WATER QUALITY MONITORING REPORT
COLUMBIA COUNTY SOIL AND WATER CONSERVATION DISTRICT
WATER QUALITY TRENDS MONITORING PROGRAM
2017-2020

PREPARED FOR

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Suggested Citation:

Lower Columbia Estuary Partnership (LCEP). 2021. Water Quality Monitoring Report Columbia County Soil and Water Conservation District Water Quality Trends Monitoring Program 2017-2020. Prepared by the Lower Columbia Estuary Partnership for the Columbia Soil & Water Conservation District. Available from the Lower Columbia Estuary Partnership, Portland, OR.

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ACKNOWLEDGMENTS

We would like to express our gratitude to Columbia Soil and Water Conservation District (CSWCD), the Oregon Department of Environmental Quality (ODEQ), and the Oregon Watershed Enhancement Board (OWEB) for funding and technical support. We extend our gratitude to all private landowners for their cooperation during sampling events. We would like to acknowledge and thank Selene Keeney, Crystalyn Bush, Matthew Schwartz, Jenny Dezso, Sneha Rao, and Dr. Sarah Kidd for their initial and continued efforts with project design, planning, sampling, and reporting for this study. We would also like to thank Jennifer Labrecque, Grace Brennan, Tiffany Thio, and Paige Suniga for their assistance with collecting samples, maintaining water quality equipment, and data entry.

ACRONYMS AND ABBREVIATIONS

ODEQ – Oregon Department of Environmental Quality

CSWCD – Columbia County Soil and Water Conservation District

HUC – Hydrologic Unit Code

TMDL – Total Maximum Daily Load

E. coli – *Escherichia coli* Bacteria

USGS – United States Geological Society

EPA – Environmental Protection Agency

7dMAM – 7-day Moving Average Maximum

MPN/100ml – Most Probable Number of viable cells in 100ml of sample (Bacteria Samples)

NTU – Nephelometric Turbidity Units

DO – Dissolved Oxygen

SAP – Sampling Analysis Plan

EXECUTIVE SUMMARY

In 2017 the Oregon Department of Environmental Quality (ODEQ) provided grant funding to establish the Columbia County water quality monitoring program to track and characterize long-term trends in water temperature, turbidity, *E. coli* bacteria, and conductivity in Clatskanie River, Beaver Creek, Milton Creek, North Scappoose Creek, and South Scappoose Creek watersheds. A total of 13 sites were selected to provide a comprehensive overview of the County watersheds between 2017 and 2020. Water quality monitoring was conducted following the methods and quality assurance protocols laid out by the ODEQ for measuring water temperature, bacteria, and turbidity. Water quality data were summarized and compared to standard parameter ranges for ideal salmonid habitat as defined by the ODEQ, Oregon Watershed Enhancement Board (OWEB), and Environmental Protection Agency (EPA). It is intended that the ODEQ will use these data to assess whether the Clatskanie River, Beaver Creek, Milton Creek, and Scappoose River watersheds are meeting water quality criteria for beneficial uses. The Columbia Soil and Water Conservation District (CSWCD), the Lower Columbia River Watershed Council, and the Scappoose Bay Watershed Council will use the long-term trend data as a baseline watershed condition for water quality and target future monitoring data focused on restoration effectiveness. The following section summarizes the water quality issues observed across the watersheds. Please refer to the full report a detailed assessment of all water quality trends.

Clatskanie River Watershed

A total of five sites were selected to represent the upper, middle, and lower reaches of the Clatskanie River. Water quality issues observed in Clatskanie Watershed were isolated to the lower reaches. Stream temperature in Middle Clatskanie and Lower Clatskanie, which are located in more pastured areas, exceeded ODEQ temperature standard for salmon habitat (18°C) during the summer over all monitoring years (2017 – 2020) when water levels were low and air temperatures were high. Overall elevated temperatures are likely caused by thermal loading, as the lower reaches of the watershed are much more developed (pastures) and lack riparian shade. These elevated temperatures also coincide with elevated counts of *E. coli* in these sites. Elevated *E. coli* bacteria levels were observed in Middle Clatskanie between June-September in 2019 and July-November in 2020, exceeding the EPA and ODEQ standards including the five-sample geometric mean. *E. coli* bacteria issues are indicative of animal waste runoff and can be very harmful to humans using these waterways for recreation. Additional research is needed to determine the exact source of the elevated *E. coli*. Animal waste or septic tank leakage into the stream are possible sources to be investigated. Depending on the source, actions that could reduce future *E. coli* exceedance events include increasing riparian buffers, excluding livestock from the creek, increasing manure management near streams, or updating failed septic systems throughout the targeted reach of the watershed. Seasonally high turbidity levels were observed during winter months across the watershed, coinciding with winter storm events and high flow conditions.

Beaver Creek Watershed

Two monitoring sites were selected to study water quality in this watershed, one in the upper and lower reaches of the watershed. Summertime stream temperature consistently exceeds the ODEQ temperature standard for salmon rearing habitat (18°C) in the lower watershed. We theorize that due to water levels being lower and more exposed to solar radiation, the lower reaches of the Beaver watershed experience more thermal loading. Upper Beaver exceeded the recommended limit on turbidity (<10 NTU) and *E. coli* standards (EPA and ODEQ) during the study. Elevated levels of turbidity and *E. coli* in the upper watershed as compared to the lower watershed are indicative of runoff and other residential use. Given the frequency and scale of *E. coli* bacteria events, adding warning signs to recreational areas along these streams that are accessible to the public is recommended.

Scappoose Bay Watershed

The Scappoose Bay watershed has been divided into three sub-watersheds: Milton Creek, North Scappoose Creek, and South Scappoose Creek. Two sites in each creek, representing upper and lower reaches of the creek, were sampled between 2017 and 2020 for temperature, turbidity, and *E. coli*. Datasets created through an intensive monitoring effort in the Scappoose Bay Watershed from 2008 to 2011 were also used to compare and evaluate water quality changes over time.

Summertime stream temperatures in the watersheds consistently exceed the ODEQ temperature standard for salmon rearing habitat (18°C). Stream temperatures were consistently lower in the upper watersheds, which have more forested areas when compared to temperatures in the lower watersheds, consisting of residential and developed areas. Temperatures were greatest at Lower Milton, which is close to a public park. These temperatures were close to ODEQ standards for lethal conditions for salmon (25°C) during August throughout the study, even exceeding the lethal conditions threshold in August 2018. When comparing 2008-2011 to the 2017-2020 data sets, trends of increasing summer temperatures over time were observed for all monitoring areas.

Milton Creek watershed exhibited elevated turbidity levels throughout the study period, with >10 NTU turbidity events observed between July and December. North Scappoose and South Scappoose Creek watersheds maintained relatively low (< 4 NTU) turbidity levels. Seasonally, the highest mean turbidity levels were recorded in the winter months (Nov., Dec., Jan.), reflecting winter storm conditions and high flow events. When comparing 2008-2011 to the 2017-2020 data sets, no significant shift in turbidity events overtime was observed across the monitoring areas.

Elevated *E. coli* levels were observed across all monitoring sites in the lower reaches and consistently exceeded EPA and ODEQ standards (Table 3) between June to October of 2019 and May to November 2020. The 2008-2011 *E. coli* bacteria sampling data indicate that *E. coli* levels have been an ongoing issue with these watersheds; however, due to the limited sampling that took place during that study period, a relative shift in these conditions could not be assessed. *E. coli* bacteria issues indicate animal waste runoff and can be very harmful to humans using these waterways for recreation. Given the frequency and scale of *E. coli* bacteria events, adding warning signs to recreational areas along these streams that are accessible to the public is recommended.

Recommendations

To address and mitigate these issues identified in the report, we recommend the following:

- A riparian canopy cover analysis of the Scappoose Bay, Clatskanie River, and Beaver Creek watersheds is recommended in order to identify areas where canopy gaps are increasing stream solarization. Once identified, these gaps could be addressed by restoring riparian vegetation buffers to reduce thermal loading on summer water temperatures. Targeted restoration of riparian vegetation and canopy cover could also reduce turbid and bacteria-laden run-off into these streams.
- On the ground and aerial surveys could also be used to identify cold refugia (cold water sources and seeps), which should be protected and enhanced. These surveys could also be used to

identify sources of non-point source pollution such as unstable stream banks (turbidity) and livestock use of the streams (bacteria).

- Additional shading and riparian buffers need to be introduced in the lower Scappoose Bay watershed to regulate stream temperatures and *E. coli* events across all monitoring sites.
- Given the scale of the *E. coli* issues observed, an evaluation of livestock access to streams and the septic tank systems should be considered to further help identify potential sources of *E. coli* throughout the County watersheds.
- Due to the ongoing *E. coli* issues, it is also recommended that warning signs are added to recreational areas along these streams that are accessible to the public, especially in the Lower reaches of Scappoose Watershed.
- Continued water quality monitoring efforts are required to assess the long-term shifts in water quality conditions resulting from restoration, mitigation actions, and developmental pressures.

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PROJECT OVERVIEW

Introduction

The Lower Columbia River and Scappoose Bay watersheds include a variety of habitats that support multiple life stages of federally ESA-listed fall Chinook, coho, and chum salmon as well as winter steelhead, cutthroat trout, and Pacific lamprey, though these species' numbers are dwindling due to poor water quality, limited and degraded habitat, and fish passage barriers. Estuary and tidal wetland habitats in the lower watershed provided off-channel floodplain refugia and rearing habitat serving many species of out-migrating juvenile salmon during spring freshet high flow periods. Historically, low gradient streams meandering through prairie and gravel plain topography provided instream and off-channel habitat features that included large wood jams, gravel retention, and pools, which supported coho spawning and rearing habitats. Additionally, middle and upper stream reaches with intact old-growth riparian forests and channel complexity provided quality Chinook and steelhead spawning and rearing habitat. The quality, quantity, and access to these habitats have been significantly impacted by lowland diking, ditching, development, and agriculture, as well as upper watershed timber production.

The Lower Columbia River Watershed drains nearly 300 square miles and is made up of three main fifth-field sub-watersheds, including the Clatskanie, Beaver, and Plympton subbasins. This project focuses on sampling the two largest- Clatskanie and Beaver. Stream channel modifications and land-use practices have reduced the quality and quantity of available native habitat. These include the construction of cut-off channels, dredging, diking, ditching and draining the lowlands to improve agriculture production. Timber harvest, splash damming, and road development have altered the middle and upper watersheds.

The Scappoose Bay Watershed encompasses 132 square miles and includes Scappoose and Milton sub-watersheds- both were sampled during this project. These sub-basins have all been drastically altered, the lowland floodplains and Oak prairies by flood control measures, surface mining, farming, livestock production, and residential development, and the forested hills by logging. These actions not only degraded habitat but also water quality. More recently, the loss of riparian forests due to commercial timber production, agriculture, and rapid residential and commercial development continues to threaten water quality. Rising housing costs and proximity to Portland Metro have resulted in increasing population pressures and development in the southern portions of Columbia County, causing concern for increasing water quality issues in the area.

Varying degrees of water quality data have been collected over the years by several entities in the focus sub-basins. These amount to sporadic monitoring events or programs that do not provide sufficient, comprehensive data to analyze watershed trends. This monitoring program was established with the goal of creating a long-term trend monitoring network to characterize ambient water quality conditions for temperature, bacteria, and turbidity in the Clatskanie River, Beaver Creek, Milton Creek, and Scappoose River watersheds (Figure 1). The Oregon Department of Environmental Quality (ODEQ) will use these data to assess whether the Clatskanie River, Beaver Creek, Milton Creek, and Scappoose River watersheds are meeting water quality criteria for beneficial uses. The Columbia Soil and Water Conservation District (CSWCD), the Lower Columbia River Watershed Council, and the Scappoose Bay Watershed Council will use the long-term trend data as a baseline watershed condition for water quality and complement future monitoring data focused on restoration effectiveness.

Site Selection

Monitored watersheds were selected based on areas of interest identified by the CSWCD. Specific sampling sites for continuous water temperature and grab sample turbidity were selected based on three factors: HUC 12 boundary, the presence of legacy ODEQ monitoring, and TMDL limited water bodies. HUC 12 boundaries divide the river or creek into discrete monitoring reaches to better define the water body to being monitored. Sampling defined reaches of the water body can identify landscape factors influencing water temperature. *E. coli* sampling was conducted in the lowest reaches of the watersheds to highlight both areas commonly accessed by humans for recreation (near urban centers) and to evaluate the cumulative condition of the water quality within each watershed. When possible, sampling locations were also chosen based on prior ODEQ sampling sites nearby. Continuing to monitor ODEQ sampling sites augments existing monitoring data on previously TMDL limited water bodies and can inform if changes have occurred over time. Alternatively, monitoring stations located in non-TMDL limited waters were selected to monitor if conditions in the watershed were unchanged.

The 13 monitoring sites chosen through this selection process provided a comprehensive overview of the four watersheds (Figure 2, Table 1). By monitoring the major tributary confluences, the CSWCD can observe differences and make comparisons of water quality conditions from the headwaters to the lower reaches. Over time, this will allow the CSWCD to identify problem areas and assess where further monitoring and possible restoration activities are needed throughout the watersheds. Detailed monitoring site descriptions can be found in Appendix A.

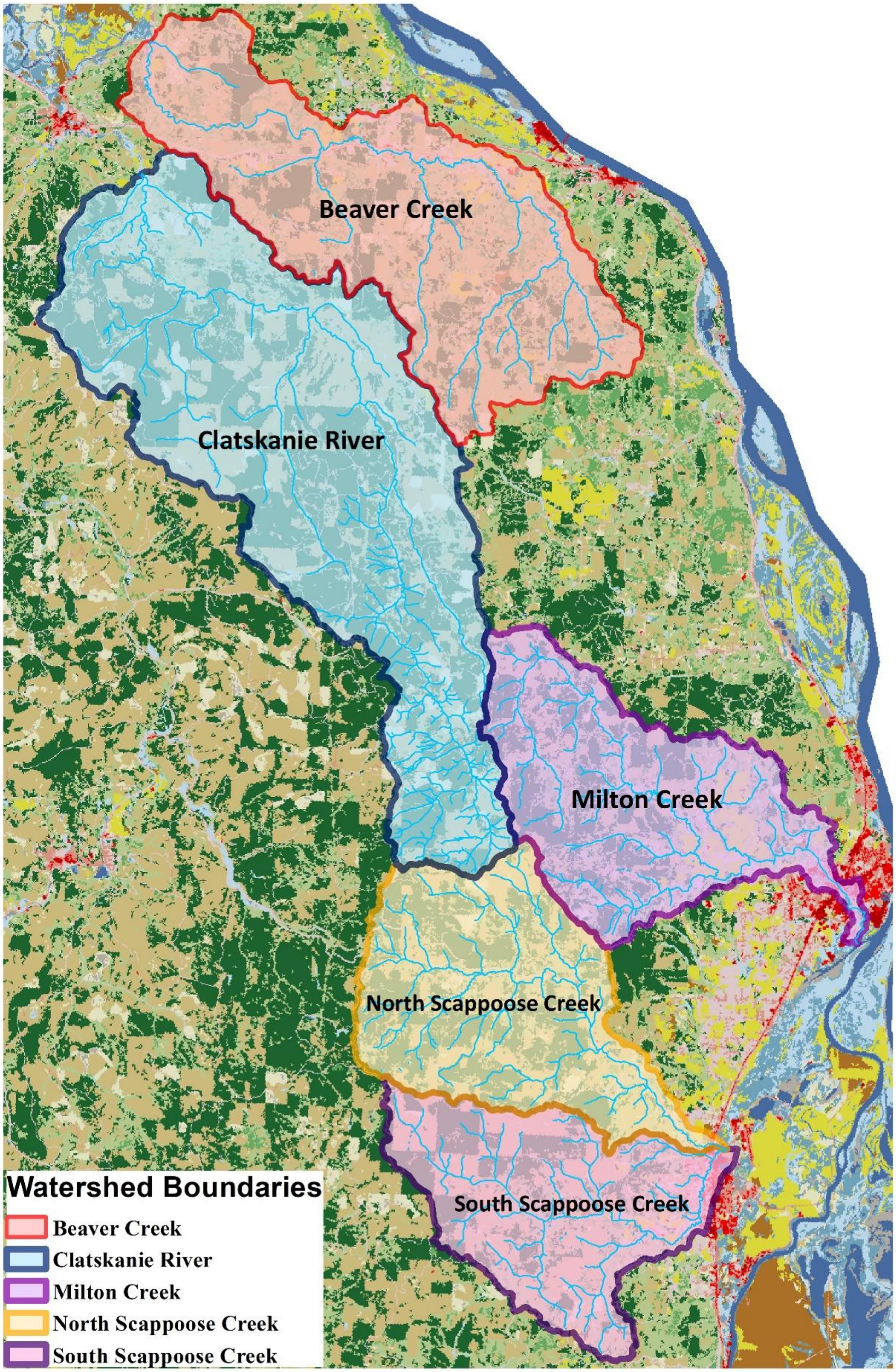


Figure 1: The Clatskanie River, Beaver Creek, Milton, and Scappoose River watersheds are in Columbia County, Oregon, USA.

Table 1: Sampling Station Descriptions, Locations, and Parameters

Station Identification	Site Code	ODEQ LASAR #	Station Description	Latitude	Longitude	Parameter
Clatskanie Watershed						
Little Clatskanie	LC	23539	Little Clatskanie River at Apiary Road, Rocky Substrate	45.9871802	-123.0391480	Temperature, E. Coli, Turbidity
Upper Clatskanie	UC	n/a	Headwaters Clatskanie River at Apiary Road, Rocky Substrate	45.9882893	-123.0402836	Temperature, E. Coli, Turbidity
Carcus Creek	CAR	23537	Carcus Creek at mouth (Clatskanie River tributary, River Mile 11.2), Rocky Substrate	46.0390038	-123.0832678	Temperature, E. Coli, Turbidity
Middle Clatskanie	MC	n/a	Clatskanie River downstream of Carcus Creek- located at Swedetown Rd. Bridge crossing, Rocky Substrate	46.0482249	-123.1197820	Temperature, E. Coli, Turbidity
Lower Clatskanie	Low C	34152	Clatskanie River above Keystone Creek (Columbia), Mixed Substrate and Large Wood	46.0802952	-123.1632107	Temperature, E. Coli, Turbidity
Beaver Creek Watershed						
Upper Beaver	UB	23535	Girt Creek at Beaver Spring Road (Beaver Creek tributary River Mile 16.6), Silt Substrate	46.0631239	-122.9649379	Temperature, E. Coli, Turbidity
Lower Beaver	LB	23526	Beaver Creek at Beaver Falls Road (Tidewater, upstream of Stewart Creek), Rocky Substrate	46.1097865	-123.1585536	Temperature, E. Coli, Turbidity
Milton Creek Watershed						
Upper Milton	UM	n/a	Cox Creek South of Yankton School (Yankton), Rocky Substrate	45.8641139	-122.8879489	Temperature, E. Coli, Turbidity
Lower Milton	LM	n/a	Milton Creek at Boise Cascade (River Mile 0.8), Silty Substrate	45.8504302	-122.8147681	Temperature, E. Coli, Turbidity
North Scappoose Creek						
Upper North Scappoose	UNS	n/a	North Scappoose Creek below Alder Creek, Rocky Substrate	45.8227512	-122.9469585	Temperature, E. Coli, Turbidity
Lower North Scappoose	LNS	23566	Scappoose Creek - North Scappoose Creek at Hwy 30, Mixed Substrate	45.7711443	-122.8787030	Temperature, E. Coli, Turbidity
South Scappoose Creek						
Upper South Scappoose	USS	23579	Scappoose Creek - South Scappoose Creek at Bankston Road, Rocky Substrate	45.7443630	-122.9596836	Temperature, E. Coli, Turbidity
Lower South Scappoose	LSS	n/a	Scappoose Creek - South Scappoose Creek at Hwy 30, Silty Substrate	45.7637674	-122.8800218	Temperature, E. Coli, Turbidity

Figure 2: Map of water quality monitoring site locations within the Columbia County Watershed Boundaries

Watershed Descriptions

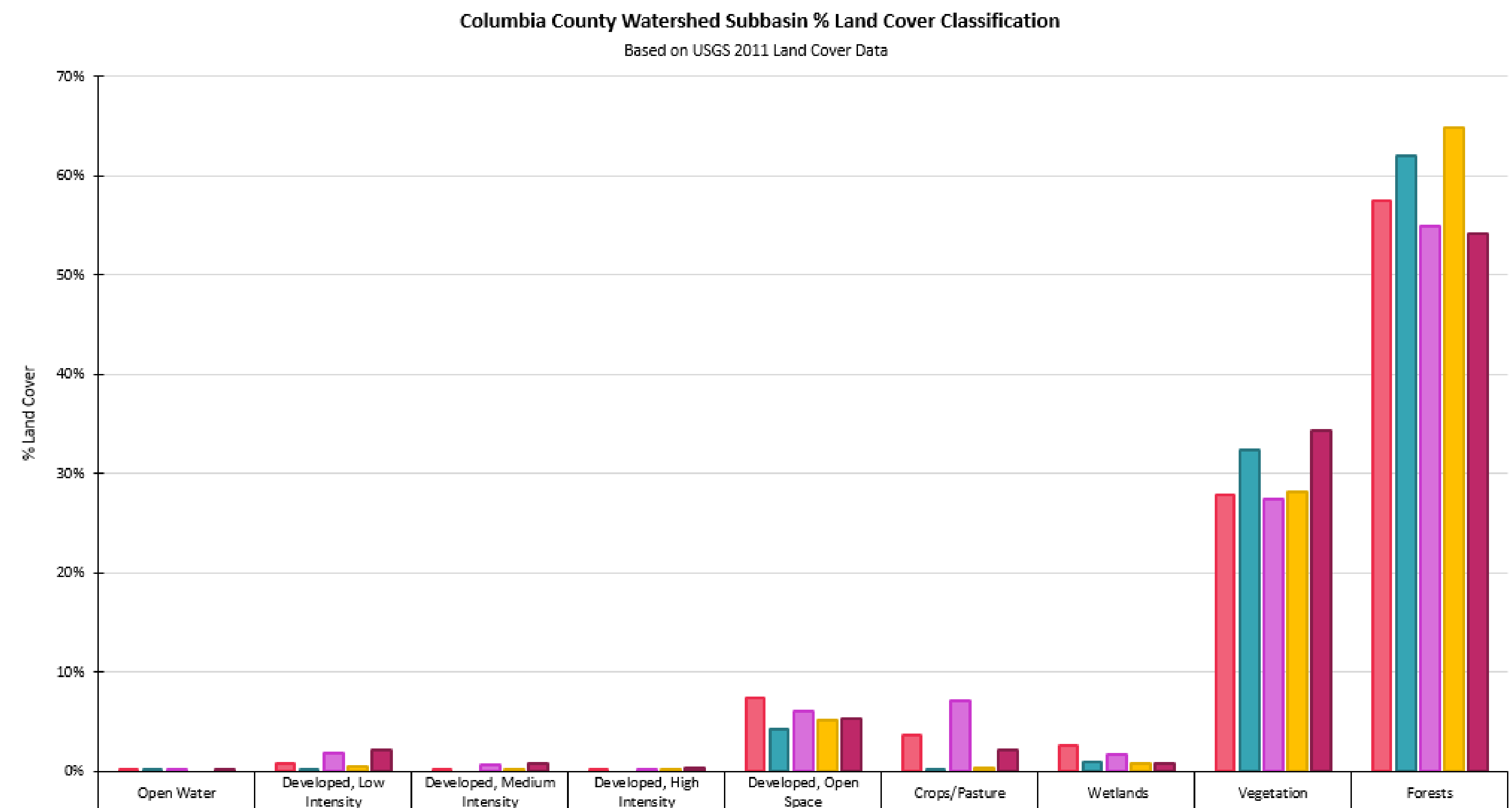
In order to classify land cover in the study site, the most recent available land cover data for the County was downloaded from USGS (2011) and re-categorized into forests, shrub/scrub, pastures, developed and open water (Figure 3, Figure 4) using ArcGIS. Areas and percent landcover were calculated for each watershed. This information will help aid the interpretation of water quality results and provide a complete picture of the watersheds studied in this effort.

The Clatskanie River is approximately 26 miles in length and enters the Columbia River at river mile 50. The Clatskanie watershed is approximately 47,984 acres, with 62% of landcover characterized as forests, 32% as shrub/scrub, and 4% of the landcover is characterized as developed (Figure 3, *Figure 4*).

Beaver Creek is approximately 19 miles in length and enters the Columbia River at the same location as the Clatskanie River at river mile 50. The Beaver Creek watershed is approximately 31,228 acres with 57.5% of landcover characterized as forests, 27.8% as shrub/scrub, and a little over 8% of the landcover characterized as developed (Figure 3, *Figure 4*).

The Scappoose Bay watershed has been divided into three sub-basins: Milton Creek, North Scappoose Creek, and South Scappoose Creek. Milton Creek is approximately 20 miles in length and enters near the mouth of the Scappoose River. The Milton Creek watershed is approximately 20,680 acres, with 55% of landcover characterized as forests, 27% as shrub/scrub, and 9% of the landcover characterized as developed (Figure 3). The North Scappoose Creek and South Scappoose Creek are 12 miles in length and enter the Columbia River via Scappoose Creek at Columbia River mile 86. The North Scappoose watershed is 20,569 acres with 65% of landcover characterized as forests, 28% as shrub/scrub and 6% of the landcover characterized developed (Figure 3). The South Scappoose Creek watershed is 17,391 acres with 54% of landcover characterized as forests, 34% as shrub/scrub and 9% of the landcover characterized as developed (Figure 3, *Figure 4*). Due to tidal influences, Scappoose Creek is not included in this study.

Land cover of Scappoose Bay watershed was previously classified in 2011 using 2001 data, the results of which are present in Appendix C. When compared to results from Figure 3, a negligible amount of change was observed.



	Open Water	Developed, Low Intensity	Developed, Medium Intensity	Developed, High Intensity	Developed, Open Space	Crops/Pasture	Wetlands	Vegetation	Forests
Beaver Creek	0.1%	0.8%	0.1%	0.0%	7.4%	3.6%	2.7%	27.8%	57.5%
Clatskanie River	0.1%	0.1%	0.0%	0.0%	4.3%	0.2%	1.0%	32.4%	62.0%
Milton Creek	0.0%	1.8%	0.7%	0.2%	6.1%	7.2%	1.7%	27.4%	54.9%
North Scappoose Creek	0.0%	0.5%	0.1%	0.0%	5.2%	0.4%	0.8%	28.1%	64.8%
South Scappoose Creek	0.2%	2.1%	0.8%	0.3%	5.3%	2.1%	0.8%	34.3%	54.1%

Figure 3: Percent land cover in Columbia County watersheds based on USGS 2011 Land cover data. Open Water, Developed high intensity, Developed medium intensity, and Developed low intensity are represented as classified by the USGS; Developed open space includes developed open space and barren land classifications; Crops/Pastures includes hay/pasture and cultivated crops classifications; Forests include Evergreen, Deciduous and Mixed forest classifications; Vegetation includes herbaceous and shrub/scrub classifications; Wetlands include emergent herbaceous wetlands and woody wetlands classifications.

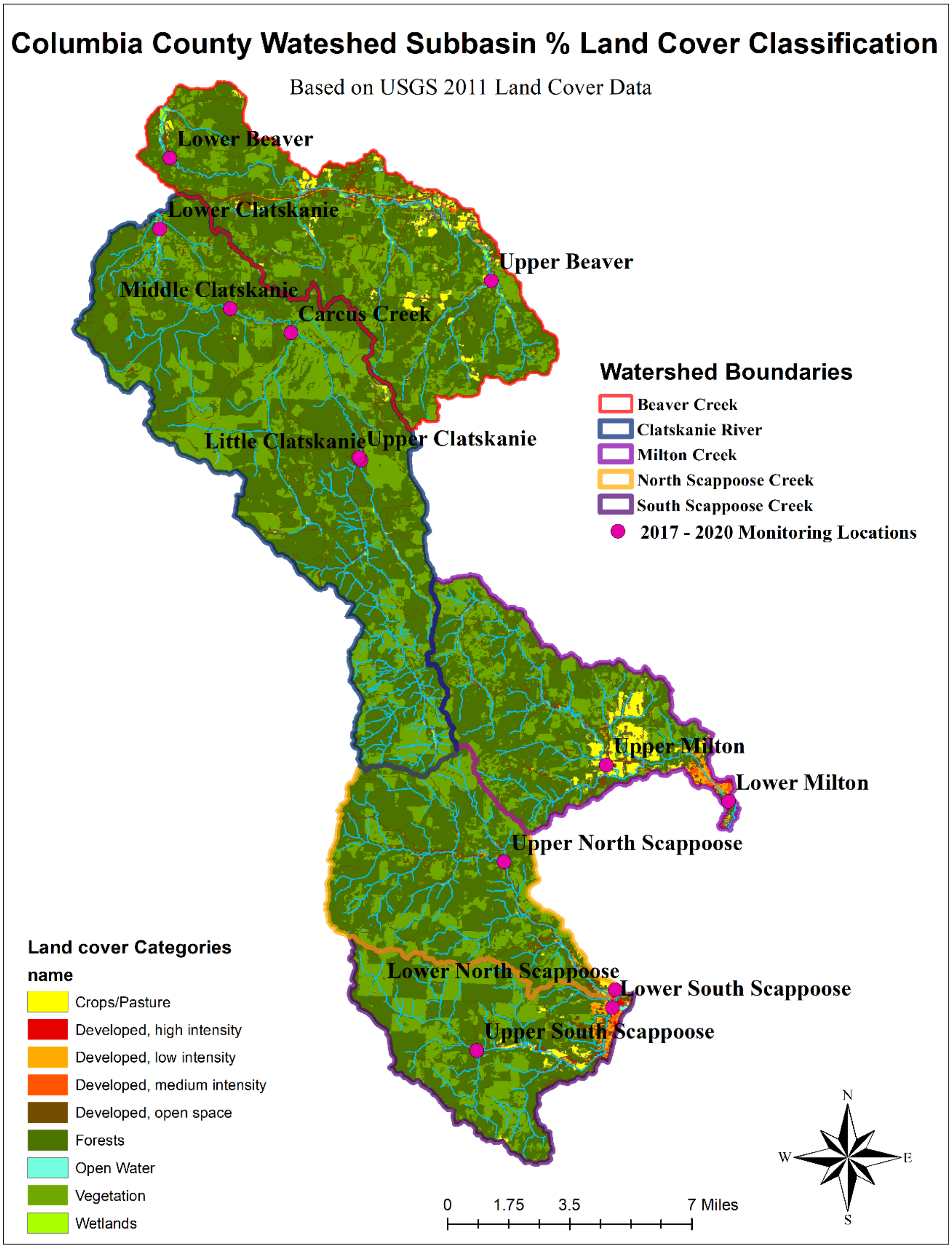


Figure 4: Columbia County Watershed Subbasin Landcover classification map. Adapted from USGS 2011 land cover data. Open Water, Developed high intensity, Developed medium intensity, and Developed low intensity are represented as classified by the USGS; Developed open space includes developed open space and barren land classifications; Crops/Pastures includes hay/pasture and cultivated crops classifications; Forests include Evergreen, Deciduous, and Mixed forest classifications; Vegetation includes herbaceous and shrub/scrub classifications; Wetlands include emergent herbaceous wetlands and woody wetlands classifications.

MONITORING METHODS

Water Quality Parameters

Water quality monitoring was conducted following the methods and quality assurance protocols laid out by the Oregon Department of Environmental Quality (ODEQ) for measuring water temperature, bacteria, and turbidity (ODEQ 2003). See *Table 2* for specifics on equipment used and accuracy ranges of each parameter measured. Data loggers were deployed at 13 monitoring stations (Table 1, Appendix A) between 2017 and 2020, and continuous water temperature collected monthly, at 30-minute intervals, throughout the year. During the monitoring period, certain instances led to data gaps, which have been represented in Figure 5. Dataloggers collecting continuous temperature data in the streams were lost during some storms and high flow events. Due to a programming issue with a hoboware data shuttle used to download logged data on-site, there was a data-loss event during September and/or October of 2019. However, despite these occasions, the long-term monitoring program was able to identify trends in water quality metrics. All site location data was collected for mapping using an Ashtech Promark 220 GPS Unit. On-site, instantaneous temperature and conductivity measurements were made at monthly intervals to serve as temperature checks for continuously collected temperature data.

Turbidity samples were collected monthly at all 13 monitoring stations between 2017 and 2020. One duplicate sample was collected per sampling event. *E. coli* samples were collected in 100 mL bottles fixed with sodium thiosulfate at the temperature monitoring stations; however, the frequency of sampling varied over the reported monitoring period. In 2017, *E. coli* samples were collected monthly between July to October, while in 2018 and 2019, *E. coli* samples were collected on a bi-monthly basis during the summer (June – September) and then monthly from October 2019 to October 2020. Bimonthly samples were also collected between June to September of 2020 to further assess if they were exceeding ODEQ thresholds for freshwater contact recreation:

a) A 90-day geometric mean of 126 E. coli organisms per 100 mL
b) No single sample may exceed 406 E. coli organisms per 100 mL.

Water Quality Data Analysis

Water quality data were summarized and compared to standard parameter ranges for ideal salmonid habitat as defined by the ODEQ, OWEB, and Environmental Protection Agency (EPA) (EPA 2001, OWEB 2001, ODEQ 2003). See Table 3 for a summary of the standard parameter ranges for salmonid habitat and general stream water quality used in this analysis.

Water temperature, turbidity, and *E. coli* data are reported by sampling location and watershed. The 7-day moving average maximum (7 dMAM) was calculated from the continuous water temperature data for the entire monitoring period. The number of days over 18°C (DEQ regulatory standards for salmonid rearing habitat, Table 3) was also calculated and summarized. Turbidity and *E. coli* data were summarized across years for each monitoring station. Monthly variation for listed parameters across years at each station were tabulated. All water quality data analysis was conducted using R 3.4.1 and Tableau 2020.4. Maps were prepared using ESRI ArcGIS Version 10.5.1.

Table 2: Water quality parameters measured, equipment used, and accuracy standards (ODEQ A level data quality standards) (OWEB 2001).

Water Quality Parameter	Equipment	Accuracy
***E. coli* Bacteria Counts**	Lab Analysis	(+/-) 0.5 log (MPN/100ml)
Turbidity	Hach Turbidity Meter	(+/-) 5% of standard value (NTU)
Stream Water Temperature	HOBO Data Logger and NIST Digital Thermometer	(+/-) 0.5 °C

Table 3: Summary of standard parameter ranges for salmonid habitat and general stream water quality (EPA 2001, OWEB 2001, ODEQ 2003, UWE 2006).

Parameters	Need	Acceptable Range	Source
***E. coli* Bacteria**	**General**	<406 MPN/100ml (DEQ) or <235 MPN/100ml (EPA)	DEQ regulatory standards (OAR 340-041), EPA recommended Criteria
Turbidity	**Salmon Habitat**	<10 NTU	University of Wisconsin Extension 2006
Temperature	**Salmon Habitat: Year-round**	18°C 7-day moving average maximum (7dMAM)	DEQ regulatory standards for salmonid rearing habitat
Temperature	**Salmon Habitat: Healthy Adult**	7.2-15.6°C (>25 °C Lethal)	OWEB Water Quality Technical Manual
Temperature	**Salmon Habitat: Healthy Juvenile**	12.2-13.9°C (>25 °C Lethal)	OWEB Water Quality Technical Manual

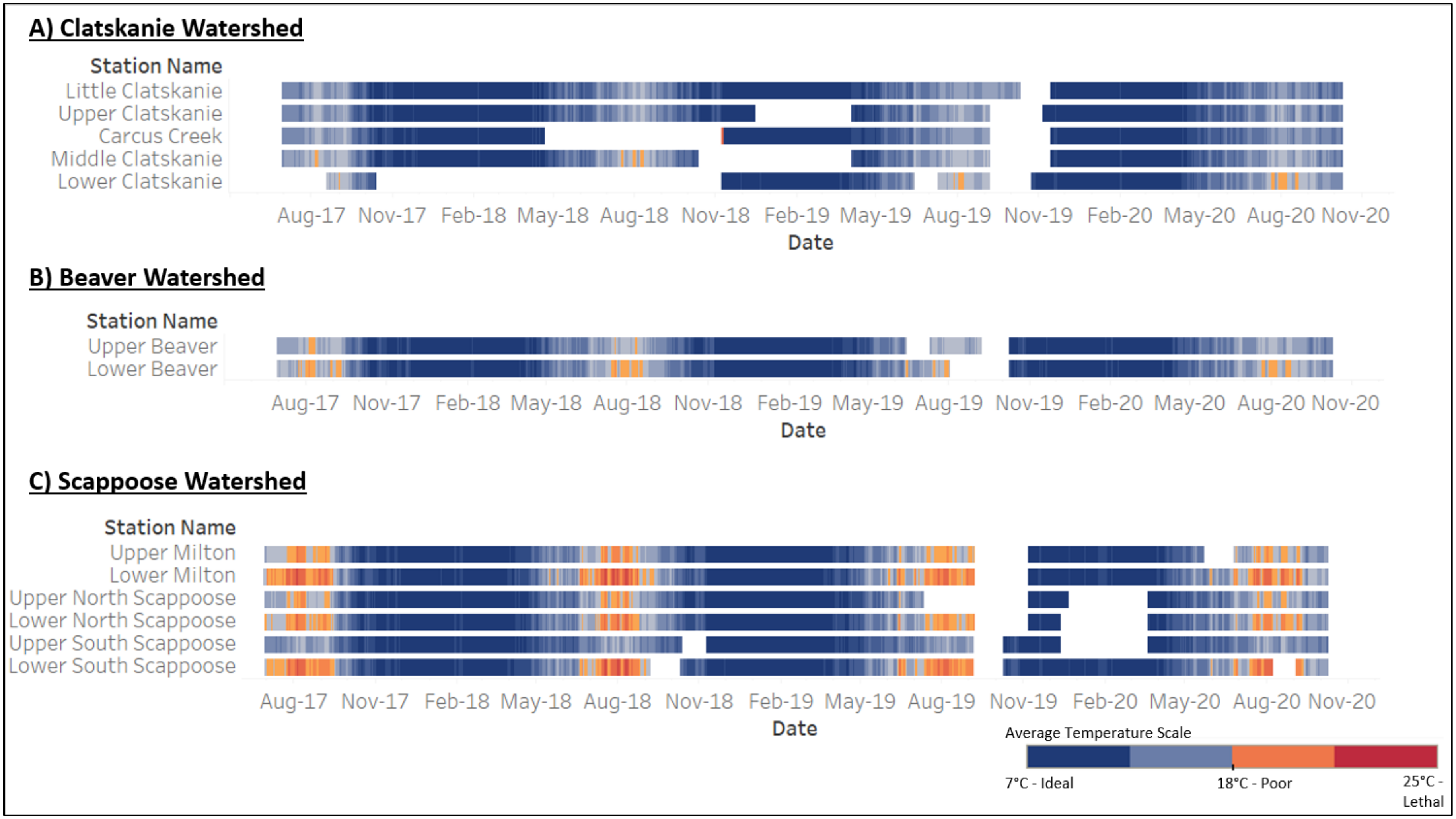


Figure 5: Data logger deployment timeline at 13 monitoring stations across three watersheds, from 2017 to 2020. The colors represent average water temperature (°C) during deployments corresponding to the temperature threshold shown in Table 3 and represented in the legend.

Comparative Analysis with Historic Datasets

Water quality data of the Scappoose Bay watershed collected as part of this sampling effort has been compared to baseline data collected as part of a watershed-wide monitoring program between 2008 to 2011 (OWEB, 2011). The baseline data collection effort monitored a total of 27 sites for temperature, dissolved oxygen (DO), pH, turbidity, and conductivity. Monitoring sites at Milton Creek, North Scappoose Creek, and South Scappoose Creek from both efforts were mapped and locations with close proximities were compared to identify changes in the monitored parameters (Figure 6). The locations used for this comparative analyses are tabulated below. 7dMAM Temperature, turbidity and *E. coli* data from both efforts were compared and variations have been summarized in this report.

Table 4: Locations of sampling stations from the current and historic data used for the comparative analysis. Years of available data are also presented.

Sub-watershed	Site Identification	Latitude, Longitude	Monitoring Years	Historic data Monitoring Site	Latitude, Longitude	Monitoring Years
Milton Creek	Upper Milton – UM	45.8641139, -122.8879489	2017-2020	Milton Creek – MIL024	45.8933333, -122.9273500	2008-2009, 2011
				Salmon Creek – SAL148	45.8670167, -122.8925667	2008-2009, 2011
	Lower Milton – LM	45.8504302, -122.8147681	2017-2020	Milton Creek – MIL002	45.8505000, -122.8143167	2008, 2011
North Scappoose Creek	Upper North Scappoose – UNS	45.8227512, -122.9469585	2017-2020	Alder Creek – ALD077	45.8204833, -122.9468500	2008-2009, 2011
	Lower North Scappoose – LNS	45.7711443, -122.8787030	2017-2020	North Scappoose – NSC001	45.7696333, -122.8743500	2008, 2011
South Scappoose Creek	Upper South Scappoose – USS	45.7443630, -122.9596836	2017-2020	Lacey Creek – LZY028	45.7467667, -122.9694833	2008-2009, 2011
				South Scappoose – SSC041	45.7548500, -122.9772833	2008-2009, 2011
	Lower South Scappoose – LSS	45.7637674, -122.8800218	2017-2020	South Scappoose – SSCJPW	45.7567500, -122.8828500	2008, 2011

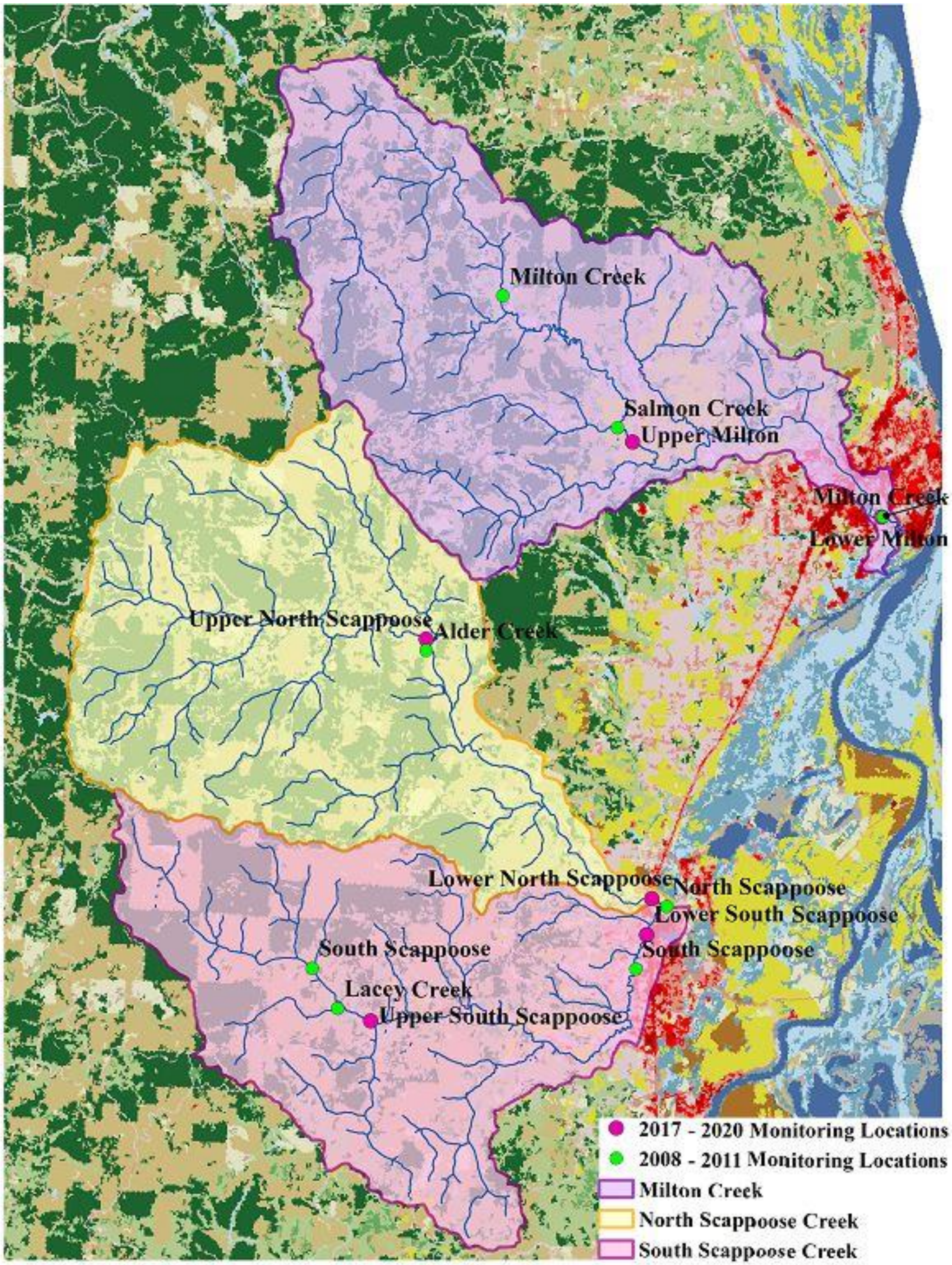


Figure 6: Locations of current and baseline monitoring sites in the Scappoose Bay Watershed. Baseline stations are represented as green dots, while current monitoring stations are represented as pink dots. Sub-watershed boundaries are also shown. Clatskanie River and Beaver Creek are not shown herein as no historic baseline data was available at the time of writing this report.

WATER QUALITY MONITORING RESULTS

Clatskanie Watershed

Study Area

Clatskanie Watershed Monitoring Locations (2017-2020)

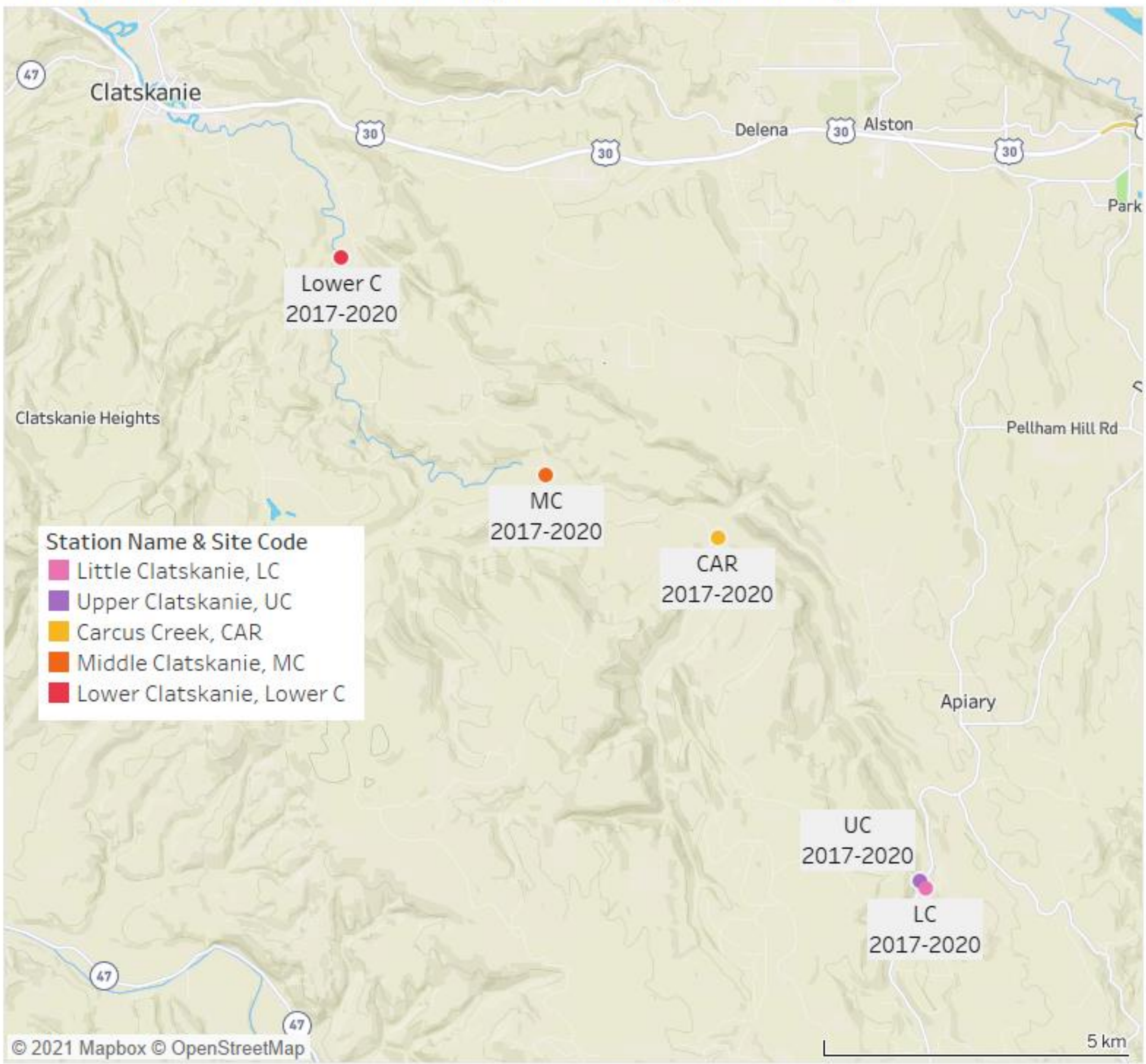


Figure 7: Focus map of Clatskanie Watershed Water Quality Monitoring Locations (2017-2020). Moving from the upper watershed with Little Clatskanie (LC) to the lower watershed, nearing the confluence of Clatskanie river with the Columbia River, at Lower Clatskanie (Lower C). For a map of watershed, boundaries see Figure 2, and for specific monitoring location details, see Table 1.

