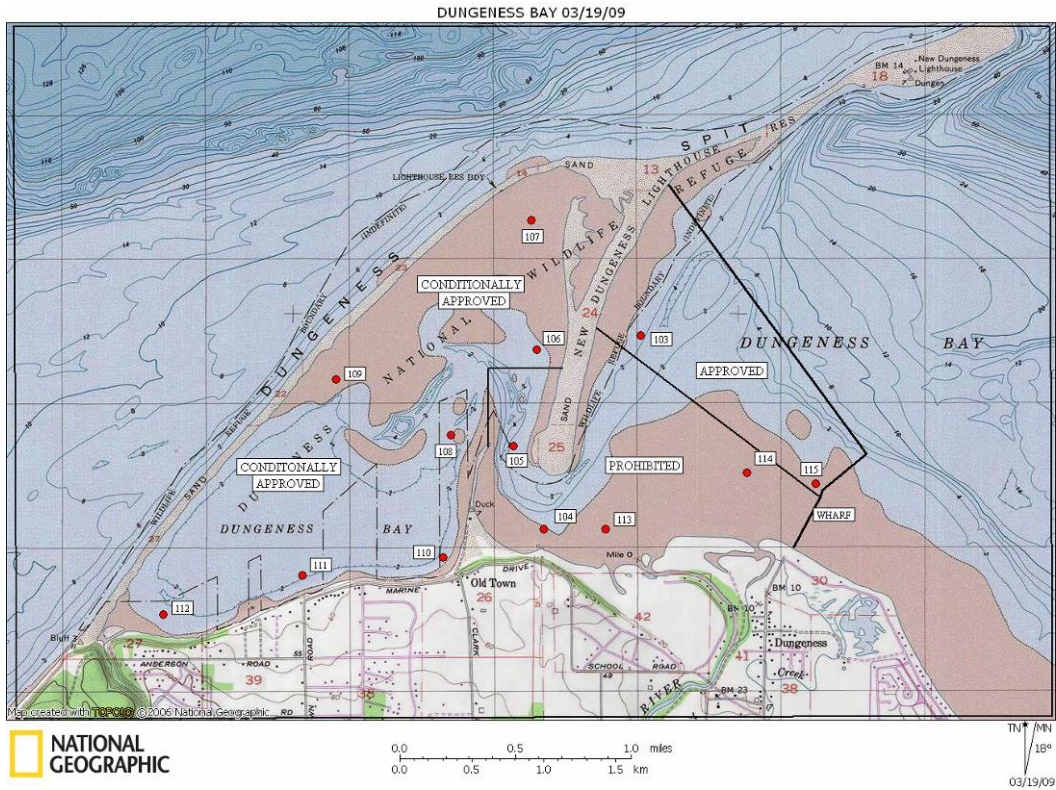


Status and Trends Summary

Fecal Coliform Pollution in Dungeness Bay through 2008



July 31, 2008

Introduction

This report describes status and trend of fecal pollution for Dungeness Bay from 1999 through 2008.

The Washington State Department of Health (DOH) protects consumers from eating shellfish contaminated by pollution. DOH continually monitors marine water for fecal pollution in shellfish growing areas and searches for pollution sources on shorelines and adjacent uplands.

Systematic Random Sampling (SRS). DOH uses a systematic random sampling (SRS) method mandated by the National Shellfish Sanitation Program (NSSP) to monitor shellfish growing areas. DOH measures levels of fecal bacteria in water samples collected at sampling stations in each area. Under SRS, samples are collected at even intervals over time. SRS purposely avoids targeting specific environmental factors, such as season, weather, tide, etc. SRS also requires a substantial minimum sample size (30 results) to calculate statistics used to classify growing areas. As a result, DOH data represent a wide range of environmental conditions encountered in the growing area. SRS ensures that unbiased, high-quality data are available for DOH tasks.

NSSP Growing Area Criteria. DOH uses the data gathered under SRS to classify shellfish beds according to level of fecal pollution. DOH applies the following NSSP criteria:

- The concentration of fecal coliform bacteria cannot exceed a geometric mean of 14 organisms per 100 milliliters (ml) in water (applied in all cases).
- The estimated 90th percentile cannot exceed 43 organisms per 100 ml of water (applied to areas where only nonpoint sources are present).

DOH has reported status and trends in fecal pollution in shellfish growing areas of Puget Sound for the Puget Sound Assessment and Monitoring Program (PSAMP) since 1998. DOH also uses the information to report progress on remedial action programs in uplands associated with the growing areas.

Status and Trends Analysis for Dungeness Bay

DOH calculated NSSP statistics (geometric means and estimated 90th percentiles) for all sampling stations in Dungeness Bay with a continuous sampling record. Statistics were calculated for the earliest sampling date possible (i.e., having the minimum required 30 results) and for all subsequent sampling dates through the end of calendar year 2008. Calculation of geometric means and estimated 90th percentiles for status and trends analysis are identical to the initial calculation for classification. All data collected according to NSSP guidelines are used for status and trends analysis. Extra sorting or editing of the data is inappropriate for status and trends analysis. However, it is sometimes necessary when classifying shellfish beds. See Appendix A (page 15) to see how the Department of Health uses the data for classification. (Note: results from targeted sampling events are not included in the databases used for either classification or status and trends.)

DOH uses estimated 90th percentiles to make inferences about status and trends because they are more sensitive to change than the geometric means. Note, however, both geometric means and 90th percentiles are included in the graphs in Figure 2.

Status of fecal pollution at each station in Dungeness Bay in 2008 using the Fecal Pollution Index

DOH developed a *fecal pollution index* (FPI) to provide a single value to describe the annual status of fecal pollution. The FPI can be applied at several geographic levels (sampling stations, growing areas, regions within Puget Sound, or Puget-Sound wide).

To calculate the annual FPI at the level of the sampling station in Dungeness Bay, the estimated 90th percentiles for all dates in each year were sorted into three categories (GOOD, FAIR, BAD), as follows:

- **GOOD:** estimated 90th percentiles do not exceed the DOH “Threatened” threshold of 30 MPN per 100ml
- **FAIR:** estimated 90th percentiles exceed the “Threatened” threshold, but do not exceed the NSSP closure criterion of 43 MPN per 100ml.
- **BAD:** estimated 90th percentiles exceed the NSSP closure criterion of 43 MPN per 100ml.

The fraction of estimated 90th percentiles within each category is then multiplied by a corresponding weighting factor (GOOD: x1.0; FAIR: x2.0; or BAD: x3.0). Next, the weighted fractions are added to produce an annual FPI. The FPI ranges between 1.0 and 3.0. If all the estimated 90th percentiles in a year are GOOD, the index is 1.0 (i.e., 100% GOOD estimated 90th percentiles × 1.0). If all the estimated 90th percentiles are BAD, the FPI is 3.0 (i.e., 100% BAD estimated 90th percentiles × 3.0).

