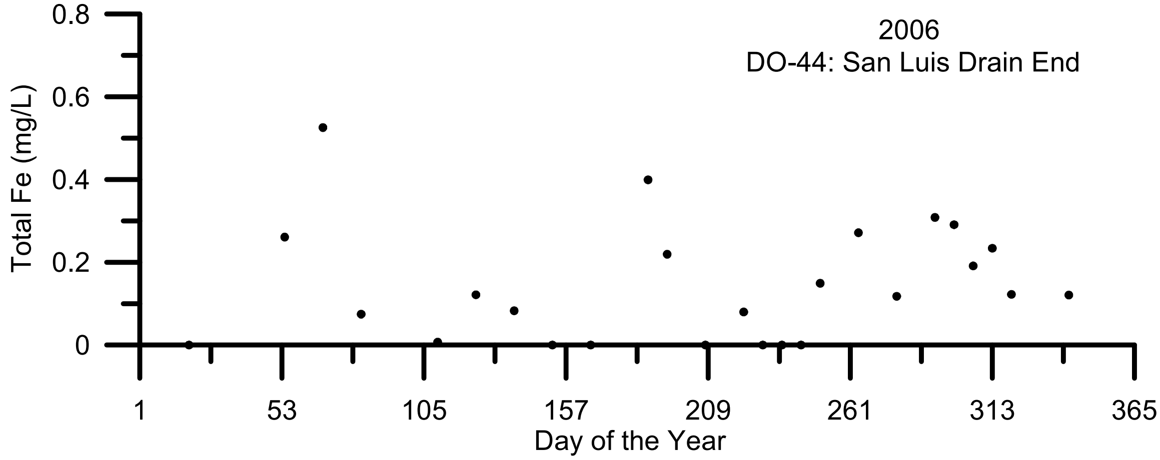

2007
DO-34: Ingram Creek Flow Station
Total Fe (mg/L)
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

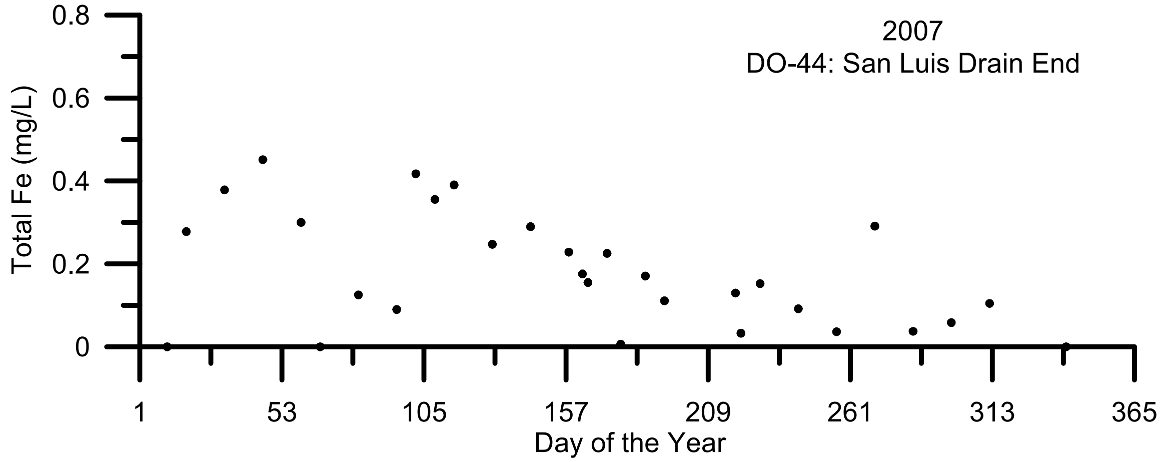

2005
DO-36: Del Puerto Creek Flow Station
Total Fe (mg/L)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

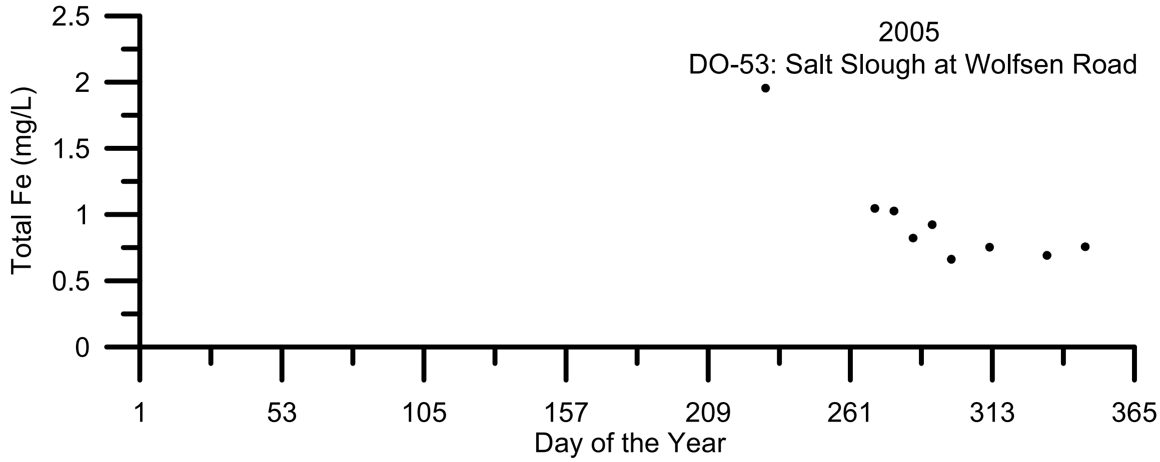

2006
DO-36: Del Puerto Creek Flow Station
Total Fe (mg/L)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

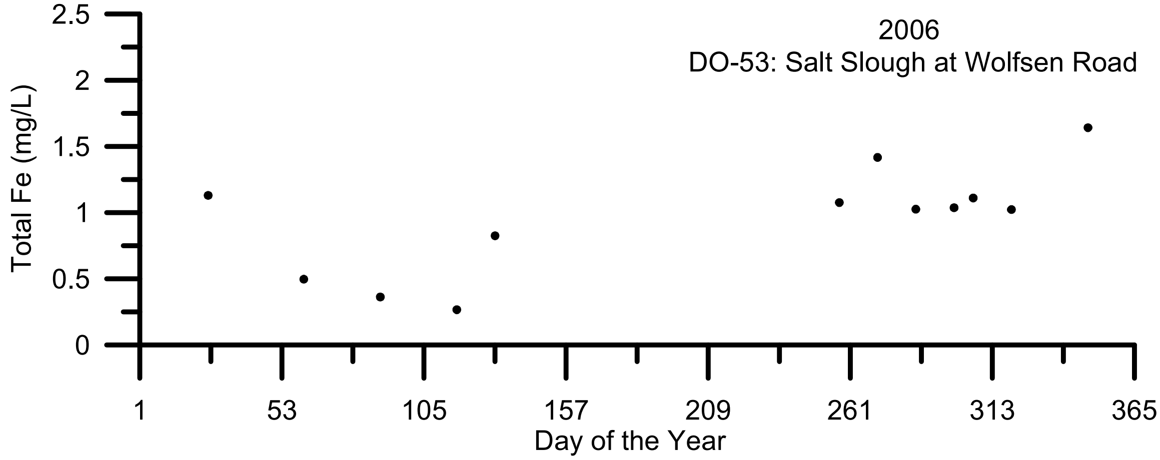

2007
DO-36: Del Puerto Creek Flow Station
Total Fe (mg/L)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

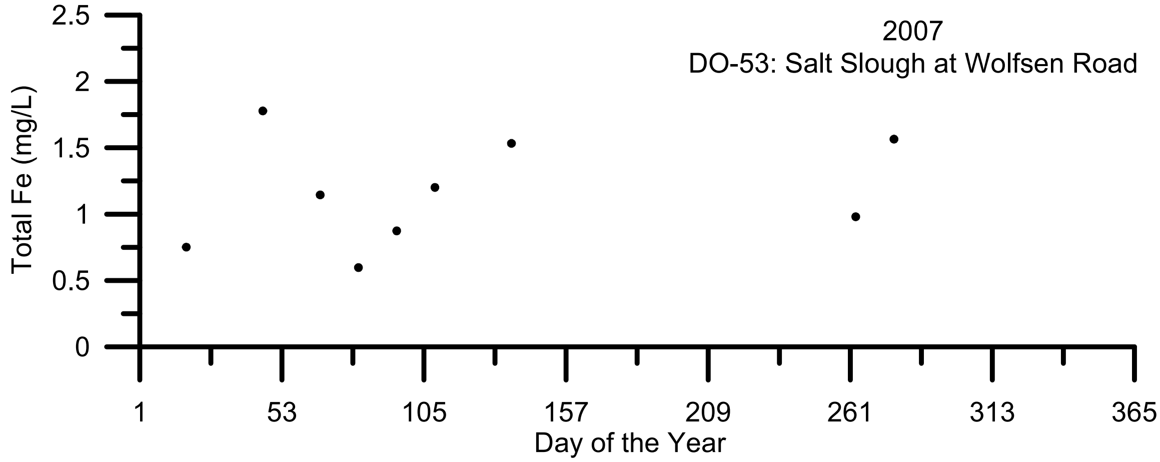

2005
DO-44: San Luis Drain End
Total Fe (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

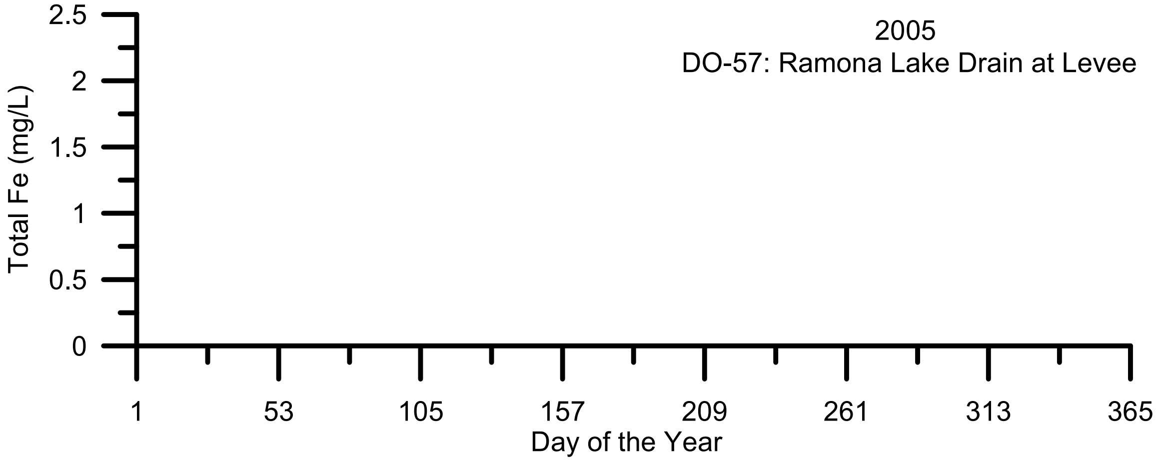

2006
DO-44: San Luis Drain End
Total Fe (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

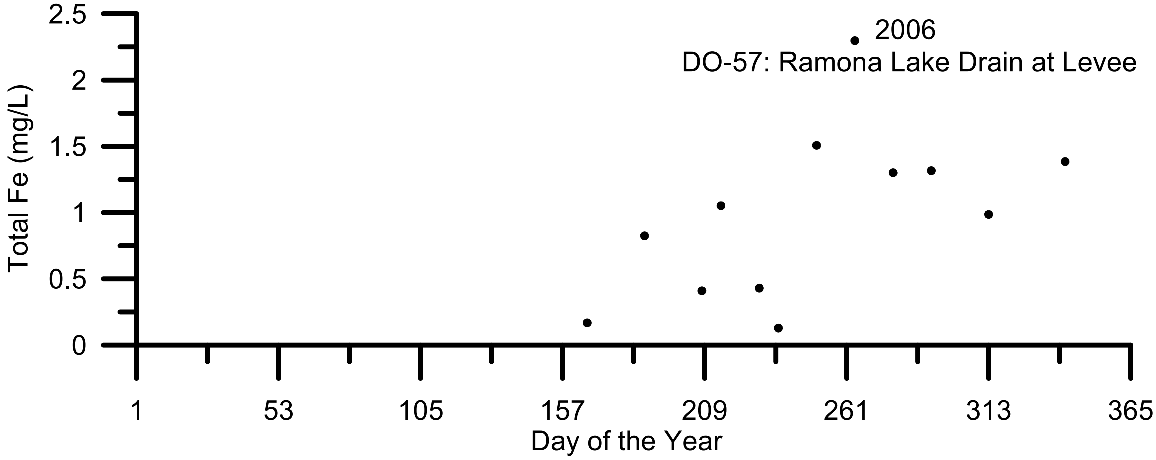

2007
DO-44: San Luis Drain End
Total Fe (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

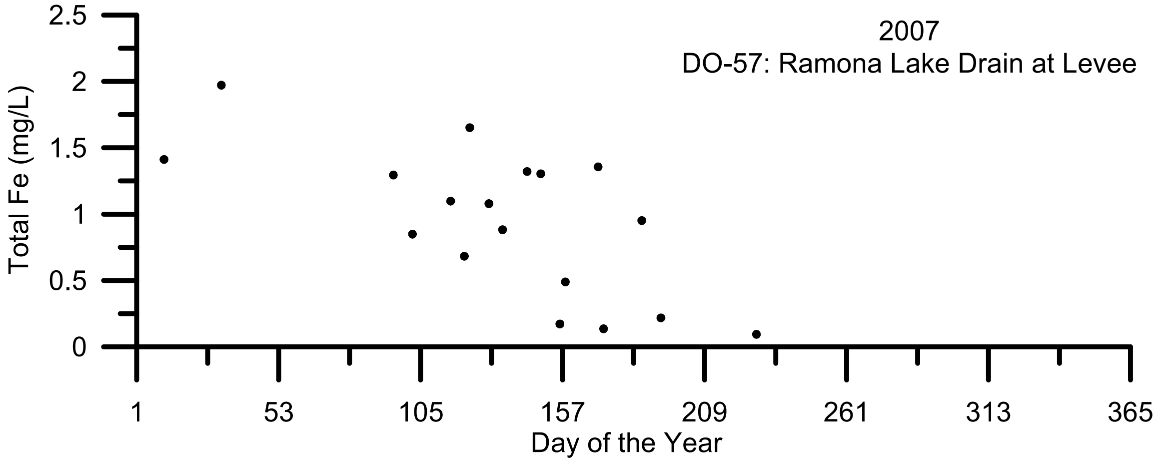

2005
DO-53: Salt Slough at Wolfsen Road
Total Fe (mg/L)
0
0.5
1
1.5
2
2.5
1
53
105
157
209
261
313
365
Day of the Year

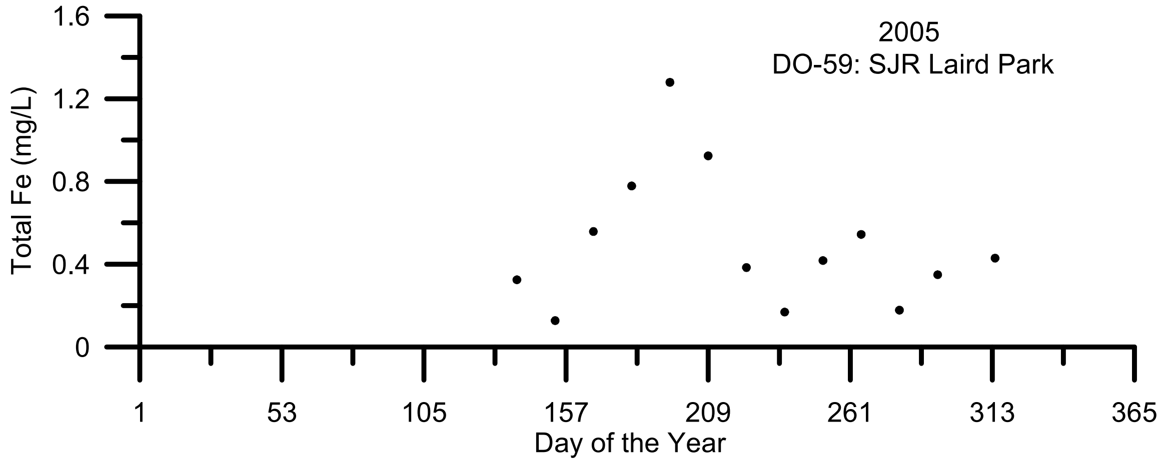

2006
DO-53: Salt Slough at Wolfsen Road
Total Fe (mg/L)
0
0.5
1
1.5
2
2.5
1
53
105
157
209
261
313
365
Day of the Year

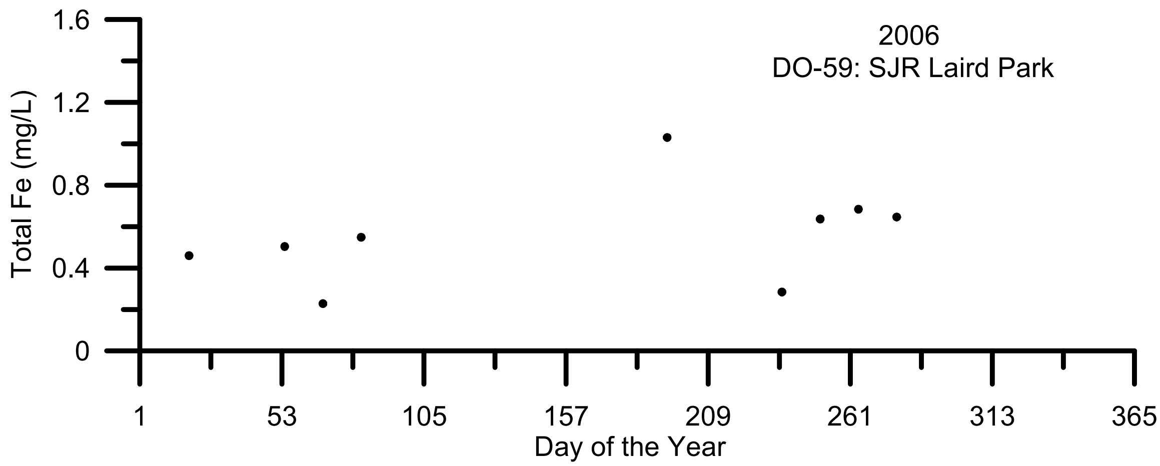

2007
DO-53: Salt Slough at Wolfsen Road
Total Fe (mg/L)
0
0.5
1
1.5
2
2.5
1
53
105
157
209
261
313
365
Day of the Year

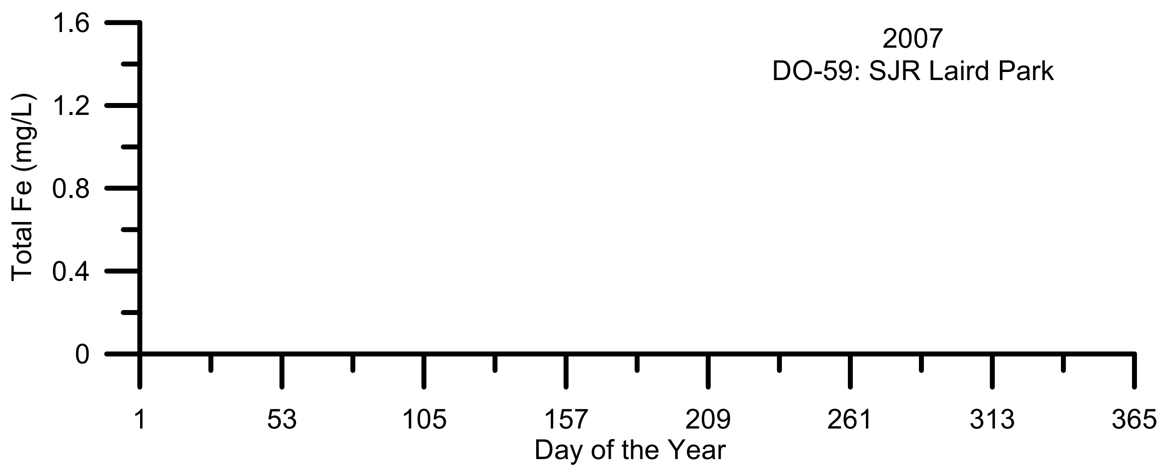

2005
DO-57: Ramona Lake Drain at Levee
Total Fe (mg/L)
0
0.5
1
1.5
2
2.5
1
53
105
157
209
261
313
365
Day of the Year

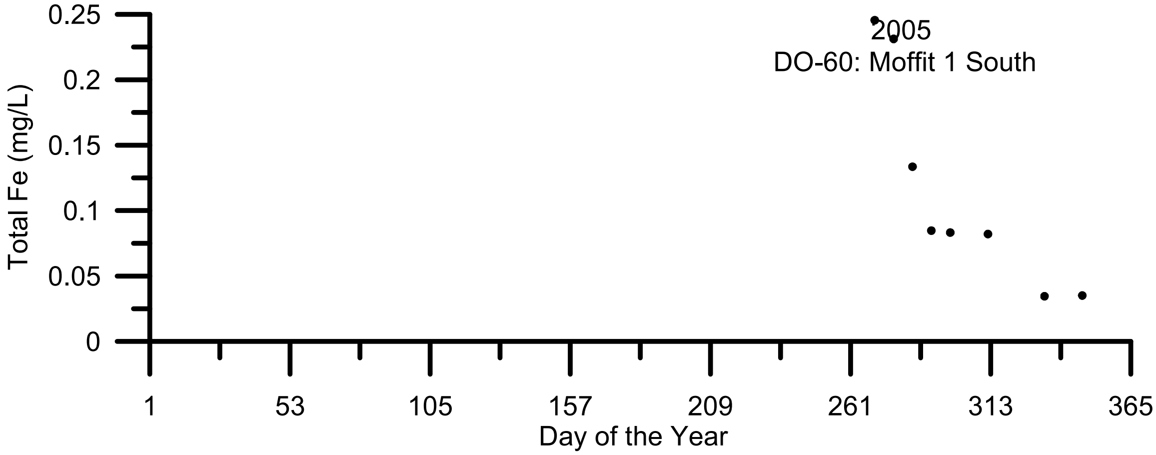

2006
DO-57: Ramona Lake Drain at Levee
Total Fe (mg/L)
0
0.5
1
1.5
2
2.5
1
53
105
157
209
261
313
365
Day of the Year

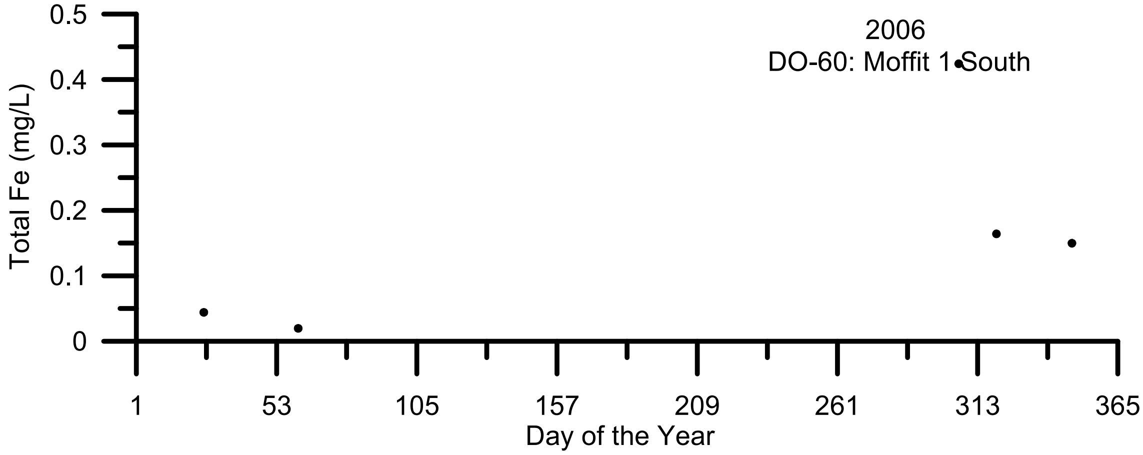

2007
DO-57: Ramona Lake Drain at Levee
Total Fe (mg/L)
0
0.5
1
1.5
2
2.5
1
53
105
157
209
261
313
365
Day of the Year

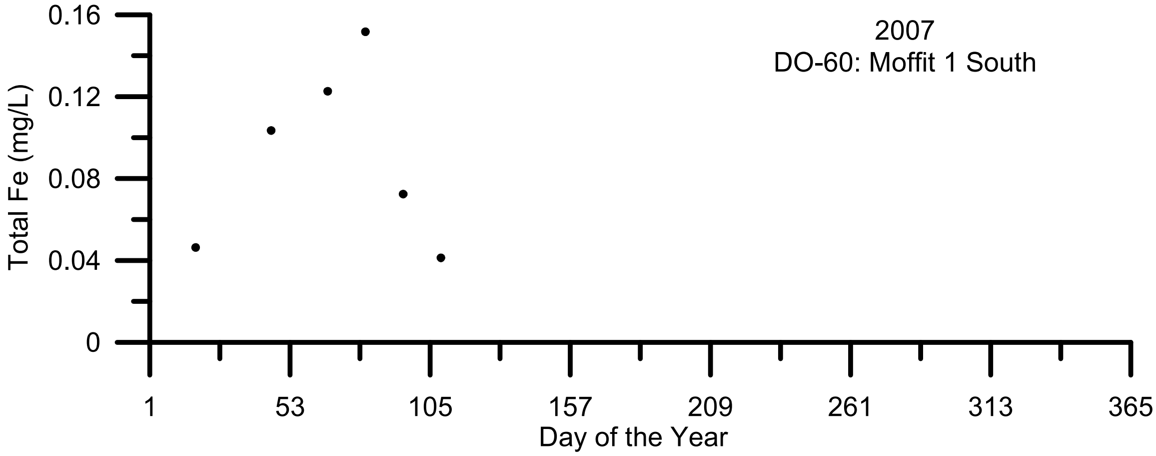

2005
DO-59: SJR Laird Park
Total Fe (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

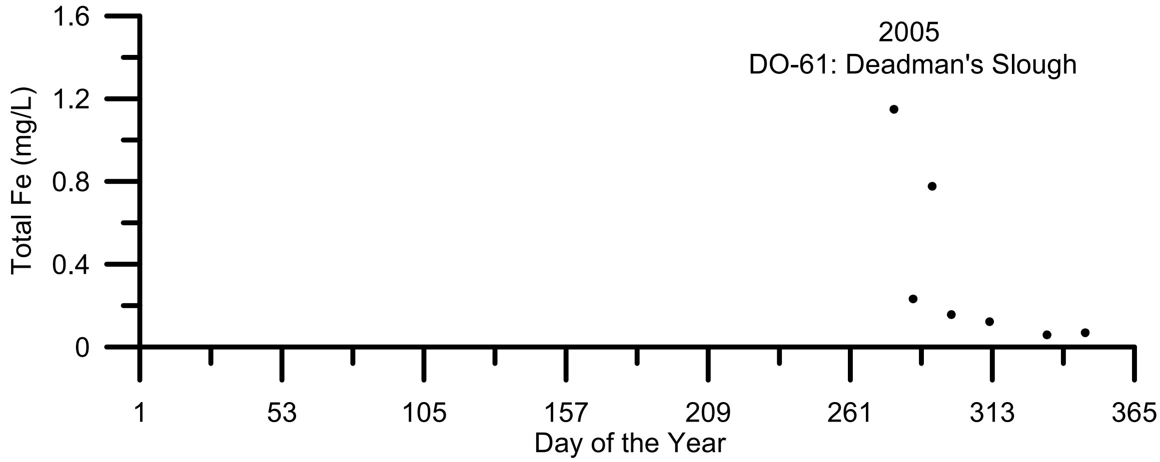

2006
DO-59: SJR Laird Park
Total Fe (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

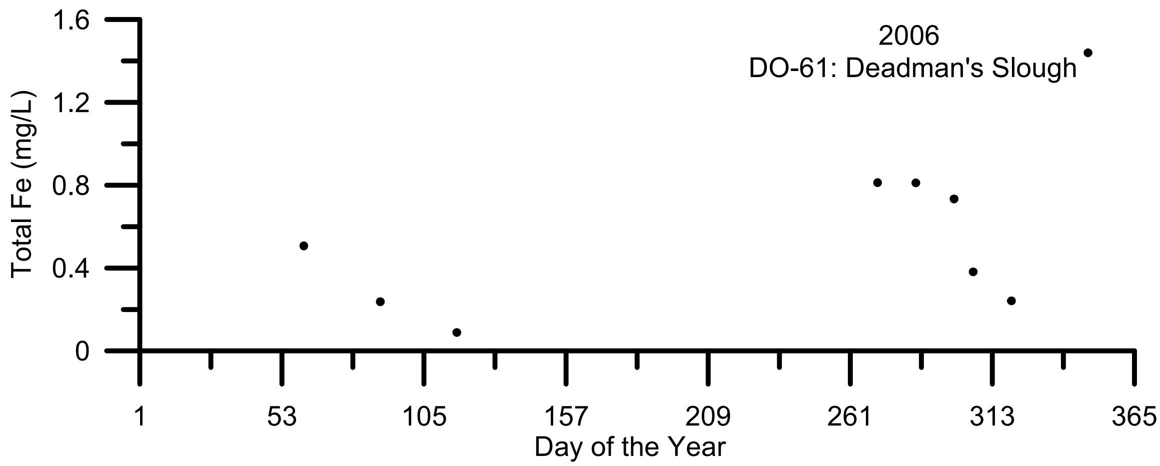

2007
DO-59: SJR Laird Park
Total Fe (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

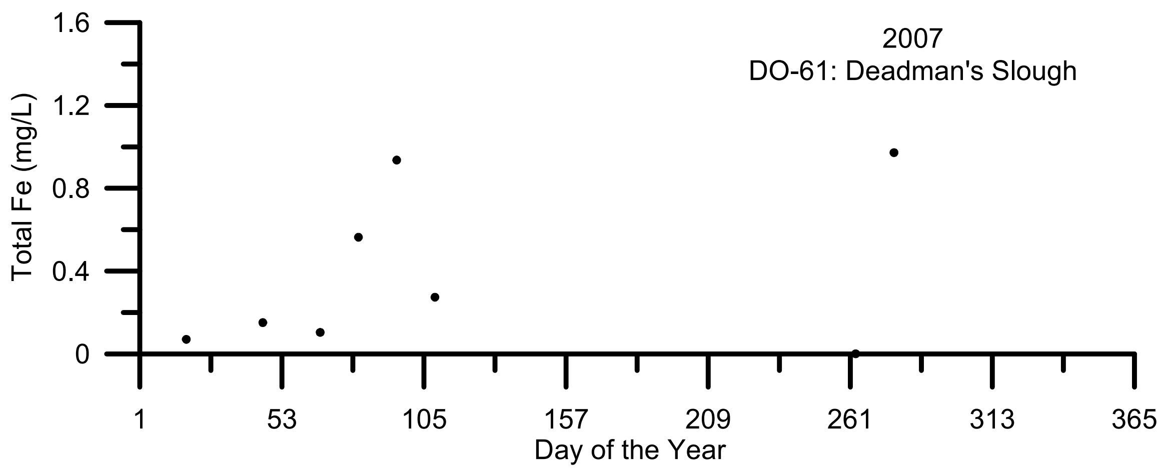

2005
DO-60: Moffit 1 South
Total Fe (mg/L)
0.25
0.2
0.15
0.1
0.05
0
1
53
105
157
209
261
313
365
Day of the Year

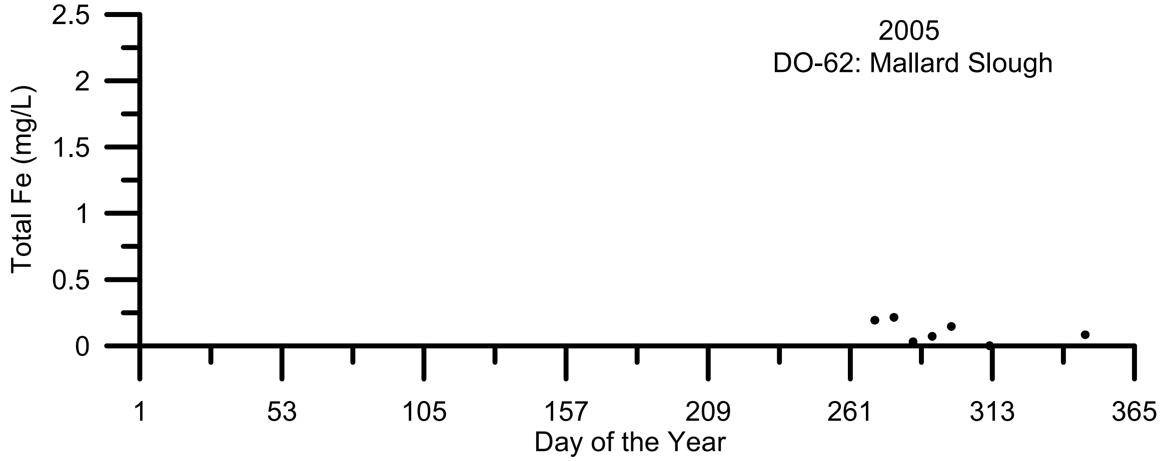

2006
DO-60: Moffit 1 South
Total Fe (mg/L)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

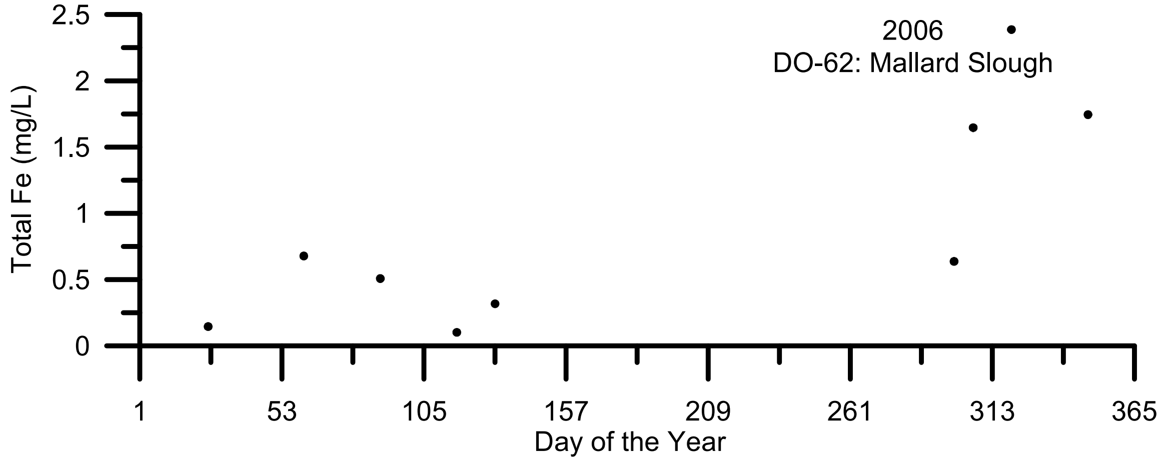

2007
DO-60: Moffit 1 South
Total Fe (mg/L)
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

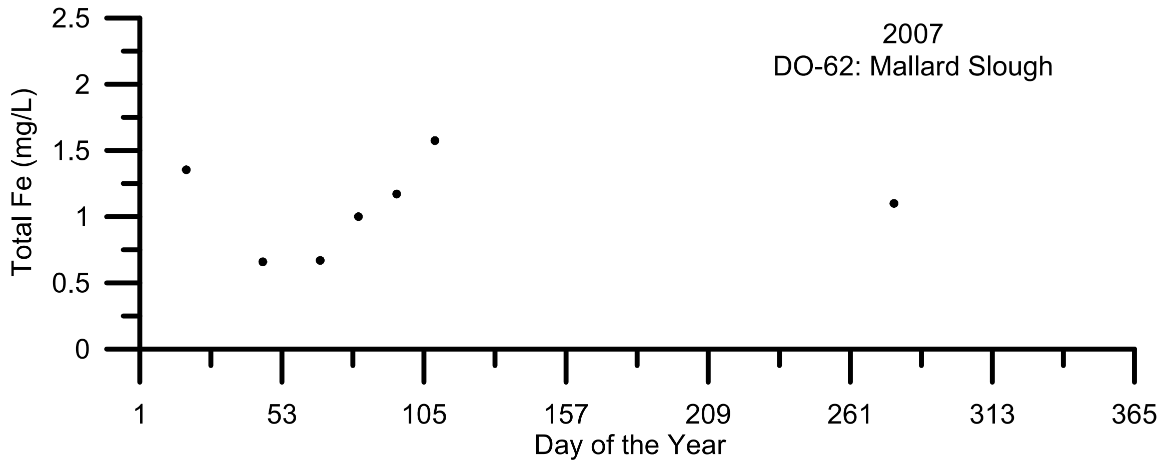

2005
DO-61: Deadman's Slough
Total Fe (mg/L)
Day of the Year
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365

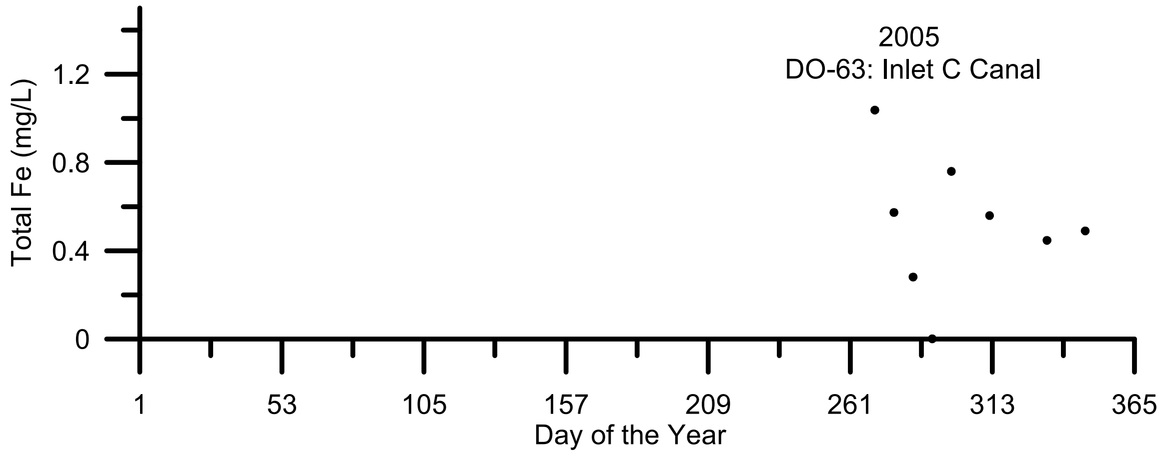

2006
DO-61: Deadman's Slough
Total Fe (mg/L)
Day of the Year
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365

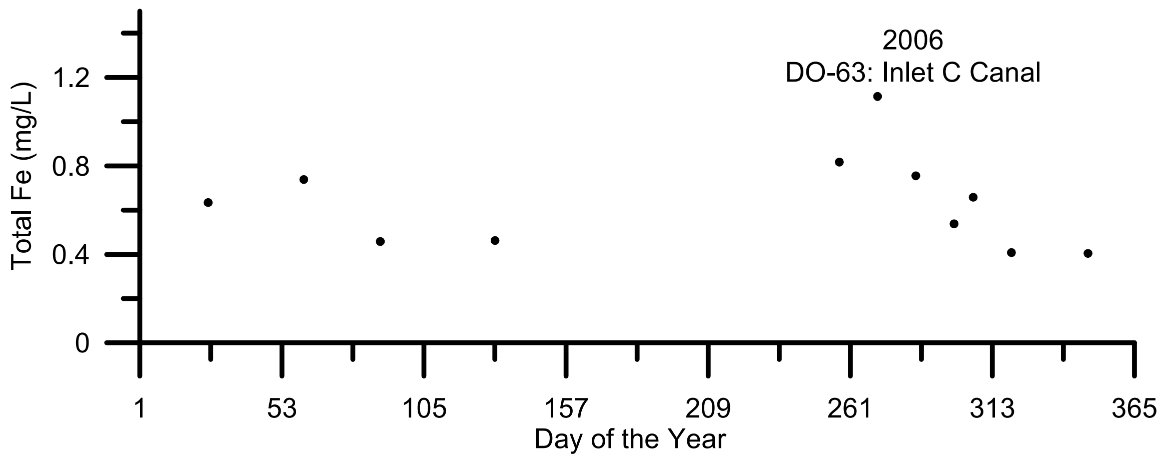

2007
DO-61: Deadman's Slough
Total Fe (mg/L)
Day of the Year
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365

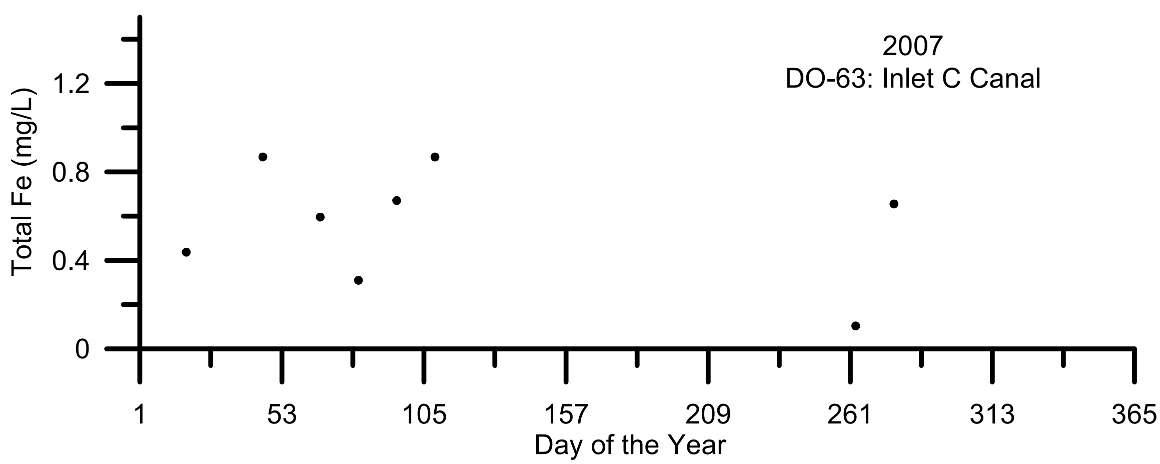

2005
DO-62: Mallard Slough
Total Fe (mg/L)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year

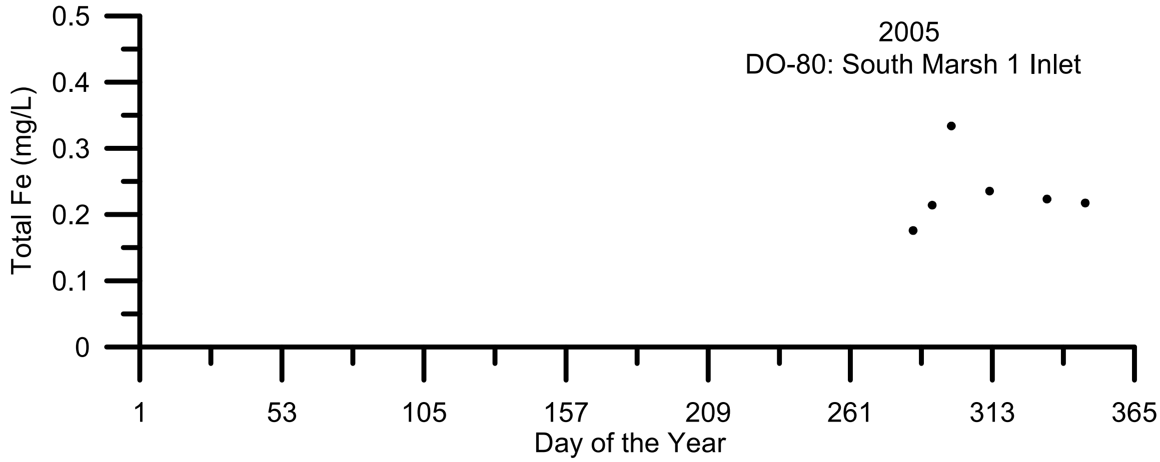

2006
DO-62: Mallard Slough
Total Fe (mg/L)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year

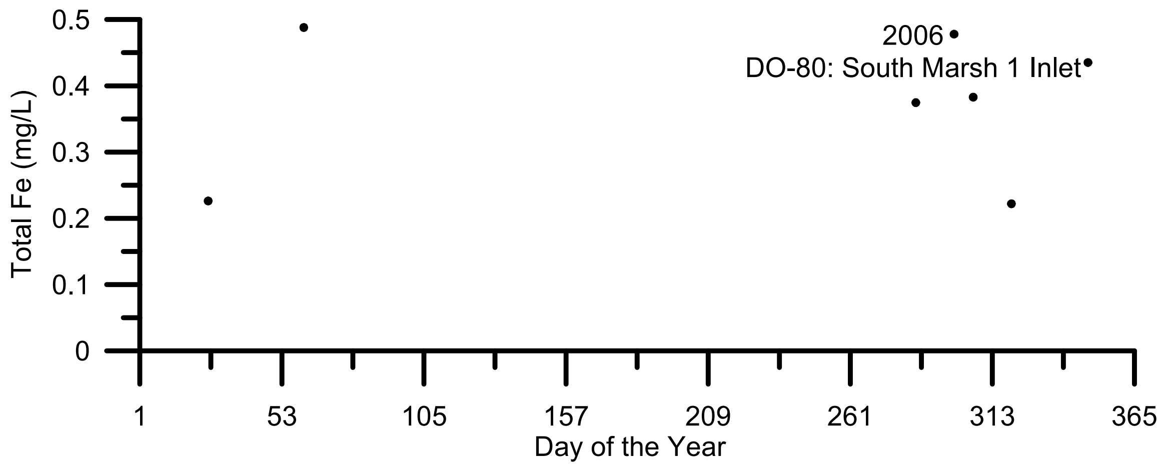

2007
DO-62: Mallard Slough
Total Fe (mg/L)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year

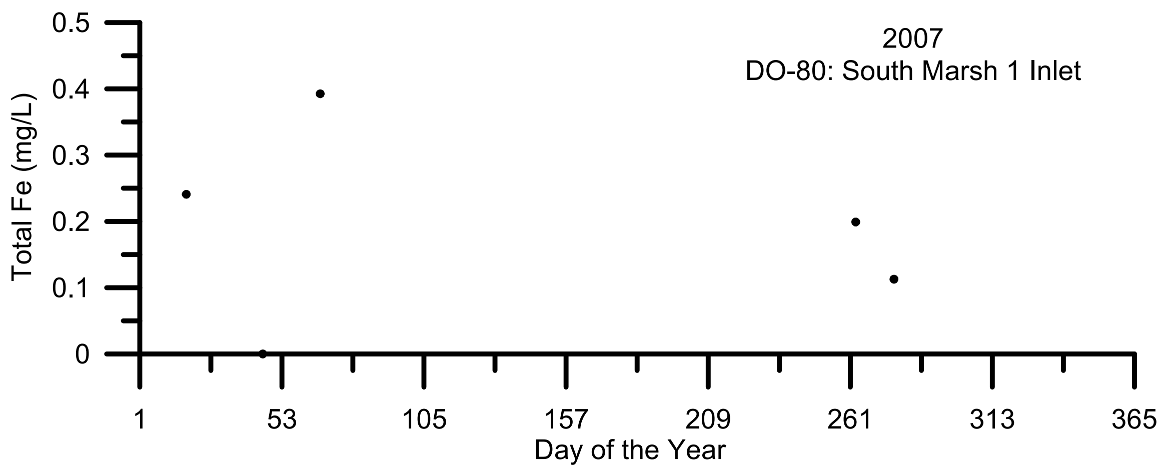

2005
DO-63: Inlet C Canal
Total Fe (mg/L)
0
0.4
0.8
1.2
1
53
105
157
209
261
313
365
Day of the Year

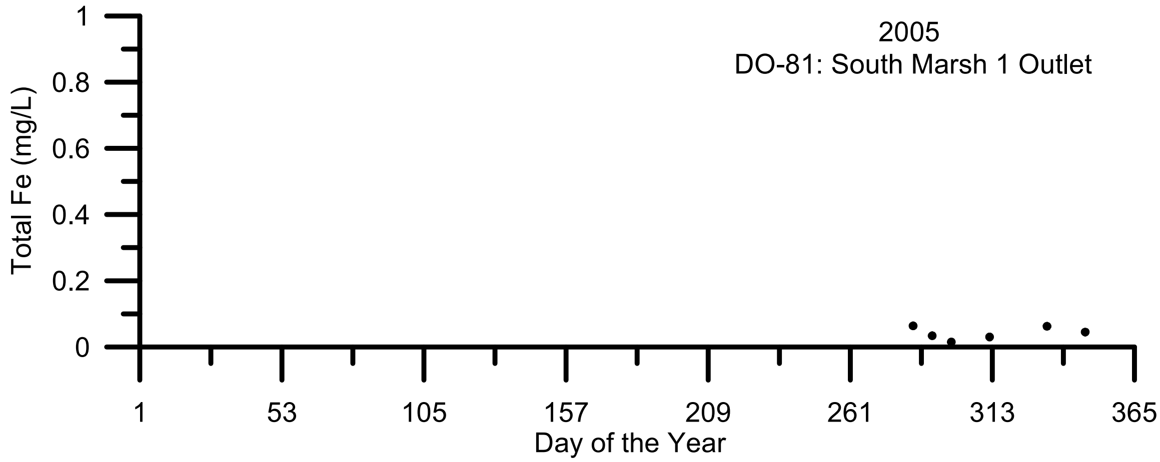

2006
DO-63: Inlet C Canal
Total Fe (mg/L)
0
0.4
0.8
1.2
1
53
105
157
209
261
313
365
Day of the Year

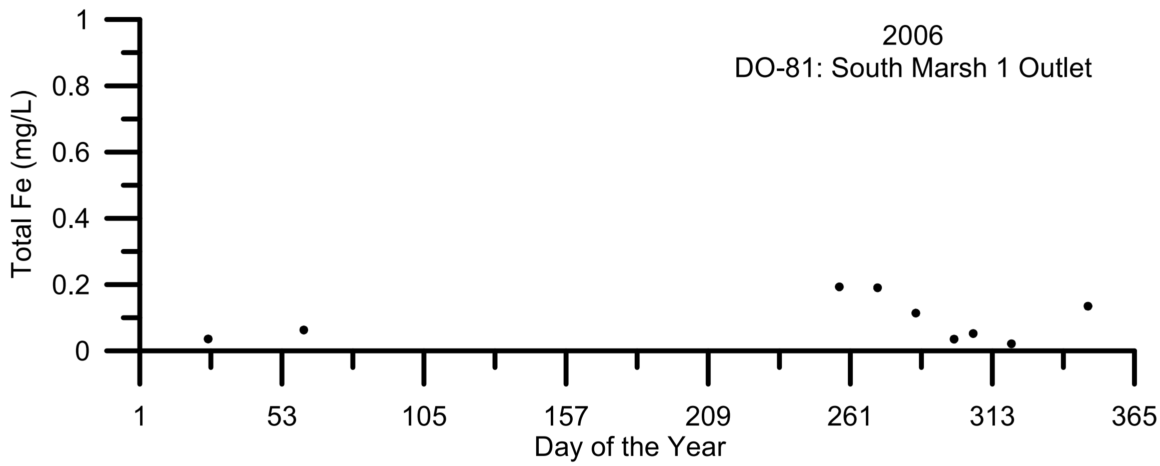

2007
DO-63: Inlet C Canal
Total Fe (mg/L)
0
0.4
0.8
1.2
1
53
105
157
209
261
313
365
Day of the Year

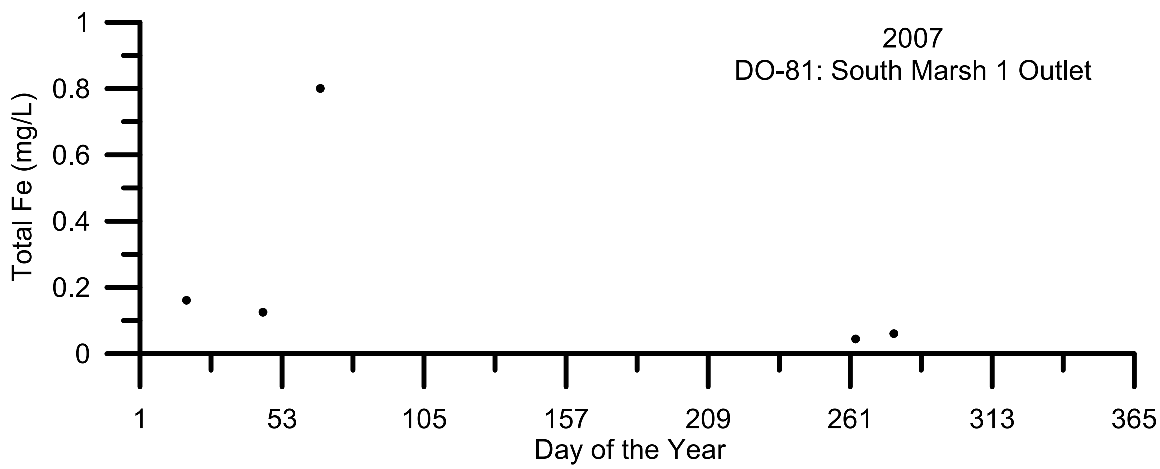

2005
DO-80: South Marsh 1 Inlet
Total Fe (mg/L)
Day of the Year
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365

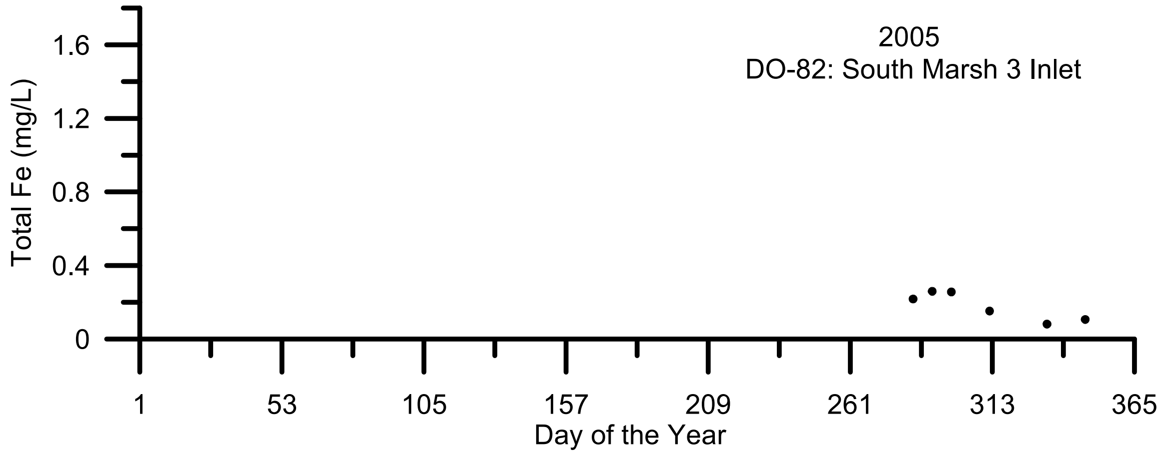

2006
DO-80: South Marsh 1 Inlet
Total Fe (mg/L)
Day of the Year
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365

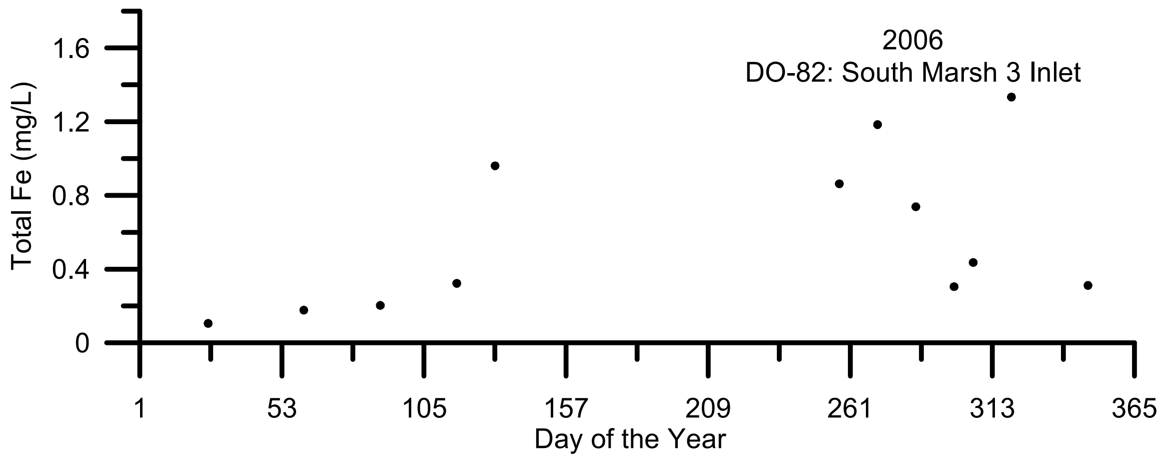

2007
DO-80: South Marsh 1 Inlet
Total Fe (mg/L)
Day of the Year
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365

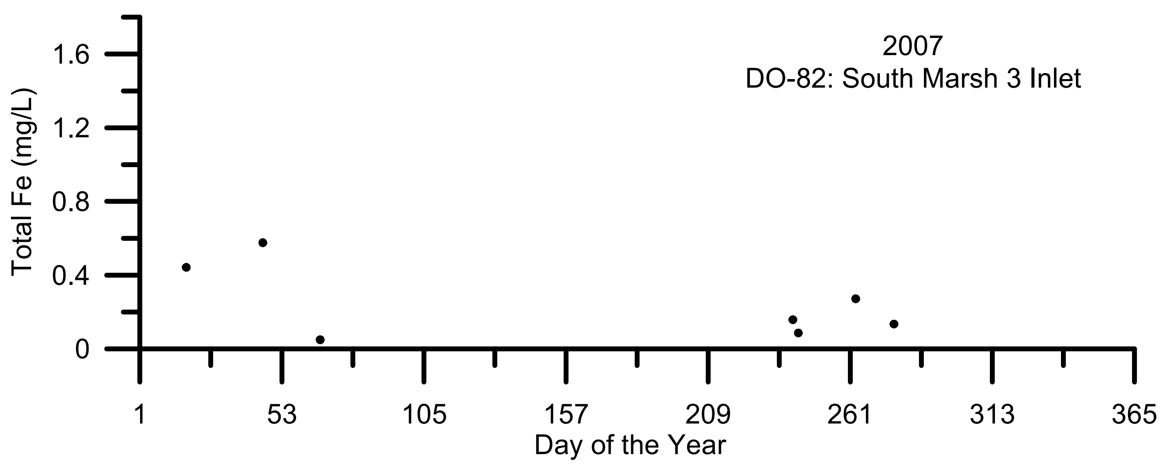

2005
DO-81: South Marsh 1 Outlet
Total Fe (mg/L)
1
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

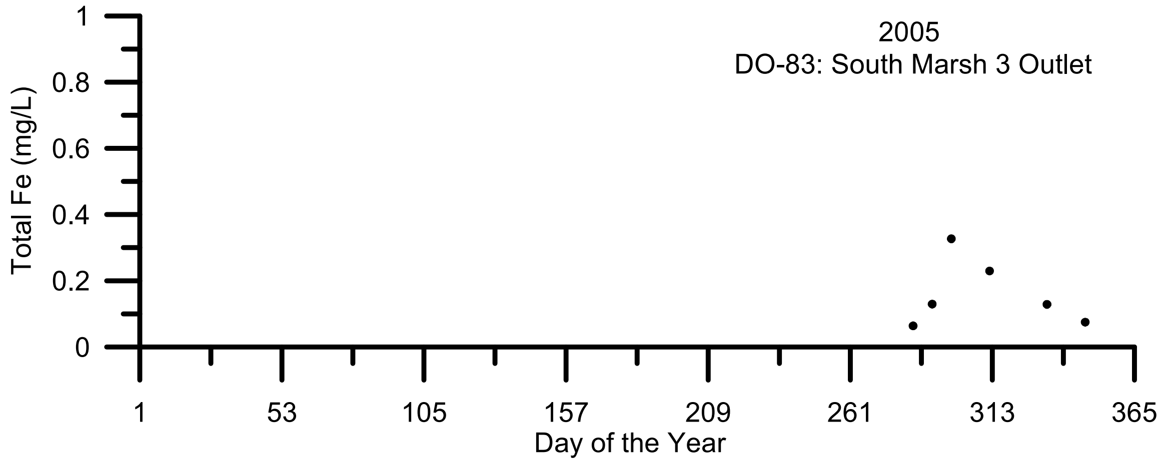

2006
DO-81: South Marsh 1 Outlet
Total Fe (mg/L)
1
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

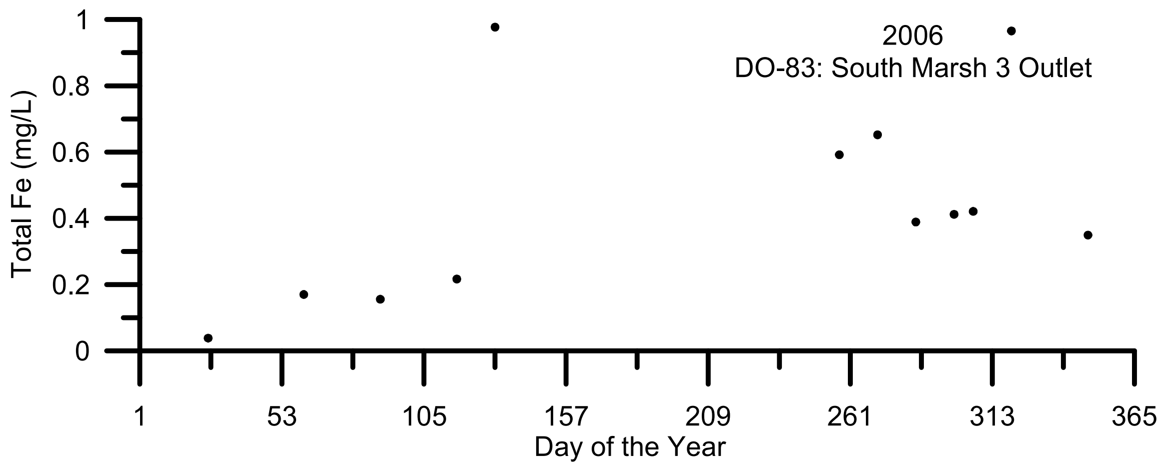

2007
DO-81: South Marsh 1 Outlet
Total Fe (mg/L)
1
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

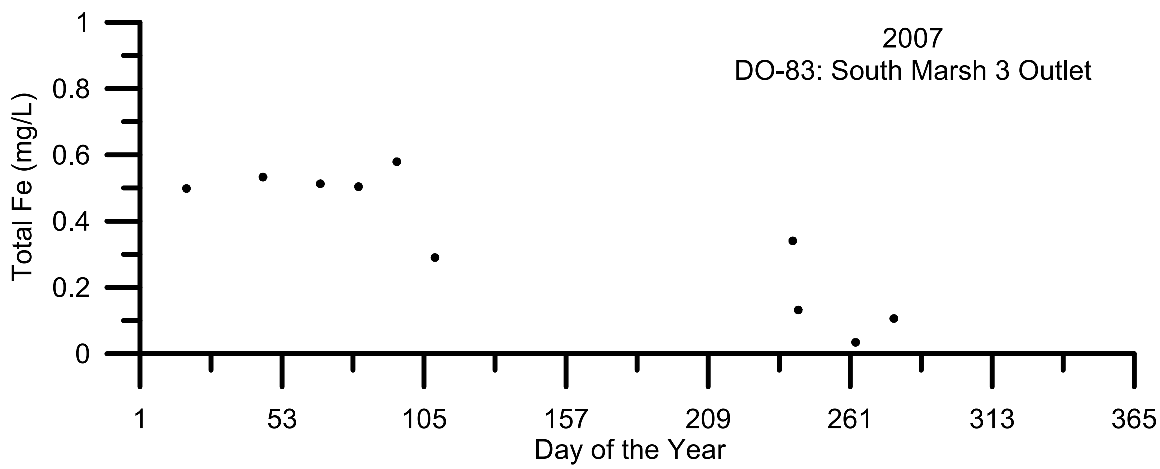

2005
DO-82: South Marsh 3 Inlet
Total Fe (mg/L)
0
0.4
0.8
1.2
1.6
1
53
105
157
209
261
313
365
Day of the Year

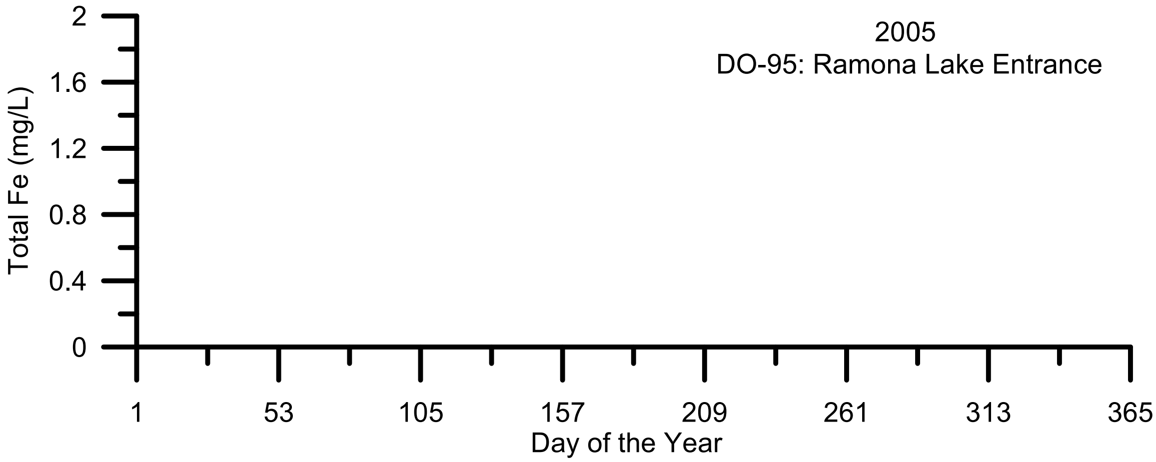

2006
DO-82: South Marsh 3 Inlet
Total Fe (mg/L)
0
0.4
0.8
1.2
1.6
1
53
105
157
209
261
313
365
Day of the Year

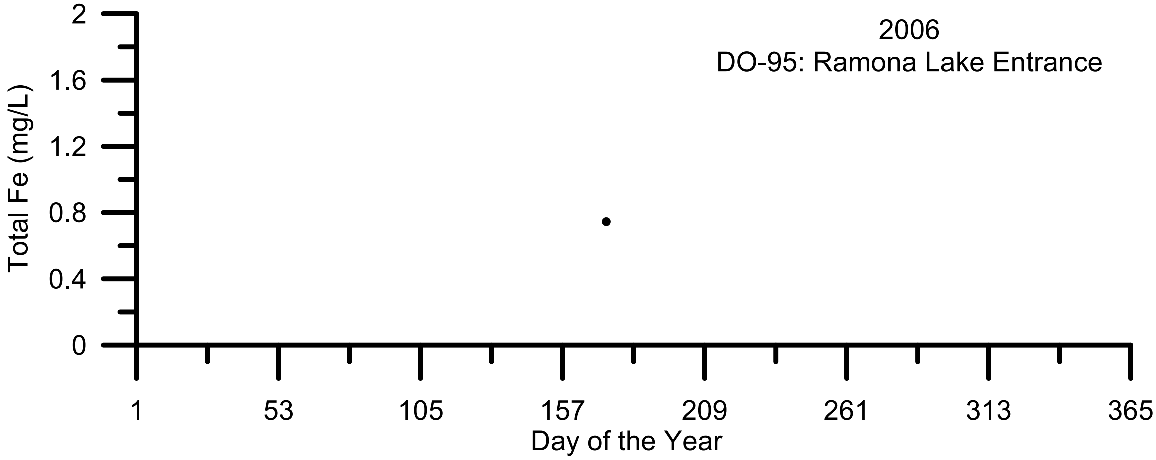

2007
DO-82: South Marsh 3 Inlet
Total Fe (mg/L)
0
0.4
0.8
1.2
1.6
1
53
105
157
209
261
313
365
Day of the Year

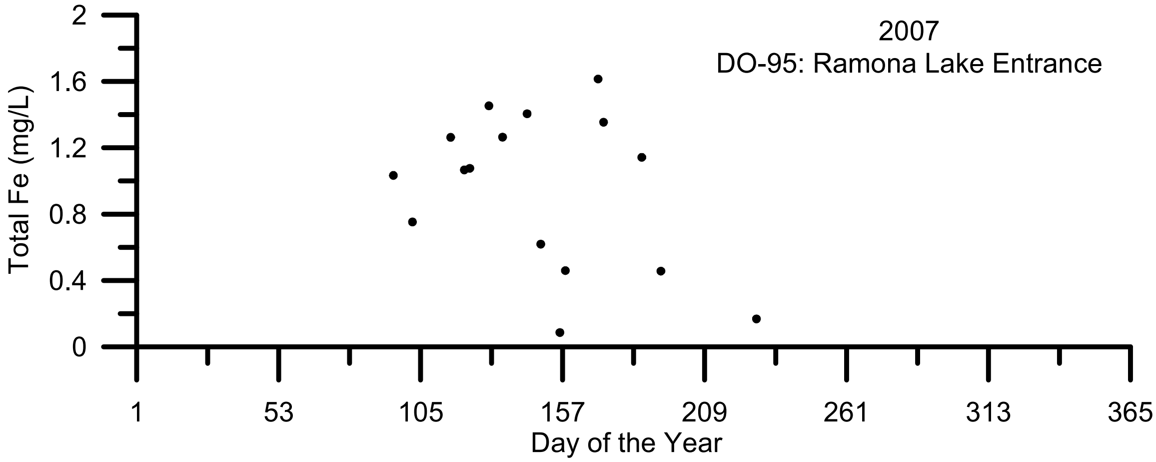

2005
DO-83: South Marsh 3 Outlet
Total Fe (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-83: South Marsh 3 Outlet
Total Fe (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-83: South Marsh 3 Outlet
Total Fe (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-95: Ramona Lake Entrance
Total Fe (mg/L)
2
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-95: Ramona Lake Entrance
Total Fe (mg/L)
2
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-95: Ramona Lake Entrance
Total Fe (mg/L)
2
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

Temporal Plots of 2005-2007 Total Ammonia Data from the Upstream San Joaquin River

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Remie Burks[1]
Sharon Borglin[1]
Randy Dahlgren[2]
Jeremy Hanlon[1]
Justin Graham[1]
William Stringfellow[1]

February 2008

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Stockton, CA 95211

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Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report includes temporal plots of total ammonia (NH_3-N) data analyzed by the EERP laboratory starting in the summer of 2007.

Methods

Depth integrated field samples were colleted during 2005-2007 in the upper San Joaquin River in accordance with EERP Field Standard Operating Procedures Protocol Book (Graham 2008). Water samples were colleted in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN). Bottles were labeled with the appropriate sample number, site name and sampling date. All bottles were rinsed with sample water prior to sample collection. Some sites required a bucket to collect sample water because of accessibility from a high bridge or platform. For these sites, the bucket was pre-rinsed with sample water and sample bottles were filled using a rinsed funnel. Care was taken to distribute water simultaneously to all sample bottles (rather than sequentially). Samples were immediately stored at 4°C after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the EERP lab on the day of sampling.

Within 24 hours of collection samples were alquotted and stored at -20°C until total NH_3-N analysis could be completed.

Starting in 2007 total NH_3-N was quantified using the TL-2800 Ammonia analyzer made by Timberline Instruments (Boulder, CO). Total NH_3-N sample was mixed with caustic solution (to pH 11-13). NH_3 (g) diffused across as gas-permeable membrane and is dissolved in a buffer solution. The dissolution of NH_3 (g) in the buffer causes a change in conductivity which can be correlated to NH_3 (g). The Timberline instrument automates the mixing of the caustic solution with the sample and pumping of the buffer solution through the gas permeable membrane (Borglin, et al, 2008) and (Carlson, 1990). The resulting peak is proportional to the NH_3-N concentration. The reportable limit for this method is 0.03 mg/L NH_3-N.

Results/Discussion

With each set of NH_3-N field samples analyzed in the EERP laboratory, quality assurance samples including a lab duplicate, field duplicate, matrix spike, matrix spike duplicate, calibration check standards, laboratory control standard, trip blank, and lab blanks were also analyzed. 98.25% of all quality assurance samples were within a passing range (Spier et al, 2008). Proficiency check samples, standards with unknown concentration to the laboratory analyst, were run approximately twice a year. Three proficiency check samples were analyzed for NH_3-N in the EERP laboratory during 2007, and all of these samples were found to be within the acceptable range. Samples were measured ranging from 0.0-4.26 mg/L NH_3-N. The average concentration of NH_3-N in samples collected was 0.15 mg/L NH_3-N. NH_3-N was also analyzed at UC Davis on all of the same water samples and has a high correlation to values measured by EERP. When all data points measured by the two labs are compared they have r^2=0.956 (Spier et al, 2008). NH3-N samples measured by EERP have about 91.1% as much NH3-N as the same samples measured by UCD (Figure 2).

All of the quality assurance samples that failed were lab banks that had higher concentrations then the detection limit. The baseline can drift for various reasons on the Timberline instrument. Normally lab blanks are run at the beginning and end of each set of samples run on the Timberline instrument. To help catch baseline drift sooner, and prevent this problem lab blanks are now also run after every 20 samples in addition to being run at the beginning and end of each set. EERP used to measure NH_3-N using the Nessler method SM 4500-NH3 C (APHA, 1992). The nessler method had a much higher detection limit, a lower correlation to UCD's NH_3-N values, and also created mercury waste so it is no longer used by EERP to measure NH_3-N.

These temporal plots (Figures 3-103) as well as the plot comparing EERP's laboratory data to UCD's data (Fiugre 2) created an easy visual way to find outliers and double check data entry for possible mistakes. For the purpose of these plots any data points that were slightly negative were changed to 0.

References

American Public Health Association (APHA). 1992. Standard Methods for the Examination of Water and Wastewater, 18^h Edition. American Public Health Association, Washington, DC.
DC.

Borglin, S., W. Stringfellow, J. Hanlon. 2005. Standard Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project. LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA

Borglin, S.E., Burks, R.D., Hanlon, J.S., Stringfellow, W.T. (2008) EERP Lab Protocol

Book, University of the Pacific, Stockton, CA.

Carlson, R.M., R. Cabrera, J. Paul, J. Quick and R.Y. Evans. 1990. Rapid direct determination of ammonium and nitrate in soil and plant tissue extracts. Comm. Soil Sci. Plant Anal. 21:1519-1530.

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008) EERP Field Protocol Book, University of the Pacific, Stockton, CA.

Stringfellow, W.T., et al., (2008) Evaluation of Vegitated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley, University of the Pacific, Stockton, CA

Spier, C., Burks, R., Borglin, S.E. (2008) Comparison of Methods for Analyzing Ammonia, Nitrate and Total Nitrogen, University of the Pacific, Stockton, CA.

YSI Environmental Operations Manual (2005) 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

Table 1: EERP Sampling Site List

DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
53	**Salt Slough at Wolfsen Road**	Wetland
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
60	**Moffit 1 South**	Wetland
61	**Deadman's Slough**	Wetland
62	**Mallard Slough**	Wetland
63	**Inlet C Canal**	Wetland
80	**South Marsh-1-Inlet**	Wetland
81	**South Marsh-1-Outlet**	Wetland
82	**South Marsh-3-Inlet**	Wetland
83	**South Marsh-3-Outlet**	Wetland
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

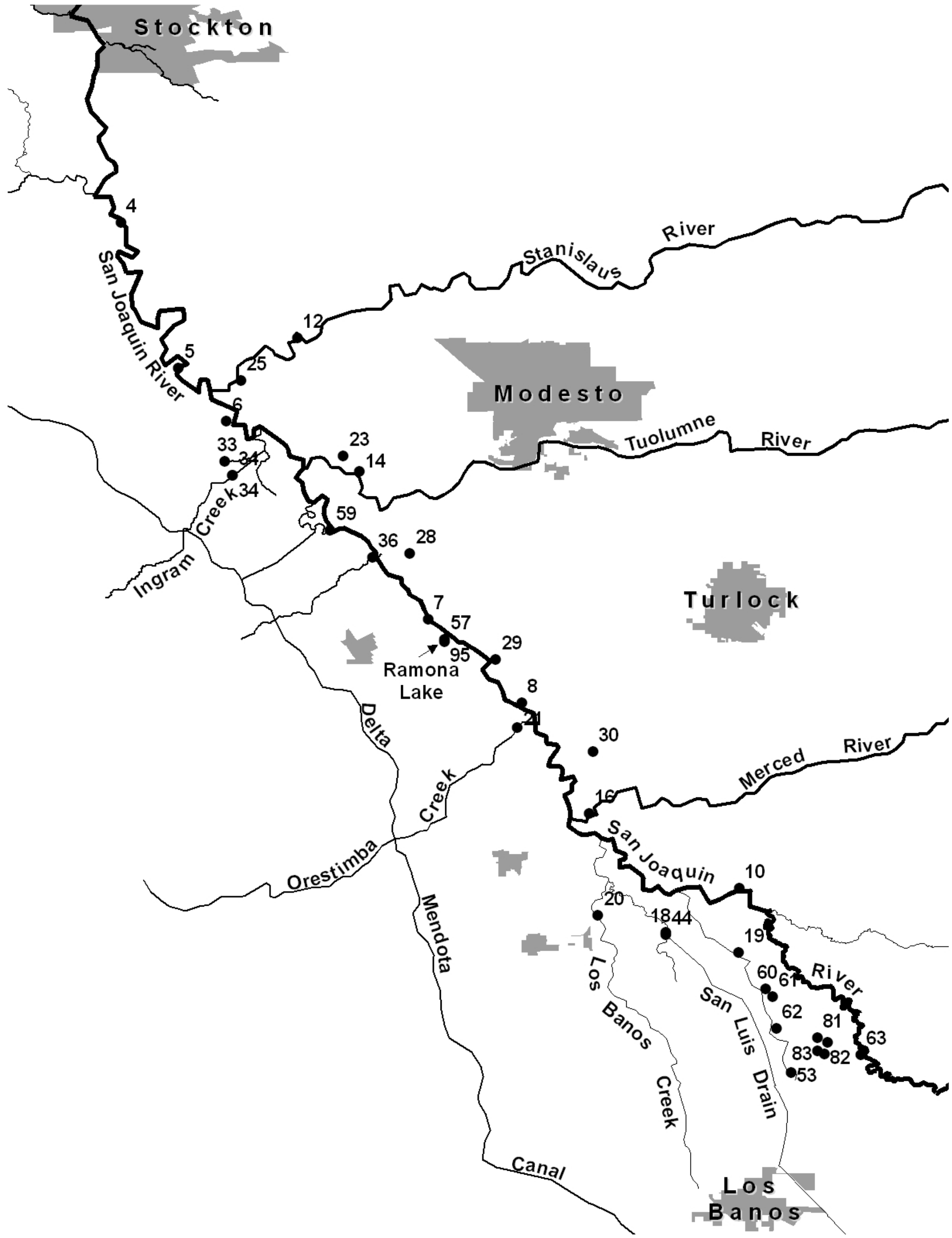
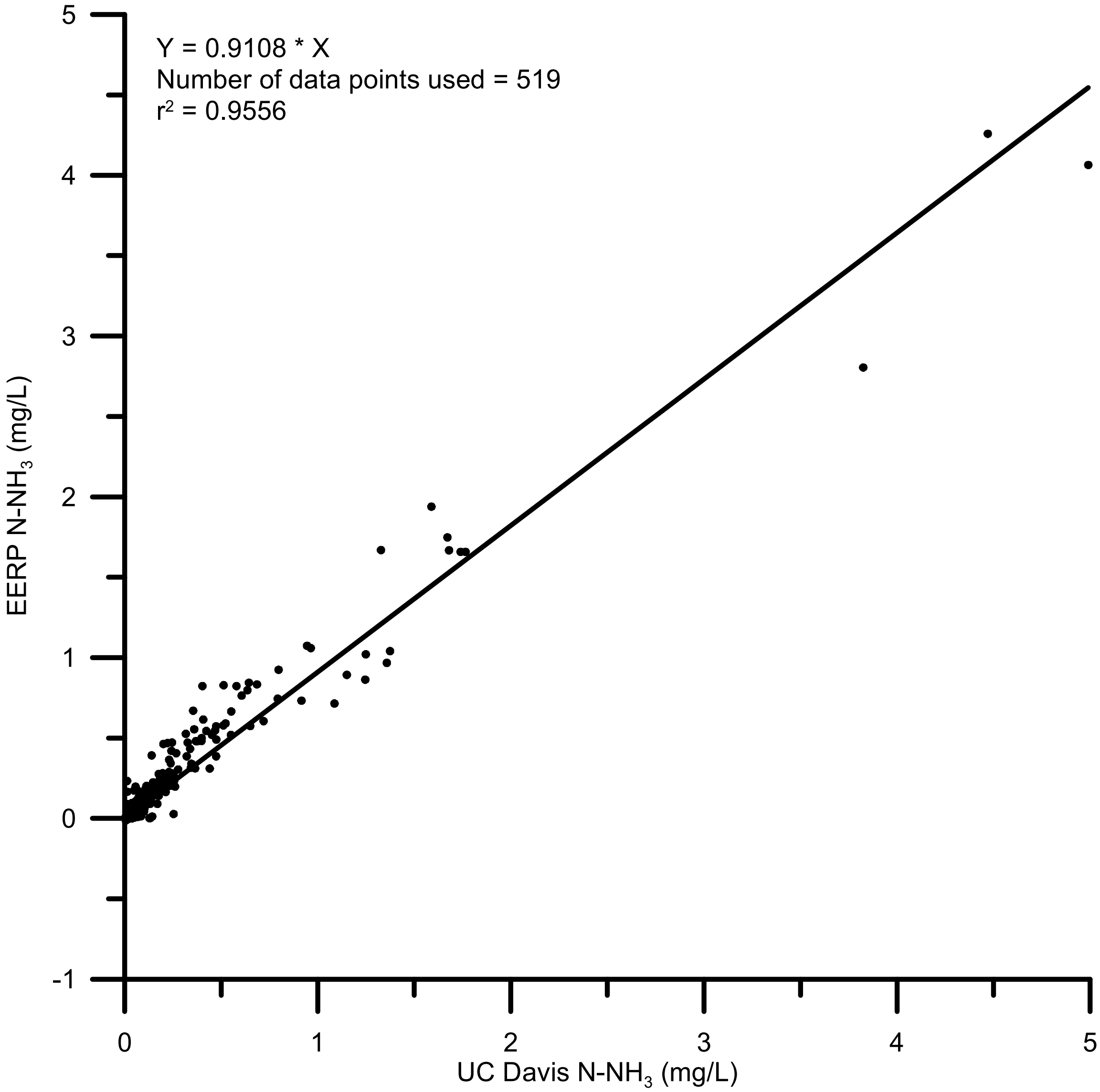
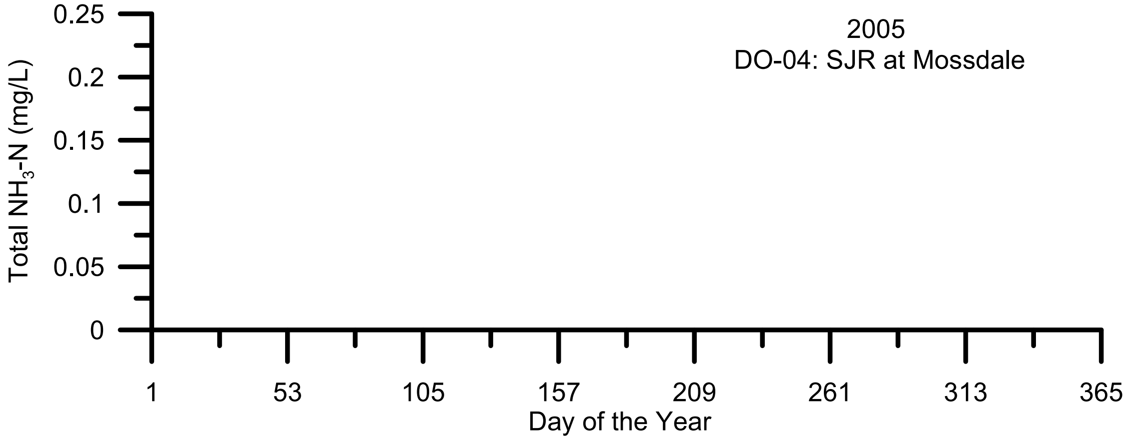
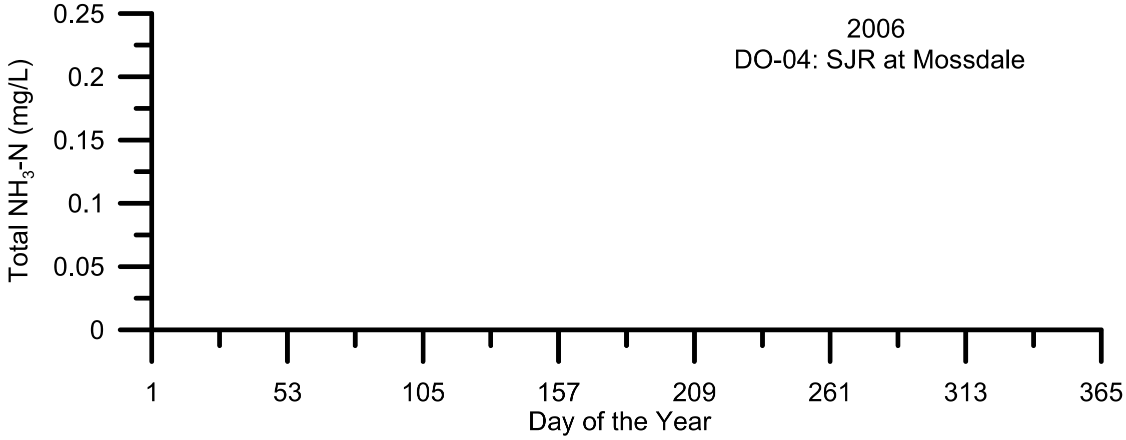


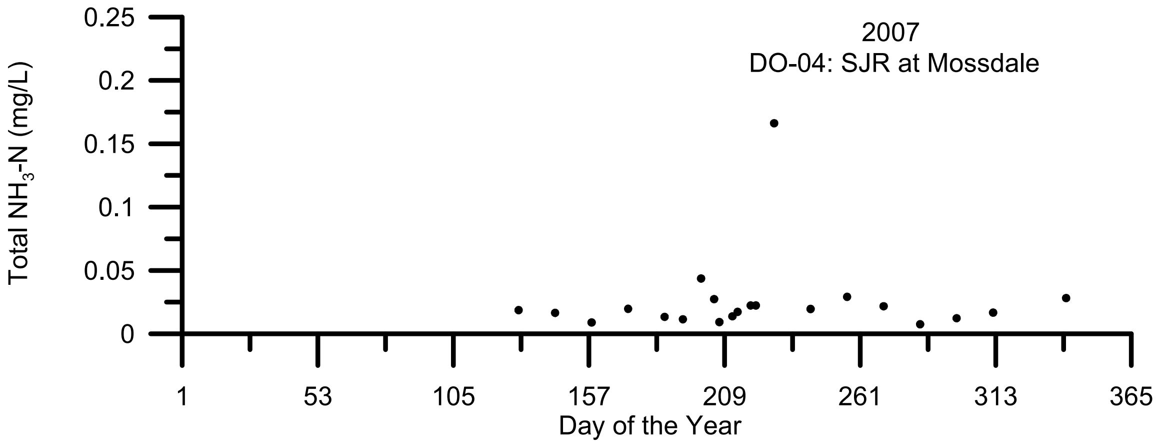
Figure 2: UCD vs EERP Timberline Plot of NH_3-N .

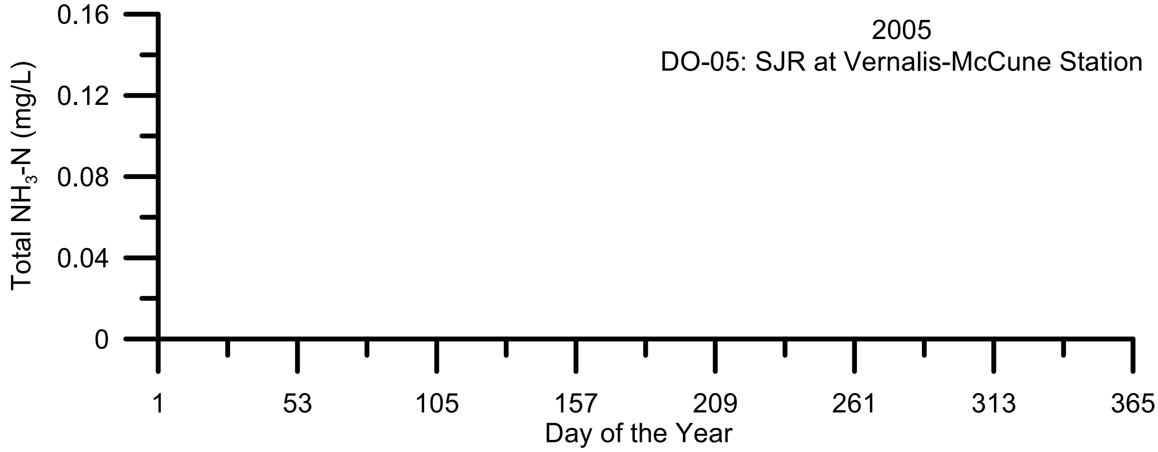


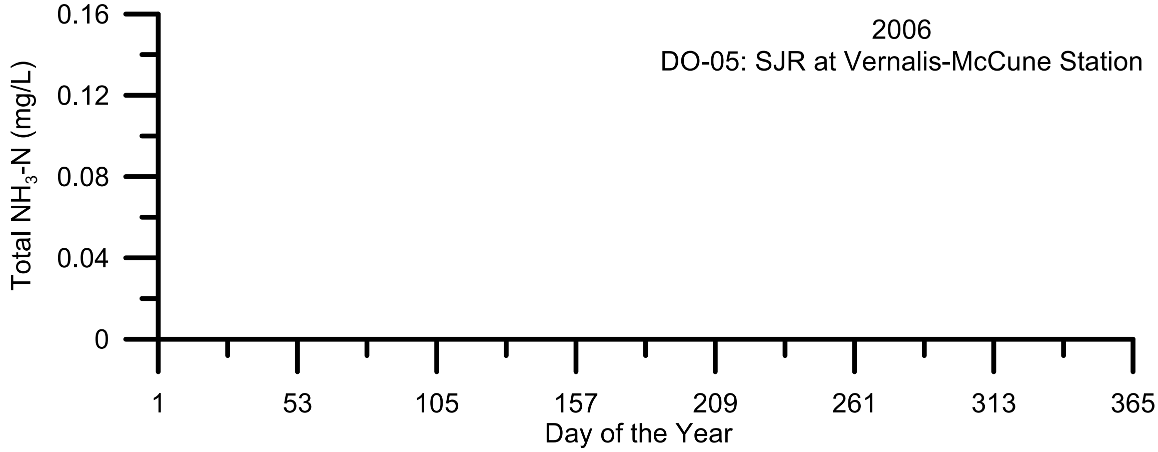
Figures 3 -104: Temporal Plots of Total NH_3-N By Site ID

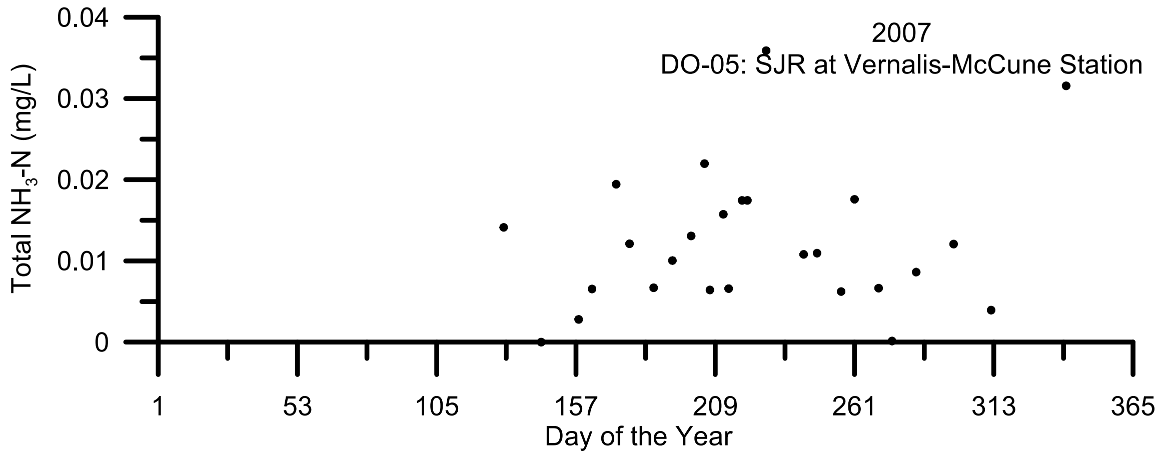


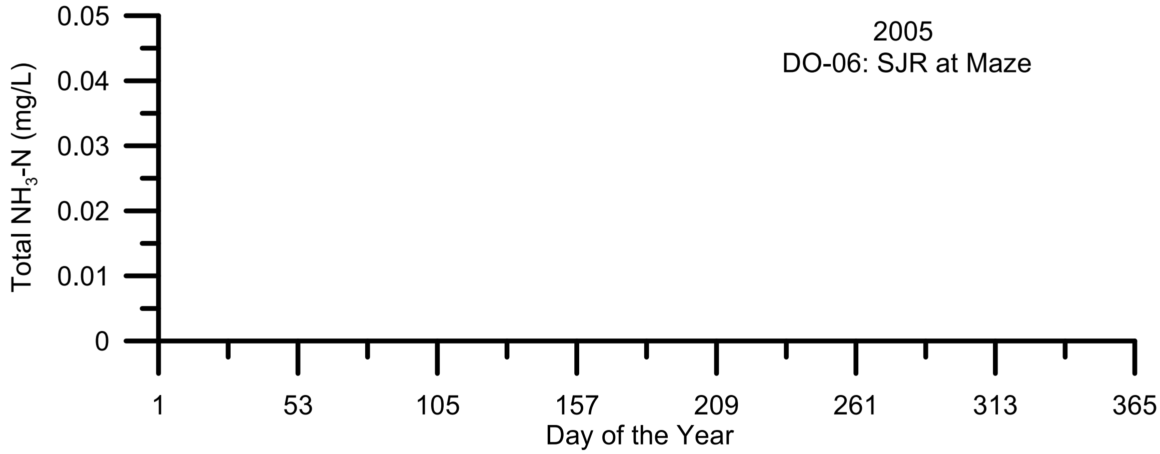




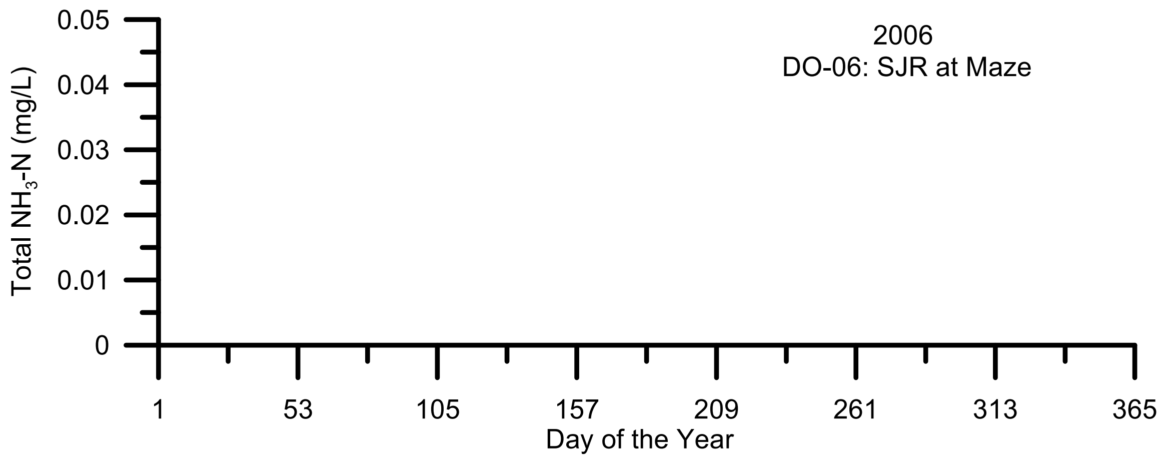

2005
DO-05: SJR at Vernalis-McCune Station
Total NH_3-N (mg/L)
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-05: SJR at Vernalis-McCune Station
Total NH_3-N (mg/L)
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

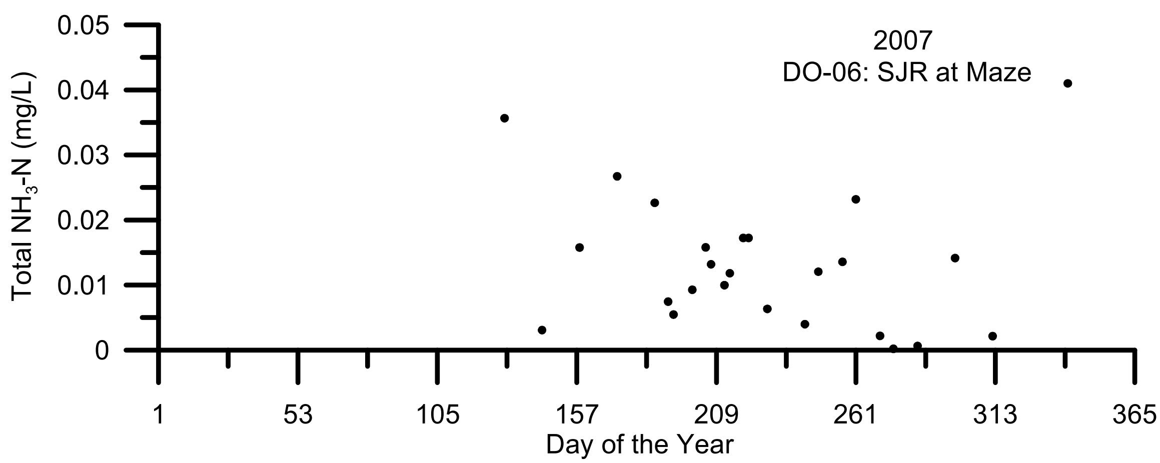

2007
DO-05: SJR at Vernalis-McCune Station
Total NH_3-N (mg/L)
0.04
0.03
0.02
0.01
0
1
53
105
157
209
261
313
365
Day of the Year



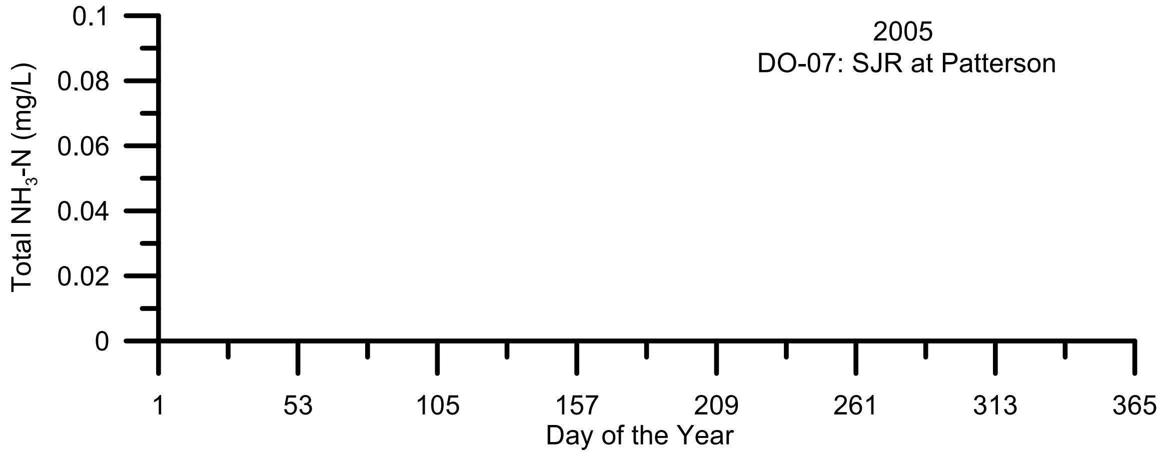
2005
DO-06: SJR at Maze
Total NH3-N (mg/L)
0.05
0.04
0.03
0.02
0.01
0
1
53
105
157
209
261
313
365
Day of the Year

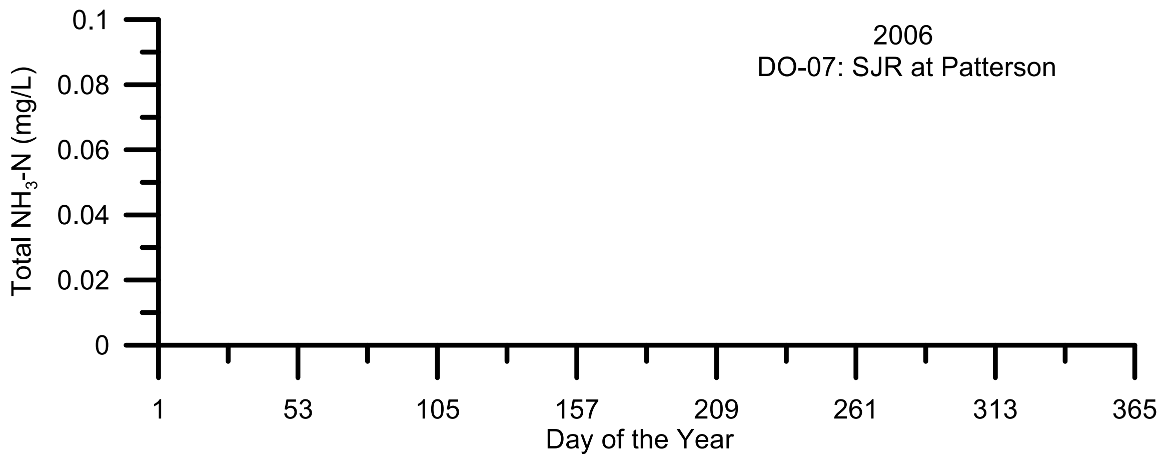


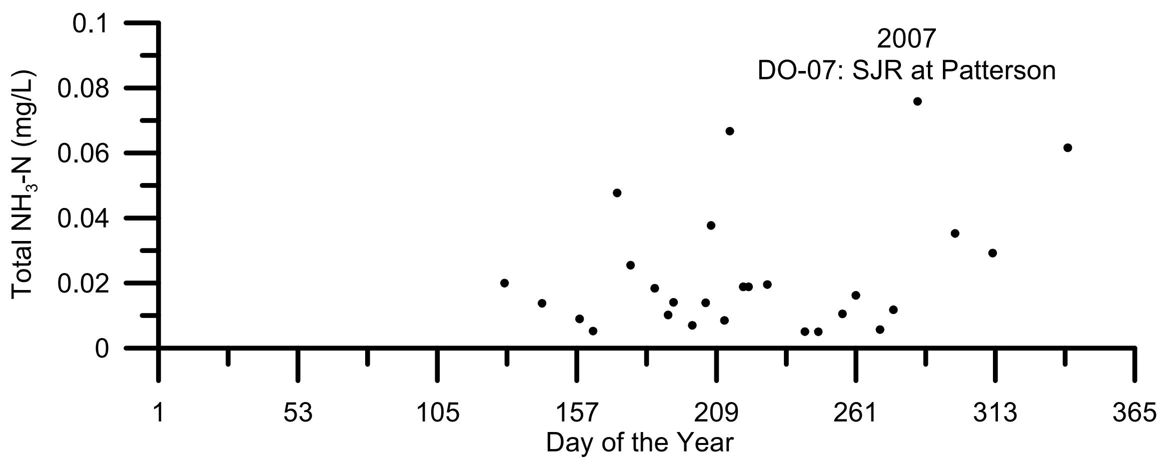
2006
DO-06: SJR at Maze
Total NH3-N (mg/L)
0.05
0.04
0.03
0.02
0.01
0
1
53
105
157
209
261
313
365
Day of the Year

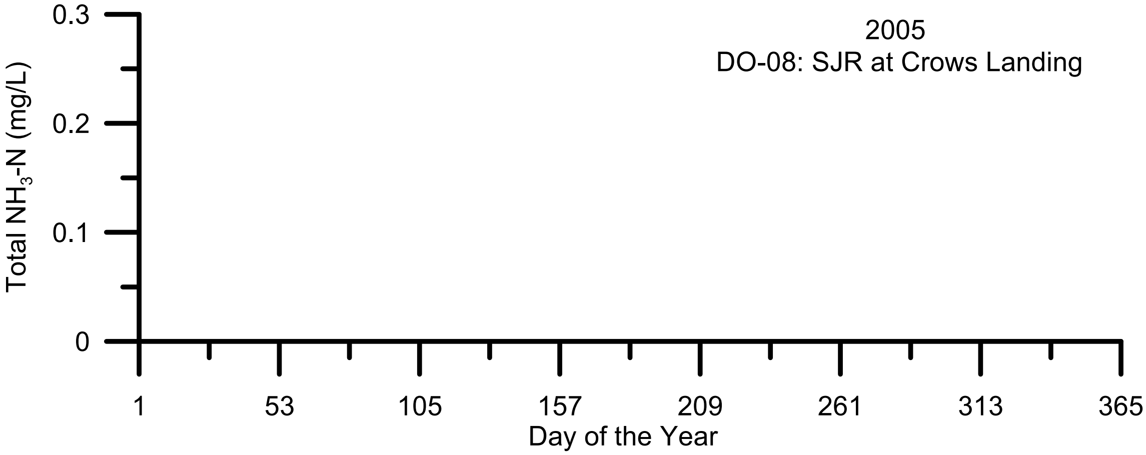


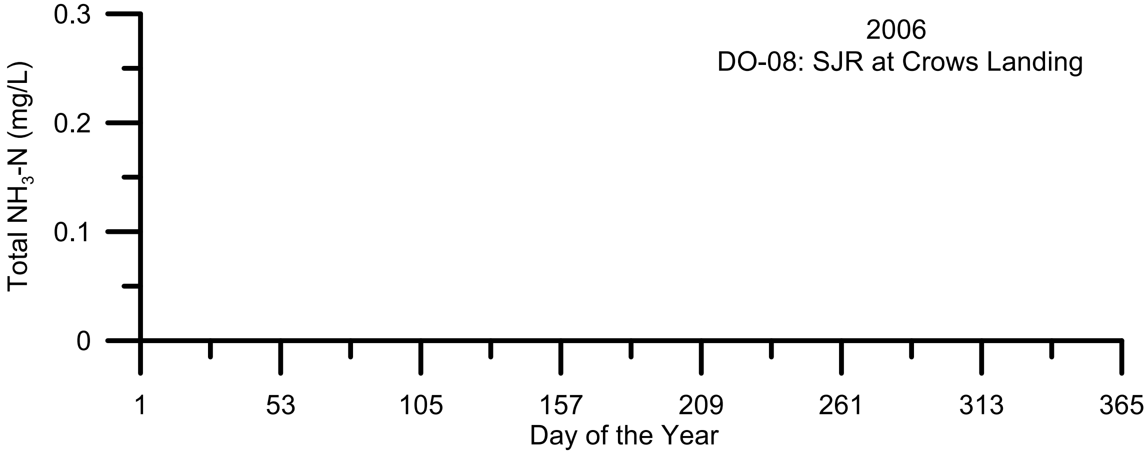
2007
DO-06: SJR at Maze
Total NH3-N (mg/L)
0.05
0.04
0.03
0.02
0.01
0
1
53
105
157
209
261
313
365
Day of the Year

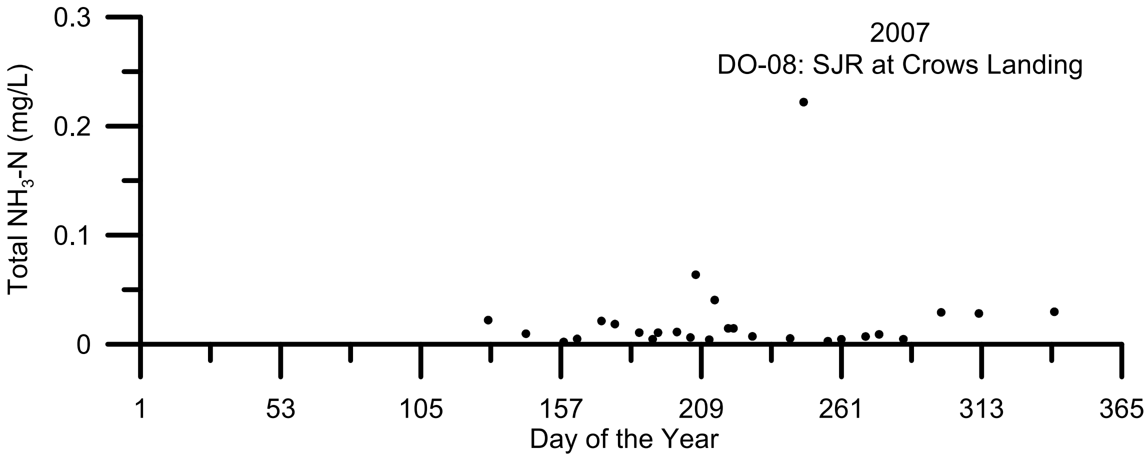

2005
DO-07: SJR at Patterson
Total NH3-N (mg/L)
0.1
0.08
0.06
0.04
0.02
0
1
53
105
157
209
261
313
365
Day of the Year

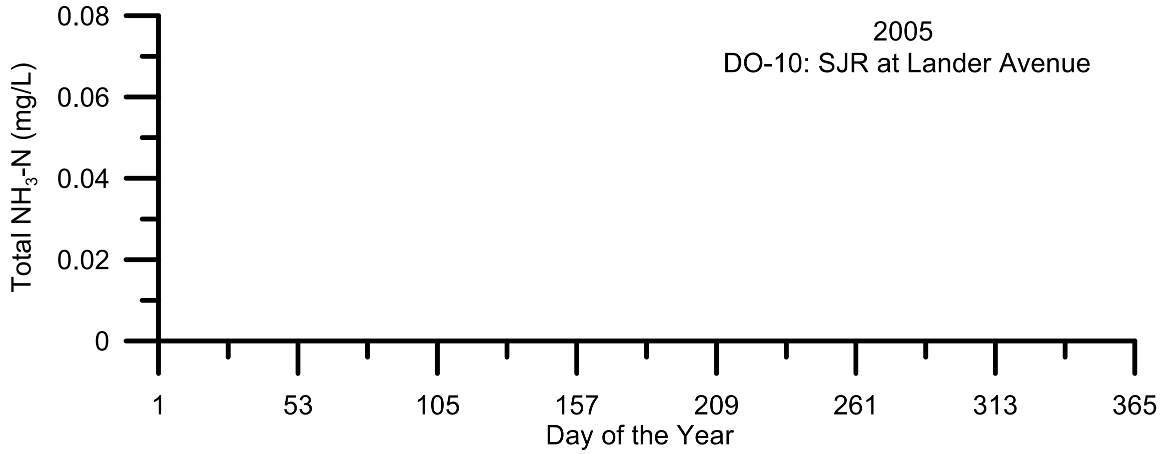

2006
DO-07: SJR at Patterson
Total NH3-N (mg/L)
0.1
0.08
0.06
0.04
0.02
0
1
53
105
157
209
261
313
365
Day of the Year

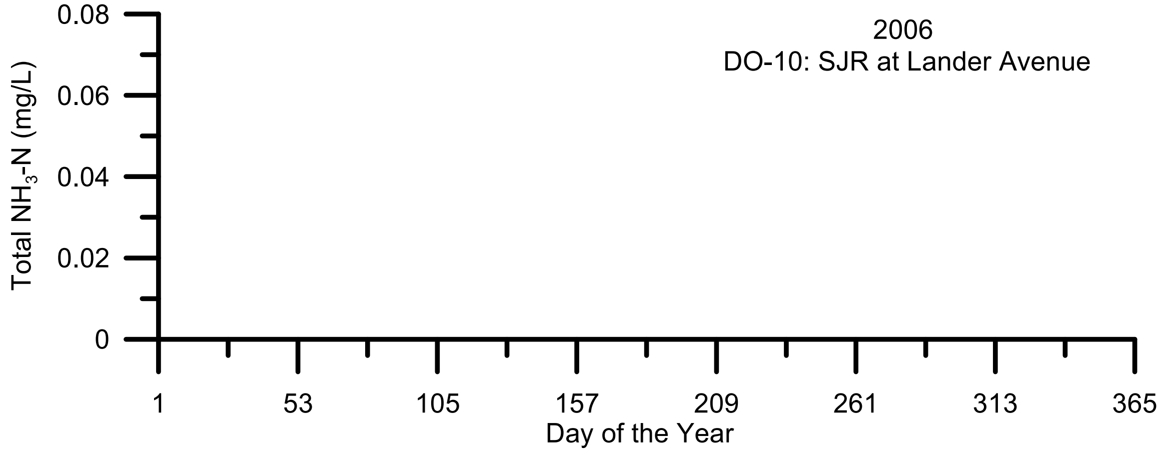

2007
DO-07: SJR at Patterson
Total NH3-N (mg/L)
0.1
0.08
0.06
0.04
0.02
0
1
53
105
157
209
261
313
365
Day of the Year

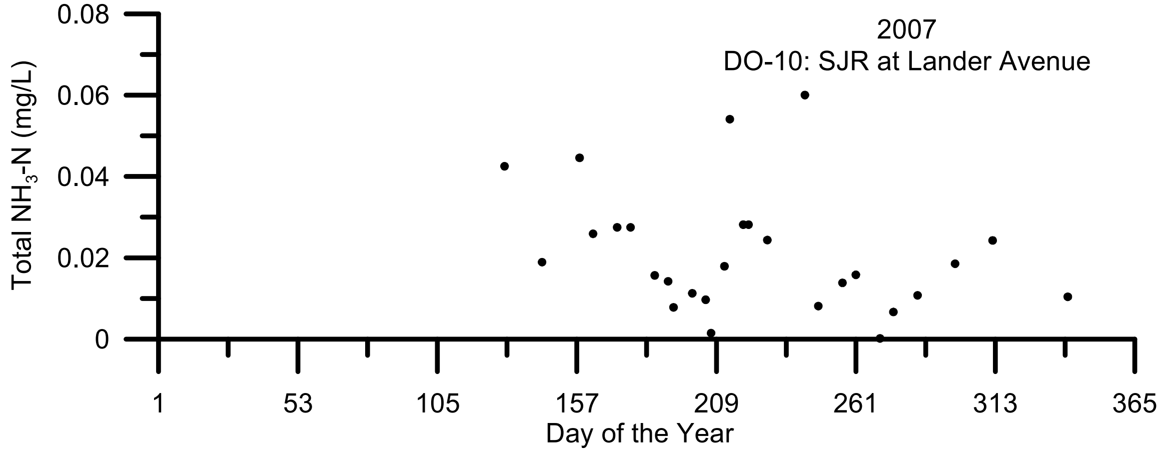

2005
DO-08: SJR at Crows Landing
Total NH_3-N (mg/L)
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

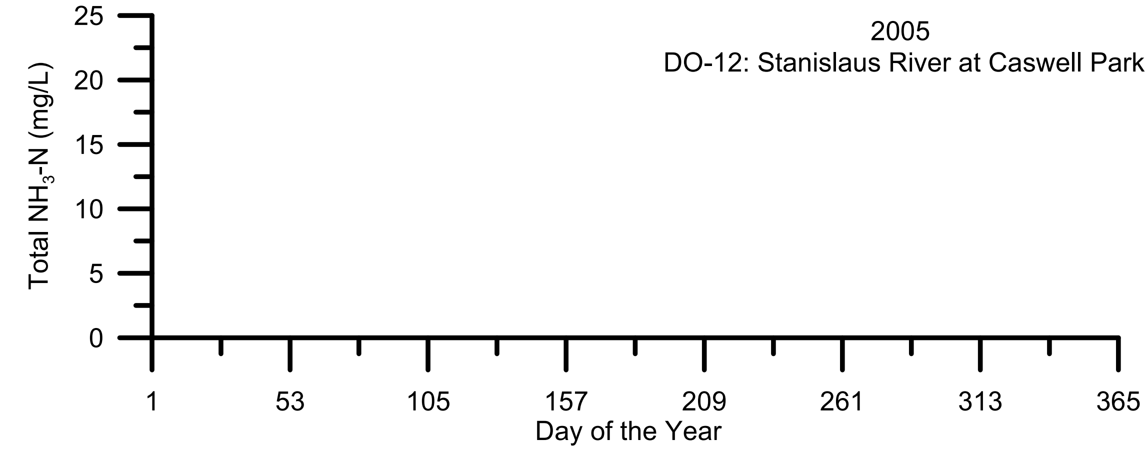

2006
DO-08: SJR at Crows Landing
Total NH_3-N (mg/L)
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

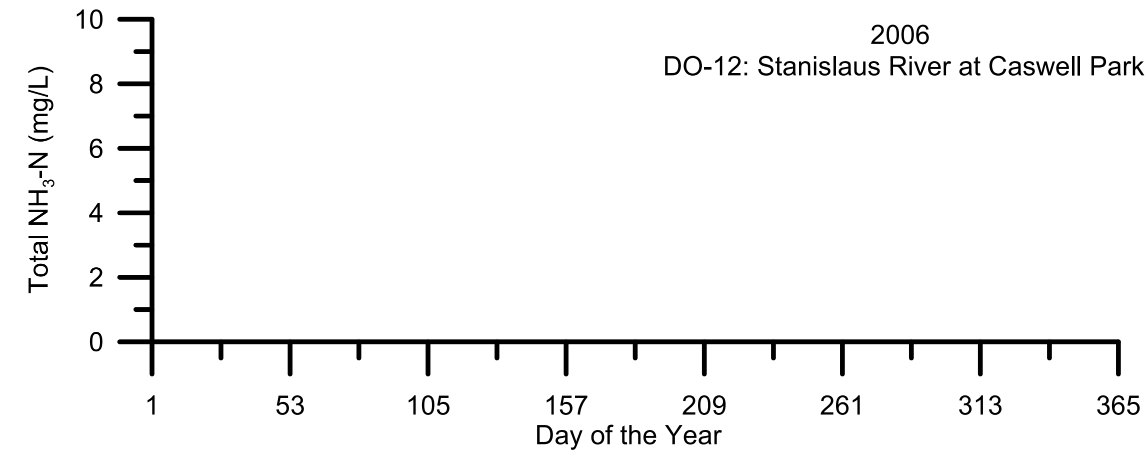

2007
DO-08: SJR at Crows Landing
Total NH_3-N (mg/L)
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

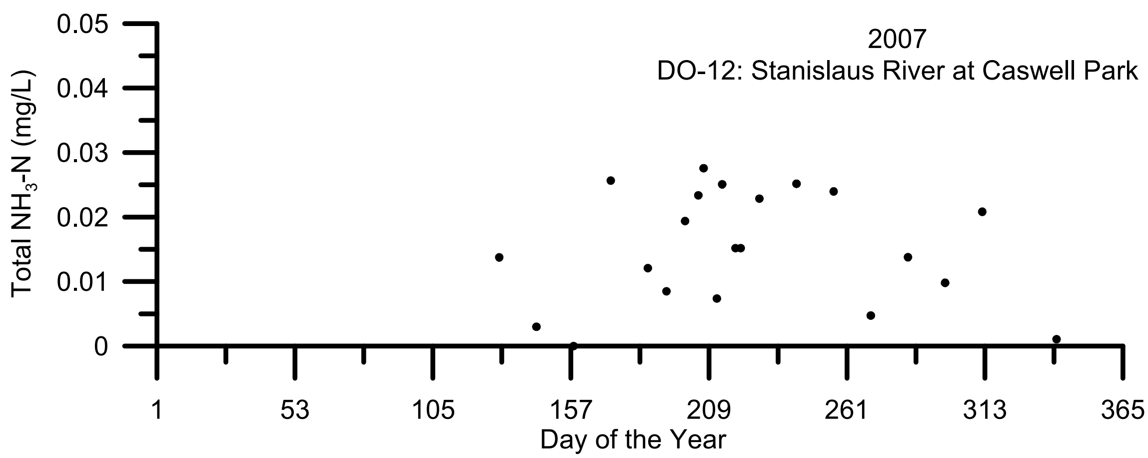

2005
DO-10: SJR at Lander Avenue
Total NH_3-N (mg/L)
0.08
0.06
0.04
0.02
0
1
53
105
157
209
261
313
365
Day of the Year

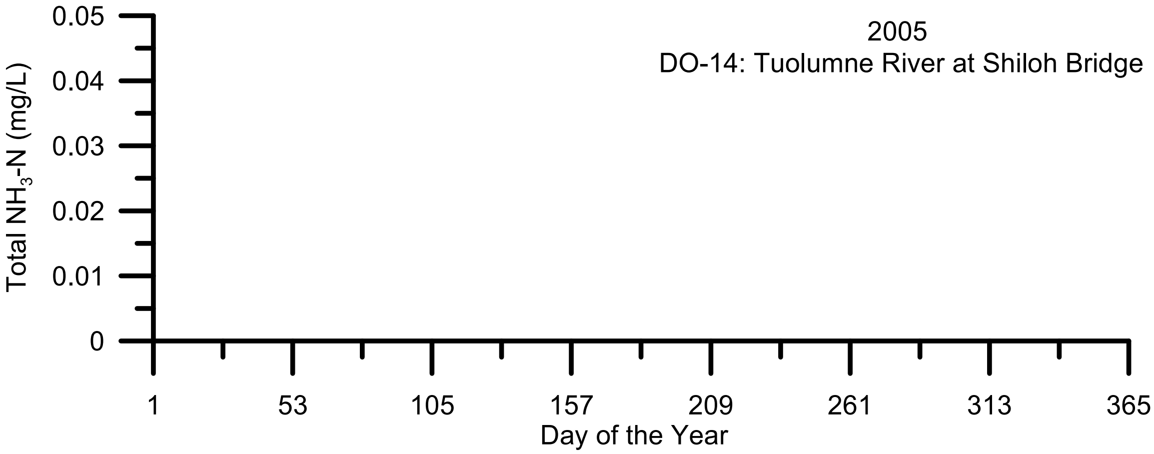

2006
DO-10: SJR at Lander Avenue
Total NH_3-N (mg/L)
0.08
0.06
0.04
0.02
0
1
53
105
157
209
261
313
365
Day of the Year

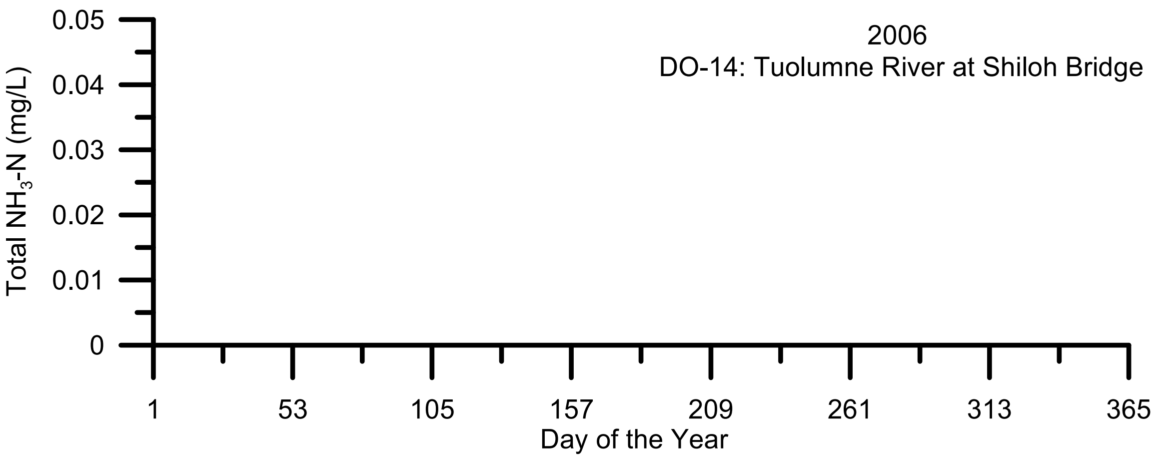

2007
DO-10: SJR at Lander Avenue
Total NH_3-N (mg/L)
0.08
0.06
0.04
0.02
0
1
53
105
157
209
261
313
365
Day of the Year

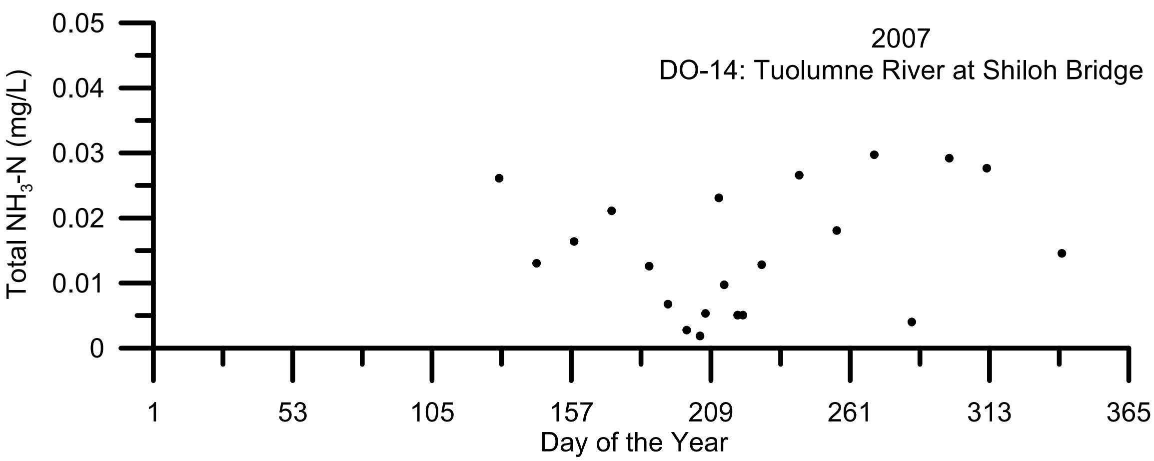

2005
DO-12: Stanislaus River at Caswell Park
Total NH_3-N (mg/L)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

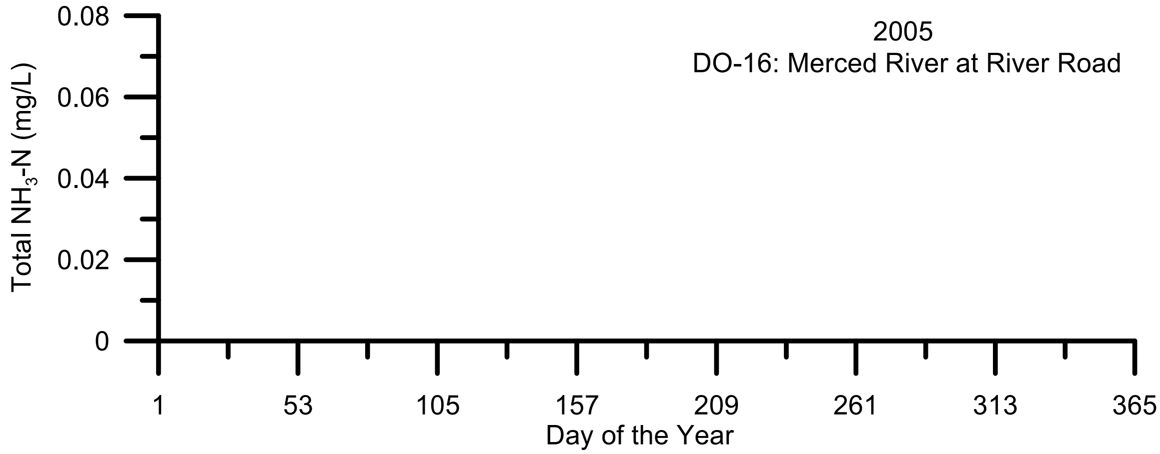

2006
DO-12: Stanislaus River at Caswell Park
Total NH_3-N (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

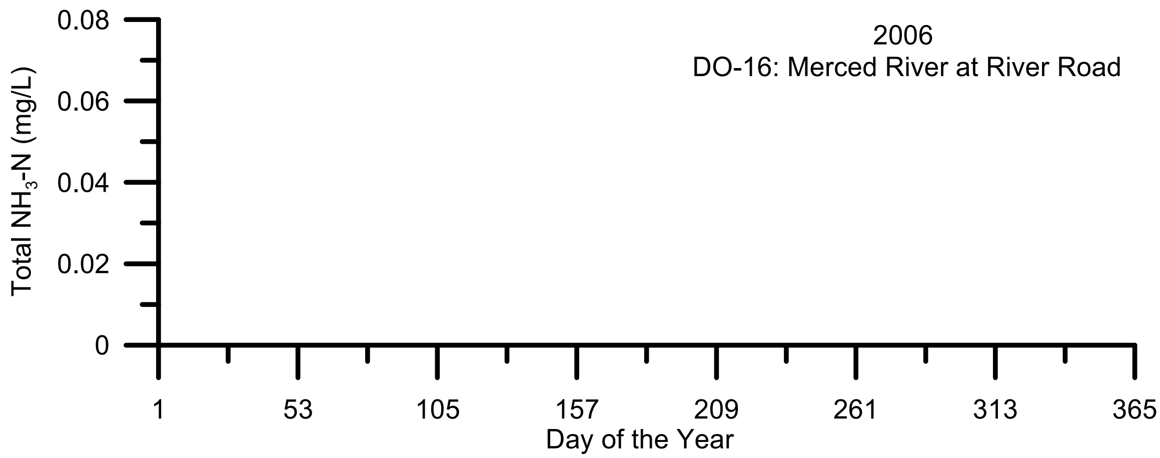

2007
DO-12: Stanislaus River at Caswell Park
Total NH_3-N (mg/L)
0
0.01
0.02
0.03
0.04
0.05
1
53
105
157
209
261
313
365
Day of the Year

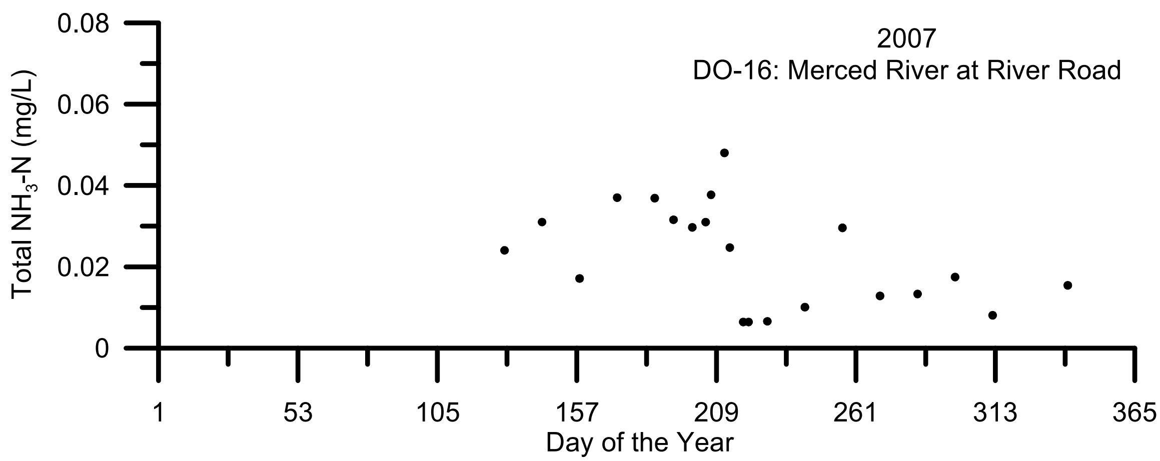

2005
DO-14: Tuolumne River at Shiloh Bridge
Total NH3-N (mg/L)
0.05
0.04
0.03
0.02
0.01
0
1
53
105
157
209
261
313
365
Day of the Year

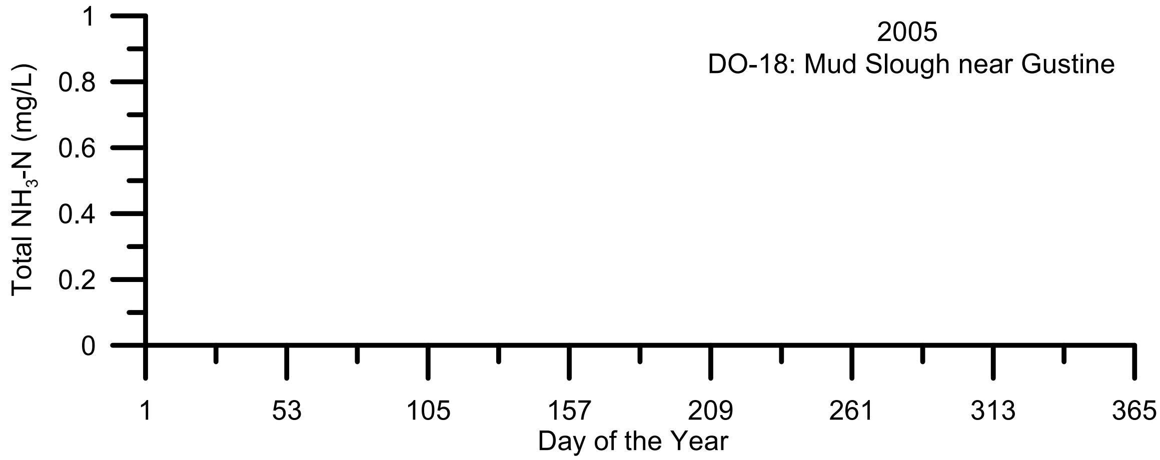

2006
DO-14: Tuolumne River at Shiloh Bridge
Total NH3-N (mg/L)
0.05
0.04
0.03
0.02
0.01
0
1
53
105
157
209
261
313
365
Day of the Year

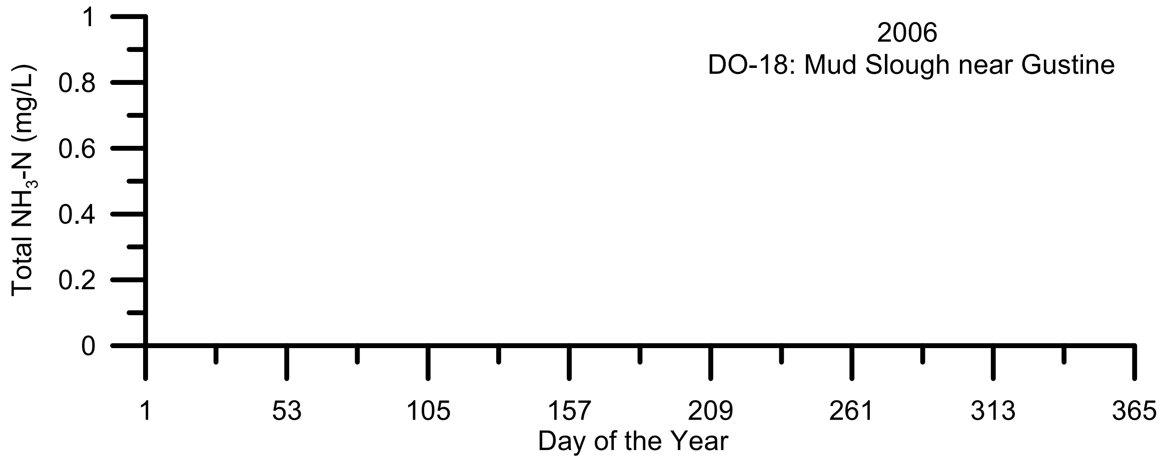

2007
DO-14: Tuolumne River at Shiloh Bridge
Total NH3-N (mg/L)
0.05
0.04
0.03
0.02
0.01
0
1
53
105
157
209
261
313
365
Day of the Year

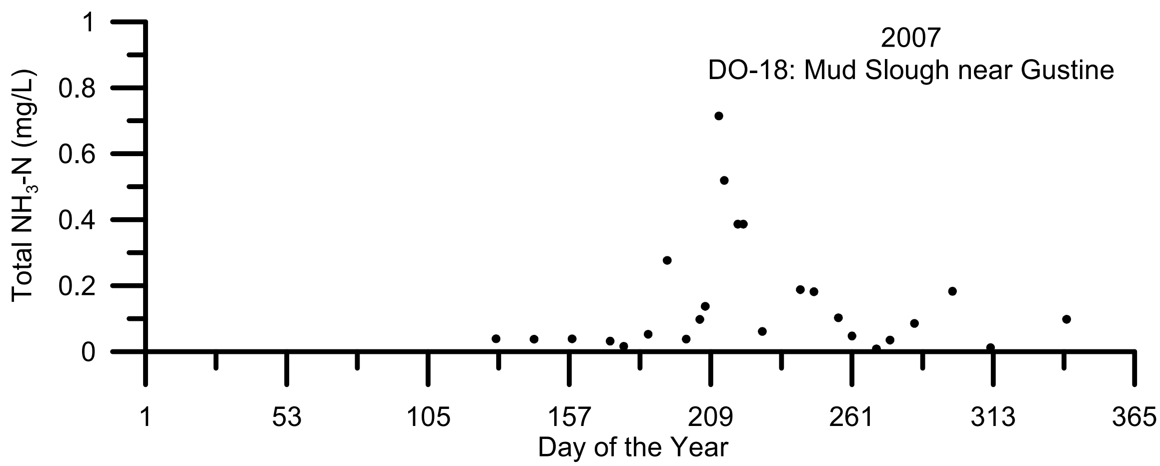

2005
DO-16: Merced River at River Road
Total NH_3-N (mg/L)
0.08
0.06
0.04
0.02
0
1
53
105
157
209
261
313
365
Day of the Year

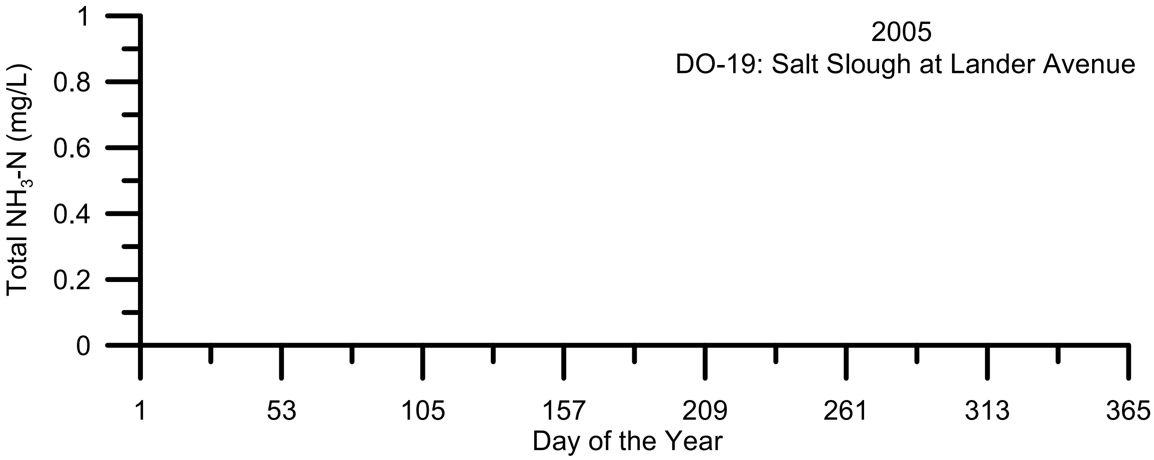

2006
DO-16: Merced River at River Road
Total NH_3-N (mg/L)
0.08
0.06
0.04
0.02
0
1
53
105
157
209
261
313
365
Day of the Year

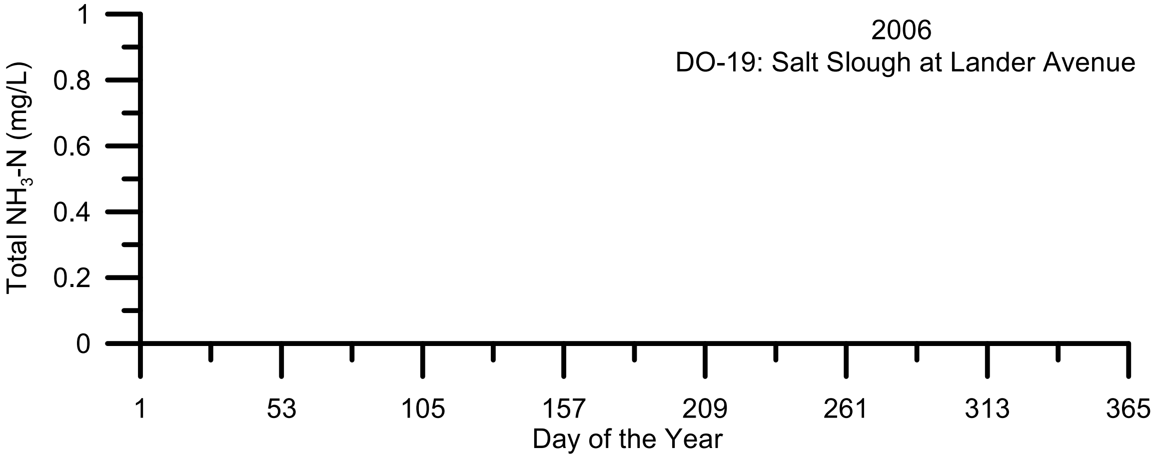

2007
DO-16: Merced River at River Road
Total NH_3-N (mg/L)
0.08
0.06
0.04
0.02
0
1
53
105
157
209
261
313
365
Day of the Year

