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

May 2015-April 2016

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Sequim-Dungeness Clean Water District
Pollution Identification & Correction Plan
Trends Monitoring Program
Annual Report
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In May 2015, Clallam County Environmental Health, with the assistance of staff and volunteers from Streamkeepers of Clallam County, initiated a monthly trends monitoring project in the Sequim-Dungeness Clean Water District (District) as part of the Pollution Identification and Correction Plan that had been devised for the District in 2014 (Clallam Conservation District, 2014). The study area covered all streams within the District, which is a shellfish protection district formed after the downgrade of commercial growing areas in Dungeness Bay in 2000, and is basically equivalent to the Marine Recovery Area designated by Clallam County in 2007.

Sampling Approach and Results

The objective of the 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 Clean Water District (CWD). This program continues the work performed by other water quality investigations over the past two decades to identify polluted water bodies and prioritize targeted investigations in the CWD. As in the past investigations, the sampling in the Trends Monitoring focuses on parameters associated with human sewage and animal waste such as fecal coliform and nutrients.

Sampling locations were established as close to the discharge points of the streams as was practical, given ownership, access, and tidal conditions. Twelve streams were considered Tier 1 sites and nine were considered Tier 2 sites. Tier 1 sites were to be sampled monthly for both fecal coliforms (fecals) and nutrients (NH4, NO2, NO3, TN, PO4, TP, and silicates) and Tier 2 were to be sampled quarterly (January, April, August, November) for fecals only. Table 1 describes the Tier 1 and Tier 2 sites, and Figures 1-3 show their locations.

To compensate for a shortfall in funding, Clallam County Environmental Health staff with approval of the Clean Water Work Group partners decided to adjust the Trends Monitoring program by decreasing the number of sampling sites. Nine instead of twelve of the Tier 1 streams were monitored monthly for fecals and nutrients, the remaining four Tier 1 streams were monitored quarterly for fecals only, and none of the Tier 2 streams were monitored. The nine Tier 1 sites were chosen for monthly sampling because they were in the areas of the PIC pilot project while the four Tier 1sites that were sampled quarterly were further east from the PIC pilot project in the Sequim Bay area. In October 2015 more funding became available from DOH and the Trends Monitoring Program increased sampling to the original proposed sampling of all twelve Tier 1 sites monthly for fecals and nutrients and sampling Tier 2 sites quarterly for fecals only.

Per the Quality Assurance Project Plan (QAPP) (Chadd and Bond, 2015), measurements were also taken of conventional water quality and water level (stage) or stream flow from streams that have real-time gauges (Dungeness and McDonald) . Water quality parameters measured initially consisted of water temperature and salinity only, but beginning in September 2015, Streamkeepers acquired a new multi-parameter meter, and additional measurements were taken of dissolved oxygen, pH, conductivity, turbidity, and barometric pressure. Table 1 describes the sites and the sampling that was conducted, and Figures 1-3 show their locations.

Table 1. Site locations and type of sampling performed from May 2015-April 2016.

Tier 1 sites were to be sampled monthly for fecal coliform and nutrients, and Tier 2 sites were to be sampled quarterly for fecal coliform only. However, an initial funding shortfall led to less sampling than planned for the last four Tier 1 sites listed and no sampling on the Tier 2 sites for the first two quarters. In the table below, cells with F were sampled for fecal coliform and with N were sampled for nutrients. At any cell with F or N, water-quality parameters were measured as described in earlier text.

Dung. Bay/R. = Dungeness Bay/River; Seq. Bay = Sequim Bay; SJF = Strait of Juan de Fuca

Tier	Stream/Site Name	Receiving Waters	5/15	6/15	7/15	8/15	9/15**	10/15	11/15	12/15	1/16	2/16	3/16	4/16
1	Dungeness 0.7	Dung.Bay	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N
1	Meadowbrook 0.1	Dung.Bay	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N
1	Meadowbrook Slough 0.23	Dung.Bay	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N
1	Golden Sands Slough 0.0	Dung.Bay	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N
1	Cooper 0.1	Dung.Bay	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N
1	Cassalery 0.0/0.6*	Dung.Bay	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N
1	Matriotti 0.3a	Dung. R.	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N
1	Lotzgesell 0.1	Dung. R.	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N	F N
1	Sequim Bay State Park Creek 0.0	Seq. Bay	F			F		F N	F N	F N	F N	F N	F N	F N
1	Bell 0.2	Seq. Bay	F			F		F N	F N	F N	F N	F N	F N	F N
1	Johnson 0.0	Seq. Bay	F			F		F N	F N	F N	F N	F N	F N	F N
1	Jimmycomelately 0.15	Seq. Bay	F			F		F N	F N	F N	F N	F N	F N	F N
2	Bagley 0.7a	SJF							F		F			F
2	Siebert 1.0	SJF							F		F			F
2	Agnew Ditch @1079 Finn Hall Rd	SJF							F		F			F
2	McDonald 01.6	SJF							F		F			F
2	Hurd 0.2	Dung. R.							F		F			F
2	Gierin 1.8	Dung.Bay							F		F			F
2	Dean 0.17	Seq. Bay							F		F			F
2	No Name 0.03	Seq. Bay							F		F			F
2	Chicken Coop 0.24	Seq. Bay							F		F			F

*Depending on tidal conditions

**Point at which water quality parameter sampling expanded from salinity and temperature only, to include dissolved oxygen, pH, conductivity, turbidity, and barometric pressure

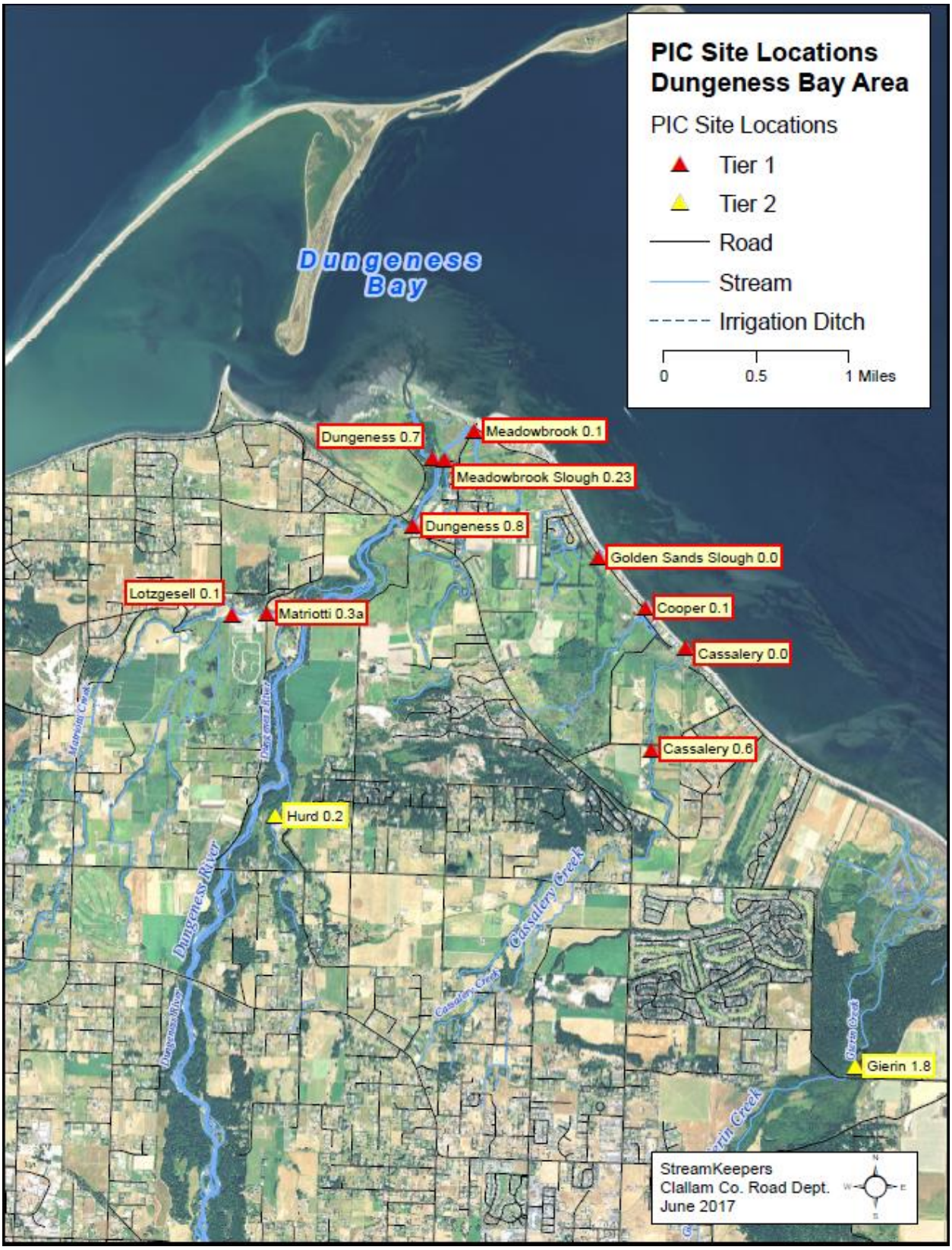

Figure 1. Sampling sites for Clean Water District PIC Trends monitoring, Dungeness Bay area. Dungeness 0.8 is the location of the Dept. of Ecology real-time flow meter, which we recorded data from.