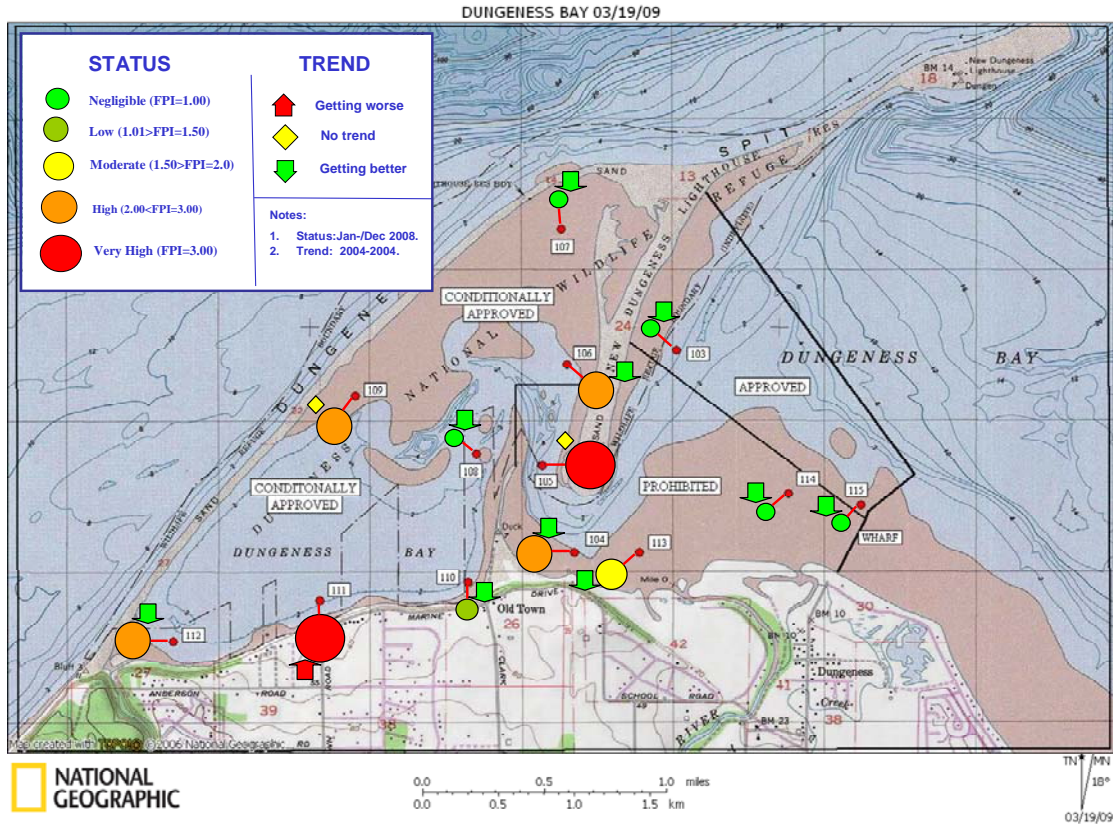
Figure 1 applies FPI to each sampling station in Dungeness Bay to show its status in 2008. Figure 3 extends the concept of the annual FPI to show temporal trend for the entire growing area of Dungeness Bay (see page 14).

Trend of fecal pollution at each station in Dungeness Bay

In addition to fecal pollution status in 2008, Figure 1 shows (by symbols) the most recent trend (2004-2008) at each station. A green arrow pointing down means fecal pollution is decreasing. A red arrow pointing up means fecal pollution is increasing. A yellow triangle signifies no significant change. Spearman's Rho was used to test the significance of the 5-year trends (significant at $p < 0.05$).

Figure 2 uses graphs to show long-term trend (1999-2008) of geometric means and estimated 90th percentiles for each station in Dungeness Bay. Note: the graphs in Figure 2 show moving statistics calculated from individual results. They are not the individual results.

Figure 1. Status and trends in fecal pollution at Dungeness Bay through 2008.



General Observations on Figure 1:

- Two of 13 stations (stations 105 and 111) showed very high fecal pollution in 2008.
- Only one station (Station 111) showed increasing fecal pollution impact over the most recent five years. Fecal pollution impact at Stations 105 and 109 were stable. The remaining 10 stations showed decreasing trend.
- Three of five stations with negligible fecal pollution impact were located outside the entrance to Dungeness Bay. The other two stations with negligible impact were located on the east side of Dungeness Bay.

Figure 2. Trend in geometric means and estimated ninetieth percentiles (NSSP statistics) from 1999 through 2008 at DOH stations in Dungeness Bay.