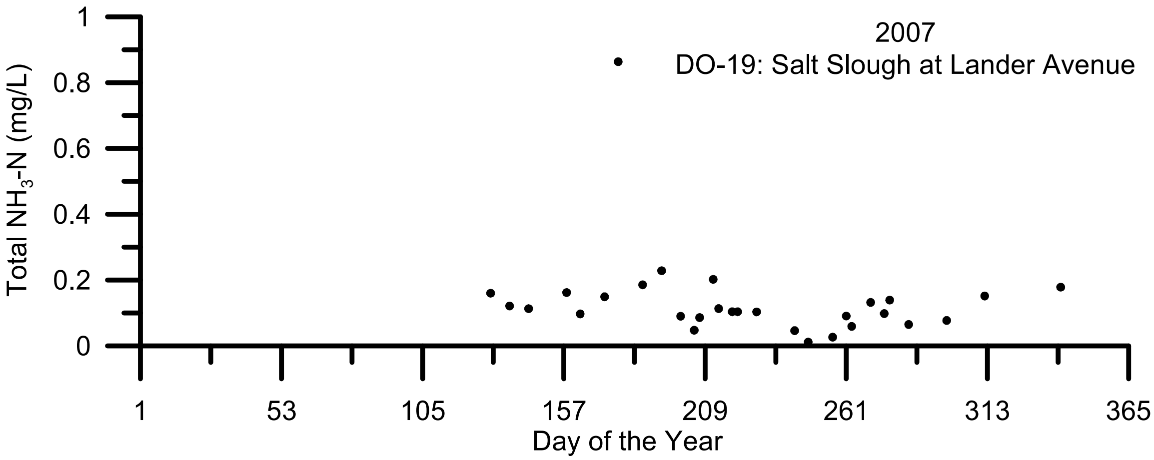

2005
DO-18: Mud Slough near Gustine
Total NH3-N (mg/L)
Day of the Year

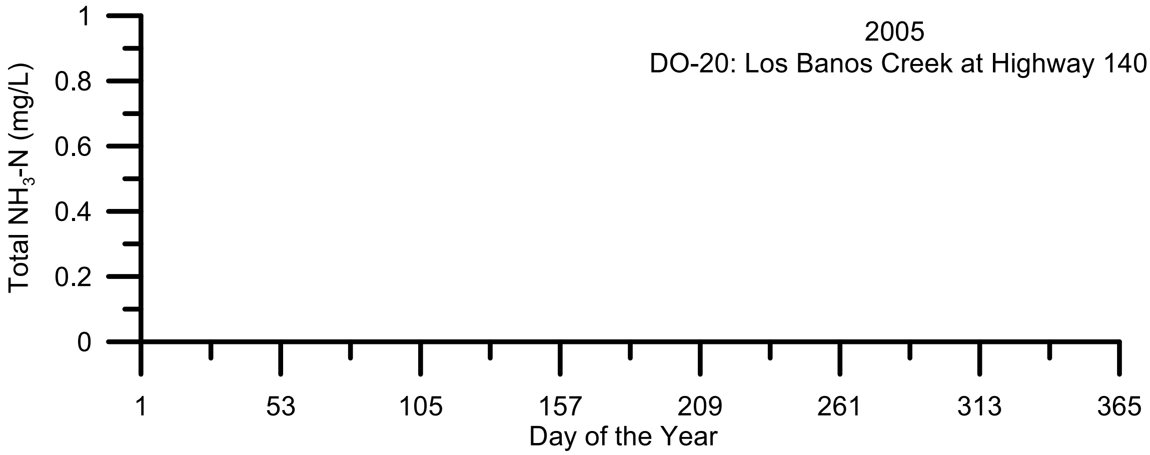

2006
DO-18: Mud Slough near Gustine
Total NH3-N (mg/L)
Day of the Year

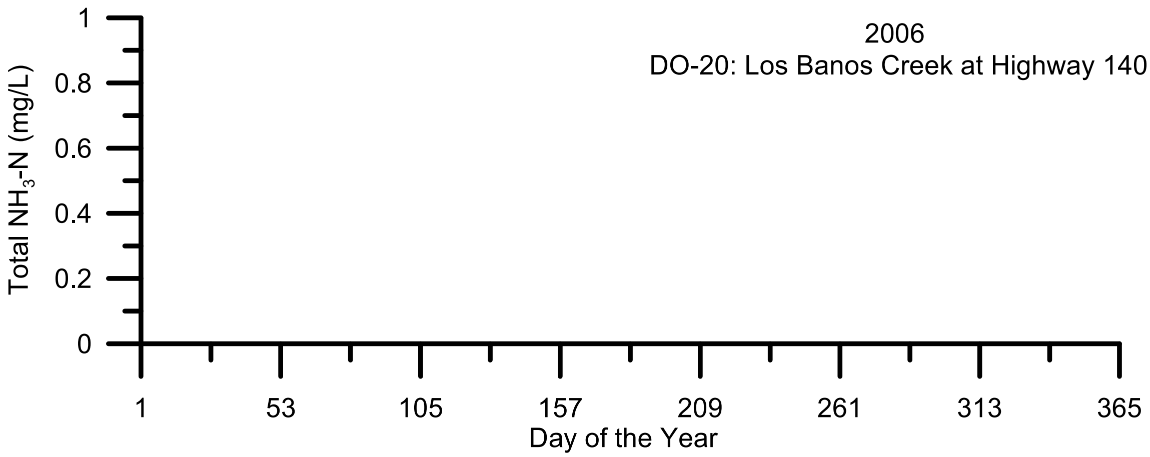

2007
DO-18: Mud Slough near Gustine
Total NH3-N (mg/L)
Day of the Year

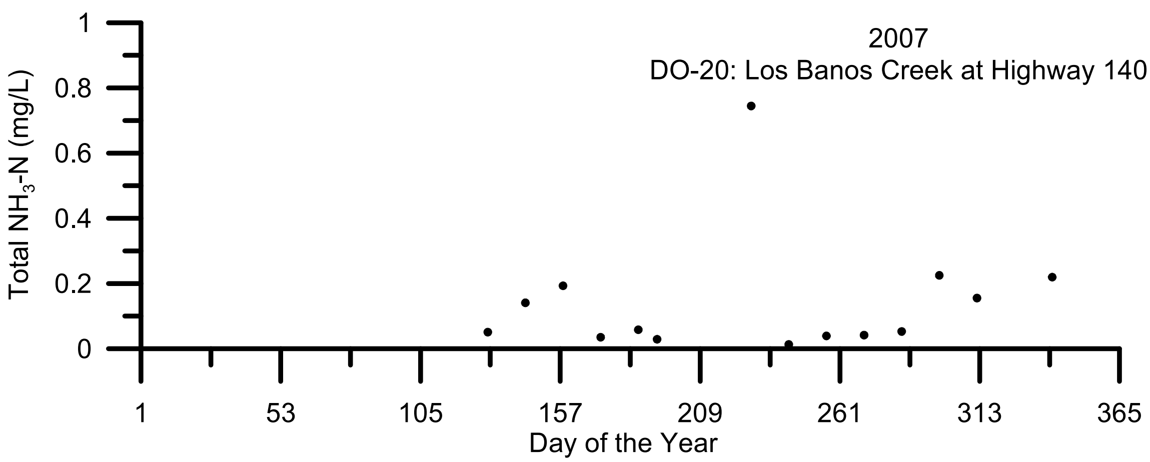

2005
DO-19: Salt Slough at Lander Avenue
Total NH3-N (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

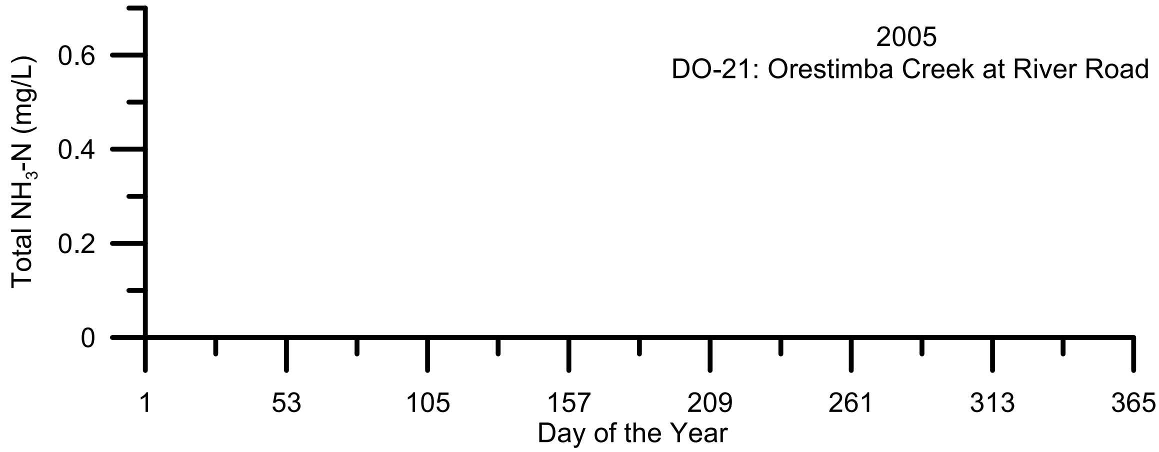

2006
DO-19: Salt Slough at Lander Avenue
Total NH3-N (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

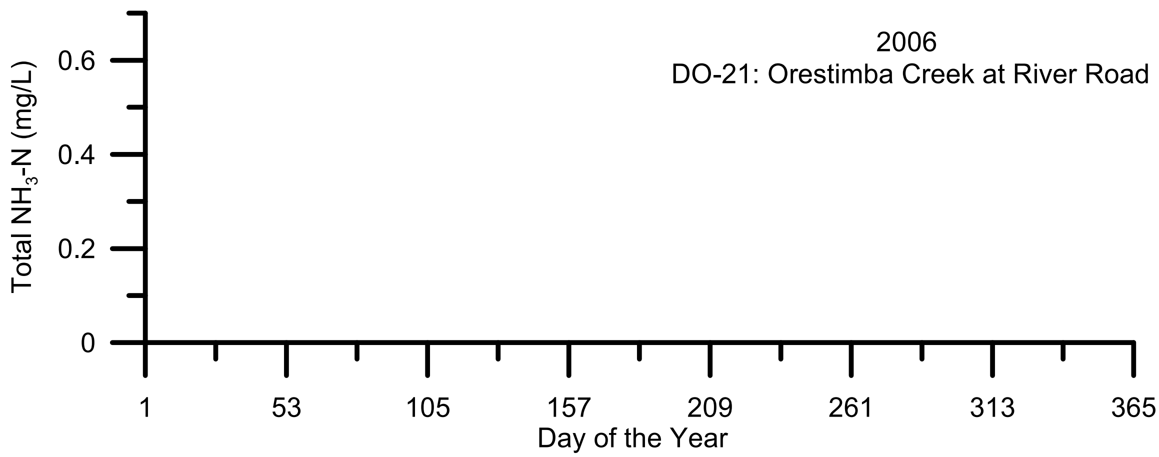

2007
DO-19: Salt Slough at Lander Avenue
Total NH3-N (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

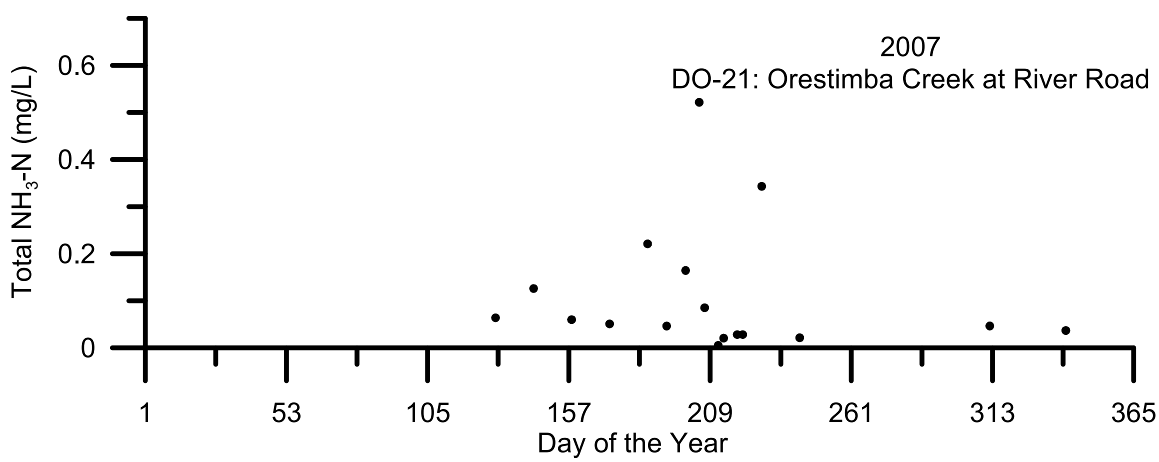

2005
DO-20: Los Banos Creek at Highway 140
Total NH_3-N (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

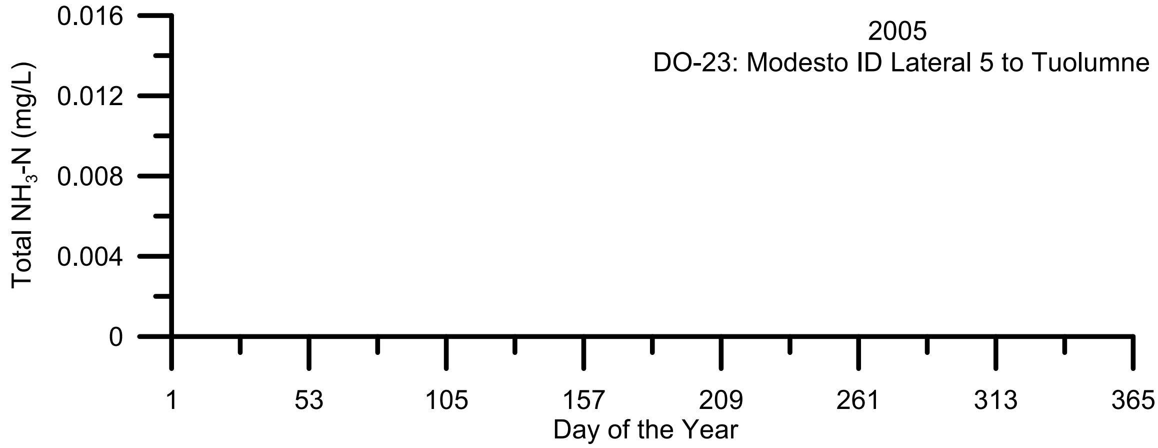

2006
DO-20: Los Banos Creek at Highway 140
Total NH_3-N (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

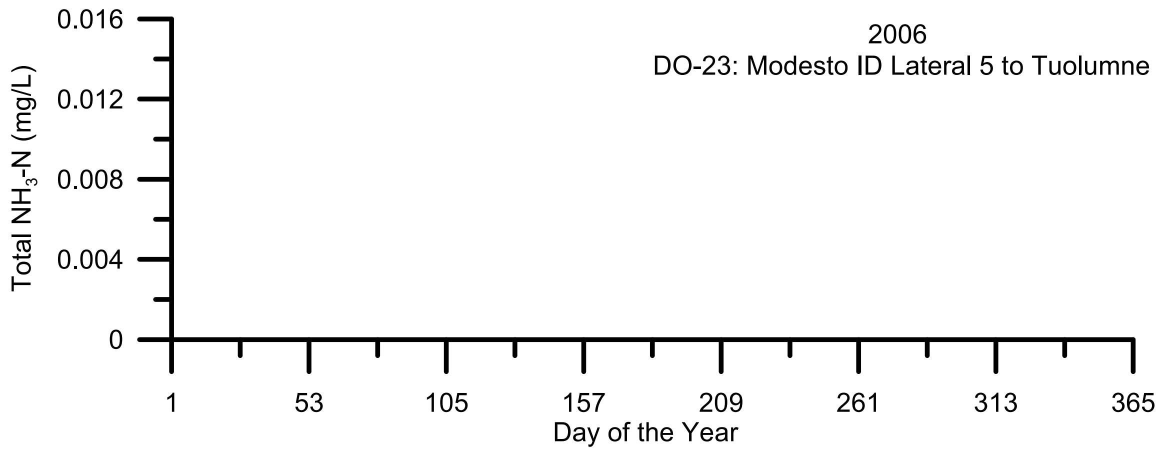

2007
DO-20: Los Banos Creek at Highway 140
Total NH_3-N (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

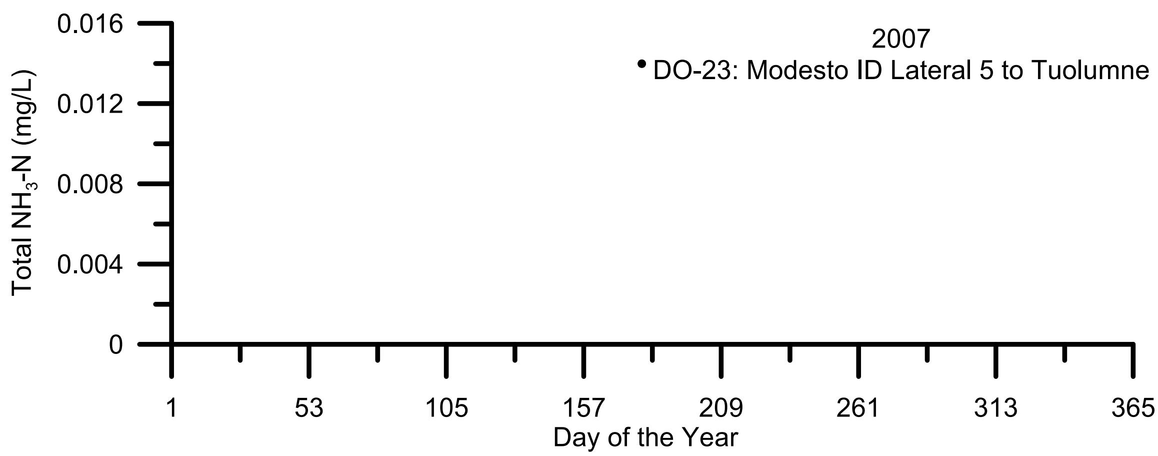

2005
DO-21: Orestimba Creek at River Road
Total NH3-N (mg/L)
0
0.2
0.4
0.6
1
53
105
157
209
261
313
365
Day of the Year

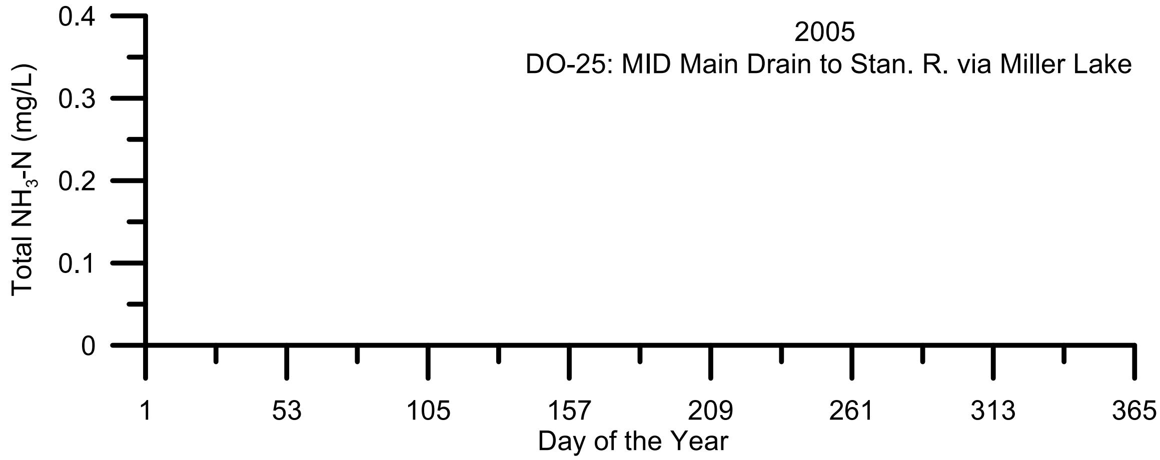

2006
DO-21: Orestimba Creek at River Road
Total NH3-N (mg/L)
0
0.2
0.4
0.6
1
53
105
157
209
261
313
365
Day of the Year

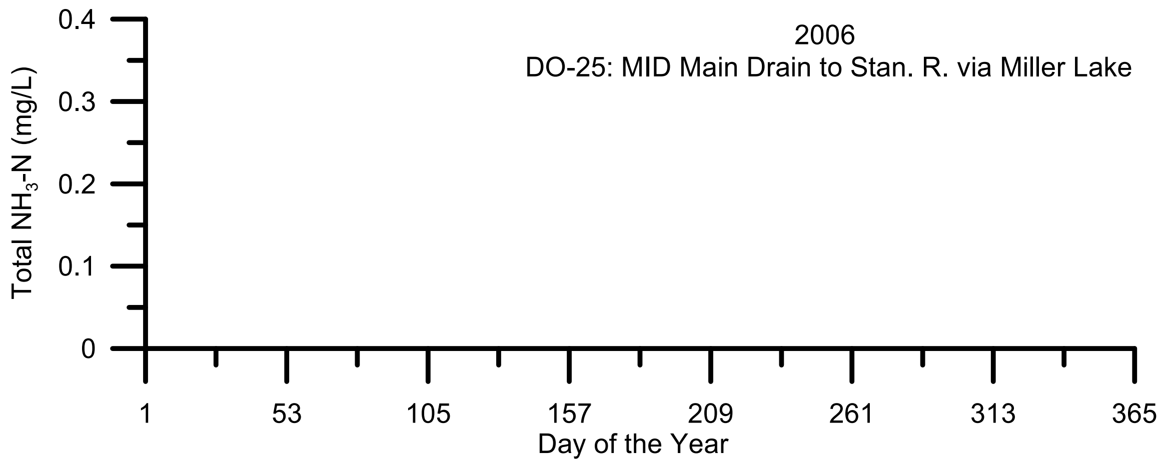

2007
DO-21: Orestimba Creek at River Road
Total NH3-N (mg/L)
0
0.2
0.4
0.6
1
53
105
157
209
261
313
365
Day of the Year

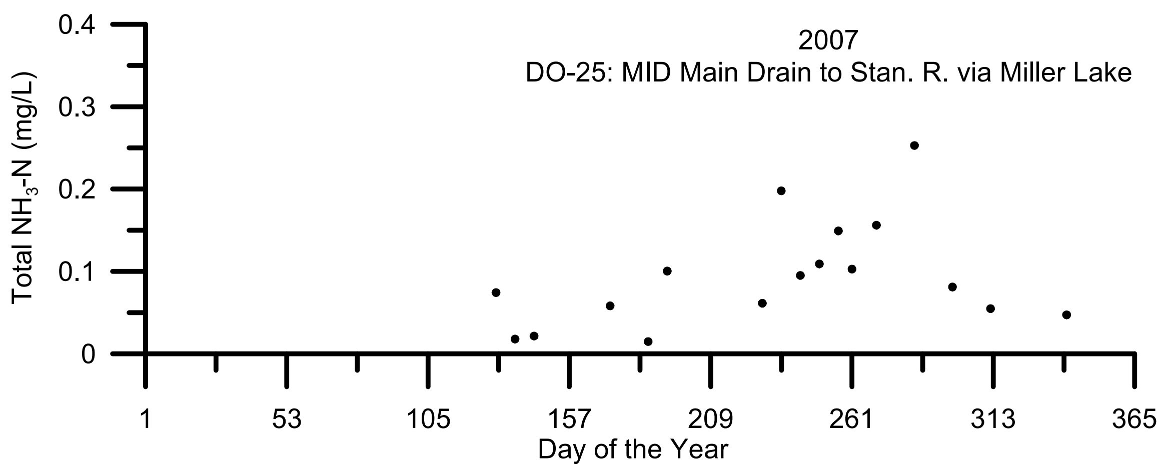

2005
DO-23: Modesto ID Lateral 5 to Tuolumne
Total NH_3-N (mg/L)
Day of the Year

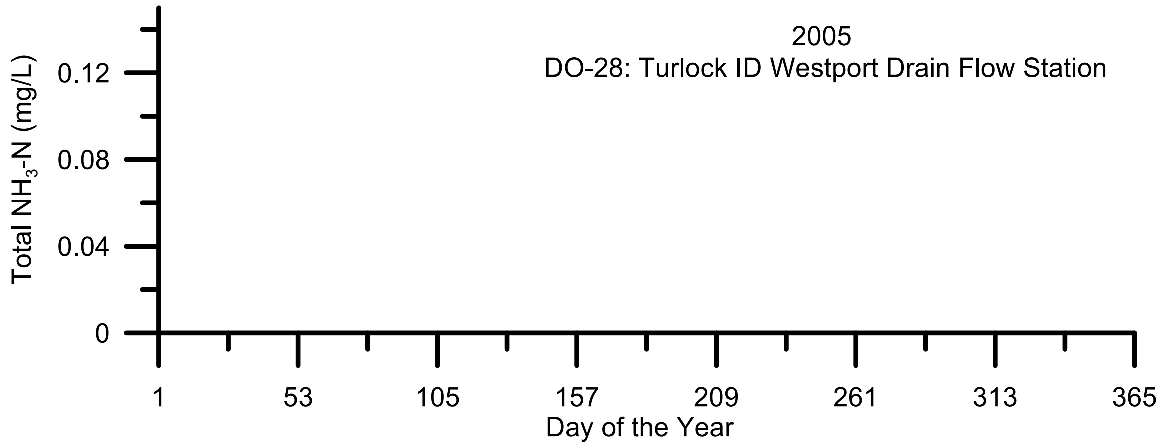

2006
DO-23: Modesto ID Lateral 5 to Tuolumne
Total NH_3-N (mg/L)
Day of the Year

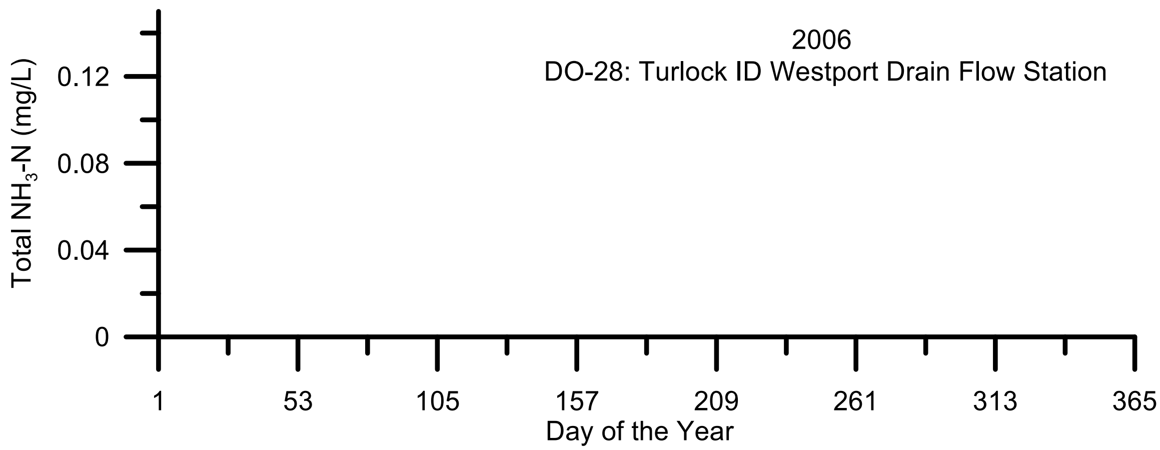

2007
DO-23: Modesto ID Lateral 5 to Tuolumne
Total NH_3-N (mg/L)
Day of the Year

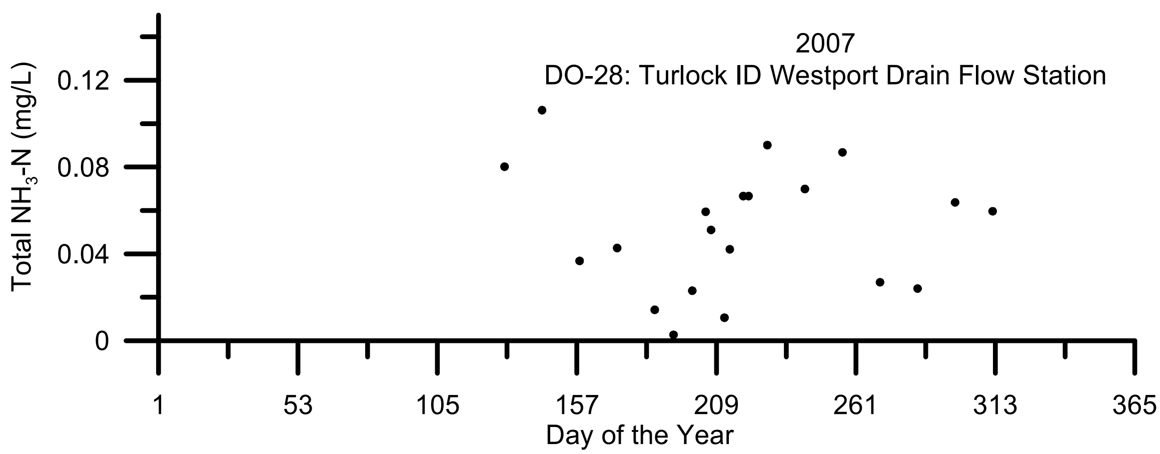

2005
DO-25: MID Main Drain to Stan. R. via Miller Lake
Total NH3-N (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

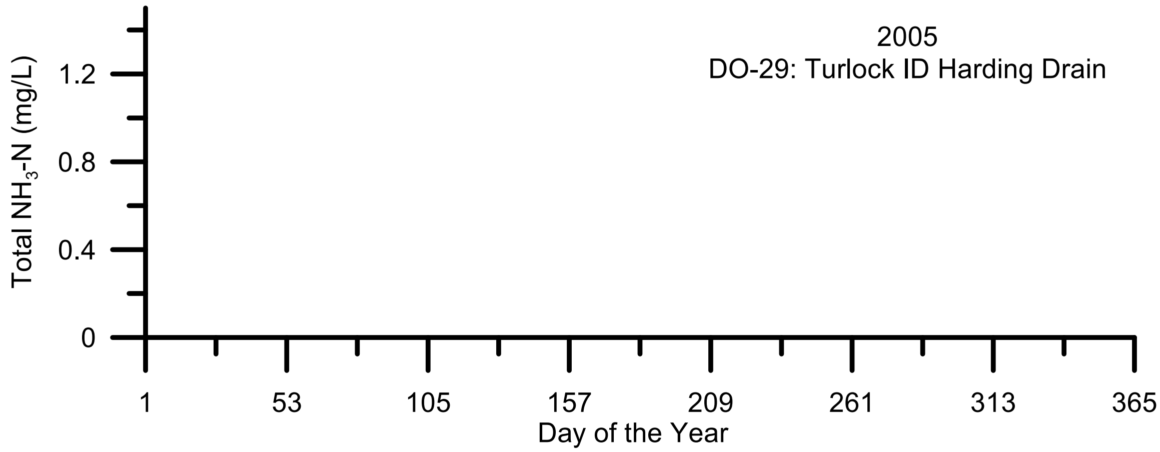

2006
DO-25: MID Main Drain to Stan. R. via Miller Lake
Total NH3-N (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

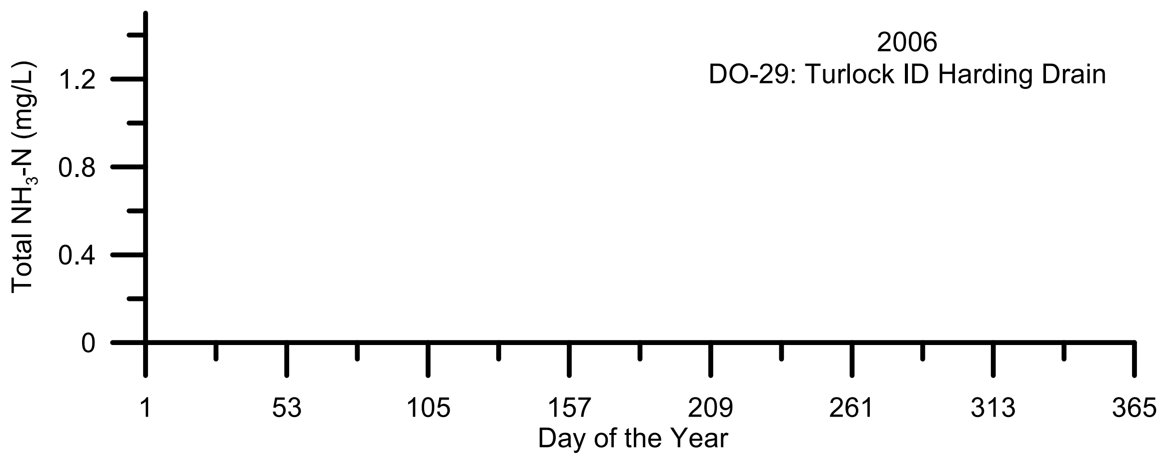

2007
DO-25: MID Main Drain to Stan. R. via Miller Lake
Total NH3-N (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

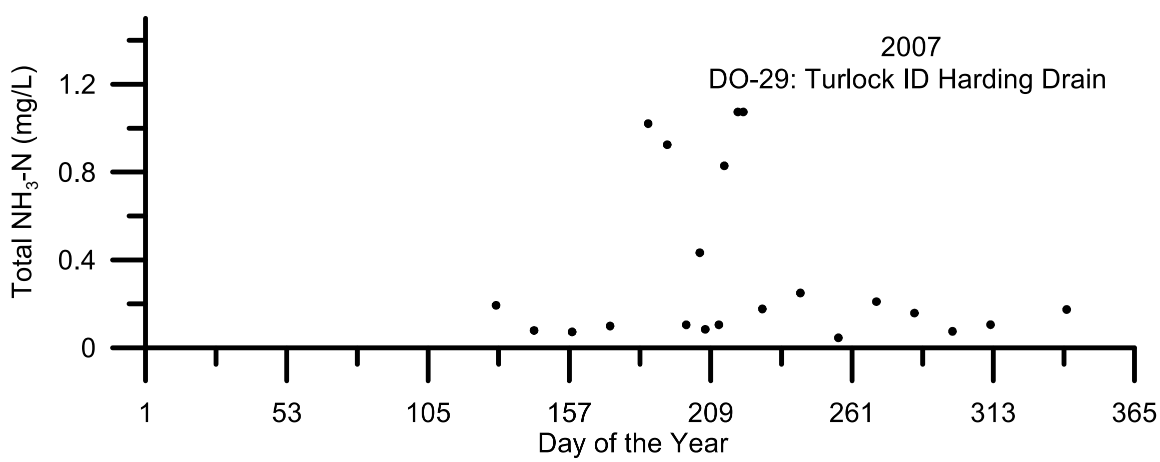

2005
DO-28: Turlock ID Westport Drain Flow Station
Total NH3-N (mg/L)
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

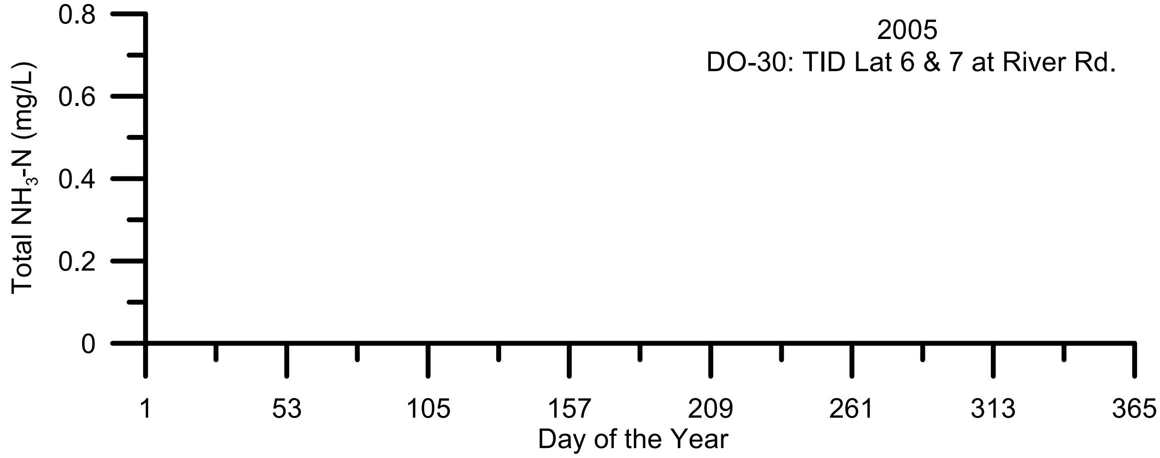

2006
DO-28: Turlock ID Westport Drain Flow Station
Total NH3-N (mg/L)
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-28: Turlock ID Westport Drain Flow Station
Total NH3-N (mg/L)
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

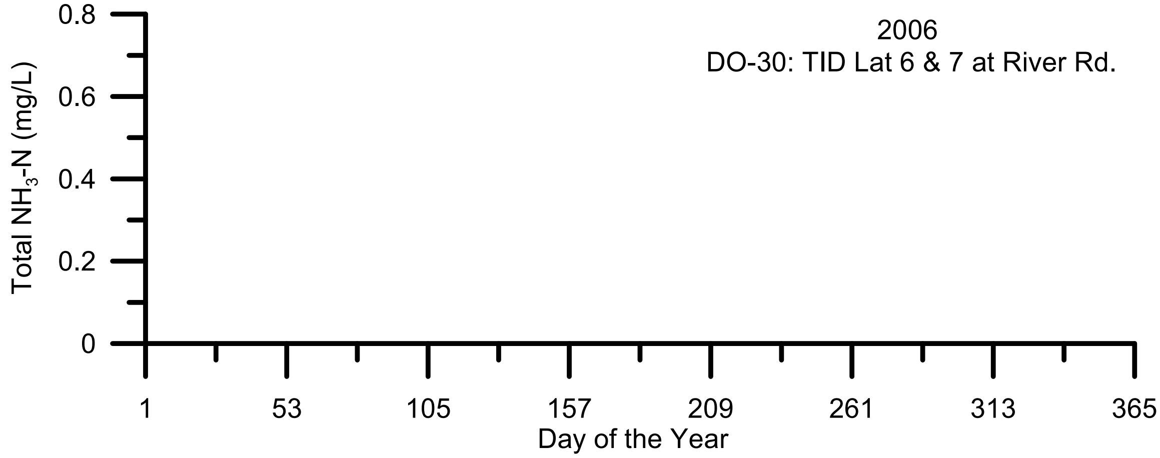

2005
DO-29: Turlock ID Harding Drain
Total NH3-N (mg/L)
Day of the Year


2006
DO-29: Turlock ID Harding Drain
Total NH3-N (mg/L)
Day of the Year

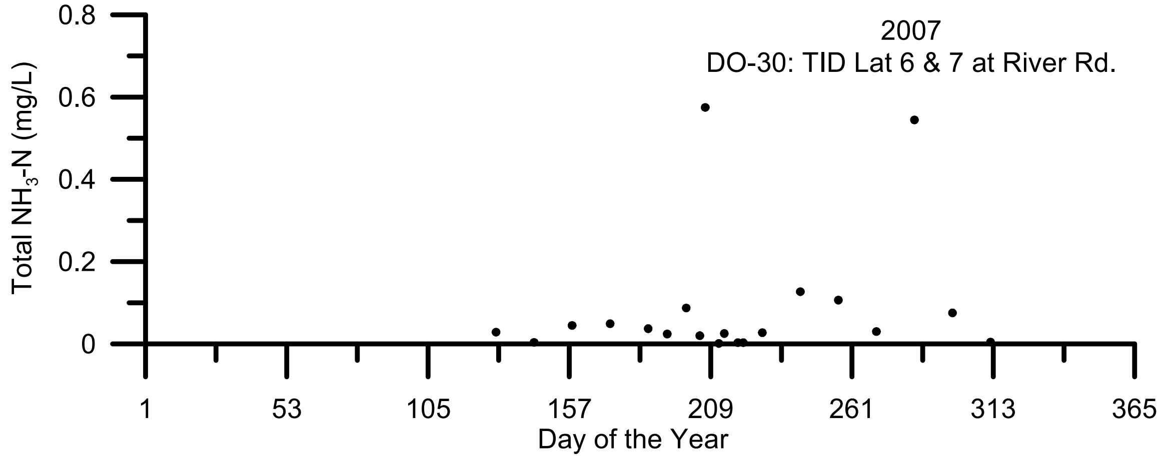

2007
DO-29: Turlock ID Harding Drain
Total NH3-N (mg/L)
Day of the Year



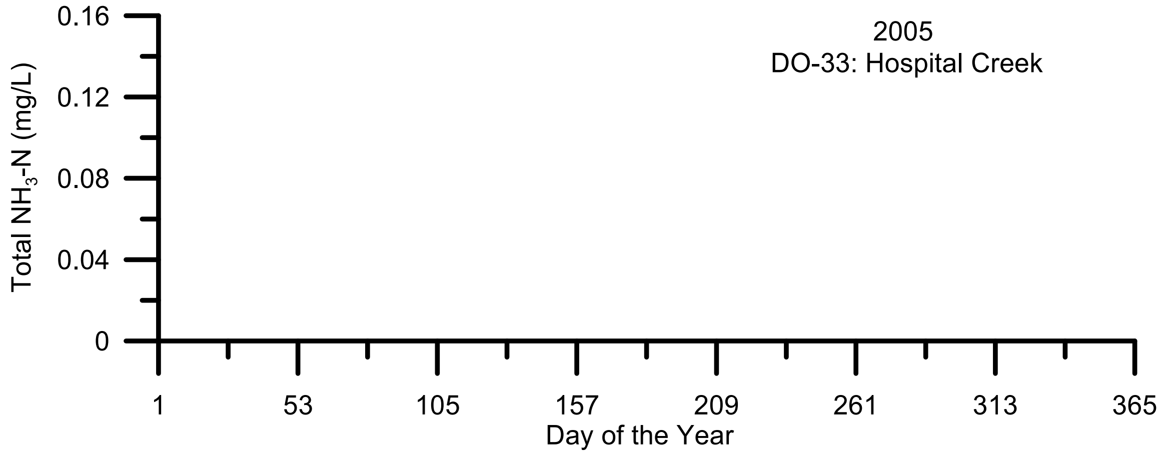
2005
DO-30: TID Lat 6 & 7 at River Rd.
Total NH_3-N (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

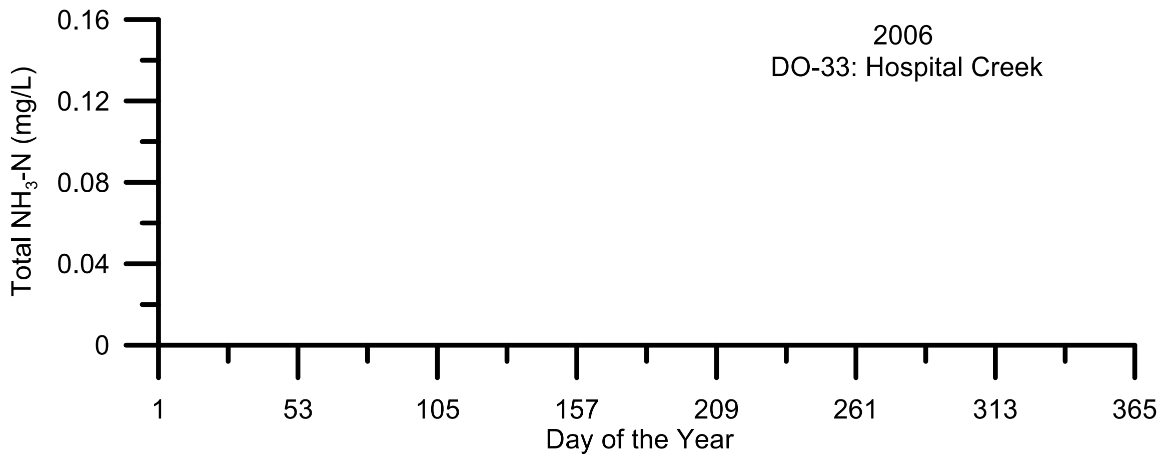


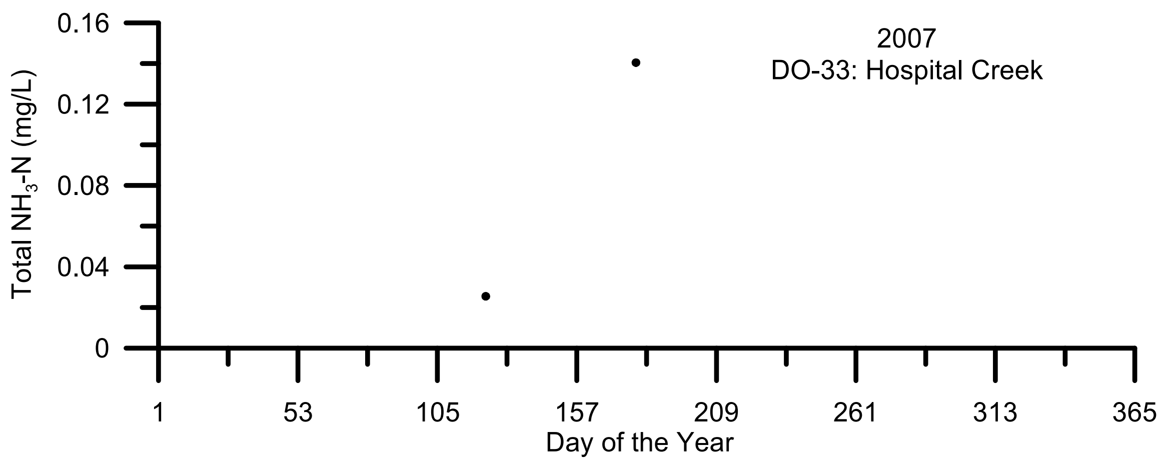
2006
DO-30: TID Lat 6 & 7 at River Rd.
Total NH_3-N (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

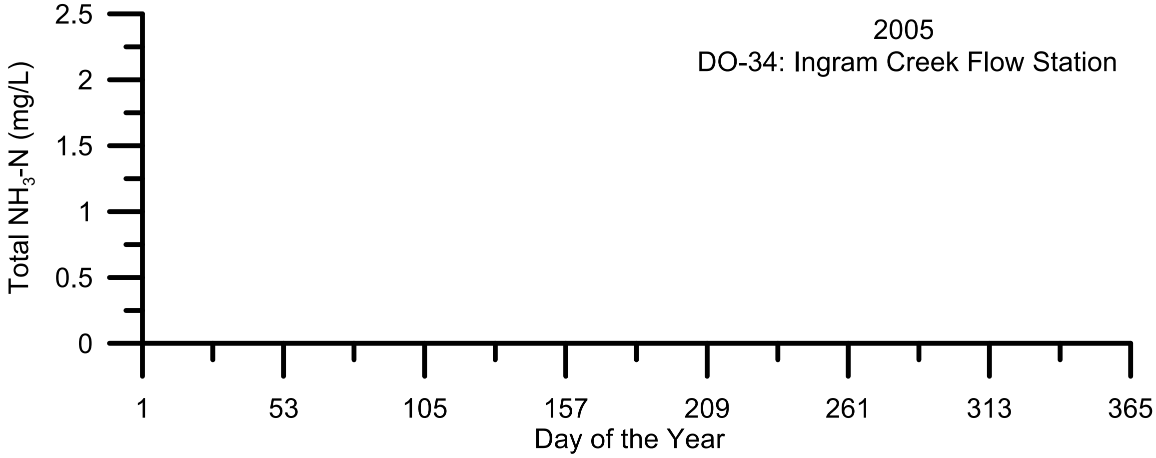


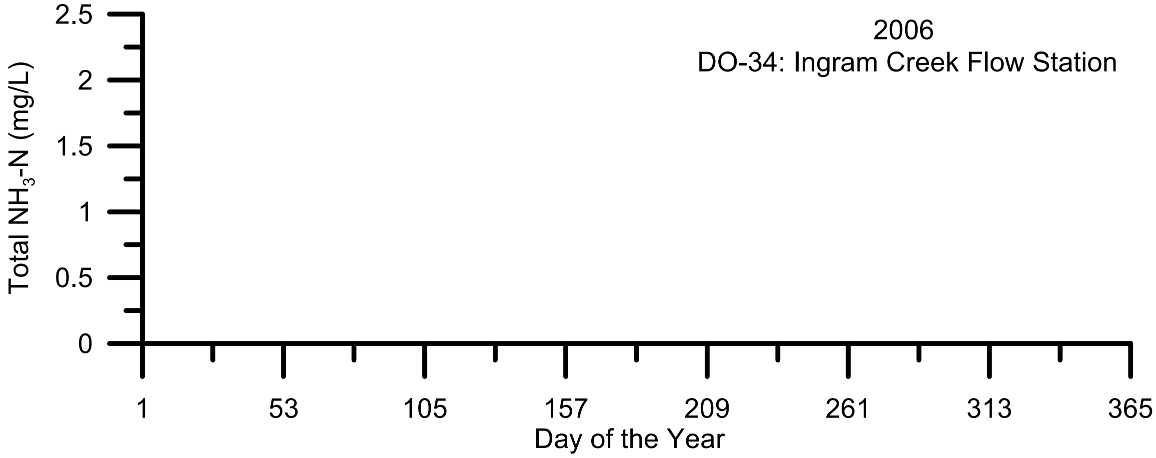
2007
DO-30: TID Lat 6 & 7 at River Rd.
Total NH_3-N (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

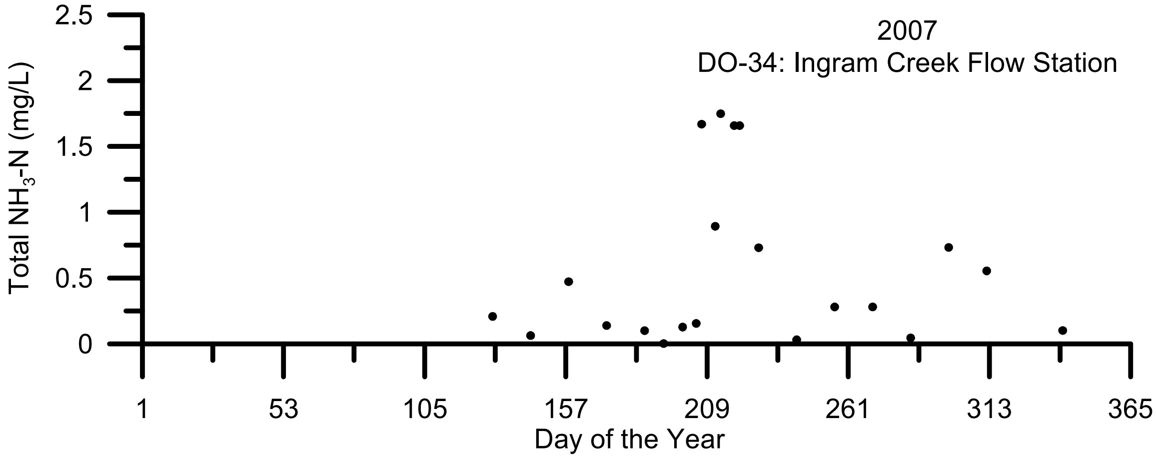

0.16
0.12
0.08
0.04
0
Total NH_3-N (mg/L)
2005
DO-33: Hospital Creek
1
53
105
157
209
261
313
365
Day of the Year

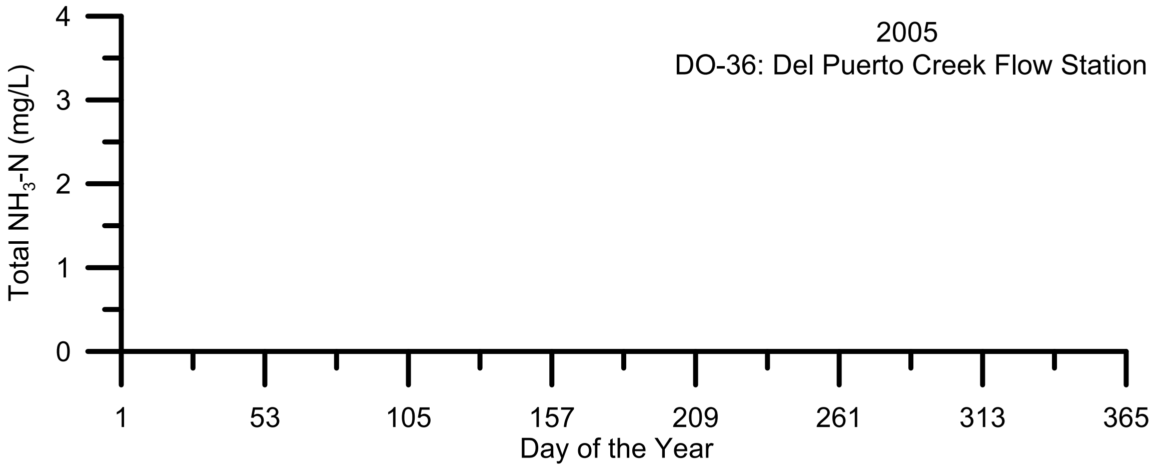

0.16
0.12
0.08
0.04
0
Total NH_3-N (mg/L)
2006
DO-33: Hospital Creek
1
53
105
157
209
261
313
365
Day of the Year

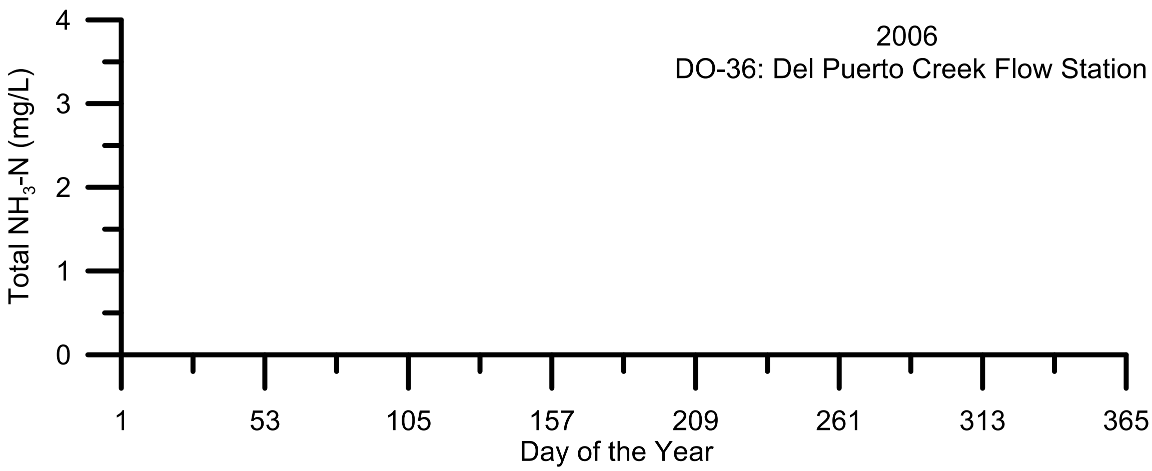

0.16
0.12
0.08
0.04
0
Total NH_3-N (mg/L)
2007
DO-33: Hospital Creek
1
53
105
157
209
261
313
365
Day of the Year

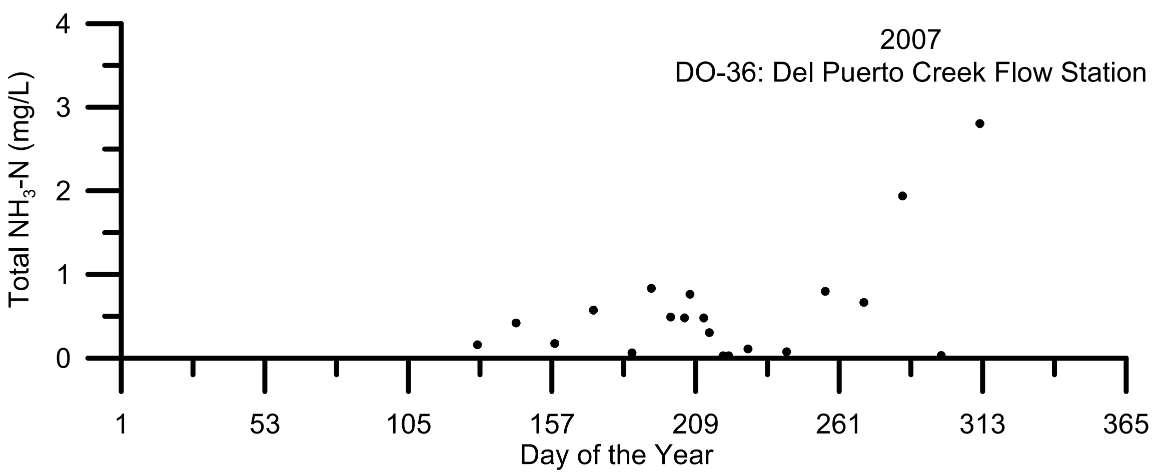

2005
DO-34: Ingram Creek Flow Station
Total NH_3-N (mg/L)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year

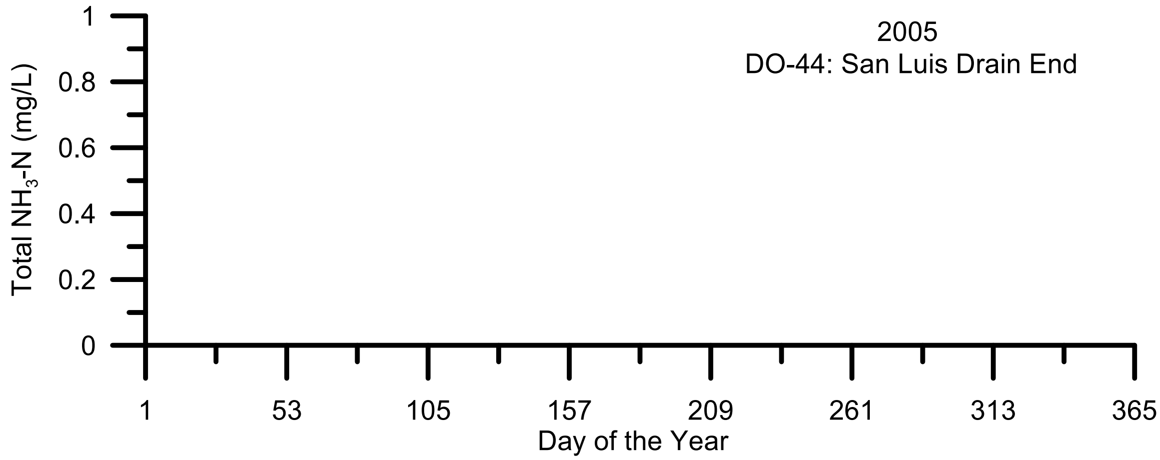

2006
DO-34: Ingram Creek Flow Station
Total NH_3-N (mg/L)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year

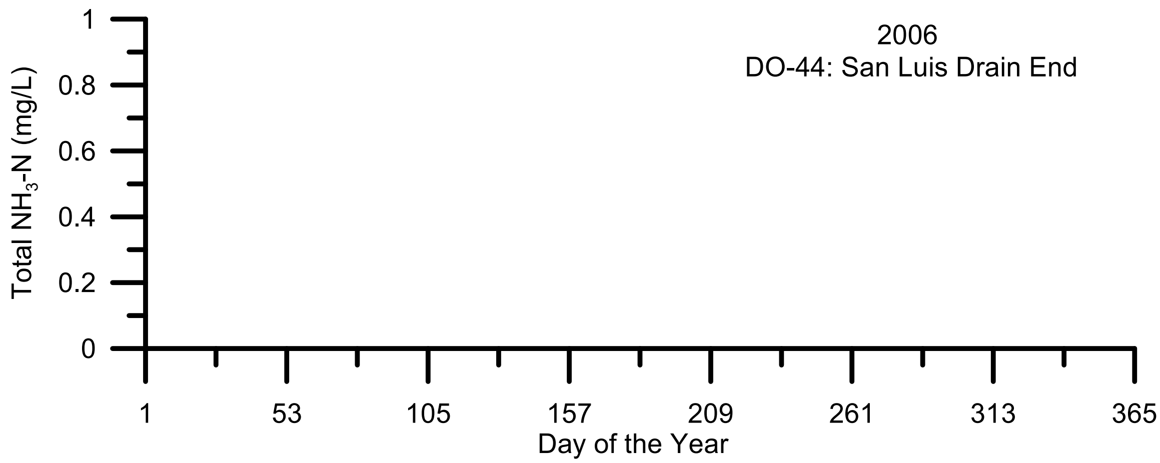

2007
DO-34: Ingram Creek Flow Station
Total NH_3-N (mg/L)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year

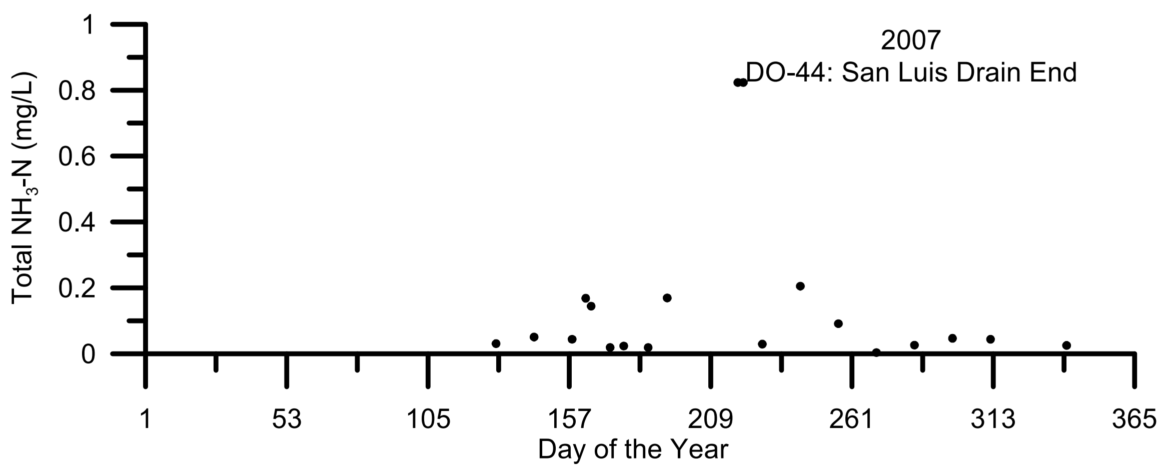

2005
DO-36: Del Puerto Creek Flow Station
Total NH3-N (mg/L)
Day of the Year

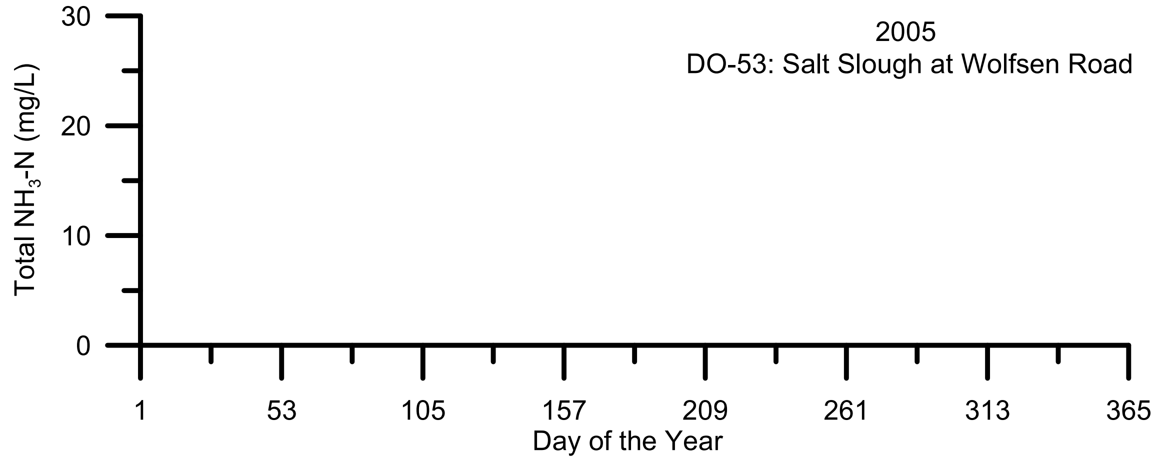

2006
DO-36: Del Puerto Creek Flow Station
Total NH3-N (mg/L)
Day of the Year

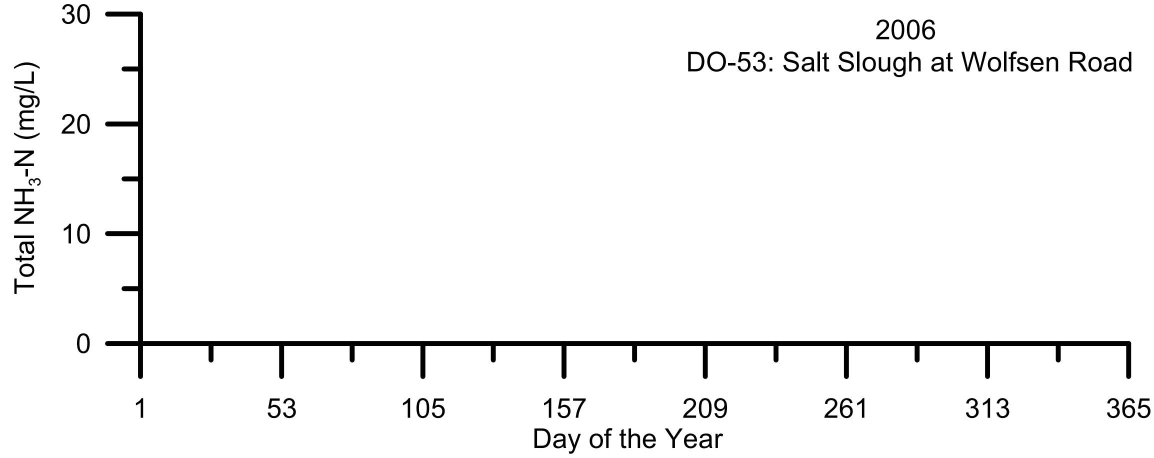

2007
DO-36: Del Puerto Creek Flow Station
Total NH3-N (mg/L)
Day of the Year

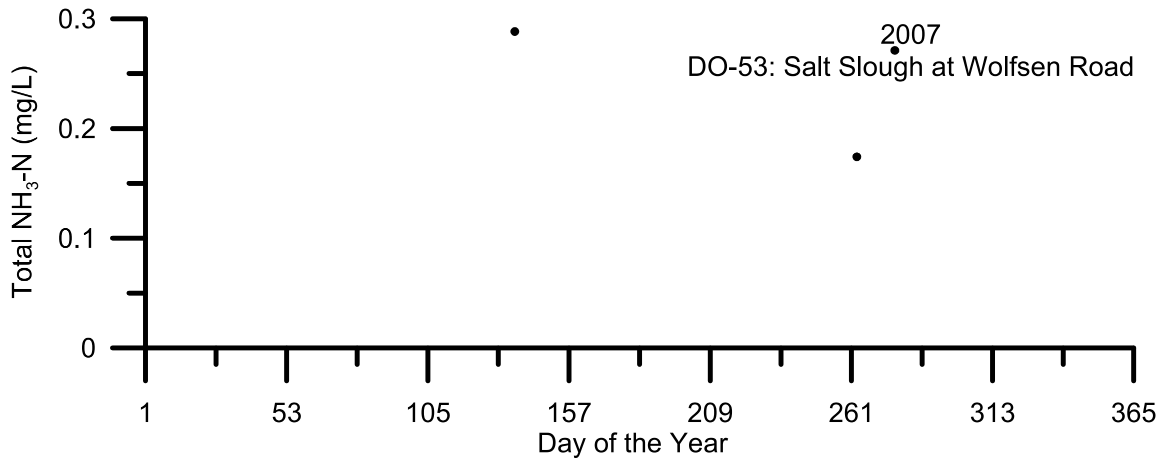

1
0.8
0.6
0.4
0.2
0
Total NH_3-N (mg/L)
2005
DO-44: San Luis Drain End
1
53
105
157
209
261
313
365
Day of the Year

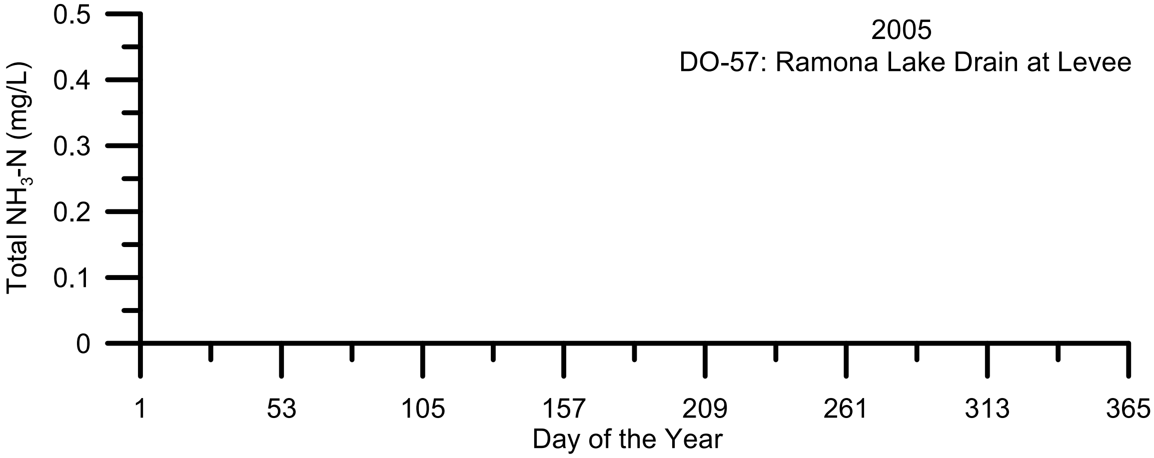

1
0.8
0.6
0.4
0.2
0
Total NH_3-N (mg/L)
2006
DO-44: San Luis Drain End
1
53
105
157
209
261
313
365
Day of the Year

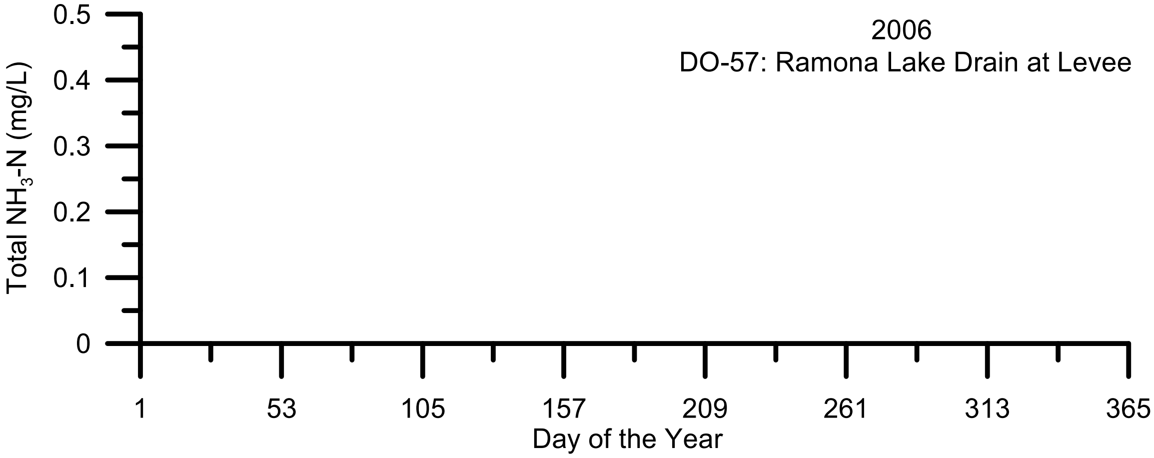

1
0.8
0.6
0.4
0.2
0
Total NH_3-N (mg/L)
2007
DO-44: San Luis Drain End
1
53
105
157
209
261
313
365
Day of the Year

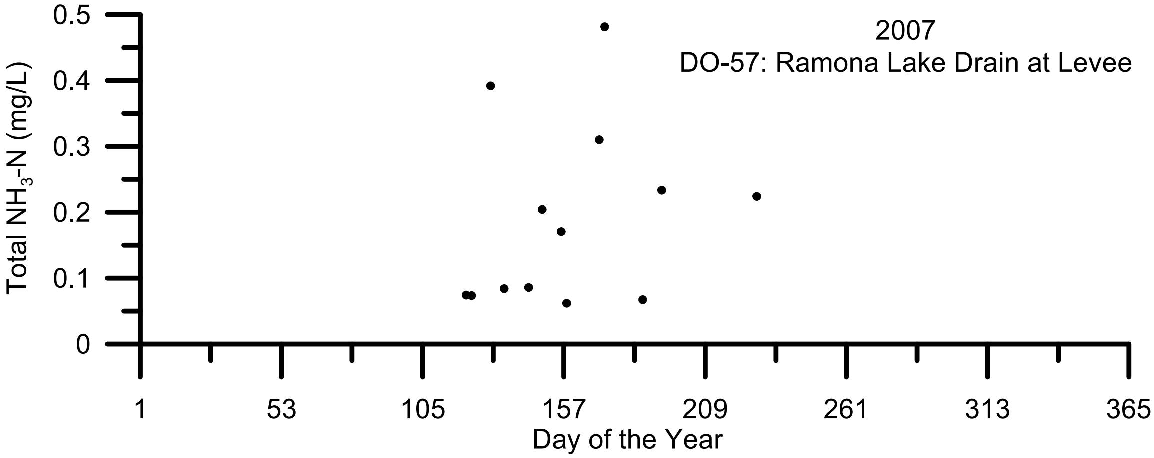

2005
DO-53: Salt Slough at Wolfsen Road
Total NH3-N (mg/L)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

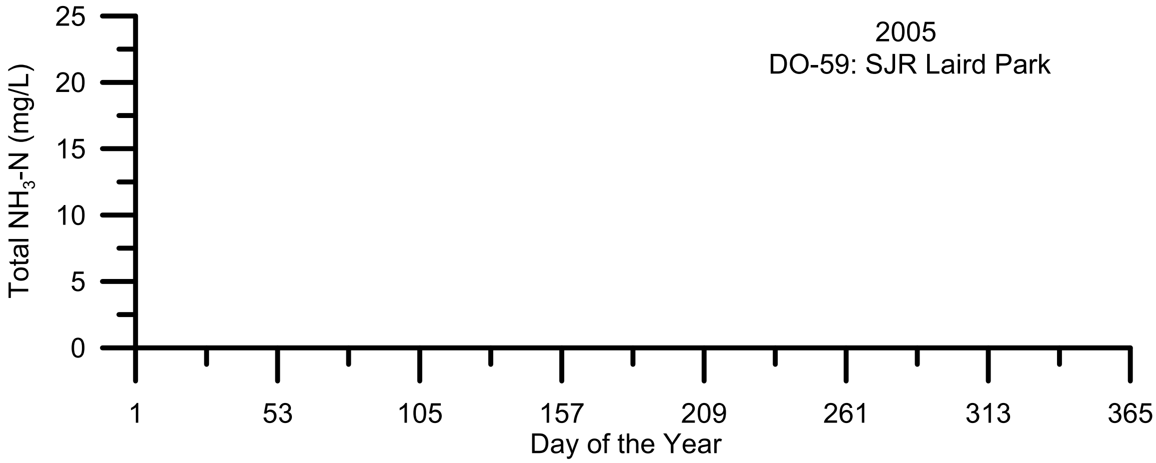

2006
DO-53: Salt Slough at Wolfsen Road
Total NH3-N (mg/L)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

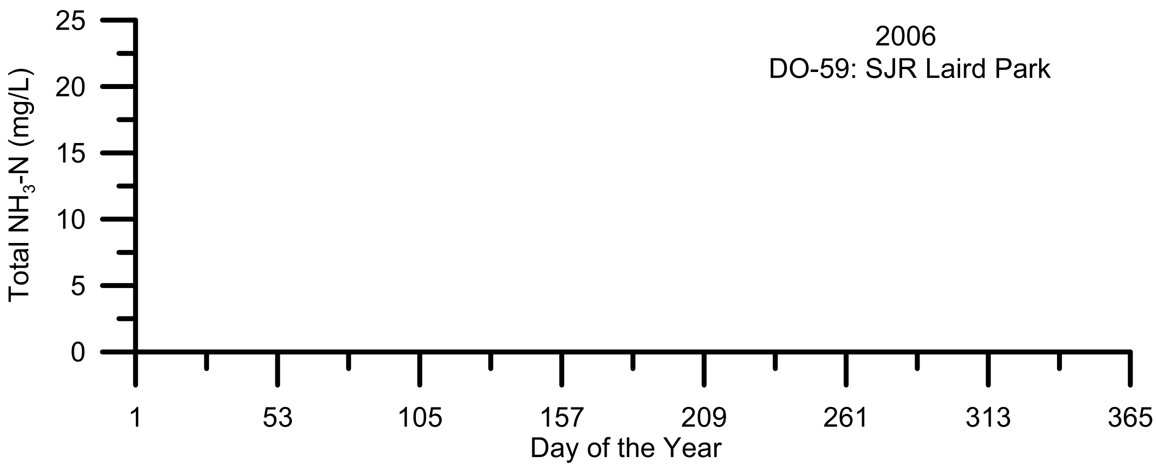

2007
DO-53: Salt Slough at Wolfsen Road
Total NH3-N (mg/L)
0
0.1
0.2
0.3
1
53
105
157
209
261
313
365
Day of the Year

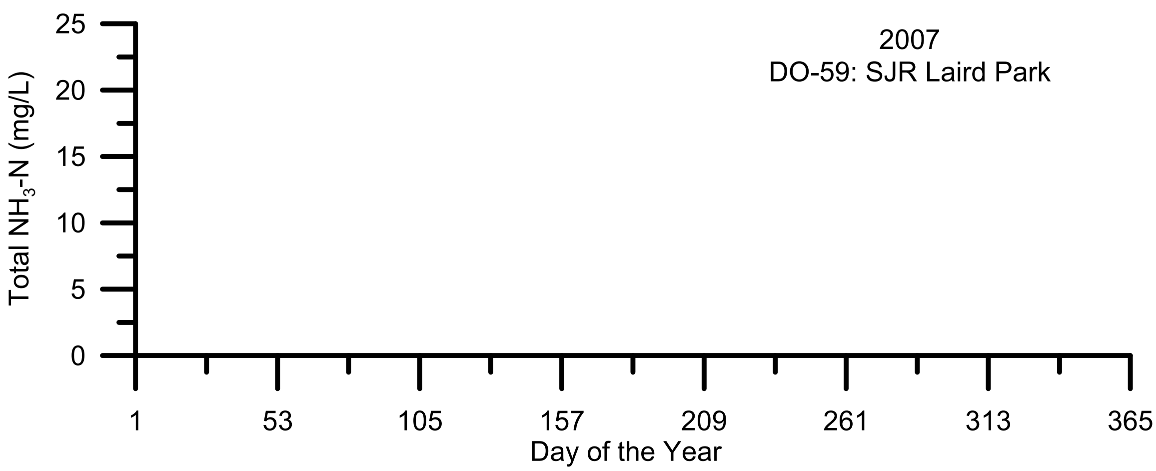

2005
DO-57: Ramona Lake Drain at Levee
Total NH3-N (mg/L)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

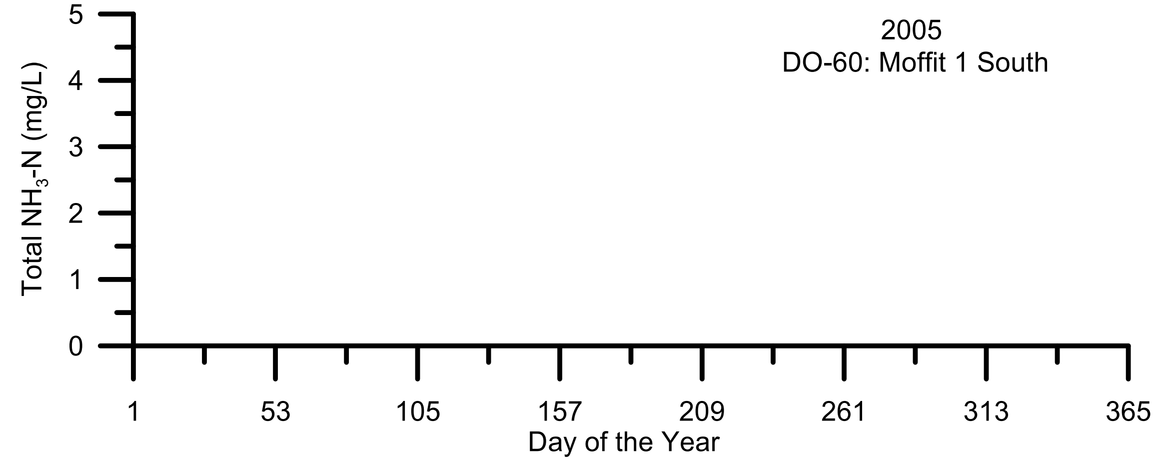

2006
DO-57: Ramona Lake Drain at Levee
Total NH3-N (mg/L)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

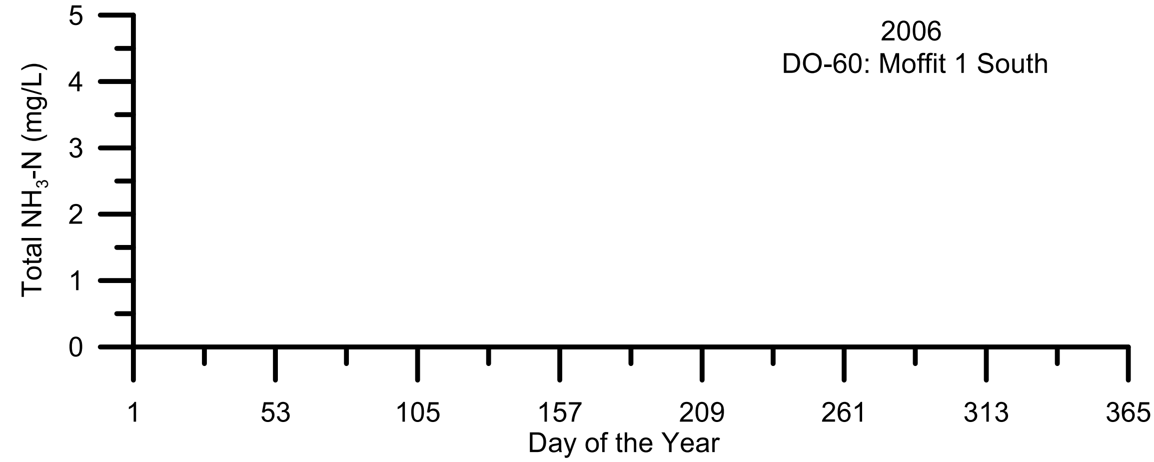

2007
DO-57: Ramona Lake Drain at Levee
Total NH3-N (mg/L)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

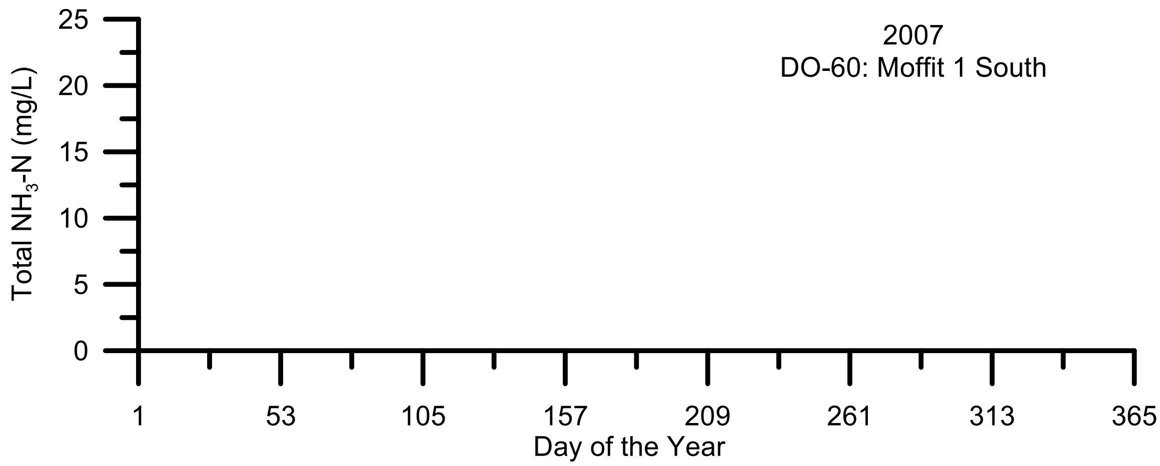

2005
DO-59: SJR Laird Park
Total NH3-N (mg/L)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

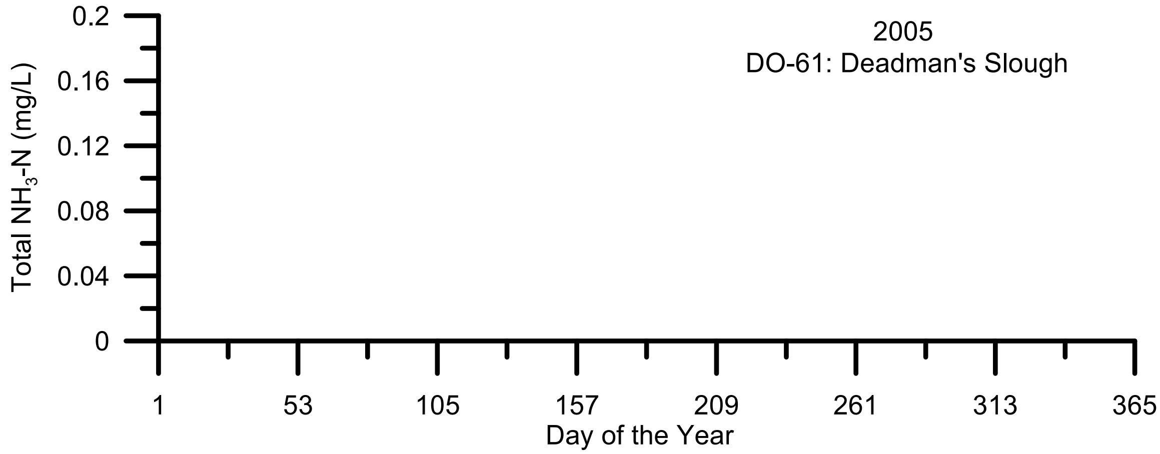

2006
DO-59: SJR Laird Park
Total NH3-N (mg/L)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-59: SJR Laird Park
Total NH3-N (mg/L)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

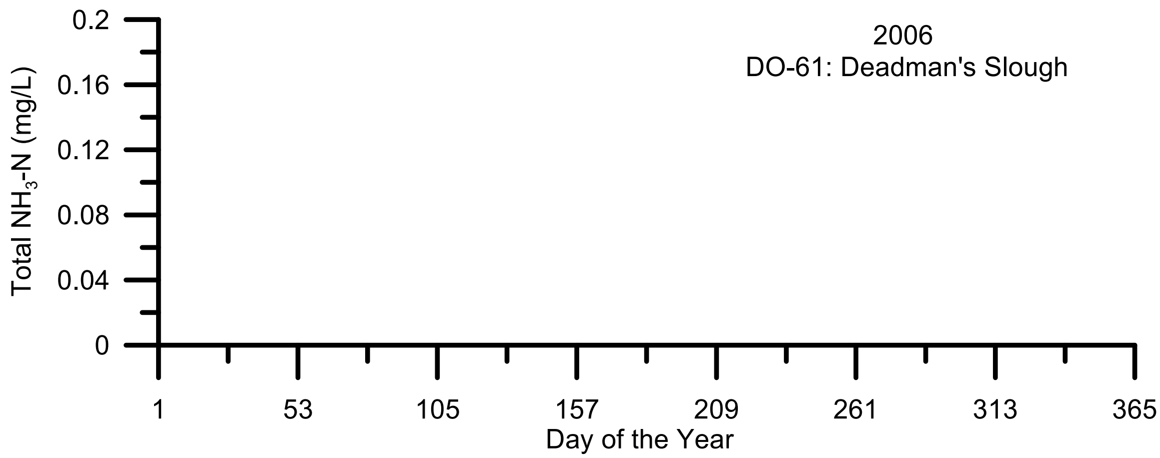

2005
DO-60: Moffit 1 South
Total NH_3-N (mg/L)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-60: Moffit 1 South
Total NH_3-N (mg/L)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

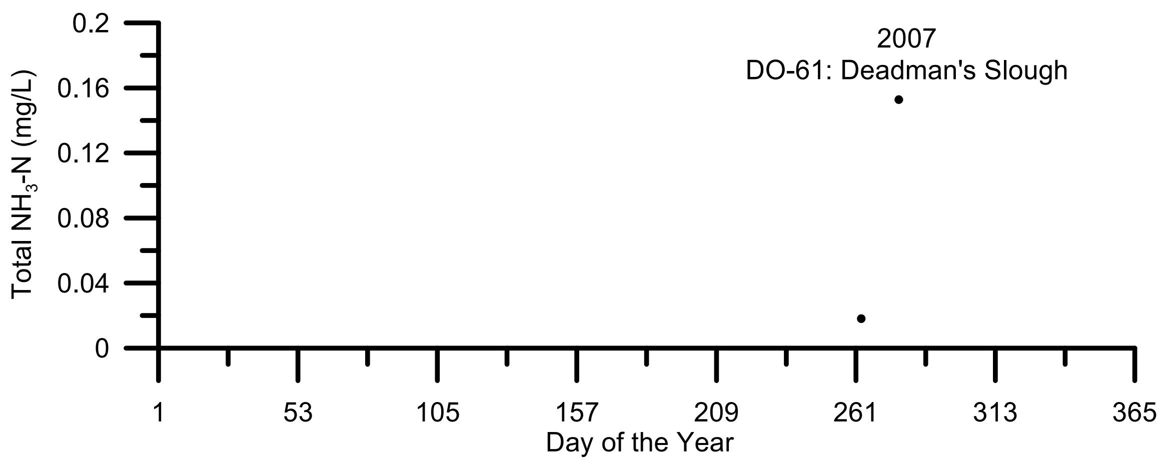

2007
DO-60: Moffit 1 South
Total NH_3-N (mg/L)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year



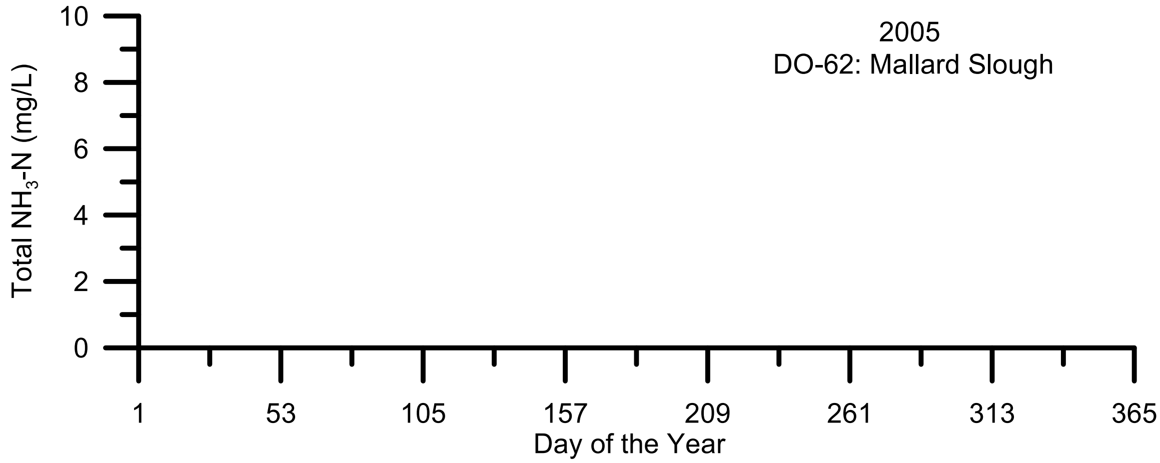
2005
DO-61: Deadman's Slough
Total NH_3-N (mg/L)
0.2
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year



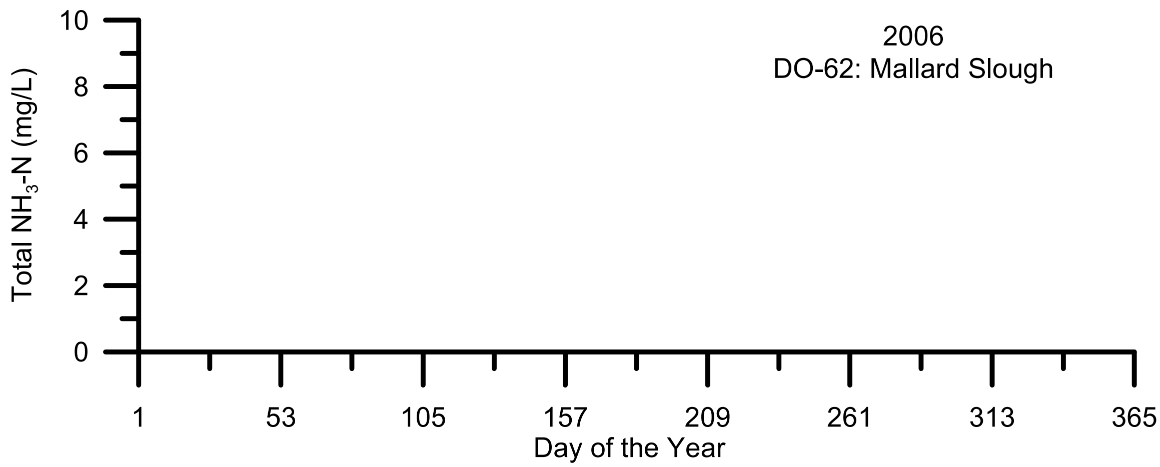
2006
DO-61: Deadman's Slough
Total NH_3-N (mg/L)
0.2
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year



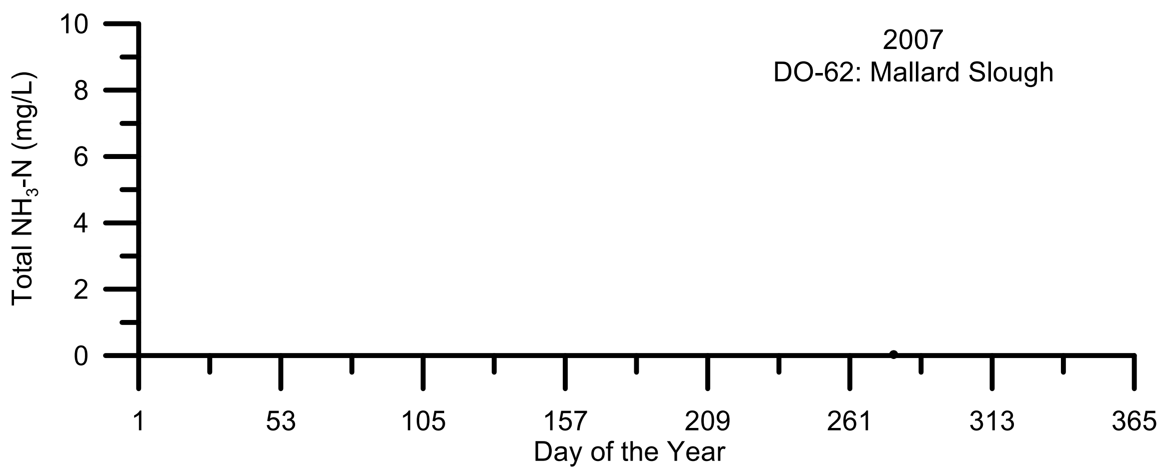
2007
DO-61: Deadman's Slough
Total NH_3-N (mg/L)
0.2
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year



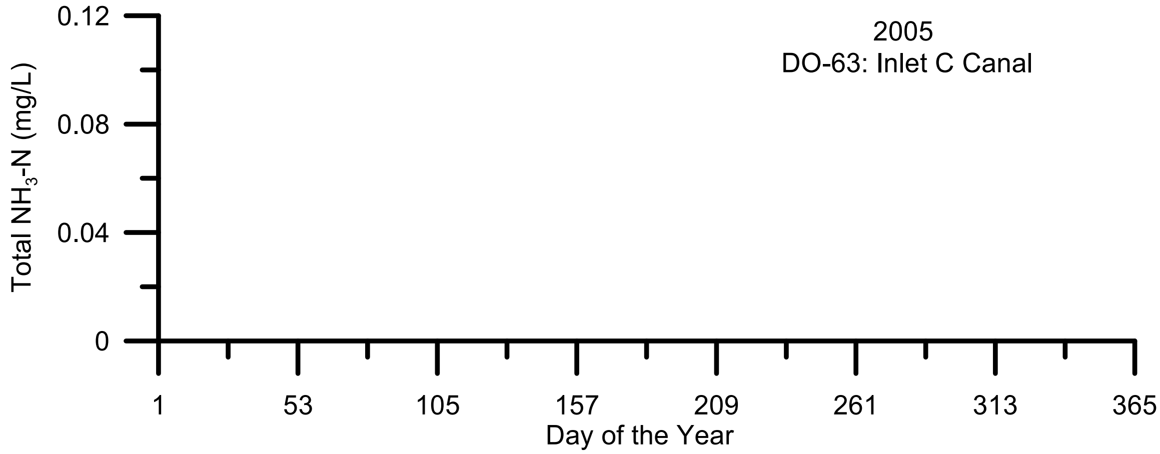
2005
DO-62: Mallard Slough
Total NH_3-N (mg/L)
Day of the Year

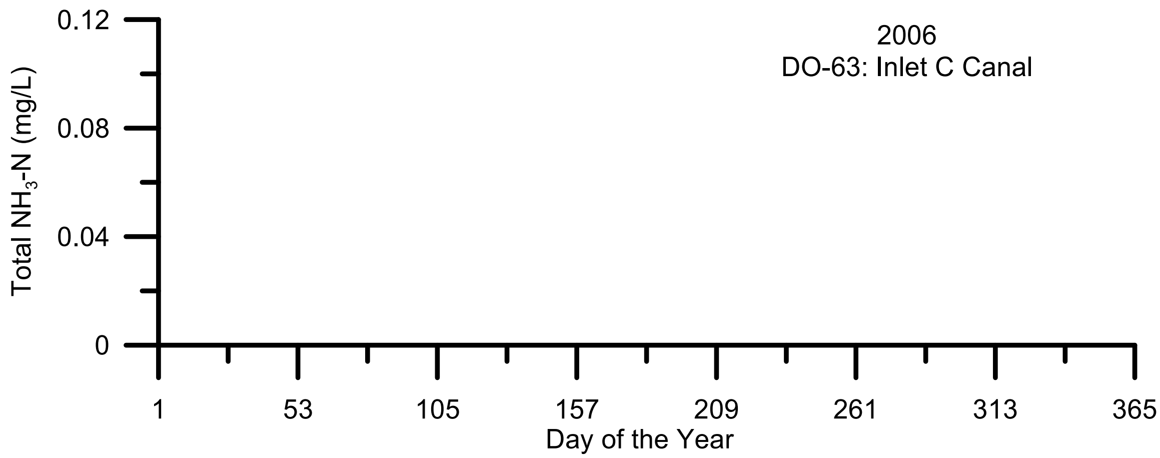


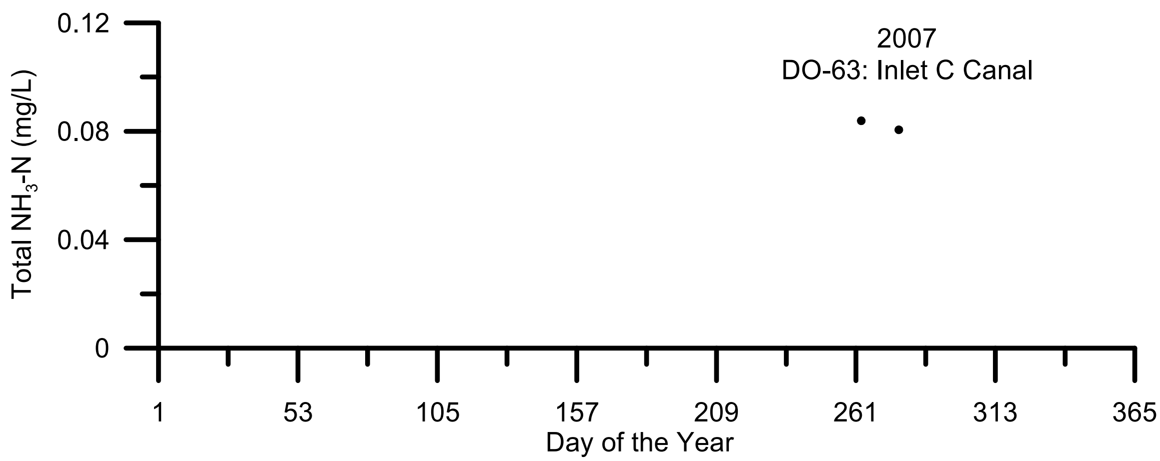
2006
DO-62: Mallard Slough
Total NH_3-N (mg/L)
Day of the Year

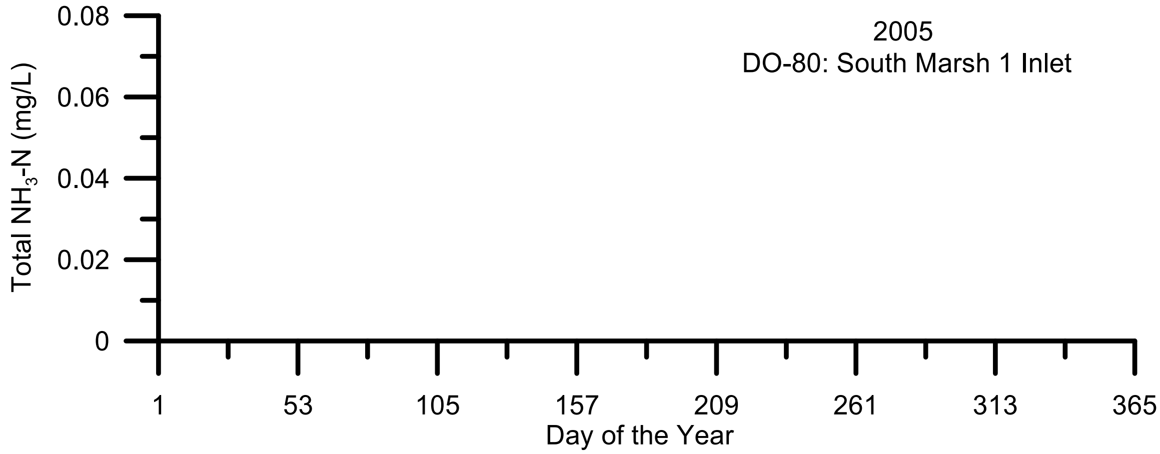


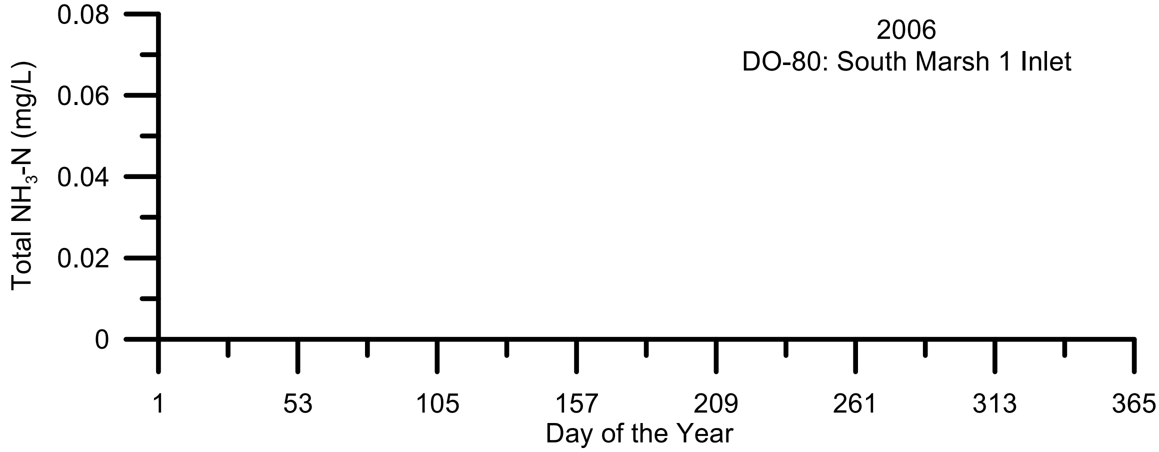
2007
DO-62: Mallard Slough
Total NH_3-N (mg/L)
Day of the Year

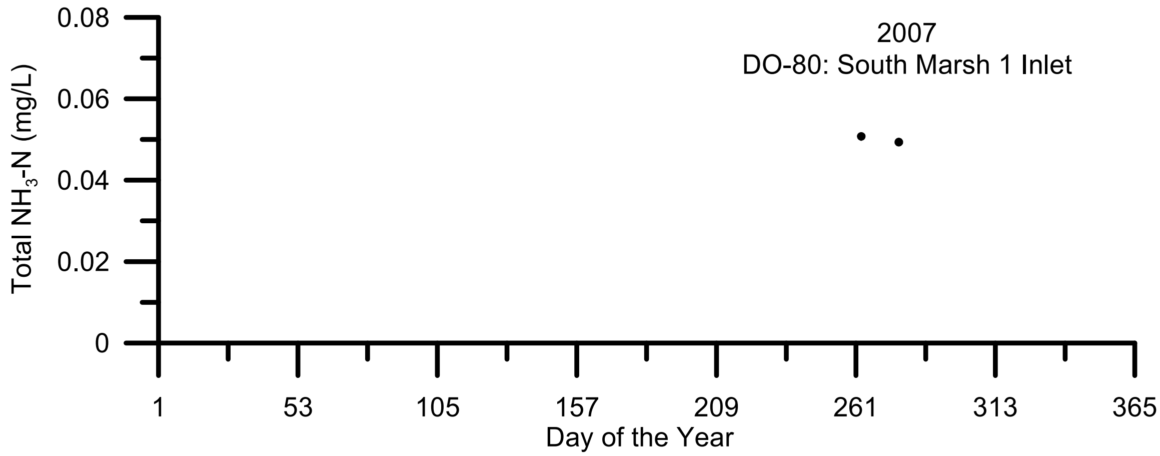

2005
DO-63: Inlet C Canal
Total NH3-N (mg/L)
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

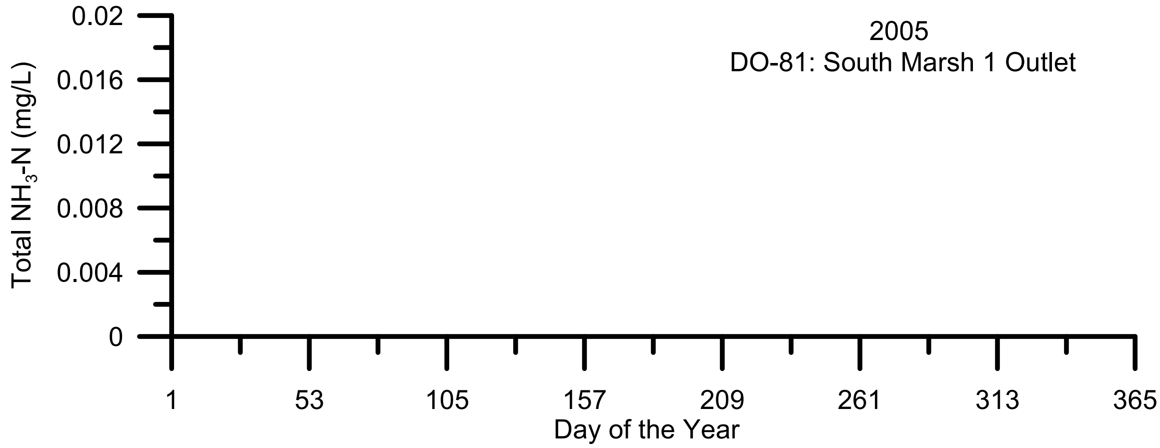

2006
DO-63: Inlet C Canal
Total NH3-N (mg/L)
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

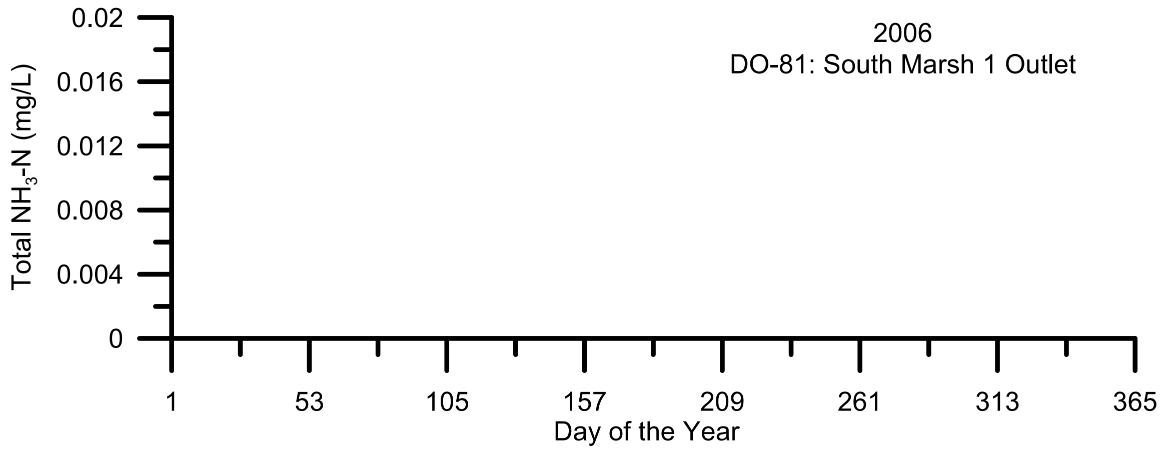

2007
DO-63: Inlet C Canal
Total NH3-N (mg/L)
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

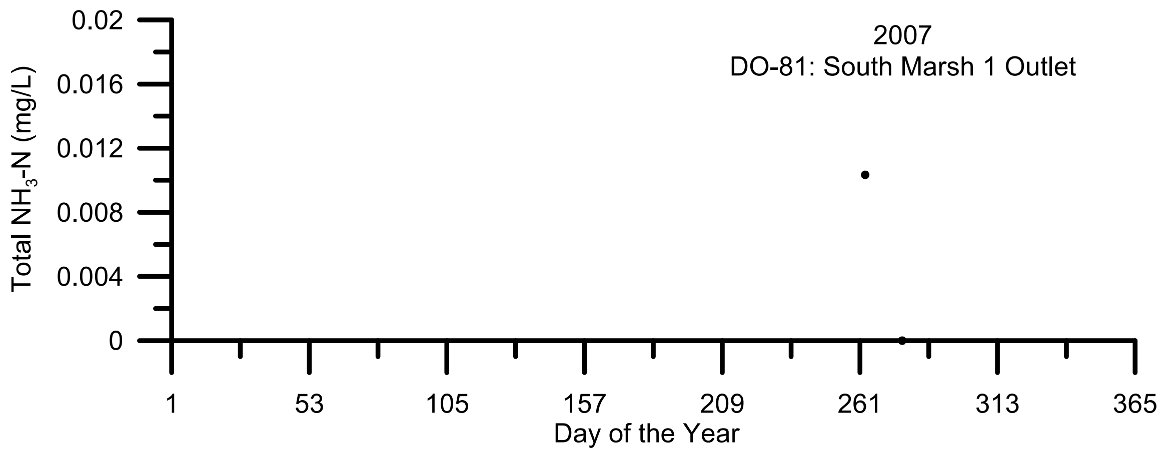

2005
DO-80: South Marsh 1 Inlet
Total NH_3-N (mg/L)
0.08
0.06
0.04
0.02
0
1
53
105
157
209
261
313
365
Day of the Year

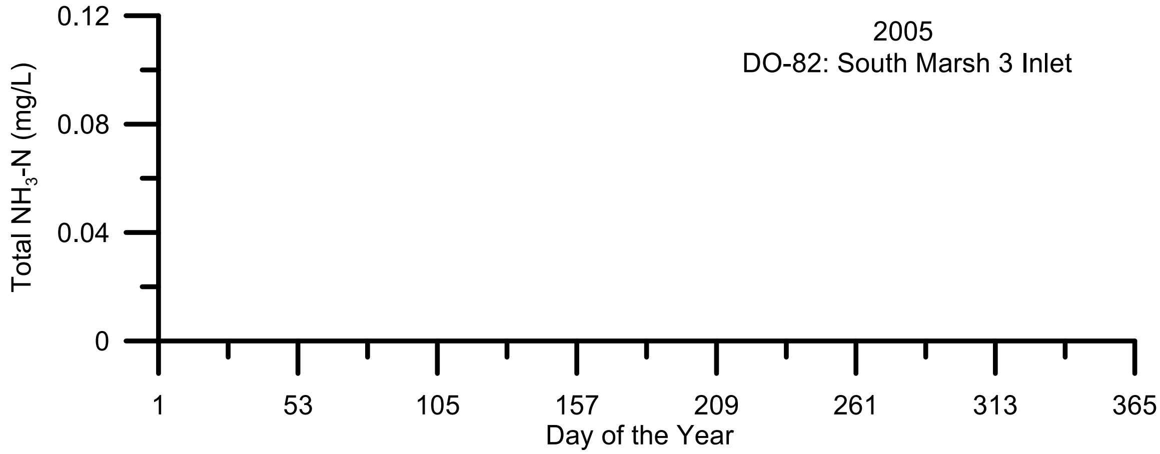

2006
DO-80: South Marsh 1 Inlet
Total NH_3-N (mg/L)
0.08
0.06
0.04
0.02
0
1
53
105
157
209
261
313
365
Day of the Year

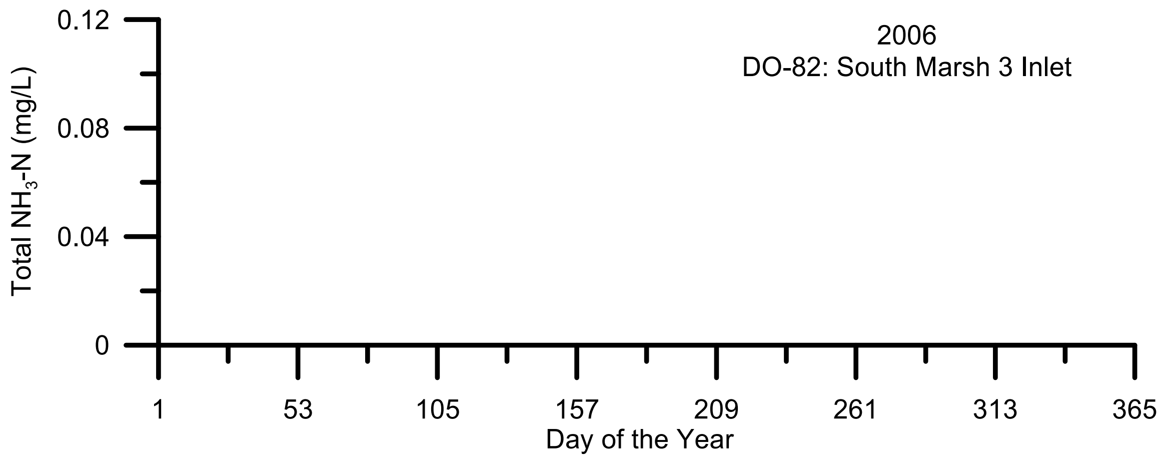

2007
DO-80: South Marsh 1 Inlet
Total NH_3-N (mg/L)
0.08
0.06
0.04
0.02
0
1
53
105
157
209
261
313
365
Day of the Year

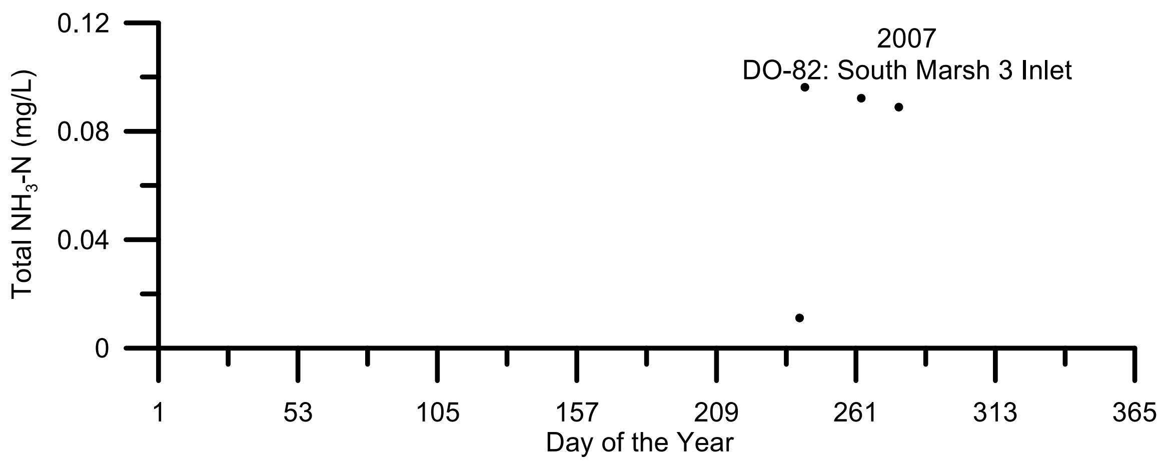

2005
DO-81: South Marsh 1 Outlet
Total NH3-N (mg/L)
0.02
0.016
0.012
0.008
0.004
0
1
53
105
157
209
261
313
365
Day of the Year

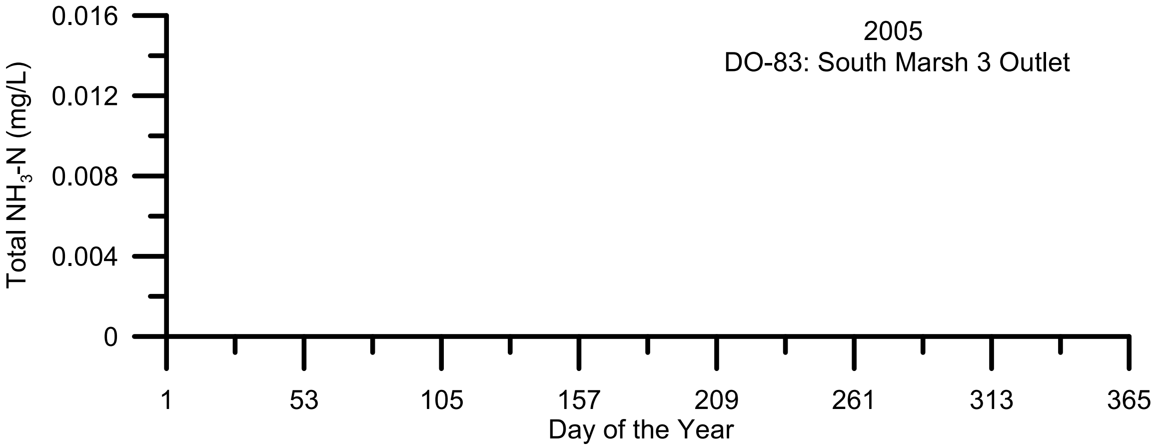

2006
DO-81: South Marsh 1 Outlet
Total NH3-N (mg/L)
0.02
0.016
0.012
0.008
0.004
0
1
53
105
157
209
261
313
365
Day of the Year

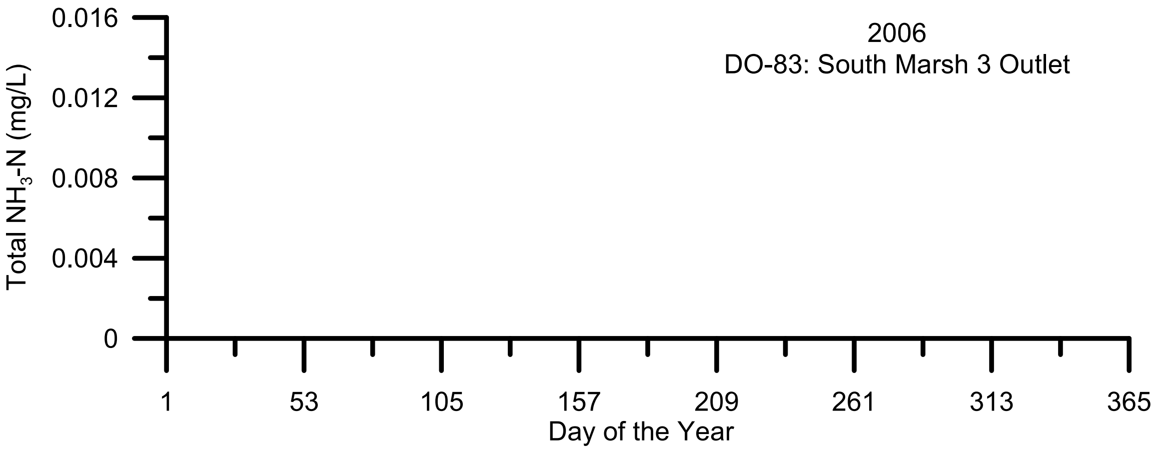

2007
DO-81: South Marsh 1 Outlet
Total NH3-N (mg/L)
0.02
0.016
0.012
0.008
0.004
0
1
53
105
157
209
261
313
365
Day of the Year

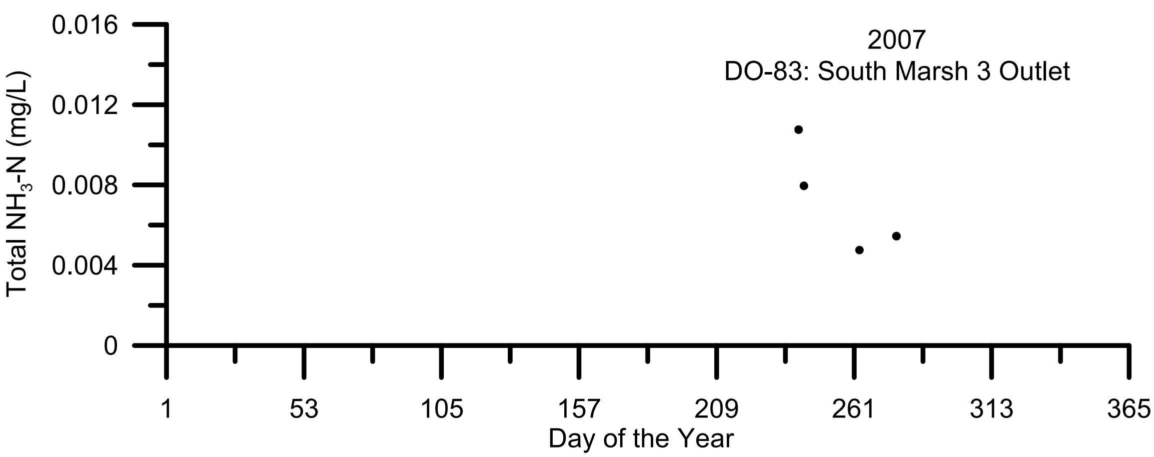

2005
DO-82: South Marsh 3 Inlet
Total NH3-N (mg/L)
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

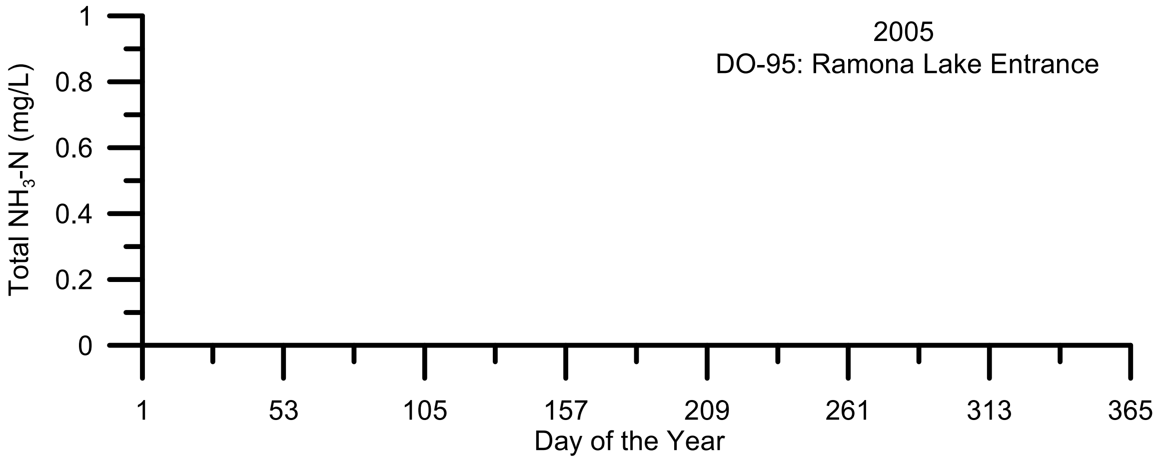

2006
DO-82: South Marsh 3 Inlet
Total NH3-N (mg/L)
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

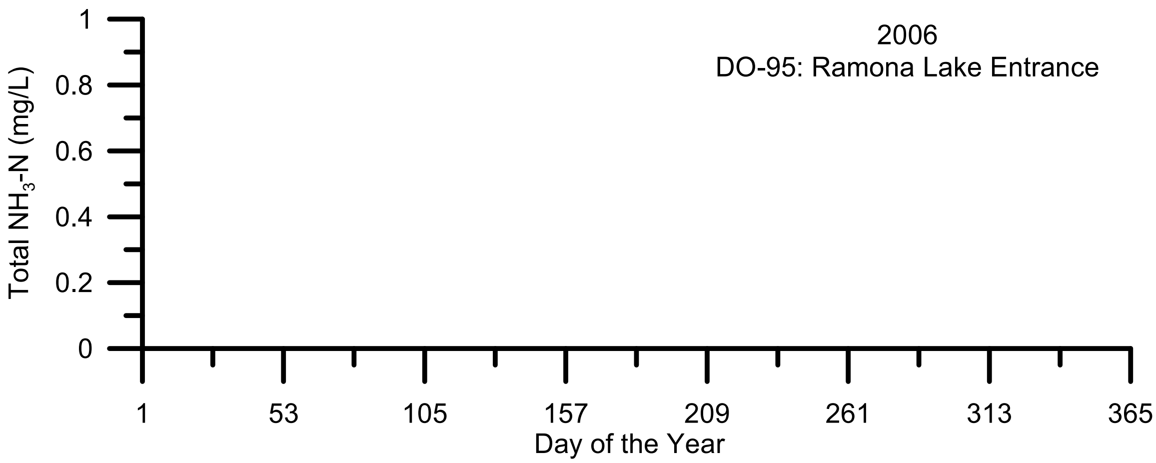

2007
DO-82: South Marsh 3 Inlet
Total NH3-N (mg/L)
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

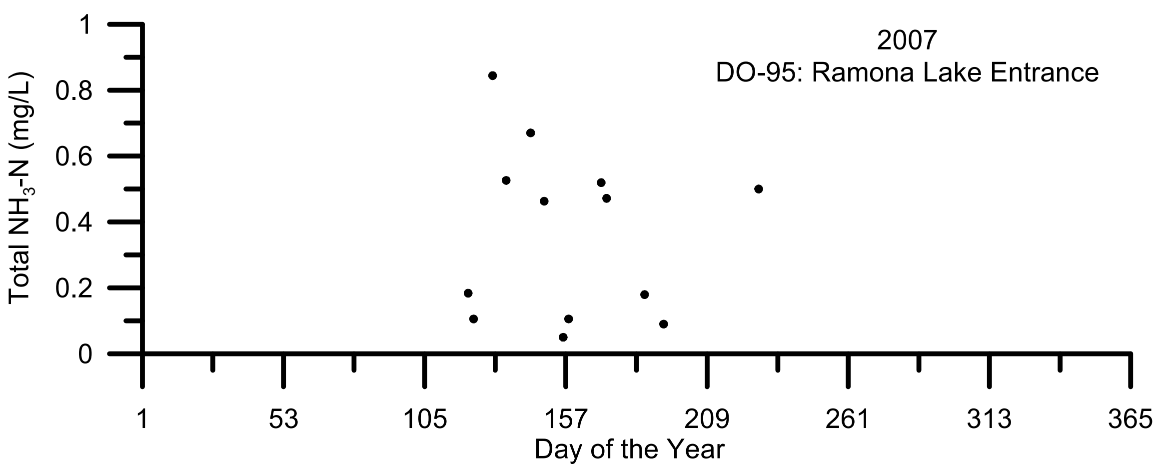

2005
DO-83: South Marsh 3 Outlet
Total NH_3-N (mg/L)
0.016
0.012
0.008
0.004
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-83: South Marsh 3 Outlet
Total NH_3-N (mg/L)
0.016
0.012
0.008
0.004
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-83: South Marsh 3 Outlet
Total NH_3-N (mg/L)
0.016
0.012
0.008
0.004
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-95: Ramona Lake Entrance
Total NH3-N (mg/L)
Day of the Year
1
53
105
157
209
261
313
365
0
0.2
0.4
0.6
0.8
1


2006
DO-95: Ramona Lake Entrance
Total NH3-N (mg/L)
Day of the Year
1
53
105
157
209
261
313
365
0
0.2
0.4
0.6
0.8
1


2007
DO-95: Ramona Lake Entrance
Total NH3-N (mg/L)
Day of the Year
1
53
105
157
209
261
313
365
0
0.2
0.4
0.6
0.8
1

UNIVERSITY OF THE
PACIFIC
Environmental Engineering
Research Program

Analysis of Volatile Suspended Solid Concentrations in the San Joaquin River Watershed
2005-2007

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Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 sampling locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report presents temporal plots of volatile suspended solids (VSS) for all sites sampled in the SJR from 2005-2007.

Methods

Field sampling consisted of collecting water samples, measuring water quality with a YSI Sonde 6600 with MDS650 hand-held display, and recording of field conditions at sites within the study area per *EERP Field Protocol Book* (Graham, 2008).

Water samples were collected in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN) in accordance with requirements for different lab analysis and volume requirements.

Samples were immediately stored at 4°C after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the lab on the day of sampling.

Samples were received by the laboratory the same day they were sampled and stored at 4°C until filtering and analysis. Samples were collected, preserved, stored, and analyzed by methods outlined in *Standard Methods for the Analysis of Water and Wastewater*, (APHA, 2005, 1998). Total suspended solids (TSS) and volatile suspended solids (VSS) were analyzed by SM 2540 D and E (APHA, 2005). Typically 1000 mL of sample was filtered on pre-weighed, pre-combusted, Whatman GF/F filters. The filters were placed in an aluminum dish and dried at 105°C under vacuum to constant weight. After drying the filter and dish were allowed to cool in a dessicator and were weighed for TSS determination. The dried and weighted filters were subsequently combusted at 550°C for 6 hours and reweighed for VSS determination. Mineral suspended solids (MSS) concentration was calculated by subtracting VSS from TSS.

Results and Discussion

Volatile suspended solids (VSS) analysis was preformed routinely over the years 2005-2007 with no modification to the standard method (APHA, 2005). A 94.44% passage rate for all QA parameters over the three years was observed (Borglin et. al., 2008).

References

Stringfellow, W.T., et al., (2008), *Evaluation of Vegetated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley*, University of the Pacific, Stockton, CA

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008), *EERP Field Protocol Book*, University of the Pacific, Stockton, CA.

Borglin, S., W. Stringfellow, J. Hanlon. (2005), Standard *Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project*, LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA

American Public Health Association, (2005), *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, Washington, D.C.

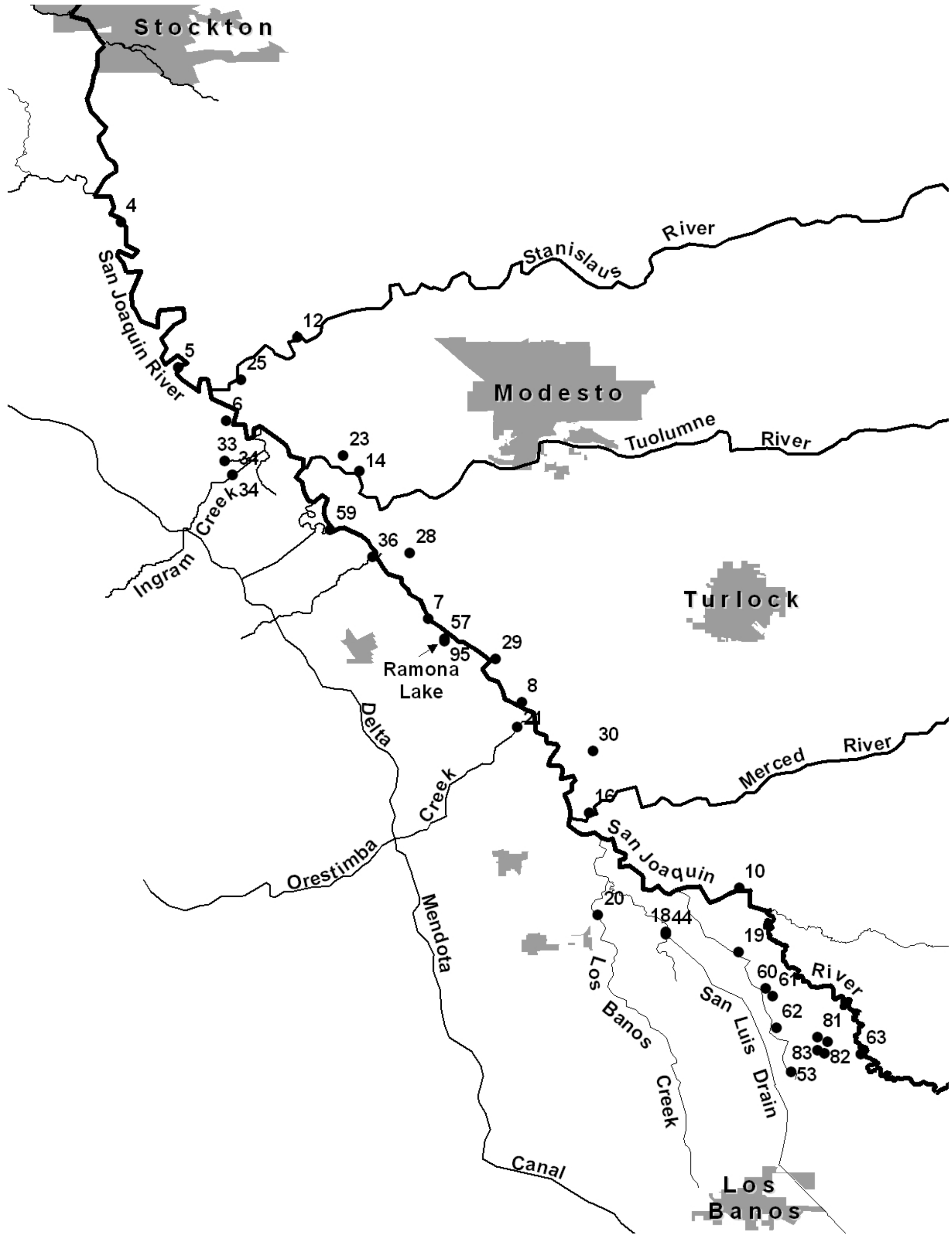
Borglin, S.E., Burks, R.D., Hanlon, J.S., Stringfellow, W.T. (2008*) EERP Lab Protocol Book*, University of the Pacific, Stockton, CA.

YSI Environmental Operations Manual, (2005), 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

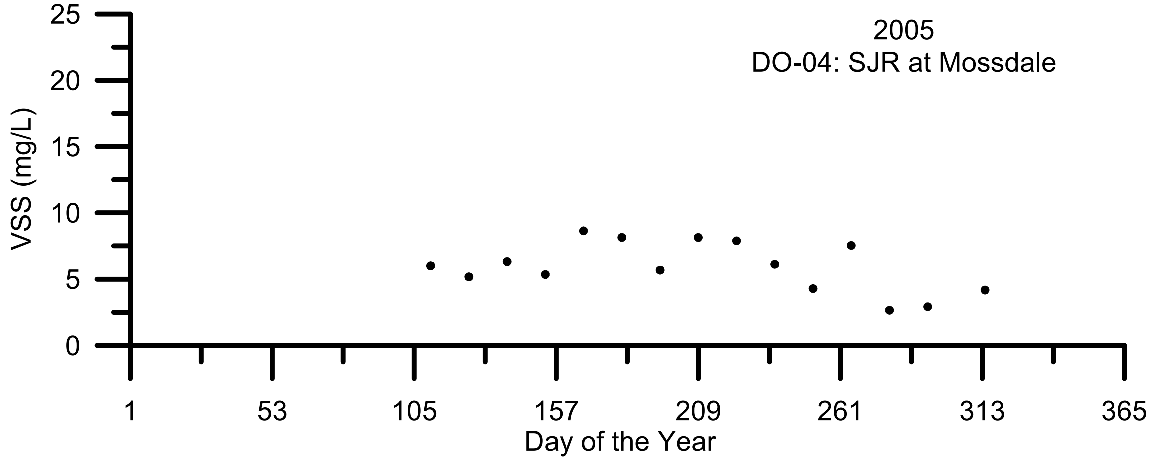
Table 1: EERP Sampling Site List

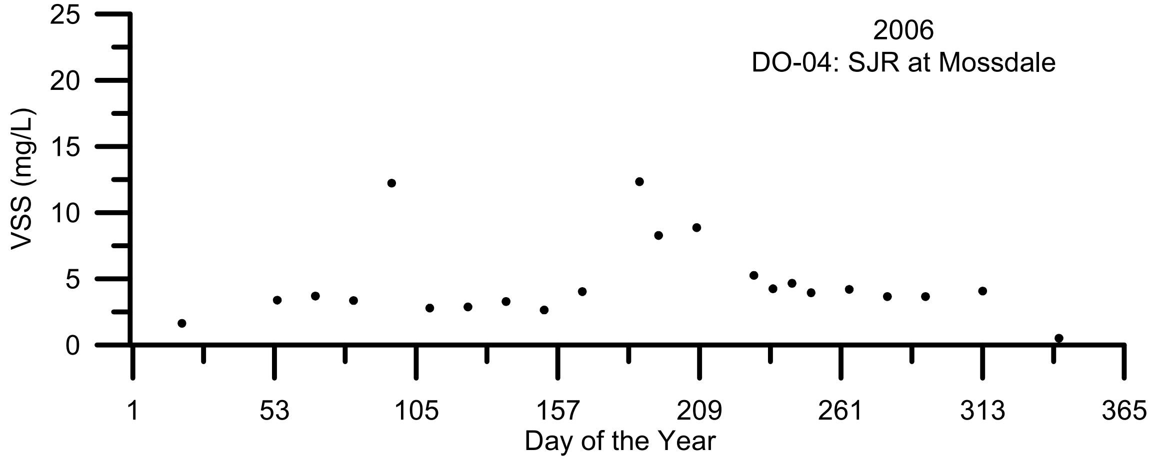
DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
53	**Salt Slough at Wolfsen Road**	Wetland
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
60	**Moffit 1 South**	Wetland
61	**Deadman's Slough**	Wetland
62	**Mallard Slough**	Wetland
63	**Inlet C Canal**	Wetland
80	**South Marsh-1-Inlet**	Wetland
81	**South Marsh-1-Outlet**	Wetland
82	**South Marsh-3-Inlet**	Wetland
83	**South Marsh-3-Outlet**	Wetland
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

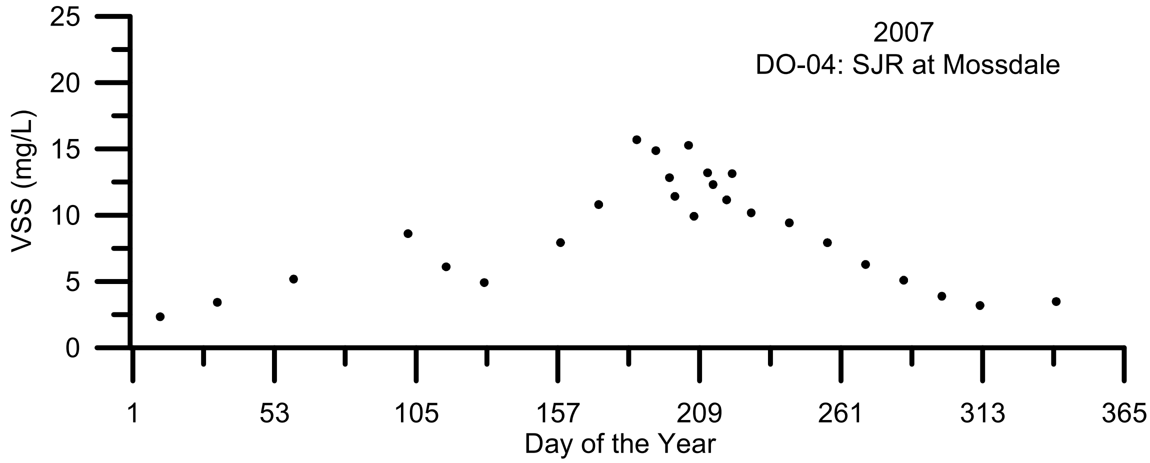
Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

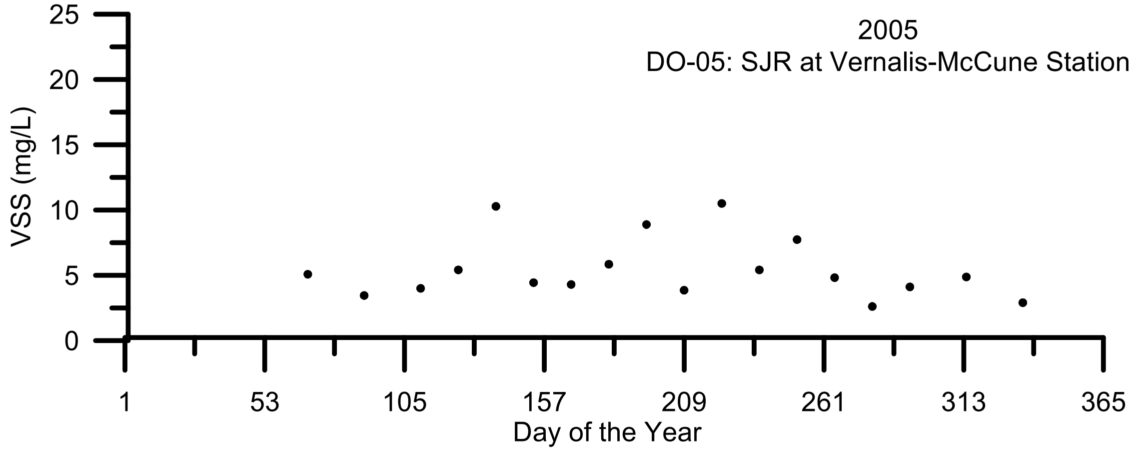


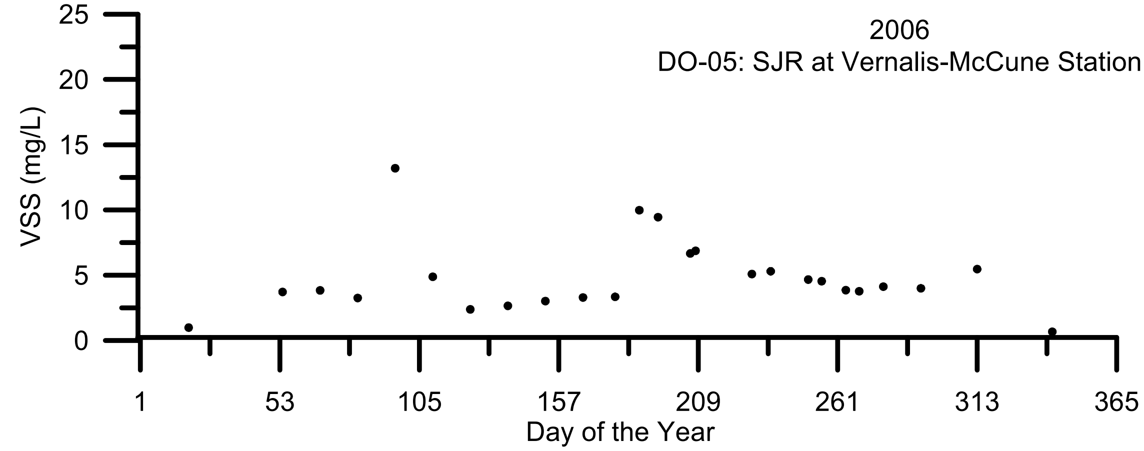
Figures 2 -101: Temporal Plots of VSS Concentrations By Site ID

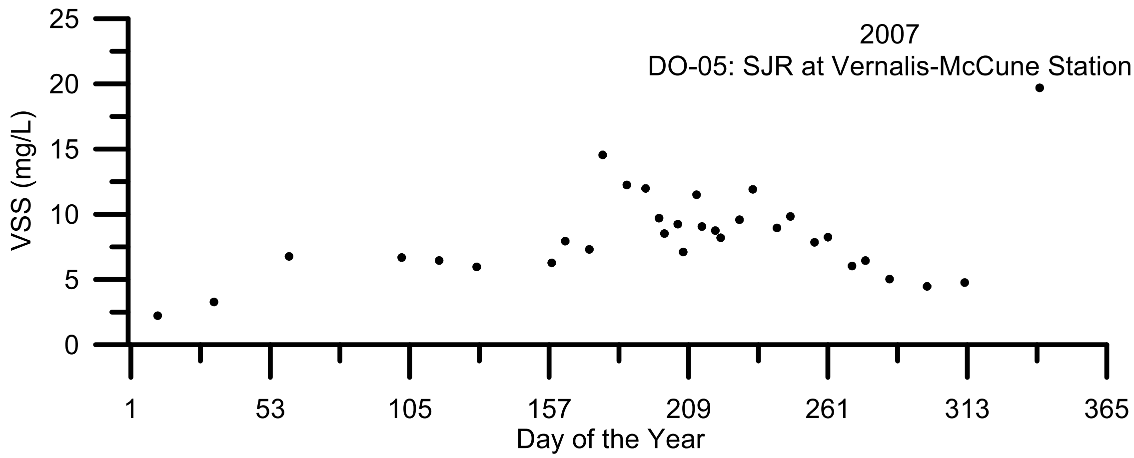


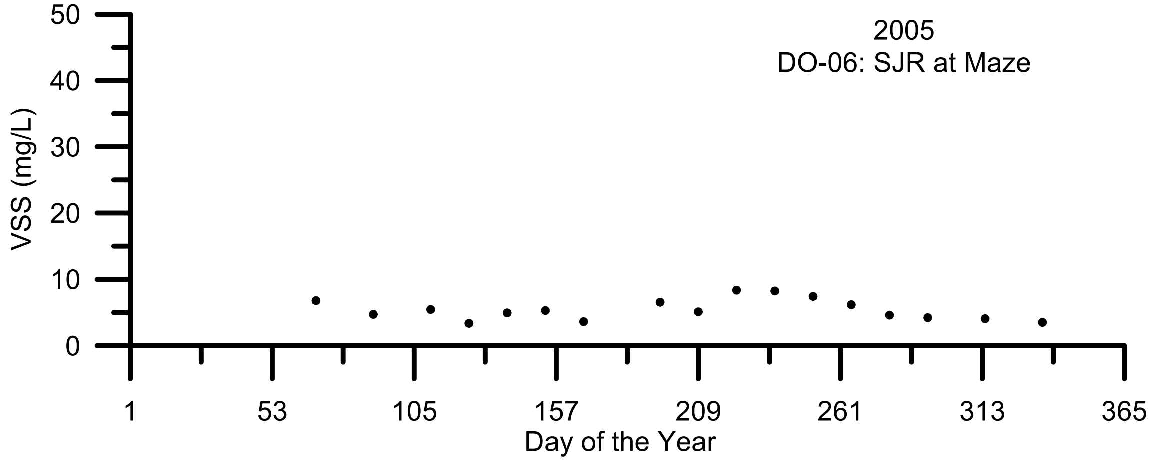


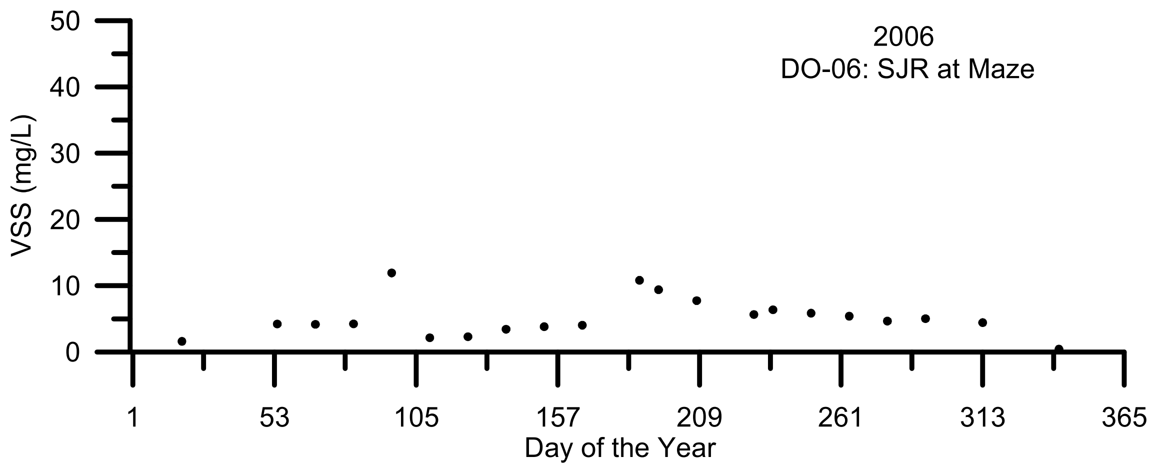


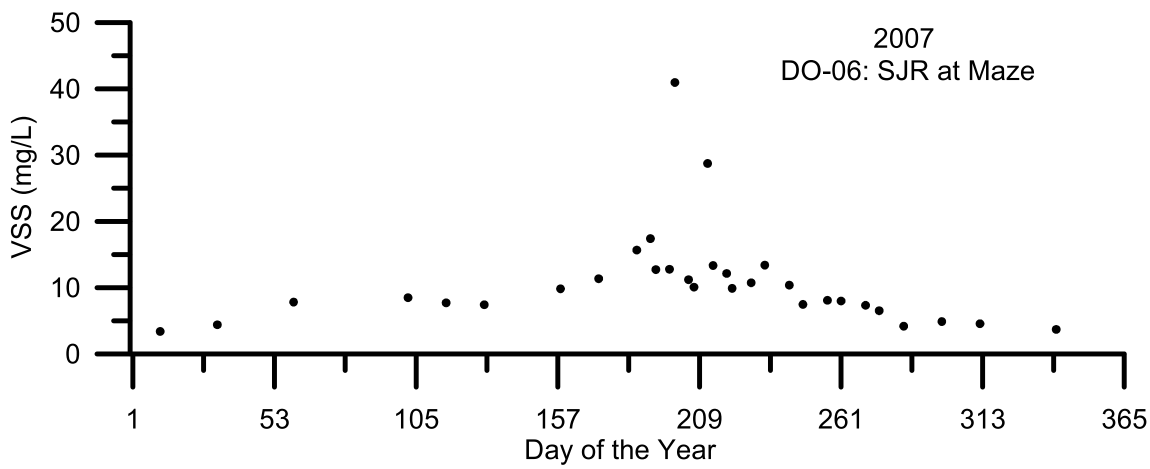

2005
DO-05: SJR at Vernalis-McCune Station
VSS (mg/L)
Day of the Year
0
5
10
15
20
25
1
53
105
157
209
261
313
365

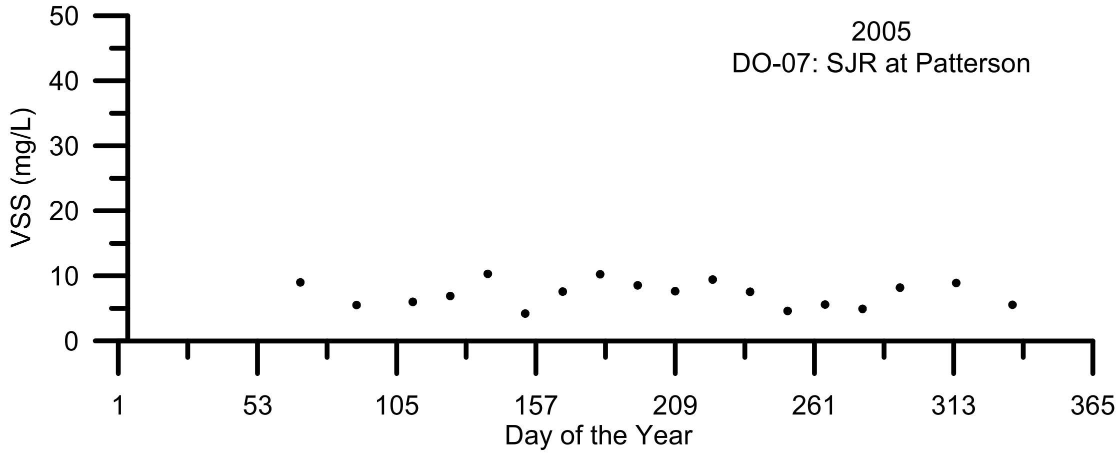

2006
DO-05: SJR at Vernalis-McCune Station
VSS (mg/L)
Day of the Year
0
5
10
15
20
25
1
53
105
157
209
261
313
365


2007
DO-05: SJR at Vernalis-McCune Station
VSS (mg/L)
Day of the Year
0
5
10
15
20
25
1
53
105
157
209
261
313
365


2005
DO-06: SJR at Maze
VSS (mg/L)
50
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-06: SJR at Maze
VSS (mg/L)
50
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-06: SJR at Maze
VSS (mg/L)
50
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-07: SJR at Patterson
VSS (mg/L)
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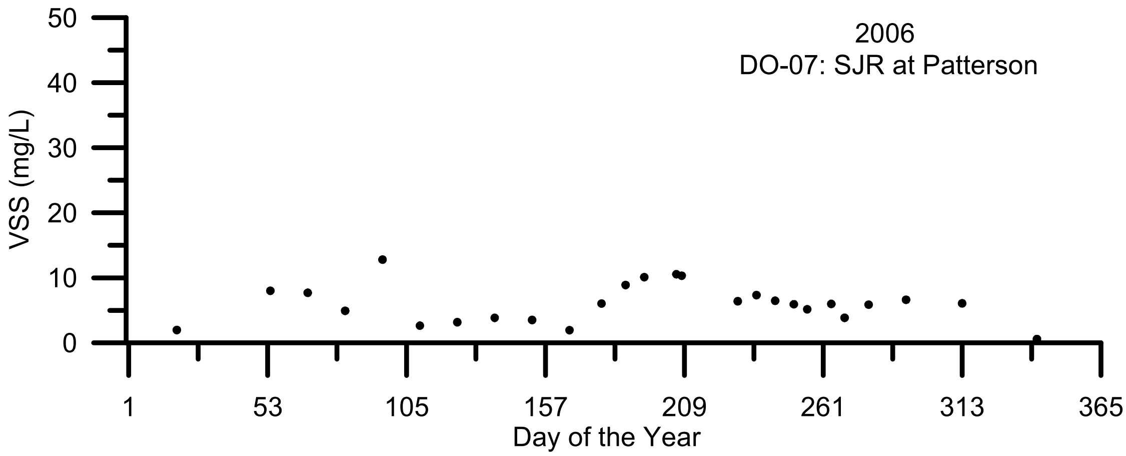
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-07: SJR at Patterson
VSS (mg/L)
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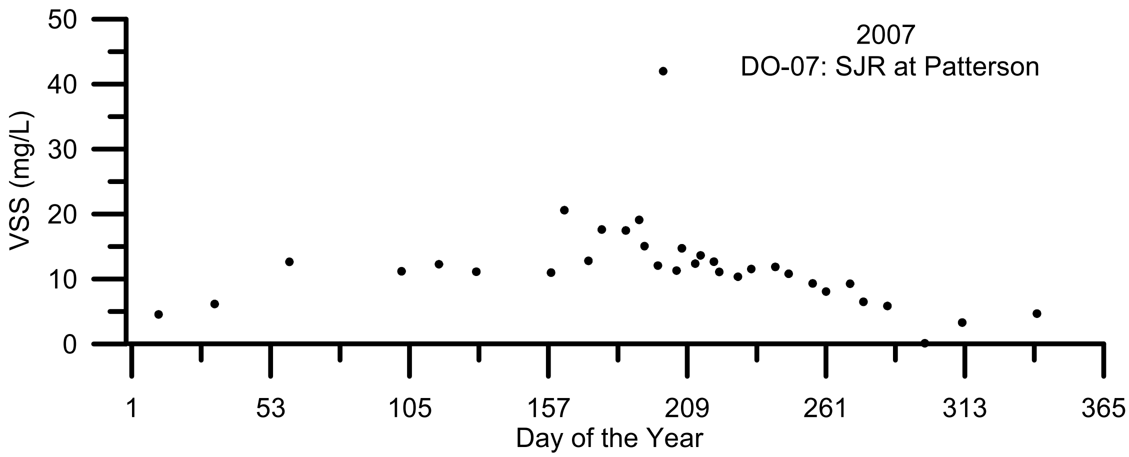
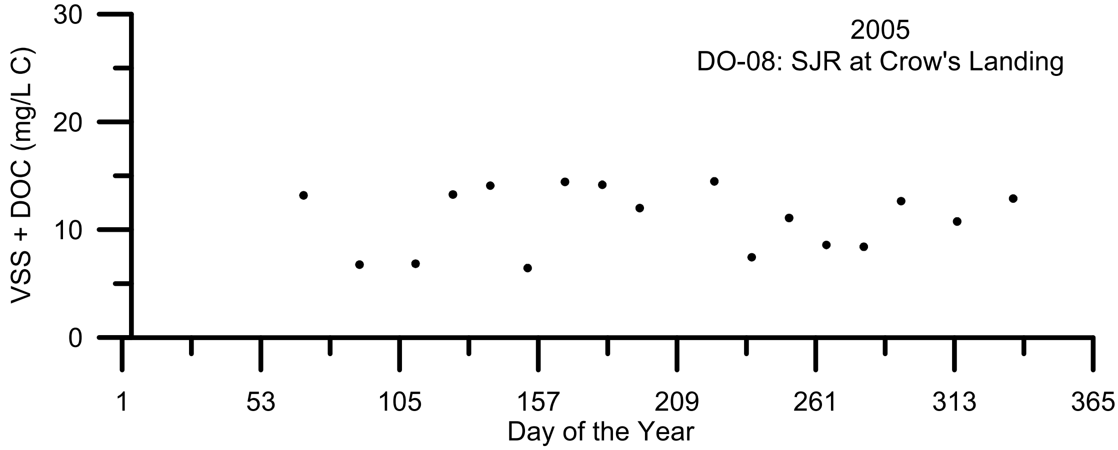
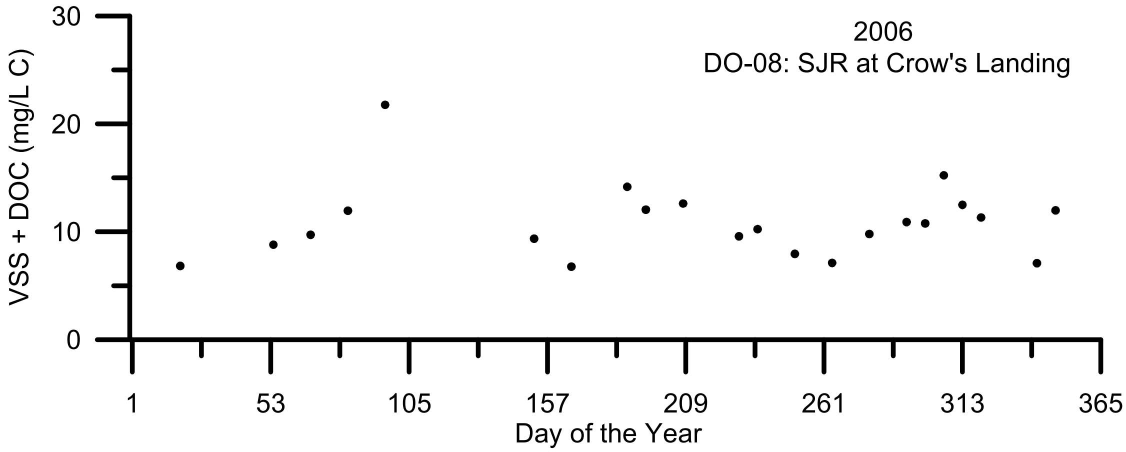
209
261
313
365
Day of the Year

