# Skagit County Monitoring Program Annual Report

## Water Year 2023

October 2022 – September 2023

Skagit County Public Works
Natural Resource Division
1800 Continental Place
Mount Vernon, WA 98273

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# Acknowledgements


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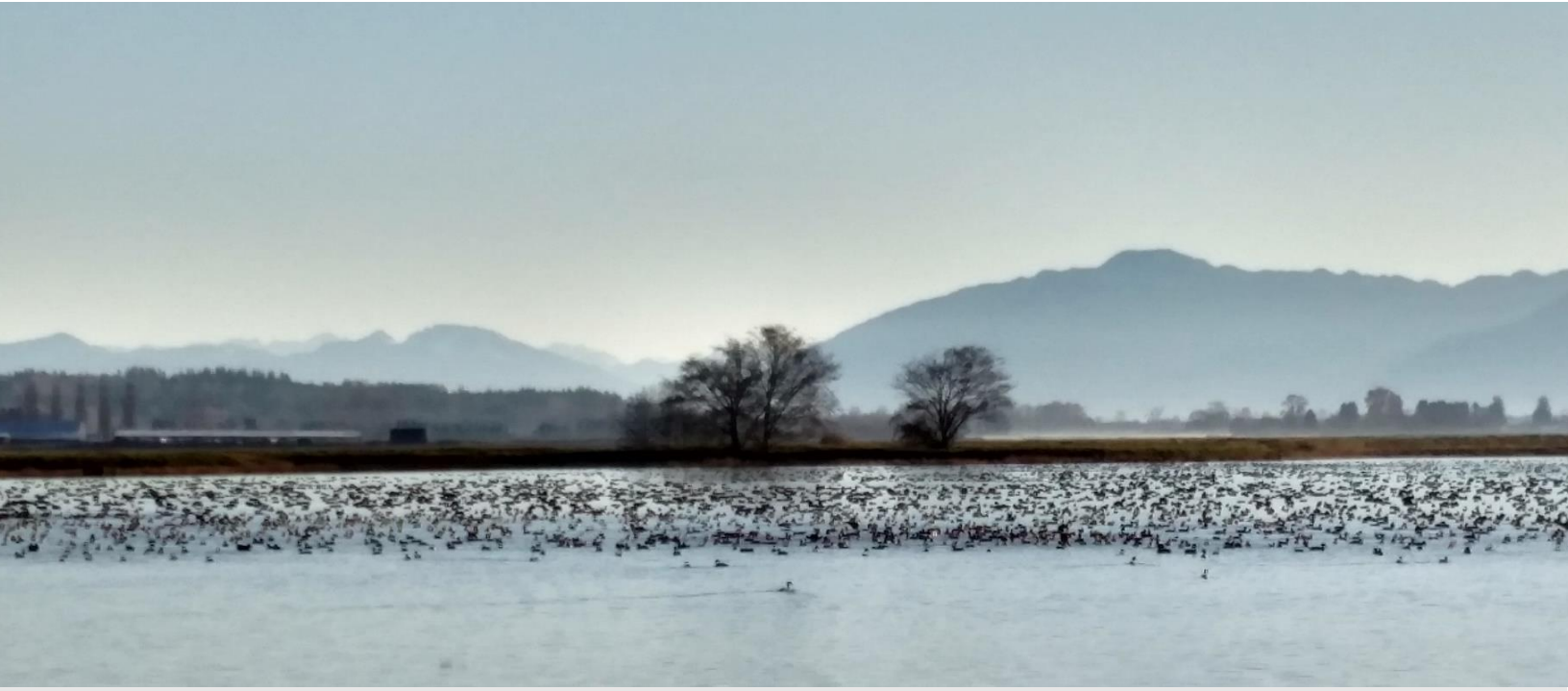
This report is available online at
https://www.skagitcounty.net/Departments/PublicWorksCleanWater/WQmonitoring.htm



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# Executive Summary

The Skagit County Monitoring Program (SCMP) has collected **20 years of water quality data from water years 2004 to 2023**. This report focuses on the most recent SCMP data collected in water year 2023 and includes trend analysis on the complete 20-year dataset.

**Many Skagit County waterways do not meet state water quality standards for temperature, and/or dissolved oxygen**, located both within and outside of agricultural areas. **A higher number of sites passed the *E. coli* state standard**, with 27 out of 40 sites passing (68%) the standard. Most of the substandard water quality occurs in slow-moving agricultural sloughs and in creeks that have low flow in the warmer months.

Based on the Water Quality Index (WQI) results in water year 2023, **11 sites in the SCMP fell into the "highest concern" category (23%). A total of 20 sites were classified in the "moderate concern" category (50%) and 9 were in the "lowest concern" (23%).** Most, but not all, "high concern" sites are agricultural drainages with little summer flow that are not considered salmonid habitat. Seven sites fell from "low" to "moderate concern" in water year 2023 due to warm temperatures, low dissolved oxygen concentrations, and high fecal coliform levels. The Lower Skagit watershed had relatively good water quality this year and had its highest average WQI score yet, while the Samish Bay and Middle Skagit watersheds had relatively low scores.

Trends analyses of water temperature, dissolved oxygen, bacterial concentrations, and other metrics revealed **a mix of improving and worsening water quality at sites and watersheds across the county. Of the significant trends identified, 63% were improvements in water quality over the past 20 years.** Most sites have not had significant changes in temperature. Approximately 39% of the SCMP sites had significant improvements in DO levels over the length of the program, while only 14% had worsening levels. For fecal coliform, about 22% of the sites had improving levels, 28% had worsening levels, and the remaining 50% did not see any significant changes. Most of the improving bacteria levels were found in the Samish Bay and Nookachamps watersheds, while most of the worsening levels were in the Lower Skagit watershed. In general, nitrogen concentrations have improved across the county, however most of the significant phosphorus trends have worsened. The sites with worsening phosphorus levels are generally found in the western portion of the County.

The water quality improvements seen across Skagit County are a result of the hard work and dedication of the residents, farmers, tribes, government, and environmental groups. While progress has been made, more work needs to be done to improve and protect our water resources for future generations to enjoy.

# Introduction

The Skagit County Monitoring Program (SCMP) has collected ambient water quality data in freshwater streams, rivers, and drainages across Skagit County since 2003. The goals of the SCMP are to assess current waterway conditions, analyze long term trends, and to help support other water quality projects in the county. This report focuses on SCMP data collected in water year 2023 (October 1st, 2022 – September 31st, 2023) and includes analysis on the full monitoring dataset collected from 2003 to 2023 (20 years).

Forty sampling sites are currently monitored in the program (Figure 1). Sites are visited every other week on routine sampling routes that are divided into the north or south portions of the county. The SCMP was initially started by Skagit County to evaluate the success of water protection measures required in agricultural areas. Because of this, many sites are located in or surrounding agricultural zoning. Other sites were chosen to provide additional data for various water clean-up efforts in Skagit County. More information on site locations and revisions can be found in the SCMP Backgrounds and Methods document (Skagit County, 2024).

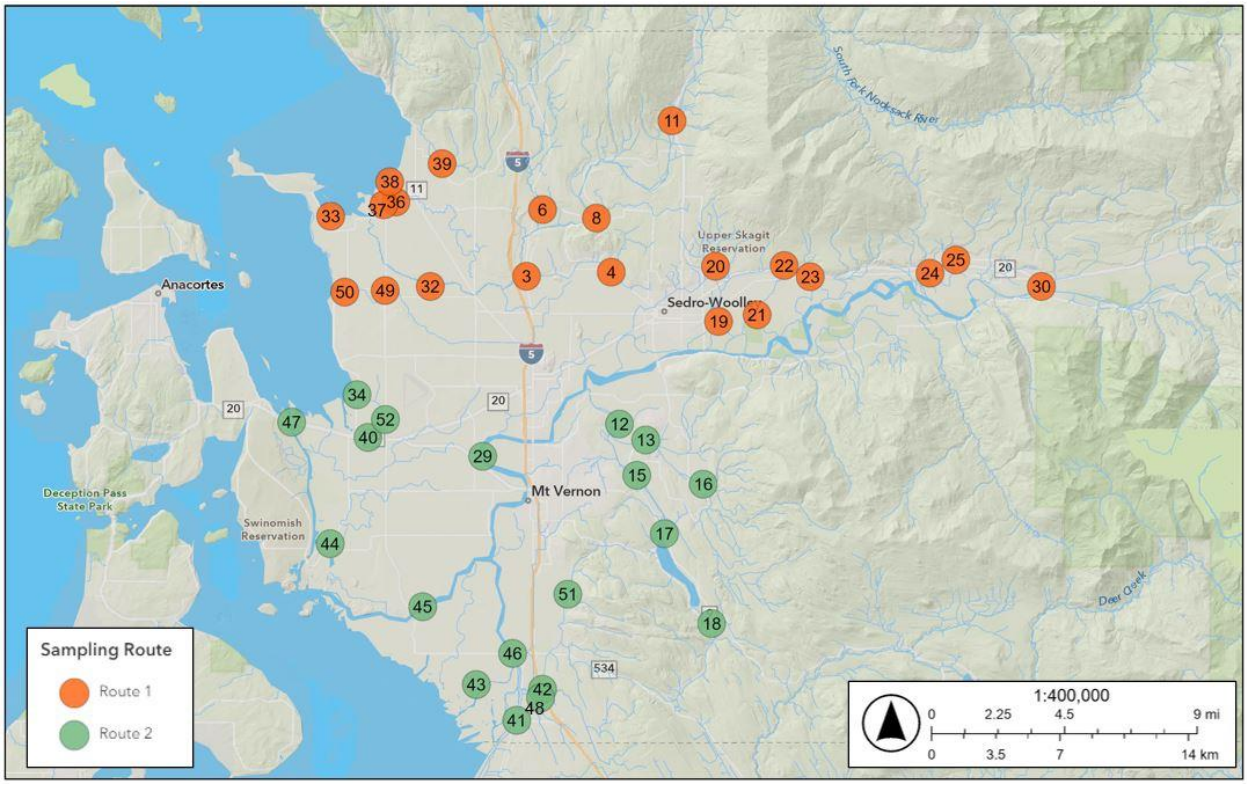



***Figure 1.*** Ambient monitoring sites in the Skagit County Monitoring Program (SCMP).

# Methods

## Sampling and Data Collection

Standard water quality sampling and data collection methods are used in the SCMP. Detailed procedures can be found in the SCMP Quality Assurance Project Plan (QAPP; Skagit County, 2004) and the SCMP Background and Methods document (Skagit County, 2024).