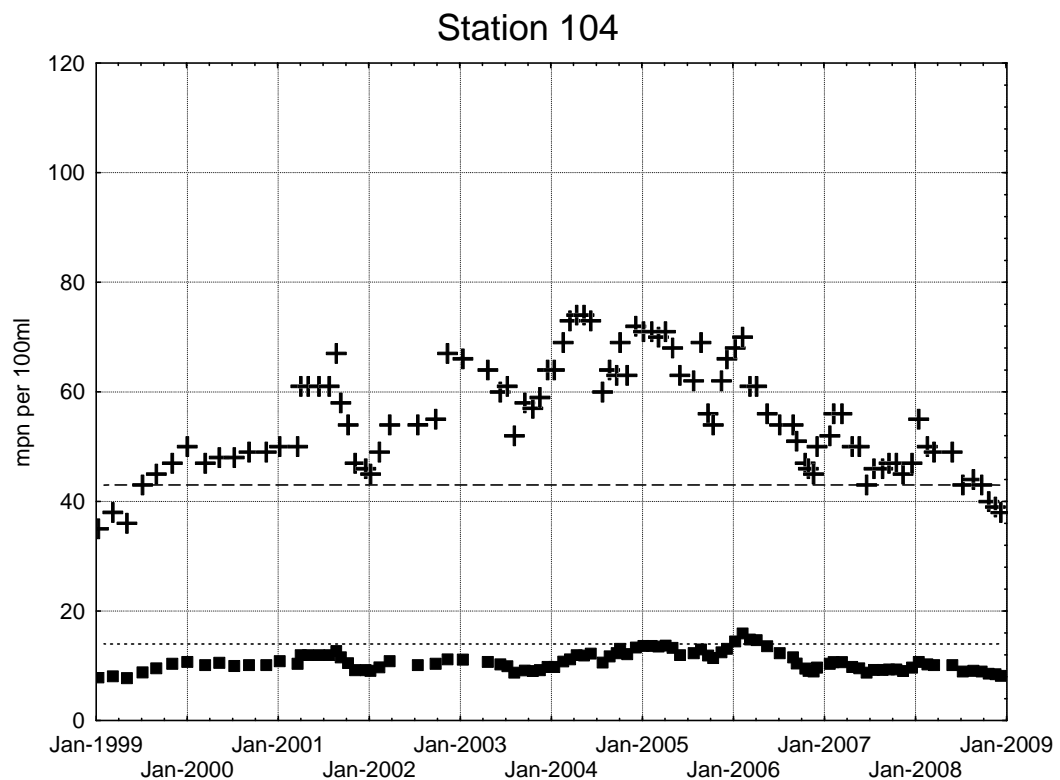
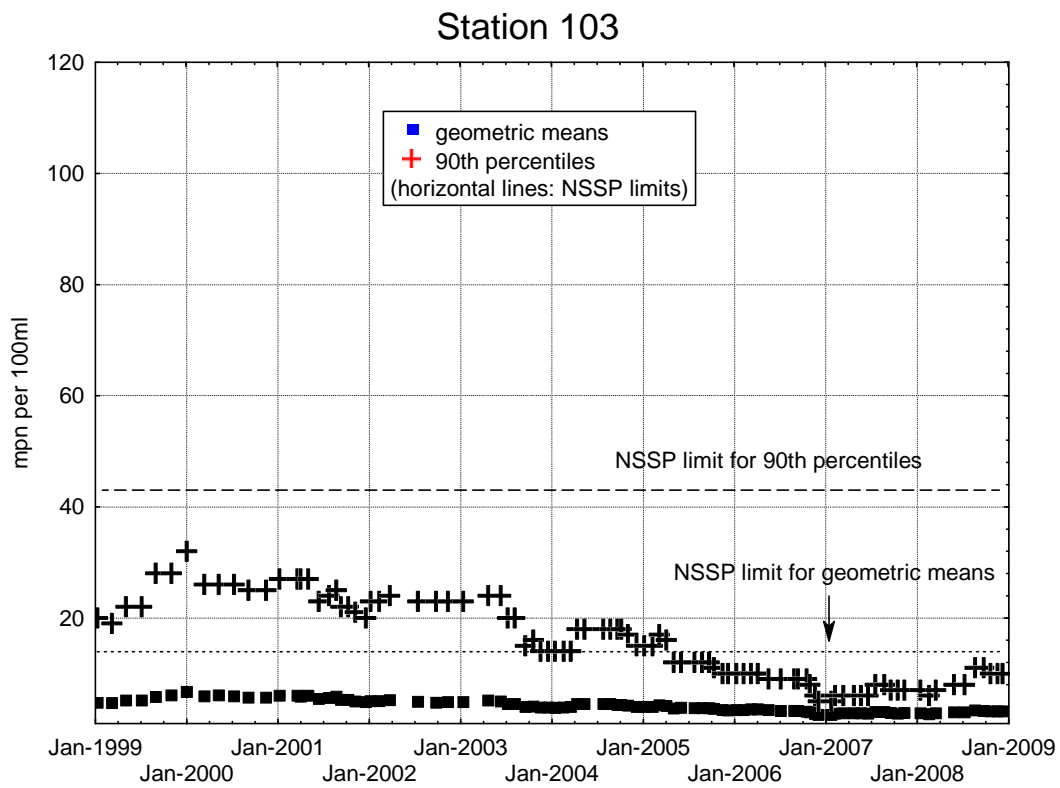


