# Sequim-Dungeness Clean Water District Pollution Identification & Correction Plan Trends Monitoring Program 2022 Report

***Prepared by*:**
**Clallam County Health & Human Services, Environmental Health Section and Clallam County Department of Community Development, Streamkeepers Program**

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## Introduction

In 2001, Clallam County established a shellfish protection district named the Sequim-Dungeness Clean Water District (District, or CWD) by adopting Chapter 27.16 of Clallam County Code (CCC). A map of the CWD is in in Appendix A. The boundaries of the District include "The Dungeness Watershed and those waters influenced by it through the irrigation system, and other independent tributaries to the Strait of Juan de Fuca, from Bagley Creek east to and including the Sequim Bay Watershed." (The boundaries of the District generally coincide with the boundaries of Clallam County's Marine Recovery Area, or MRA, where the County is also required to implement an enhanced Onsite Sewage Management Plan under RCW 70.118A).

State law (RCW 90.72) directs formation of shellfish protection districts where nonpoint pollution threatens water quality "…upon which the continuation or restoration of shellfish farming or harvesting is dependent." By 1997 water quality monitoring had begun to show increasing bacterial pollution in and around Dungeness Bay. In 2000, 2001, and 2003, the Washington State Department of Health downgraded portions of the Dungeness Bay shellfish growing area due to bacterial pollution caused by nonpoint sources within the watershed.

In May 2015, Clallam County Environmental Health, with the assistance of staff and volunteers from Streamkeepers of Clallam County, initiated a Baseline Trends Monitoring Program to track surface water quality in the Sequim-Dungeness Clean Water District. The Pollution Identification & Correction Plan called for this effort for the Sequim Bay-Dungeness Watershed Clean Water District (PIC Plan). Created by PIC Project Partners for the District in 2014, the PIC Plan is one element of the shellfish downgrade response plan for the Sequim-Dungeness Clean Water District. The Baseline Trends Monitoring study area includes major freshwater drainages within the District.

This PIC Trends Monitoring Report covers calendar year 2022. The information gathered through PIC Trends monitoring and presented in annual reports helps guide Pollution Identification and Correction activities within the Clean Water District.

## Sampling Approach and Results

The objective of the Baseline Trends Monitoring Program is to consistently monitor long-term water quality in order to evaluate trends at or near the mouths of waterways throughout the District. This information helps prioritize waterways for further targeted investigation and eventual pollution cleanup as described in the PIC Plan. Further, trends monitoring builds upon at least two decades of prior water quality studies. As in past investigations, water quality parameters associated with human sewage and animal waste such as fecal coliforms and nutrients were used to evaluate the water quality.

Sampling locations were selected as close to the mouths of the streams as practical given ownership, access, and tidal conditions. Twelve streams were designated Tier 1 sites and nine streams were designated Tier 2 sites. Tier 1 sites were sampled monthly as for both fecal coliforms (fecal or FC) and nutrients (nitrate-nitrogen, nitrite-nitrogen, ammonia-nitrogen/NH3), phosphate-phosphorous, silicate-silica, total nitrogen, and total phosphate). Tier 2 sites were sampled quarterly (January, May, August, November) for fecal coliforms only.
In addition to bacteria and nutrients sampling, water temperature and salinity data were recorded at all sample sites. Table 1 describes sites and sampling conducted while Figures 1-3 show sample site locations.

Barometric pressure, dissolved oxygen, pH, specific conductivity, and turbidity data are readily recorded alongside standard in-situ measurements with a YSI Pro-DSS multi-parameter water quality meter. Stream stage is recorded where appropriate reference points exist. Data collection not specifically called for in the Pollution Identification and Correction Quality Assurance Project Plan (QAPP, Bond et al. 2019) is performed following the Streamkeepers Program (SK QAPP, Chadd et al. 2019).

Streamkeepers volunteers Peggy McClure and Linda Sumner collect samples from the Dungeness River for nutrient and fecal coliform analysis.

**Table 1: Site locations and type of sampling performed from January 2022 through December 2022.** Tier 1 sites were sampled monthly as possible for fecal coliforms (F) and nutrients (N). Tier 2 sites were sampled quarterly for fecal coliforms only. Water temperature and salinity data were collected at all sites on every visit. Dung. Bay/R. = Dungeness Bay/River. Seq. Bay = Sequim Bay. SJF = Strait of Juan de Fuca. Cells highlighted in pink lack data for the sampling interval. Reasons for data gaps include: Golden Sands Slough 0.0: January - obstructed culvert, no flow; Sequim Bay State Park Creek 0.0/0.1: January and February - high tide at lower site, upper site not safely accessible; September and October – no flow; Dean 0.17: May – no access.

| | Stream/ Site Name | Receiving Waters | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tier 1 Streams | Dungeness 0.7 | Dung. Bay | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F |
| | Meadowbrook 0.2 | Dung. Bay | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F |
| | Golden Sands Slough 0.0 | Dung. Bay | | F | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F |
| | Cooper 0.1 | Dung. Bay | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F |
| | Cassalery 0.0/ 0.6* | Dung. Bay | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F |
| | Matriotti 0.3a | Dung. R. | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F |
| | Lotzgesell 0.1 | Dung. R. | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F |
| | Sequim Bay State Park Creek 0.0/0.1 * | Seq. Bay | | | F<br>N | F | F<br>N | F | F<br>N | F | | | F<br>N | F |
| | Bell 0.2 | Seq. Bay | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F |
| | Johnson 0.0 | Seq. Bay | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F |
| | Jimmycomelately 0.15 | Seq. Bay | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F | F<br>N | F |
| Tier 2 Streams | Bagley 0.7a | SJF | F | | | | F | | | F | | | F | |
| | Siebert 1.0 | SJF | F | | | | F | | | F | | | F | |
| | Agnew Creek/ Ditch 0.3 | SJF | F | | | | F | | | F | | | F | |
| | McDonald 01.6 | SJF | F | | | | F | | | F | | | F | |
| | Hurd 0.2 | Dung. R. | F | | | | F | | | F | | | F | |
| | Gierin 1.8 | Dung. Bay | F | | | | F | | | F | | | F | |
| | Dean 0.17 | Seq. Bay | F | | | | | | | F | | | F | |
| | No Name 0.03 | Seq. Bay | F | | | | F | | | F | | | F | |
| | Chicken Coop 0.24 | Seq. Bay | F | | | | F | | | F | | | F | |

* Tide Dependent

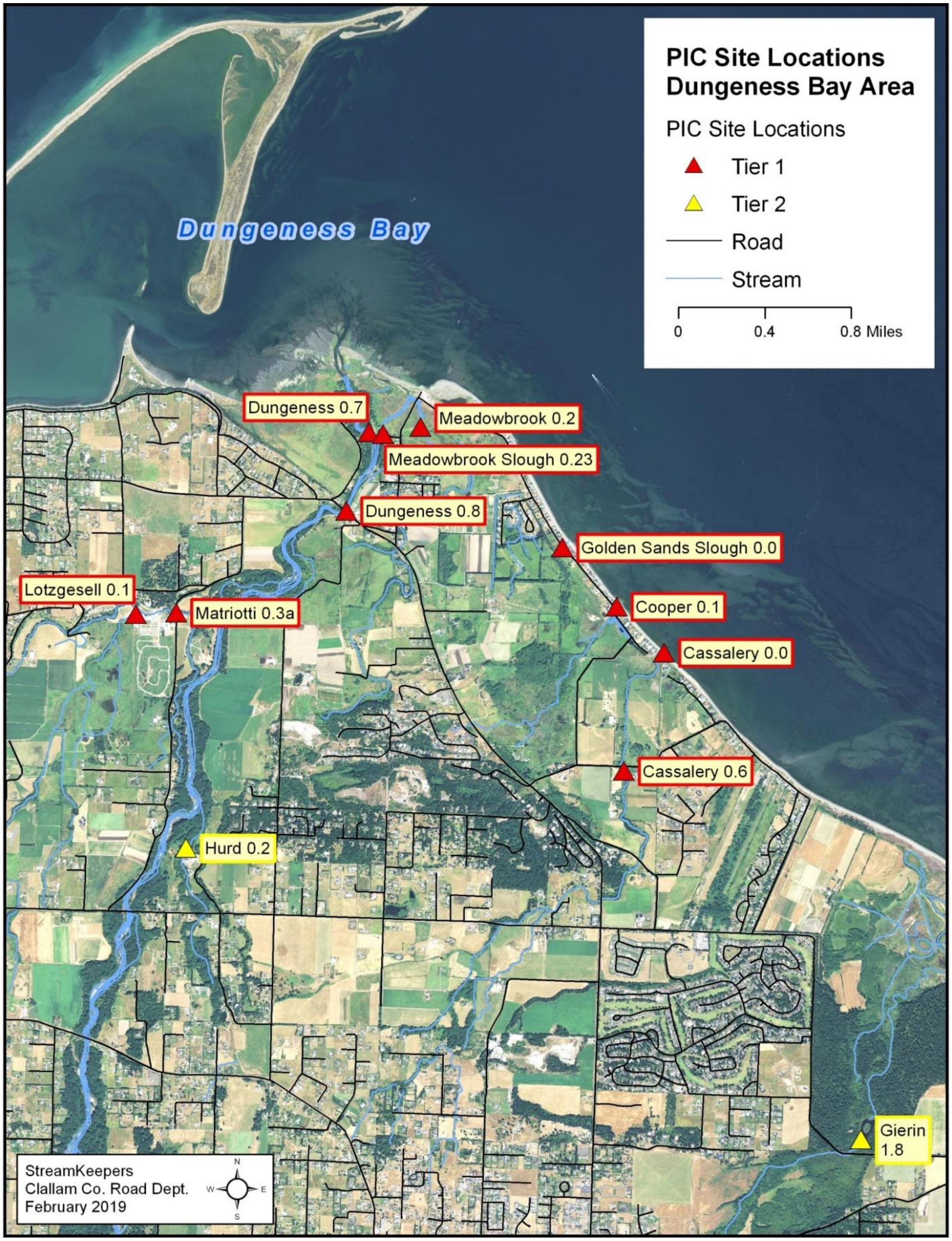


**Figure 1. PIC Baseline Trends Monitoring sample sites, Dungeness Bay area (Washington State Department of Ecology real-time flow meter located at Dungeness 0.8)**