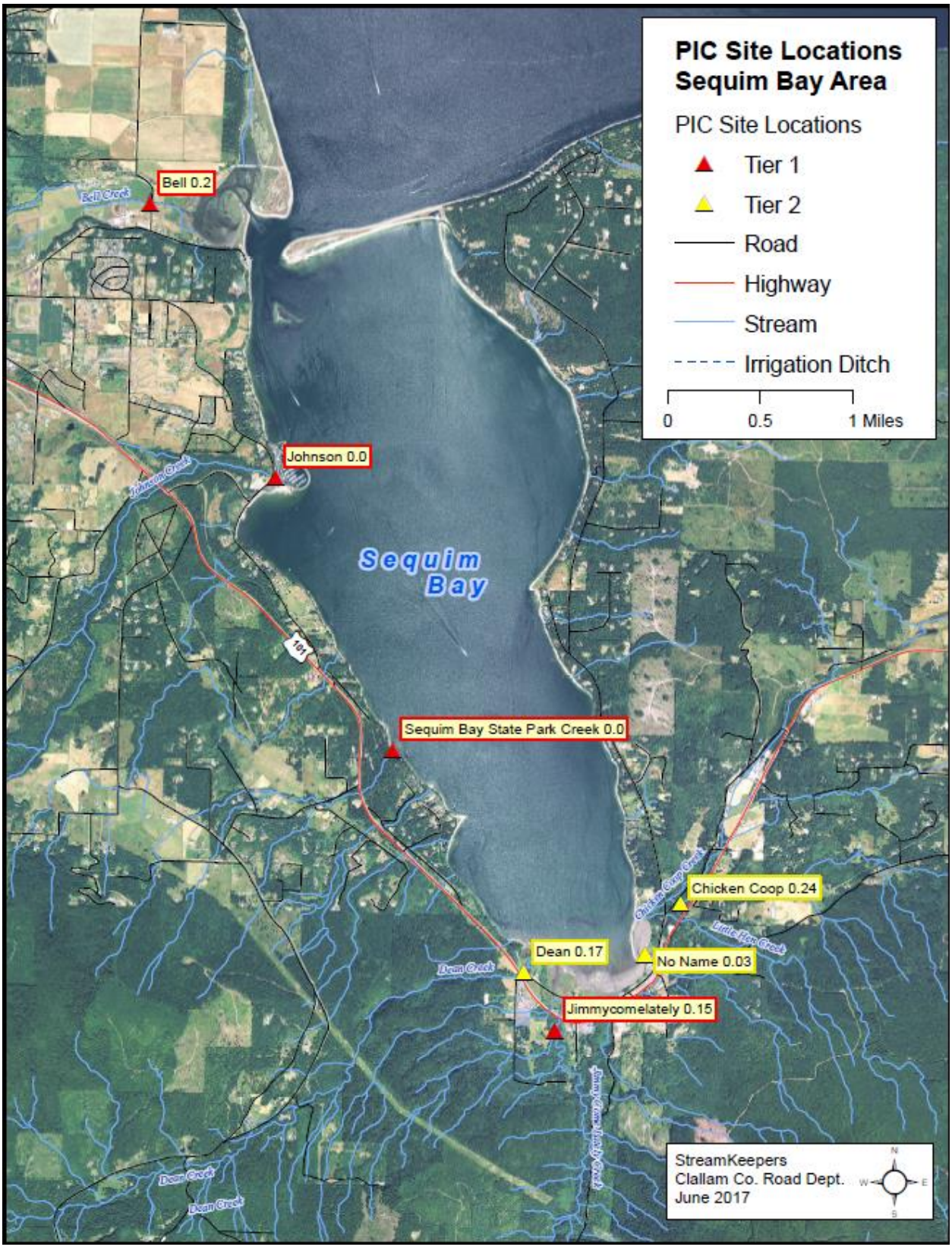

Figure 2. Sampling sites for Clean Water District PIC Trends monitoring, Sequim Bay area.

Figure 3. Sampling sites for Clean Water District PIC Trends monitoring, streams west of Dungeness Bay.

Data caveats

In the analysis of data, there are some items of note:

- Nutrients samples were analyzed by the University of Washington Marine Chemistry Lab (UW). As of 2015, the WA Dept. of Ecology no longer recognizes the validity of UW nutrients analysis procedures for data interpretation for the 303(d) list under the Clean Water Act. Hence, the nutrients data is for general descriptive purposes only. We chose to use the UW lab rather than a lab whose results would qualify for 303(d) analysis, such as Ecology's lab, because the UW lab has traditionally been used for nutrients samples in the Clean Water District, it is least expensive and easiest to collect the samples for UW, side-by-side comparisons between the UW and Ecology labs in 2013-14 showed generally good correlation, and 303(d)-qualifying data are not deemed necessary for nutrient data in this project, which is more focused on bacterial contamination.
- Data qualifiers used are per Ecology's Environmental Information Management (EIM) system.
- No rejected (REJ) data are used in our analyses.
- Field replicates are averaged with regular samples. Replicate/sample comparisons, as well as other QC analyses, are examined in a later section of this report.

- Field blanks were recorded and are used for QC analyses but are not used in this report in generating statistics or figures.
- Some of the sites are tidally influenced to varying degrees, as can be seen in the figure below presenting the salinity data. We tried sampling during low-tide conditions, but this was not always possible.

Data quality analysis

Blanks analysis

All fecal coliform blanks were non-detects. For nutrients blanks, results were as follows:

Table 2. Nutrients field blank (FB) results and QC analysis. Values greater than the synthesized Reporting Limit are highlighted; results corresponding to these cases have been qualified per the QAPP.

Arrival date	PO_4-P	SiO_4-Si	NO_3-N	NO_2-N	NH_4-N	TP	TN
12-May-15	0.4	21.2	0.5	0.0	4.2	5.9	46.3
11-Jun-15	1.4	92.6	0.2	0.1	2.2	5.9	46.3
7-Jul-15	0.1	10.7	0.0	0.1	0.5	2.4	90.0
13-Aug-15	0.8	6.3	0.0	0.2	0.9	0.0	20.7
10-Sep-15	0.8	8.0	-0.4	0.2	0.3	0.0	63.7
8-Oct-15	0.9	11.8	0.0	0.0	2.6	1.5	74.8
23-Nov-15	2.1	36.6	0.9	0.4	1.4	0.7	22.0
17-Dec-15	1.1	29.9	0.2	0.0	2.8	2.3	97.4
25-Jan-16	0.5	25.4	0.0	0.0	0.0	1.4	93.1
17-Feb-16	0.0	54.9	0.0	0.0	4.3	3.0	88.5
15-Mar-16	0.3	25.9	0.0	0.0	0.0	0.2	45.4
11-Apr-16	0.0	4.6	1.9	0.0	1.8	0.0	53.3
FB means	0.7	27.3	0.3	0.1	1.7	1.9	61.8
Standard Deviation of field blank	0.6	25.2	0.6	0.1	1.5	2.1	27.0
2015 MDL(ug/L)—from lab	0.5	13.2	2.0	0.3	0.5	0.5	4.8
2014 MDL (for comparison)	0.9	16.6	2.1	0.3	1.7	1.1	6.2
2015-16 synthesized Reporting Limit*	1.6	52.6	6.4	1.0	3.3	4.0	88.8
*Per QAPP, RL is the larger of 3.18 * MDL or mean field blank measurement +1 SD							
Highlighted cells represent blanks ≥ synthesized Reporting Limit							
Comparison to 2013-14 means and reporting limits:							
2013-14 means	0.4	107.0	2.2	0.1	2.4	1.6	67.0
2013-14 synthesized Reporting Limit	2.9	158.0	6.7	1.0	5.4	3.5	96.7

Field replicate analysis: fecal coliform

Fecal coliform field replicate results passed all QC criteria, as shown below.

Table 3. Fecal coliform field replicate results and QC analysis.

Date	QC_Type	Qualifier/Comments	Fecal Coliform		Prim/Rep RSD%	RSD% excluded*
5/12/2015	Primary		174		2.8	
5/12/2015	Replicate		181			
6/11/2015	Primary		60		30.0	
6/11/2015	Replicate		39			
7/7/2015	Primary		54		49.5	
7/7/2015	Replicate		26			
8/13/2015	Primary	G	366		6.5	
8/13/2015	Replicate	G	401			
9/10/2015	Primary		104		8.9	
9/10/2015	Replicate		118			
10/8/2015	Primary		224		2.2	
10/8/2015	Replicate		217			
11/23/2015	Primary		26			42.4
11/23/2015	Replicate		14			
12/17/2015	Primary		120		14.3	
12/17/2015	Replicate		98			
1/25/2016	Primary		80		7.4	
1/25/2016	Replicate		72			
2/17/2016	Primary		242		28.8	
2/17/2016	Replicate		160			
3/15/2016	Primary		50		8.0	
3/15/2016	Replicate		56			
4/11/2016	Primary		208		13.0	
4/11/2016	Replicate		173			
		*Excluded datum < 20 cfu, per QAPP		**Total qualifying pairs:**		**11**

		Total	%	% Criterion	Passed?
Analysis of field replicate pair precision, per QAPP:	**Pairs <20% RSD:**	**8**	**73**	**50**	**Yes**
	Pairs <50% RSD:	**11**	**100**	**90**	**Yes**
	Pairs <85% RSD:	**11**	**100**	**100**	**Yes**

Field replicate analysis: nutrients

Nutrients field replicate results passed all QC criteria, as shown below.

Table 4. Nutrients field replicate results and QC analysis.

Analyte	# pairs	# pairs > median RSD criterion	median RSD%	Criterion	Pass?
Phosphate	12	0	1.8	10%	Yes
Silicate	12	0	0.4	10%	Yes
Nitrate	12	0	1.7	10%	Yes
Nitrite	12	0	0	10%	Yes
Ammonia	12	1	3.8	15%	Yes
TN	12	0	0.8	10%	Yes
TP	12	0	3.1	10%	Yes

Nutrients laboratory standards checks

UW lab standards check results all passed QC criteria, as shown below.

Table 5. Laboratory nutrients standards checks QC analysis.

	PO4-P	SiO4-Si	NO3-N	NO3-N	NH4-N	TP	TN
# results*	24	24	24	24	24	10	10
stdev of % differences	1.90%	3.59%	0.43%	1.91%	1.87%	2.21%	1.8%
stdev allowable per QAPP	20.0%	15.0%	15.0%	20.0%	20.0%	10.0%	10.0%
# results > allowable per QAPP	0	0	0	0	0	0	0
% measurements which pass QC	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

* Dissolved nutrients standards are checked before and after nutrients analysis: 12 months * 2 tests = 24. Total nutrients standards are checked only after nutrients analysis, and in two cases, two months' batches were combined; therefore a total of 10 tests.

Deviations from QAPP

As the Trends Monitoring progressed, adjustments were made that led to some deviations from the QAPP:

- Deviations in frequency of fecal and nutrients samples are noted in Table 1.
- Additional water quality parameters were added in September 2015 per Table 1.
- Nutrient laboratory MDLs for 2015 differed from those listed in the QAPP for 2014, as noted in Table 2 above.
- QAPP holding temperature for all laboratory samples was listed at 4°C. After correspondence with Ecology personnel and consultation with EPA 40 CFR and Standard Methods, holding temperatures were revised as follows:

- Fecal coliform samples: 10°C
- Nutrients samples: 6°C
- Samples held less than two hours do not need to meet the above temperatures but do need to show signs of chilling down toward those temperatures.

Environmental data summary

Data are detailed in Appendix 1. This section presents a summary of the data.

Fecal Coliform

Water samples were stored in ice chests and analyzed at Clallam County Environmental Laboratory for fecal coliform with a holding time less than 8 hours. The results by site are summarized in Figure 4.

