# Fidalgo Bay Water Quality Data Summary Report: 2005-2018

**Prepared by**

**Samish Indian Nation Department of Natural Resources**

**March 2019**

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# Introduction

## *Historical Information*

The Samish Indian Nation Department of Natural Resources received grant funding to monitor the water quality of stormwater outfalls into Fidalgo Bay in July of 2005. Identification of all outfalls into Southern Fidalgo Bay commenced immediately. All accessible outfalls were mapped and sampled. Sampling activity began in September of 2005 and has continued, under various funding sources, through the present date (Spring 2019) and will continue indefinitely as funding allows. Samples have been taken twice a month for a portion of the study and are currently taken once monthly.

This study focuses on the stormwater that flows from the Fidalgo Bay watershed into the bay. The watershed includes the March's Point oil refineries, some of the Anacortes Community Forest Lands, and the City of Anacortes.

The study has been refined substantially since its inception in 2005. Sampling sites that had intermittent flows or displayed consistently low levels of fecal coliform and nutrients were eliminated from the study, to allow Samish DNR to focus monitoring efforts on sites where changes in stormwater management or removal of contamination sources could lead to improvements. The 43 sites originally identified have been narrowed down to 16. (See Figure 1, original sampling map, versus Figure 2, current sampling map.) Basic water quality parameters, dissolved oxygen, temperature, pH, salinity and specific conductivity, are collected using a YSI multiprobe. Fecal coliform samples have been taken twice per month during the first half of the study, and once per month for the second half of the study. Water samples for nitrate/nitrate and total phosphorus have been taken since 2010.

The Quality Assurance Project Plan (QAPP) for this project was reviewed and approved by US EPA. Project data are housed in a Microsoft Access database on the Samish server, and are submitted on a regular basis to EPA's STORET online data storage system.

The Samish Indian Nation would like to thank the Environmental Protection Agency and the Puget Sound Partnership for their steady financial assistance from the very beginning of this study and our initial water quality work. Long term data sets such as these are rare and valuable, and these agencies' support has been crucial. We look forward to our continued relationship in future studies.

## *Study Area*

Fidalgo Bay is a shallow embayment located in Northern Puget Sound, northwestern Skagit County, Washington (Figures 1 and 2). It encompasses approximately 1,575 acres of tide flats, salt marsh, mudflats and sand and gravel beaches. It is bordered by the City of Anacortes to the west and March's Point to the east. Much of the shoreline is modified with rip rap and other development including the City of Anacortes, March's Point oil refineries, a tribally owned RV park and private residences located near the shoreline. A former railroad grade that has been converted into a public walking path is also armored along the shoreline.

Due to its diverse habitat types, including extensive eelgrass beds, Fidalgo Bay supports a wide range of invertebrate, fish, bird, and mammal species. Shellfish abound in the intertidal area and large populations of crab are found throughout the bay. Surf smelt, herring and other fish, including salmonids and flatfish use the bay for most life stages. Herons, gulls, ducks and other water birds are found year-round in Fidalgo Bay and it is an important area along the Pacific Flyway for a wide range of migratory birds. There are at least three nesting pairs of bald eagles utilizing the bay and osprey and other raptors have been observed in the area. The

remaining upland forests support a wide range of songbirds as well. Fidalgo Bay provides habitat for mammals such as harbor seals and river otters as well. The quality of the water entering the bay is important for all these species, as well as for human uses of the bay and the species inhabiting it.

In April of 2008, Washington State Department of Natural Resources designated 781 acres of Fidalgo Bay as an Aquatic Reserve in a ceremony at the Fidalgo Bay Resort. The Aquatic Reserve management guidelines inform management and restoration in Fidalgo Bay. Please see the link to the DNR Aquatic Reserve website in the Works Cited section for more information.


*Figure 1. Map of original sampling sites--all accessible stormwater outfalls to Fidalgo Bay. Map from 2011.*


*Figure 2. 2018 map of Fidalgo Bay water quality sampling sites. This map includes sites GR1-3, which we sampled for our colleagues at Skagit Land Trust for a one-year term. The GR sites will not be considered in this report.*

# Methods

Grab samples for fecal coliform, total inorganic nitrogen (nitrate and nitrite) and total phosphorus are taken once monthly. Samples are taken by dipping the bottle into the water facing upstream. When the flow is difficult to reach, an extended sampling cup is triple-rinsed and then used to fill both bottles from the same sample. Replicates of ten percent of the samples are taken for quality control. Samples are kept in a cooler on ice until they arrive at the lab.

Samples are taken to Edge Analytical, a Washington State Department of Ecology accredited lab in Burlington, for processing. Fecal samples bottles are 120 mL and contain a small amount of preservative. Fecal coliform is measured using the MPN (Most Probable Number) method, which uses the products of bacterial respiration and a probability index to calculate the most probable number of fecal colony-forming units in a sample.

Nutrients (nitrogen and phosphorus) are measured in milligrams per liter (mg/L), which is equivalent to parts per million. Nutrient bottles are 250 mL and contain sulfuric acid as a preservative; these samples are also processed at Edge Analytical.

Dissolved oxygen, pH, salinity, temperature and specific conductance are recorded using a YSI multiprobe. The YSI is calibrated before each sampling event and audited afterward at the Samish DNR facility.

Turbidity samples are obtained in the same manner as fecal and nutrient samples. Turbidity is measured in NTU, (Nephelometric Turbidity Units) and samples are processed at the Samish facility using a Hach turbidimeter. Sample bottles are agitated to emulsify contents and a portion of each sample is poured into three glass vials, which are placed in the turbidimeter and read by a technician. An average of the turbidity values for the three vials is used as the final data value to ensure accuracy.

# Results and Discussion

## *Fecal Coliform*

Because none of the creeks or other outfalls into Fidalgo Bay meet the criteria for anadromous fish habitat, we use the primary contact recreation standard of 100 colonies/100 mL (Washington State Water Quality Standards). The graphs below are grouped by type of site (upland, suburban, urban outfall, and marine.) The geomean values for each season are graphed by site; values exceeding the state standard are indicated in red. Please take note of the scale on each graph; the colony count numbers are so wildly disparate that it was impractical to scale the graphs accurately by size.

To calculate a geomean with reasonable accuracy, the number of samples must be greater than 5. Dates that are missing a bar had fewer than 5 samples, generally because the tide at that site did not accommodate sampling for several months or because the site dried up in the summer. In addition, the 2016-2017 year unfortunately saw a gap in funding, which is why most of the data sets end in 2016. Sampling resumed in September 2017, but at the time of this writing, there was generally not enough data to generate fecal results for 2017-2018.

The lab results for fecal coliform generally range from the lowest detectable/undetected amount, which is listed as <1.8, to >1600. Occasionally we requested exact counts for some of the sites with high fecal numbers, but in most cases, the upper threshold is 1600. Sites listed as 1.8 may have had lower values as well.

Upland Wooded Sites

Site FB2B comes out of Whistle Lake and is within the Anacortes Community Forest Lands.

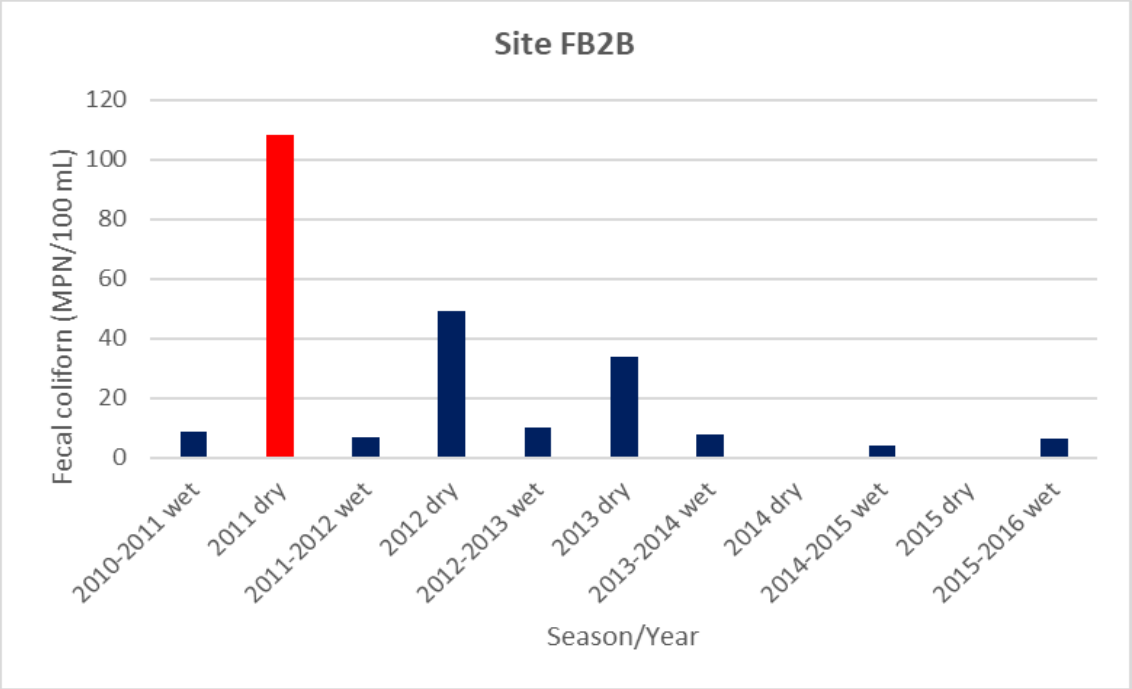


*Figure 3. Geometric mean of fecal coliform most probable numbers, site FB2B, 2010-2016. Red bars indicate a violation of state water quality standards. See figure 2 for map of site locations.*

Upland suburban sites

These sites are in the middle of the watershed in suburban areas and contain some roads and driveways, but overall more shrubs and lawn than impervious surfaces. They are located along the streams that feed into the COA8 and COA7 outfalls and are labeled accordingly (see map.)

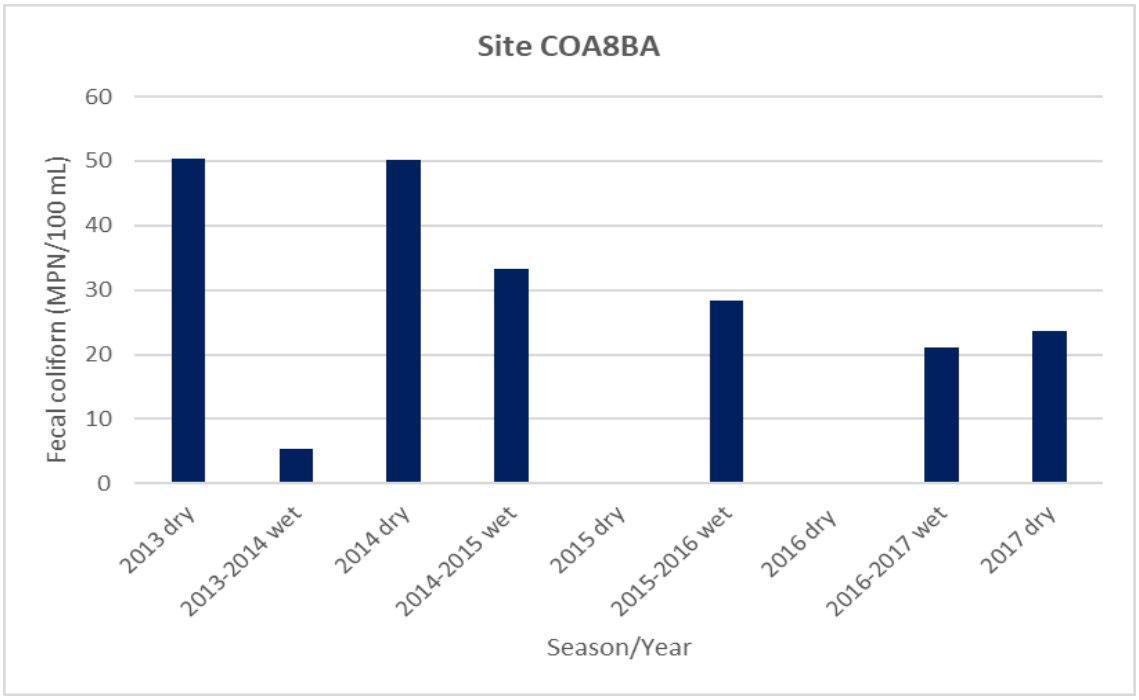


*Figure 4. Geometric mean of fecal coliform most probable numbers, site COA8BA, 2013-2017. Red bars indicate a violation of state water quality standards. See figure 2 for map of site locations.*

