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PROJECT OVERVIEW

INTRODUCTION

This report incorporates two major monitoring projects conducted within the Umpqua Watershed by the Partnership for the Umpqua Rivers (PUR) and funded by the Oregon Watershed Enhancement Board (OWEB) and an Oregon Department of Environmental Quality (DEQ) 319 Grant. Part I, PUR Water Quality Monitoring, includes the presentation of water quality data collected between 2004 and 2010 by PUR's volunteer monitoring participants and monitoring coordinator. Part II, Thermal Refugia Investigation, presents the results and analysis of thalweg temperature data gathered by Insight Consultants and PUR during the summer of 2009 in a 25 mile stretch of the Upper Umpqua River. The purpose of the study was to quantify the dynamic response of the thalweg temperature within a temporal and spatial context and relate the results to site specific physical characteristics of the river. One clarification should be mentioned, as reference is made to the Umpqua Basin Watershed Council (UBWC). UBWC changed its name (January 5, 2006) during the course of the monitoring reported in this document to become the Partnership for the Umpqua Rivers. PUR remains the same watershed council only the name has changed. The grant funding referenced on the title page funded monitoring for two years from 2008-2010. Secure Rural Schools and Self-Determination Act (RAC) grants funded earlier work from 2003. OWEB asked that all data be included in this report to provide a longer term data set.

The PUR's *Mission Statement* reads: "Through collaboration with diverse participants, the Partnership for the Umpqua Rivers maintains and improves water quality & fish populations from source to sea in the streams of the Umpqua. We educate people about the value of healthy streams; we work with willing landowners to improve stream conditions; we monitor the health of the streams and their fish populations. Through these actions the Partnership contributes to the ecological and economic well-being of the basin."

THE UMPQUA BASIN

The Umpqua Basin (see Figure 1 for map) coincides closely with the boundary of Douglas County Oregon. It encompasses 2,996,000 acres and is the largest watershed draining into the Pacific Ocean along the Oregon Coast, south of the Columbia. There are over 2,600 stream miles of potential anadromous fish habitat. "The Umpqua is one of Oregon's most important producers of spring Chinook, fall Chinook, winter steelhead, summer steelhead, coho, and sea-run cutthroat trout. The Umpqua system accounts for more total and wild coho spawners than any other river system in Oregon and about 15% of coho spawners coast-wide" (Barnes & Associates, Inc., 2007, p. 3).

Land cover and ownership is quite varied throughout the basin. The eastern one third of the watershed is managed by the U.S. Forest Service, with a small piece managed by the National Park Service around Crater Lake. The central part of the watershed is made up of a checker board pattern of BLM and private lands. Land cover is 75.4% forest, 14.8% agriculture, 8.3% shrub/grasslands, 0.6% urban, and 0.9% water (Oregon Watershed Enhancement Board, 2008, p. 8).

The rivers, streams, and creeks of the Umpqua Basin are used extensively for many purposes. ODEQ's Table 320A - List of Designated Beneficial Uses for the Rivers of the Umpqua Basin (Appendix A) indicates beneficial uses by major river system. These uses include commercial navigation, hydroelectric power, public and private domestic water supply, industrial water supply, irrigation, livestock supply, fish and aquatic life, fishing, boating, water contact recreation as well as aesthetic quality. These numerous uses of the river are critical to the local economy and general well-being of the communities within Douglas County, population of about 108,000. Everyone is connected to the river in some way. Most population centers in the county are rural and located on major rivers. Most communities rely on surface water from the river for drinking water. Recreational and commercial fishing are important components of the local economy.

As part of our mission, PUR has produced 18 separate watershed assessments. These documents, along with a multi-agency collaborative effort, were used to develop the Umpqua Basin Action Plan (June 2007). The Action Plan (Barnes & Associates, Inc., 2007) on page 21, identifies the need to, "Continue monitoring streams already monitored for water quality. (and to) expand monitoring efforts to include key streams not currently monitored." Also, the Partnership's recently completed council Strategic Plan 2011-2014 Goal 3 identifies the following "Monitor Aquatic Conditions: Monitor the health of Umpqua Basin streams by identifying trends in basin conditions and evaluating project effectiveness, and disseminating the results." (Partnership for the Umpqua Rivers, 2010) Thus, PUR chose to monitor primarily on private lands providing data from areas never collected before. BLM and the Forest Service conduct monitoring on the lands that they manage. ODEQ's Ambient Monitoring Program has eight stations in the Umpqua that are monitored only every other month. These include four sites on the South Umpqua, and one each at the mouths of the North Umpqua, Calapooya Creek, Elk Creek (at Elkton) and Cow Creek. PUR's data has increased the information available at three of these sights and provided a great deal of information on numerous smaller tributaries that otherwise would not have been monitored. We have also partnered with the Forest Service to provide water quality data in Elk Creek, near Tiller, where a basin wide restoration is occurring. The Forest Service is collecting the summer continuous temperature data while PUR is conducts a set of other water quality parameters year-round (see Water Quality Parameters under Monitoring Methods).

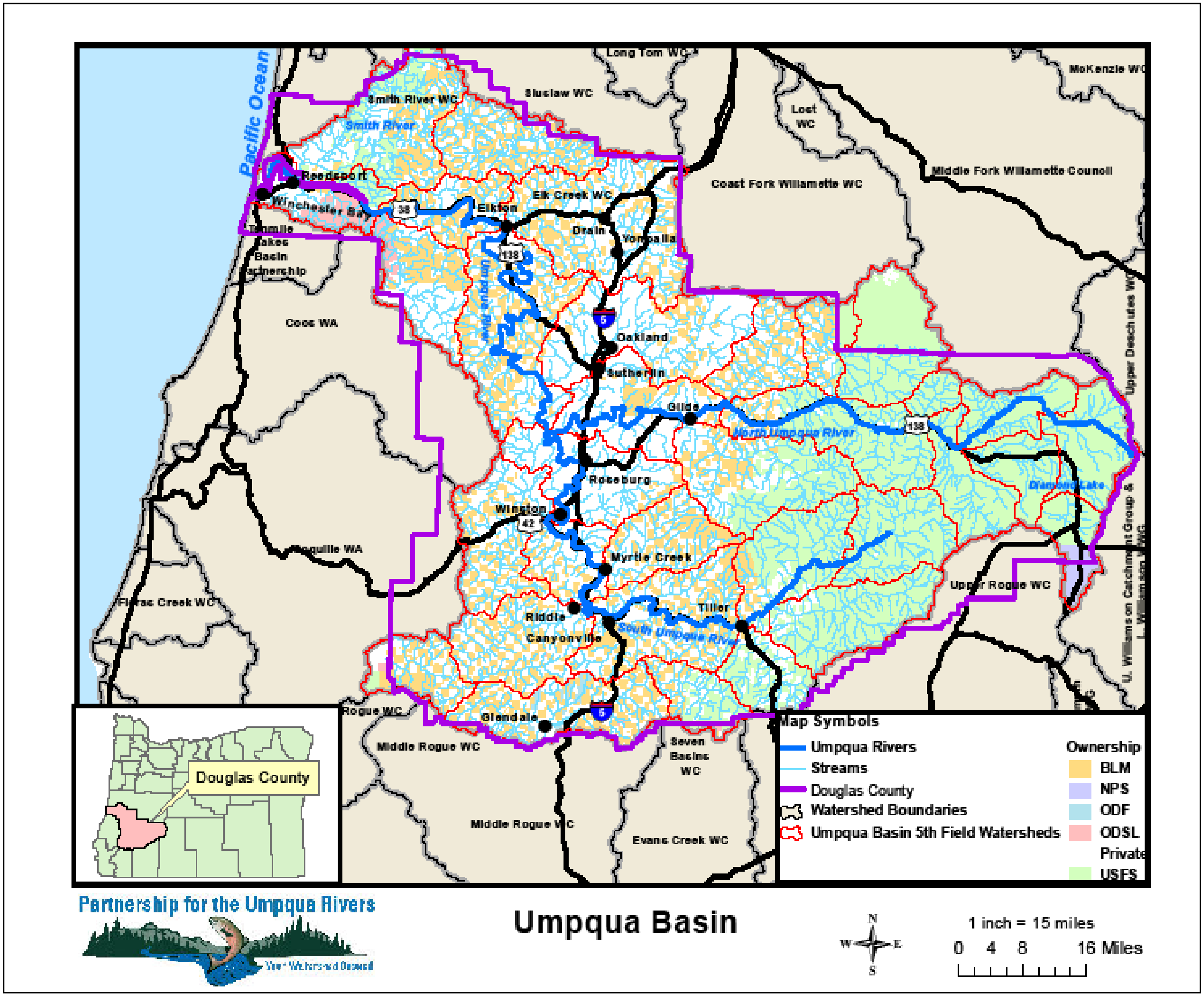


Figure 1: Umpqua Basin and Area Location Map

PUR'S VOLUNTEER MONITORING PROGRAM & SITE SELECTIONS

PUR hired a monitoring coordinator in mid-November of 2003 who was tasked with developing both a water quality monitoring program and a volunteer monitoring program to assist in water quality monitoring.

The objectives of water quality monitoring were to:

- Establish an approved Quality Assurance Project Plan (QAPP) with DEQ
- Gather data on temperature, turbidity, conductivity, dissolved oxygen, pH, total coliform and *E. coli* bacteria that will lead to scientifically-based understanding of current and changing watershed conditions;
- Provide current water quality information to PUR's project planning team to support restoration planning;
- Collect and provide water quality data to complement others' work;
- Collect and provide data where none is currently being gathered;
- Gather data where future restoration efforts are being planned so that "pre" water quality parameters can be recorded;
- Track areas of previous restoration efforts to detect a quantifiable change in water quality parameters as a result of our restoration projects;
- Maintain a close working relationship with other watershed stakeholders and act as the lead to share, gather and upload data to the Umpqua Basin Explorer website;
- Provide "A" quality data to the ODEQ Laboratory Analytical Storage and Retrieval (LASAR) database.

The objectives of the volunteer monitoring program were to:

- Establish a recognized volunteer monitoring program under the guidance of ODEQ
- Recruit volunteers
- Hold workshops for training and recruitment of volunteers
- Have volunteers share their knowledge and expertise by participating in the planning of areas to be monitored and in developing a water quality monitoring plan
- Begin monitoring with volunteer assistance
- Train monitoring volunteers to conduct monitoring on their own
- Continue recruitment and training of volunteers

By May of 2004, PUR conducted three trainings on water quality testing parameters with the help of local experts and Steve Hanson, head of ODEQ's Volunteer Monitoring Program. Also the Xerces Society presented two trainings on macro invertebrates and ODFW provided a workshop on fish surveying and snorkeling.

While the workshops and trainings were ongoing, Janice Green, a Board Member of what was then the Umpqua Basin Watershed Council, had already been studying site selections in her local watershed – the Calapooya. She was instrumental in convincing the Council to hire a Monitoring Coordinator and was anxious to gather data that could be included in the TMDL process for the Umpqua Basin which was then underway. Janice quickly recruited the aid of the newly hired Monitoring Coordinator to help her get a QAPP written and approved by DEQ. This accomplished and with equipment on loan from DEQ, the Calapooya Watershed became our first monitoring effort consisting of only four monitoring events (6/22/04, 6/29/04, 8/30/04, 11/29/04- 11/30/04) designed to cover four seasons. The Calapooya was not monitored again until the site near the mouth was added to the Coast "Run" in 2008 (discussed below).

When PUR started its volunteer water quality monitoring program in 2004 it was decided that, because of the size of the Umpqua Basin, we would focus on one 5th field watershed until we developed our proficiency and a long-term monitoring strategy. We held several monitoring committee meetings and considered: PUR Watershed Assessments, TMDL development needs, BLM high-priority targeted watersheds, size and land ownership diversity of the watersheds, and location of volunteers. The Myrtle Creek 5th Field Watershed was identified in each of the previous categories as being an area of high concern. In addition, several Myrtle Creek volunteers had attended the trainings. They were specifically asking why there were not more salmon in their watershed. Through discussions with long-time local residents, they had heard stories of huge salmon runs. They wanted to find out how and why things have changed, and what could be done to restore these runs to their watershed by working to create and maintain a healthy watershed for fish and humans.

All of these considerations came together to select the Myrtle Creek 5th field Watershed as our highest priority. Once having settled on the Myrtle Creek Watershed, we then began planning to determine our sites. We decided to compare water quality data on various land use areas (forest, farm, rural residential and city) on North and South Myrtle Creek, and the main stem Myrtle Creek. We also chose to monitor the mouths of major tributaries of North and South Myrtle Creeks. This approach provided a diversity of sites that reflected the overall water quality for the watershed.

PUR soon had a volunteer monitoring program consisting of an ambitious team that recruited and trained new volunteers, gathered equipment, developed a monitoring plan, gained approval of a quality assurance plan by DEQ and created a water quality laboratory. This laboratory is managed by PUR and cooperatively shared with DEQ, the Cow Creek Band of the Umpqua Tribe of Indians, and Douglas Soil and Water Conservation District (DSWCD).

After evaluating our first year's data in the Myrtle Creek Watershed, we decided for the second year of monitoring to adjust some sites by dropping several tributaries and adding others in order to get a more complete picture. Our data also led to the identification of Weaver Creek as a creek that could benefit from riparian restoration and fencing. PUR planners have since designed, developed, and implemented two such projects on Weaver Creek. We will continue to monitor this site watching for post project improvements.

The third year, in addition to continued monitoring in Myrtle Creek, we expanded our monitoring into the South Umpqua Watershed following the same approach as we used for setting up sites in Myrtle Creek. In order to economically capture as broad a spectrum of the Umpqua Basin as we could, we selected sites along the main rivers and then the mouths of tributaries. Further investigation of tributaries that raised concern could be added in later years. The fourth year PUR added a run of sites along the main Umpqua between Roseburg and the coast. A second run was added that year consisting of a set of sites in the Elk Creek Watershed, above Tiller, in conjunction with the Tiller Ranger District. These two projects have now been monitored for two years, Myrtle Creek for six years, and the South Umpqua five years all ending for the purposes of this report in December, 2010. Figure 2 is a map highlighting the 5th Field watersheds in which PUR is regularly monitoring as part of its Volunteer Monitoring Program.

All monitoring was performed by PUR staff and trained volunteers under the supervision and/or direction of PUR staff. Sandy Lyon is in charge of our volunteer monitoring program. Sandy is a graduate of the University of California, San Diego with a degree in biology. She worked for 25 years in medical research at U.C.S.D. before moving to Oregon. Her research experience serves her well in directing our water quality monitoring efforts. Since joining PUR she has attended numerous conferences and trainings about water quality monitoring, including two trainings on HABs (one at OSU and one on the coast) and has become an OSU Master Watershed Steward and is now teaching the water quality component of the next Master Watershed Steward class here in the Umpqua.

PUR received approval for their *Quality Assurance Project Plan* (QAPP) with the Oregon Department of Environmental Quality Laboratory and Environmental Assessment Division before monitoring was begun. It has been amended as needed to reflect monitoring protocol and site location changes. The protocols follow the standard methods as described in the *Oregon Plan for Salmon and Watersheds Water Quality Monitoring Technical Guide Book* (1999) and the *EPA Volunteer Stream Monitoring: A Methods Manual* (1997).

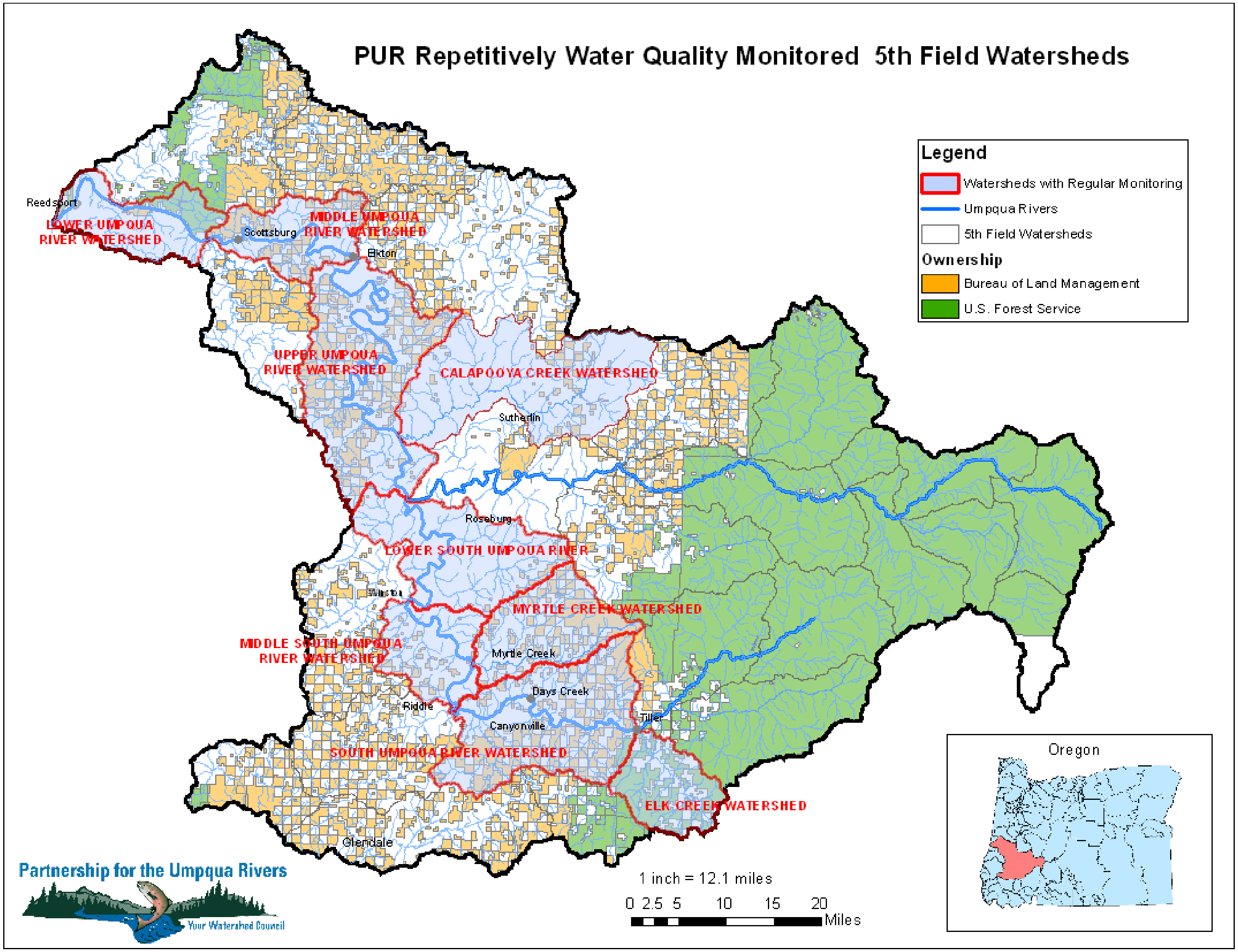


Figure 2: Fifth Field Watershed s in which PUR has performed regular water quality monitoring.

Monitoring Methods

WATER QUALITY PARAMETERS

We began our water quality monitoring collecting data with equipment and supplies provided by the DEQ Volunteer Monitoring Program. This consisted of turbidity, pH, dissolved oxygen, conductivity, *E. coli,* and temperature. Considering cost and experience these are the parameters most often used by beginning volunteer monitoring groups to capture an overall watershed health.

Monitoring of all parameters followed standard methods as described in *Oregon Plan for Salmon and Watersheds Water Quality Monitoring Technical Guide Book*, *The EPA Guide to Volunteer Monitoring, YSI Product Training Manual* and the manufacturers' equipment manual recommendations. In 2007 PUR purchased a YSI Sonde multi-parameter device with funds received by the Council that were dedicated to improvement of water quality. DEQ uses Sondes for some of their data collection and approved its use in our *Quality Assurance Project Plan, 2008 Addendum.* Parameters and methods used are listed in Table 1.

Parameter	Method
E. coli & total coliform	IDEXX Colilert method, manufacturer's protocol
Turbidity	Nephelometric, Hach 2100P, following manufacturer protocols
Field Turbidity	YSI Optical wiping turbidity sensor in 6920V2 Sonde datalogger, following manufacturer's protocols
Dissolved Oxygen	Hach kit Modified Winkler Method, manufacturer protocols
Dissolved Oxygen	YSI Dissolved Oxygen 550A Meter following manufacturer's protocols
Dissolved Oxygen	YSI ROX Optical Dissolved Oxygen Sensor in 6920V2 Sonde datalogger, following manufacturer's protocols
Temperature	NIST thermometer and Sonde thermometer
Continuous Temperature	Onset Data Loggers
Conductivity	YSI Conductivity Meter Model 30 following manufacturer's protocols
Conductivity	YSI Conductivity Sensor in 6920V2 Sonde datalogger, following manufacturer's protocols
pH	Orion pH probe and meter
pH	YSI Low Ionic Water pH sensor Combination pH and Gel Reference, manufacturer protocols

Table 1: Parameters monitored and methods used in PUR's water quality monitoring.

Calibration and Accuracy Checks:

- The Orion pH meter was calibrated by the monitoring coordinator or a trained volunteer, prior to any day's monitoring, with pH 7.01 and 10.01 buffers according to methods described in the user's manual.
- YSI Low Ionic Water pH sensor was calibrated prior to any day's monitoring with certified pH 7.01 and 10.01 buffers and calibration was checked at end of monitoring day
- The YSI Model 30 Conductivity meter was returned to DEQ for annual calibration. Accuracy checks were performed at the beginning and end of each sampling session with a standard solution of 1413 uS/cm.
- The YSI Conductivity Sensor was calibrated prior to any day's monitoring with a certified standard solution of 1413 uS/cm and calibration was checked at end of monitoring day
- The Hach 2100P Turbidimeter was calibrated with of 800, 100, 20 and <0.10 standards every three months as per manufacturer's instructions. Each monitoring session accuracy checks were recorded before and after monitoring with field standards 0-10 NTU, 10-100 NTU, 100-1000 NTU which had their exact value determined immediately after calibration.
- The YSI Optical wiping turbidity sensor was calibrated prior to any day's monitoring with distilled water (0) and a certified YSI standard solution of 126 NTU. Calibration was checked at end of monitoring day
- The Hach DO Digital Titrator's results were checked by doing split samples twice a year with DEQ.
- The YSI DO meter was calibrated prior to day's monitoring with water saturated air corrected by the Sonde for barometric pressure. Calibration was checked at end of monitoring day and checked for accuracy against a titrated DO Analysis twice each monitoring session.
- The NIST Traceable Digital Thermometer was returned to DEQ annually for calibration.
- Data loggers had an accuracy test performed before and after deployment and NIST Thermometer readings were taken at the logger sites at least twice during the summer.
- *E. coli* split samples were done twice annually with DEQ. A comparator was used whenever samples were read. Blank samples were collected twice annually. A field blank using DI water was collected to check handling technique.

Parameter	Precision	Accuracy	Measurement Range
Temperature	±1.0°C	±0.5°	-5 to 35°C
pH	±0.3 SU	±0.2 SU	0 to 14 SU
Turbidity	±5% of Std. Value	±5% of Std. Value	0 to 1000 NTU
Conductivity	±10% of Std. Value	±7% of Std. Value	0 to 4999 μS/cm
Dissolved Oxygen	±0.3 mg/l	0.2 mg/l	1 to 14.6 mg/l
E. coli	±0.6 log		0 to >2420 MPN
Photo Points		± 3 feet	

Table 2: Precision and accuracy of water quality parameters measured.

Precision: Duplicate sample results were used to determine the precision of water quality measurements for each sampling event. Differences between duplicate values were compared against precision requirements outlined in the DEQ Data Quality Matrix to assign data precision classifications (http://www.deq.state.or.us/lab/qa/deq04-lab-0003-gd.pdf).

Accuracy: Accuracy for pH, turbidity, and conductivity were determined by measuring standards before and after each sampling event. Deviations from standards were compared to accuracy ranges defined in the Data Quality Matrix to assign an accuracy classification for samples collected for each parameter. Temperatures were obtained with a NIST traceable thermometer that is calibrated by Oregon DEQ annually.

Split Samples: Split samples were conducted with the Oregon DEQ at least twice a year to further assess quality assurance.

Representativeness: Site selections were carefully chosen stream reaches that did not have contributing factors such as pond outflow or beaver dams upstream of collection sites. Samples were, when possible, collected from the center of the stream channel where the water is well mixed and, thus, most representative of the stream conditions.

Comparability: We hoped to insure comparability with similar projects by following standardized sampling protocols and procedures developed by state agencies. We also performed split samples at least twice a year ensure that our techniques produced results comparable to those of Oregon DEQ.

Turbidity Overview:
Turbidity in a stream appears cloudy to the human eye due to suspended particles. These particles could be silt or clay from sediment runoff, but could also be from microscopic organisms. Measuring turbidity is fairly easy with a light source and a detector such is supplied in the HACH kit and the YSI optical sensor used by PUR. These devises are able to measure the amount of light scattered by the particles in the water which is then picked up by a detector. The result is expressed in nephelometric turbidity units or NTUs. High turbidity levels are a problem for both public and private drinking water systems. Furthermore, fish may experience trouble breathing if particles get into their gills. Fish and other aquatic creatures have trouble feeding due to diminished vision. Fish eggs and fry may suffocate if fine particles are deposited into the gravels where they are developing. Migrating salmon will chose to avoid waters with high turbidity and may even stop their migration until the waters clear. Several researchers have reported that turbidity levels in the 60-70 NTU range will disrupt the feeding behaviors of juvenile coho. Fry that have newly emerged are even more susceptible and have demonstrated reduced growth and a tendency to emigrate from streams with levels of 25-50 NTU. “Effects on salmonids will differ based on their developmental stage. Suspended sediments may affect salmonids by altering their physiology, behavior, and habitat, all of which may lead to physiological stress and reduced survival rates” (Bash, 2001).

The result of turbidity can even affect stream temperature. The deposition of fines has been shown to decrease streambed connectivity and reduce the exchange of ground water and surface water across the stream bed. "Sediment may alter the dynamics of heating, cooling, and temperature buffering. The two-way exchange between the stream channel and the hyporheic zone is perhaps the most important buffer to high stream temperatures" (Poole and Berman 2001 referenced by Bash, 2001).

Interpreting the results of turbidity data is more difficult than collecting it. Natural background levels can differ by unique individual watershed processes and historical changes to the watershed. For examples, headwater streams tend to be less turbid than mainstems. Grab sample monitoring makes it all the more difficult to draw conclusions because it is only a single moment in time and does not give a complete picture over space and time. DEQ standards for turbidity are currently under revision. As DEQ reports, "The current turbidity standard is outdated and inadequate to fully protect Oregon's waters from potential effects from turbidity. The current provisions, adopted in 1976, require no more than a ten percent increase over natural background turbidity levels. At low natural turbidity levels that are prevalent in Oregon waters much of the year, a ten percent increase is within the error range of measurement and does not correspond with an impact on beneficial uses. In addition, the expression of the standard has made it challenging to implement across all of DEQ's water quality programs" (Appendix B) (Turbidity Rulemaking Fact Sheet, 2010). Appendix C: British Columbia Turbidity and Suspended Sediment Standards has been included to provide specific levels that experts view of concern for various beneficial uses.

For the purpose of this report we provide the percentage of grab sample readings at an individual site that exceed 10 NTU. This serves only as an indicator of sites that could use further investigation to determine if stream improvement projects might contribute to more favorable conditions for salmonids and other aquatic organisms.

pH Overview:

The negative logarithm of the hydrogen ion concentration of a solution is defined as pH with the scale from 0 to 14. This scale indicates the acidity or alkalinity of a solution, with pH 7.0 being neutral. As you climb the scale from 7 the solution becomes more basic or caustic. From 7 down the scale to 0 it becomes more acidic. In a logarithmic scale, each whole unit of incremental change is equal to a ten-fold increase or decrease in acidity or alkalinity. See Appendix D for a scale indicating the pH of common products.

The equipment used to measure pH consists of a meter and an electrode. The electrode measures the amount of positive hydrogen ions in the water by running a very low electric current through the water. The electrode placed in the stream then develops an electrical potential that is proportional to the pH of the solution. A reference electrode is needed to complete the circuit and provide a stable reference potential. The voltage is then passed to the meter, amplified, and converted to the pH scale. Because temperature influences the electrical potential of pH electrodes, pH probes must be equipped with a thermometer and automatic temperature compensation. Inaccuracy can be a problem when measuring low ionic strength waters common in the Umpqua. Ions need to be present in order to pass the low electric current. PUR purchased a special pH probe from YSI that is made to work in low ionic strength streams. This not only increases the accuracy, but also reduces the time for the equipment to become stable when moved from one stream to the next.

The following is DEQ's pH criteria for the Umpqua Basin, a summarization from the 303(d) Listing criteria at http://www.deq.state.or.us/wq/assessment/docs/methodology0406.pdf

Parameter	Criteria	Assessment Method	Data Requirements
pH	$6.5 \leq pH \leq 8.5$ Estuarine and fresh waters	Greater than 10 percent of the samples are outside the range of the appropriate criterion and a minimum of at least two samples outside the range of the appropriate criterion for the time period of interest.	A minimum of 5 representative data points available per site collected on separate days for each time period of interest Time periods are Summer: June 1 through September 30; Fall-Winter-Spring (FWS): October 1 to May 31

Table 3: DEQ pH criteria for the Umpqua Basin

Evaluating grab sample pH data is difficult. As with other parameters, grab samples provide only a momentary snap-shot. Levels of pH cycle daily and seasonally. Photosynthesis of aquatic plants during the day takes the sun's energy and consumes carbon dioxide (an acid) producing a base - hydroxide. Therefore, during the day, pH levels become more basic (rise). At night the reverse occurs and plants respire releasing carbon dioxide making the waters more acid; peaking just before dawn. During summer there can be increased plant growth and nutrients that greatly increase this diurnal affect. Increasing acidity can have additional affects because it acts as a solvent and may leach toxic metals from sediments and substrate depending on local conditions. An unexplained change in pH might be an indication of contamination of the water by possible toxic materials from a spill or urban runoff and should be investigated.

Streams tend to have a narrow range of pH values that typically fall between 6 and 9. The level of the pH in freshwater streams is important for all forms of wildlife and humans. Aquatic organisms generally prefer a pH range between 6.5 and 8.5 and suffer when the pH lies outside this range. It is important to have safe pH ranges for juvenile development. "Chronic effects from low pH can occur at levels that are not toxic to adult fish but that impair reproduction including altered spawning behavior, reduced egg viability, decreased hatchability and reduced survival of the early life stages" (Carter, 2008). Persistent high pH levels can be harmful to salmonids by reducing their activity and feeding levels. Extremely low or high levels can even cause death.

Dissolved Oxygen Overview:
Oxygen is as necessary to aquatic life as it is to life on land. The amount of oxygen found in water is called dissolved oxygen (DO). Many factors influence how much oxygen water can contain as well as how it gets there. Temperature (oxygen is more soluble at colder temperatures), atmospheric pressure (increasing altitude results in less pressure and therefore less ability of water to hold dissolved oxygen), and salinity (increasing salt concentration results in lower DO) all affect DO. Turbulent water can also increase DO as does photosynthesis of

aquatic plants during the day. At night, aquatic plant respiration consumes the DO. Decomposition of organic matter also uses up dissolved oxygen. Once again grab sampling can only provide a snap-shot of that moment in time of day, season of year, and current stream condition.

Appendix E contains DEQ's flow chart depicting the evaluation process to determine which dissolved oxygen criteria would apply to any particular water body. Though not as thorough, it easier to understand in the following summarization from the 303(d) Listing criteria at http://www.deq.state.or.us/wq/assessment/docs/methodology0406.pdf

Parameter	Criteria	Assessment Method	Data Requirements
Dissolved Oxygen	*Spawning*: DO ≥ 11.0 mg/l or 95 % saturation; *Cold-water:* ≥ 8.0 mg/l or 90% as an absolute minimum; *Cool-water*: ≥ 6.5 mg/l; *Warm-water*: 5.5 mg/l.	For 10 or more samples greater than 10 percent of the samples may not exceed the appropriate criterion and a minimum of at least two exceedances of the criterion for the time period of interest. For 5 to 9 samples in the time period of interest, there may be no exceedances of the appropriate criteria.	A minimum of 5 representative data points available per site collected on separate days per applicable time period. Applicable time periods and fish use available on DEQ's Water Quality Standards web page.

Table 4: DEQ Dissolved Oxygen criteria for the Umpqua Basin

Dissolved oxygen is critical at all life stages of salmonids but, as is indicated in the criteria during time of spawning, there is the greatest need for high DO for survival of the eggs placed in the gravel. Without 11.0 mg/l egg development will be impaired or stopped altogether. Reduced DO concentrations can adversely affect swimming performance of migration salmonids. Sustained swimming speed dropped sharply when DO fell to 6.5-7.0 mg/l (Bjornn T. a., 1991 pg.85).

PUR began DO analysis using a Hach DO Kit which employs the Winkler chemical titration method. Since obtaining the YSI Sonde multi-parameter instrument we are now using an optical probe to measure DO concentrations. YSI's ROX probe detects oxygen when it interacts with a luminescing sensing element and the change in luminescence is recorded. It is easily calibrated using either air-saturated water or water-saturated air and inputting the local barometric pressure. In 2008 PUR began monitoring dissolved oxygen, conductivity, turbidity and pH with this probe in place of the previous methods (See pages 9-10). We ran duplicate samples for a year comparing the Winkler/Hach method to the optical YSI probe. It became apparent that the YSI probe consistently ran about .4 mg/l higher. We discussed this with Steve Hanson at DEQ who indicated that this might well be due to the Hach chemical packet method as the Hach Kit appeared to give lower readings than DEQ's wet chemical method. The all YSI probes were comparing well with split sampling with DEQ.

Conductivity Overview:
Conductivity is a measure of water's ability to conduct an electric current. It is measured in units of current called microsiemens (µS) per centimeter (cm) or µS/cm. Conductivity increases with the amount of dissolved ions present in water and with increasing temperature. Conductivity probes come with a built in temperature probe and software that corrects the reading for the effect of temperature, normalizing conductivity to 25°C. This is then called specific conductance. Conductivity varies 2% with each 1°C change in temperature. Conductivity is affected by the natural local conditions/geology. Because it is a measure of the ions dissolved in the water, conductivity increase in areas with soils that will dissolve easily such as clay soils. Increases in conductivity may be an indication of human influences, such as leaking septic systems or spills of substances containing salts (ionic compounds, not just sodium chloride) that reach the streams. There are many types of soluble salts that increase conductivity when they are dissolved in water. Examples include potassium chloride, calcium chloride, and magnesium chloride. Acids and bases will also increase the conductivity of a solution. Organic compounds have a very low ability to conduct current, so substances like oil, and sugar have a very low conductivity.

The largest body of water on earth, the ocean, has an extremely high conductivity reaching 53 mS/cm – that is <u>millisiemens</u> per centimeter not microsiemens which is 1000 times more conductive. On the other end of the scale pure water has a conductivity of 0.055 µS/cm and typical city water is around 50 µS/cm. Because the Umpqua Basin extends all the way to the Pacific Ocean, the levels in its waters range from less than 100 µS/cm to 53,000 µS/cm with tidally influenced streams varying dramatically in the course of a day. Small, non-tidally influenced, streams can demonstrate quite different conductivity levels that are seasonally affected. As a small stream reduces its flow and starts to go dry, it may demonstrate an increase in conductivity as its natural salts and minerals become concentrated in the little remaining water. During winter rains the conductivity may be reduced due to the increased volume of the rainwater. However, in storm events the surface water runoff may increase conductivity readings.

There are no established standards for conductivity; however, "Conductivity is useful as a general measure of stream water quality. Each stream tends to have a relatively constant range of conductivity that, once established, can be used as a baseline for comparison with regular conductivity measurements. Significant changes in conductivity could then be an indicator that a discharge or some other source of pollution has entered a stream." "Studies in inland fresh waters indicate that streams supporting good mixed fisheries have a range between 150 and 500 uS/cm" (EPA, 2012).

***E. coli* Overview:**
E. coli is monitored as an indicator species of bacteria. It would be extremely difficult and expensive to monitor for many of the organisms that carry disease. Therefore only *E. coli* was chosen for monitoring because its presence is an indication of fecal contamination and a warning that other pathogens may also be present. It can also be an indicator that best management practices of livestock are not being observed, of failing septic systems, of a large

concentration of warm-blooded wildlife contaminating the water, or of a malfunctioning or overloaded wastewater treatment plant.

E. coli is easily measured with EPA approval by using the protocol and supplies from IDEXX Laboratories, Inc. A sample is collected in a sterile 100 milliliter (ml) bottle, kept on ice, and returned to a laboratory for analysis. The results are expressed in terms of a most probable number (MPN) of *E. coli* organisms in a 100 ml sample. The standard is a little difficult to comprehend, but a level greater than or equal to 126 MPN/100 ml determined five times in a 30 day period could cause a stream to be listed. A single reading greater than 406 MPN/100 ml could also trigger a listing.
The 303(d) Listing criteria for *E. coli* by Oregon Department of Environmental Quality listed at http://www.deq.state.or.us/wq/assessment/docs/methodology0406.pdf is shown below. The national Environmental Protection Agency uses a more conservative, lower criteria of 235 MPN/100 ml. In this report we will indicate both the 406 and the 235 criteria for comparison. The 235 MPN/100 ml criteria will be used as an indicator for evaluating streams in need of further investigation.

	Criteria	Assessment Method	Data Requirements
Bacteria - *E. coli (Escherichia coli)*	30-day log mean ≤ 126 *E. coli* MPN/100 ml on a minimum of 5 samples.	A 30-day log mean of 126 *E. coli* organisms per 100 ml.	A minimum of 5 representative data points available per site collected on separate days for each time period of interest. Time periods are Summer: June 1 through September 30; Fall-Winter-Spring (FWS): October 1 to May 31
Bacteria - *E. coli (Escherichia coli)*	No single sample may exceed 406 *E. coli* organisms per 100 milliliters.	When more than 10 samples are available, listing occurs if greater than 10% of the samples exceed 406 *E. coli* organisms per 100 ml, with at least two exceedances. If data from 5 to 9 samples are available, any exceedances of 406 *E. coli* organisms per 100 ml result in listing.	A minimum of 10 representative data points available per site collected on separate days for each time period of interest. Time periods are Summer: June 1 through September 30; Fall-Winter-Spring (FWS): October 1 to May 31

Table 5: DEQ *E.coli* criteria for the Umpqua Basin

Temperature Overview:
Stream temperature is an important factor affecting all aquatic organisms including fish. For salmonids (salmon and trout), which are coldwater fish, healthy growth is supported by water temperatures ranging from 40-66°F, outside this range they generally don't grow in size and extreme temperatures can be lethal (The Oregon Plan for Salmon and Watersheds, 1999, pp. 6-1). These temperature extremes can affect every life stage of the salmonids (Bjornn & Reiser, 1991, pp. 106, 112). Temperature and dissolved oxygen (DO) are inversely proportional, therefore, as stream temperature increases the amount of DO available decreases (The Oregon Plan for Salmon and Watersheds, 1999, pp. 6-1). Decreases in DO may metabolically stress

salmonids and also increase the likelihood of disease (The Oregon Plan for Salmon and Watersheds, 1999, pp. 6-1) (see DO section for a discussion of DO results for this study).

As water temperature increases to stressful levels, salmonids seek cold water refugia (The Oregon Plan for Salmon and Watersheds, 1999, pp. 6-1) and (Nielsen, Lisle, & Ozaki, 1994). Extremely high water temperatures can be lethal to coldwater fish. One study found the upper lethal limits for steelhead was 75.0°F and for cutthroat trout was 73.0°F (Bell, 1990, p. 11.4). The upper lethal limit for young coho salmon and Chinook salmon acclimated to 70°F was 78.8°F, measured as 50% mortality after 16.7 hours (Brett, 1952, pp. 282-3). Many of our monitoring sites exceeded these potentially lethal temperatures for steelhead and cutthroat and some even exceeded the higher lethal temperatures for coho and Chinook. However, unlike in these lab studies, in natural streams there is diurnal temperature fluctuation associated with night cooling, so these high stream temperatures are not sustained.
The driving factors for stream temperature are stream characteristics, such as flow and surface area, and radiant energy; the most important source being solar radiation. Solar radiation is reduced by shading and cloud cover and increased by solar input, which is often reflected by higher air temperatures. Streams in the Umpqua basin have been anthropogenically altered by removal of riparian vegetation, water withdrawals, and altered stream characteristics.

Since cloud cover and air temperatures vary daily and annually, there is also annual variability in stream temperatures and in seven day average maximum (7DAM) stream temperatures. Stream temperature increases as it flows downstream due to decreased shading as the stream widens and increased surface area (Murphy & Meehan, 1991, pp. 35-36). In addition stream temperatures may increase lower in the watershed due to a decreasing portion of cooler ground water inflow and increasing air temperature at lower elevations. The Umpqua Basin Stream Characterization project continuously monitored 269 stream temperature sites in the Umpqua basin from 1998 to 2001 and found a relationship between the sites distance to the drainage divide and the 7DAM stream temperature (Smith, K., 2003, p. 3). When graphed comparing miles to divide vs. temperature, the lower edge of the data cluster would be considered optimal sites (Smith, K., 2003, p. 3). A line denoting these optimal sites for each sub-basin was figured and termed the cold limit line (Smith, K., 2003, p. 3). These cold-limit lines for the different Umpqua sub-basins (Smith, K., 2003, Appx. 1) were used to compare stream temperatures for sites along a stream as distance to divide increases. By comparing our data to this line, we are able to detect sites that are disproportionately above the line than other sites. This indicates conditions that might benefit from restoration practices to decrease stream temperature. Five reference streams in the Umpqua Basin Stream Characterization Project have been monitored for 12-13 years (Dammann, D.M., 2011, p. 3); that work is most currently funded through PUR under an OWEB grant (Project #210-2060). The 7DAM stream temperatures of these sites have varied annually between 6.1 to 8.3°F depending on the site during the 12-13 year period of record (Appendix F). During the years of this study (2005-2010) the 7DAM stream temperature of the reference sites varied between 5.0 to 7.4°F depending on the site. This annual variability complicates the comparison of stream temperatures, especially when there is a short or inconsistent period of record.

Continuous Temperature:

Continuous summer temperatures were monitored from 2005-2010 using the protocol in the Water Quality Monitoring Technical Guide Book (The Oregon Plan for Salmon and Watersheds, 1999, pp. 6-1 to 6-12). A total of 38 sites were monitored by PUR staff and volunteers for this project. Sites varied by year, with the number of years monitored varying from one to six years depending on the site. Onset water temperature recorders (Tidbit, Hobo, or Tidbit v2 models) were placed in streams in late spring or early summer and retrieved late summer or fall depending on flows and logistical concerns. Water temperature recorders were tied to rocks to prevent movement of the devices and hidden in the streams. Careful site selection was made to ensure there would be flow and good mixing (not stagnant) at the site in late summer when flows are the lowest in order to ensure the site would be representative of the stream at that location.

Prior to stream placement of water temperature recorders, pre-deployment accuracy checks were performed on all devices according to established protocols (The Oregon Plan for Salmon and Watersheds, 1999, pp. 6-5 to 6-7) and later modified by DEQ in2010. Water temperature recorders are placed in warm and ice water baths comparing temperatures to National Institute of Standards and Technology (NIST) certified VWR Traceable Digital Thermometers that are inspected annually for accuracy by the DEQ Lab. Post-deployment accuracy checks are completed after retrieval of the water temperature recorders using the same method. Field accuracy checks are also conducted comparing NIST certified VWR Traceable Digital Thermometer temperatures to that of the water temperature recorders, when possible, at the time of deployment, mid-season, and at the time of retrieval. Care is taken to check the temperature with the digital thermometer near the location of the water temperature recorder.

Representativeness of Data:

Though our data will be compared from site to site, month to month and year to year, it must be stated that, except for the continuous temperature data, all water quality data are from grab sampling. As much as was possible, sampling runs were conducted at the same time of day and in the same direction, upstream or downstream, as previous runs. By taking monthly measurements it was possible to get some indication of annual changes, but even these monthly changes can be greatly affected by diurnal changes. Streamflow, pH, dissolved oxygen, trace elements, nutrients suspended particles as well as temperature are known to vary greatly over the course of a 24 hour period. Many of these changes are due to the effect of the sun either directly or indirectly – weather changes, seasonal changes, photosynthesis, rainfall, snowmelt, and streamflow. Other changes can be caused by human influence, such as the release of effluent from waste water treatment plants, release of water from reservoirs and irrigation withdrawals. “The amplitude of the diel changes can be as large as changes occurring on annual timescales” (Nimick, Gammons, & and Parker, 2011). Certainly, it would have been ideal to deploy data loggers for all water quality parameters and monitor 24 hours a day. With only one multi-parameter probe available, this would have severely limited the number of sites that could be monitored. Thus, we settled for grab sampling and report the data for what it is; a snap shot of water quality conditions at a particular place at a specific time. Data exceeding ODEQ standards is reported but conditions producing these exceedances may very well have occurred far more often than just at the time of our grab sampling.

WATER QUALITY DATA ANALYSIS

All grab sample data was entered into ODEQ's Volunteer Water Quality Grab Sample Data Submittal Excel Spreadsheet which is available for download from their website (www.deq.state.or.us/lab/wqm/volmonresources.htm).
"The workbook contains two required worksheets. 1) **Worksheet1: Project Information-** This required worksheet includes specific project information needed to add the data into the DEQ LASAR database. 2) **Worksheet 2 Raw Data-** This worksheet contains all the fields needed to describe monitoring stations and result values in LASAR. The first six rows describe the monitoring location. The date and time define when the site was visited. The remaining rows are for entering the raw data results and all the information needed to describe each result in LASAR--including data quality. Each parameter has a family of 6 or 7 columns containing information needed for upload to LASAR: result value, duplicate value, precision, accuracy (not for all parameters), data quality level, method and parameter comment" (DEQ, 2010).

Only data which ranked as "A" or "B" quality was included for analysis in this report. (See Appendix G) Almost all of the data was "A"; in only a few cases was the data rated "B." Graphs were produced to compare individual sites and temporal changes. Box plots were used to summarize individual sites over the course of the period of record. (See Appendix H: Interpreting a Box Plot for help in understanding box plots.) For this report we did not discard any "outliers"; the data was carefully reviewed and notes recorded at the time of sampling considered. It was felt that particularly low or high values were real and denoted a natural occurrence that was indicative of the particular watershed. Scatter plots were used to display sites' values over time and compared to DEQ standard criteria. Site values were summarized and presented in a table, when there was enough data to warrant doing so, by percent of measurements exceeding the parameter's standard criteria. For this report two time periods were used: 1. June through September and 2. October through May. This differs from the often used Summer (June, July, August) and Fall/Winter/Spring (September through May) that others have employed. The weather conditions in the study area seem to lend themselves to this division as the month of September lends itself to inclusion as a summer month far better than skewing the Fall/Winter/Spring grouping with the warm September conditions.

Continuous Temperature:

All continuous temperature data collected were downloaded from the water temperature recorders with Onset's Boxcar or HOBOware Pro software and summarized using Microsoft Excel software and ESRI ArcGIS. Continuous temperature data was compared to ODEQ temperature criteria for continuous summer temperature (ODEQ, 2011, p. 46) and Figure 320A & 320B (ODEQ, 2003) See Appendix I and J, using ODEQ's Temperature macro (for Microsoft Excel software) modified by Kent Smith for Excel 2007/2010 and for ODEQ's current temperature criteria (ODEQ, 2011, p. 46). All pre-deployment accuracy checks, post-deployment accuracy checks, and field audits were compiled on ODEQ's ExampleContinuousSample.xls workbooks (ODEQ, 2009) and submitted to the ODEQ lab. All data except one site were A quality (+/- 5°C) as per DEQ criteria (DEQ, 2010). The one site that was not A quality will be discussed in the appropriate result section.

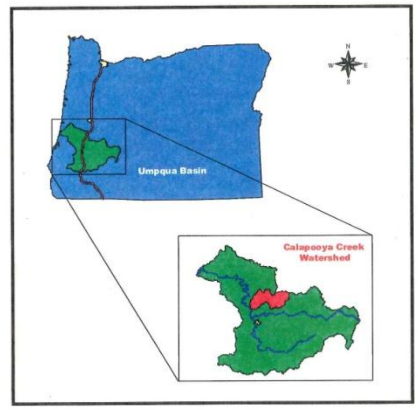
In the analysis, degrees Fahrenheit were chosen as the unit of temperature instead of degrees Celsius because PUR works with partners that use Fahrenheit as the standard of measure. For ease of communication to the public, and greater understanding, degrees Fahrenheit were chosen as the unit of measure.

Data was compared to that collected from a previous PUR large scale basin wide temperature study, Umpqua Basin Stream Temperature Characterization Project (Smith, K., 2003) and annual updates 2005-2010 (Smith, K., 2005), (Dammann, D.M. and K. Smith, 2006), (Dammann, D.M., 2007), (Dammann, D.M., 2008), (Dammann, D.M., 2009), and (Dammann, D.M., 2010).

Water Quality Monitoring Results

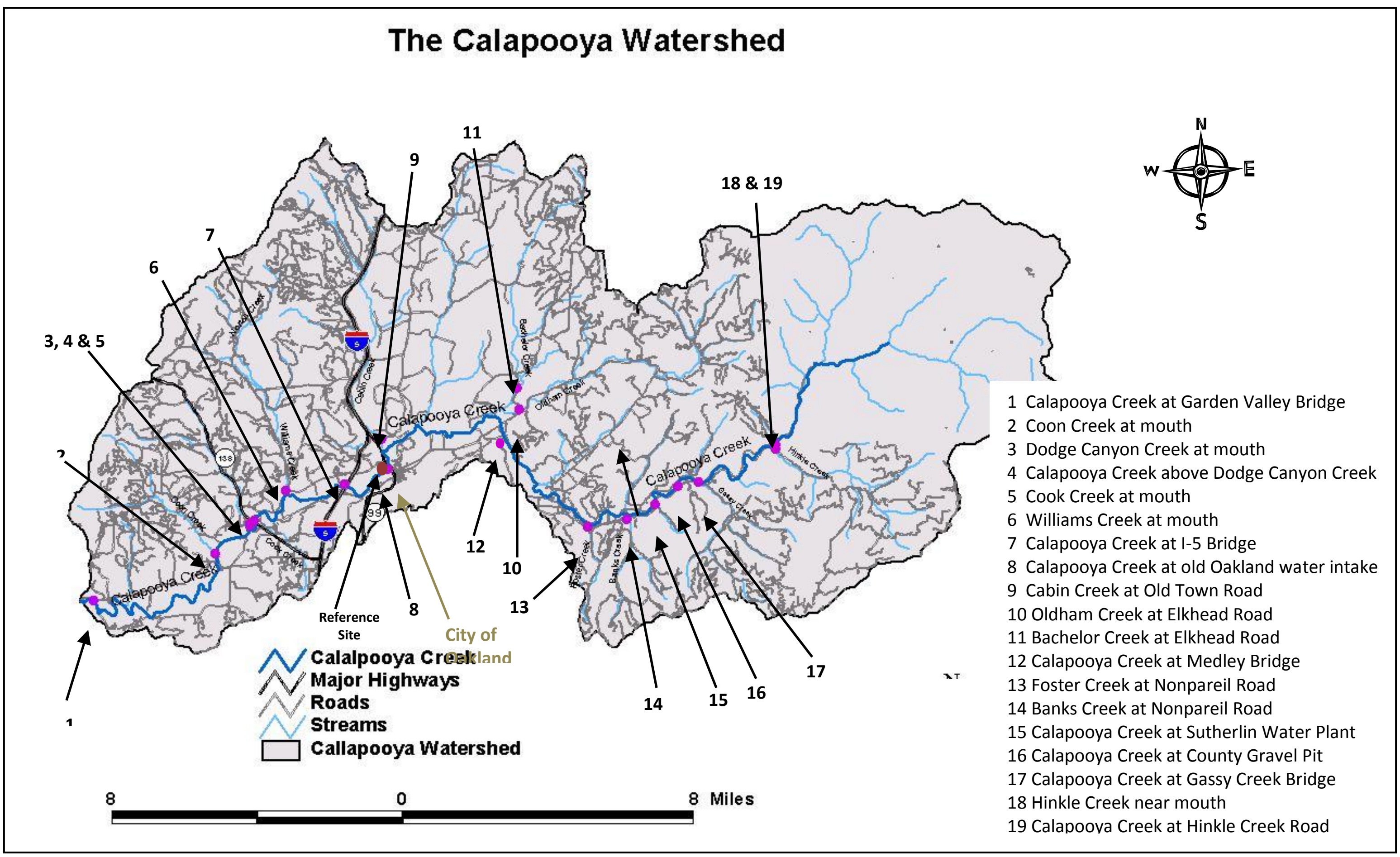
CALAPOOYA CREEK AREA

Area Description, Background & Monitoring Sites



The Calapooya Creek fifth-field watershed is located in Douglas County, Oregon and is 157,281 acres. The watershed stretches a maximum of 13 miles north to south and 27 miles east to west. There are three highways within the western portion of the watershed: Interstate Five (I-5), Highway 99, and Highway 138. The City of Oakland is entirely within the watershed boundary. The northwestern section of Sutherlin is also within the Calapooya Creek Watershed (Geyer, Calapooya Creek Watershed Assessment and Action Plan, 2003).
Calapooya Creek is a major tributary of the upper mainstem Umpqua and enters the mainstem about river mile 102.The lower 30 miles of creek pass through mostly agricultural land, although there are several minor communities as well as the city of Oakland. Oakland and Sutherlin draw their drinking water from the Calapooya as well as discharging treated waste water into it.

Figure 3: Calapooya Watershed Water Quality Monitoring Site Map



This project was UBWC's first volunteer monitoring effort. Janice Green, of Umpqua, had long waited UBWC's expanding its undertakings to include water quality monitoring. With the hiring of a monitoring coordinator in late 2003, Janice was quick to suggest monitoring begin in the Calapooya and Myrtle Creek watersheds, which had been known to be major contributors to diminished water quality; this was even quite visually evident – see Photo #1 below.

A quality assurance project plan (QAPP) was written by Janice Green, with Sandy Lyon's technical help, and received approval by DEQ. The purpose of this project was to better characterize the negative contributions of various tributaries of the lower Calapooya Creek, thus indicating potential design and placement of remediation projects or targeting of such activities as community education (Green, 2004). Janice worked closely with David Swenson, an Oakland middle school science teacher, to bring our monitoring efforts and results to Dave's middle school classes, permitting them to better understand their own watershed.

Photo #1: Calapooya Creek at Garden Valley Road near Umpqua

Photo #2: Janice Green and Oakland middle school students Monitoring at the Sutherlin water intake at Nonpareil.

The intent of this project was not to do long term monitoring, but to provide a quick snapshot of the Calapooya watershed which might be used in the TMDL process. Sampling was limited to three collection events: one in early summer, one late summer, and the final one taken in late fall. Site #1, the Calapooya at Garden Valley Road Bridge, will be included again with the Umpqua section of this report for comparison to sampling done at this site several years later.

RESULTS - Calapooya Creek Area
Temperature

Continuous temperature data loggers were not used for this short study but grab sample water temperatures were recorded with the other water parameters. No seven day moving average maximum temperature (7DMAM) was possible to evaluate whether sites met or exceeded (ODEQ) regulatory criteria, however it is apparent from the data (see Figure 5) that all of the sites with water present were well over 18°C (64.4°F) on August 30th. Fourteen of the sites exceeded the 64.4°F criteria on 6/29/04 as well. It is most likely that all sites would have had enough days at that temperature to have exceeded the standard listing criteria. Three of the sites were dry on the 30th of August, these were: Coon Creek at the mouth, Cabin Creek at Old Town Road and Banks Creek at Nonpareil Road. None of the streams reached the >25°C (77°F) marker of lethality for salmon on the days monitored, but it is quite clear that the temperature ranges recorded were sufficient to stress fish everywhere.

In 1999 Kent Smith with Insight Consulting conducted *The Calapooya Creek Stream Temperature Study* (Smith, 1999). This Umpqua Basin Watershed project was funded by grants from EPA and OWEB. Eight of the streams studied in 2004 had been studied for with continuous temperature data loggers in 1999. Seven of them exceeded the 7-Day Average Max criteria for temperature:

Site Name	Seasonal Maximum 1999		7-Day Average Max 1999	
	Date	°F	Date	°F
Calapooya Creek at mouth	7/13/1999	82.0	7/12/1999	80.0
Coon Creek at mouth	7/13/1999	74.2	7/12/1999	71.7
Dodge Canyon Creek at mouth	6/23/1999	65.3	8/27/1999	63.0
Williams Creek at mouth	7/13/1999	73.3	7/26/1999	72.0
Oldham Creek at Elkhead Rd	8/3/1999	81.1	7/31/1999	79.4
Calapooya At Driver Valley Road	8/10/1999	74.7	7/12/1999	72.6
Calpooya above Gassy Creek	8/28/1999	75.5	7/31/1999	73.5
Hinkle Creek at mouth	8/28/1999	66.6	8/26/1999	65.0

Table 6: Calapooya Creek and tributaries stream temperatures 1999 (Smith, 1999)

Although there are no 7DMAM values for our grab sample sites in 2004, it is apparent from Figure 4 that all of these streams are still exceeding temperature criteria and would benefit from riparian restorations that might reduce stream temperature. After the 1999 Study a reference site (the Calapooya above Cabin Creek) was measured each summer – see Figure 6. This data indicates that the 7DMAM values from 1999 through 2005 greatly exceeded the 64.4°F criteria and that the watershed is severely impacted by high summer stream temperatures.

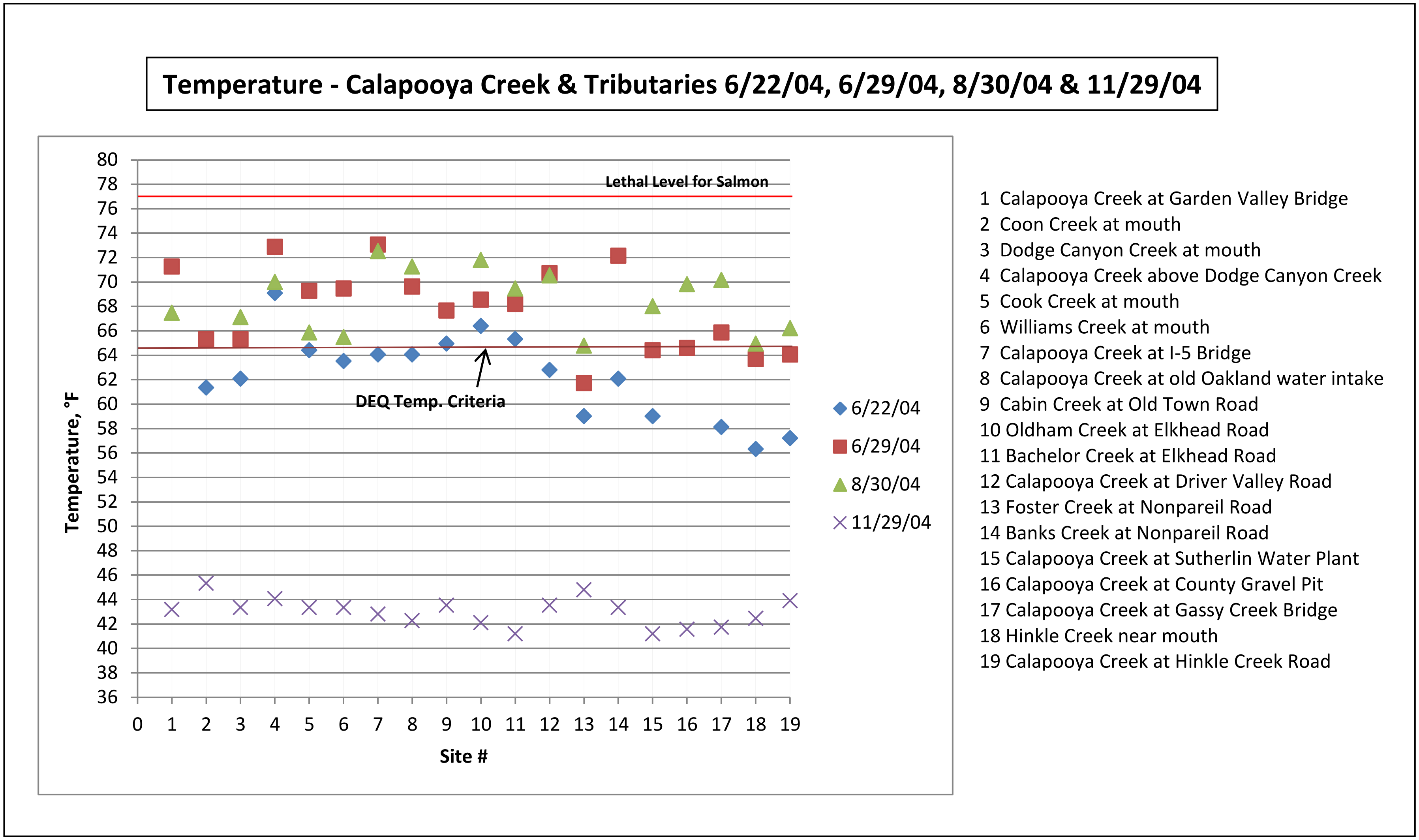


Figure 4: Grab Sample Temperature for nineteen sites in the Calalpooya Watershed, four events summer 2004

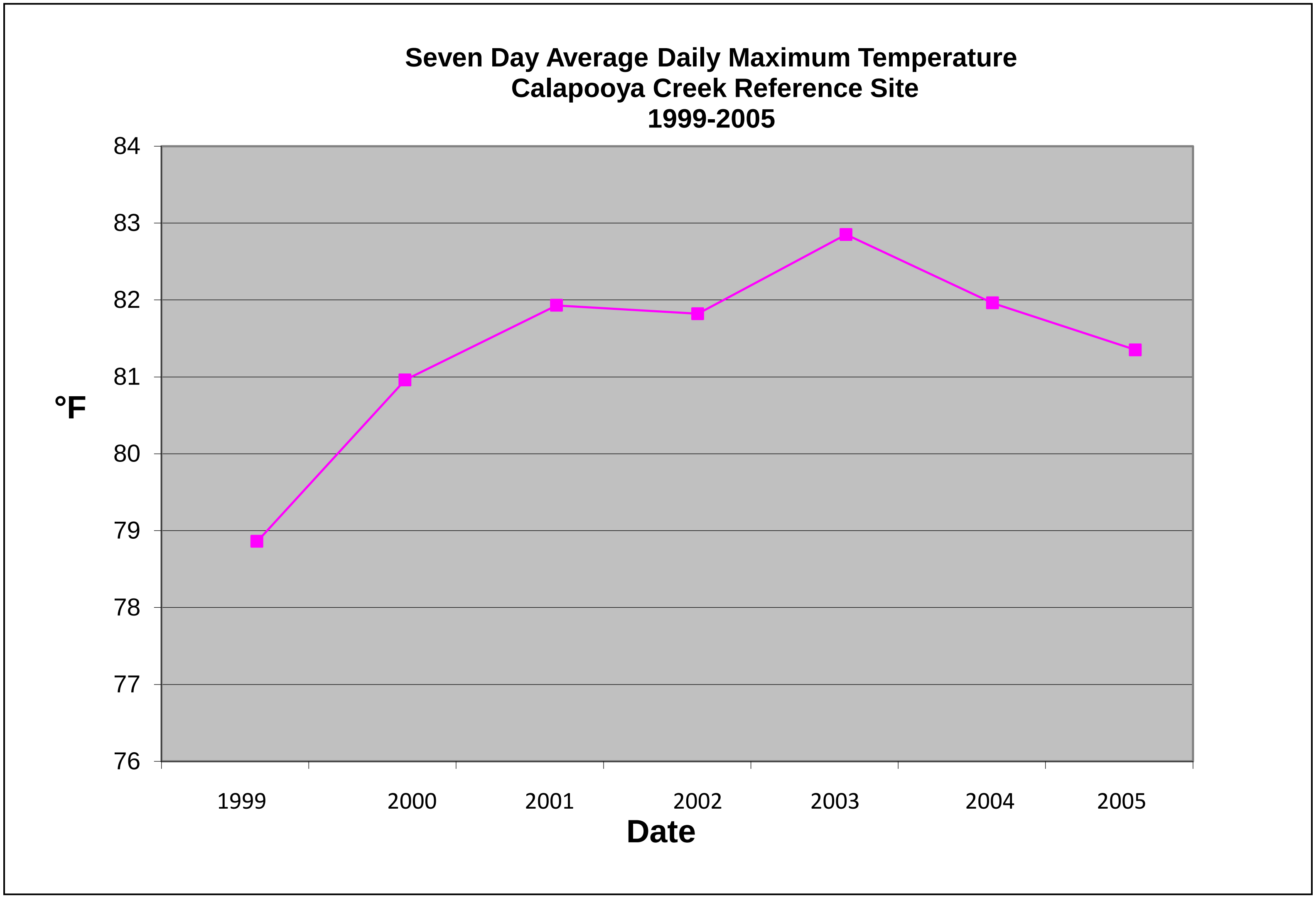


Figure 5: Continuous summer stream 7-day average daily maximum temperature at Calalpooya Creek Reference Study Site above Cabin Creek for years 1999-2005. This data is part of PUR's basin stream temperature study and 2005 update (Smith, K., 2003 and Smith, K., 2005).

RESULTS - Calapooya Creek Area
Turbidity

Seventeen of the nineteen sites monitored in the Calapooya Watershed in 2004 had turbidity levels <10 NTU which is ideal for salmon habitat. The mouth of Cook Creek however, greatly exceeded that level at all three monitoring events, two of which occurred during the summer and could not be attributed to rain events. On August 30, 2004, Williams Creek also exceeded 20 NTU (See Figure 8).

The site near the mouth of the Calalpooya at Garden Valley Road (see Figure 6) was also monitored as part of the Umpqua Study 2009-2010 included in this report. Of the 17 monitoring events, 35% (six) turbidity readings exceeded 10 NTU. All of these occurred during the winter or spring.

From these preliminary investigations it appears that some tributaries have turbidity issues during the summer and that the Calapooya Creek itself is quite turbid, exceeding levels of acceptability for salmon during the winter.

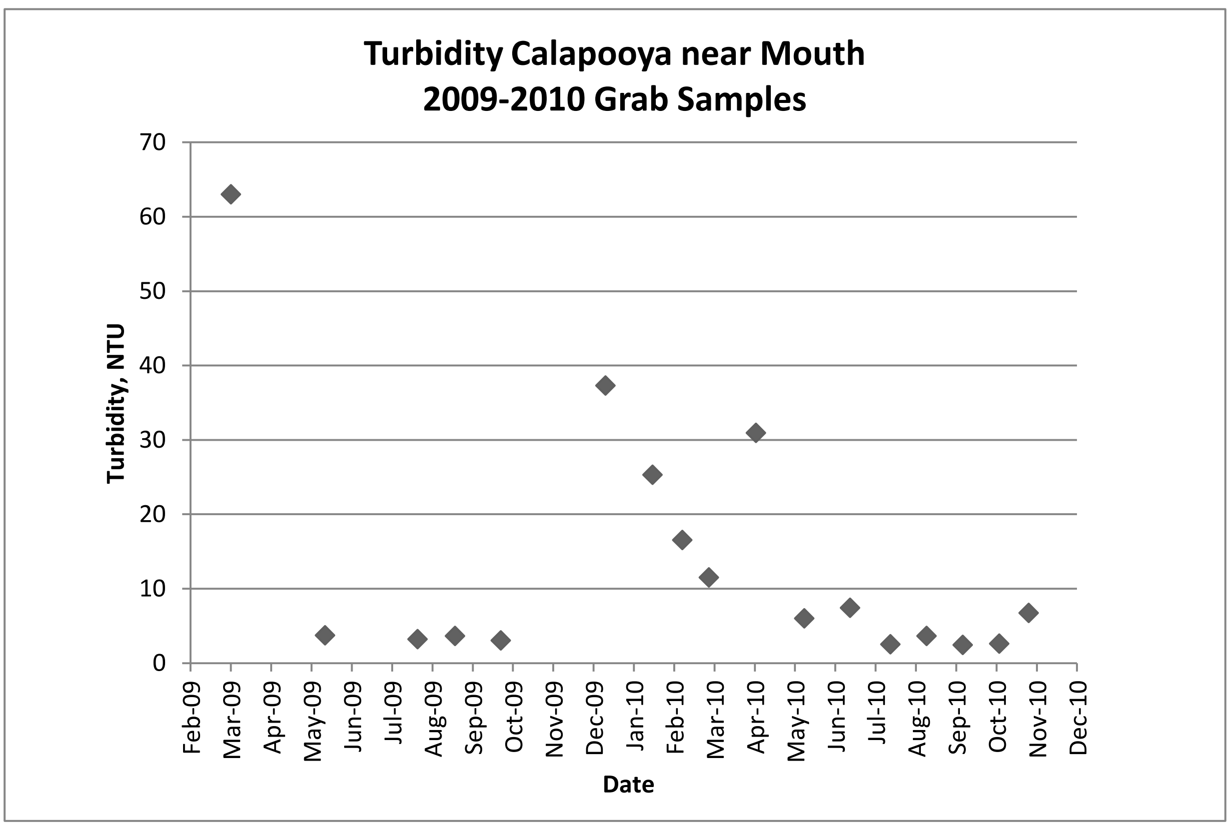


Figure 6: Stream Turbidity Calapooya Creek near mouth 2009-2010

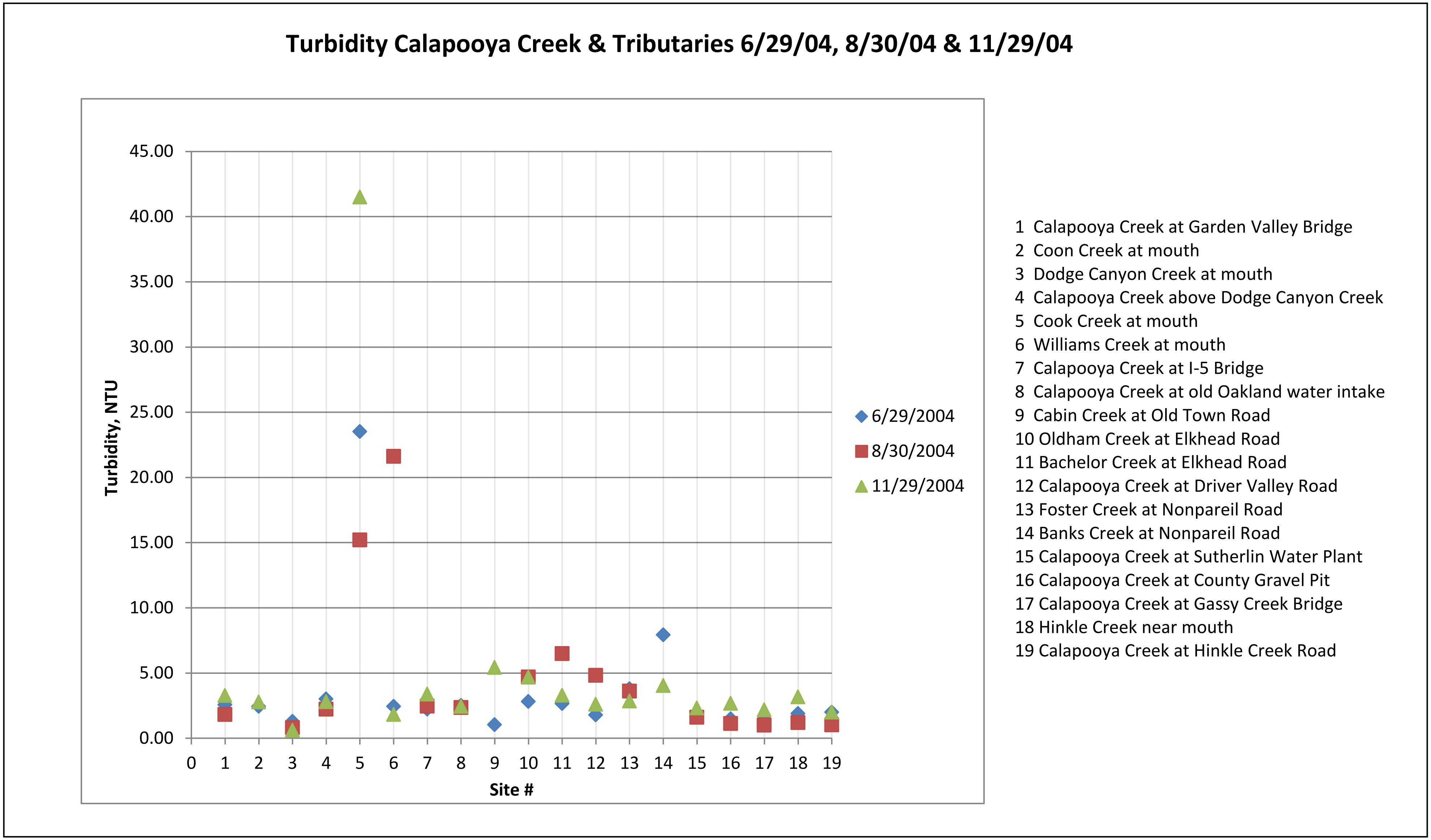


Figure 7: Stream Turbidity 19 sites within the Calapooya Creek Watershed - 6/29/2004, 8/302004,11/29/2004

RESULTS - Calapooya Creek Area
Dissolved Oxygen

Two of the dates that monitoring was conducted, in 2004, in the Calapooya Watershed (6/29 & 8/30) fell within the time period for Non-spawning Criteria (May 16 to October 14). Dissolved Oxygen levels for this period need to be greater than 8 mg/l for salmon. Both Cook Creek and the Calapooya at Garden Valley Road failed to meet criteria on both dates. Dodge Creek, Williams Creek, Cabin Creek, and the Calapooya at the Old Oakland water intake all failed to meet criteria one time each. This resulted in 21% of the monitoring events resulting in failure to meet the Non-spawning criteria. The 11/29/04 monitoring event fell within the Spawning criteria requiring DO to be greater than 11 mg/ml. Dodge Canyon Creek, Cook Creek and Cabin Creek failed to meet the criteria for 10.5% failure.

The site near the mouth of the Calapooya at Garden Valley Road was also monitored as part of the Umpqua Study 2009-2010 (see Figure 8). Two out of ten measurements the summer criteria of dissolved oxygen was below 8 mg/l; thus 20% did not meet criteria. The winter criteria of needing to exceed 11 mg/l failed to be met six out of eight times for a failure rate of 75%.

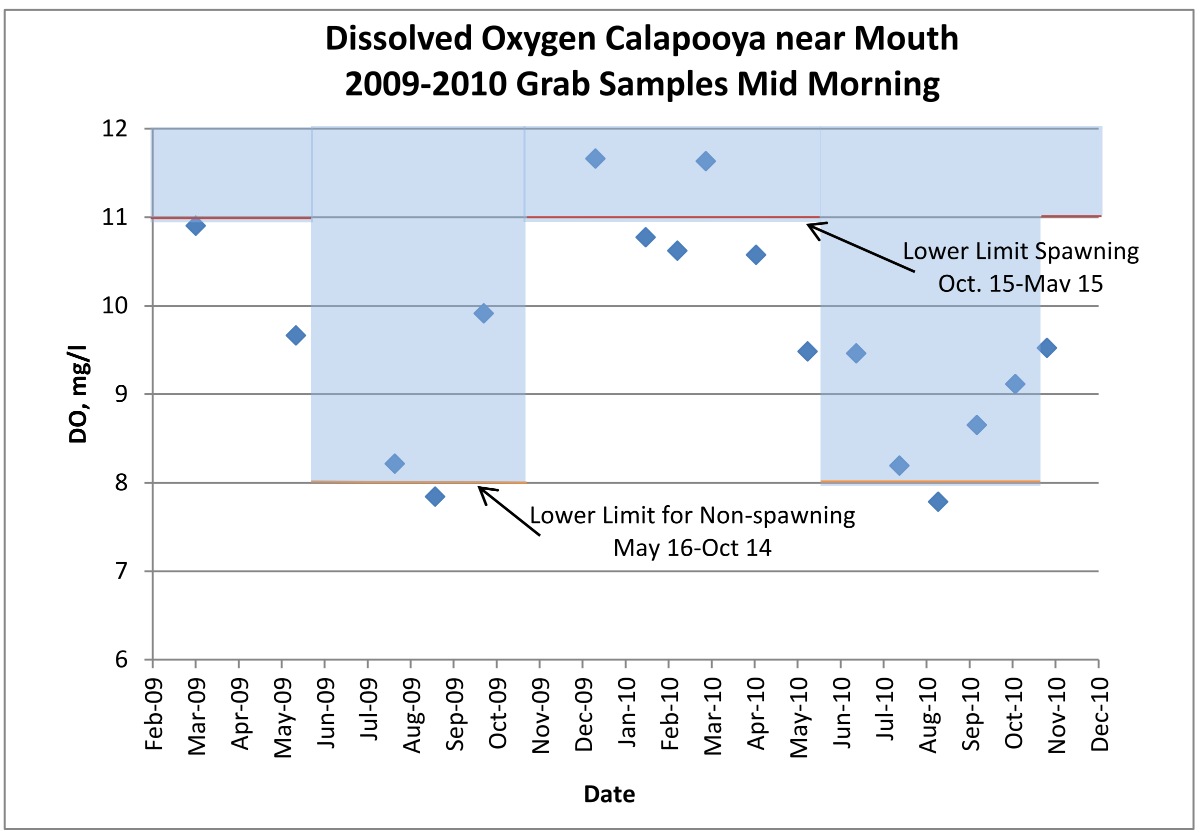


Figure 8: Dissolved Oxygen Calapooya Creek near mouth 2009-2010

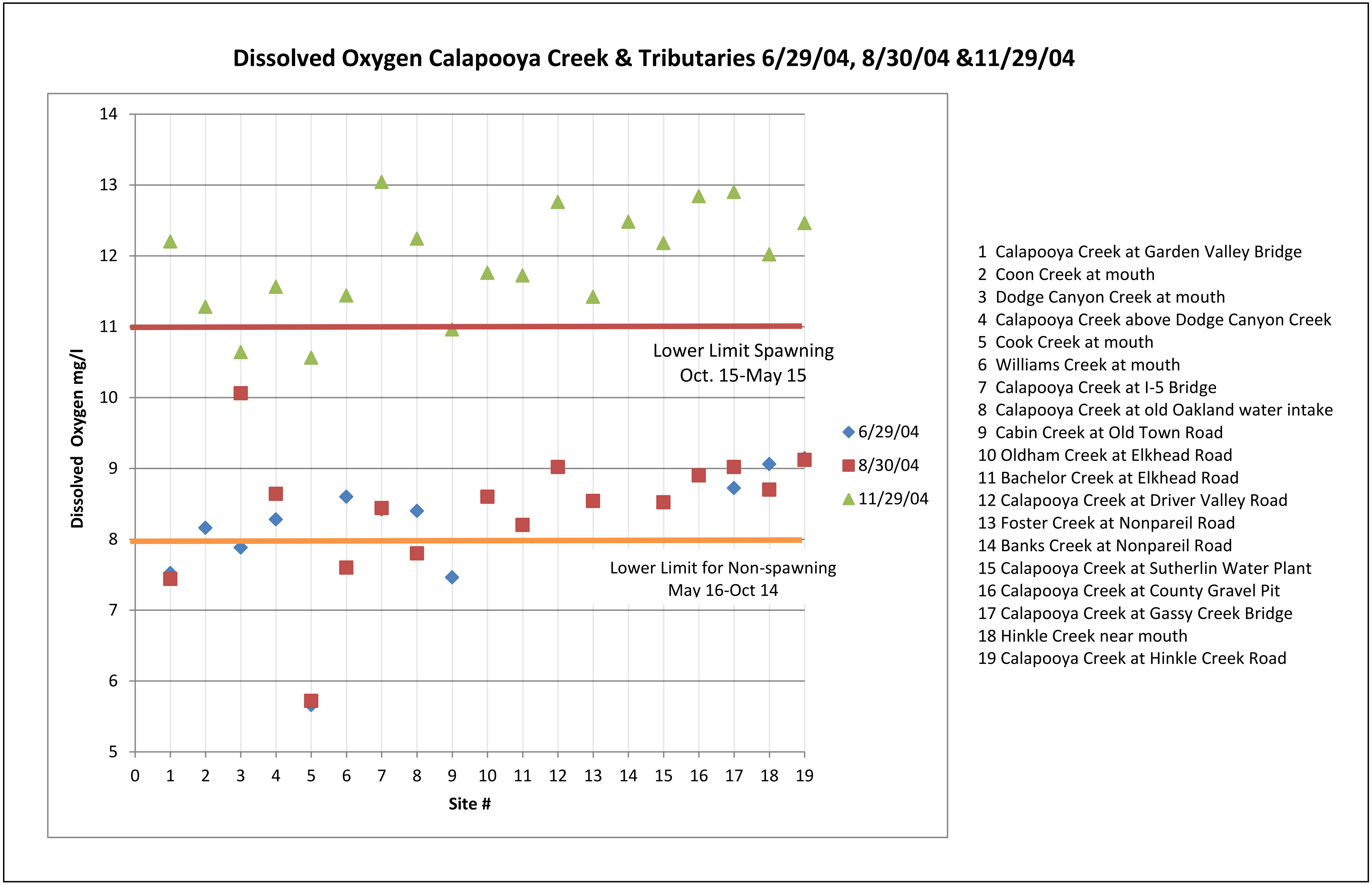


Figure 9: Stream Dissolved Oxygen 19 sites within the Calapooya Creek Watershed - 6/29/2004, 8/302004,11/29/2004

RESULTS - Calapooya Creek Area
E. Coli

Out of 53 samples analyzed over three days of sampling (see figure 12), 12 (22.6%), exceeded the EPA Criteria for *E. Coli.* Ten exceeded DEQ's Criteria resulting in 19% of the samples. Cook Creek exceeded criteria all three sampling events; Williams Creek exceeded on 2 sampling events; and Coon Creek, Dodge Creek, Cabin Creek, Oldham Creek, Banks Creek, and the Calapooya Creek at Garden Valley Road (near the mouth) all had one each. None of the other seven sites on the Calalpooya that were higher in the watershed recorded any high levels on any of the three sampling events.

The site near the mouth of the Calapooya at Garden Valley Road was also monitored as part of the Umpqua Study 2009-2010 (see Figure 10). Out of 17 sampling events four (23.5%) exceeded EPA criteria for *E. Coli*, and two (11.8%) exceeded DEQ's Criteria.

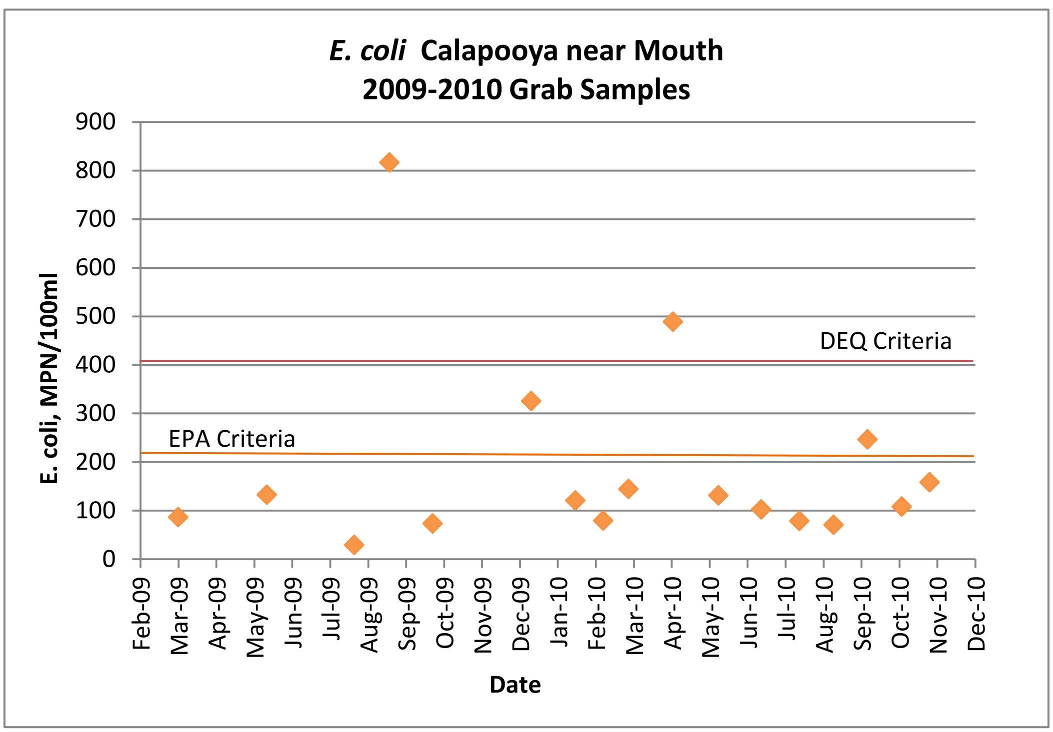
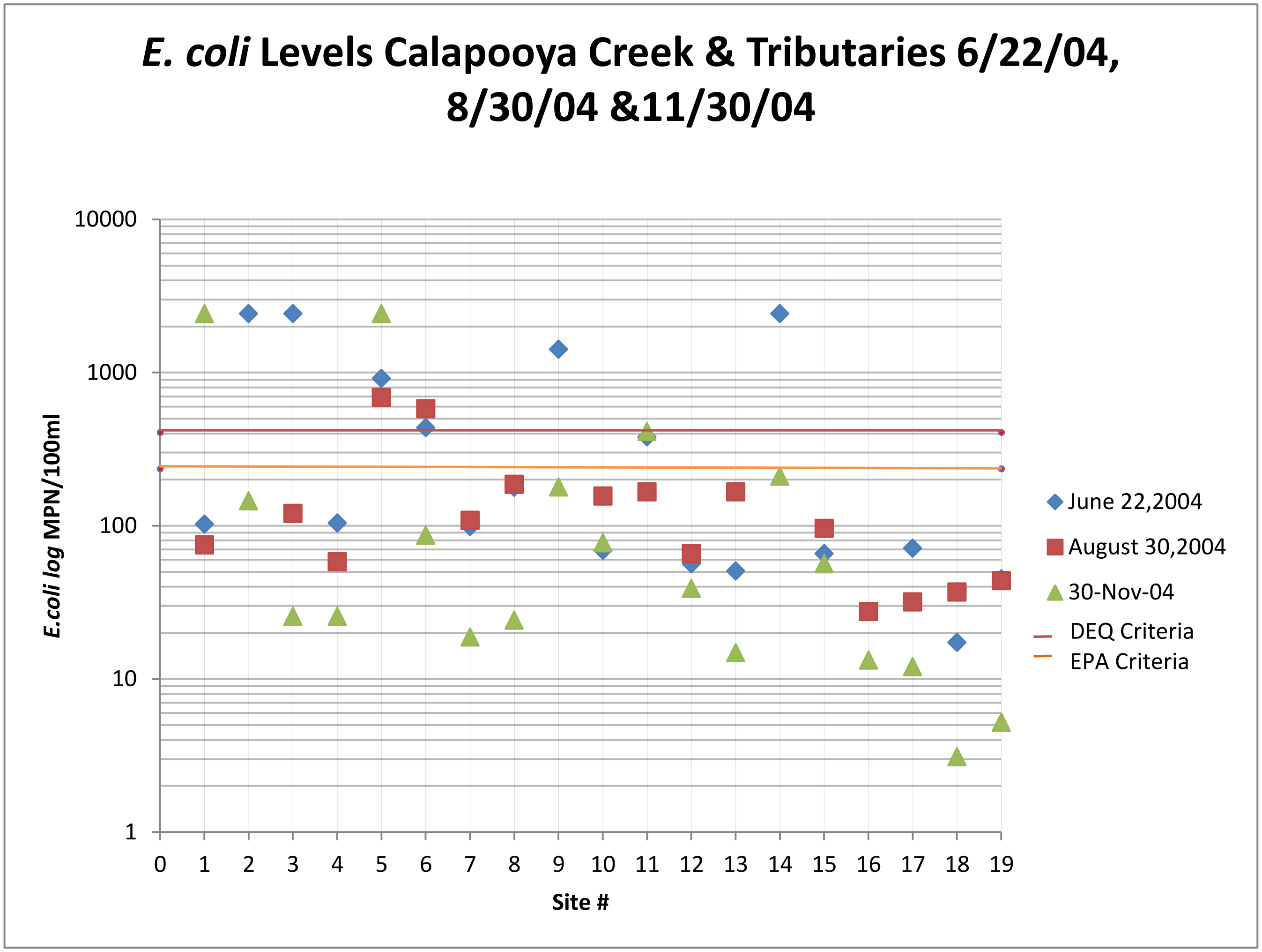


Figure 10: *E. coli* Levels Calapooya Creek near mouth 2009-2010



1 Calapooya Creek at Garden Valley Bridge
2 Coon Creek at mouth
3 Dodge Canyon Creek at mouth
4 Calapooya Creek above Dodge Canyon Creek
5 Cook Creek at mouth
6 Williams Creek at mouth
7 Calapooya Creek at I-5 Bridge
8 Calapooya Creek at old Oakland water intake
9 Cabin Creek at Old Town Road
10 Oldham Creek at Elkhead Road
11 Bachelor Creek at Elkhead Road
12 Calapooya Creek at Driver Valley Road
13 Foster Creek at Nonpareil Road
14 Banks Creek at Nonpareil Road
15 Calapooya Creek at Sutherlin Water Plant
16 Calapooya Creek at County Gravel Pit
17 Calapooya Creek at Gassy Creek Bridge
18 Hinkle Creek near mouth
19 Calapooya Creek at Hinkle Creek Road

Figure 11: Stream *E. coli* Levels 19 sites within the Calapooya Creek Watershed - 6/22/2004, 8/302004,11/30/2004

RESULTS - Calapooya Creek Area
Summary

Table 7 provides a visual summary of the rating of each creek for temperature, turbidity, dissolved oxygen and *E. coli.* The data for the Calapooya Creek at Garden Valley Road (near the mouth) represents 20 different sampling events for turbidity, dissolved oxygen and *E. coli* which adds weight to the validity of its ratings. The temperature rating for Calapooya Creek at Garden Valley Road should be considered valid as it is based on the 7DMAM of seven years of data. All of the other sites' ratings were based on only 3 sampling events in one year and should be considered as preliminary and used only for directing further investigation.

Color Key: Blue = Good; Green = Fairly Good; Yellow = Concern; Red = Needs Improvement	**Temperature**	**Turbidity**	**Dissolved Oxygen**	***E. coli***
1 Calapooya Creek at Garden Valley Bridge	Red	Red	Red	Red
2 Coon Creek at mouth	Red	Blue	Blue	Red
3 Dodge Canyon Creek at mouth	Red	Blue	Red	Red
4 Calapooya Creek above Dodge Canyon Creek	Red	Blue	Blue	Green
5 Cook Creek at mouth	Red	Red	Red	Red
6 Williams Creek at mouth	Red	Yellow	Red	Red
7 Calapooya Creek at I-5 Bridge	Red	Blue	Blue	Green
8 Calapooya Creek at old Oakland water intake	Red	Blue	Red	Green
9 Cabin Creek at Old Town Road	Red	Green	Red	Red
10 Oldham Creek at Elkhead Road	Red	Blue	Red	Green
11 Bachelor Creek at Elkhead Road	Red	Green	Blue	Yellow
12 Calapooya Creek at Driver Valley Road	Red	Blue	Blue	Blue
13 Foster Creek at Nonpareil Road	Red	Blue	Blue	Green
14 Banks Creek at Nonpareil Road	Red	Green	Blue	Red
15 Calapooya Creek at Sutherlin Water Plant	Red	Blue	Blue	Blue
16 Calapooya Creek at County Gravel Pit	Red	Blue	Blue	Green
17 Calapooya Creek at Gassy Creek Bridge	Red	Blue	Blue	Green
18 Hinkle Creek near mouth	Red	Blue	Blue	Blue
19 Calapooya Creek at Hinkle Creek Road	Red	Blue	Blue	Blue

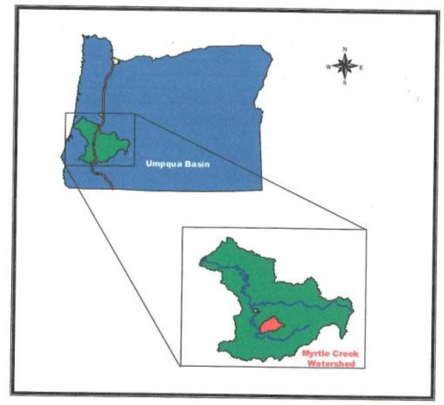
Table 7: Summary rating of Temperature, Turbidity, Dissolved Oxygen and *E.coli* for Creeks of the Calapooya Watershed. Note this data is based on very few sampling events and should be used only for general guidelines for further investigation.

Rating	**Color**	**Temperature**	**Turbidity NTU**	**Dissolved Oxygen**	***E. coli* MPN/100ml**
Good	Blue	<64.4°F	< 5	No Exceedances	<100
Fairly Good	Green		1 sample >5 <10		>100<235
Concern	Yellow		1 sample >10		>235<406
Needs Improvement	Red	>64.4°F	3 samples >10	Exceeding Criteria	> 406

Table 8: Criteria used for determining rating Calapooya Sites

MYRTLE CREEK AREA

Area Description & Monitoring Sites



The Myrtle Creek fifth-field watershed is located in Douglas County, Oregon, and is 76,322.2 acres. The watershed stretches a maximum of 10.8 miles north to south and 17.2 miles east to west. Myrtle Creek is a tributary of the South Umpqua River. Myrtle Creek flows 0.7 miles from the confluence of its two main tributaries to the mouth of the South Umpqua River. North Myrtle Creek is 17.7 miles from the headwater to its confluence with South Myrtle Creek. South Myrtle Creek is 22.2 miles long. Land use in this watershed is typical of land use countywide. The most common land use in the Myrtle Creek drainage is forestry (79%) followed by agriculture (18%). Land ownership is primarily private (57%), with public ownership (43%) administered mostly by the Bureau of Land Management. The city of Myrtle Creek sits at the bottom of this watershed, with the two major streams, North Myrtle and South Myrtle meeting within city limits. Myrtle Creek is the only city within the watershed. According to the US Census Bureau, the city's total population in 2000 was 3,419. (Lyon, Quality Assurance Project Plan For the Umpqua Basin Watershed Council Volunteer Monitoring Program, 2004) (Geyer, Myrtle Creek Assessment and Action Plan, 2003)

Myrtle Creek was selected out of all the possible watersheds in the Umpqua Basin for several reasons. It is centrally located, is of a manageable size, contains several of UBWC's/PUR's completed and proposed project sites, and has water quality limiting issues representative of the problems of the South Umpqua Sub Basin. This sub basin has water quality concerns evident by numerous 303(d) listings. Oregon coastal cutthroat and coho populations are severely depressed in this sub basin.