Water Temperature

Between 2017 and 2020, 7-day moving average maximum temperatures (7dMAM) in the Clatskanie watershed varied from 4.5°C to 19.7°C (Table 5). Stream temperatures tend to increase from the upper basin to the lower basin (Figure 8). The highest seasonal temperatures were observed during August throughout the monitoring period (Figure 9), when air temperatures tended to be the highest and water levels are low.

DEQ temperature standard for salmon rearing habitat is less than 18°C, and streams with temperatures higher than 18°C are considered poor quality for salmon. Little Clatskanie, Upper Clatskanie, and Carcus Creek 7dMAM temperature remained below the 18°C temperature threshold throughout the study (Figure 10). These monitoring locations are in forested areas of the watershed (Figure 4) and due to shading and lack of anthropogenic influences temperatures remain within ideal conditions (Table 3). In Middle, Clatskanie temperatures exceeded 18°C in August between 2018 and 2020. The temperature in the Lower mainstem Clatskanie River exceeded 18° C more regularly than other sites in the watershed, with summer temperatures consistently holding above the 18°C temperature threshold. These sites are in areas with pastures with runoffs and reduced shading, which may increase temperatures. Monthly temperature comparison across years shows winter temperatures being higher in 2020 (Table 5).

Table 5: Monthly variation in 7dMAM temperatures from 2017 to 2020 for creeks in Clatskanie Watershed. Temperatures have been color-coded according to salmonid thresholds listed in Table 3, with blue representing cooler, ideal conditions, and yellow/orange representing temperatures crossing 18°C.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Little Clatskanie	2017							15.1	16.3	14.4	9.5	8.2	5.2
	2018	6.9	6.2	6.8	9.7	13.4	13.5	16.0	16.7	13.1	9.8	7.7	6.2
	2019	6.2	4.5	6.1	10.1	13.1	14.1	15.3	16.0	16.1	15.8	6.6	5.5
	2020	7.1	6.6	6.8	10.0	12.4	13.6	14.8	15.8	14.5	13.5		
Upper Clatskanie	2017							15.1	16.3	14.4	9.5	8.2	5.2
	2018	6.9	6.2	6.8	9.7	13.4	13.5	16.0	16.7	13.3	9.8	7.4	5.2
	2019				9.9	13.5	14.9	16.0	16.7	16.6		6.4	5.3
	2020	7.1	6.8	6.6	10.0	12.2	13.7	15.8	16.9	15.1	13.8		
Carcus Creek	2017							15.2	16.5	14.9	10.3	8.7	6.2
	2018	7.5	6.9	7.1	8.7							7.3	6.7
	2019	6.7	5.3	6.2	9.4	11.6	13.5	15.0	15.9	16.2		7.3	6.0
	2020	7.5	7.3	7.1	9.7	11.6	13.0	14.6	15.9	14.7	13.7		
Middle Clatskanie	2017							16.8	17.8	15.6	10.3	8.6	5.8
	2018	7.3	6.7	7.1	9.7	13.7	14.5	17.4	17.9	14.3	12.0		
	2019				10.3	13.4	15.5	17.2	18.0	17.4		7.2	5.8
	2020	7.4	7.1	7.1	10.1	12.7	14.4	16.6	18.3	16.0	14.5		
Lower Clatskanie	2017								19.1	17.2	12.4		
	2018											7.4	6.9
	2019	7.0	5.4	7.0	10.7	14.7	17.4	19.0	19.0	19.1	9.0	7.3	6.1
	2020	7.6	7.3	7.5	10.8	13.9	15.8	17.9	19.7	16.9	15.6		

Average Temperature Scale

7°C - Ideal 18°C - Poor 25°C - Lethal

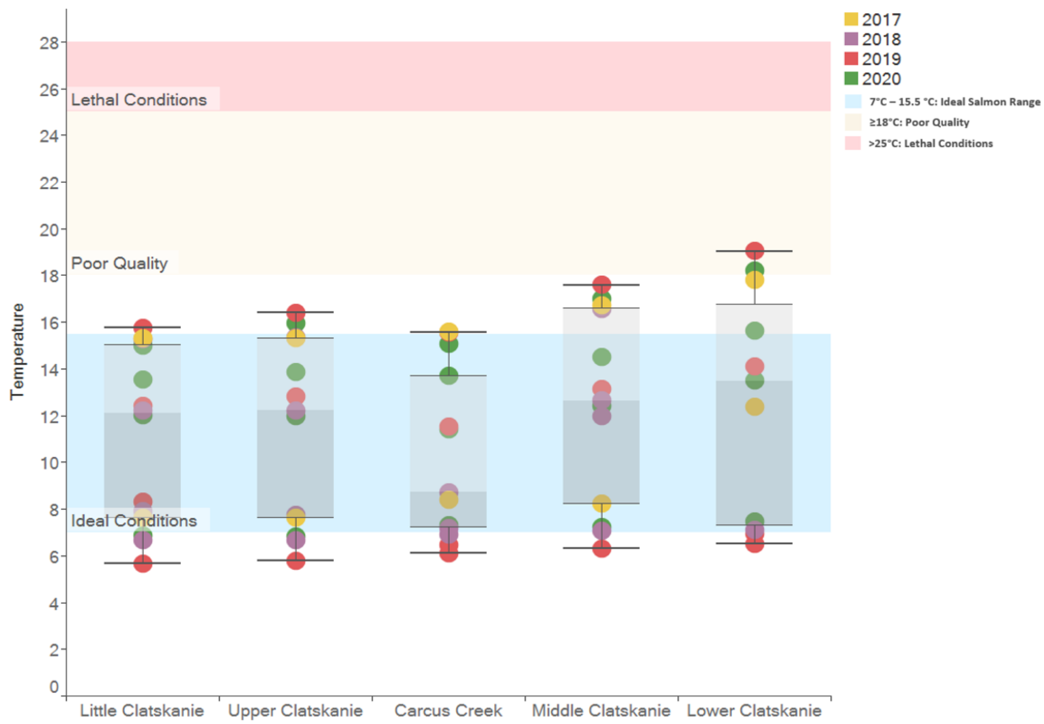


Figure 8: Clatskanie Watershed 7dMAM Temperature range from 2017 to 2020, overlaid on the DEQ stream temperature standard ranges for healthy salmon habitat (Table 3). Data points represent the months monitored in a year.

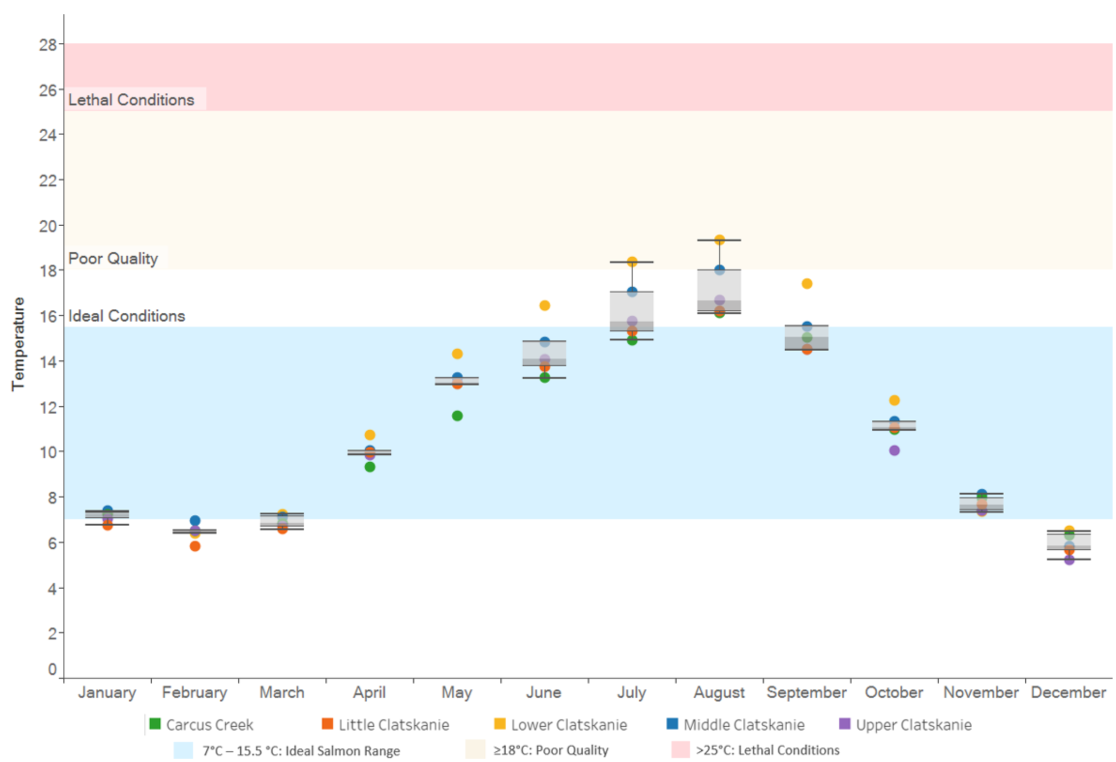


Figure 9: Monthly variation in 7dMAM temperature in the Clatskanie River watershed between 2017 – 2020.

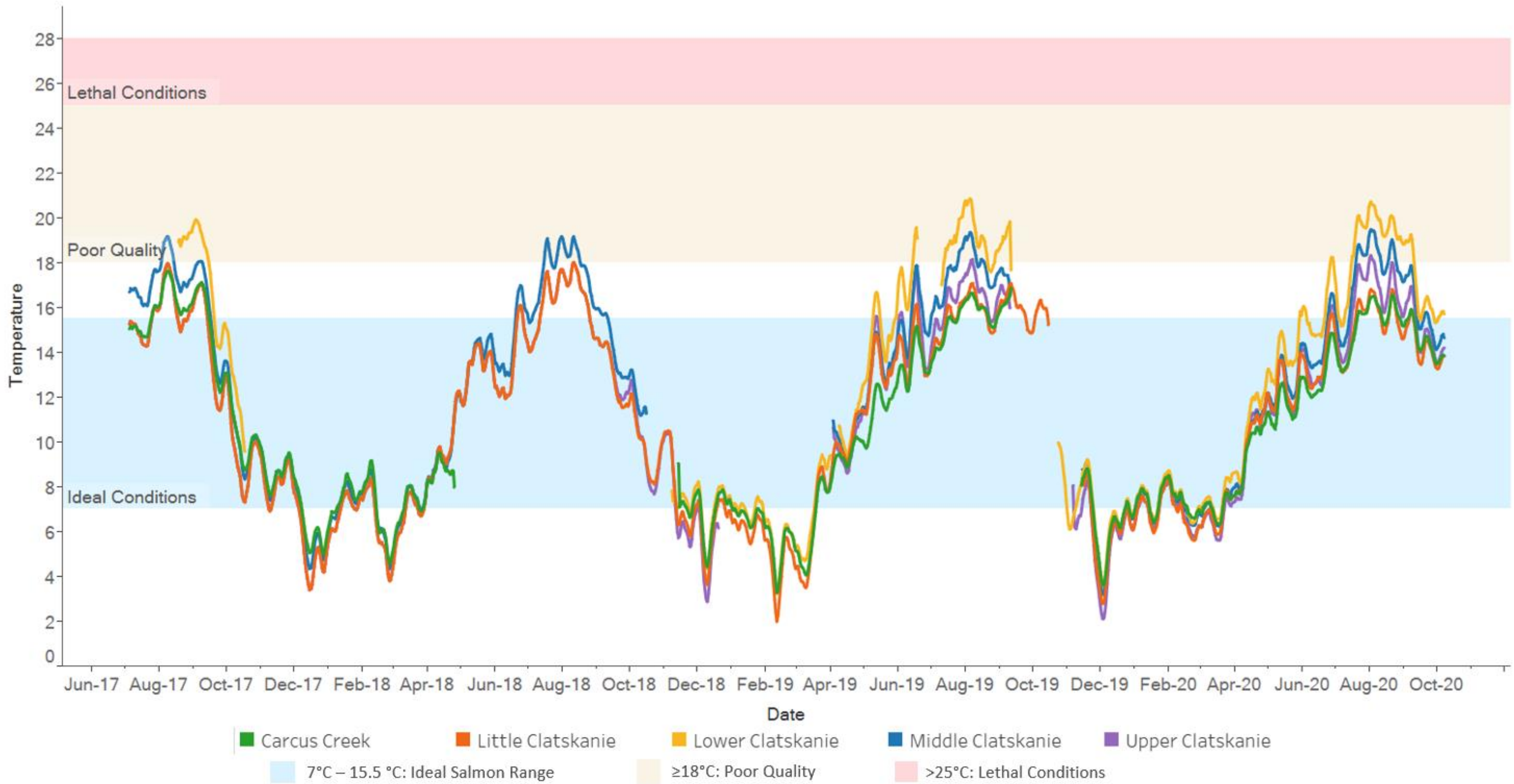


Figure 10: Clatskanie Watershed 7-day average maximum temperatures (7dMAM) from June 2017 to October 2020 overlayed on salmonid temperature threshold ranges. See Table 3 for temperature threshold details.

Temperatures in the lower Clatskanie watershed exceed 18°C for longer periods of time, with the highest number of days exceeding the temperature threshold in 2020 (Table 6).

Table 6: Number of days over 18°C in the Clatskanie watershed between 2017 to 2020. Winter and spring months have been excluded from this table as stream temperature conditions are within ideal conditions at that time.

		May	June	July	August	September	October
Little Clatskanie	2017			0	0	0	0
	2018	0	0	0	1	0	0
	2019	0	0	0	0	0	0
	2020	0	0	0	0	0	0
Upper Clatskanie	2017			0	0	0	0
	2018	0	0	0	1	0	0
	2019	0	0	0	2	0	
	2020	0	0	0	6	0	0
Carcus Creek	2017			0	0	0	0
	2019	0	0	0	0	0	
	2020	0	0	0	0	0	0
Middle Clatskanie	2017			0	12	4	0
	2018	0	0	11	16	0	0
	2019	0	0	7	13	0	
	2020	0	0	12	18	0	0
Lower Clatskanie	2017				14	14	0
	2019	0	4	19	24	10	0
	2020	0	2	16	31	9	0

Water Turbidity Levels

Over the four-year monitoring period, on average, Carcus Creek, Little Clatskanie Creek, Upper Clatskanie, Mid-Clatskanie, and Lower Clatskanie River sampling locations maintained relatively low (< 4 NTU) turbidity levels (Table 7, Figure 11-Figure 12). Seasonally, the highest turbidity levels were recorded in the winter months (Nov., Dec., Jan.), reflecting winter storm conditions and high flow events (Figure 11). Elevated turbidity events were primarily observed at the headwater sampling locations Little Clatskanie, Upper Clatskanie, and Carcus Creek (Figure 12). All sites remained below the 10 NTU salmon habitat turbidity threshold during the study period.

Table 7: Summary Table for Clatskanie Watershed Monthly Turbidity (NTU), 2017-2020 Grab Samples. Turbidity grab sampling results for Clastkanie Watershed broken down across years and watershed sampling locations. n = number of samples collected. No samples collected went over the 10 NTU threshold.

Summary Table: Clatskanie Watershed Monthly Turbidity (NTU)
2017-2020 Grab Samples

		n	Max	Mean	+/- SD
2017	Little Clatskanie	4	5.11	2.68	2.05
	Upper Clatskanie	4	5.11	3.17	1.47
	Carcus	4	2.24	1.16	1.12
	Middle Clatskanie	4	3.03	1.33	1.16
	Lower Clatskanie	3	4.50	2.17	2.02
2018	Little Clatskanie	11	6.82	3.45	1.79
	Upper Clatskanie	11	7.49	3.85	1.60
	Carcus	11	3.11	1.25	0.85
	Middle Clatskanie	11	4.55	2.03	1.20
	Lower Clatskanie	11	4.42	2.09	1.31
2019	Little Clatskanie	11	7.42	3.46	1.79
	Upper Clatskanie	11	7.35	3.34	1.59
	Carcus	11	7.75	1.68	2.06
	Middle Clatskanie	13	3.59	1.83	0.95
	Lower Clatskanie	12	3.13	1.52	0.83
2020	Little Clatskanie	15	8.32	4.03	2.36
	Upper Clatskanie	15	5.40	3.15	1.10
	Carcus	15	7.65	2.22	1.86
	Middle Clatskanie	15	3.47	1.61	0.80
	Lower Clatskanie	15	3.80	1.50	0.98

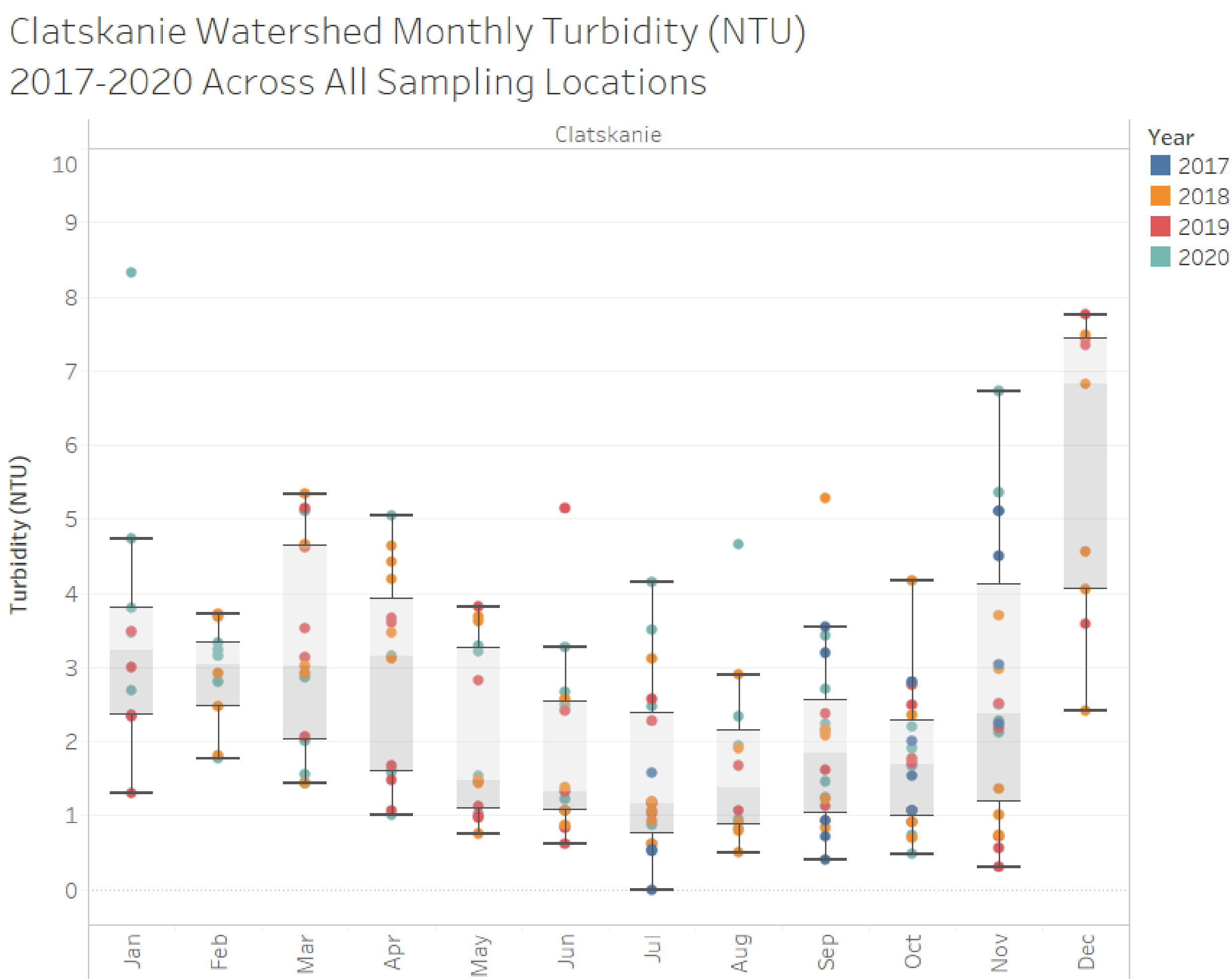


Figure 11: Turbidity (NTU) grab sampling results (boxplots) for Clatskanie watershed broken down across months sampled incorporating all watershed sampling locations. Sampling years ranging from 2017 to 2020 are highlighted within each boxplot. No samples collected went over the 10 NTU threshold. These data broken down across monitoring locations within the watershed can be seen in Figure 12.

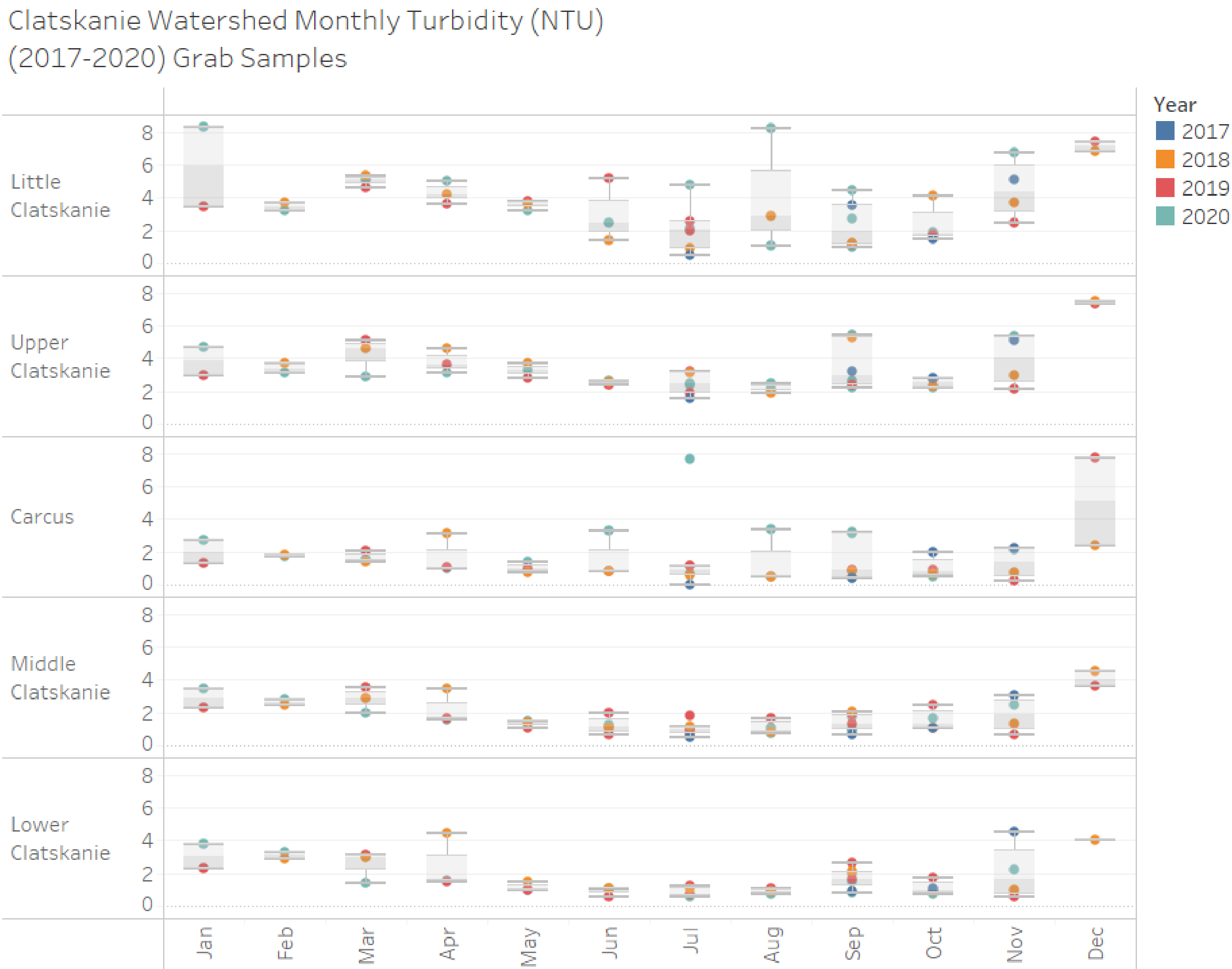


Figure 12: Turbidity (NTU) grab sampling results (boxplots) for Clatskanie Watershed broken down across sampling locations and months sampled. Sampling years ranging from 2017 to 2020 are highlighted within each boxplot. No samples collected went over the 10 NTU threshold. A summary of these data can be found in Table 7.

Water Bacteria Levels

In 2017, stream sampling of *E. coli* bacteria levels in the Clatskanie Watershed were only collected in Lower Clatskanie Creek during September and October 2017 and exhibited low *E. coli* levels (<100 MPN/100 ml) during these sampling events (Table 8, Figure 13-Figure 14). More intensive bacteria sampling was conducted in 2019 and 2020, with bi-monthly samples collected in the summer months (ODEQ, 2020). On average *E. coli* bacteria levels across most sampling sites remained below the EPA (235 MPN/100) and ODEQ (406 MPN/100) thresholds; however, Lower Clatskanie, Middle Clatskanie, Little Clatskanie, and Upper Clatskanie did experience elevated *E. coli* events during the 2017-2020 sampling period. These elevated sample readings primarily occurred between June-September (Figure 13-Figure 14), corresponding with summer high water temperatures (Figure 10).

The 90-day geometric mean state-mandated water quality threshold for Oregon is 126 MPN/100; Middle Clatskanie violated this threshold during the following sampling periods June-September 2019 and July-November 2020 (Table 9). Middle Clatskanie also violated the no single sample over 406 MPN/100 threshold in June of 2019 with a sample reading of 2,490 MPN/100 (Table 8). These water quality conditions merit continued monitoring and additional investigation into the cause of elevated *E. coli* levels to ensure they do not continue to decline.

Table 8: Summary Table of Clatskanie Watershed Monthly E. coli (2017-2020) MPN/100 ml Grab Samples. E. coli bacteria grab sampling results for Clatskanie watershed broken down across years and watershed sampling locations. Sampling locations that experienced events over the EPA (235 MPN/100) and ODEQ (406 MPN/100) thresholds for E.coli bacteria levels are highlighted in red. n = number of samples collected, for monthly max data, see Appendix B.

Summary Table: Clatskanie Watershed Monthly *E. coli* (MPN/100 ml) 2017-2020 Grab Samples

		n	Max	Mean	+/- SD
2017	Little Clatskanie	0			
	Upper Clatskanie	0			
	Carcus	0			
	Middle Clatskanie	0			
	Lower Clatskanie	2	69	57	18
2018	Little Clatskanie	0			
	Upper Clatskanie	0			
	Carcus	0			
	Middle Clatskanie	0			
	Lower Clatskanie	0			
2019	Little Clatskanie	7	140	36	49
	Upper Clatskanie	7	144	44	48
	Carcus	6	126	30	47
	Middle Clatskanie	11	2,490	303	732
	Lower Clatskanie	8	271	90	85
2020	Little Clatskanie	14	345	72	90
	Upper Clatskanie	14	365	62	95
	Carcus	14	114	22	30
	Middle Clatskanie	14	248	109	86
	Lower Clatskanie	14	190	71	54

Table 9: 90 Day geometric mean (5 samples or greater) of E. coli bacteria levels (MPN/100ml) across all sampling sites, those durations that are above the state-mandated threshold of 126 MPN/100 ml for the 90 day geometric mean are highlighted with red text.

Clatskanie Watershed *E. coli* (MPN/100 ml)
90 Day Geometric Mean (5 samples or greater)

		May - Aug	Jun - Sep	Jul - Oct	Aug - Nov
2019	Middle Clatskanie		133.3	66.7	
	Lower Clatskanie		113.7	113.7	
2020	Little Clatskanie	41.2	54.3	63.3	67.8
	Upper Clatskanie	55.5	58.4	50.0	40.4
	Carcus	11.2	18.2	17.7	21.3
	Middle Clatskanie	53.7	88.9	129.7	147.7
	Lower Clatskanie	58.6	78.4	76.5	99.1

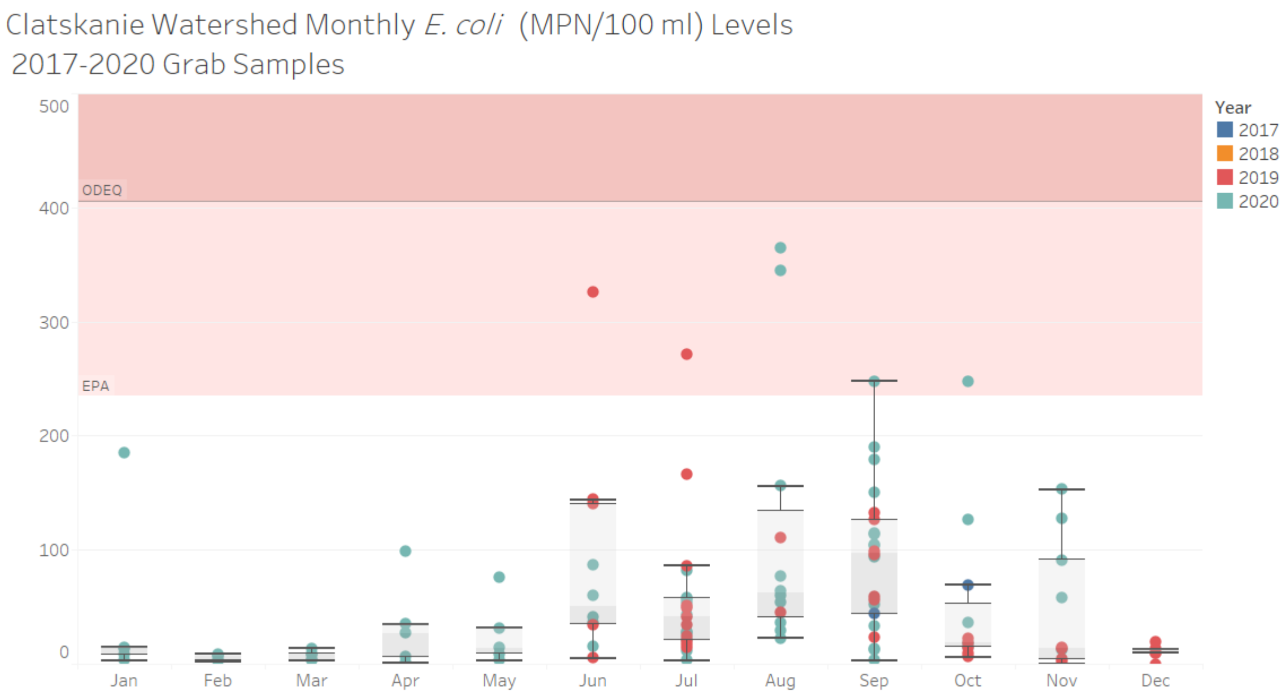


Figure 13: E. coli bacteria grab sampling results (boxplots) for Clastkanie watershed broken down across months sampled incorporating all watershed sampling locations. Sampling years ranging from 2017 to 2020 are highlighted within each boxplot. EPA (235 MPN/100) and ODEQ (406 MPN/100) thresholds for E. coli bacteria levels are highlighted on each graph. June 2019 Middle Clatskanie 2490 MPN/100 sample results not shown.

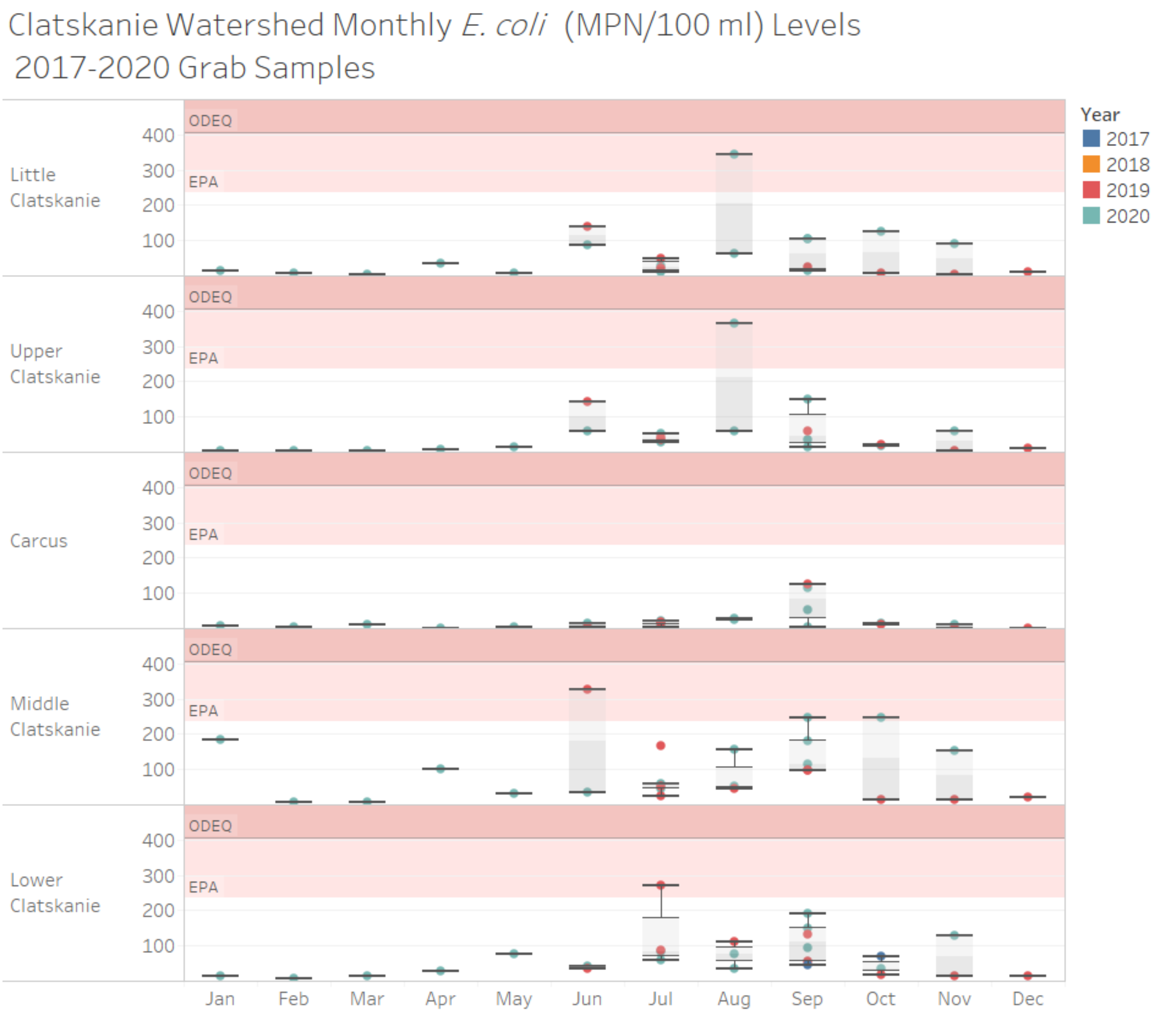


Figure 14: E. coli bacteria grab sampling results (boxplots) for Clatskanie watershed broken down across months sampled and watershed sampling location. Sampling years ranging from 2017 to 2020 are highlighted within each boxplot. EPA (235 MPN/100) and ODEQ (406 MPN/100) thresholds for E. coli bacteria levels are highlighted on each graph. June 2019 Middle Clatskanie 2490 MPN/100 sample results not shown.

Water Conductivity Levels

Stream conductivity levels were monitored starting in July 2018. Conductivity levels varied seasonally across all monitoring locations within the Clatskanie watershed (Figure 15-Figure 16,

Table *10*). Annual increases in water conductivity being observed between April to October and declining from November to February (Figure 15). Over time, Carcus Creek has exhibited the lowest overall mean conductivity levels, followed by Upper Clatskanie, Little Clatskanie, Middle Clatskanie, and Lower Clatskanie sampling locations (Figure 16,

Table *10*). These data provide baseline conductivity levels that can be used to identify new and emerging water quality issues or improvements over time. Pollution from runoff or increased turbidity levels from sediment can result in higher conductivity levels; however, there is no EPA or ODEQ threshold for conductivity in the region.

Table 10: Summary Table of Clatskanie watershed monthly conductivity (µs/cm) data for 2018-2020 grab samples. Conductivity (µs/cm) samples broken down across months sampled and watershed sampling location. n = number of samples collected. For monthly data by site, see Appendix B.

Clatskanie Watershed Monthly Mean Conductivity Levels (µs/cm)
2018-2020 Grab Samples

		n	Max	Mean	+/- SD
2018	Little Clatskanie	6	85	66	20
	Upper Clatskanie	6	80	61	17
	Carcus	6	57	46	11
	Middle Clatskanie	6	73	59	15
	Lower Clatskanie	6	88	73	18
2019	Little Clatskanie	11	103	63	26
	Upper Clatskanie	11	109	63	27
	Carcus	10	71	49	18
	Middle Clatskanie	14	101	71	25
	Lower Clatskanie	12	110	80	28
2020	Little Clatskanie	16	126	71	29
	Upper Clatskanie	16	105	67	26
	Carcus	16	131	57	25
	Middle Clatskanie	16	107	73	25
	Lower Clatskanie	16	115	83	24

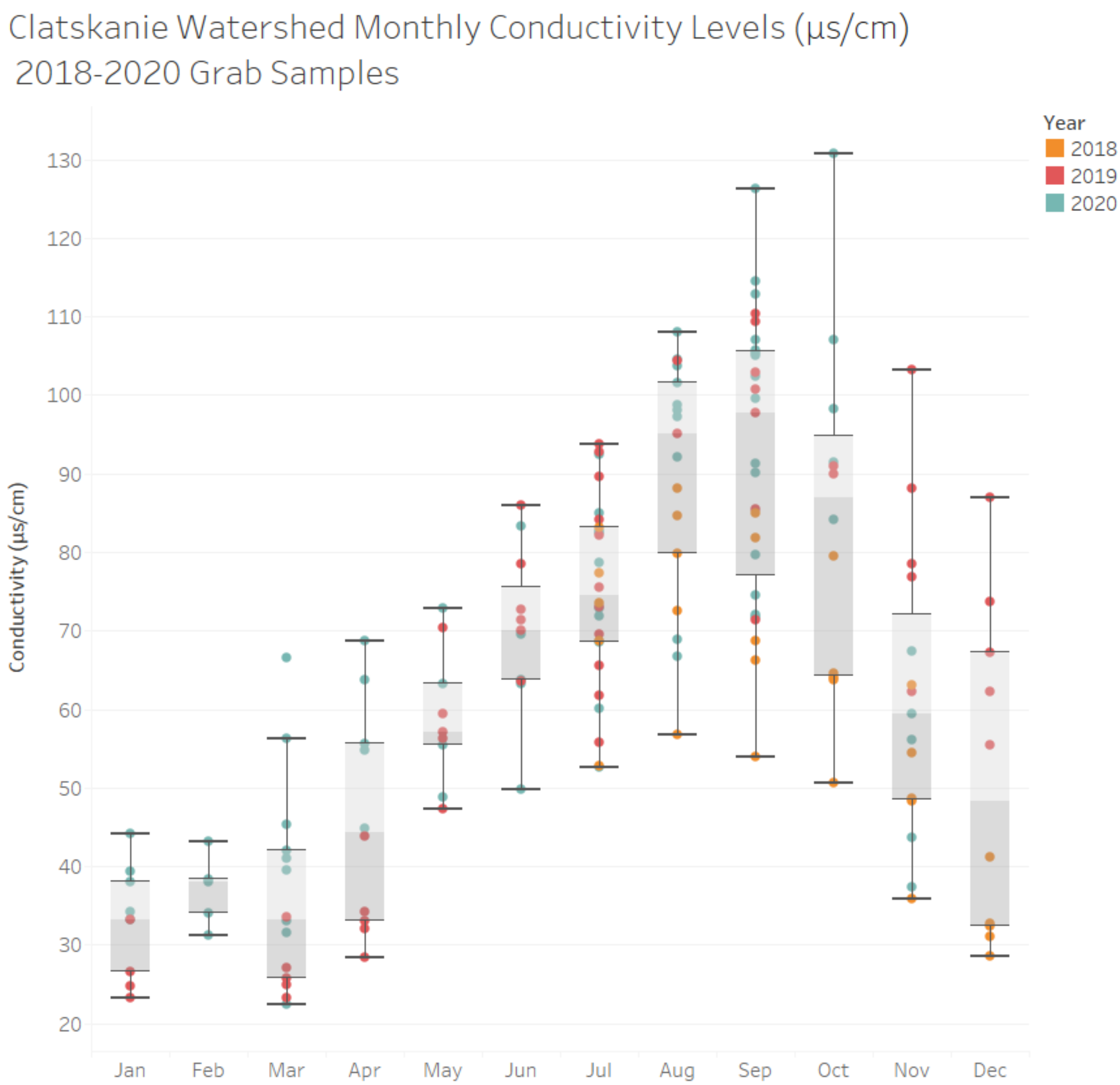


Figure 15: Conductivity levels (µs/cm) 2018-2020 Grab Samples results (boxplots) for Clatskanie watershed broken down across months sampled. Sampling years ranging from 2018 to 2020 are highlighted within each boxplot.

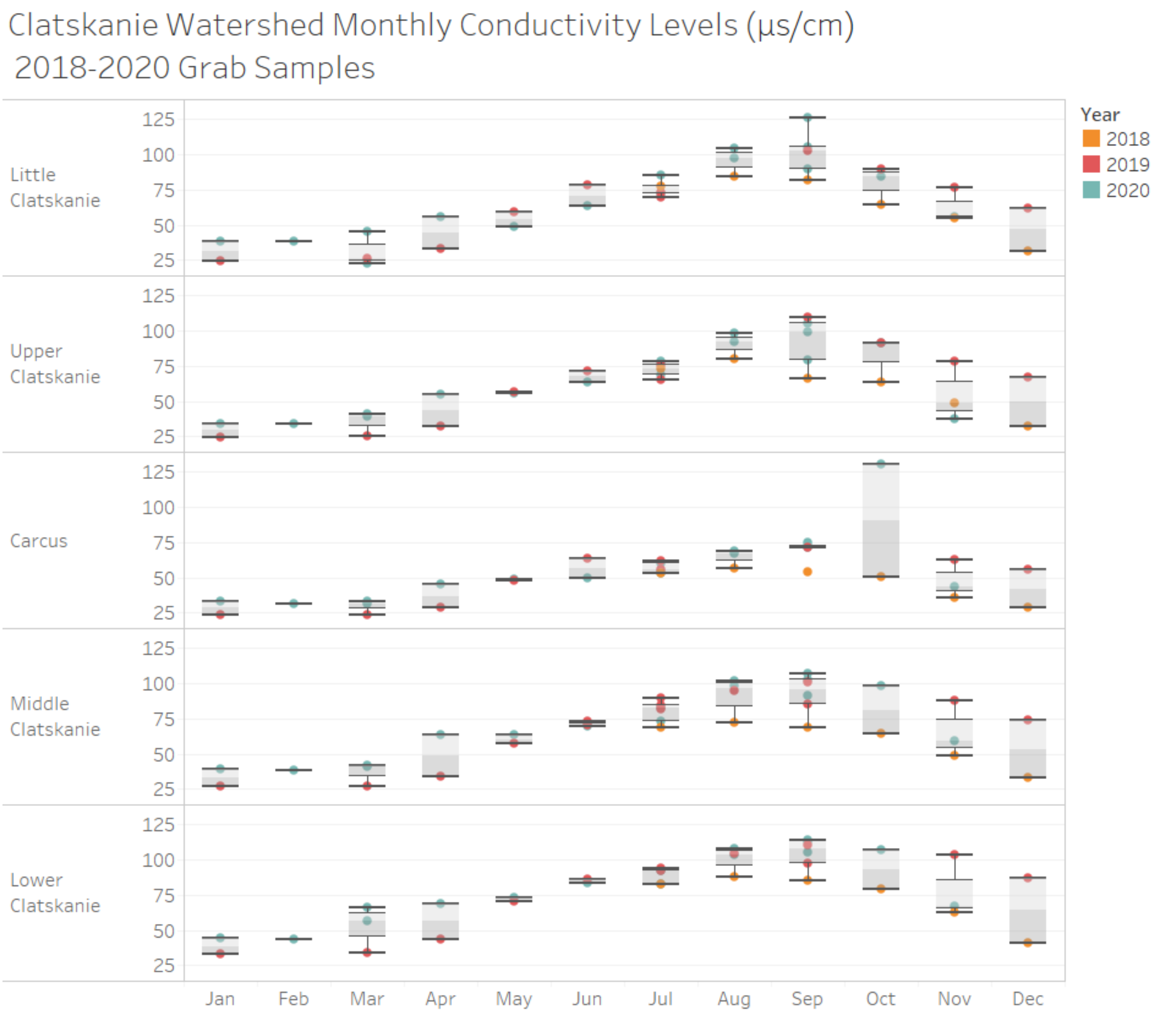


Figure 16: Conductivity levels (µs/cm) 2018-2020 Grab Samples results (boxplots) for Clatskanie watershed broken down across months sampled and watershed sampling location. Sampling years ranging from 2018 to 2020 are highlighted within each boxplot.

Water Quality Issues

Water quality issues observe in Clatskanie Watershed were isolated to the lower reaches. Water quality (temperature, turbidity, *E. coli*) in the upper reaches of the Clatskanie Watershed, which is predominantly forested, meets minimum EPA and ODEQ requirements for salmon habitat. The temperature in Middle and Lower Clatskanie exceeded the 18°C thresholds for salmon habitat during the summer across all monitoring years (2017-2020), when water levels were low, and air temperatures are high (*Table 5*). Overall elevated temperatures are likely caused by solar loading, as the lower reaches of the watershed are much more developed (pastures) and lack riparian shade (Figure 4). Low water temperatures are critical for supporting aquatic life including endangered Salmonids in the Pacific Northwest; reducing solar radiation and reducing urban and agricultural runoff can help keep water temperatures down and protect these stream habitats (USGS 2021). These elevated temperatures also coincide with elevated counts of *E. coli* in these sites. Elevated *E. coli* bacteria levels were observed in Middle Clatskanie between June-September in 2019 and July-November in 2020, exceeding the EPA and

ODEQ standards including the five sample geometric mean (Table 3,*Table 37* Table 9). *E. coli* bacteria issues are indicative of animal waste runoff and can be very harmful to humans using these waterways for recreation (Pandey et al. 2014). Additional research is needed to determine the exact source of the elevated *E. coli*. Animal waste or septic tank leakage into the stream are possible sources to be investigated. Depending on the source, actions that could reduce future *E. coli* exceedance events include increasing riparian buffers, excluding livestock from the creek, increasing manure management near streams, or updating failed septic systems throughout the targeted reach of the watershed (Pandey et al. 2014). Given the frequency and scale of *E. coli* bacteria events in the lower watershed adding warning signs to recreational areas along this reach of the stream and/or notifying nearby homeowners is recommended. No significant issues or shifts in stream water turbidity or conductivity levels were detected in Clatskanie Watershed during this study.

