

Portage Bay Shellfish Protection District Shellfish Recovery Plan

Advisory Committee Recommendations to the Whatcom County Council

2014 Update

A Community Effort for Clean Water

Executive Summary

The Portage Bay Shellfish Protection District was formed by the Whatcom County Council in 1998 after the Washington State Department of Health (DOH) downgraded portions of Portage Bay to “Prohibited” and “Restricted” due to deteriorating water quality (60 acres in 1997 and 90 additional acres in 1999). The Lummi Nation estimated an economic loss of about \$850,000 per year associated with the shellfish closure (LIBC 2010). The *Portage Bay Initial Closure Response Strategy* was developed in 1998 by a team of federal, tribal, state, and local representatives outlining potential pollution sources and actions to identify and address these sources. As a result of implementing the shellfish closure response strategy, the Total Maximum Daily Load (TMDL) Detailed Implementation Plan (Hood 2002), federal compliance enforcement inspections, and the Dairy Nutrient Management Act, many actions were taken to address agricultural sources, sewage sources, and implement monitoring, compliance enforcement, and community outreach projects. These actions resulted in improved water quality observed both in the freshwater and marine waters. Portions of the shellfish growing area were re-opened in 2003 and the remaining closed areas were reopened in 2006.

In 2004, fecal coliform levels in the mainstem of the Nooksack River began increasing again. Between 2009 and 2012, the geometric mean of the mainstem site located at Marine Drive (M1) more than doubled and then plateaued. Similar patterns of increasing bacteria levels were observed throughout the Nooksack drainage. While the levels in the mainstem Nooksack River are still meeting water quality standards, this substantial increase creates concern for the potential impact on the shellfish growing area status. Due to elevated bacteria levels, 5 of 12 marine monitoring stations in Portage Bay were described as “Threatened” and 2 of 12 were described as sites “Of Concern” in DOH’s 2012 Annual Growing Area Review (Schultz 2013). The 2013 Annual Growing Area Review identified 4 of 12 stations as “Threatened” and 4 of 12 stations “Of Concern”.

The increasing bacteria levels and threat of another shellfish downgrade prompted the Portage Bay Shellfish Protection District Advisory Committee to begin actively meeting again in 2013 and initiate efforts to review and update the shellfish recovery plan. The Portage Bay Initial Closure Response Strategy (1998) focused on reducing fecal coliform bacteria from agriculture, on-site septic system, sewage treatment plant, and stormwater runoff sources. This update provides a summary of accomplishments that led to the original shellfish growing area upgrade and the advisory committee’s current recommendations for ongoing and new projects to prevent another shellfish downgrade. There are six objectives including 1) control agricultural sources, 2) control stormwater sources, 3) control wastewater treatment plant and on-site sewage system sources, 4) monitor water quality, 5) engage the community, and 6) provide funding for the district program. Each of these objectives has specific recommendations to help the district meet these objectives.

However, the Portage Bay Shellfish Protection District has given highest priority to one overarching recommendation outlined below.

Implement an effective pollution identification and correction (PIC) program.

- Conduct water quality monitoring and use data to identify priority areas for PIC program.
- Develop and implement a comprehensive community outreach program that connects with and engages a diverse set of groups and interests. The common message is that everyone needs clean water.
- In priority areas, begin work with community outreach meetings specific to that area. Conduct additional water quality monitoring to identify hot spots within the drainage. Through a tiered-approach, work with landowners to identify problems and address these problems with technical and financial assistance if desired by the landowners. The initial stages of the program will be voluntary in nature to assist landowners with identifying and addressing pollutant sources. This will include an on-the-ground staff/contractor to work directly with landowners. For egregious problems in situations where landowners will not participate in the voluntary program, compliance and enforcement actions will be taken.
- Set milestones for contacts with the community, water quality improvements, and when the program can move into another priority area.
- Report to community members the results of the program.

Background

Portage Bay is located in western Bellingham Bay, between the Lummi Peninsula and Portage Island. The Portage Bay shellfish growing area lies about three and a half miles to the southwest of the mouth of the Nooksack River, the dominant freshwater discharge to this area. The bay supports commercial, ceremonial, and subsistence shellfish harvest for members of the Lummi Nation.

Bacterial Pollution

Fecal coliform bacteria are found in the fecal matter of human and other warm-blooded animals and is used as an indicator of water pollution. While most fecal coliform strains do not cause human illness, detection of fecal coliform in a creek or bay indicates that human and/or animal wastes and the associated harmful pathogens are polluting the water. Examples of pathogen-related illnesses are giardia, salmonella, viral gastroenteritis, hepatitis, and cholera. People are exposed to these pathogens through direct water contact, such as swimming, wading, or eating shellfish from waters with high bacteria levels. The key potential sources of bacteria that have been identified in Whatcom County coastal drainages are (1) **animal waste** from agricultural operations, domestic pets, waterfowl, and urban wildlife, and (2) **human sewage** from failing on-site sewage systems (OSS), leaking sewers, or cross-connections (WCPW 2012).



Figure 1. Map of Whatcom County monitoring regions depicting the Nooksack River watershed in orange.