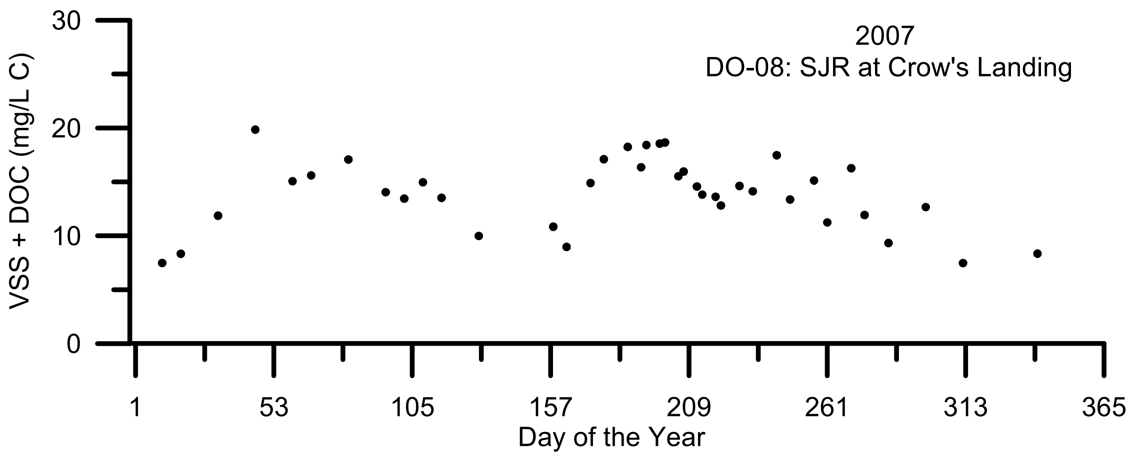

2007
DO-07: SJR at Patterson
VSS (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year



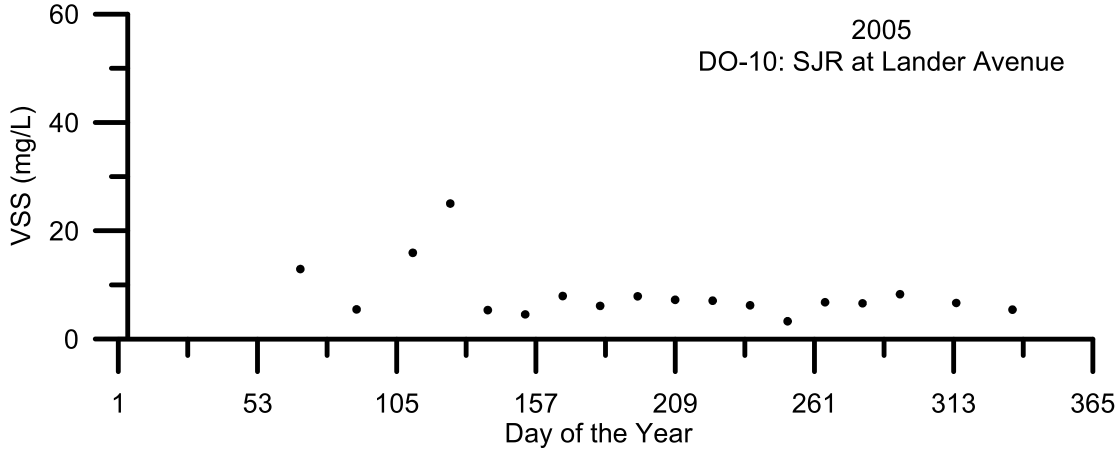
2005
DO-08: SJR at Crow's Landing
VSS + DOC (mg/L C)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

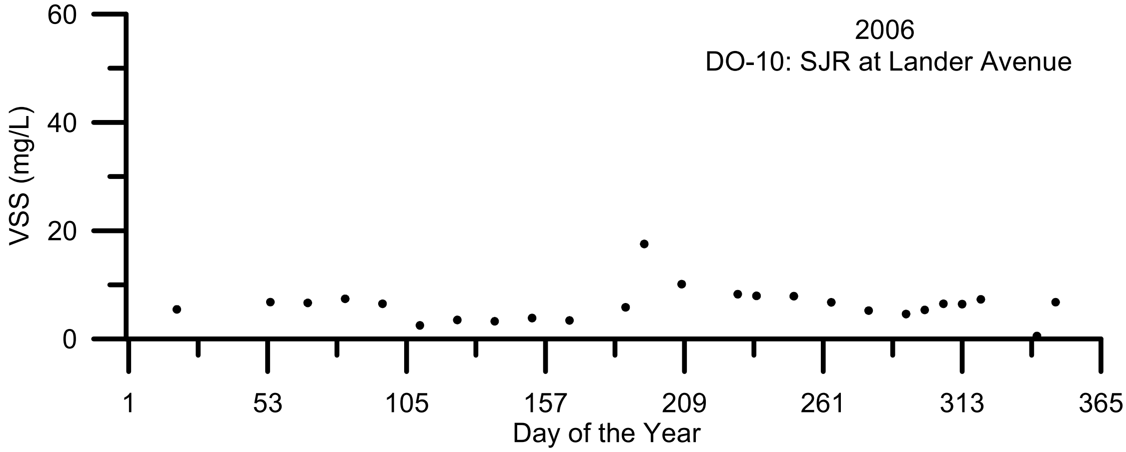


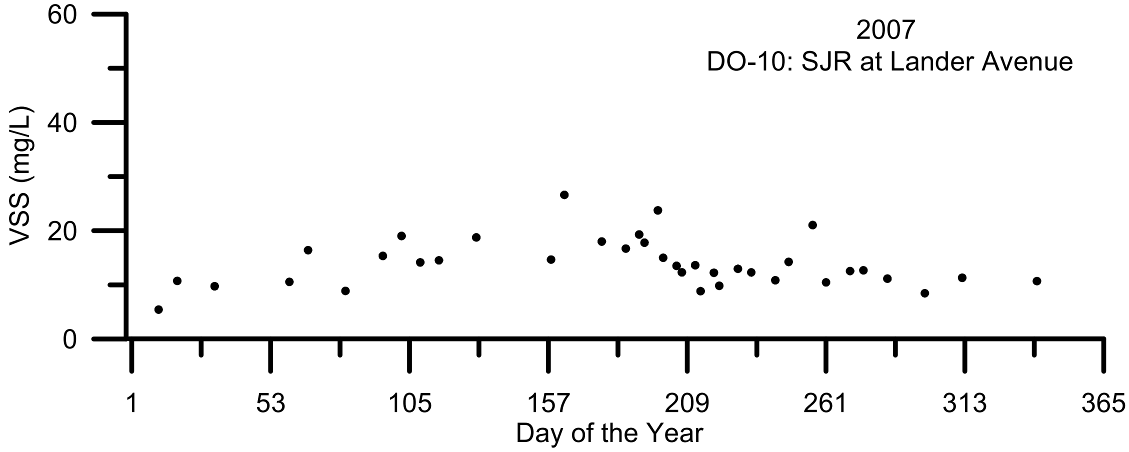
2006
DO-08: SJR at Crow's Landing
VSS + DOC (mg/L C)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

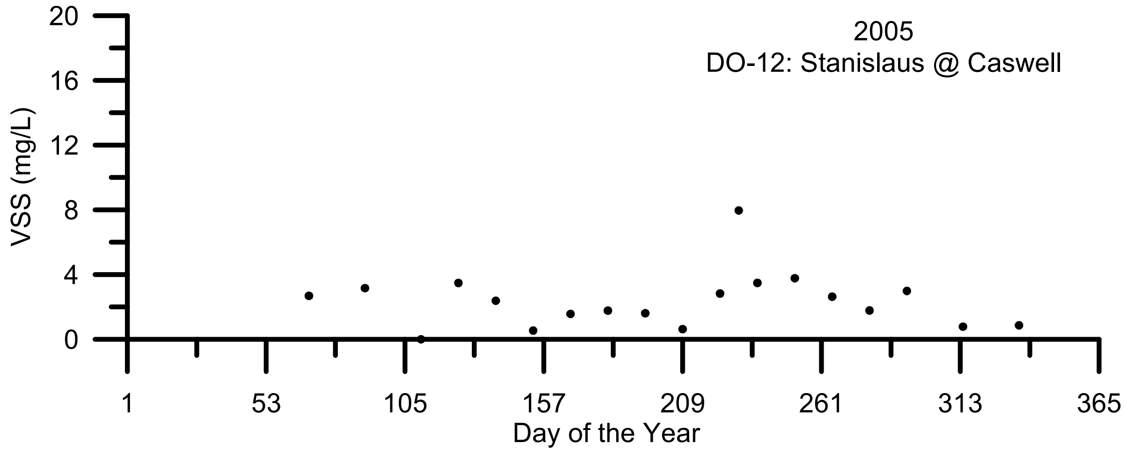


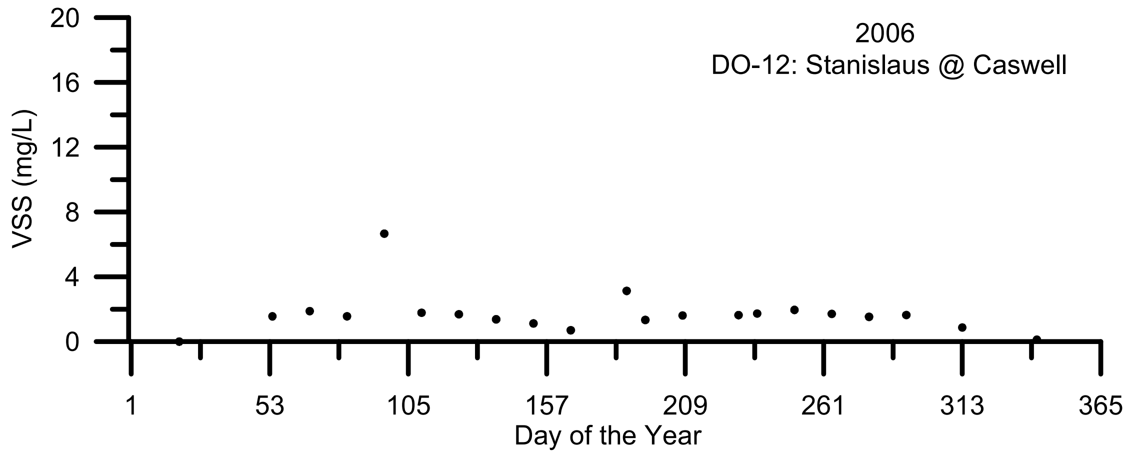
2007
DO-08: SJR at Crow's Landing
VSS + DOC (mg/L C)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-10: SJR at Lander Avenue
VSS (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-10: SJR at Lander Avenue
VSS (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-10: SJR at Lander Avenue
VSS (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-12: Stanislaus @ Caswell
VSS (mg/L)
Day of the Year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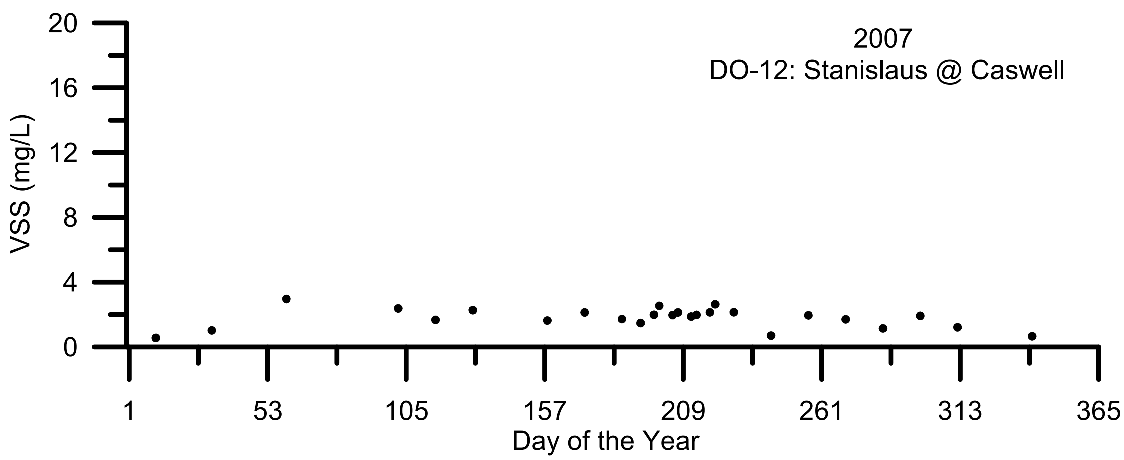
DO-12: Stanislaus @ Caswell
VSS (mg/L)
Day of the Year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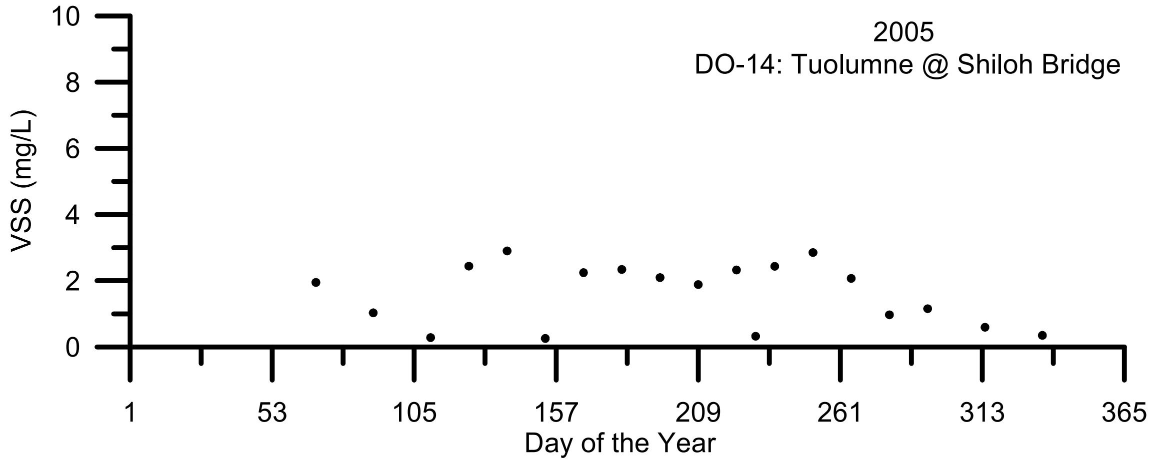
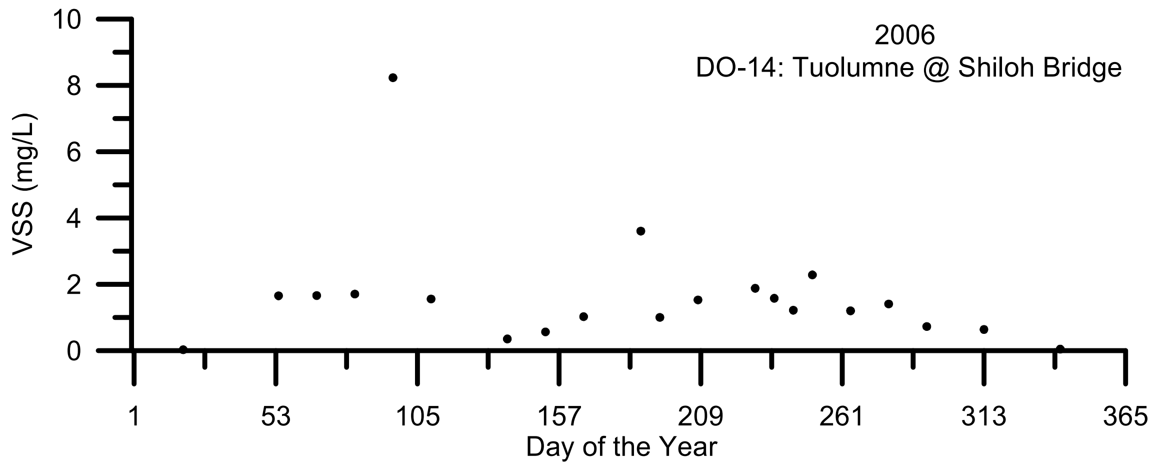
DO-12: Stanislaus @ Caswell
VSS (mg/L)
Day of the Year


2005
DO-14: Tuolumne @ Shiloh Bridge
VSS (mg/L)
Day of the Year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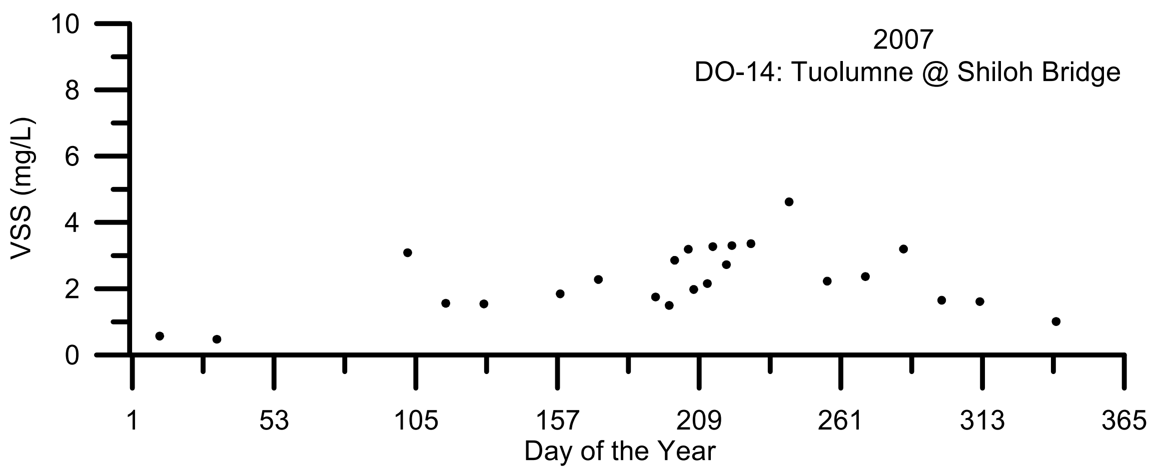
DO-14: Tuolumne @ Shiloh Bridge
VSS (mg/L)
Day of the Year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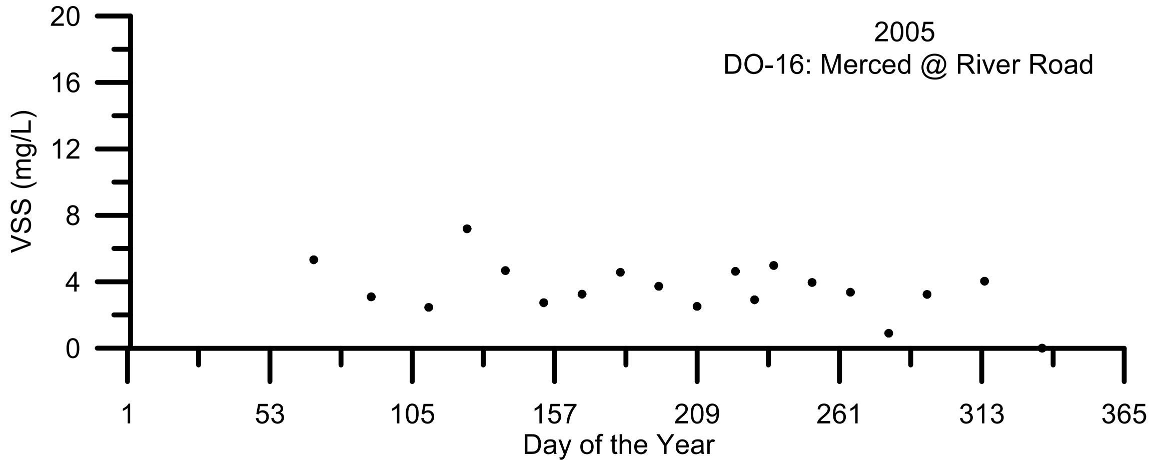
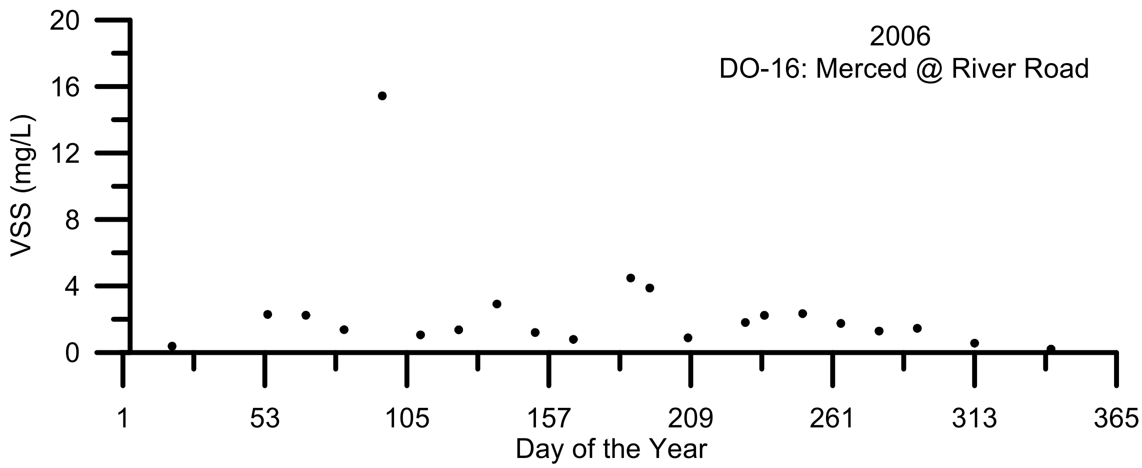
DO-14: Tuolumne @ Shiloh Bridge
VSS (mg/L)
Day of the Year


2005
DO-16: Merced @ River Road
VSS (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-16: Merced @ River Road
VSS (mg/L)
20
16
12
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0
1
53
105
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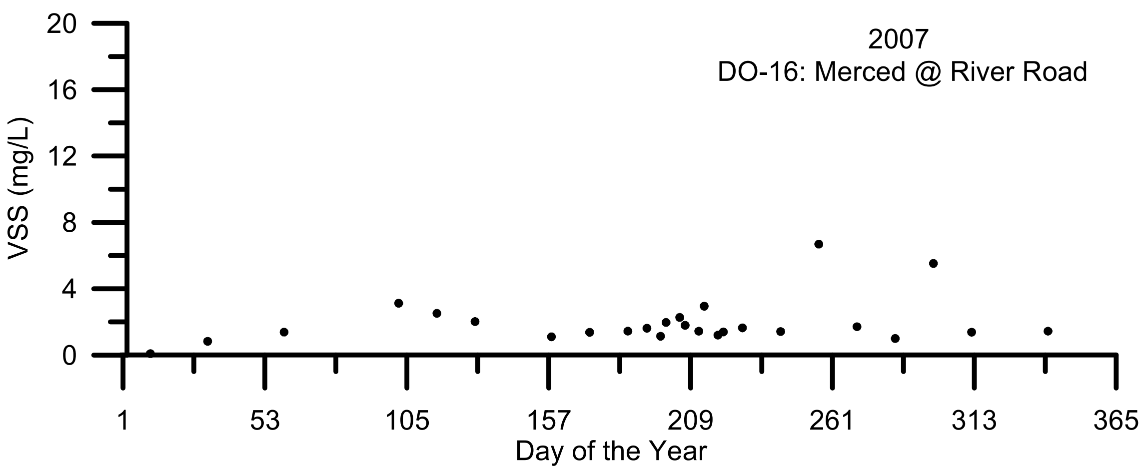
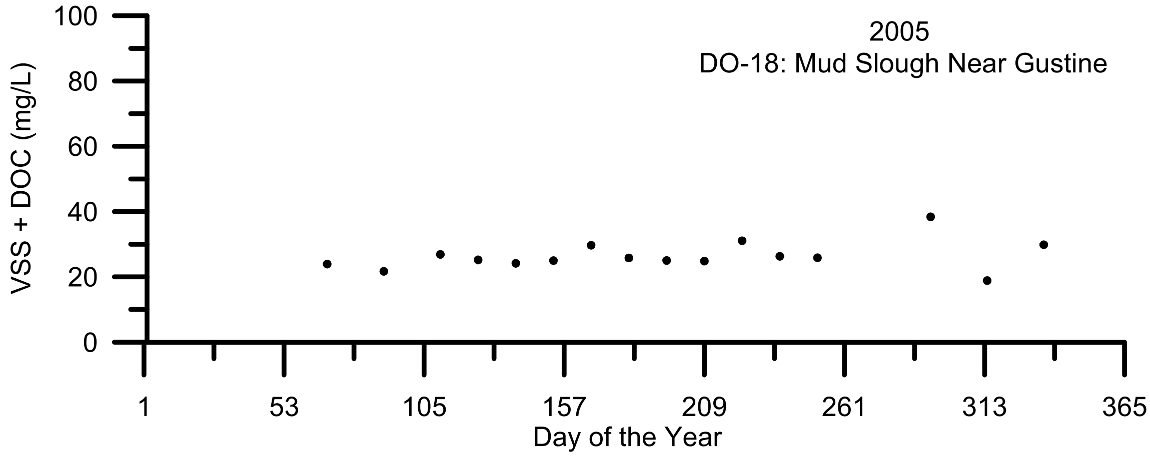
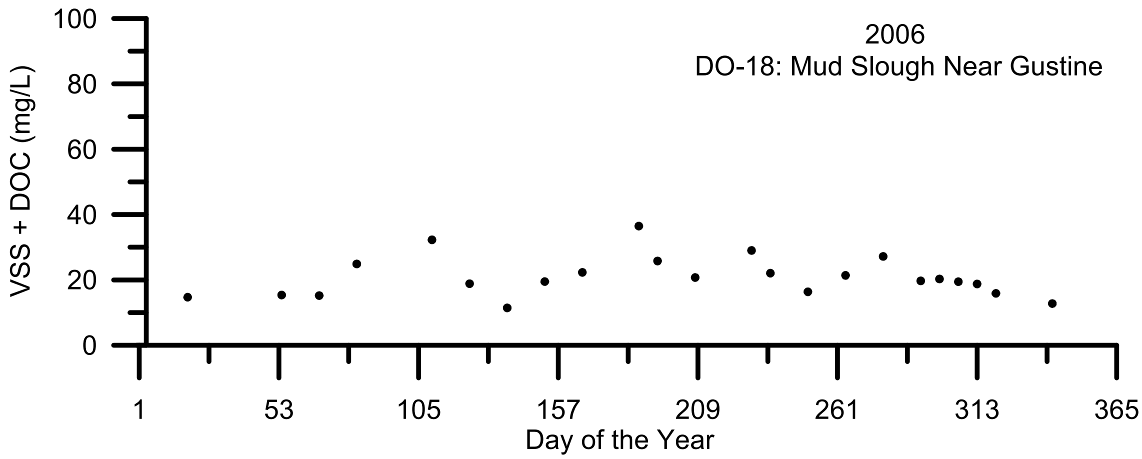
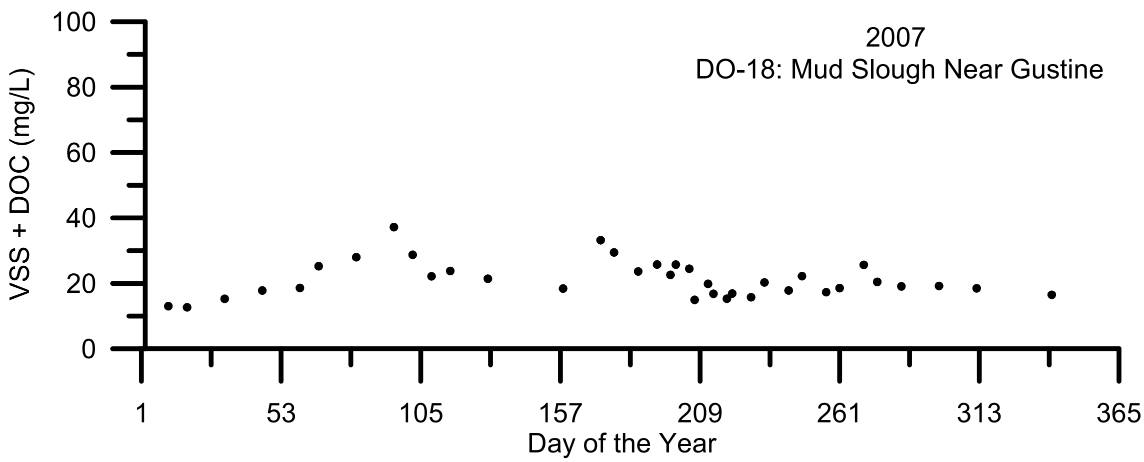
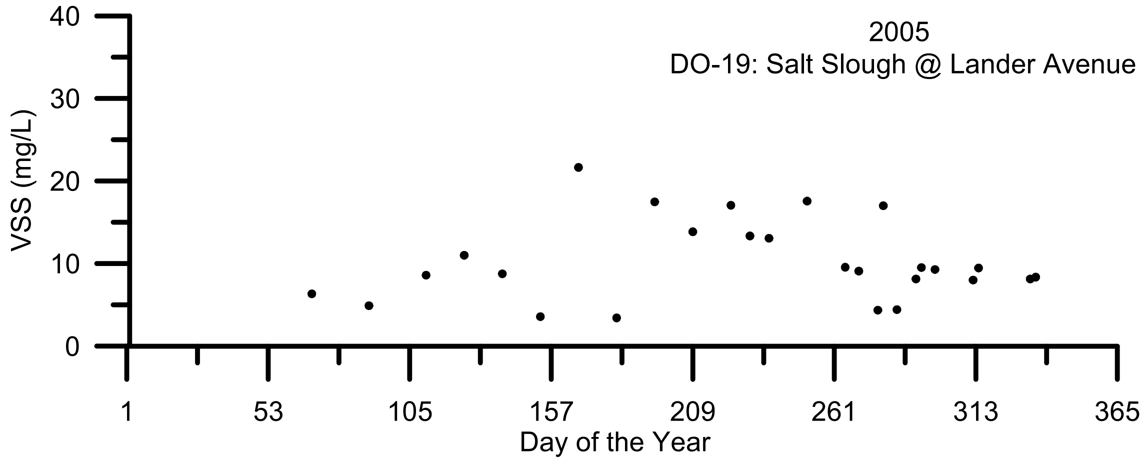
261
313
365
Day of the Year


2007
DO-16: Merced @ River Road
VSS (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

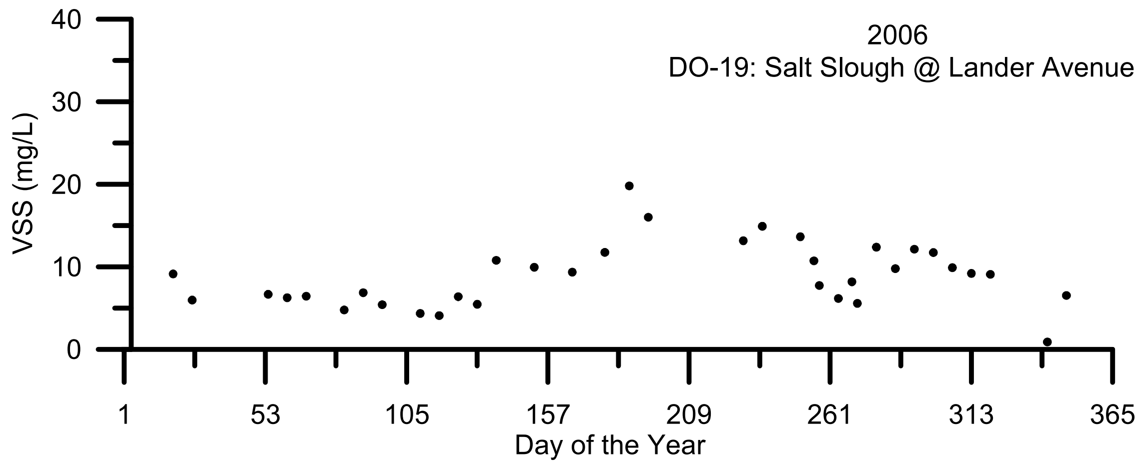

2005
DO-18: Mud Slough Near Gustine
VSS + DOC (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-18: Mud Slough Near Gustine
VSS + DOC (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

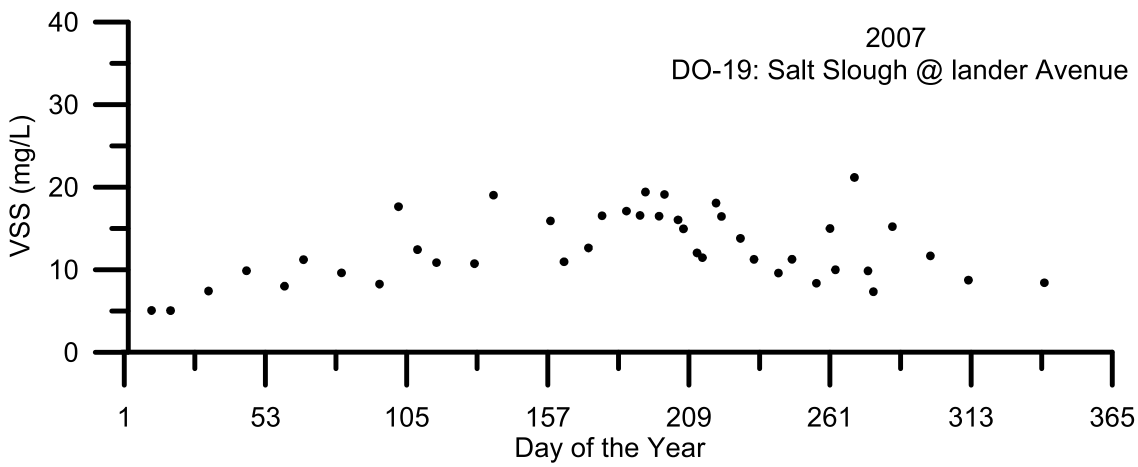

2007
DO-18: Mud Slough Near Gustine
VSS + DOC (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year



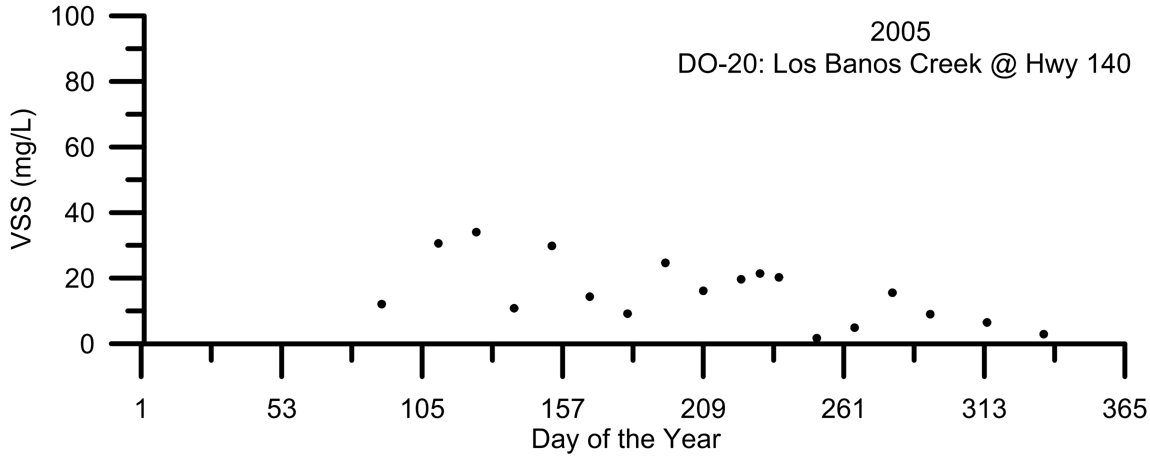
2005
DO-19: Salt Slough @ Lander Avenue
VSS (mg/L)
Day of the Year

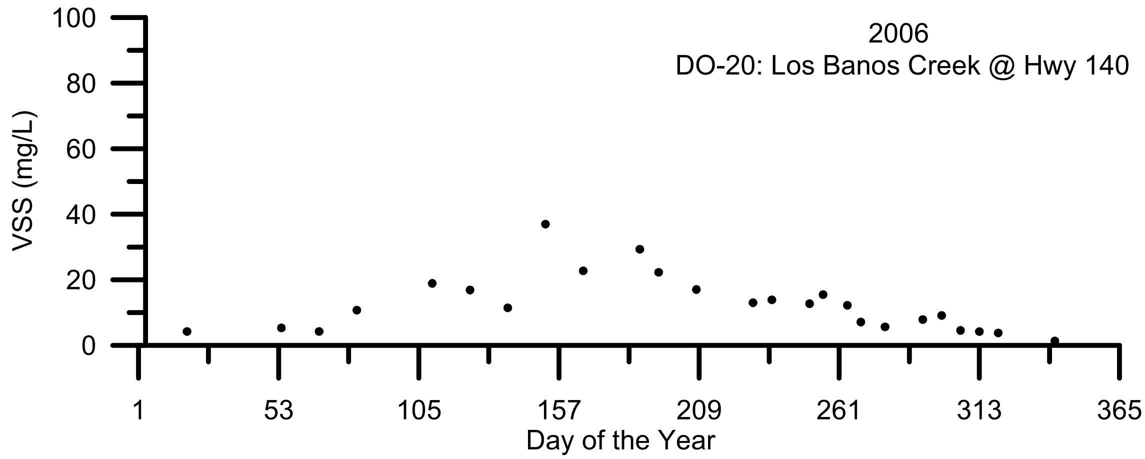


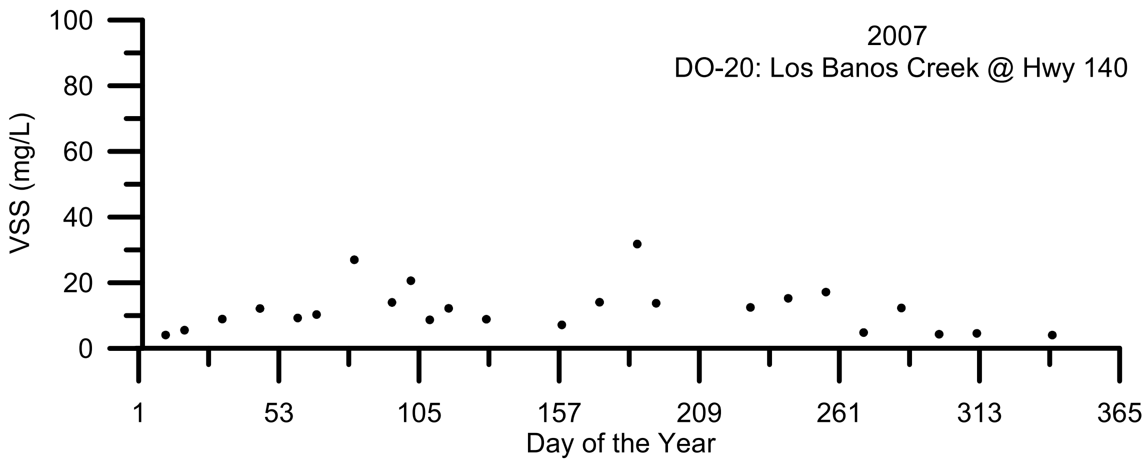
2006
DO-19: Salt Slough @ Lander Avenue
VSS (mg/L)
Day of the Year

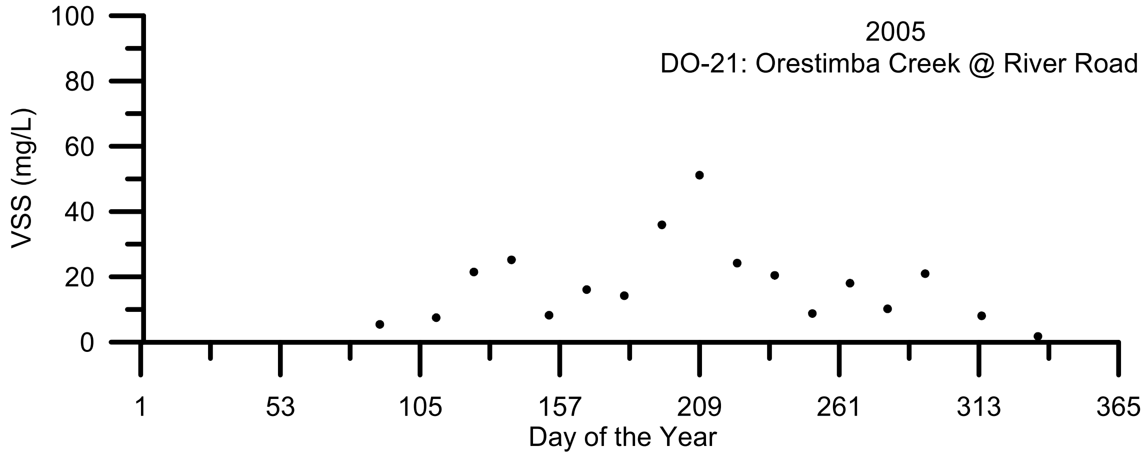


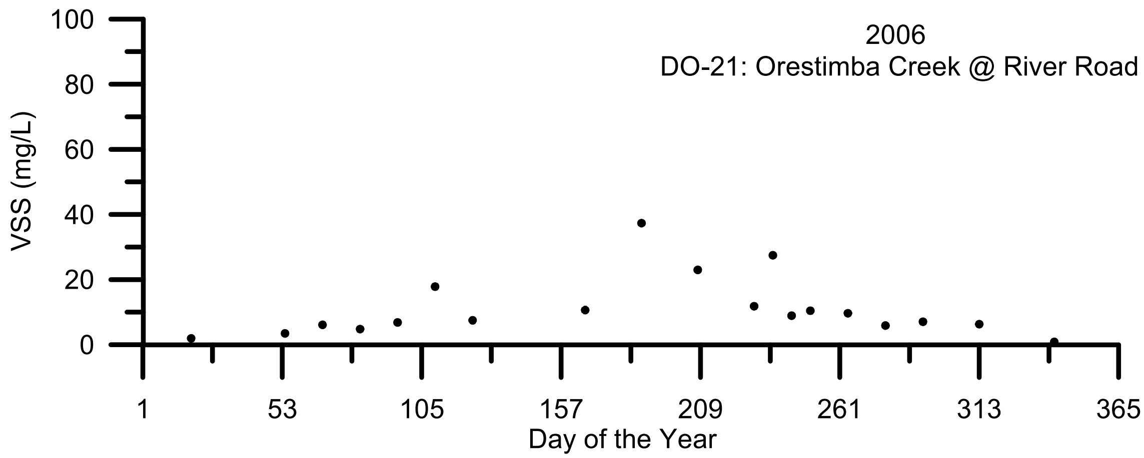
2007
DO-19: Salt Slough @ lander Avenue
VSS (mg/L)
Day of the Year

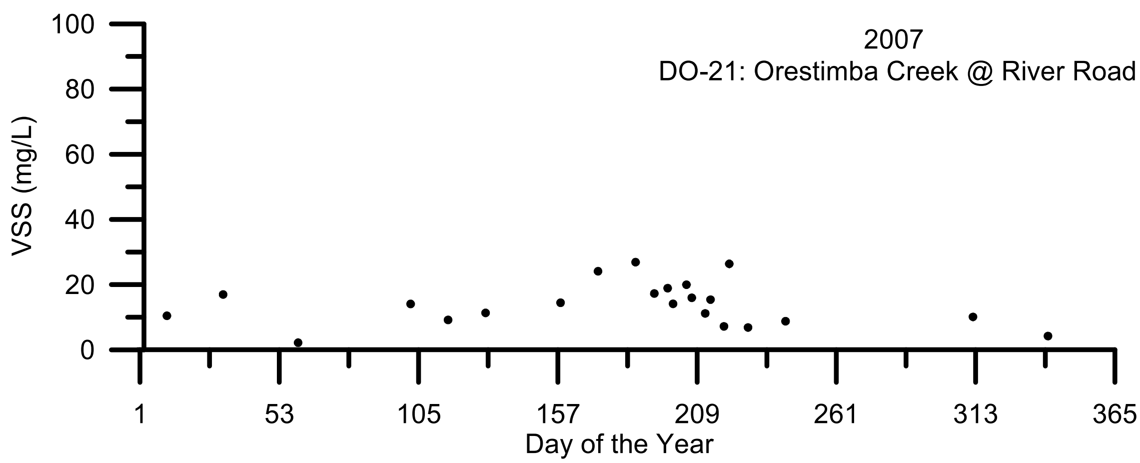

2005
DO-20: Los Banos Creek @ Hwy 140
VSS (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

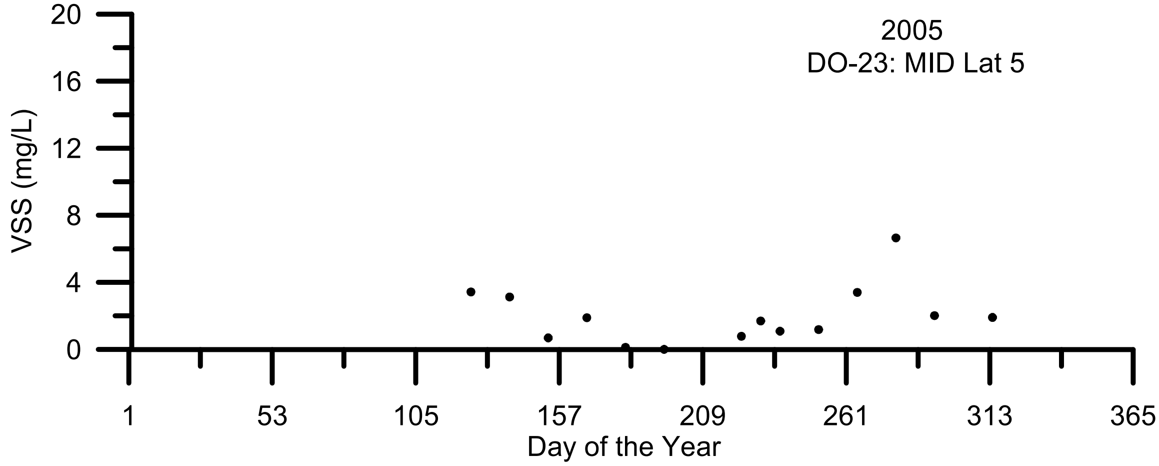

2006
DO-20: Los Banos Creek @ Hwy 140
VSS (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

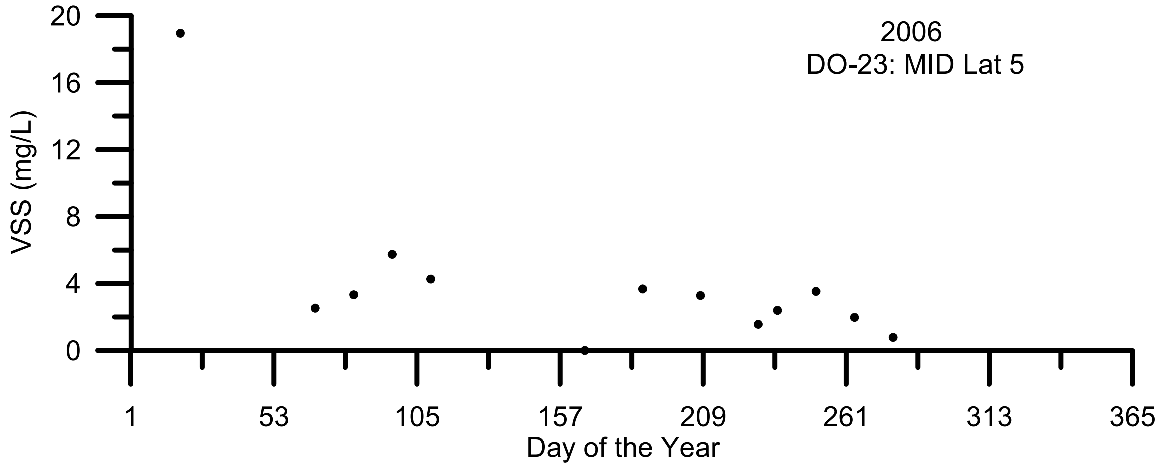

2007
DO-20: Los Banos Creek @ Hwy 140
VSS (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

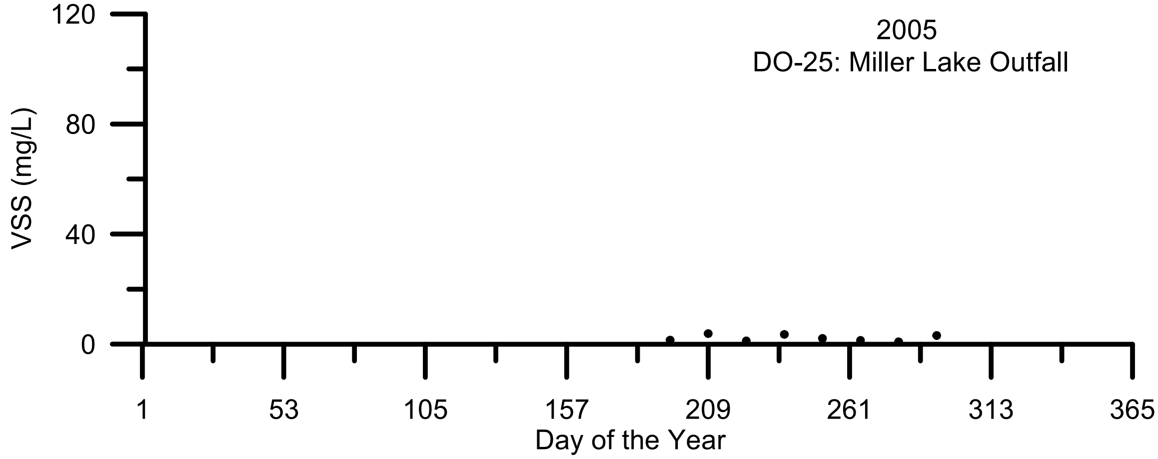

2005
DO-21: Orestimba Creek @ River Road
VSS (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

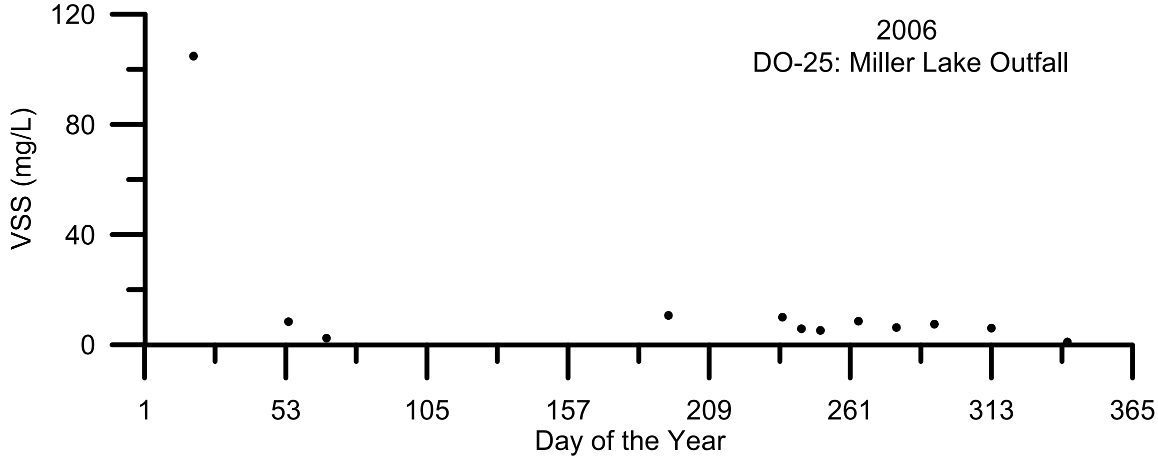

2006
DO-21: Orestimba Creek @ River Road
VSS (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

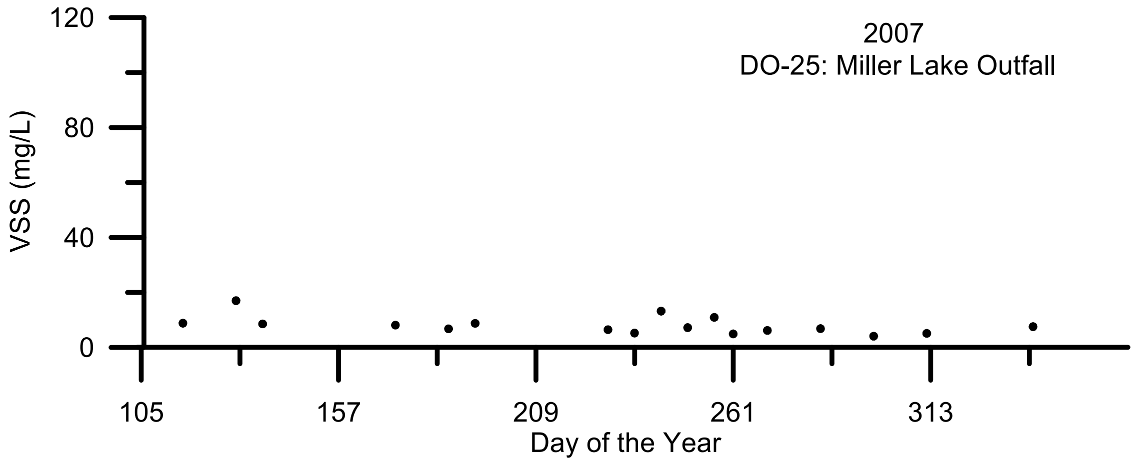

2007
DO-21: Orestimba Creek @ River Road
VSS (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

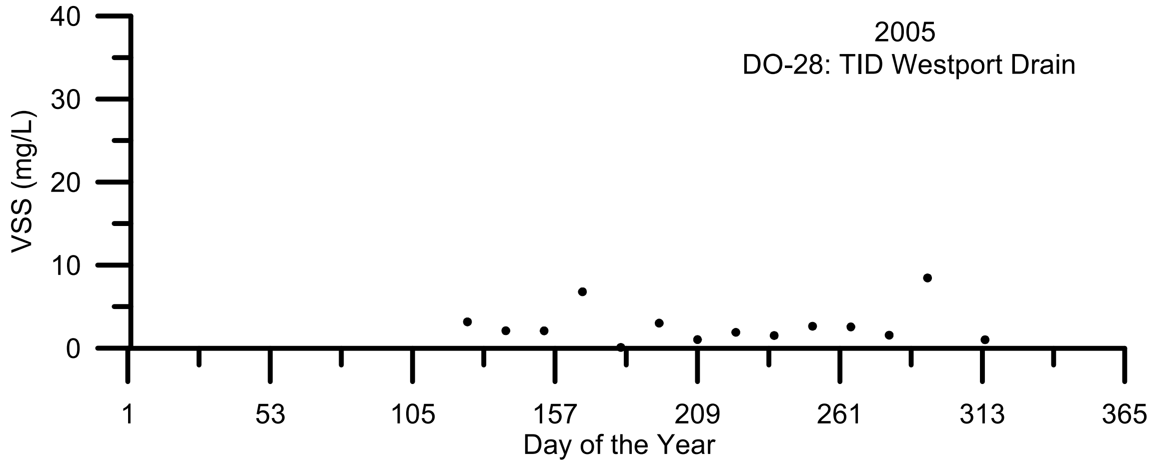

2005
DO-23: MID Lat 5
VSS (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

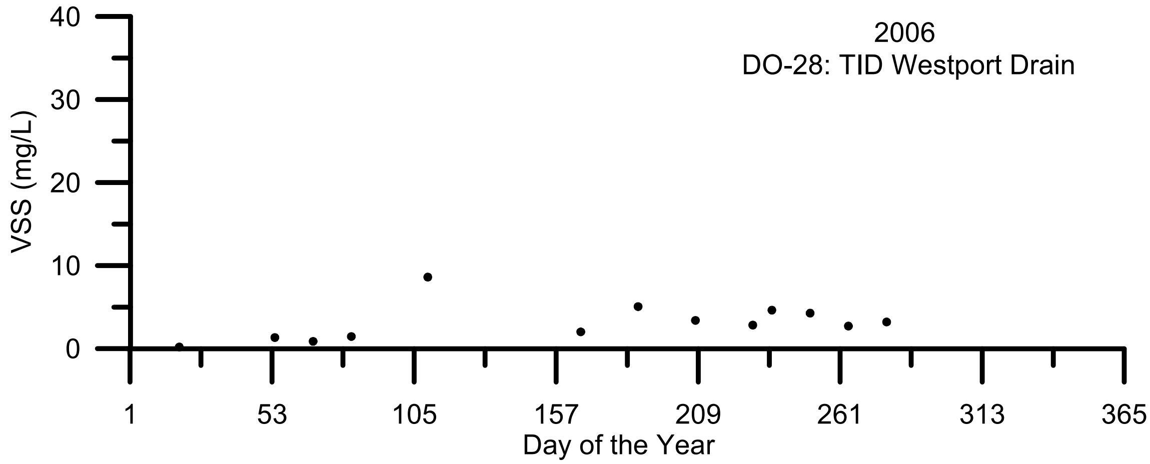

2006
DO-23: MID Lat 5
VSS (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

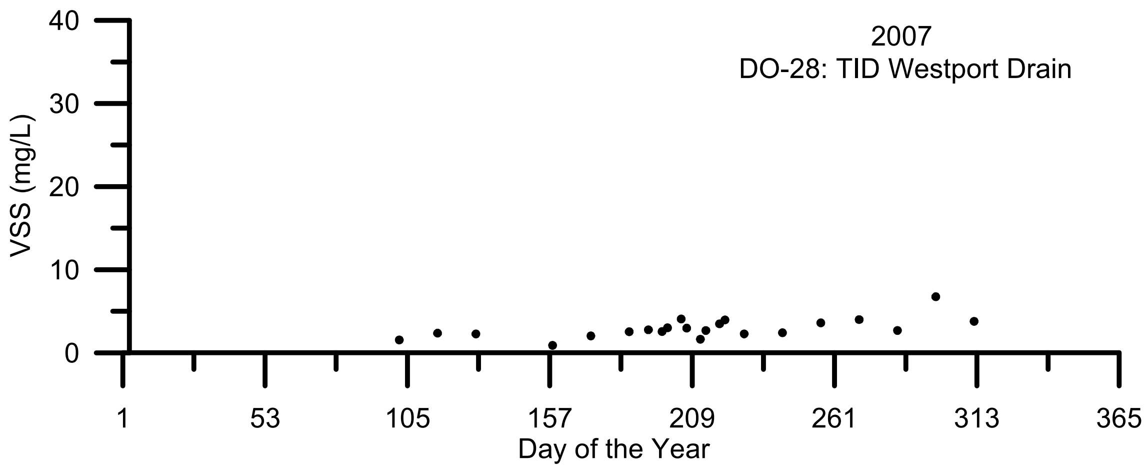

2005
DO-25: Miller Lake Outfall
VSS (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

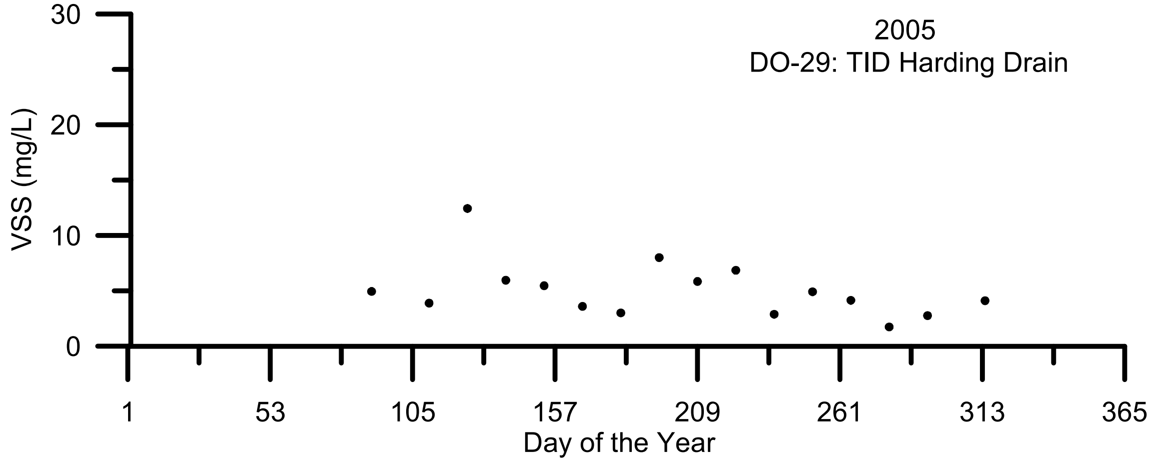

2006
DO-25: Miller Lake Outfall
VSS (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

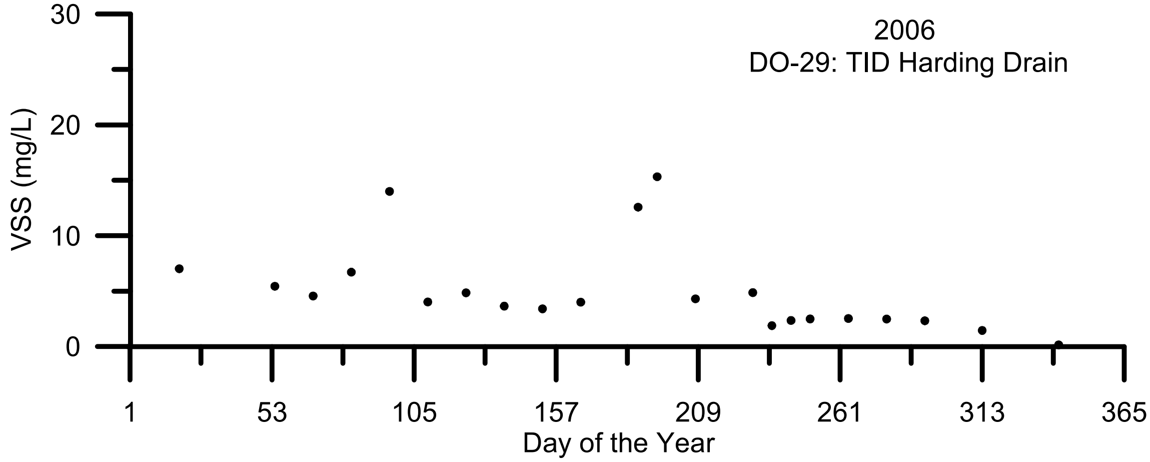

2007
DO-25: Miller Lake Outfall
VSS (mg/L)
120
80
40
0
105
157
209
261
313
Day of the Year

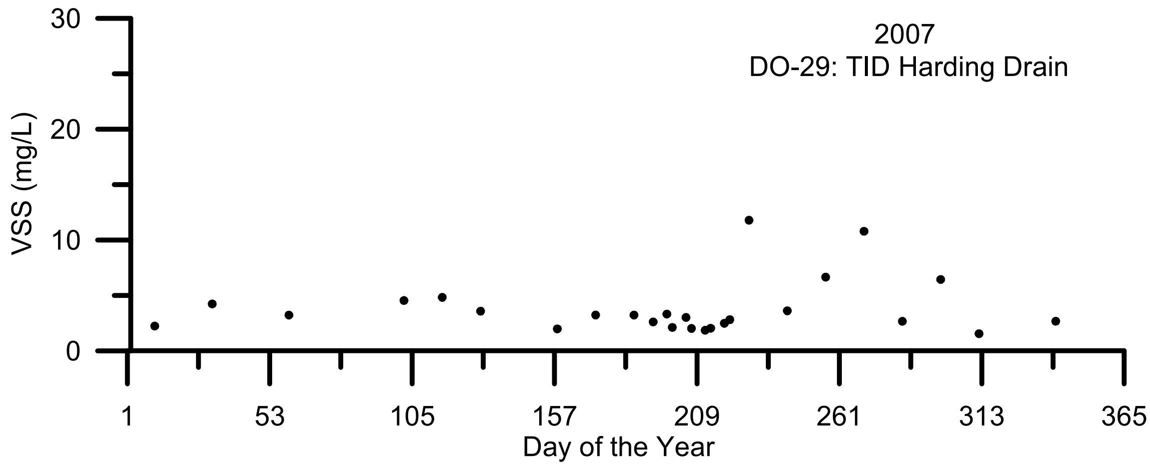

2005
DO-28: TID Westport Drain
VSS (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

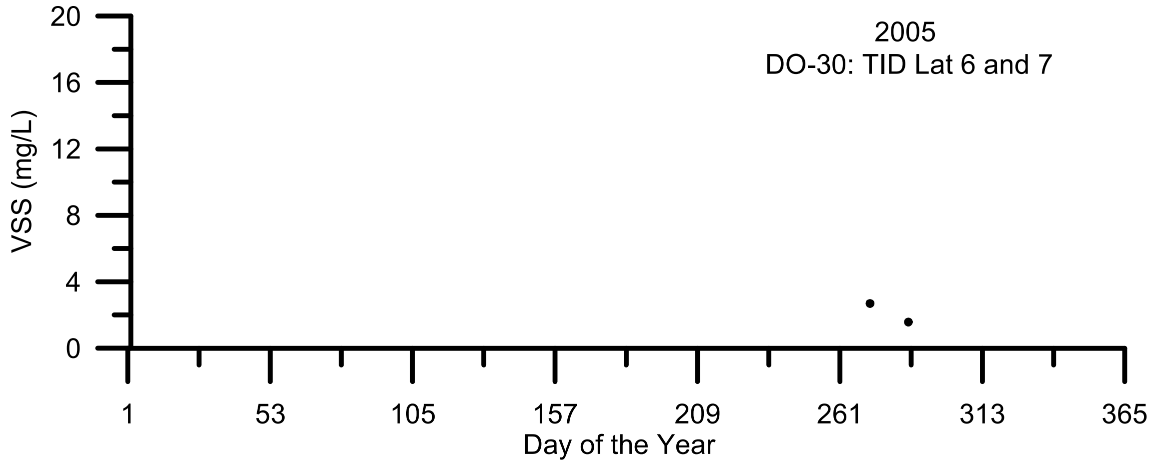

2006
DO-28: TID Westport Drain
VSS (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

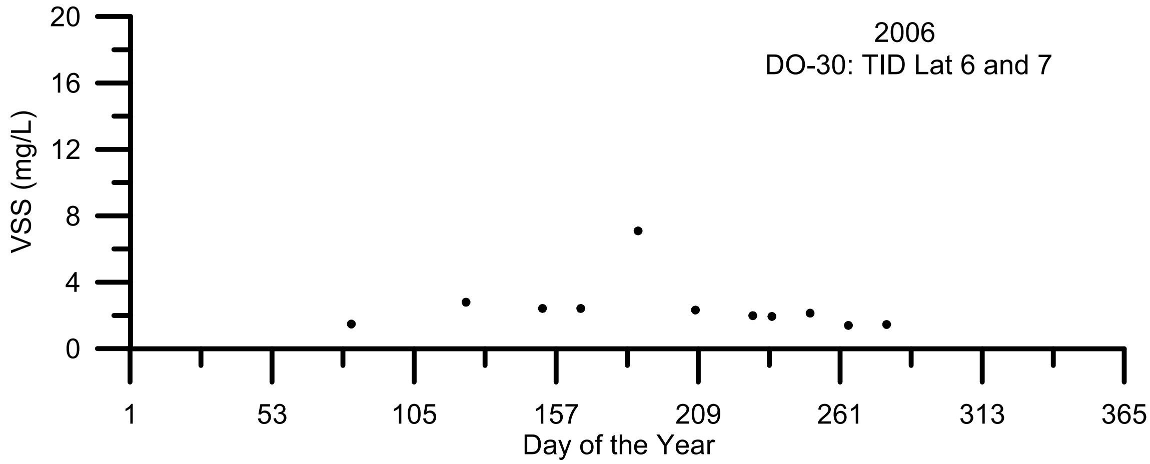

2007
DO-28: TID Westport Drain
VSS (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

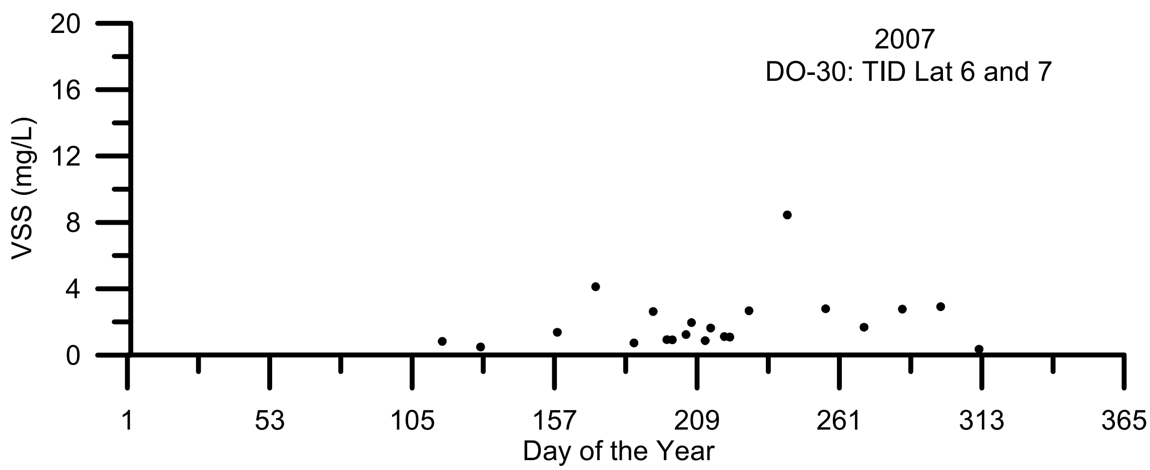

2005
DO-29: TID Harding Drain
VSS (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

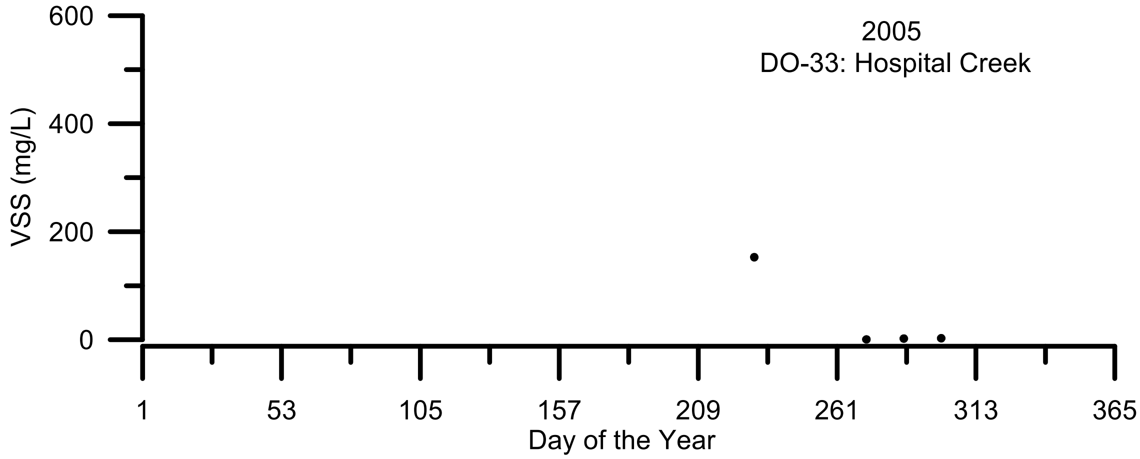

2006
DO-29: TID Harding Drain
VSS (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-29: TID Harding Drain
VSS (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

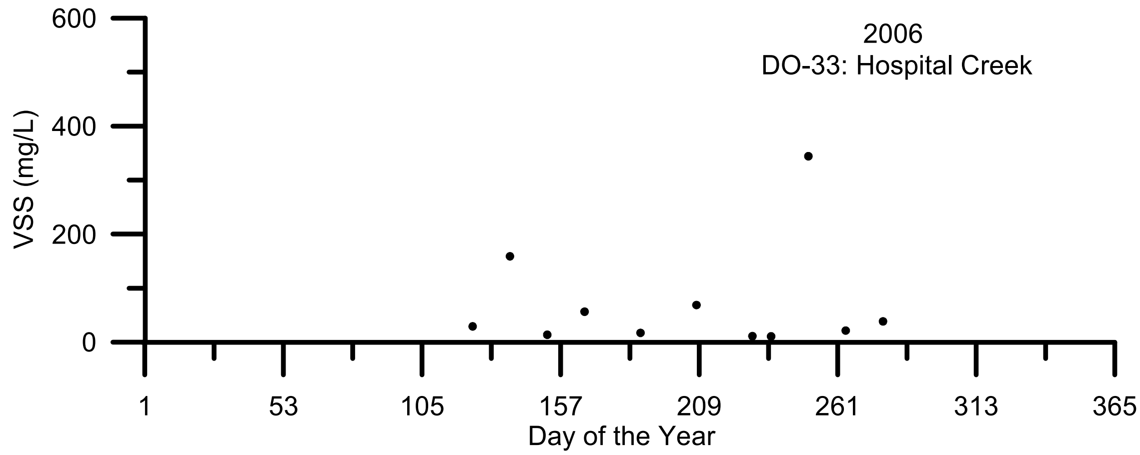

2005
DO-30: TID Lat 6 and 7
VSS (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-30: TID Lat 6 and 7
VSS (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

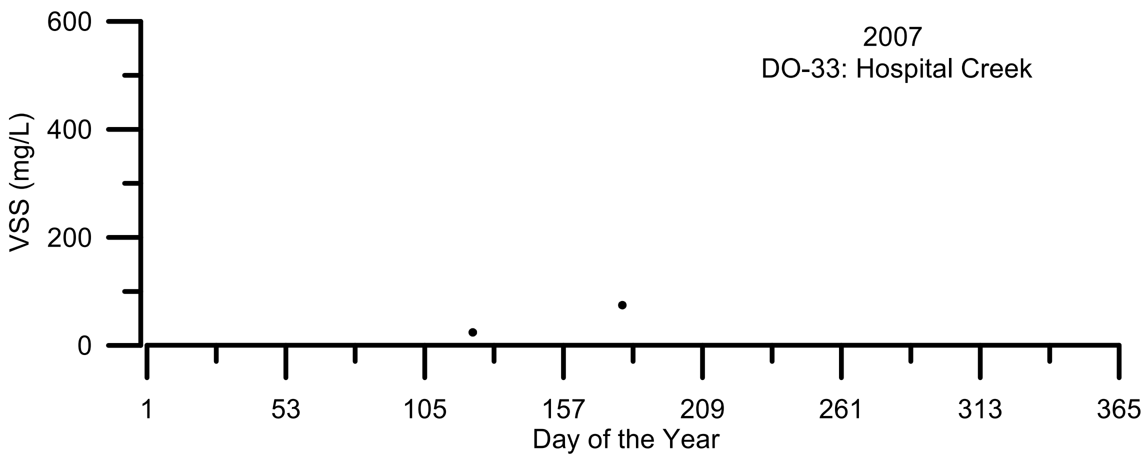

2007
DO-30: TID Lat 6 and 7
VSS (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year



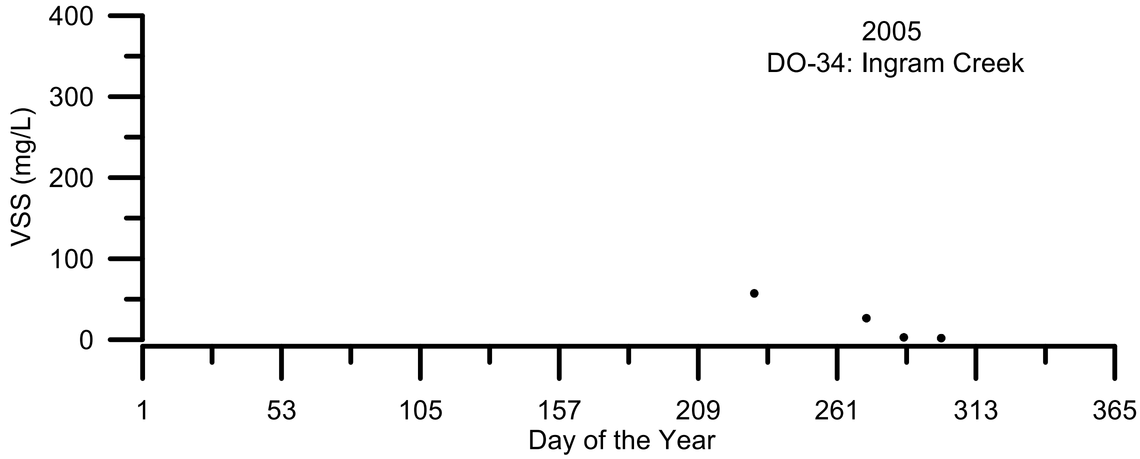
2005
DO-33: Hospital Creek
VSS (mg/L)
Day of the Year

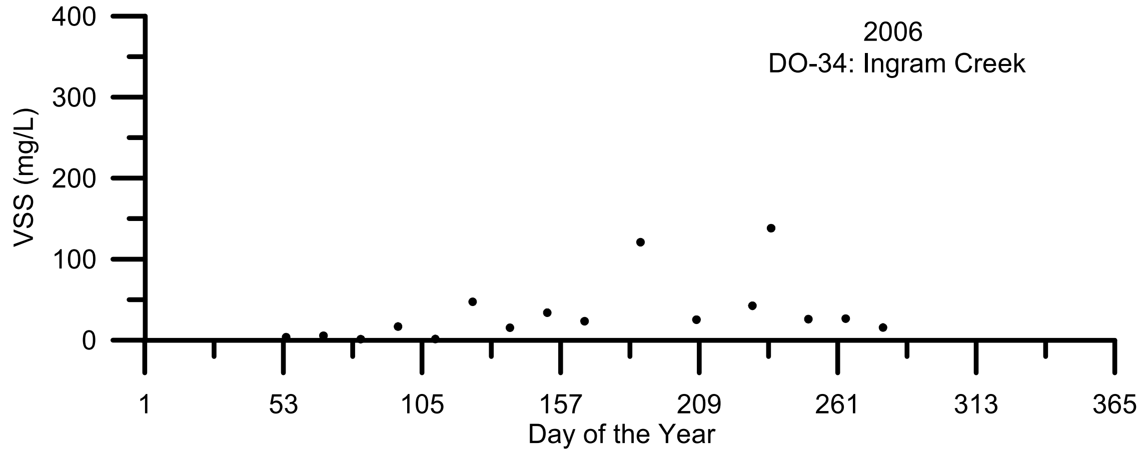


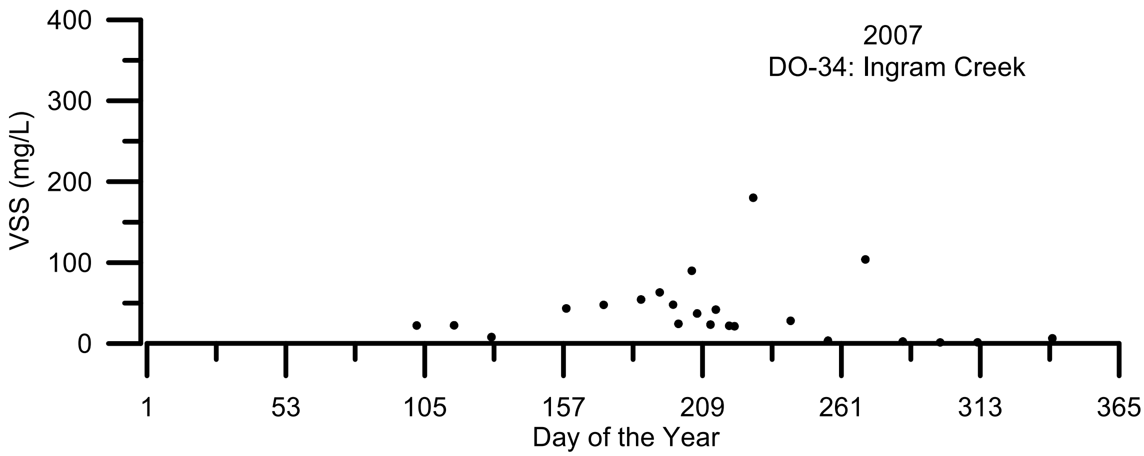
2006
DO-33: Hospital Creek
VSS (mg/L)
Day of the Year

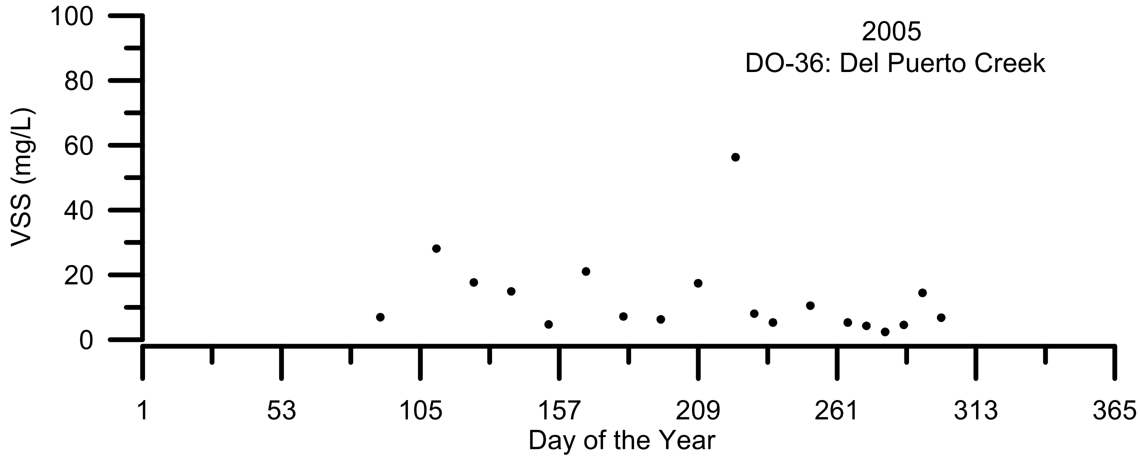


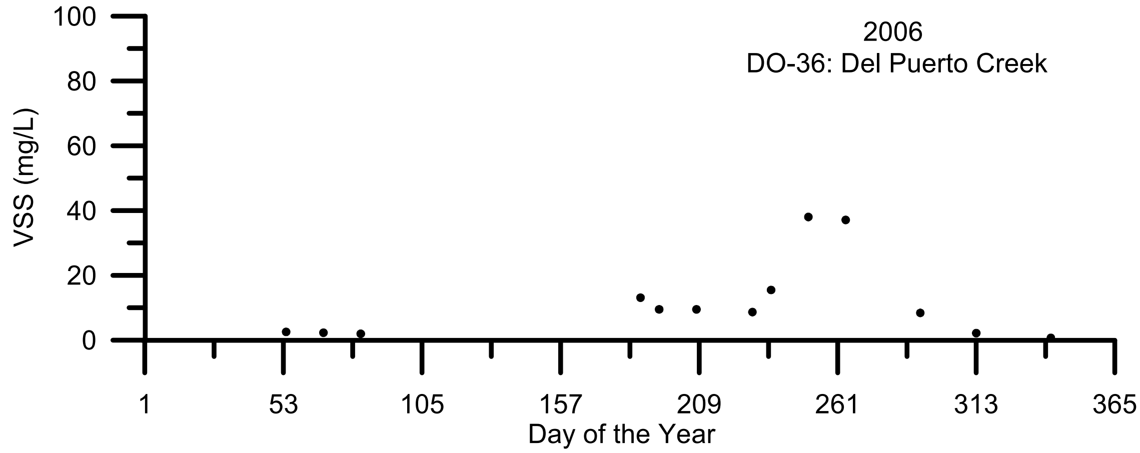
2007
DO-33: Hospital Creek
VSS (mg/L)
Day of the Year

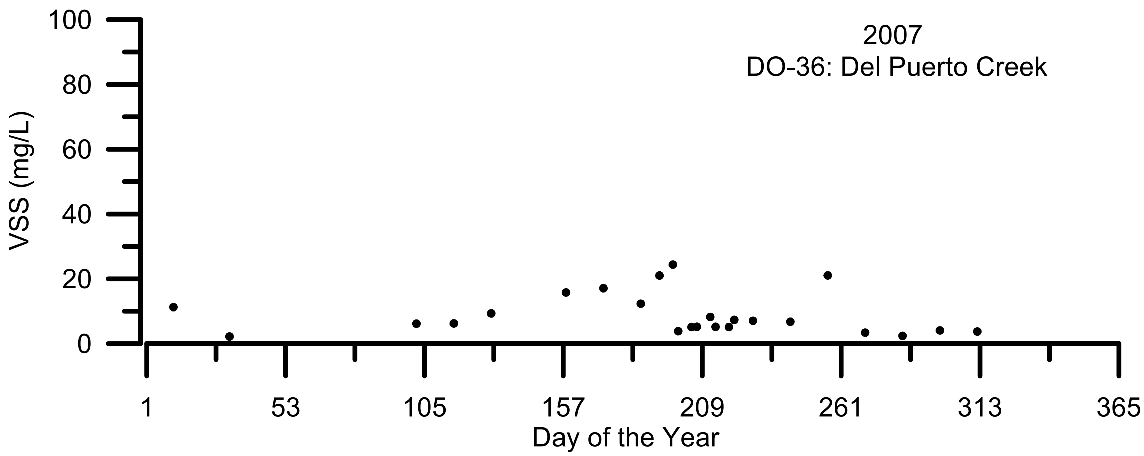

2005
DO-34: Ingram Creek
VSS (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

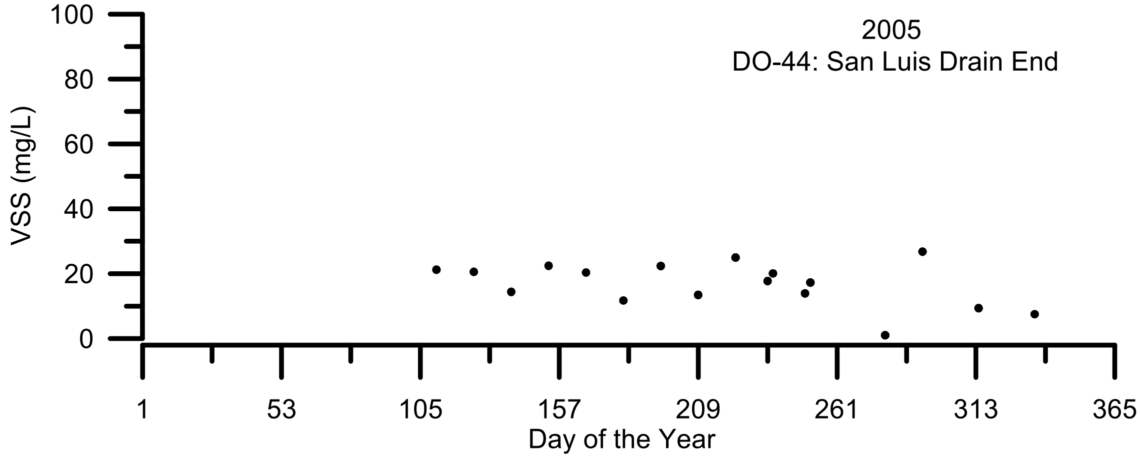

2006
DO-34: Ingram Creek
VSS (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

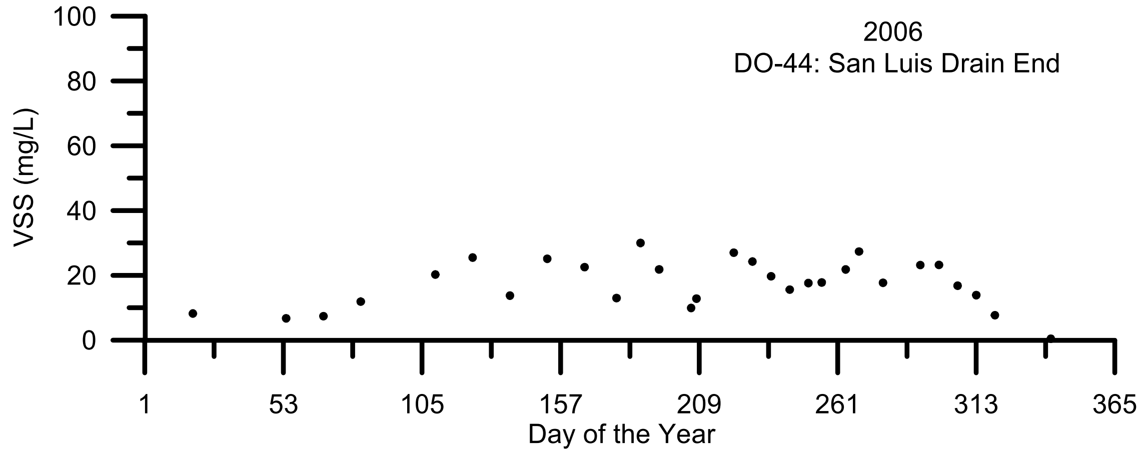

2007
DO-34: Ingram Creek
VSS (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

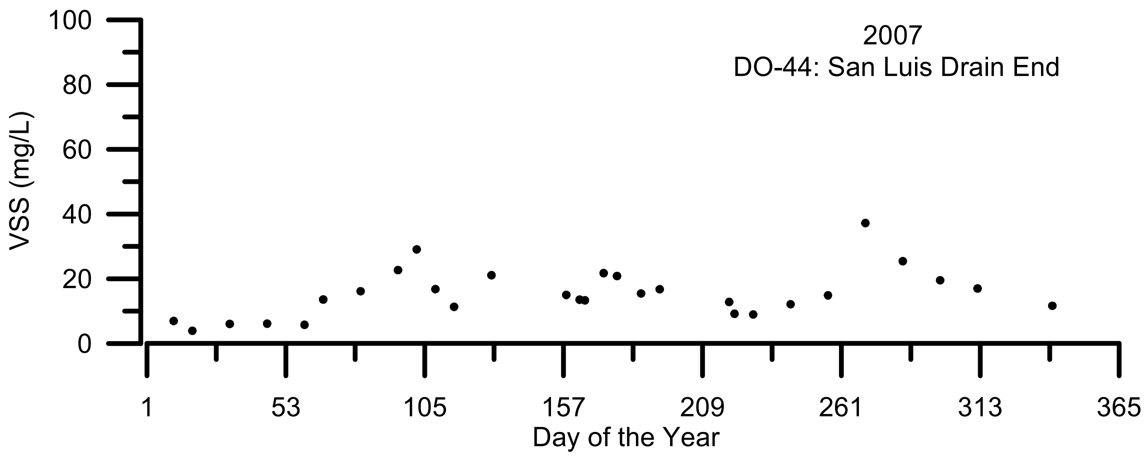

2005
DO-36: Del Puerto Creek
VSS (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

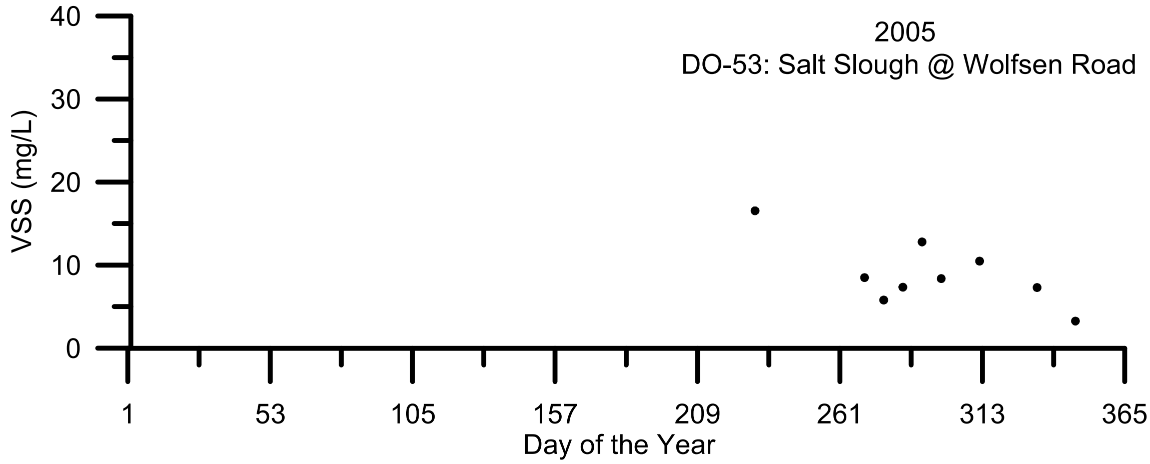

2006
DO-36: Del Puerto Creek
VSS (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

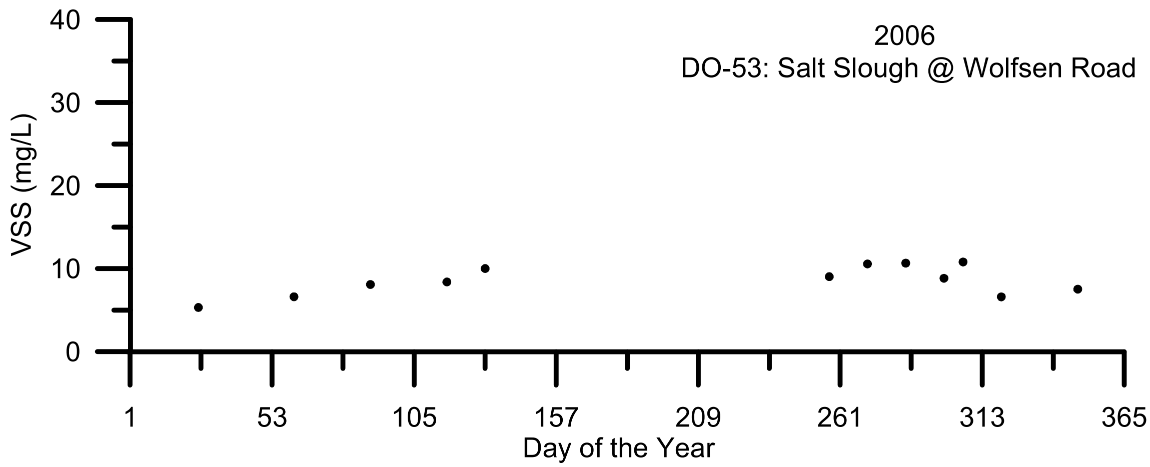

2007
DO-36: Del Puerto Creek
VSS (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

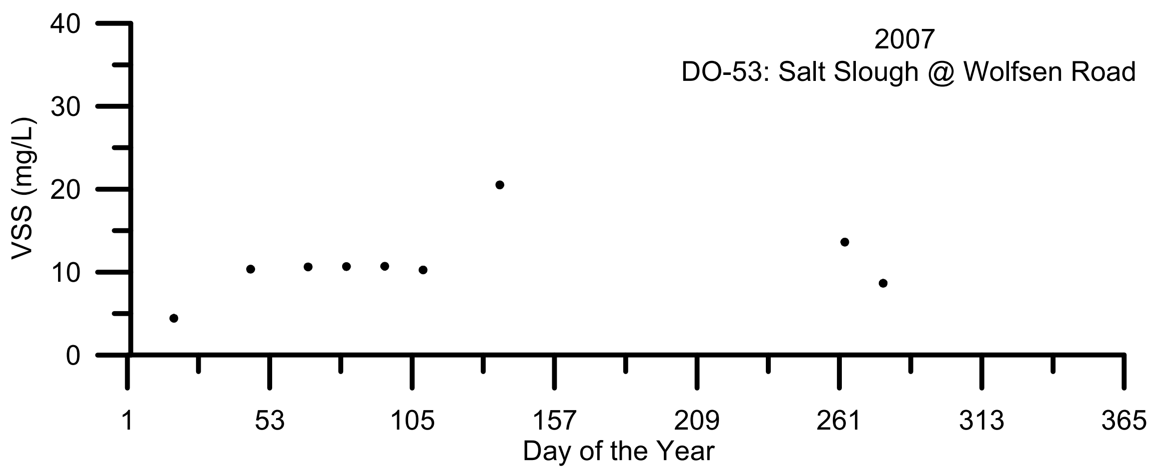

2005
DO-44: San Luis Drain End
VSS (mg/L)
Day of the Year

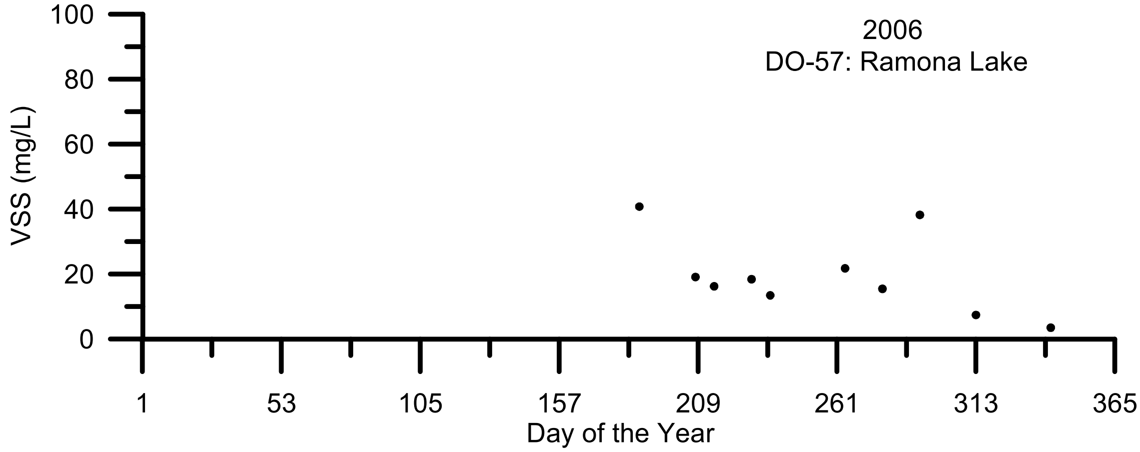

2006
DO-44: San Luis Drain End
VSS (mg/L)
Day of the Year

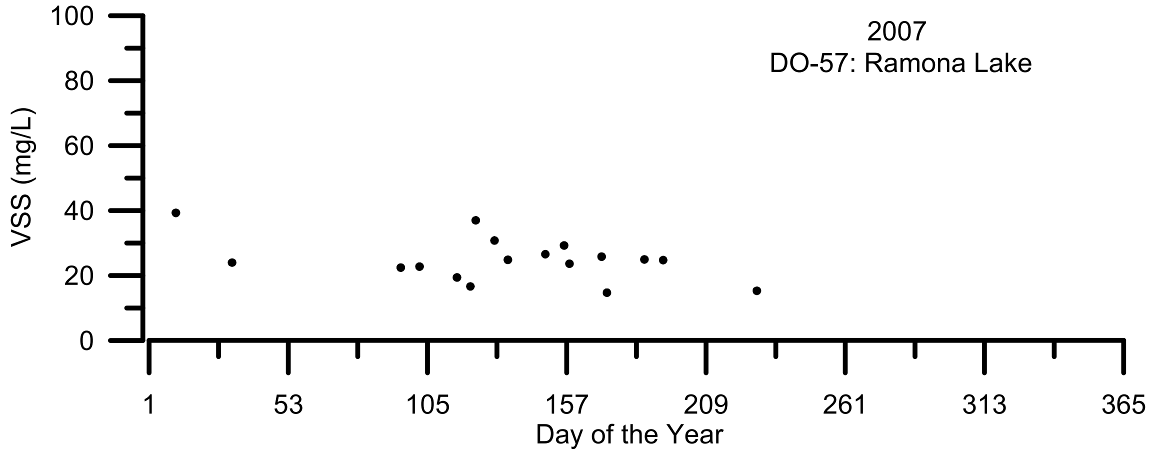

2007
DO-44: San Luis Drain End
VSS (mg/L)
Day of the Year

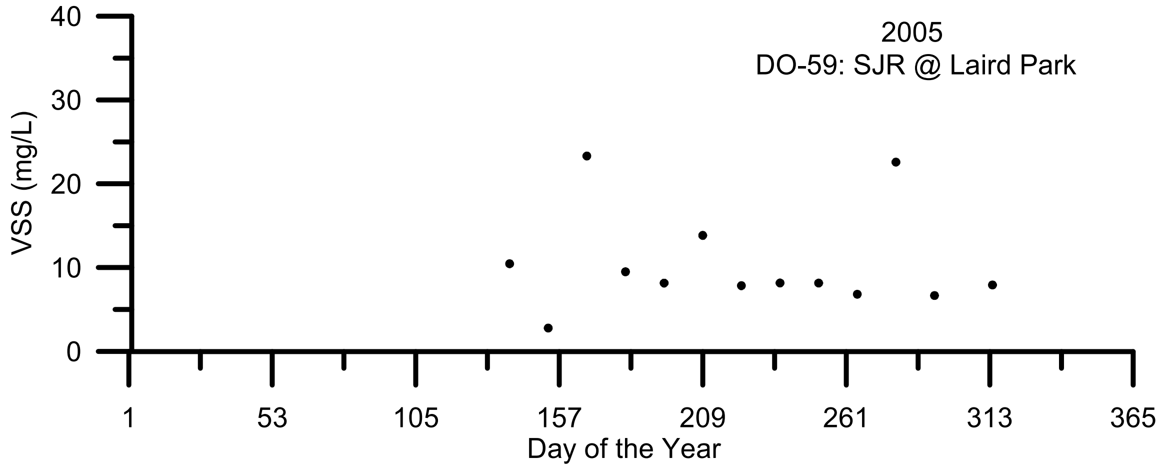

2005
DO-53: Salt Slough @ Wolfsen Road
VSS (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-53: Salt Slough @ Wolfsen Road
VSS (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

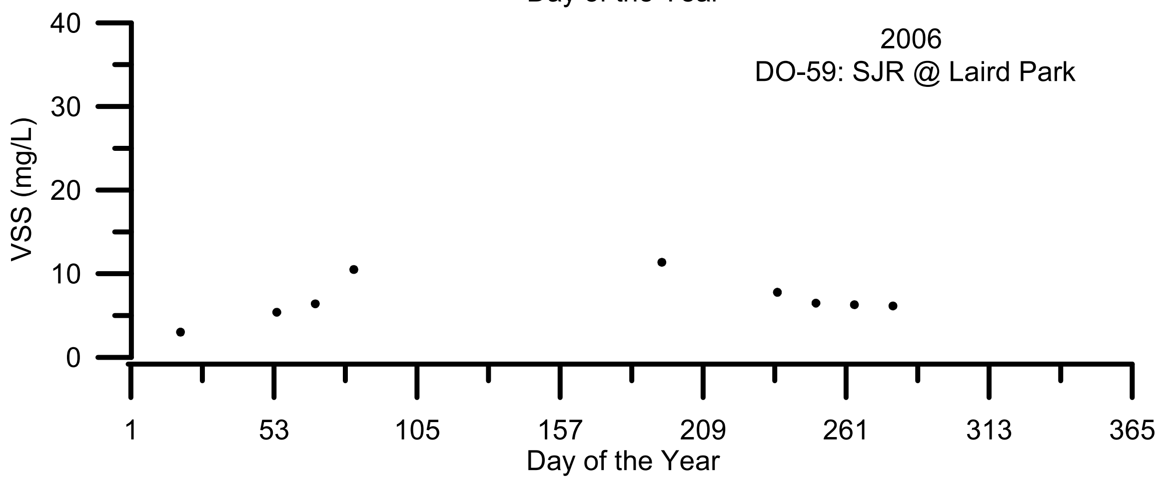

2007
DO-53: Salt Slough @ Wolfsen Road
VSS (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-57: Ramona Lake
VSS (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

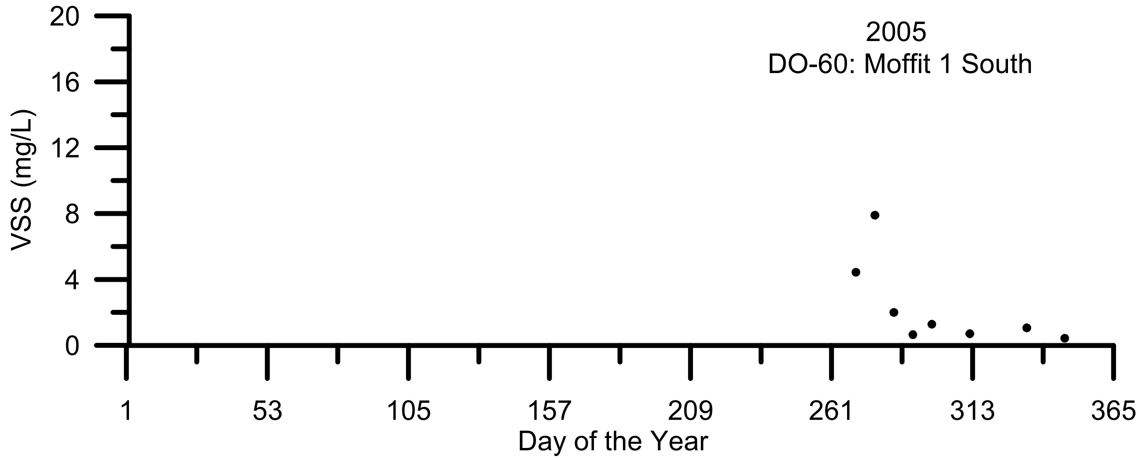

2007
DO-57: Ramona Lake
VSS (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

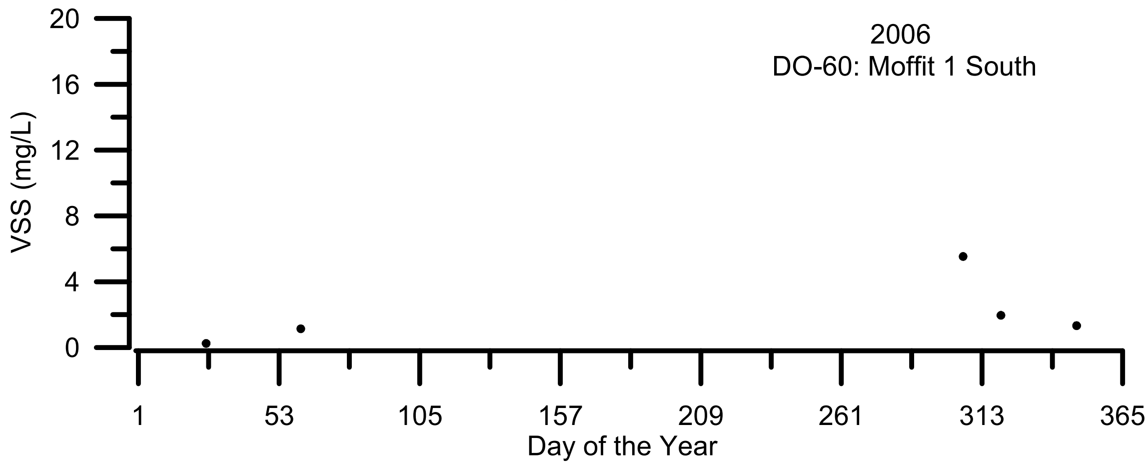


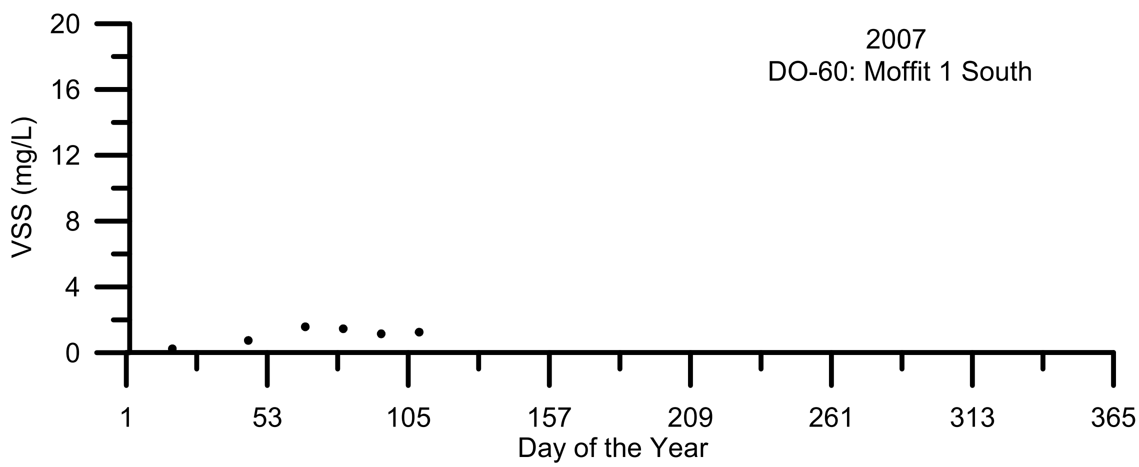
2005
DO-59: SJR @ Laird Park
VSS (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

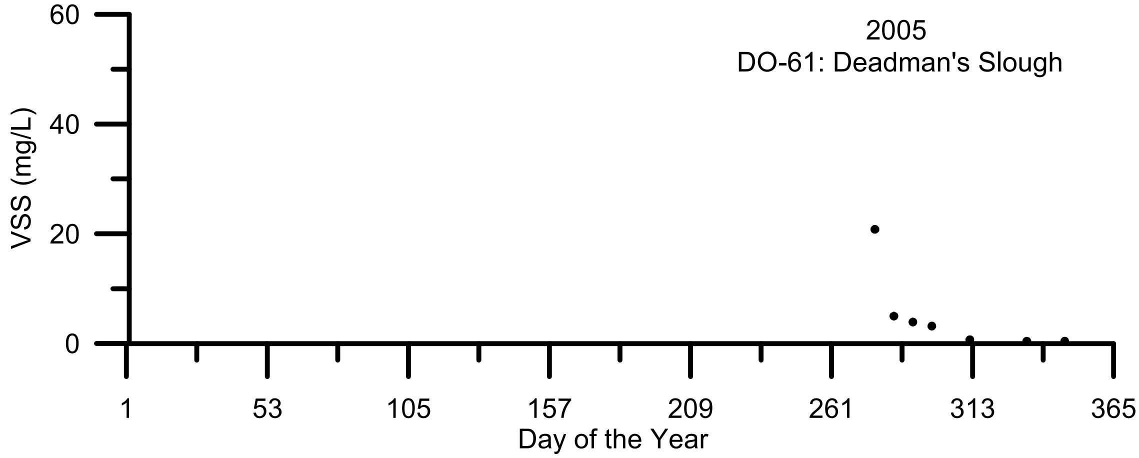


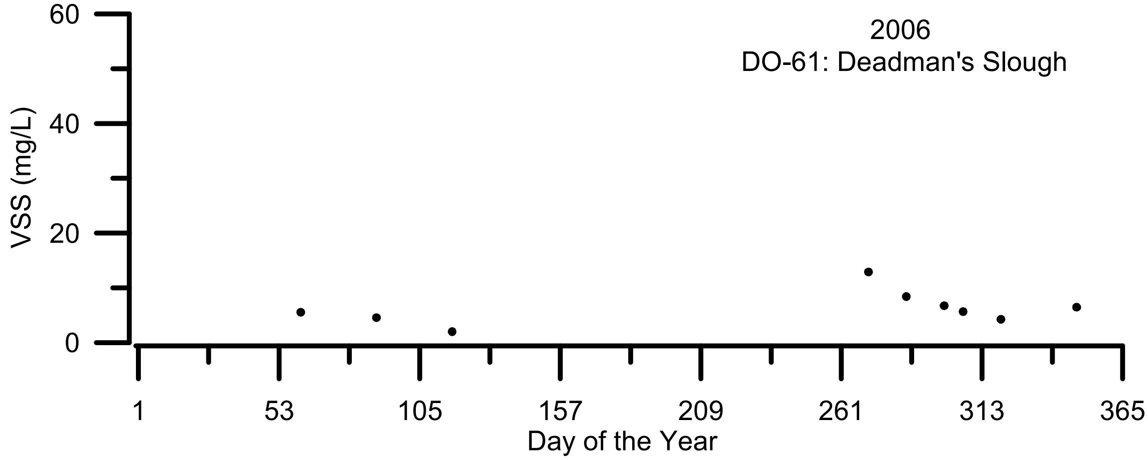
2006
DO-59: SJR @ Laird Park
VSS (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

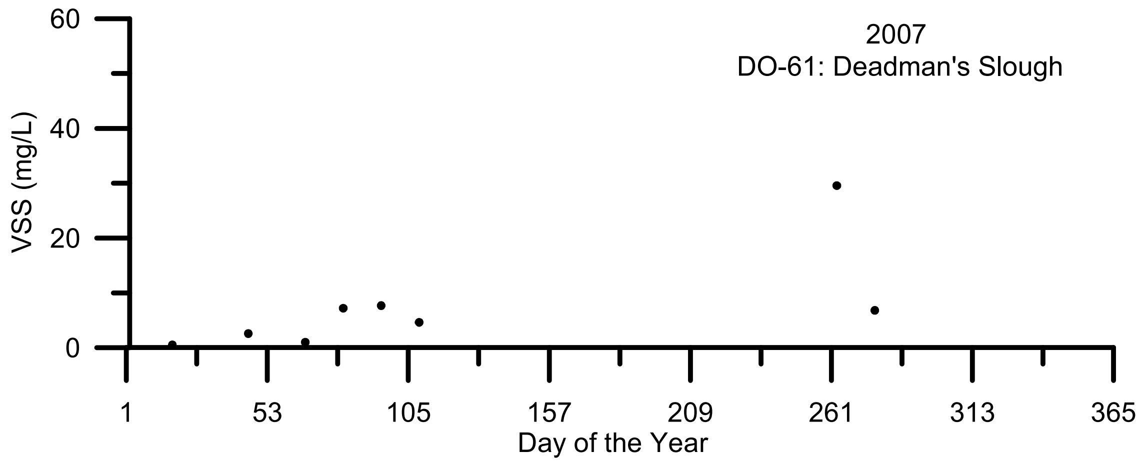

2005
DO-60: Moffit 1 South
VSS (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

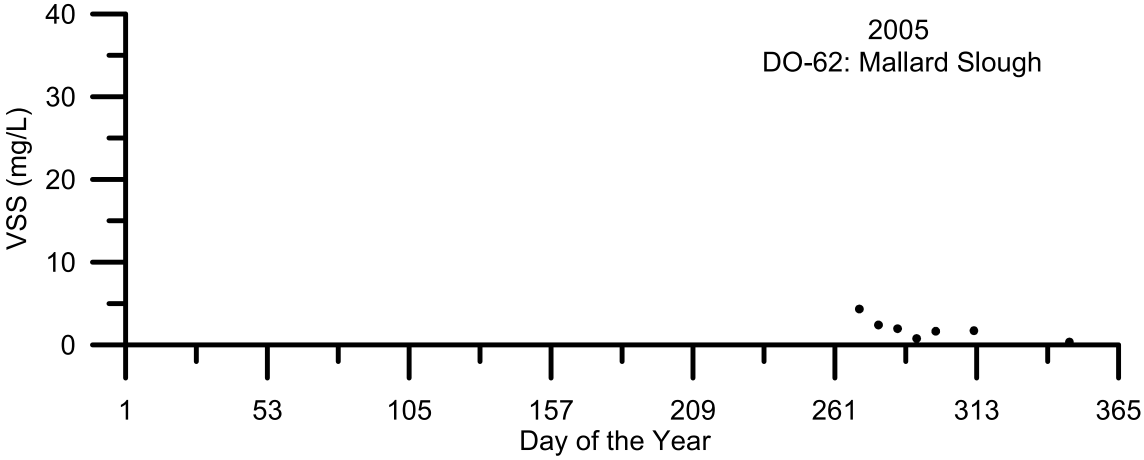

2006
DO-60: Moffit 1 South
VSS (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

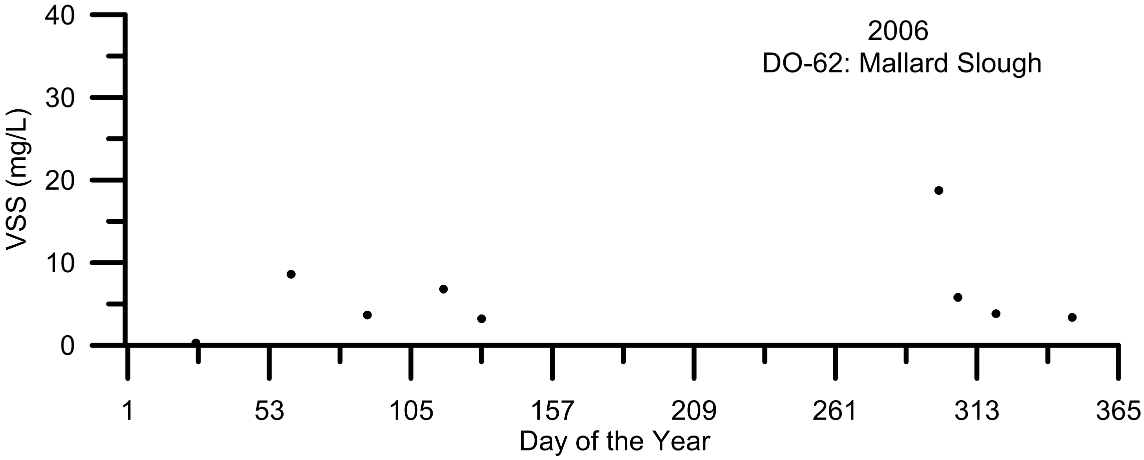

2007
DO-60: Moffit 1 South
VSS (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

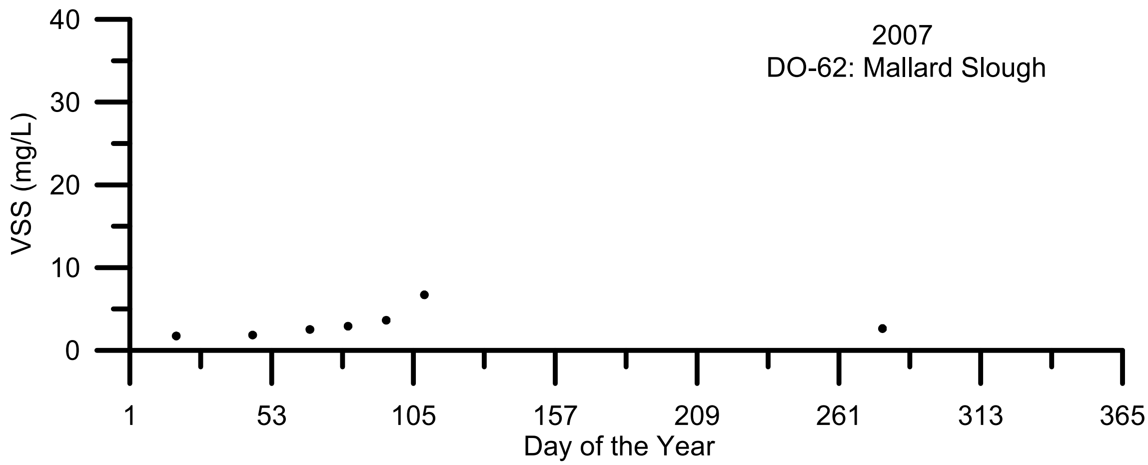

2005
DO-61: Deadman's Slough
VSS (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

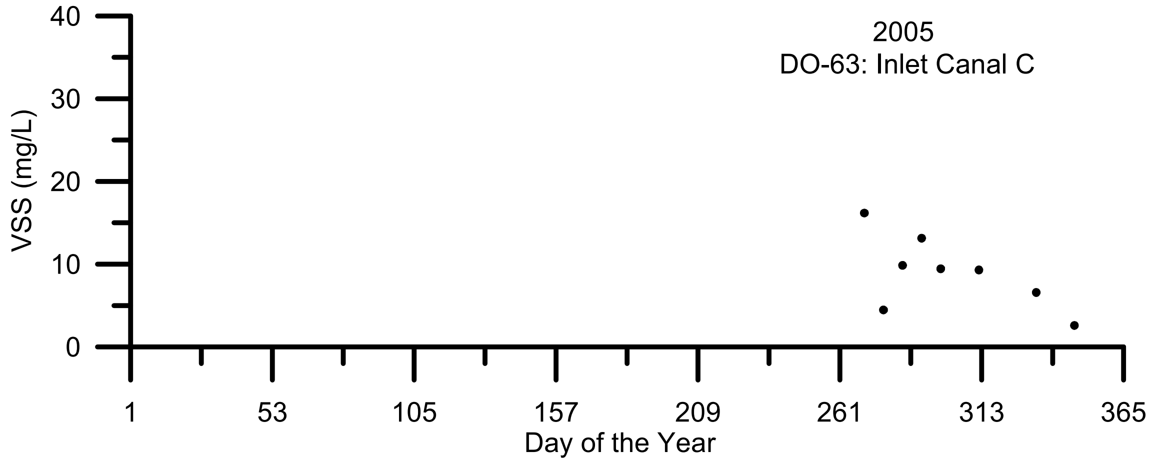

2006
DO-61: Deadman's Slough
VSS (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

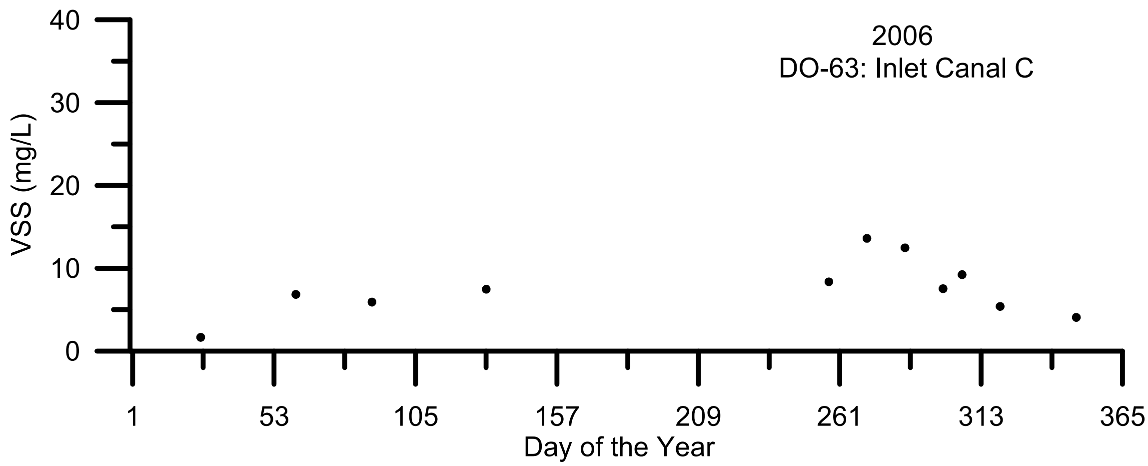

2007
DO-61: Deadman's Slough
VSS (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

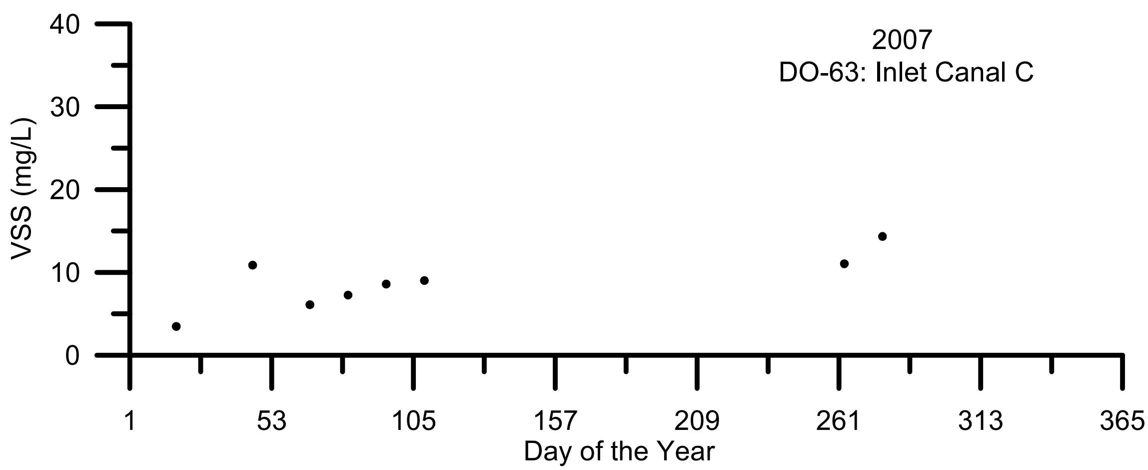

2005
DO-62: Mallard Slough
VSS (mg/L)
Day of the Year

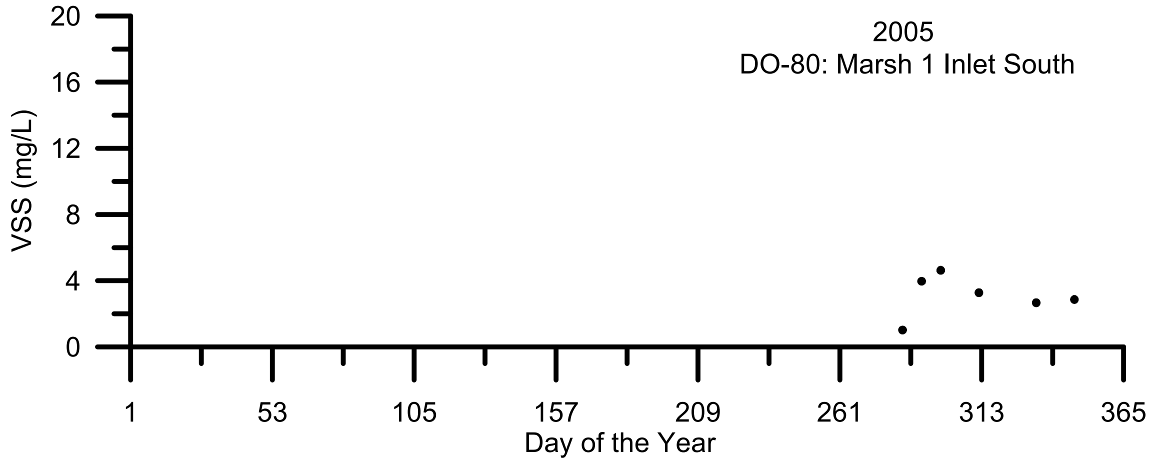

2006
DO-62: Mallard Slough
VSS (mg/L)
Day of the Year

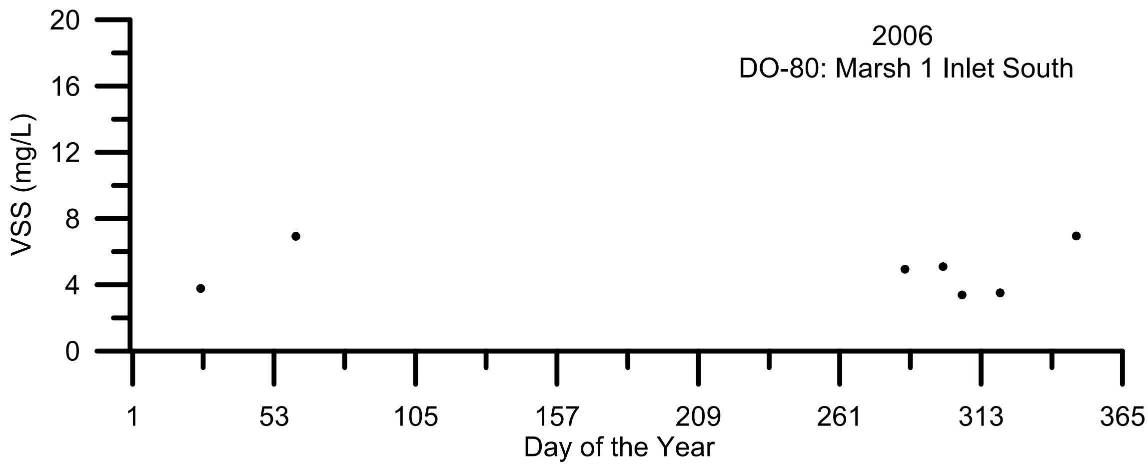

2007
DO-62: Mallard Slough
VSS (mg/L)
Day of the Year

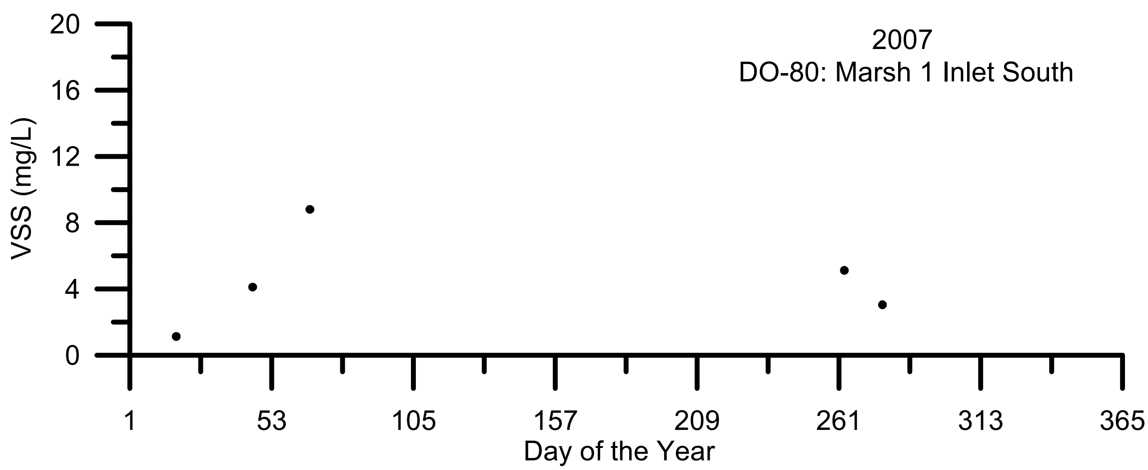

2005
DO-63: Inlet Canal C
VSS (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

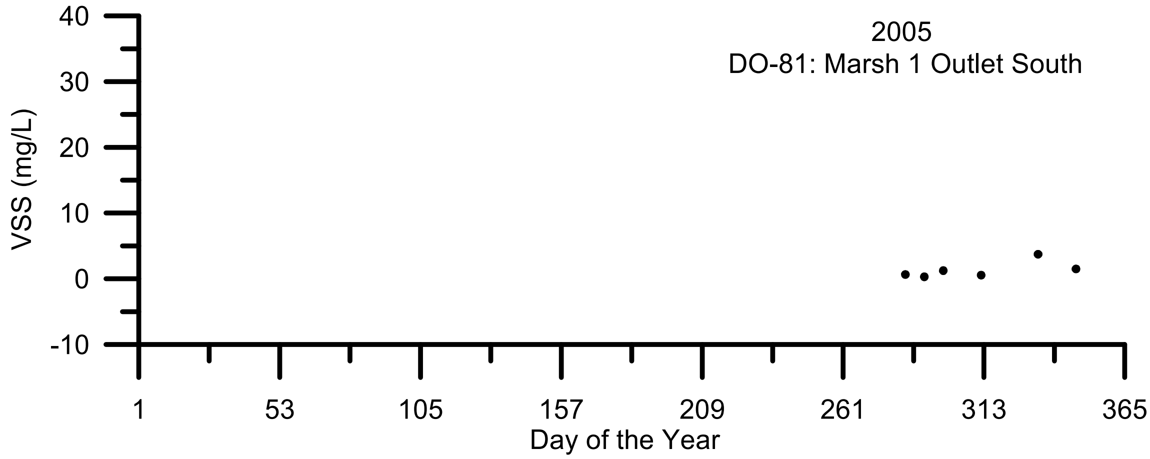

2006
DO-63: Inlet Canal C
VSS (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

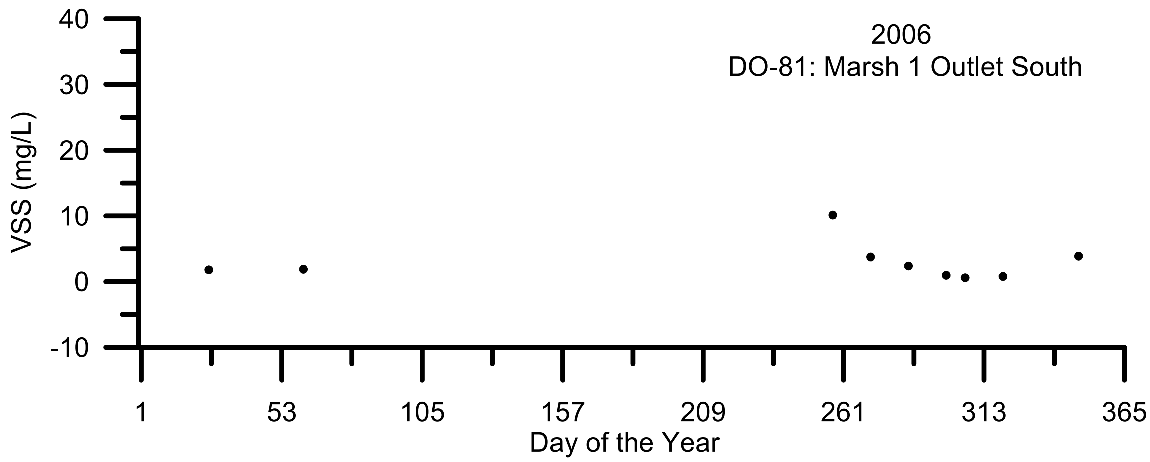

2007
DO-63: Inlet Canal C
VSS (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

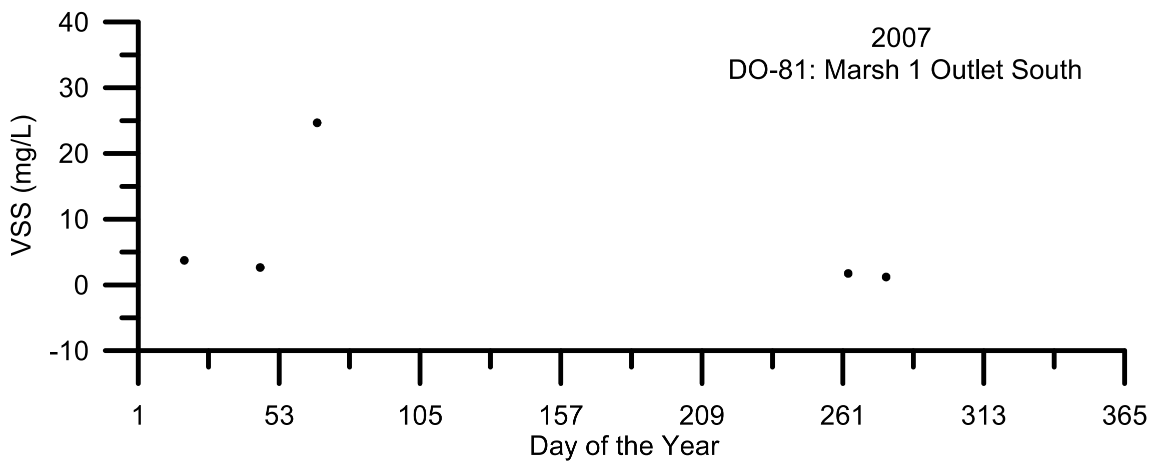

2005
DO-80: Marsh 1 Inlet South
VSS (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

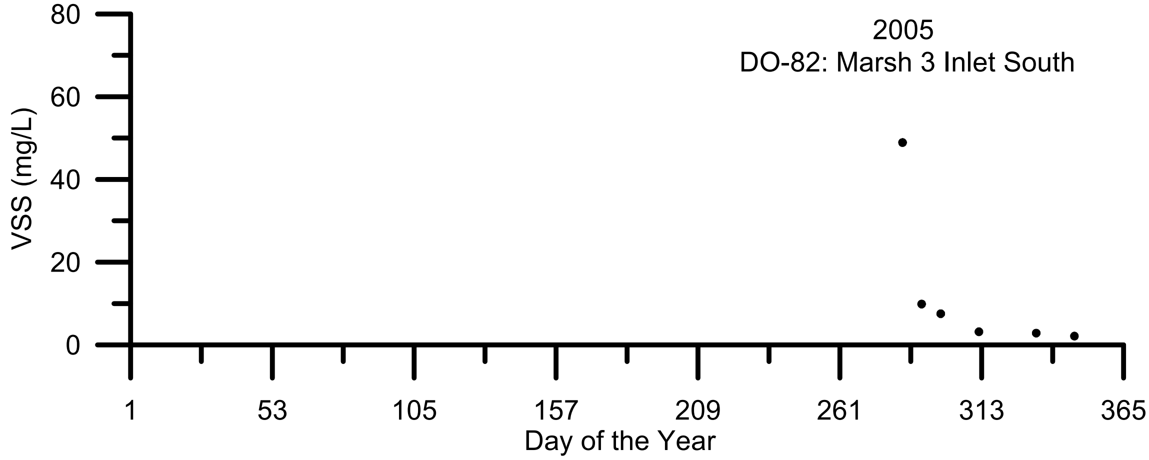

2006
DO-80: Marsh 1 Inlet South
VSS (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

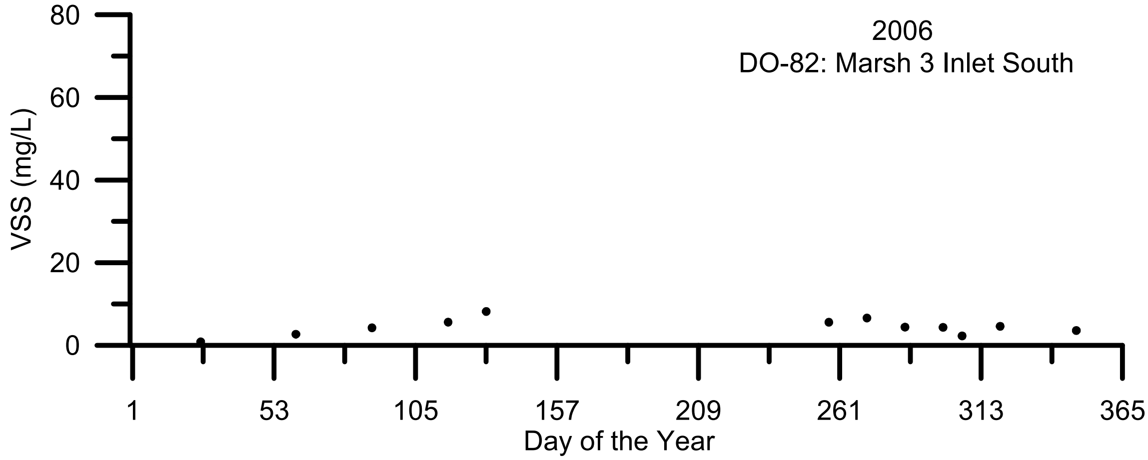

2007
DO-80: Marsh 1 Inlet South
VSS (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

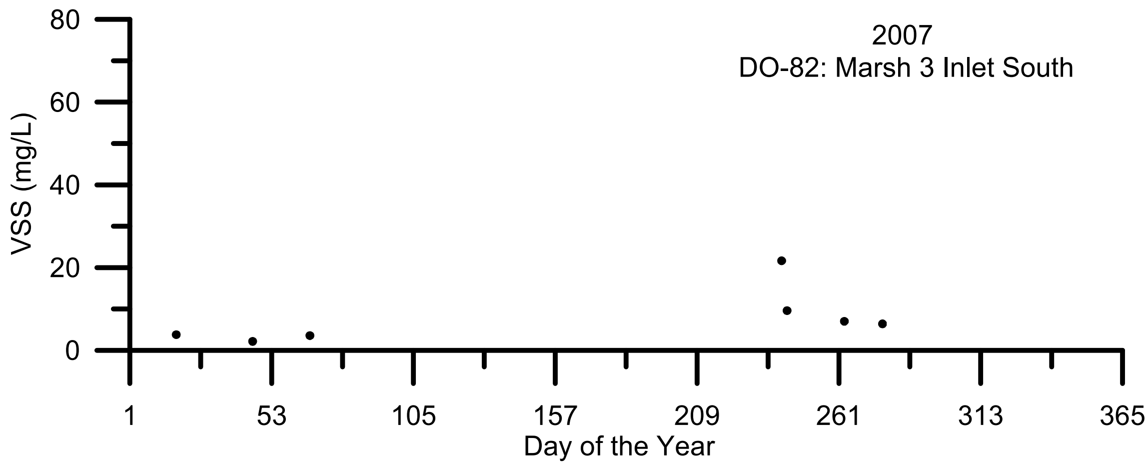

2005
DO-81: Marsh 1 Outlet South
VSS (mg/L)
40
30
20
10
0
-10
1
53
105
157
209
261
313
365
Day of the Year

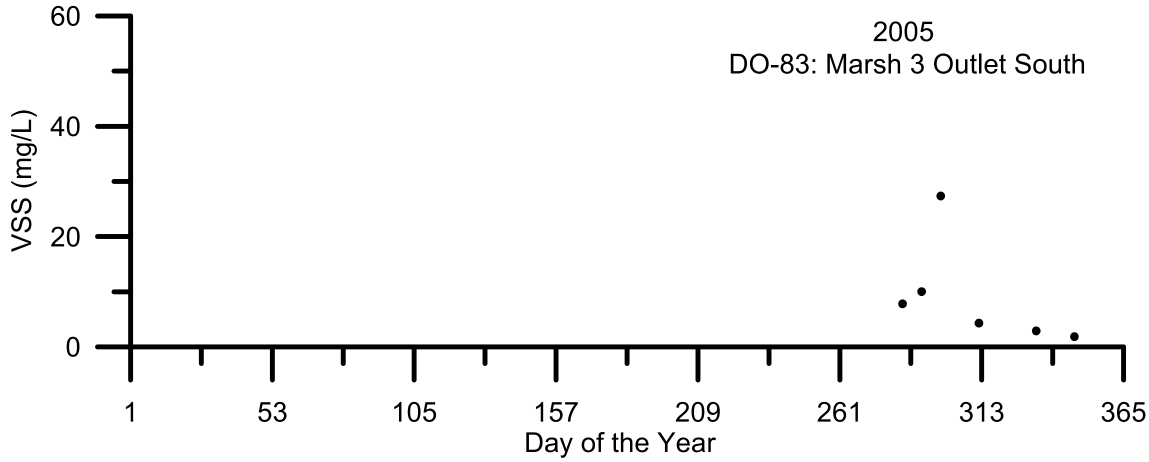

2006
DO-81: Marsh 1 Outlet South
VSS (mg/L)
40
30
20
10
0
-10
1
53
105
157
209
261
313
365
Day of the Year

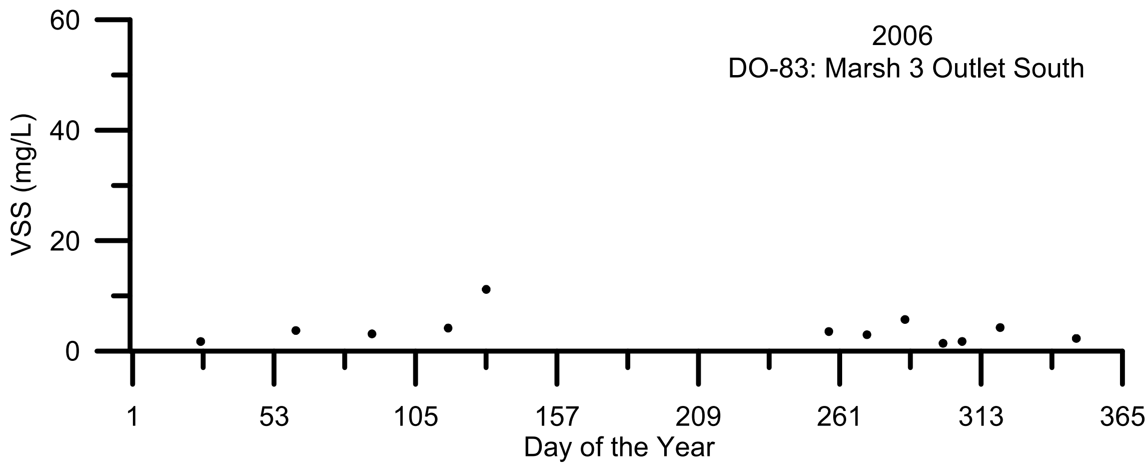

2007
DO-81: Marsh 1 Outlet South
VSS (mg/L)
40
30
20
10
0
-10
1
53
105
157
209
261
313
365
Day of the Year

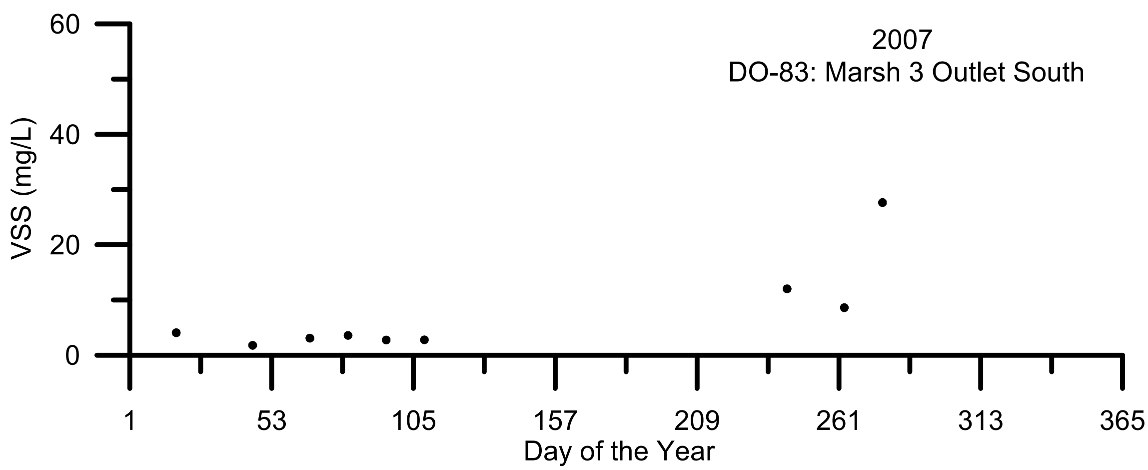

2005
DO-82: Marsh 3 Inlet South
VSS (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

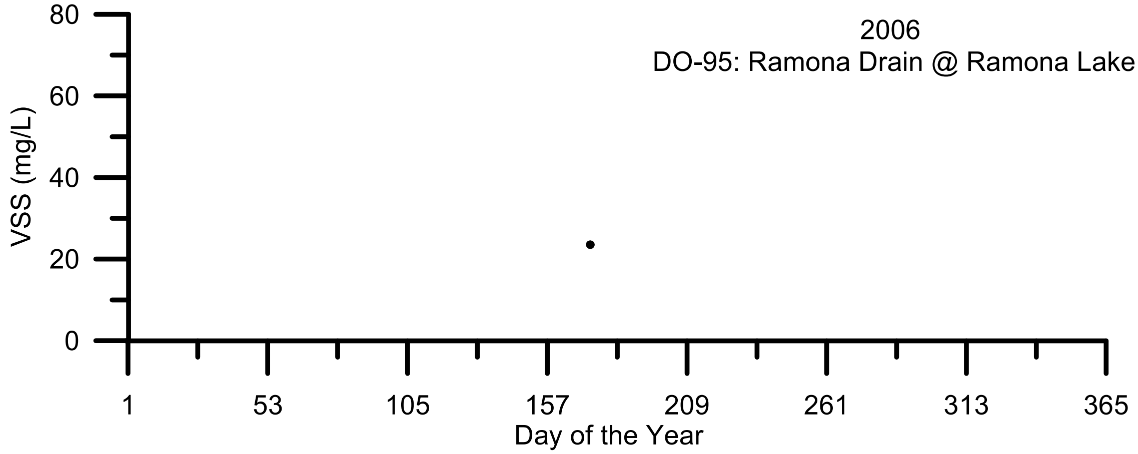

2006
DO-82: Marsh 3 Inlet South
VSS (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-82: Marsh 3 Inlet South
VSS (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

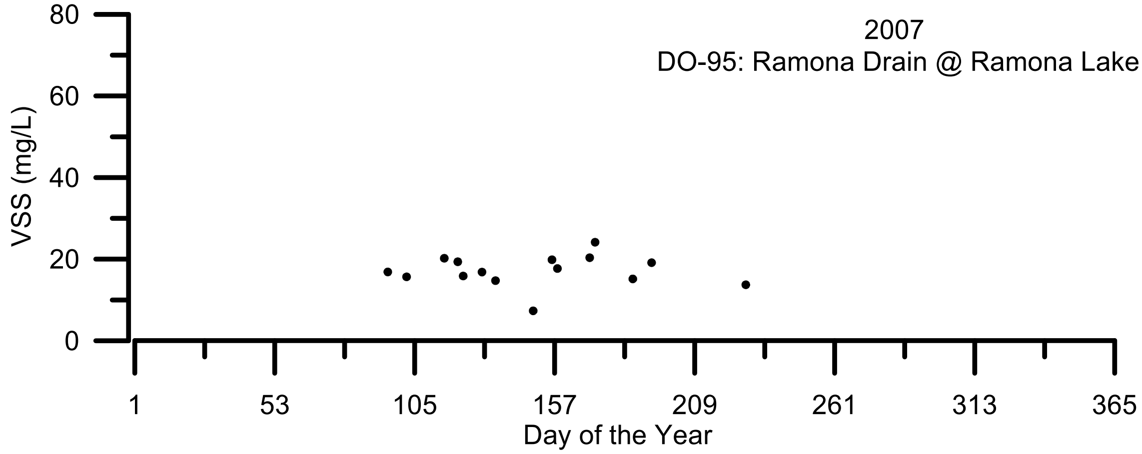

2005
DO-83: Marsh 3 Outlet South
VSS (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-83: Marsh 3 Outlet South
VSS (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-83: Marsh 3 Outlet South
VSS (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year



2006
DO-95: Ramona Drain @ Ramona Lake
VSS (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year



2007
DO-95: Ramona Drain @ Ramona Lake
VSS (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

Analysis of Dissolved Organic Carbon in Addition to Volatile Suspended Solid (VSS + DOC) Concentrations, as a Measure of Total Organic Solids in the San Joaquin River Watershed 2005-2007

Remie Burks
Chelsea Spier
Sharon Borglin
Jeremy Hanlon
Justin Graham
William Stringfellow

February 2008

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University of the Pacific
3601 Pacific Avenue, Sears Hall
Stockton CA 95211

Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 sampling locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report presents temporal plots of volatile suspended solids in addition to dissolved organic carbon as a measure of total organic solids for all sites sampled in the SJR from 2005-2007.

