Siuslaw Watershed Council

Volunteer Water Quality Monitoring Program
Final Monitoring Report
OWEB GRANT #1024-12398

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I. Project Introduction

This report is for the monitoring completed by the Siuslaw Watershed Council (SWC) Volunteer Water Quality Monitoring Program (VWQMP) in 2016. Grant funds for this monitoring were provided by Oregon Watershed Enhancement Board (OWEB) through project #1024-12398 and match was contributed by SWC, Oregon Department of Environmental Quality (DEQ), Bureau of Land Management, Surfrider Foundation, and Mapleton School District.

Project Background & Overview

The Siuslaw River Basin was historically home to some of the largest anadromous salmonid runs in the Pacific Northwest. Today, populations of steelhead, sea-run cutthroat trout, and ESA-listed Oregon Coast coho salmon are believed to be limited by stream complexity and a lack of clean, cold water habitat within the basin and thus remain well below historic population levels. Over 236 river miles in the Siuslaw basin have been identified as "impaired" (placed on the CWA Section 303d list) by the U.S. Environmental Protection Agency (EPA) and DEQ, with temperature, bacteria, biological criteria, sedimentation and dissolved oxygen cited as water quality limitations. Likewise, the Oregon Coastal Coho Assessment identified water quality as population-limiting across the Siuslaw basin. A Total Maximum Daily Load (TMDL) has not been completed yet, but the Siuslaw Watershed Council has been working with DEQ TMDL staff since 2005 to inform the process.

It was 1999 when area residents and the SWC staff came together to establish the SWC VWQMP. In the spirit of The Oregon Plan, citizens took an active role in local watershed enhancement through water quality data collection and analysis. Originally, the goal was to establish baseline water quality data for eight sampling sites. By 2016, the program included 12 grab sample sites, six continuous temperature sites and six continuous dissolved oxygen sites, and has progressed from establishing baseline data to identifying and understanding trends in water quality dynamics, which in turn informs watershed management and restoration decision-making.

In addition to benefitting watershed planning, the VWQMP has broader impacts that ensure the long-term sustainability of the watershed through citizen engagement. By collaborating with the Siuslaw and Mapleton School districts, students were trained as volunteers for field data collection and lab processing, building skills and personal interest in their local watershed. These same students recruited their parents to participate in SWC programs, thereby strengthening community ties to their watershed.

Grab Sampling

In 2016, SWC continued monthly monitoring at 12 existing grab sample sites. The following water quality parameters were monitored: temperature, dissolved oxygen (DO), turbidity, clarity, salinity (estuary sites), and bacteria. Additional qualitative metrics included weather conditions and tidal stage. Monitoring days were on the third Tuesday of each month. Trained volunteers collected samples and field measurements, and processed bacteria samples in the SWC lab. Trained Mapleton Middle and High School science students processed DO samples under direct supervision of SWC staff. All volunteers were trained to follow the protocols described in the DEQ Water Quality Volunteer Monitoring and Quality Assurance Project Plan (2009) and the Oregon Plan for Salmon and Watersheds' Water Quality Monitoring Technical Guide Book. The data were reviewed by the SWC staff, submitted to DEQ Volunteer Water Quality Monitoring Program (VWQMP), and uploaded by DEQ into the Ambient Water Quality Monitoring System (AWQMS) water monitoring data portal. The AWQMS portal allows access to DEQ data and data provided from partner groups, such as watershed councils, for the public to view, query, chart, graph, and download.

Continuous Monitoring

In addition to the grab sampling, SWC continued the five continuous temperature monitoring sites established in OWEB grant #1035-10976 along the mainstem Siuslaw River and Lake Creek. We also deployed six continuous DO/temp loggers at previous LASAR sites, replicating the density of loggers deployed in SWC's 2005 season and to provide a 10-year update and support for the Siuslaw Basin Dissolved Oxygen TMDL development process.

The SWC VWQMP is multi-purpose and continuous data collection efforts help: (a) assess current conditions against state standards (b) assist in the Siuslaw Basin TMDL development process, and (c) assess and update restoration opportunities and priorities. Continuous temperature monitoring data is used to calculate a "rolling" the seven-day-average maximum temperature (based on the preceding and following three days of a given daily maximum) that will facilitate a better understanding of the frequency and extent of thermal maximums that can negatively impact salmonids and other cold water aquatic species. This metric also matches the Oregon Administrative Rules, chapter 340, Division 41: "The seven-day-average maximum temperature of a stream identified as having salmon and trout rearing and migration…may not exceed 18.0 degrees Celsius" (see appendix A). This is the same metric used by the DEQ and

EPA when listing 105 river miles of the mainstem Siuslaw as Category 5, water quality limited, needing a TMDL, 303 (d), in the Oregon Integrated Report. The results section of this Final Analysis and Report graphs the mainstem Siuslaw 7-day rolling averages with the State standard of 18˚C.

Continuous DO monitoring is used to calculate a "rolling" 30-day minimum mean of DO concentrations (based on the preceding 30 days) that will facilitate a better understanding of DO conditions along the 105 river miles of the Siuslaw also listed as Category 5, water quality limited, needing a TMDL, 303 (d), for low DO concentration. The 30-day minimum mean was used by the DEQ and EPA for the Integrated Report listing, and is the standard established in the Oregon Administrative Rules, Chapter 340, Division 41 (see appendix A). The results section of this Final Analysis and Report graphs the mainstem Siuslaw 30-day minimum mean DO concentration with the State standard of 8 mg/L.

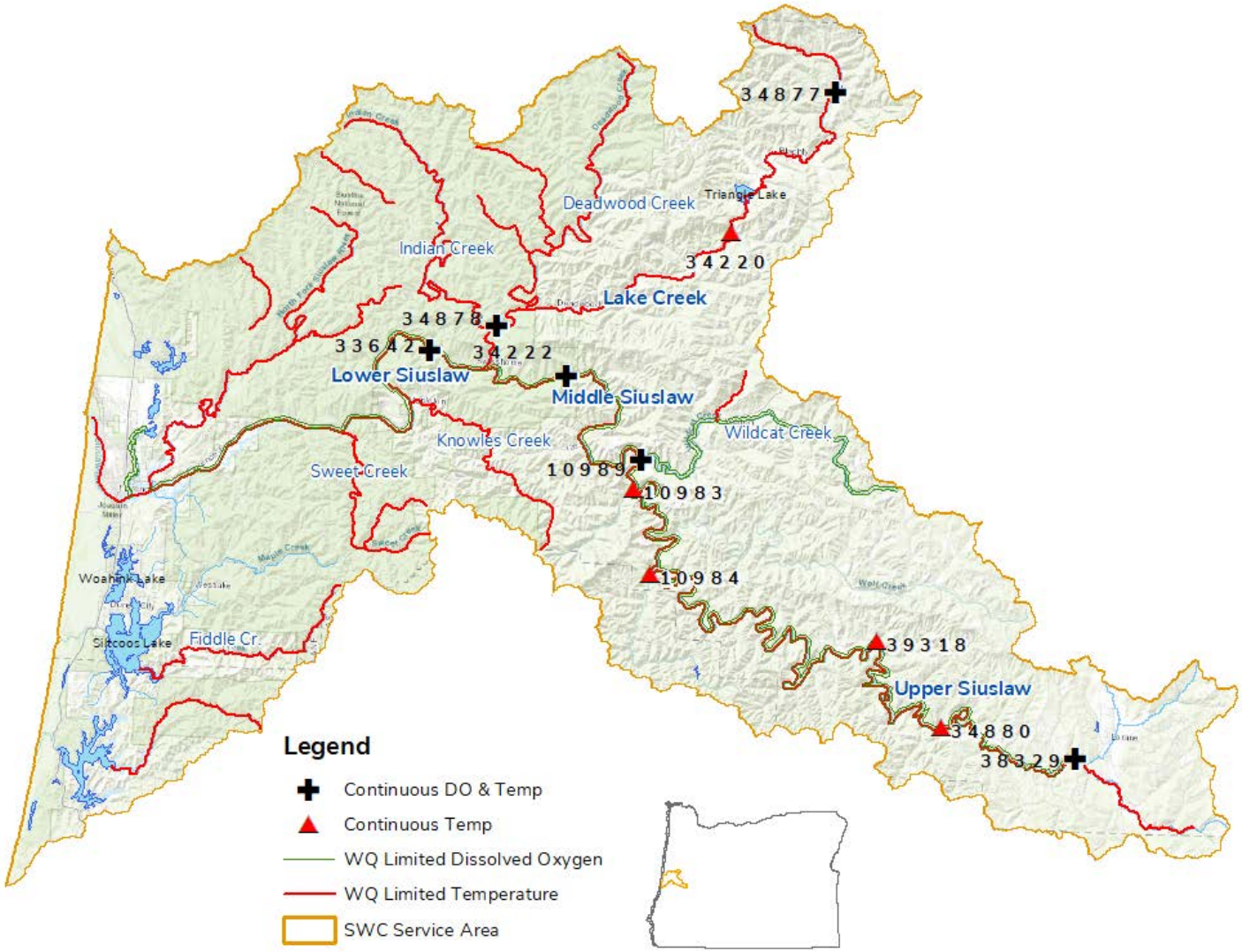
Nutrients and Supporting Chemistry/TMDL Support

DEQ is developing TMDLs on a watershed-by-watershed basis using continuous DO data collected during periods when data show standards are not consistently being met as a basis for developing nonpoint source load and point source waste load allocations. SWC continuous DO, temperature, and nutrient data are being used to populate, calibrate, and validate a process-based model, QUAL2Kw, that will enable DEQ to examine factors controlling dissolved oxygen dynamics in the Siuslaw. When continuous DO data are combined with nutrients and other supporting chemistry, analysts can assess whether the primary limiting drivers of DO are nutrients and organic matter (and associated diel photosynthetic and respiration cycles), temperature, or a combination of these factors.

DEQ performed continuous DO studies at the Tide Wayside station in 2008 (spring and fall). The 2016 SWC program complemented that dataset and provided updated information with which to calibrate and improve models. Until 2016, no continuous DO data had been collected in the upper Siuslaw watershed. Our 2016 efforts provided a basis for use of river metabolism and mechanistic watershed models in evaluating patterns, drivers and assessment of potential management actions to improve DO conditions in the entire 303(d) (DO) listed section of the mainstem Siuslaw River.

SWC planned to collect nutrient and supporting chemistry samples during typical low flows, prior to onset of the spawning season in 2016. This was postponed until 2017 and is discussed in the final analysis and report for the 2017 monitoring season.

II. Monitoring Sites



Continuous Temperature & Dissolved Oxygen Monitoring Sites

All sites monitored were at or near sites that were previous monitored for TMDL development and most are LASAR sites. The following provides a list of the sites:

• Siuslaw River at Tide wayside (TWS): This site is a current DEQ Ambient station (LASAR 33642 - Siuslaw River at Tide boat ramp) with data collected by DEQ in 2008. Conducting continuous DO-Temp data collection assists in determining the current status (impaired or meeting criteria) and if impaired, whether TMDLs should be developed using steady-state or other tools.

• Siuslaw above Barber (SBT, 34222): This location is an established LASAR site. This site will aid in understanding the Middle Siuslaw's temperature and dissolved oxygen regime above the confluence of Lake Creek. Continuous data for temperature has been collected at this site in 2005, 2007, 2014 and 2015. We will compare this continuous DO data with the Tide wayside data to determine how much Lake Creek influences fluctuations in dissolved oxygen.

• Siuslaw River above Whittaker Creek (SAW, 10983): This location is an established LASAR site from 2005 and continuous temperature data complemented our sampling efforts at MU-15. Continuous temperature data was collected here in 2005.

• Siuslaw River above Esmond Creek (SAE, 10984): This location is an established LASAR site and helps characterize the temperature regime in the mid-to-upper Siuslaw River. Continuous temperature data was collected here in 2005 and 2015.

• Siuslaw River above Pheasant Creek (SPT, 39318): This location is an established LASAR site and helps characterize the temperature regime in the middle Upper Siuslaw sub-basin. Continuous temperature data was collected here in 2005 and 2015.

• Siuslaw above Doe Creek (SDT, 34880): This location is an established LASAR site in the Upper Siuslaw site which will facilitate an understanding of the temperature regime of the upper reaches in the mainstem Siuslaw. This site is located below Siuslaw Falls and above the transition into forested land managed by the BLM and industrial timber companies. Continuous temperature data was collected in 2005, 2014, and 2015.

• Upper Siuslaw River below North and South Forks (FRB, 38329): This site is located just upstream of the LO- 16 grab sample site. Continuous temperature and conductivity data has been collected during the summers of 2014 and 2015. SWC deployed a continuous DO/temperature logger in the summer of 2016 to determine the extent of

dissolved oxygen conditions near the headwaters and compare them with the TWS and SBT sites.

• Lake Creek above Indian Creek (SIT, 34878): This location is an established LASAR site. It is above the confluence of Lake Creek and the Siuslaw and above the confluence with Indian Creek. This site aids in assessing the contribution of Lake Creek to the Middle Siuslaw temperature regime. SWC deployed a temperature/DO logger to determine the dissolved oxygen conditions on Lake Creek and to compare with the upstream LAL site near the headwaters. Continuous temperature data was collected here in 2007, 2014 and 2015.

• Lake Creek above Fish Creek (LFT, 34220): This location is an established LASAR site. Lake Creek is a major tributary to the mainstem Siuslaw. This site is below Triangle Lake, providing an important characterization of the lotic influences on thermal dynamics. Continuous temperature data was collected here in 2007, 2014 and 2015.

• Lake Creek below Hult (LAL, 34877): This site is located on Lake Creek, a major tributary to the Siuslaw, about ¼ mile below the Hult Log Pond. Continuous temperature data has been collected here in 2007, 2014 and 2015. A temperature/DO logger will help us understand the dissolved oxygen conditions on Lake Creek as it discharges from this man-made waterbody.

• Wildcat Creek (WCS, 10989), located 100 meters upstream of the confluence with Siuslaw River: This site is located just above the mouth of Wildcat Creek and was new in 2016. Adding density and future deployments seasons on Wildcat is a goal for DEQ and SWC.

Continuous loggers were strategically placed along the Siuslaw mainstem at 7 sites (4 temperature & 3 temperature/dissolved oxygen) to understand temperature and DO regimes and 3 sites (1 temperature & 2 temperature/dissolved oxygen) along Lake Creek to address the need for additional dissolved oxygen data. This need on Lake Creek was identified after SWC staff reviewed the 6 years of grab data from BT-14 and 10 years of grab data from TL-12 and noticed that the dissolved oxygen and percent saturation were consistently below DEQ standards in the winter and summer months (see appendix B). We deployed two temperature/dissolved oxygen loggers in Lake Creek at two existing continuous temperature LASAR sites (LAL & SIT) above and below Triangle Lake. This area is classified as a moderate to high priority sub-basin and is 303(d) listed for exceeding summer temperatures (cold water aquatic life criteria). The loggers will advance our ability to understand the timing and magnitude of temperature and dissolved oxygen exceedances and more accurately prioritize water-quality-focused restoration efforts.

Segments, or reaches, of the mainstem Siuslaw River have been identified as water quality limited by the DEQ for temperatures that exceed state standards (Siuslaw RM 5.7-105.9; Lake Creek RM 0 to 28.3), dissolved oxygen levels exceeding standards (RM 5.7-105.9) and high sediment loads (NF Siuslaw RM .4 to 27.3). DEQ has seasonal criteria for these pollutants based on many factors including what aquatic organisms like salmon need in order to spawn and rear in our streams.

In coordination with DEQ's TMDLs program and the DEQ Lab, we deployed three temperature/dissolved oxygen loggers at sites in the Siuslaw River near Tide (TWS), the Siuslaw River above Barber (SBT) and the Upper Siuslaw River above the Fire Road bridge (FRB). The two existing 303(d) listings for dissolved oxygen (spawning and non-spawning) on the mainstem Siuslaw River are based on data from one Mapleton monitoring location for River Mile 5.7 to the headwaters at River Mile 105.9. Because of the occasional tidal incursions at the former ambient site in Mapleton, the site was moved a short distance upstream to the Tide Wayside in mid-summer 2006. DEQ conducted follow up monitoring at the Tide Wayside site in June and November 2008 and collected continuous DO, temperature, pH, conductivity data, plus grab nutrients. Based on that monitoring, dissolved oxygen values at this site appeared to meet standards; however a data review conducted by DEQ in 2015 indicates the 2008 data does not provide a clear understanding of the status of DO conditions in this segment of the mainstem. The 2016 SWC continuous DO data bookends the listed reach with Tide Wayside (TWS, 33642) on the downstream and Fire Road Bridge (FRB, 38329) on the upstream extent in order to provide a clearer understanding of the status of DO concentration in this reach.

Grab Sample Sites

Estuarine sites

The estuary had been determined to be of the highest priority for restoration through the 2007 SWC Siuslaw Watershed and Coastal Lakes Seventh Field Aquatic Priority Classification process. The OWEB-funded Siuslaw River Strategic Action Plan for Coho Recovery underscores the importance of the estuary in the life history strategy of Siuslaw River OC coho population and identifies the estuary as a high priority area for restoration. The estuary monitoring sites served as baseline locations for past and future restoration projects. These sites were chosen because they represent three tiers of estuarine brackish water dilution, are proximal to confluences of major estuary tributaries, and have public access. Collection at these four sites and a partnership on

an additional site (North Fork Siuslaw River near the mouth, in partnership with the Confederated Tribes of the Coos, Lower Umpqua and Siuslaw Indians) resulted in a valuable long-term water quality dataset.

• Florence Boat Basin (SWC ID FB-2, LASAR ID 38327): This is the furthest downstream site in the program, and is the SWC's only urban site. Data has been collected here since August, 2002. Data from this site has been reasonably characterized, and new data is now being analyzed for trending.

• South Slough (SS-3, 34085): This site is below the tidegate on the South Slough, one of the major direct tributaries to the estuary. Data has been collected at this site since August, 2002. Data from this site has been reasonably characterized, and new data is now being analyzed for trending and is informative about tidegate management and water quality.

• Mapleton Dock (MD-6, 10392): This site is located near the head of tide and allows us to monitor a location on the mainstem that has less estuarine influence. Samples are collected at this site by Mapleton Middle and High School Science students with Siuslaw Institute staff during the school months. Data has been collected at this site since August, 2002. This site previously served as a DEQ ambient site. According to the Oregon Water Quality Index, this site was characterized as having poor water quality and was determined to have an 80% likelihood of a negative trend in water quality. This site is no longer a state ambient water quality monitoring site yet given the aforementioned likelihood.


38331
Deadwood Creek
Triangle Lake
Indian Creek
Lake Creek
38328
38330
Lower Siuslaw
Middle Siuslaw
34879
10392
Knowles Creek
Wildcat Creek
34082
Sweet Creek
38327
10983
34085
10990
Upper Siuslaw
Fiddle Cr.
38329
Legend
SWC Grab Sites
WQ Limited Dissolved Oxygen
WQ Limited Temperature
SWC Service Area
DEQ Lakes

• Karnowsky Creek Lower Bridge (KC-7, 34082): This site is located downstream of the Karnowsky Creek Restoration project and serves as a long-term estuary monitoring site for this project. Samples are collected by students in the Siuslaw Institute's Mapleton Schools Natural Resource Education Program and volunteers. Data has been collected at this site since September, 2003; data has been reasonably characterized, and new data is now being analyzed for trending.

Freshwater Grab Sample Sites

The middle and upper watershed freshwater sites were selected due to their downstream proximity to rural residential areas, to medium and high priority restoration areas, and changes in land use and public access. We also selected two sites above and below the largest lake in the watershed to explore the impacts of the unique waterbody on water quality.

• North Fork Siuslaw at Minerva (NF-M, 38330): a new site in 2011. The North Fork of the Siuslaw is a major contributor to the estuary. This location is significant as it is at a transition in land use/land management from primarily USFS Late Successional Reserve managed forest lands to privately owned land managed primarily for livestock and agriculture. There is a Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians (CTCLUSI) monitoring site downstream in the estuary, which allows for paired comparison with varied salinity when datasets are combined.

• Chickahominy Creek (CH-11, 34879): Located in the highest priority sub-basin in the Wildcat fifth-field HUC. The Chickahominy subwatershed has undergone many recent restoration projects based on its anchor coho salmon habitat and proactive community base in Walton. Data has been collected at this site since October, 2005. The bacteria data collected at this site were requested and examined by DEQ after receiving pollution complaints from landowners in the Walton area.

• Lake Creek above Triangle Lake (TL-12, 38331): This monitoring site is located above Triangle Lake, which will allow us to have better knowledge of water quality conditions up- and downstream of the lake.

• Deadwood Creek (DW-13, 38328): The site is downstream of two high priority subwatersheds (Upper and Lower Deadwood Creek). Numerous restoration projects exist upstream of this site, along with rural residential developments. An expanded role of current volunteers allowed us to reopen this site in June, 2009. Deadwood community members are supportive of a monitoring site.

• Lake Creek at Fish Creek (BT-14, 34220): This site provides a monitoring site below Triangle Lake and at the confluence of an important tributary of Lake Creek. A new volunteer allowed us to open this site in August, 2009.

• Middle/Upper Siuslaw, above Whittaker Creek (MU-15, 10983): This site is a LASAR site, established during the temperature TMDL data collection process in 2005.

• Upper Siuslaw, Lorane (LO-16, 38329): Headwaters of the Upper Siuslaw are located in a unique ecoregion compared to the rest of the basin, the Southern Willamette Ecoregion, and therefore the Upper Siuslaw is affected by different hydrologic and ecological processes. In January 2015, LO-10 was discontinued because it was located on the North Fork, not the mainstem, and a SWC volunteer sampled a new site (named LO-16) downstream of the confluence of the South Fork and North Fork Siuslaw where SWC deployed a temperature and conductivity logger in summer 2014 and 2015, and a temp/DO logger in 2016-2018. Grab and continuous sampling efforts will complement each other and allow for both broad and fine scale comparisons throughout the year. The land directly upstream of the site is intensely managed for agriculture and rural residential use, whereas downstream is used heavily for timber production.

• Wolf Creek (WC-17, 10990): In 2016, we added one grab site on BLM property 500 feet upstream of the bridge at the mouth of Wolf Creek to assist in characterizing this watershed and address its influence on the Upper Siuslaw River. This watershed is a medium priority for restoration, and therefore, a priority for water quality monitoring. The site is located upstream of the bridge so that is it not influenced by the Siuslaw River, especially during high winter flows. BLM has invested effort to collect multiple years of continuous temperature data near this site (1995 to 2005), which will help complement our grab sample data. Additionally, this is an established LASAR site (#10990) at the bridge and DEQ has collected toxics data here in 2013, as well as a year of monthly grab samples for field parameters plus E. coli from March 2007 – February 2008. There is enough data from LASAR and BLM to establish an expected range and variability of field conditions.

III. Parameters and Methods

Continuous loggers

Continuous dissolved oxygen and temperature were measured using Onset U26 Dissolved Oxygen Data Loggers and Hobo U22 temperature loggers. Pre- and post-deployment accuracy checks were performed before and after the rearing season deployments (June 1st – September 14th). Monthly audits were conducted with a NIST-certified thermometer that measures air and water temperature near the logger. DO field audits occurred at deployment and retrieval with Winkler or calibrated DO meters. Loggers must be within +/- 0.5 degrees Celsius of the reference temperature and +/- 0.3 mg/L of the calibrated DO meter in order to be useable data.

Grab Samples

Temperature grab samples were conducted using thermometers that are accuracy checked with NIST standards. Temperature impacts biological and chemical processes and aquatic organisms depend on water within a certain temperature range for survival. Temperature impacts the oxygen content of the water, photosynthesis rates, and metabolic rates of organisms.

Turbidity is the measurement of clarity. Suspended materials such as soil, algae, plankton, and microbes in water block the passage of light. High turbidity limits photosynthesis by blocking sunlight and increases water temperature because suspended particles absorb more heat. This can reduce the concentration of dissolved oxygen because warm water holds less dissolved oxygen than cold. Suspended or settling particles can also black fish gills and smother eggs. Turbidity was measured in Nephelometric Turbidity Units (NTU) using a Portable Turbidity Meter (Hach 2001P). The meter was checked for accuracy monthly and measurements were within 5% of standards during 2016. Field volunteers performed three tests with each sample and the average was recorded.

Dissolved Oxygen (DO) is both produced and consumed in streams. Streams gain oxygen from the atmosphere and from plants as a result of photosynthesis. Riffles and rapids in water, because of the agitation, dissolve more oxygen than still water, such as a lake. Respiration by aquatic organisms, decomposition, and various chemical reactions consume oxygen. DO samples were collected by field volunteers in 300 mL bottles and measured using the Winkler Titration Method. Volunteers performed two tests with 100 mL of sample water; if the results of these tests were within 5%, the average was recorded. If the results were not within 5%, another sample was titrated and used to average

Escherichia coli (E. coli) are used as indicators of sewage contamination because they are commonly found in human and animal feces and the EPA recommends testing for *E. coli* in recreational waters. *E. coli* was measured using the Colilert-18 method. Estuary samples were diluted 1:10, freshwater samples were not diluted. To verify the accuracy of these tests, we concurrently ran a Blank sample, using distilled water, a Replicate sample (two samples taken from the same location at the same time; for freshwater sites) and a Split sample (two tests processed from the same sample bottle; for saltwater sites). For Surfrider partner beach sites, the Enterolert method was used.

Salinity is the concentration of salt in water measured in parts per thousand (ppt). Salinity was measured using a Refractometer. Samples were read twice and the average was recorded. Estuarine organisms have tolerance ranges for salinity and when salinity goes outside of that range they are negatively affected. Salinity also affects dissolved oxygen in the estuary because the amount of oxygen that can dissolve in water decreases as salinity increases.

Clarity, or transparency, was measured using a Secchi Disk (metal disk, eight inches in diameter that is lowered into the water on a rope. The depth at which the disk can no longer be seen is the Secchi depth. When clarity is high, Secchi depth is high. SWC volunteers read the disk was twice and the average depth was recorded.

IV. QA/QC

The SWC Volunteer Water Quality Monitoring Program has an approved SAP on file with the ODEQ. We update QA/QC procedures as they evolve and follow the ODEQ's QAPP Water Quality Volunteer Monitoring and amend SWC's SAP to include continuous dissolved oxygen loggers according to the ODEQ QAPP (See appendix C).

Trained volunteers collected data at established VWQMP sites. The volunteers represent a wide variety of watershed residents, including students from Mapleton Schools, retirees, and other community members. The volunteers were trained to follow the protocols set forth in the Oregon Plan for Salmon and Watersheds Water Quality Monitoring Technical Guide Book and the ODEQ's QAPP Water Quality Volunteer Monitoring. When volunteers were unable to sample, SWC staff collected the samples whenever possible. Trained lab volunteers and SWC staff processed bacterial and turbidity samples in the SWC lab. Trained Mapleton Middle and High School science students processed the DO samples under supervision of SWC staff. Per DEQ protocol, bacteria samples and collection methods were verified using blank, replicate, and split samples. SWC staff entered and reviewed data prior to upload, distribution, and submission to the DEQ VWQMP. If missing information could not be resolved through lab or field notes, samples were removed. Outliers were retained in the VWQMP database.

For continuous temperature loggers, SWC staff conducted pre- and post-deployment accuracy checks for dissolved oxygen and temperature loggers. In situ field audits and cleanings were conducted at the deployment sites regularly. Field audits were completed using an Orion ASTAR 329 multi-parameter probe that is checked for temperature and conductivity accuracy annually. Before and after field audits, SWC staff documented stable DO and temperature readings over the course of five minutes that were within .3 mg/L of each other. Field audit procedures were based on the USGS protocols for continuous water quality monitors (http://pubs.water.usgs.gov/tm1d3). Loggers must be within +/- 0.5 degrees Celsius of the reference temperature and +/- 0.3 mg/L of the calibrated DO meter.

To verify accuracy of continuous monitoring devices, SWC deployed two separate units at Lake Creek above Indian Creek (LASAR 34878) in 2016. One was the Onset Hobo continuous temperature logger and the other was the Onset U26 continuous DO/temp logger. We charted the daily minima and maxima recorded by the two units over the deployment period and all measurements were within the DEQ tolerance for grade 'A' data (See Appendix C).

V. Results by Parameter

Continuous Monitoring

The following tables and graphs compare the 2016 SWC VWQMP temperature and dissolved oxygen measurements to State water quality criteria. Actual discussion of these measurements follows in the Discussion section. Tables 1 and 3 follow the format of Oregon's 2012 Integrated Report Assessment Database and 303(d) List. Rows ascend by river mile and are grouped by water body: Siuslaw River and Lake Creek for temperature; Siuslaw River, Lake Creek, and Wildcat for dissolved oxygen. In column two, logger locations describe the site relative to known tributaries or landmarks, and LASAR IDs refer to DEQ LASAR station identification number and are mapped at the beginning of this section. Although the listing for temperature on the Siuslaw River is year-round, the deployment period was during the summer rearing season and the 18˚C criterion is the standard during this time. The Siuslaw is listed for low DO concentration during the rearing season (June 1st – September 14th) which correlates to our deployment period. SWC and DEQ staff deployed loggers on the first date in the range of the Deployment Period column, and retrieved the continuous loggers on the second date. The data collected during the deployment period were all checked and validated by DEQ and are final. The 2016 Logger Data column follows the model of the Integrated Report Assessment Database format, stating the number of days during the monitoring that the pollutant exceeded the State criterion. Additionally, the column contains the date and time of the maxiumum discrete temperature recorded at each site during the deployment period.

Temperature

TABLE 1

Waterbody	Logger Location, LASAR ID	Pollutant/Season	Deployment Period	2016 Logger Data
Siuslaw River Mile 26.3 SWC ID: TWS	Siuslaw River upstream of Tide Wayside, 33642	Temperature DEQ criteria: salmon and trout rearing and migration: 18.0 degrees Celsius 7-day-average maximum (See appendix A) Year round	6/16/2016 to 10/12/2016	• Max Temp. 28.4°C 83.2°F 7/29/2016 5:15pm • **6/16/2016 to 9/15/2016 92 days with 7-day-average maximum > 18°C**
Siuslaw River Mile 32.9 SWC ID: SAB	Siuslaw R. upstream of Barber Creek, 34222		6/23/2016 to 10/12/2016	• Max Temp. 26.58°C 79.84°F 7/29/2016 5:00 pm • **6/23/2016 to 10/12/2016 87 days with 7-day-average maximum > 18°C**
Siuslaw River Mile 45 SWC ID: SAW	Siuslaw River upstream of Whittaker Creek, 10983		6/16/2016 to 7/28/2016 *short deployment	• Max Temp. 25.5 °C 77.9°F 7/27/2016 • **6/16/2016 to 7/28/2016 45 days with 7-day-average maximum > 18°C (*shorter deployment)**
Siuslaw River Mile 55 SWC ID: SAE	Siuslaw River upstream of Esmond Creek, 34881		6/30/2016 to 10/12/2016	• Max Temp. 25.4°C 77.7°F 7/29/2016 5:00pm • **7/10/2016 to 10/4/2016 70 days with 7-day-average maximum > 18°C**
Siuslaw River Mile 82.4 SWC ID: SAP	Siuslaw River upstream of Pheasant Creek, 39318		6/30/2016 to 10/12/2016	• Max Temp. 22.27°C 72°F 7/29/2016 8:30 pm • **6/30/2016 to 10/12/2016 67 days with 7-day-average maximum > 18°C**

Siuslaw River Mile 95 SWC ID: SDT	Siuslaw River upstream of Doe Creek, 34880		6/30/2016 to 10/12/2016	• Max Temp. 20.6°C 69.08°F 7/29/2016 4:30pm • **7/3/2016 to 10/12/2016 42 days with 7-day-average maximum > 18°C**
Siuslaw River Mile 105 SWC ID: SAF	Siuslaw River below confluence of North and South Forks, 38329		6/16/2016 to 11/3/2016	• Max Temp. 19.86°C 67.7°F 7/29/2016 6:30pm • **6/16/2016 to 11/3/2016 21 days with 7-day-average maximum > 18°C**
Lake Creek Mile 2.5 SWC ID: SIT	Lake Creek above confluence with Indian Creek, 34878		6/23/2016 to 10/12/2016	• Max Temp. 28.04°C 82.4°F 7/29/2016 • **154 days with 7-day-average maximum > 18°C**
Lake Creek Mile 17.1 SWC ID: LAF	Lake Creek above confluence with Fish Creek, 34220		6/30/2016 to 10/12/2016	• Max Temp. 24.5°C 76.1°F 7/29/2016 6:30pm • **76 days with 7-day-average maximum > 18°C**
Lake Creek Mile 29.8 SWC ID: LAL	Lake Creek below Hult Log Pond, 34877		6/28/2016 to 10/12/2016	• Max Temp. 25.5°C, 77.9 °F 7/29/2016 6:30pm • **85 days with 7-day-average maximum > 18°C**

FIGURE 1

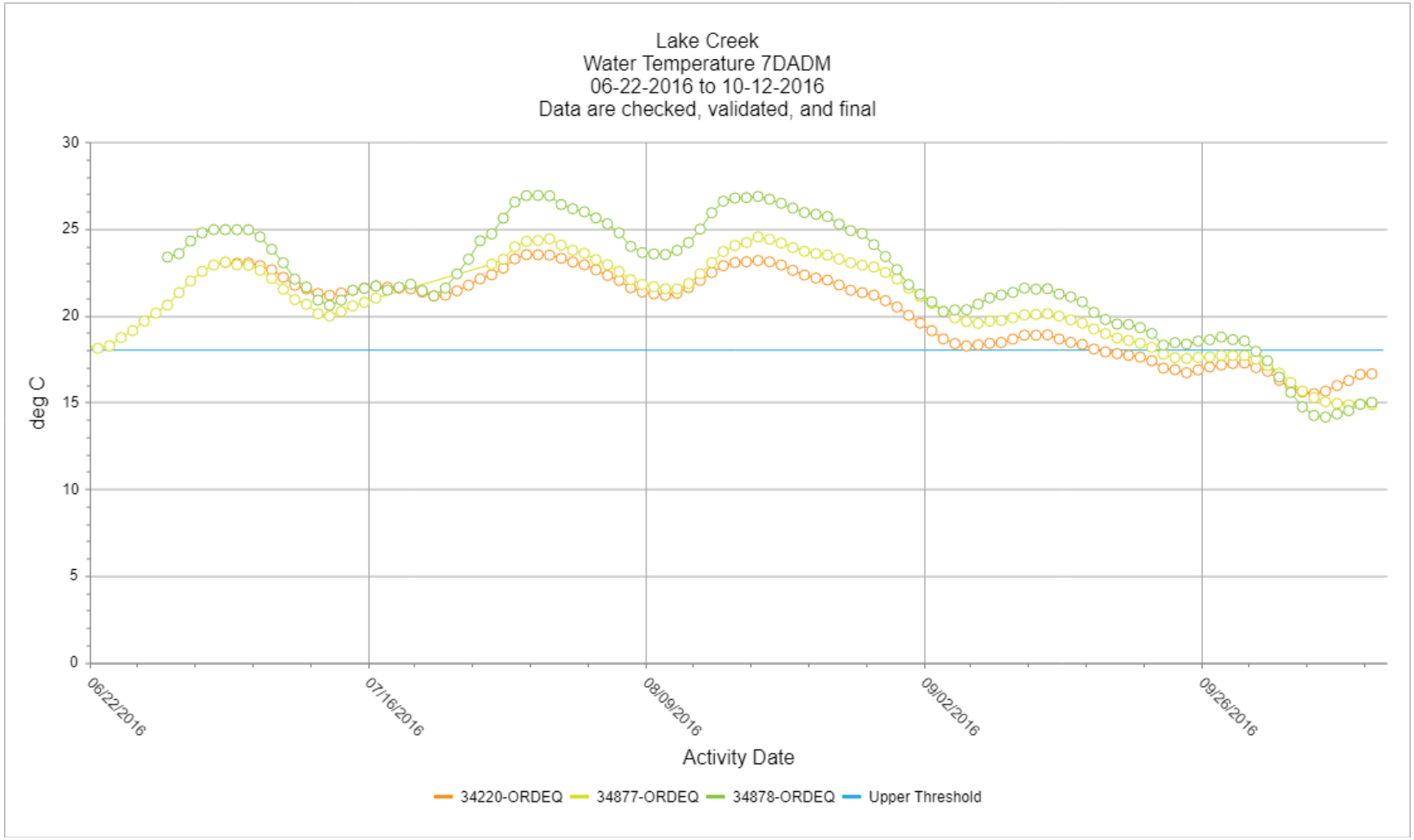

Lake Creek
Water Temperature 7DADM
06-22-2016 to 10-12-2016
Data are checked, validated, and final
30
25
20
15
10
5
0
deg C
06/22/2016
07/16/2016
08/09/2016
09/02/2016
09/26/2016
Activity Date
34220-ORDEQ
34877-ORDEQ
34878-ORDEQ
Upper Threshold

FIGURE 2

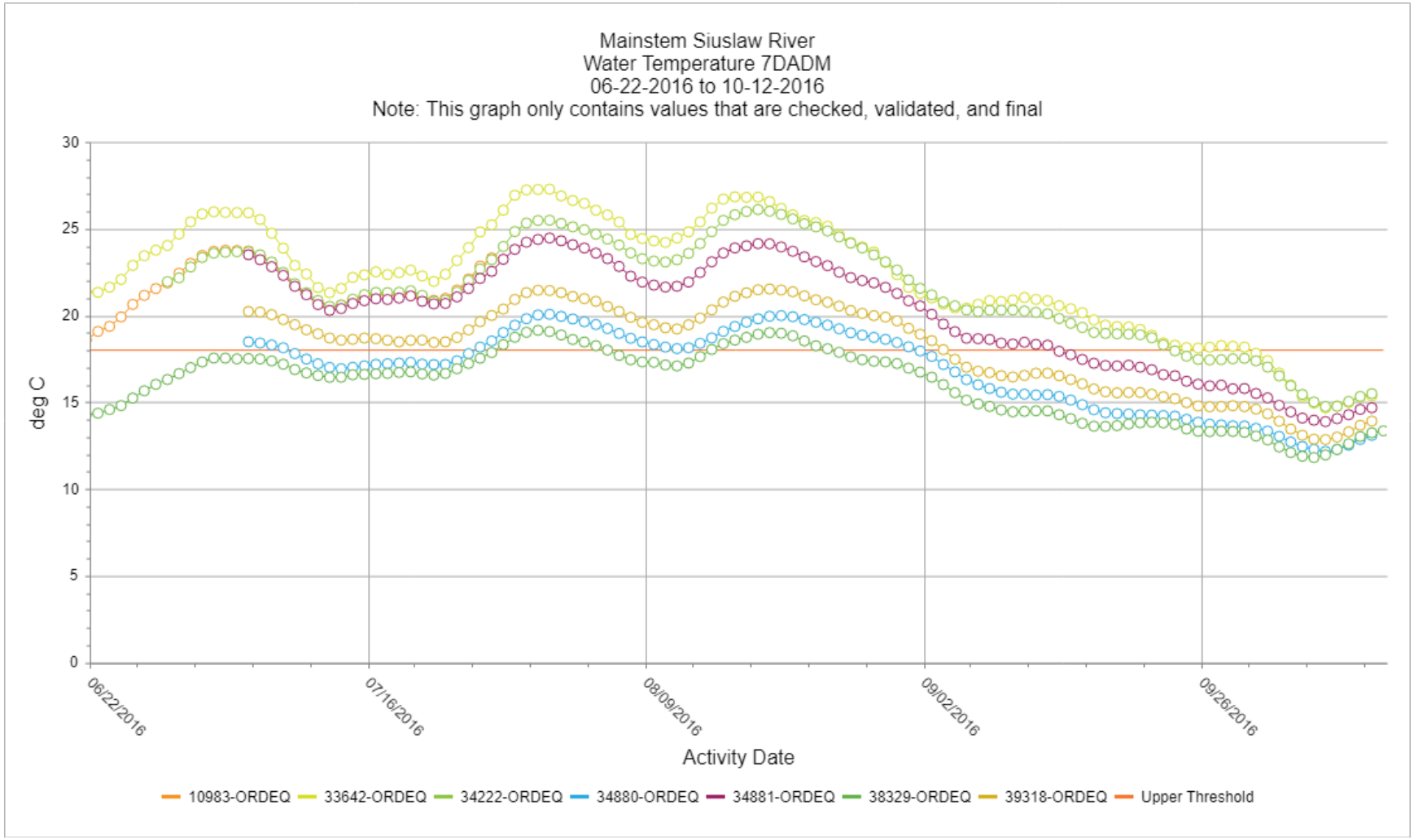

Mainstem Siuslaw River
Water Temperature 7DADM
06-22-2016 to 10-12-2016
Note: This graph only contains values that are checked, validated, and final
deg C
30
25
20
15
10
5
0
06/22/2016
07/16/2016
08/09/2016
09/02/2016
09/26/2016
Activity Date
10983-ORDEQ
33642-ORDEQ
34222-ORDEQ
34880-ORDEQ
34881-ORDEQ
38329-ORDEQ
39318-ORDEQ
Upper Threshold

FIGURE 3

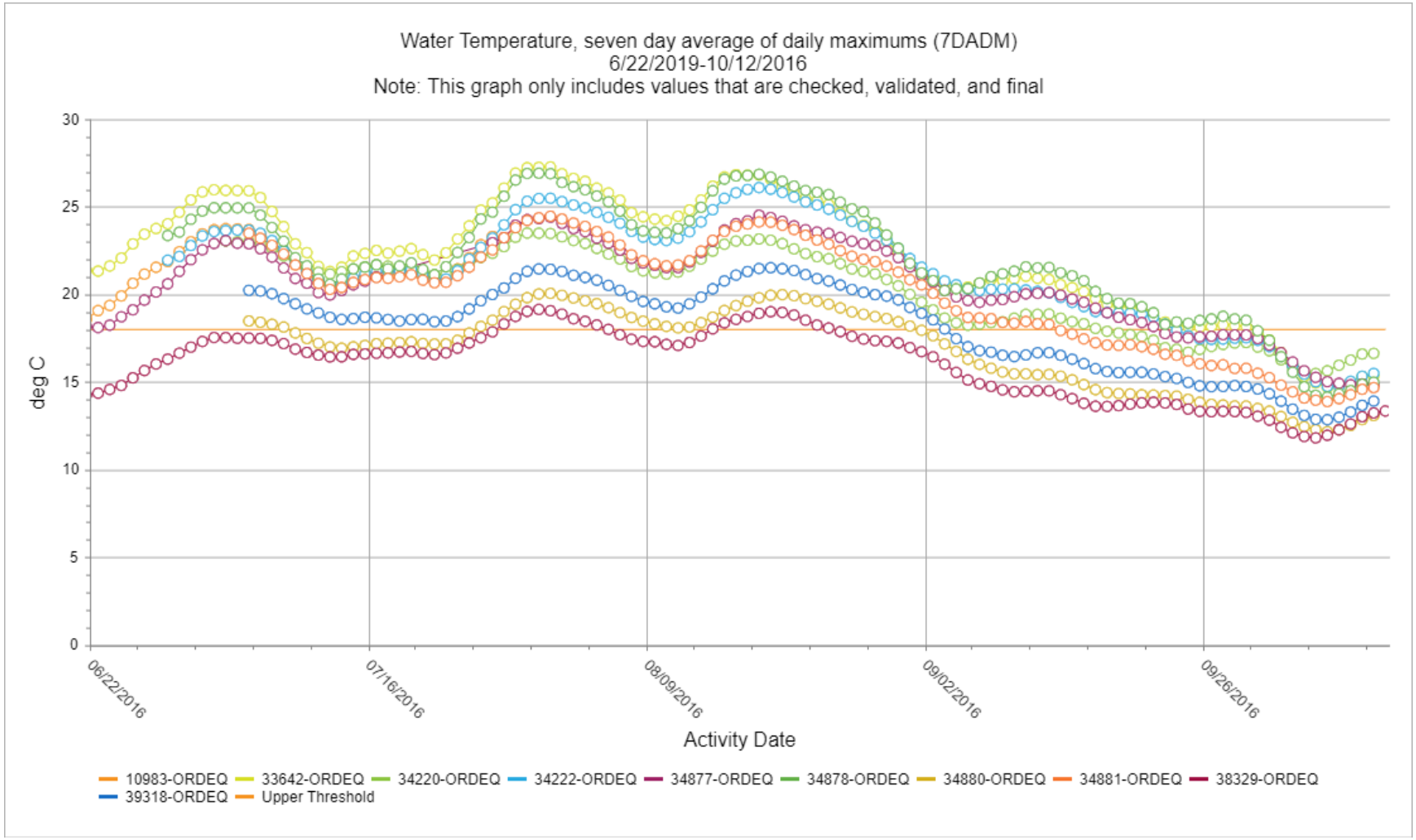

Water Temperature, seven day average of daily maximums (7DADM)
6/22/2019-10/12/2016
Note: This graph only includes values that are checked, validated, and final
deg C
30
25
20
15
10
5
0
06/22/2016
07/16/2016
08/09/2016
09/02/2016
09/26/2016
Activity Date
10983-ORDEQ
33642-ORDEQ
34220-ORDEQ
34222-ORDEQ
34877-ORDEQ
34878-ORDEQ
34880-ORDEQ
34881-ORDEQ
38329-ORDEQ
39318-ORDEQ
Upper Threshold

FIGURE 4

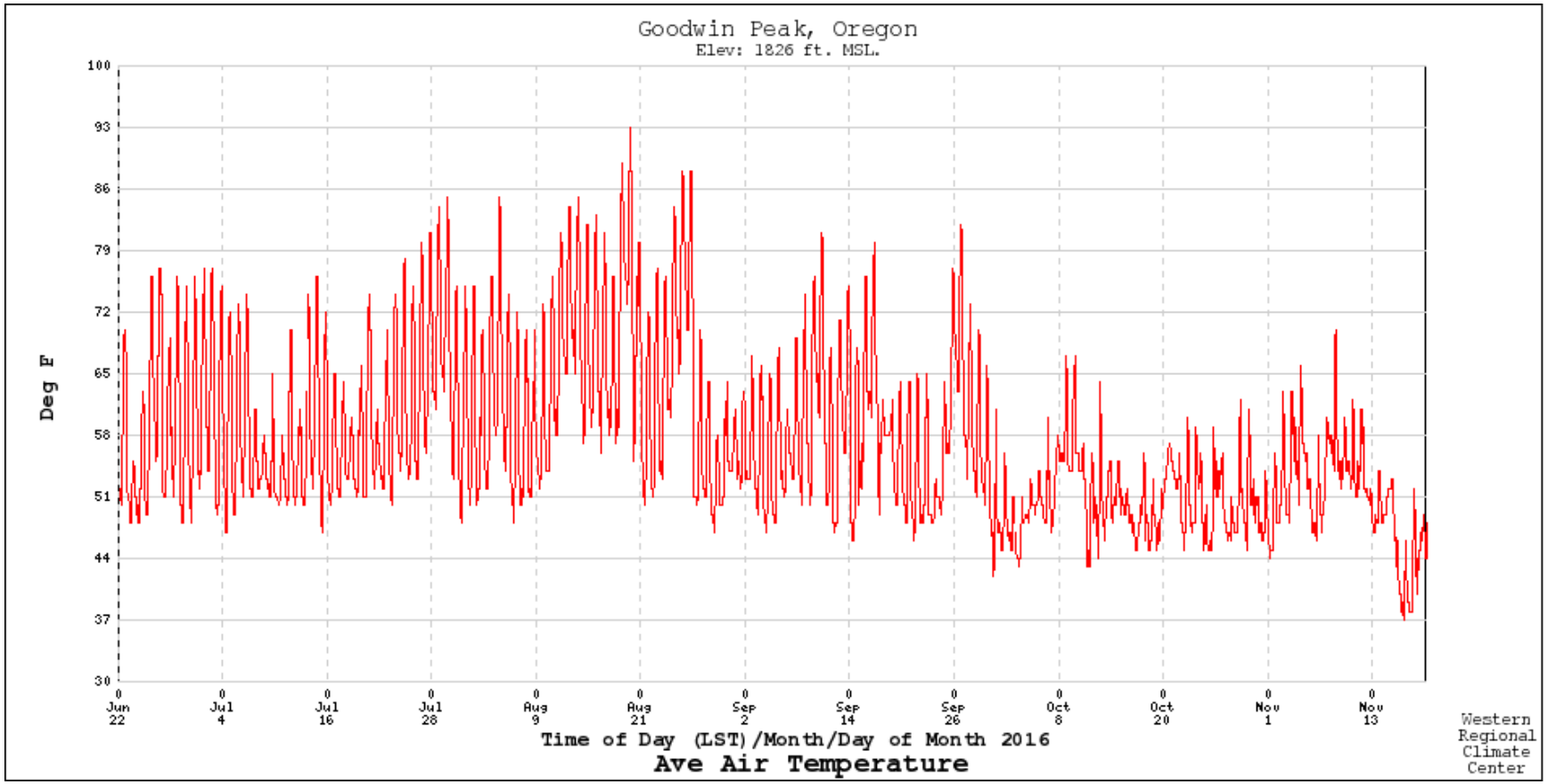

Goodwin Peak, Oregon
Elev: 1826 ft. MSL.
Deg F
100
93
86
79
72
65
58
51
44
37
30
Jun 22
Jul 4
Jul 16
Jul 28
Aug 9
Aug 21
Sep 2
Sep 14
Sep 26
Oct 8
Oct 20
Nov 1
Nov 13
Time of Day (LST)/Month/Day of Month 2016
Ave Air Temperature
Western Regional Climate Center