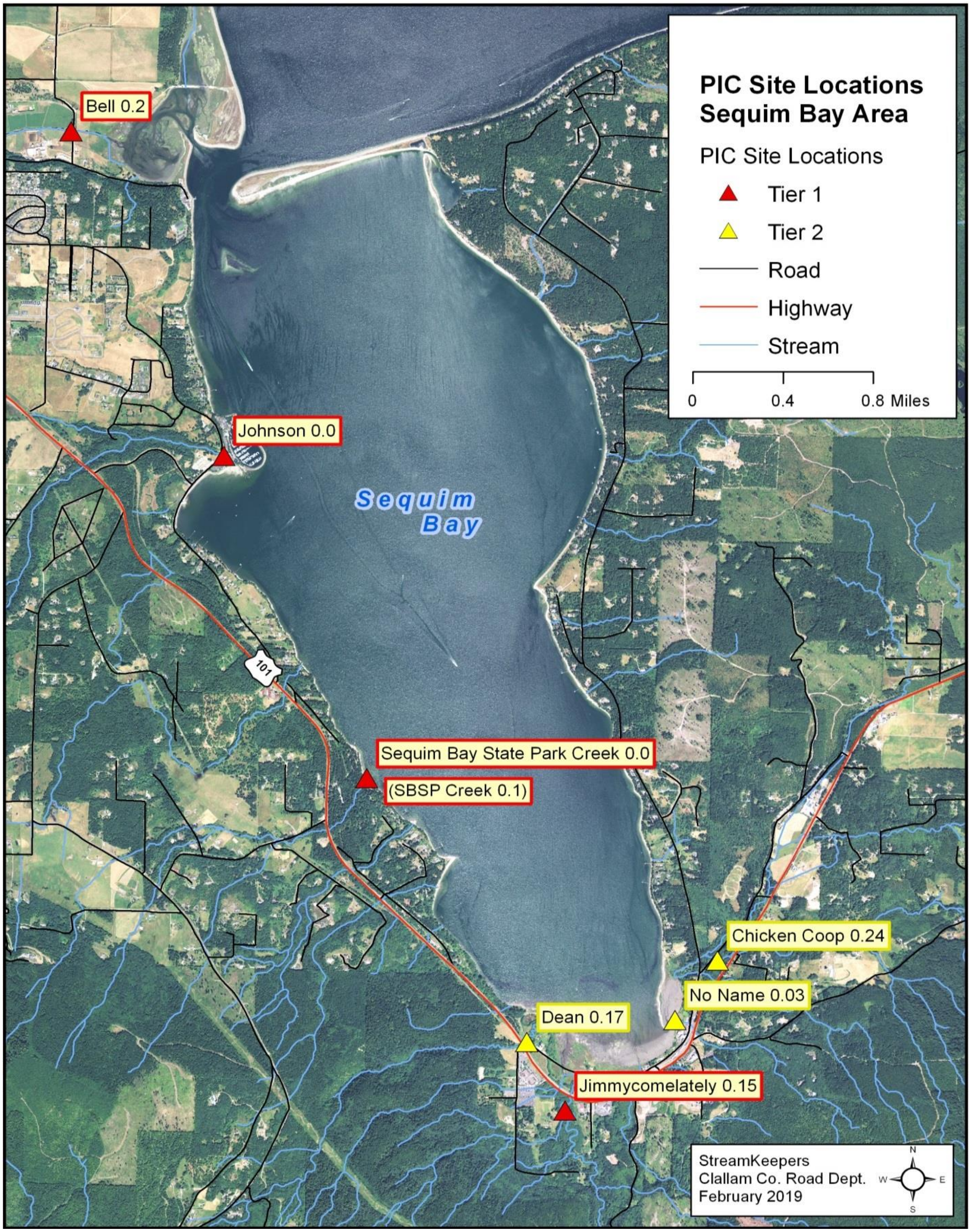


**Figure 2. PIC Baseline Trends Monitoring sample sites, Sequim Bay area**

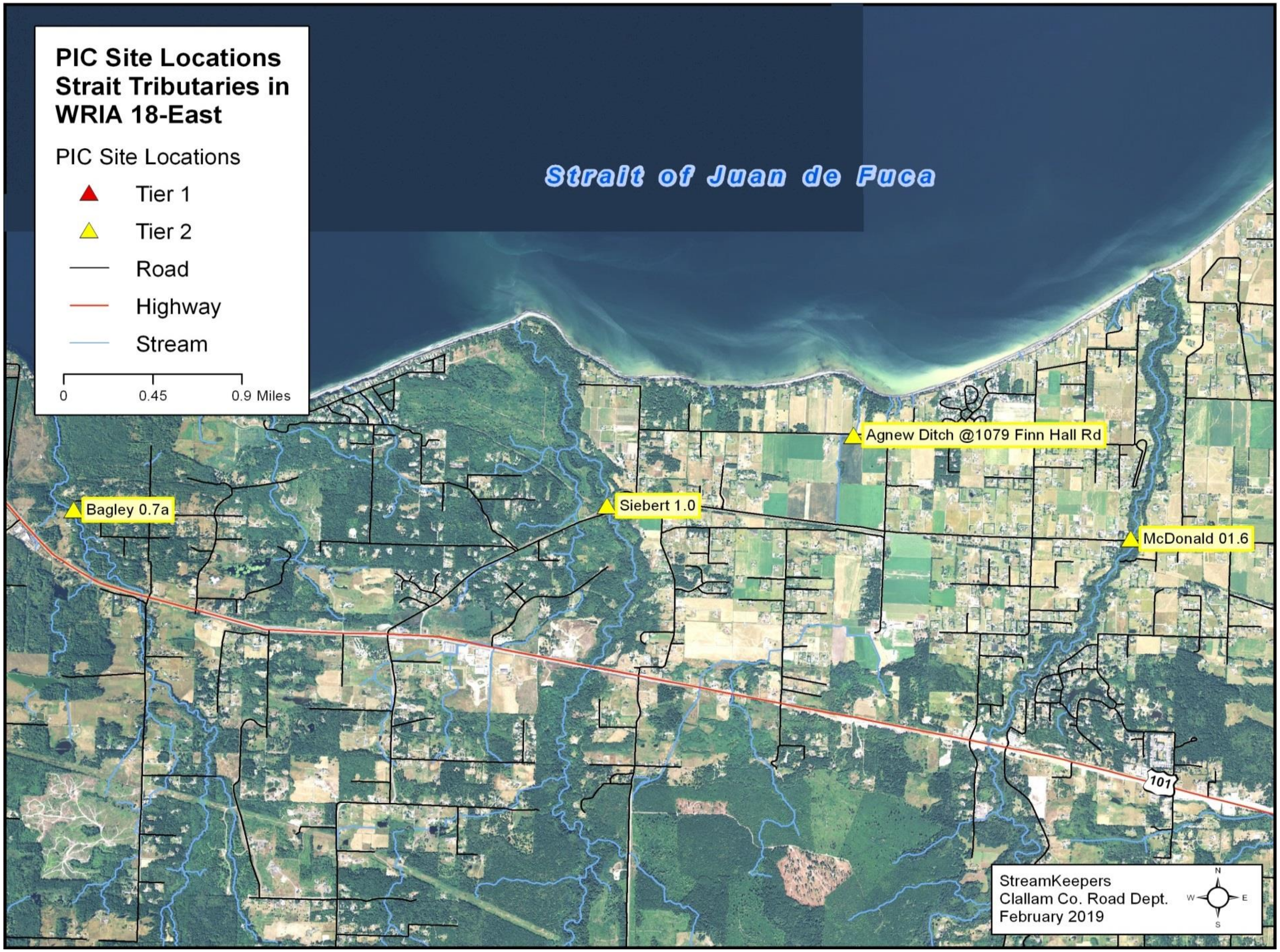


**Figure 3. PIC Baseline Trends Monitoring sample sites, waters west of Dungeness Bay**

## Data Caveats

- Data qualifiers used are per Washington State Department of Ecology's (Ecology) Environmental Information Management (EIM) system.
- Rejected (REJ) data are not used in our analyses.
- Field replicates were averaged with primary samples.
- Field blanks were recorded and used for quality assurance (QA)/quality control (QC) analyses but were not used in this report to generate statistics or figures.
- Some sites are tidally influenced, as can be seen in the salinity data presented below. The sampling procedure dictates sampling during low-tide conditions, but this is not always possible. Alternate sites were sampled at Cassalery Creek and Sequim Bay State Park when tides prohibited collection of freshwater observations at the primary sample sites due to the lack of accessibility or impacts marine water has on the quality of the sample.

## Data Quality Analysis

The following data quality analyses help PIC Project Partners decide where Measurement Quality Objectives (MQO) have been met.

### Blanks Analysis—Fecal Coliforms

In general, one fecal coliform field blank is prepared each sampling tour. From January 2022 through December 2022, all fecal coliform field blanks were "non-detects" since the analyte was not detected at or above the detection limit. This detection limit is usually 2 CFU/100ml at Clallam County Environmental Health Laboratory, but on May 9, samples were analyzed by Spectra Labs in Poulsbo, WA which has a detection limit of 10 CFU/ml. On November 16 and December 5, due to lab dilution of all samples, the detection limit was 4 CFU/100 ml. The fact that all blanks were non-detects indicates proper handling of grab samples.

In addition to field blanks, Clallam County Environmental Health Laboratory prepares and analyzes a lab blank 1) before running samples, 2) after every ten samples, and 3) after running all samples. Lab blank results are not reported to the PIC Baseline Trends Monitoring Program. Rather, these blanks serve as an internal control for the laboratory. For the period of this report no fecal coliform data were rejected or qualified due to laboratory blanks. Clallam County Environmental Health Laboratory is accredited by Ecology and follows Membrane Filter Standardized Method SM9222D.

**Blanks Analysis—Nutrients**

At least one nutrient field blank (FB) is prepared for each PIC Baseline Trends Monitoring tour. Table 2 summarizes nutrient field blank results. UW Marine Chemistry Laboratory provides annual Minimum Detection Limits (MDL). Synthesized Reporting Limit (RL) is calculated as the greater of either 3.18 × Annual MDL *or* FB mean + 1 Standard Deviation (SD), per the PIC QAPP (Bond et al. 2019).

For most nutrients, the synthetic RL was defined by the MDLs multiplied by the factor 3.18. Ammonia nitrogen and total nitrogen synthetic RL were determined by FB mean + 1 SD. The fraction of field blank nutrient analyses exceeding the reporting limit was 5% for 2020-2022.

Beyond field blanks, UW Marine Chemistry Laboratory internal QA/QC involves nutrient lab blank preparation and analysis. These analyses are not presented here, as the lab only reports data that have passed internal controls. To date, laboratory nutrient blanks have never prompted data qualification or corrective action.

Bell Creek estuary, fed by Bell Creek, near the mouth of Sequim Bay

**Table 2. Nutrients field blank (FB) results and synthetic reporting limit (RL) calculations.** All values in [µg/L]. RL is calculated as the max of (FB Mean + 1 SD, 3.18 × MDL), per QAPP (Bond et al., 2019). Field blanks (FB) greater than the synthetic RL are shaded in pink.

| Arrival date | [ $PO_4$-P ] | [ $SiO_4$-Si ] | [ $NO_3$-N ] | [ $NO_2$-N ] | [ $NH_4$-N ] | TP | TN | |
|---|---|---|---|---|---|---|---|---|
| 22-Jan-22 | 0.9 | 0 | 0 | 0 | 0 | 2.3 | 80.8 | |
| 14-Mar-22 | 0.8 | 2.1 | 2.1 | 0 | 0 | 2.0 | 101.9 | |
| 8-May-22 | 1.3 | 6.3 | 1.8 | 0.1 | 0.3 | 1.9 | 81.2 | |
| 12-Jul-22 | 2.9 | 7.5 | 1.7 | 0 | 10.9 | 0.8 | 52.6 | |
| 12-Sep-22 | 1.2 | 10.8 | 1.9 | 0 | 8.7 | 9.1 | 90.1 | |
| 16-Nov-22 | 0.6 | 23.6 | 5.5 | 0 | 6.3 | 0.3 | 34.6 | |
| | | | | | | | | |
| 2022 MDL | 0.9 | 13.0 | 2.5 | 0.1 | 1.3 | 9.5 | 0.4 | |
| 2022 FB Mean | 1.3 | 8.4 | 2.2 | 0.0 | 4.4 | 2.7 | 73.5 | |
| 2022 SD | 0.8 | 8.4 | 1.8 | 0.0 | 4.9 | 3.2 | 25.1 | |
| *FB Mean + 1 SD* | *2.1* | *16.8* | *4.0* | *0.0* | *9.3* | *5.9* | *98.6* | |
| *3.18 × 2022 MDL* | *2.9* | *41.3* | *8.0* | *0.3* | *4.1* | *30.2* | *1.3* | |
| **2022 synthetic RL** | **2.9** | **41.3** | **8.0** | **0.3** | **9.3** | **30.2** | **98.6** | |
| | | | | | | | | |
| # of FB > RL, 2020 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| # of FB > RL, 2021 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 4 |
| # of FB > RL, 2022 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 |
| **Total FB > RL (all)** | **0** | **0** | **1** | **0** | **2** | **1** | **2** | **6** |
| **% FB > RL** | **0.0%** | **0.0%** | **5.9%** | **0.0%** | **11.8%** | **5.9%** | **11.8%** | **5.0%** |

## Field Replicate Analysis—Fecal Coliforms

Field replicates of fecal coliform grab samples are collected at the rate of  one for every 5% of sites or at least one per sampling event. Field replicates help assess precision and confidence in sampling procedures.

Primary samples and replicates from each sampling event are compared in terms of relative standard deviation (RSD). In general, Clallam County Water Laboratory analyzes the field replicate and a laboratory duplicate of the field replicate; the mean of these two values is reported as “replicate” in Table 3, below.

QAPP section 6.2 describes the desired level of agreement between qualifying pairs of primary FC samples and field replicates (after pairs with averages below 20 CFU/100mL have been excluded). Half of all pairs should have less than or equal to 20% RSD, ninety percent of qualifying pairs should have less than or equal to 50% RSD, and all qualifying pairs should have less than 85% RSD. Table 4, below, compares observed results against these criteria for the reporting period. No fecal coliform data were qualified based on field replicate analyses, as replicate pairs met measurement quality objectives described in QAPP section 6.2 (Bond et al. 2019).

**Table 3. Fecal coliform field replicate results.** Here each field replicate and a laboratory duplicate of the field replicate are averaged and reported as a single, composite value called "replicate."

| Date | Site | Type | FC CFU | Mean | %RSD |
|---|---|---|---|---|---|
| 1/11/2022 | Agnew Creek/Ditch 3.0 | Primary<br>Replicate | 42<br>44 | 43.0 | 3.3% |
| 5/26/2022 | Agnew Creek/Ditch 3.0 | Primary<br>Replicate | 26<br>10 | 18.0 | N/A Excluded |
| 8/9/2022 | Agnew Creek/Ditch 3.0 | Primary<br>Replicate | 154<br>120 | 137.0 | 17.5% |
| 11/16/2022 | Agnew Creek/Ditch 3.0 | Primary<br>Replicate | 92<br>48 | 70.0 | 44.4% |
| 1/10/2022 | Bell 0.2 | Primary<br>Replicate | 53<br>48 | 50.0 | 5.7% |
| 2/14/2022 | Bell 0.2 | Primary<br>Replicate | 80<br>64 | 72.0 | 15.7% |
| 3/14/2022 | Bell 0.2 | Primary<br>Replicate | 40<br>40 | 40.0 | 0.0% |
| 4/26/2022 | Bell 0.2 | Primary<br>Replicate | 54<br>30 | 42.0 | 40.4% |
| 5/9/2022 | Bell 0.2 | Primary<br>Replicate | 20<br>80 | 50.0 | 84.9% |
| 6/13/2022 | Bell 0.2 | Primary<br>Replicate | 1,848<br>1,344 | 1,596.0 | 22.3% |
| 7/12/2022 | Bell 0.2 | Primary<br>Replicate | 250<br>238 | 244.0 | 2.8% |
| 8/8/2022 | Bell 0.2 | Primary<br>Replicate | 2,856<br>3,360 | 3,108.0 | 11.5% |
| 9/12/2022 | Bell 0.2 | Primary<br>Replicate | 720<br>740 | 730.0 | 1.9% |
| 10/10/2022 | Bell 0.2 | Primary<br>Replicate | 360<br>380 | 370.0 | 3.8% |
| 11/14/2022 | Bell 0.2 | Primary<br>Replicate | 50<br>100 | 75.0 | 47.1% |
| 12/5/2022 | Bell 0.2 | Primary<br>Replicate | 24<br>12 | 18.0 | N/A Excluded |
| | | | | | Total pairs: 16<br>Excluded pairs: 2<br>Qualifying pairs: 14 |

*Primary/replicate pairs with means less than 20 CFU are excluded from MQO analysis.*

**Table 4: Fecal coliform data Measurement Quality Objectives**

| QC tiers | Pairs in Tier | % Pairs in Tier | % Pairs Required | MQO Met? |
|---|---|---|---|---|
| Pairs <= 20% RSD | 9 | 64.3% | 50.0% | YES |
| Pairs <= 50% RSD | 13 | 92.9% | 90.0% | YES |
| Pairs <= 85% RSD | 14 | 100.0% | 100.0% | YES |

### Field Replicate Analysis—Nutrients

Nutrient field replicates are also collected alongside 5% of all samples (or at least one replicate each sampling event). These replicates are again compared against their primary samples to calculate Relative Standard Deviation. Primary/replicate pairs with means less than five times the reporting limit are excluded from RSD calculation. QAPP Table 1 (Bond et al. 2019) describes acceptable annual median RSD values, and sampling results are compared against the criteria below.

Nutrient sample replicate analysis generally showed a high degree of precision among primary/replicate pairs and no data were qualified as a result of this analysis.

**Table 5: Nutrients field replicate results and QC analysis for data pairs with mean > 5 RL**

| Analyte | Data Pairs | Median RSD | RSD Criterion | Data Qualified |
|---|---|---|---|---|
| Ammonia | 5 | 8.7% | 15% | none |
| Nitrate | 6 | 0.7% | 10% | none |
| Nitrite | 0 | | 10% | none |
| Phosphate | 6 | 4.3% | 10% | none |
| Silicate | 6 | 1.3% | 10% | none |
| Total N | 6 | 0.8% | 10% | none |
| Total P | 6 | 1.8% | 10% | none |

### Field Replicate Analysis—Physical and Chemical Parameters

The PIC Baseline Trends Water Quality Monitoring Program calls for in situ measurements of water temperature and salinity at all sample sites. Barometric pressure (BP), dissolved oxygen (DO), pH, specific conductance (SpC), and turbidity measurements are also collected (though not required), given the ease of data collection with multiparameter water quality meters. These data are collected in accordance with the Streamkeepers Program QAPP (Chadd et al. 2019).

Measurement quality objectives of physical and chemical data are described in terms of maximum allowable percent relative standard deviation and/or maximum allowable difference between primary samples and replicates. Where two criteria are provided, at least one must be met for data to pass unqualified and avoid corrective action. Table 6, below, summarizes comparison of environmental data against MQO criteria. Salinity and temperature criteria were described in the PIC Project QAPP (Bond et al. 2019) while measuring and reporting methods for other criteria were described in the Streamkeepers Program QAPP (Chadd et al. 2019).