Watershed Characteristics

The Nooksack River watershed is approximately 826 square miles, straddles the borders with Canada and Skagit County, and discharges into Bellingham Bay (Figure 1). The watershed includes a diverse landscape ranging from the Cascade Mountain Range, the foothills, and into the lowlands. The lower basin, beginning at river mile 36.6, has been the focus of fecal coliform bacteria reduction efforts. Land uses in the upper basin are predominately timber management and recreational uses on federal, state, and private lands. In the upper basin there is some

agriculture, commercial and residential use along the valley floors. In contrast, in the lower basin there is a mix of agriculture, rural residential, and urban land uses. Whatcom County is a top dairy and berry producer in Washington State, with the majority of agricultural production occurring in the Nooksack basin. The wastewater treatment plants for the cities of Everson, Lynden, and Ferndale discharge into the Nooksack River. (Joy 2000)

Shellfish Growing Area

In 1996, the Lummi Nation voluntarily closed a 60-acre portion of the commercial shellfish growing area in Portage Bay at the request of the Washington State Department of Health due to water quality that did not meet the National Shellfish Sanitation Program (NNSP) standards (Lummi Nation 2002). The Portage Bay Shellfish Protection District was formed by the Whatcom County Council in 1998 after the Washington State Department of Health (DOH) downgraded Portage Bay to “Prohibited” and “Restricted” due to deteriorating water quality (60 acres in 1997 and 90 additional acres in 1999). The Lummi Nation estimated an economic loss of about \$850,000 per year associated with the shellfish closure (LIBC 2010). The *Portage Bay Initial Closure Response Strategy* was developed in 1998 by a team of federal, tribal, state, and local representatives outlining potential pollution sources and actions to identify and address these sources.

In this same time period, the Washington State Department of Ecology conducted a Total Maximum Daily Load (TMDL) study for fecal coliform in the Lower Nooksack River (Joy 2000). Samples were collected and analyzed for fecal coliform from a primary monitoring network of six mainstem, eleven tributary, and four point source locations. Some of the primary findings from this study were that bacteria levels doubled on the mainstem of the Nooksack River between Lynden and Ferndale. Tributaries discharging to this portion of the mainstem had consistently high bacteria levels. Target fecal coliform geometric means were established to help guide bacteria reduction efforts in the watershed. Through the shellfish closure response strategy, federal compliance enforcement inspections, the Dairy Nutrient Management Act, the and TMDL Detailed Implementation Plan (Hood 2002) many actions were taken to address agricultural sources, sewage sources, and implement monitoring, compliance enforcement, and community outreach projects. These actions resulted in improved water quality observed both in the freshwater and marine waters. Portions of the shellfish growing area were re-opened in 2003 and the remaining closed areas were reopened in 2006.

In 2004, fecal coliform levels in the mainstem of the Nooksack River began increasing again. Between 2009 and 2012, the geometric mean of the mainstem site located at Marine Drive (M1) more than doubled from 16 to 40 FC/100mL (Figure 2). The geometric mean at M1 generally plateaued in 2012 and held at 32 FC/100ml in December 2013. Similar patterns of increasing bacteria levels were observed throughout the Nooksack drainage as illustrated in Figure 3, representing bacteria levels observed over time in Fishtrap Creek.

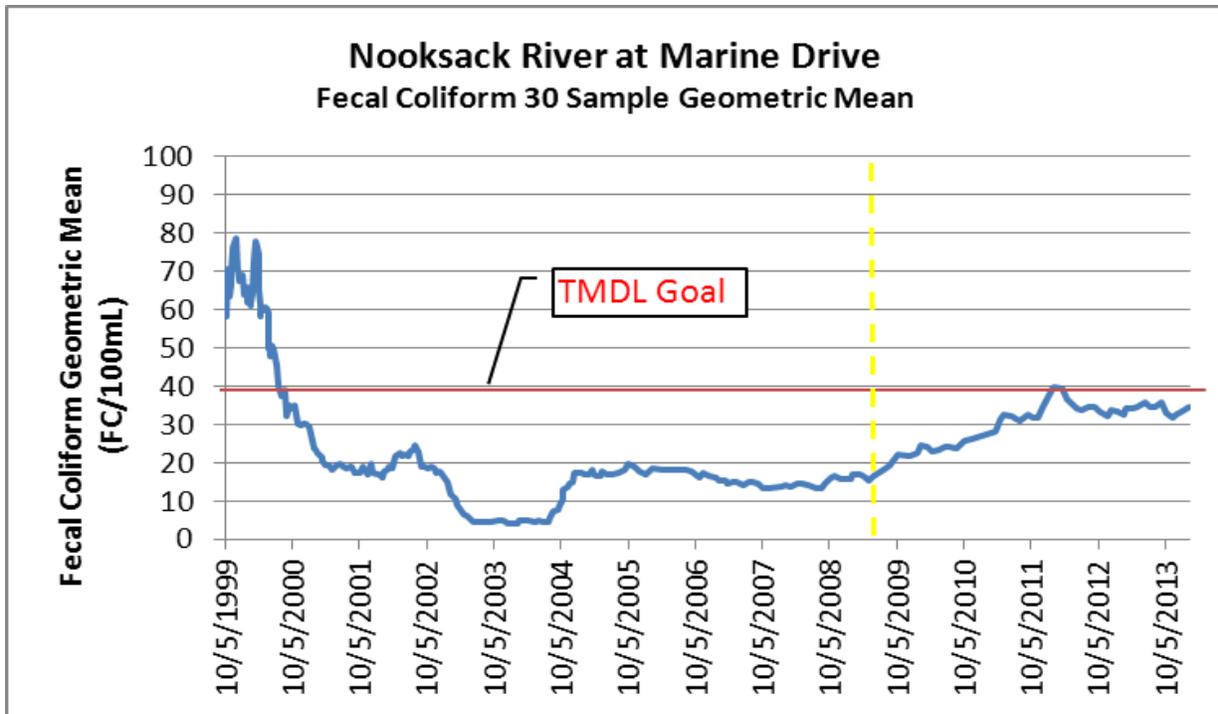


Figure 2. Fecal coliform 30 sample geometric mean at Marine Drive between 2002 and 2014. The red line indicates the TMDL goal and yellow dashed line indicates the period in which the rapid increase of bacteria was observed.