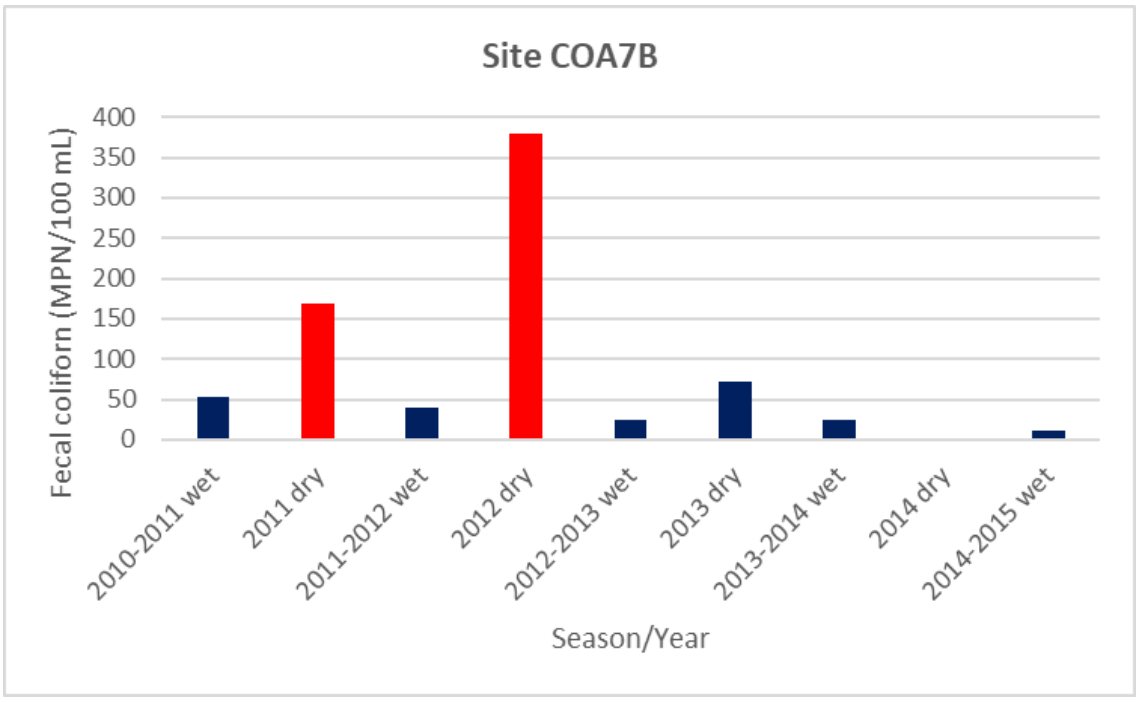


*Figure 5. Geometric mean of fecal coliform most probable numbers, site COA7B, 2010-2015. Red bars indicate a violation of state water quality standards. See figure 2 for map of site locations.*

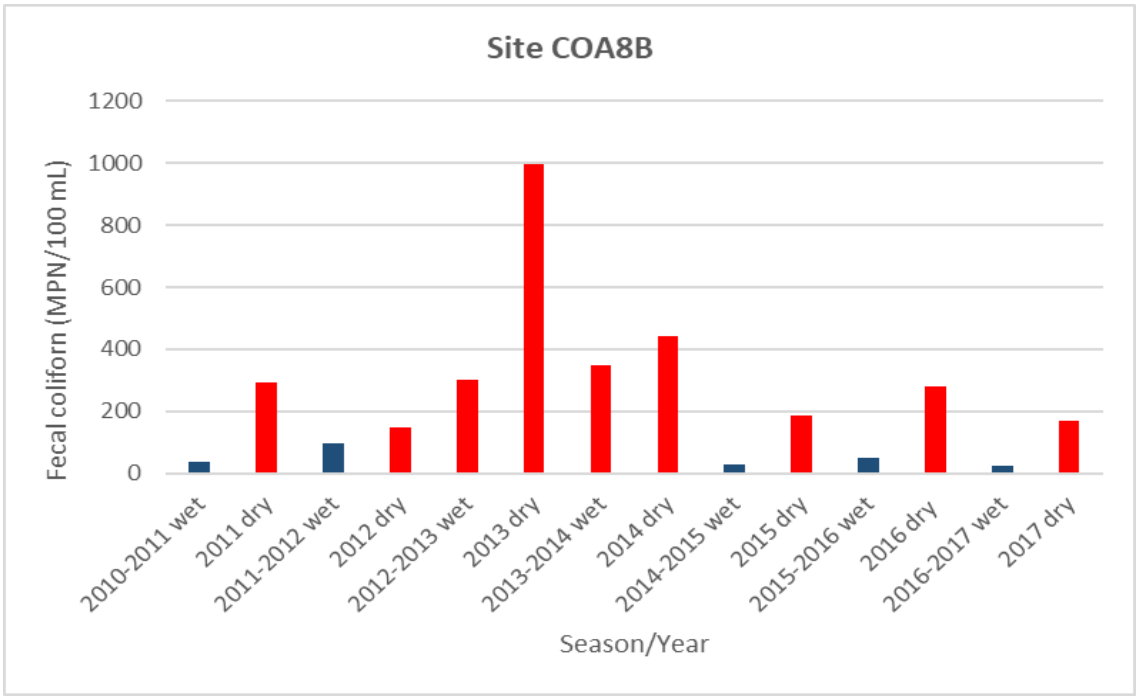


*Figure 6. Geometric mean of fecal coliform most probable numbers, site COA8B, 2010-2017. Red bars indicate a violation of state water quality standards. See figure 2 for map of site locations.*

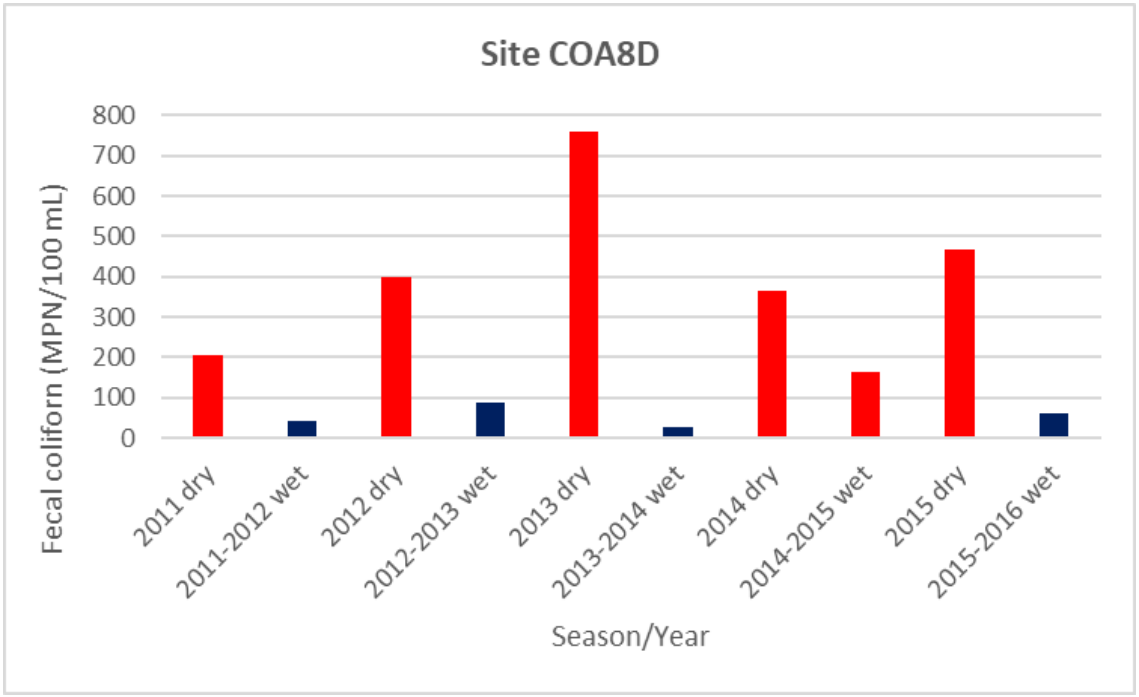


*Figure 7. Geometric mean of fecal coliform most probable numbers, site COA8D, 2011-2016. Red bars indicate a violation of state water quality standards. See figure 2 for map of site locations.*

March's Point (Refinery) Outfall Site

One of the properties that drains these sites hosts a modest number of cows. The landowner has worked with the Skagit Conservation District to develop a farm plan and best management practices to prevent livestock manure entering the drainage.

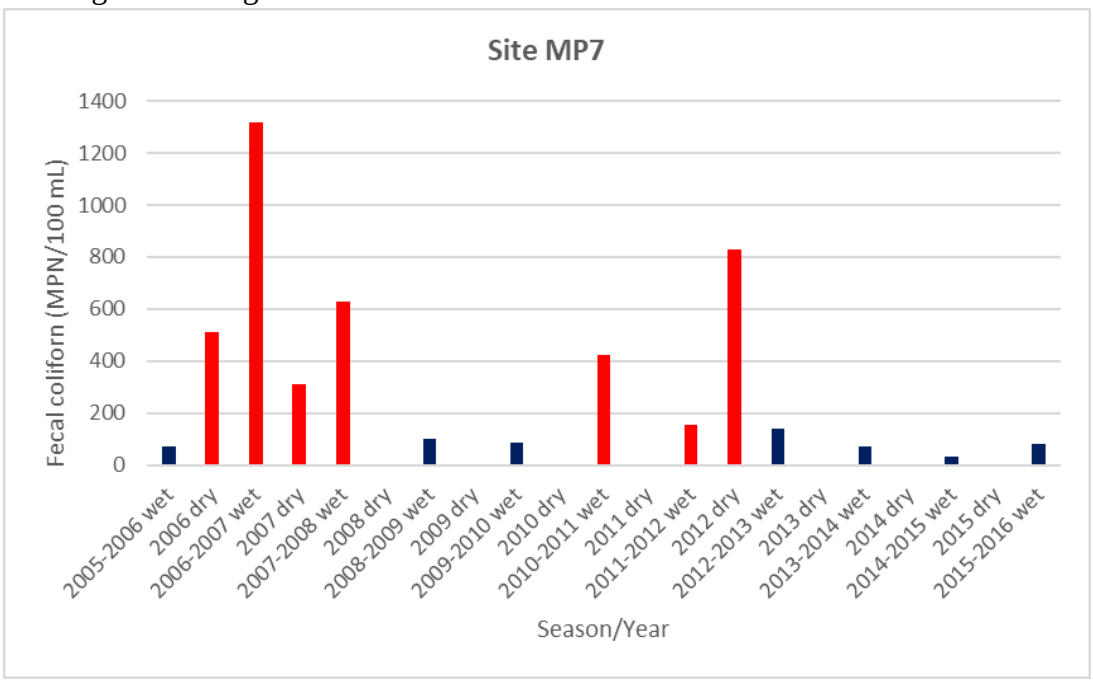


*Figure 8. Geometric mean of fecal coliform most probable numbers, site MP7, 2005-2016. Red bars indicate a violation of state water quality standards. See figure 2 for map of site locations.*

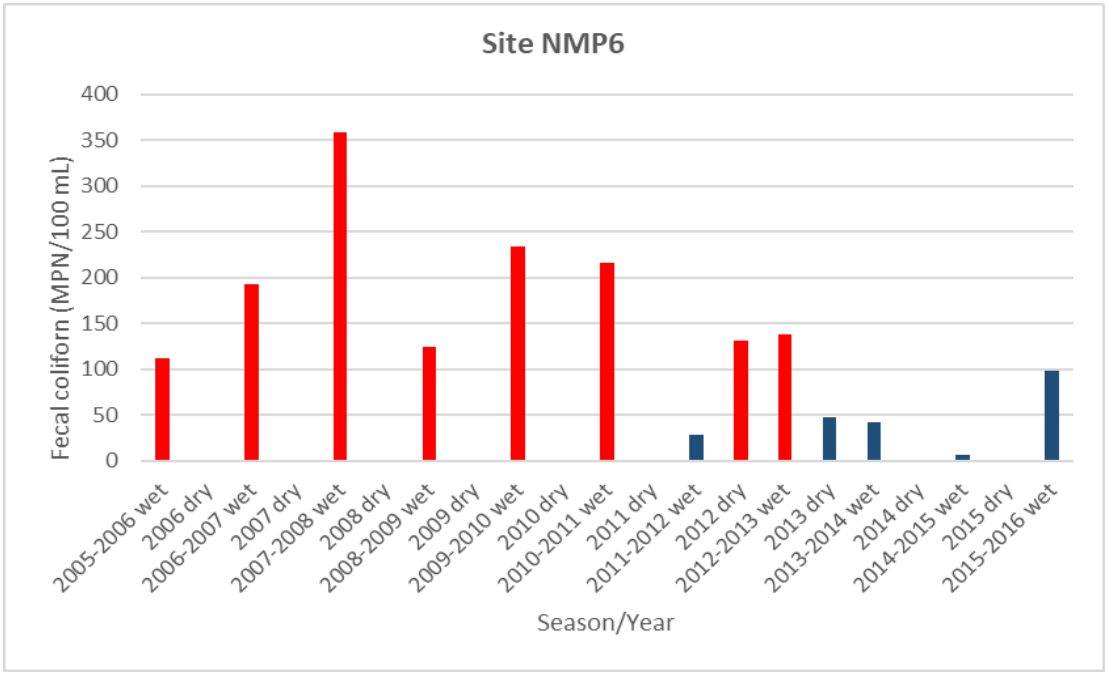


*Figure 9. Geometric mean of fecal coliform most probable numbers, site NMP6, 2005-2016. Red bars indicate a violation of state water quality standards. See figure 2 for map of site locations.*

Wooded Outfall Sites

These outfalls drain into Fidalgo Bay from a predominantly forested slope with a few rural residences and pass under Highway 20 through a culvert.