**Table 6. Physical/chemical water quality field replicate QC analysis**

| Parameter | Units | Data Pairs | Max RSD (by pairs) | RSD Criterion | Max Difference Observed | Difference Criteria | Data Qualified |
|---|---|---|---|---|---|---|---|
| BP | Hg | 16 | | | 0 | 0.05 | None |
| DO | mg/L | 16 | | 1% per pair | 0 | 0.2 | None |
| pH | N/A | 16 | | | 1 | 0.2 | 6/13/22, 8/9/22 |
| Salinity | PSU (ppt) | 15 | | 5% per pair | 0.00 | 0.2 | None |
| Sp Cond | µs/cm | 16 | 1.1% | 5% per pair | | | None |
| Water T | ◦C | 16 | | | 0.1 | 0.2 | None |
| Turbidity | FNU | 16 | 31.0% | 7% per pair | | 1 | 1/10/22, 5/26/22 |

*Salinity difference criteria changed from the previous value of 0.02 PSS. Data is recorded to nearest 0.1 PSS*

### Laboratory Standards Checks—Nutrients

In addition to internal controls metioned previously, UW Marine Chemistry Laboratory uses check standards to assess bias stemming from analytical methods. Wherever standards are not met, analyses are repeated. Data reported by the lab have passed all internal QA/QC screening. To date no nutrient data have required qualification or corrective action following laboratory data quality analyses.

## Compliance with Project QAPP and SOPs

In compliance with the project QAPP (Bond et al. 2019), environmental data were collected following standard operating procedures (SOP). Water samples for the purpose of fecal coliform testing were collected in sterile polypropylene (PP) bottes, stored in coolers with ice packs for less than 8 hours, and analyzed at Clallam County Water Laboratory. Samples for nutrients testing were collected in either acid-washed PP or acid-washed high-density polyethylene (HDPE) bottles, chilled with ice packs in coolers, and shipped overnight to UW Marine Chemistry Laboratory in Seattle, WA.

In situ physical and chemical water quality measurements (water temperature, dissolved oxygen concentration, pH, specific conductance, salinity, turbidity) were collected using a YSI ProDSS field meter which was calibrated prior to sampling events. Where necessary, data have been flagged with appropriate qualifiers based on QA/QC measures.

## Monitoring Results

PIC Baseline Trends Monitoring environmental data collected between January 1, 2022 and December 31, 2022 are given in Appendix B. These data are presented visually in the charts to follow and explored in the Discussion section of this report. Rejected data have been excluded. Additional data for parameters not described in the PIC Quality Assurance Project Plan (dissolved oxygen, pH, turbidity, specific conductivity), collected according to the Streamkeepers QAPP, are presented in Appendix C.

Streamkeepers volunteer Linda Sumner collects a sample for nutrient analysis at Meadowbrook Creek, while volunteer Peggy McClure looks on. Photo Credit: Joel Green

**Fecal Coliforms**

As in 2020-2021, in 2022 the geometric mean fecal coliform level in Bell creek was higher than 100 CFU/100mL (Figures 4 and 5). Cassalery, Matriotti, Meadowbrook, Agnew and Gierin creeks had geometric mean fecal coliform levels above 50 CFU/100mL. Matriotti Creek showed an improvement in fecal coliform levels compared to 2019-2021, with the geometric mean going from above 100 CFU/100mL to 50 CFU/100mL. Mean fecal coliform levels in McDonald and Chicken Coop creeks also showed an improvement as compared to 2021, with the geometric mean dropping below 50 CFU/100mL. In contrast, Cassalery and Agnew creek geometric means rose to above 50 CFU/100mL.

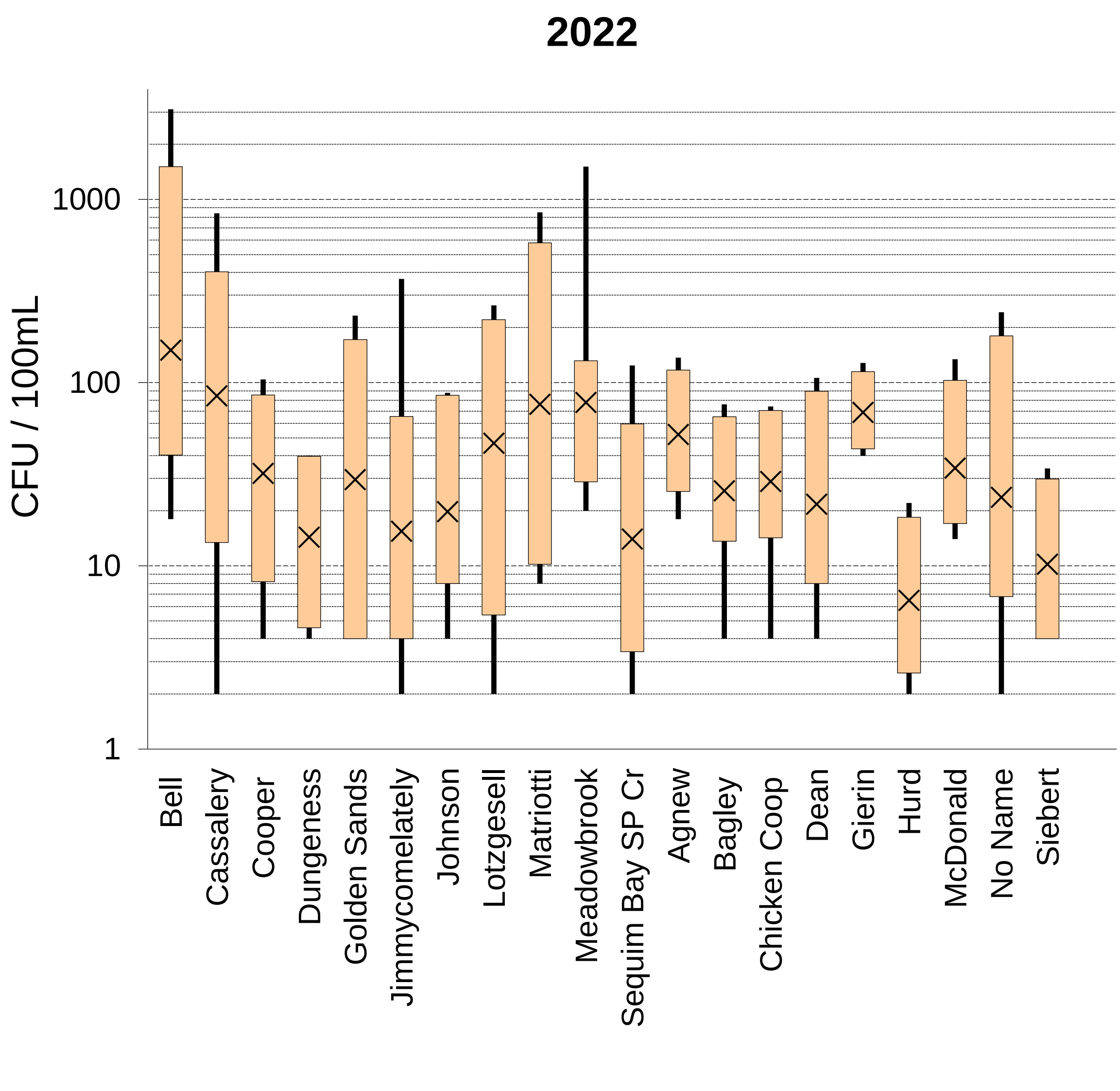


**Figure 4. Fecal Coliforms, all CWD streams.** Fecal coliforms were measured as colony-forming units (CFU) per 100 ml. Note log scale. X marks geometric mean; bottom and top of box represent observed 10$^{th}$ and 90$^{th}$ percentiles; ends of whiskers represent extremes. From left to right, the first 11 streams are Tier 1 streams, and the remaining 9 streams are Tier 2 streams.

| Site | Tier | 2015 | | 2016 | | 2017 | | 2018 | | 2019 | | 2020 | | 2021 | | 2022 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Geo Mean > 50 | Geo Mean > 100 | Geo Mean > 50 | Geo Mean > 100 | Geo Mean > 50 | Geo Mean > 100 | Geo Mean > 50 | Geo Mean > 100 | Geo Mean > 50 | Geo Mean > 100 | Geo Mean > 50 | Geo Mean > 100 | Geo Mean > 50 | Geo Mean > 100 | Geo mean >50 | Geo Mean > 100 |
| Agnew | 2 | | | X | | | | | | X | | X | X | | | X | |
| Bagley | 2 | | | | | | | | | | | | | | | | |
| Bell | 1 | | | | | | | | | | | X | X | X | X | X | X |
| Cassalery | 1 | | | | | | | | | X | | X | | | | X | |
| Chicken Coop | 2 | | | | | | | | | | | | | X | | | |
| Cooper | 2 | | | | | | | | | | | | | | | | |
| Dean | 2 | | | | | | | | | | | | | | | | |
| Dungeness | 1 | | | | | | | | | | | | | | | | |
| Gierin | 2 | | | | | | | | | | | | | X | | X | |
| Golden Sands | 1 | X | | X | | | | | | X | | | | | | | |
| Hurd | 2 | | | | | | | | | | | | | | | | |
| Jimmycomelately | 1 | | | | | | | | | | | | | | | | |
| Johnson | 1 | | | | | | | | | | | | | | | | |
| Lotzgesell | 1 | | | | | | | | | X | | X | | X | | | |
| Matriotti | 1 | X | | X | | X | | X | | X | X | X | X | X | X | X | |
| McDonald | 2 | | | | | | | | | | | X | | X | | | |
| Meadowbrook | 1 | | | | | | | | | | | X | | X | | X | |
| Meadowbr. Slough | 1 | | | | | | | X | X | X | X | X | X | | | | |
| No Name | 2 | | | | | | | | | | | | | | | | |
| Sequim Bay SP Cr | 1 | | | | | | | | | | | | | | | | |
| Siebert | 2 | | | | | | | | | | | | | | | | |

**Figure 5. Trends in bacterial pollution in monitored streams, 2015-2022.** Monitored streams are shown in the left column. Tier 1 streams were monitored monthly, Tier 2 streams quarterly. For each year, the following fecal coliform metrics are reported for each stream: 1) geometric mean fecal coliform > 50 CFU/100 ml, and 2) geometric mean fecal coliform > 100 CFU/100 ml. If neither threshold is exceeded, blocks are green. If the lower threshold is exceeded, blocks are orange; if the higher is exceeded, blocks are red. Due to small sample size (usually 4 per year, sometimes 3), results for Tier 2 streams should not be considered definitive. When less than three samples were collected in a year, data were considered insufficient to report here, and blocks are white.

**Nutrients**

Nutrients results are summarized in the charts below. Nutrients data were collected monthly at CWD Tier 1 streams only. As seen in Figure 6, Bell, Cassalery, Lotzgesell, and Matriotti creeks have the highest mean levels of nitrogen as nitrate in the 2022 results. Bell creek also has the highest nitrite levels, with similar levels among Cassalery, Golden Sands, Lotzgesell, Matriotti and Meadowbrook creeks (Figure 7).

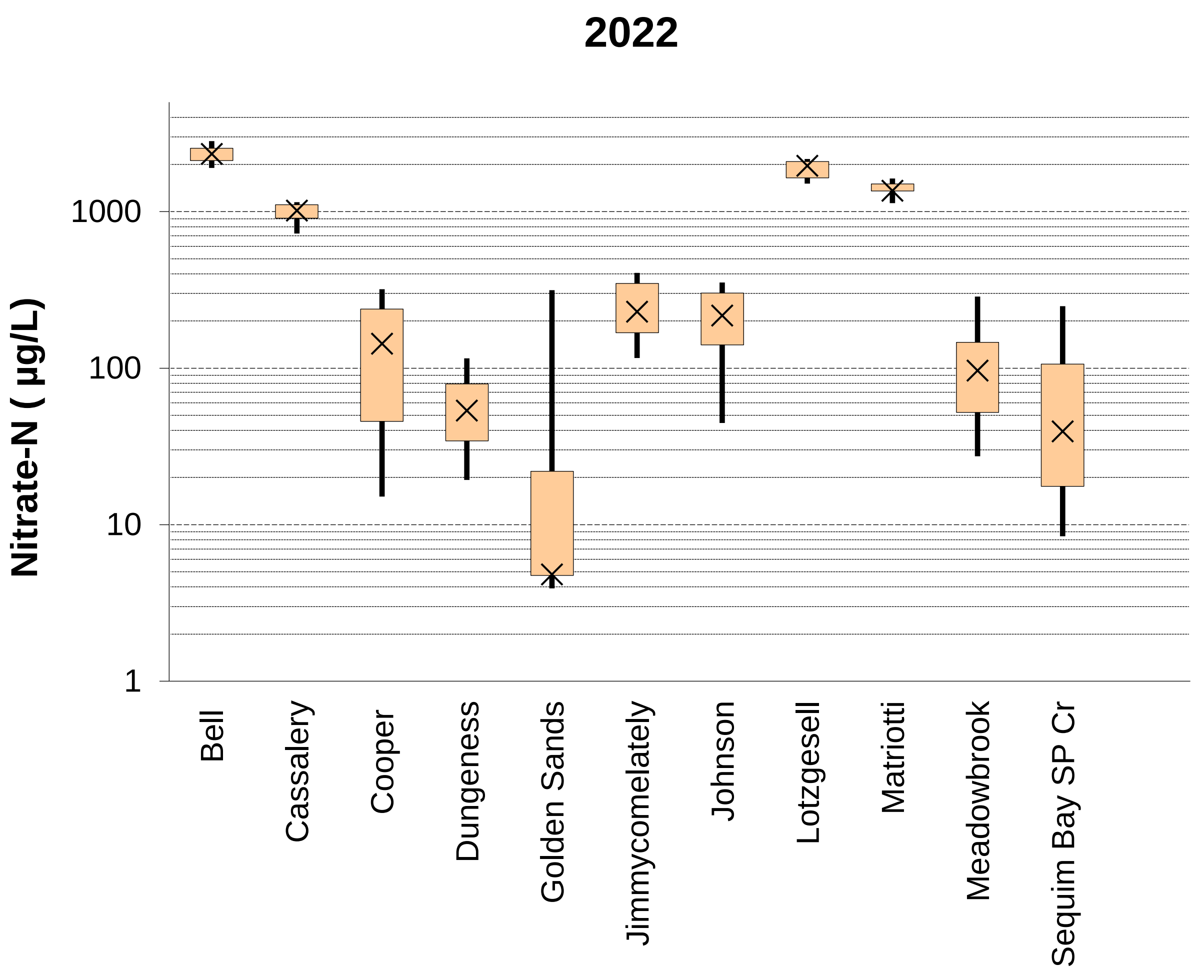


**Figure 6. Nitrate as N, Tier 1 streams.** Note log scale. X marks. median; bottom and top of box represent 1st and 3rd quartiles; ends of whiskers represent min. and max. values.