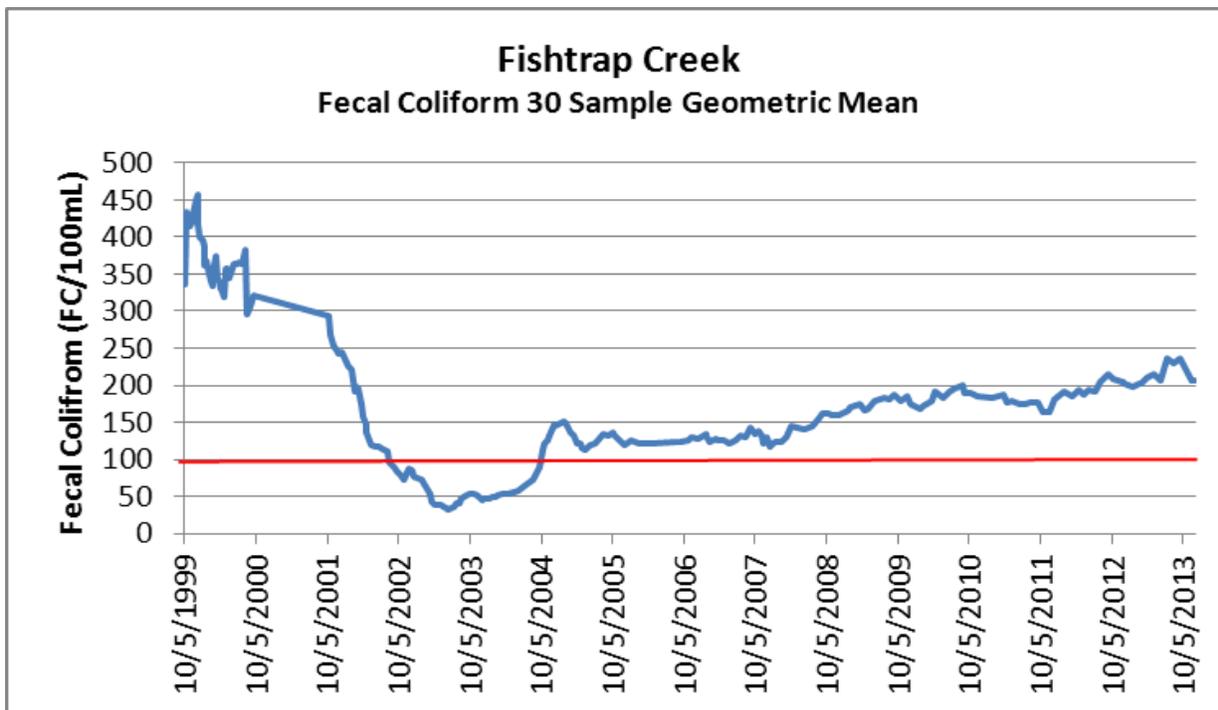


Figure 3. Fecal coliform 30 sample geometric mean between 1999 and 2012. Red line indicates DOE geometric mean threshold for fecal coliform standard.

As of April 2014, all of the monitored creeks discharging into the Nooksack River were exceeding water quality standards for fecal coliform bacteria (Figures 4, 5, and 6). At the majority of stations, fecal coliform levels measured in the last twelve months have been higher than those levels seen in the last three years (Figures 5 and 6).

