A Department of Ecology Report

Monitoring Report of Fecal Coliform Concentrations in Freshwater Seeps and Ditches along Inner Dungeness Bay

Abstract

Dungeness Bay is located in Clallam County near Sequim, Washington, on the northeast coast of the Olympic Peninsula. Dungeness Bay is marine water designated for extraordinary aquatic uses, shellfish harvest, and extraordinary primary contact recreation. The Inner Dungeness Bay is closed to shellfish harvesting from November 1 through January 31 due to elevated fecal coliform (FC) bacteria. The annual pattern of freshwater contributions of FC bacteria from the seeps and ditches in the area had not been fully characterized. This study was performed to identify potential sources contributing FC bacteria to the inner bay.

Generally, the Inner Dungeness seeps have little flow entering Inner Dungeness Bay. However, Seeps 3, 7, and 8 had elevated concentrations of fecal coliform concentrations after a summer rain. Seep 8 is an area of concern due this higher concentration and its relatively higher discharge. Bluff Ditch 2 (BD2), BD3, BD4, and near shore outfall NS7 failed to meet the extraordinary primary contact criterion. The irrigation ditches BD2 and NS7 were elevated in the summer months. Roadside ditches BD3 and BD4 were elevated during the winter months. Potential sources for elevated fecal coliform bacteria seen in the Inner Dungeness Bay may include wildlife, livestock, domesticated animals and faulty septic systems.

If local stakeholders decide to direct their resources in these areas, sampling should focus on the roadside ditches, irrigation ditches and Seep 8. If elevated FC concentrations are found, further sampling and investigations should be conducted to identify the source for the bacteria.

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Background

Dungeness Bay is located in Clallam County near Sequim, Washington, on the northeast coast of the Olympic Peninsula (Figure 1). The area is in Elwha-Dungeness Water Resource Inventory Area 18. The outer edge of Dungeness Bay is defined by Dungeness Spit, extending in a narrow 5½ mile curve into the Straits of Juan de Fuca. The Bay is nearly divided by Graveyard Spit, which extends south from Dungeness Spit, and Cline Spit which extends north from the mainland. A relatively narrow opening between these two spits allows tidal waters to flow between West Dungeness Bay (the inner bay) and East Dungeness Bay (the outer bay). The Dungeness River is the main freshwater tributary to the Bay.

Dungeness Bay is marine water designated for extraordinary aquatic uses, shellfish harvest, and extraordinary primary contact recreation. The bay supports recreational harvest of salmon and bottom fish as well as providing important salt marsh habitat. Dungeness crab, oysters, and clams are harvested commercially and recreationally in the Bay. Other uses of the area include recreational waterfowl hunting, bird watching, hiking, and boating. The area also includes the Dungeness National Wildlife Refuge which provides additional areas for recreation and habitat for marine birds and mammals.

Land uses in Dungeness watershed include forest, residential, commercial and agricultural. The area is seeing a noticeable increase in residential development. The city of Sequim is on a sewer system, but residences and commercial properties in the rural areas are on on-site septic systems.

FC bacteria are common in the intestines of warm-blooded animals and are used as a water quality indicator of fecal contamination in the environment. They can indicate a direct discharge of waste from mammals or birds, agricultural and stormwater runoff, or from human sewage. While FC bacteria may not be directly harmful, they can indicate a higher risk of pathogens present in the waters, which may cause water borne illnesses and contamination of shellfish for human consumption.

This project to monitor FC bacteria in select seeps and ditches that contribute to Inner Dungeness Bay was conducted at the request of the Dungeness Clean Water Workgroup (Workgroup). Inner Dungeness Bay is closed to shellfish harvesting from November 1 through January 31 due to elevated bacteria concentrations. The Workgroup was initiated in 2001 in response to the shellfish closure. Members of the Workgroup have included representatives from U.S. Fish & Wildlife Service (Dungeness Wildlife Refuge), Dungeness Farms, Inc., Battelle Marine Sciences Laboratory, Washington Department of Health, Clallam County Environmental Health, Clallam County Streamkeepers, City of Sequim, Clallam Conservation District, Jamestown S'Klallam Tribe, the Sequim-Dungeness Agricultural Water Users Association and the Washington Department of Ecology. The members have been intently focused on cleaning up the waters over the years. This study is important to the Workgroup as part of the on-going TMDL implementation to clean up water quality. The annual pattern of freshwater contributions of FC from the seeps and ditches had not been fully characterized. This study was performed to identify potential sources contributing FC bacteria to the inner bay by collecting samples once a month for a year.

Project Description

The objectives of this study were to:

- Characterize FC concentrations from the select freshwater seeps and stormwater ditches once a month for a year.
- Compare FC concentrations results to the extraordinary primary contact water quality criterion for fresh water.
- Use study results to guide water quality implementation activities for cleaner water and the protection of shellfish beds.