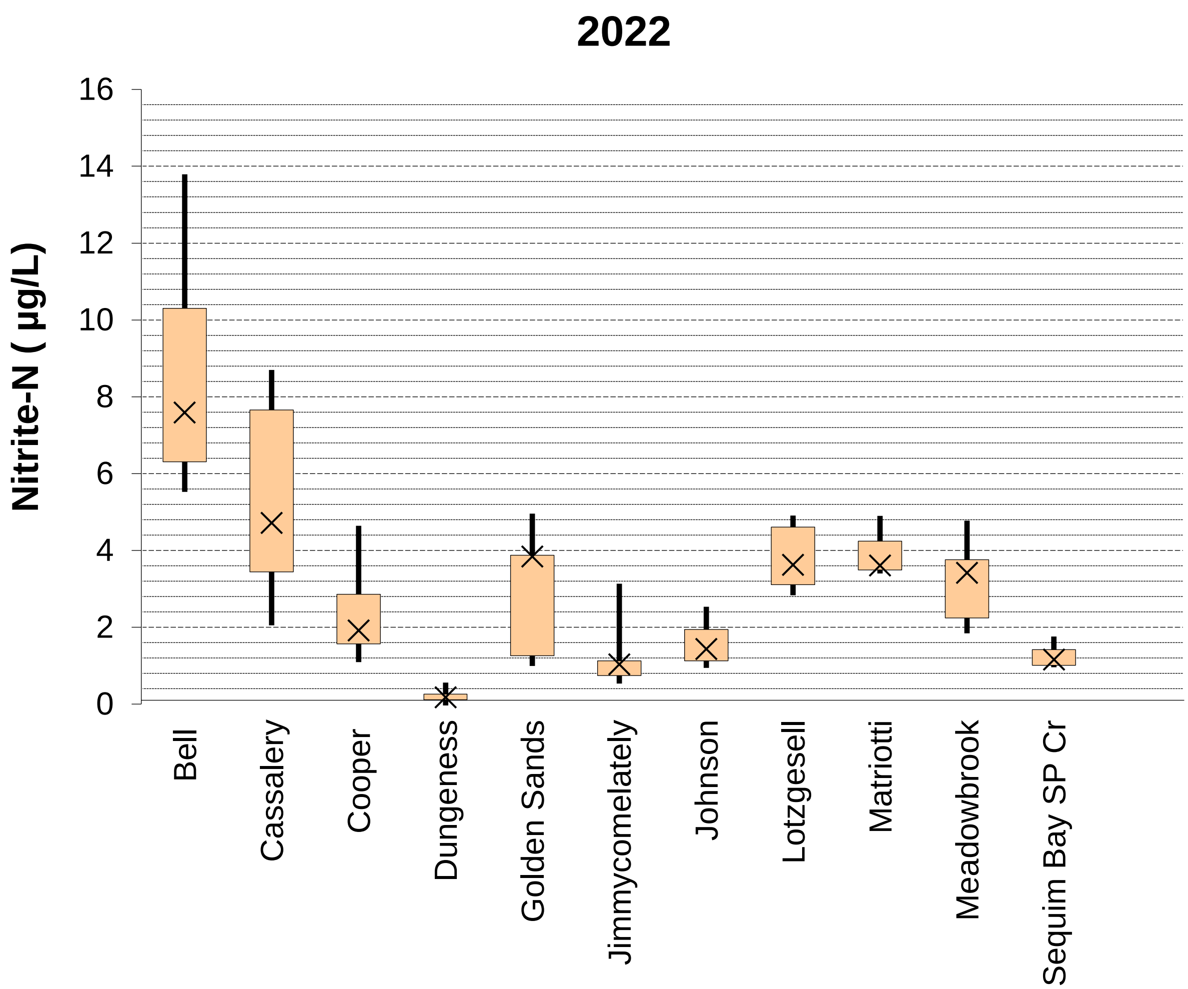


**Figure 7. Nitrite as N, Tier 1 streams.** X marks median; bottom and top of box represent 1st and 3rd quartiles; ends of whiskers represent min. and max. values.

The mean ammonia values in 2022 were highest at Bell, Cassalery, Cooper, Golden Sands, and Meadowbrook creeks, and relatively low at remaining CWD creeks (Fig. 8).

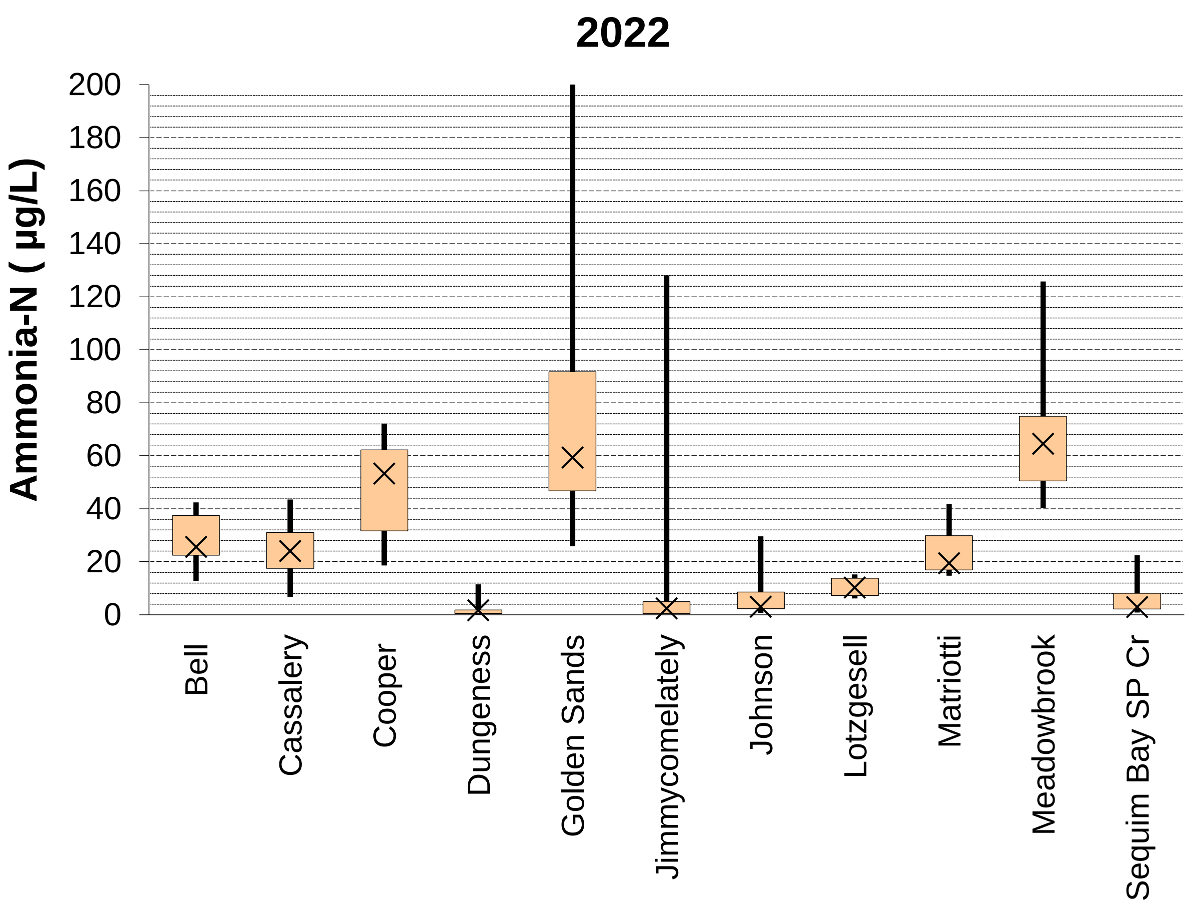


**Figure 8. Ammonia as N, Tier 1 streams.** X marks median; bottom and top of box represent 1st and 3rd quartiles; ends of whiskers represent min. and max. values.

Similar to 2020-2021, Bell, Cassalery, Lotzgesell, and Matriotti creeks, continued to have mean total nitrogen levels above 1000 µg/L in 2022 (Fig. 9). The fact that these same creeks had relatively high levels of fecal coliform suggests common causes for elevated levels of both fecal coliform and nitrogen.

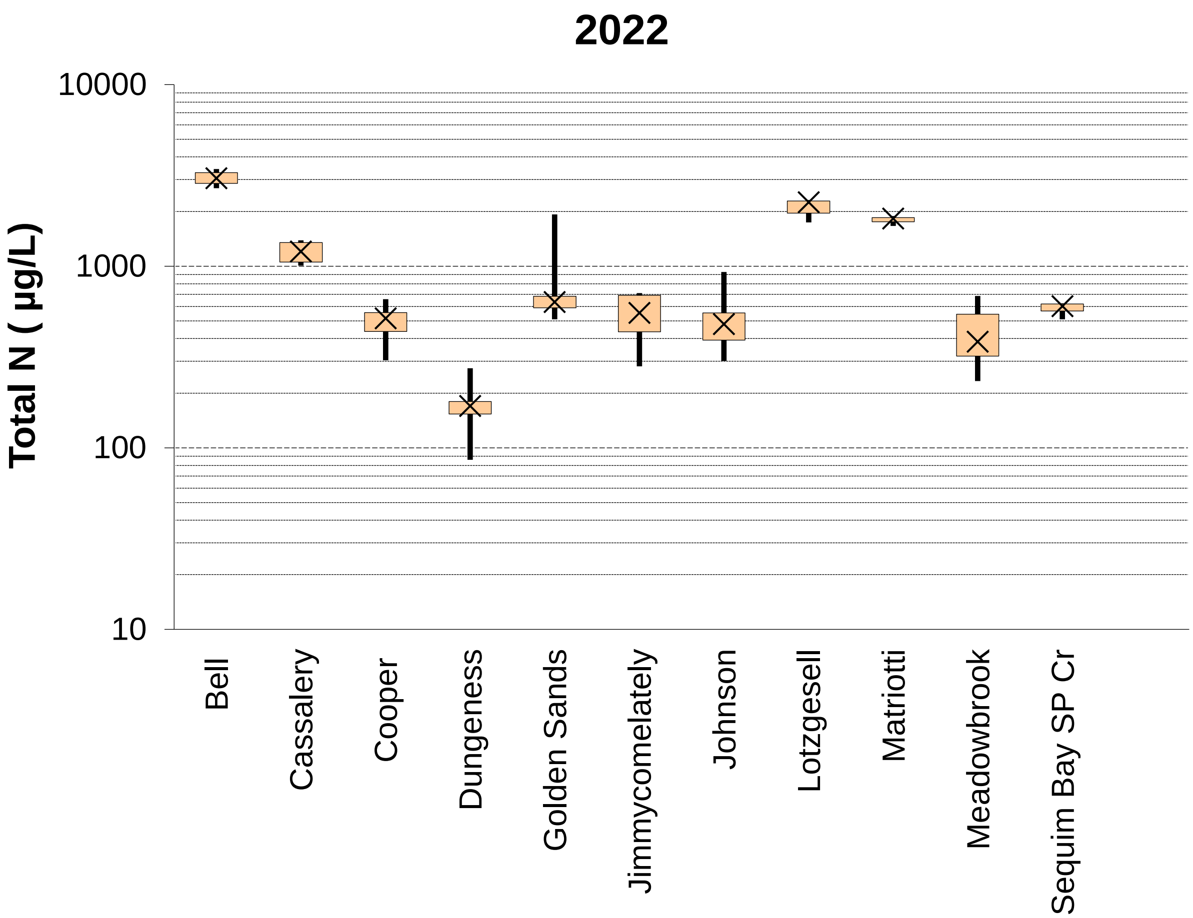


**Figure 9. Total nitrogen, Tier 1 streams.** Note log scale. X marks median; bottom and top of box represent 1st and 3rd quartiles; ends of whiskers represent min. and max. values.

In monitored creeks, levels of Phosphorous as Phosphate and total Phosphorous had similar patterns in 2022, with Bell Creek, Golden Sands Slough, Johnson and Sequim Bay State Park Creek having the highest mean values (Figs. 10 and 11). As marine water typically has a much higher concentration of phosphate-P than unpolluted freshwater, and Golden Sands Slough has input of marine water as evidenced by relatively high salinity, it is possible that the high level of phosphate-P at Golden Sands is partially due to input of marine water.

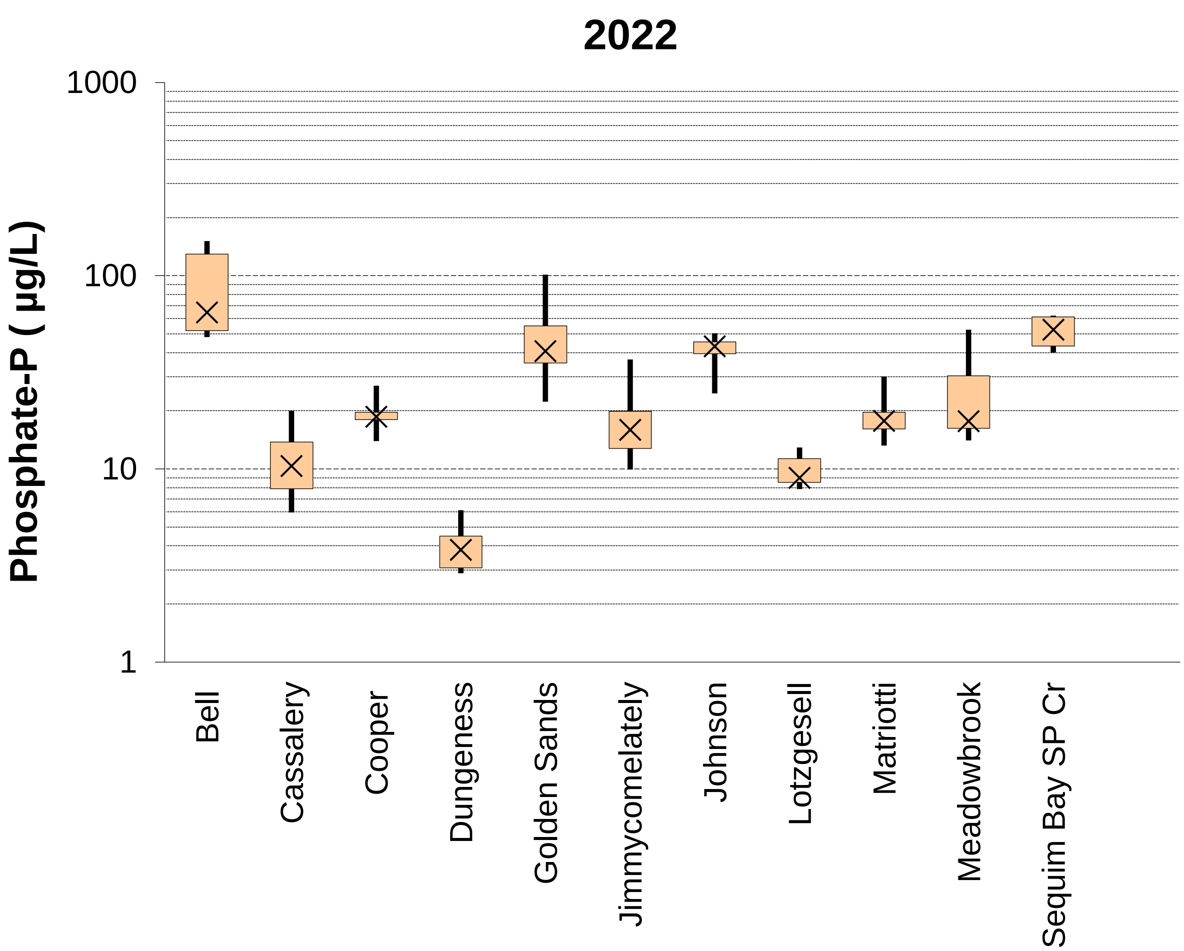


**Figure 10. Phosphate as P, Tier 1 streams.** Note log scale. X marks median; bottom and top of box represent 1st and 3rd quartiles; ends of whiskers represent min. and max. values.

