Quality Assurance Project Plan

Risk Based Management of Marine Pathogens and Biotoxins: Vibrio Project

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Each study conducted by EPA, or external parties funded by EPA, must have an approved Quality Assurance Project Plan (QAPP). This plan describes the objectives of the study and the procedures to be followed to achieve those objectives. It will be available upon request from the WDOH, as will be the final report.

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July 2013

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2.0 Abstract

Washington State is in the process of moving from reactive to proactive *Vibrio parahaemolyticus* (*Vibrio*) management. In the current *Vibrio* control plan, the occurrence of sporadic illnesses triggers time-to-temperature reductions and growing areas closures. The Washington State Department of Health (DOH) is working with a Vibrio Advisory Committee comprised of industry members and other interested stakeholders to move towards risk-based *Vibrio* management. A key component of moving towards a proactive management approach is collecting and analyzing environmental monitoring data. With well-established links between *Vibrio* growth and temperature (Nordstrom *et al.* 2004; Oberbeckmann *et al*. 2012), it is critical that DOH expand monitoring efforts to include continuous water temperature data collection. The NEP funded component of this work will focus on collecting temperature data from 17 *Vibrio* monitoring sites in order to better understand the relationship between temperature and *Vibrio* growth. The results of this study will be combined with other data to inform a proactive *Vibrio* management approach for the State of Washington.

3.0 Background

Washington State Department of Health (DOH) is the Shellfish Authority for the state and tasked with regulation of the commercial shellfish industry by the Food and Drug Administration (FDA). As the Shellfish Authority, DOH regulates WAC 246-282-006, the Washington state Vibrio parahaemolyticus (Vibrio) control plan. This rule governs the harvest, temperature control and transportation of oysters intended for raw consumption during the months of May through September. Under the control plan, the occurrence of two sporadic Vibrio illnesses linked to a growing area within a thirty day period leads to a time-to-temperature reduction, the occurrence of an additional two sporadic illnesses within a thirty day period leads to a closure of the implicated growing area. These measures are intended to reduce the occurrence of Vibrio illnesses, but given challenges with the timeliness of illness reporting and trackback processes, actions are often taken weeks after the illnesses occurred and when environmental conditions may be less favorable to *Vibrio* growth.

Washington State is in the process of moving from this reactive management approach working with a Vibrio Advisory Committee comprised of industry members and other interested stakeholders. DOH is collecting landings data from oyster harvesters to calculate the risk of *V. parahaemolyticus*-associated gastroenteritis by growing area. This information can then be used to develop a tiered management approach where growing areas with higher risk adhere to more stringent harvest controls than areas with lower risk. DOH believes this proactive *Vibrio* management approach will reduce the number of sporadic *Vibrio* illnesses and protect public health. A key component of moving towards a tiered management approach is collecting and analyzing environmental monitoring data.

DOH monitors the populations (total and potentially pathogenic) of *Vibrio* bacteria in oysters from shellfish growing areas. While collecting samples, DOH also records current weather conditions, air, water, and tissue temperatures, and salinity. Although extensive, these monitoring efforts provide only a snapshot of environmental conditions. Sampling is conducted at low tide on a weekly schedule. Growing area waters undergo rapid water temperature changes based on changing weather conditions and tidal cycles. Given the temporal resolution of DOH's sampling schedule, these daily and even hourly fluctuations are not captured by our current monitoring efforts. With well-established links between *Vibrio* growth and temperature (Nordstrom *et al.* 2004; Oberbeckmann *et al*. 2012), it is critical that DOH expand monitoring efforts to include continuous water temperature data collection. The NEP funded component of this work will focus on collecting temperature data from 17 *Vibrio* monitoring sites in Hood Canal and Puget Sound in order to better understand the correlation between temperature and *Vibrio* growth. The results of this study will be combined with other data to inform a proactive *Vibrio* management approach for the State of Washington.

4.0 Project Description

4.1 Project goals

The goal of this project is to identify whether there is a clear threshold water temperature above which the risk of *V. parahaemolyticus*-associated gastroenteritis increases in the 17 growing areas historically associated with *V. parahaemolyticus*-associated gastroenteritis and address whether a reasonable tiered control can be developed based on water temperatures.