Figure 2. (Cont.)

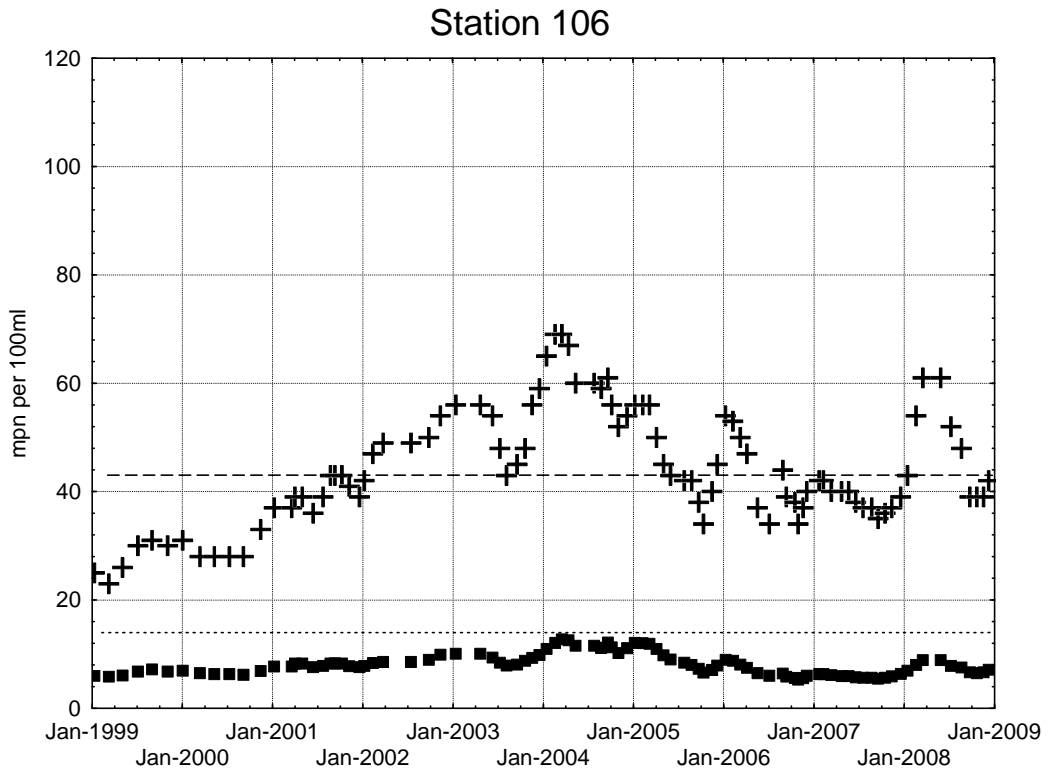
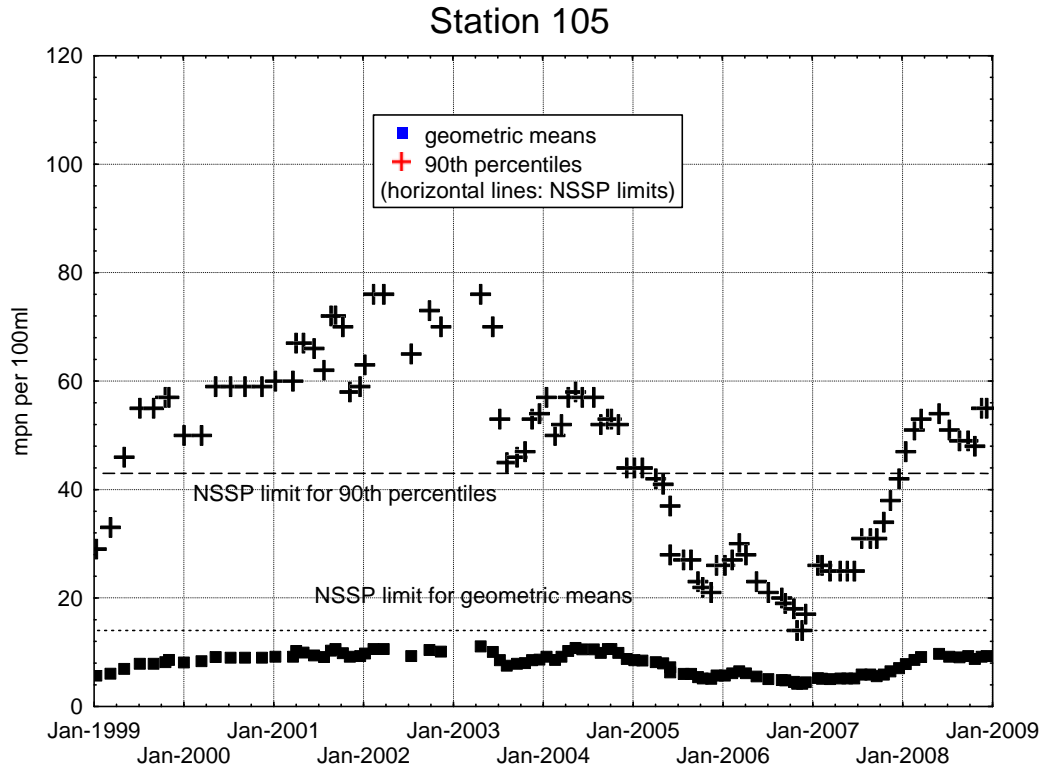