At each site visit, dissolved oxygen (DO), temperature, conductivity, and salinity are measured *in situ* with a water quality probe, and turbidity and pH are measured with instruments in the field. Water samples are also collected for fecal coliform and *Escherichia coli* (*E. coli*) lab analysis at every site visit (Figure 2). On a quarterly basis, additional water samples are collected for nutrient analysis that includes nitrate ($NO_3^-$), nitrite ($NO_2^-$), ammonia ($NH_3$), total Kjeldahl nitrogen (TKN), orthophosphate (OP), total phosphorus (TP), and total suspended solids (TSS).

All ambient sampling trips were completed on schedule during water year 2023. The two sampling routes have been designed so that each station is visited at approximately the same time of day on each visit. Reducing the variation in sampling time minimizes the effects of the diurnal variability observed in many of the water quality parameters. The timing of the site visits in water year 2023 varied no more than 2.5 hours.

***Figure 2.*** Sampling the Skagit River near Hamilton.

Over the summer, continuous temperature loggers are deployed at 23 of the monitoring sites to determine compliance with state temperature standards. Sites were prioritized for logger deployment based on fish presence, historical temperature data, and other factors. Most of the agricultural drainages and sloughs that are not considered salmonid habitat did not have loggers deployed. The loggers are normally deployed June through September and are set to record temperature every 30 minutes.

Of the 23 data loggers installed in water year 2023, one logger was unable to be retrieved on the lower Samish River (Site 32) due to high water flows. Additionally, two loggers, located at Mannser (Site 24) and lower Thomas Creeks (Site 3), had incomplete datasets because the loggers were out of the water for a portion of the summer due to low flows. These sensors did not likely capture the highest 7-day average of the daily maximum temperatures (7-DADMax) that is required to determine compliance with state standards.

The full SCMP dataset from water years 2004 – 2024 is available upon request.

### Data Quality

The SCMP operates under a QAPP approved by Washington State Department of Ecology (Ecology) that details quality control and assurance procedures (Skagit County 2004). Laboratory samples for bacteria and nutrients are analyzed by Edge Analytical of Burlington, WA, an Ecology-certified laboratory.

Duplicate field samples are collected to assess the accuracy and precision of the analytical methods. In water year 2023, the fecal coliform and *E. coli* duplicate results had average relative standard deviations (RSD) of 42% and 47%, respectively. These results did not meet the quality control criteria of 33% RSD set in the QAPP. However, these RSDs are consistent with the average RSDs observed over the past 20 years of bacteria data collection. The nutrient duplicates analyzed for total phosphorus, orthophosphate, nitrate, and ammonia met the 10% RSD quality control criteria.

### Data Analysis

Summary statistics for each parameter at every site can be found in *Appendix A* and *Appendix B*. These statistics offer a general overview of the current and historical water quality at each station. To assess long term trends, the Seasonal Kendall's Test was used. This test is designed to determine overall trends in water quality for parameters that vary seasonally, like temperature and DO. Detailed results from all the Seasonal Kendall's tests run, including p-values and slopes, can be found in *Appendix C*. Trend analysis was not completed on the sites added in water year 2022 (Sites 49, 50, 51, and 52) due to insufficient data of less than five years. Similarly, trends for *E. coli* were not assessed as five years of data have not yet been collected.

Statistics from the full 20 years of data are focused on in this report. The previous ten- and five-year periods were also analyzed to provide a more detailed understanding of changes across the county but are not presented in this report for simplicity. All the statistical results are available in *Appendix C.* For some parameters, statistics were analyzed using both monthly averages and individual results from each site visit. Monthly averages reduce the probability of autocorrelation and are displayed throughout this report when applicable, including the parameters temperature, dissolved oxygen, fecal coliform, and turbidity. The results from individual site visits are also provided in *Appendix C*.

### Improving and Worsening Water Quality Health

In this report, significant trends are classified as either improving or worsening water quality health (Table 1). Increasing trends are classified as worsening water quality health, while decreasing trends are considered improving for all parameters other than DO and pH. The significant DO trends are classified as the opposite. Both increasing and decreasing pH trends can be harmful when pH measurements move

outside the range of 6.5 to 8.5 units. As these conditions vary by site and to simplify results, significant pH trends are not considered improving or worsening water quality health.

***Table 1.*** Classifications on whether significantly increasing ( ↗ ) or decreasing ( ↘ ) trends are considered improving or worsening water quality health. pH trends are not classified as either.

| Parameter | Improving Health | Worsening Health |
|---|---|---|
| Temperature | ↘ | ↗ |
| Dissolved Oxygen | ↗ | ↘ |
| Fecal coliform | ↘ | ↗ |
| Turbidity | ↘ | ↗ |
| Ammonia | ↘ | ↗ |
| Nitrate + Nitrite | ↘ | ↗ |
| Total Kjeldahl Nitrogen | ↘ | ↗ |
| Orthophosphate | ↘ | ↗ |
| Total Phosphorus | ↘ | ↗ |
| pH | - | - |

### 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, the impact the parameter has on aquatic life, and the natural conditions of the site. The standards for each site are detailed in the SCMP Background and Methods document (Skagit County, 2024).

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.

The measurements used to determine the compliance with water quality standards can be found in *Appendix D*.

### 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, fecal coliform, and

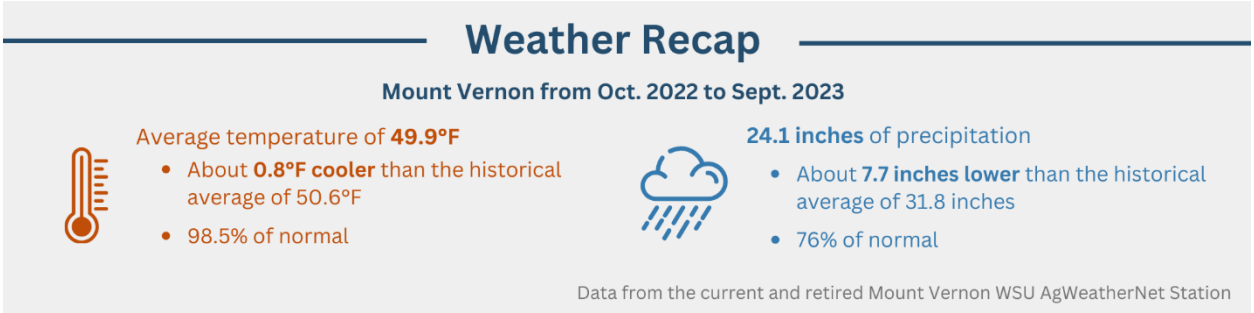
nutrients, and a single number from one to 100 is calculated. A higher number indicates better water quality. We calculate the annual WQI using quarterly data (four site visits), as our nutrient data is collected on this frequency. The most ideal scenario would be to calculate the annual WQI scores from 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 listed below:

| 0 – 40<br>High Concern | 41 – 80<br>Moderate Concern | 81 – 100<br>Low Concern |
|---|---|---|

# Water Year 2023 Overview

## Water Year Conditions

Changes in weather can affect water quality by altering flow patterns, water temperature, and run-off that flows into waterways. Abnormally dry to extreme drought conditions were experienced throughout most of the water year, with the most severe drought levels occurring from August through September 2023. Precipitation in Mount Vernon during water year 2023 was only 76% of normal. Despite a good snowpack at the end of winter, the snow quickly melted out during a record-breaking warm May. A combination of the quick melt-out and a warm and dry summer, led to lower-than-normal stream flows during the summer and into September.




## Water Quality Standards

Data collected during this project indicates that many streams and waterways across the County do not meet state standards for temperature, DO, or *E. coli*. No sites passed all three standards where assessed. Of the 20 sites where continuous temperature measurements were successfully measured, only three sites passed. These sites were at upper Thomas Creek, the upper Samish River, and Fisher Creek. Only two out if 40 sites met the state standard for DO. These sites were Wiseman and Red Cabin Creeks, which are both located in the Middle Skagit watershed. The *E. coli* state standard was passed at over half of the sites, with 27 out of 40 sites meeting the standard. The Skagit River and Lower Skagit watershed had the highest percentage of sites passing the *E. coli* standard (100% and 83%, respectively), while the lowest percentage was the Samish Bay watershed (55%).

Waterways not meeting these conditions represent less than ideal conditions for recreation, salmonoid populations, and downstream shellfish resources. Most of the substandard water quality occurs in creeks that have low flow in the warmer months and in slow-moving agricultural sloughs. Some cases may represent natural conditions rather than human-caused problems. More details about which sites met the standards can be found in the following watershed sections and *Appendix D*.

## Water Quality Index

Based on WQI results in water year 2023, 11 sites in the SCMP fell into the “highest concern” category (28%). Most, but not all, are agricultural drainages with low summer flow that are not considered salmonid habitat. The number of sites classified in this category have changed very little throughout the length of the program, ranging between 8 to 12 sites.