4.2 Project objectives

The following objectives will be used to meet this goal:

1. Collect continuous water temperature data from 17 oyster harvest sites where monitoring for presence and growth of *Vibrio* is ongoing.
2. Analyze the continuous temperature data in conjunction with field temperature and salinity measurements as well as laboratory tissue results for *Vibrio* growth to identify trends / relationships.
3. Analyze temperature trends and assess whether warmer temperatures are associated with the occurrence of illnesses and at what temperatures there appears to be a heightened risk of *V. parahaemolyticus*-associated gastroenteritis.
4. Recommend tiered *Vibrio* controls based on these results if a clear threshold can be identified.

4.3 Information needed and sources

Information will be gathered through the collection of water temperature data. Illness data and instantaneous field measurements will be collected separately but will be used in the data analysis.

4.4 Target population

Temperatures in shellfish growing areas in Hood Canal and Puget Sound operating in the *Vibrio* control months that have been associated with *V. parahaemolyticus*-associated gastroenteritis.

4.5 Study boundaries

Table 1. *Vibrio* monitoring sites in Hood Canal and Puget Sound (in WSG84).

Y	X	Growing Area	Site Address	Site ID
47.856039	-122.80634	Dabob Bay	1619 Dabob Post Office Rd, Quilcene	JCHC013
47.203897	-123.027488	Hammersley Inlet	210 SE Orca Ln, Shelton	MCHI019
47.69606	-122.897202	Hood Canal 3	pulloff on US 101, Brinnon	JCHC020
47.540226	-123.040654	Hood Canal 5	35846 N Hwy 101, Lilliwaup	MCHC005
47.356016	-123.086529	Hood Canal 6	5721 E SR 106, Union	MCHC011
47.361519	-123.025293	Hood Canal 7	12201 NE North Shore Rd, Belfair	MCHC019
47.349435	-123.039051	Hood Canal 7	8371 E SR 106, Union	MCHC042
47.382169	-122.946784	Hood Canal 8	13611 Hwy 106, Belfair	MCHC060
47.409662	-122.883003	Hood Canal 9	17321 E SR 106, Belfair	MCHC059
47.155008	-123.01926	Skookum Inlet	212 SE Sells Dr, Shelton	MCSS018
47.374638	-122.814841	North Bay	pulloff on 302 past Victor, Belfair	MCSS008
47.224112	-123.045505	Oakland Bay	800 E Sunset Rd, Shelton	MCSS013
47.802718	-122.86833	Quilcene Bay	1601 Linger Longer Rd, Quilcene	JCHC011
48.61057	-122.437455	Samish Bay	2182 Chuckanut Dr, Bow	SKSB003
48.575538	-122.497322	Samish Bay	Blue Heron Rd, Bow	SKSB004
47.120362	-123.059334	Totten Inlet	1042 SE Bloomfield Rd, Shelton	MCSS0T2
47.147148	-122.965586	Totten Inlet	Hargis St NW, Olympia	TCSS0T3

4.6 Tasks required

LASCAR Electronics EasyLog Data Loggers (EL-USB-1) will be programmed to take temperature readings in degrees Celsius (°C) at thirty minute increments and deployed at all *Vibrio* monitoring sites in Hood Canal and Puget Sound at an approximately one foot tide height. Bi-weekly the data loggers will be brought back to DOH so the data can be downloaded, organized and filed. At the end of September the temperature data will be compiled and analyzed in conjunction with confirmed *V. parahaemolyticus*-associated gastroenteritis illnesses that can be traced back to specific growing areas where temperatures were continuously monitored. The results will be shared in a final report and with the Vibrio Advisory Committee to assist in developing a tiered management approach.

4.7 Practical constraints

As the data loggers will be deployed in intertidal areas, readings will include both air and water temperatures, depending on the bed elevation of each deployment site and the tidal height. Although site access should not be a constraint of this study, it is a possibility as all but they Quilcene Bay sampling site are on commercial tide flats with owner permission. Given that the Quilcene Bay site is a public access site, permission has been obtained to deploy the data logger at Coast Seafood's site next to the Quilcene Yacht Club. Each data logger with be staked into the ground in a cage, but given the sometime strong weather conditions experienced in intertidal settings, it is also possible a device may be lost during deployment. The data loggers will be

deployed in two week increments with re-deployment to ensure continuous monitoring. Although the data loggers have the capacity to continuously record data for an 11-month period, if they stop functioning due to unintentional seawater exposure or another malfunction we will lose critical data. By re-deploying (or swapping out) the data loggers, we will ensure minimum information loss. Data loggers will also be temporarily sealed in their case with Loctite thread locker to safeguard against saltwater intrusion. Given the large quantity of temperature data from multiple sites, files will be identified by unique site IDs, which correspond to the site IDs in the DOH Shellfish Sample System database where *Vibrio* monitoring results are recorded. This nomenclature will ensure temperatures are linked to the correct growing area and sampling site.

