Skagit County Monitoring Program Background and Methods

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Acknowledgements

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This report is available online at
https://www.skagitcounty.net/Departments/PublicWorksCleanWater/WQmonitoring.htm

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Abbreviations

Ag-CAO	-	Critical Areas Ordinance: Ongoing Agriculture
Ag-NRL	-	Agricultural Natural Resource Lands
BMP	-	Best Management Practice
County	-	Skagit County
CSI	-	Samish Initiative
CV	-	Coefficient of Variation
DO	-	Dissolved Oxygen
Ecology	-	Washington State Department of Ecology
EPA	-	Environmental Protection Agency
FC	-	Coliform
GMHB	-	Growth Management Hearings Board
MPN	-	Most Probable Number
NH3	-	Ammonia
NO_3^-+ NO_2^-	-	Nitrate + Nitrite
NTU	-	Nephelometric Turbidity Units
OP	-	Orthophosphate
pH	-	Power of Hydrogen
PIC	-	Pollution Identification and Correction
QAPP	-	Quality Assurance Project Plan
RR-NRL	-	Rural Resource Natural Resource Lands
RSD	-	Relative Standard Deviation
SCC	-	Skagit County Code
SCMP	-	Skagit County Monitoring Program
7-DADMax	-	7-Day Average of Daily Maximum Temperatures
SRC	-	Site Report Card
TKN	-	Total Kjeldahl Nitrogen
TMDL	-	Total Maximum Daily Load
TP	-	Total Phosphorous
TSS	-	Total Suspended Solids
VSP	-	Voluntary Stewardship Program
WQI	-	Water Quality Index
WRC	-	State of Washington Water Research Center
WY	-	Water Year

1. Introduction

The purpose of this reference document is to provide historical background and to describe the methodology used in the Skagit County Monitoring Program (SCMP).

The SCMP began in October 2003 as part of Skagit County's (County) program to assess the effectiveness of Skagit County Code (SCC) Chapter 14.24.120: Critical Areas Ordinance for Areas of Ongoing Agriculture (Ag-CAO). The revised ordinance (Skagit County Ordinance O20030020) was passed by the Skagit County Board of Commissioners in June 2003 in response to a compliance order from the Western Washington Growth Management Hearings Board (GMHB).

The ordinance requires farmers to "do no harm" to adjacent watercourses and relies on specific watercourse protection measures and more generalized best management practices (BMPs) to protect the watercourses instead of requiring buffers. The associated Skagit County Resolution R20030210 committed the County to conduct water quality monitoring in the agricultural areas as one method of assessing if the ordinance was sufficient to protect the aquatic resources in agricultural areas. The resolution was subsequently amended in June 2004, as Resolution R20040211, in response to additional compliance orders from the Western Washington GMHB. This second resolution provided details about the water quality monitoring program in addition to other topics not associated with water quality. Included in R20040211 is the requirement for annual reporting on the water quality monitoring program. This document is intended to satisfy that requirement for the 2022 Water Year (WY). Results from the first eighteen years of this program have been reported previously (Skagit County 2004-2021). This current report contains data and analysis from water years 2004 – 2022.

R20040211 also required the County to conduct a triennial review of the Ag-CAO, including the water quality monitoring program, to seek public comment and to make changes if necessary. However, the State of Washington passed SSB 5248 in 2007, which placed a "time out" on changes to critical areas regulations impacting agriculture until 2010, while the statewide issues regarding agricultural regulation were studied. The legislature subsequently passed additional legislation to extend the "time out" to 2011. In 2011, the Washington State Legislature adopted the recommendations from one research group studying the critical areas regulations and created the Voluntary Stewardship Program (VSP). Skagit County enrolled in the program in 2012. The counties that enrolled agreed to maintain existing critical areas protections and ensure streams are protected using voluntary measures.