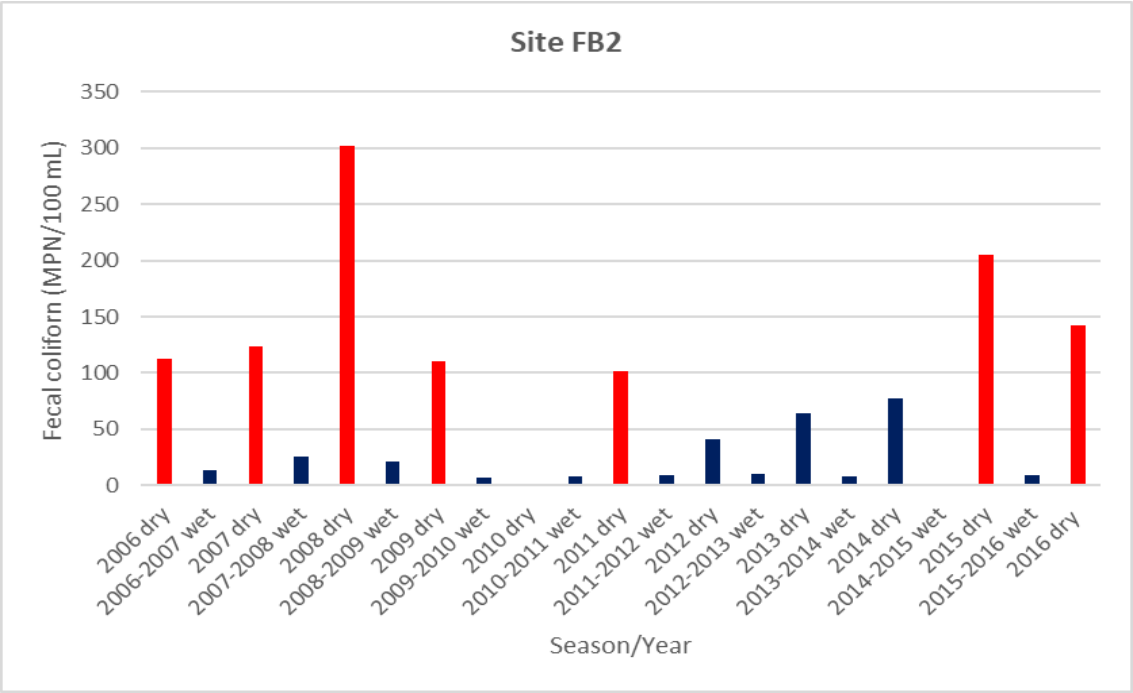


*Figure 10. Geometric mean of fecal coliform most probable numbers, site FB2, 2006-2016. Red bars indicate a violation of state water quality standards. See figure 2 for map of site locations.*

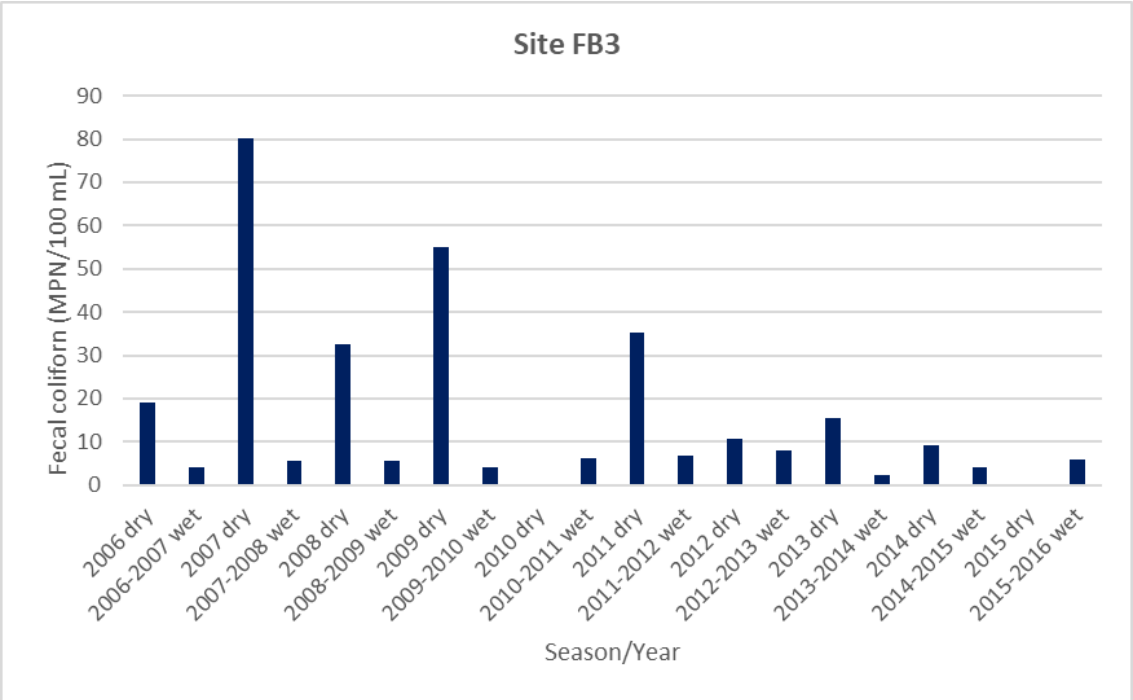


*Figure 11. Geometric mean of fecal coliform most probable numbers, site FB3, 2006-2016. Red bars indicate a violation of state water quality standards. See figure 2 for map of site locations.*

Urban Outfall Sites

The water entering Fidalgo Bay at these sites passes through the heart of urban Anacortes in pipes under the City. They collect water from the City's storm drains and persistently return exceptionally high fecal counts.

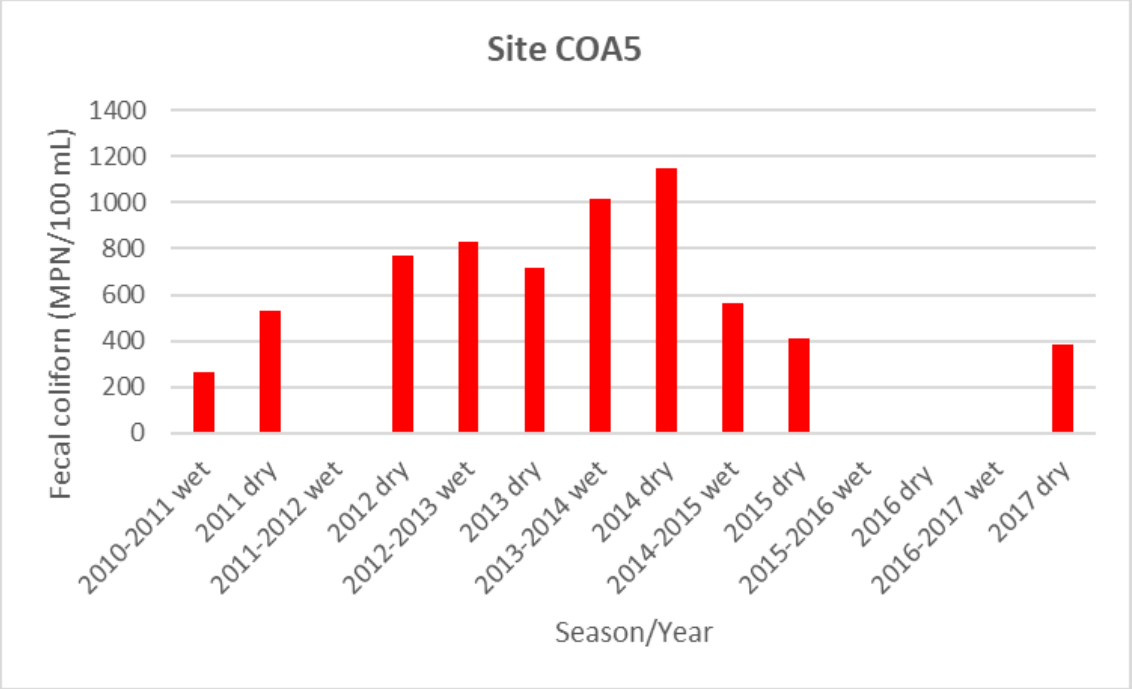


*Figure 12. Geometric mean of fecal coliform most probable numbers, site COA5, 2010-2016. Red bars indicate a violation of state water quality standards. See figure 2 for map of site locations.*

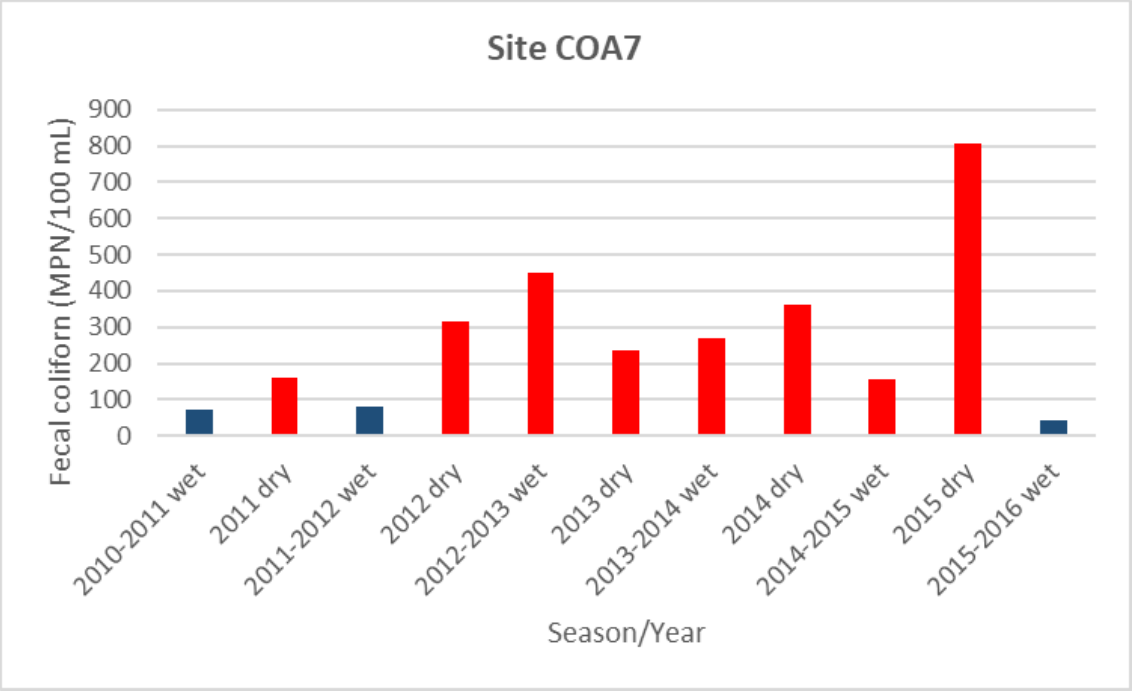


*Figure 13. Geometric mean of fecal coliform most probable numbers, site COA7, 2010-2016. Red bars indicate a violation of state water quality standards. See figure 2 for map of site locations.*

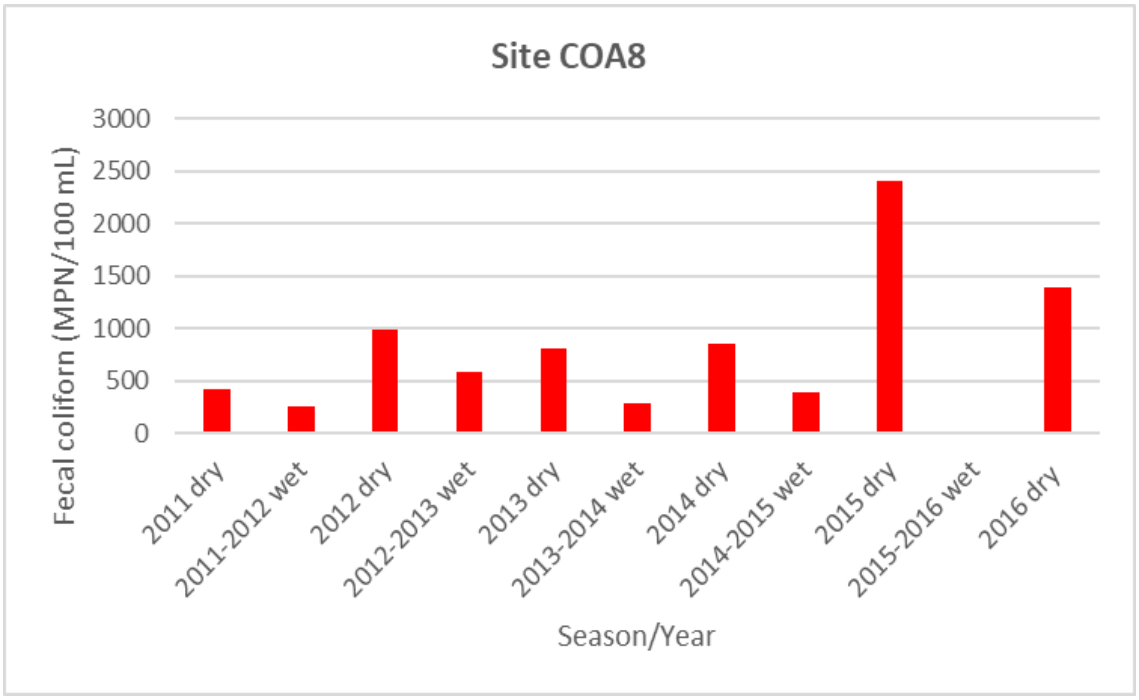


*Figure 14. Geometric mean of fecal coliform most probable numbers, site COA8, 2011-2016. Red bars indicate a violation of state water quality standards. See figure 2 for map of site locations.*

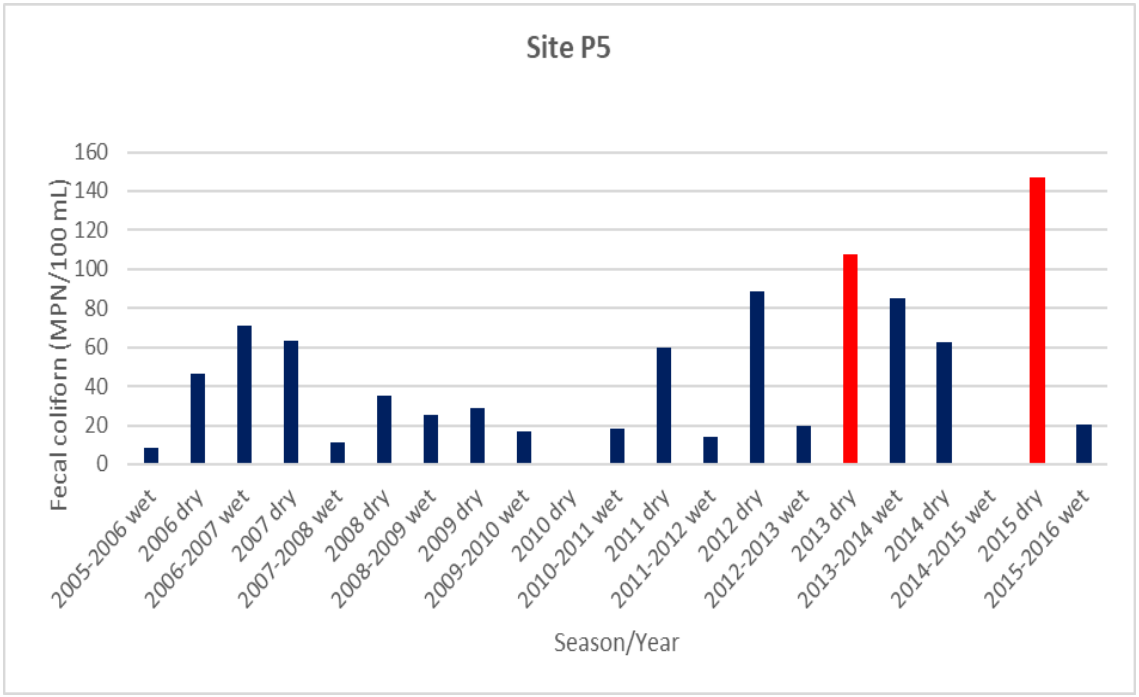


*Figure 15. Geometric mean of fecal coliform most probable numbers, site P5, 2005-2016. Red bars indicate a violation of state water quality standards. See figure 2 for map of site locations.*

Marine Sites

The marine sites never violated state standards for fecal coliform, and we have concluded sampling at those locations. We continue to do continuous temperature monitoring in Fidalgo Bay as part of our ongoing eelgrass study, and to monitor the other background water quality parameters as part of our beach seining and eelgrass studies. The fecal findings at these sites indicate that the highly contaminated water entering Fidalgo Bay is diluted substantially at a distance from the outfalls in question.