4.8 Systematic planning process used

This QAPP serves as the project preparation for this activity.

5.0 Organization and Schedule

5.1 Key individuals and their responsibilities (project team, decision-makers, stakeholders, lab, etc.)

The project team includes Laura Wigand, Amy Holler and Dalila Zelkanovic. Ms. Wigand will be responsible for project management, training and quality assurance. Ms. Holler and Ms. Zelkanovic will be responsible for deploying data loggers and downloading data. Decision-makers include Jerrod Davis, Rick Porso, Cari Franz-West and Laura Wigand. Stakeholders include the shellfish industry, Vibrio Advisory Committee, the FDA and NOAA.

5.2 Organization chart

Given the small size of the project team, an organizational chart was not developed. See section 5.1 for information on how the project team will interact.

5.3 Project schedule

Table 2. Project schedule.

	Approved Quality Assurance Project Plan (QAPP		July 2013
1	Deploy data loggers.		July 2013*
2	Collect and analyze data.		Bi-weekly July – September 2013
3	Reporting: Prepare a draft and final report, including methods and materials, water temperature data and a brief summary of how the data will inform policy.	Final presentation to the Vibrio Advisory Committee Draft† and Final reports	October 2013 Draft: October 2013 Final: December 2013

* Data loggers deployed prior to QAPP approval funded by WDOH
† Draft report will be reviewed by peers and NEP QC

5.4 Limitations on schedule

Limitations to this project may include personnel availability to deploy the data loggers while conducting regular *Vibrio* monitoring activities, the tidal cycle which may limit timeframe to deploy and retrieve data loggers, and personnel availability to analyze data given the short timeframe between the end of this study and the Vibrio Advisory Committee Meeting.

5.5 Budget and funding

Budget: Vibrio project	**Amount**
Salaries (1 FTE--Environmental Specialist 1)	39,516
Benefits @ 28%	11,064
Supplies @ $450/month/FTE	5,400
Supplies project	3,000
Equipment	0
Travel	1,500
Other (rent/computers/phone) @ $130/FTE/mo + $6,944/yr/FTE	8,504
Direct DOH subtotal	68,984
Indirect on direct charges @ 22.2%	15,314
Total project budget	**84,298**

6.0 Quality Objectives

The goal of this project is to better understand the link between temperature and *V. parahaemolyticus*-associated gastroenteritis and determine if temperature thresholds exist and may be used to inform a tiered management approach under the *Vibrio* control plan. Continuous temperature data is critical to this effort in order to provide the temporal resolution necessary to link growing area temperatures and the occurrence of illness.

6.1 Decision Quality Objectives (DQOs)

DQOs are used to select between two clear alternative conditions, or to determine compliance with a standard, such as in some hazardous waste site clean-ups. DQOs are not necessary for this project.

6.2 Measurement Quality Objectives

MOQs include ensuring calibration checks are performed on the instruments and ensuring each site collects continuous temperature data for a minimum of 30 days.

6.2.1 Table of targets for:

6.2.1.1 Precision

Precision is a measure of the variability in the results of replicate measurements due to random error. Precision of the data loggers will be checked when the data loggers return to the office and before re-deployment to the field. A data logger accuracy and calibration check will be performed to determine if drift should be accounted for in results (Appendix A) (Adams 2013). In addition we will take independent reading with a calibrated thermometer when the data loggers are deployed and retrieved.

6.2.1.2 Bias

Bias is the difference between the population mean and the true value. Bias will be reduced to the extent possible through adhering to the project's sampling procedures and conducting regular calibration and maintenance of field equipment.

6.2.1.3 Sensitivity

Sensitivity is a measure of the capability of a method to detect a substance. The data loggers being used for this study have a sensitivity of ±1 degree Celsius.