1.1. Sampling Locations

Figure 1 is a map of the 40 sampling sites currently monitored in the SCMP. Table 1 and Table 2 list the sampling site's names and their land use designations. These sites are located primarily in agricultural zones, designated by the County as Agriculture-Natural Resource Lands (Ag-NRL) and Rural Resource-Natural Resource Lands (RR-NRL). Other sites were selected to provide context to, and comparisons with, the sites in the agricultural zones. These include sites located just upstream or downstream of agricultural areas or in streams draining suburban watersheds. The SCMP was designed to determine current conditions and long-term trends in water quality at these sampling locations. The data are also suitable for determining compliance with state water quality standards.

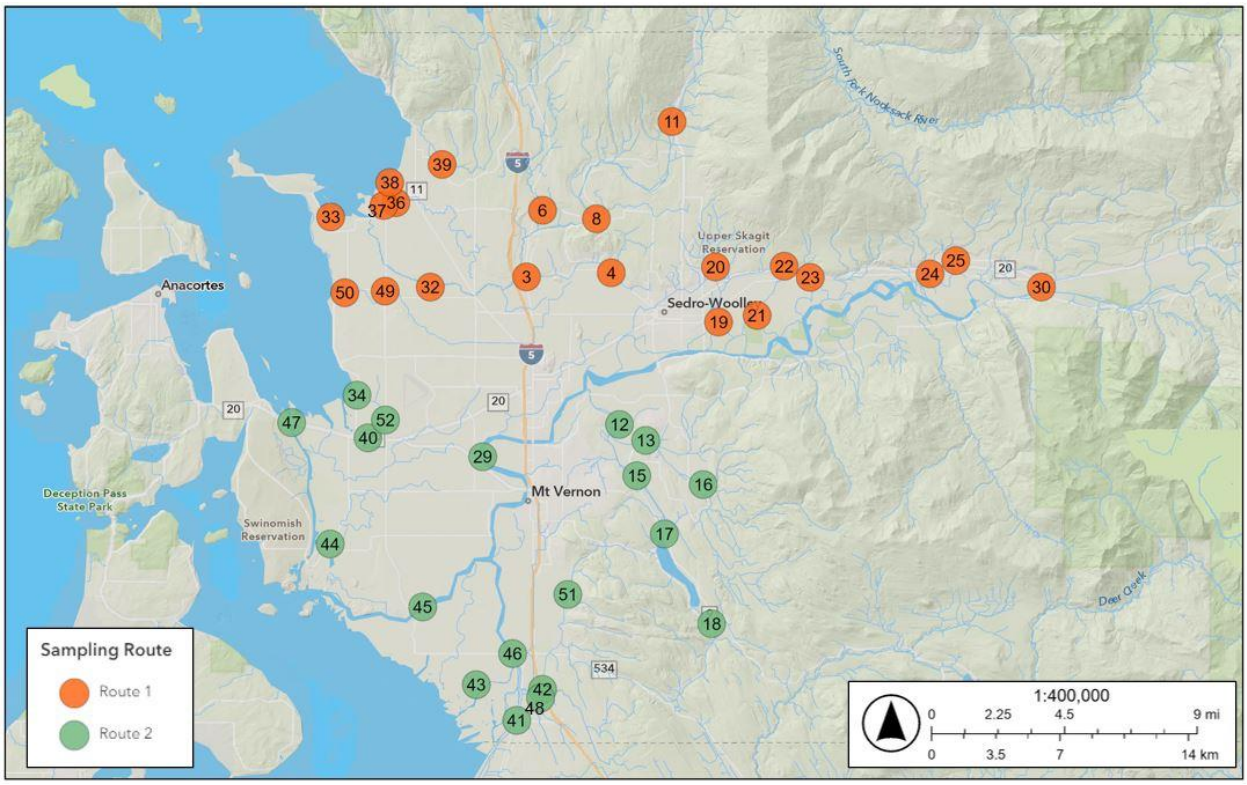

Figure 1. Ambient monitoring sites in the Skagit County Monitoring Program (SCMP).

Table 1. Sample site locations and types in the SCMP.