Photo 3: Mouth of Myrtle Creek entering the South Umpqua River

The water quality monitoring project in Myrtle Creek consisted of two parts: 1) ambient baseline water quality monitoring at selected sites and 2) continuous summer temperature monitoring at selected sites.

Sampling was carried out using the standard protocols described in the OWEB Water Quality Monitoring Guidebook. Samples were obtained from as close to the highest flow area (thalweg) as possible – either from the bank with a long armed grabber or from a bridge with a bucket.

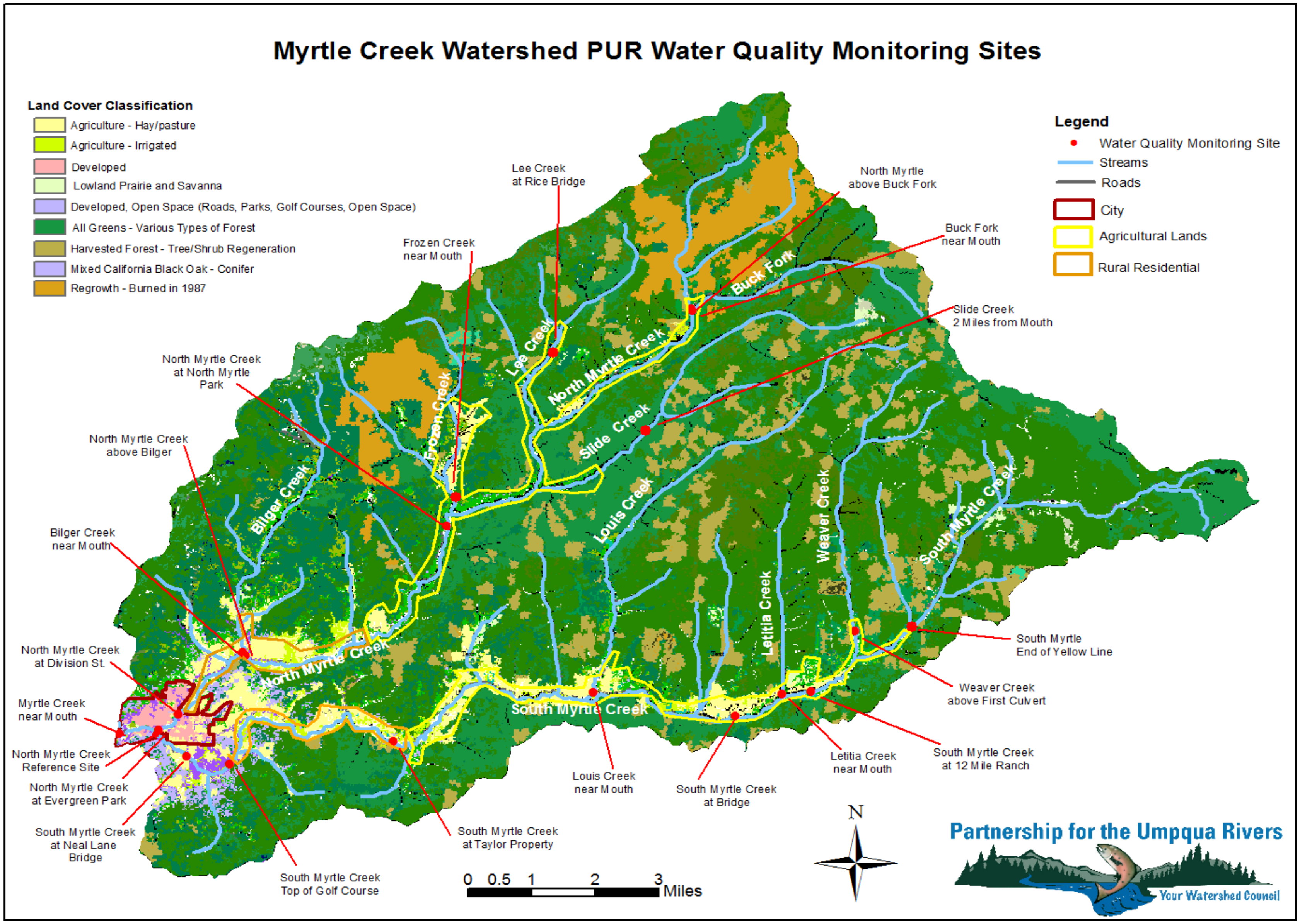


Figure 12: Myrtle Creek Watershed PUR Water Quality Monitoring Sites

Myrtle Creek Monitoring Sites

Site ID #	Site Name	Site Location	Type Site	Latitude	Longitude
M1	Millsite Park	Myrtle Creek below Main Street bridge	City	43°01.418'N	123°17.314'W
SM1	Neal Lane Bridge	South Myrtle Creek at Neil Lane Bridge, below golf course	Golf Course, city wastewater discharge	43°01.033'N	123°16.460'W
SM2	DC Cutoff Rd	Days Creek Cutoff Road at private bridge	Above Golf Course	43°00.912'N	123°15.633'W
SM3	Steve Taylor's	Steve Taylor's Property 4891 S. Myrtle	Rural Residential	43°01.337'N	123°12.593'W
SM3a	Louis Creek	Louis Creek near mouth at S. Myrtle Road bridge	Farmlands and Rural Residential	43°02.139'N	123°08.900'W
SM4	South Myrtle Bridge	Bridge over South Myrtle at 11,200 S. Myrtle Creek Road	Below irrigation project and farm land	43°01.825'N	123°06.361'W
SM5a	Litetia Creek	Litetia Creek near mouth at 11,800 S. Myrtle Creek Road	Tributary -2006 PUR projects upstream	43°02.190'N	123°05.362'W
SM5	South Myrtle at 12 Mile Ranch	UBWC South Myrtle Dam Removal Site 12 mile ranch	Farmland	43°02.238N	123°01.829W
SM6	Weaver Creek Culvert	First Culvert Hidden Homestead Road	Tributary Forest & Farm	43°03.148'N	123°04.054W
SM7	South Myrtle at end of yellow line	Across South Myrtle Road from BLM 28-3-35.2	Forest	43°05.058N	123°0.1274W
NM1a	Evergreen Park	End of Cedar Street	Residential	43°01.643'N	123°16.588'W
NM1	Super Y	City Creek Access across from Super Y	Residential	43°01.639N	123°16.624W
NM2	Bilger Creek	Bilger at mouth at confluence with North Myrtle Creek	Rural Residential	43°02.536'N	123°15.465'W
NM3	North Myrtle at Bilger	North Myrtle Above Confluence with Bilger Creek	Rural Residential	43°02.531'N	123°15.461'W
NM5a	Frozen Creek	Frozen Creek near mouth	Tributary Farmland and Rural Residential	43°04.772'N	123°11.652'W
NM4	North Myrtle Park	North Myrtle Park From entry bridge	Farmland	43°04.507'N	123°11.735'W
NM5	Slide Creek	Slide Creek Mid Log Placement 1.9 miles off N. Myrtle Road	Tributary Forest	43°05.939N	123°08.155W
NM6	Rice Bridge	Lee Creek at Rice Bridge	Tributary Forest	43°07.588N	123°09.576W
NM7a	Mouth Buck Fork	North Myrtle Creek Road on Buck Fork Creek	Tributary Forest	43°07.787N	123°07.262W
NM7	1 mile up Buck Fork from mouth	15391 North Myrtle Creek Road on Buck Fork Creek	Tributary Forest	43°08.229N	123°05.799W
NM8	North Myrtle	North Myrtle above Buck Fork	Forest	43°07.784N	123°07.302W

Table 9: Myrtle Creek Watershed Monitoring Sites Description and Location

RESULTS - Myrtle Creek Area
Turbidity

Large increases in turbidity levels in the Myrtle Creek Watershed occurred only during winter months as shown in Figure 13. Comparison of the amount of rainfall and turbidity levels in Figure 14 demonstrates that this is storm related. Figures 15-18 depict the stream turbidity levels for Myrtle Creek, South Myrtle Creek and North Myrtle Creek as individual values for each monitoring event and as a summation for each site as box and whisker graphs. Outliers were included as these were real events denoting characteristics of the watershed. One of particular note is the high stream turbidity levels in North Myrtle Creek on 1/11/06 that can be tracked from above Buck Fork Creek all the way to the mouth of Myrtle Creek. The turbidity was recorded as high as 501 NTU at Buck Fork that day. Investigation upstream led to the discovery of a substantial debris flow which reconfigured the entire valley of the tributary it followed. In addition, it provided a considerable sediment bed load to North Myrtle Creek which most likely proved beneficial to spawning salmon over time.

Table 10 summarizes the results from this study (2004-2010) and rates the streams based on exceedances of EPA and DEQ criteria. In addition, it compares whether the exceedances occurred during "summer" May 1 – September 30 or "winter" October 1 – April 30. Excluding two storm events in December 2004 and January 2006, there appear to be no trends over time in watershed turbidity levels.

Photo 4 & 5: Result of debris flow on tributary of upper North Myrtle January 2006

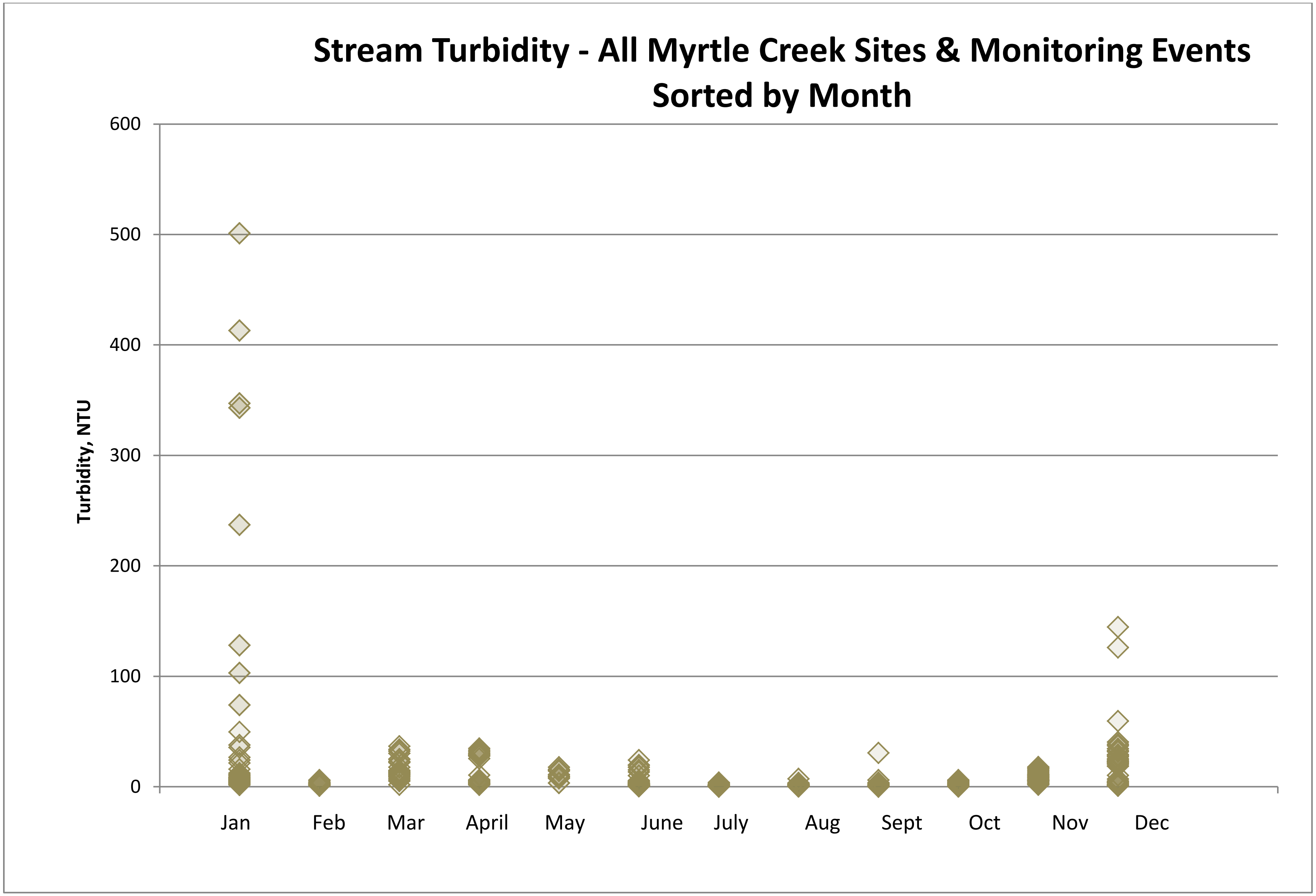


Figure 13: Stream Turbidity levels at all Myrtle Creek sites and monitoring events sorted by month of year.

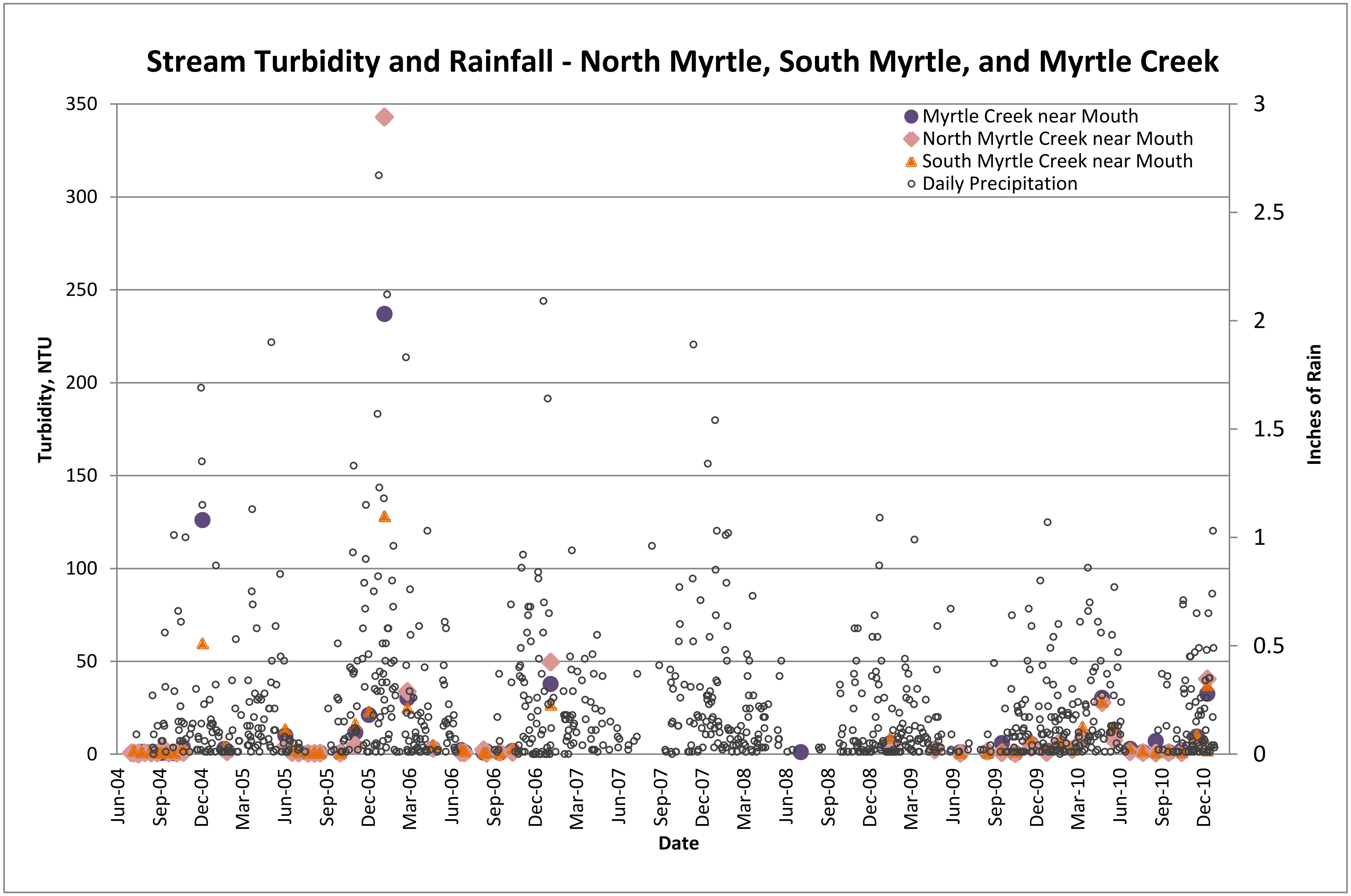


Figure 14: Stream Turbidity levels 2004-2010, Myrtle Creek, North Myrtle near mouth, and South Myrtle near mouth compared with daily precipitation at Roseburg, Oregon.

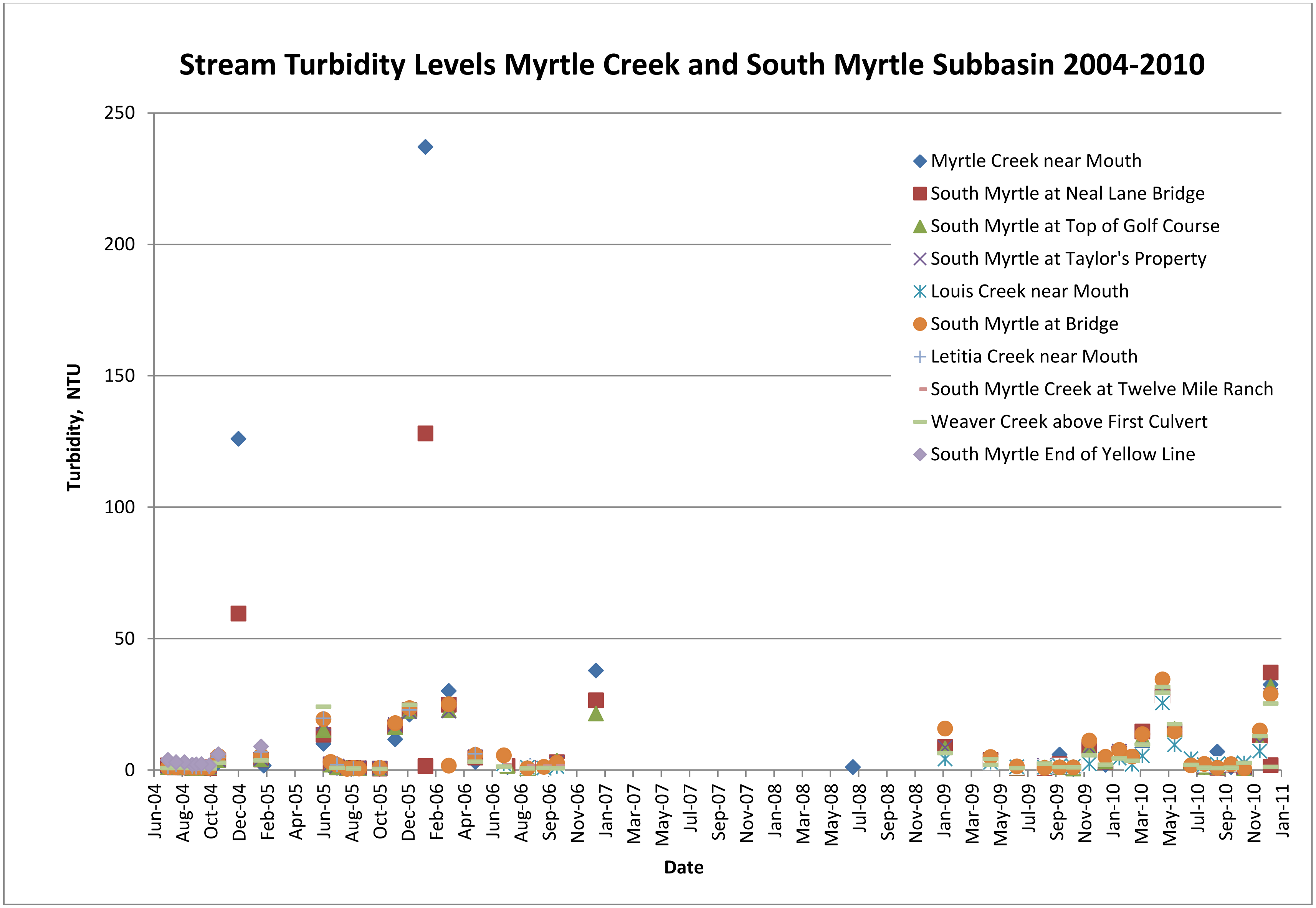


Figure 15: Stream Turbidity levels Myrtle Creek and South Myrtle Creek Subbasin 2004-2010

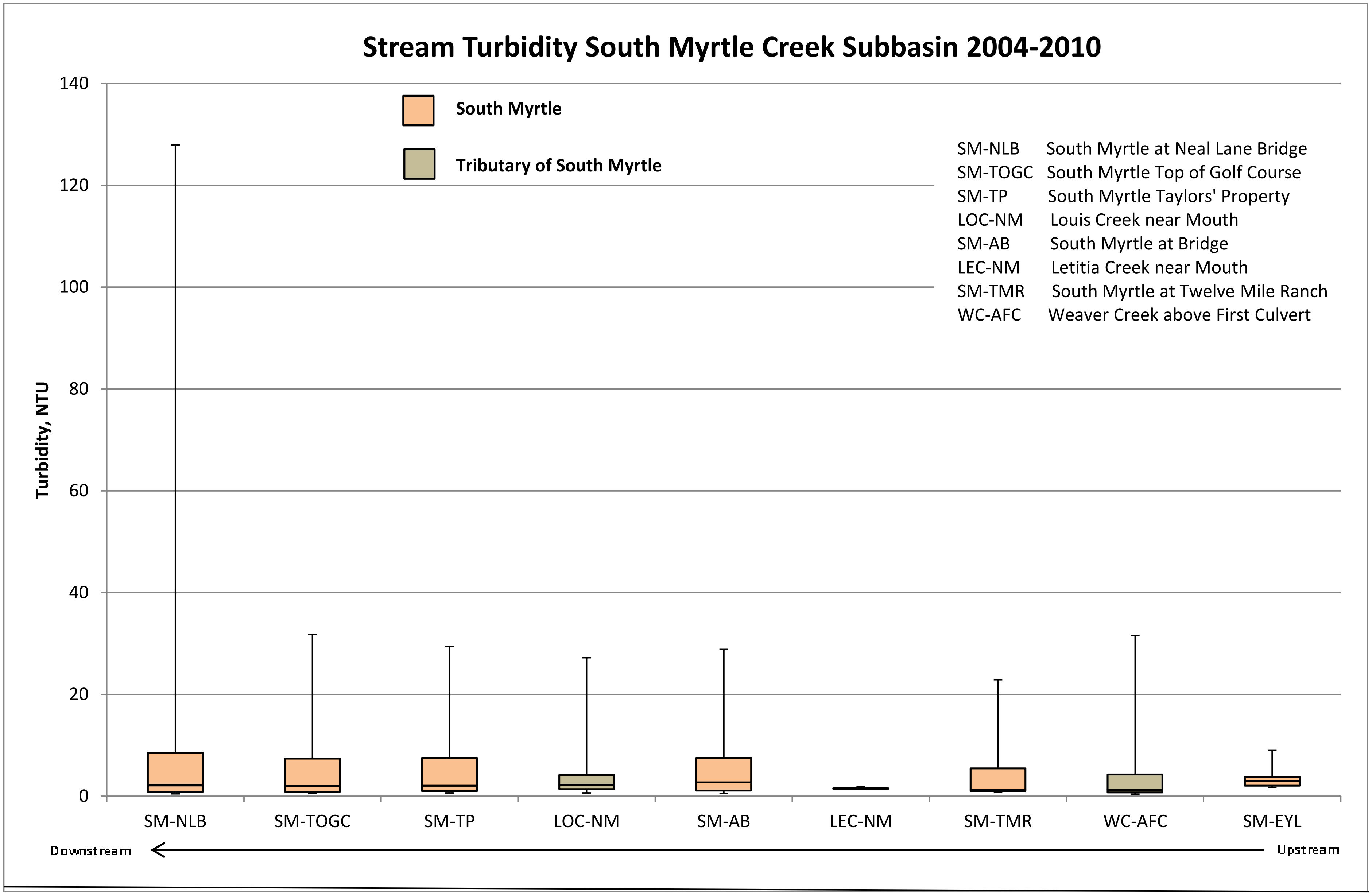


Figure 16: Stream Turbidity South Myrtle Creek and Tributaries 2004-2010

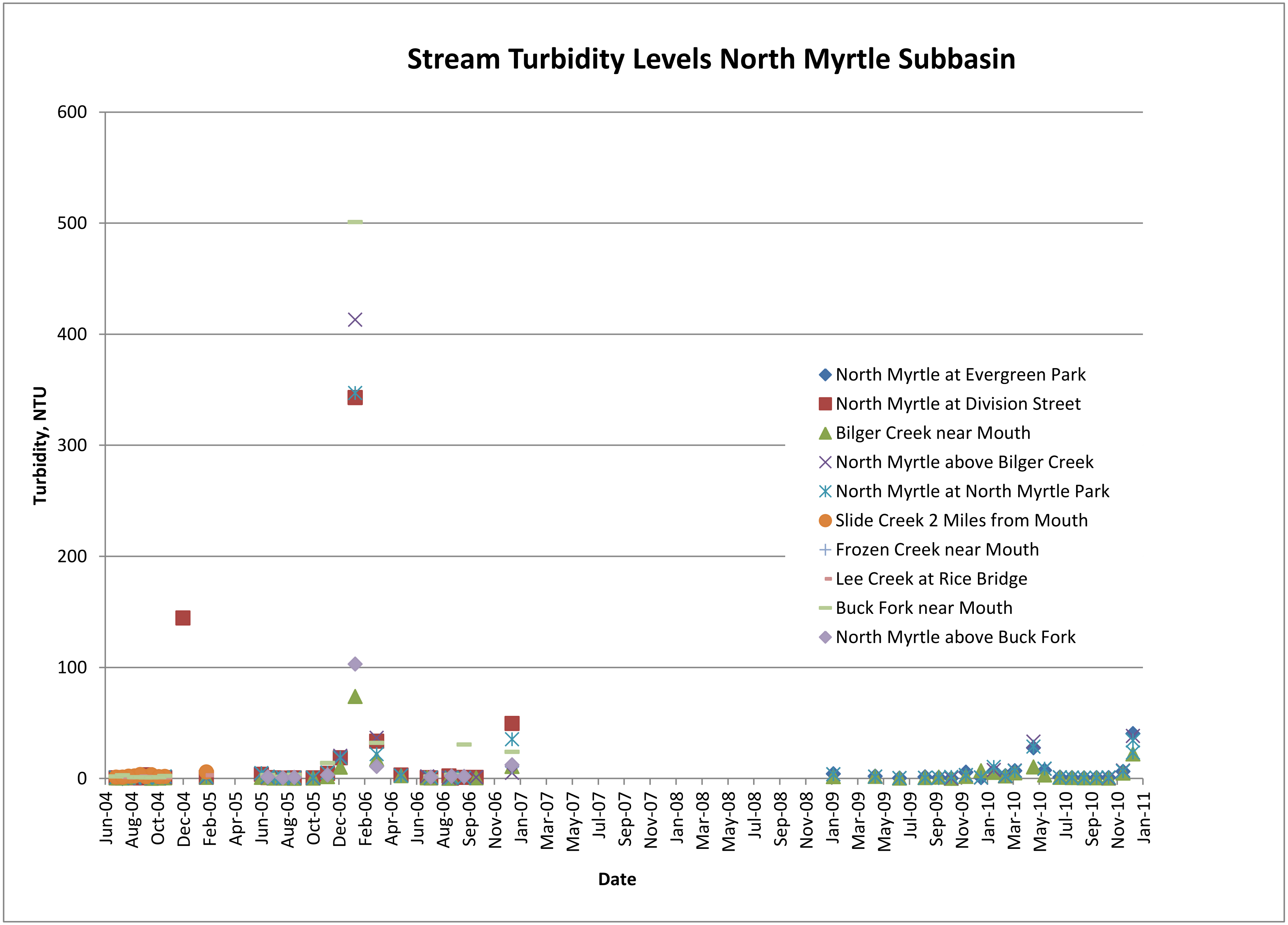


Figure 17: Stream Turbidity Levels North Myrtle Subbasin 2004-2010

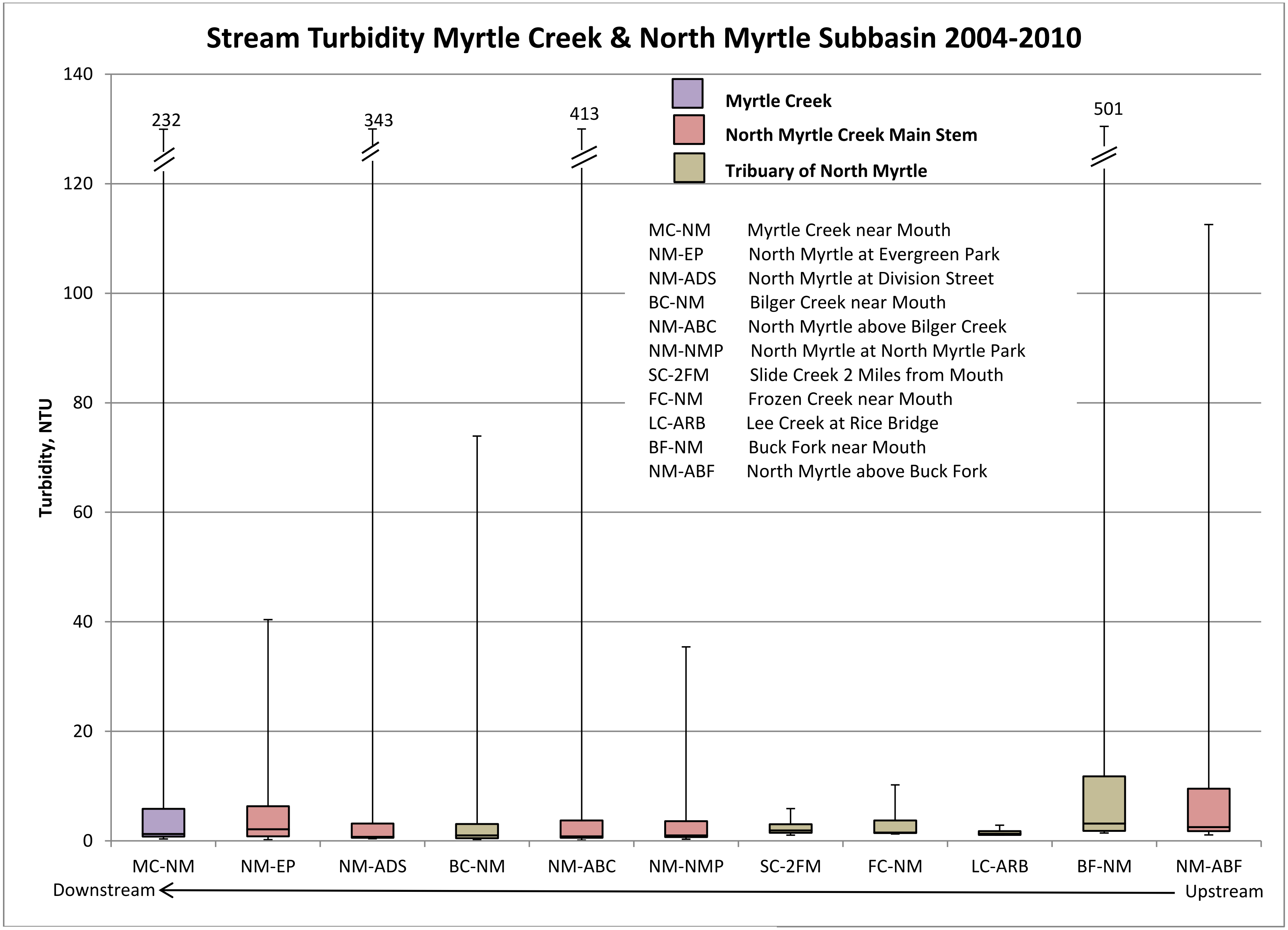


Figure 18: Stream Turbidity Myrtle Creek & North Myrtle Subbasin 2004-2010

Myrtle Creek Sites – Summer/Winter Stream Rating for Turbidity

SITE	Summer (May 1- Sept. 30)		Winter (Oct. 1-April 30)		Rating
	# SAMPLES	% > 10 NTU	# SAMPLES	% > 10 NTU	
Myrtle Creek at Millsite Park	29	0	26	35	[red]
North Myrtle Creek across from Super Y	21	0	12	42	[red]
North Myrtle at Evergreen Park	7	0	13	15	[yellow]
Bilger Creek at mouth	21	0	24	25	[red]
North Myrtle Creek above Bilger Creek	25	0	25	20	[red]
North Myrtle Creek at North Myrtle Park	23	0	23	30	[red]
Slide Creek 1.9 miles off North Myrtle Rd.	7	0	3	0	[blue]
Frozen Creek	3	0	1	100	[red]
Lee Creek at bridge on Bill Rice's	7	0	3	0	[red]
Buck Fork Creek at 15391 N. Myrtle Creek Rd.	6	0	2	0	[blue]
Buck Fork at mouth	6	17	4	100	[red]
North Myrtle just above Buck Fork	6	0	4	75	[red]
South Myrtle Creek at Neal Lane Bridge	24	4	25	44	[red]
South Myrtle Creek, DC Cutoff Road	24	4	23	39	[red]
South Myrtle Creek at Taylors'	22	5	22	36	[red]
Louis Creek	10	0	14	14	[yellow]
South Myrtle at bridge	22	5	23	43	[red]
South Myrtle Creek at 12 Mile Ranch	9	11	6	17	[yellow]
Litetia Creek	3	0	1	0	[blue]
Weaver Creek at first culvert	19	5	23	26	[red]
South Myrtle Creek at end of yellow line	6	0	3	0	[red]

Rating	Color	Turbidity
Good	[blue]	< 10 NTU
Concern	[yellow]	Between 10% and 20% , 10 NTU or greater
Needs Improvement	[red]	20% or more 10 NTU or greater

Table 10: Stream turbidity Myrtle Creek Watershed sites, summer and winter, % of monitoring events at each site with readings >10 NTU with color rating criteria key.

RESULTS - Myrtle Creek Area

pH

All of the grab samples for the Myrtle Creek Watershed fell within the DEQ criteria for healthy streams of >6.5 and <8.5 pH (see Figures 19-24) except two occurrences. A few streams neared the upper limit during summer but did not exceed 8.5 during the hours that monitoring occurred. North Myrtle Creek at Division Street did reach 8.5 on 6/27/06 and exceeded 8.25 on three other dates. Myrtle Creek near the mouth reached 8.5 on 6/27/06 and exceeded 8.25 six times. The pH exceeded 8.25 on two occasions at North Myrtle at Evergreen Park; South Myrtle at Neal Lane Bridge, seven times; Weaver Creek, six times; South Myrtle at the top of the golf course, five times; and South Myrtle Bridge, three times. It is likely that had monitoring occurred later in the afternoon these, and many other sites, would have exceeded pH 8.5 frequently in summer as a great deal of algae was present in numerous streams as well as the mainstems. Unfortunately, the logistics of grab sample monitoring a number of sites during one day make it impractical to create an aggregate summary of changing conditions for a site over 24 hours. To maintain consistent data, sites were monitored in a pre-established order. This allows us to draw more accurate comparisons overtime, for an individual site, as each site is monitored at approximately the same time of day. It is not, however, ideal for comparison between sites where conditions will be different due to the different time of day.

Table 11 indicates a rating of sites for pH based available data. Figures 20 and 23 indicate no significant change over time in watershed pH levels.

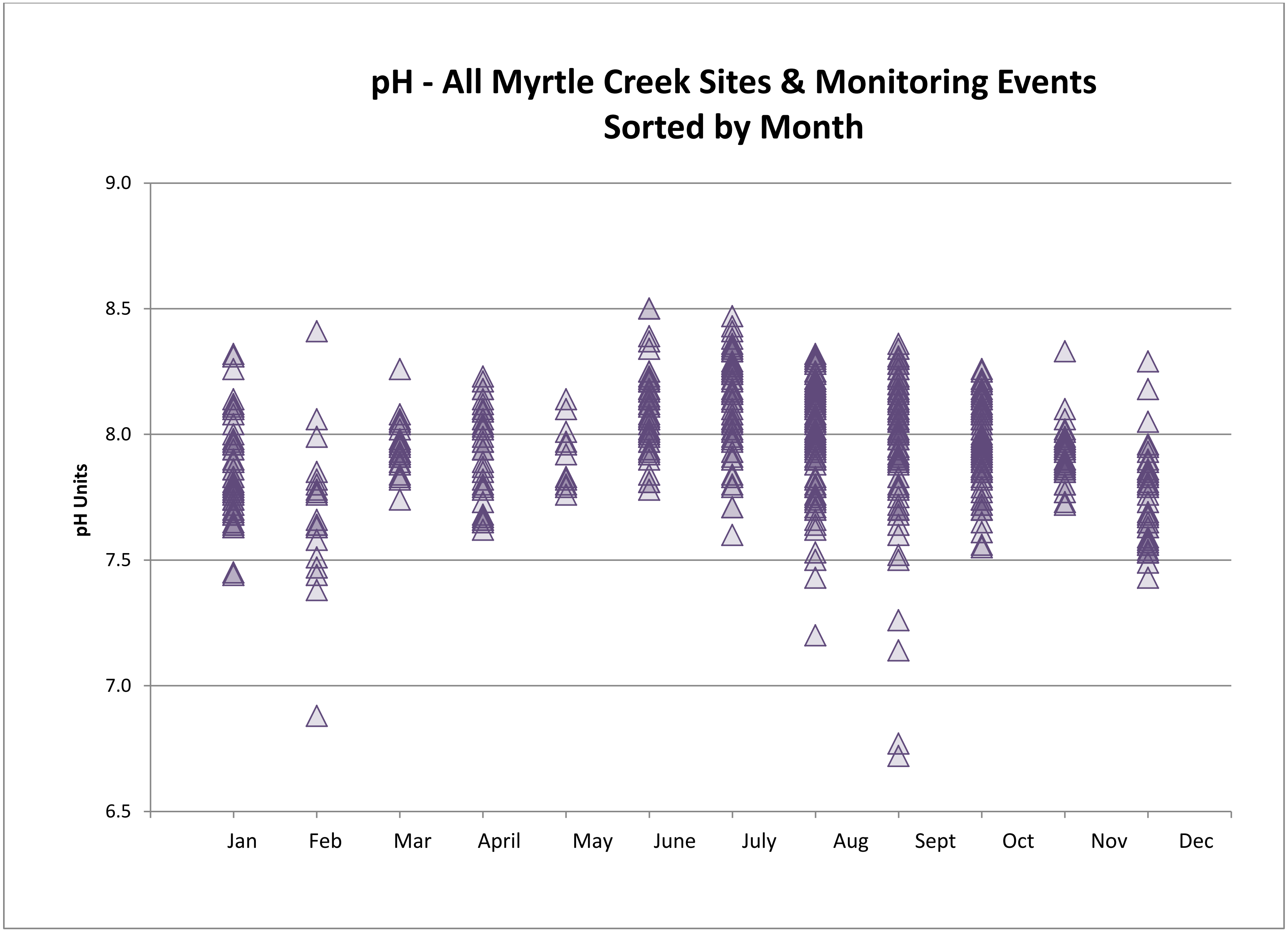


Figure 19: Stream pH levels at all Myrtle Creek sites and monitoring events sorted by month of year.

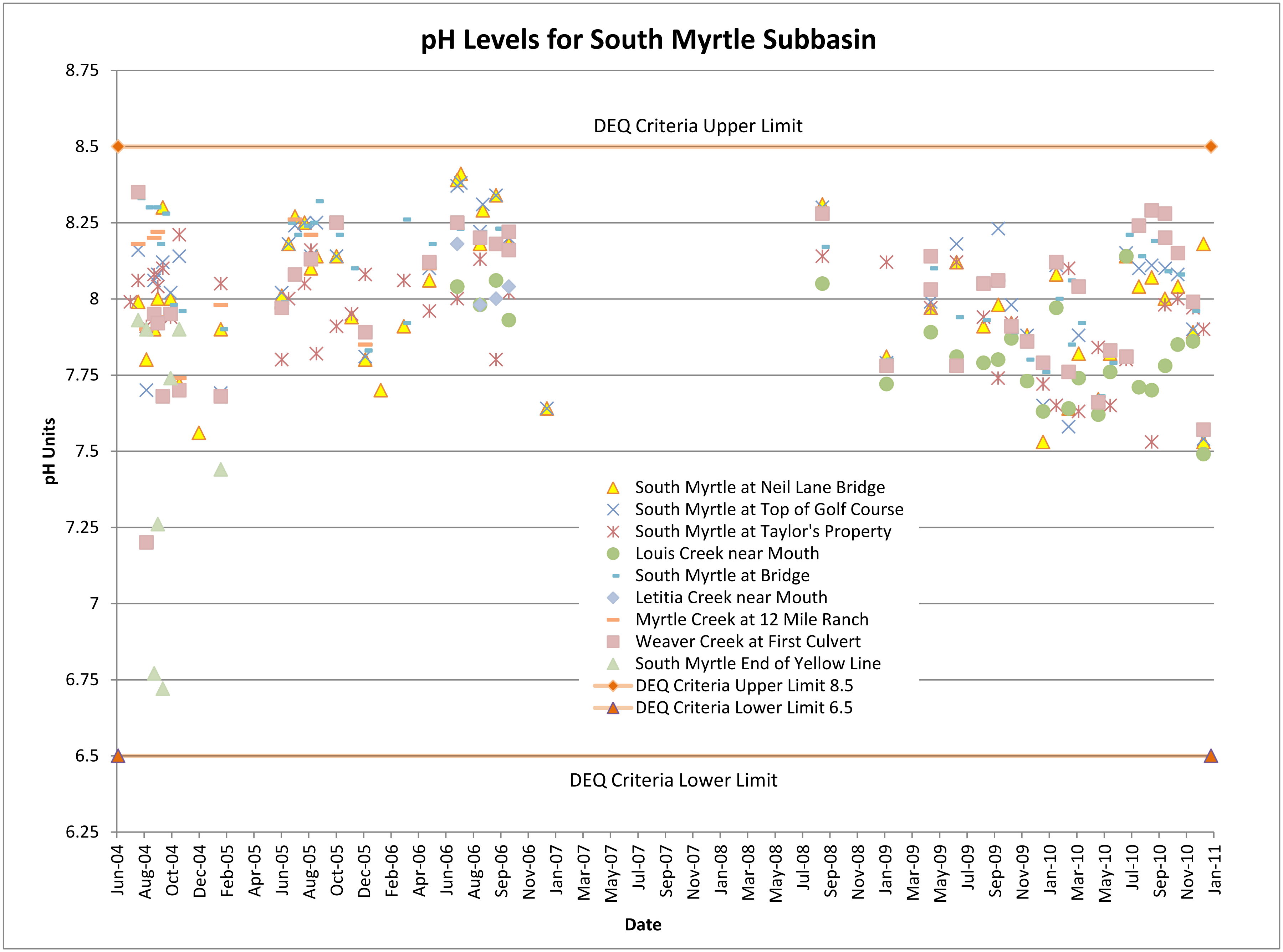


Figure 20: pH levels by site and date for the South Myrtle Creek Subbasin.

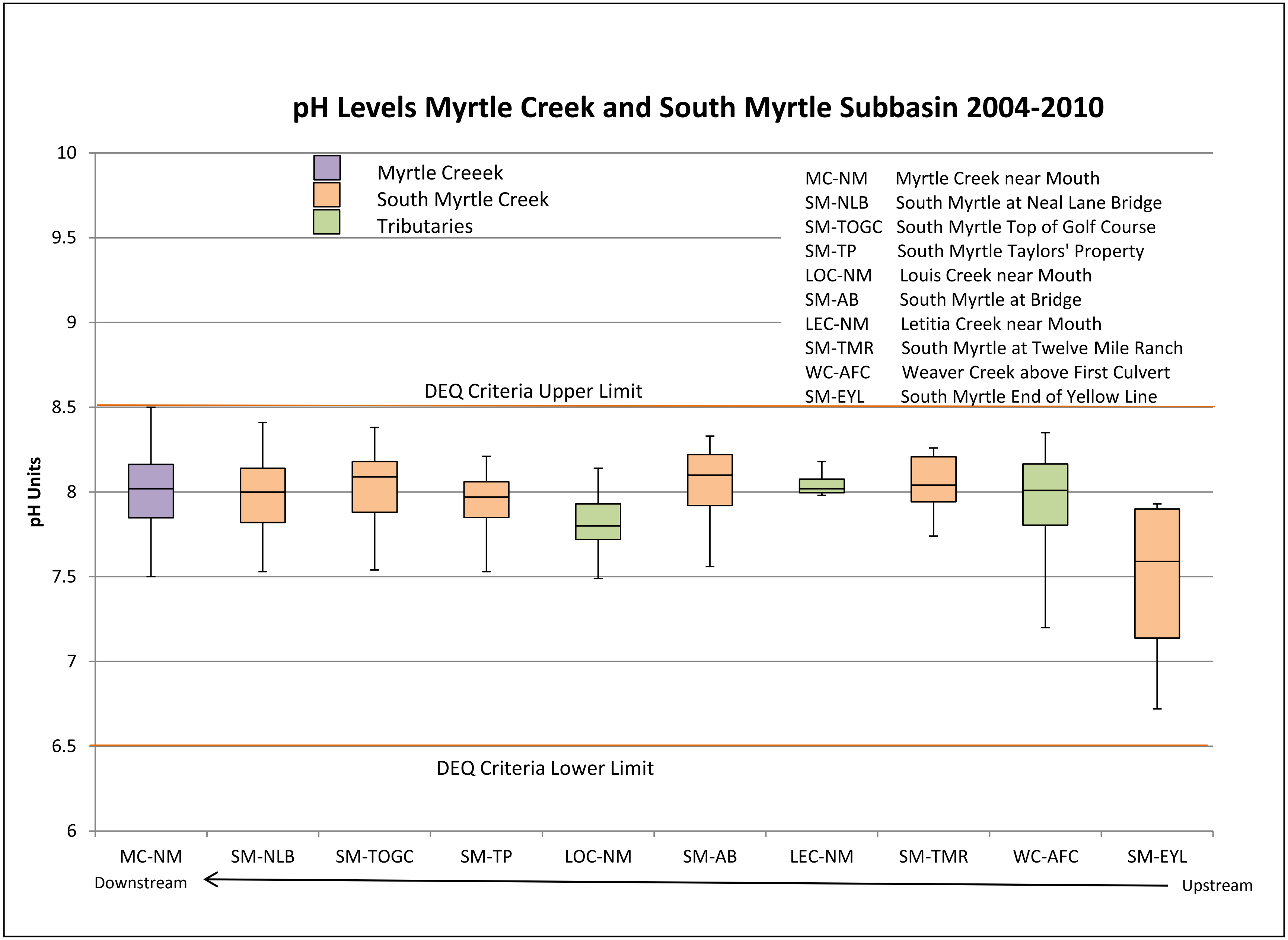


Figure 21: Stream pH Myrtle Creek & North Myrtle Subbasin 2004-2010.

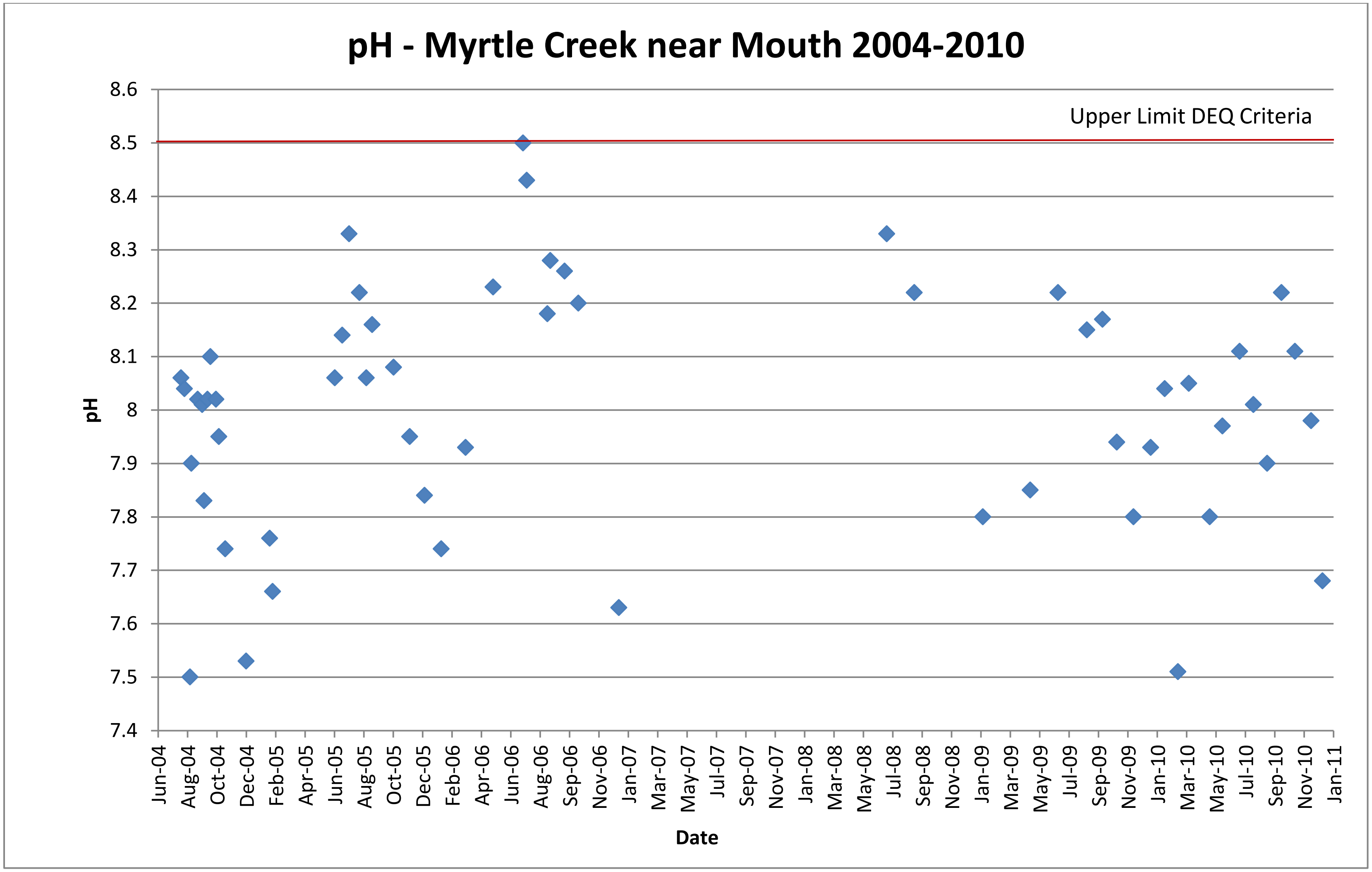


Figure 22: pH Myrtle Creek near mouth 2004-2010.

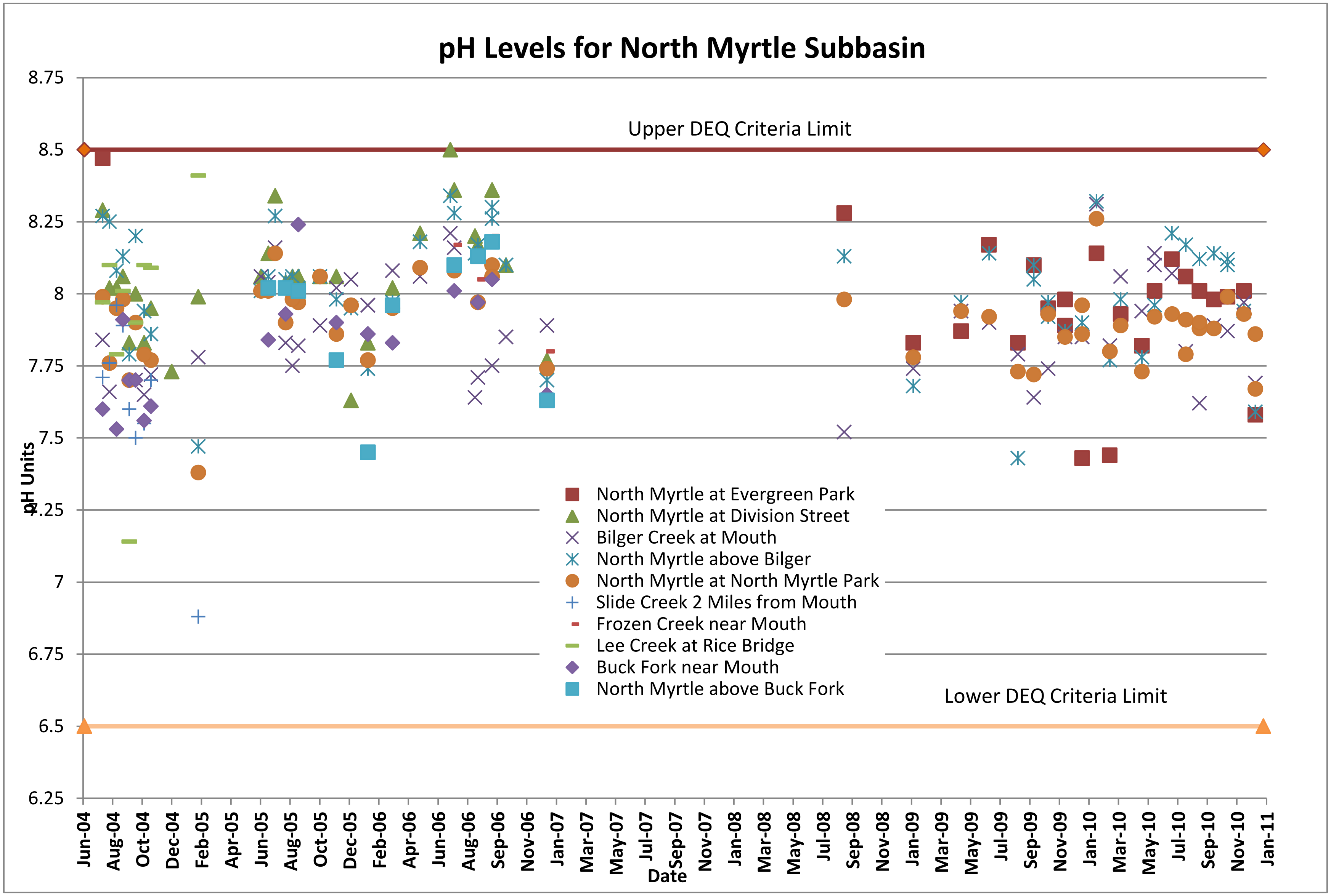


Figure 23: pH levels monitoring sites and date in North Myrtle Creek Subbasin 2004-2010.

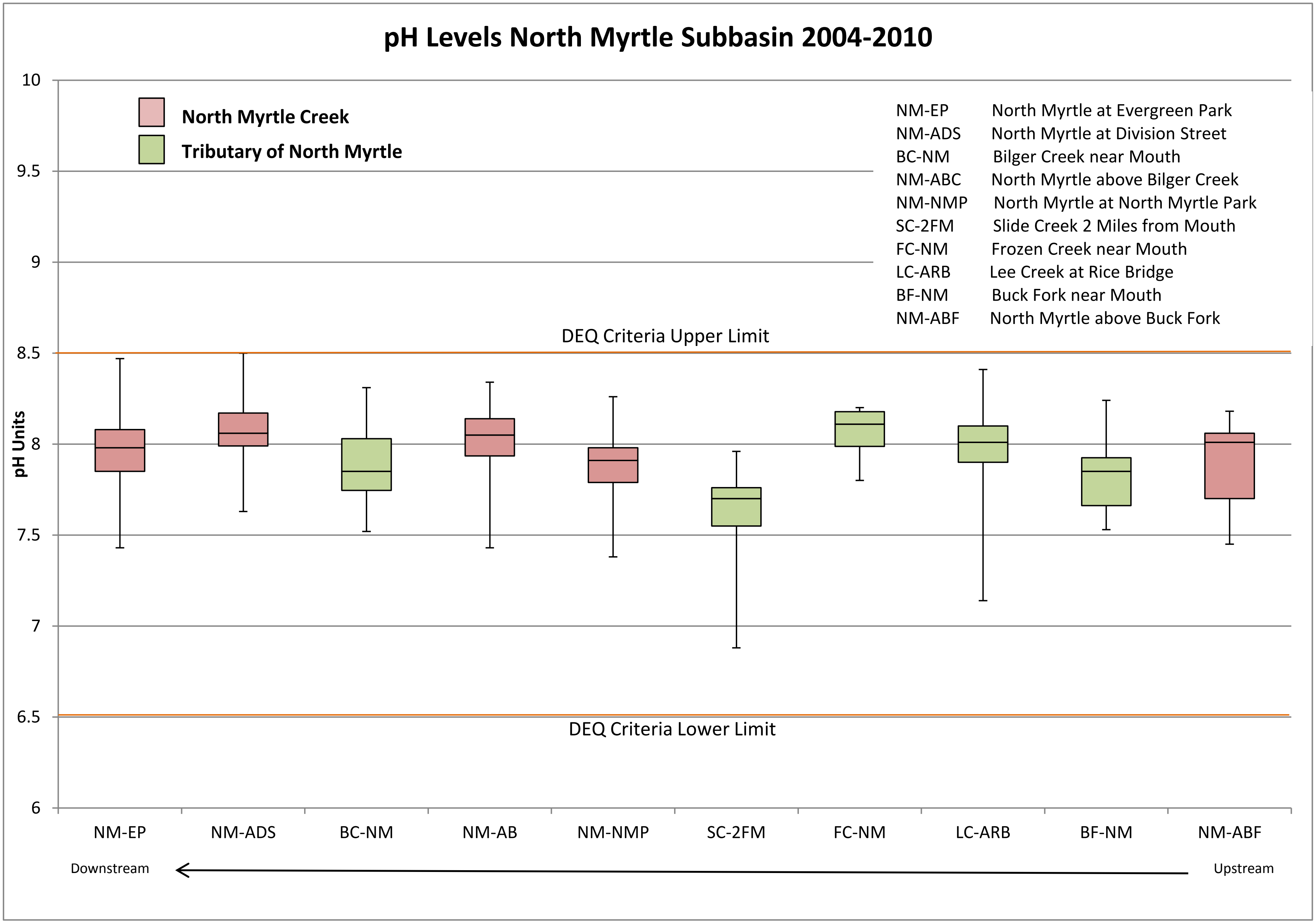


Figure 24: pH levels at monitoring sites in North Myrtle Creek Subbasin 2004-2010.

pH Rating Myrtle Creek Sites

SITE	Rating
Myrtle Creek at Millsite Park	[red]
North Myrtle Creek across from Super Y	[red]
North Myrtle at Evergreen Park	[yellow]
Bilger Creek at mouth	[blue]
North Myrtle Creek above Bilger Creek	[blue]
North Myrtle Creek at North Myrtle Park	[blue]
Slide Creek 1.9 miles off North Myrtle Rd.	[blue]
Frozen Creek	[blue]
Lee Creek at bridge on Bill Rice's	[blue]
Buck Fork Creek at 15391 N. Myrtle Creek Rd.	[blue]
Buck Fork Creek just above N.Myrtle Creek	[blue]
North Myrtle just above Buck Fork	[blue]
South Myrtle Creek at Neal Lane Bridge	[yellow]
South Myrtle Creek, DC Cutoff Road	[yellow]
South Myrtle Creek at Taylors'	[blue]
Louis Creek	[blue]
South Myrtle at bridge	[yellow]
South Myrtle Creek at 12 Mile Ranch	[blue]
Litetia Creek	[blue]
Weaver Creek at first culvert	[yellow]
South Myrtle Creek at end of yellow line	[blue]

pH Rating Code

Rating	Color	pH Criteria
Good	[blue]	None above 8.25
Concern	[yellow]	1 or more ≥ 8.25
Needs Improvement	[red]	1 or more ≥ 8.5

Table 11: Rating of Myrtle Creek sites for pH and pH Rating Code

RESULTS - Myrtle Creek Area

Dissolved Oxygen

As with pH values, dissolved oxygen levels were sampled at approximately the same time each day of monitoring. Therefore the results are limited to this time period and are not indicative of 24 hour fluctuations. A great deal of algae was present in this watershed during summer; for this reason D.O. levels would have fallen during the night while algae were in the respiration phase. Figure 25 demonstrates the typical annual variation of dissolved oxygen due to seasonal temperature change. The lowest values were in July/August when temperatures were at their highest.

Figures 26 and 27 display the data for Myrtle Creek and South Myrtle Creek sites; Figures 28 and 29 are comparable graphs for South Myrtle Creek sites. The blue shaded area in Figures 26 and 28 represent the levels and dates that fall within DEQ criteria for healthy salmon growth and spawning. These data are summarized in Table 12 where the streams are rated by exceedances of the spawning and non-spawning criteria.

Bilger Creek has the highest number of exceedances with 46% of the non-spawning, and 48% of the spawning samples falling below acceptable levels of dissolved oxygen. Many other sites on North Myrtle Creek also had significant exceedances of the criteria as did sites on South Myrtle Creek. Myrtle Creek at the mouth had a significant number of exceedances. Creeks higher in the watershed and more likely to have lower temperatures reflect higher dissolved oxygen levels and less exceedances of the criteria – Slide Creek, Frozen Creek, Lee Creek, Buck Fork Creek, North Myrtle above Buck Fork, and Litetia Creek.

Figures 26 and 28 appear to indicate increasing levels of dissolved oxygen in the later years, starting in 2008. In 2008, PUR obtained a YSI multi-parameter probe and began monitoring dissolved oxygen, conductivity, turbidity and pH with this probe replacing previous methods (See pages 9-10). We ran duplicate samples for a year comparing the Winkler/Hach method to the optical YSI probe. It became apparent that the YSI probe ran an average of 0.4 mg/l higher. We discussed this with Steve Hanson at DEQ who indicated that this might well be due to the Hach chemical packet method as the Hach Kit appeared to give lower readings than DEQ's wet chemical method. All YSI probes were comparing well with split samples with DEQ. Therefore, we believe that there is no appreciable increase in dissolved oxygen levels over time.

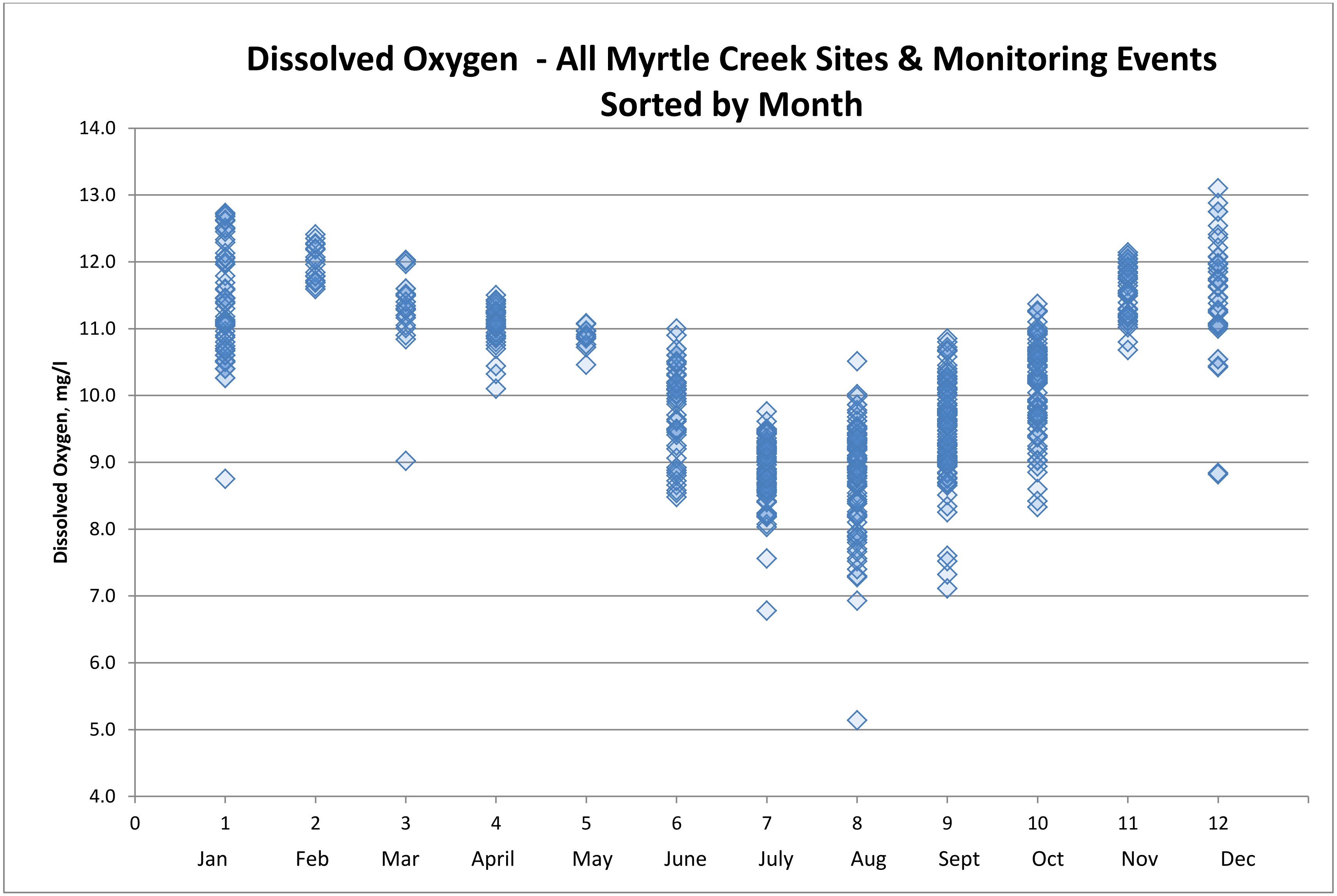


Figure 25: Stream Dissolved Oxygen, All Myrtle Creek Sites by Month 2004-2010.

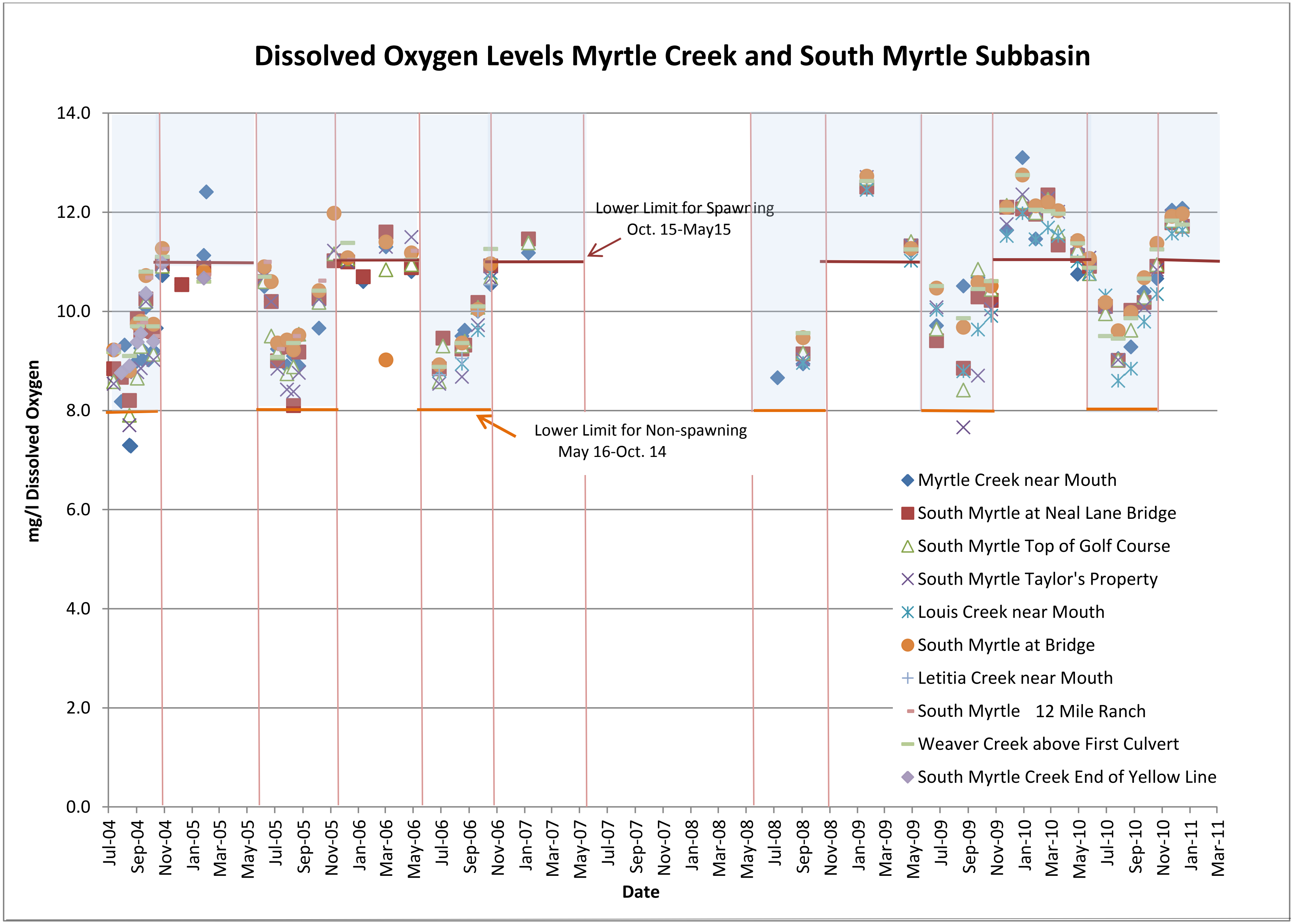


Figure 26: Stream Dissolved Oxygen, Myrtle Creek & South Myrtle Sites with bars and shading to denote the criteria for spawning and non-spawning seasons.

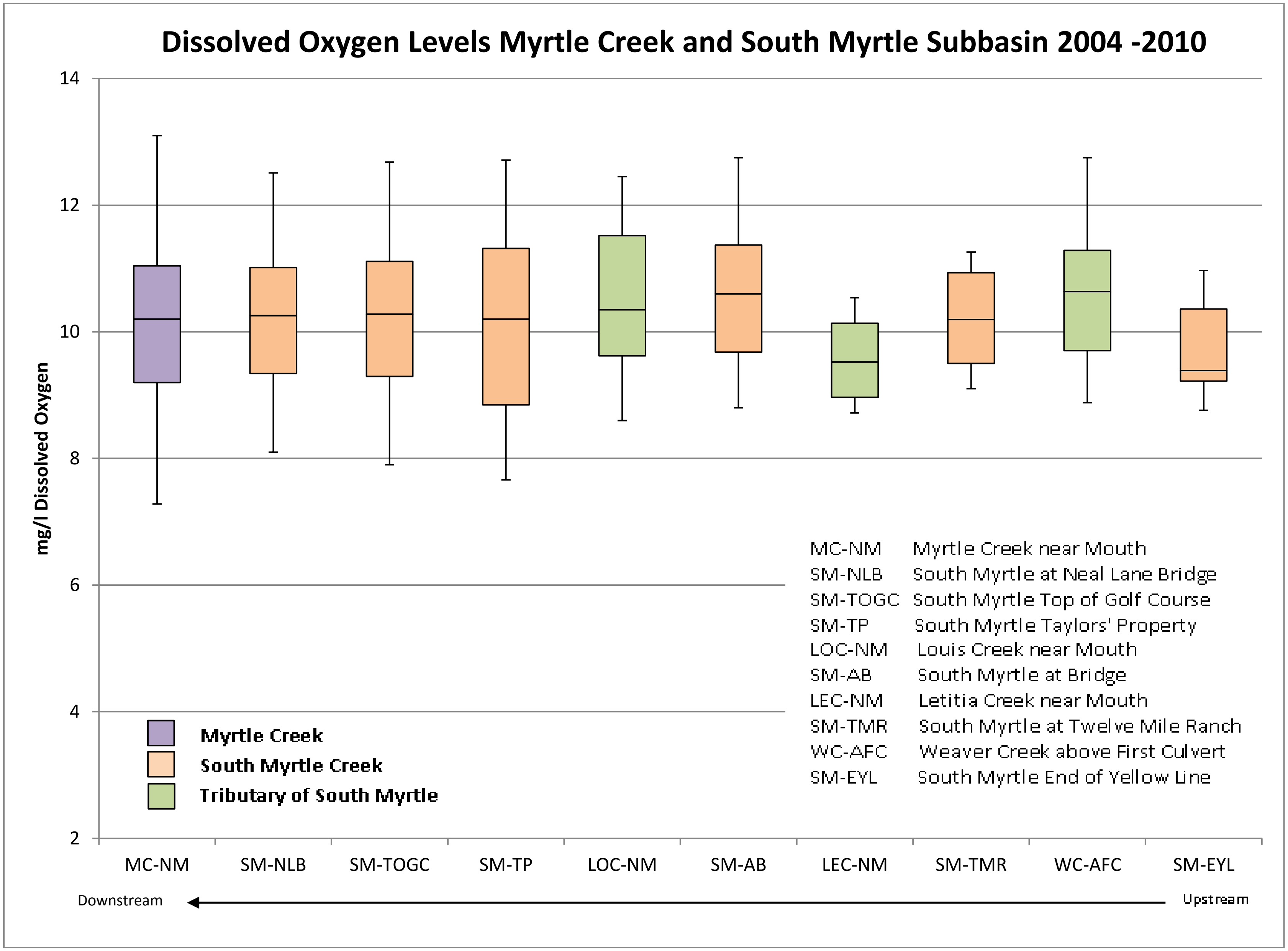


Figure 27: Stream Dissolved Oxygen, Myrtle Creek & South Myrtle 2004-2010 Sites

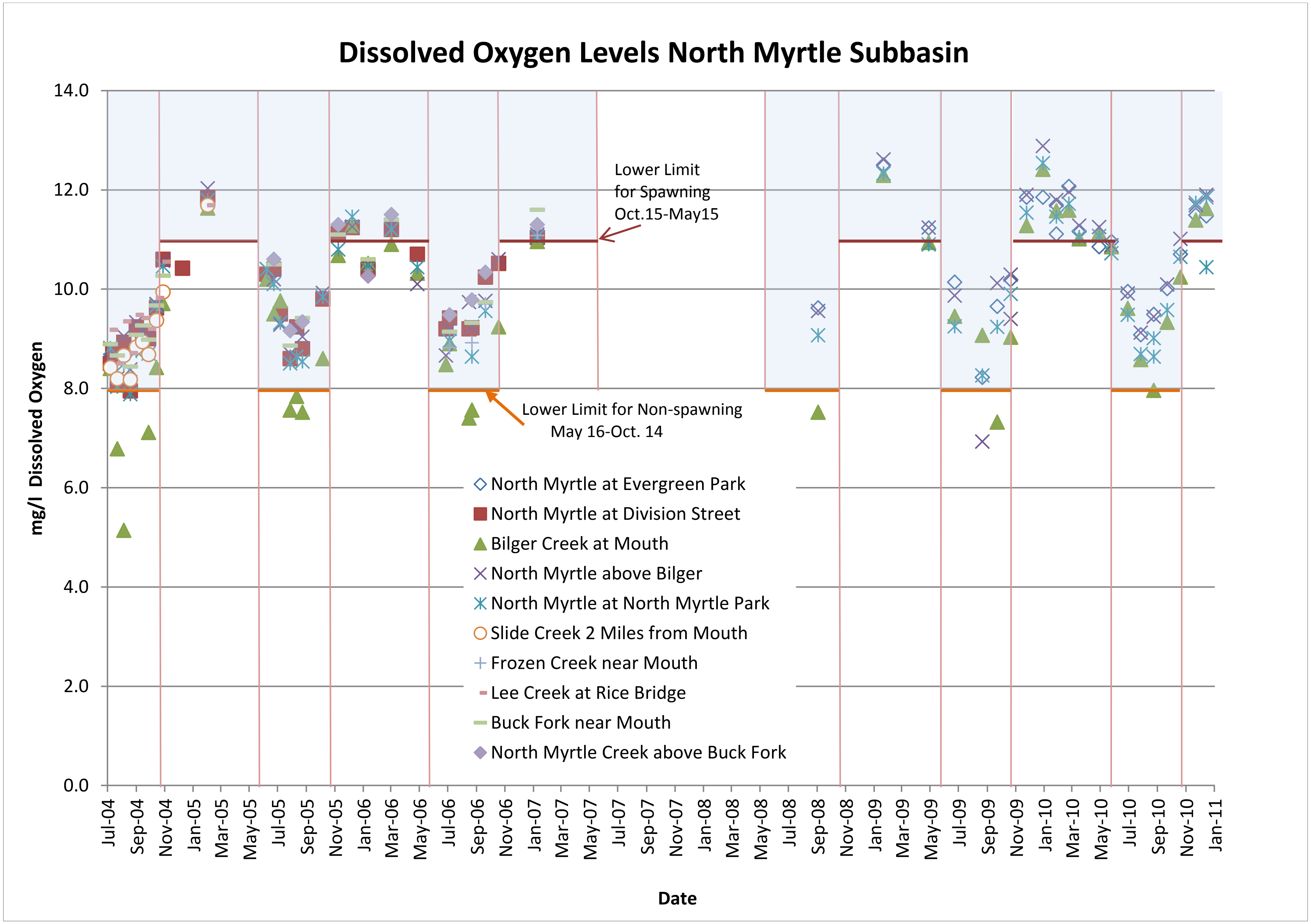


Figure 28: Stream Dissolved Oxygen North Myrtle Creek Sites with Criteria Bars

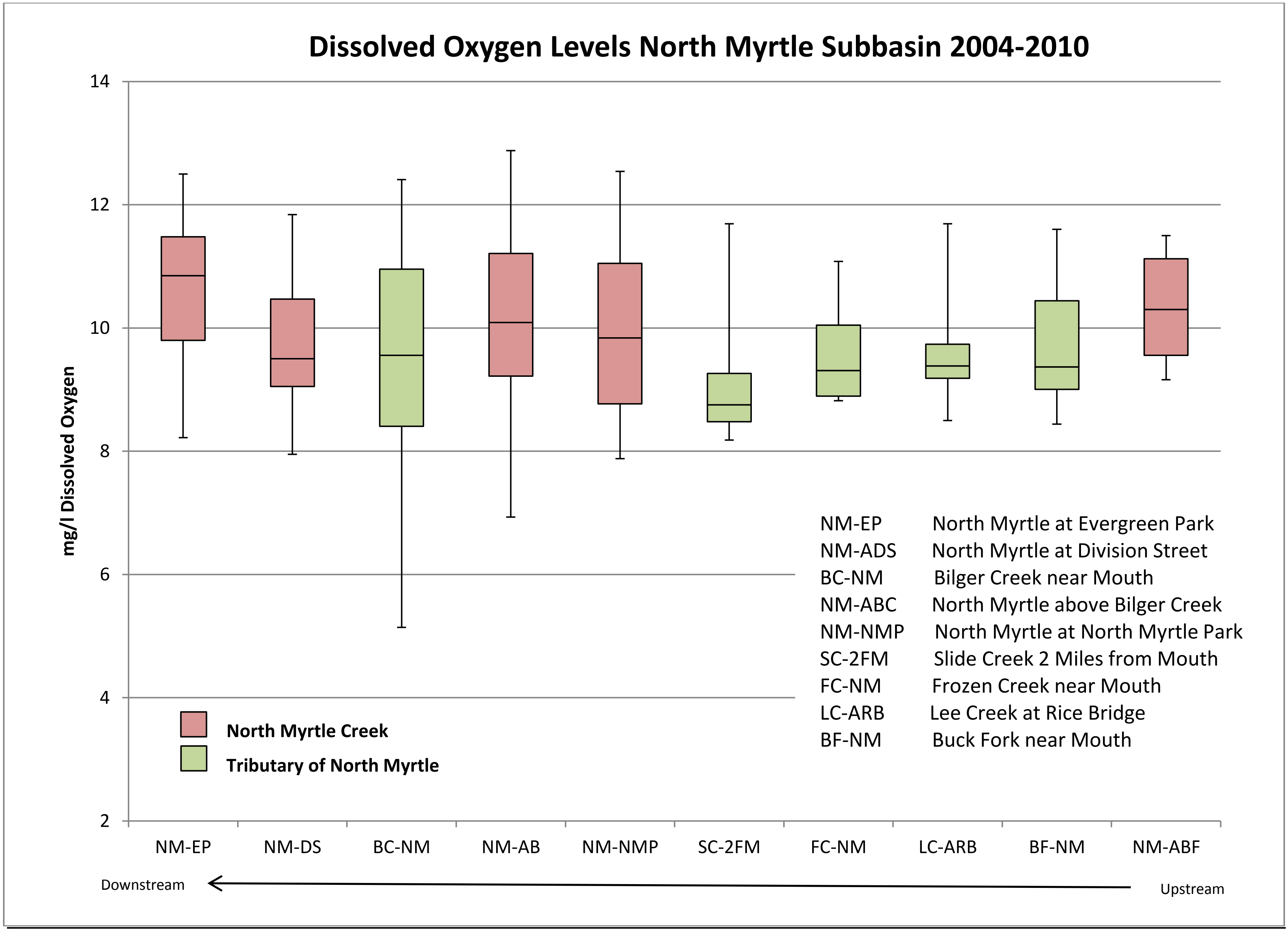


Figure 29: Stream Dissolved Oxygen, North Myrtle Creek Sites 2004-2010

Dissolved Oxygen Ratings for Myrtle Creek Sites, Spawning and Non-spawing Seasons

SITE DESCRIPTION (Location)	Non-spawning Season May 16-October 14				Spawning Season October 13-May 15			
	Total # Samples	# Below Minimum D.O. Criteria of 8 mg/l	% Below Minimum D.O. Criteria of 8 mg/l	Rating	Total # Samples	# Below Minimum D.O. Criteria of 11 mg/l	% Below Minimum D.O. Criteria of 11 mg/l	Rating
Myrtle Creek at Millsite Park	34	2	6	(red)	23	8	35	(red)
North Myrtle Creek across from Super Y	23	1	4	(red)	8	4	50	(red)
North Myrtle at Evergreen Park	10	0	0	(blue)	12	3	25	(red)
Bilger Creek at mouth	26	12	46	(red)	21	10	48	(red)
North Myrtle Creek above Bilger Creek	29	1	3	(red)	22	5	23	(red)
North Myrtle Creek at North Myrtle Park	27	1	4	(red)	20	7	35	(red)
Slide Creek 1.9 miles off North Myrtle Rd.	8	0	0	(blue)	2	1	50	(green)
Frozen Creek	3	0	0	(blue)	1	0	0	(blue)
Lee Creek at bridge on Bill Rice's	8	0	0	(blue)	2	1	50	(green)
Buck Fork Creek at 15391 N. Myrtle Creek Rd.	7	0	0	(blue)	1	1	100	(green)
Buck Fork Creek just above N.Myrtle Creek	6	0	0	(blue)	4	1	25	(green)
North Myrtle just above Buck Fork	6	0	0	(blue)	4	1	25	(green)
South Myrtle Creek at Neal Lane Bridge	28	0	0	(blue)	22	8	36	(red)
South Myrtle Creek, DC Cutoff Road	27	1	4	(red)	20	7	35	(red)
South Myrtle Creek at Taylors'	25	2	8	(red)	19	5	26	(red)
Louis Creek	12	0	0	(blue)	13	3	23	(red)
South Myrtle at bridge	25	0	0	(blue)	20	4	20	(red)
South Myrtle Creek at 12 Mile Ranch	11	0	0	(blue)	3	3	100	(red)
Litetia Creek	3	0	0	(blue)	1	1	100	(green)
Weaver Creek at first culvert	22	0	0	(blue)	20	3	15	(red)
South Myrtle Creek at end of yellow line	7	0	0	(blue)	2	2	100	(red)

Color Key:	(blue)	Good	No Exceedances of Criteria
	(green)	Fairly Good	Only 1 Exceedance of Criteria
	(yellow)	Concern	2 Exceedances of Criteria
	(red)	Needs Improvement	3 or more Exceedances of Criteria

Table 12: Rating of Myrtle Creek Sites for Stream Dissolved Oxygen Levels compared to Spawning Season and Non-spawning Season DEQ Criteria

RESULTS - Myrtle Creek Area

Conductivity

Conductivity levels in the Myrtle Creek Watershed varied by season over the years. Figure 30 indicates that the range was typically between 50-400 uS/cm with levels decreasing during the fall, winter and spring, and increasing during the summer. Figures 31, 33 and 35 suggest this is likely due to dilution and concentration since conductivity levels show an inverse relationship to rainfall. Rain water has low conductivity and increasing water levels due to rain dilute the mineral content.
Bilger Creek is the only stream that measured greater than 400 uS/cm. In 2004, Bilger Creek's conductivity exceeded 1000. That year Bilger Creek went dry at the monitoring site. In 2005, 2006, 2009 and 2010, Bilger levels reached the 500 range and the flow was greatly deminished but still actively flowing. In summer months Bilger demonstratess the opposite effect of dilution with less water dissolved solids are more concentrated and therefore conductivity levels are higher.

Table 13 summarizes and rates the streamsfor conductivity in the Mytle Creek Watershed.