A total of 20 sites were classified in the “moderate concern” category (50%) and 9 were in the “lowest concern” (23%). This year, seven sites dropped from the “lowest concern” category to “moderate concern”. Warm temperatures and low DO concentrations in the early summer contributed to the WQI decline for Friday, lower Hansen, and lower Coal Creeks. For Swede, upper Hansen, Wiseman, and Fisher Creeks, high fecal coliform counts were found during one or multiple sampling events, lowering their overall WQI scores.

Since about 2010, the watersheds in Skagit County have had mostly consistent average WQI scores (Figure 3). The Lower Skagit had relatively good water quality in water year 2023 and had its highest WQI score yet, while the Samish Bay and Middle Skagit watersheds had relatively low scores compared to recent years.

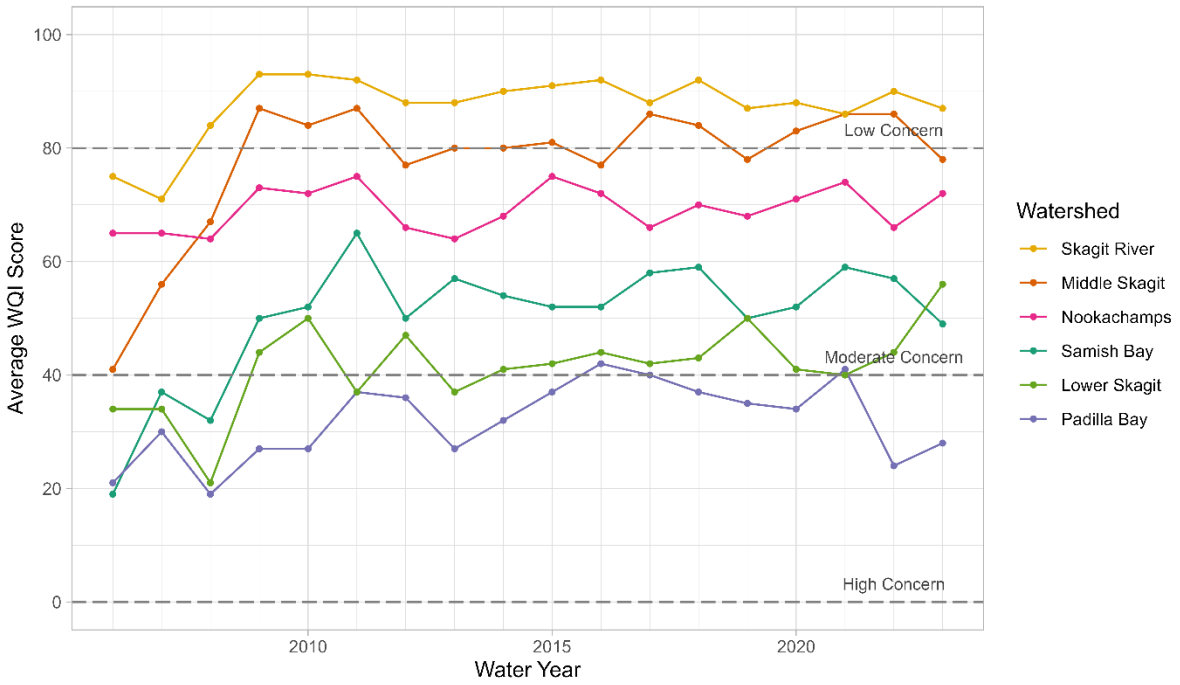



***Figure 3.*** Average Water Quality Index (WQI) scores for each watershed from water year 2005 – 2023.

## Trends

Over the past 20 years of monitoring, most sites and watersheds have had a mix of both improving and worsening water quality trends. All the SCMP sites have seen changes in at least four water quality parameters. Of the significant trends identified, 63% were improvements in water quality. It’s important to note that parameters without significant trends may be continuing to sustain good water quality or the opposite and with poor water quality. Additionally, the amount of change observed is not generally discussed in this report but can be found in *Appendix C* by comparing the slopes of significant trends.

Most sites did not have significant changes in temperature over the length of the program (Figure 4). Three of the four sites that did see significant warming trends are in the Middle Skagit watershed. These temperature trends are based on the discrete measurements collected at each site visit around the same time of day.

About 39% of the SCMP sites had significant improvements in DO over the past 20 years, while about 14% had worsening conditions. Significant improvements in DO levels were found at three out of the four monitoring sites in the Skagit River. None of the sites in the Padilla Bay watershed had significant changes in DO, indicating the continuation of low levels throughout most of the year.

About half of the sites in the SCMP have had no significant changes in fecal coliform levels over the length of the program, while about one-quarter of the sites had improving bacteria levels and the final quarter had worsening levels. Most of the improvements in fecal coliform were found in the Samish Bay and Nookachamps watersheds and most of the worsening conditions were in the Lower Skagit watershed.

Nearly all the significant trends in nitrogen concentrations ($NH_3$, $NO_3^-$ + $NO_2^-$, and TKN) were decreasing, pointing to improvements in water quality. On the other hand, all the significant changes in phosphorus levels (OP and TP) have increasing concentrations, indicating worsening water quality. Most of the sites with worsening phosphorus levels were in the western portions of the county.

Most sites in the SCMP had decreasing pH trends (67%), indicating more acidic waters than at the beginning of the program. A subset of three sites (8%) had significant pH trends increasing or becoming more basic.

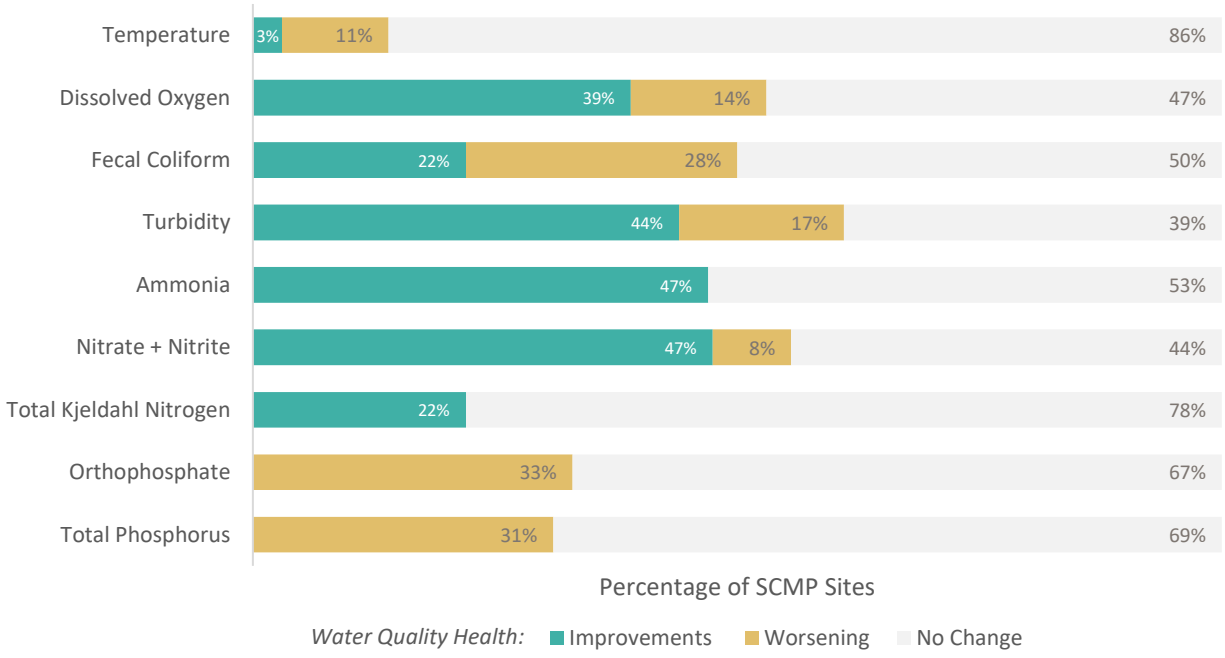



***Figure 4.*** Percentage of sites with trends that show improving, worsening or no significant changes in water quality health.

# Samish Bay Watershed

The Samish Bay watershed is in the northwestern portion of Skagit County and extends north into Whatcom County (Figure 5). The largest subbasins within the watershed are the Samish River and two of its tributaries, Friday, and Thomas Creeks. Other waterways, including Colony Creek, Oyster Creek, and several other drainages and sloughs, also empty into Samish Bay. Most of the lower Samish watershed land is used for agriculture, such as crop farming and cattle operations. The upper watershed is dominated by rural residential uses, with small agriculture and natural resource practices throughout.


Data sources: Dewitz, 2023; ESRI, 2023; WSDA, 2023.