FIGURE 5

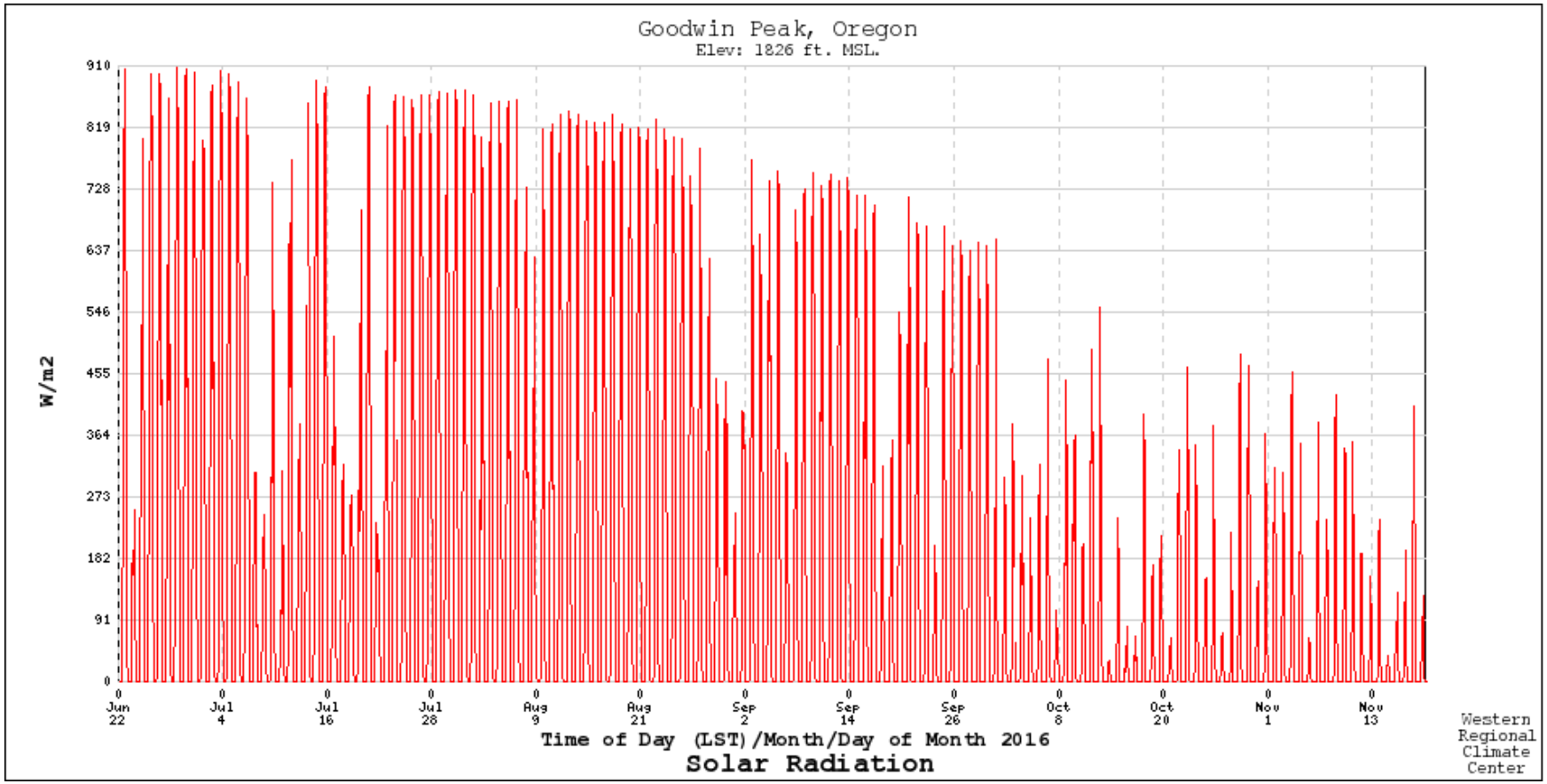

Goodwin Peak, Oregon
Elev: 1826 ft. MSL.
W/m2
910
819
728
637
546
455
364
273
182
91
0
Jun 22
Jul 4
Jul 16
Jul 28
Aug 9
Aug 21
Sep 2
Sep 14
Sep 26
Oct 8
Oct 20
Nov 1
Nov 13
Time of Day (LST)/Month/Day of Month 2016
Solar Radiation
Western Regional Climate Center

FIGURE 6

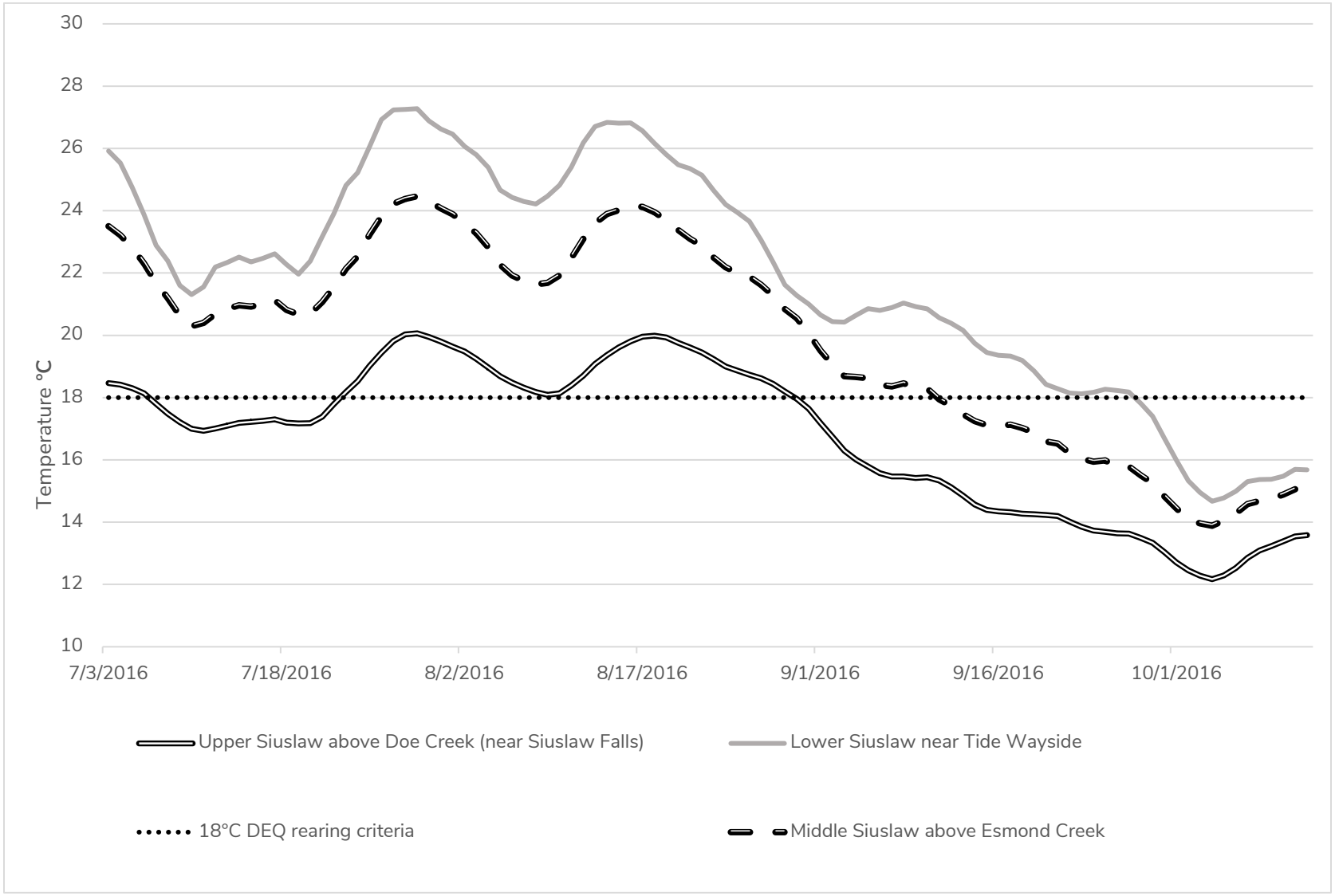

30
28
26
24
22
20
18
16
14
12
10
Temperature °C
7/3/2016
7/18/2016
8/2/2016
8/17/2016
9/1/2016
9/16/2016
10/1/2016
Upper Siuslaw above Doe Creek (near Siuslaw Falls)
Lower Siuslaw near Tide Wayside
18°C DEQ rearing criteria
Middle Siuslaw above Esmond Creek

FIGURE 7


Lake Creek
Temperature, water, 1 Day Delta
06-22-2016 to 10-12-2016
deg C
0
1
2
3
4
5
6
7
8
9
06/22/2016
07/16/2016
08/09/2016
09/02/2016
09/26/2016
Activity Date
34220-ORDEQ
34877-ORDEQ
34878-ORDEQ

FIGURE 8


Siuslaw River
Temperature, water, 1 Day Delta
06-22-2016 to 10-12-2016
deg C
0
1
2
3
4
5
6
7
8
06/22/2016
07/16/2016
08/09/2016
09/02/2016
09/26/2016
Activity Date
10983-ORDEQ
33642-ORDEQ
34222-ORDEQ
34880-ORDEQ
34881-ORDEQ
38329-ORDEQ
39318-ORDEQ

FIGURE 9

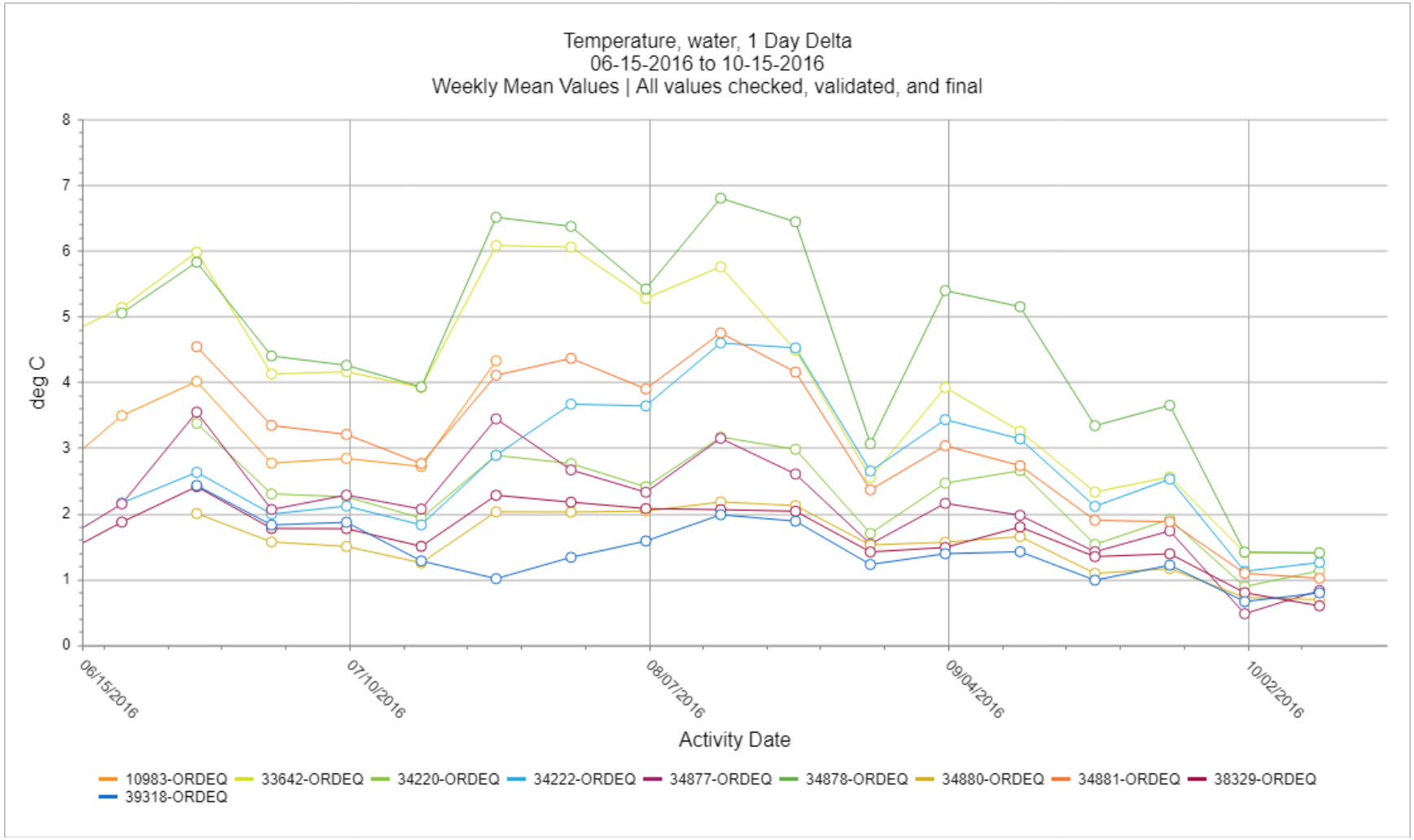

Temperature, water, 1 Day Delta
06-15-2016 to 10-15-2016
Weekly Mean Values | All values checked, validated, and final
deg C
0
1
2
3
4
5
6
7
8
06/15/2016
07/10/2016
08/07/2016
09/04/2016
10/02/2016
Activity Date
10983-ORDEQ
33642-ORDEQ
34220-ORDEQ
34222-ORDEQ
34877-ORDEQ
34878-ORDEQ
34880-ORDEQ
34881-ORDEQ
38329-ORDEQ
39318-ORDEQ

TABLE 2

LASAR	Site Name	Ave. Delta	RM from ocean
33642-ORDEQ	Siuslaw River at Tide boat ramp	4.12	26
34878-ORDEQ	Lake Creek above Indian Creek	4.6	30.5
34222-ORDEQ	Siuslaw River u/s of Barber Creek	2.7	33
10983-ORDEQ	Siuslaw River at Whitaker Creek Road	3.2	45
34220-ORDEQ	Lake Creek at Fish Creek Road	2.28	45
34881-ORDEQ	Siuslaw River Upstream of Esmond Creek	3.07	55
34877-ORDEQ	Lake Creek Below Hult Pond (Siuslaw R)	2.17	58
39318-ORDEQ	Siuslaw R Below Pheasant Cr	1.4	82
34880-ORDEQ	Siuslaw River Above Doe Creek	1.5	95
38329-ORDEQ	Siuslaw R Below Confluence of N and S Forks	1.68	105

FIGURE 10

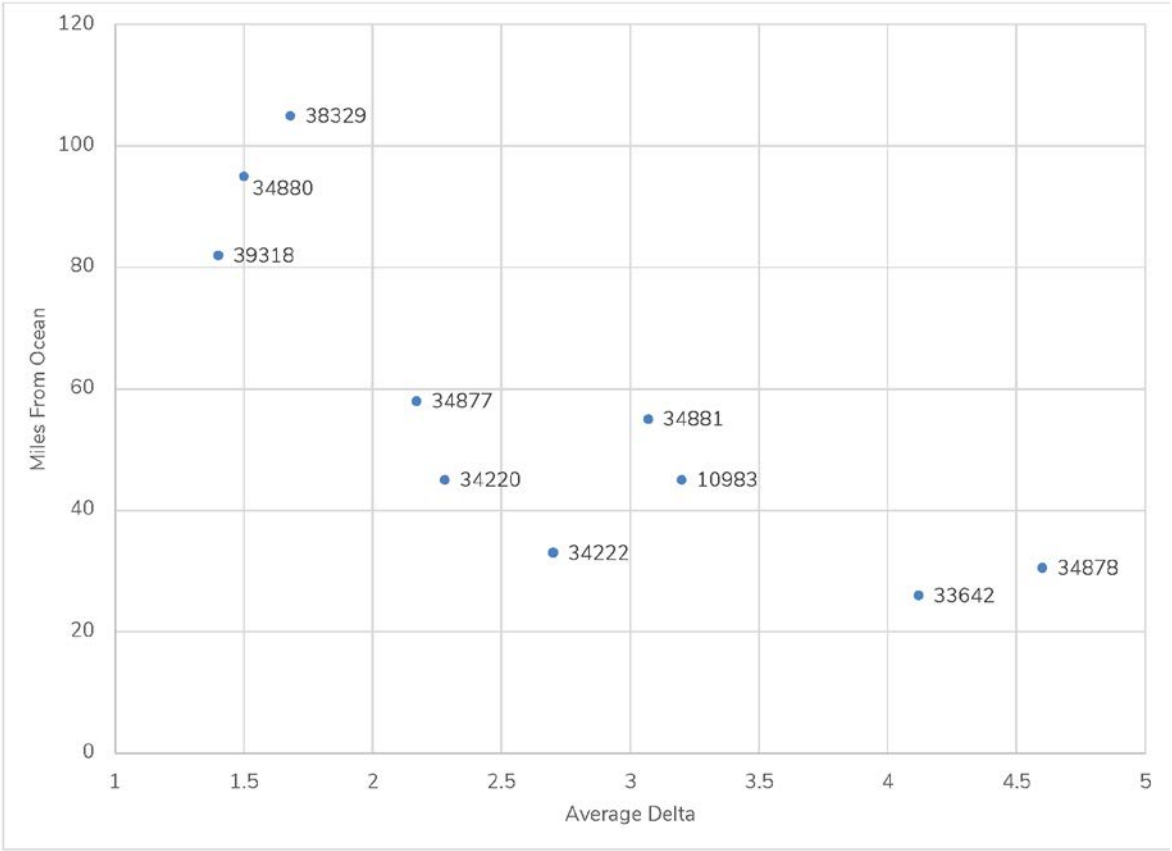
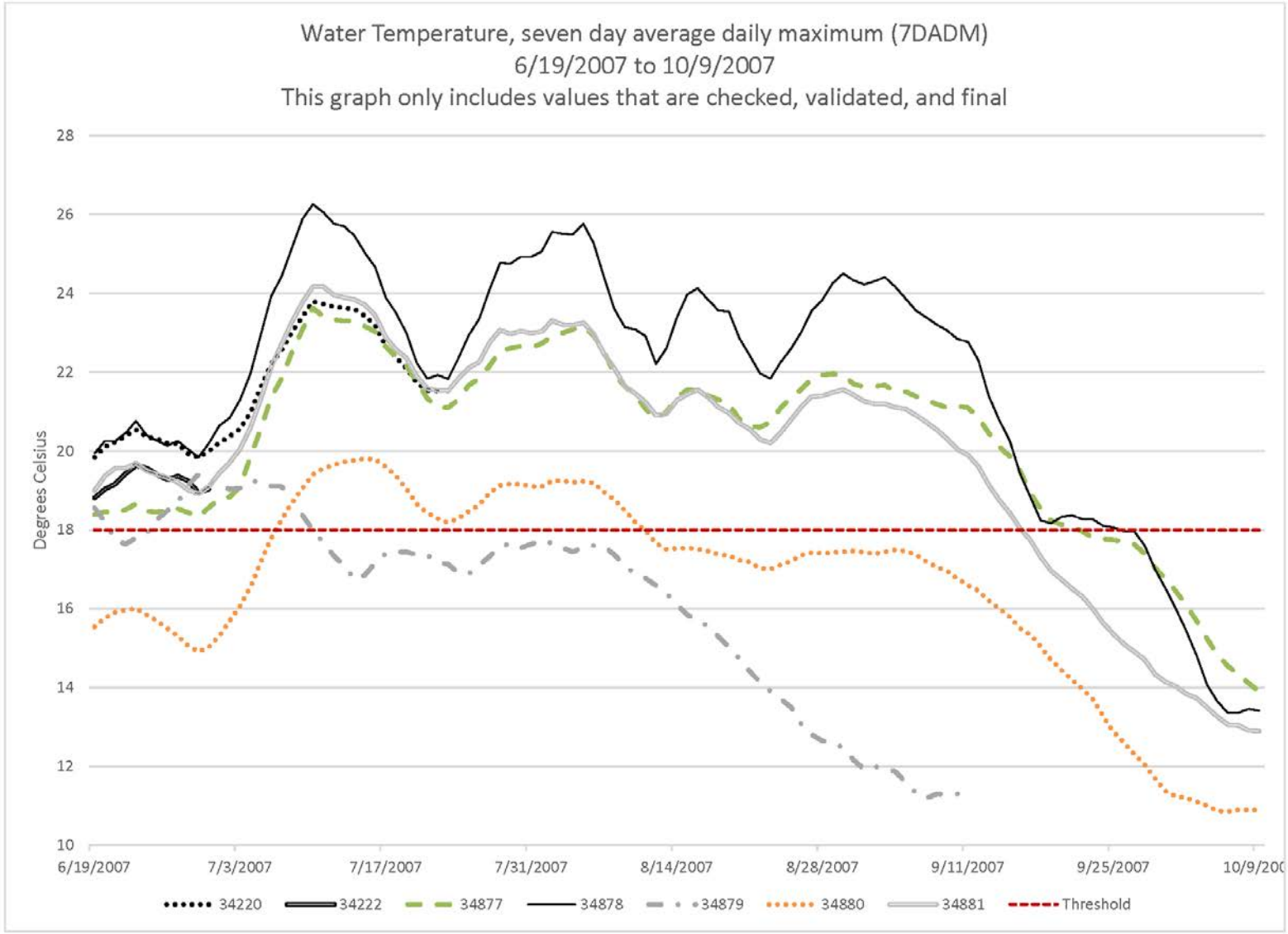


FIGURE 11


Water Temperature, seven day average daily maximum (7DADM)
6/19/2007 to 10/9/2007
This graph only includes values that are checked, validated, and final
Degrees Celsius
28
26
24
22
20
18
16
14
12
10
6/19/2007
7/3/2007
7/17/2007
7/31/2007
8/14/2007
8/28/2007
9/11/2007
9/25/2007
34220
34222
34877
34878
34879
34880
34881
Threshold

Dissolved Oxygen

TABLE 3

Water Body/SWC ID	Logger Location, LASAR ID	Pollutant, season, criteria	Deployment Period	2016 Logger Data
Siuslaw River Mile 26.3 SWC ID TWS	Siuslaw River upstream of Tide Wayside, 33642	Dissolved Oxygen Rearing: June 1 – September 14 DEQ criteria – 30-day mean minimum not less than 8.0 mg/l or 90% of saturation See appendix A, Oregon Administrative Rules	5/23/2016 to 10/12/2016	100 % of samples were above the 8 mg/l criteria, % saturation levels consistently met criteria Cat 5 303(d) listed
Siuslaw River Mile 32 SWC ID SAB	Siuslaw River above Barber Creek, 34222		6/23/2016 to 10/12/2016	The 8 mg/l criteria were met for 100% of samples and % saturation levels consistently met criteria Cat 5 303(d) listed
Siuslaw River Mile 105 SWC ID SAF	Siuslaw River below confluence of North and South Forks, 38329		6/16/2016 to 11/1/2016	100% of concentration samples above 8 mg/L but lowest DO saturation sampled. Upper extent of Cat 5 303(d) listed reach
Lake Creek RM 2.5 SWC ID: SIT	Lake Creek above confluence with Indian Creek, 34878		6/23/2016 to 10/12/2016	100% of concentration samples above 8 mg/L, 100 % of saturation levels above 90% Lake Creek is not on 303(d) list
Lake Creek Mile 29.8 SWC ID: LAL	Lake Creek below Hult Log Pond, 34877		6/28/2016 to 10/12/2016	100% of concentration samples above 8 mg/L, 100 % of saturation levels above 90%

				Lake Creek is not on 303(D) list

Wildcat Creek SWC ID WCS	Wildcat Creek 100 meters upstream of Siuslaw, 10989	Dissolved Oxygen Spawning: October 15 – May 15 DEQ criteria – 30-day mean minimum not less than 11.0 mg/l or 95% of saturation	8/23/2016 to 11/3/2016 *Wildcat Creek is not on 303 (d) list during the rearing season. Logger retrieved 11/3/2016. Min. mean is calculated using preceding 30 days, therefore no spawning season data was collected.	100 % of concentration samples below 11mg/L, 100 % of daily min. saturation values from 10/15-11/3 above 95%. Concentration not met but saturation met or exceeded threshold.

FIGURE 12

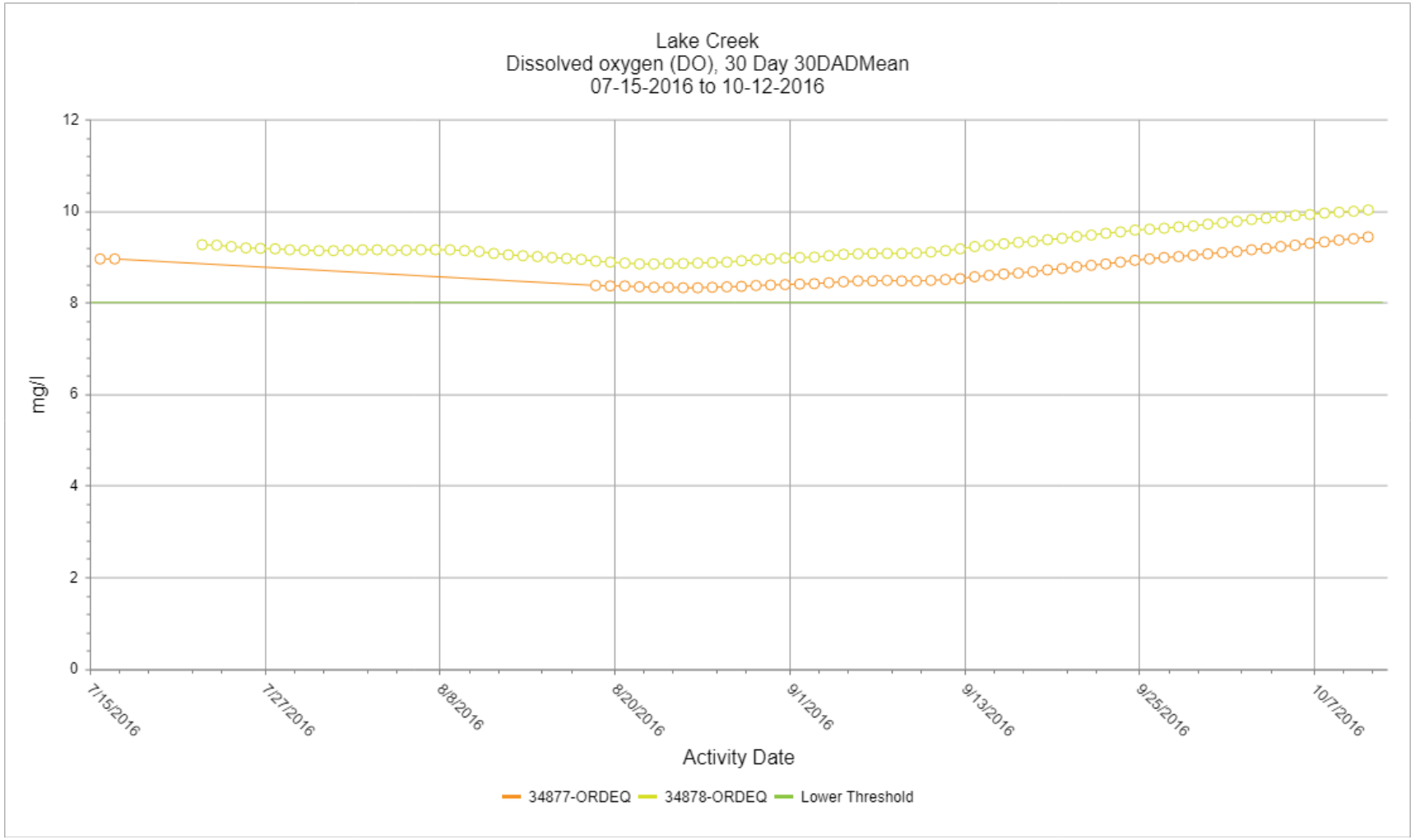

Lake Creek
Dissolved oxygen (DO), 30 Day 30DADMean
07-15-2016 to 10-12-2016
12
10
8
6
4
2
0
mg/l
7/15/2016
7/27/2016
8/8/2016
8/20/2016
9/1/2016
9/13/2016
9/25/2016
10/7/2016
Activity Date
34877-ORDEQ
34878-ORDEQ
Lower Threshold

FIGURE 13

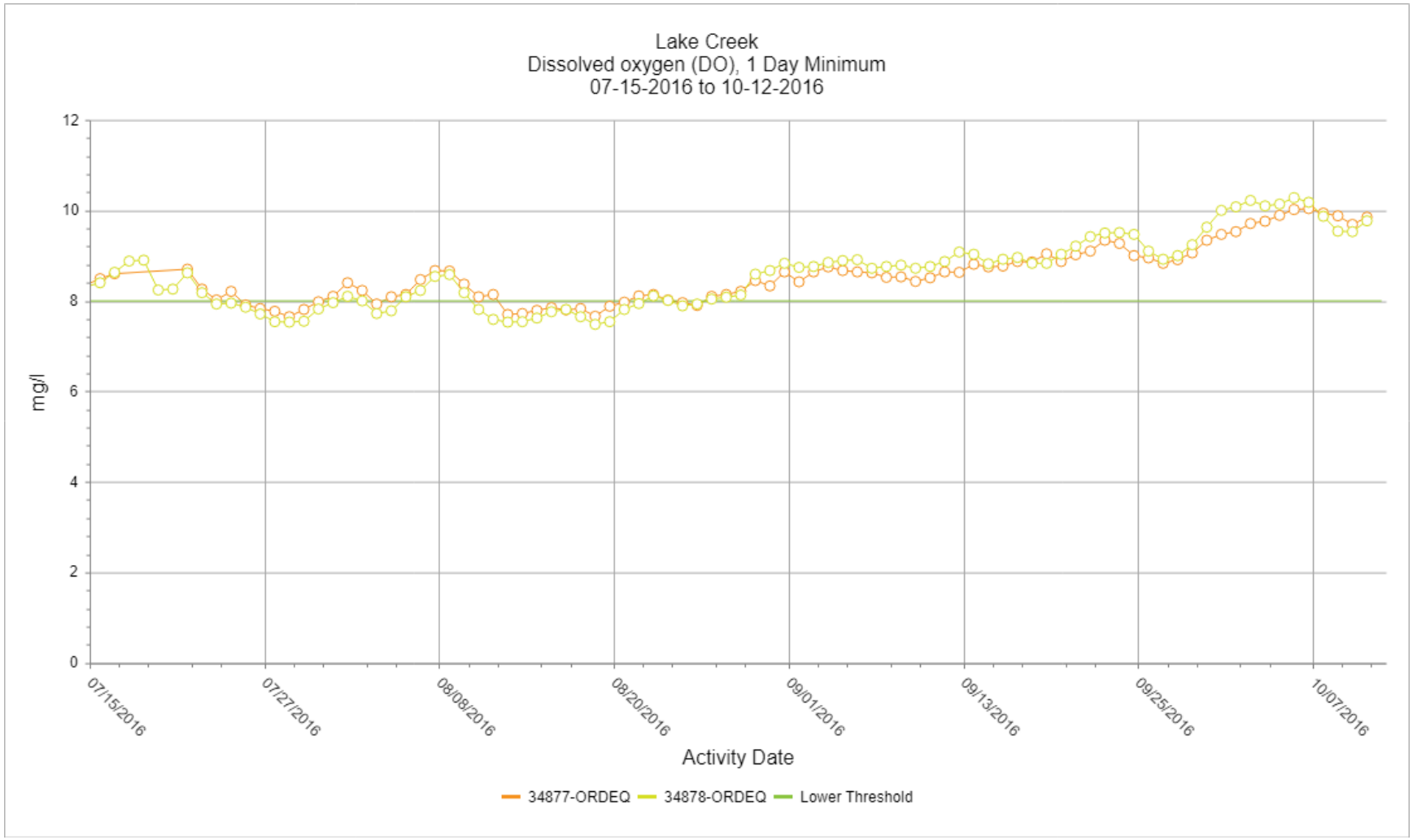

Lake Creek
Dissolved oxygen (DO), 1 Day Minimum
07-15-2016 to 10-12-2016
12
10
8
6
4
2
0
mg/l
07/15/2016
07/27/2016
08/08/2016
08/20/2016
09/01/2016
09/13/2016
09/25/2016
10/07/2016
Activity Date
34877-ORDEQ
34878-ORDEQ
Lower Threshold

FIGURE 14

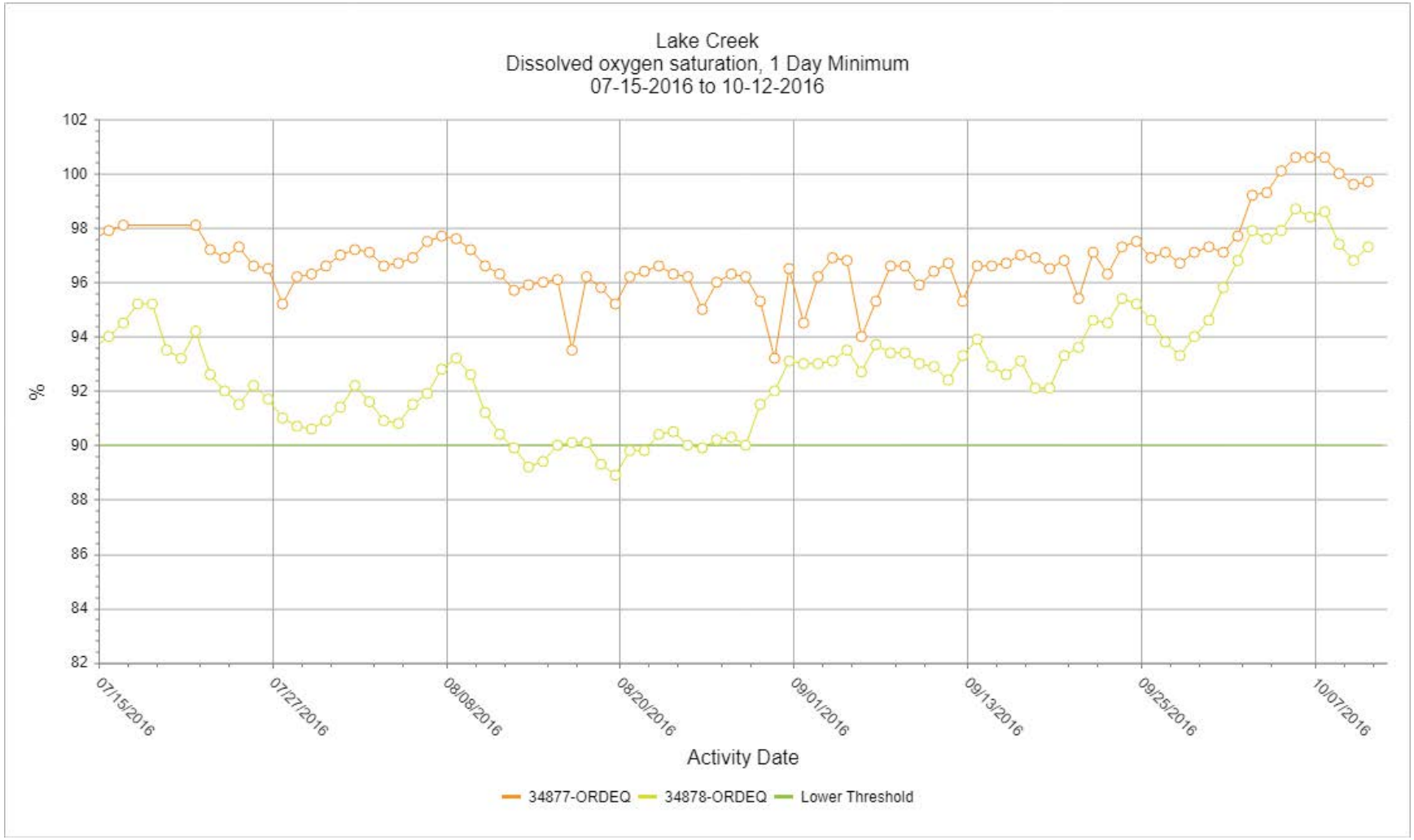

Lake Creek
Dissolved oxygen saturation, 1 Day Minimum
07-15-2016 to 10-12-2016
102
100
98
96
94
92
90
88
86
84
82
%
07/15/2016
07/27/2016
08/08/2016
08/20/2016
09/01/2016
09/13/2016
09/25/2016
10/07/2016
Activity Date
34877-ORDEQ
34878-ORDEQ
Lower Threshold

FIGURE 15

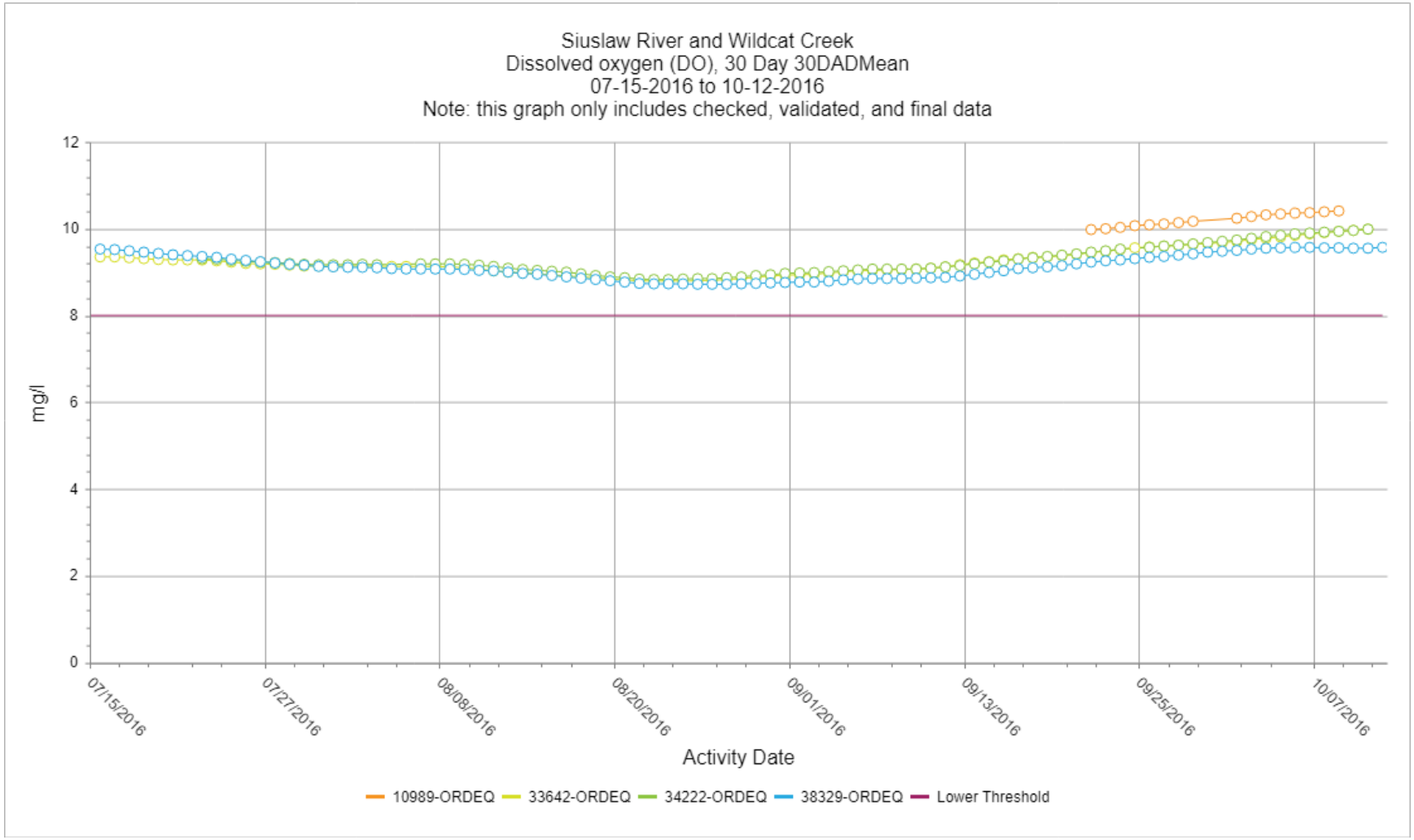

Siuslaw River and Wildcat Creek
Dissolved oxygen (DO), 30 Day 30DADMean
07-15-2016 to 10-12-2016
Note: this graph only includes checked, validated, and final data
12
10
8
6
4
2
0
mg/l
07/15/2016
07/27/2016
08/08/2016
08/20/2016
09/01/2016
09/13/2016
09/25/2016
10/07/2016
Activity Date
10989-ORDEQ
33642-ORDEQ
34222-ORDEQ
38329-ORDEQ
Lower Threshold

FIGURE 16

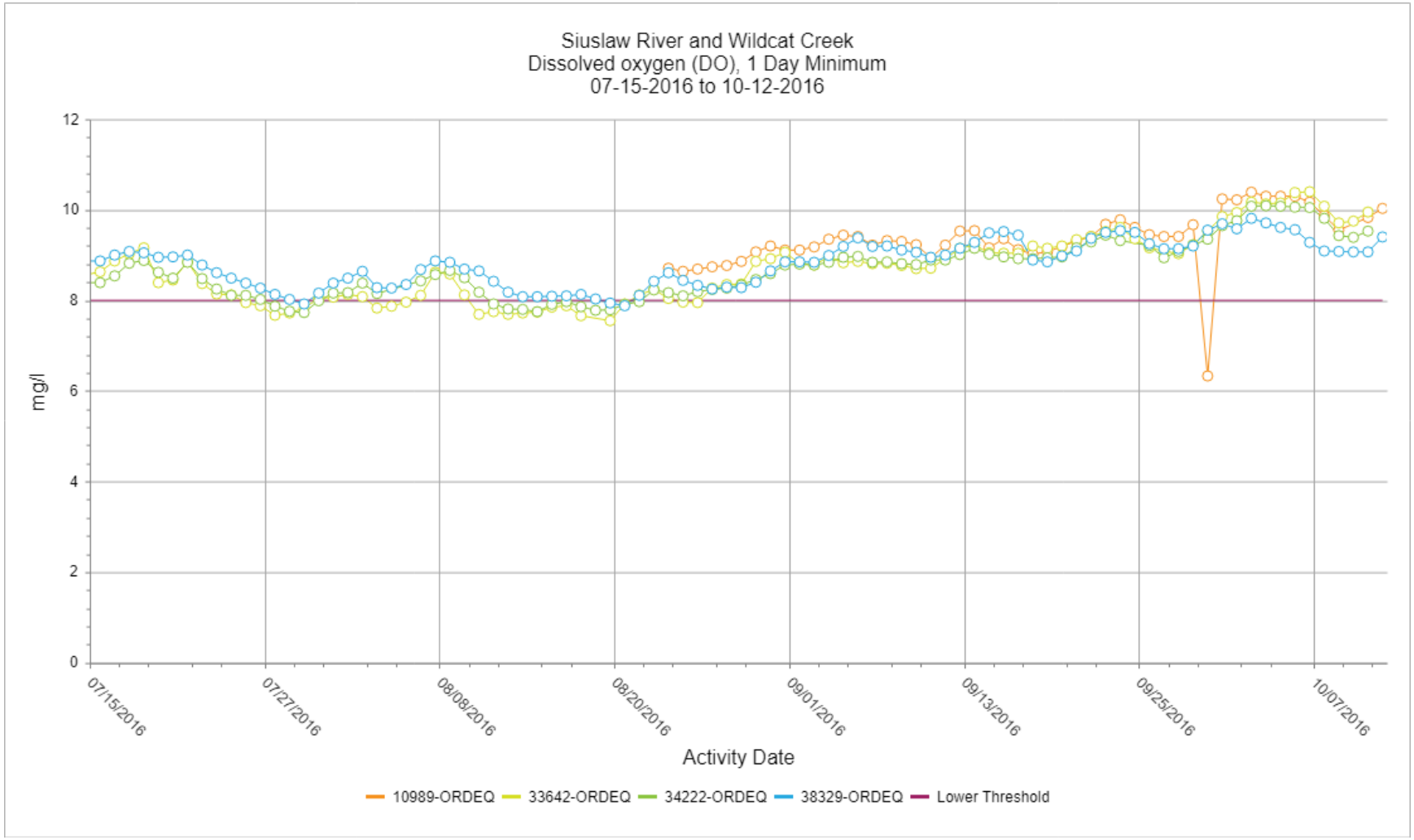

Siuslaw River and Wildcat Creek
Dissolved oxygen (DO), 1 Day Minimum
07-15-2016 to 10-12-2016
12
10
8
6
4
2
0
mg/l
07/15/2016
07/27/2016
08/08/2016
08/20/2016
09/01/2016
09/13/2016
09/25/2016
10/07/2016
Activity Date
10989-ORDEQ
33642-ORDEQ
34222-ORDEQ
38329-ORDEQ
Lower Threshold

FIGURE 17

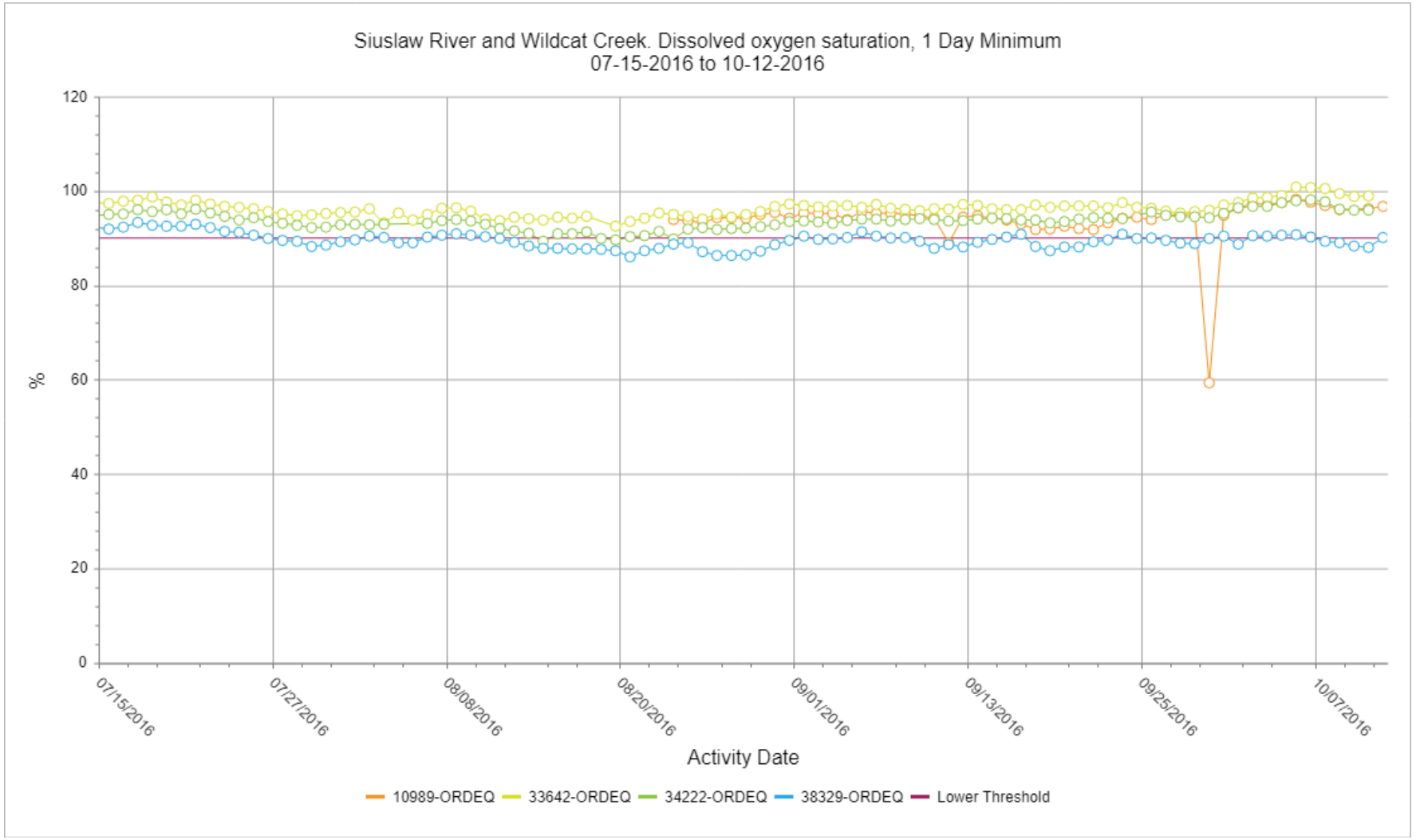
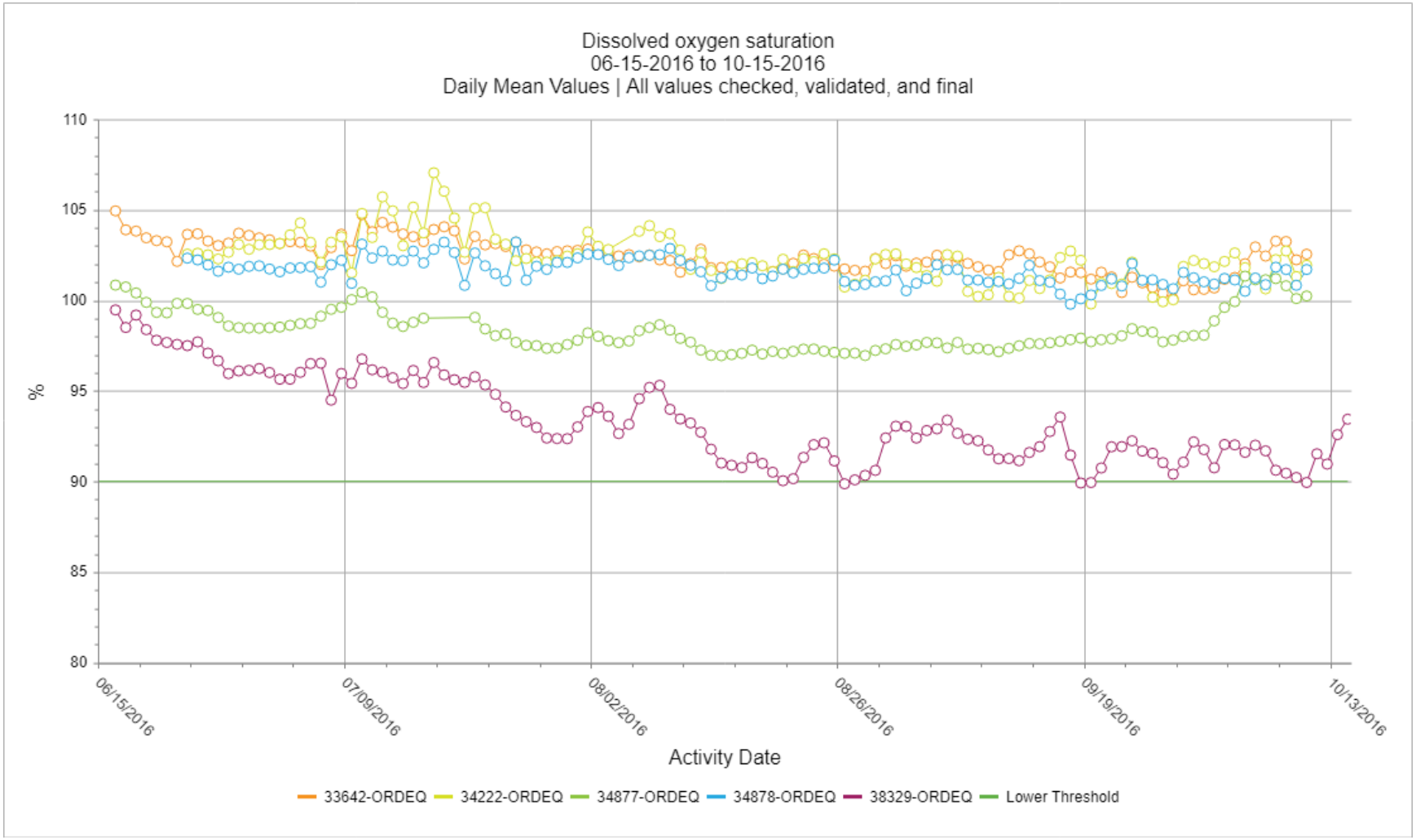

Siuslaw River and Wildcat Creek. Dissolved oxygen saturation, 1 Day Minimum
07-15-2016 to 10-12-2016
120
100
80
60
40
20
0
%
07/15/2016
07/27/2016
08/08/2016
08/20/2016
09/01/2016
09/13/2016
09/25/2016
10/07/2016
Activity Date
10989-ORDEQ
33642-ORDEQ
34222-ORDEQ
38329-ORDEQ
Lower Threshold

FIGURE 18


Dissolved oxygen saturation
06-15-2016 to 10-15-2016
Daily Mean Values | All values checked, validated, and final
110
105
100
95
90
85
80
%
06/15/2016
07/09/2016
08/02/2016
08/26/2016
09/19/2016
10/13/2016
Activity Date
33642-ORDEQ
34222-ORDEQ
34877-ORDEQ
34878-ORDEQ
38329-ORDEQ
Lower Threshold


3 8 3 3 1
Triangle Lake
Deadwood Creek
Indian Creek
Lake Creek
3 8 3 2 8
3 8 3 3 0
Lower Siuslaw
Middle Siuslaw
3 4 8 7 9
1 0 3 9 2
Knowles Creek
Wildcat Creek
3 4 0 8 2
Sweet Creek
3 8 3 2 7
1 0 9 8 3
3 4 0 8 5
1 0 9 9 0
Woahink Lake
Siltcoos Lake
Fiddle Cr.
Upper Siuslaw
3 8 3 2 9
Legend
SWC Grab Sites
WQ Limited Dissolved Oxygen
WQ Limited Temperature
SWC Service Area
DEQ Lakes

Grab Sample Results

The following figures were created to better understand the issues described in the monitoring design for this program. Graphs of each site by parameter for the 2016 season are included in Appendix E. In addition to gathering baseline data and monitioring for trends, we wanted to answer specific questions:

- Are there spatial or temporal patterns seen in the data?
- What are the baseline ambient water quality conditions at these sites?
- Are there any long term trends?
- How is water quality different upstream and downstream of Triangle Lake?
- Are the temperatures exceeding standards at the MU-15 site which was established in 2005 during the temperature TMDL?
- Has restoration been effective and are trends evident in Deadwood Creek?