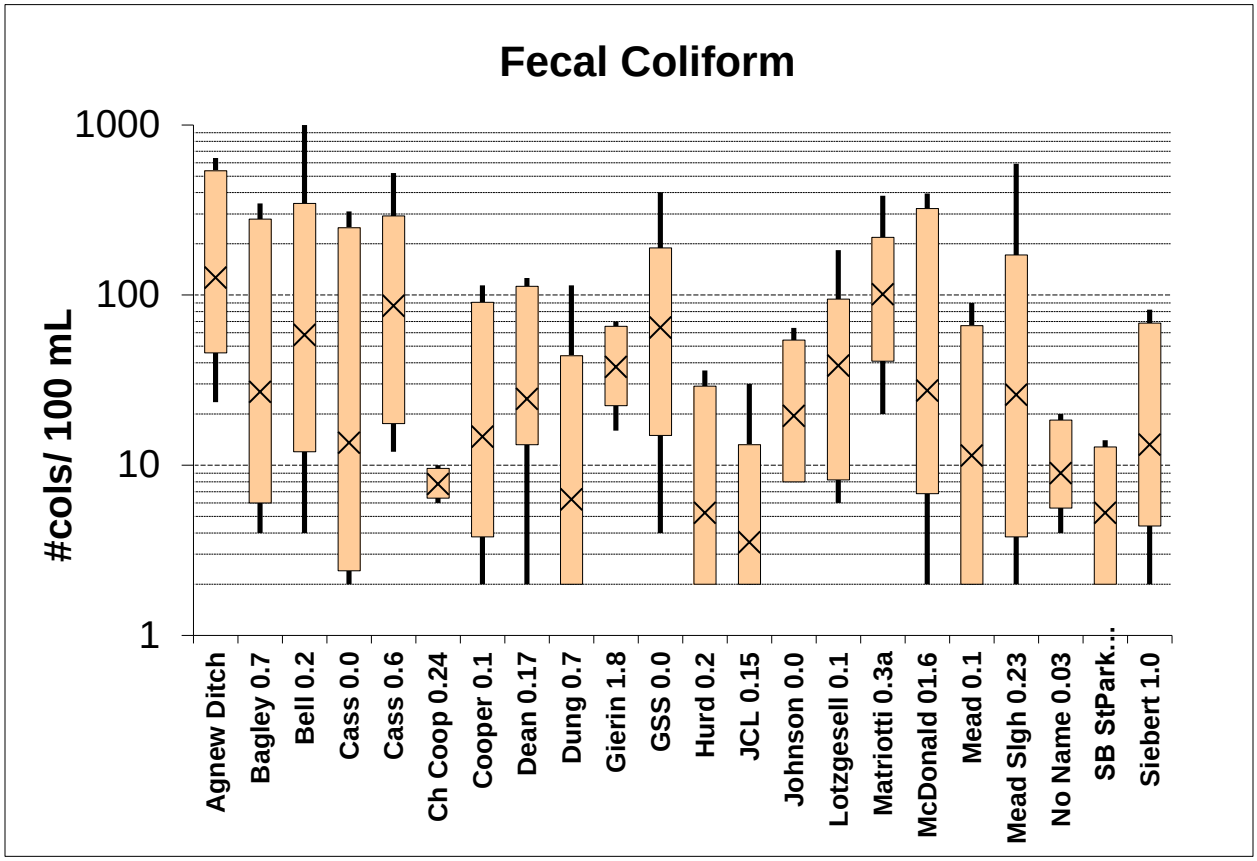

Figure 4. Fecal Coliform. Note log scale. X marks the geometric mean; bottom and top of the box represent the 10th and 90th percentiles; ends of the whiskers represent extremes.

Nutrients: As explained above, nutrients data reported here are from the UW lab.

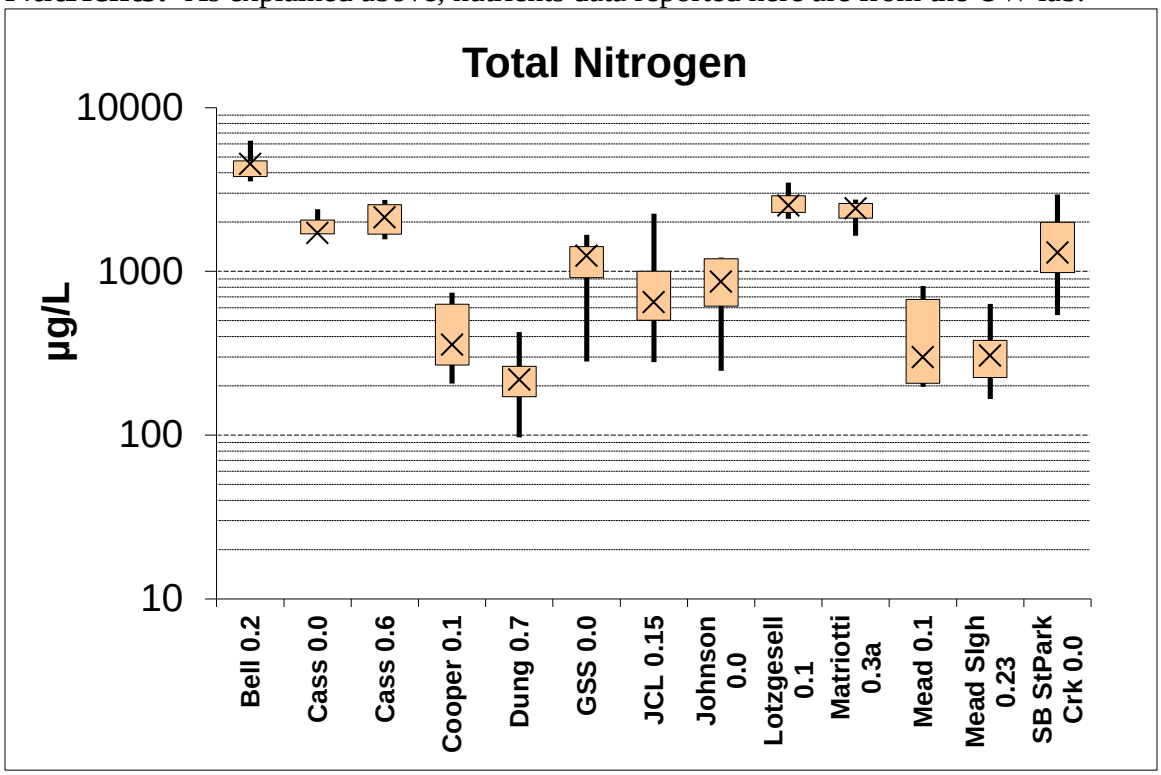

Figure 5. Total nitrogen. X marks median, box the 1st and 3rd quartiles, and bars the min and max values.

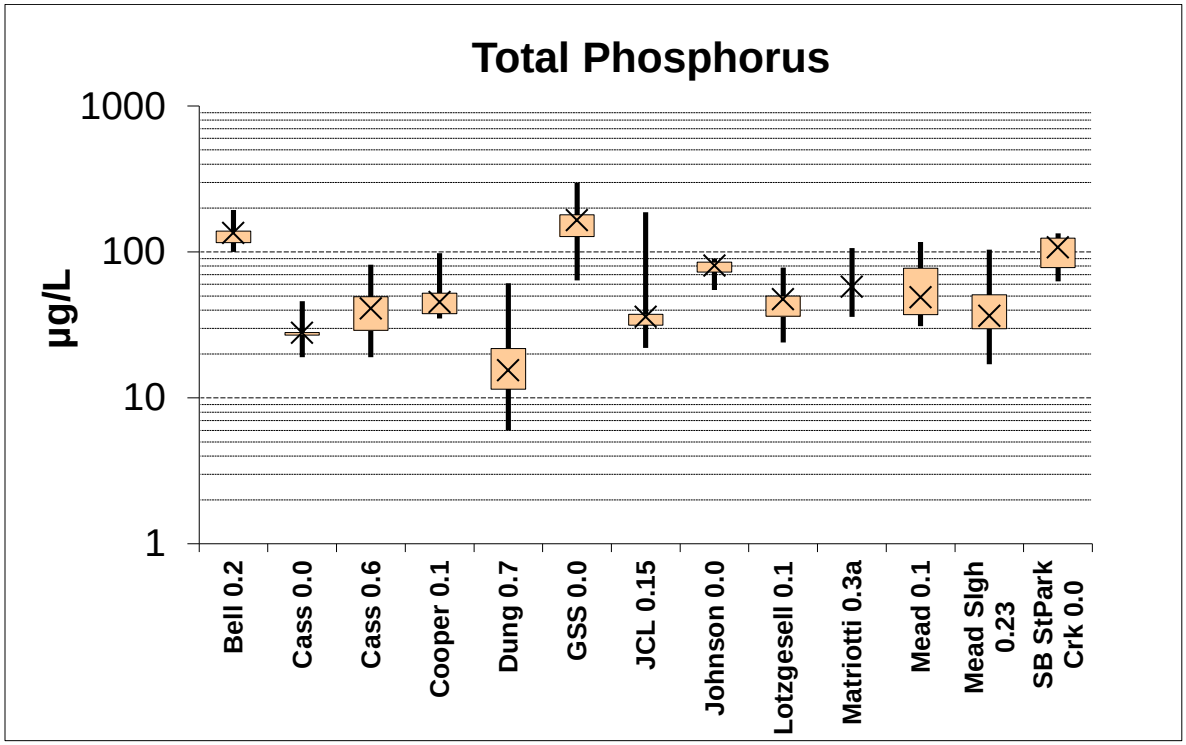

Figure 6. Total phosphorus. X marks median, box the 1st and 3rd quartiles, and bars the min and max values.

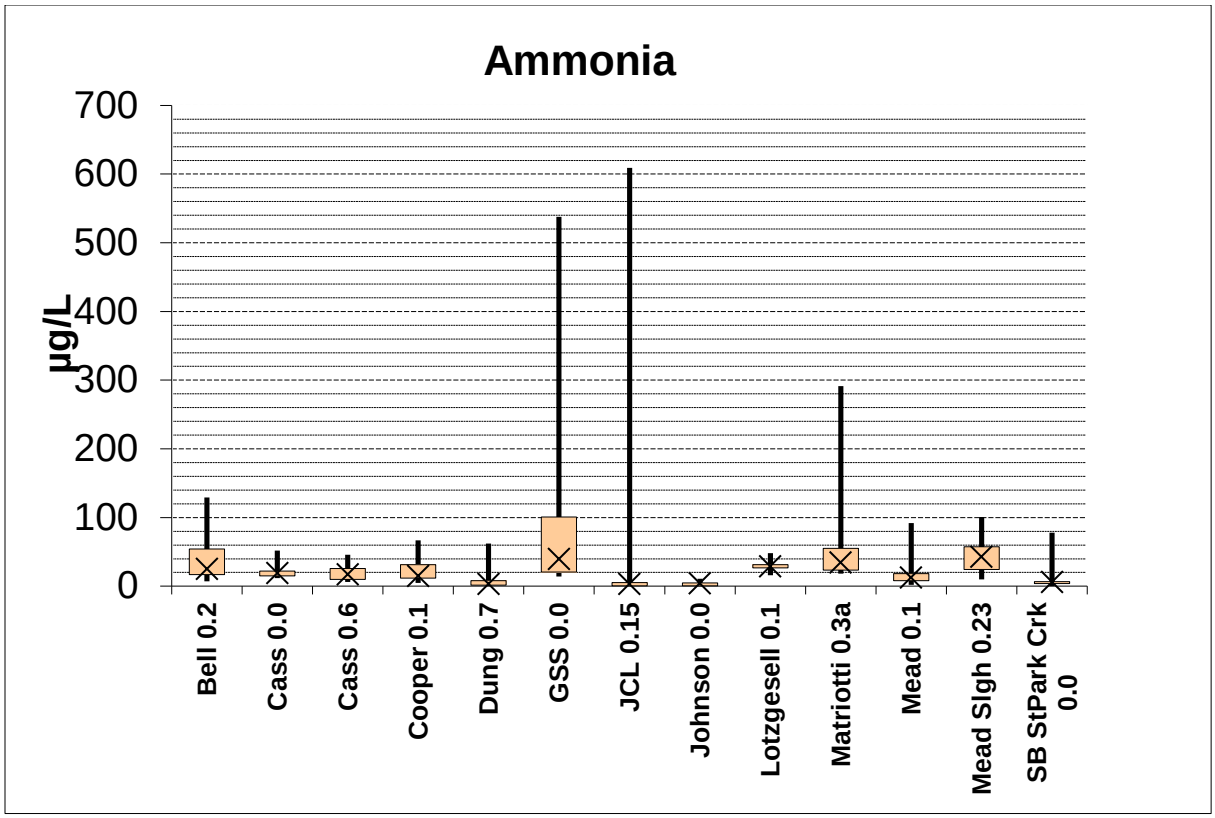

Figure 7. Ammonia (NH3). X marks median, box the 1st and 3rd quartiles, and bars the min and max values.