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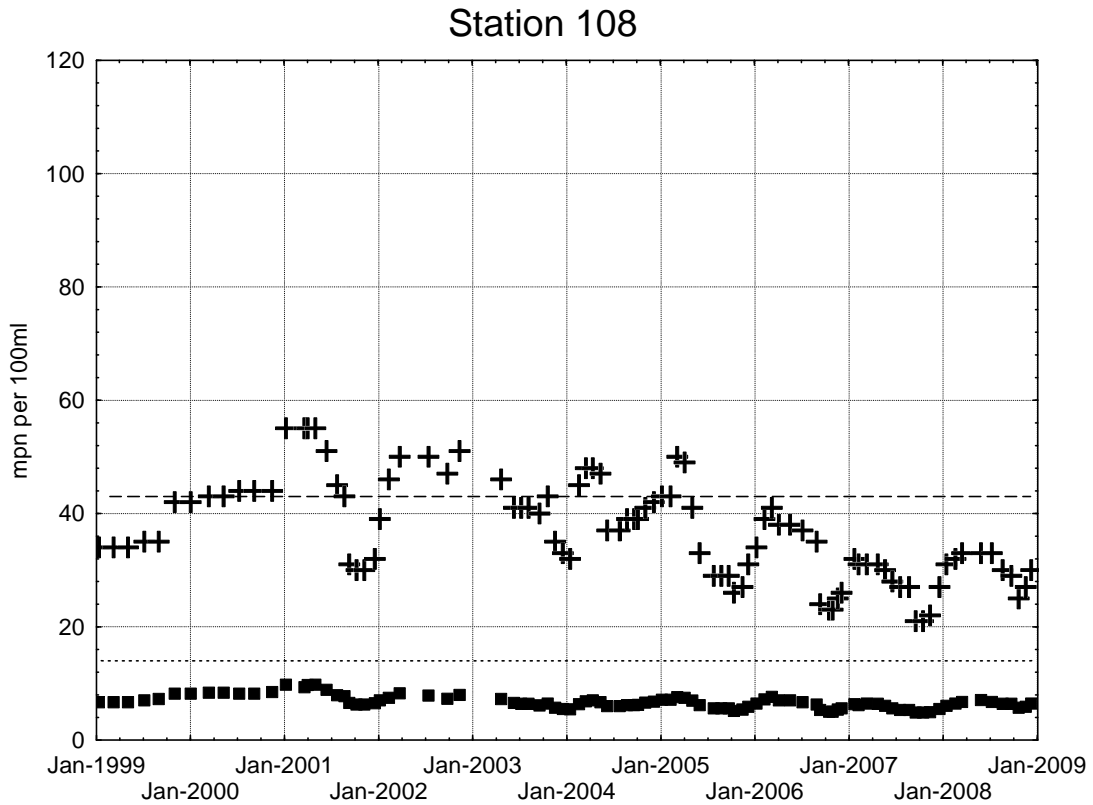
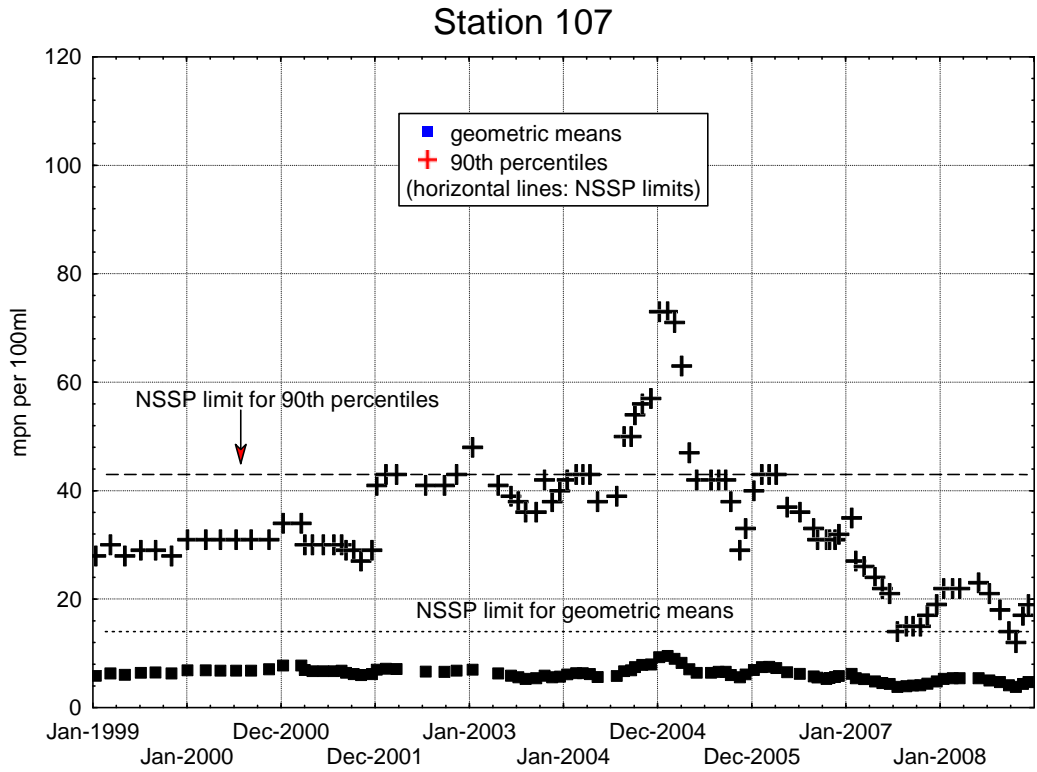
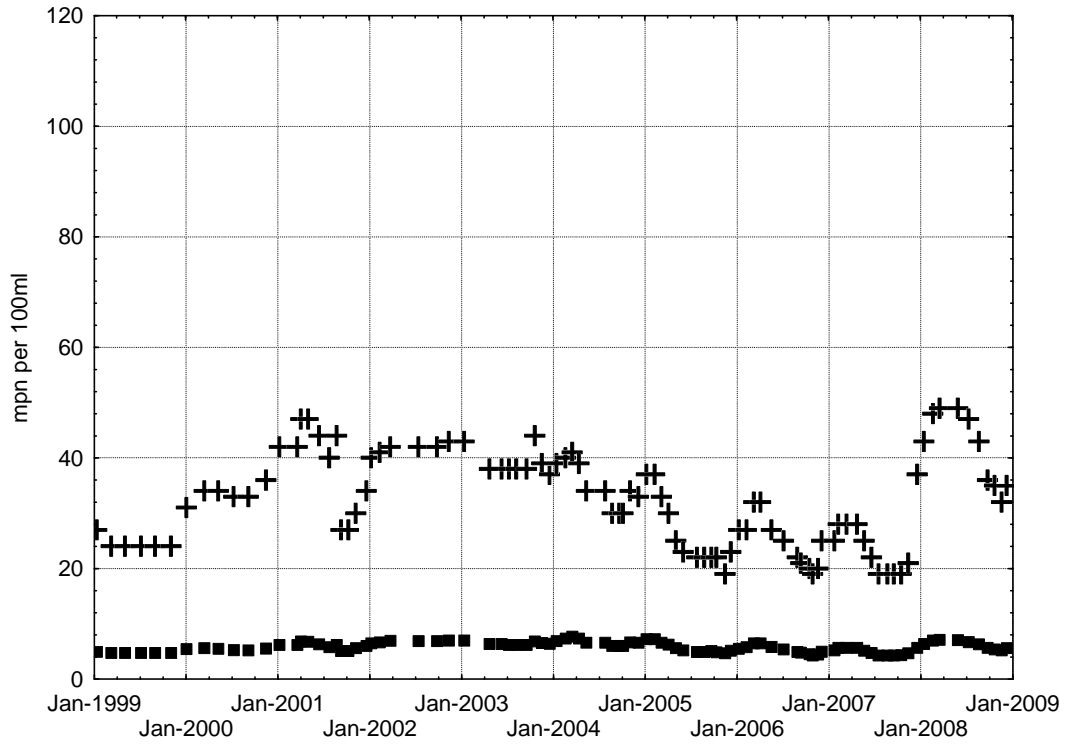