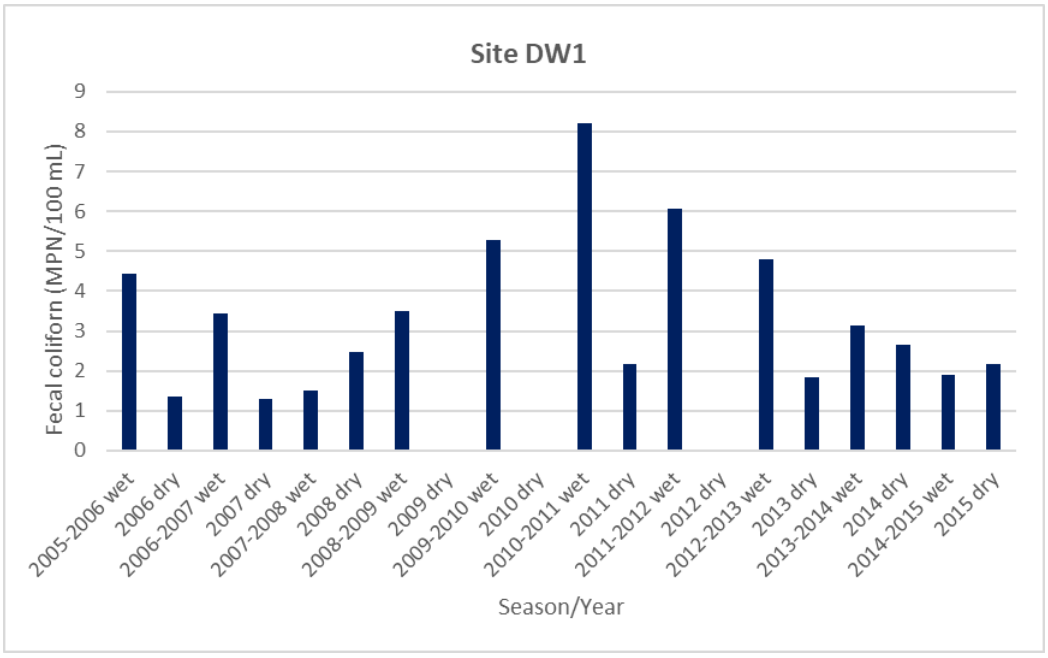


*Figure 16. Geometric mean of fecal coliform most probable numbers, site DW1, 2005-2015. Red bars indicate a violation of state water quality standards. See figure 2 for map of site locations.*

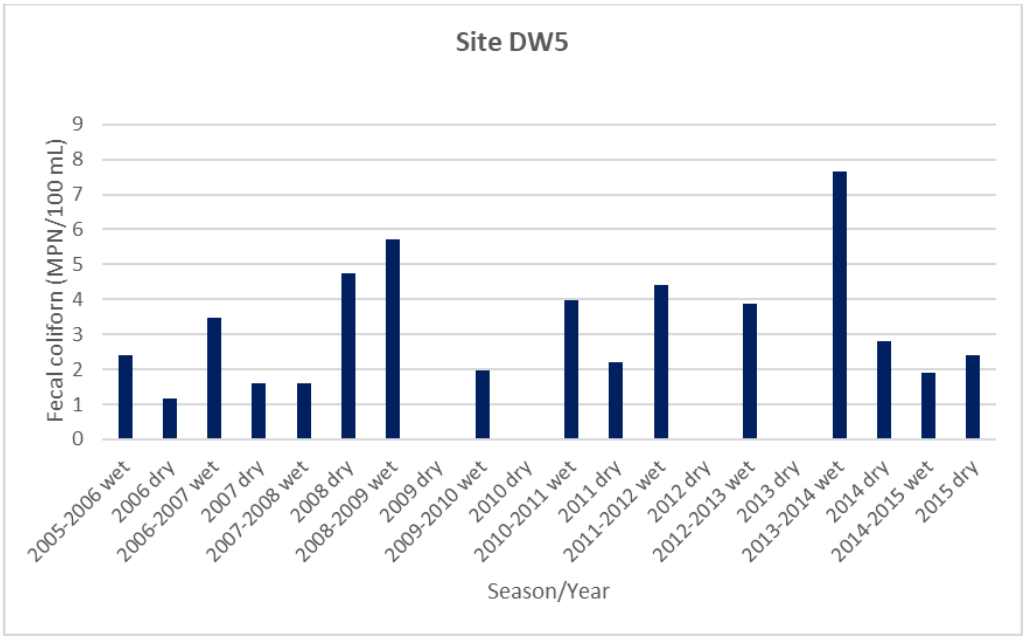


*Figure 17. Geometric mean of fecal coliform most probable numbers, site DW5, 2005-2015. Red bars indicate a violation of state water quality standards. See figure 2 for map of site locations.*

With some variation by site, the general trend indicates that the water flowing into Fidalgo Bay becomes more contaminated as it flows downhill, particularly after it has flowed through the urban areas of Anacortes. (Presumably, dilution is responsible for the low fecal coliform levels in the marine sites.)

The lab does not count colonies beyond 1600, so consider these results to be conservative. Because the state standard for fishable and swimmable waters is 100 MPN, 1600 is a sufficiently high threshold; the fecal counts could be even higher, but at this threshold it is abundantly apparent that we have a fecal coliform problem.

In agricultural areas, we expect to see high fecal counts in the wet season, because water runs over pastures and flushes livestock waste into streams and rivers. To some degree, we see this at the March's Point sites, where there are cows. In the suburban and urban areas of Anacortes, the opposite trend appears to be true and we largely see higher fecal counts in the dry season. When flows are low, it is likely that fecal coliform bacteria can take advantage of warmer, slower-moving water to reproduce within the storm system (Marino and Gannon 1991.)

Samish DNR has utilized the data collected in this study to drive improvements in the Anacortes stormwater system. We have tracked fecal coliform counts from the outfalls up the watershed and have removed several sources of fecal contamination over the years. In 2016, Samish DNR worked with the City of Anacortes to pilot an optical brightener study (please see Appendix A, Optical Brightener Methods.) In this study, swatches of unbleached cotton were anchored in the storm drain, left for 24 hours, removed to the Samish facility, and observed under a black light. Optical brighteners are a class of "sticky" molecules that are used in laundry detergent to make white clothes look brighter; they fluoresce under a black light. In the course of this study, we found and corrected a cross-connected laundry machine as well as a commercial dryer vent spewing a large volume of microplastics. In cooperation with the City of Anacortes, Samish DNR has helped to detect four additional homes whose sewer or graywater systems were connected erroneously into the storm drain system. These additional homes were found by tracking our fecal counts—or even following up on suspicious fecal odors. In all cases, the City has worked successfully with home and business owners to correct those connections, and the adjacent fecal results have responded favorably. For privacy reasons, the exact locations of those homes and businesses may not be disclosed in this report.

Despite multiple interventions, fecal coliform numbers remain high at the urban outfalls. More work to address fecal contamination is warranted, and the effort needs to be focused primarily in the urban areas. That effort could include DNA testing; more tracking of fecal sources in the urban heart of Anacortes; and testing of various filtration and water retention methods such as rain gardens.

### *Inorganic Nitrogen*

While there is not a state standard for nitrogen loading for sources other than drinking water, the City of Anacortes has elected to use the guidelines laid out in the Illicit Discharge Indicator Thresholds Memorandum (see Works Cited.) The lower threshold—1 mg/L—is the current City standard. Anthropogenic nitrogen plays an important and ominous role in the marine environment. Because marine systems are nitrogen limited, the addition of nitrogen can lead to an overgrowth of algae. The die-off of excess algae can lead to eutrophication and the "dead zones" we have seen in Puget Sound in recent years (National Research Council.)

There is some question as to whether the nitrogen inputs to Fidalgo Bay are anthropogenic or derived from natural processes. This is currently under investigation.

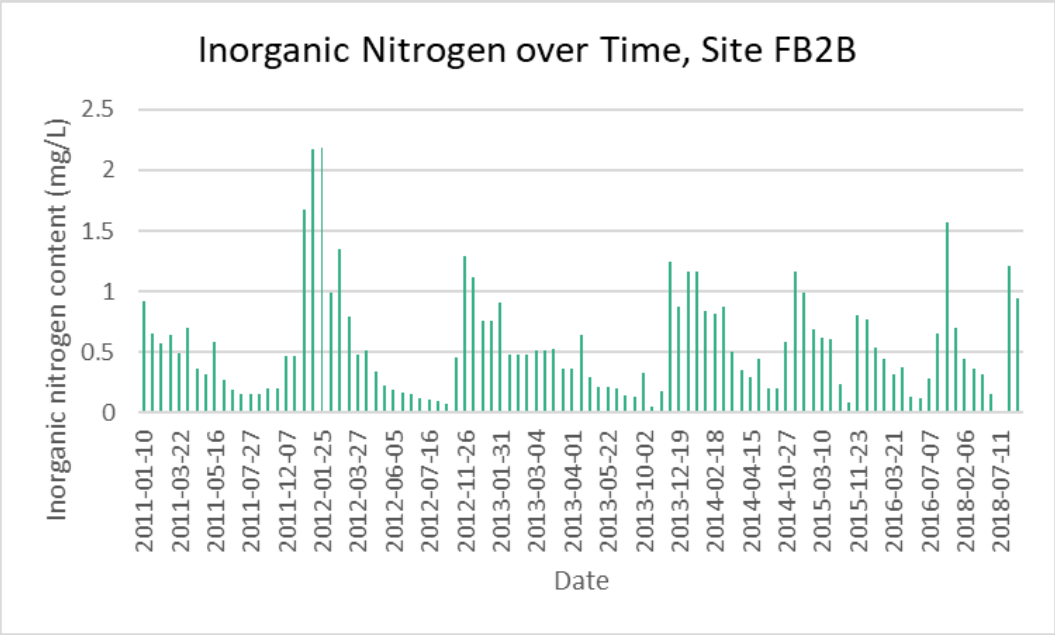


*Figure 18. Inorganic nitrogen values recorded at site FB2B, 2011-2018. Please see figure 2 for map location. The local standard for stormwater inorganic nitrogen content is >1 mg/L. Anacortes, WA 2018*

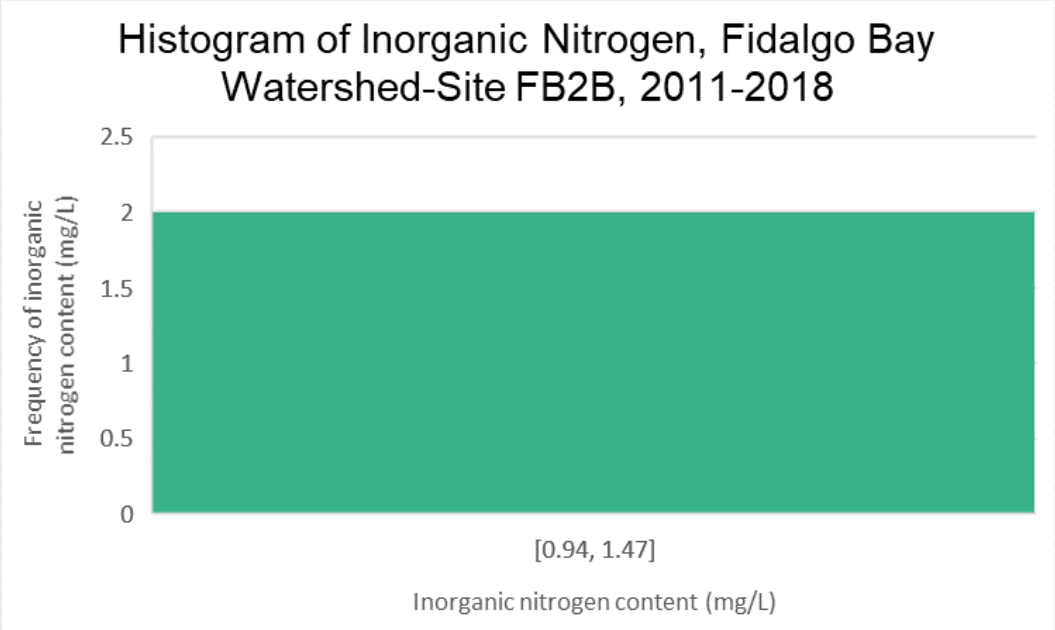


*Figure 19. Histogram of inorganic nitrogen values recorded at site FB2B, 2011-2018. Please see figure 2 for map location. The histogram illustrates how frequently the given values occurred at the site. The local standard for stormwater inorganic nitrogen content is >1 mg/L. Anacortes, WA 2018*