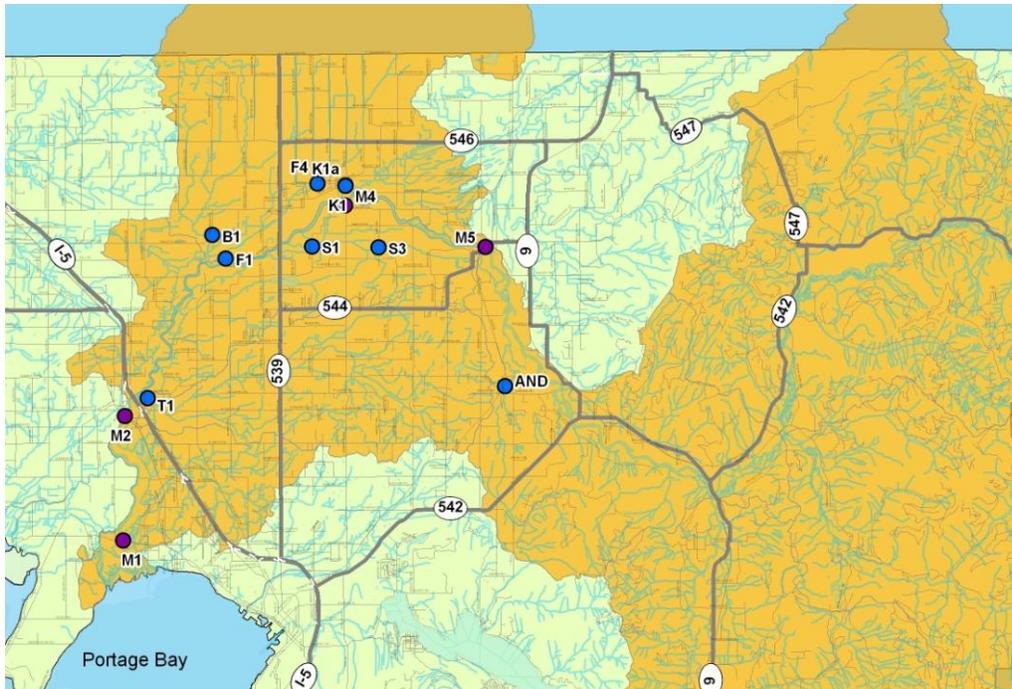


Figure 4. Portage Bay Shellfish Protection District (Nooksack watershed) monitoring stations. Purple dots indicate mainstem stations and blue dots indicate creeks discharging to the Nooksack River.

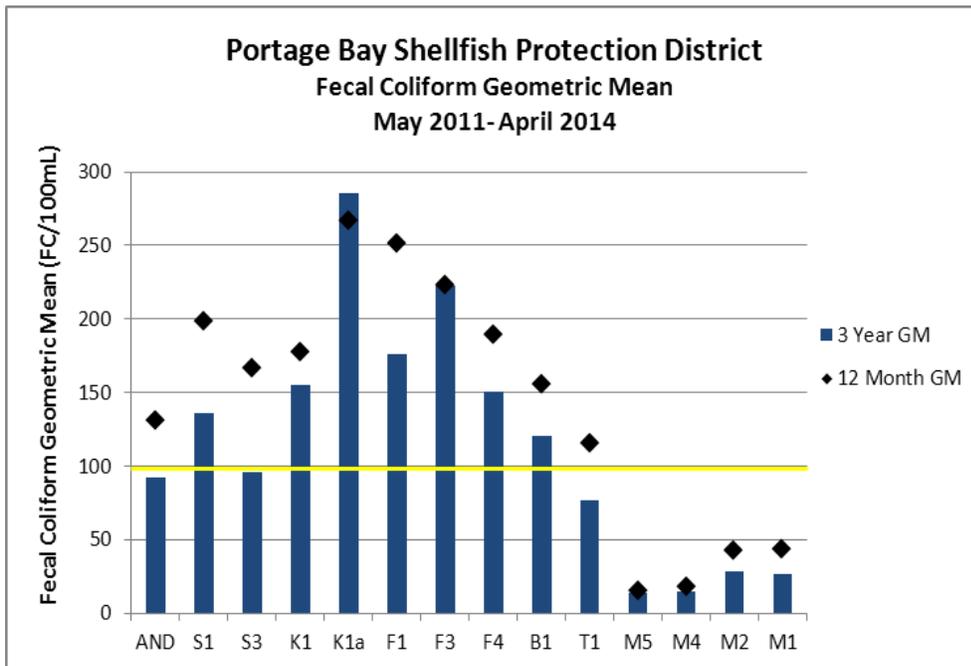


Figure 5. Fecal coliform geometric means for Nooksack watershed monitoring stations. The black diamond indicates the geometric mean for samples collected in the last twelve months. The blue bar indicates geometric means for samples collected over the last three years. The yellow line illustrates the water quality standard.

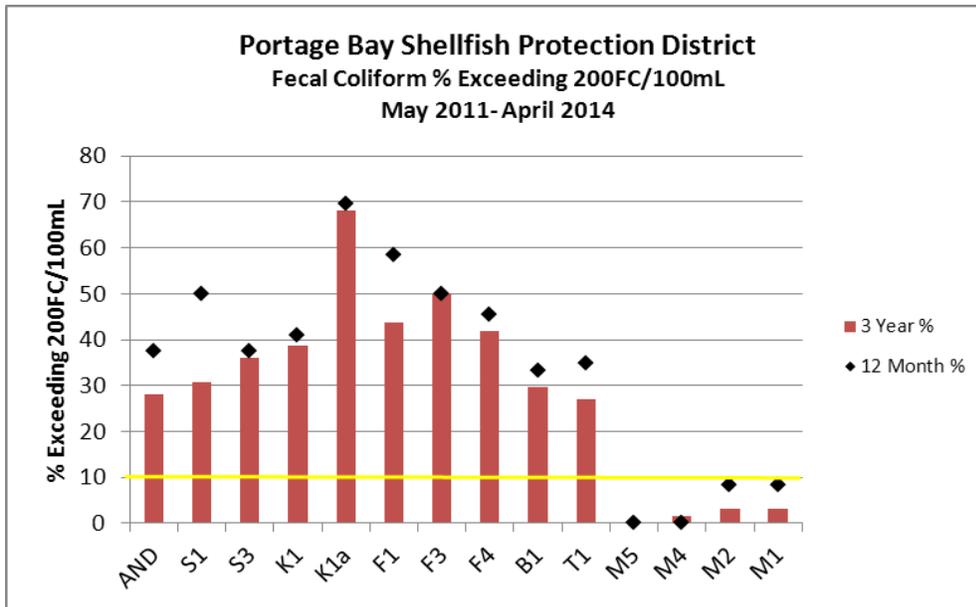


Figure 6. Percent of samples exceeding 200 FC/ 100mL for Nooksack watershed monitoring stations. The black diamond indicates percent exceeding 200 FC/100mL for samples collected in the last twelve months. The blue bar indicates percent exceeding 200 FC/100mL for samples collected over the last three years. The yellow line illustrates the water quality standard.