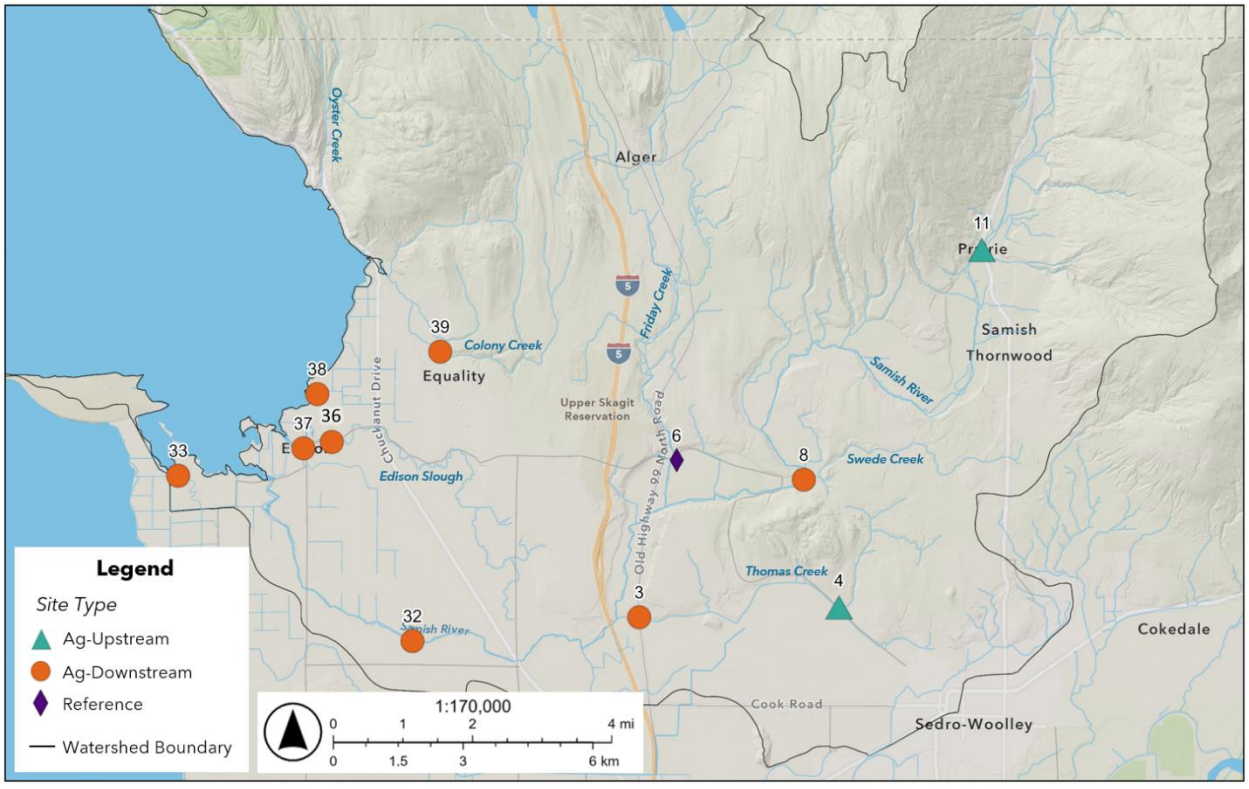



***Figure 5.*** Monitoring sites in the Samish Bay watershed and the site type.

## Current Conditions in WY2023 – Samish Bay Watershed

No sites in the Samish watershed met all three measured water quality standards in water year 2023 (Table 2). The upper Samish River met both the temperature and *E. coli* standards, however, did not meet the DO standard.

Based on WQI scores, four sites were ranked in the "highest concern" category, including lower Thomas Creek, the North and South Edison drainages, and the Alice Bay drainage. The lowest scoring site in the watershed was the South Edison Drainage with a score of 3, which is also the lowest out of all the sites in the SCMP this year. The lower Samish River had the highest WQI in the Samish Bay watershed with a score of 89, placing it in "lowest concern" category.

Friday, Swede, lower Thomas, and Colony Creeks had poor water quality this year when compared to previous years. These sites dropped between 17 to 24 WQI points from water year 2022 to 2023. These lower scores are due to a combination of warm temperatures and low DO concentrations in the summer, and high fecal coliform levels at one or more sampling events.

***Table 2.*** Site compliance with state water quality standards and water quality index (WQI) scores in the Samish Bay watershed in water year 2023. Sites are organized upstream to downstream along the Samish River and then north to south for the remaining sites.

| Site | Waterbody | Temperature Standard (7DADMax) | Dissolved Oxygen Standard | *E. coli* Standard | WQI Score |
|---|---|---|---|---|---|
| 11 | Upper Samish River | ✓ | X | ✓ | 72 |
| 8 | Swede Creek | X | X | ✓ | 63 |
| 6 | Friday Creek | X | X | ✓ | 71 |
| 4 | Upper Thomas Creek | ✓ | X | X | 64 |
| 3 | Lower Thomas Creek | -* | X | ✓ | 29 |
| 32 | Lower Samish River | -* | X | ✓ | 89 |
| 39 | Colony Creek | X | X | ✓ | 47 |
| 38 | North Edison Drainage | - | X | X | 16 |
| 36 | Edison Slough | - | X | X | 53 |
| 37 | South Edison Drainage | - | X | X | 3 |
| 33 | Alice Bay Drainage | - | X | X | 34 |

*Unable to retrieve logger or an incomplete dataset.
For further details see Appendix D.

| ***Legend*** | | | | |
|---|---|---|---|---|
| *Water Quality Standards:* | ✓ Passed | X Failed | - Not measured | |
| *WQI Scores:* | Highest Concern (0 – 40) | Moderate Concern (41 – 80) | Lowest Concern (81 – 100) | |

## Long Term Trends – Samish Bay Watershed

Over the past 20 years most trends in the Samish Bay watershed showed improvements in water quality (Table 3). None of the sites in this watershed had any significant changes in temperature. DO concentrations significantly improved at Friday Creek, upper Thomas Creek, and the upper and lower Samish River. Most of the significant fecal coliform trends were improvements found in Swede, upper Thomas, and Colony Creeks, while the South Edison Drainage and Edison Slough have worsened. Upper Thomas Creek had the greatest improvement of fecal coliform in the SCMP. Nitrogen concentrations ($NH_3$, $NO_3^-$ + $NO_2^-$, and/or TKN) improved at all the sites other than the North Edison Drainage. Significant phosphorus trends showed worsening water quality, which were generally located in the lower portions of the watershed associated with agriculture. Most pH trends in the watershed were decreasing or acidifying, other than the upper and lower Samish River sites.

Notably, the two Samish River sites only had all improving water quality trends over the past 20 years. The drainages and sloughs near Edison (Sites 37, 36, 38, 33) had a greater proportion of worsening trends when compared to those further upstream in the watershed.

***Table 3.*** Trend analysis results for sites in the Samish Bay watershed over the past 20 years. Sites are organized upstream to downstream along the Samish River and then north to south for the remaining sites.

| Site | Waterbody | Temp. | DO | FC | Turb. | Amm-onia | Nitrate + Nitrite | TKN | Ortho-phos. | Total Phos. | pH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | - | - | ↘ | - | ↘ | ↘ | - | ↗ | - | ↘ |
| 38 | North Edison Drainage | - | ↘ | - | ↘ | - | ↗ | - | ↗ | ↗ | ↘ |
| 36 | Edison Slough | - | - | ↗ | - | ↘ | - | ↘ | ↗ | ↗ | ↘ |
| 37 | South Edison Drainage | - | - | ↗ | ↘ | - | - | - | ↗ | - | ↘ |
| 33 | Alice Bay Drainage | - | - | ↘ | ↘ | ↘ | - | - | ↗ | - | ↘ |

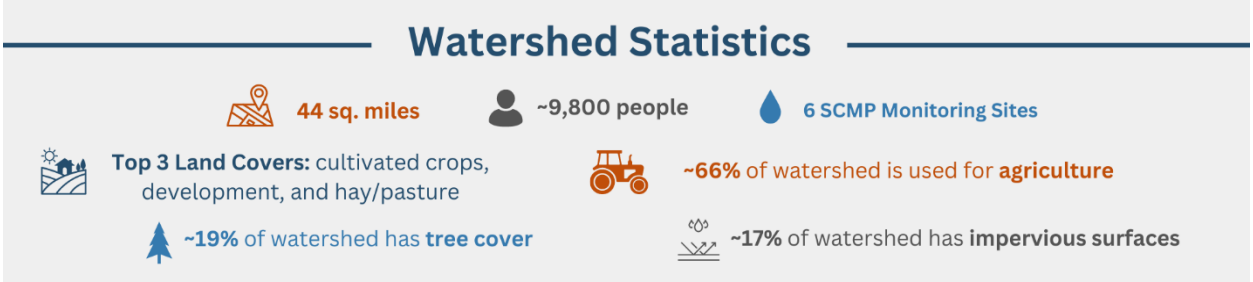
Temp. = Temperature, DO = Dissolved oxygen (mg/L), FC = Fecal coliform, Turb. = Turbidity, TKN = Total Kjeldahl Nitrogen, Ortho-Phos. = Orthophosphate, Total Phos. = Total phosphorus. For further details see Appendix C.

| ***Legend*** | | | | |
|---|---|---|---|---|
| | *Water Quality Health:* | | Improving | Worsening |
| | *Trends:* | ↗ Increasing | ↘ Decreasing | - Not significant | No stats run |

# Padilla Bay Watershed

The Padilla Bay watershed is located directly south of the Samish Bay watershed in the northwest portion of Skagit County (Figure 5). Extensive diking and drainage have taken place in the watershed to make it suitable for settlement and agricultural development. The four major waterways in the Padilla Bay watershed are Joe Leary, No Name, Big Indian, and Little Indian Sloughs. Many agricultural and water management ditches flow into these sloughs. The watershed is primarily used for commercial agriculture, rural residences, and includes several large industrial areas including the Port of Skagit.

The marine reference site in the Swinomish Channel has also been included in this watershed as it exchanges with Padilla Bay. Data at this site is collected from surface water at a boat launch, so the bottom water and center of the channel could have differing results.




Data sources: Dewitz, 2023; ESRI, 2023; WSDA, 2023.