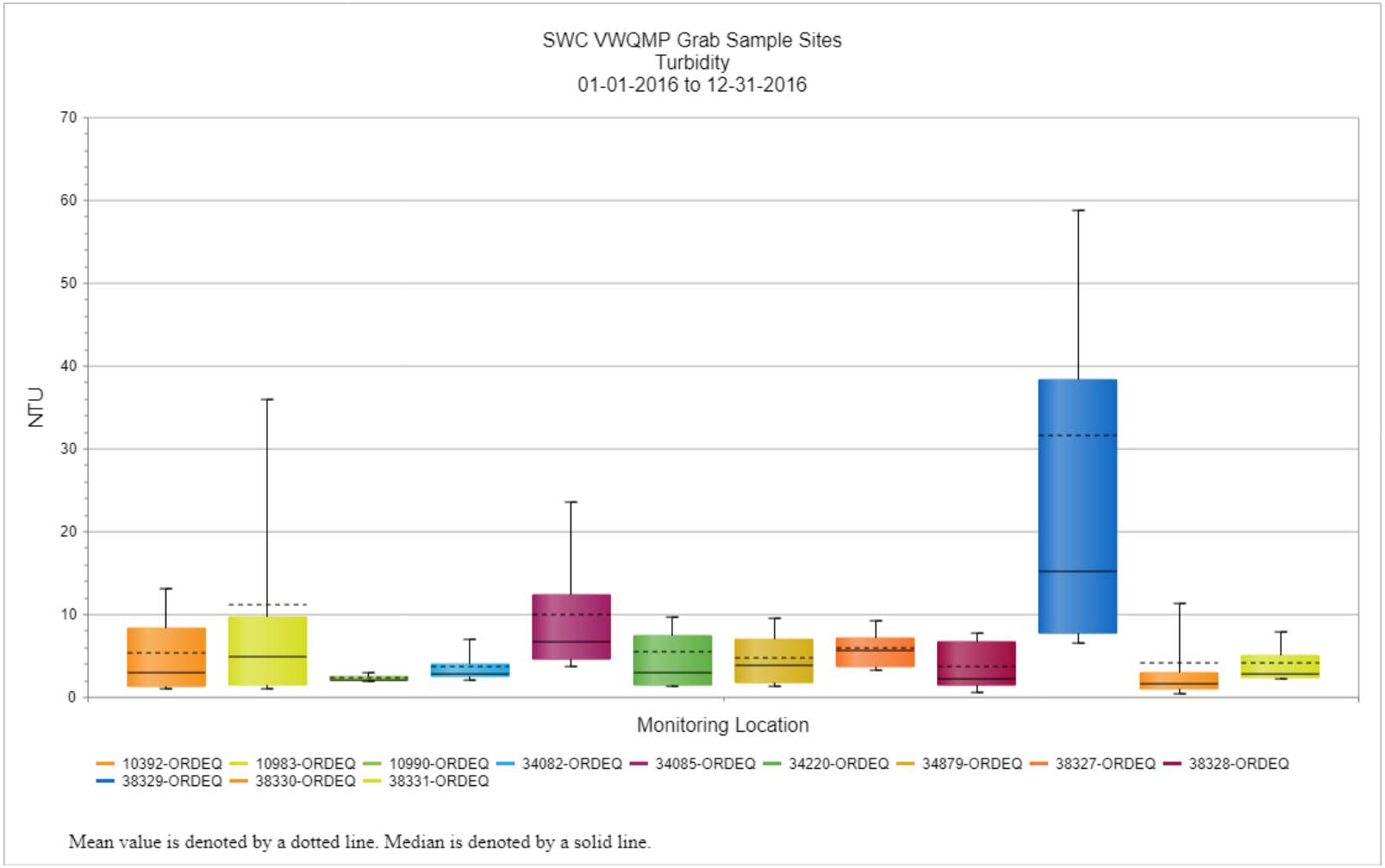
Spatial and temporal patterns in the data

Turbidity

We saw turbidity follow precipitation patterns in all sites sampled during 2016. Sites 38329, 34085, and 10983 measured the highest turbidity. 34085 is the South Slough, a tidal slough flowing into the estuary. The higher turbidity measured at this site is likely due to tide changes and the associated upwelling of sediments from the river bed. Turbidity grab samples at the LO-16 site (LASAR 38329) were highest in the Siuslaw and Lake Creek. The 2016 high was in October, 131 NTUs. Additionally, conductivity measurements during our audits at this and other sites near the confluence average 70 µS/cm while the rest of the watershed averages 40 µS/cm. Causes of high turbidity include: soil erosion, wastewater discharges, urban runoff, agricultural and forestry practices, eroding stream banks, and excessive algae

growth. The mid-to-upper Siuslaw land use is predominantly industrial forestry. The checkerboard pattern of Bureau of Land Management and industrial timber company ownership fills most of this section of the Siuslaw watershed. Upstream from there, near the 38329 sites, agriculture is dominant.

FIGURE 19



Above and below Triangle Lake

FIGURE 20

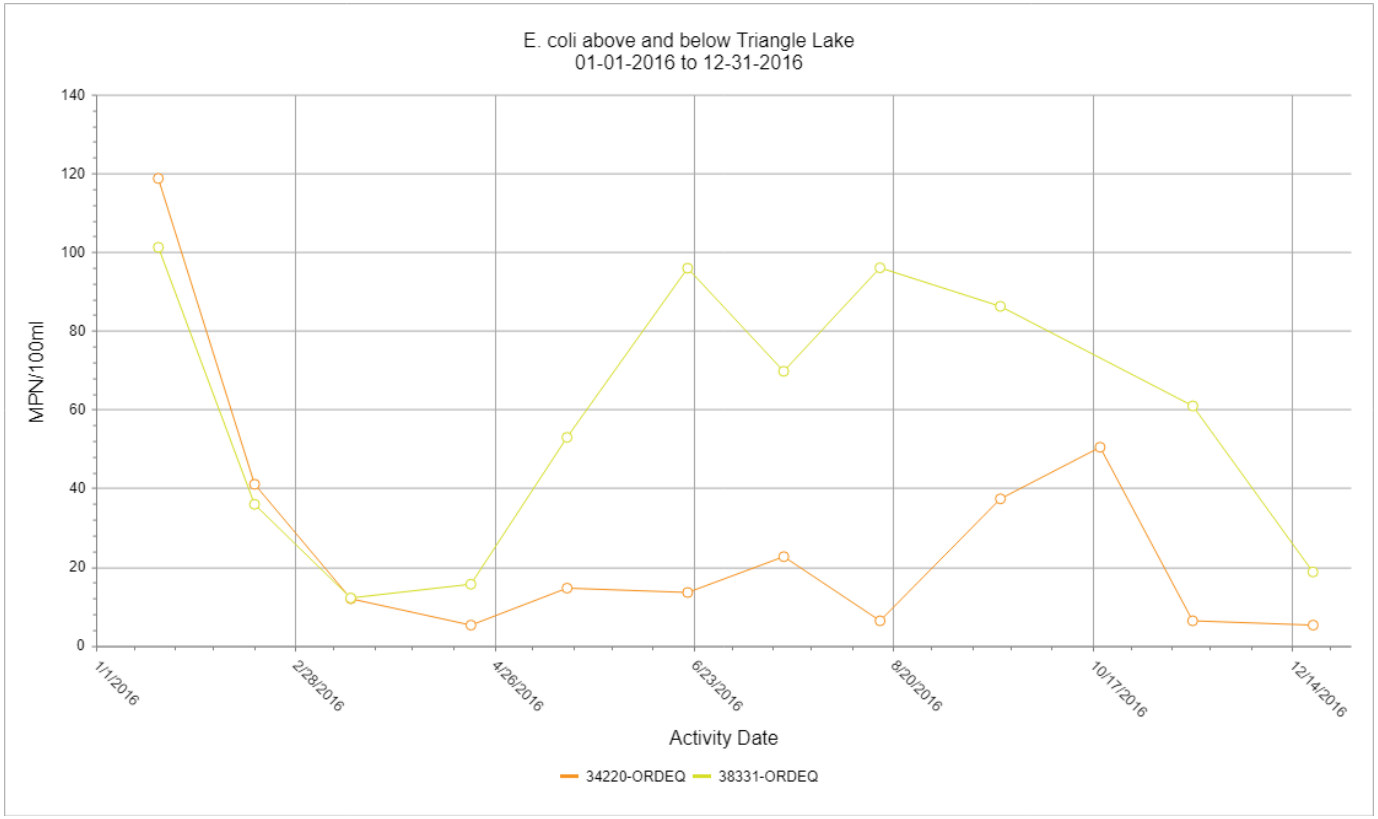


FIGURE 21: STATION 34220-ORDEQ IS DOWNSTREAM OF THE LAKE, AND 38331-ORDEQ IS UPSTREAM OF TRIANGLE LAKE

SWC established sites 38331 and 34220 upstream and downstream of Triangle Lake to explore the impact of the lake on water quality. The unincorporated community of the same name includes development on the southwest side of the 298-acre, natural lake which is popular for swimming, fishing, boating and other summer recreation. LASAR 38331 is located in a low-gradient reach upstream of the lake where agriculture is dominant. LASAR 34220 is downstream of the lake, in a higher gradient reach, upstream of all agriculture downstream of the waterbody. *E. coli* indicate sewage or livestock contamination because they are commonly found in human and animal feces and the EPA recommends testing for *E. coli* in recreational waters. In 2016, *E. coli* measurements upstream of the lake were higher than downstream.

FIGURE 22

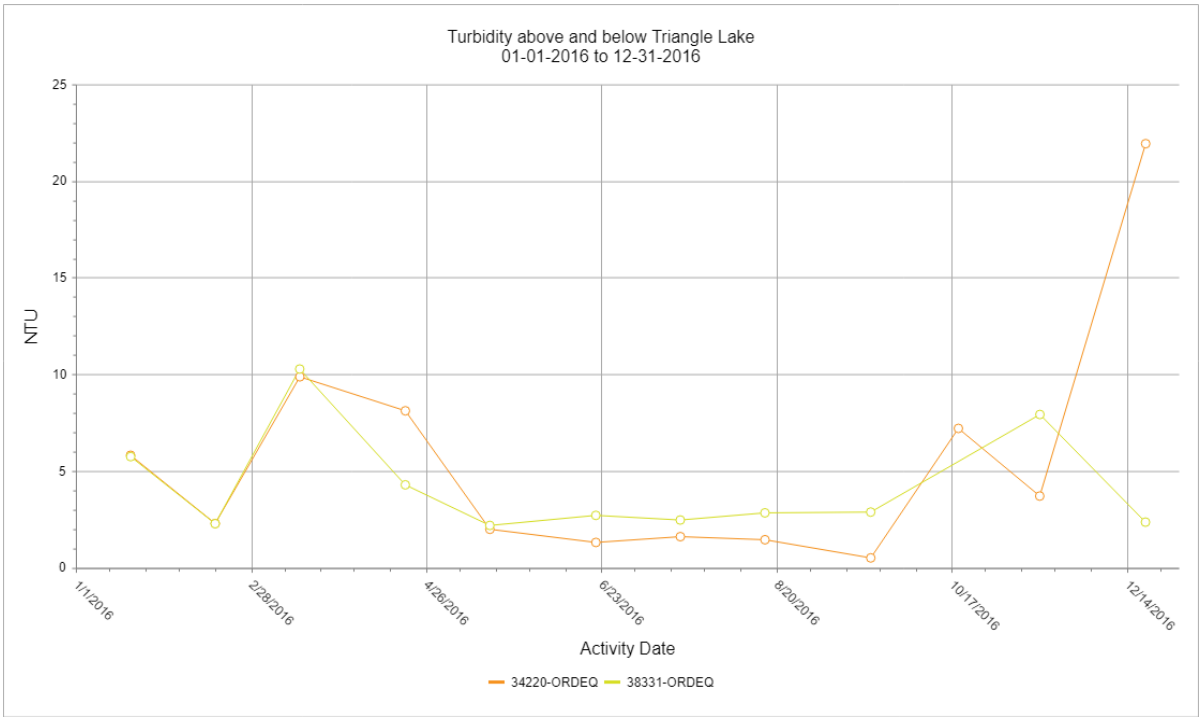


FIGURE 23 STATION 34220-ORDEQ IS DOWNSTREAM OF THE LAKE, AND 38331-ORDEQ IS UPSTREAM OF TRIANGLE LAKE

The three sites with the most E. coli in 2016 were LASAR stations 34085 (South Slough), 34082 (Karnowsky Creek), and 38329 (upper Siuslaw below the North and South Forks). The site with the most was the Upper Siuslaw which is also where we measured the highest levels of turbidity and conductivity, and where we identified a lower oxygen saturation than anywhere else we monitored.

FIGURE 24

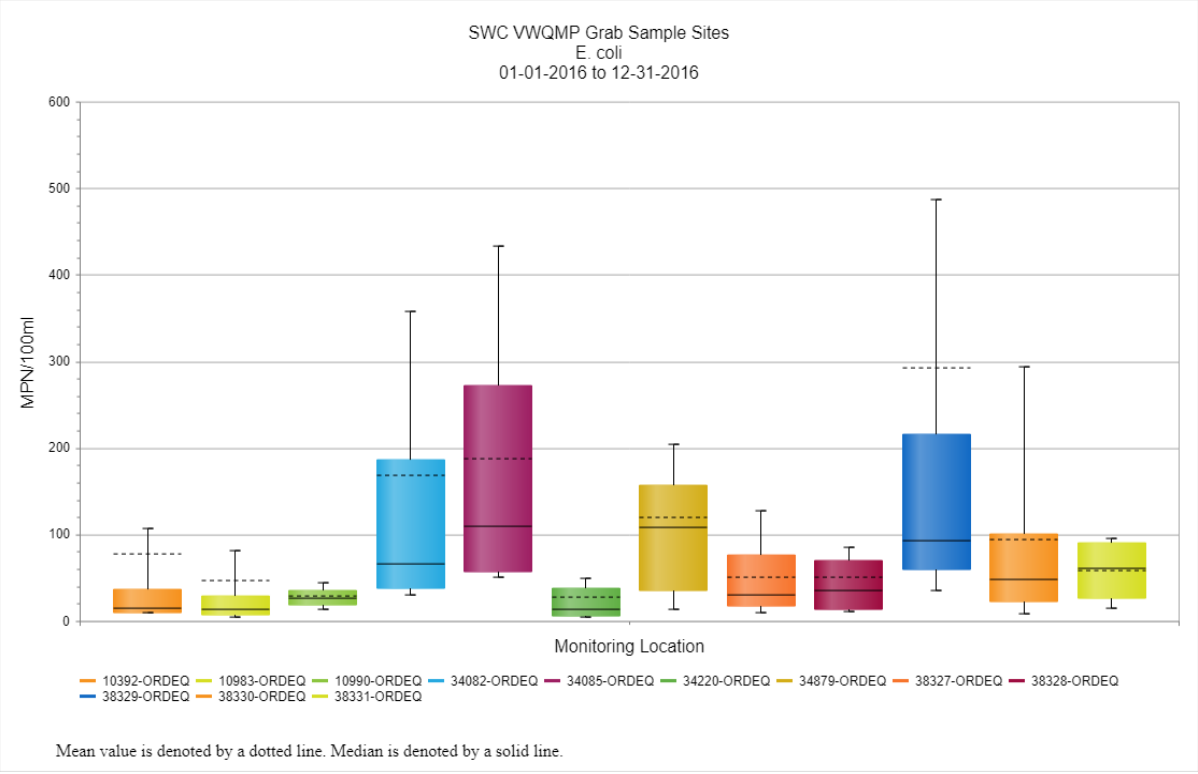


FIGURE 25

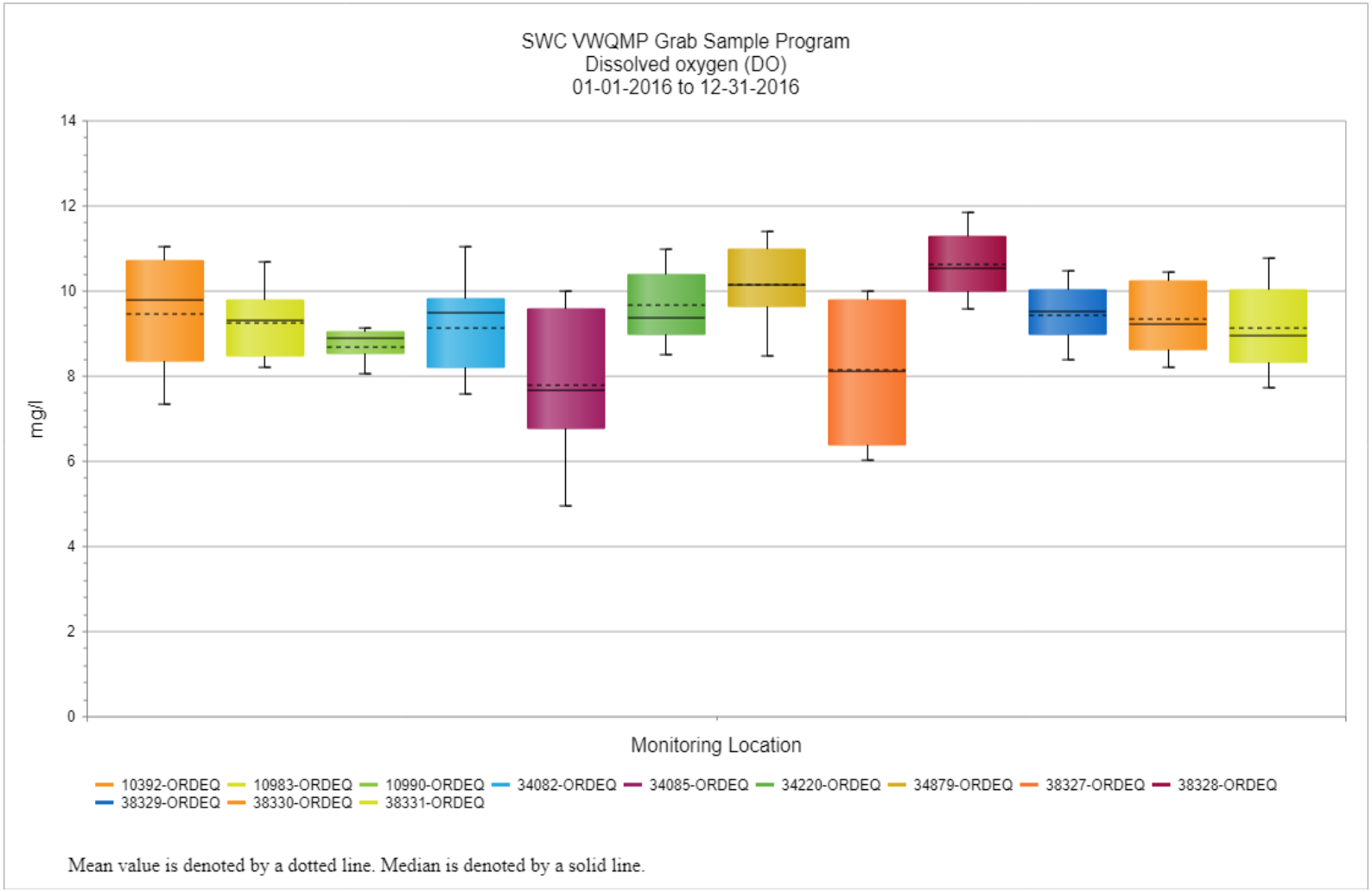

SWC VWQMP Grab Sample Program
Dissolved oxygen (DO)
01-01-2016 to 12-31-2016
mg/l
14
12
10
8
6
4
2
0
Monitoring Location
10392-ORDEQ
10983-ORDEQ
10990-ORDEQ
34082-ORDEQ
34085-ORDEQ
34220-ORDEQ
34879-ORDEQ
38327-ORDEQ
38328-ORDEQ
38329-ORDEQ
38330-ORDEQ
38331-ORDEQ
Mean value is denoted by a dotted line. Median is denoted by a solid line.

FIGURE 26 E. COLI GRAB SAMPLE RESULTS NEAR MOUTH OF DEADWOOD CREEK.

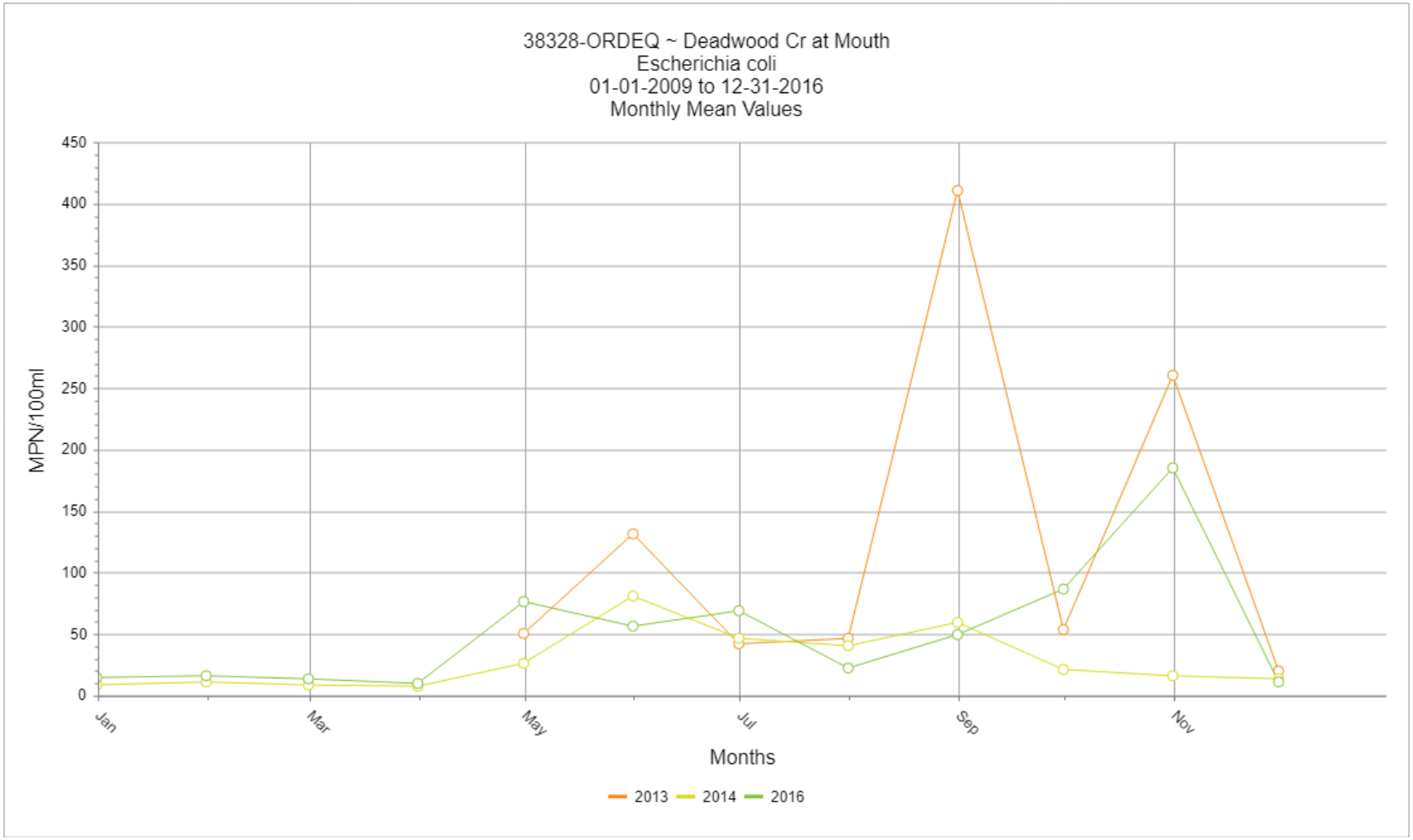
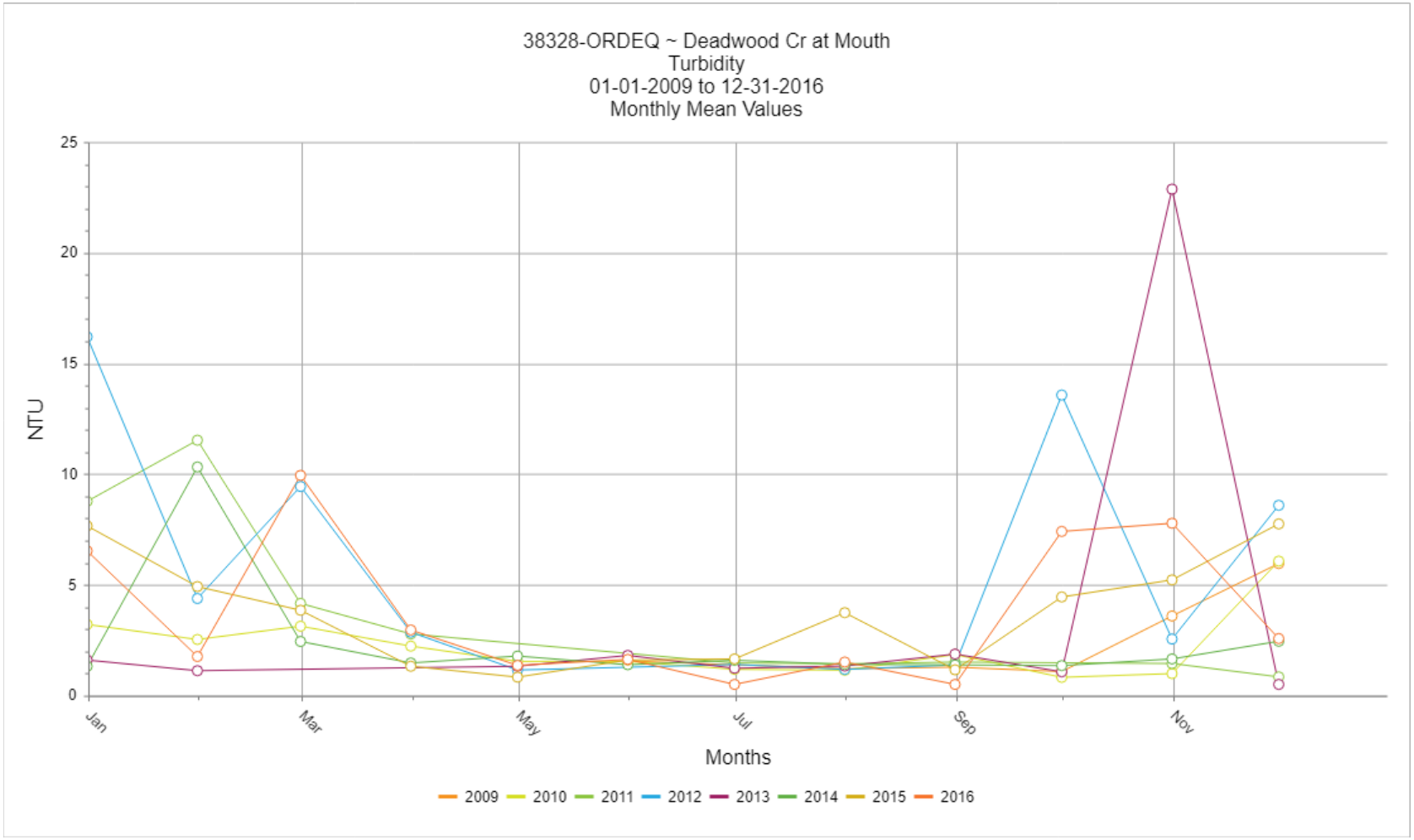


FIGURE 27 TURBIDITY GRAB SAMPLE RESULTS NEAR MOUTH OF DEADWOOD CREEK.



VI. Discussion

Temporal and spatial distribution of thermal maximums

The mainstem Siuslaw and Lake Creek temperatures started off the 2016 deployment season above the state threshold of 18˚C for rearing of juvenile salmonid fish species, excluding the two most upstream (38329 and 34880). Water temperatures followed the pattern of air temperature and solar radiation as seen in the correlation to the RAWS data from Goodwin Peak (Figures 4 and 5). This indicates the young salmon rearing in the lower and mid-Siuslaw are likely seeking cool water refuge in tributaries, deep pools, and in complex habitats such as woody debris jams. The temperatures in the two upper sites breach the 18˚C threshold in early August and remain warm until late August when temperatures start to fall below the threshold one by one, starting with the upstream sites and ending with the farthest downstream. The temperatures in the lower to mid-mainsteam Siuslaw, and all of Lake Creek, were unhealthy for salmon and trout during the rearing period. The only sites where we collected temperature data that was not above 18˚C for most of the rearing season were the three upper Siuslaw sites, near Pheasant Creek, Doe Creek, and the forks (39318, 34880, 38329).

We installed the temperature logger at Siuslaw above Barber (34222) to gain a better understanding of the temperature regime in the mid-Siuslaw-from Barber Creek up to Esmond (34881)—and what we found were temperatures that exceeded standards for healthy rearing of native aquatic species through the entire mid-Siuslaw from June through mid-September. This site documented interesting dynamics in the daily temperature fluctuation (Delta) which are discussed later.

The temperatures measured below Hult Log Pond in Upper Lake Creek (38329) were higher than those of the upper Siuslaw sites. This may be a result of the shallow (<3m) spillway at the outlet of the pond, where water flowing out of the pond is heated. This segment of Lake Creek could provide cool water refuge for juvenile fish during the rearing season, like the sites in the Upper Siuslaw, if the impact from Hult Log Pond on temperature could be mitigated.

Daily change in temperature (Delta)

Describing the impacts of daily variation in water temperature on aquatic organisms is beyond the scope of this report. Although, we did graph and list spatial and temporal patterns in delta during the 2016 rearing season in this section. A pattern of delta decreasing as sampling moves upstream is evident (see Table 2 and Figure 10). The

change in temperature also typically increases and decreases following the same pattern as stream and air temperature, and solar radiation. The Siuslaw above Barber Creek, LASAR station 34222, is atypical relative to the other sites in the Siuslaw and Lake Creek. Despite being the second most downstream site, the delta at 34222 starts the season similar to the three upstream sites (38329, 34880, 39318), fluctuating only between 2 and 3˚C each day, and not following temperature patterns as closely. At this time, the most comparable site, Lake Creek above Indian and Siuslaw at Tide (34878, 33642), are varying between 5 and 6˚C daily. Starting in mid-July, the delta at Siuslaw above Barber starts to shift more closely to that of the other downstream sites and finally in mid-August it follows the patterns of those sites more closely.

Temperature summary

The SWC 2016 temperature data shows reason for concern through much of the salmon and trout rearing season, with a high of 28.4°C, or 83.2°F, on July 29th near Tide Wayside. Temperature exceedances occur along the entire listed reach of the Siuslaw and Lake Creek, extending from the estuary to the upper watersheds. Figure 6 graphs the differences in maximum temperature for the lower, middle and upper Siuslaw River. Note that the temperature exceeds state standards for 42 days as high up in the system as Siuslaw at Doe Creek (SDT) and increases as you move downstream. There are multiple factors affecting temperature, including differences in physical channel characteristics (channel roughness, substrate, depth, gradient), amount of direct solar gain on the stream, riparian conditions (shade from tree canopy), and elevation as one goes from the smaller headwater streams toward the estuary. Flow (discharge) also increases so the river responds dynamically to changes in these factors.

Dissolved Oxygen

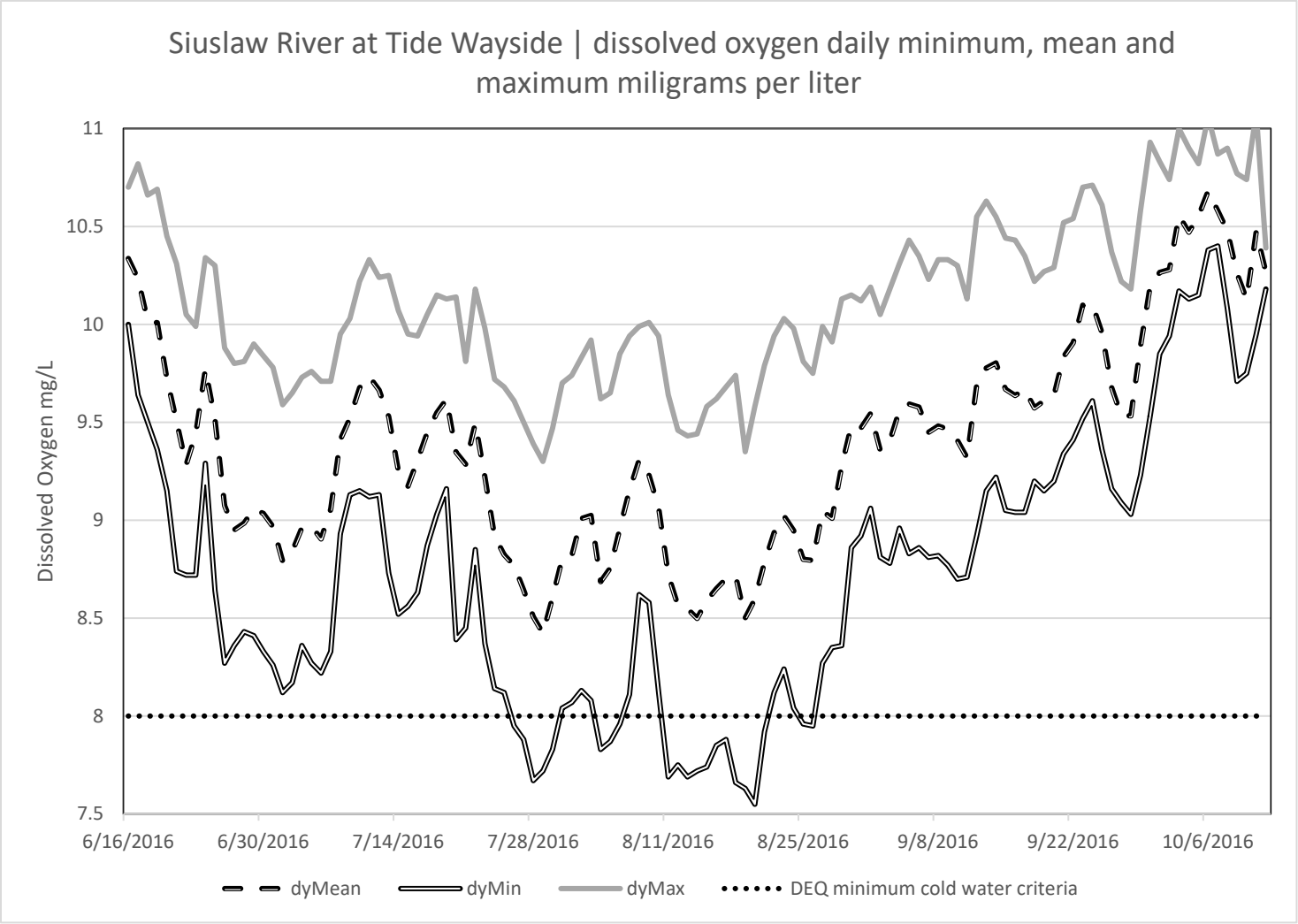
DO Concentration

Mainstem Siuslaw and Lake Creek dissolved oxygen concentrations were above 8 mg/L through the entire 2016 deployment period. In addition, the 30-day minimum mean did not fall below the State 8 mg/L standard during the 2016 rearing season at the five sites in Lake Creek and the Siuslaw River.

Daily minimums in concentration - Although the 30-day minimum mean was above State standards throughout the rearing season, discrete measurements of dissolved oxygen concentration levels fell below the standard following the patterns of higher water and air temperature, and increased solar radiation. Figures 13 and 16 in the Results section graph the minimum dissolved oxygen values measured on each day. The devices collected a measurement every 15 minutes, or 96 times per day, and the graphs show the lowest of the 96 measurements. OAR Chapter 41 states that as an absolute minimum, DO concentration should not be below 6.5 mg/L (see appendix A) which it did not at any of the sites we monitored.

SWC deployed at the 38329, upper Siuslaw below the forks, site to determine dissolved oxygen conditions near the headwaters and compare them with the TWS and SBT sites. We deployed the 34222 logger above Barber Creek to see impacts Lake Creek dissolved oxygen may be having on the mainstem Siuslaw downstream. Concentrations at the Upper Siuslaw and Tide sites were closer to each other than expected but significant differences in the water temperature and DO percent saturation. Compared to the rest of the sites we monitored, the upper Siuslaw reach may be capable of absorbing and containing more dissolved oxygen. The influence Lake Creek may be having on the Siuslaw appears to be one of temperature and dissolved oxygen saturation instead of concentration. Dissolved oxygen concentration measurements at 34222 (above Barber Creek), 34878 (Lake Creek above Indian Creek), and 33642 were similar comparison chart) but temperature and percent saturation were comparatively higher in Lake Creek at the confluence compared to the Siuslaw (Figures 12, 15, 18). The increases in temperature and percent saturation from Barber (34222) to Tide (33642) were intensified by the influence of Lake Creek.

FIGURE 289B


Siuslaw River at Tide Wayside | dissolved oxygen daily minimum, mean and maximum miligrams per liter
Dissolved Oxygen mg/L
11
10.5
10
9.5
9
8.5
8
7.5
6/16/2016
6/30/2016
7/14/2016
7/28/2016
8/11/2016
8/25/2016
9/8/2016
9/22/2016
10/6/2016
dyMean
dyMin
dyMax
DEQ minimum cold water criteria

Tide Wayside (33642) site is a current DEQ Ambient station (LASAR 33642 - Siuslaw River at Tide boat ramp) with data collected by DEQ in 2008. Conducting continuous DO-Temp data collection assists in determining the current status of the reach (impaired or meeting criteria) and if it's found to be impaired, whether TMDLs should be developed using steady-state or other tools. A review of internal data conducted by the DEQ in 2015 indicated that the site is not in equilibrium and their 2008 data did not provide a clear understanding of the status of DO conditions in this reach of the mainstem. SWC deployed a logger in 2016 to assist in the understanding of DO conditions at Tide and the 30-day minimum mean did not drop below the state criteria.

DO percent saturation

Percent saturation—a relative measure of the concentration of oxygen that is dissolved or carried in a given medium—in this case the surface water of the Siuslaw River and Lake Creek. Percent saturation increases due to many factors including the presence of photosynthetic aquatic oxygen producers. Cooler water can carry more oxygen, therefore samples with the same concentration of DO will have different percent saturation unless the temperatures are the same. OAR Chapter 41 states for water bodies where conditions of barometric pressure, altitude, and temperature preclude attainment of the 8.0 mg/l, dissolved oxygen may not be less than 90 percent of saturation (See appendix A). Barometric pressure, altitude, and temperature conditions at the 2016 did not preclude attainment of the 8.0 mg/l but there are patterns in the percent saturation we will explore in this report.

In the Siuslaw River, percent saturation decreases moving upstream, likely because the cooler upper Siuslaw segments have capacity for higher DO concentration and the warmer, downstream segments experience more photosynthesis and solar absorption. Percent saturation in the Siuslaw and Lake Creek increases at every site during the cooling months of late summer, excluding LASAR station 38329, the upper Siuslaw below the North and South Forks, which remained low—about 90%--through the deployment period.

In Lake Creek, at the site just downstream of Hult Log Pond, percent saturation was impacted significantly by the earthen dam and reservoir just upstream—as was temperature. The percent saturation was higher here than at Lake Creek above Indian Creek, which is 28 river miles downstream.

VII. Recommendations

Recommendation for restoration

The state standard for dissolved oxygen was met in 2016. Although daily minimum dissolved oxygen concentration is not the state standard parameter—it is the 30-day minimum mean—the daily minimum dropped below the standards following temporal patterns in air and water temperatures, and solar radiation, indicating that those influence dissolved oxygen significantly. Considering the majority of our continuous temperature monitoring sites exceeded standards throughout most of the rearing season, restoration actions that reduce water temperatures should be implemented in the listed segments. The increases in temperature and percent saturation from Barber (34222) to Tide (33642) were intensified by the influence of Lake Creek while the impact on DO concentration was negligible; therefore, projects aimed at reducing water temperature in listed segments may have the highest restoration value between the Siuslaw/Lake Creek confluence and Triangle Lake.

Turbidity grab samples at the upper Siuslaw LO-16 site (LASAR 38329) were highest in the Siuslaw and Lake Creek. The 2016 high was in October, 131 NTUs. We also measured higher turbidity at LASAR 10983 in the middle Siuslaw. Furthermore, conductivity measurements during SWC audits at this and other sites near the forks average 70 µS/cm while the rest of the watershed averages 40 µS/cm. This area is dominated by agriculture and forestry practices. SWC staff have observed many eroding stream banks in this area as well. The mid-to-upper Siuslaw land use is predominantly forestry and ownership is staggered in the checkerboard between BLM and private industrial forestry. Restoration projects designed to restore riparian function, exclude cattle from the riparian area, and limit runoff are recommended from interpretation of water quality monitoring.

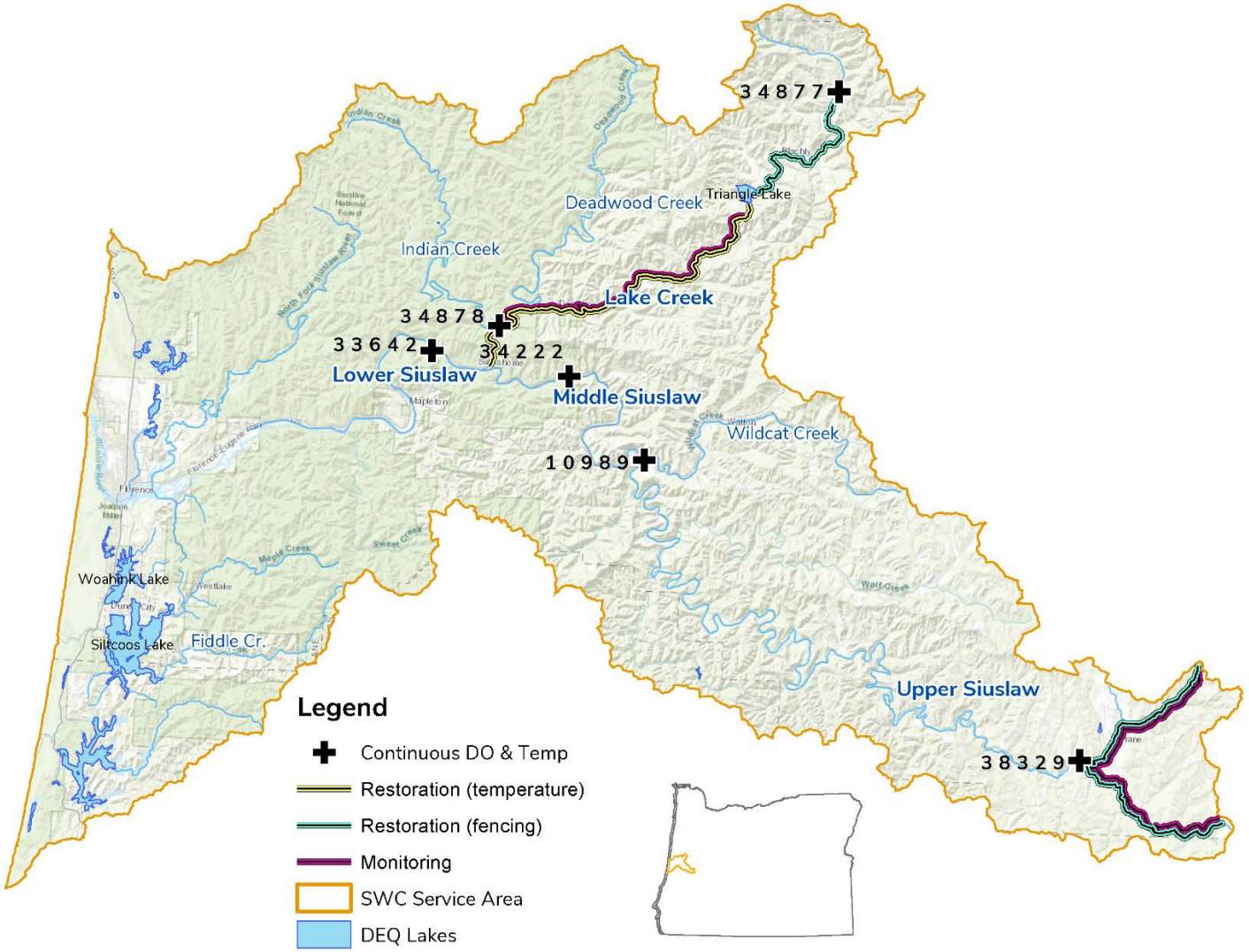
E. coli indicate sewage or livestock contamination because they are commonly found in human and animal feces and the EPA recommends testing for *E. coli* in recreational waters. SWC *E. coli* measurements in 2016 were higher upstream of Triangle Lake were than downstream. Triangle Lake is a popular destination during summer months for recreation such as water skiing, fishing, and swimming—especially downstream at the BLM-managed day use area. Restoration projects that exclude livestock from the Lake Creek and its tributaries upstream of the lake would likely decrease the number of E. coli in the water, especially during summer months. Off-channel watering systems

and other best management practices for small farmers would be suitable in the communities of Blachly and Triangle Lake.