While the levels in the mainstem Nooksack River are still meeting water quality standards, this substantial increase creates concern for the potential impact on the shellfish growing area status. Due to elevated bacteria levels, 5 of 12 marine monitoring stations in Portage Bay were described as “Threatened” and 2 of 12 were described as sites “Of Concern” in DOH’s 2012 Annual Growing Area Review (Schultz 2013). The 2013 Annual Growing Area Review identified 4 of 12 stations as “Threatened” and 4 of 12 stations as “Of Concern” as illustrated in Figure 7 (Schultz 2014). Figure 8 provides an illustration of marine water quality in Portage Bay over time.

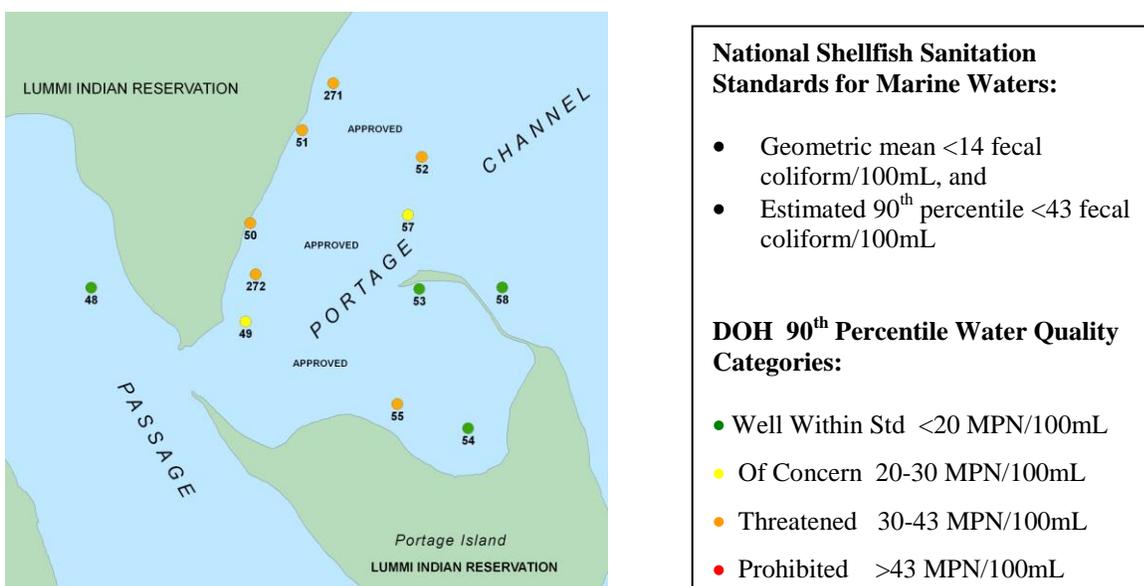


Figure 7. Portage Bay marine water quality status in December 2013.

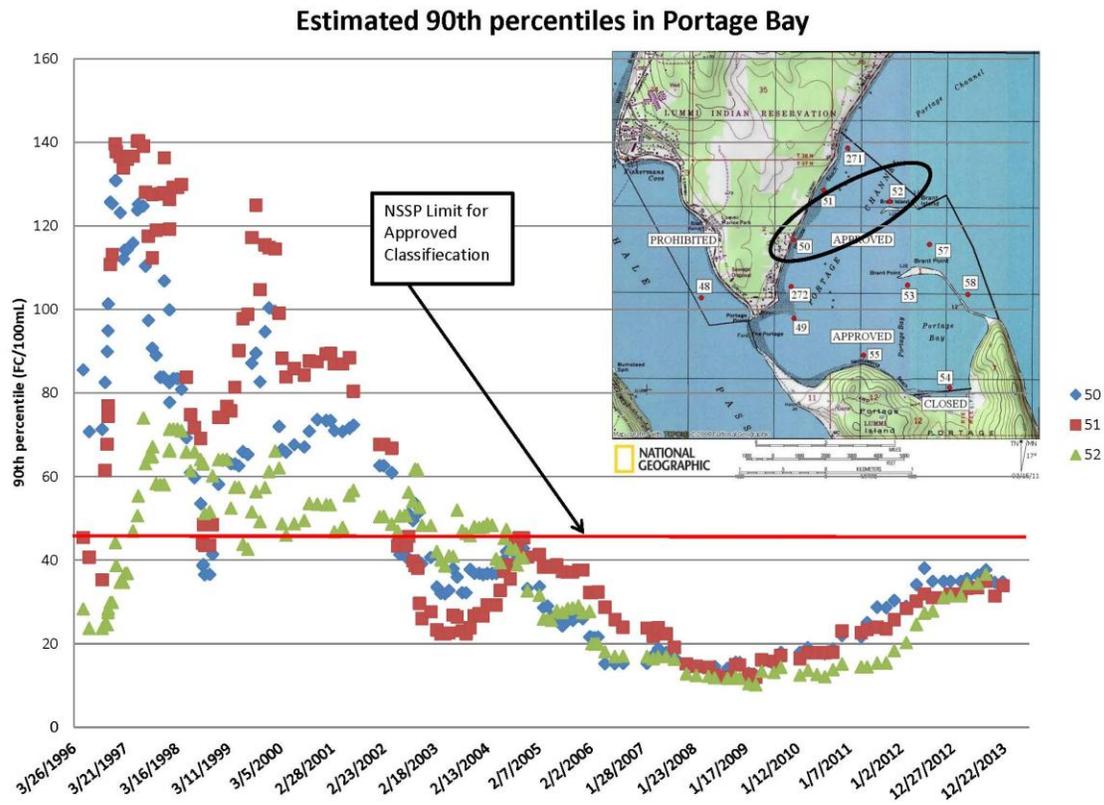


Figure 8. Washington State Department of Health graph illustrating fecal coliform bacteria levels in Portage Bay over time.