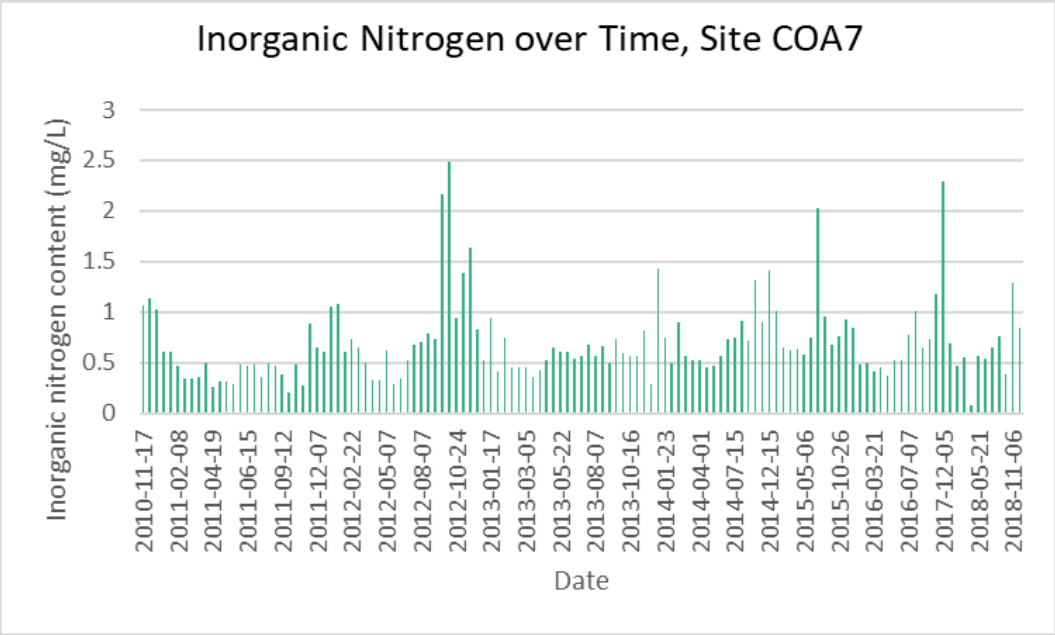


*Figure 20. Inorganic nitrogen values recorded at site COA7, 2010-2018. Please see figure 2 for map location. The local standard for stormwater inorganic nitrogen content is >1 mg/L. Anacortes, WA 2018*

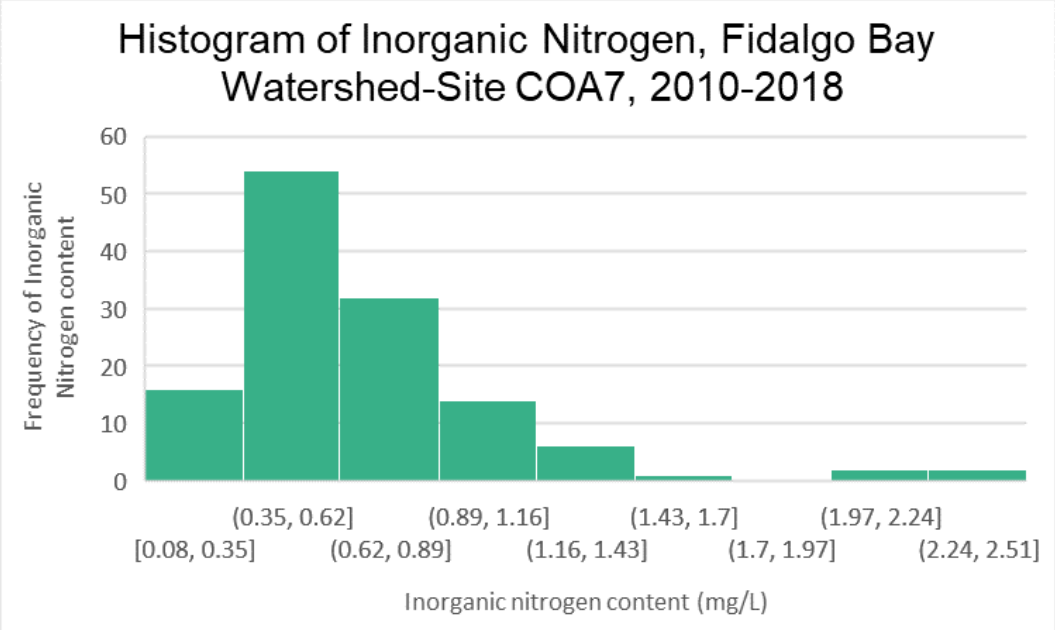


*Figure 21. Histogram of inorganic nitrogen values recorded at site COA7, 2010-2018. Please see figure 2 for map location. The histogram illustrates how frequently the given values occurred at the site. The local standard for stormwater inorganic nitrogen content is >1 mg/L. Anacortes, WA 2018*

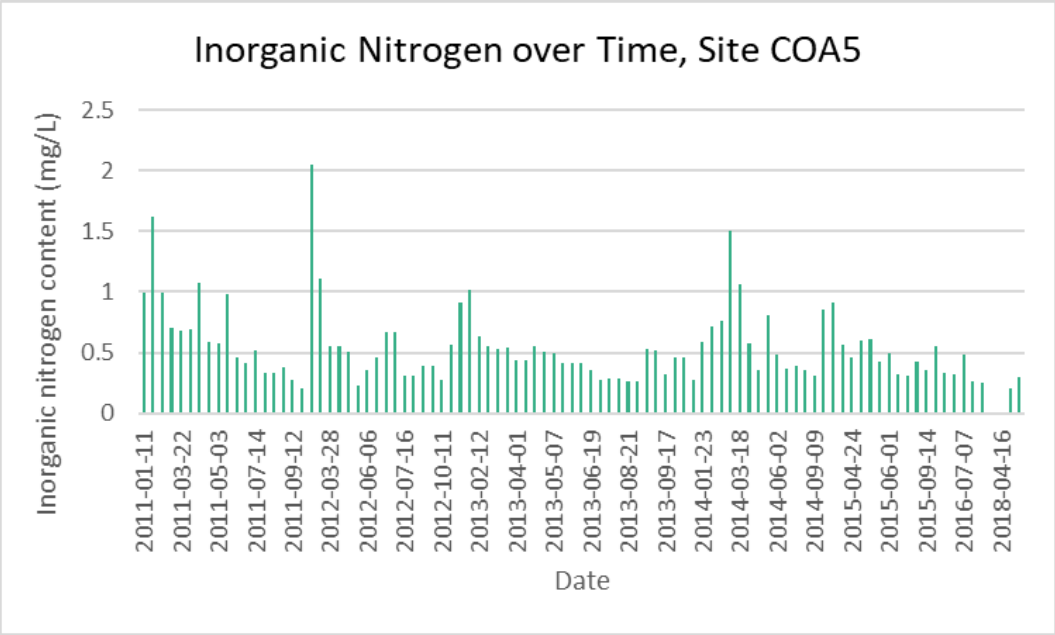


*Figure 22. Inorganic nitrogen values recorded at site COA5, 2011-2018. Please see figure 2 for map location. The local standard for stormwater inorganic nitrogen content is >1 mg/L. Anacortes, WA 2018*

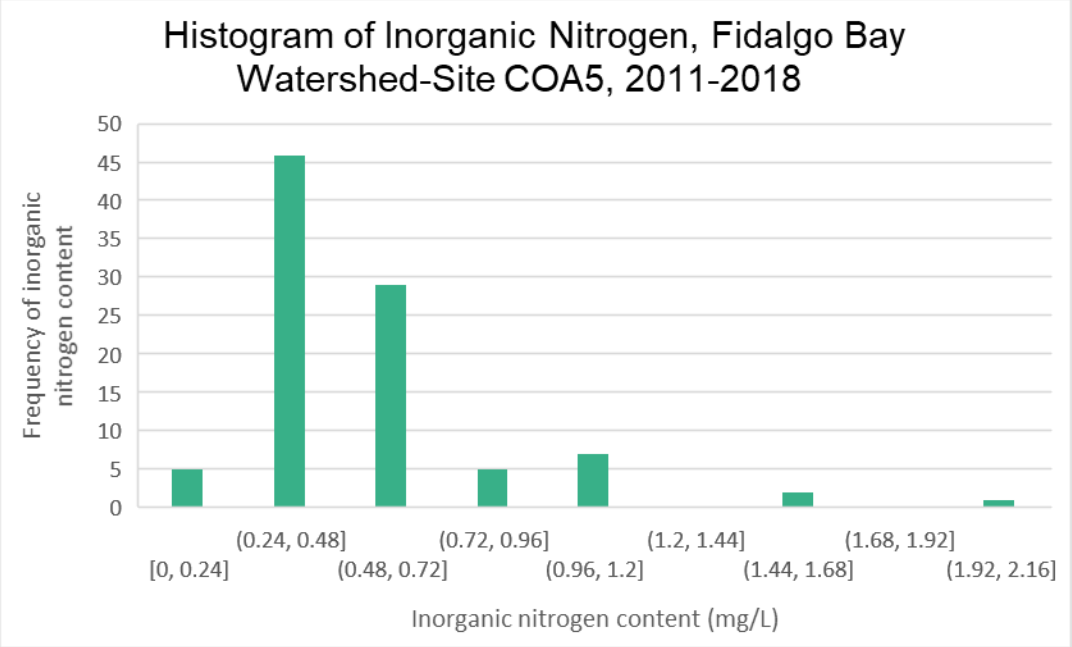


*Figure 23. Histogram of inorganic nitrogen values recorded at site COA5, 2011-2018. Please see figure 2 for map location. The histogram illustrates how frequently the given values occurred at the site. The local standard for stormwater inorganic nitrogen content is >1 mg/L. Anacortes, WA 2018*

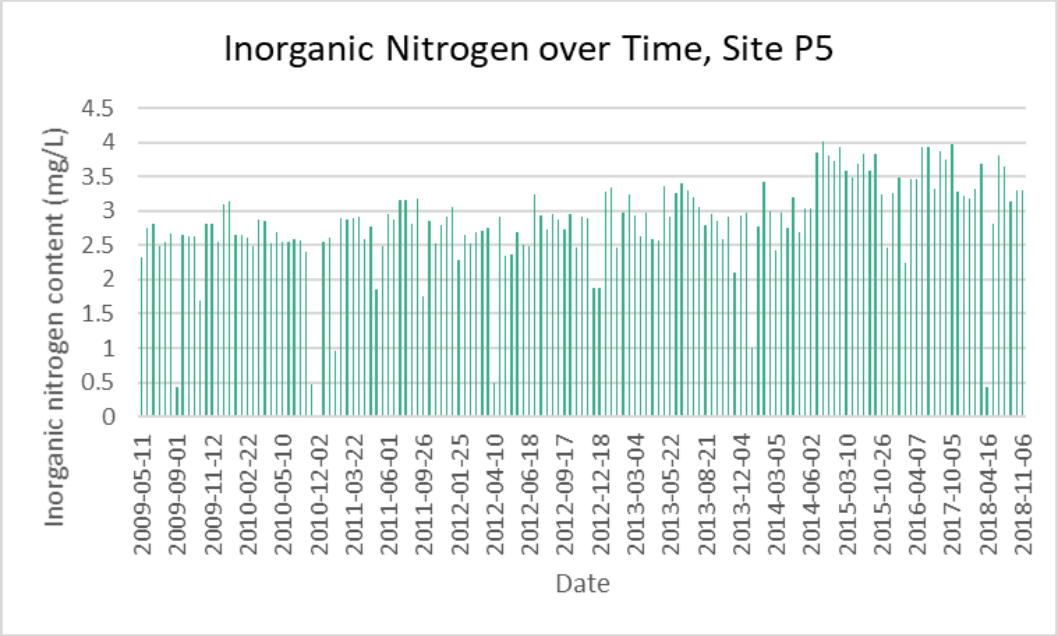


*Figure 24. Inorganic nitrogen values recorded at site P5, 2009-2018. Please see figure 2 for map location. The local standard for stormwater inorganic nitrogen content is >1 mg/L. Anacortes, WA 2018*