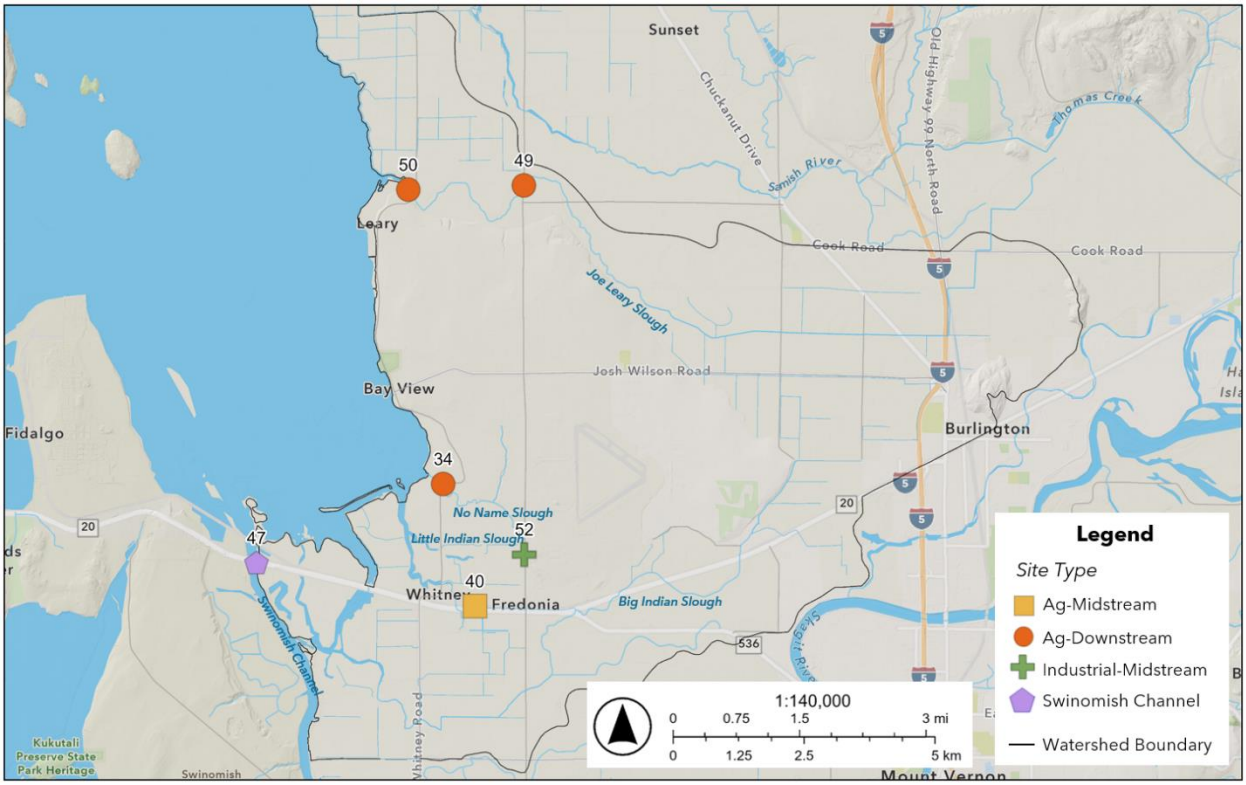



***Figure 6.*** Monitoring sites in the Padilla Bay watershed and the site type.

## Current Conditions in WY2023 – Padilla Bay Watershed

Table 4 outlines which sites met the state water quality standards of temperature, DO, and *E. coli,* and each site's WQI score in water year 2023. No continuous temperature loggers were deployed in the Padilla Bay watershed. Based on the discrete temperature measurements collected throughout the water year, it is very unlikely that these waterways would pass the temperature standard. The sloughs that flow into Padilla Bay did not meet the state water quality standard for DO in water year 2023. The *E. coli* standard was met at Big Indian Slough and both Joe Leary Slough sites.

All the sloughs in the Padilla Bay watershed were ranked in the "highest concern" category based on WQI scores. Little Indian Slough had the lowest with a WQI score of 5, followed by middle Joe Leary Slough with a score of 8. Excluding the Swinomish Channel, the highest WQI score in the watershed was No Name Slough with a score of 37.

Because the Swinomish Channel is a marine site, it has different state standards than the freshwater sites. These standards are ranked on a scale from "fair" to "extraordinary" quality. The Swinomish Channel met the state water quality standard under the "excellent" category with a minimum DO concentration greater than 6.0 mg/L, but less than 8.0 mg/L. The WQI was created for freshwater sites, however, a WQI score was calculated for the Swinomish Channel site for reference and to identify changes. The Swinomish Channel had the highest WQI score in the watershed, with a score of 70.

***Table 4.*** Site compliance with state water quality standards and water quality index (WQI) scores in the Padilla Bay watershed in water year 2023. The sites are organized from north to south.

| Site | Waterbody | Temperature Standard (7DADMax) | Dissolved Oxygen Standard | *E. coli* Standard | WQI Score |
|---|---|---|---|---|---|
| 49 | Middle Joe Leary Slough | - | X | ✓ | 8 |
| 50 | Lower Joe Leary Slough | - | X | ✓ | 32 |
| 34 | No Name Slough | - | X | X | 37 |
| 52 | Little Indian Slough | - | X | X | 5 |
| 40 | Big Indian Slough | - | X | ✓ | 18 |
| 47 | Swinomish Channel | - | *Excellent* | - | 70 |

For further details see Appendix D.

| ***Legend*** | | | | |
|---|---|---|---|---|
| *Water Quality Standards:* | ✓ Passed | X Failed | - Not measured | |
| *WQI Scores:* | Highest Concern (0 – 40) | Moderate Concern (41 – 80) | Lowest Concern (81 – 100) | |

## Long Term Trends – Padilla Bay Watershed

Only three sites in the Padilla Bay watershed were analyzed for trends: No Name Slough, Big Indian Slough, and the Swinomish Channel (Table 5). The sites on Little Indian and Joe Leary Sloughs have only been monitored for two water years and additional data collection is needed to complete accurate trend analysis.

No Name Slough saw the greatest number of changes across the 20-year timespan in the SCMP, however it had a combination of both improving and worsening water quality health. The improving parameters included DO, fecal coliform, turbidity, and nitrogen levels. The worsening parameters included temperature and phosphorus levels. The pH trend in No Name Slough was significantly decreasing or acidifying.

Big Indian Slough was found to have improvements in turbidity levels and nitrogen concentrations. However, the site had worsening trends for fecal coliform and phosphorus levels. A significantly decreasing or acidifying pH trend was also found at Big Indian Slough.

Swinomish Channel generally has had worsening water quality health over the past 20 years, with increasing levels of fecal coliform, nitrate + nitrite, orthophosphate, and total phosphorus concentrations increasing. The one trend indicating improving water quality was declining concentrations of ammonia. Swinomish Channel also had a significantly decreasing trend in pH, indicating more acidic waters.

***Table 5.*** Trend analysis results for sites in the Padilla Bay watershed over the past 20 years. The sites are organized from north to south.

| Site | Waterbody | Temp. | DO | FC | Turb. | Amm-onia | Nitrate + Nitrite | TKN | Ortho-phos. | Total Phos. | pH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 49 | Middle Joe Leary Slough | | | | | | | | | | |
| 50 | Lower Joe Leary Slough | | | | | | | | | | |
| 34 | No Name Slough | ↗ | ↗ | ↘ | ↘ | ↘ | ↘ | ↘ | ↗ | ↗ | ↘ |
| 52 | Little Indian Slough | | | | | | | | | | |
| 40 | Big Indian Slough | - | - | ↗ | ↘ | ↘ | ↘ | ↘ | - | ↗ | ↘ |
| 47 | Swinomish Channel | - | - | ↗ | - | ↘ | ↗ | - | ↗ | ↗ | ↘ |

Temp. = Temperature, DO = Dissolved oxygen (mg/L), FC = Fecal coliform, Turb. = Turbidity, TKN = Total Kjeldahl Nitrogen, Ortho-Phos. = Orthophosphate, Total Phos. = Total phosphorus. For further details see Appendix C.

| ***Legend*** | | | | |
|---|---|---|---|---|
| | | *Water Quality Health:* | Improving | Worsening |
| | *Trends:* | ↗ Increasing | ↘ Decreasing | - Not significant | No stats run |

# Middle Skagit Watershed

The Middle Skagit watershed is located between Sedro Woolley and Concrete in central Skagit County (Figure 7). This watershed has many streams and tributaries that feed into the Skagit River. The SCMP monitoring sites are located north of the Skagit River at Red Cabin, Mannser, Wiseman, Coal, and Hansen Creeks. The upland area in the watershed has been managed for timber harvest and the lowland area is dominated by small farms and rural residential development. Many of the creeks in the lowlands have been modified by channelization.

Multiple streams in this watershed run dry in the summer, including Red Cabin and Wiseman Creeks. The lower sections of Coal and Hansen Creeks also run dry during the summer. This was an unusually dry year where many of these streams took longer to start flowing again after summer 2022. The following watershed statistics are based on the portion of the watershed north of the Skagit River.

## Watershed Statistics

**47 sq. miles** | ~4,600 people | **7 SCMP Monitoring Sites**

**Top 3 Land Covers:** forest, hay/pasture, and shrub/herbaceous vegetation

**~19%** of watershed is used for **agriculture**

**~82%** of watershed has **tree cover**

**~7%** of watershed has **impervious surfaces**

Data sources: Dewitz, 2023; ESRI, 2023; WSDA, 2023.