The increasing bacteria levels and threat of another shellfish downgrade prompted the Portage Bay Shellfish Protection District Advisory Committee to begin actively meeting again in 2013 and initiate efforts to review and update the shellfish recovery plan. The Portage Bay Initial Closure Response Strategy (1998) focused on reducing fecal coliform bacteria from agriculture, on-site septic system, sewage treatment plant, and stormwater runoff sources. This update will provide a summary of accomplishments that led to the original shellfish growing area upgrade and the advisory committee’s current recommendations for ongoing and new projects to prevent another shellfish downgrade.

Overall Program Recommendations

Dedicate sufficient resources to implement an effective Pollution Identification and Correction (PIC) Program. The program should be adequately staffed to coordinate the implementation of the shellfish recovery plan, support water quality monitoring, identification of priority drainages, community outreach and education, inspections to identify potential pollutant sources, technical and financial assistance, and a regulatory backstop. The program should identify priority areas, focus efforts in priority areas, and show measureable outcomes.

The current pollution identification and correction efforts in the Portage Bay Shellfish Protection District are being implemented through the Whatcom Clean Water Program, guided through the Washington Shellfish Initiative, which is a partnership of federal, tribal, state, and local agencies. It is currently funded through 2015 and the state agencies are leading the pollution identification efforts. The Advisory Committee recommends transitioning this program into a locally-driven, locally-supported, and sustainable program funded through a combination of federal, state, and local resources.

Objective 1: Control Agricultural Sources

Agricultural wastes originating in the Nooksack River watershed were identified in the Sanitary Surveys of Portage Bay (DOH 1997, Lennartson 2003) and Portage Bay Initial Response Strategy (1998) as the primary potential contributor of fecal coliform pollution in the Nooksack watershed. Agricultural sources include dairies, commercial non-dairy farms, and non-commercial farms.

In the late 1990's, there were approximately 200 dairy farms in the watershed. By 2003, all dairies had completed Nutrient Management Plans as required by SB6161. Additionally, the Washington State Department of Ecology implemented a dairy inspection program. The dairy inspection program was transferred to the Washington State Department of Agriculture in 2003. Each dairy is inspected approximately every two years. The 2003 Portage Bay Sanitary Survey noted that improvement of water quality seen at that time was due in part to a combination of a reduced number of dairies and implementation of Nutrient Management Plans (Lennartson 2003).

In addition to the dairy operations, there are a large number of commercial and non-commercial farm operations throughout the Nooksack River drainage. Whatcom Conservation District has consistently provided technical and financial assistance to landowners to develop farm plans and implement Best Management Practices (BMPs). The level of assistance available to landowners has varied depending on funding resources for the Conservation District.

Currently, the Whatcom Clean Water Program (through the Washington Shellfish Initiative) is a federal, tribal, state, and local partnership to improve water quality in freshwater sources impacting Portage Bay and Drayton Harbor. The program includes water quality monitoring, non-dairy farm inspections, technical and financial assistance for landowners and a compliance/enforcement backstop. The initial area of focus has been the Bertrand subwatershed.

Recommendation 1.1: Provide letters of support for financial assistance programs for dairies to implement upgraded best management practices and updated nutrient management plans to protect water quality. Most of these funds are allocated through the state and the USDA Natural Resources Conservation Service (NRCS).

Recommendation 1.2: Provide letters of support for technical assistance programs for dairies to complete risk management assessments and adaptively manage farm operations as conditions change to protect water quality.

Recommendation 1.3: Provide letters of support for programs that provide financial assistance for aquaculture as well as upland farming.

Recommendation 1.4: Continue concentrating investigation and enforcement follow-up in priority drainages identified through water quality monitoring programs using quality assurance project plans (QAPPs) and standard protocols. Due to the large number of non-commercial animal rearing operations throughout Whatcom County, an inspection program should be implemented for non-dairy commercial agricultural operations and hobby farms as well as dairy farms. Corrective actions should be taken when problems are found.

Recommendation 1.5: Dedicate adequate staff resources to support, uphold, and enforce the Critical Areas Ordinance (CAO). Provide farmers the flexibility to operate in CAO buffers through the Conservation Planning on Agricultural Lands (CPAL) Program. Provide farmers with the ability to voluntarily comply within a set timeframe prior to invoking enforcement actions. A tiered approach is recommended for this program which would include 1) community education, 2) involvement in fixing the problem (through technical and financial assistance), and 3) an enforcement backstop for landowners that do not voluntarily take action to protect critical areas and demonstrate egregious violations.

Recommendation 1.6: Provide technical assistance to non-dairy farmers to complete risk assessments of their farm operations and recommend solutions to protect water quality. Provide financial assistance to non-dairy farmers to implement the recommended solutions.