Methods

Field sampling consisted of collecting water samples, measuring water quality with a YSI Sonde 6600 with MDS650 hand-held display, and recording of field conditions at sites within the study area per *EERP Field Protocol Book* (Graham, 2008).

Water samples were collected in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN) in accordance with requirements for different lab analysis and volume requirements.

Samples were immediately stored at 4°C after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the lab on the day of sampling.

Samples were received by the laboratory the same day they were sampled and stored at 4°C until filtering and analysis. Samples were collected, preserved, stored, and analyzed by methods outlined in *Standard Methods for the Analysis of Water and Wastewater*, (APHA, 2005, 1998). Filtered water samples were analyzed for dissolved organic carbon (DOC) on a Teledyne-Tekmar Apollo 9000 (Mason, OH) by high temperature combustion according to SM 5310 B (APHA, 2005) and quantified on using a NDIR detector. DOC samples were preserved < pH 2 with concentrated H_3PO_4 and stored at 4°C until analysis. The limit of detection for DOC is 1.00mg/L C.

Total suspended solids (TSS) and volatile suspended solids (VSS) were analyzed by SM 2540 D and E (APHA, 2005). Typically 1000 mL of sample was filtered on pre-weighed, pre-combusted, Whatman GF/F filters. The filters were placed in an aluminum dish and dried at 105°C under vacuum to constant weight. After drying the filter and dish were allowed to cool in a dessicator and were weighed for TSS determination. The dried and weighted filters were subsequently combusted at 550°C for 6 hours and reweighed for VSS determination. Mineral suspended solids (MSS) concentration was calculated by subtracting VSS from TSS.

Dissolved organic carbon results (mg/L C) were than added to volatile suspended solid values (mg/L) for the following samples as a measure of total organic solids for each sample.

Results and Discussion

Both volatile suspended solid (VSS) analysis and dissolved organic carbon analysis were preformed routinely over the years 2005-2007 although using two different Apollo 9000HS instruments for DOC analysis. VSS analysis had a 94.44% passage rate while DOC had a 98.94% passage rate for all QA parameters over the three year period (Borglin et. al., 2008). Apollo 9000 high sensitivity instruments are challenging to maintain and on a few occasions sample sets were analyzed by outside laboratories due to malfunctions of the instrument that could not be repaired within the holding time for these samples.

References

Stringfellow, W.T., et al., (2008), *Evaluation of Vegetated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley*, University of the Pacific, Stockton, CA

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008), *EERP Field Protocol Book*, University of the Pacific, Stockton, CA.

Borglin, S., W. Stringfellow, J. Hanlon. (2005), Standard *Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project*, LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA

American Public Health Association, (2005), *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, Washington, D.C.

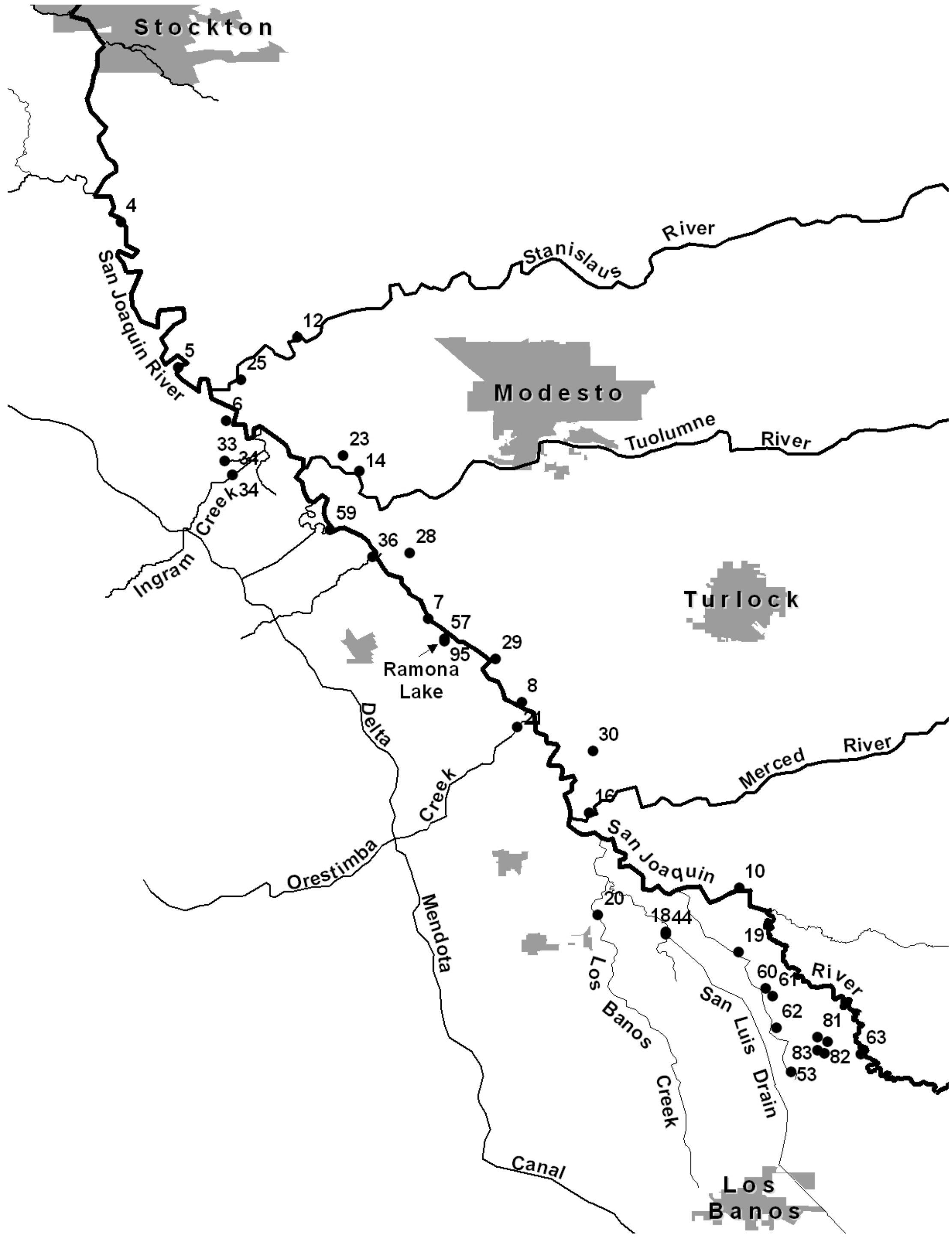
Borglin, S.E., Burks, R.D., Hanlon, J.S., Stringfellow, W.T. (2008*) EERP Lab Protocol Book*, University of the Pacific, Stockton, CA.

YSI Environmental Operations Manual, (2005), 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

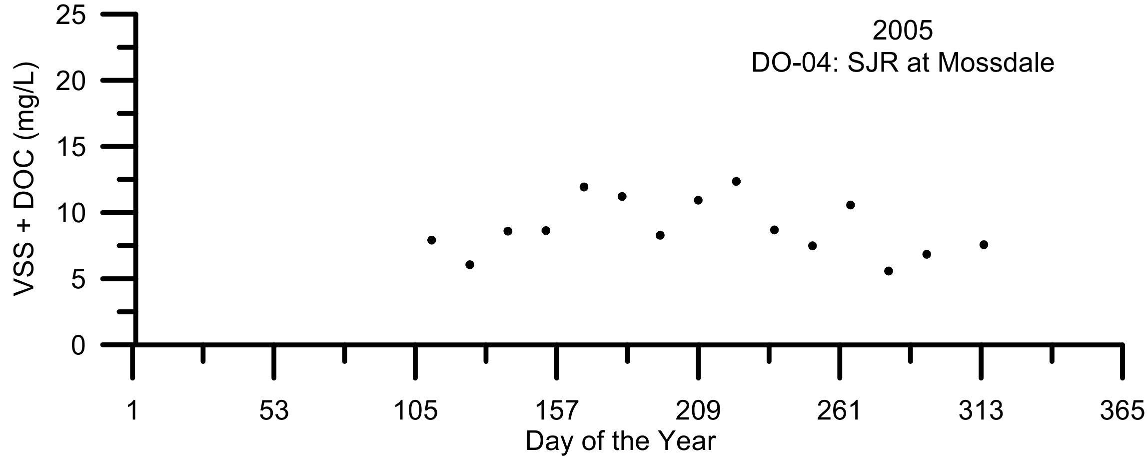
Table 1: EERP Sampling Site List

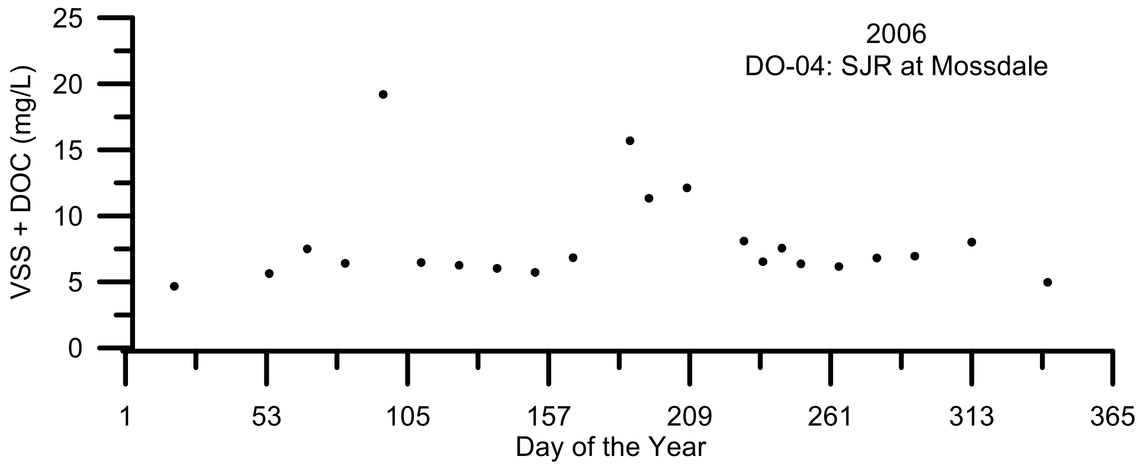
DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
53	**Salt Slough at Wolfsen Road**	Wetland
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
60	**Moffit 1 South**	Wetland
61	**Deadman's Slough**	Wetland
62	**Mallard Slough**	Wetland
63	**Inlet C Canal**	Wetland
80	**South Marsh-1-Inlet**	Wetland
81	**South Marsh-1-Outlet**	Wetland
82	**South Marsh-3-Inlet**	Wetland
83	**South Marsh-3-Outlet**	Wetland
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

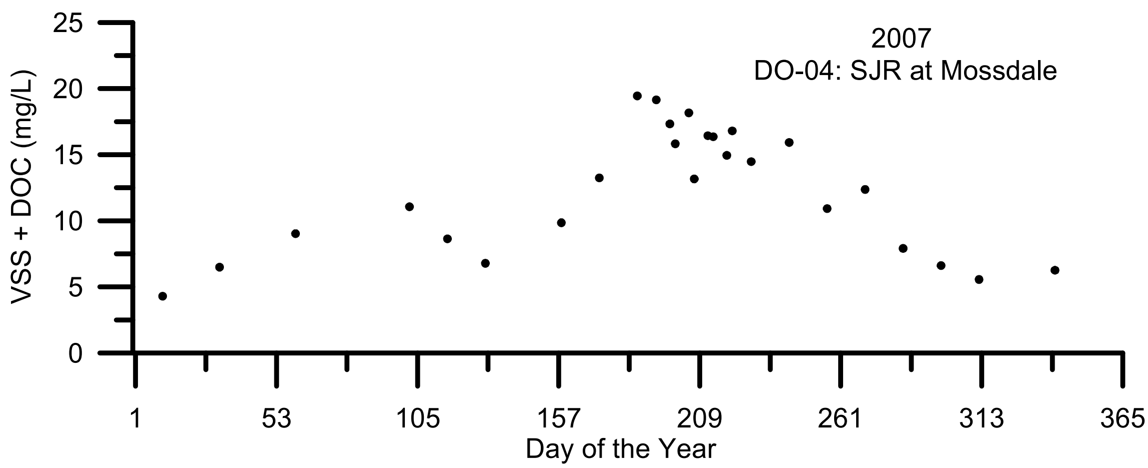
Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

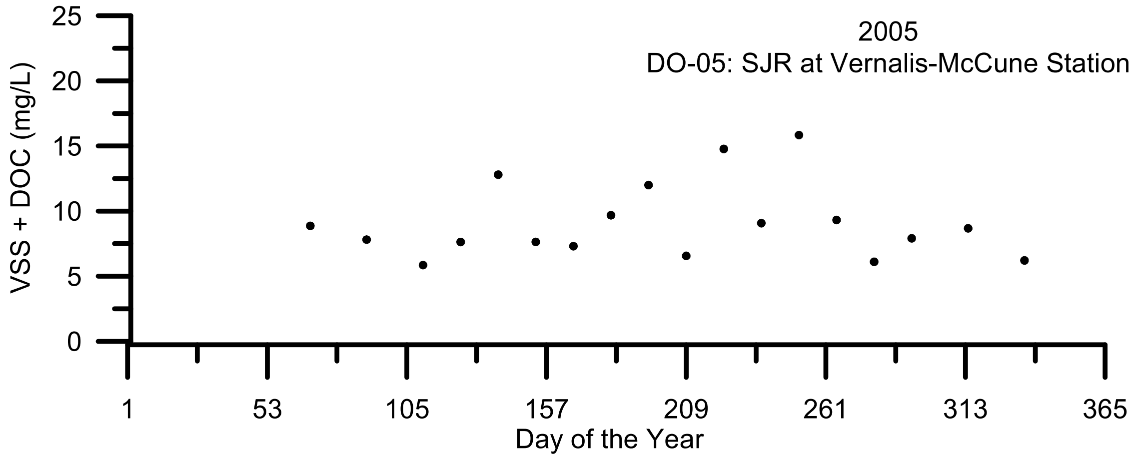


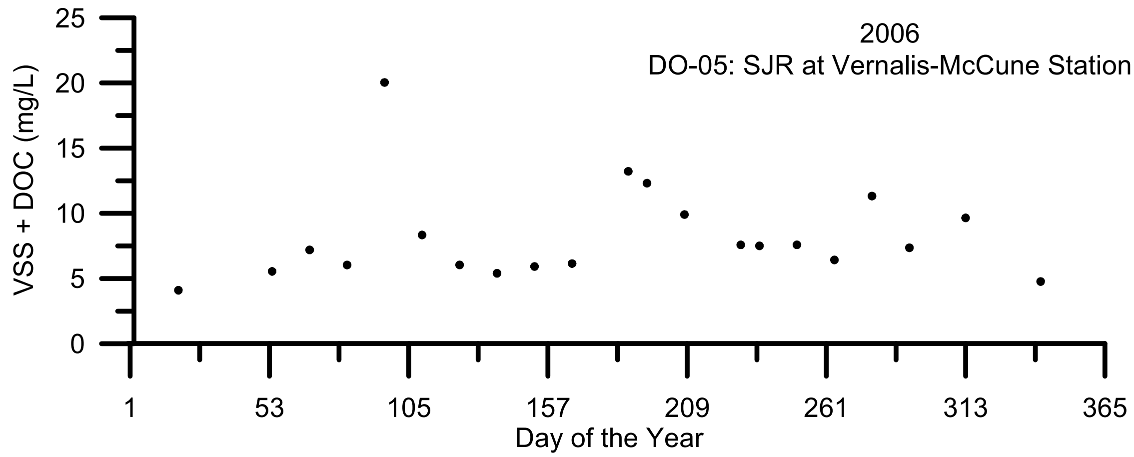
Figures 2 -101: Temporal Plots of VSS + DOC Concentrations By Site ID








2005
DO-05: SJR at Vernalis-McCune Station
VSS + DOC (mg/L)
Day of the Year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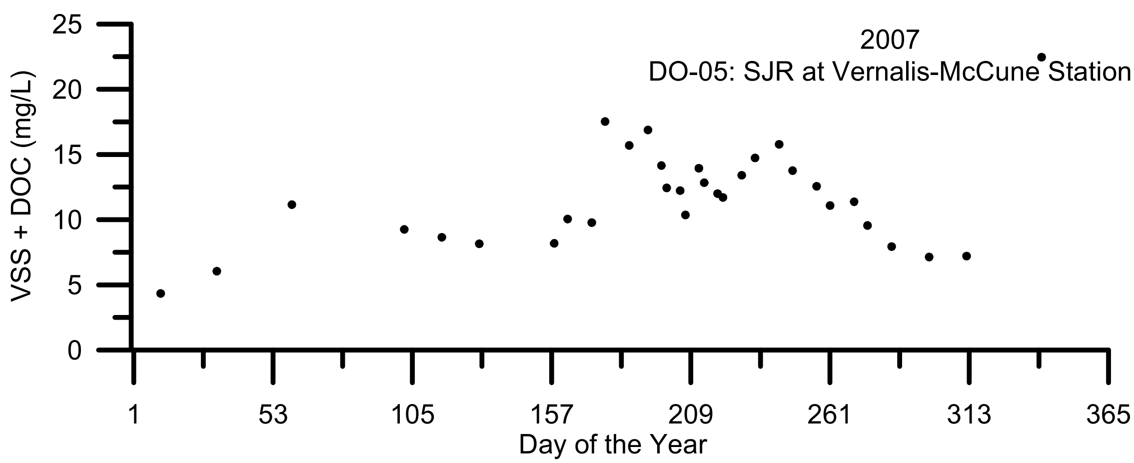
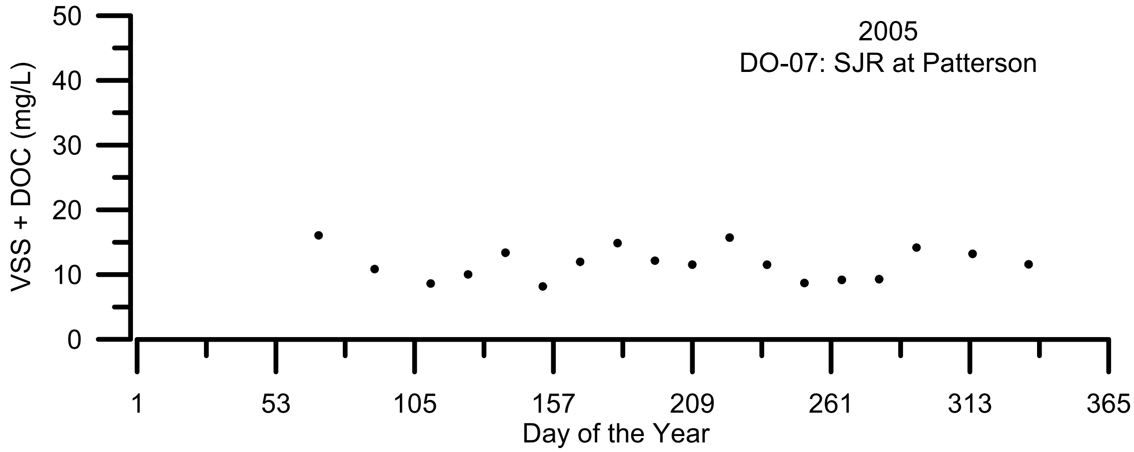
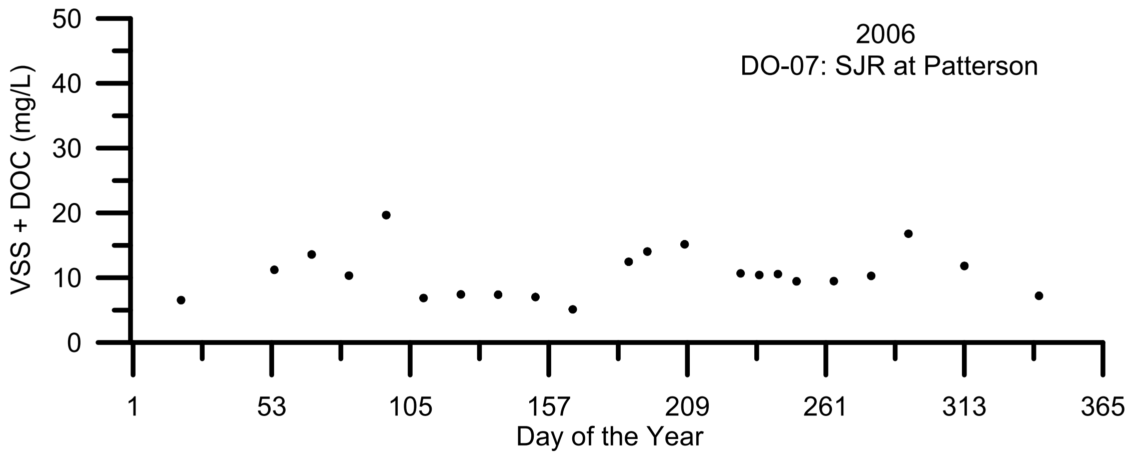
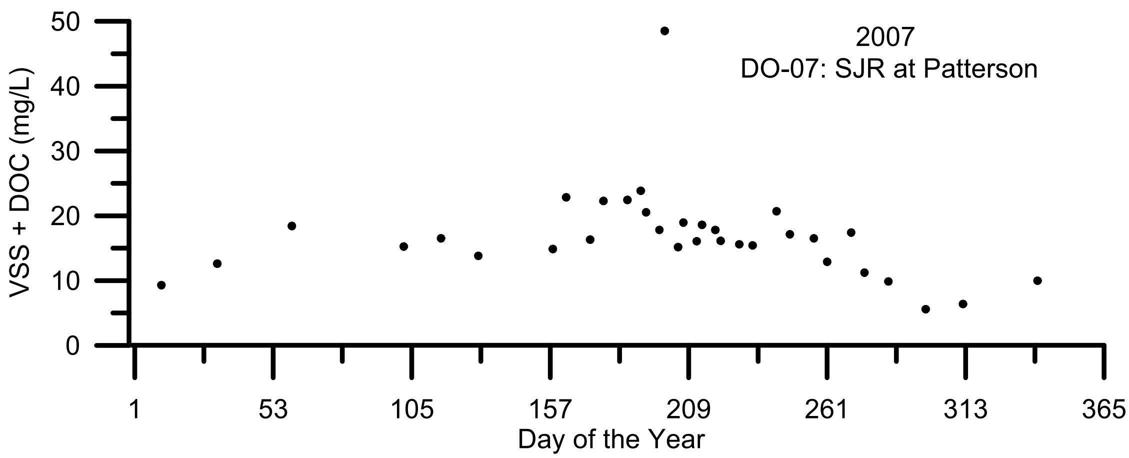
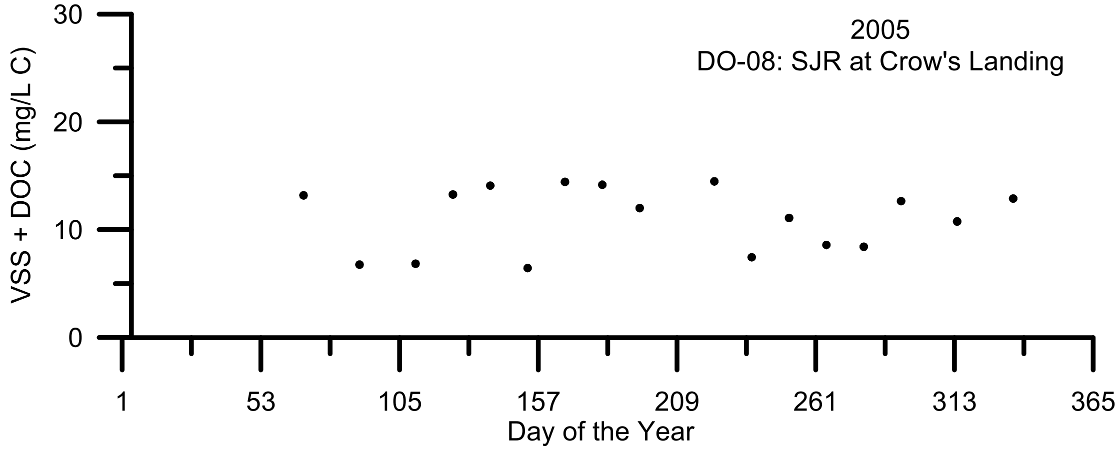
DO-05: SJR at Vernalis-McCune Station
VSS + DOC (mg/L)
Day of the Year

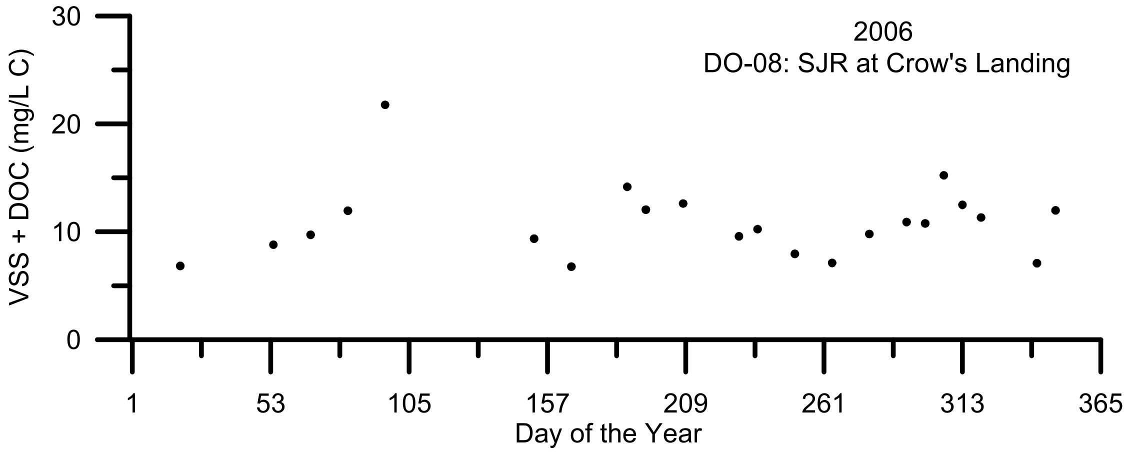

2007
DO-05: SJR at Vernalis-McCune Station
VSS + DOC (mg/L)
Day of the Year

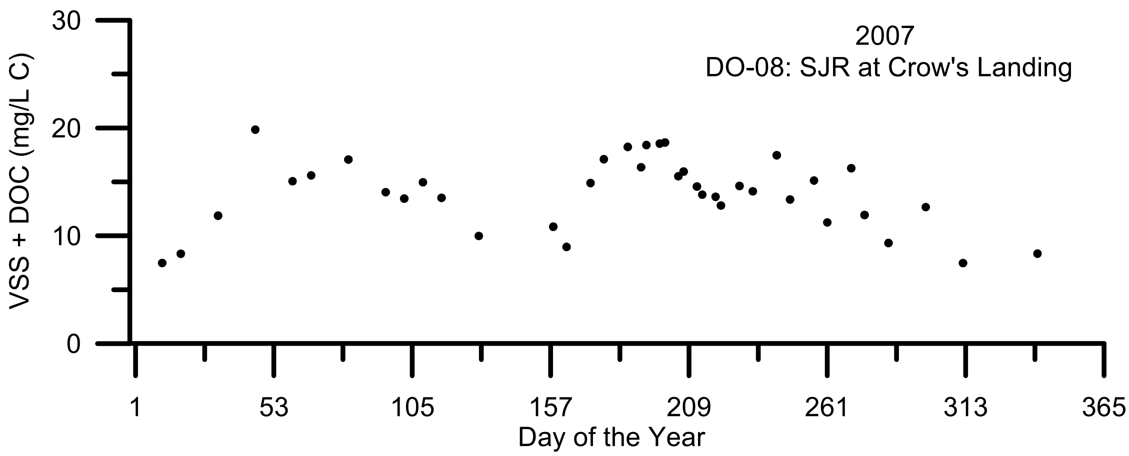

2005
DO-07: SJR at Patterson
VSS + DOC (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

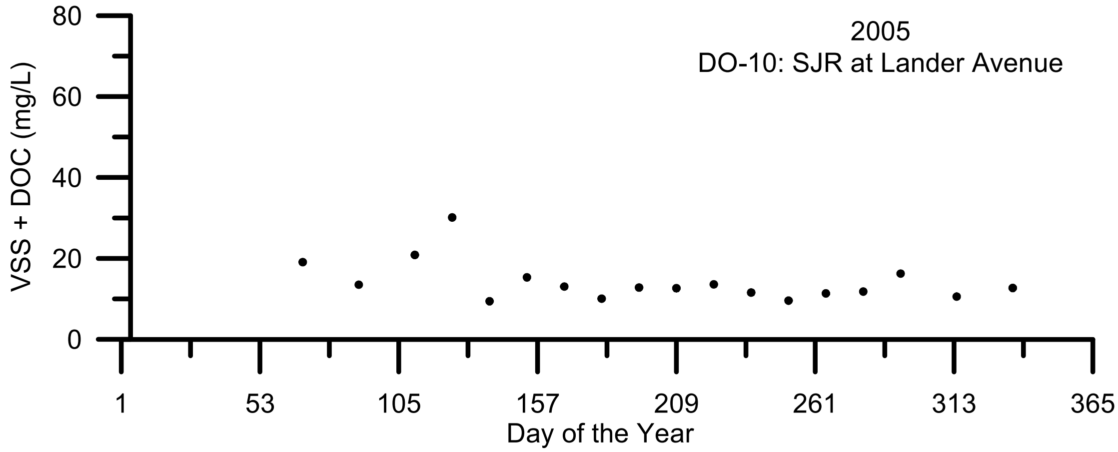

2006
DO-07: SJR at Patterson
VSS + DOC (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

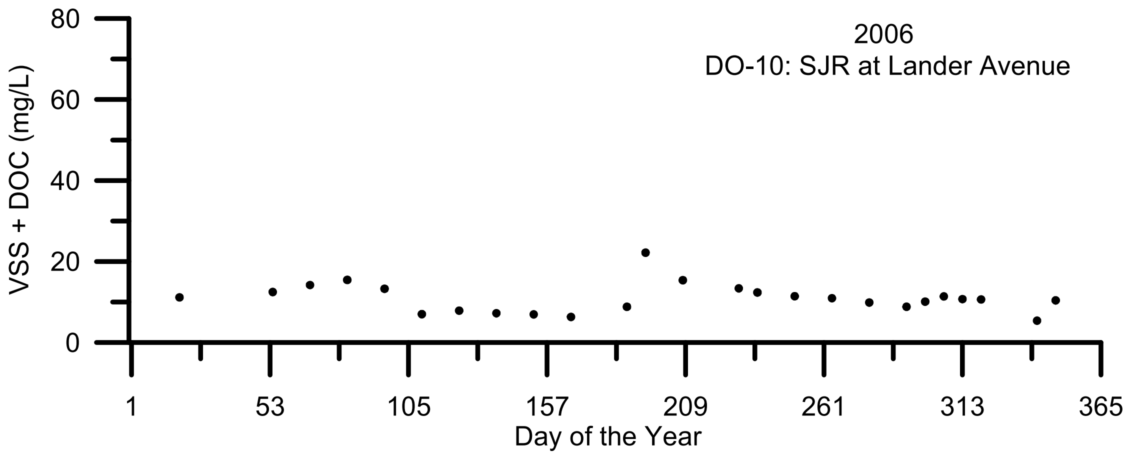

2007
DO-07: SJR at Patterson
VSS + DOC (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

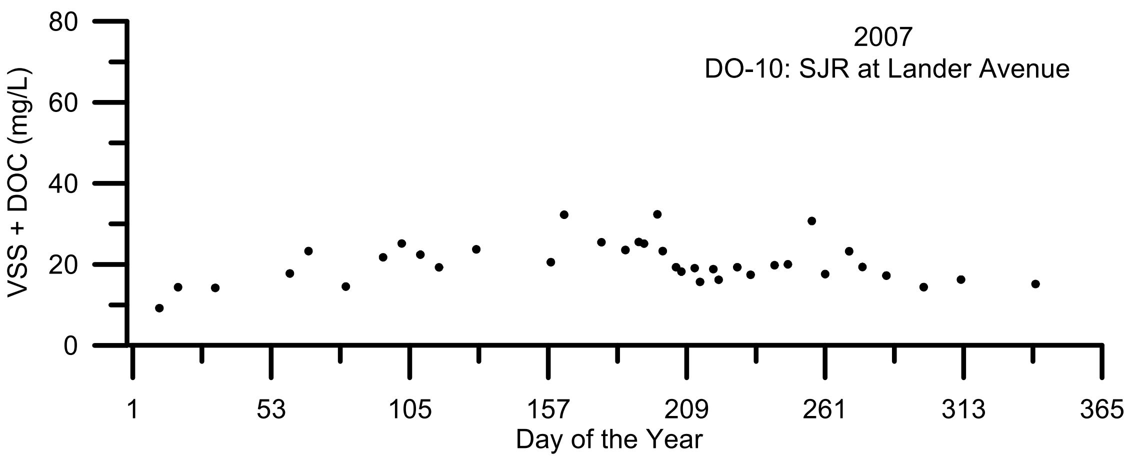

2005
DO-08: SJR at Crow's Landing
VSS + DOC (mg/L C)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

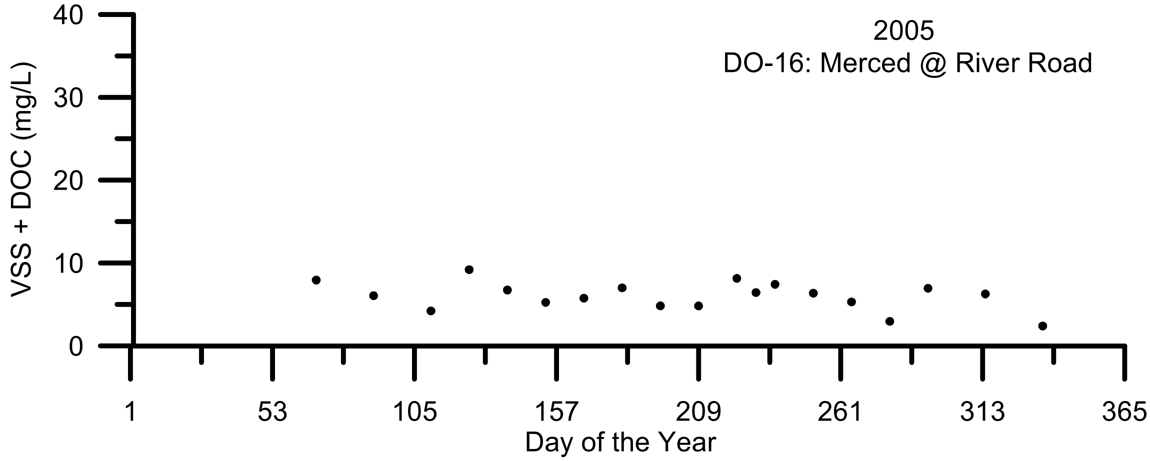

2006
DO-08: SJR at Crow's Landing
VSS + DOC (mg/L C)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

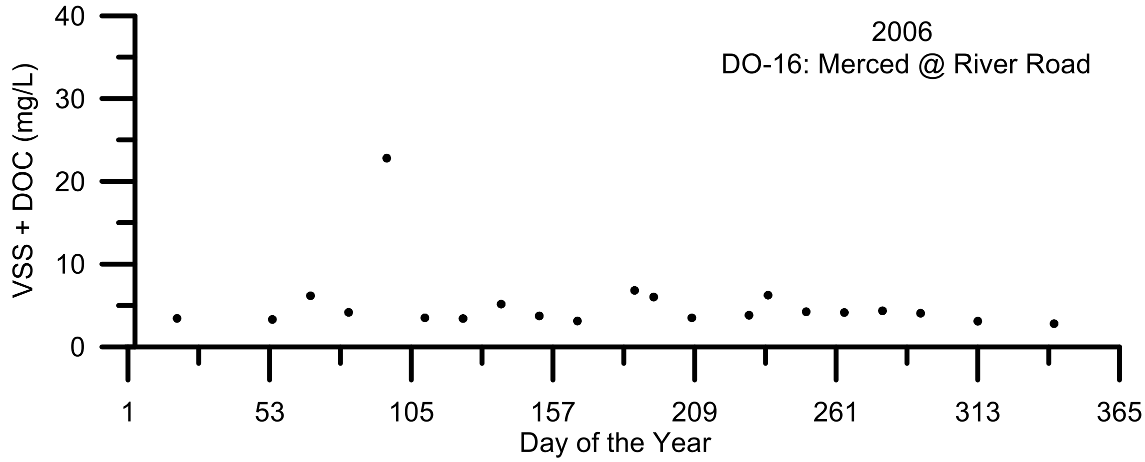

2007
DO-08: SJR at Crow's Landing
VSS + DOC (mg/L C)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

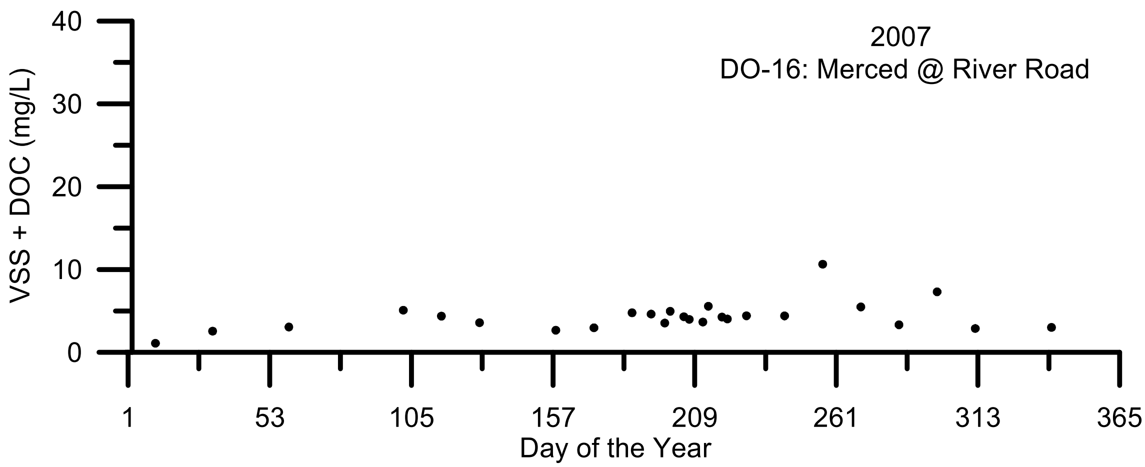

2005
DO-10: SJR at Lander Avenue
VSS + DOC (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

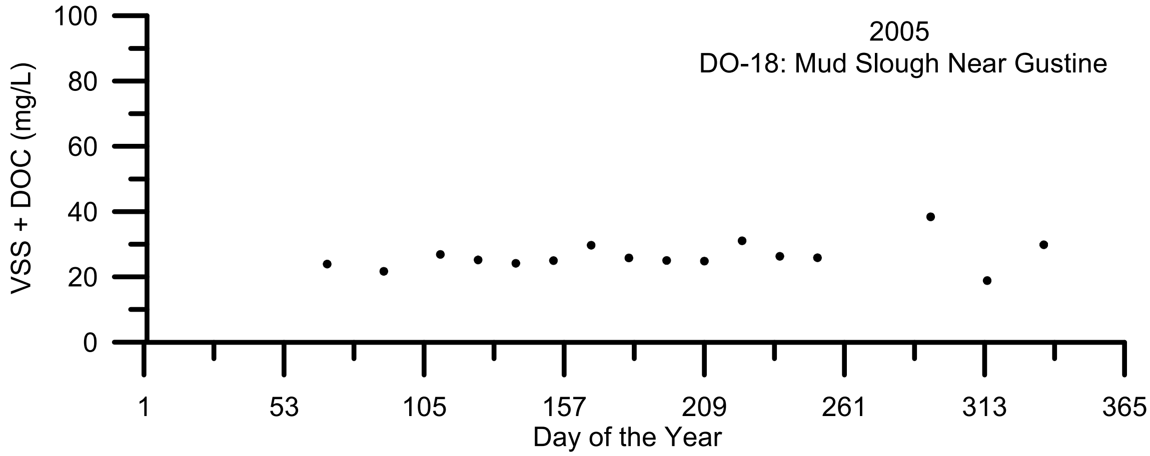

2006
DO-10: SJR at Lander Avenue
VSS + DOC (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

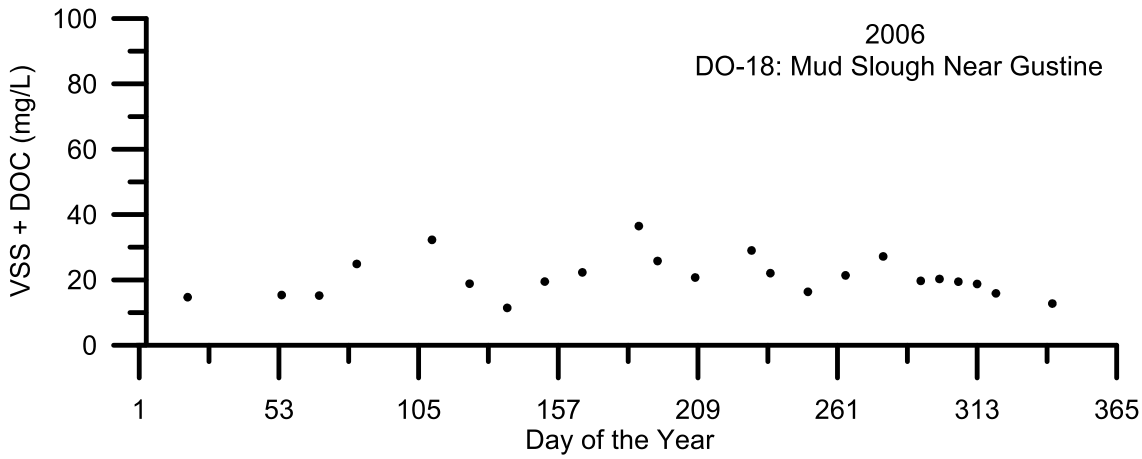

2007
DO-10: SJR at Lander Avenue
VSS + DOC (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

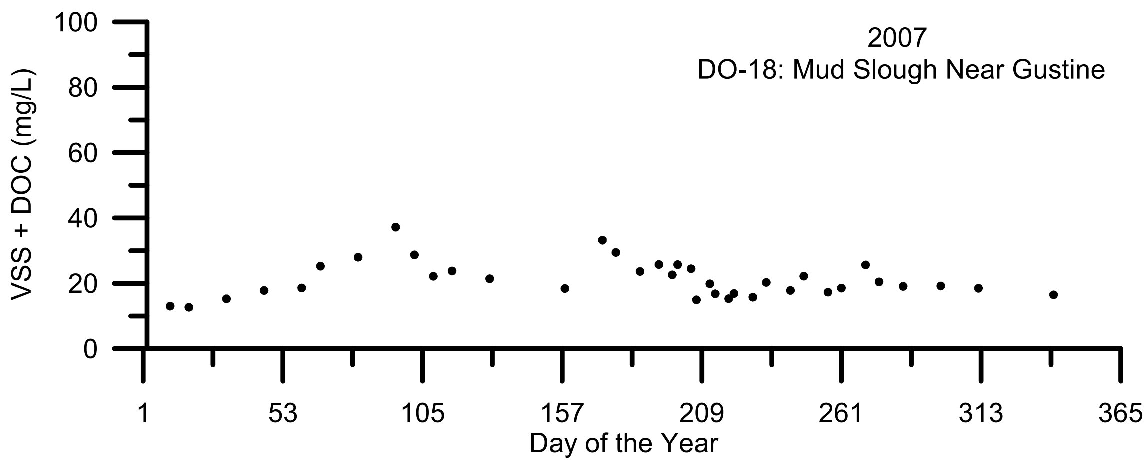

2005
DO-16: Merced @ River Road
VSS + DOC (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

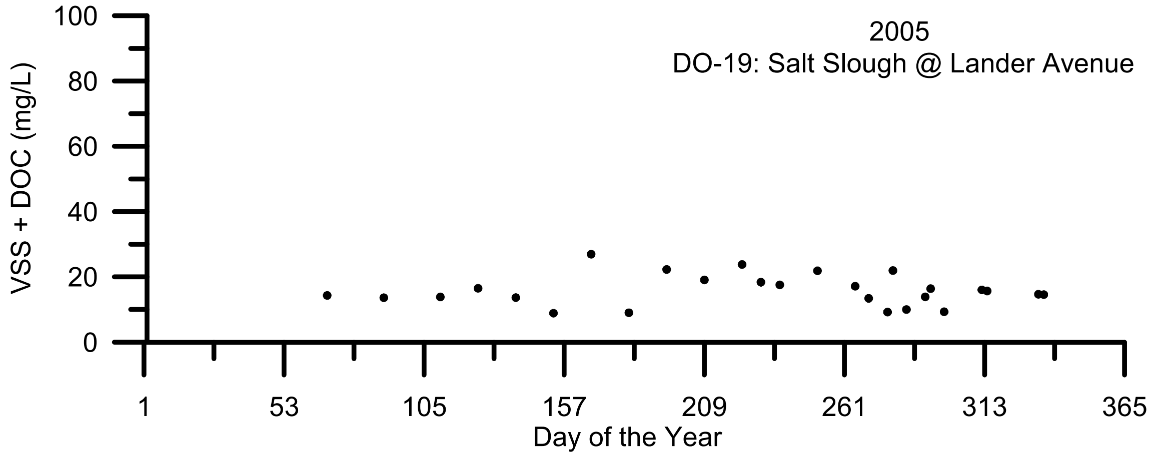

2006
DO-16: Merced @ River Road
VSS + DOC (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-16: Merced @ River Road
VSS + DOC (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

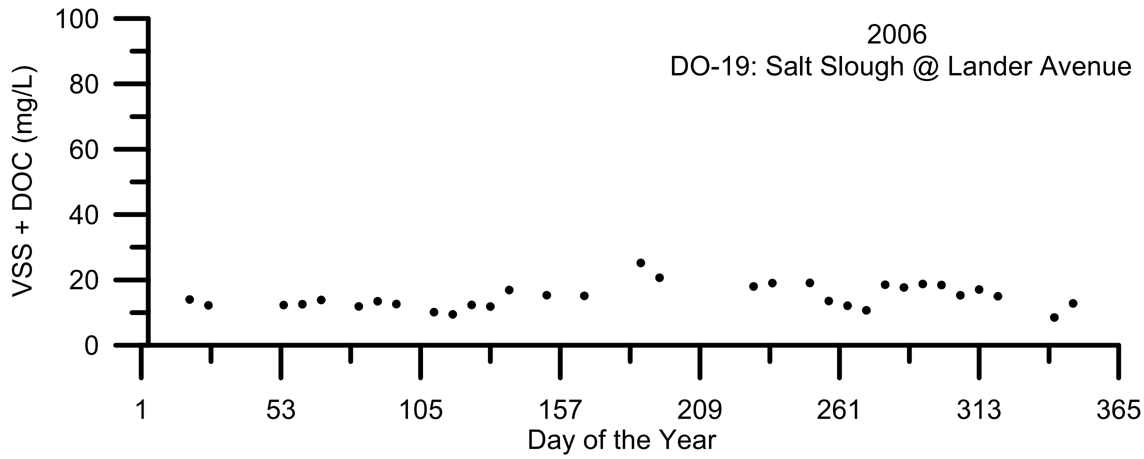

2005
DO-18: Mud Slough Near Gustine
VSS + DOC (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-18: Mud Slough Near Gustine
VSS + DOC (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

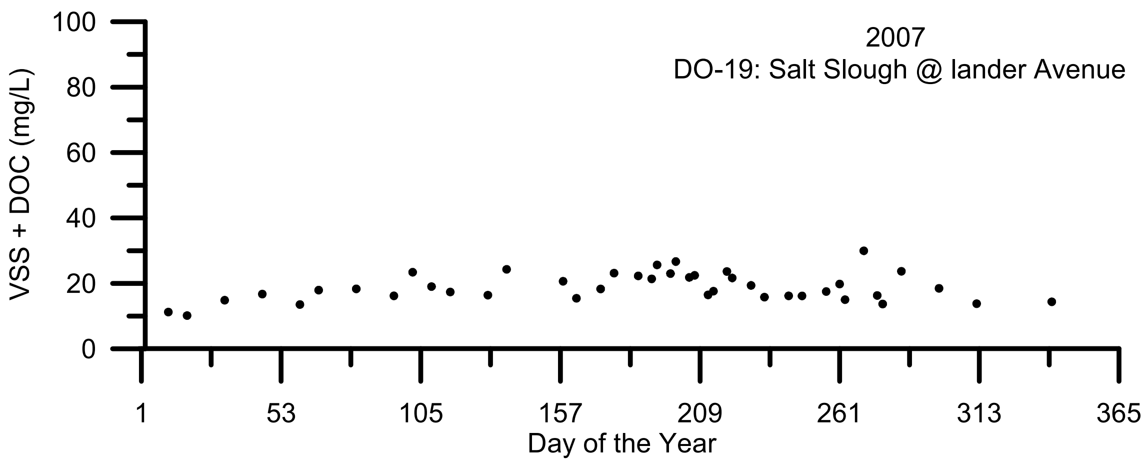

2007
DO-18: Mud Slough Near Gustine
VSS + DOC (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year



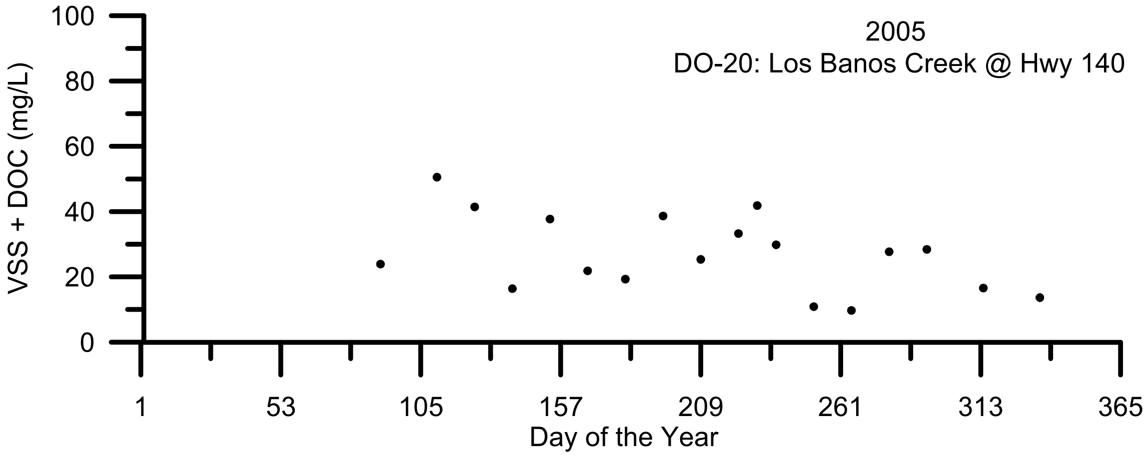
2005
DO-19: Salt Slough @ Lander Avenue
VSS + DOC (mg/L)
Day of the Year



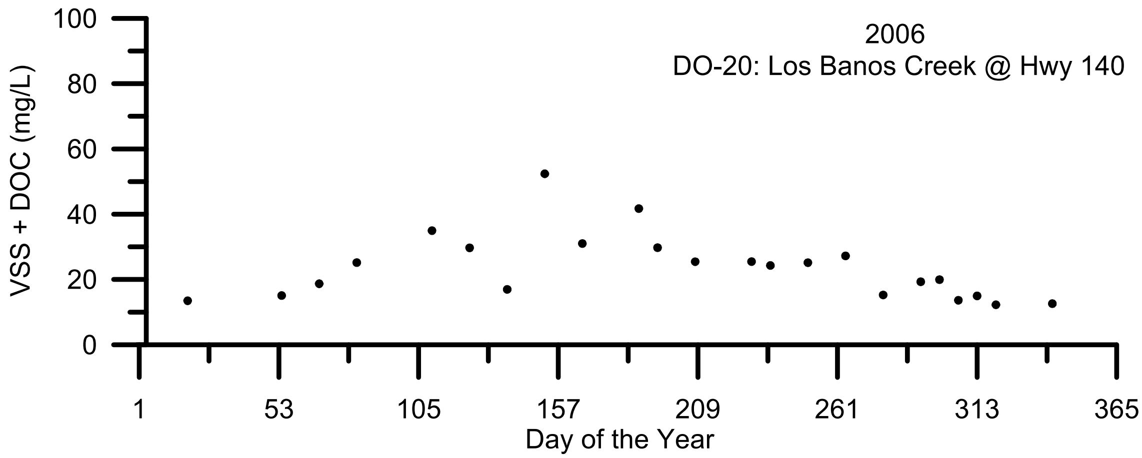
2006
DO-19: Salt Slough @ Lander Avenue
VSS + DOC (mg/L)
Day of the Year



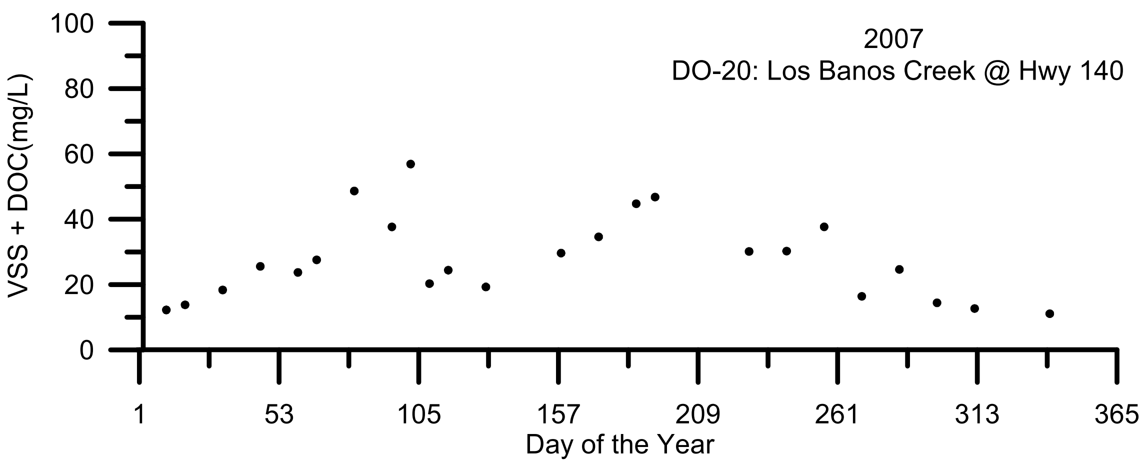
2007
DO-19: Salt Slough @ lander Avenue
VSS + DOC (mg/L)
Day of the Year



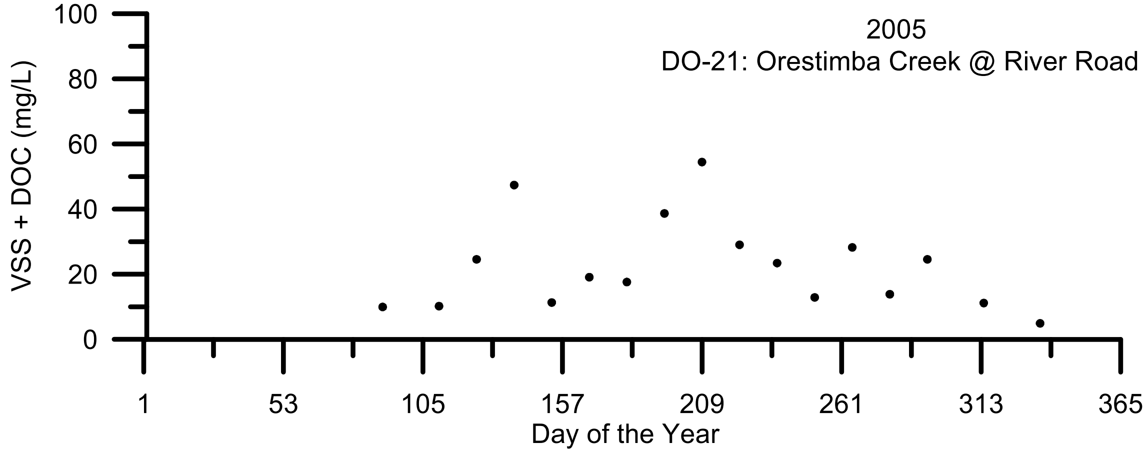
2005
DO-20: Los Banos Creek @ Hwy 140
VSS + DOC (mg/L)
Day of the Year

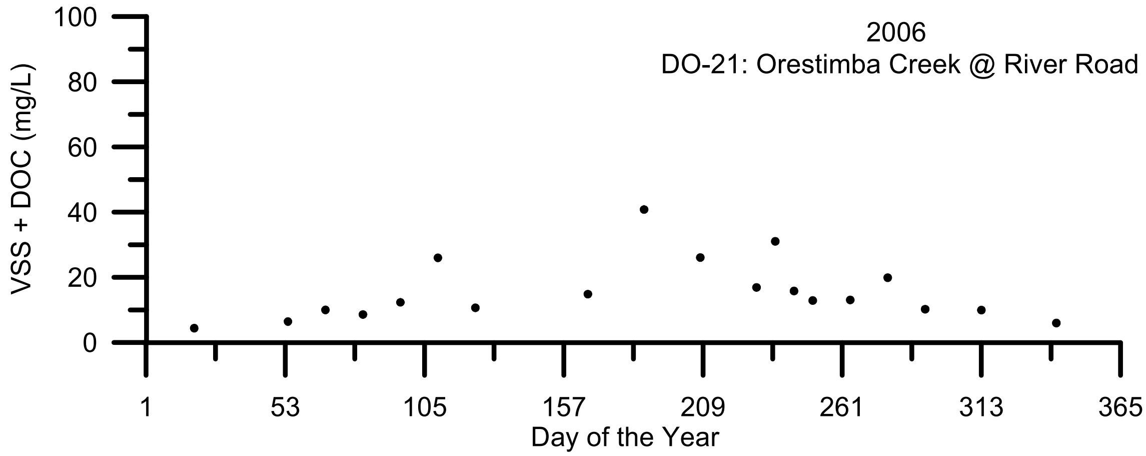


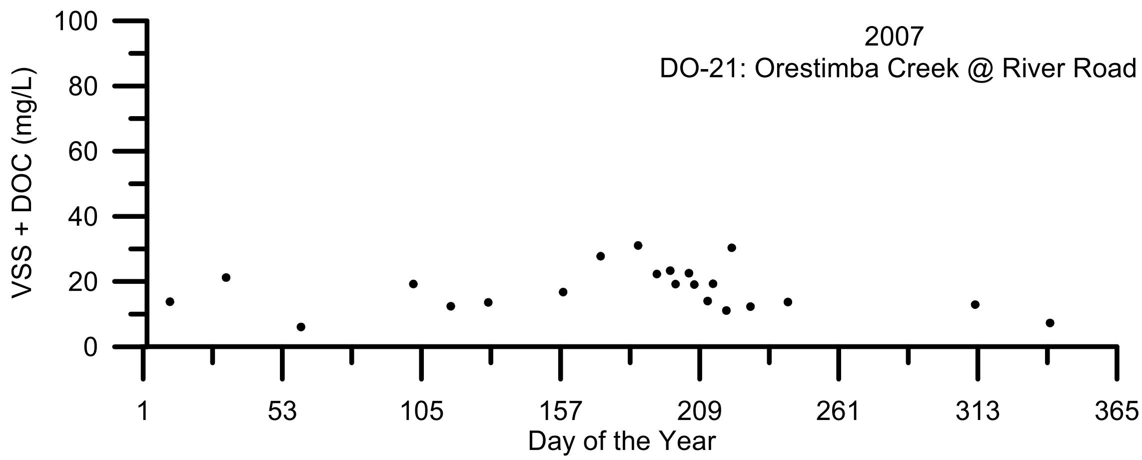
2006
DO-20: Los Banos Creek @ Hwy 140
VSS + DOC (mg/L)
Day of the Year

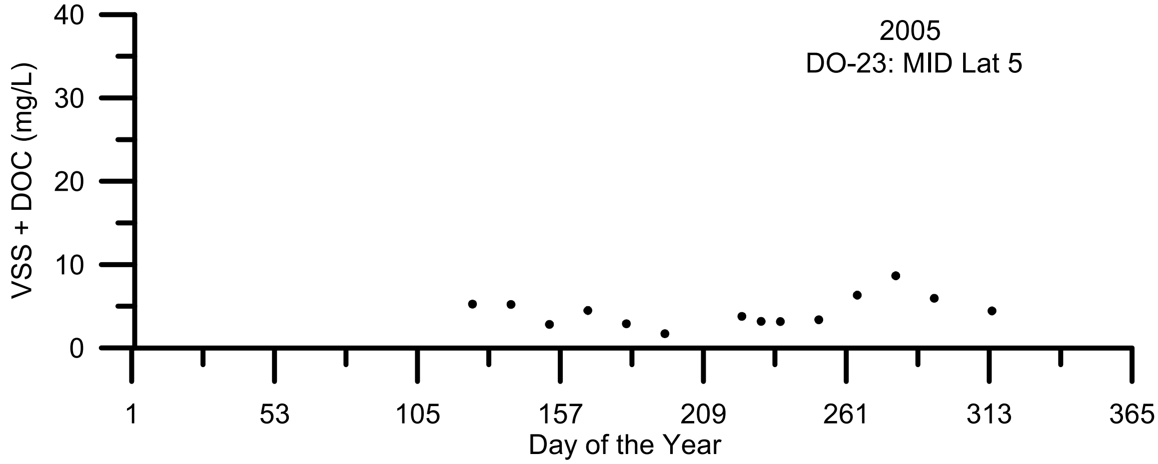


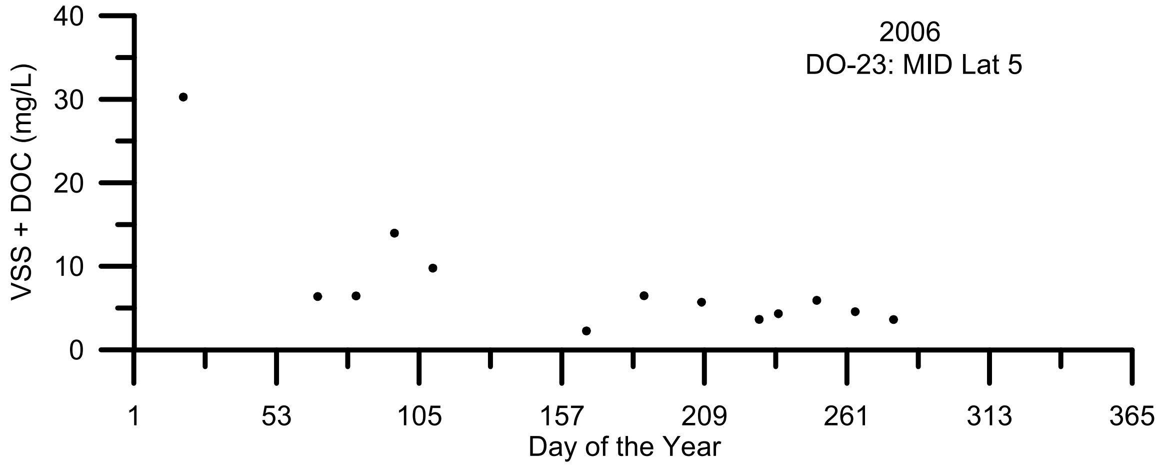
2007
DO-20: Los Banos Creek @ Hwy 140
VSS + DOC(mg/L)
Day of the Year

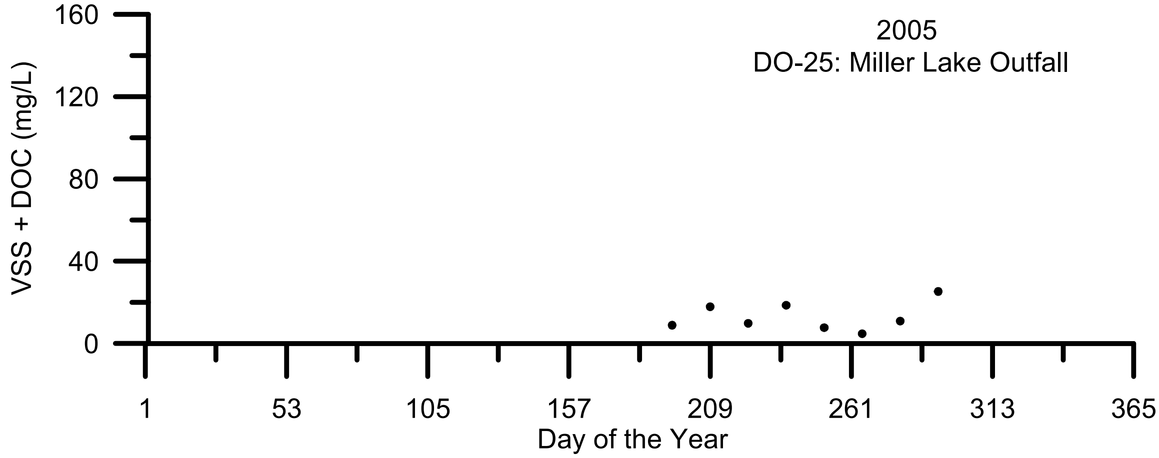

2005
DO-21: Orestimba Creek @ River Road
VSS + DOC (mg/L)
Day of the Year
0
20
40
60
80
100
1
53
105
157
209
261
313
365

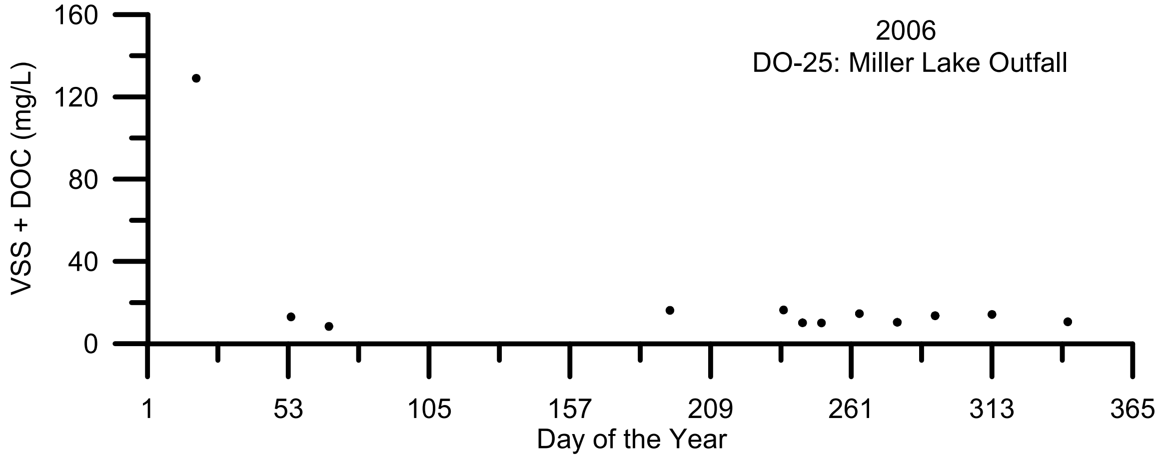

2006
DO-21: Orestimba Creek @ River Road
VSS + DOC (mg/L)
Day of the Year
0
20
40
60
80
100
1
53
105
157
209
261
313
365

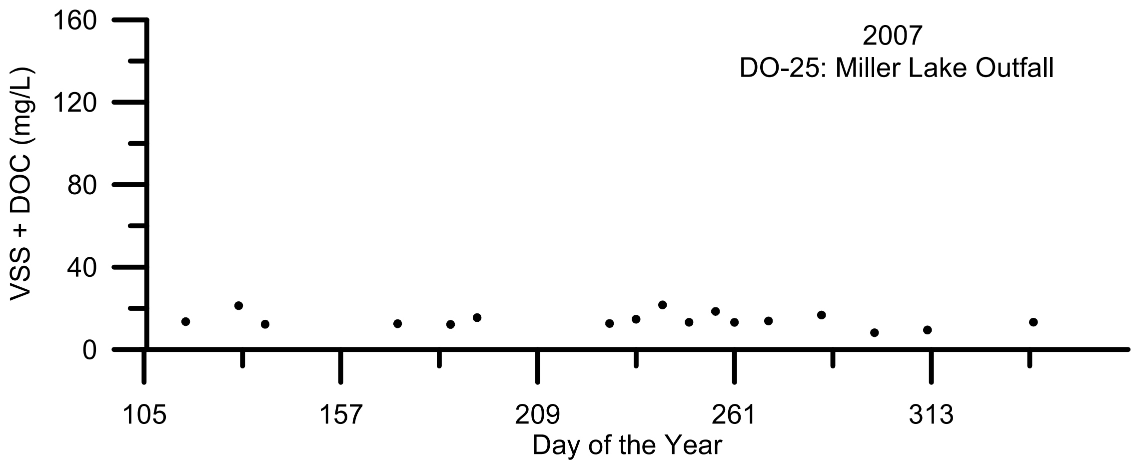

2007
DO-21: Orestimba Creek @ River Road
VSS + DOC (mg/L)
Day of the Year
0
20
40
60
80
100
1
53
105
157
209
261
313
365

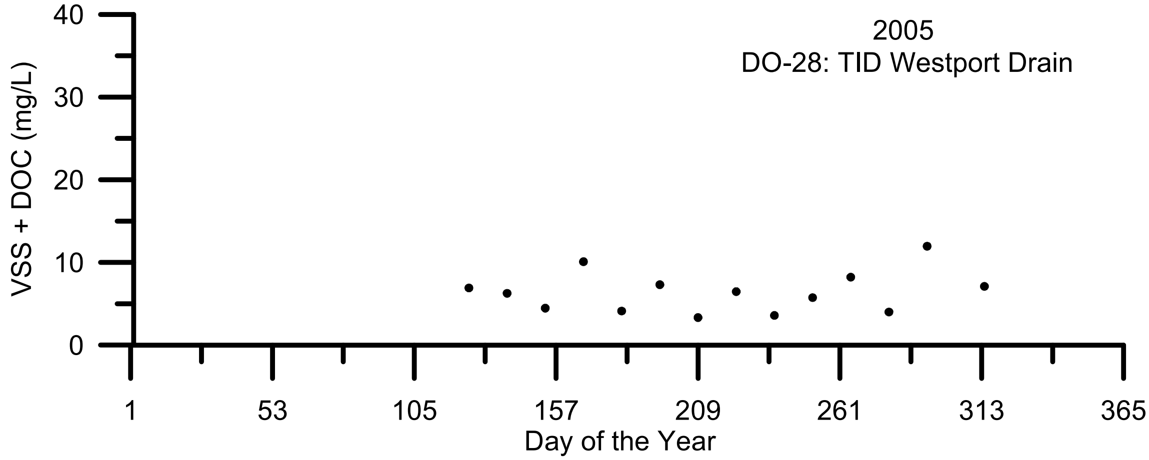

2005
DO-23: MID Lat 5
VSS + DOC (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

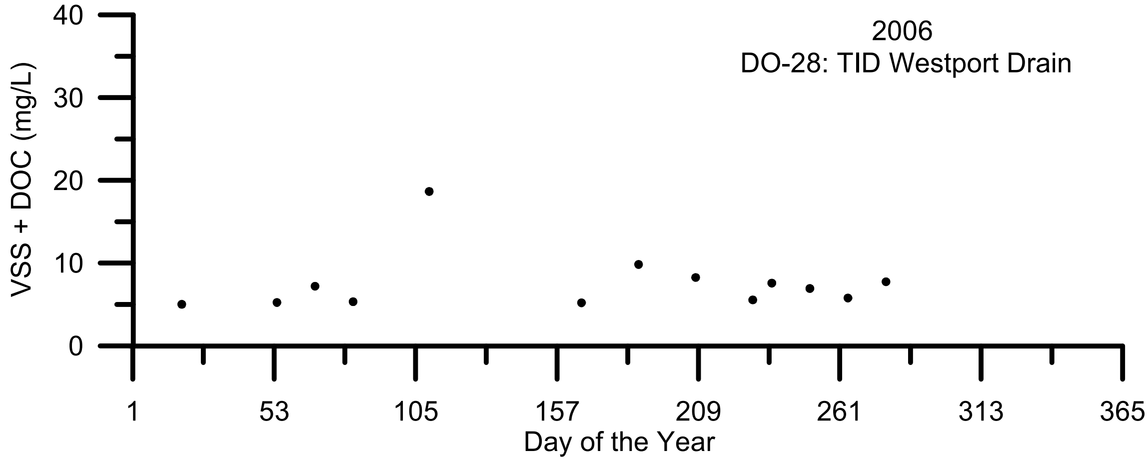

2006
DO-23: MID Lat 5
VSS + DOC (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

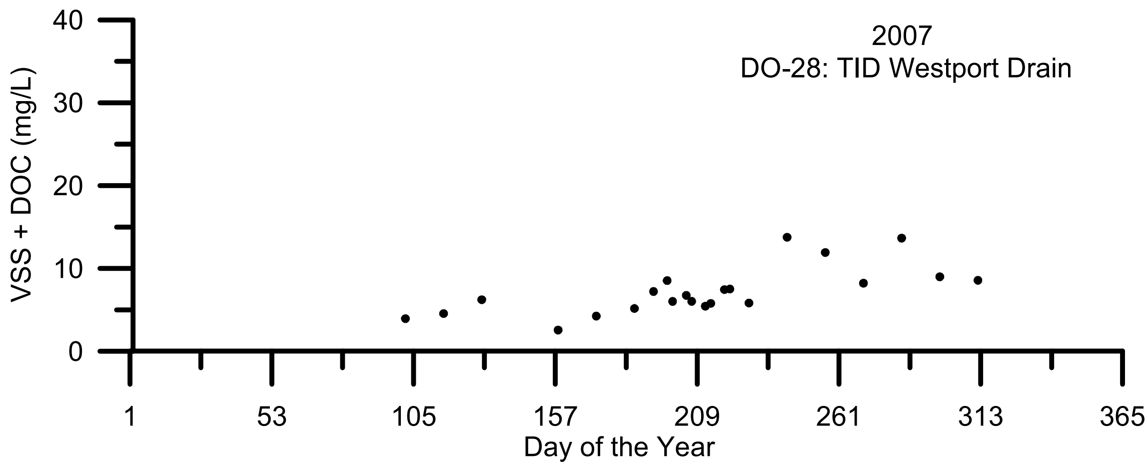

2005
DO-25: Miller Lake Outfall
VSS + DOC (mg/L)
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

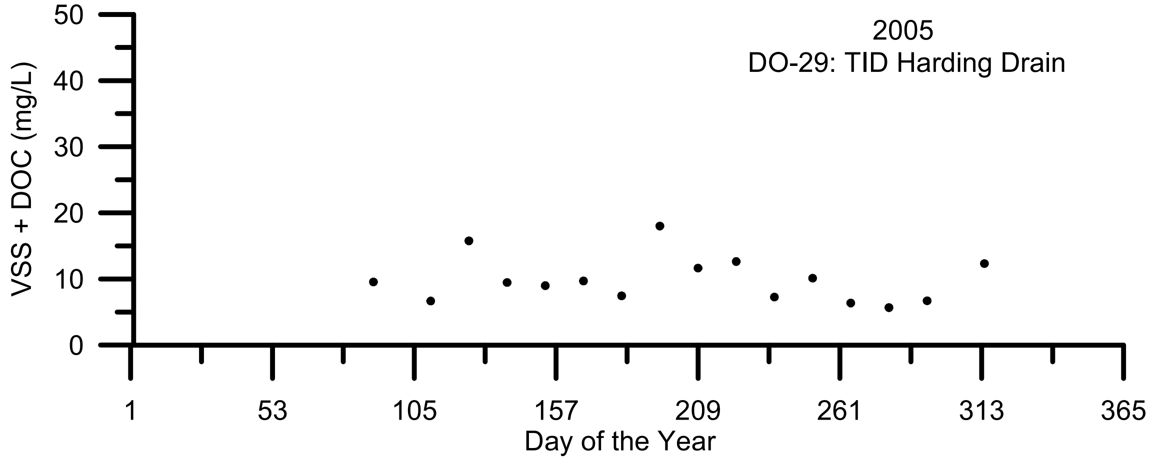

2006
DO-25: Miller Lake Outfall
VSS + DOC (mg/L)
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

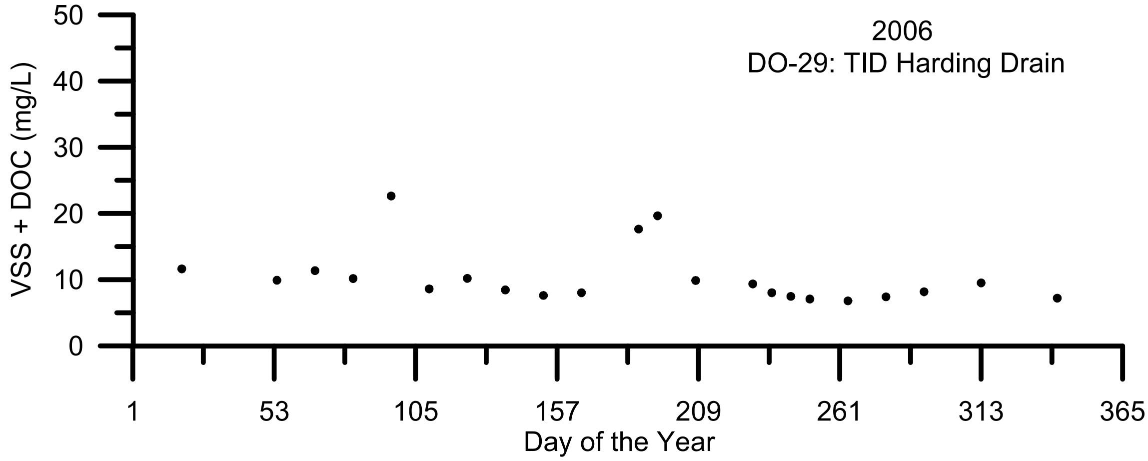

2007
DO-25: Miller Lake Outfall
VSS + DOC (mg/L)
160
120
80
40
0
105
157
209
261
313
Day of the Year

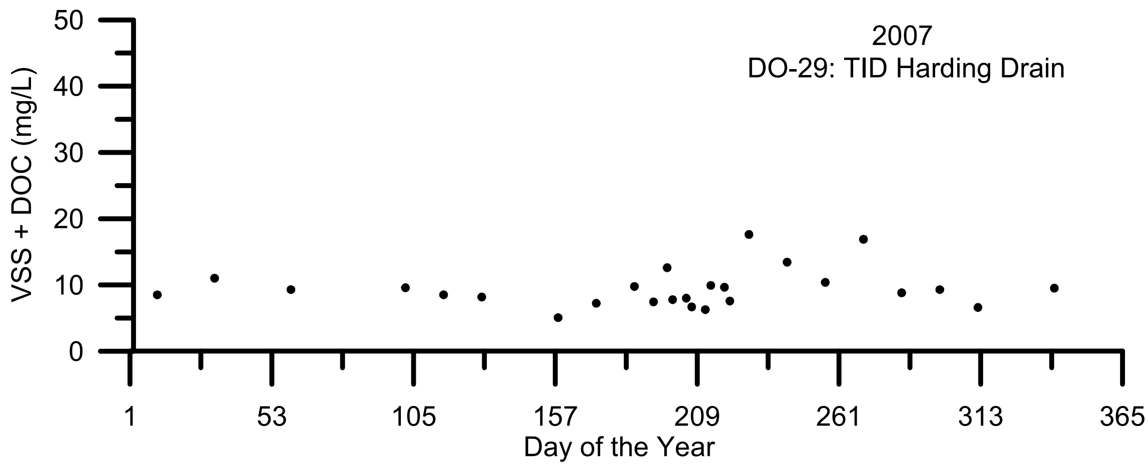

2005
DO-28: TID Westport Drain
VSS + DOC (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

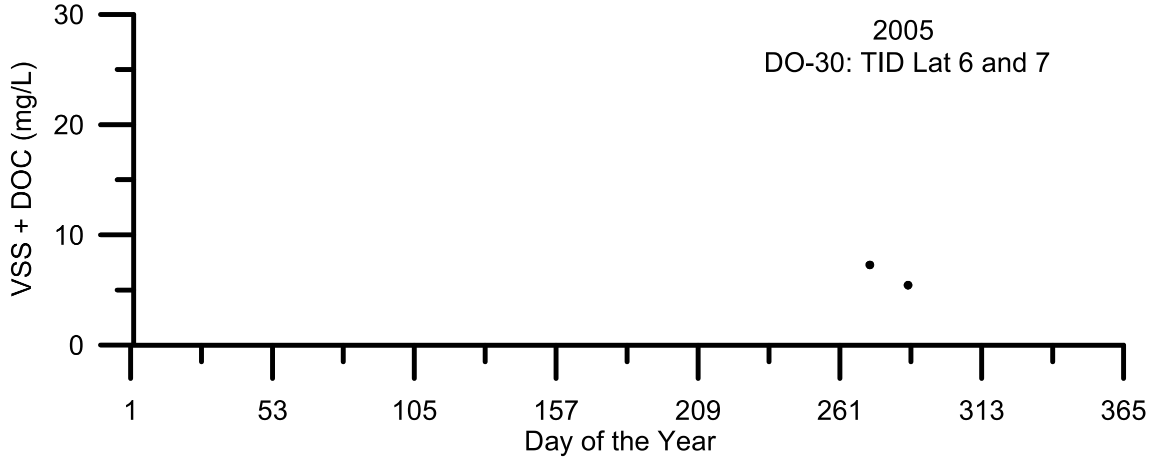

2006
DO-28: TID Westport Drain
VSS + DOC (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

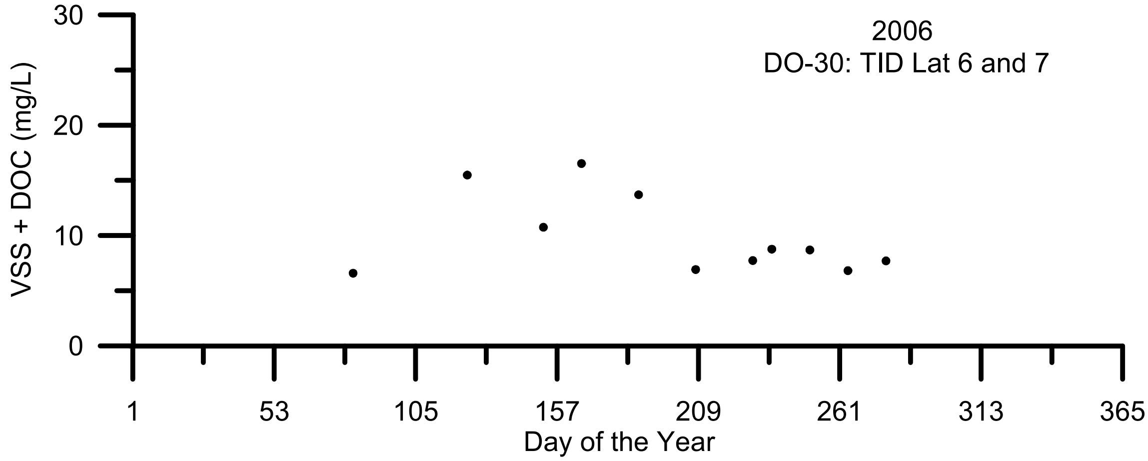

2007
DO-28: TID Westport Drain
VSS + DOC (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

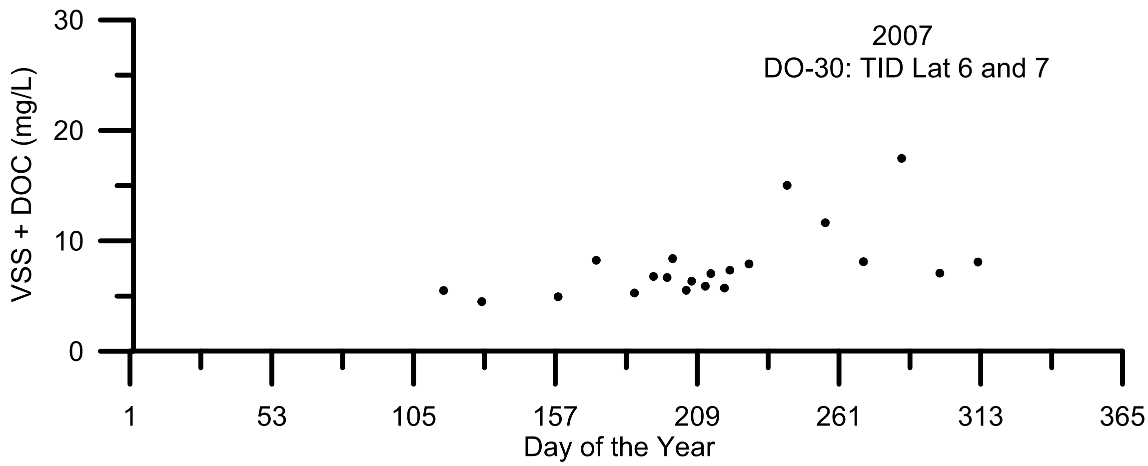

2005
DO-29: TID Harding Drain
VSS + DOC (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

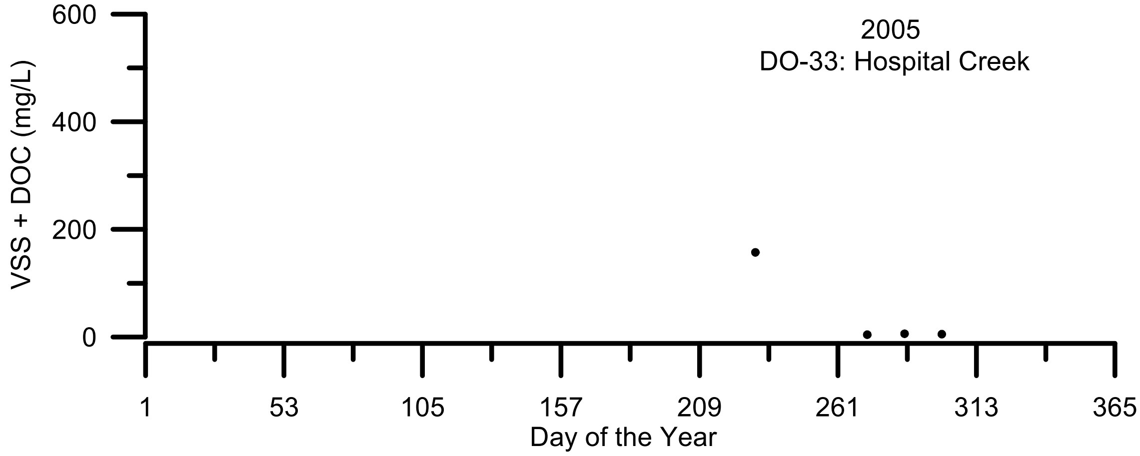

2006
DO-29: TID Harding Drain
VSS + DOC (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

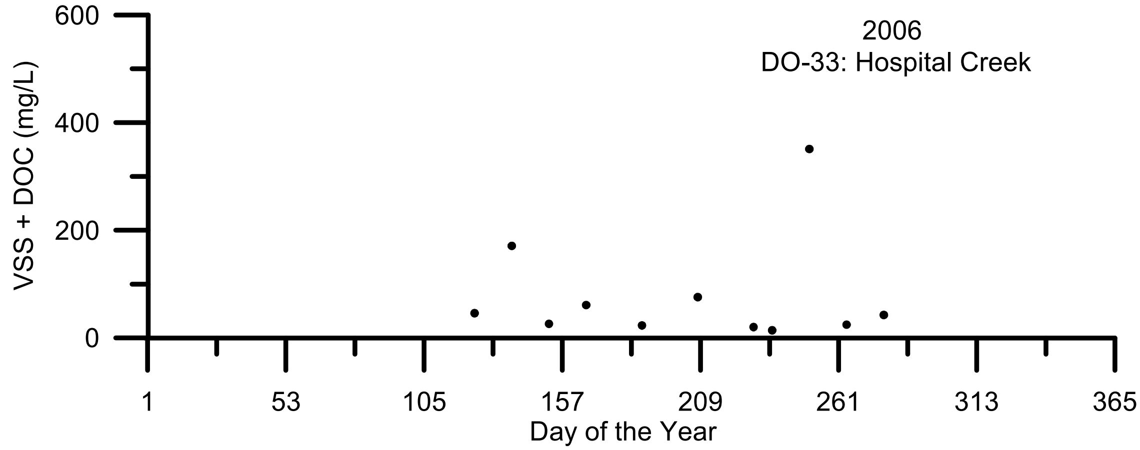

2007
DO-29: TID Harding Drain
VSS + DOC (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

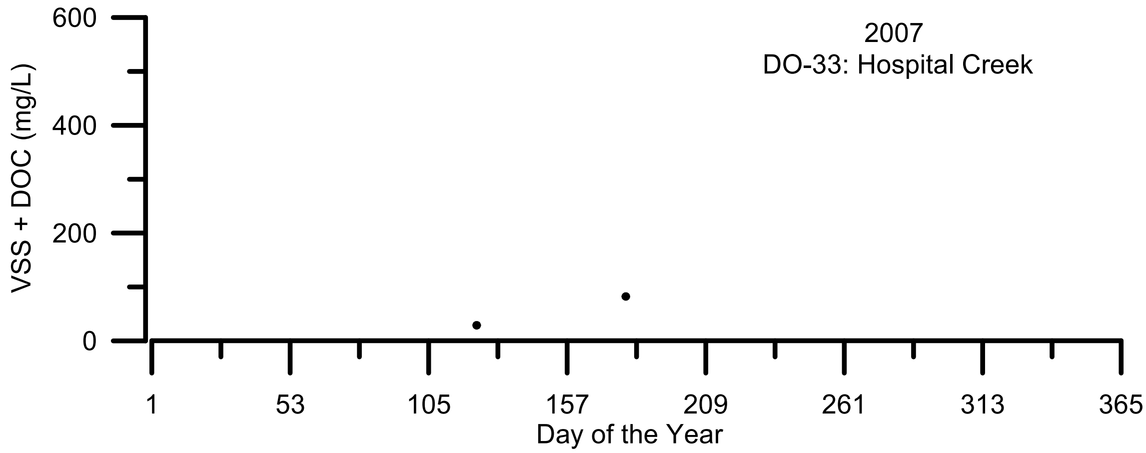

2005
DO-30: TID Lat 6 and 7
VSS + DOC (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

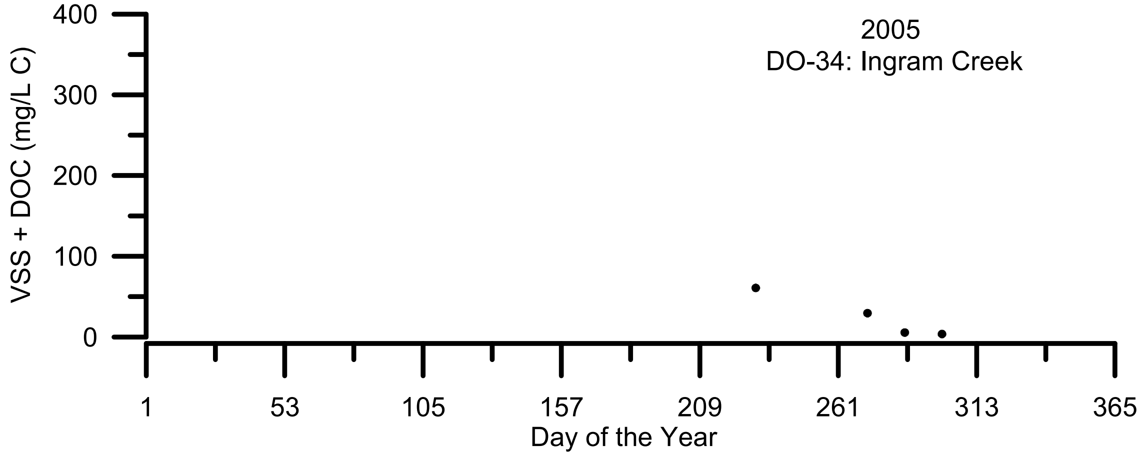

2006
DO-30: TID Lat 6 and 7
VSS + DOC (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

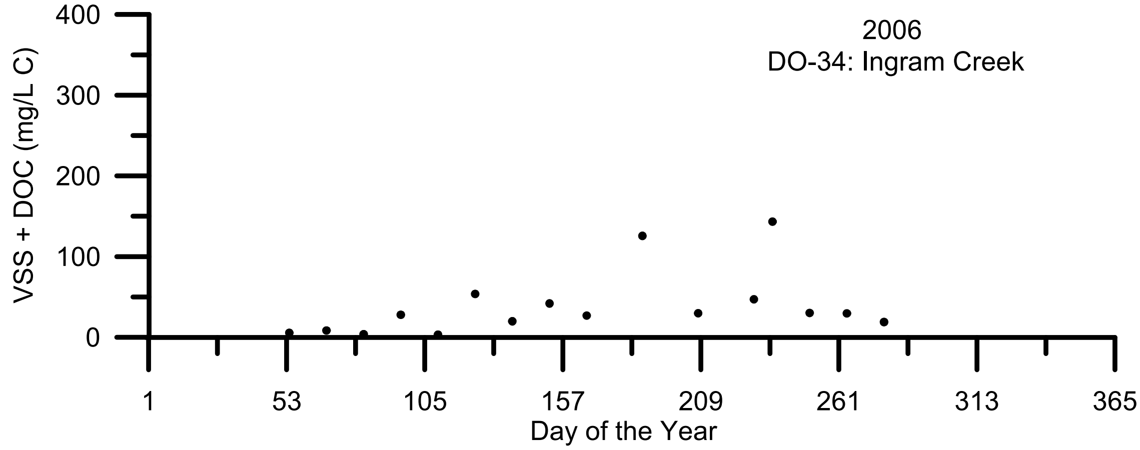

2007
DO-30: TID Lat 6 and 7
VSS + DOC (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

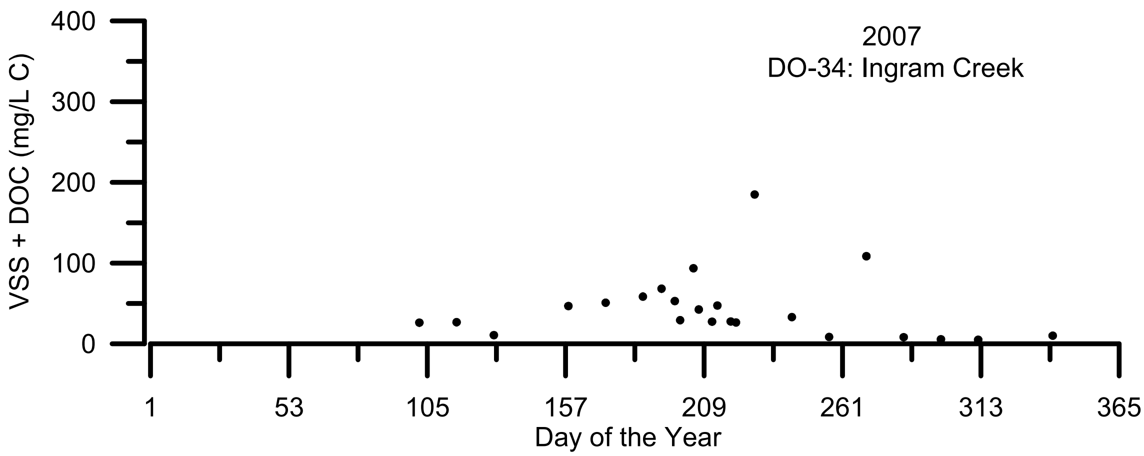

2005
DO-33: Hospital Creek
VSS + DOC (mg/L)
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

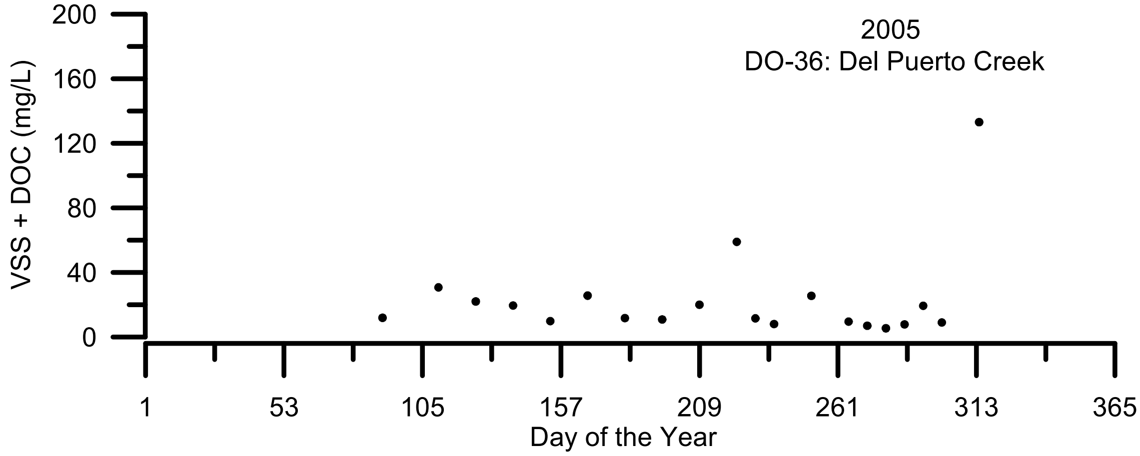

2006
DO-33: Hospital Creek
VSS + DOC (mg/L)
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

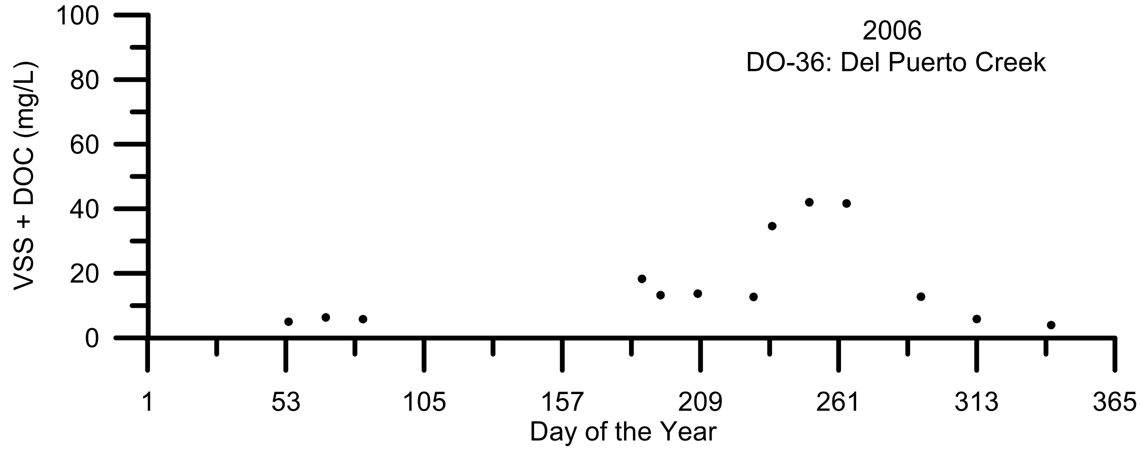

2007
DO-33: Hospital Creek
VSS + DOC (mg/L)
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

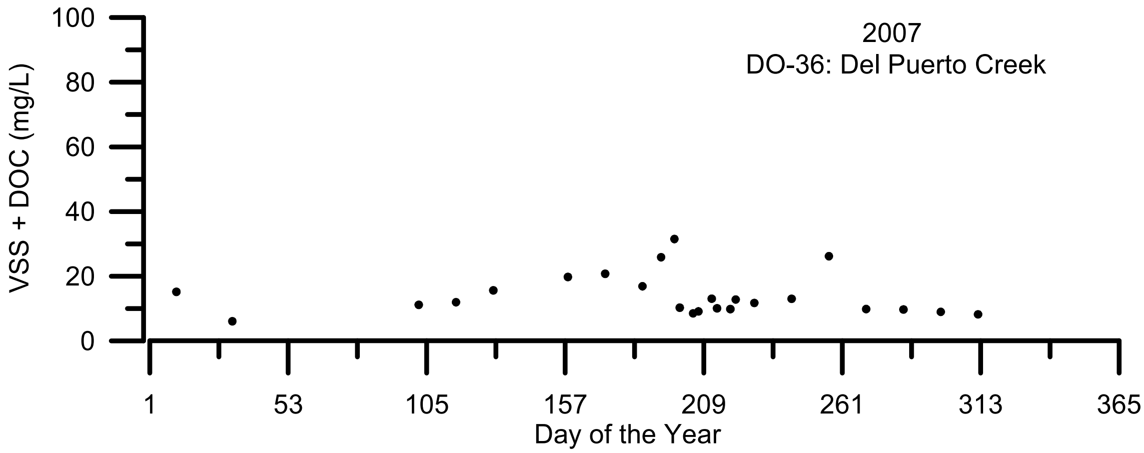

2005
DO-34: Ingram Creek
VSS + DOC (mg/L C)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

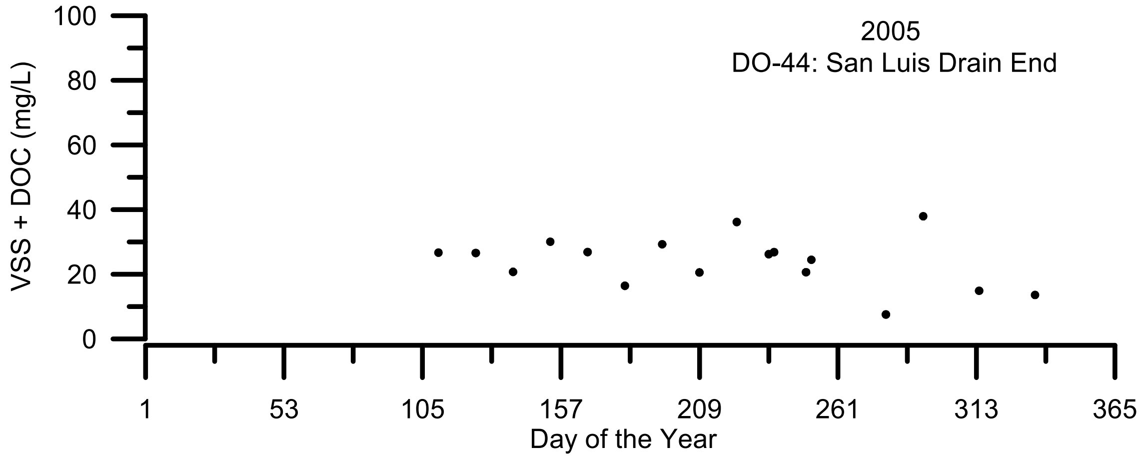

2006
DO-34: Ingram Creek
VSS + DOC (mg/L C)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-34: Ingram Creek
VSS + DOC (mg/L C)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

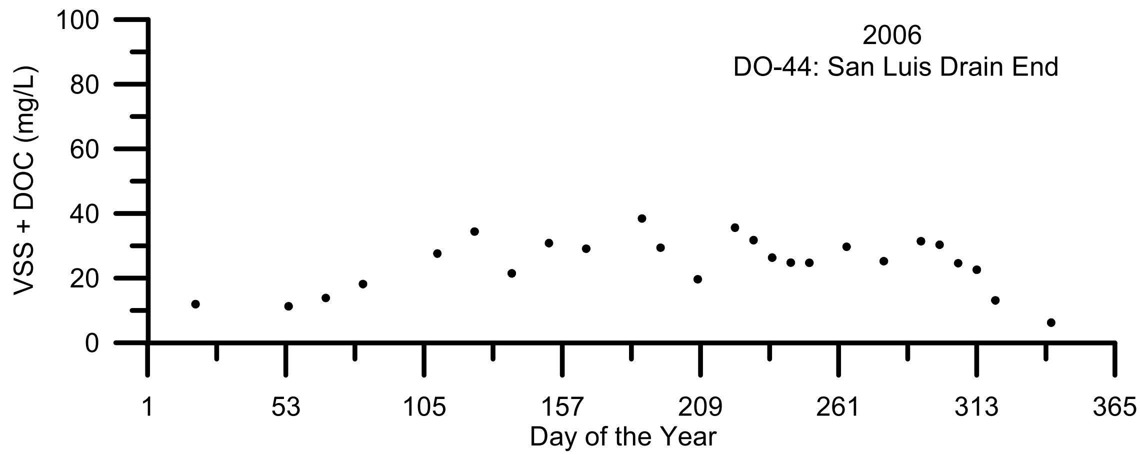

2005
DO-36: Del Puerto Creek
VSS + DOC (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-36: Del Puerto Creek
VSS + DOC (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

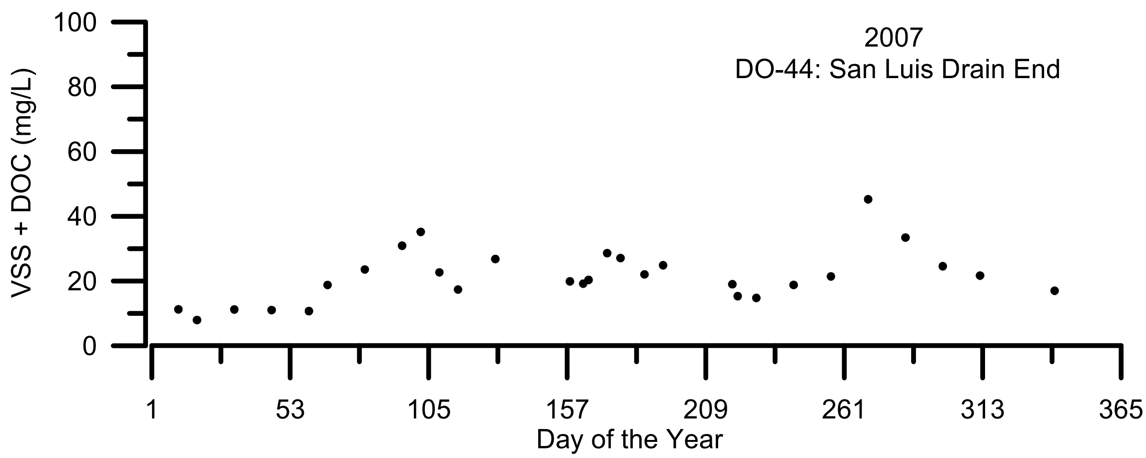

2007
DO-36: Del Puerto Creek
VSS + DOC (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year



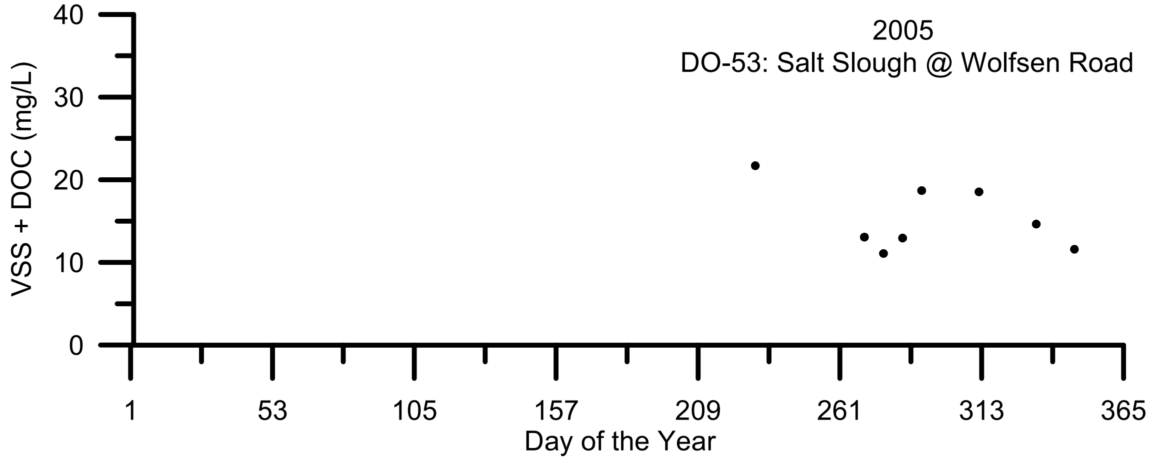
2005
DO-44: San Luis Drain End
VSS + DOC (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

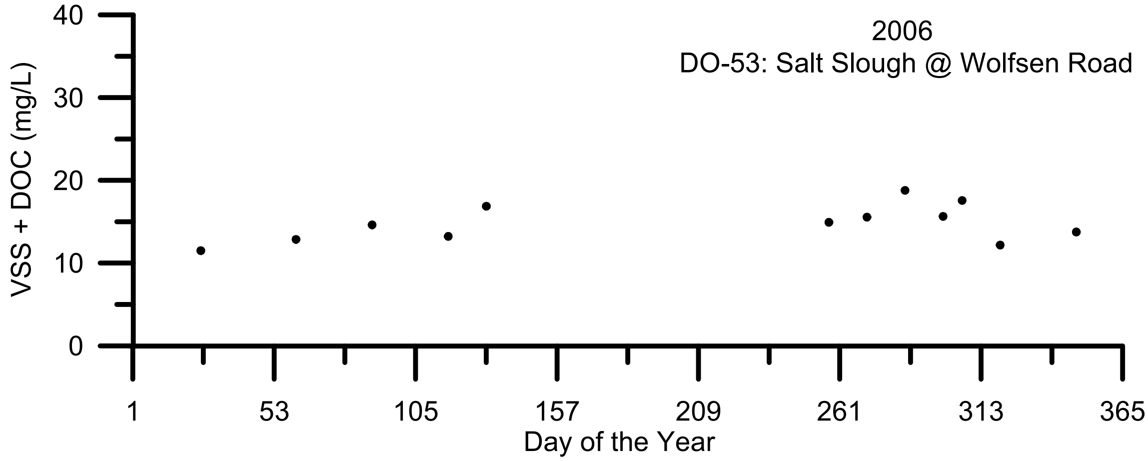


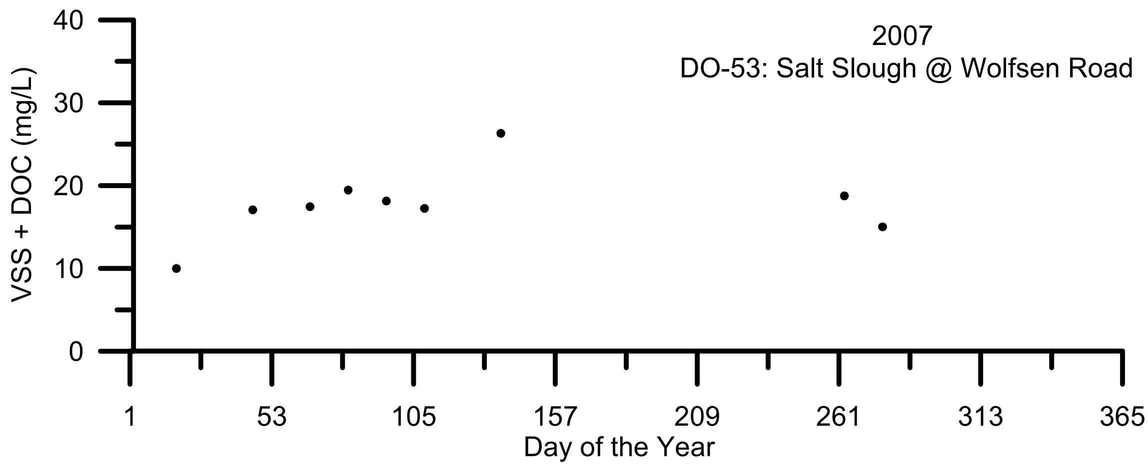
2006
DO-44: San Luis Drain End
VSS + DOC (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

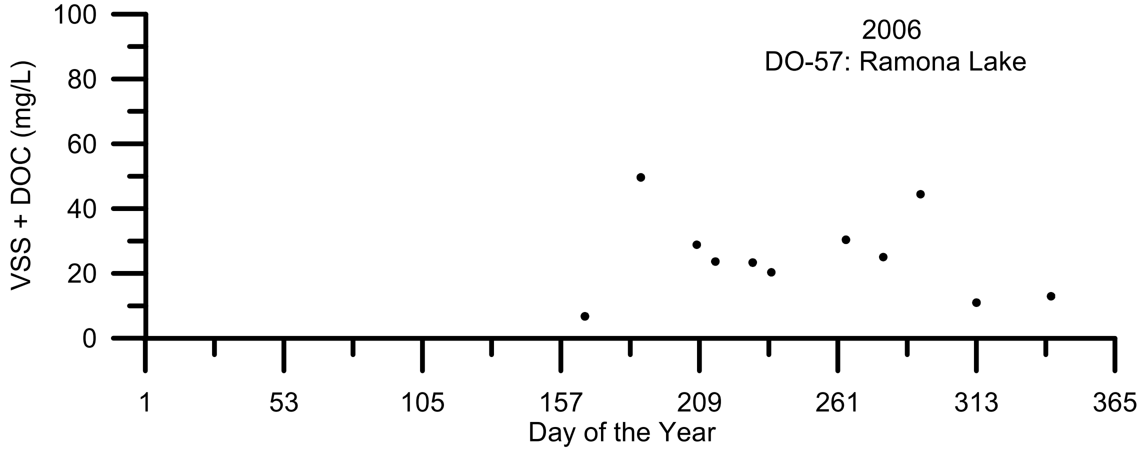


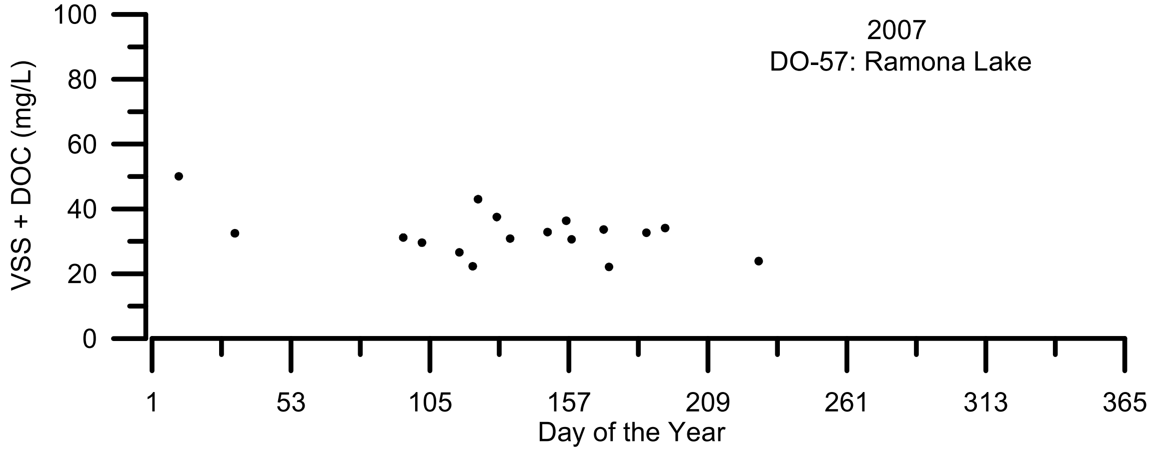
2007
DO-44: San Luis Drain End
VSS + DOC (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

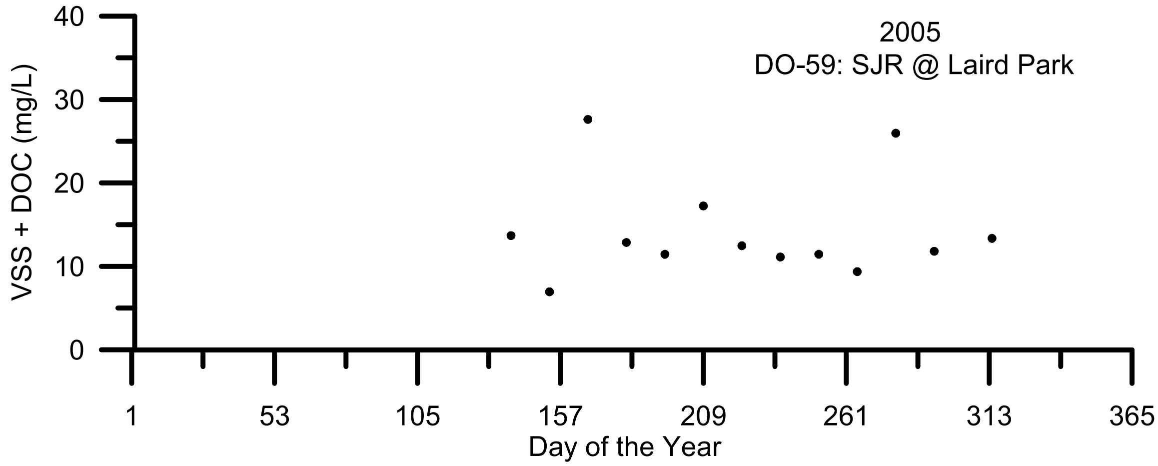

2005
DO-53: Salt Slough @ Wolfsen Road
VSS + DOC (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-53: Salt Slough @ Wolfsen Road
VSS + DOC (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

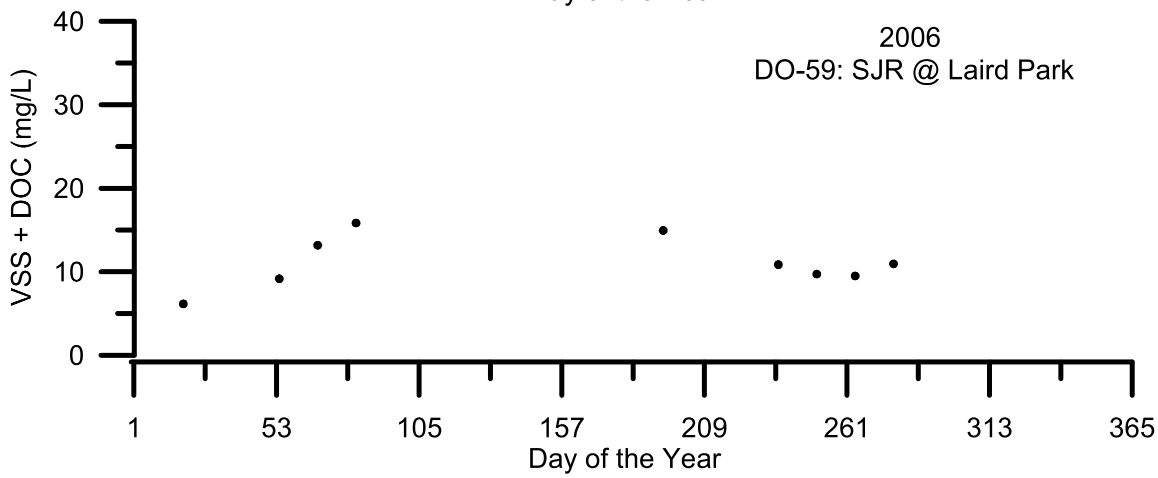

2007
DO-53: Salt Slough @ Wolfsen Road
VSS + DOC (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-57: Ramona Lake
VSS + DOC (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

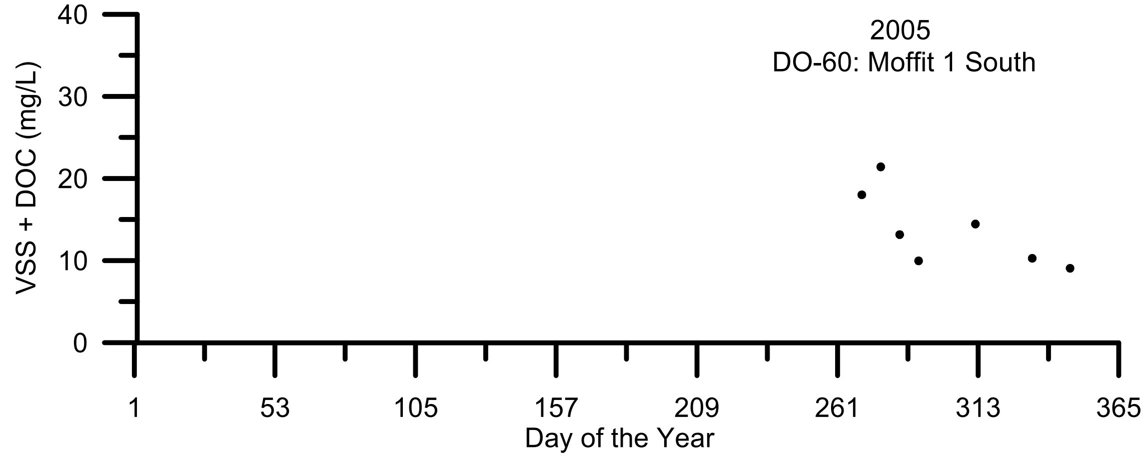

2007
DO-57: Ramona Lake
VSS + DOC (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

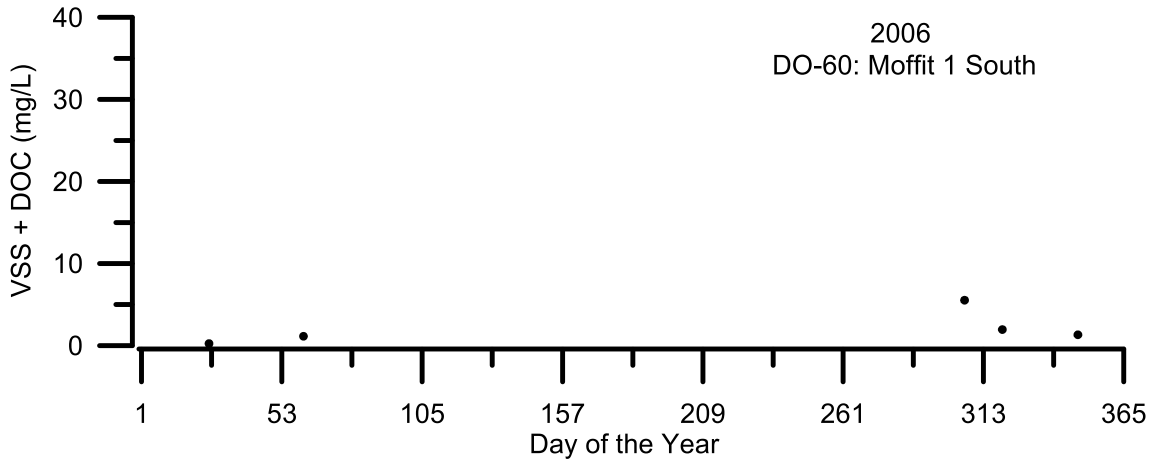


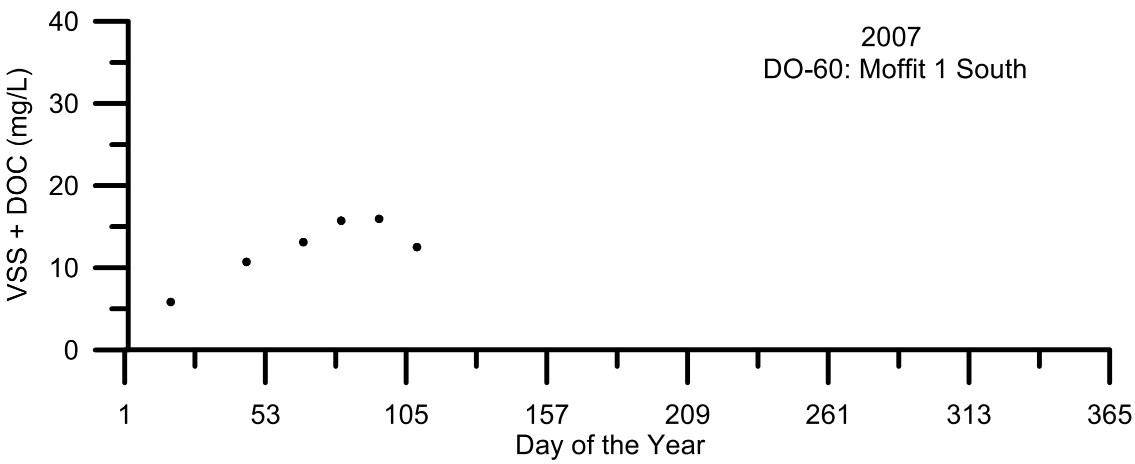
2005
DO-59: SJR @ Laird Park
VSS + DOC (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

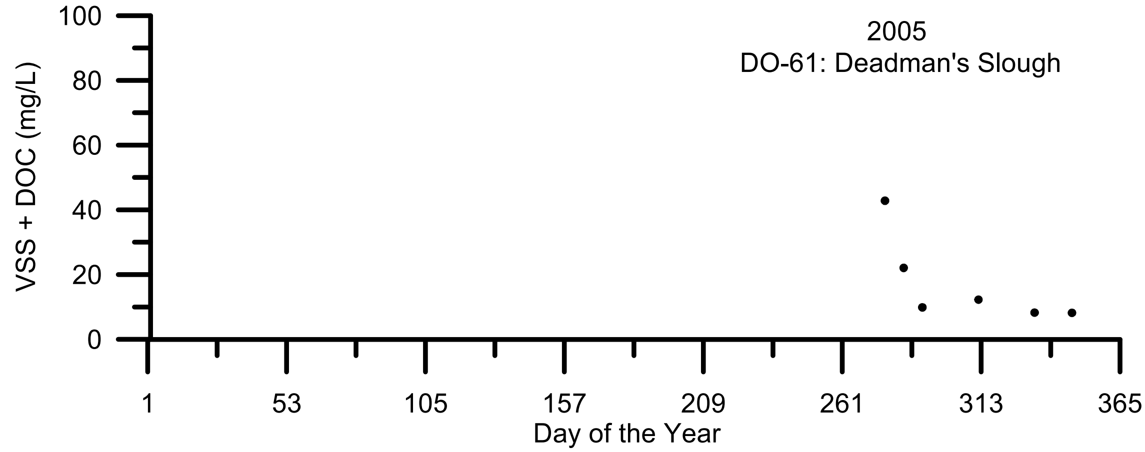


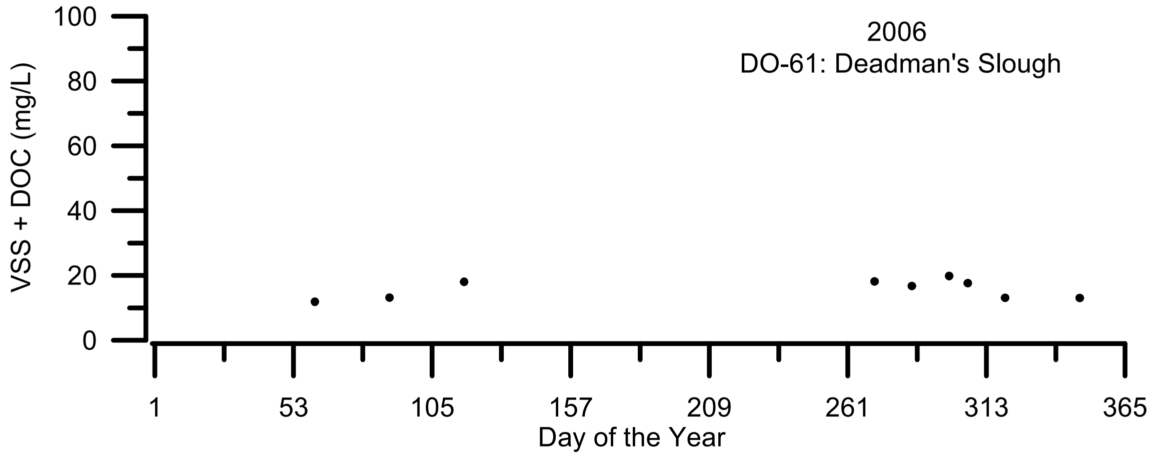
2006
DO-59: SJR @ Laird Park
VSS + DOC (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

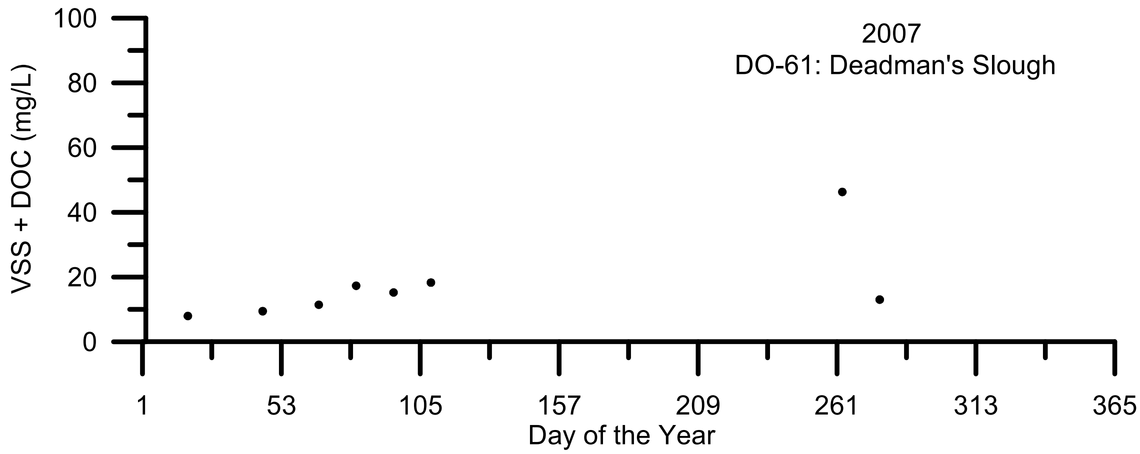

2005
DO-60: Moffit 1 South
VSS + DOC (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

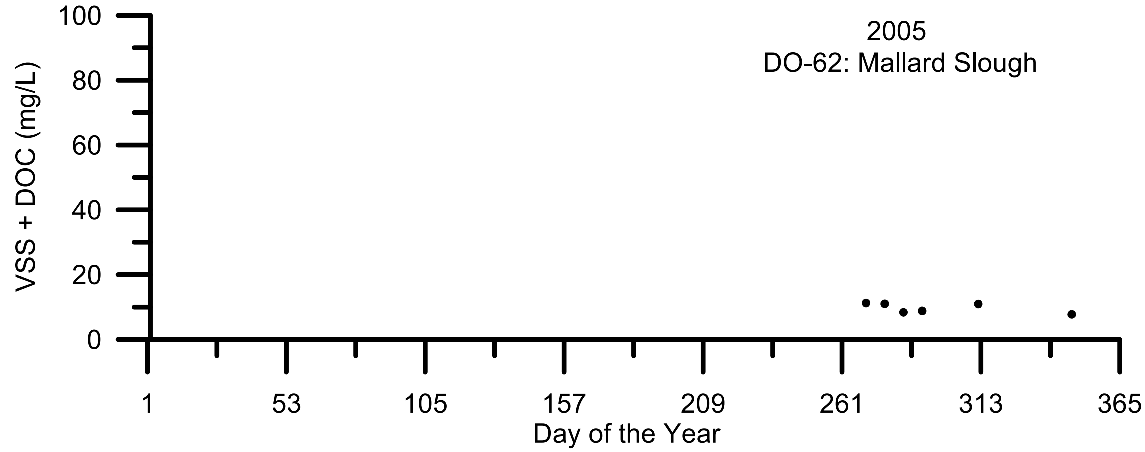

2006
DO-60: Moffit 1 South
VSS + DOC (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

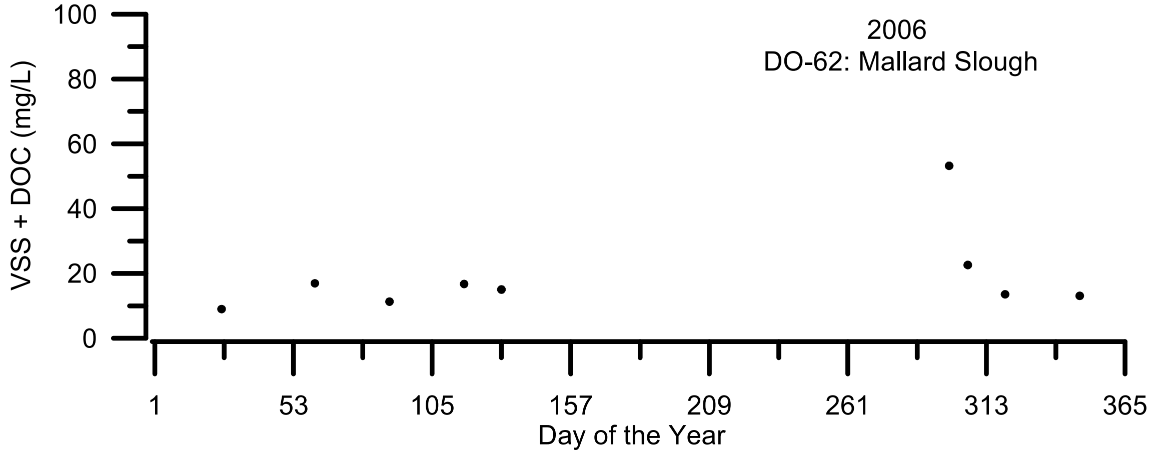

2007
DO-60: Moffit 1 South
VSS + DOC (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

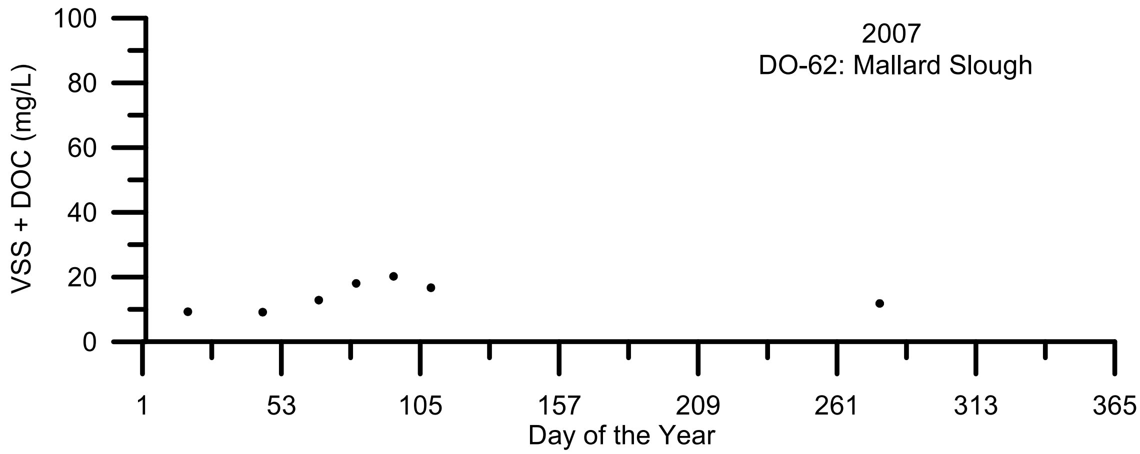

2005
DO-61: Deadman's Slough
VSS + DOC (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

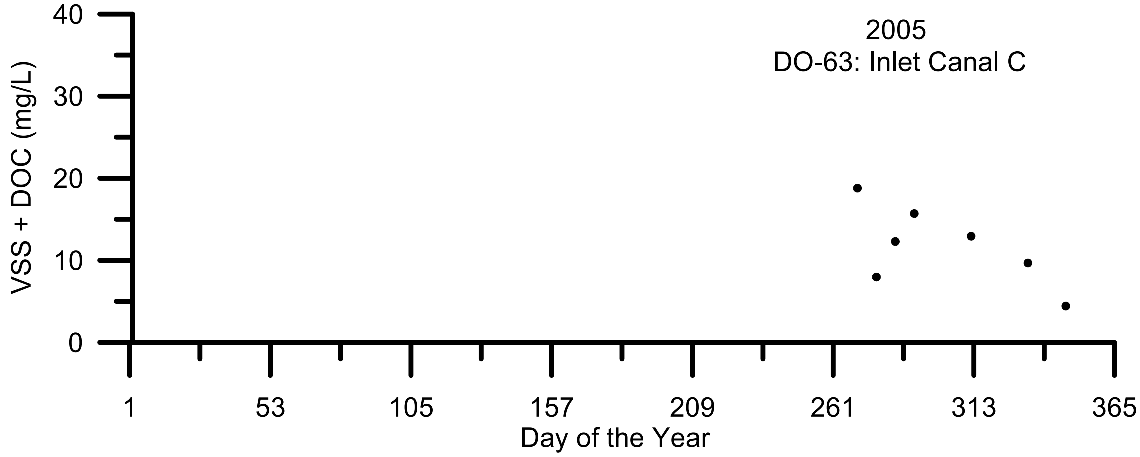

2006
DO-61: Deadman's Slough
VSS + DOC (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

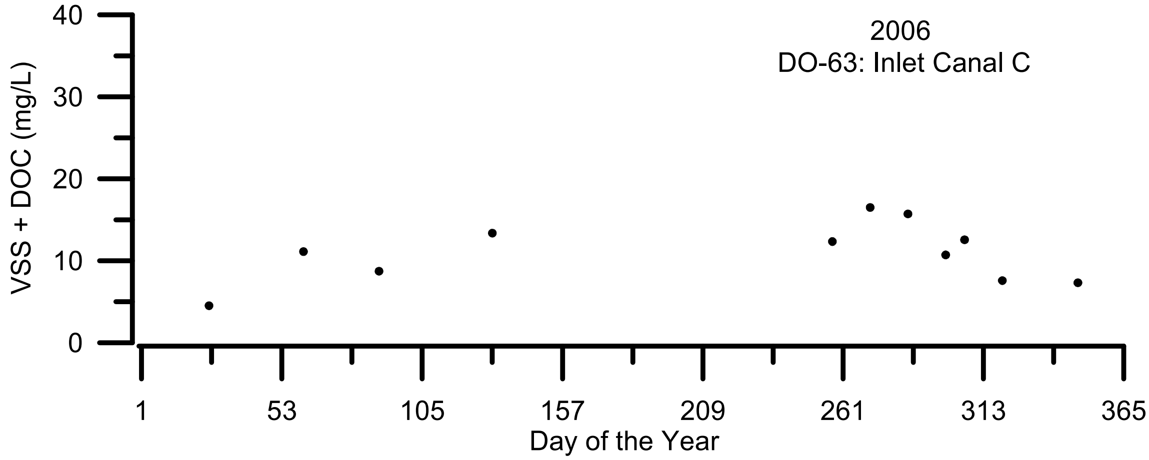

2007
DO-61: Deadman's Slough
VSS + DOC (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

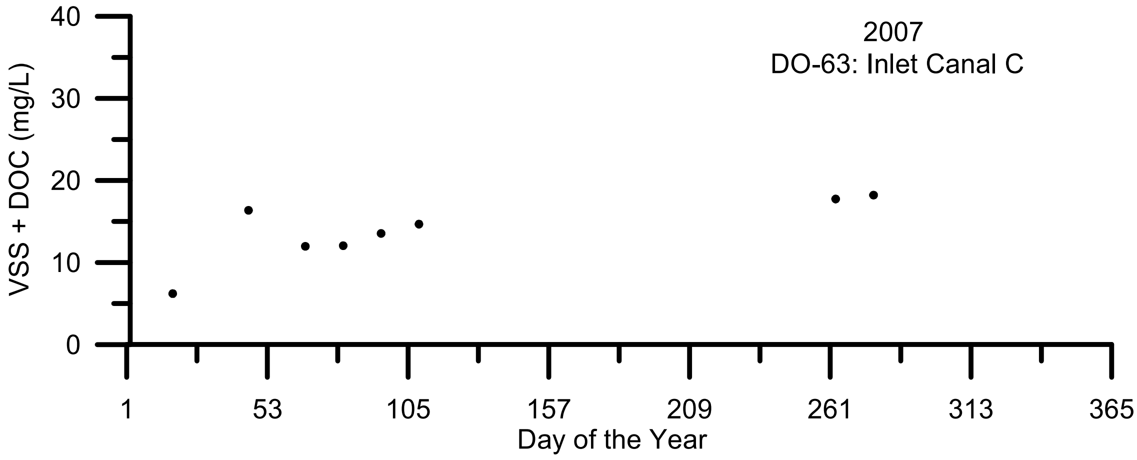

2005
DO-62: Mallard Slough
VSS + DOC (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

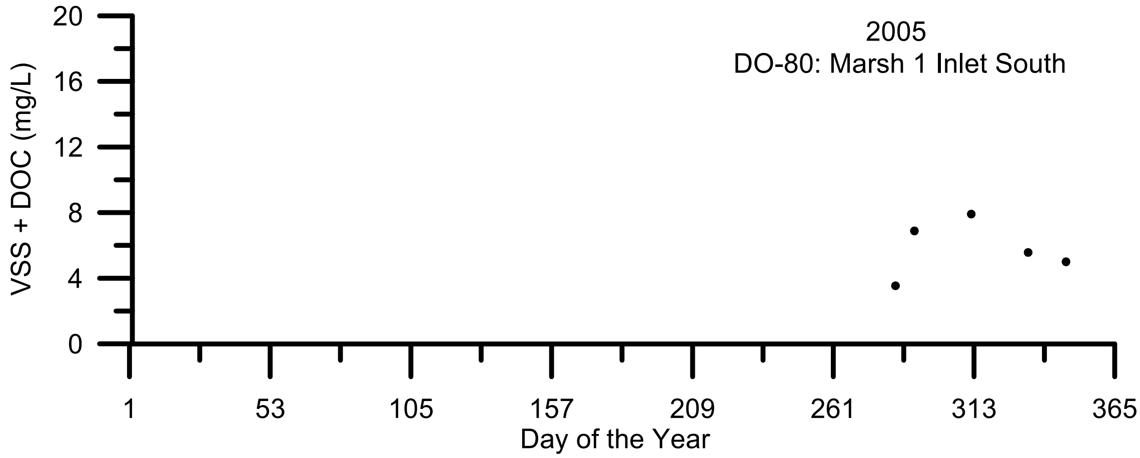

2006
DO-62: Mallard Slough
VSS + DOC (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

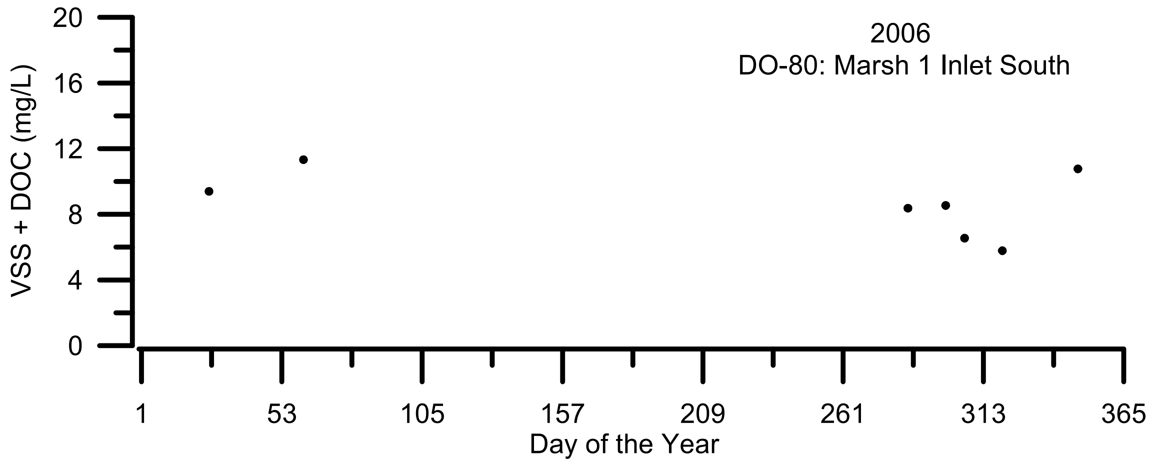

2007
DO-62: Mallard Slough
VSS + DOC (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

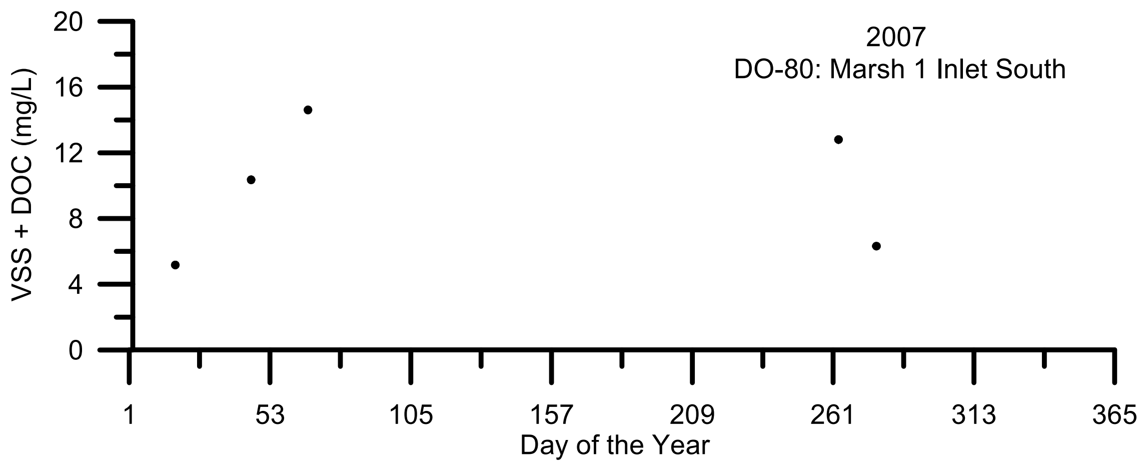

2005
DO-63: Inlet Canal C
VSS + DOC (mg/L)
Day of the Year
0
10
20
30
40
1
53
105
157
209
261
313
365

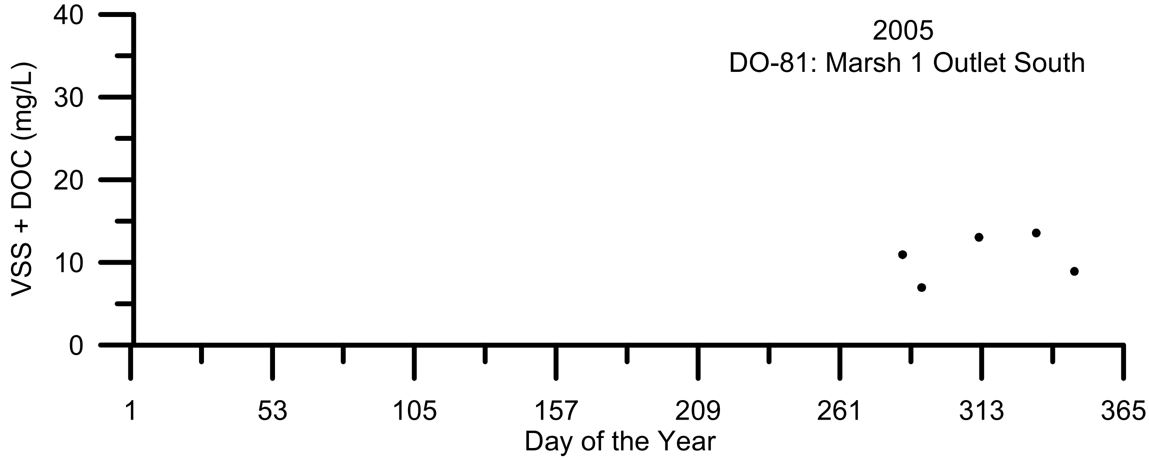

2006
DO-63: Inlet Canal C
VSS + DOC (mg/L)
Day of the Year
0
10
20
30
40
1
53
105
157
209
261
313
365

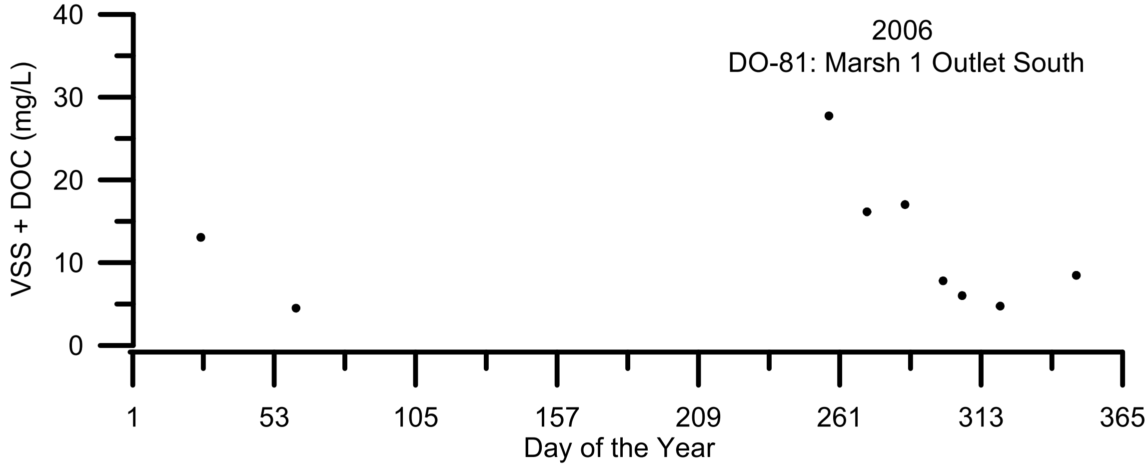

2007
DO-63: Inlet Canal C
VSS + DOC (mg/L)
Day of the Year
0
10
20
30
40
1
53
105
157
209
261
313
365

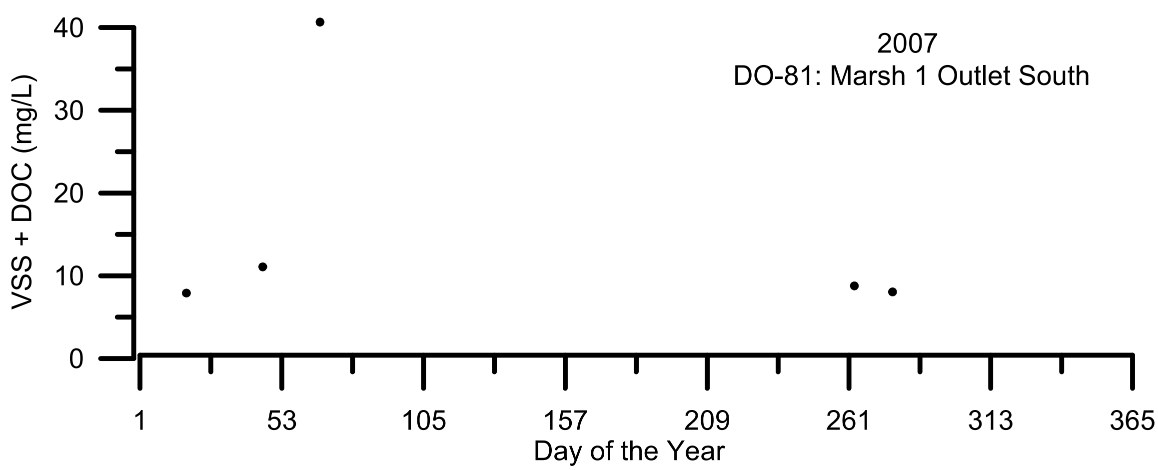

2005
DO-80: Marsh 1 Inlet South
VSS + DOC (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

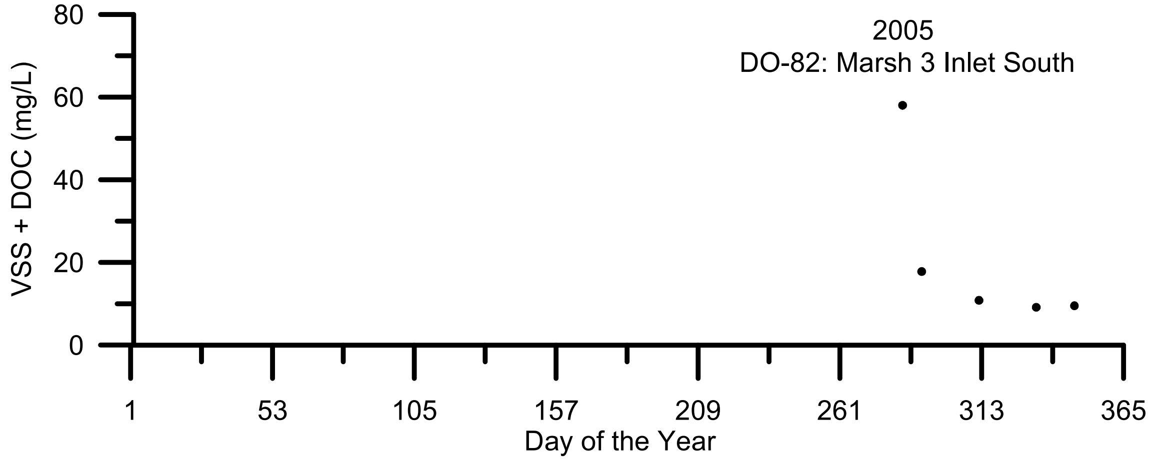

2006
DO-80: Marsh 1 Inlet South
VSS + DOC (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

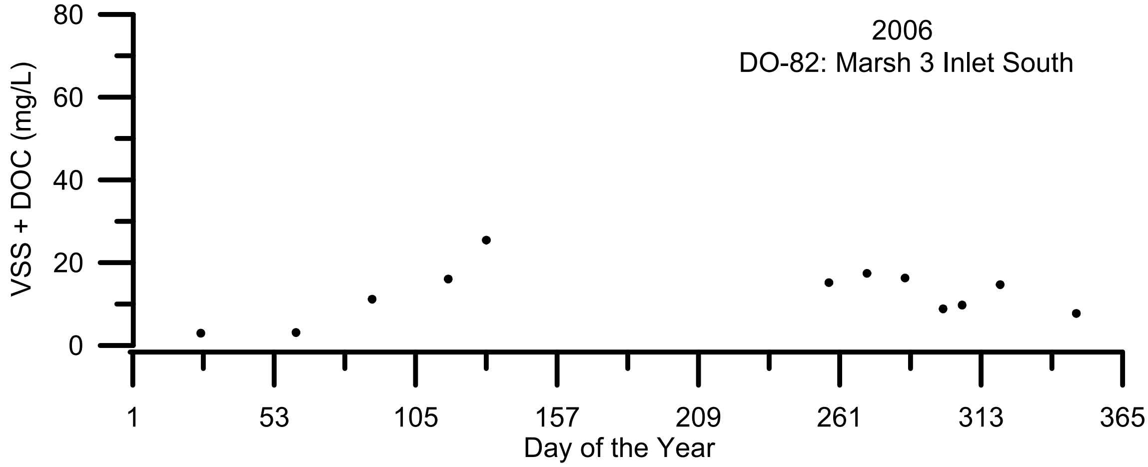

2007
DO-80: Marsh 1 Inlet South
VSS + DOC (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

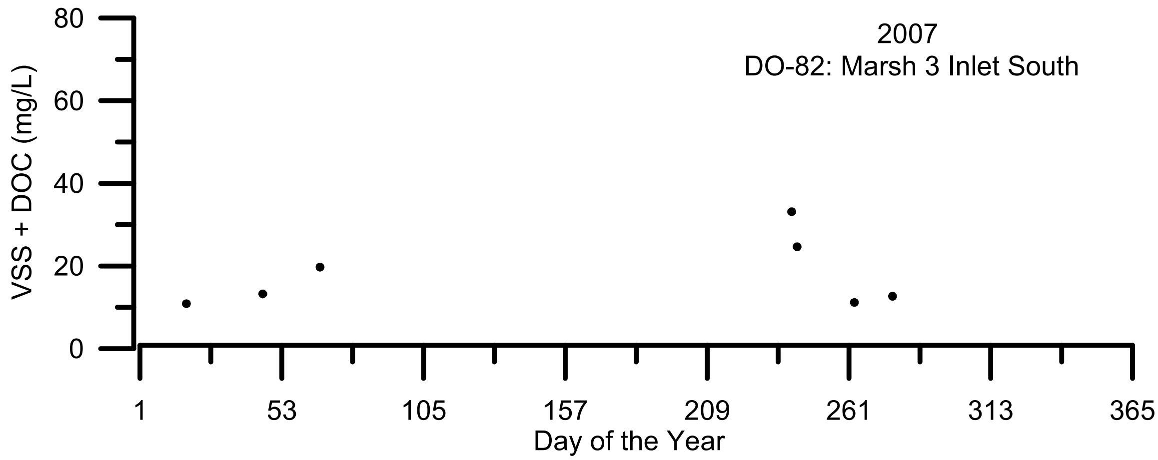

2005
DO-81: Marsh 1 Outlet South
VSS + DOC (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

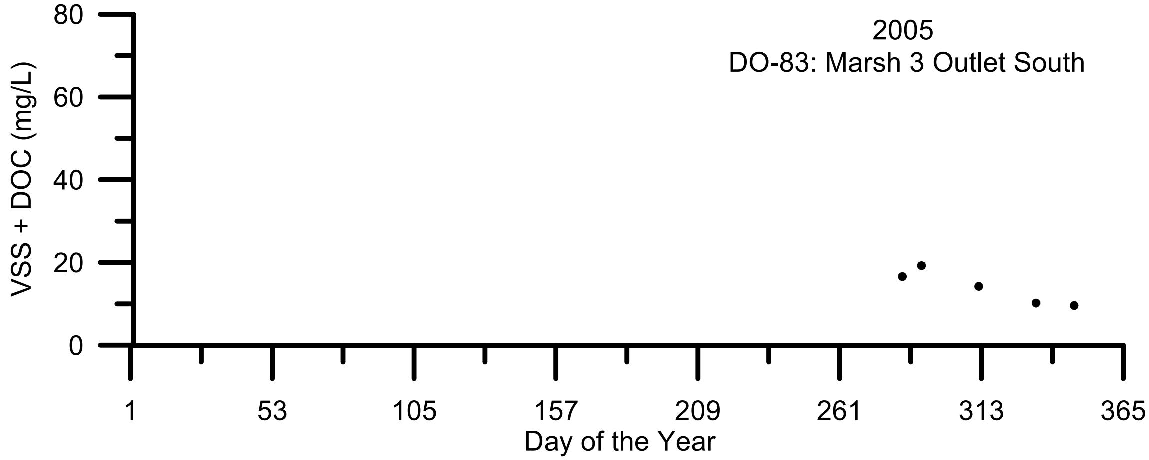

2006
DO-81: Marsh 1 Outlet South
VSS + DOC (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-81: Marsh 1 Outlet South
VSS + DOC (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

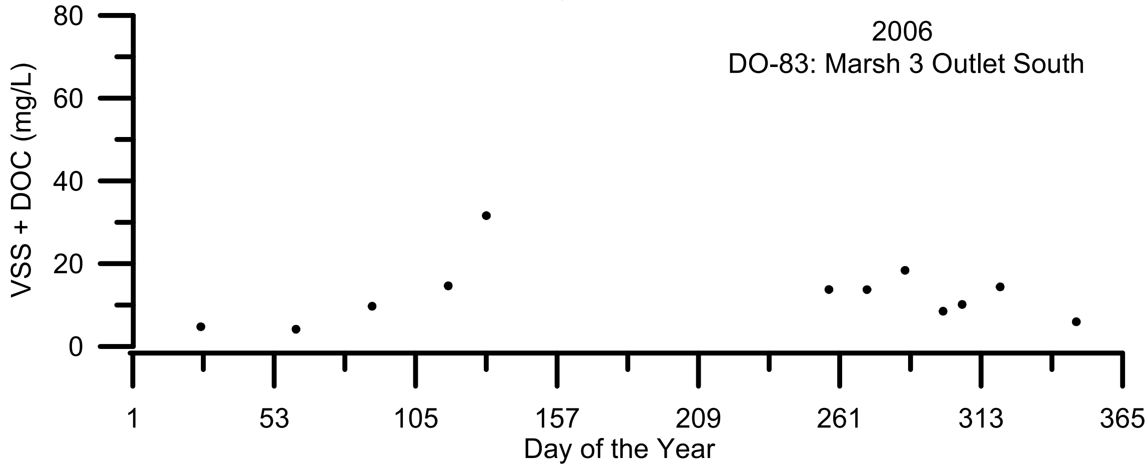

2005
DO-82: Marsh 3 Inlet South
VSS + DOC (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-82: Marsh 3 Inlet South
VSS + DOC (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

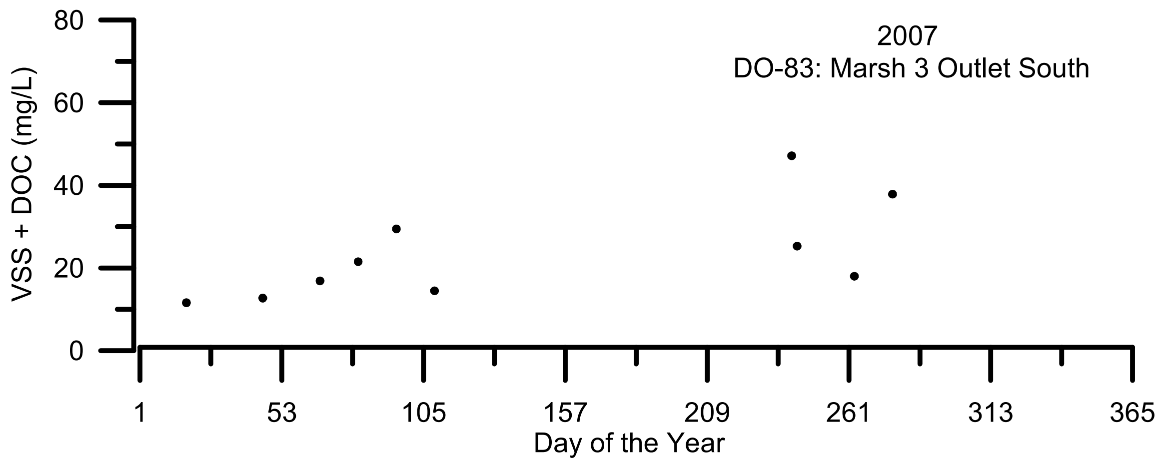

2007
DO-82: Marsh 3 Inlet South
VSS + DOC (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year



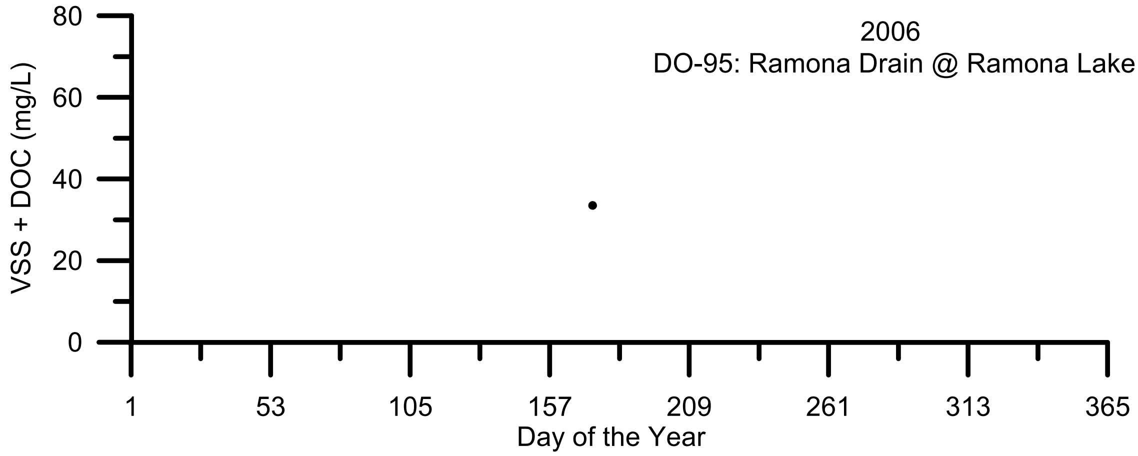
2005
DO-83: Marsh 3 Outlet South
VSS + DOC (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

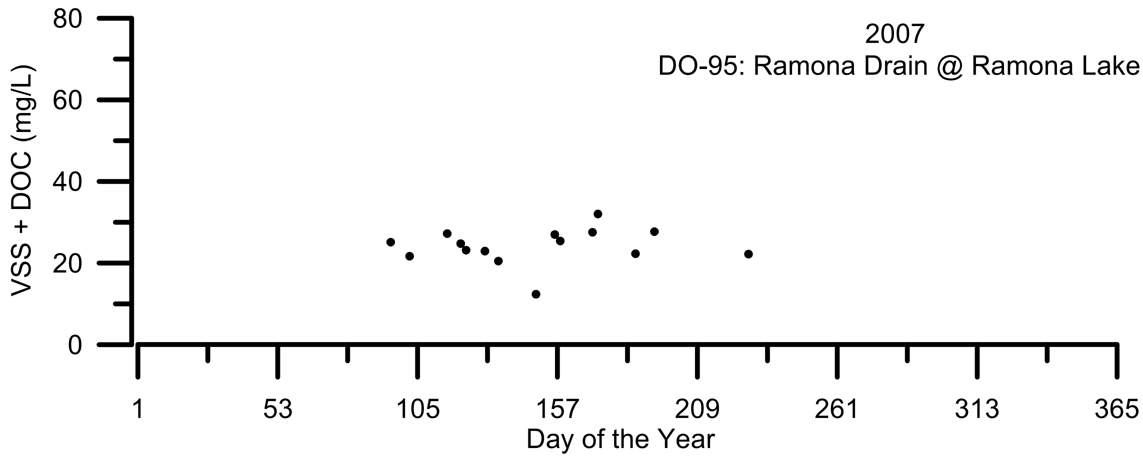


2006
DO-83: Marsh 3 Outlet South
VSS + DOC (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year



2007
DO-83: Marsh 3 Outlet South
VSS + DOC (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-95: Ramona Drain @ Ramona Lake
VSS + DOC (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-95: Ramona Drain @ Ramona Lake
VSS + DOC (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

Analysis of Total Suspended Solid Concentrations in the San Joaquin River Watershed 2005-2007

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Chelsea Spier
Sharon Borglin
Jeremy Hanlon
Justin Graham
William Stringfellow

February 2008

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Stockton CA 95211

Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 sampling locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report presents temporal plots of total suspended solids (TSS) for all sites sampled in the SJR from 2005-2007.