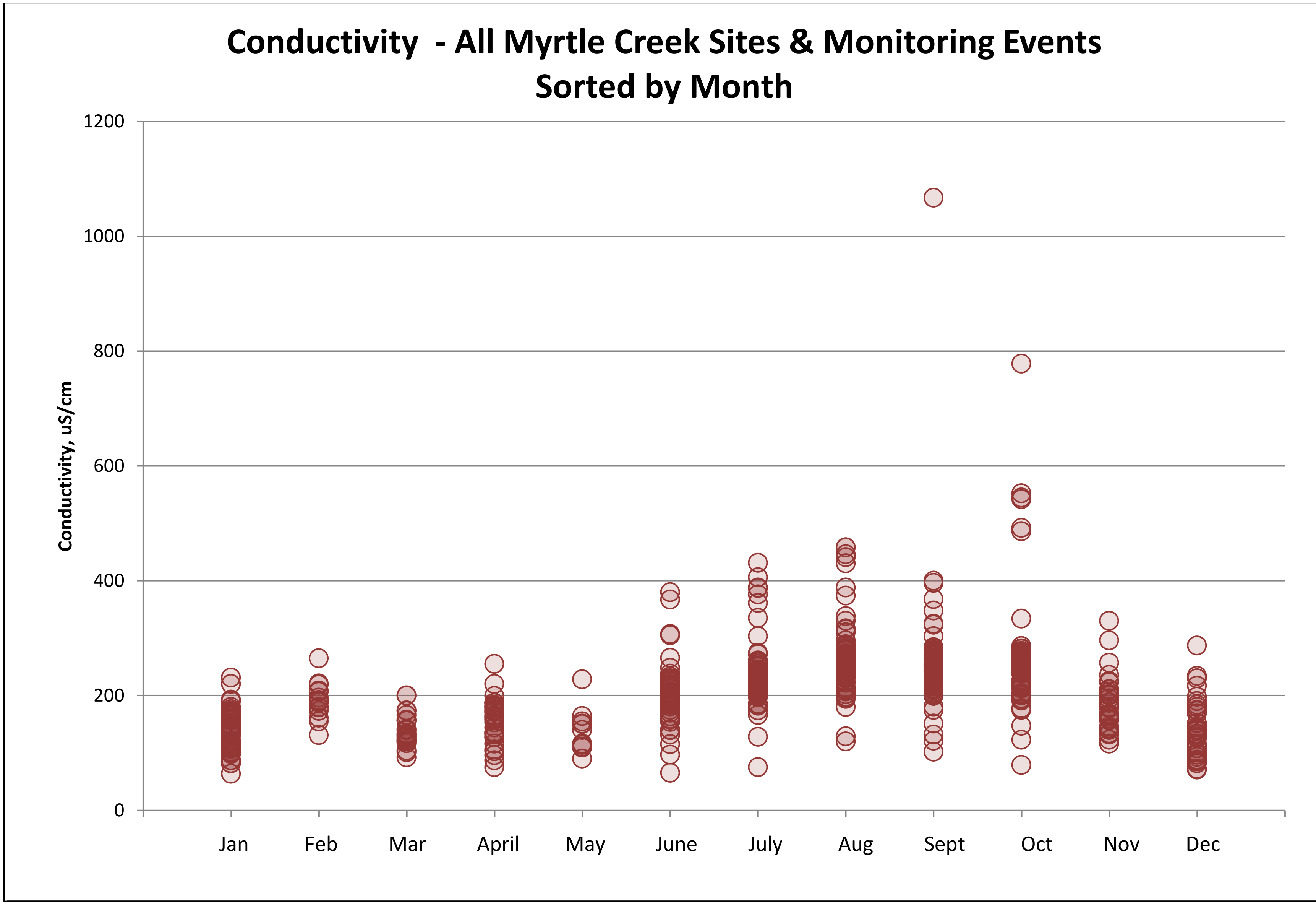


Figure 30: Stream conductivity levels by month for all Myrtle Creek data

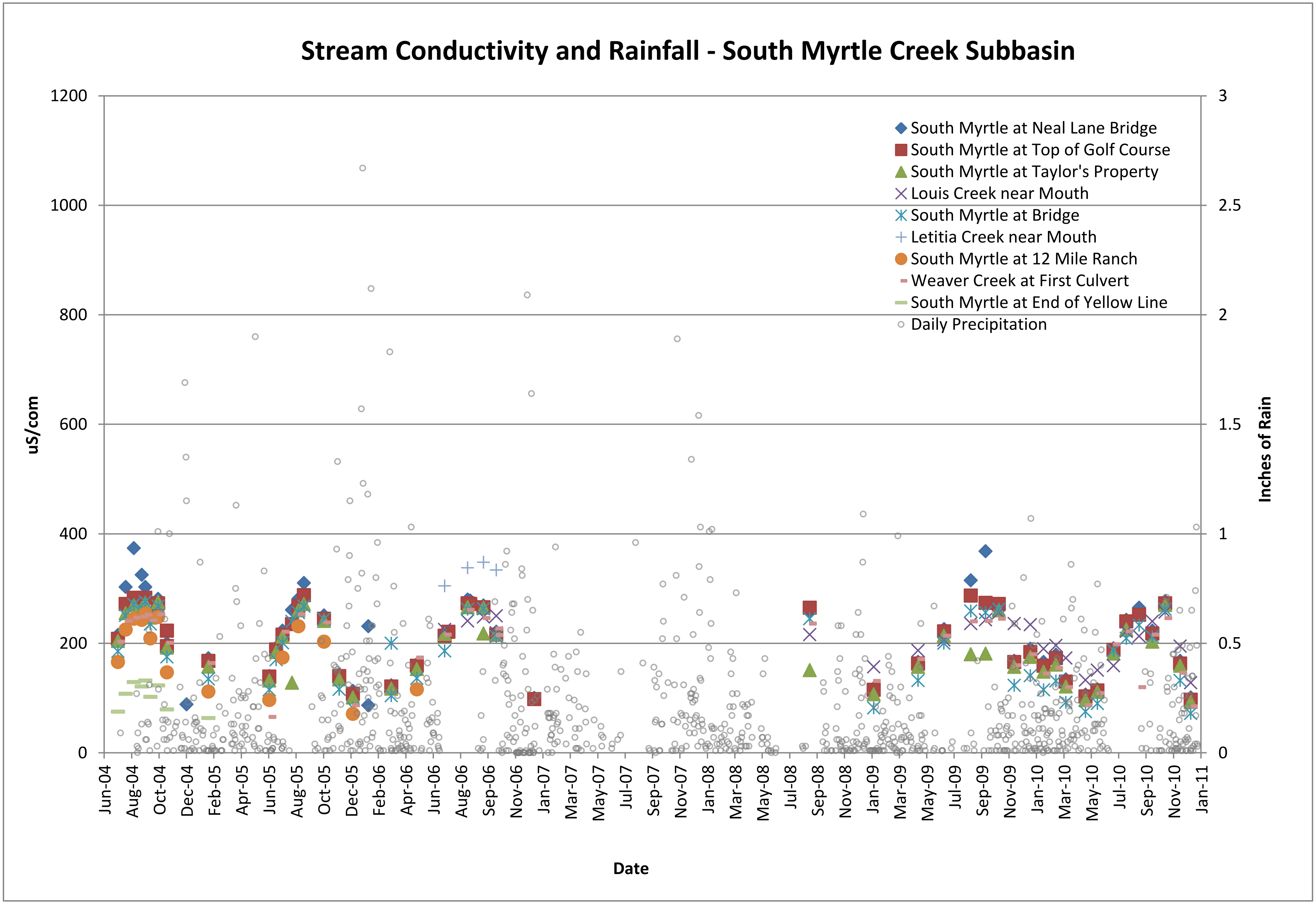


Figure 31: Stream conductivity South Myrtle Creek sites compared to rainfall at Roseburg, OR 2004-2010

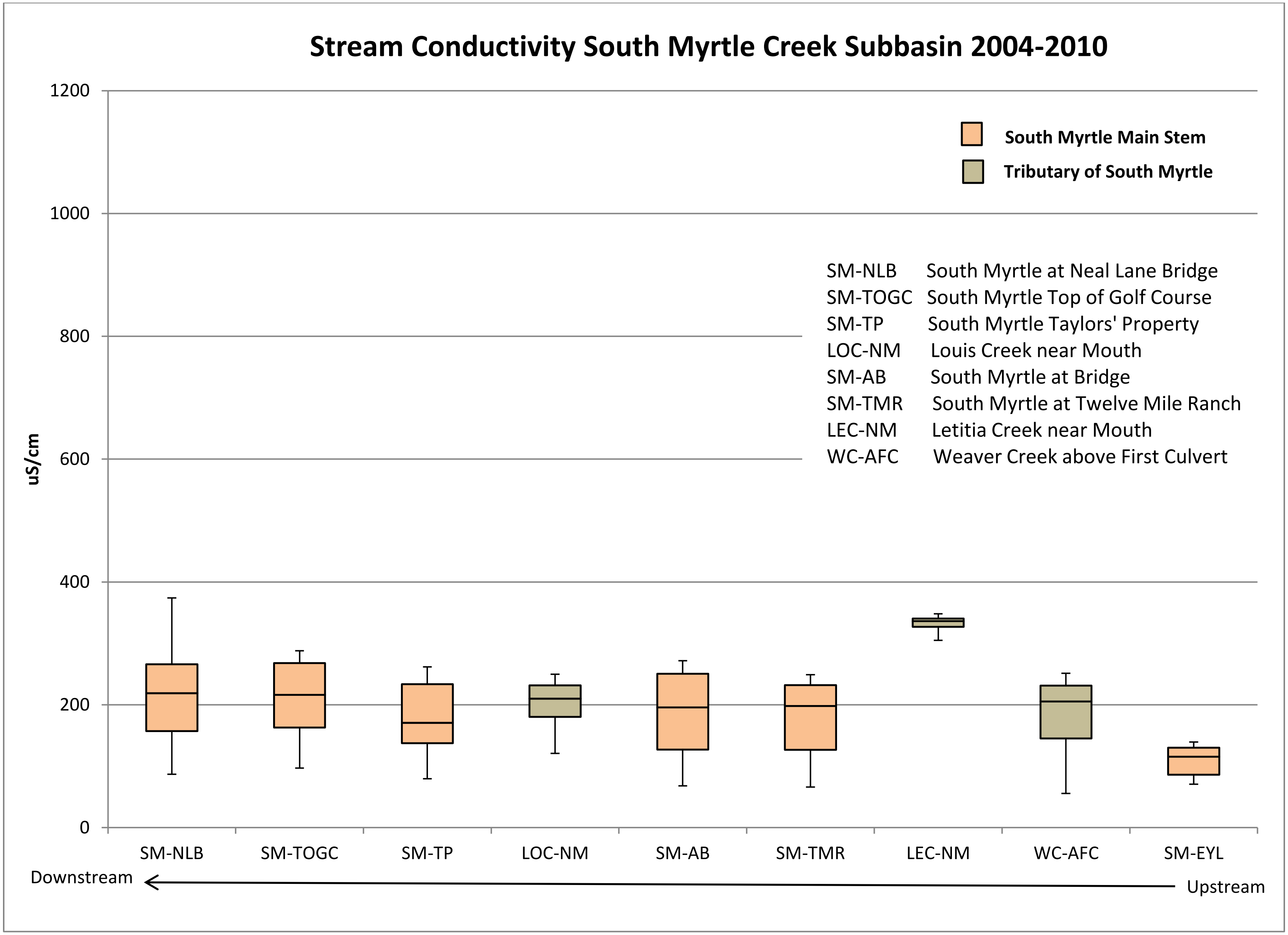


Figure 32: Stream conductivity South Myrtle Creek sites 2004-2010

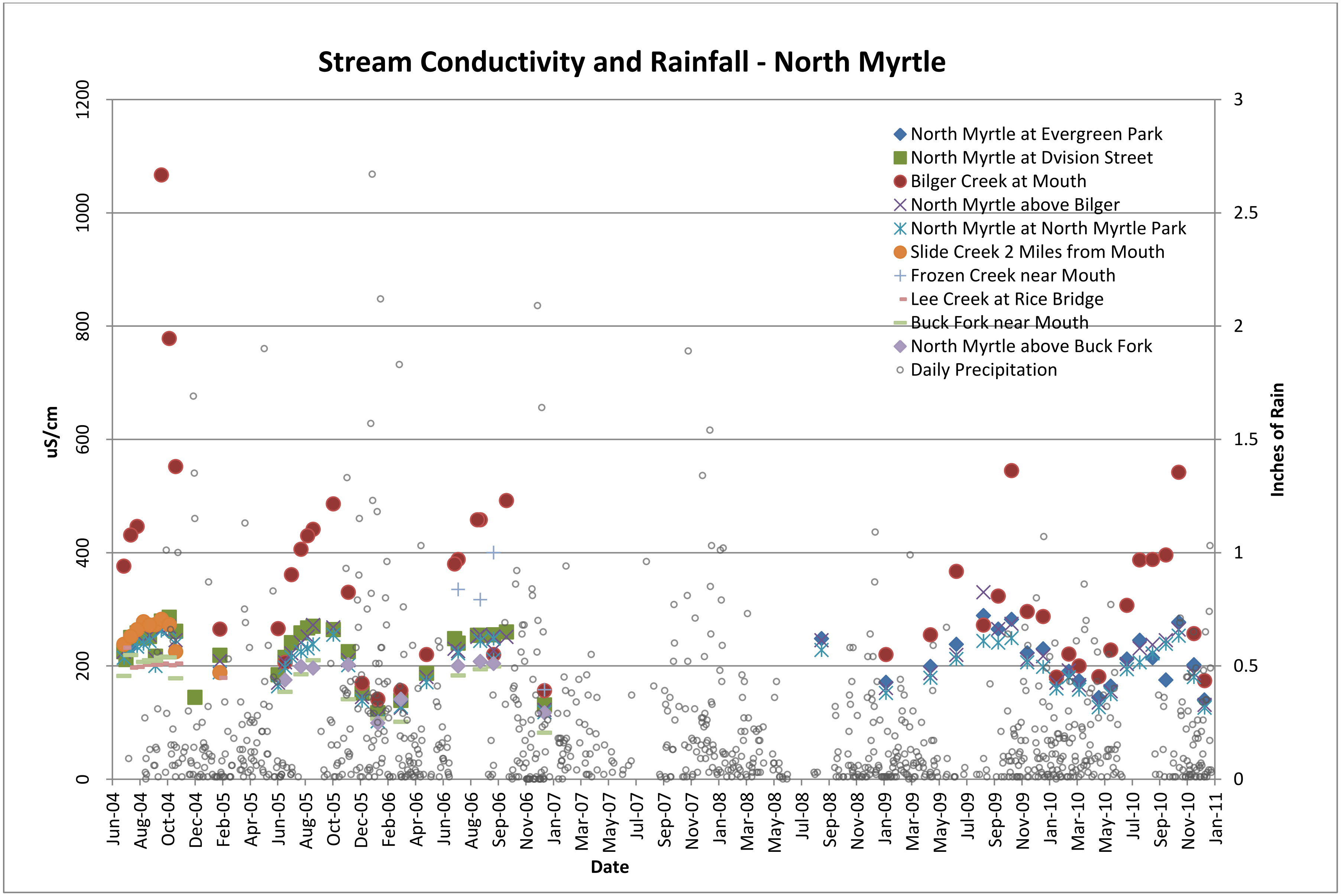


Figure 33: Stream conductivity North Myrtle Creek sites compared to rainfall at Roseburg, OR 2004-2010

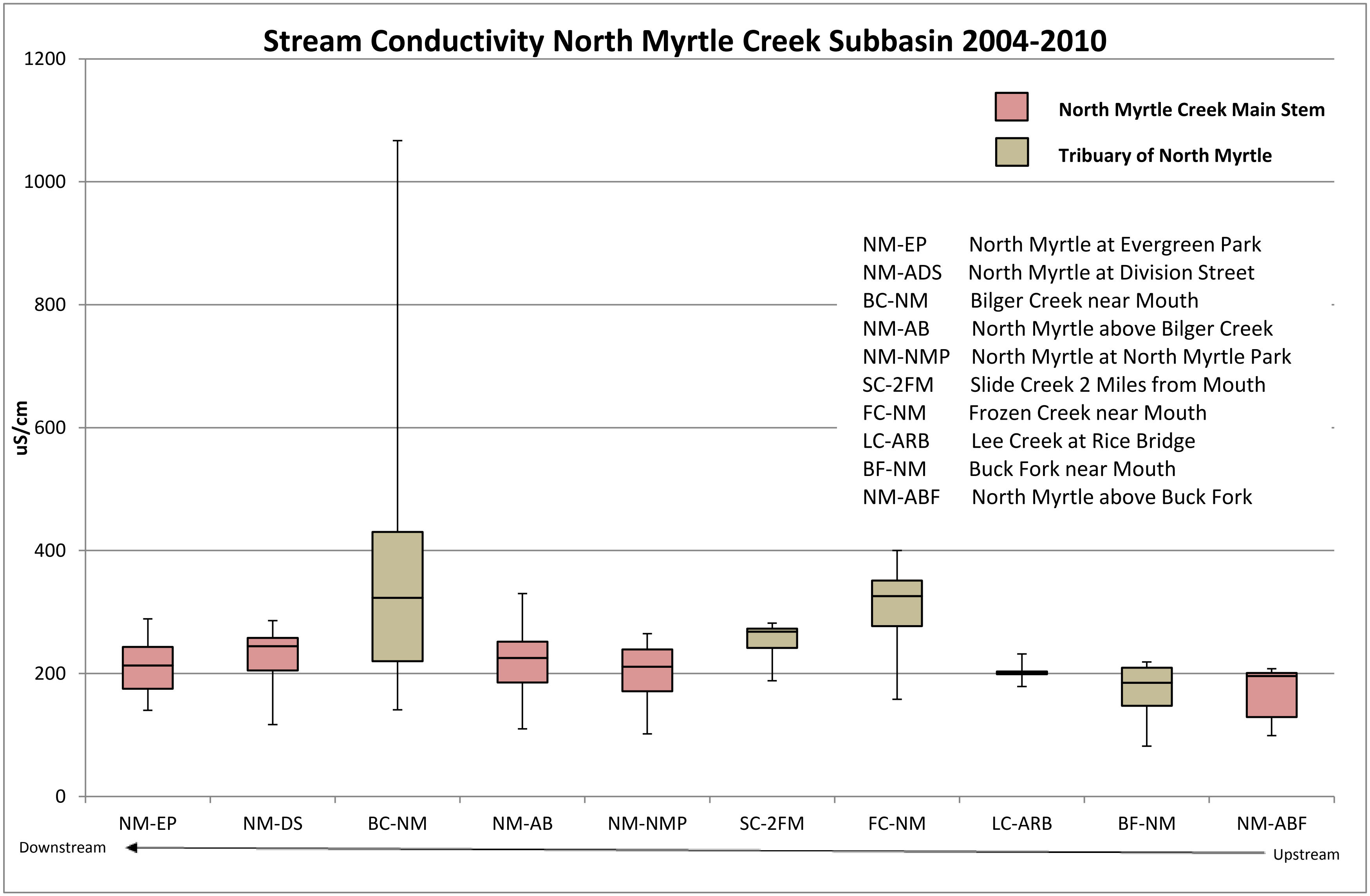


Figure 34: Stream conductivity North Myrtle Creek sites 2004-2010

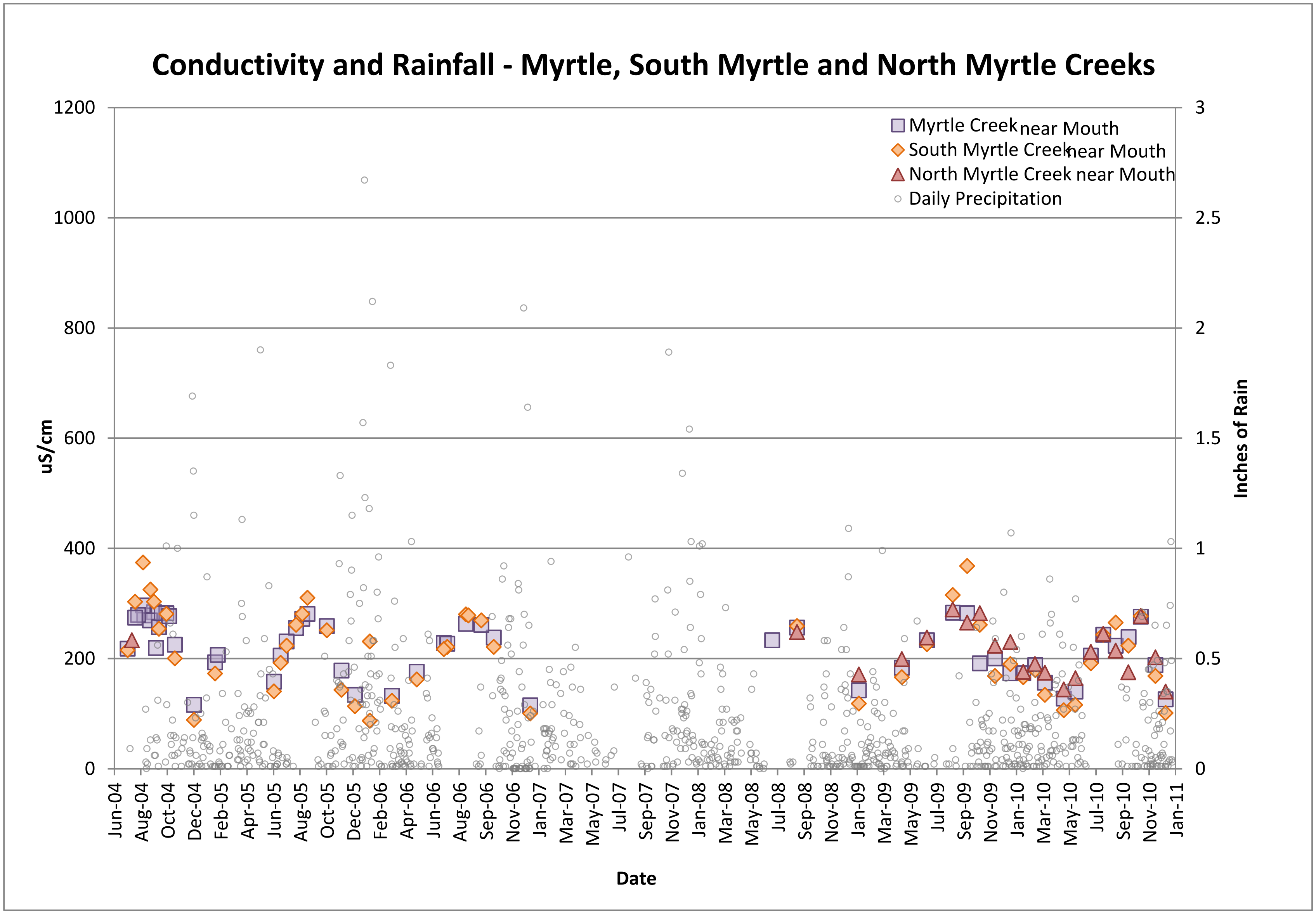


Figure 35: Conductivity levels North Myrtle, South Myrtle and Myrtle Creek compared to rain fall at Roseburg, OR 2004-2010

Rating of Myrtle Creek Sites for Stream Conductivity

SITE	Conductivity
Myrtle Creek at Millsite Park	
North Myrtle Creek across from Super Y	
North Myrtle at Evergreen Park	
Bilger Creek at mouth	
North Myrtle Creek above Bilger Creek	
North Myrtle Creek at North Myrtle Park	
Slide Creek 1.9 miles off North Myrtle Rd.	
Frozen Creek	
Lee Creek at bridge on Bill Rice's	
Buck Fork Creek at 15391 N. Myrtle Creek Rd.	
Buck Fork Creek just above N.Myrtle Creek	
North Myrtle just above Buck Fork	
South Myrtle Creek at Neal Lane Bridge	
South Myrtle Creek, DC Cutoff Road	
South Myrtle Creek at Taylors'	
Louis Creek	
South Myrtle at bridge	
South Myrtle Creek at 12 Mile Ranch	
Litetia Creek	
Weaver Creek at first culvert	
South Myrtle Creek at end of yellow line	

Rating	Color	Conductivity Level
Good		<500 uS/cm
Needs Improvement		>500 uS/cm

Table 13: Rating of Myrtle Creek Sites for Stream Conductivity and Rating Key

RESULTS - Myrtle Creek Area

E. coli Bacteria

E. coli levels a substantial concern in the Myrtle Creek Watershed. Figure 36, which displays all of the data by month, indicates the June through October period has very occurrences; there is also a spike in January. We hypothesize that the summer high levels are due to low flows which make *E. coli* levels concentrated. During the winter months there may be reduced contamination and/or dilution due to higher water flows; see Figure 41 for comparison to rainfall. The spike in January may be due to storm events which carry contamination from further off river sites into waterways. Figure 41 to supports this theory, as particularly high rainfall is seen to occur in January. Figure 41 also indicates that *E. coli* levels at the mouth of Myrtle Creek tend to drop from 2004 to 2010 but so are the precipitation levels for the same period. Table 14 summarizes all the monitoring sites and rates them in terms of *E. coli* levels. Trendlines are included in Figure 44, a plot of all *E. coli* data analyzed from 2004 through 2010, and Figure 41, Myrtle near the mouth, a plot of *E. coli* and rainfall. Though the trendlines demonstrate a slight downward trend they should not be considered valid due to unacceptably low R^2 statistic. This data is characterized by a few very high values (with the power to skew a regression line and significantly lower the R^2 statistic) while most measurements are clustered lower, thus simple linear regression is probably not the best way to determine trends in *E. coli.*

In establishing our original monitoring sites and plan, concern had been expressed by locals that there might be increased *E. coli* levels in South Myrtle Creek below the area of the golf course. We monitored two sites in this area, the first near the top of the golf course referred to as Days Creek Cutoff; the second below the golf course where Neil Lane Bridge crosses South Myrtle Creek (see Figure 47 for data graph). We tested whether *E. coli* levels differed significantly between these two sites. The mean value of *E. coli* measurements was 527.02 at Neal Lane Bridge, and 298.78 at Days Creek Cutoff. We used a two-sample Welch's t-test to test the hypothesis that the mean value for *E. coli* measurements is lower at the Days Creek Cutoff than at Neal Lane Bridge (Welch's t-test assumes unequal variance between the two samples. We rejected the equal variance hypothesis based on a variance ratio test or F-test at the .01 significance level). Our null hypothesis is that there is no difference between the mean values of *E. coli* measurements above and below the golf course. We used a significance level of $\alpha = .05$. The t-test yielded a p-value of .0158. Thus, we reject the null hypothesis. Figure 40 compares *E. coli* box plots for these two sites**.** Although both means were skewed upward by the presence of outliers, the plots do not appear to contradict our conclusion that there is a significant increase in *E. coli* levels below the golf course. Further investigation would be necessary to determine the source of this contamination. There are houses along South Myrtle Creek in this area that are very near the creek, there are several small tributaries that come off farmlands across Days Creek Cutoff Road and at certain times of the year treated wastewater is used to irrigate the golf course. We do not know whether these factors might be contributing to the problem or whether there are other variables at play.

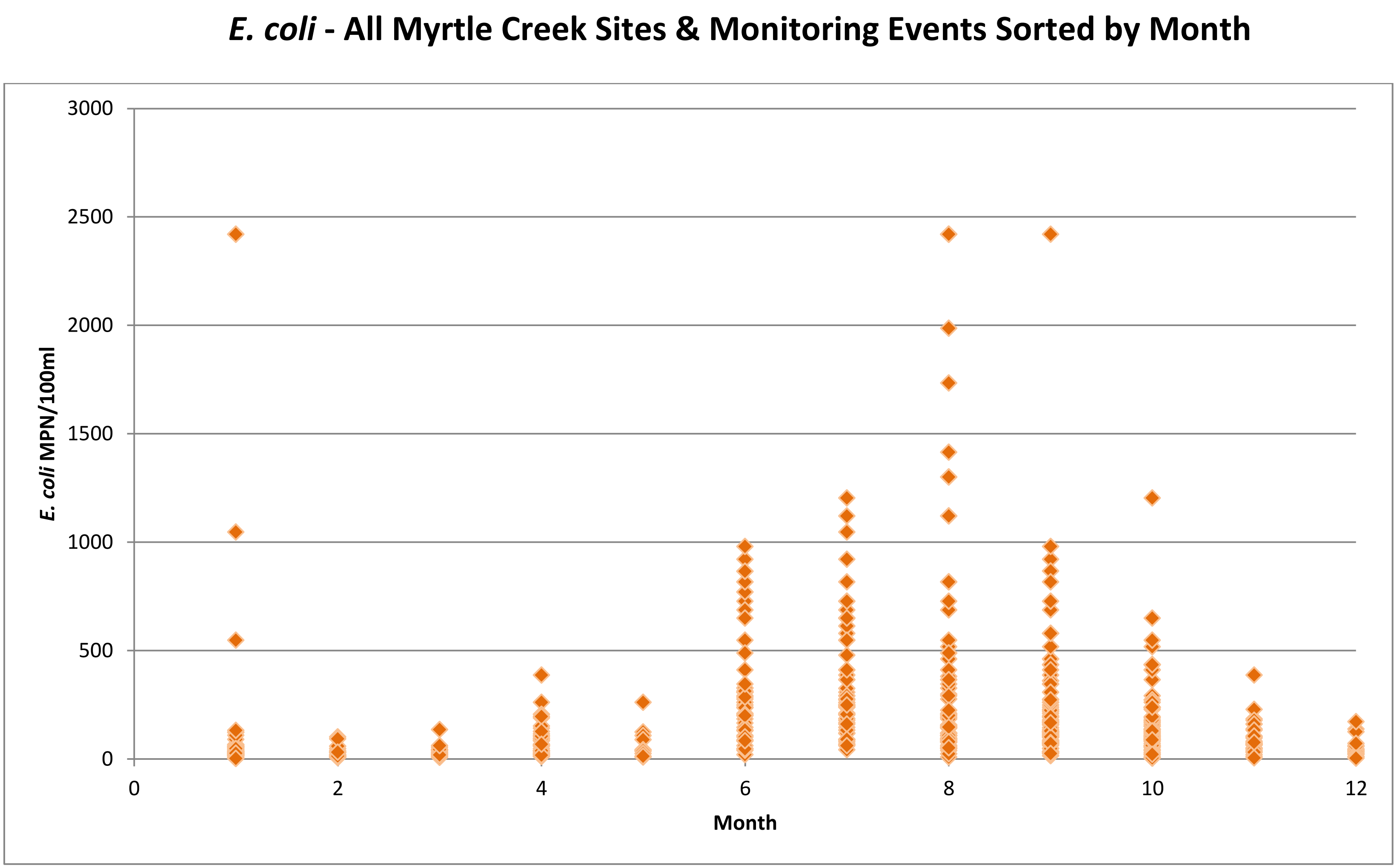


Figure 36: *E. Coli* - All Myrtle Creek Sites & Monitoring Events Sorted by Month

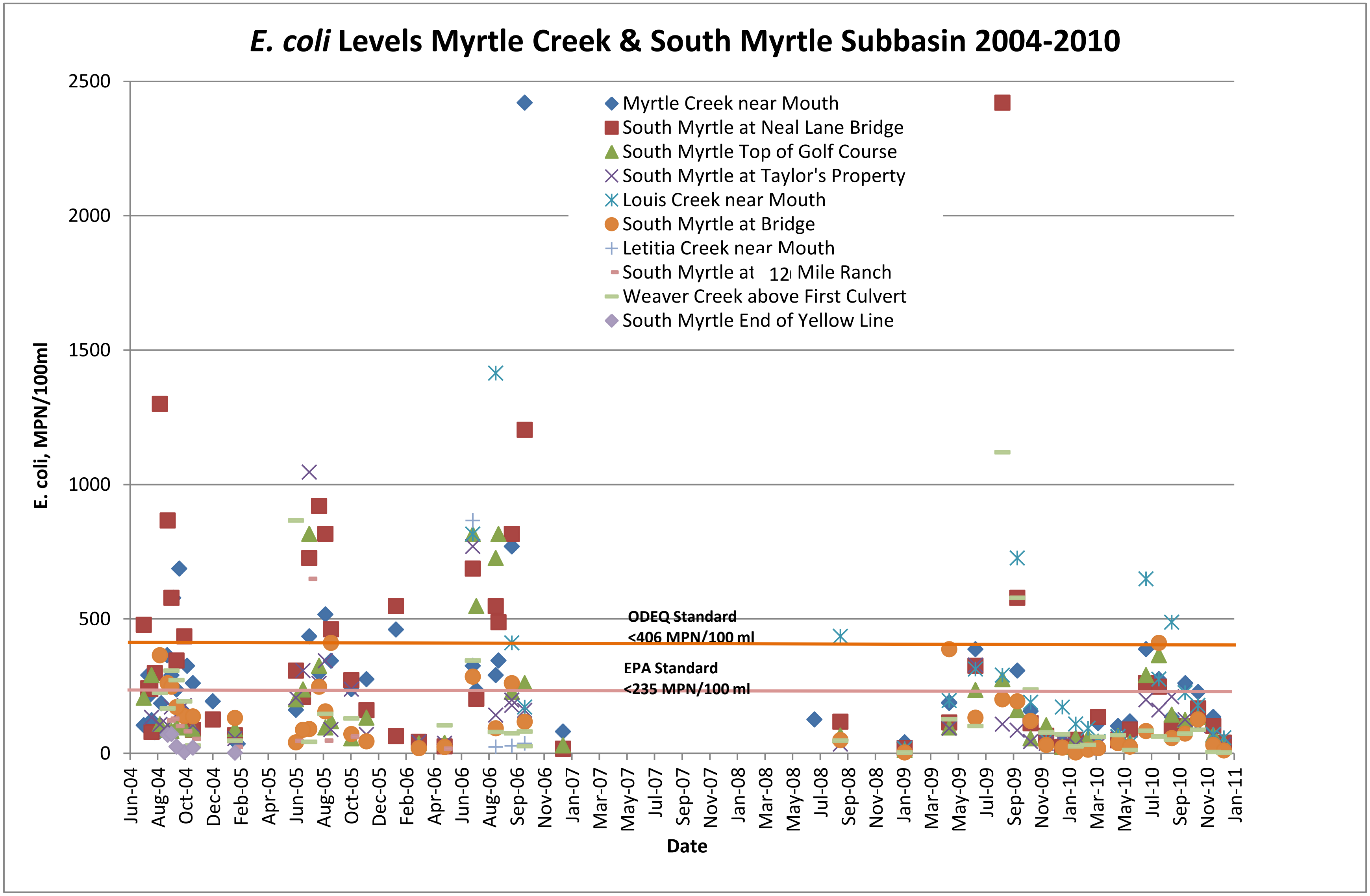


Figure 37: *E. coli* Levels Myrtle Creek & South Myrtle Subbasin 2004-2010.

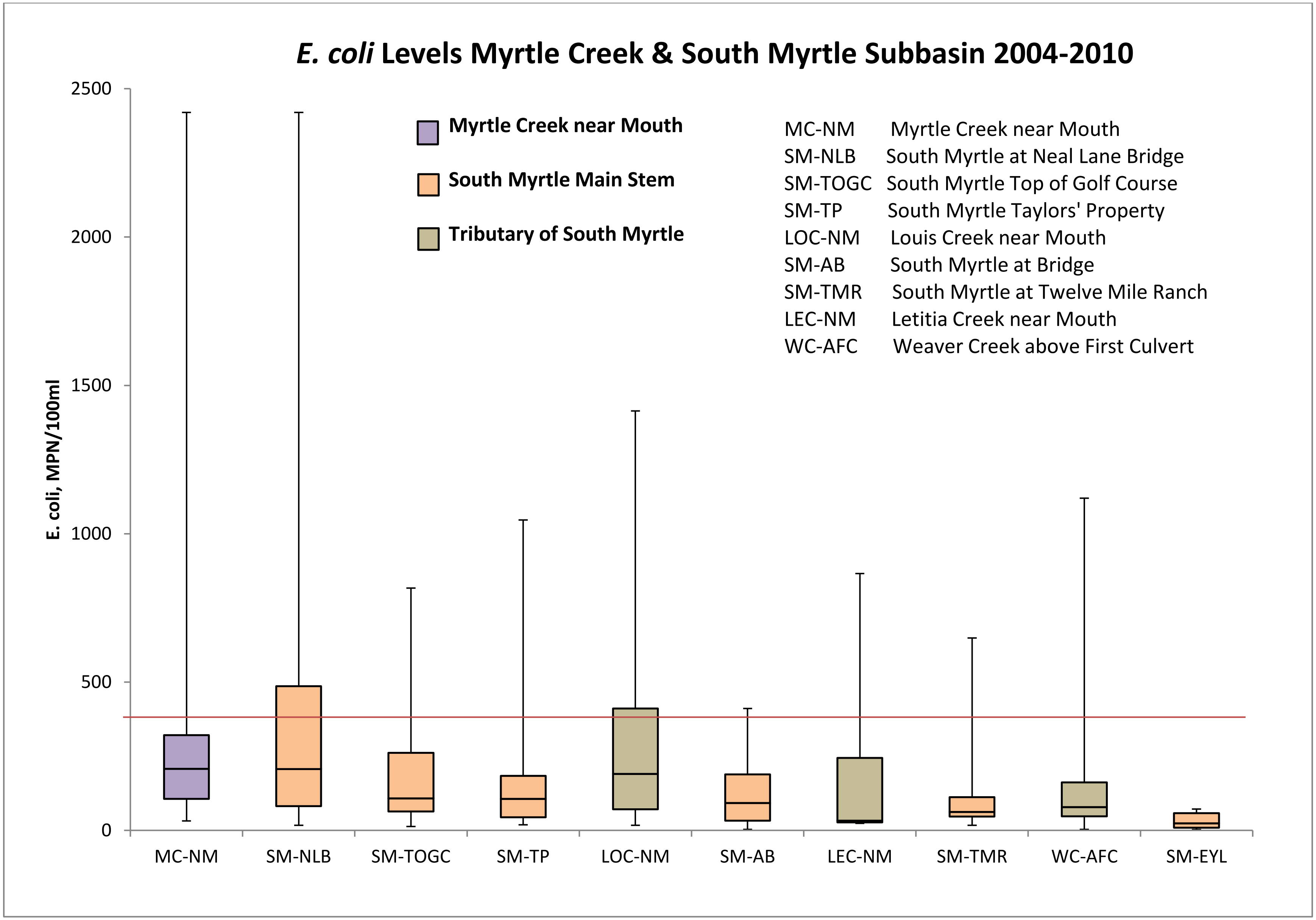


Figure 38: *E. coli* Levels Myrtle Creek & South Myrtle Subbasin 2004-2010.

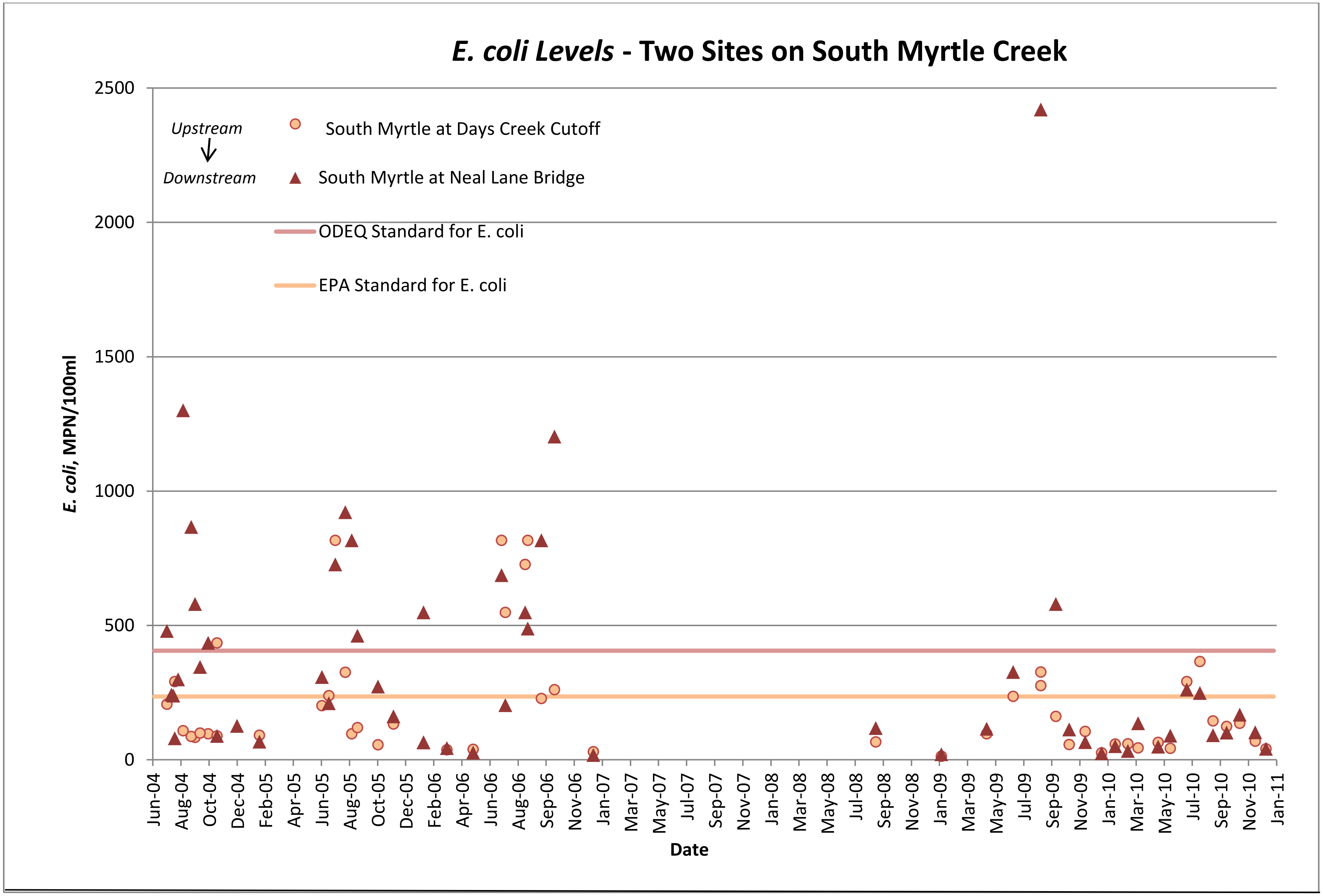


Figure 39: *E. coli* Levels Myrtle Creek & South Myrtle Subbasin 2004-2010.

Comparison of *E. coli* Levels at Two Sites on South Myrtle Creek

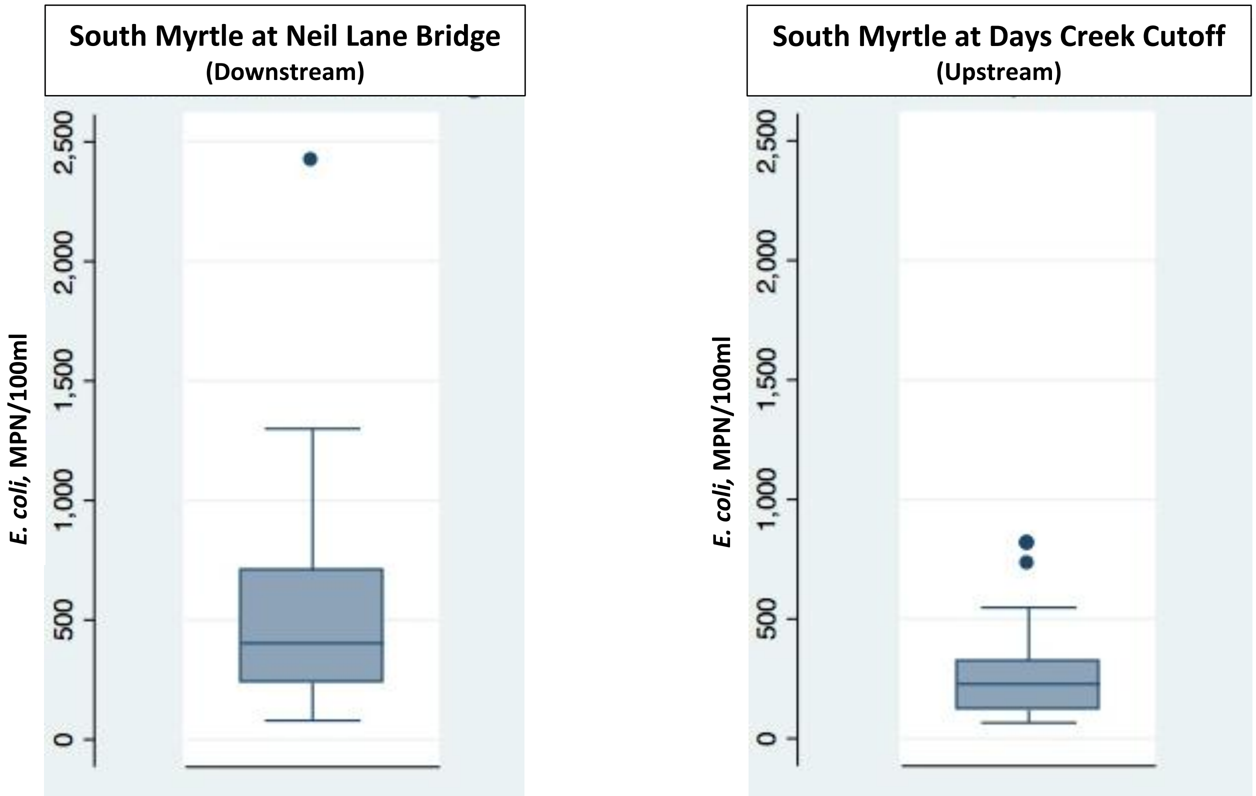


Figure 40: These boxplots describe the spread of *E. coli* data at Neal Lane Bridge and Days Creek Cutoff monitoring sites. Dots represent outliers, rather than being included in the whisker as presented elsewhere in this report.

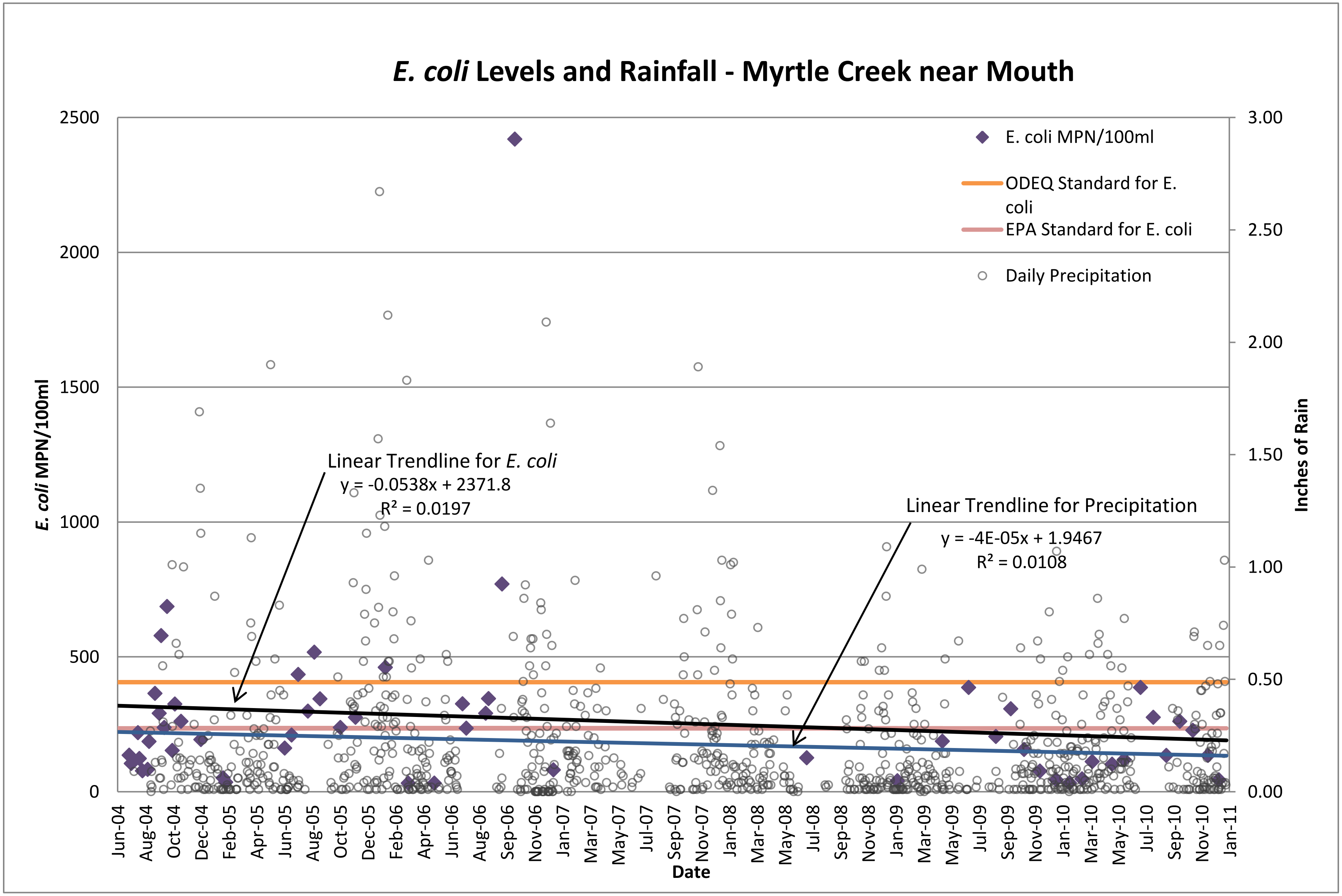


Figure 41: Stream *E. coli* Levels Myrtle Creek near Mouth and Rainfall at Roseburg, OR. Note the unacceptably low r^2 values.

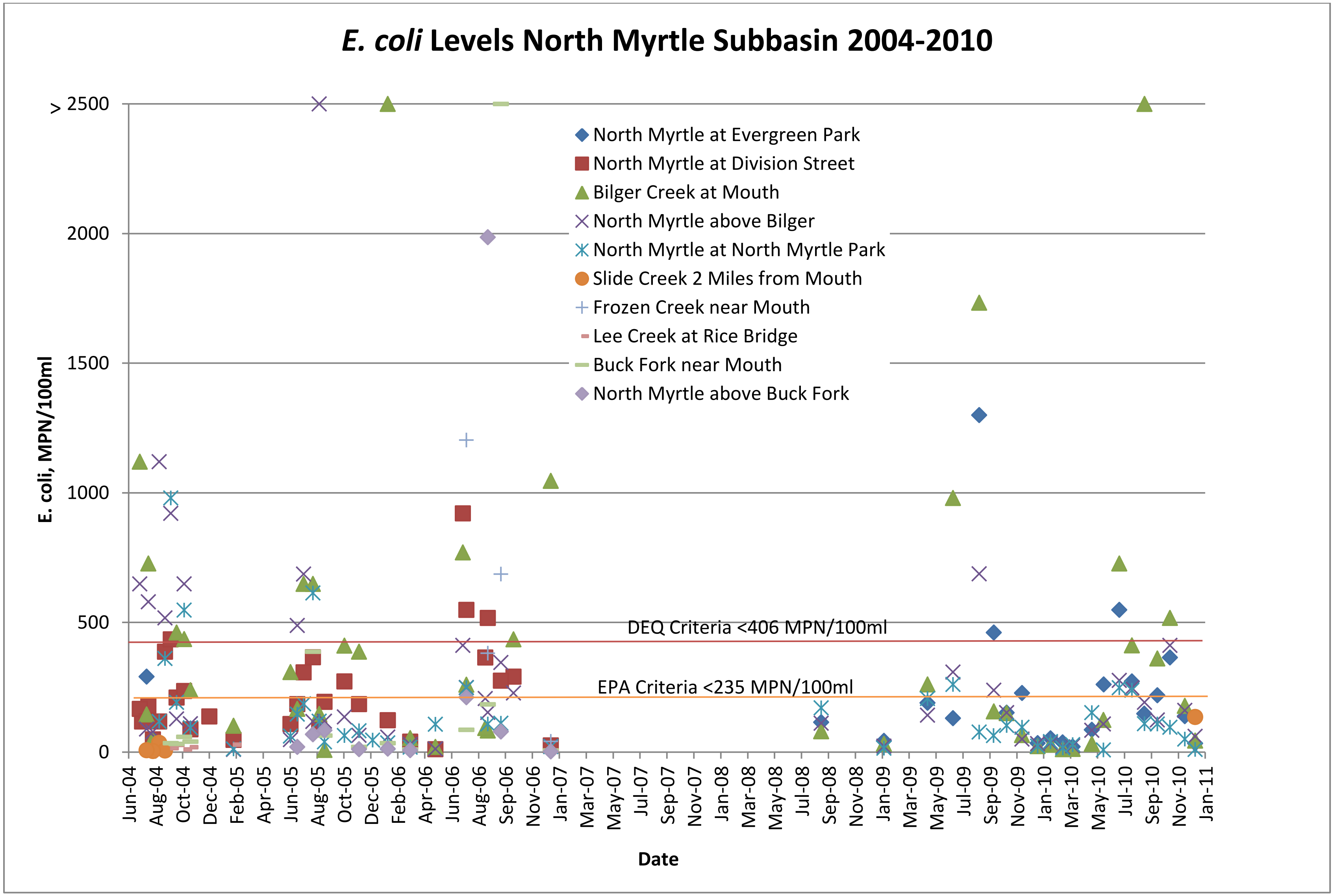


Figure 42: ***E. coli*** **levels, North Myrtle Subbasin, 2004-2010**

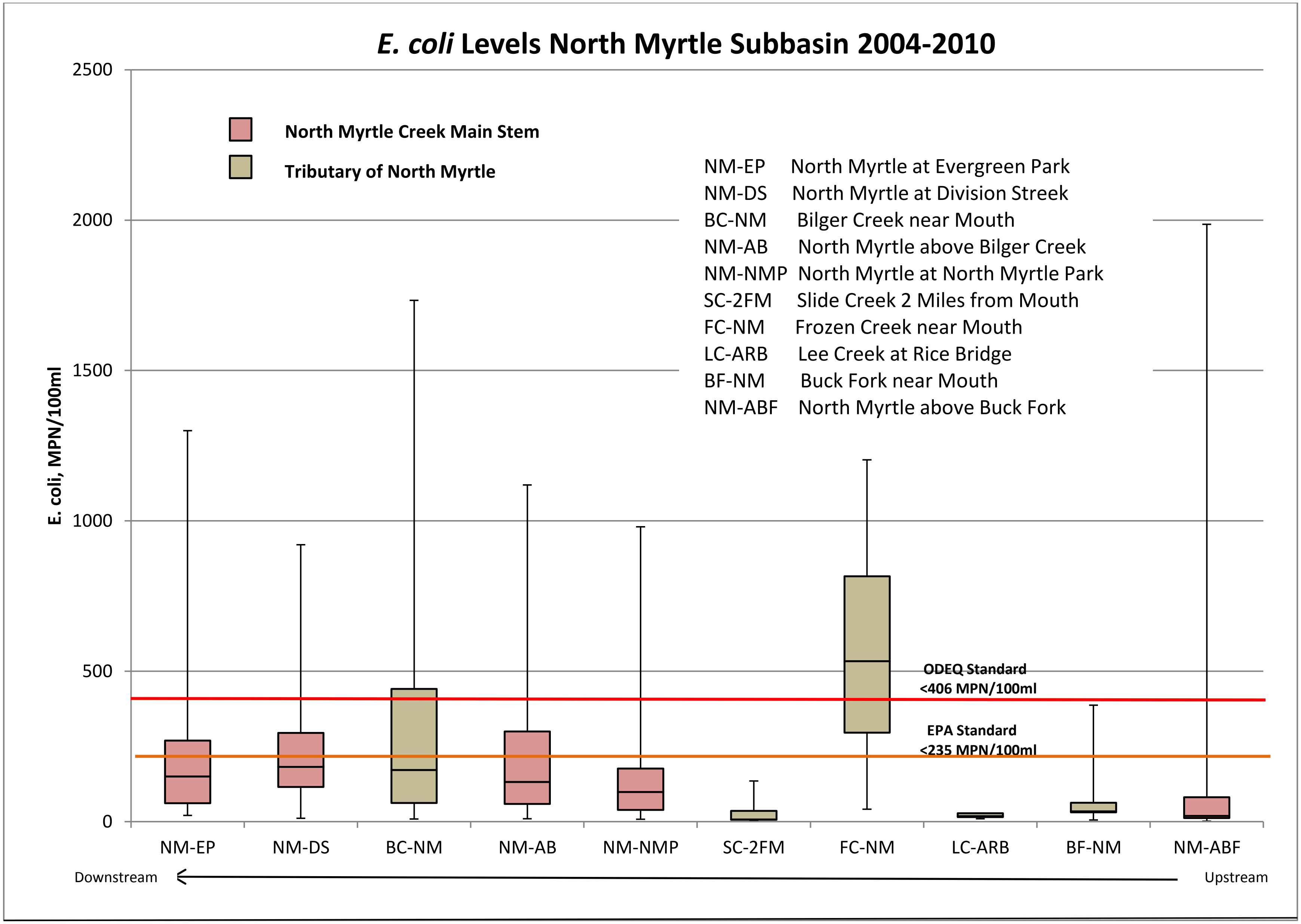


Figure 43: ***E. coli*** **levels, North Myrtle Subbasin, 2004-2010**

Rating of Myrtle Creek Sites for *E. coli*, Summer and Winter

SITE	Summer				Winter			
	# SAMPLES	% ABOVE EPA Criteria (235 MPN/100ml)	% ABOVE ODEQ Criteria (406 MPN/100ml)	Rating	# SAMPLES	% ABOVE EPA Criteria (235 MPN/100ml)	% ABOVE ODEQ Criteria (406 MPN/100ml)	Rating
Myrtle Creek at Millsite Park	30	63	17		26	23	8	
North Myrtle Creek across from Super Y	20	45	20		11	27	0	
North Myrtle at Evergreen Park	9	56	33		13	15	0	
Bilger Creek at mouth	23	61	48		22	41	27	
North Myrtle Creek above Bilger Creek	27	59	37		22	9	9	
North Myrtle Creek at North Myrtle Park	21	33	10		23	4	4	
Slide Creek 1.9 miles off North Myrtle Rd.	2	0	0		3	0	0	
Frozen Creek	3	100	67		1	0	0	
Lee Creek at bridge on Bill Rice's	2	0	0		3	0	0	
Buck Fork Creek at 15391 N. Myrtle Creek Rd.	2	0	0		2	0	0	
Buck Fork Creek just above N.Myrtle Creek	5	40	20		4	0	0	
North Myrtle just above Buck Fork	6	17	17		4	0	0	
South Myrtle Creek at Neal Lane Bridge	28	79	50		24	13	8	
South Myrtle Creek, DC Cutoff Road	25	48	20		22	5	0	
South Myrtle Creek at Taylors'	23	26	9		21	5	0	
Louis Creek	11	91	64		14	0	0	
South Myrtle at bridge	21	38	10		21	5	0	
South Myrtle Creek at 12 Mile Ranch	6	17	17		5	0	0	
Litetia Creek	3	33	33		1	0	0	
Weaver Creek at first culvert	18	33	17		21	5	0	
South Myrtle Creek at end of yellow line	3	0	0		3	0	0	

Rating	Color	*E. coli* MPN/100ml
Good		<100
Fairly Good		>100<235
Concern		>235<406
Needs Improvement		> 406

Table 14: Rating and key for all Myrtle Creek sites for *E. coli,* summer and winter.

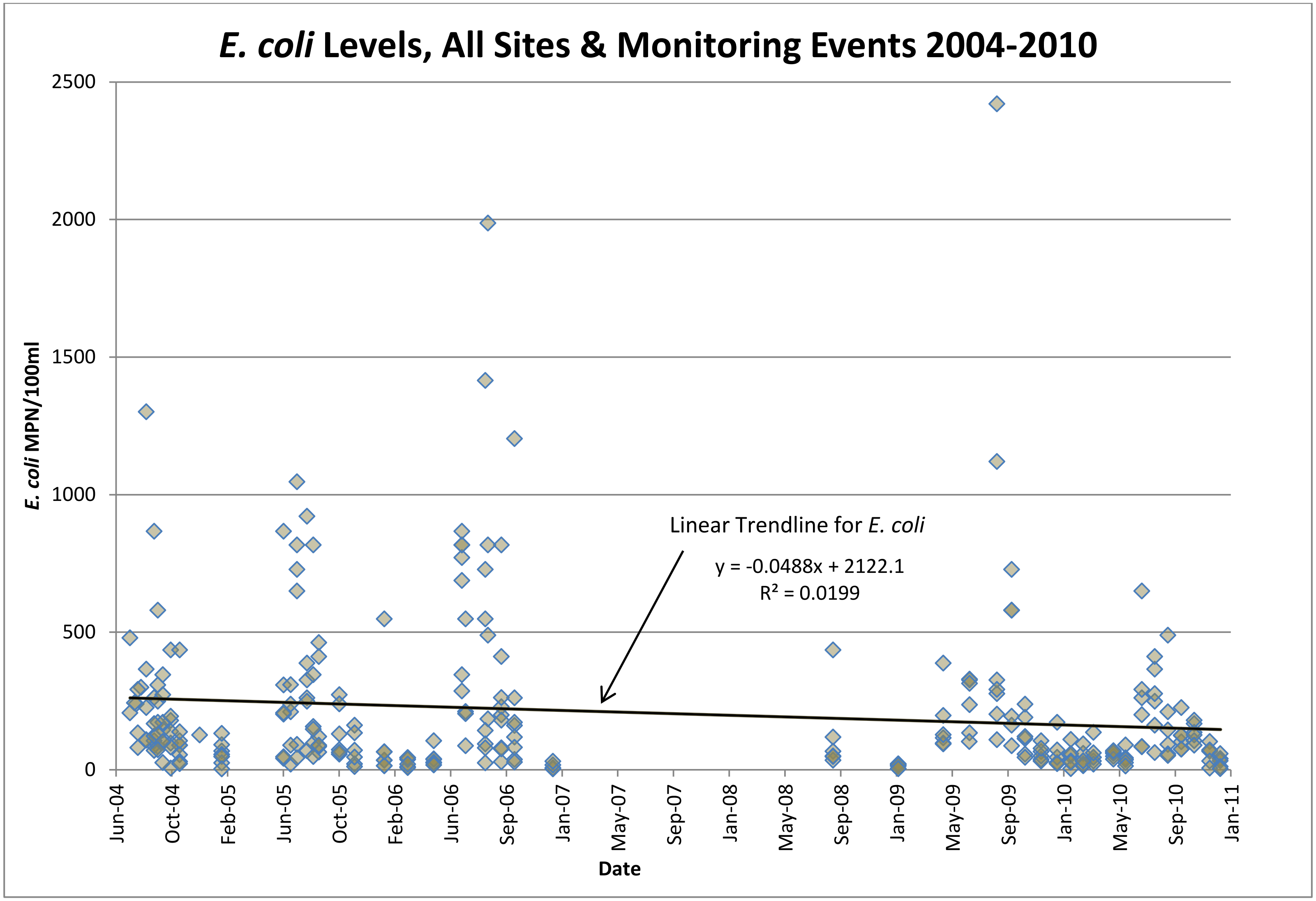


Figure 44: *E. coli* levels all sites and monitoring events 2004-2010.Note the unacceptably low r^2 value.

RESULTS - Myrtle Creek Area

Temperature

Continuous Temperature

The Myrtle Creek area had 16 PUR continuous temperature monitoring sites and one Reference site "North Myrtle Creek at Mouth." This reference site is a long-term monitoring site originally monitored for the large-scale Umpqua Basin Stream Temperature Characterization Project (Smith, K., 2003) and annual updates 2005-2010 (Smith, K., 2005), (Dammann, D.M. and K. Smith, 2006), (Dammann, D.M., 2007), (Dammann, D.M., 2008), (Dammann, D.M., 2009), and (Dammann, D.M., 2010). Dates of continuous summer stream temperature monitoring in the Myrtle Creek area, seasonal maximum and minimum stream temperatures, diurnal fluctuations, seven day average maximum (7DAM) stream temperatures, and days above the DEQ criteria (ODEQ, 2003) and (ODEQ, 2011, p. 46) are listed in Appendix K. All streams in the Myrtle Creek area fall into the designated fish use of salmon and trout rearing and migration (ODEQ, 2003) and therefore the 7DAM stream temperatures may not exceed 64.4°F (ODEQ, 2011, p. 46). The 7DAM stream temperatures for the streams monitored in the Myrtle Creek area during this study (2005-2010) ranged from 65.2°F to 80.7°F, all exceeding the DEQ criteria (Appendix K).

Many monitoring sites exceeded the potentially lethal temperatures Bell (1990, p. 11.4) found for steelhead and cutthroat trout (75.0°F and 73.0°F respectively) (Appendix K). Some sites even exceeded the higher lethal stream temperatures (Brett, 1952) found for young coho and Chinook salmon of ≥78.8°F (Table 15). Brett found 50% mortality at this temperature after 16.7 hours. However, of those Myrtle Creek area sites that were ≥78.8°F they were only at this temperature for up to eight hours with a minimum temperature on the date of maximum stream temperature ranging from 68.4°F to 72.7°F (Table 15). Though the temperatures of these sites may exceed the lethal limit for several days, this temperature did not last more than 8 hours/day. Therefore, it is unlikely that these lethal levels actually killed fish. None the less metabolic stress and increased possibility of disease likely occurred.

Table 15. Seasonal maximum stream temperatures (SMST) for Myrtle Creek area sites that meet or exceed 78.8°F, which has been described at the lethal limit for young coho and Chinook salmon acclimated to 70°F (measured as 50% mortality after 16.7 hours) (Brett, 1952, p. 282)**. N. Myrtle Creek at Mouth is from reference site data** (Dammann, D.M. and K. Smith, 2006) **and** (Dammann, D.M., 2009)**.**

Site	Year	Seasonal Maximum Stream Temperature (SMST) (°F)	Hours ≥78.8°F on Date of SMST	Minimum Temperature on Date of SMST (°F)
Myrtle Ck. near Mouth	2006	80.9	6	72.7
	2009	80.8	6.5	71.5
N. Myrtle Ck. at Mouth	2006	81.0	5	72.0
	2009	81.5	6.5	70.8
N. Myrtle Ck. above Bilger Ck.	2006	79.4	4	69.2
	2009	78.9	1.5	69.4
N. Myrtle Ck. at Evergreen Park	2008	78.8	2.5	68.4
	2009	82.1	6.5	72.4
S. Myrtle Ck. at Neal Lane Bridge	2006	80.9	6	71.3
S. Myrtle Ck. at Taylor's Property	2006	80.3	6	70.6
S. Myrtle Ck. at Top of Golf Course	2006	81.6	4.5	72.8
	2009	82.9	8	70.5

In the Myrtle Creek area, there is consistent continuous stream temperature data annually from July 9 to September 2. The percentage of days within this time period that the temperature exceeded the 64.4°F criteria is mapped along with land use in Figure 45. Years were combined to reduce the effect of annual variability, though not all streams were monitored each year (Appendix K). Overall, the tributaries and upper reaches of North and South Myrtle Creeks had fewer days exceeding the criteria, while the lower reaches and the Myrtle Creek site had greater than 91% of the days exceeding the criteria (Figure 45). Since water temperatures in the upper 60's is a stressor to salmonids (Bjornn & Reiser, 1991, p. 84) and (The Oregon Plan for Salmon and Watersheds, 1999, pp. 6-1), the percent of days above 68°F was also mapped (Figure 46). The lower reaches had fewer days above this criteria, but still greater than 81% (Figure 46). North Myrtle Creek at Division Street had 91% of days above 68°F. This is because it was only monitored in 2005 and 2007, both of which had warmer stream temperatures throughout the Umpqua basin; the downstream site, North Myrtle Creek at Evergreen Park, was monitored 2008-2010 and 2008 and 2010 both of which had cooler stream temperatures throughout the Umpqua basin (Appendix K). The effect of this annual variability combined with non-annual monitoring resulted in North Myrtle at Division Street appearing to have higher temperatures than downstream sites. In 2005, the South Myrtle Creek at Neal Lane Bridge site only has data until 8/15, however, by comparing existing data in this shorter data set to similarly behaving sites nearby, the whole data set could be extrapolated enough to determine that even with a complete data set, there would be no change to the percent range on either Figure 45 or 46.

When the cold limit line (Smith, K., 2003, Apx. 1, p. 9) is graphed with the 7DAM stream temperatures for sites along North Myrtle Creek, it shows that all are above the optimal stream temperature; in addition, sites closer to divide are closer to the cold limit line compared to sites further from the divide, or further downstream (Figures 47 and 48). Sites along South Myrtle Creek and Myrtle Creek follow the same pattern (Figures 49 and 50). This could be due to increased anthropogenic effects downstream. Land use for sites along North and South Myrtle Creeks changes from forested land to agricultural lands to rural residential to city further downstream (Figures 47 and 50). A tabular form of these differences in 7DAM stream temperature, for each site and land use by year, is shown in Table 16.

Overall, the North Myrtle Creek sites have higher differences from the cold limit line than other streams (Figures 47 and 48 and Table 16), which is consistent with the findings that the North Myrtle Creek sites had higher percentage of days above 64.4°F and 68°F (45 and 46). The 7DAM stream temperatures for North Myrtle Creek and Buck Fork (a major contributor to North Myrtle Creek at its confluence) are almost equidistant from the cold limit line when monitored in 2006 with differences of 7.0°F and 6.9°F respectively (Table 16). Given that consistency, it makes it even more interesting to follow the rest of the sites further from the divide along North Myrtle Creek in 2006 in Figure 48. The 7DAM stream temperatures of the other sites monitored that year range from 9.7 to 11.0°F from the cold limit line, which is much higher than the upstream sites (Table 16). This same pattern of large differences in the 7DAM stream temperatures compared to the cold limit line is present at all downstream sites on North Myrtle Creek (at Myrtle Park, above Bilger Creek, at Division Street, at Evergreen Park, and at the mouth). The land use at these sites is city, rural residential, or agriculture. The 7DAM stream temperatures at North Myrtle Creek at North Myrtle Park have some of the highest differences from the cold limit line every year, indicating this site, which is downstream from agricultural land, may be in need of the most restoration related to improving stream temperature (Figures 47 and 48 and Table 16). North Myrtle Creek at Evergreen Park had very high stream temperatures in 2008 which skew the data when comparing it to the site at the mouth which is only 0.1 miles downstream (Figures 47 and 48 and Table 16). The reason for this anomaly is unknown.

As with North Myrtle Creek, sites closest to the divide along South Myrtle Creek have the smallest differences between the cold limit line and the 7DAM stream temperatures, though these sites are in agricultural land use (Figures 49 and 50 and Table 16). South Myrtle at the Top of the Golf Course and South Myrtle Creek at Taylor's Property both have the highest differences from the cold limit line compared to other sites along South Myrtle Creek (Table 16). This same trend is seen when looking at the annual data (Figure XX-M4), which indicates that there is more impact upstream from these sites negatively affecting water temperature at these two sites. In 2005, the South Myrtle Creek at Neal Lane Bridge site only has data until 8/15, however the 7DAM stream temperature was captured, as compared to other sites in the area, so there is no error due to this short data set.

Tributaries of North and South Myrtle Creeks monitored do not have as large of a difference in 7DAM stream temperature compared to the cold limit line as does North Myrtle, South Myrtle, or Myrtle Creek sites (Figure 51 and Table 16). This could be due to their smaller distance to divide so there hasn't been as much stream heating. Letitia Creek, Weaver Creek and Louis Creek are all forested upstream, with some agriculture upstream of Louis; however, there isn't much difference with Bilger Creek either, which is rural residential (Figure 51 and Table 16).

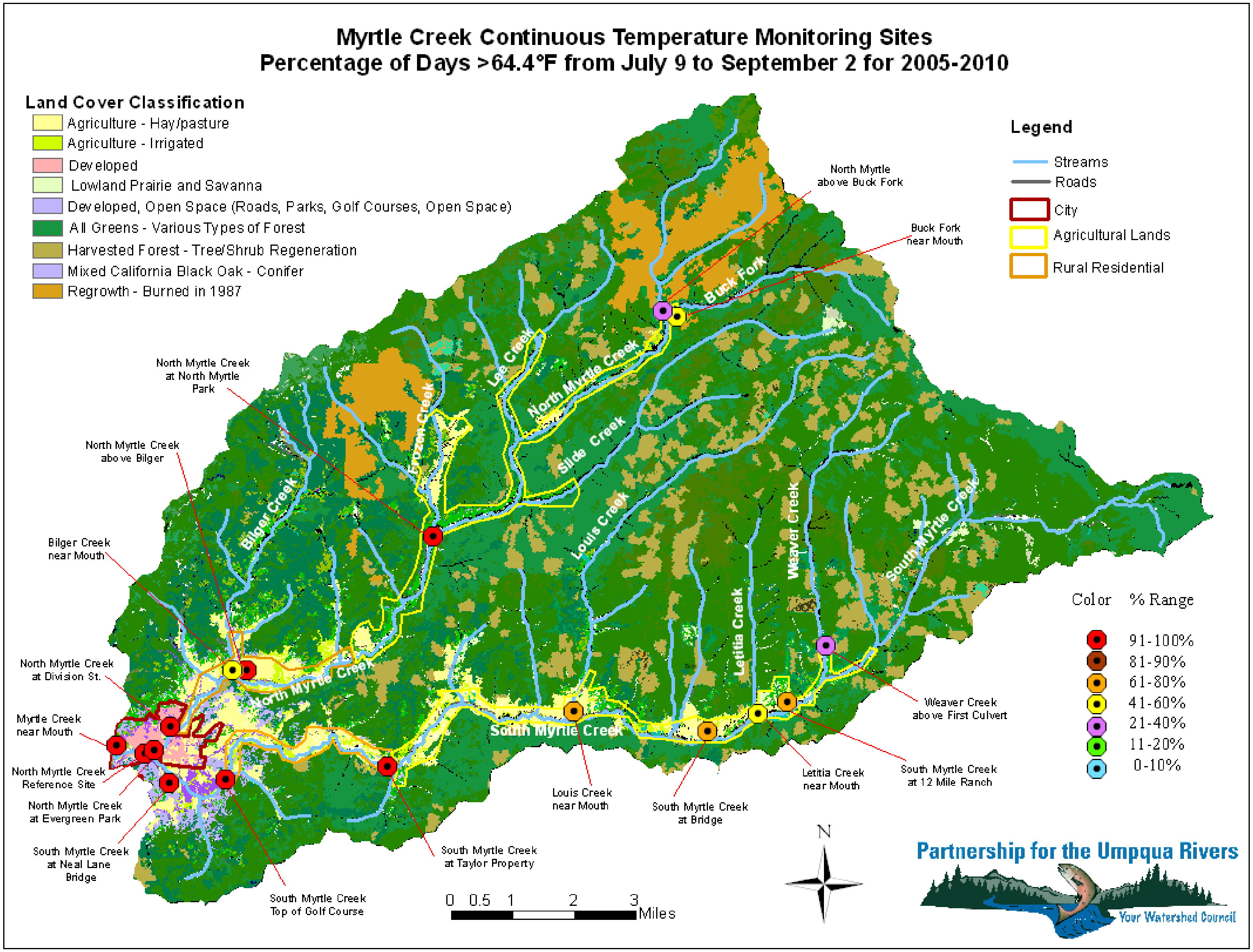


Figure 45: Myrtle Creek area continuous summer stream temperatures from 2005-2010. Percent of days from 7/9 to 9/2 with the 7-day average maximum stream temperatures exceeding 64.4°F (18°C). The temperature criteria for streams in the Myrtle Creek area, which is designated salmon and trout rearing and migration use, is 64.4°F (DEQ, 2003 and DEQ, 2011, pg. 46). The date range chosen is most complete date set that encompasses the period from 2005-2010, except for one site in 2005, S. Myrtle Creek at Neal Lane Bridge, which only had data until 8/15 that year. The North Myrtle Creek Reference Site is a long-term stream characterization monitoring site (Smith, K., 2005), (Dammann, D.M. and K. Smith, 2006), (Dammann, D.M., 2007), (Dammann, D.M., 2008), (Dammann, D.M., 2009), and (Dammann, D.M., 2010).

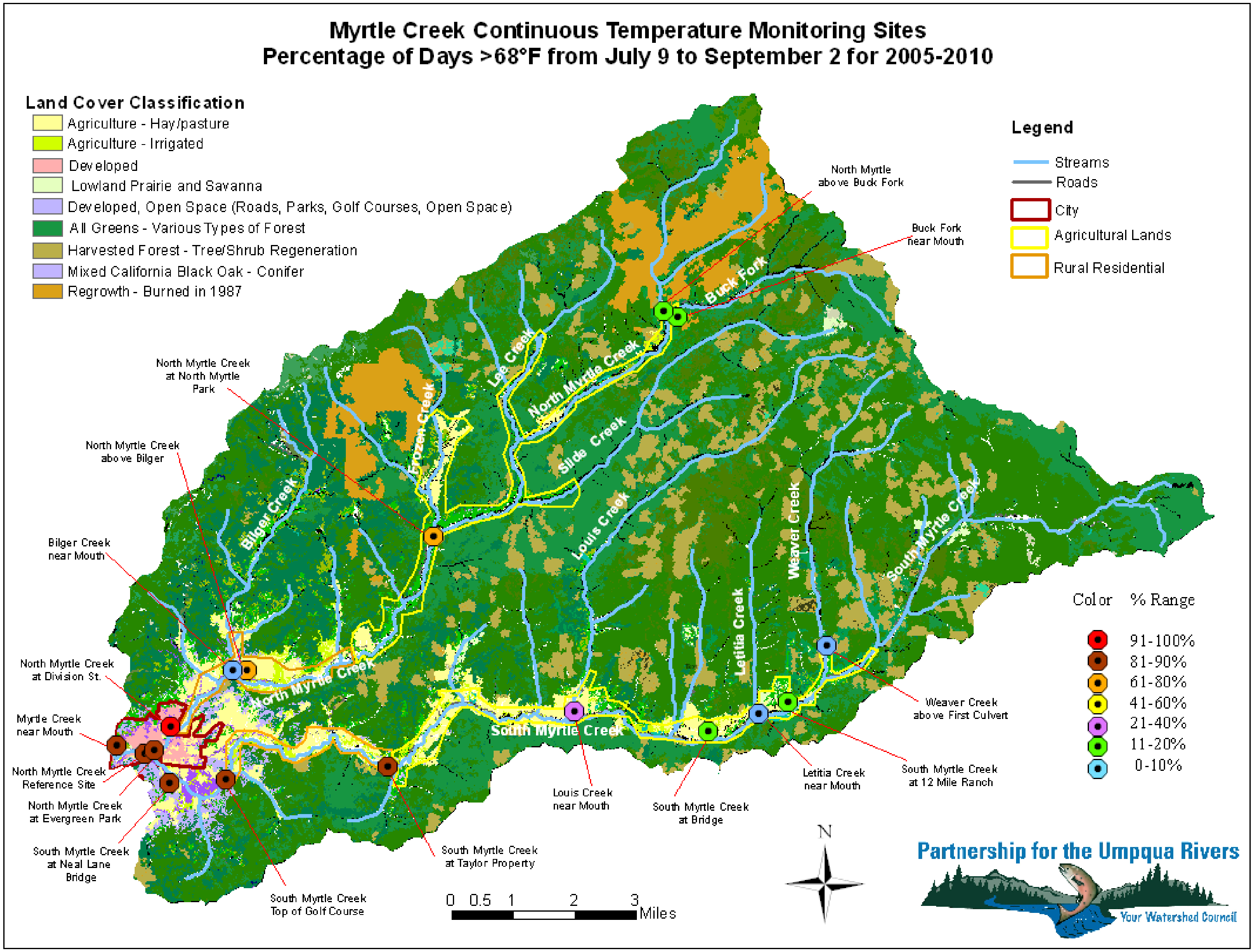


Figure 46: Myrtle Creek area continuous summer stream temperatures for 2005-2010. Percent of days from 7/9 to 9/2 with the 7-day average maximum stream temperatures exceeding 68°F which is a temperature that would limit salmonid migration corridor use (ODEQ, 2003) and (ODEQ, 2011, pg. 46). The date range chosen is the most complete date set that encompasses the period from 2005-2010, except for one site in 2005, S. Myrtle Creek at Neal Lane Bridge, which only had data until 8/15 that year. The North Myrtle Creek Reference Site is a long-term stream characterization monitoring site (Smith, K., 2005), (Dammann, D.M. and K. Smith, 2006), (Dammann, D.M., 2007), (Dammann, D.M., 2008), (Dammann, D.M., 2009), and (Dammann, D.M., 2010)

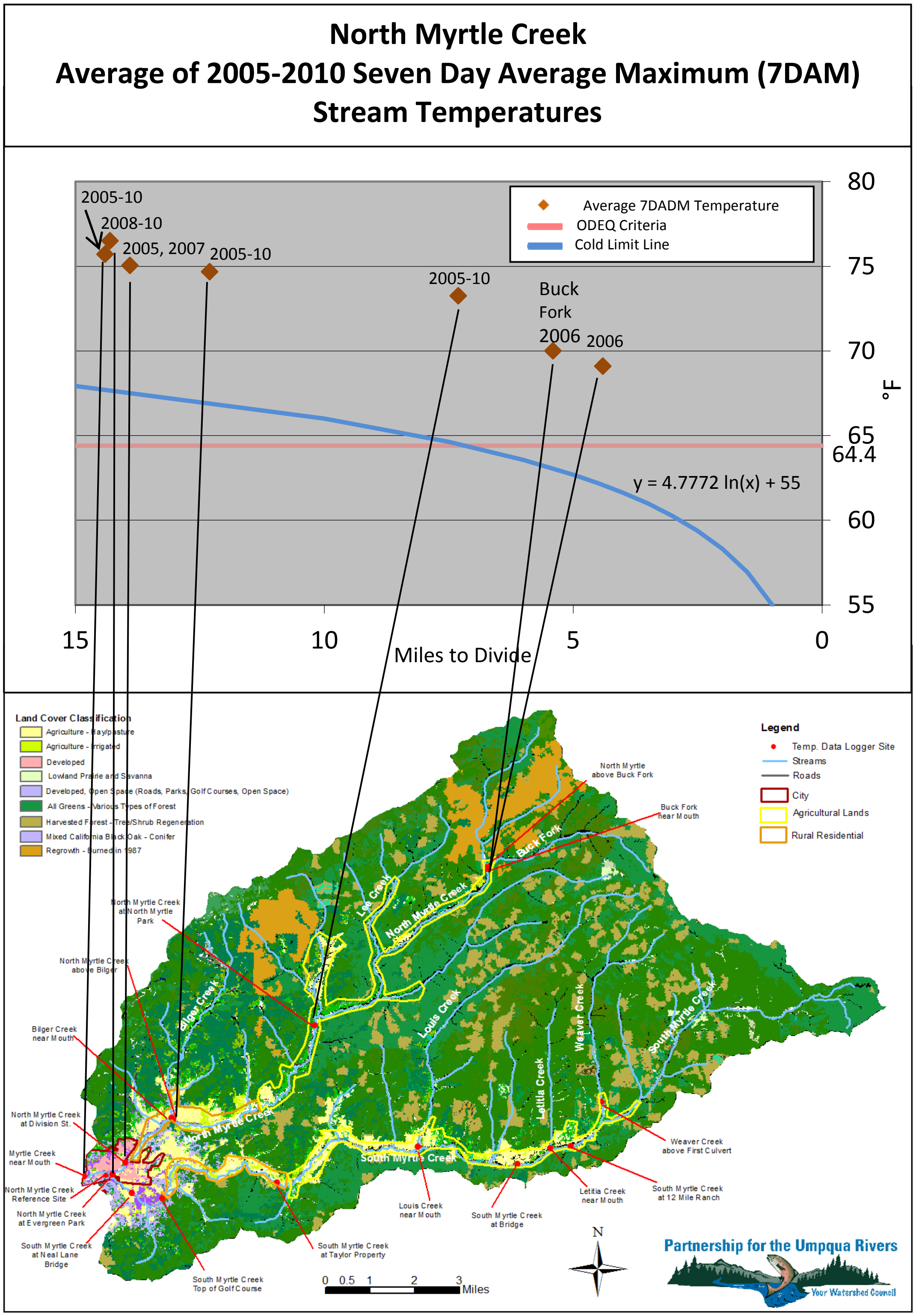


Figure 47: North Myrtle Creek 7-day average maximum stream temperatures from 2005-2010 and corresponding land use map. Buck Fork is included since it has a similar distance to divide, drainage area, and flow as North Myrtle Creek at the confluence. The temperature criteria for streams in the Myrtle Creek area which is designated salmon and trout rearing and migration use is 64.4°F (ODEQ, 2003) and (ODEQ, 2011, p. 46). The cold limit line represents the optimal stream temperatures for streams in the South Umpqua sub-basin as distance to the ridgeline divide increases (Smith, K., 2003). The North Myrtle Creek Reference Site is a long-term stream characterization monitoring site (Smith, K., 2005), (Dammann, D.M. and K. Smith, 2006), (Dammann, D.M., 2007), (Dammann, D.M., 2008), (Dammann, D.M., 2009), and (Dammann, D.M., 2010).

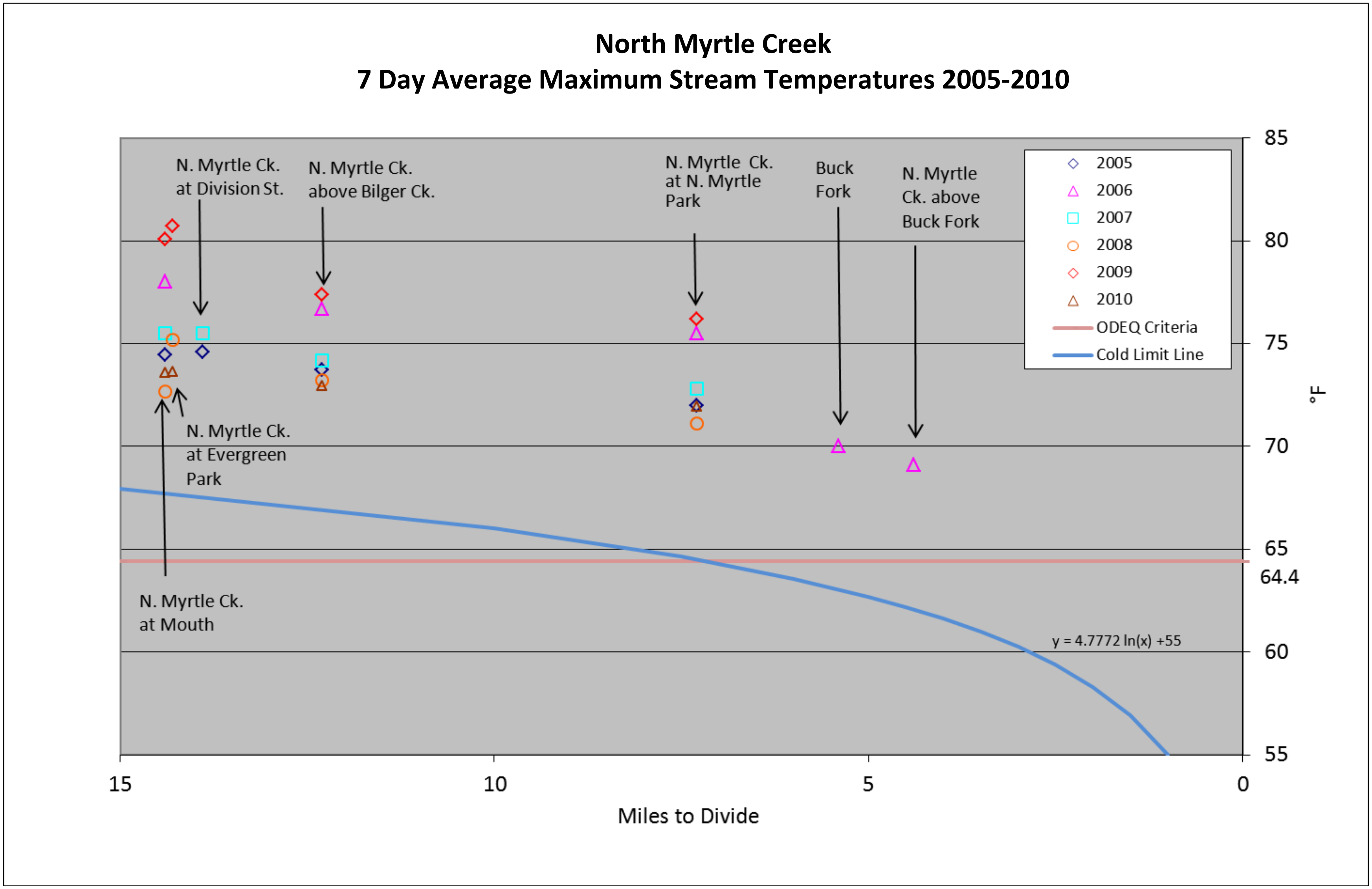


Figure 48: North Myrtle Creek 7-day average maximum stream temperatures from 2005-2010 Buck Fork is included since it has a similar distance to divide, drainage area, and flow as North Myrtle Creek at the confluence. The temperature criteria for streams in the Myrtle Creek area, which is designated salmon and trout rearing and migration use, is 64.4°F (ODEQ, 2003) and (ODEQ, 2011, p. 46). The cold limit line represents the optimal stream temperatures for streams in the South Umpqua sub-basin as distance to the ridgeline divide increases (Smith, K., 2003). The North Myrtle Creek Reference Site is a long-term stream characterization monitoring site (Smith, K., 2005), (Dammann, D.M. and K. Smith, 2006), (Dammann, D.M., 2007), (Dammann, D.M., 2008), (Dammann, D.M., 2009), and (Dammann, D.M., 2010).

Myrtle Creek and South Myrtle Creek
Average of 2005-2010 Seven Day Average Maximum (7DAM) Stream Temperature

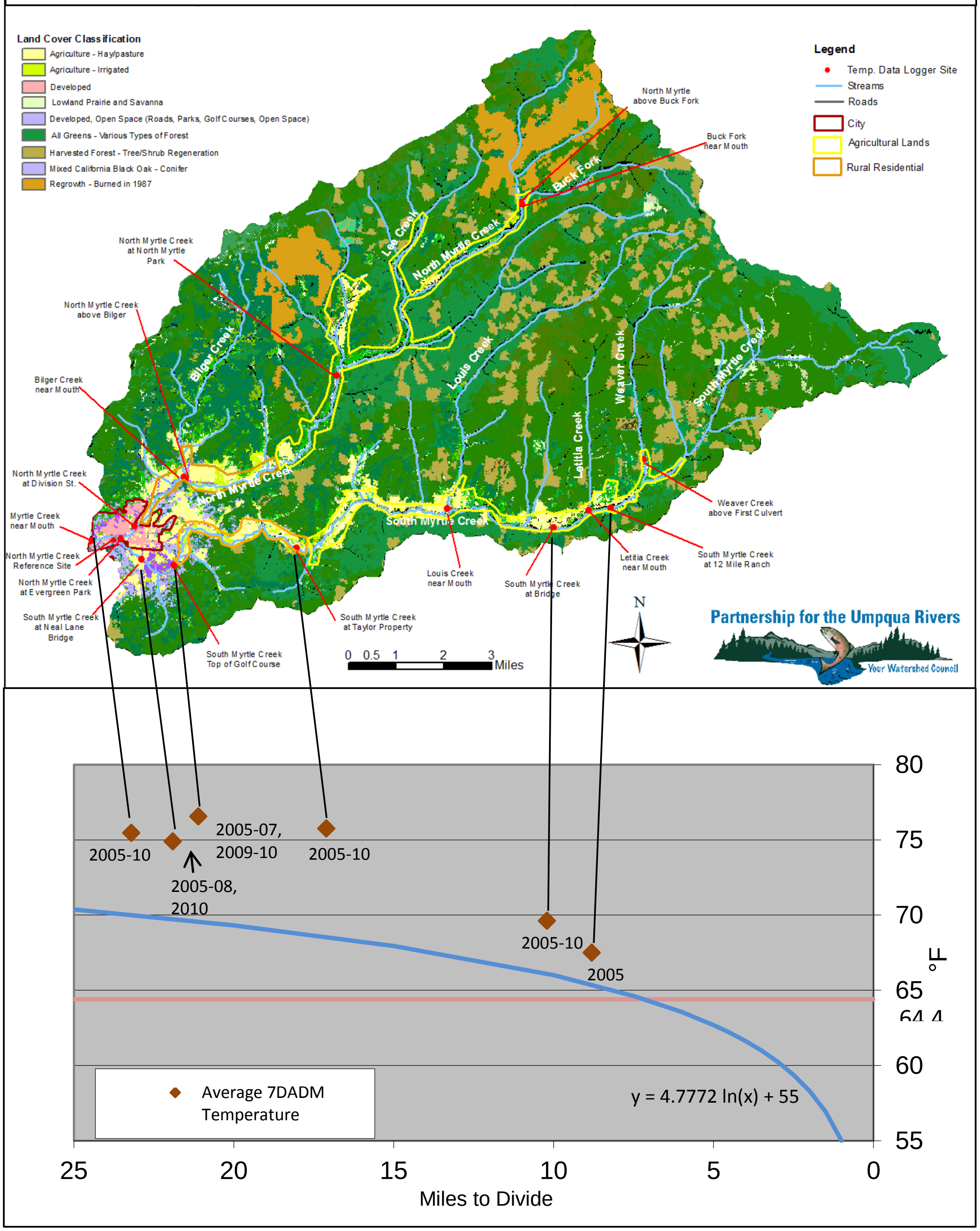


Figure 49: Myrtle Creek and South Myrtle Creek 7-day average maximum stream temperatures from 2005-2010 and corresponding land use map. The ODEQ temperature criteria line for the Myrtle Creek area which is designated salmon and trout rearing and migration use is 64.4°F (ODEQ, 2003) and (ODEQ, 2011, p. 46). The cold limit line represents the optimal stream temperatures for streams in the South Umpqua sub-basin as distance to the ridgeline divide increases (Smith, K., 2003).

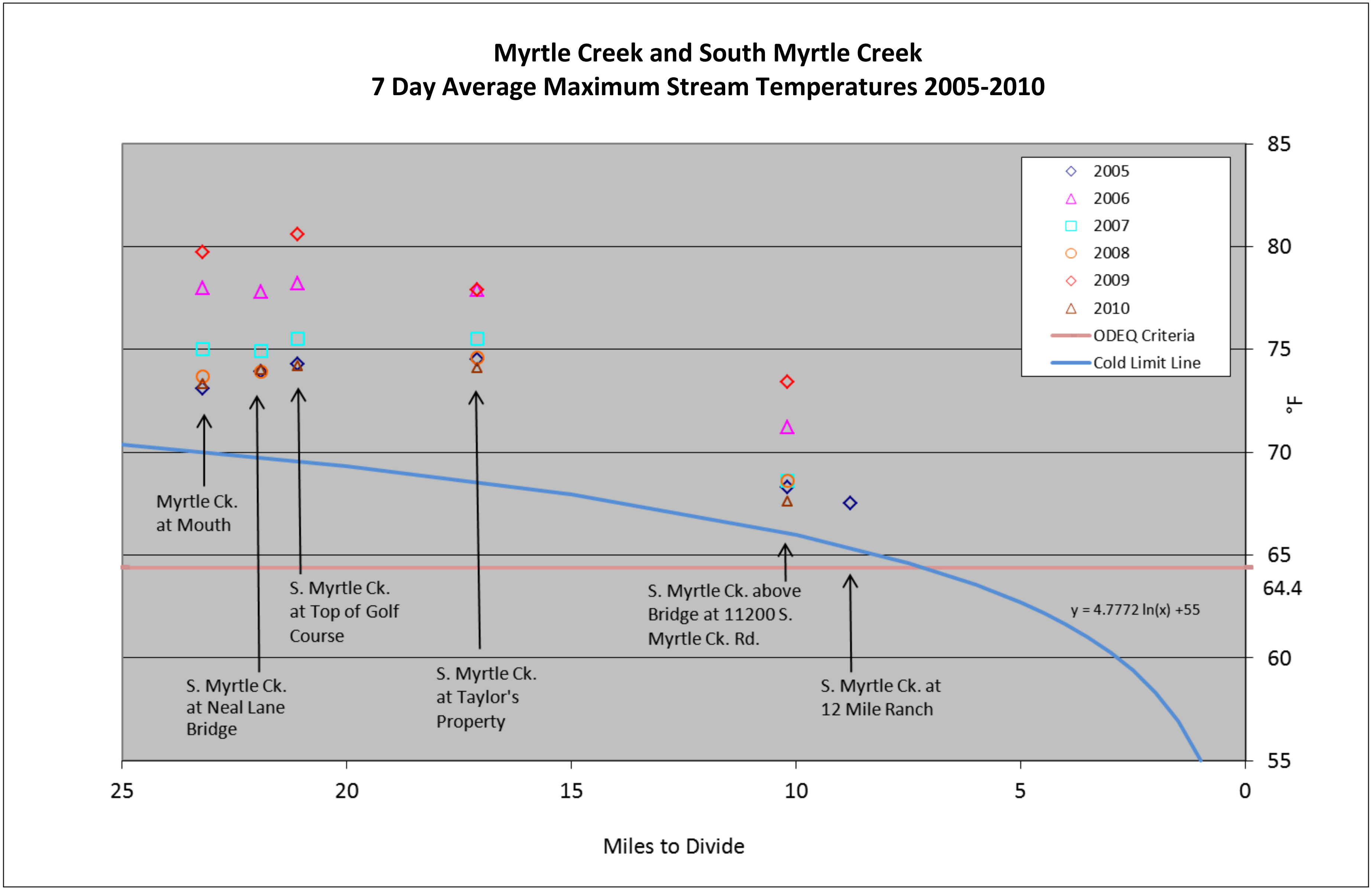


Figure 50: Myrtle Creek and South Myrtle Creek 7-day average maximum stream temperatures from 2005-2010. The temperature criteria for streams in the Myrtle Creek area, which is designated salmon and trout rearing and migration use, is 64.4°F (ODEQ, 2003) and (ODEQ, 2011, p. 46). The cold limit line represents the optimal stream temperatures for streams in the South Umpqua sub-basin as distance to the ridgeline divide increases (Smith, K., 2003).

Site	Upstream Land Use	Distance to Divide	Difference from Cold Limit Line to 7DADM Stream Temperatures 2005	2006	2007	2008	2009	2010	To Avg. 7DADM 2005-10
Myrtle and South Myrtle Sites									
Myrtle Creek near Mouth	City	23.2	3.1	8.0	5.0	3.7	9.7	3.3	5.4
S. Myrtle Creek at Neal Lane Bridge	Developed Open Space	21.9	4.2	8.1	5.2	4.2		4.3	5.2
S. Myrtle Creek at Top of Golf Course	Rural Residential	21.1	4.7	8.6	5.9		11.0	4.6	7.0
S. Myrtle Creek at Taylor's Property	Agricultural Lands	17.1	5.9	9.3	6.9	6.0	9.3	5.5	7.2
S. Myrtle Ck. below Bridge at 11200 S. Myrtle Ck. Rd.	Agricultural Lands	10.2	2.2	5.1	2.5	2.5	7.3	1.5	3.5
S. Myrtle Creek at 12 Mile Ranch	Agricultural Lands	8.8	2.1						2.1
North Myrtle Sites									
N. Myrtle Creek at Mouth - Reference Site	City	14.4	6.7	10.3	7.8	4.9	12.3	5.8	8.0
N. Myrtle Creek at Evergreen Park	City	14.3				7.5	13.0	5.9	8.8
N. Myrtle Creek at Division Street	Rural Residential	13.9	7.0		7.9				7.5
N. Myrtle Creek above Bilger Creek	Rural Residential	12.3	6.7	9.7	7.2	6.2	10.4	5.9	7.7
N. Myrtle Creek at N. Myrtle Park	Agriculture	7.3	7.5	11.0	8.3	6.6	11.7	7.4	8.8
Buck Fork (a significant contributor)	Forested Land	5.4		6.9					6.9
N. Myrtle above Buck Fork	Forested Land	4.4		7.0					7.0
Tributaries									
Louis Creek near Mouth	Forested Land (some Ag)	9.5			3.8	3.0	7.9		4.9
Bilger Creek near Mouth	Rural Residential	6				3.2	6.0		4.6
Letitia Creek near Mouth	Forested Land	4.5			4.1				4.1
Weaver Creek above First Culvert	Forested Land	5.7	3.8		3.3	2.8	7.5	1.9	3.8

Table 16: Myrtle Creek area monitoring sites land use, distance to divide, and difference in 2005-2010 7-day average maximum stream temperature compared to the cold limit line (y = 4.7772 ln(x) + 55), which represents the optimal stream temperatures for streams in the South Umpqua sub-basin as distance to the ridgeline divide increases (Smith, K., 2003).

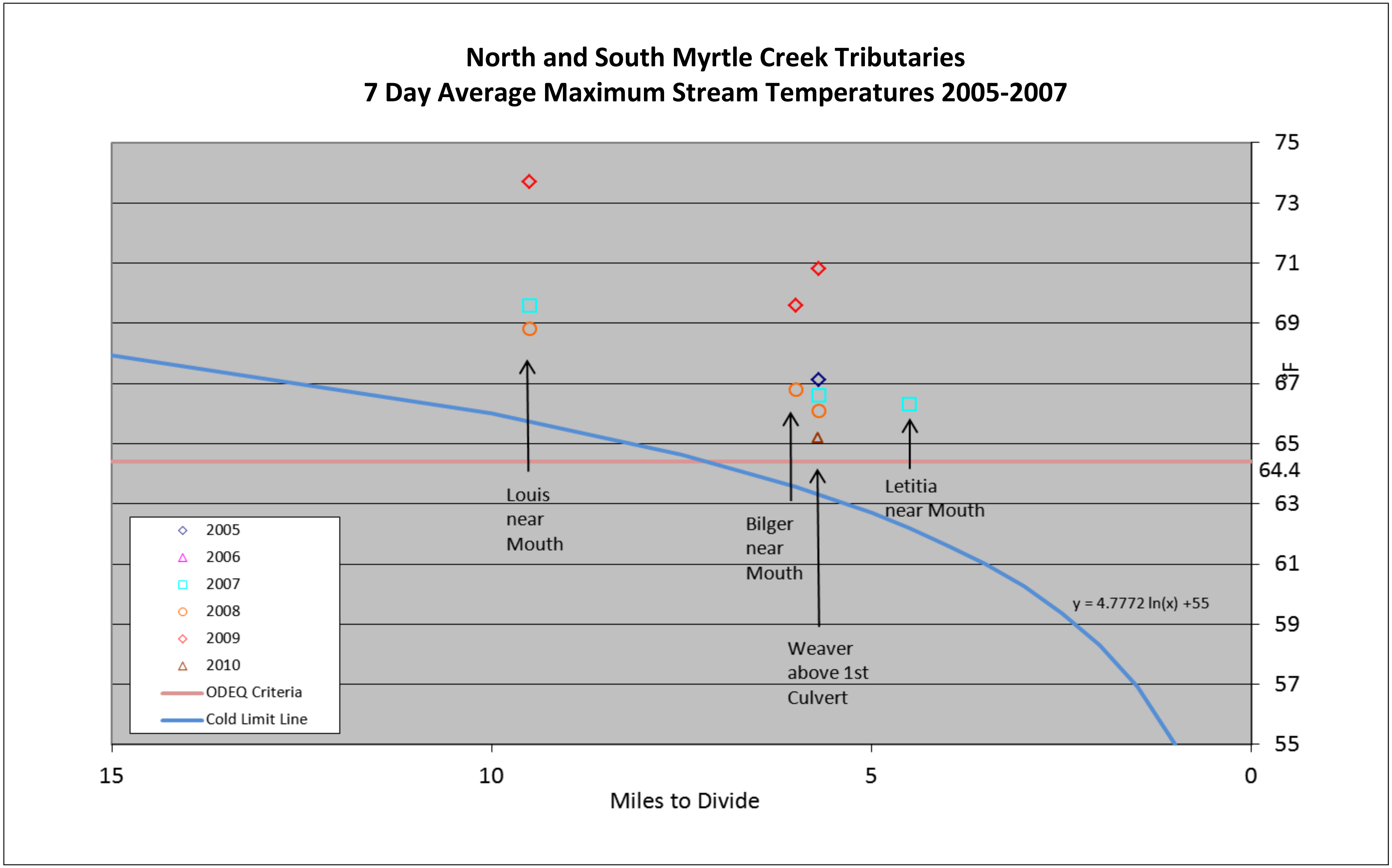


Figure 51: North and South Myrtle Creek tributaries 7-day average maximum stream temperatures from 2005-2010 and corresponding land use map. The temperature criteria for streams in the Myrtle Creek area, which is designated salmon and trout rearing and migration use, is 64.4°F (ODEQ, 2003) **and** (ODEQ, 2011, p. 46)**. The cold limit line represents the optimal stream temperatures for streams in the South Umpqua sub-basin as distance to the ridgeline divide increases** (Smith, K., 2003)**.**

RESULTS – Myrtle Creek Area

Grab Sample Temperature

Slide Creek, Frozen Creek, Lee Creek and South Myrtle Creek at the end of the yellow line monitoring sites never had continuous temperature data measured. However, grab sample temperatures were recorded at each monitoring run. It is evident in Figure 52 that for all monitoring events, none of the four sites exceeded the DEQ Criteria of 64.4° F.