6.2.2 Targets developed for:

6.2.2.1 Comparability

A standardized operating procedure (SOP) will be used (Appendix B). The results from this study will also be comparable to instantaneous field collection results.

6.2.2.2 Representativeness

The sites have been selected based on the use of these areas for routine *Vibrio* monitoring and representative of commercial harvest sites within growing areas.

6.2.2.3 Completeness

A sample will be considered complete if a deployment results in 30 days of continuous temperature data.

7.0 Sampling Process Design (Experimental Design)

7.1 Study Design

7.1.1 Sampling location and frequency

Thirty minute interval sampling from 17 sites in Hood Canal and Puget Sound. Locations were determined based on the location of routine monitoring sites for Vibrio sampling and represents the higher elevation of typical shellfish harvest in each location.

7.1.2 Parameters to be determined

Temperature.

7.1.3 Field measurements

Temperature measured in degrees Celsius (°C).

7.2 Maps or diagram

Figure 1 Map of deployment site locations

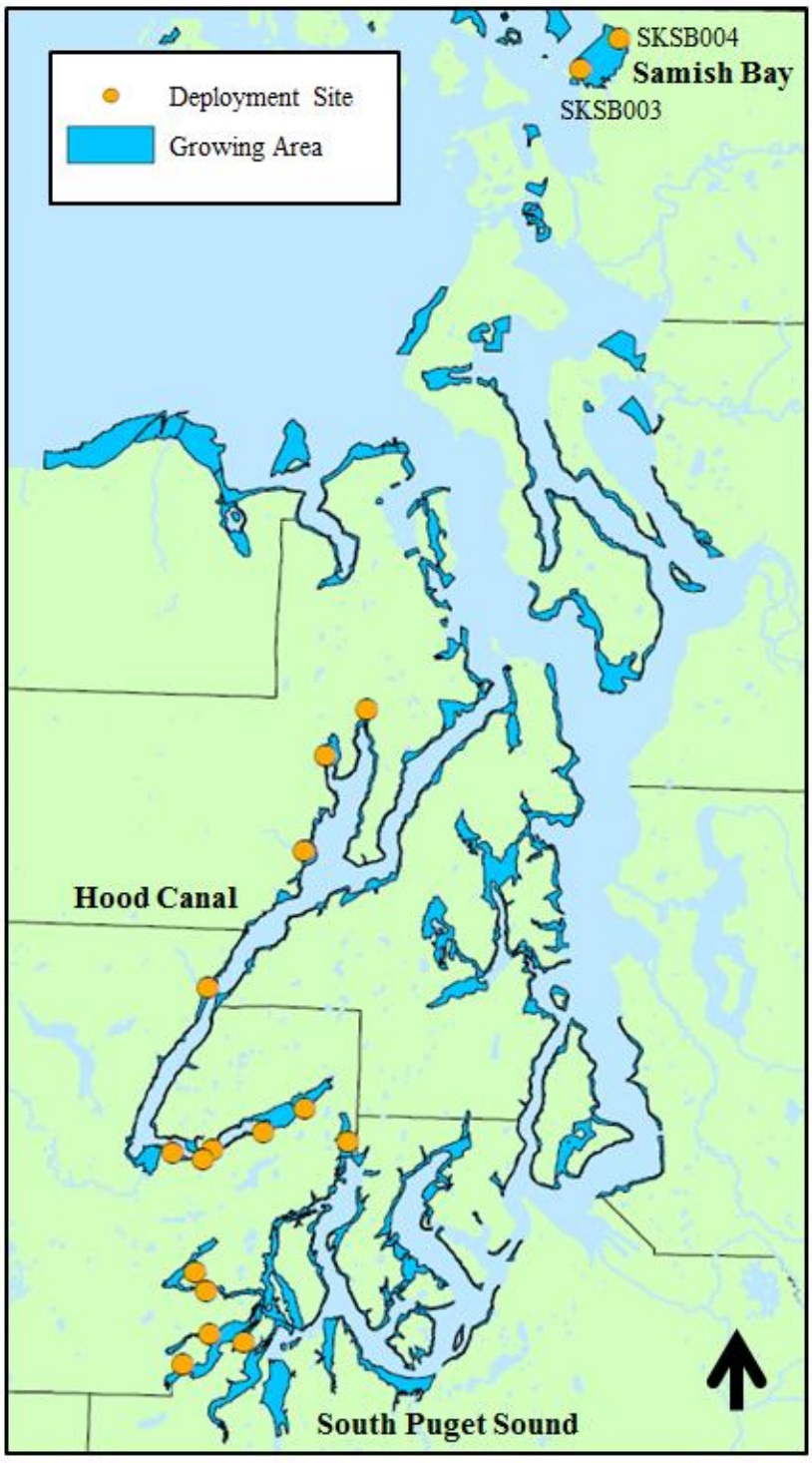


Figure 2 Map of Hood Canal site locations with labels

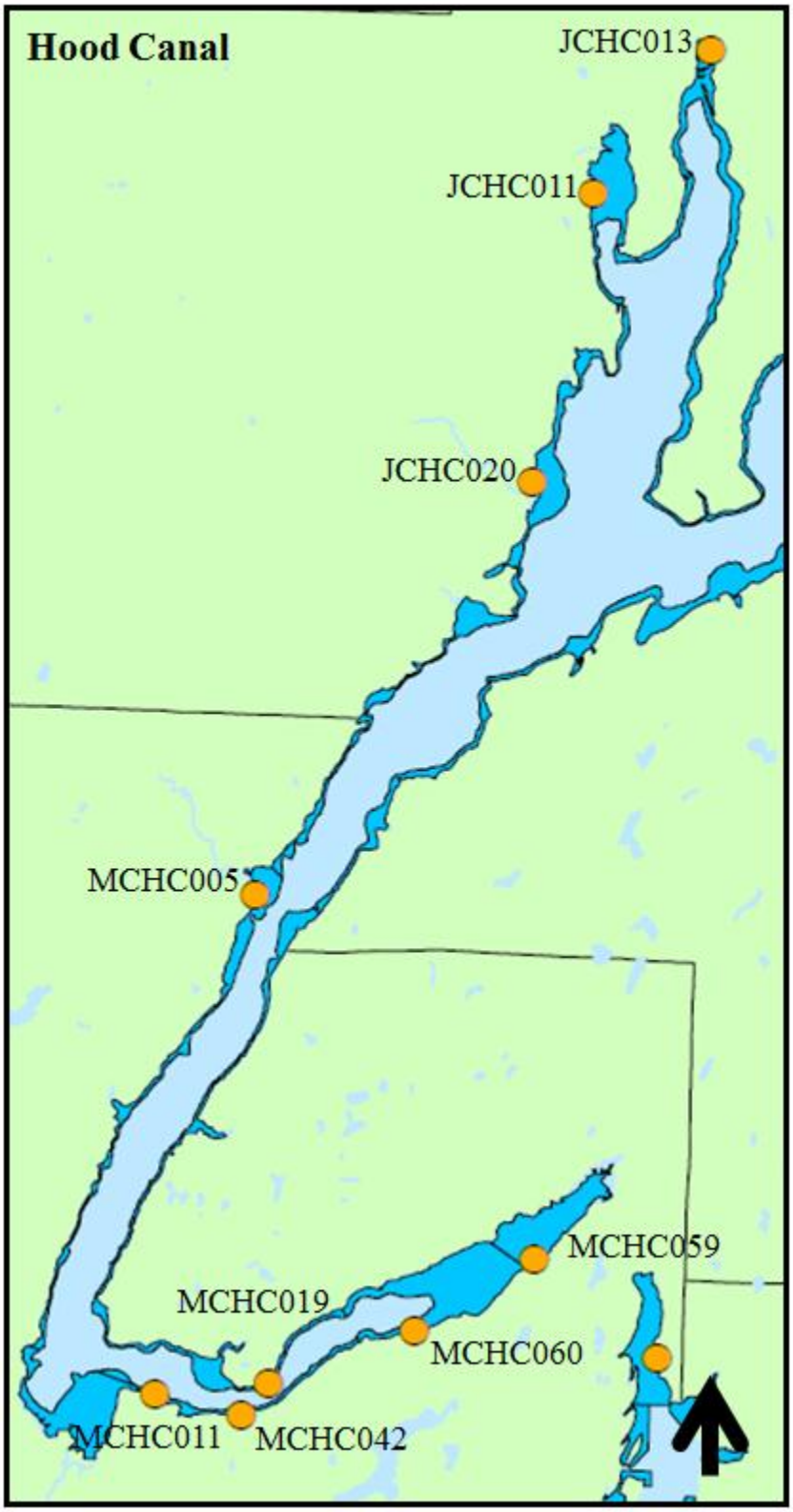
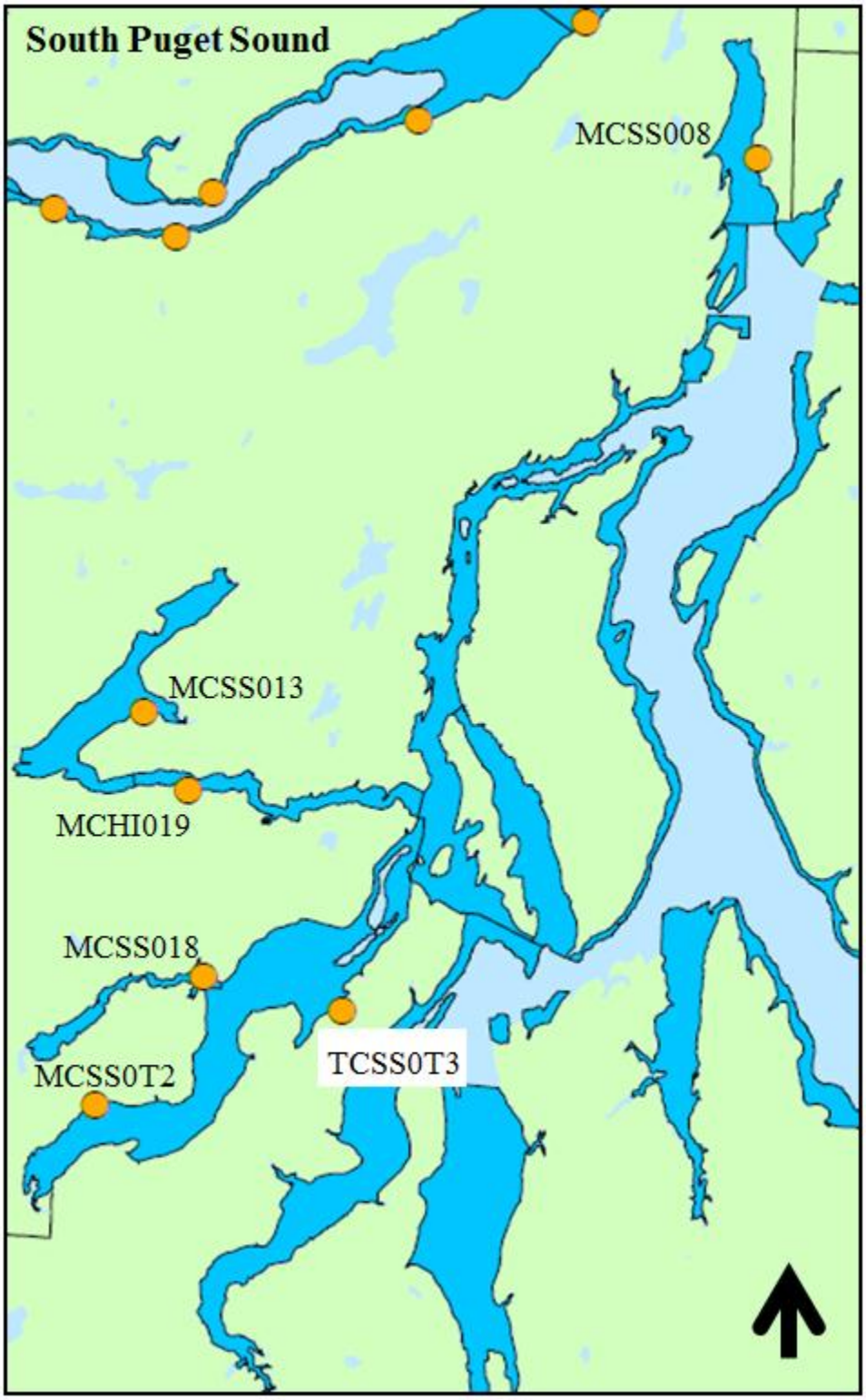