The extraordinary primary contact criterion for fresh water is used to characterize the ditches and determine compliance. The criterion states that fecal coliform levels must not exceed a geometric mean value of 50 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than 10 sample points exist) obtained for calculating the geometric mean value exceeding 100 colonies/100 mL (Ecology, 2006).

Seeps are waters of the state but the water quality standards are used to provide a threshold to determine potential areas of concern not as an assessment for compliance or submission for the 303d list.

Eight seeps and four ditches were initially planned to be sampled (Table 1 and Figure 2). One additional ditch (BD5) and two ditch outfalls (NSD5 and NS7) were added to the study after the study began. The sampling locations are those selected and sampled previously by the Dungeness Clean Water Workgroup partners. Sample sites were named based on those already being used in Ecology's Environmental Information Management (EIM) database. Sampling events were timed to correspond with low tide for seep access.

Refer to the Quality Assurance Project Plan (B. Dickes, 2011) (https://fortress.wa.gov/ecy/publications/publications/**1110089**.pdf) to obtain more details regarding the project description and protocols.

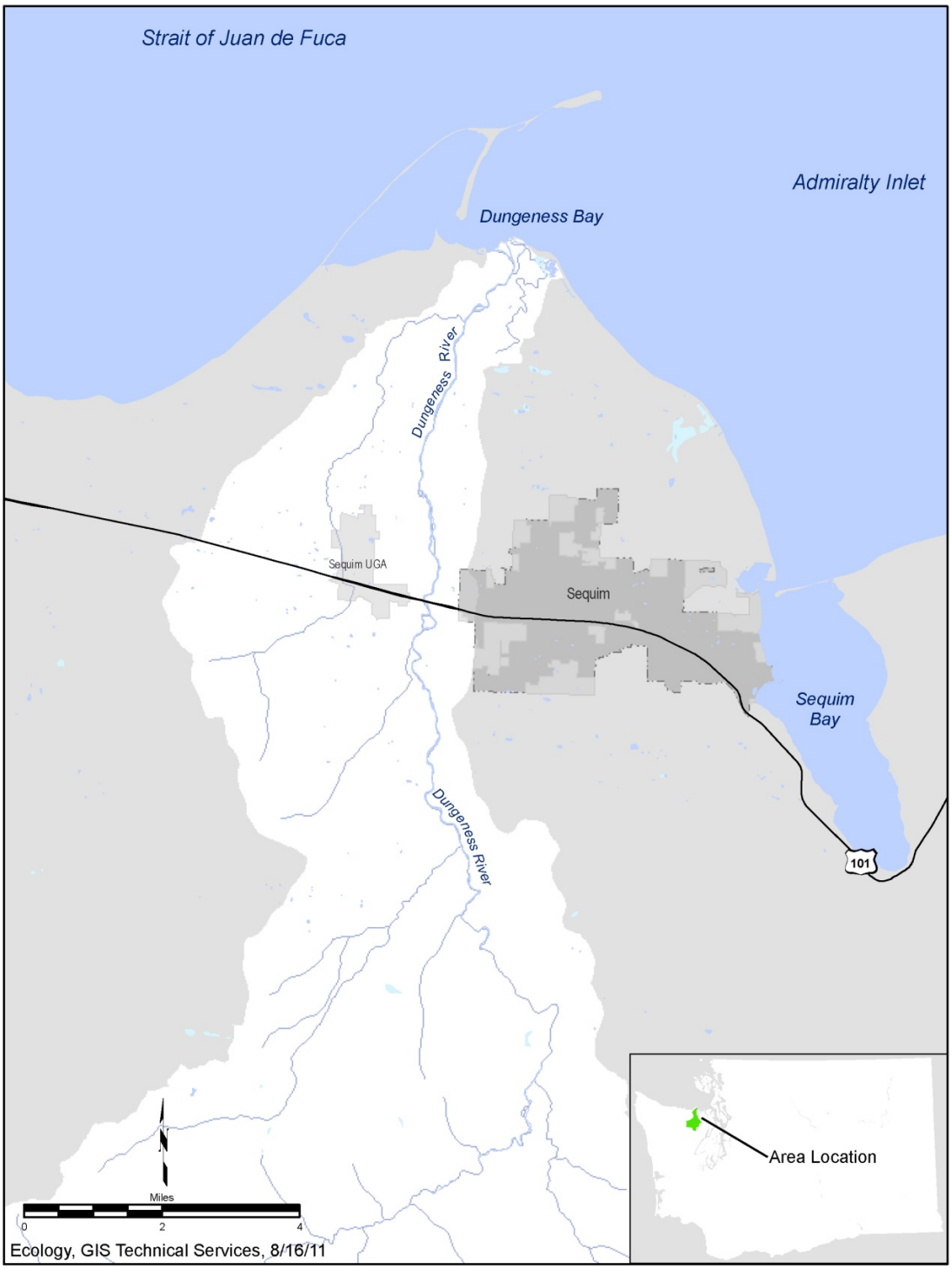

Figure1. Map of Dungeness Bay and surrounding area.