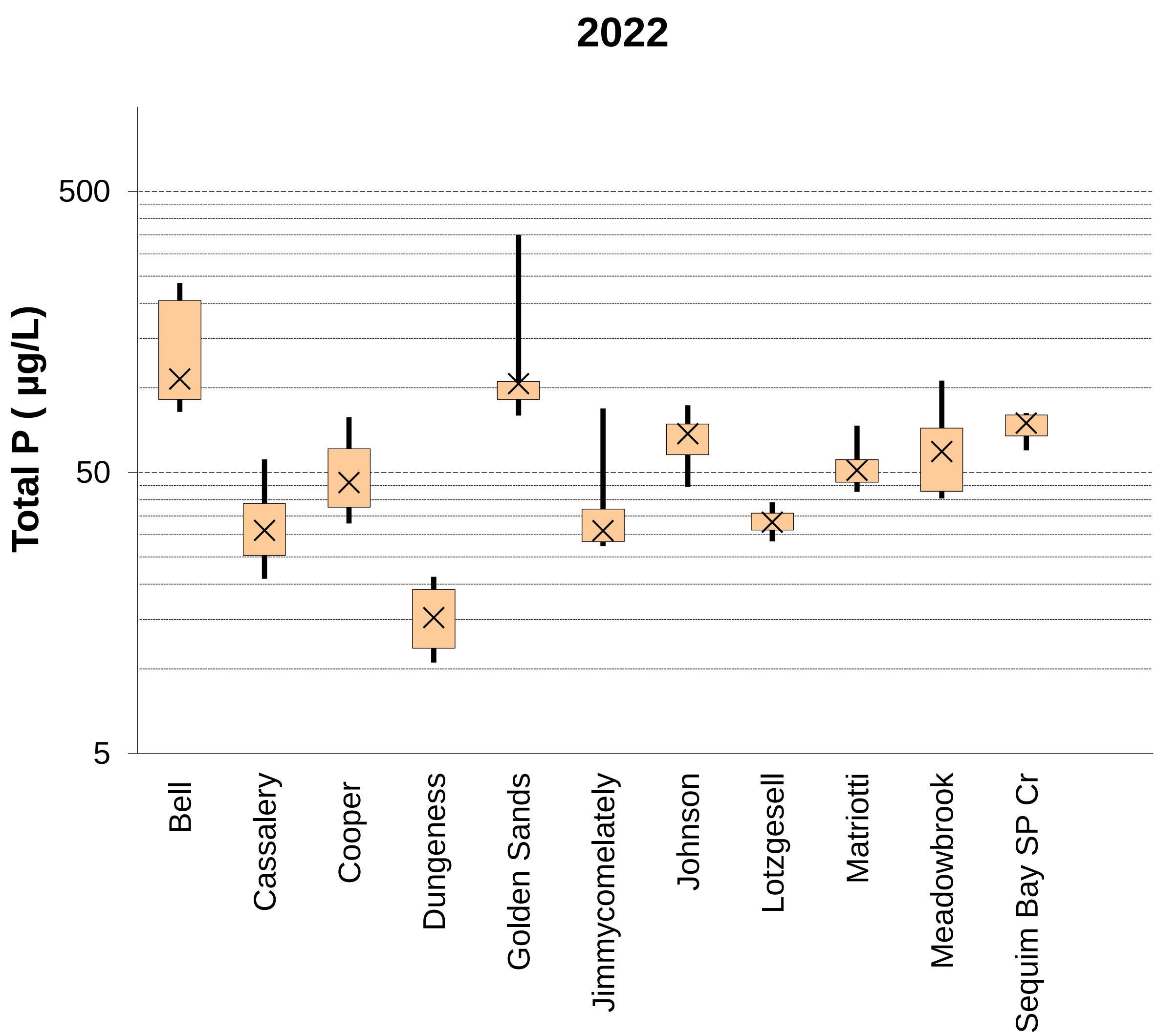


**Figure 11. Total Phosphorus, Tier 1 streams.** Note log scale. X marks median; bottom and top of box represent 1st and 3rd quartiles; ends of whiskers represent min. and max. values.

### Water Temperature and Salinity

Summaries of water temperature and salinity data covering the reporting period follow. Physical and chemical data are collected monthly at Tier I streams and quarterly at Tier II streams. Additional measurements collected following the Streamkeepers program QAPP include barometric pressure, dissolved oxygen, pH, specific conductance, and turbidity data. These measurements are not specifically required by the PIC QAPP and are not discussed here, though they are available from the Clallam County Water Resources Database. Data summaries are presented in Appendix C. Figures 12 and 13 highlight water temperature and salinity for all CWD creeks. As in previous years, Golden Sands Slough, Cooper Creek, and Meadowbrook Creek had the highest measured water temperatures in 2022, possibly due to lack of riparian vegetation providing shade, and slow-moving water.

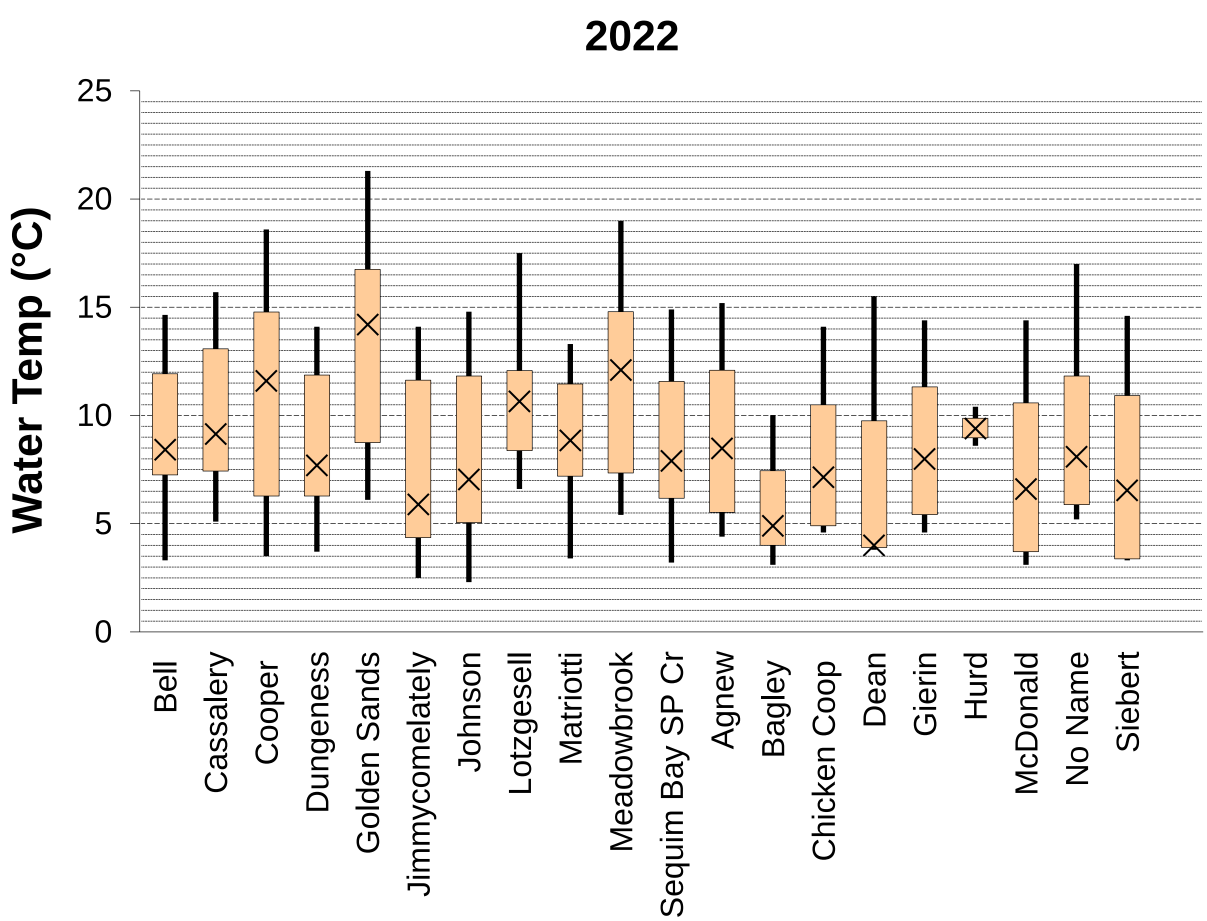


**Figure 12. Water Temperature, all CWD streams**. X marks median; bottom and top of box represent 1st and 3rd quartiles; ends of whiskers represent min. and max. values. For evaluative purposes, the State's maximum 7-day average of daily maxima salmonid core summer habitat (the designated use for all sites) is 16 °C (WAC 173-201A-200, 2022).

Cooper Creek, Golden Sands Slough, and Meadowbrook Creek salinity data are indicative of periodic marine water influence at these sites. Golden Sands Slough, with mean salinity over 25 ppm in 2022, is most influenced by influx of marine water. Due to the potential for tidal influence, secondary sample sites were added at Sequim Bay State Park Creek (0.1) and Cassalery Creek (0.6) to avoid complications with low flow events and tides that occasionally confound data collection. The highest salinity measurements at Sequim Bay State Park Creek and Cassalery Creek come from the lower, primary sample sites when the secondary site was not used.

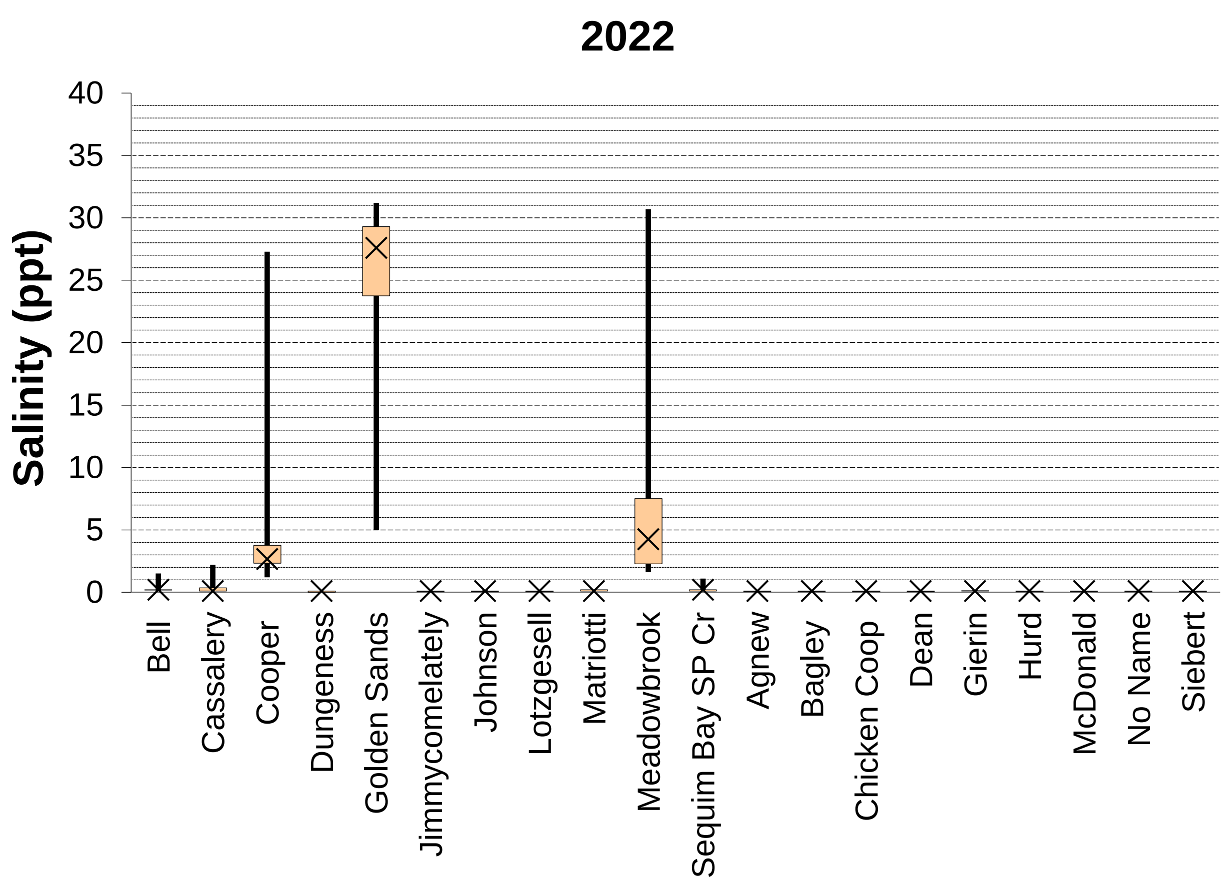


**Figure 13. Salinity, all CWD streams.** X marks median; bottom and top of box represent 1st and 3rd quartiles; ends of whiskers represent min. and max. values.

**Availability of Data to the Public**

Data is stored in Clallam County's Water Resources Database, and is available upon request (email to streamkeepers@clallamcountywa.gov). Data is submitted to Washington Dept. of Ecology's Environmental Information Management (EIM) database, and following Ecology's review, is posted and available to government agency personnel, nongovernmental organizations, and the public at https://ecology.wa.gov/Research-Data/Data-resources/Environmental-Information-Management-database and at EPA's WQX database (https://www.epa.gov/waterdata/water-quality-data-wqx).

**Discussion**

Pollution Identification and Correction work involves seeking and correcting upland sources of bacterial pollution that impact streams and receiving marine waters—especially where shellfish harvest activities exist. Baseline Trends Water Quality Monitoring helps highlight sub-watersheds for selection as PIC Focus Areas for further targeted investigation and pollution control. To date, Baseline Trends data have helped select Golden Sands and Meadowbrook Slough (2015-2017 PIC Focus Area), lower Matriotti and Lotzgesell Creeks (2017-2019 PIC Focus Area), and, most recently, upper Matriotti and lower Bell Creeks (2019-2022 PIC Focus Area).