Site ID	Watercourse	Location	Latitude	Longitude	Site Type[1]
3	Thomas Creek	Old Hwy 99 N	48.526	-122.339	3
4	Thomas Creek	F&S Grade Rd	48.528	-122.276	2
6	Friday Creek	Prairie Rd	48.559	-122.327	4
8	Swede Creek	Grip Rd	48.555	-122.287	3
11	Samish River	State Route 9	48.602	-122.231	1
12	Nookachamps Creek	Swan Rd	48.454	-122.270	3,6
13	E.F. Nookachamps Creek	State Route 9	48.446	-122.251	3,6
15	Nookachamps Creek	Knapp Rd	48.429	-122.258	2,6
16	E.F. Nookachamps Creek	Beaver Lake Rd	48.424	-122.208	2,6
17	Nookachamps Creek	Big Lake Outlet	48.400	-122.237	1,6
18	Lake Creek	State Route 9	48.356	-122.202	1,6
19	Hansen Creek	Hoehn Rd	48.504	-122.197	3,6
20	Hansen Creek	Northern State	48.531	-122.199	1,6
21	Coal Creek	Hoehn Rd	48.507	-122.169	3
22	Coal Creek	Highway 20	48.531	-122.149	1
23	Wiseman Creek	Minkler Rd	48.526	-122.130	1
24	Mannser Creek	Lyman Hamilton Hwy	48.528	-122.041	2
25	Red Cabin Creek	Hamilton Cem. Rd	48.534	-122.023	1
29	Skagit River	River Bend Rd	48.439	-122.372	5,6
30	Skagit River	Cape Horn Rd	48.521	-121.960	5
32	Samish River	Thomas Rd	48.521	-122.410	3
33	Alice Bay Pump Station	Samish Island Rd	48.555	-122.483	3
34	No Name Slough	Bayview-Edison Rd	48.468	-122.464	3
36	Edison Slough	W. Bow Hill Rd	48.562	-122.436	3
37	South Edison Pump Station	Farm to Market Rd	48.561	-122.444	3
38	North Edison Pump Station	North Edison Rd	48.572	-122.441	3
39	Colony Creek	Colony Rd	48.581	-122.401	2
40	Big Indian Slough	Bayview-Edison Rd	48.447	-122.457	3
41	Maddox Slough/Big Ditch	Milltown Rd	48.309	-122.346	3
42	Hill Ditch/Carpenter	Cedardale Rd	48.324	-122.327	3
43	Wiley Slough	Wylie Rd	48.326	-122.372	3
44	Sullivan Slough	La Conner-Whitney	48.395	-122.485	3
45	Skagit River – North Fork	Moore Rd	48.364	-122.416	5,6
46	Skagit River – South Fork	Fir Island Rd	48.342	-122.349	5,6
47	Swinomish Channel	Twin Bridges Boat Launch	48.455	-122.512	8
48	Fisher Creek	Franklin Rd	48.320	-122.328	3,6
49	Joe Leary Slough	Farm to Market Rd	48.519	-122.444	3,6
50	Joe Leary Slough	Bayview-Edison Rd	48.518	-122.474	3,6
51	Carpenter Creek	East Stackpole Rd	48.370	-122.310	1,6
52	Little Indian Slough	Farm to Market Rd	48.459	-122.444	6

[1]See Table 2 for site type descriptions.

Table 2. Sample site type descriptions for the SCMP.

Site Type Number	Description	Number of Sites[1]
1	Ag-upstream: Located to determine status/trends at upstream end of agricultural areas.	8
2	Ag-midstream: Located to determine status/trends in the middle of agricultural areas.	4
3	Ag-downstream: Located to determine status/trends at downstream end of a watercourse in agricultural areas.	20
4	Reference: Located to determine status/trends in a non-agricultural area, such as urban/suburban or rural reserve, for comparison with agricultural area results.	1
5	Skagit River: Located to determine status/trends in the mainstem Skagit River or the forks. The Skagit may show effects from a wide variety of sources.	4
6	TMDL: Located to provide information for the Department of Ecology's TMDL efforts.	16
7	Swinomish Channel: Located to provide a water quality baseline for Swinomish Channel	1

[1]Some sites have more than one type of designation

1.2. Sample Site Revisions

A total of 19 of the 40 sites (sites 3 - 13, 15 - 25) are continued from the Skagit County Baseline Monitoring Project (Skagit County 2004a). The Baseline project used nearly identical methods to monitor water quality at 27 sites. Five additional sites were part of the Samish Bay Watershed Water Quality Monitoring Program (Skagit County 2003). The data from the Baseline and Samish Projects are used to help interpret trends in water quality for sites continued in the SCMP. Not all Baseline sites could be continued into the current program due to limited resources and the need to expand the current program into the Skagit Delta. Several intermediate sites on the Samish River were discontinued, leaving one upstream and one downstream site on the Samish.