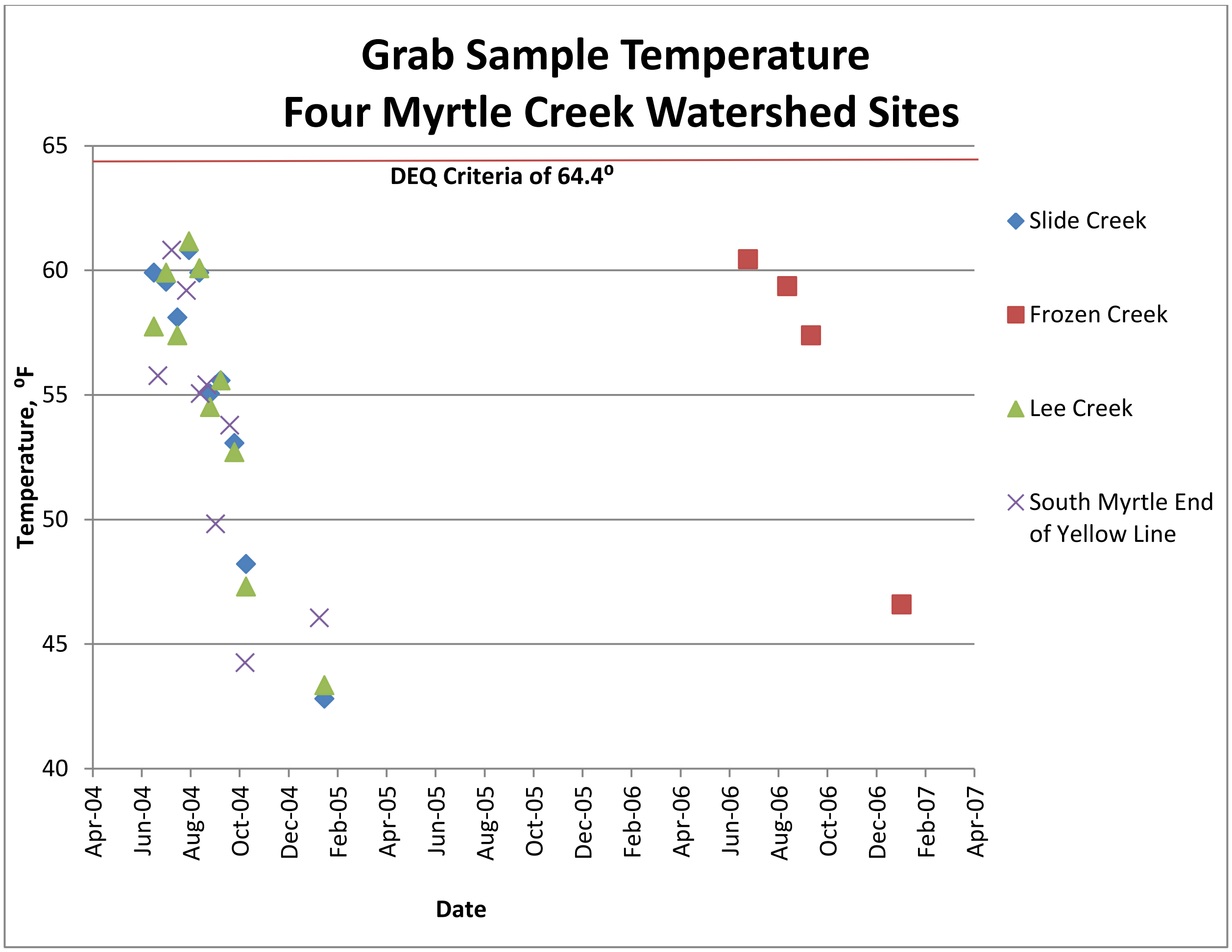


Figure 52: Grab sample temperature for four sites in the Myrtle Creek Watershed.

Stream Temperature Rating for Myrtle Creek Sites

Site	Temperature
Myrtle Creek at Millsite Park	
North Myrtle Creek across from Super Y	
North Myrtle at Evergreen Park	
Bilger Creek at mouth	
North Myrtle Creek above Bilger Creek	
North Myrtle Creek at North Myrtle Park	
Slide Creek 1.9 miles off North Myrtle Rd.	
Frozen Creek	
Lee Creek at bridge on Bill Rice's	
Buck Fork Creek at 15391 N. Myrtle Creek Rd.	
Buck Fork Creek just above N.Myrtle Creek	
North Myrtle just above Buck Fork	
South Myrtle Creek at Neal Lane Bridge	
South Myrtle Creek, DC Cutoff Road	
South Myrtle Creek at Taylors'	
Louis Creek	
South Myrtle at bridge	
South Myrtle Creek at 12 Mile Ranch	
Litetia Creek	
Weaver Creek at first culvert	
South Myrtle Creek at end of yellow line	

Rating	Color	% of Monitoring Days >64.4^{o} F
Good		0-20
Fairly Good		21-40
Concern		41-60
Needs Improvement		61-100

Table 17: Steam Temperature ratings for Myrtle Cree k sites, continuous temperature and grab sample monitoring

RESULTS – Myrtle Creek Area
Summary

Table 18 provides a summary of the rating of each creek in our study for turbidity, pH, dissolved oxygen, conductivity, *E. coli* and temperature. One of our original objectives for the volunteer monitoring program was to compare water quality data between different land usages in the Myrtle Creek Watershed. This was not as easy to accomplish as we had hoped. It is difficult to designate a monitoring site as belonging to one category because, though the site might be on a farm or residential site, what is immediately upstream can be quite different. Obviously the water being analyzed contains the effects upstream conditions. Once one leaves the city of Myrtle Creek land usages are not so clearly defined with many being interspersed. Table 19 presents the data (with conductivity removed for clarity) and sorted by land usage, as best we could define it. From this table it appears that water quality is degraded in all five parameters (turbidity, pH, dissolved oxygen, *E. coli*, and Temperature) as water travels down the watershed. Forest lands are the least impacted, followed by: farm and farm/forest mix, rural residential/forest mix, rural residential/farm mix, rural residential, residential and city in order of declining water quality. It is difficult to conclude whether this is an accumulative effect or whether each of these areas is, itself, significantly contributing to the problem. One can make some assumptions in reference to temperature, as is discussed in the continuous temperature part of the Myrtle Creek report starting on page 78, but it is more difficult to do so with other parameters.

Several streams monitored exceeded lethal temperatures for young coho and Chinook salmon. However, they did not meet the hours above the criteria to reach lethal limits. Therefore it is unlikely that reaching these lethal temperatures would kill the fish, but would result in metabolic stress and increased likelihood of diseases. For all Myrtle area sites, those sites in forested land use tended to have lower temperatures and temperatures were closer to the optimal cold limit line than sites with the land use of agriculture, rural residential, developed open space, or city. This was the case regardless of distance to divide, though tributaries to North and South Myrtle Creeks (with very low distances to divide) were all closer to the optimal cold limit line than sites along the mainstem of North or South Myrtle Creeks regardless of their land use. While any project to maintain or decrease stream temperature (riparian planting, decreasing water withdrawals, etc.) would be advisable, the results of this analysis indicate there are locations where the most improvements are needed. Stream temperatures of reaches downstream from the confluence of North Myrtle Creek and Louis Creek and downstream from the confluence of South Myrtle Creek and Buck Fork would all benefit from restoration to maintain and restore riparian vegetation and to increase water quantity. Along North Myrtle Creek, reaches in the agricultural land upstream from North Myrtle Creek at North Myrtle Park and downstream from the confluence with Buck Fork would be the highest priority for restoration to improve stream temperature. Along South Myrtle Creek, reaches from Louis Creek to the confluence with North Myrtle Creek would be the highest priority for restoration to improve stream temperature. Since there are up to six years of continuous summer temperature data at several of these Myrtle Creek area sites and they are strategically placed to show effects of different land uses on stream temperature, continued monitoring at these sites would be recommended. Continuing monitoring sites with longer term data sets and other existing (or new) sites if restoration is proposed would provide useful information for effectiveness monitoring of future projects.

What is apparent from our data is that there are significant water quality issues with turbidity, dissolved oxygen, *E. coli*, pH, and temperature in the Myrtle Creek Watershed. This data should prove useful in helping to prioritize streams for restoration efforts.

Summary Rating for Myrtle Creek Monitoring Sites – Six Water Quality Parameters

	Turbidity	pH	Dissolved Oxygen	Conductivity	*E. coli*	Temperature	Land Usage
Myrtle Creek at Millsite Park	Red	Red	Red	Blue	Red	Red	City
North Myrtle at Evergreen Park	Yellow	Yellow	Red	Blue	Red	Red	Residential
North Myrtle Creek across from Super Y	Red	Red	Red	Blue	Red	Red	City
Bilger Creek at mouth	Red	Blue	Red	Red	Red	Yellow	Rural Residential
North Myrtle Creek above Bilger Creek	Red	Blue	Red	Blue	Red	Red	Rural Residential
Frozen Creek	Red	Blue	Blue	Blue	Red	Blue	Farm
North Myrtle Creek at North Myrtle Park	Red	Blue	Red	Blue	Red	Red	RR & Farm
Slide Creek 1.9 miles off North Myrtle Rd.	Blue	Blue	Green	Blue	Blue	Blue	Forest
Lee Creek at bridge on Bill Rice's	Red	Blue	Green	Blue	Blue	Blue	Forest
Buck Fork Creek just above N .Myrtle Creek	Red	Blue	Green	Blue	Red	Yellow	RR & Forest
Buck Fork Creek at 15391 N. Myrtle Creek Rd.	Blue	Blue	Green	Blue	Blue	Yellow	RR & Forest
North Myrtle just above Buck Fork	Red	Blue	Green	Blue	Red	Green	RR & Forest
South Myrtle Creek at Neal Lane Bridge	Red	Yellow	Red	Blue	Red	Red	Residential
South Myrtle Creek, DC Cutoff Road	Red	Yellow	Red	Blue	Red	Red	Rural Residential
South Myrtle Creek at Taylors'	Red	Blue	Red	Blue	Red	Red	Rural Residential
Louis Creek	Yellow	Blue	Red	Blue	Red	Red	RR & Farm
South Myrtle at bridge	Red	Yellow	Red	Blue	Red	Red	RR & Farm
Litetia Creek	Blue	Blue	Green	Blue	Red	Yellow	Farm & Forest
South Myrtle Creek at 12 Mile Ranch	Yellow	Blue	Red	Blue	Red	Red	Farm & Forest
Weaver Creek at first culvert	Red	Yellow	Red	Blue	Red	Blue	Farm & Forest
South Myrtle Creek at end of yellow line	Red	Blue	Red	Blue	Blue	Blue	Forest

Table 18: Rating summary of Myrtle Creek area monitoring sites. See individual parameter's summary for the criteria used in establishing the color.

Rating	Color
Good	Blue
Fairly Good	Green
Concern	Yellow
Needs improvement	Red

	Turbidity	pH	Dissolved Oxygen	*E. coli*	Temperature	Land Usage
Myrtle Creek at Millsite Park	Red	Red	Red	Red	Red	City
North Myrtle Creek across from Super Y	Red	Red	Red	Red	Red	City
North Myrtle at Evergreen Park	Yellow	Yellow	Red	Red	Red	Residential
South Myrtle Creek at Neal Lane Bridge	Red	Yellow	Red	Red	Red	Residential
Bilger Creek at mouth	Red	Blue	Red	Red	Yellow	Rural Residential
North Myrtle Creek above Bilger Creek	Red	Blue	Red	Red	Red	Rural Residential
South Myrtle Creek, DC Cutoff Road	Red	Yellow	Red	Red	Red	Rural Residential
South Myrtle Creek at Taylors'	Red	Blue	Red	Red	Red	Rural Residential
North Myrtle Creek at North Myrtle Park	Red	Blue	Red	Red	Red	RR & Farm
Louis Creek	Yellow	Blue	Red	Red	Red	RR & Farm
South Myrtle at bridge	Red	Yellow	Red	Red	Red	RR & Farm
Buck Fork Creek just above N.Myrtle Creek	Red	Blue	Green	Red	Yellow	RR & Forest
Buck Fork Creek at 15391 N. Myrtle Creek Rd.	Blue	Blue	Green	Blue	Yellow	RR & Forest
North Myrtle just above Buck Fork	Red	Blue	Green	Red	Green	RR & Forest
Frozen Creek	Red	Blue	Blue	Red	Blue	Farm
Litetia Creek	Blue	Blue	Green	Red	Yellow	Farm & Forest
South Myrtle Creek at 12 Mile Ranch	Yellow	Blue	Red	Red	Red	Farm & Forest
Weaver Creek at first culvert	Red	Yellow	Red	Red	Blue	Farm & Forest
Slide Creek 1.9 miles off North Myrtle Rd.	Blue	Blue	Green	Blue	Blue	Forest
Lee Creek at bridge on Bill Rice's	Red	Blue	Green	Blue	Blue	Forest
South Myrtle Creek at end of yellow line	Red	Blue	Red	Blue	Blue	Forest

Table 19: Rating summary of Myrtle Creek area monitoring sites sorted by land use with conductivity removed.

Rating	Color
Good	Blue
Fairly Good	Green
Concern	Yellow
Needs improvement	Red

RESULTS – Myrtle Creek Area
Spotlight: Weaver Creek Project

PUR's Weaver Creek Project was partially due to the monitoring program's detection of elevated levels of *E. coli* at a monitoring site above the first culvert on Hidden Homestead Road. This was unexpected, as visually it appeared that we were monitoring downstream of forest lands. (Perhaps we should have paid more attention to the name of the road, as we had been referring to it, incorrectly, as Weaver Creek Road.) Upon further investigation we discovered that there were two houses and a ranch upstream which did not restrict the livestock from the creek. Contacts were made and the ranch's landowner was happy to participate in a project to fence the creek, limiting access to a hardened crossing, and to permit an instream restoration project. In September, 2006 forty-eight logs were placed in Weaver Creek in a 0.5 mile stretch which started 0.5 miles upstream from the first culvert. Both sides of the creek were also fenced for that same 0.5 mile stretch to prevent cattle grazing along the stream and in the riparian area.

We had never planned this project to include effectiveness monitoring and had we done so would have added more sites including immediately above and below the project location. However, since we had been monitoring for some time prior to the project we thought it would be beneficial to examine the data.

We tested whether *E. coli* levels at Weaver Creek differed significantly before and after the project's completion in September 2006. We used a Student's t-test to test the hypothesis that the mean value for *E. coli* measurements at Weaver Creek was lower after September 2006. An F-test at the 0.05 significance level returned a p-value of 0.2492, so we assumed equal variance between the two samples. We tested our theory against the null hypothesis that there was no difference in the mean of *E. coli* measurements taken before and after the Weaver Creek project.
We used a significance level of $\alpha = 0.05$. The t-test yielded a p-value of 0.3338, thus we cannot reject the null hypothesis. However, we must be careful when drawing conclusions about the efficacy of the project. The boxplots in Figure 54 present Weaver Creek *E. Coli* data before and after the project. These plots display the pattern found to be typical for E. coli data. The distribution of data tends to be skewed by very high outliers. Note that there are several of these outliers present in the post-September 2006 Weaver Creek data. It is possible that the presence of these outliers has camouflaged generally decreased *E. coli* levels. Since our monitoring site is 0.5 mile downstream of the project, it is possible that wildlife such as deer, elk or bear could be contaminating the stream with *E. coli* below the project but above our monitoring site; for that matter it could be introduced above the project as well. In addition, there is the possibility that fecal contamination could occur at the hardened crossing where livestock are allowed access to cross the creek. Therefore, little can be concluded from this attempt and further sampling would have the same issues.

Since baseline summer water temperature at the Weaver Creek above 1st Culvert site was monitored continuously in 2005, and then monitored again during the four years following the restoration, 2007-2010, stream temperature was another parameter that could be compared pre and post project. Logs in streams obstruct flow and alter channel hydraulics which enhances the scour of pools, thereby increasing the frequency and depth of pools with increased amount of in-channel logs (Montgomery, Collins, Buffington, & Abbe, 2003, p. 27). These deep pools are cooler than surface waters and create cool water refuges for fish (Bilby, 1984, p. 593). In addition log structures may help to accumulate and hold increased substrate above the structures providing the possibility for increasing retention time in the cooler substrate. Since there is no upstream temperature site to compare the temperature data to, it was instead compared to data from two reference sites (Smith, K., 2005), (Dammann, D.M. and K. Smith, 2006), (Dammann, D.M., 2007), (Dammann, D.M., 2008), (Dammann, D.M., 2009), and (Dammann, D.M., 2010) to determine if there was an effect from the log placement on water temperature (Figure 54) beyond the annual variability.

In the four years following the log placement, the 7DAM stream temperature of the Weaver Creek site decreased in 2007 and 2008 and then increased in 2009 and decreased again in 2010 (Figure 54). This is the same pattern exhibited by the 7DAM stream temperatures at the two reference sites (North Myrtle Creek at the Mouth and Windy Creek near Glendale High School) (Figure 54). Therefore, any temperature change at the Weaver Creek site is due to annual variability and not project effects.

Therefore no downstream temperature effect was shown with four years of data post log placement. Continued monitoring and more years of data would show if further increase in pool depth or pool quantity, and substrate retention over time results in a decrease in temperature at the site or if there is no discernible effect. Again it should be noted that sampling points make these conclusions unreliable and that monitoring was not designed for project effectiveness purposes.

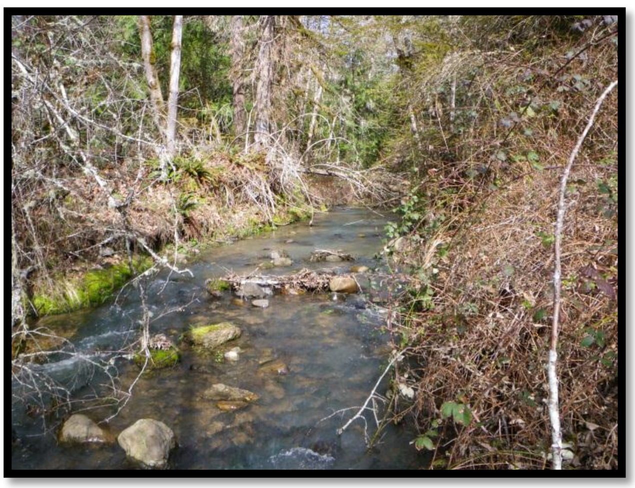


Photo 6: Monitoring site on Weaver Creek

Photo 7: Completed fencing project and hardened crossing upstream on Weaver Creek

Photo 8: Completed instream log placement project upstream on Weaver Creek

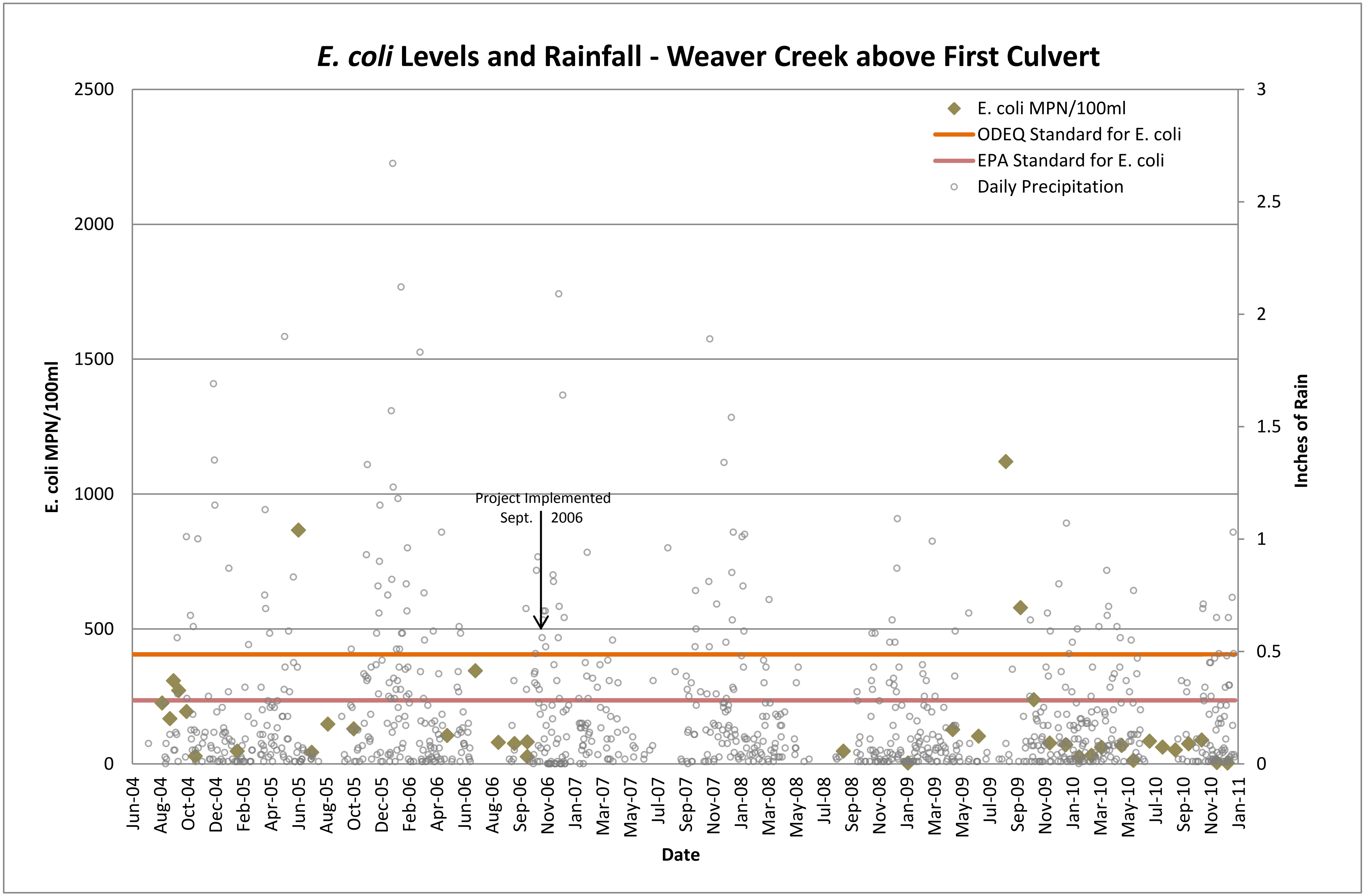


Figure 53: *E. coli* levels at first culvert and rainfall at Roseburg, Oregon. Arrow indicates where Weaver Creek Project occurred on timeline.

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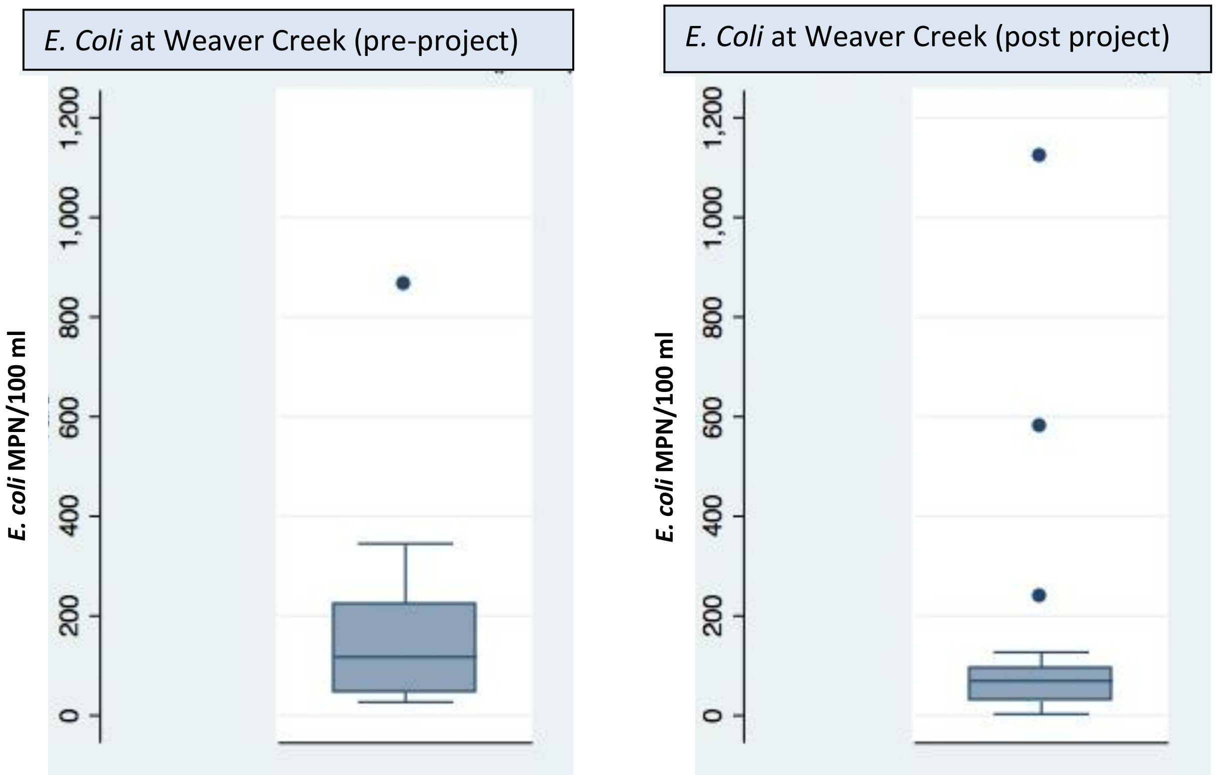


Figure 54: ***E. coli*** **levels box plots at first culvert before and after project implementation**

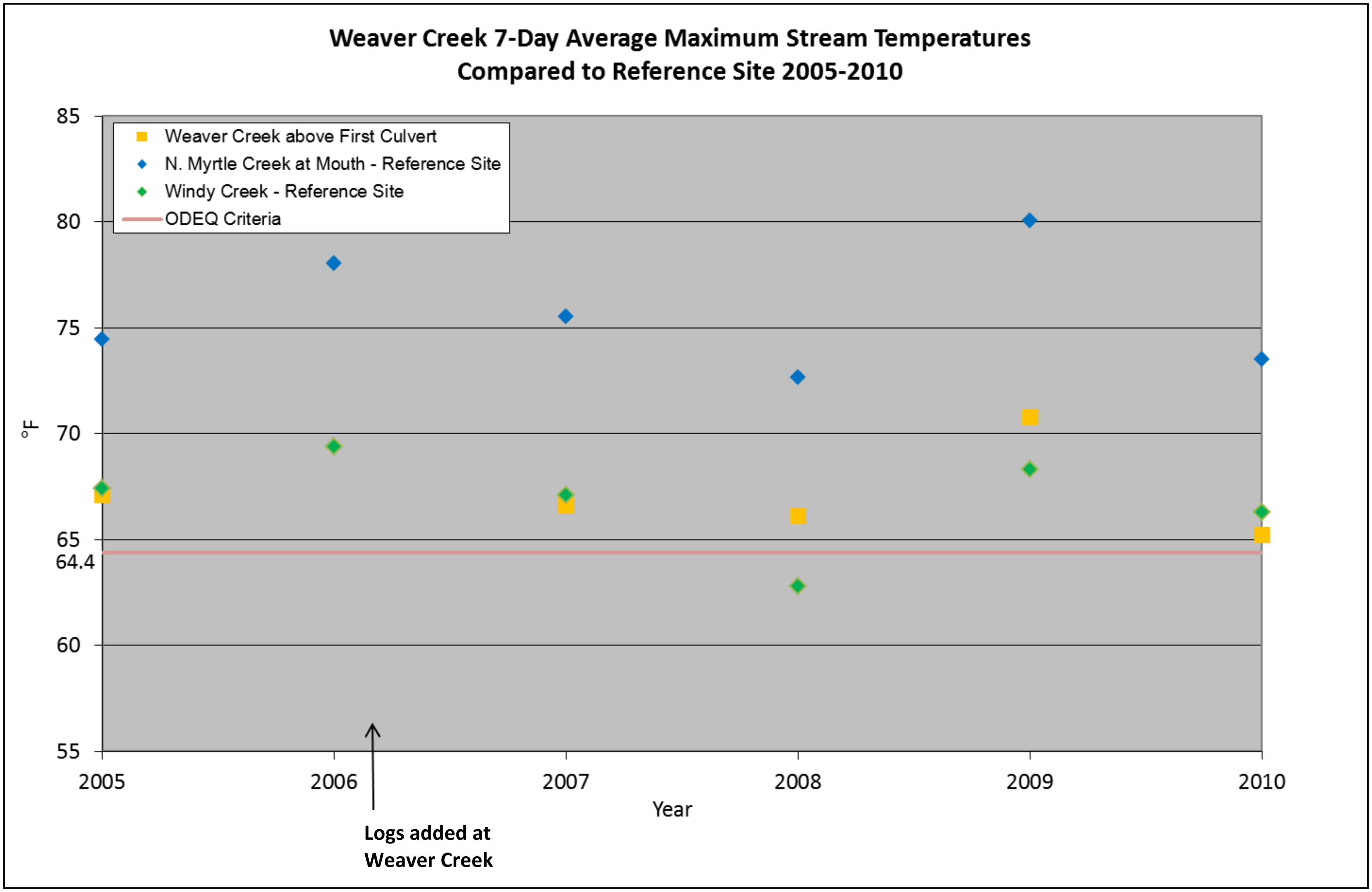
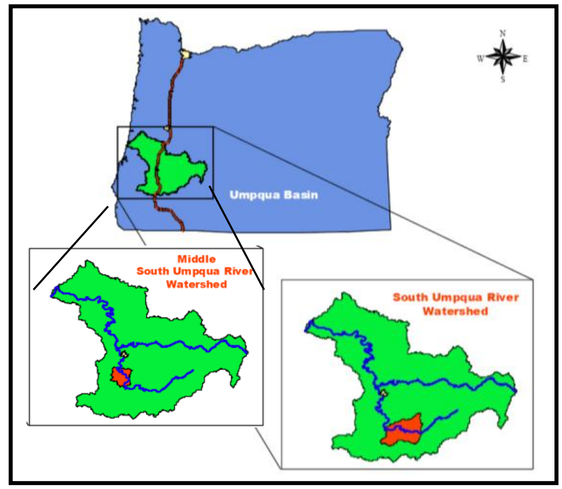


Figure 55. 7DAM stream temperature of the Weaver Creek above 1st Culvert monitoring site (5.7 miles to divide) compared with the North Myrtle Creek at Mouth (18.3 miles to divide) and Windy Creek (9.6 miles to divide) reference sites (Smith, K., 2005), (Dammann, D.M. and K. Smith, 2006), (Dammann, D.M., 2007), (Dammann, D.M., 2008), (Dammann, D.M., 2009), and (Dammann, D.M., 2010).

SOUTH UMPQUA
Middle & South Umpqua Watersheds



Area Description, Background & Monitoring Sites
PUR's "South Umpqua Volunteer Monitoring Run" encompasses sites within two fifth-field Watersheds – the South Umpqua Watershed and the Middle South Umpqua Watershed.

The South Umpqua Watershed encompasses 141,575 acres stretching 14 miles north to south and 20 miles east to west. The only incorporated city in the areas is Canyonville; other unincorporated population centers include Days Creek and Milo. Interstate Five runs through the western portion of the watershed with Tiller Trail Highway following the South Umpqua River through the watershed for 28 miles of the South Umpqua River. The largest tributary in this region is Days Creek (13.9 miles). The largest land usage in the watershed is forestry at 89% of land base for public and private forestry. Agriculture constitutes 9% of the land usage being most prevalent along the South Umpqua and Days Creek floodplains. Residential, industrial and commercial lands each constitute approximately one percent of the watershed. Ownership is 55% private with public ownership mostly administered by BLM, City, state, county and the Cow Creek Tribe of the Umpqua Indians each constituting less than 1% of the watershed. Eighty percent of the watershed consists of ownership parcels that are over 100 acres. (Geyer, South Umpqua Watershed Assessment and Action Plan, 2003).

The Middle South Umpqua Watershed encompasses 59,441 acres downstream of the South Umpqua Watershed. It stretches 10.9 miles east to west and 10.6 miles north to south. Small parts of Myrtle Creek fall within this watershed, as do all of Dillard and the Tri-City area. Interstate Five, Highway 99 and Highway 42 cross through the watershed. The watershed begins approximately 47 miles from the mouth of the South Umpqua River and proceeds for 22 miles upstream. There are numerous tributaries to the South Umpqua in this region, the largest being Rice Creek which is 7.3 miles long. Agriculture accounts for 40% of the land use in this region. Federal lands administered by the BLM make up 13% of the watershed. Lands owned by cities, Douglas County and the Cow Creek Band of the Umpqua Tribe of Indians each accounting for less than 1%. Over 66% of the tax lot parcels are over 100 acres. ODFW estimates the following stream miles supporting anadromous salmonids in the Middle South Umpqua Watershed: spring Chinook, 22 miles; fall Chinook, 24 miles; coho, 64 miles; and winter steelhead, 63 miles. Water use during the summer months is a concern. Galesville Dam has slightly increased summer flows but the South Umpqua can have less than 100 cfs flow during the summer. The largest use of water is for irrigation consuming 53.8% , with industry using 24.9% and municipal use at 16.5%. (Geyer, Middle South Umpqua Watershed Assessment and Action Plan, 2003).

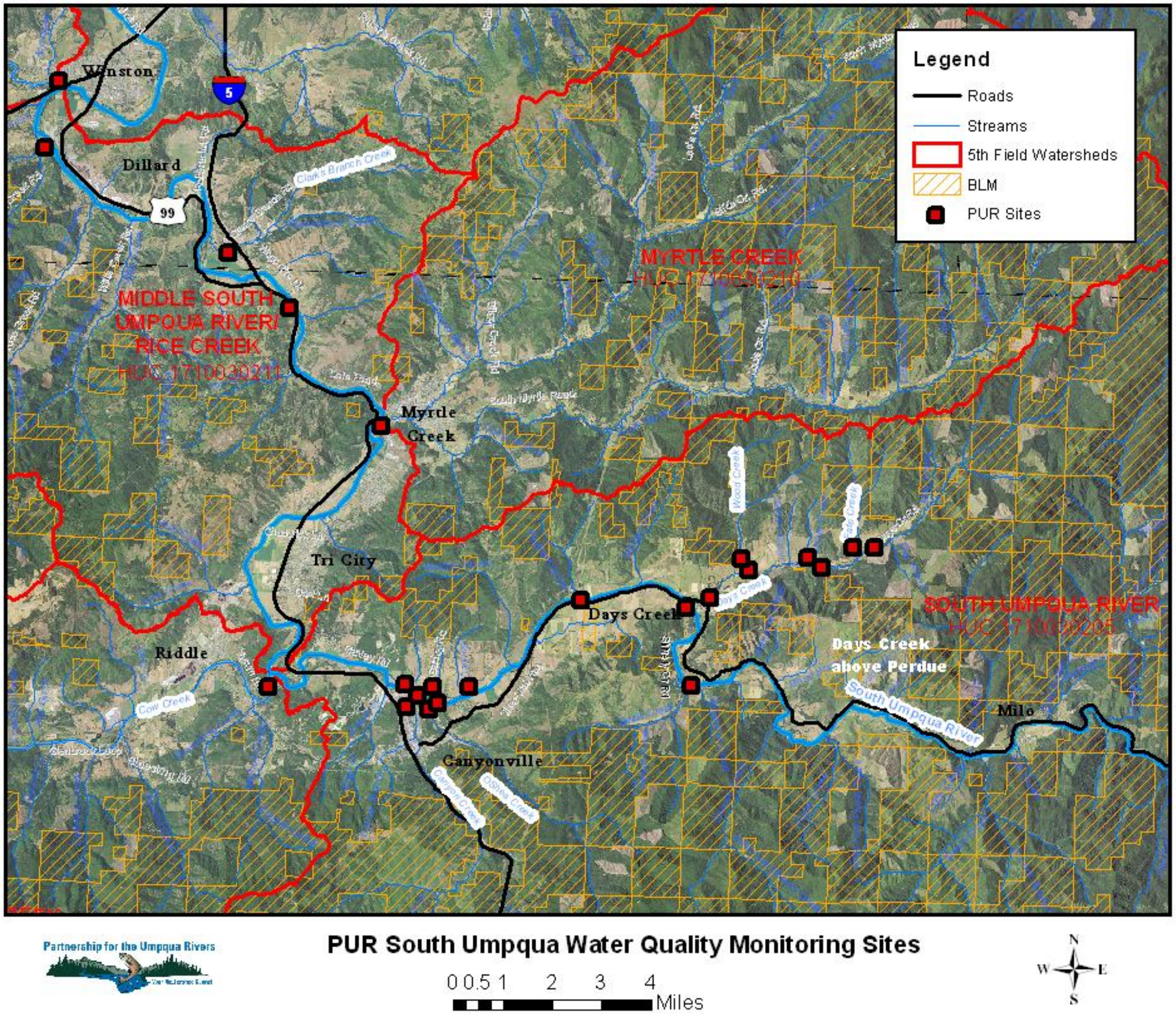


Figure 56: Map of South Umpqua area water quality monitoring sites

South Umpqua Area Monitoring Sites Description and Location

Site Name	Site Location	Type Site	Latitude	Longitude
Days Creek	Days Creek above Fate Creek at Foot Bridge	Below Project	42°59.241N	123°06.172W
Fate Creek	Near mouth of Fate Creek	Below project	42°59.241N	123°06.172W
Days Creek	Days Creek Above Perdue	Mid Days Creek	42°59.126N	123°07.448W
Days Creek	Days Creek at Woods Creek Road	Rural residential and agriculture	42°58.440N	123°08.995W
Woods Creek	Woods Creek near mouth	Rural Residential and agriculture	42°58.440N	123°09.003
Days Creek	Days Creek at Highway 1 Bridge	Rural residential and agriculture	42°58.351N	123°10.312W
South Umpqua	South Umpqua above Days Creek at Berry Farm Lane	Rural residential and agriculture	42°56.962N	123°09.412W
South Umpqua	South Umpqua at Days Creek Bridge	Residential/small town	42°58.351N	123°10.312W
South Umpqua	South Umpqua DC Cutoff Bridge	Rural Residential and agriculture	42°58.271N	123°12.845W
South Umpqua	South Umpqua at Canyonville Park	Rural Residential and agriculture	42°56.402N	123°15.926W
OShea Creek	OShea Creek at Tiller-Trail Hwy	Rural	42°55.880N	123°15.983W
Canyon Creek	Canyon Creek at Primary School Foot bridge	City	42°55.828N	123°16.702W
South Umpqua	South Umpqua Above Canyon Creek	City	42°56.548N	123°16.838W
Canyon Creek	Canyon Creek at mouth	City	42°56.545N	123°16.893W
South Umpqua	Gazley Road Bridge	City	42°56.619N	123°17.155W
South Umpqua	South Umpqua at Stanton Park	City and agriculture	42°56.867N	123°17.479W
Cow Creek	At Yokum Road bridge	Summation of Cow Creek	42°56.567N	123°20.207W
South Umpqua	South Umpqua at MC RR Trestle	South Umpqua River before Myrtle Creek	43°01.016N	123°17.993W
South Umpqua	South Umpqua below MC Bridge	South Umpqua below Myrtle Creek confluence	43°01.536N	123°17.808W
South Umpqua	Beach on South Umpqua just North of Boomerhill off side road	South Umpqua well below Myrtle Creek confluence	43°02.630N	123°19.858W
Clarks Branch	Clarks Branch at Dole Road Culvert	Summation of Clarks Branch	43°04.288N	123°21.524W
South Umpqua	Bridge at Brockway Road at Dillard	South Below Mill and before Dillard/Winston	43°05.891N	123°25.854W
Lookkinglass Creek	Lookingglass at Highway 42 Bridge near Mouth	Downstream of Farmland and Rural Residential	43°07.062N	123°25.698W

Table 20: Description and Location of South Umpqua area monitoring sites

**Photo 9: Typical stretch of the South Umpqua River on a summer day.
Monitoring site above Canyon Creek**

Photo 10: Same stretch of the South Umpqua River on a winter day.

RESULTS - South Umpqua Area

Turbidity

South Umpqua sites and tributary turbidity data are summarized and rated in Table 21. Only one site, Canyon Creek at the footbridge to the primary school, did not produce any readings over 10 NTU, either in summer or winter. All of the other sites had no readings over 10 NTU for summer but had significantly elevated readings during the winter months.

Figure 57 displays all turbidity readings for all sites monitored in the South Umpqua area. There were three storm events that caused all of the streams to exceed 40 NTU. These occurred on 5/15/09, 3/30/10, and 12/28/10. Woods Creek, a tributary to Days Creek, and Lookingglass Creek evidenced the highest levels both in 2010. Woods Creek frequently produced higher levels than all other streams. Figure 58 separates Days Creek and its tributaries for comparison, and Figure 59 displays the South Umpqua and its tributaries. Days Creek and Lookingglass Creek had the two highest upper quartile levels of all the streams with Lookingglass Creek having by far the highest; 25% of its readings were greater than 24 NTU.

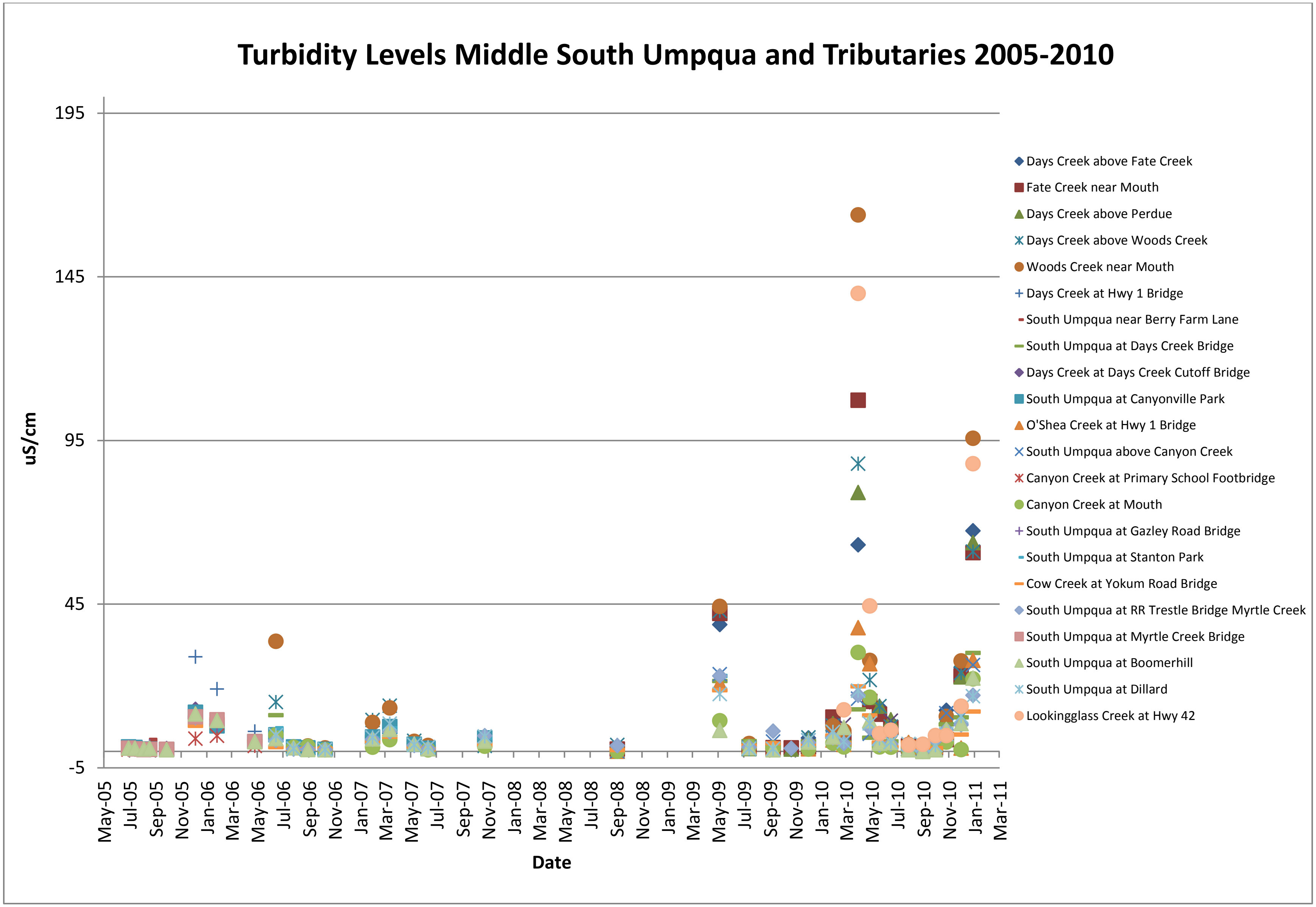


Figure 57: Turbidity Levels Middle South Umpqua and Tributaries 2005-2010

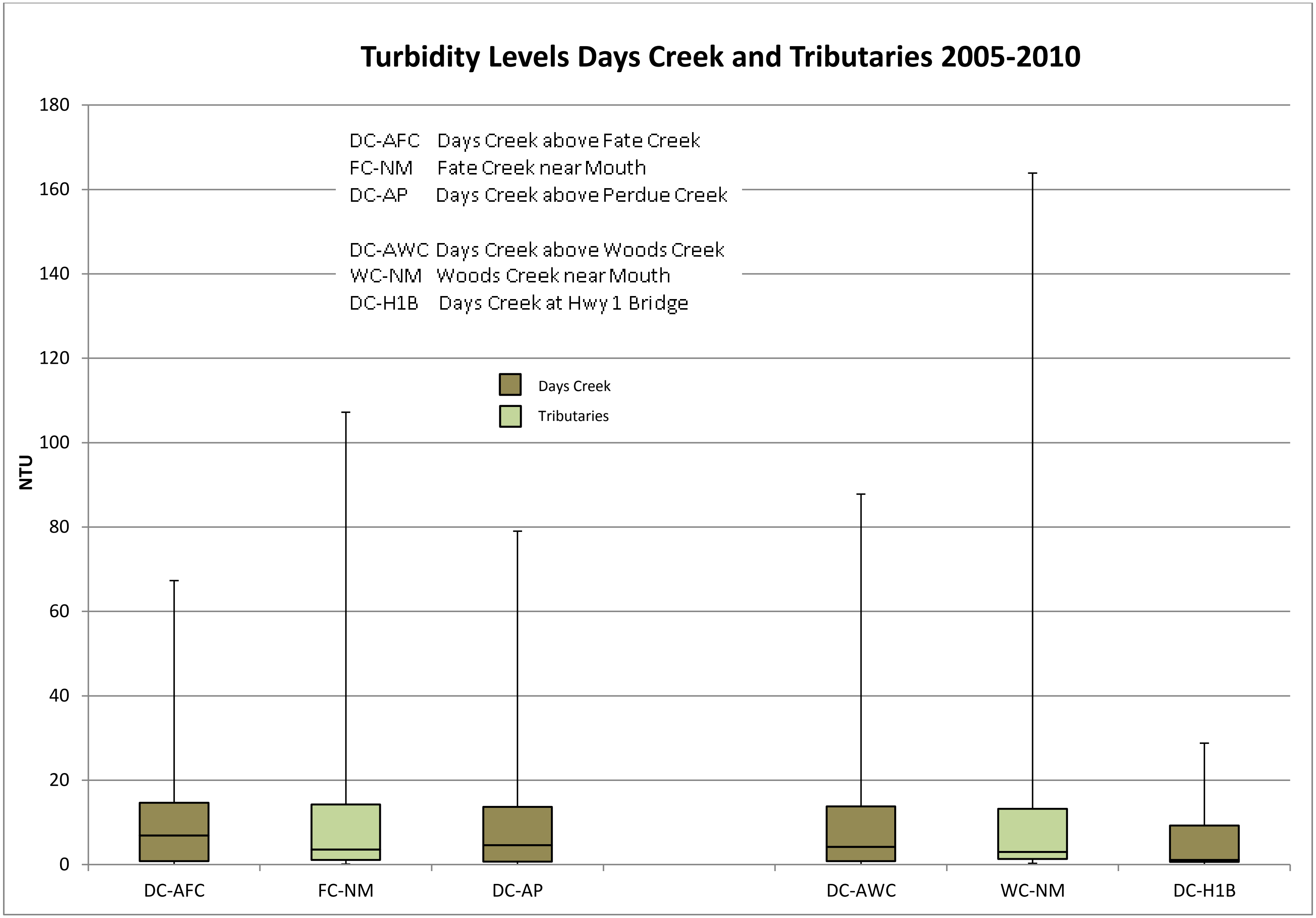


Figure 58: Turbidity Levels Days Creek and Tributaries 2005-2010

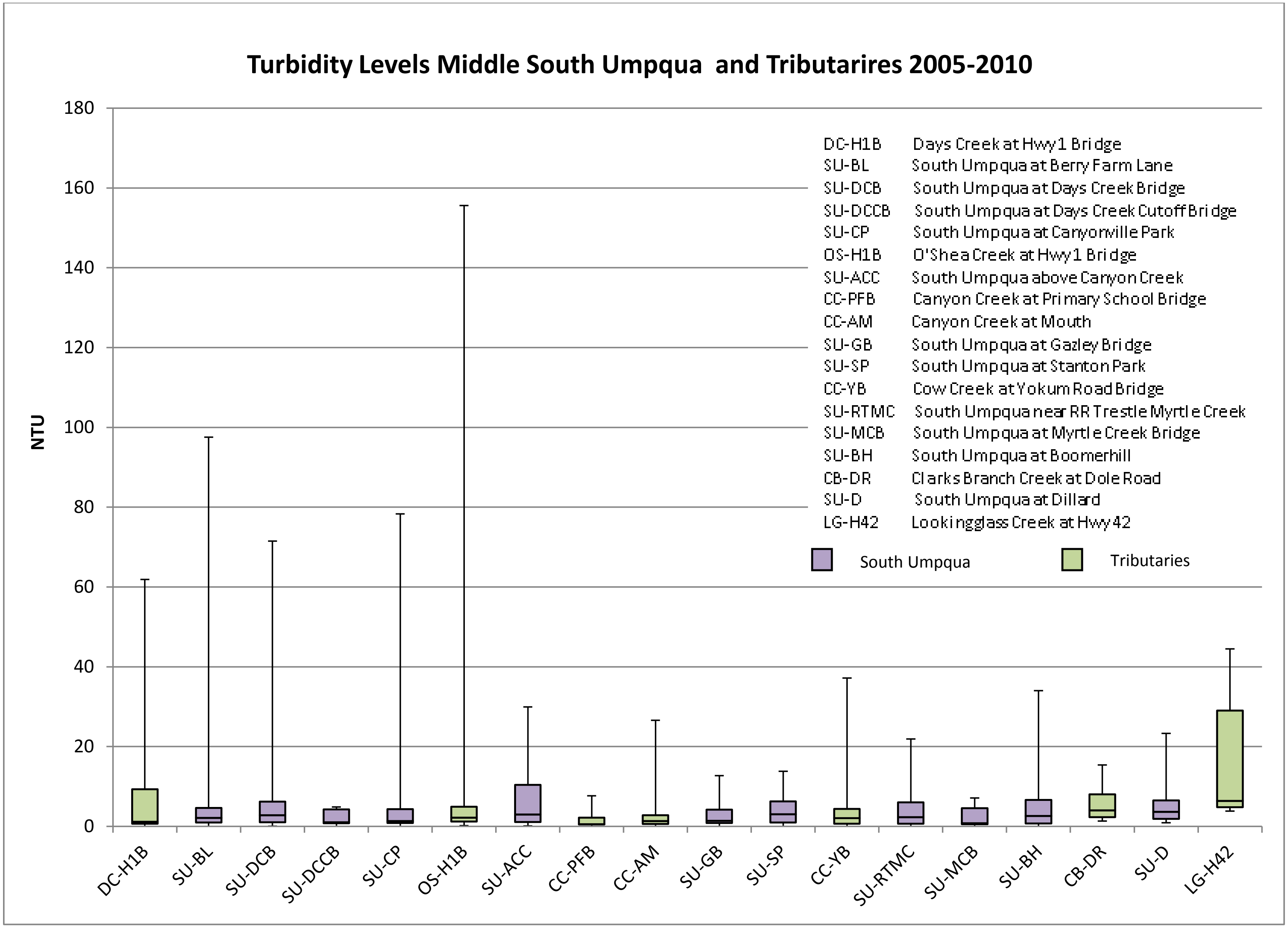


Figure 59: Turbidity Levels Middle South Umpqua and Tributarires 2005-2010

South Umpqua Sites – Turbidity Exceeding 10 NTU, Summer and Winter

SITE	Total # Monitoring Events	Summer		Winter		Rating
		# Samples	% > 10 NTU	winter	% > 10 NTU	
Days Creek above Fate Creek	20	7	0	13	54	
Fate Creek near mouth	18	7	0	11	64	
Days Creek above Perdue Creek	17	7	0	10	60	
Days Creek at Woods Creek Road Bridge	28	12	8	16	44	
Woods Creek near mouth at Woods Creek Road Culvert	29	12	8	17	41	
Days Creek at Highway 1 Bridge	8	5	0	3	67	
South Umpqua upriver of Days Creek at Berry Farm Lane	8	5	0	3	33	
South Umpqua at Days Creek Bridge	26	14	7	12	17	
South Umpqua at Days Creek Cutoff bridge	8	0	0	3	33	
South Umpqua at Canyonville Park	18	10	0	8	13	
O'Shea Creek at Tiller Trail Hwy	19	8	0	11	36	
Canyon Creek at Primary School Footbridge	8	5	0	3	0	
Canyon Creek at Mouth	33	16	0	14	14	
South Umpqua above Canyon Creek	18	7	0	11	45	
South Umpqua at Gazley Bridge Road Bridge	8	5	0	3	33	
South Umpqua at Stanton Park	11	5	0	6	17	
Cow Creek at Yokum Road bridge	35	16	0	19	21	
South Umpqua River at RR Tressel Upstream of Myrtle Creek	40	17	0	23	22	
South Umpqua below Mrytle Creek bridge	8	5	0	3	33	
South Umpqua River at Boomerhill	37	17	0	20	15	
Clarks Branch at Dole Road	20	5	0	14	29	
South Umpqua at Dillard	25	9	0	16	25	
Lookingglass Creek at Highway 42 Winston	11	4	0	7	71	

Rating	Color	Turbidity
Good		< 10 NTU
Concern		Between 10% and 20% , 10 NTU or greater
Needs Improvement		20% or more 10 NTU or greater

Table 21: South Umpqua Sites – Turbidity exceeding 10 NTU, summer and winter

RESULTS - South Umpqua Area

pH

A number of sites in the South Umpqua area exceeded the upper pH limit of 8.5, as can be seen in Figure 60. As mentioned previously, more exceedances may have been detected if monitoring had occurred later in the day during summer months. No pH values of less than 6.5, the lower criteria limit, were ever detected. In fact, no levels below pH 7.0 were measured. “Days Creek above Fate Creek site” often has the lowest pH values. Streams of the South Umpqua area are summarized for DEQ pH criteria exceedances in Table 22. Figure 61, pH of Days Creek and its tributaries, displays an interesting trend. As one proceeds down Days Creek, the pH values, both of the tributaries and of Days Creek, increase. It is unlikely that this was caused by the variations in time of day samples were collected as they were all collected within a fairly short time period and it is only four miles from the first Days Creek site to its mouth. Perdue Creek was added for this study. It is a small tributary that goes dry quickly in summer. Observation has offered no theory as to why this is occurring. Figure 62 displays the sites along the South Umpqua and its tributaries in order of confluence. Six sites on the South Umpqua exceeded pH 8.5: Berry Farm Lane above Days Creek, Gazley Road, Myrtle Creek railroad trestle, Myrtle Creek bridge, Boomerhill, and Dillard. Cow Creek was the only tributary to exceed pH 8.5. It is, by far, the largest of the tributaries.

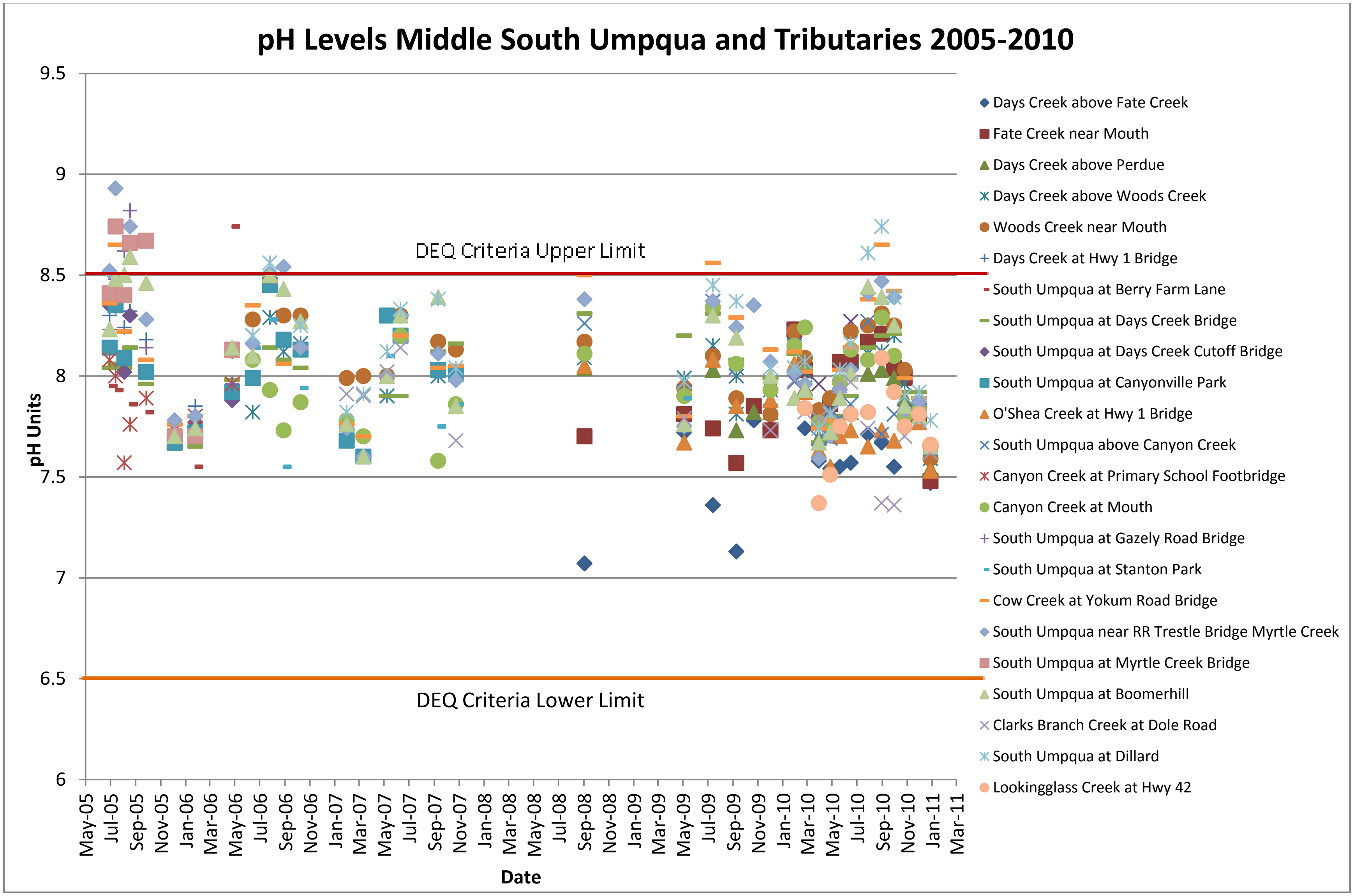


Figure 60: pH levels all sites South Umpqua and tributaries 2005-2010

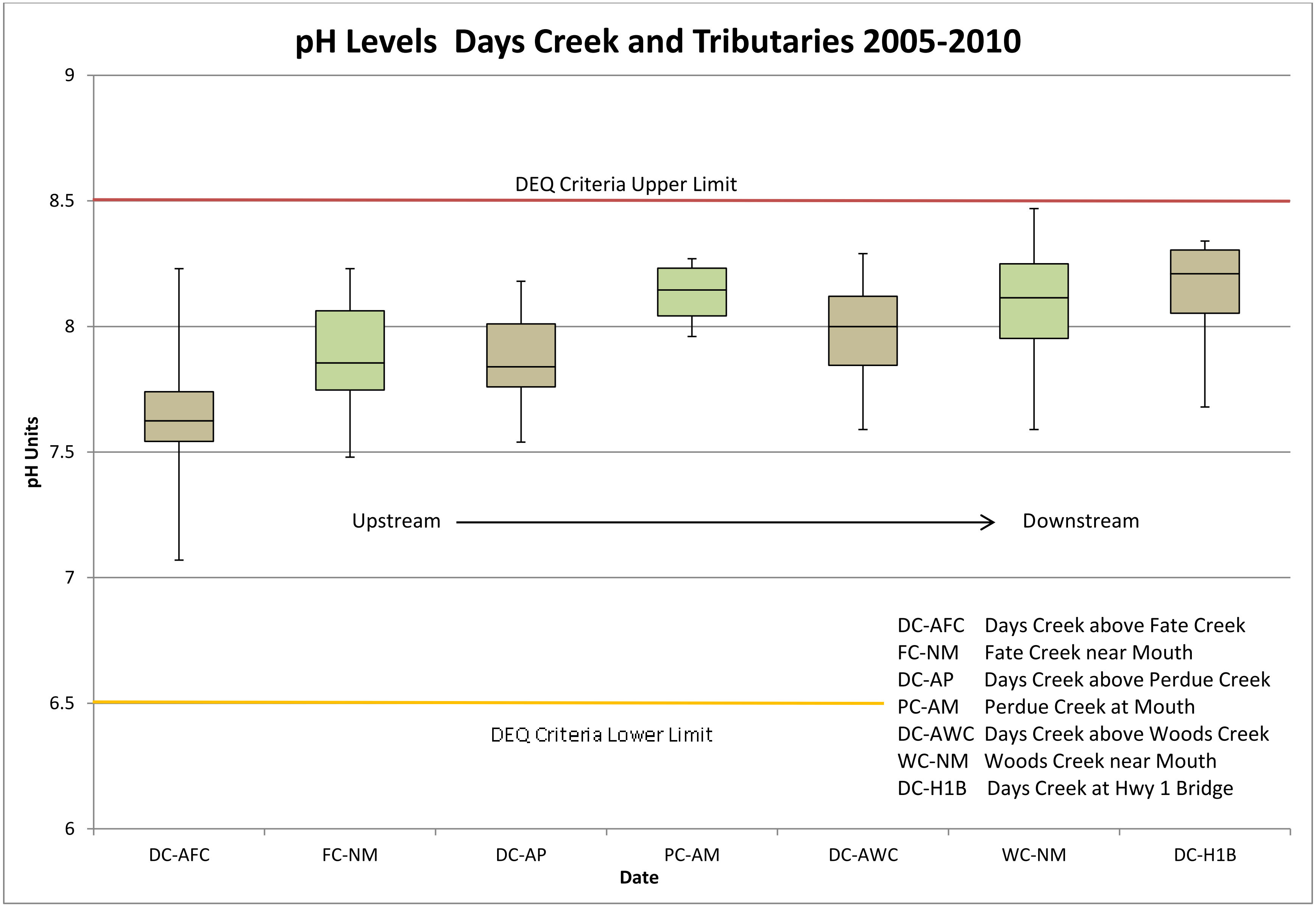


Figure 61: Turbidity levels for Days Creek and its tributaries

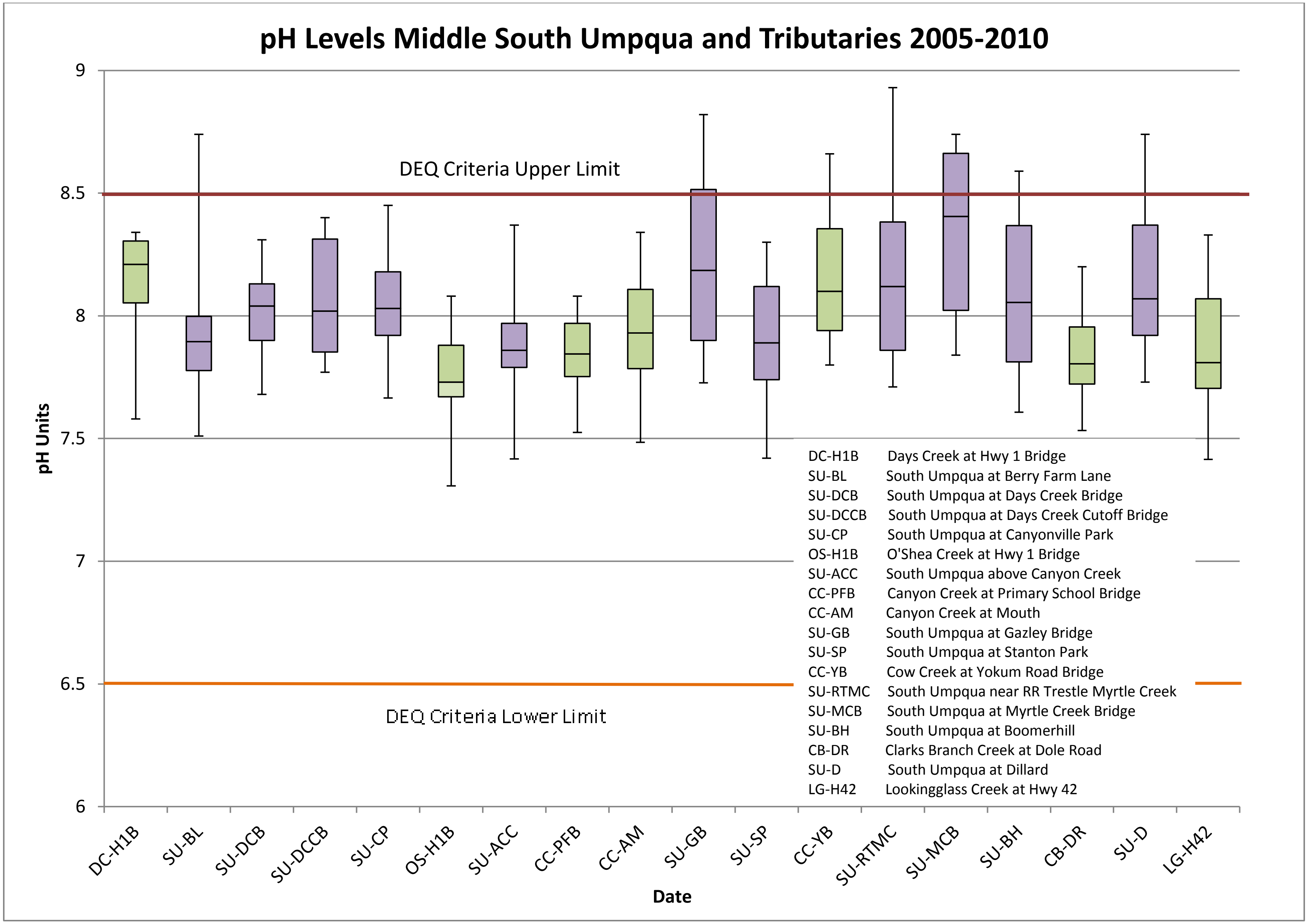


Figure 62: pH levels for South Umpqua sites and tributaries

pH Site Ratings for South Umpqua Area

Site	pH
Days Creek above Fate Creek	Blue
Fate Creek near mouth	Blue
Days Creek above Perdue Creek	Blue
Days Creek at Woods Creek Road Bridge	Blue
Woods Creek near mouth at Woods Creek Road Culvert	Red
Days Creek at Highway 1 bridge	Yellow
S. Umpqua upriver of Days Creek at Berry Farm Lane	Red
South Umpqua at Days Creek Bridge	Yellow
South Umpqua at Days Creek Cutoff bridge	Yellow
South Umpqua at Canyonville Park	Yellow
O'Shea Creek at Tiller Trail Hwy	Blue
Canyon Creek at Primary School foot bridge	Blue
South Umpqua above Canyon Creek	Yellow
Canyon Creek at mouth	Yellow
South Umpqua at Gazley Bridge Road bridge	Red
South Umpqua at Stanton Park	Yellow
Cow Creek at Yokum Road bridge	Red
South Umpqua River at RR bridge upstream of Myrtle Creek	Red
South Umpqua below Mrytle Creek bridge	Red
South Umpqua River at Boomerhill	Red
Clarks Branch at Dole Road	Blue
South Umpqua at Dillard	Red
Lookingglass Creek at Hwy 42 Winston OR	Yellow

pH Rating Key		
Rating	**Color**	**pH Criteria**
Good	Blue	None above 8.25
Concern	Yellow	1 or more ≥ 8.25
Needs Improvement	Red	1 or more ≥ 8.5

Table 22: pH site ratings for South Umpqua area monitoring

RESULTS - South Umpqua Area

Dissolved Oxygen

Figure 63 indicates that the majority of dissolved oxygen level readings in the South Umpqua monitoring area fell within the DEQ criteria for spawning and non-spawning time periods. Low values at sites in 2005 and 2006 may be mistakenly low due to use of the Hach dry packet chemical analysis. From 2008-2010, when the Sonde was used for measuring D.O., Days Creek and Clarks Branch Creek were low. Values for Days Creek's flow reduce dramatically during summer months and on several dates the water was coming from subsurface flow which would be depleted in oxygen. Photo 11 shows typical pooling at Days Creek above Fate Creek site before instream structures were added. The pools remained throughout the summer so monitoring was continued because fish fry were still present. Similar conditions occurred at Clarks Branch Creek. Figure 64 indicates that dissolved oxygen In 2010 for the edges of the spawning season in early May and early November were below the D.O. criteria. It will be of interest to see if the effects of the instream project above the monitoring site will help to increase D.O. at those times of year. It appears that the dissolved oxygen levels consistently increase in a downstream direction, as can be seen in Figure 64, Days Creek at Woods Creek has higher D.O. than Days Creek above Perdue, and Days Creek above Perdue has higher than Days Creek above Fate Creek.

Photo 11: Days Creek above Fate Creek summer conditions

Table 23 summarizes the stream ratings for dissolved oxygen for the South Umpqua monitoring area. The ratings are based on data without correction for monitoring technique employed or for nearness to the criteria dates. Close examination of Figure 63 reveals that many of the exceedances occurred at the very edge of the time periods dividing spawning and non-spawning criteria. If monitoring had occurred a few days earlier or later, the values would have been appropriate for a different criterion.

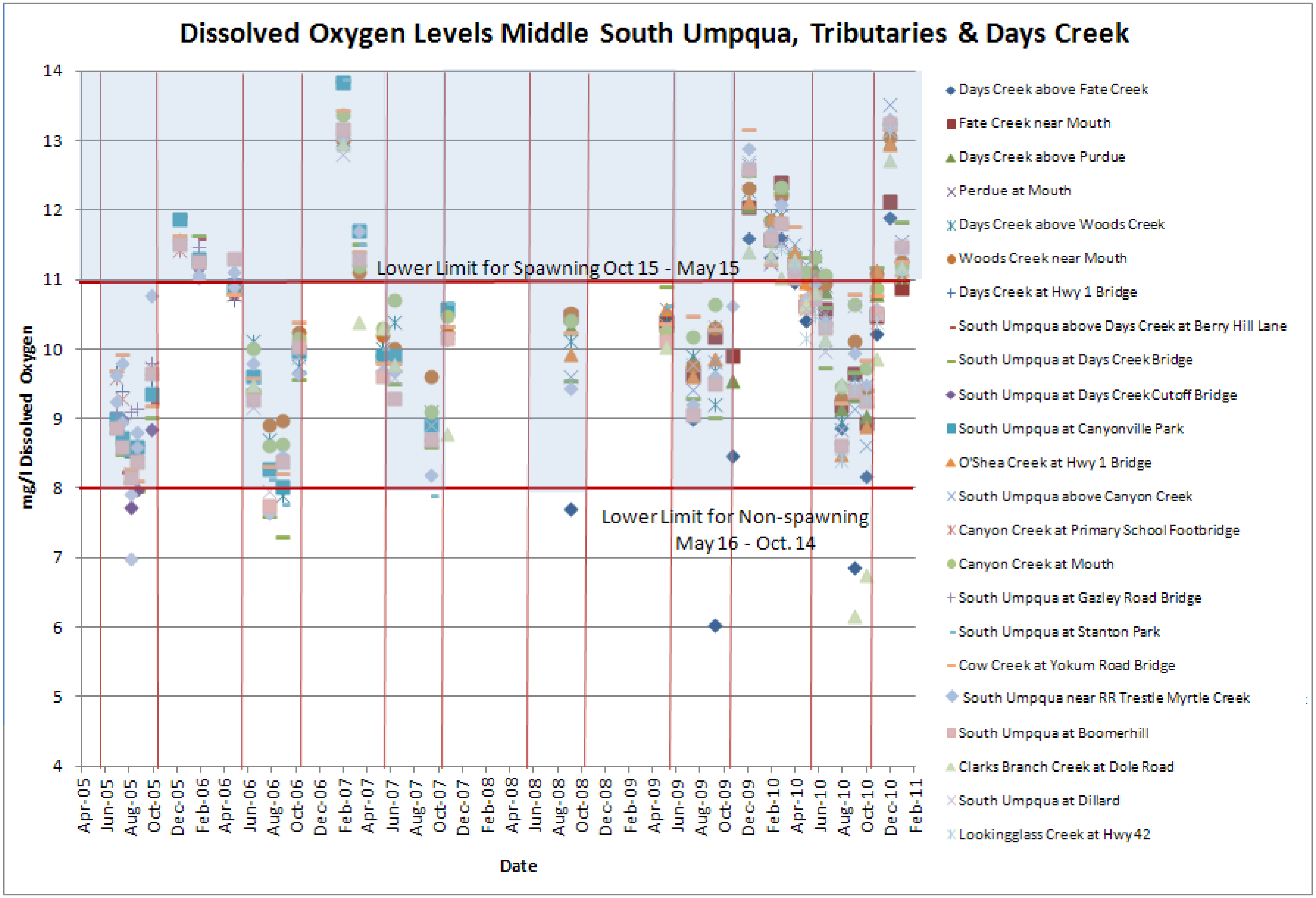


Figure 63: Dissolved oxygen levels for South Umpqua sites and tributaries

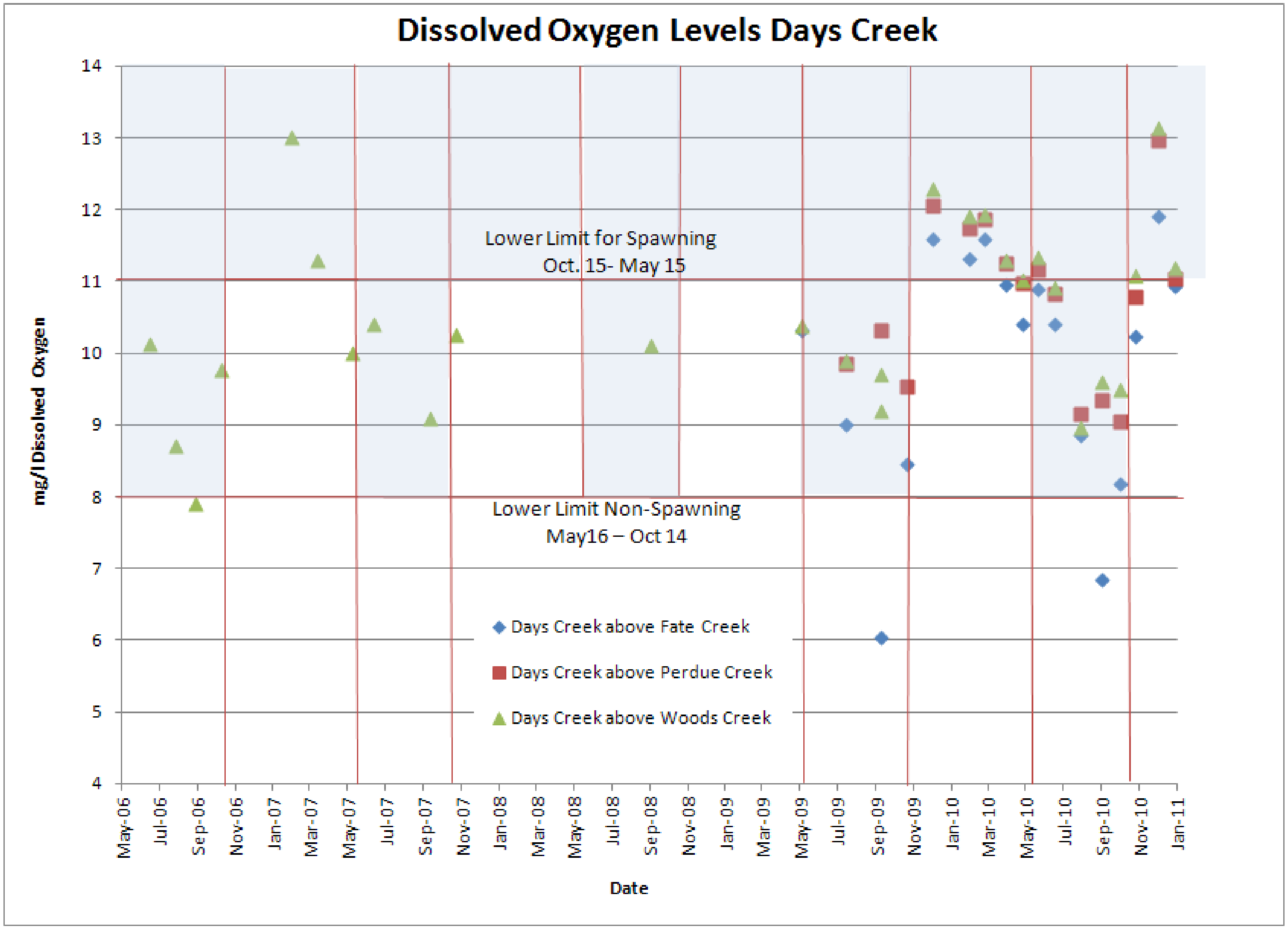


Figure 64: Dissolved oxygen levels Days Creek

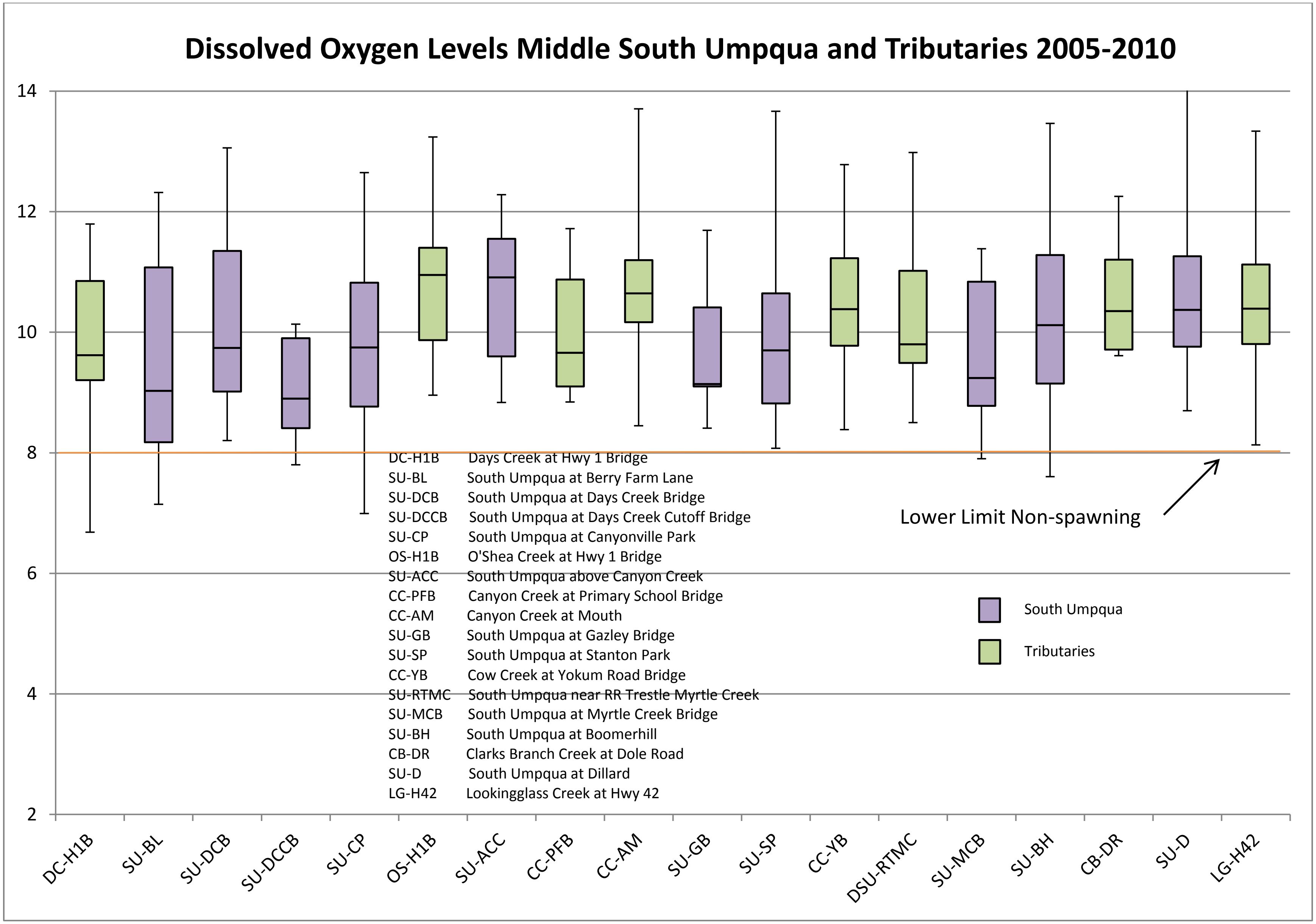


Figure 65: Dissolved oxygen levels for South Umpqua area sites and tributaries

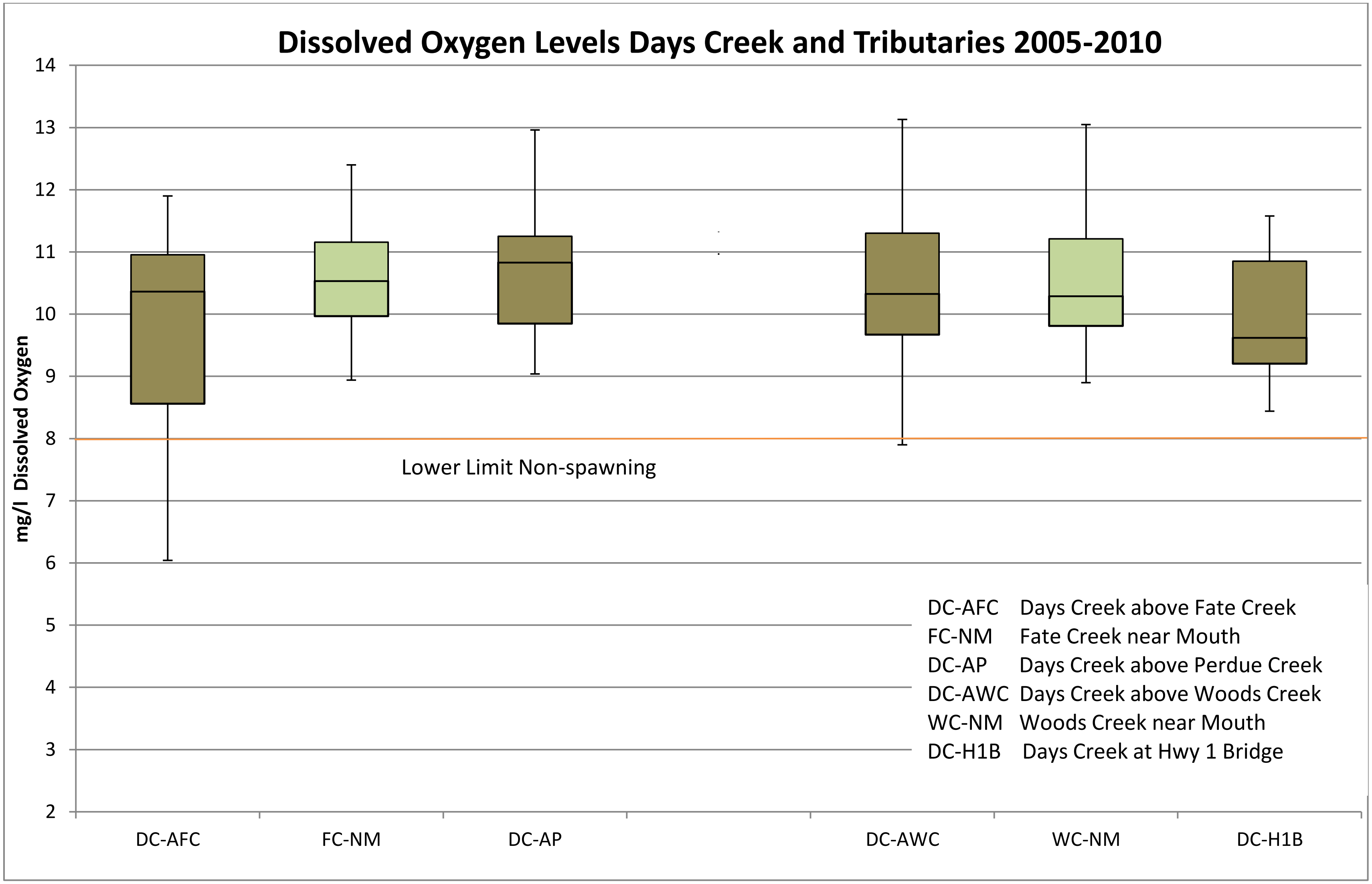


Figure 66: Dissolved oxygen levels for Days Creek and tributaries

Dissolved Oxygen Levels for South Umpqua Area Sites Rated for Non-spawning and Spawning Seasons

SITE	Non-spawning Season May 16-October 14				Spawning Season October 13-May15			
	# Samples	# Below Minimum D.O. Criteria of 8 mg/l	% Below Minimum D.O. Criteria of 8 mg/l	Rating	# Samples	# Below Minimum D.O. Criteria of 11 mg/l	% Below Minimum D.O. Criteria of 11 mg/l	Rating
Days Creek above Fate Creek	8	3	0		12	7	33	
Fate Creek near mouth	8	0	0		10	5	45	
Days Creek above Perdue Creek	8	0	29		9	3	46	
Days Creek at Woods Creek Road Bridge	15	1	0		14	4	50	
Woods Creek near mouth at Woods Creek Road Culvert	14	1	38		15	6	58	
Days Creek at Hway 1 bridge	5	0	0		3	1	33	
S. Umpqua up river of Days Creek at Berry Farm Lane	5	2	7		3	1	29	
South Umpqua at Days Creek Bridge	20	3	0		17	6	33	
South Umpqua at Days Creek Cutoff bridge	5	0	0		3	1	50	
South Umpqua at Canyonville Park	11	0	0		7	3	33	
O'Shea Creek at Tiller Trail Hwy	9	0	0		11	5	45	
Canyon Creek at Primary School foot bridge	5	0	13		3	1	30	
Canyon Creek at mouth	14	0	0		11	5	43	
South Umpqua above Canyon Creek	8	1	5		10	3	33	
South Umpqua at Gazley Bridge Road bridge	5	0	11		3	1	48	
South Umpqua at Stanton Park	6	2	15		5	3	35	
Cow Creek at Yokum Road bridge	19	0	33		18	9	60	
South Umpqua River at RR bridge upstream of Myrtle Creek	19	2	7		21	10	40	
South Umpqua below Mrytle Creek bridge	5	1	40		3	2	33	
South Umpqua River at River Mile 36.4	19	1	0		18	6	43	
Clarks Branch at Dole Road	7	2	0		13	6	33	
South Umpqua at Dillard	11	0	20		14	6	67	
Lookingglass Creek at Hwy 42 Winston OR	5	0	0		6	2	33	

Table 23: Dissolved oxygen levels for South Umpqua sites and tributaries rated for non-spawning and spawning seasons

RESULTS - South Umpqua Area
Conductivity

The South Umpqua monitoring area had only one monitoring site, Clarks Branch Creek, which exceeded 500 us/cm. This was one of the two creeks that lost their surface flow for a period during summer (See Figure 67). Like Bilger Creek, in the Myrtle Creek Watershed, as the stream flow reduced, concentration of natural minerals increased. Days Creek never exceeded the 500 us/cm level of concern as Clarks Branch did. All of the other streams were within normal conductivity range for the Umpqua Basin.

Table 24 rates the conductivity of all streams monitored in the South Umpqua area.