Beaver Creek Watershed

Study Area

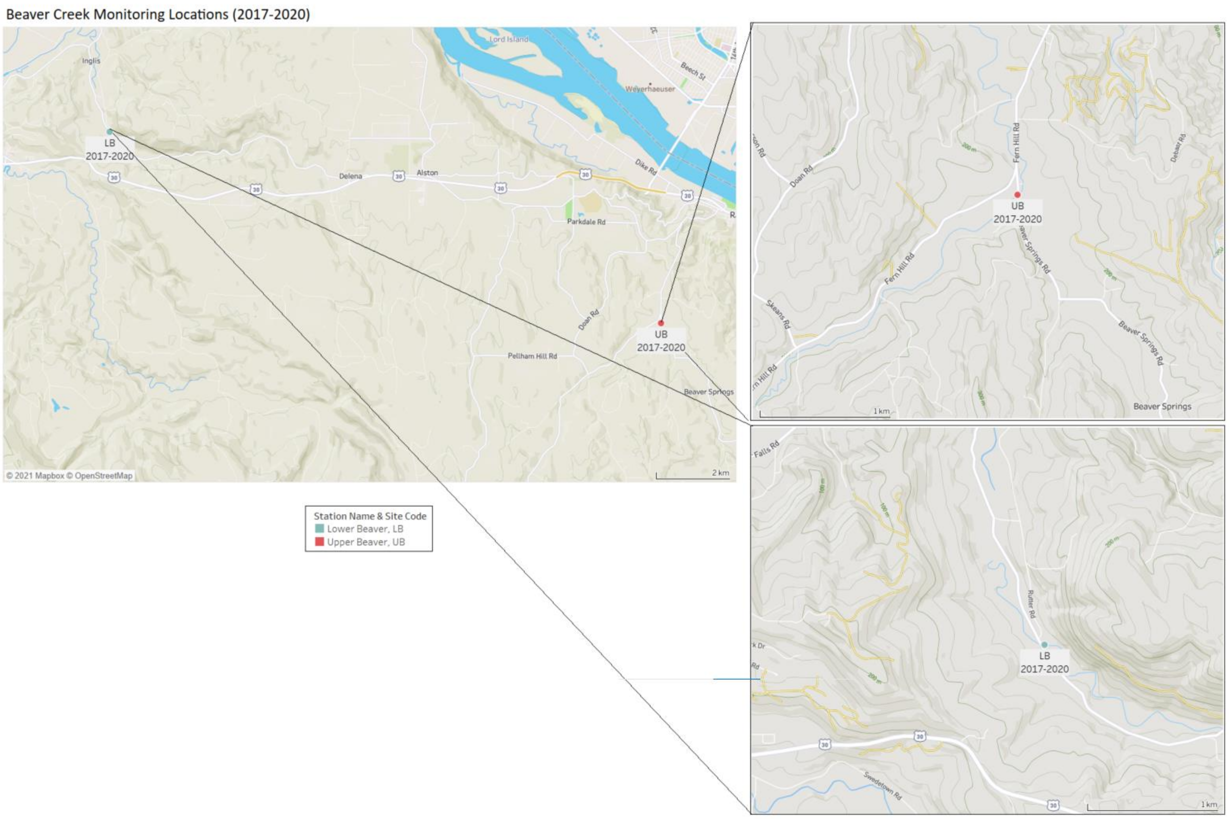


Figure 17: Focus map of Beaver Creek watershed monitoring locations; for an overview map of watershed boundaries, see Figure 2. For specific monitoring location details, see Table 1.

Water Temperature

7dMAM temperature in the Beaver Creek watershed range from 4.6°C to 19.6°C (Table 11) during the monitoring period, with temperatures being higher in the lower basin (Figure 18). Upper Beaver (Girt Creek) and Lower Beaver creeks had similar winter (January, February) and fall (November – December) temperature trends throughout the study period, with the highest seasonal temperatures being observed in July and/or August (Table 11, Figure 19).

DEQ temperature standard for salmon rearing habitat is less than 18°C, and streams with temperatures higher than 18°C are considered poor quality for salmon. The highest 7dMAM temperatures in Upper Beaver Creek were observed in August every year, exceeding 18°C only once in August 2017. Summer temperatures in Lower Beaver Creek consistently exceeded 18°C throughout the study period, with peak temperatures observed in late July or early August (Table 11).

Table 11: Monthly variation in 7dMAM temperatures from 2017 to 2020 for creeks in Beaver Creek Watershed. Temperatures have been color-coded according to salmonid thresholds listed in Table 3, with blue representing cooler, ideal conditions and yellow/orange representing temperatures crossing 18°C.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper Beaver	2017							16.7	18.1	15.5	9.8	8.5	5.8
	2018	7.4	6.8	7.2	10.0	14.2	14.8	17.4	17.8	14.0	10.2	7.6	6.3
	2019	6.7	5.0	6.6	10.2	13.8	15.4	17.0	17.3	17.5	8.5	6.0	5.6
	2020	7.5	7.2	7.2	10.4	13.2	14.9	16.2	17.4	15.4	14.4		
Lower Beaver	2017							18.8	19.6	16.8	10.8	8.7	5.4
	2018	7.3	6.7	7.1	10.1	14.8	16.1	19.4	19.2	15.3	11.5	8.0	6.3
	2019	6.5	4.6	6.5	10.6	14.3	16.6	18.4	19.3		9.2	7.0	5.8
	2020	7.6	7.2	7.4	10.8	13.8	15.8	17.8	19.5	17.0	15.5		

Average Temperature Scale

7°C - Ideal 18°C - Poor 25°C - Lethal

When the number of days exceeding 18°C were compared between May to October every year, it was observed that the lower watershed had longer time periods where stream temperatures were considered of poor quality, according to DEQ standards, even though the lower watershed has more vegetation and forests. However, the monitoring station at Upper Beaver is placed in a well-shaded spot, which seems to be reducing stream temperatures at the location. However, canopy cover analysis was not conducted as part of this report; hence, definitive statements about shading cannot be made through this study.

Table 12: Number of days over 18°C in the Beaver Creek watershed between 2017 to 2020. Winter and spring months have been excluded from this table as stream temperature conditions are within ideal conditions at that time.

		May	June	July	August	September	October
Upper Beaver	2017			0	13	7	0
	2018	0	0	11	17	0	0
	2019	0	0	0	4	0	0
	2020	0	0	5	7	0	0
Lower Beaver	2017			27	31	13	0
	2018	0	6	22	25	0	0
	2019	0	4	18	6		0
	2020	0	4	16	31	9	0

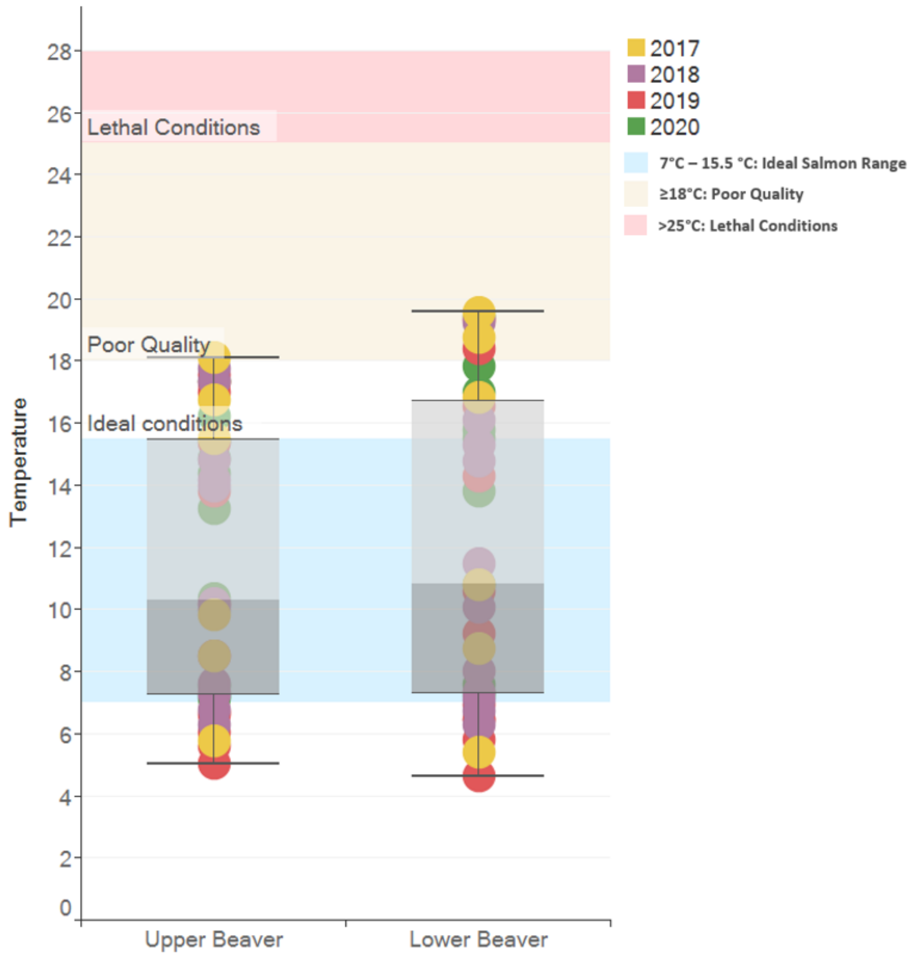


Figure 18: 7dMAM temperature variation in the Beaver Creek watershed, overlaid on the DEQ stream temperature standard ranges for healthy salmon habitat (Table 3). Data points represent the months monitored in a year.

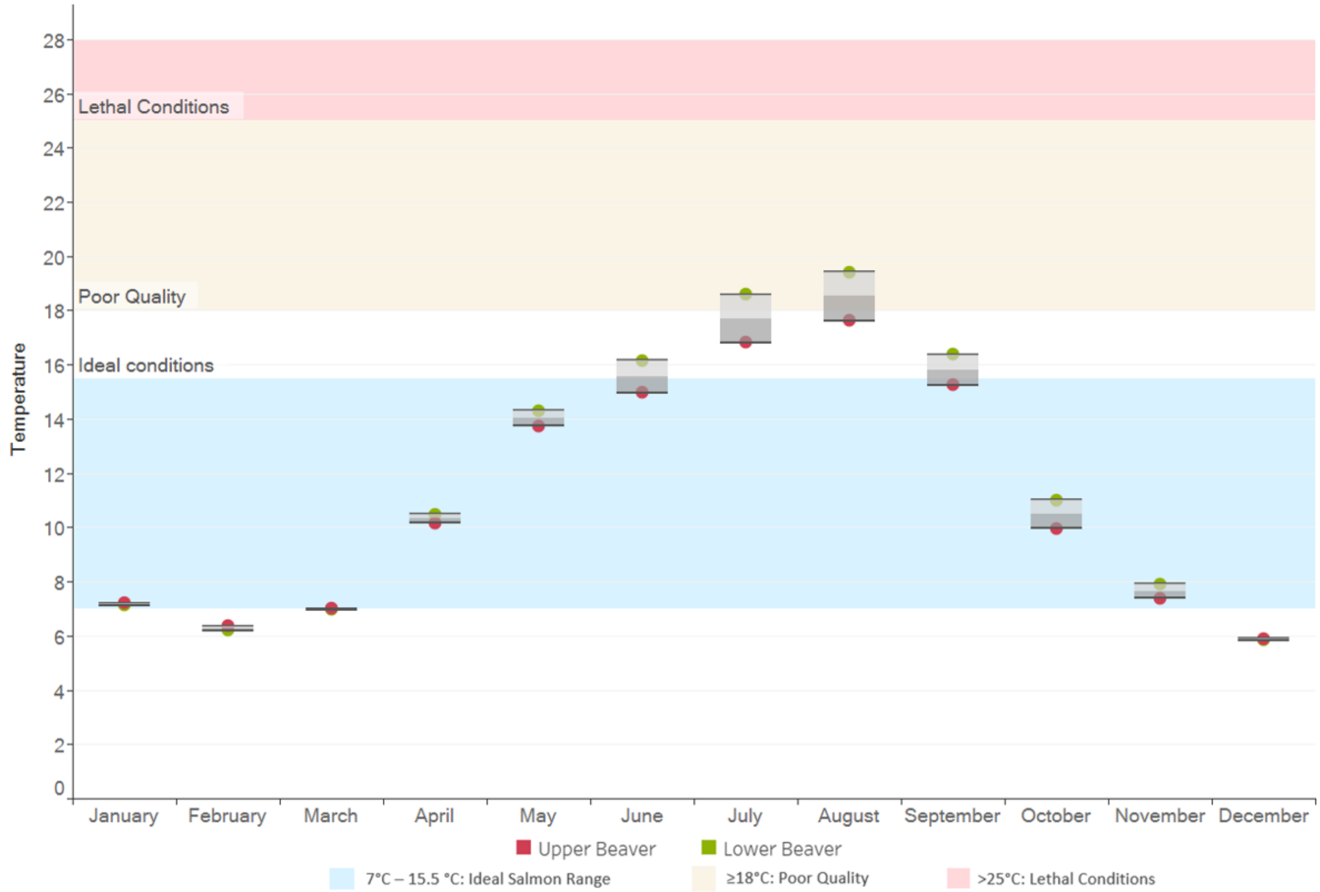


Figure 19: Monthly variation in 7dMAM temperature in the Beaver Creek watershed between 2017 – 2020.

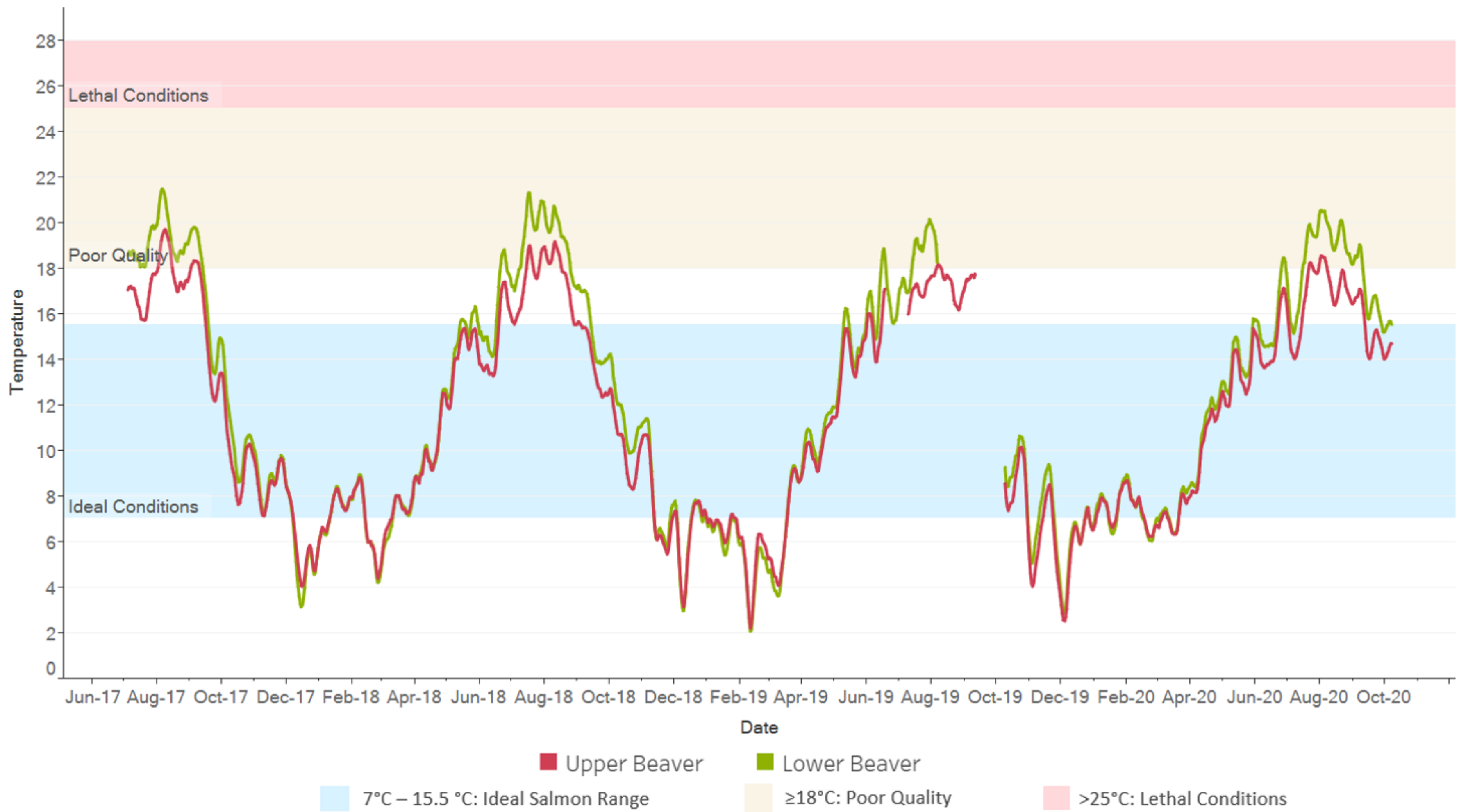


Figure 20: Beaver Creek Watershed 7-day average maximum temperatures (7dMAM) from June 2017 to October 2020 overlayed on salmonid temperature threshold ranges. See Table 3 for temperature threshold details.

Water Turbidity Levels

Lower Beaver Creek consistently experienced lower turbidity levels than Upper Beaver Creek (Girt Creek), with mean levels ranging from 2.2-3.4 NTU at Lower Beaver and 6.4-7.9 at Upper Beaver Creek across the 2017-2020 study period (Figure 21, Table 13). Upper Beaver Creek exhibited elevated turbidity levels throughout the study period, with >10 NTU turbidity observed from July through September (Figure 21, Table 13). Land use above the Upper Beaver monitoring location is more developed with agriculture and residential than the portion of the watershed above Lower Beaver Creek, which may explain the elevated turbidity levels. Additionally, the substrate of Upper Beaver creek is primarily silty while Lower Beaver is rocky, which further highlights the potential differences in turbidity observations (Table 1). Riparian improvements in the upper basin could help reduce these harmful turbidity levels long-term.

Table 13: Summary Table for Beaver Creek Watershed Monthly Turbidity (NTU), 2017-2020 Grab Samples. Grab sample data broken down across years and watershed sampling locations. n = number of samples collected—red highlights when a sample location experienced a maximum over the 10 NTU threshold.

Summary Table: Beaver Creek Watershed Turbidity Levels (NTU)
2017-2020 Grab Samples

		n	Max	Mean	+/- SD
Upper Beaver	2017	4	10.8	7.9	2.5
	2018	11	11.2	6.5	1.8
	2019	15	12.3	7.5	2.5
	2020	15	10.5	6.9	2.2
Lower Beaver	2017	5	5.9	2.2	2.1
	2018	11	6.7	3.4	1.8
	2019	11	6.2	3.2	1.6
	2020	15	5.9	3.4	1.4

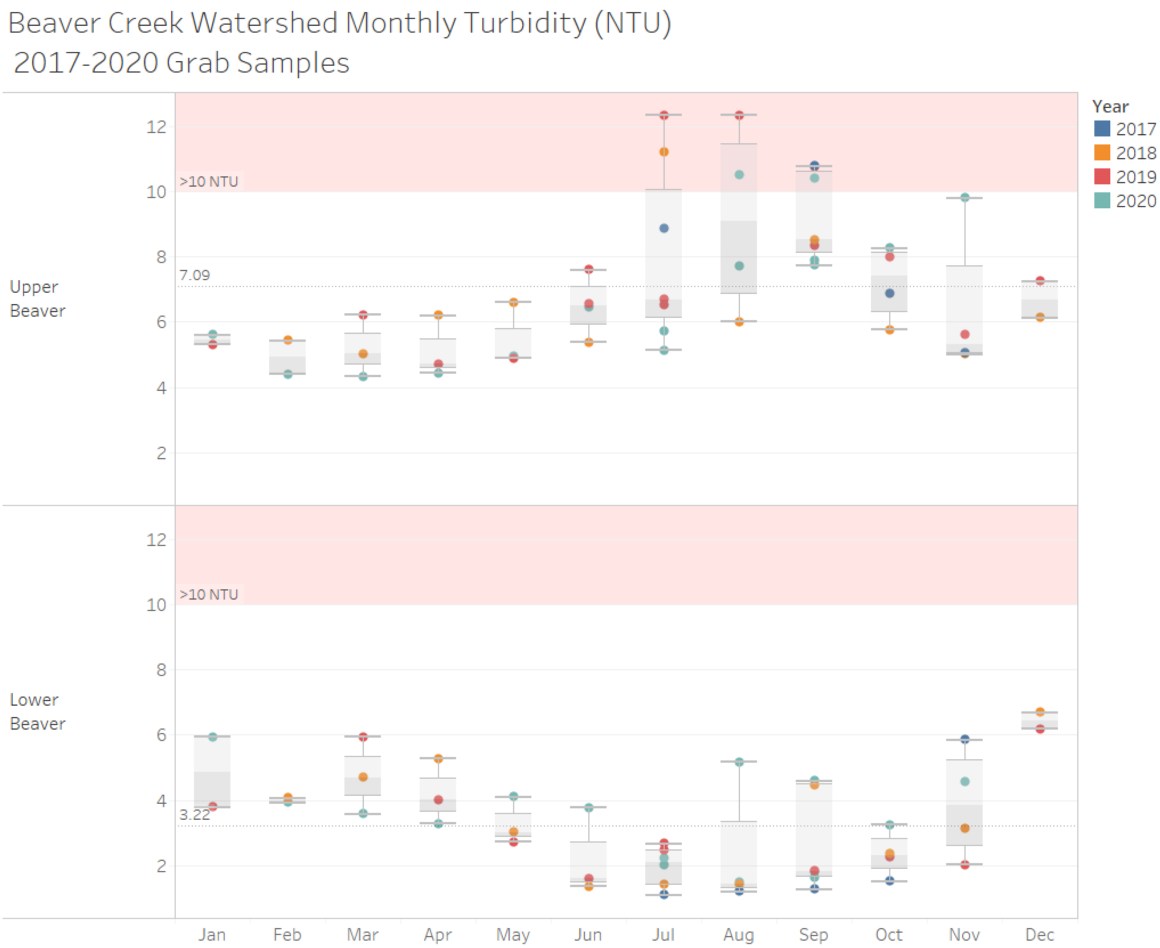


Figure 21: Turbidity (NTU) grab sampling results (boxplots) for Beaver Creek Watershed broken down across sampling locations and months sampled. Sampling years ranging from 2017 to 2020 are highlighted within each boxplot. 10 NTU threshold highlighted in pink. The overall mean for the study period is highlighted in each graph. A summary of these data can be found in Appendix B.

Water Bacteria Levels

In 2017, only Lower Beaver Creek was monitored for *E. coli* bacteria levels; during this time, elevated levels, 345 MPN/100 ml, were detected in October, with July-September samples falling within a normal range (<126 MPN/100) (Figure 22, *Table 14*-Table 16). In 2018, elevated *E. coli* bacteria levels were detected in Upper Beaver Creek (Girt Greek) in August, 323 MPN/100, and September, 727 MPN/100, and in Lower Beaver Creek in September, 2,420 MPN/100 (Figure 22, *Table 14*-Table 16). These extreme bacteria events encouraged more intensive sampling during the 2019 and 2020 monitoring years, including bi-monthly sampling in the summer, which allowed for the calculation of the 90-day geometric mean (Table 16).

The 90-day geometric mean state-mandated water quality threshold for Oregon is 126 MPN/100. In 2019 Upper Beaver Creek exhibited elevated *E. coli* bacteria levels from June-October with a geometric means ranging from 214-214 MPN/100 and May-Nov in 2020 ranging from 172-224 MPN/100 (Table 16). In comparison, Lower Beaver Creek also experienced an elevated event in March 2020, 649 MPN/100, and August 2020, 299 MPN/100, but the overall mean (Table 15) and geometric mean (Table 16) *E. coli* bacteria levels remained below the 126 MPN/100 threshold. These water quality conditions merit continued monitoring and additional investigation into the cause of elevated *E. coli* levels to ensure they do not continue to persist or decline.

Table 14: Beaver Creek watershed monthly max E. coli (MPN/100 ml) grab samples. Grab sampling results for broken down across years and watershed sampling locations. Sampling locations that experienced events over the EPA (235 MPN/100) and ODEQ (406 MPN/100) thresholds for E. coli bacteria levels are highlighted in red. n = number of samples collected.

Summary Table: Beaver Creek Watershed Monthly Max *E. coli* (MPN/100 ml)
2017-2020 Grab Samples

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper Beaver	2017												
	2018						166	98	308	727			
	2019						816	387	308	240	248	15	51
	2020	11	4	16	45	153	69	206	276	435	185	55	
Lower Beaver	2017							82	58	42	345		
	2018						56	37	41	2,420			
	2019						30	152		49	24	4	31
	2020	62	24	649	74	50	26	81	299	146	70	32	

Table 15: Summary table of Beaver Creek watershed E. coli (2017-2020) MPN/100 ml grab samples. Grab sample data broken down across years and watershed sampling locations. Sampling locations that experienced events over the EPA (235 MPN/100) and ODEQ (406 MPN/100) thresholds for E. coli bacteria levels are highlighted in red. n = number of samples collected; for monthly max data, see Table 14.

Summary Table: Beaver Creek Watershed Monthly Max *E. coli* (MPN/100 ml)
2017-2020 Grab Samples

		n	Max	Mean	+/- SD
Upper Beaver	2017	0			
	2018	4	727	325	282
	2019	11	816	290	246
	2020	15	435	147	119
Lower Beaver	2017	4	345	132	143
	2018	4	2,420	639	1,188
	2019	7	152	44	50
	2020	15	649	118	162

Table 16: 90 Day geometric mean (5 samples or greater) of E. coli bacteria levels (MPN/100ml) across all sampling sites, those durations that are above the state-mandated threshold of 126 MPN/100 ml for the 90 days geometric mean are highlighted with red text.

Beaver Creek Watershed *E. coli* (MPN/100 ml)
90 Day Geometric Mean (5 samples or greater)

		May-Aug	Jun-Sep	Jul-Oct	Aug-Nov
Upper Beaver	2019		291.1	214.8	
	2020	172.6	193.7	224.4	174.2
Lower Beaver	2020	66.4	78.8	90.4	71.4

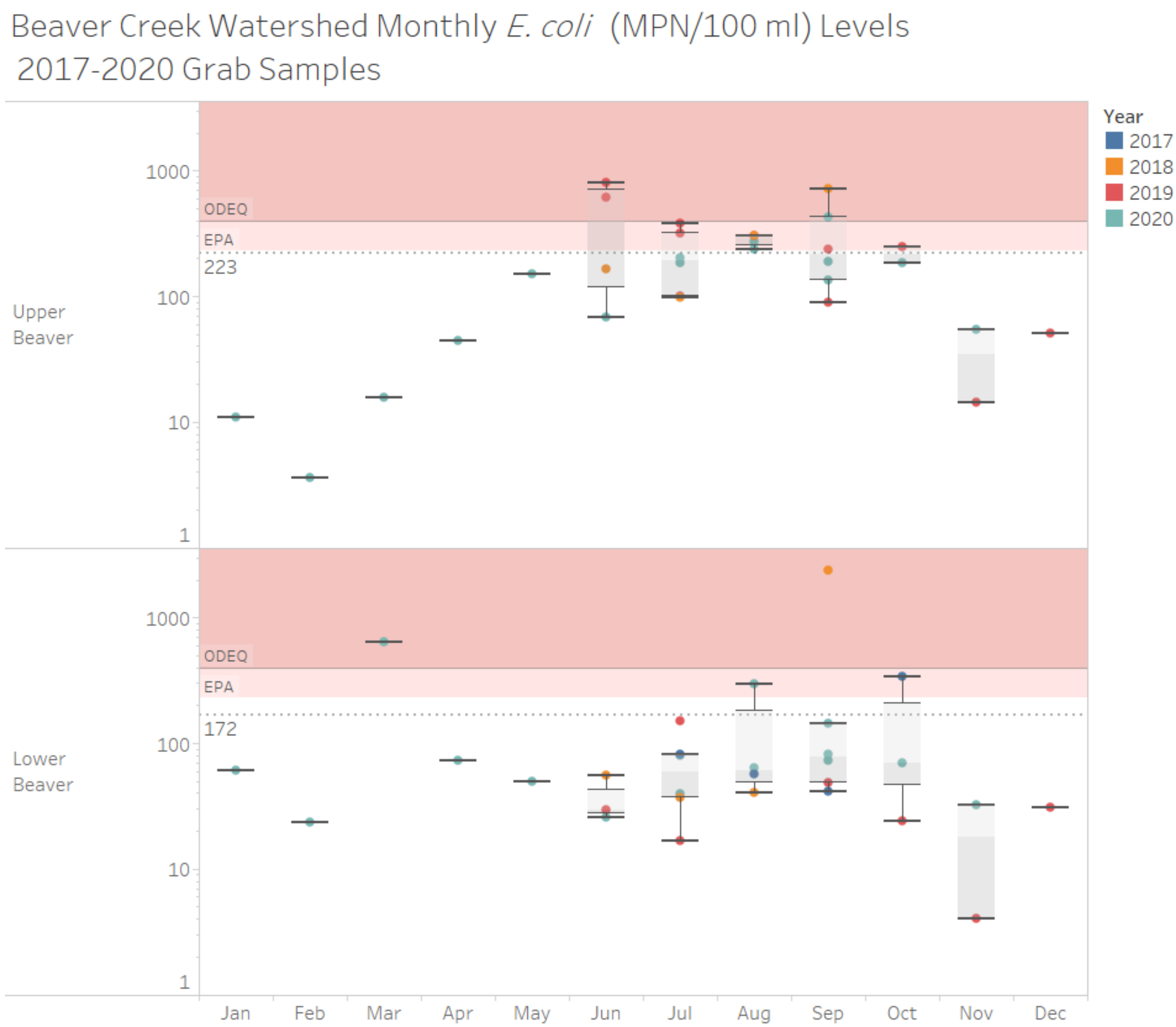


Figure 22. E. coli bacteria grab sampling results (boxplots) for Beaver Creek Watershed broken down across months sampled and watershed sampling locations. Sampling year ranging from 2017 to 2020 are highlighted within each boxplot. EPA (235 MPN/100) and ODEQ (406 MPN/100) thresholds for E. coli bacteria levels are highlighted on each graph. The overall mean for the study period highlighted in each graph. Logarithmic scale used on the y-axis.

Water Conductivity Levels

Conductivity levels varied seasonally across both monitoring locations within the Beaver Creek watershed (Figure 20, Table 17). At both locations, annual increases in water conductivity were observed between April to September and declined from October to February (Figure 20, Table 17). Between 2018-2020, Lower Beaver Creek exhibited lower overall mean conductivity levels ranging from 60-74 µs/cm compared to 80-89 µs/cm observed at the Upper Beaver (Girt Creek) monitoring location (Figure 20, Table 17). These data provide baseline conductivity levels that can be used to identify new and emerging water quality issues or improvements over time. Pollution from runoff or increased turbidity levels from sediment can result in higher conductivity levels; however, there is no EPA or ODEQ threshold for conductivity in the region.

Table 17: Summary Table of Beaver Creek watershed monthly conductivity (µs/cm) data for 2018-2020 grab samples. Conductivity (µs/cm) samples broken down across months sampled and watershed sampling location. n = number of samples collected. For monthly data by site, see Appendix B.

Summary Table: Beaver Creek Watershed Conductivity Levels (µs/cm)
2018-2020 Grab Samples

		n	Max	Mean	+/- SD
Upper Beaver	2018	5	85	60	19
	2019	15	100	67	26
	2020	16	103	74	19
Lower Beaver	2018	6	109	82	27
	2019	10	129	80	33
	2020	16	137	89	30

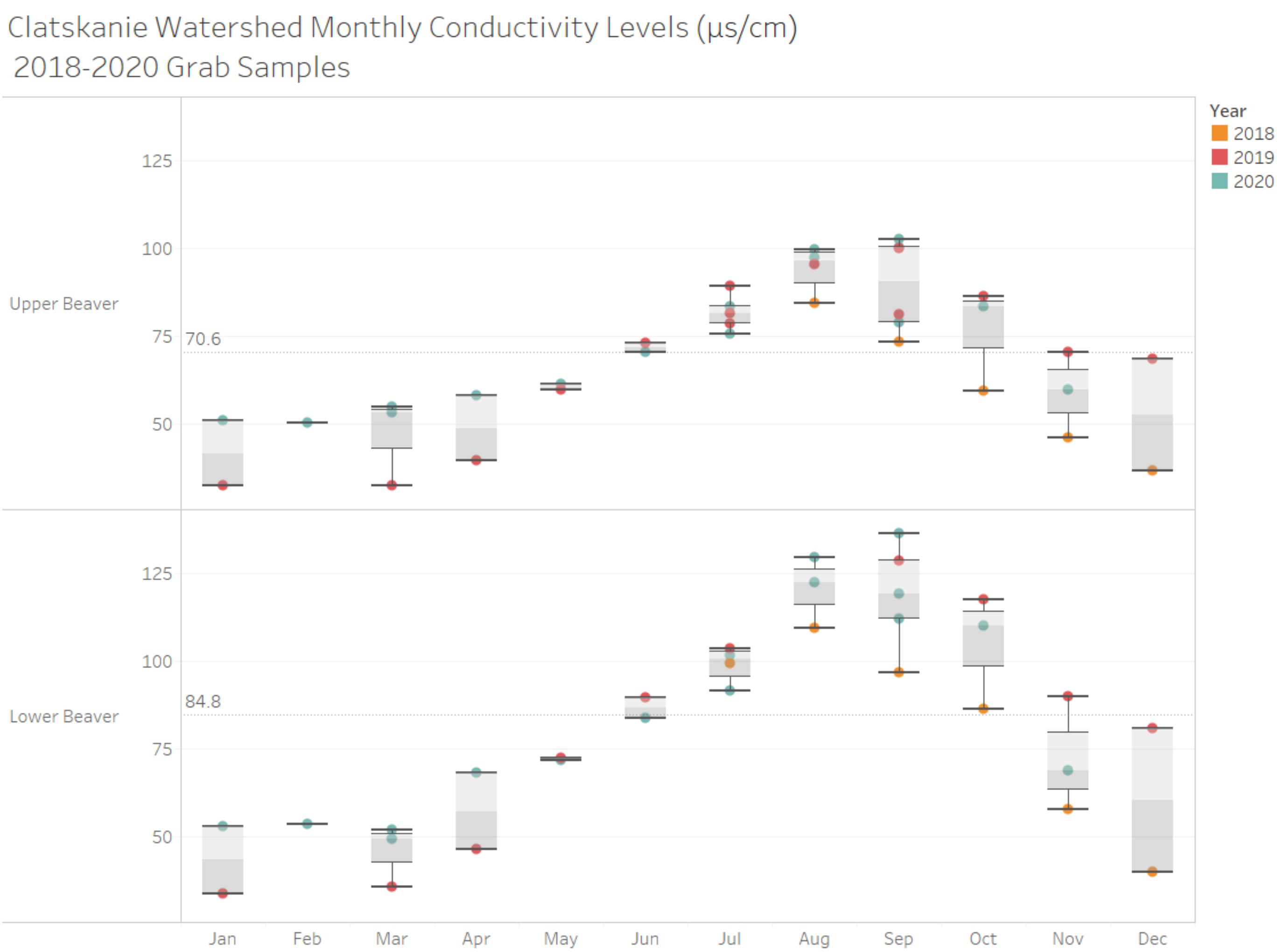


Figure 23: Conductivity levels (µs/cm) 2018-2020 Grab Samples results (boxplots) for Clastkanie watershed broken down across months sampled and watershed sampling location. Sampling years ranging from 2018 to 2020 are highlighted within each boxplot. The overall mean for the study period is highlighted in each graph.

Water Quality Issues

Water quality issues observed in Beaver Watershed include high summer temperatures (>18°C) between June and September (Table 11). Overall elevated temperatures are likely caused by solar loading as the water moved through the watershed. Beaver Creek has extensive residential and agricultural development in the upper watershed, which increases the amount and duration of solar loading experienced by the water moving through the watershed (Figure 4). Low water temperatures are critical for supporting aquatic life, including endangered Salmonids in the Pacific Northwest; reducing solar radiation and reducing urban and agricultural runoff can help keep water temperatures down and protect these stream habitats (USGS 2021). Turbidity events above the 10 NTU threshold were also observed in the Upper reaches of Beaver Creek every year during the 2017-2020 study period. Overall monthly averages of turbidity remained below the 10 NTU threshold, however, were elevated compared to Lower Beaver Creek (Table 13). Similar to recommendations for temperature improvements, increasing riparian cover and reducing runoff can reduce erosion events and sediment loading in stream environments.

Additionally, elevated E. coli bacteria levels were observed in the watershed between June-October throughout the 2017-2020 study period, exceeding the EPA and ODEQ standards, including the five sample geometric mean in Upper Beaver Creek in 2019 and 2020 (Table 3, Table 16). *E. coli* bacteria issues are indicative of animal waste runoff and can be very harmful to humans using these waterways for recreation (Pandey et al. 2014). Additional research is needed to determine the exact source of the elevated *E. coli*. Animal waste or septic tank leakage into the stream are possible sources to be investigated. Depending on the source, actions that could reduce future *E. coli* exceedance events include increasing riparian buffers, excluding livestock from the creek, increasing manure management near streams, or updating failed septic systems throughout the targeted reach of the watershed (Pandey et al. 2014). Given the frequency and scale of *E. coli* bacteria events adding warning signs to recreational areas along the stream in the Upper watershed is recommended. No significant issues or shifts in stream water conductivity levels were detected in Beaver Creek Watershed during this study.

Scappoose Bay Watershed

Milton Creek

Study Area

Milton Creek Watershed Distribution of Monitoring Locations (2008-2011, 2017-2020)

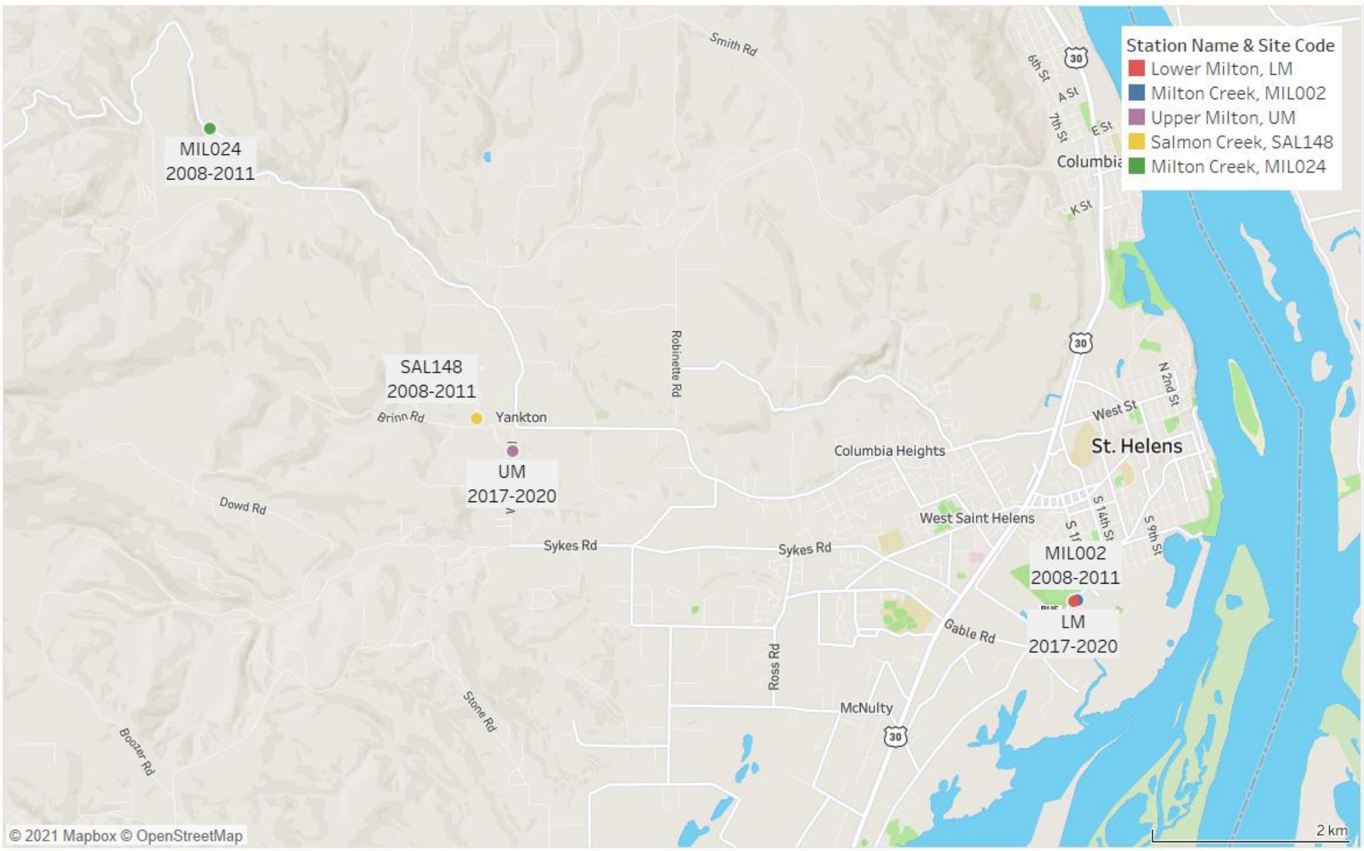


Figure 24: Overview map of Milton Creek watershed monitoring locations; for a map of watershed boundaries, see Figure 2 for specific monitoring location details, see Table 1. Upper watershed monitoring starts at MIL024 and then moves through the watershed with MIL002 being closest to the outlet of Milton Creek into Scappoose Creek and the Columbia River.

Upper Milton Creek Distribution of Monitoring Locations (2008-2011, 2017-2020)

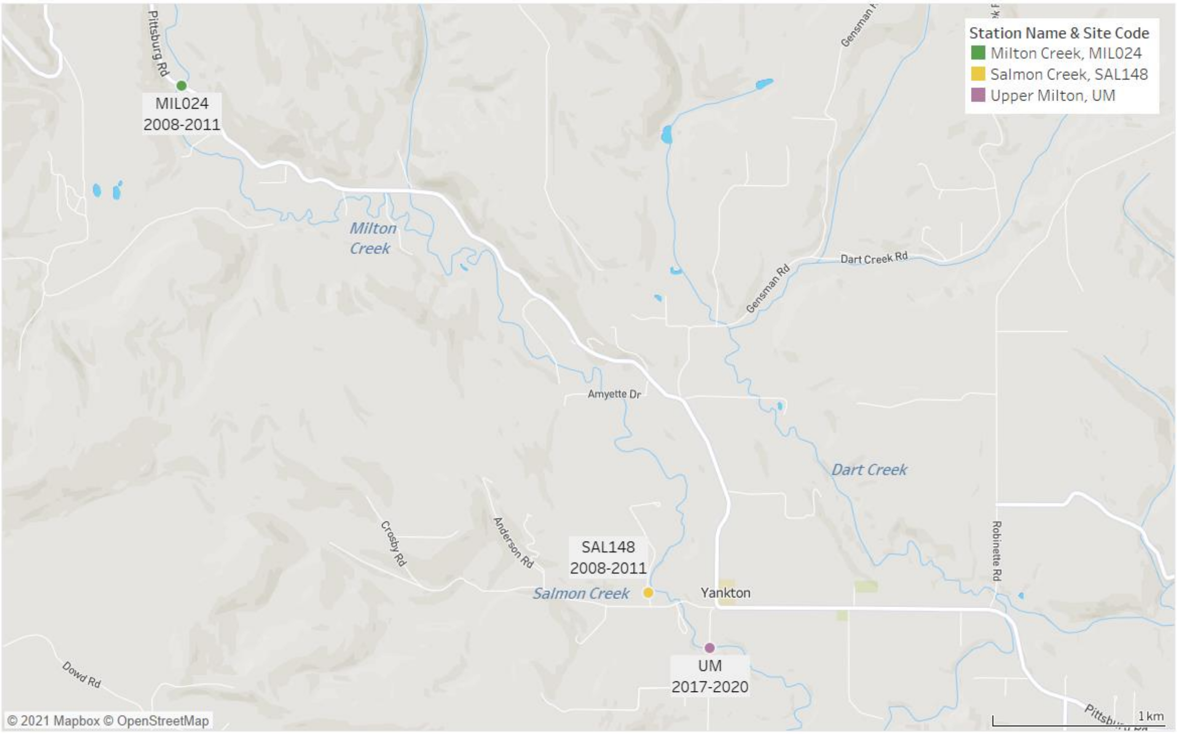


Figure 25: Focus map of Upper Milton Creek watershed monitoring locations; for a map of watershed boundaries, see Figure 2, and a general overview map, see Figure 24. For specific monitoring location details, see Table 1.

Lower Milton Creek Distribution of Monitoring Locations (2008-2011, 2017-2020)

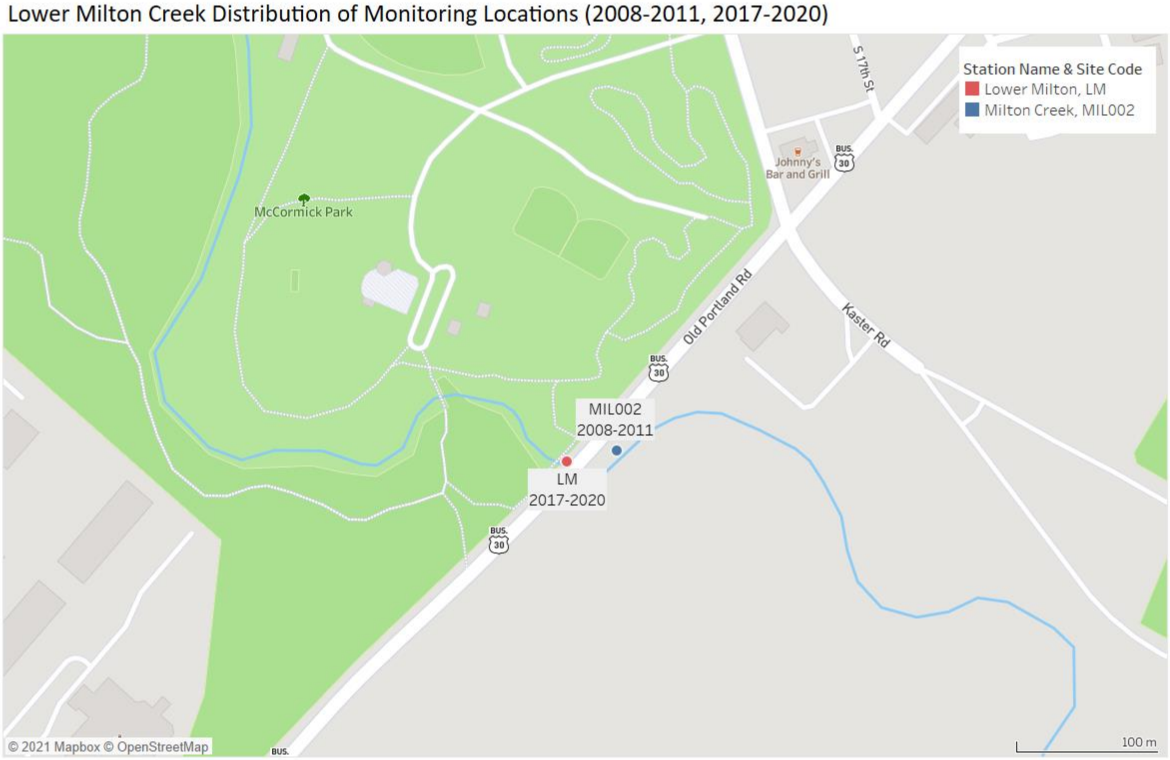


Figure 26: Focus map of Lower Milton Creek watershed monitoring locations; for a map of watershed boundaries, see Figure 2, and a general overview map, see Figure 24. For specific monitoring location details, see Table 1.