Recommendations for further monitoring and research

Dissolved oxygen percent saturation in the Siuslaw and Lake Creek increases at every site during the cooling months of late summer, excluding LASAR station 38329, the upper Siuslaw below the North and South Forks, where it drops. Denser sampling of continuous dissolved oxygen, saturation, and temperature is recommended here, along with researching land use and other factors that may be causing the late summer drop in saturation.

The increases in temperature and percent saturation from Barber (34222) to Tide (33642) were intensified by the influence of Lake Creek while the impact on DO concentration was minute. Denser temperature monitoring in Lake Creek and its major tributaries downstream of Triangle Lake is recommended in order to identify mainstem thermal patterns and tributary influences on temperature.


34877
Deadwood Creek
Triangle Lake
Indian Creek
Lake Creek
34878
33642
34222
Lower Siuslaw
Middle Siuslaw
Wildcat Creek
10989
Woahink Lake
Siltcoos Lake
Fiddle Cr.
Upper Siuslaw
38329
Legend
Continuous DO & Temp
Restoration (temperature)
Restoration (fencing)
Monitoring
SWC Service Area
DEQ Lakes

Appendix A

Oregon Administrative Rules (OARs)

340-041-0028

Temperature

(1) Background. Water temperatures affect the biological cycles of aquatic species and are a critical factor in maintaining and restoring healthy salmonid populations throughout the State. Water temperatures are influenced by solar radiation, stream shade, ambient air temperatures, channel morphology, groundwater inflows, and stream velocity, volume, and flow. Surface water temperatures may also be warmed by anthropogenic activities such as discharging heated water, changing stream width or depth, reducing stream shading, and water withdrawals.

(4) Biologically Based Numeric Criteria. Unless superseded by the natural conditions criteria described in section (8) of this rule, or by subsequently adopted site-specific criteria approved by EPA, the temperature criteria for State waters supporting salmonid fishes are as follows:

(c) The seven-day-average maximum temperature of a stream identified as having salmon and trout rearing and migration use on subbasin maps set out at OAR 340-041-0101 to 340-041-0340: Figures 130A, 151A, 160A, 170A, 220A, 230A, 271A, 286A, 300A, 310A, 320A, and 340A, may not exceed 18.0 degrees Celsius (64.4 degrees Fahrenheit);

Oregon Administrative Rules (OARs)

340-041-0016

Dissolved Oxygen

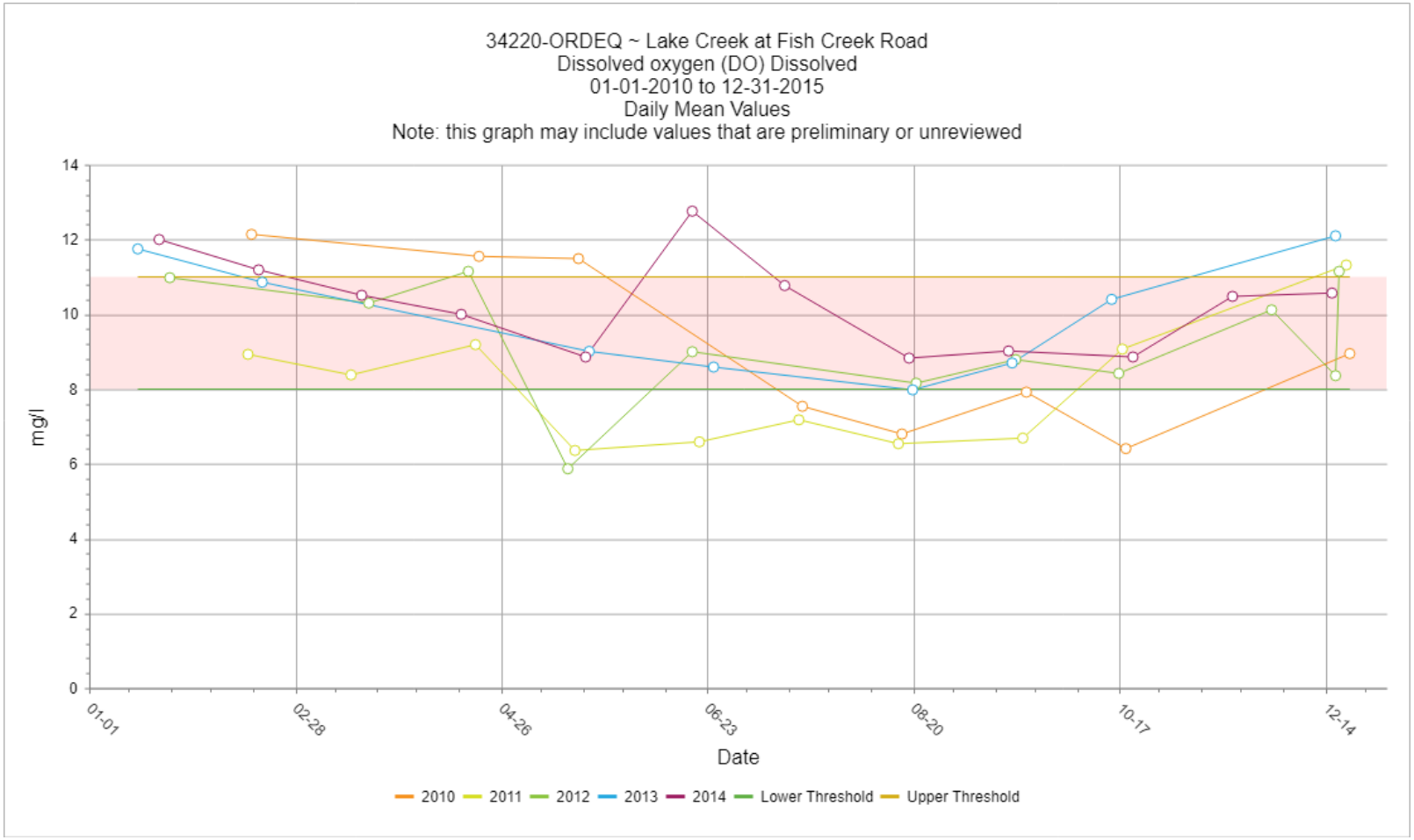
Dissolved oxygen (DO): No wastes may be discharged and no activities may be conducted that either alone or in combination with other wastes or activities will cause

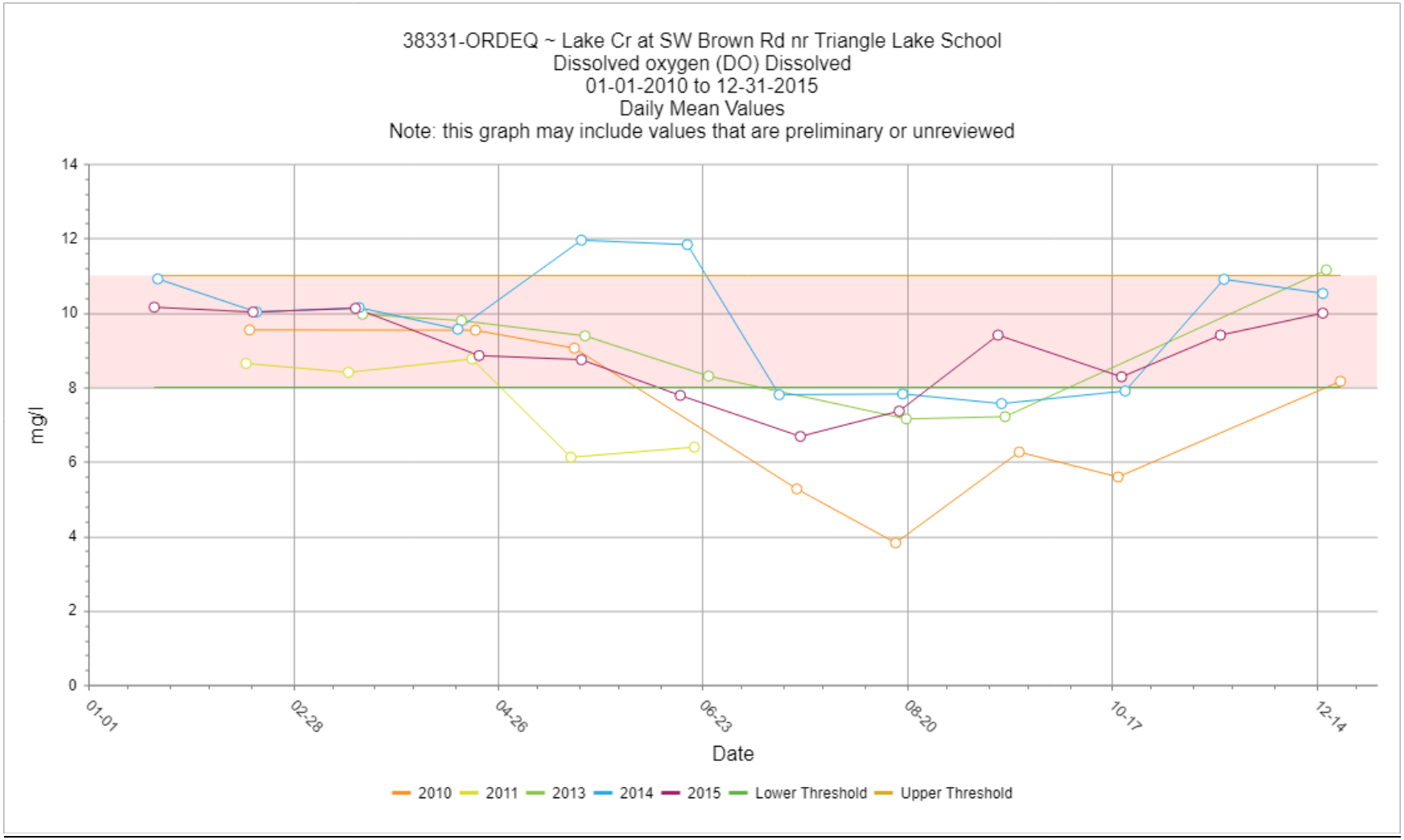
violation of the following standards: The changes adopted by the Commission on January 11, 1996, become effective July 1, 1996. Until that time, the requirements of this rule that were in effect on January 10, 1996, apply:

(2) For water bodies identified by the Department as providing cold-water aquatic life, the dissolved oxygen may not be less than 8.0 mg/l as an absolute minimum. Where conditions of barometric pressure, altitude, and temperature preclude attainment of the 8.0 mg/l, dissolved oxygen may not be less than 90 percent of saturation. At the discretion of the Department, when the Department determines that adequate information exists, the dissolved oxygen may not fall below 8.0 mg/l as a 30-day mean minimum, 6.5 mg/l as a seven-day minimum mean, and may not fall below 6.0 mg/l as an absolute minimum (Table 21);

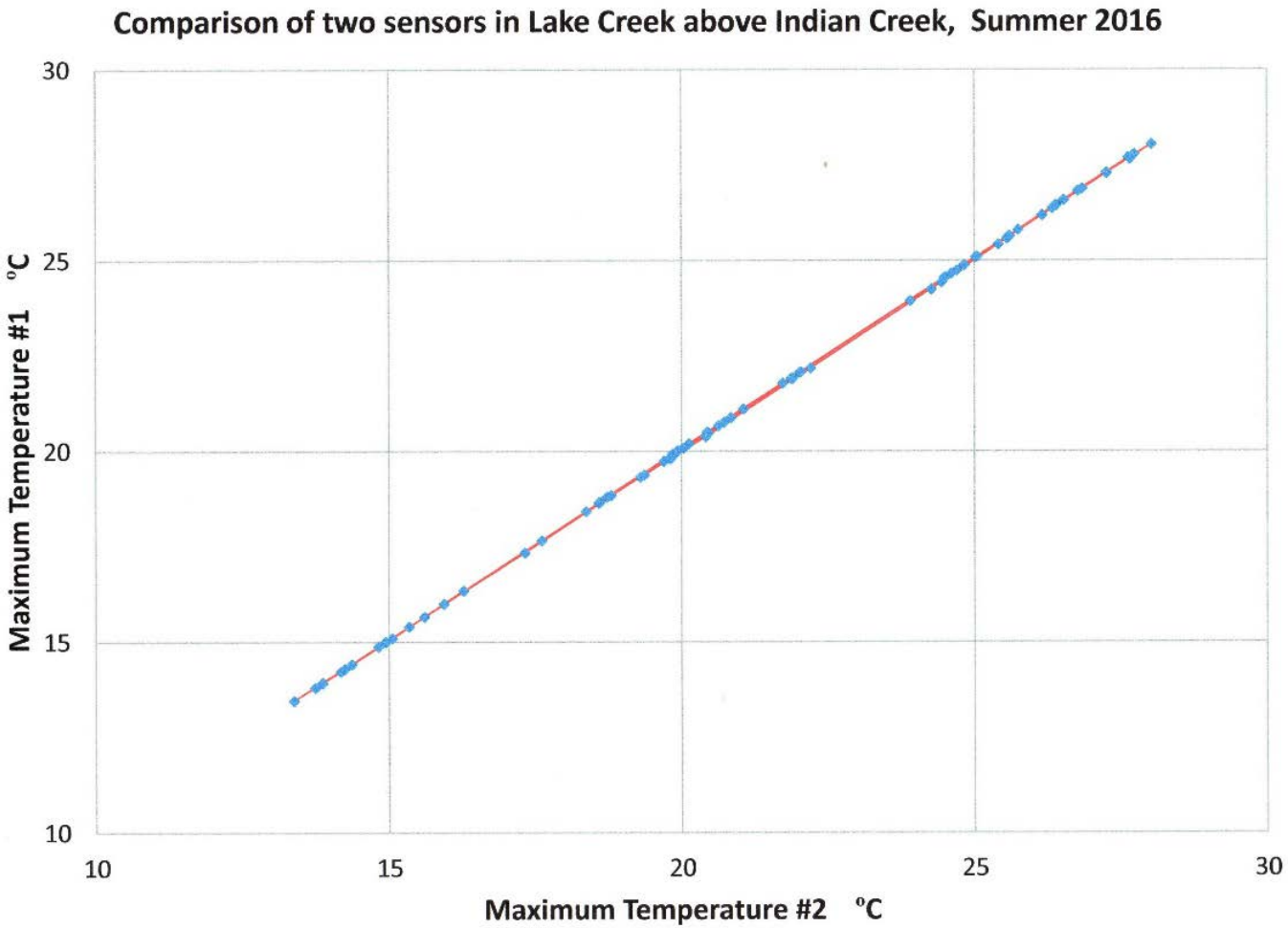
Stat. Auth.: ORS 468.020, 468B.030, 468B.035 & 468B.048
Stats. Implemented: ORS 468B.030, 468B.035 & 468B.048
Hist.: DEQ 17-2003, f. & cert. ef. 12-9-03; DEQ 2-2007, f. & cert. ef. 3-15-07

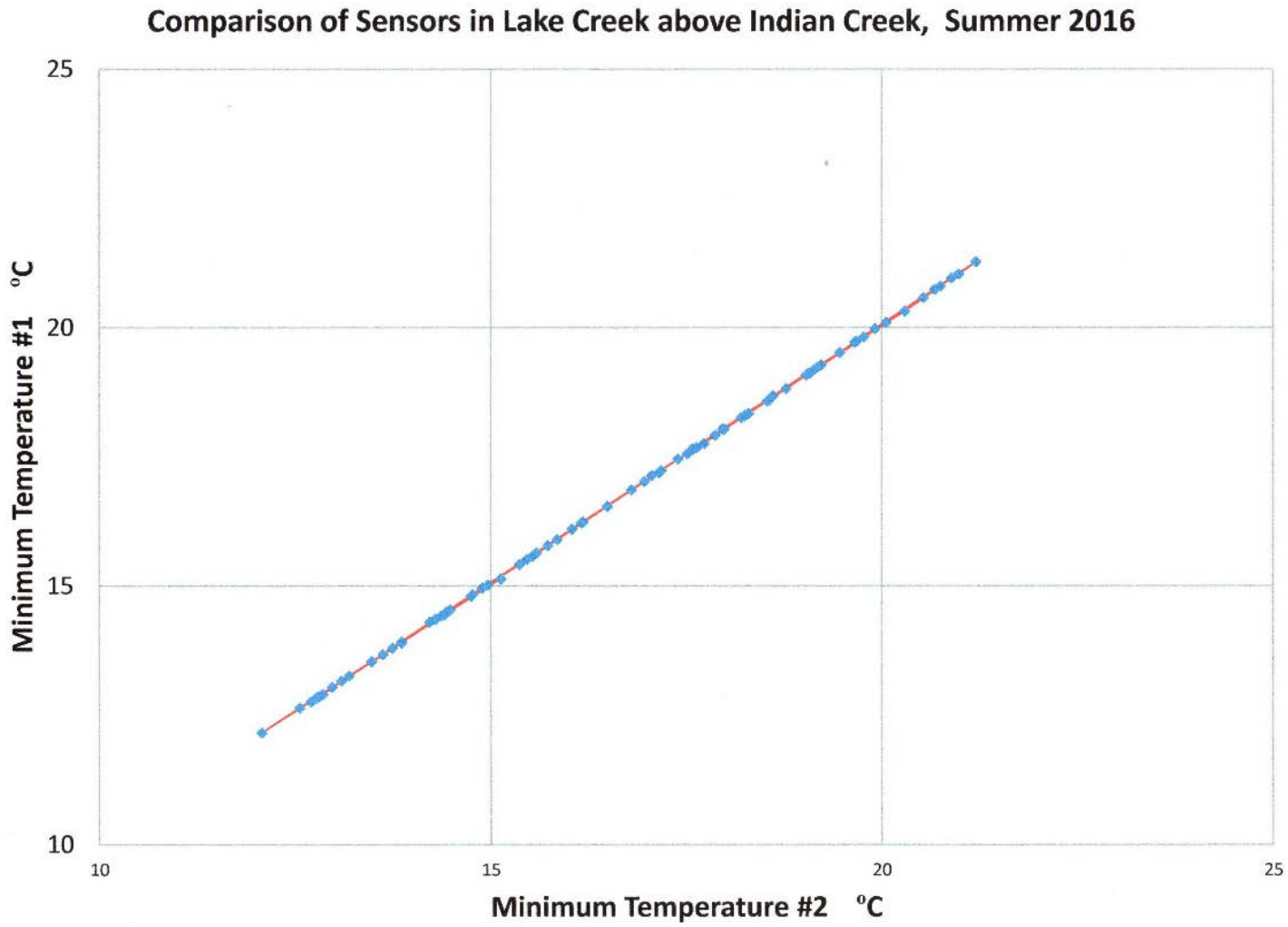
Appendix B


34220-ORDEQ ~ Lake Creek at Fish Creek Road
Dissolved oxygen (DO) Dissolved
01-01-2010 to 12-31-2015
Daily Mean Values
Note: this graph may include values that are preliminary or unreviewed
mg/l
14
12
10
8
6
4
2
0
01-01
02-28
04-26
06-23
08-20
10-17
12-14
Date
2010
2011
2012
2013
2014
Lower Threshold
Upper Threshold


38331-ORDEQ ~ Lake Cr at SW Brown Rd nr Triangle Lake School
Dissolved oxygen (DO) Dissolved
01-01-2010 to 12-31-2015
Daily Mean Values
Note: this graph may include values that are preliminary or unreviewed
mg/l
14
12
10
8
6
4
2
0
01-01
02-28
04-26
06-23
08-20
10-17
12-14
Date
2010
2011
2013
2014
2015
Lower Threshold
Upper Threshold

Appendix C


Comparison of two sensors in Lake Creek above Indian Creek, Summer 2016
Maximum Temperature #1 °C
30
25
20
15
10
10
15
20
25
30
Maximum Temperature #2 °C


Comparison of Sensors in Lake Creek above Indian Creek, Summer 2016
Minimum Temperature #1 °C
25
20
15
10
10
15
20
25
Minimum Temperature #2 °C

SAMPLE & ANALYSIS PLAN

Volunteer Water Quality Monitoring: Siuslaw Watershed Council VWQMP

DEQ04-LAB-0047-SAP
Version1.3– October 2014

Siuslaw Watershed Council
PO Box 422
Mapleton, OR 97453
Phone: (541)268-3044
Fax: (541)268-3045
www.siuslaw.org

Group A: PROJECT MANAGEMENT

A1. Title and Approval Sheet

Tyler Pedersen / Project Manager	Date
Dan Carpenter/ Watershed Council Coordinator	Date
Monitoring Partner	Date
Steve Hanson / DEQ Volunteer Monitoring Specialist	Date
Chris Redman / DEQ Quality Assurance Officer (QAO)	Date

December 2004

PRINTED ON RECYCLED PAPER

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A2. Table of Contents

A3. Distribution List

Name	Organization	Contact
Steve Hanson	DEQ	503.229.5449
Bobbi Lindberg	DEQ	541.687.7353
Bill Conroy	USFS	541.563.8406
Brian Vollmer-Buhl	Mapleton Schools	541.268.4322

A4. Project/Task Organization

In a table give information for individuals or organizations that will be leaders in the project. Example below:

Name	Project Title/Responsibility	Contact
Tyler Pedersen	Project Manager	541.268.3044
SWC Volunteers	Sample collection	541.268.3044
Tyler Pedersen	Sample Analysis	541.268.3044
Tyler Pedersen	Data Clerk/Data Management	541.268.3044
Tyler Pedersen	Data Analysis and Presentation	541.268.3044
Tyler Pedersen	Report Writing	541.268.3044
Steve Hanson	DEQ Vol. Mon. Specialist	503.229.5449

A5. Purpose Statement/Problem Definition/Background

Our objective is to document the baseline ambient water quality conditions of water in the Siuslaw River and its tributaries. The data collected will be used by the SWC, researchers, and state agency staff to characterize current water quality conditions, identify specific water quality problem areas, and to develop enhancement and restoration projects. The SWC will also use the data to educate and inform local residents on the connections between land use and water quality.

The monitoring data collected under the scope of this grant proposal will be incorporated into the EPA funded Siuslaw Watershed Restoration Initiative (SWRI). The SWRI will develop and implement a whole-basin watershed monitoring and evaluation project that tracks restoration and conservation progress across ownership and over time. This project will provide a geo-database that incorporates physical, biological, and chemical measures of the basin that will greatly aid in restoration planning and monitoring. The field data collection by the VWQM Program will serve as an important component of the SWRI.

The 504,000 acre (773 square mile) Siuslaw River Basin is located on the Central Oregon Coast. Historically, relative to its size, the Siuslaw Basin was one of the most abundant anadromous fish producers in the Pacific Northwest (Assessment, p. 14), and was the largest producer south of the Columbia River. Coho salmon, Chinook salmon, steelhead, and sea-run cutthroat trout are among the major fish populations that rely on clean, cool water for spawning and rearing. Coho salmon are especially diminished compared to historical numbers. The mainstem Siuslaw river is water-quality limited per 303(d) listings for temperature and dissolved oxygen (summer miles 20 to 105.9, 2002 list; year round miles 0 to 105.9; 2004 draft 303(d) list). Sediment issues are cited as one of the priority water-quality impairments in the basin (2004 draft 303(d) list). The mainstem Siuslaw River is water-quality limited per the 2004 303(d) listings for fecal coliform year round from mile 5.7 to 105.9.

A6. Project Task/Description

We propose to continue monitoring the following parameters: dissolved oxygen (DO), turbidity, bacteria, temperature, salinity (in estuary only), weather conditions, and tidal stages (in estuary only). Trained volunteers will collect samples/monitor for these seven parameters, once a month at the sampling sites. The volunteers are trained to follow the protocols set forth in the "Water Quality Monitoring Technical Guide Book" and the DEQ's *QAPP Water Quality Volunteer Monitoring*. Monitoring days will remain the same every month (i.e. the third Wednesday of the month). Trained Mapleton Middle and High School science students will continue to process the DO and turbidity samples under supervision of the project manager. We will continue to partner with the Siuslaw Institute's Mapleton Schools Natural Resource Education Program as we work with students in the lab and collecting field data. Lab safety equipment is provided by the SWC and Mapleton Schools.

Siuslaw VWQMP Timetable:

Tasks to be completed	Months for year 2007 - 2016											
	1	2	3	4	5	6	7	8	9	10	11	12
Sampling Planning and revision									x	x		
Monthly sampling and processing of samples	x	x	x	x	x	x	x	x	x	x	x	x
Data entry	x	x	x	x	x	x	x	x	x	x	x	x
Data analysis and reporting	x	x	x	x	x	x	x	x	x	x	x	x

The VWQMP is funded through June 2017. Funding is being sought for 2017-18. If funding is not available, the program may cease or function on a very limited basis. The level of limited sampling would have to be determined based on the resources available at the time.

A7. Measurement Quality Objectives

Parameter	**Data Quality Level**
Temperature	B
Dissolved Oxygen	A
E. coli	A
Turbidity	A

Salinity	The Clean Water Team Guidance Compendium for Watershed Monitoring and Assessment, California State Water Resources Board, SOP 3.1.3.3.

VWQMP's sampling will characterize ambient water quality.

A8. Training Requirements and Certification

The VWQMP Coordinator (SWC Projects Manager) has received training from the former Project Manager. The VWQMP Coordinator will train volunteers using the approved methods. Volunteers will be retrained annually.

A9. Documentation and Records:

Document or Record Name and Description	Storage Location	Storage Time
ODEQ Quality Assurance Project Plan (QAPP)- DEQ04-LAB-0047-QAPP project description and assurance procedures.	DEQ Internet Page	5 years
Siuslaw VWQMP Sampling Analysis Plan- specific sampling information for the Siuslaw VWQMP.	DEQ Laboratory & SWC office	5 years
OWEB Water Quality Monitoring Guidebook ODEQ Laboratory Mode of Operations Manual- Methods manual	SWC office	5 years
Equipment Notebooks - records of quality control checks, calibrations and maintenance.	DEQ equipment boxes	5 years
Field Data Sheets – records of volunteer field data collection.	SWC office	5 years

Group B: DATA GENERATION AND ACQUISITION

B1. Sampling Process Design

Parameter	Reason	Sites Sampled	Sampling Schedule
Temperature	303(d) listing, influence on DO	All	Monthly*, First flush
Dissolved Oxygen	303(d) listing	All	Monthly*, First flush
E. coli	Human health, assess land use, Fecal coliform 303(d) listing	All	Monthly*, First flush
Turbidity	Informational, Sediment 303(d) listing	All	Monthly*, First flush
Salinity	Informational	Estuary	Monthly*, First flush
* On the same day every month (for example, the third Tuesday), morning to early afternoon.			

Grab Sample Sites

Site ID #	Tributary or Mainstem	Site Name/Location	Length of record (years)	Coordinates	Site Selection Factors
FB-2	Mainstem Siuslaw/Tidal	Florence Boat Dock, Old Town Florence, RM 5	2002-2016	-124.10128, 43.96752	Estuary sites: The estuary has been determined to be of the highest priority for restoration through the 2007 SWC Siuslaw Watershed and Coastal Lakes Seventh Field Aquatic Priority Classification process. The estuary monitoring sites serve as baseline locations for historic (KC-7) and future restoration projects. These sites were chosen because they represent three tiers of estuarine brackish water dilution, are proximal to confluences of major estuary tributaries, and have public access. Continuing collection at these four sites and a partnership on an additional site (North Fork near the mouth, CTCLUSI) will allow us to have long-term water quality data that can serve as trend data and reference sites.
SS-3	Tributary/Tidal	South Slough, below tide gate, RM 2	2002-2016	-124.05996, 43.95122	
MD-6	Mainstem Siuslaw/Tidal	Mapleton Public Dock, RM 20	2004-2016	-123.85750, 44.03030	
KC-7	Tributary/Tidal	Karnowsky Creek, County Bridge above confluence with Siuslaw River	2003-2016	-123.99589, 44.00339	
NF-M	Tributary	North Fork Siuslaw River, Minerva	2011-2016	-123.979993, 44.058332	Upper-watershed/Freshwater Sites: The middle and upper watershed freshwater sites were selected due to their downstream proximity to rural residential areas, to medium and high priority restoration areas, and changes in land use and public access. We also selected two sites above and below the largest lake in the watershed.
CH-11	Tributary	Chickahominy at bridge, Walton, RM 4	2005-2016	-123.57618, 44.04639	
TL-12	Mainstem Lake Creek	Lake Creek above Triangle Lake, 4 RM above Triangle Lake	2005-2016	-123.54290, 44.19919	
DW-13	Tributary	Deadwood Creek, Hwy 36 bridge above confluence with Lake Creek	2007-2016	-123.75918, 44.09504	
BT-14	Mainstem Lake Creek	Below Triangle Lake on Lake Creek below confluence with Fish Creek, RM 17	2009-2016	-123.58324, 43.14798	

MU-15	Mainstem Siuslaw	Middle/Upper Siuslaw Mainstem above Whittaker	2011-2016	-123.65930, 43.98494	
LO-16	Mainstem Siuslaw	Above confluence of North & South Forks of Upper Siuslaw River, at Fire Road bridge near Lorane	2015-2016	-123.26780, 43.82577	
WC-17	Lower Wolf Creek (New)	0.2 miles above confluence with Upper Siuslaw River; 8.4 miles up Siuslaw River Rd from Hwy 126	2016	-123.621, 43.960	
Continuous dissolved oxygen/temperature sites					
LAL	Mainstem Lake Creek	Lake Creek below Hult Pond	2007, 2014, 2015, 2016 (temp); 2016 (DO/temp)	-123.49679, 44.23781	All continuous sites are at or near sites that were previous monitored for TMDL (LASAR sites) or are near SWC grab sites.
SIT	Mainstem Lake Creek	Lake Creek above Indian Creek, RM 11	2007, 2014, 2015, 2016 (temp); 2016 (DO/temp)	-123.78402, 44.08383	
SBT	Lower Mainstem Siuslaw	Siuslaw River above Barber Creek	2005, 2007, 2014, 2015, 2016 (temp); 2016 (DO)	-123.72179, 44.0539	
TWS	Lower Mainstem Siuslaw	Siuslaw River above Tide Wayside	2016 (DO & temp)	-123.84132, 44.06664	
SAF	Upper Mainstem Siuslaw	Siuslaw River below confluence of N/S Forks, 300 feet U/S of Fire Road bridge	2014 & 2015 (temp & conductivity); 2016 (DO & temp)	-123.2678, 43.82577	
WCS	Wildcat Creek	Wildcat Creek 100 meters above confluence with Siuslaw/covered bridge	2016	-123.65388, 44.00350	
Continuous temperature sites					
SPT	Upper Mainstem Siuslaw	Siuslaw River below Pheasant Creek	2005, 2015, 2016	-123.443, 43.8960	
SDT	Upper Mainstem Siuslaw	Siuslaw River above Doe Creek	2005, 2014, 2015, 2016	-123.38527, 43.84246	

SAE	Upper Mainstem Siuslaw	Siuslaw River above Esmond Creek	2005, 2015, 2016	-123.6420, 43.9320	
SAW	Upper Mainstem Siuslaw	Siuslaw River above Whittaker Creek	2016	-123.660, 43.984	
LFT	Mainstem Lake Creek	Lake Creek above Fish Creek	2007, 2014, 2015, 2016	-123.58324, 44.14798	
Continuous conductivity/temperature site					
NFS	North Fork Siuslaw	North Fork Siuslaw 420 feet D/S of bridge at Minerva	2014, 2015, 2016	-123.96, 44.07	

B2. Sampling Method Requirements

- Sample collection will be performed from bridges, docks, and road crossings (culverts or tidegates).
- We will follow ODEQ Volunteer Monitoring QAPP for sample collection containers, holding times, and/or preservations.

B3. Sample Handling and Custody Procedures

- In the field, samples and the field sheet will be labeled with site name, date, time, type of sample, and volunteer name(s). Field sheet is attached as Appendix 1.

B4. Analytical Methods Requirements

Parameter	Method	Method Source	Analysis Location
Field Temperature	Ambient	ODEQ QAPP DEQ04-LAB-0047-QAPP	Field
Dissolved Oxygen	Modified Winkler	ODEQ QAPP DEQ04-LAB-0047-QAPP	SWC/Mapleton Schools Lab
Turbidity	Nephlometric	ODEQ QAPP DEQ04-LAB-0047-QAPP	SWC/Mapleton Schools Lab
E. coli	IDEXX Colilert-18 (ODEQ Approved Method)	ODEQ QAPP DEQ04-LAB-0047-QAPP	SWC/Mapleton Schools Lab
Salinity	Refractometer	The Clean Water Team Guidance Compendium for Watershed Monitoring and Assessment, California State Water Resources Board, SOP 3.1.3.3.	Field

- The SWC VWQMP follows the ODEQ's protocols on sample disposal.

B5. Quality Control Requirements

- We will follow the protocols as described in the ODEQ QAPP DEQ04-LAB-0047-QAPP.
- Duplicate quality control (QC) samples for all water quality measurements will be taken at a minimum of 10% of the total number of monitoring sites (1 duplicate for every 10 sites) during each sampling period. When stream temperature and conductivity will be measured in stream, two readings should be taken to serve as a duplicate.
- IDEXX Colilert reagents will be tested with IDEXX Quanti-Cult culture to test the media at the start and end of the monitoring year. Incubator temperatures will be checked at the beginning and end of each incubation and recorded in a log book kept with the incubator.
- Marine influenced E. coli samples will be run with a 1:10 dilution. To ensure that the dilution water is not affecting the results, blank samples will be run each sampling event and spiked samples will be run with each new bottle of dilution water.
- Volunteers will run replicate titrations of the DO samples to measure the precision of the results. Where the results are not within 5% of each other a third titration will be performed.
- Accuracy checks for turbidity will be conducted at the beginning and end of each event to confirm accuracy is with in the guidelines defined for "A" level data in the Oregon DEQ Data Quality Matrix (DQM). If accuracy exceeds limits defined in the DQM the result values for that parameter will be appropriately flagged and not be used for calculations comparing CBO and DEQ results.

- For split samples duplicate quality control (QC) samples will be collected at a minimum of 10% of the total number of monitoring sites, or at least once per sample event.
- If quality control results show a sampling problem we will retest, contact the manufacturer if appropriate, and/or contact the DEQ Vol. Mon. Specialist if appropriate.

B6. Instrument/Equipment Testing, Inspection, and Maintenance Requirements

The SWC VWQMP will follow the maintenance and inspection table in the ODEQ QAPP DEQ04-LAB-0047-QAPP.

B7. Instrument Calibration and Frequency

The SWC VWQMP will follow the Instrument Calibration and Frequency table in section B7 of the ODEQ QAPP DEQ04-LAB-0047-QAPP.

B8. Inspection/Acceptance Requirements

Individual volunteers are responsible for storing their equipment between sampling dates and taking basic care of their equipment. Lab equipment and supplies will be maintained by the SWC VWQMP Project Manager and will be stored at the SWC and Mapleton School Labs.

We will follow the supply and Inspection/Acceptance Requirements in section B8 of the ODEQ QAPP DEQ04-LAB-0047-QAPP.

B9. Data Acquisition Requirements

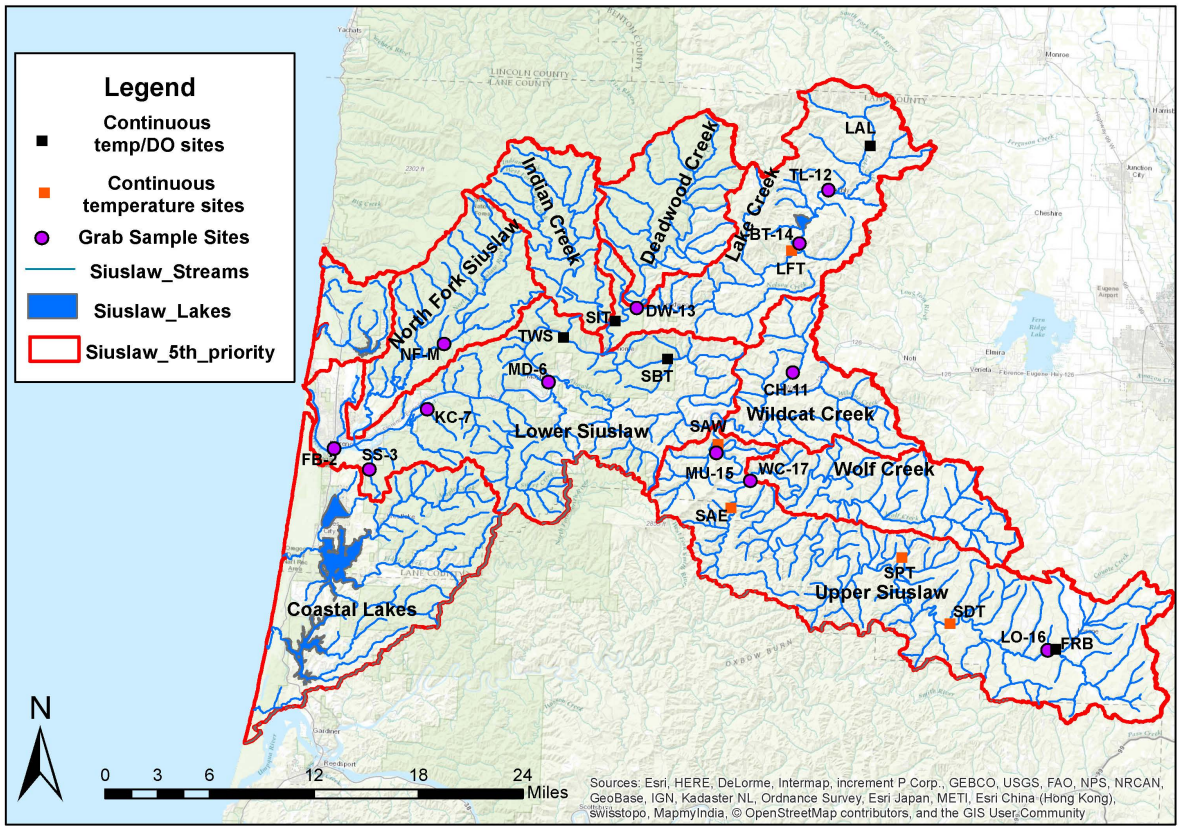
We will follow the Data Acquisition and Requirements section B9 of the ODEQ QAPP DEQ04-LAB-0047-QAPP.

B10. Data Management

Review the Data Management section B10 of the ODEQ VOLUNTEER MONITORING QAPP. Include the following information to document your internal data management:

- Field volunteers will turn their field data sheets over to the project manager. The project manager supervises use of the data sheets in the lab during analysis. The project manager will enter the data from the field data sheets into the Siuslaw VWQMP database. Data from the Siuslaw VWQMP database will be submitted to the ODEQ by the project manager.
- Field data sheets will be stored at the SWC office for a minimum of 5 years. The data will be stored electronically (Access and ArcGIS) on SWC office computers indefinitely.
- Electronic data will be stored in a Microsoft Access database (.mdb) and an ArcGIS database (.dbf) and will include date and time of sampling, abbreviations of site locations and water quality data.
- Data fields will include turbidity, dissolved oxygen, bacteria, temperature, clarity and salinity.
- Data will be checked for completeness, reasonableness, and transcription and calculation errors by the project manager.
- Electronic data will be stored on SWC office computers and will be backed up on an external hard drive.
- We will follow instructions for data formatting and submission outlined in section B10 of the ODEQ QAPP DEQ04-LAB-0047-QAPP. (A map showing all of the sites is included below.)
- The data will be analyzed in Microsoft Access and ArcGIS.

SWC Grab Sample & Continuous temp/DO Site Map



Group C: ASSESSMENT AND OVERSIGHT

C1. Assessment and Response Actions

- We will follow the procedures of assessment and response outlined in section C1 of the ODEQ QAPP DEQ04-LAB-0047-QAPP.
- We will follow the procedures of reporting the results of the quality control tests and other project assessments outlined in section C2 of the ODEQ QAPP DEQ04-LAB-0047-QAPP.

Group D: DATA VALIDATION AND USABILITY

D1. Data Review, Validation, and Verification

We will follow the procedures of data review, validation and verification in section D1 of the ODEQ QAPP DEQ04-LAB-0047-QAPP.

D2. Validation and Verification Methods

We will follow the procedures of data validation and verification in section D2 of the ODEQ QAPP DEQ04-LAB-0047-QAPP.

D3. Reconciliation with Data Quality Objectives

We will follow procedures for reconciliation with data quality objectives in section D3 of the ODEQ QAPP DEQ04-LAB-0047-QAPP.