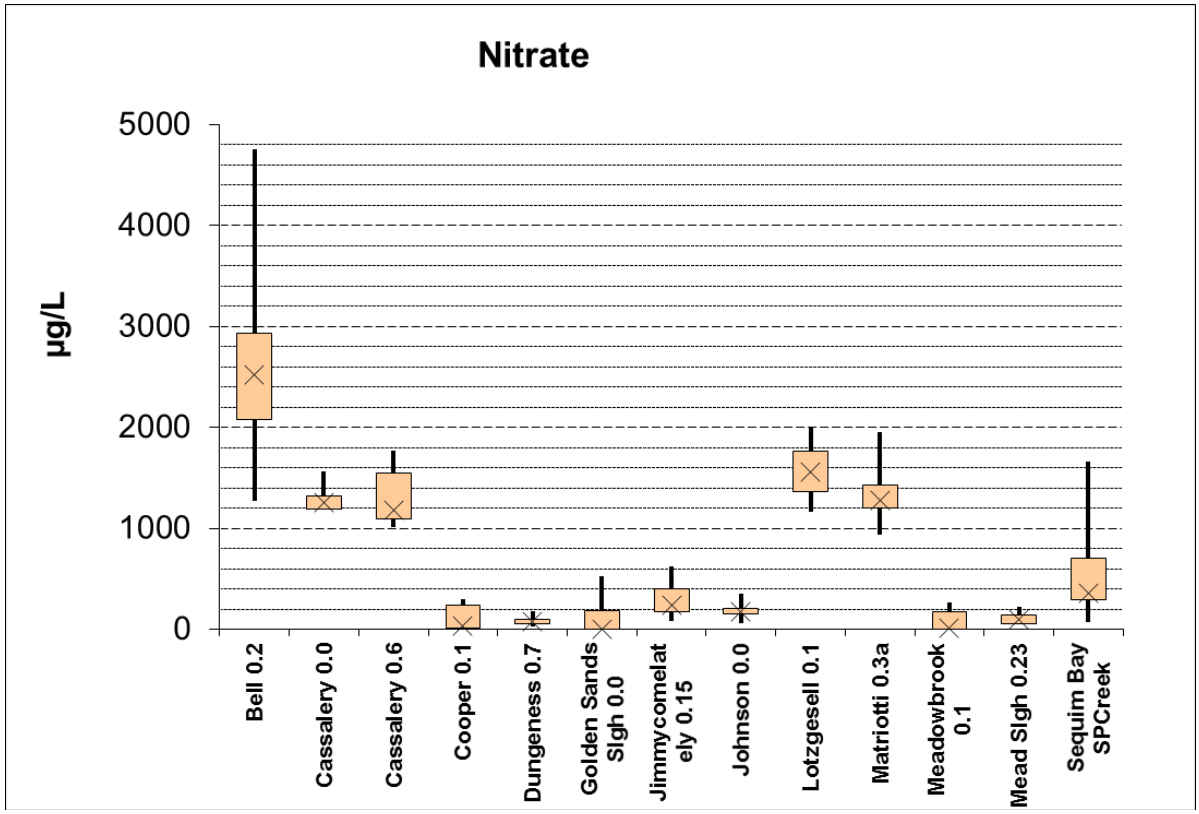

Figure 8. Nitrate as N. X marks median, box the 1st and 3rd quartiles, and bars the min and max values.

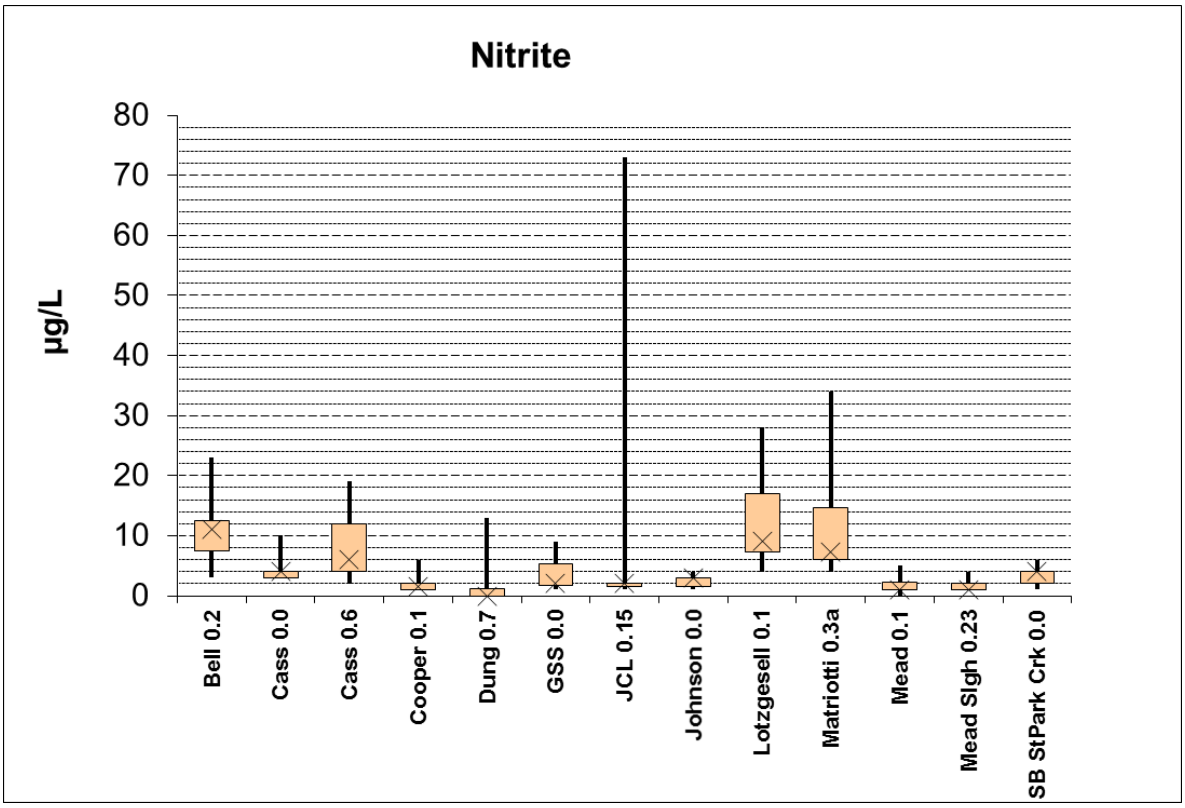

Figure 9. Nitrite as N. X marks median, box the 1st and 3rd quartiles, and bars the min and max values.

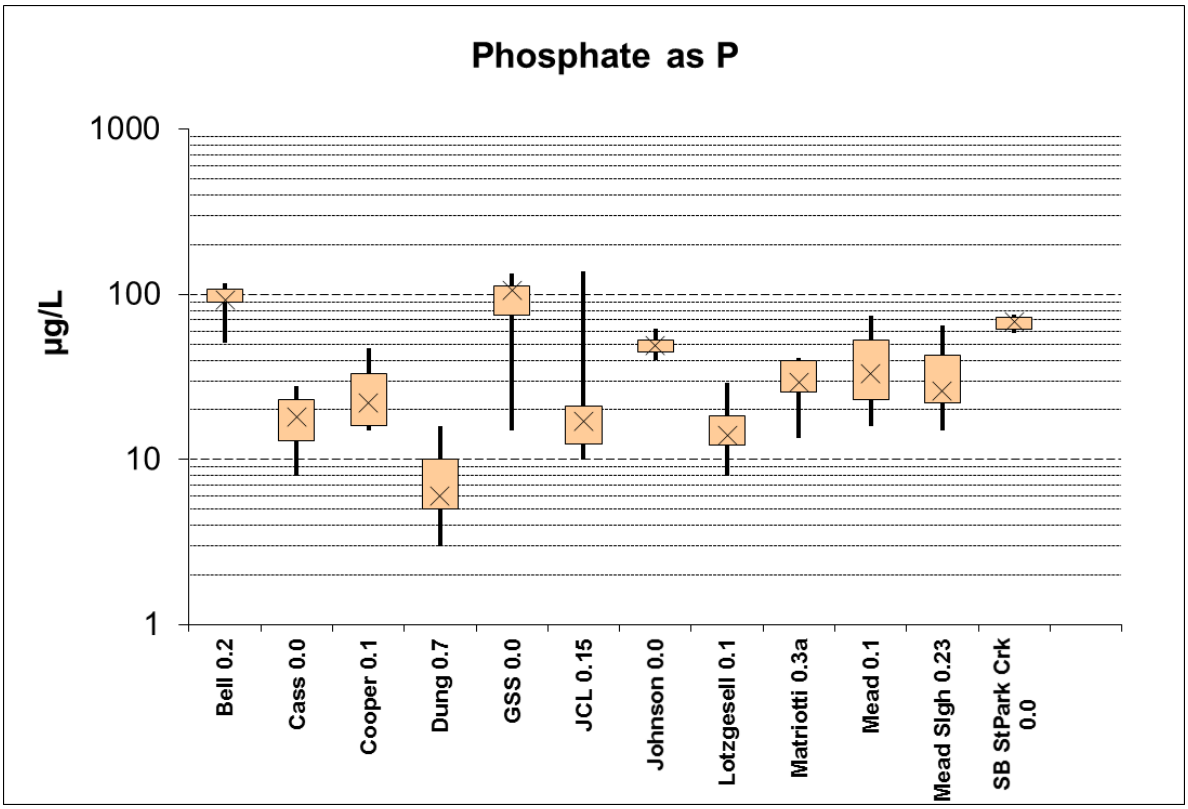

Figure 10. Phosphate as P. X marks median, box the 1st and 3rd quartiles, and bars the min and max values.

Water Chemistry

Water chemistry measurements (temperature, DO concentration, pH, specific conductance, salinity, turbidity) were taken with a YSI ProDSS field meter which was calibrated prior to sampling episodes and then checked afterward. The next several figures illustrate water chemistry results, along with bars representing state water quality standards where appropriate.