Water Temperature

Between 2017 and 2020, 7dMAM temperature in the Milton watershed ranged from 5.2°C to 23.2°C (Table 18), with increased temperatures in the lower watershed (Figure 27). The highest seasonal temperature in the Milton Creek sub-watershed was observed in August during most of the monitoring period, apart from Lower Milton in July 2018 (Figure 28). Upper Milton and Lower Milton creeks have similar winter temperature trends (December, January-February) (Table 18), after which around late-March or early-April, 7dMAM temperature of Lower Milton Creek starts increasing faster than Upper Milton. DEQ temperature standard for salmon rearing habitat is less than 18°C, and streams with temperatures higher than 18°C are considered poor quality for salmon. Between 2017 and 2020, the temperature at Upper Milton exceeded 18°C mostly during July and August during 2017 and 2018; however, this phenomenon becomes extended during 2019 and 2020, where temperatures exceed 18°C from June to September. Lower Milton Creek temperatures exceed 18°C from June to September during most of the monitoring period, reaching close to DEQ lethal conditions threshold (25°C) and even exceeding 25°C during the first week of August in 2018 (Figure 29).

Table 18: Monthly variation in 7dMAM temperatures from 2017 to 2020 for Upper Milton and Lower Milton creeks. Temperatures have been color-coded according to salmonid thresholds listed in Table 3, with blue representing cooler, ideal conditions, and yellow/orange representing temperatures crossing 18°C. Temperatures close to or exceeding lethal conditions have been represented in red.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper Milton	2017							18.4	19.6	16.7	10.4	8.4	5.6
	2018	7.7	7.1	7.5	10.0	14.4	15.5	18.9	19.3	15.1	10.9	7.5	6.2
	2019	6.7	5.2	6.6	10.4	14.0	16.5	17.8	18.7	19.2		6.8	5.6
	2020	7.9	7.6	7.3	10.6	13.2	18.2	17.6	19.0	16.3	14.9		
Lower Milton	2017							22.4	22.8	19.3	12.1	9.0	5.6
	2018	7.7	7.3	8.0	10.9	17.2	19.1	23.2	22.7	17.8	12.8	8.6	6.4
	2019	6.8	5.4	7.8	11.9	17.0	19.7	21.2	21.8	22.0		7.5	5.9
	2020	7.9	7.6	8.5	12.6	16.0	18.1	21.0	22.7	19.1	17.3		

Average Temperature Scale

When the number of days was compared across the watershed, temperatures in the lower watershed remain above 18°C for extended periods during the summer. This coincides with land use data for the two monitoring stations. Lower Milton is situated in a more developed area and thus is more exposed to solar radiation and human use during the summer (Table 19).

Table 19: Number of days over 18°C in the Milton Creek watershed between 2017 to 2020. Winter and spring months have been excluded from this table as stream temperature conditions are within ideal conditions at that time.

		May	June	July	August	September	October
Upper Milton	2017			17	31	14	0
	2018	0	3	20	25	0	0
	2019	0	5	16	24	11	
	2020	0	4	14	26	7	0
Lower Milton	2017			27	31	18	0
	2018	13	16	31	31	13	0
	2019	8	25	31	31	11	
	2020	3	13	31	31	13	0

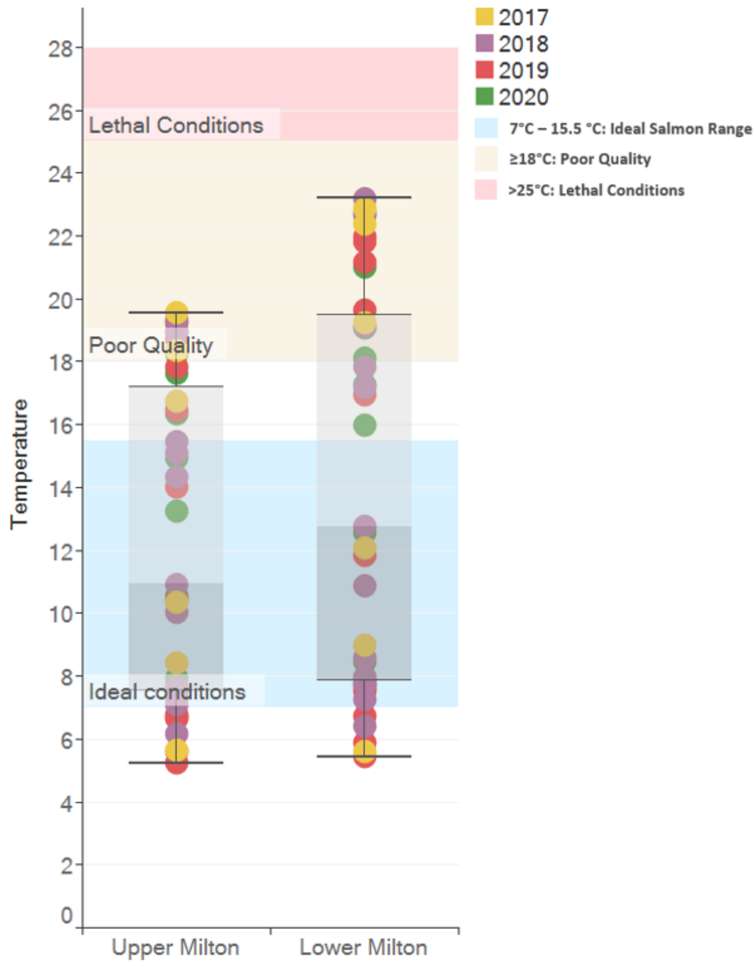


Figure 27: 7dMAM temperature variation in the Milton Creek sub-watershed, overlaid on the DEQ stream temperature standard ranges for healthy salmon habitat (Table 3). Data points represent the months monitored in a year.

Figure 28: Monthly variation in 7dMAM temperature in the Milton Creek watershed between 2017 – 2020.

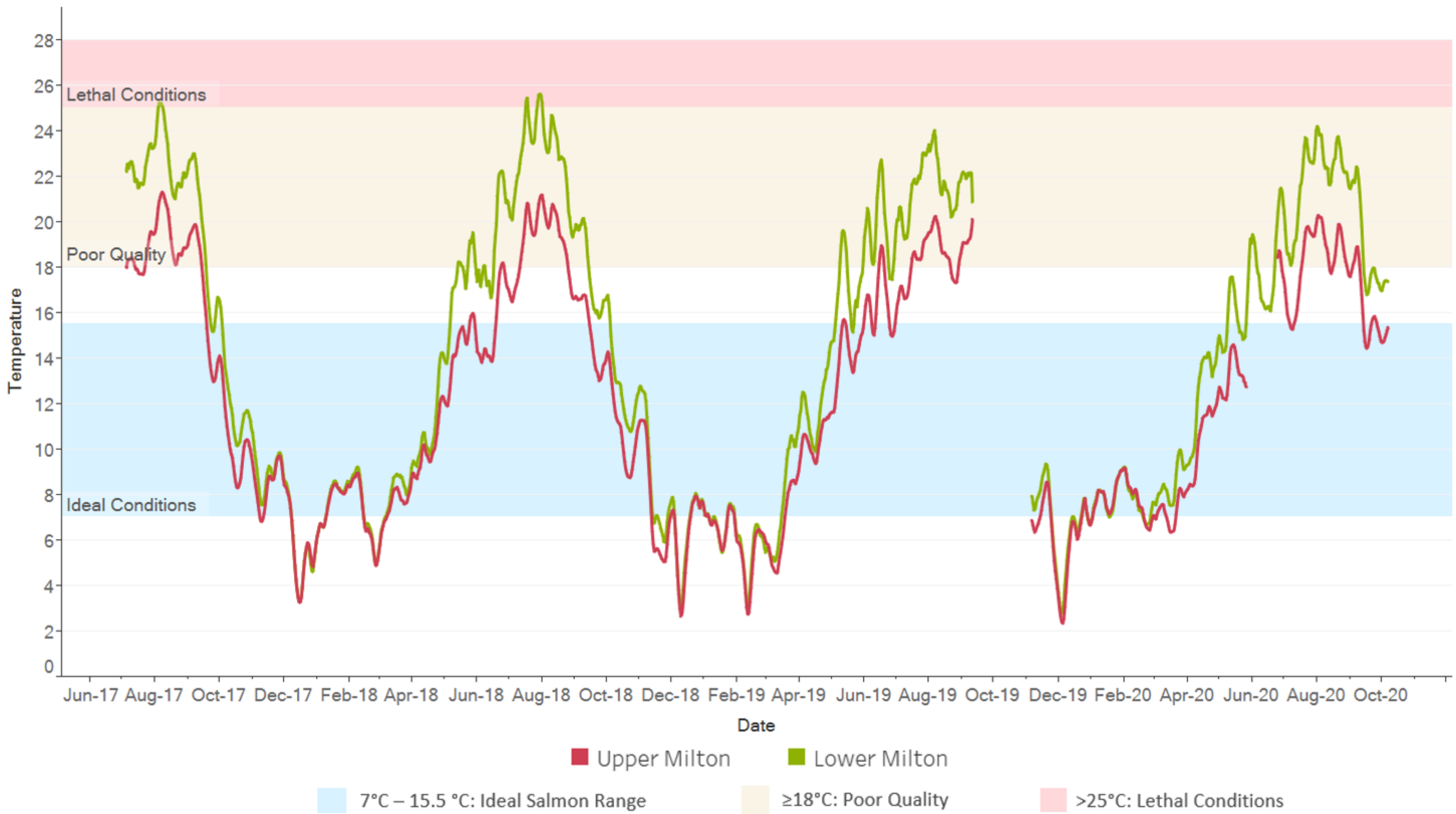


Figure 29: Milton Creek Watershed 7-day average maximum temperatures (7dMAM) from June 2017 to October 2020, overlayed on salmonid temperature threshold ranges. See Table 3 for temperature threshold details.

When May to October temperature 7dMAM temperature data was compared to the overlapping timeframe from 2008-2011, an average increase of 1.4°C was observed in the watershed. However, it should be noted that the complete temperature profile is unavailable for the 2008 – 2011 dataset, and 2010 data was missing from this dataset, so we cannot definitively say whether this increase is consistent (Figure 30).

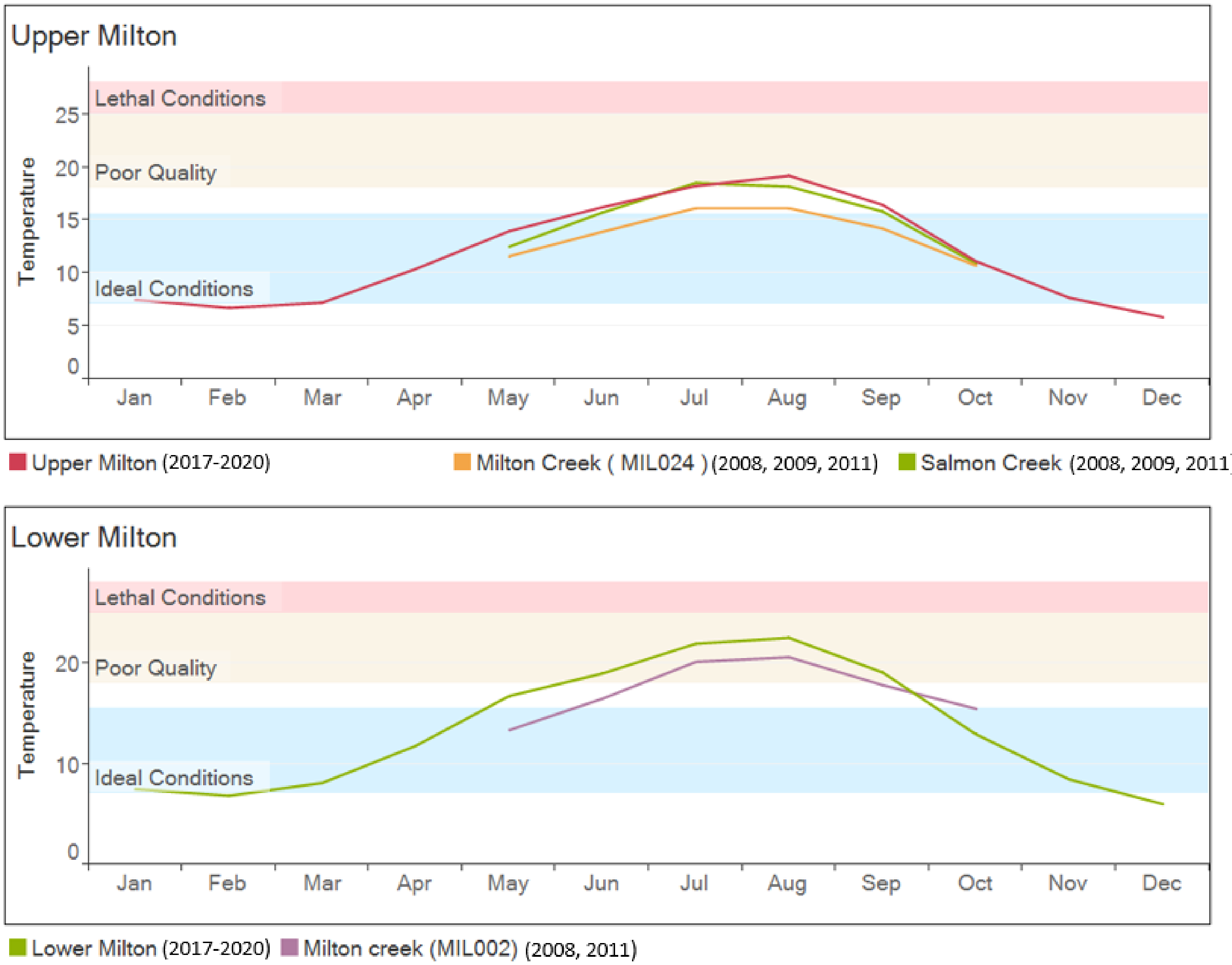


Figure 30: Monthly 7dMAM temperature comparisons between 2017-2020 data and 2008-2011 data for Milton Creek Watershed. Upper Milton and Lower Milton have data available from June 2017 to October 2020. Milton Creek (MIL002) has data available for May to October of 2008 and 2011. Milton Creek (MIL024) and Salmon Creek (SAL148) have data available for May to October of 2008, 2009, and 2011.

Water Turbidity Levels

Lower Milton Creek consistently experienced lower turbidity levels than Upper Milton Creek, with mean levels ranging from 3.7-5.9 NTUs at Lower Milton and 6.0-7.9 at Upper Milton Creek across the 2017-2020 study period (Figure 31, Table 20). Upper and Lower Milton creeks exhibited elevated turbidity levels throughout the study period, with >10 NTU turbidity events observed between July and December

(Figure 31, Table 20). When comparing the 2018-2020 data to the 2008-2011 data, no significant shift in turbidity was observed for Upper Milton Creek (Figure 32). Riparian improvements in the basin could help reduce these harmful turbidity levels long-term.

Table 20: Summary Table for Milton Creek Watershed Monthly Turbidity (NTU), 2017-2020 Grab Samples. Grab sample data broken down across years and watershed sampling locations. n = number of samples collected—red highlights when a sample location experienced a maximum over the 10 NTU threshold. For monthly data by site, see Appendix B.

Summary Table: Milton Creek Watershed Turbidity Levels (NTU)
20017-2020 Grab Samples

		n	Max	Mean	+/- SD
Upper Milton	2017	4	11.5	7.9	3.1
	2018	11	9.8	6.5	1.7
	2019	14	11.5	6.3	2.6
	2020	15	9.5	6.0	1.5
Lower Milton	2017	5	7.6	3.7	2.2
	2018	11	8.7	5.1	1.5
	2019	15	13.5	5.9	3.8
	2020	15	12.5	5.3	2.8

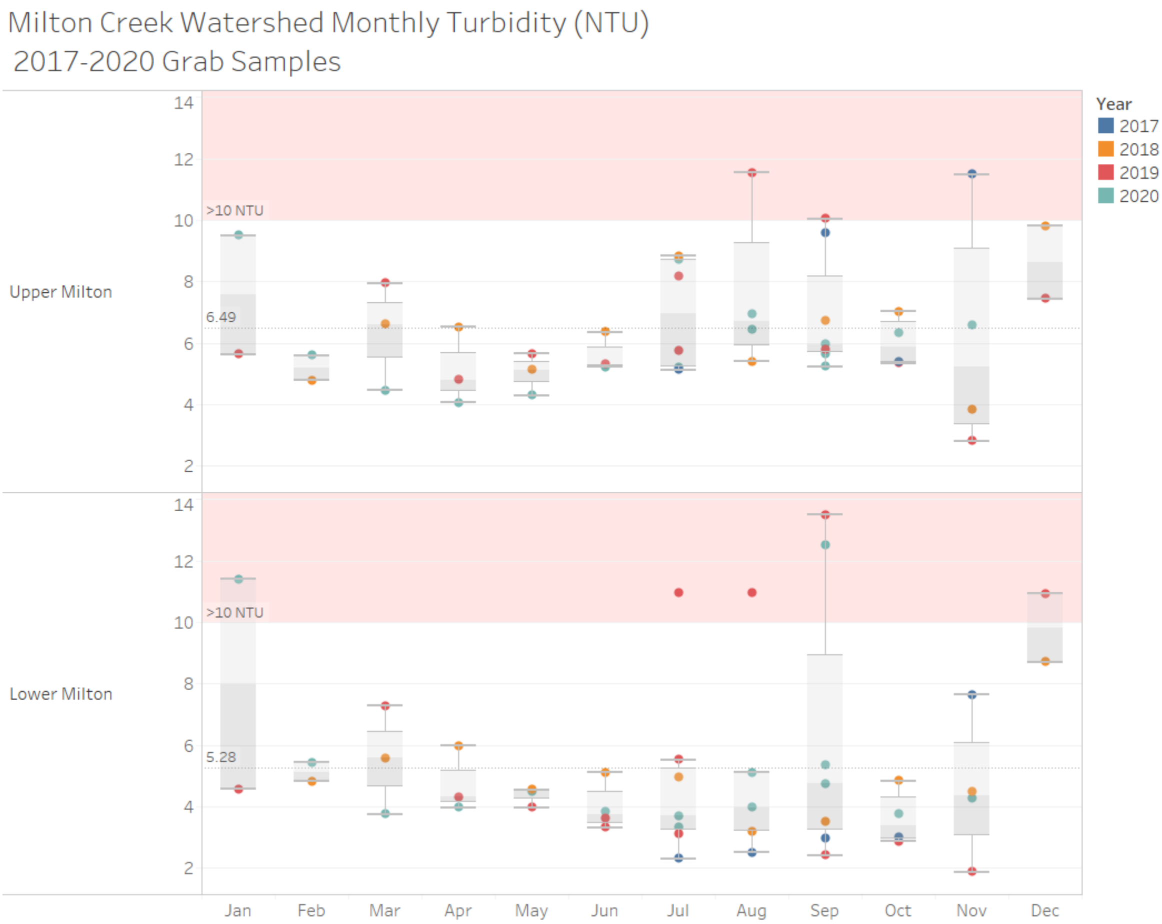


Figure 31. Turbidity (NTU) grab sampling results (boxplots) for Milton Creek Watershed broken down across sampling locations and months sampled. Sampling years ranging from 2017 to 2020 are highlighted within each boxplot. 10 NTU threshold highlighted in pink. The overall mean for the study period highlighted in each graph. A summary of these data can be found in Appendix B.

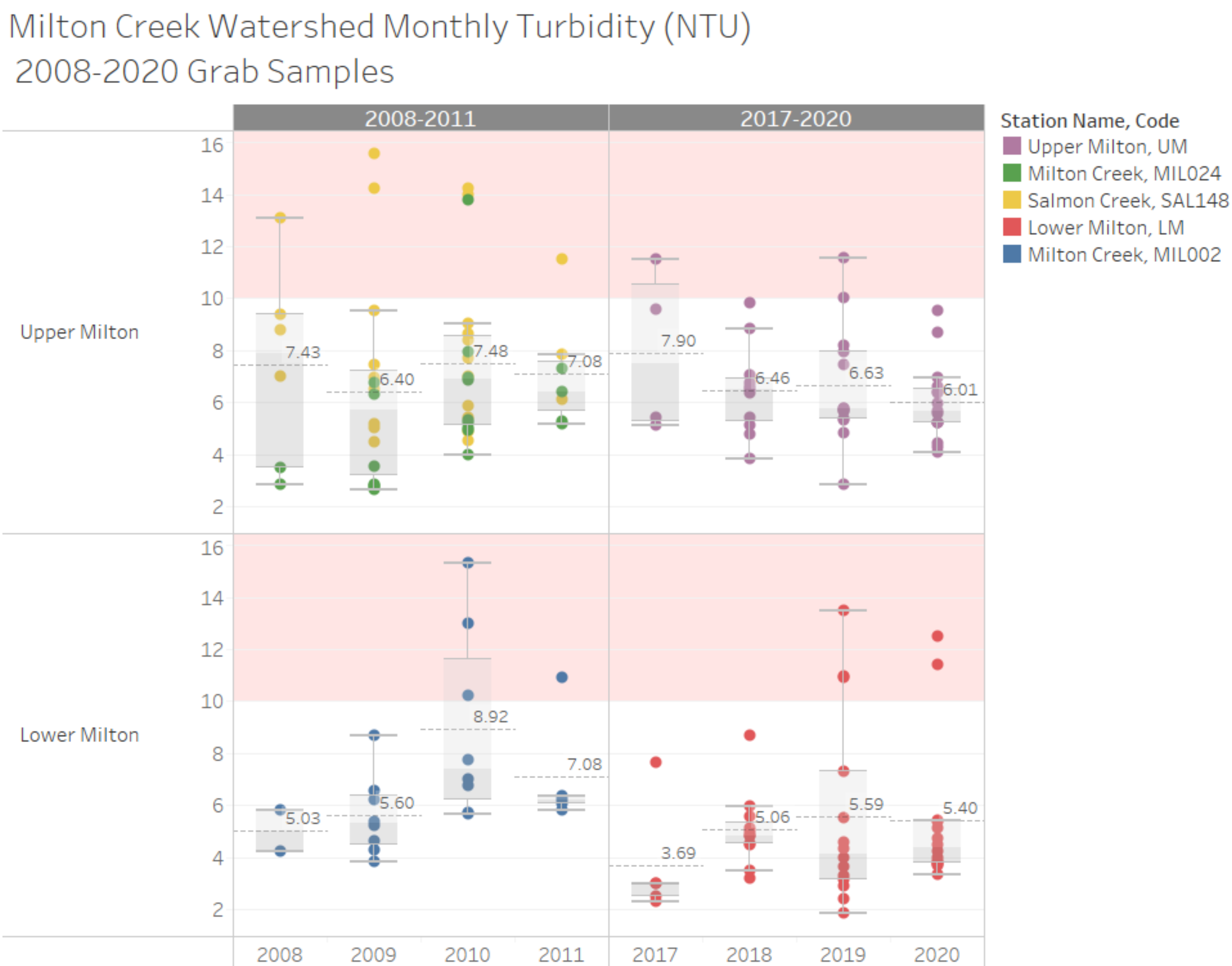


Figure 32: Turbidity (NTU) grab sampling results (boxplots) for Milton Creek Watershed broken down across years sampled. Sampling locations are highlighted within each boxplot. 10 NTU threshold highlighted in pink. Overall mean for each year highlighted. A summary of these data can be found in Appendix B.

Water Bacteria Levels

In 2017, only Lower Milton Creek was monitored for *E. coli* bacteria levels; during this time, elevated levels exceeding the EPA health standard <235 MPN/100 ml were detected in July, September, and October (Figure 33, Table 21-Table 23). In 2018, elevated *E. coli* bacteria levels were only detected in Lower Milton Creek in July, 291 MPN/100 ml, and August, 322 MPN/100 ml (Table 21). These bacteria events encouraged more intensive sampling during the 2019 and 2020 monitoring years, including bi-monthly sampling in the summer which allowed for the calculation of the 90-day geometric mean (Table 23). The 90-day geometric mean state-mandated water quality threshold for Oregon is 126 MPN/100. In 2019, Upper Milton Creek exhibited elevated *E. coli* bacteria levels from June-October with a geometric means ranging from 162-189 MPN/100 in 2019 and from May-Sept in 2020 ranging from 128-190 MPN/100 (Table 23). In comparison, Lower Milton Creek also experienced elevated *E. coli* bacteria levels in 2019 from June-October with a geometric means ranging from 194-227 MPN/100 and May-November in 2020 ranging from 204-244 MPN/100 (Table 23).

When comparing the 2017-2020 data to the 2008-2011 data, it is clear that Upper and Lower Milton have historically experienced elevated *E. coli* bacteria events (Figure 34). The frequency of these events, however, appears to be increasing in Lower Milton creek when comparing overall monthly maximum values between 2017-2020 to 2008-2011 (Figure 34). These water quality conditions merit continued monitoring and additional investigation into the cause of elevated *E. coli* levels to ensure they do not continue to persist or decline.

Table 21: Milton Creek watershed monthly max E. coli (MPN/100 ml) grab samples. Grab sampling results for broken down across years and watershed sampling locations. Sampling locations that experienced events over the EPA (235 MPN/100) and ODEQ (406 MPN/100) thresholds for E. coli bacteria levels are highlighted in red.

Milton Creek Watershed Monthly Max *E. coli* (MPN/100 ml)
2017-2020 Grab Samples

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper Milton	2017												
	2018						62	90	36				
	2019						121	411	219	365	72	24	78
	2020	120	5	13	26	228	214	326	119	192	38	205	
Lower Milton	2017							248	61	1,046	365		
	2018						67	291	322				
	2019						488	185	138	980	166	86	219
	2020	28	25	59	156	167	219	387	205	461	365	111	

Table 22: Summary table of Milton Creek watershed E. coli (2017-2020) MPN/100 ml grab samples. Grab sample data broken down across years and watershed sampling locations. Sampling locations that experienced events over the EPA (235 MPN/100) and ODEQ (406 MPN/100) thresholds for E. coli bacteria levels are highlighted in red. n = number of samples collected, for monthly max data, see

Table 22.

Summary Table: Milton Creek Watershed *E. coli* (MPN/100 ml)
2017-2020 Grab Samples

		n	Max	Mean	+/- SD
Upper Milton	2017	0			
	2018	3	90	63	27
	2019	10	411	173	141
	2020	15	326	122	94
Lower Milton	2017	4	1,046	430	429
	2018	3	322	227	139
	2019	11	980	259	263
	2020	15	461	190	127

Table 23: Milton Creek watershed 90 Day geometric mean (5 samples or greater) of E. coli bacteria levels (MPN/100ml) across all sampling sites, those durations that are above the state-mandated threshold of 126 MPN/100 ml for the 90 day geometric mean are highlighted with red text.

Milton Creek Watershed *E. coli* (MPN/100 ml)
90 Day Geometric Mean (5 samples or greater)

		May Aug	Jun Sep	Jul Oct	Aug Nov
Upper Milton	2019		185.8	162.2	
	2020	189.8	127.5	99.5	89.4
Lower Milton	2019		226.5	194.1	
	2020	222.0	221.6	244.4	204.4

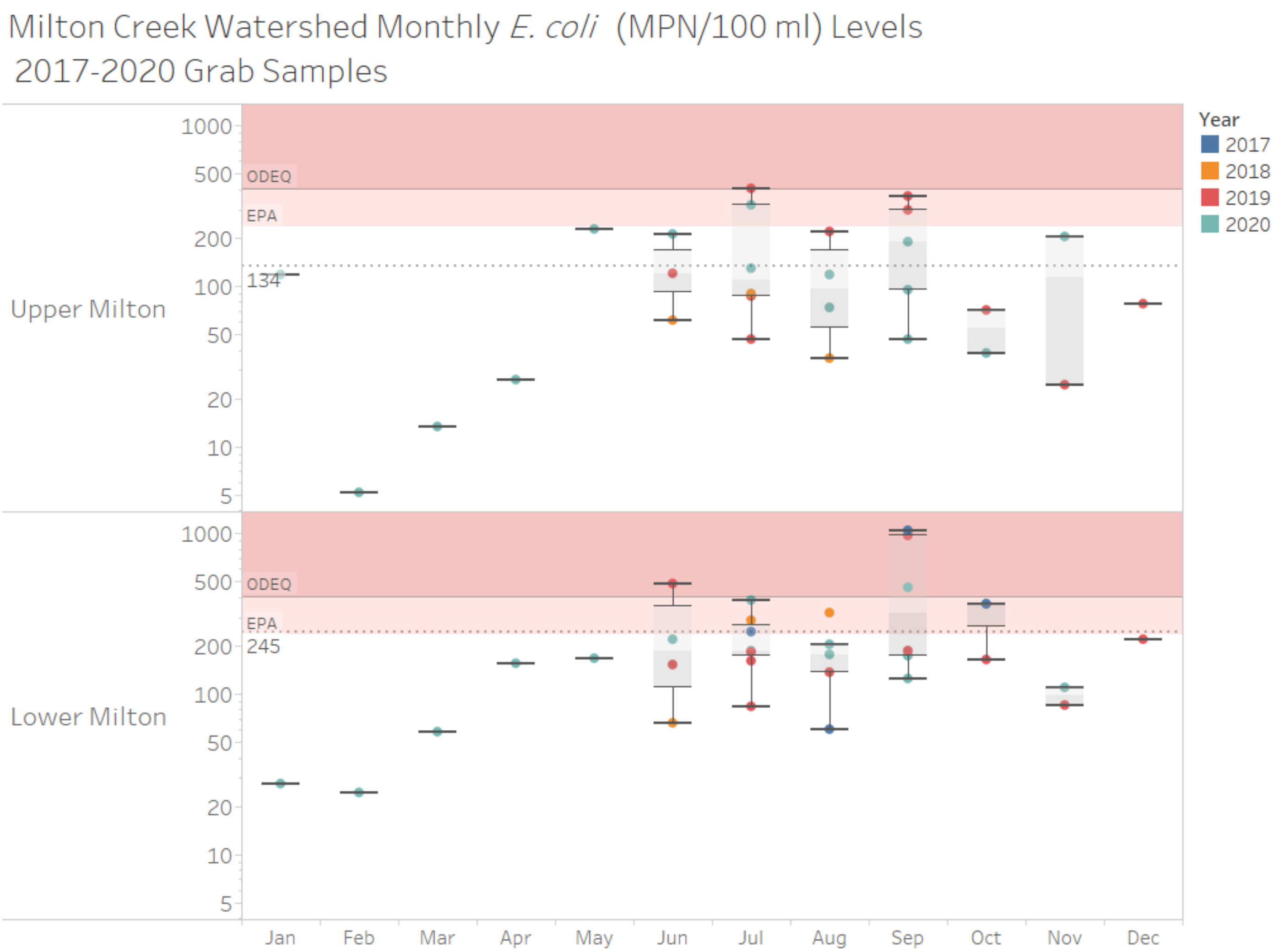


Figure 33. E. coli bacteria grab sampling results (boxplots) for Milton Creek Watershed broken down across months sampled and watershed sampling locations. Sampling years ranging from 2017 to 2020 are highlighted within each boxplot. EPA (235 MPN/100) and ODEQ (406 MPN/100) thresholds for E. coli bacteria levels are highlighted on each graph. The overall mean for the study period highlighted in each graph. Logarithmic scale used on the y-axis.

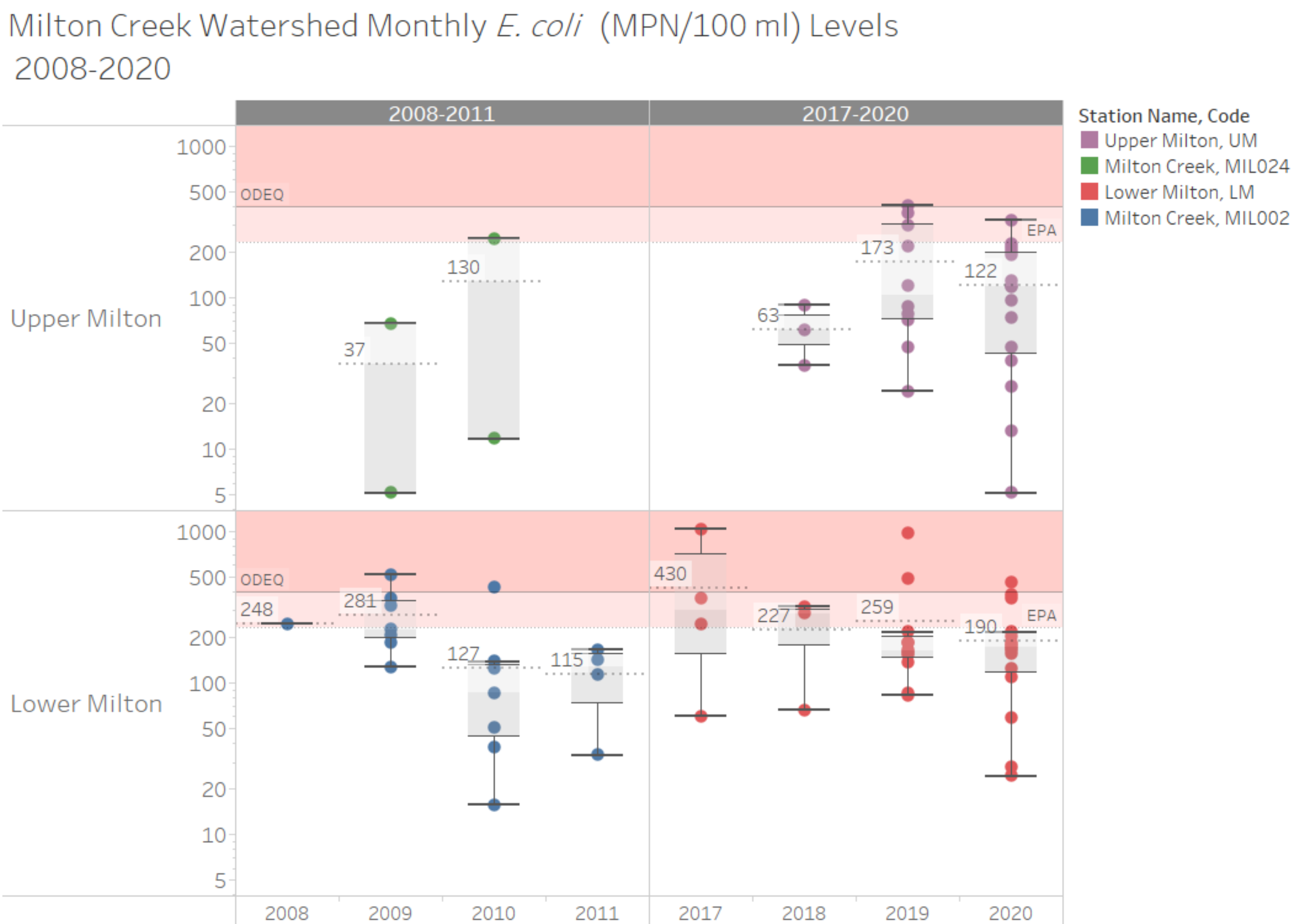


Figure 34: E. coli bacteria grab sampling results (boxplots) for Milton Creek Watershed broken down across years sampled and watershed sampling locations. Sampling location highlighted within each boxplot. EPA (235 MPN/100) and ODEQ (406 MPN/100) thresholds for E. coli bacteria levels are highlighted on each graph. The overall mean for the study period highlighted in each graph. Logarithmic scale used on the y-axis. Monthly data can be found in Appendix B.

Water Conductivity Levels

Conductivity levels varied seasonally across both monitoring locations within the Milton Creek watershed (Figure 35, Pollution from runoff or increased turbidity levels from erosion can result in higher conductivity levels; however, there is no EPA or ODEQ threshold for conductivity in the region.

Table 24). At both locations, annual increases in water conductivity were observed between April to September and declined from October to February (Figure 35, Pollution from runoff or increased turbidity levels from erosion can result in higher conductivity levels; however, there is no EPA or ODEQ threshold for conductivity in the region.

Table 24). Between 2018-2020, Upper Milton Creek exhibited lower overall mean conductivity levels ranging from 59-71 µs/cm compared to 70-79 µs/cm observed at the Lower Milton Creek monitoring location (Figure 35, Pollution from runoff or increased turbidity levels from erosion can result in higher conductivity levels; however, there is no EPA or ODEQ threshold for conductivity in the region.

Table 24). These data provide baseline conductivity levels that can be used to identify new and emerging water quality issues or improvements over time. When comparing the 2018-2020 data to the 2008-2011 data, no significant shift in conductivity was observed (Figure 36). Pollution from runoff or increased turbidity levels from erosion can result in higher conductivity levels; however, there is no EPA or ODEQ threshold for conductivity in the region.

Table 24: Summary Table of Milton Creek watershed monthly conductivity (µs/cm) data for 2018-2020 grab samples. Conductivity (µs/cm) samples broken down across months sampled and watershed sampling location. n = number of samples collected. For monthly data by site, see Appendix B.

Summary Table: Milton Creek Watershed Conductivity Levels (µs/cm)
2018-2020 Grab Samples

			n	Max	Mean	+/- SD
Upper Milton	Upper Milton, UM	2018	6	79	59	16
		2019	14	89	64	21
		2020	16	98	71	20
Lower Milton	Lower Milton, LM	2018	6	108	75	27
		2019	15	97	70	21
		2020	16	131	79	26

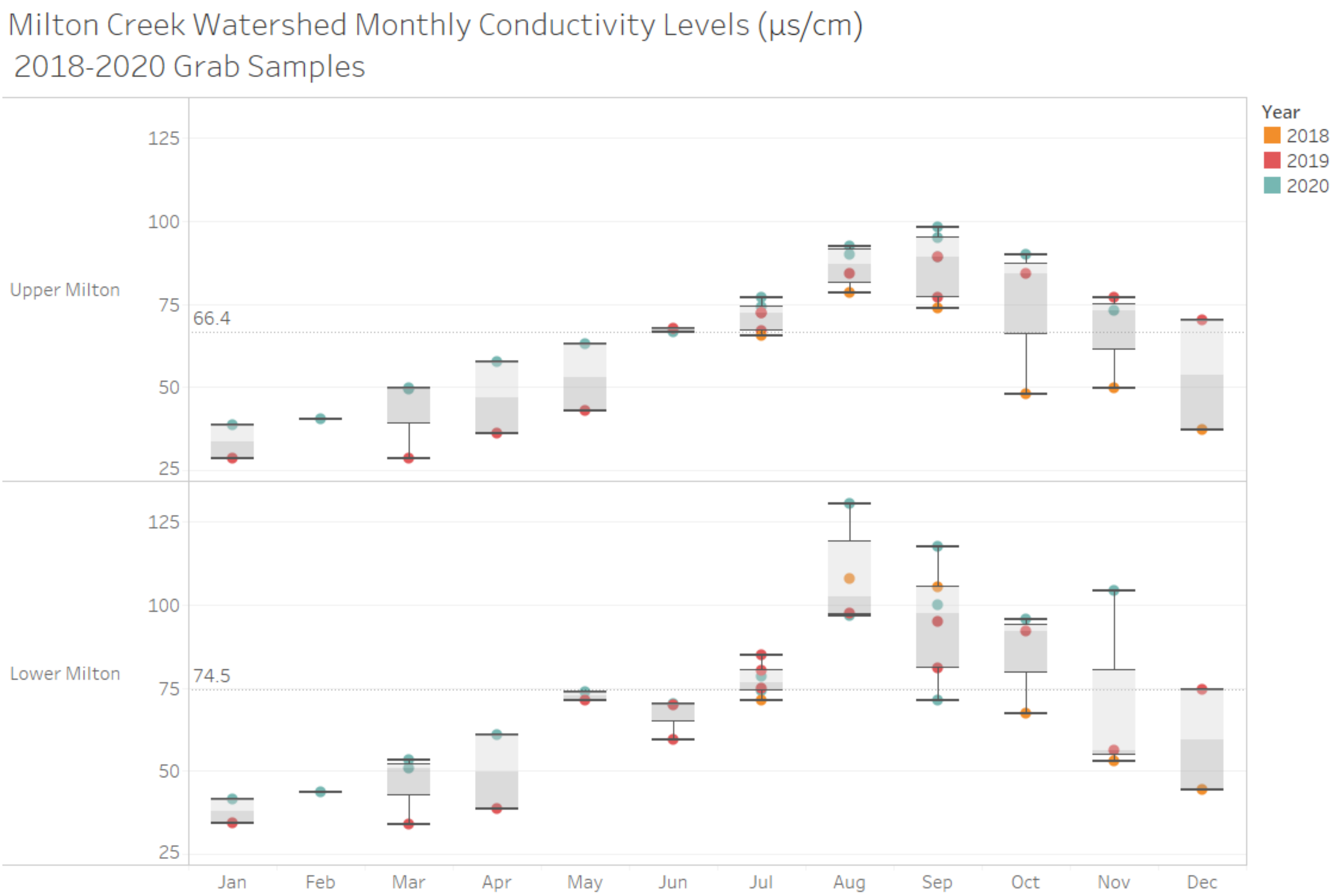


Figure 35: Conductivity levels (µs/cm) 2018-2020 Grab Samples results (boxplots) for Milton Creek watershed broken down across months sampled and watershed sampling location. Sampling years ranging from 2018 to 2020 are highlighted within each boxplot. The overall mean for the study period is highlighted in each graph.

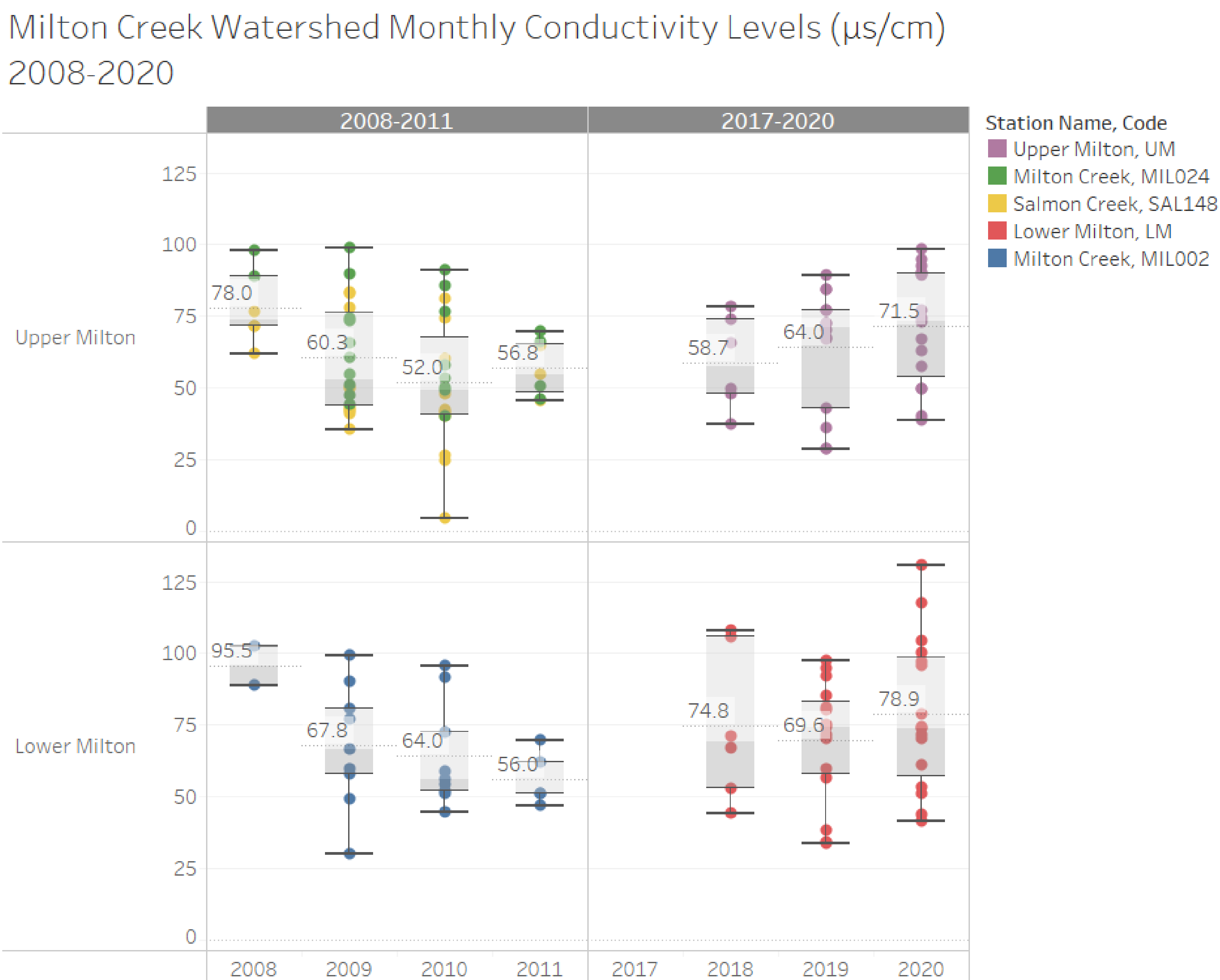


Figure 36: Conductivity levels (µs/cm) 2008-2020 Grab Samples results (boxplots) for Milton Creek watershed broken down across years, with monitoring location highlighted within each boxplot. Sampling years ranging from 2008-2011 and 2018- 2020. Overall mean for each year annotated.

Water Quality Issues

Water quality issues observed in Milton Creek Watershed include high summer temperatures (>18°C) in the upper and lower watershed between June and September (Table 18). Overall elevated temperatures are likely caused by solar loading, especially within the lower reaches of the watershed, which are much more heavily developed and lack riparian shade (Figure 4). Both Upper and Lower portions of Milton Creek have experienced a potential increase in water temperatures since the previous 2008-2011 study indicating that further action is required to prevent continued temperature issues in the basin (Figure 30). Low water temperatures are critical for supporting aquatic life including endangered Salmonids in the Pacific Northwest; reducing solar radiation and reducing urban and agricultural runoff can help keep water temperatures down and protect these stream habitats (USGS 2021). Multiple turbidity events above the 10 NTU threshold were also observed in the Upper and Lower reaches of Milton Creek during the 2017-2020 study period. Overall monthly averages of turbidity remained below the 10 NTU threshold, however, were elevated compared to the North and South Scappoose Creek watersheds (Table 46, Table 52, Table 56). Similar to recommendations for temperature improvements, increasing riparian cover and reducing runoff can aid in reducing erosion events and sediment loading in stream environments.

Additionally, elevated *E. coli* bacteria levels were observed in the watershed between May-November in throughout the 2017-2020 study period, exceeding the EPA and ODEQ standards including the five sample geometric mean in 2019 and 2020 (Table 3, Table 21). *E. coli* bacteria issues are indicative of animal waste runoff and can be very harmful to humans using these waterways for recreation (Pandey et al. 2014). Additional research is needed to determine the exact source of the elevated *E. coli*. Animal waste or septic tank leakage into the stream are possible sources to be investigated. Depending on the source, actions that could reduce future *E. coli* exceedance events include increasing riparian buffers, excluding livestock from the creek, increasing manure management near streams, or updating failed septic systems throughout the targeted reach of the watershed (Pandey et al. 2014). Given the frequency and scale of *E. coli* bacteria events adding warning signs to recreational areas along the stream is recommended. No significant issues or shifts in stream water conductivity levels were detected in Milton Creek Watershed during this study.