Methods

Field sampling consisted of collecting water samples, measuring water quality with a YSI Sonde 6600 with MDS650 hand-held display, and recording of field conditions at sites within the study area per *EERP Field Protocol Book* (Graham, 2008).

Water samples were collected in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN) in accordance with requirements for different lab analysis and volume requirements.

Samples were immediately stored at $4^{\circ}C$ after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the lab on the day of sampling.

Samples were received by the laboratory the same day they were sampled and stored at $4^{\circ}C$ until filtering and analysis. Samples were collected, preserved, stored, and analyzed by methods outlined in *Standard Methods for the Analysis of Water and Wastewater*, (APHA, 2005, 1998). Total suspended solids (TSS) and volatile suspended solids (VSS) were analyzed by SM 2540 D and E (APHA, 2005). Typically 1000 mL of sample was filtered on pre-weighed, pre-combusted, Whatman GF/F filters. The filters were placed in an aluminum dish and dried at $105^{\circ}C$ under vacuum to constant weight. After drying the filter and dish were allowed to cool in a dessicator and were weighed for TSS determination. The dried and weighted filters were subsequently combusted at $550^{\circ}C$ for 6 hours and reweighed for VSS determination. Mineral suspended solids (MSS) concentration was calculated by subtracting VSS from TSS.

Results and Discussion

Total Suspended Solids (TSS) was analyzed routinely over the years 2005-2007 with no modification to the standard method (APHA, 2005). A 96.30% passage rate for all QA parameters over the three years was observed as well as a rate of 100% for proficiency check samples (Borglin et. al., 2008).

References

Stringfellow, W.T., et al., (2008), *Evaluation of Vegetated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley*, University of the Pacific, Stockton, CA

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008), *EERP Field Protocol Book*, University of the Pacific, Stockton, CA.

Borglin, S., W. Stringfellow, J. Hanlon. (2005), Standard *Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project*, LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA

American Public Health Association, (2005), *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, Washington, D.C.

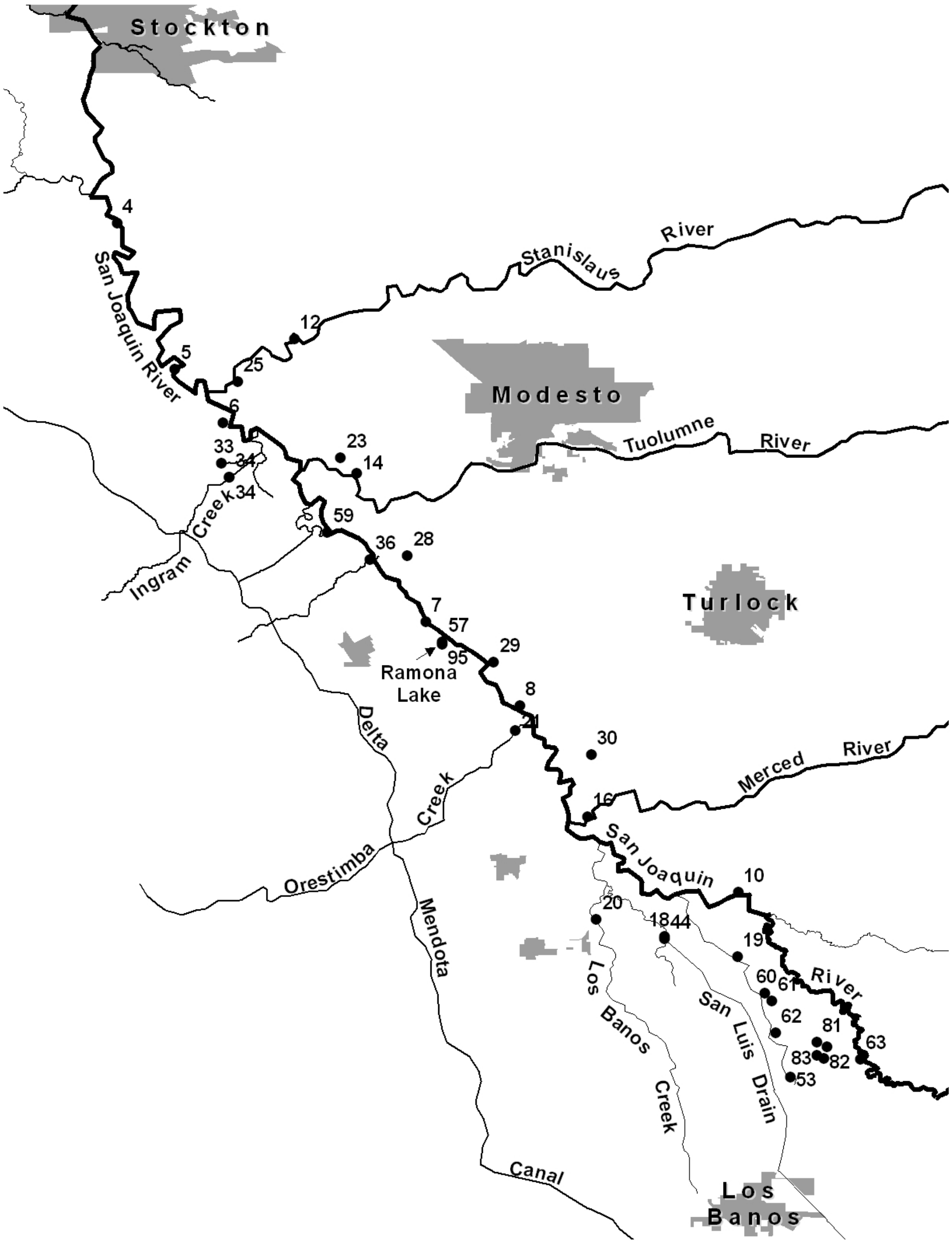
Borglin, S.E., Burks, R.D., Hanlon, J.S., Stringfellow, W.T. (2008*) EERP Lab Protocol Book*, University of the Pacific, Stockton, CA.

YSI Environmental Operations Manual, (2005), 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

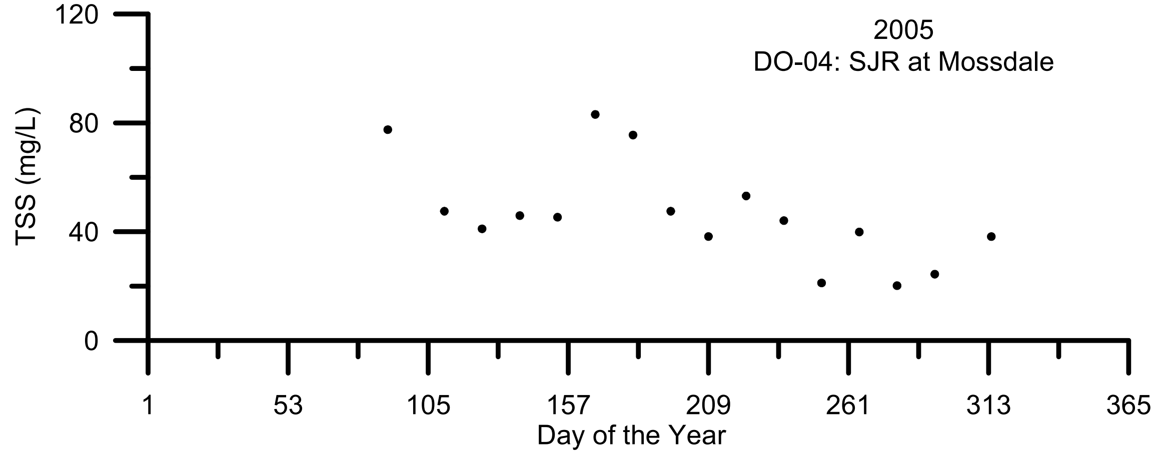
Table 1: EERP Sampling Site List

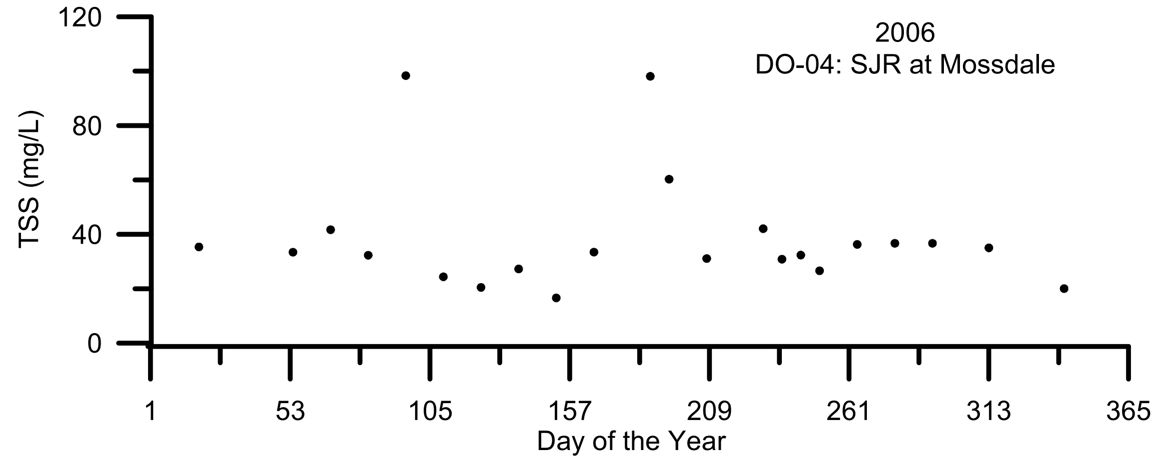
DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
53	**Salt Slough at Wolfsen Road**	Wetland
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
60	**Moffit 1 South**	Wetland
61	**Deadman's Slough**	Wetland
62	**Mallard Slough**	Wetland
63	**Inlet C Canal**	Wetland
80	**South Marsh-1-Inlet**	Wetland
81	**South Marsh-1-Outlet**	Wetland
82	**South Marsh-3-Inlet**	Wetland
83	**South Marsh-3-Outlet**	Wetland
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

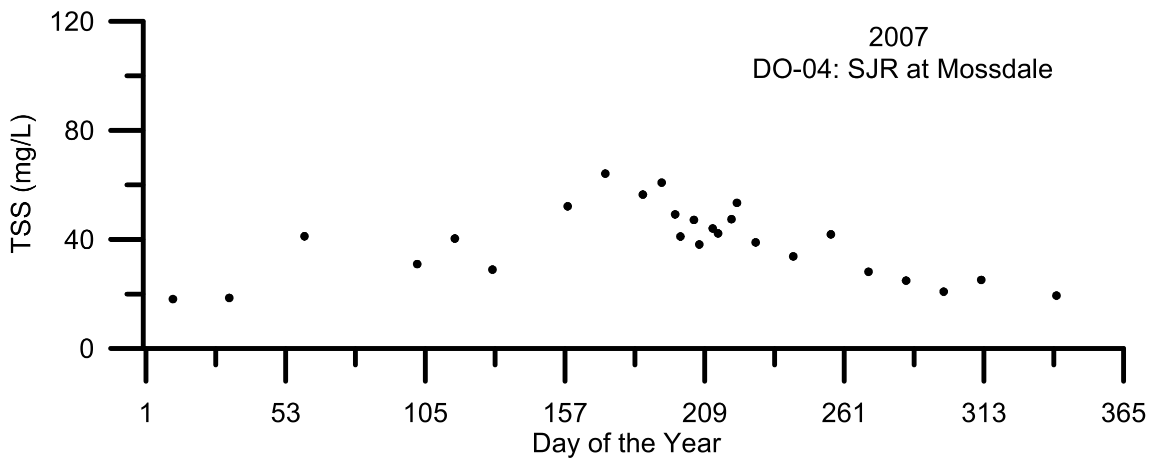
Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

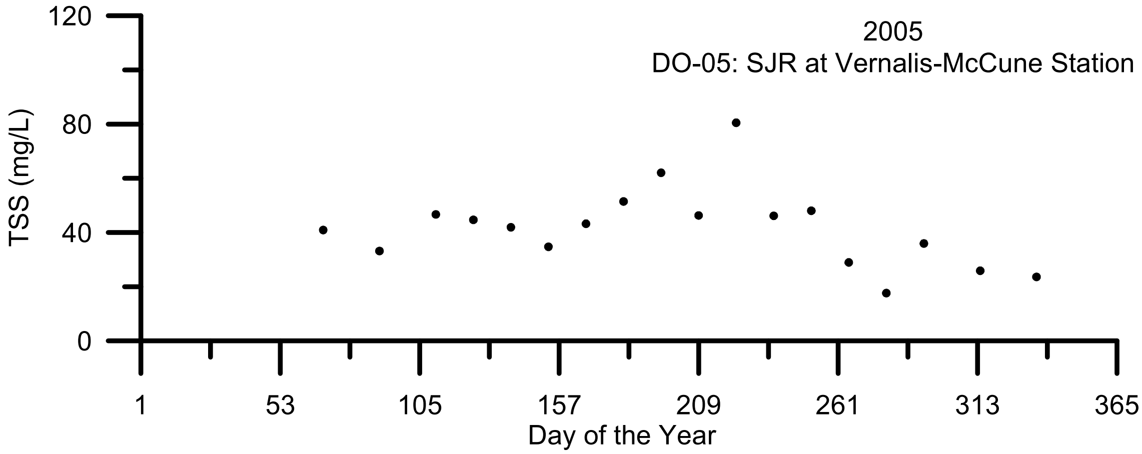


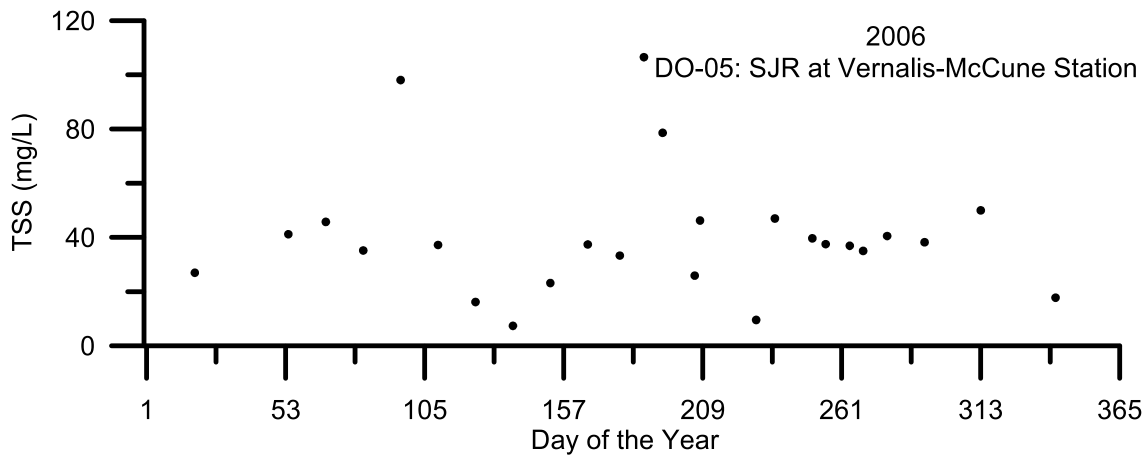
Figures 2 -101: Temporal Plots of TSS Concentrations By Site ID

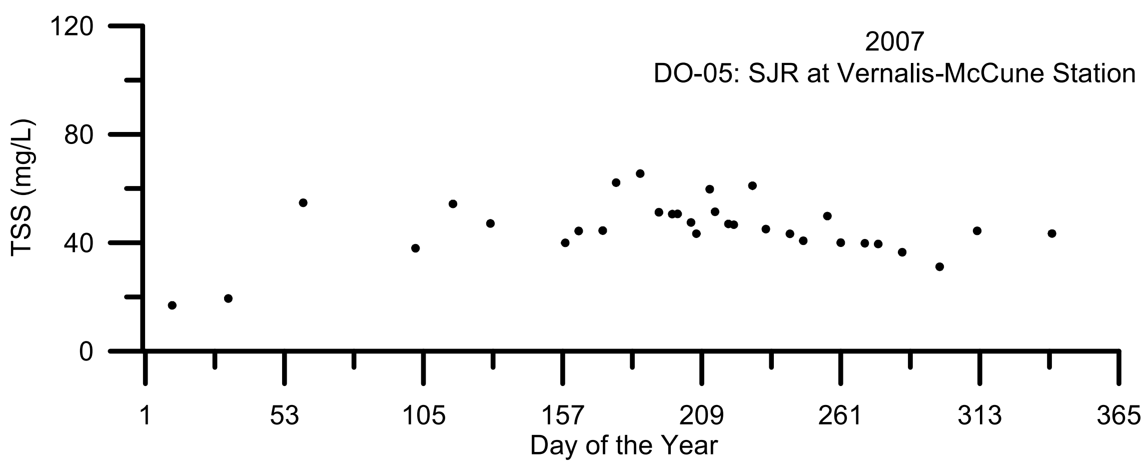


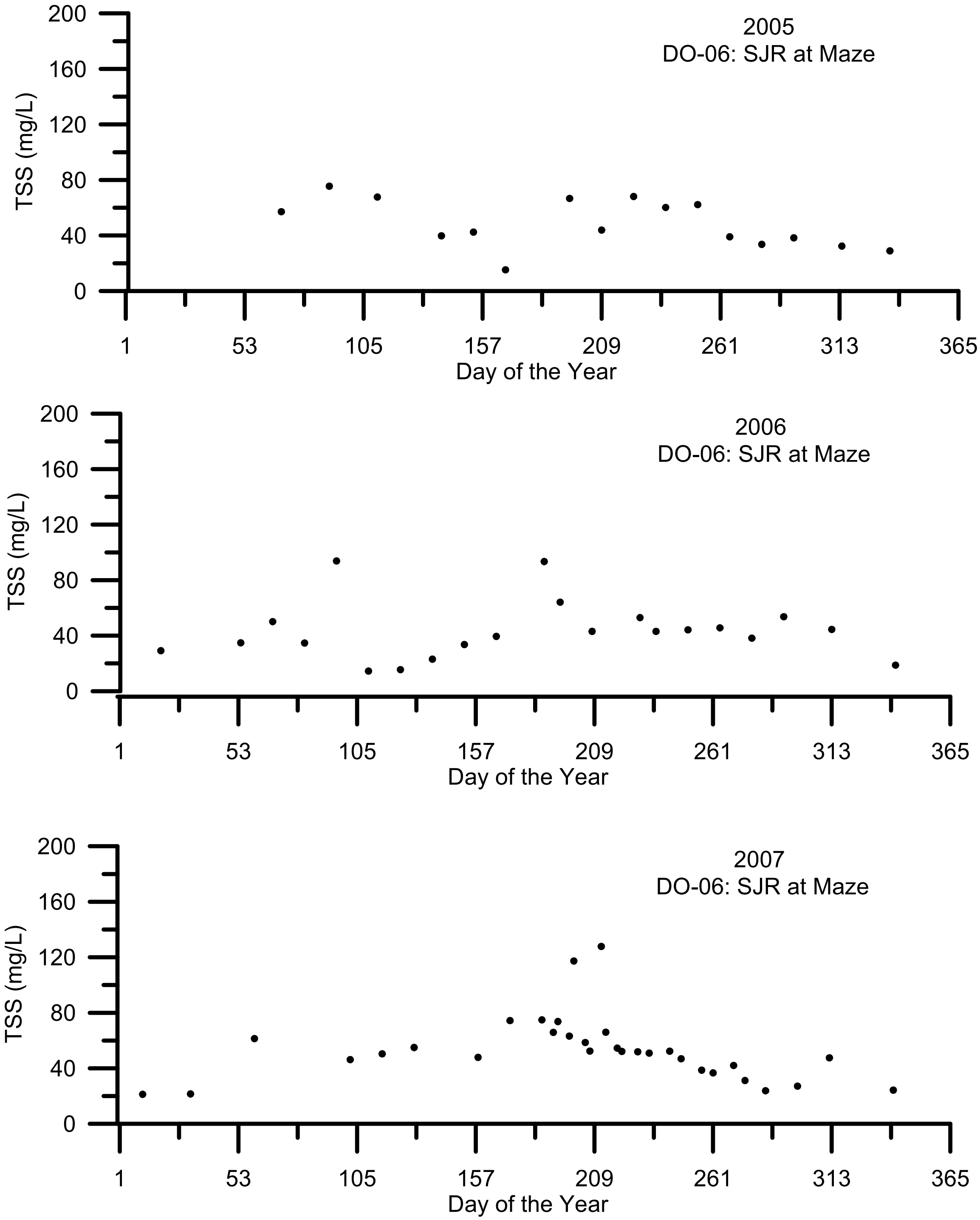


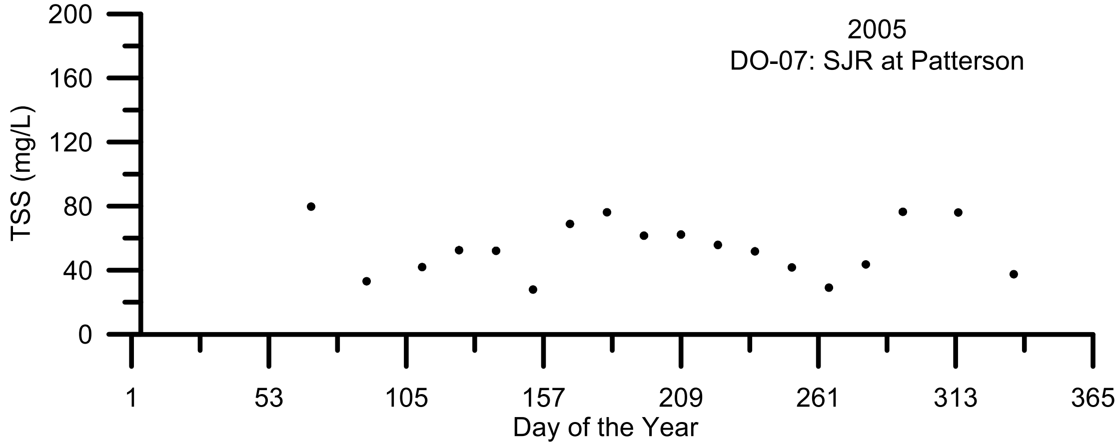


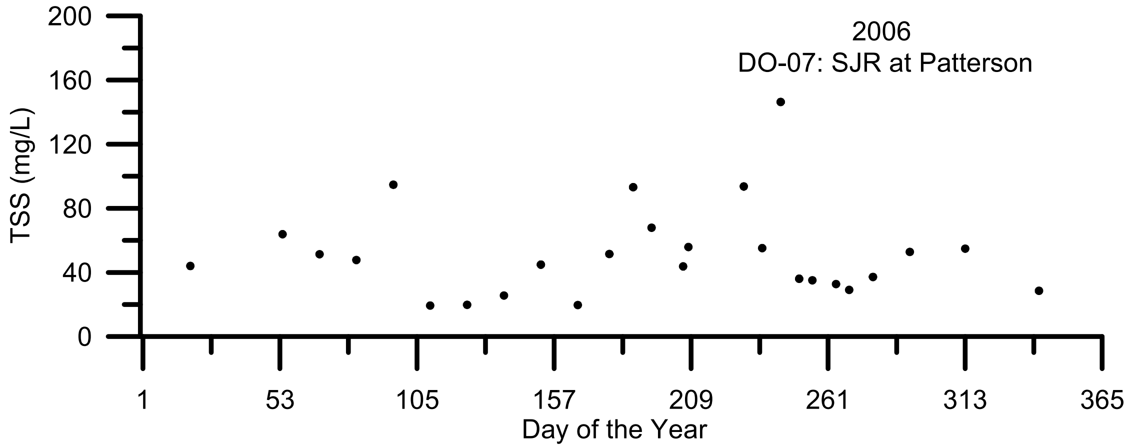

2005
DO-05: SJR at Vernalis-McCune Station
TSS (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

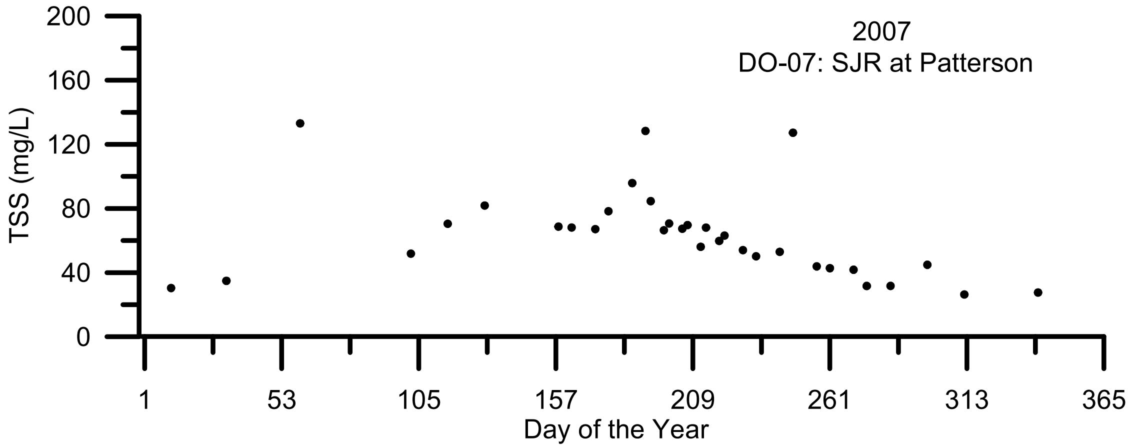

2006
DO-05: SJR at Vernalis-McCune Station
TSS (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

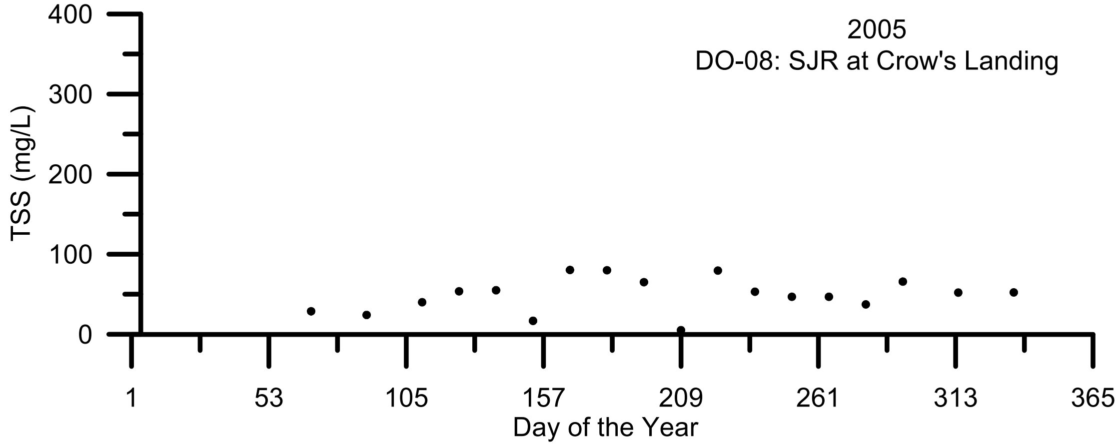

2007
DO-05: SJR at Vernalis-McCune Station
TSS (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

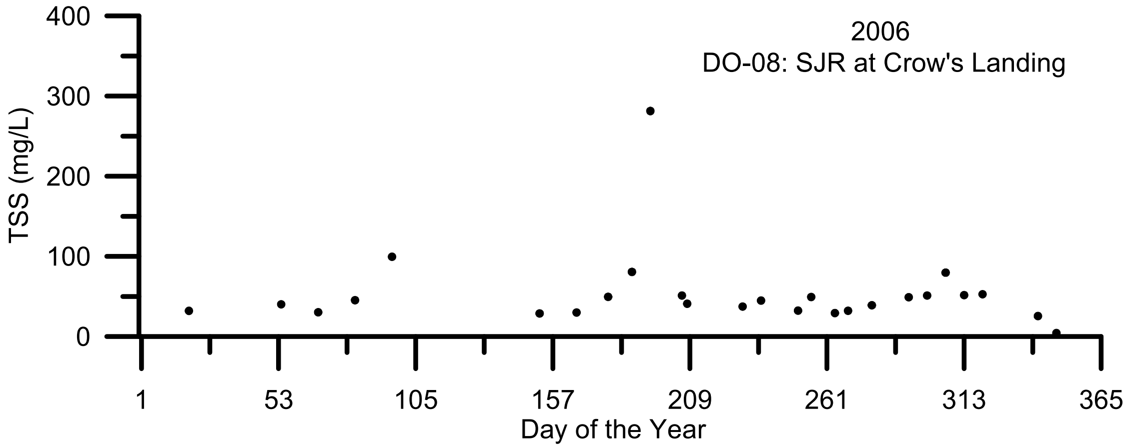

2005
DO-06: SJR at Maze
TSS (mg/L)
0
40
80
120
160
200
1
53
105
157
209
261
313
365
Day of the Year
2006
DO-06: SJR at Maze
TSS (mg/L)
Day of the Year
2007
DO-06: SJR at Maze
TSS (mg/L)
Day of the Year

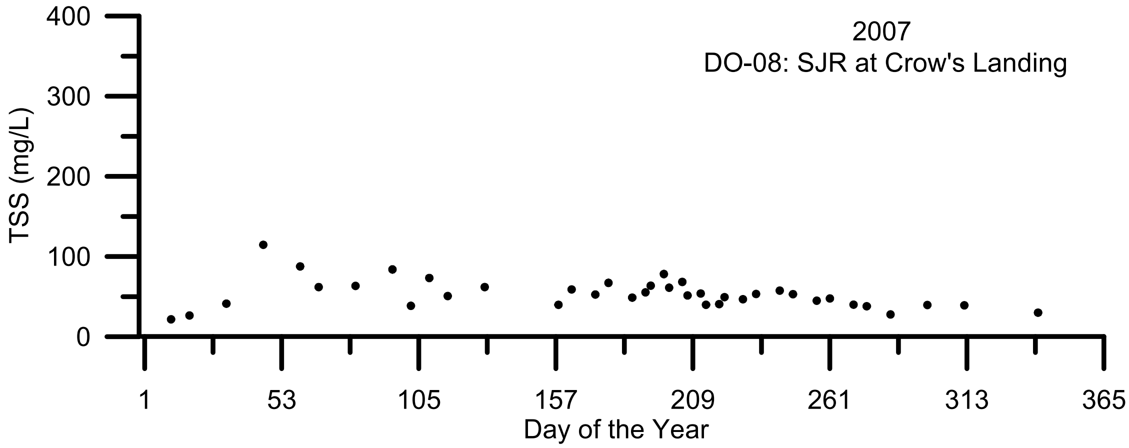

2005
DO-07: SJR at Patterson
TSS (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

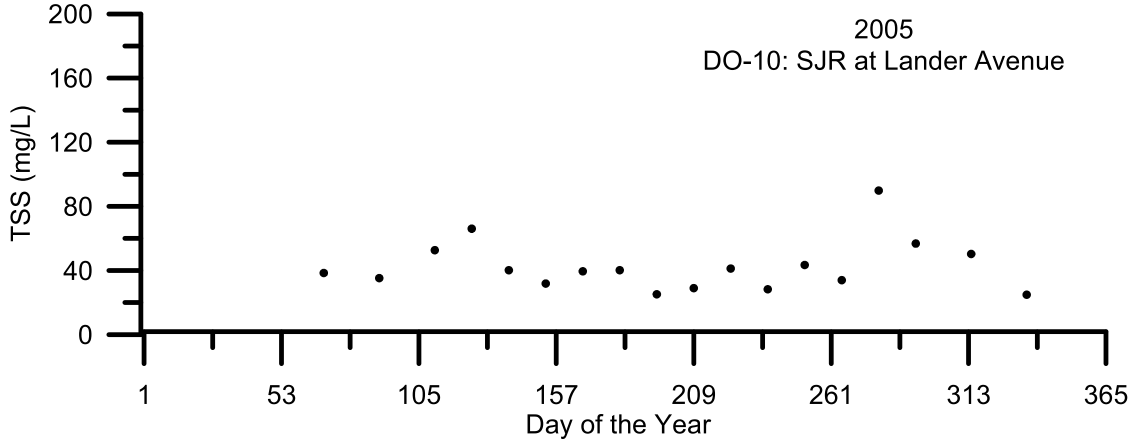

2006
DO-07: SJR at Patterson
TSS (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

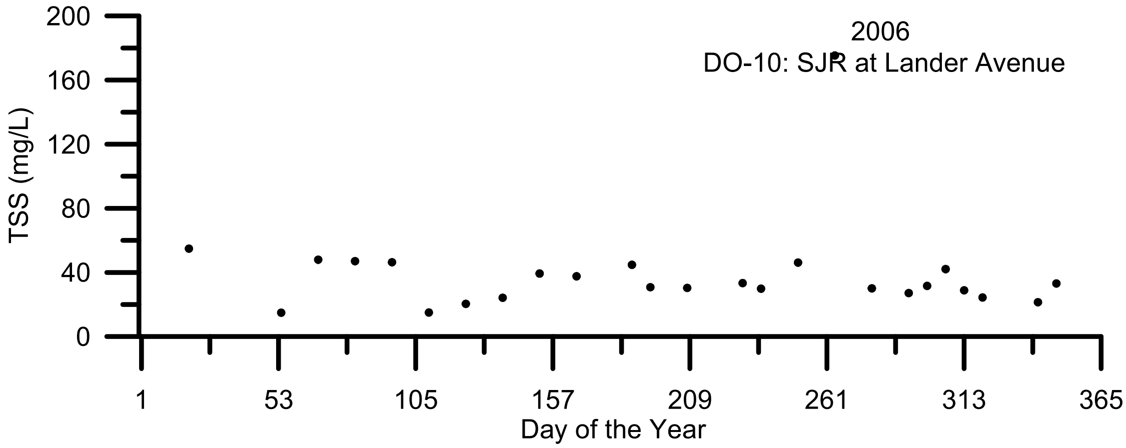

2007
DO-07: SJR at Patterson
TSS (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

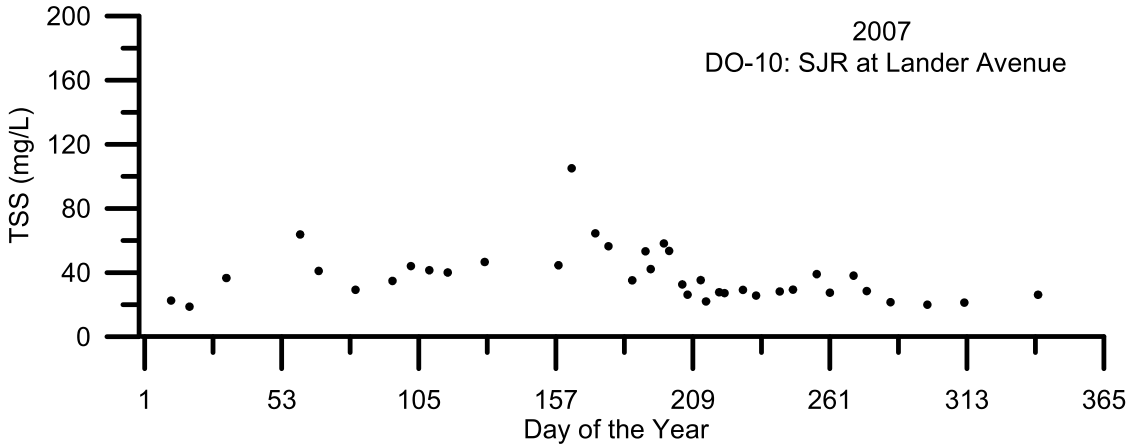

2005
DO-08: SJR at Crow's Landing
TSS (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

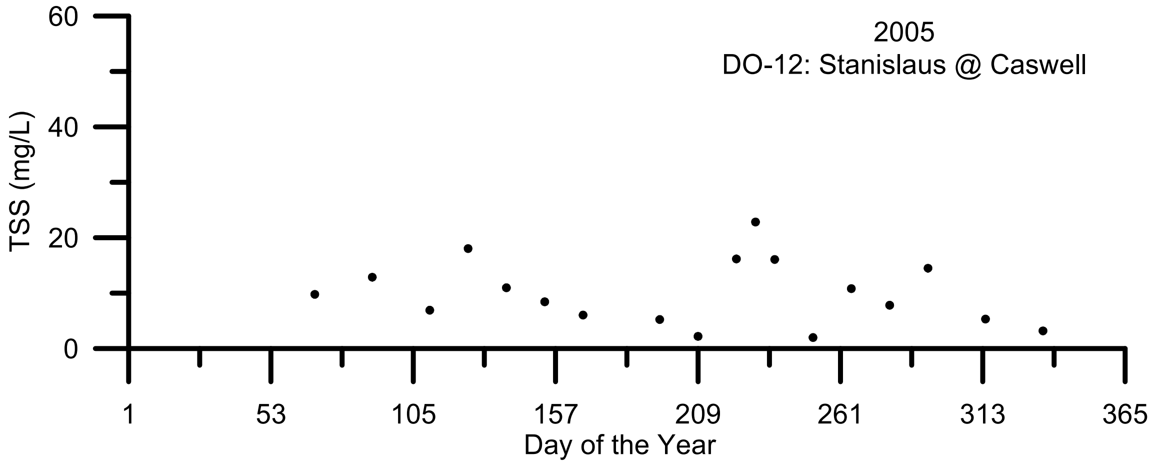

2006
DO-08: SJR at Crow's Landing
TSS (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

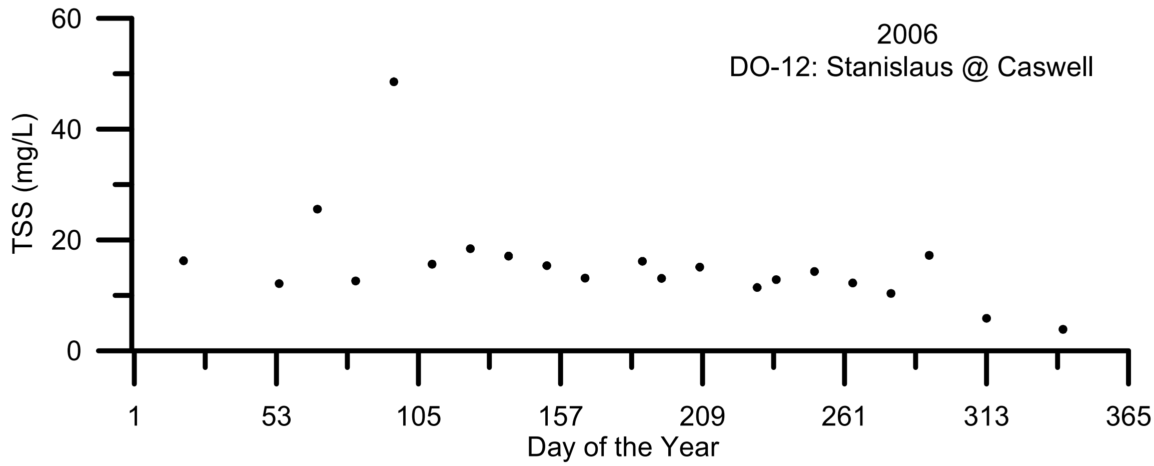

2007
DO-08: SJR at Crow's Landing
TSS (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

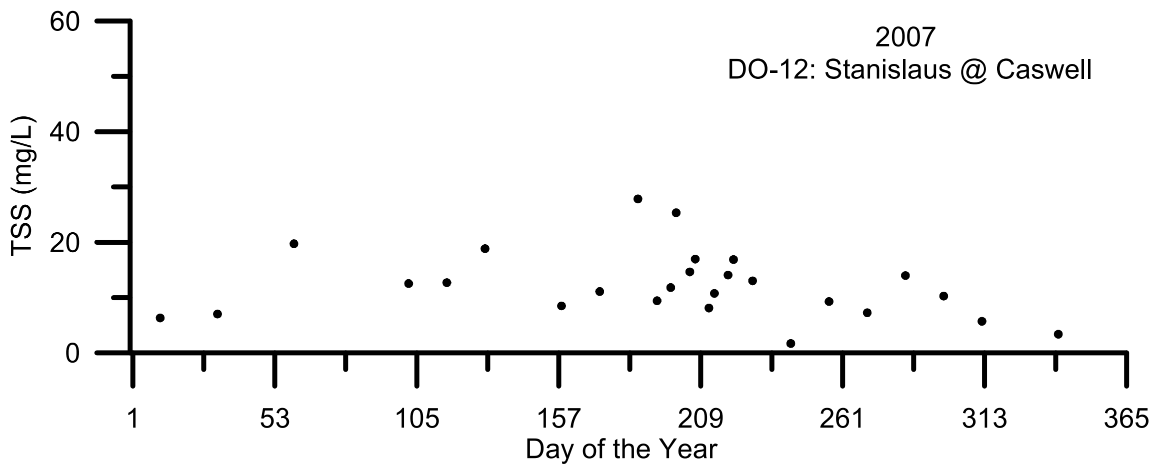

2005
DO-10: SJR at Lander Avenue
TSS (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

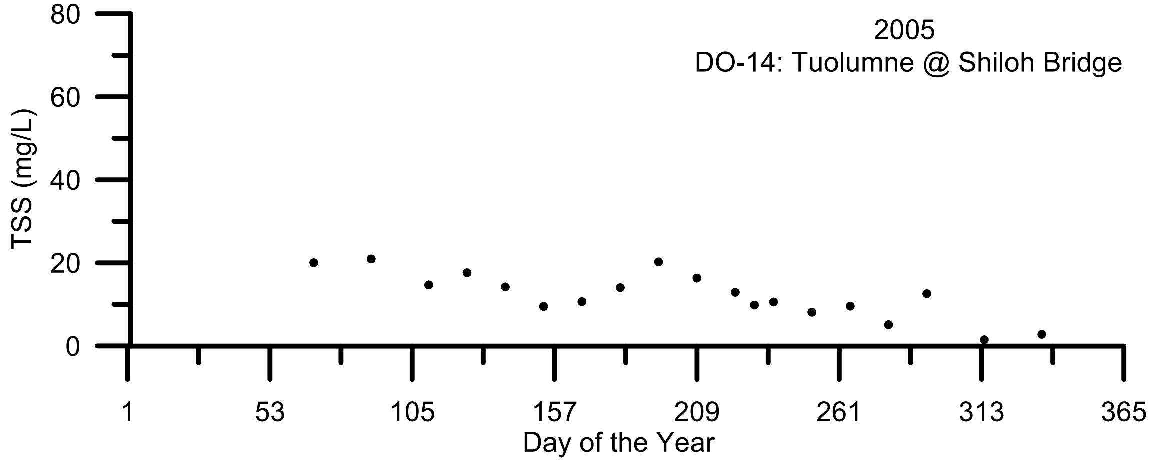

2006
DO-10: SJR at Lander Avenue
TSS (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

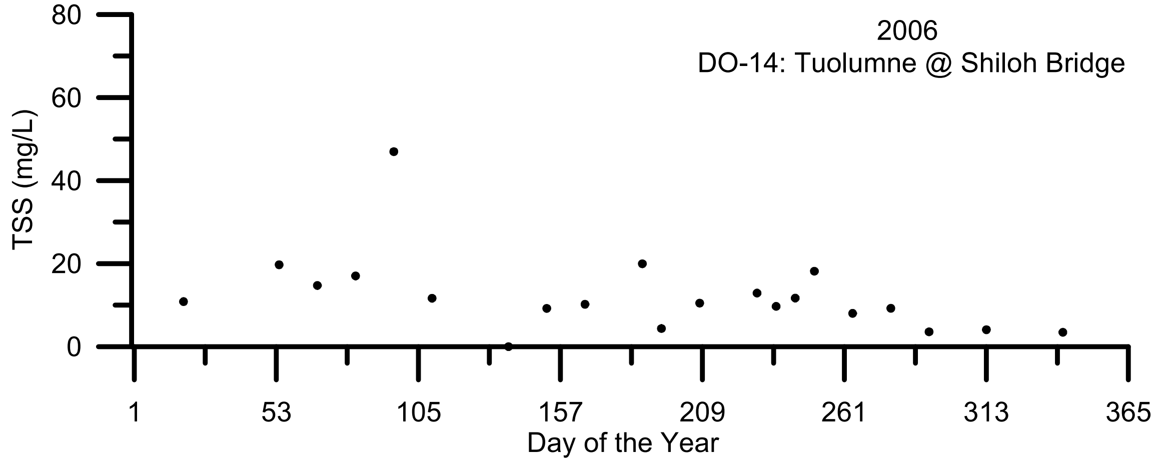

2007
DO-10: SJR at Lander Avenue
TSS (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-12: Stanislaus @ Caswell
TSS (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-12: Stanislaus @ Caswell
TSS (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-12: Stanislaus @ Caswell
TSS (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-14: Tuolumne @ Shiloh Bridge
TSS (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-14: Tuolumne @ Shiloh Bridge
TSS (mg/L)
0
20
40
60
80
1
53
105
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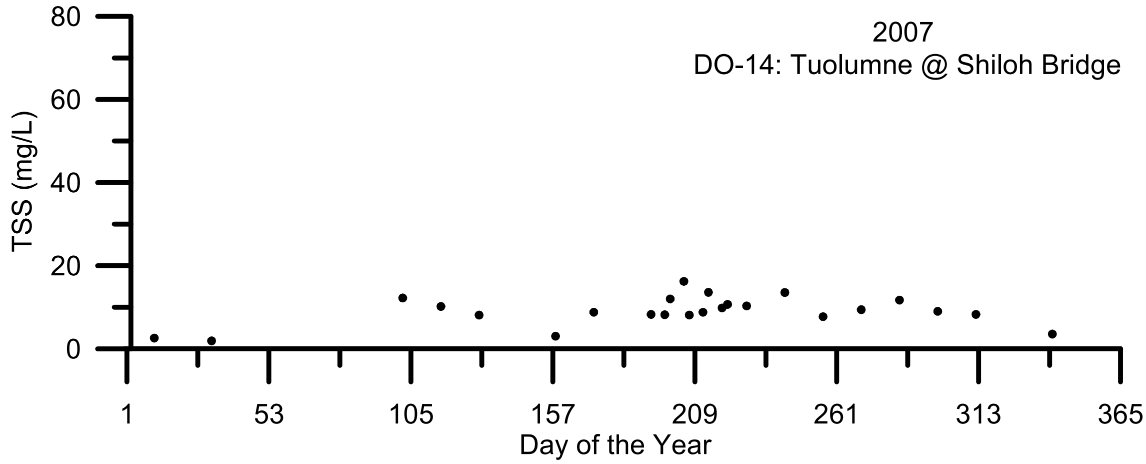
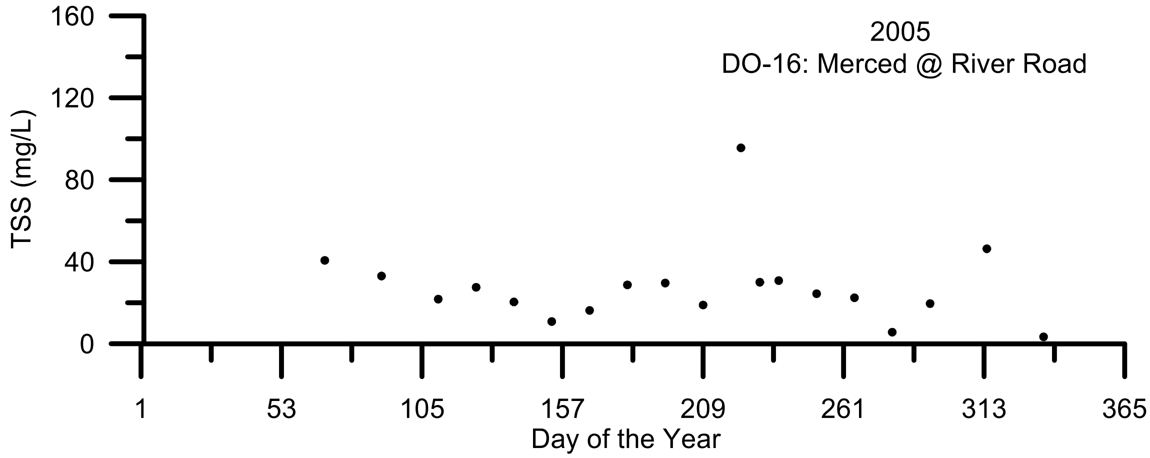
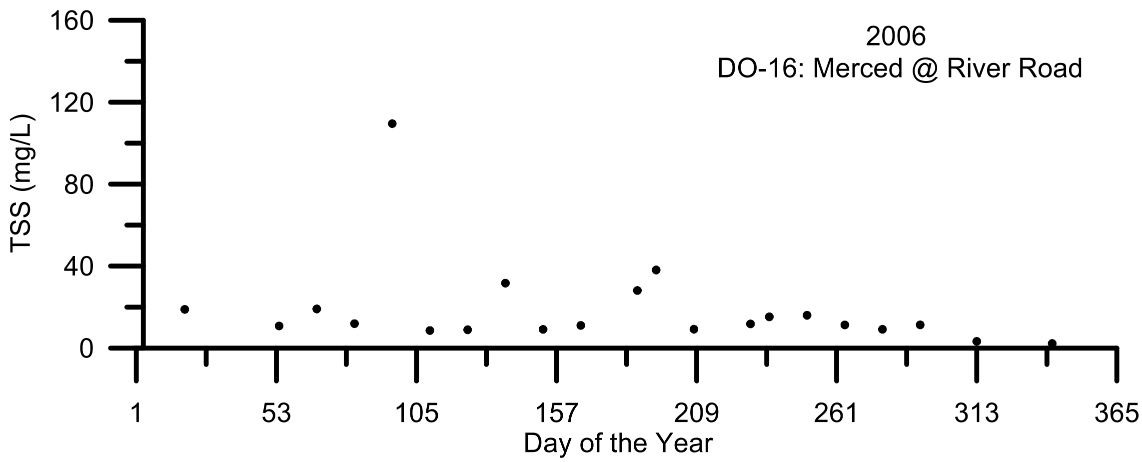
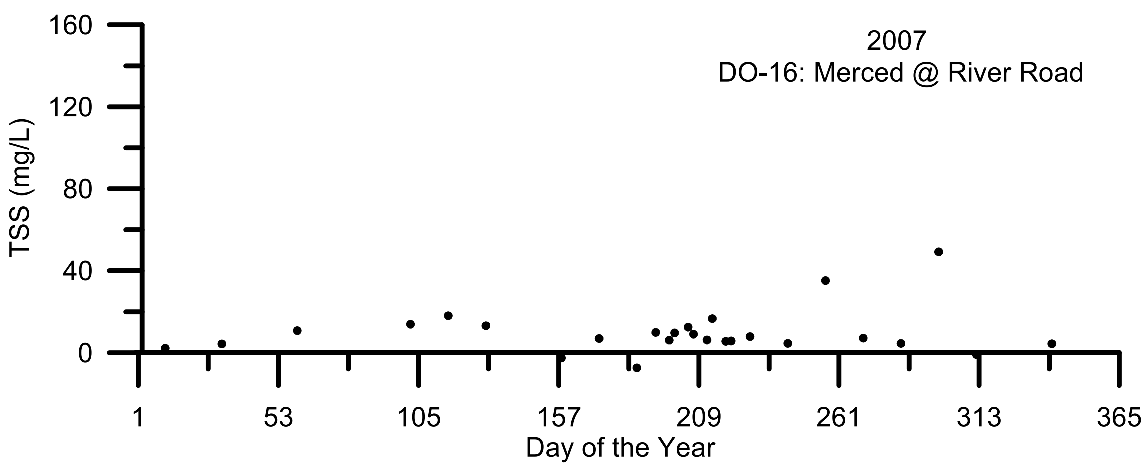
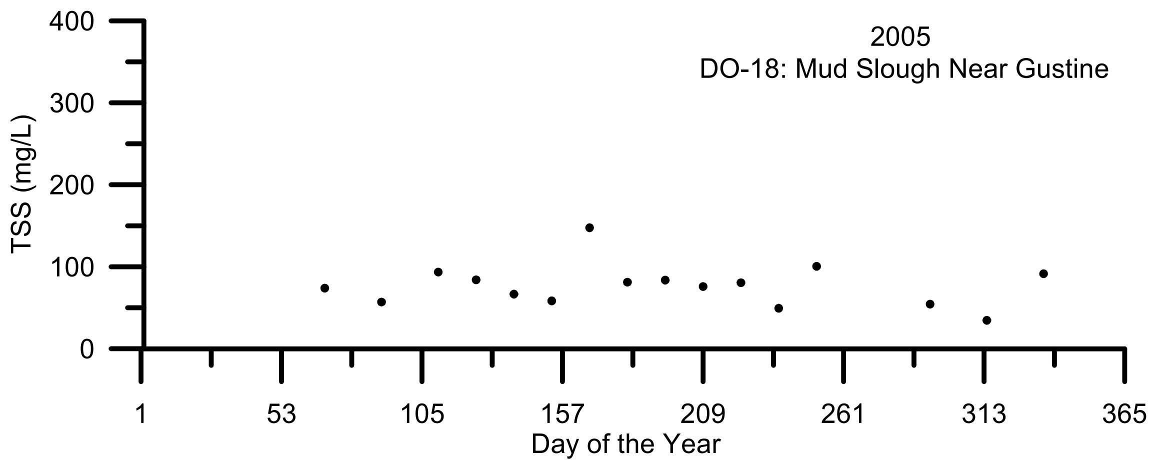
261
313
365
Day of the Year

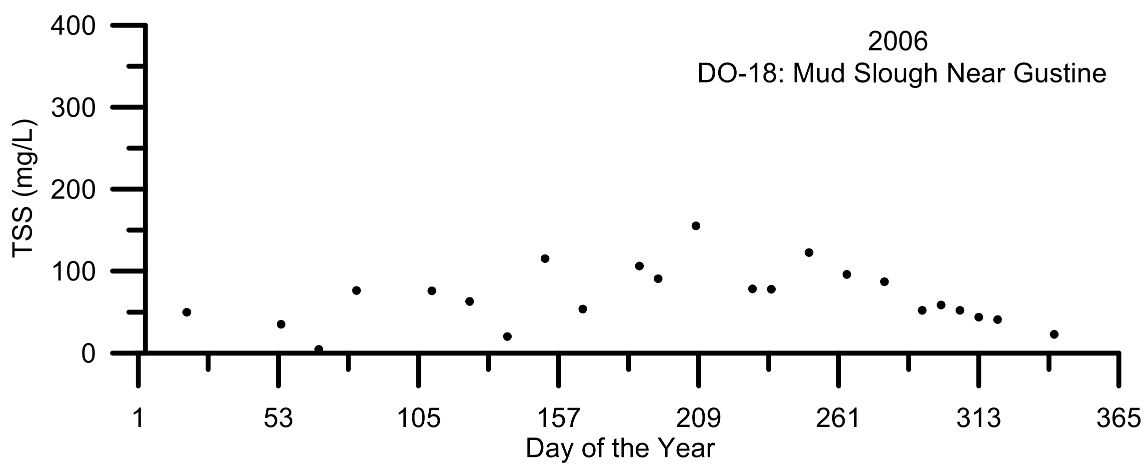

2007
DO-14: Tuolumne @ Shiloh Bridge
TSS (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

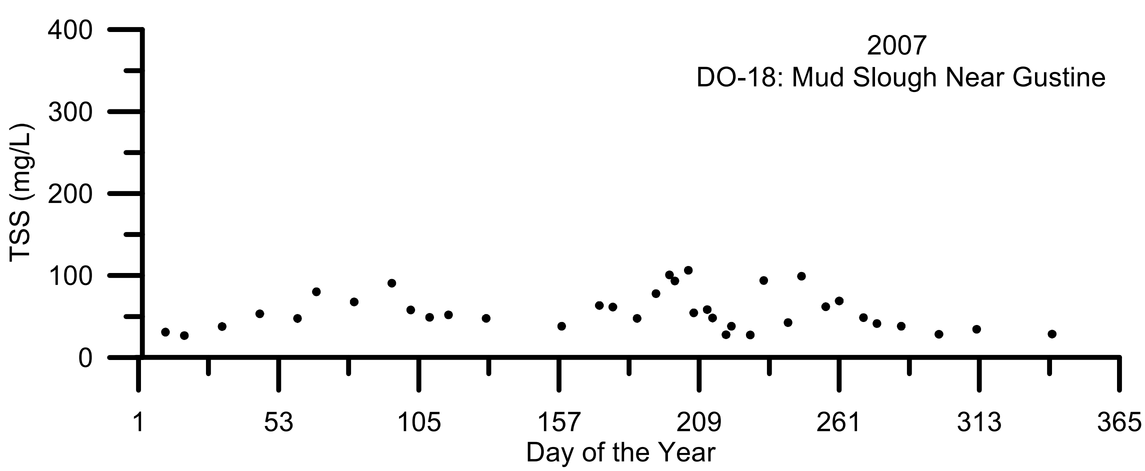

2005
DO-16: Merced @ River Road
TSS (mg/L)
Day of the Year
160
120
80
40
0
1
53
105
157
209
261
313
365

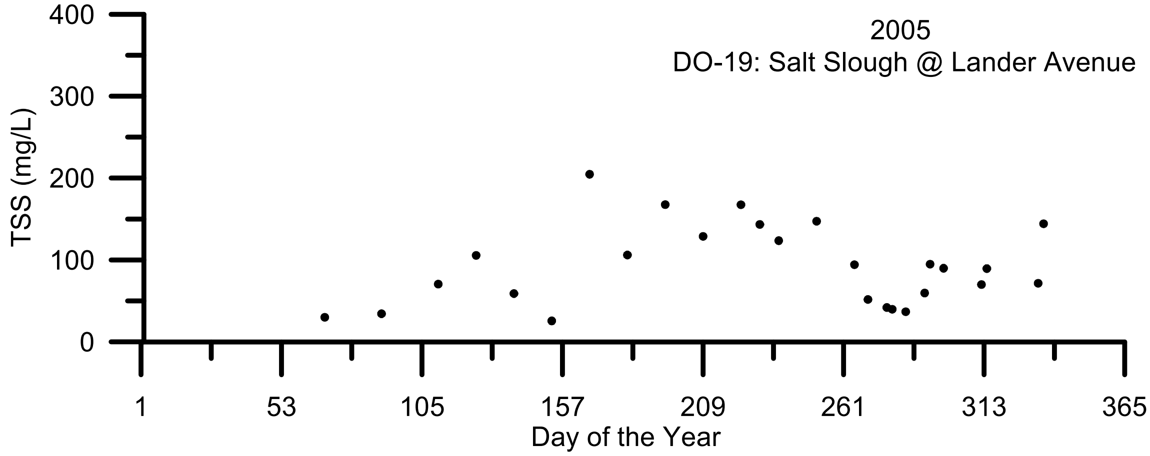

2006
DO-16: Merced @ River Road
TSS (mg/L)
Day of the Year
160
120
80
40
0
1
53
105
157
209
261
313
365

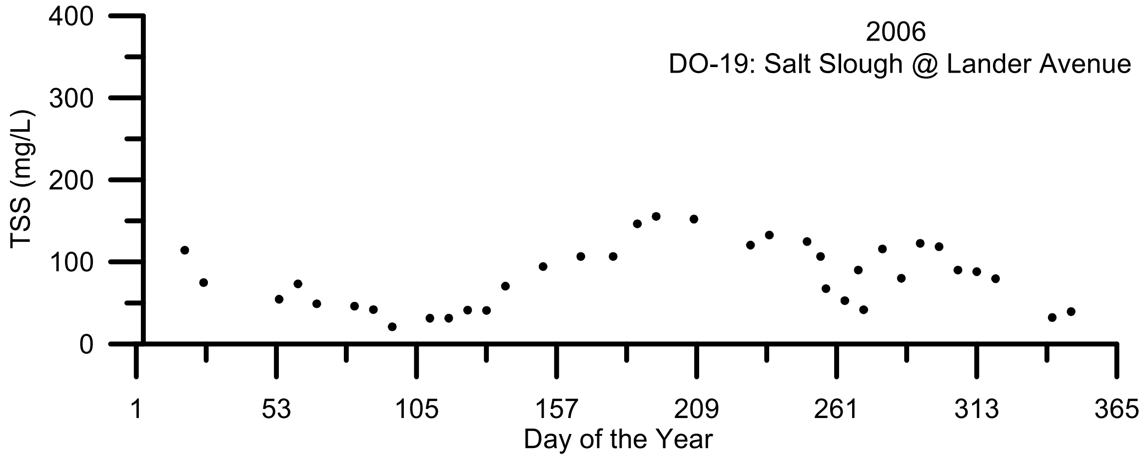

2007
DO-16: Merced @ River Road
TSS (mg/L)
Day of the Year
160
120
80
40
0
1
53
105
157
209
261
313
365

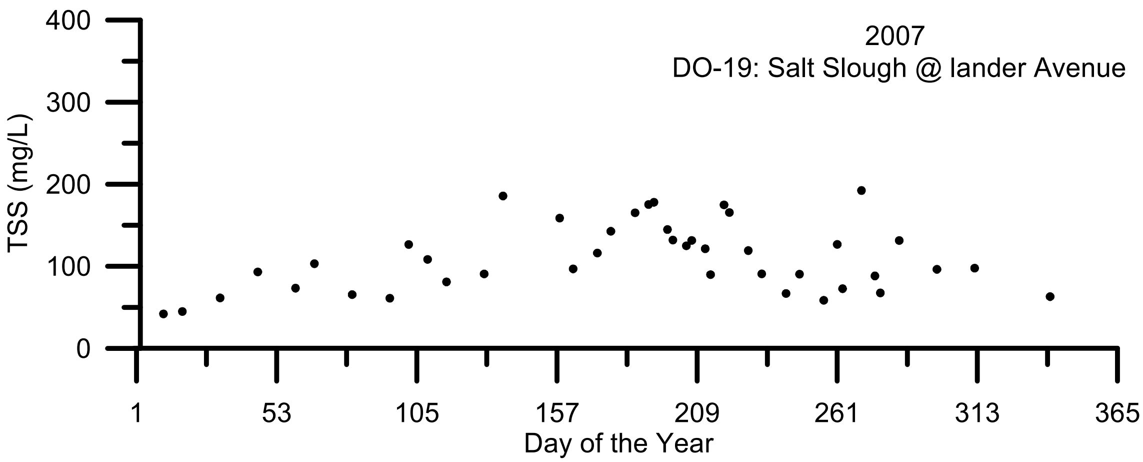

2005
DO-18: Mud Slough Near Gustine
TSS (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

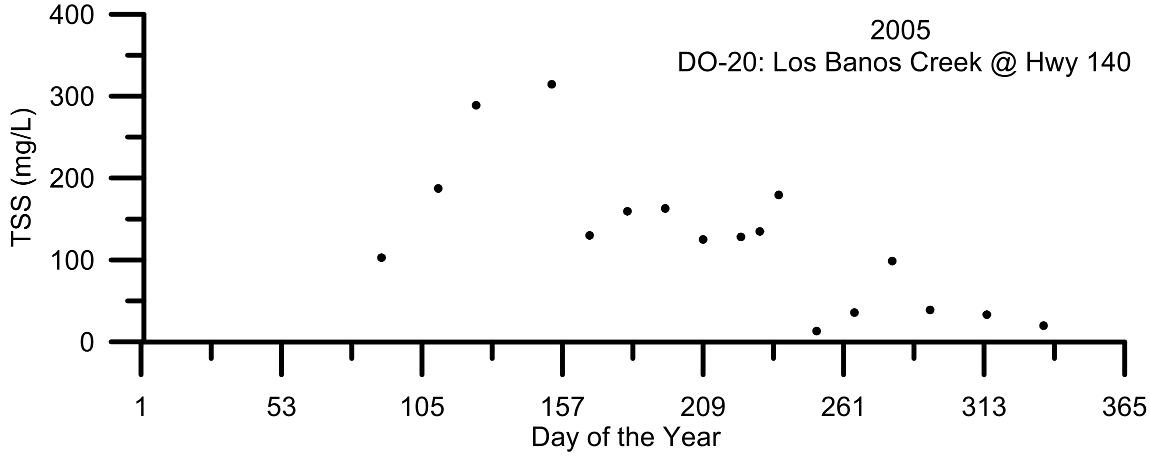

2006
DO-18: Mud Slough Near Gustine
TSS (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

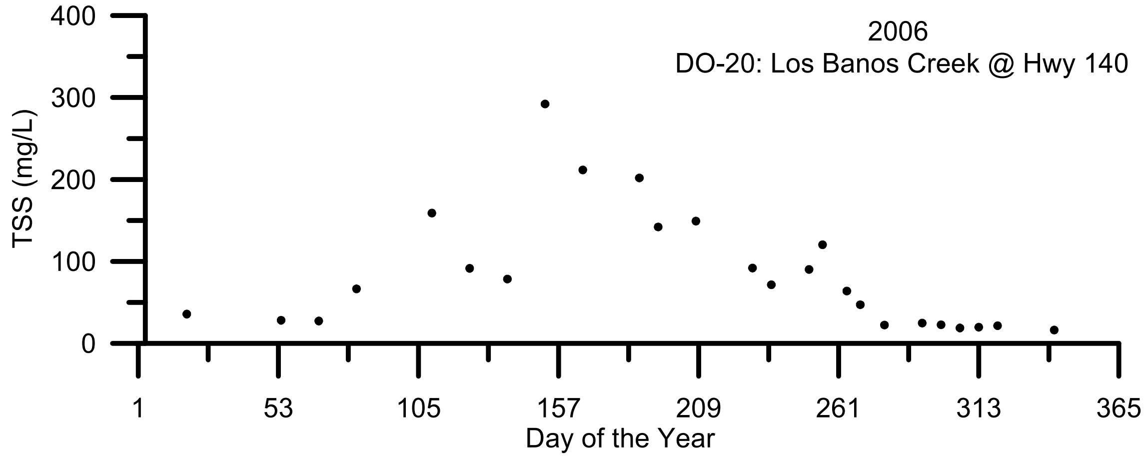

2007
DO-18: Mud Slough Near Gustine
TSS (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

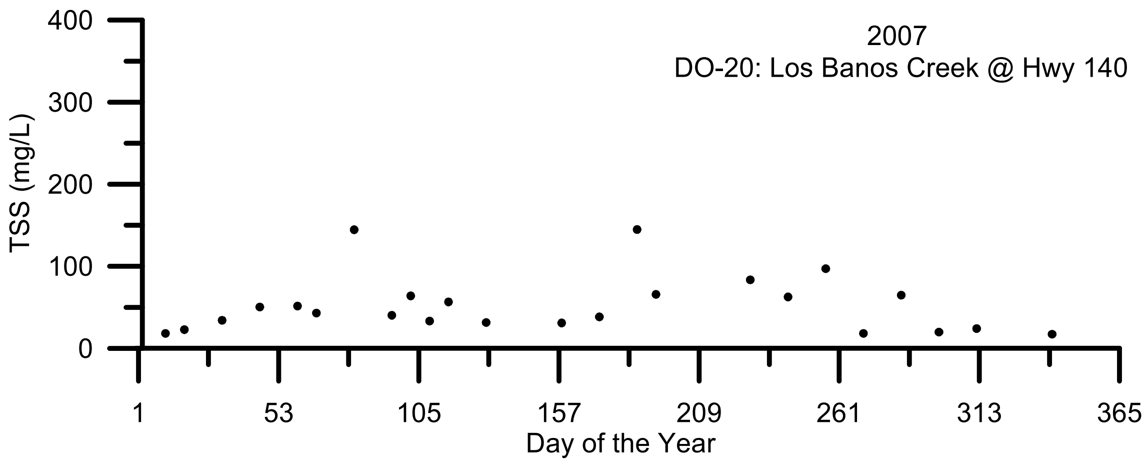

2005
DO-19: Salt Slough @ Lander Avenue
TSS (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

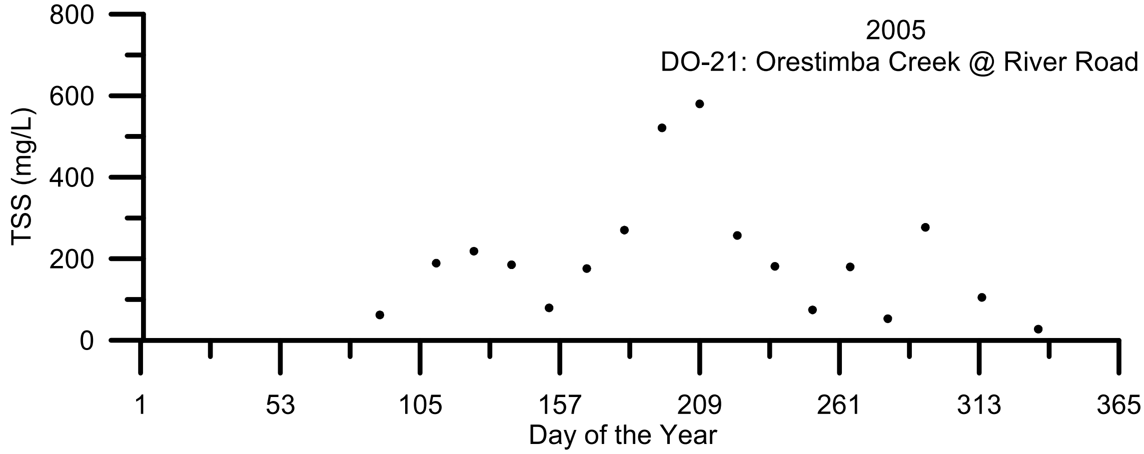

2006
DO-19: Salt Slough @ Lander Avenue
TSS (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

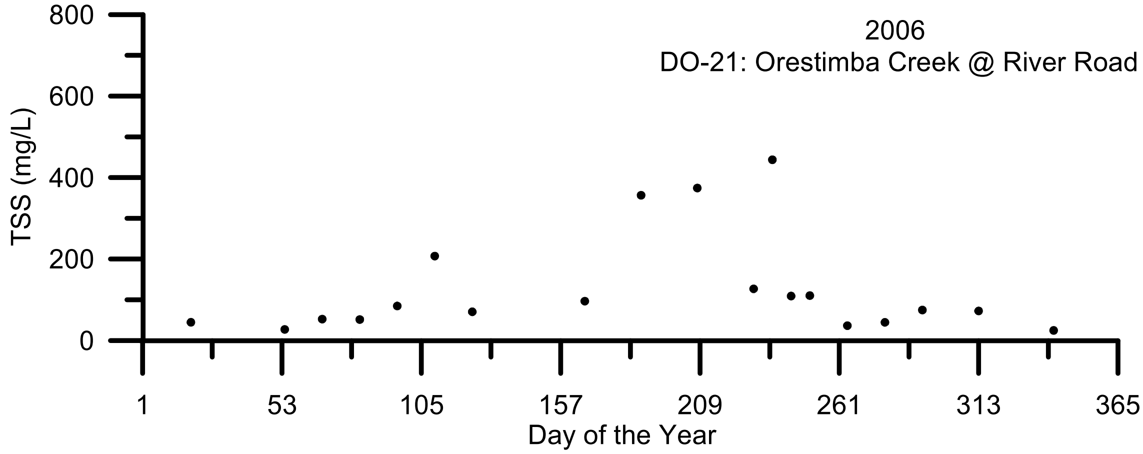

2007
DO-19: Salt Slough @ lander Avenue
TSS (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

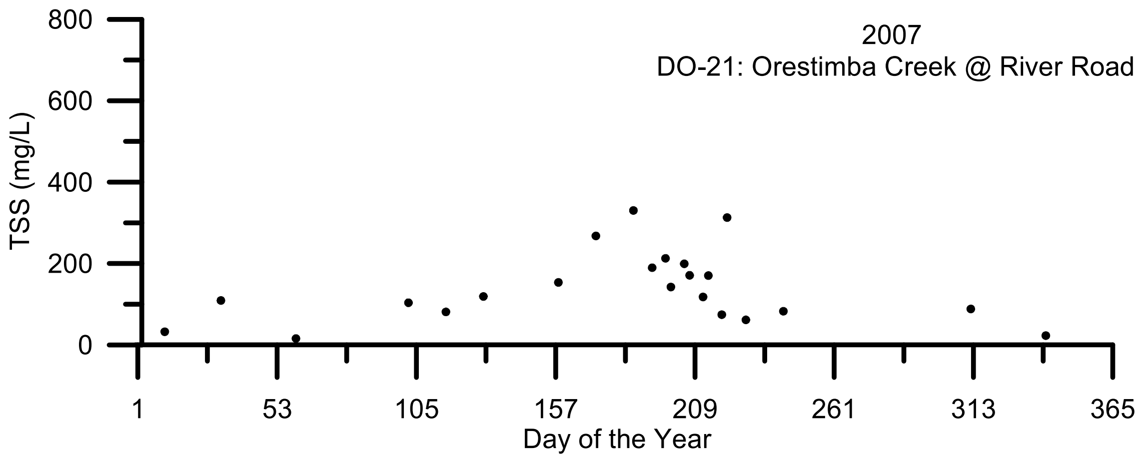

2005
DO-20: Los Banos Creek @ Hwy 140
TSS (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

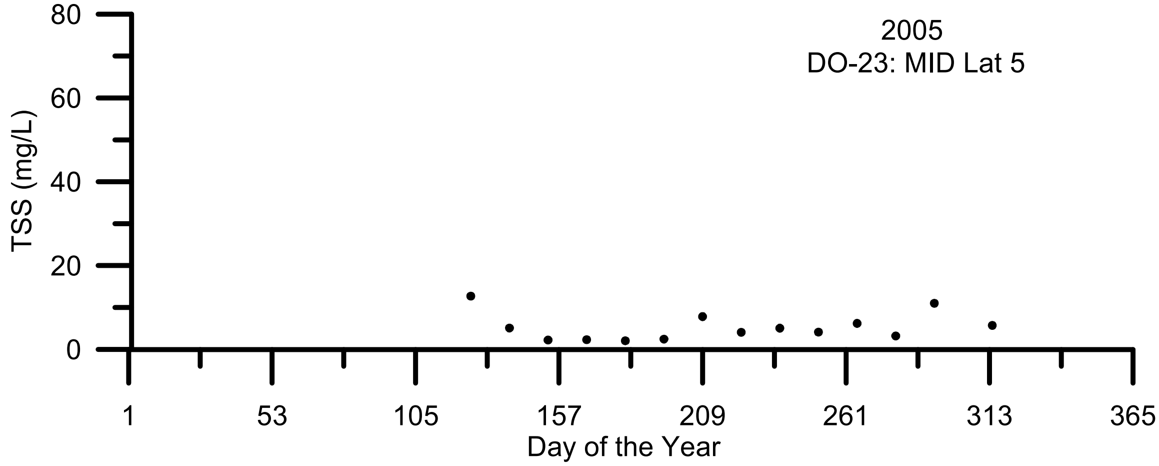

2006
DO-20: Los Banos Creek @ Hwy 140
TSS (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-20: Los Banos Creek @ Hwy 140
TSS (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

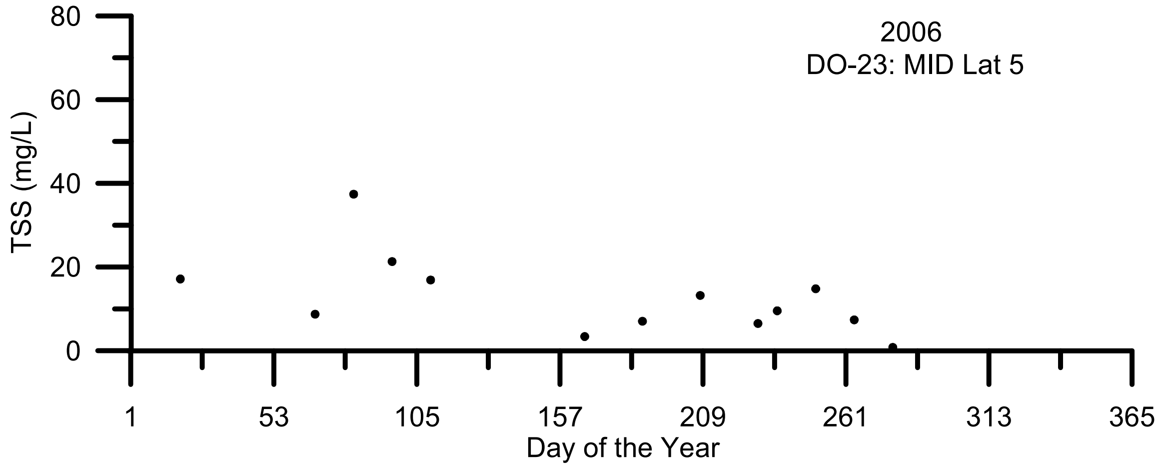

2005
DO-21: Orestimba Creek @ River Road
TSS (mg/L)
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-21: Orestimba Creek @ River Road
TSS (mg/L)
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

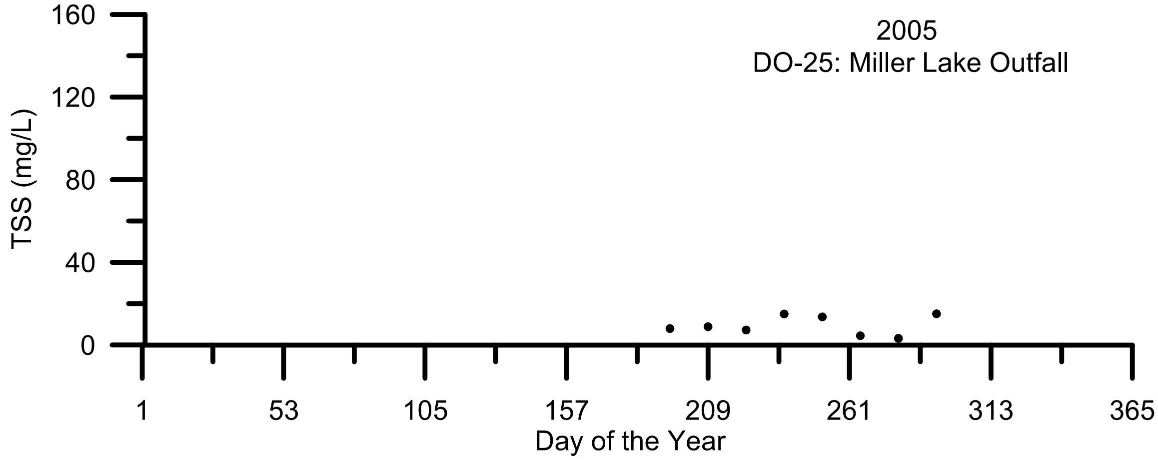

2007
DO-21: Orestimba Creek @ River Road
TSS (mg/L)
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

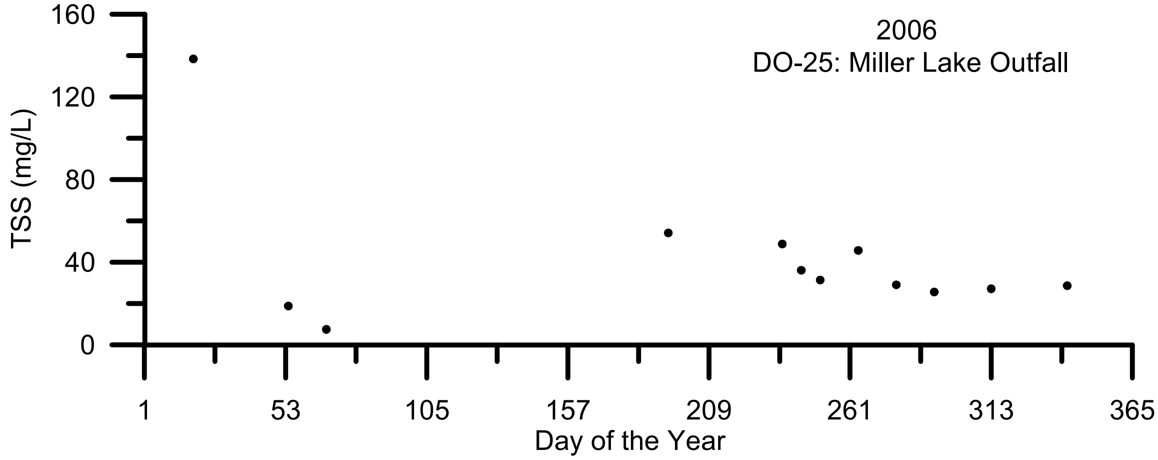


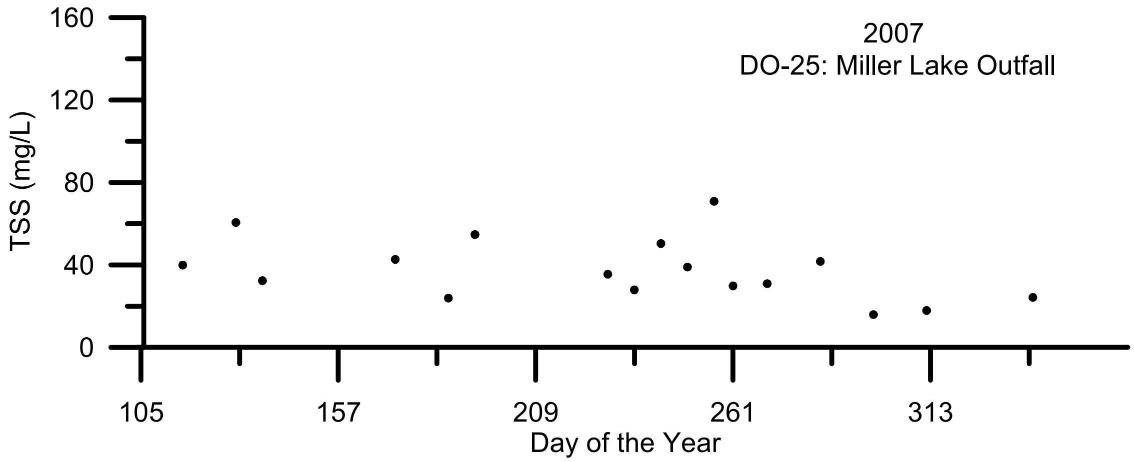
2005
DO-23: MID Lat 5
TSS (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

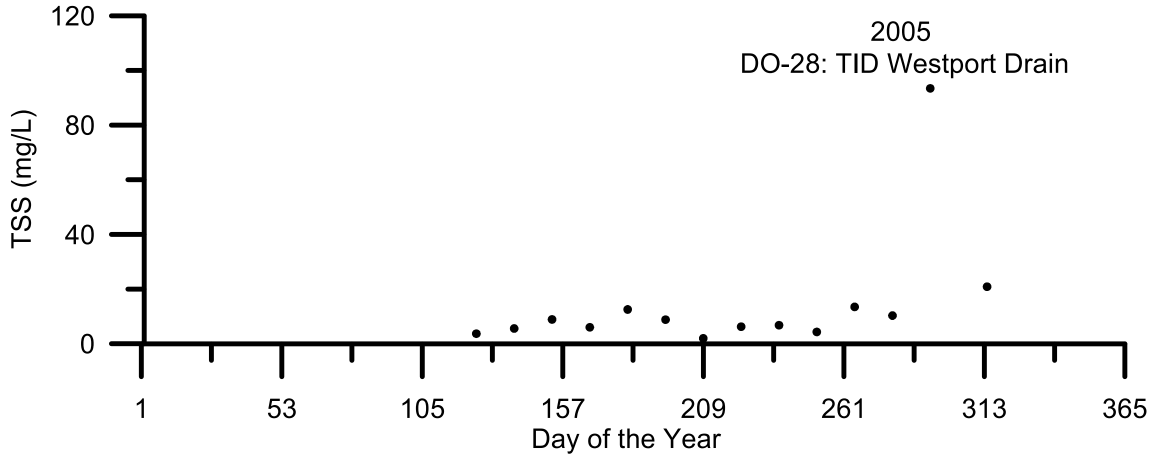


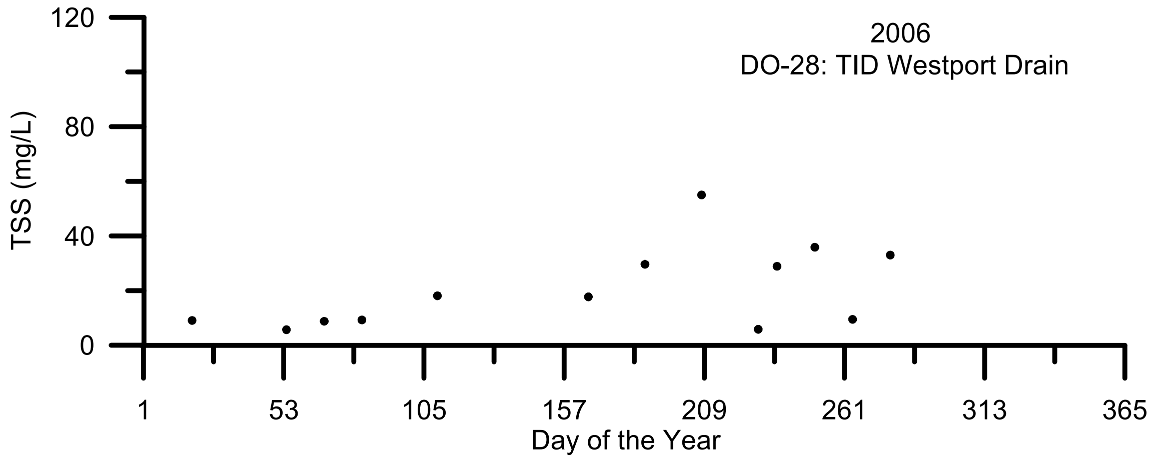
2006
DO-23: MID Lat 5
TSS (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

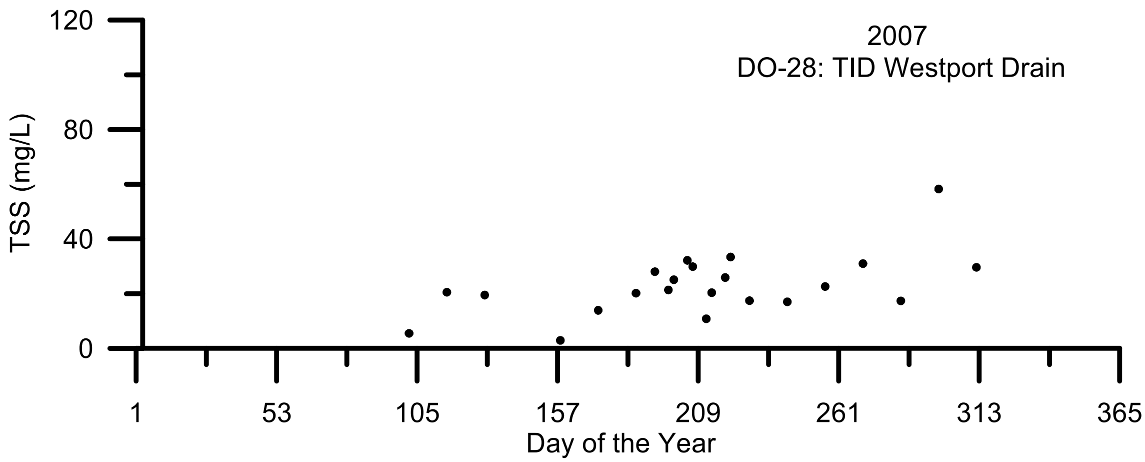

2005
DO-25: Miller Lake Outfall
TSS (mg/L)
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

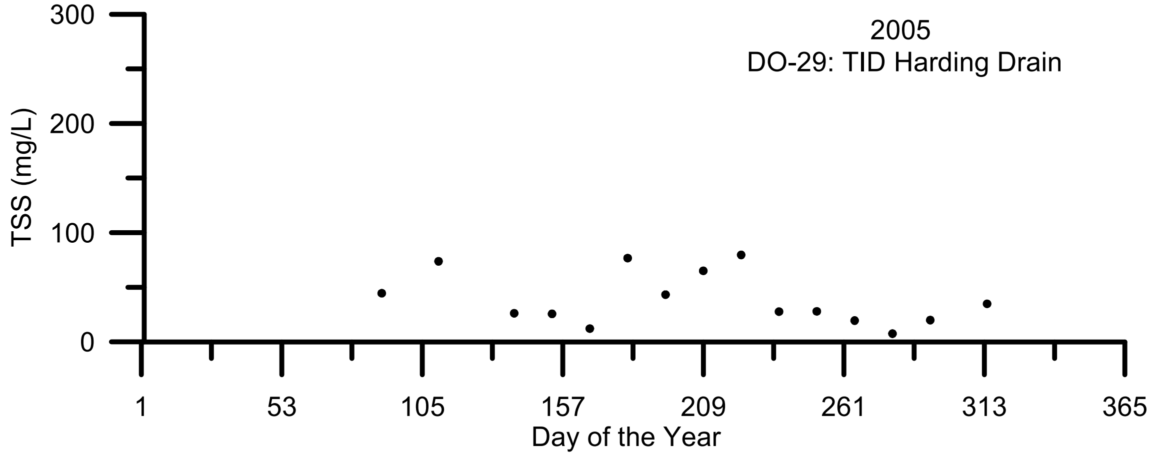

2006
DO-25: Miller Lake Outfall
TSS (mg/L)
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

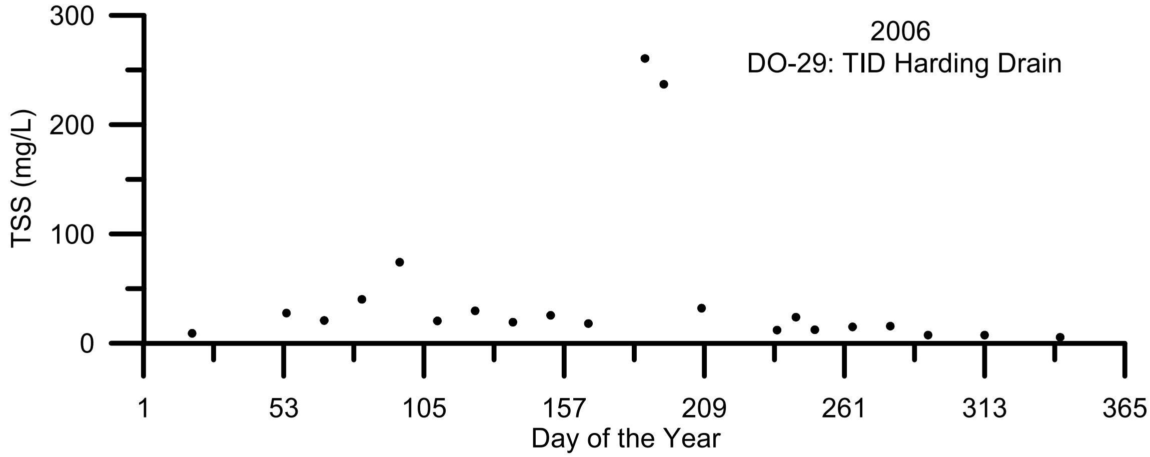

2007
DO-25: Miller Lake Outfall
TSS (mg/L)
160
120
80
40
0
105
157
209
261
313
Day of the Year

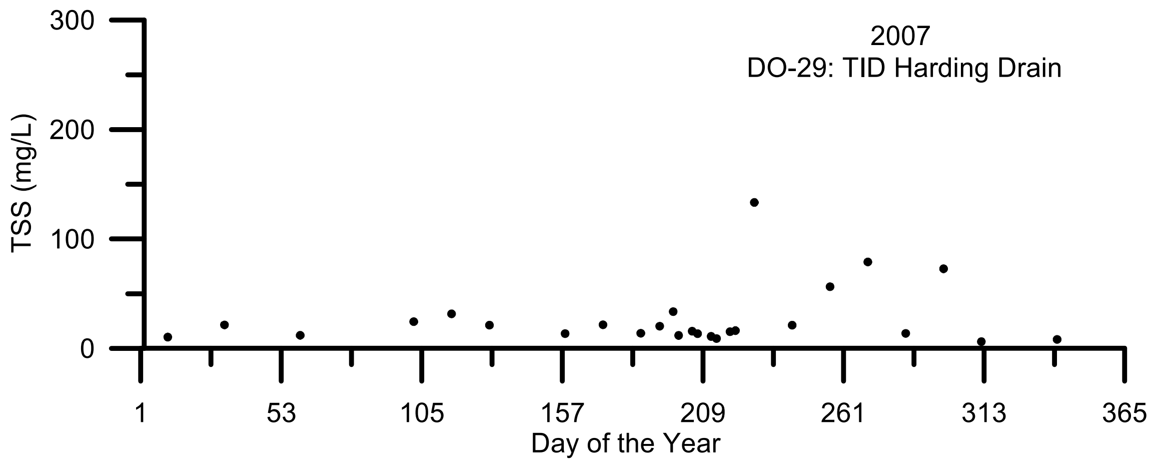

2005
DO-28: TID Westport Drain
TSS (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

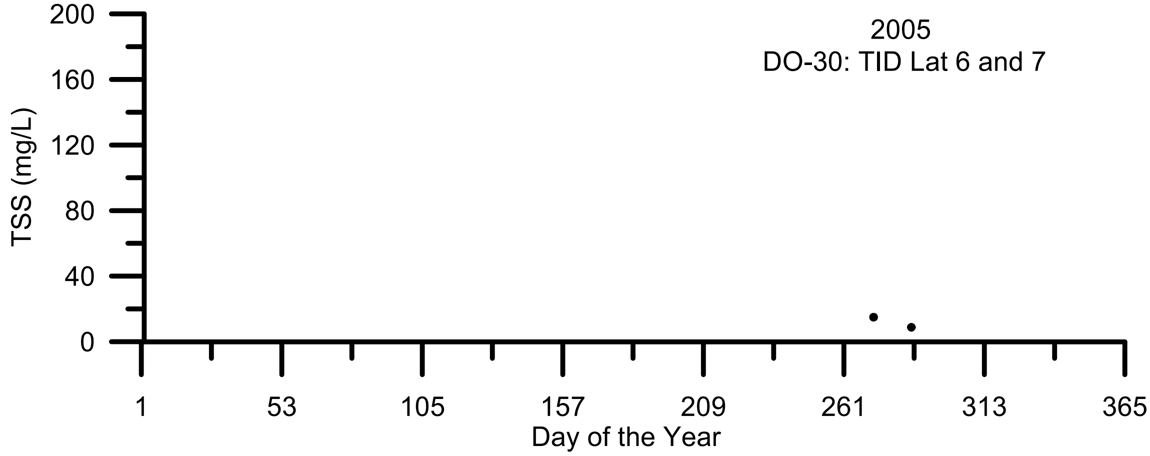

2006
DO-28: TID Westport Drain
TSS (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

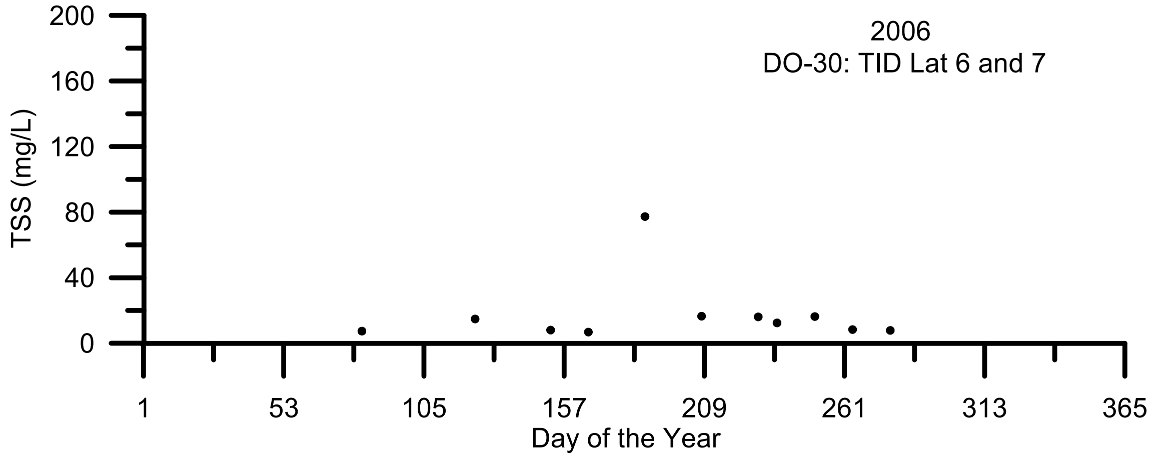

2007
DO-28: TID Westport Drain
TSS (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

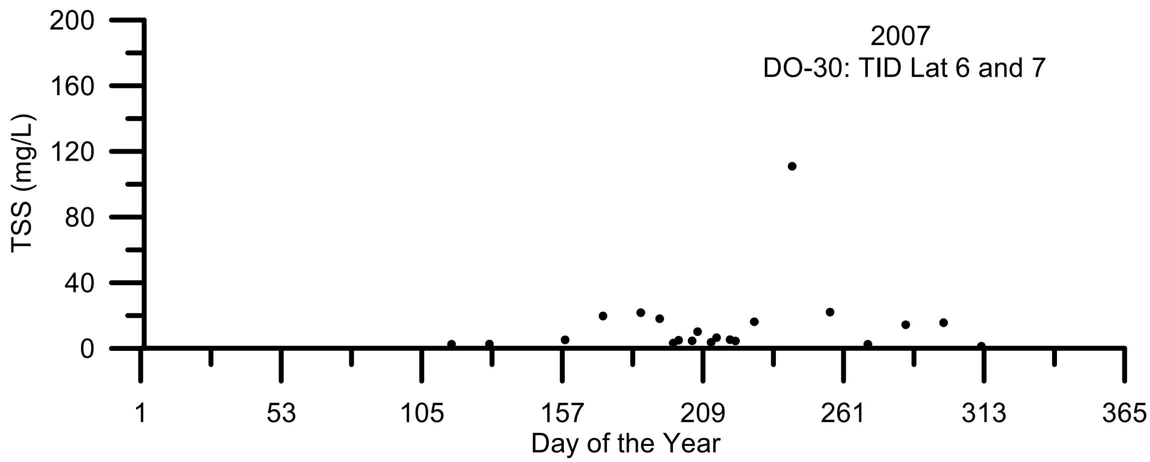

2005
DO-29: TID Harding Drain
TSS (mg/L)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

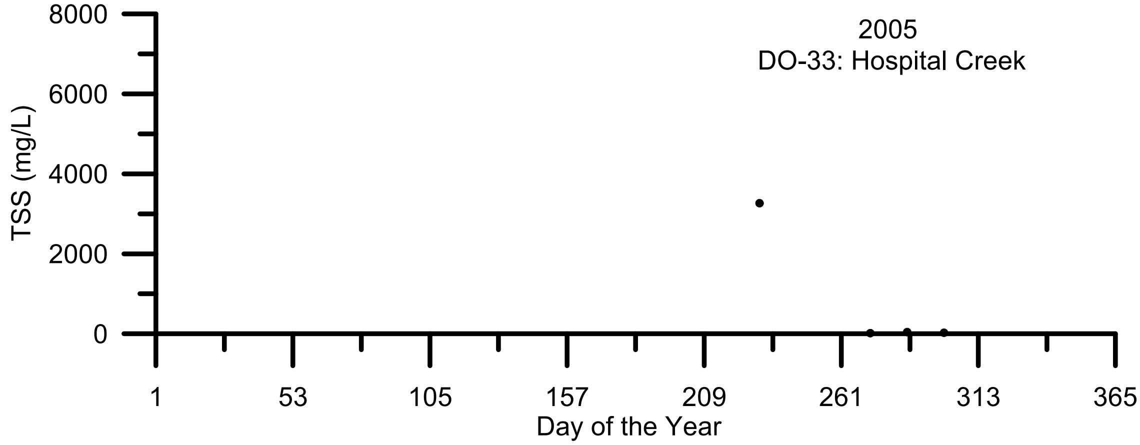

2006
DO-29: TID Harding Drain
TSS (mg/L)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

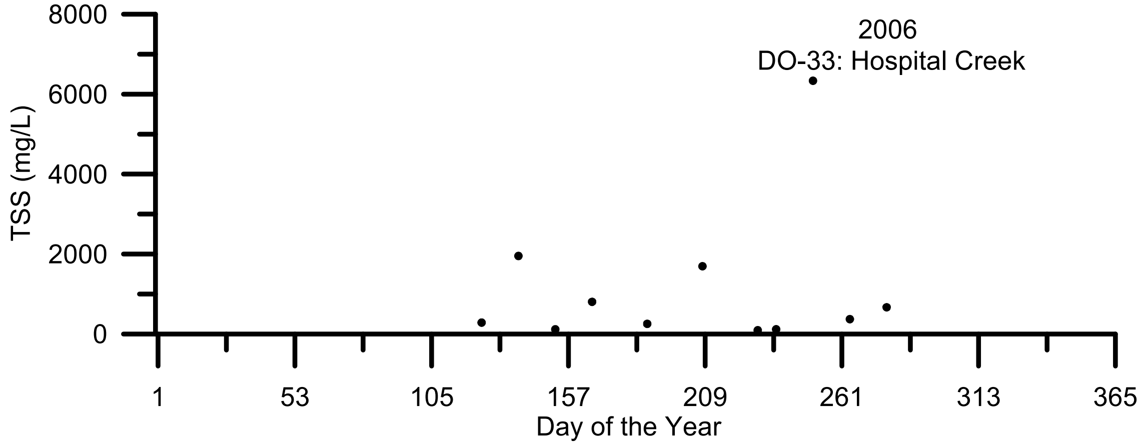

2007
DO-29: TID Harding Drain
TSS (mg/L)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

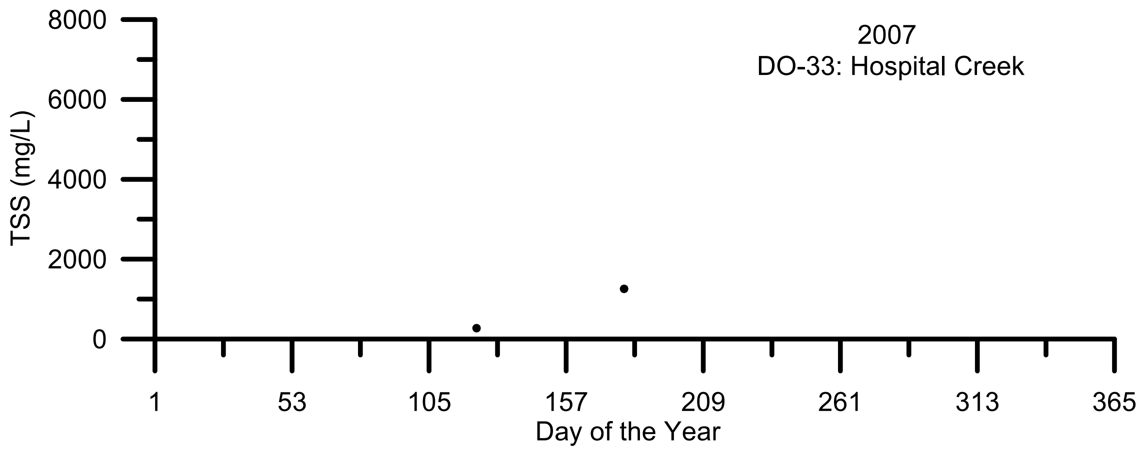

2005
DO-30: TID Lat 6 and 7
TSS (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

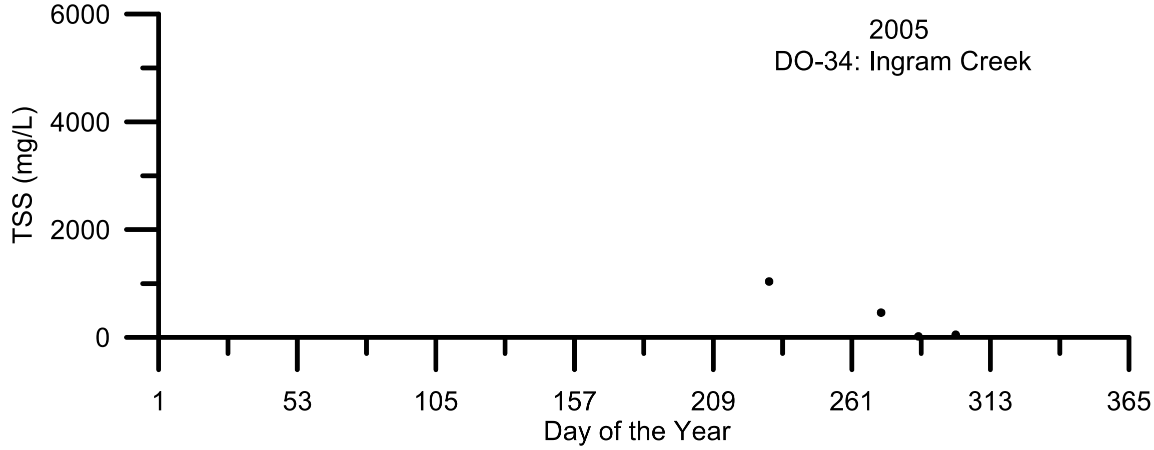

2006
DO-30: TID Lat 6 and 7
TSS (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

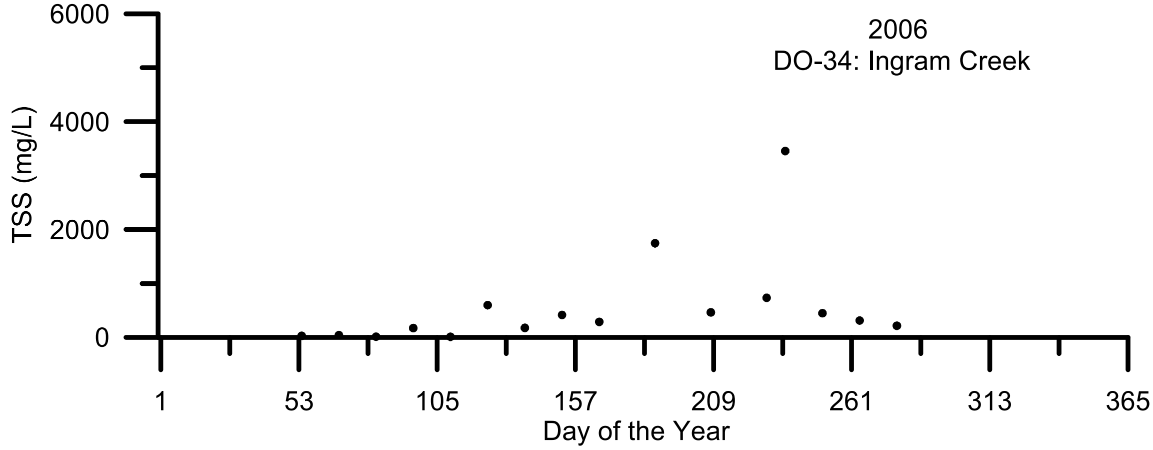

2007
DO-30: TID Lat 6 and 7
TSS (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

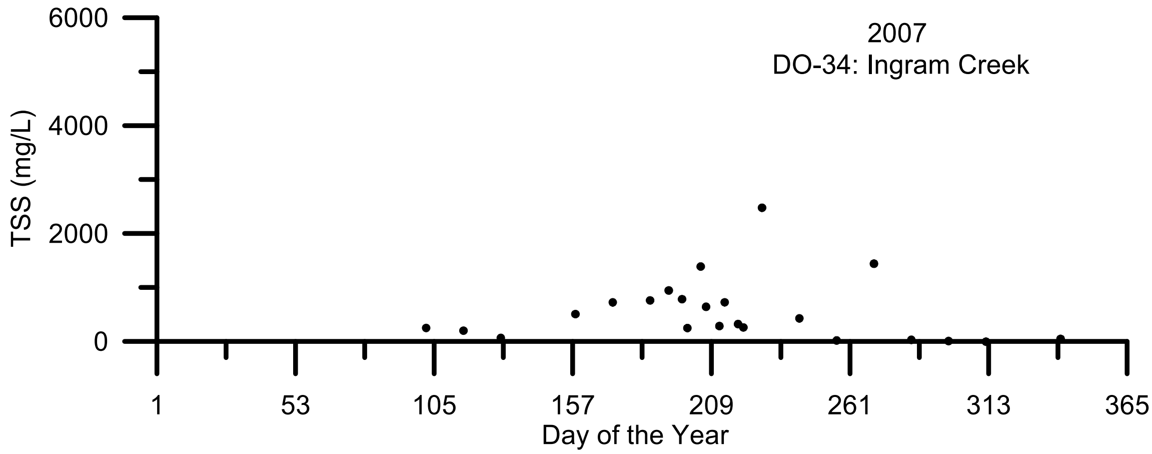

2005
DO-33: Hospital Creek
TSS (mg/L)
8000
6000
4000
2000
0
1
53
105
157
209
261
313
365
Day of the Year

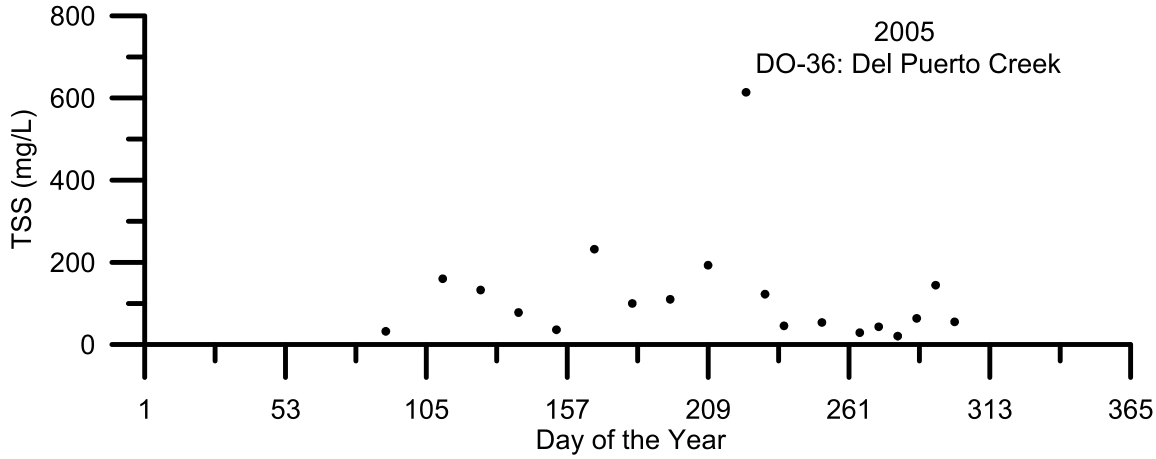

2006
DO-33: Hospital Creek
TSS (mg/L)
8000
6000
4000
2000
0
1
53
105
157
209
261
313
365
Day of the Year

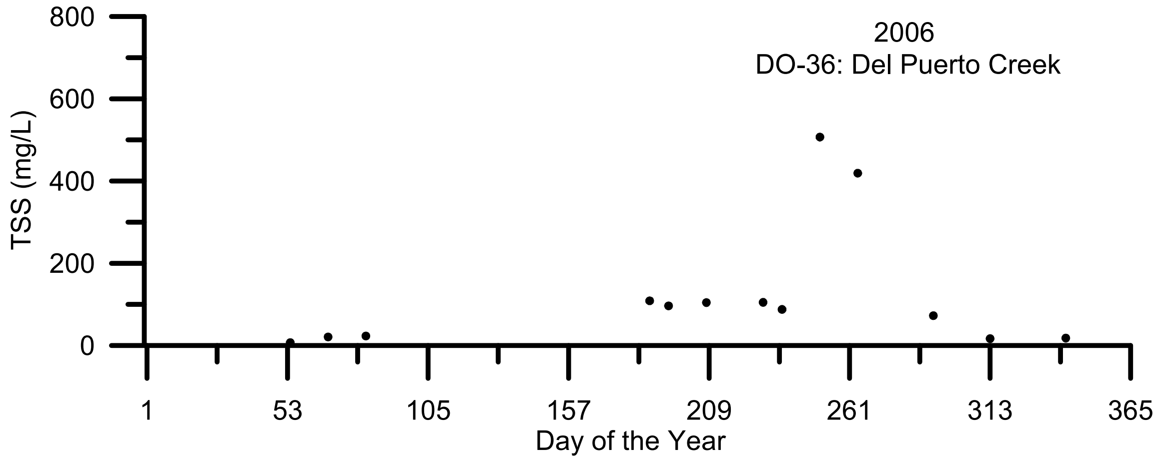

2007
DO-33: Hospital Creek
TSS (mg/L)
8000
6000
4000
2000
0
1
53
105
157
209
261
313
365
Day of the Year

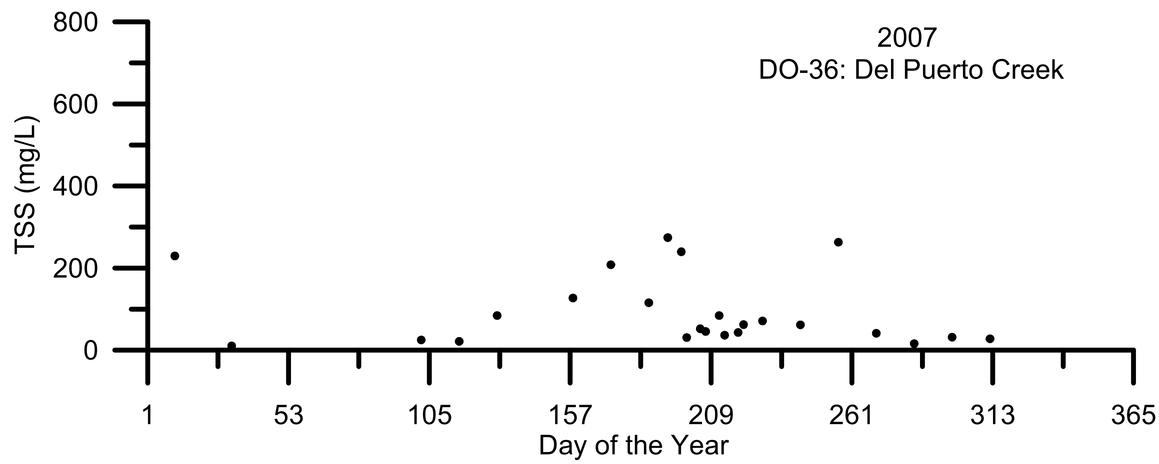

2005
DO-34: Ingram Creek
TSS (mg/L)
6000
4000
2000
0
1
53
105
157
209
261
313
365
Day of the Year

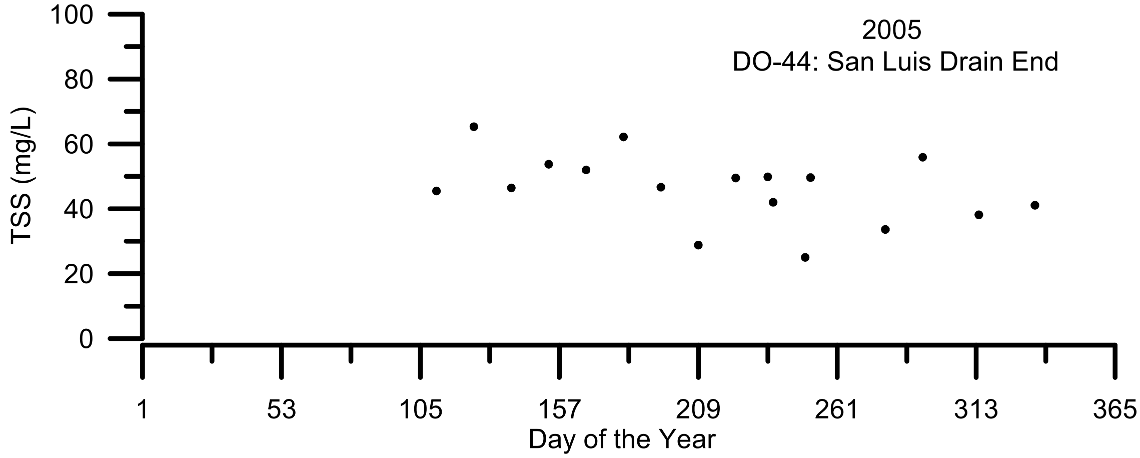

2006
DO-34: Ingram Creek
TSS (mg/L)
6000
4000
2000
0
1
53
105
157
209
261
313
365
Day of the Year

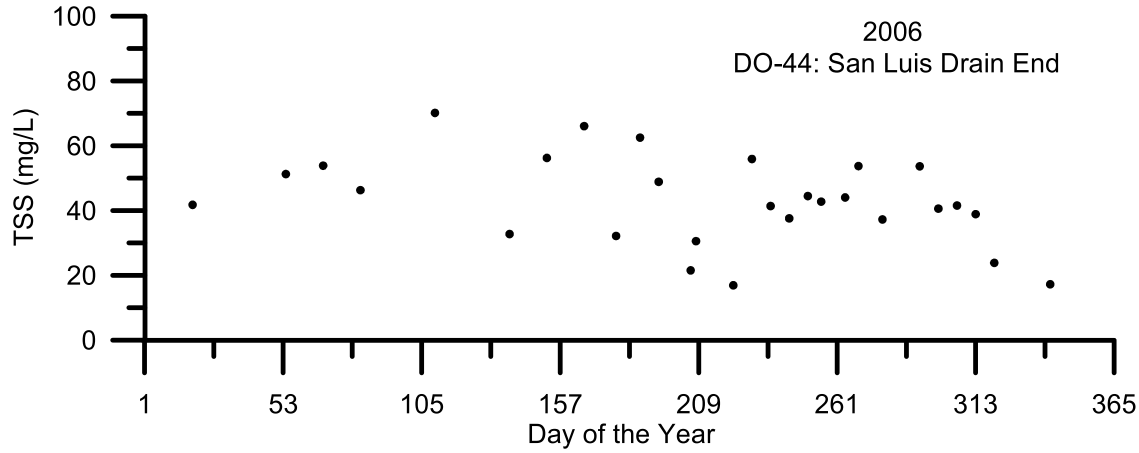

2007
DO-34: Ingram Creek
TSS (mg/L)
6000
4000
2000
0
1
53
105
157
209
261
313
365
Day of the Year

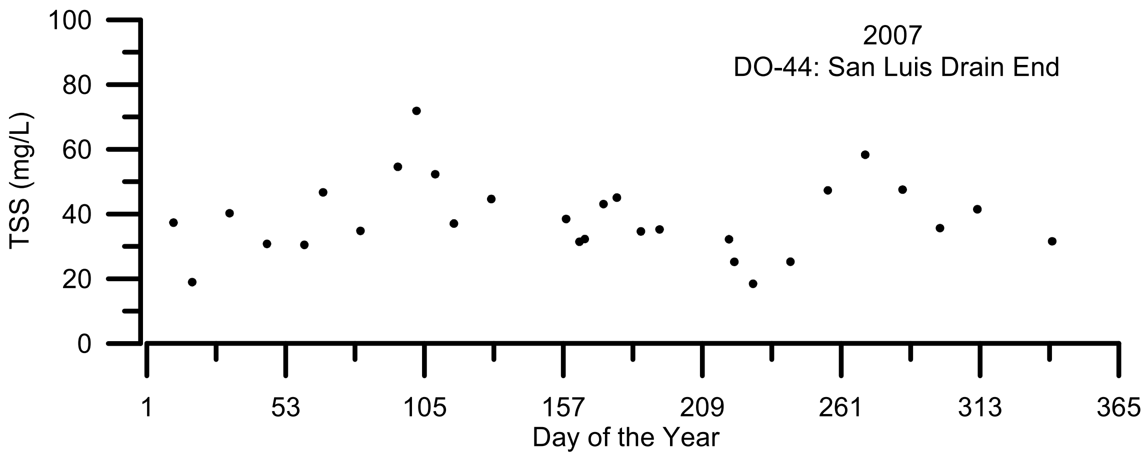

2005
DO-36: Del Puerto Creek
TSS (mg/L)
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

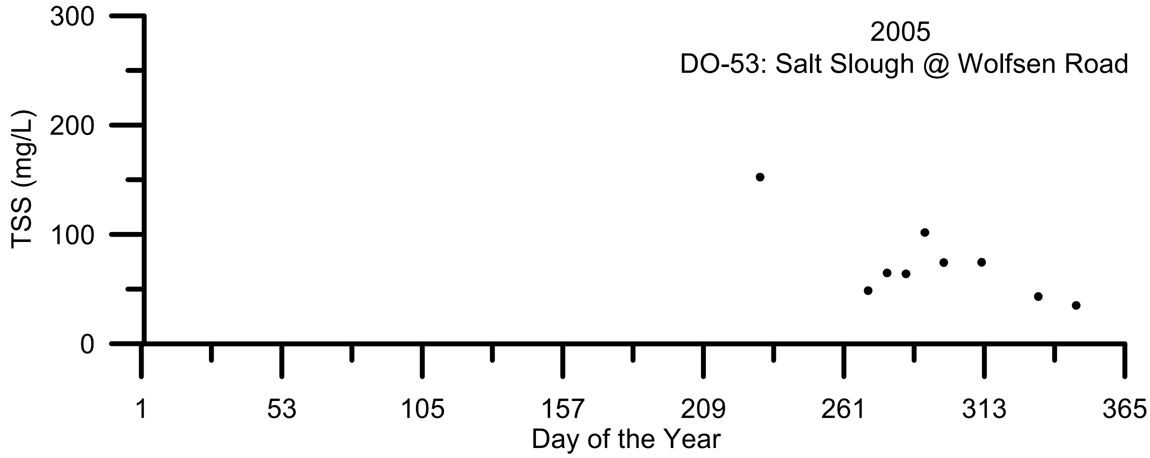

2006
DO-36: Del Puerto Creek
TSS (mg/L)
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

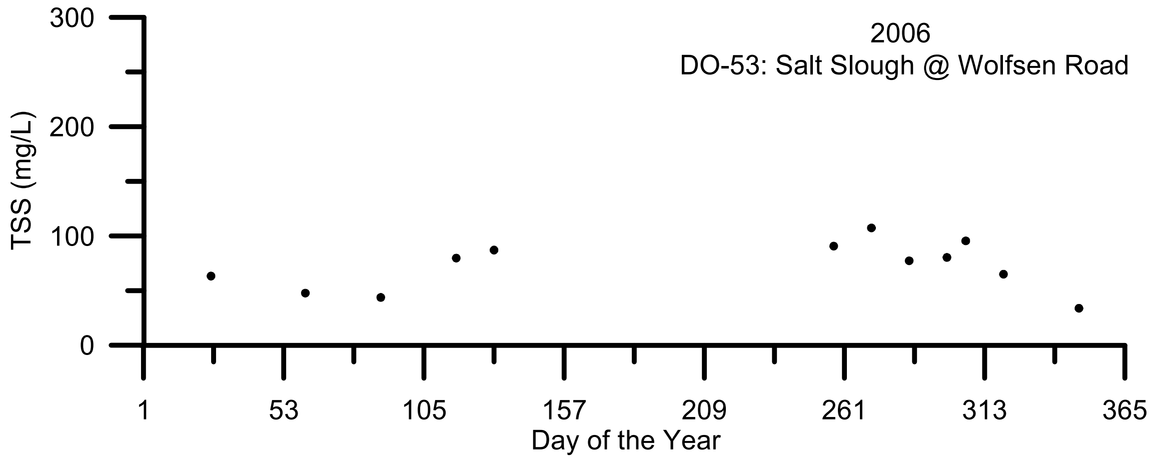

2007
DO-36: Del Puerto Creek
TSS (mg/L)
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

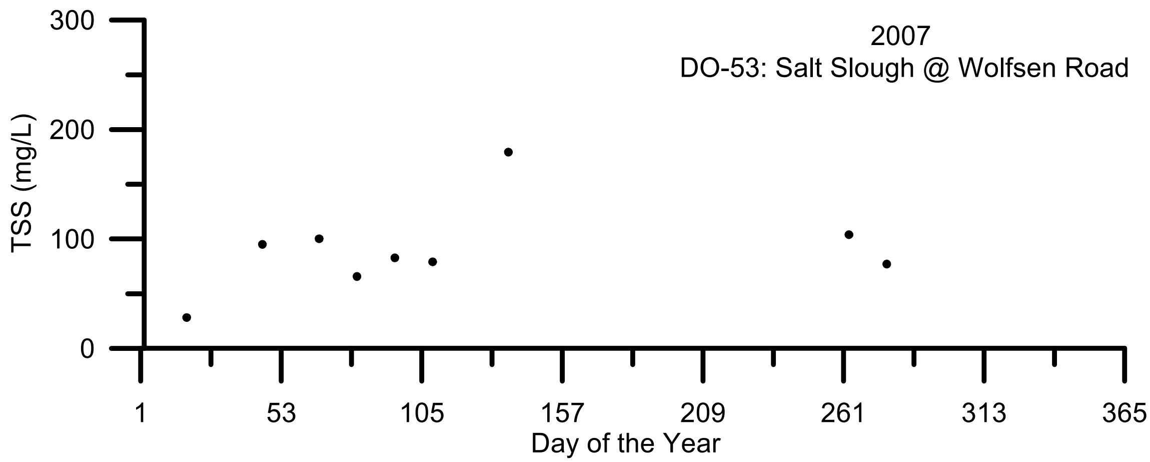

2005
DO-44: San Luis Drain End
TSS (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

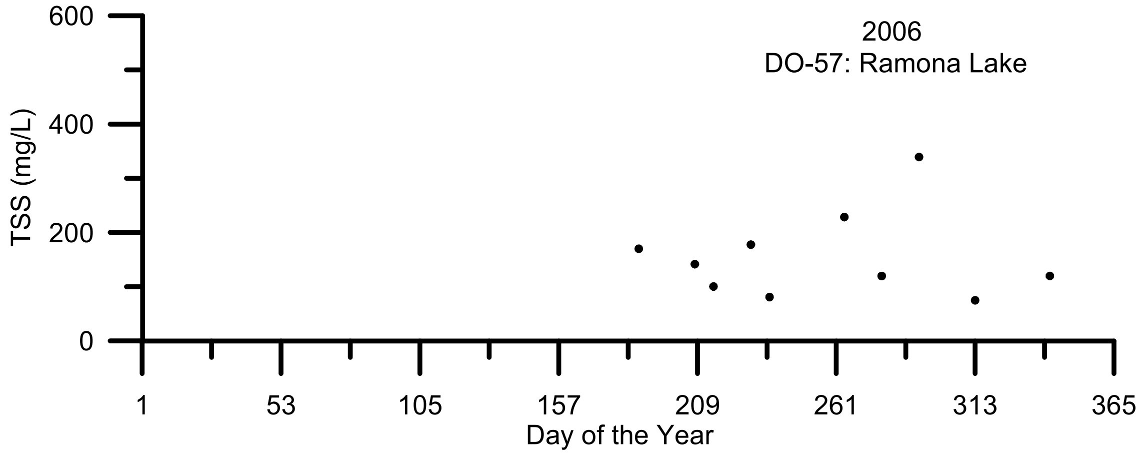

2006
DO-44: San Luis Drain End
TSS (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-44: San Luis Drain End
TSS (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

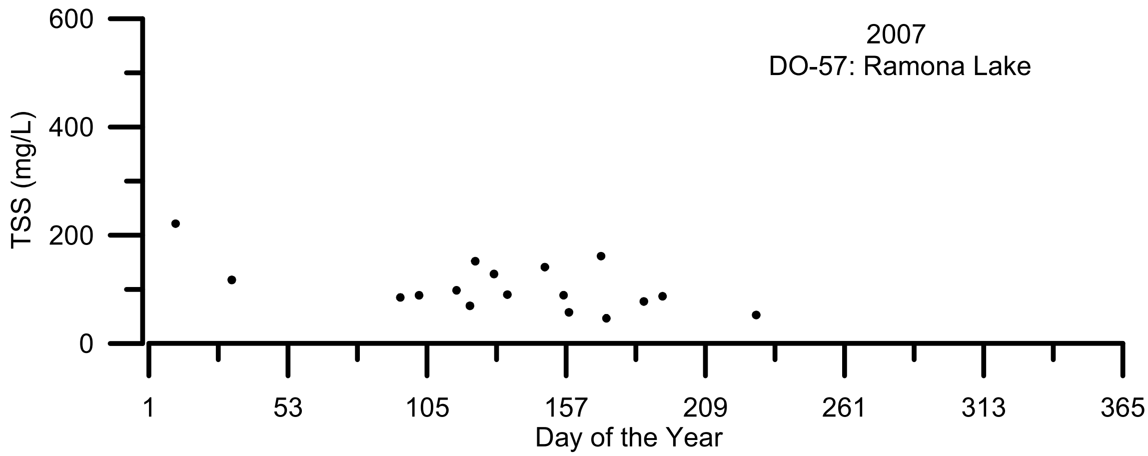

2005
DO-53: Salt Slough @ Wolfsen Road
TSS (mg/L)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-53: Salt Slough @ Wolfsen Road
TSS (mg/L)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

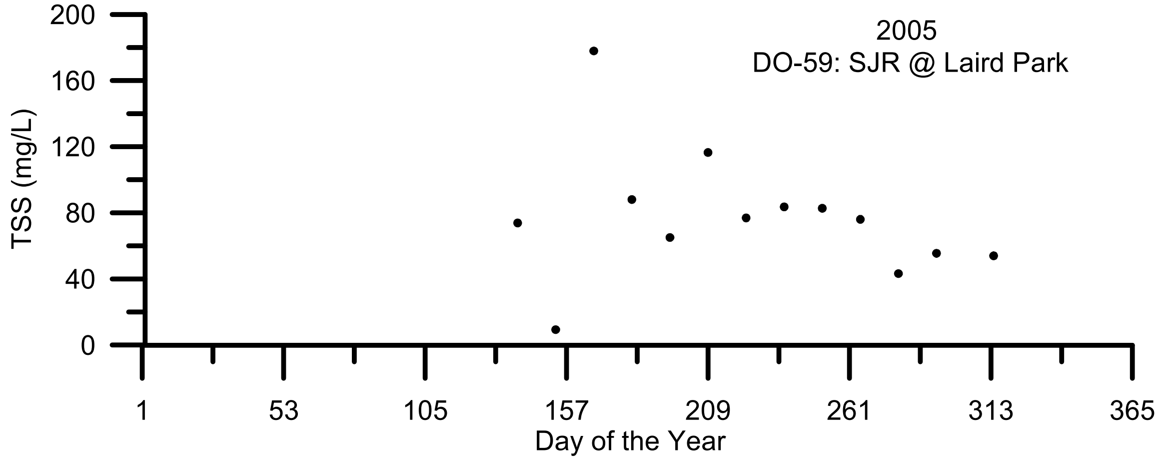

2007
DO-53: Salt Slough @ Wolfsen Road
TSS (mg/L)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

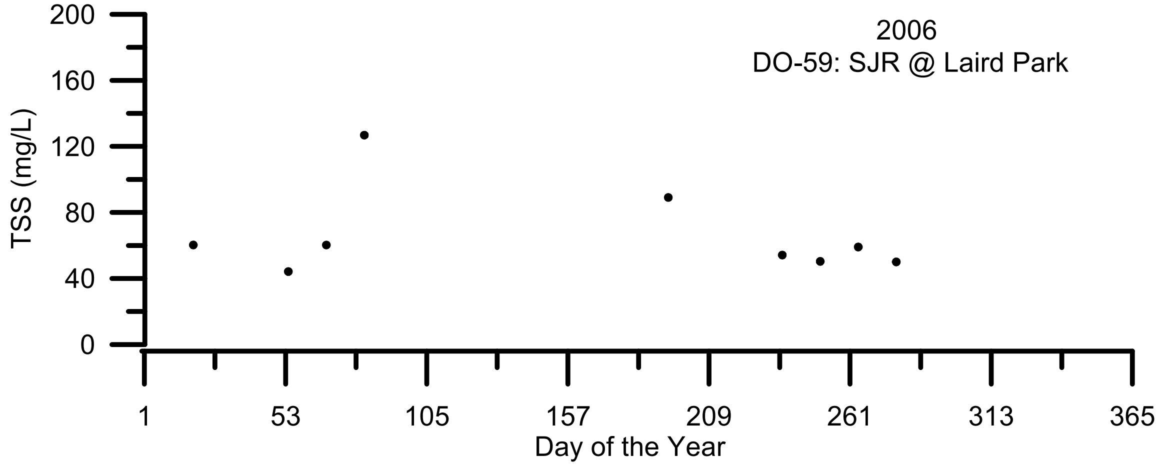


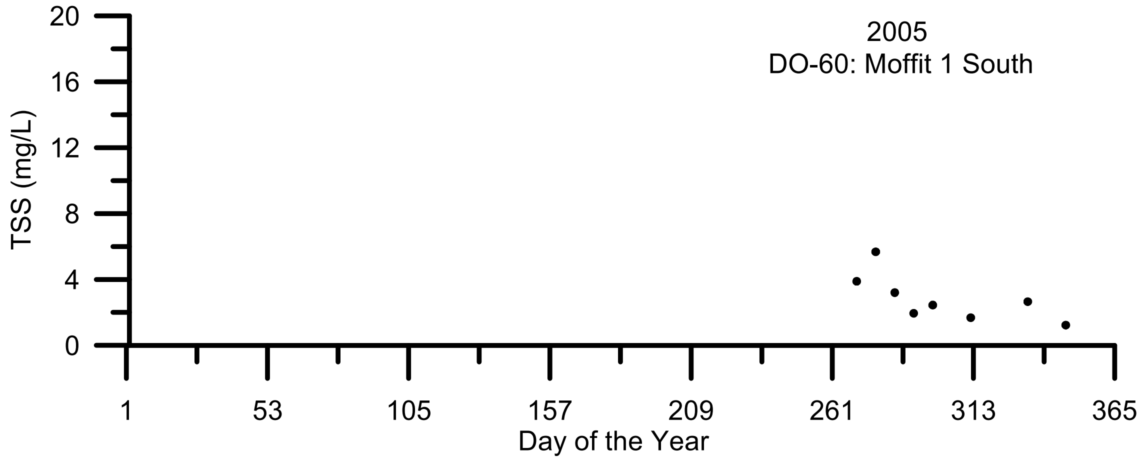
2006
DO-57: Ramona Lake
TSS (mg/L)
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