Two sample sites were moved from their original locations as delineated in the Quality Assurance Project Plan (QAPP). Site 40 on Big Indian Slough was moved approximately 2,800 feet upstream to solve right-of-entry problems and to move away from the tide gate and associated saltwater intrusion. This change was made prior to any sampling. Site 42 on Hill Ditch/Carpenter Creek was moved approximately 4,300 feet upstream because the original site at Pioneer Highway was subject to backwater from the Skagit River. The early samples it was determined that primarily Skagit River water was being sampled instead of Hill Ditch/Carpenter Creek water. These changes were approved by Ecology as revisions to the QAPP in 2003 and 2004.

In June 2005, the sample site at Rexville Pump Station (Site 44), at the east end of the Sullivan Slough watershed, was moved to the west end of Sullivan Slough, at La Conner-Whitney Road. This move was made in consultation with Ecology and the Western Washington Agricultural Association. Most of the flow from that system discharges through the west end into Swinomish Channel. The Rexville Pump Station site was initially chosen because it was cited as a possible fecal coliform source in the Lower Skagit Fecal Coliform TMDL (Pickett 1997). However, fecal coliform (FC) readings at the site during this study were generally low. Because of the low FC readings, coupled with the infrequent discharges from the pump station, it was determined that sampling efforts would be better spent nearer the outlet of the slough.

For the 2017 season, Skagit County re-designated two sites to better reflect current land use patterns: Site 16 (East Fork Nookachamps Creek) was moved from Ag-Upstream to Ag-Midstream due to some agricultural activity directly upstream of the sample location. Site 23 (Wiseman Creek) was moved from Ag-Midstream to Ag-Upstream due to the cessation of agricultural activities upstream of the sample location.

In 2018, construction activities required Skagit County to pause sampling at Site 31, located near Dike District 20's floodgate near Francis Road. Sampling at the site was not resumed post-construction and the site was officially removed from the sampling list in 2022.

At the start of the 2022 water year, three original sites were removed from the sampling plan and four new sites were added. Site 14 along College Creek was dropped due to its location outside of Skagit County's jurisdiction. Site 28, an urban reference site located on Brickyard Creek, was removed due to being dry for large portions of the year and not being as helpful in understanding the primarily agricultural sites. Site 35 on Joe Leary Slough was also removed from the sampling program.

In replacement of Site 35, two sites were added on Joe Leary Slough to narrow down pollution sources and to help inform the Padilla Bay Bacteria TMDL. Site 49 was added as a midstream site on Joe Leary Slough at Farm to Market Road and Site 50 was added at the tide gate terminus where the waterway meets Padilla Bay.

Site 51, located on Carpenter Creek at East Stackpole Road, was added to understand worsening trends observed downstream at Site 42. The data collected at this site also helps support the Lower Skagit Tributaries Temperature TMDL and other Ecology work related to Skagit Bay shellfish monitoring.

Site 52, located on Little Indian Slough at Farm to Market Road, was added based on high bacteria levels observed by Skagit County Stream and Storm Teams and Ecology. The regular monitoring at this site helps inform the efforts to reduce pollution and the Padilla Bay Bacteria TMDL.