Figure 2. (Cont.)

Station 109



Station 110

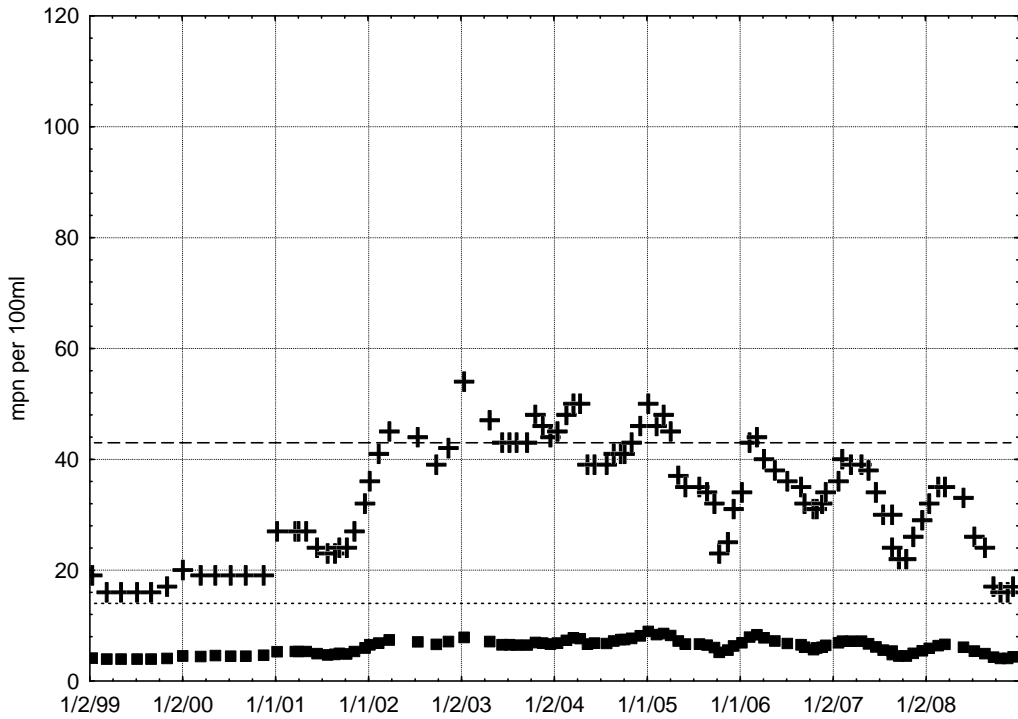


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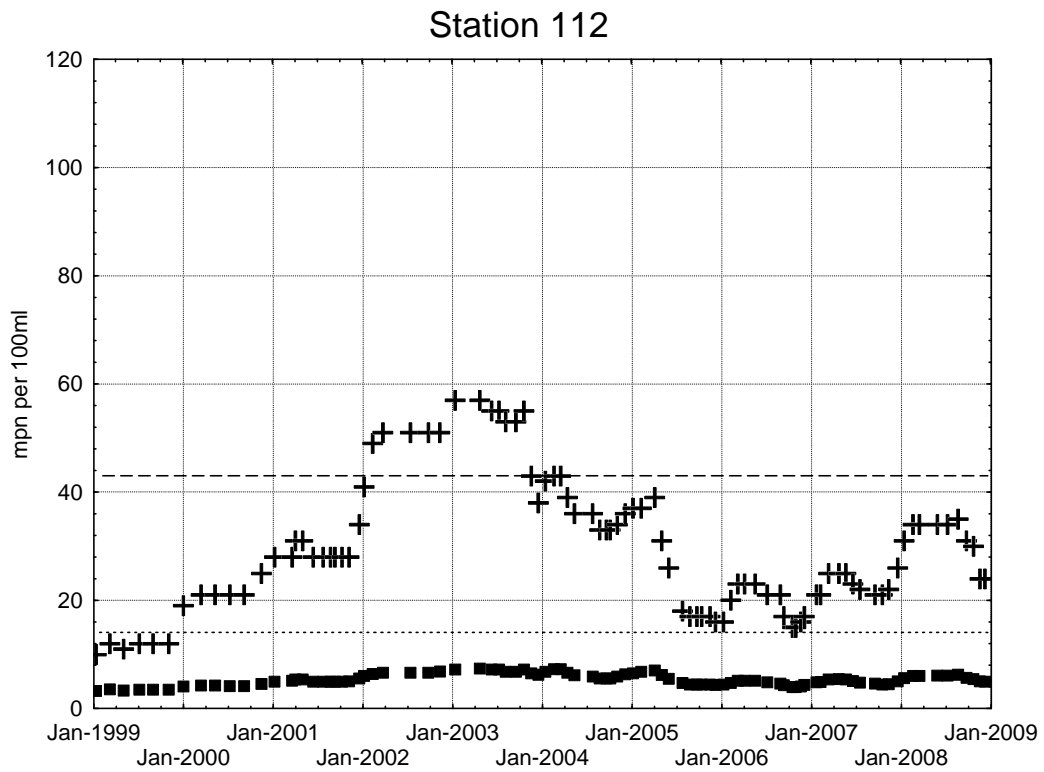
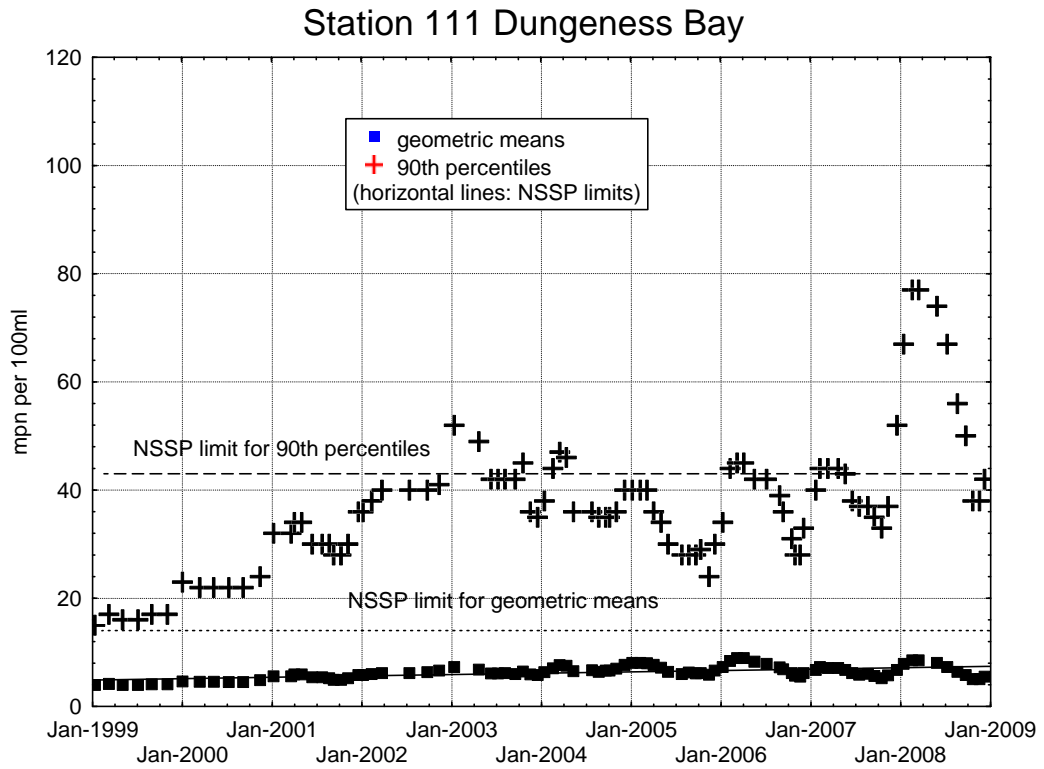