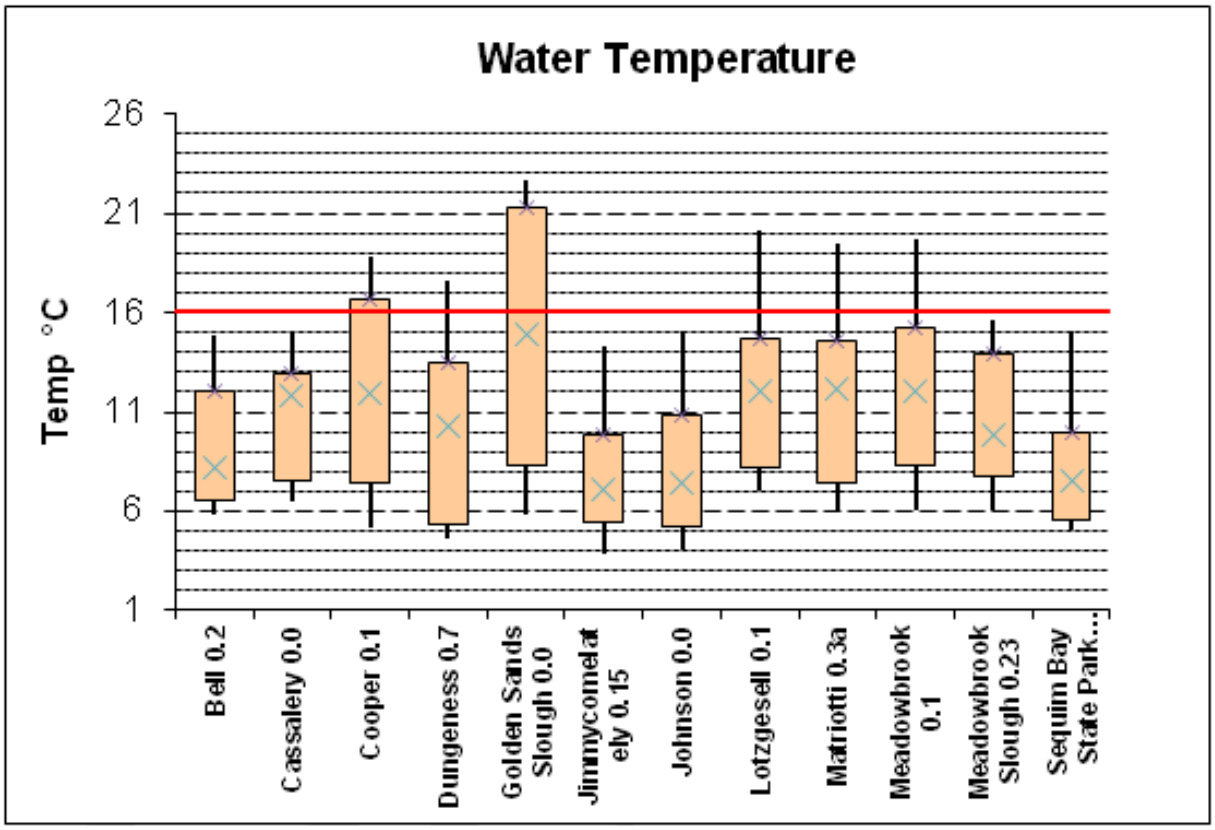

Figure 11. Water temperature. X marks median, box the 1st and 3rd quartiles, and bars the min and max values. These results cannot be used per se to determine compliance with state standards, but for comparative purposes, the red line represents 16°C, the state's maximum 7-day average of daily maxima for salmonid core summer habitat, the designated use for all these sites (Ecology 2006).

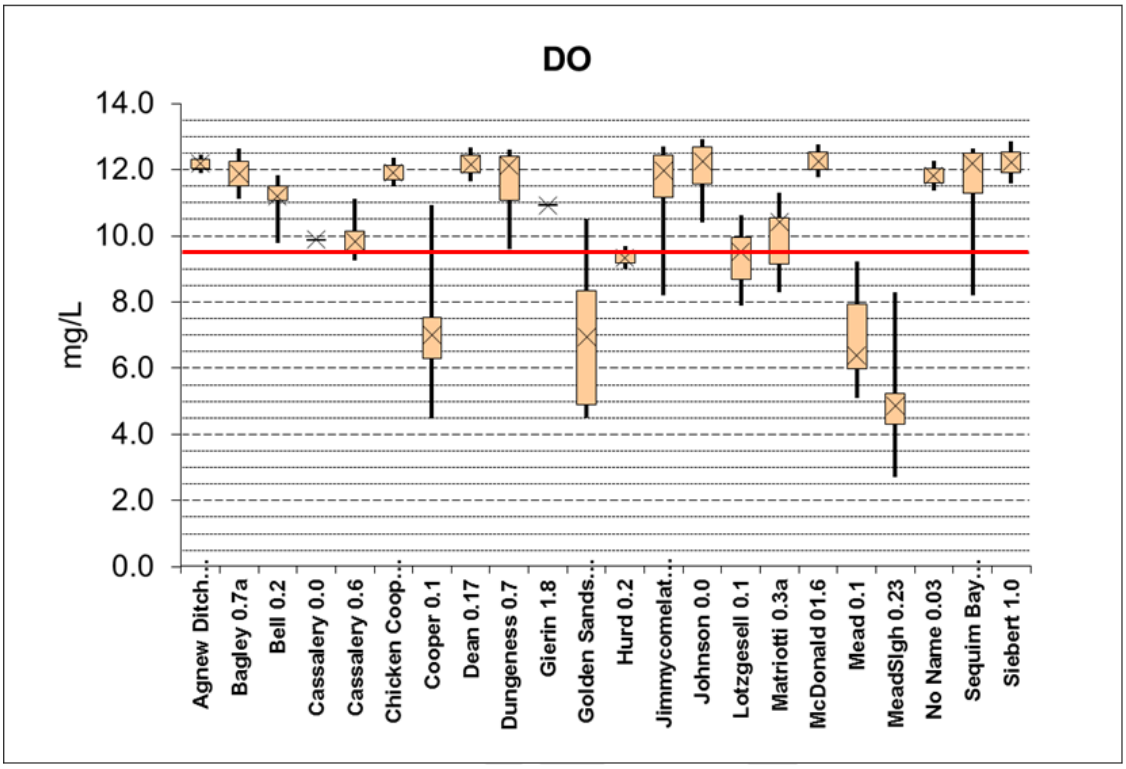

Figure 12. Dissolved Oxygen. X marks median, box the 1st and 3rd quartiles, and bars the min and max values. These results cannot be used per se to determine compliance with state standards, but for comparative purposes, the red line represents 9.5 mg/L, the state one-day minimum for the salmonid core summer habitat critical period, the designated use for all these sites (Ecology 2006).

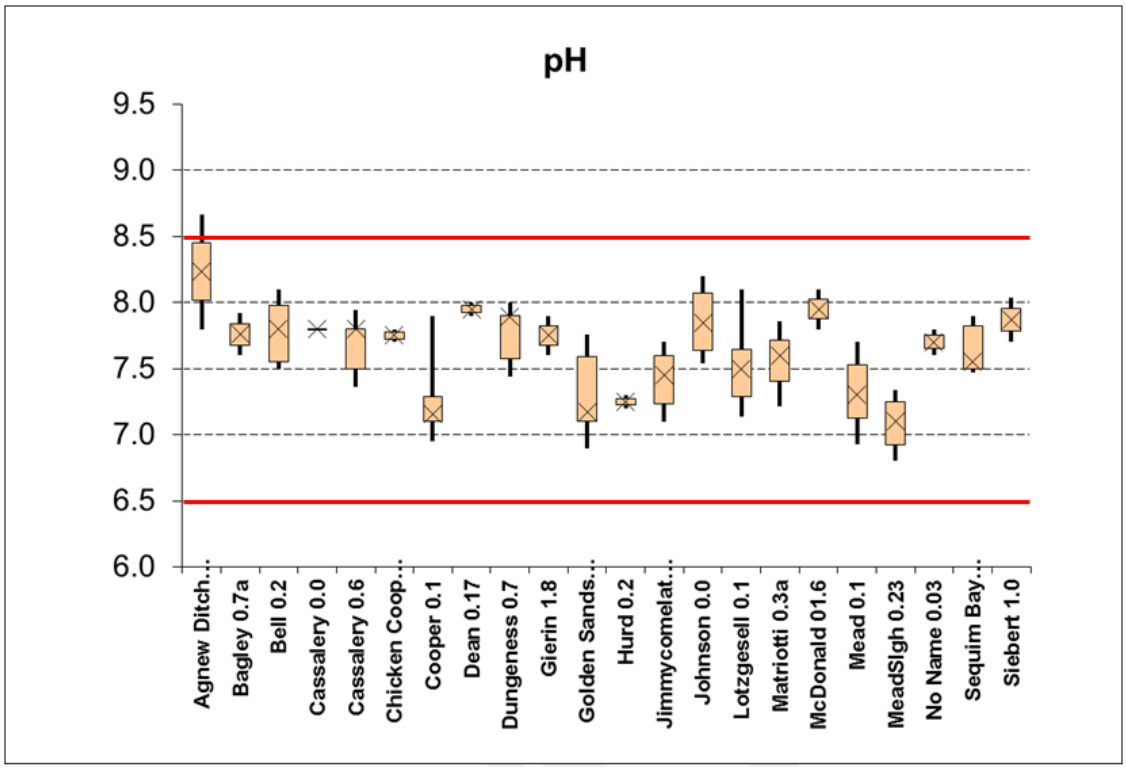

Figure 13. pH. X marks median, box the 1st and 3rd quartiles, and bars the min and max values. These results cannot be used per se to determine compliance with state standards, but for comparative purposes, but the red lines at 6.5 and 8.5 represent the state standards for the designated uses of all these sites (Ecology 2006).

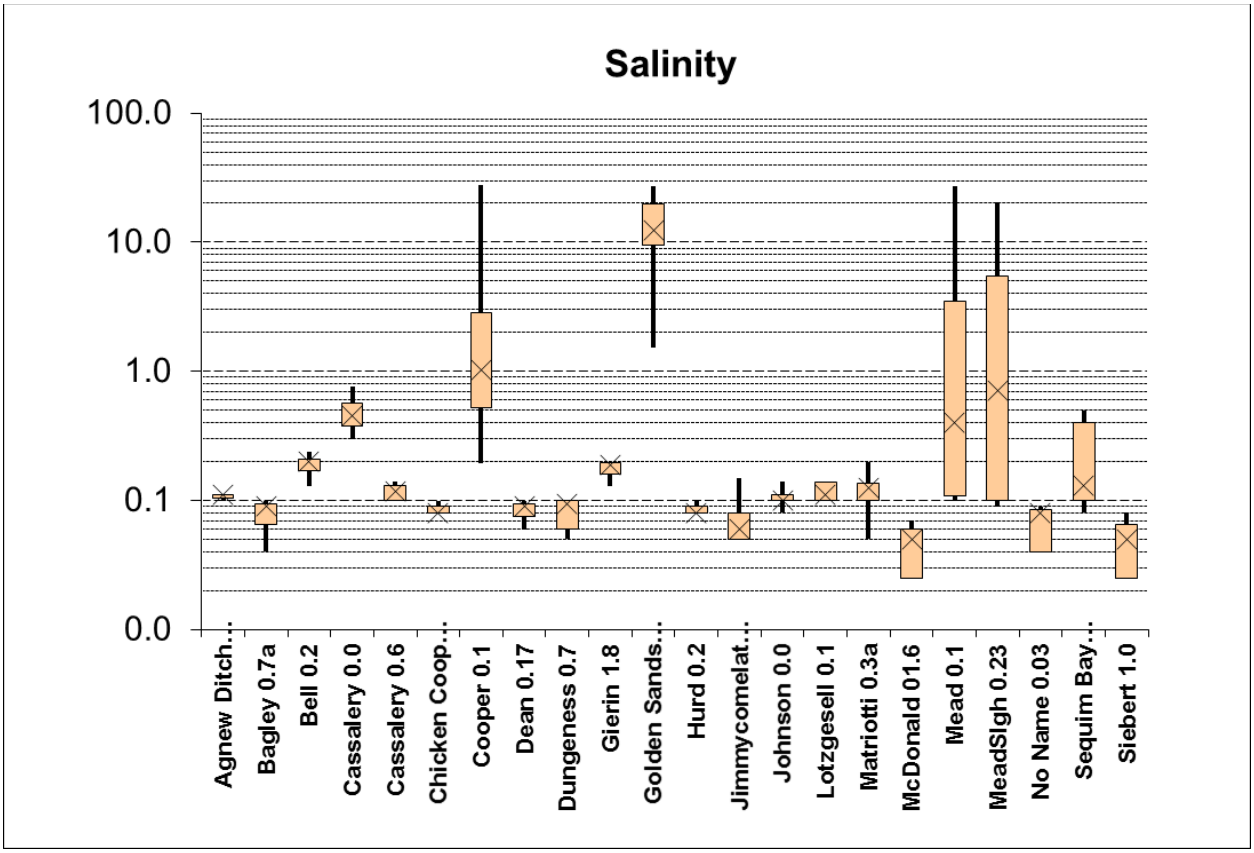

Figure 14. Salinity (PSS). X marks median, box the 1st and 3rd quartiles, and bars the min and max values.