North Scappoose Creek

Study Area

North and South Scappoose Creek Watersheds
Distribution of Monitoring Locations (2008-2011, 2017-2020)

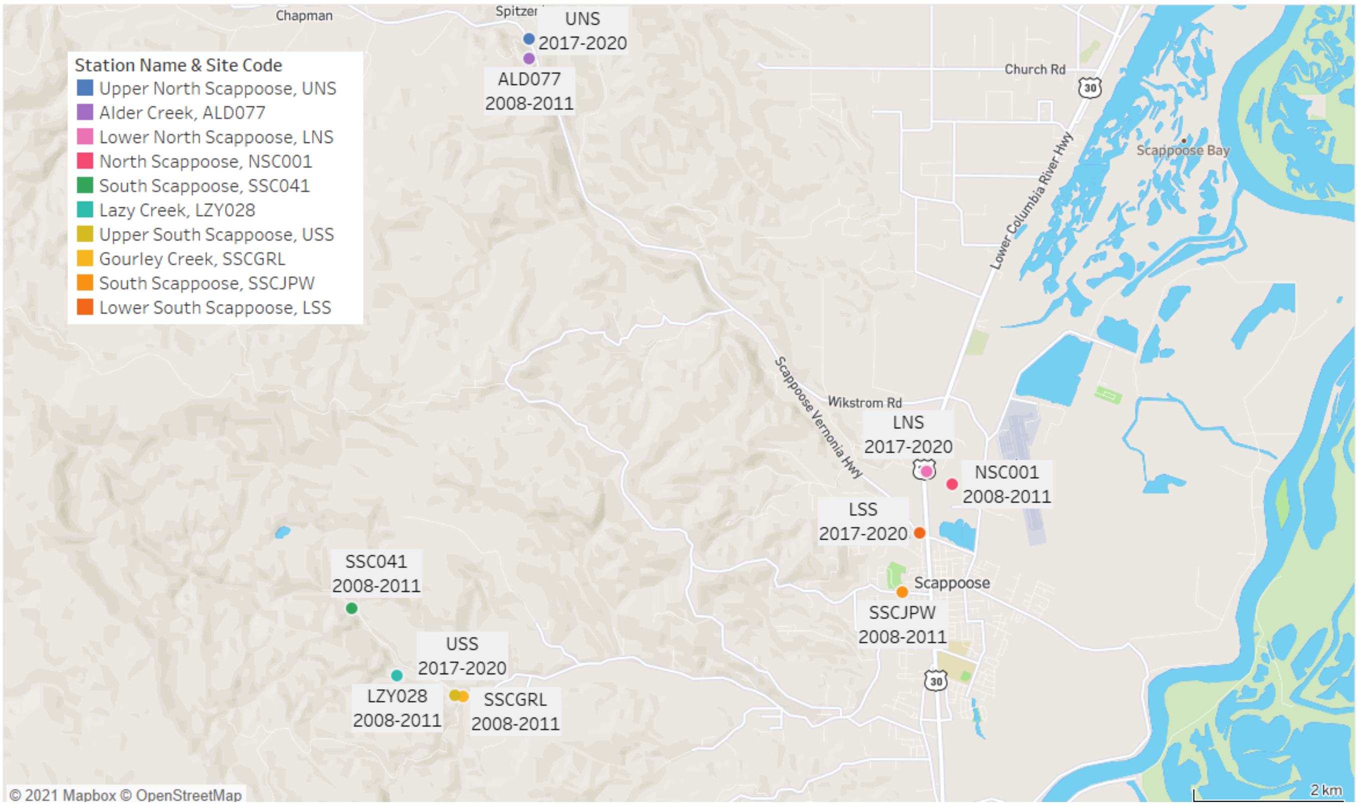


Figure 37: Overview map of North and South Scappoose Creek monitoring locations, for watershed boundaries, see Figure 2. For specific monitoring location details, see Table 1.

Upper North Scappoose Creeks Distribution of Monitoring Locations (2008-2011, 2017-2020)

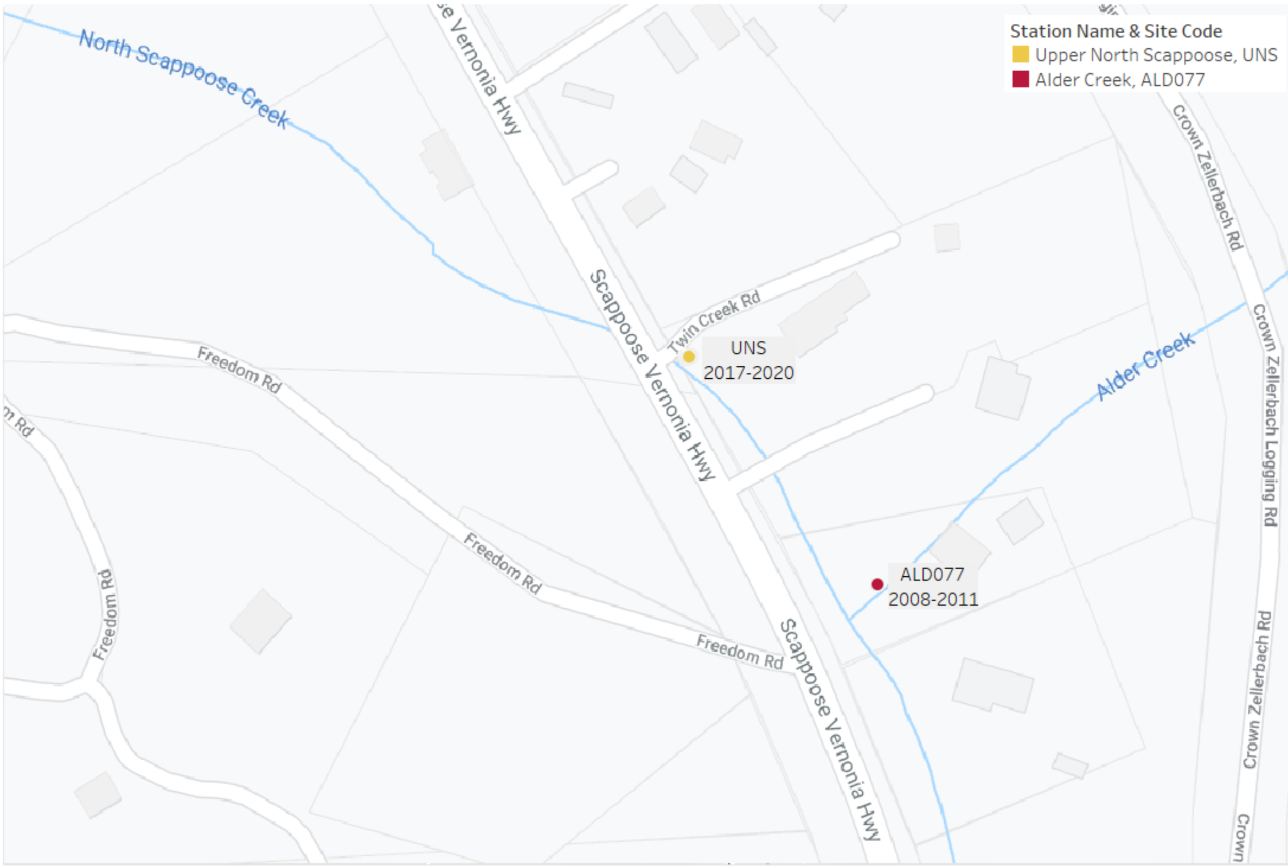


Figure 38: Focus map of Upper North Scappoose Creek monitoring locations; for an overview map, see Figure 2 & Figure 37. For specific monitoring location details, see Table 1.

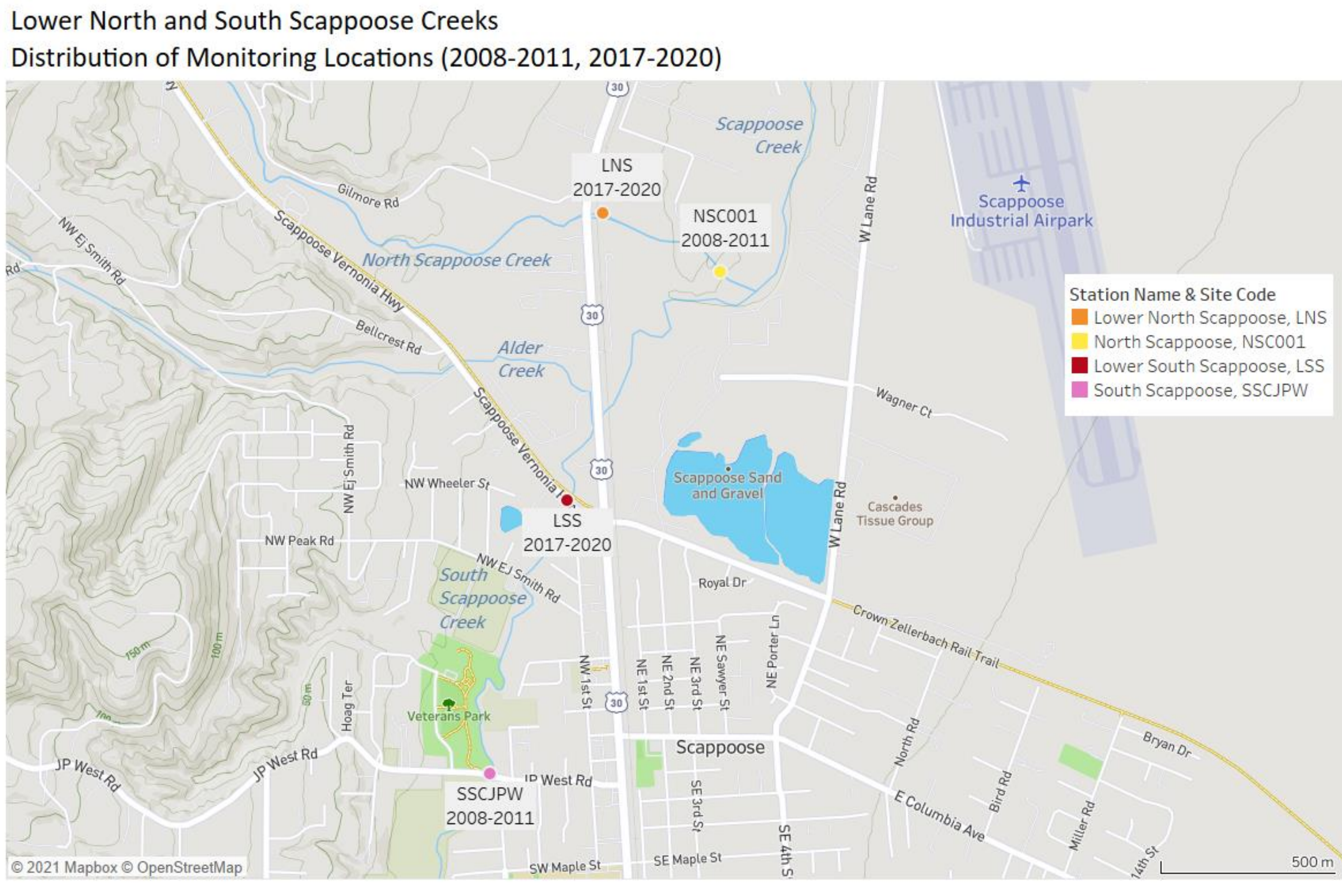


Figure 39: Focus map of Lower North and South Scappoose Creek monitoring locations; for an overview map, see Figure 2 & Figure 37. For specific monitoring location details, see Table 1.

Water Temperature

Between 2017 and 2020, 7dMAM temperature ranged from 5°C to 21.5°C in the North Scappoose Creek Watershed (Table 25). Temperatures were higher in the lower watershed (Figure 40), with seasonally highest temperatures observed in August (Figure 41).

Upper and Lower North Scappoose creeks followed similar temperature trends during the winter months of 2018 and 2019 (January – February). DEQ temperature standard for salmon rearing habitat is less than 18°C and streams with temperatures higher than 18°C are considered poor quality for salmon. Temperatures in the Upper North Scappoose Creek exceeded 18°C consistently in August every year, except in 2019 when data was unavailable; however, these temperatures dropped below 18°C in September and October. Lower North Scappoose Creek maintained temperatures above 18°C during July and August (Figure 42) and for a greater number of days in the monitoring period (Table 26). The lower temperatures at Upper North Scappoose are indicative of the presence of forests and vegetation providing adequate shading and lesser runoffs. Lower North Scappoose is located in a medium intensity developed area of the watershed. The creek passes through developed areas and temperatures at the Lower North Scappoose monitoring station are heightened seemingly due to solar exposure, runoffs etc.

Table 25: Monthly variation in 7dMAM temperatures from 2017 to 2020 for Upper North Scappoose and Lower North Scappoose creeks. Temperatures have been color-coded according to salmonid thresholds listed in Table 3, with blue representing cooler, ideal conditions and yellow/orange representing temperatures crossing 18°C. Temperatures close to or exceeding lethal conditions have been represented in red.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper North Scappoose	2017							18.1	18.8	16.1	9.8	8.1	5.3
	2018	7.2	6.5	7.0	9.5	13.7	15.1	18.4	19.0	14.7	10.5	7.0	5.9
	2019	6.4	5.0	6.1	9.8	13.3	16.0	15.9				6.1	5.1
	2020			7.7	9.7	12.7	14.6	17.0	18.2	15.9	14.0		
Lower North Scappoose	2017							20.5	21.5	18.2	11.4	8.6	5.4
	2018	7.5	6.9	7.5	10.0	14.9	16.7	21.1	21.0	16.9	12.2	8.1	6.3
	2019	6.6	5.3	6.9	10.7	14.8	18.1	19.5	20.6	21.3		7.4	5.1
	2020			9.4	11.4	14.3	16.6	19.4	21.0	17.8	16.2		

Average Temperature Scale

7°C - Ideal 18°C - Poor 25°C - Lethal

Table 26: Number of days over 18°C in the North Scappoose Creek Watershed between 2017 to 2020. Winter and spring months have been excluded from this table as stream temperature conditions are within ideal conditions at that time.

		May	June	July	August	September	October
Upper North Scappoose	2017			15	21	12	0
	2018	0	0	19	24	0	0
	2019	0	3	0			
	2020	0	0	13	15	2	0
Lower North Scappoose	2017			27	31	17	0
	2018	0	11	31	31	12	0
	2019	0	13	25	31	11	
	2020	0	7	20	31	12	0

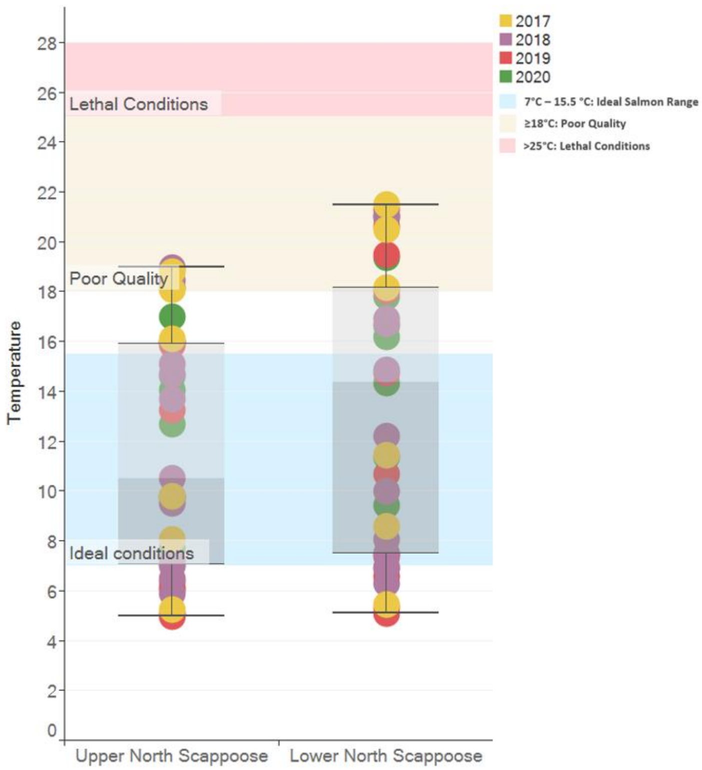


Figure 40: 7dMAM temperature variation in the North Scappoose Creek Watershed, overlaid on the DEQ stream temperature standard ranges for healthy salmon habitat (Table 3). Data points represent the months monitored in a year.

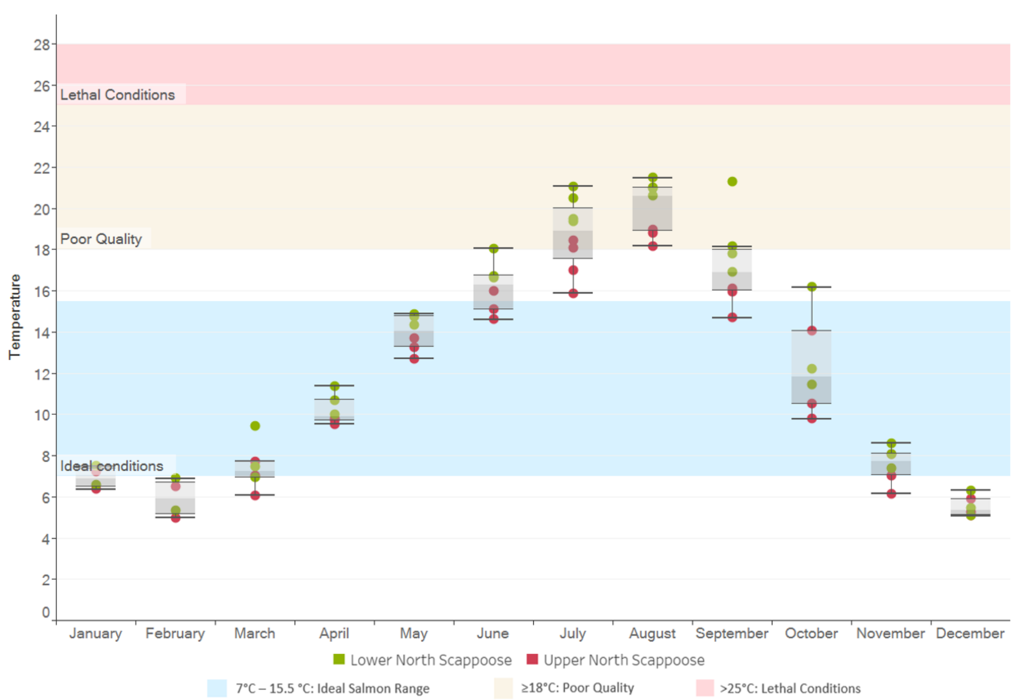


Figure 41: Monthly variation in 7dMAM temperature in the North Scappoose Creek Watershed between 2017 – 2020.

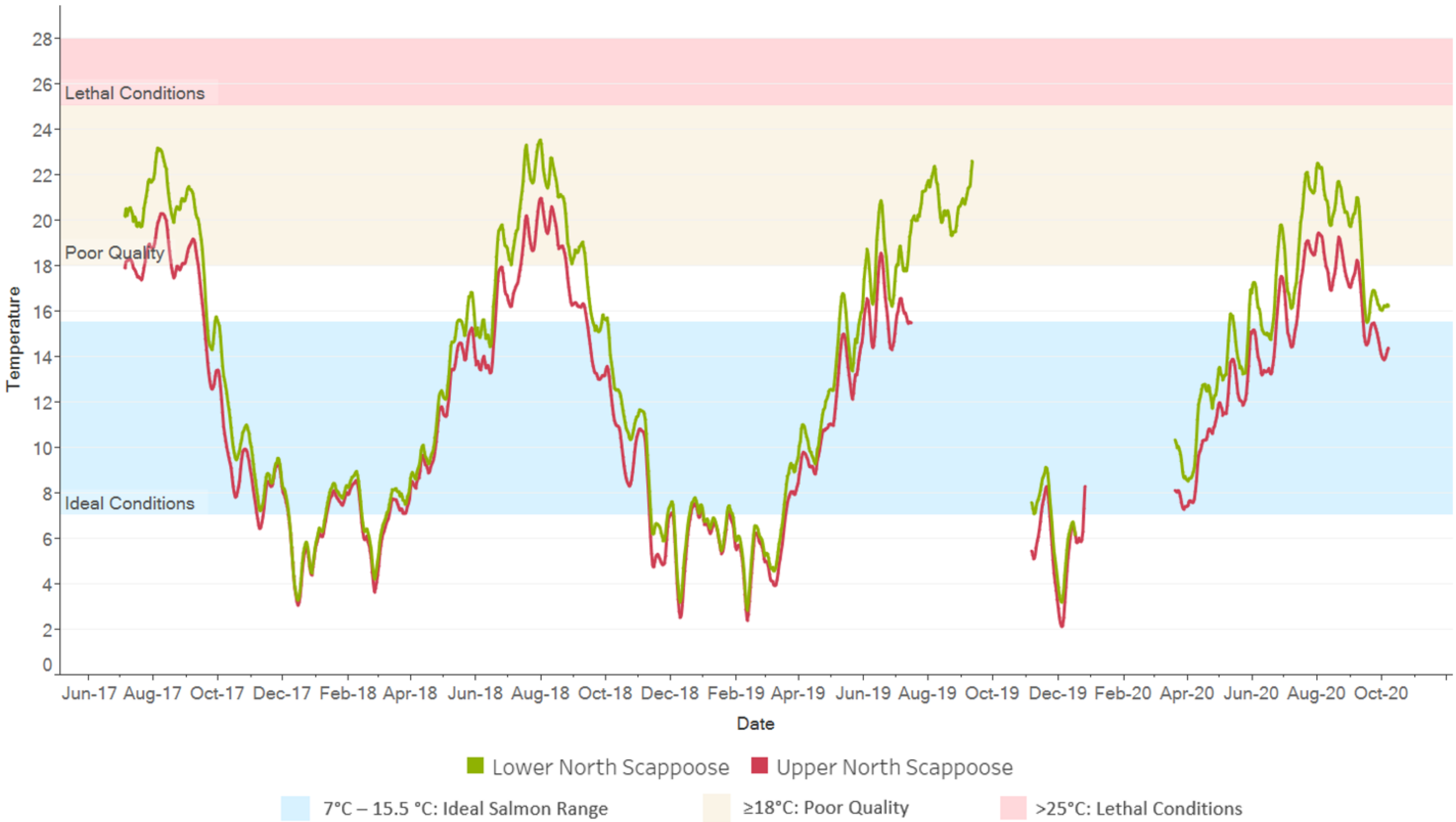


Figure 42: 7-day average maximum temperatures (7dMAM) for Lower North Scappoose and Upper North Scappoose creeks from June 2017 to October 2020 overlayed on salmonid temperature threshold ranges. See Table 3 for temperature threshold details.

When May to October temperature 7dMAM temperature data was compared to the overlapping timeframe from 2008-2011, increased temperature trends were observed; however, the average increase is greater in the lower watershed. There was an average increase of 0.7°C in the upper watershed whereas during the same time, the average increase in the lower watershed was 1.5°C. However, it should be noted that the complete temperature profile is unavailable for the 2008 – 2011 dataset and 2010 data was missing from this dataset, so we cannot definitively say whether this increase is consistent (Figure 43).

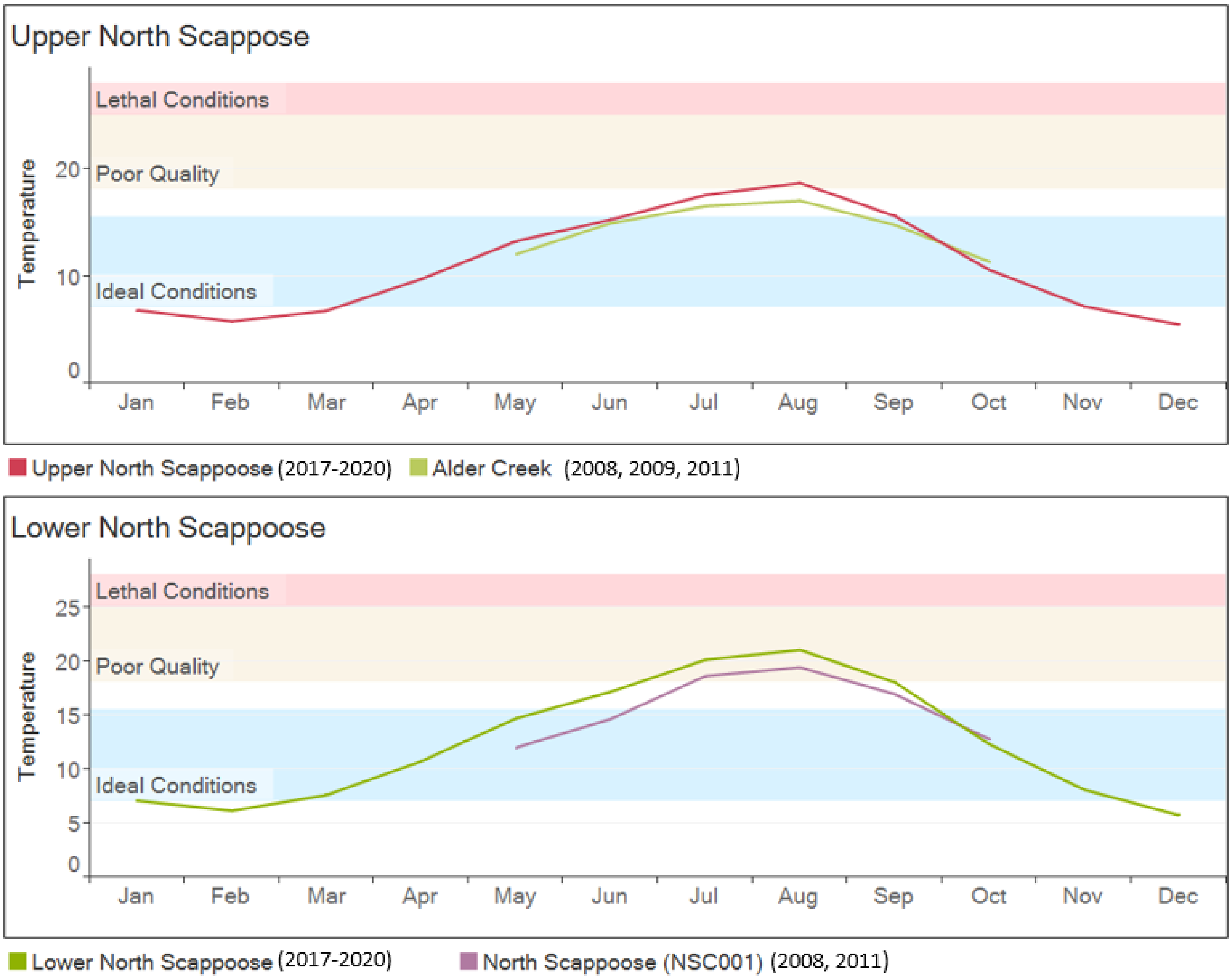


Figure 43: Monthly 7dMAM temperature comparisons between 2017-2020 data and 2008-2011 data for North Scappoose Creek Watershed. Upper North Scappoose and Lower North Scappoose have data available from June 2017 to October 2020. Alder Creek has data available for May to October of 2008, 2009 and 2011. North Scappoose (NSC001) has data available for May to October of 2008 and 2011.

Water Turbidity Levels

Over the four-year monitoring period, on average, Upper and Lower North Scappoose Creek sampling locations maintained relatively low (< 4 NTU) turbidity levels (Table 27, Figure 44). Seasonally, the highest turbidity levels were recorded in the winter months (Nov, Dec, Jan), reflecting winter storm conditions and high flow events (Figure 44). Only one occurrence above the 10 NTU salmon habitat turbidity threshold was recorded in Lower North Scappoose Creek during the 2017-2020 study period (Table 27, Figure 44). When comparing the 2018-2020 data to the 2008-2011 data, no significant shift in turbidity was observed between Upper and Lower North Scappoose Creek (Figure 45).

Table 27: Summary Table for North Scappoose Creek Watershed Monthly Turbidity (NTU), 2017-2020 Grab Samples. Grab sample data broken down across years and watershed sampling locations. n = number of samples collected—red highlights when a sample location experienced a maximum over the 10 NTU threshold. For monthly data by site, see Appendix B.

Summary Table: North Scappoose Creek Watershed Turbidity Levels (NTU)
2017-2020 Grab Samples

		n	Max	Mean	+/- SD
Upper North Scappoose	2017	4	4.9	2.7	1.5
	2018	11	5.3	2.9	1.2
	2019	14	7.0	2.9	1.9
	2020	15	8.9	3.4	1.9
Lower North Scappoose	2017	5	5.2	2.0	1.8
	2018	11	5.0	2.9	1.3
	2019	15	7.2	3.2	2.0
	2020	15	10.1	2.9	2.2

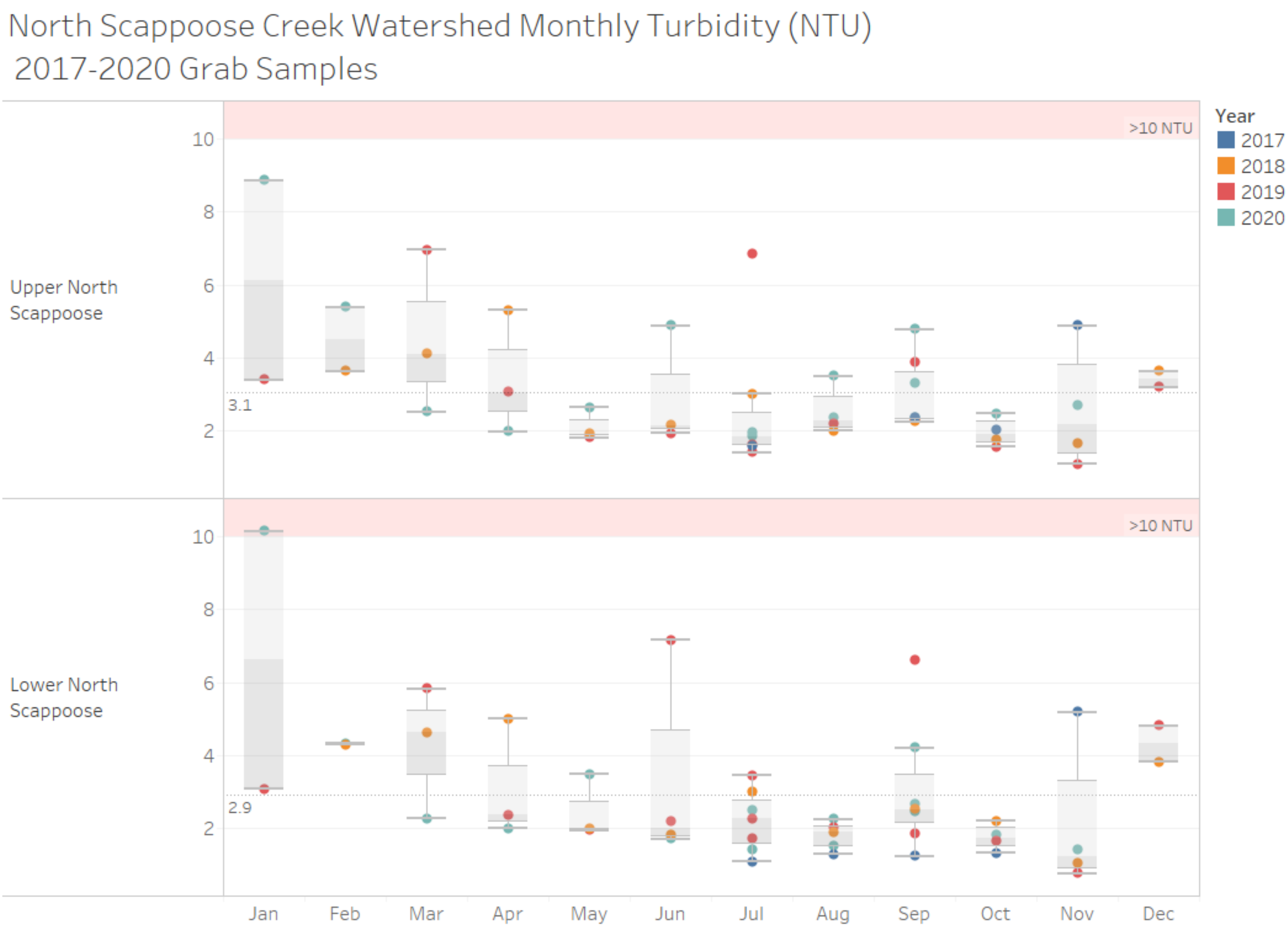


Figure 44. Turbidity (NTU) grab sampling results (boxplots) for North Scappoose Creek Watershed broken down across sampling locations and months sampled. Sampling years ranging from 2017 to 2020 are highlighted within each boxplot. 10 NTU threshold highlighted in pink. The overall mean for the study period highlighted in each graph. A summary of these data can be found in Appendix B.

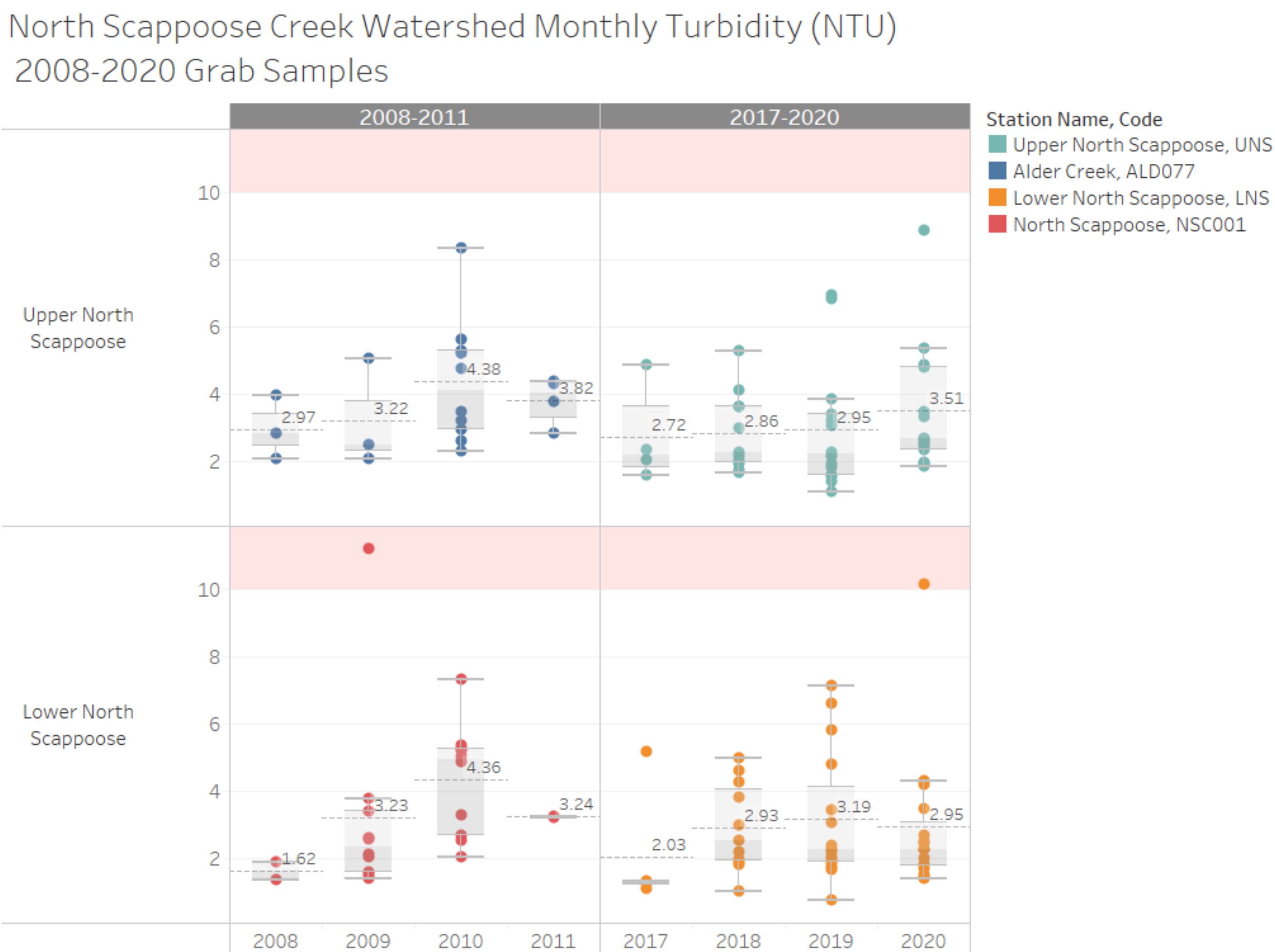


Figure 45: Turbidity (NTU) grab sampling results (boxplots) for North Scappoose Creek Watershed broken down across years sampled. Sampling locations are highlighted within each boxplot. 10 NTU threshold highlighted in pink. Overall mean for each year highlighted. A summary of these data can be found in Appendix B.

Water Bacteria Levels

In 2017, only Lower North Scappoose Creek was monitored for *E. coli* bacteria levels; during this time, elevated levels exceeding the EPA health standard <235 MPN/100 ml were detected in September (

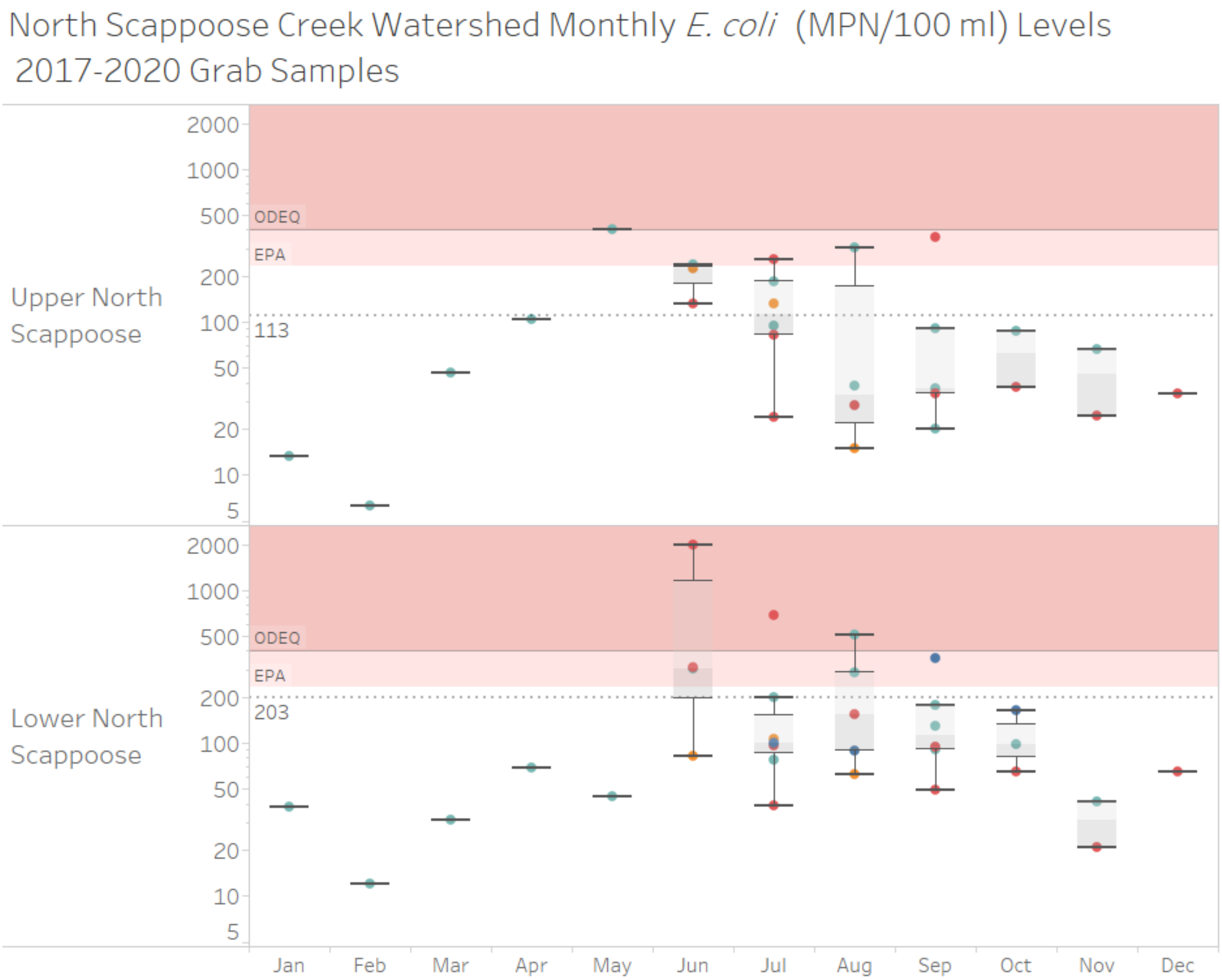


Figure 46, Table 28-Table 30). In 2018, sampling only took place between June-August and no elevated samples were collected (Table 28). More intensive sampling was conducted during the 2019 and 2020 monitoring years, including bi-monthly sampling in the summer which allowed for the calculation of the 90-day geometric mean (Table 30). The 90-day geometric mean state-mandated water quality threshold for Oregon is 126 MPN/100. In 2020, Upper North Scappoose Creek exhibited elevated *E. coli* bacteria levels from May-August with a geometric mean of 221.9 MPN/100 (Table 28-Table 30). In comparison, Lower North Scappoose Creek also experienced elevated *E. coli* bacteria levels in 2019 from June-September with a geometric mean of 199.5 MPN/100 and May-November in 2020 ranging from 128.8-187.7 MPN/100 (Table 28-Table 30). Seasonally, both Upper and Lower North Scappoose monitoring locations tend to have elevated bacteria levels starting in late spring and going through the fall,

coinciding with generally warmer stream temperatures (Figure 41,

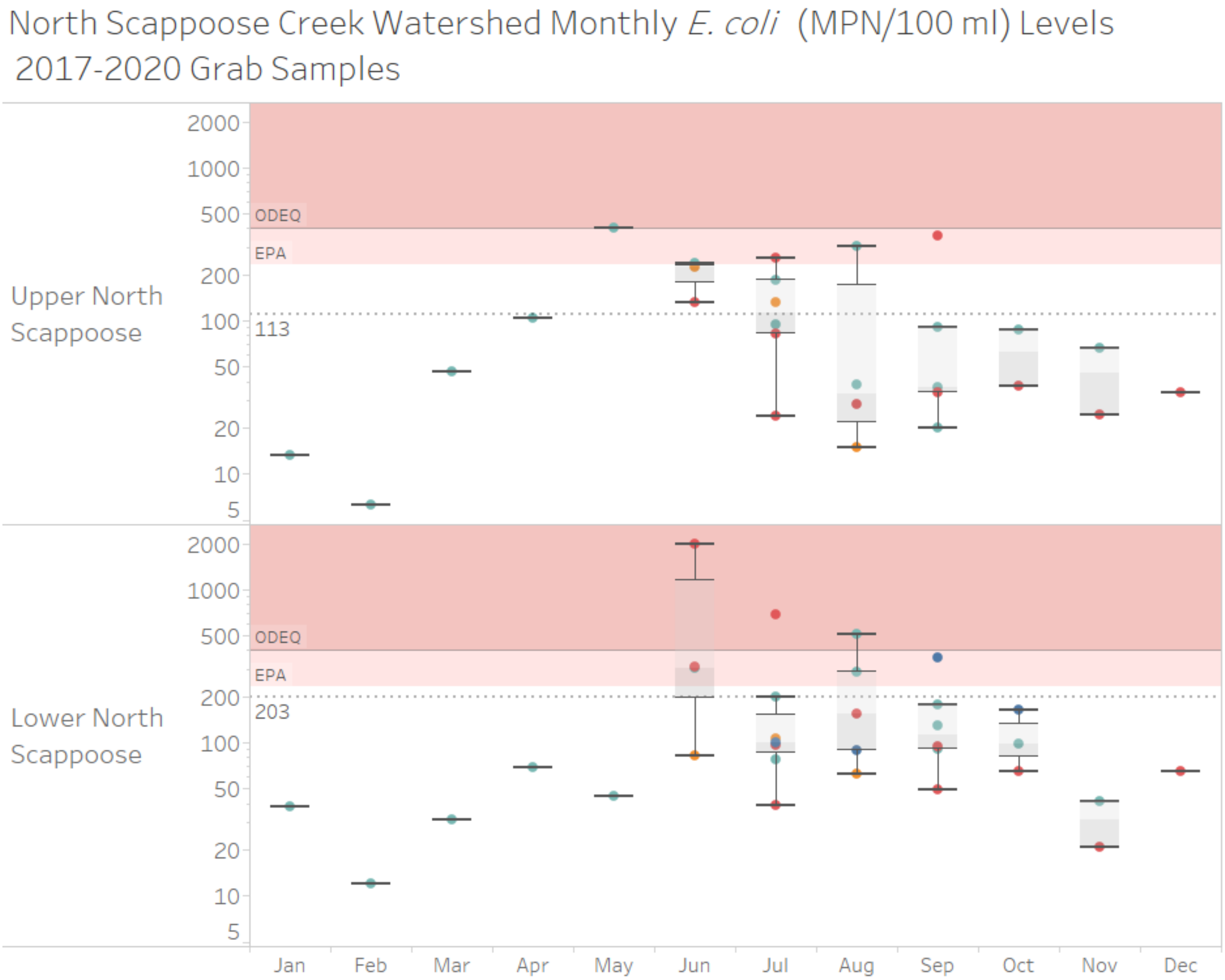


Figure *46*).

When comparing the 2017-2020 data to the 2008-2011 data, it is clear that both Upper and Lower North Scappoose have historically experienced elevated *E. coli* bacteria events (

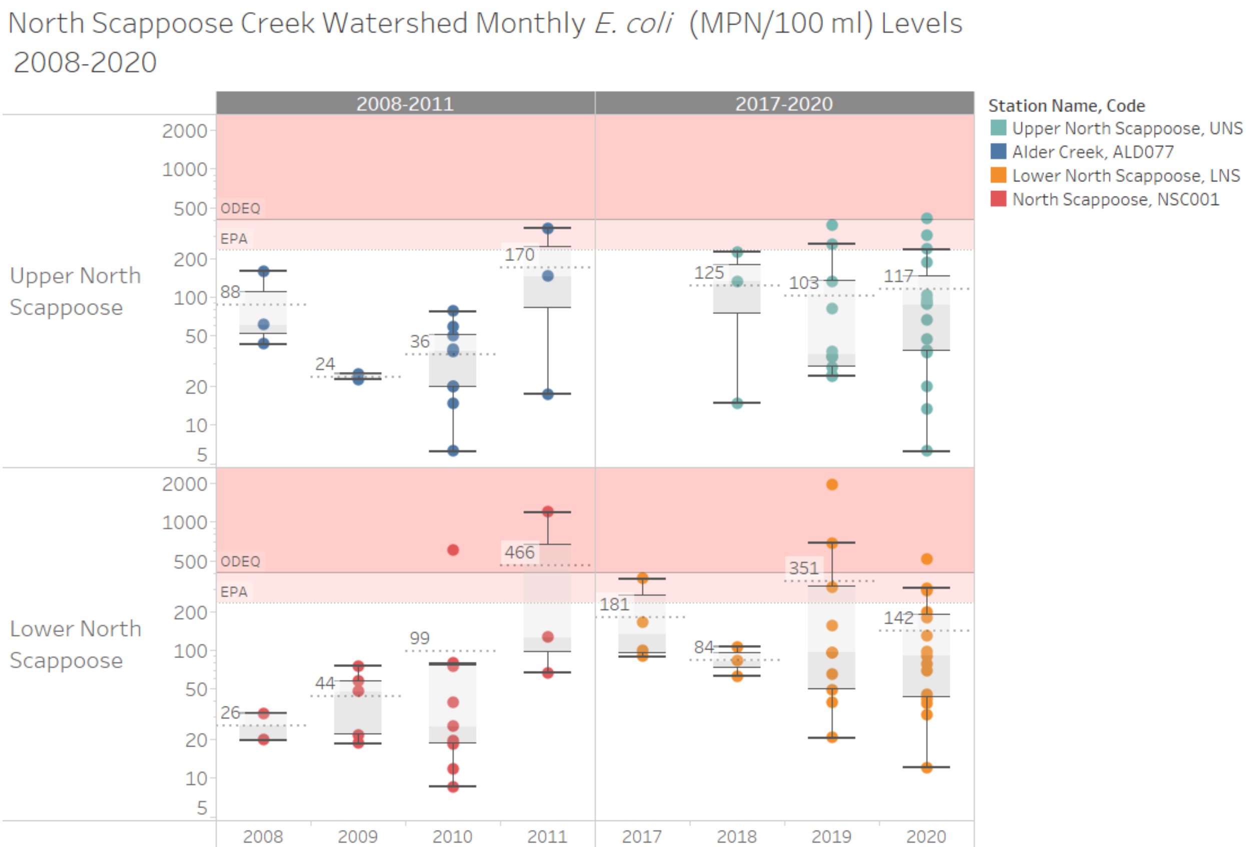


Figure 47). The frequency of these events, however, appears to be increasing, especially in Lower North Scappoose creek, when comparing overall monthly values between 2017-2020 to 2008-2011 (

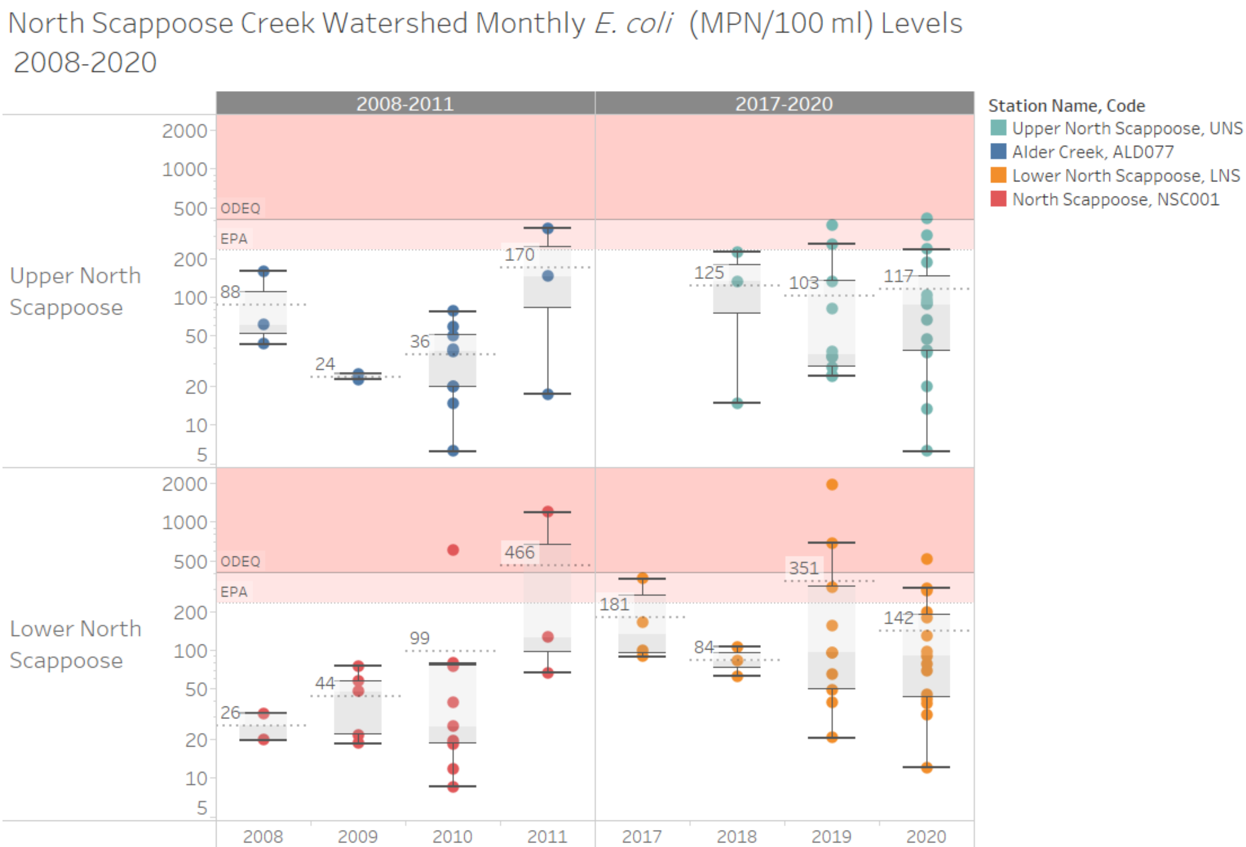


Figure 47). These water quality conditions merit continued monitoring and additional investigation into the cause of elevated *E. coli* levels to ensure they do not continue to persist or continue to decline.