1.3. Clean Samish Initiative

The Clean Samish Initiative (CSI) was established by Ecology in fall 2008 to foster cooperation between local, state, tribal, and federal agencies, non-governmental groups, and citizens to address FC pollution in the Samish Bay Watershed. Excess FC pollution in the Samish River and other bay tributaries has resulted in numerous closures of the commercial shellfish beds in Samish Bay. The CSI participants (over 20 organizations) developed a work plan that included education and outreach, detailed water quality

sampling to locate pollution sources, referrals of landowners to resource agencies for pollution abatement, and enforcement of water quality and land use regulations if necessary. Skagit County applied for and received EPA funding in 2010 to conduct a PIC project in the Samish Basin, incorporating CSI work plan elements into a program designed to locate and reduce FC pollution in the Samish Basin.

The CSI grew out of Ecology's TMDL activities in the Samish Basin. Ecology's sampling demonstrated that the Samish River was the largest source of FC bacteria to Samish Bay. While some of the independent Samish Bay tributaries (e.g., Edison Slough and Colony Creek) and agricultural drainages also contribute bacterial pollution to Samish Bay, the comparatively high discharge rate of the river combined with occasional high coliform counts determined that the river was, and continues to be, the most important pollution source for Samish Bay.

1.4. 2008 Review by the State of Washington Water Research Center

Skagit County contracted with the State of Washington Water Research Center (WRC) for a review of its water quality program. The WRC Review Report draft was received in March 2008, and the final report was received in June 2008 (Cichosz and Barber 2008).

Skagit County is implementing the report recommendations as the budget allows. Recommendations that have already been incorporated into the program include expansion of the sampling program to better identify pollution source locations (through the PIC program), increased use of stream discharge information, and some statistical analysis recommendations.

1.5. Funding

A proposal was submitted in February 2003 to Ecology for consideration in its fiscal year 2004 Centennial Clean Water Grants program. The proposal was accepted and a grant of nearly $500,000 was awarded to support five years of the monitoring program, fiscal year 2004 through fiscal year 2008.

The Centennial Clean Water Grant, that funded the program at 75%, ended in December 2008, with the remaining 25% having come from County funds. Work since that date has been funded by Skagit County's Clean Water Program (CWP). Skagit County has received some EPA funding to address Samish Bay watershed FC issues, but the core activities of the SCMP will continue to be funded out of the CWP.

2. Methods

2.1. Sampling and Data Collection

Standard water quality monitoring methods are used in the SCMP. The methods are derived from several sources, including guidance from Ecology and the EPA. A brief description of monitoring procedures follows, and detailed monitoring procedures can be found in the QAPP developed for the program (Skagit County 2004b).

2.1.1. Biweekly Data Collection

Each site in the monitoring program is visited once every two weeks. Sites are sampled on one of two routes, with each route being completed every other week. The sample routes are designed so that each station is visited at approximately the same time of day on each visit to minimize the effects of diurnal variation in water quality parameters on overall data variability through the length of the program. Sampling may have taken place on different days each week, depending on scheduling and logistics.

At each visit, dissolved oxygen (DO), temperature, pH, turbidity, conductivity, and salinity are measured with a water quality sonde or field instruments. Water samples are then obtained for FC and E. coli (EC) determinations. On a quarterly basis, additional water samples are obtained for laboratory quantification of nutrients that include total Kjeldahl nitrogen (TKN), ammonia (NH_3), nitrate (NO_3^-) and nitrite (NO_2^-), total phosphorus (TP), orthophosphate (OP), and total suspended solids (TSS).

Data collected in the field from the water quality sonde are recorded paper field sheets and later entered in an electronic database. The data entry is reviewed against the original datasheet for QA/QC purposes. Microsoft Excel spreadsheets are used for data summary and analysis.

2.1.2. Continuous Temperature Measurements

Over the summer, continuous temperature loggers are deployed at 23 of the monitoring sites to determine compliance with state temperature standards (Table 3). Sites were chosen for logger deployment based on the presence of fish habitat and other recorded temperature data. Most of the agricultural drainages and sloughs do not have loggers deployed at them. The loggers are normally deployed June through September and are set to record temperature every 30 minutes.

Table 3. Sites where continuous temperature loggers are deployed.