Data comments:

- Fecal coliform: problem areas to note from the point of view of loading include:
    - Matriotti/Lotzgesell, which accounted for a good portion of the loading in the Dungeness in our 2013-14 study, which measured stream flows in addition to the other parameters (Clallam 2014, and see table below). This system does not seem to have improved.
    - Cassalery, which seems to be declining in water quality, but only carries about half the water of Matriotti, per our 2013-14 study (Clallam 2014).
    - Agnew Ditch, where we have only three data points so far but shows signs of concern.
    - Golden Sands, which has shown some signs of improvement in the past year—perhaps due to the focus of the PIC team?
    - Bell Creek, with the highest geometric mean for fecals—but State DOH sampling indicates fairly good water quality at the outlet in Sequim Bay.
    - Some indication of declining water quality in McDonald, Siebert, and Bagley Creeks, when compared to retrospective data through 2014.

A caveat on fecal coliform loading: though the Dungeness River has one of the lowest geometric mean concentrations, it was by far the greatest source of loading to Dungeness Bay in our 2013-14 study (see table below). Matriotti/Lotzgesell accounts for roughly half the loading in the lower Dungeness, but the other half comes from points on the Dungeness upstream of the

Matriotti confluence. We need to keep this significant loading source in mind as we proceed in our water quality remediation activities. Below we reprint a table from our 2013-14 study (Clallam 2014) pertaining to loading:

Table 6. Fecal coliform loading in 2013-14, in units of 1000 colony-forming units (CFU) per second, arranged in loading order from upstream to downstream, where tributaries to sites below are indented. Fecal coliform concentrations reported as <2 cfu/100 mL are interpreted as 1 cfu/100 mL. N/A = not available due to lack of fecal and/or flow data. Dungeness 3.0 flows are estimated by subtracting the flow at Matriotti 0.1 from that at Dungeness 0.8. (Clallam 2014)

Site / Date	4/13	5/13	6/13	7/13	8/13	9/13	10/13	11/13	1213	1/14	2/14	3/14
Dungeness 3.0	N/A	172	362	336	564	729	399	105	272	104	527	425
Matriotti 4.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Matriotti 3.2	28	61	5	90	6	27	9	1	11	18	14	39
Matriotti 1.9	11	17	17	144	31	241	59	N/A	13	10	17	42
Lotzgesell 1.5	N/A	N/A	2	17	13	69	5	9	2	8	1	2
Matriotti 0.1	116	491	1273	309	583	753	141	41	412	153	748	202
Dungeness 0.8	79	2112	2954	1217	1281	1295	680	777	481	216	1053	111
Meadowbrook 2.0	24	43	31	15	9	78	17	12	18	10	156	10
Meadowbrook 0.1	2	38	64	105	27	50	24	N/A	31	8	32	N/A
Cassalery 1.6	13	105	144	141	104	121	255	71	32	14	73	4
Cassalery 0.6	2	52	92	22	9	14	34	6	768	4	2	2
Cassalery 0.0	N/A	N/A	152	56	N/A	N/A	85	N/A	N/A	N/A	N/A	28
Cooper 0.1	10	198	48	94	N/A	109	77	N/A	34	N/A	N/A	55
Golden Sands Slough	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

- Nutrients:
    - Highest nitrogen and nitrate concentration is in Bell Creek.
    - Highest phosphorus and ammonia levels are in Golden Sands Slough. Ammonia might be due to septic pollution; phosphate could be due to septics or tidal action and marine organisms, though other sites are tidally influenced, as demonstrated by the salinity data. Golden Sands has the most impounded outlet.
    - Note frequent to ubiquitous tidally-influenced conditions at Golden Sands, Cooper, Meadowbrook Slough, and Meadowbrook Creek. Golden Sands was always tidally influenced, but its pollution signals are apparently not simply to be attributed to the tidal influence, as seen by the higher pollutant levels when compared to the similarly-tidally-influenced and nearby Cooper Creek.

Conclusion and Recommendations for Future Sampling

Water quality goals are still not met, but the PIC program aims to systematically improve them by using the trends sampling data to identify priority areas for remediation, then targeting sampling in those areas to identify and remediate pollution sources. This program is still in an early stage and has a year more of sampling to undertake.

REFERENCES

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- **Equipment wrangling: Karen Robinson**
- **Data analyses, graphics, lab data import: Dr. Ron Sidwell**
- **Database management and upload of data to Ecology's EIM database: Walt Johnson and Steve Belcher**

Appendix 1: Data from May 2015 – April 2016

Primary Name	Arrival	Fecal	TN	TP	NH3	Nitrate	Nitrite	PO4	SO4	DO	pH	Salinity	Spc Cond	Turb	Temp	Bar P	Stage	Flow
Agnew Ditch @1079 Finn Hall Rd	11/24/2015	623								11.9	7.80	0.11	230.8	37	6.5	29.9	-1.75	
Agnew Ditch @1079 Finn Hall Rd	1/26/2016	135										0.10	225.3		6.6		-1.68	
Agnew Ditch @1079 Finn Hall Rd	4/12/2016	28								12.4	8.66	0.11	235.0	5	11.8	29.9	-2.07	
Bagley 0.7a	11/24/2015	346								12.6	7.60	0.04	94.3	66	5.5	29.9		
Bagley 0.7a	1/26/2016	4										0.10	113.7		5.9		-12.36	
Bagley 0.7a	4/12/2016	14								11.1	7.92	0.09	189.0	2	9.3	29.9	-12.52	
Bell 0.2	5/12/2015	182										0.20			12.1		0.94	
Bell 0.2	8/13/2015	4										0.20			14.8		0.96	
Bell 0.2	10/8/2015	136	3888	109	7.4	2524.2	3.4	50.80	8534	9.8	8.00	0.21	444.0	5	12.4	30.1	1.00	
Bell 0.2	11/23/2015	14	6299	139	25.0	4751.6	11.1	116.90	11589	11.2	7.90	0.24	505.0	3	6.6	29.9	1.10	
Bell 0.2	12/17/2015	18	4637	139	24.2	2390.2	8.0	109.20	11078	11.6	7.70	0.17	360.9	5	6.0	29.7	1.52	
Bell 0.2	1/25/2016	132	4526	123	25.5	2537.9	13.2	93.17	9408			0.20	377.4		5.8		1.30	
Bell 0.2	2/17/2016	1000	3693	194	128.6	1759.6	23.4	105.43	8416	11.0	7.50	0.13	371.8	9	8.2	29.4	1.54	
Bell 0.2	3/15/2016	102	3545	135	82.5	1272.1	11.7	90.23	10469	11.8	7.50	0.16	342.9	7	6.6	30.2	1.52	
Bell 0.2	4/11/2016	23	4811	100	10.2	3336.8	7.0	89.66	7801	11.2	8.10	0.22	460.0	4	10.3	30.1	1.00	
Cassalery 0.0	5/12/2015	4	1693	27	14.7	1184.4	3.7	13.80	6202			0.30			12.5			
Cassalery 0.0	6/11/2015	2	1693	28	22.5	1315.9	3.6	17.10	481			0.40			12.9			2.00
Cassalery 0.0	7/7/2015	2	2057	29	18.6	1191.4	3.1	13.70	6321			0.50			15.0			2.00
Cassalery 0.0	8/13/2015		1719	19	11.5	1250.5	3.1	8.50	8610									
Cassalery 0.0	1/25/2016																	
Cassalery 0.0	4/11/2016	310	2398	46	52.1	1561.7	9.5	28.08	6193	9.9	7.80	0.76	1495.0	6	11.6	30.1		6.10