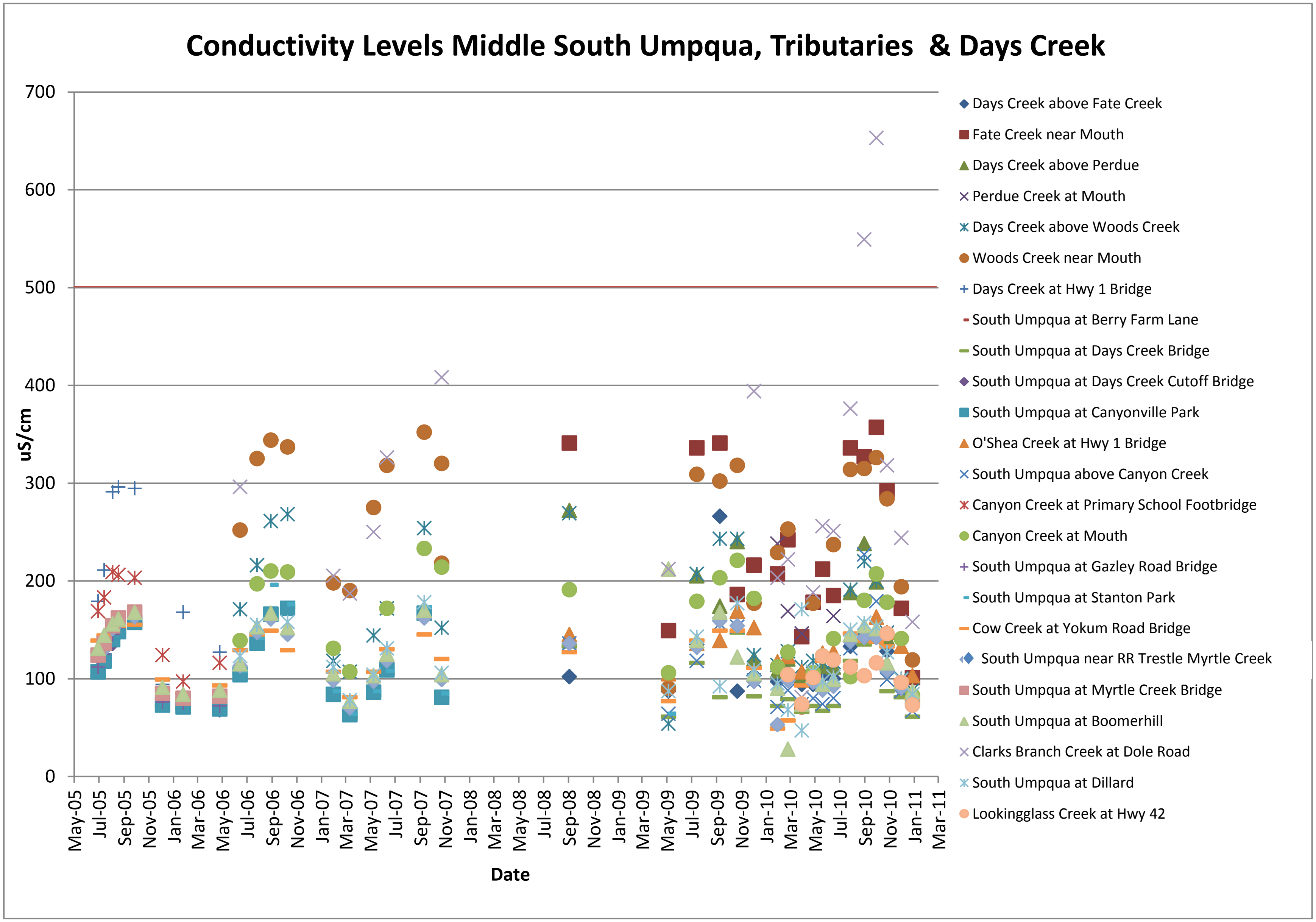


Figure 67: Conductivity levels for South Umpqua area sites

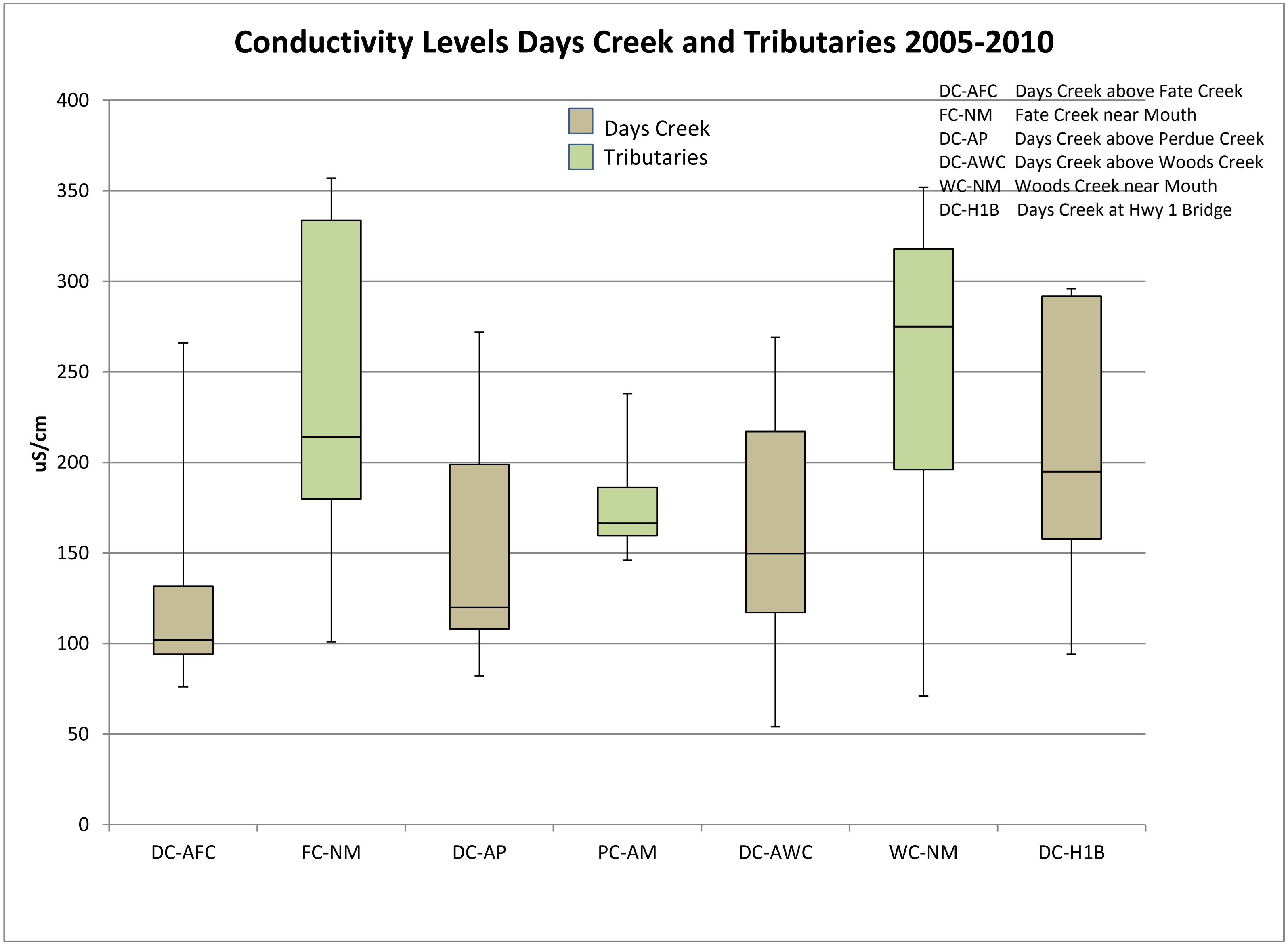


Figure 68: Conductivity levels for Days Creek area sites

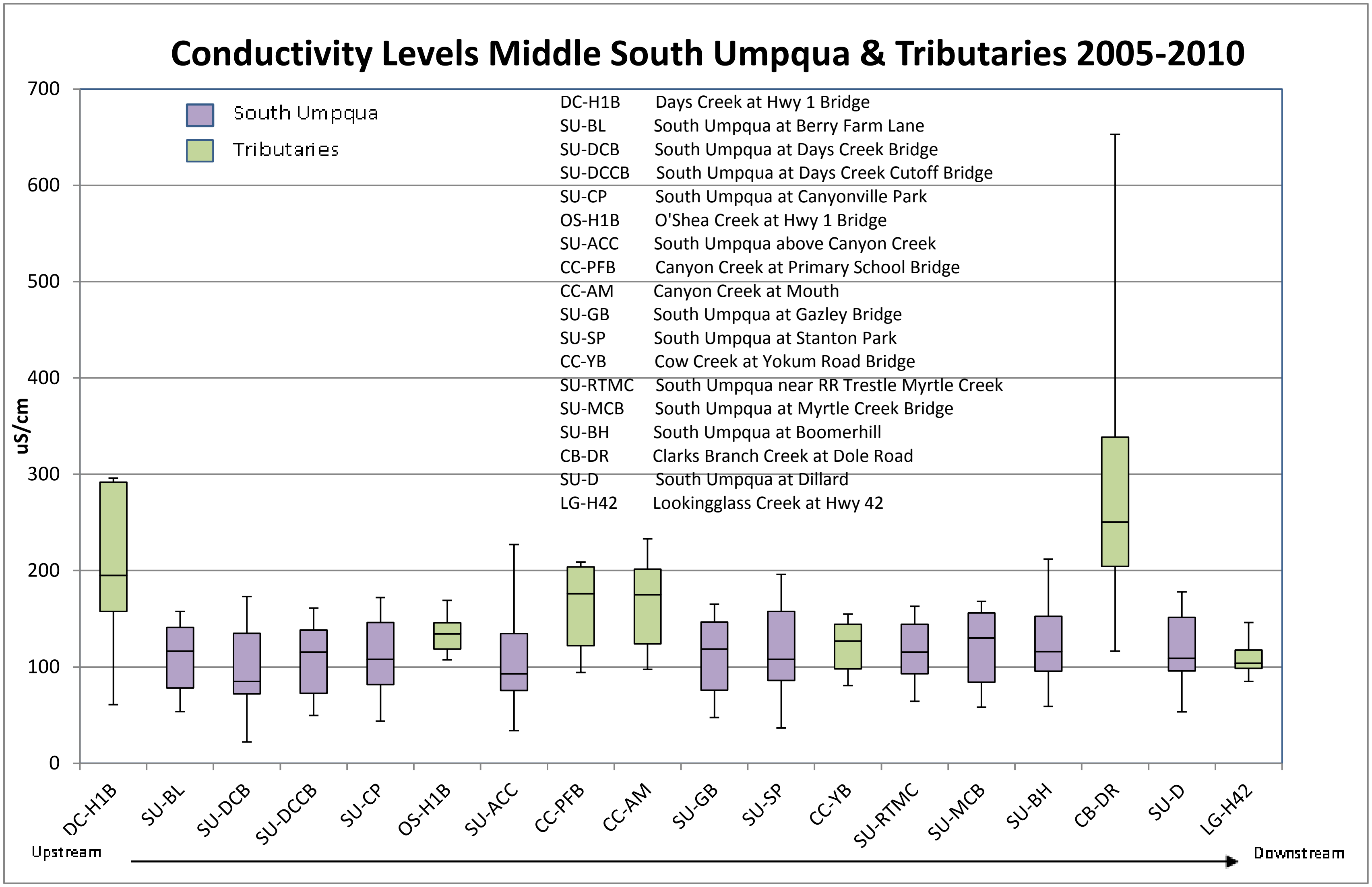


Figure 69: Conductivity levels for South Umpqua area sites

Conductivity Level Rating for South Umpqua Area Sites

Site	Conductivity
Days Creek above Fate Creek	
Fate Creek near mouth	
Days Creek above Perdue Creek	
Days Creek at Woods Creek Road Bridge	
Woods Creek near mouth at Woods Creek Road Culvert	
Days Creek at Hway 1 bridge	
S. Umpqua up river of Days Creek at Berry Farm Lane	
South Umpqua at Days Creek Bridge	
South Umpqua at Days Creek Cutoff bridge	
South Umpqua at Canyonville Park	
O'Shea Creek at Tiller Trail Hwy	
Canyon Creek at Primary School foot bridge	
South Umpqua above Canyon Creek	
Canyon Creek at mouth	
South Umpqua at Gazley Bridge Road bridge	
South Umpqua at Stanton Park	
Cow Creek at Yokum Road bridge	
South Umpqua River at RR bridge upstream of Myrtle Creek	
South Umpqua below Mrytle Creek bridge	
South Umpqua River at River Mile 36.4	
Clarks Branch at Dole Road	
South Umpqua at Dillard	
Lookingglass Creek at Hwy 42 Winston OR	

Rating	Color	Conductivity Level
Good		<500 uS/cm
Needs Improvement		>500 uS/cm

Table 24: Conductivity level rating for South Umpqua area sites

RESULTS - South Umpqua Area

E. coli Bacteria

The Middle South Umpqua area presented serious *E. coli* problems with spikes exceeding the limits of the test (>2420 MPN/100ml) and numerous exceedances of ODEQ criteria (≥406 MPN/100ml. These are evident in Figure 70 and rated in Table 25. Figure 71 displays the Days Creek area, with E. *coli* levels increasing the further downstream samples were collected. Woods Creek especially contributed high E. *coli* levels. Figure 72 displays Canyon Creek, Clarks Branch Creek and Lookingglass Creek each having very high levels at times, and, Clarks Branch Creek and Lookingglass Creek each with the upper 25% of data exceeding the DEQ Criteria.

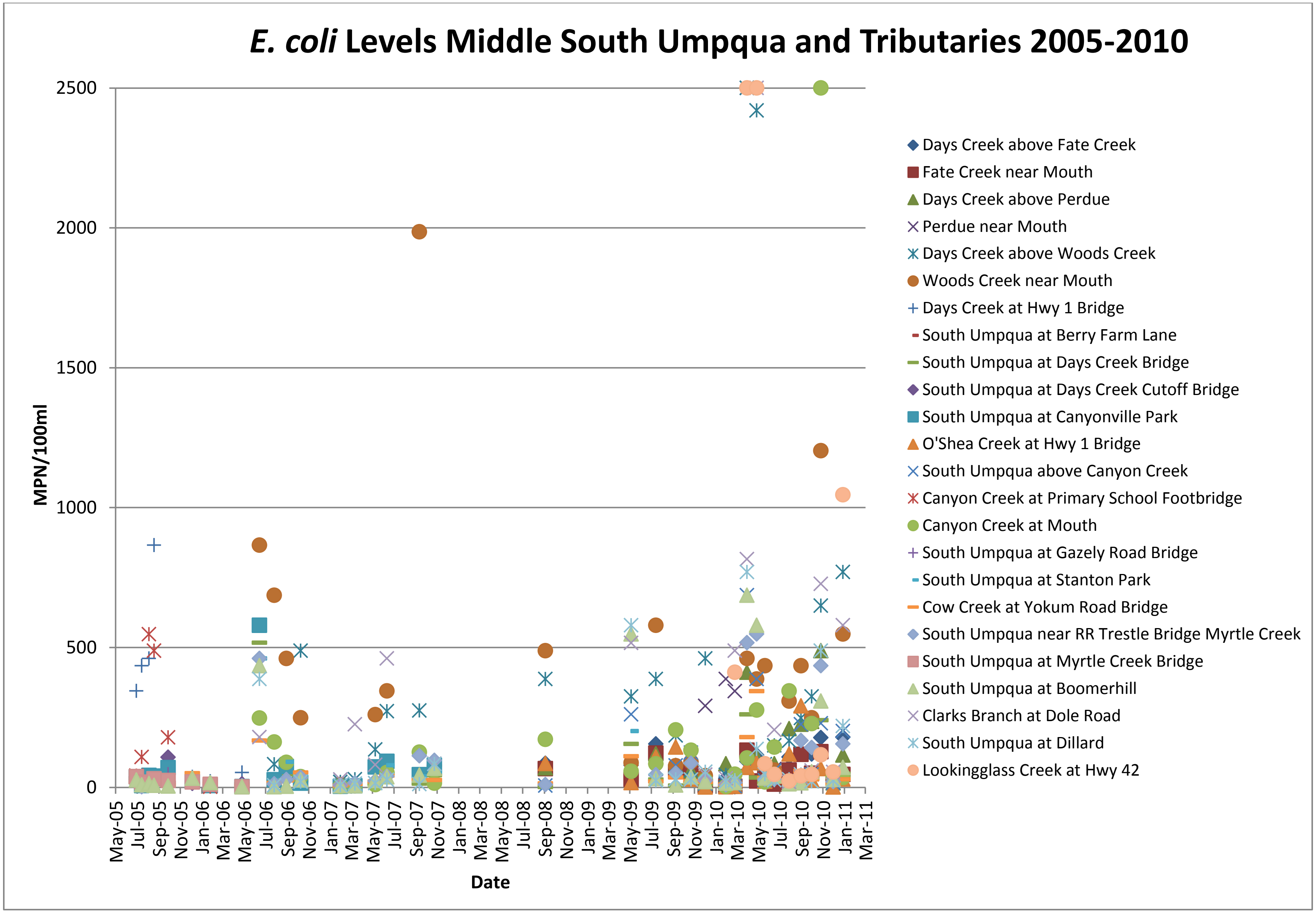


Figure 70: *E. coli* levels for South Umpqua area sites

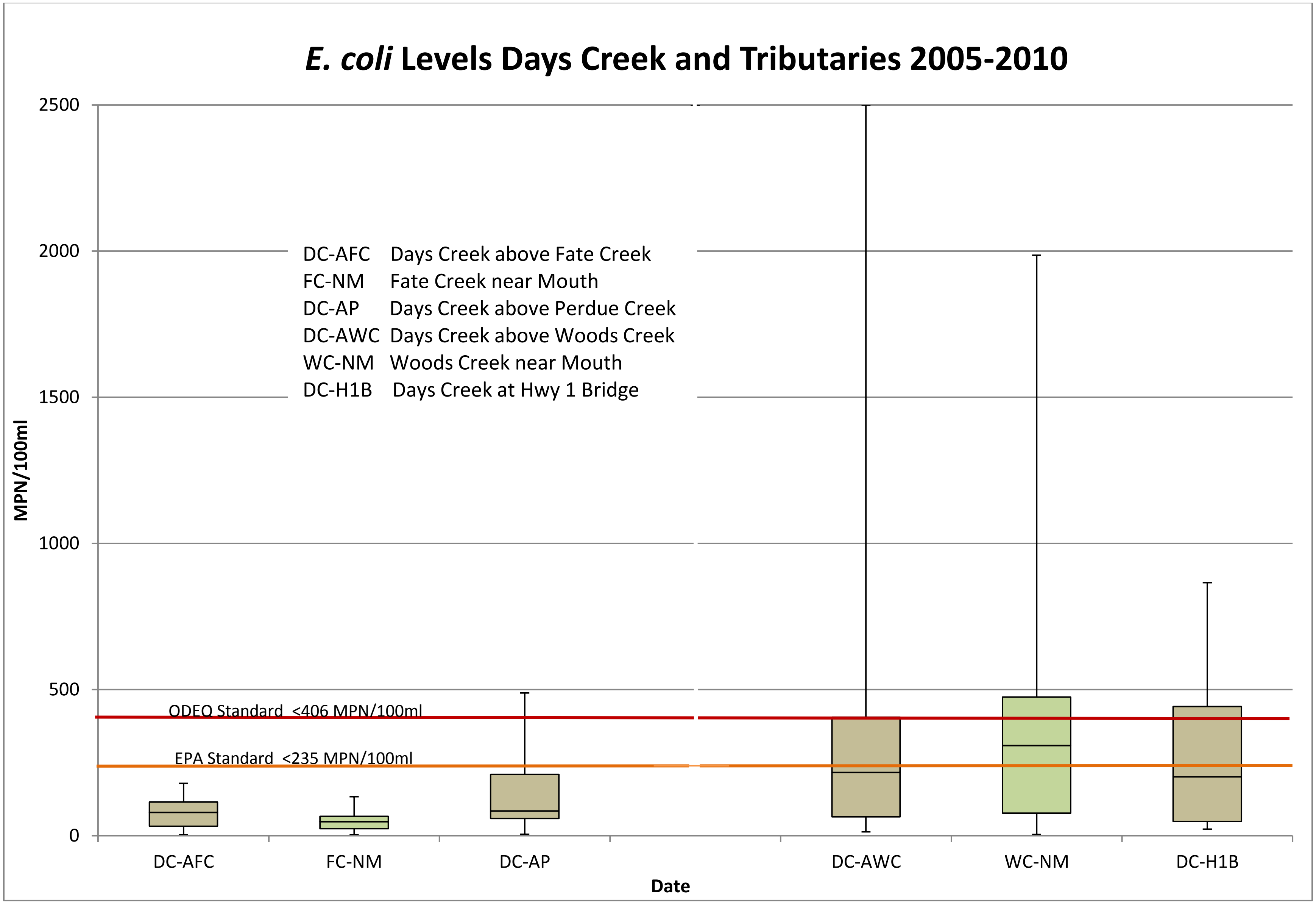


Figure 71: *E. coli* levels for Days Creek area sites

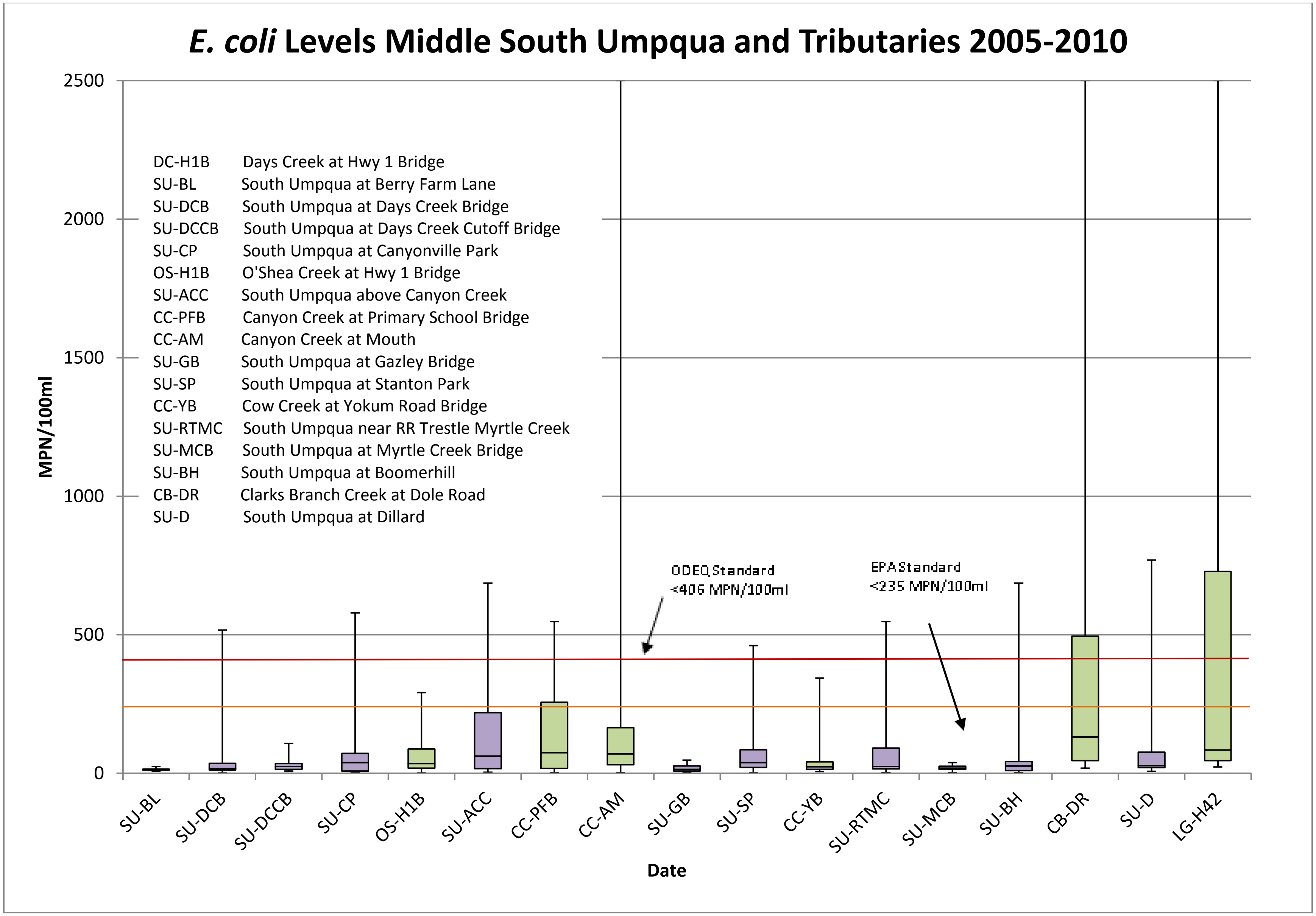


Figure 72: ***E. coli*** **levels for South Umpqua area sites**

Rating of South Umpqua Area Sites for *E. coli*, Summer and Winter

Site	Summer				Winter			
	# Samples	% Above EPA Criteria (235 MPN/100ml)	% Above ODEQ Criteria (406 MPN/100ml)	Rating	# Samples	% Above EPA Criteria (235 MPN/100ml)	% Above ODEQ Criteria (406 MPN/100ml)	Rating
Days Creek above Fate Creek	7	0	0		13	0	0	
Fate Creek near mouth	7	0	0		11	0	0	
Days Creek above Perdue Creek	7	14	0		10	20	20	
Days Creek at Woods Creek Road Bridge	13	54	8		16	44	38	
Woods Creek near mouth at Woods Creek Road Culvert	12	83	58		17	47	29	
Days Creek at Hway 1 bridge	5	80	60		3	0	0	
S. Umpqua up river of Days Creek at Berry Farm Lane	5	0	0		3	0	0	
South Umpqua at Days Creek Bridge	18	6	6		19	11	0	
South Umpqua at Days Creek Cutoff bridge	5	0	0		3	0	0	
South Umpqua at Canyonville Park	10	10	10		8	0	0	
O'Shea Creek at Tiller Trail Hwy	8	13	0		12	0	0	
Canyon Creek at Primary School foot bridge	5	40	40		3	0	0	
South Umpqua above Canyon Creek	7	0	0		11	27	9	
Canyon Creek at mouth	12	17	0		13	15	8	
South Umpqua at Gazley Bridge Road bridge	5	0	0		3	0	0	
South Umpqua at Stanton Park	5	20	20		6	0	0	
Cow Creek at Yokum Road bridge	17	0	0		20	5	0	
South Umpqua River at RR bridge upstream of Myrtle Creek	17	6	6		23	17	13	
South Umpqua below Mrytle Creek bridge	5	0	0		3	0	0	
South Umpqua River at River Mile 36.4	17	6	6		20	20	15	
Clarks Branch at Dole Road	6	17	17		14	43	43	
South Umpqua at Dillard	9	11	0		16	19	19	
Lookingglass Creek at Hwy 42 Winston OR	4	0	0		7	57	57	

Rating	Color	*E. coli* MPN/100ml
Good		<100
Fairly Good		>100<235
Concern		>235<406
Needs Improvement		> 406

Table 25: Rating of South Umpqua Area Sites for *E. coli*, Summer and Winter

RESULTS - South Umpqua Area

Continuous Temperature

PUR monitored six continuous temperature sites in the South Umpqua area between 2006 and 2010. This includes a site at the mouth of Fate Creek which is downstream from a restoration project. Due to its upstream proximity to this Fate Creek restoration project, a long-term BLM monitoring site was analyzed in this study as well (Fate Creek at Lowest Extent of BLM). Dates of continuous summer stream temperature monitoring in the South Umpqua area, seasonal maximum and minimum stream temperatures, diurnal fluctuations, 7-day average maximum (7DAM) stream temperatures, and days above the ODEQ criteria (ODEQ, 2003) and (ODEQ, 2011, p. 46) are listed in Appendix K All streams in the South Umpqua area fall into the designated fish use of salmon and trout rearing and migration (ODEQ, 2003) and therefore the 7DAM stream temperatures may not exceed 64.4°F (ODEQ, 2011, p. 46). The 7DAM stream temperatures for the streams monitored in the South Umpqua area during this study (2006-2010) ranged from 65.4°F to 88.0°F, all exceeding the ODEQ criteria (Appendix K).

Some monitoring sites in the South Umpqua area exceeded the potentially lethal temperatures Bell (1990, p. 11.4) found for steelhead and cutthroat trout (75.0°F and 73.0°F respectively). These sites were Canyon Creek near Mouth all years monitored, Days Creek above Fate Creek in 2006, Days Creek above Woods Creek all years monitored, South Umpqua above Canyon Creek all years monitored, and Woods Creek at Mouth in 2009. (Appendix K). Some sites even exceeded the lethal stream temperatures Brett (1952, pg. 282-3) found for young coho and Chinook salmon, acclimated to 70°F, of ≥78.8°F (Table 26). Brett (1952, pp. 282-283) found 50% mortality at this temperature after 16.7 hours.

One site, South Umpqua River above Canyon Creek reached a maximum stream temperature of 89.3°F which was maintained above 78.8°F for 46 hours in July, 2009 (Table 26). While these river temperatures in the high 80’s are extremely high and were maintained for almost 30 hours more than the 16.7 hours Brett (1952, pp. 252-253) found resulted in 50% mortality, there are ecological conditions that may reduce the likelihood of a lethal situation. Unlike in laboratory conditions, these fish have the ability to move out of the areas of high temperature either upstream or to cooler areas nearby. Pools in the river may be cooler than surface waters and create cool water refuges for fish (Bilby, 1984, p. 593). However, the South Umpqua River is broad and shallow during the summer in this location and there are few pools. The temperature of tributaries in this region is not providing any cooling since they are also quite high. (See Part II. Thermal Refugia Investigation for more information on thermal refugia.) Therefore, while temperatures may or may not be lethal, there is a likelihood that the high temperatures could cause metabolic stress and increased likelihood of diseases to salmonids living in those river temperatures.

The South Umpqua above Canyon Creek sites in 2008 and 2010 exceeded 78.8°F for 14.5 and 11.5 hours respectively; the other two sites on tributaries exceeded the temperature for less than four hours (Table 26). The minimum temperature on the date of maximum stream temperature ranged from 67.6°F to 75.6°F for these sites (Table 26). Though the temperatures of these sites may be above the lethal temperature, and they may be occurring more than one day, it was less than the 16.7 hours that Brett (1952) study found to result in 50% mortality (Table 26). This reduces the likelihood that reaching these lethal temperatures would kill fish, but would instead result in metabolic stress and increased possibility of diseases.

Table 26: Seasonal maximum stream temperatures for South Umpqua area sites that meet or exceed 78.8°F, which has been described at the lethal limit for young coho and Chinook salmon acclimated to 70°F (measured as 50% mortality after 16.7 hours) (Brett, 1952, p. 282).

Site	Year	Seasonal Maximum Stream Temperature (SMST) (°F)	Hours ≥78.8°F on Date of SMST	Minimum Temperature on Date of SMST (°F)
Canyon Ck. near Mouth	2009	79.5	3.5	72.0
Days Ck. above Woods Ck.	2008	79.2	2.5	67.6
S. Umpqua above Canyon Ck.	2008	86.2	14.5	75.6
S. Umpqua above Canyon Ck.	2009	89.3	46*	79.6
S. Umpqua above Canyon Ck.	2010	83.4	11.5	73.4

* was above 78.8°F from before 8am on 7/29 to after 5:30pm on 7/31.

In the South Umpqua area there is fairly consistent continuous stream temperature data annually from July 16 to August 31. However, there are a few sites that had shorter monitoring periods due to equipment failure or the equipment going out of water. In 2008, Days Creek above Fate was only monitored until August 14 and in 2009 monitoring didn't begin until August 3; South Umpqua above Canyon Creek started on July 29 in 2010. The percent of days that the temperature exceeds ODEQ's 64.4°F criteria within the time period of July 16 to August 31 is mapped on Figure 73. Years were combined to reduce the effect of annual variability, though not all streams were monitored each year (Appendix K).

Canyon Creek near the mouth and the South Umpqua above Canyon Creek both had greater than 91% of the days exceeding the criteria (Figure 73). Fate Creek had the smallest percent of days (21-40%) above 64.4°F (Figure 73). Days Creek had more days exceeding the criteria at the downstream site compared to the upstream Days Creek site; and the tributary Woods Creek (at the Mouth) had more days than Fate Creek near the mouth (Figure 73).

Since water temperature in the upper 60's is a stressor to salmonids (Bjornn & Reiser, 1991, p. 84) and (The Oregon Plan for Salmon and Watersheds, 1999, pp. 6-1), the percentage of days from July 16 to August 31 above 68°F was also mapped (Figure 74). By comparing existing data in the short data sets listed above to similarly behaving sites nearby, the whole data set for temperatures exceeding 68°F could be extrapolated enough to determine that there would be no change to the percentage ranges on Figure 74 for these sites. The South Umpqua above Canyon Creek site had greater than 91% of the days above this value (Figure 74). Fate Creek near Mouth, Days Creek above Fate Creek and Days Creek above Woods Creek all had ≤10% of the days between July 16 and August 31st above 68°F, compared to Woods Creek at Mouth which had more days (11-20%) (Figure 74). Canyon Creek near the mouth, which is downstream of the city of Canyonville, had 61-80% of the days above 68°F (Figure 74).

When the cold limit line (Smith, K., 2003, Apx. 1, p. 9) is graphed with the 7DAM stream temperatures for sites in the South Umpqua area, all are above the predicted minimum stream temperature (Figure 75 and Table 27). The further the stream temperatures are from the minimum predicted temperatures on the cold limit line indicates a potential anthropogenic effect resulting in increased stream temperatures. South Umpqua above Canyon Creek has the largest difference to the cold limit line compared to the other sites for every year except 2008 (Figure 75 and Table 27). Canyon Creek near Mouth also has a larger distance from the cold limit line (Figure 75 and Table 27). Both streams are downstream of the City of Canyonville and the South Umpqua at this site is downstream of agricultural land.

The upstream Days Creek site, Days Creek above Fate Creek, is the closest to the minimum predicted cold limit line every year (Figure 75 and Table 27). This is an interesting anomaly if one were to report the continuous temperature data alone. In summer, Days Creek in this region is on the edge of where surface flow ends but there is enough sub-surface (hyporheic) flow to maintain water in the deeper pools. The downstream Days Creek site, Days Creek above Woods, is much further from the cold limit line, indicating the normal warming to Days Creek that would be occurring in this region where the stream stays above the surface below the confluence with Fate Creek. Temperatures at Woods Creek at its mouth overall were further from the cold limit line than all other sites, except the South Umpqua (Figure 75 and Table 27). This is consistent with the Days above 68°F map (Figure 74) which shows an increased number of warmer days for Woods Creek compared to Days and Fate Creeks. This high level is due to higher stream temperatures in 2008 and very high stream temperatures compared to the cold limit line in 2009. High stream temperatures in 2009 were observed county wide.

Three streams monitored exceeded lethal temperatures for young coho and Chinook salmon. Only one site one year, exceeded the hours above the criteria to reach 50% mortality as measured in lab studies (Brett, 1952, pp. 252-3). For the majority of instances, due to the low number of hours that the temperature were exceeded, it is unlikely that reaching these lethal temperatures would kill the fish directly, but would result in metabolic stress and increased likelihood of diseases. At the South Umpqua above Canyon Creek site, stream temperatures exceeded the temperature criteria by 10.5°F and these temperatures were maintained for three times as long as Brett (1952, pp. 252-3) found resulted in 50% mortality. However, the fish’s ability to move would also limit the likelihood of lethal conditions, though there would be high physical stress on the animals from being exposed to or migrating from these extremely high stream temperatures.

The theory behind the cold limit line is that the further from divide, natural conditions (solar input) would increase stream temperature. We are finding that in addition to the distance from divide, land use practices can contribute to stream temperatures. This is evident in the South Umpqua area stream temperatures. The South Umpqua above Canyon Creek and the Canyon Creek near Mouth sites were the two furthest from divide and had the highest stream temperatures compared to expected, as shown by distance from the cold limit line, and the most days that these high temperatures were maintained. Projects upstream of these sites to maintain or decrease stream temperature (riparian planting, decreasing water withdrawals, etc.) may reduce these anthropogenic increases.

While any projects to maintain or decrease stream temperature in other parts of the South Umpqua area recommended, Woods Creek may also be a good place to focus restoration given that the temperatures were higher. Further discussion of recommendations for Fate and Days Creek are described in the Spotlight Section at the end of this section.

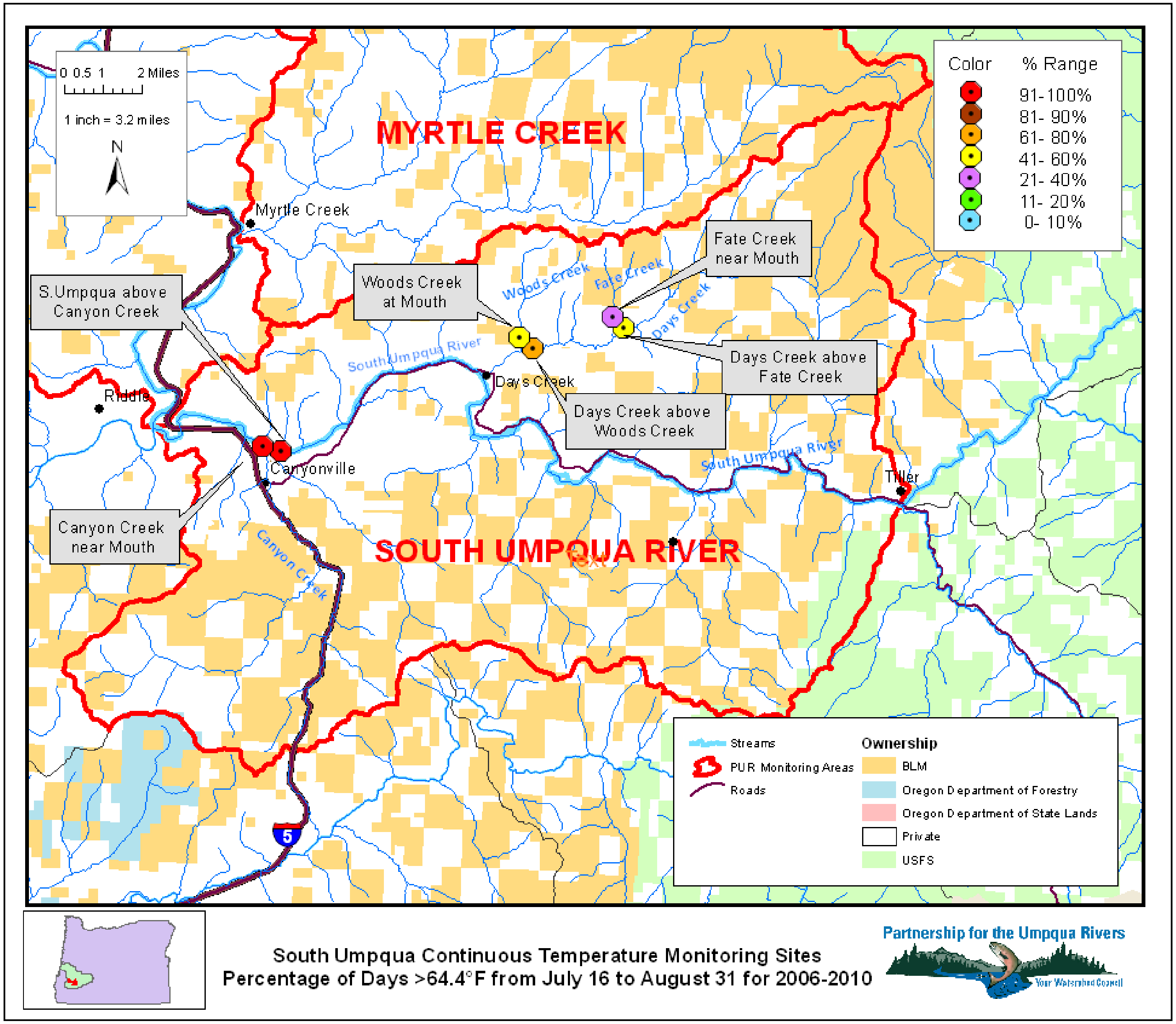


Figure 73. South Umpqua area continuous summer stream temperatures from 2006-2010. Percent of days from 7/16 to 8/31 with stream temperatures exceeding 64.4°F (18°C). The temperature criteria for streams in the South Umpqua area, which is designated salmon and trout rearing and migration use is 64.4°F (DEQ, 2003 and DEQ, 2011, pg. 46). The date range chosen is the most complete date set that encompasses the period from 2006-2010, except for Days Ck. above Fate Ck. in 2008 and 2009 and S. Umpqua above Canyon Ck. in 2010. By comparing existing data in these short data sets to similarly behaving sites nearby, the whole data set for temperatures exceeding 64.4°F could be extrapolated enough to determine that both sites would still fall within the same Percent Range category on the map.

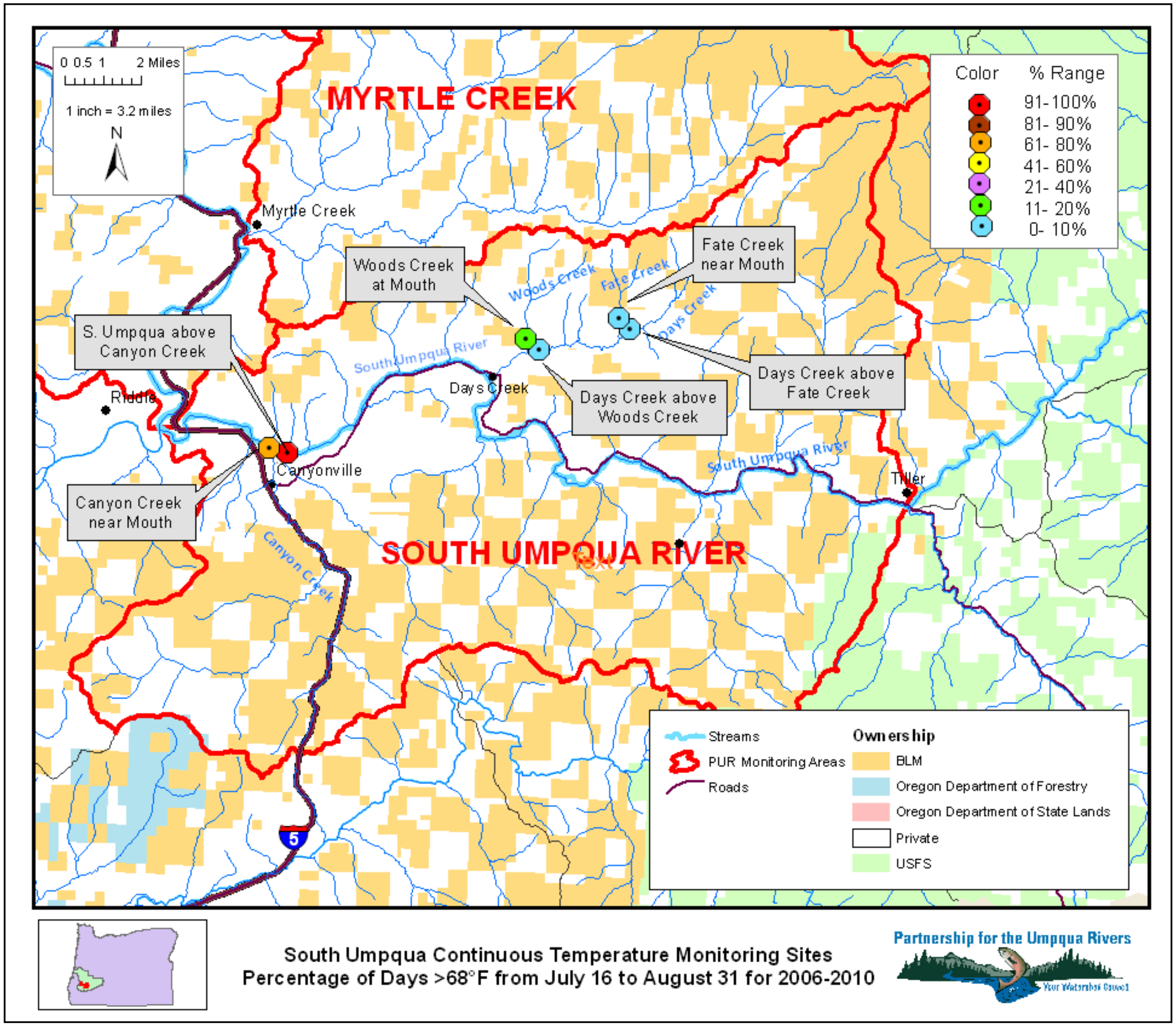


Figure 74. South Umpqua area continuous summer stream temperatures for 2006-2010. Percent of days from 7/16 to 8/31 with the stream temperatures exceeding 68°F which is a temperature that would limit salmonid migration corridor use (DEQ, 2003 and DEQ, 2011, pg. 46). The date range chosen is the most complete date set that encompasses the period from 2006-2010, except for Days Ck. above Fate Ck. in 2008 and 2009 and S. Umpqua above Canyon Ck. in 2010. By comparing existing data in these short data sets to similarly behaving sites nearby, the whole data set for temperatures exceeding 68°F could be extrapolated enough to determine that both sites would still fall within the same Percent Range category on the map.

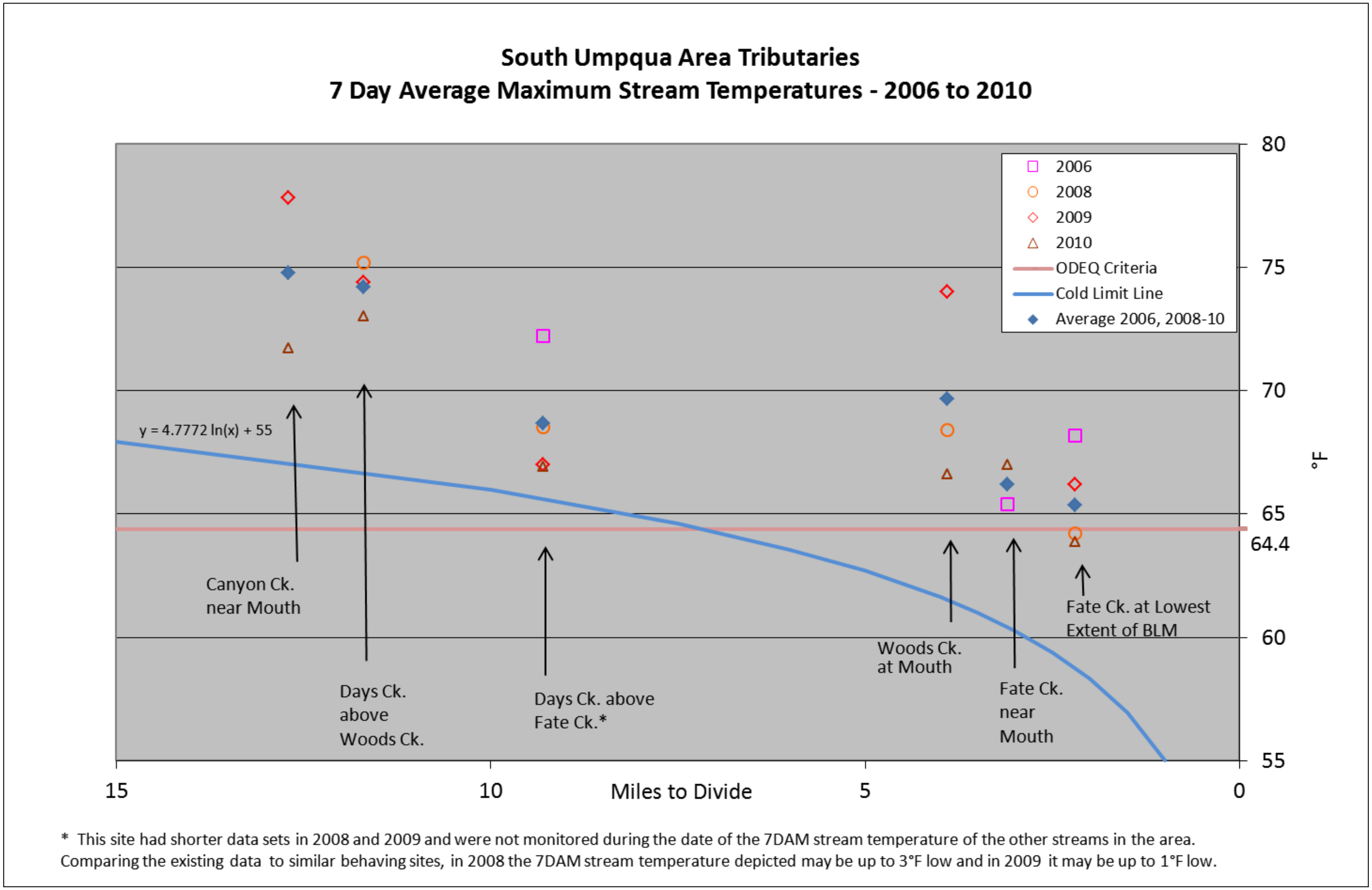


Figure 75: South Umpqua area tributaries 7-day average maximum stream temperatures from 2006-2010. The temperature criteria for streams in the South Umpqua area, which is designated salmon and trout rearing and migration use, is 64.4°F (ODEQ, 2003) and (ODEQ, 2011, p. 46). The cold limit line represents the optimal stream temperatures for streams in the South Umpqua sub-basin as distance to the ridgeline divide increases (Smith, K., 2003). The water temperature recorder used in 2006 for the Fate near Mouth site was consistently 0.7-1.3°F lower than the NIST thermometer for all accuracy checks (see Water Quality Data Analysis – Continuous Temperature section), therefore, corrected site temperatures would be approximately 1°F higher than listed. Fate Creek at Lowest Extent of BLM is a long-term BLM monitoring site.

Table 27: South Umpqua area monitoring sites distance to divide and difference in 2006, 2008-2010 7-day average maximum (7DAM) stream temperature compared to the cold limit line (y = 4.7772 ln(x) + 55), which represents the optimal stream temperatures for streams in the South Umpqua sub-basin as distance to the ridgeline divide increases (Smith, K., 2003). Fate Creek at Lowest Extent of BLM is a long-term BLM monitoring site.

	Distance to Divide	Difference from Cold Limit Line to 7DAM Stream Temperatures (°F)				
Site	**(Miles)**	**2006**	**2008**	**2009**	**2010**	**To Avg. 7DAM (2006, 2008-10)**
S. Umpqua above Canyon Creek	62.5		7.9	13.2	7.1*	9.4
Canyon Creek near Mouth	12.7			10.7	4.6	7.6
Days Creek above Woods Creek	11.7		8.5	7.7	6.3	7.5
Days Creek above Fate Creek	9.3	6.5	2.8*	1.3*	1.2	3.0
Woods Creek at Mouth	3.9		6.9	12.5	5.1	8.2
Fate Creek near Mouth	3.1	5.0**			6.6	5.8
Fate Creek at Lowest Extent of BLM	2.2	9.4	5.4	7.4	5.1	6.8

*Days Ck. above Fate Ck. in 2008 and 2009 and S. Umpqua above Canyon in 2010 all had shorter data sets that did not include the 7DAM stream temperature shown by other streams in the area. Comparing them to similar behaving sites, Days Ck. above Fate Ck. in 2008 may be to 3°F low and the other two may be up to 1°F low.

** The water temperature recorder used in 2006 for the Fate near Mouth site was consistently 0.7-1.3°F lower than the NIST thermometer for all accuracy checks (see Water Quality Data Analysis – Continuous Temperature section), therefore, corrected site temperatures would be approximately 1°F higher than listed.

RESULTS – South Umpqua Area

Grab Sample Temperature Monitoring

Of the 24 monitoring sites in the South Umpqua area, we were able to record continuous temperature readings at only six sites. Temperature was recorded at each of our grab sample monitoring events, and though this does not allow evaluation for DEQ temperature criteria, it is included here for evaluation and stream rating in order to provide additional information for planning restoration sites. The rating table of all sites in the South Umpqua area or temperature, Table 28, indicates which evaluations were based on grab sampling or continuous monitoring (loggers).

Rating of South Umpqua Area Sites for Stream Temperature

	Temperature
Days Creek above Fate Creek	Logger
Fate Creek near mouth	CLogger
Days Creek above Perdue Creek	Grab Sample
Days Creek at Woods Creek Road Bridge	Logger
Woods Creek near mouth at Woods Creek Road Culvert	Logger
Days Creek at Hway 1 bridge	Grab Sample
S. Umpqua up river of Days Creek at Berry Farm Lane	Grab Sample
South Umpqua at Days Creek Bridge	Grab Sample
South Umpqua at Days Creek Cutoff bridge	Grab Sample
South Umpqua at Canyonville Park	Grab Sample
O'Shea Creek at Tiller Trail Hwy	Grab Sample
Canyon Creek at Primary School foot bridge	Grab Sample
South Umpqua above Canyon Creek	Logger
Canyon Creek at mouth	Logger
South Umpqua at Gazley Bridge Road bridge	Grab Sample
South Umpqua at Stanton Park	Grab Sample
Cow Creek at Yokum Road bridge	Grab Sample
South Umpqua River at RR bridge upstream of Myrtle Creek	Grab Sample
South Umpqua below Mrytle Creek bridge	Grab Sample
South Umpqua River at Boomerhill	Grab Sample
Clarks Branch at Dole Road	Grab Sample
South Umpqua at Dillard	Grab Sample
Lookingglass Creek at Hwy 42 Winston OR	Grab Sample

Rating	Color	% of Monitoring Days >64.4° F Continuous Temp	Grab Sample Temperatures
Good		0-20	< 64.4° F
Fairly Good		21-40	
Concern		41-60	
Needs Improvement		61-100	>64.4° F

Table 28 : Temperature rating of South Umpqua area monitoring sites.

RESULTS – South Umpqua Area

Summary

As can be seen in Table 29, the South Umpqua area has serious water quality issues. None of the 23 sites monitored ranked acceptable in all factors. Table 29 should prove useful in deciding what issues might be addressed by restoration efforts at a particular site. Disregarding conductivity, three sites fell into the “red” or needs improvement category for the other 5 water quality parameters. These sites were: Woods Creek near the mouth, the South Umpqua at the railroad trestle in Myrtle Creek, and the South Umpqua at Dillard. Also excluding conductivity, seven sites consisted of only red and yellow ratings. These sites were: South Umpqua at Days Creek bridge, South Umpqua at Canyonville Park, South Umpqua above Canyon Creek, Canyon Creek at the mouth, South Umpqua at Stanton Park, Cow Creek at Yokum Road bridge, and South Umpqua at Boomerhill.

Summary Rating for South Umpqua Area Monitoring Sites – Six Water Quality Parameters

	Turbidity	pH	Dissolved Oxygen	Conductivity	*E. coli*	Temperature
Days Creek above Fate Creek						
Fate Creek near mouth						
Days Creek above Perdue Creek						
Days Creek at Woods Creek Road Bridge						
Woods Creek near mouth at Woods Creek Road Culvert						
Days Creek at Hway 1 bridge						
S. Umpqua up river of Days Creek at Berry Farm Lane						
South Umpqua at Days Creek Bridge						
South Umpqua at Days Creek Cutoff bridge						
South Umpqua at Canyonville Park						
O'Shea Creek at Tiller Trail Hwy						
Canyon Creek at Primary School foot bridge						
South Umpqua above Canyon Creek						
Canyon Creek at mouth						
South Umpqua at Gazley Bridge Road bridge						
South Umpqua at Stanton Park						
Cow Creek at Yokum Road bridge						
South Umpqua River at RR bridge upstream of Myrtle Creek						
South Umpqua below Mrytle Creek bridge						
South Umpqua River at Boomerhill						
Clarks Branch at Dole Road						
South Umpqua at Dillard						
Lookingglass Creek at Hwy 42 Winston OR						

Table 29: Rating summary of South Umpqua area monitoring sites. See individual parameter's summary for the criteria used in establishing the color.

RESULTS – South Umpqua Area
Spotlight: Fate/Days Creek Project

Lower Fate Creek and Days Creek near the confluence of Fate flow through a cattle ranch. Riparian restoration along lower Fate Creek, and Days Creek above Fate began in the 1990’s with the fencing of the riparian area along both sides of Fate Creek. In 2001, Fate Creek dam improvements were made and off channel stock watering was added. There has been riparian weed removal and planting in 2008 and again in 2011. In 2010, log and boulder structures were placed in both creeks. On Fate Creek this included 50 boulders, 25 cut logs and 8 whole trees placed. On Days Creek this included 20 whole trees and 50 boulders. Locations of restoration are shown in Figure 76.

Riparian fencing prevents cattle from entering the stream. Eliminating cattle presence can reduce erosion, domestic animal waste in the stream, and reduce trampling of young riparian vegetation, which could be shade producing in the future. Logs in streams obstruct flow and alter channel hydraulics which enhances the scour of pools, thereby increasing the frequency and depth of pools with increased amount of in-channel logs (Montgomery, Collins, Buffington, & Abbe, 2003, p. 27). These deep pools are cooler than surface waters and create cool water refuges for fish (Bilby, 1984, p. 593). In addition log structures may help to accumulate and hold increased substrate above the structures providing the possibility for increasing stream water retention time in the cooler substrate.

The monitoring at Days Creek and Fate Creek was not designed for project effectiveness monitoring but since data had been collected over several years, we thought it would be beneficial to examine the data.

Fate Creek near Mouth in 2006 had lower 7DAM stream temperatures compared to the trend with other sites that year. Stream temperatures throughout the Umpqua Basin were high in 2006 (Appendix F). Then they typically trended down until 2009, when they increased again and then decreased in 2010 (Appendix F). This is the case with the Windy Creek reference site and with the Fate Creek at Lowest Extent of BLM (BLM long-term monitoring site), both of which were surveyed annually from 2006-2010 (Figure 77). Days Creek above Fate followed the same trend, but was cooler in 2009 and 2010, when compared to the cold limit line and other sites (Figure 75 and 77). With only two years of data and one being unexplainably low, it’s difficult to detect any trend in the Fate Creek near mouth data. Since log and boulder placements were completed in 2010, it will be an interesting site to continue monitoring to see if any temperature effect is noted. More years of data would show if further increases in pool depth or pool quantity related to instream restoration, and substrate retention over time results in a change in temperature at the site.

It was unfortunate that data was not collected in the 1990’s before any restoration work was undertaken. The stream had already managed significant recovery just as a result of fencing. There is little doubt that *E.coli* and turbidity levels would have already been greatly reduced. As it is now, we were unable to find any trend in any of these parameters in the more recent data. Visual observations however indicate a dramatic increase in macro-invertebrate population and in coho fry, as well dramatic growth of willows that were staked through the Days Creek reach in the 90’s.

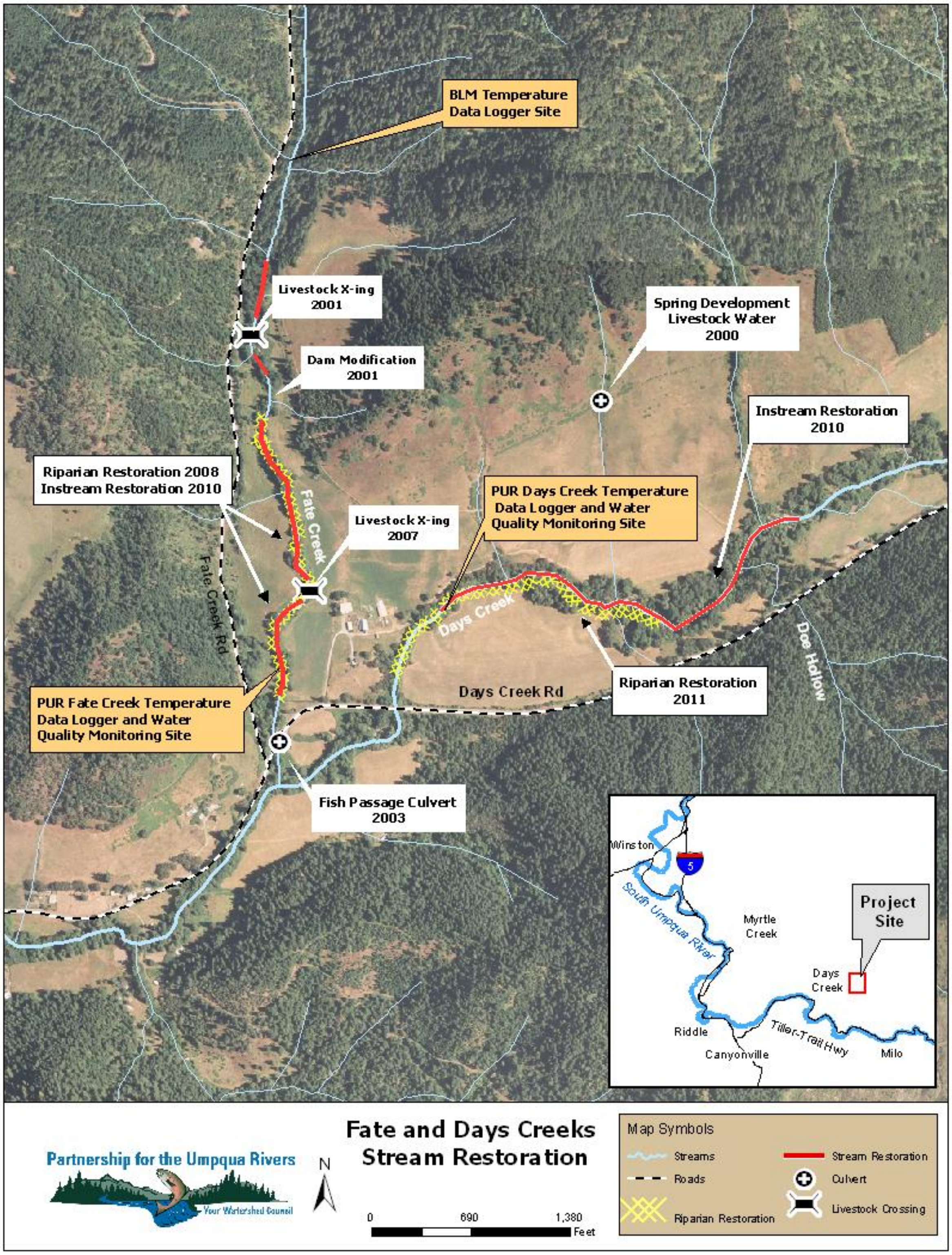


Figure 76: Map of Fate Creek and Days Creek stream restorations

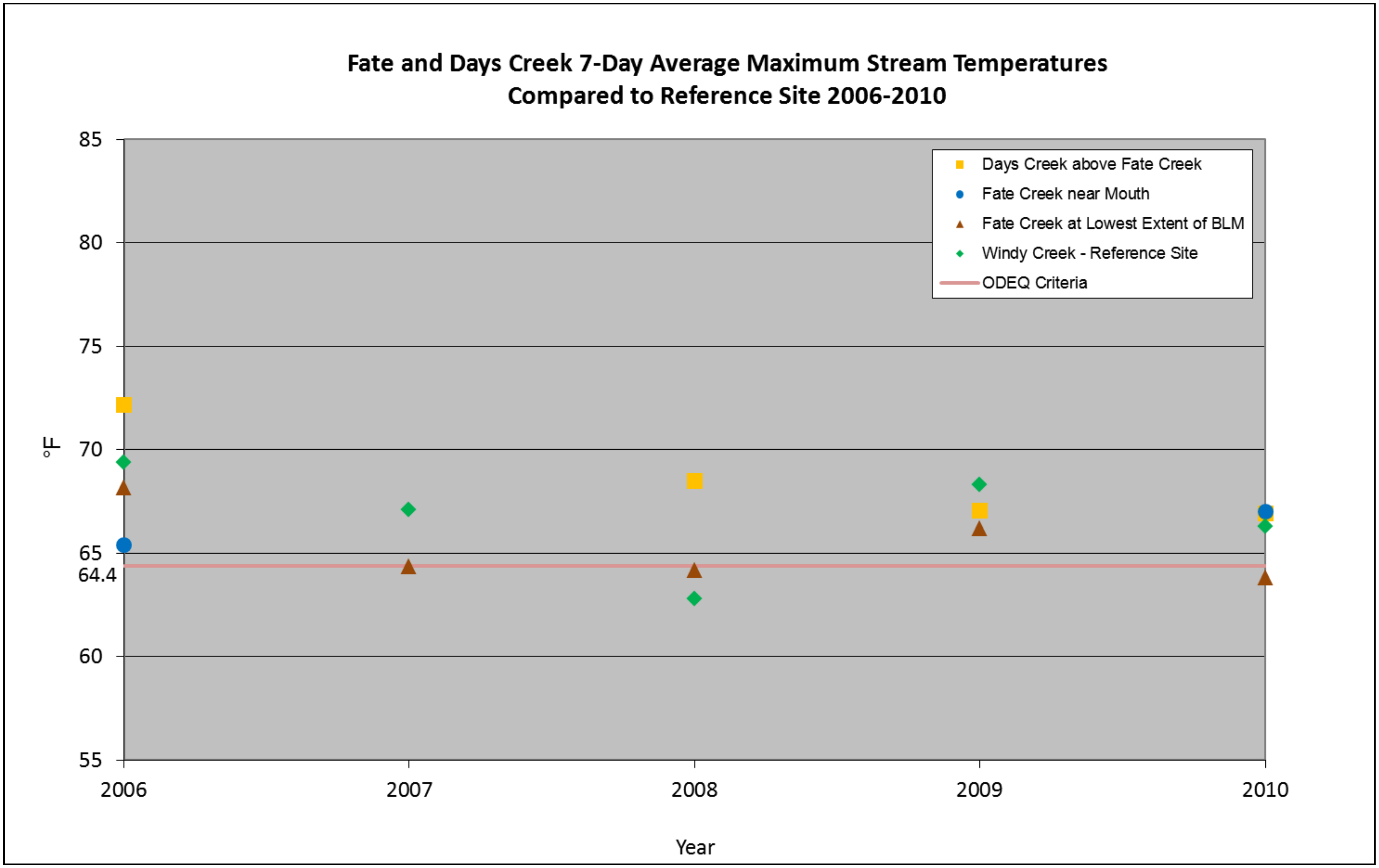
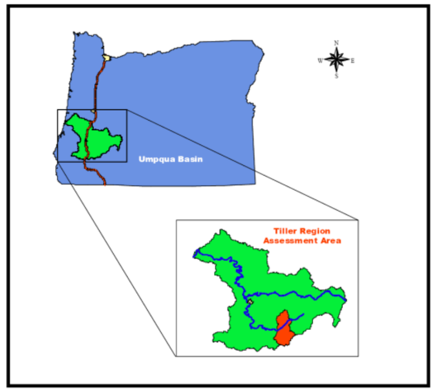


Figure 77: 7DAM stream temperature of the Fate and Days Creek sites for 2006-2010 compared to the temperatures from Windy Creek reference site (Smith, K., 2005), (Dammann, D.M. and K. Smith, 2006), (Dammann, D.M., 2007), (Dammann, D.M., 2008), (Dammann, D.M., 2009), and (Dammann, D.M., 2010). The temperature criteria for streams in the South Umpqua area, which is designated salmon and trout rearing and migration use, is 64.4°F (ODEQ, 2003) and (ODEQ, 2011, p. 46). The Fate Creek at Lowest Extent of BLM is a long-term BLM monitoring site.

ELK CREEK/TILLER

Area Description, Background & Monitoring Sites



The Elk Creek sixth field watershed consists of private lands and lands managed by the U.S.F.S./ Tiller Ranger District. A majority of the region is within the Umpqua Cascades Ecoregion with a portion of the area around Callahan Creek falling in the Inland Siskiyous Ecorgion. Expect for small plateaus along Tiller Trail Highway, the area consists mainly of deep “V”-shaped valleys and steep slopes. The Tiller Region is 983 feet elevation at the confluence of Elk Creek and the South Umpqua River. Many of the streams in the Tiller Region are dominated by surface water input rather than groundwater due to the lack of permeability of the rock dominated area.

The longest tributary to the South Umpqua in the Tiller area is Elk Creek, which is 14.6 miles long and has a 3.2% gradient. The land use in the area is dominated by forest with around 2% being agriculture, the majority of which is along, or very near Tiller Trail Highway. Instream water rights, or water that is to remain in the stream and not be removed from the stream for other water uses, exceeds the average flow available from September through November in Elk Creek. The summer flow in Elk Creek can drop below one cfs.

The Elk Creek Watershed has been the focus of an ongoing comprehensive collaborative watershed restoration project which has included private landowners, federal agencies (USFS and NRCS), state agencies (ODFW and OWEB) and non-profits including the Nature Conservancy and the Partnership for the Umpqua Rivers. Joe Hall Creek, Brownie Creek and Elk Creek have already had large instream restoration projects completed and many more are being planned. Currently the South Umpqua Rural Community Partnership and the Cow Creek Band of the Umpqua Tribe of Indians are also participating in these projects.

The USFS and PUR cooperated to maintain ongoing monitoring of this watershed.

Photo 12: The mouth of Elk Creek meeting the South Umpqua River at Tiller.

Elk Creek/Tiller Area Monitoring Sites Description and Location

Site ID #	Site Name	Site Location	Latitude	Longitude
E1	Mouth of Elk Creek	Mouth of Elk Creek	42°55.603'N	122°57.087'W
E2	Callahan Creek	Lower Callahan Creek	42°53.792'N	122°56.466'W
E3	Drew Creek	Drew Creek at mouth	42°53.359'N	122°55.301'W
E4	Elk Creek above Drew Creek	Elk Creek above Drew Creek	42°53.383'N	122°55.272'W
E5	Joe Hall Creek	Mouth of Joe Hall Creek	42°52.050'N	122°52.942'W
E6	Elk Creek above Joe Hall	Elk Creek above Joe Hall	42°52.028'N	122°52.936'W
E7	Brownie Creek	Brownie Creek near mouth	42°521.736'N	122°52.549'W
E8	Shed Creek (also known as Flat Creek)	Shed at mouth	42°50.024'N	122°50.929W
E9	Elk Creek above Shed Creek	Elk Creek above Shed Creek	42°50.002'N	122°50.929W
SUT	South Umpqua at Tiller	South Umpqua at Tiller Bridge above Elk Creek	42°55.636'N	122°57.073'W
STM	Stouts Creek at mouth	Stouts Creek at mouth	42°55.776'N	123°03.121'W
SUBS	South Umpqua below Stouts Creek	South Umpqua below Stouts Creek	42°55.778'N	123°03.143'W

Table 30: Sites in the Elk Creek/Tiller monitoring area

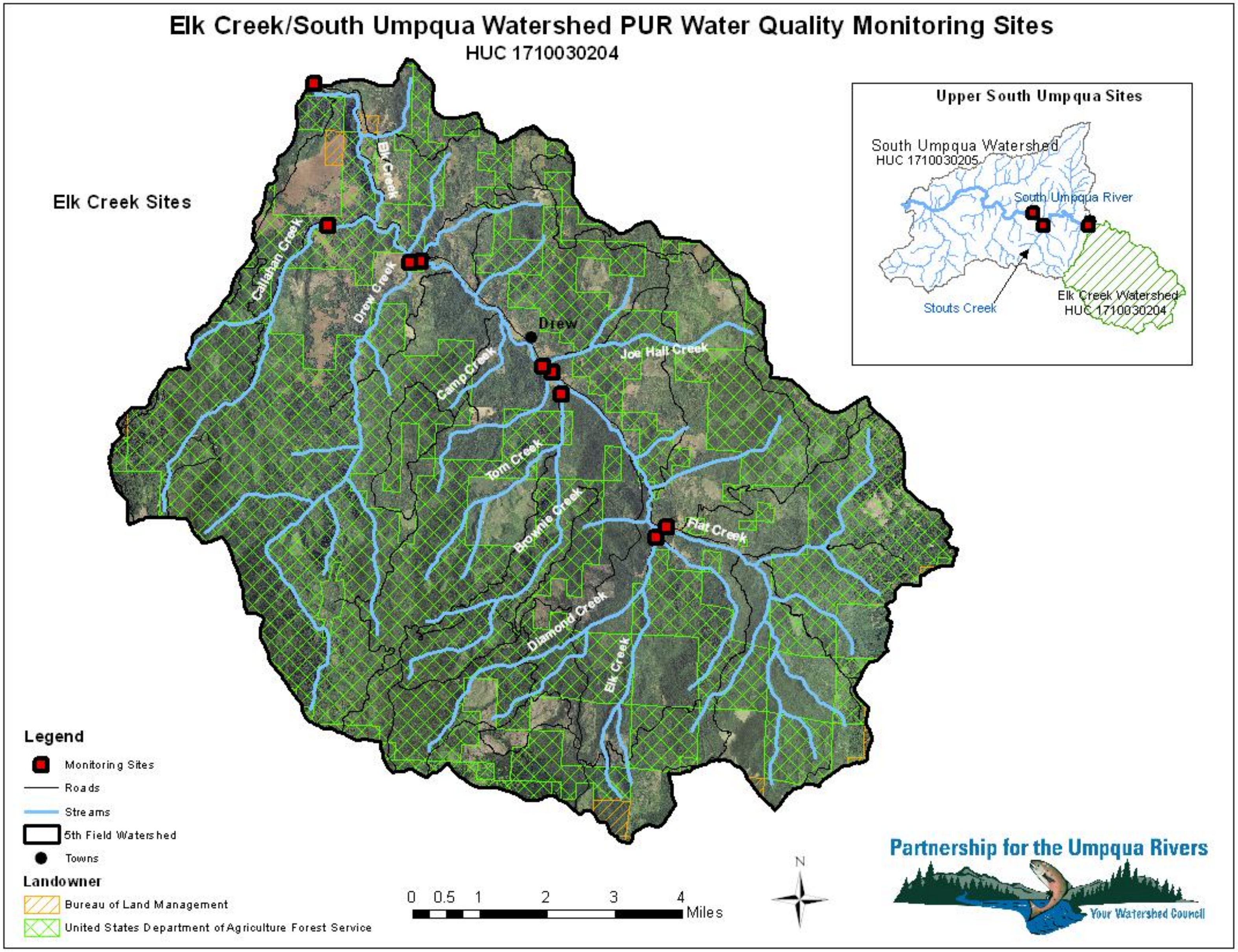


Figure 78: Elk Creek/Tiller monitoring sites map

RESULTS – Elk Creek/Tiller Area

Turbidity

Turbidity is an issue in the Elk Creek Watershed as is evident in Photo 12 on page 147. It is exclusively a rain/storm related occurrence, see Figures 79-81. The five instances of summer measurements exceeding 10 NTU all occurred on 6/8/10 right on the edge of the summer designation. Table 31 rates the streams based on exceedances above 10 NTU. Note the absence of data for Joe Hall Creek in mid-summer is due to there being no surface flow.

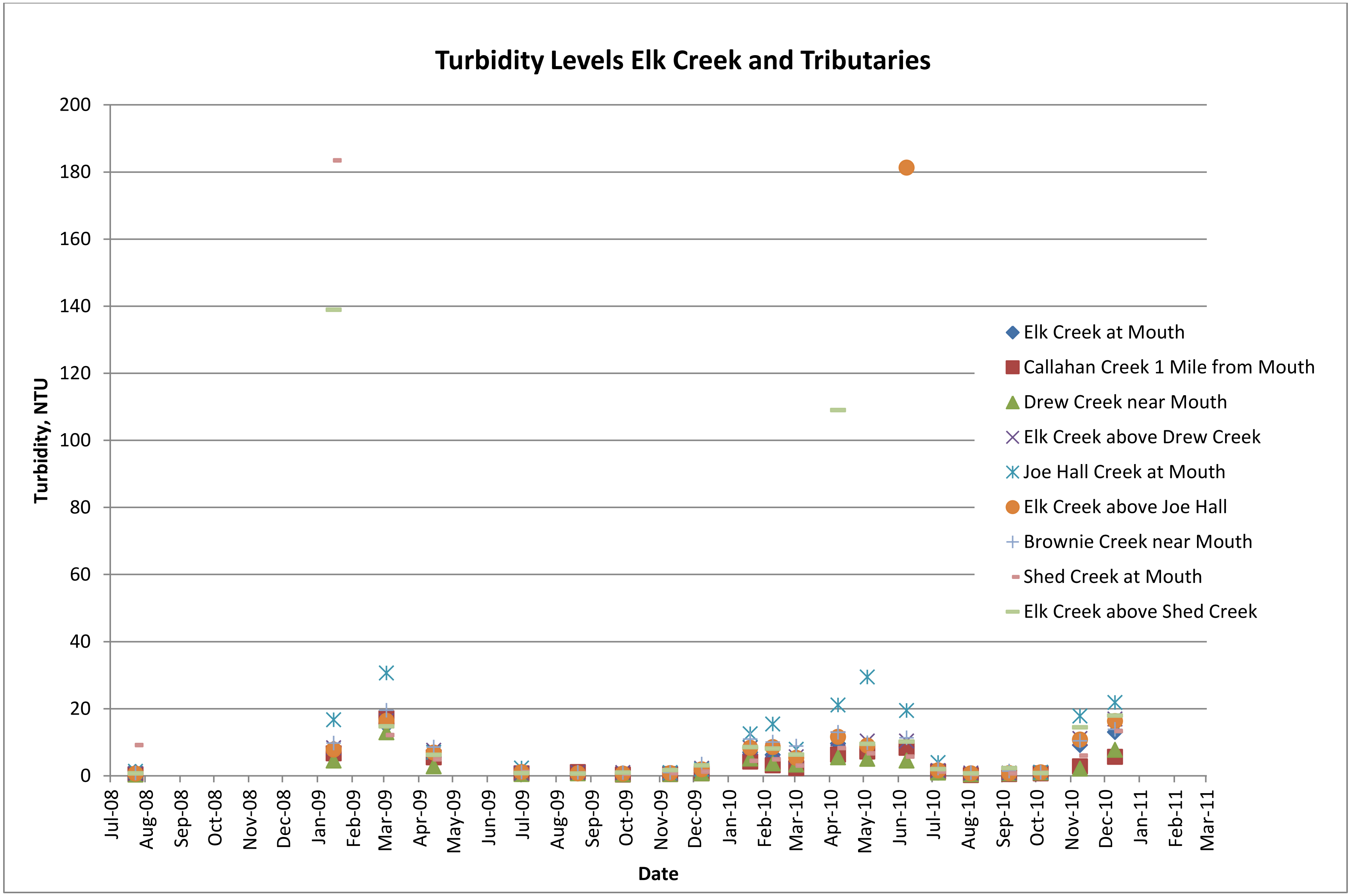


Figure 79: Turbidity levels Elk Creek and tributaries

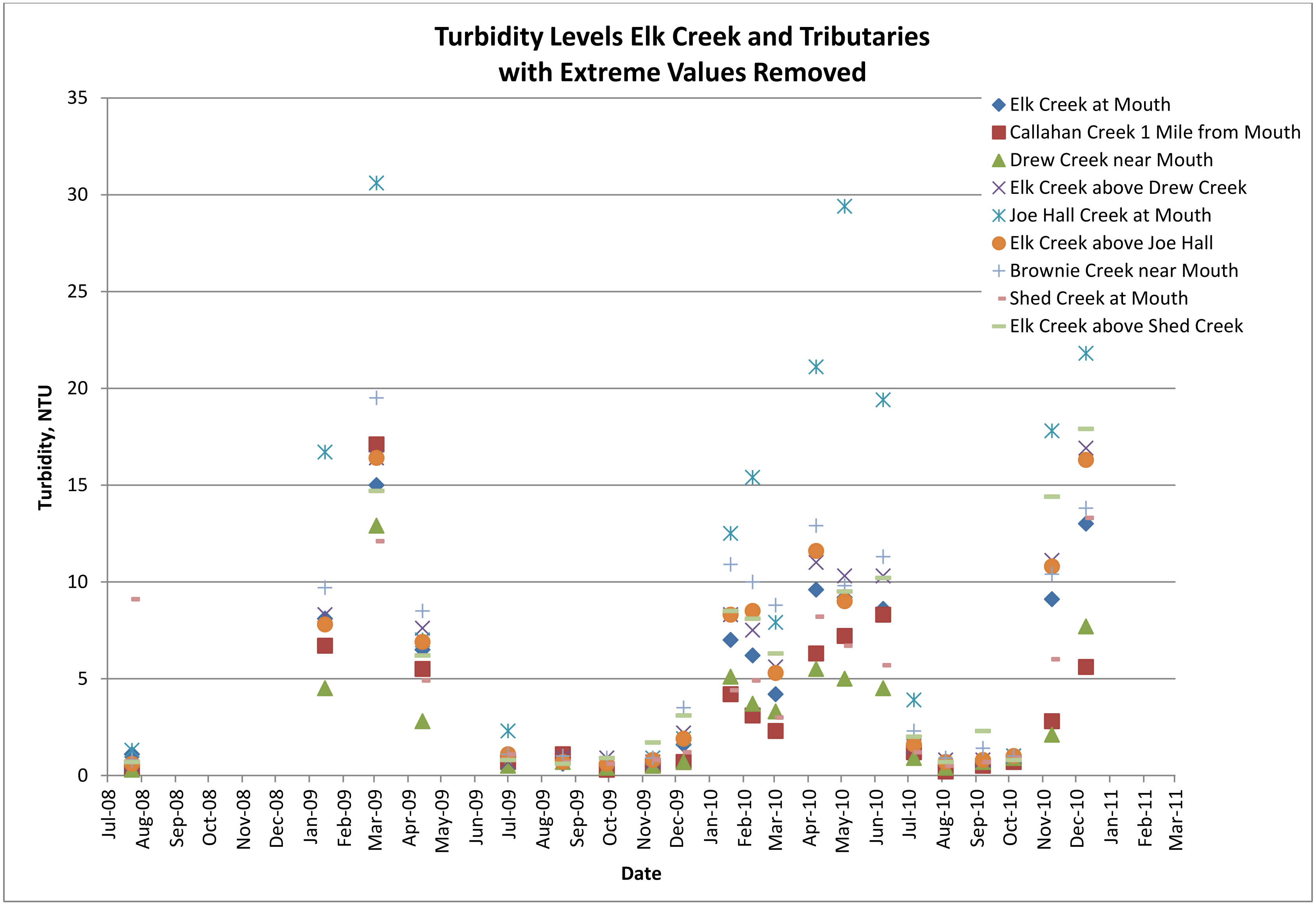


Figure 80: Turbidity levels Elk Creek and tributaries, extreme values for better display of difference between sites

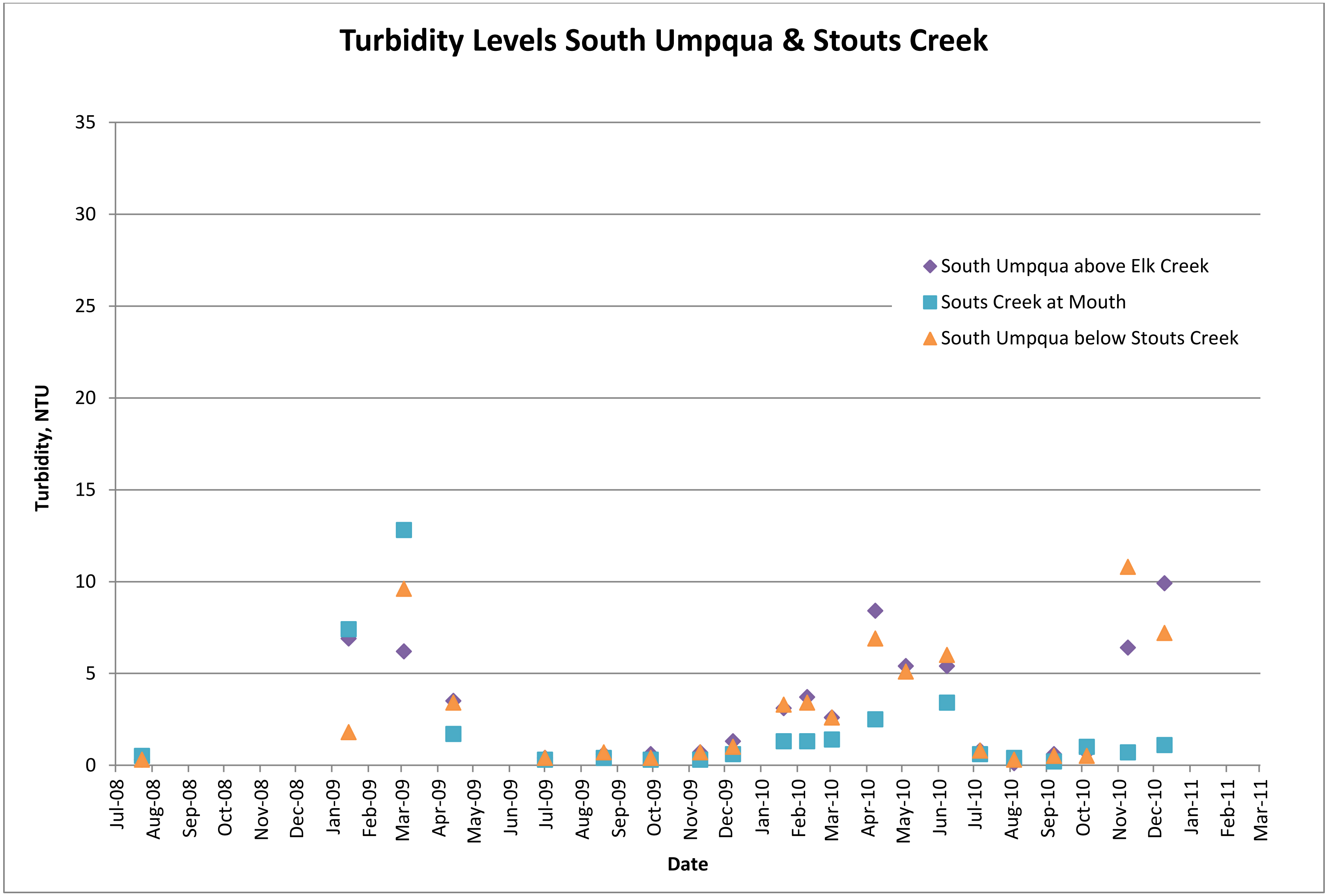


Figure 81: Turbidity levels South Umpqua at Tiller and below Stouts Creek

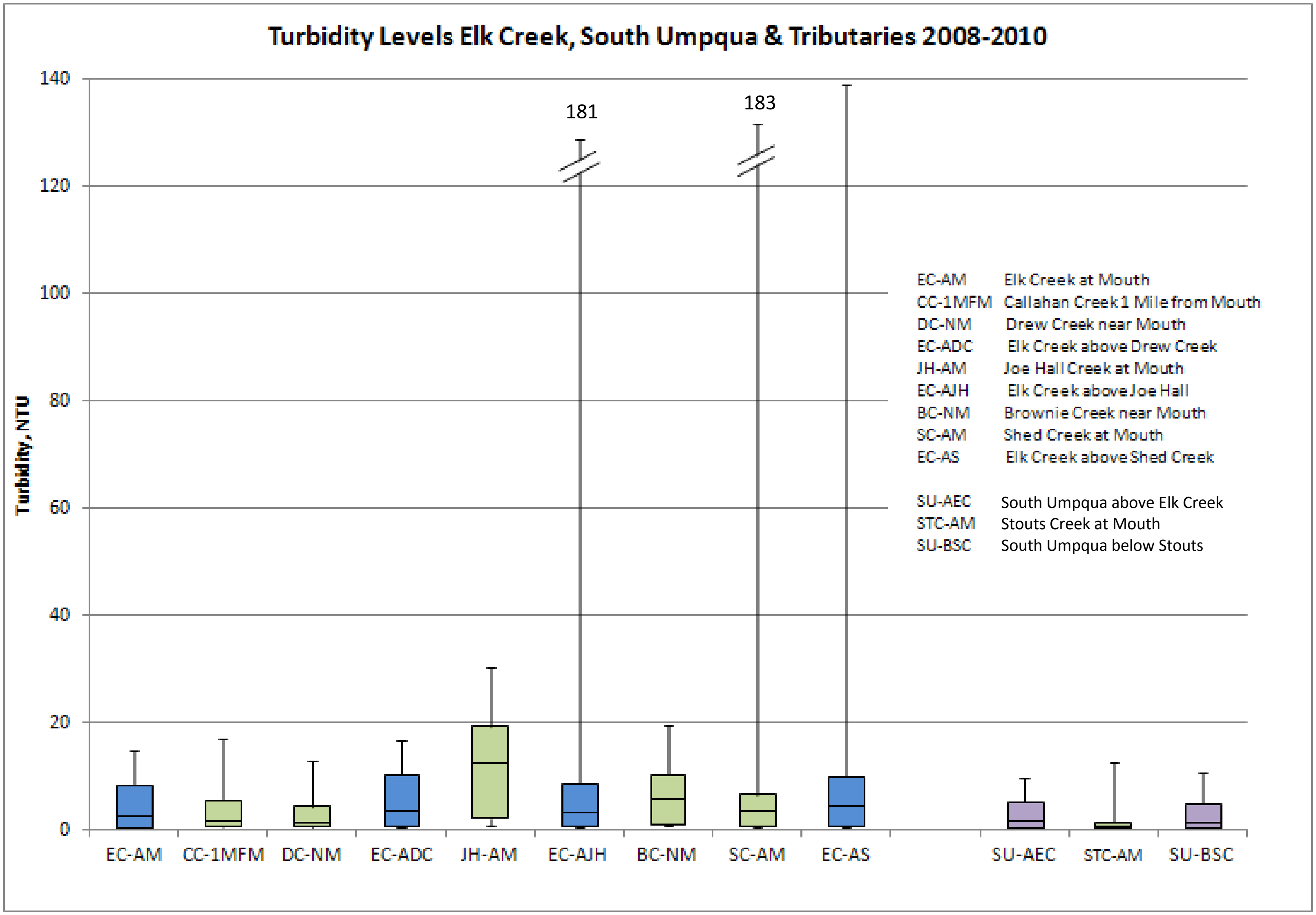


Figure 82: Turbidity levels Elk Creek and tributaries, South Umpqua and Stouts Creek 2008-2010

Turbidity Levels, Summer and Winter, Elk Creek/Tiller Area Sites

SITE	Summer (May 1 - Sept.30)		Winter (Oct 1-April 30)		Rating
	# Samples	% > 10 NTU	# Samples	% > 10 NTU	
Callahan Creek	8	0	13	8	
Mouth Drew Creek	8	0	13	8	
Elk Creek above Drew Creek	8	13	13	38	
Mouth Joe Hall Creek	4	25	13	62	
Elk Creek above Joe Hall Creek	8	13	13	31	
Brownie Creek near mouth	8	13	13	38	
Mouth Shed Creek (Flat Creek)	8	0	13	23	
Elk Creek above Shed Creek	8	13	13	38	
Mouth Elk Creek	8	0	13	15	
South Umpqua above Elk Creek (Tiller, Bridge over S Ump)	8	0	13	0	
South Umpqua below Stouts Creek	8	0	13	8	
Mouth Stouts Creek	8	0	12	8	

Rating	**Color**	**Turbidity**
Good		< 10 NTU
Fairly Good		Between1 % and 9% 10NTU or greater
Concern		Between 10% and 20% 10 NTU or greater
Needs Improvement		20% or more 10 NTU or greater

Table 31: Turbidity levels summer and winter Elk Creek/Tiller area sites

RESULTS - Elk Creek/Tiller Area

pH

Four monitoring sites exceeded the DEQ maximum pH of 8.5: Elk Creek at its mouth, Shed Creek at its mouth, South Umpqua above Elk Creek, and South Umpqua above Stouts Creek. Six sites had pH values ≥8.25 which we rate as" of concern" because there is a good chance that they would have surpassed the 8.5 level if samples later in the day. Two sites, Joe Hall at its mouth and Brownie Creek near its mouth had no pH readings ≥ 8.25. Elevated pH levels at all sites occurred during summer months, as would be expected due to heavy algal growth, see Figures 82 and 83. See Table 32 for pH ratings of all streams monitored in the Elk Creek/Tiller area.

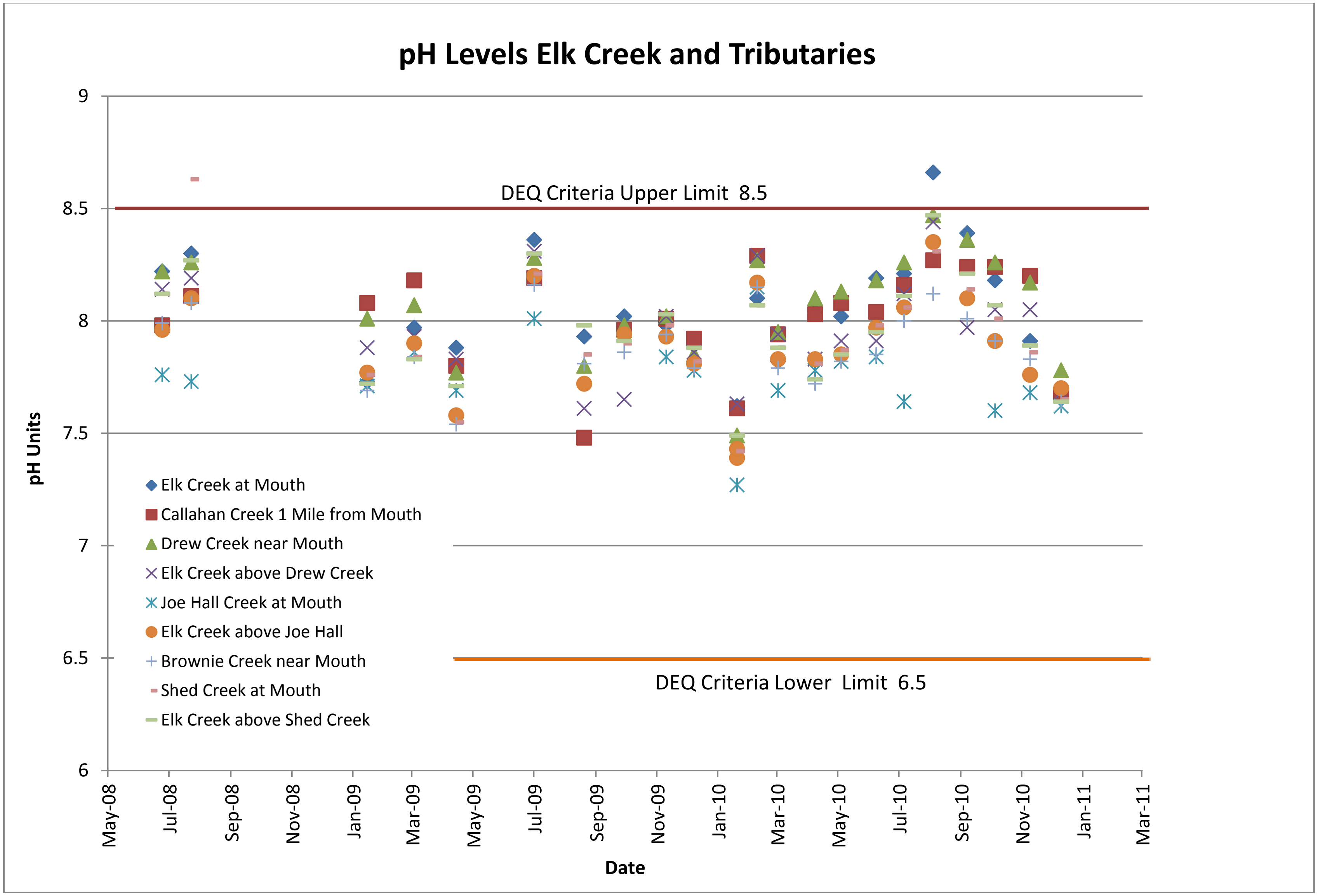


Figure 82: pH levels Elk Creek and tributaries monitoring sites

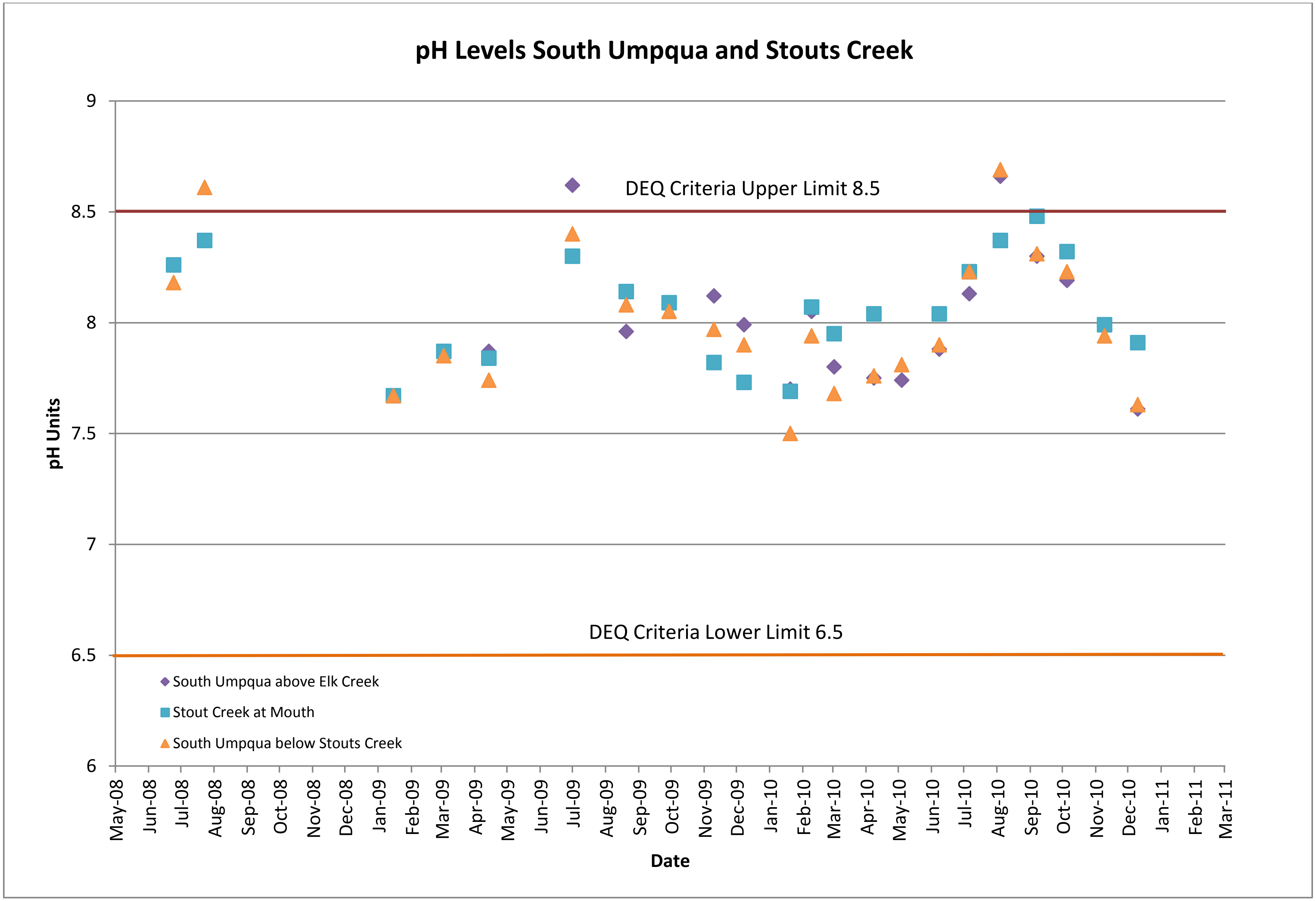


Figure 83: pH levels South Umpqua at Tiller, Stouts Creek and South Umpqua below Stouts Creek

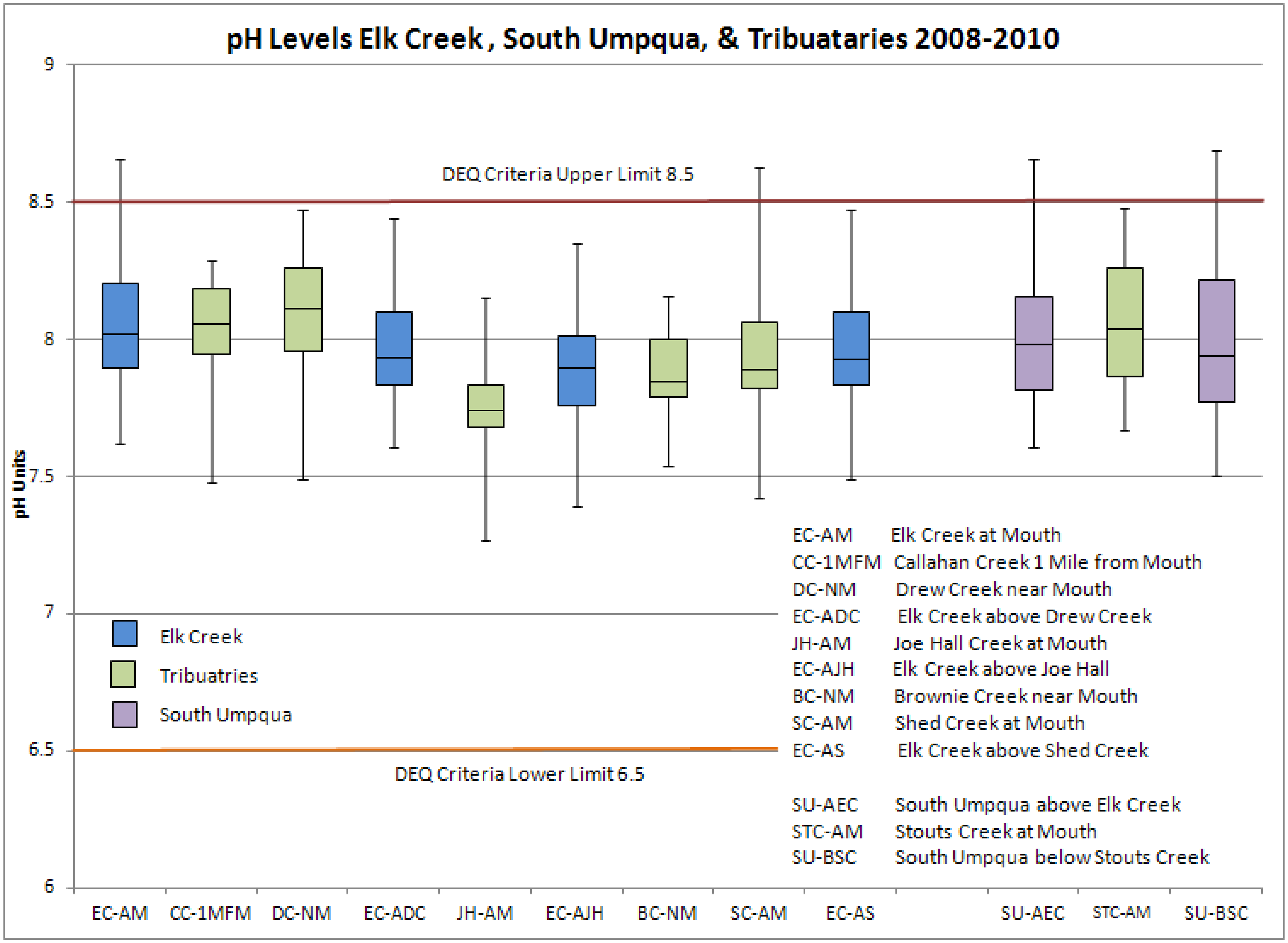


Figure 84: pH levels Elk Creek, South Umpqua and tributaries monitoring sites 2008-2010

Elk Creek/Tiller Area Sites Rated for pH Levels

SITE	Rating
Callahan Creek	Yellow
Mouth Drew Creek	Yellow
Elk Creek above Drew Creek	Yellow
Mouth Joe Hall Creek	Blue
Elk Creek above Joe Hall Creek	Yellow
Brownie Creek near mouth	Blue
Mouth Shed Creek (Flat Creek)	Red
Elk Creek above Shed Creek	Yellow
Mouth Elk Creek	Red
South Umpqua above Elk Creek (Tiller, Bridge over S Ump)	Red
South Umpqua below Stouts Creek	Red
Mouth Stouts Creek	Yellow

pH Rating Code		
Rating	**Color**	**pH Criteria**
Good	Blue	None above 8.25
Concern	Yellow	1 or more ≥ 8.25
Needs Improvement	Red	1 or more ≥ 8.5

Table 32: Elk Creek/Tiller area sites rated for pH levels

RESULTS - Elk Creek/Tiller Area
Dissolved Oxygen

Only one site, the South Umpqua above Elk Creek at Tiller, had no exceedances of the DEQ dissolved oxygen criteria – see Table 33 for stream ratings. Almost all exceedances occurred during the spawning period. Figure 87, however, indicates that when the total data is evaluated in box plots, all of the sites indicated that 25% (the upper quartile-(see Appendix H) of their data was above 11 mg/l, and 50 % (the median quartile) was above 10.5 with many being right at 11. It is evident that salmon are reproducing well in this area even if a few times conditions are not optimal.