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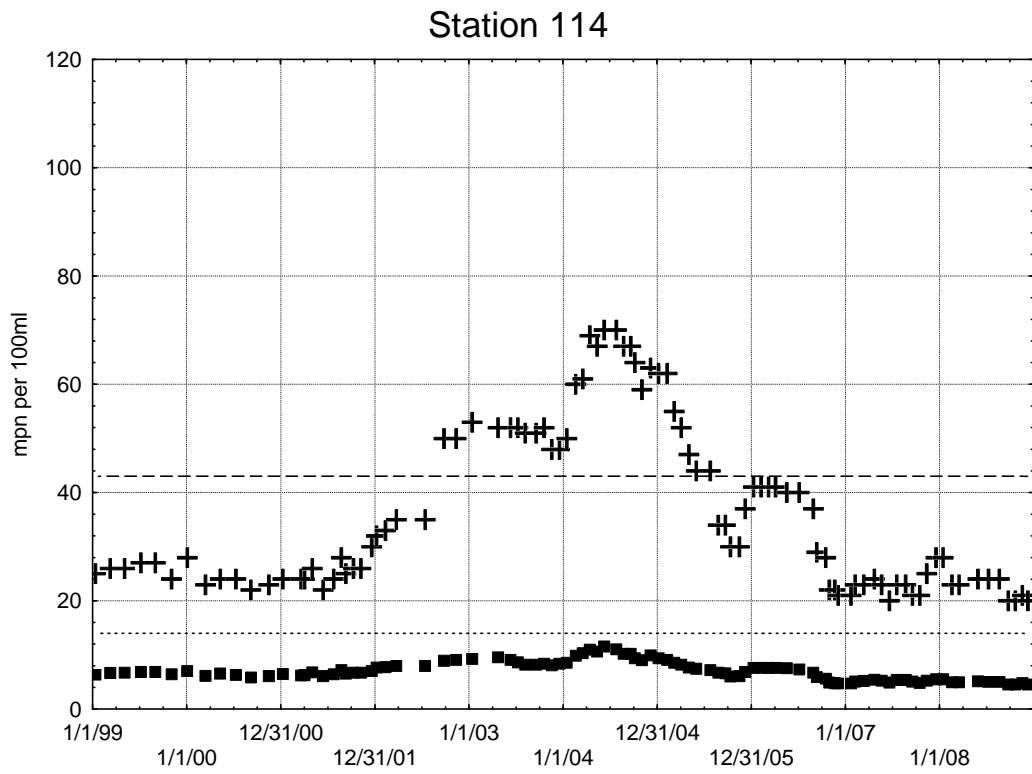
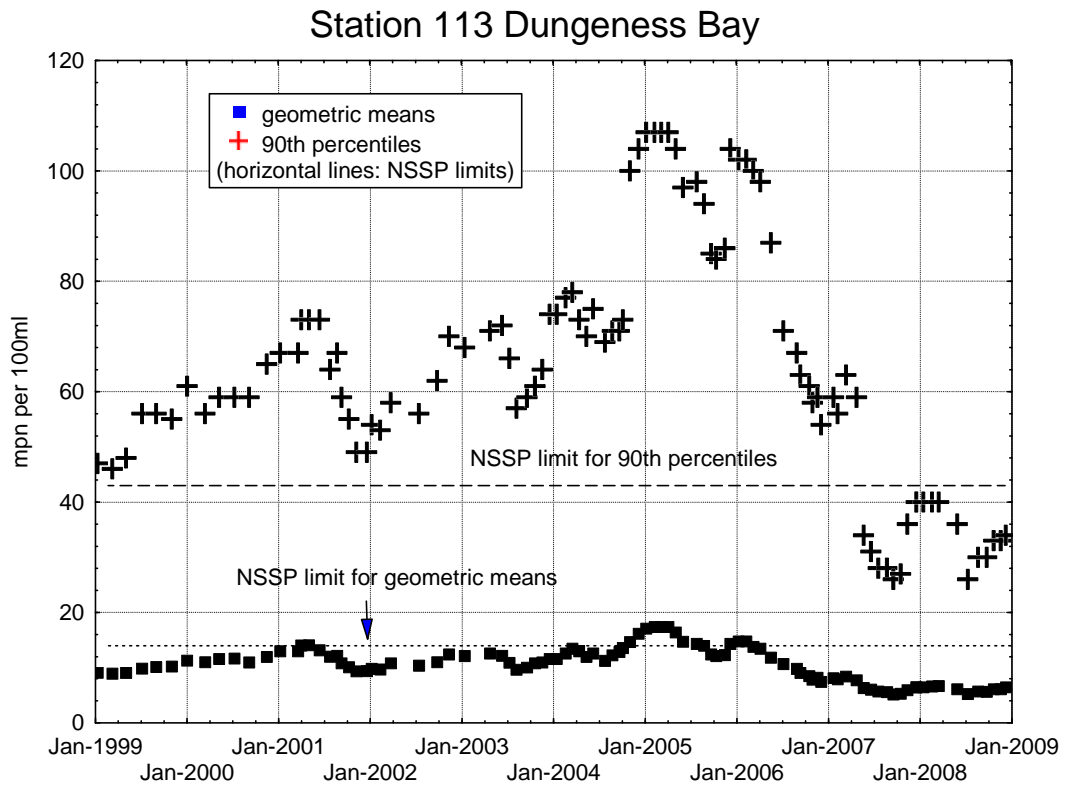
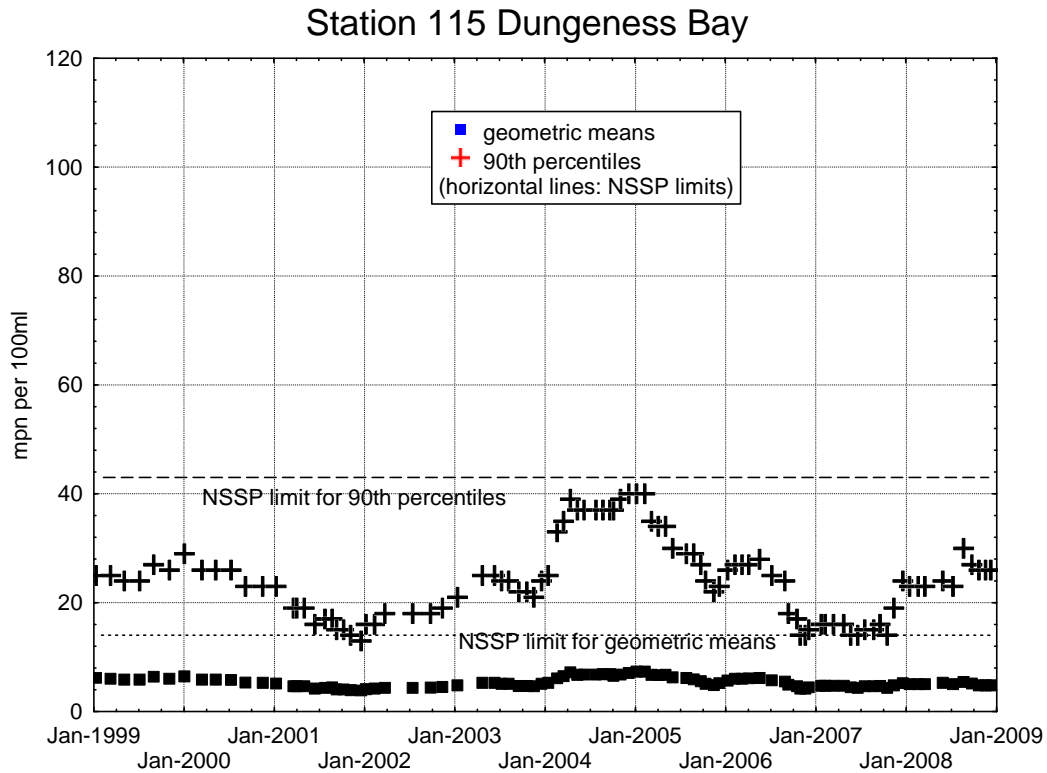