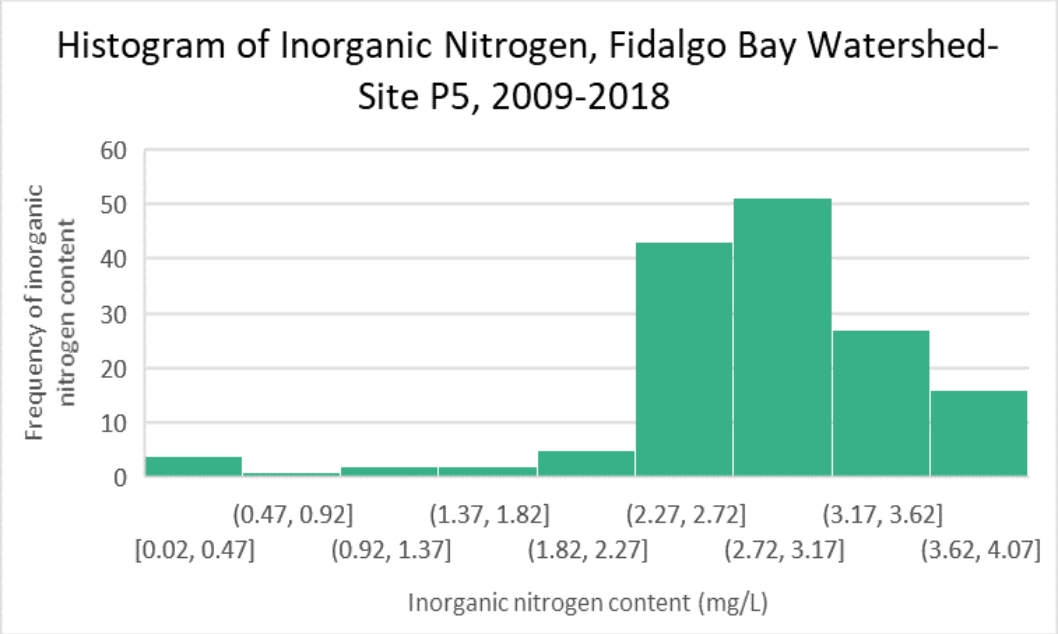


*Figure 25. Histogram of inorganic nitrogen values recorded at site P5, 2009-2018. Please see figure 2 for map location. The histogram illustrates how frequently the given values occurred at the site. The local standard for stormwater inorganic nitrogen content is >1 mg/L. Anacortes, WA 2018*

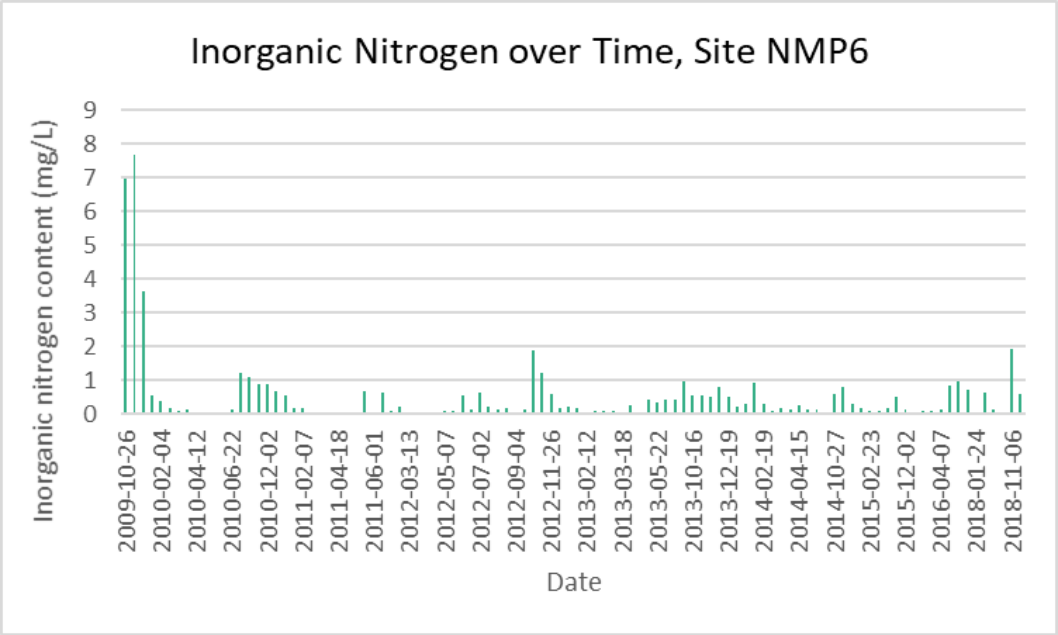


*Figure 26. Inorganic nitrogen values recorded at site NMP6, 2009-2018. Please see figure 2 for map location. The local standard for stormwater inorganic nitrogen content is >1 mg/L. Anacortes, WA 2018*

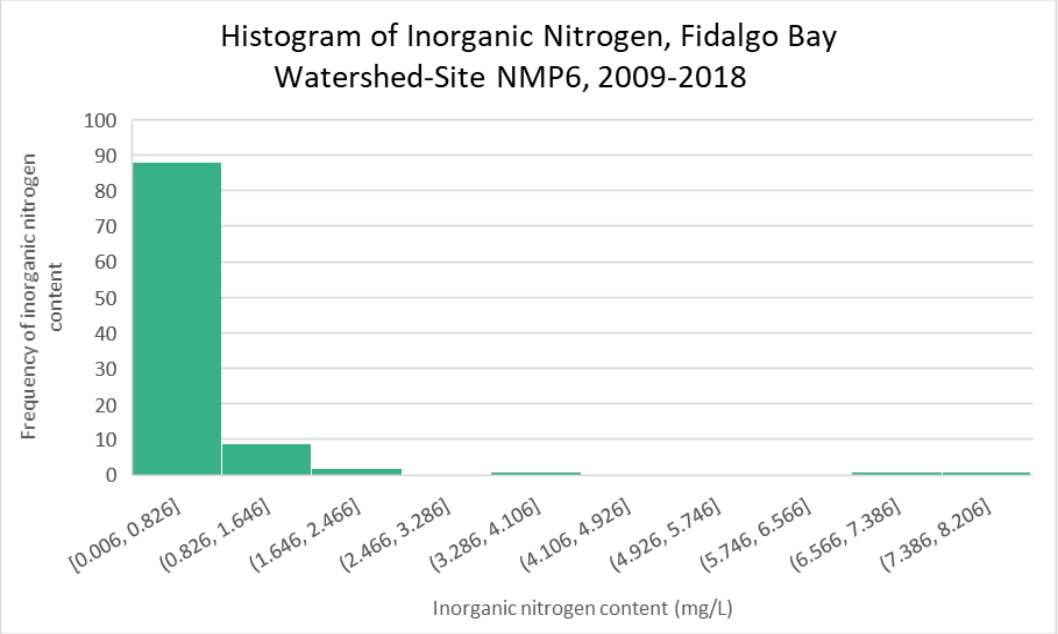


*Figure 27. Histogram of inorganic nitrogen values recorded at site NMP6, 2009-2018. Please see figure 2 for map location. The histogram illustrates how frequently the given values occurred at the site. The local standard for stormwater inorganic nitrogen content is >1 mg/L. Anacortes, WA 2018*

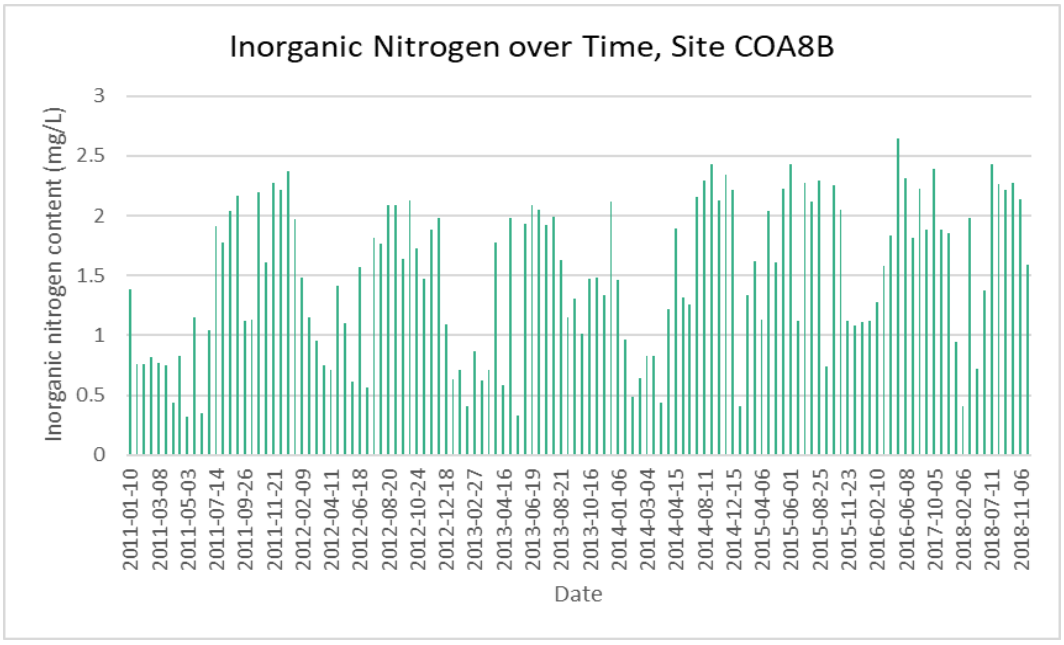


*Figure 28. Inorganic nitrogen values recorded at site COA8B, 2011-2018. Please see figure 2 for map location. The local standard for stormwater inorganic nitrogen content is >1 mg/L. Anacortes, WA 2018*

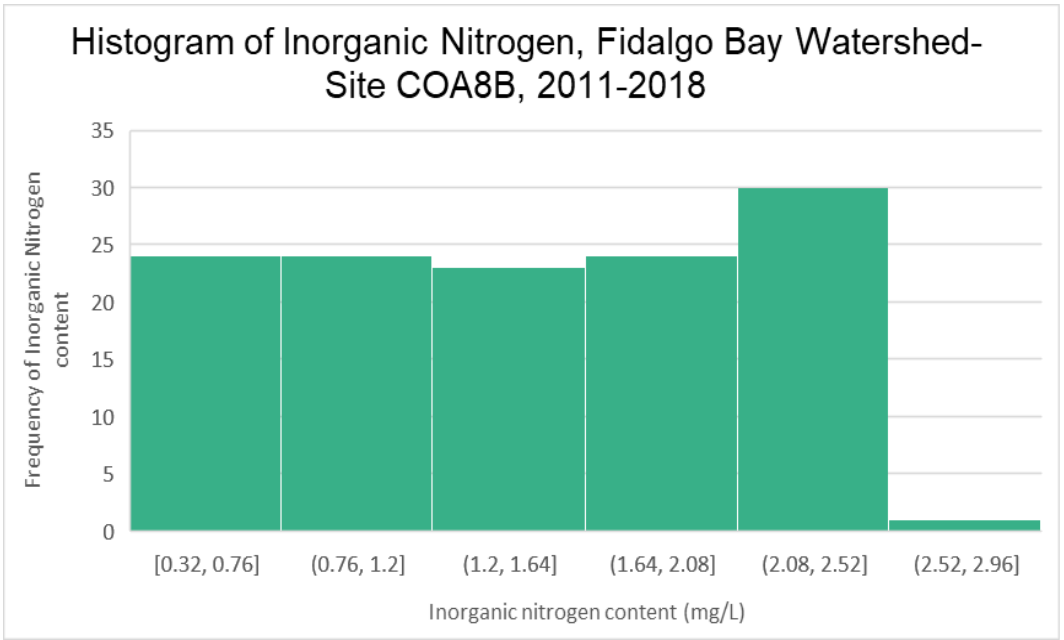


*Figure 29. Histogram of inorganic nitrogen values recorded at site COA8B, 2011-2018. Please see figure 2 for map location. The histogram illustrates how frequently the given values occurred at the site. The local standard for stormwater inorganic nitrogen content is >1 mg/L. Anacortes, WA 2018*

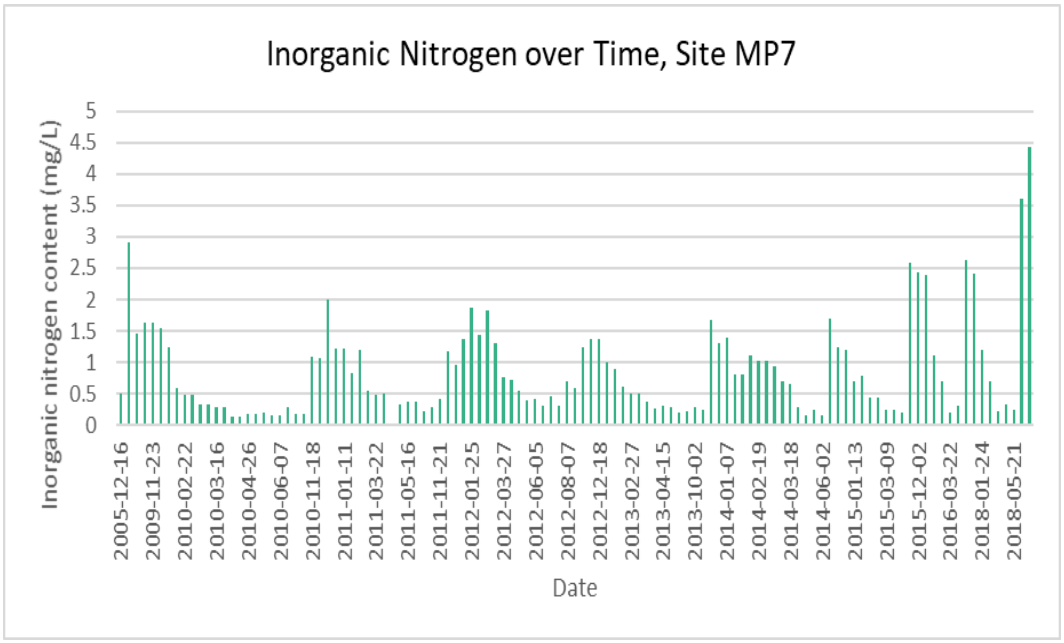


*Figure 30. Inorganic nitrogen values recorded at site MP7, 2005-2018. Please see figure 2 for map location. The local standard for stormwater inorganic nitrogen content is >1 mg/L. Anacortes, WA 2018*