Entered Into Database: ☐ Yes by
Database Reviewed: ☐ Yes by

SURVEY: _____ Date Sampled: _____

Major Basin: _____ Date Received in Lab: _____ Date Reported: _____

Collected by: _____ Weather: _____

BACTERIA ANALYSIS REPORT

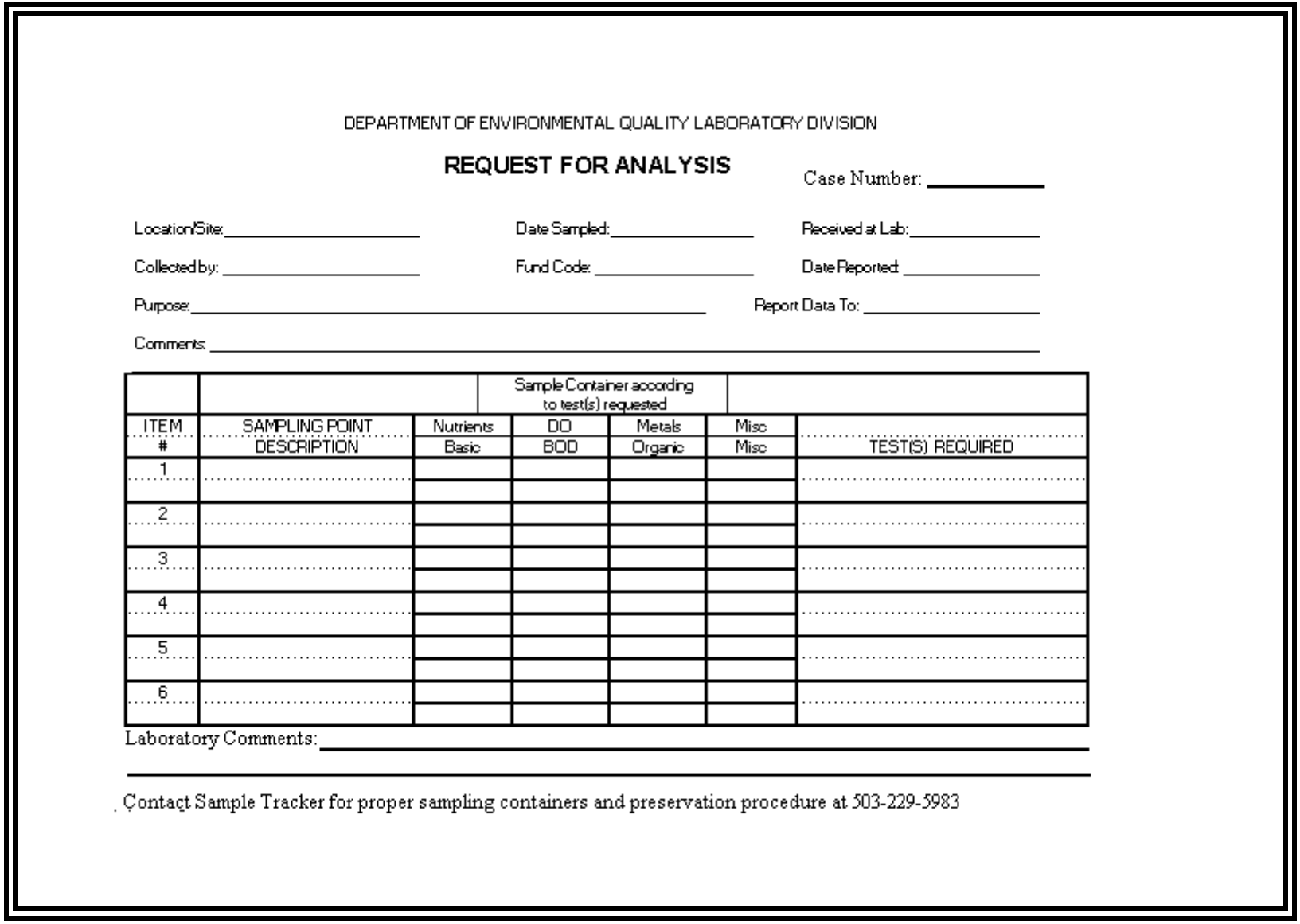
Item #	SITE #	SITE NAME	DO Poly	Time (HH MM)	Temp. (DegC)	FCond. (umhos)	D.O. (mg/l)	DO Sat. (%)	Field Turb. (NTU)	Bact Bottle	Date/Time in / Date/Time out	Temp in / Temp out	T. coliform / *E.coli*
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
		ACCUARCY DATA QUALTY LEVEL BASED ON STANDARDS CHECKS			NA		NA	NA		Cond: A ≤ ±7%, B ≤ ±10%; Turb ≤ ±5%, B ≤ ±30%			
		PRECISON DATA QUALITY LEVEL BASED ON DUPLICATE SAMPLES								Temp: A ≤ ±0.5,B ≤ ±1; Cond: A ≤ ±10%, B ≤ ±15%; DO: A ≤ ±0.3, B ≤ ±1; Turb ≤ ±5%, B ≤ ±30%			

Bacteria Analyst

Comments: _____

PAGE_____OF_____

Figure 1 Stream Survey



DEPARTMENT OF ENVIRONMENTAL QUALITY LABORATORY DIVISION

REQUEST FOR ANALYSIS

Case Number: _____

Location/Site: _____ Date Sampled: _____ Received at Lab: _____

Collected by: _____ Fund Code: _____ Date Reported: _____

Purpose: _____ Report Data To: _____

Comments: _____

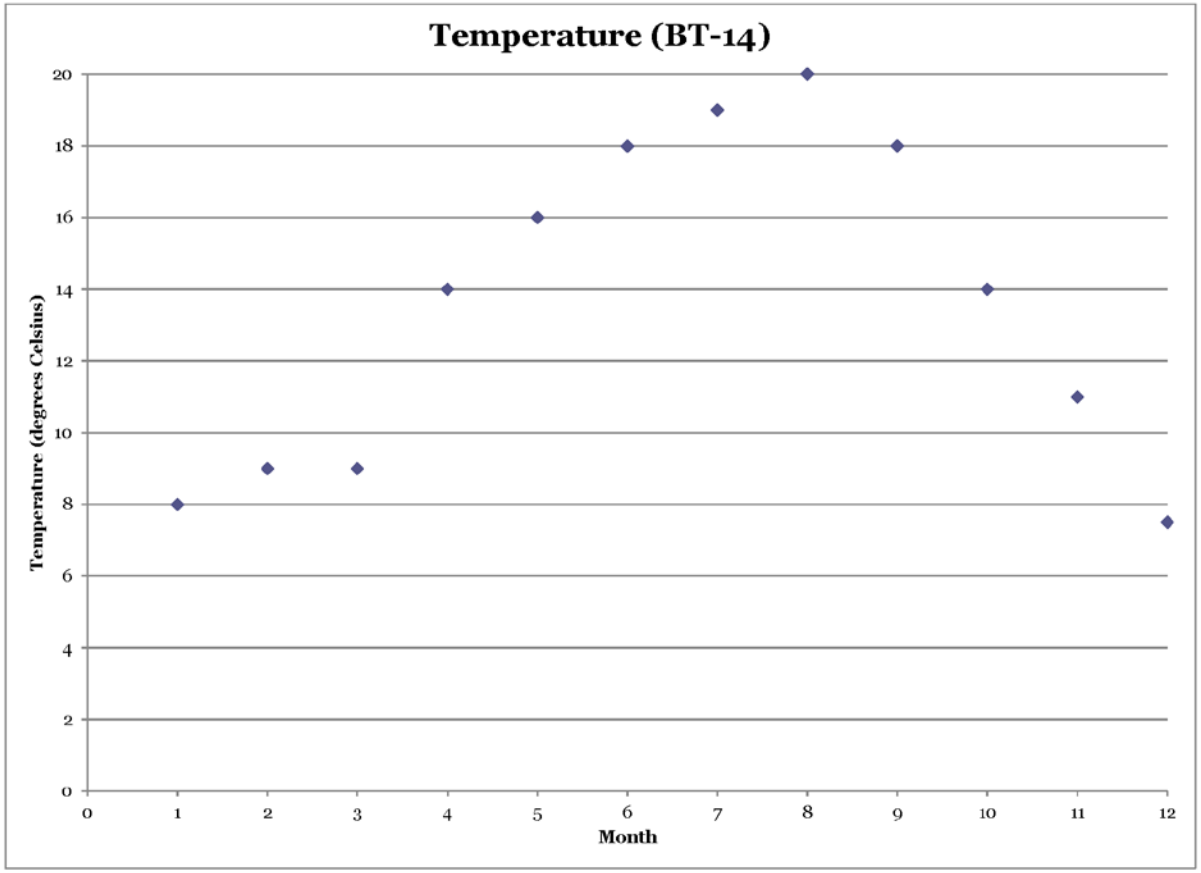
		Sample Container according to test(s) requested				
ITEM #	SAMPLING POINT DESCRIPTION	Nutrients Basic	DO BOD	Metals Organic	Misc Misc	TEST(S) REQUIRED
1						
2						
3						
4						
5						
6						

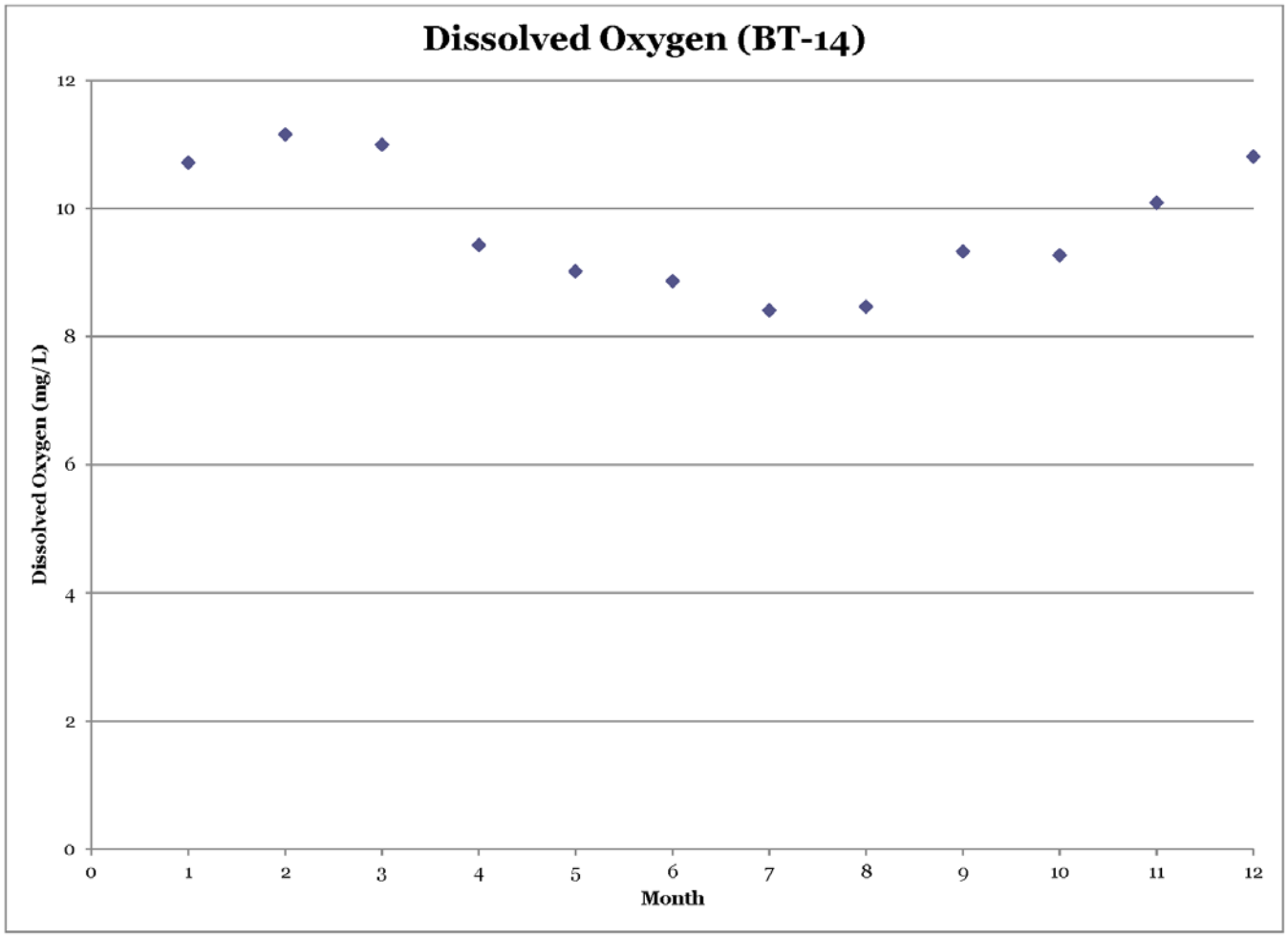
Laboratory Comments: _____

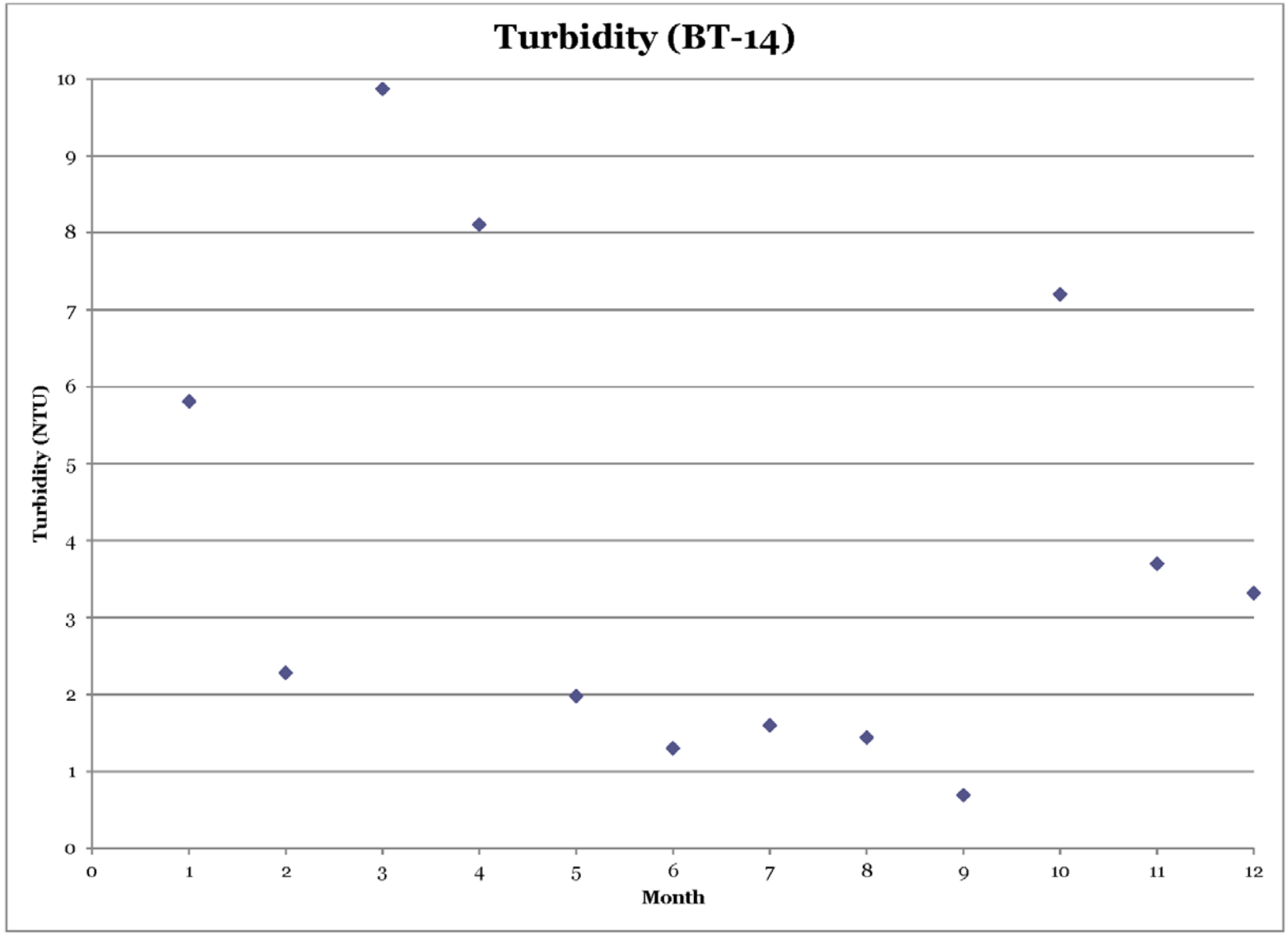
Contact Sample Tracker for proper sampling containers and preservation procedure at 503-229-5983

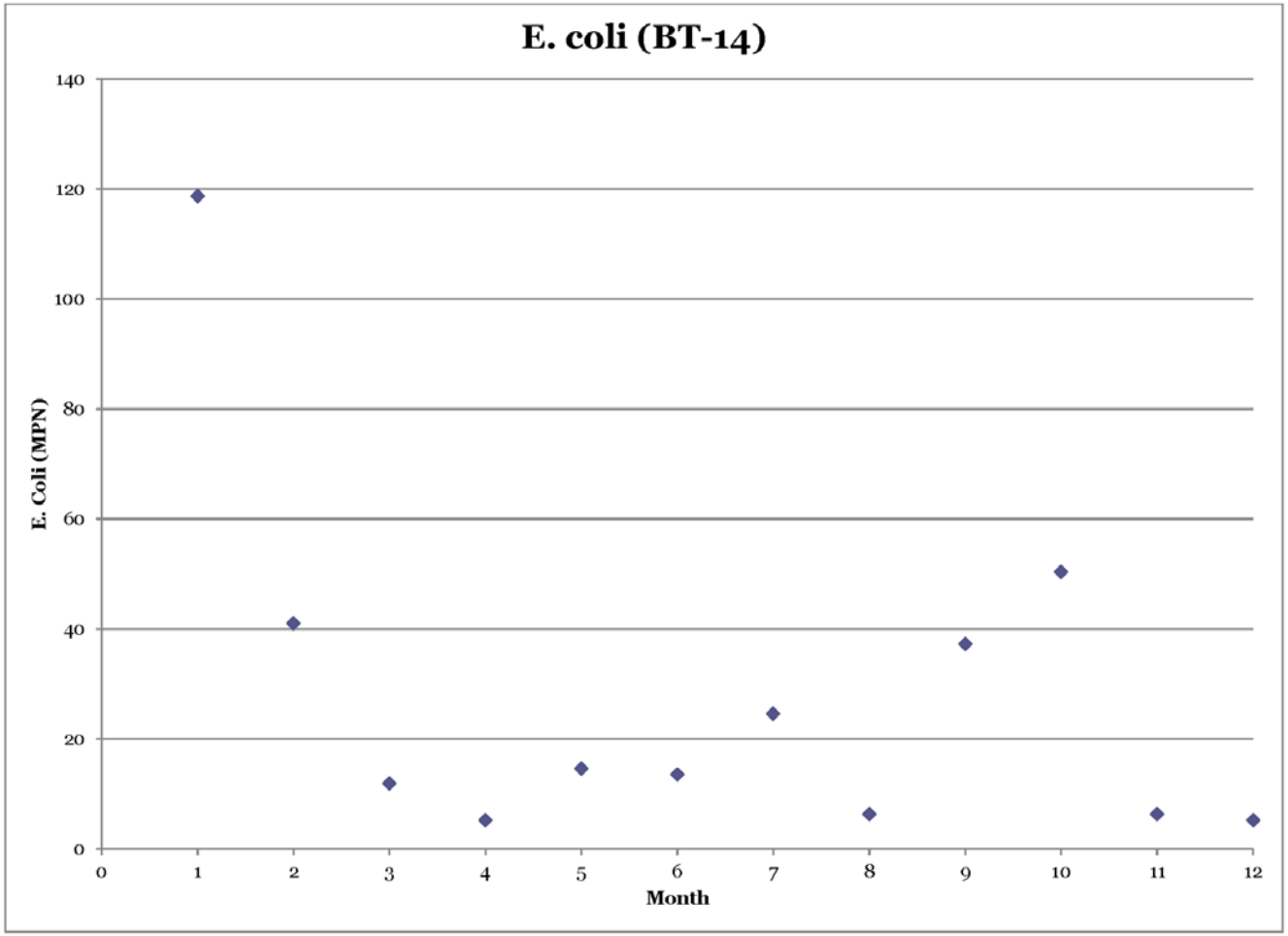
Figure 2 Blue Form

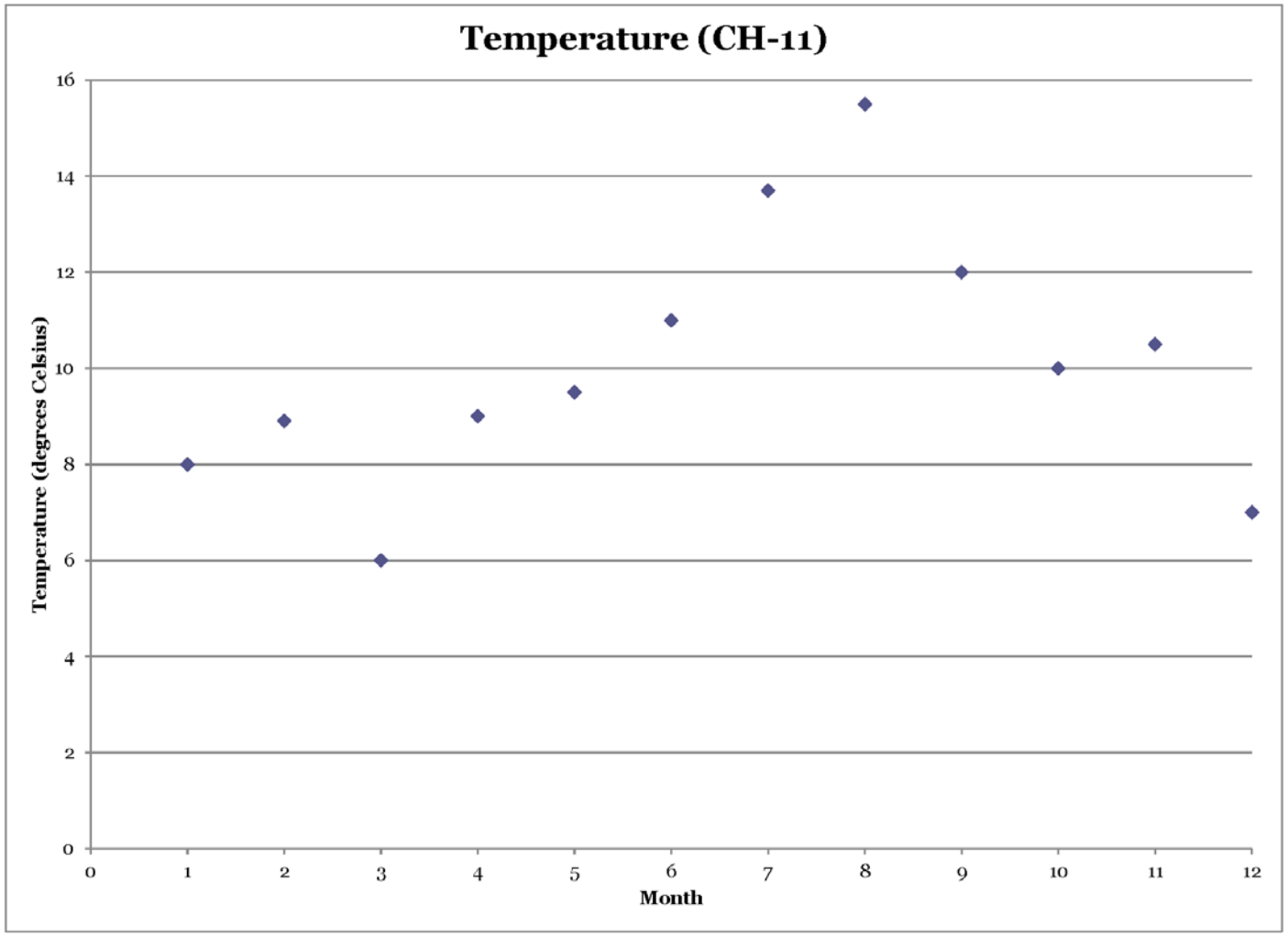
Appendix D

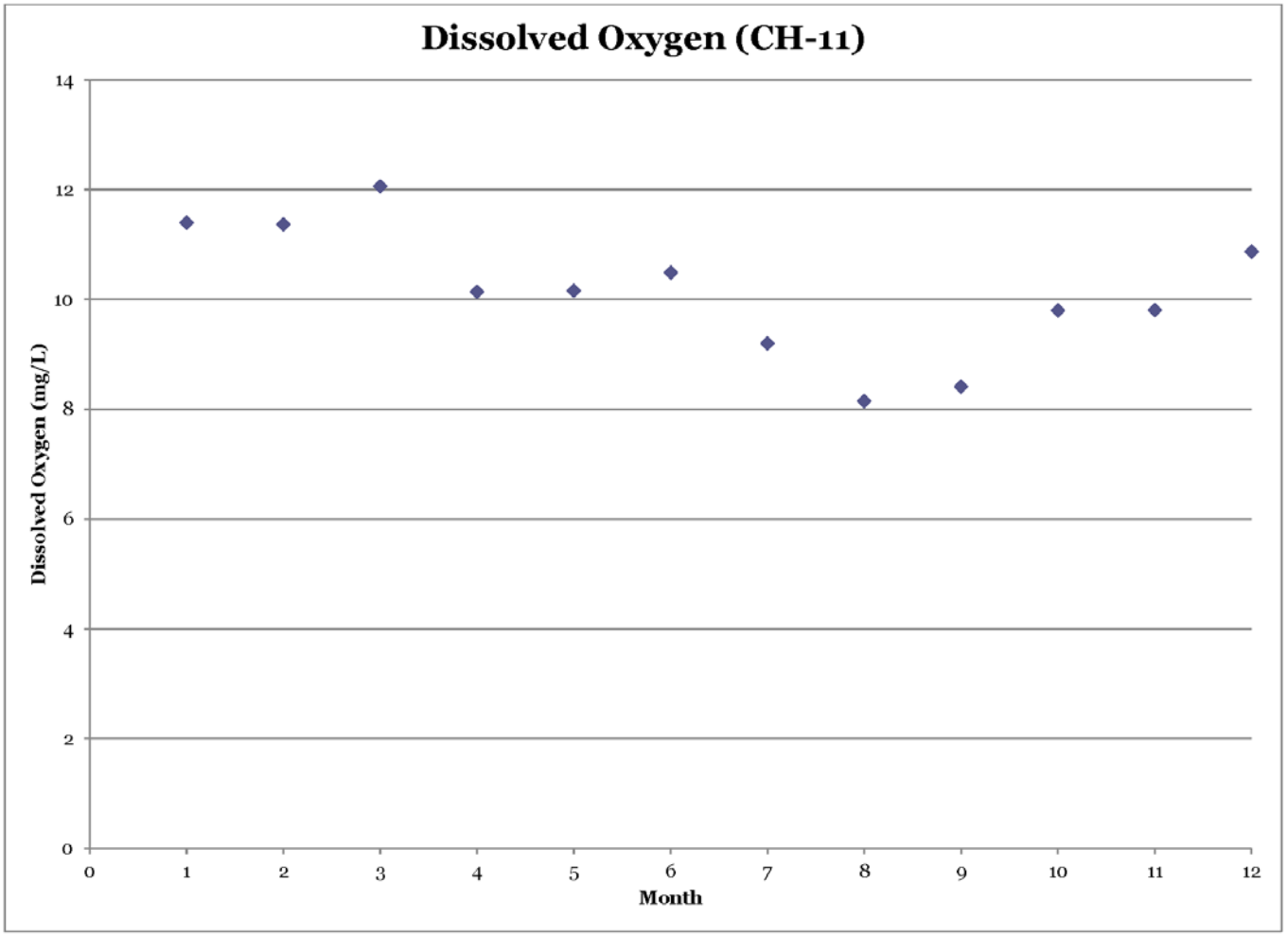

Temperature (BT-14)
Temperature (degrees Celsius)
20
18
16
14
12
10
8
6
4
2
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

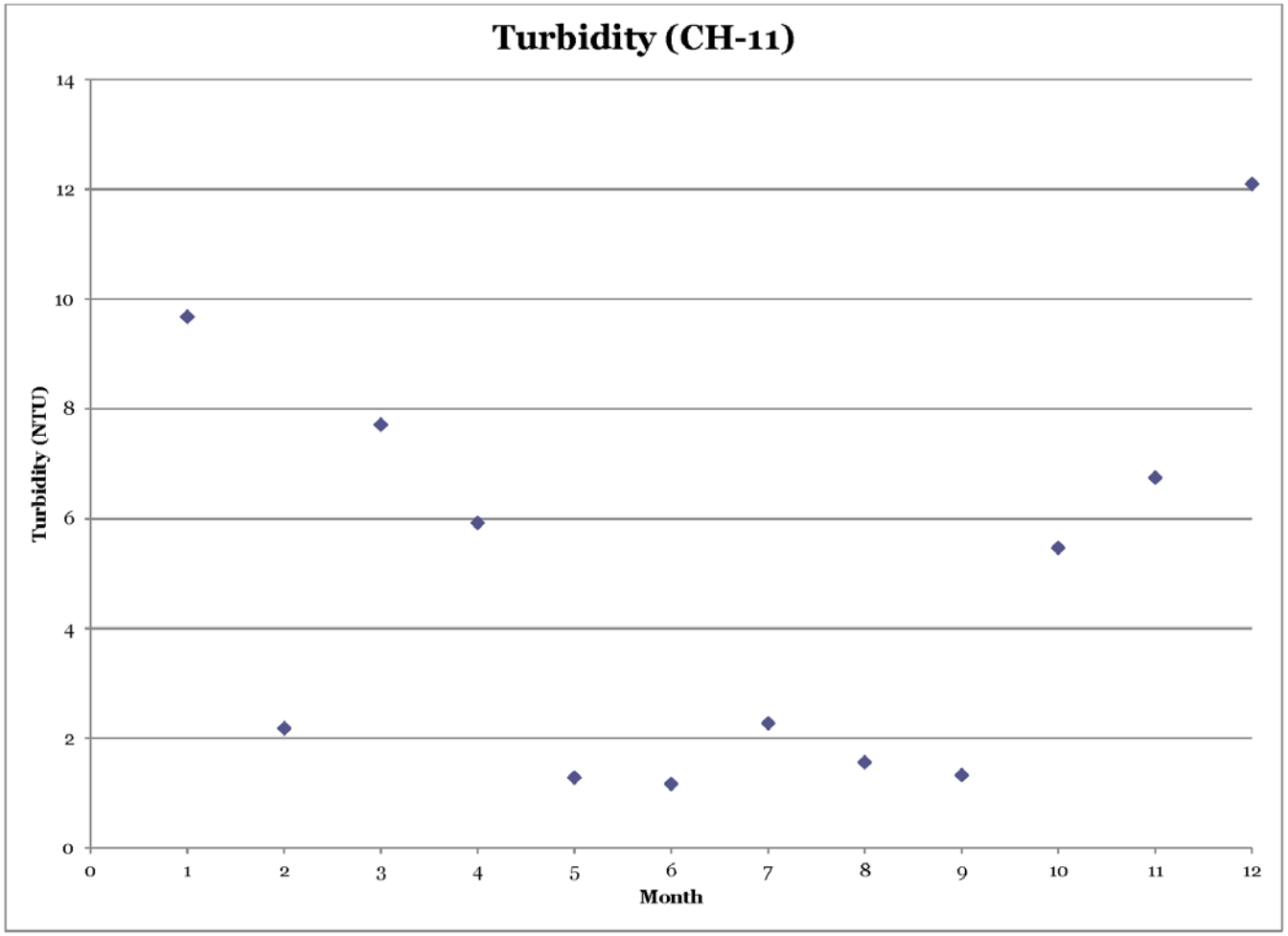

Dissolved Oxygen (BT-14)
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

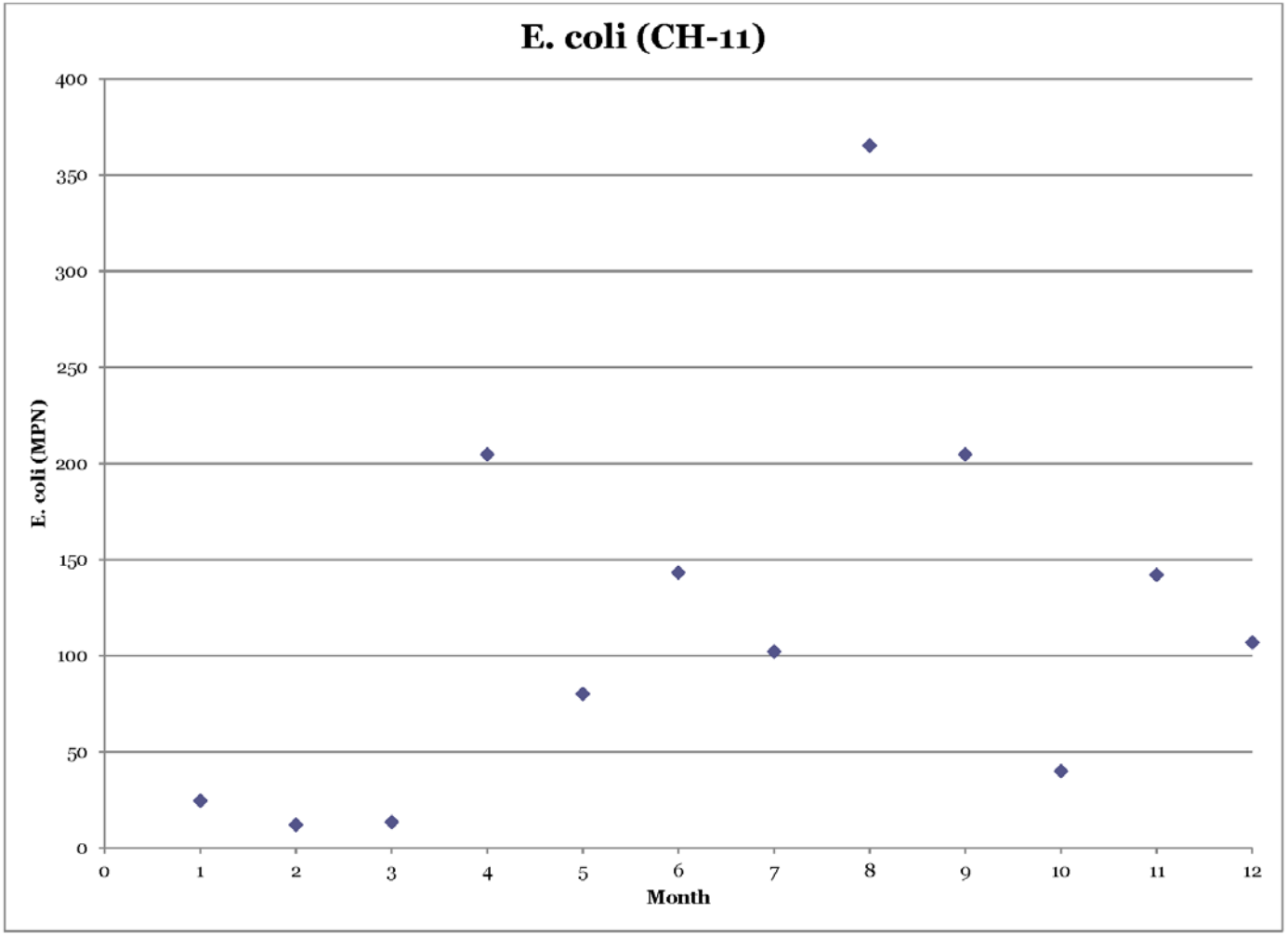

Turbidity (BT-14)
Turbidity (NTU)
10
9
8
7
6
5
4
3
2
1
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

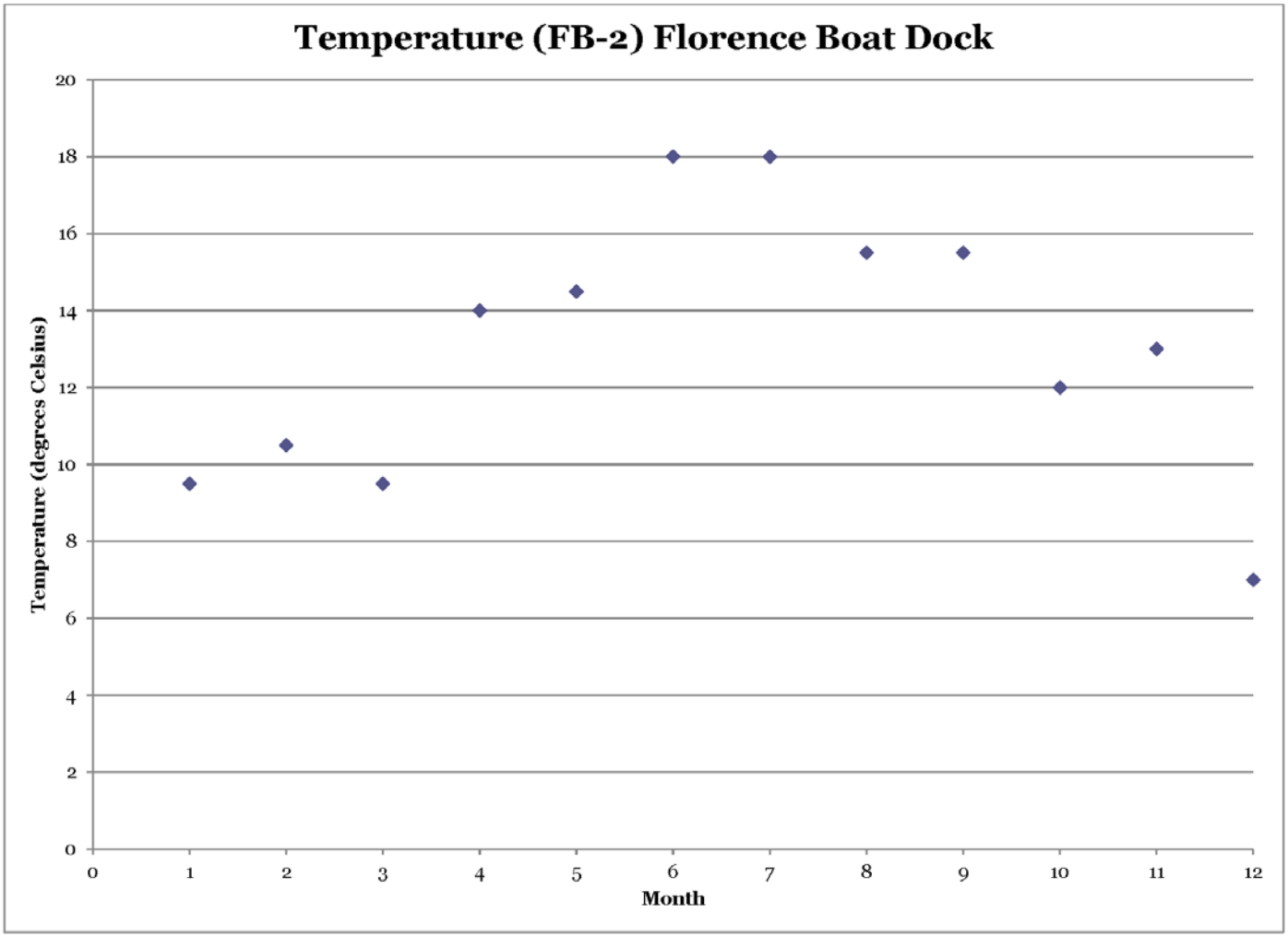

E. coli (BT-14)
E. Coli (MPN)
140
120
100
80
60
40
20
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

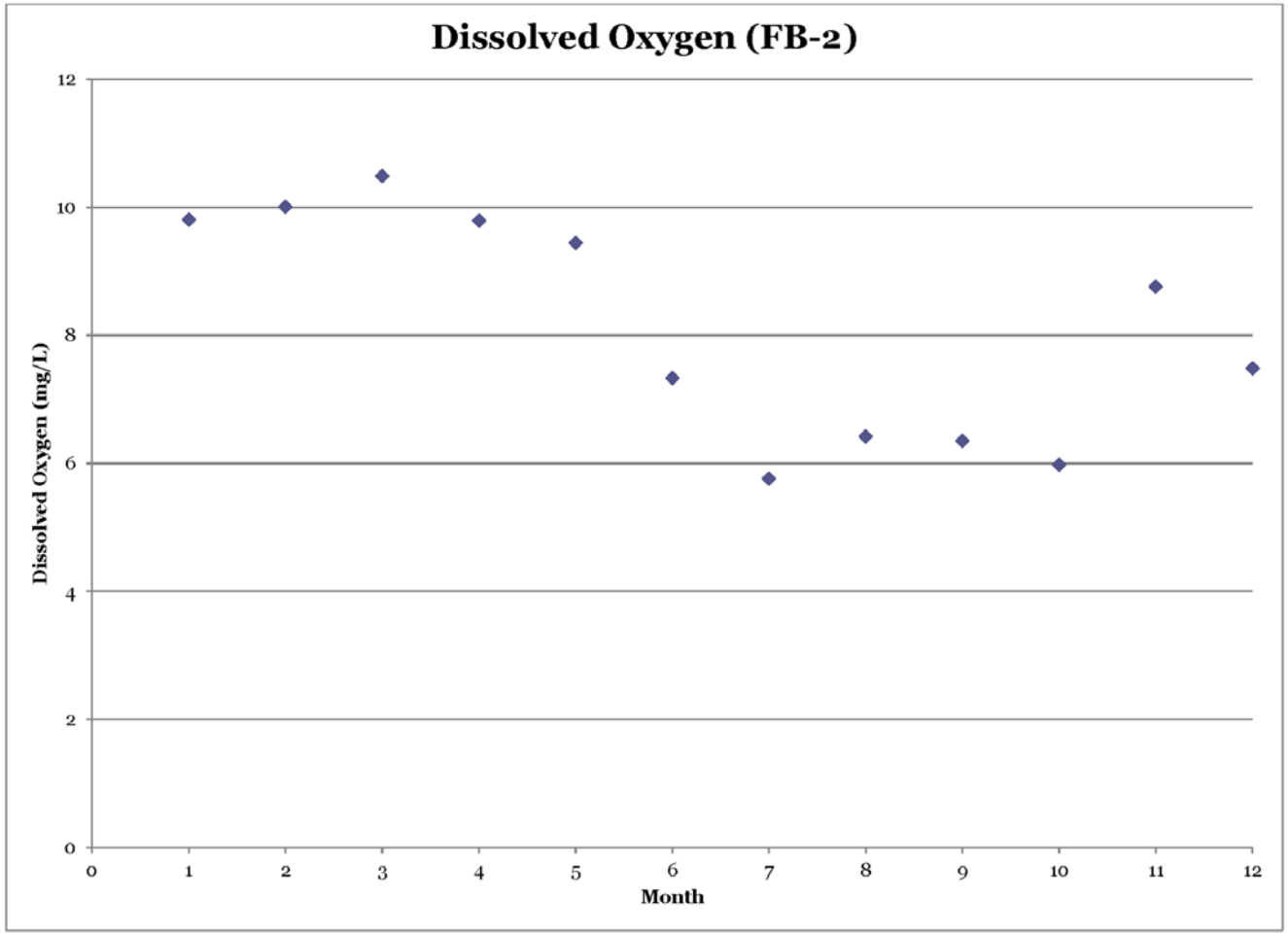

Temperature (CH-11)
Temperature (degrees Celsius)
16
14
12
10
8
6
4
2
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

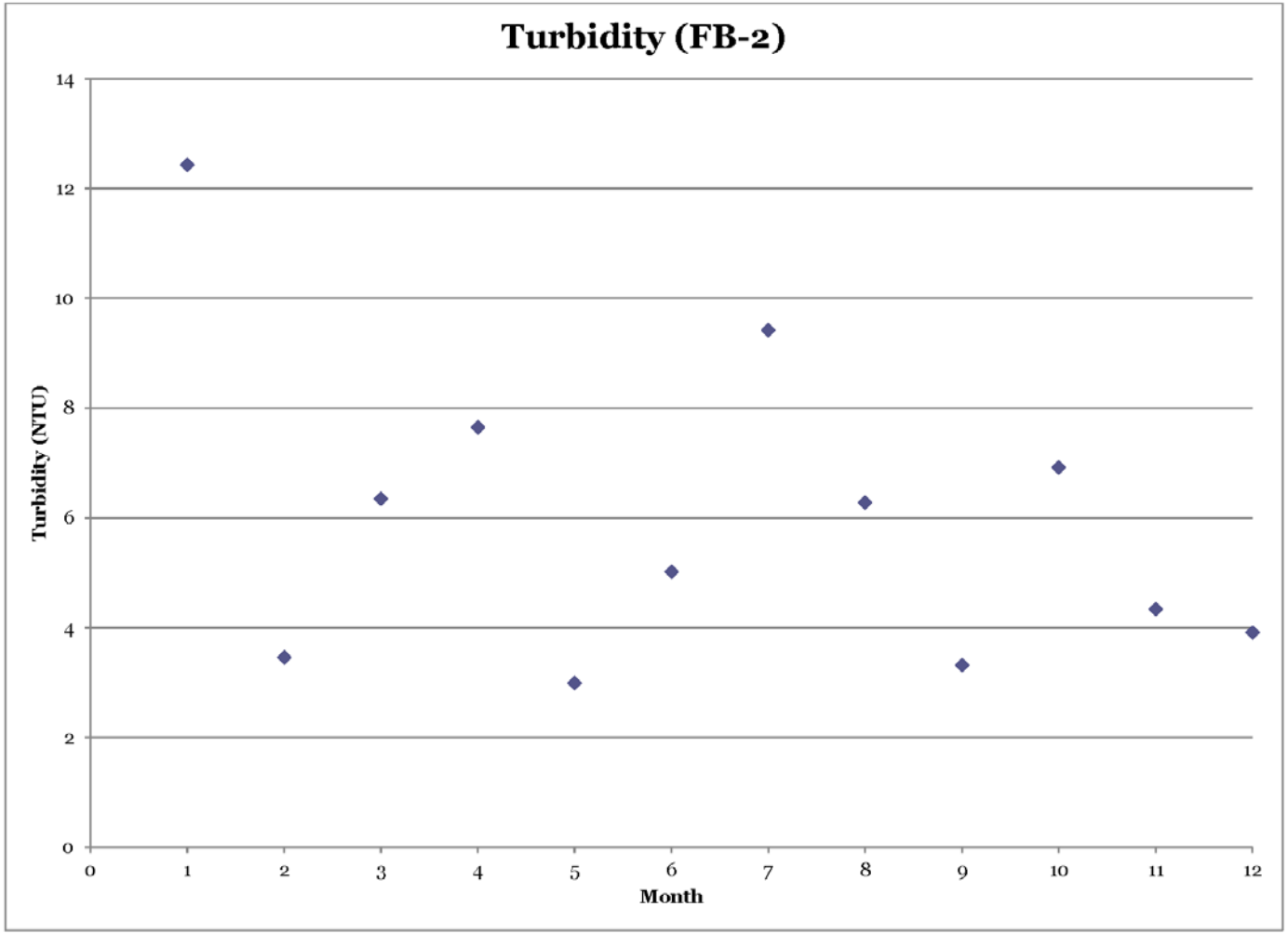

Dissolved Oxygen (CH-11)
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

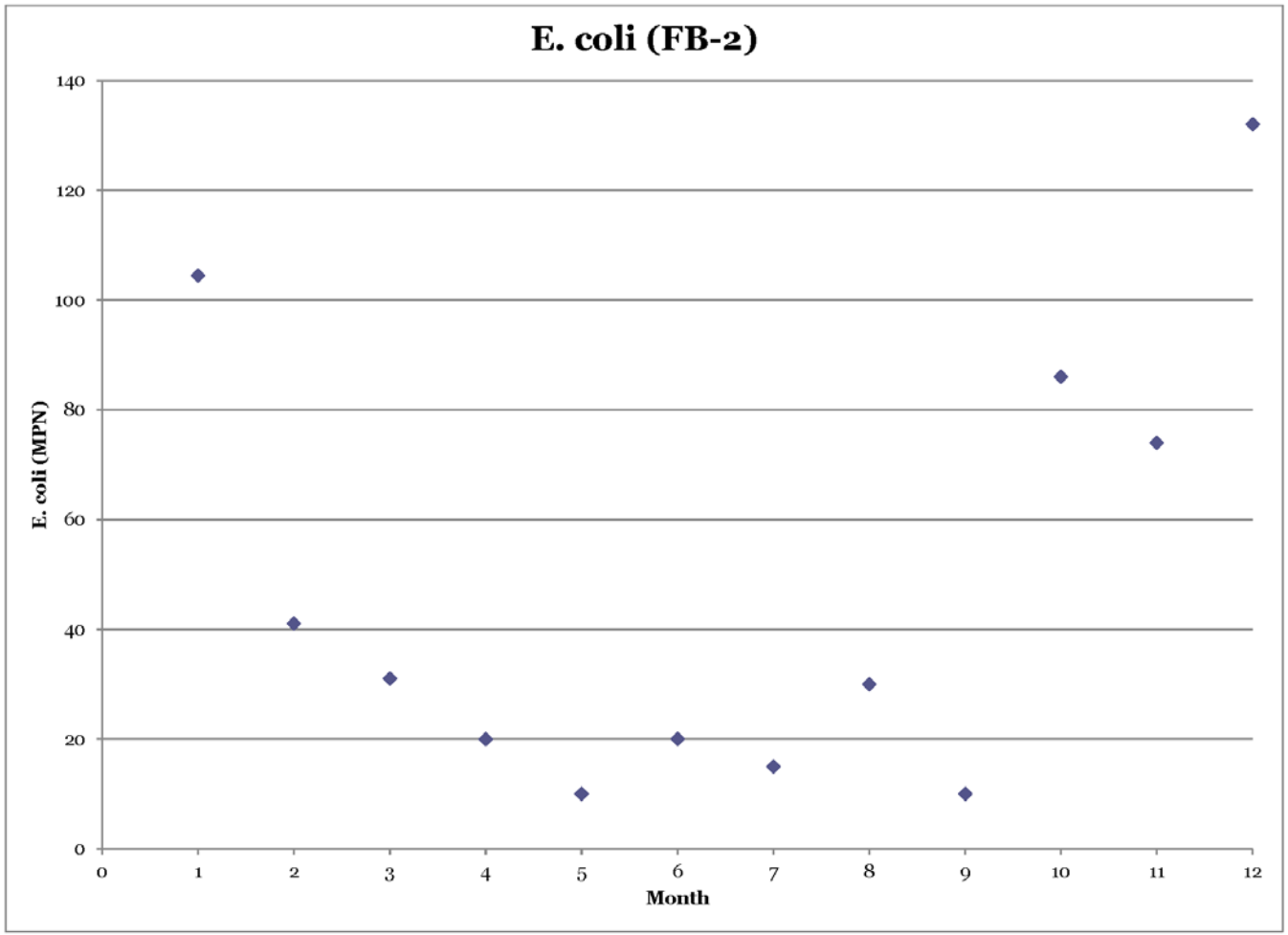

Turbidity (CH-11)
Turbidity (NTU)
14
12
10
8
6
4
2
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

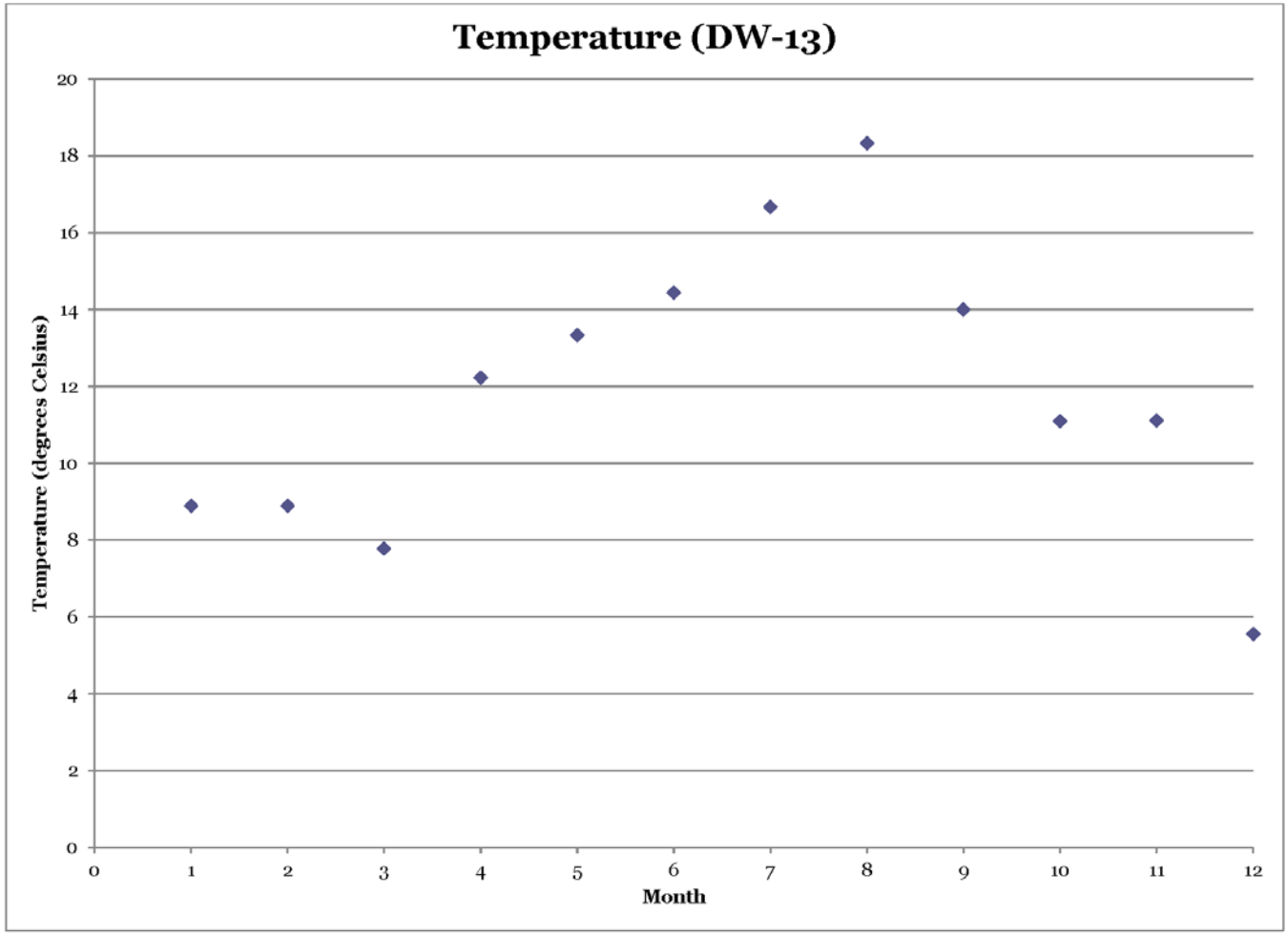

E. coli (CH-11)
E. coli (MPN)
400
350
300
250
200
150
100
50
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

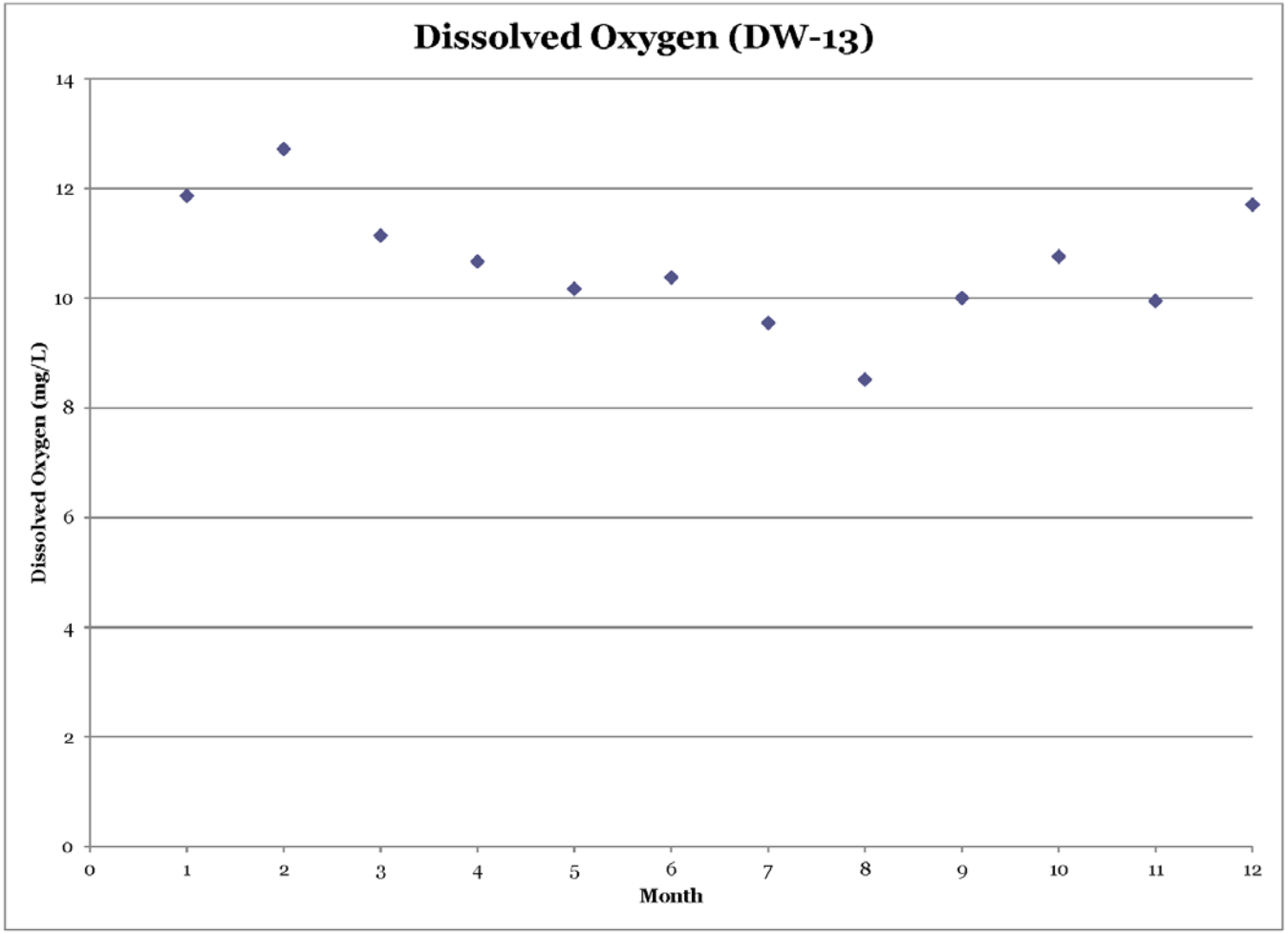

Temperature (FB-2) Florence Boat Dock
Temperature (degrees Celsius)
20
18
16
14
12
10
8
6
4
2
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