Primary Name	Arrival	Fecal	TN	TP	NH3	Nitrate	Nitrite	PO4	SO4	DO	pH	Salinity	Spc Cond	Turb	Temp	Bar P	Stage	Flow
Cassalery 0.6	6/11/2015																0.55	
Cassalery 0.6	7/7/2015																0.58	
Cassalery 0.6	8/13/2015	20										0.10			13.7		0.44	
Cassalery 0.6	9/10/2015	194	1608	19	9.5	1116.9	2.5	7.40	8700	9.3	7.94	0.11	239.8	6	13.2	30.1	0.58	
Cassalery 0.6	10/8/2015	122	1768	41	5.5	1007.5	2.6	7.50	6696	9.5	7.80	0.10	240.0	0	12.1	30.1	0.63	
Cassalery 0.6	11/23/2015	12	1570	20	16.7	1063.6	5.0	11.50	9268	9.8	7.80	0.13	268.6	1	6.5	29.9	0.66	
Cassalery 0.6	12/17/2015	522	2142	51	25.3	1181.1	7.9	20.50	8800	10.2	7.80	0.13	275.2	4	6.8	29.7	0.80	
Cassalery 0.6	1/25/2016	122	2442	48	26.9	1475.7	15.7	28.73	7145			0.10	273.4		7.0		0.74	
Cassalery 0.6	2/17/2016	84	2737	82	46.2	1624.2	19.3	40.01	6905	9.9	7.36	0.14	298.7	6	9.4	29.4	0.74	
Cassalery 0.6	3/15/2016	100	2675	38	10.5	1769.6	6.4	12.77	8126	11.1	7.50	0.13	277.6	8	7.7	30.2	0.74	
Cassalery 0.6	4/11/2016																0.62	
Chicken Coop 0.24	11/24/2015	10								12.4	7.70	0.08	172.5	10	5.5	29.9	-2.56	
Chicken Coop 0.24	1/26/2016	2										0.10	110.7		6.4		-2.30	
Chicken Coop 0.24	4/12/2016	6								11.5	7.80	0.08	161.0	2	8.6	30.0	-4.20	
Cooper 0.1	5/12/2015	2	272	40	18.2	17.7	1.1	20.40	7983			0.80			17.1			
Cooper 0.1	6/11/2015	4	288	52	12.1	15.7	1.2	25.40	9570			0.60			16.8			
Cooper 0.1	7/7/2015	2	255	45	6.9	6.8	1.0	22.60	8401			0.80			16.6			
Cooper 0.1	8/13/2015	12	206	35	4.7	4.0	0.7	15.60	10886			0.30			18.8			
Cooper 0.1	9/10/2015	26	243	35	11.6	8.7	0.7	15.40	11089	7.3	7.43	0.20	390.6	7	15.8	30.1		
Cooper 0.1	10/8/2015	114	327	38	11.6	21.0	1.3	16.00	8621	6.1	7.20	0.20	468.0	0	11.5	30.1		
Cooper 0.1	11/23/2015	88	729	98	67.2	281.7	5.6	47.10	7837	4.5	7.10	27.69	43507.0	11	7.1	29.9		
Cooper 0.1	12/17/2015	26	706	47	42.1	263.3	1.9	18.40	10807	10.9	7.90	1.26	2448.0	2	5.2	29.7		
Cooper 0.1	1/25/2016	20	740	57	54.9	297.4	3.1	33.34	8461			3.70	6780.0		5.9			
Cooper 0.1	2/17/2016	6	606	53	15.6	223.5	1.6	32.87	5472	6.5	7.11	2.57	4750.0	2	9.1	29.4		
Cooper 0.1	3/15/2016	2	500	37	14.2	113.1	1.5	22.04	7820	7.8	6.95	5.63	10033.0	3	7.5	30.2		
Cooper 0.1	4/11/2016	6	386	46	28.5	47.1	1.8	30.50	6923	7.0	7.32	1.35	2590.0	3	12.3			
Dean 0.17	11/24/2015	126								12.7	7.90	0.06	128.8	24	5.0	29.9		
Dean 0.17	1/26/2016	58										0.10	112.9		5.8		-5.09	
Dean 0.17	4/12/2016	2								11.7	8.00	0.09	196.0	3	8.7	30.1	-4.23	

Primary Name	Arrival	Fecal	TN	TP	NH3	Nitrate	Nitrite	PO4	SO4	DO	pH	Salinity	Spc Cond	Turb	Temp	Bar P	Stage	Flow
Dungeness 0.7	5/12/2015	2	143		3.2	35.3	0.5	3.00	3154			0.10			12.4			
Dungeness 0.7	6/11/2015	2	260	15	4.9	41.6	0.5	5.30	4018			0.10			13.7			
Dungeness 0.7	7/7/2015	4	173	12	8.8	60.8	0.9	4.80	3417			0.10			14.9			
Dungeness 0.7	8/13/2015	4	168	10	8.0	95.7	2.2	5.00	4629			0.10			17.6			
Dungeness 0.7	9/10/2015	12	320	17	59.4	174.1	3.6	10.50	4693	9.6	7.93	0.09	167.5	17	13.3	30.1		
Dungeness 0.7	10/8/2015	114	426	24	62.1	165.7	13.1	16.00	3705	10.3	7.90	0.10	177.0	0	12.1	30.1		
Dungeness 0.7	11/23/2015	2	176	16	2.7	96.0	0.4	9.20	4262	12.4	8.00	0.06	124.4	9	5.2	29.8		
Dungeness 0.7	12/17/2015	14	240	27	0.2	92.1	0.3	5.20	4787	12.4	7.90	0.06	133.6	14	5.2	29.6		
Dungeness 0.7	1/25/2016	2	265	61	2.8	79.7	1.0	11.56	3742			0.10	115.3		4.6			
Dungeness 0.7	2/17/2016	2	262	21	2.4	80.2	0.1	5.26	3353	12.1	7.44	0.05	113.0	16	6.4	29.3		
Dungeness 0.7	3/15/2016	2	197	15	0.0	57.9	0.3	5.84	5128	12.6	7.47	0.06	131.3	14	5.4	30.2		
Dungeness 0.7	4/11/2016	2	97	7	1.1	26.6	0.3	3.77	3035	11.8	7.88	0.05	116.0	4	8.5	30.1		
Dungeness 0.8	5/12/2015																	235.00
Dungeness 0.8	6/11/2015																	200.00
Dungeness 0.8	7/7/2015																	89.10
Dungeness 0.8	8/13/2015																	64.20
Dungeness 0.8	9/10/2015																	80.60
Dungeness 0.8	10/8/2015																	80.50
Dungeness 0.8	11/23/2015																	557.00
Dungeness 0.8	12/17/2015																	656.00
Dungeness 0.8	1/25/2016																	793.00
Dungeness 0.8	2/17/2016																	883.00
Dungeness 0.8	3/15/2016																	644.00
Dungeness 0.8	4/11/2016																	584.00
Gierin 1.8	11/24/2015	48								10.9	7.90	0.19	385.4	5	6.8	29.9	-0.81	
Gierin 1.8	1/26/2016	16										0.20	393.9		6.4		-1.03	
Gierin 1.8	4/12/2016	70								11.0	7.60	0.13	278.0	12	9.3	30.0	-0.90	
Gierin 1.8	5/2/2016	118															-0.79	

Primary Name	Arrival	Fecal	TN	TP	NH3	Nitrate	Nitrite	PO4	SO4	DO	pH	Salinity	Spc Cond	Turb	Temp	Bar P	Stage	Flow
Golden Sands Slough 0.0	5/12/2015	112	1146	177	76.3	2.1	1.5	80.10	4552			7.60			22.7		-0.86	
Golden Sands Slough 0.0	6/11/2015	24	281	64	19.9	1.1	0.7	24.00	2179			13.70			21.1		-0.84	
Golden Sands Slough 0.0	7/7/2015	64	1411	146	23.2	0.2	0.8	55.40	2585			22.30			18.5		-0.75	
Golden Sands Slough 0.0	8/13/2015	45	586	73	32.2	0.8	4.8	15.10	4287			22.80			22.0		-0.62	
Golden Sands Slough 0.0	9/10/2015	100	1677	298	538.2	2.0	2.0	110.10	10908	4.5	7.76	10.11	234.7	15	22.3	30.1	-0.75	
Golden Sands Slough 0.0	10/8/2015	402	1088	279	95.5	0.2	1.8	111.60	6821	10.5	7.70	16.00	26048.0	10	15.1	30.1	-0.75	
Golden Sands Slough 0.0	11/23/2015	112	1347	169	131.0	526.5	8.6	134.50	3941	4.6	7.10	27.29	42850.0	7	7.6	29.9	-0.43	
Golden Sands Slough 0.0	12/17/2015	196	1405	167	116.5	240.1	5.7	106.30	6765	6.9	7.25	10.75	18100.0	7	5.8	29.7	0.39	
Golden Sands Slough 0.0	1/25/2016	130	1438	164	47.1	174.0	3.9	89.45	9193			2.20	4125.0		6.0			
Golden Sands Slough 0.0	2/17/2016	98	1536	189	20.6	220.4	6.4	117.38	8462	5.2	6.90	1.53	2939.0	5	8.5	29.4		
Golden Sands Slough 0.0	3/15/2016	4	600	70	13.6	128.5	2.3	40.33	3842	8.1	7.10	18.90	31000.0	4	9.3	30.2		
Golden Sands Slough 0.0	4/11/2016	14	1023	157	18.6	3.9	1.4	75.05	5096	8.6	7.72	11.00	18600.0	8	14.7	30.1	-0.10	
Hurd 0.2	11/24/2015	36								9.0	7.30	0.08	169.6	1	9.5	29.9		
Hurd 0.2	1/26/2016	2										0.10	174.7		9.0		-2.30	
Hurd 0.2	4/12/2016	2								9.7	7.20	0.08	173.0	0	9.4	30.0	-2.25	
Jimmycomelately 0.15	5/12/2015	2										0.10			9.9		0.76	
Jimmycomelately 0.15	8/13/2015	2										0.00			14.3		0.61	
Jimmycomelately 0.15	10/8/2015	6	2250	187	608.8	515.4	73.2	136.60	9380	8.2	7.60	0.15	305.0	5	11.1	30.1	0.69	
Jimmycomelately 0.15	11/23/2015	30	1307	38	0.8	626.6	1.8	22.20	11153	12.7	7.60	0.07	150.3	5	3.9	29.9	0.78	
Jimmycomelately 0.15	12/17/2015	4	649	37	0.2	286.9	2.1	9.60	11615	12.3	7.10	0.05	104.8	11	5.6	29.7	1.36	
Jimmycomelately 0.15	1/25/2016	2	694	35	3.0	234.4	2.3	17.03	9088			0.00	102.8		4.7		1.22	
Jimmycomelately 0.15	2/17/2016	2	466	28	2.8	181.7	1.1	12.90	8965	11.7	7.30	0.06	124.6	5	7.1	29.4	0.98	
Jimmycomelately 0.15	3/15/2016	2	540	36	0.0	164.9	1.8	11.86	11659	12.5	7.21	0.05	96.4	17	5.4	30.2		
Jimmycomelately 0.15	4/11/2016	2	279	22	8.2	77.2	1.1	20.07	9419	11.0	7.70	0.08	177.0	2	8.8	30.1		