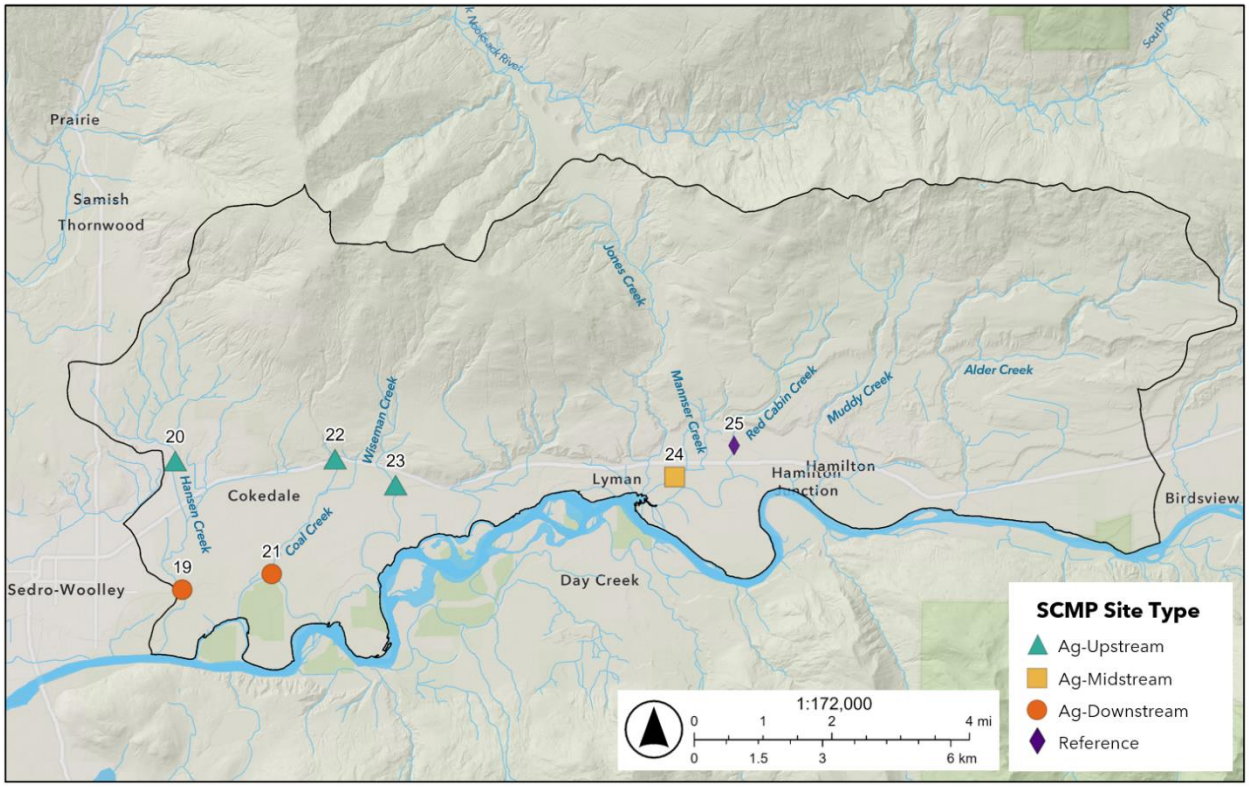



***Figure 7.*** Monitoring sites in the Middle Skagit watershed and the site type.

## Current Conditions in WY2023 – Middle Skagit Watershed

All the sites in the Middle Skagit watershed were assessed for DO and *E. coli* compliance, and a subset of four sites were tested for temperature compliance. Red Cabin Creek met both the DO and *E. coli* state water quality standards in water year 2023 (Table 6). Individual standards were met by Wiseman Creek for DO and by lower Coal Creek for *E. coli*. No sites met the temperature standard.

Based on WQI scores in water year 2023, five sites were ranked in the "moderate concern" category. Mannser Creek ranked the lowest with a score of 65. Compared to last year, Wiseman Creek worsened and dropped 19 WQI points into the "moderately concerned" category. This was caused by high fecal coliform levels in the summer and fall samplings. Red Cabin Creek (a reference site) and upper Coal Creek were both in the category of "lowest concern". No sites in the Middle Skagit watershed were ranked in the "highest concern" category.

***Table 6.*** Site compliance with state water quality standards and water quality index (WQI) scores in the Middle Skagit watershed in water year 2023. The sites are generally organized from east to west.

| Site | Waterbody | Temperature Standard (7DADMax) | Dissolved Oxygen Standard | *E. coli* Standard | WQI Score |
|---|---|---|---|---|---|
| 25 | Red Cabin Creek | - | ✓ | ✓ | 92 |
| 24 | Mannser Creek | -* | X | ✓ | 65 |
| 23 | Wiseman Creek | - | ✓ | X | 74 |
| 22 | Upper Coal Creek | X | X | ✓ | 85 |
| 21 | Lower Coal Creek | X | X | X | 79 |
| 20 | Upper Hansen Creek | X | X | ✓ | 77 |
| 19 | Lower Hansen Creek | X | X | ✓ | 74 |

*Incomplete dataset.

For further details see Appendix D.

| ***Legend*** | | | | |
|---|---|---|---|---|
| *Water Quality Standards:* | ✓ Passed | X Failed | - Not measured | |
| *WQI Scores:* | Highest Concern (0 – 40) | Moderate Concern (41 – 80) | Lowest Concern (81 – 100) | |

## Long Term Trends – Middle Skagit Watershed

The sites monitored in the Middle Skagit watershed had a mixture of both improving and worsening water quality health over the past 20 years (Table 7). Water temperature significantly warmed at Mannser, upper Coal, and lower Hansen Creeks. Interestingly, DO concentrations also increased at Mannser Creek, despite the inverse relationship between temperature and oxygen. Red Cabin and upper Hansen Creek also saw improvements in DO concentrations. Nitrate + nitrite was the only nutrient parameter to have significant trends. These trends were improvements found in Wiseman Creek, lower Coal Creek, and upper and lower Hansen Creek. Nearly all the sites in the watershed also had a decreasing or acidifying pH trend.

Upper Hansen and lower Coal only had improving water quality trends. Lower Hansen Creek had worsening trends for both temperature and DO.

***Table 7.*** Trend analysis results for sites in the Middle Skagit watershed over the past 20 years. The sites are generally organized from east to west.

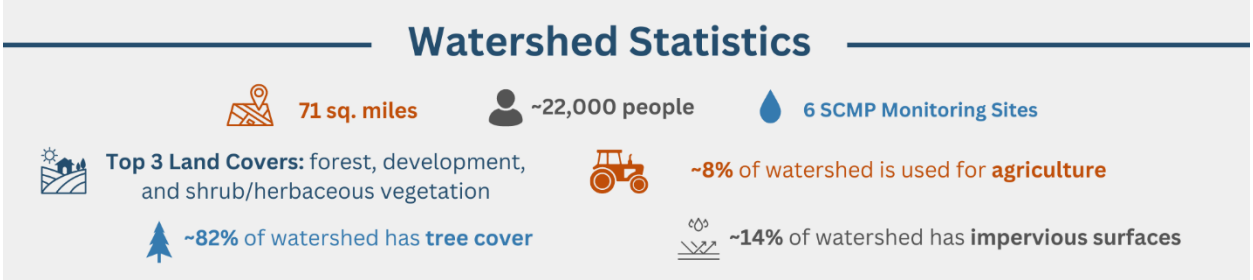
| Site | Waterbody | Temp. | DO | FC | Turb. | Amm-onia | Nitrate + Nitrite | TKN | Ortho-phos. | Total Phos. | pH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 25 | Red Cabin Creek | - | ↗ | - | ↗ | - | - | - | - | - | ↘ |
| 24 | Mannser Creek | ↗ | ↗ | - | ↗ | - | - | - | - | - | - |
| 23 | Wiseman Creek | - | - | ↗ | - | - | ↘ | - | - | - | ↘ |
| 22 | Upper Coal Creek | ↗ | - | - | ↘ | - | - | - | - | - | ↘ |
| 21 | Lower Coal Creek | - | - | ↘ | ↘ | - | ↘ | - | - | - | ↘ |
| 20 | Upper Hansen Creek | - | ↗ | - | - | - | ↘ | - | - | - | ↘ |
| 19 | Lower Hansen Creek | ↗ | ↘ | - | ↘ | - | ↘ | - | - | - | ↘ |

Temp. = Temperature, DO = Dissolved oxygen (mg/L), FC = Fecal coliform, Turb. = Turbidity, TKN = Total Kjeldahl Nitrogen, Ortho-Phos. = Orthophosphate, Total Phos. = Total phosphorus. For further details see Appendix C.

| ***Legend*** | | | | |
|---|---|---|---|---|
| | *Water Quality Health:* | Improving | Worsening | |
| | *Trends:* | ↗ Increasing | ↘ Decreasing | - Not significant | No stats run |

# Nookachamps Watershed

The Nookachamps watershed is a main tributary of the lower Skagit River that is located east of Mount Vernon (Figure 8). Nookachamps Creek branches into two main subbasins: the mainstem Nookachamps Creek that routes through Big Lake, and the East Fork Nookachamps Creek that flows further east. The upland areas in the watershed have been managed for timber harvest and the lowland areas in the valley are primarily used by small farms and residential development. Most of the downstream sections of both creeks have been channelized, which has resulted in wide, shallow channels with sparse riparian vegetation. This watershed is an important salmon-producing tributary of the lower Skagit River.




Data sources: Dewitz, 2023; ESRI, 2023; WSDA, 2023.

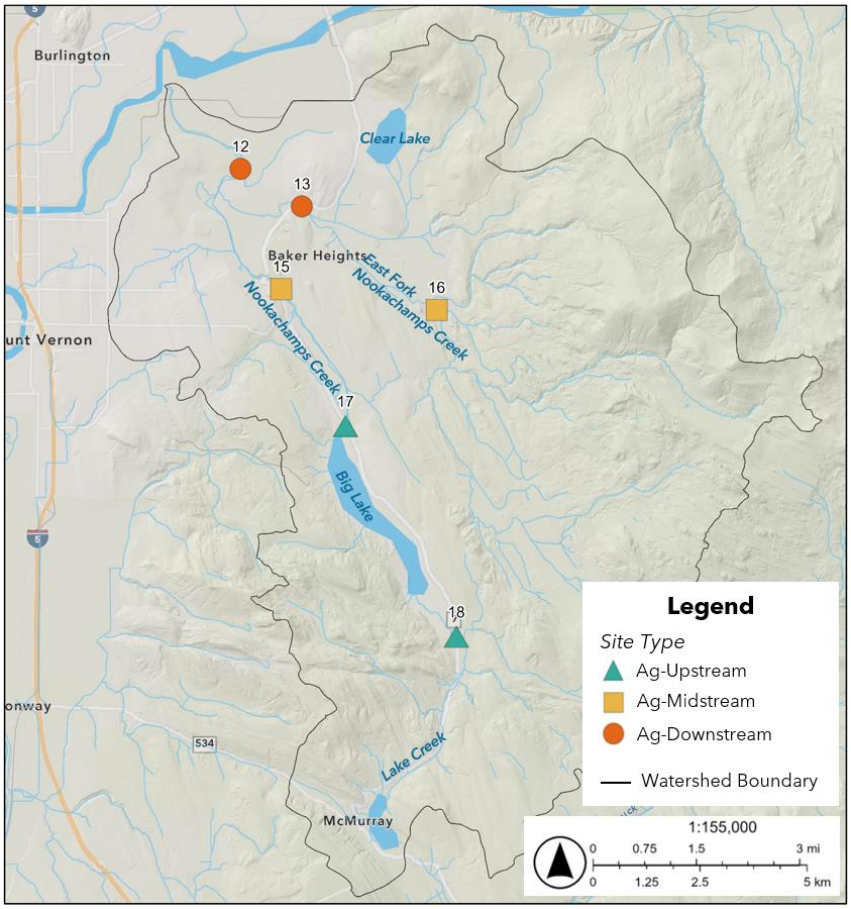



***Figure 8.*** Monitoring sites in the Nookachamps watershed and the site type.

## Current Conditions in WY2023 – Nookachamps Watershed

No sites in the Nookachamps watershed met the temperature or DO state standards in water year 2023 (Table 8). The sites further upstream in the watershed passed the *E. coli* standard, but the lower East Fork Nookachamps and the lower Nookachamps sites did not pass.