PIC Project Partners elected to include lower Bell Creek as part of the 2019-2022 PIC Focus Area in an effort to seek and eliminate potential sources of bacterial pollution in the Bell Creek watershed. Bell Creek drains to Bell Creek estuary at the mouth of Sequim Bay, and potentially influences water quality in Sequim Bay Growing Area to the east and Jamestown Growing Area to the west.

In 2018, 90 acres of shellfish growing area in Sequim Bay were upgraded from Prohibited to Approved, and in 2019, 44 acres were downgraded from Approved to Prohibited. Initial work began in the 2019-2022 Focus Area including Bell Creek in December 2019. In 2020, 23 acres in the Jamestown Growing Area were upgraded from Prohibited to Approved. There were no upgrades or downgrades to shellfish growing areas in the Sequim-Dungeness Clean Water District in 2021 or 2022.

In 2022, through the Clallam County On-site Septic System Operations and Maintenance Cost-Share Program, there were two septic system repairs, one in Golden Sands, and one upstream of Meadowbrook Slough. Trends sampling before and after these repairs allowed Clallam County to monitor for any pre- and post-installation issues downstream of these properties.

While improvements have been made in the monitored watersheds in regards to individual landowner practices as a result of this PIC project, more work is needed to reduce bacterial pollution inputs and achieve improved water quality in Dungeness Bay and Sequim Bay, which would allow for opening more shellfish growning areas. In Dungeness Bay in 2022, there were no upgrades or downgrades for shellfish growning areas by Washington Dept. of Health, classifications have remained constant since 2016. However several of the sites monitored by Dept. of Health in Dungeness Bay had higher measured fecal coliform levels in November 2022 vs. November 2021, based on estimated 90th percentiles of 30 samples at each sample site (Trevor Swanson's report to the Clean Water Work Group, 12/14/2022) . Both PIC Trends data and Dept. of Health data highlights the need for continued water quality monitoring and followup landowner outreach efforts.

Volunteer Linda Sumner pushes a water sample through a syringe filter to prepare the sample for laboratory analysis of nutrient content.

## Conclusion

Long-Term PIC Baseline Trends Monitoring continues to help project partners adaptively manage the PIC Program and select focus areas where limited resources will lead to the greatest improvements in water quality.

Many needed corrections identified during the course of PIC project monitoring from 2015-2022 have taken place. Many of these corrections were related to repairs and installations of onsite septic systems. Some of these septic system installations happened thanks to low-interest loans (such as Clean Water Loans offered by Craft3), Clallam County On-site Septic System Operations and Maintenance Cost-Share Program, and cost-share funding accessed by Clallam Conservation District. To continue pollution reduction, it will be necessary to continue tracking recalcitrant wastewater disposal problems and use all available tools to compel property owners to comply with wasterwater best practices.

Parcel surveys and source investigations along Matriotti Creek noted several potential critical areas problems, including removed vegetated buffers. Cleared stream corrider appears prevalent across properties of varying uses from commercial to residential to agricultural. Clallam County's Clean Water Strategy for Addressing Bacteria Pollution in Dungeness Bay and Watershed (Streeter and Hempleman 2004) notes: "Although not considered a pollution source, the lack of vegetation along ditches and stream banks limits the landscape's ability to filter contaminated run-off." Additionally, the U.S. EPA considers infrared heat a pollutant (hence, Ecology can develop TMDLs based on temperature), and maintaining and/or restoring riparian buffers are effective best management practices to reduce temperature and increase infiltration. Water quality in Matriotti Creek can be improved by protecting the remaining vegetated corridor bordering the streams, and restoring vegetated buffers previously removed contrary to criticial areas codes. This would lead to improved stream temperature conditions for fish, and reduced bacterial pollution.

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**Appendix A: Map of Clean Water District**

## Appendix B: Data from January 2022 – December 2022

This table presents data for fecal coliform (FC), nitrate-nitrogen ($NO_3$-N), nitrite-nitrogen ($NO_2$-N), ammonia-nitrogen ($NH_3$-N), phosphate-phosphorus ($PO_4$-P), silicate-silicon ($SiO_4$-Si), total nitrogen (TN), total phosphorus (TP), water temperature, turbidity, and dissolved oxygen.

| Site | Date | FC (CFU/ 100ml) | $NO_3$-N (µg/L) | $NO_2$-N (µg/L) | $NH_3$-N (µg/L) | $PO_4$-P (µg/L) | $SiO_4$-Si (µg/L) | TN (µg/L) | TP (µg/L) | Temp $H_2O$ °C | Turbidity (FNU) | Dissolved Oxygen (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Agnew Creek/Ditch 0.3 | 1/11/2022 | 43 | | | | | | | | 4.4 | 12.5 | 12.90 |
| Agnew Creek/Ditch 0.3 | 5/26/2022 | 18 | | | | | | | | 11.1 | 9 | 10.90 |
| Agnew Creek/Ditch 0.3 | 8/9/2022 | 137 | | | | | | | | 15.2 | 3 | 9.80 |
| Agnew Creek/Ditch 0.3 | 11/16/2022 | 70 | | | | | | | | 5.9 | 3 | 12.60 |
| Bagley 0.7a | 1/11/2022 | 40 | | | | | | | | 3.1 | 23 | 13.60 |
| Bagley 0.7a | 5/26/2022 | 36 | | | | | | | | 10.0 | 2 | 10.90 |
| Bagley 0.7a | 8/9/2022 | 76 | | | | | | | | | 2 | 9.90 |
| Bagley 0.7a | 11/16/2022 | 4 | | | | | | | | 4.9 | 2 | 12.60 |
| Bell 0.2 | 1/10/2022 | 50 | 1903 | 11 | 41 | 77 | 7072 | 2685 | 121 | 3.3 | 8 | 12.90 |
| Bell 0.2 | 2/14/2022 | 72 | | | | | | | | 6.8 | 4 | 11.70 |
| Bell 0.2 | 3/14/2022 | 40 | 2594 | 6 | 22 | 52 | 6746 | 3109 | 94 | 7.4 | 4 | 11.80 |
| Bell 0.2 | 4/26/2022 | 42 | | | | | | | | 8.4 | 3.5 | 11.80 |
| Bell 0.2 | 5/9/2022 | 50 | 2305 | 6 | 13 | 48 | 6411 | 3330 | 90 | 8.4 | 5 | 11.50 |
| Bell 0.2 | 6/13/2022 | 1596 | | | | | | | | 11.3 | 8 | 10.20 |
| Bell 0.2 | 7/12/2022 | 244 | 2374 | 14 | 42 | 151 | 7088 | 2981 | 236 | 13.8 | 8.5 | 9.50 |
| Bell 0.2 | 8/8/2022 | 3108 | | | | | | | | 14.7 | 7 | 8.70 |
| Bell 0.2 | 9/12/2022 | 730 | 2057 | 9 | 28 | 147 | 6668 | 2815 | 232 | 14.6 | 7 | 9.30 |
| Bell 0.2 | 10/10/2022 | 370 | | | | | | | | 10.9 | 5.5 | 10.50 |
| Bell 0.2 | 11/14/2022 | 75 | 2821 | 6 | 24 | 52 | 7954 | 3429 | 82 | 7.6 | 2 | 11.20 |
| Bell 0.2 | 12/5/2022 | 18 | | | | | | | | 4.9 | 1 | 12.10 |
| Cassalery 0.0 | 6/13/2022 | 332 | | | | | | | | 12.6 | 8 | 9.70 |
| Cassalery 0.0 | 7/12/2022 | 298 | 900 | 6 | 33 | 20 | 5101 | 1008 | 56 | 15.2 | 10 | 8.70 |
| Cassalery 0.0 | 8/8/2022 | 840 | | | | | | | | 15.7 | 6 | 8.70 |
| Cassalery 0.0 | 9/12/2022 | 410 | 925 | 3 | 24 | 12 | 4836 | 1122 | 37 | 14.5 | 5 | 9.20 |

| Site | Date | FC (CFU/ 100ml) | $NO_3$-N (µg/L) | $NO_2$-N (µg/L) | $NH_3$-N (µg/L) | $PO_4$-P (µg/L) | $SiO_4$-Si (µg/L) | TN (µg/L) | TP (µg/L) | Temp $H_2O$ °C | Turbidity (FNU) | Dissolved Oxygen (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cassalery 0.0 | 10/10/2022 | 280 | | | | | | | | 11.4 | 5 | 10.20 |
| Cassalery 0.6 | 1/10/2022 | 68 | 1106 | 8 | 43 | 14 | 5488 | 1390 | 40 | 5.6 | 5 | 11.20 |
| Cassalery 0.6 | 2/14/2022 | 68 | | | | | | | | 7.5 | 8 | 10.80 |
| Cassalery 0.6 | 3/14/2022 | 50 | 1105 | 3 | 15 | 9 | 5766 | 1289 | 25 | 8.4 | 5 | 11.10 |
| Cassalery 0.6 | 4/26/2022 | 2 | | | | | | | | 9.6 | 3 | 10.70 |
| Cassalery 0.6 | 5/9/2022 | 10 | 1150 | 2 | 7 | 6 | 5704 | 1373 | 21 | 8.7 | 3 | 11.10 |
| Cassalery 0.6 | 11/14/2022 | 70 | 723 | 9 | 24 | 8 | 5505 | 1032 | 26 | 7.2 | 2 | 10.70 |
| Cassalery 0.6 | 12/5/2022 | 44 | | | | | | | | 5.1 | 3 | 11.10 |
| Chicken Coop 0.24 | 1/11/2022 | 62 | | | | | | | | 5.0 | 74 | 12.90 |
| Chicken Coop 0.24 | 5/26/2022 | 74 | | | | | | | | 9.3 | 3 | 11.30 |
| Chicken Coop 0.24 | 8/9/2022 | 38 | | | | | | | | 14.1 | 1 | 9.90 |
| Chicken Coop 0.24 | 11/16/2022 | 4 | | | | | | | | 4.6 | 1 | 12.90 |
| Cooper 0.1 | 1/10/2022 | 8 | 320 | 1 | 19 | 18 | 6818 | 659 | 33 | 3.5 | 1 | 10.40 |
| Cooper 0.1 | 2/14/2022 | 64 | | | | | | | | 5.9 | 2 | 8.70 |
| Cooper 0.1 | 3/14/2022 | 38 | 225 | 2 | 27 | 14 | 6539 | 499 | 36 | 8.8 | 2 | 8.10 |
| Cooper 0.1 | 4/26/2022 | 10 | | | | | | | | 12.1 | 3 | 9.30 |
| Cooper 0.1 | 5/9/2022 | 70 | 41 | 2 | 46 | 19 | 6049 | 415 | 65 | 12.0 | 4 | 8.90 |
| Cooper 0.1 | 6/13/2022 | 86 | | | | | | | | 15.0 | 5 | 8.70 |
| Cooper 0.1 | 7/12/2022 | 104 | 15 | 3 | 61 | 27 | 5414 | 533 | 79 | 18.6 | 4 | 7.00 |
| Cooper 0.1 | 8/8/2022 | 52 | | | | | | | | 18.2 | 5 | 5.80 |
| Cooper 0.1 | 9/12/2022 | 4 | 61 | 5 | 72 | 20 | 6346 | 303 | 49 | 14.7 | 3 | 5.80 |
| Cooper 0.1 | 10/10/2022 | 34 | | | | | | | | 11.2 | 2 | 6.90 |
| Cooper 0.1 | 11/14/2022 | 82 | 243 | 2 | 63 | 19 | 5464 | 561 | 43 | 6.4 | 2 | 8.30 |
| Cooper 0.1 | 12/5/2022 | 16 | | | | | | | | 5.2 | 5 | 8.30 |
| Dean 0.17 | 1/11/2022 | 24 | | | | | | | | 4.0 | 40 | 13.30 |
| Dean 0.17 | 8/9/2022 | 106 | | | | | | | | 15.5 | 1 | 8.40 |
| Dean 0.17 | 11/16/2022 | 4 | | | | | | | | 3.8 | 10 | 13.40 |
| Dungeness 0.7 | 1/10/2022 | 12 | 116 | 0 | 2 | 6 | 3200 | 274 | 20 | 3.7 | 5 | 13.20 |
| Dungeness 0.7 | 2/14/2022 | 10 | | | | | | | | 7.9 | 4 | 11.80 |
| Dungeness 0.7 | 3/14/2022 | 10 | 60 | 0 | 2 | 3 | 3322 | 182 | 11 | 6.4 | 2 | 12.50 |
| Dungeness 0.7 | 4/26/2022 | 4 | | | | | | | | 7.5 | 2 | 12.20 |
| Dungeness 0.7 | 5/9/2022 | 10 | 30 | 0 | 0 | 4 | 3243 | 149 | 11 | 7.5 | 2 | 12.00 |