Table 1. Location IDs and descriptions of sampling sites. *The location ID is the name identified in the Environmental Information Management (EIM) database under BEDI0018.*

EIM Location ID	EIM Location Name	Latitude	Longitude
SEEPS			
DUN-SEEP1	Inner Dungeness Seep 1	48.147851	-123.170942
DUN-SEEP2	Inner Dungeness Seep 2	48.147337	-123.172346
DUN-SEEP3	Inner Dungeness Seep 3	48.14609	-123.17846
DUN-SEEP4	Inner Dungeness Seep 4	48.14165	-123.17884
DUN-SEEP5	Inner Dungeness Seep 5	48.14611	-123.17938
DUN-SEEP6	Inner Dungeness Seep 6	48.14603	-123.17989
DUN-SEEP7	Inner Dungeness Seep 7	48.14619	-123.18043
DUN-SEEP8	Inner Dungeness Seep 8	48.14630	-123.18080
DITCHES			
BD2_BLUFF	Bluff Ditch Inner Dungeness Bay 2	48.14973	-123.15588
BD3_BLUFF	Bluff Ditch Inner Dungeness Bay 3	48.14937	-123.16124
BD4_BLUFF	Bluff Ditch Inner Dungeness Bay 4	48.14899	-123.16519
BD5_BLUFF	Bluff Ditch Inner Dungeness Bay 5	48.14863	-123.16666
NSD5	Nearshore Ditch Inner Dungeness Bay 5	48.14884	-123.16681
BD7_ANDERSON RD	Bluff Ditch 7 at Anderson Road	48.14509	-123.1695
NS7	Near Shore 7 outfall	48.14815	-123.16949

Figure 2. Locations of sampling sites. *The names are abbreviated for simplicity.*

Results

The results of the study are summarized in Table 2. The individual sample concentrations can be found in Ecology's EIM database website www.ecy.wa.gov/eim/index.htm under Study ID BEDI0018.

- Eleven sample events were completed during the year-long sampling project. The January 2012 sampling event was cancelled due to snow and dangerous road conditions.
- Field replicates were averaged and analyzed as one result value. The expectations for field quality assurance were met.
- Wildlife (birds, seals, coyote, and deer) and dogs were seen on the shore and in the waters of Inner Dungeness Bay. Cows were observed in the upland study area.
- Elevated concentrations were seen on February 14, 2012 and July 17, 2012 when at least 0.2 inches of rain had fallen during the days prior to sampling.
  - Many ditches were elevated on February 14, 2012, but the seeps were all 6 cfu/100 mL or below.
  - On July 17, 2012 most of the ditches were dry except for BD2 and NS7; both are irrigation ditches. BD2 was 155 cfu/100 mL and NS7 was 92 cfu/100 mL. The seeps that were flowing and sampled on this date were all above 50 cfu/100 mL.

SEEPS

- On September 17, 2012, four out of 5 seep samples were analyzed up to fifteen minutes outside of the 24 hour holding time. These samples were accepted with a qualifier 'J' (estimate).
- Many seeps had very low flow (estimated at < 1 liter/minute) or went dry. Samples were collected only if contamination could be avoided. However, on July 17, 2012, Seep 6 was sampled and later eliminated from the data set due to noted concern for sediment contamination.
- Seep 8 had the highest individual concentration for the study at 185 cfu/100 mL on July 17, 2012, but the geometric mean of the 11 samples was only 6 cfu/100mL. This seep had the highest relative volume of flowing water (estimated at > 1 liter/minute).
- There were 11 samples collected at Seep 7. This site had the highest geometric mean of 12 cfu/100. The highest individual concentration for this site was 78 cfu/100 mL collected on July 17, 2012.
- Seep 1and 2 were dry on all sampling event days.

DITCHES

- The ditches were often dry resulting in insufficient data for analysis. To calculate a geometric mean at a site for fecal coliform, there must be at least five data points.
- BD7 was sampled once (71 cfu/100 mL). It was either dry or filled with aquatic vegetation and ineffective to sample. Sampling was moved to the NS7 outfall in April 2012.