Table 28: North Scappoose Creek watershed monthly max E. coli (MPN/100 ml) grab samples. Grab sampling results for broken down across years and watershed sampling locations. Sampling locations that experienced events over the EPA (235 MPN/100) and ODEQ (406 MPN/100) thresholds for E. coli bacteria levels are highlighted in red.

North Scappoose Creek Watershed Monthly Max *E. coli* (MPN/100 ml)
2017-2020 Grab Samples

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper North Scappoose	2017												
	2018						226	133	15				
	2019						133	261	29	365	38	25	34
	2020	13	6	47	105	411	238	186	308	91	88	67	
Lower North Scappoose	2017							101	90	365	166		
	2018						83	107	63				
	2019						1,990	687	156	96	65	21	65
	2020	39	12	32	70	45	308	201	517	179	99	42	

Table 29: Summary table of North Scappoose Creek watershed E. coli (2017-2020) MPN/100 ml grab samples. Grab sample data broken down across years and watershed sampling locations. Sampling locations that experienced events over the EPA (235 MPN/100) and ODEQ (406 MPN/100) thresholds for E. coli bacteria levels are highlighted in red. n = number of samples collected, for monthly max data, see Table 28 and Appendix B.

Summary Table: North Scappoose Creek Watershed Monthly Max *E. coli* (MPN/100 ml) 2017-2020 Grab Samples

		n	Max	Mean	+/- SD
Upper North Scappoose	2017	0			
	2018	3	226	125	106
	2019	10	365	103	119
	2020	15	411	117	118
Lower North Scappoose	2017	4	365	181	127
	2018	3	107	84	22
	2019	11	1,990	325	585
	2020	15	517	142	138

Table 30: North Scappoose Creek watershed 90 Day geometric mean (5 samples or greater) of E. coli bacteria levels (MPN/100ml) across all sampling sites, those durations that are above the state-mandated threshold of 126 MPN/100 ml for the 90 day geometric mean are highlighted with red text.

North Scappoose Creek Watershed *E. coli* (MPN/100 ml)
90 Day Geometric Mean (5 samples or greater)

		May Aug	Jun Sep	Jul Oct	Aug Nov
Upper North Scappoose	2019		75.6	68.5	
	2020	221.9	87.7	68.4	50.1
Lower North Scappoose	2019		199.5	103.4	
	2020	178.7	187.7	181.0	128.8

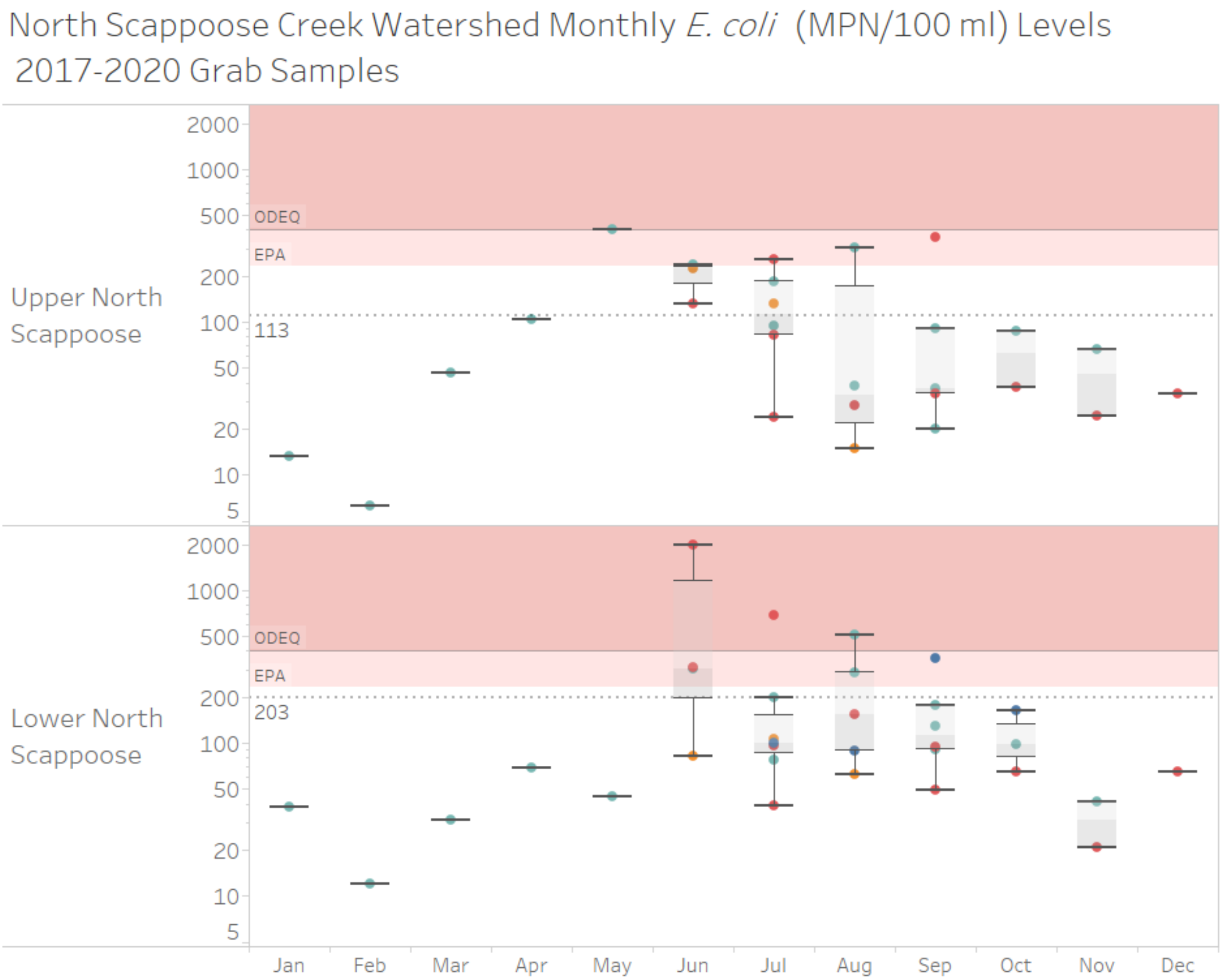


Figure 46. E. coli bacteria grab sampling results (boxplots) for North Scappoose Creek Watershed broken down across months sampled and watershed sampling locations. Sampling year ranging from 2017 to 2020 are highlighted within each boxplot. EPA (235 MPN/100) and ODEQ (406 MPN/100) thresholds for E. coli bacteria levels are highlighted on each graph. The overall mean for the study period highlighted in each graph. Logarithmic scale used on the y-axis.

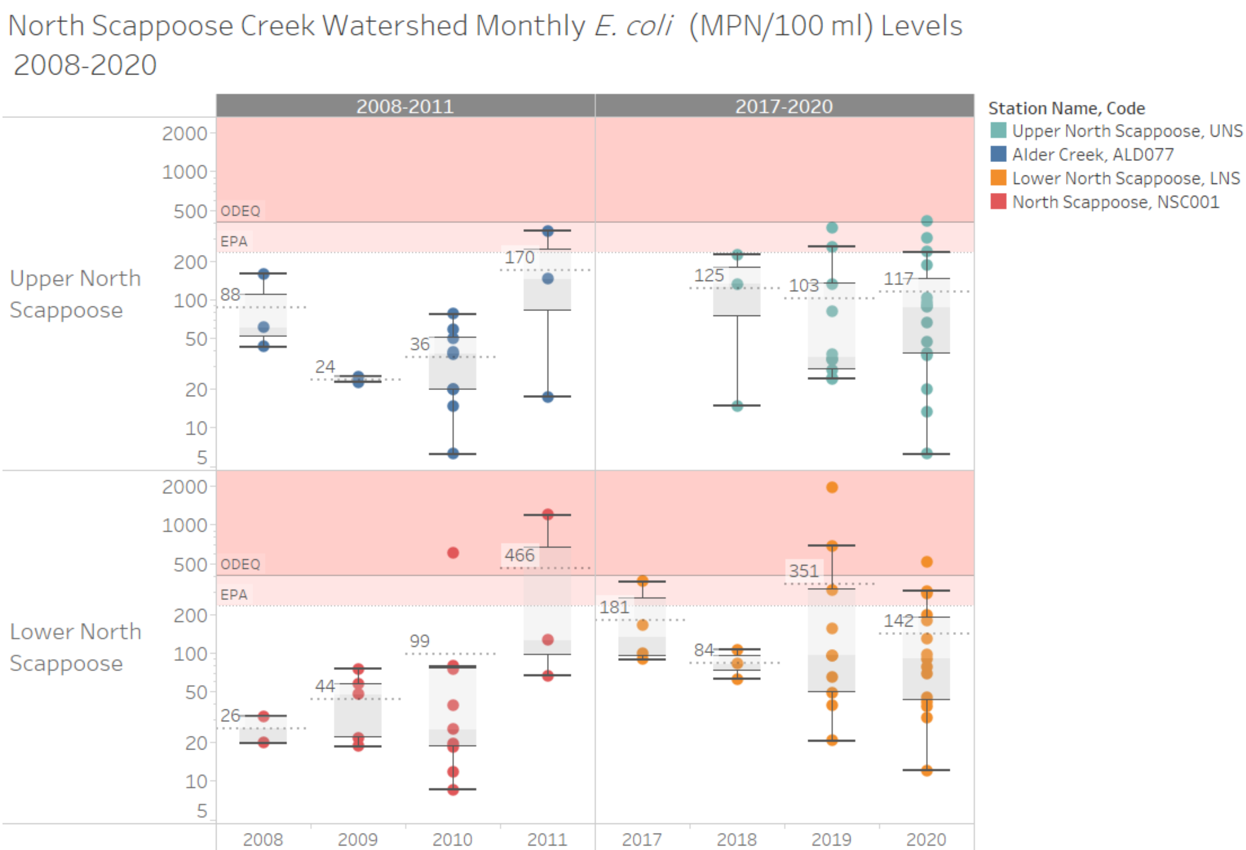


Figure 47: E. coli bacteria grab sampling results (boxplots) for North Scappoose Creek Watershed broken down across years sampled and watershed sampling locations. Sampling location highlighted within each boxplot. EPA (235 MPN/100) and ODEQ (406 MPN/100) thresholds for E. coli bacteria levels are highlighted on each graph. The overall mean for the study period highlighted in each graph. Logarithmic scale used on the y-axis. Monthly data can be found in Appendix B.

Water Conductivity Levels

Conductivity levels varied seasonally across monitoring locations within the North Scappoose Creek watershed (Figure 48, Table 31). At both locations, annual increases in water conductivity were observed between April to September and declined from October to February (Figure 48). Between 2018-2020, Upper North Scappoose Creek exhibited lower overall mean conductivity levels ranging from 62-74 µs/cm compared to 72-84 µs/cm observed at the Lower North Scappoose Creek monitoring location (Figure 48, Table 31). These data provide baseline conductivity levels that can be used to identify new and emerging water quality issues or improvements over time. When comparing the 2018-2020 data to the 2008-2011 data, no significant shift in conductivity was observed (Figure 49). Pollution from runoff or increased turbidity levels from erosion can result in higher conductivity levels; however, there is no EPA or ODEQ threshold for conductivity in the region.

Table 31: Summary Table of North Scappoose Creek watershed monthly conductivity (µs/cm) data for 2018-2020 grab samples. Conductivity (µs/cm) samples broken down across months sampled and watershed sampling location. n = number of samples collected. For monthly data by site, see Appendix B.

Summary Table: North Scappoose Creek Watershed Conductivity Levels (µs/cm)
2008-2020 Grab Samples

		n	Max	Mean	+/- SD
Upper North Scappoose	2018	6	73	62	10
	2019	14	92	69	22
	2020	16	93	74	17
Lower North Scappoose	2018	6	88	72	13
	2019	15	106	78	25
	2020	16	107	84	21

Figure 48: Conductivity levels (µs/cm) 2018-2020 Grab Samples results (boxplots) for North Scappoose Creek watershed broken down across months sampled and watershed sampling location. Sampling years ranging from 2018 to 2020 are highlighted within each boxplot. The overall mean for the study period highlighted in each graph.

North Scappoose Creek Watershed Monthly Conductivity Levels (µs/cm)
2018-2020 Grab Samples

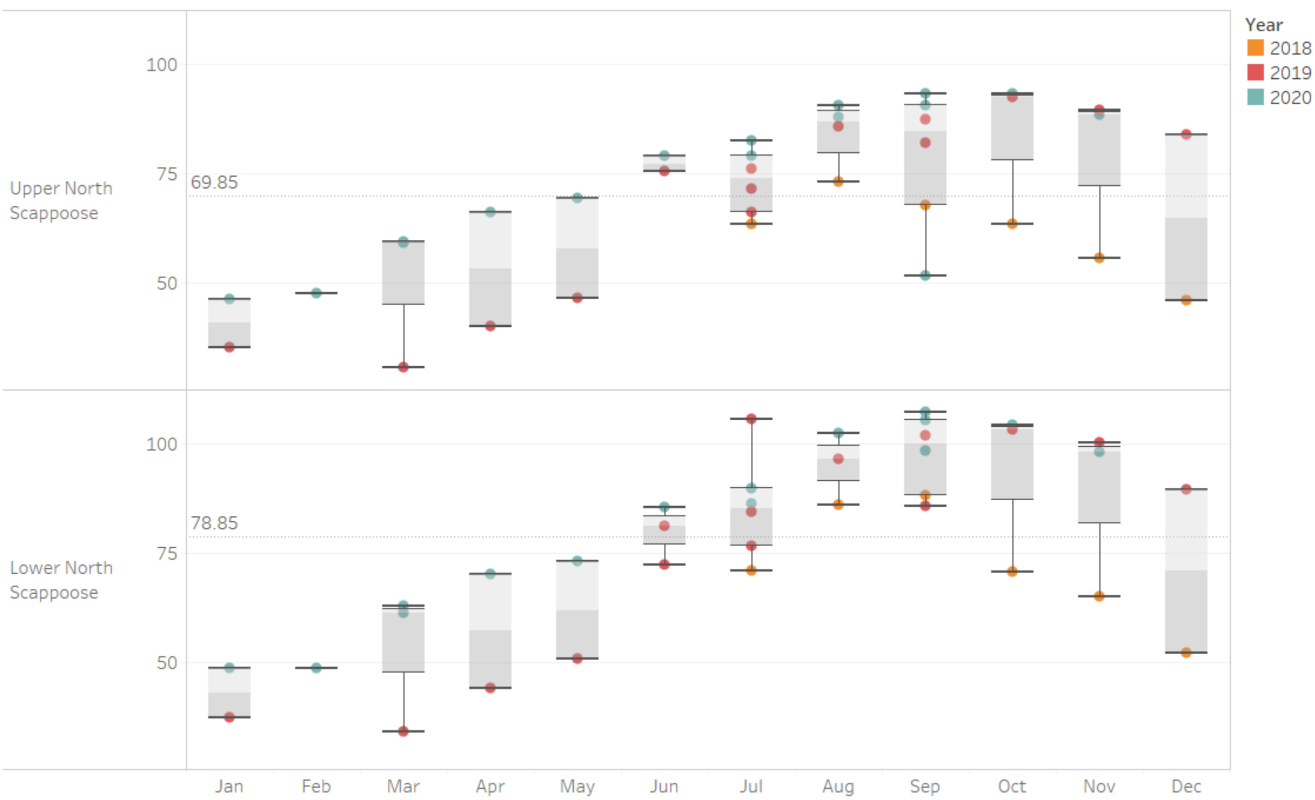
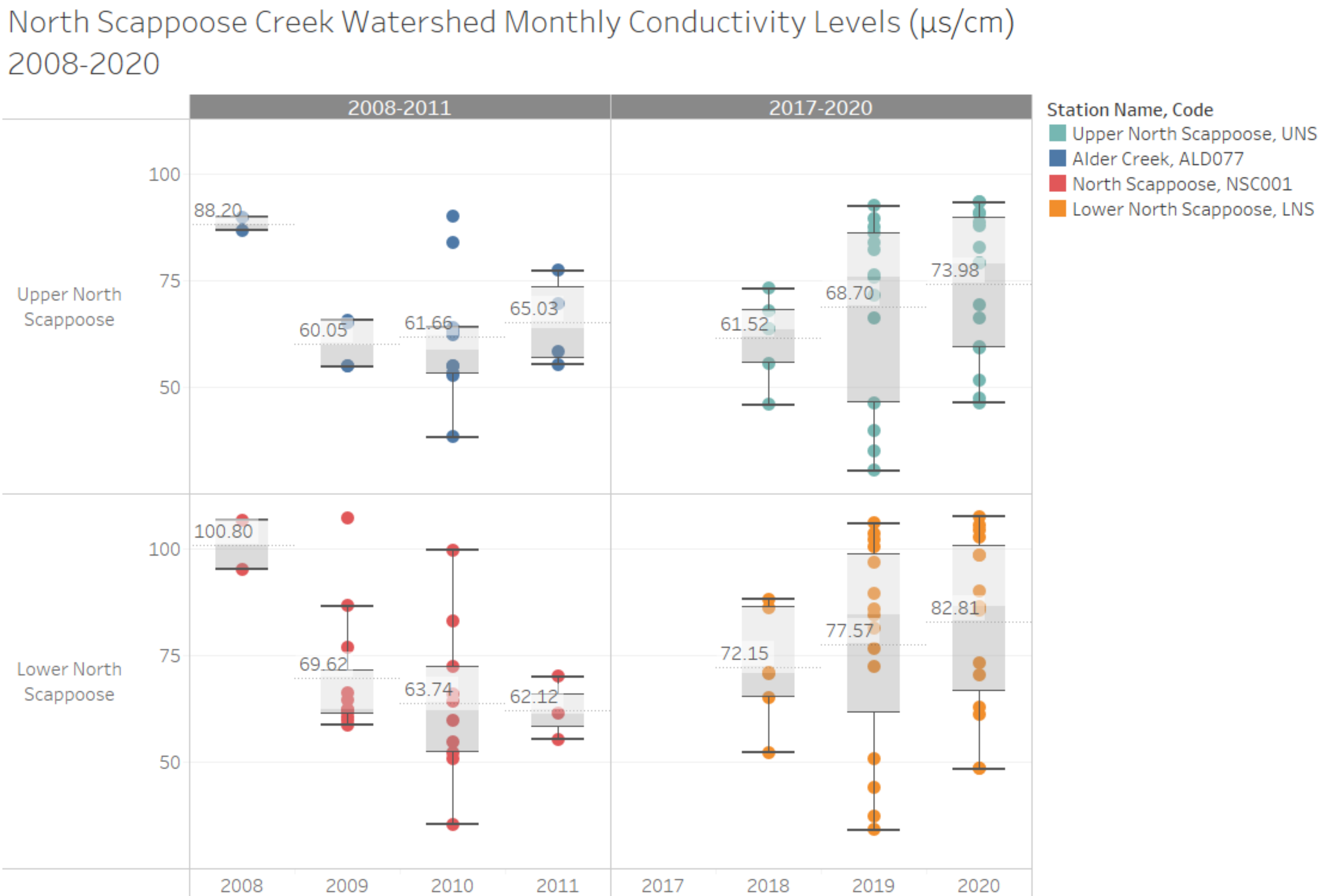


Figure 49: Conductivity levels (µs/cm) 2008-2020 Grab Samples results (boxplots) for North Scappoose Creek watershed broken down across years, with monitoring location highlighted within each boxplot. Sampling years ranging from 2008-2011 and 2018- 2020. Overall mean for each year annotated.



Water Quality Issues

Water quality issues observed in North Scappoose Watershed include high summer temperatures (>18°C) in the upper and lower watershed between June and September (Table 25). Overall elevated temperatures are likely caused by solar loading, especially within the lower reaches of the watershed, which are much more heavily developed and lack riparian shade (Figure 4). Both Upper and Lower North Scappoose have experienced a potential increase in water temperatures since the previous 2008-2011 study indicating that further action is required to prevent continued temperature issues in the basin (Figure 43). Low water temperatures are critical for supporting aquatic life including endangered Salmonids in the Pacific Northwest; reducing solar radiation, and reducing urban and agricultural runoff can help keep water temperatures down and protect these stream habitats (USGS 2021). Additionally, elevated *E. coli* bacteria levels were observed in the watershed between May-November 2020, exceeding the EPA and ODEQ standards including the five sample geometric mean (Table 3, Table 27). *E. coli* bacteria issues are indicative of animal waste runoff and can be very harmful to humans using these waterways for recreation (Pandey et al. 2014). Additional research is needed to determine the exact source of the elevated *E. coli*. Animal waste or septic tank leakage into the stream are possible sources to be investigated. Depending on the source, actions that could reduce future *E. coli* exceedance events include increasing riparian buffers, excluding livestock from the creek, increasing manure management near streams, or updating failed septic systems throughout the targeted reach of the watershed (Pandey et al. 2014). Given the frequency and scale of *E. coli* bacteria events in the lower watershed adding warning signs to recreational areas along the stream is recommended. No significant issues or shifts in stream water turbidity or conductivity levels were detected in North Scappoose Watershed during this study.

South Scappoose Creek

Study Area

Upper South Scappoose Creek Distribution of Monitoring Locations (2008-2011, 2017-2020)

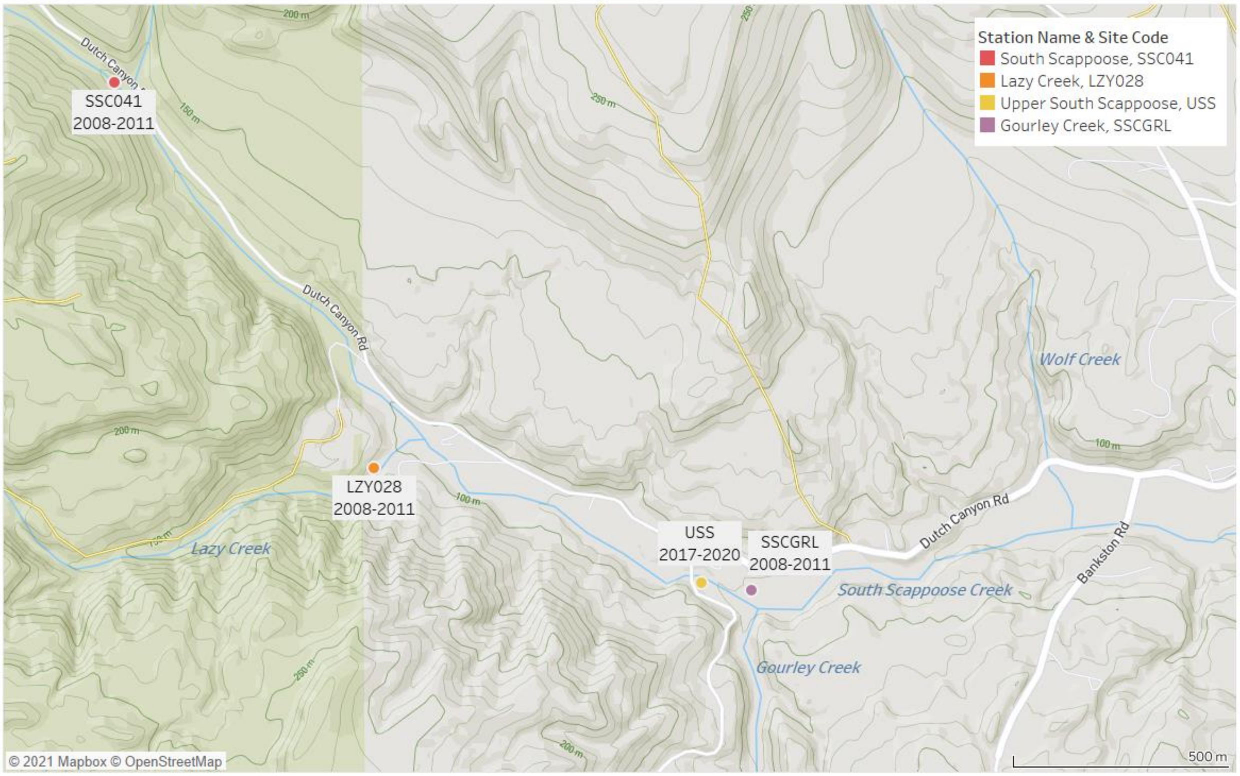


Figure 50: Focus map of Upper South Scappoose Creek monitoring locations, for an overview map, see Figure 2 & Figure 37. For specific monitoring location details see Table 1.

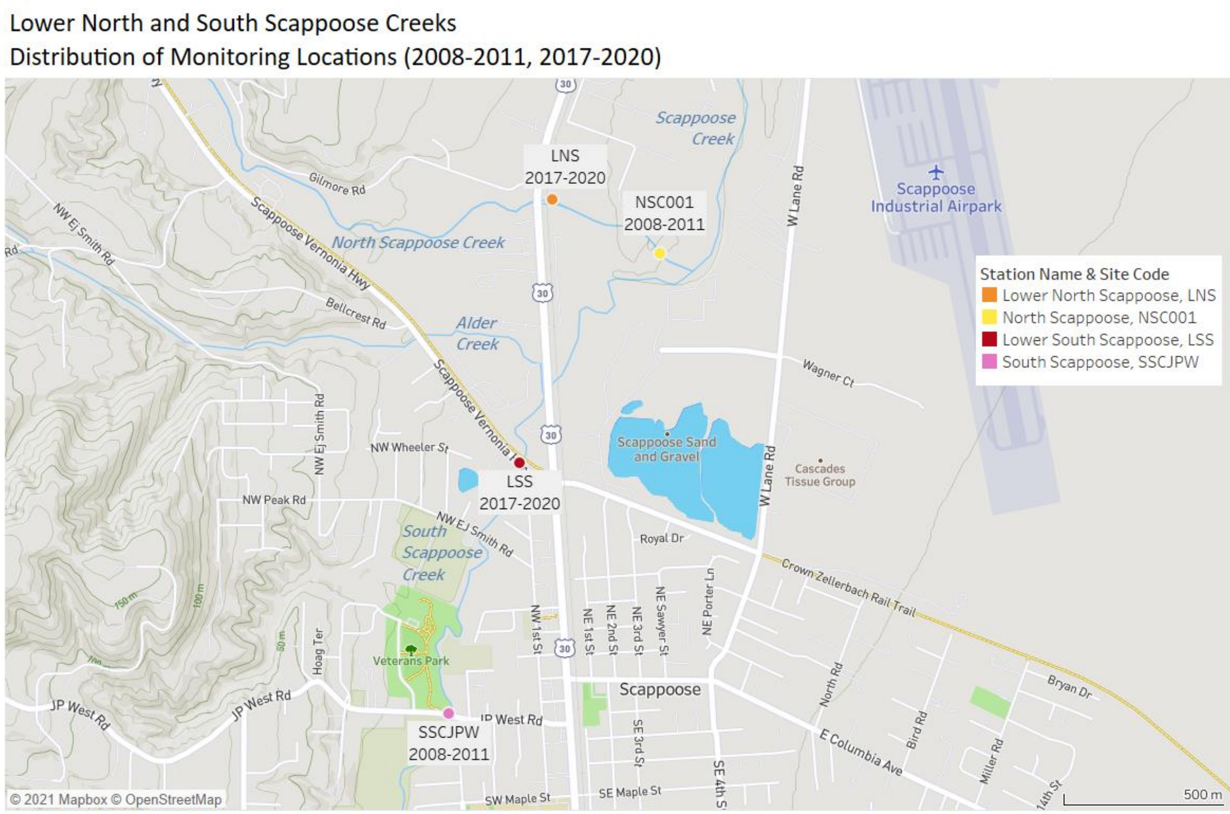


Figure 51: Focus map of Lower North and South Scappoose Creek monitoring locations; for an overview map, see Figure 2 & Figure 37. For specific monitoring location details, see Table 1.

Water Temperature

Between 2017 and 2020, 7dMAM temperatures in the South Scappoose Creek ranged from 5.3°C to 22.4°C (Table 32). The lower watershed had higher temperatures throughout the study (Figure 52), and seasonally highest temperatures were observed in August in the watershed (Figure 53). Similar to Milton and North Scappoose creeks, winter temperature trends in Upper South Scappoose and Lower South Scappoose creeks follow the same patterns (Figure 54).

DEQ temperature standard for salmon rearing habitat is less than 18°C, and streams with temperatures higher than 18°C are considered poor quality for salmon. The monthly average 7dMAM temperature in Upper South Scappoose consistently stay below 18°C throughout the study; however, there were brief periods in the summer of 2017 and 2018 where temperatures exceeded 18°C (Table 32, Figure 54). Lower South Scappoose Creek maintained temperatures above 18°C during July and August; however, these temperatures dropped below 18°C in September and October between 2017 and 2020. Late-Spring, Summer and Fall temperatures of Lower South Scappoose are consistently higher than the temperature of Upper South Scappoose Creek throughout the study period (Table 32, Figure 54). When the number of days over 18°C were compared across the watershed, it was observed that the lower watershed exceeded DEQ temperature standards throughout summer months (Table 33).

Table 32: Monthly variation in 7dMAM temperatures from 2017 to 2020 for Upper South Scappoose and Lower South Scappoose creeks. Temperatures have been color-coded according to salmonid thresholds listed in Table 3, with blue representing cooler, ideal conditions and yellow/orange representing temperatures crossing 18°C. Temperatures close to or exceeding lethal conditions have been represented in red.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper South Scappoose	2017							15.8	17.0	15.0	10.4	8.5	5.9
	2018	7.7	7.1	7.6	9.8	12.6	13.3	16.5	17.0	13.9	11.7	6.8	6.5
	2019	6.9	5.7	7.1	10.1	12.3	14.1	15.2	16.3	16.5	9.1	7.1	5.3
	2020			8.6	10.2	11.9	13.4	15.3	16.7	15.1	14.2		
Lower South Scappoose	2017							20.2	21.5	18.4	11.6	8.9	5.8
	2018	7.8	7.3	8.2	10.9	15.0	16.6	21.2	21.6	18.5	11.5	8.3	6.5
	2019	7.0	5.7	7.2	11.0	14.6	18.1	19.8	21.1	21.0	10.2	7.0	6.0
	2020	7.9	7.8	8.2	11.1	14.0	16.7	19.7	22.4	18.1	16.2		

Average Temperature Scale

7°C - Ideal 18°C - Poor 25°C - Lethal

Table 33: Number of days over 18°C in the South Scappoose Creek sub-watershed between 2017 to 2020. Winter and spring months have been excluded from this table as stream temperature conditions are within ideal conditions at that time.

		May	June	July	August	September	October
Upper South Scappoose	2017			0	5	0	0
	2018	0	0	6	4	0	0
	2019	0	0	0	0	0	0
	2020	0	0	0	0	0	0
Lower South Scappoose	2017			27	31	17	0
	2018	0	10	31	31	11	0
	2019	0	12	31	31	10	0
	2020	0	6	21	12	11	0

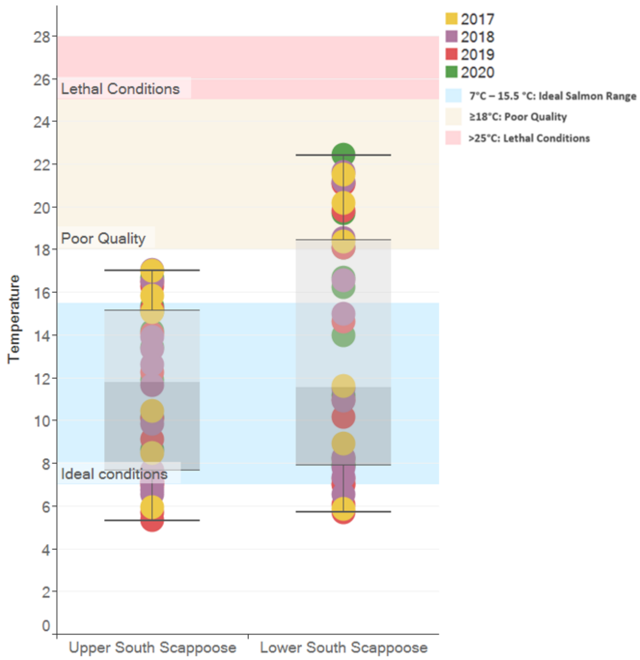


Figure 52: 7dMAM temperature variation in the South Scappoose Creek watershed, overlaid on the DEQ stream temperature standard ranges for healthy salmon habitat (Table 3). Data points represent the months monitored in a year.

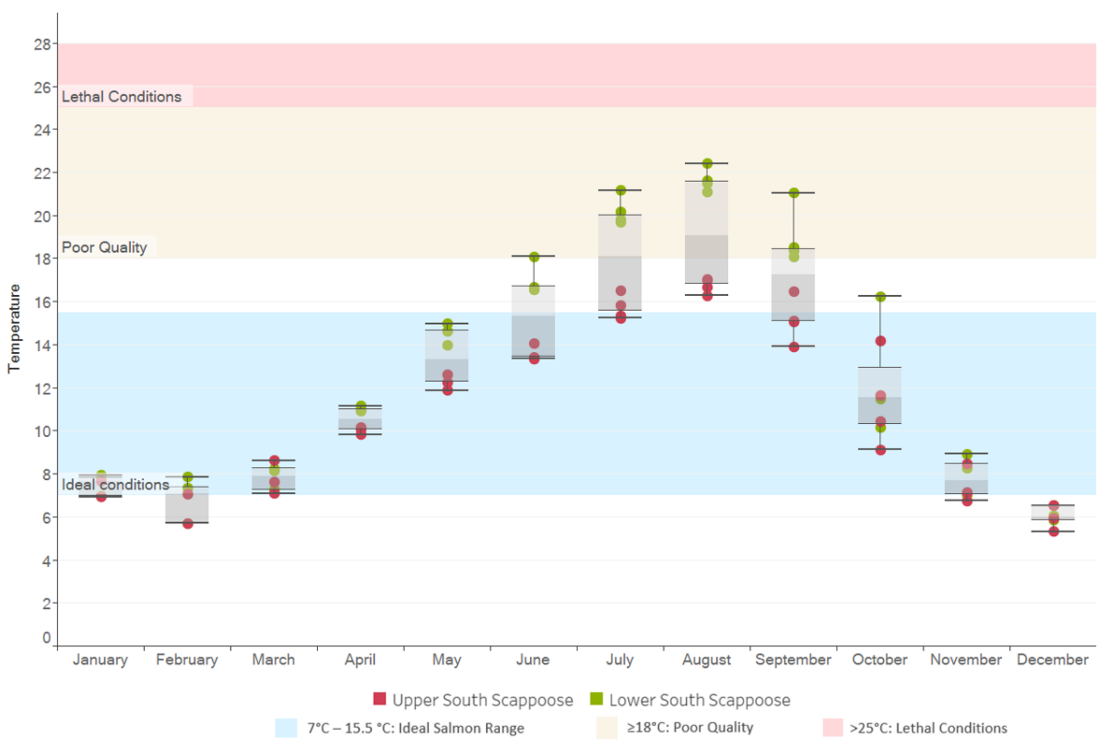


Figure 53: Monthly variation in 7dMAM temperature in the North Scappoose Creek watershed between 2017 – 2020.

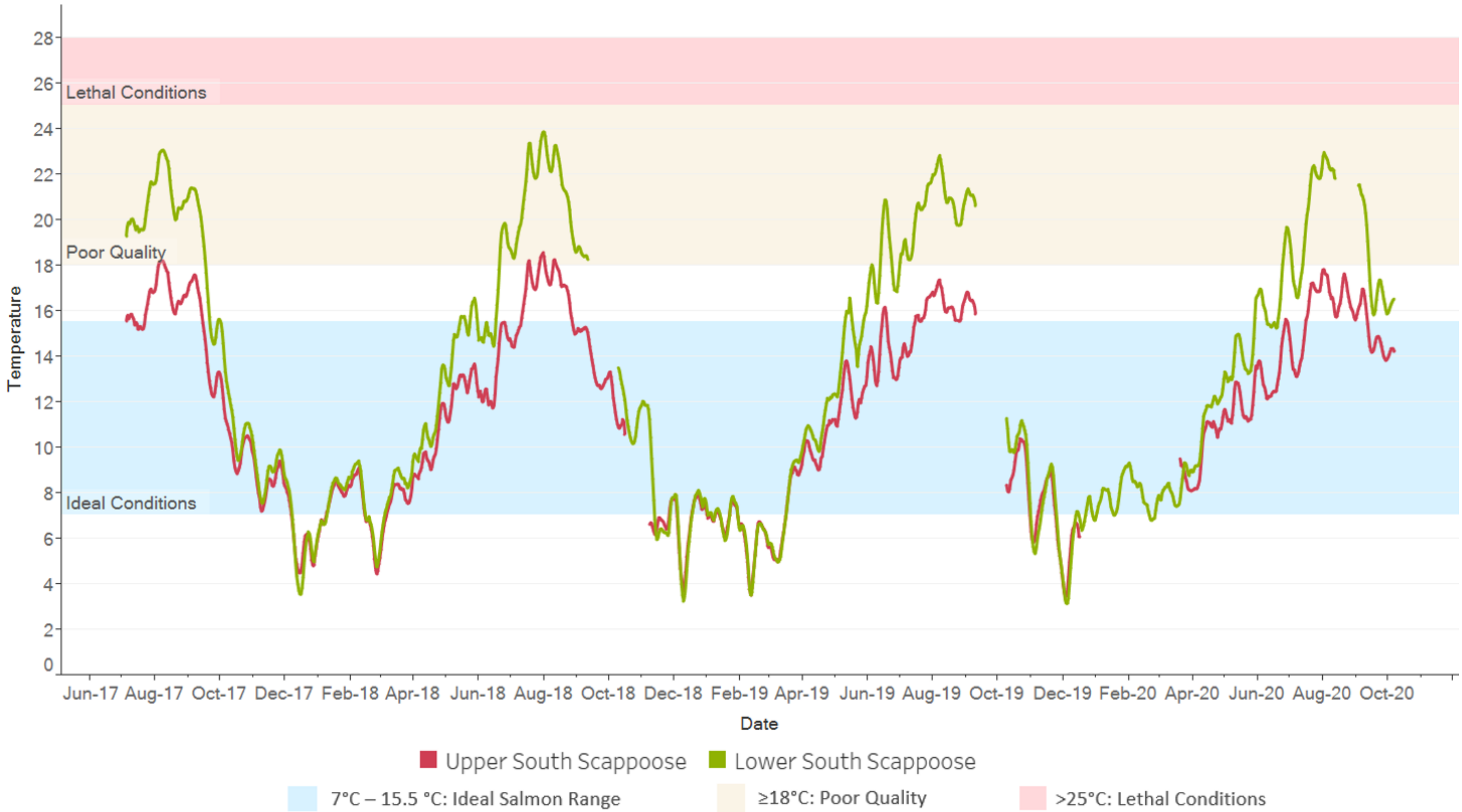


Figure 54: 7-day average maximum temperatures (7dMAM) for Upper South Scappoose and Lower South Scappoose creeks from June 2017 to October 2020 overlayed on salmonid temperature threshold ranges. See Table 3 for temperature threshold details.

When May to October temperature 7dMAM temperature data was compared to the overlapping timeframe from 2008-2011, increased temperature trends were observed; however, the average increase is greater in the lower watershed. There was an average increase of 1.3°C in the upper watershed whereas, during the same time, the average increase in the lower watershed was 1.9°C. However, it should be noted that complete temperature profile is unavailable for the 2008 – 2011 dataset and 2010 data was missing from this dataset, so we cannot definitively say whether this increase is consistent.

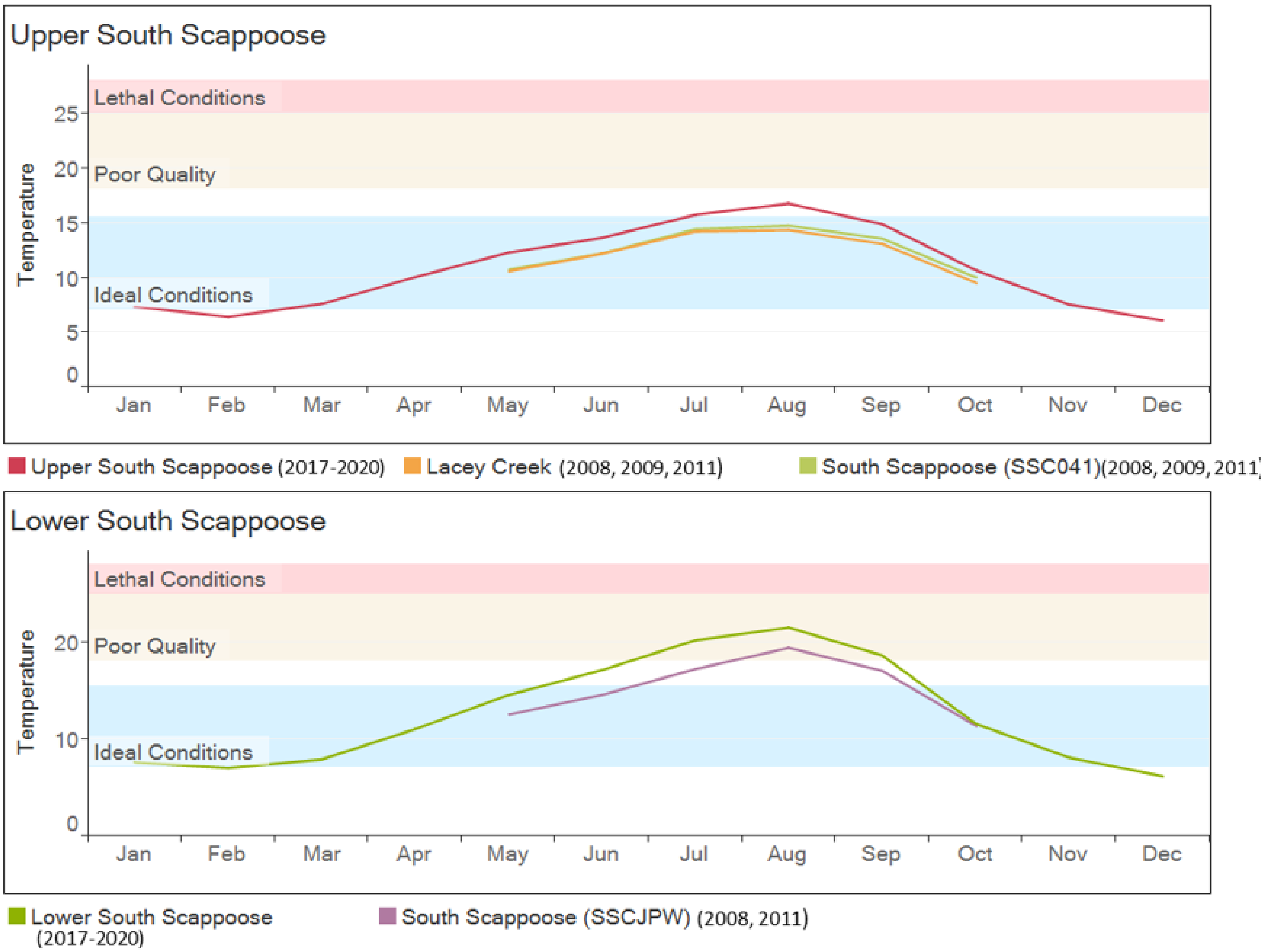


Figure 55: Monthly 7dMAM temperature comparisons between 2017-2020 data and 2008-2011 data for South Scappoose Creek Watershed. Upper South Scappoose and Lower South Scappoose have data available from June 2017 to October 2020. Lacey Creek and South Scappoose (SSC041) has data available for May to October of 2008, 2009 and 2011. South Scappoose (SSCJPW) has data available for May to October of 2008 and 2011.