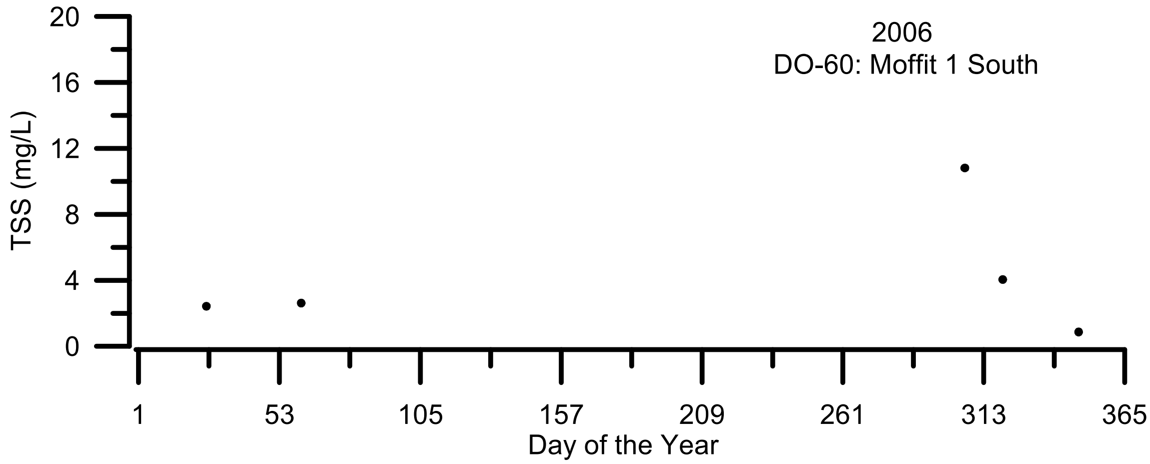


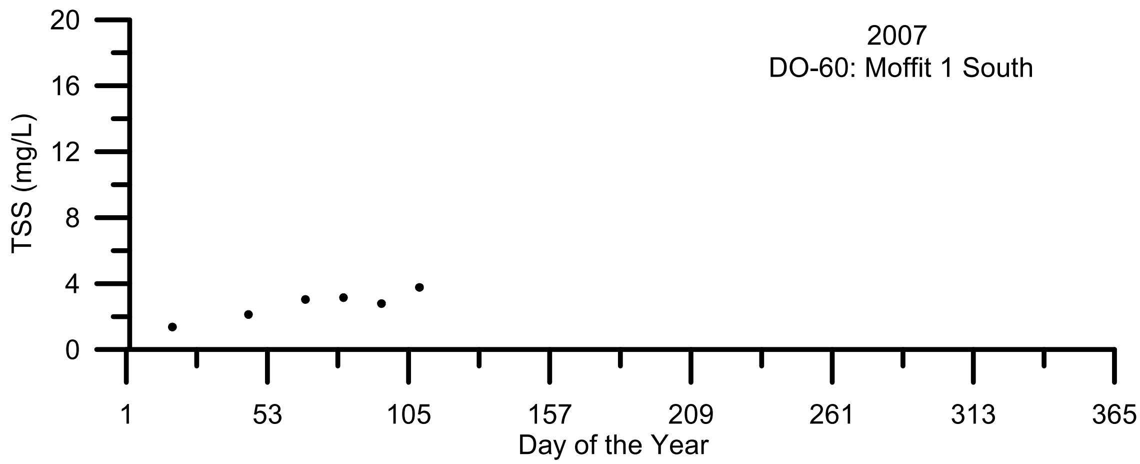
2007
DO-57: Ramona Lake
TSS (mg/L)
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

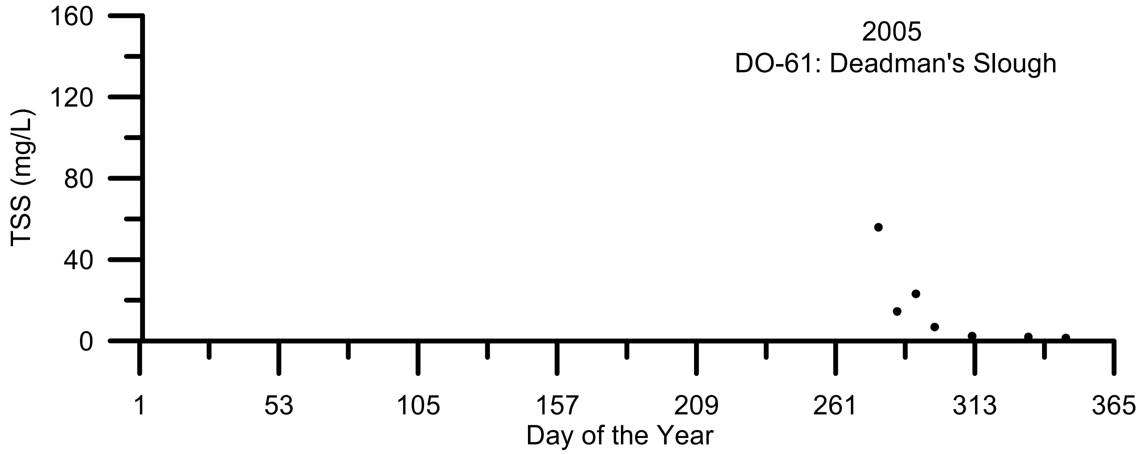

2005
DO-59: SJR @ Laird Park
TSS (mg/L)
0
40
80
120
160
200
1
53
105
157
209
261
313
365
Day of the Year

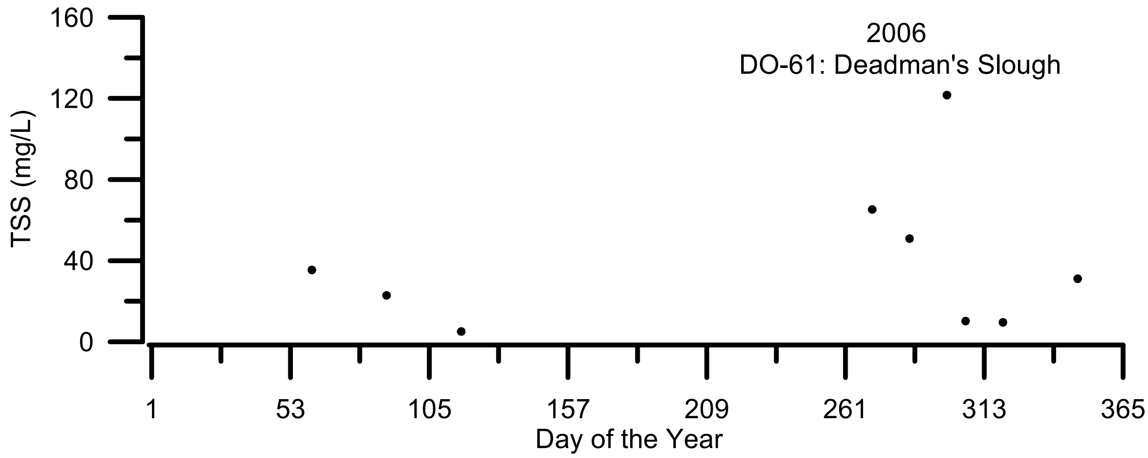

2006
DO-59: SJR @ Laird Park
TSS (mg/L)
0
40
80
120
160
200
1
53
105
157
209
261
313
365
Day of the Year

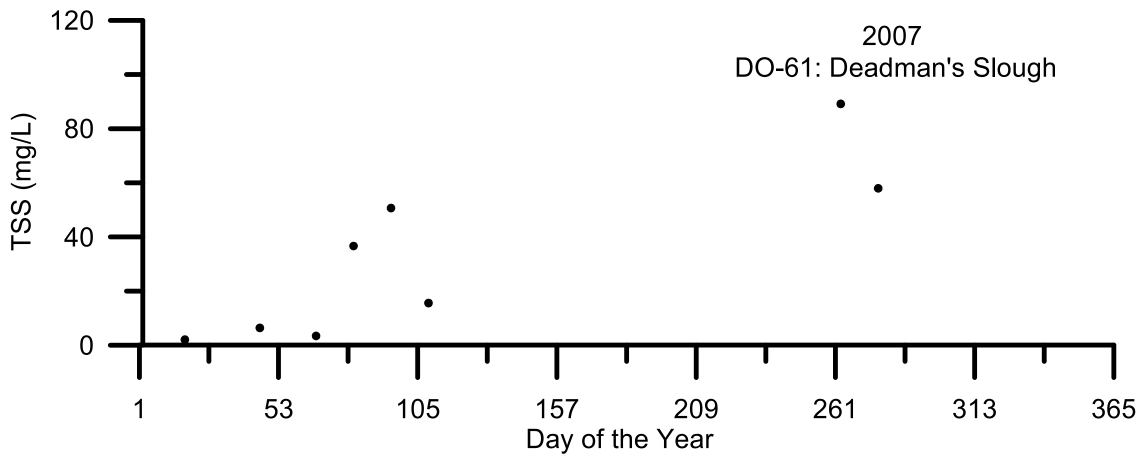

2005
DO-60: Moffit 1 South
TSS (mg/L)
Day of the Year

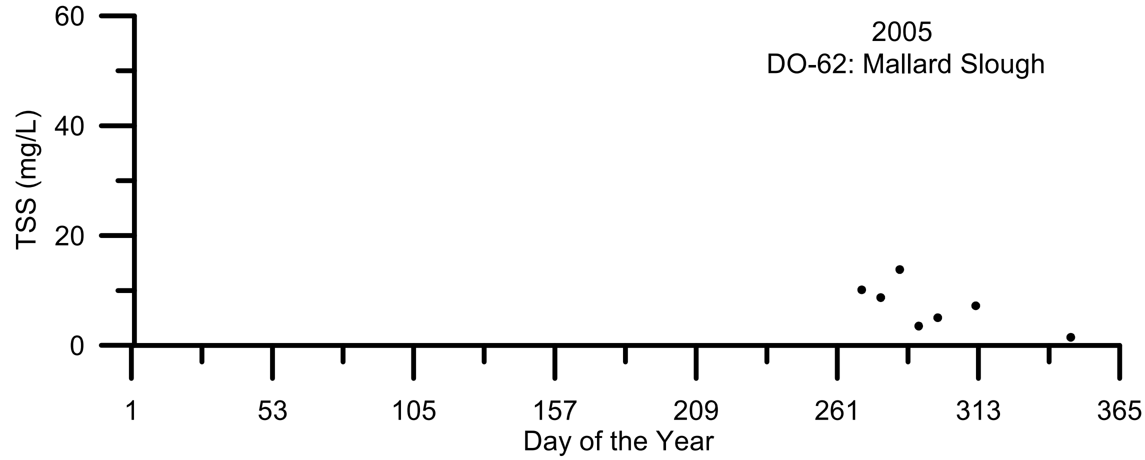

2006
DO-60: Moffit 1 South
TSS (mg/L)
Day of the Year

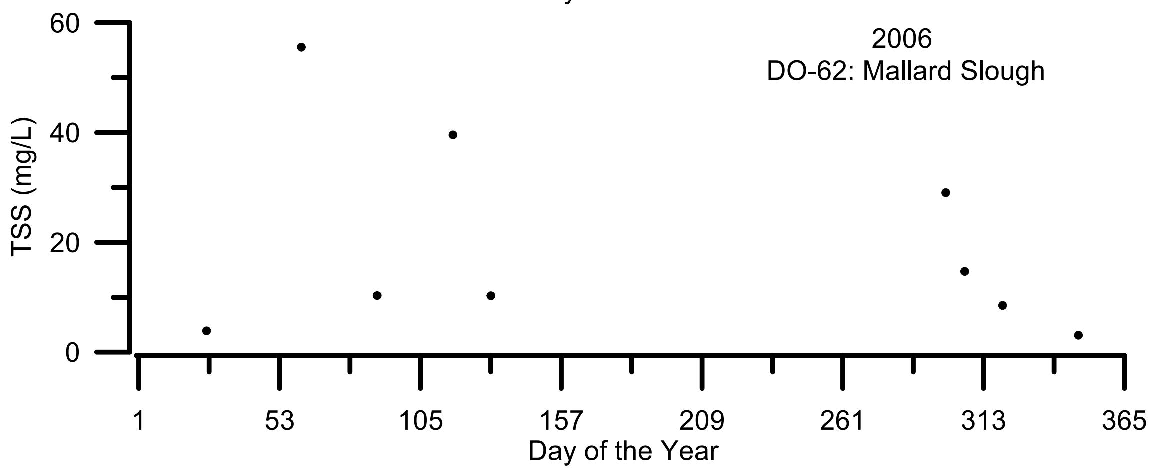

2007
DO-60: Moffit 1 South
TSS (mg/L)
Day of the Year

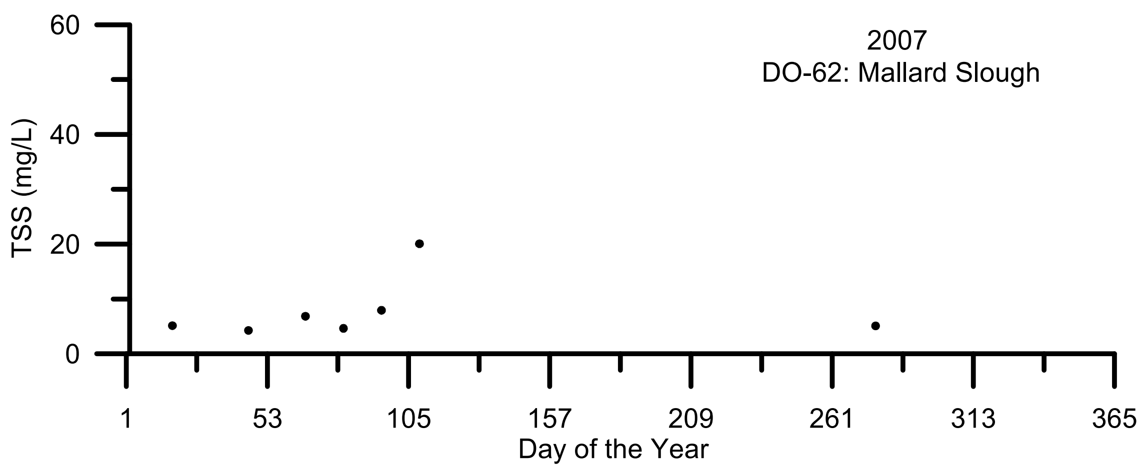

2005
DO-61: Deadman's Slough
TSS (mg/L)
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

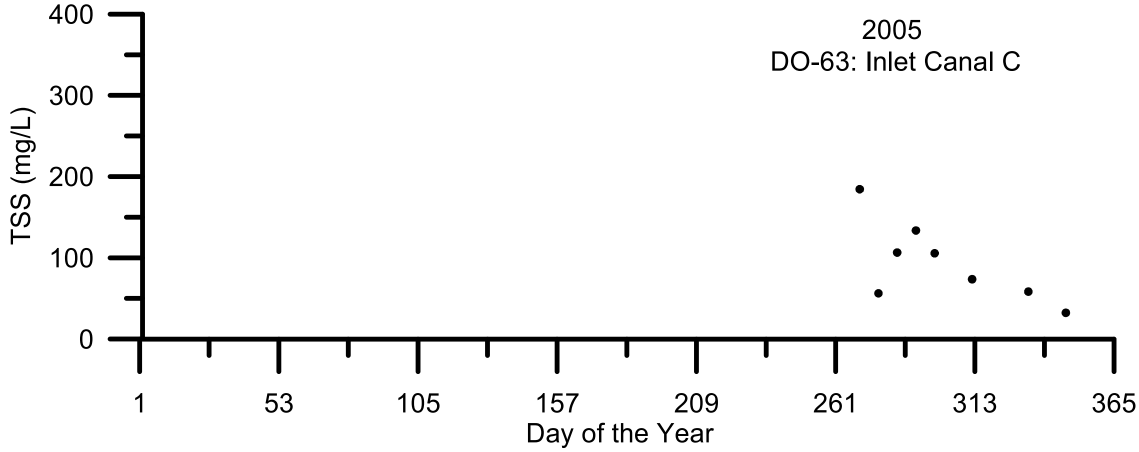

2006
DO-61: Deadman's Slough
TSS (mg/L)
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

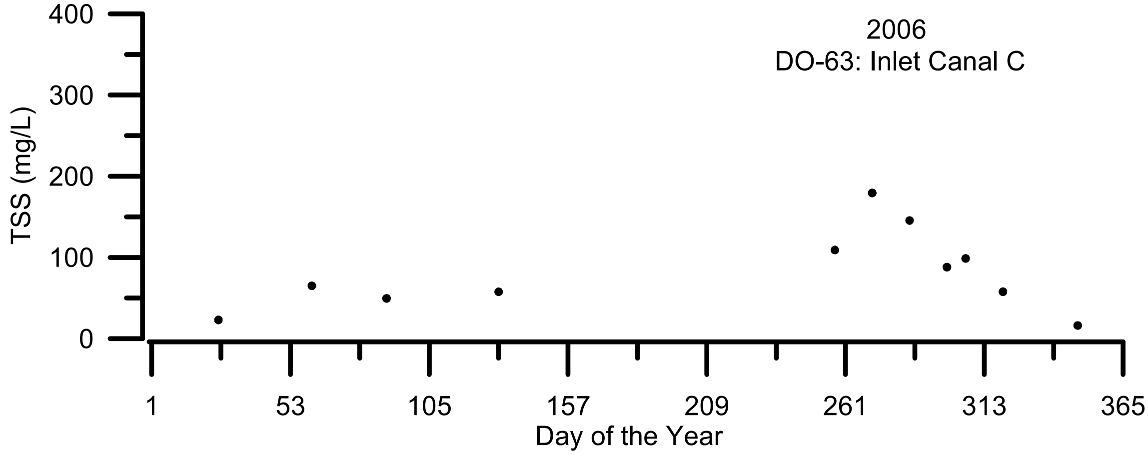

2007
DO-61: Deadman's Slough
TSS (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

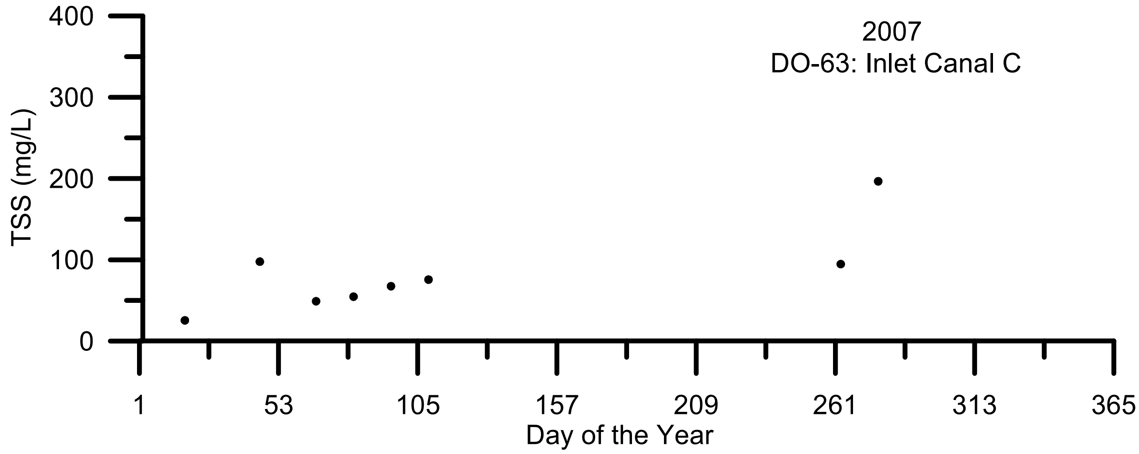

2005
DO-62: Mallard Slough
TSS (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year

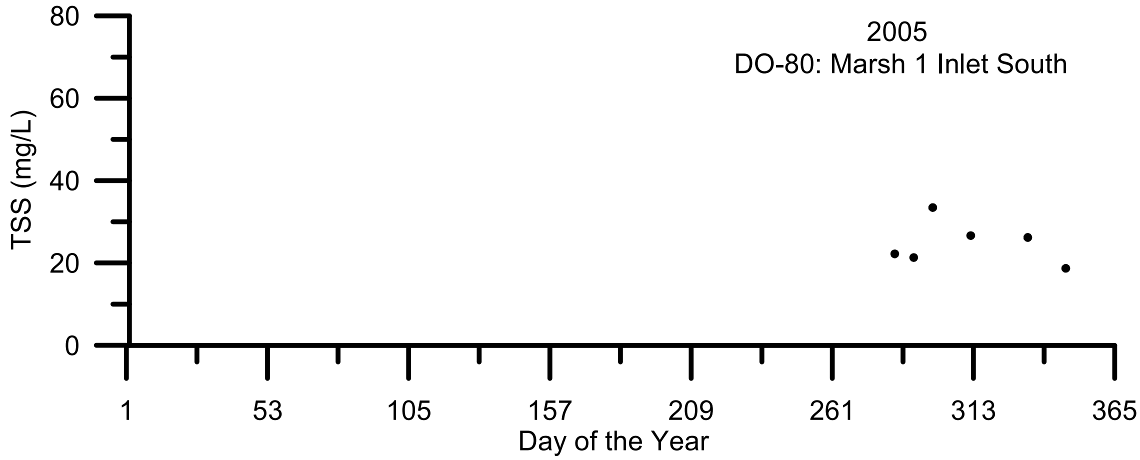

2006
DO-62: Mallard Slough
TSS (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year

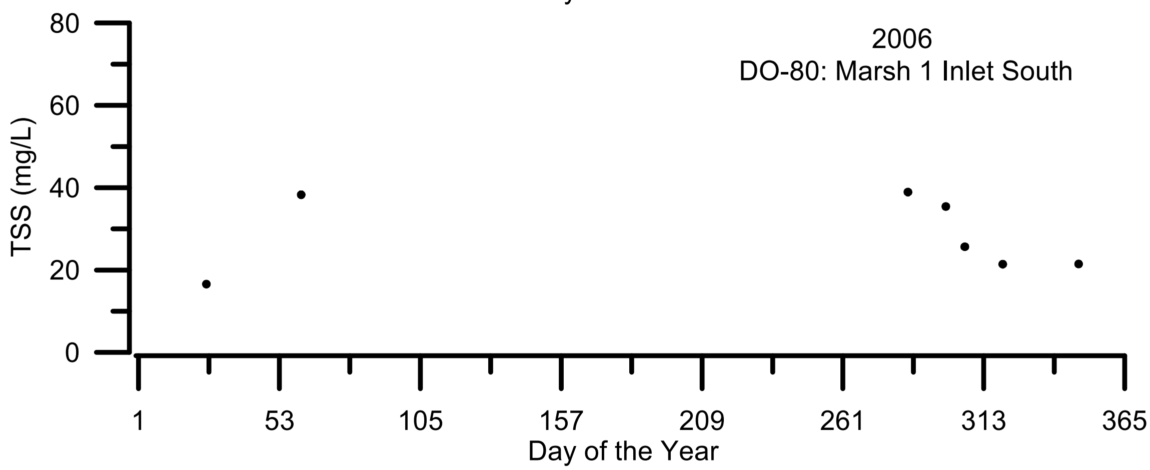

2007
DO-62: Mallard Slough
TSS (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year

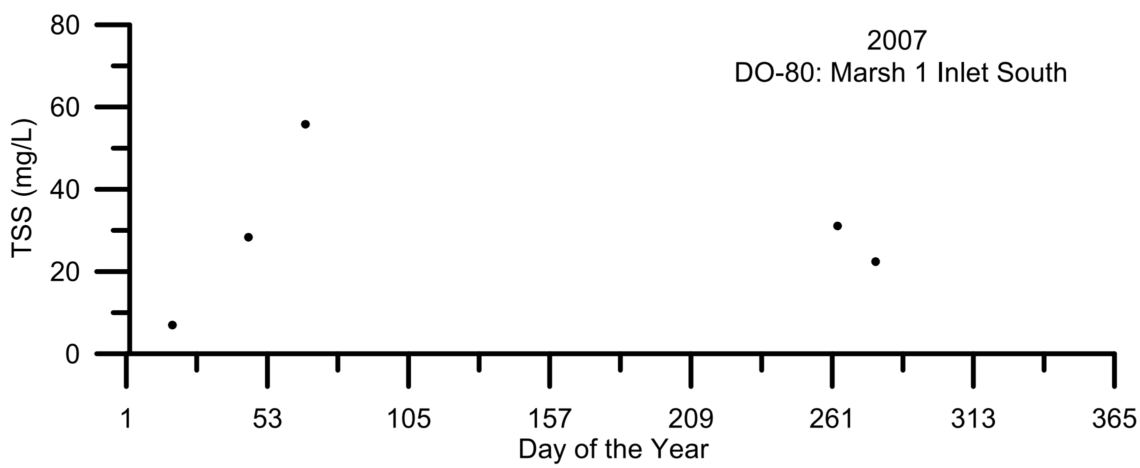

2005
DO-63: Inlet Canal C
TSS (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

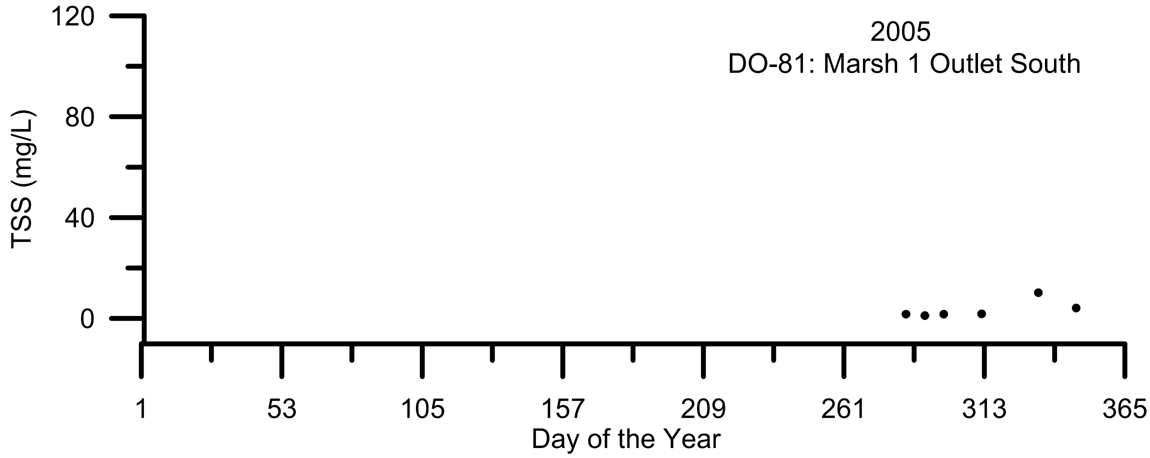

2006
DO-63: Inlet Canal C
TSS (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

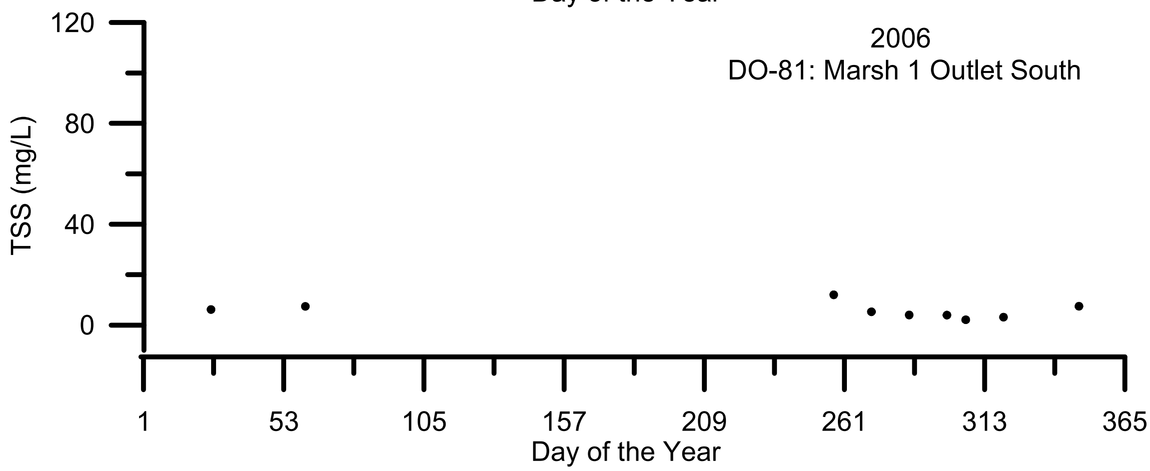

2007
DO-63: Inlet Canal C
TSS (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

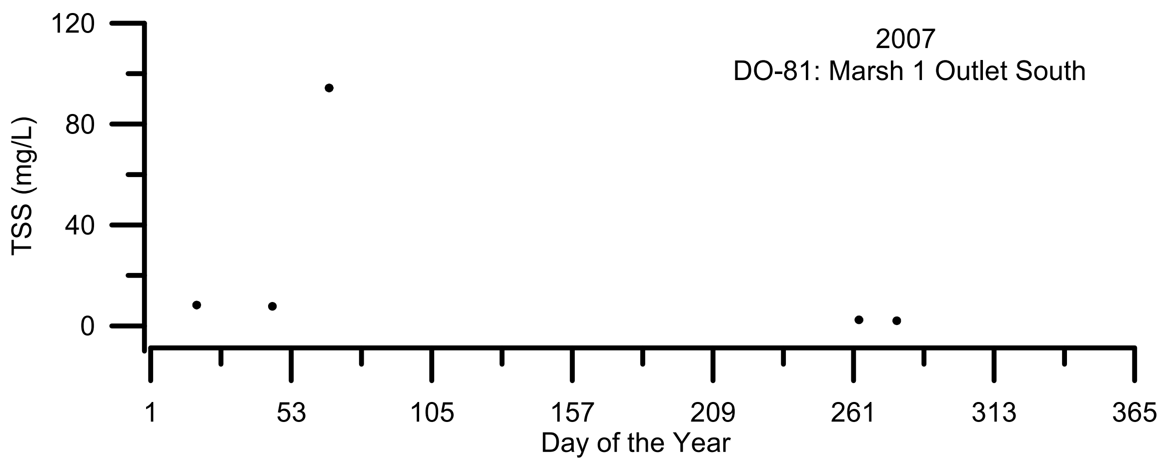

2005
DO-80: Marsh 1 Inlet South
TSS (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

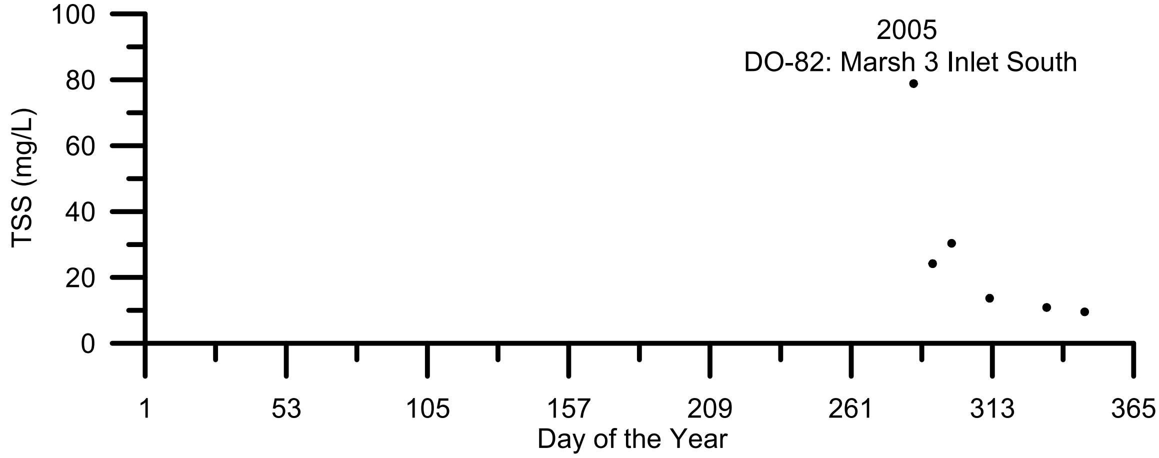

2006
DO-80: Marsh 1 Inlet South
TSS (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

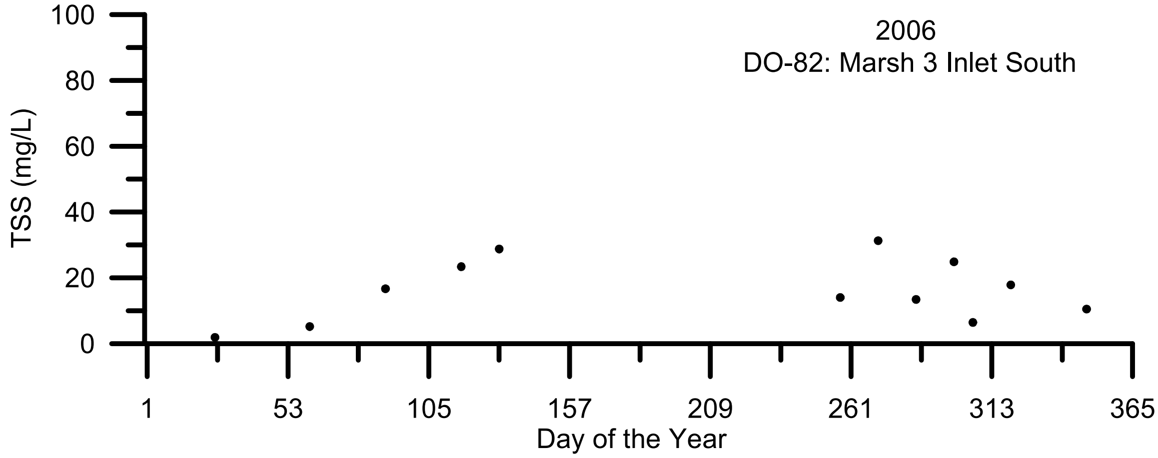

2007
DO-80: Marsh 1 Inlet South
TSS (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

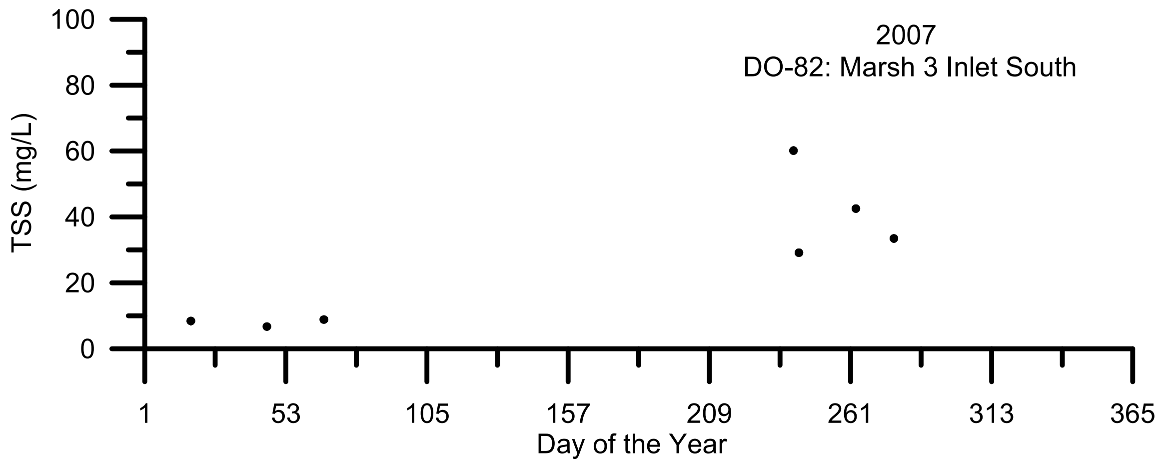

2005
DO-81: Marsh 1 Outlet South
TSS (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

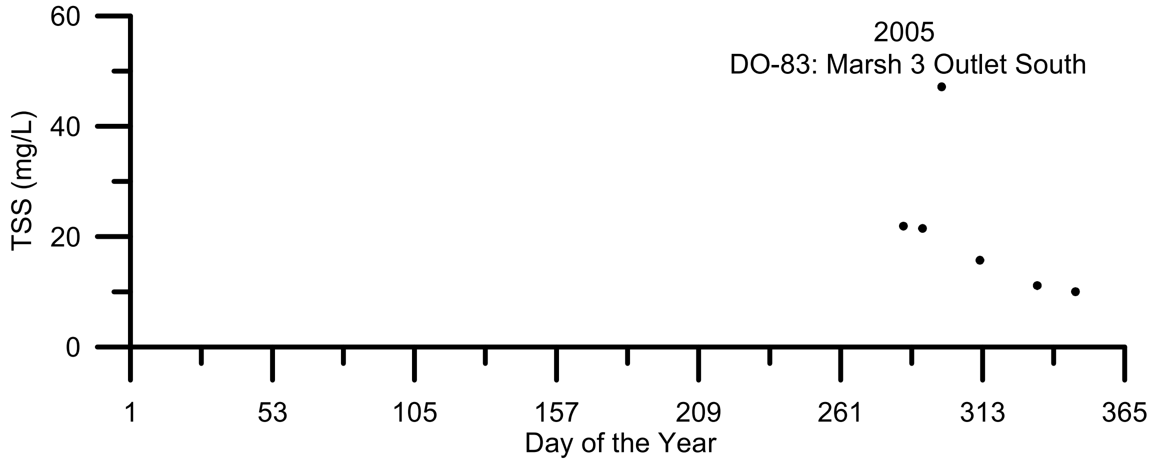

2006
DO-81: Marsh 1 Outlet South
TSS (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

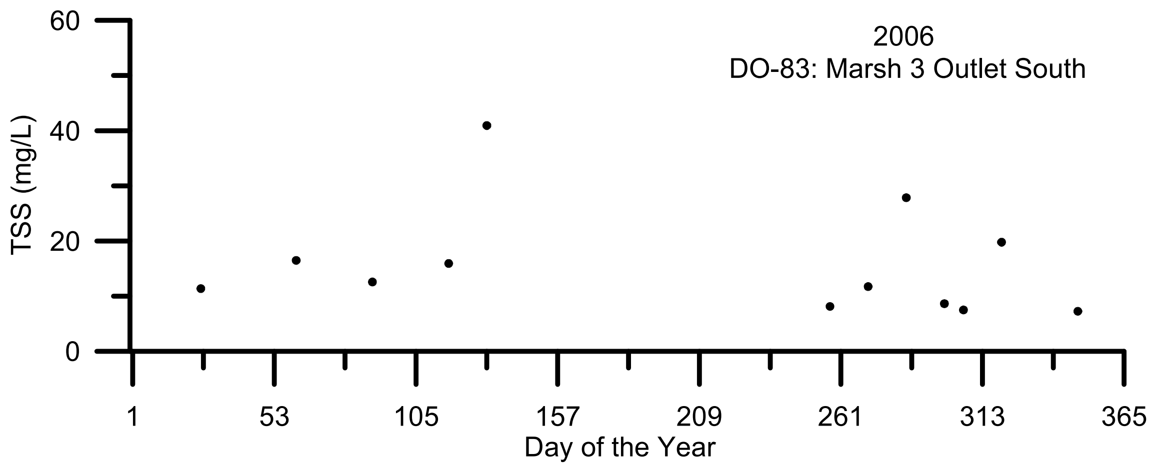

2007
DO-81: Marsh 1 Outlet South
TSS (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

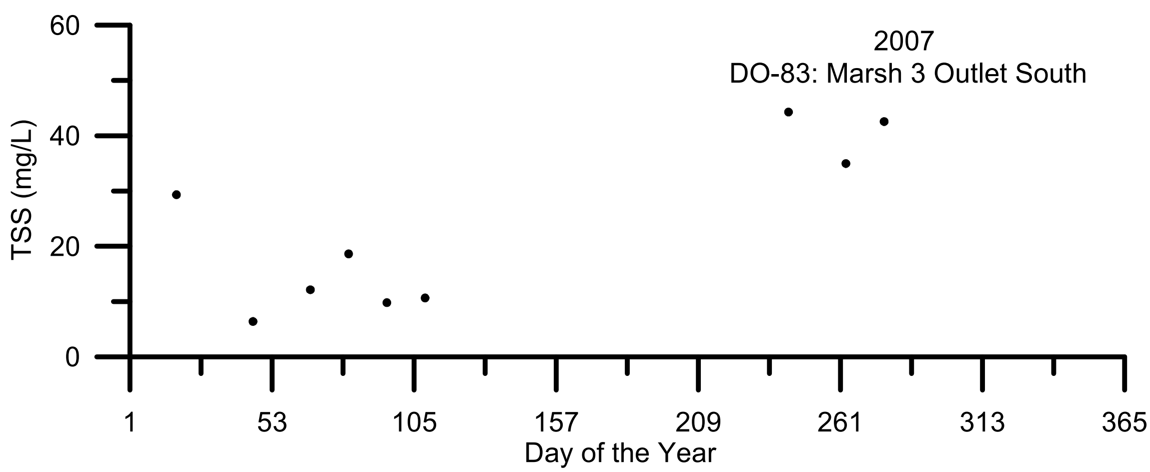

2005
DO-82: Marsh 3 Inlet South
TSS (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

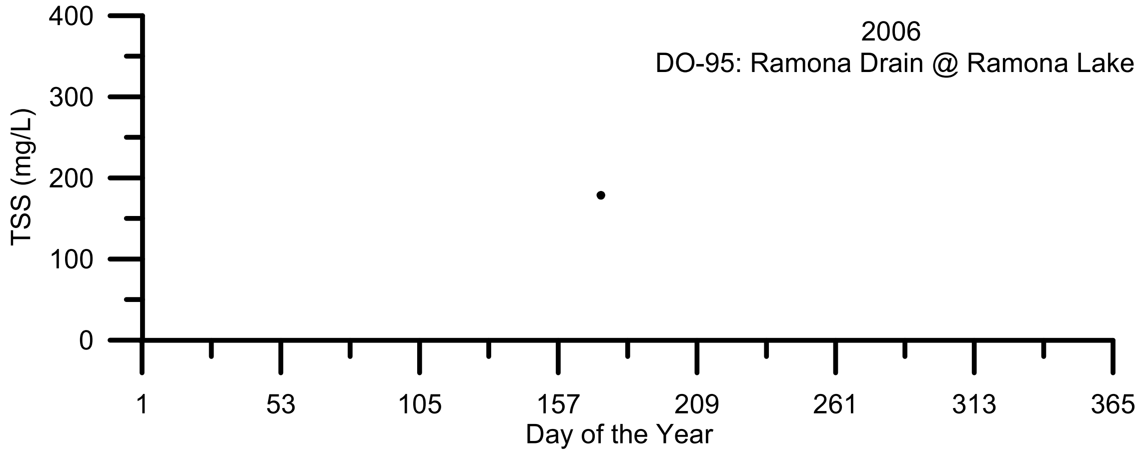

2006
DO-82: Marsh 3 Inlet South
TSS (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-82: Marsh 3 Inlet South
TSS (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

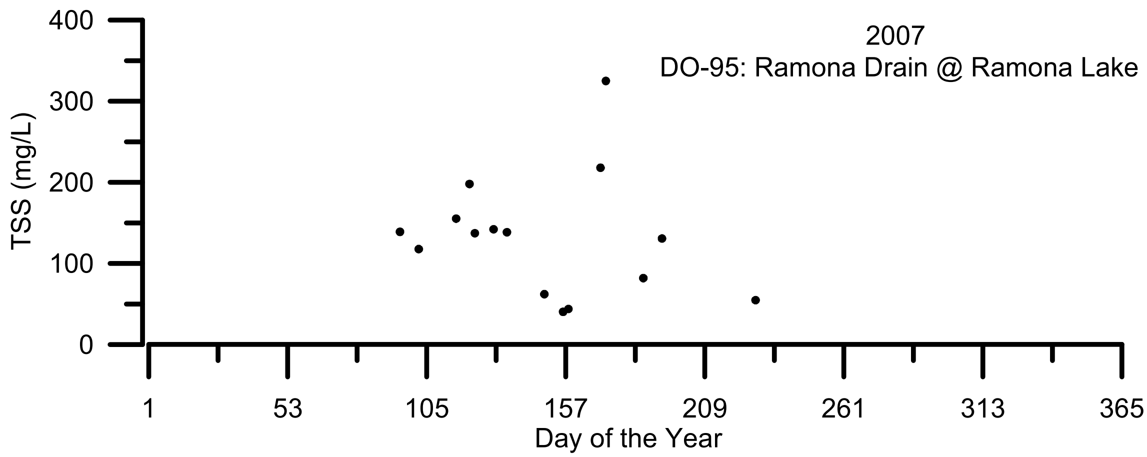

2005
DO-83: Marsh 3 Outlet South
TSS (mg/L)
Day of the Year
0
20
40
60
1
53
105
157
209
261
313
365


2006
DO-83: Marsh 3 Outlet South
TSS (mg/L)
Day of the Year
0
20
40
60
1
53
105
157
209
261
313
365


2007
DO-83: Marsh 3 Outlet South
TSS (mg/L)
Day of the Year
0
20
40
60
1
53
105
157
209
261
313
365



2006
DO-95: Ramona Drain @ Ramona Lake
TSS (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year



2007
DO-95: Ramona Drain @ Ramona Lake
TSS (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

UNIVERSITY OF THE PACIFIC
Environmental Engineering Research Program

Analysis of Total Protein Concentrations in the San Joaquin River Watershed 2005-2007

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Chelsea Spier
Sharon Borglin
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Justin Graham
William Stringfellow

February 2008

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3601 Pacific Avenue, Sears Hall
Stockton CA 95211

Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 sampling locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report presents temporal plots of total protein for all sites sampled in the SJR from 2005-2007.

Methods

Field sampling consisted of collecting water samples, measuring water quality with a YSI Sonde 6600 with MDS650 hand-held display, and recording of field conditions at sites within the study area per *EERP Field Protocol Book* (Graham, 2008).

Water samples were collected in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN) in accordance with requirements for different lab analysis and volume requirements.

Samples were immediately stored at 4°C after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the lab on the day of sampling.

Samples were received by the laboratory the same day they were sampled and stored at 4°C until filtering and analysis. Samples were collected, preserved, stored, and analyzed by methods outlined in *Standard Methods for the Analysis of Water and Wastewater*, (APHA, 2005, 1998). Total protein was quantified in all the samples using the Lowry method (Pierce Biosciences, Rockford, IL). The analysis was scaled up from the standard kit so the analysis was performed on 1 mL samples and analyzed in cuvettes with a 5 cm path length. Standard curves were made using bovine albumin from Pierce Biosciences (Rockford, IL). Samples were frozen within 24 hours of collection and defrosted prior to analysis. The limit of detection for this analysis is 0.5 mg/L Protein.

Results and Discussion

Total protein analysis was preformed intermittently over the three year period with the scale increase modification of the standard method.

References

Stringfellow, W.T., et al., (2008), *Evaluation of Vegetated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley*, University of the Pacific, Stockton, CA

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008), *EERP Field Protocol Book*, University of the Pacific, Stockton, CA.

Borglin, S., W. Stringfellow, J. Hanlon. (2005), Standard *Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project*, LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA

American Public Health Association, (2005), *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, Washington, D.C.

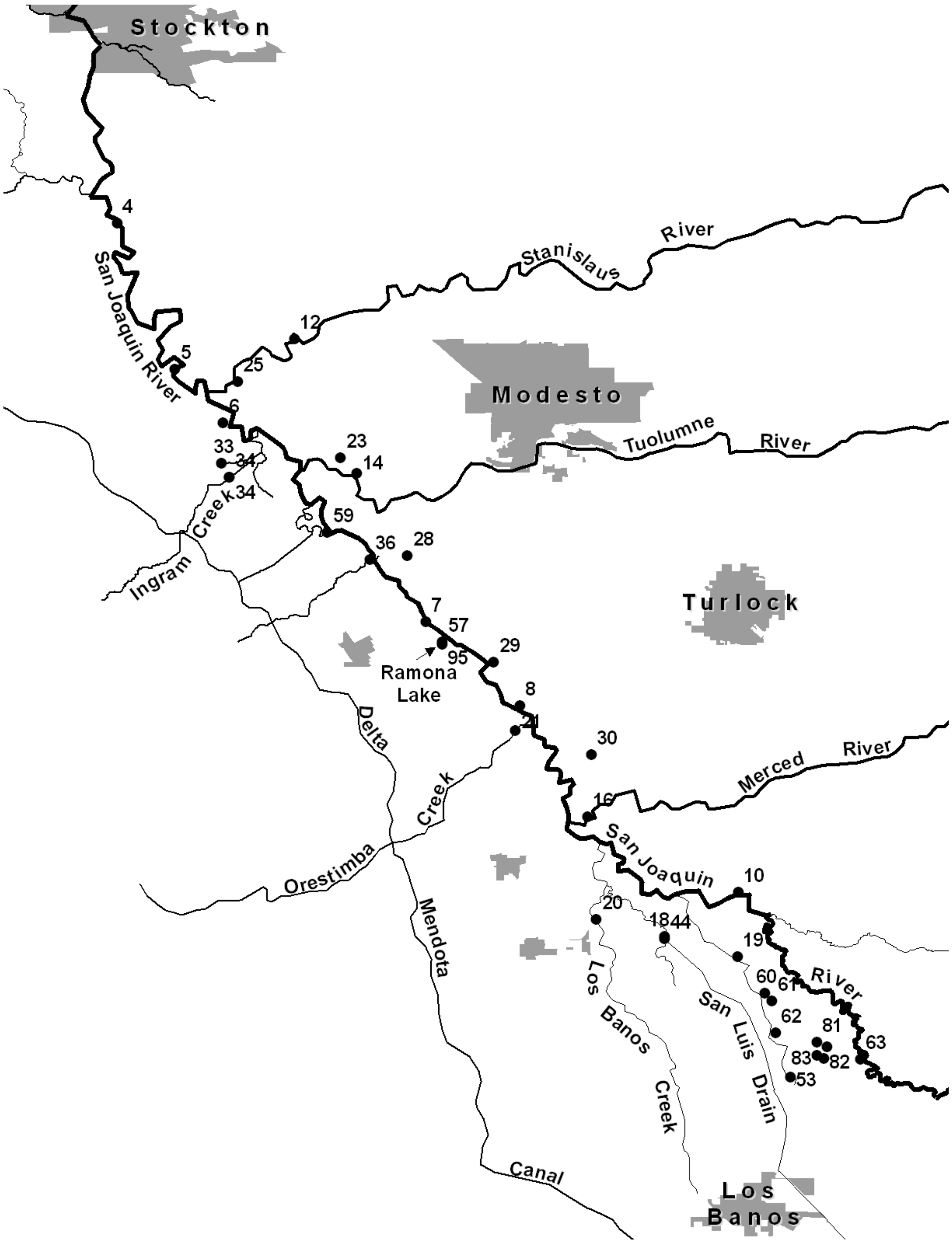
Borglin, S.E., Burks, R.D., Hanlon, J.S., Stringfellow, W.T. (2008*) EERP Lab Protocol Book*, University of the Pacific, Stockton, CA.

YSI Environmental Operations Manual, (2005), 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

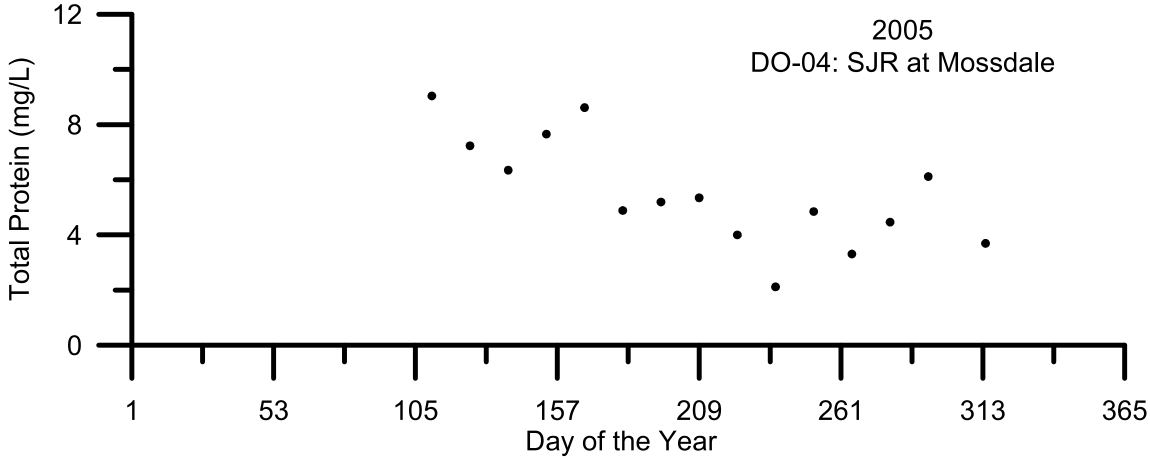
Table 1: EERP Sampling Site List

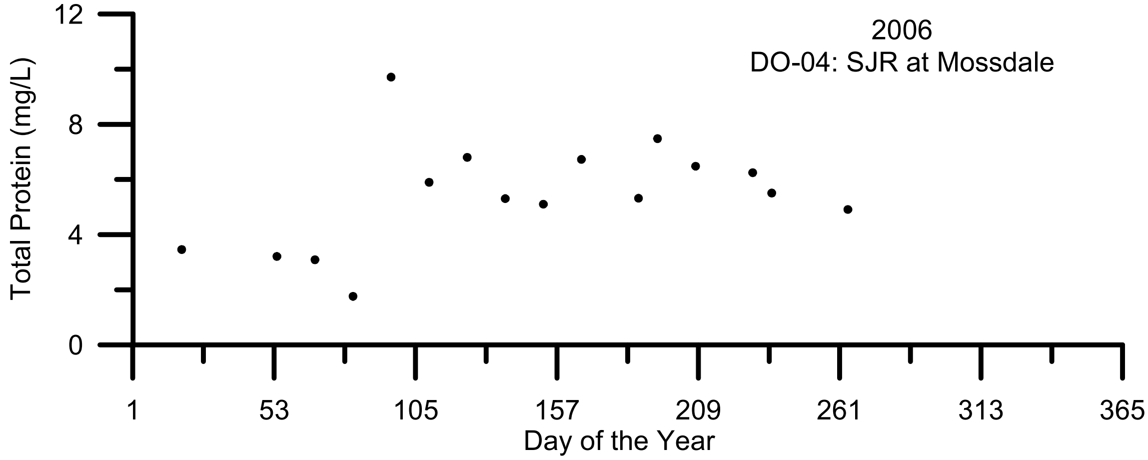
DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
53	**Salt Slough at Wolfsen Road**	Wetland
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
60	**Moffit 1 South**	Wetland
61	**Deadman's Slough**	Wetland
62	**Mallard Slough**	Wetland
63	**Inlet C Canal**	Wetland
80	**South Marsh-1-Inlet**	Wetland
81	**South Marsh-1-Outlet**	Wetland
82	**South Marsh-3-Inlet**	Wetland
83	**South Marsh-3-Outlet**	Wetland
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

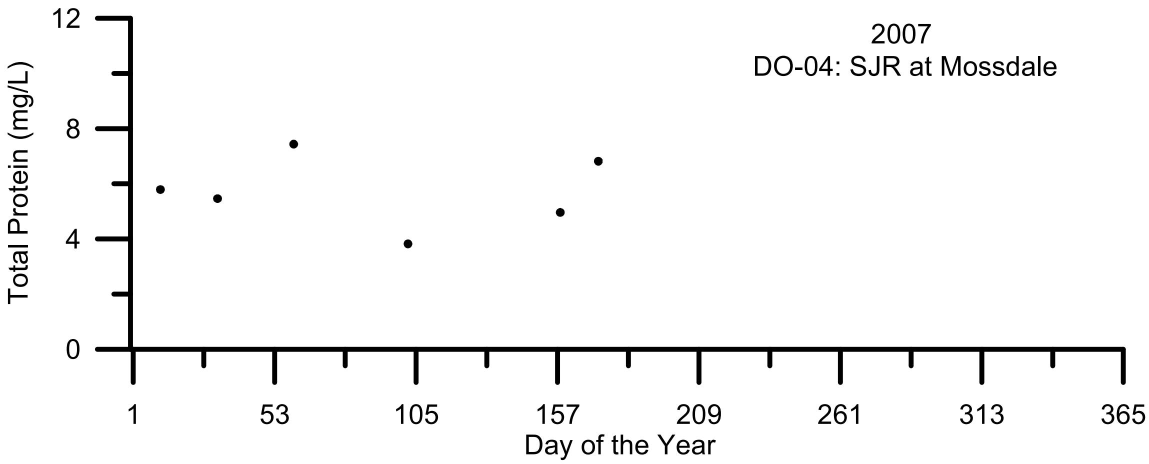
Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

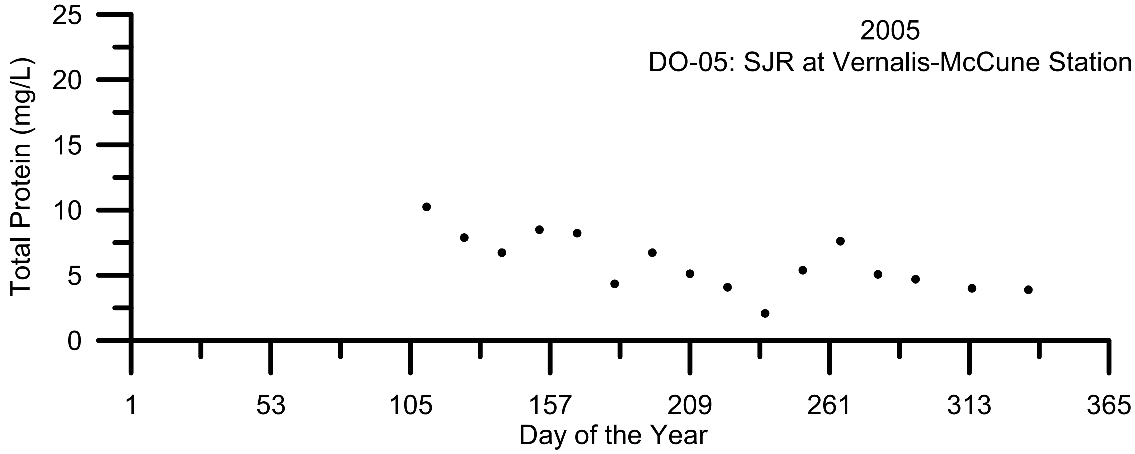


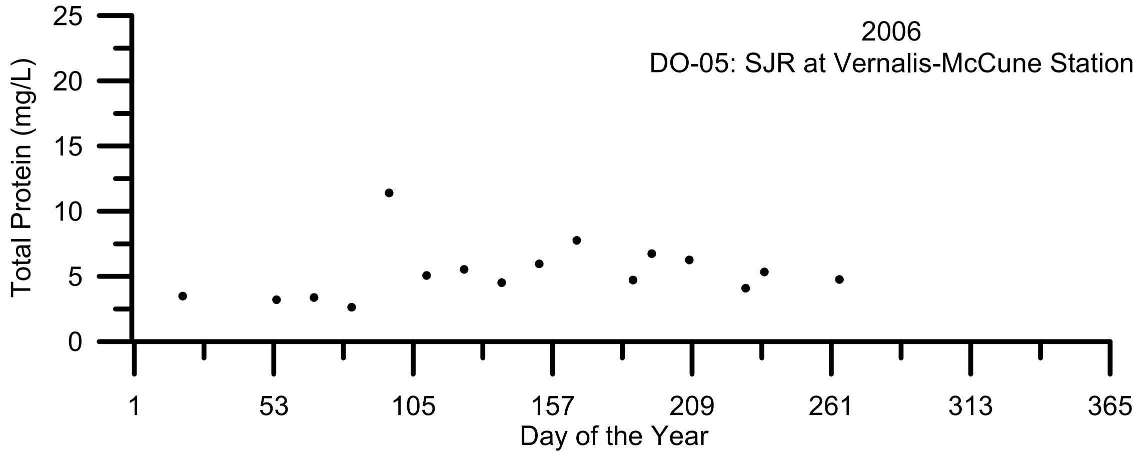
Figures 2 -101: Temporal Plots of Total Protein Concentrations By Site ID

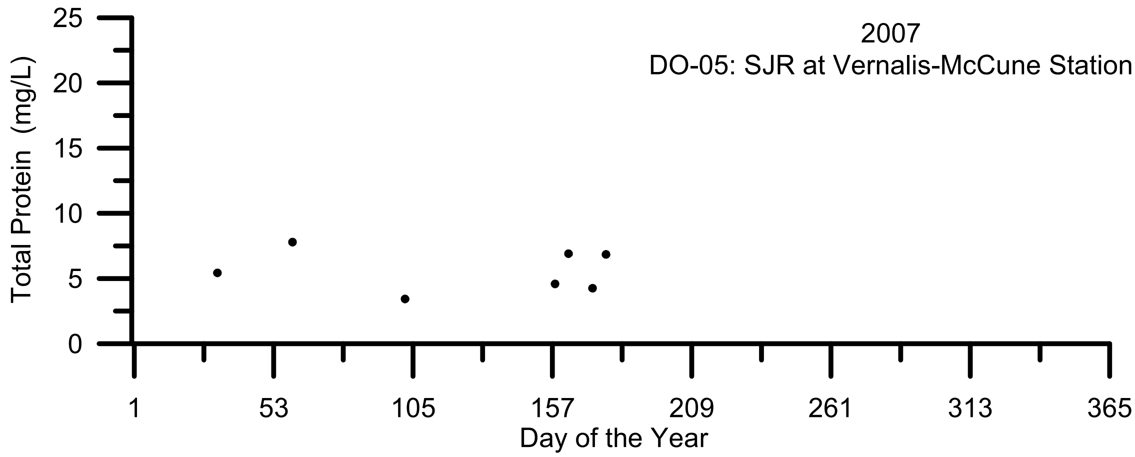


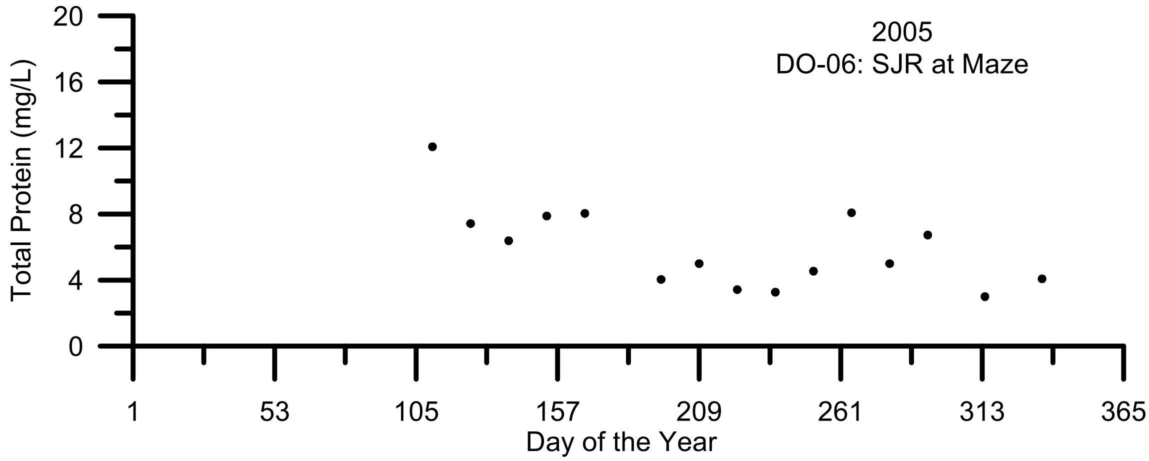


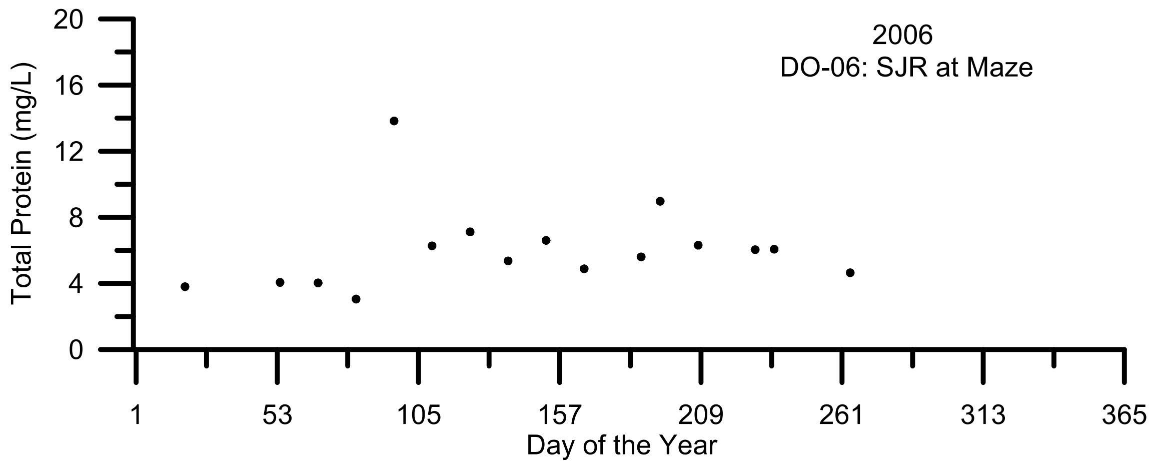


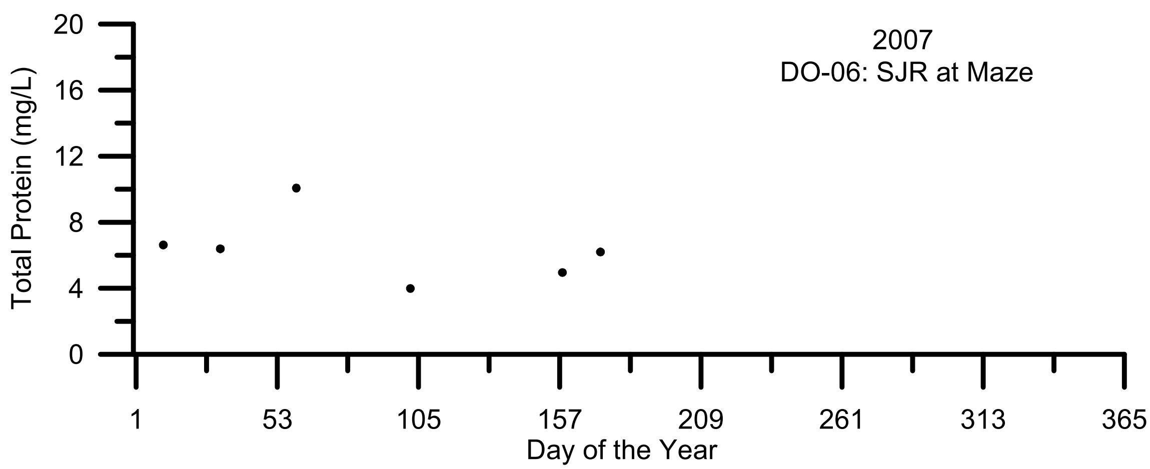

2005
DO-05: SJR at Vernalis-McCune Station
Total Protein (mg/L)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

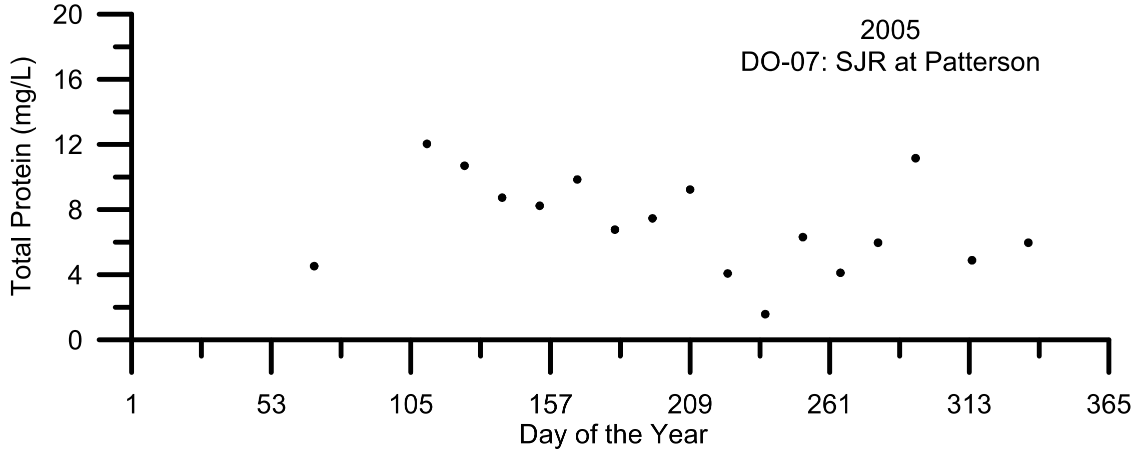

2006
DO-05: SJR at Vernalis-McCune Station
Total Protein (mg/L)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

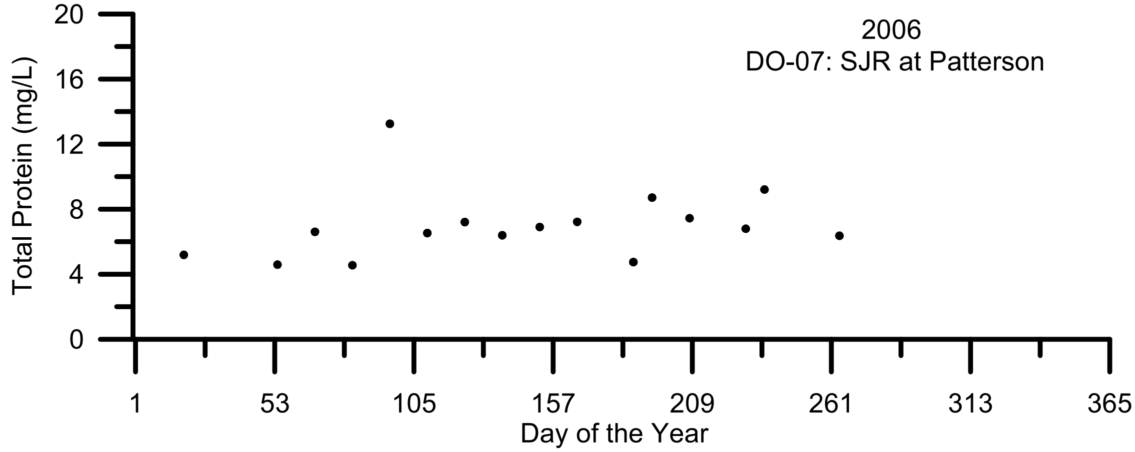

2007
DO-05: SJR at Vernalis-McCune Station
Total Protein (mg/L)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

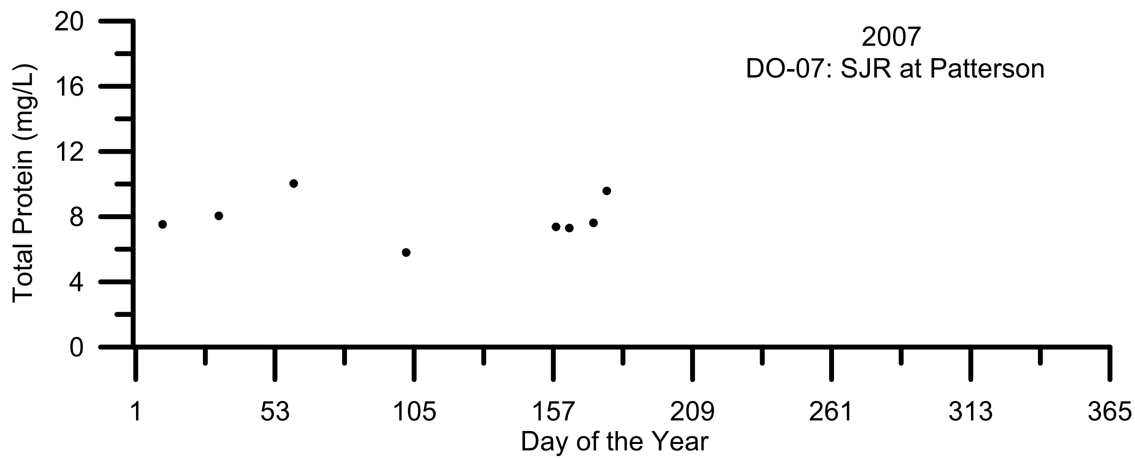

2005
DO-06: SJR at Maze
Total Protein (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

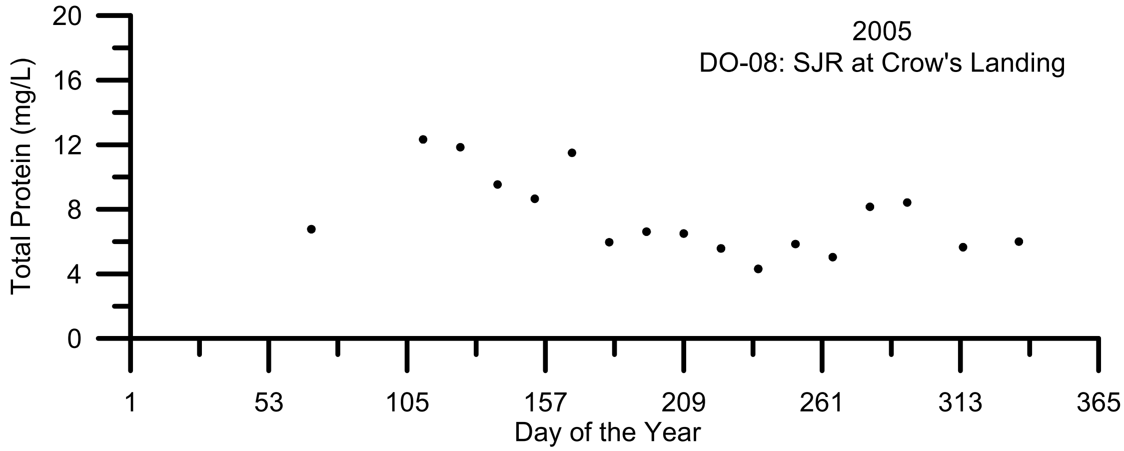

2006
DO-06: SJR at Maze
Total Protein (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

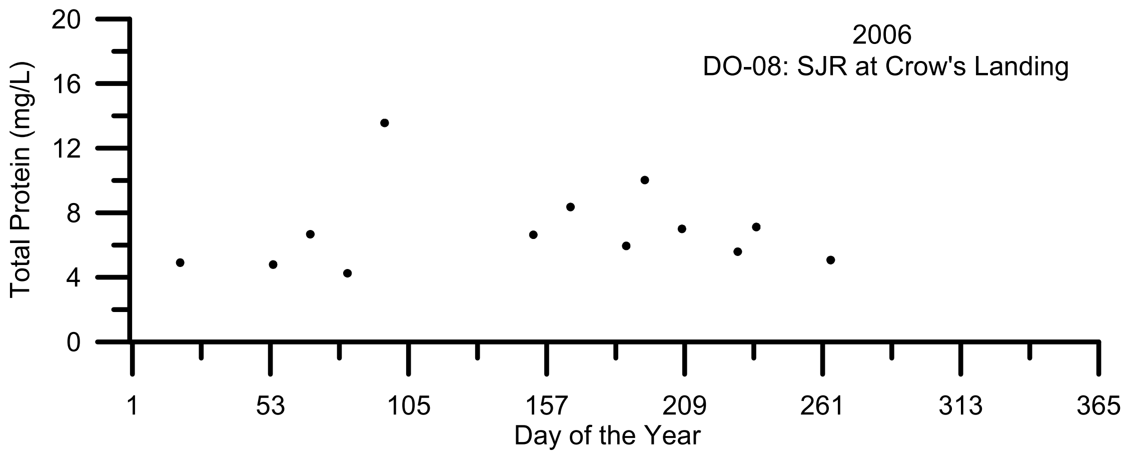

2007
DO-06: SJR at Maze
Total Protein (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

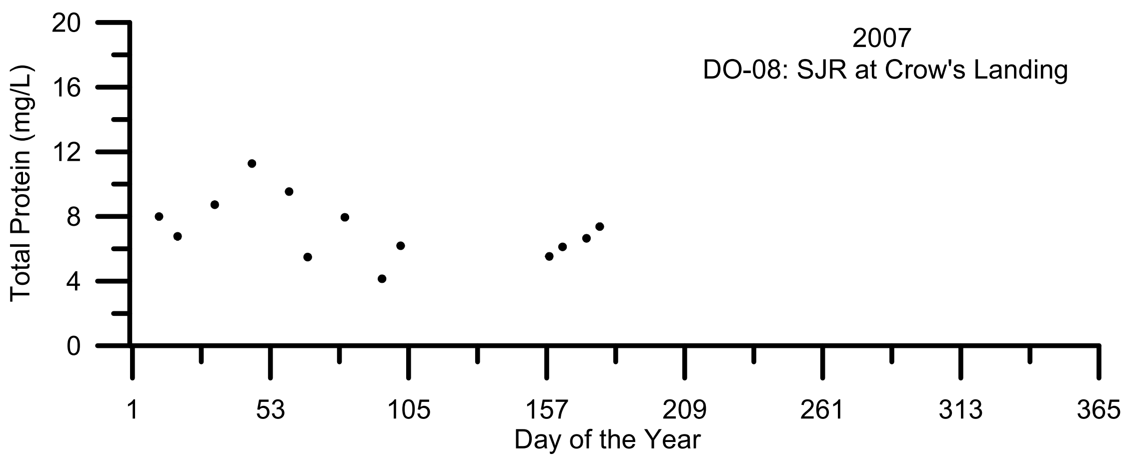

2005
DO-07: SJR at Patterson
Total Protein (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

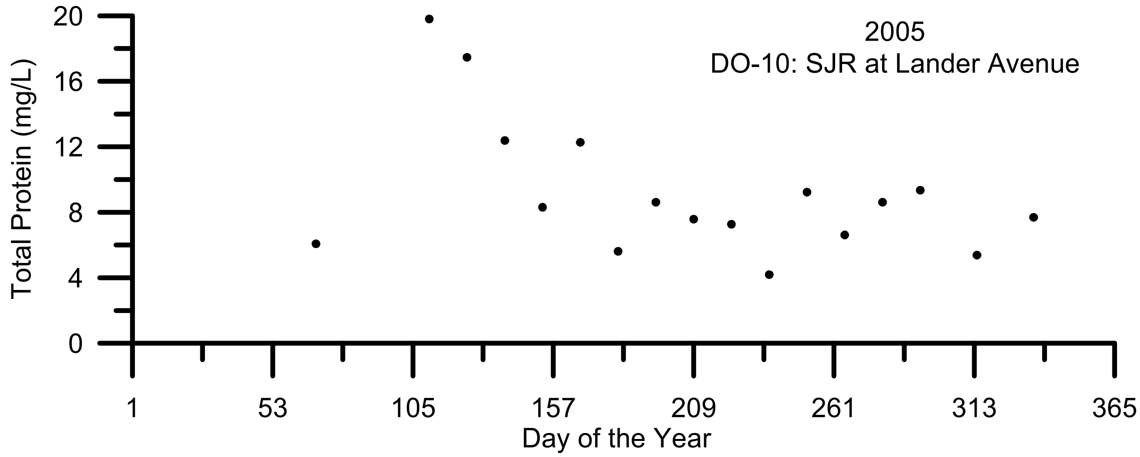

2006
DO-07: SJR at Patterson
Total Protein (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

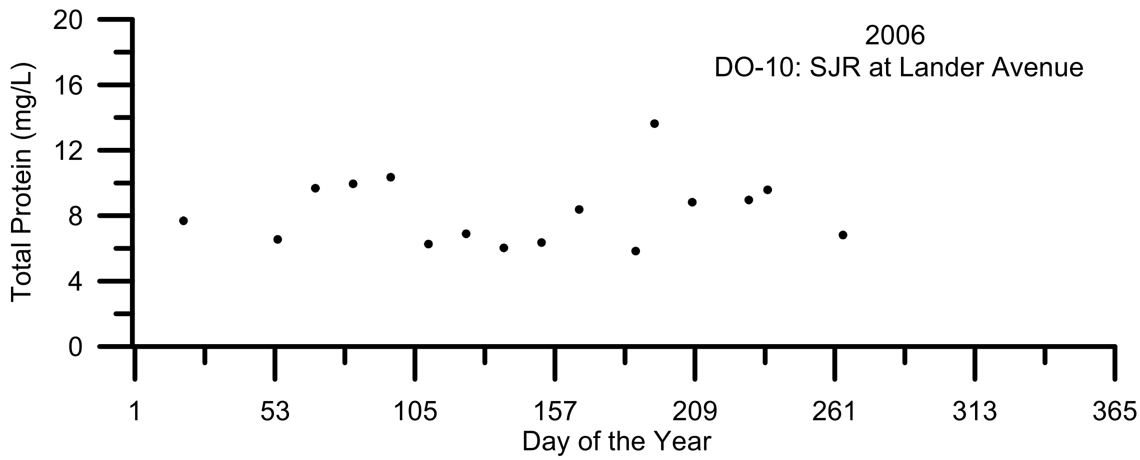

2007
DO-07: SJR at Patterson
Total Protein (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

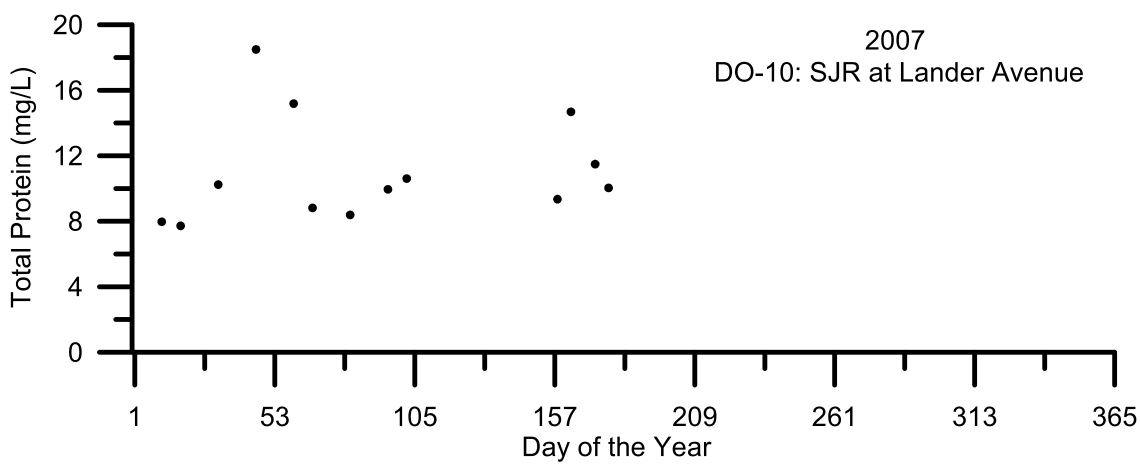

2005
DO-08: SJR at Crow's Landing
Total Protein (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

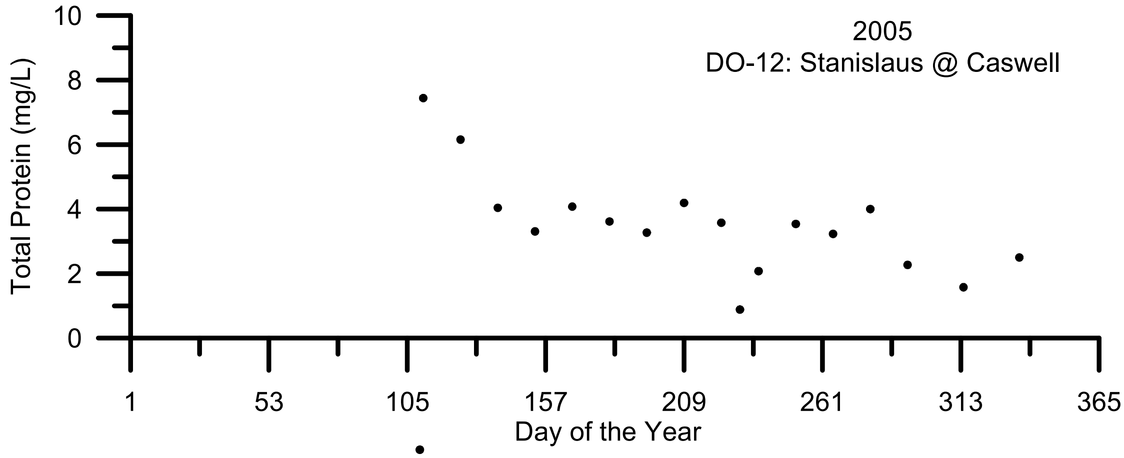

2006
DO-08: SJR at Crow's Landing
Total Protein (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

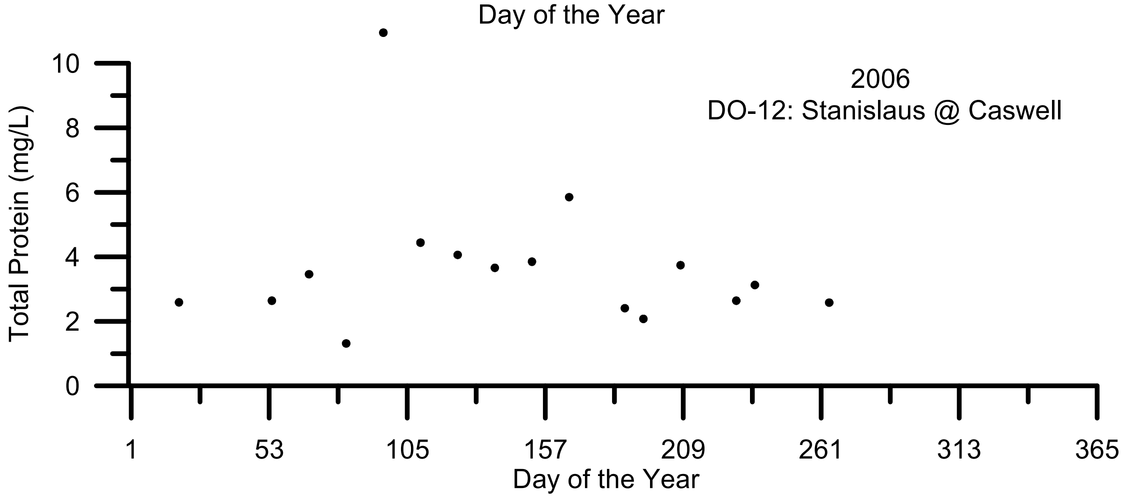

2007
DO-08: SJR at Crow's Landing
Total Protein (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

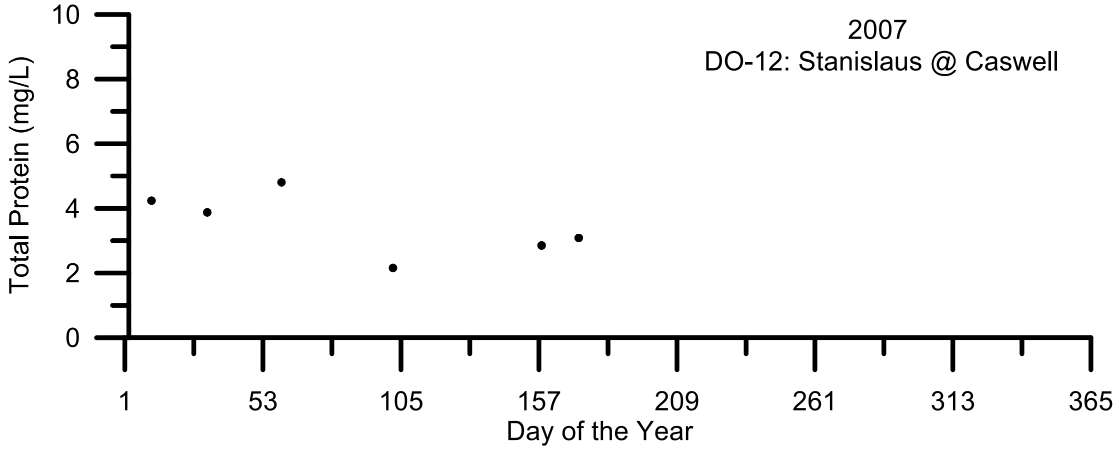

2005
DO-10: SJR at Lander Avenue
Total Protein (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

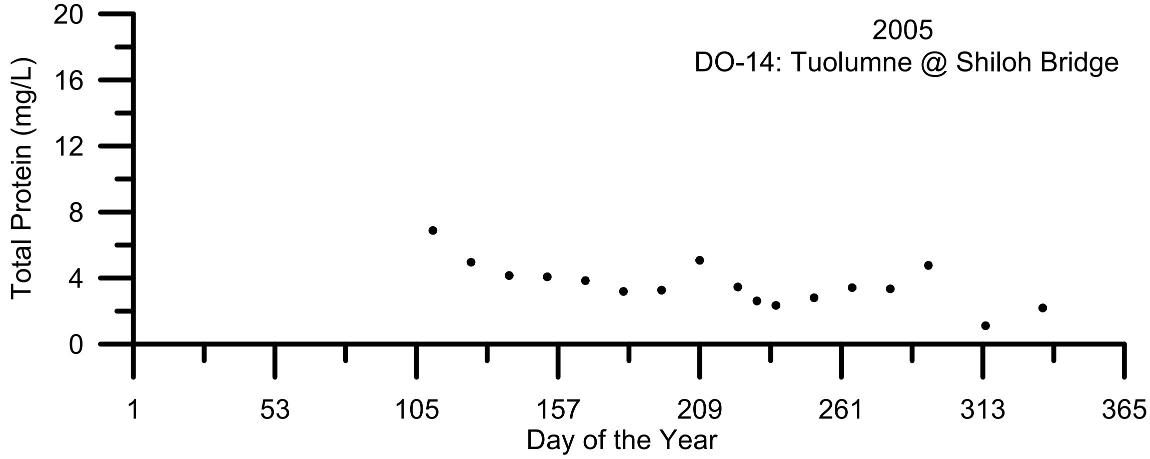

2006
DO-10: SJR at Lander Avenue
Total Protein (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

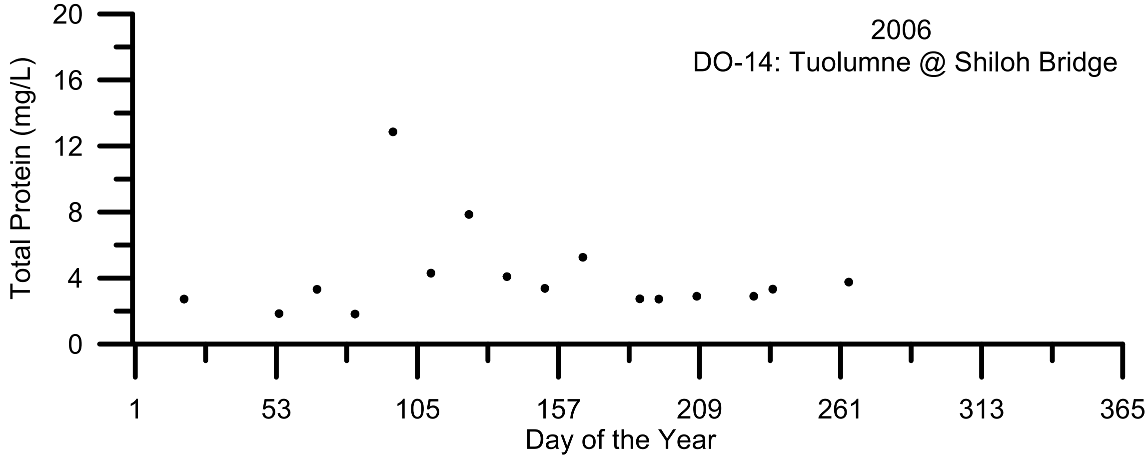

2007
DO-10: SJR at Lander Avenue
Total Protein (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

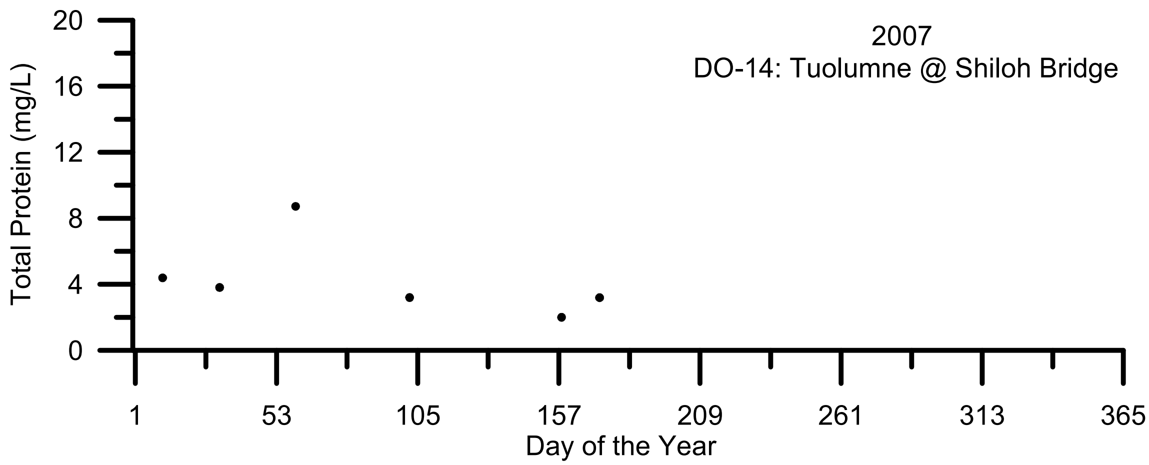

2005
DO-12: Stanislaus @ Caswell
Total Protein (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

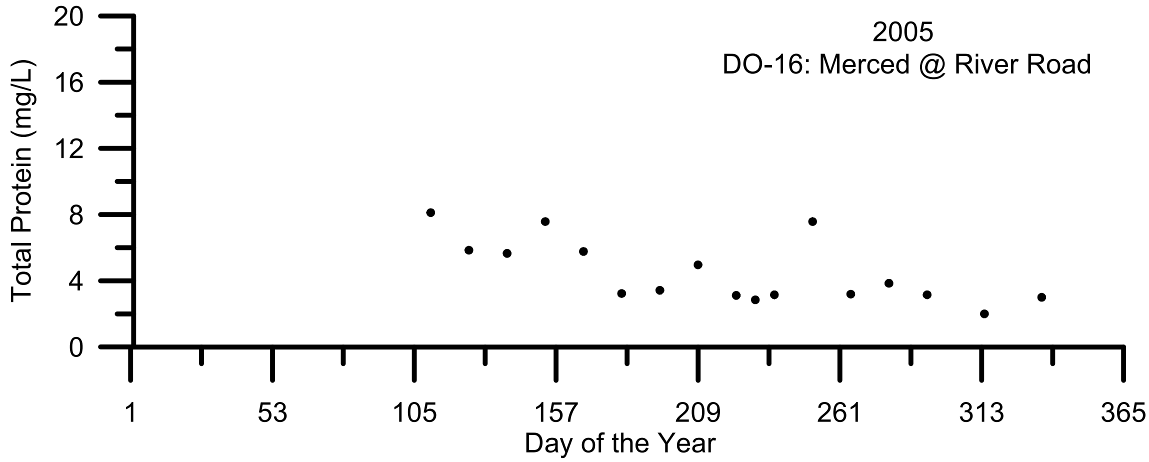

2006
DO-12: Stanislaus @ Caswell
Total Protein (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

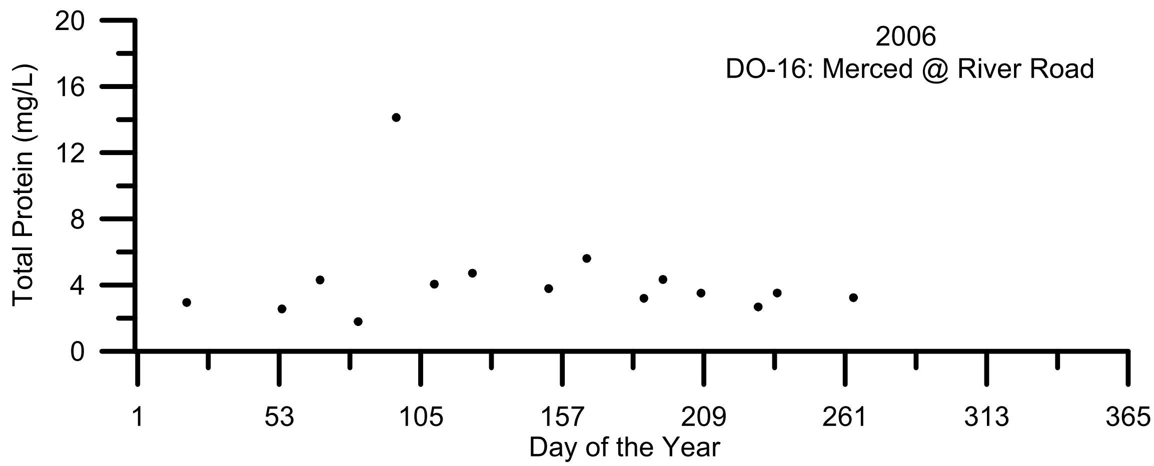

2007
DO-12: Stanislaus @ Caswell
Total Protein (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

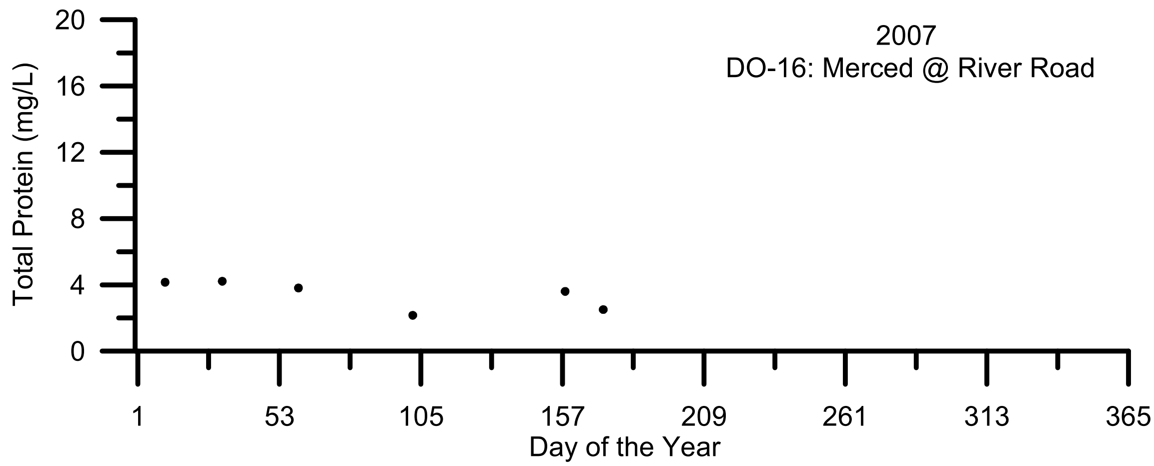

2005
DO-14: Tuolumne @ Shiloh Bridge
Total Protein (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

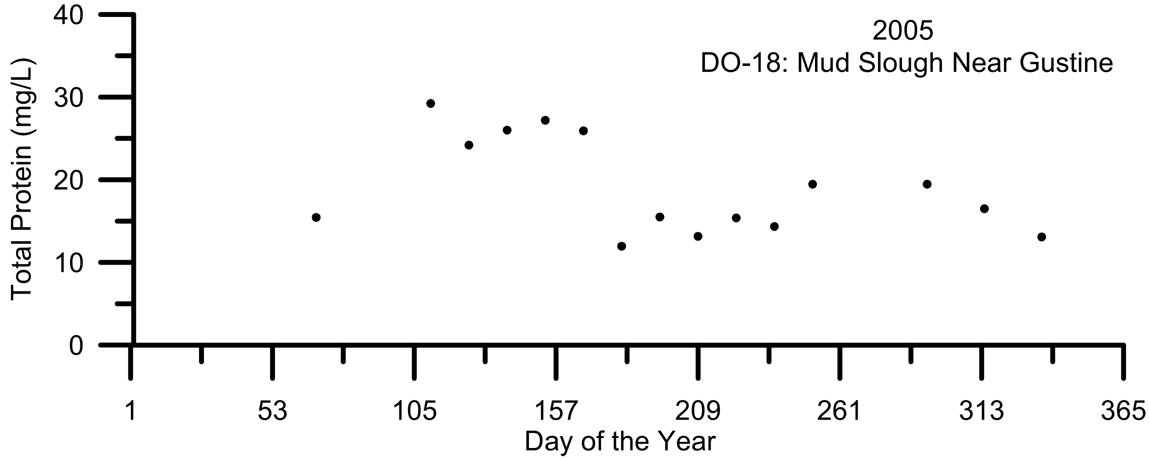

2006
DO-14: Tuolumne @ Shiloh Bridge
Total Protein (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

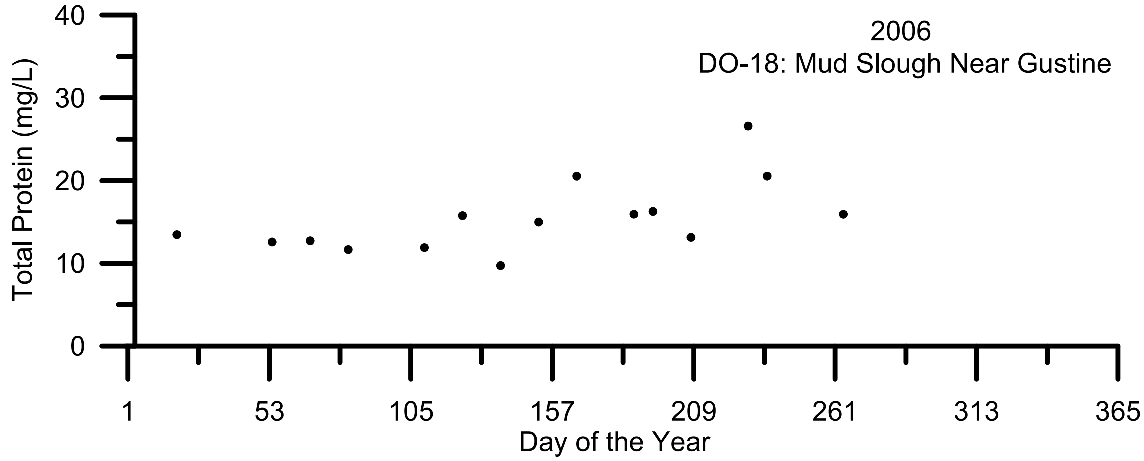

2007
DO-14: Tuolumne @ Shiloh Bridge
Total Protein (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

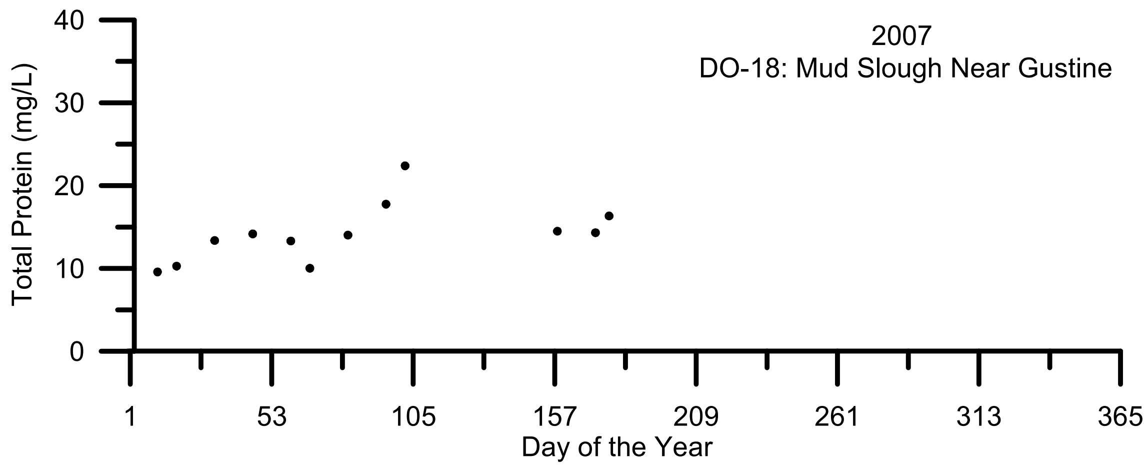

2005
DO-16: Merced @ River Road
Total Protein (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

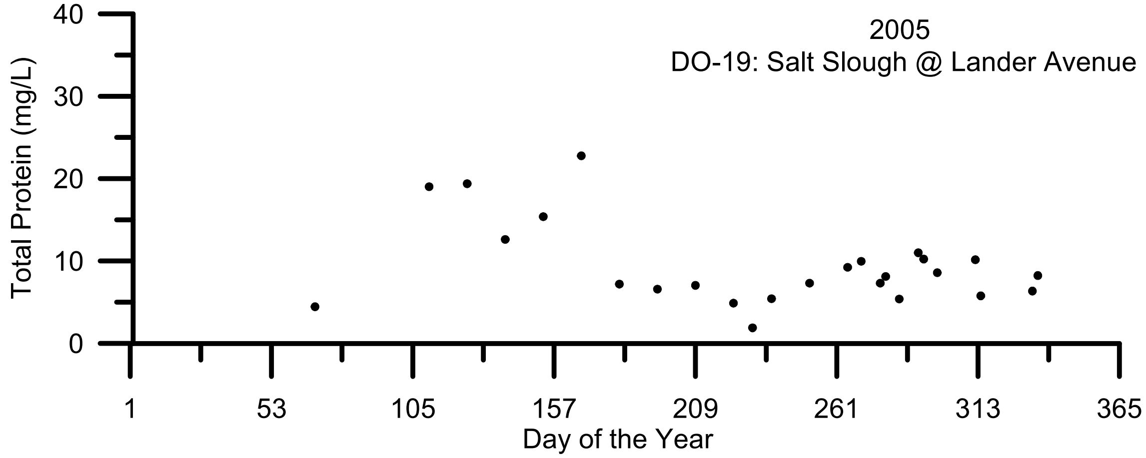

2006
DO-16: Merced @ River Road
Total Protein (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

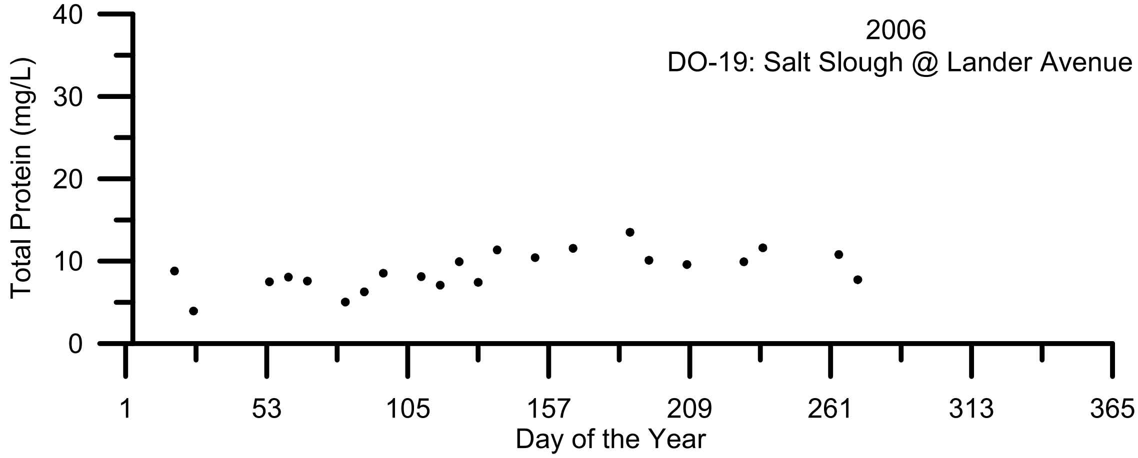

2007
DO-16: Merced @ River Road
Total Protein (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

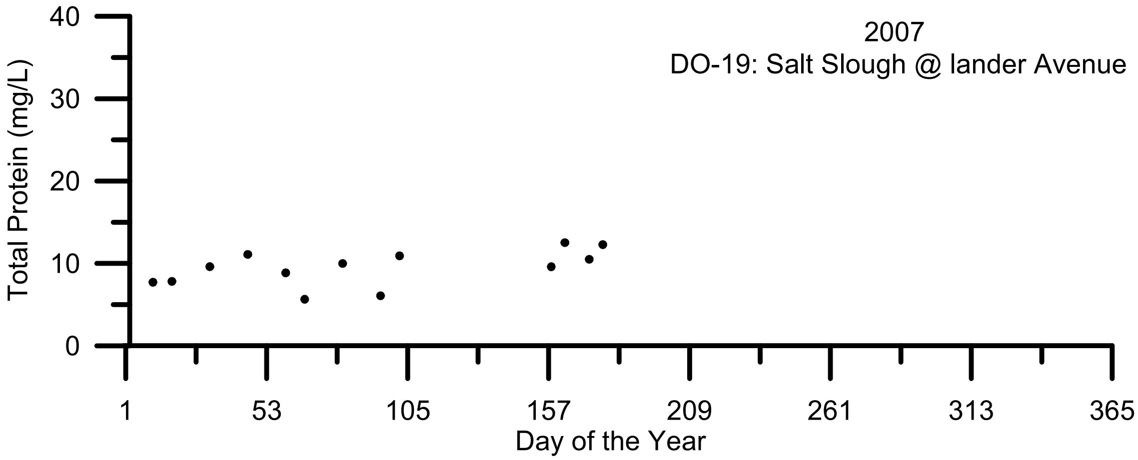

2005
DO-18: Mud Slough Near Gustine
Total Protein (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

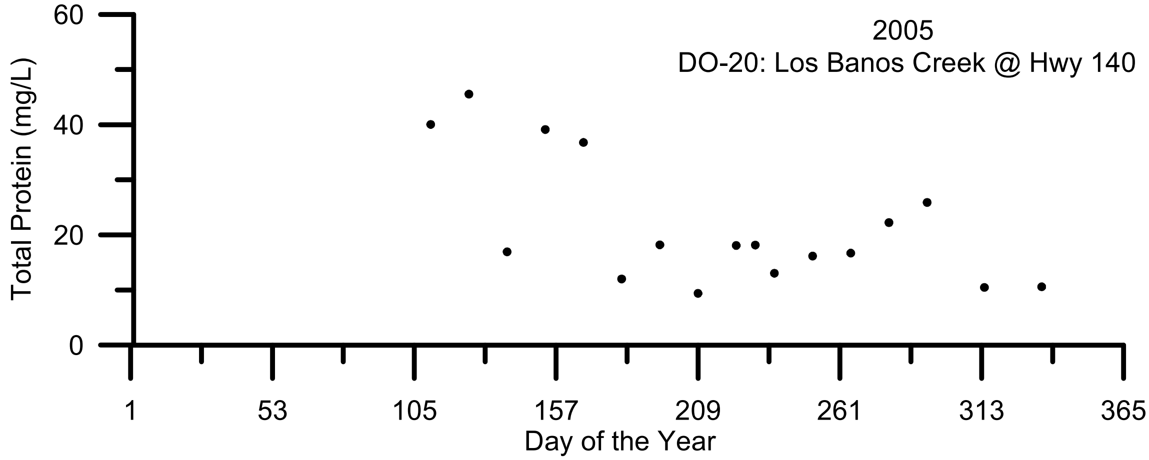

2006
DO-18: Mud Slough Near Gustine
Total Protein (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

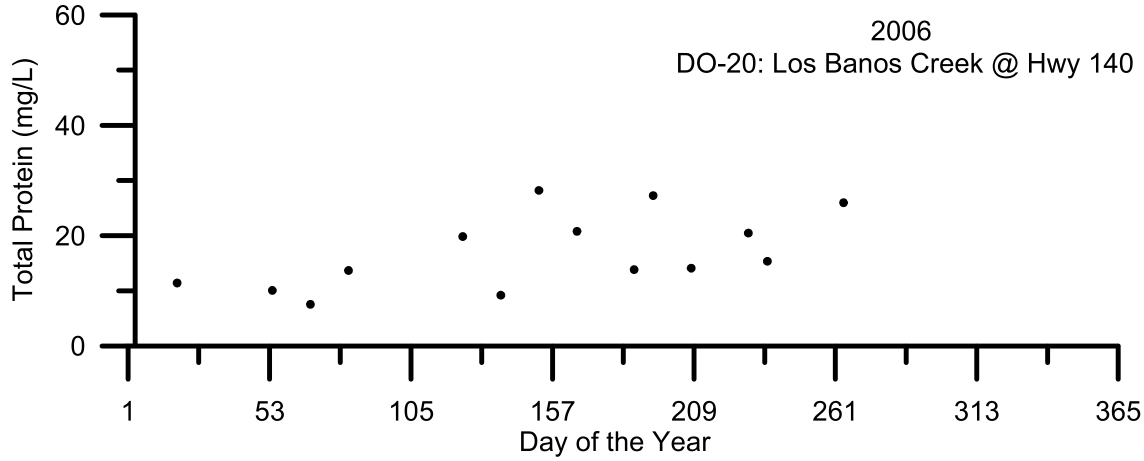

2007
DO-18: Mud Slough Near Gustine
Total Protein (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

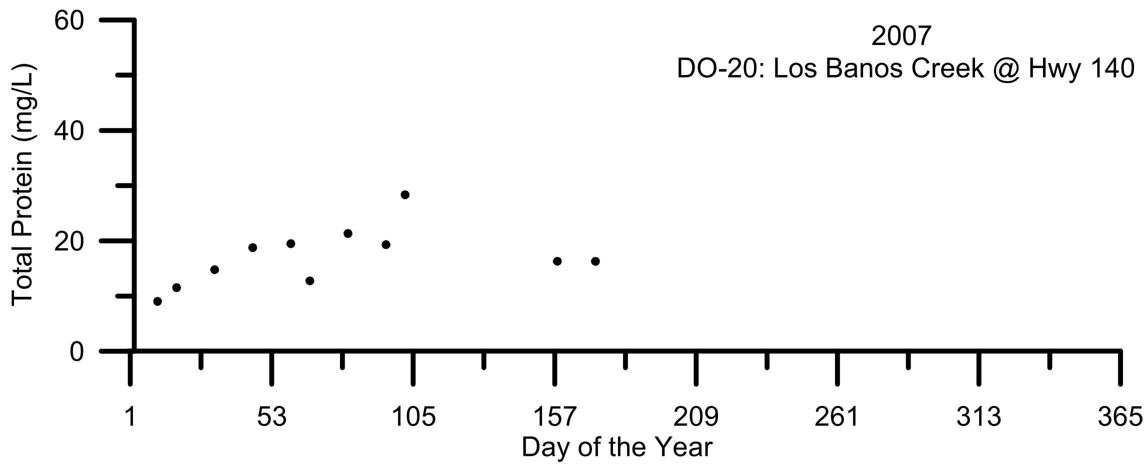

2005
DO-19: Salt Slough @ Lander Avenue
Total Protein (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

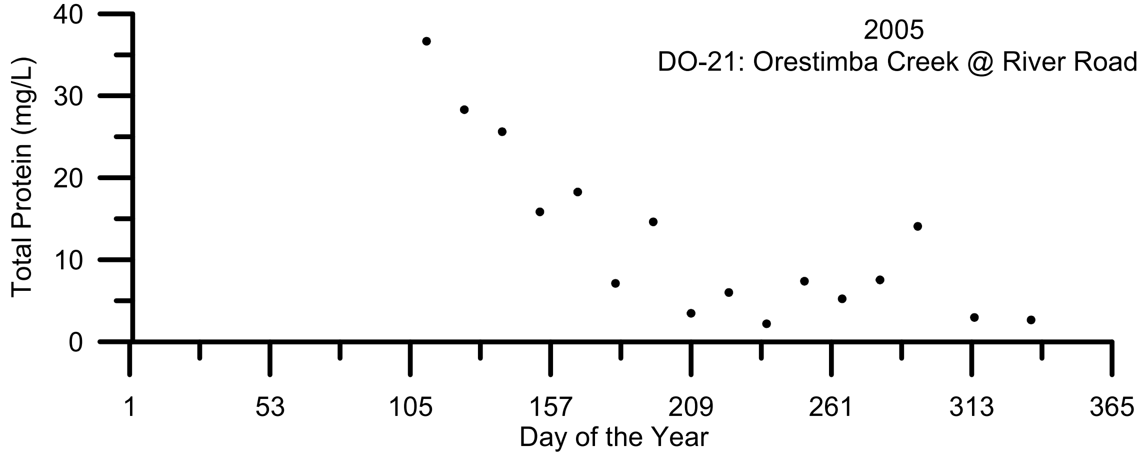

2006
DO-19: Salt Slough @ Lander Avenue
Total Protein (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

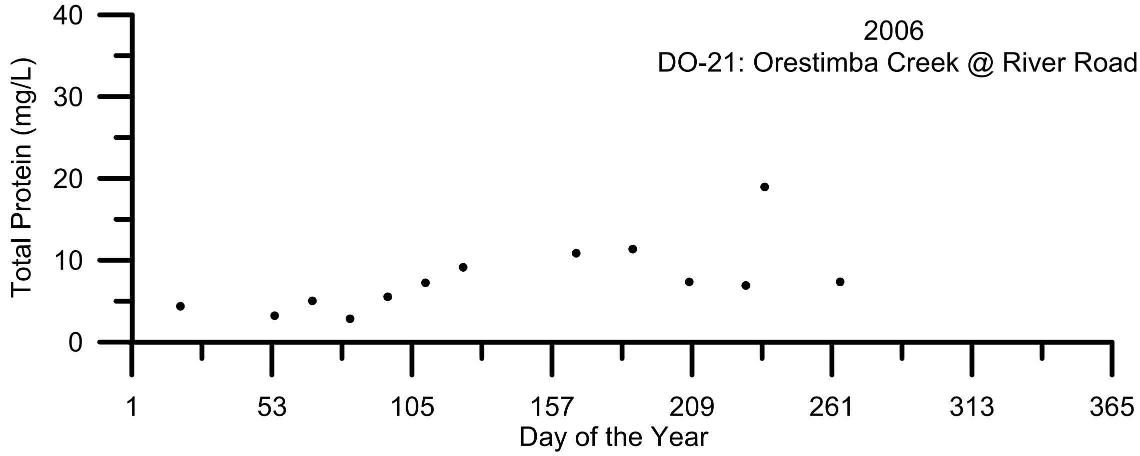

2007
DO-19: Salt Slough @ lander Avenue
Total Protein (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

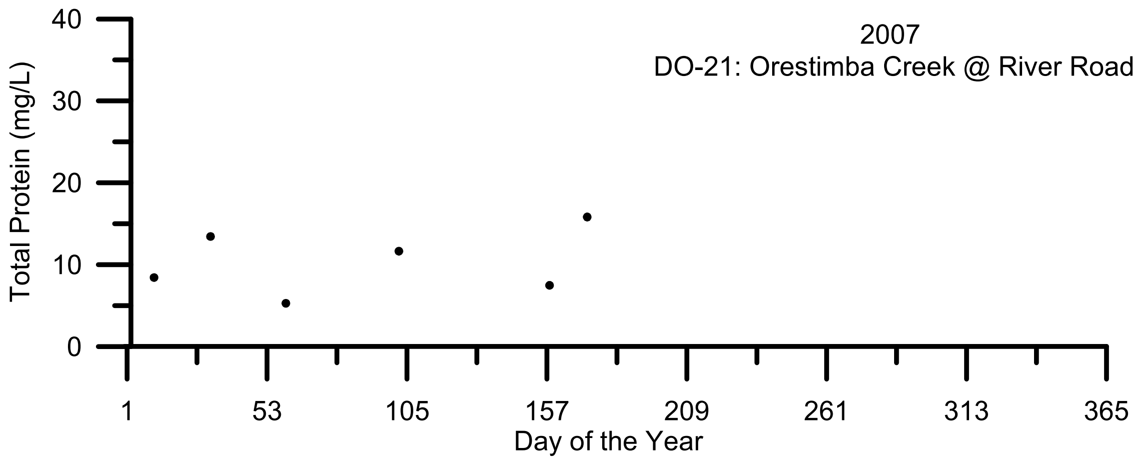

2005
DO-20: Los Banos Creek @ Hwy 140
Total Protein (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year

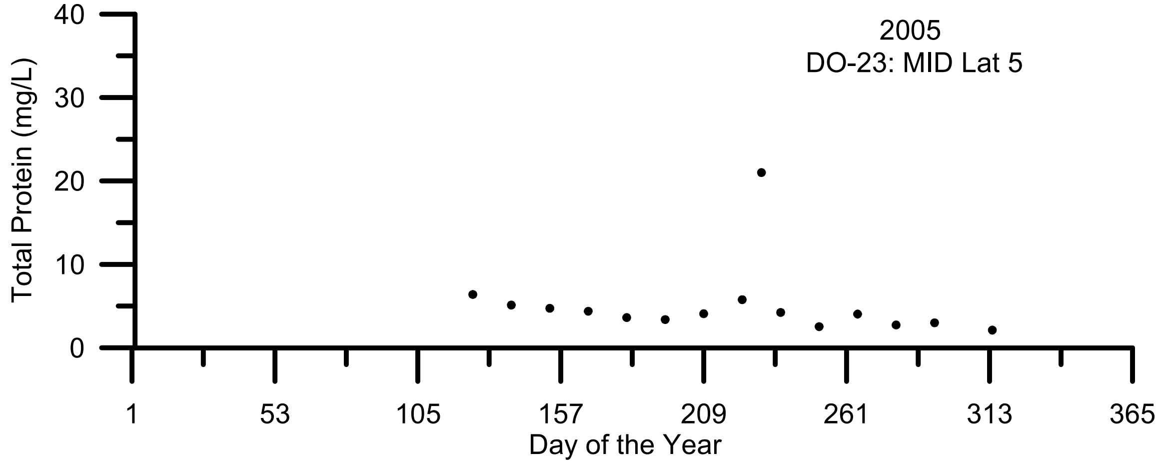

2006
DO-20: Los Banos Creek @ Hwy 140
Total Protein (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year

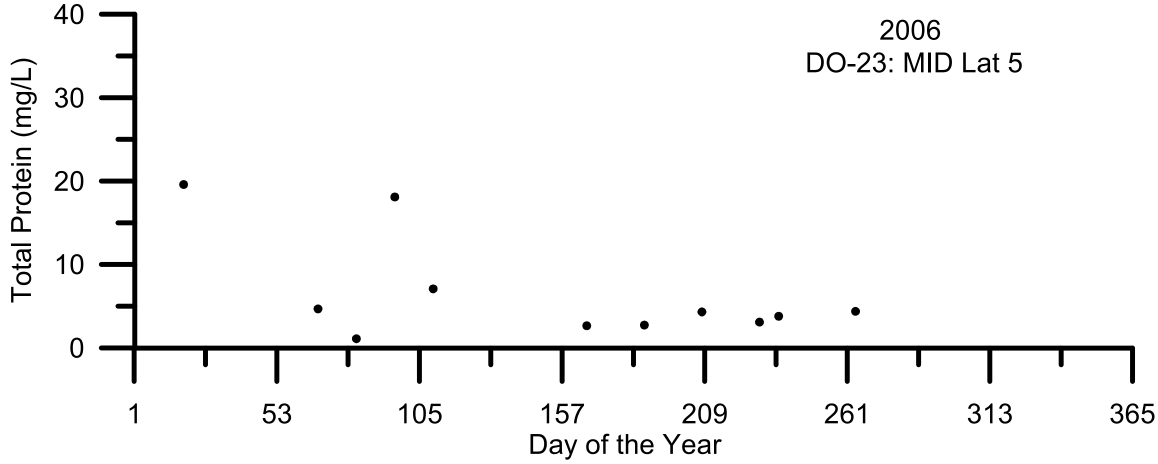

2007
DO-20: Los Banos Creek @ Hwy 140
Total Protein (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year

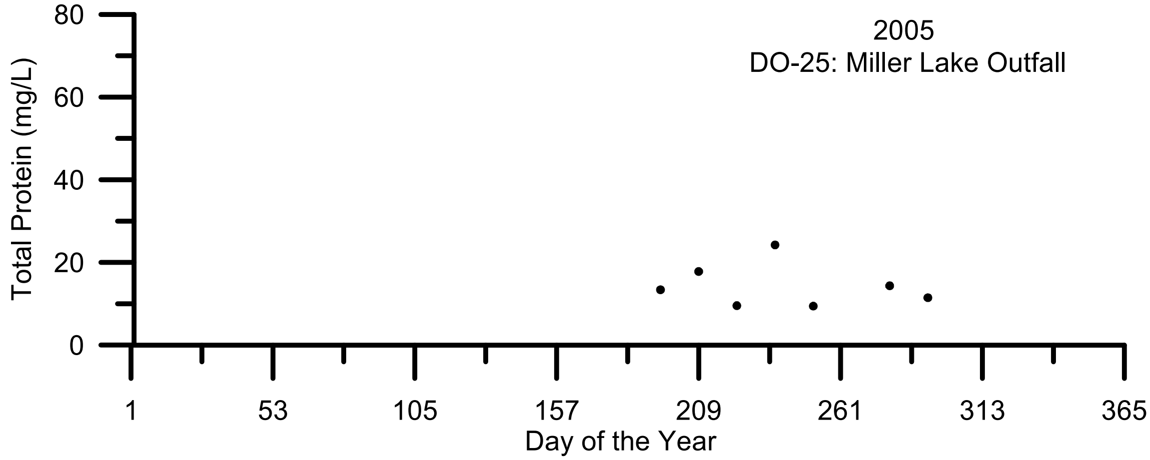

2005
DO-21: Orestimba Creek @ River Road
Total Protein (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

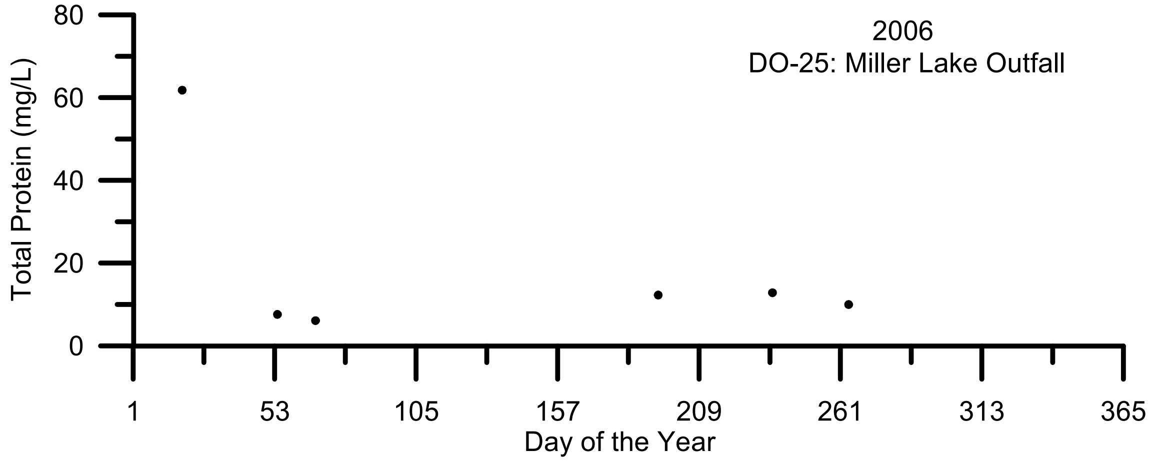

2006
DO-21: Orestimba Creek @ River Road
Total Protein (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

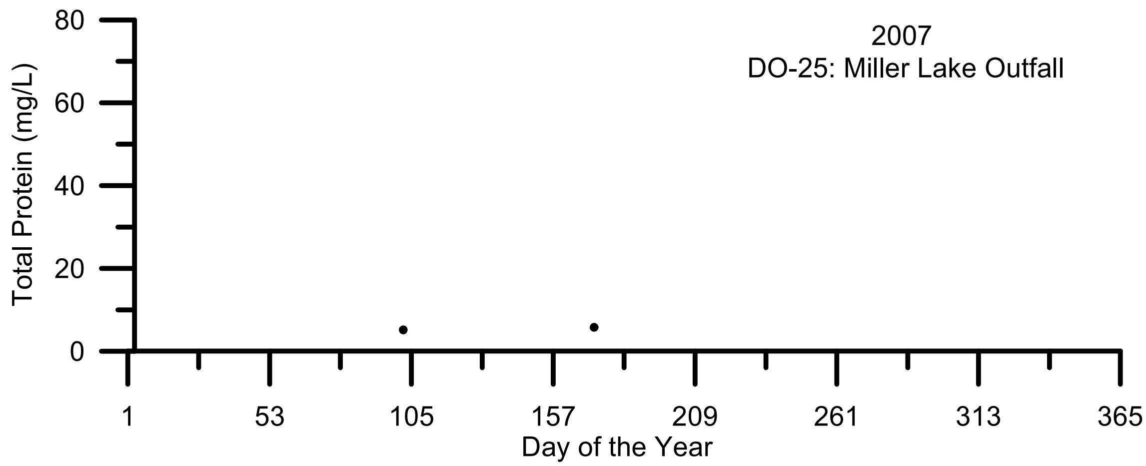

2007
DO-21: Orestimba Creek @ River Road
Total Protein (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

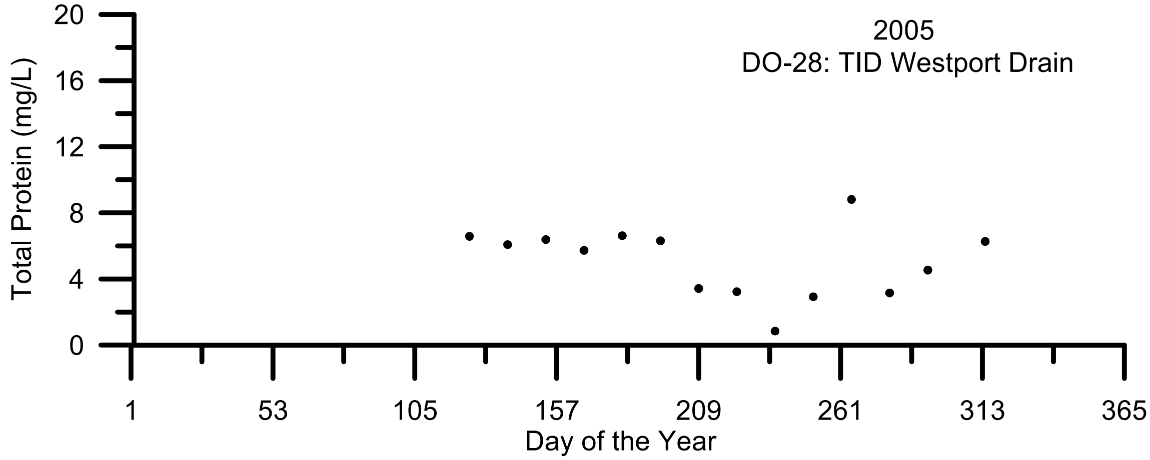

2005
DO-23: MID Lat 5
Total Protein (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-23: MID Lat 5
Total Protein (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

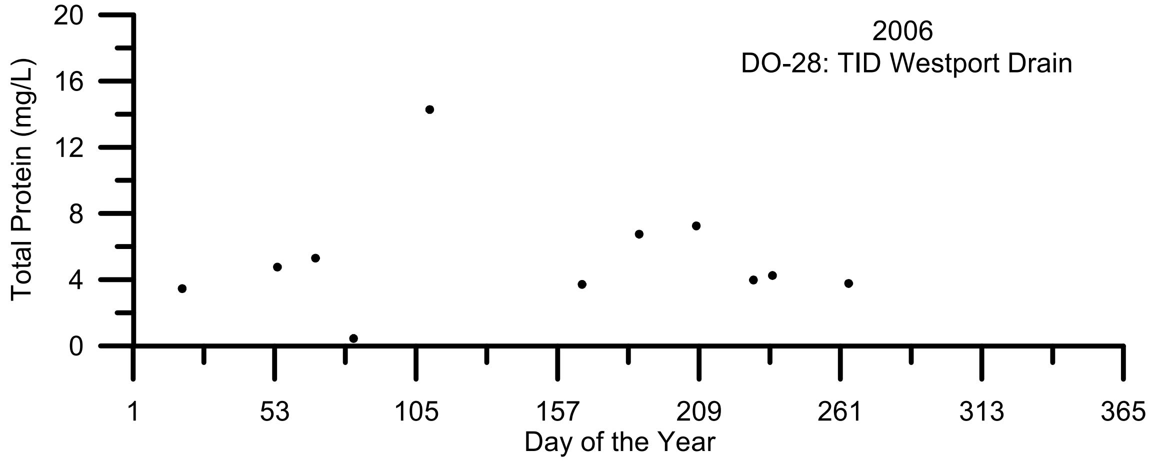

2005
DO-25: Miller Lake Outfall
Total Protein (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-25: Miller Lake Outfall
Total Protein (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

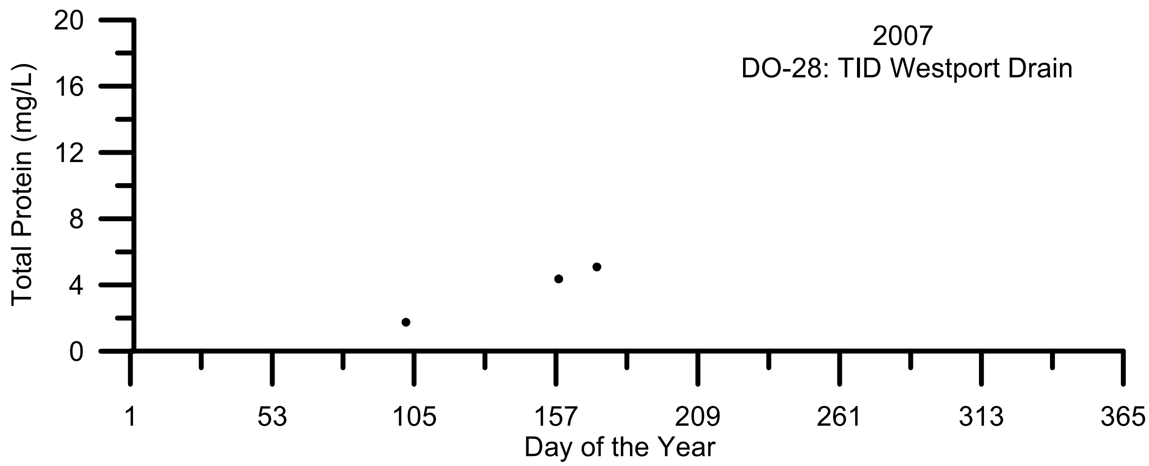

2007
DO-25: Miller Lake Outfall
Total Protein (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year



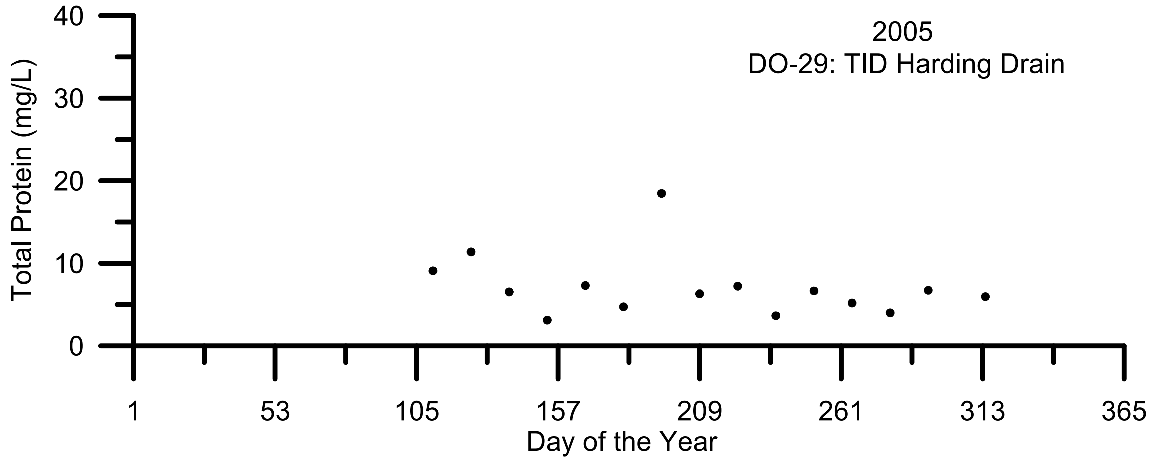
2005
DO-28: TID Westport Drain
Total Protein (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

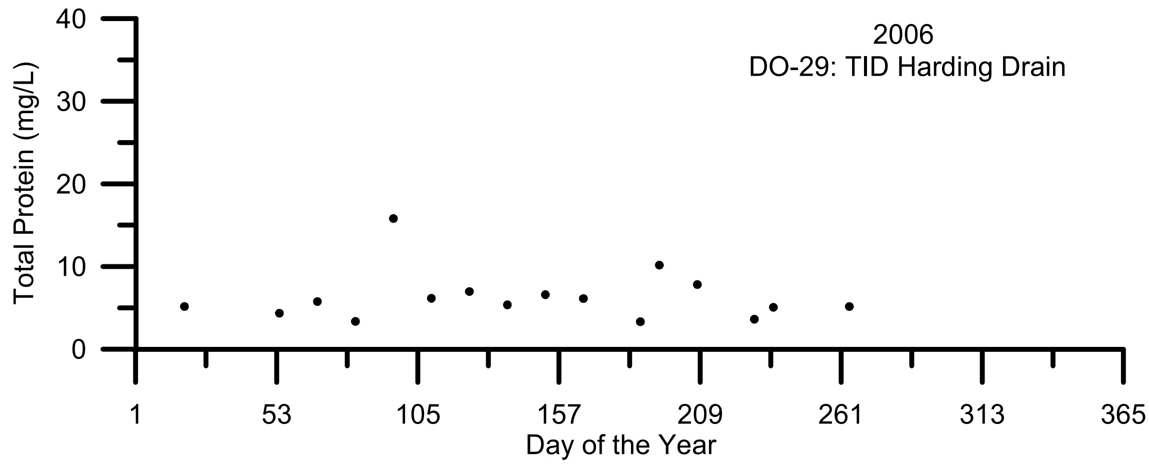


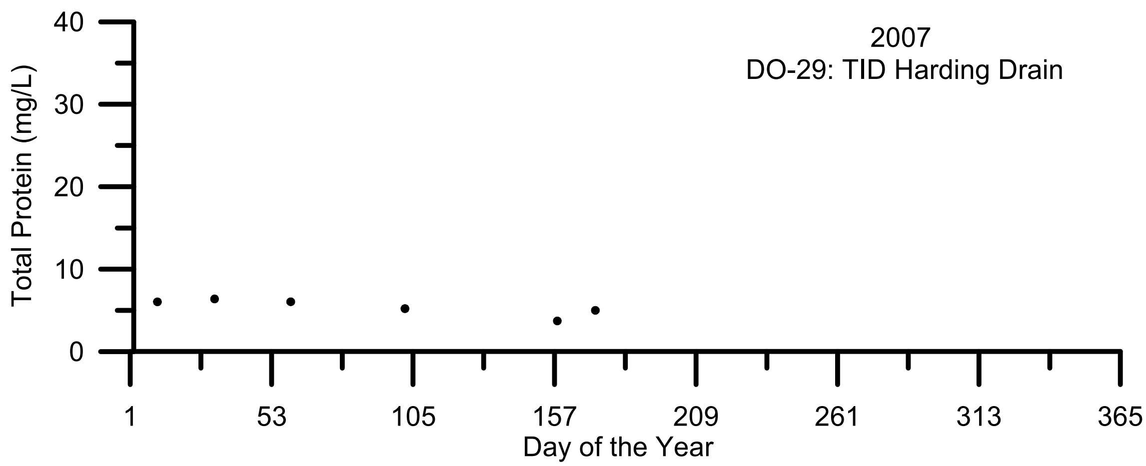
2006
DO-28: TID Westport Drain
Total Protein (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

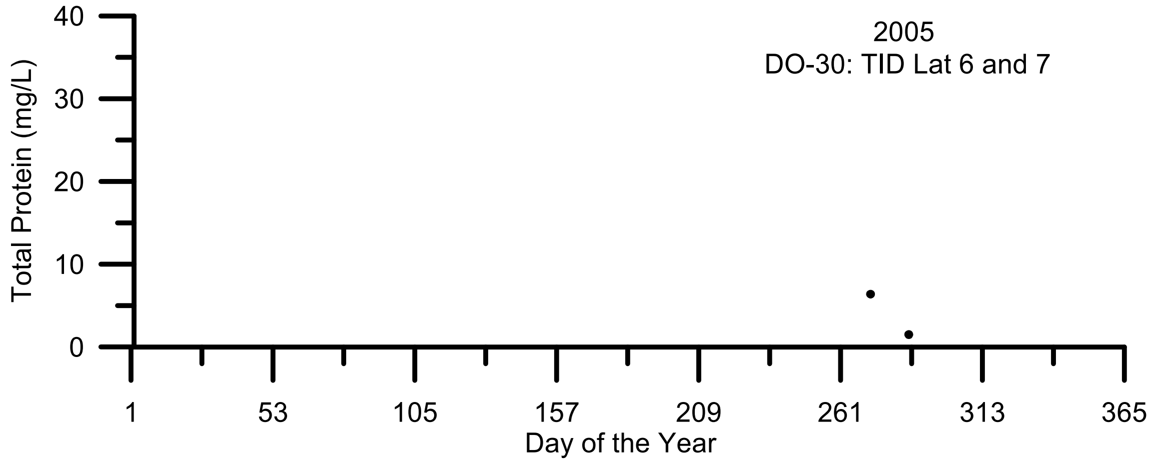


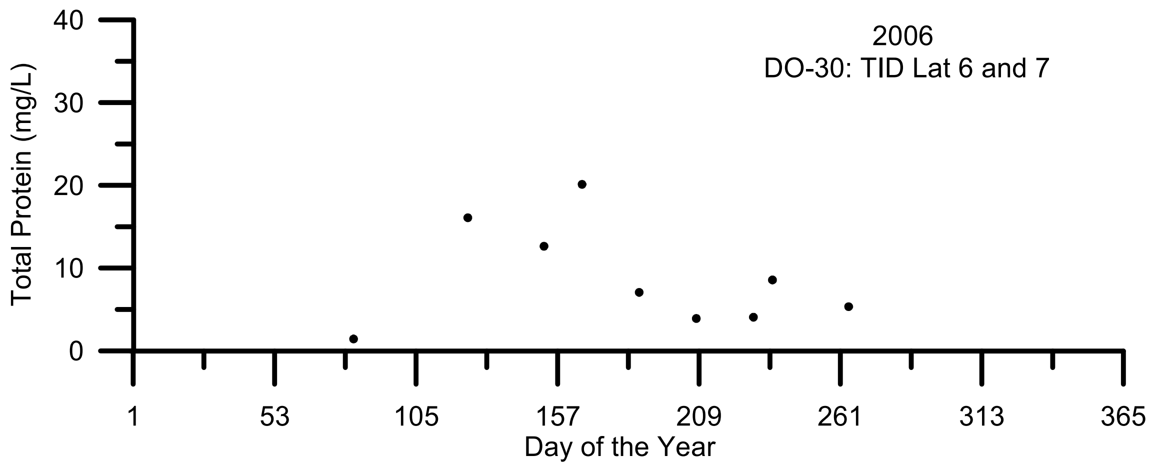
2007
DO-28: TID Westport Drain
Total Protein (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