The sites furthest upstream in the sub-basins, Lake Creek, and upper East Fork Nookachamps, were ranked in the "lowest concern" category. The four other sites in the watershed were in the "moderate concern" category, with WQI scores ranging from 59 - 72. These scores were about the same as recent years. No sites were ranked in the "highest concern" category.

***Table 8.*** Site compliance with state water quality standards and water quality index (WQI) scores in the Nookachamps watershed in water year 2023. The sites are generally organized from upstream to downstream.

| Site | Waterbody | Temperature Standard (7DADMax) | Dissolved Oxygen Standard | *E. coli* Standard | WQI Score |
|---|---|---|---|---|---|
| 18 | Lake Creek | X | X | ✓ | 93 |
| 17 | Upper Nookachamps Creek | X | X | ✓ | 72 |
| 15 | Middle Nookachamps Creek | X | X | ✓ | 59 |
| 16 | Upper East Fork Nookachamps Creek | X | X | ✓ | 85 |
| 13 | Lower East Fork Nookachamps Creek | X | X | X | 61 |
| 12 | Lower Nookachamps Creek | X | X | X | 61 |

For further details see Appendix D.

| ***Legend*** | | | | |
|---|---|---|---|---|
| *Water Quality Standards:* | ✓ Passed | X Failed | - Not measured | |
| *WQI Scores:* | Highest Concern (0 – 40) | Moderate Concern (41 – 80) | Lowest Concern (81 – 100) | |

## Long Term Trends – Nookachamps Watershed

Most of the Nookachamps watershed had a mixture of improving and worsening water quality health (Table 9). The sites in the Nookachamps watershed did not have any significant changes in temperature over the past 20 years. The lower East Fork Nookachamps and lower Nookachamps both had worsening health in terms of DO. Although, further upstream at the middle Nookachamps and upper East Fork Nookachamps Creek sites, DO trends were improving. Improvements in fecal coliform levels were found at the Lake Creek and the middle Nookachamp Creek sites. The upper Nookachamps Creek site, located near the outlet of Big Lake, has seen worsening turbidity trends and more acidic pH levels since the beginning of the program. Nitrogen levels have improved over the past 20 years at all the sites other than at Lake Creek. Phosphorus levels worsened at the middle and lower Nookachamps Creek sites.

Very little change has been observed at Lake Creek over the past 20 years, with only one improving trend in fecal coliform levels.

***Table 9.*** Trend analysis results for sites in the Nookachamps watershed over the past 20 years. The sites are generally organized from upstream to downstream.

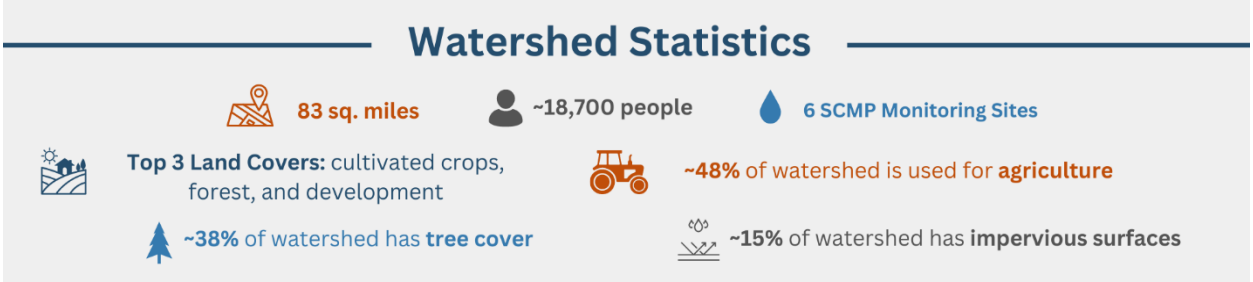
| Site | Waterbody | Temp. | DO | FC | Turb. | Amm-onia | Nitrate + Nitrite | TKN | Ortho-phos. | Total Phos. | pH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 18 | Lake Creek | - | - | ↘ | - | - | - | - | - | - | - |
| 17 | Upper Nookachamps Creek | - | - | - | ↗ | ↘ | - | - | - | - | ↘ |
| 15 | Middle Nookachamps Creek | - | ↗ | ↘ | - | ↘ | - | ↘ | ↗ | ↗ | - |
| 16 | Upper East Fork Nookachamps Creek | - | ↗ | - | - | - | ↘ | - | - | - | ↘ |
| 13 | Lower East Fork Nookachamps Creek | - | ↘ | - | - | ↘ | ↘ | - | - | - | - |
| 12 | Lower Nookachamps Creek | - | ↘ | - | - | ↘ | ↘ | ↘ | ↗ | - | - |

Temp. = Temperature, DO = Dissolved oxygen (mg/L), FC = Fecal coliform, Turb. = Turbidity, TKN = Total Kjeldahl Nitrogen, Ortho-Phos. = Orthophosphate, Total Phos. = Total phosphorus. For further details see Appendix C.

| ***Legend*** | | | | |
|---|---|---|---|---|
| | | | *Water Quality Health:* | Improving / Worsening |
| | *Trends:* | ↗ Increasing | ↘ Decreasing | - Not significant / No stats run |

# Lower Skagit Watershed

The Lower Skagit watershed is a combination of the streams, drainages, and sloughs that flow into the Skagit River or Skagit Bay in southwest Skagit County (Figure 9). The main waterways monitored in the SCMP include Carpenter Creek (Hill Ditch), Fisher Creek, Wiley Slough, and Maddox Creek/Slough (Big Ditch). The upper portions of Carpenter and Fisher Creeks drain the hills located to the east and southeast of the low-lying Skagit plain. We also monitor Sulivan Slough, a drainage that flows into Swinomish Channel and Skagit Bay near La Conner. The creeks and drainages in the Skagit plain are often channelized and diked with little riparian vegetation. Most of the Lower Skagit watershed is used for commercial agriculture and rural residential development.




Data sources: Dewitz, 2023; ESRI, 2023; WSDA, 2023.

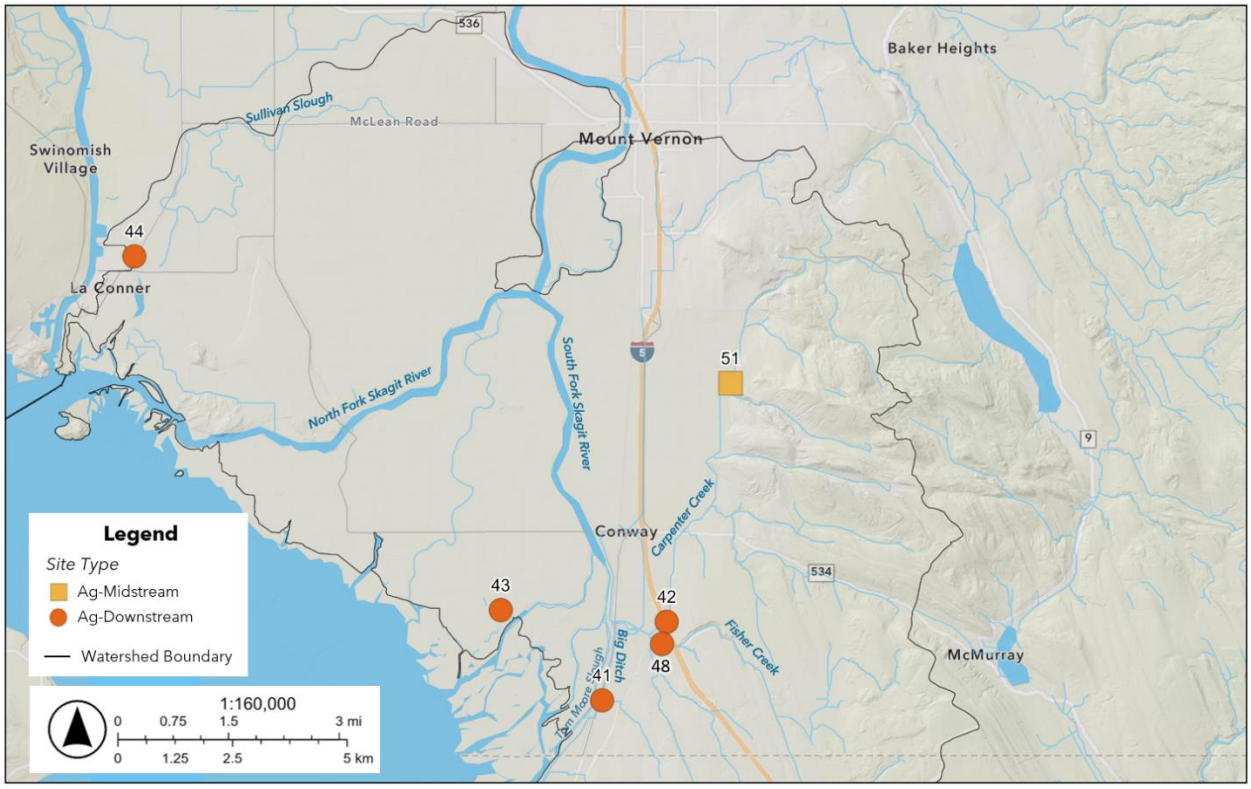



***Figure 9.*** Monitoring sites in the Lower Skagit watershed and the site type.

## Current Conditions in WY2023 – Lower Skagit Watershed

Fisher Creek was the only site in the Lower Skagit watershed that met the state temperature standard in water year 2023 (Table 10). None of the Lower Skagit watershed sites met the DO state standard. All sites, excluding Maddox Slough, met the *E.* coli standard in water year 2023.