Water Turbidity Levels

Over the four-year monitoring period, on average, Upper and Lower South Scappoose Creek sampling locations maintained relatively low (< 4 NTU) turbidity levels (

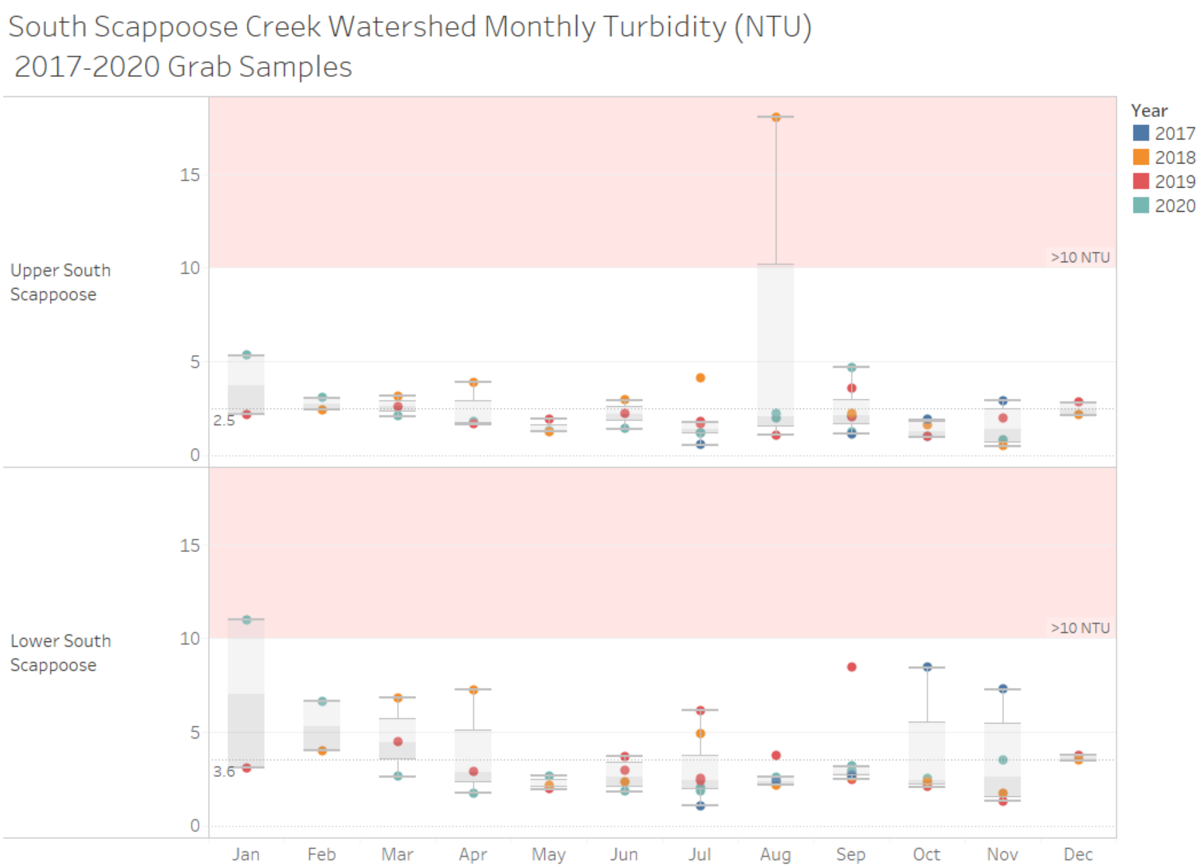


Figure 56), similar to those observed in North Scappoose Creek. Seasonally, the highest turbidity levels were recorded in the winter months (Oct-Jan), reflecting winter storm conditions and high flow events (Figure 56). With the exception of one 18 NTU event in August of 2018 in Upper South Scappoose Creek, only one other occurrence above the 10 NTU salmon habitat turbidity threshold was recorded in Lower South Scappoose Creek during the 2017-2020 study period (

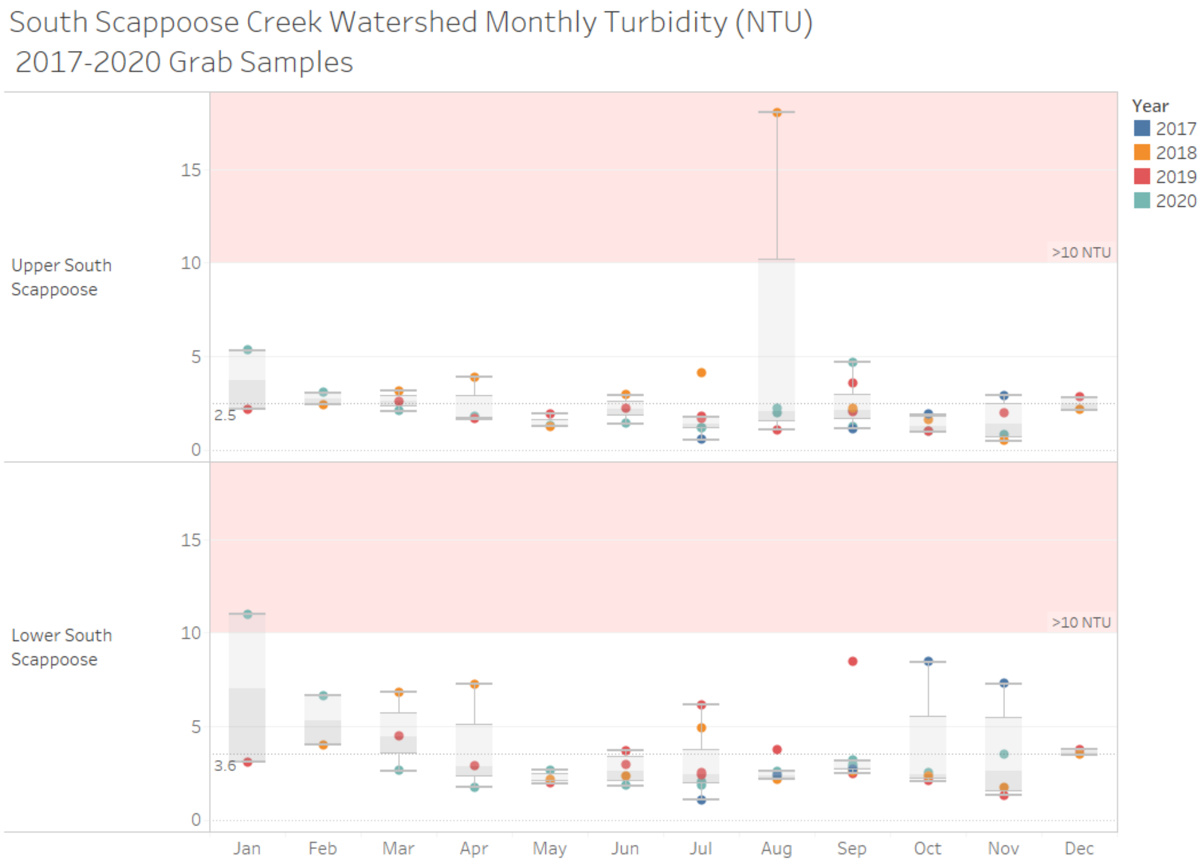


Figure 56). When comparing the 2018-2020 data to the 2008-2011 data, no significant shift in turbidity was observed between Upper and Lower South Scappoose Creek (Figure 57).

Table 34: Summary Table for South Scappoose Creek Watershed Monthly Turbidity (NTU), 2017-2020 Grab Samples. Grab sample data broken down across years and watershed sampling locations. n = number of samples collected—red highlights when a sample location experienced a maximum over the 10 NTU threshold. For monthly data by site, see Appendix B.

Summary Table: South Scappoose Creek Watershed Turbidity Levels (NTU)
2017-2020 Grab Samples

		n	Max	Mean	+/- SD
Upper South Scappoose	2017	4	2.9	1.6	1.0
	2018	11	18.0	3.9	4.8
	2019	13	3.6	2.0	0.7
	2020	15	5.3	2.1	1.3
Lower South Scappoose	2017	5	8.5	4.4	3.3
	2018	11	7.3	3.6	1.9
	2019	15	8.5	3.5	1.8
	2020	15	11.0	3.4	2.4

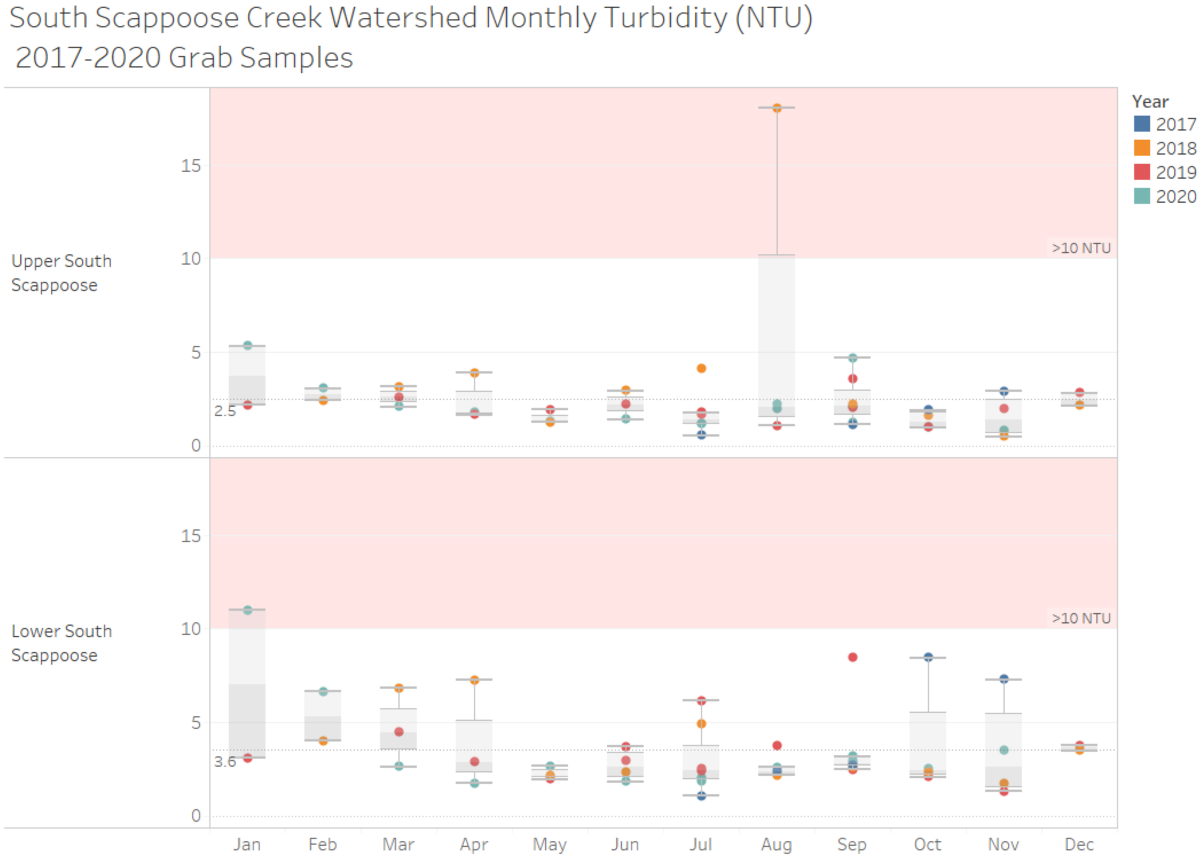


Figure 56. Turbidity (NTU) grab sampling results (boxplots) for South Scappoose Creek Watershed broken down across sampling locations and months sampled. Sampling years ranging from 2017 to 2020 are highlighted within each boxplot. 10 NTU threshold highlighted in pink. The overall mean for the study period is highlighted in each graph. A summary of these data can be found in Appendix B.

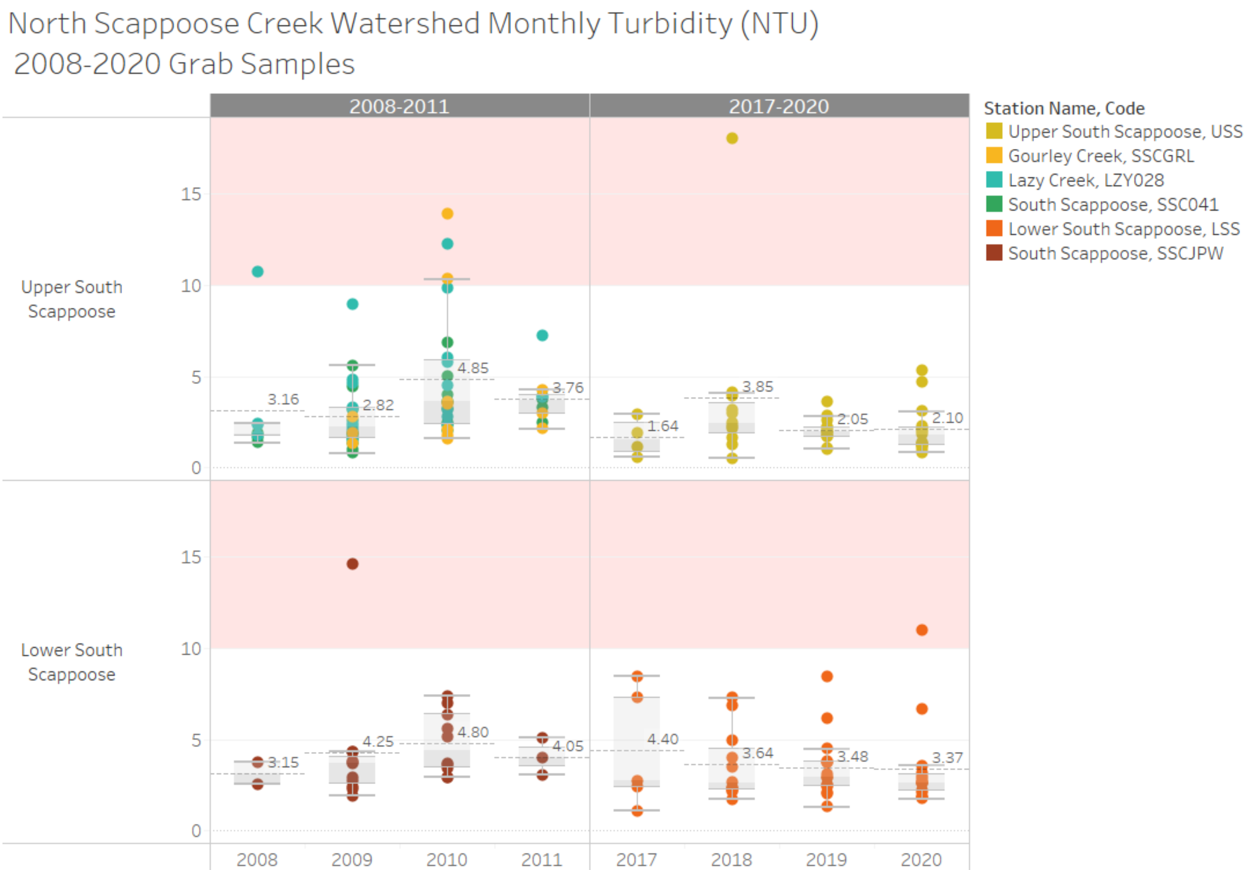


Figure 57: Turbidity (NTU) grab sampling results (boxplots) for South Scappoose Creek Watershed broken down across years sampled. Sampling locations are highlighted within each boxplot. 10 NTU threshold highlighted in pink. Overall mean for each year highlighted. A summary of these data can be found in Appendix B.

Water Bacteria Levels

In 2017, only Lower South Scappoose Creek was monitored for *E. coli* bacteria levels; during this time, elevated levels exceeding the EPA health standard <235 MPN/100 ml were detected in July and September (Figure 58, Table 35-Table 37). In 2018, elevated *E. coli* bacteria levels were only detected in Lower South Scappoose Creek in June, 921 MPN/100 ml, July, 345 MPN/100 ml and August, 326 MPN/100 ml (Table 35). These bacteria events encouraged more intensive sampling during the 2019 and 2020 monitoring years, including bi-monthly sampling in the summer which allowed for the calculation of the 90-day geometric mean (Table 37). The 90-day geometric mean state-mandated water quality threshold for Oregon is 126 MPN/100. In 2019, Upper South Scappoose Creek exhibited elevated *E. coli* bacteria levels from June-October with a geometric means ranging from 181-317.5 MPN/100 in 2019 (Table 37). In comparison, Lower North Scappoose Creek also experienced elevated *E. coli* bacteria levels in 2019 from June-October with a geometric means ranging from 215.5-277.8 MPN/100 and from May-November in 2020 ranging from 202.3-368.1 MPN/100 (Table 19). Seasonally, both Upper and Lower North Scappoose monitoring locations tend to have elevated bacteria levels starting in late spring and going through the fall, coinciding with generally warmer stream temperatures (Figure 41, Figure 58).

When comparing the 2017-2020 data to the 2008-2011 data, it is clear that Lower South Scappoose has historically experienced elevated *E. coli* bacteria events (Figure 59). The frequency of these events, however, appears to be increasing in Lower South Scappoose creek when comparing overall monthly maximum values between 2017-2020 to 2008-2011 (Figure 59). These water quality conditions merit continued monitoring and additional investigation into the cause of elevated *E. coli* levels to ensure they do not continue to persist or continue to decline.

Table 35: South Scappoose Creek watershed monthly max E. coli (MPN/100 ml) grab samples. Grab sampling results for broken down across years and watershed sampling locations. Sampling locations that experienced events over the EPA (235 MPN/100) and ODEQ (406 MPN/100) thresholds for E. coli bacteria levels are highlighted in red.

South Scappoose Creek Watershed Monthly Max *E. coli* (MPN/100 ml)
2017-2020 Grab Samples

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper South Scappoose	2017												
	2018						77	34	73				
	2019						68	2,600	504	343	11	19	12
	2020	1	3	3	9	114	54	133	488	192	86	17	
Lower South Scappoose	2017							248	172	326	166		
	2018						921	345	326				
	2019						1,200	308	178	816	201	46	189
	2020	9	8	42	172	1,200	308	435	238	276	140	411	

Table 36: Summary table of South Scappoose Creek watershed E. coli (2017-2020) MPN/100 ml grab samples. Grab sample data broken down across years and watershed sampling locations. Sampling locations that experienced events over the EPA (235 MPN/100) and ODEQ (406 MPN/100) thresholds for E. coli bacteria levels are highlighted in red. n = number of samples collected, for monthly max data, see

Table 22.

Summary Table: South Scappoose Creek Watershed Monthly Max *E. coli* (MPN/100 ml)
2017-2020 Grab Samples

		n	Max	Mean	+/- SD
Upper South Scappoose	2017	0			
	2018	3	77	61	24
	2019	9	2,600	414	837
	2020	15	488	91	125
Lower South Scappoose	2017	4	326	228	75
	2018	3	921	531	338
	2019	11	1,200	375	377
	2020	15	1,200	264	289

Table 37: South Scappoose Creek watershed 90 Day geometric mean (5 samples or greater) of E. coli bacteria levels (MPN/100ml) across all sampling sites, those durations that are above the state-mandated threshold of 126 MPN/100 ml for the 90 days geometric mean are highlighted with red text.

South Scappoose Creek Watershed *E. coli* (MPN/100 ml)
90 Day Geometric Mean (5 samples or greater)

		May Aug	Jun Sep	Jul Oct	Aug Nov
Upper South Scappoose	2019		317.5	181.0	
	2020	101.4	91.7	92.9	67.7
Lower South Scappoose	2019		277.8	215.2	
	2020	368.1	230.5	202.3	208.2

Figure 58. E. coli bacteria grab sampling results (boxplots) for South Scappoose Creek Watershed broken down across months sampled and watershed sampling locations. Sampling year ranging from 2017 to 2020 are highlighted within each boxplot. EPA (235 MPN/100) and ODEQ (406 MPN/100) thresholds for E. coli bacteria levels are highlighted on each graph. The overall mean for the study period highlighted in each graph. Logarithmic scale used on the y-axis.

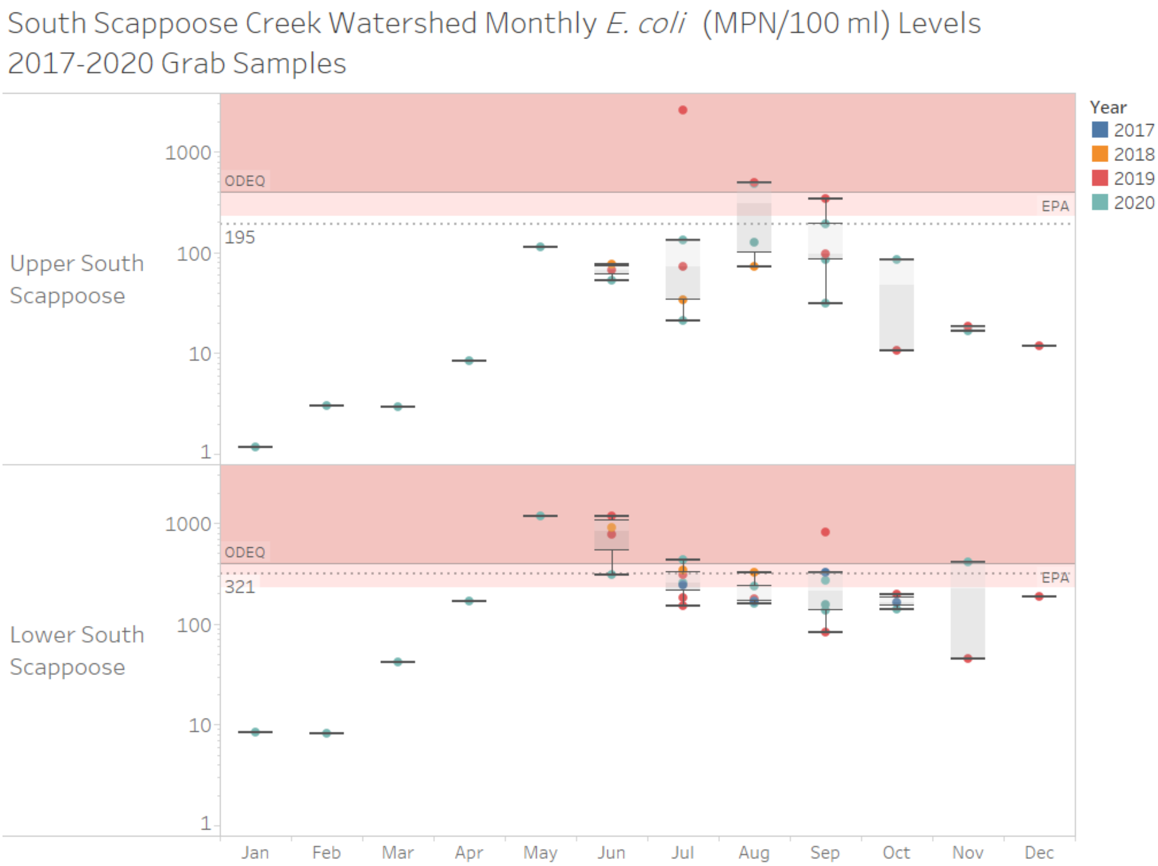
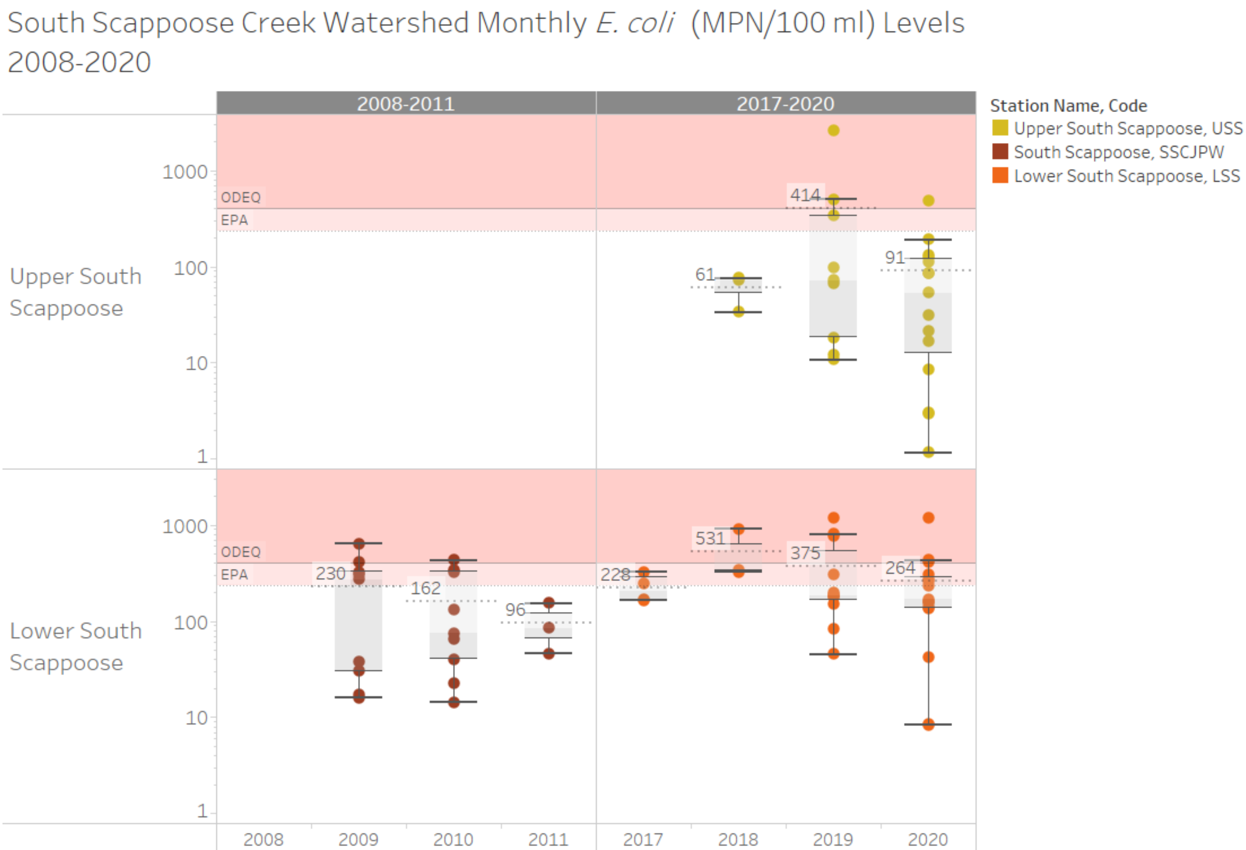


Figure 59: E. coli bacteria grab sampling results (boxplots) for South Scappoose Creek Watershed broken down across years sampled and watershed sampling locations. Sampling location highlighted within each boxplot. EPA (235 MPN/100) and ODEQ (406 MPN/100) thresholds for E. coli bacteria levels are highlighted on each graph. The overall mean for the study period highlighted in each graph. Logarithmic scale used on the y-axis. Monthly data can be found in Appendix B.



Water Conductivity Levels

Conductivity levels varied seasonally across monitoring locations within the South Scappoose Creek watershed (Figure 60, *Table 38*). At both locations, annual increases in water conductivity were observed between April to September and declined from October to February (Figure 60, *Table 38*). Between 2018-2020, Upper South Scappoose Creek exhibited lower overall mean conductivity levels ranging from 59-71 µs/cm compared to 70-79 µs/cm observed at the Lower South Scappoose Creek monitoring location (Figure 60, *Table 38*). These data provide baseline conductivity levels that can be used to identify new and emerging water quality issues or improvements over time. When comparing the 2018-2020 data to the 2008-2011 data, no significant shift in conductivity was observed (Figure 61). Pollution from runoff or increased turbidity levels from erosion can result in higher conductivity levels; however, there is no EPA or ODEQ threshold for conductivity in the region.

Table 38: Summary Table of South Scappoose Creek watershed monthly conductivity (µs/cm) data for 2018-2020 grab samples. Conductivity (µs/cm) samples broken down across months sampled and watershed sampling location. n = number of samples collected. For monthly data by site, see Appendix B.

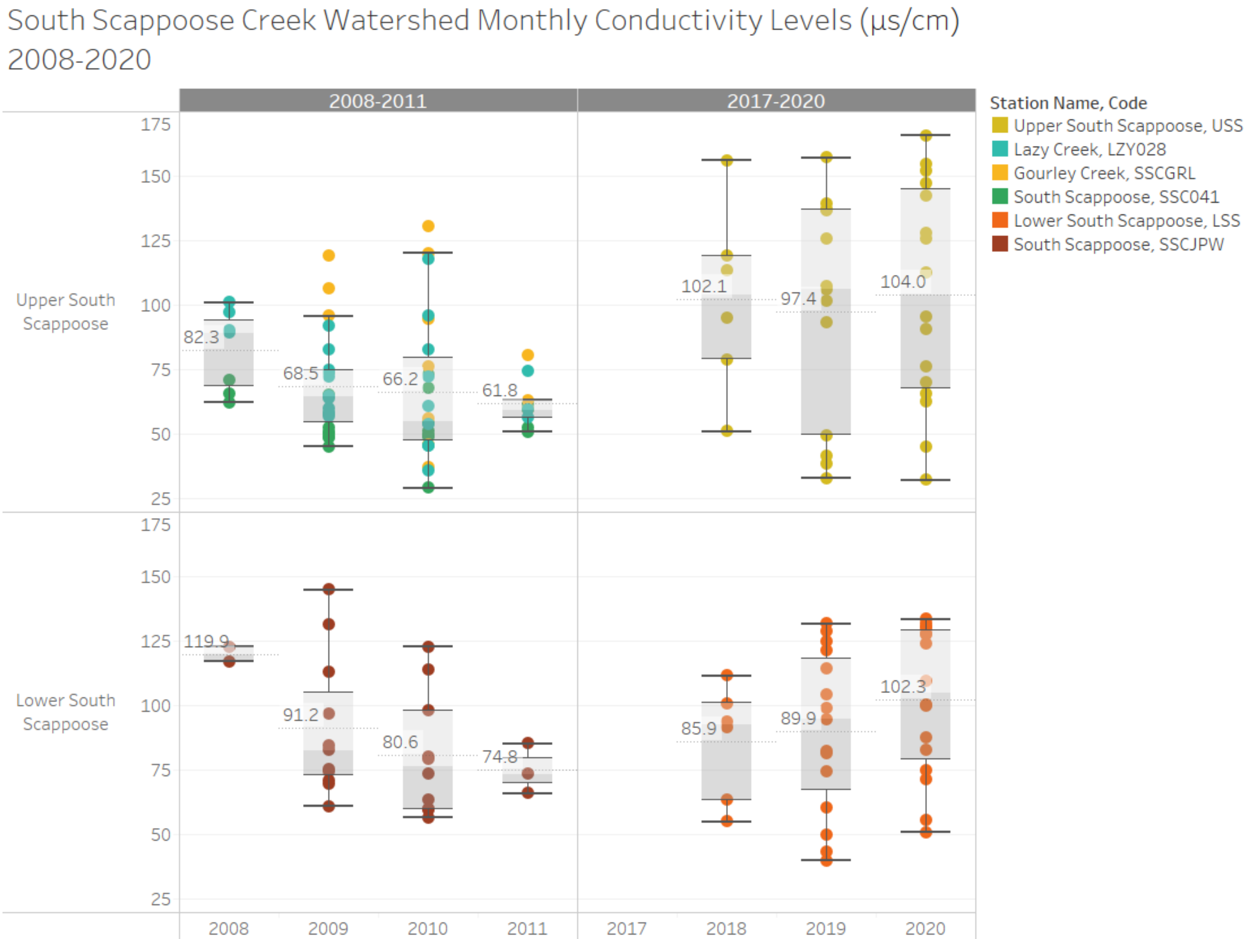
South Scappoose Creek Watershed Monthly Mean Conductivity (µs/cm)
2018-2020 Grab Samples

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper South Scappoose	2018							78.8	113.2	118.9	156.1	94.8	50.9
	2019	38.2		32.7	41.2	49.3	93.0	121.4	125.8	132.3	137.0	139.4	101.7
	2020	45.0	32.0	63.9	69.7	76.2	90.5	103.9	140.2	151.9	151.8	127.9	
Lower South Scappoose	2018							91.3	111.5	100.8	93.6	54.9	63.2
	2019	43.0		39.8	49.9	60.4	90.1	100.2	121.3	113.2	128.6	124.7	74.1
	2020	50.6	55.3	72.9	82.8	87.4	99.6	105.0	127.2	129.1	133.4	130.0	

Figure 60: Conductivity levels (µs/cm) 2018-2020 Grab Samples results (boxplots) for South Scappoose Creek watershed broken down across months sampled and watershed sampling location. Sampling years ranging from 2018 to 2020 are highlighted within each boxplot. The overall mean for the study period highlighted in each graph.

South Scappoose Creek Watershed Monthly Conductivity Levels (µs/cm)
2018-2020 Grab Samples

Figure 61: Conductivity levels (µs/cm) 2008-2020 Grab Samples results (boxplots) for South Scappoose Creek watershed broken down across years, with monitoring location highlighted within each boxplot. Sampling years ranging from 2008-2011 and 2018- 2020. Overall mean for each year annotated.



Water Quality Issues

Water quality issues observed in South Scappoose Watershed include high summer temperatures (>18°C) in the lower watershed between June and September (Figure 52). Elevated temperatures are likely caused by solar loading within the lower reaches of the watershed, which are much more heavily developed and lack riparian shade (Figure 4). Both Upper and Lower South Scappoose have experienced a potential increase in water temperatures since the previous 2008-2011 study indicating that further action is required to prevent continued temperature issues in the basin (Figure 55). Low water temperatures are critical for supporting aquatic life including endangered Salmonids in the Pacific Northwest; reducing solar radiation and reducing urban and agricultural runoff can help keep water temperatures down and protect these stream habitats (USGS 2021). Additionally, elevated *E. coli* bacteria levels were observed in the watershed between June to October of 2019 and between May to November 2020 that exceeded EPA and ODEQ standards including the five sample geometric mean (Table 3, **Error! Reference source not found.**). *E. coli* bacteria issues are indicative of animal waste runoff and can be very harmful to humans using these waterways for recreation (Pandey et al. 2014). Additional research is needed to determine the exact source of the elevated *E. coli*. Animal waste or septic tank leakage into the stream are possible sources to be investigated. Depending on the source, actions that could reduce future *E. coli* exceedance events include increasing riparian buffers, excluding livestock from the creek, increasing manure management near streams, or updating failed septic systems throughout the targeted reach of the watershed (Pandey et al. 2014). Given the frequency and scale of *E. coli* bacteria events adding warning signs to recreational areas along the streams, especially in the lower reaches of South Scappoose creek, is recommended. No significant issues or shifts in stream water turbidity or conductivity levels were detected in South Scappoose Watershed during this study.

CONCLUSIONS AND RECOMMENDATIONS

The Columbia County water quality monitoring program was established in 2017 to track and characterize long-term trends in water temperature, turbidity, *E. coli*, and conductivity in Clatskanie River, Beaver Creek, Milton Creek, North Scappoose Creek and South Scappoose Creek watersheds. A total of 13 sites were selected to provide a comprehensive overview of the County watersheds. Through this study, we were able to identify trends similar across all watersheds in the county and certain characteristics that are unique to each watershed. Datasets that were created through an intensive monitoring effort in the Scappoose Bay Watershed from 2008 to 2011 were also used to evaluate water quality changes over time. Ongoing water quality issues have been identified and these data can be used to determine priority stream reaches for restoration.

Temperature

During the study period (2017 – 2020), upper and lower watersheds follow similar winter temperature patterns (Dec., Jan., Feb.). These patterns start diverging during mid-to-late spring, with lower watersheds recording elevated temperatures, often exceeding the ODEQ threshold for salmon rearing habitat (18°C, Table 3) during summers. The lower watersheds in the county are usually developed, pastures or residential areas where adequate stream shading is unavailable and temperatures are influenced by runoffs. The only exception to this is Lower Beaver, which recorded warmer summer temperatures compared to the Upper Beaver despite being in a forested area (Figure 18). This is likely due to thermal loading as the water moved through the upper, more developed headwaters and then into the lower, forested reach. Seasonally highest temperatures in the county were recorded during the month of August throughout the study when water levels are low and ambient air temperatures are highest during the monitoring years. Summertime temperatures at Lower Milton, located in a community park, often reach close to the ODEQ threshold for lethal conditions for salmon (25°C, Table 3) and even exceeded this lethal threshold in August 2018 (Table 18, Figure 30). Throughout the study, the upper reaches of Clatskanie River (Upper Clatskanie, Little Clatskanie, Carcus Creek) and Upper South Scappoose remained below 18°C. These areas are well shaded and have very few anthropogenic influences. Other studies have shown that adequate shading reduces stream temperatures (Johnson, 2004).

When temperature data for overlapping months between 2017 – 2020 and 2008-2011 were compared for Milton Creek, North Scappoose Creek, and South Scappoose Creek, an elevated trend was observed in all three watersheds. The highest average increase was observed in Lower South Scappoose (1.9°C, Figure 55). However, it should be noted that the complete temperature profile is unavailable for the 2008 – 2011 dataset and 2010 data was missing from this dataset. Year to year regional climate variability is an influential factor for seasonal temperature conditions, however, long-term water temperature increases have also been found in the Columbia River (EPA 2018, EPA 2020), indicating an overall regional trend of warming summer water conditions are likely. Increasing riparian cover and reducing run-off will be important for ensuring long-term resilience in these streams systems, especially with the pressures of ongoing watershed development and climate change (EPA 2020).

Turbidity

For turbidity, the highest turbidities were recorded in the headwaters of Beaver Creek and Milton Creek watersheds. For mainstem sites, South Scappoose Creek consistently had higher turbidity than most other headwater sites. Ongoing turbidity monitoring is important for identifying erosion and stream stability issues across all watersheds. Similar to recommendations for temperature improvements, increasing riparian cover and reducing runoff can aid in reducing erosion events and sediment loading in stream environments.

E. coli Bacteria

Across all the sites, *E. coli* Bacteria levels were greatest across all watersheds between May through October. Milton Creek generally had the greatest counts of *E. coli*, followed by Lower North Scappoose and Lower South Scappoose. During the intensive monitored 2019 and 2020 sampling years, all watersheds violated the ODEQ five sample geometric mean threshold of 126 *E. coli* organisms per 100 mL and experienced individual events exceeding the 406 *E. coli* organisms per 100 mL limit. *E. coli* bacteria issues are indicative of animal waste runoff and can be very harmful to humans using these waterways for recreation (Pandey et al. 2014). Additional research is needed to determine the exact source of the elevated *E. coli*. Animal waste or septic tank leakage into the stream are possible sources to be investigated. Depending on the source, actions that could reduce future *E. coli* exceedance events include increasing riparian buffers, excluding livestock from the creek, increasing manure management near streams, or updating failed septic systems throughout the targeted reach of the watershed (Pandey et al. 2014). Given the frequency and scale of *E. coli* bacteria events adding warning signs to recreational areas along these streams, especially in the lower reaches, is recommended.

Conductivity

Across all sites, water conductivity levels were within the regional range of <150 (µs/cm). Seasonal trends were also observed with conductivity levels increasing during the summer months; this is likely a result of low water levels increasing concentrations in the streams and warmer water conditions generally increasing water conductivity seasonally. These data provide baseline conductivity levels that can be used to identify new and emerging water quality issues or improvements over time. Pollution from runoff or increased turbidity levels from erosion can result in higher conductivity levels; however, there is no EPA or ODEQ threshold for conductivity in the region.

Next Steps

This water quality monitoring report highlights elevated summertime temperatures and *E. coli* levels in the lower reaches of the Columbia County Watersheds. To address and mitigate these issues, we recommend the following:

- A riparian canopy cover analysis of the Scappoose Bay, Clatskanie River, and Beaver Creek watersheds is recommended in order to identify areas where canopy gaps are increasing stream solarization. Once identified, these gaps could be addressed by restoring riparian vegetation buffers to reduce thermal loading on summer water temperatures. Targeted restoration of riparian vegetation and canopy cover could also reduce turbid and bacteria-laden run-off into these streams.
- On the ground and aerial surveys could also be used to identify cold refugia (cold water sources and seeps), which should be protected and enhanced. These surveys could also be used to identify sources of non-point source pollution such as unstable stream banks (turbidity) and livestock use of the streams (bacteria).
- Additional shading and riparian buffers need to be introduced in the lower Scappoose Bay watershed to regulate stream temperatures and *E. coli* events across all monitoring sites.

- Given the scale of the *E. coli* issues observed, an evaluation of livestock access to streams and the septic tank systems should be considered to further help identify potential sources of *E. coli* throughout the County watersheds.
- Due to the ongoing *E. coli* issues, it is also recommended that warning signs are added to recreational areas along these streams that are accessible to the public, especially in the Lower reaches of Scappoose Watershed.
- Continued water quality monitoring efforts are required to assess the long-term shifts in water quality conditions resulting from restoration, mitigation actions, and developmental pressures.

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APPENDICES

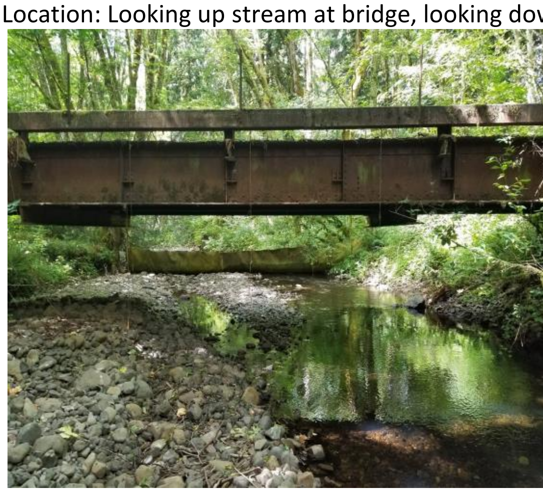
Appendix A: Monitoring Site Locations and Descriptions

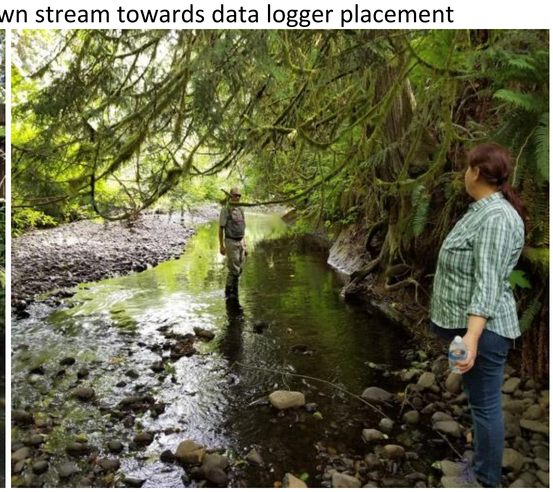
Clatskanie Watershed						
Site Code	**Site Name**	**Description**	**GPS Coordinates**	**Logger Serial Number**	**Installed Date/Time**	**Installed Temp °C**
LC	Lower Clatskanie	Data: Bacteria, Temp/WL, Turbidity	Lat: 46.080002 Long: -123.166841	20112654	8/17/2017 15:30	19.8
Site Code	**Site Name**	**Description**	**GPS Coordinates**	**Logger Serial Number**	**Installed Date/Time**	**Installed Temp °C**
MC	Middle Clatskanie	Data: Temp/WL, Turbidity Private property (must notify owner ahead of time) off of Swedetown road, walk through field behind the home, then cross through an old gate to access river. Data logger placed near an undercut bank with some overhanging roots	Lat: 46.045193 Long: -123.095813	20112657	6/28/2017 15:28	14.6

Location Image: River access just beyond old fence gate, near bank root overhang

Site Code	Site Name	Description	GPS Coordinates	Logger Serial Number	Installed Date/Time	Installed Temp °C
CAR	Carcus	Data: Temp/WL, Turbidity Stream accessed via private drive off Swedetown Rd, data logger placed a few meters upstream of the bridge (to be out of way of impending construction).	Lat: 46.038533 Long: -123.085543	20112662	6/28/2017 15:54	14.1

Location: Looking up stream at bridge, looking down stream towards data logger placement





Matt standing near data logger placement location, under vine maple (flagged with pink tape)

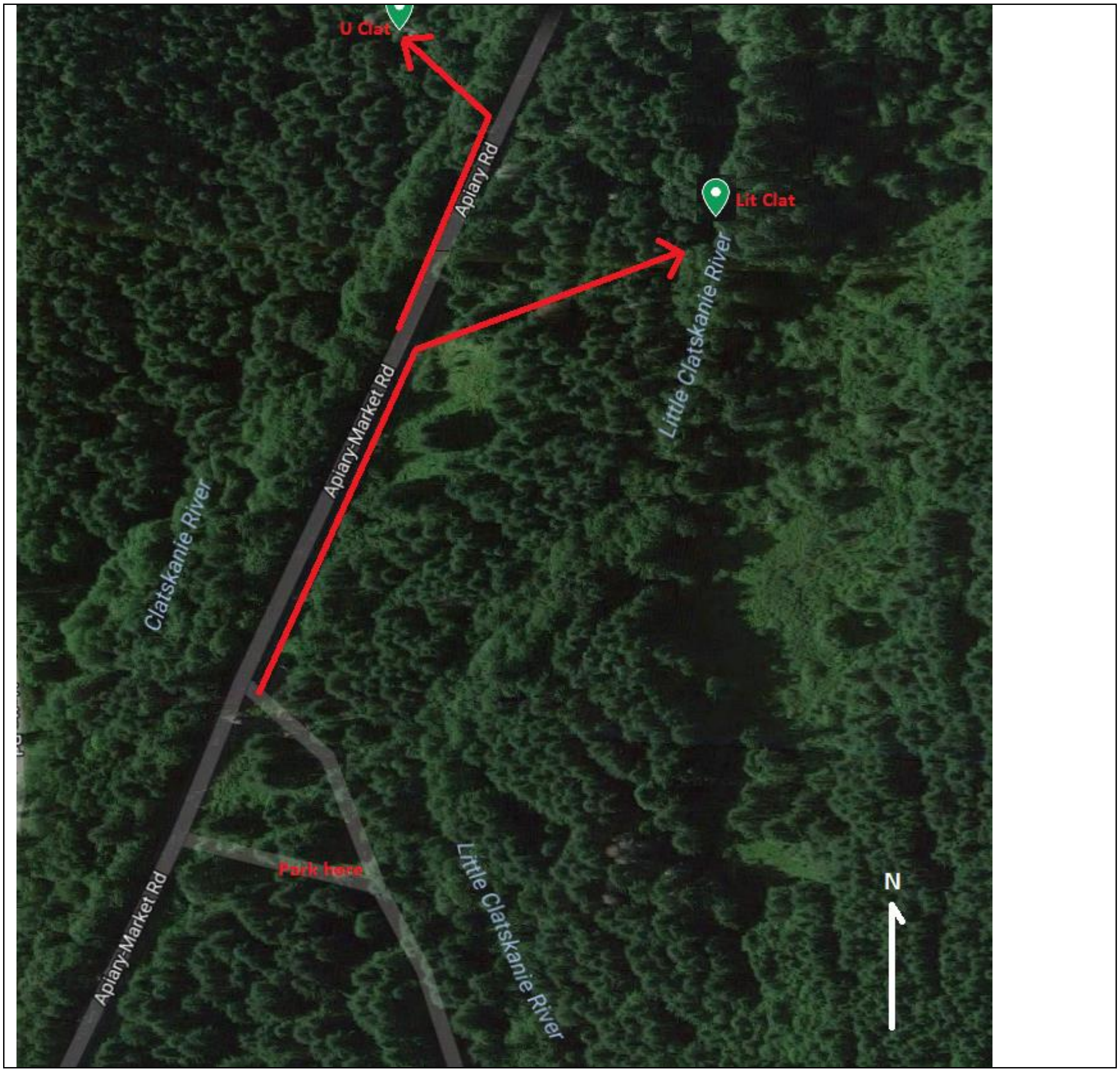
Site Code	Site Name	Description	GPS Coordinates	Logger Serial Number	Installed Date/Time	Installed Temp °C
UC	Upper Clatskanie	Data: Temp/WL, Turbidity Just north of LC location on the other side of the Apiary road. Steep descent from road to stream. Data logger near large rock on road side of river bank.	Lat: 45.987717 Long: -123.040371	20112651	6/29/2017 11:43	12.8

Location images: Data logger located near large rock along the river bank

Site Code	**Site Name**	**Description**	**GPS Coordinates**	**Logger Serial Number**	**Installed Date/Time**	**Installed Temp °C**
LitC	Little Clatskanie	Data: Temp/WL, Turbidity Park at pull out for logging road (on little Clat side of the road) along Apiary Market Rd and then access river via grassy opening along right side of road side north of car pull out, follow pink flagging to data logger location (downstream of large data logger housing)	Lat: 45.987598 Long: -123.038492	20112659	6/29/2017 11:23	12.7

Location Images:
Grassy opening along right side of road side north of car pull out, data logger is located near flagging next to salmon berry shrub and cedar stump

Map of Upper Clat and Lit Clat locations along Apiary Market Rd

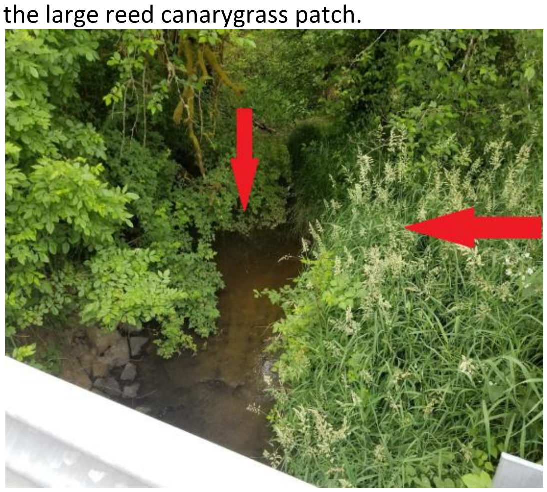

U Clat
Apiary Rd
Lit Clat
Little Clatskanie River
Apiary-Market Rd
Clatskanie River
Park here
Apiary-Market Rd
Little Clatskanie River
N

Beaver Creek Watershed						
Site Code	**Site Name**	**Description**	**GPS Coordinates**	**Logger Serial Number**	**Installed Date/Time**	**Installed Temp °C**
LB	Lower Beaver	Pull out before the bridge at Beaver Falls Rd, data logger placed at the end of a rock pile just upstream of the bridge (large current shrub on shore).	Lat: 46.108942 Long: -123.158919	20112663	6/29/2017 10:09	14.3

Location images: Park on side of the road and access stream on upstream side of bridge, data logger placed at the end of a rock pile just upstream of the bridge (large current shrub on shore). Large rock near data logger placement marked with a black X.