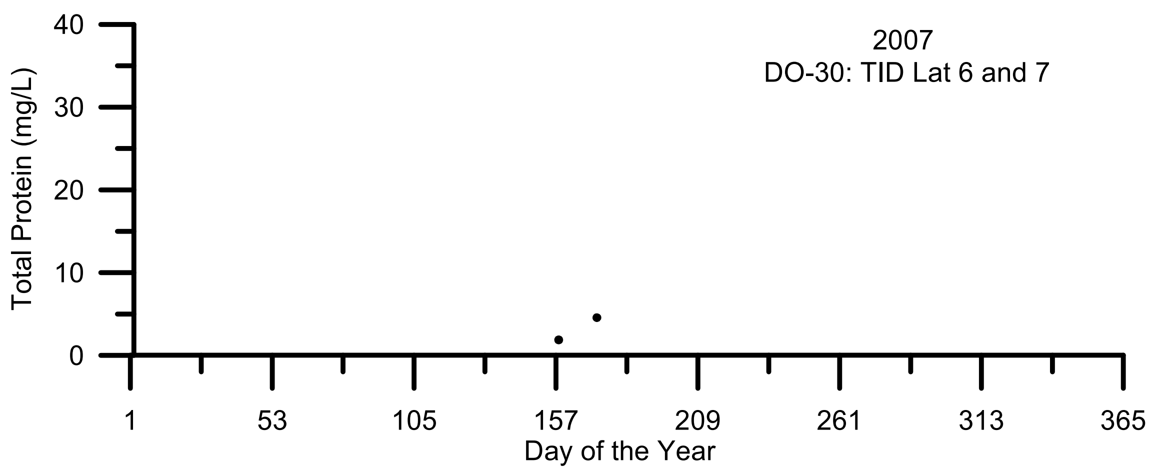

2005
DO-29: TID Harding Drain
Total Protein (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

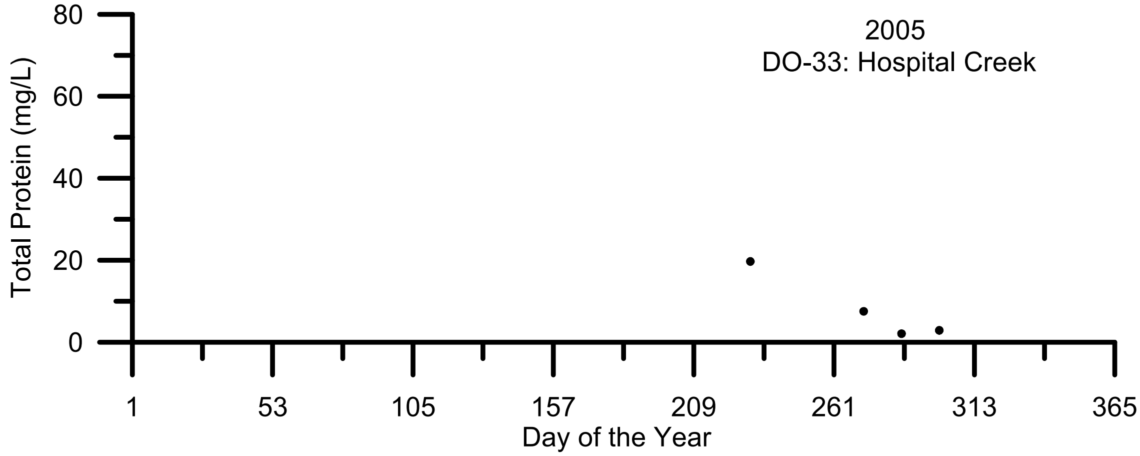

2006
DO-29: TID Harding Drain
Total Protein (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

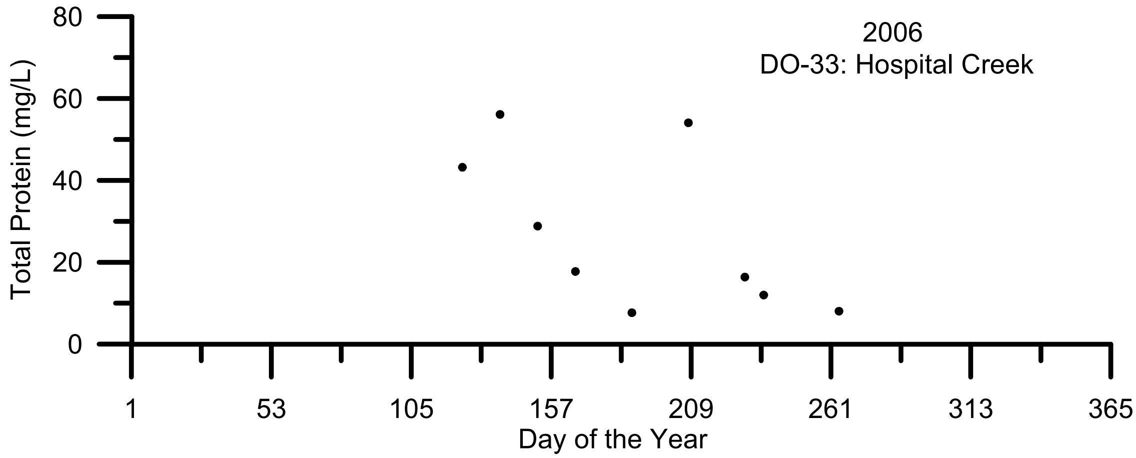

2007
DO-29: TID Harding Drain
Total Protein (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

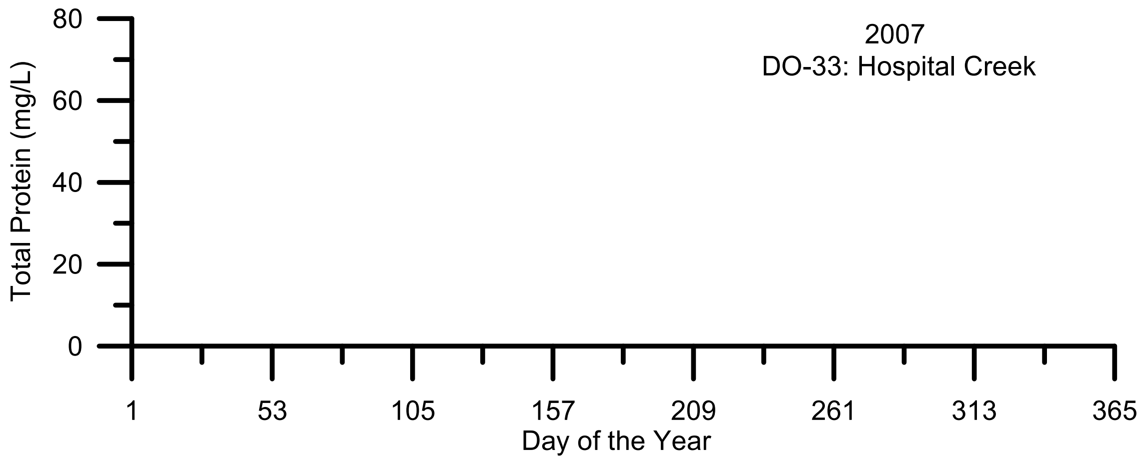

2005
DO-30: TID Lat 6 and 7
Total Protein (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

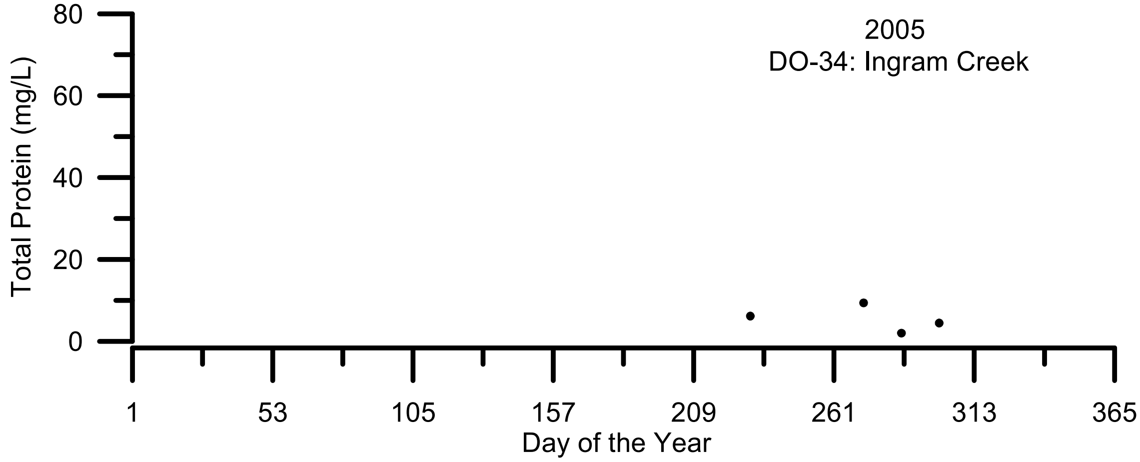

2006
DO-30: TID Lat 6 and 7
Total Protein (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

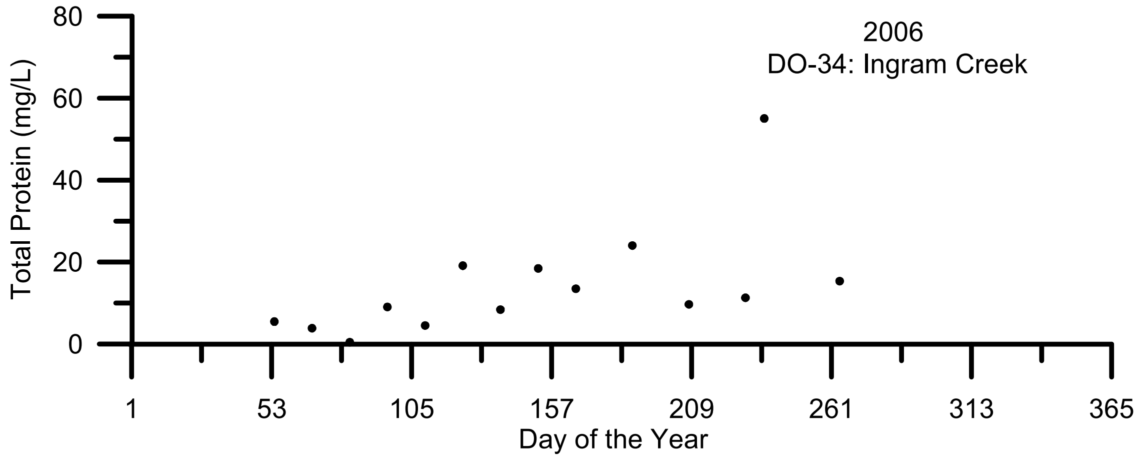

2007
DO-30: TID Lat 6 and 7
Total Protein (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

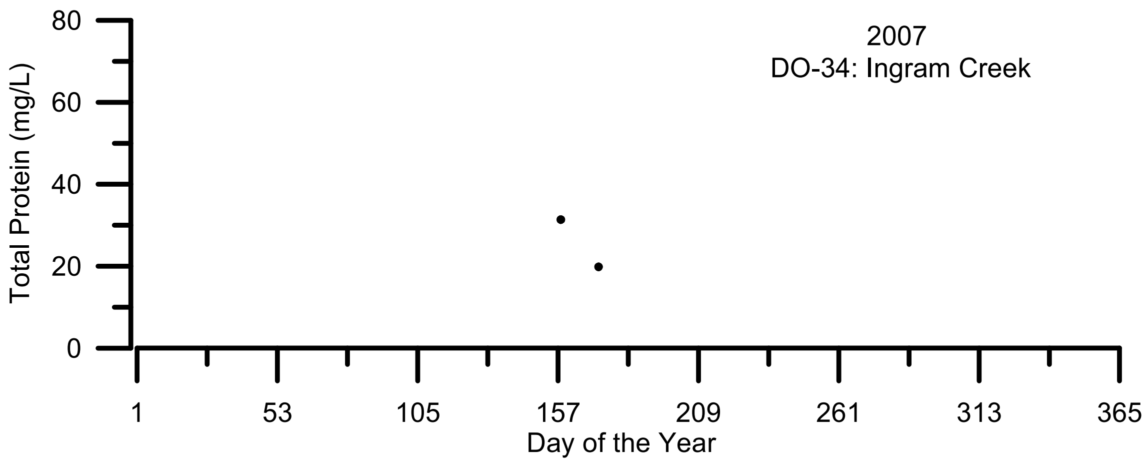

2005
DO-33: Hospital Creek
Total Protein (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

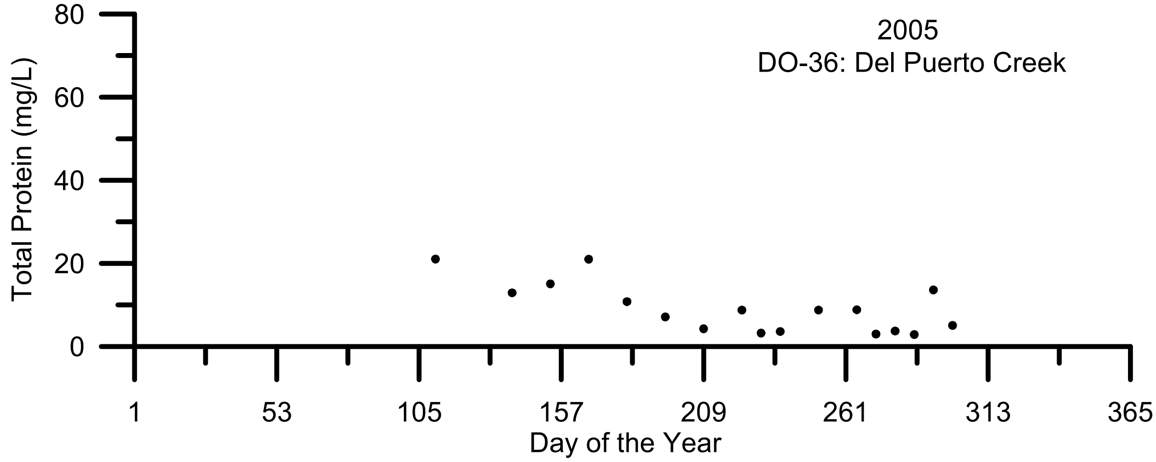

2006
DO-33: Hospital Creek
Total Protein (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

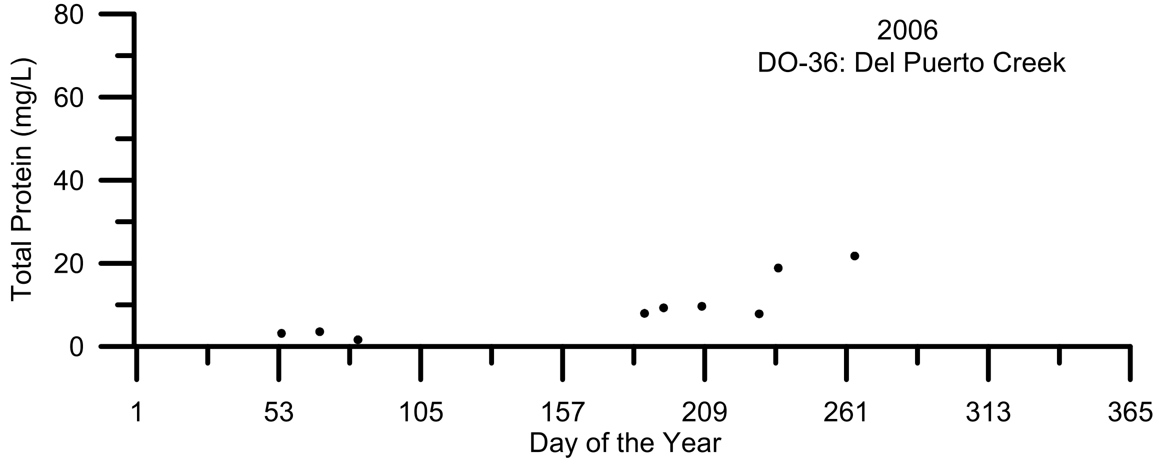

2007
DO-33: Hospital Creek
Total Protein (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

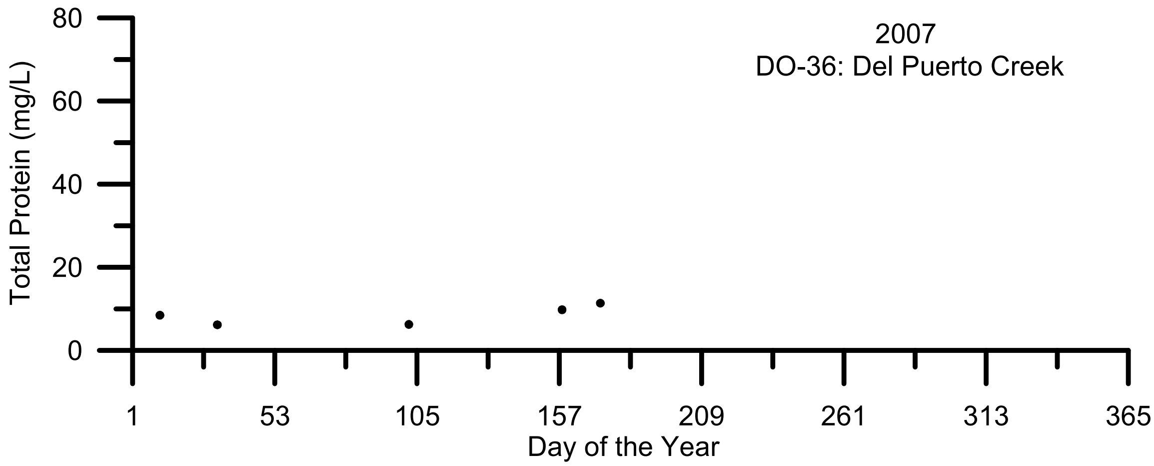

2005
DO-34: Ingram Creek
Total Protein (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

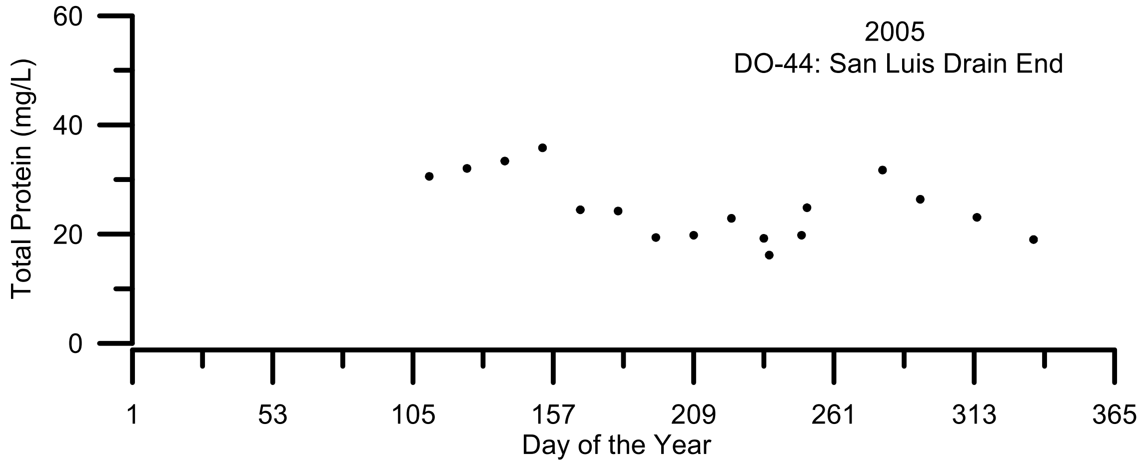

2006
DO-34: Ingram Creek
Total Protein (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-34: Ingram Creek
Total Protein (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

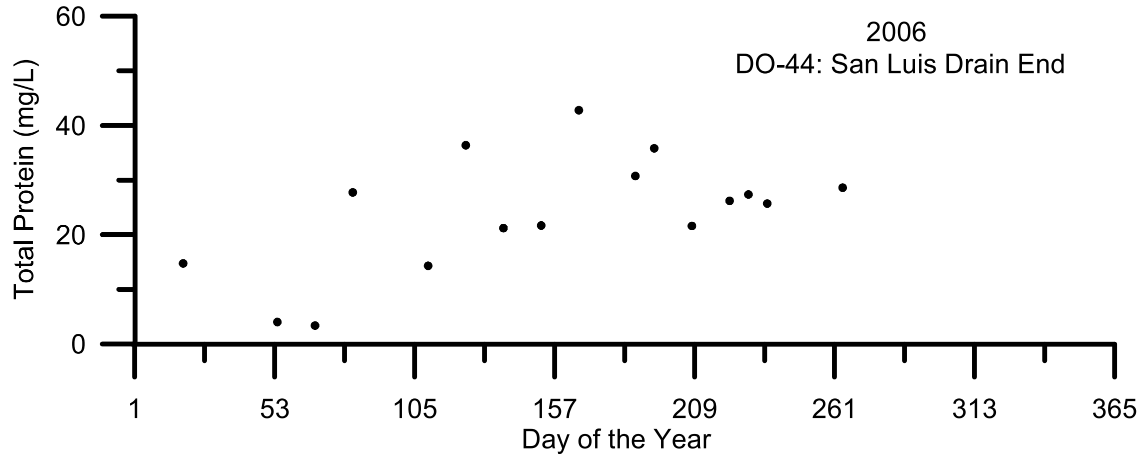

2005
DO-36: Del Puerto Creek
Total Protein (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-36: Del Puerto Creek
Total Protein (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

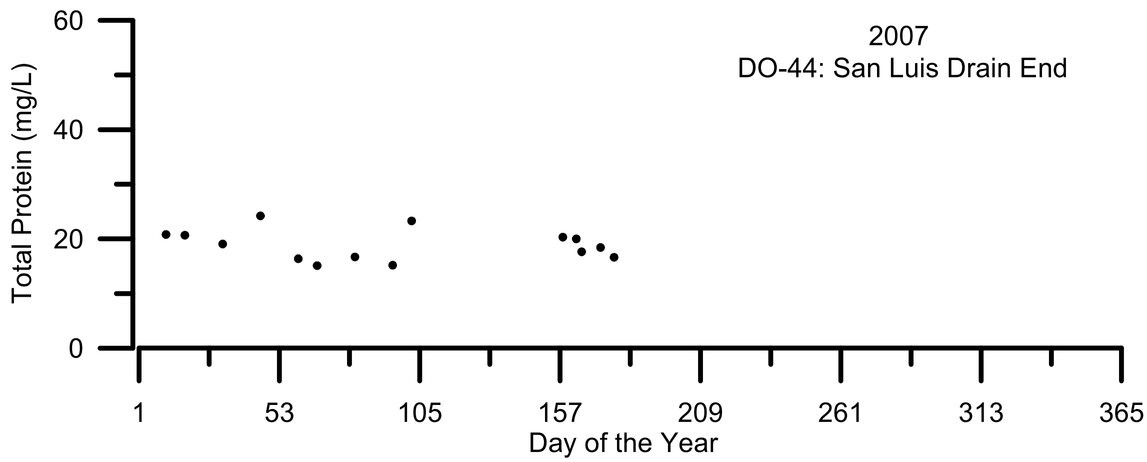

2007
DO-36: Del Puerto Creek
Total Protein (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year



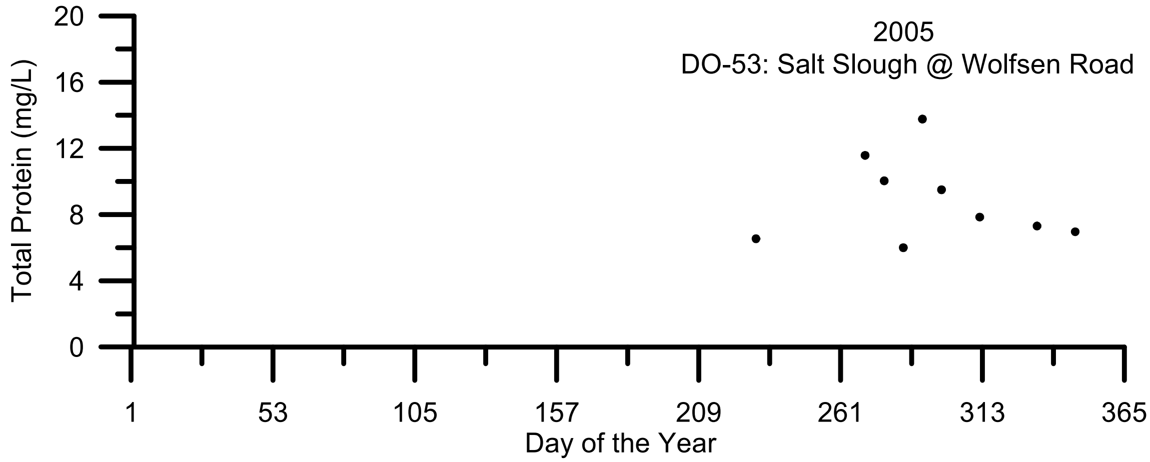
2005
DO-44: San Luis Drain End
Total Protein (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

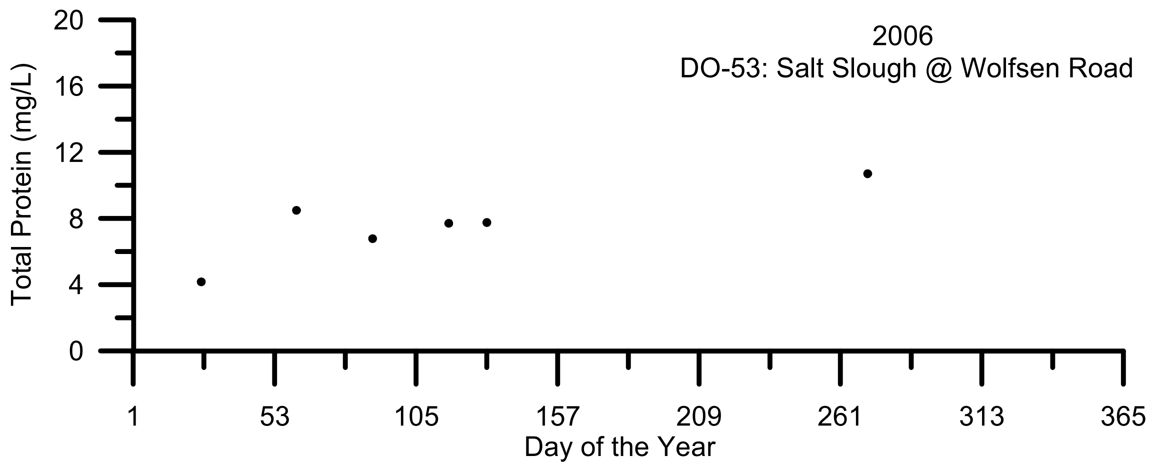


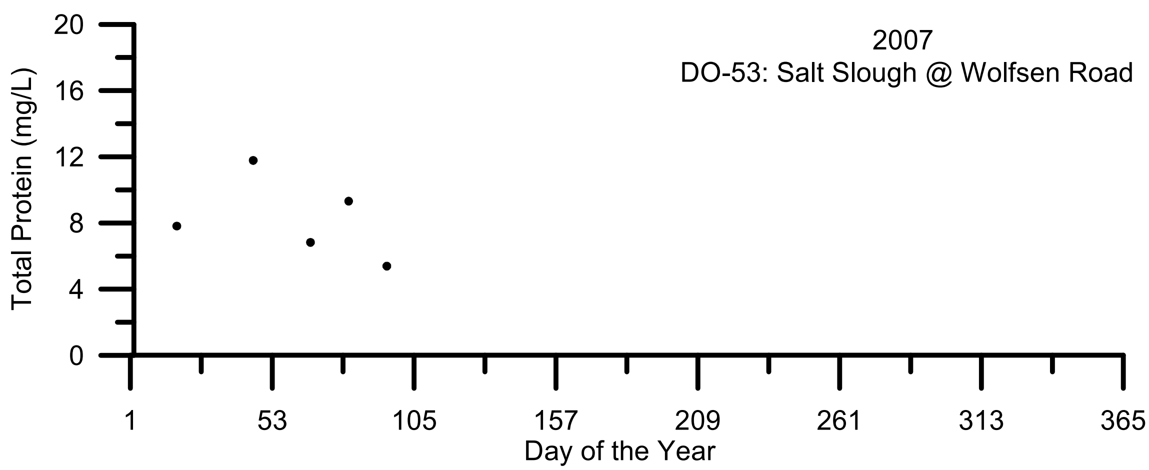
2006
DO-44: San Luis Drain End
Total Protein (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

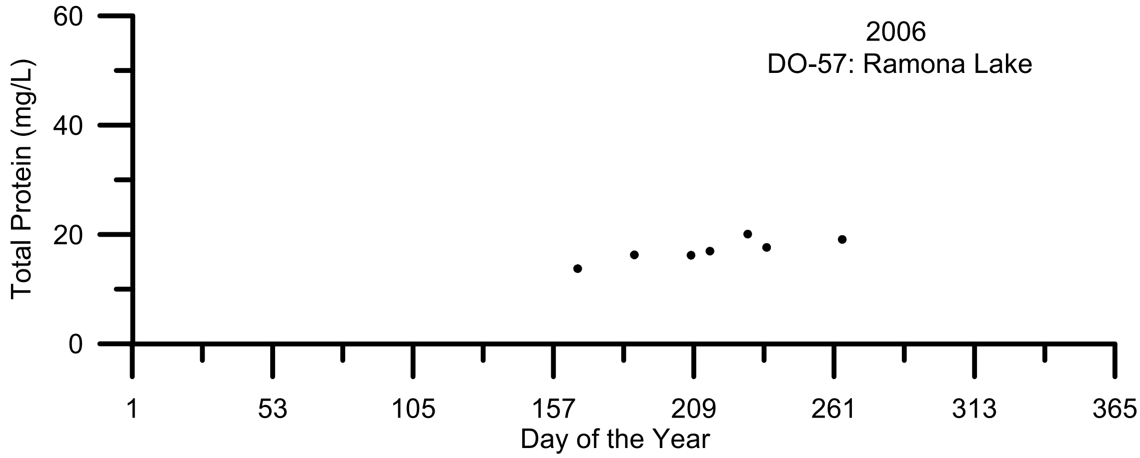


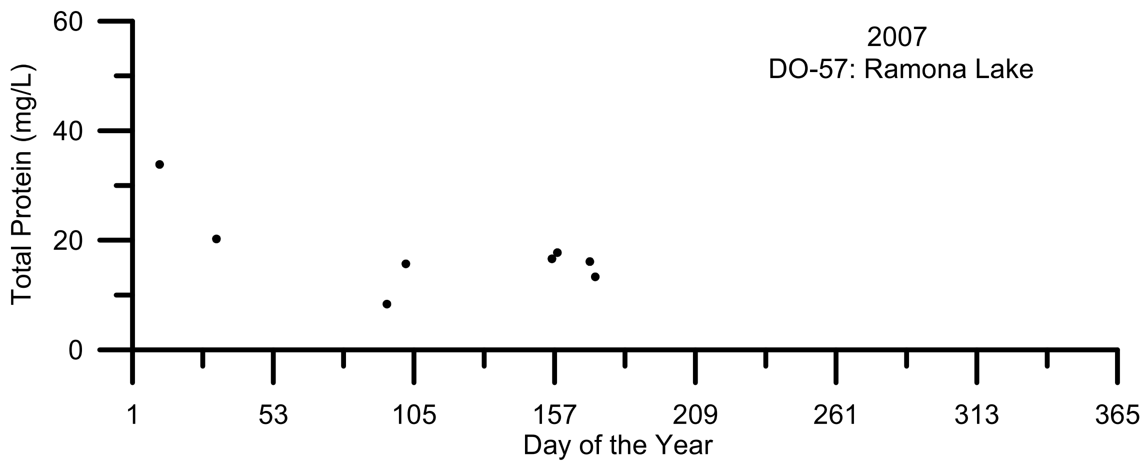
2007
DO-44: San Luis Drain End
Total Protein (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

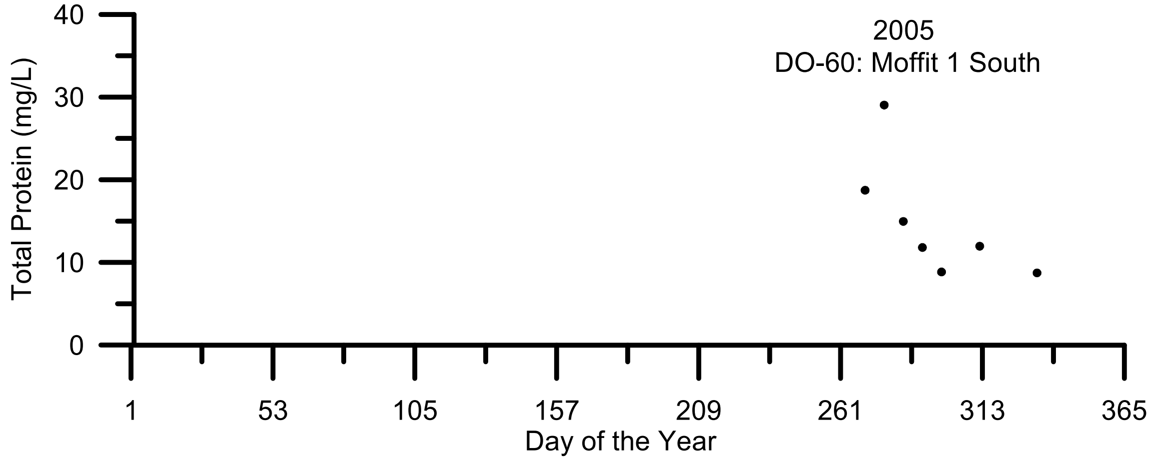

2005
DO-53: Salt Slough @ Wolfsen Road
Total Protein (mg/L)
Day of the Year

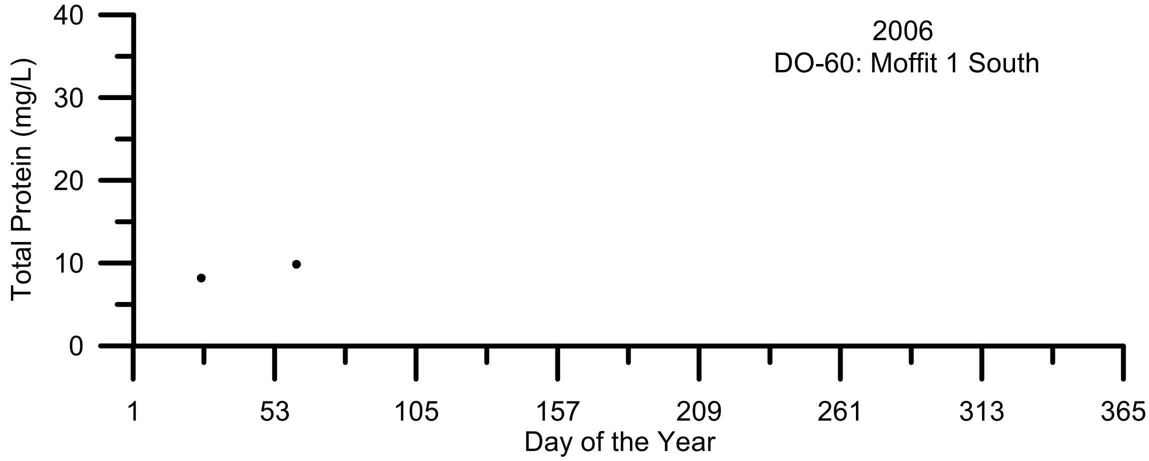

2006
DO-53: Salt Slough @ Wolfsen Road
Total Protein (mg/L)
Day of the Year

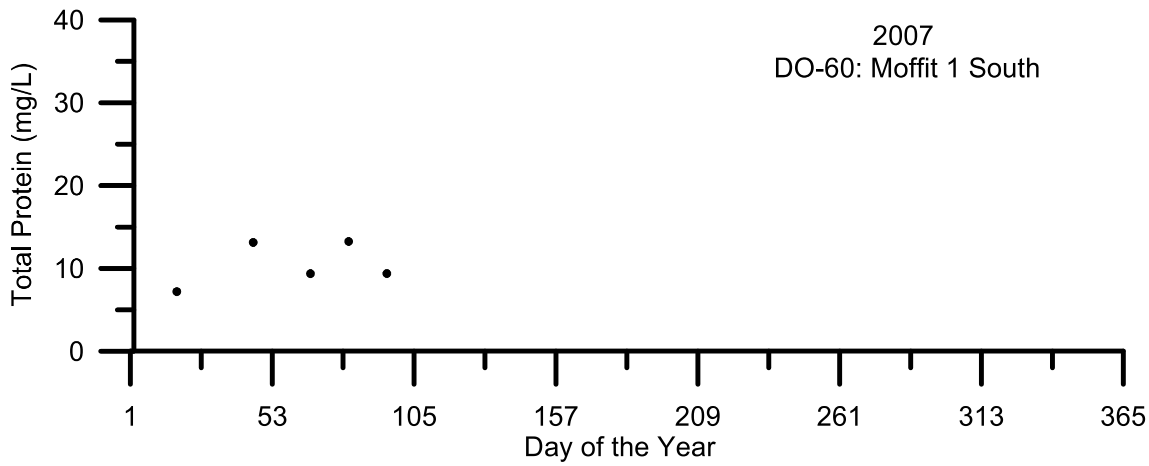

2007
DO-53: Salt Slough @ Wolfsen Road
Total Protein (mg/L)
Day of the Year

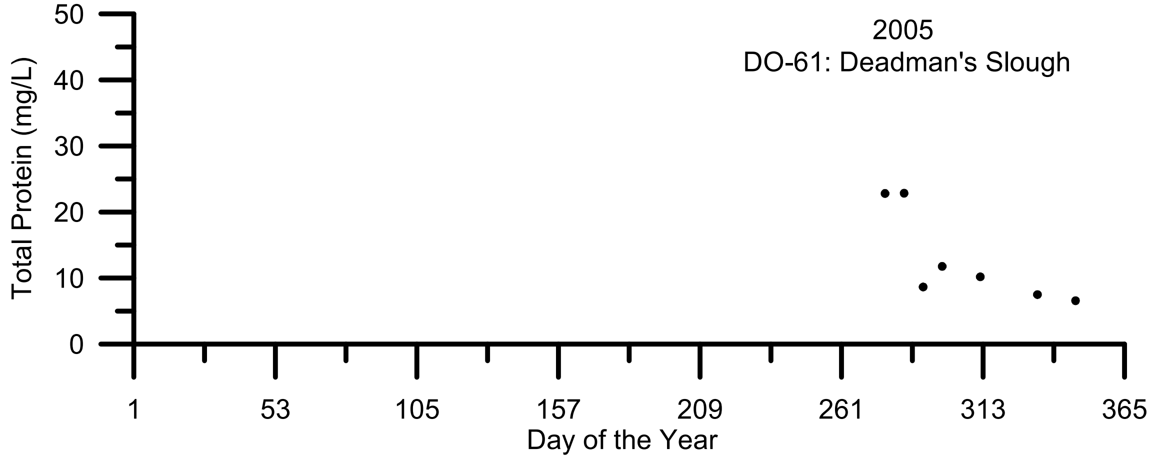

2006
DO-57: Ramona Lake
Total Protein (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

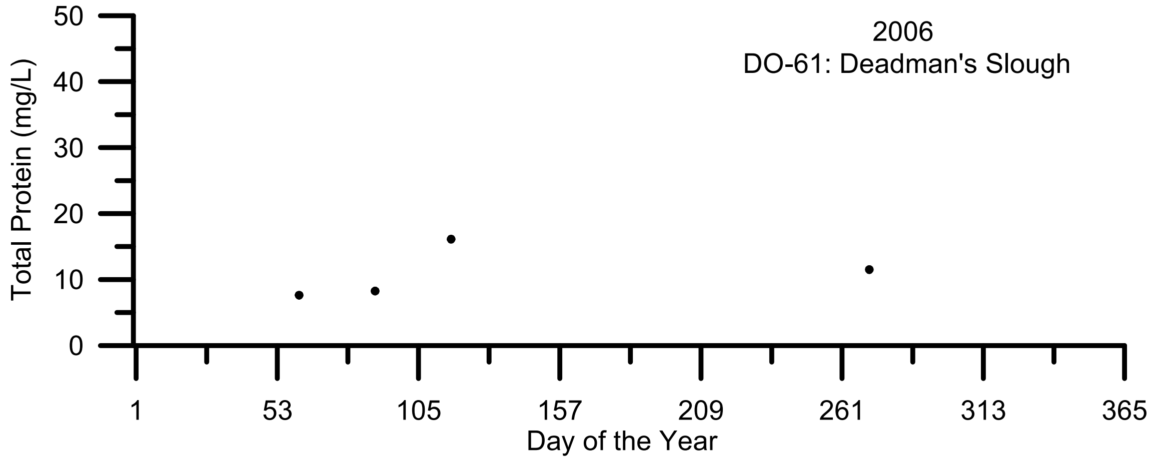

2007
DO-57: Ramona Lake
Total Protein (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

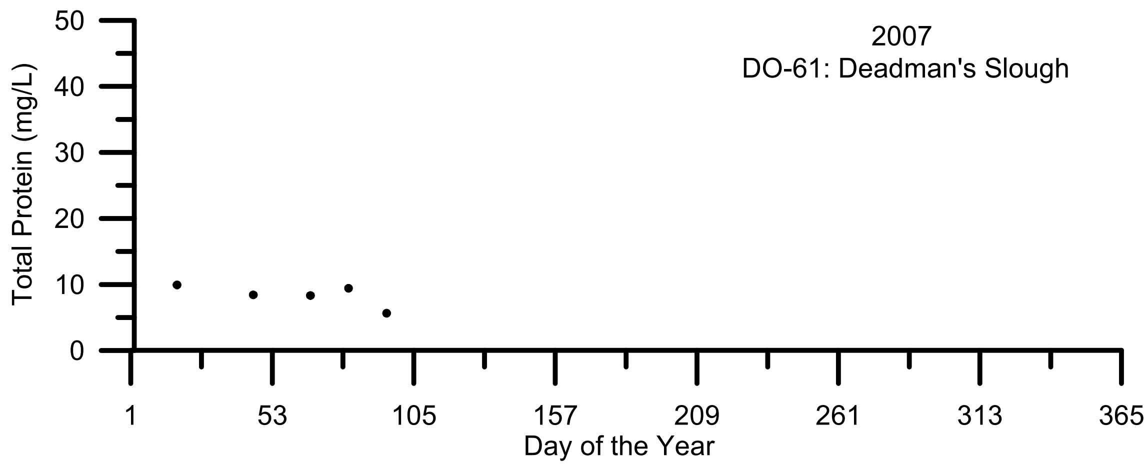

2005
DO-60: Moffit 1 South
Total Protein (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

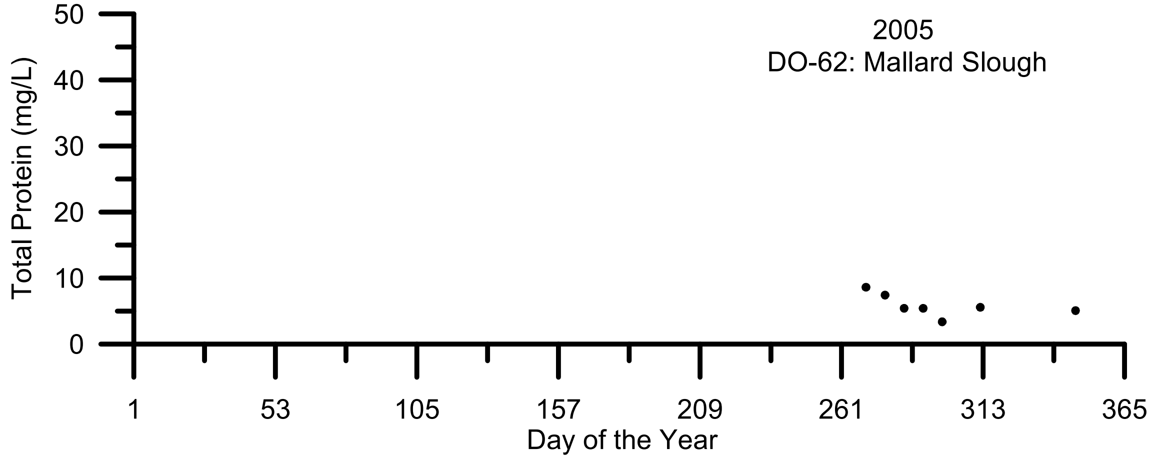

2006
DO-60: Moffit 1 South
Total Protein (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

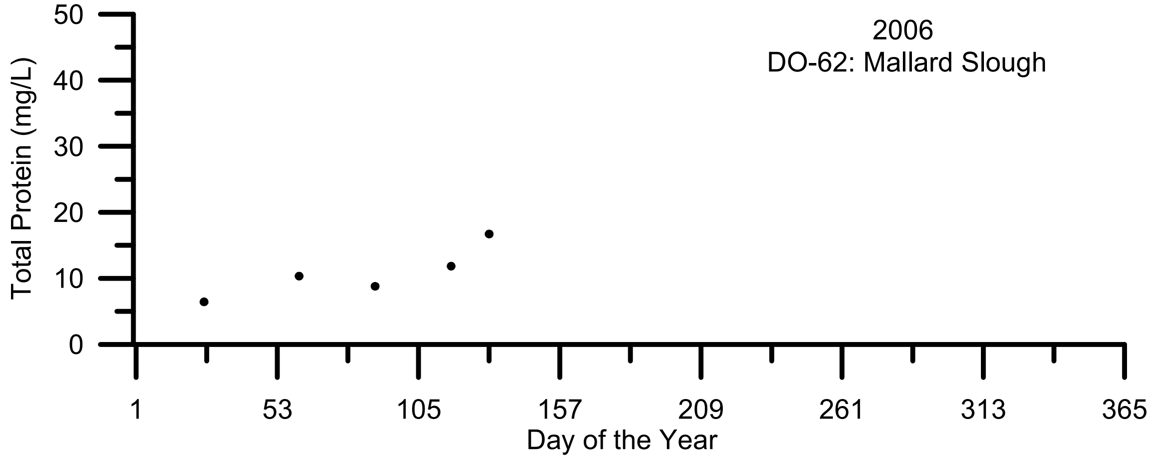

2007
DO-60: Moffit 1 South
Total Protein (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

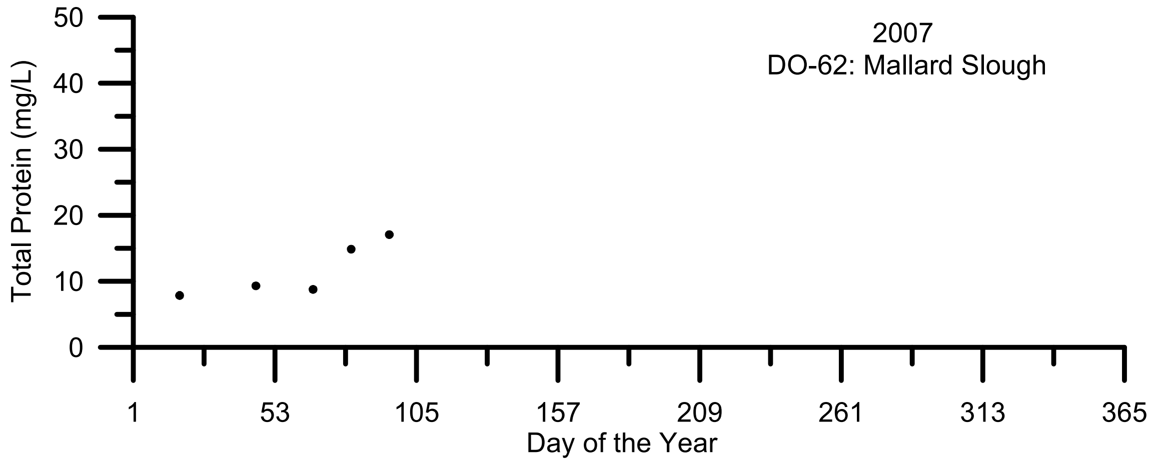

2005
DO-61: Deadman's Slough
Total Protein (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

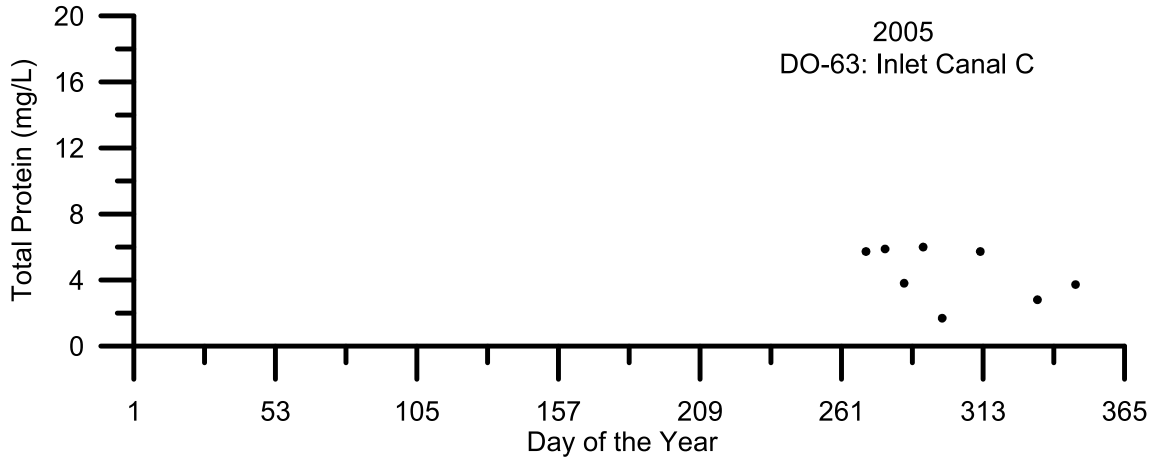

2006
DO-61: Deadman's Slough
Total Protein (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

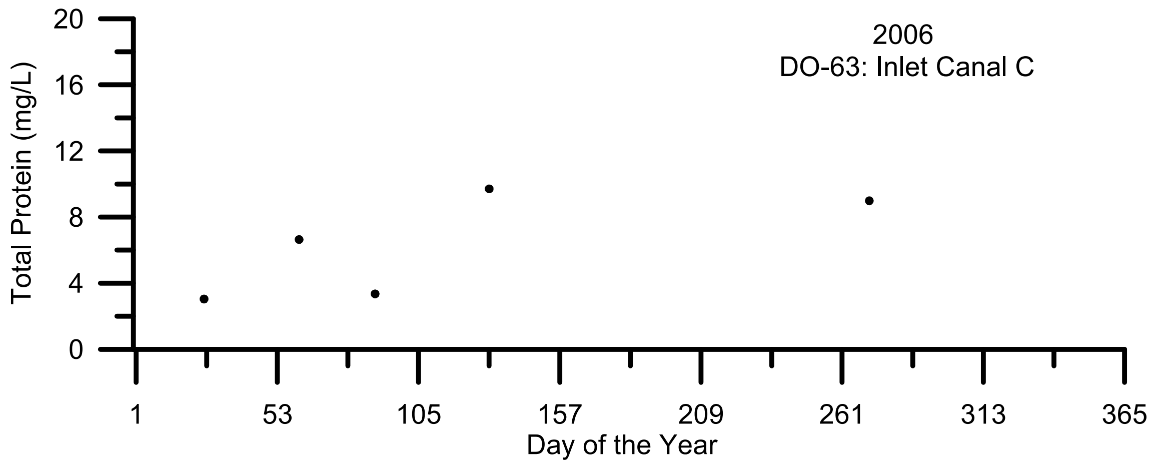

2007
DO-61: Deadman's Slough
Total Protein (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

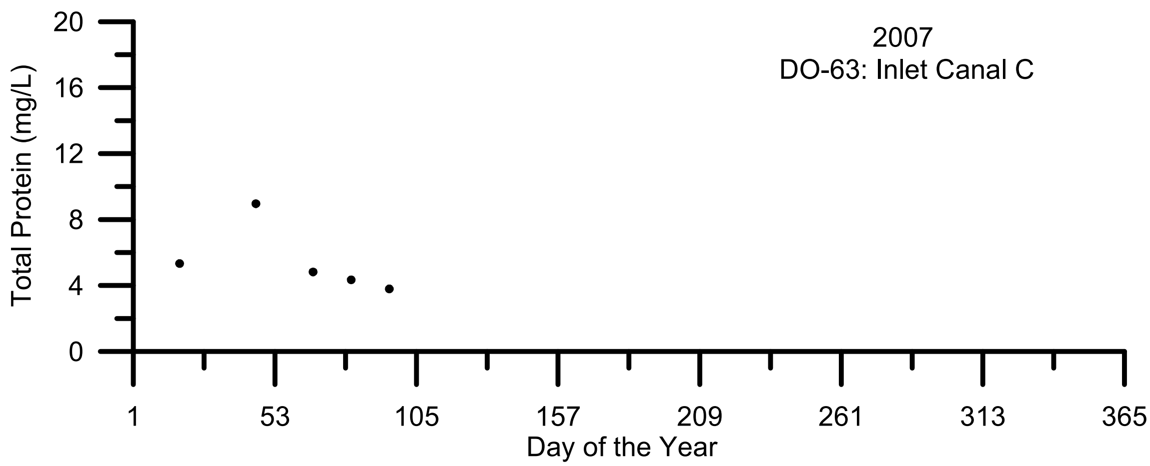

2005
DO-62: Mallard Slough
Total Protein (mg/L)
50
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

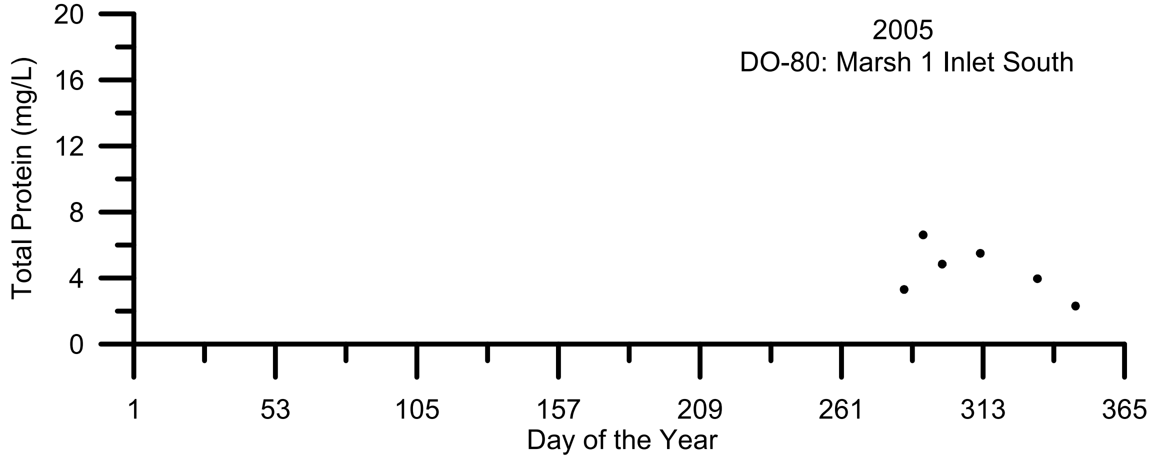

2006
DO-62: Mallard Slough
Total Protein (mg/L)
50
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

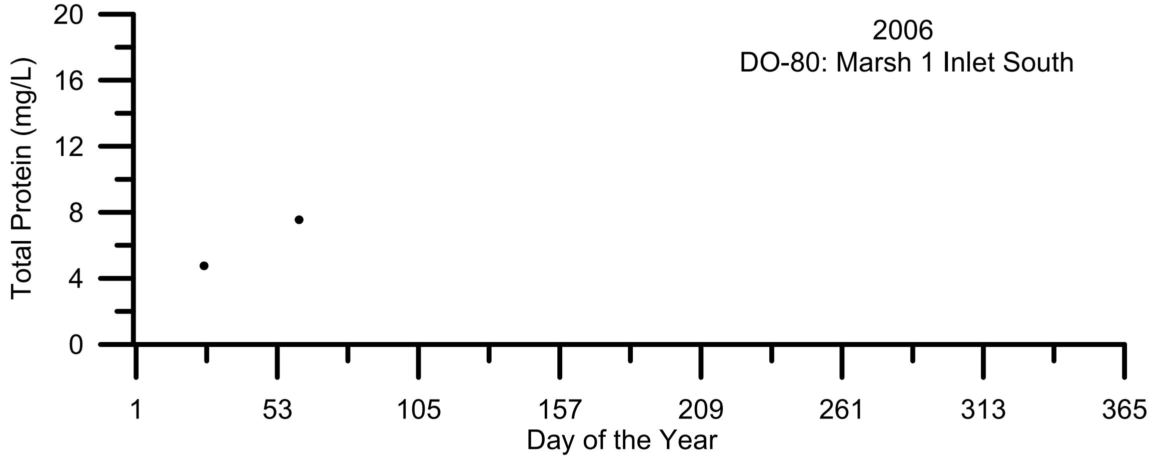

2007
DO-62: Mallard Slough
Total Protein (mg/L)
50
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

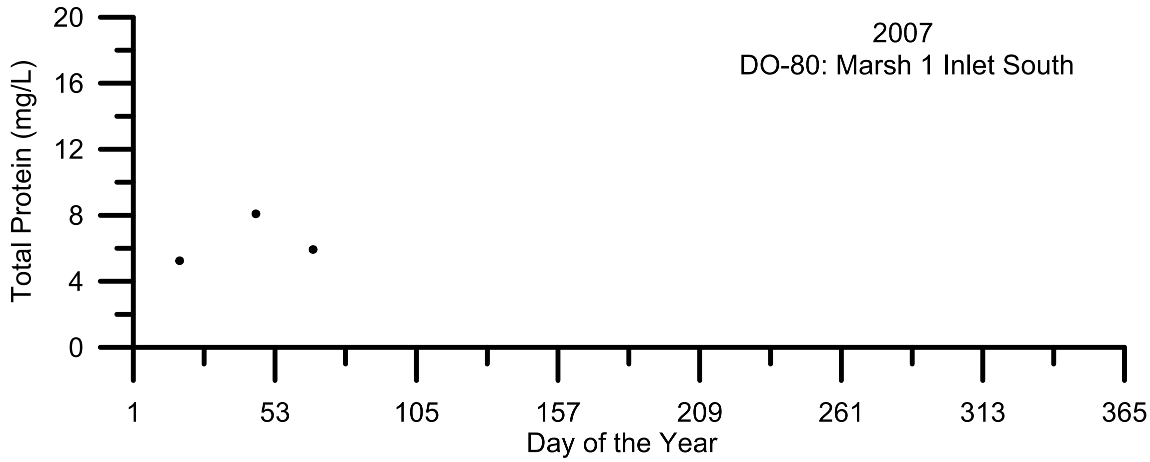

2005
DO-63: Inlet Canal C
Total Protein (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

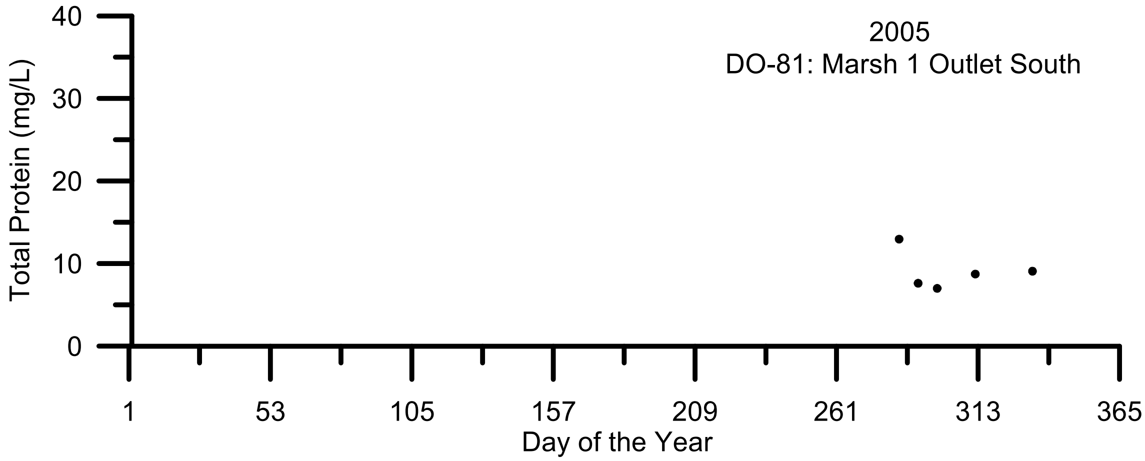

2006
DO-63: Inlet Canal C
Total Protein (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

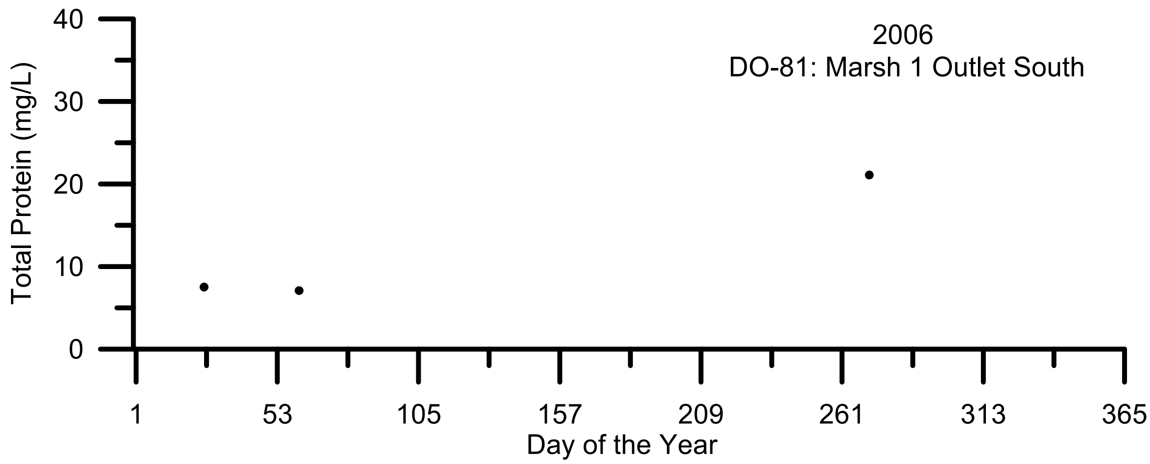

2007
DO-63: Inlet Canal C
Total Protein (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

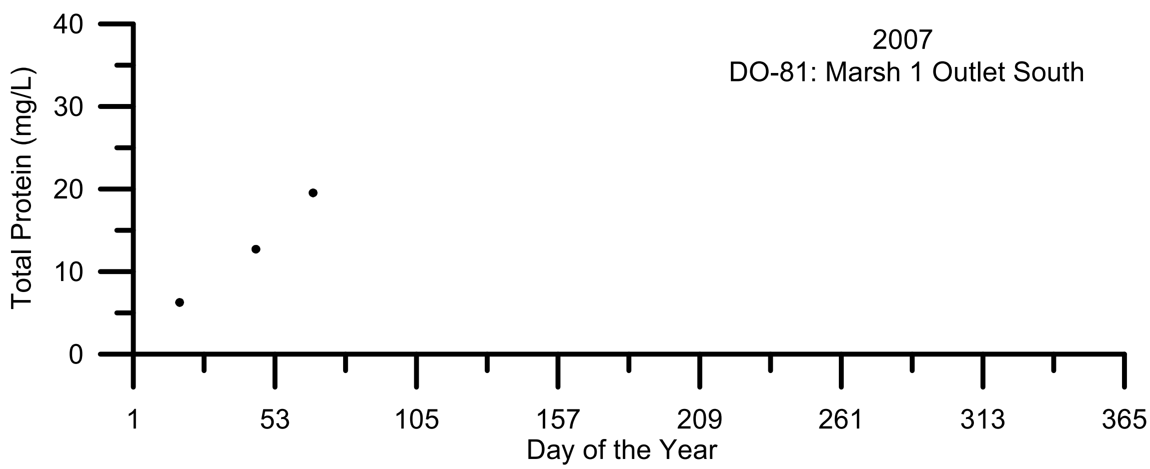

2005
DO-80: Marsh 1 Inlet South
Total Protein (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

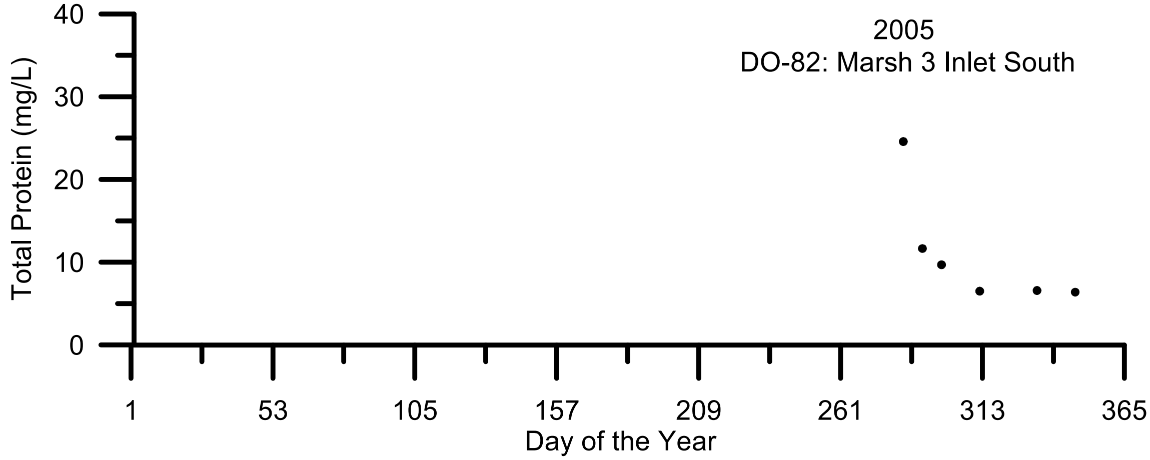

2006
DO-80: Marsh 1 Inlet South
Total Protein (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

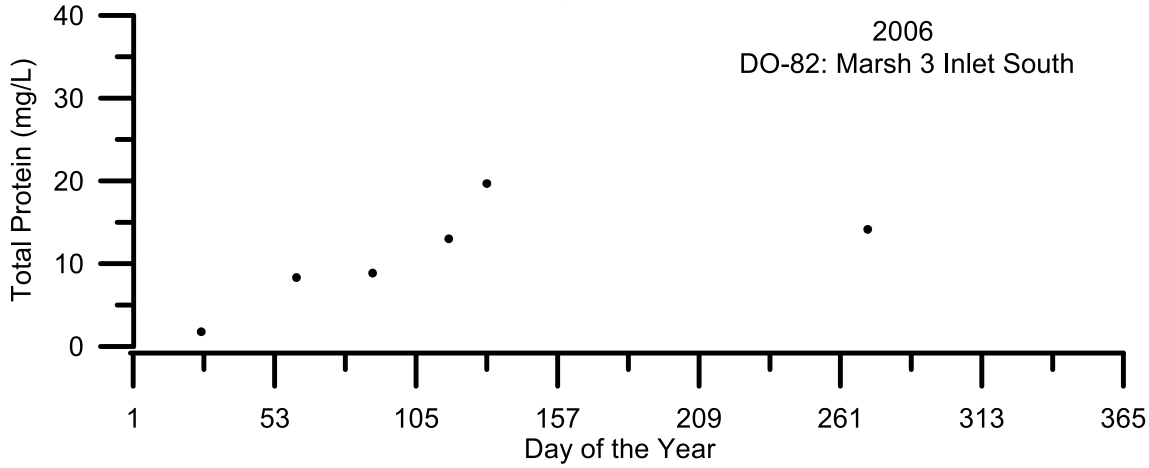

2007
DO-80: Marsh 1 Inlet South
Total Protein (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

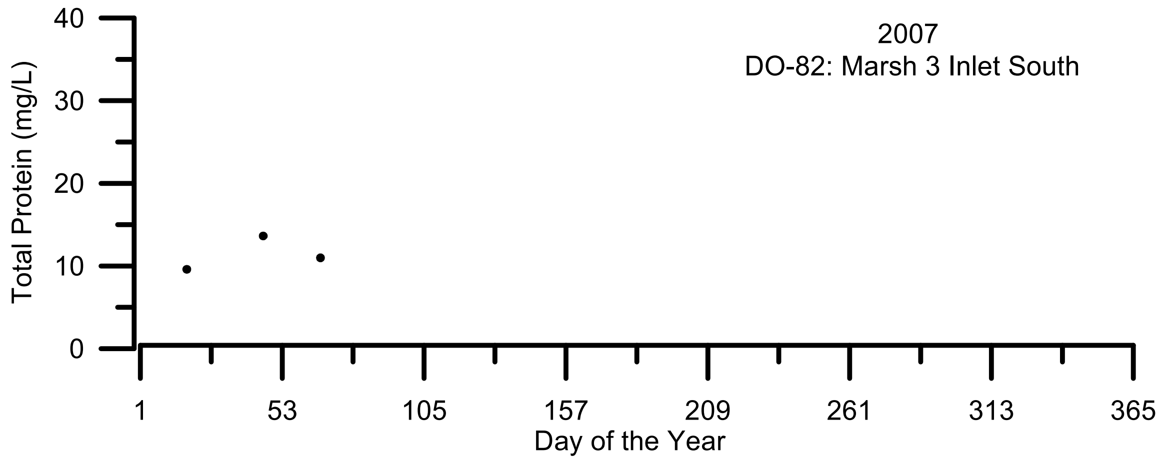

2005
DO-81: Marsh 1 Outlet South
Total Protein (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

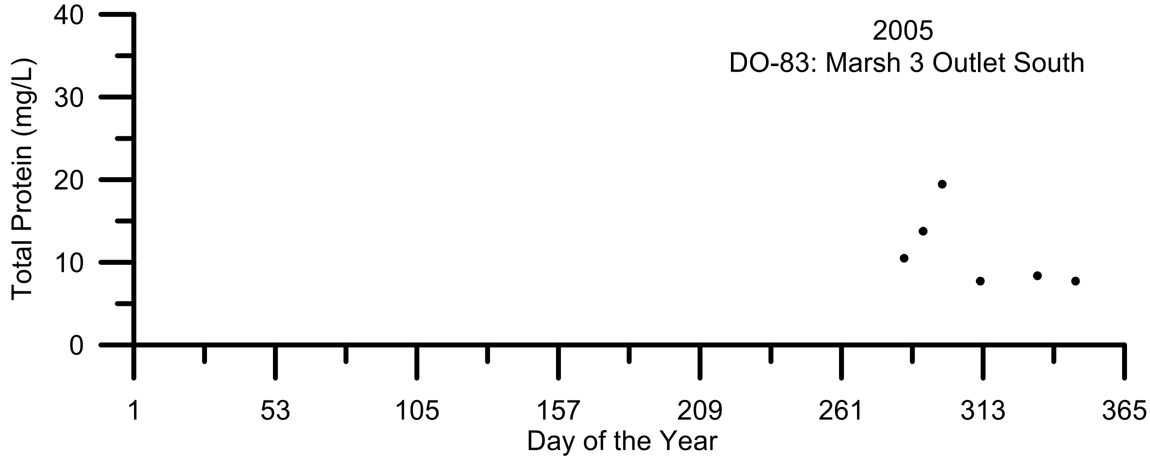

2006
DO-81: Marsh 1 Outlet South
Total Protein (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

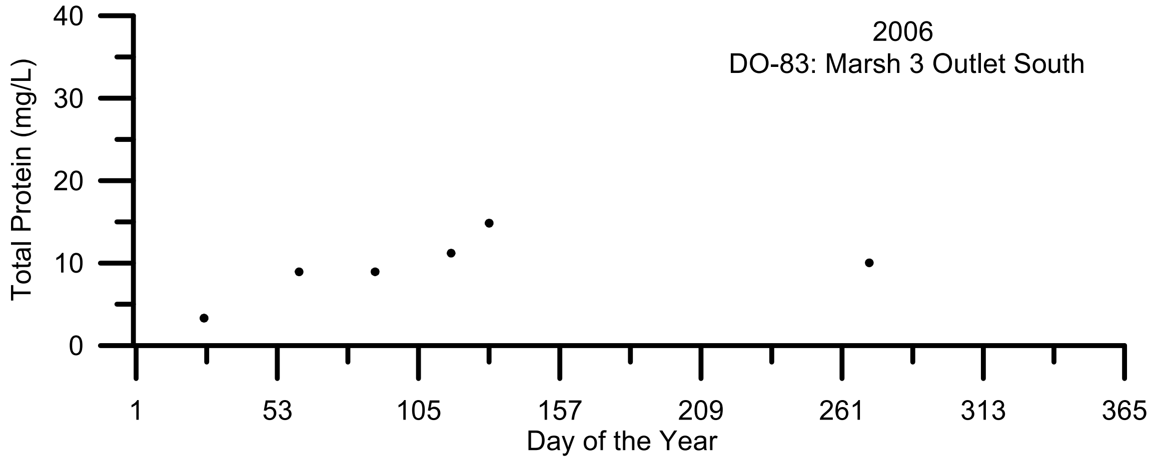

2007
DO-81: Marsh 1 Outlet South
Total Protein (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

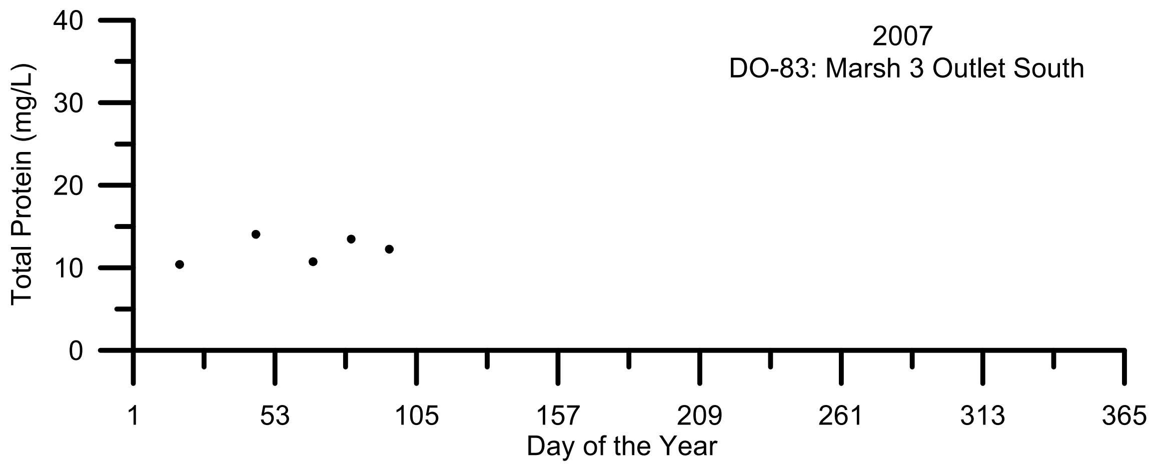

2005
DO-82: Marsh 3 Inlet South
Total Protein (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

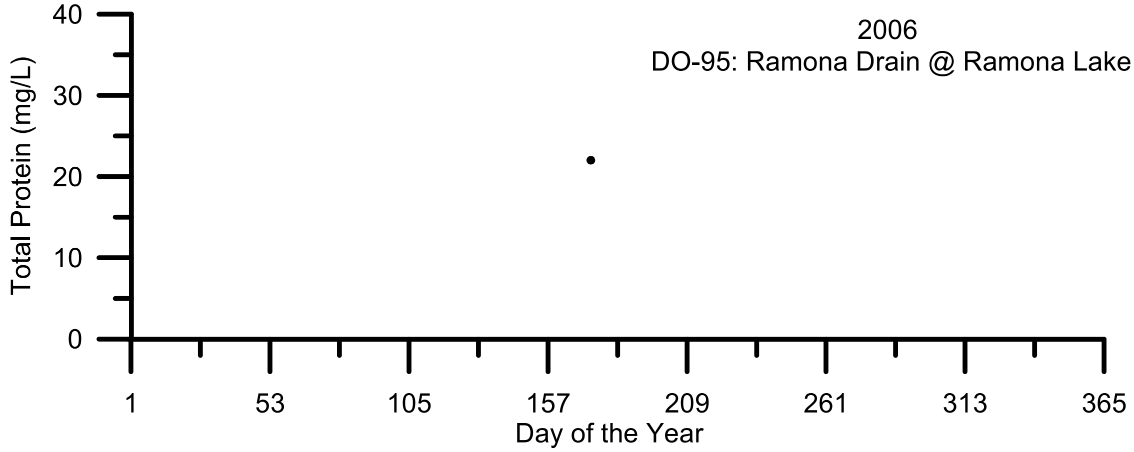

2006
DO-82: Marsh 3 Inlet South
Total Protein (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-82: Marsh 3 Inlet South
Total Protein (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

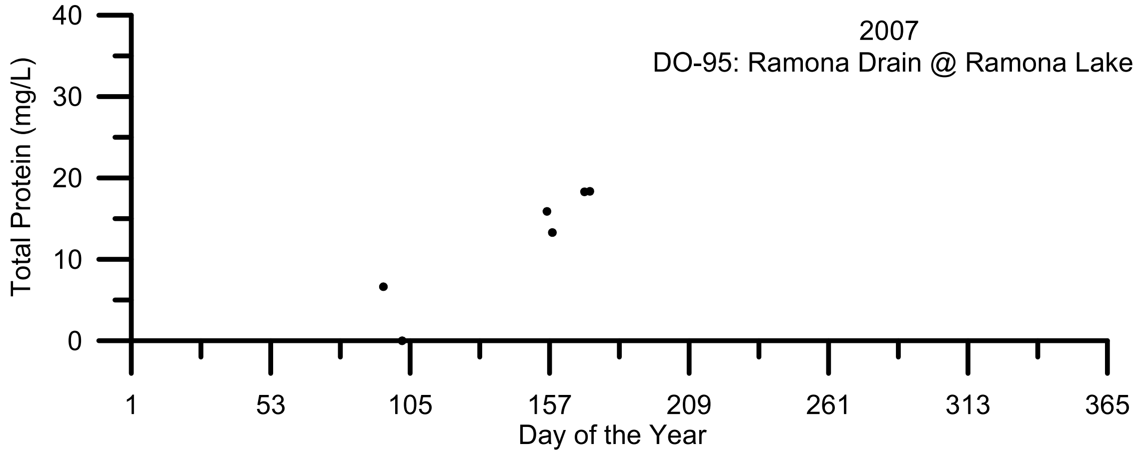

2005
DO-83: Marsh 3 Outlet South
Total Protein (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-83: Marsh 3 Outlet South
Total Protein (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-83: Marsh 3 Outlet South
Total Protein (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year



2006
DO-95: Ramona Drain @ Ramona Lake
Total Protein (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year



2007
DO-95: Ramona Drain @ Ramona Lake
Total Protein (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

Analysis of Total Organic Carbon Concentrations in the San Joaquin River Watershed 2005-2007

Remie Burks
Chelsea Spier
Sharon Borglin
Jeremy Hanlon
Justin Graham
William Stringfellow

February 2008

Environmental Engineering Research Program
University of the Pacific
3601 Pacific Avenue, Sears Hall
Stockton CA 95211

Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 sampling locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report presents temporal plots of total organic carbon (TOC) for all sites sampled in the SJR from 2005-2007.

Methods

Field sampling consisted of collecting water samples, measuring water quality with a YSI Sonde 6600 with MDS650 hand-held display, and recording of field conditions at sites within the study area per *EERP Field Protocol Book* (Graham, 2008).

Water samples were collected in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN) in accordance with requirements for different lab analysis and volume requirements.

Samples were immediately stored at 4°C after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the lab on the day of sampling.

Samples were received by the laboratory the same day they were sampled and stored at 4°C until filtering and analysis. Samples were collected, preserved, stored, and analyzed by methods outlined in *Standard Methods for the Analysis of Water and Wastewater*, (APHA, 2005, 1998). Total organic carbon (TOC) was analyzed on a Teledyne-Tekmar Apollo 9000 (Mason, OH) by high temperature combustion according to SM 5310 B (APHA, 2005) and quantified on using a NDIR detector. TOC samples were preserved < pH 2 with concentrated H_3PO_4 and stored at 4°C until analysis. The limits of detection for TOC and DOC is 1.00mg/L C and for IC 5.00mg/L.

Results and Discussion

This analysis was preformed routinely over the years 2005-2007 using two different Apollo 9000HS instruments. This analysis had a 99.19% passage rate for all QA parameters over the three year period and a 85.71% passage rate for proficiency check samples during that time (Borglin et. al., 2008). These high sensitivity instruments are challenging to maintain and on a few occasions sample sets were analyzed by outside laboratories due to malfunctions of the instrument that could not be repaired within the holding time for these samples.

References

Stringfellow, W.T., et al., (2008), *Evaluation of Vegetated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley*, University of the Pacific, Stockton, CA

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008), *EERP Field Protocol Book*, University of the Pacific, Stockton, CA.

Borglin, S., W. Stringfellow, J. Hanlon. (2005), Standard *Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project*, LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA

American Public Health Association, (2005), *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, Washington, D.C.

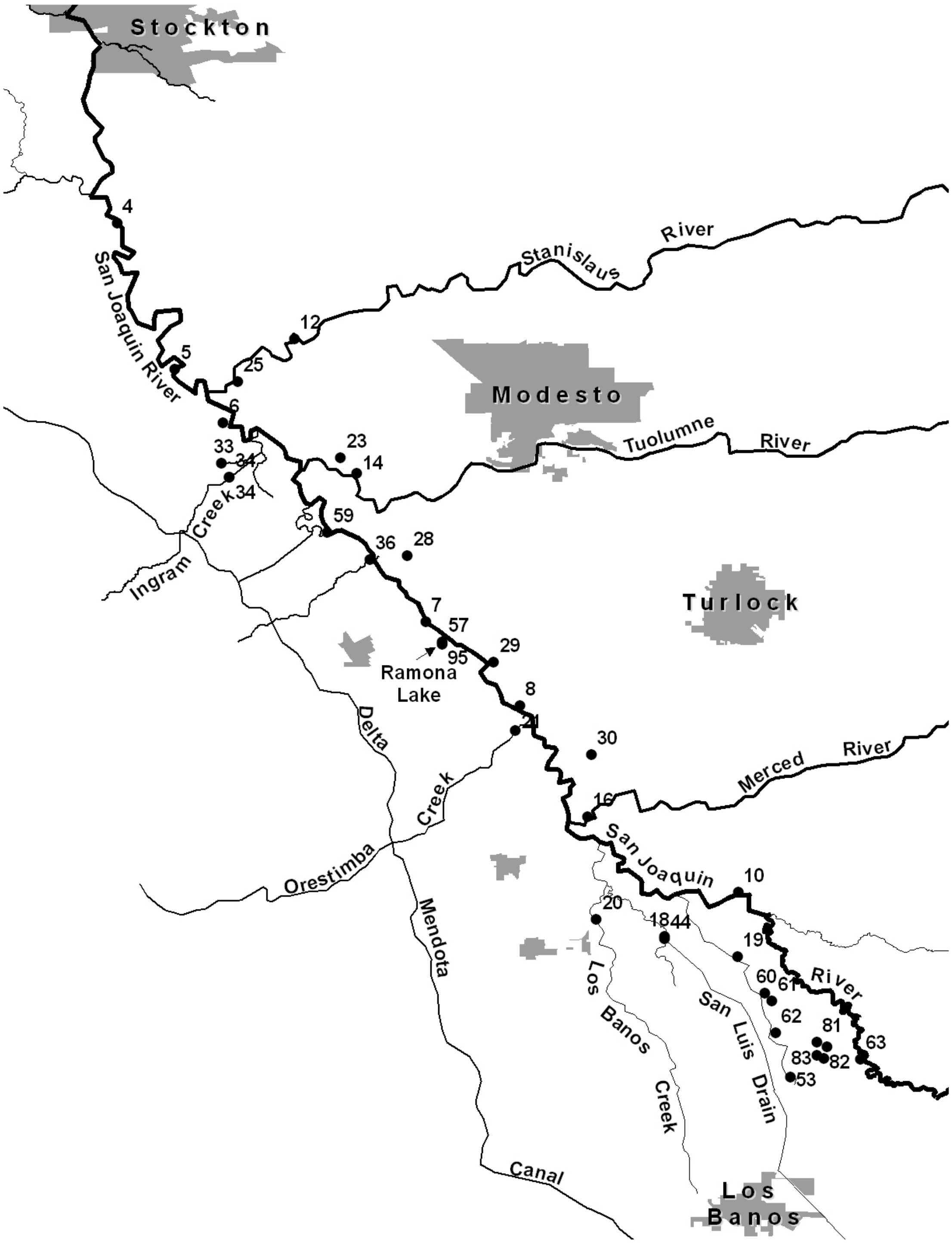
Borglin, S.E., Burks, R.D., Hanlon, J.S., Stringfellow, W.T. (2008*) EERP Lab Protocol Book*, University of the Pacific, Stockton, CA.

YSI Environmental Operations Manual, (2005), 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

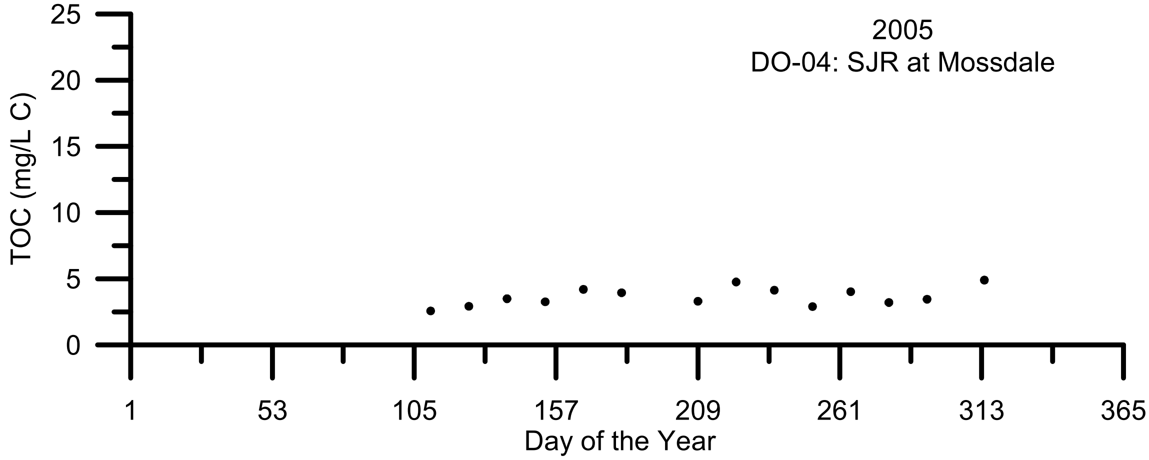
Table 1: EERP Sampling Site List

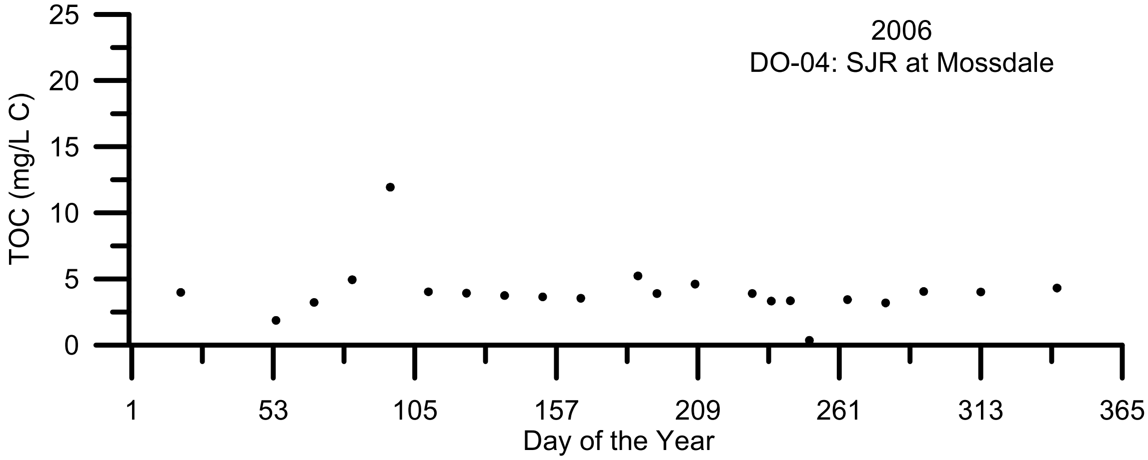
DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
53	**Salt Slough at Wolfsen Road**	Wetland
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
60	**Moffit 1 South**	Wetland
61	**Deadman's Slough**	Wetland
62	**Mallard Slough**	Wetland
63	**Inlet C Canal**	Wetland
80	**South Marsh-1-Inlet**	Wetland
81	**South Marsh-1-Outlet**	Wetland
82	**South Marsh-3-Inlet**	Wetland
83	**South Marsh-3-Outlet**	Wetland
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

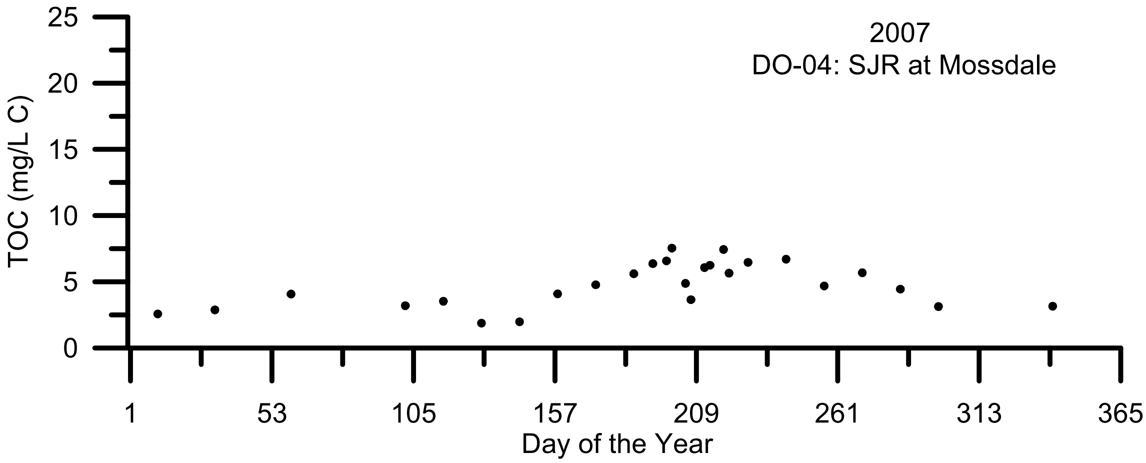
Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

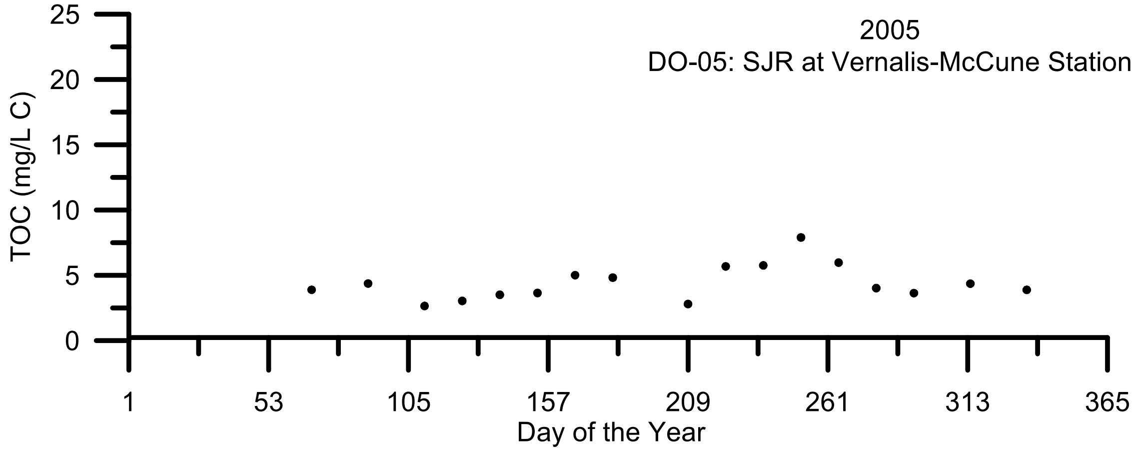


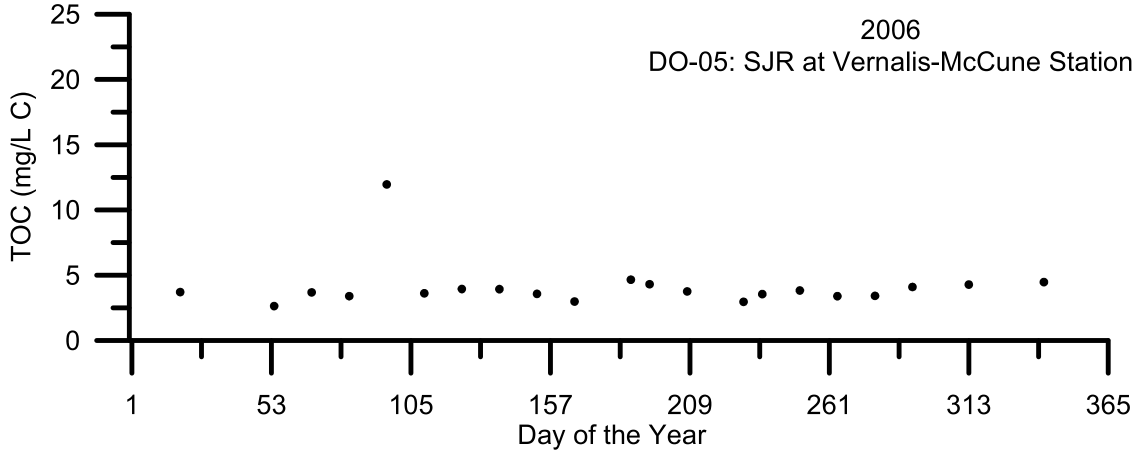
Figures 2 -101: Temporal Plots of Total Organic Carbon Concentrations By Site ID

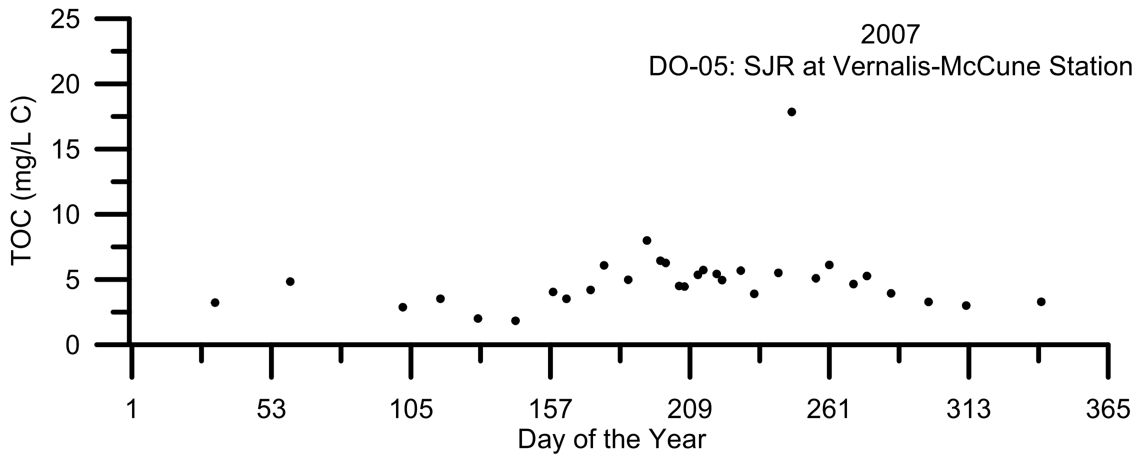

2005
DO-04: SJR at Mossdale
TOC (mg/L C)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

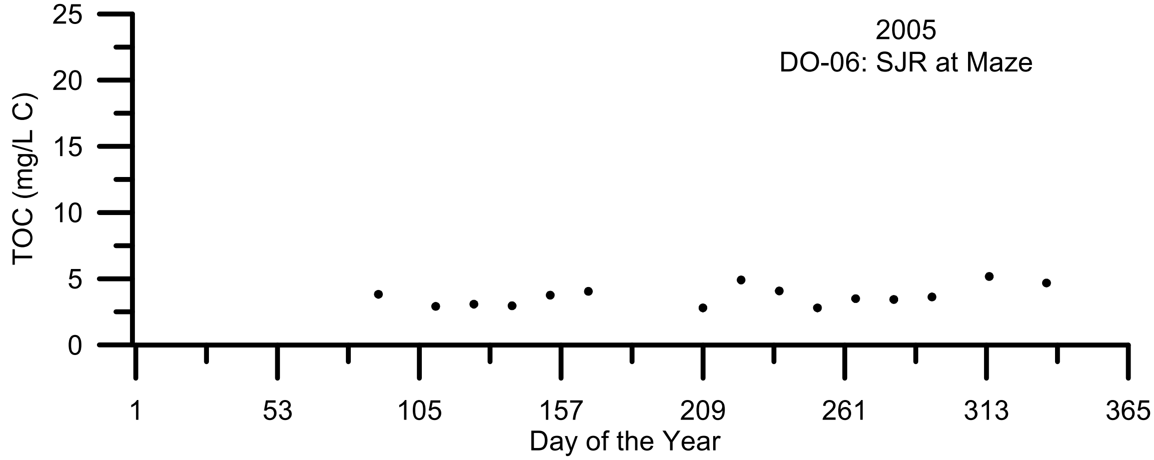

2006
DO-04: SJR at Mossdale
TOC (mg/L C)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

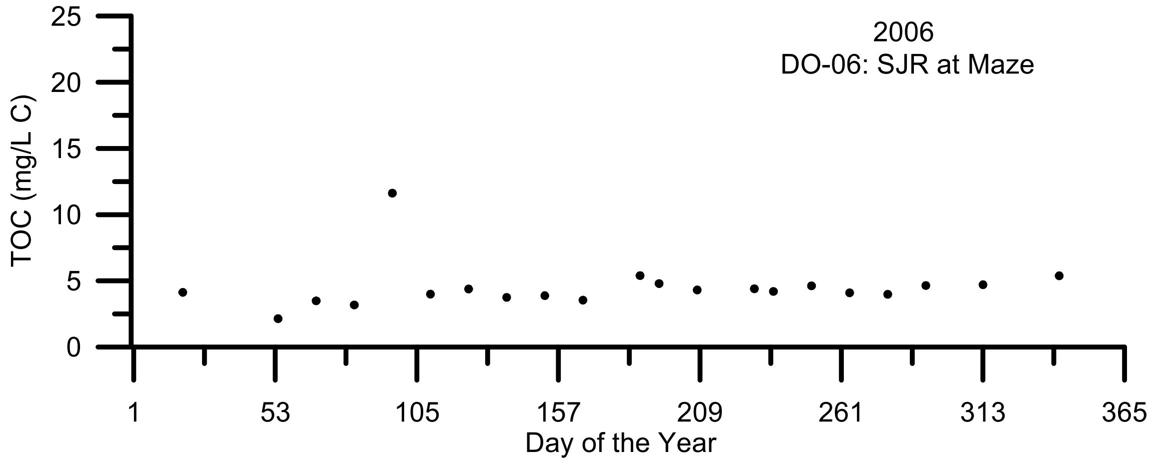

2007
DO-04: SJR at Mossdale
TOC (mg/L C)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

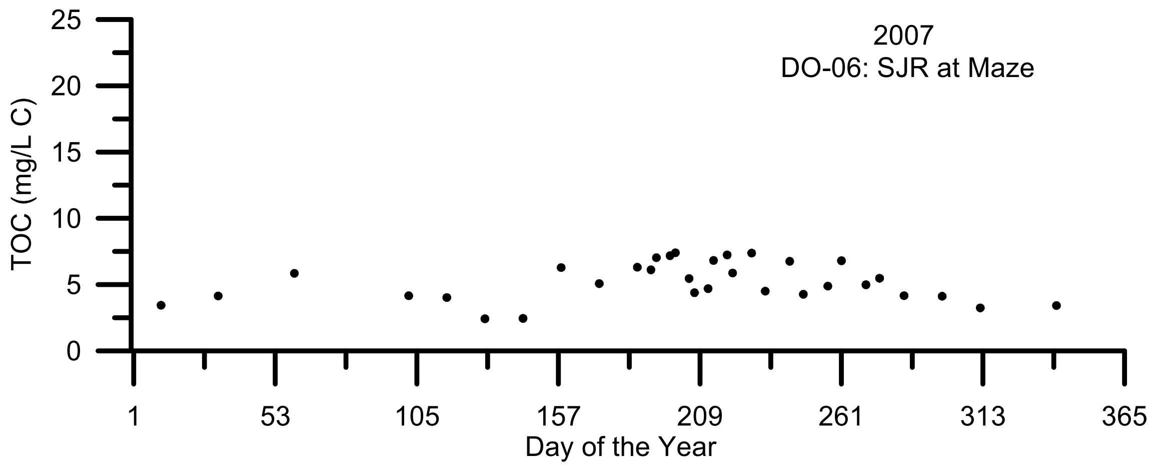

2005
DO-05: SJR at Vernalis-McCune Station
TOC (mg/L C)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

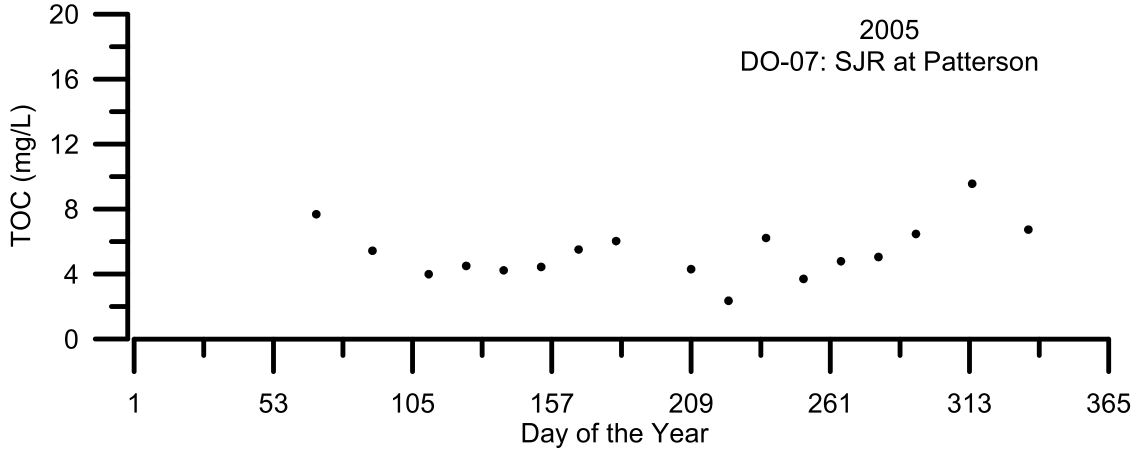

2006
DO-05: SJR at Vernalis-McCune Station
TOC (mg/L C)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

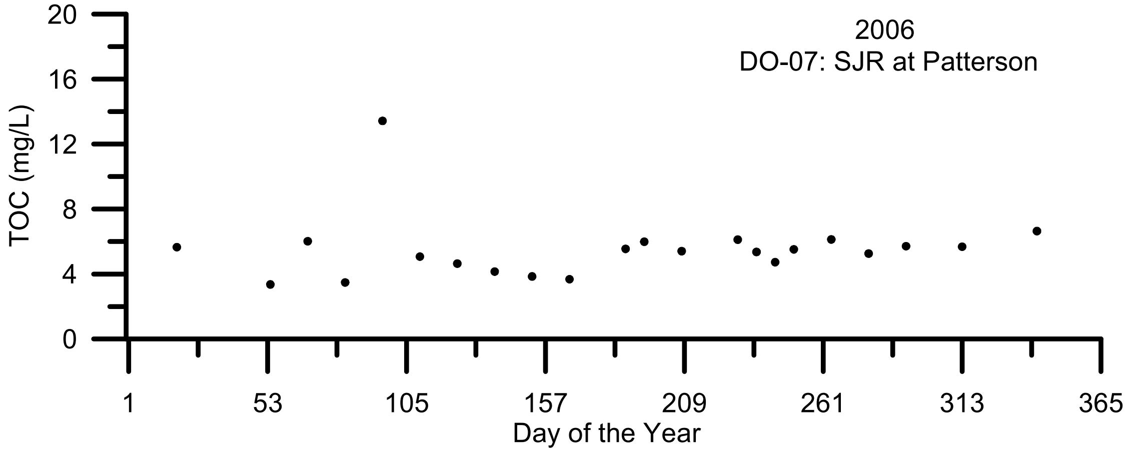

2007
DO-05: SJR at Vernalis-McCune Station
TOC (mg/L C)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

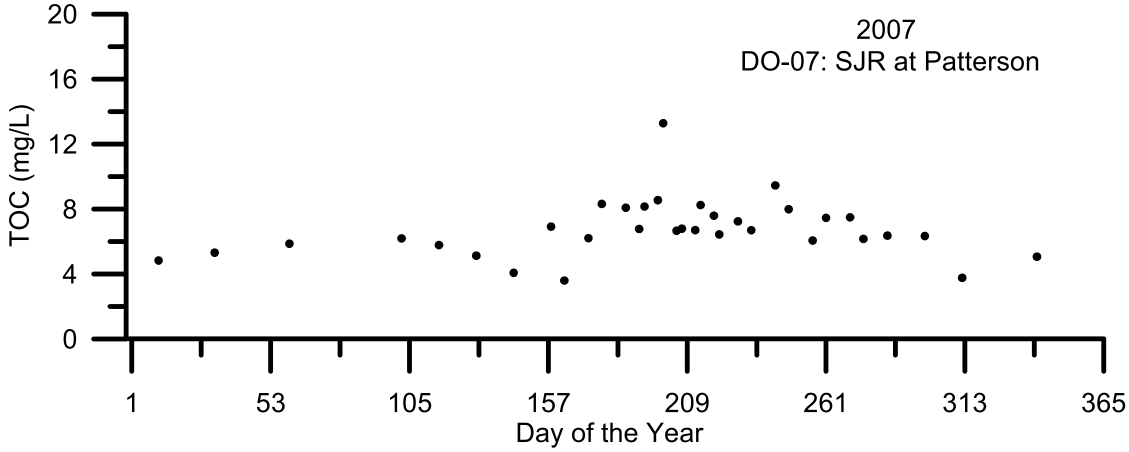

2005
DO-06: SJR at Maze
TOC (mg/L C)
25
20
15
10
5
0
1
53
105
157
209
261
313
365
Day of the Year

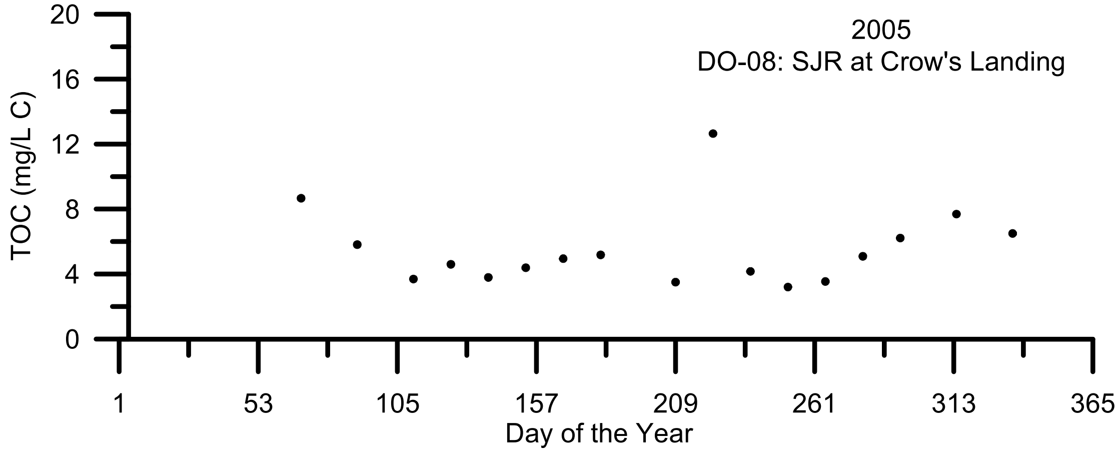

2006
DO-06: SJR at Maze
TOC (mg/L C)
25
20
15
10
5
0
1
53
105
157
209
261
313
365
Day of the Year

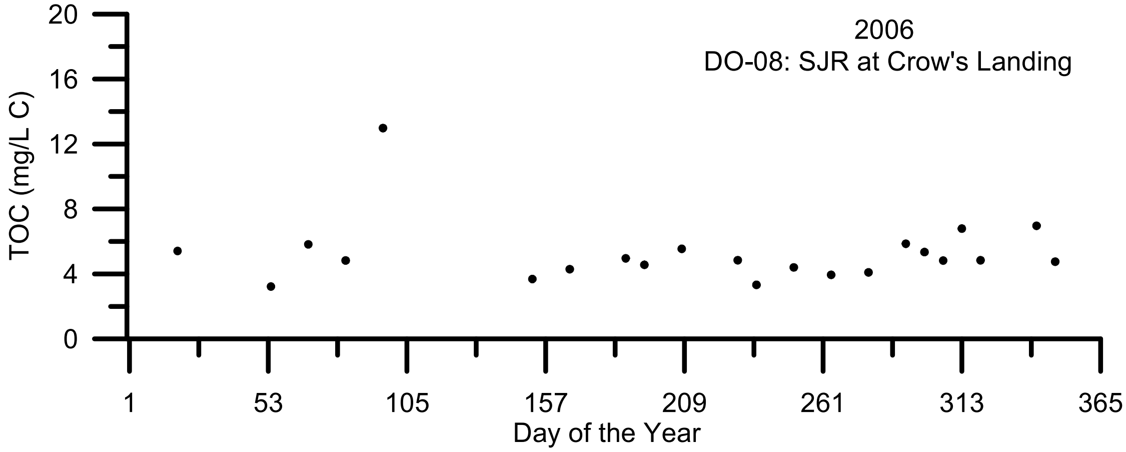

2007
DO-06: SJR at Maze
TOC (mg/L C)
25
20
15
10
5
0
1
53
105
157
209
261
313
365
Day of the Year

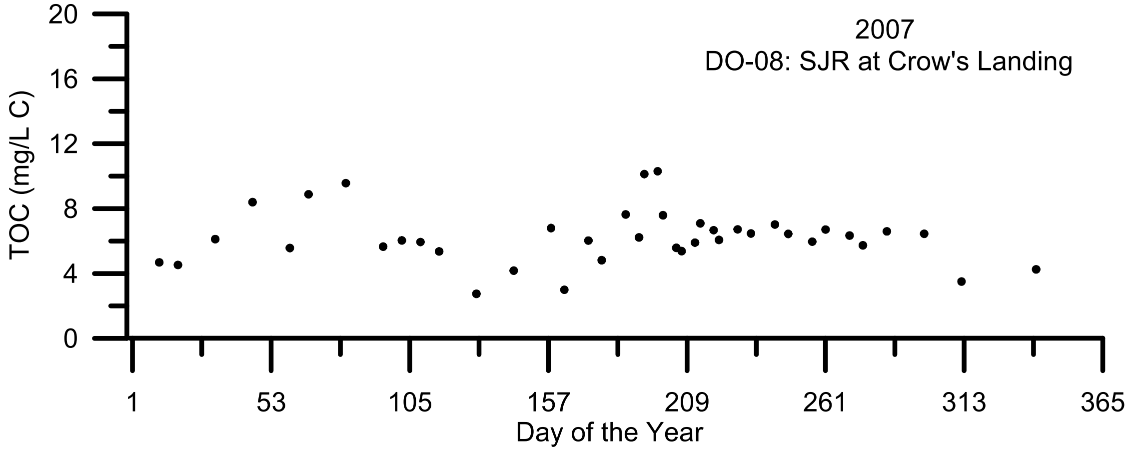

2005
DO-07: SJR at Patterson
TOC (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

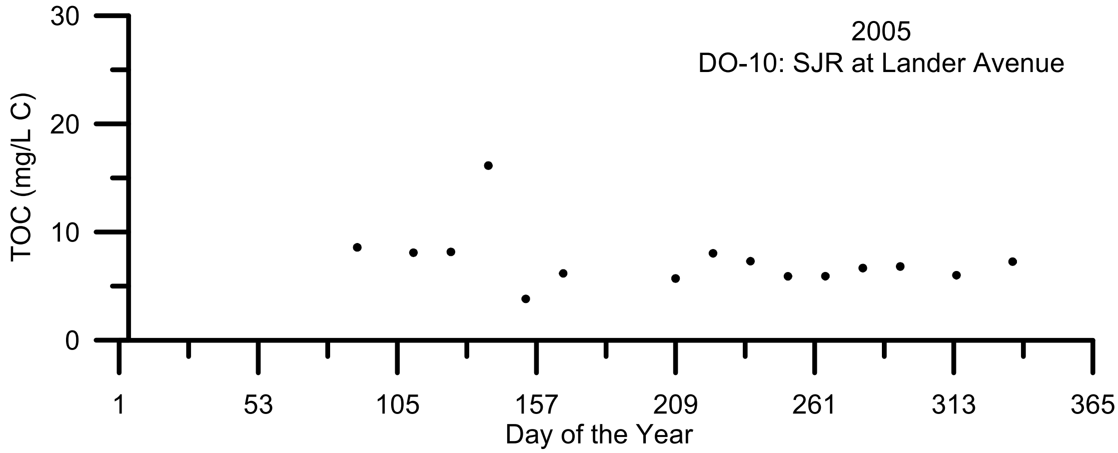

2006
DO-07: SJR at Patterson
TOC (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-07: SJR at Patterson
TOC (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

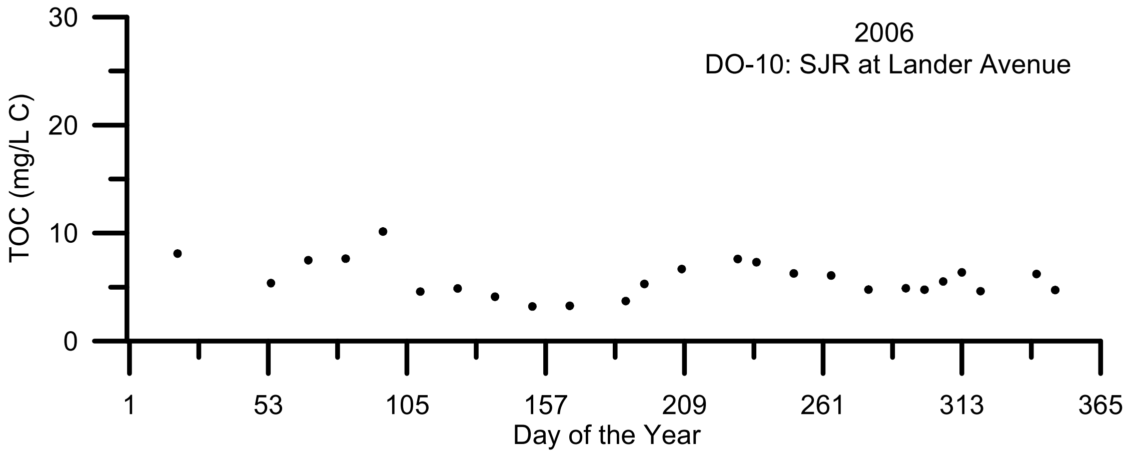

2005
DO-08: SJR at Crow's Landing
TOC (mg/L C)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-08: SJR at Crow's Landing
TOC (mg/L C)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

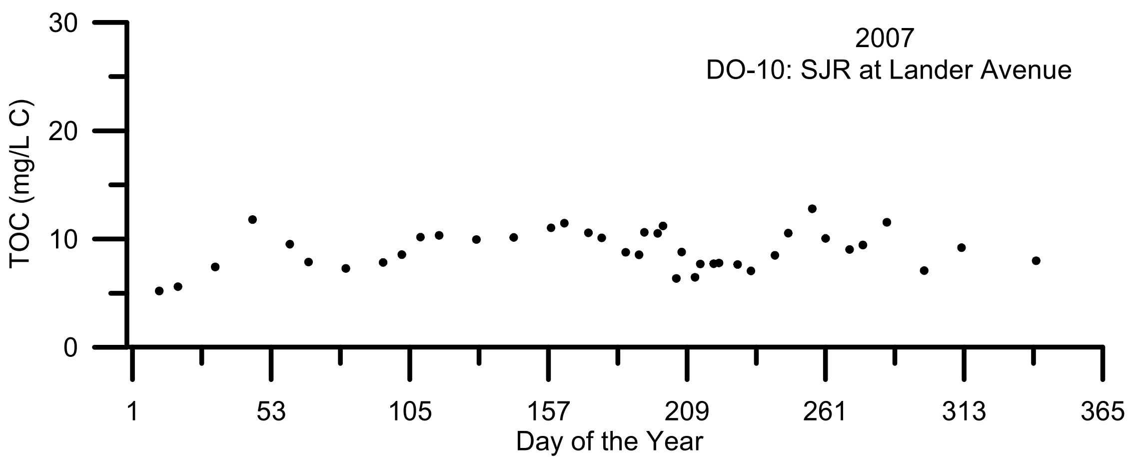

2007
DO-08: SJR at Crow's Landing
TOC (mg/L C)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year



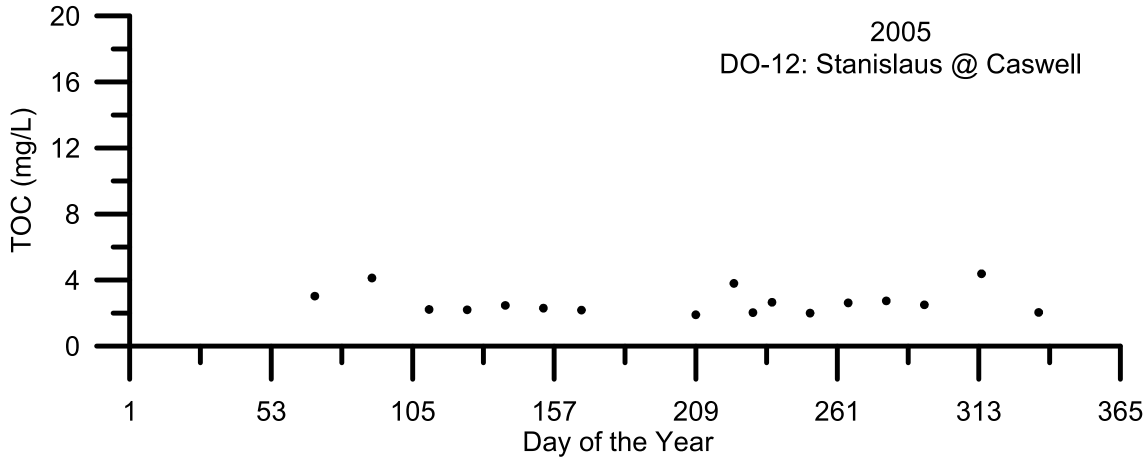
2005
DO-10: SJR at Lander Avenue
TOC (mg/L C)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

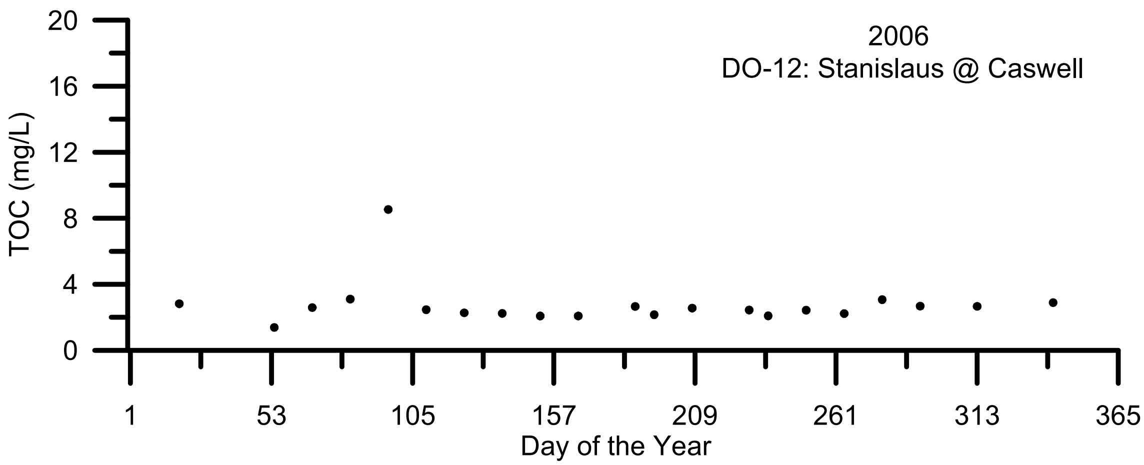


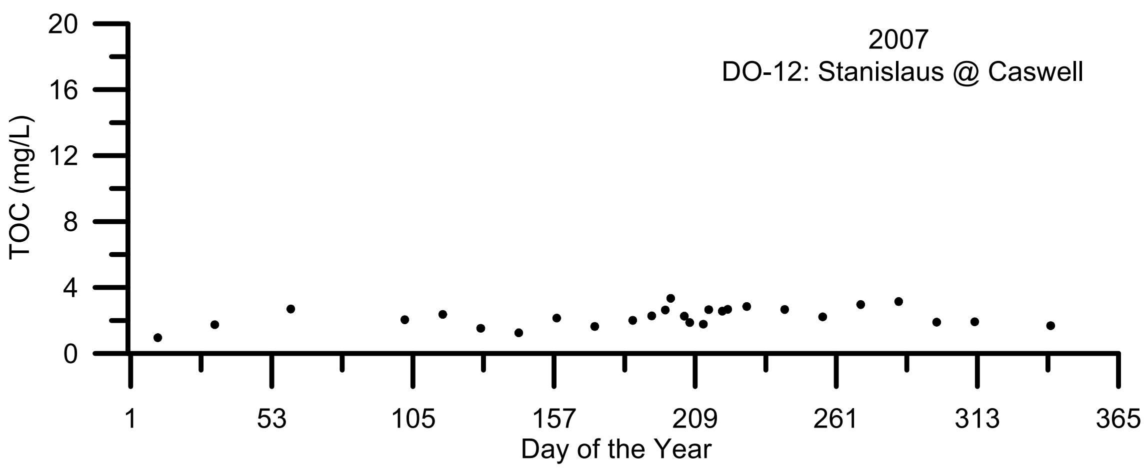
2006
DO-10: SJR at Lander Avenue
TOC (mg/L C)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

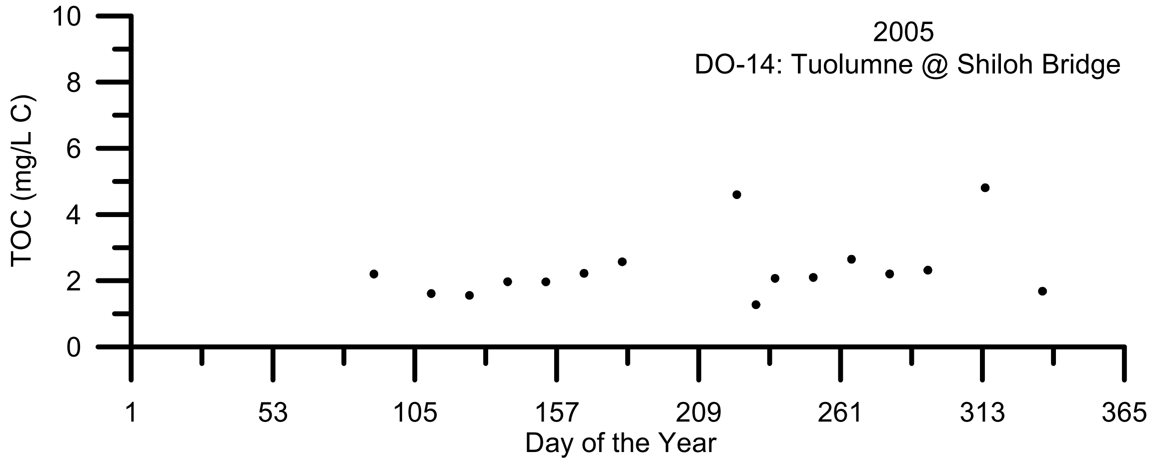


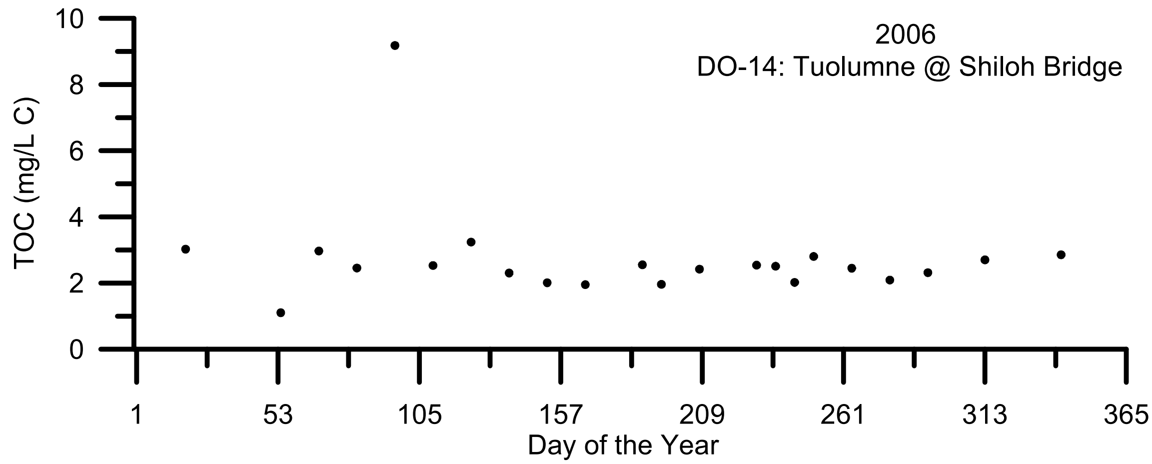
2007
DO-10: SJR at Lander Avenue
TOC (mg/L C)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