Watershed	Site	Waterbody
Samish Bay	11	Upper Samish River
	8	Swede Creek
	6	Friday Creek
	4	Upper Thomas Creek
	3	Lower Thomas Creek
	32	Lower Samish River
	39	Colony Creek
Middle Skagit	24	Mannser Creek
	22	Upper Coal Creek
	21	Lower Coal Creek
	20	Upper Hansen Creek
	19	Lower Hansen Creek
Nookachamps	18	Lake Creek
	17	Upper Nookachamps Creek
	15	Middle Nookachamps Creek
	16	Upper East Fork Nookachamps Creek
	13	Lower East Fork Nookachamps Creek
	12	Lower Nookachamps Creek
Lower Skagit	42	Lower Carpenter Creek
	48	Fisher Creek
	41	Maddox Creek/Big Ditch
Skagit River	30	Skagit River near Hamilton
	45	North Fork Skagit River

2.1.3.Discharge Measurements

Discharge measurements were made up until 2008 in selected locations and were intended to provide a general indication of the flow regime for that watercourse and as an aid in interpreting other water quality parameters. As Ecology has added several stream gauges in the area, Skagit County has de-emphasized performing manual discharge measurement.

2.2. Data Quality

2.2.1. Quality Assurance Project Plan (QAPP)

The SCMP operates under a QAPP that was approved by Ecology in 2003. This plan details sampling strategies, equipment to be used, and all other aspects of the sampling program. Ecology approval of the QAPP was required for Skagit County to be eligible for grant funds.

2.2.2. Equipment Calibration and Maintenance

The turbidity meter (Lamotte Model 2020we) is calibrated the afternoon before or the morning of each sampling trip, and the reading before calibration is recorded.

The pH meter (Hanna Instruments Model 8314) is calibrated on the morning of each sampling trip. The pH meter is recalibrated during the trip if questionable results are obtained.

The DO/temperature/conductivity meter (YSI Model 2030 Pro) is calibrated for DO using the built-in calibration chamber (water-saturated air). The meter is recalibrated to local elevation at each sample site prior to sampling. The DO meter probe is deployed in areas with sufficient current (> 0.5 feet per second) to produce reliable results, or the probe is stirred to produce adequate velocity across the membrane. Samples for pH and turbidity are obtained from the thalweg of the stream whenever possible with sample containers rinsed at least three times with sample water and are analyzed immediately.

2.2.3. Lab Samples

Laboratory samples for nutrients are collected using clean equipment with a sampling wand as close as possible to the thalweg of the watercourse. Care is taken to prevent oversampling of the surface film or disturbing the bottom. For nutrient and TSS samples the sampling container is rinsed at least three times with the water to be sampled. The sample is then poured into the bottles provided by the contract lab, Edge Analytical of Burlington, WA, an Ecology-certified laboratory. Samples are capped and placed in a cooler with ice until they are delivered to the lab on the same day. Samples for FC are collected directly into sterile bottles and transported under ice to the laboratory within eight hours of collection.

2.2.4. Personnel

The project manager performs most samplings events. Any other staff that perform samplings and collections are adequately trained by the project manager according to EPA-approved sampling methods prior to sampling. Due to regular staff turnover and availability of assisting staff members, some staff may collect sample data only once, though repeated participation and experience with the project manager is preferred when possible.

2.2.5. Duplicate Analysis

Duplicate field samples are collected to assess the accuracy and precision of the analytical methods. FC duplicates are randomly collected at a 20% rate and nutrient duplicates are randomly collected at a 10% rate. The selected nutrient duplicates (TP, OP, NO_3^-, and NH_3) are intended to provide a precision estimate for all the nutrient analyses.

2.3. Data Analysis

2.3.1.Statistics

Summary statistics are calculated for all measured parameters at each sampling site. These statistics can be used as a general indication of water quality at each station. However, water quality conditions vary greatly at each station over time and the summary statistics should not be used as a sole indicator of water quality.

A primary goal of the SCMP is to detect trends in water quality over time. The purpose of the trends analysis is to provide indications of whether water quality in agricultural areas is improving, staying the same, or worsening. Once trends are detected, efforts should be undertaken to determine if they are caused by local activities or by regional conditions such as changes in climate. By comparing trends at

stations inside and outside of the agricultural areas and by monitoring climate conditions, it should be possible to determine conditions that are likely caused by local circumstances.