Recommendation 1.7: Support a collaborative team of local, state, tribal, and federal agencies to avoid duplication of roles and interactions with landowners. The team will meet periodically, share data, and share information regarding inspections.

Recommendation 1.8: Conduct a comprehensive review of the utility and adequacy of the Whatcom County manure management ordinance. Update the ordinance accordingly.

Objective 2: Control Stormwater Sources

Stormwater sources originating in the Nooksack River watershed were identified in the Sanitary Surveys of Portage Bay (DOH 1997, 2003) as minor potential contributors of fecal coliform pollution in the Nooksack watershed. There are stormwater outfalls in the vicinity of the shellfish beds located to the west of Lummi Shore Road. These discharges have had inconsistent fecal coliform levels and volumes, thus representing a minor source. The cities of Lynden and Ferndale and portions of unincorporated Whatcom County have National Pollution Discharge Elimination System (NPDES) Phase II permits for stormwater. These permits have requirements for stormwater program elements including 1) public education and outreach, 2) public involvement, 3) illicit discharge detection and elimination, 4) construction site stormwater control, 5) pollution prevention, good housekeeping, and operation and maintenance, 6) post construction stormwater management for new development and redevelopment, 7) compliance with TMDL requirements, and 8) monitoring.

Recommendation 2.1: Partner with Lynden, Ferndale, and other special districts (e.g. WIDs) to develop a program to assist with the maintenance of neighborhood stormwater ponds/facilities.

Recommendation 2.2: Provide support to Lynden, Ferndale, and other special districts for stormwater retrofits that provide water quality improvement and protection.

Recommendation 2.3: Identify potential areas for riparian restoration along tributaries to the Nooksack River and share these with Lynden, Ferndale, and other special districts for potential project partnerships.

Objective 3: Control Wastewater Treatment Plant and On-Site Sewage System Sources

Sewage sources originating in the Nooksack River watershed were identified in the Sanitary Survey of Portage Bay (DOH 1997, 2003) as low to medium potential contributor of fecal coliform pollution in the Nooksack watershed. Potential sewage sources include wastewater treatment plants (WWTP) at Everson-Nooksack, Lynden, and Ferndale, as well as on-site sewage systems (OSS) throughout the watershed. The NPDES permits for the WWTPs have been updated since the initial closure response strategy and effluent thresholds were drastically decreased to meet the TMDL requirements. There have been several upgrades to the WWTP facilities and operations and they each routinely meet the NPDES permit requirements. There are future upgrades planned for the Everson-Nooksack and Ferndale plants.

Recommendation 3.1: Provide support for the upgrade of the City of Everson wastewater treatment plant.

Recommendation 3.2: Request annual reports on the status of Everson, Lynden, and Ferndale wastewater treatment plants. Requested information would include how well operations met permit requirements, permit exceedances for bacteria levels, failures of the system (pump stations, etc.), maintenance/repairs completed, and any projected upgrades to the plant or collection system. Provide letters of support for needed repairs or upgrades of systems identified through these reports (e.g. grants, loans, etc.).

Recommendation 3.3: Review how sewage is treated in Deming, potential problems, and develop recommendations as needed.

Recommendation 3.4: Expand the Marine Recovery Area (MRA) or Sensitive Area for the On-Site Sewage System Operation and Maintenance Local Management Plan to include priority drainages (based upon water quality) of the Portage Bay Shellfish Protection District. Require an evaluation of all OSS in these priority areas within three years once the area has been included in the MRA.

Recommendation 3.5: Continue to support the low-interest loan program for OSS repairs and replacements.

Objective 4: Monitor Water Quality

Since 1998, the Northwest Indian College has been collecting fecal coliform samples at sites in the Nooksack River watershed. A portion of this sampling was completed to support the Nooksack River TMDL Detailed Implementation Plan (Hood 2002). In the Nooksack River

watershed, the number of sites and frequency of sampling has varied over the years due to funding limitations. Forty-nine sites were identified throughout the watershed for monitoring to support the implementation of the Nooksack TMDL. In 2007 following the upgrade of the shellfish growing areas, the sites were reduced to approximately fifteen long-term ambient sites to monitor water quality patterns in the major tributaries to the Nooksack (Figure 5).

In 2012, Whatcom County began supplementing this monitoring program with a second sampling event per month at about fifteen priority sites. Currently, the Nooksack River routine monitoring program includes twice monthly sampling at fifteen fixed-network sites in the Nooksack River watershed. Additionally, in 2013, DOE began implementing short-term ambient monitoring and bracket sampling in the Bertrand subwatershed to assist pollution identification and correction efforts in this area. The short-term ambient monitoring project involves bi-weekly sampling of 10 fixed network sites. The bracketing monitoring further segments areas where consistently high bacteria counts have been observed.

The Lummi Natural Resources Department has conducted an ambient water quality monitoring program of Reservation waters since 1993 and that now includes sampling at approximately 50 surface water sites. As part of the program, the Nooksack River mainstem where it flows into the Reservation near Marine Drive is sampled approximately four times per month.

Recommendation 4.1: Continue implementing a water quality monitoring program with long-term ambient, short-term ambient, and bracketing elements. Routine monitoring should occur throughout the basin to characterize the mainstem of the Nooksack and the major tributaries to the Nooksack. Long-term ambient results will be reviewed once per year to identify new focus areas. Focus areas will have short-term ambient stations and bracketing monitoring to help identify sources of bacteria. Consider adding a long-term ambient station to characterize bacteria levels in Silver Creek.