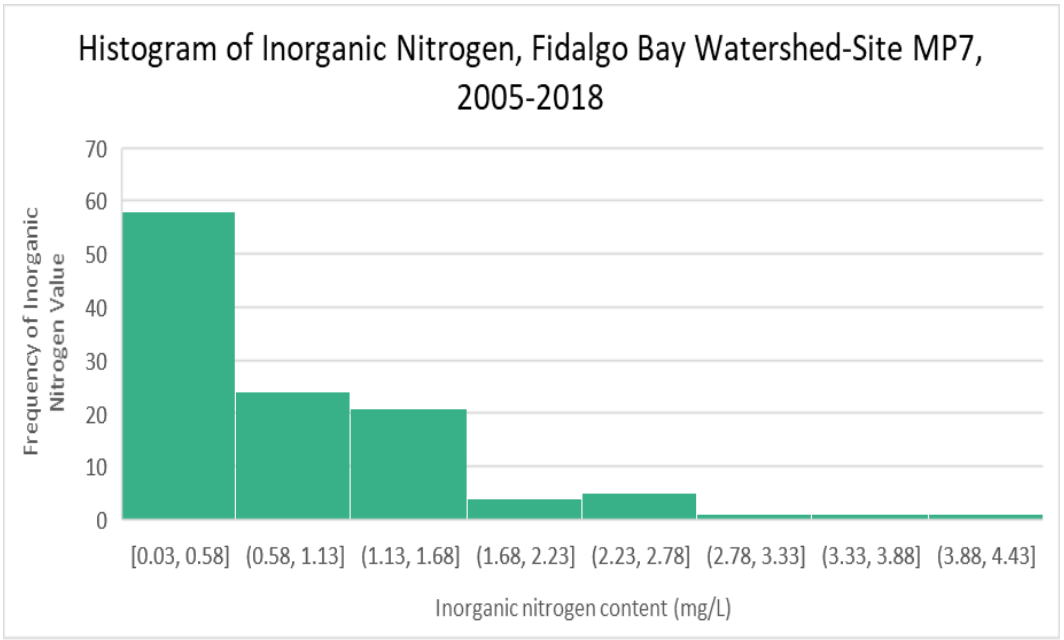


*Figure 31. Histogram of inorganic nitrogen values recorded at site MP7, 2005-2018. Please see figure 2 for map location. The histogram illustrates how frequently the given values occurred at the site. The local standard for stormwater inorganic nitrogen content is >1 mg/L. Anacortes, WA 2018*

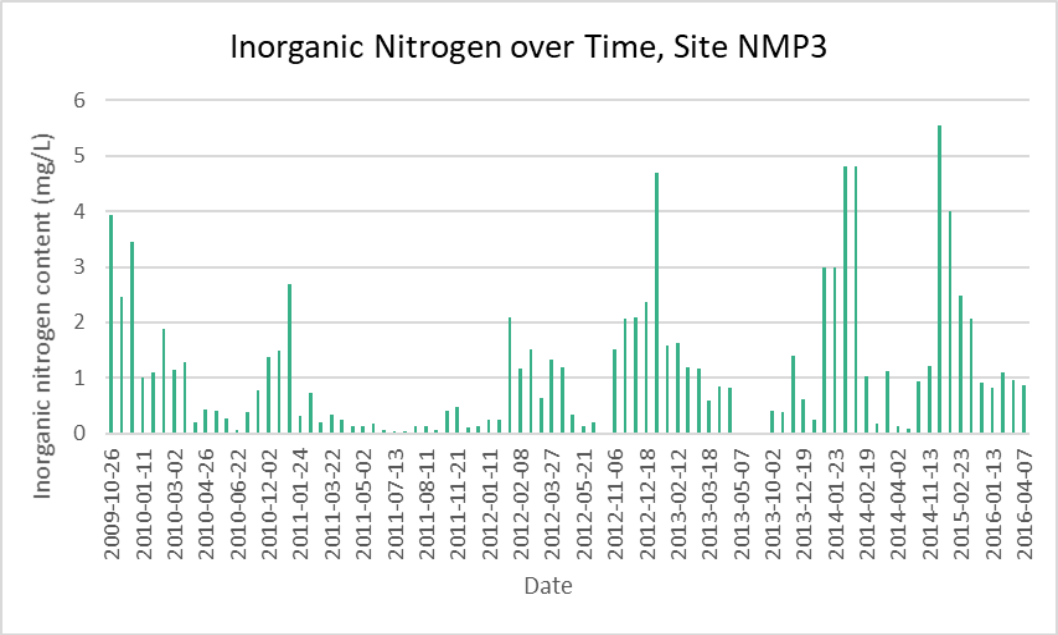


*Figure 32. Inorganic nitrogen values recorded at site NMP3, 2009-2016. Please see figure 2 for map location. The local standard for stormwater inorganic nitrogen content is >1 mg/L. Anacortes, WA 2018*

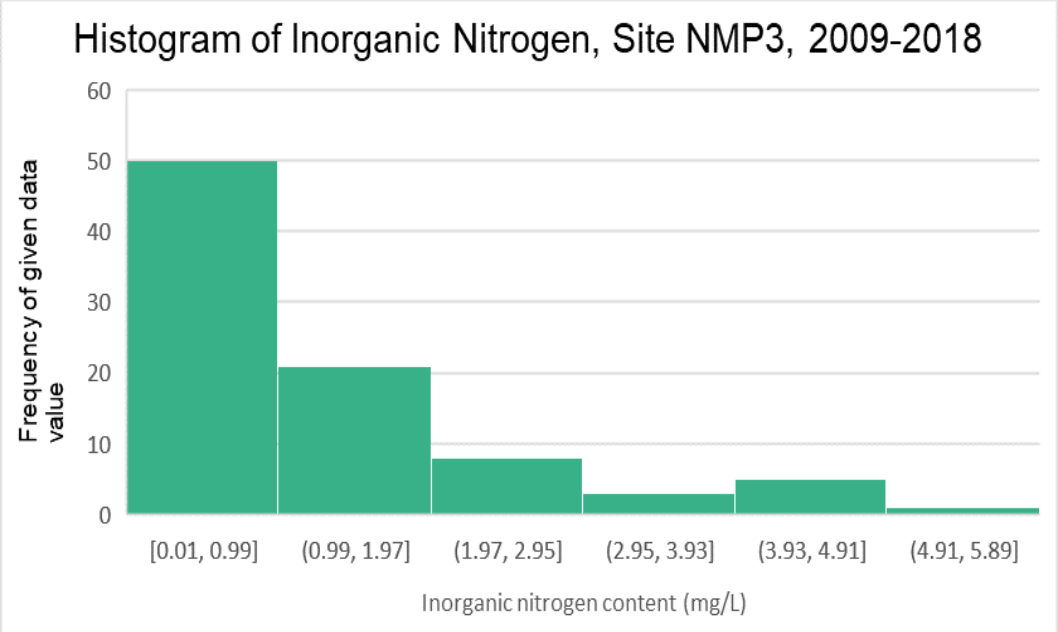


*Figure 33. Histogram of inorganic nitrogen values recorded at site NMP3, 2009-2018. Please see figure 2 for map location. The histogram illustrates how frequently the given values occurred at the site. The local standard for stormwater inorganic nitrogen content is >1 mg/L. Anacortes, WA 2018*

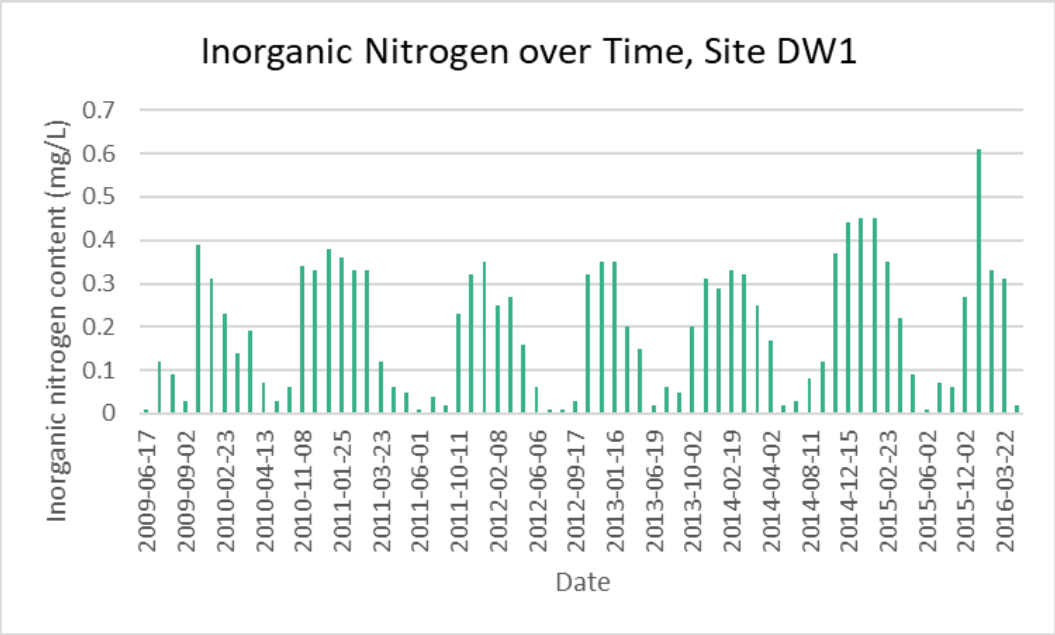


*Figure 34. Inorganic nitrogen values recorded at site DW1, 2009-2016. Please see figure 2 for map location. The local standard for stormwater inorganic nitrogen content is >1 mg/L. Anacortes, WA 2018*

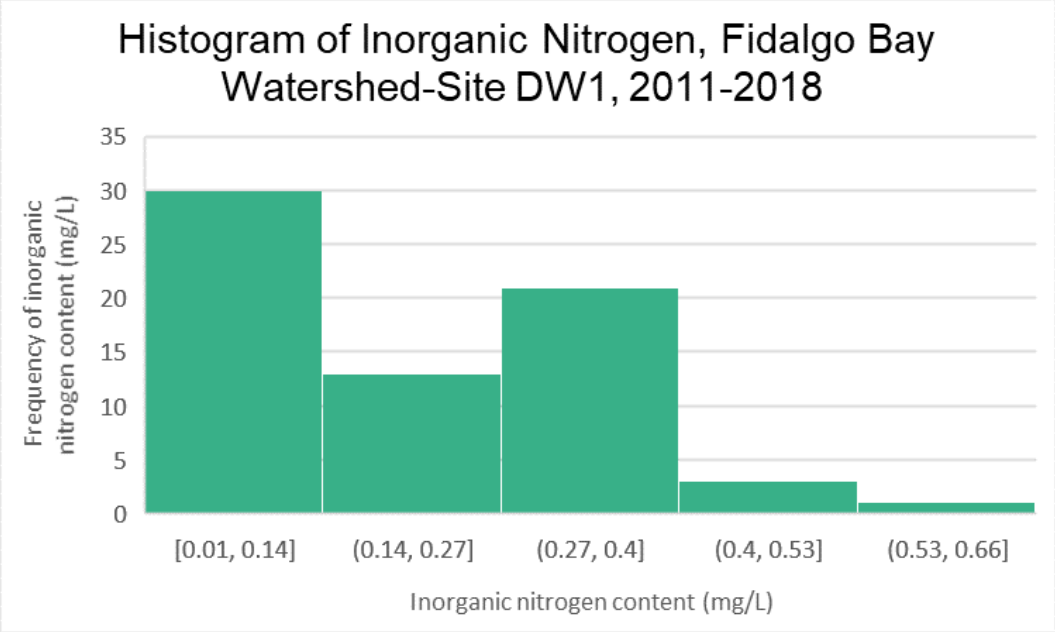


*Figure 35. Histogram of inorganic nitrogen values recorded at site DW1, 2011-2018. Please see figure 2 for map location. The histogram illustrates how frequently the given values occurred at the site. The local standard for stormwater inorganic nitrogen content is >1 mg/L. Anacortes, WA 2018*

The United States Geological Survey lists Washington State as having low background nitrate concentrations (0.1-0.3 mg/L) (USGS.) Most of our sites see a seasonal pattern of higher nitrogen loads in the wet months. This is expected, as higher flows leach more nitrogen off the land and plant growth is much reduced in the winter. Common contributors to nutrient loading include pet waste, wastewater treatment plants and yard fertilizers, though "urban areas" are also cited as a contributor because of the wide range of potentially contaminating activities (National Research Council.) Site P5 has particularly high nutrient loads and is worth investigating, and a few other sites (MP7, COA8B, NMP6) display either upward trends or consistently high nutrient values. These sites are worth investigating as well.

### *pH*

The state standard for pH in acceptable salmonid habitat is 6.5 to 8.5. While there is no documented salmon spawning activity currently in our study area, the fish habitat standard provides a good benchmark for water quality. This histogram contains pH data for all sites considered in this report.