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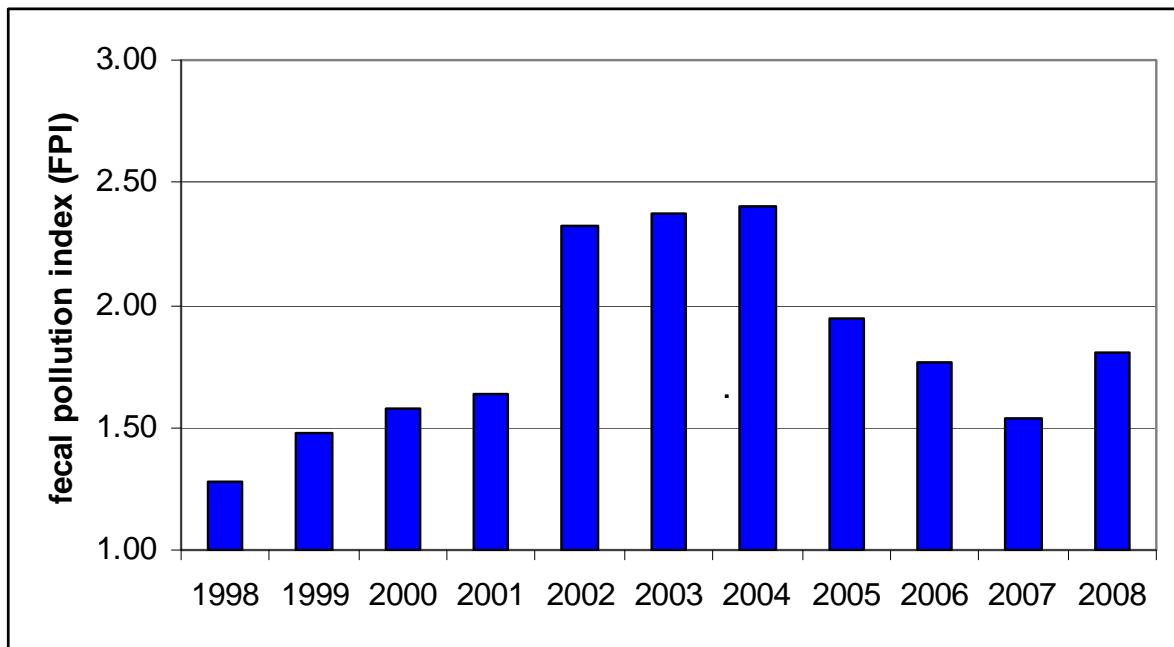
General Observations:

- The graphs suggest a general increase in fecal pollution impact at most stations until mid-decade (2003-2005).
- Most stations showed a general pattern of improvement for several years from mid-decade.
- Fecal pollution impact appears to have increased again at eight of 13 stations in 2008. Impact at three stations (stations 105, 109, and 111) has increased substantially. The increase for Station 105 actually seems to have begun in early 2007.

Fecal Pollution Trend in Dungeness Bay 1998-2009 using the FPI.

Figure 3 extends the concept of the Fecal Pollution Index (FPI) to all of Dungeness Bay. For each year of record, the estimated 90th percentiles for all dates and all stations in Dungeness Bay are sorted into the three categories (GOOD, FAIR, BAD) described on page 4. All 90th percentiles are included regardless of the classification of the sub area in which it is located (Approved, Conditionally Approved, etc.). The FPI is then calculated as described on page 5.

Figure 3. Trend in fecal pollution impact in Dungeness Bay from 1998 through 2008 estimated by the fecal pollution index (FPI).



General Observations:

- Fecal pollution impact increased steadily from 1998 to 2002.
- Fecal pollution remained stable from 2002 through 2004.
- Fecal pollution declined through 2007, but increased again in 2008.

APPENDIX A

Classifying Shellfish Growing Areas

DOH applies guidelines set by the National Shellfish Sanitation Program (NSSP). Each harvest area is classified into one or more of four categories:

- An area is classified **Approved** for unlimited harvest if water quality criteria are met and significant pollutant sources are absent.
- An area is classified **Conditionally Approved** if water quality criteria are met, except during pollution events that are *episodic* and *predictable*, such as rain-related runoff. Harvests from Conditionally Approved areas require a “Conditionally Approved Area Management Plan” (or CAAMP).
- An area is classified **Restricted** if it is subject to limited pollution. Shellfish from Restricted areas cannot be harvested directly. They may be “relayed” under strict supervision to clean waters for natural cleansing.
- If an area receives pollution that is *chronically excessive* and/or *unpredictable*, it is classified **Prohibited (P)**.

To classify a growing area, DOH evaluates two questions:

1. Does the area comply with the NSSP requirements for unlimited harvest of shellfish (Approved)?
2. If unlimited harvesting is not possible, are there conditions under which harvesting can be done (Conditionally Approved)?

Question 1: Does an area comply with Approved classification? DOH collects water samples in the growing area according to SRS (see **Introduction** on page 3). NSSP requires at least 30 samples be collected from each sampling station in a growing area. DOH calculates a geometric mean and a 90th percentile from the 30 results. These are compared to the NSSP criteria. Both the geometric mean and 90th percentile must meet the NSSP criteria.

1. The concentration of fecal coliform bacteria cannot exceed a geometric mean of 14 organisms per 100 milliliters (ml) in water (applied in all cases).
2. The estimated 90th percentile cannot exceed 43 organisms per 100 ml of water (applied to areas where only nonpoint sources are present); OR not more than ten percent of the samples are to exceed 43 organisms per 100 ml of water (applied where point sources are present).

Besides the collection of fecal pollution data, DOH carries out a “shoreline survey” of the upland watershed and the marine shoreline to find and assess pollution sources. DOH cannot approve an area if the shoreline survey reveals pollution that presents a public health hazard, even if the water quality meets the NSSP criteria. If statistics from all stations meet the NSSP criteria and

the shoreline survey does not reveal significant pollution that presents a public health hazard, DOH classifies the area Approved.

Question 2. Can a growing area be classified Conditionally Approved? If a shellfish growing area cannot be classified as Approved, DOH looks at the data to see if it can be classified Conditionally Approved. If conditions are found that would allow safe harvest, DOH prepares a “Conditionally Approved Area Management Plan” (CAAMP) for the area.

The most common Conditionally Approved classification is based on 24-hour rainfall. To set the rain-related condition, statistics are recalculated from edited data (i.e., fecal coliform results from the rainiest days are removed) to see if an upper limit on 24-hour rainfall exists below which harvest can be done. DOH puts the rainfall limit into a “Conditionally Approved Area Management Plan” (CAAMP) for the area. The current CAAMP for Dungeness Bay requires that the Conditionally Approved portion of Dungeness Bay be closed seasonally from November 1 through the last day of February.

Growing areas may also be classified Conditionally Approved based on season. To set the seasonally related condition, DOH calculates NSSP statistics after removing fecal coliform data collected during the rainiest months. If the statistics calculated from the edited data comply with the NSSP criteria, DOH prepares a CAAMP that permits harvest during the approved months. Under the seasonal CAAMP for Dungeness Bay, shellfish may be harvested during all months except November through the last day of February.

DOH reviews the classification of a growing area periodically. An objective review requires updated analysis of the water quality and the shoreline survey. For this reason DOH continues fecal pollution monitoring under SRS to ensure unbiased results are available when needed. Thus, DOH sampling continues even while the area does not meet the conditions specified in the CAAMP.