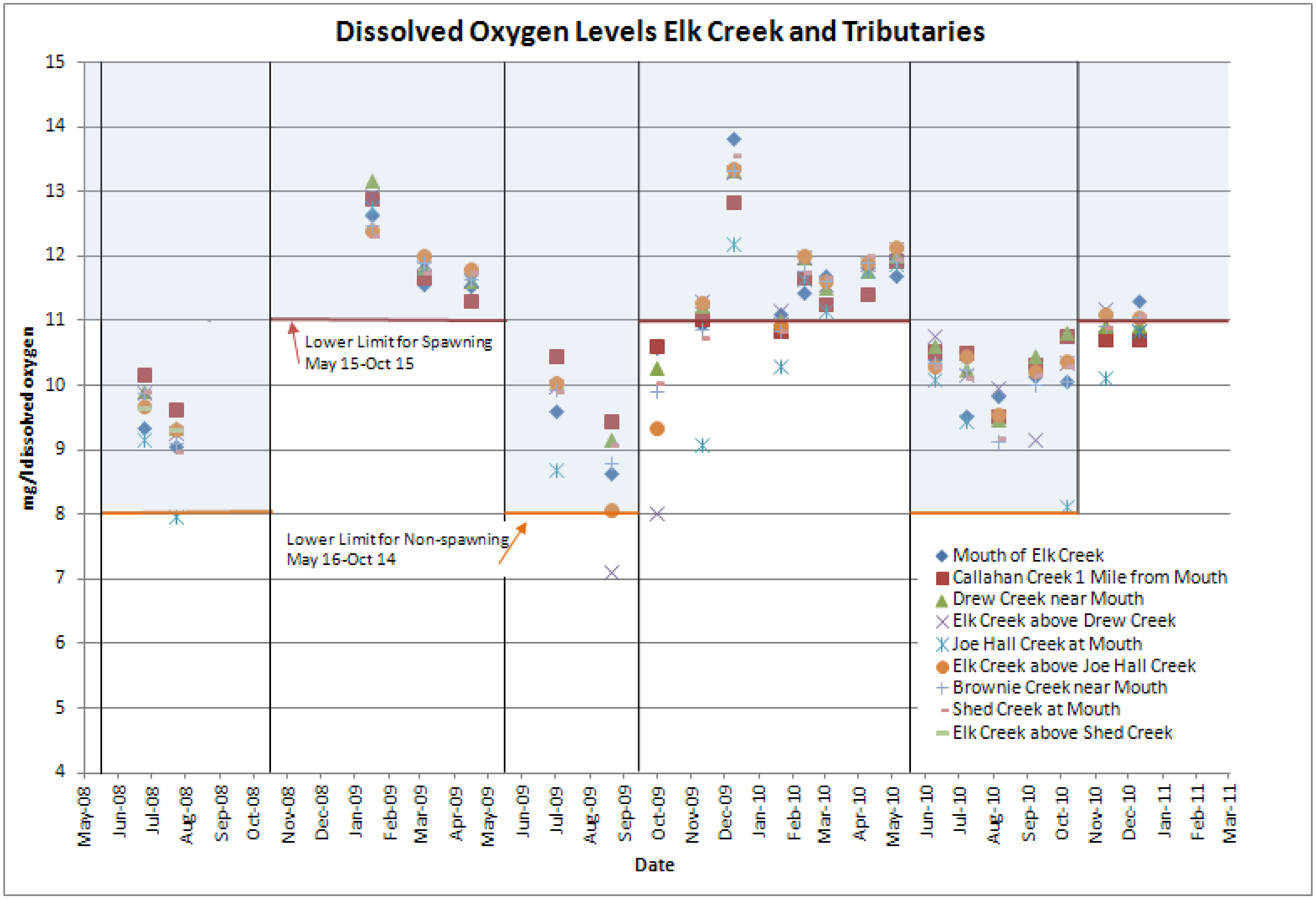


Figure 85: Dissolved oxygen levels of site in the Elk Creek/Tiller monitoring area compared for spawning and non-spawning DEQ criteria.

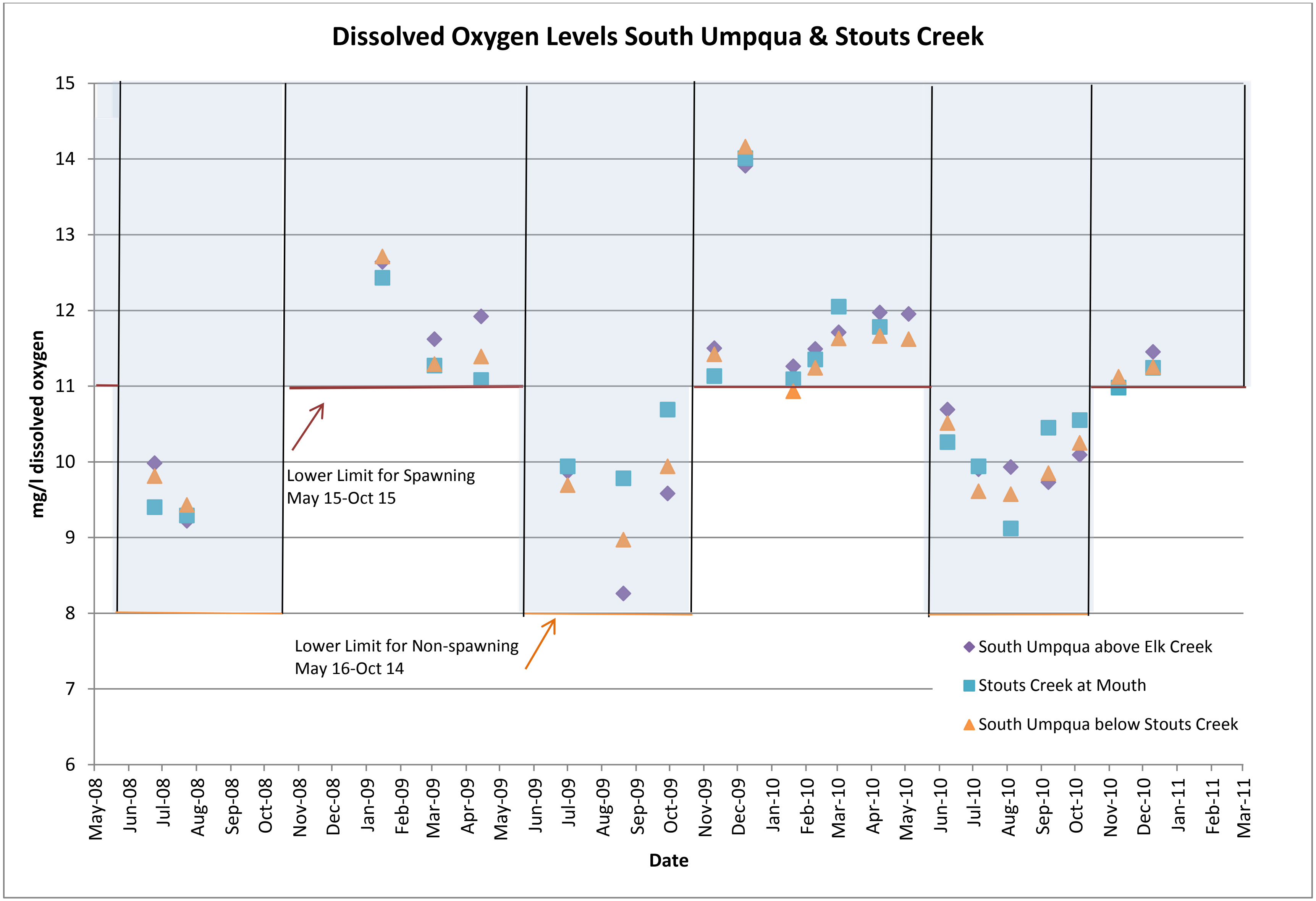


Figure 86: Dissolved oxygen levels of sites on the South Umpqua and Stouts Creek compared for spawning and non-spawning DEQ criteria.

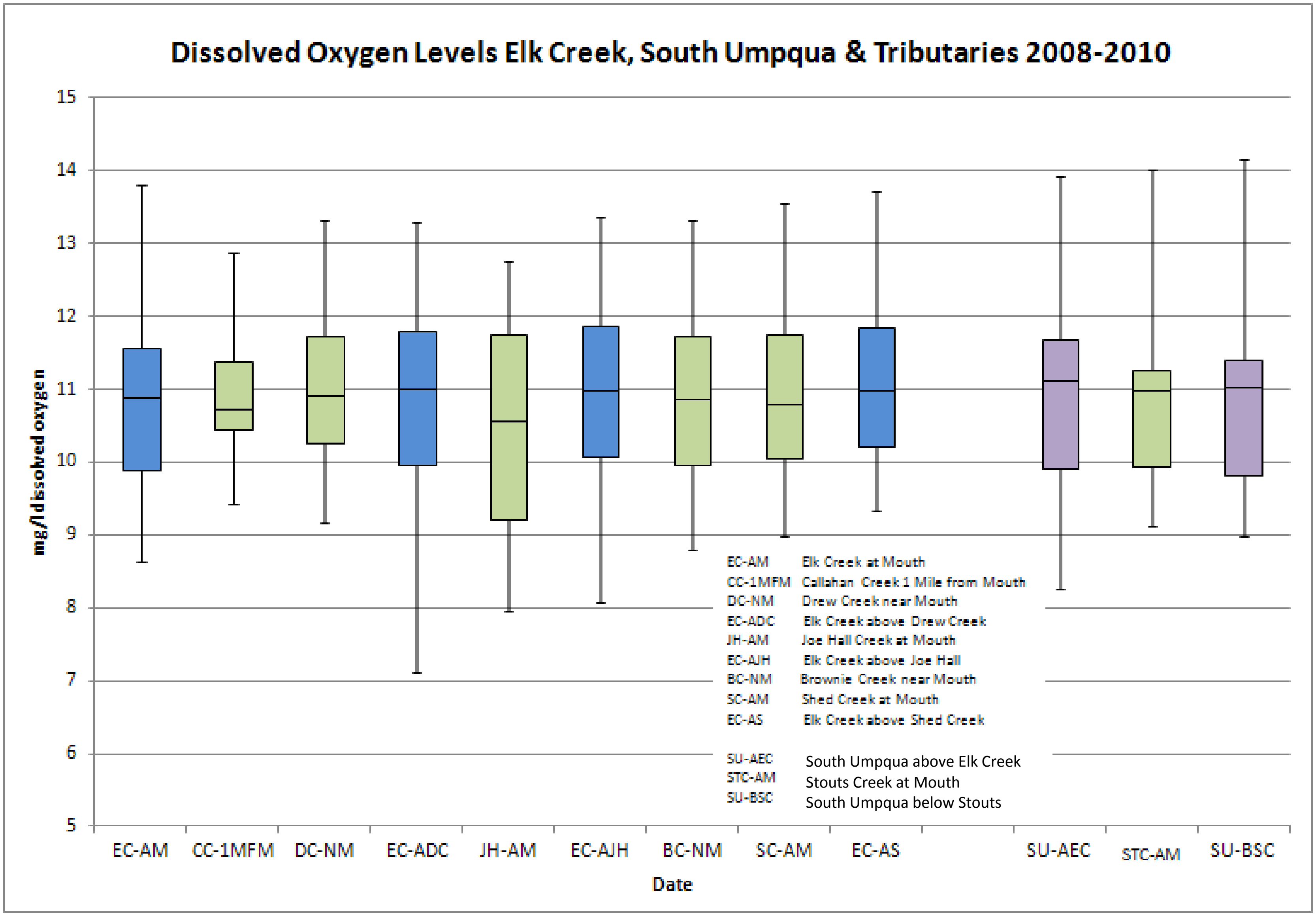


Figure 87: Dissolved oxygen levels of site in the Elk Creek/Tiller monitoring area

Dissolved Oxygen Ratings for Elk Creek/Tiller Area Sites, Spawning and Non-spawning Seasons

SITE	Non-spawning Season May 16-October 14				Spawning Season October 13-May 15			
	Total # Samples	# Below Minimum D.O. Criteria of 8 mg/l	% Below Minimum D.O. Criteria of 8 mg/l	Rating	Total # Samples	# Below Minimum D.O. Criteria of 11 mg/l	% Below Minimum D.O. Criteria of 11 mg/l	Rating
Callahan Creek	10	0	0		12	3	25	
Mouth Drew Creek	10	0	0		12	2	17	
Elk Creek above Drew Creek	10	1	10		12	1	8	
Mouth Joe Hall Creek	6	1	17		12	4	33	
Elk Creek aove Joe Hall Creek	10	0	0		12	1	8	
Brownie Creek near mouth	10	0	0		12	3	25	
Mouth Shed Ceerk (Flat Creek)	10	0	0		12	3	25	
Elk Creek above Shed Creek	10	0	0		12	1	8	
Mouth Elk Creek	10	0	0		12	2	17	
South Umpqua above Elk Creek (Tiller, Bridge over S Ump)	10	0	0		12	0	0	
South Umpqua below Stouts Creek	10	0	0		12	1	8	
Mouth Stouts Creek	10	0	0		11	1	9	

Color Key:		Good	No Exceedances of Criteria
		Fairly Good	Only 1 Exceedance of Criteria
		Concern	2 Exceedances of Criteria
		Needs Improvement	3 or more Exceedances of Criteria

Table 33: Rating of Elk Creek/Tiller area sites for stream dissolved oxygen levels compared to Spawning Season and Non-spawning Season DEQ Criteria

RESULTS - Elk Creek/Tiller Area

Conductivity

All conductivity levels in the Elk Creek/Tiller monitoring area were within normal ranges for the Umpqua Basin, and none exceeded 500 us/cm. Two tributaries, Drew Creek and Stouts Creek had the highest levels which is most likely indicative of differing geological makeup.

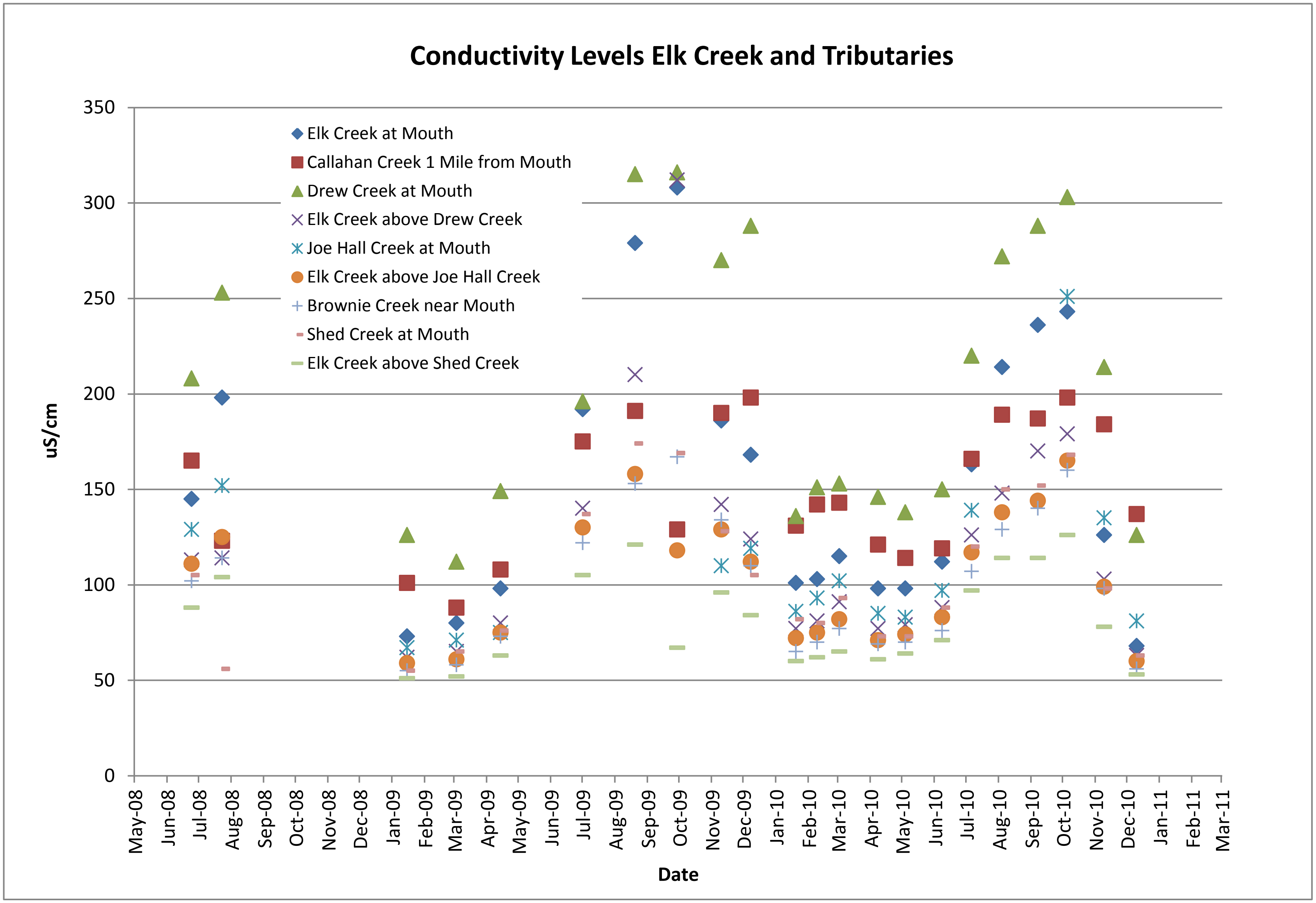


Figure 88: Conductivity levels Elk Creek and tributaries

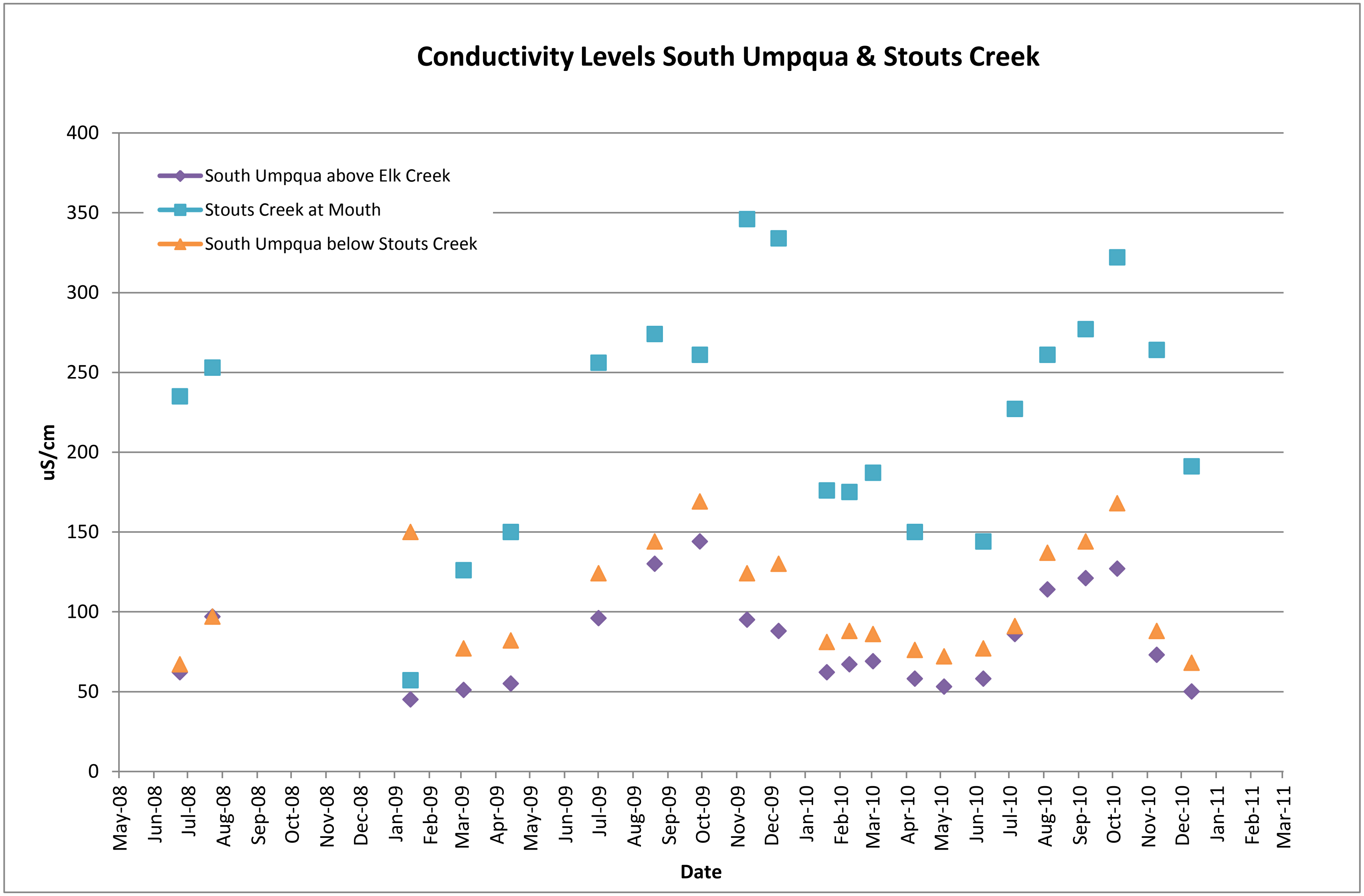


Figure 89: Conductivity South Umpqua and Stouts Creek

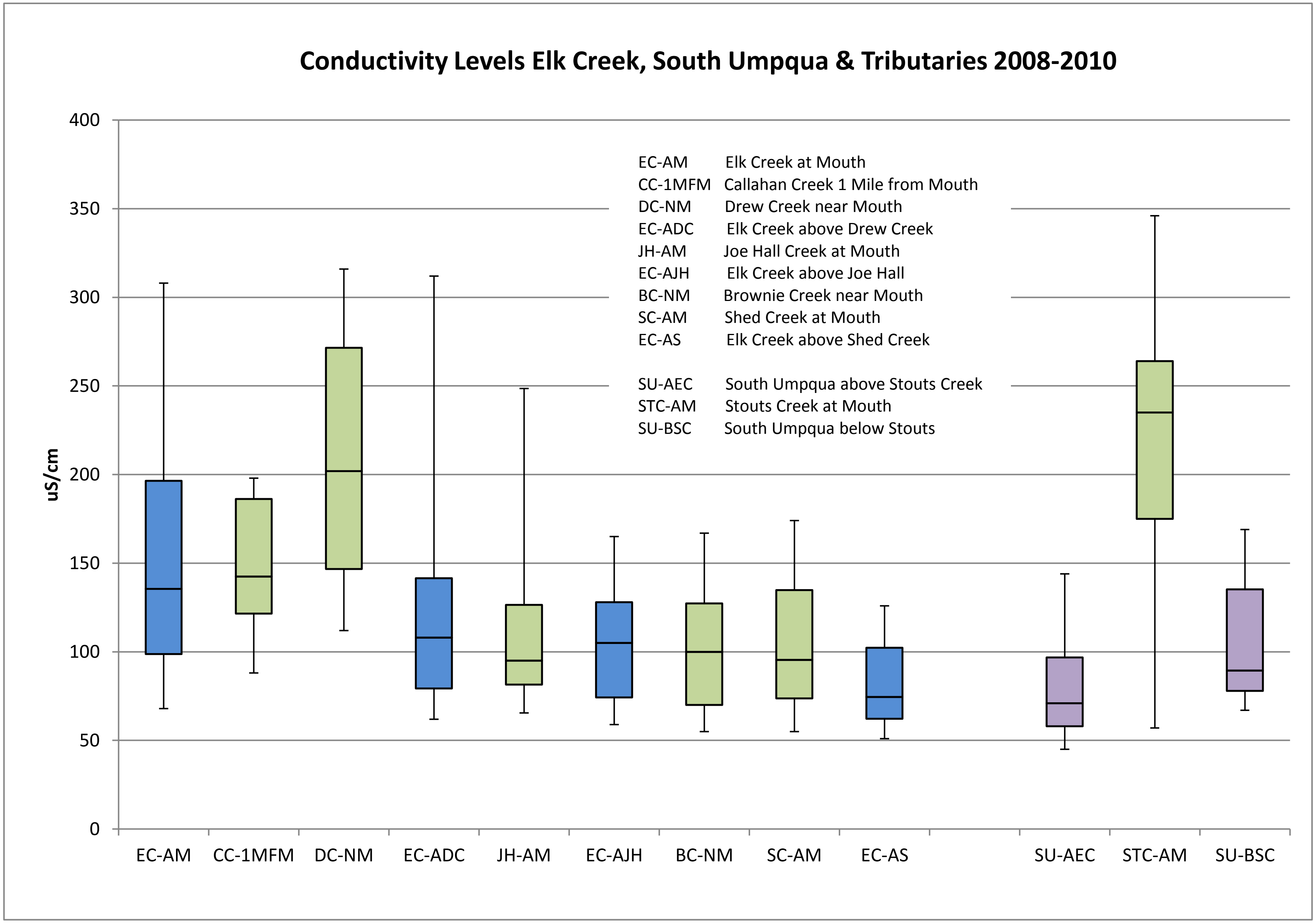


Figure 90: Conductivity levels Elk Creek/Tiller area sites

Conductivity Level Rating of Elk Creek/Tiller Area Monitoring Sites

SITE	Rating
Callahan Creek	
Mouth Drew Creek	
Elk Creek above Drew Creek	
Mouth Joe Hall Creek	
Elk Creek above Joe Hall Creek	
Brownie Creek near mouth	
Mouth Shed Creek (Flat Creek)	
Elk Creek above Shed Creek	
Mouth Elk Creek	
South Umpqua above Elk Creek (Tiller, Bridge over S Ump)	
South Umpqua below Stouts Creek	
Mouth Stouts Creek	

Rating	Color	Conductivity Level
Good		<500 uS/cm
Needs Improvement		>500 uS/cm

Table 34: Conductivity level rating of Elk Creek/Tiller area monitoring sites

RESULTS - Elk Creek/Tiller Area
E. coli Bacteria

Only two monitoring sites in the Elk Creek/Tiller monitoring area showed exceedances of the DEQ *E. coli* criteria (406 MPN/100ml), and those occurred in summer. Those sites were Brownie Creek at its mouth and Shed Creek at its mouth. There were no exceedances of DEQ criteria during the winter and only the site at the mouth of Drew Creek showed exceedances of the EPA criteria (235 MPN/100ml) in winter. In summer 5 sites exceeded the EPA standard but not the DEQ standard: Drew Creek at the mouth, Elk Creek above Joe Hall, Elk Creek above Shed Creek, Elk Creek at the mouth, and Stouts Creek at the mouth. Four sites had no *E. coli* levels >100 MPN/100ml. These were Callahan Creek, Joe Hall Creek, South Umpqua above Elk Creek, and South Umpqua below Stouts Creek. See Table 35 for the *E. coli* rating of all creeks in the Elk Creek/Tiller monitoring area.

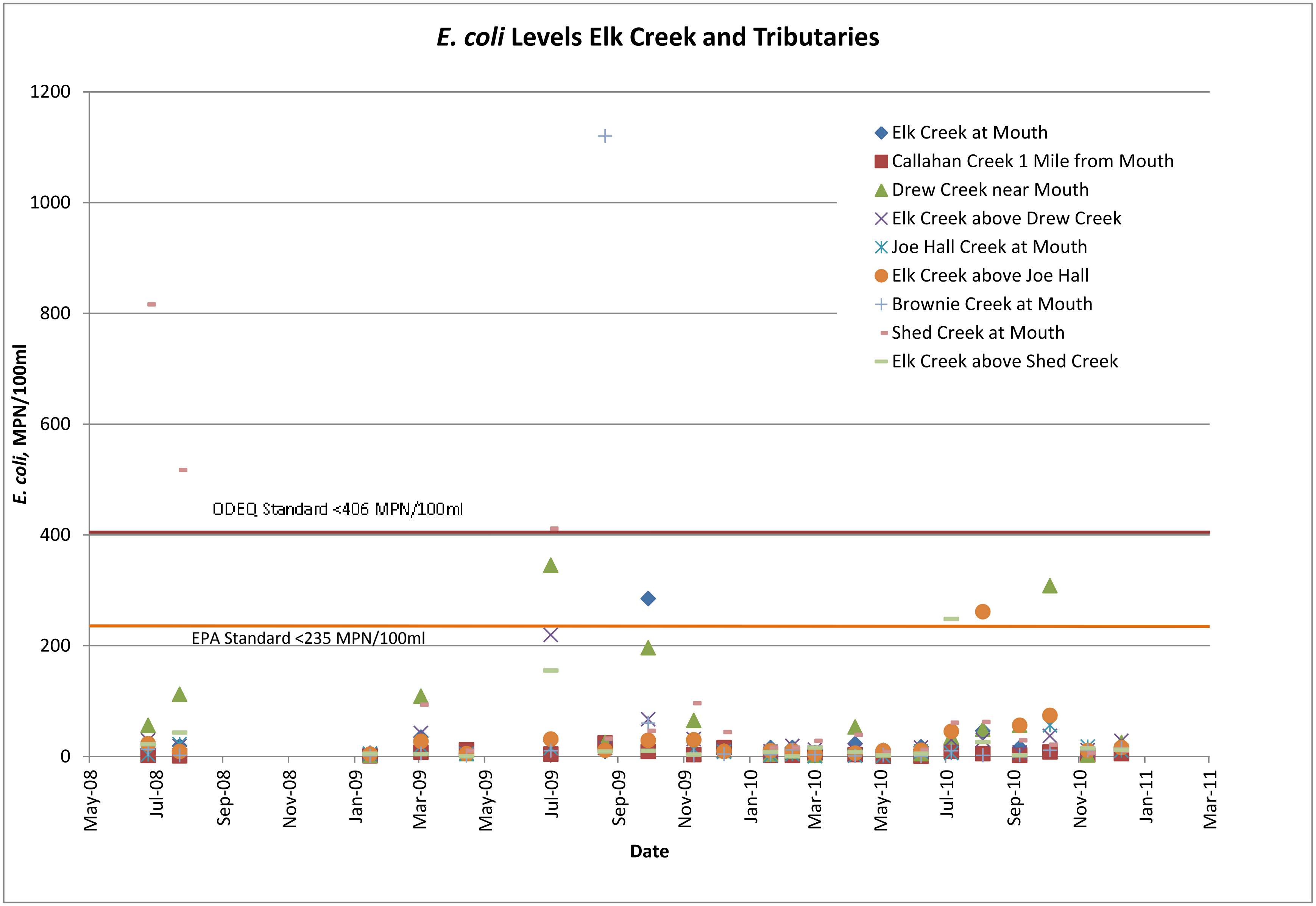


Figure 91: ***E. coli*** **levels Elk Creek and tributaries**

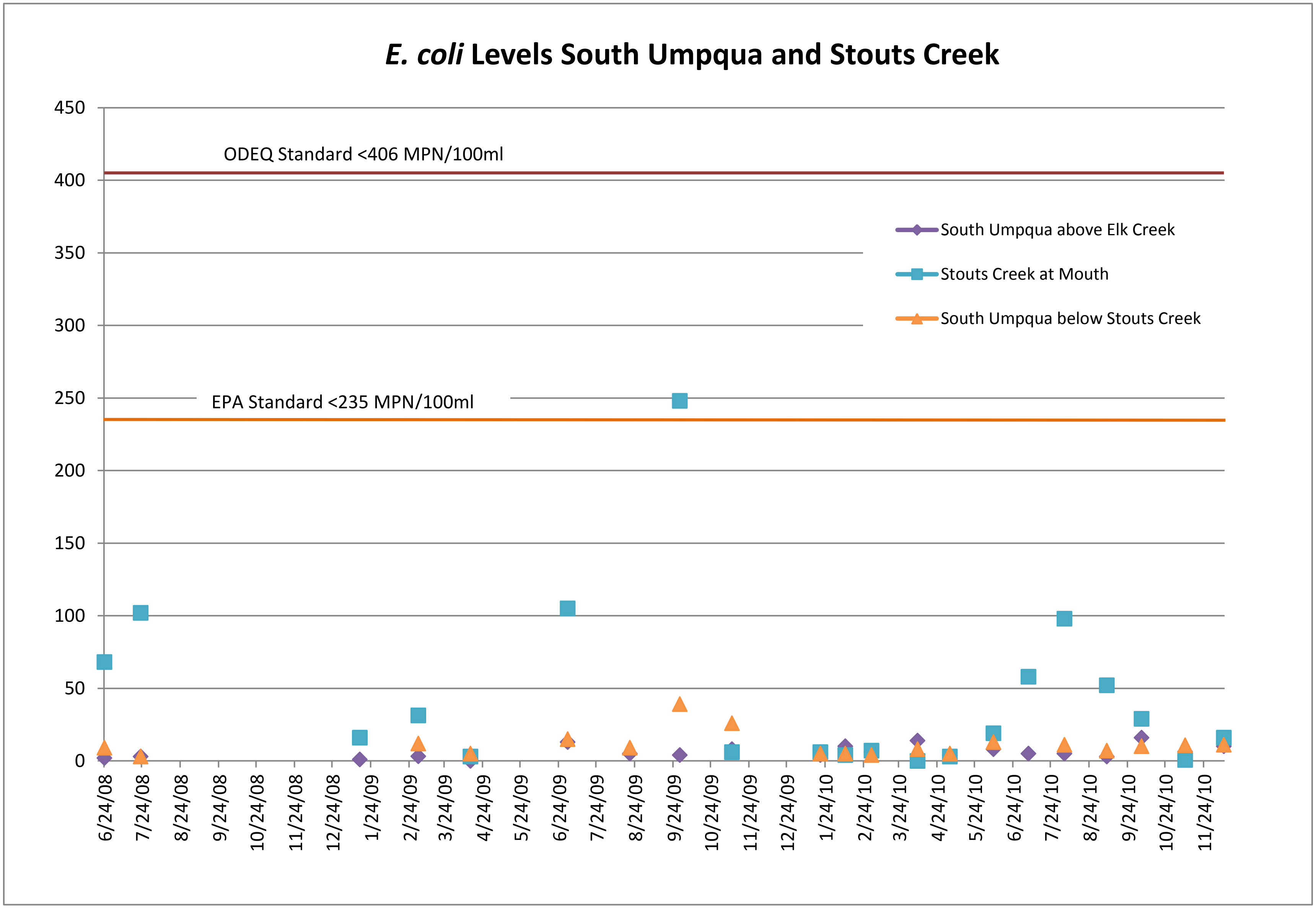


Figure 92: *E. coli* levels South Umpqua and Stouts Creek

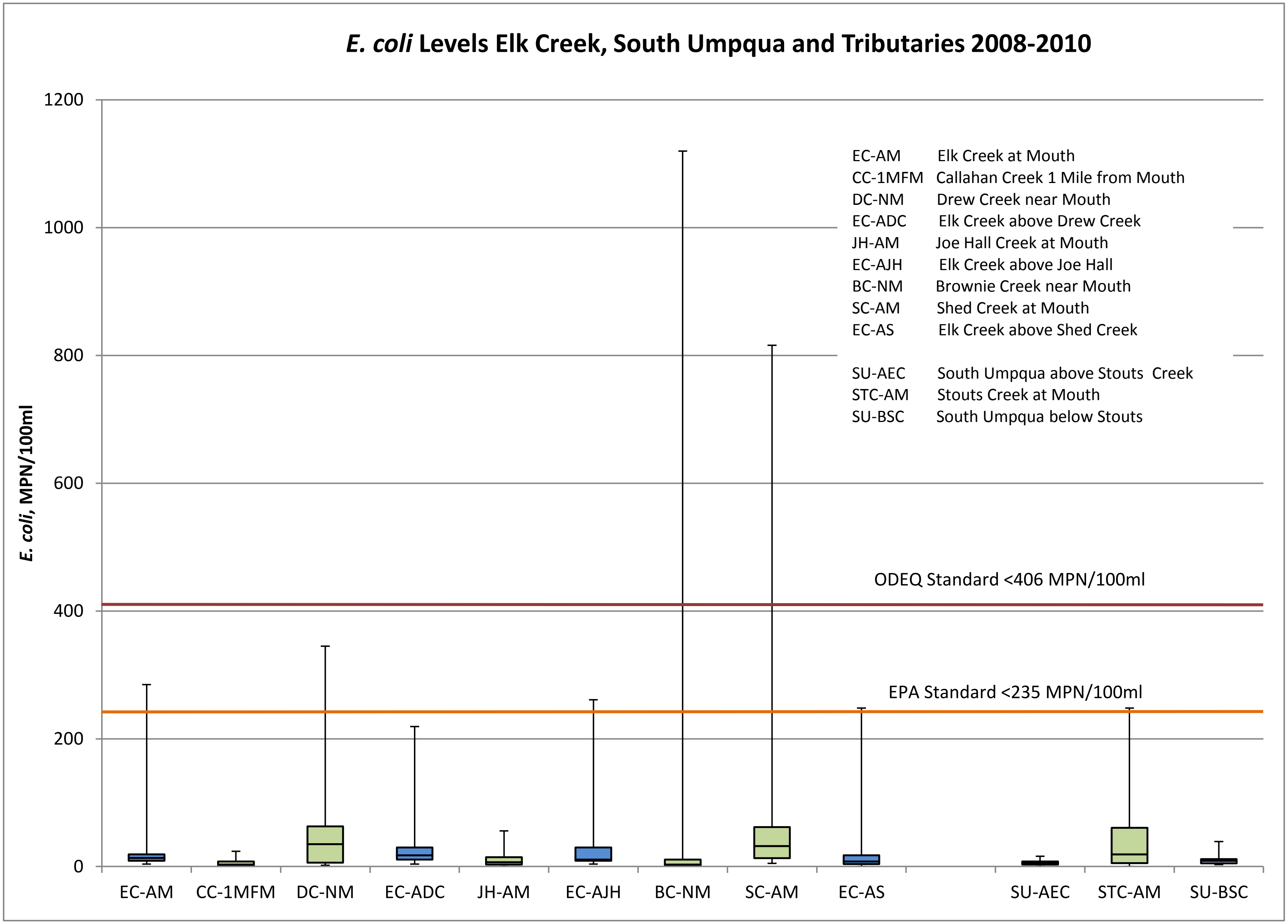


Figure 93: *E. coli* levels Elk Creek/Tiller monitoring area sites

Rating of Elk Creek Sites for *E. coli*, Summer and Winter

SITE	Summer				Winter			
	# Samples	% Above EPA Criteria (235 MPN/100ml)	% Above ODEQ Criteria (406 MPN/100ml)	Rating	# Samples	% Above EPA Criteria (235 MPN/100ml)	% Above ODEQ Criteria (406 MPN/100ml)	Rating
Callahan Creek	9	0	0		13	0	0	
Mouth Drew Creek	9	11	0		13	8	0	
Elk Creek above Drew Creek	9	0	0		12	0	0	
Mouth Joe Hall Creek	5	0	0		13	0	0	
Elk Creek aove Joe Hall Creek	9	11	0		13	0	0	
Brownie Creek near mouth	9	11	11		13	0	0	
Mouth Shed Ceerk (Flat Creek)	9	33	33		13	0	0	
Elk Creek above Shed Creek	9	11	0		11	0	0	
Mouth Elk Creek	9	11	0		12	0	0	
South Umpqua above Elk Creek (Tiller, Bridge over S Ump)	9	0	0		12	0	0	
South Umpqua below Stouts Creek	8	0	0		11	0	0	
Mouth Stouts Creek	8	13	0		12	0	0	

Table 35: Rating of all Elk Creek Sites for *E. coli*, Summer and Winter

Rating	**Color**	***E. coli* MPN/100ml**
Good		<100
Fairly Good		>100<235
Concern		>235<406
Needs Improvement		> 406

RESULTS Elk Creek/Tiller Area

Continuous Temperature

PUR partnered with the USFS Tiller Ranger District in the monitoring of the Elk Creek/Tiller area with PUR collecting the grab sample water quality parameters and the Forest Service providing the data from their continuous summer temperature monitoring sites. For this study, we analyzed the USFS data for 2008-2010 for sites that are the same as, or in proximity to, PUR's water quality monitoring sites for those same years.

Dates of continuous summer stream temperature monitoring in the Elk Creek/Tiller area, seasonal maximum and minimum stream temperatures, diurnal fluctuations, 7-day average maximum (7DAM) stream temperatures, and days above the ODEQ criteria (ODEQ, 2003) and (ODEQ, 2011, p. 46) are listed in Appendix K. All streams in the Elk Creek/Tiller area fall into the designated fish use of core cold-water habitat (ODEQ, 2003) and therefore the 7DAM stream temperatures may not exceed 60.8°F (ODEQ, 2011, p. 46). The Elk Creek/Tiller area is the only area of the four in this study that falls into the designated use of core cold-water habitat. The 7DAM stream temperatures for the streams monitored in the Elk Creek/Tiller area during this study (2008-2010) ranged from 64.5°F to 74.3°F, all exceeding the DEQ criteria of 60.8°F (Appendix K).

A few of the sites in the Elk Creek/Tiller area exceeded the potentially lethal temperatures Bell (1990, p. 11.4) found for steelhead and cutthroat trout (75.0°F and 73.0°F respectively). These sites were Drew Creek at Mouth in 2008, Elk Creek at Tiller all three years monitored, and Flat Creek at Mouth in 2009 (Appendix K). No sites exceeded the lethal stream temperatures Brett (1952, pg. 282-3) found for young coho and Chinook salmon, acclimated to 70°F, of ≥78.8°F (Appendix K). Though the temperatures of these sites exceed the lethal limit for steelhead and/or cutthroat trout, due to the diurnal fluctuation of stream temperatures associated with night cooling, the streams are not above these temperatures for very long.

In the Elk Creek/Tiller area, there is fairly consistent continuous stream temperature data annually from June 24 to September 17. However, there are a few sites that had shorter monitoring periods due to later placement or the equipment going out of water. Brownie Creek at Mouth in 2008 began monitoring on July 2 and Joe Hall Creek at Mouth was only monitored until August 4 in 2008 and July 27 in 2009 due to Joe Hall surface flow drying up. The percentage of days within the time period, June 24 to September 17 that the temperature exceeds the 60.8°F criteria is mapped on Figure 94. Years were combined to reduce the effect of annual variability. All streams were monitored 2008-2010 except there is no data for Joe Hall Creek at Mouth in 2010. Elk Creek at Tiller had 81-90% of the days exceeding the criteria; Flat Creek at Mouth and Brownie Creek had 61-80% exceeding the criteria, and Drew Creek and Callahan Creek had 41-60% exceeding the criteria (Figure 94). Given that there are only eight days missing from the Brownie Creek data set in 2008, there would be no change to the Percent Range category for Figure 94 if there were a complete data set.

Joe Hall Creek had the most days above the 60.8°F criteria with ≥91% of the days above the criteria. The data at Joe Hall Creek at Mouth was only from June 24 to August 4 in 2008 and June 24 to July 27 in 2009 when the creek went dry and did not flow again until after the continuous temperature monitoring season.

Since water temperature in the upper 60's is a stressor to salmonids (Bjornn & Reiser, 1991, p. 84) and (The Oregon Plan for Salmon and Watersheds, 1999, pp. 6-1), the percentage of days from June 24 to September 17 above 68°F was also mapped (Figure 95). Elk Creek at Tiller had 41-60% of the days above 68°F and the sites at the mouths of Brownie, Callahan, Drew, and Flat Creeks had ≤10% (Figure 95) Joe Hall Creek at Mouth had 22% of the days above 68°F (Figure 95 and Appendix K), but due to Joe Hall Creek at Mouth only having data from June 24 to August 4 in 2008 and June 24 to July 27 in 2009 when it went dry each year, it has greater issues than just the days above 68°F. Given that there are only eight days missing from the Brownie Creek data set in 2008, there would be no change to the Percent Range category for Figure 95, if there were a complete data set.

When the cold limit line (Smith, K., 2003, Apx. 1, p. 9) is graphed with the 7DAM stream temperatures for sites in the Elk Creek/Tiller area, it shows that all are above the predicted minimum stream temperature (Figure 96 and Table 36). The further the stream temperatures are from the predicted temperatures on the cold limit line indicates a potential anthropogenic effect resulting in increased stream temperatures. Elk Creek at Tiller had fairly consistent temperatures all three years monitored; however, all of the tributaries had very high temperatures in 2009 compared to the other years (Figure 96). Flat Creek at Mouth in 2009 was the furthest from the cold limit line followed by Drew Creek at Mouth, Joe Hall at Mouth, Callahan Creek at Mouth and Brownie Creek at Mouth.

The tributaries' temperatures are consistent with stream temperature throughout the Umpqua basin in that they were consistently higher in 2009 compared to 2008 and 2010 (Appendix K). Averaging the years studied, Joe Hall Creek at Mouth is the furthest from the cold limit line compared to other sites in the Elk Creek/Tiller area (Figure 96 and Table 36). The next furthest from the cold limit line was Flat Creek at Mouth, followed by Drew Creek at Mouth, Brownie Creek at Mouth, then Callahan Creek at Mouth which was the closest to the cold limit line and therefore the coolest compared to the best that could be expected (Figure 96 and Table 36). The results for Brownie Creek were not skewed by the short data set in 2008 since the dates monitored included the date of the 7DAM stream temperatures for the area.

There were no sites monitored in the Elk Creek/Tiller area that exceeded lethal temperatures for young coho and Chinook salmon. However, a few sites exceeded the lethal limits for steelhead and cutthroat trout. Due to the diurnal fluctuation of stream temperatures, the streams do not exceed these temperatures for very many hours in a given day. These streams may have spots of thermal refugia that would give salmonids a refuge from these higher temperatures. However, there would still be increased metabolic stress on the salmonids exposed to these higher stream temperatures.

The 7DAM stream temperatures compared to the cold limit line that had the smallest differences, therefore were the coolest compared to predicted minimum, were at the mouths of Callahan Creek, followed by Brownie Creek, then Drew Creek, then Flat (Shed) Creek. This would indicate a priority order to restoration to improve stream temperatures with Flat Creek being the highest priority of these other tributaries.

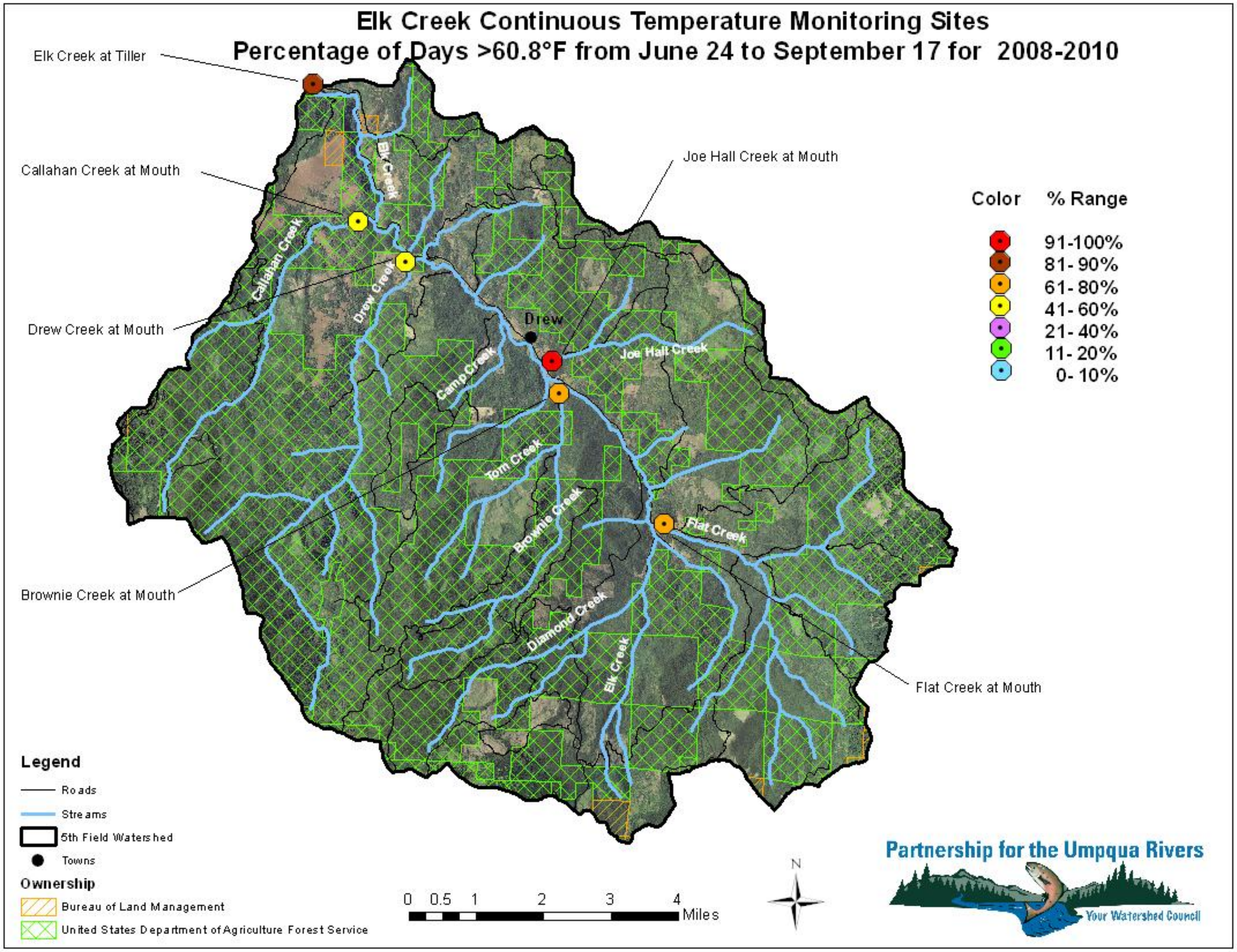


Figure 94: Elk Creek/Tiller area continuous summer stream temperatures from 2008-2010. Percentage of days from 6/24 to 9/17 with the stream temperatures exceeding 60.8°F (16°C). The temperature criteria for streams in the Elk Creek/Tiller area, which is designated core cold-water habitat, is 60.8°F (DEQ, 2003 and DEQ, 2011, pg. 46). The date range chosen is the most complete date set that encompasses the period from 2008-2010, except for Joe Hall Creek which only had water until 8/4 in 2008 and 7/27 in 2009. All data is from USFS and they are long-term monitoring sites.

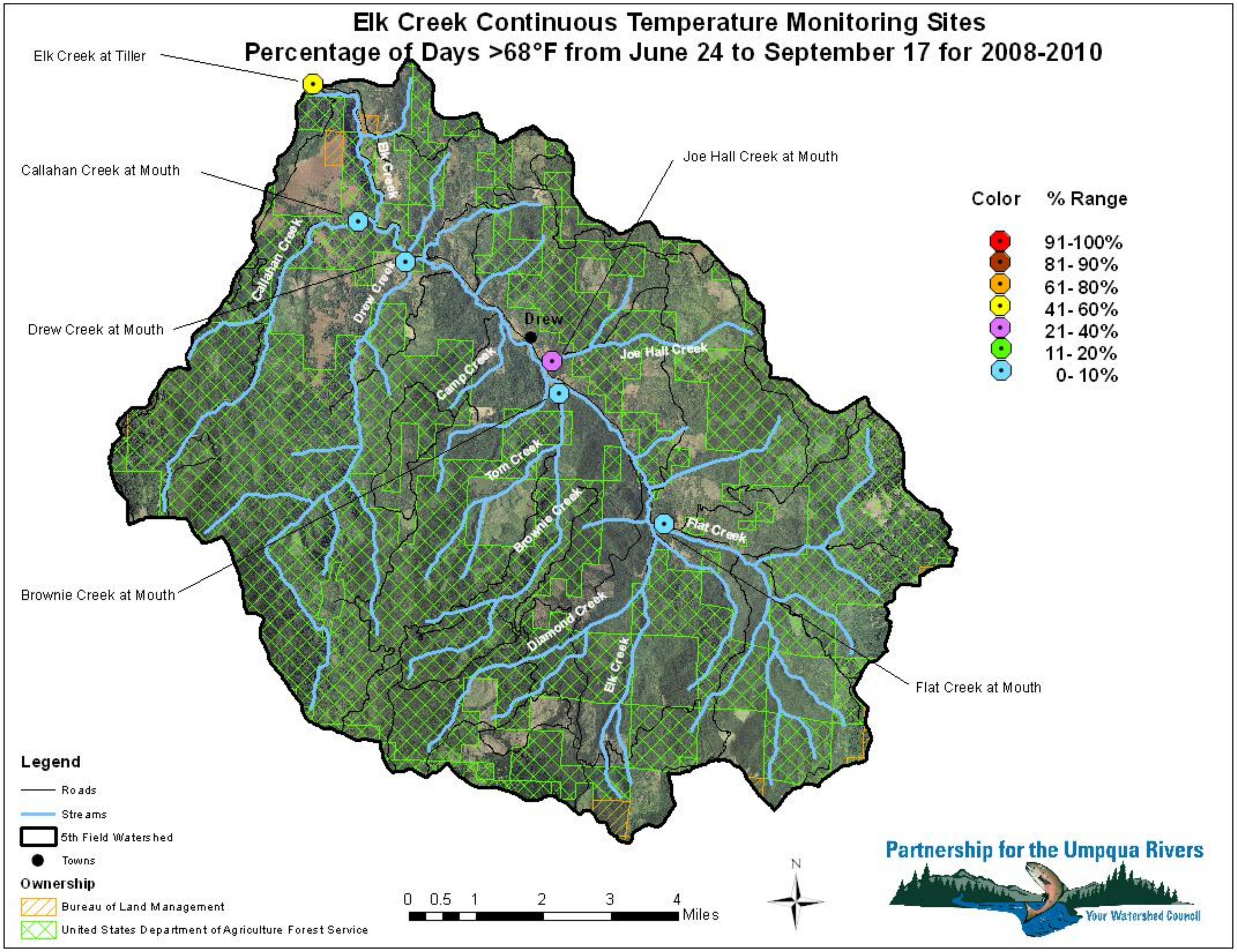


Figure 95: Elk Creek/Tiller area continuous summer stream temperatures for 2008-2010. Percentage of days from 6/24 to 9/17 with the stream temperatures exceeding 68°F, a temperature that would limit salmonid migration corridor use (ODEQ, 2003) and (ODEQ, 2011, pg. 46). The date range chosen is the most complete data set that encompasses the period from 2008-2010, except for Joe Hall Creek which was only monitored until 8/4 in 2008 and 7/27 in 2009 when it went dry. All data is from USFS and they are long-term monitoring sites.

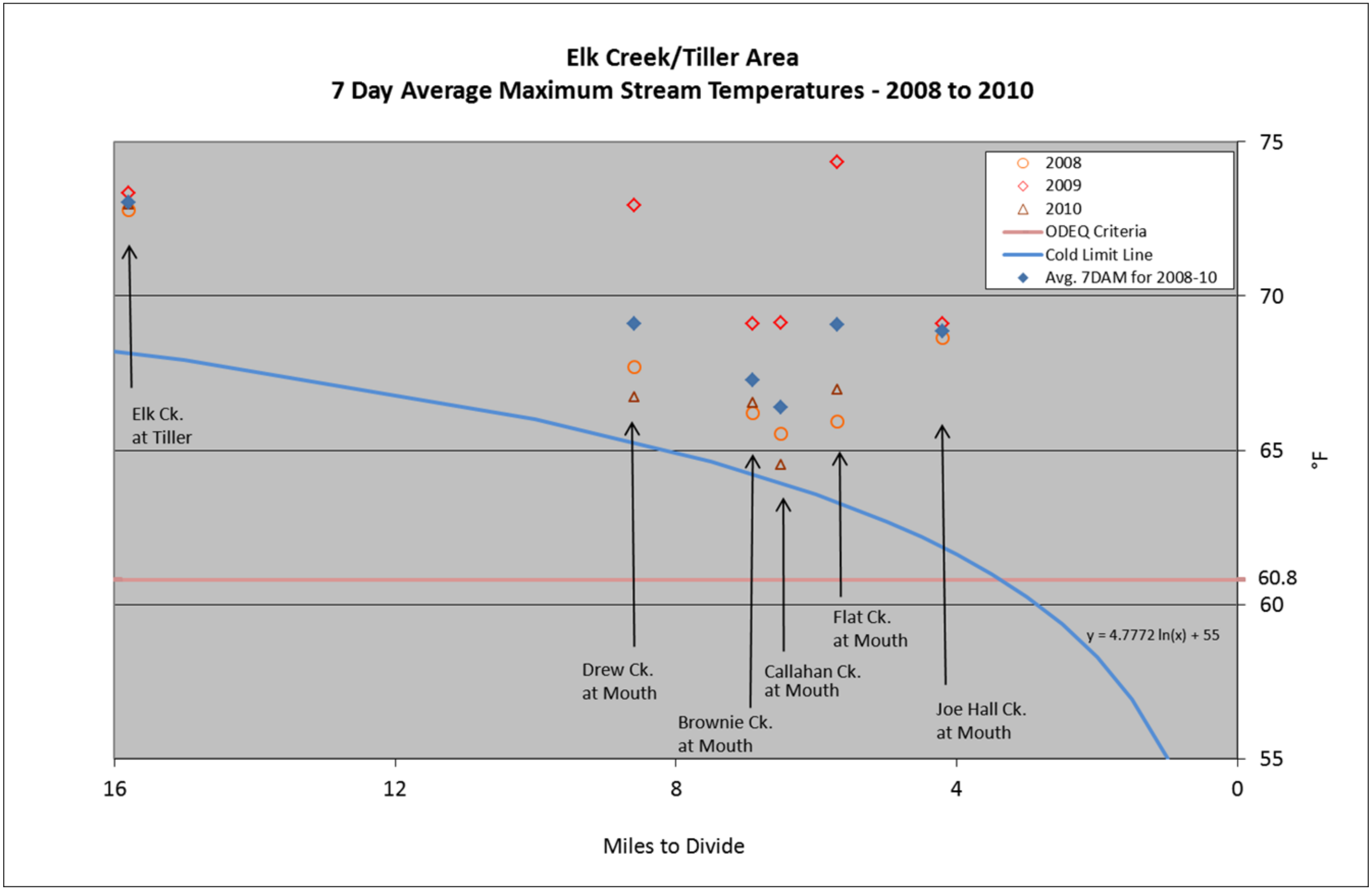


Figure 96: Elk Creek/Tiller area tributaries 7-day average maximum (7DAM) stream temperatures from 2008-2010. The temperature criteria for streams in the Elk Creek/Tiller area, which is designated core cold-water habitat use, is 60.8°F (ODEQ, 2003) and (ODEQ, 2011, p. 46). The cold limit line represents the minimum achievable stream temperatures for streams in the South Umpqua sub-basin as distance from ridgeline divide increases (Smith, K., 2003). Joe Hall Creek was only monitored until 8/4 in 2008 and 7/27 in 2009 and was dry during the time of the 7DAM stream temperatures for the other tributaries; therefore, the value graphed for Joe Hall Creek is misleading. All data is from USFS and they are long-term monitoring sites.

Table 36: Elk Creek/Tiller area monitoring sites distance to divide and difference in 2008-2010 7-day average maximum (7DAM) stream temperature compared to the cold limit line (y = 4.7772 ln(x) + 55), which represents the predicted minimum stream temperatures for streams in the South Umpqua sub-basin as distance to the ridgeline divide increases (Smith, K., 2003). All data is from USFS and they are long-term monitoring sites.

Site	Distance to Divide (Miles)	Difference from Cold Limit Line to 7DAM Stream Temperatures (°F)			
		2008	2009	2010	To Avg. 7DAM (2008-10)
Elk Creek at Tiller	15.8	4.6	5.1	4.8	4.9
Drew Creek at the mouth	8.6	2.4	7.7	1.4	3.8
Brownie Creek at the mouth	6.9	2.0	4.9	2.3	3.1
Callahan Creek @ Mouth	6.5	1.6	5.2	0.6	2.5
Flat Creek at the mouth	5.7	2.6	11.0	3.6	5.8
Joe Hall Creek @ Mouth	4.2	6.8*	7.2*		7.0*

* Joe Hall Creek was only monitored until 8/4 in 2008 and 7/27 in 2009 and had no water during the time of the 7DAM stream temperatures for the other tributaries; therefore, the value listed for Joe Hall Creek is misleading in comparison to the others.

RESULTS Elk Creek/Tiller Area

Grab Sample Monitoring

Of the 12 monitoring sites in the South Umpqua area, the USFA only recorded continuous temperature readings at six sites. Temperature was recorded at each of our grab sample monitoring events, and though this does not allow evaluation for DEQ temperature criteria, it is included here for evaluation and stream rating in order to provide additional information for planning restoration sites. The rating table of all sites in the Elk Creek/Tiller area for temperature, Table 37, indicates which evaluations were based on grab sampling or continuous monitoring (loggers). Two of the sites, South Umpqua below Stouts Creek and Stouts Creek at its mouth, are in the area designated by DEQ as Migration and Rearing and need to meet the criteria of <64.4^{o} F. The other ten sites fall into designated area for Core Cold Water which must meet the criteria of <60.8^{o} F. Table 37 accounts for these different stream criteria.

Temperature Ratings for Elk Creek/Tiller Area Monitoring Sites

SITE	Rating
Callahan Creek*	USFS Logger
Mouth Drew Creek*	USFS Logger
Elk Creek above Drew Creek*	PUR Grab Sample
Mouth Joe Hall Creek*	USFS Logger
Elk Creek above Joe Hall Creek*	PUR Grab Sample
Brownie Creek near mouth *	USFS Logger
Mouth Shed Creek (Flat Creek)*	USFS Logger
Elk Creek above Shed Creek*	PUR Grab Sample
Mouth Elk Creek*	USFS Logger
South Umpqua above Elk Creek (Tiller, Bridge over S Ump)*	PUR Grab Sample
South Umpqua below Stouts Creek◊	PUR Grab Sample
Mouth Stouts Creek ◊	PUR Grab Sample

Rating	Color	% of Monitoring Days >60.8° F Continuous Temp	Grab Sample Temperatures Core Cold Water Habitat*	Grab Sample Temperatures Rearing and Migration◊
Good		0-20	< 60.8° F	<64.4° F
Fairly Good		21-40		
Concern		41-60		
Needs Improvement		61-100	>60.8° F	>64.4° F

Table 37: Temperature ratings for Elk Creek/Tiller monitoring area sites. Note the first 10 sites must meet the core cold water criteria of < 60.8° F while the last two need only meet the rearing and migration temperature of <64.4° F.

RESULTS Elk Creek/Tiller Area

Summary

Table 38 presents the summary of ratings of all six water quality parameters monitored in the Elk Creek/Tiller area. It is evident that this area's worst problem is exceedances of the temperature criteria with every site failing to meet DEQ criteria. Conductivity, on the other hand, is of no concern at any of the sites. Turbidity in winter is the significant concern. Dissolved oxygen, pH, and *E. coli* follow in order of concern. Shed Creek, also known as Flat Creek, has the most exceedances with five parameters failing to meet criteria. Next in number failing to meet criteria is Brownie Creek with four and Joe Hall with three.

Summary Rating for Elk Creek/Tiller Area Monitoring Sites – Six Water Quality Parameters

Site	Turbidity	pH	Dissolved Oxygen	Conductivity	*E. coli*	Temperature
Callahan Creek	[green]	[yellow]	[red]	[blue]	[blue]	[red]
Mouth Drew Creek	[green]	[yellow]	[yellow]	[blue]	[yellow]	[red]
Elk Creek above Drew Creek	[red]	[yellow]	[green]	[blue]	[green]	[red]
Mouth Joe Hall Creek	[red]	[blue]	[red]	[blue]	[blue]	[red]
Elk Creek above Joe Hall Creek	[red]	[yellow]	[green]	[blue]	[yellow]	[red]
Brownie Creek near mouth	[red]	[blue]	[red]	[blue]	[red]	[red]
Mouth Shed Creek (Flat Creek)	[red]	[red]	[red]	[blue]	[red]	[red]
Elk Creek above Shed Creek	[red]	[yellow]	[green]	[blue]	[yellow]	[red]
Mouth Elk Creek	[yellow]	[red]	[yellow]	[blue]	[yellow]	[red]
South Umpqua above Elk Creek (Tiller, Bridge over S Ump)	[blue]	[red]	[blue]	[blue]	[blue]	[red]
South Umpqua below Stouts Creek	[green]	[red]	[green]	[blue]	[blue]	[red]
Mouth Stouts Creek	[green]	[yellow]	[green]	[blue]	[yellow]	[red]

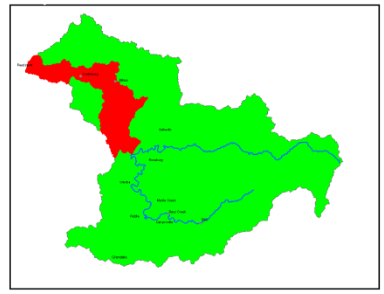
Table 38: Summary ratings for Elk Creek/Tiller area monitoring sites – six water quality parameters

RESULTS Elk Creek/Tiller Area

Mini Spotlight Joe Hall Creek

In 2006, 32 structures, with a total of 161 logs and 220 boulders, were placed in a mile of private land upstream of the mouth of Joe Hall Creek. The following year in 2007, Joe Hall Creek had 20 log structures with a total of 74 logs, placed in a mile of USFS managed land immediately upstream of the first project. Hopefully with more years, Joe Hall Creek's restoration efforts will continue to retain more gravel and create more pools as has been occurring each year since the restoration projects. Juvenile fish numbers have dramatically increased but thus far the juveniles have still needed to be trapped and transported out of the creek before it dries up. Each year a few more pools are able to maintain water over the summer, but as yet, summer surface flow has not returned to Joe Hall Creek. Hopefully with further years of monitoring we will be able to report a full summer's set of continuously monitored stream temperature and that those temperatures will show cool waters closer to the cold limit line.

UMPQUA



Area Description, Background & Monitoring Sites

The Umpqua monitoring spanned three 5th Field Watersheds: The Upper Umpqua River, Middle Umpqua River, and Lower Umpqua River. The Umpqua River begins at the confluence of the North and South Umpqua Rivers at Roseburg. From there it proceeds through these three 5th Fields to Winchester Bay where it flows into the Pacific Ocean. Highway 138 travels along the Umpqua River providing a major connecting route between the Umpqua Valley and the coast.

The Upper Umpqua River Watershed encompasses 169,676 acres from the confluence of the North and South Umpqua Rivers (also known as River Forks) to where Elk Creek joins the Umpqua in Elkton, 62 miles downstream. A large tributary, the Calapooya, flows into the Umpqua approximately 8 miles downstream from River Forks. Many other large tributaries join the Umpqua before it reaches Elkton, including one sixth field watershed – Wolf Creek. Streams in this region can be flashy and respond quickly to rainfall due to high stream density and seep topography. Approximately 70% of the watershed is forested. Sixteen percent of the land use is agriculture, occurring mostly in the floodplains of the Umpqua and its tributaries. Irrigation comprises 75.6% of the total water usage for the watershed, followed by agricultural water use of 19.5%. Less than 1% of water rights in the Upper Umpqua Watershed are secured for recreation, fish or wildlife. During the summer and fall, water is often over-allocated. PUR has completed numerous projects in this watershed in Camp, Bear, Hubbard, Case Knife, Miner, Heddin, Martin, and Yellow Creeks. In addition PUR has partnered with BLM and Roseburg Forest Products to conduct a 6th field wide restoration of the Wolf Creek Watershed.

Photo 13:: Mouth of Paradise Creek entering the Umpqua River - 3/18/09.

The Middle Umpqua River Watershed encompasses 63,505 acres of another Umpqua River subbasin that drains into the Umpqua River between the confluence with Mill Creek, below Scottsburg and upstream to the confluence with Elk Creek at Elkton; encompassing 24 miles of the Umpqua River. Elkton, Scottsburg, and Wells Creek are the only population centers. These communities, along with rural residential and agricultural lands, occupy 19% of the watershed, with the remainder being forest land. Land use is dominated by forestry (about 78%), with agriculture constituting about 8%. The landscape varies from steep-sloped, highly-dissected headwaters to low-gradient broad floodplains. Again there are many major tributaries in this region, the largest being Paradise and Weatherly Creeks (six to eight stream miles respectively). As in the Upper Umpqua, the streams are flashy, responding very quickly to rainfall. Irrigation uses 92.8% of water, with domestic water using 4.3%. There are less than 1% of water rights secured for recreation, fish or wildlife. PUR has completed several large instream projects in this watershed in Paradise and Lutsinger Creeks with more in the planning stage.

Photo 14: Umpqua River at Scott Boat Ramp 7/22/10

The Lower Umpqua River Watershed encompasses 67,930 acres extending from the mouth of the Umpqua River upstream to the confluence of Mill Creek just below Scottsburg (23 miles of the Umpqua River). The population centers consist of Reedsport, Gardiner and Winchester Bay. Highway 38 from Roseburg meets the Coast Highway 101 at Reedsport. The upper part of landscape is steep-sloped and has highly-dissected headwaters ending in gradient broad floodplains; however, the Coastal Lowlands Ecoregion is found at the lower end of the Umpqua River and comprises 11% of this watershed. This region is characterized by very low-gradient, meandering streams being affected by tidal influence and bordered mostly by floodplains. There are 121.3 stream miles in the Lower Umpqua River Watershed; the longest is Scholfield Creek which is approximately 15 miles long. Land usage is, once again, predominately forestry – 69%. Agriculture, mostly in the floodplains, constitutes 3% of land use. Land ownership is divided between private (39.8%), state-managed (27.8%), federally-managed (22.3%), and over 10% of the land is covered by water. Elliott State Forest comprises 28% of the watershed. Water use, in general, is not a significant issue in this watershed. Domestic use is the largest use of water followed by commercial and irrigation use. This watershed may be one of the single most important watersheds in the Umpqua Basin. The tidal wetlands provide critical habitat to many aquatic species, particularly the anadromous species which must acclimate between fresh and ocean water. The Partnership for the Umpqua Rivers has hired a wetlands specialist who is developing projects exclusively in this watershed. Many have already occurred, such as the Dean Creek Wetland restoration, Harvey Creek restoration, Charlotte and Luder instream restorations and Upper Dean Creek Phase I and Phase II.

PUR Umpqua Water Quality Monitoring Sites

Site ID #	Site Name	Site Location	Lat/Long
U1	Calapooya River	Bridge at Garden Valley Road	N43 21.973 W123 27.643
U2	Umpqua River	James Wood Boat Ramp	N43 24.231 W123 32.157
U3	Yellow Creek	Private Property	N43 29.502 W123 29.077
U4	Umpqua River	Yellow Creek Boat Ramp Dave Lisha Memorial	N43 30.150 W123 29.625
U5	Umpqua River	Elkton Boat Ramp	N43 38.207 W123 34.269
U6	Elk Creek	Elk Creek above mouth	N43 38.134 W123 33.831
U7	Paradise Creek	Paradise at mouth	N43 40.361 W123 39.120
U8	Umpqua River	Scott Creek Boat Ramp	N43 39.782 W123 42.080
	Weatherly Creek	Weatherly Creek at Hwy 38 Bridge	N43 39.682 W123 44.174
U9	Umpqua River	Scottsburg Park Boat Ramp Dock	N43 38.991 W123 50.353
U10	Dean Creek	Mouth at Hwy 38 Bridge	N43 41.603 W123 59.984
	Dean Creek	Dean Creek at First Bridge on Dean Creek Road	N43 41.156 W124 11.280
	Dean Creek	Dean Creek at End of Road	N43 39.672 W123 59.720
U11	Umpqua River	Discovery Center Dock in Reedsport	N43 42.288 W124 05.660
	Smith/Umpqua River	Smith River/Umpqua River N. Bolin Island	N43 43.106 W124 05.995
U12	Schofield Creek	Schofield near mouth at Hwy 101 Bridge	N43 41.816 W124 06.914
U13	Winchester Creek	Winchester Creek at Salmon Harbor Drive	N43 40.494 W124 10.696

Table 39: Umpqua run monitoring sites and locations.

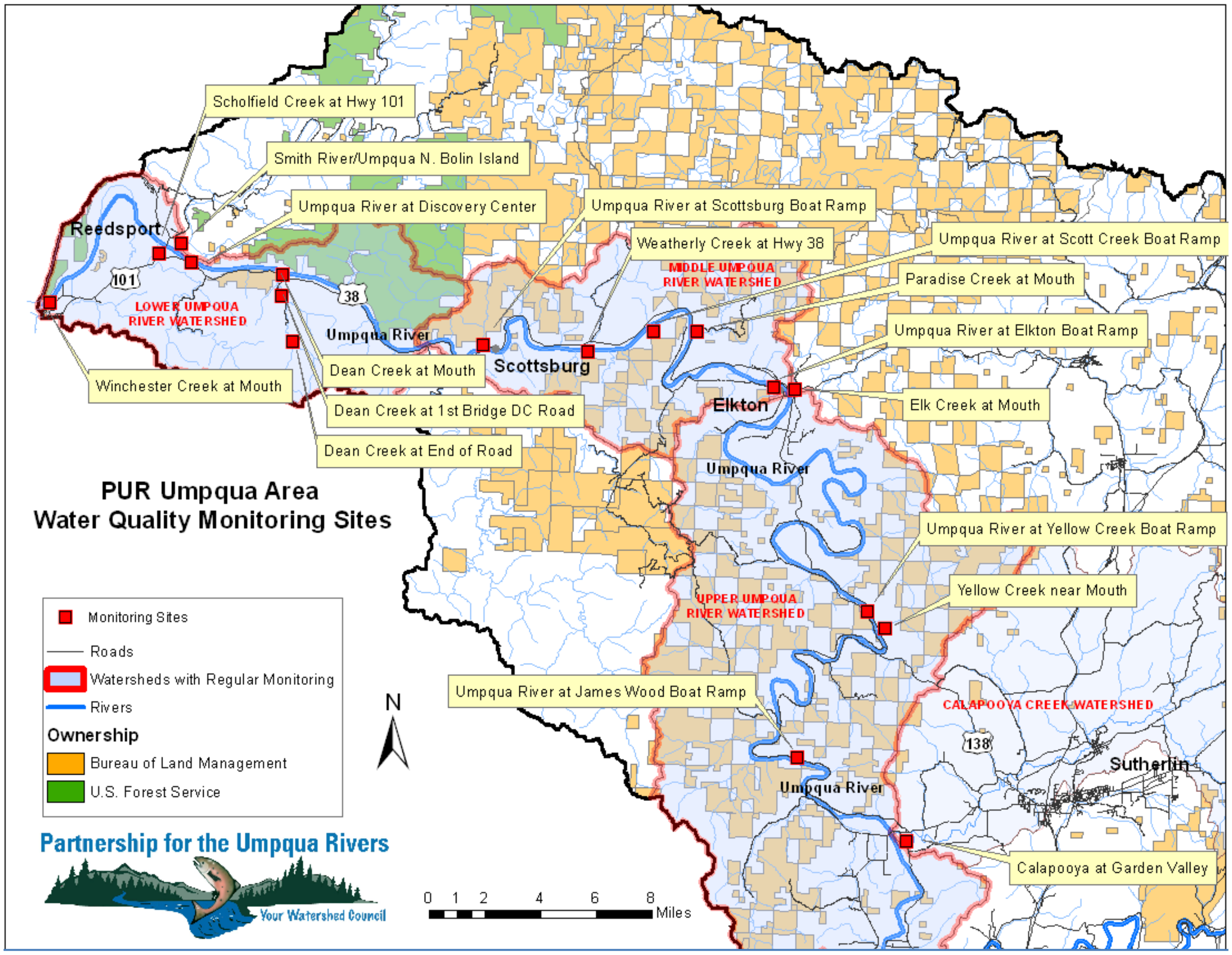


Figure 97: Map of PUR Umpqua area monitoring sites.

RESULTS – Umpqua Area

Turbidity

Turbidity levels at 12 of the 17 sites monitored in the Umpqua area exceeded 10 NTU for 20% or more of the monitoring events. Figure 99 indicates that the high spikes occurred in winter months and most likely were storm related. The five sites that did not exceed this criterion were three tributaries in the lower end of the Umpqua Watershed: Dean Creek, Scholfield Creek and Winchester Creek. Three sites were monitored on Dean Creek. The site at the end of Dean Creek Road, where the stream, comes out of the forest was very clear, then turbidity increases going downstream towards the mouth. Calapooya Creek had the highest total amount of turbidity with 25% of monitoring events being over 20 NTU (see Figure 98). Table 40 indicates the ratings for all the creeks in the Umpqua monitoring area.

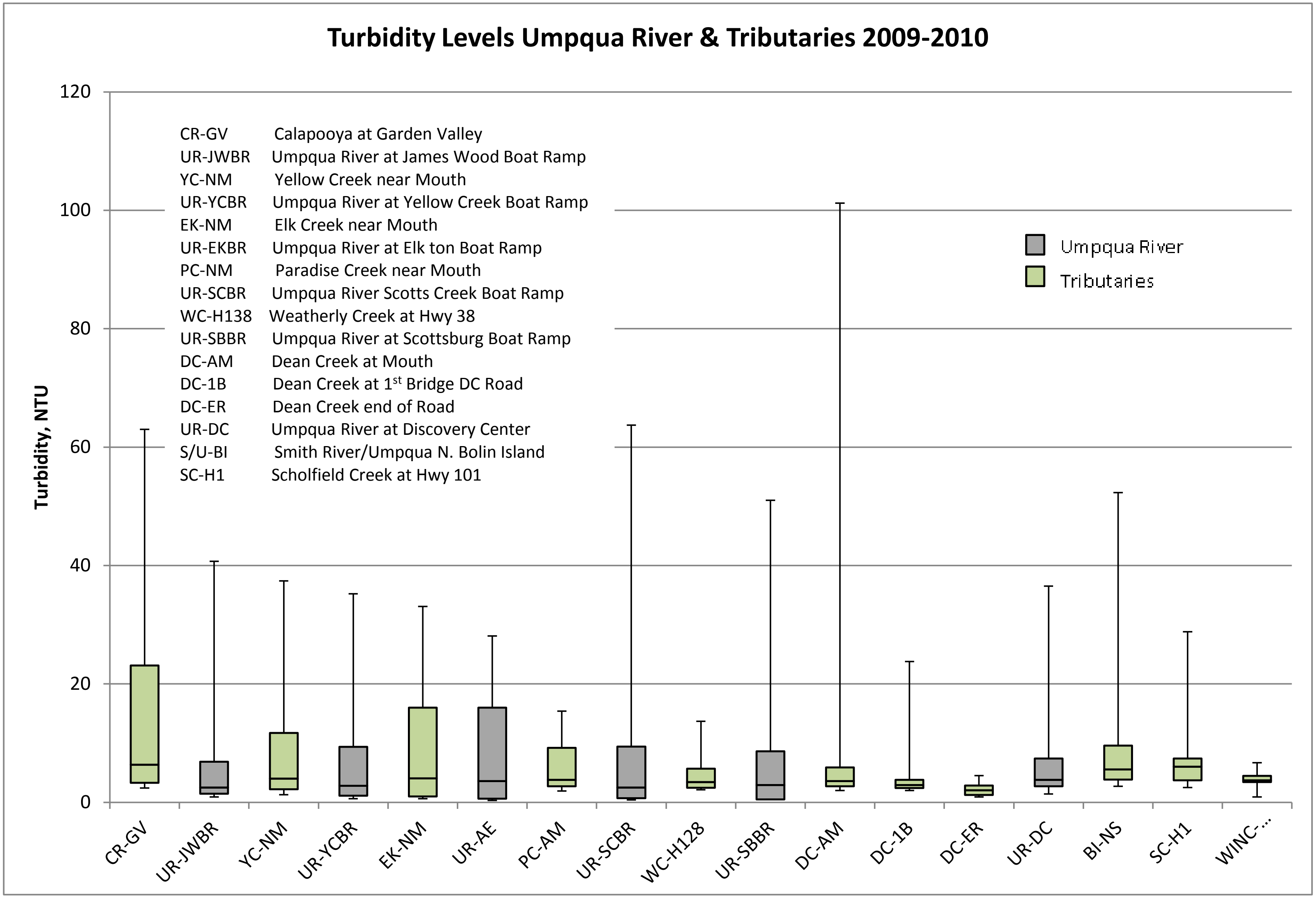


Figure 98: Turbidity levels Umpqua River & tributaries 2009-2010.

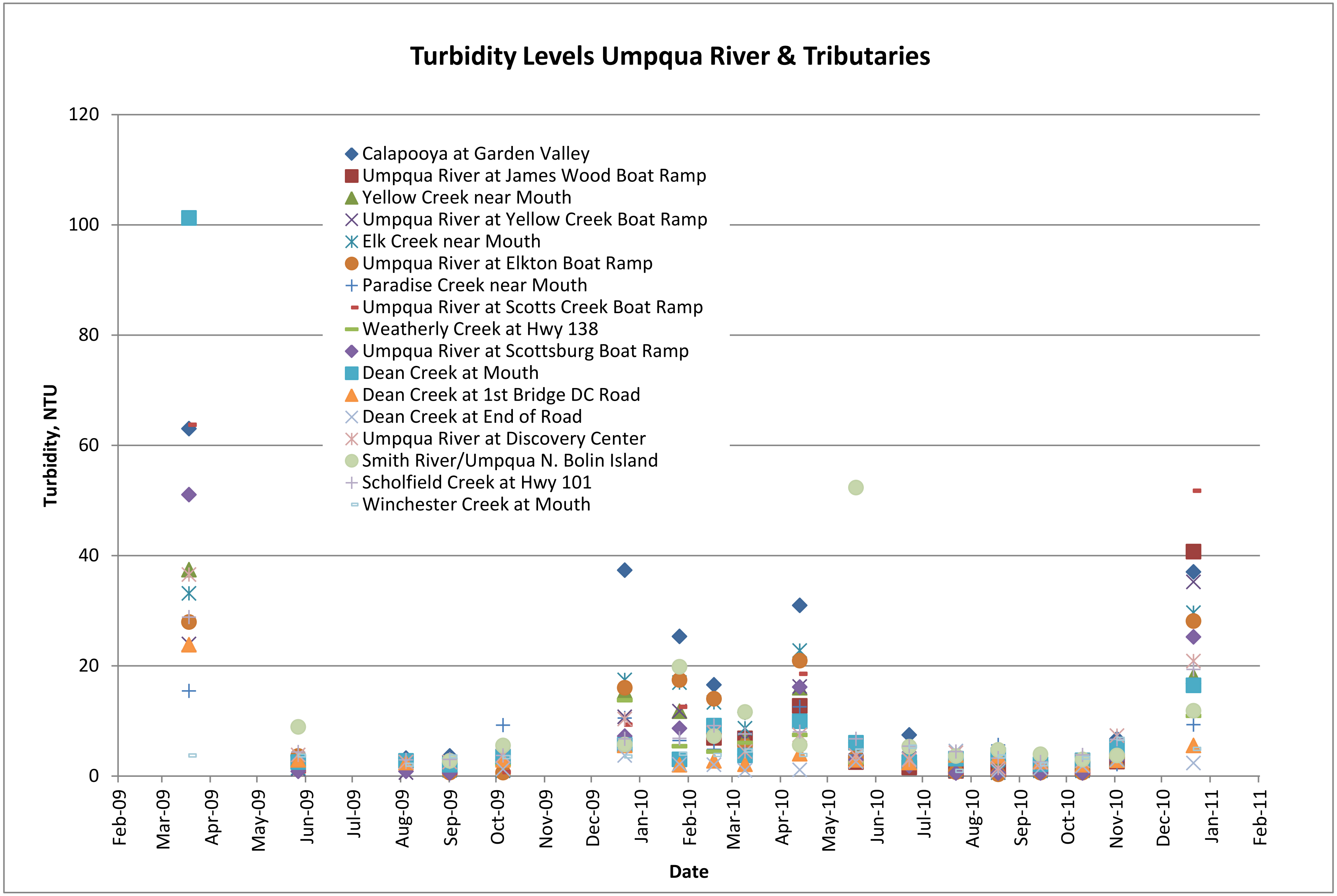


Figure 99: Turbidity levels Umpqua River & tributaries 2009-2010.

Rating of Monitoring Sites in the Umpqua Area for Turbidity

SITE	Summer (May 1-Sept. 30)		Winter (Oct.1-April 30)		Rating
	# Samples	% > 10 NTU	# Samples	% > 10 NTU	
Calapooya River at Garden Valley	6	0	12	58	
Umpqua River at Mac Brown Park	4	0	7	29	
Yellow Creek	5	0	12	42	
Umpqua River at Yellow Cr Boat Ramp	8	0	12	42	
Elk Creek at Elkton	6	0	12	50	
Umpqua River at Elkton	5	0	12	50	
Paradise Creek at mouth	5	0	12	25	
Umpqua River at Scott Boat Ramp	5	0	12	33	
Weatherly Creek at Highway 38 Bridge	5	0	14	21	
Umpqua River at Scottsburg Boat Ramp	7	0	11	27	
Dean Creek at mouth	7	0	12	17	
Dean Creek at 1st bridge up Dean Creek Road	5	0	12	8	
Dean Creek at end of road	4	0	10	0	
Umpqua River at Discovery Center	7	0	12	25	
Bolin Island at boat ramp	5	0	11	36	
Schofield Creek at Highway 101	7	0	12	17	
Winchester Creek at mouth	7	0	12	0	

Rating	Color	Turbidity
Good		< 10 NTU
Concern		Between 10% and 20% , 10 NTU or greater
Needs Improvement		20% or more 10 NTU or greater

Table 40: Rating of monitoring sites in the Umpqua area for turbidity

RESULTS - Umpqua Area

pH

The Umpqua River had numerous exceedances of the DEQ pH Criteria's upper limit of ≥8.5, but none for the lower limit of pH 6.5, Figure 100. It was borderline at the furthest upstream point monitored at Mac Brown Park, but then exceeded 8.5 at the Yellow Creek Boat Ramp at Elkton, at Scott Creek Boat Ramp and at Scottsburg Boat Ramp. Tributaries, Calapooya Creek, Yellow Creek, Weatherly Creek, Dean Creek at the furthest upstream site, and Scholfield Creek all fell within the lower and upper limits meeting criteria. Elk Creek exceeded 8.25, as did Dean Creek at the lower two monitoring sites. All of the sites in the estuary met the 8.5 criteria, (Figure 101), but in addition to the two Dean Creek sites, the Bolin Island monitoring site also exceeded 8.25. The Umpqua River at Scotts Boat Ramp consistently had the highest pH levels with 25% of its readings almost reaching the 8.5 level, Figure 102. Table 41 displays the ratings of all the creeks in the Umpqua monitoring area.