| Site | Date | FC (CFU/ 100ml) | $NO_3$-N (µg/L) | $NO_2$-N (µg/L) | $NH_3$-N (µg/L) | $PO_4$-P (µg/L) | $SiO_4$-Si (µg/L) | TN (µg/L) | TP (µg/L) | Temp $H_2O$ °C | Turbidity (FNU) | Dissolved Oxygen (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dungeness 0.7 | 6/13/2022 | 12 | | | | | | | | 9.0 | 8 | 11.50 |
| Dungeness 0.7 | 7/12/2022 | 40 | 19 | 0 | 2 | 3 | 2216 | 86 | 17 | 12.4 | 4 | 10.70 |
| Dungeness 0.7 | 8/8/2022 | 36 | | | | | | | | 14.1 | 2 | 10.50 |
| Dungeness 0.7 | 9/12/2022 | 40 | 86 | 1 | 11 | 4 | 3184 | 166 | 14 | 13.9 | 0 | 10.50 |
| Dungeness 0.7 | 10/10/2022 | 36 | | | | | | | | 11.7 | 1 | 11.00 |
| Dungeness 0.7 | 11/14/2022 | 4 | 47 | 0 | 0 | 5 | 2475 | 173 | 21 | 5.9 | 1 | 12.20 |
| Dungeness 0.7 | 12/5/2022 | 16 | | | | | | | | 3.8 | 2 | 13.10 |
| Gierin 1.8 | 1/11/2022 | 52 | | | | | | | | 4.6 | 4 | 12.10 |
| Gierin 1.8 | 5/26/2022 | 40 | | | | | | | | 10.3 | 9 | 10.70 |
| Gierin 1.8 | 8/9/2022 | 128 | | | | | | | | 14.4 | 16 | 9.80 |
| Gierin 1.8 | 11/16/2022 | 84 | | | | | | | | 5.7 | 5 | 12.00 |
| Golden Sands Slough 0.0 | 2/14/2022 | 18 | | | | | | | | 7.9 | 1 | 8.40 |
| Golden Sands Slough 0.0 | 3/14/2022 | 4 | 315 | 5 | 26 | 55 | 1268 | 682 | 105 | 8.8 | 15 | 8.60 |
| Golden Sands Slough 0.0 | 4/26/2022 | 4 | | | | | | | | 14.0 | 5 | 8.40 |
| Golden Sands Slough 0.0 | 5/9/2022 | 110 | 5 | 1 | 59 | 22 | 969 | 634 | 91 | 15.4 | 3 | 9.90 |
| Golden Sands Slough 0.0 | 6/13/2022 | 172 | | | | | | | | 16.0 | 5 | 7.80 |
| Golden Sands Slough 0.0 | 7/12/2022 | 232 | 5 | 1 | 47 | 35 | 1579 | 589 | 103 | 19.5 | 3 | 10.10 |
| Golden Sands Slough 0.0 | 8/8/2022 | 24 | | | | | | | | 21.3 | 4 | 10.00 |
| Golden Sands Slough 0.0 | 9/12/2022 | 6 | 4 | 4 | 92 | 41 | 972 | 509 | 80 | 17.5 | 4 | 9.60 |
| Golden Sands Slough 0.0 | 10/10/2022 | 10 | | | | | | | | 14.2 | 5 | 9.90 |
| Golden Sands Slough 0.0 | 11/14/2022 | 170 | 22 | 4 | 768 | 101 | 6284 | 1930 | 350 | 8.7 | 47 | 0.00 |
| Golden Sands Slough 0.0 | 12/5/2022 | 48 | | | | | | | | 6.1 | 10 | 7.50 |
| Hurd 0.2 | 1/11/2022 | 2 | | | | | | | | 8.6 | 1 | 10.00 |
| Hurd 0.2 | 5/26/2022 | 10 | | | | | | | | 9.7 | 1 | 10.00 |
| Hurd 0.2 | 8/9/2022 | 22 | | | | | | | | 10.4 | 1 | 9.30 |
| Hurd 0.2 | 11/16/2022 | 4 | | | | | | | | 9.1 | 0 | 10.00 |
| Jimmycomelately 0.15 | 1/10/2022 | 2 | 407 | 1 | 0 | 12 | 6714 | 711 | 31 | 3.4 | 7 | 13.30 |
| Jimmycomelately 0.15 | 2/14/2022 | 8 | | | | | | | | 4.2 | 2 | 12.60 |
| Jimmycomelately 0.15 | 3/14/2022 | 4 | 205 | 1 | 1 | 15 | 7734 | 430 | 27 | 5.5 | 3 | 12.40 |
| Jimmycomelately 0.15 | 4/26/2022 | 4 | | | | | | | | 6.3 | 5 | 12.20 |
| Jimmycomelately 0.15 | 5/9/2022 | 10 | 156 | 1 | 0 | 10 | 7157 | 454 | 28 | 5.2 | 6 | 12.50 |
| Jimmycomelately 0.15 | 6/13/2022 | 12 | | | | | | | | 9.2 | 4 | 11.20 |

| Site | Date | FC (CFU/ 100ml) | $NO_3$-N (µg/L) | $NO_2$-N (µg/L) | $NH_3$-N (µg/L) | $PO_4$-P (µg/L) | $SiO_4$-Si (µg/L) | TN (µg/L) | TP (µg/L) | Temp $H_2O$ °C | Turbidity (FNU) | Dissolved Oxygen (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jimmycomelately 0.15 | 7/12/2022 | 42 | 116 | 1 | 5 | 21 | 8122 | 280 | 39 | 12.9 | 1 | 9.90 |
| Jimmycomelately 0.15 | 8/8/2022 | 368 | | | | | | | | 14.1 | 1 | 9.40 |
| Jimmycomelately 0.15 | 9/12/2022 | 24 | 255 | 3 | 128 | 37 | 8561 | 652 | 85 | 13.3 | 11 | 8.40 |
| Jimmycomelately 0.15 | 10/10/2022 | 68 | | | | | | | | 11.2 | 1 | 7.60 |
| Jimmycomelately 0.15 | 11/14/2022 | 20 | 378 | 1 | 4 | 17 | 7482 | 703 | 32 | 4.4 | 2 | 12.50 |
| Jimmycomelately 0.15 | 12/5/2022 | 12 | | | | | | | | 2.5 | 1 | 13.00 |
| Johnson 0.0 | 1/10/2022 | 10 | 328 | 3 | 30 | 42 | 7278 | 930 | 87 | 2.9 | 23 | 13.70 |
| Johnson 0.0 | 2/14/2022 | 8 | | | | | | | | 4.9 | 2 | 12.70 |
| Johnson 0.0 | 3/14/2022 | 8 | 209 | 1 | 3 | 39 | 8232 | 571 | 55 | 5.8 | 5 | 12.70 |
| Johnson 0.0 | 4/26/2022 | 4 | | | | | | | | 7.6 | 4 | 12.10 |
| Johnson 0.0 | 5/9/2022 | 10 | 118 | 2 | 2 | 25 | 6665 | 465 | 44 | 6.5 | 8 | 12.30 |
| Johnson 0.0 | 6/13/2022 | 58 | | | | | | | | 9.6 | 5 | 11.40 |
| Johnson 0.0 | 7/12/2022 | 78 | 353 | 2 | 10 | 50 | 8406 | 495 | 75 | 13.7 | 1 | 10.10 |
| Johnson 0.0 | 8/8/2022 | 86 | | | | | | | | 14.8 | 1 | 9.90 |
| Johnson 0.0 | 9/12/2022 | 32 | 225 | 1 | 3 | 44 | 7061 | 368 | 72 | 14.3 | 1 | 10.00 |
| Johnson 0.0 | 10/10/2022 | 88 | | | | | | | | 11.2 | 1 | 10.80 |
| Johnson 0.0 | 11/14/2022 | 16 | 45 | 1 | 1 | 46 | 9178 | 301 | 65 | 5.1 | 2 | 12.70 |
| Johnson 0.0 | 12/5/2022 | 8 | | | | | | | | 2.3 | 0 | 13.50 |
| Lotzgesell 0.1 | 1/10/2022 | 40 | 1545 | 5 | 15 | 13 | 6589 | 1873 | 34 | 6.6 | 6 | 10.40 |
| Lotzgesell 0.1 | 2/14/2022 | 46 | | | | | | | | 8.3 | 5 | 10.40 |
| Lotzgesell 0.1 | 3/14/2022 | 2 | 1943 | 3 | 8 | 9 | 7038 | 2224 | 31 | 9.8 | 5 | 10.70 |
| Lotzgesell 0.1 | 4/26/2022 | 18 | | | | | | | | 10.6 | 5 | 10.80 |
| Lotzgesell 0.1 | 5/9/2022 | 110 | 1989 | 3 | 6 | 8 | 6939 | 2290 | 28 | 10.7 | 6 | 10.80 |
| Lotzgesell 0.1 | 6/13/2022 | 222 | | | | | | | | 11.8 | 7 | 9.80 |
| Lotzgesell 0.1 | 7/12/2022 | 188 | 2116 | 5 | 13 | 9 | 7022 | 2317 | 39 | 12.9 | 8 | 9.20 |
| Lotzgesell 0.1 | 8/8/2022 | 210 | | | | | | | | 12.9 | 7 | 9.30 |
| Lotzgesell 0.1 | 9/12/2022 | 80 | 2166 | 4 | 14 | 8 | 6811 | 2280 | 36 | 17.5 | 5 | 9.70 |
| Lotzgesell 0.1 | 10/10/2022 | 264 | | | | | | | | 11.0 | 5 | 9.80 |
| Lotzgesell 0.1 | 11/14/2022 | 20 | 1511 | 3 | 7 | 12 | 7530 | 1745 | 32 | 8.4 | 2 | 8.80 |
| Lotzgesell 0.1 | 12/5/2022 | 4 | | | | | | | | 6.6 | 2 | 9.80 |
| Matriotti 0.3a | 1/10/2022 | 40 | 1545 | 5 | 15 | 13 | 6589 | 1873 | 34 | 6.6 | 6 | 10.40 |
| Matriotti 0.3a | 2/14/2022 | 46 | | | | | | | | 8.3 | 5 | 10.40 |

| Site | Date | FC (CFU/ 100ml) | $NO_3$-N (µg/L) | $NO_2$-N (µg/L) | $NH_3$-N (µg/L) | $PO_4$-P (µg/L) | $SiO_4$-Si (µg/L) | TN (µg/L) | TP (µg/L) | Temp $H_2O$ °C | Turbidity (FNU) | Dissolved Oxygen (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Matriotti 0.3a | 3/14/2022 | 2 | 1943 | 3 | 8 | 9 | 7038 | 2224 | 31 | 9.8 | 5 | 10.70 |
| Matriotti 0.3a | 4/26/2022 | 18 | | | | | | | | 10.6 | 5 | 10.80 |
| Matriotti 0.3a | 5/9/2022 | 110 | 1989 | 3 | 6 | 8 | 6939 | 2290 | 28 | 10.7 | 6 | 10.80 |
| Matriotti 0.3a | 6/13/2022 | 222 | | | | | | | | 11.8 | 7 | 9.80 |
| Matriotti 0.3a | 7/12/2022 | 188 | 2116 | 5 | 13 | 9 | 7022 | 2317 | 39 | 12.9 | 8 | 9.20 |
| Matriotti 0.3a | 8/8/2022 | 210 | | | | | | | | 12.9 | 7 | 9.30 |
| Matriotti 0.3a | 9/12/2022 | 80 | 2166 | 4 | 14 | 8 | 6811 | 2280 | 36 | 17.5 | 5 | 9.70 |
| Matriotti 0.3a | 10/10/2022 | 264 | | | | | | | | 11.0 | 5 | 9.80 |
| Matriotti 0.3a | 11/14/2022 | 20 | 1511 | 3 | 7 | 12 | 7530 | 1745 | 32 | 8.4 | 2 | 8.80 |
| Matriotti 0.3a | 12/5/2022 | 4 | | | | | | | | 6.6 | 2 | 9.80 |
| McDonald 01.6 | 1/11/2022 | 30 | | | | | | | | 3.1 | 21 | 13.60 |
| McDonald 01.6 | 5/26/2022 | 14 | | | | | | | | 9.3 | 2 | 11.60 |
| McDonald 01.6 | 8/9/2022 | 134 | | | | | | | | 14.4 | 2 | 10.20 |
| McDonald 01.6 | 11/16/2022 | 24 | | | | | | | | 3.9 | 1 | 13.30 |
| Meadowbrook 0.2 | 1/10/2022 | 60 | 287 | 4 | 78 | 34 | 3256 | 687 | 72 | 5.4 | 10 | 8.30 |
| Meadowbrook 0.2 | 2/14/2022 | 100 | | | | | | | | 6.7 | 3 | 9.60 |
| Meadowbrook 0.2 | 3/14/2022 | 42 | 153 | 3 | 66 | 16 | 5770 | 392 | 40 | 9.1 | 2 | 9.70 |
| Meadowbrook 0.2 | 4/26/2022 | 28 | | | | | | | | 11.8 | 4 | 9.00 |
| Meadowbrook 0.2 | 5/9/2022 | 50 | 48 | 2 | 46 | 14 | 5674 | 301 | 47 | 12.6 | 4 | 8.90 |
| Meadowbrook 0.2 | 6/13/2022 | 100 | | | | | | | | 14.7 | 4 | 8.60 |
| Meadowbrook 0.2 | 7/12/2022 | 76 | 27 | 2 | 63 | 18 | 5233 | 377 | 71 | 17.9 | 4 | 8.30 |
| Meadowbrook 0.2 | 8/8/2022 | 1512 | | | | | | | | 19.0 | 18 | 6.10 |
| Meadowbrook 0.2 | 9/12/2022 | 20 | 66 | 4 | 40 | 17 | 5082 | 233 | 41 | 15.1 | 2 | 8.20 |
| Meadowbrook 0.2 | 10/10/2022 | 36 | | | | | | | | 12.4 | 3 | 8.30 |
| Meadowbrook 0.2 | 11/14/2022 | 132 | 127 | 5 | 126 | 53 | 4495 | 596 | 106 | 7.5 | 4 | 6.50 |
| Meadowbrook 0.2 | 12/5/2022 | 128 | | | | | | | | 6.9 | 2 | 6.20 |
| No Name 0.03 | 1/11/2022 | 18 | | | | | | | | 5.2 | 72 | 12.80 |
| No Name 0.03 | 5/26/2022 | 2 | | | | | | | | 10.1 | 6 | 11.20 |
| No Name 0.03 | 8/9/2022 | 242 | | | | | | | | 17.0 | 17 | 8.90 |
| No Name 0.03 | 11/16/2022 | 36 | | | | | | | | 6.1 | 2 | 12.50 |
| Sequim Bay State Park Creek 0.0 | 3/14/2022 | 2 | 58 | 1 | 23 | 40 | 7505 | 585 | 60 | 6.3 | 4 | 12.30 |
| Sequim Bay State Park Creek 0.0 | 4/26/2022 | 24 | | | | | | | | 8.3 | 3 | 11.60 |

| Site | Date | FC (CFU/ 100ml) | $NO_3$-N (µg/L) | $NO_2$-N (µg/L) | $NH_3$-N (µg/L) | $PO_4$-P (µg/L) | $SiO_4$-Si (µg/L) | TN (µg/L) | TP (µg/L) | Temp $H_2O$ °C | Turbidity (FNU) | Dissolved Oxygen (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sequim Bay State Park Creek 0.0 | 5/9/2022 | 30 | 21 | 2 | 3 | 44 | 7860 | 625 | 70 | 7.5 | 5 | 11.80 |
| Sequim Bay State Park Creek 0.0 | 6/13/2022 | 16 | | | | | | | | 11.1 | 2 | 10.60 |
| Sequim Bay State Park Creek 0.0 | 8/8/2022 | 124 | | | | | | | | 14.9 | 2 | 7.10 |
| Sequim Bay State Park Creek 0.0 | 12/5/2022 | 4 | | | | | | | | 3.2 | 3 | 13.30 |
| Sequim Bay State Park Creek 0.1 | 7/12/2022 | 32 | 249 | 1 | 1 | 61 | 8061 | 619 | 81 | 13.0 | 2 | 9.50 |
| Sequim Bay State Park Creek 0.1 | 11/14/2022 | 4 | 8 | 1 | 3 | 62 | 7188 | 511 | 80 | 5.8 | 1 | 12.40 |
| Siebert 1.0 | 1/11/2022 | 20 | | | | | | | | 3.3 | 32 | 13.50 |
| Siebert 1.0 | 5/26/2022 | 4 | | | | | | | | 9.7 | 1 | 11.50 |
| Siebert 1.0 | 8/9/2022 | 34 | | | | | | | | 14.6 | 1 | 10.20 |
| Siebert 1.0 | 11/16/2022 | 4 | | | | | | | | 3.4 | 1 | 13.50 |

## Appendix C: Charts of Additional Physical and Chemical Parameters

Summaries of data collected per Streamkeepers QAPP (in addition to data collected per the PIC QAPP) are presented in the charts below.