- NS7, the irrigation ditch outfall, was the one sampling location that had enough samples (n=5) for analysis of both parts of the extraordinary primary contact criterion. The geometric mean of 10 cfu/100 mL met the criterion, but the site failed to meet the second part of the criterion with a concentration of 110 cfu/100 mL in August. It had a relatively heavy flow during most of the study.
- Ditches BD2, BD3, and BD4 were often dry. Less than 5 samples were collected at each site over the study period. However, each site had one sample greater than 100 cfu/100 mL, resulting in their failure to meet the FC water quality criterion. BD2, an irrigation ditch, was elevated in July 2012. BD3 and BD4 were high in February 2012 during the rain event.
- BD4 had water one time during the study. The concentration on February 14, 2012, was 480 cfu/100 mL; the highest concentration identified during the study. It was raining while sampling and cows were in the upper field.

Table 2. Summary fecal coliform data for Inner Dungeness Bay freshwater sampling sites 2011- 2012.

Field Name	**Field Location**	**Geometric Mean*** (cfu/100 mL)	**Range** (cfu/100 mL)	**# samples >100 cfu/100mL**	**# of Samples**
Seep 1	Base of bluff *east*	dry			0
Seep 2		dry			0
Seep 3		3	1-63	0	9
Seep 4		6	1-28	0	8
Seep 5		2	1-8	0	5
Seep 6		2	1-10	0	8
Seep 7		12	1-78	0	11
Seep 8	Base of bluff *west*	6	1-185	1	11
BD2	South side of road 520 Marine Dr. (irrigation)	N/A	3-155	1	4
BD3	Small bridge east side of Thornton Dr. near Marine Dr.	N/A	1-110	1	3
BD4	Ditch at 80 Marine Dr.	N/A	480	1	1
BD5	East ditch at 90° corner of Marine Dr west of BD4.	N/A	11	0	1
NSD5	Base of Bluff for BD5	N/A	2	0	1
BD7	Ditch at 134 W. Anderson Rd. (irrigation)	N/A	71	0	1
NS7	Base of Bluff – outfall for BD7 (irrigation)	10	1-110	1	5

* 5 samples required to calculate a geometric mean

Conclusions and Recommendations

Conclusions

Storm events were not targeted during this study due to resource limitations and the logistics of commuting from Olympia. However, the samples taken during and after rain events did relate to elevated bacteria concentrations.

Generally, the Inner Dungeness seeps discharge little flow into Inner Dungeness Bay. However, Seeps 3, 7, and 8 had elevated FC bacteria concentrations after summer rain.

Seep 8 is an area of concern due to the elevated concentration in July 2012 and relatively high discharge.

The ditches were often dry. However, the irrigation ditches BD2 and NS7 had elevated FC bacteria concentrations in July and August respectively. These sites failed to meet the second part of the two-part criterion for extraordinary primary contact.

Roadside ditch sites BD3 and BD4 had elevated concentrations during the February rain event. These sites failed to meet the second part of the two-part criterion for extraordinary primary contact.

Potential sources for elevated fecal coliform bacteria seen in the Inner Dungeness Bay may include wildlife, livestock, domesticated animals, and faulty septic systems.

Recommendations

If local stakeholders determine it is the best use of their resources, FC sampling should focus on:

- Roadside ditches during and after winter rain events,
- Irrigation ditches and Seep 8 during and after summer rain events.

If elevated concentrations are found, further investigations and sampling should be conducted to identify the source for the bacteria. Source controls should be implemented.

References

Dickes, B., 2011. *Quality Assurance Project Plan Fecal Coliform Monitoring of Freshwater Seeps and Ditches along Inner Dungeness Bay*. Washington State Department of Ecology, Olympia, WA. Publication No. 11-10-089. https://fortress.wa.gov/ecy/publications/publications/**1110089**.pdf

Ecology, 2006. WAC 173-201A. *Water Quality Standards for Surface Waters in the State of Washington*, Washington State Department of Ecology, Olympia, WA. www.ecy.wa.gov/biblio/wac173201a.html

Appendix: Glossary, Acronyms, and Abbreviations

Extraordinary primary contact: Waters providing extraordinary protection against waterborne disease or that serve as tributaries to extraordinary quality shellfish harvesting areas.

Fecal coliform (FC): That portion of the coliform group of bacteria which is present in intestinal tracts and feces of warm-blooded animals as detected by the product of acid or gas from lactose in a suitable culture medium within 24 hours at 44.5 plus or minus 0.2 degrees Celsius. FC are “indicator” organisms that suggest the possible presence of disease-causing organisms. Concentrations are measured in colony forming units per 100 milliliters of water (cfu/100 mL).

Geometric mean: A mathematical expression of the central tendency (an average) of multiple sample values. A geometric mean, unlike an arithmetic mean, tends to dampen the effect of very high or low values, which might bias the mean if a straight average (arithmetic mean) were calculated. This is helpful when analyzing bacteria concentrations, because levels may vary anywhere from ten to 10,000 fold over a given period. The calculation is performed by either: (1) taking the nth root of a product of n factors, or (2) taking the antilogarithm of the arithmetic mean of the logarithms of the individual values.