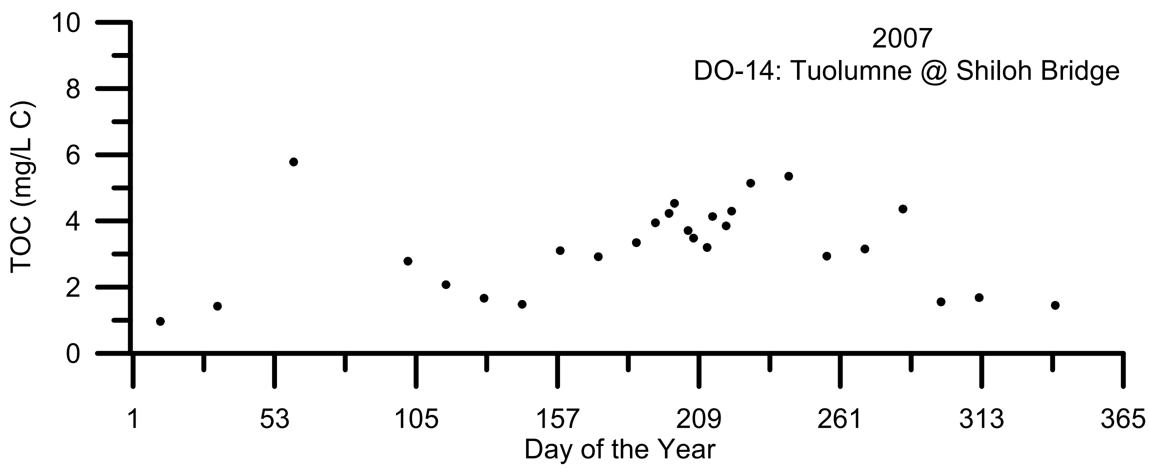

2005
DO-12: Stanislaus @ Caswell
TOC (mg/L)
Day of the Year

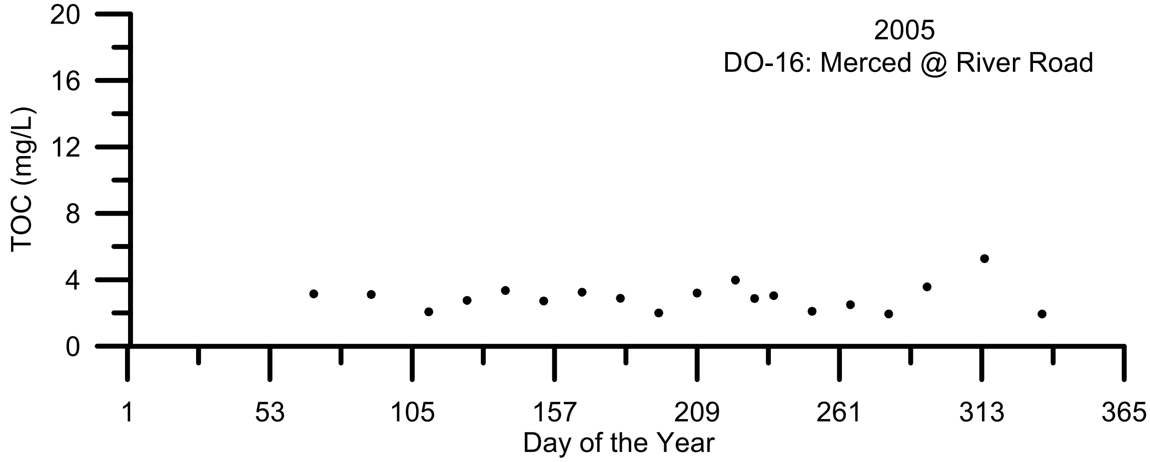

2006
DO-12: Stanislaus @ Caswell
TOC (mg/L)
Day of the Year

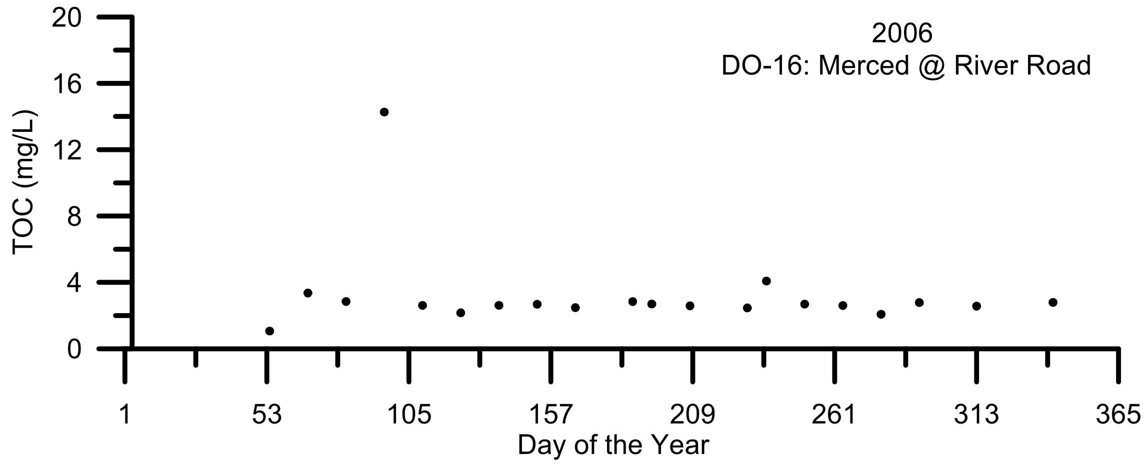

2007
DO-12: Stanislaus @ Caswell
TOC (mg/L)
Day of the Year

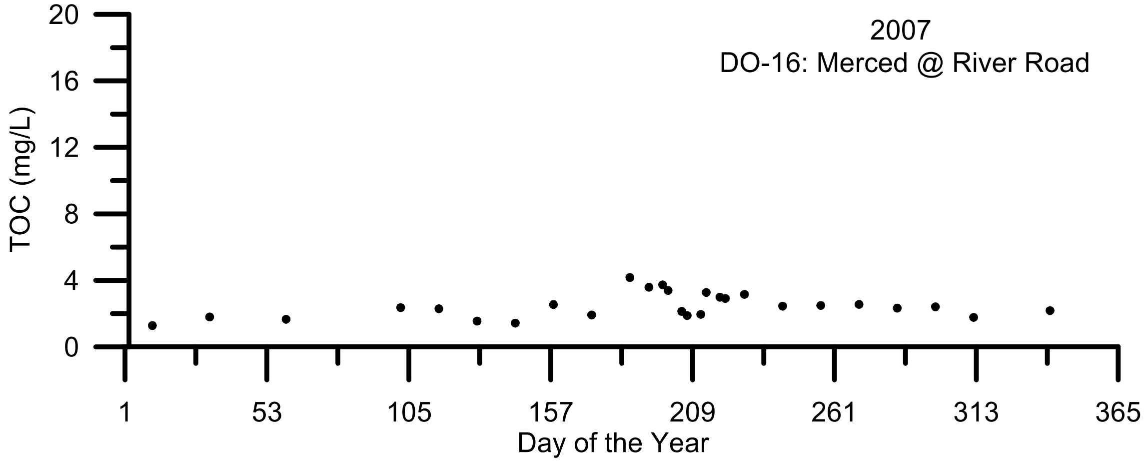

2005
DO-14: Tuolumne @ Shiloh Bridge
TOC (mg/L C)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

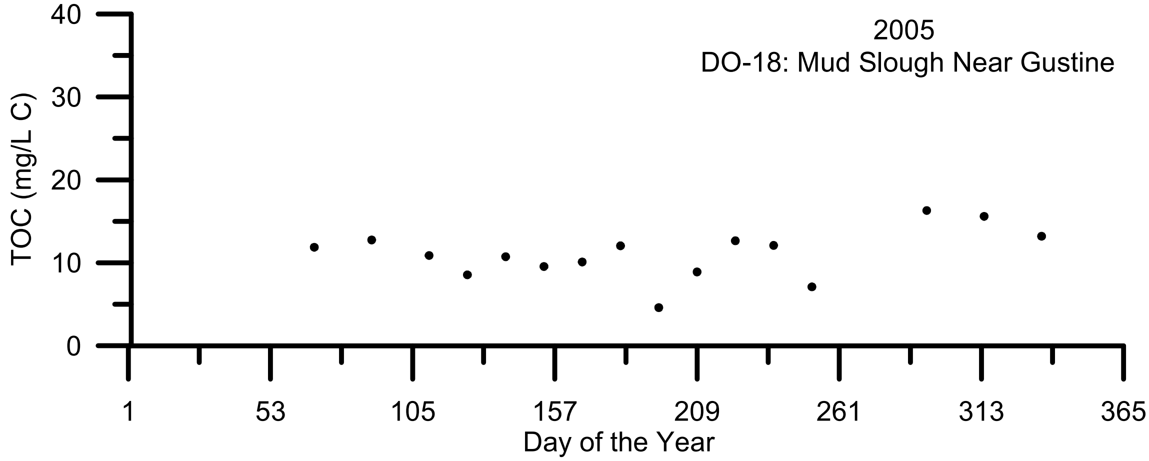

2006
DO-14: Tuolumne @ Shiloh Bridge
TOC (mg/L C)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

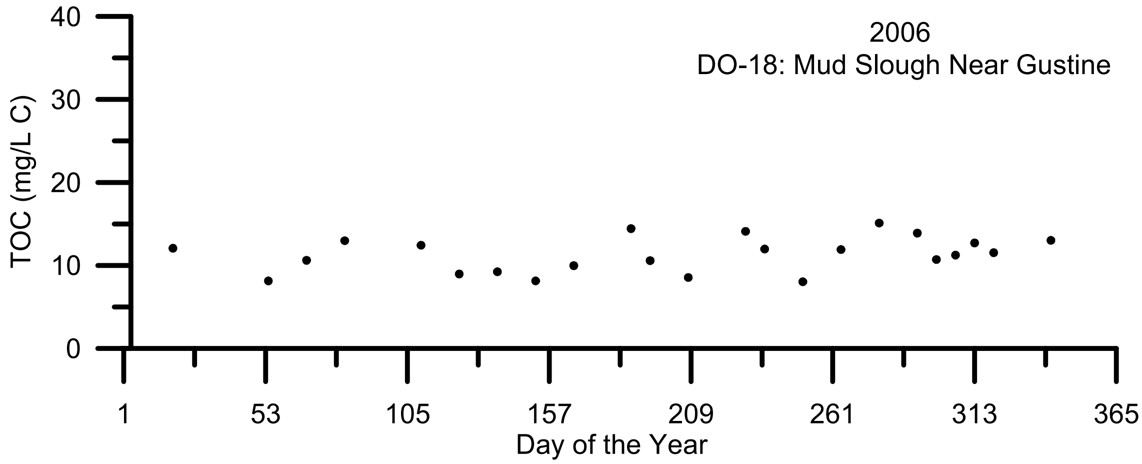

2007
DO-14: Tuolumne @ Shiloh Bridge
TOC (mg/L C)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

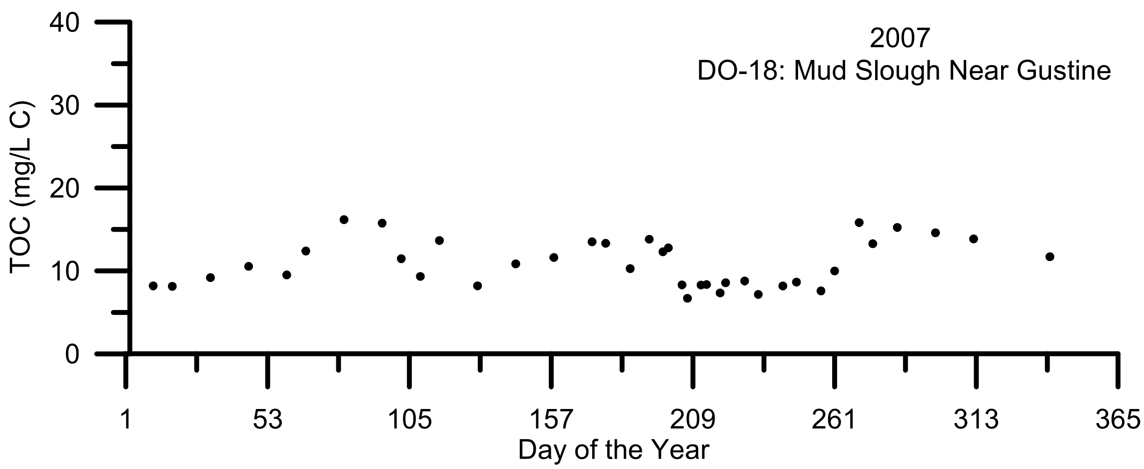

2005
DO-16: Merced @ River Road
TOC (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

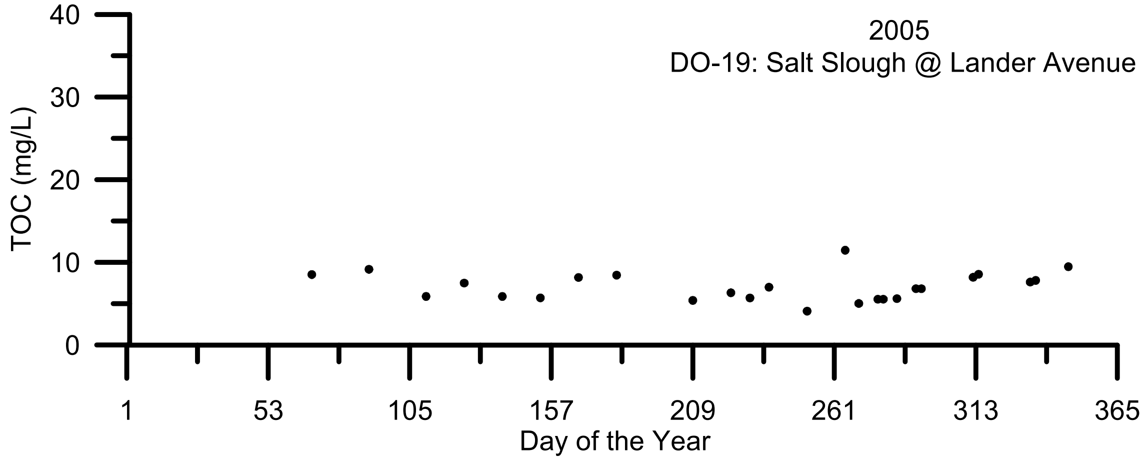

2006
DO-16: Merced @ River Road
TOC (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

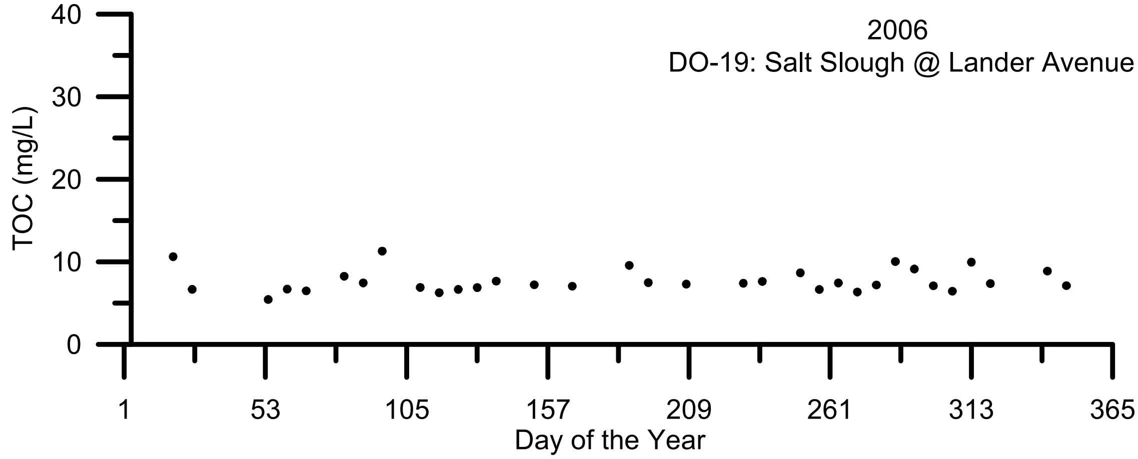

2007
DO-16: Merced @ River Road
TOC (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

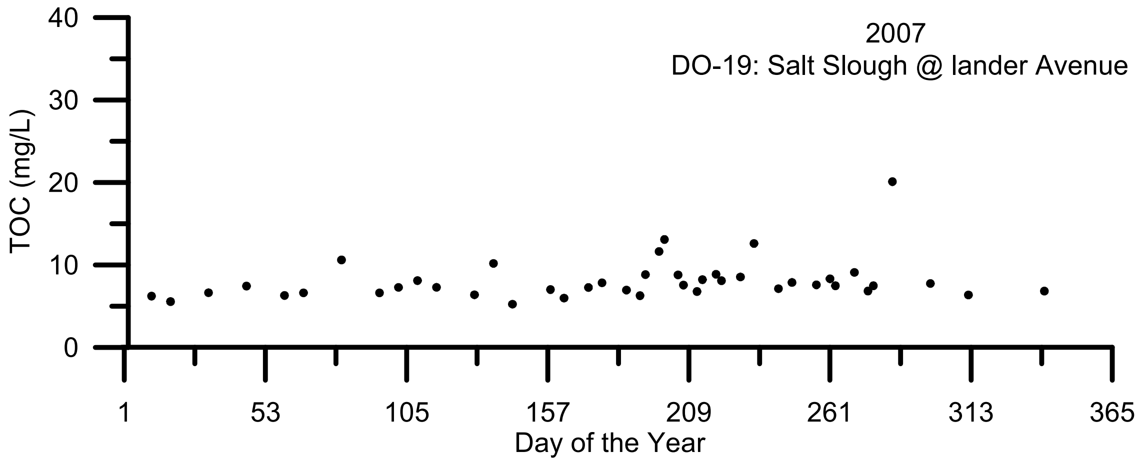

2005
DO-18: Mud Slough Near Gustine
TOC (mg/L C)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

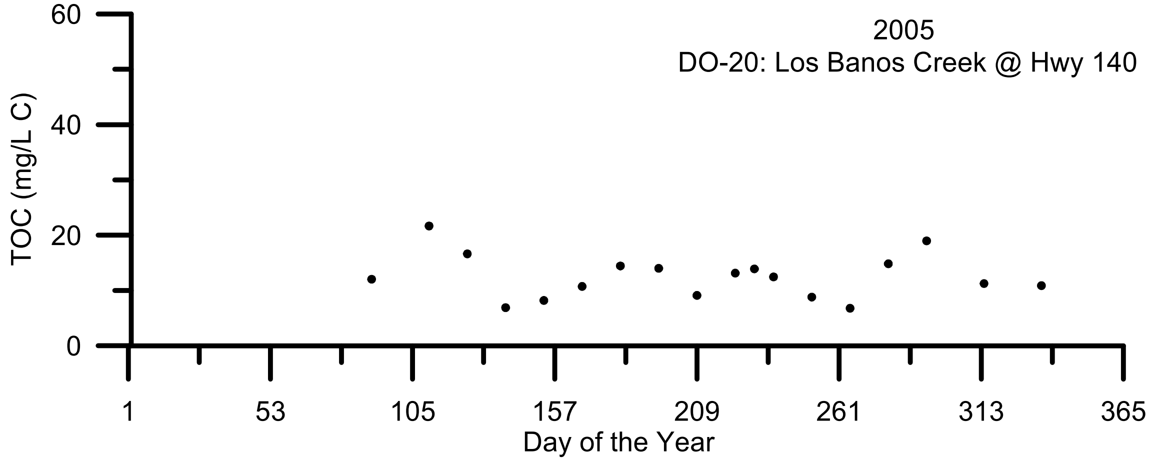

2006
DO-18: Mud Slough Near Gustine
TOC (mg/L C)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

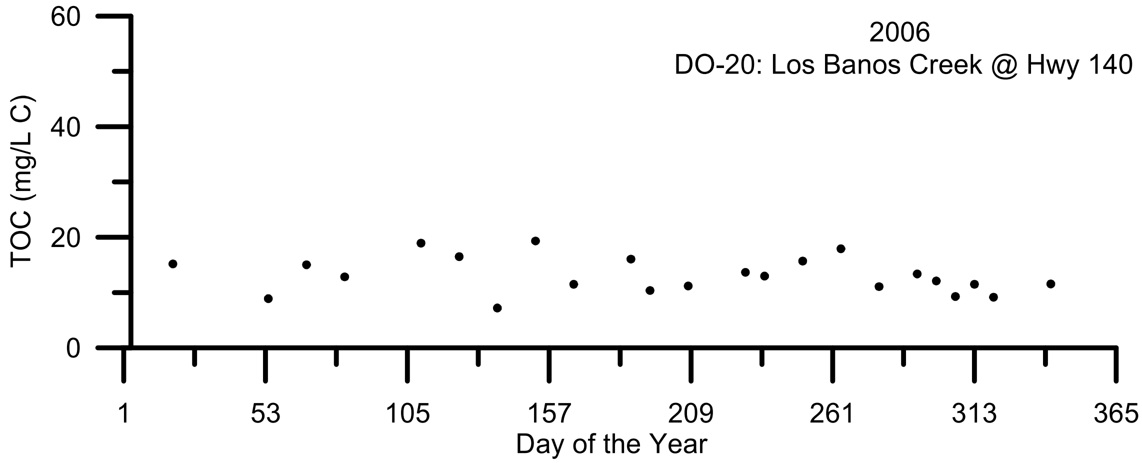

2007
DO-18: Mud Slough Near Gustine
TOC (mg/L C)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

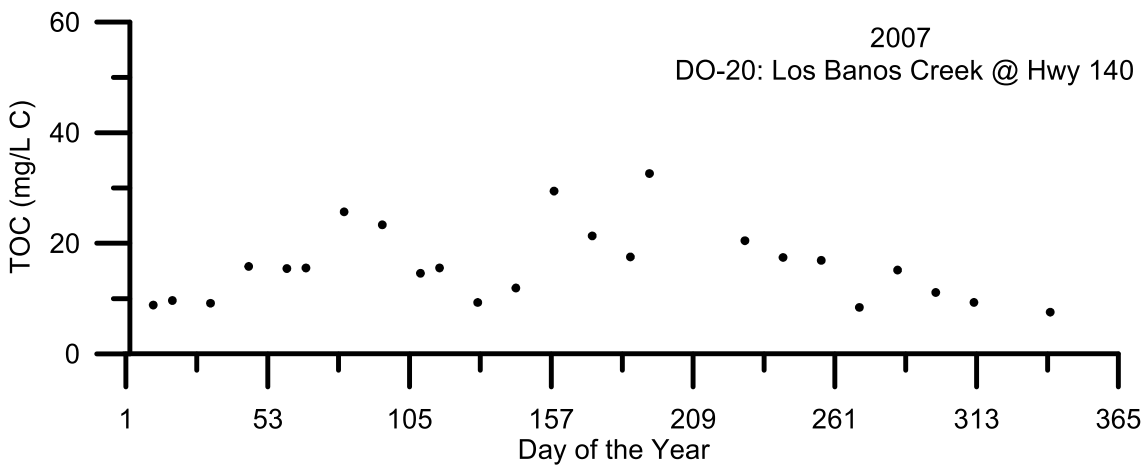

2005
DO-19: Salt Slough @ Lander Avenue
TOC (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

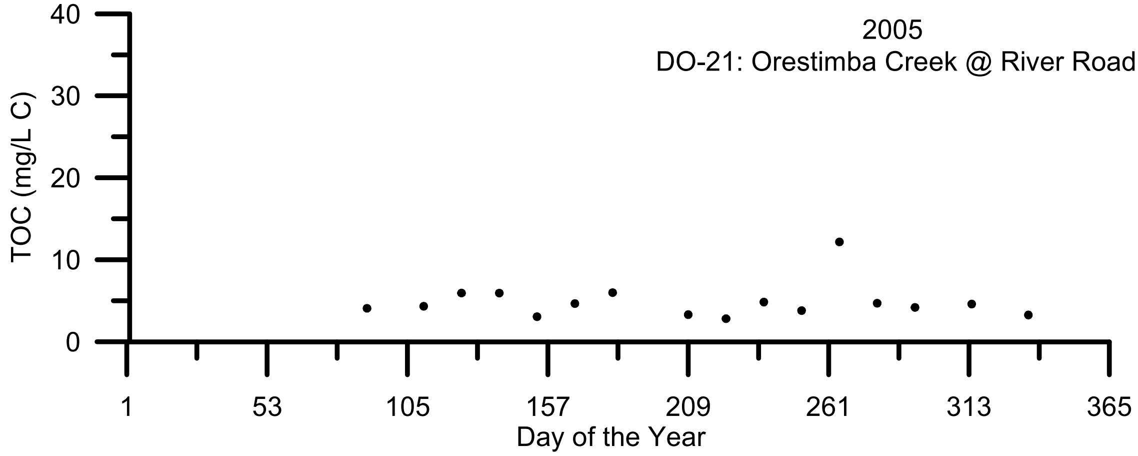

2006
DO-19: Salt Slough @ Lander Avenue
TOC (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

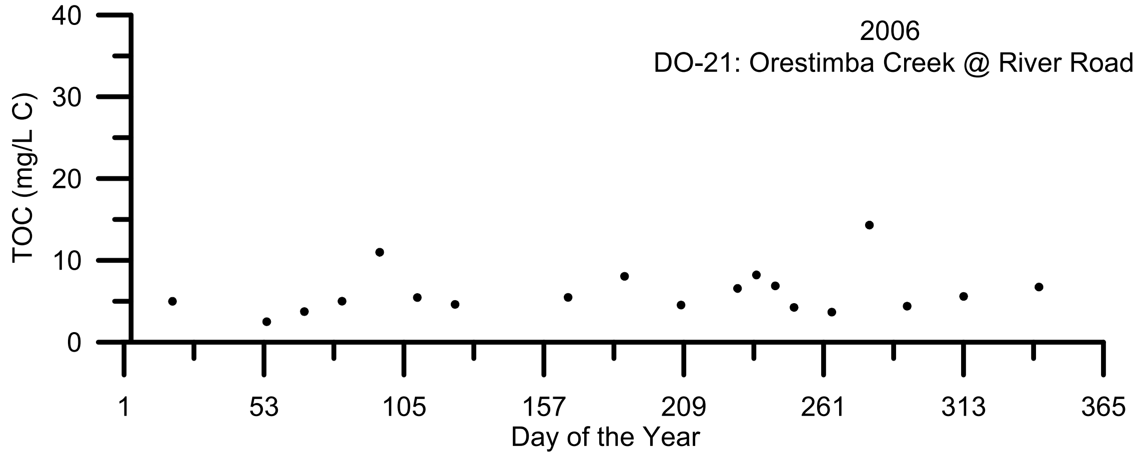

2007
DO-19: Salt Slough @ lander Avenue
TOC (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

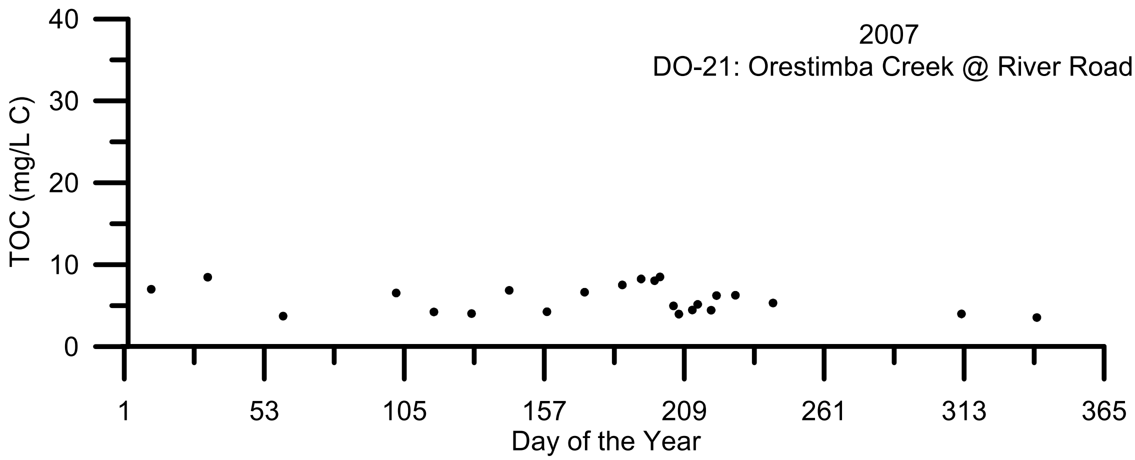

2005
DO-20: Los Banos Creek @ Hwy 140
TOC (mg/L C)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

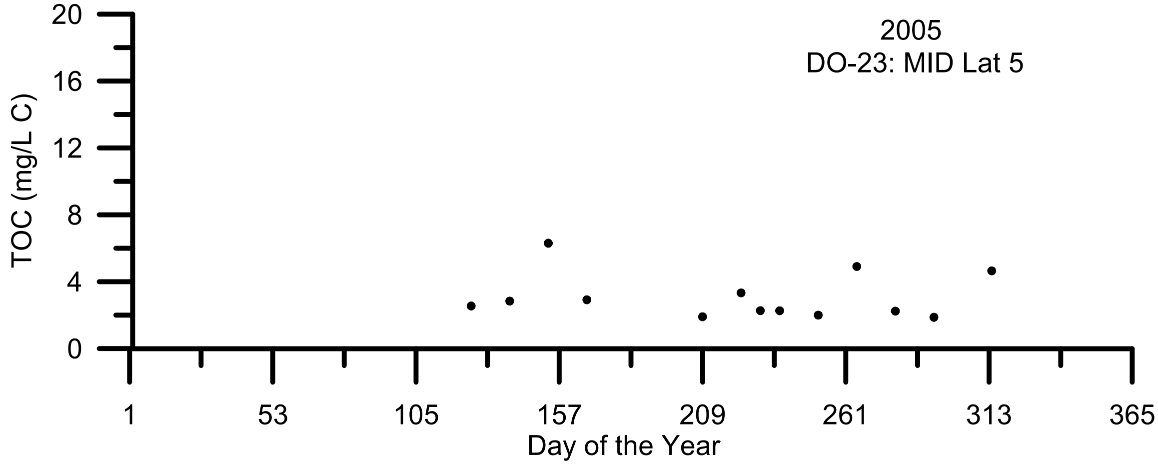

2006
DO-20: Los Banos Creek @ Hwy 140
TOC (mg/L C)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

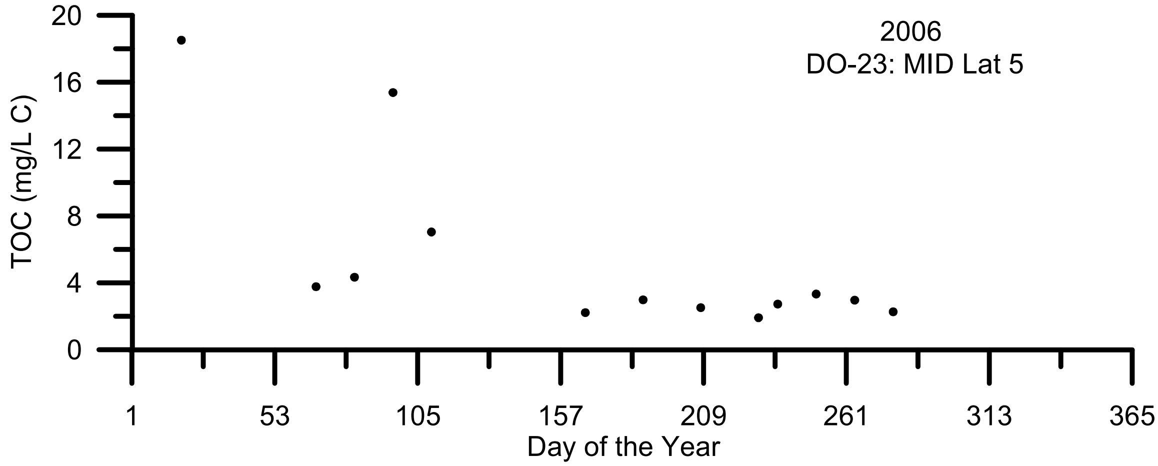

2007
DO-20: Los Banos Creek @ Hwy 140
TOC (mg/L C)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

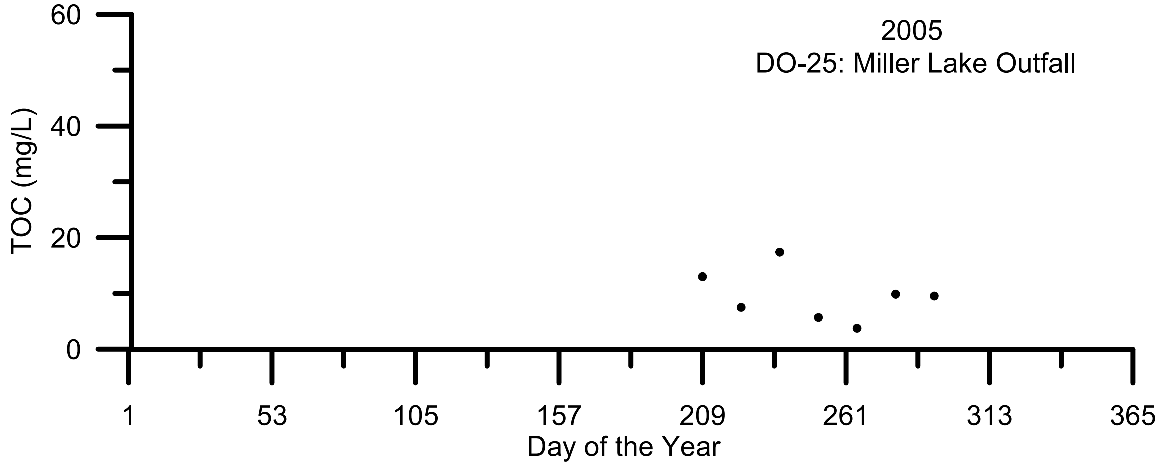

2005
DO-21: Orestimba Creek @ River Road
TOC (mg/L C)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

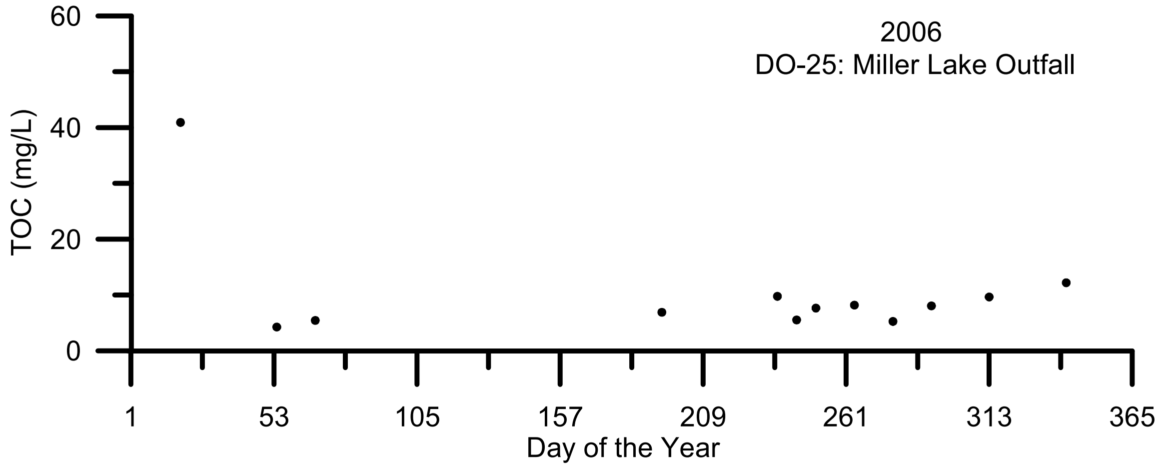

2006
DO-21: Orestimba Creek @ River Road
TOC (mg/L C)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

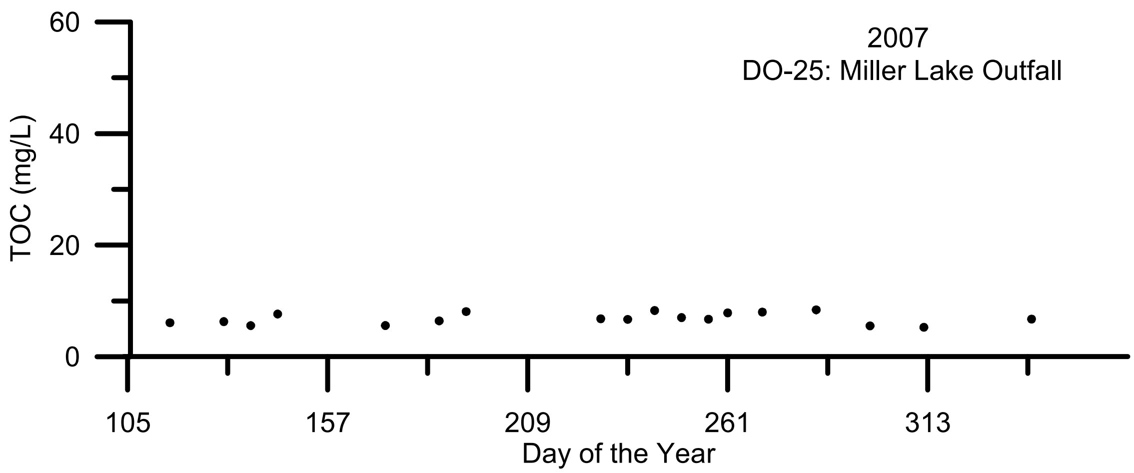

2007
DO-21: Orestimba Creek @ River Road
TOC (mg/L C)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

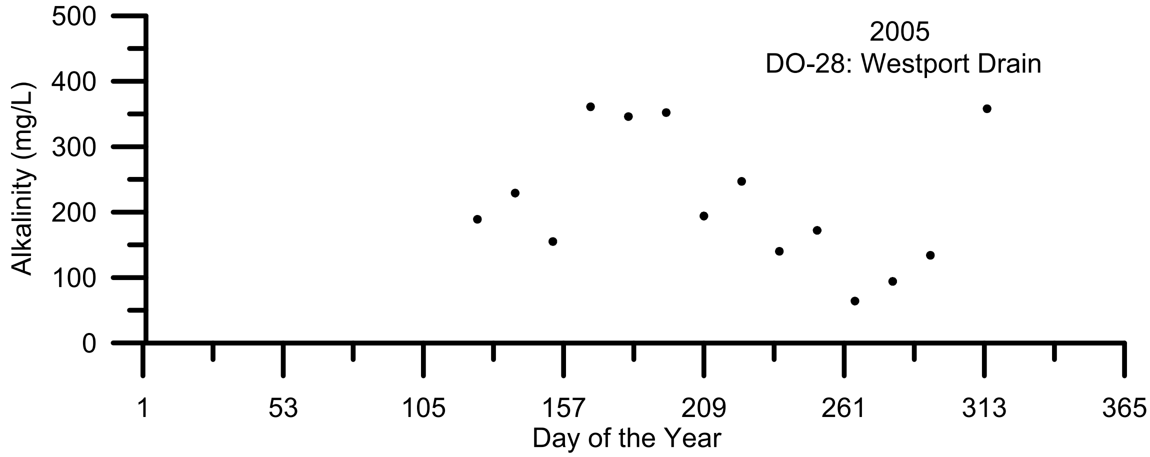

2005
DO-23: MID Lat 5
TOC (mg/L C)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

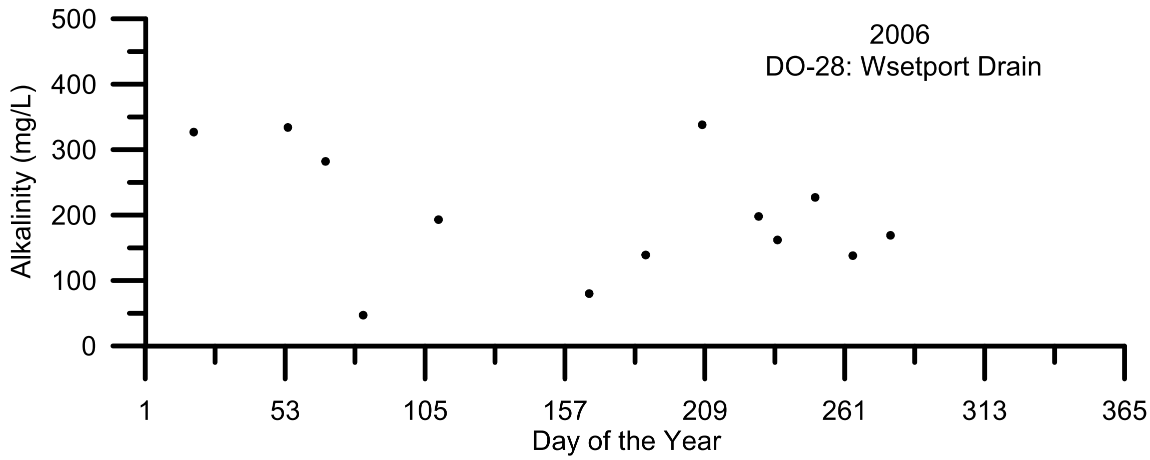

2006
DO-23: MID Lat 5
TOC (mg/L C)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

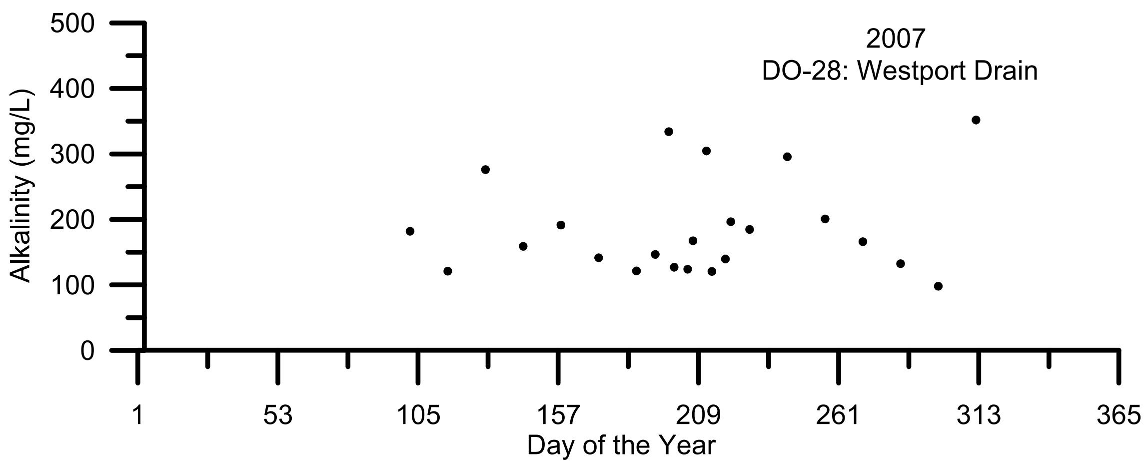

2005
DO-25: Miller Lake Outfall
TOC (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

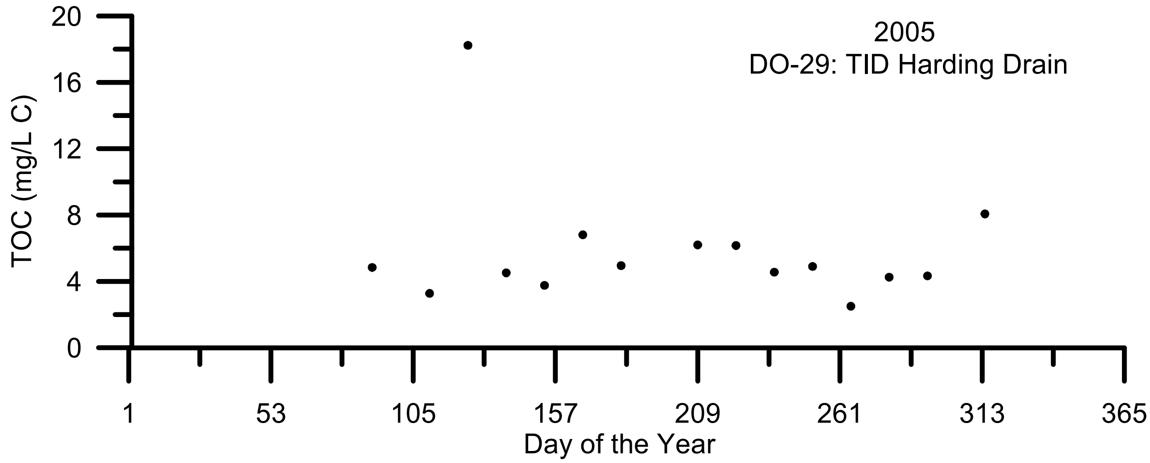

2006
DO-25: Miller Lake Outfall
TOC (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

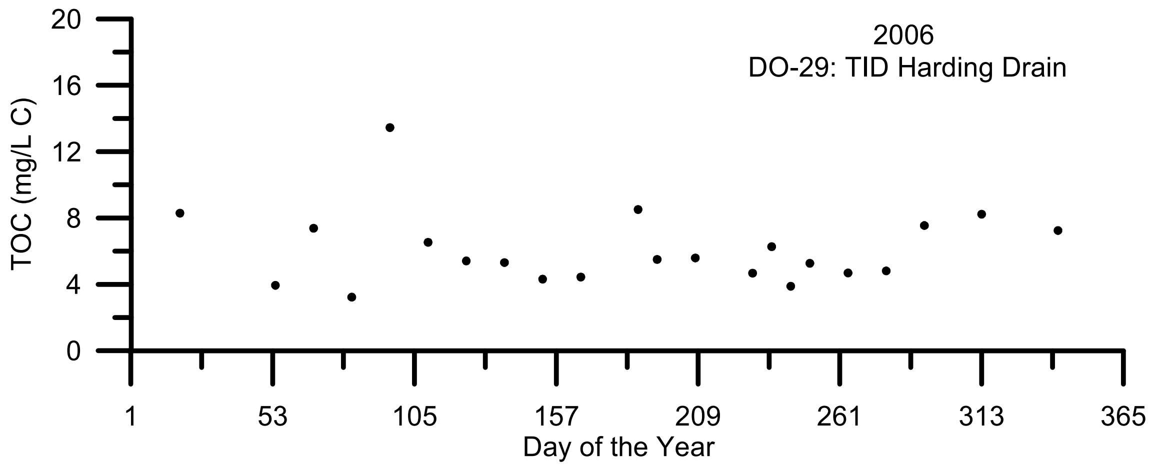

2007
DO-25: Miller Lake Outfall
TOC (mg/L)
60
40
20
0
105
157
209
261
313
Day of the Year

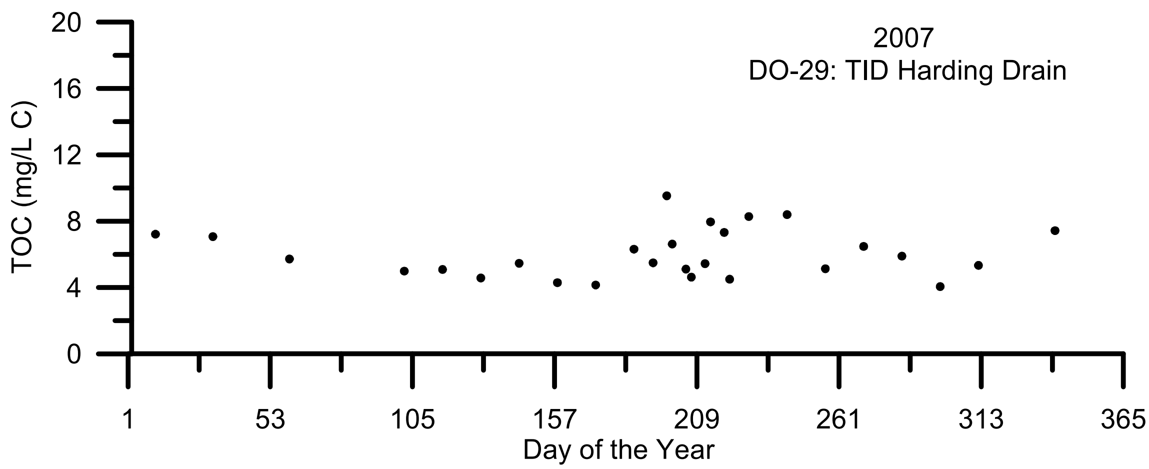

2005
DO-28: Westport Drain
Alkalinity (mg/L)
0
100
200
300
400
500
1
53
105
157
209
261
313
365
Day of the Year

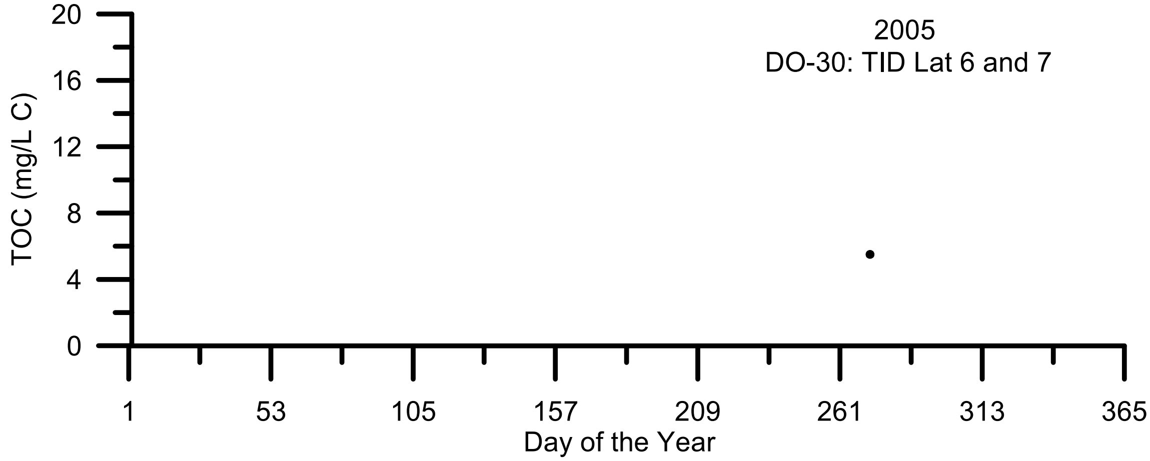

2006
DO-28: Wsetport Drain
Alkalinity (mg/L)
0
100
200
300
400
500
1
53
105
157
209
261
313
365
Day of the Year

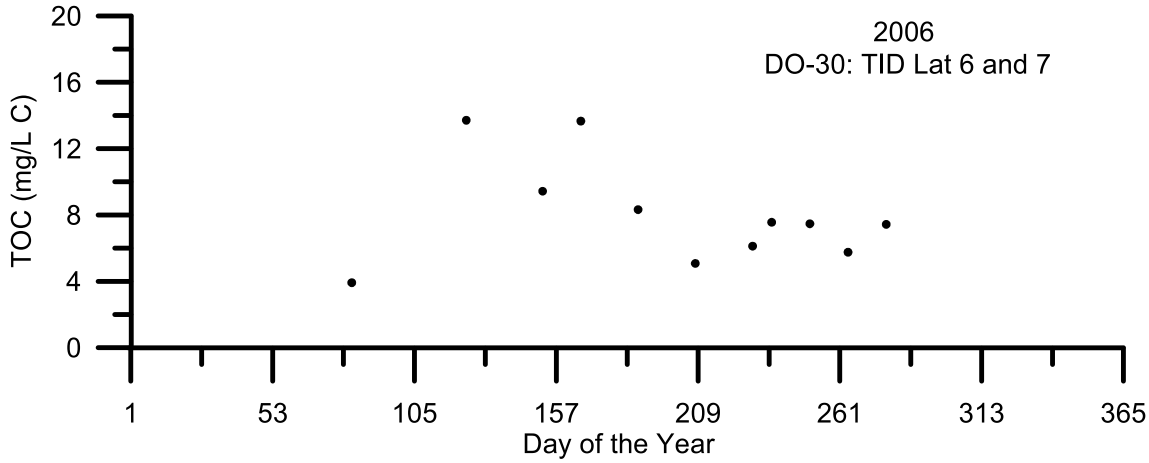

2007
DO-28: Westport Drain
Alkalinity (mg/L)
0
100
200
300
400
500
1
53
105
157
209
261
313
365
Day of the Year

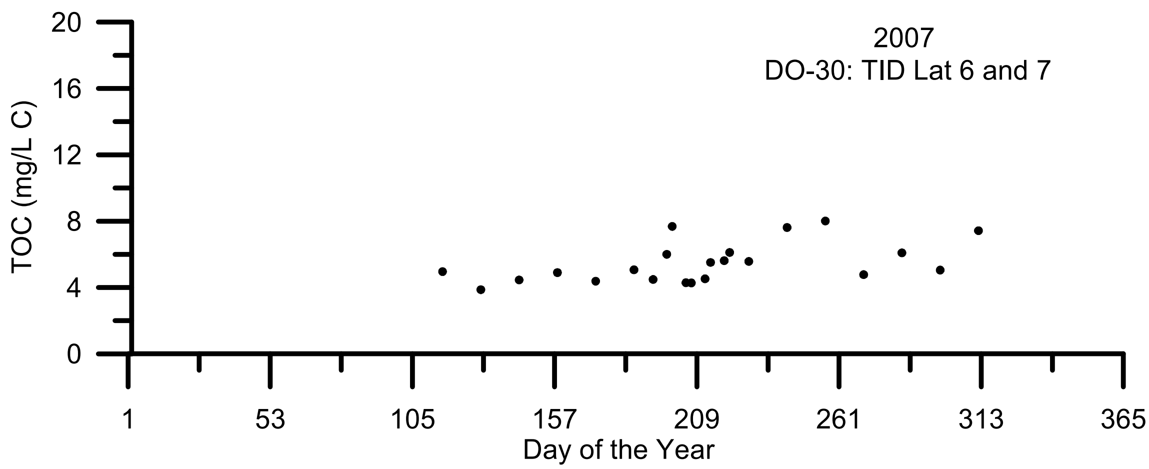

2005
DO-29: TID Harding Drain
TOC (mg/L C)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

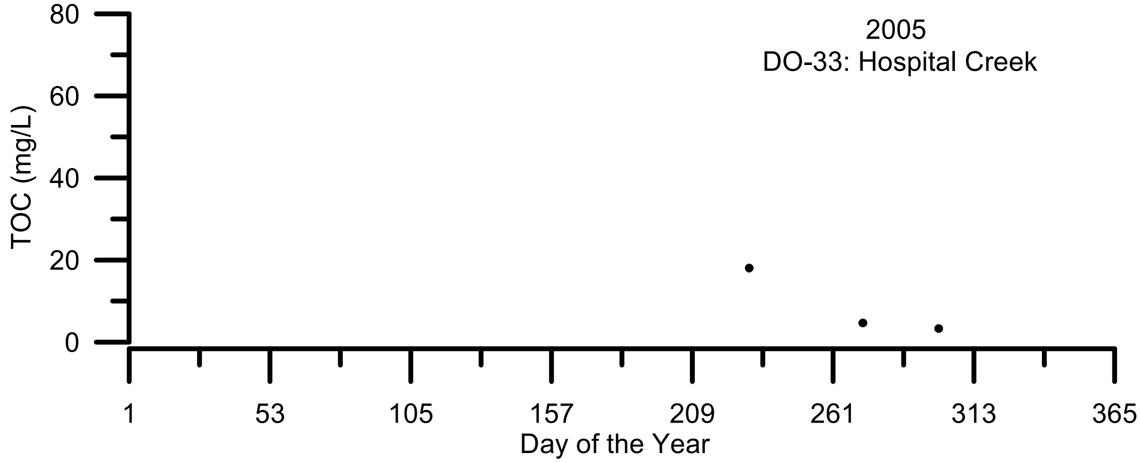

2006
DO-29: TID Harding Drain
TOC (mg/L C)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

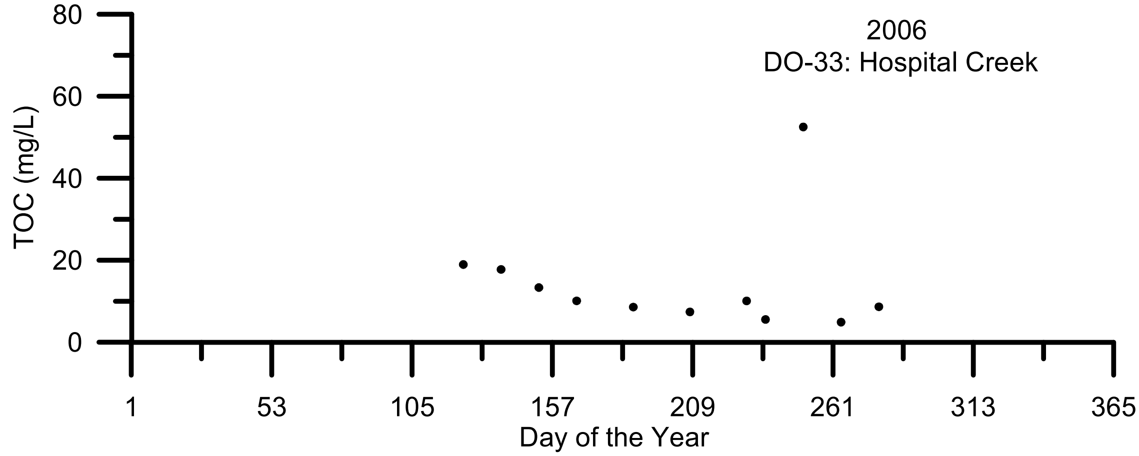

2007
DO-29: TID Harding Drain
TOC (mg/L C)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

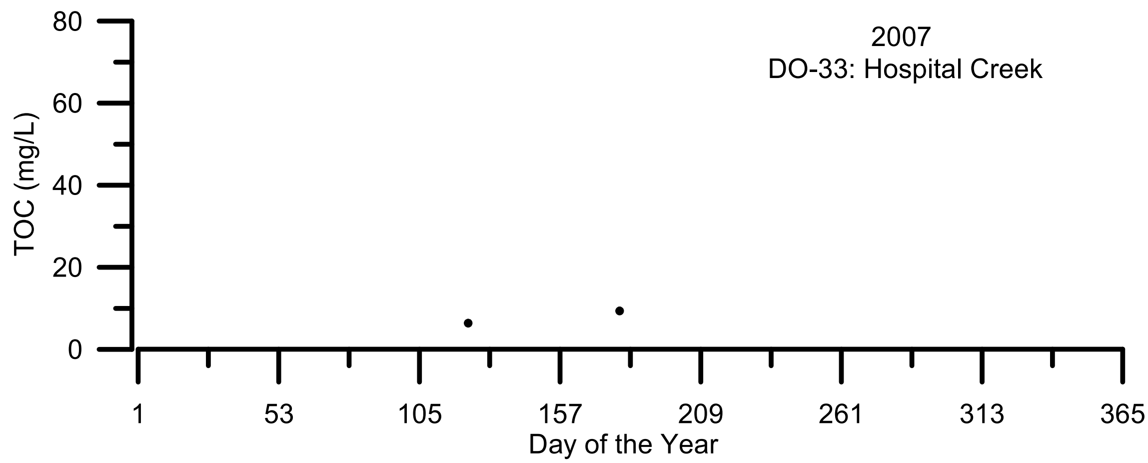

2005
DO-30: TID Lat 6 and 7
TOC (mg/L C)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

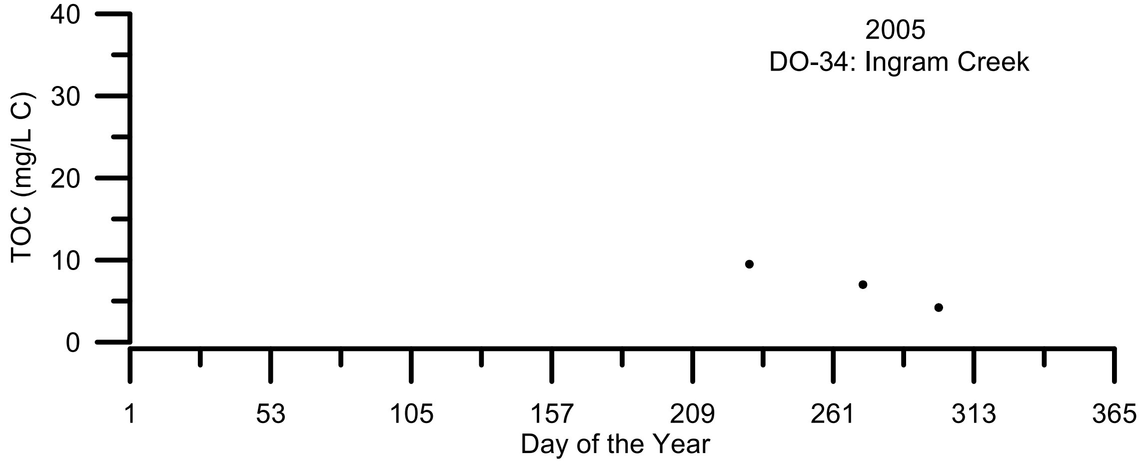

2006
DO-30: TID Lat 6 and 7
TOC (mg/L C)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

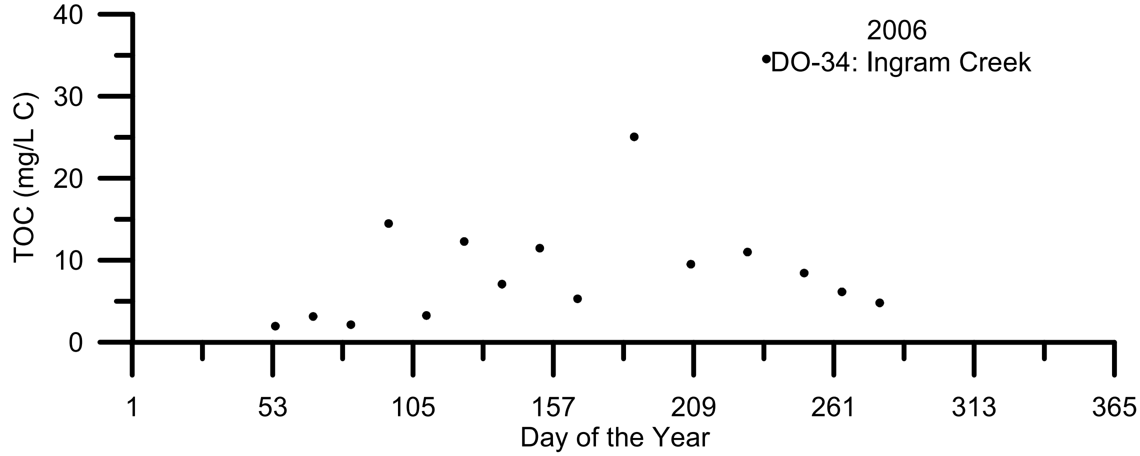

2007
DO-30: TID Lat 6 and 7
TOC (mg/L C)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

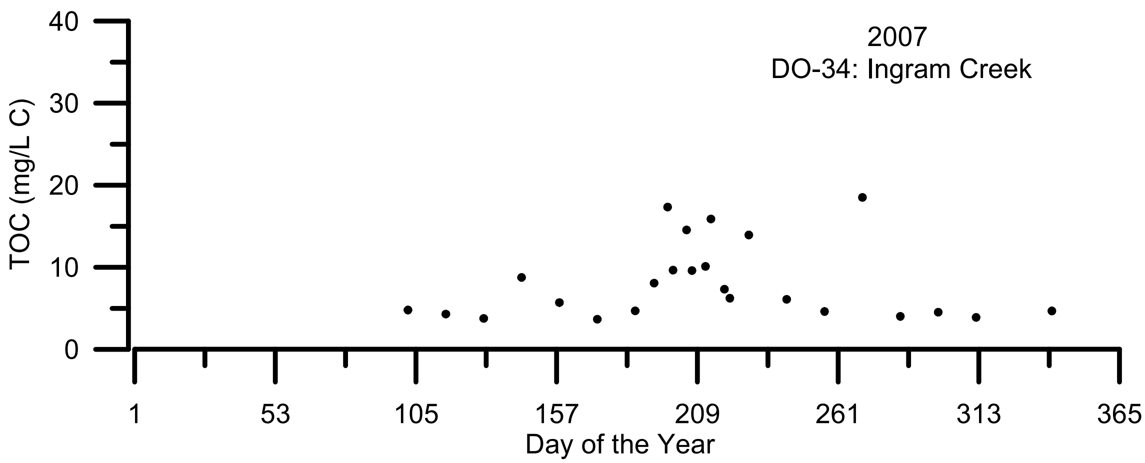

2005
DO-33: Hospital Creek
TOC (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

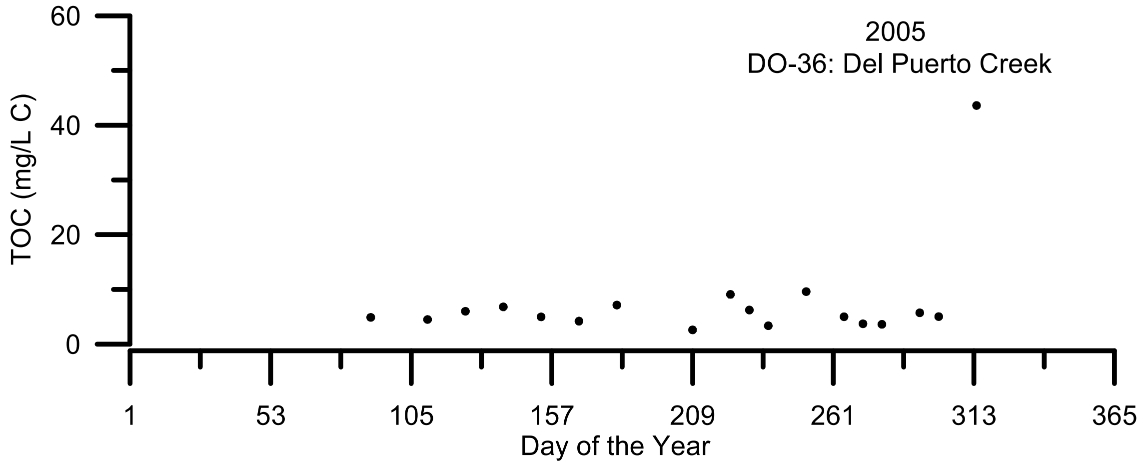

2006
DO-33: Hospital Creek
TOC (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

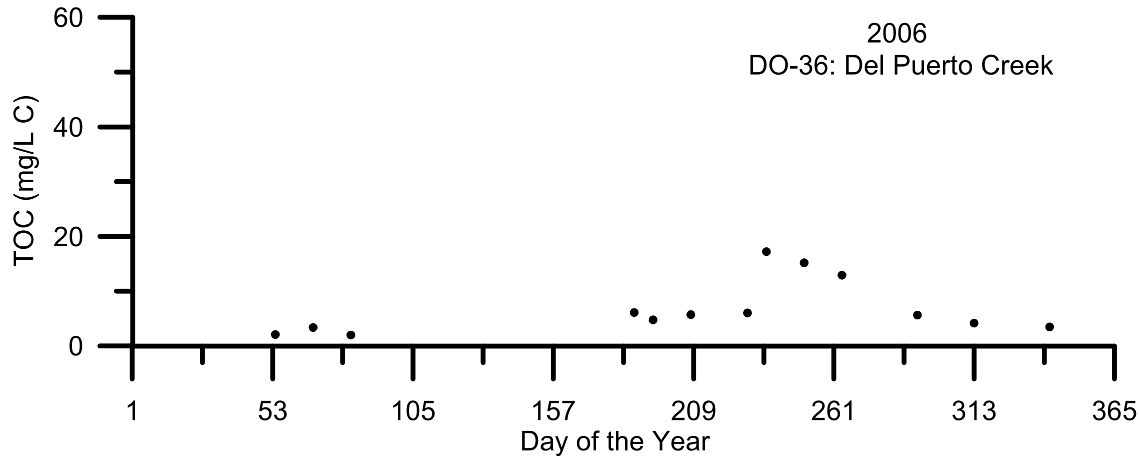

2007
DO-33: Hospital Creek
TOC (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

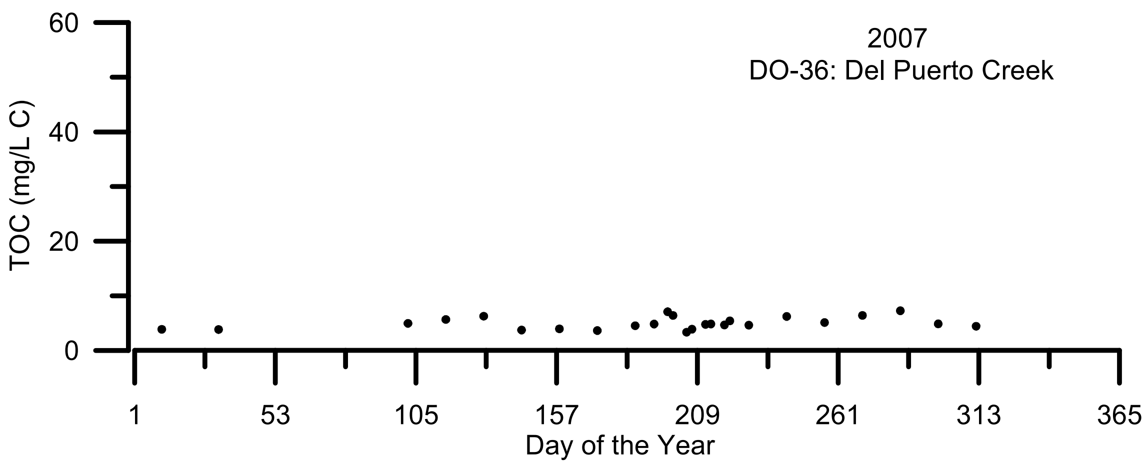

2005
DO-34: Ingram Creek
TOC (mg/L C)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

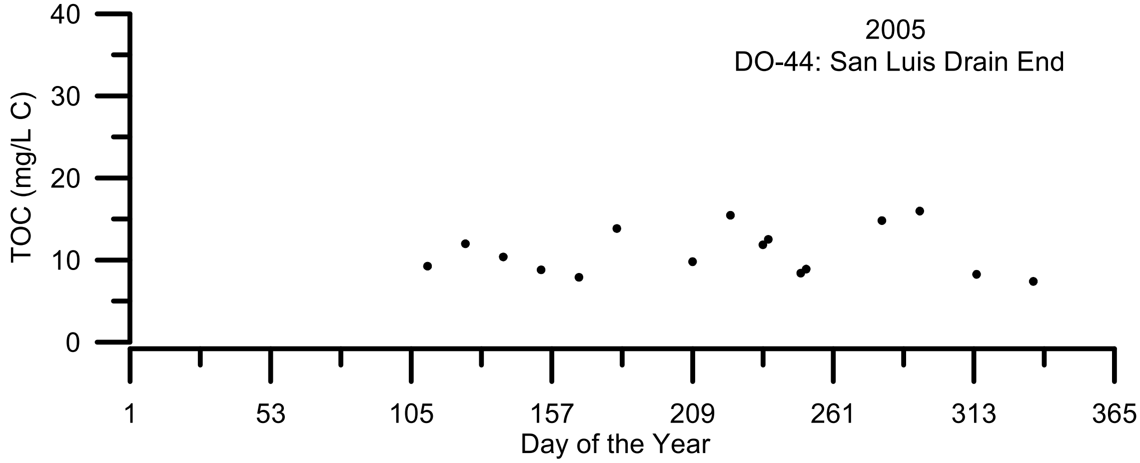

2006
DO-34: Ingram Creek
TOC (mg/L C)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

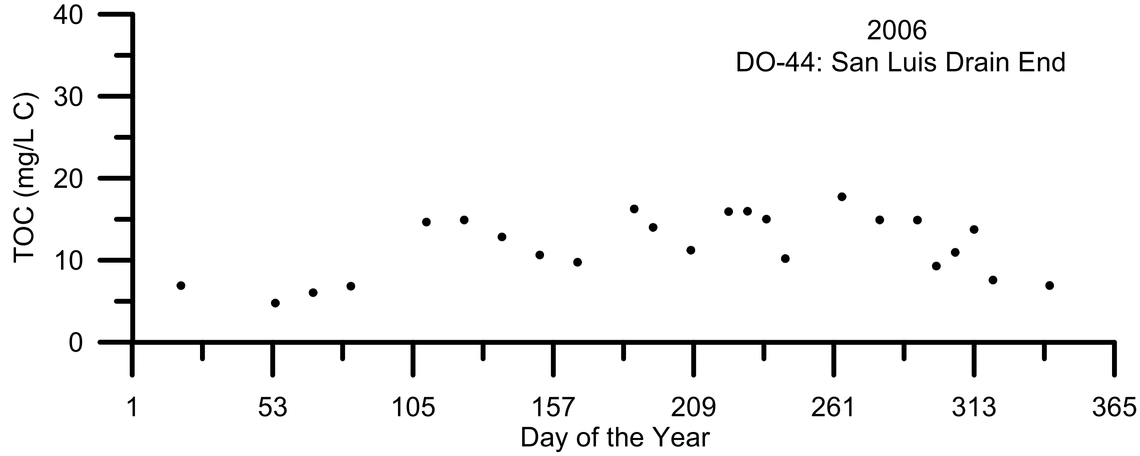

2007
DO-34: Ingram Creek
TOC (mg/L C)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

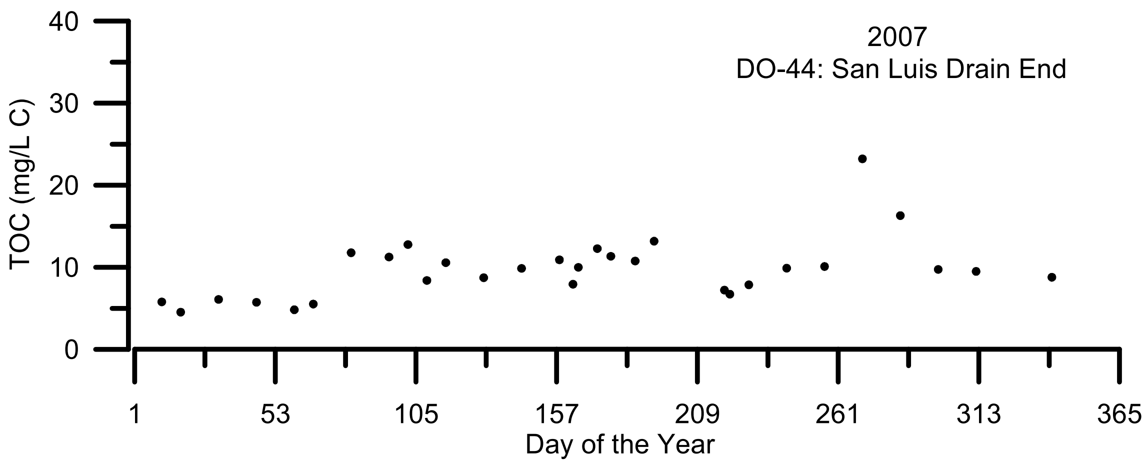

2005
DO-36: Del Puerto Creek
TOC (mg/L C)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

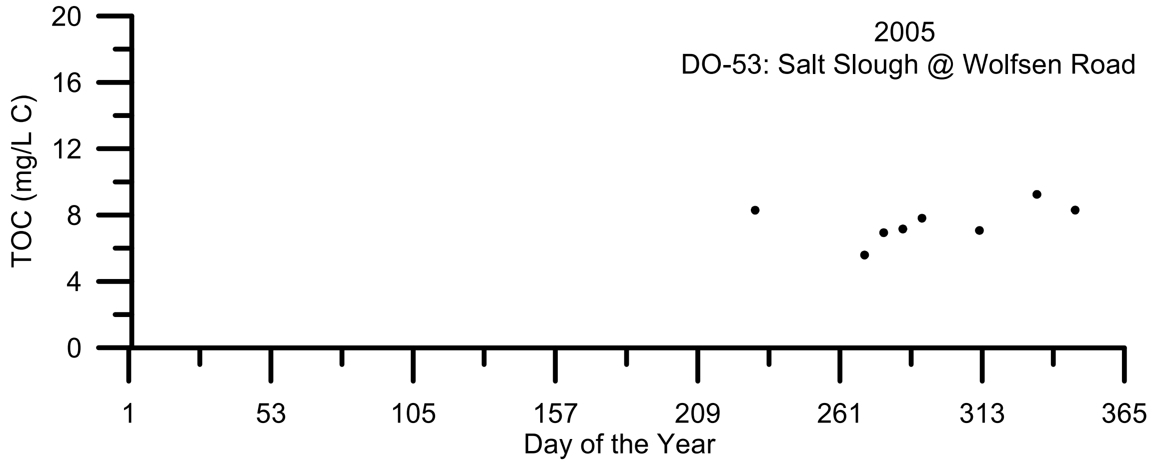

2006
DO-36: Del Puerto Creek
TOC (mg/L C)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-36: Del Puerto Creek
TOC (mg/L C)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

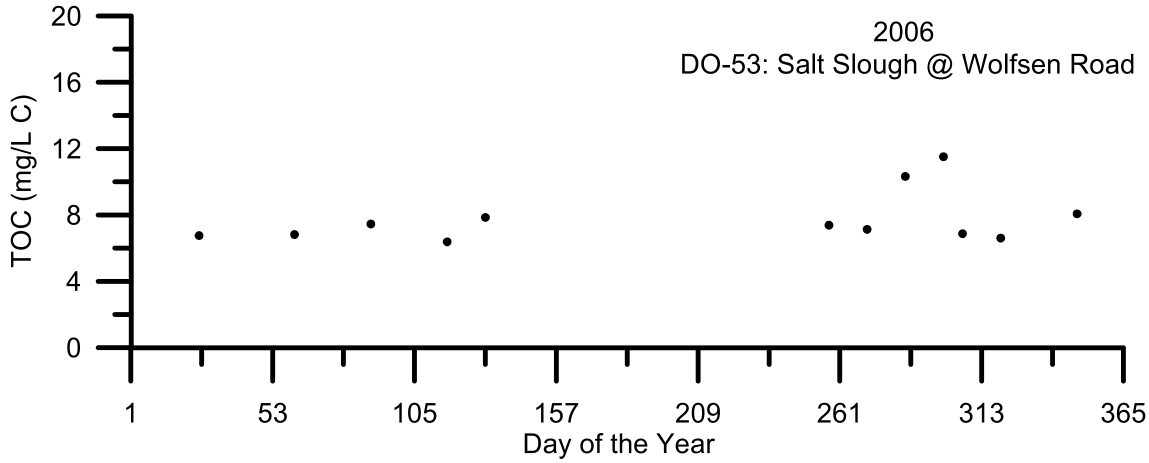

2005
DO-44: San Luis Drain End
TOC (mg/L C)
Day of the Year


2006
DO-44: San Luis Drain End
TOC (mg/L C)
Day of the Year

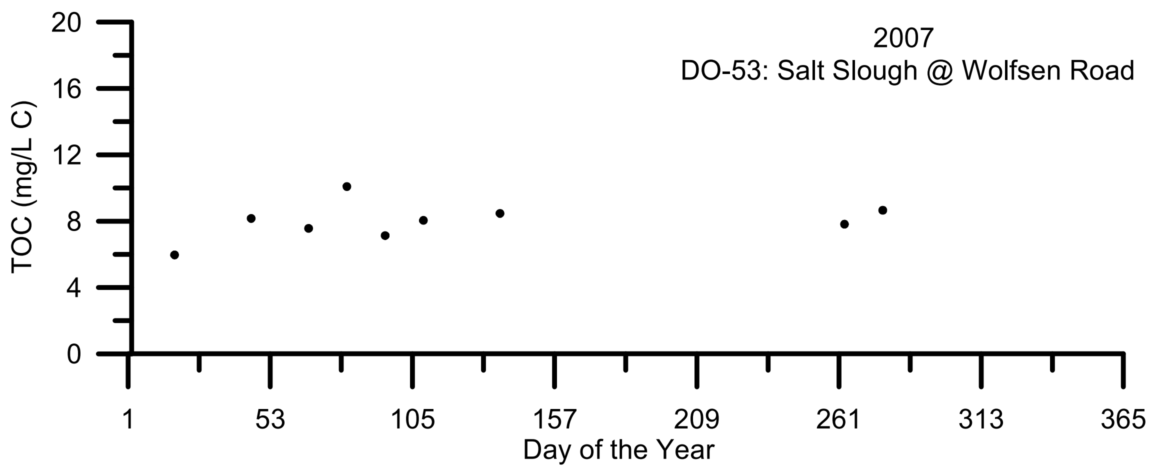

2007
DO-44: San Luis Drain End
TOC (mg/L C)
Day of the Year



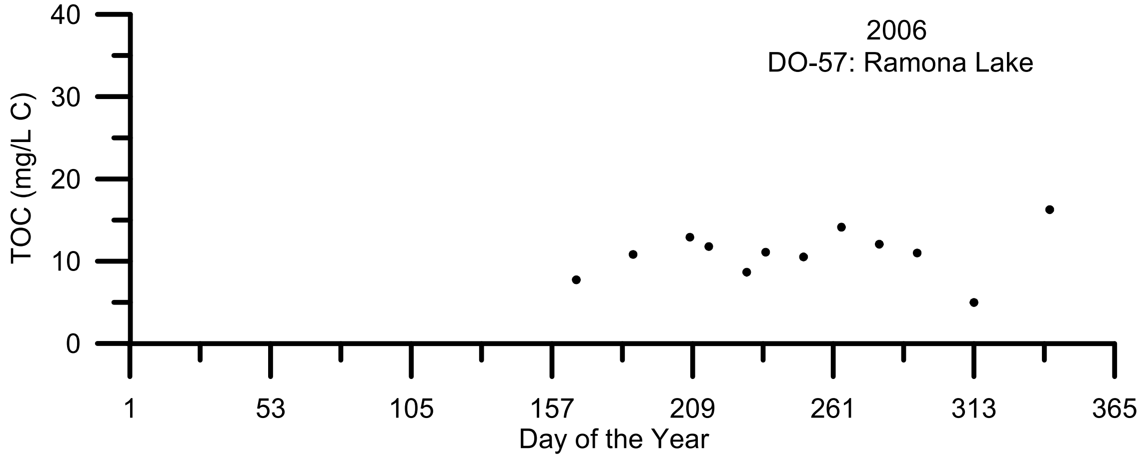
2005
DO-53: Salt Slough @ Wolfsen Road
TOC (mg/L C)
Day of the Year

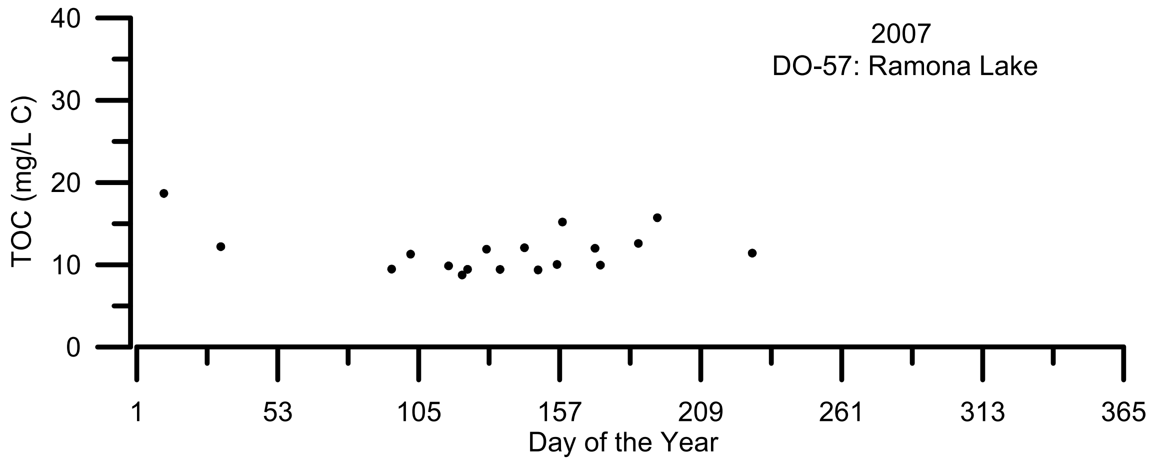


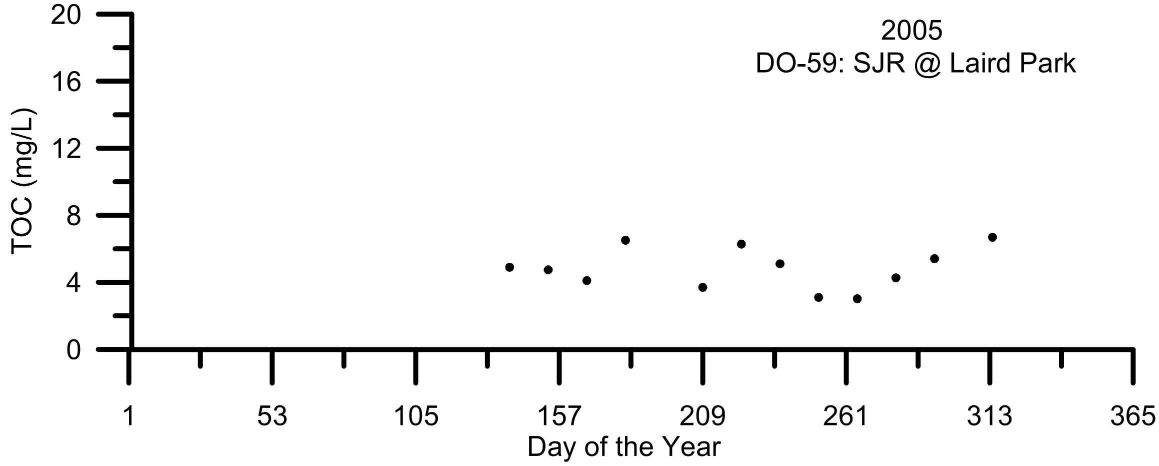
2006
DO-53: Salt Slough @ Wolfsen Road
TOC (mg/L C)
Day of the Year

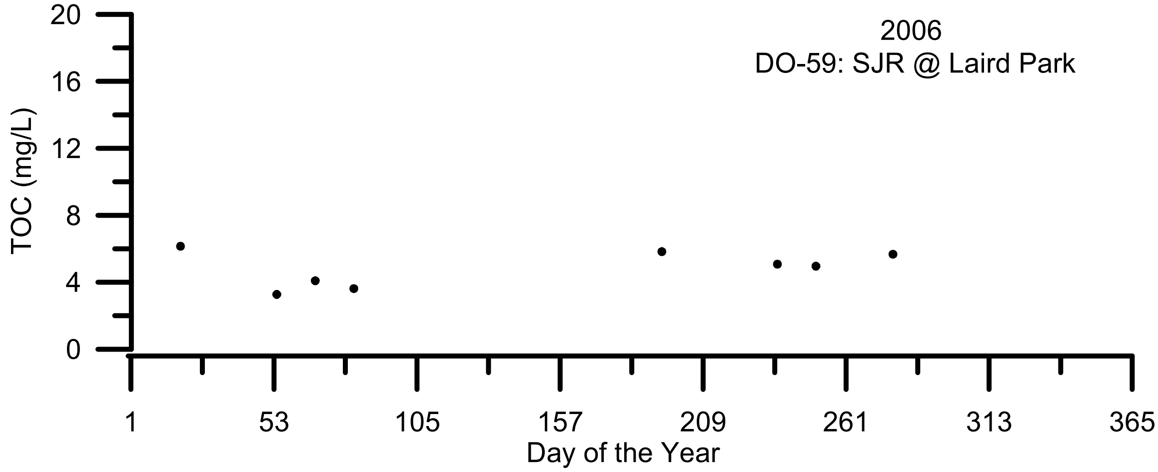


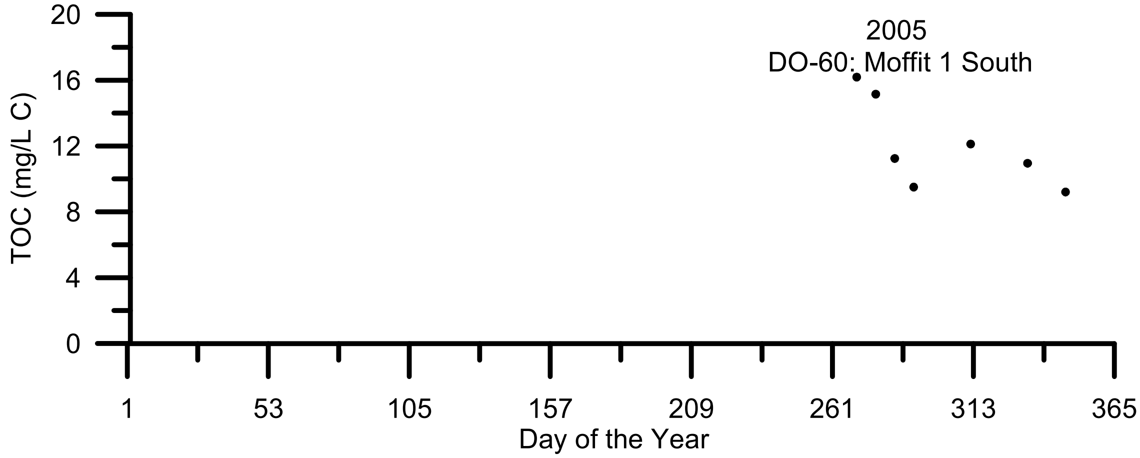
2007
DO-53: Salt Slough @ Wolfsen Road
TOC (mg/L C)
Day of the Year

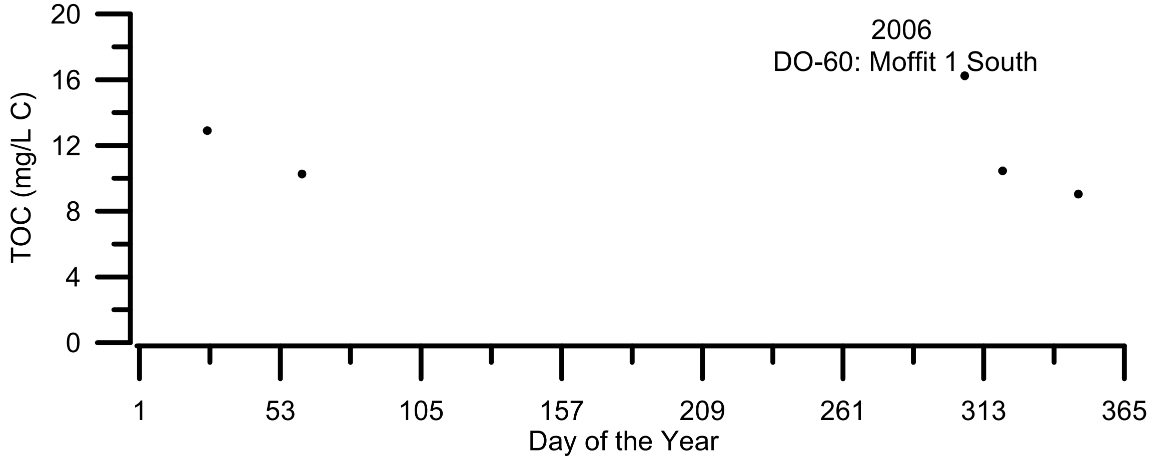

2006
DO-57: Ramona Lake
TOC (mg/L C)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

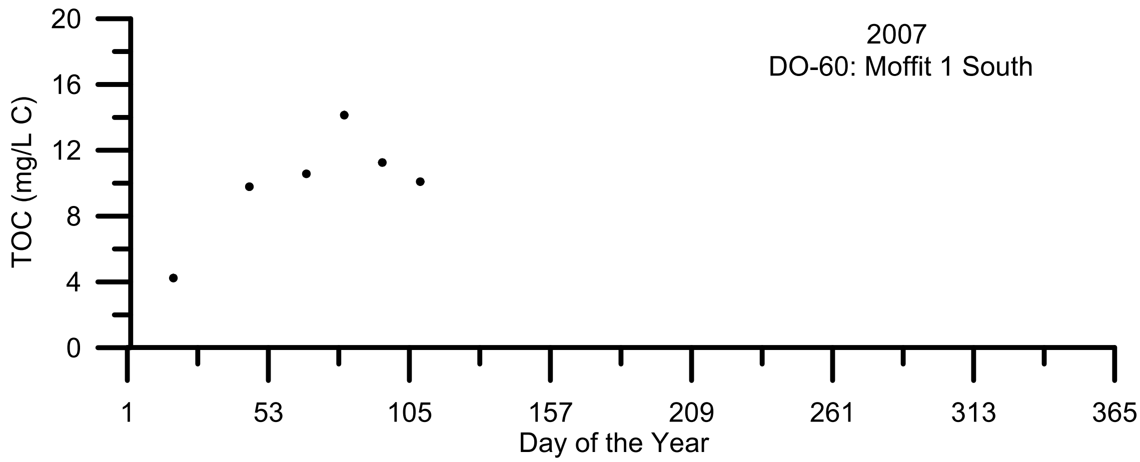

2007
DO-57: Ramona Lake
TOC (mg/L C)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

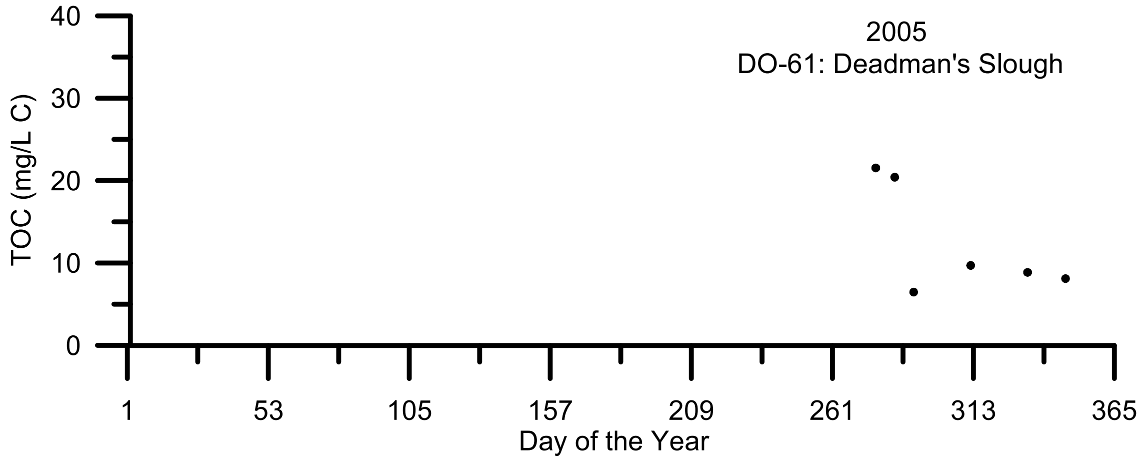

2005
DO-59: SJR @ Laird Park
TOC (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

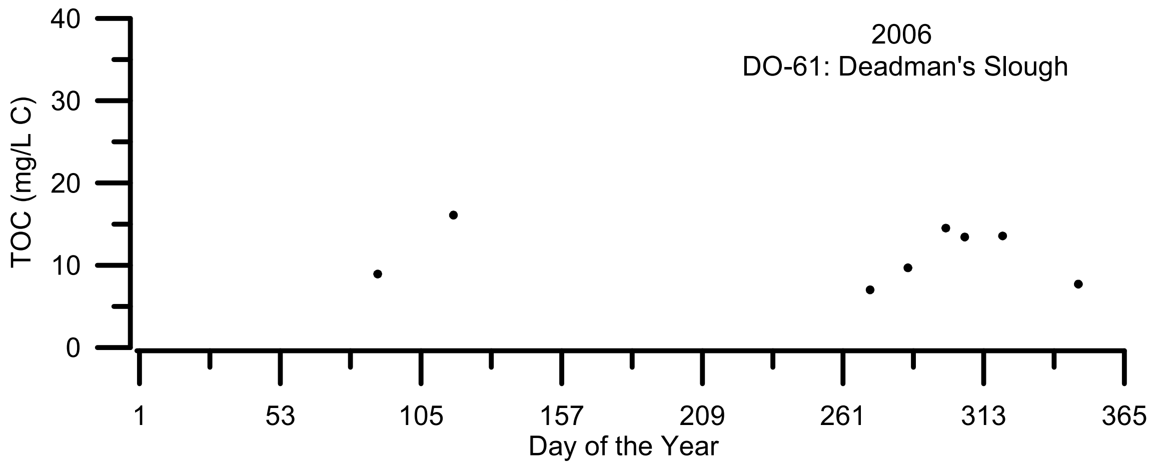

2006
DO-59: SJR @ Laird Park
TOC (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

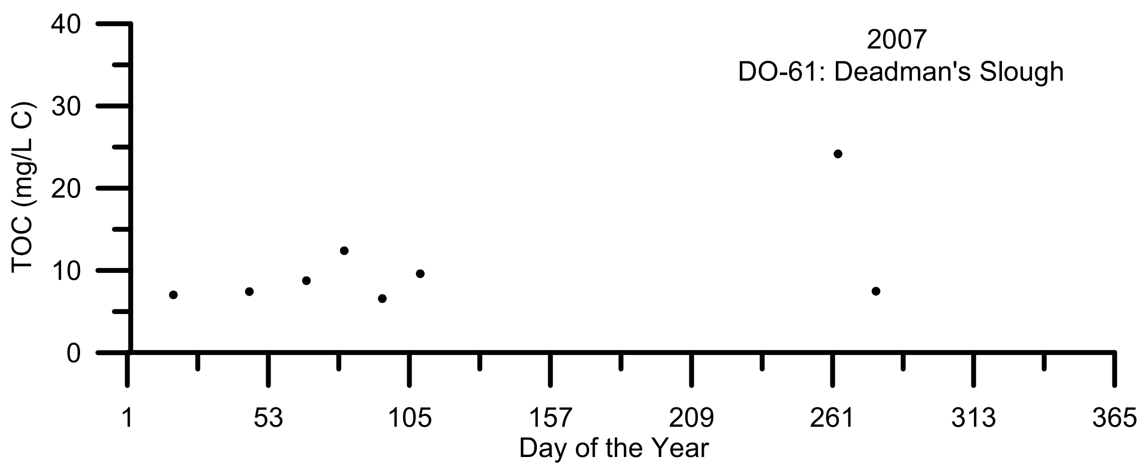

2005
DO-60: Moffit 1 South
TOC (mg/L C)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

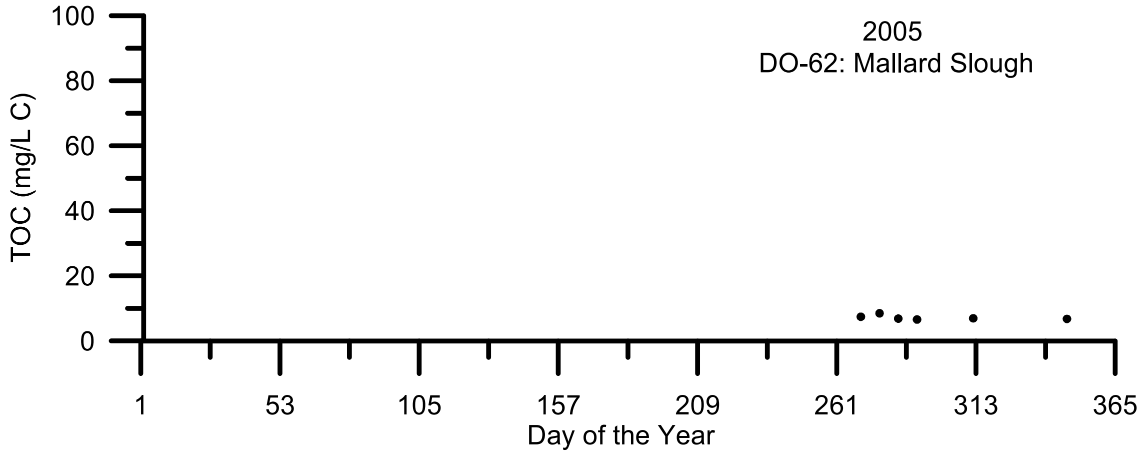

2006
DO-60: Moffit 1 South
TOC (mg/L C)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

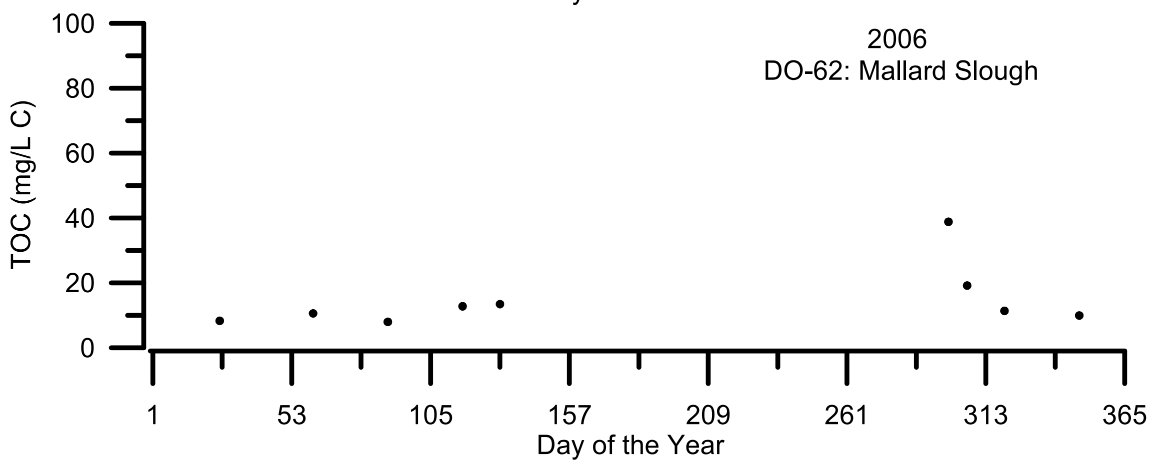

2007
DO-60: Moffit 1 South
TOC (mg/L C)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

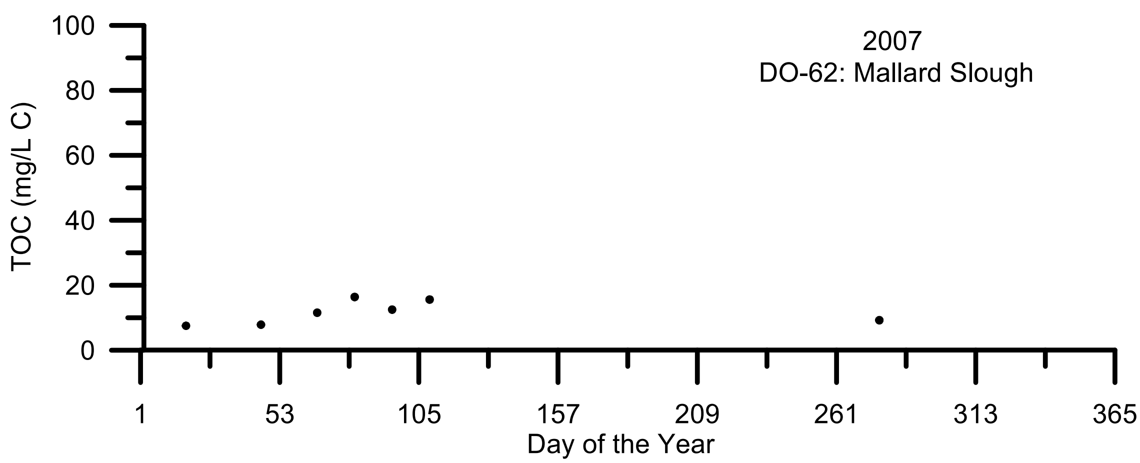

2005
DO-61: Deadman's Slough
TOC (mg/L C)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

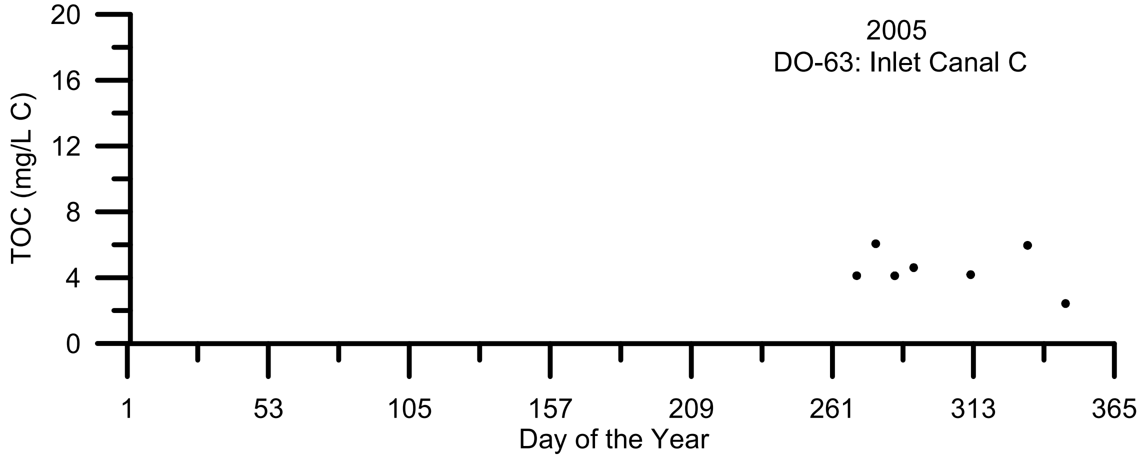

2006
DO-61: Deadman's Slough
TOC (mg/L C)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

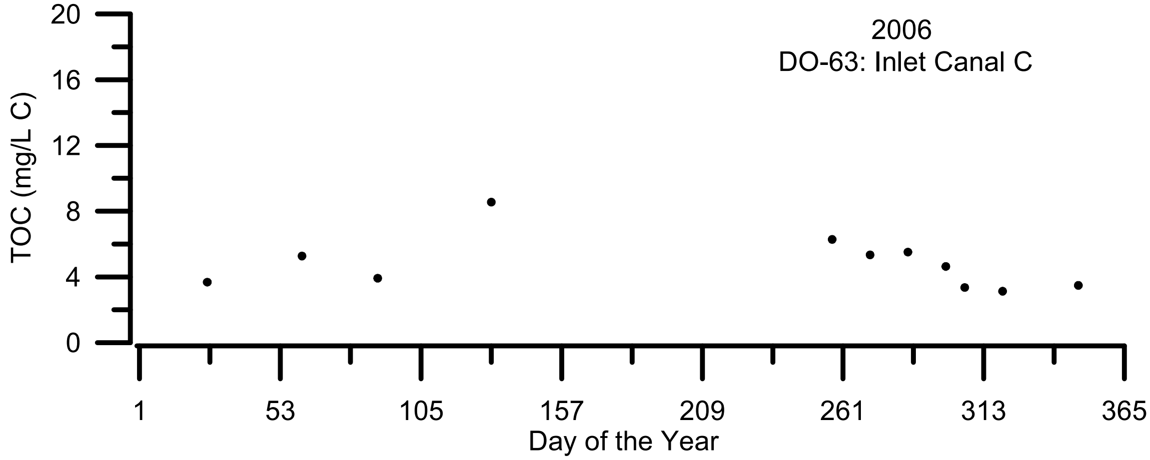

2007
DO-61: Deadman's Slough
TOC (mg/L C)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

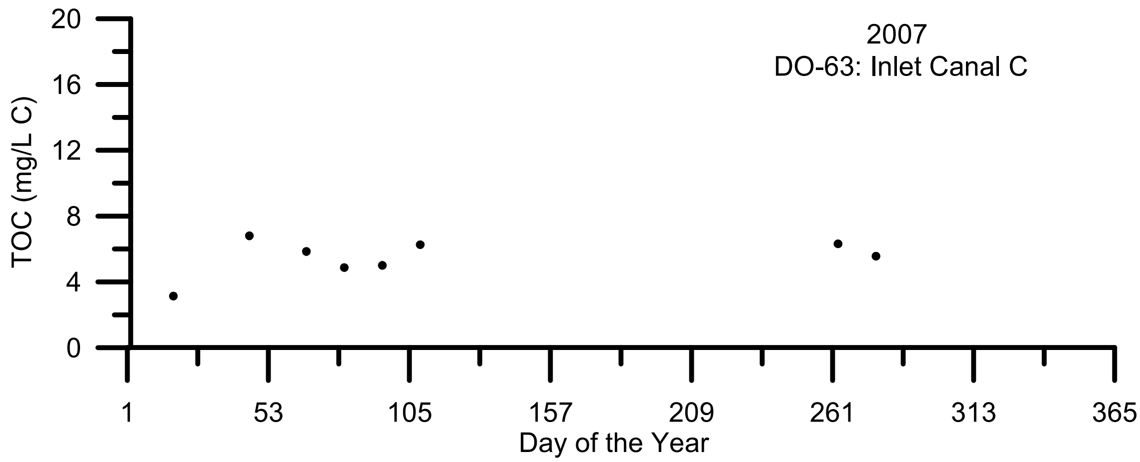

2005
DO-62: Mallard Slough
TOC (mg/L C)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

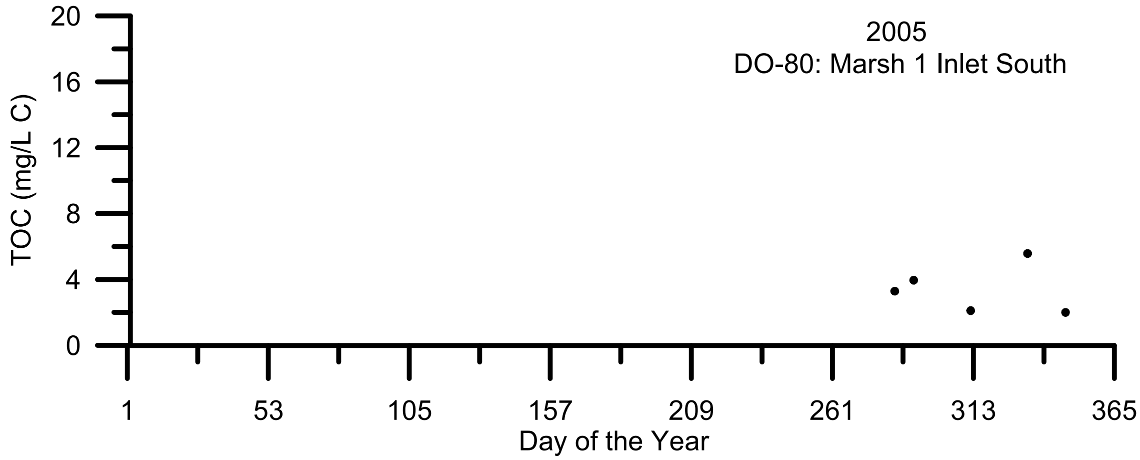

2006
DO-62: Mallard Slough
TOC (mg/L C)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

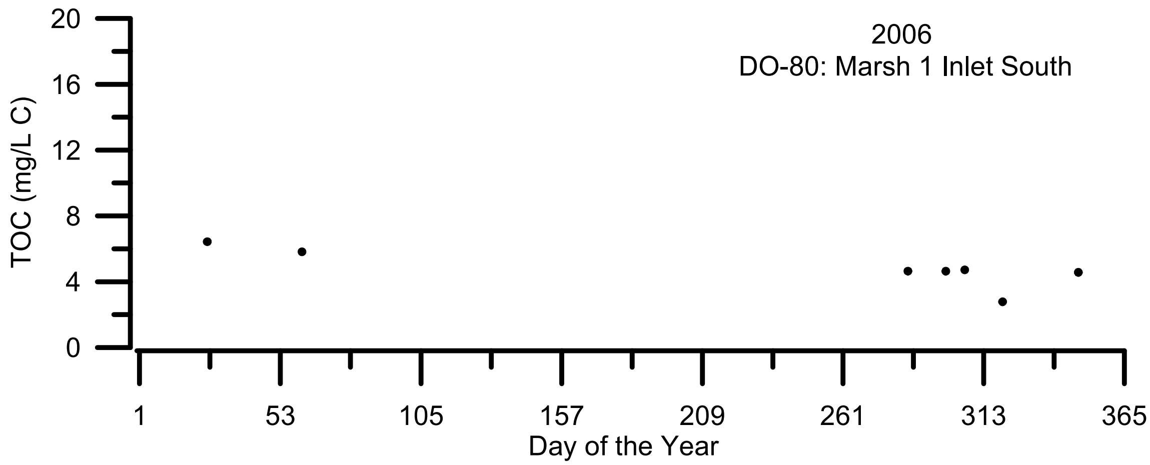

2007
DO-62: Mallard Slough
TOC (mg/L C)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

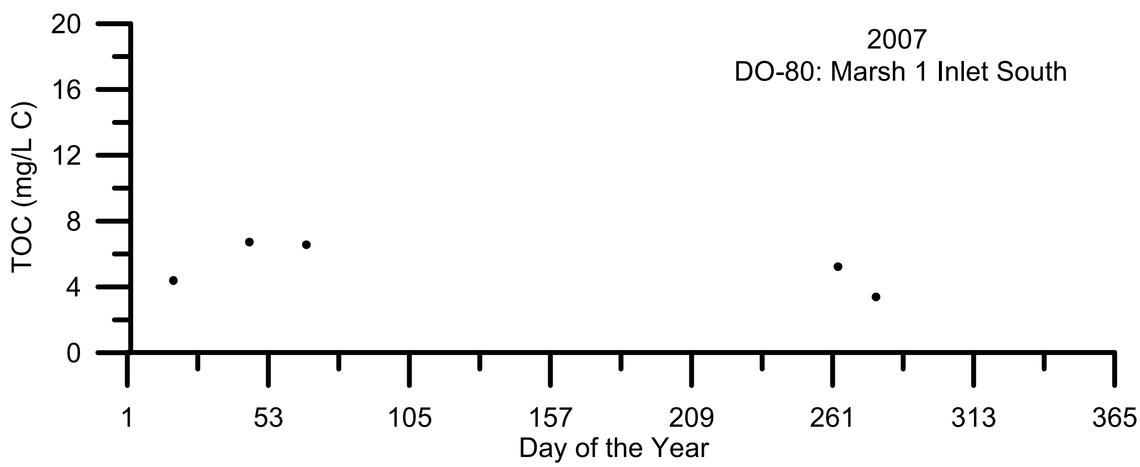

2005
DO-63: Inlet Canal C
TOC (mg/L C)
Day of the Year

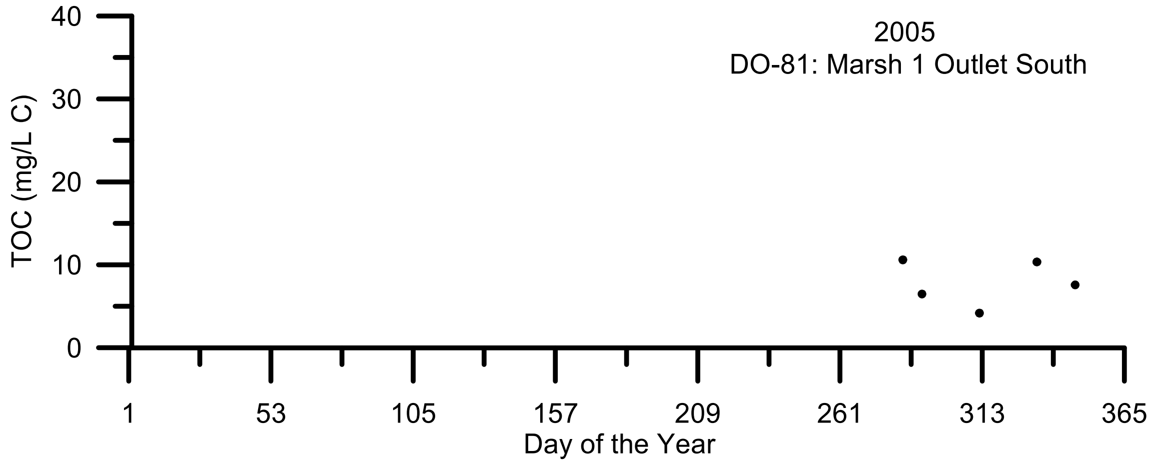

2006
DO-63: Inlet Canal C
TOC (mg/L C)
Day of the Year

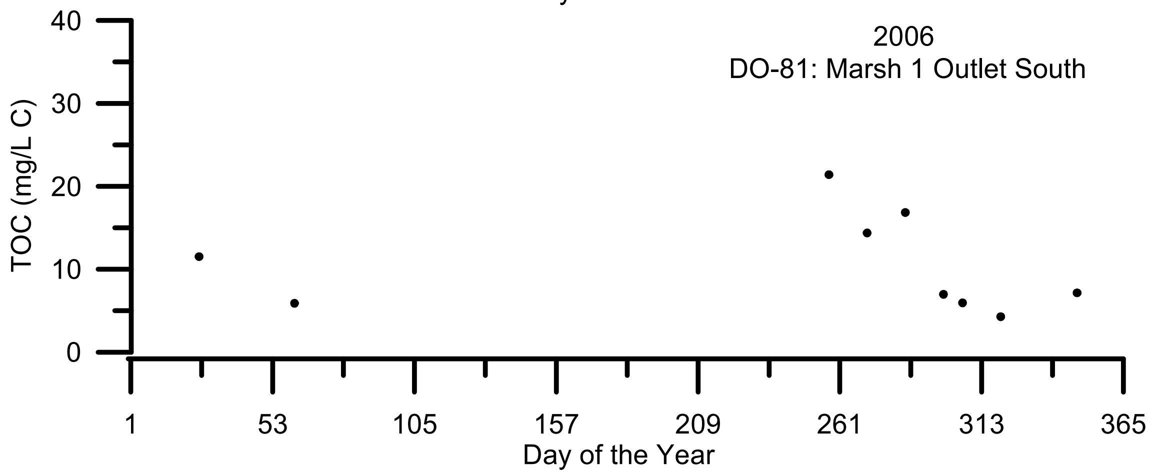

2007
DO-63: Inlet Canal C
TOC (mg/L C)
Day of the Year

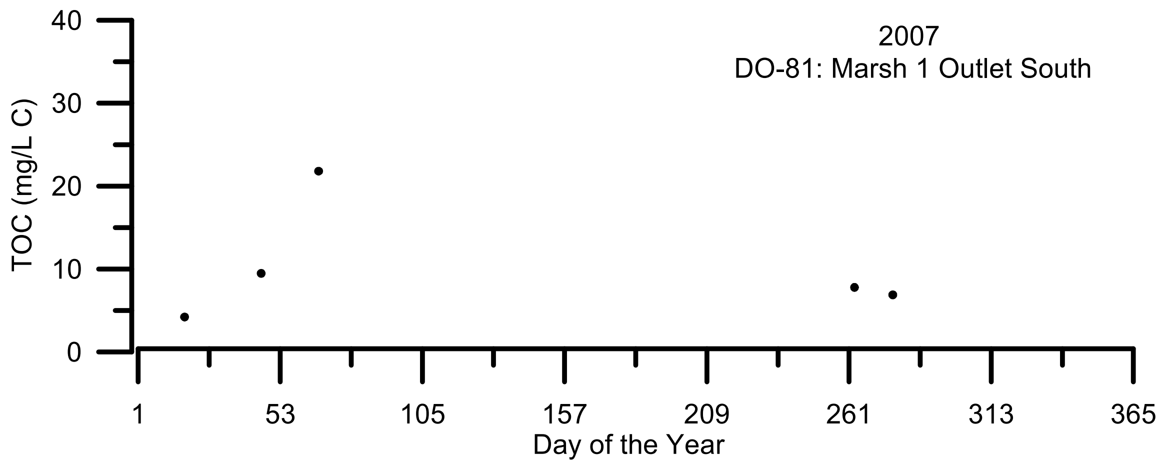

2005
DO-80: Marsh 1 Inlet South
TOC (mg/L C)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

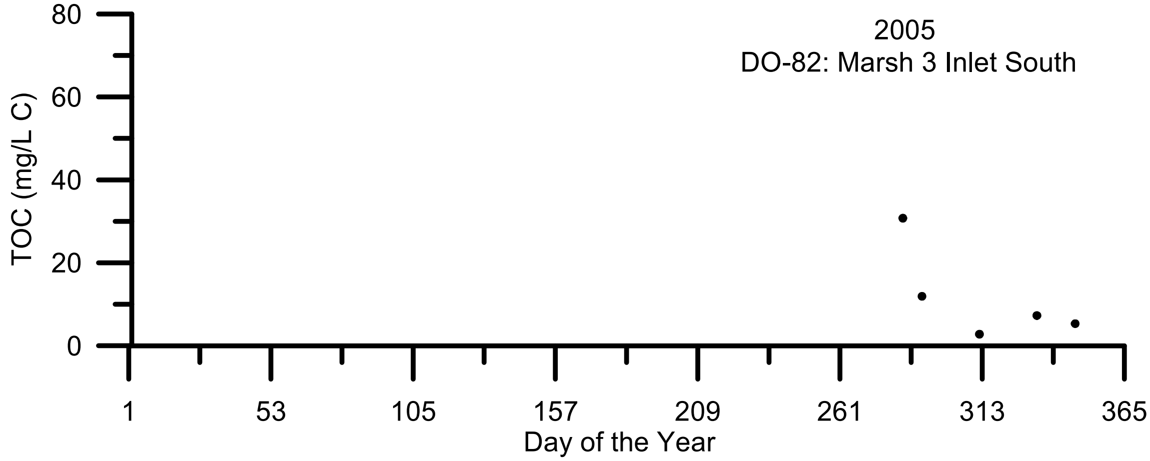

2006
DO-80: Marsh 1 Inlet South
TOC (mg/L C)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

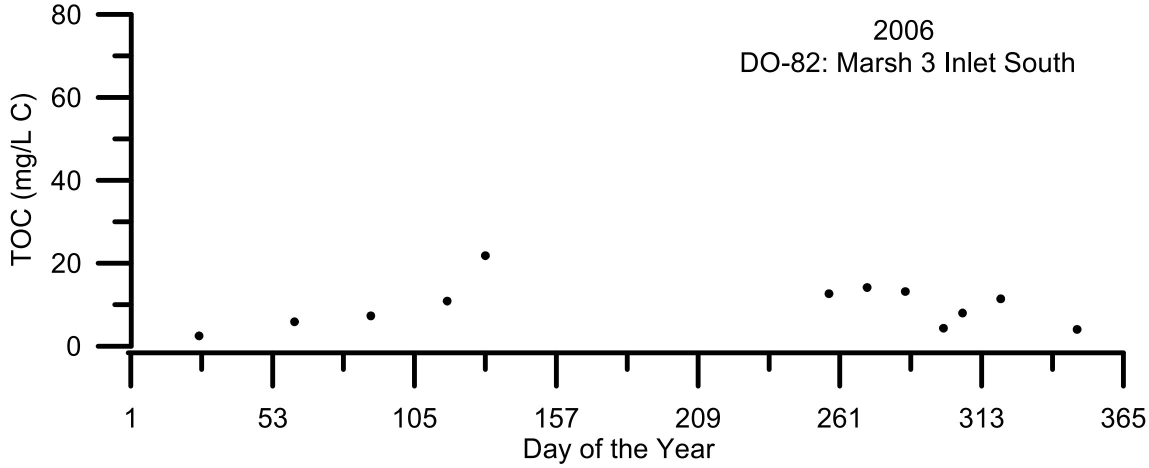

2007
DO-80: Marsh 1 Inlet South
TOC (mg/L C)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

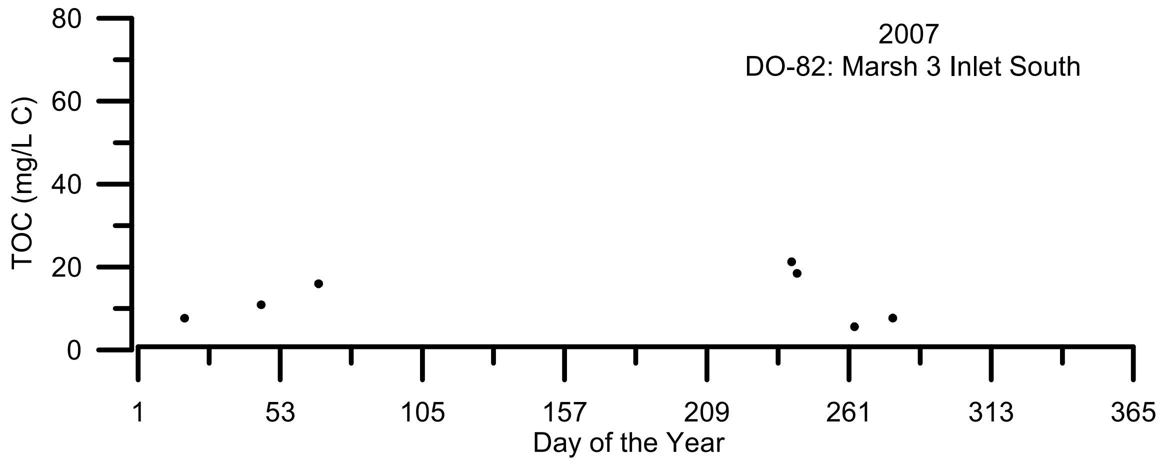

2005
DO-81: Marsh 1 Outlet South
TOC (mg/L C)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

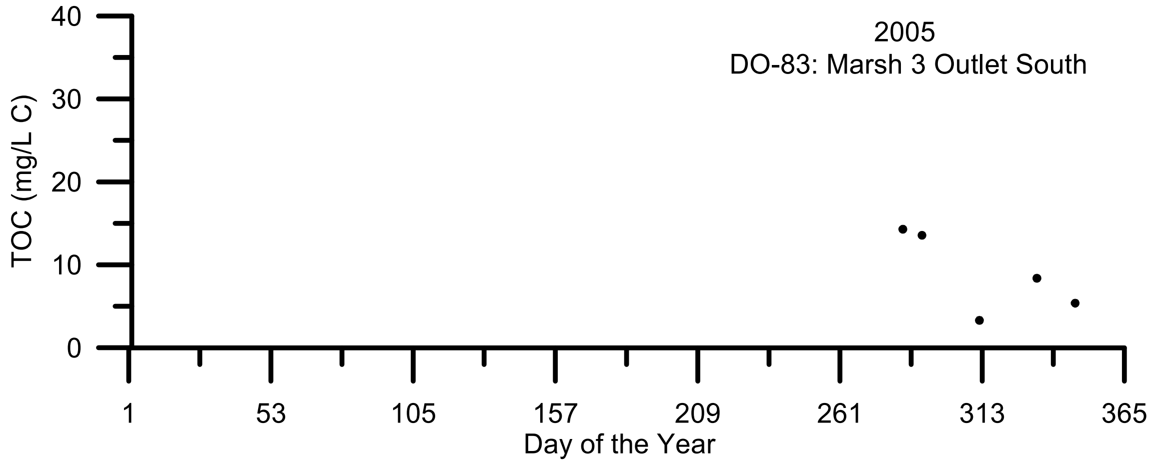

2006
DO-81: Marsh 1 Outlet South
TOC (mg/L C)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

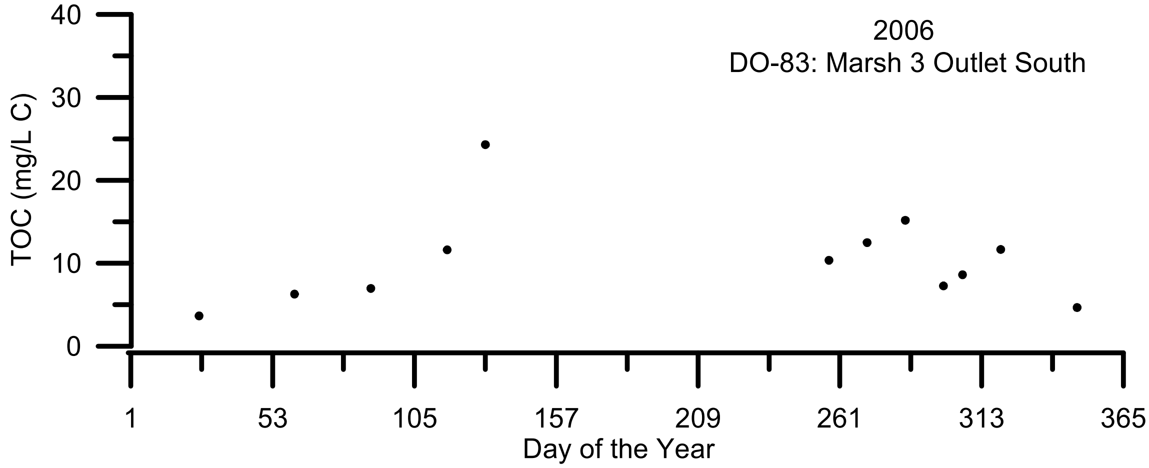

2007
DO-81: Marsh 1 Outlet South
TOC (mg/L C)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

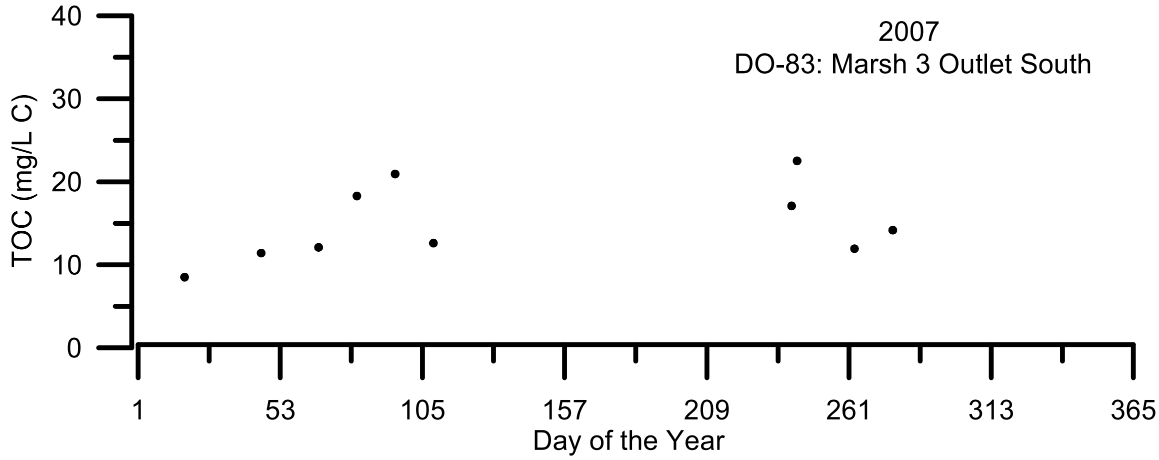

80
60
40
20
0
TOC (mg/L C)
2005
DO-82: Marsh 3 Inlet South
1
53
105
157
209
261
313
365
Day of the Year

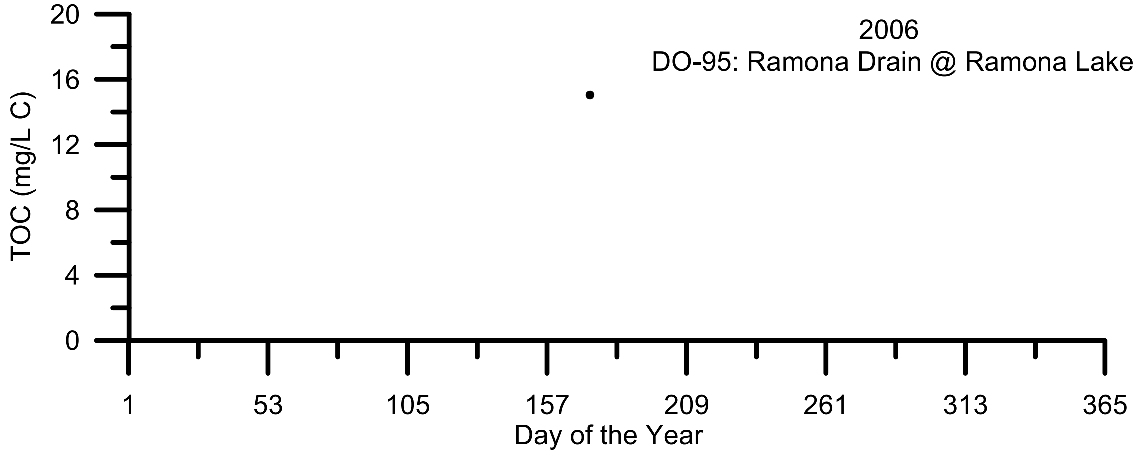

80
60
40
20
0
TOC (mg/L C)
2006
DO-82: Marsh 3 Inlet South
1
53
105
157
209
261
313
365
Day of the Year

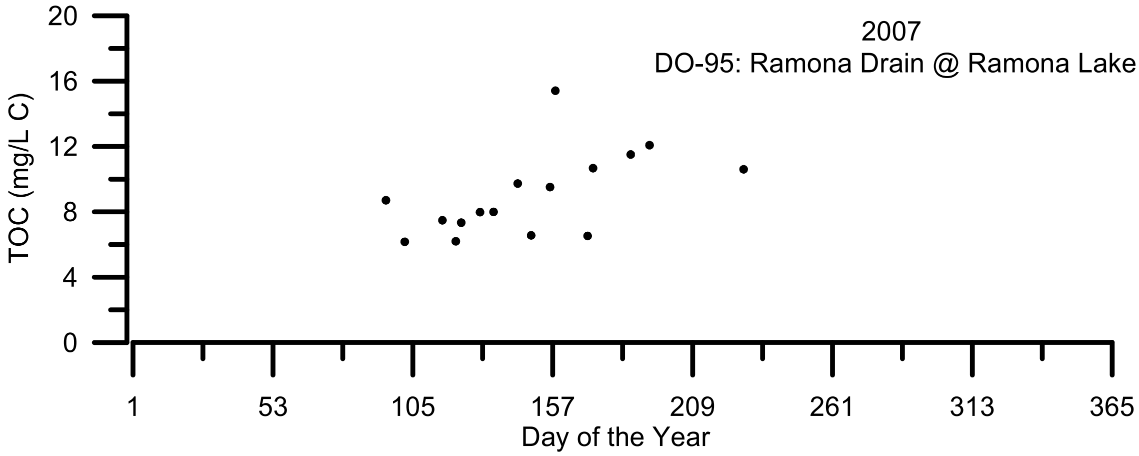

80
60
40
20
0
TOC (mg/L C)
2007
DO-82: Marsh 3 Inlet South
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-83: Marsh 3 Outlet South
TOC (mg/L C)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-83: Marsh 3 Outlet South
TOC (mg/L C)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-83: Marsh 3 Outlet South
TOC (mg/L C)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-95: Ramona Drain @ Ramona Lake
TOC (mg/L C)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-95: Ramona Drain @ Ramona Lake
TOC (mg/L C)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

Trichromatic Method Chlorophyll *A* Extract Data for the San Joaquin River Watershed 2005-2007

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Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 sampling locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report presents temporal plots of total chlorophyll *A* concentration as determined by the tri-chromatic method for all sites sampled in the SJR from 2005-2007.

Methods

Field sampling consisted of collecting water samples, measuring water quality with a YSI Sonde 6600 with MDS650 hand-held display, and recording of field conditions at sites within the study area per the *EERP Field Protocol Book*. Water samples were collected in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN) in accordance with requirements for different lab analysis and volume requirements. Bottles were labeled with the appropriate sample number, site name and sampling date. All bottles were rinsed with sample water prior to collection of a depth-integrated sample. Some sites required a bucket to collect sample water because of accessibility from a high bridge or platform. For these sites, the bucket was pre-rinsed with sample water and sample bottles were filled using a rinsed funnel. Care was taken to distribute water simultaneously to all sample bottles (rather than sequentially). Samples were immediately stored at 4°C after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the lab on the day of sampling. All bottle numbers, meter readings, and time in and out of the sample site were recorded in the field notebook.

Samples were received by the laboratory the same day they were sampled, logged in and inspected for damage, and stored at 4°C until filtering. Chlorophyll-a (chl-a) and pheophytin-a (pha-a) were extracted and analyzed using UV absorption as described in SM 10200 H (APHA, 2005). Both the trichromatic chl-a and the pha-a methods were used for quantification. Approximately 1000 mL of samples were filtered using a vacuum filtration onto a Whatman GF/F filter within 24 hours of sample collection. The sample was kept in the dark during storage and filtration. After the water was removed saturated $MgCO_3$ was applied to the sample on the filter and the filter was stored at -20°C for up to 21 days before analysis. Extraction was performed by grinding the filter with a Teflon tissue grinder in acetone saturated with 10% by weight $MgCO_3$. The extracted sample was centrifuged for 20 minutes at 2000 rpm and the chl-a and pha-a was quantified by measurement of the supernatant on a Perkin-Elmer Lambda 35 spectrophotometer (Wellesley, MA) using a 5 cm path length (Borglin, et al 2008).

Results and Discussion

Chlorophyll was analyzed routinely over the years 2005-2007 with no modification to the standard method (APHA, 2005). No standard solutions for this analysis were available so only duplicates and blanks could be analyzed to insure uniformity and accuracy in the application of the method and for those two QA parameters, there was an 86.07% passage rate for this analysis.

References

Stringfellow, W.T., et al., (2008), *Evaluation of Vegetated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley*, University of the Pacific, Stockton, CA

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008), *EERP Field Protocol Book*, University of the Pacific, Stockton, CA.

Borglin, S., W. Stringfellow, J. Hanlon. (2005), Standard *Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project*, LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA

American Public Health Association, (2005), *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, Washington, D.C.

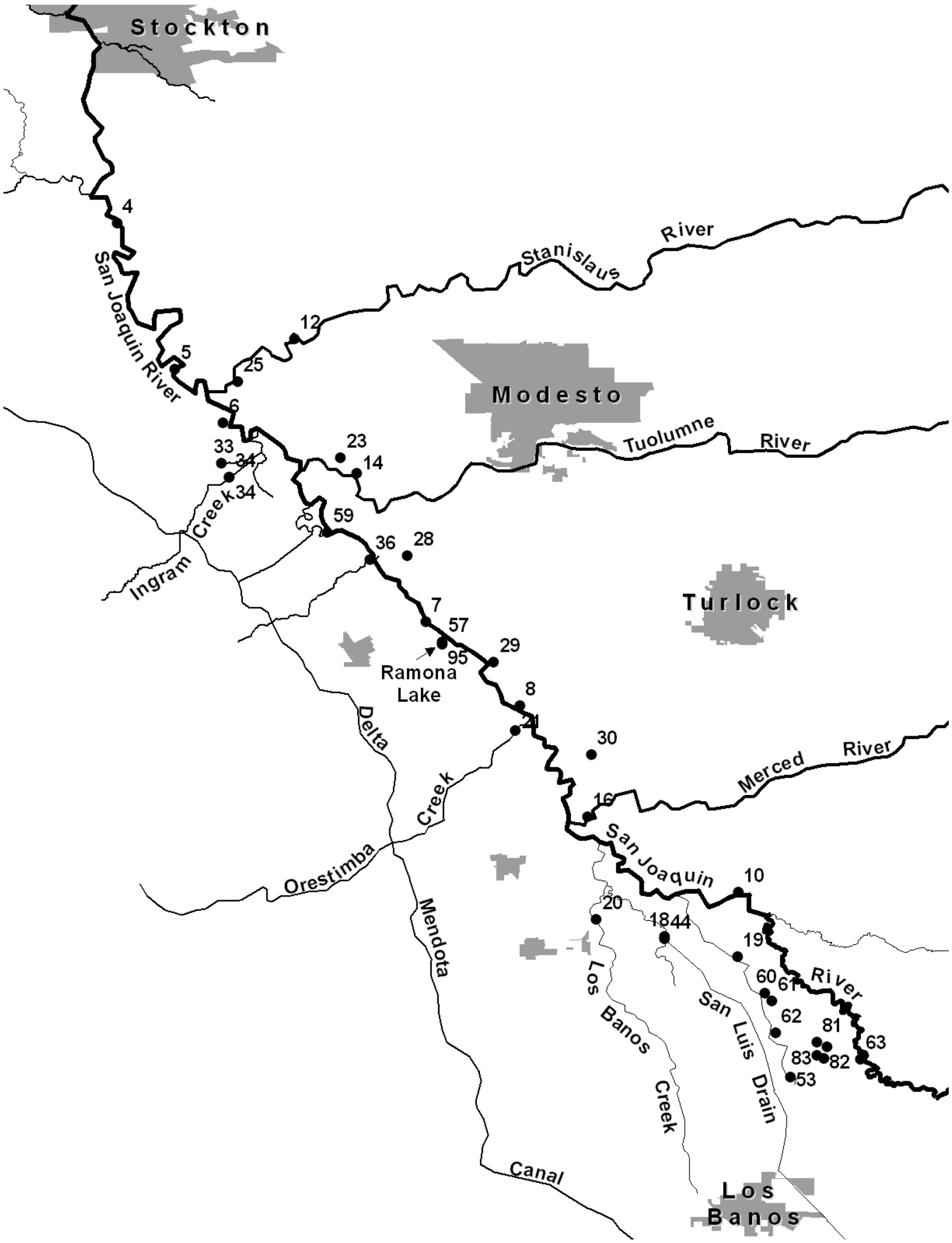
Borglin, S.E., Burks, R.D., Hanlon, J.S., Stringfellow, W.T. (2008*) EERP Lab Protocol Book*, University of the Pacific, Stockton, CA.

YSI Environmental Operations Manual, (2005), 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

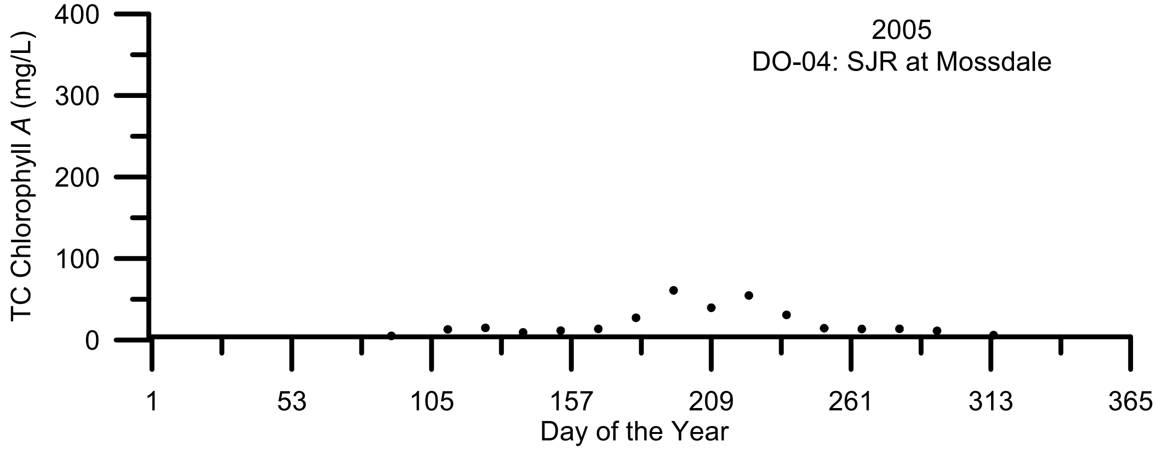
Table 1: EERP Sampling Site List

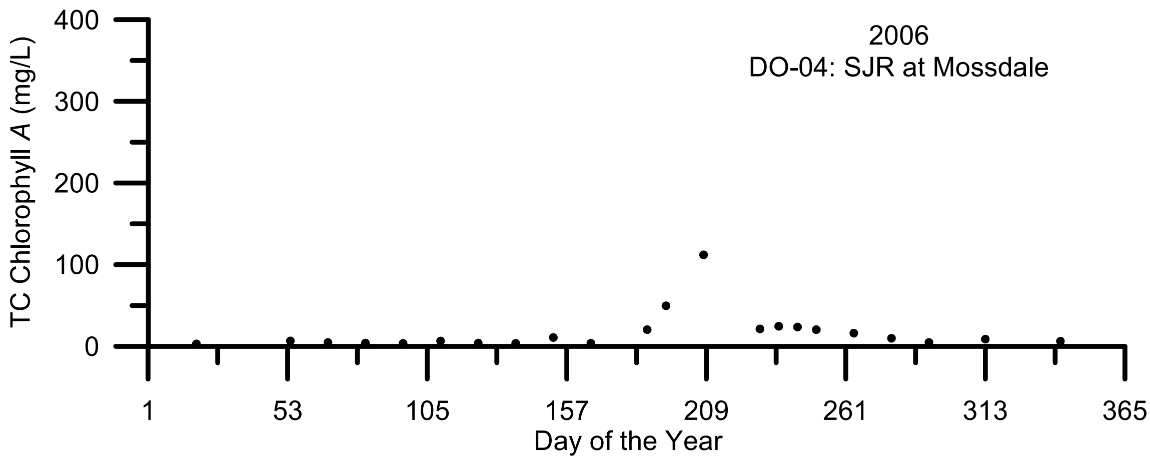
DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

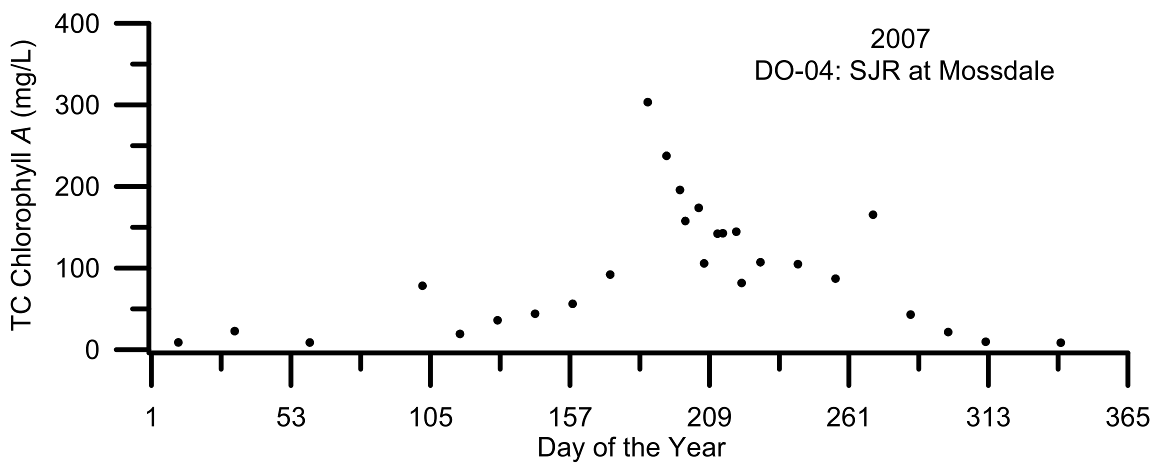
Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

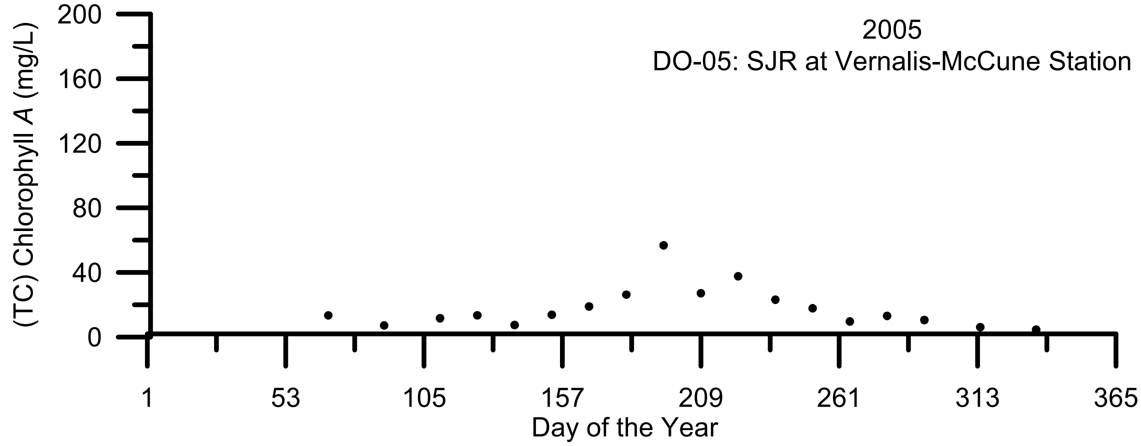


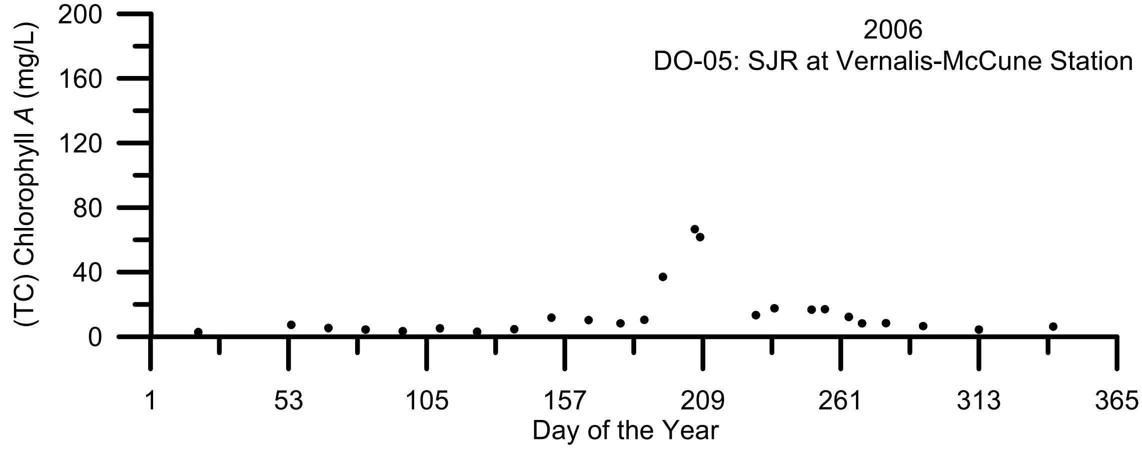
Figures 2 -72: Temporal Plots of TC Chlorophyll *A* Concentration By Site ID

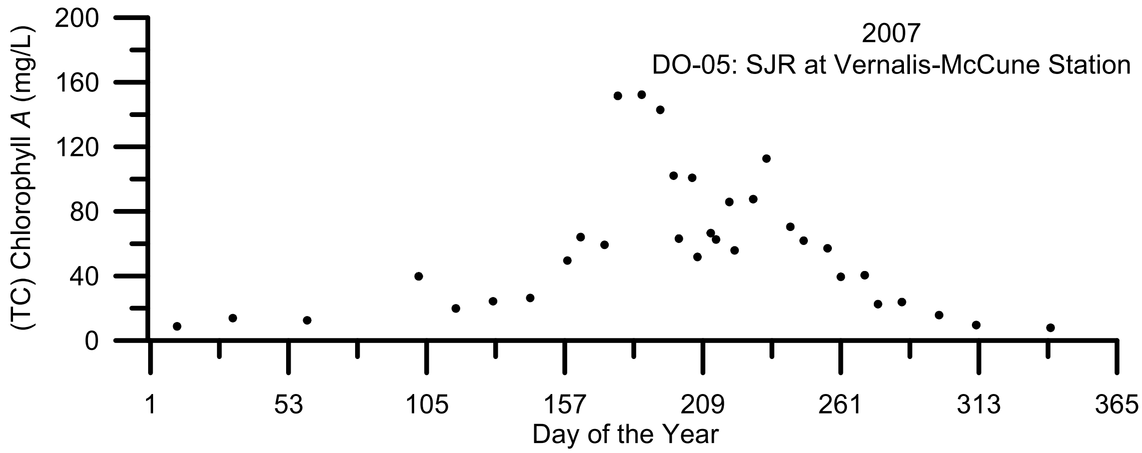


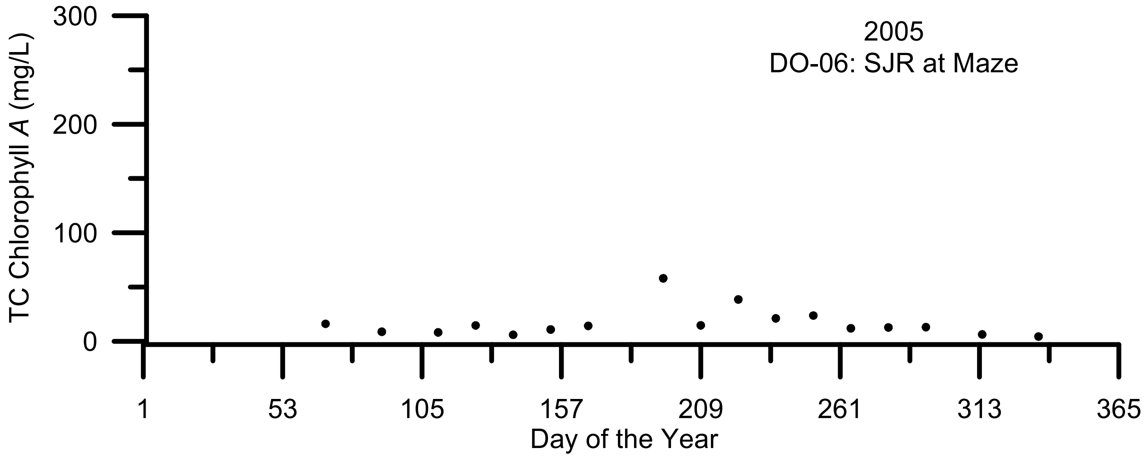


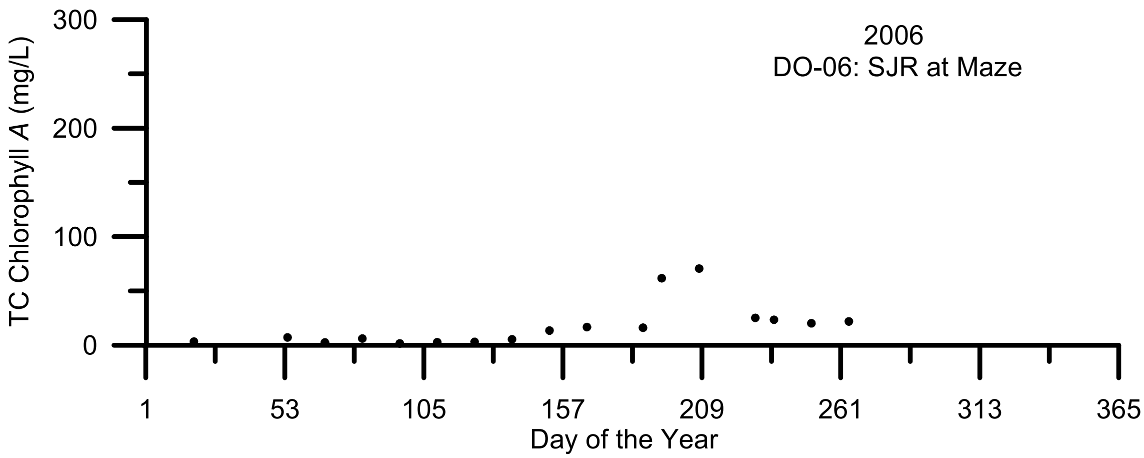


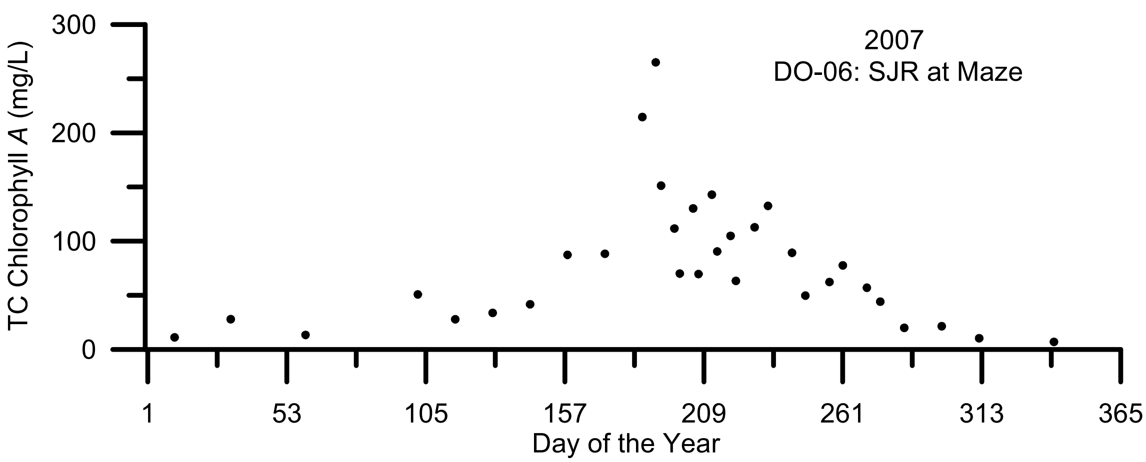

2005
DO-05: SJR at Vernalis-McCune Station
(TC) Chlorophyll A (mg/L)
0
40
80
120
160
200
1
53
105
157
209
261
313
365
Day of the Year

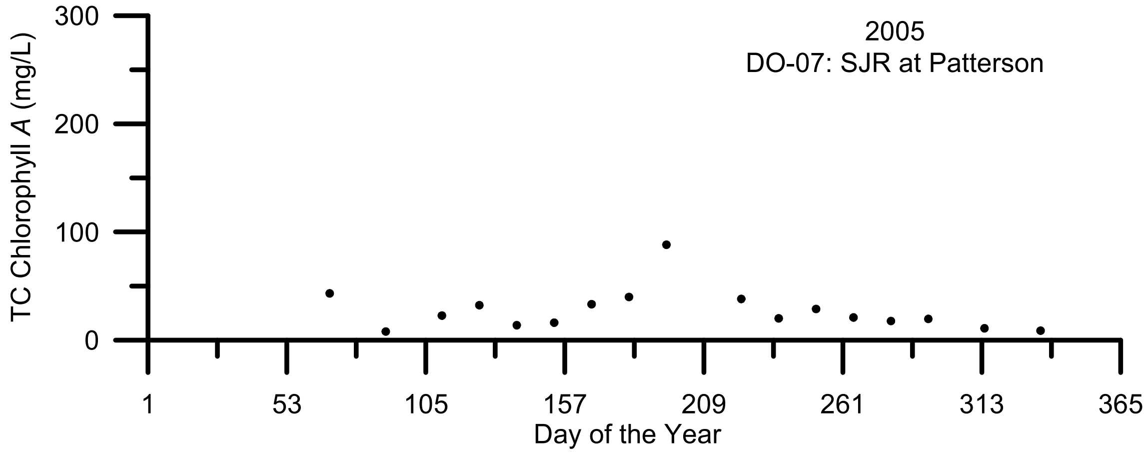

2006
DO-05: SJR at Vernalis-McCune Station
(TC) Chlorophyll A (mg/L)
0
40
80
120
160
200
1
53
105
157
209
261
313
365
Day of the Year

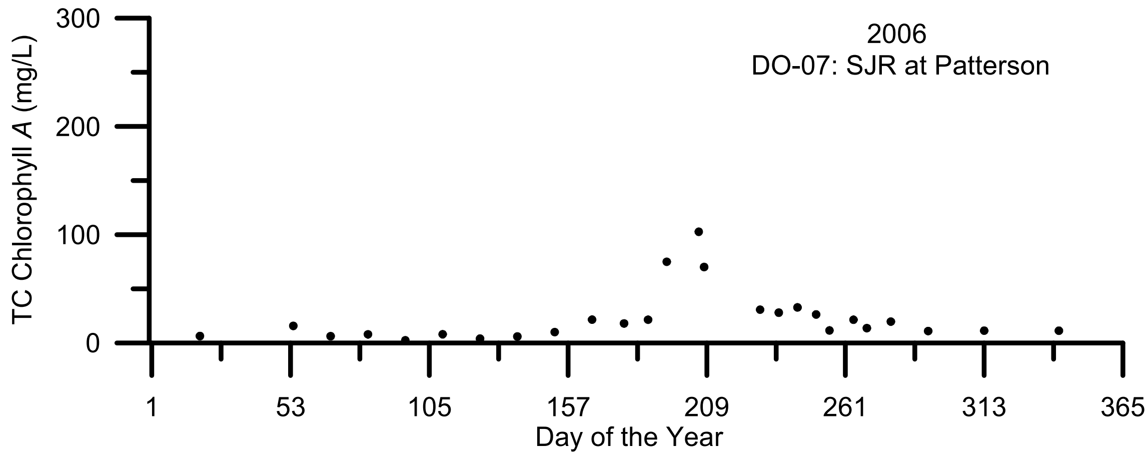

2007
DO-05: SJR at Vernalis-McCune Station
(TC) Chlorophyll A (mg/L)
0
40
80
120
160
200
1
53
105
157
209
261
313
365
Day of the Year

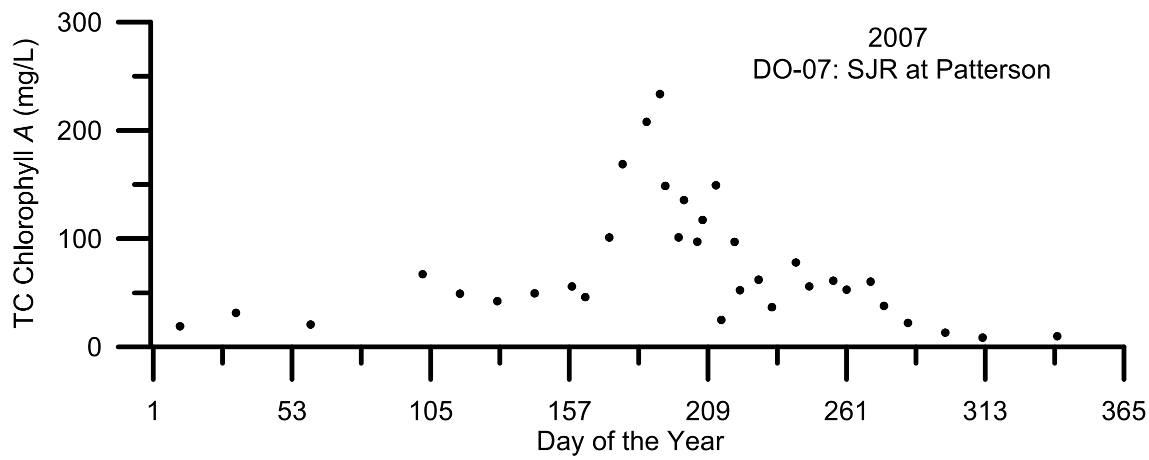

2005
DO-06: SJR at Maze
TC Chlorophyll A (mg/L)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

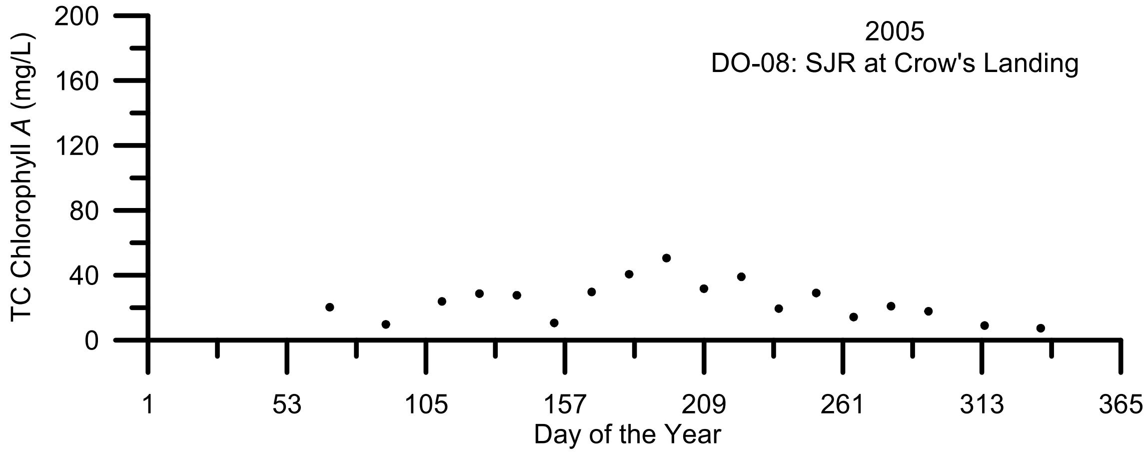

2006
DO-06: SJR at Maze
TC Chlorophyll A (mg/L)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

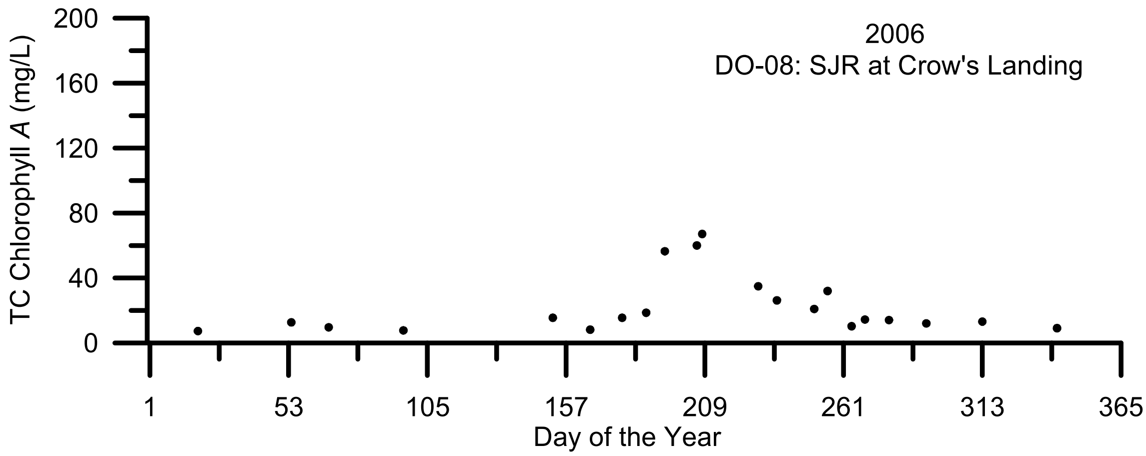

2007
DO-06: SJR at Maze
TC Chlorophyll A (mg/L)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

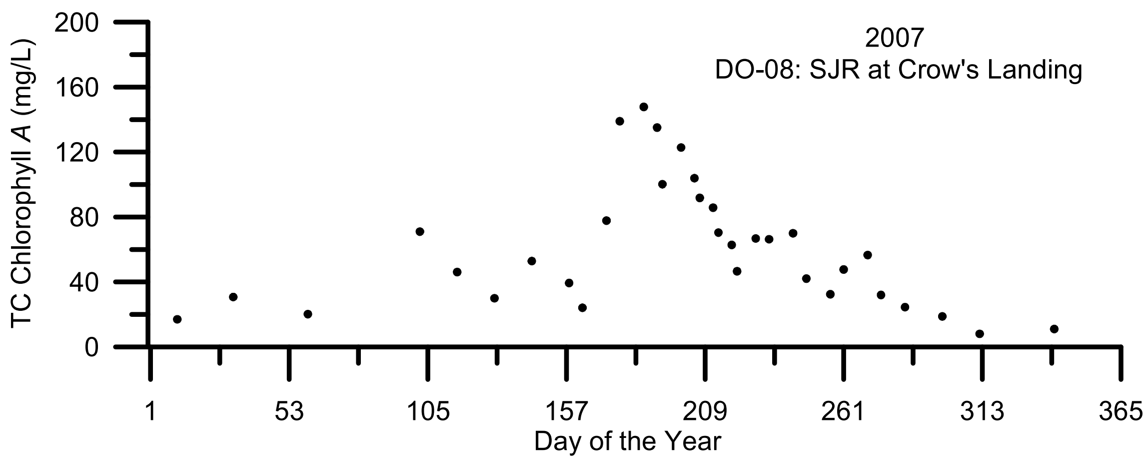

300
200
100
0
TC Chlorophyll A (mg/L)
2005
DO-07: SJR at Patterson
1
53
105
157
209
261
313
365
Day of the Year

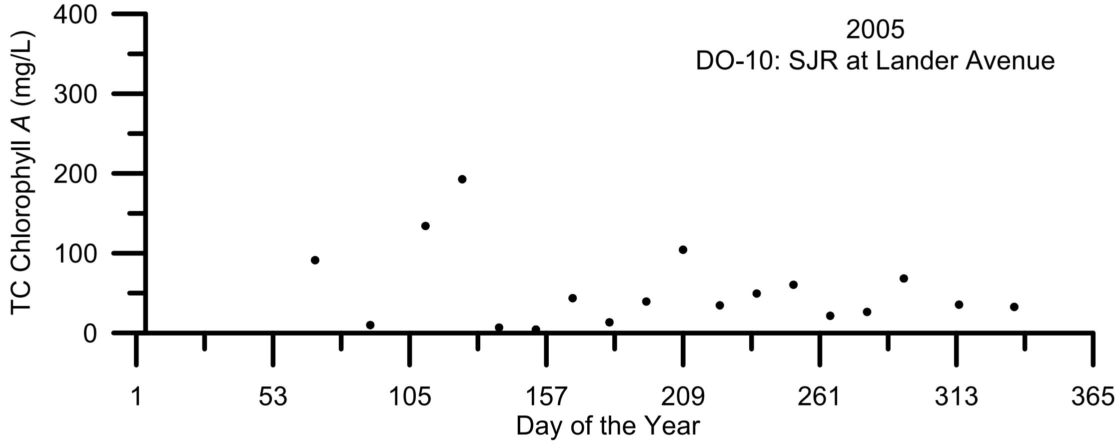

300
200
100
0
TC Chlorophyll A (mg/L)
2006
DO-07: SJR at Patterson
1
53
105
157
209
261
313
365
Day of the Year

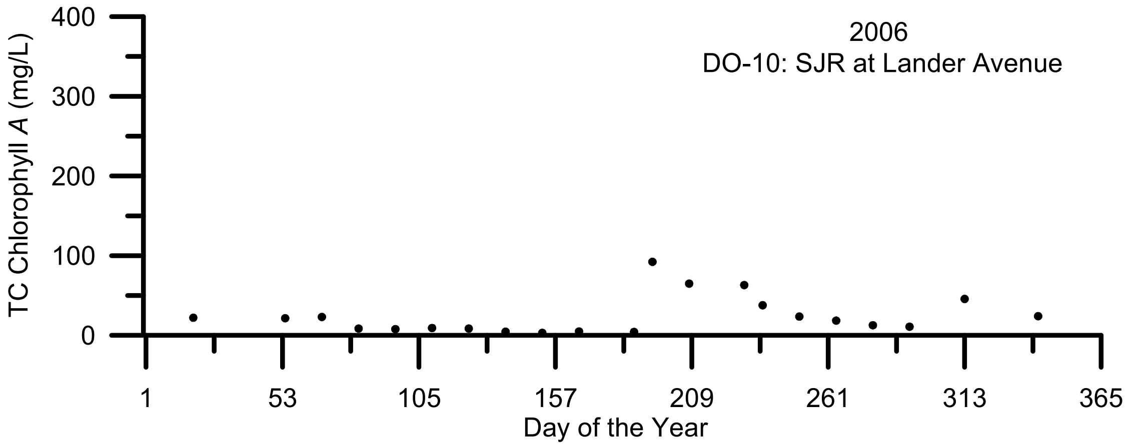

300
200
100
0
TC Chlorophyll A (mg/L)
2007
DO-07: SJR at Patterson
1
53
105
157
209
261
313
365
Day of the Year

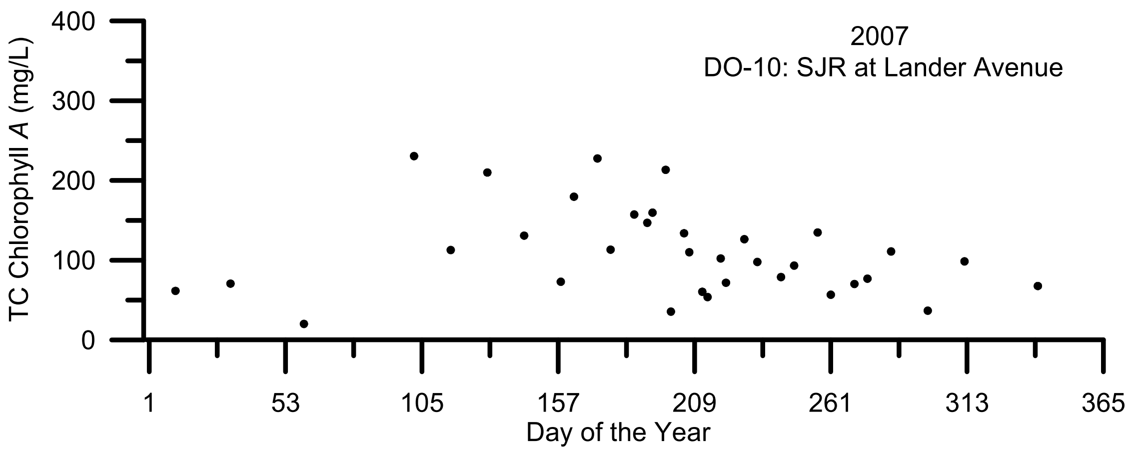

2005
DO-08: SJR at Crow's Landing
TC Chlorophyll A (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

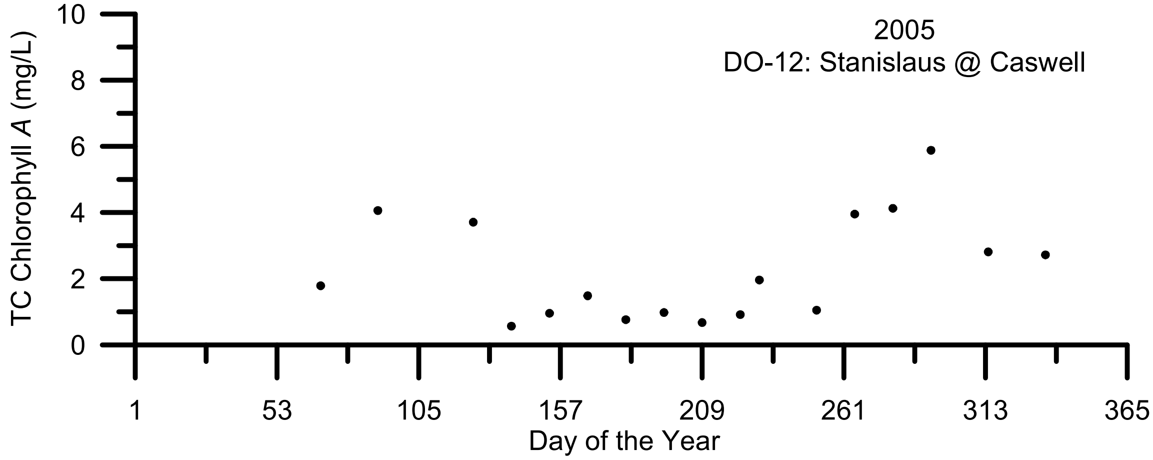

2006
DO-08: SJR at Crow's Landing
TC Chlorophyll A (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

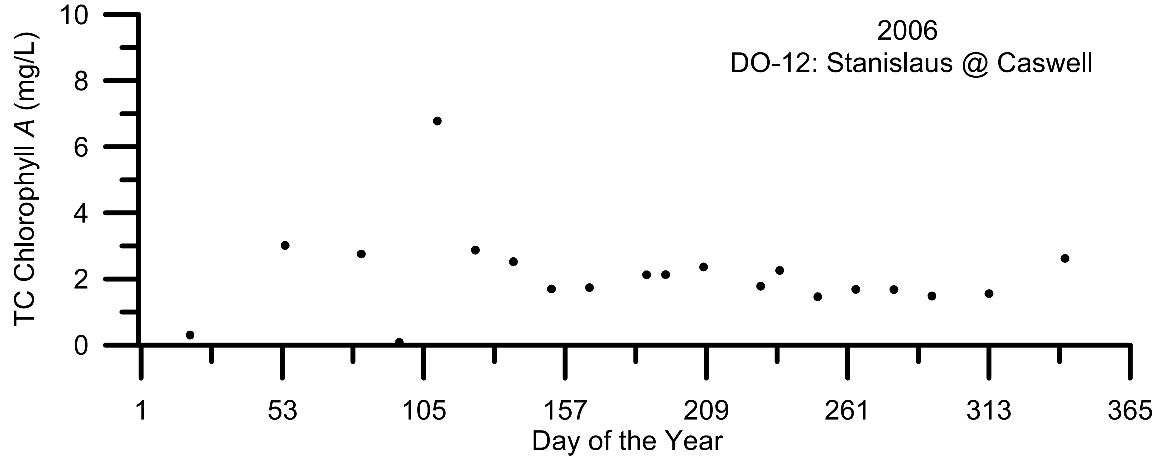

2007
DO-08: SJR at Crow's Landing
TC Chlorophyll A (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

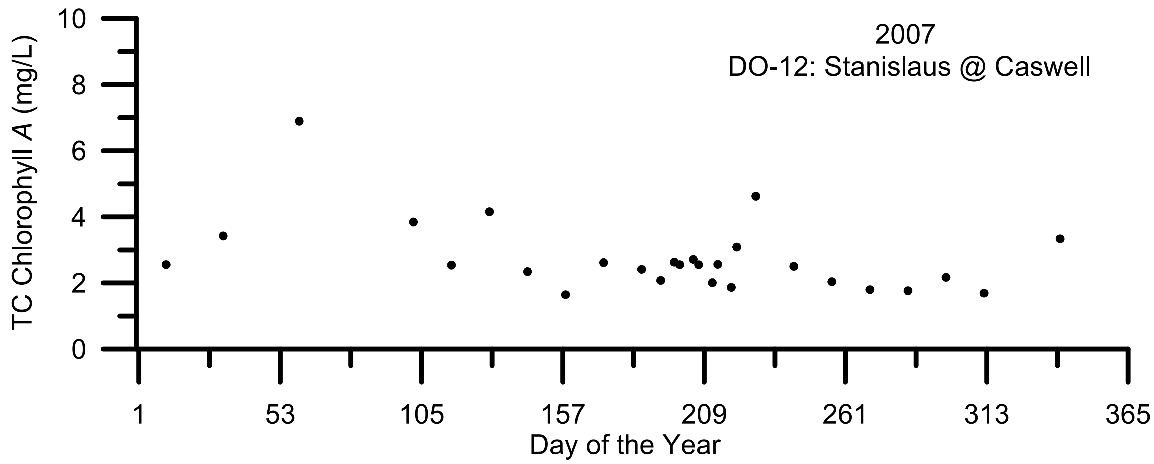

2005
DO-10: SJR at Lander Avenue
TC Chlorophyll A (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

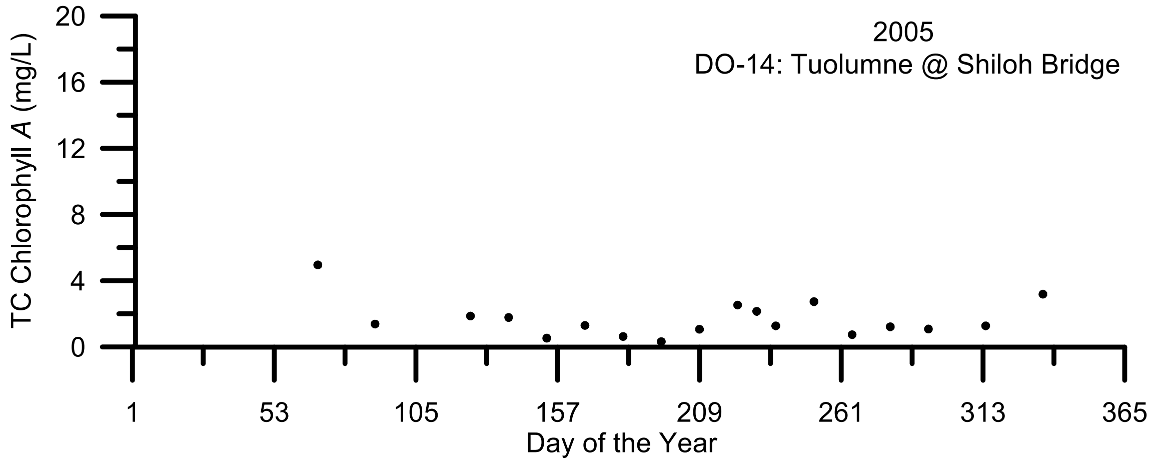

2006
DO-10: SJR at Lander Avenue
TC Chlorophyll A (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

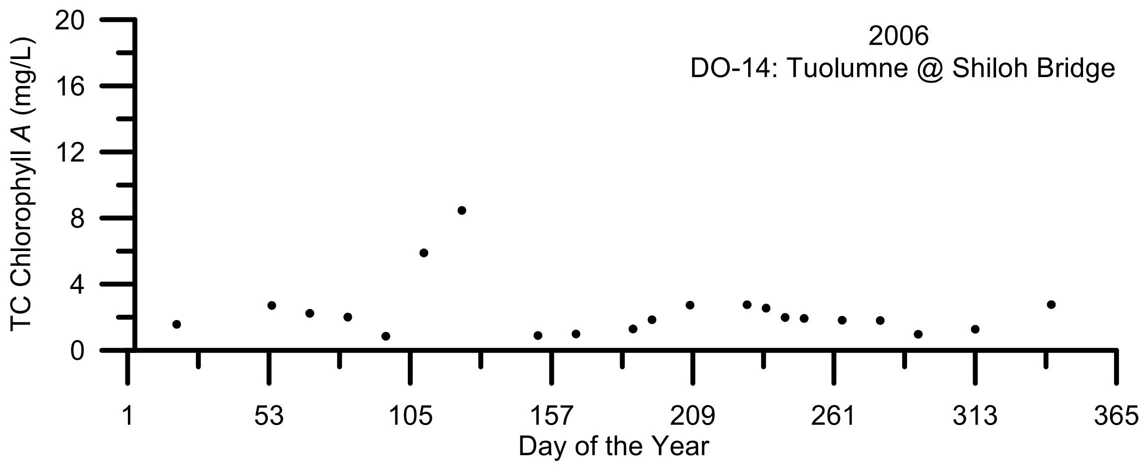

2007
DO-10: SJR at Lander Avenue
TC Chlorophyll A (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-12: Stanislaus @ Caswell
TC Chlorophyll A (mg/L)
Day of the Year
0
2
4
6
8
10
1
53
105
157
209
261
313
365


2006
DO-12: Stanislaus @ Caswell
TC Chlorophyll A (mg/L)
Day of the Year
0
2
4
6
8
10
1
53
105
157
209
261
313
365


2007
DO-12: Stanislaus @ Caswell
TC Chlorophyll A (mg/L)
Day of the Year
0
2
4
6
8
10
1
53
105
157
209
261
313
365


2005
DO-14: Tuolumne @ Shiloh Bridge
TC Chlorophyll A (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-14: Tuolumne @ Shiloh Bridge
TC Chlorophyll A (mg/L)
20
16
12
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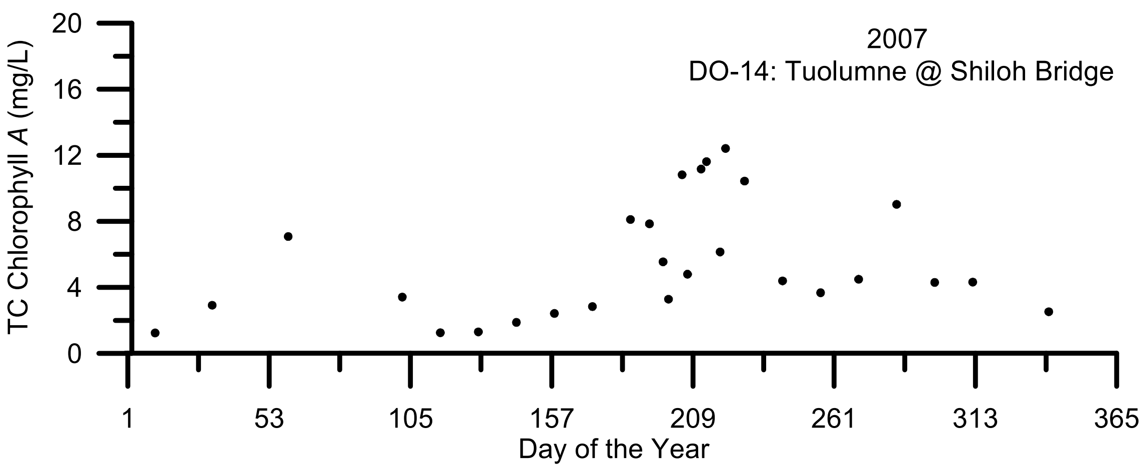
261
313
365
Day of the Year


2007
DO-14: Tuolumne @ Shiloh Bridge
TC Chlorophyll A (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year