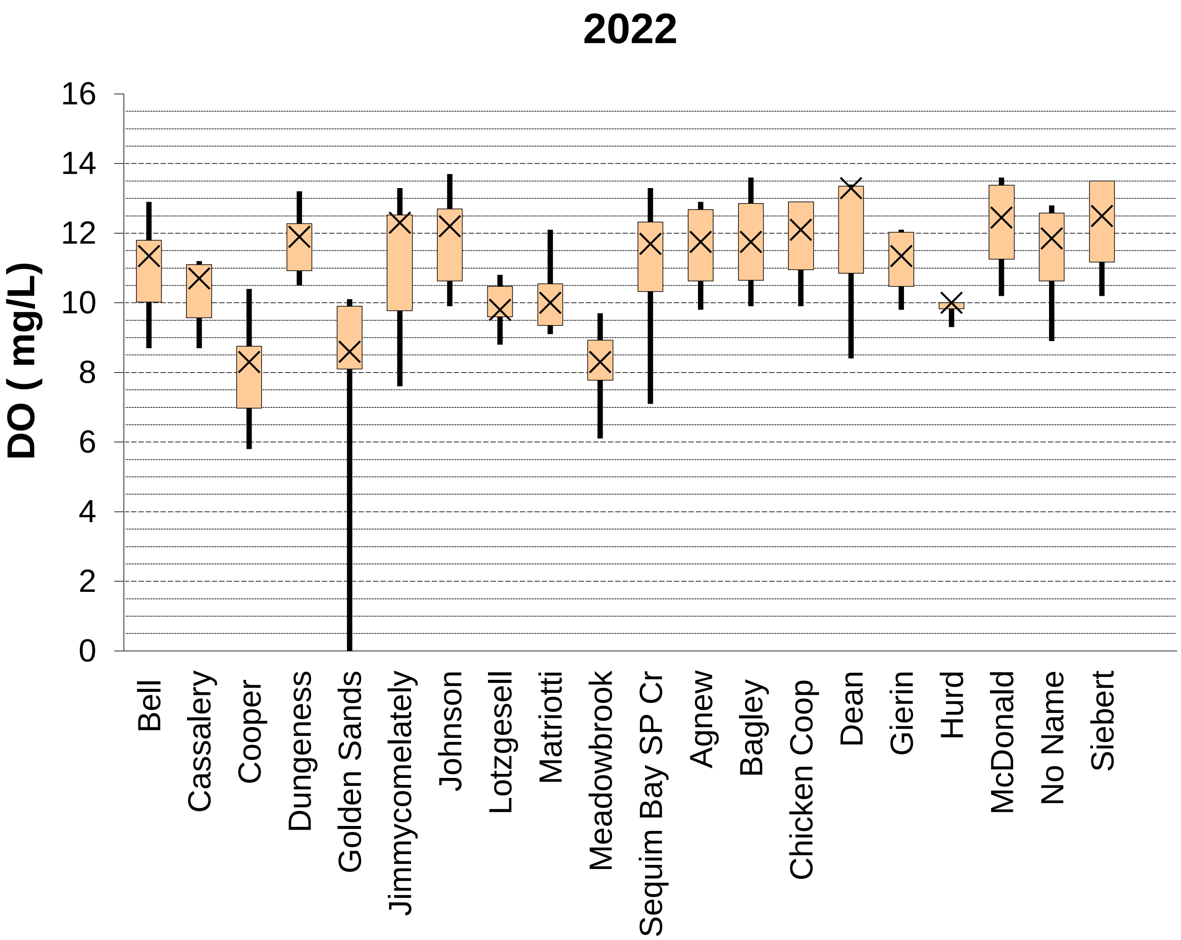


**Figure 14. Dissolved Oxygen, all CWD streams.** X marks median; bottom and top of box represent 1st and 3rd quartiles; ends of whiskers represent min. and max. values. According to Washington State Freshwater Aquatic Life Criteria for salmonid spawning and rearing, the 1-day minimum D.O. for Core Summer Salmonid Habitat is 9.5 mg/L (WAC 173-201A-200, 2019). According to Washington State Marine Aquatic Life Criteria for fish and shellfish spawning and rearing (extraordinary quality category), the 1-day minimum D.O. is 7.0 mg/L (WAC 173-201A-210, 2022).

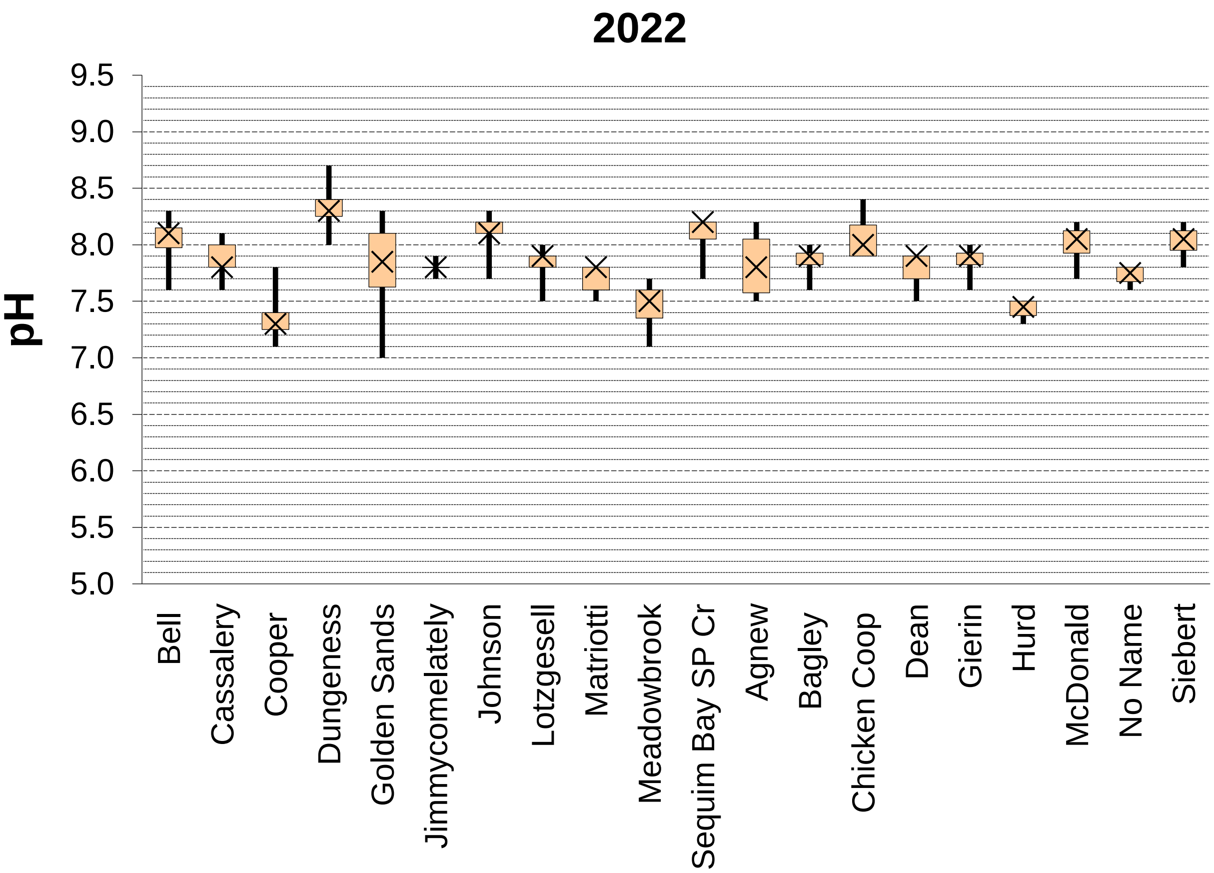


**Figure 15. pH, all CWD streams.** X marks median; bottom and top of box represent 1st and 3rd quartiles; ends of whiskers represent min. and max. values. According to Washington State Freshwater Aquatic Life Criteria for Core Summer Salmonid Habitat, pH should be in the range 6.5-8.5 (WAC 173-201A-200, 2022).

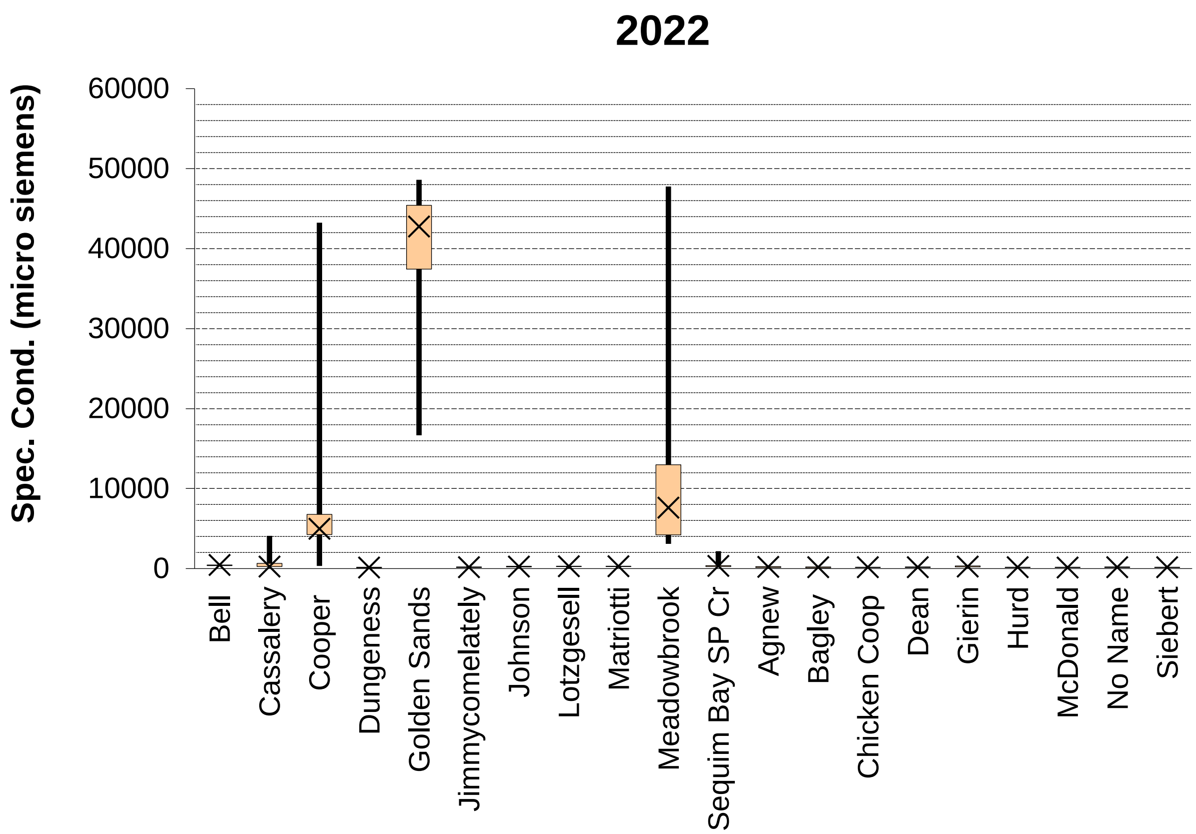


**Figure 16. Specific conductivity, all CWD streams.** X marks median; bottom and top of box represent 1st and 3rd quartiles; ends of whiskers represent min. and max. values.

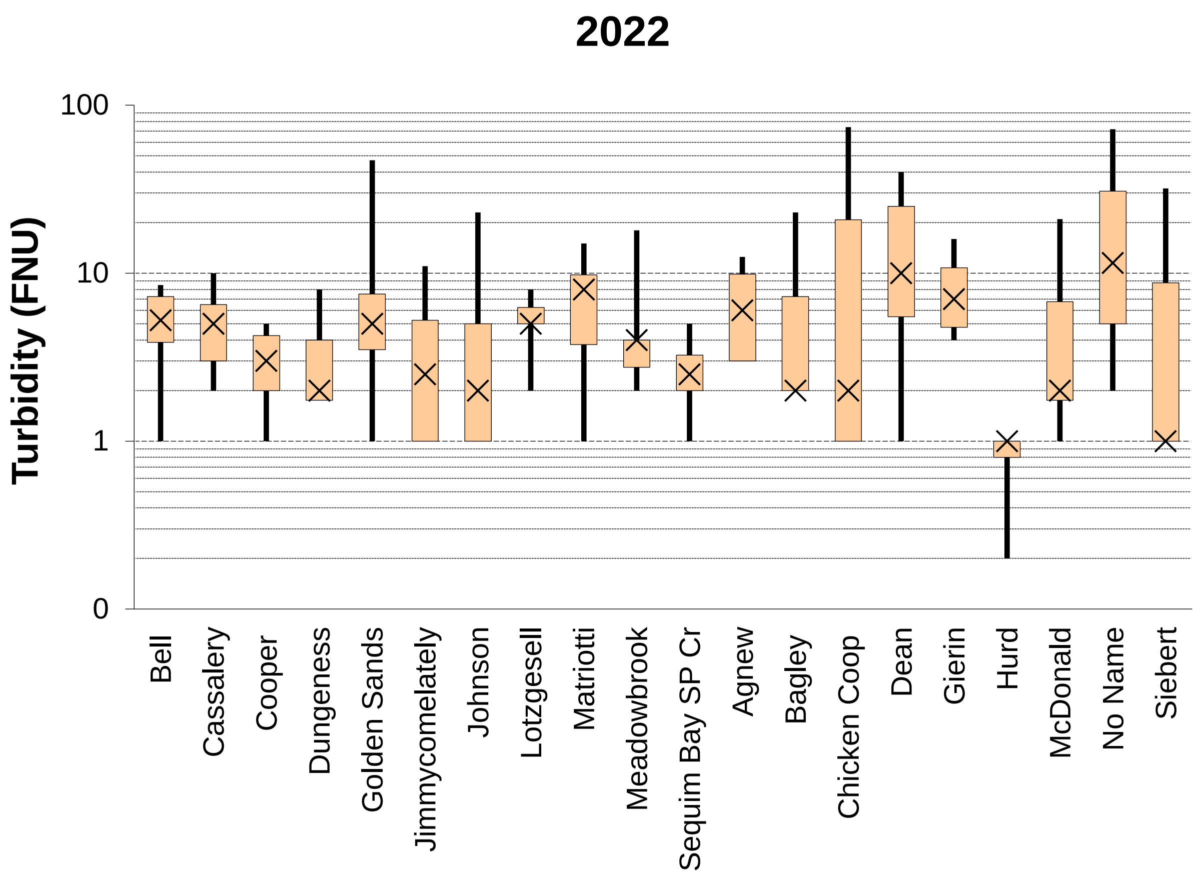


**Figure 17. Turbidity, all CWD streams.** Note log scale. X marks median; bottom and top of box represent 1st and 3rd quartiles; ends of whiskers represent min. and max. values.