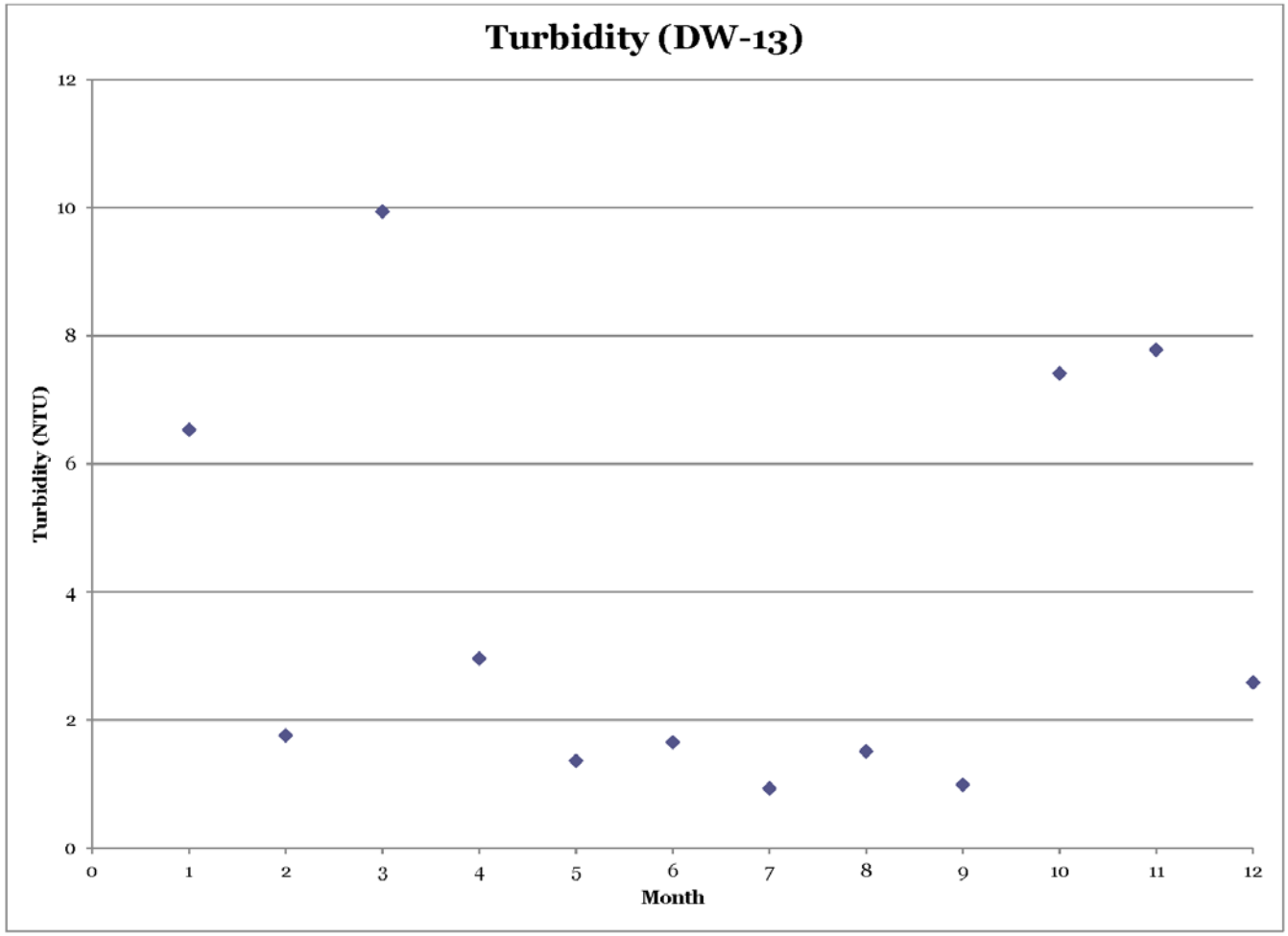

Dissolved Oxygen (FB-2)
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

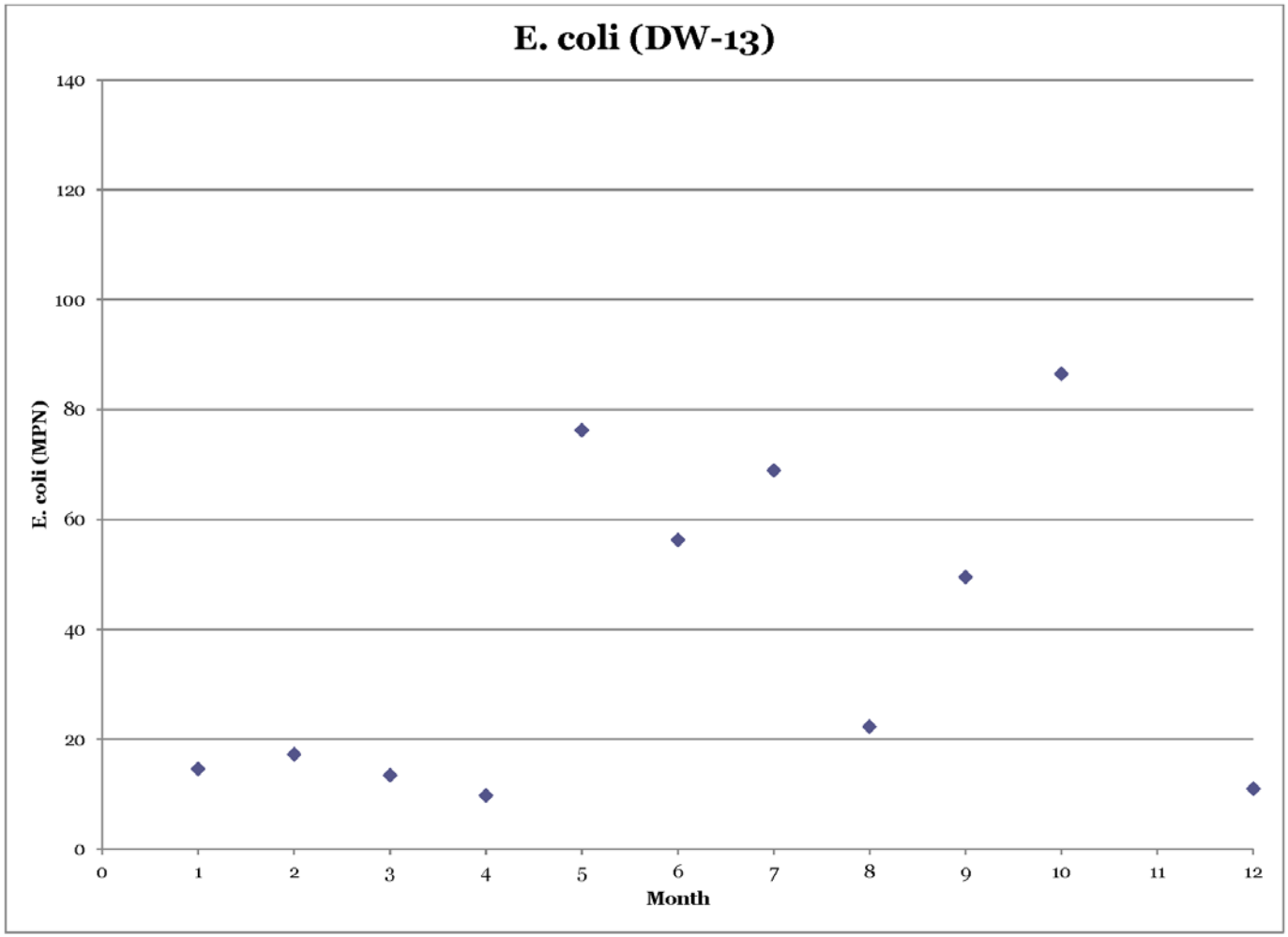

Turbidity (FB-2)
Turbidity (NTU)
14
12
10
8
6
4
2
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

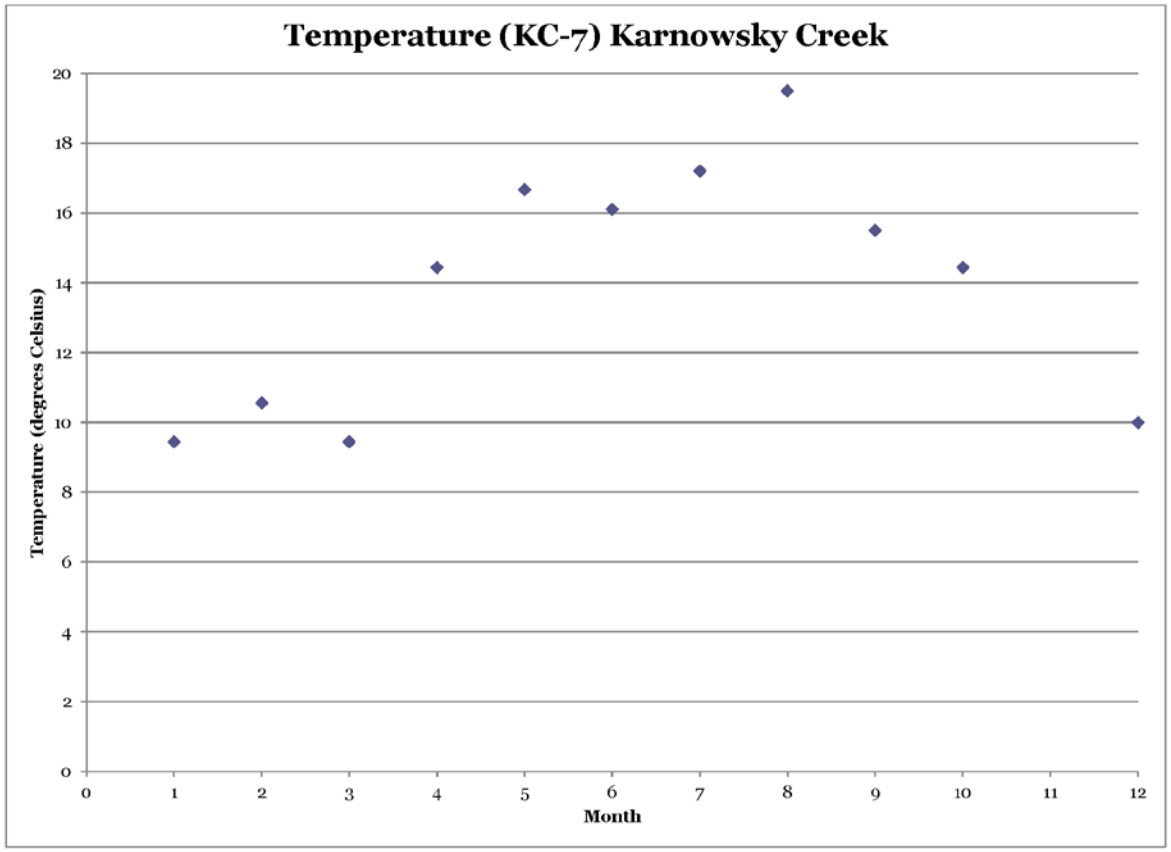

E. coli (FB-2)
E. coli (MPN)
140
120
100
80
60
40
20
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

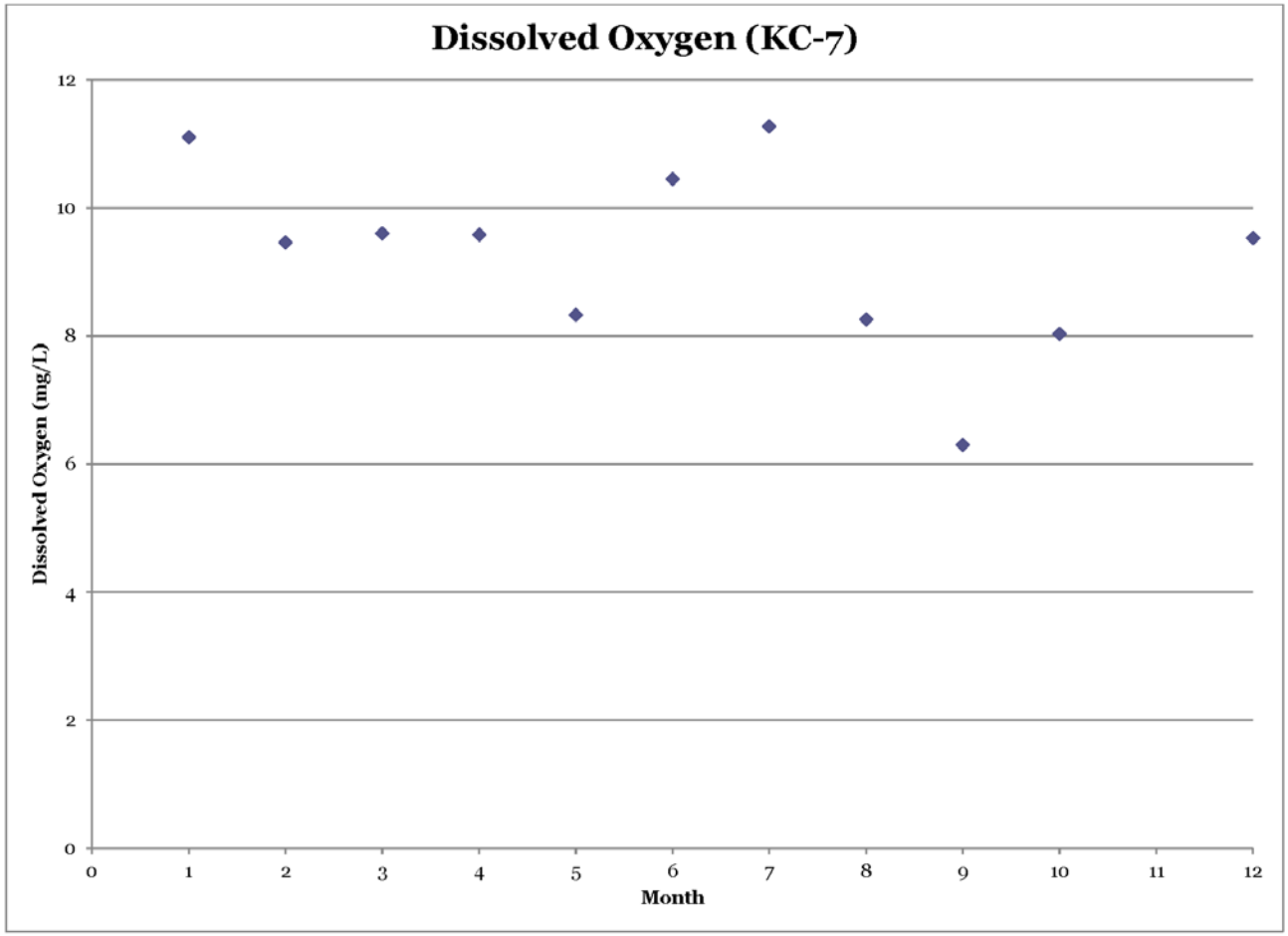

Temperature (DW-13)
Temperature (degrees Celsius)
20
18
16
14
12
10
8
6
4
2
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

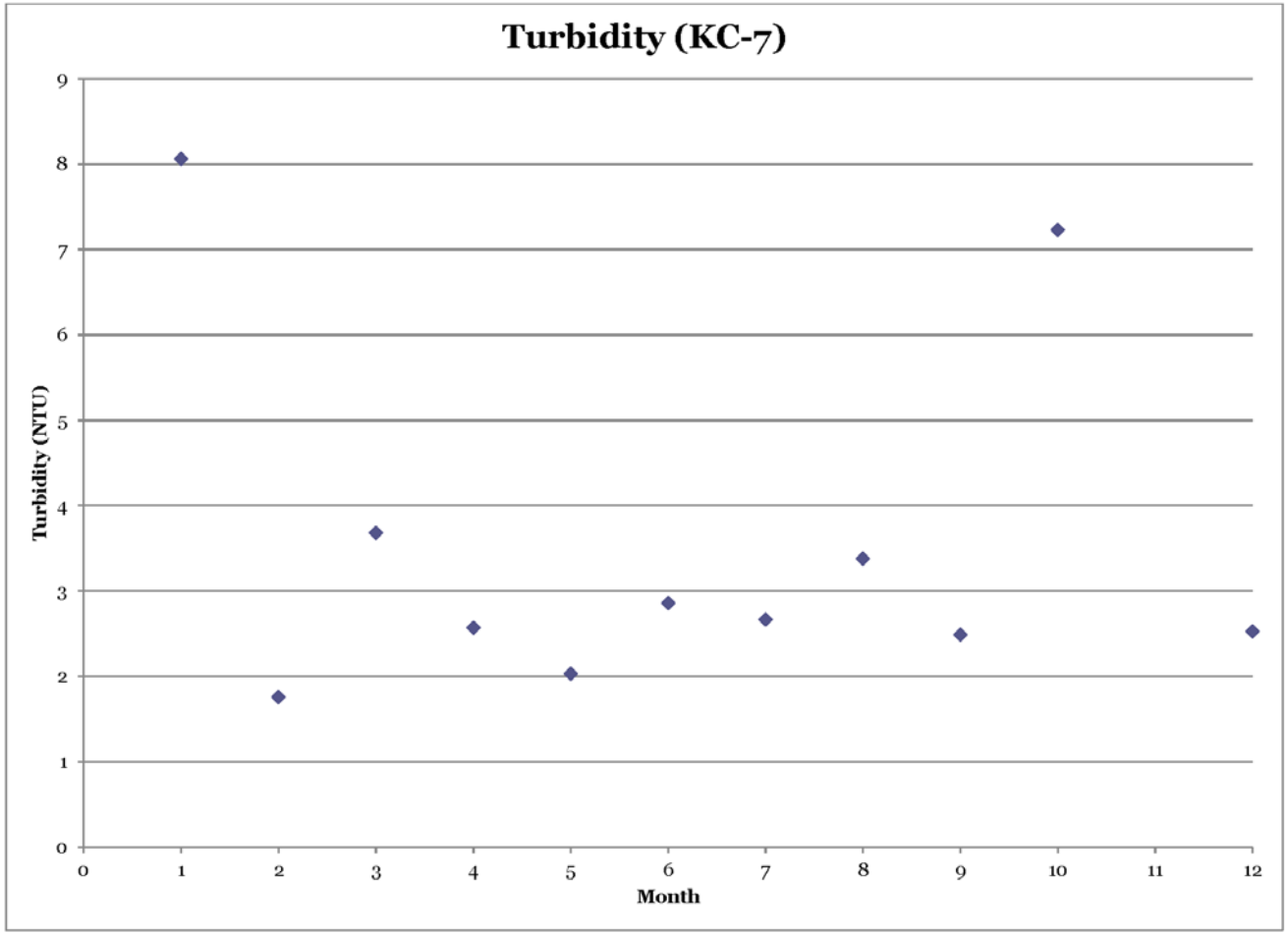

Dissolved Oxygen (DW-13)
Dissolved Oxygen (mg/L)
14
12
10
8
6
4
2
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

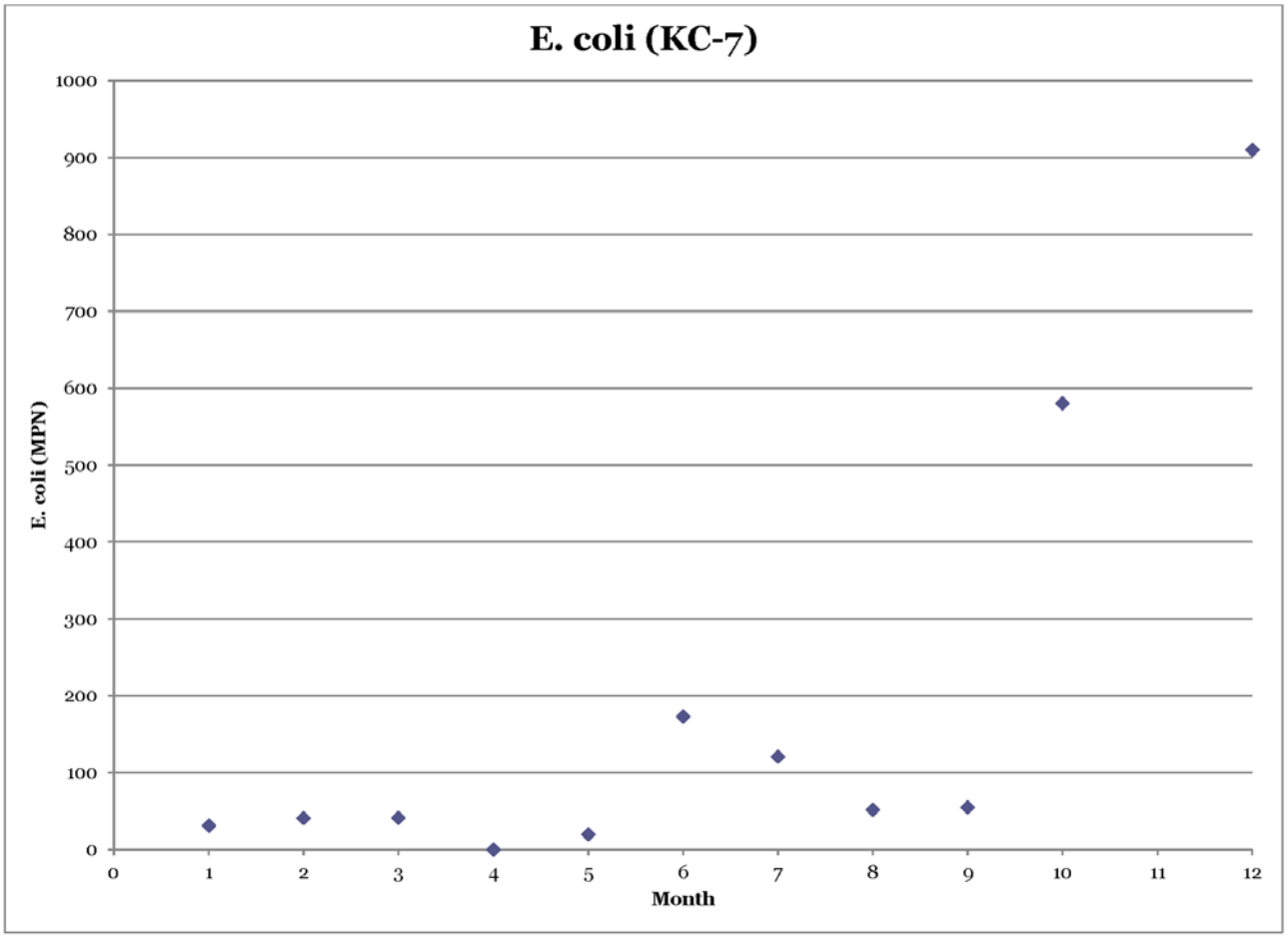

Turbidity (DW-13)
Turbidity (NTU)
0
2
4
6
8
10
12
0 1 2 3 4 5 6 7 8 9 10 11 12
Month

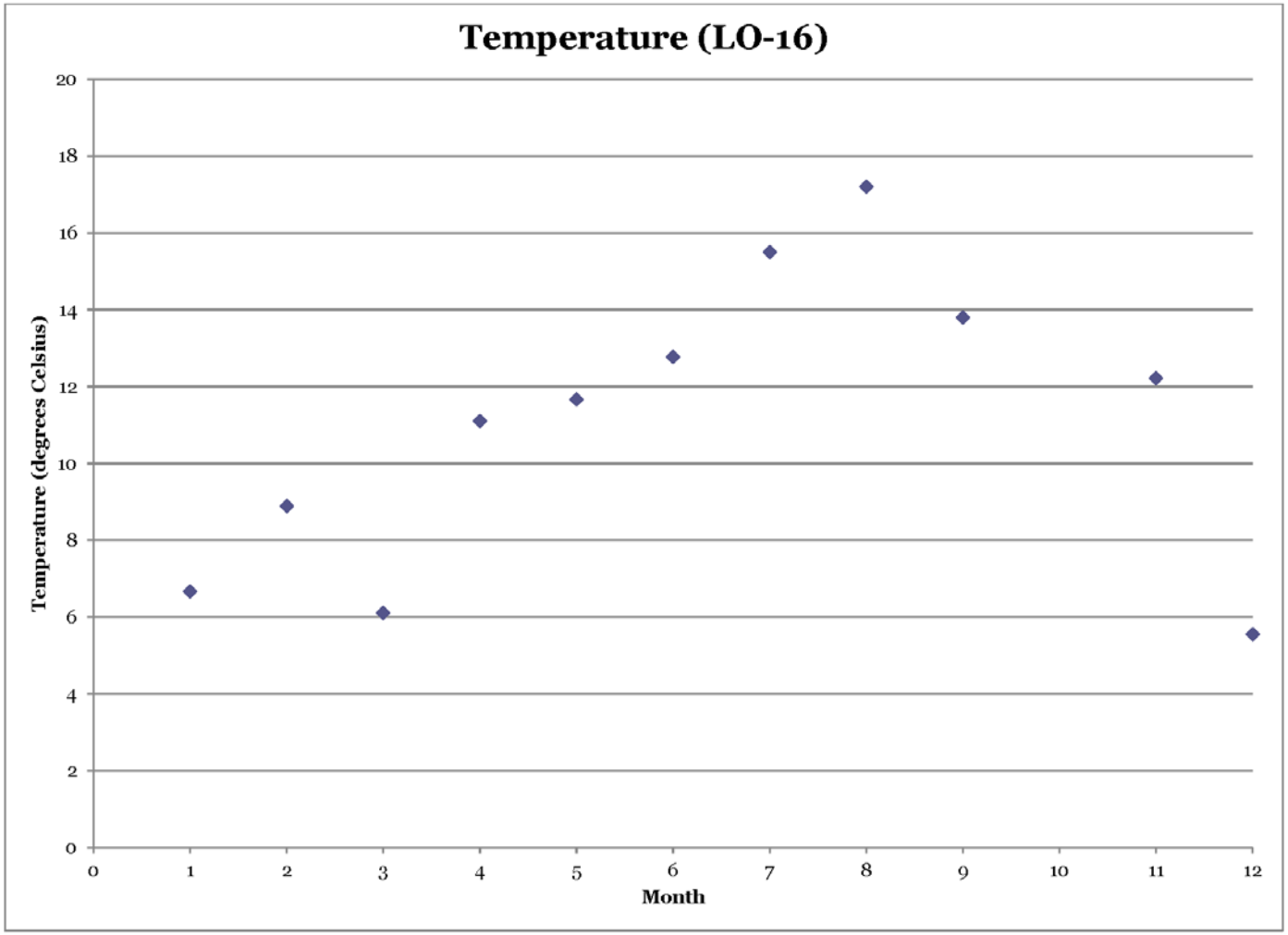

E. coli (DW-13)
E. coli (MPN)
140
120
100
80
60
40
20
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

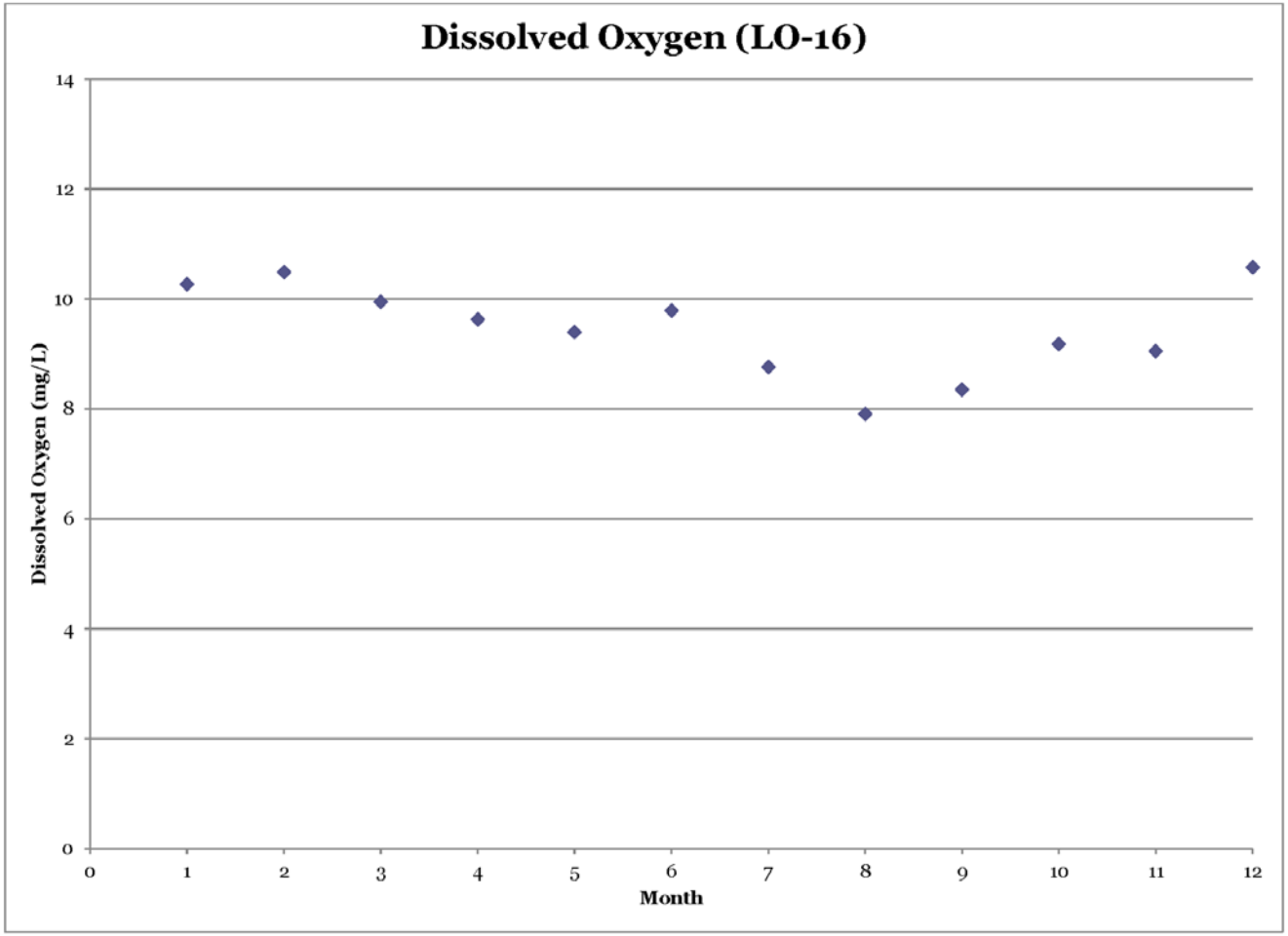

Temperature (KC-7) Karnowsky Creek
Temperature (degrees Celsius)
Month
0
2
4
6
8
10
12
14
16
18
20
0
1
2
3
4
5
6
7
8
9
10
11
12

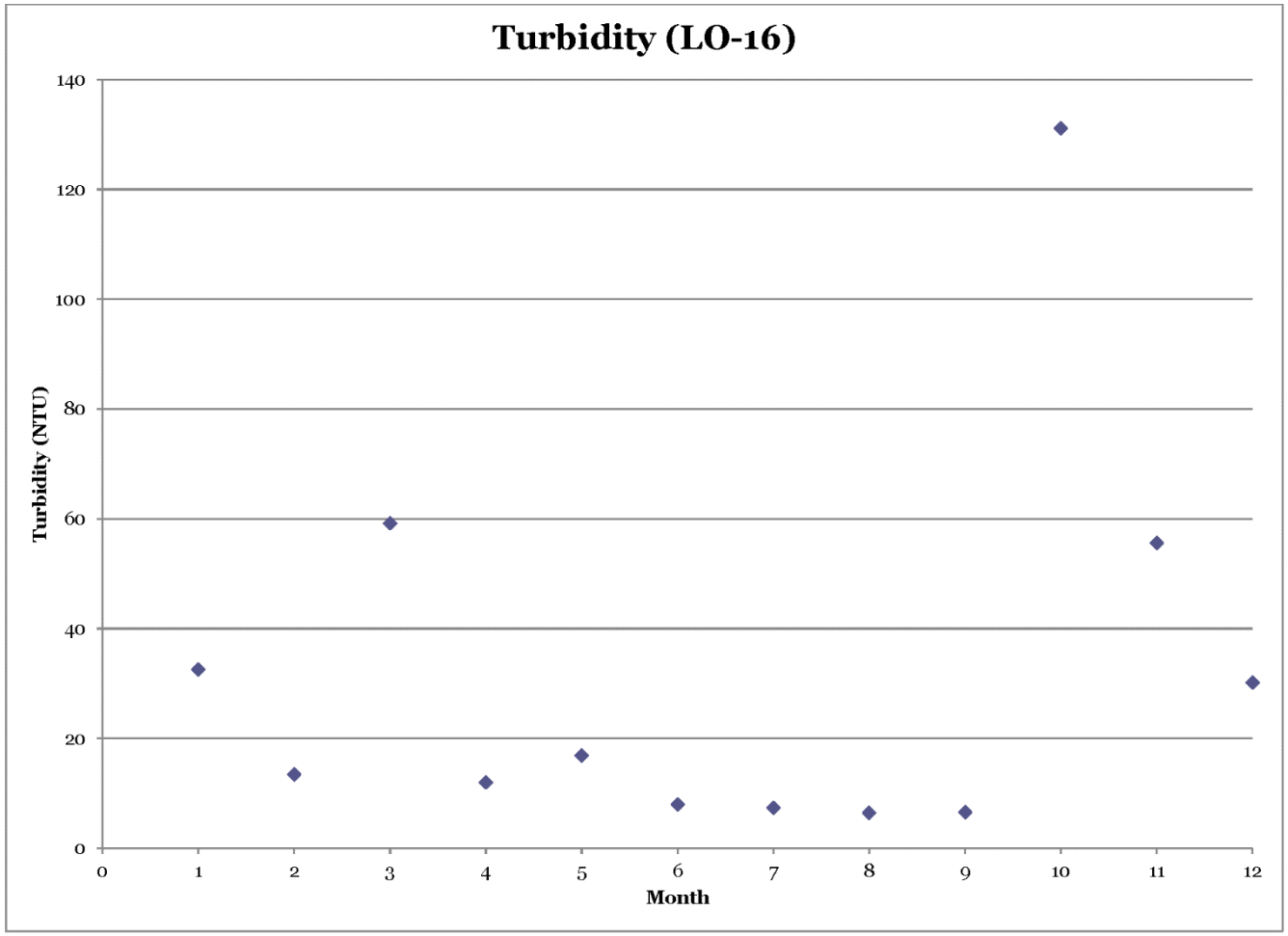

Dissolved Oxygen (KC-7)
Dissolved Oxygen (mg/L)
Month
0
2
4
6
8
10
12
0
1
2
3
4
5
6
7
8
9
10
11
12

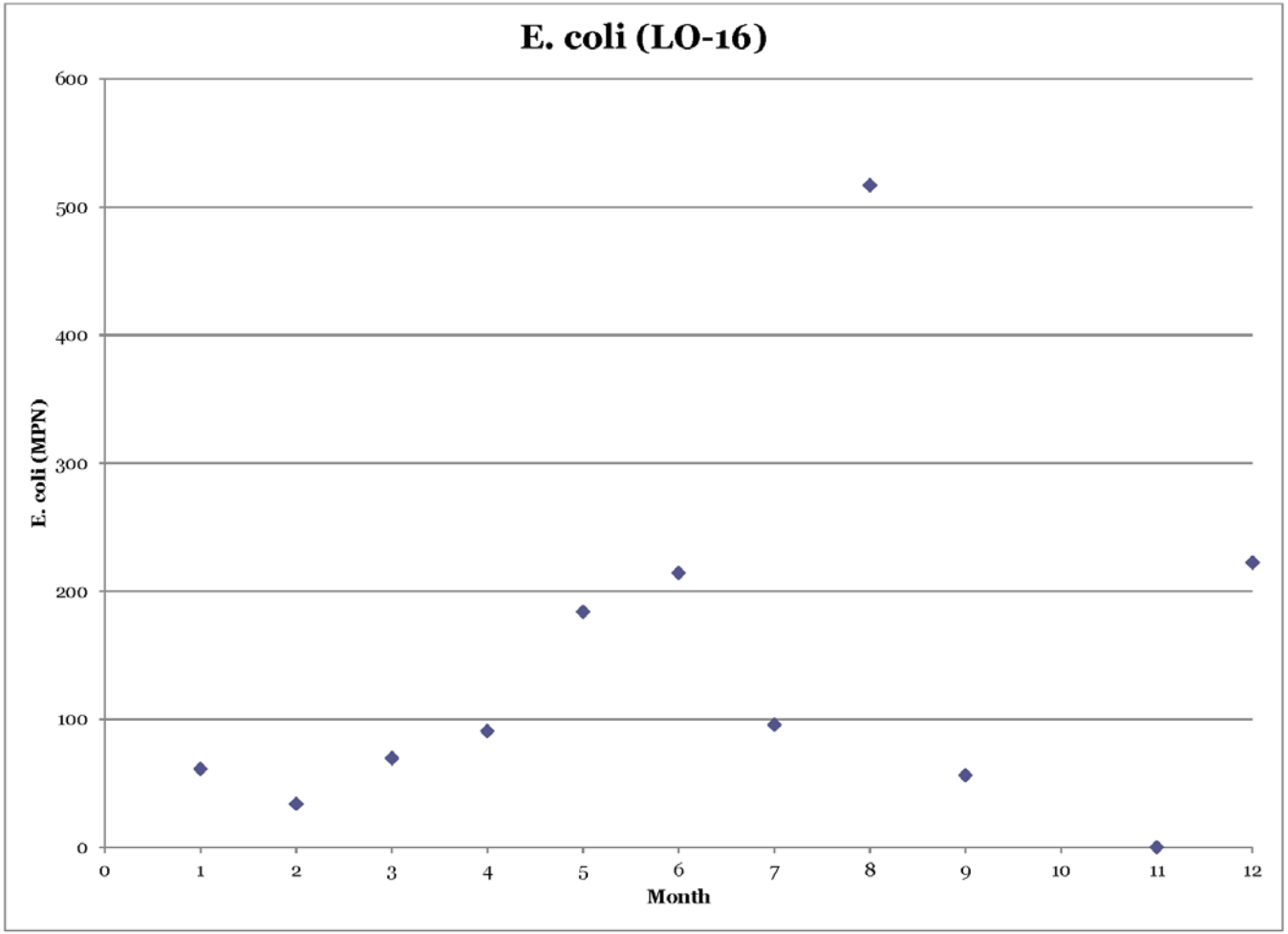

Turbidity (KC-7)
Turbidity (NTU)
0
1
2
3
4
5
6
7
8
9
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

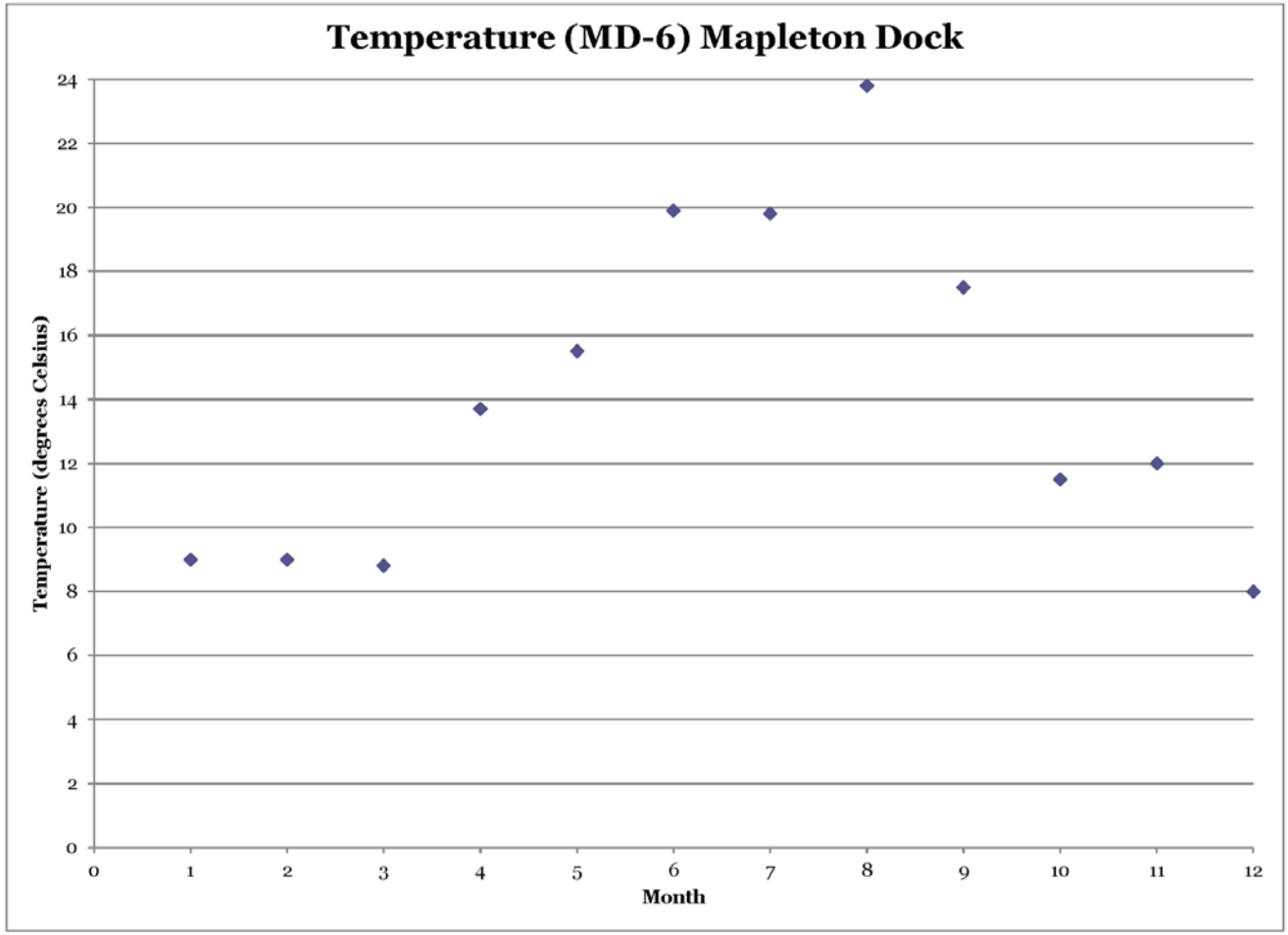

E. coli (KC-7)
E. coli (MPN)
1000
900
800
700
600
500
400
300
200
100
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

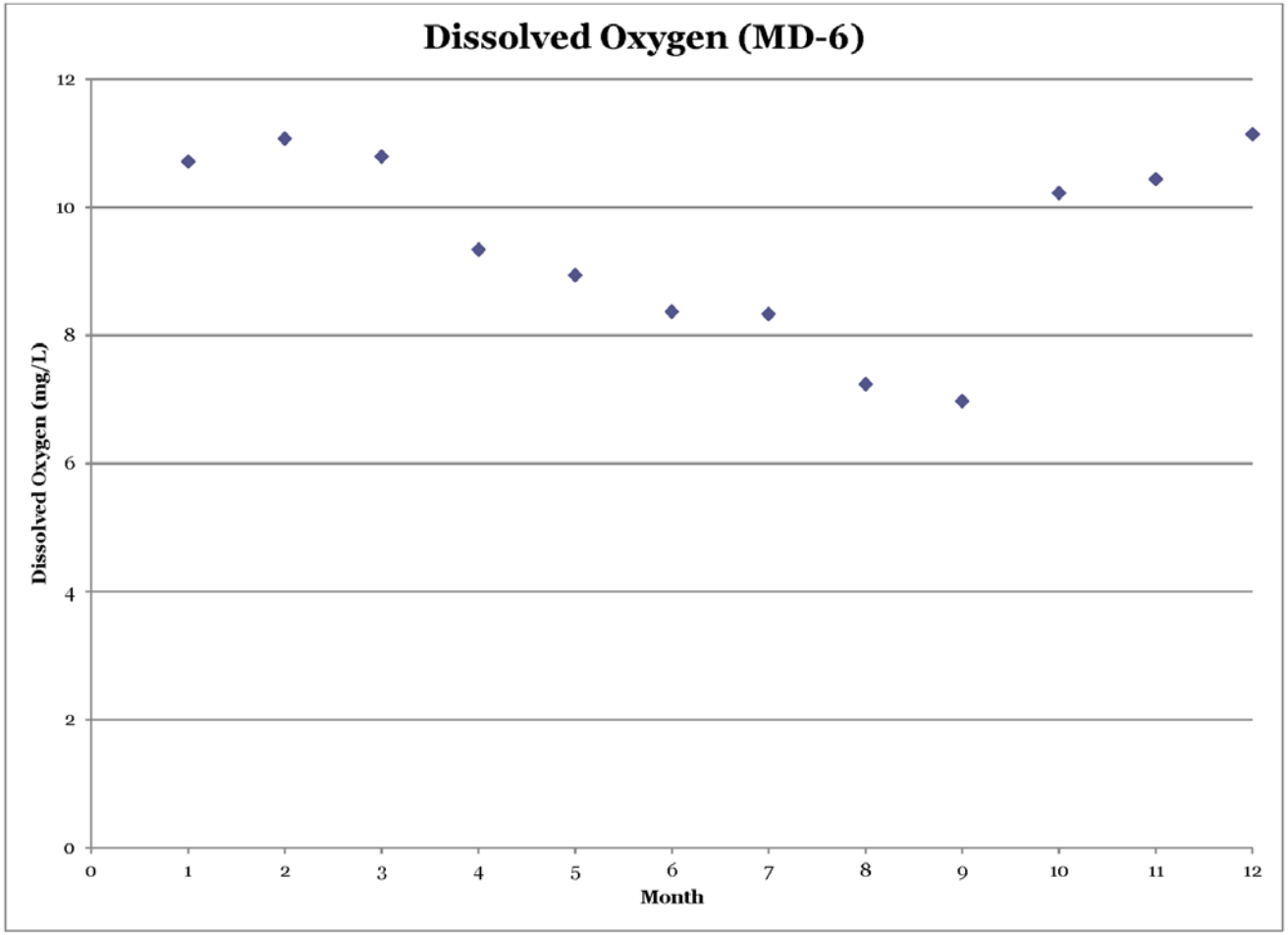

Temperature (LO-16)
Temperature (degrees Celsius)
20
18
16
14
12
10
8
6
4
2
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