Primary Name	Arrival	Fecal	TN	TP	NH3	Nitrate	Nitrite	PO4	SO4	DO	pH	Salinity	Spc Cond	Turb	Temp	Bar P	Stage	Flow
Johnson 0.0	5/12/2015	18										0.10			10.8		0.68	
Johnson 0.0	8/13/2015	26										0.10			15.1		0.47	
Johnson 0.0	10/8/2015	64	247	70	10.9	59.7	1.2	61.70	8588	10.4	8.10	0.14	290.0	5	11.8	30.1	0.49	
Johnson 0.0	11/23/2015	52	1216	83	0.0	348.9	1.9	54.00	12497	12.9	8.00	0.11	226.7	11	4.1	29.9	0.80	
Johnson 0.0	12/17/2015	18	866	87	0.8	208.7	4.1	39.60	11739	12.6	7.70	0.08	169.8	19	5.2	29.7	0.88	
Johnson 0.0	1/25/2016	14	757	76	4.5	177.0	3.3	46.22	9928			0.10	178.5		4.5		0.76	
Johnson 0.0	2/17/2016	8	1178	90	4.8	208.4	3.3	51.18	9375	11.9	7.62	0.10	204.6	14	7.4	29.4	0.90	
Johnson 0.0	3/15/2016	16	1209	81	0.0	165.2	3.0	43.57	11610	12.7	7.54	0.08	167.9	26	5.3	30.2	1.04	
Johnson 0.0	4/11/2016	8	469	55	5.1	143.5	1.5	49.37	8826	11.4	8.20	0.13	280.0	2	9.3		0.48	
Lotzgesell 0.1	5/12/2015	58	2097	47	25.6	1184.3	8.9	12.50	7402			0.10			18.5		-1.53	
Lotzgesell 0.1	6/11/2015	28	2097	48	36.7	1629.7	14.9	15.90	9761			0.10			17.8		-1.38	
Lotzgesell 0.1	7/7/2015	64	2460	50	29.7	1458.1	23.5	11.50	8192			0.10			13.6		-1.70	
Lotzgesell 0.1	8/13/2015	98	2584	54	47.8	1489.4	28.1	17.70	10530			0.10			20.1		-1.65	
Lotzgesell 0.1	9/10/2015	52	2672	40	16.5	1724.9	4.7	8.00	10945	8.4	7.66	0.12	282.7	12	12.8	30.1	-1.33	
Lotzgesell 0.1	10/8/2015	184	2151	78	32.6	1158.3	22.6	29.10	8485	7.9	7.50	0.10	290.0	13	12.6	30.1	-1.22	
Lotzgesell 0.1	11/23/2015	6	2429	31	30.1	1383.5	9.2	14.10	10582	9.0	7.50	0.14	286.8	4	7.2	29.8	-0.94	
Lotzgesell 0.1	12/17/2015	58	2345	37	28.7	1306.9	7.8	13.90	9876	9.5	8.10	0.14	284.0	5	7.0	29.6	-0.60	
Lotzgesell 0.1	1/25/2016	34	2745	48	27.1	1692.3	8.0	13.32	8095			0.10	277.0		7.5		-0.85	
Lotzgesell 0.1	2/17/2016	34	3489	50	29.1	1881.0	4.9	19.53	8270	9.6	7.14	0.14	292.0	10	9.5	29.3	-0.50	
Lotzgesell 0.1	3/15/2016	6	3393	34	22.5	1939.9	4.1	10.40	10340	10.6	7.22	0.14	292.0	6	8.5	30.2	-0.99	
Lotzgesell 0.1	4/11/2016	44	3349	24		2000.3	14.8		7894	10.3	7.69	0.14	283.0	9	11.5	30.1	-1.17	
Matriotti 0.3a	5/12/2015	179	1990	49	40.2	941.7	9.1	18.90	7245			0.05			16.4		-8.50	
Matriotti 0.3a	6/11/2015	46	1990	52	59.7	1506.0	13.5	25.60	9042			0.10			16.9		-8.58	
Matriotti 0.3a	7/7/2015	35	2361	49	31.8	1350.8	21.6	19.15	8153			0.10			13.9		-8.70	
Matriotti 0.3a	8/13/2015	389	2740	76	291.6	1346.8	33.6	41.30	10619			0.10			19.4		-8.73	
Matriotti 0.3a	9/10/2015	113	2518	43	18.6	1554.0	5.9	13.45	11143	8.6	7.78	0.12	300.6	9	13.3	30.1	-8.55	
Matriotti 0.3a	10/8/2015	219	2158	89	53.4	1208.0	18.3	32.70	8725	8.3	7.60	0.20	309.0	8	12.6	30.1	-8.64	
Matriotti 0.3a	11/23/2015	18	2500	43	36.4	1402.3	8.4	22.15	11162	9.7	7.60	0.15	310.0	4	6.9	29.8	-8.22	
Matriotti 0.3a	12/17/2015	105	2205	63	19.7	1064.5	5.5	29.65	10330	10.7	7.75	0.13	263.4	9	6.1	29.6	-7.80	
Matriotti 0.3a	1/25/2016	75	2574	76	23.9	1204.4	6.3	39.54	8658			0.10	268.6		6.9		-8.00	
Matriotti 0.3a	2/17/2016	187	2676	107	25.1	1202.9	6.4	41.16	8479	10.4	7.21	0.13	266.0	15	8.6	29.3	-7.60	
Matriotti 0.3a	3/15/2016	54	1651	63	21.7	1195.0	4.2	26.00	10616	11.3	7.34	0.13	278.7	12	7.6	30.2	-7.97	
Matriotti 0.3a	4/11/2016	185	2724	36	74.9	1949.3	5.7	25.31	8315	10.4	7.86	0.15	315.0	8	11.7	30.1	-8.44	

Primary Name	Arrival	Fecal	TN	TP	NH3	Nitrate	Nitrite	PO4	SO4	DO	pH	Salinity	Spc Cond	Turb	Temp	Bar P	Stage	Flow
McDonald 01.6	11/24/2015	396								12.8	7.80	0.05	108.6	35	4.8	29.9		6.00
McDonald 01.6	1/26/2016	26										0.00	96.2		4.9			37.00
McDonald 01.6	4/12/2016	2								11.8	8.10	0.07	139.0	1	8.6	29.9		11.80
Meadowbrook 0.1	5/12/2015	2	197	35	5.0	2.1	0.5	19.10	6070			0.10			15.5		2.23	
Meadowbrook 0.1	6/11/2015	2	197	35	7.5	4.3	0.6	27.60	8157			0.40			15.2		2.22	
Meadowbrook 0.1	7/7/2015	10	261	53	13.0	5.6	0.6	24.70	6729			0.50			16.2		2.23	
Meadowbrook 0.1	8/13/2015	2	203	38	2.4	4.3	0.7	16.30	8701			0.10			19.7		2.15	
Meadowbrook 0.1	9/10/2015	2	209	31	11.8	9.6	0.6	15.90	9464	5.8	7.34	0.11	255.5	7	15.1	30.1	2.25	
Meadowbrook 0.1	10/8/2015	90	329	46	12.4	10.8	0.9	23.10	7570	5.1	7.30	0.10	283.0	0	11.7	30.1		
Meadowbrook 0.1	11/23/2015	24	758	107	92.0	226.5	5.0	73.70	2953	6.4	7.60	27.34	42860.0	13	8.7	29.8	3.35	
Meadowbrook 0.1	12/17/2015	56	814	117	63.7	266.9	5.3	72.60	4039	9.2	7.70	21.48	34600.0	17	6.1	29.6	3.70	
Meadowbrook 0.1	1/25/2016	2	667	76	17.1	187.4	3.2	47.84	8477			0.40	748.0		6.1		2.79	
Meadowbrook 0.1	2/17/2016	10	697	82	23.0	164.2	1.8	52.76	7625	6.2	6.93	12.00	15000.0	3	8.9	29.4	3.49	
Meadowbrook 0.1	3/15/2016	4	535	70	14.0	66.7	1.1	33.39	9226	8.2	7.07	0.67	1329.0	2	7.3	30.2	2.82	
Meadowbrook 0.1	4/11/2016	2	270	43	8.2	8.7	0.7	32.70	6450	7.6	7.30	0.18	381.0	1	12.4	30.1	2.62	
Meadowbrook 0.1	7/19/2016	20	401	79	1.0	5.0	1.3	35.95	6842	4.3	7.18	0.27	560.0	6	17.2	30.1	2.65	
Meadowbrook Slough 0.23	5/12/2015	14	166	24	19.3	50.7	1.0	15.40	4293			0.50			9.3		-2.53	
Meadowbrook Slough 0.23	6/11/2015	4	236	30	56.6	54.6	1.1	22.60	5004			0.10			12.1		-2.25	
Meadowbrook Slough 0.23	7/7/2015	2	304	47	57.6	57.1	0.7	24.70	3754			12.00			14.7		-2.54	
Meadowbrook Slough 0.23	8/13/2015	2	192	33	15.1	98.5	1.6	22.50	5920			0.10			15.6		-2.65	
Meadowbrook Slough 0.23	9/10/2015	72	294	29	26.5	107.7	0.9	19.80	5951	4.4	7.34	0.09	176.5	6	14.7	30.1	-2.64	
Meadowbrook Slough 0.23	10/8/2015	590	522	40	31.0	194.7	2.1	26.20	3836	4.2	7.30	0.09	187.0	1	13.2	30.1	-2.60	
Meadowbrook Slough 0.23	11/23/2015	84	367	34	51.9	225.4	3.0	26.20	6015	2.7	7.10	2.17	4055.0	2	9.8	29.9	-2.23	
Meadowbrook Slough 0.23	12/17/2015	126	634	104	100.9	176.4	3.6	65.10	5517	8.3	7.30	20.60	32900.0	18	6.2	29.7	-0.80	
Meadowbrook Slough 0.23	1/25/2016	55	333	63	73.2	105.4	1.3	43.14	4976			0.50	1071.0		6.1		-1.96	
Meadowbrook Slough 0.23	2/17/2016	12	418	69	51.3	135.3	1.8	52.65	4862	4.9	6.80	0.93	1823.0	3	7.1	29.4	-1.18	
Meadowbrook Slough 0.23	3/15/2016	4	308	39	34.6	59.8	1.3	29.14	4789	5.5	6.86	6.32	5559.7	2		30.2	-1.87	
Meadowbrook Slough 0.23	4/11/2016	2	182	17	10.2	72.2	1.3	15.87	4225	5.0	7.10	5.17	9205.0	1	8.5	30.1	-2.12	
No Name 0.03	11/24/2015	20								12.3	7.80	0.09	194.9	6	6.0	29.9	-2.42	
No Name 0.03	1/26/2016	4										0.00	103.1		6.7		-2.34	
No Name 0.03	4/12/2016	2								11.4	7.60	0.08	170.0	4	9.1	30.1	-2.44	

Primary Name	Arrival	Fecal	TN	TP	NH3	Nitrate	Nitrite	PO4	SO4	DO	pH	Salinity	Spc Cond	Turb	Temp	Bar P	Stage	Flow
Sequim Bay State Park Creek 0.0	5/12/2015	2										0.40			10.0		-5.92	
Sequim Bay State Park Creek 0.0	8/13/2015	2										0.50			15.1		-6.00	
Sequim Bay State Park Creek 0.0	10/8/2015	2	752	71	78.2	264.4	2.0	58.20	8338	8.2	7.60	0.44	892.0	4	11.3	30.1	-5.98	0.00
Sequim Bay State Park Creek 0.0	11/23/2015	2	2956	85	0.0	1663.8	2.2	61.70	11402	12.5	7.90	0.13	281.2	6	5.1	29.9	-5.79	
Sequim Bay State Park Creek 0.0	12/17/2015	12	2166	134	1.6	903.8	5.9	75.30	11365	12.5	7.50	0.08	176.4	19	5.6	29.7	-4.00	
Sequim Bay State Park Creek 0.0	1/25/2016	8	1301	116	5.7	362.8	4.1	68.28	9388			0.10	209.5		5.2		-5.70	
Sequim Bay State Park Creek 0.0	2/17/2016	14	1220	108	6.1	330.0	4.0	70.76	9032	11.9	7.50	0.10	201.0	17	7.5	29.4	-4.91	
Sequim Bay State Park Creek 0.0	3/15/2016	10	1828	133	6.5	507.0	4.1	74.69	11699	12.6	7.47	0.08	163.1	27	5.6	30.2	-5.42	
Sequim Bay State Park Creek 0.0	4/11/2016	2	541	63	6.9	70.1	1.2	60.55	9019	11.1	7.90	0.18	369.0	2	9.2	30.1	-5.78	
Siebert 1.0	11/24/2015	82								12.9	7.70	0.05	103.0	44	4.6	29.9		
Siebert 1.0	1/26/2016	14										0.00	90.4		5.2		-17.30	
Siebert 1.0	4/12/2016	2								11.6	8.04	0.08	165.0	1	9.3	29.9	-17.95	