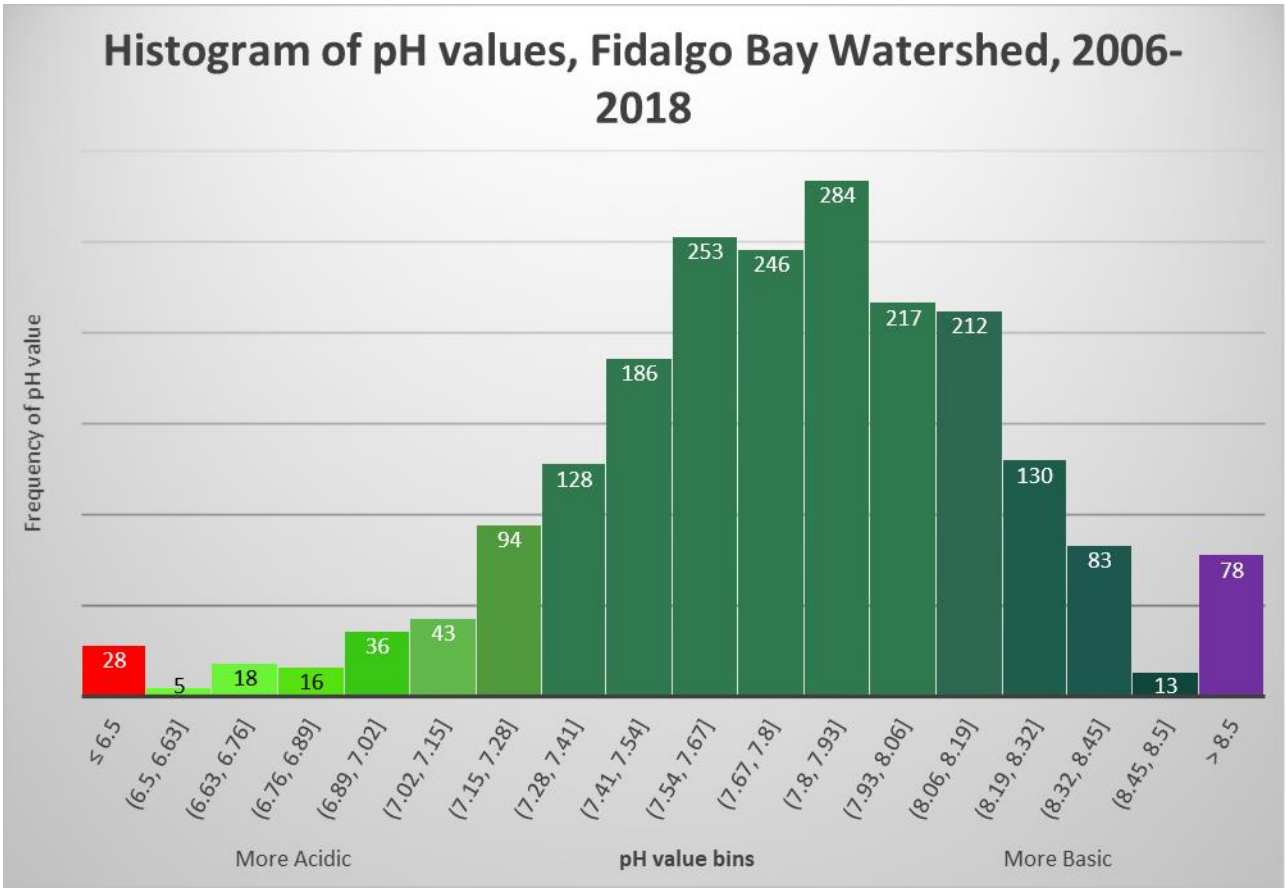


*Figure 36. Histogram summary of all pH values recorded at all sites considered in this study (see figure 2) over the range of dates considered in this study. pH values between 6.5 and 8.5 are considered safe for fish. Anacortes, WA 2018*

3.77% of pH values were too basic (>8.5), and 1.35% were too acidic (<6.5) to meet the state standard for fish habitat. Values that violated state standards show no patterns by site or over time, so it is difficult to take action to correct problems; but since just over 5% of pH samples violated the state standard over a period of thirteen years, variations in pH are likely incidental and not a cause for deep concern.

### *Phosphorus*

The phosphorus values in the Fidalgo Bay streams are consistently well below state standards for the most pristine of lakes. Phosphorus is not currently a cause for concern in the Fidalgo Bay watershed.

### *Dissolved Oxygen*

State standards for dissolved oxygen are based on a "lowest 1-day minimum," which requires continuous monitoring, so our dissolved oxygen data cannot be used to accurately portray the adherence of Fidalgo Bay streams to state standards. The state standard of 8.0 mg/L is designed to protect salmonid use of stream waters, which is not currently a concern in the Fidalgo Bay watershed. However, even a snapshot of dissolved oxygen trends can provide some insights against which to measure future change. In general, most sites averaged above 8.0 mg/L, with the exception of some very low flows in the dry season. This graph considers DO values for all sites considered in this report.

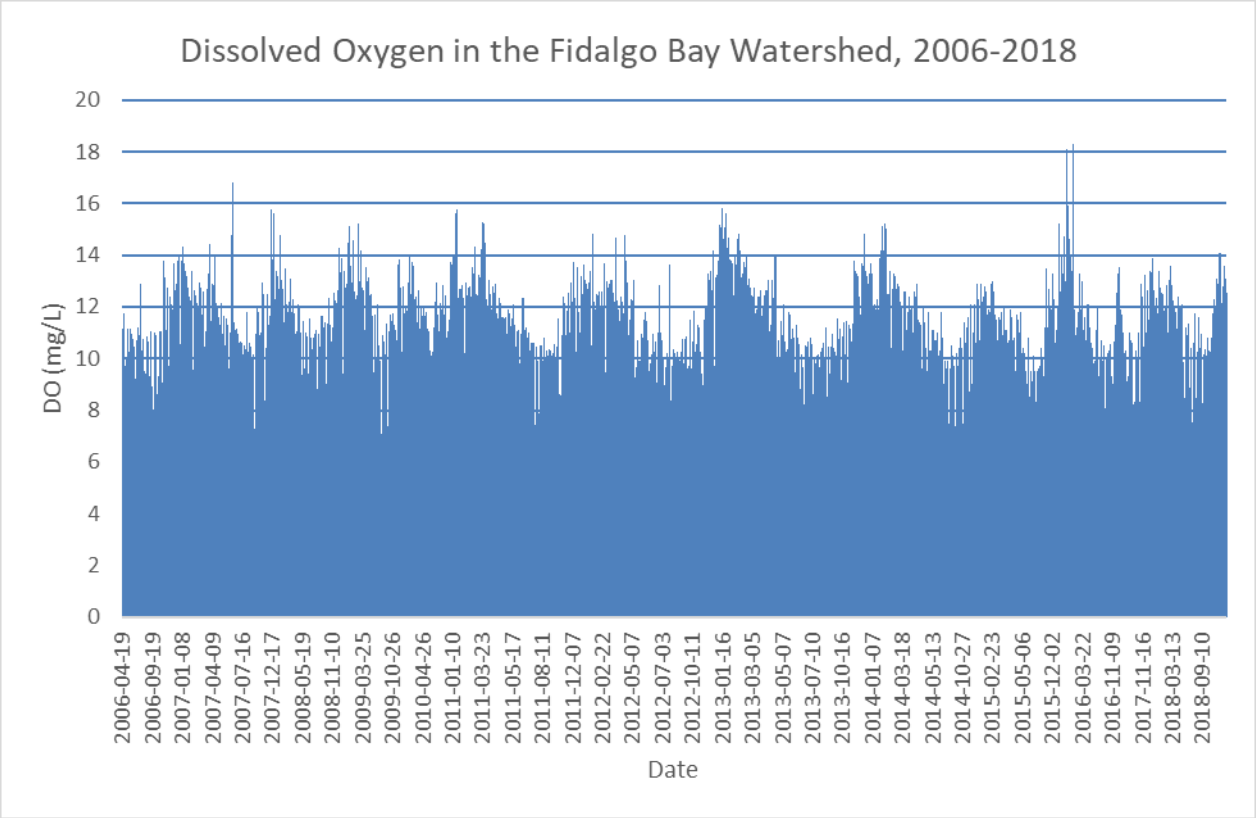


*Figure 37. Summary of all dissolved oxygen values recorded at all sites considered in this study (see figure 2) over the range of dates considered in this study. Dissolved oxygen should be present in amounts greater than 8.0 mg/L for fish habitat, which is not currently a concern on Fidalgo Island. Anacortes, WA 2018*

Dissolved oxygen retention in water decreases as temperature increases, so the seasonal fluctuations seen in the above chart are expected.

**Temperature**

State temperature standards are based on the 7-day average of the maximum daily temperatures. Therefore, our data points cannot be authoritatively compared to these standards; the state standard line in this graph is to be used only as a reference.

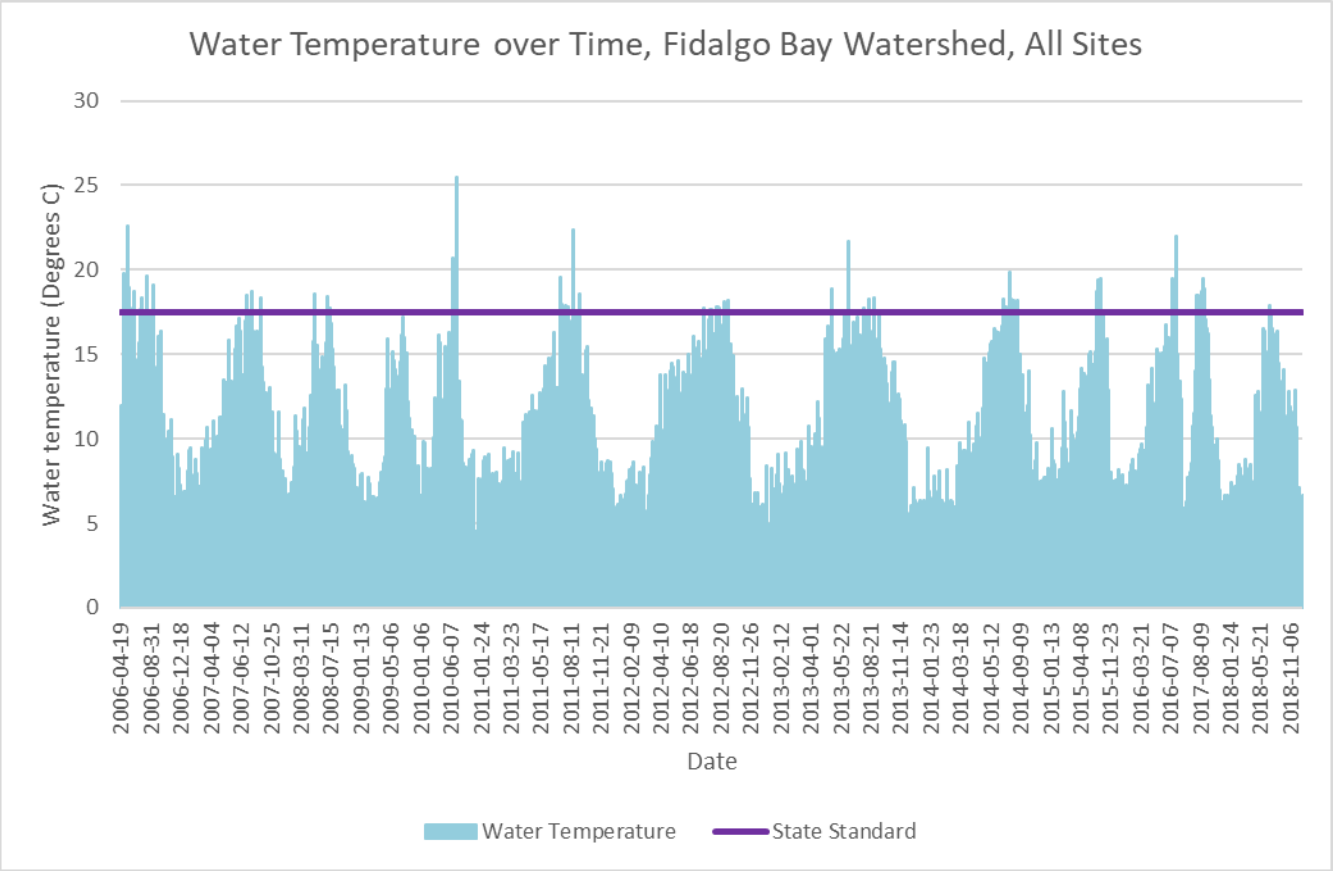


*Figure 38. Summary of all water temperature values recorded at all sites considered in this study (see figure 2) over the range of dates considered in this study. The state standard for salmonid habitat is less than 17.5 degrees C, represented by the purple horizontal line on the graph. Though salmonid habitat is not currently a concern on Fidalgo Island, the state standard provides a benchmark of healthy water temperature, which is sometimes exceeded in the summer months in our study area. Anacortes, WA 2018*

In general, the summer months bring temperatures above 17.5 degrees C, the temperature standard for salmon spawning, rearing and migration. This is less of a concern on Fidalgo Island than it might be elsewhere, since there are not salmon in the streams we are monitoring; but temperature data are still a necessary component of water quality monitoring. Samish DNR conducts continuous temperature monitoring in Fidalgo Bay itself as part of other projects; those data will be made available in other reports.

*Turbidity*

Turbidity in the streams entering Fidalgo Bay is generally between 0.5 and 20 NTU, with the larger values occurring primarily in the winter months. Site NMP6 has seen spikes above 100 NTU three times in the past ten years; future instances of such a large deviation from the norm may warrant further investigation.

*Salinity and Specific Conductance*

Salinity and specific conductance are primarily used to determine whether a site should be compared to the freshwater or the marine water quality standards. Since we have shifted our priorities in this project to focus on

freshwater inputs to Fidalgo Bay, this information is largely obsolete, but since the YSI unit logs these values automatically, we are continuing to collect these data for consistency.

## Conclusion

The Fidalgo Bay watershed faces substantial challenges in terms of fecal coliform entering Fidalgo Bay, primarily from urban areas. Attempts to remove contributing sources of fecal bacteria have been helpful but have yet to provide lasting change. Nutrient inputs warrant further investigation. As time goes forward and the region faces pressure from climate change and further development, long-term data sets such as this will become increasingly important in charting a course toward a balanced future, one that includes healthy waters, healthy ecosystems, and a healthy and responsible human community.

For further clarification, raw data, or any other questions or concerns about the content of this report, please contact the Samish Indian Nation, Department of Natural Resources.

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