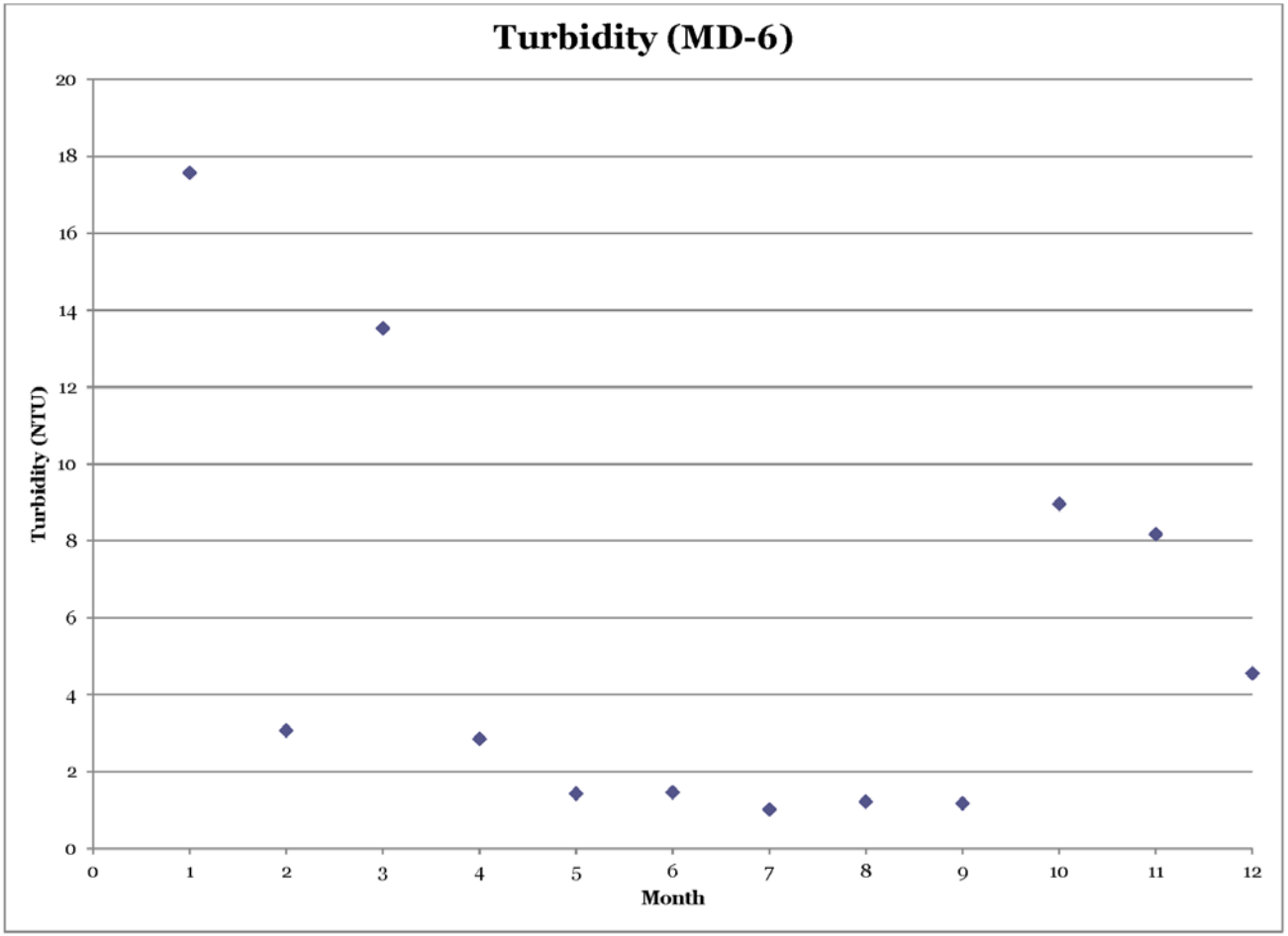

Dissolved Oxygen (LO-16)
Dissolved Oxygen (mg/L)
14
12
10
8
6
4
2
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

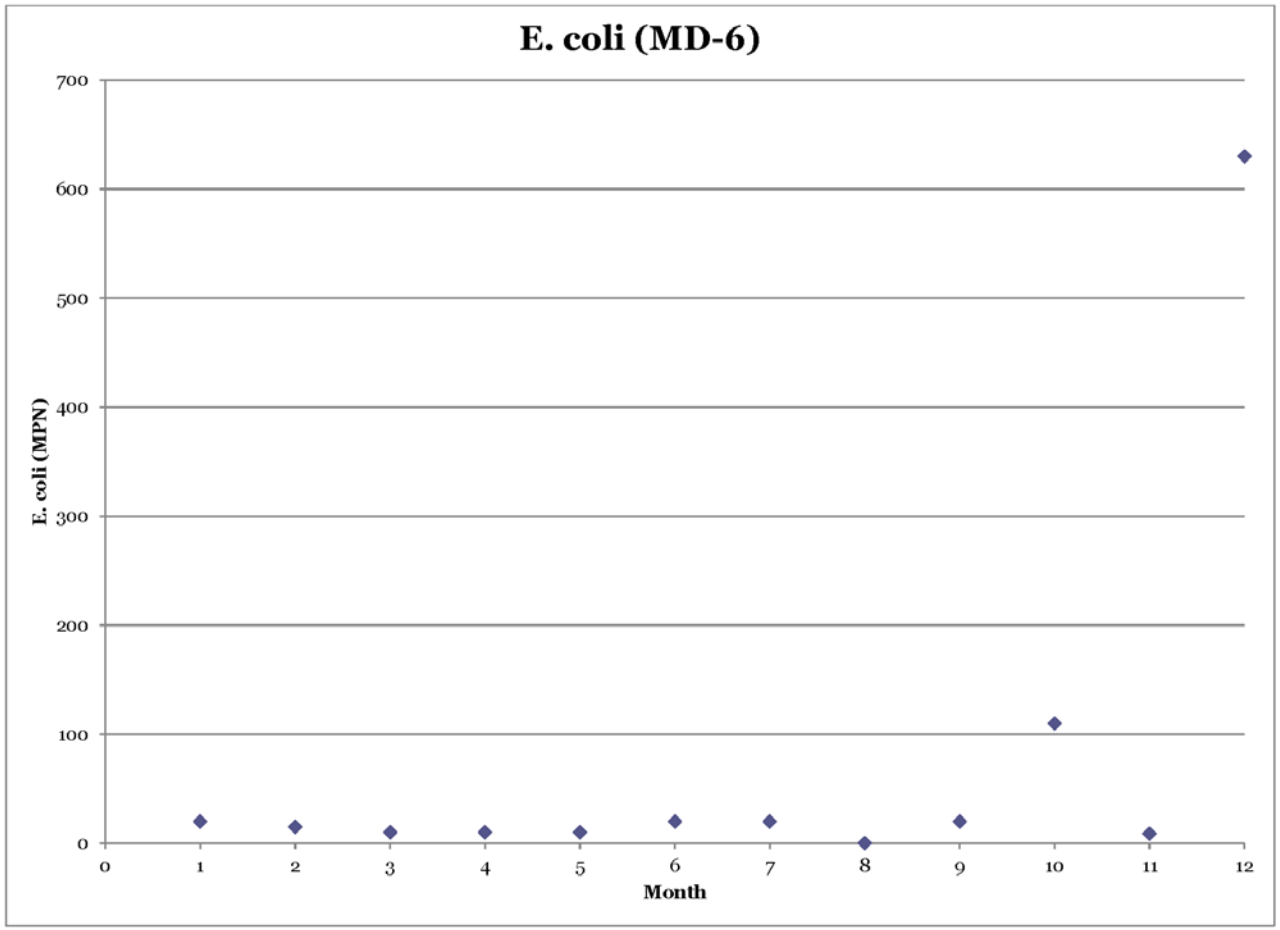

Turbidity (LO-16)
Turbidity (NTU)
140
120
100
80
60
40
20
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

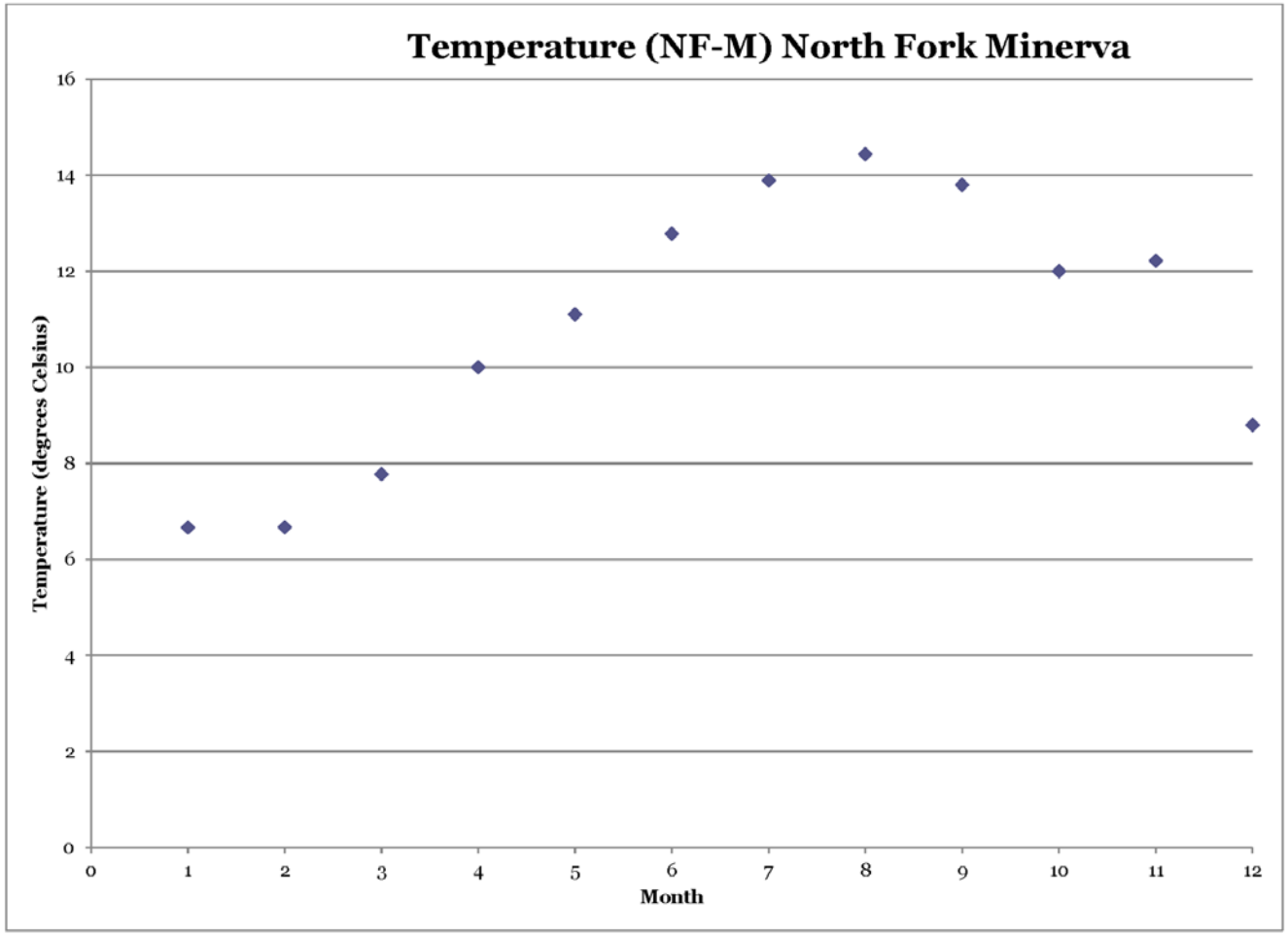

E. coli (LO-16)
E. coli (MPN)
600
500
400
300
200
100
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

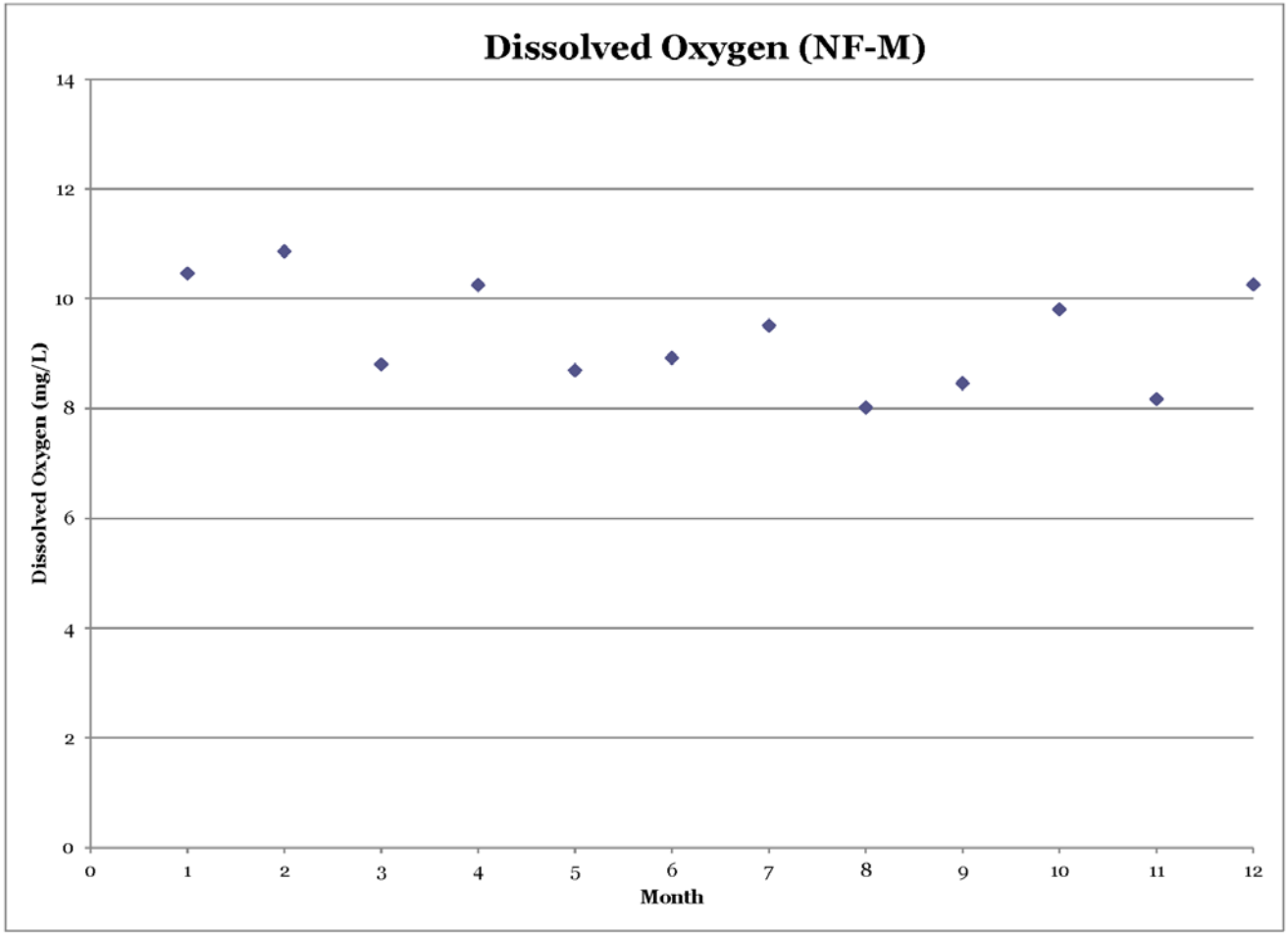

Temperature (MD-6) Mapleton Dock
Temperature (degrees Celsius)
24
22
20
18
16
14
12
10
8
6
4
2
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

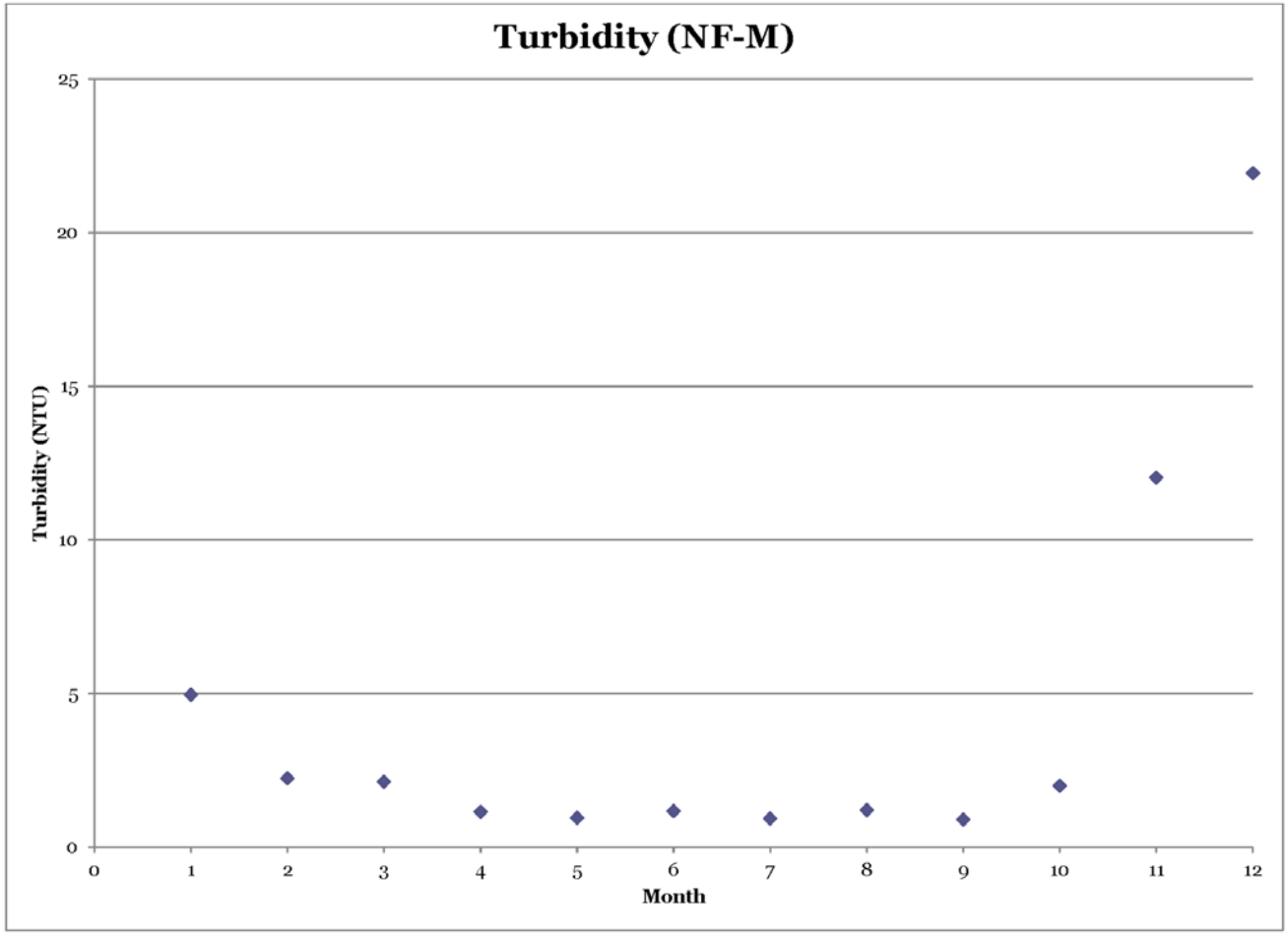

Dissolved Oxygen (MD-6)
Dissolved Oxygen (mg/L)
12
10
8
6
4
2
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

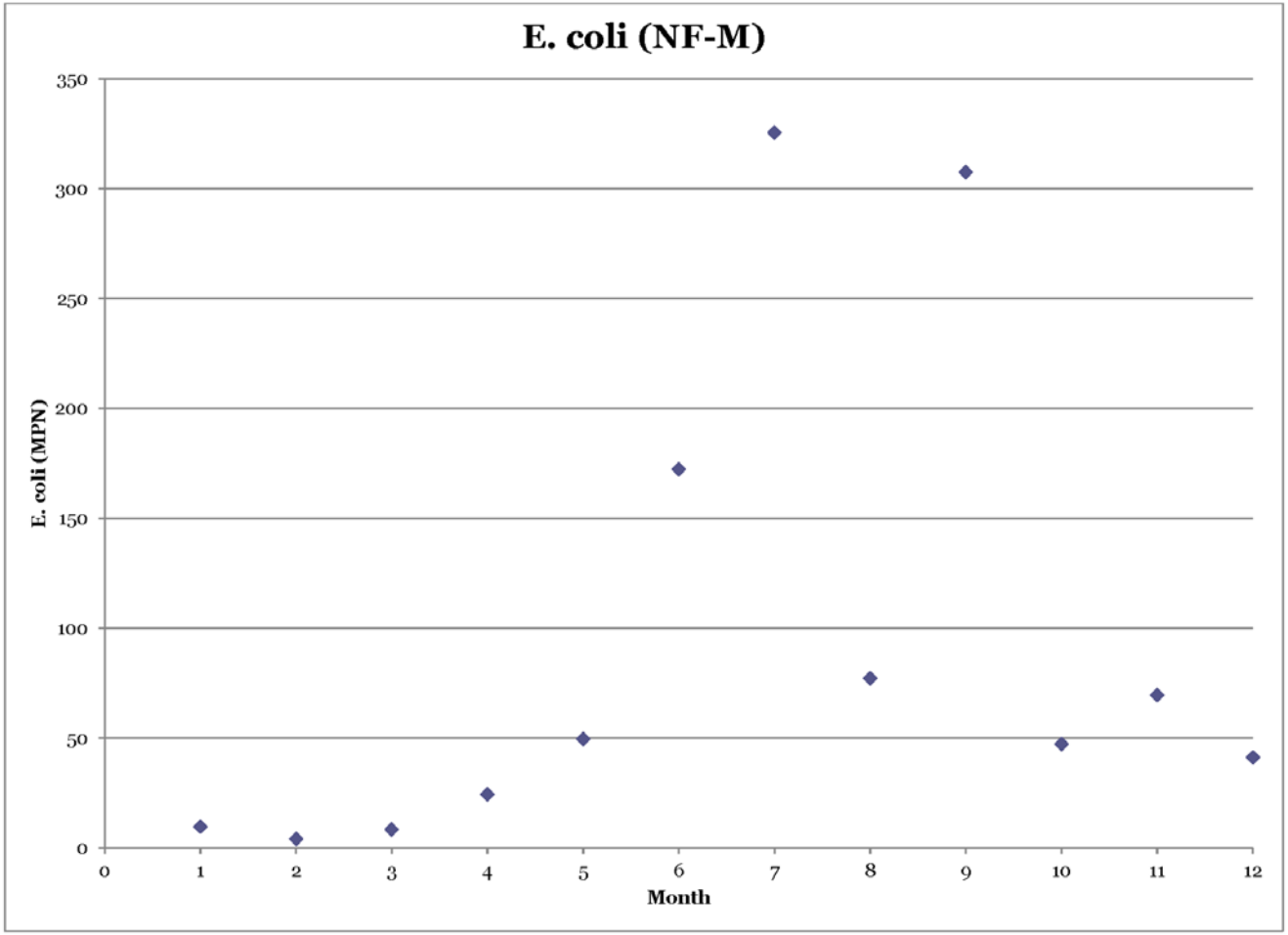

Turbidity (MD-6)
Turbidity (NTU)
20
18
16
14
12
10
8
6
4
2
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

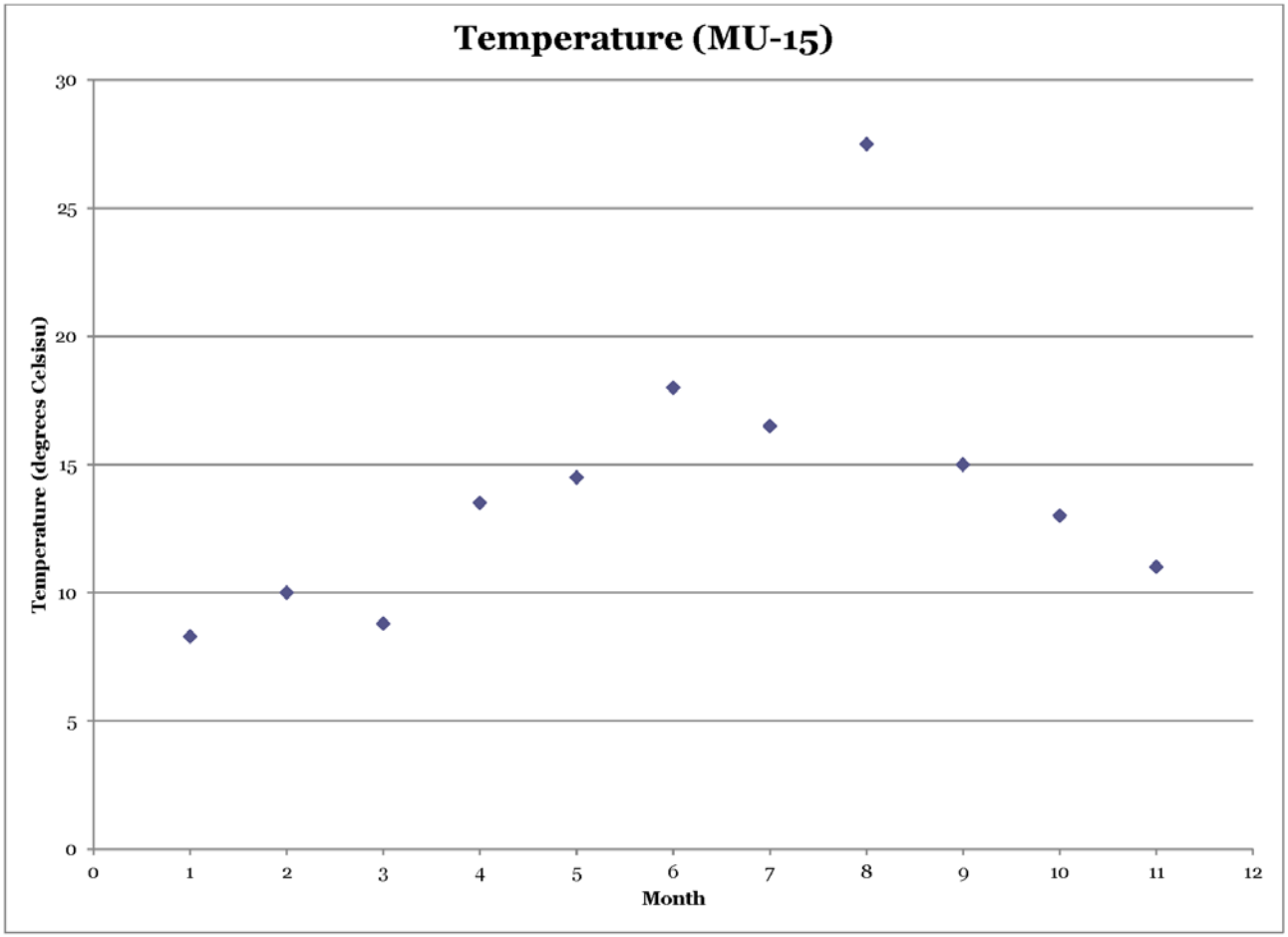

E. coli (MD-6)
700
600
500
400
300
200
100
0
E. coli (MPN)
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

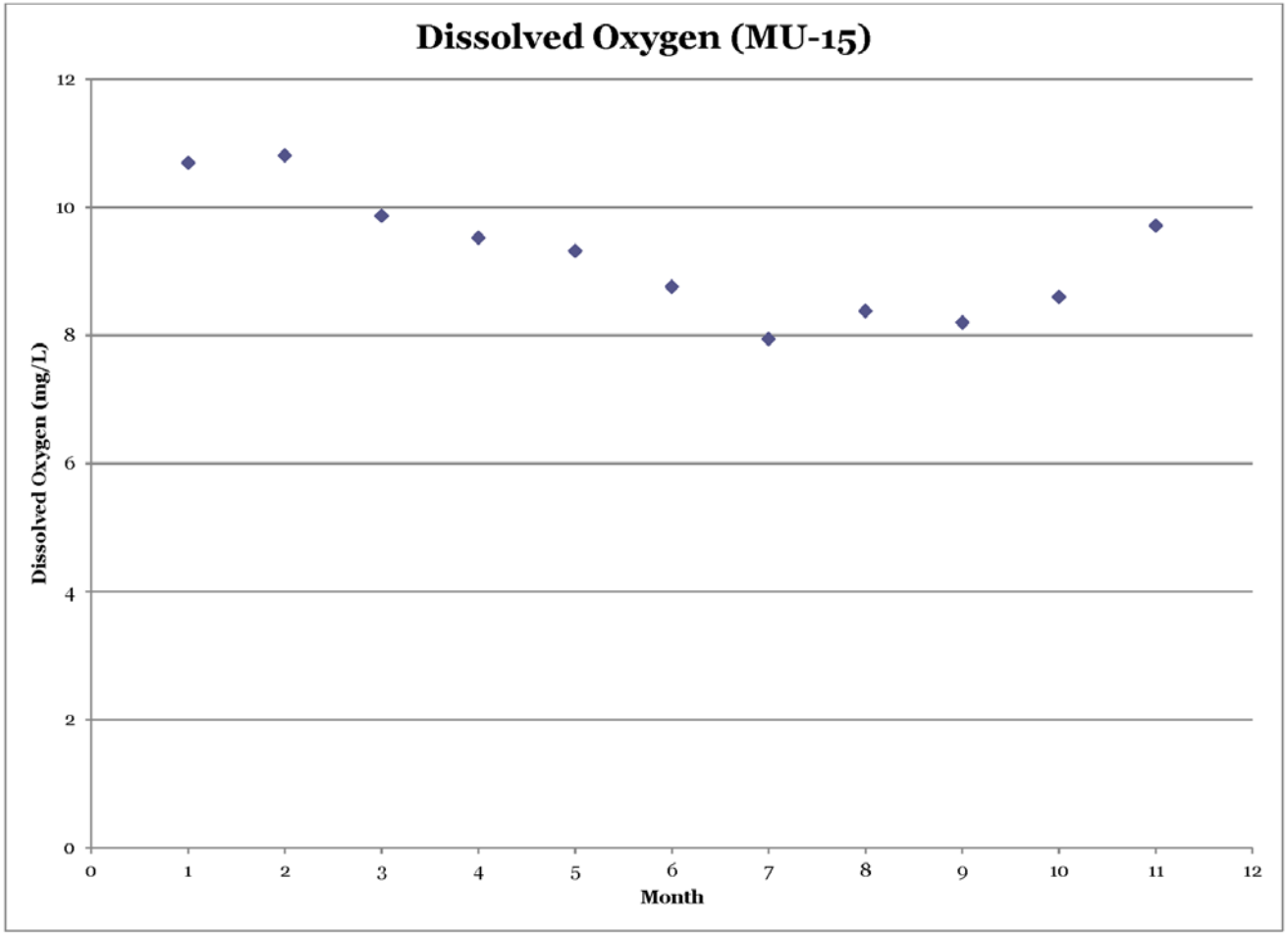

Temperature (NF-M) North Fork Minerva
Temperature (degrees Celsius)
16
14
12
10
8
6
4
2
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

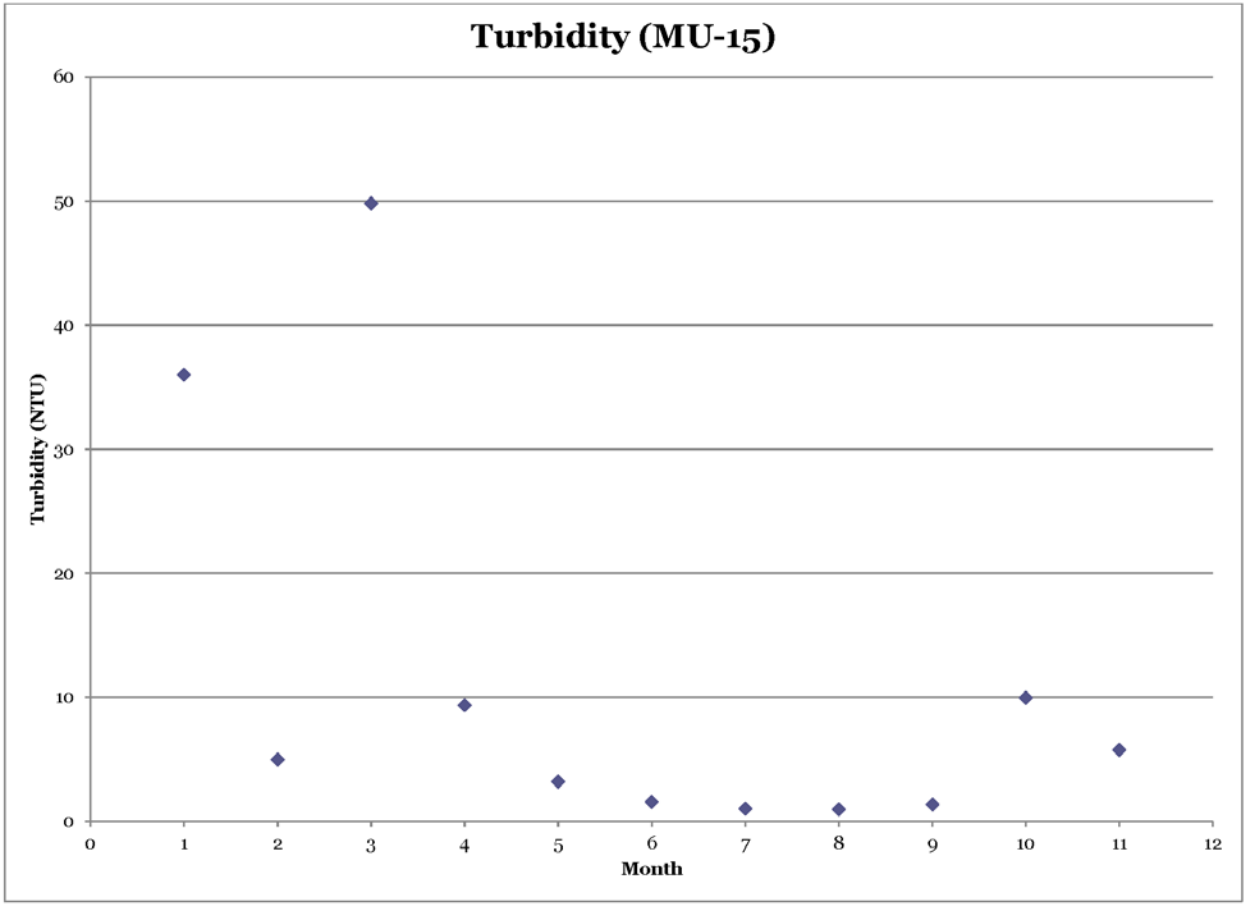

Dissolved Oxygen (NF-M)
Dissolved Oxygen (mg/L)
14
12
10
8
6
4
2
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

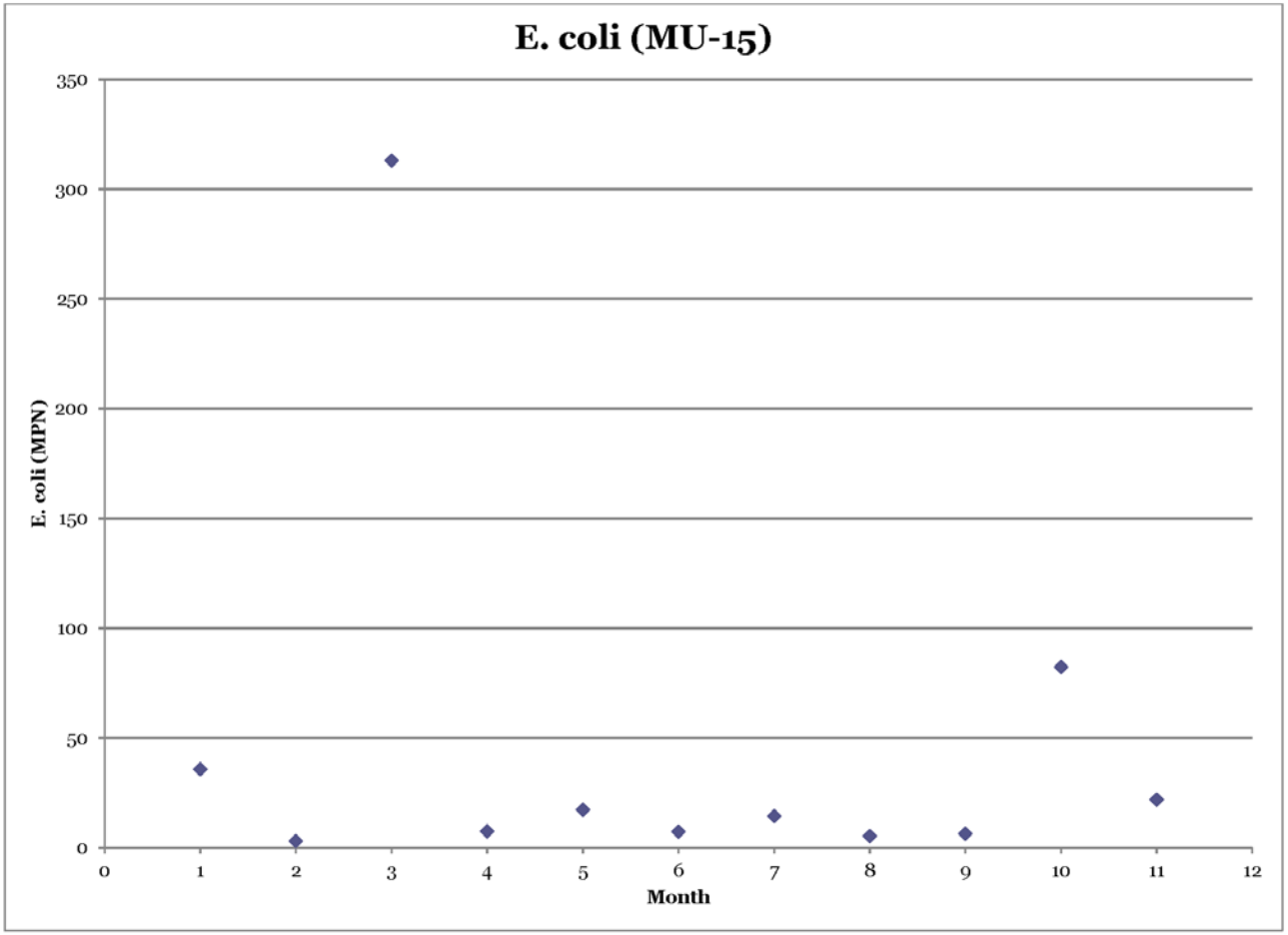

Turbidity (NF-M)
Turbidity (NTU)
25
20
15
10
5
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

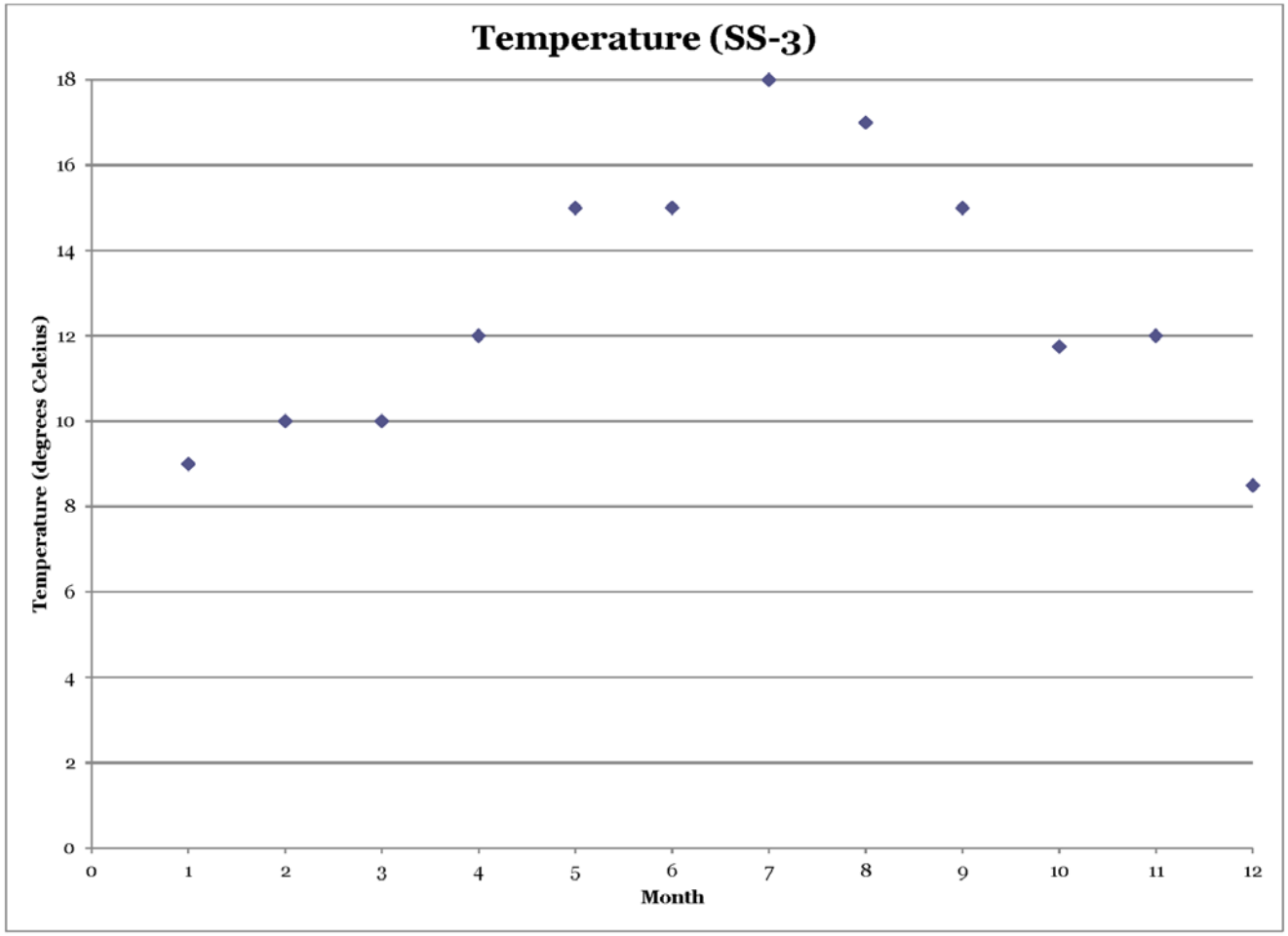

E. coli (NF-M)
E. coli (MPN)
350
300
250
200
150
100
50
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

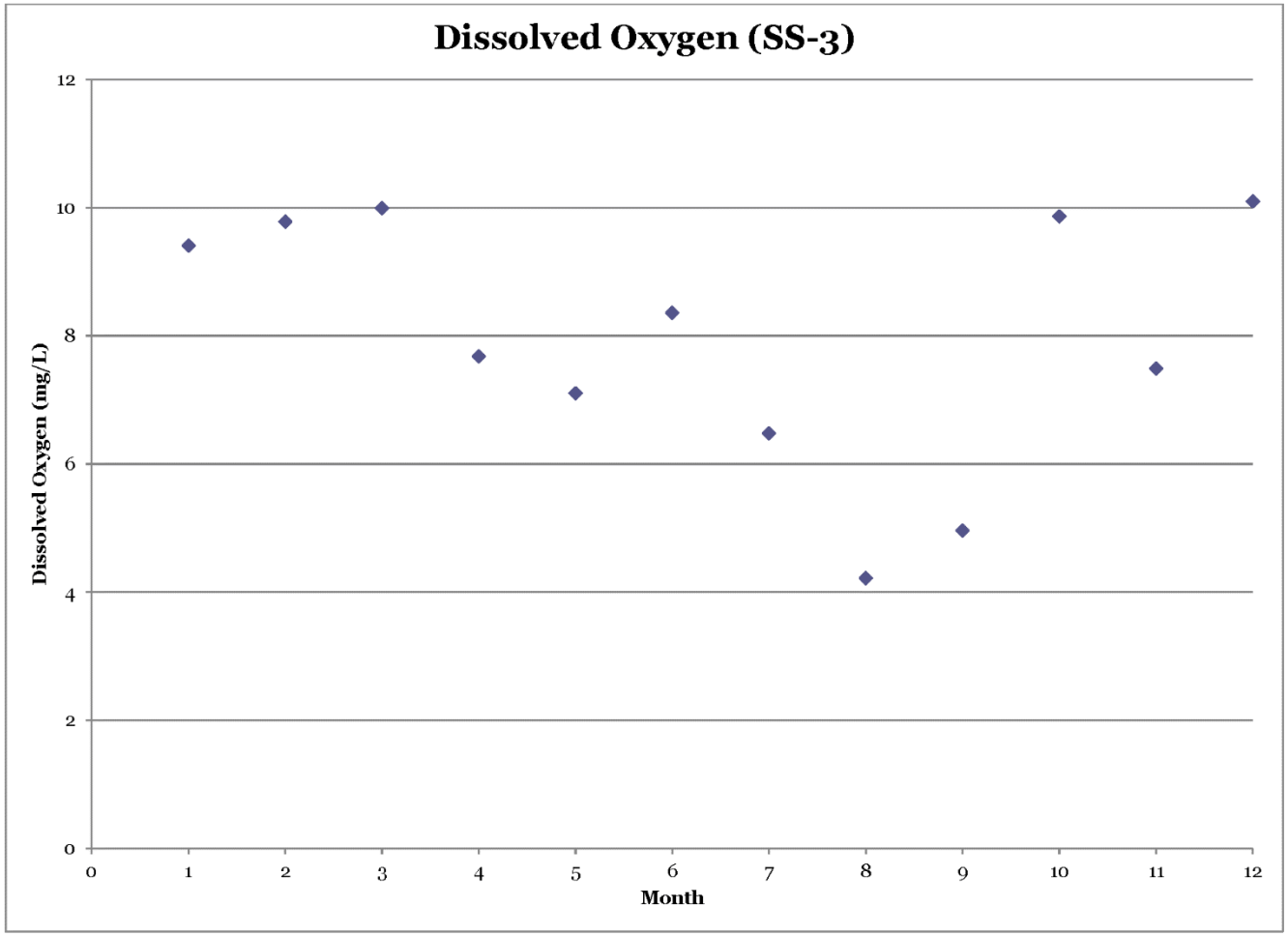

Temperature (MU-15)
Temperature (degrees Celsius)
30
25
20
15
10
5
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