Site Code	Site Name	Description	GPS Coordinates	Logger Serial Number	Installed Date/Time	Installed Temp °C
UB	Upper Beaver UB	Data: Temp/WL, Turbidity Park just past bridge on Fernhill Road (near 73723 Fern Hill Rd), and walk down on the upstream side of the bridge through the large reed canarygrass patch. Located upstream of bridge, under a large current shrub with pink flagging marking its location	Lat: 46.062373 Long: -122.965167	20112653	6/29/2017 10:44	14.0

Location images: Park just past bridge on Fernhill Road (near 73723 Fern Hill Rd Rainier, Oregon), and walk down on the upstream side of the bridge through the large reed canarygrass patch.



Data logger located under Currant shrub on far side of stream.

Scappoose Bay Watershed: Lower Milton Creek						
Site Code	**Site Name**	**Description**	**GPS Coordinates**	**Logger Serial Number**	**Installed Date/Time**	**Installed Temp °C**
LM	Lower Milton	Data: Bacteria, Temp/WL, Turbidity Located in McCormick Park on the downstream side of the Old Portland Road Bridge - under woody debris	Lat: 45.850289 Long: -122.816039	20112656	6/28/2017 11:28	16.3

Location Image (looking down from the bridge, Matt is bending over data logger placement):

Site Code	Site Name	Description	GPS Coordinates	Logger Serial Number	Installed Date/Time	Installed Temp °C
UM	Upper Milton	Data: Temp/WL, Turbidity Downstream side of W. Kappler Rd bridge (very steep), data logger located downstream of bridge under flagged cedar tree.	Lat: 45.864193 Long: -122.886893	20112650	6/29/2017 12:58	15.4

Location images: Downstream of bridge (a bit) near the north stream bank under flagged cedar tree in pool

Scappoose Bay Watershed: North Scappoose Creek						
Site Code	**Site Name**	**Description**	**GPS Coordinates**	**Logger Serial Number**	**Installed Date/Time**	**Installed Temp °C**
LNS	Lower North Scappoose	Data: Bacteria, Temp/WL, Turbidity Pull off HWY 30 just north of bridge along Rosewood lane. Enter stream on the north bank at the railroad bridge (large patch of reed canarygrass) crossing. Data logger tided to old piling (flagged) on north bank of stream under railroad bridge.	Lat: 45.771786	20112652	6/29/2017 14:19	17.2

Location images: Pull off HWY 30 just north of bridge along Rosewood lane.

Enter stream on the north bank at the railroad bridge (large patch of reed canarygrass) crossing. Data logger tided to old piling on north bank of stream under railroad bridge.

Site Code	**Site Name**	**Description**	**GPS Coordinates**	**Logger Serial Number**	**Installed Date/Time**	**Installed Temp °C**
UNS	Upper North Scappoose	Data: Temp/WL, Turbidity Pull off close to the bridge crossing river near 30161 Scappoose Vernonia Hwy. Descend on the upstream side of the bridge on the North bank. Data logger placed on North bank under maple tree (flagged).	Lat: 45.823753 Long: -122.946923	20112655	6/29/2017 13:37	14.4

Location images: Descend on the upstream side of the bridge on the North bank. Data logger placed on North bank under maple tree (flagged).

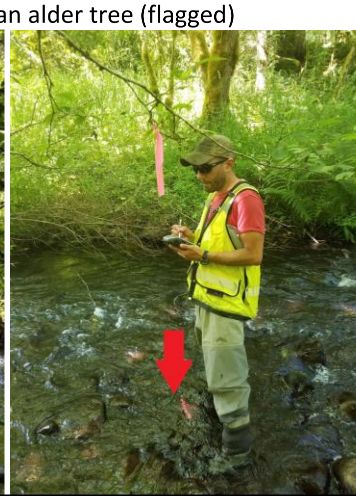
Scappoose Bay Watershed: South Scappoose Creek						
Site Code	**Site Name**	**Description**	**GPS Coordinates**	**Logger Serial Number**	**Installed Date/Time**	**Installed Temp °C**
LSS	Lower South Scappoose	Data: Bacteria, Temp/WL, Turbidity Park at the CZ trail area just off HWY 30, then decent on the south side of the bridge on the upstream side. Data logger tied to piling under bridge on south bank. Piling flagged.	Lat: 45.762739 Long: -122.880973	20112658	6/29/2017 13:59	16.3

Location images:

Site Code	Site Name	Description	GPS Coordinates	Logger Serial Number	Installed Date/Time	Installed Temp °C
USS	Upper South Scappoose	Data: Temp/WL, Turbidity Pull off on the south side of the bridge on Otto Miller Rd just past the Dutch Canyon Rd turn off (see image). Data logger located downstream of bridge under an alder tree (flagged).	Lat: 45.744219 Long: -122.961964	20112664	6/29/2017 14:44	13.7

Location images: Pull off on the south side of the bridge on Otto Miller Rd just past the Dutch Canyon Rd turn off

Data logger located downstream of bridge under an alder tree (flagged)



Appendix B: Supplemental Data Tables

Clatskanie Watershed Supplemental Data Tables

Table 39: Summary Table of Clatskanie Watershed Monthly Turbidity (NTU), 2018-2020. Grab Samples. Grab sampling results for Clatskanie watershed broken down across years and watershed sampling locations.

Summary Table: Clatskanie Watershed Monthly Mean Turbidity (NTU)
2017-2020 Grab Samples

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2017	Little Clatskanie							0.5		3.6	1.5	5.1	
	Upper Clatskanie							1.6		3.2	2.8	5.1	
	Carcus							0.0		0.4	2.0	2.2	
	Middle Clatskanie							0.5		0.7	1.1	3.0	
	Lower Clatskanie									0.9	1.1	4.5	
2018	Little Clatskanie		3.7	5.3	4.2	3.6	1.4	0.9	2.9	1.2	4.2	3.7	6.8
	Upper Clatskanie		3.7	4.7	4.6	3.7	2.6	3.1	1.9	5.3	2.4	3.0	7.5
	Carcus		1.8	1.4	3.1	0.8	0.9	0.6	0.5	0.8	0.7	0.7	2.4
	Middle Clatskanie		2.5	2.9	3.5	1.4	1.1	1.2	0.8	2.1	1.1	1.4	4.6
	Lower Clatskanie		2.9	3.0	4.4	1.5	1.1	1.1	0.9	2.2	0.9	1.0	4.0
2019	Little Clatskanie	3.5		4.6	3.7	3.8	5.2	2.3		1.1	1.8	2.5	7.4
	Upper Clatskanie	3.0		5.1	3.6	2.8	2.4	2.6		2.4	2.8	2.2	7.4
	Carcus	1.3		2.1	1.1	1.0	0.8	1.2		0.9	0.9	0.3	7.8
	Middle Clatskanie	2.3		3.5	1.7	1.1	1.3	1.2	1.7	1.6	2.5	0.7	3.6
	Lower Clatskanie	2.4		3.1	1.5	1.0	0.6	1.0	1.1	2.1	1.7	0.6	3.0
2020	Little Clatskanie	8.3	3.2	5.1	5.0	3.2	2.5	3.5	4.7	2.7	1.9	6.7	
	Upper Clatskanie	4.7	3.2	2.9	3.2	3.3	2.7	2.5	2.3	3.4	2.2	5.4	
	Carcus	2.7	1.8	1.6	1.0	1.5	3.3	4.2	1.9	2.2	0.5	2.1	
	Middle Clatskanie	3.5	2.8	2.0	1.6	1.5	1.2	0.9	0.9	1.2	1.7	2.5	
	Lower Clatskanie	3.8	3.3	1.4	1.6	1.0	1.1	0.6	0.8	1.5	0.7	2.3	

Table 40: Summary Table of Clatskanie Watershed Monthly E. coli (2017-2020) MPN/100 ml Grab Samples. E. Coli bacteria grab sampling results for Clatskanie watershed broken down across years and watershed sampling locations. Sampling locations that experienced events over the EPA (235 MPN/100) and ODEQ (406 MPN/100) thresholds for E. coli bacteria levels are highlighted in red.

Summary Table: Clatskanie Watershed Monthly Max *E. coli* (MPN/100 ml)
2017-2020 Grab Samples

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2017	Little Clatskanie												
	Upper Clatskanie												
	Carcus												
	Middle Clatskanie												
	Lower Clatskanie									44	69		
2018	Little Clatskanie												
	Upper Clatskanie												
	Carcus												
	Middle Clatskanie												
	Lower Clatskanie												
2019	Little Clatskanie						140	50		23	6	4	10
	Upper Clatskanie						144	41		59	22	2	10
	Carcus						5	18		126	10	0	0
	Middle Clatskanie						2,490	166	46	99	15	13	20
	Lower Clatskanie						35	271	111	132	19	15	13
2020	Little Clatskanie	15	9	3	35	9	87	27	345	105	126	91	
	Upper Clatskanie	3	3	3	6	14	60	54	365	150	19	58	
	Carcus	8	2	9	1	3	16	21	29	114	15	12	
	Middle Clatskanie	185	7	9	99	31	36	58	156	248	248	153	
	Lower Clatskanie	13	8	14	27	76	41	82	77	190	36	127	

Table 41: *Summary Table of Clatskanie Watershed Monthly Mean Conductivity Levels (µs/cm) 2018-2020. Grab samples results for Clatskanie watershed broken down across years and watershed sampling locations.*

Clatskanie Watershed Monthly Mean Conductivity Levels (µs/cm) 2018-2020 Grab Samples

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2018	Little Clatskanie							77.3	84.7	81.8	64.6	54.5	31.1
	Upper Clatskanie							73.5	79.8	66.3	63.7	48.4	32.4
	Carcus							52.8	56.7	54.0	50.6	35.8	28.6
	Middle Clatskanie							68.7	72.6	68.8	64.0	48.6	32.8
	Lower Clatskanie							83.1	88.2	84.9	79.5	63.0	41.2
2019	Little Clatskanie	24.7		25.7	33.1	59.5	78.5	71.4		102.9	89.9	76.8	62.2
	Upper Clatskanie	24.7		24.9	32.0	56.3	71.3	70.6		109.4	91.0	78.5	67.3
	Carcus	23.3		23.2	28.4	47.4	63.6	58.7		71.4		62.3	55.5
	Middle Clatskanie	26.6		27.1	34.3	57.1	71.4	85.3	95.1	93.2		88.2	73.7
	Lower Clatskanie	33.2		33.5	43.8	70.4	85.9	93.3	104.4	104.1		103.3	86.9
2020	Little Clatskanie	38.0	38.0	33.9	55.6	48.8	63.3	78.5	100.9	107.4	84.1	56.1	
	Upper Clatskanie	34.3	34.1	40.3	54.8	55.5	63.8	73.6	95.1	94.8	91.4	37.3	
	Carcus	33.3	31.2	32.3	44.8	48.8	49.8	56.4	67.8	72.8	130.7	43.6	
	Middle Clatskanie	39.4	38.3	41.5	63.7	63.2	69.6	77.7	100.2	100.3	98.2	59.4	
	Lower Clatskanie	44.1	43.2	61.4	68.7	72.8	83.4	87.6	105.9	110.9	107.0	67.4	

Beaver Creek Watershed Supplemental Data Tables

Beaver Creek Monitoring Locations (2017-2020)

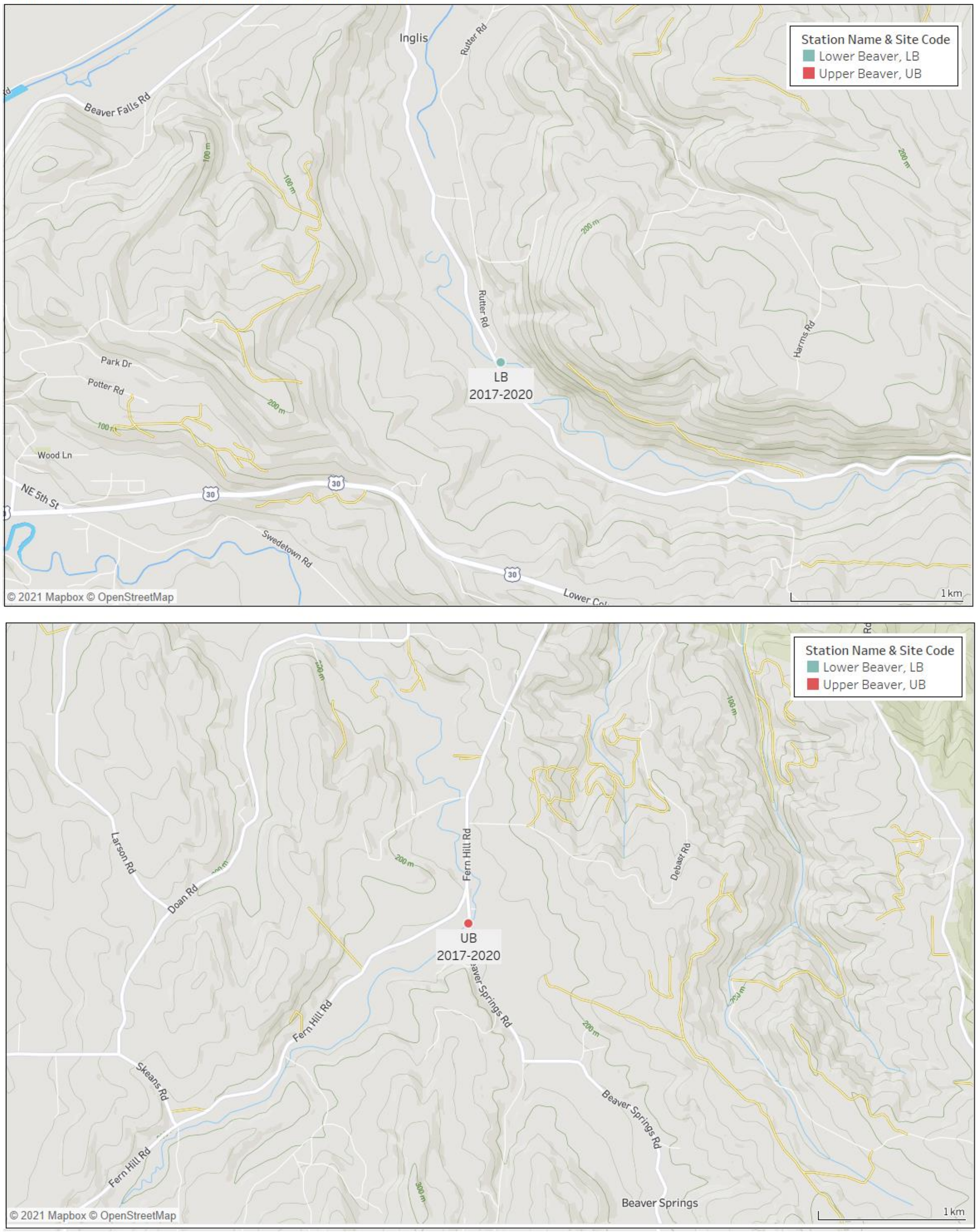


Figure 62: Beaver Creek Monitoring Locations, focused maps higlighting near by road and waterways.

Table 42: Summary Table of Beaver Creek Watershed Monthly Turbidity (NTU), 2018-2020. Grab Samples. Grab sampling results for Clatskanie watershed broken down across years and watershed sampling locations. Mean monthly turbidity levels over the 10 NTU threshold are highlighted in red.

Summary Table: Beaver Creek Watershed Monthly Mean Turbidity (NTU)
2017-2020 Grab Samples

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper Beaver	2017							8.9		10.8	6.9	5.0	
	2018		5.4	5.0	6.2	6.6	5.4	11.2	6.0	8.5	5.8	5.0	6.1
	2019	5.3		6.2	4.7	4.9	7.1	8.5	12.3	9.5	8.0	5.6	7.2
	2020	5.6	4.4	4.3	4.4	4.9	6.5	5.4	9.1	8.7	8.3	9.8	
Lower Beaver	2017							1.1	1.2	1.3	1.5	5.9	
	2018		4.1	4.7	5.3	3.0	1.4	1.4	1.4	4.5	2.4	3.1	6.7
	2019	3.8		5.9	4.0	2.7	1.6	2.6		1.8	2.2	2.0	6.2
	2020	5.9	3.9	3.6	3.3	4.1	3.8	2.1	3.3	2.7	3.2	4.6	

Table 43: Summary Table of Beaver Creek Watershed Monthly Mean Conductivity Levels (µs/cm) 2018-2020. Grab samples results for Clatskanie watershed broken down across years and watershed sampling locations.

Summary Table: Beaver Creek Watershed Monthly Mean Conductivity (µs/cm)
2018-2020 Grab Samples

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lower Beaver	2018							99.4	109.4	96.8	86.4	57.8	40.1
	2019	34.0		35.9	46.4	72.5	89.7	103.6		128.5	117.7	90.0	81.0
	2020	53.2	53.6	50.8	68.3	71.8	84.0	96.8	126.0	122.6	110.2	69.0	
Upper Beaver	2018								84.5	73.4	59.4	46.1	36.7
	2019	32.5		32.7	39.8	59.7	43.4	83.2	95.5	90.7	86.3	70.7	68.7
	2020	51.2	50.3	54.2	58.1	61.5	70.4	79.6	98.7	94.1	83.6	59.8	

Milton Creek Watershed Supplemental Data Tables

Table 44: Milton Creek Watershed Monthly Turbidity (NTU), 2008-2020. Grab Samples. Grab sampling results for Clatskanie watershed broken down across years and watershed sampling locations. Mean monthly turbidity levels over the 10 NTU threshold are highlighted in red.

Summary Table: Milton Creek Watershed Monthly Mean Turbidity (NTU)
2008-2020 Grab Samples

				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper Milton	Milton Creek	MIL024	2008							3.5		2.9			
			2009	6.7			3.5		2.9	2.6	3.5	2.8	2.8	6.3	
			2010	7.9	4.9	5.0	13.8	6.9	6.8	5.2	5.3	4.0			
			2011				7.3	6.4	5.2	5.3					
	Salmon Creek	SAL148	2008							8.8		9.4	10.0		
			2009	4.5	6.9	5.2	5.0		7.4	9.5	15.6	14.3	6.5	6.5	
			2010	7.7	4.5	7.0	4.9	6.6	8.4	9.0	14.0	14.3			
			2011					6.1	7.8	11.5					
	Upper Milton	UM	2017							5.1		9.6	5.4	11.5	
			2018		4.8	6.6	6.5	5.1	6.4	8.8	5.4	6.7	7.0	3.8	9.8
			2019	5.6		8.0	4.8	5.7	5.3	5.3	11.5	7.9	5.4	2.8	7.4
			2020	9.5	5.6	4.5	4.1	4.3	5.2	7.0	6.7	5.6	6.3	6.6	
Lower Milton	Milton Creek	MIL002	2008							4.2		5.8			
			2009	6.5			3.9	6.2	4.6	4.3	5.4	6.2	5.2	8.7	
			2010	13.0	7.8	7.0	15.3	10.2	6.8	5.7		5.7			
			2011				10.9	6.1	6.2	6.1					
	Lower Milton	LM	2017							2.3	2.5	3.0	3.0	7.6	
			2018		4.8	5.6	6.0	4.5	5.1	5.0	3.2	3.5	4.8	4.5	8.7
			2019	4.6		7.3	4.3	4.0	3.5	6.5	11.0	8.0	2.9	1.9	10.9
			2020	11.4	5.4	3.8	4.0	4.5	3.9	3.5	4.5	7.5	3.8	4.3	

Table 45: *Summary Table of Milton Creek Watershed Turbidity (NTU), 2008-2020. Grab Samples. Grab sampling results for Clatskanie watershed broken down across years and watershed sampling locations. Mean monthly turbidity levels over the 10 NTU threshold are highlighted in red.*

Summary Table: Milton Creek Watershed Turbidity Levels (NTU)
2008-2020 Grab Samples

				n	Max	Mean	+/- SD
Upper Milton	Milton Creek	MIL024	2008	2	3.5	3.2	0.5
			2009	8	6.7	3.9	1.7
			2010	9	13.8	6.7	2.9
			2011	4	7.3	6.0	1.0
	Salmon Creek	SAL148	2008	4	13.1	9.6	2.6
			2009	10	15.6	8.1	3.9
			2010	11	14.3	8.2	3.3
			2011	3	11.5	8.5	2.8
	Upper Milton	UM	2017	4	11.5	7.9	3.1
			2018	11	9.8	6.5	1.7
			2019	14	11.5	6.3	2.6
			2020	15	9.5	6.0	1.5
Lower Milton	Milton Creek	MIL002	2008	2	5.8	5.0	1.1
			2009	9	8.7	5.7	1.5
			2010	8	15.3	8.9	3.6
			2011	5	10.9	7.1	2.1
	Lower Milton	LM	2017	5	7.6	3.7	2.2
			2018	11	8.7	5.1	1.5
			2019	15	13.5	5.9	3.8
			2020	15	12.5	5.3	2.8

Table 46:Milton Creek watershed monthly turbidity (NTU), 2008-2020 grab samples.

Milton Creek Watershed Monthly Turbidity (NTU)
2008-2020 Grab Samples

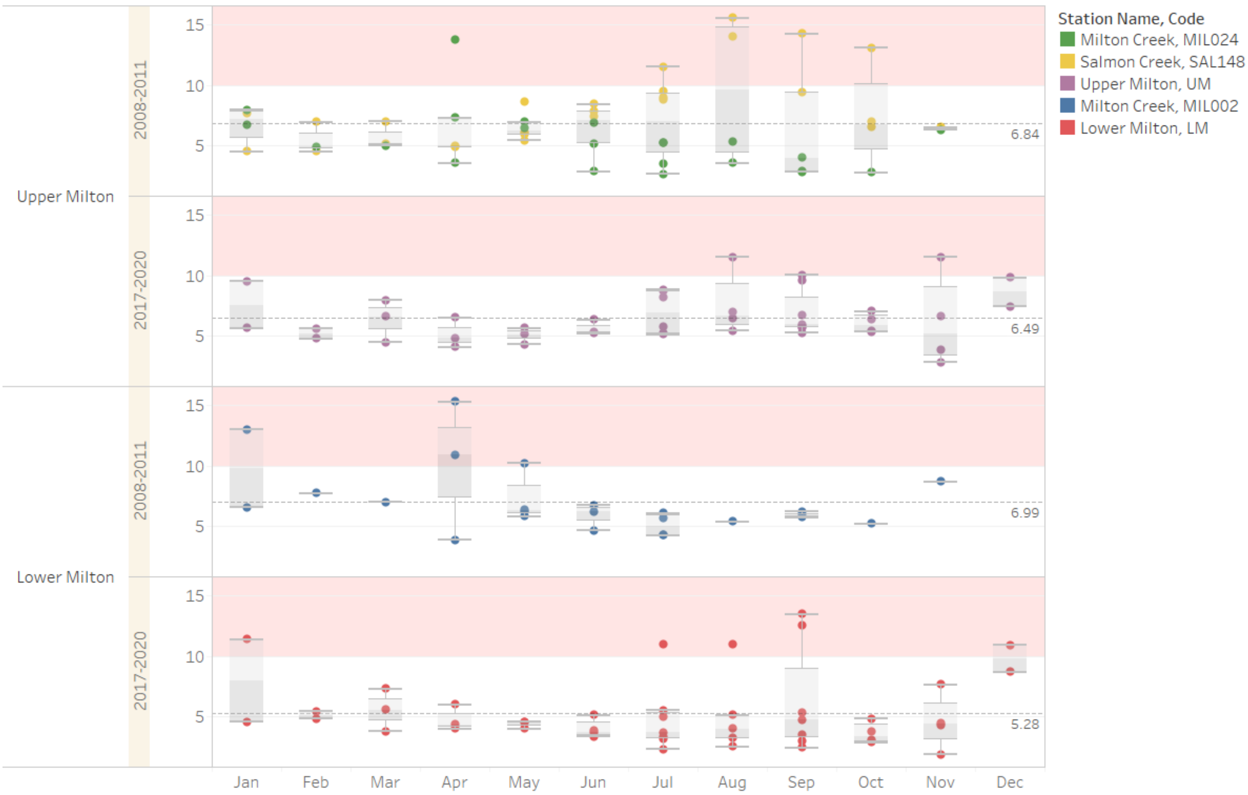


Table 47: Milton watershed monthly max E. coli (MPN/100 ml) grab samples. Grab sampling results for broken down across years and watershed sampling locations. Sampling locations that experienced events over the EPA (235 MPN/100) and ODEQ (406 MPN/100) thresholds for E. coli bacteria levels are highlighted in red. n = number of samples collected.

Summary Table: Milton Creek Watershed Monthly Max *E. coli* (MPN/100 ml)
2008-2020 Grab Samples

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper Milton	Milton Creek, MIL024	2008												
		2009			5					68				
		2010						12		248				
		2011												
	Upper Milton, UM	2017												
		2018						62	90	36				
		2019						121	411	219	365	72	24	78
		2020	120	5	13	26	228	214	326	119	192	38	205	
Lower Milton	Milton Creek, MIL002	2008							248					
		2009			210		228	326	187	365	129	525		
		2010	38	51	16		140	435	87	435	126			
		2011				144	34	115	166					
	Lower Milton, LM	2017							248	61	1,046	365		
		2018						67	291	322				
		2019						488	185	138	980	166	86	219
		2020	28	25	59	156	167	219	387	205	461	365	111	

Table 48: Summary table of Milton Creek watershed E. coli (MPN/100 ml) grab samples. Grab sampling results for broken down across years and watershed sampling locations. Sampling locations that experienced events over the EPA (235 MPN/100) and ODEQ (406 MPN/100) thresholds for E. coli bacteria levels are highlighted in red. n = number of samples collected.

Summary Table: Milton Creek Watershed Monthly Max *E. coli* (MPN/100 ml)
2008-2020 Grab Samples

			n	Max	Mean	+/- SD
Upper Milton	Milton Creek, MIL024	2008	0			
		2009	2	68	37	45
		2010	2	248	130	167
		2011	0			
	Upper Milton, UM	2017	0			
		2018	3	90	63	27
		2019	10	411	173	141
		2020	15	326	122	94
Lower Milton	Milton Creek, MIL002	2008	1	248	248	
		2009	7	525	281	134
		2010	8	435	166	171
		2011	4	166	115	58
	Lower Milton, LM	2017	4	1,046	430	429
		2018	3	322	227	139
		2019	11	980	259	263
		2020	15	461	190	127

Table 49: Milton Creek Watershed Monthly Mean Conductivity Levels (µs/cm) 2008-2020. Grab samples results for watershed broken down across years and watershed sampling locations.

Milton Creek Watershed Monthly Mean Conductivity (µs/cm)
2008-2020 Grab Samples

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper Milton	Milton Creek, MIL024	2008							88.9		98.0			
		2009	44.2		47.4	54.7	50.8	74.4	60.4	73.2	98.8	89.7	65.5	
		2010	40.1	53.1	50.2	49.2		57.6	76.3	85.5	91.2			
		2011				46.0	50.6	65.9	69.9					
	Salmon Creek, SAL148	2008							71.4		76.3	66.7		
		2009	41.7	43.4	40.8	35.5		49.7	77.7	83.3	82.8	49.9	42.5	
		2010	24.7	26.3	4.6	40.0	41.7	47.9	60.3	74.1	81.3			
		2011					45.6	54.7	64.6					
	Upper Milton, UM	2018							65.5	78.5	73.6	47.8	49.6	37.1
		2019	28.4		28.4	36.1	42.8	67.5	70.4	84.1	83.2	84.2	77.0	70.0
		2020	38.5	40.2	49.6	57.5	62.8	66.7	75.5	91.3	94.2	89.8	72.9	
Lower Milton	Milton Creek, MIL002	2008							88.7		102.3			
		2009	49.0		57.6	59.6	29.9	66.6	80.8		99.3	90.4	77.0	
		2010	44.7	54.0	51.9	56.0	51.1	58.7	72.3	91.7	95.5			
		2011				46.7	51.0	61.7	69.7					
	Lower Milton, LM	2018							71.1	107.8	105.5	67.1	53.0	44.2
		2019	34.3		33.8	38.4	71.4	64.7	80.1	97.4	87.9	92.1	56.3	74.4
		2020	41.3	43.5	52.0	60.9	73.9	70.2	76.3	113.7	96.4	95.5	104.4	

Table 50: Summary Table of Milton Creek Watershed Conductivity Levels (µs/cm) 2008-2020. Grab samples results for watershed broken down across years and watershed sampling locations.

Summary Table: Milton Creek Watershed Conductivity Levels (µs/cm)
2008-2020 Grab Samples

			n	Max	Mean	+/- SD
Upper Milton	Milton Creek, MIL024	2008	2	98	93	6
		2009	10	99	66	18
		2010	8	91	63	19
		2011	4	70	58	12
	Salmon Creek, SAL148	2008	4	76	70	6
		2009	10	83	55	19
		2010	11	81	44	22
		2011	3	65	55	10
	Upper Milton, UM	2018	6	79	59	16
		2019	14	89	64	21
		2020	16	98	71	20
Lower Milton	Milton Creek, MIL002	2008	2	102	95	10
		2009	9	99	68	22
		2010	9	96	64	18
		2011	5	70	56	9
	Lower Milton, LM	2018	6	108	75	27
		2019	15	97	70	21
		2020	16	131	79	26

North Scappoose Creek Watershed Supplemental Data Tables

Table 51: North Scappoose Watershed Monthly Turbidity (NTU), 2008-2020. Grab Samples. Grab sampling results for Clatskanie watershed broken down across years and watershed sampling locations. Mean monthly turbidity levels over the 10 NTU threshold are highlighted in red.

Summary Table: North Scapoose Creek Watershed Monthly Mean Turbidity (NTU)
2008-2020 Grab Samples

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper North Scappoose	Alder Creek, ALD077	2008								2.1		4.0		2.9
		2009	5.1									2.1	2.5	
		2010	8.3	4.8	5.2	5.6	4.4	3.2	3.0	2.3	2.6			
		2011				4.4	3.8	2.8	4.3					
	Upper North Scappoose, UNS	2017							1.6		2.4	2.0	4.9	
		2018		3.6	4.1	5.3	1.9	2.2	3.0	2.0	2.3	1.8	1.7	3.6
		2019	3.4		7.0	3.1	1.8	1.9	3.3	2.2	3.1	1.6	1.1	3.2
		2020	8.9	5.4	2.5	2.0	2.7	4.9	1.9	2.9	3.5	2.5	2.7	
Lower North Scappoose	North Scappoose, NSC001	2008							1.9			1.4		
		2009	2.6	11.2	3.4	2.1	2.6	1.6	6.4	3.8		1.4	2.1	
		2010	7.3	4.9	5.3	5.4	4.2	5.2	2.5	2.0	2.7			
		2011					3.3	3.2						
	Lower North Scappoose, LNS	2017							1.1	1.3	1.3	1.3	5.2	
		2018		4.3	4.6	5.0	2.0	1.8	3.0	1.9	2.5	2.2	1.0	3.8
		2019	3.1		5.8	2.4	2.0	4.7	2.5	2.0	4.2	1.7	0.8	4.8
		2020	10.1	4.3	2.3	2.0	3.5	1.7	2.0	1.9	3.1	1.8	1.4	

Table 52: Summary Table of North Scappoose Creek Watershed Turbidity (NTU), 2008-2020. Grab Samples. Grab sampling results for Clatskanie watershed broken down across years and watershed sampling locations. Mean monthly turbidity levels over the 10 NTU threshold are highlighted in red.

Summary Table: North Scappoose Creek Watershed Turbidity Levels (NTU)
2008-2020 Grab Samples

			n	Max	Mean	+/- SD
Upper North Scappoose	Alder Creek, ALD077	2008	3	4.0	3.0	0.9
		2009	3	5.1	3.2	1.6
		2010	10	8.3	4.4	1.8
		2011	4	4.4	3.8	0.7
	Upper North Scappoose, UNS	2017	4	4.9	2.7	1.5
		2018	11	5.3	2.9	1.2
		2019	14	7.0	2.9	1.9
		2020	15	8.9	3.4	1.9
Lower North Scappoose	North Scappoose, NSC001	2008	2	1.9	1.6	0.4
		2009	11	11.2	4.0	3.7
		2010	10	7.3	4.4	1.7
		2011	2	3.3	3.2	0.0
	Lower North Scappoose, LNS	2017	5	5.2	2.0	1.8
		2018	11	5.0	2.9	1.3
		2019	15	7.2	3.2	2.0
		2020	15	10.1	2.9	2.2

Table 53: North Scappoose Creek watershed monthly max E. coli (MPN/100 ml) grab samples. Grab sampling results for broken down across years and watershed sampling locations. Sampling locations that experienced events over the EPA (235 MPN/100) and ODEQ (406 MPN/100) thresholds for E. coli bacteria levels are highlighted in red. n = number of samples collected.

Summary Table: North Scappoose Creek Watershed Monthly Max *E. coli* (MPN/100 ml)
2008-2020 Grab Samples

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper North Scappoose	Alder Creek, ALD077	2008								160		61		44
		2009	23										25	
		2010		6	20	15	59	20	50	78	38			
		2011					18	147	345					
	Upper North Scappoose, UNS	2017												
		2018						226	133	15				
		2019						133	261	29	365	38	25	34
		2020	13	6	47	105	411	238	186	308	91	88	67	
Lower North Scappoose	North Scappoose, NSC001	2008							20			32		
		2009	19		22				48			75	57	
		2010	20	9	19	12	79	613	26	76				
		2011				67	127	1,203						
	Lower North Scappoose, LNS	2017							101	90	365	166		
		2018						83	107	63				
		2019						1,990	687	156	96	65	21	65
		2020	39	12	32	70	45	308	201	517	179	99	42	

Table 54: North Scappoose Creek Watershed Monthly Mean Conductivity Levels (µs/cm) 2008-2020. Grab samples results for watershed broken down across years and watershed sampling locations.

North Scappoose Creek Watershed Monthly Mean Conductivity (µs/cm)
2008-2020 Grab Samples

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper North Scappoose	Alder Creek, ALD077	2008								86.7				89.7
		2009	54.9	65.0								65.6	54.8	
		2010	52.6	54.8	54.9	53.2	51.1	62.3	63.0	83.9	89.8			
		2011				55.2	58.2	69.4	77.3					
	Upper North Scappoose, UNS	2018							63.5	73.0	67.8	63.5	55.5	45.8
		2019	35.1		30.4	39.8	46.3	75.5	71.3	85.9	84.7	92.4	89.5	83.8
		2020	46.2	47.4	59.2	66.2	69.2	78.9	80.8	89.2	78.5	93.3	88.5	
Lower North Scappoose	North Scappoose, NSC001	2008							95.1			106.5		
		2009	64.3	62.3	60.6	59.7	58.6	66.0	74.4	107.1		76.7	61.7	
		2010	50.8	35.3	54.6	52.2	62.7	64.2	72.2	83.0	99.6			
		2011				55.2	61.2	70.0						
	Lower North Scappoose, LNS	2018							70.8	86.1	88.1	70.7	65.1	52.1
		2019	37.1		34.0	43.9	50.6	76.8	88.9	96.6	93.9	103.4	100.4	89.5
		2020	48.4	48.5	62.0	70.2	73.1	85.5	88.1	102.6	103.7	104.3	98.3	

Table 55: Summary Table of North Scappoose Creek Watershed Conductivity Levels (µs/cm) 2008-2020. Grab samples results for watershed broken down across years and watershed sampling locations.

Summary Table: North Scappoose Creek Watershed Conductivity Levels (µs/cm) 2008-2020 Grab Samples

			n	Max	Mean	+/- SD
Upper North Scappoose	Alder Creek, ALD077	2008	2	90	88	2
		2009	4	66	60	6
		2010	10	90	62	15
		2011	4	77	65	10
	Upper North Scappoose, UNS	2018	6	73	62	10
		2019	14	92	69	22
		2020	16	93	74	17
Lower North Scappoose	North Scappoose, NSC001	2008	2	107	101	8
		2009	11	107	70	15
		2010	10	100	64	18
		2011	3	70	62	7
	Lower North Scappoose, LNS	2018	6	88	72	13
		2019	15	106	78	25
		2020	16	107	84	21

South Scappoose Creek Watershed Supplemental Data Tables

Table 56: South Scappoose Watershed Monthly Turbidity (NTU), 2008-2020. Grab Samples. Grab sampling results for Clatskanie watershed broken down across years and watershed sampling locations. Mean monthly turbidity levels over the 10 NTU threshold are highlighted in red.

Summary Table: South Scapoose Creek Watershed Monthly Mean Turbidity (NTU)
2008-2020 Grab Samples

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper South Scappoose	Gourley Creek, SSCGRL	2009									2.8	1.9	1.3	
		2010	13.9	10.3	3.5			3.6	1.8	2.1	1.6			
		2011				4.3	2.1	3.0						
	Lacey Creek, LZY028	2008							2.4	1.8		10.7	2.3	
		2009	3.2	4.8	4.6	2.4	9.0	2.1	2.3		1.7	3.3	1.5	
		2010	12.3	9.8	6.0	3.6	5.7	4.5	2.8	3.2	2.3			
		2011				7.2	3.8	3.9						
	South Scappoose, SSC041	2008							1.4	1.9			1.7	
		2009	5.6	4.4	2.6	1.9	3.2	1.8	1.6		1.0	0.8	1.3	
		2010	5.0		4.0	3.6	6.9	3.3	2.5	2.3	2.0			
		2011				3.7	2.5	3.3						
	Upper South Scappoose, USS	2017							0.6		1.2	1.9	2.9	
		2018		2.4	3.2	3.9	1.3	3.0	4.1	18.0	2.3	1.6	0.5	2.2
		2019	2.2		2.6	1.7	1.9	2.2	1.7	1.1	2.8	1.0	2.0	2.8
		2020	5.3	3.1	2.1	1.8	1.3	1.4	1.2	2.1	2.7	1.0	0.8	
Lower South Scappoose	South Scappoose, SSCJPW	2008								3.7			2.6	
		2009	4.3	14.6	3.7	1.9	2.9	2.7	3.8	4.3	3.7	2.4	2.3	
		2010	7.4	6.3	5.2	7.0	4.5	3.6	3.6	2.9	2.9			
		2011					4.5	3.1						
	Lower South Scappoose, LSS	2017							1.1	2.4	2.7	8.5	7.3	
		2018		4.0	6.8	7.3	2.2	2.4	4.9	2.2	2.6	2.3	1.7	3.5
		2019	3.1		4.5	2.9	2.0	3.3	3.7	3.8	5.5	2.1	1.3	3.8
		2020	11.0	6.7	2.6	1.8	2.7	1.9	2.0	2.4	3.0	2.6	3.5	

Table 57: Summary Table of South Scappoose Creek Watershed Turbidity (NTU), 2008-2020. Grab Samples. Grab sampling results for Clatskanie watershed broken down across years and watershed sampling locations. Mean monthly turbidity levels over the 10 NTU threshold are highlighted in red.

Summary Table: South Scappoose Creek Watershed Turbidity Levels (NTU)
2008-2020 Grab Samples

			n	Max	Mean	+/- SD
Upper South Scappoose	Gourley Creek, SSCGRL	2009	3	2.8	2.0	0.7
		2010	7	13.9	5.3	4.9
		2011	3	4.3	3.1	1.1
	Lacey Creek, LZY028	2008	4	10.7	4.3	4.3
		2009	10	9.0	3.5	2.2
		2010	9	12.3	5.6	3.4
		2011	3	7.2	5.0	1.9
	South Scappoose, SSC041	2008	3	1.9	1.6	0.3
		2009	10	5.6	2.4	1.6
		2010	8	6.9	3.7	1.6
		2011	3	3.7	3.2	0.6
	Upper South Scappoose, USS	2017	4	2.9	1.6	1.0
		2018	11	18.0	3.9	4.8
		2019	13	3.6	2.0	0.7
		2020	15	5.3	2.1	1.3
Lower South Scappoose	South Scappoose, SSCJPW	2008	2	3.7	3.1	0.8
		2009	11	14.6	4.2	3.5
		2010	10	7.4	4.8	1.7
		2011	3	5.1	4.0	1.0
	Lower South Scappoose, LSS	2017	5	8.5	4.4	3.3
		2018	11	7.3	3.6	1.9
		2019	15	8.5	3.5	1.8
		2020	15	11.0	3.4	2.4

Table 58: South Scappoose watershed monthly max E. coli (MPN/100 ml) grab samples. Grab sampling results for broken down across years and watershed sampling locations. Sampling locations that experienced events over the EPA (235 MPN/100) and ODEQ (406 MPN/100) thresholds for E. coli bacteria levels are highlighted in red. n = number of samples collected.

South Scappoose Creek Watershed Monthly Max *E. coli* (MPN/100 ml)
2008-2020 Grab Samples

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper South Scappoose	Upper South Scappoose, USS	2017												
		2018						77	34	73				
		2019						68	2,600	504	343	11	19	12
		2020	1	3	3	9	114	54	133	488	192	86	17	
Lower South Scappoose	South Scappoose, SSCJPW	2008												
		2009	17	326	16	38		411	649	276		308	31	
		2010	23	15	65	40	131	75	435	345	326			
		2011					157	86						
	Lower South Scappoose, LSS	2017							248	172	326	166		
		2018						921	345	326				
		2019						1,200	308	178	816	201	46	189
		2020	9	8	42	172	1,200	308	435	238	276	140	411	

Table 59: Summary table of South Scappoose Creek watershed E. coli (MPN/100 ml) grab samples. Grab sampling results for broken down across years and watershed sampling locations. Sampling locations that experienced events over the EPA (235 MPN/100) and ODEQ (406 MPN/100) thresholds for E. coli bacteria levels are highlighted in red. n = number of samples collected.

Summary Table: South Scappoose Creek Watershed Monthly Max *E. coli* (MPN/100 ml)
2008-2020 Grab Samples

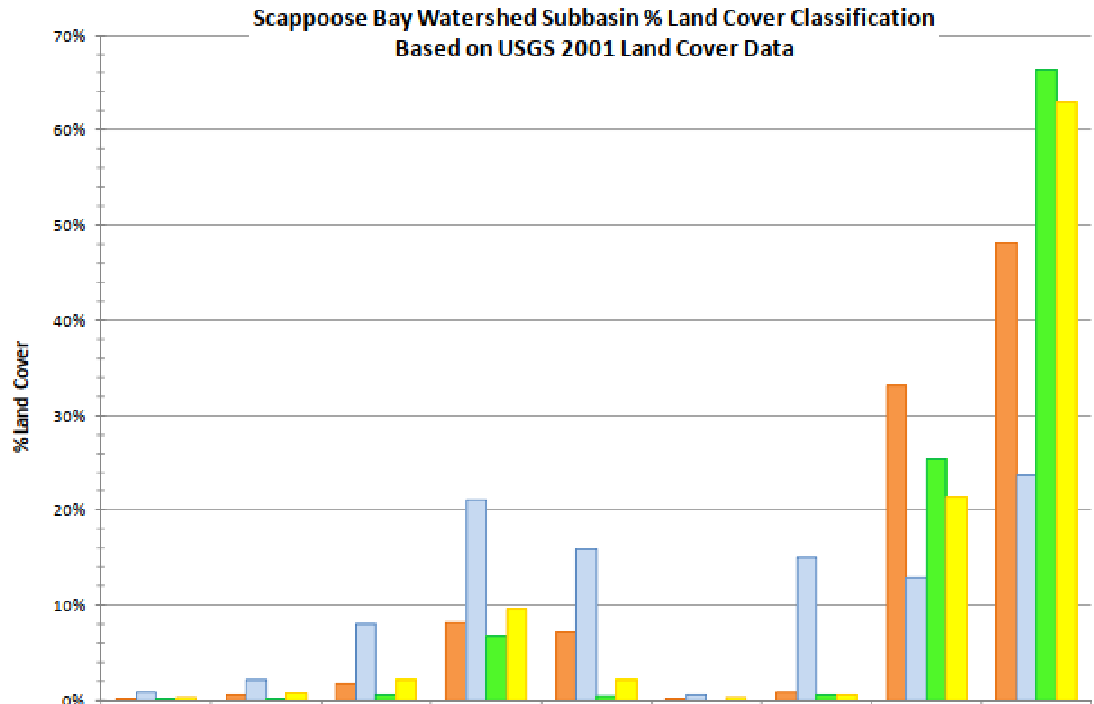
			n	Max	Mean	+/- SD
Upper South Scappoose	Upper South Scappoose, USS	2017	0			
		2018	3	77	61	24
		2019	9	2,600	414	837
		2020	15	488	91	125
Lower South Scappoose	South Scappoose, SSCJPW	2008	0			
		2009	9	649	230	222
		2010	9	435	162	161
		2011	3	157	96	56
	Lower South Scappoose, LSS	2017	4	326	228	75
		2018	3	921	531	338
		2019	11	1,200	375	377
		2020	15	1,200	264	289

Table 60: South Scappoose Creek watershed Monthly Mean Conductivity Levels (µs/cm) 2008-2020. Grab samples results for watershed broken down across years and watershed sampling locations.

South Scappoose Creek Watershed Monthly Mean Conductivity (µs/cm)
2008-2020 Grab Samples

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper South Scappoose	Gourley Creek, SSCGRL	2009									119.1	106.4	95.7	
		2010	45.7	55.8	36.9			76.0	94.3	130.5	120.0			
		2011				59.2	62.9	80.5						
	Lazy Creek, LZY028	2008							90.0	97.3		101.0	89.2	
		2009	56.8	64.5	60.0	72.0	58.0	63.6	91.8		74.9	73.7	82.8	
		2010	45.3	53.8	35.7	60.9	45.5	72.2	82.6	117.6	95.8			
		2011				56.1	59.2	74.3						
	South Scappoose, SSC041	2008							65.6	70.8			62.1	
		2009	48.8	52.2	50.7	57.4	45.1	48.6	65.0		73.9	50.0	64.5	
		2010	28.9		49.4	51.0	54.0	48.9	49.2	67.5	72.8			
		2011				50.6	52.4	61.4						
	Upper South Scappoose, USS	2018							78.8	113.2	118.9	156.1	94.8	50.9
		2019	38.2		32.7	41.2	49.3	93.0	121.4	125.8	132.3	137.0	139.4	101.7
		2020	45.0	32.0	63.9	69.7	76.2	90.5	103.9	140.2	151.9	151.8	127.9	
Lower South Scappoose	South Scappoose, SSCJPW	2008								122.7			117.1	
		2009	69.4	82.6	70.9	60.8	74.2	84.3	113.0	131.3	144.9	96.8	75.0	
		2010	56.4	59.5	63.2	59.7	76.4	79.8	97.9	113.8	122.6			
		2011					69.6	85.2						
	Lower South Scappoose, LSS	2018							91.3	111.5	100.8	93.6	54.9	63.2
		2019	43.0		39.8	49.9	60.4	90.1	100.2	121.3	113.2	128.6	124.7	74.1
		2020	50.6	55.3	72.9	82.8	87.4	99.6	105.0	127.2	129.1	133.4	130.0	

Appendix C: Scappoose Bay Watershed Landcover Classification



Subbasin	Developed, High Intensity	Developed, Medium Intensity	Developed, Low Intensity	Developed, Open Space	Crops/ Pasture	Open Water	Wetlands	Vegetation (Shrub & Herb)	Forest
Milton Creek	0.2%	0.6%	1.7%	8.2%	7.2%	0.0%	0.9%	33.2%	48.2%
Honeyman/McNulty Creek	0.8%	2.2%	8.1%	21.0%	15.9%	0.5%	15.0%	12.9%	23.6%
North Scappoose Creek	0.0%	0.1%	0.5%	6.7%	0.4%	0.0%	0.6%	25.4%	66.3%
South Scappoose Creek	0.3%	0.6%	2.1%	9.6%	2.1%	0.3%	0.6%	21.4%	63.0%

Figure 63: Percent land cover in Scappoose bay watersheds based on USGS 2001 Land cover data. Open Water, Developed high intensity, Developed medium intensity and Developed low intensity are represented as classified by the USGS; Developed open space includes developed open space and barren land classifications; Crops/Pastures includes hay/pasture and cultivated crops classifications; Forests include Evergreen, Deciduous and Mixed forest classifications; Vegetation includes herbaceous and shrub/scrub classifications; Wetlands include emergent herbaceous wetlands and woody wetlands classifications.