One statistical tool in use to assess trends is the Seasonal Kendall's Test. This test is designed to determine overall trends in water quality for parameters that vary seasonally, such as temperature and DO. The Seasonal Kendall's Test has been widely employed for similar purposes in Washington, Oregon, and throughout the country (e.g., Cude 2002, Ehinger 1993, Holdeman et al 2003). Most parameters measured in the SCMP have seasonal variation, caused by our local climate, which produces comparatively high-water flows and low temperatures in the winter and spring, and lower flows with higher temperatures in the summer and early fall.

The Seasonal Kendall's Test for the Annual Report was computed using Sanitas software from water year 2004 to 2022 (Intelligent Design Technologies, 1998). Starting in water year 2023, R Statistical software with the package "envstats" was used to run the Seasonal Kendall's Test. For most analyses, twelve seasons were designated, starting with the beginning of each month. This approach was recommended in the review of the SCMP by the WRC. Observations below detection limits were replaced with one-half of the detection limit based on the Sanitas software user manual. Missing data is ignored data, so no accommodation for absent data was necessary.

The SCMP completes trends analysis via the Seasonal Kendall's Test for 18 key parameters at each sampling location. The parameters tested include pH, DO, DO percent saturation, temperature, turbidity, FC, NH_3, NO_3^-+NO_2^-, TP, OP, TKN, and TSS. Temperature data from biweekly sampling visits are used for this analysis instead of continuous data collected during the summer months because the test is not designed for summer-only data. Skagit County continues to examine methods for determining trends in the continuous temperature data. Since the temperature data from bi-weekly visits are collected at the same time of day for any individual station, the trends analysis should not be biased by differences caused by sampling time of day.

Several sites have extended dry periods during most summers and/or are flooded during high water events and are not sampled. The Sanitas trends analysis program is unable to compute trends based on 12 seasons for those sites due to the consistent lack of data for the dry or flooded periods. For those sites, trends were calculated based on four seasons, beginning in January, April, July, and October. All trend analyses on nutrient data mentioned above are also performed using four seasons, as these are only sampled quarterly.

Three time periods are analyzed for trends: the full SCMP data from the start of the program in 2003, the most recent ten years of data, and the most recent five years of data. Analyzing trends over three different timeframes allows a more detailed picture of what changes have been occurring across the county. For example, a creek may exhibit a small trend in increasing DO from ten years ago as compared to now, but it may also show a strong trend in decreasing DO from five years ago as compared to now. Analyzing a combination of time periods reveals a clearer picture of what is happening than can be ascertained from a single trend over the course of the program.

Data used for the Seasonal Kendall's Test can be subject to autocorrelation, where each successive datum is correlated with the previous point. This situation usually occurs when samples are collected more frequently than monthly. For the SCMP, DO, temperature, and FC data are collected biweekly. Tests are available to detect autocorrelation, but in some cases may be confounded by the very seasonality we

are trying to accommodate. Our approach for these parameters has been to conduct the analysis using all data and repeat the analysis using monthly averages to avoid autocorrelation. In the cases where there are differences, it would probably be prudent to use the monthly averages.

2.3.2. Water Quality Standards

Washington state has established water quality standards for multiple parameters measured in the SCMP (WAC 173-201A-200). These standards differ for each site depending on how the water is used and the impact the parameter has on aquatic life. Table 4, Table ***5***, and Table ***6*** outline which standards apply to which sites. All the SCMP sites are assessed for compliance with DO and EC state standards. The 23 sites where the continuous temperature loggers are deployed are assessed for temperature state standards.

Washington State uses the highest 7-day average of the daily maximum water temperatures (7DADMax) to determine temperature compliance. Continuous temperature measurements over the warmest parts of the year are required to assess this standard.

For DO levels, Washington state determines compliance based on the minimum concentration recorded throughout the day. Although continuous DO measurements aren't collected in the SCMP, the discrete measurements collected can still indicate whether a site is likely to have met or not met the standard. This standard can be assessed by DO concentrations measured in mg/L or percent saturation.