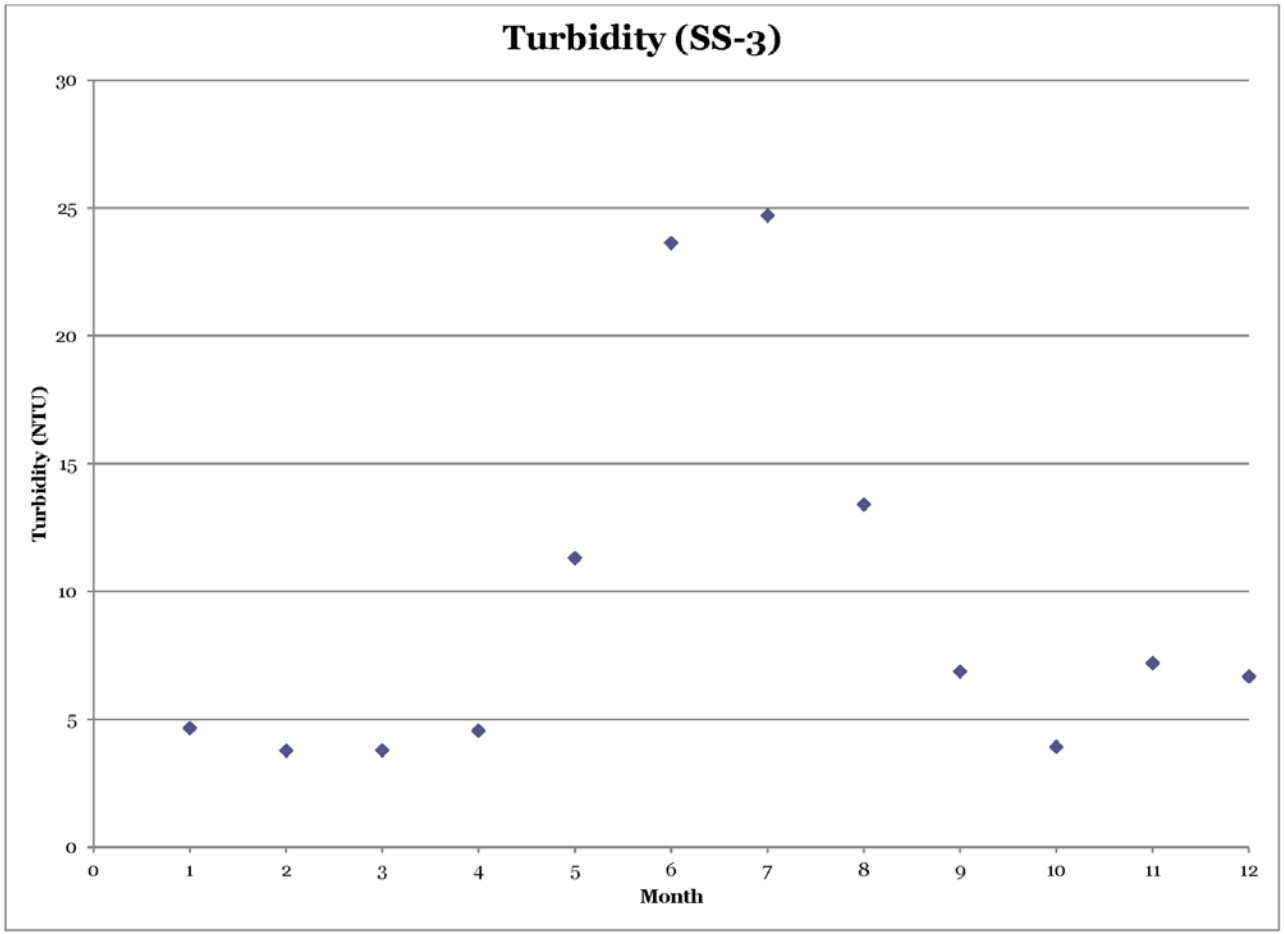

Dissolved Oxygen (MU-15)
Dissolved Oxygen (mg/L)
12
10
8
6
4
2
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

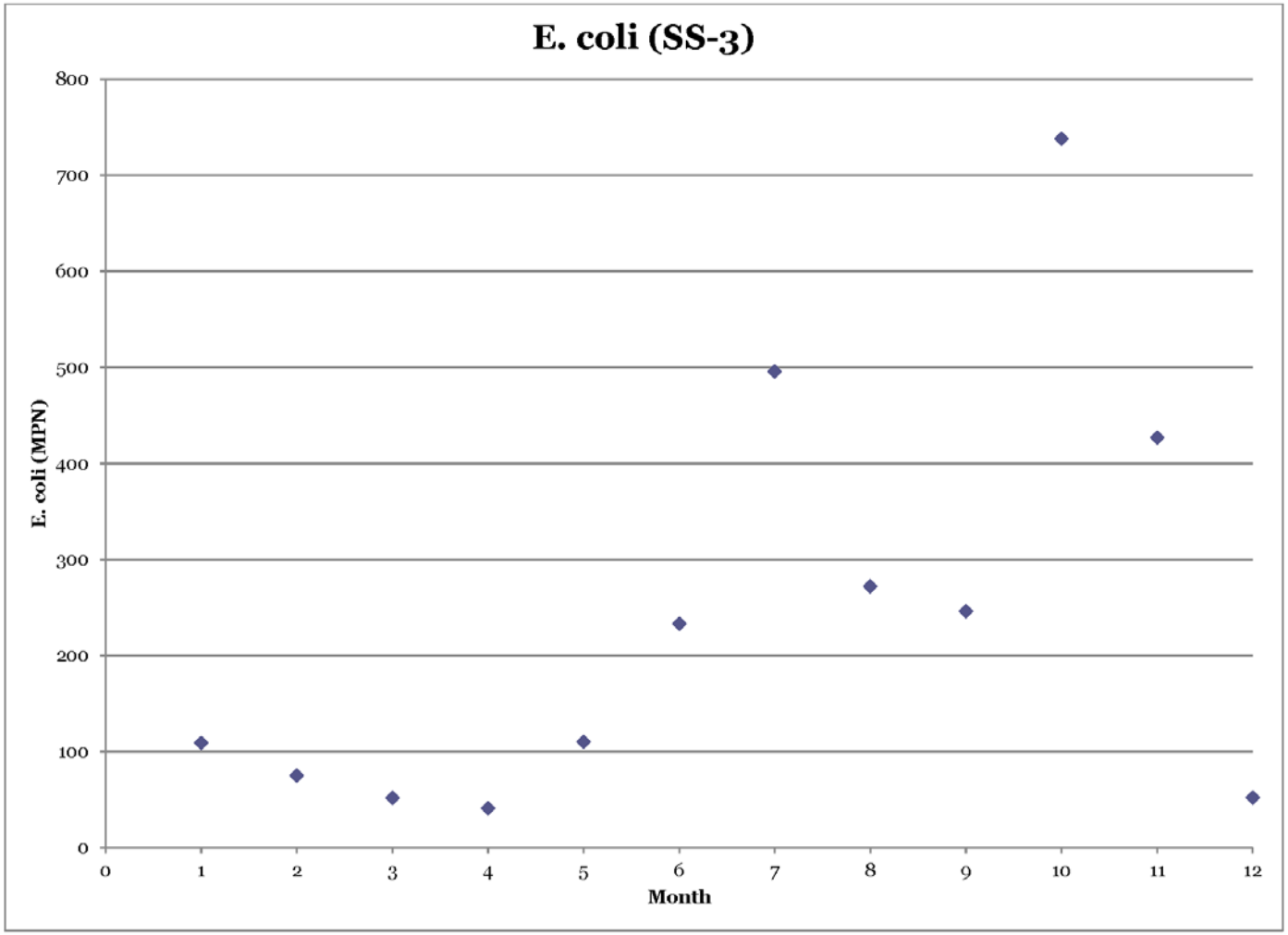

Turbidity (MU-15)
Turbidity (NTU)
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

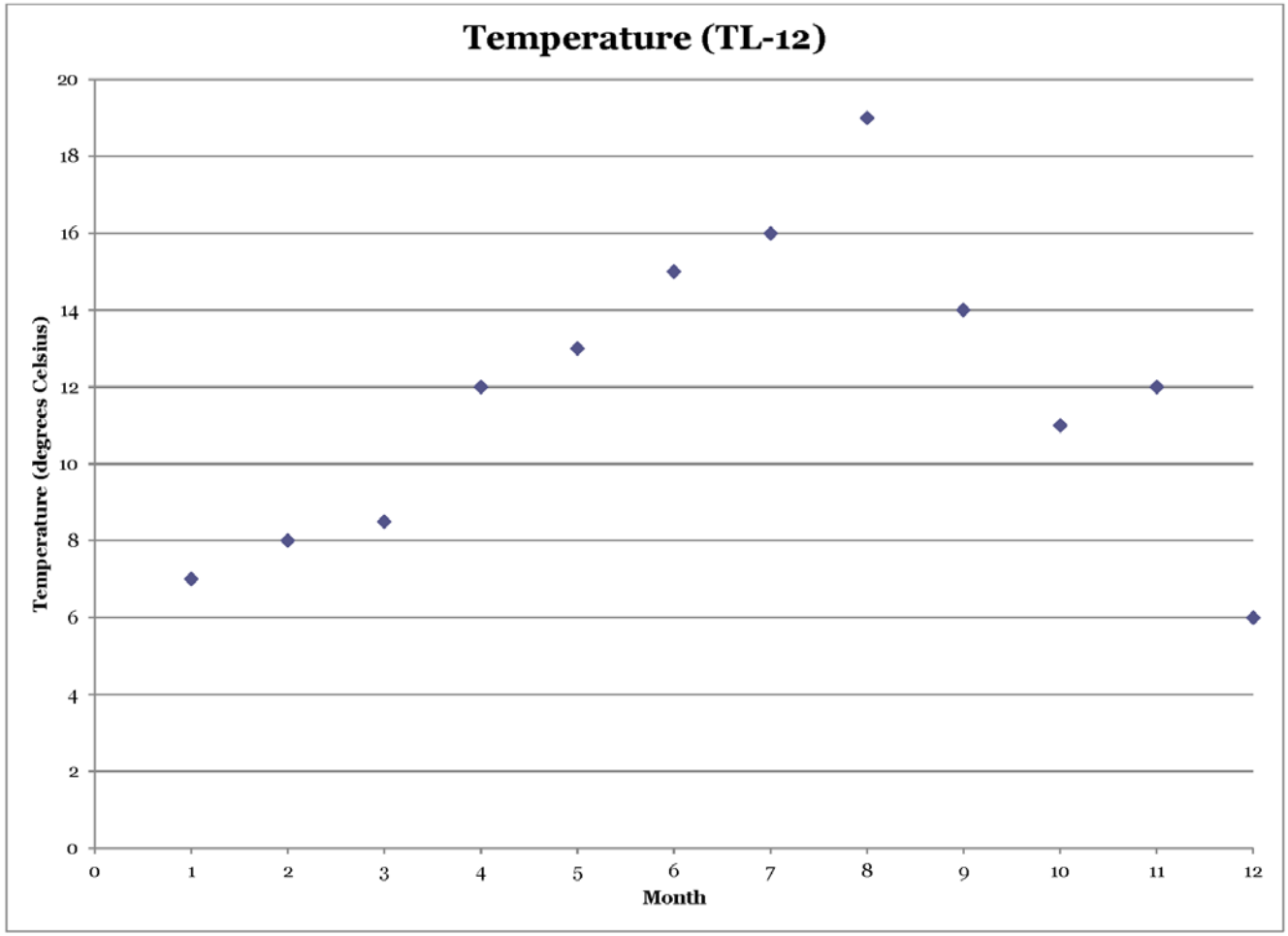

E. coli (MU-15)
E. coli (MPN)
350
300
250
200
150
100
50
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

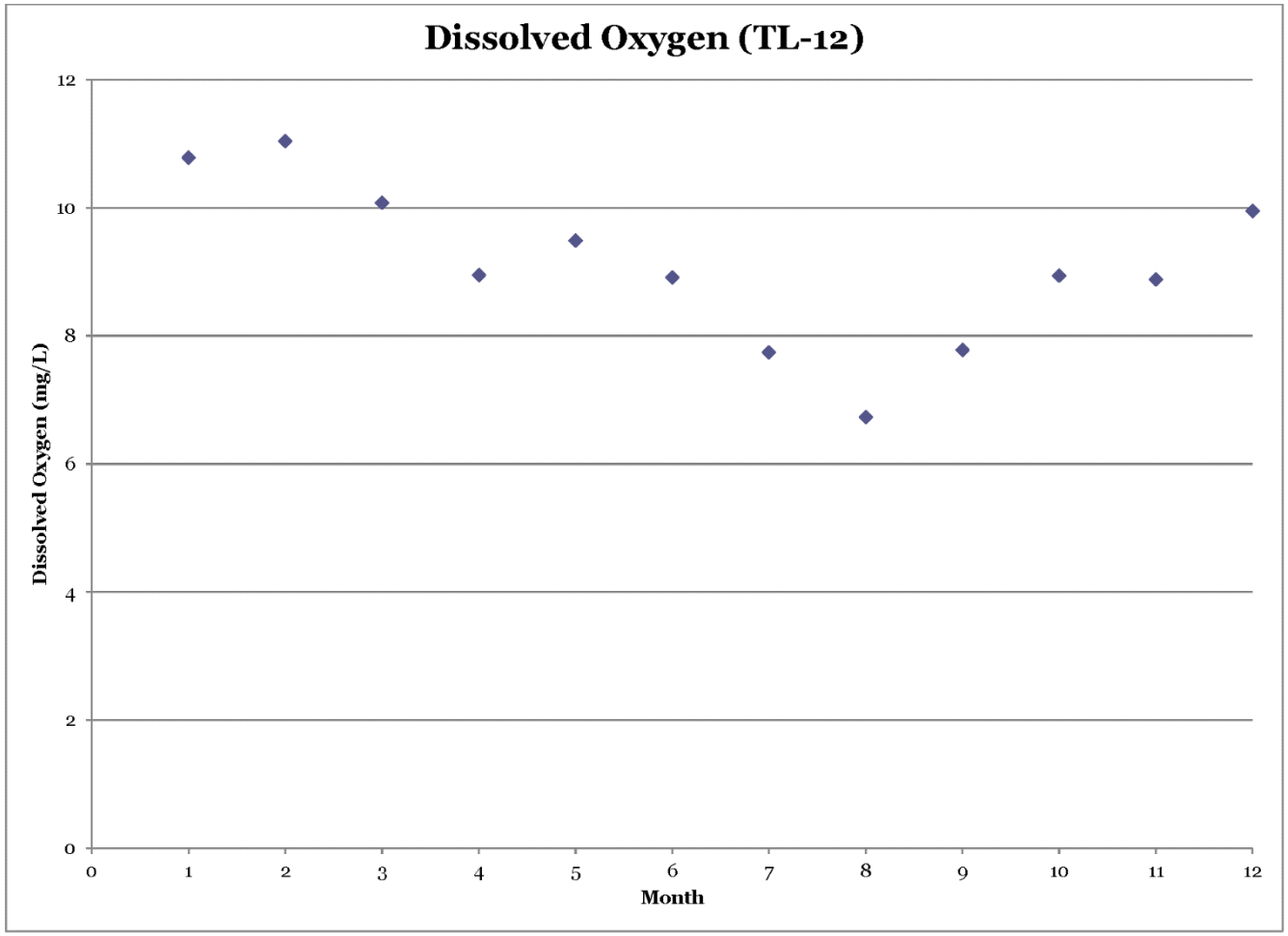

Temperature (SS-3)
Temperature (degrees Celcius)
18
16
14
12
10
8
6
4
2
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

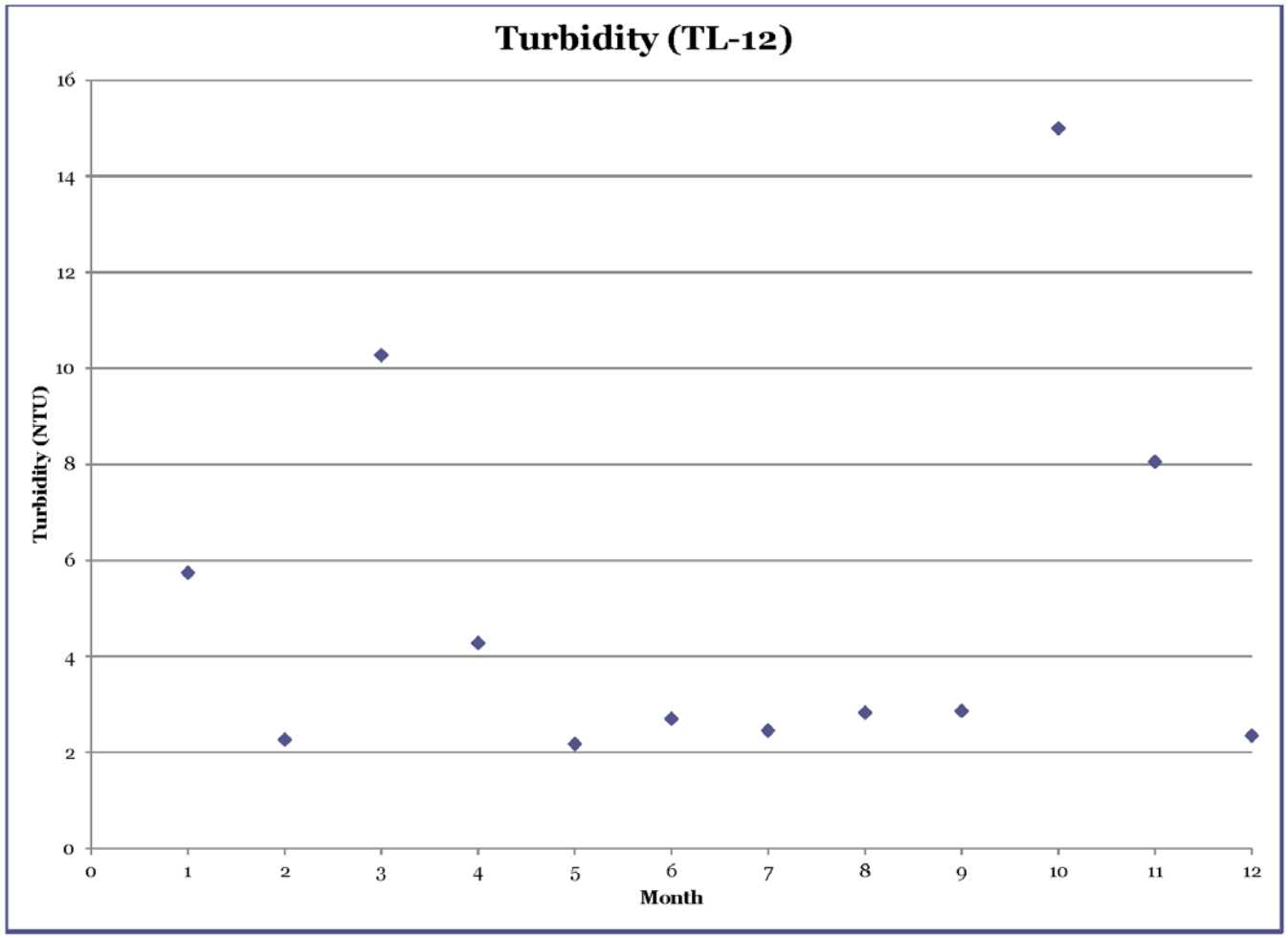

Dissolved Oxygen (SS-3)
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

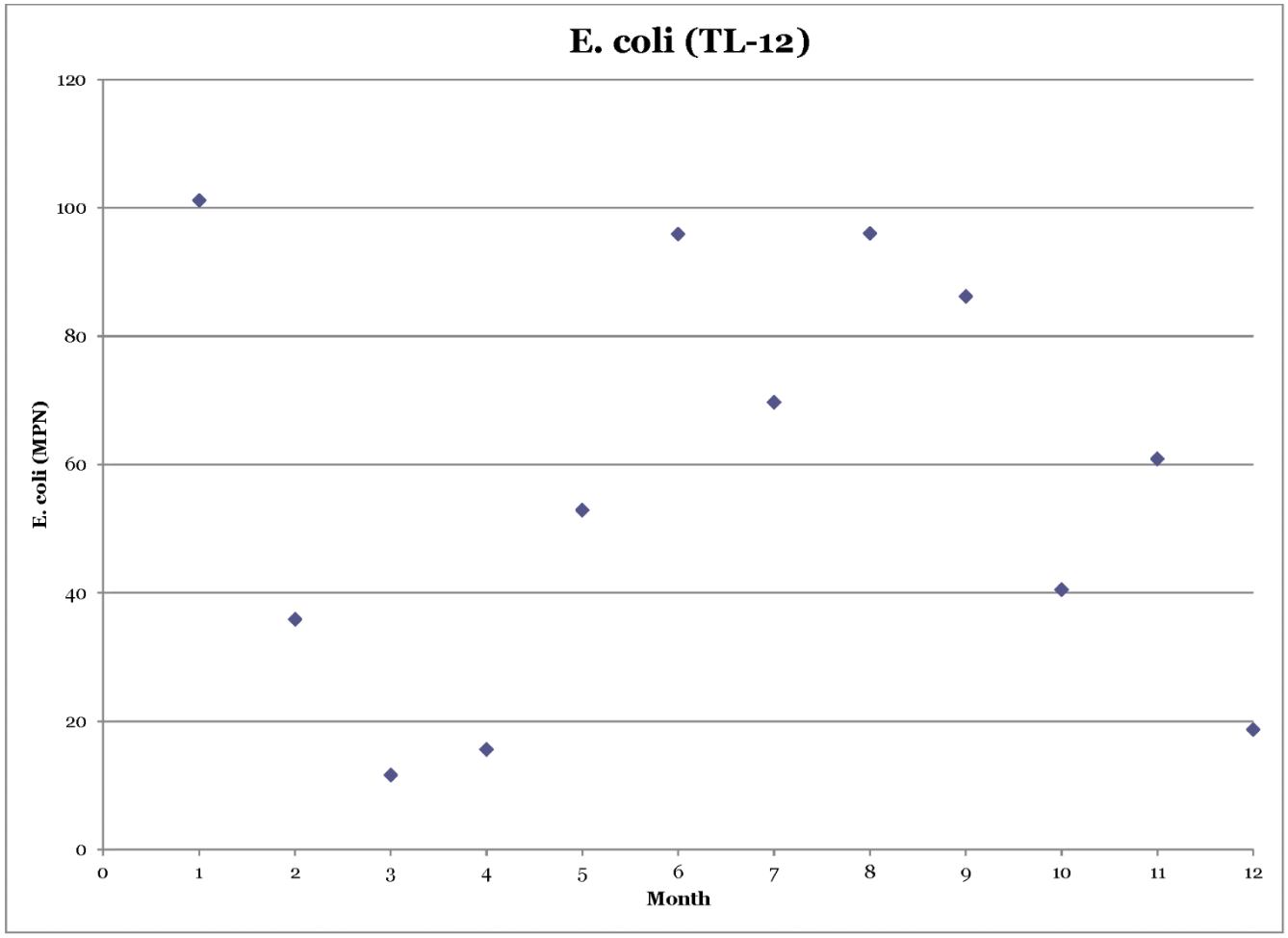

Turbidity (SS-3)
Turbidity (NTU)
30
25
20
15
10
5
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

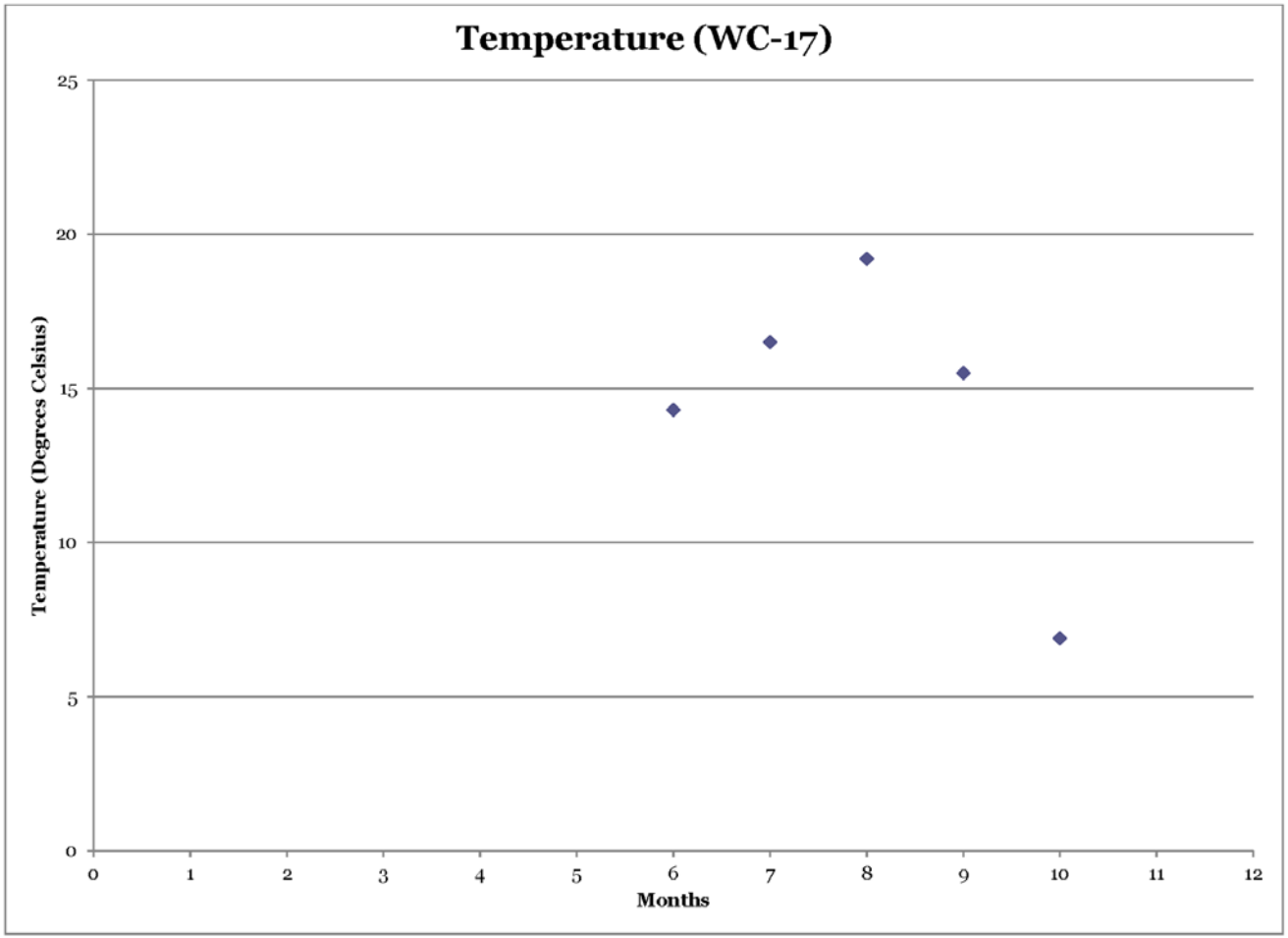

E. coli (SS-3)
E. coli (MPN)
800
700
600
500
400
300
200
100
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

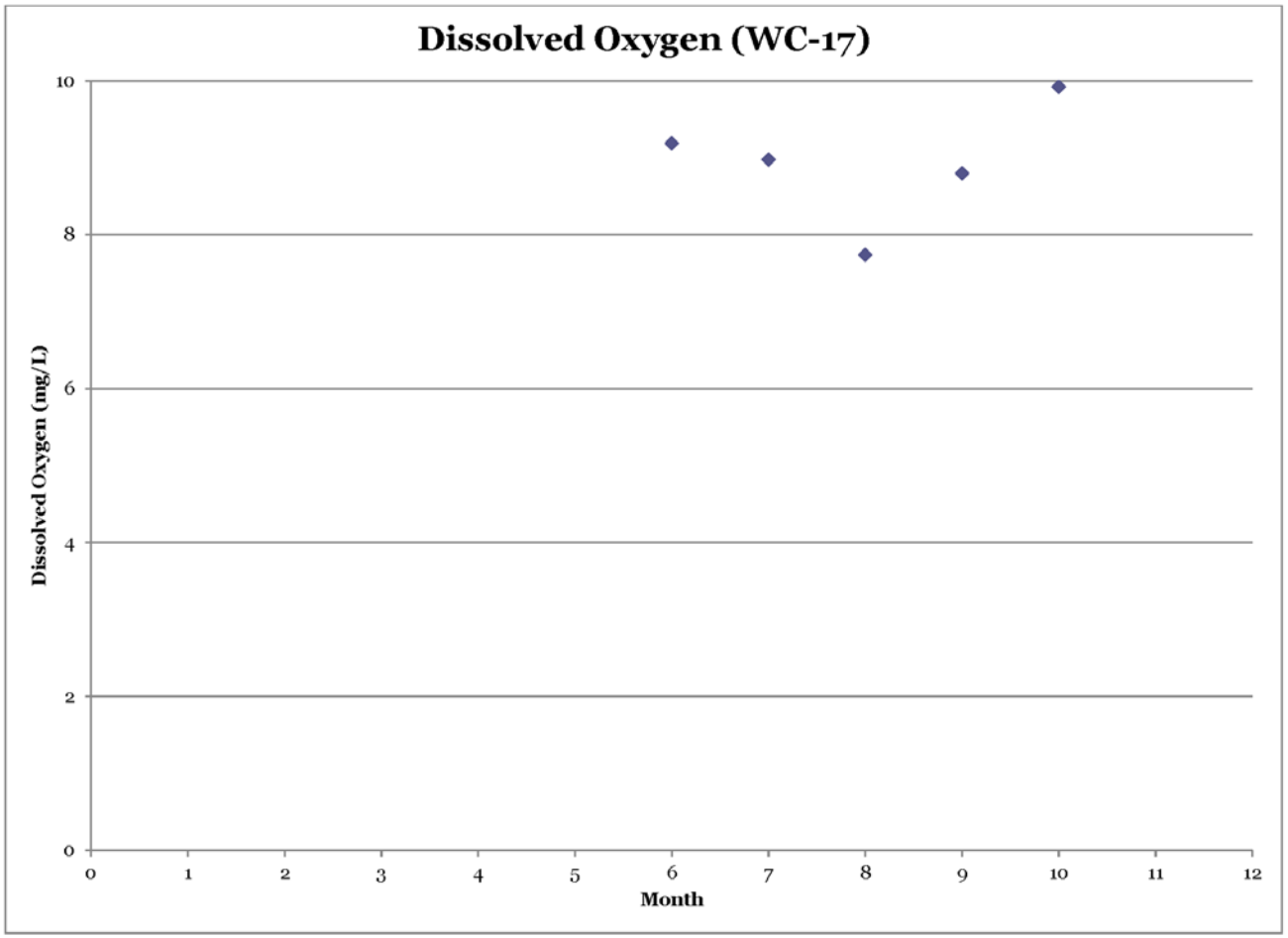

Temperature (TL-12)
Temperature (degrees Celsius)
20
18
16
14
12
10
8
6
4
2
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

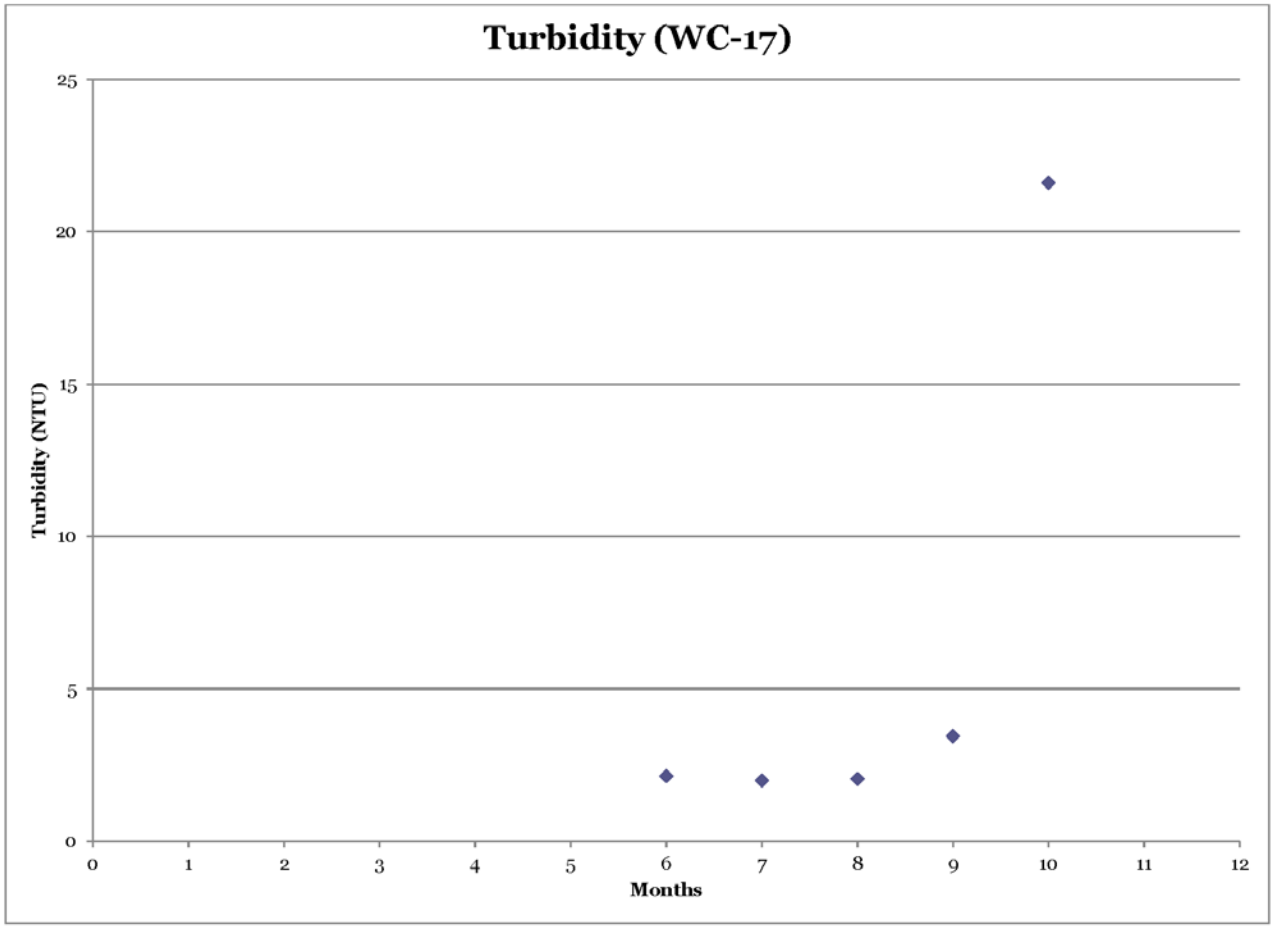

Dissolved Oxygen (TL-12)
Dissolved Oxygen (mg/L)
12
10
8
6
4
2
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

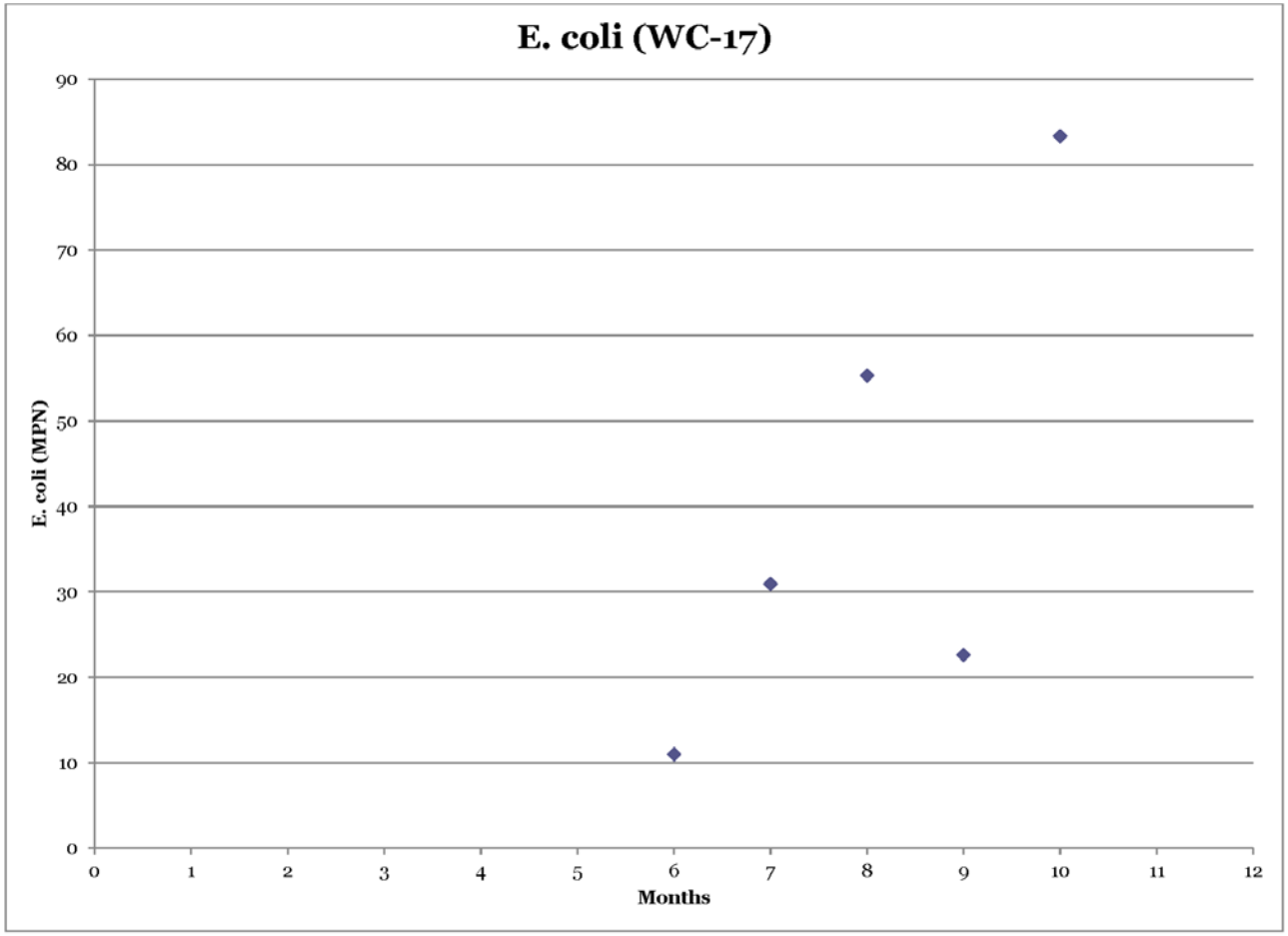

Turbidity (TL-12)
Turbidity (NTU)
16
14
12
10
8
6
4
2
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

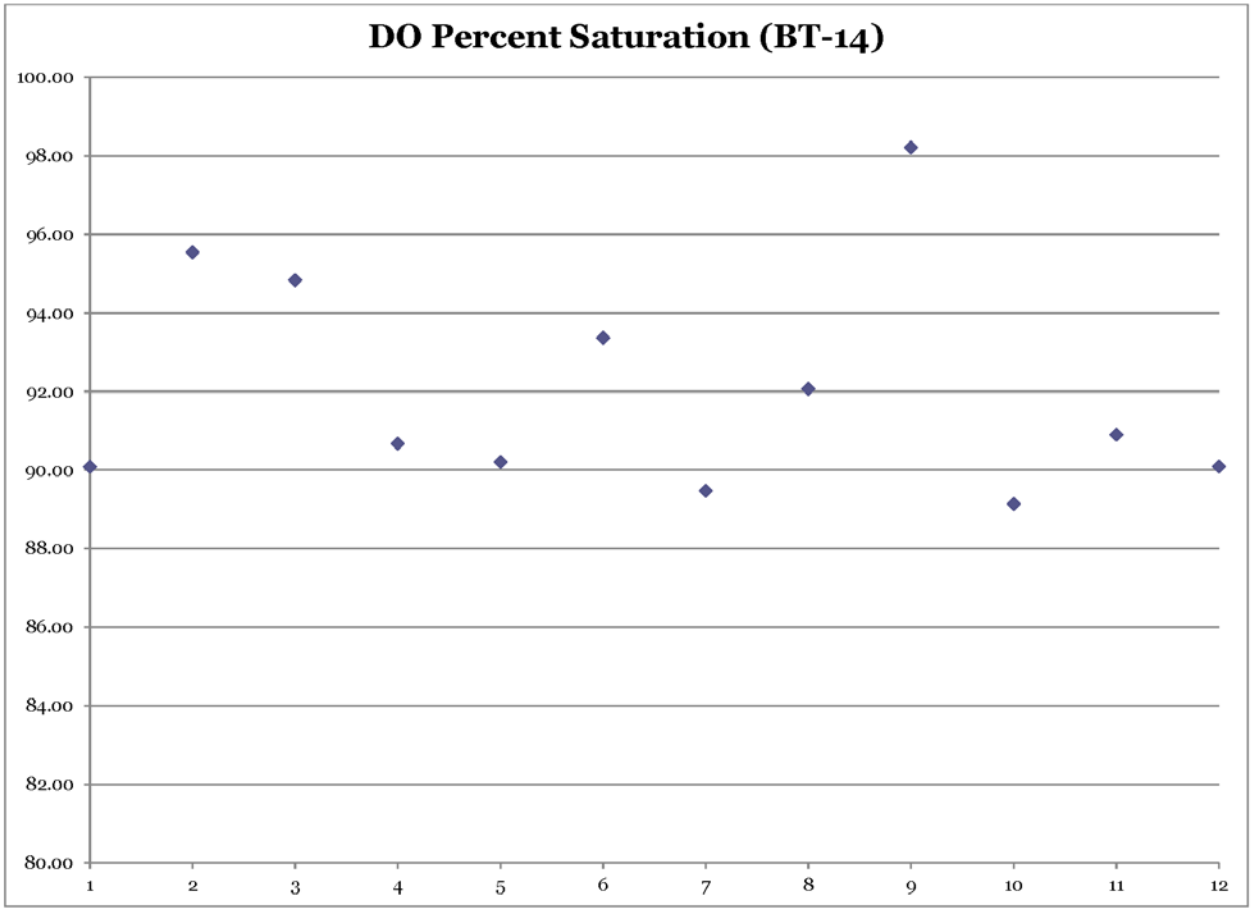

E. coli (TL-12)
E. coli (MPN)
120
100
80
60
40
20
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

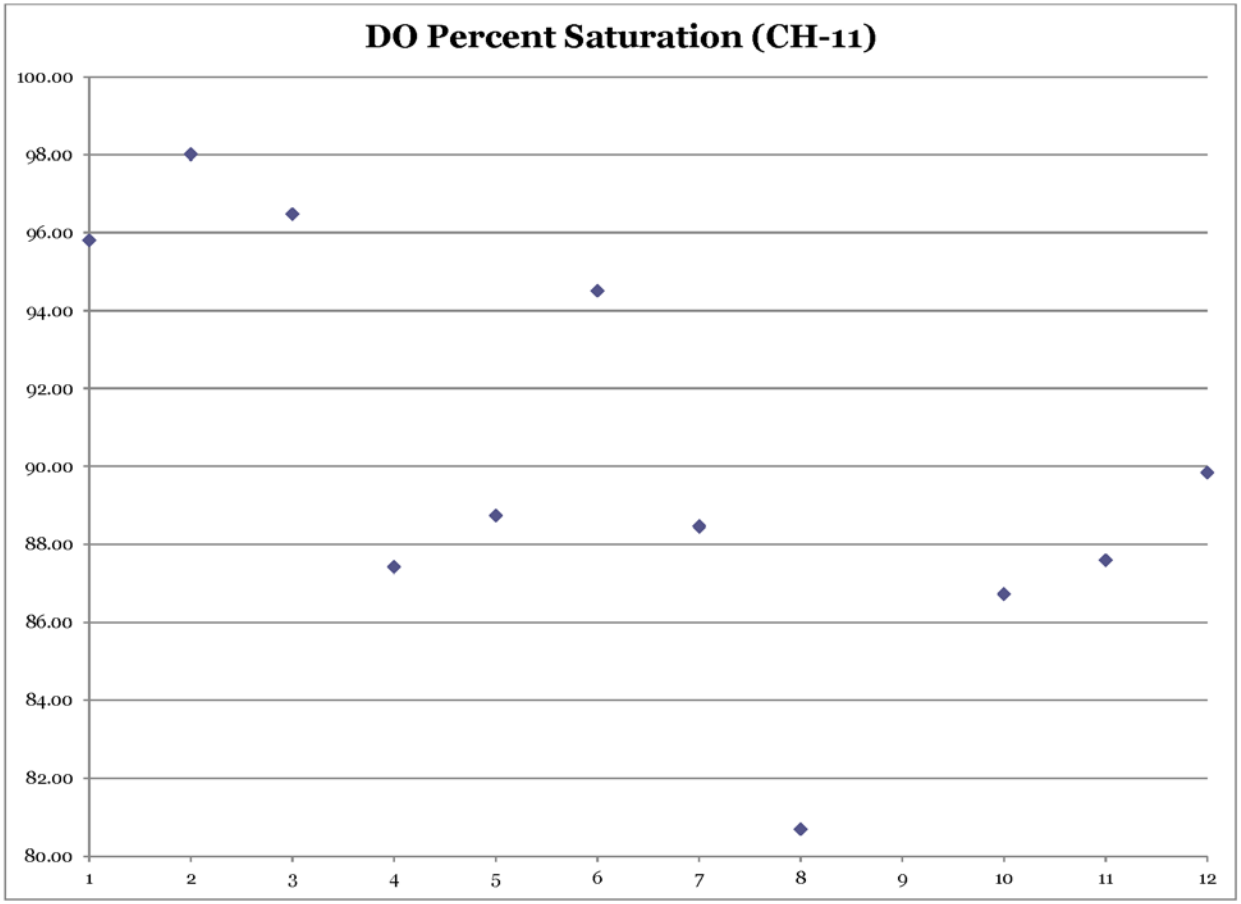

Temperature (WC-17)
Temperature (Degrees Celsius)
25
20
15
10
5
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Months

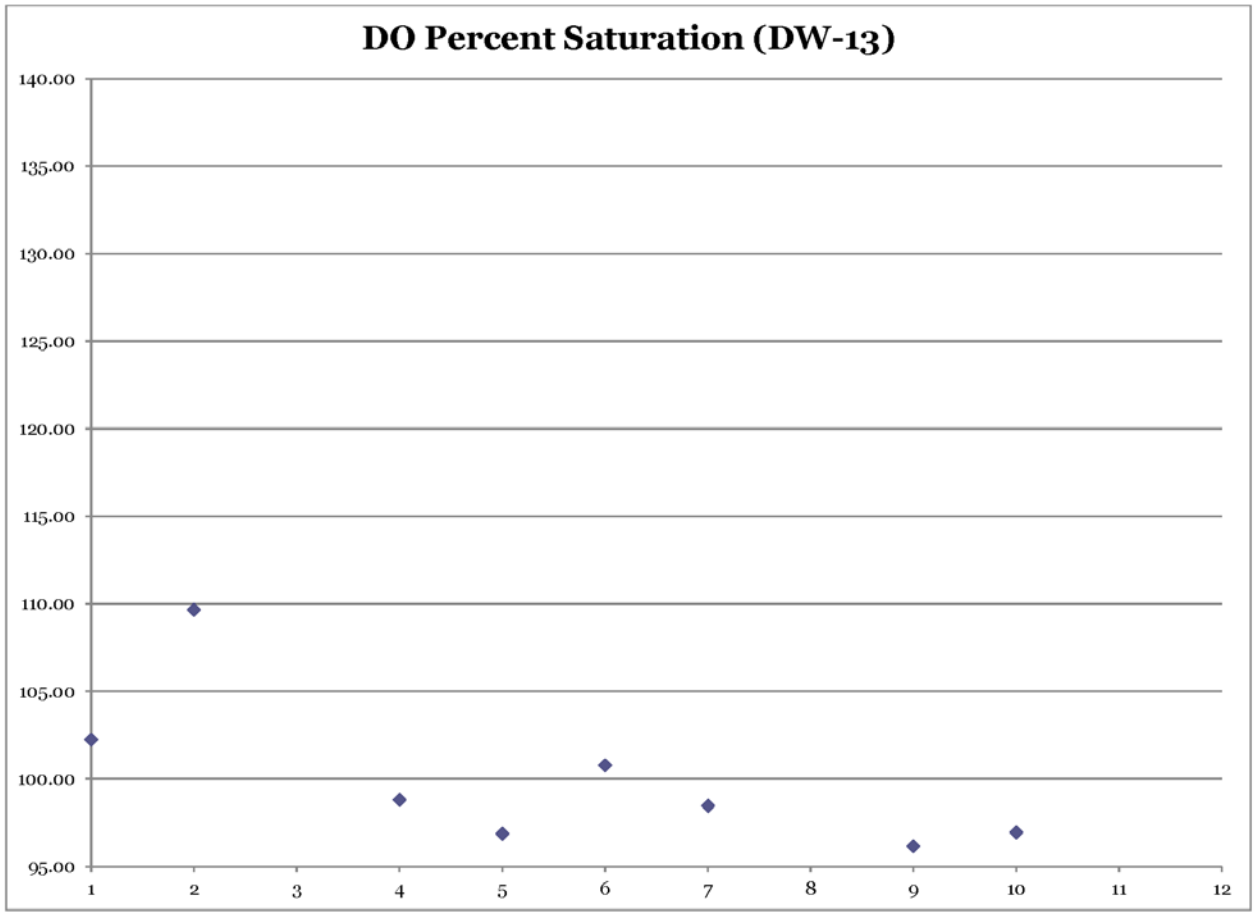

Dissolved Oxygen (WC-17)
Dissolved Oxygen (mg/L)
10
8
6
4
2
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Month


Turbidity (WC-17)
Turbidity (NTU)
25
20
15
10
5
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Months


E. coli (WC-17)
E. coli (MPN)
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Months


DO Percent Saturation (BT-14)
100.00
98.00
96.00
94.00
92.00
90.00
88.00
86.00
84.00
82.00
80.00
1
2
3
4
5
6
7
8
9
10
11
12


DO Percent Saturation (CH-11)
100.00
98.00
96.00
94.00
92.00
90.00
88.00
86.00
84.00
82.00
80.00
1
2
3
4
5
6
7
8
9
10
11
12


DO Percent Saturation (DW-13)
140.00
135.00
130.00
125.00
120.00
115.00
110.00
105.00
100.00
95.00
1
2
3
4
5
6
7
8
9
10
11
12