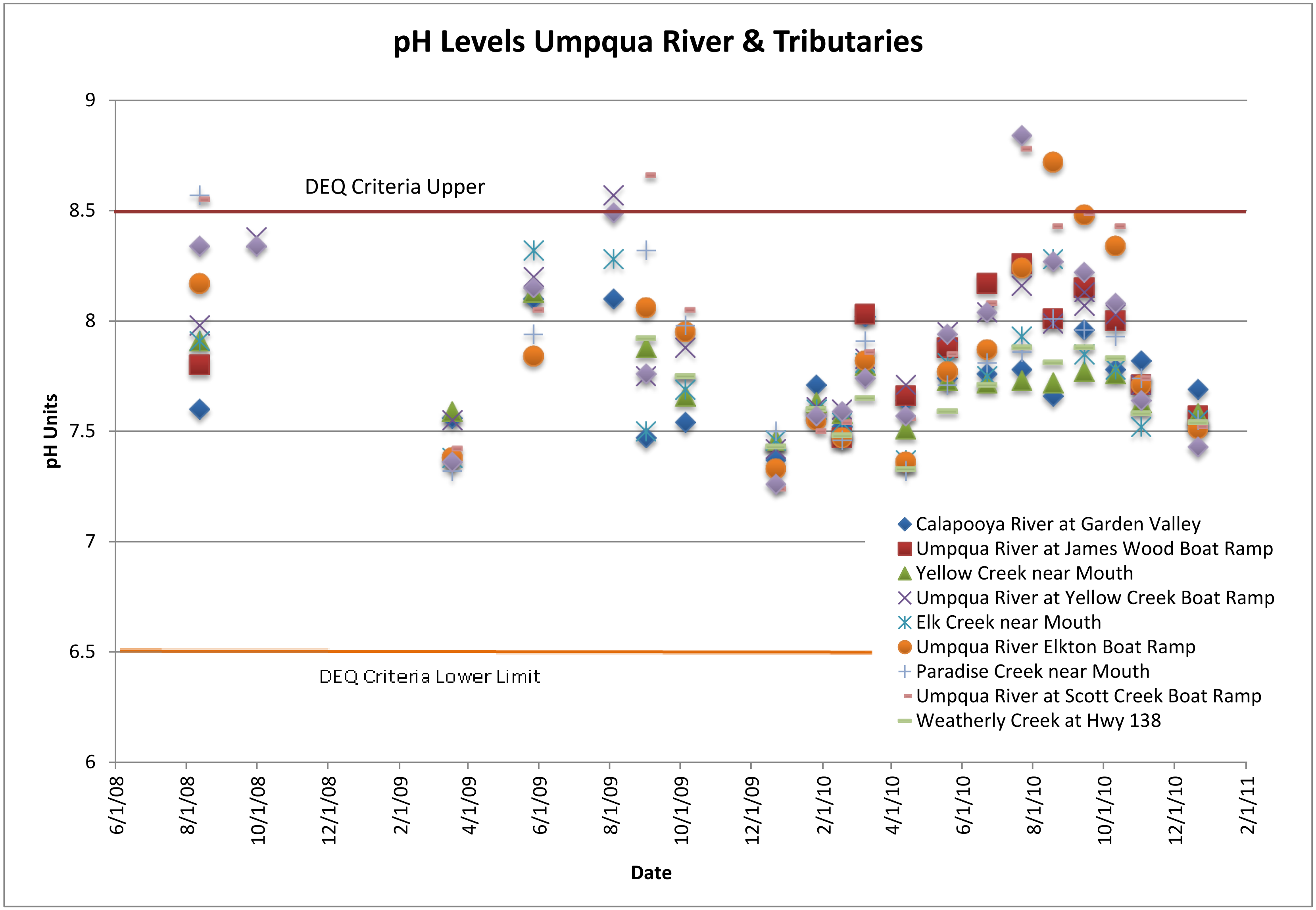


Figure 100: Levels of pH for the Umpqua River and tributaries, not including areas of saline influence

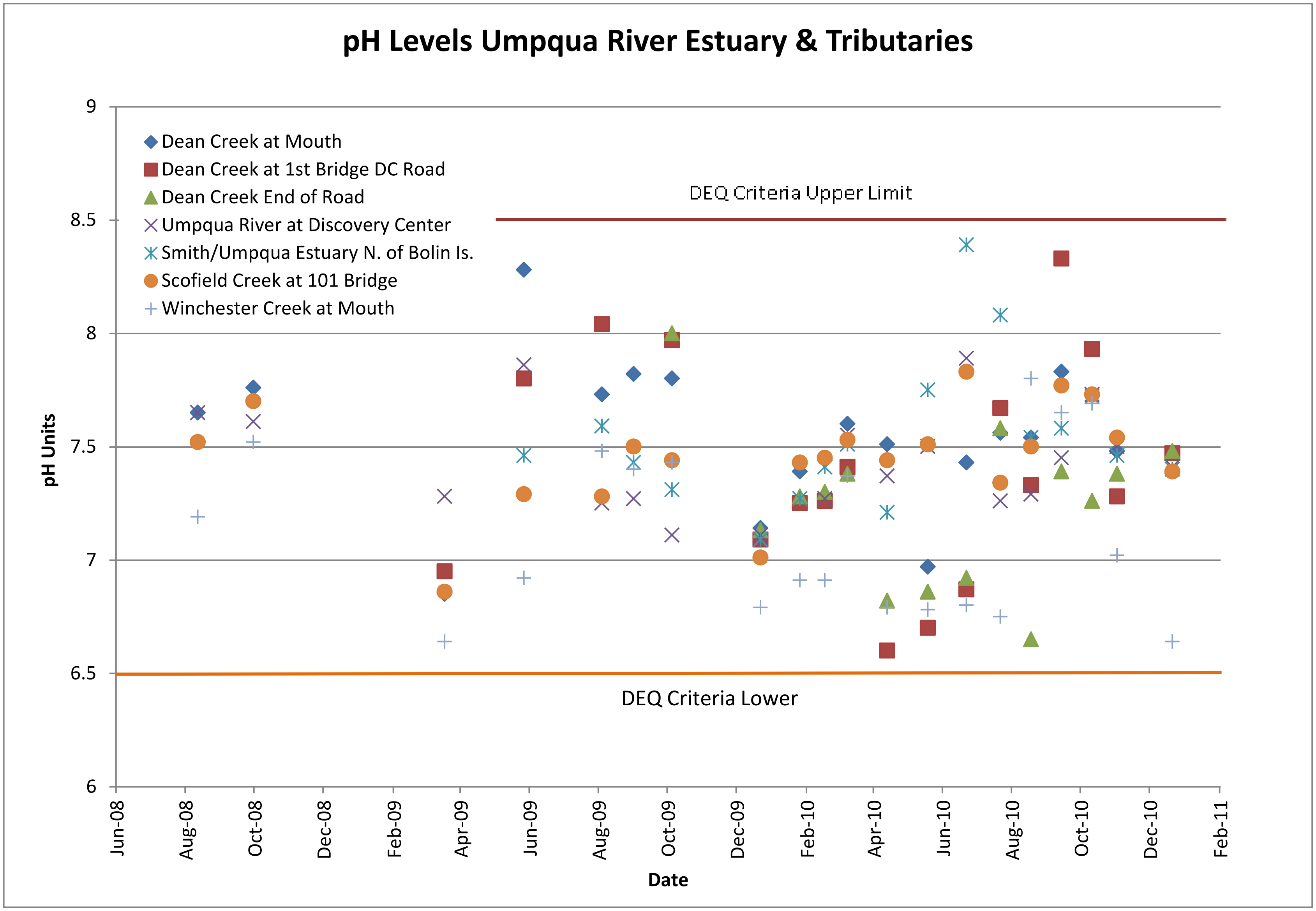


Figure 101: Levels of pH for Umpqua River estuary & tributaries

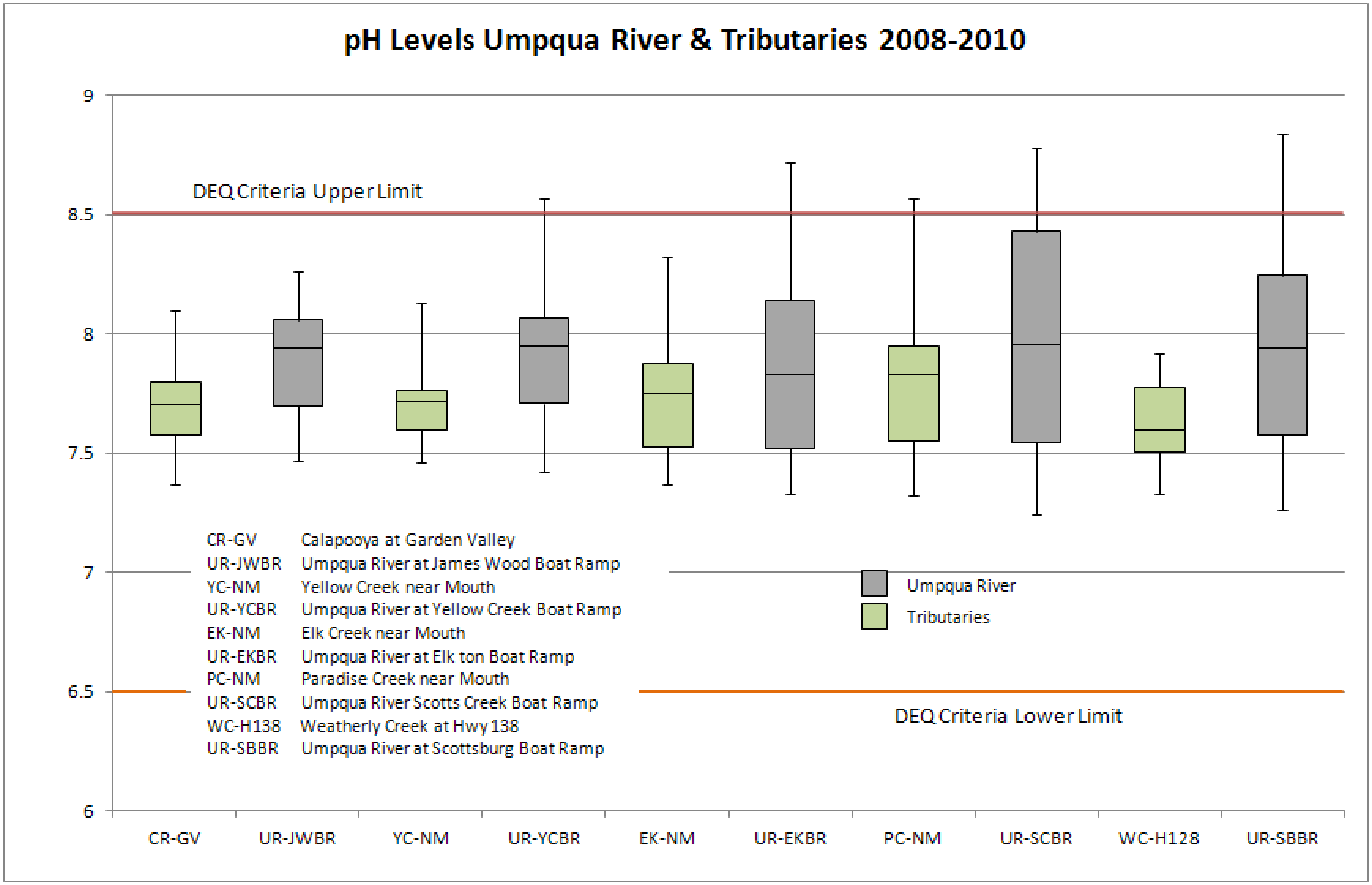


Figure 102: Levels of pH for the Umpqua River and tributaries, not including areas of saline influence 2008-2010

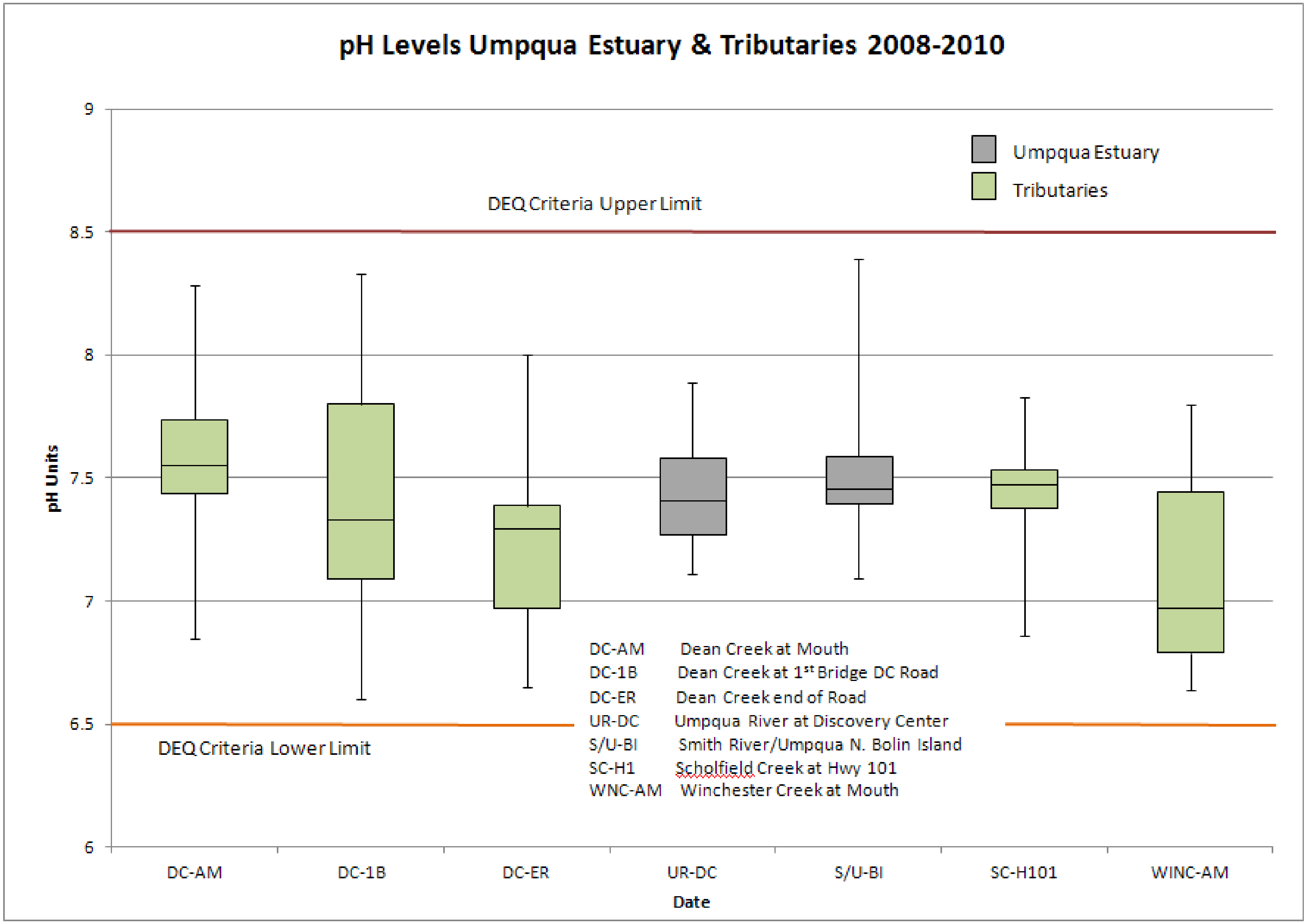


Figure 103: Levels of pH for Umpqua River estuary & tributaries 2008-2010

Ratings for pH of All Umpqua Area Monitoring Sites

Site	Rating
Calapooya River at Garden Valley	Blue
Umpqua River at Mac Brown Park	Yellow
Yellow Creek	Blue
Umpqua River at Yellow Cr Boat Ramp	Red
Elk Creek at Elkton	Yellow
Umpqua River at Elkton	Red
Paradise Creek at mouth	Red
Umpqua River at Scott Boat Ramp	Red
Weatherly Creek at Highway 38 Bridge	Blue
Umpqua River at Scottsburg Boat Ramp	Red
Dean Creek at mouth	Yellow
Dean Creek at 1st bridge up Dean Creek Road	Yellow
Dean Creek at end of road	Blue
Umpqua River at Discovery Center	Blue
Bolin Island at boat ramp	Yellow
Schofield Creek at Highway 101	Blue
Winchester Creek at mouth	Blue

pH Rating Code		
Rating	**Color**	**pH Criteria**
Good	Blue	None above 8.25
Concern	Yellow	1 or more ≥ 8.25
Needs Improvement	Red	1 or more ≥ 8.5

Table 41: Rating for pH of all Umpqua area monitoring sites

RESULTS - Umpqua Area

Dissolved Oxygen

The Umpqua area monitoring sites will be reviewed, for dissolved oxygen, in two groups: the freshwater part of the Umpqua and the tributaries in that region, and the Umpqua estuary and the tributaries monitored in that region. The amount of salinity in the water affects its ability to hold dissolved oxygen. Therefore, it is not possible to attain the same levels of D.O. as is possible in the upper river. The dissolved oxygen limit for aquatic life in the estuary is considered to be 6.5 mg/l.

There were a number of exceedances of spawning and non-spawning dissolved oxygen criteria for monitoring sites on the Umpqua River and its tributaries. These mostly occurred during the spawning season. Two tributaries, Calapooya Creek and Elk Creek, were the only sites to have exceedances during the non-spawning period, Figure 104. Calapooya Creek was the only site to meet “needs improvement” rating for both seasons. See table 42 for ratings for all sites.

Two sites generated readings below the 6.5 mg/l level of concern for aquatic life. Only one low reading occurred at the mouth of Winchester Creek, while three instances were measured at the end of the road site on Dean Creek. The readings at this Dean Creek site were caused by low flows occurring in late summer where most of the flow was likely from subsurface with no air contact, furthermore, there was very little turbulent mixing. Figure 107 indicates that this site had the widest range of D.O. readings, which is consistent with decreasing D.O. levels caused by decreasing flow.

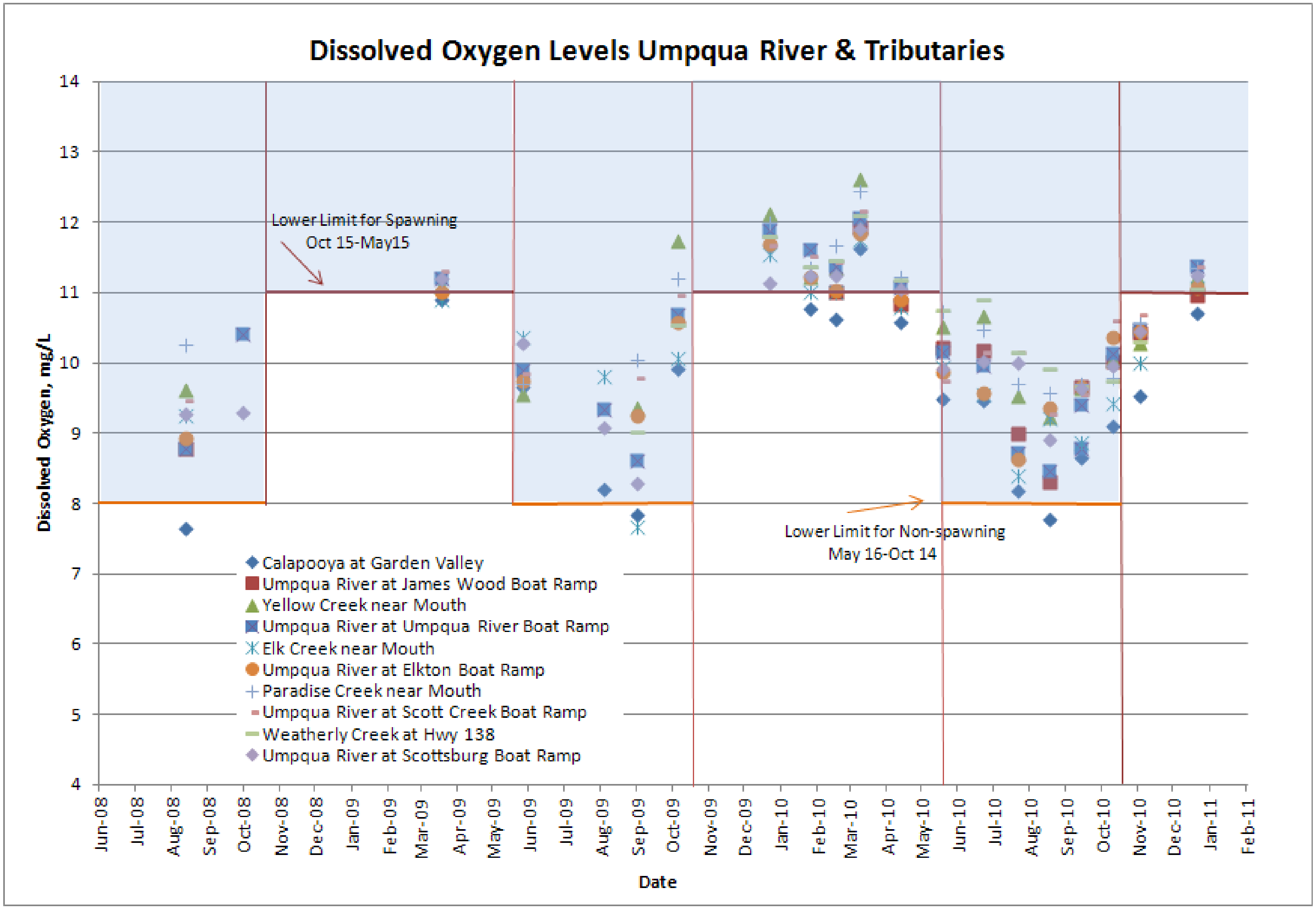


Figure 104: Dissolved oxygen levels at monitoring sites on the Umpqua River and tributaries

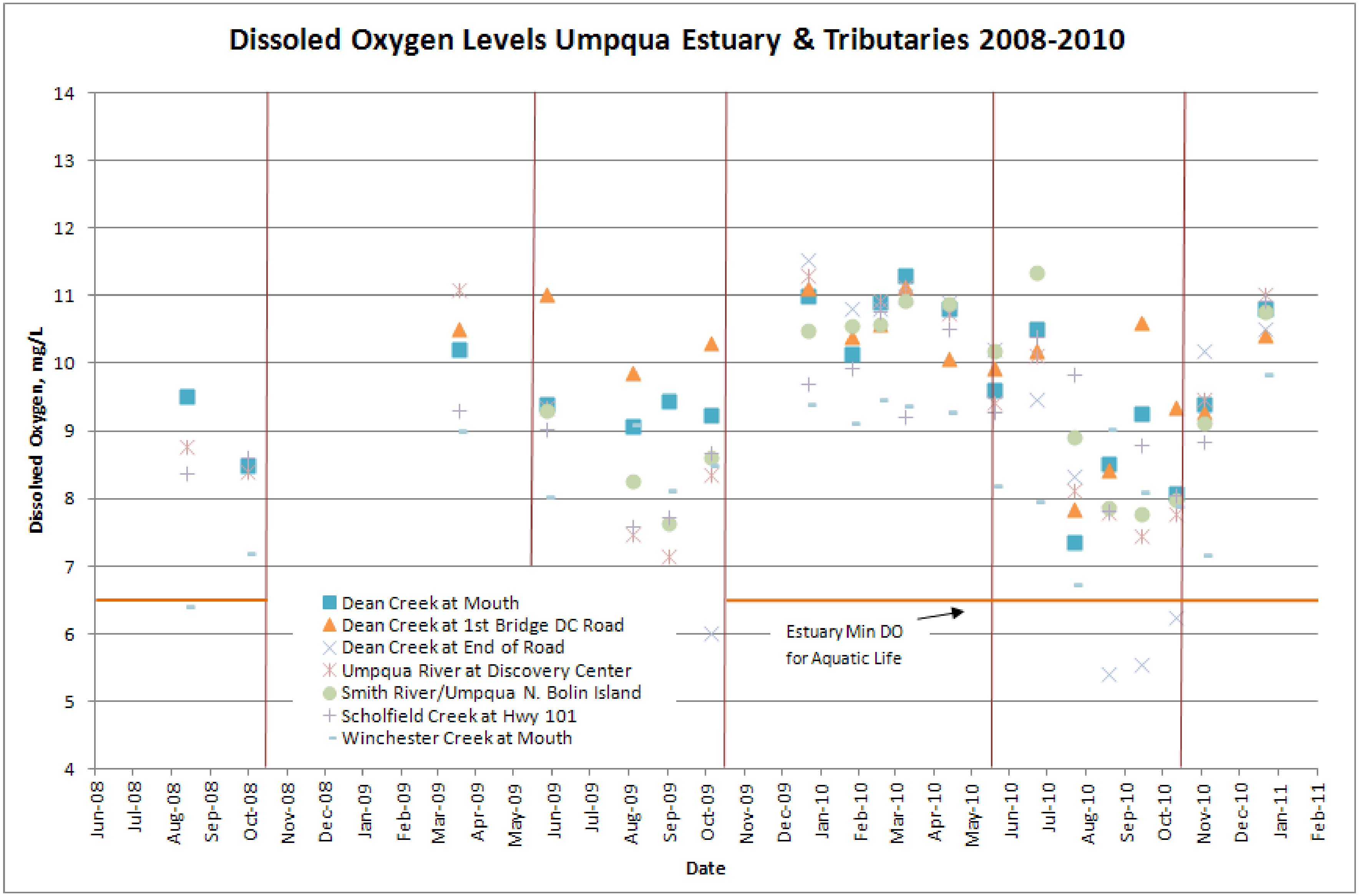


Figure 105: Dissolved oxygen levels at monitoring sites on the Umpqua estuary and tributaries

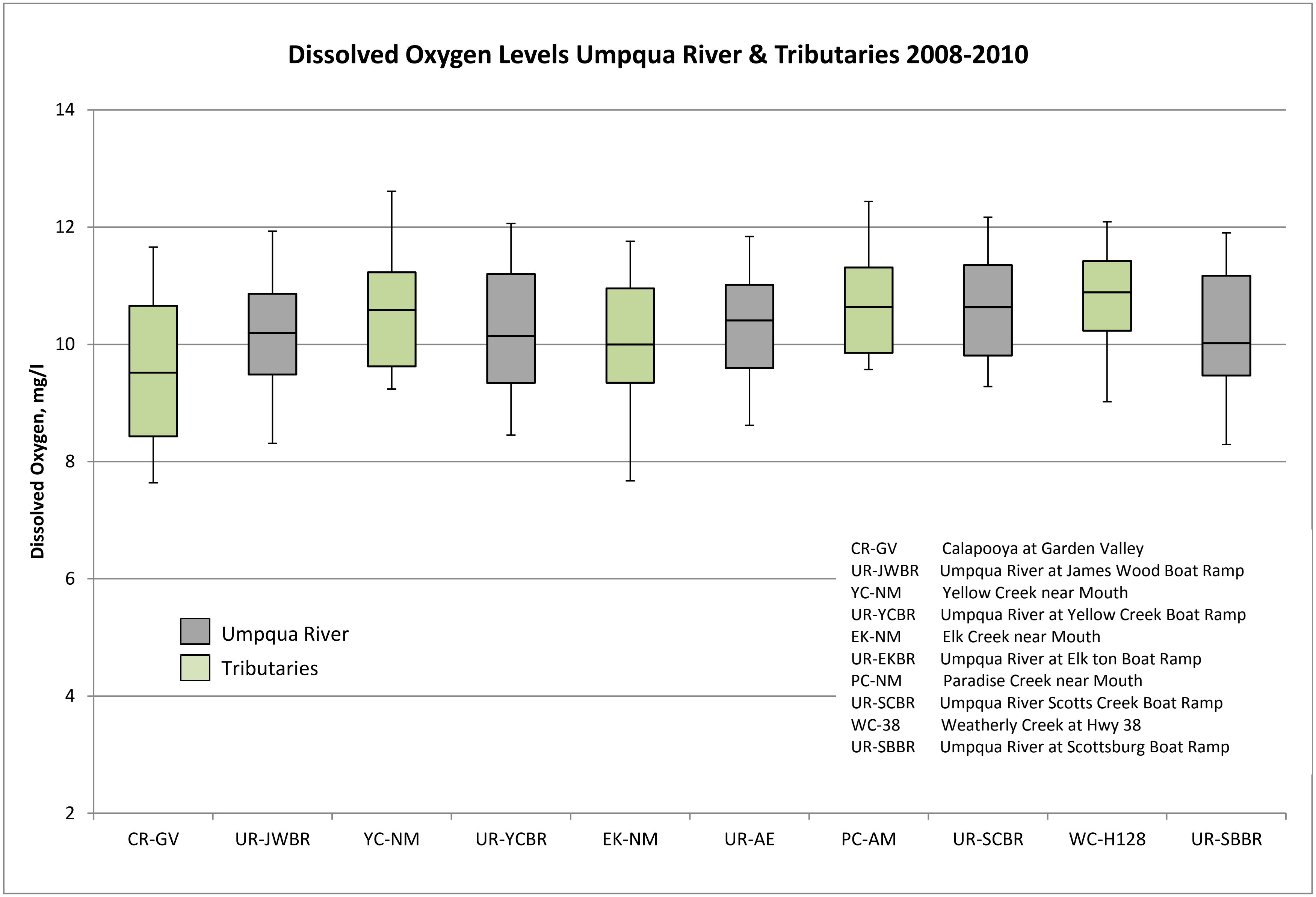


Figure 106: Dissolved oxygen levels at monitoring sites on the Umpqua River and tributaries 2008-2010

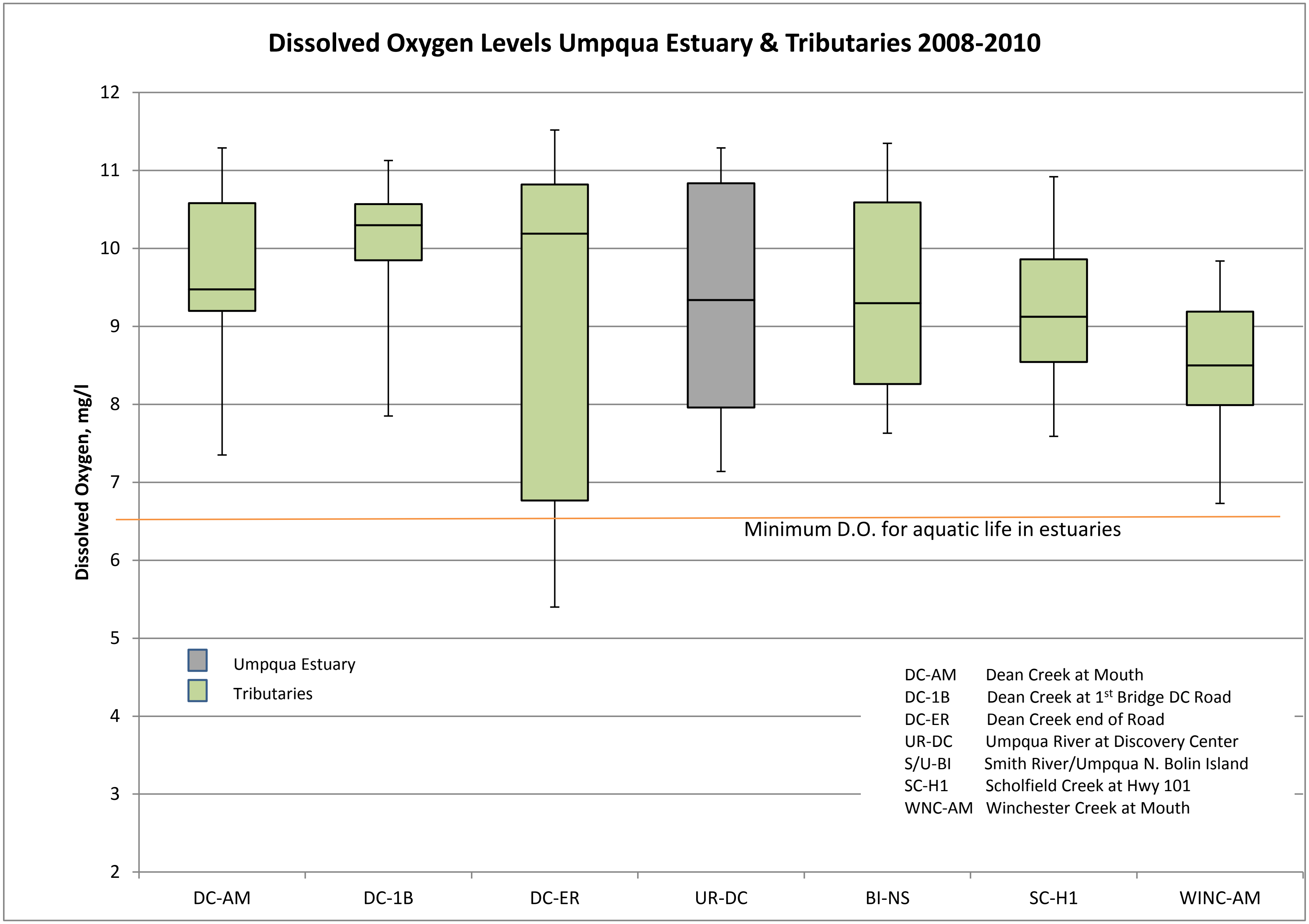


Figure 107: Dissolved oxygen levels at monitoring sites on the Umpqua estuary and tributaries 2008-2010

Rating of Umpqua Area Monitoring Sites for Dissolved Oxygen

SITE	Non-spawning Season May 16-October 14				Spawning Season October 13-May 15			
	# Samples	# Below Minimum D.O. Criteria of 8 mg/l	% Below Minimum D.O. Criteria of 8 mg/l	Rating	# Samples	# Below Minimum D.O. Criteria of 11 mg/l	% Below Minimum D.O. Criteria of 11 mg/l	Rating
Calapooya River at Garden Valley	11	3	27		8	6	75	
Umpqua River at Mac Brown Park	7	0	0		5	3	60	
Yellow Creek	10	0	0		8	1	13	
Umpqua River at Yellow Cr Boat Ramp	13	0	0		8	1	13	
Elk Creek at Elkton	11	1	9		8	3	38	
Umpqua River at Elkton	10	0	0		8	2	25	
Paradise Creek at mouth	10	0	0		8	1	13	
Umpqua River at Scott Boat Ramp	10	0	0		8	1	13	
Weatherly Creek at Highway 38 Bridge	9	0	0		10	1	10	
Umpqua River at Scottsburg Boat Ramp	11	0	0		8	1	13	
Dean Creek at mouth	12	1	8		8	6	75	
Dean Creek at 1st bridge up Dean Creek Road	9	1	11		8	6	75	
Dean Creek at end of road	7	4	57		7	6	86	
Umpqua River at Discovery Center	12	5	42		7	3	43	
Bolin Island at boat ramp	10	4	40		7	7	100	
Schofield Creek at Highway 101	12	3	25		8	8	100	
Winchester Creek at mouth	12	5	42		8	8	100	

Table 42: Rating of streams of the Umpqua Area monitoring for dissolved oxygen levels winter and summer

Color Key:		Good	No Exceedances of Criteria
		Fairly Good	Only 1 Exceedance of Criteria
		Concern	2 Exceedances of Criteria
		Needs Improvement	3 or more Exceedances of Criteria

RESULTS - Umpqua Area

Conductivity

All conductivity levels were within expected normal ranges for the Umpqua Basin and the Umpqua Estuary which demonstrated tidal saline effects. See Figures 108 and 110 for the river and tributaries sites, and Figures 109 and 111 for the Estuary and tributary sites.

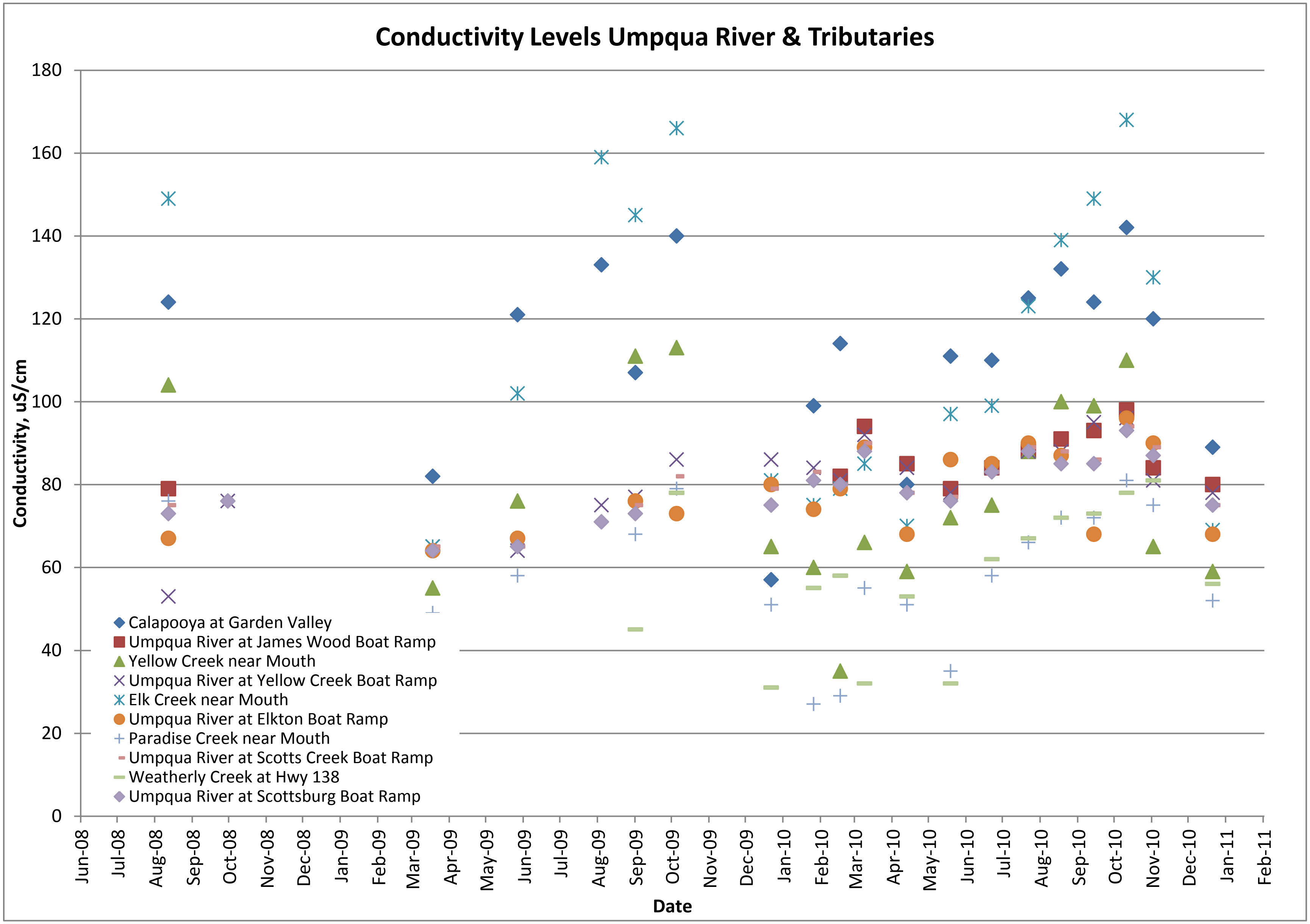


Figure 108: Conductivity levels at Umpqua River and tributary monitoring sites

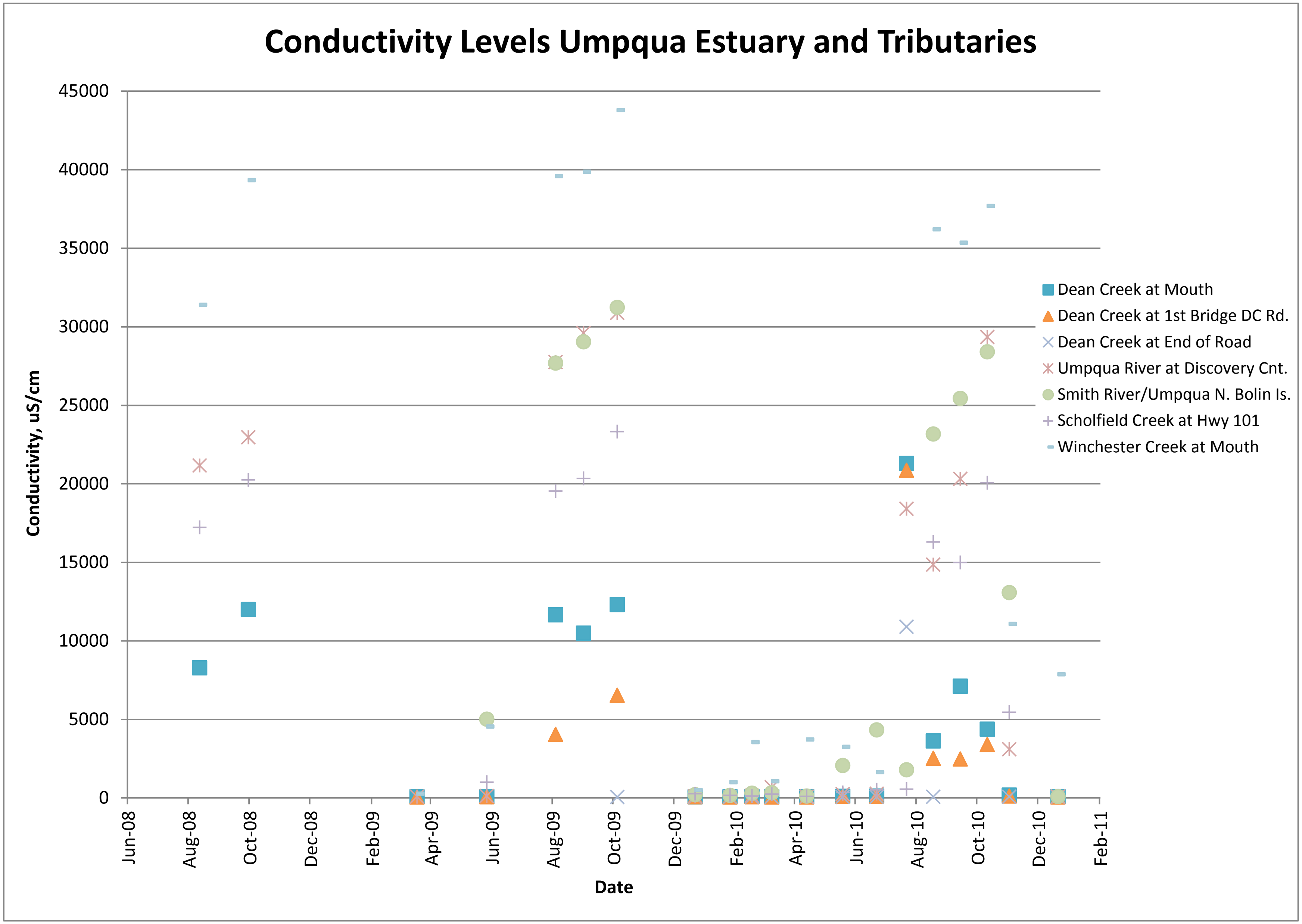


Figure 109: Conductivity levels at Umpqua estuary and tributary monitoring sites

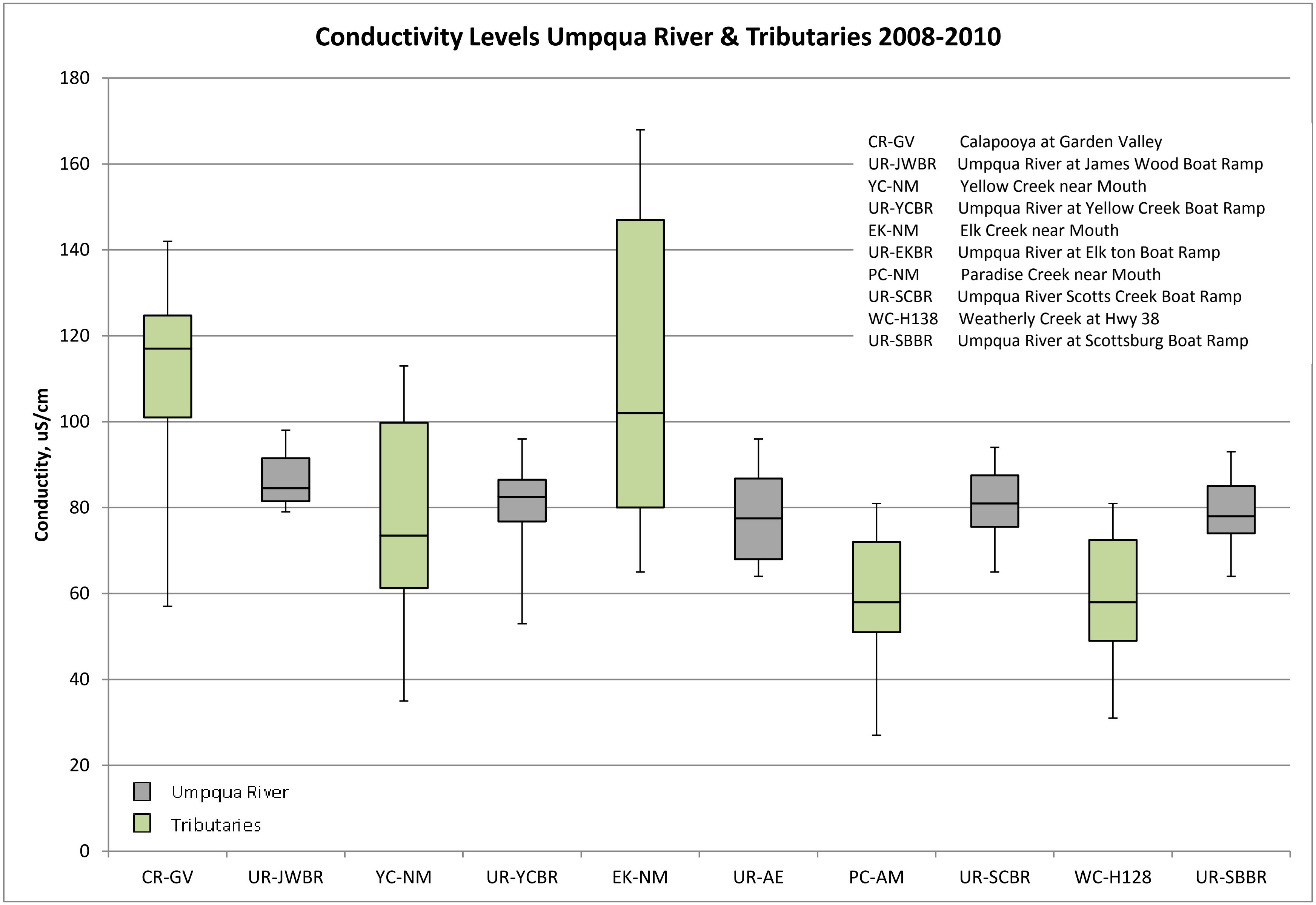


Figure 110: Conductivity levels at Umpqua River and tributary monitoring sites 2008-2010

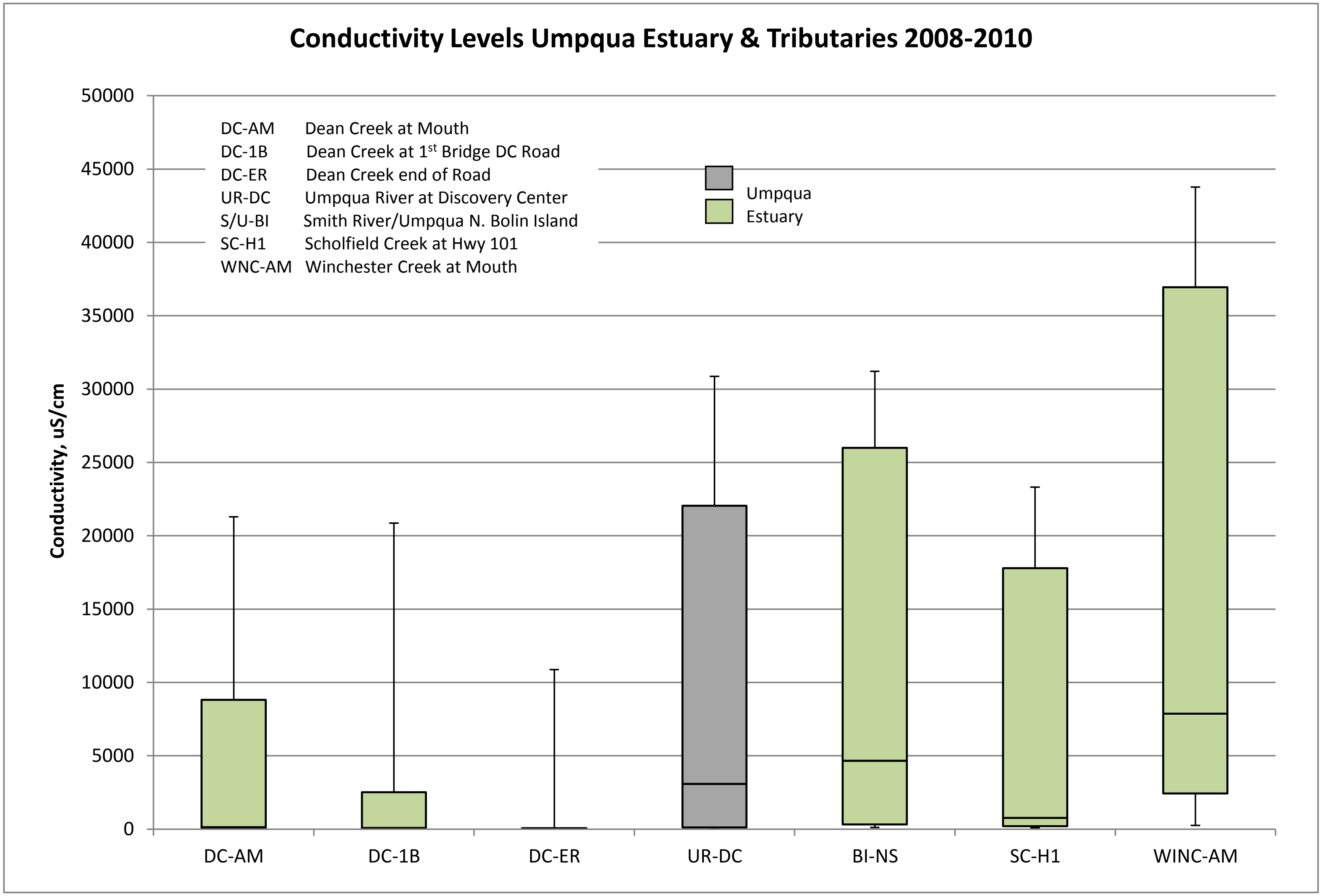


Figure 111: Conductivity levels at Umpqua Estuary and tributary monitoring sites 2008-2010

RESULTS - Umpqua Area

E. coli Bacteria

The Calapooya Creek site was the only site to exceed DEQ crieteria of 406 MPN/100ml in both summer and winter. Weatherly Creek, Scholfield Creek and the site at Bolin Island were the only other sites to have exceedances of the DEQ criteria at either time periods. Weatherly Creek had the greatest number of high readings, see Figure 113. There were a number of exceedances of the EPA criteria of 235 MPN/100ml, see Table 43 for a summary of all site ratings. Any sites that registered an elevated conductivity reading in the estuary area were diluted 1:10 during the *E. coli* analysis to prevent false positives, and the result corrected by multiplying by 10.

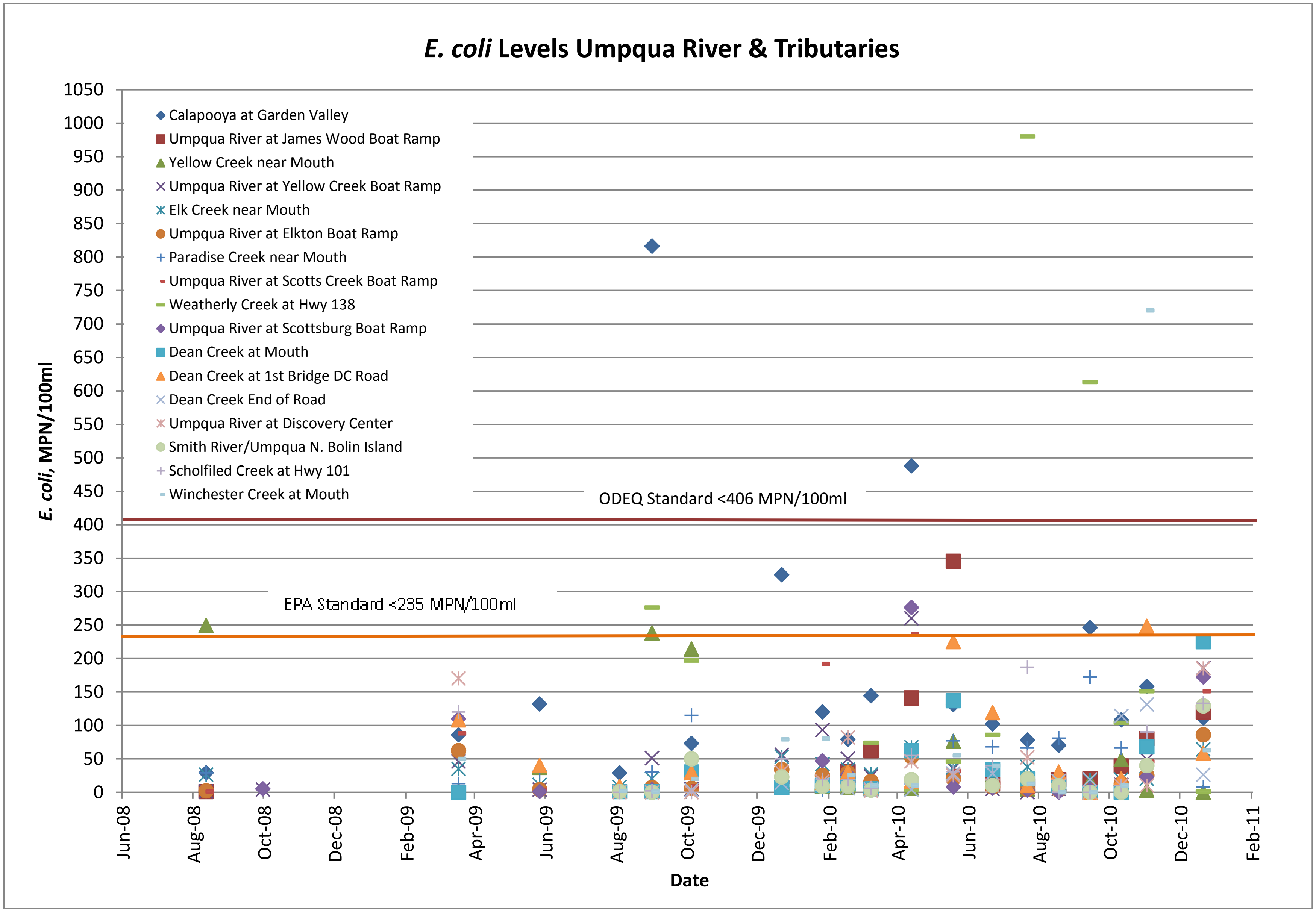


Figure 112: *E. coli* levels at Umpqua River, Estuary and tributary monitoring sites

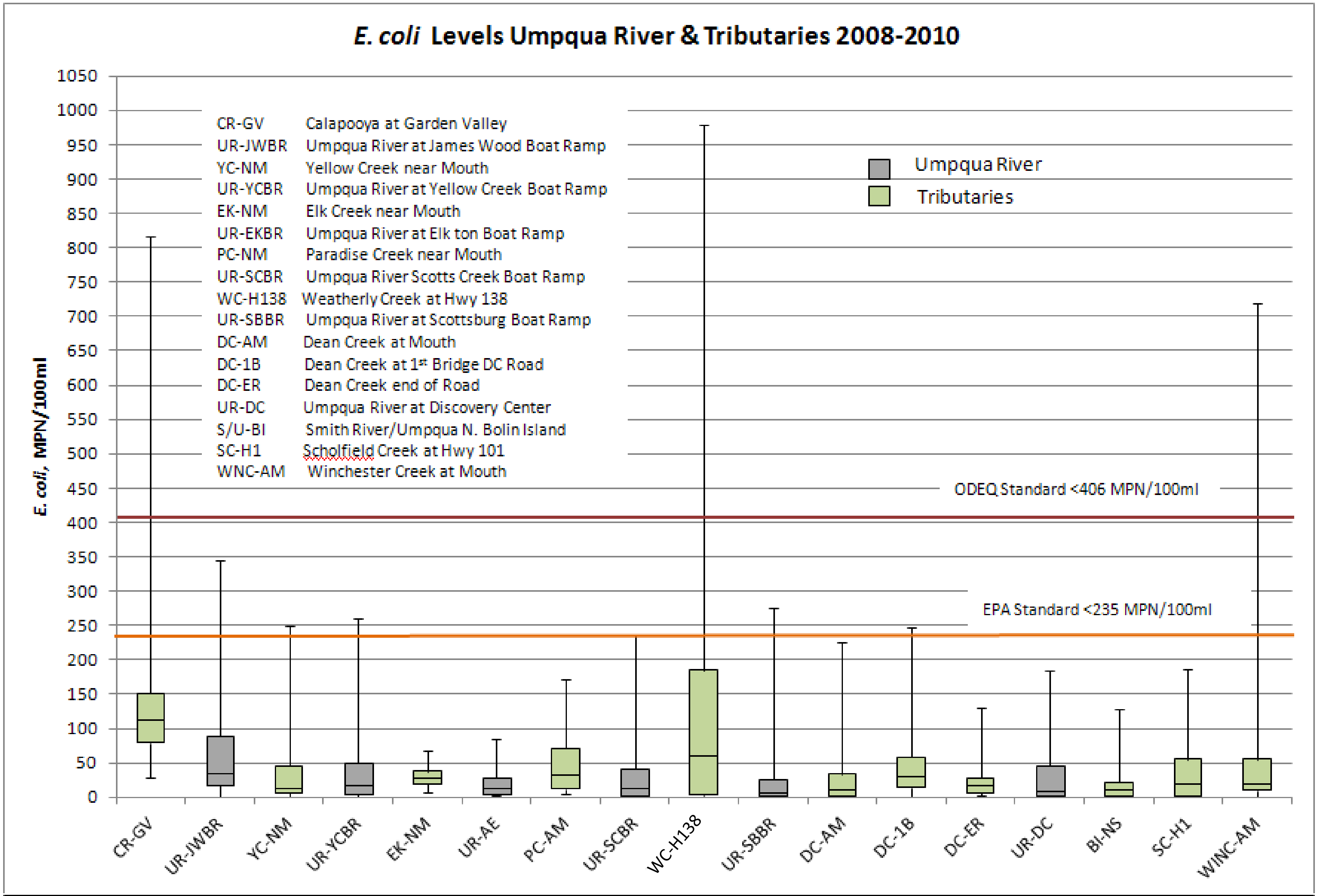


Figure 113: ***E. coli*** **levels at Umpqua River, Estuary and tributary monitoring sites 2008-2010**

E. coli Ratings for Monitoring Sites in the Umpqua Area

Site	Summer				Winter			
	# Samples	% Above EPA Criteria (235 MPN/100ml)	% Above DEQ Criteria (406 MPN/100ml)	Rating	# Samples	% Above EPA Criteria (235 MPN/100ml)	% Above DEQ Criteria (406 MPN/100ml)	Rating
Calapooya River at Garden Valley	7	29	14		12	17	8	
Umpqua River at Mac Brown Park	5	0	0		7	14	0	
Yellow Creek	6	33	0		12	0	0	
Umpqua River at Yellow Cr Boat Ramp	9	0	0		12	8	0	
Elk Creek at Elkton	7	0	0		12	0	0	
Umpqua River at Elkton	6	0	0		12	0	0	
Paradise Creek at mouth	6	0	0		12	0	0	
Umpqua River at Scott Boat Ramp	6	0	0		12	8	0	
Weatherly Creek at Highway 38 Bridge	4	75	50		14	0	0	
Umpqua River at Scottsburg Boat Ramp	7	0	0		11	9	0	
Dean Creek at mouth	6	0	0		11	0	0	
Dean Creek 1st bridge up Dean Creek Rd.	5	0	0		12	8	0	
Dean Creek at end of road	4	0	0		10	0	0	
Umpqua River at Discovery Center	6	0	0		11	0	0	
Bolin Island at boat ramp	6	0	0		10	10	10	
Schofield Creek at Highway 101	6	0	0		11	0	0	
Winchester Creek at mouth	6	0	0		11	9	9	

Table 43: Rating of Umpqua area monitoring sites for *E. coli* levels.

Rating	Color	*E. coli* MPN/100ml
Good		<100
Fairly Good		>100<235
Concern		>235<406
Needs Improvement		> 406

RESULTS Umpqua Area

Continuous Temperature

PUR monitored fifteen continuous stream temperature sites in the Umpqua area between 2008 and 2010. Dates of continuous summer stream temperature monitoring in the Umpqua area, seasonal maximum and minimum stream temperatures, diurnal fluctuations, 7-day average maximum (7DAM) stream temperatures, and days above the ODEQ criteria (ODEQ, 2003) and (ODEQ, 2011, p. 46) are listed in Appendix K. All streams in the Umpqua area fall into the designated fish use of salmon and trout rearing and migration (ODEQ, 2003) and therefore the 7DAM stream temperatures may not exceed 64.4°F (ODEQ, 2011, p. 46). The 7DAM stream temperatures for the streams monitored in the Umpqua area during this study (2008-2010) ranged from 60.8°F to 80.4°F, all but two sites exceeding the ODEQ criteria (Appendix K). Charlotte Creek near Mouth in 2008 had a 7DAM stream temperature of 60.8°F which was recorded in a pool that was maintained by hyporheic flow when the creek no longer had surface flow. Dean Creek at Furthest Upstream Bridge in 2009 and 2010 had 7DAM stream temperatures of 63.1°F, both years. This site is 3.2 miles from the mouth, and has no tidal influence. The Umpqua area is the only one of the four areas in this analysis to have streams that did not exceed the ODEQ criteria (Appendix K). All streams in the Umpqua Area are shown on the map on Figure 114.

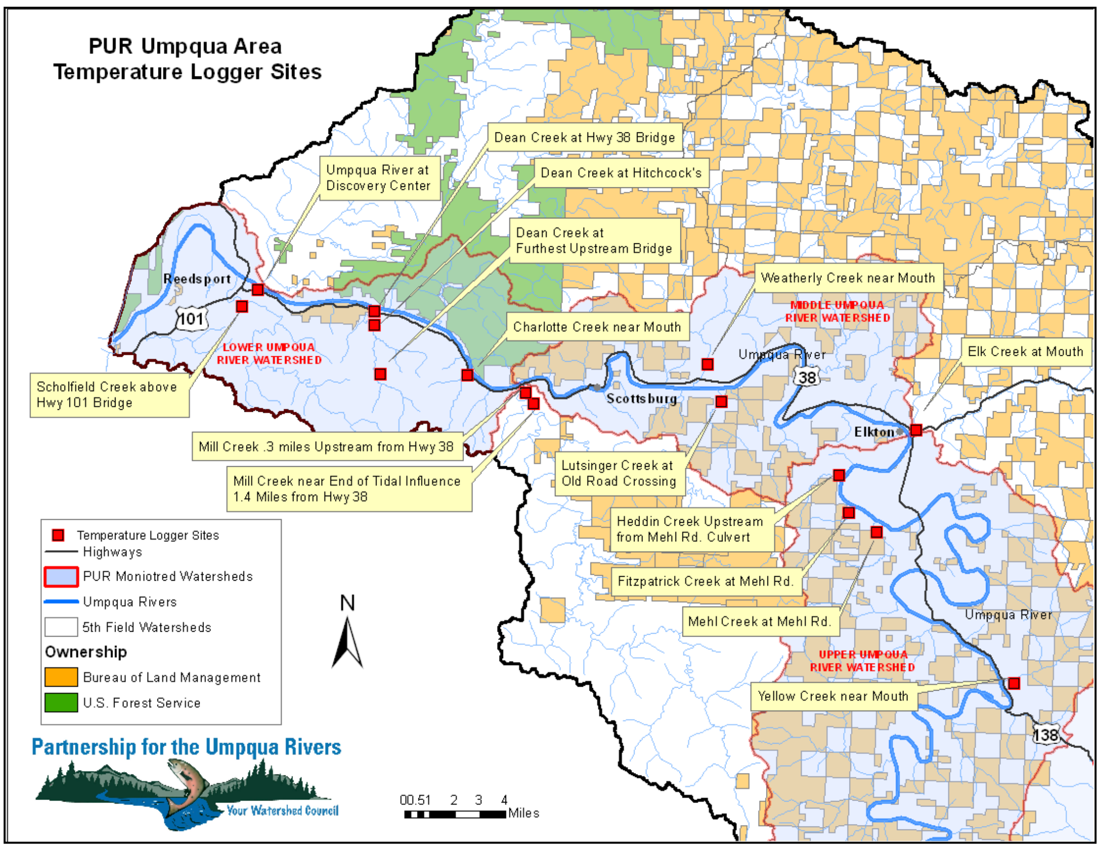


Figure 114: Umpqua area continuous summer temperature sites for 2008-2010.

As with the other three areas, some monitoring sites in the Umpqua area exceeded the potentially lethal temperatures Bell (1990, p. 11.4) found for steelhead and cutthroat trout (75.0°F and 73.0°F respectively). Almost half of the sites monitored exceeded these lethal temperatures for steelhead and cutthroat at least one year (Appendix K). Some sites even exceeded the lethal stream temperatures Brett (1952, pg. 282-3) found for young coho and Chinook salmon, acclimated to 70°F, of ≥78.8°F (Table 44). Brett (1952, pp. 282-283) found 50% mortality at this temperature after 16.7 hours.

However, of those Umpqua area sites that were ≥78.8°F, they were only that temperature for up to nine hours with a minimum temperature on the date of maximum stream temperature ranging from 67.7°F to 70.5°F (Table 44). Though the temperatures of these sites may be above the lethal limit, and that may be occurring more than one day, it was ≤3.5 hours per day (Table 44), meaning that it is unlikely that reaching these lethal temperatures would kill fish, but would instead result in metabolic stress and increased possibility of diseases. Also, unlike in laboratory conditions, these fish have the ability to move out of the areas of high temperature, either upstream or to cooler areas nearby. Pools in streams can be cooler than surface waters and create cool water refuges for fish (Bilby, 1984, p. 593).

Table 44: Seasonal maximum stream temperatures for Umpqua area sites that meet or exceed 78.8°F, which has been described at the lethal limit for young coho and Chinook salmon acclimated to 70°F (measured as 50% mortality after 16.7 hours) (Brett, 1952, p. 282).

Site	Year	Seasonal Maximum Stream Temperature (SMST) (°F)	Hours ≥78.8°F on Date of SMST	Minimum Temperature on Date of SMST (°F)
Dean Creek at Hitchcock’s	2008	79.7	3.5	67.7
Yellow Creek near Mouth	2009	81.0	2.5	70.5
Elk Creek near Mouth	2010	79.3	2	69.7

Because the Umpqua River is tidally influenced many miles upstream from the ocean, the Umpqua River site along that zone and some of the tributary sites are tidally influenced as well. Tidal influence can bring cooler ocean water upstream and “back up” downstream river water, resulting in changes to stream temperature that do not follow the typical diurnal fluctuation patterns. Sites that are minimally tidal influenced may have some dips in temperature depending on the timing of the tides. Sites that are strongly tidal influenced will have two peaks and two minimum stream temperatures each day.

In the Umpqua area, there are fairly consistent continuous stream temperature data annually from July 24 to September 21. However, there are two sites that had shorter monitoring periods in 2009. In 2009, the Umpqua River at Discovery Center was only monitored from August 5 to August 31, and Dean Creek at Furthest Upstream Bridge began monitoring on August 5. The percent of days that the temperature exceeded ODEQ’s 64.4°F criteria within the time period of July 24 to September 21 is shown on Table 45, as well as the years monitored and if the site is tidally influenced. This data was not mapped, since 15 sites were only monitored one year, and due to annual variability, the temperatures may not be indicative of overall conditions. For instance, the Umpqua Basin Stream Characterization Project which has stream temperature references sites since 1998, found that 2008 tended to have some of the coolest 7DAM stream temperatures for the period of record, 2009 some of the warmest, and 2010 was more typical (Appendix F). Since water temperature in the upper 60's is a stressor to salmonids (Bjornn & Reiser, 1991, p. 84) and (The Oregon Plan for Salmon and Watersheds, 1999, pp. 6-1), the percentage of days from July 24 to September 21 above 68°F was also shown (Table 45).

The two downstream Dean Creek sites exceeded the 64.4°F temperature criteria 100% of the time. Interestingly, those two sites are also tidally influenced. The upstream site, Dean Creek at Furthest Upstream Bridge, which is out of tidal influence, exceeded the criteria 1% of the days. For Dean Creek, stream warming conditions out-weighed the tidal influence. The two downstream Dean Creek sites were above 68°F for 81-90% of the days and the upstream site never exceeded 68°F (Table 45).

Elk Creek near Mouth, the lower Mill Creek site and both Umpqua River sites exceeded ODEQ's 64.4°F criteria 100% of the time and were above 68°F the majority of the days as well (Table 45). The listed range of days for the Umpqua River at Discovery Center site is due to the small data set. By comparing existing data in the small data set to similarly behaving sites, and to 2010 data at that site, the whole data set could be extrapolated. Scholfield Creek, the upper Mill Creek site, and Yellow Creek near mouth have between 80-95% of the days exceeding the criteria (Table 45). The sites on Fitzpatrick Creek, Heddin Creek, Lutsinger Creek, Mehl Creek, and Weatherly Creek all had 20-30% of the days exceed the criteria and ≤10% of the days greater than 68°F (Table 45). As previously mentioned, Charlotte Creek was the coolest site that had no days exceeding the criteria.

Three sites monitored exceeded lethal temperatures for young coho and Chinook salmon. However, none also exceeded the hours above the criteria to reach 50% mortality as measured in lab studies (Brett, 1952, pp. 252-3). Due to short time period that the temperature was exceeded, it is unlikely that reaching these lethal temperatures would kill the fish directly, but may result in metabolic stress and an increased likelihood of diseases.

Some sites that were tidally influenced had large numbers of days exceeding ODEQ's 64.4°F temperature criteria and some that were not tidally influenced had the same. Other factors seemed to have a stronger influence on whether the criterion was exceeded, such as miles to divide (from Figure 114) and anthropogenic influences. The Umpqua River sites had some of the highest 7DAM stream temperatures and highest percentage of days exceeding the criteria, but were also the furthest from the divide.

While any project to maintain or decrease stream temperature throughout the analysis area is recommended, there are some sites that are more worthy of projects to decrease stream temperatures due to anthropogenically influenced increases. The Scholfield Creek above Hwy 101 Bridge site, near the city of Reedsport, had a high percentage of days that exceeded the criteria. The Elk Creek near Mouth and Mill Creek sites also had very high percentage of days exceeding the criteria. Elk Creek is downstream of agricultural land. Projects upstream of the Elk Creek, Mill Creek, and Scholfield Creek sites to maintain or decrease stream temperature (riparian planting, decreasing water withdrawals, etc.) are recommended.

Table 45: Umpqua area continuous summer stream temperatures from 2008-2010. Percentage of days from 7/24 to 9/21 with stream temperatures exceeding 64.4°F, which is the criteria for streams designated salmon and trout rearing and migration use, and the percentage of days exceeding 68°F (which is a temperature that would limit salmonid migration corridor use) (DEQ, 2003 and DEQ, 2011, pg. 46). The date range of 7/24 to 9/21 is the most complete data set that encompasses the period from 2008-2010, except for two sites in 2009: Umpqua River at Discovery Center, which was monitored from August 5 to August 31 and Dean Creek at Furthest Upstream Bridge which didn't begin monitoring until August 5 of that year. This table also includes the years monitored and whether or not the site is tidally influenced.

Site	Tidally Influenced	% Days > 64.4°F	% Days > 68°F	Years Monitored 2008	2009	2010
Charlotte Creek near mouth	Some - in winter	0	0	X		
Dean Creek at Hwy 38 Bridge	Yes	100	88	X		X
Dean Creek at Hitchcocks	Yes	100	83	X		
Dean Creek at Furthest Upstream Bridge	No	1	0	X	X	X
Elk Creek near Mouth	No	100	80			X
Fitzpatrick Creek at Mehl Road	No	20	3		X	
Heddin Creek Upstream from Mehl Road Culvert	No	27	8		X	
Lutsinger Creek at Old Road Crossing	No	28	10		X	
Mehl Creek at Mehl Rd	No	25	10		X	
Mill Ck near end of Tidal Influence (1.4 Miles from Hwy 38)	Some	92	70	X		
Mill Creek 0.3 Miles Upstream from Hwy 38	Yes	100	93	X		
Scholfield Creek above Hwy 101 Bridge	Yes	95	70	X		
Umpqua River at Discovery Center	Yes	100	57-78		X	
Weatherly Creek near Mouth	No	30	10		X	
Yellow Creek near Mouth	No	80	48	X	X	

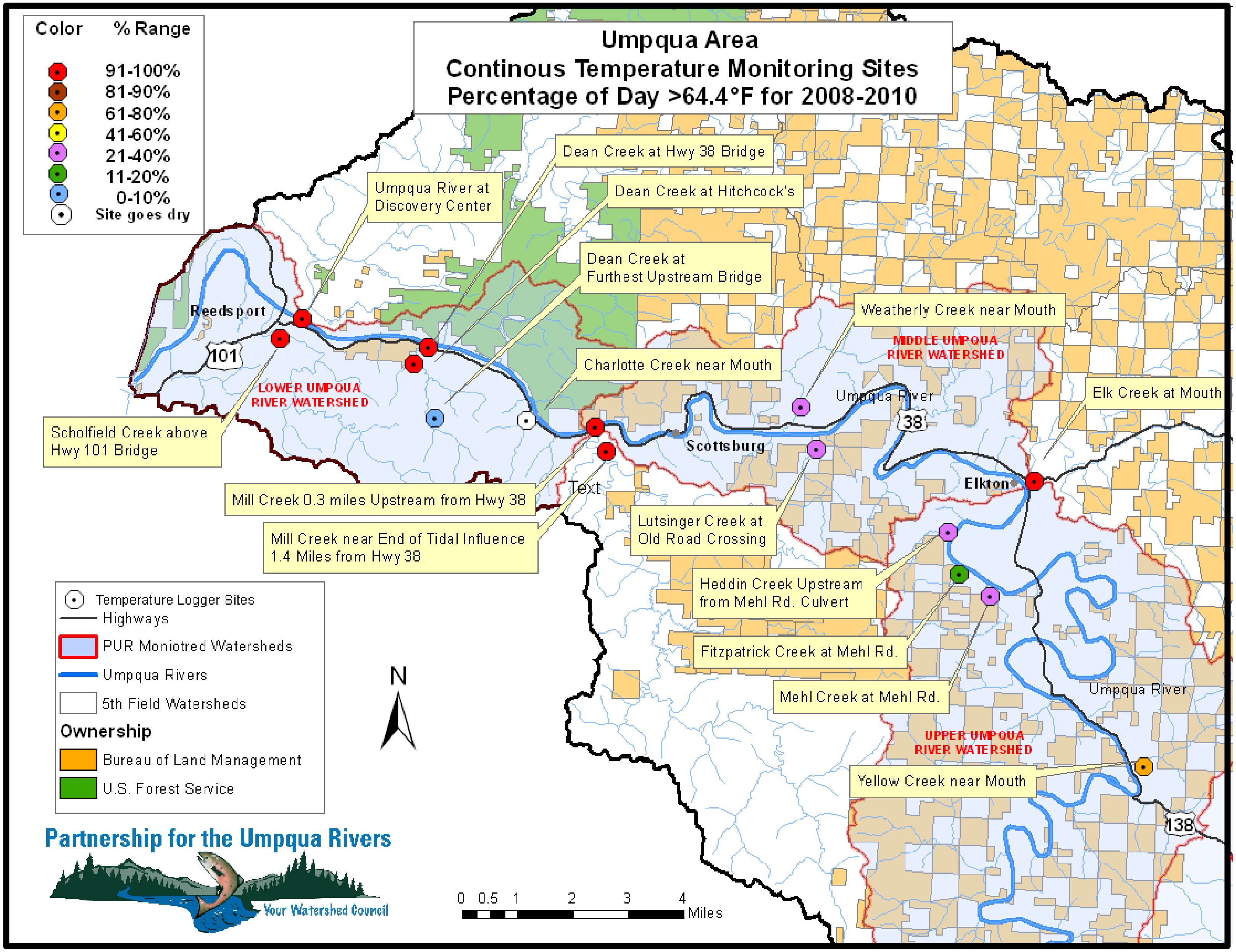


Figure 115: Umpqua area continuous temperature monitoring site percentage of days >64.4°F for 2008-2010

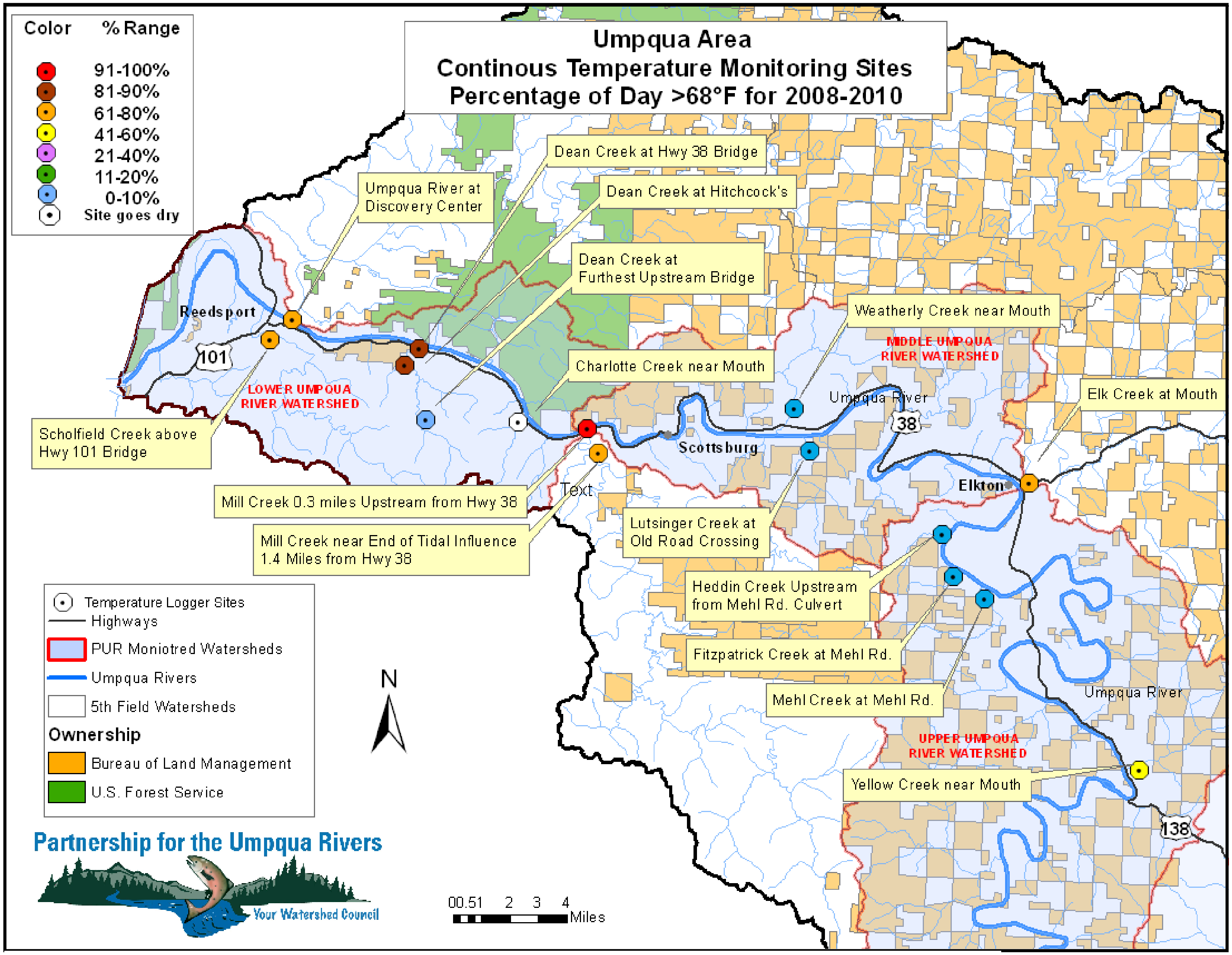


Figure 116: Umpqua area continuous temperature monitoring site percentage of days >68^{o}F for 2008-2010

RESULTS Umpqua Area

Grab Sample Temperature

Of the 17 monitoring sites in the Umpqua area, eight had continuous temperature readings recorded. Temperature was recorded at each of our grab sample monitoring events, and though this does not allow for assessment of DEQ temperature criteria, it is included here for evaluation and stream rating in order to provide additional information for the planning of restoration sites. The rating table of all sites in the Umpqua area for temperature, Table 46, indicates which evaluations were based on grab sampling or continuous monitoring (loggers). Every grab sample site had readings over 64.4^{o}F.

During the 2009 Umpqua River temperature study (Part II of this report), grab sample readings were recorded at 25 sites as we boated down the Umpqua from James Wood Boat Ramp above Wolf Creek to the Big K Ranch upstream of Elkton placing the temperature data loggers for that study. This data is presented in Part II of this report, Appendix A: 2009 PUR Supplemental Data. Of particular note were the measurements taken at the water's surface compared to the bottom of the river where the loggers were placed. Even at sites as deep as 20 feet, there were no differences intemperature, conductivity, pH, turbidity or dissolved oxygen concentrations.

Temperature Ratings for Umpqua Area Monitoring

Site	Rating
Calapooya River at Garden Valley	Grab Sample
Umpqua River at Mac Brown Park	Grab Sample
Yellow Creek	Logger
Umpqua River at Yellow Cr Boat Ramp	Grab Sample
Elk Creek at Elkton	Logger
Umpqua River at Elkton	Grab Sample
Paradise Creek at mouth	Grab Sample
Umpqua River at Scott Boat Ramp	Grab Sample
Weatherly Creek at Highway 38 Bridge	Logger
Umpqua River at Scottsburg Boat Ramp	Grab Sample
Dean Creek at mouth	Logger
Dean Creek at 1st bridge up Dean Creek Road	Logger
Dean Creek at end of road	Logger
Umpqua River at Discovery Center	Logger
Bolin Island at boat ramp	Grab Sample
Schofield Creek at Highway 101	Logger
Winchester Creek at mouth	Grab Sample
Mill Creek	Logger
Lutsinger Creek	Logger
Heddin Creek	Logger
Fitzpatrick	Logger
Mehl Creek	Logger

Rating	Color	% of Monitoring Days >64.4° F Continuous Temp	Grab Sample Temperatures Rearing and Migration°
Good		0-20	<64.4° F
Fairly Good		21-40	
Concern		41-60	
Needs Improvement		61-100	>64.4° F

Table 46: Temperature ratings for Umpqua area monitoring sites.

RESULTS Umpqua Area

Summary

Table 47 presents the summary of ratings for all six water quality parameters monitored in the Umpqua area. It is evident that this area's three worst problems are exceedances of turbidity, temperature, and dissolved oxygen criteria. *E. coli* and pH also are at concerning levels. Conductivity is the only parameter that fell within expected levels when it is considered that the estuary sites are naturally high in salinity.

Summary Rating for Umpqua Area Monitoring Sites – Six Water Quality Parameters

Site	Turbidity	pH	Dissolved Oxygen	Conductivity	*E. coli*	Temperature
Calapooya River at Garden Valley						
Umpqua River at Mac Brown Park						
Yellow Creek						
Umpqua River at Yellow Cr Boat Ramp						
Elk Creek at Elkton						
Umpqua River at Elkton						
Paradise Creek at mouth						
Umpqua River at Scott Boat Ramp						
Weatherly Creek at Highway 38 Bridge						
Umpqua River at Scottsburg Boat Ramp						
Dean Creek at mouth						
Dean Creek at 1st bridge up Dean Creek Road						
Dean Creek at end of road						
Umpqua River at Discovery Center						
Bolin Island at boat ramp						
Schofield Creek at Highway 101						
Winchester Creek at mouth						

Table 47: Summary rating for Umpqua area monitoring sites – six water quality parameters

RESULTS Umpqua Area
Spotlight Dean Creek Restoration

Another PUR project area that was monitored prior to, and continued after, restoration projects were completed, was in the Dean Creek area, a tributary of the Umpqua Estuary. Wetland restoration occurred in 2009, large logs were anchored in the lower part of Dean Creek, and spruce trees were then planted into the logs. Logs were placed instream in the upper part of Dean Creek in the Elliott Forest in two phases, first in 2009 and further upstream in 2010. Monitoring was not originally planned for project effectiveness, but interesting tidal influences were observed when the data was analyzed. No changes were detected as a result of restoration efforts, as all parameters had values that seemed to display only annual variability.

In analyzing the data it became evident that it would be impossible to compare pre/post data in the wetlands due to tidal effects. Photos 16 and 17 demonstrate the range of tidal effects that occur near the mouth of Dean Creek. River temperature, high tide, low tide, moon phase, time of day, and annual weather variability will all affect readings in this area. Figure 118 shows the two lower sites on Dean Creek are being influenced by tidal water in different ways. The Camp Creek reference site displays a typical non-tidally influenced stream in this area, at the same time period. Dean Creek at the furthest upstream bridge represents the temperature exiting the Elliott Forest. Figure 119 is expanded to show the effects of day and night time, in addition to tidal influence. Figure 120 is a comparison of the continuous temperature readings of the Umpqua at the Discovery Center in Reedsport compared to the site at the mouth of Deans Creek which is approximately 5 miles upstream. The final figure, Figure 121, displays a year of continuous monitoring at the mouth of Dean Creek, indicating a range of temperatures from 37 to 79^{o}F for 2008. All of these graphs indicate how temperature (and therefore many of the other water quality parameters) are intertwined and influenced by many factors in tidally influenced settings.

Photo 15:
Dean Creek
Wetlands
11/19/09

Photo 16:
Dean Creek
Bridge at Mouth
5/27/09

Photo 17:
Dean Creek Upstream of
Bridge at Mouth
8/4/09

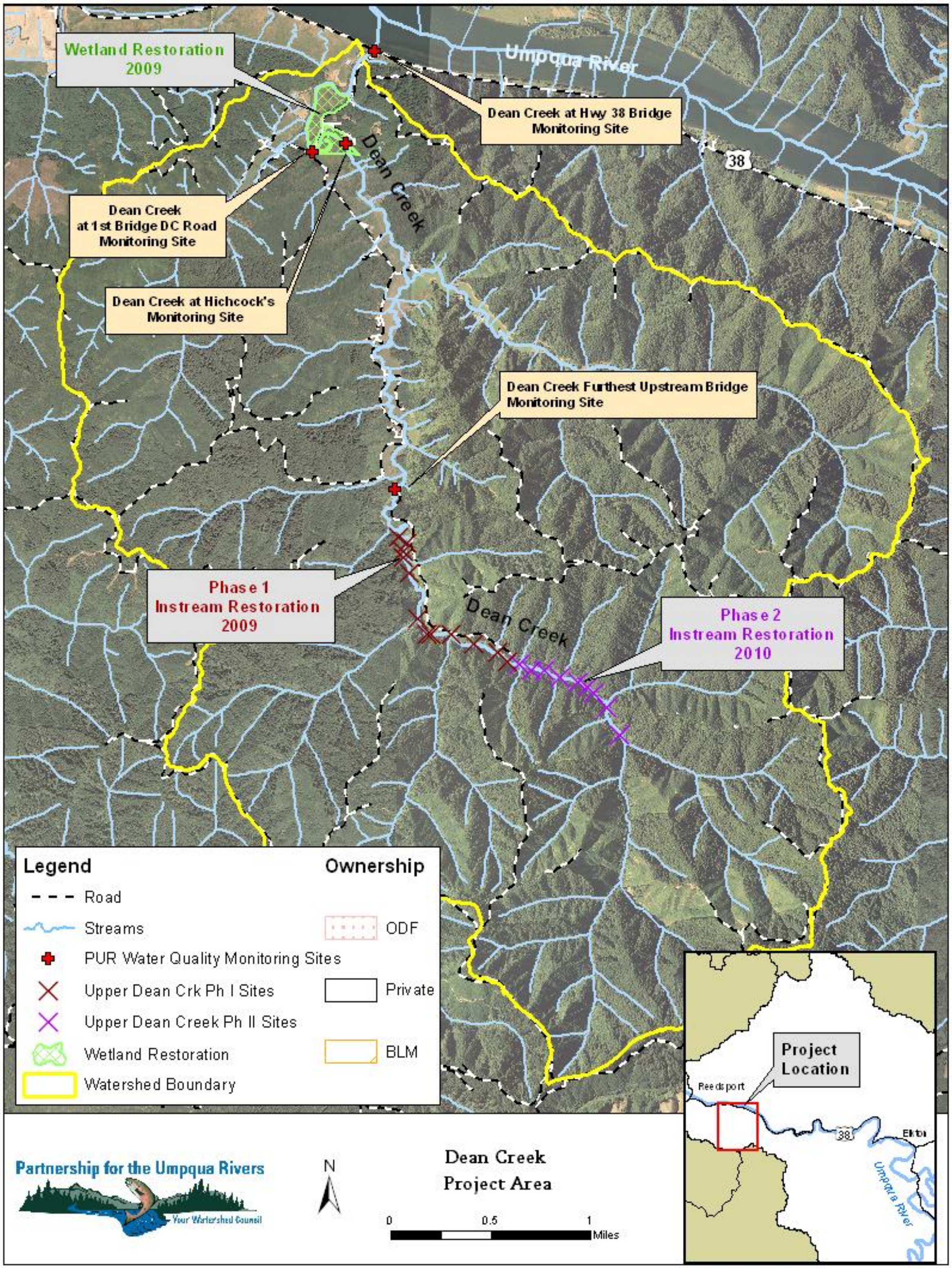


Figure 117: Map of Dean Creek project area.

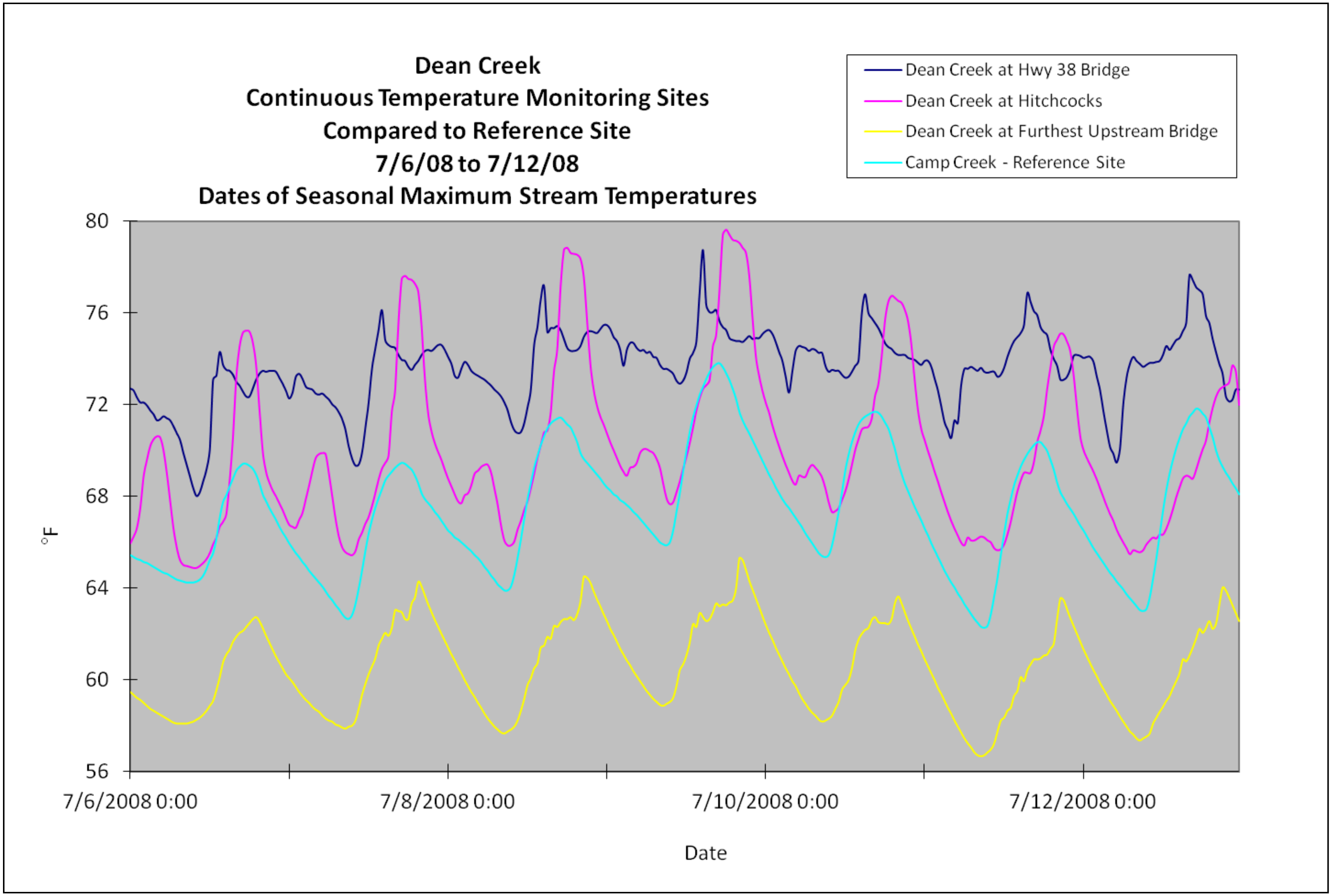


Figure 118: Data from continuous temperature loggers at three Dean Creek sites and a nearby reference site for 7/6/08 to 7/12/08, the dates of seasonal maximum stream temperature that year.

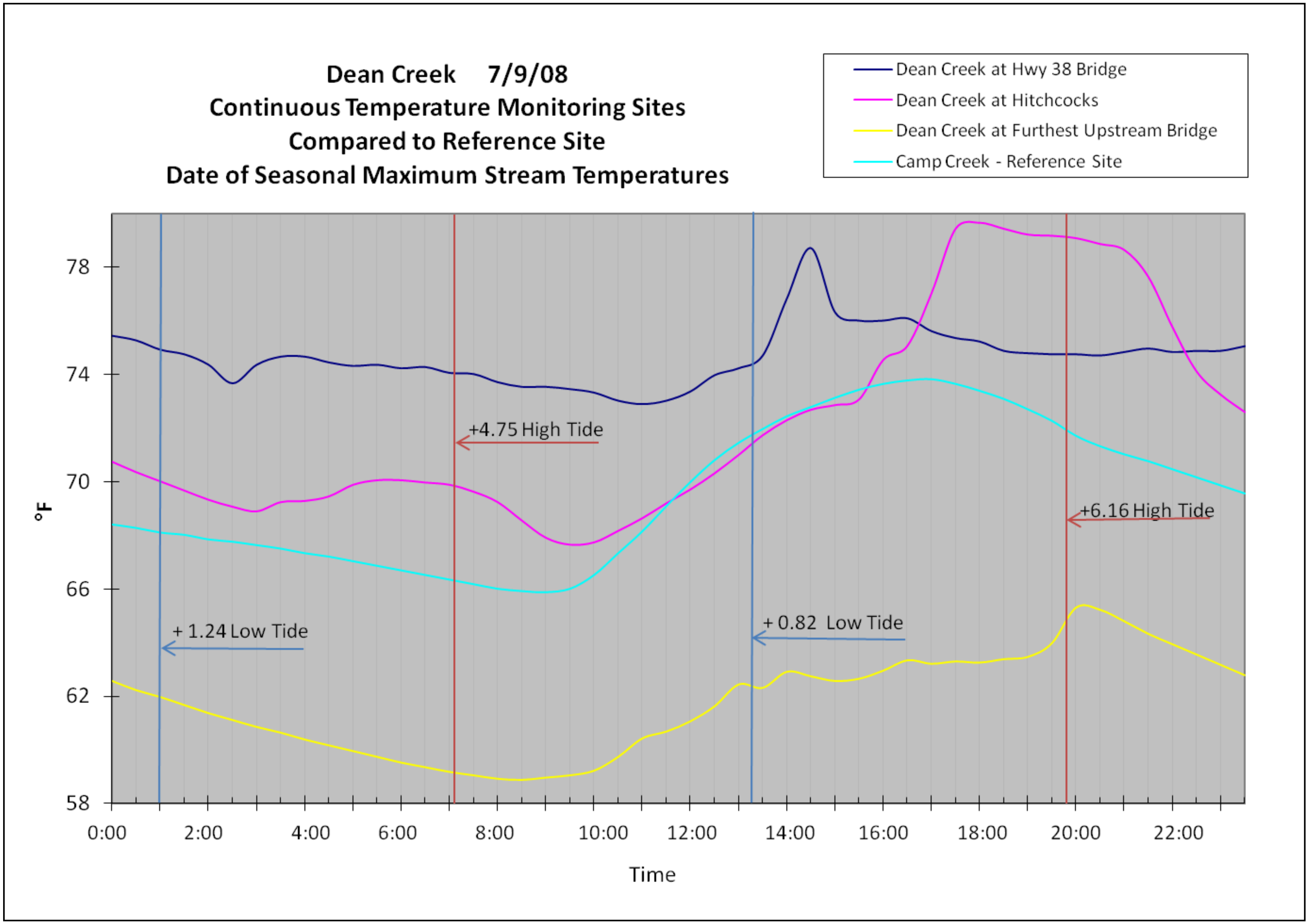


Figure 119: Data from continuous temperature loggers at three Dean Creek sites and a nearby reference site for 7/9/08 the date of seasonal maximum stream temperatures.