The *E. coli* standard for Washington state has two components. The *E. coli* results within a sample period must have a geometric mean (geomean) below 100 MPN/100 mL. Additionally, no more than 10% of the samples can be greater than 320 MPN/100 mL.

Table 4. State water quality standards for the core summer salmon habitat waterbodies and the SCMP sites these standards apply to.

Core Summer Salmon Habitat Standards	
Temperature (7DADMax)	16.0°C
Dissolved Oxygen (1-day minimum)	10.0 mg/L or 95% saturation
E. coli	Geometric mean of 100 MPN/100mL with less than 10% of the samples greater than 320 MPN/100mL

Sites Standards Apply to	
6*	Friday Creek
8	Swede Creek
11*	Upper Samish River
12	Lower Nookachamps Creek
13	Lower East Fork Nookachamps Creek
15	Middle Nookachamps Creek
16*	Upper East Fork Nookachamps Creek
17	Upper Nookachamps Creek
18*	Lake Creek
19*	Lower Hansen Creek
20*	Upper Hansen Creek
21	Lower Coal Creek
22	Upper Coal Creek
23	Wiseman Creek
24	Mannser Creek
25	Red Cabin Creek
29	Skagit River near Mount Vernon
30**	Skagit River near Hamilton
39	Colony Creek
42	Lower Carpenter Creek/Hill Ditch
45	Skagit River, North Fork
46	Skagit River, South Fork
48	Fisher Creek
51	Upper Carpenter Creek/Hill Ditch

*Additional Spawning and Incubation Protection from 2/15 – 6/15 at 13°C
**Additional Spawning and Incubation Protection from 9/1 – 5/15 at 13°C

Table 5. State water quality standards for the salmon, spawning, rearing, and migration waterbodies and the SCMP sites these standards apply to.

Salmon Spawning, Rearing, and Migration Standards	
Temperature (7DADMax)	17.5°C
Dissolved Oxygen (1-day minimum)	10.0 mg/L or 90% saturation
E. coli	Geometric mean of 100 MPN/100mL with less than 10% of the samples greater than 320 MPN/100mL

Sites Standards Apply to	
3	Lower Thomas Creek
4	Upper Thomas Creek
32	Lower Samish River
33	Alice Bay Drainage
34	No Name Slough
36	Edison Slough
37	South Edison Drainage
38	North Edison Drainage
40	Big Indian Slough
41	Maddox Creek/Big Ditch
43	Wiley Slough
44	Sullivan Slough
49	Middle Joe Leary Slough
50	Lower Joe Leary Slough
52	Little Indian Slough

Table 6. State water quality standards for marine waterbodies and the SCMP sites these standards apply to.

Marine	
Temperature (1-day maximum)	*Extraordinary:* 13.0°C *Excellent:* 16.0°C *Good:* 19.0°C *Fair:* 22.0 °C
Dissolved Oxygen (1-day minimum)	*Extraordinary:* 7.0 mg/L *Excellent:* 6.0 mg/L *Good:* 5.0 mg/L *Fair:* 4.0 mg/L
Fecal coliform (expired on 12/31/2020)	Geometric mean of 14 MPN/100mL with less than 10% of the samples greater than 110 MPN/100mL

Sites Standards Apply to	
47	Swinomish Channel

2.3.3. Water Quality Index

The Water Quality Index (WQI) is a tool created by Ecology to assess water quality at a site. It combines various water quality measures, including temperature, DO, pH, turbidity, TSS, FC, and nutrients, and compares these to set standards (Hallock, 2002). A single number from 1 to 100 is calculated, where higher numbers indicate better water quality. We calculate the annual WQI using quarterly data (four site visits), as our nutrient data is collected on this frequency. The most ideal scenario would be to calculate the annual WQI scores from 12 data points instead of four, to capture the full variability between seasons and reduce the chance of skewed results. The annual WQI scores are categorized into one of three concern levels: high concern (score of 0 – 40), moderate concern (score of 41 – 80), and low concern (score of 81- 100).

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