Recommendation 4.2: Monitoring data should be used to implement a response strategy to identify and address pollution sources. The previous Portage Bay Response Strategy will be reviewed to determine successes and challenges and to update the response strategy. Progress of the Whatcom Clean Water Program will be considered.

Recommendation 4.3: Tributary reaches between sample stations should be ground surveyed to identify animal access and drainage from non-dairy commercial farms and hobby farms in addition to commercial dairy farms.

Recommendation 4.4: When a monitoring station has met the water quality standard for one year, sampling frequency should be reduced to one time per month (rather than twice per month) to focus resources elsewhere and to communicate progress in this drainage.

Recommendation 4.5: Partner with Ferndale and Lynden on urban stormwater sampling and source control.

Objective 5: Engage the Community

Community outreach programs are invaluable in developing the community's understanding of water quality status, impacts to shellfish beds and recreational uses of water, and engaging community members in identifying and implementing programs and projects to improve and protect water quality.

An example of a successful watershed restoration project driven by community involvement was the Tenmile Watershed Restoration Project. Fecal coliform bacteria levels in this subwatershed dropped below the TMDL targets and remained at these levels for several years. In the past two years, bacteria levels have been increasing once again. In the fall of 2013, ReSources reinvigorated a community effort to improve water quality in this subwatershed. There were approximately 50 community members at the first meeting and 30 community members are remaining engaged in the effort.

Recommendation 5.1: As a pollution identification and correction program moves into a new priority drainage, host a kick-off meeting to describe water quality issues and how the program will move forward in the specific drainage area. For each priority drainage, a standard process for community outreach should be implemented with a minimum of three community meetings (pre-project, mid-term, and project-end), postcard notifications, and a question and answer session. Periodically re-evaluate how to approach each focus area.

Recommendation 5.2: Create an educational position at the Whatcom Conservation District to develop and implement a rural education program including topics such as small farms, manure management, pasture rotation, and OSS operation and maintenance. The program should be evaluated on a regular basis for effectiveness using surveys and other tools.

Recommendation 5.3: Create a community-driven, neighbor to neighbor process to communicate water quality problems and find community solutions.

Recommendation 5.4: Work with community members and landowners to develop positive reinforcement by celebrating good BMPs and successes. Build community awareness of the issues, solutions, and continued progress. Examples include signs recognizing implemented BMPs (e.g. pasture rotation, cover crop signs) and regular progress reports to the County Council and newspapers.

Recommendation 5.5: Use public access television, radio, the internet, and newspapers as tools in community outreach to inform a broader community about water quality issues, patterns, impacts, and solutions to improve water quality.

Recommendation 5.6: Provide training opportunities for individuals working in the shellfish protection district to learn about farm plans, the content and requirements, and how best management practices are adapted to meet changing land, animals, and environmental conditions.

Recommendation 5.7: Place signs at high public use locations at creeks that have consistently high bacteria levels (e.g. Lynden Park along Fishtrap Creek) alerting the public of the potential public health threat with water contact recreational activities.

Recommendation 5.8: Install signs at main creek crossings indicating current water quality status.

Recommendation 5.9: Work with Lynden, Ferndale, and other special district to develop and comprehensive stormwater outreach program that with assist with meeting NPDES Phase II stormwater requirments for urban areas in the Nooksack drainage. The messages should connect stormwater, water quality, marine waters, and shellfish harvest. Include presentations to City Councils in this program.

Recommendation 5.10: Continue support for dairy and livestock education programs such as websites, presentations, and the dairy speaker series.

Objective 6: Funding

Recommendation 6.1: Update the Shellfish Protection District ordinance in 2014 to continue the Portage Bay Shellfish Protection District through at least 2016.

Recommendation 6.2: Provide adequate funding to implement the Portage Bay Shellfish Recovery Plan.

References

1998. Portage Bay Initial Closure Response Strategy: A Community Effort to Reclaim Lost Shellfish Resources.

Department of Health (DOH). 1997. Report: Sanitary Survey of Portage Bay. Washington State Department of Health. Office of Shellfish Programs.

Joy, J. 2000. Lower Nooksack River Basin Bacteria Total Maximum Daily Load Evaluation. Washington State Department of Ecology. Environmental Assessment Program. Publication 00-03-006.

Hood, S. 2002. Nooksack River Watershed Bacteria Total Maximum Daily Load: Detailed Implementation Plan. Washington State Department of Ecology. Water Quality Program. Publication 01-10-060.

Lennartson, D. 2003. Sanitary Survey of Portage Bay. Washington State Department of Health. Office of Food Safety and Shellfish Programs.

Lummi Nation. 2002. Nooksack River Water Quality and Portage Bay Shellfish.

Lummi Indian Business Council (LIBC). 2010. Letter to EPA Re: Nooksack River Basin Water Quality, Tribal Shellfish Beds, and the Management of Animal Wastes in Washington State. May 27, 2010.

Schultz, J. 2013. Annual Growing Area Report: Portage Bay. Washington State Department of Health. Office of Shellfish and Water Protection.

Schultz, J. 2014. Annual Growing Area Report: Portage Bay. Washington State Department of Health. Office of Shellfish and Water Protection.

Whatcom County Public Works (WCPW). 2012. Whatcom County 2012 Water Quality Report and Priority Areas: Fecal Coliform in Coastal Drainages.