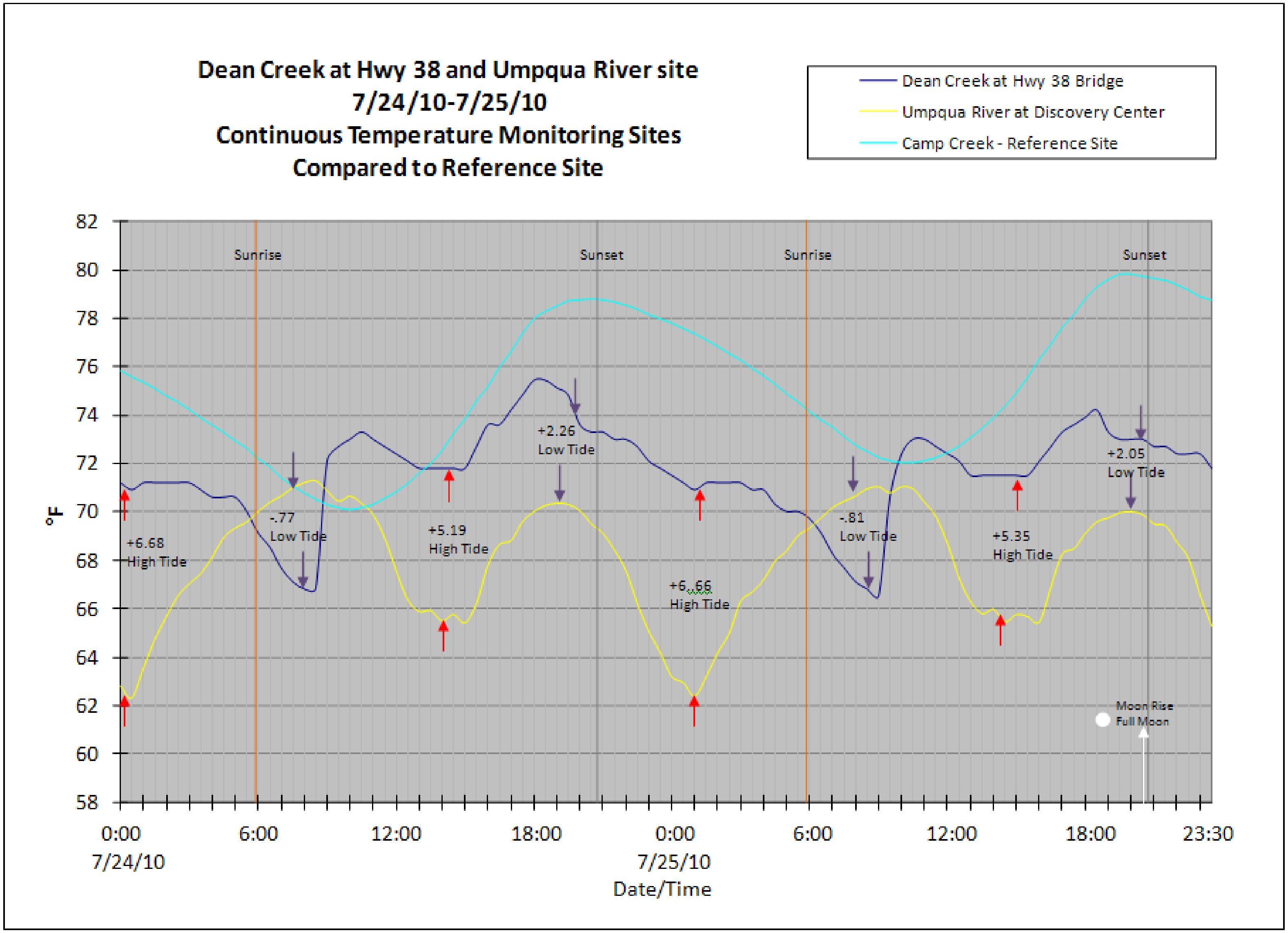


Figure 120: Data from continuous temperature loggers: Dean Creek at Highway 138, Umpqua River at Discover Center and a nearby reference site for 7/24/08 to 7/25/08.

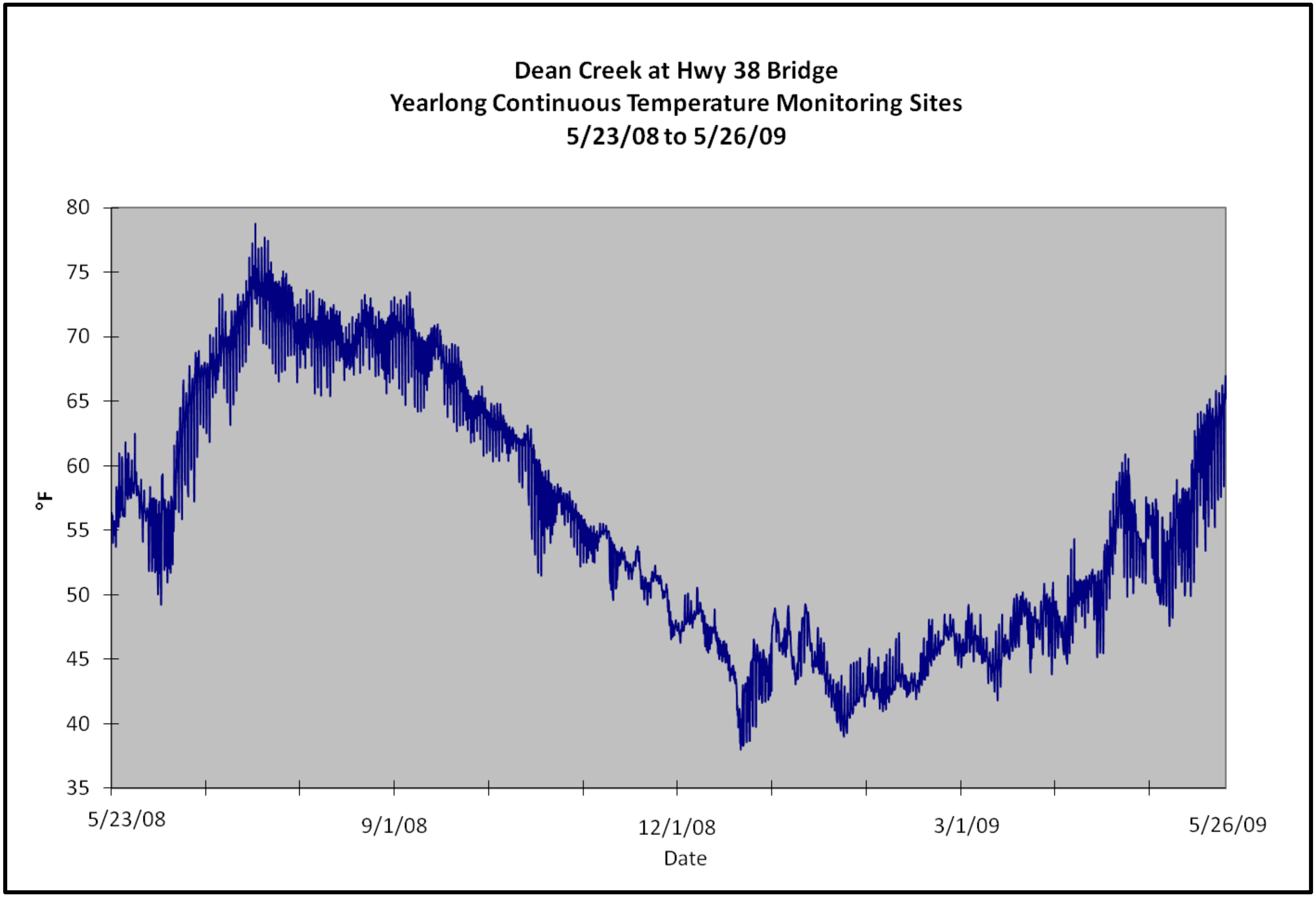


Figure 121: Yearlong continuous temperature monitoring at the mouth of Dean Creek.

ACRONYMS

- ODEQ: Oregon Department of Environmental Quality
- DO: Dissolved Oxygen
- EPA: Environmental Protection Agency
- NTU: Nephelometric Turbidity Units
- OWEB: Oregon Watershed Enhancement Board
- PUR: Partnership for the Umpqua Rivers
- QAPP: Quality Assurance Project Plan
- RAC: Secure Rural Schools and Self-Determination Act of 2000 (Public law 110-343)
- UBWC: Umpqua Basin Watershed Council

Bibliography

Turbidity Rulemaking Fact Sheet. (2010, July 1). Retrieved from Oregon Department of Environmental Quality: http://www.deq.state.or.us/wq/pubs/factsheets/standards/TurbidityRuleFS10WQ006.pdf

Water Quality Standards. (2010). Retrieved April 23, 2012, from Oregon Department of Environmental Quality: http://www.deq.state.or.us/wq/standards/turbidity.htm#cur

Barnes & Associates, Inc. (2007). *Umpqua Basin Action Plan June 2007.* Roseburg: Partnership for the Umpqua Rivers.

Bash, J. B. (2001). *Effects of Turbidity and Suspended Solids on Salmonids.* Seattle: Center for Streamside Studies, University of Washington.

Bell, M. (1990). *Fisheries Handbook of Engineering Requirements and Biological Criteria.* Portland: U.S. army Corps of Engineers, Office of the Chief of Engineers, Fish Passage Development and Evaluation Program.

Bilby, R. E. (1984). Characteristicsw and frequency of cool-water areas in a Western Washington stream. *Journal of Freshwater Ecology*, 593-602.

Bjornn, T. a. (1991). *Influence of Forest and Rangeland Management on Salmonid Fishes and Their Habitats.* Herndon: American Fisheries Society.

Bjornn, T., & Reiser, D. (1991). Habitat Requirements of Salmonids in Streams. In W. R. Meehan, *Influences of Forest and Rangeland Management on Salmonid Fishes and their Habitats.* Bethesda: American Fisheries Society Special Publication 19.

Brett, J. (1952). Temperature tolerance in young pacific salmon, Genus Oncorhynchus. *Journal of the Fisheries Research Board of Canada, 9*(6), 265-323.

Carter, K. (2008). *Effects of Temperature, Dissolved Oxygen/Total Dissolved Gas, Ammonia, and pH on Salmonids.* Santa Roas: North Coast Regional Water Quality Control Board.

Dammann, D. M. (2007). *Umpqua Basin Stream Temperature Characterization - Reference Site Update 2007.* Roseburg: Partnership for the Umpqua Rivers.

Dammann, D.M. (2008). *Umpqua Basin Stream Temperature Characterization - Reference Site Update 2008.* Roseburg: Partnership for the Umpqua Rivers.

Dammann, D.M. (2009). *Umpqua Basin Stream Temperature Characterization - Reference Site Update 2009.* Roseburg: Partnership for the Umpqua Rivers.

Dammann, D.M. (2010). *Umpqua Basin Stream Temperature Characterization - Reference Site Update 2010.* Roseburg: Partnership for the Umpqua Rivers.

Dammann, D.M. (2011). *Umpqua Basin Stream Temperature Characterization - Reference Site Update 2011.* Roseburg: Partnership for the Umpqua Rivers.

Dammann, D.M. and K. Smith. (2006). *PUR Umpqua Basin Stream Temperature Characterization - Reference Site Update - 2006 Data.* Roseburg: Partnership for the Umpqua Rivers.

DEQ. (2005). *Draft Revised Figure 320B: Salmon and Steelhead Spawning Use Designations, Umpqua Basin, Oregon.* Portland.

DEQ. (2009). *ExampleContinuousSample.xls Workbook.* Portland: www.deq.state.or.us/wq/assessment/docs/ExampleContinuousSamplexls.

DEQ. (2010). *DEQ 2010 Data Submittal General Information.* Portland: www.deq.state.or.us.

DEQ. (2011). *Methodology for Oregon's 2010 Water Quality Report and List of Water Quality Limited Waters.* Portland: DEQ.

EPA. (1997). *Volunteer Stream Monitoring: A Methods Manual.* Washington,D.C.: United States Environmental Protection Agency.

EPA. (2012). *Water: Monitoring & Assessment.* Washington, D.C.: EPA.

Geyer, N. (2003). *Calapooya Creek Watershed Assessment and Action Plan.* Roseburg: Umpqua Basin Watershed Council.

Geyer, N. (2003). *Middle South Umpqua Watershed Assessment and Action Plan.* Roseburg: Umpqua Basin Watershed Council.

Geyer, N. (2003). *Myrtle Creek Assessment and Action Plan.* Roseburg: Umpqua Basin Watershed Council.

Geyer, N. (2003). *South Umpqua Watershed Assessment and Action Plan.* Roseburg: Umpqua Basin Watershed Council.

Geyer, N. (2003). *Tiller Region Assessment and Action Plan.* Roseburg: Umpqua Basin Watershed Council.

Green, J. (2004). *Sampling and Analysis Project Plan Calapooya Creek Bacteria Monitoring Plan DEQ-LAB-0035-SAT.* Roseburg: Umpqua Basin Watershed Council.

Lyon, S. (2004). *Quality Assurance Project Plan For the Umpqua Basin Watershed Council Volunteer Monitoring Program.* Oregon: Partnership for the Umpqua Rivers.

Lyon, S. (2005). *2005 Addendum to Quality Assurance Project Plan For the Umpqua Basin Watershed Council Volunteer Monitoring Program September 3, 2004 DEQ-04-WQ-0041-QAPP & Sampling and Analysis Project Plan Project Name: Calapooya Creek Bacteria Monitoring Plan June 2004.* Roseburg: Umpqua Basin Watershed Council.

Montgomery, D. R., Collins, B. D., Buffington, J. M., & Abbe, T. B. (2003). Geomorphic Effects of Wood in Rivers. In S. Gregory, K. Boyer, & A. Gurnell, *Teh Ecology and Management of Wood in World Rivers.* Bethesda: American Fisheries Society, Symposium 37.

Murphy, M., & Meehan, W. (1991). Stream Ecosystems. In W. R. Meehan, *Influences of Forest and Rangeland Management on Salmonid Fishes and their Habitats.* Bethesda: American Fisheries Society Publication 19.

Nielsen, J. L., Lisle, T. E., & Ozaki, V. (1994). Thermally stratified pools and their use by steelhead in Northern California streams. *Transactions of the American Fisheries Society, 123*, 613-626.

Nimick, D. A., Gammons, C. H., & and Parker, S. R. (2011). Diel biogeochmeical processes and their effect on the aqueous chemistry of streams: A review. *Chemical Geology*, 3-17.

ODEQ. (2003). *Figure 320A: Fish Use Designations, Umpqua Basin, Oregon.* Portland.

ODEQ. (2005). *Draft Revised Figure 320B: Salmon and Steelhead Spawning Use Designations, Umpqua Basin, Oregon.* Portland.

ODEQ. (2009). *ExampleContinuousSample.xls Workbook.* Portland: www.deq.state.or.us/wq/assessment/docs/ExampleContinuousSamplexls.

ODEQ. (2010). *DEQ 2010 Data Submittal General Information.* Portland: www.deq.state.or.us.

ODEQ. (2011). *Methodology for Oregon's 2010 Water Quality Report and List of Water Quality Limited Waters.* Portland: DEQ.

Oregon Watershed Ehanncement Board. (2008). *The Oregon Plan for Salmon and Watersheds Biennial Report 2005-2007.* Salem: Oregon Watershed Enhancement Board.

Partnership for the Umpqua Rivers. (2010). *Strategic Plan 2011-2014.* Roseburg: Partnership for the Umpqua Rivers.

Poole, G. a. (2001). An Ecological Perspective on In-stream Temperature. *Environmental mangement*, 787-802.

Quality, O. D. (2010). *Water Quality Standards*. Retrieved 7 16, 2012, from Oregon Department of Environmental Quality: http://www.deq.state.or.us/wq/standards/turbidity.htm#cur

Smith, K. (1999). *The Calapooya Creek Stream Temperature Study 1999.* Roseburg: Umpqua Basin Watershed Council.

Smith, K. (2003). *Stream Temperature in the Umpqua Basin Characteristics and Management Implications.* Roseburg: Umpqua Basin Watershed Council (now PUR).

Smith, K. (2005). *UBWC Stream Temperature Characterization Project Reference Site Update 2005 Data.* Roseburg: Umpqua Basin Watershed Council (now PUR).

The Oregon Plan for Salmon and Watersheds. (1999). *Water Quality Monitoring Technical Guide Book.* Portland: OWEB.

Yau, N. (2008, February 15). *How to Read (and Use) a Box-and-Whisker Plot.* Retrieved from FlowingData: http://flowingdata.com/2008/02/15/how-to-read-and-use-a-box-and-whisker-plot/

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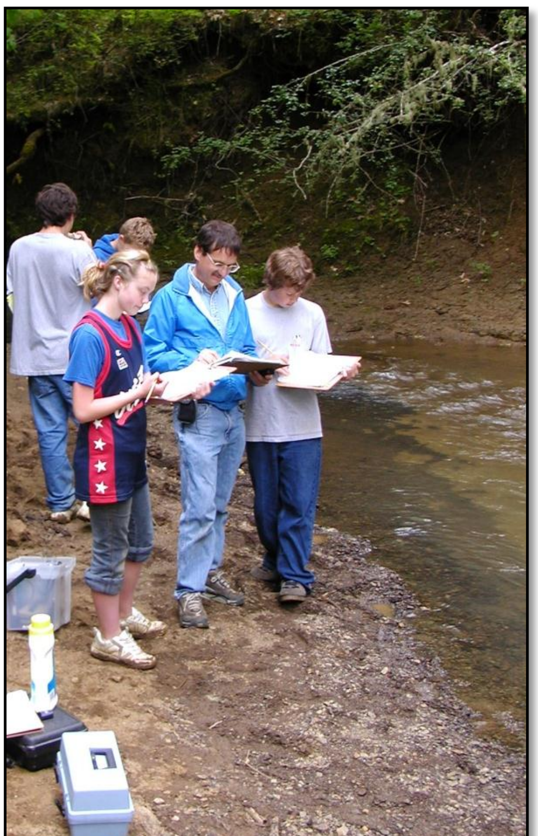


Photo # 17
David Swenson
1954-2007

Appendix A: Designated Beneficial Uses for the Umpqua Basin

Table 320A

Designated Beneficial Uses
Umpqua Basin
(340-41-0320)

Beneficial Uses	Umpqua R. Estuary to Head of Tidewater & Adjacent Marine Waters	Umpqua R. Main from Head of Tidewater to Confluence of N. & S. Umpqua Rivers	North Umpqua River Main Stem	South Umpqua River Main Stem	All Other Tributaries to Umpqua, North & South Umpqua Rivers
Public Domestic Water Supply[1]		X	X	X	X
Private Domestic Water Supply[1]		X	X	X	X
Industrial Water Supply	X	X	X	X	X
Irrigation		X	X	X	X
Livestock Watering		X	X	X	X
Fish & Aquatic Life[2]	X	X	X	X	X
Wildlife & Hunting	X	X	X	X	X
Fishing	X	X	X	X	X
Boating	X	X	X	X	X
Water Contact Recreation	X	X	X	X	X
Aesthetic Quality	X	X	X	X	X
Hydro Power			X	X	X
Commercial Navigation & Transportation	X				

[1] With adequate pretreatment (filtration & disinfection) and natural quality to meet drinking water standards.

[2] See also Figures 320A and 320B for fish use designations for this basin.

Table produced November, 2003

Appendix B: ODEQ Current Turbidity Rule

Turbidity Rule (OAR 340-041-0036) (Water Quality Standards, 2010)

Turbidity (Nephelometric Turbidity Units, NTU): No more than a ten percent cumulative increase in natural stream turbidities may be allowed, as measured relative to a control point immediately upstream of the turbidity causing activity. However, limited duration activities necessary to address an emergency or to accommodate essential dredging, construction or other legitimate activities and which cause the standard to be exceeded may be authorized provided all practicable turbidity control techniques have been applied and one of the following has been granted:

1. Emergency activities: Approval coordinated by the Department with the Oregon Department of Fish and Wildlife under conditions they may prescribe to accommodate response to emergencies or to protect public health and welfare;
2. Dredging, Construction or other Legitimate Activities: Permit or certification authorized under terms of section 401 or 404 (Permits and Licenses, Federal Water Pollution Control Act) or OAR 14l-085-0100 et seq. (Removal and Fill Permits, Division of State Lands), with limitations and conditions governing the activity set forth in the permit or certificate.

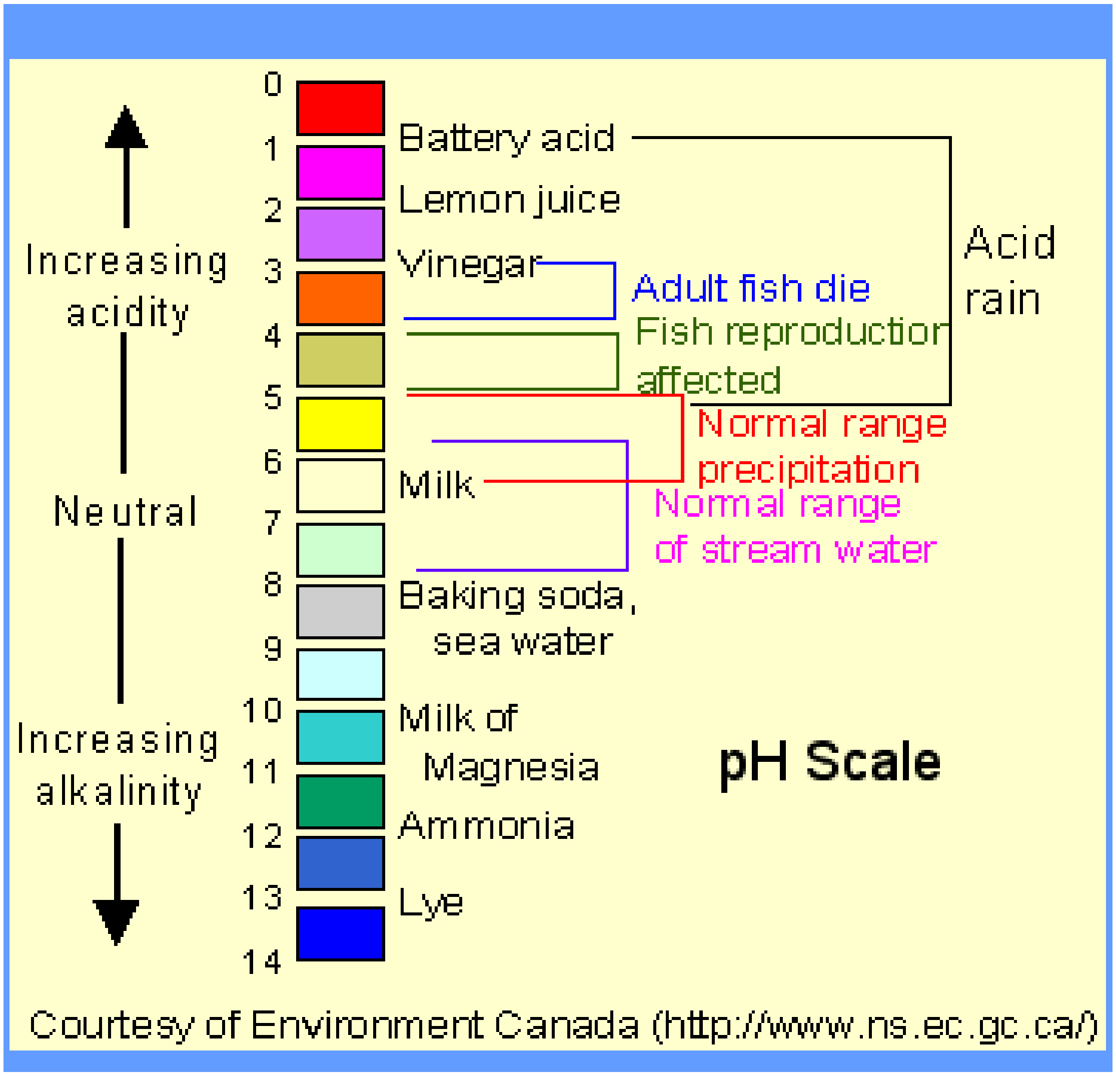
Appendix C: British Columbia Turbidity and Suspended Sediment Standards Taken from Bash, 2001, p. 70.

Table C-3. British Columbia turbidity and suspended sediment standards

Water Use	Maximum Induced Turbidity – NTU or % of background	Maximum Induced Suspended Sediments –mg/l or % of background	Streambed Substrate Composition
Drinking Water – raw untreated	1 NTU when background is less than or equal to 5	No guideline	No guideline
Drinking Water – raw treated	5 NTU when background is less than or equal to 50	No guideline	No guideline
Recreation and Aesthetics	Maximum 50 NTU ….. secchi disc visible at 1.2 m	No guideline	No guideline
Aquatic Life -fresh- -marine- -estuarine-	8 NTU in 24 hours when background is less than or equal to 8 …. Mean of 2 NTU in 30 days when background is less than or equal to 8	25 mg/l in 24 hours when background is less than or equal to 25 …. Mean of 5 mg/l in 30 days when background is less than or equal to 25	Fines not to exceed -10% as less than 2mm- -19% as less than 3mm- -25% as less than 6.35mm- at salmonid spawning sites
Aquatic Life -fresh- -marine- -estuarine-	8 NTU when background is between 8 and 80 …. 10% when background is greater than or equal to 80	25 mg/l when background is between 25 and 250 …. 10% when background is greater than or equal to 250	Geometric mean diameter not less than 12 mm …. Fredle number not less than 5mm
Terrestrial Life -wildlife- -livestock water- Irrigation Industrial	10 NTU when background is less than or equal to 50 …. 20% when background is greater than or equal to 50	20 mg/l when background is less than or equal to 100 …. 20% when background is greater than or equal to 100	No guideline

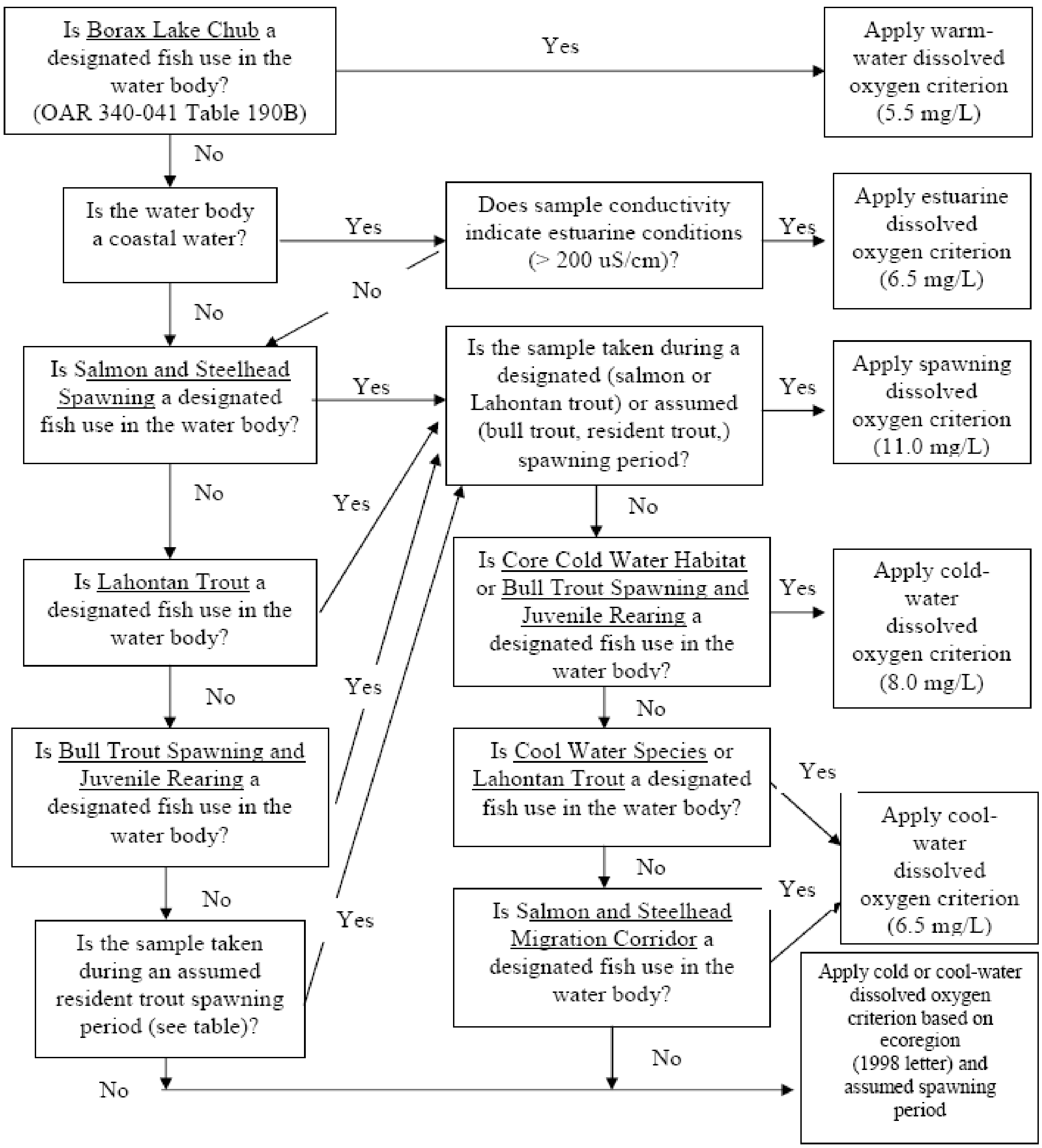
(Web Site Ref. #2)

Appendix D: pH Scale



Appendix E: Dissolved Oxygen Evaluation Flow Chart

Flow Chart illustrating the evaluation process for dissolved oxygen data collected from Oregon water bodies (Assessment Methodology for Oregon's 2004/2006 Integreated Report on Water Quality Status – ODEQ Water Quality Division)



Appendix F: Annual 7 Day Average Maximum Stream Temperature for Umpqua Basin Stream Characterization Project Reference Sites from 1998-2011 (Dammann, D.M., 2011, p. 2).

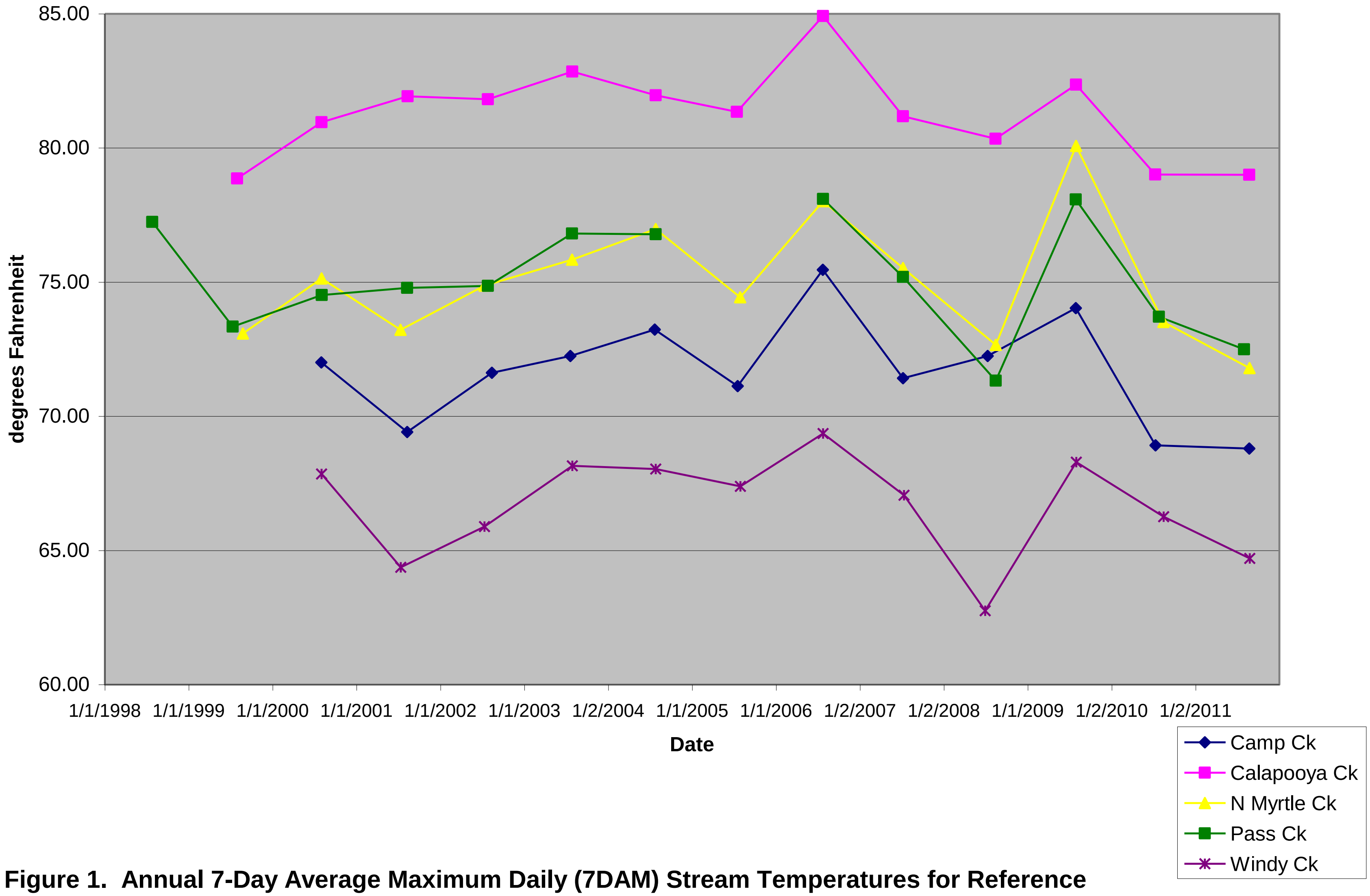


Figure 1. Annual 7-Day Average Maximum Daily (7DAM) Stream Temperatures for Reference Sites, 1998-2011, Umpqua Basin.

Appendix G: Oregon DEQ Data Quality Matrix

Data Quality Matrix
DEQ04-LAB-0003-QAG
Version 4.0

Oregon Department of Environmental Quality
March 09 2009
Page 1 of 2

Data Validation Criteria for Water Quality Parameters Measured in the Field

Quality Level	Quality Assurance Plan	Water Temperature Methods	pH Methods	Dissolved Oxygen Methods	Turbidity Methods	Conductivity Methods	Bacteria Methods	Data Uses
A+	DEQ QAPP approved by DEQ QA Officer	Thermometer Accuracy checked with NIST standards A ≤ ± 0.5ºC P ≤ ± 0.5ºC	Calibrated pH electrode A ≤ ± 0.2 S.U. P ≤ ± 0.3 S.U.	Winkler titration or calibrated Oxygen meter A ≤ ± 0.2 mgL^{-1} P ≤ ± 0.3 mgL^{-1}	Nephelometric Turbidity meter A ≤ ± 5% Standard value P ≤ ± 5% (± 1 NTU if NTU < 20)	Meter with temp correction to 25ºC A ≤ ± 7% of standard value P ≤ ± 10%	DEQ Approved Methods Absolute difference between log-transformed values P ≤ 0.6 log	Regulatory, permitting, compliance (e.g., 303(d) and 305(b) assessments)
A	External QAPP	External Data Thermometer Accuracy checked with NIST standards A ≤ ± 0.5ºC P ≤ ± 0.5ºC	External Data Calibrated pH electrode A ≤ ± 0.2 S.U. P ≤ ± 0.3 S.U.	External Data Winkler titration or calibrated Oxygen meter A ≤ ± 0.2 mgL^{-1} P ≤ ± 0.3 mgL^{-1}	External Data Nephelometric Turbidity meter A ≤ ± 5% Standard value P ≤ ± 5% (± 1 NTU if NTU <20)	External Data Meter with temp correction to 25ºC A ≤ ± 7% of standard value P ≤ ± 10%	External Data DEQ Approved Methods Absolute difference between log-transformed values P ≤ 0.6 log	Regulatory, permitting, compliance (e.g., 303(d) and 305(b) assessments)
B	Minimum Data Acceptance Criteria Met	Thermometer Accuracy checked with NIST standards A ≤ ± 1.0ºC P ≤ ± 2.0ºC	Any Method A ≤ ± 0.5 S.U. P ≤ ± 0.5 S.U.	Winkler titration or calibrated Oxygen meter A ≤ ± 1 mgL^{-1} P ≤ ± 1 mgL^{-1}	Any Method A ≤ ± 30% P ≤ ± 30%	Meter with temp correction to 25ºC A ≤ ± 10% of standard value P ≤ ± 15%	DEQ Approved Methods Absolute difference between log-transformed values P ≤ 0.8 log	Regulatory, permitting, compliance (e.g., 303(d) and 305(b) assessments) <u>with professional judgment</u>
C		A > ± 1.0ºC P > ± 2.0ºC	A > ± 0.5 S.U. P > ± 0.5 S.U.	A > ± 2 mgL^{-1} P > ± 2 mgL^{-1}	A > 30% P > 30%	A > ± 10% P > ± 15%	Absolute difference between log-transformed values P > 0.8 log	Void data. Not used for 303(d) and 305(b) assessments
D		Missing Data	Missing Data	Missing Data	Missing Data	Missing Data	Missing Data	Missing Data
E	No QAPP provided	No Precision Checks	Any Method No Precision Checks	Any Method No Precision Checks or A ≤ ± 2 mgL^{-1} P ≤ ± 2 mgL^{-1}	Any Method No precision checks	Meter without routine calibration No precision checks	Any Method No precision checks	Informational purposes only
F	See accompanying notes							

Appendix G: Oregon DEQ Data Quality Matrix

Data Validation Criteria for Water Quality Parameters Measured in the Field

Notes:

QA definitions of Data Quality Levels

- **A+** – Data of known Quality; collected by DEQ; meets QC limits established in the QAPP.
- **A** – Data of known Quality; submitted by entities outside of DEQ; meets QC limits established in a *DEQ-approved* QAPP.
- **B** – Data of known *but lesser* Quality; data may not meet established QC but is within marginal acceptance criteria; or data value may be accurate, however controls used to measure Data Quality Objective elements failed (e.g., batch failed to meet blank QC limit); the data may be useful in limited situations or in supporting other, higher quality data.

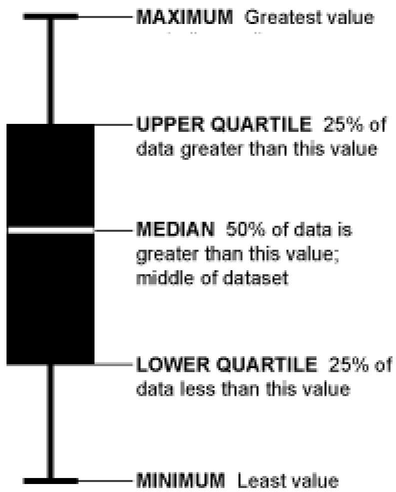
Note: Statistics for **turbidity, conductivity,** and **bacteria** are concentration-dependent; thus low-concentration B level data may be considered acceptable for all uses.

- **C** – Data of unacceptable Quality; data are typically discarded (Void) in response to analytical failure. **Note:** There may be rare instances where there may be field data that may still meet DQOs as determined by the Project Officer. In these cases a result should be entered instead of "Void" however the grade must remain at C. There must also be a comment in the final report that explains the qualification.
- **D** – Incomplete data; no sample collected or no reportable results, typically due to sampling failure.
- **E** – Data of unknown quality or known to be of poor quality; no QA information is available, data could be valid, however, no evidence is available to prove either way. Data is provided for Educational Use Only.
- **F** – Exceptional Event; "A" quality data (data is of known quality), but not representative of sampling conditions as required by the project plan.(e.g., a continuous water quality monitor intended to collect background environmental conditions collects a sample impacted by a fire that created anomalous conditions to the environment).

Data Quality Level Grading Criteria:

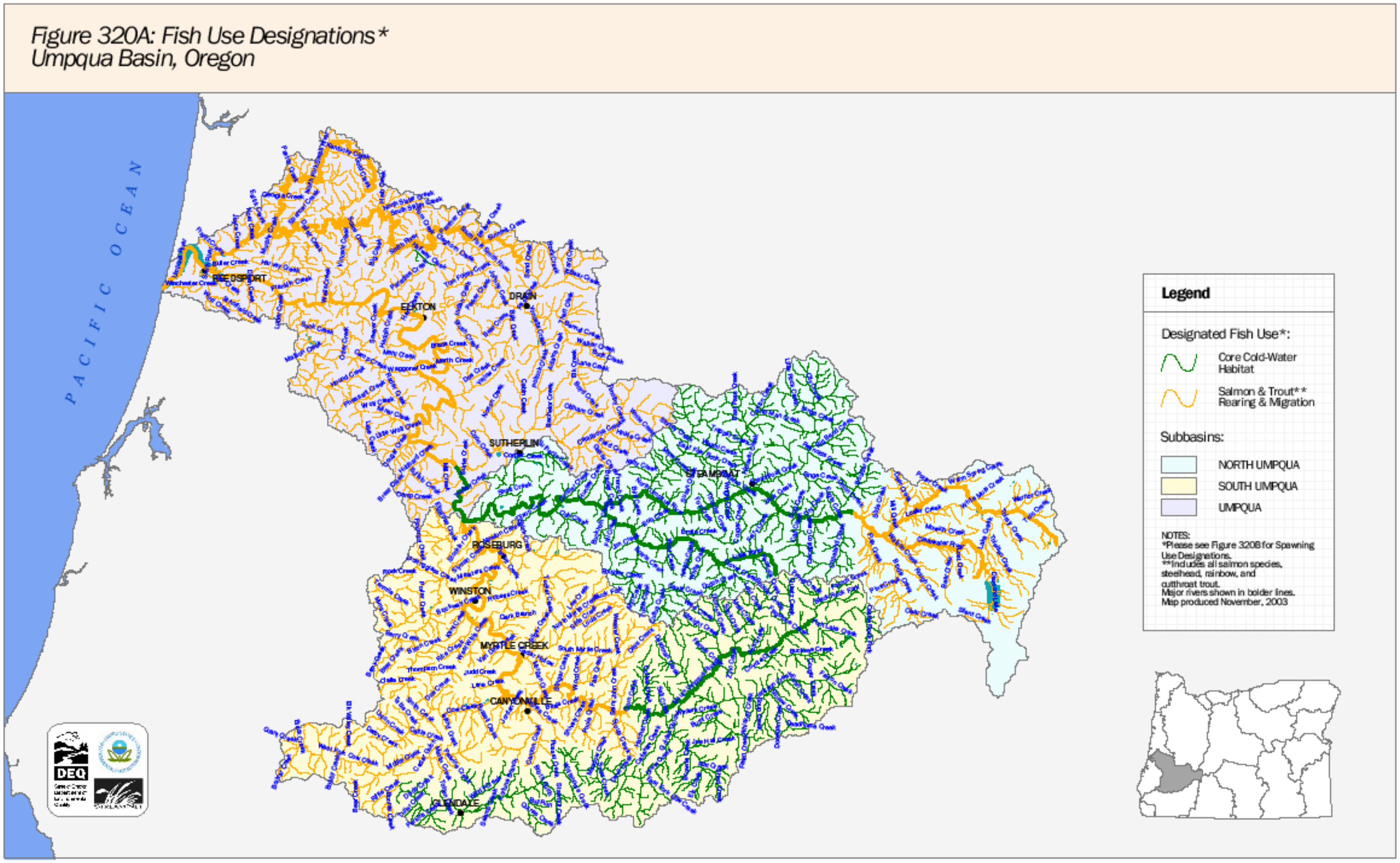
- **A** = Accuracy as determined by comparison with standards, e.g., during equipment calibration or pre- and post-deployment checks
- **P** = Precision as determined by replicate measurements, e.g., during field duplicates, field audits, or split sample

Appendix H: Interpreting a Box Plot

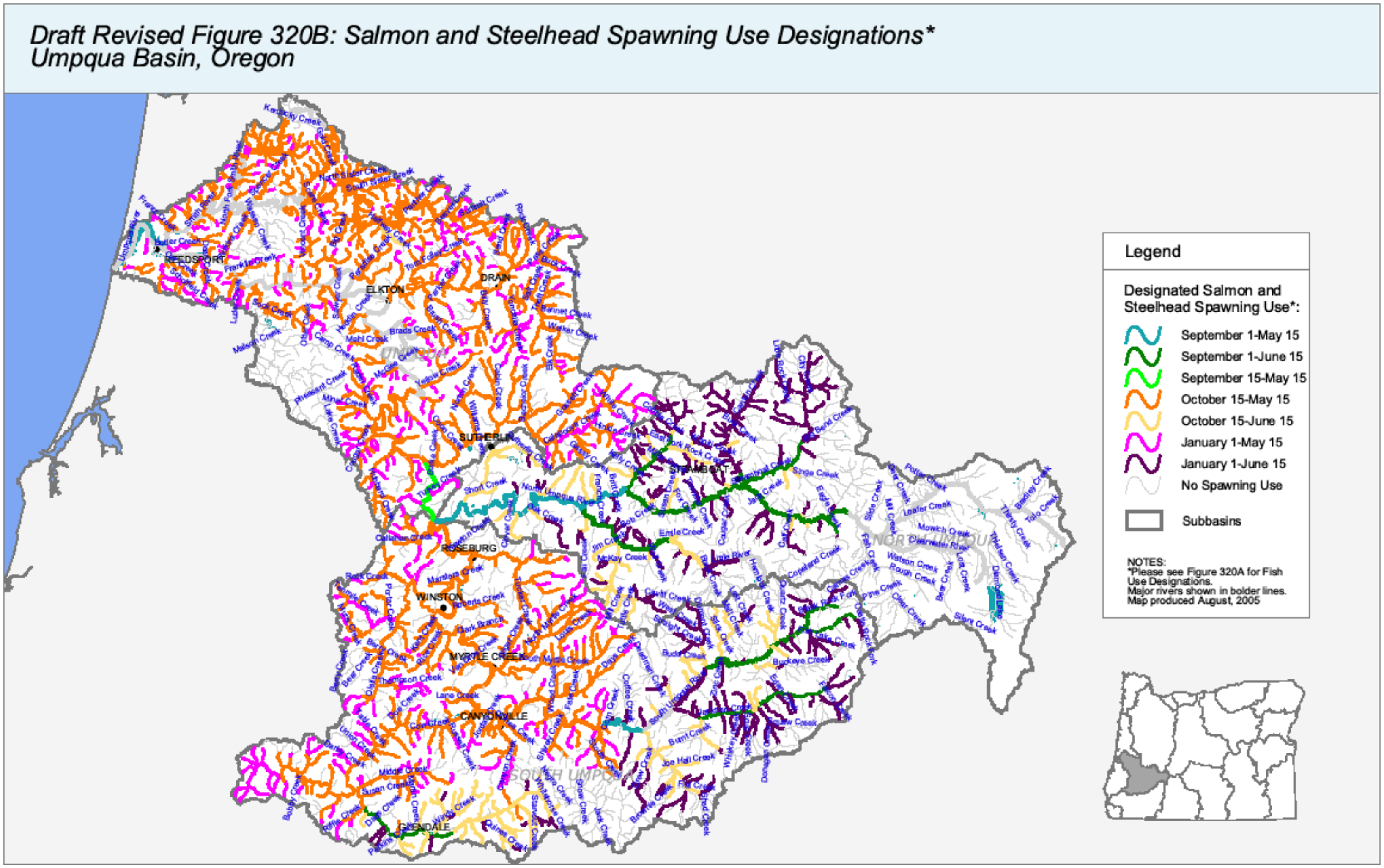


(Yau, 2008)

Appendix I: Umpqua Basin Fish Use Designations from ODEQ 2003



Appendix J: Umpqua Basin Salmon and Steelhead Spawning Use Designations from ODEQ 2003



Appendix K: Summary of PUR Continuous Summer Temperature Data 2005-2010

Summary of Continuous Summer Temperature Data from 2005-2010 for all Volunteer Monitoring Sites and Associated USFS and BLM Sites. ODEQ temperature criteria listed is from ODEQ (2003) and ODEQ (2011, p. 46). The North Myrtle Creek at Mouth Reference Site is a long-term stream characterization monitoring site (Smith, K., 2005), (Dammann, D.M. and K. Smith, 2006), (Dammann, D.M., 2007-2010).

Site Name			Seasonal Maximum Stream Temperature		Seasonal Minimum Stream Temperature		Seasonal Maximum ΔT		7-Day Averages			
	Start Date	Stop date	Date	(°F)	Date	(°F)	Date	(Δ °F)	Date	Maximum Temp (°F)	Minimum Temp (°F)	ΔT (Δ °F)
Myrtle Creek												
Bilger Creek near Mouth - 2008	07/03/08	09/02/08	07/05/08	67.6	09/02/08	55.0	08/03/08	4.3	07/07/08	66.8	64.1	2.7
Bilger Creek near Mouth - 2009	06/24/09	09/21/09	07/30/09	70.0	09/21/09	53.4	09/18/09	9.7	07/31/09	69.6	65.1	4.5
Buck Fork near Confluence with N. Myrtle Creek - 2006	07/06/06	09/19/06	07/24/06	72.3	09/17/06	48.8	07/20/06	10.1	07/25/06	70.0	62.8	7.2
Letitia Creek near Mouth - 2007	06/28/07	09/25/07	07/11/07	67.6	09/25/07	47.8	09/10/07	9.0	07/13/07	66.3	62.0	4.3
Louis Creek near Mouth - 2007	06/28/07	09/25/07	07/11/07	71.4	09/25/07	47.8	07/10/07	9.9	07/08/07	69.6	61.3	8.3
Louis Creek near Mouth - 2008	06/04/08	09/02/08	08/16/08	71.3	06/08/08	48.7	06/27/08	9.9	08/15/08	68.8	63.2	5.6
Louis Creek near Mouth - 2009	06/24/09	09/21/09	07/30/09	74.7	09/08/09	52.8	08/19/09	9.6	07/31/09	73.7	66.7	7.0
Louis Creek near Mouth - 2010	06/30/10	09/21/10	08/16/10	69.4	07/04/10	52.9	07/06/10	10.4	07/27/10	68.4	61.9	6.6
Myrtle Creek near Mouth - 2005	07/08/05	10/05/05	07/31/05	74.4	09/25/05	49.5	08/04/05	8.5	08/07/05	73.1	66.1	7.0
Myrtle Creek near Mouth - 2006	06/28/06	09/19/06	07/24/06	80.9	09/17/06	53.8	07/20/06	10.8	07/25/06	78.0	69.4	8.6
Myrtle Creek near Mouth - 2007	06/28/07	09/25/07	07/11/07	76.8	09/25/07	49.7	07/10/07	11.0	07/08/07	75.0	66.1	8.9
Myrtle Creek near Mouth - 2008	07/03/08	09/03/08	08/16/08	76.4	09/03/08	54.5	07/08/08	10.3	08/14/08	73.7	66.4	7.2
Myrtle Creek near Mouth - 2009	06/24/09	09/21/09	07/28/09	80.8	09/08/09	55.7	07/02/09	11.1	07/31/09	79.7	71.5	8.2
Myrtle Creek near Mouth - 2010	06/30/10	09/21/10	08/17/10	74.6	09/06/10	55.7	07/15/10	9.8	07/27/10	73.3	65.5	7.8
N. Myrtle Creek above Bilger Creek - 2005	07/08/05	10/05/05	07/18/05	75.9	09/25/05	49.0	07/17/05	11.5	07/20/05	73.7	64.6	9.1
N. Myrtle Creek above Bilger Creek - 2006	06/28/06	09/19/06	07/23/06	79.4	09/17/06	53.1	07/08/06	13.0	07/25/06	76.7	67.8	9.0
N. Myrtle Creek above Bilger Creek - 2007	06/28/07	09/25/07	07/10/07	76.0	09/25/07	49.4	06/30/07	11.8	07/08/07	74.2	64.9	9.3
N. Myrtle Creek above Bilger Creek - 2008	07/03/08	09/02/08	08/16/08	76.5	09/02/08	55.7	07/08/08	11.2	07/11/08	73.2	63.4	9.7
N. Myrtle Creek above Bilger Creek - 2009	06/24/09	09/21/09	07/28/09	78.9	09/08/09	55.0	06/27/09	12.9	07/30/09	77.4	69.5	7.9
N. Myrtle Creek above Bilger Creek - 2010	06/30/10	09/21/10	07/11/10	74.7	09/06/10	55.3	07/06/10	12.3	07/26/10	72.9	64.4	8.6
N. Myrtle Creek at Division St - 2005	07/08/05	10/05/05	07/18/05	75.9	09/25/05	49.1	07/26/05	11.2	08/07/05	74.6	65.1	9.6
N. Myrtle Creek at Division St - 2007	06/28/07	09/25/07	07/11/07	78.0	09/25/07	49.2	08/29/07	12.3	07/08/07	75.5	65.7	9.8
N. Myrtle Creek at Evergreen Park - 2008	07/03/08	09/03/08	08/16/08	78.8	09/03/08	53.9	07/13/08	12.1	08/14/08	75.2	65.7	9.5
N. Myrtle Creek at Evergreen Park - 2009	06/24/09	09/21/09	07/30/09	82.1	09/08/09	54.9	08/19/09	12.6	07/31/09	80.7	70.9	9.8
N. Myrtle Creek at Evergreen Park - 2010	06/30/10	09/21/10	08/17/10	75.2	09/06/10	54.7	08/25/10	11.3	08/15/10	73.6	64.4	9.3
N. Myrtle Creek at Mouth - Reference - 2005	06/28/05	09/19/05	07/18/05	76.0	09/19/05	54.3	07/26/05	11.0	07/29/05	74.4	65.2	9.2
N. Myrtle Creek at Mouth - Reference - 2006	06/22/06	09/23/06	07/24/06	81.0	09/23/06	53.7	06/24/06	11.6	07/25/06	78.0	68.9	9.1
N. Myrtle Creek at Mouth - Reference - 2007	06/24/07	10/06/07	07/11/07	77.5	09/25/07	49.2	08/29/07	11.9	07/08/07	75.5	65.8	9.7
N. Myrtle Creek at Mouth - Reference - 2008	06/02/08	09/23/08	08/16/08	74.6	06/02/08	51.8	07/13/08	9.4	08/15/08	72.7	67.1	5.5
N. Myrtle Creek at Mouth - Reference - 2009	06/08/09	10/03/09	07/28/09	81.5	10/02/09	50.7	08/20/09	12.2	07/30/09	80.1	70.3	9.8
N. Myrtle Creek at Mouth - Reference - 2010	06/21/10	09/25/10	08/16/10	75.0	06/21/10	54.4	08/25/10	10.8	08/15/10	73.5	64.6	9.0
N. Myrtle Creek at N. Myrtle Park - 2005	07/08/05	10/05/05	07/18/05	73.4	09/25/05	48.8	07/17/05	11.7	07/20/05	72.0	62.0	10.1
N. Myrtle Creek at N. Myrtle Park - 2006	07/06/06	09/19/06	07/24/06	77.5	09/17/06	52.8	07/08/06	12.1	07/25/06	75.5	66.1	9.4
N. Myrtle Creek at N. Myrtle Park - 2007	06/28/07	09/25/07	07/11/07	74.0	09/25/07	50.2	06/30/07	11.5	07/08/07	72.8	63.2	9.6
N. Myrtle Creek at N. Myrtle Park - 2008	07/03/08	09/02/08	08/16/08	72.6	09/02/08	56.6	07/08/08	10.5	07/11/08	71.1	61.6	9.4
N. Myrtle Creek at N. Myrtle Park - 2009	06/24/09	09/21/09	07/28/09	77.2	09/08/09	55.4	06/27/09	13.3	07/30/09	76.2	68.3	7.9
N. Myrtle Creek at N. Myrtle Park - 2010	06/30/10	09/21/10	07/11/10	73.0	07/04/10	53.9	07/07/10	13.1	07/26/10	71.9	61.9	10.0
N. Myrtle Creek near Confluence with Buck Fork Ck - 2006	07/06/06	09/19/06	07/24/06	71.2	09/17/06	48.8	07/20/06	10.3	07/25/06	69.1	61.0	8.1

Appendix K: Summary of PUR Continuous Summer Temperature Data 2005-2010

Site Name	Start Date	Stop date	Seasonal Maximum Stream Temperature Date	Seasonal Maximum Stream Temperature (°F)	Seasonal Minimum Stream Temperature Date	Seasonal Minimum Stream Temperature (°F)	Seasonal Maximum ΔT Date	Seasonal Maximum ΔT (Δ °F)	7-Day Averages Date	7-Day Averages Maximum Temp (°F)	7-Day Averages Minimum Temp (°F)	7-Day Averages ΔT (Δ °F)
Myrtle Creek												
S. Myrtle Creek at 12 Mile Ranch - 2005	07/08/05	10/05/05	07/31/05	68.5	09/25/05	44.8	07/26/05	9.4	07/30/05	67.5	59.9	7.6
S. Myrtle Creek at Neal Lane Bridge - 2005	07/08/05	08/15/05	07/18/05	76.4	08/03/05	61.3	07/26/05	11.2	07/20/05	73.9	65.8	8.2
S. Myrtle Creek at Neal Lane Bridge - 2006	06/28/06	09/19/06	07/23/06	80.9	09/17/06	53.6	09/01/06	11.7	07/25/06	77.8	69.4	8.4
S. Myrtle Creek at Neal Lane Bridge - 2007	06/28/07	09/04/07	07/11/07	77.4	08/28/07	58.0	07/10/07	11.1	07/08/07	74.9	66.2	8.7
S. Myrtle Creek at Neal Lane Bridge - 2008	07/03/08	09/02/08	08/16/08	76.8	09/02/08	55.0	07/13/08	11.1	08/14/08	73.9	65.4	8.5
S. Myrtle Creek at Neal Lane Bridge - 2010	06/30/10	09/21/10	07/25/10	75.0	09/06/10	54.7	08/24/10	11.3	07/26/10	74.0	65.3	8.7
S. Myrtle Creek at Taylor's Property - 2005	07/08/05	10/05/05	07/18/05	76.3	09/25/05	49.7	07/17/05	11.5	07/20/05	74.5	64.9	9.6
S. Myrtle Creek at Taylors Property - 2006	06/28/06	09/19/06	07/24/06	80.3	09/17/06	52.6	07/08/06	13.5	07/25/06	77.9	67.8	10.1
S. Myrtle Creek at Taylors Property - 2007	06/29/07	09/25/07	07/11/07	77.6	09/25/07	50.0	06/30/07	12.7	07/08/07	75.5	64.7	10.8
S. Myrtle Creek at Taylors Property - 2008	06/04/08	09/02/08	08/16/08	77.1	06/05/08	48.6	06/27/08	14.5	07/11/08	74.6	62.4	12.2
S. Myrtle Creek at Taylors Property - 2009	06/24/09	09/21/09	07/29/09	78.6	09/08/09	55.6	06/27/09	13.3	07/30/09	77.9	70.4	7.5
S. Myrtle Creek at Taylor's Property - 2010	06/30/10	09/21/10	07/11/10	75.5	07/04/10	54.7	07/07/10	13.6	07/27/10	74.1	64.1	10.0
S. Myrtle Creek at Top of Golf Course - 2005	07/08/05	10/10/05	07/19/05	76.4	09/25/05	49.5	07/26/05	10.9	07/20/05	74.3	66.0	8.3
S. Myrtle Creek at Top of Golf Course - 2006	06/28/06	09/19/06	07/24/06	81.6	09/17/06	53.2	08/13/06	11.5	07/25/06	78.2	69.5	8.8
S. Myrtle Creek at Top of Golf Course - 2007	06/28/07	09/24/07	07/11/07	78.2	09/24/07	49.2	07/10/07	11.0	07/08/07	75.5	66.2	9.3
S. Myrtle Creek at Top of Golf Course - 2009	06/24/09	09/21/09	07/28/09	82.9	09/21/09	55.1	07/27/09	13.3	07/30/09	80.6	70.2	10.4
S. Myrtle Creek at Top of Golf Course - 2010	06/30/10	09/21/10	08/17/10	76.1	09/06/10	54.7	08/25/10	12.4	08/15/10	74.2	64.6	9.6
S. Myrtle Creek below Bridge at 11200 S. Myrtle Ck Rd - 2005	07/09/05	10/05/05	07/18/05	69.7	09/25/05	46.0	07/26/05	8.6	07/20/05	68.3	61.4	6.9
S. Myrtle Creek below Bridge at 11200 S. Myrtle Ck Rd - 2006	06/28/06	09/19/06	07/24/06	73.7	09/17/06	49.3	07/20/06	9.7	07/25/06	71.2	63.4	7.8
S. Myrtle Creek below Bridge at 11200 S. Myrtle Ck Rd - 2007	06/28/07	09/25/07	07/11/07	70.6	09/24/07	45.9	07/10/07	9.8	07/12/07	68.6	61.8	6.8
S. Myrtle Creek below Bridge at 11200 S. Myrtle Ck Rd - 2008	07/03/08	09/03/08	08/16/08	71.8	09/03/08	49.6	07/13/08	10.3	08/15/08	68.6	61.3	7.2
S. Myrtle Creek below Bridge at 11200 S. Myrtle Ck Rd - 2009	06/24/09	09/21/09	07/29/09	74.7	09/08/09	51.0	06/27/09	10.9	07/31/09	73.4	66.0	7.5
S. Myrtle Creek below Bridge at 11200 S. Myrtle Ck Rd - 2010	06/30/10	09/21/10	08/16/10	69.2	09/06/10	50.5	08/25/10	9.3	08/15/10	67.6	59.9	7.7
Weaver Creek above 1st Culvert - 2005	07/08/05	10/05/05	07/18/05	68.4	09/25/05	45.8	07/26/05	8.8	08/07/05	67.1	60.0	7.1
Weaver Creek above 1st Culvert - 2007	06/28/07	09/25/07	07/11/07	68.1	09/24/07	46.6	06/30/07	7.6	07/13/07	66.6	61.9	4.7
Weaver Creek above 1st Culvert - 2008	06/04/08	09/02/08	08/16/08	68.7	06/12/08	47.0	06/13/08	9.5	08/15/08	66.1	61.2	4.9
Weaver Creek above 1st Culvert - 2009	06/24/09	09/21/09	07/30/09	71.8	09/08/09	51.6	06/27/09	7.8	07/31/09	70.8	65.2	5.6
Weaver Creek above 1st Culvert - 2010	06/30/10	09/21/10	08/17/10	66.6	09/11/10	50.9	07/06/10	8.4	07/27/10	65.2	59.9	5.3

Appendix K: Summary of PUR Continuous Summer Temperature Data 2005-2010

Site Name	Total Monitored Days Exceeding ODEQ Criterias			% of Days from 7/9-9/2 Exceeding Criteria - Myrtle Sites			Warmest Day of 7-Day Maximum Stream Temperature			Monitoring Organization or Agency
	Days > 60.8 °F	Days > 64.4 °F	Days > 68 °F	% Days > 60.8 °F	% Days > 64.4 °F	% Days > 68 °F	Date	Maximum Temp (°F)	Minimum Temp (°F)	
Myrtle Creek										
Bilger Creek near Mouth - 2008	60	15	0	96	16	0	07/04/08	67.6	64.4	PUR
Bilger Creek near Mouth - 2009	90	69	14	100	84	18	07/30/09	70.0	65.5	PUR
Buck Fork near Confluence with N. Myrtle Creek - 2006	59	24	6	95	43	11	07/24/06	72.3	65.4	PUR
Letitia Creek near Mouth - 2007	76	34	0	100	50	0	07/11/07	67.6	63.3	PUR
Louis Creek near Mouth - 2007	78	53	18	100	80	23	07/11/07	71.4	66.1	PUR
Louis Creek near Mouth - 2008	74	54	15	95	75	14	08/16/08	71.3	65.1	PUR
Louis Creek near Mouth - 2009	88	62	24	100	88	38	07/30/09	74.7	67.8	PUR
Louis Creek near Mouth - 2010	63	48	11	95	79	20	07/28/10	69.4	63.3	PUR
Myrtle Creek near Mouth - 2005	73	62	47	100	100	84	08/05/05	73.8	66.7	PUR
Myrtle Creek near Mouth - 2006	81	77	59	100	100	84	07/24/06	80.9	72.7	PUR
Myrtle Creek near Mouth - 2007	82	77	59	100	100	84	07/11/07	76.8	70.7	PUR
Myrtle Creek near Mouth - 2008	63	59	52	100	95	82	08/16/08	76.4	69.1	PUR
Myrtle Creek near Mouth - 2009	90	83	70	100	100	91	07/28/09	80.8	71.5	PUR
Myrtle Creek near Mouth - 2010	83	62	50	98	95	82	07/25/10	74.1	65.1	PUR
N. Myrtle Creek above Bilger Creek - 2005	74	60	47	100	100	84	07/18/05	75.9	65.7	PUR
N. Myrtle Creek above Bilger Creek - 2006	81	72	48	100	96	70	07/23/06	79.4	69.2	PUR
N. Myrtle Creek above Bilger Creek - 2007	82	75	51	100	100	71	07/10/07	76.0	64.4	PUR
N. Myrtle Creek above Bilger Creek - 2008	62	58	43	100	93	66	07/09/08	74.7	64.6	PUR
N. Myrtle Creek above Bilger Creek - 2009	90	83	57	100	100	75	07/28/09	78.9	69.4	PUR
N. Myrtle Creek above Bilger Creek - 2010	81	63	48	98	95	79	07/25/10	73.9	64.2	PUR
N. Myrtle Creek at Division St - 2005	77	63	52	100	100	93	08/06/05	75.6	65.7	PUR
N. Myrtle Creek at Division St - 2007	83	79	65	100	100	89	07/11/07	78.0	70.3	PUR
N. Myrtle Creek at Evergreen Park - 2008	63	59	56	100	95	89	08/16/08	78.8	68.4	PUR
N. Myrtle Creek at Evergreen Park - 2009	90	86	74	100	100	95	07/29/09	82.1	71.1	PUR
N. Myrtle Creek at Evergreen Park - 2010	82	61	50	98	95	82	08/17/10	75.2	66.6	PUR
N. Myrtle Creek at Mouth - Reference - 2005	84	73	57	100	100	91	07/29/05	75.6	66.6	PUR - Reference
N. Myrtle Creek at Mouth - Reference - 2006	90	83	66	100	100	88	07/24/06	81.0	72.0	PUR - Reference
N. Myrtle Creek at Mouth - Reference - 2007	89	82	67	100	100	91	07/11/07	77.5	70.5	PUR - Reference
N. Myrtle Creek at Mouth - Reference - 2008	101	77	55	100	95	79	08/16/08	74.6	69.1	PUR - Reference
N. Myrtle Creek at Mouth - Reference - 2009	112	98	78	100	100	95	07/28/09	81.5	70.8	PUR - Reference
N. Myrtle Creek at Mouth - Reference - 2010	94	67	51	98	95	82	08/16/10	75.0	65.5	PUR - Reference
N. Myrtle Creek at N. Myrtle Park - 2005	70	61	45	100	100	80	07/18/05	73.4	62.6	PUR
N. Myrtle Creek at N. Myrtle Park - 2006	72	68	47	100	100	80	07/24/06	77.5	68.4	PUR
N. Myrtle Creek at N. Myrtle Park - 2007	81	77	48	100	100	70	07/10/07	74.0	62.8	PUR
N. Myrtle Creek at N. Myrtle Park - 2008	61	57	33	98	91	48	07/09/08	72.2	62.4	PUR
N. Myrtle Creek at N. Myrtle Park - 2009	90	83	62	100	100	84	07/28/09	77.2	68.1	PUR
N. Myrtle Creek at N. Myrtle Park - 2010	80	61	46	98	95	77	07/26/10	72.4	62.6	PUR
N. Myrtle Creek near Confluence with Buck Fork Ck - 2006	57	19	6	91	34	11	07/24/06	71.2	63.1	PUR

Appendix K: Summary of PUR Continuous Summer Temperature Data 2005-2010

Site Name	Total Monitored Days Exceeding ODEQ Criterias			% of Days from 7/9-9/2 Exceeding Criteria - Myrtle Sites			Warmest Day of 7-Day Maximum Stream Temperature			Monitoring Organization or Agency
	Days > 60.8 °F	Days > 64.4 °F	Days > 68 °F	% Days > 60.8 °F	% Days > 64.4 °F	% Days > 68 °F	Date	Maximum Temp (°F)	Minimum Temp (°F)	
Myrtle Creek										
S. Myrtle Creek at 12 Mile Ranch - 2005	57	38	7	100	68	13	07/31/05	68.5	60.4	PUR
S. Myrtle Creek at Neal Lane Bridge - 2005	*39	*39	*36	*100	*100	*95	07/18/05	76.4	67.4	PUR
S. Myrtle Creek at Neal Lane Bridge - 2006	81	74	59	100	98	86	07/23/06	80.9	71.3	PUR
S. Myrtle Creek at Neal Lane Bridge - 2007	69	69	60	100	100	86	07/11/07	77.4	70.1	PUR
S. Myrtle Creek at Neal Lane Bridge - 2008	62	59	51	100	95	80	08/16/08	76.8	68.2	PUR
S. Myrtle Creek at Neal Lane Bridge - 2010	81	61	50	98	95	84	07/25/10	75.0	65.0	PUR
S. Myrtle Creek at Taylor's Property - 2005	71	63	51	100	100	91	07/18/05	76.3	65.8	PUR
S. Myrtle Creek at Taylors Property - 2006	80	77	59	100	100	84	07/24/06	80.3	70.6	PUR
S. Myrtle Creek at Taylors Property - 2007	81	76	62	100	100	91	07/11/07	77.6	69.1	PUR
S. Myrtle Creek at Taylors Property - 2008	82	76	64	100	95	91	07/09/08	75.9	63.5	PUR
S. Myrtle Creek at Taylors Property - 2009	90	84	65	100	100	86	07/29/09	78.6	70.9	PUR
S. Myrtle Creek at Taylor's Property - 2010	82	63	50	100	95	82	07/28/10	74.7	65.5	PUR
S. Myrtle Creek at Top of Golf Course - 2005	75	63	46	100	100	82	07/18/05	76.4	67.1	PUR
S. Myrtle Creek at Top of Golf Course - 2006	79	76	57	100	100	80	07/24/06	81.6	72.8	PUR
S. Myrtle Creek at Top of Golf Course - 2007	82	79	55	100	100	79	07/11/07	78.2	70.9	PUR
S. Myrtle Creek at Top of Golf Course - 2009	90	84	79	100	98	96	07/28/09	82.9	70.0	PUR
S. Myrtle Creek at Top of Golf Course - 2010	80	63	51	98	96	84	08/17/10	76.1	66.8	PUR
S. Myrtle Creek below Bridge at 11200 S. Myrtle Ck Rd - 2005	58	44	15	100	79	27	07/18/05	69.7	62.4	PUR
S. Myrtle Creek below Bridge at 11200 S. Myrtle Ck Rd - 2006	71	37	8	96	54	13	07/24/06	73.7	66.4	PUR
S. Myrtle Creek below Bridge at 11200 S. Myrtle Ck Rd - 2007	76	46	7	100	68	11	07/11/07	70.6	65.0	PUR
S. Myrtle Creek below Bridge at 11200 S. Myrtle Ck Rd - 2008	59	36	5	95	54	9	08/16/08	71.8	63.4	PUR
S. Myrtle Creek below Bridge at 11200 S. Myrtle Ck Rd - 2009	81	46	21	98	71	32	07/29/09	74.7	65.7	PUR
S. Myrtle Creek below Bridge at 11200 S. Myrtle Ck Rd - 2010	56	36	7	93	61	13	08/16/10	69.2	61.1	PUR
Weaver Creek above 1st Culvert - 2005	58	38	2	100	68	4	08/05/05	67.9	60.6	PUR
Weaver Creek above 1st Culvert - 2007	64	25	1	89	36	2	07/11/07	68.1	64.1	PUR
Weaver Creek above 1st Culvert - 2008	61	25	1	88	25	2	08/16/08	68.7	63.3	PUR
Weaver Creek above 1st Culvert - 2009	74	28	9	95	45	16	07/30/09	71.8	66.3	PUR
Weaver Creek above 1st Culvert - 2010	51	15	0	84	27	0	07/26/10	65.8	60.4	PUR

*Short Data Set

Appendix K: Summary of PUR Continuous Summer Temperature Data 2005-2010

Site Name			Seasonal Maximum Stream Temperature		Seasonal Minimum Stream Temperature		Seasonal Maximum ΔT		7-Day Averages			
	Start Date	Stop date	Date	(°F)	Date	(°F)	Date	(Δ °F)	Date	Maximum Temp (°F)	Minimum Temp (°F)	ΔT (Δ °F)
South Umpqua												
Canyon Creek near Mouth - 2009	07/15/09	09/08/09	07/30/09	79.5	09/08/09	56.1	07/16/09	8.5	07/31/09	77.8	71.0	6.8
Canyon Creek near Mouth - 2010	06/17/10	09/29/10	08/17/10	73.4	06/20/10	53.4	07/07/10	10.2	08/16/10	71.7	65.1	6.6
Days Creek above Fate Creek - 2006	07/09/06	09/23/06	07/24/06	73.8	09/17/06	53.6	07/20/06	9.3	07/25/06	72.2	65.3	6.8
Days Creek above Fate Creek - 2008	07/02/08	08/14/08	07/09/08	69.4	08/03/08	57.0	07/13/08	8.7	07/11/08	68.5	60.4	8.2
Days Creek above Fate Creek 7.02.09 to 7.20.09 - 2009	07/02/09	07/20/09	07/04/09	68.5	07/07/09	57.8	07/04/09	8.7	07/17/09	67.0	59.9	7.2
Days Creek above Fate Creek 8.03.09 to 9.05.09 - 2009	08/03/09	09/05/09	08/03/09	69.3	09/03/09	57.8	09/02/09	6.3	08/06/09	65.6	63.2	2.4
Days Creek above Fate Creek - 2010	06/17/10	09/29/10	07/26/10	67.9	06/17/10	50.7	07/06/10	8.5	07/25/10	66.9	60.1	6.7
Days Creek above Woods Creek - 2008	07/02/08	09/02/08	08/16/08	79.2	09/02/08	53.1	07/13/08	13.6	08/14/08	75.2	64.5	10.7
Days Creek above Woods Creek - 2009	07/15/09	09/08/09	07/28/09	75.6	09/08/09	53.8	07/15/09	12.8	07/31/09	74.4	68.5	5.9
Days Creek above Woods Creek - 2010	06/17/10	09/29/10	07/11/10	74.2	06/17/10	51.5	07/15/10	12.9	07/26/10	73.0	63.1	9.9
Fate Creek at Lowest Extent of BLM - 2005	05/26/05	09/22/05	07/18/05	66.7	09/22/05	47.1	07/26/05	10.2	07/20/05	65.3	57.1	8.3
Fate Creek at Lowest Extent of BLM - 2006	05/26/06	10/25/06	07/24/06	70.4	10/11/06	43.3	06/24/06	11.1	07/25/06	68.2	59.4	8.8
Fate Creek at Lowest Extent of BLM - 2007	05/17/07	09/16/07	07/11/07	65.5	05/22/07	46.9	08/02/07	10.2	07/08/07	64.4	56.0	8.4
Fate Creek at Lowest Extent of BLM - 2008	06/10/08	09/24/08	08/16/08	66.6	09/23/08	47.1	07/13/08	9.9	08/14/08	64.2	56.6	7.6
Fate Creek at Lowest Extent of BLM - 2009	06/19/09	11/16/09	07/30/09	67.1	11/16/09	41.8	08/04/09	7.4	07/31/09	66.2	60.5	5.8
Fate Creek at Lowest Extent of BLM - 2010	05/26/10	09/21/10	08/17/10	65.1	09/05/10	47.9	09/05/10	9.5	08/15/10	63.8	55.9	8.0
Fate Creek near Mouth - 2006	07/09/06	09/23/06	07/24/06	67.0	09/23/06	50.6	09/01/06	5.0	07/25/06	65.4	62.1	3.3
Fate Creek near Mouth - 2010	06/17/10	09/29/10	08/17/10	68.6	09/12/10	50.8	08/24/10	9.4	08/16/10	67.0	59.2	7.8
S. Umpqua above Canyon Creek - 2008	07/02/08	09/02/08	08/16/08	86.2	09/02/08	61.5	07/26/08	11.6	08/14/08	82.7	73.1	9.6
S. Umpqua above Canyon Creek - 2009	07/15/09	09/01/09	07/30/09	89.3	08/24/09	66.3	08/19/09	12.2	07/31/09	88.0	78.2	9.8
S. Umpqua above Canyon Creek 6.17.10 to 7.13.10 - 2010	06/17/10	07/13/10	07/11/10	80.7	06/17/10	54.5	07/13/10	10.5	07/10/10	77.8	69.9	7.9
S. Umpqua above Canyon Creek 7.29.10 to 9.29.10 - 2010	07/29/10	09/29/10	08/16/10	83.4	09/23/10	59.6	08/24/10	11.9	08/16/10	81.9	72.7	9.1
Woods Creek at Mouth - 2008	07/02/08	09/02/08	08/16/08	71.1	09/02/08	53.4	08/05/08	8.3	08/15/08	68.4	63.2	5.2
Woods Creek at Mouth - 2009	07/15/09	09/08/09	07/30/09	75.7	09/08/09	52.8	08/19/09	9.3	07/31/09	74.0	67.6	6.5
Woods Creek at Mouth - 2010	06/17/10	09/29/10	08/17/10	68.2	06/17/10	51.4	07/06/10	7.5	08/16/10	66.6	61.4	5.3

Appendix K: Summary of PUR Continuous Summer Temperature Data 2005-2010

Site Name	Total Monitored Days Exceeding ODEQ Criteria			% of Days from 7/16-8/31 Exceeding Criteria - SUmp. Sites			Warmest Day of 7-Day Maximum Stream Temperature			Monitoring Organization or Agency
	Days > 60.8 °F	Days > 64.4 °F	Days > 68 °F	% Days > 60.8 °F	% Days > 64.4 °F	% Days > 68 °F	Date	Maximum Temp (°F)	Minimum Temp (°F)	
South Umpqua										
Canyon Creek near Mouth - 2009	56	52	38	100	98	74	07/30/09	79.5	72.0	PUR
Canyon Creek near Mouth - 2010	93	64	41	98	91	70	08/17/10	73.4	67.2	PUR
Days Creek above Fate Creek - 2006	65	43	17	100	77	28	07/24/06	73.8	67.0	PUR
Days Creek above Fate Creek - 2008	*44	*38	*7	*97	*77	*0	07/09/08	69.4	61.3	PUR
Days Creek above Fate Creek 7.02.09 to 7.20.09 - 2009	19	18	1	100	21	7	07/16/09	67.6	59.2	PUR
Days Creek above Fate Creek 8.03.09 to 9.05.09 - 2009	34	6	2	see above	see above	see above	08/03/09	69.3	66.4	PUR
Days Creek above Fate Creek - 2010	68	32	0	83	49	0	07/26/10	67.9	60.9	PUR
Days Creek above Woods Creek - 2008	63	60	55	100	98	87	08/16/08	79.2	67.6	PUR
Days Creek above Woods Creek - 2009	55	45	28	100	87	57	07/28/09	75.6	68.4	PUR
Days Creek above Woods Creek - 2010	92	59	42	94	79	68	07/25/10	73.6	62.8	PUR
Fate Creek at Lowest Extent of BLM - 2005	60	21	0	87	43	0	07/18/05	66.7	58.0	BLM
Fate Creek at Lowest Extent of BLM - 2006	72	20	3	87	19	6	07/24/06	70.4	61.8	BLM
Fate Creek at Lowest Extent of BLM - 2007	54	5	0	70	4	0	07/11/07	65.5	59.8	BLM
Fate Creek at Lowest Extent of BLM - 2008	53	3	0	74	4	0	08/16/08	66.6	59.1	BLM
Fate Creek at Lowest Extent of BLM - 2009	30	9	0	57	19	0	07/30/09	67.1	60.8	BLM
Fate Creek at Lowest Extent of BLM - 2010	41	3	0	66	6	0	08/16/10	65.1	57.4	BLM
Fate Creek near Mouth - 2006	20	6	0	32	13	0	07/24/06	67.0	64.1	PUR
Fate Creek near Mouth - 2010	63	30	2	91	53	4	08/17/10	68.6	61.1	PUR
S. Umpqua above Canyon Creek - 2008	63	63	63	100	100	100	08/16/08	86.2	75.6	PUR
S. Umpqua above Canyon Creek - 2009	49	49	49	100	100	100	07/30/09	89.3	79.6	PUR
S. Umpqua above Canyon Creek 6.17.10 to 7.13.10 - 2010	24	23	20	100	100	97	07/11/10	80.7	72.9	PUR
S. Umpqua above Canyon Creek 7.29.10 to 9.29.10 - 2010	63	63	57	see above	see above	see above	08/16/10	83.4	73.4	PUR
Woods Creek at Mouth - 2008	60	38	5	98	51	11	08/16/08	71.1	65.5	PUR
Woods Creek at Mouth - 2009	53	40	20	100	77	43	07/30/09	75.7	68.4	PUR
Woods Creek at Mouth - 2010	65	29	2	91	49	4	08/17/10	68.2	63.3	PUR

*Short Data Set

Appendix K: Summary of PUR Continuous Summer Temperature Data 2005-2010

Site Name			Seasonal Maximum Stream Temperature		Seasonal Minimum Stream Temperature		Seasonal Maximum ΔT		7-Day Averages			
	Start Date	Stop date	Date	(°F)	Date	(°F)	Date	(Δ °F)	Date	Maximum Temp (°F)	Minimum Temp (°F)	ΔT (Δ °F)
Elk Creek/Tiller												
Brownie Creek at Mouth - 2008	07/02/08	09/17/08	08/16/08	68.4	09/03/08	49.9	07/08/08	8.4	08/17/08	66.2	62.3	3.9
Brownie Creek at Mouth - 2009	06/24/09	10/08/09	08/02/09	70.0	10/07/09	42.8	06/27/09	9.1	08/01/09	69.1	65.6	3.5
Brownie Creek at Mouth - 2010	06/16/10	09/26/10	08/16/10	67.8	06/16/10	47.8	07/06/10	11.0	07/27/10	66.5	59.1	7.5
Callahan Creek at Mouth - 2008	06/10/08	09/17/08	08/16/08	67.5	06/12/08	47.4	06/13/08	6.8	08/17/08	65.5	62.4	3.1
Callahan Creek at Mouth - 2009	06/24/09	10/08/09	08/02/09	69.8	10/07/09	43.7	06/27/09	5.9	08/01/09	69.1	66.0	3.1
Callahan Creek at Mouth - 2010	06/16/10	09/26/10	07/27/10	65.2	06/16/10	48.9	07/06/10	6.4	07/27/10	64.5	60.6	3.9
Drew Creek at Mouth - 2008	06/10/08	09/17/08	08/16/08	70.1	06/12/08	47.9	06/13/08	8.1	08/17/08	67.7	63.7	4.0
Drew Creek at Mouth - 2009	06/24/09	10/08/09	07/30/09	73.9	10/07/09	43.4	06/27/09	8.1	07/31/09	72.9	66.9	6.0
Drew Creek at Mouth - 2010	06/16/10	09/26/10	07/27/10	67.6	06/16/10	49.6	07/06/10	7.7	07/27/10	66.7	61.2	5.5
Elk Creek at Tiller - 2008	06/11/08	09/22/08	07/09/08	74.0	06/11/08	49.8	06/27/08	9.3	07/07/08	72.8	66.1	6.7
Elk Creek at Tiller - 2009	06/17/09	09/30/09	08/04/09	74.4	09/30/09	52.9	06/24/09	7.5	08/02/09	73.3	70.4	2.9
Elk Creek at Tiller - 2010	06/23/10	09/22/10	07/28/10	73.9	09/12/10	54.7	07/07/10	9.0	07/27/10	73.0	66.3	6.6
Flat Creek at Mouth - 2008	06/10/08	09/25/08	08/16/08	68.3	06/12/08	44.9	06/27/08	8.2	08/15/08	65.9	61.3	4.6
Flat Creek at Mouth - 2009	06/16/09	10/13/09	07/30/09	75.6	10/12/09	42.2	07/27/09	11.2	07/31/09	74.3	65.4	9.0
Flat Creek at Mouth - 2010	06/18/10	10/23/10	08/16/10	68.8	10/20/10	43.7	08/24/10	10.1	08/16/10	67.0	59.2	7.8
Joe Hall Creek at Mouth - 2008	06/10/08	08/04/08	07/09/08	69.4	06/12/08	46.6	07/11/08	9.6	07/11/08	68.6	59.5	9.1
Joe Hall Creek at Mouth - 2009	06/16/09	07/27/09	07/27/09	72.1	06/23/09	54.2	07/27/09	12.0	07/24/09	69.1	59.7	9.4

Appendix K: Summary of PUR Continuous Summer Temperature Data 2005-2010

Site Name	Total Monitored Days Exceeding ODEQ Criteria			% of Days from 6/24-9/17 Exceeding Criteria - Elk Sites			Warmest Day of 7-Day Maximum Stream Temperature			Monitoring Organization or Agency
	Days > 60.8 °F	Days > 64.4 °F	Days > 68 °F	% Days > 60.8 °F	% Days > 64.4 °F	% Days > 68 °F	Date	Maximum Temp (°F)	Minimum Temp (°F)	
Elk Creek/Tiller										
Brownie Creek at Mouth - 2008	*54	*19	*2	*63	*22	*2	08/16/08	68.4	62.7	USFS
Brownie Creek at Mouth - 2009	59	22	6	69	26	7	08/02/09	70.0	67.2	USFS
Brownie Creek at Mouth - 2010	55	23	0	64	27	0	07/27/10	67.3	60.1	USFS
Callahan Creek at Mouth - 2008	57	15	0	66	17	0	08/16/08	67.5	63.2	USFS
Callahan Creek at Mouth - 2009	49	14	8	57	16	9	08/02/09	69.8	67.3	USFS
Callahan Creek at Mouth - 2010	49	7	0	57	8	0	07/27/10	65.2	61.5	USFS
Drew Creek at Mouth - 2008	65	38	4	76	44	5	08/16/08	70.1	64.4	USFS
Drew Creek at Mouth - 2009	83	41	13	94	48	15	07/30/09	73.9	67.6	USFS
Drew Creek at Mouth - 2010	57	28	0	66	33	0	07/27/10	67.6	62.2	USFS
Elk Creek at Tiller - 2008	82	66	38	81	74	44	07/09/08	74.0	66.0	USFS
Elk Creek at Tiller - 2009	90	62	33	93	66	35	08/04/09	74.4	70.4	USFS
Elk Creek at Tiller - 2010	76	61	46	86	71	53	07/27/10	73.9	67.4	USFS
Flat Creek at Mouth - 2008	53	10	1	62	12	1	08/16/08	68.3	63.1	USFS
Flat Creek at Mouth - 2009	90	52	22	95	60	26	07/30/09	75.6	66.3	USFS
Flat Creek at Mouth - 2010	56	29	2	63	34	2	08/16/10	68.8	60.1	USFS
Joe Hall Creek at Mouth - 2008	*44	*34	*12	*100	*81	*29	07/09/08	69.4	60.3	USFS
Joe Hall Creek at Mouth - 2009	*40	*21	*5	*100	*59	*15	07/27/09	72.1	60.1	USFS

*Short Data Set

Appendix K: Summary of PUR Continuous Summer Temperature Data 2005-2010

Site Name			Seasonal Maximum Stream Temperature		Seasonal Minimum Stream Temperature		Seasonal Maximum ΔT		7-Day Averages			
	Start Date	Stop date	Date	(°F)	Date	(°F)	Date	(Δ °F)	Date	Maximum Temp (°F)	Minimum Temp (°F)	ΔT (Δ °F)
Umpqua												
Charlotte Creek near mouth - 2008	05/22/08	10/02/08	08/14/08	61.7	05/23/08	47.8	06/27/08	6.7	08/14/08	60.8	57.2	3.5
Dean Creek at Hitchcocks - 2008	05/23/08	05/26/09	07/09/08	79.7	12/17/08	41.0	07/08/08	13.0	07/09/08	76.7	66.0	10.7
Dean Creek at Hwy 38 Bridge - 2008	05/22/08	05/26/09	07/09/08	78.7	12/17/08	38.0	05/22/08	15.3	07/10/08	77.2	70.7	6.5
Dean Creek at Hwy 38 Bridge - 2010	07/24/10	11/01/10	07/24/10	75.4	10/27/10	49.9	08/23/10	9.4	07/27/10	73.0	66.5	6.5
Dean Creek at Furthest Upstream Bridge - 2008	05/23/08	09/29/08	07/09/08	65.3	06/08/08	48.0	06/19/08	11.1	07/11/08	64.3	58.0	6.3
Dean Creek at Furthest Upstream Bridge - 2009	08/05/09	10/04/09	08/11/09	63.6	10/04/09	50.9	08/10/09	5.2	08/11/09	63.1	59.7	3.4
Dean Creek at Furthest Upstream Bridge - 2010	07/24/10	11/01/10	07/24/10	65.1	10/27/10	49.7	07/24/10	6.1	07/27/10	63.1	59.2	3.9
Elk Creek near Mouth - 2010	07/24/10	11/01/10	08/16/10	79.3	10/29/10	50.0	08/24/10	10.4	08/15/10	77.7	69.7	8.0
Fitzpatrick Creek at Mehl Road - 2009	07/23/09	09/23/09	07/29/09	68.4	09/23/09	53.4	09/17/09	6.8	07/29/09	67.0	62.9	4.1
Heddin Creek Upstream from Mehl Road Culvert - 2009	07/23/09	10/04/09	07/29/09	71.7	10/04/09	46.1	09/22/09	10.0	07/29/09	69.2	63.8	5.4
Lutsinger Creek at Old Road Crossing - 2009	07/23/09	10/04/09	07/28/09	72.6	10/04/09	47.0	07/27/09	7.5	07/30/09	69.8	64.1	5.7
Mehl Creek at Mehl Rd - 2009	07/23/09	10/04/09	07/29/09	70.7	10/04/09	47.9	07/25/09	5.8	07/30/09	69.2	65.1	4.0
Mill Ck near end of Tidal Influence (1.4 mi. from Hwy 38)-2008	07/24/08	09/29/08	08/14/08	78.2	09/23/08	55.1	07/24/08	10.8	08/13/08	76.1	67.8	8.3
Mill Creek 0.3 Miles Upstream from Hwy 38 - 2008	07/23/08	09/29/08	08/16/08	76.7	09/28/08	59.7	08/29/08	7.9	08/16/08	75.8	69.3	6.5
Scholfield Creek above Hwy 101 Bridge - 2008	05/22/08	10/02/08	07/08/08	77.8	06/02/08	49.8	06/15/08	14.0	07/10/08	75.2	69.6	5.6
Umpqua River at Discovery Center - 2009	08/05/09	08/31/09	08/11/09	72.7	08/20/09	61.1	08/20/09	9.8	08/13/09	71.9	66.9	5.0
Umpqua River at Discovery Center - 2010	07/23/10	11/01/10	07/23/10	71.5	10/31/10	52.3	08/09/10	9.6	07/26/10	70.5	62.3	8.3
Weatherly Creek near Mouth - 2009	07/23/09	10/04/09	07/28/09	72.0	10/04/09	47.5	07/27/09	7.8	07/29/09	69.5	63.4	6.1
Yellow Creek near Mouth - 2008	06/26/08	09/29/08	08/16/08	76.4	09/23/08	51.1	08/11/08	11.1	08/14/08	74.1	64.7	9.5
Yellow Creek near Mouth - 2009	07/11/09	10/04/09	07/28/09	81.0	10/04/09	48.6	07/28/09	10.5	07/29/09	78.1	68.9	9.2

Appendix K: Summary of PUR Continuous Summer Temperature Data 2005-2010

Site Name	Total Monitored Days Exceeding ODEQ Criteria			% of Days from 7/24-9/21 Exceeding Criteria - Umpqua Sites			Warmest Day of 7-Day Maximum Stream Temperature			Monitoring Organization or Agency
	Days > 60.8 °F	Days > 64.4 °F	Days > 68 °F	% Days > 60.8 °F	% Days > 64.4 °F	% Days > 68 °F	Date	Maximum Temp (°F)	Minimum Temp (°F)	
Umpqua										
Charlotte Creek near mouth - 2008	3	0	0	5	0	0	08/14/08	61.7	57.1	PUR
Dean Creek at Hitchcocks - 2008	126	94	80	100	100	83	07/09/08	79.7	67.7	PUR
Dean Creek at Hwy 38 Bridge - 2008	137	114	87	100	100	90	07/09/08	78.7	72.9	PUR
Dean Creek at Hwy 38 Bridge - 2010	86	75	57	100	100	87	07/24/10	75.4	66.8	PUR
Dean Creek at Furthest Upstream Bridge - 2008	63	3	0	63	0	0	07/09/08	65.3	58.9	PUR
Dean Creek at Furthest Upstream Bridge - 2009	32	0	0	53	0	0	08/10/09	63.6	58.4	PUR
Dean Creek at Furthest Upstream Bridge - 2010	44	1	0	63	2	0	07/24/10	65.1	58.9	PUR
Elk Creek near Mouth - 2010	79	71	53	100	100	80	08/14/10	79.3	70.3	PUR
Fitzpatrick Creek at Mehl Road - 2009	29	12	2	47	20	3	07/28/09	68.4	64.1	PUR
Heddin Creek Upstream from Mehl Road Culvert - 2009	49	16	5	80	27	8	07/29/09	71.7	66.1	PUR
Lutsinger Creek at Old Road Crossing - 2009	43	17	6	70	28	10	07/28/09	72.6	65.8	PUR
Mehl Creek at Mehl Rd - 2009	34	15	6	55	25	10	07/29/09	70.7	67.2	PUR
Mill Ck near end of Tidal Influence (1.4 Miles from Hwy 38) - 2008	67	55	42	100	92	70	08/14/08	78.2	68.7	PUR
Mill Creek 0.3 Miles Upstream from Hwy 38 - 2008	69	68	57	100	100	93	08/16/08	76.7	69.3	PUR
Scholfield Creek above Hwy 101 Bridge - 2008	124	100	72	100	95	70	07/08/08	77.8	70.1	PUR
Umpqua River at Discovery Center - 2009	*27	*27	*27	*45	*45	*45	08/11/09	72.7	67.7	PUR
Umpqua River at Discovery Center - 2010	85	75	43	100	100	68	07/23/10	71.5	63.1	PUR
Weatherly Creek near Mouth - 2009	51	18	6	83	30	10	07/28/09	72.0	64.9	PUR
Yellow Creek near Mouth - 2008	87	78	55	98	85	52	08/16/08	76.4	66.1	PUR
Yellow Creek near Mouth - 2009	74	57	36	98	75	43	07/28/09	81.0	70.5	PUR

* Short Data Set