The highest WQI score in the Lower Skagit watershed was Fisher Creek, with a score of 80, on upper edge of the "moderate concern" category. Both Carpenter Creek sites and the Wiley Slough site are also ranked in the "moderate concern" category. This was the highest score Wiley Slough has had over the past 20 years. The lowest scoring sites were Maddox and Sullivan Sloughs with scores of 35 and 39, respectively. Despite Sullivan Slough being a low WQI score within the watershed, it was relatively high compared to previous years.

***Table 10.*** Site compliance with state water quality standards and water quality index (WQI) scores in the Lower Skagit watershed in water year 2023. The sites are generally organized from north to south.

| Site | Waterbody | Temperature Standard (7DADMax) | Dissolved Oxygen Standard | *E. coli* Standard | WQI Score |
|---|---|---|---|---|---|
| 51 | Upper Carpenter Creek | - | X | ✓ | 71 |
| 42 | Lower Carpenter Creek/Hill Ditch | X | X | ✓ | 65 |
| 48 | Fisher Creek | ✓ | X | ✓ | 80 |
| 43 | Wiley Slough | - | X | ✓ | 44 |
| 44 | Sullivan Slough | - | X | ✓ | 39 |
| 41 | Maddox Creek/Big Ditch | X | X | X | 35 |

For further details see Appendix D.

| ***Legend*** | | | | |
|---|---|---|---|---|
| *Water Quality Standards:* | ✓ Passed | X Failed | - Not measured | |
| *WQI Scores:* | Highest Concern (0 – 40) | Moderate Concern (41 – 80) | Lowest Concern (81 – 100) | |

## Long Term Trends – Lower Skagit Watershed

Improving and worsening water quality health was observed in the Lower Skagit watershed (Table 11). Data has only been collected at upper Carpenter Creek for two years and additional data collection is needed to complete accurate trend analysis.

Sullivan Slough was the one site in the SCMP that saw significantly cooling temperatures over the past 20 years. Interestingly, Sulivan Slough also had decreasing DO concentrations. The opposite is generally expected due to cooler temperatures having the ability to hold more oxygen. Both lower Carpenter and Fisher Creeks had improving DO trends.

Other than Fisher Creek, all the sites in the Lower Skagit watershed had worsening fecal coliform levels. Turbidity worsened at lower Carpenter, Wiley Slough, and Maddox Creek, but improved at Sullivan Slough. Nitrogen concentrations improved at lower Carpenter Creek, Fisher Creek, and Maddox Creek. Uniquely, the one worsening nitrogen trend in the SCMP, was found at Sullivan Slough with increasing nitrate + nitrite concentrations. Phosphorus concentrations were worsening at most of the sites in the watershed. Most sites had significantly decreasing or acidifying pH trends.

***Table 11.*** Trend analysis results for sites in the Lower Skagit watershed over the past 20 years. The sites are generally organized from north to south.

| Site | Waterbody | Temp. | DO | FC | Turb. | Amm-onia | Nitrate + Nitrite | TKN | Ortho-phos. | Total Phos. | pH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 51 | Upper Carpenter Creek | | | | | | | | | | |
| 42 | Lower Carpenter Creek/Hill Ditch | - | ↗ | ↗ | ↗ | ↘ | - | ↘ | - | - | - |
| 48 | Fisher Creek | - | ↗ | - | - | ↘ | ↘ | ↘ | - | ↗ | ↘ |
| 43 | Wiley Slough | - | - | ↗ | ↗ | - | - | - | - | ↗ | ↘ |
| 41 | Maddox Creek/ Big Ditch | - | - | ↗ | ↗ | ↘ | - | - | ↗ | ↗ | ↘ |
| 44 | Sullivan Slough | ↘ | ↘ | ↗ | ↘ | - | ↗ | - | - | ↗ | ↘ |

Temp. = Temperature, DO = Dissolved oxygen (mg/L), FC = Fecal coliform, Turb. = Turbidity, TKN = Total Kjeldahl Nitrogen, Ortho-Phos. = Orthophosphate, Total Phos. = Total phosphorus. For further details see Appendix C.

| ***Legend*** | | | | |
|---|---|---|---|---|
| | *Water Quality Health:* | | Improving | Worsening |
| | *Trends:* | ↗ Increasing | ↘ Decreasing | - Not significant | No stats run |

# Skagit River

The Skagit River is the largest river that flows into Puget Sound, accounting for approximately one-third of all the fresh water that empties into the estuary. The Skagit River originates in British Columbia, flows across the border into Ross Lake, and continues westward through Skagit County for a total length of 150 miles. The Skagit River watershed encompasses the sub-basins Middle Skagit, Nookachamps, and Lower Skagit focused on in this report. The river supports many wildlife and their habitats, including wild populations of all five salmon species (Chinook, coho, pink, sockeye, and chum) and three species of anadromous trout (bull, steelhead, and chum).

The SCMP monitors four sites on the Skagit River, ranging as far upstream as Hamilton to downstream locations in the North and South Forks (Figure 10). The Skagit River data collected in the SCMP is not a comprehensive analysis of the river's health but can be used as indicators for further investigation. The water quality data and samples are collected from the banks of the river near the surface, so the thalweg and deeper depths could have differing results than those we recorded.


***Figure 10.*** Monitoring sites on the Skagit River.

## Current Conditions in WY2023 – Skagit River

The Skagit River at Hamilton and the North Fork did not meet the state temperature standards in water year 2023 (Table 12). None of the Skagit River sites met the state DO standard, while all the sites met the *E. coli* state standard.

In water year 2023, all four Skagit River sites were categorized in the "lowest concern" category based on WQI scores. The highest scoring site was the North Fork with a score of 93, which is the highest scoring site in the SCMP this year. The three other sites had WQI scores of 85.

***Table 12.*** Site compliance with state water quality standards and water quality index (WQI) scores on the Skagit River in water year 2023. The sites are organized from upriver to downriver.

| Site | Waterbody | Temperature Standard (7DADMax) | Dissolved Oxygen Standard | *E. coli* Standard | WQI Score |
|---|---|---|---|---|---|
| 30 | Skagit River near Hamilton | X | X | ✓ | 85 |
| 29 | Skagit River near Mount Vernon | - | X | ✓ | 85 |
| 45 | North Fork Skagit River | X | X | ✓ | 93 |
| 46 | South Fork Skagit River | - | X | ✓ | 85 |

For further details see Appendix D.

| ***Legend*** | | | | |
|---|---|---|---|---|
| *Water Quality Standards:* | ✓ Passed | X Failed | - Not measured | |
| *WQI Scores:* | Highest Concern (0 – 40) | Moderate Concern (41 – 80) | Lowest Concern (81 – 100) | |

## Long Term Trends – Skagit River

The Skagit River sites have had very few significant trends and have changed very little over the past 20 years (Table 13). The few significant trends were primarily water quality improvements. DO concentrations increased at three of the four Skagit River sites, with the one exception at the site near Mount Vernon. Additionally, turbidity levels at all the Skagit River sites have significantly improved.

The one trend indicating worsening water quality was increases in fecal coliform levels at the South Fork site. Decreasing or acidifying pH levels were found at the site near Mount Vernon, while further downstream at the North Fork site, pH levels were found to be increasing or becoming more basic.

Based on our discrete temperature measurements, there were no significant changes in temperature at the Skagit River sites over the past 20 years. Nitrogen and phosphorus concentrations also did not change significantly at any of the sites on the Skagit River since the beginning of the program.

***Table 13.*** Trend analysis results for sites on the Skagit River over the past 20 years. The sites are organized from upriver to downriver.

| Site | Waterbody | Temp. | DO | FC | Turb. | Amm-onia | Nitrate + Nitrite | TKN | Ortho-phos. | Total Phos. | pH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | Skagit River near Hamilton | - | ↗ | - | ↘ | - | - | - | - | - | - |
| 29 | Skagit River near Mount Vernon | - | - | - | ↘ | - | - | - | - | - | ↘ |
| 45 | North Fork Skagit River | - | ↗ | - | ↘ | - | - | - | - | - | ↗ |
| 46 | South Fork Skagit River | - | ↗ | ↗ | ↘ | - | - | - | - | - | - |

Temp. = Temperature, DO = Dissolved oxygen (mg/L), FC = Fecal coliform, Turb. = Turbidity, TKN = Total Kjeldahl Nitrogen, Ortho-Phos. = Orthophosphate, Total Phos. = Total phosphorus. For further details see Appendix C.

| ***Legend*** | | | | |
|---|---|---|---|---|
| | *Water Quality Health:* | | Improving | Worsening |
| | *Trends:* | ↗ Increasing | ↘ Decreasing | - Not significant | No stats run |

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