Figure 3 Map of South Puget Sound site locations with labels



7.3 Assumptions underlying design

These sampling locations were selected based on the routine *Vibrio* monitoring locations. They are considered representative of the growing areas in which the sites are located, but there is also great variability within growing areas. The sites are all, with the exception of Quilcene Bay, located within commercial growing areas. The use of commercial growing areas means that these sites are more representative of temperatures on the day of harvest when linking illness occurrence to growing area temperatures, but as each site is unique, the temperatures recorded through this study may not precisely match those at harvest. Measuring temperature via data loggers at only one site and bed elevation within the growing areas will adequately represent the growing area for this initial research effort. As data is collected it may be valuable in future studies to include data loggers at different sites and bed elevations. Air and water temperatures measured frequently at each site will adequately reflect internal oyster tissue temperatures for the purpose of exploring the relationship between temperature and harvest date.

7.4 Relation to objectives and site characteristics

The site locations are all easily accessible and are used for routine *Vibrio* monitoring. By collecting continuous temperature data from these sites, DOH will have greater temporal resolution in this dataset to look for trends and to analyze the relationship between temperature and illness prevalence.

7.5 Characteristics of existing data

This study will provide continuous temperature data for 17 growing areas historically associated with *V. parahaemolyticus*-associated gastroenteritis illnesses. To date, DOH is unaware of a data set with this temporal resolution for Hood Canal and Puget Sound shellfish growing areas. DOH does collect air and water temperature data during routine *Vibrio* monitoring efforts, but this data set consists of bi-monthly to weekly data points.

8.0 Sampling Procedures

8.1 Field measurement and field sampling SOPs

Appendix B contains the SOP describing how continuous field measurements of temperature will be made (Danielson 2006).

WDOH staff will monitor *Vibrio* in oysters as part of its ongoing program. Oyster tissue samples will be collected, handled, stored, and transferred to the WDOH laboratory, for *Vibrio* analysis, as is described in WDOH (2012).

8.2 Measurement and sample collection

Protocols for Measuring Continuous Water Temperature Using an Onset Data Logger developed by Tom Danielson, Maine Department of Environmental Protection will adapted for use in intertidal areas and be used for this study (see Appendix B).

8.3 Containers, preservation methods, holding times

Data loggers will be deployed in LASCAR Electronic's cases designed for water deployments. They will be sealed with Loctite to guard against saltwater intrusion. The devices will be placed in mussel cages designed by Mckay Shrimp and Crab Gear and staked in place. Placing the devices in the staked cages will ensure they are not lost while deployed and ensure easy recovery of devices throughout the study.

8.4 Invasive species evaluation

Invasive species contamination is unlikely. Deployment cases will be thoroughly cleaned of any biofouling before re-deployment. Cages and other supplies will be cleaned at the end of the study period.

8.5 Equipment decontamination

This may be necessary when sampling substances that contain high levels of contaminants, bacterial contamination, or contain for organic materials that stick to the sampling devices. Decontamination will not be necessary for this project.

8.6 Sample ID

Sample IDs will match site IDs following the program's established nomenclature. See Table 1 for site ID information for each location. Data loggers will each have their own identifier. See Appendix C for how the data logger ID will be tracked with the sample ID for each deployment.

8.7 Chain-of-custody, if required

The program's established chain of custody will be followed.

8.8 Field log requirements

A field log will not be completed as part of this project, but a Locality Documentation and Logger Information Metadata Sheet will be compiled for each sampling site (Appendix C) (Adams 2013).

8.9 Other sampling-related activities

Interns will be trained on the deployment and retrieval of data loggers. Field instruments will be maintained following steps in section 4.0 Project Description.

9.0 Measurement Methods

9.1 Lab Measurement Methods Table. This includes:

9.1.1 Analyte

Temperature.

9.1.2 Matrix

Air and water.

9.1.3 Number of samples

Temperature at 17 sites will be sampled continuously (at 30 minute intervals) for at least one month. This will result in 1400-1500 temperature measurements per site.

9.1.4 Expected range of results

Temperature results will likely vary by site, time of day and daily weather conditions. The approximately range of temperatures expected is 10^{o}-32^{o} C?

9.1.5 Analytical methods

LASCAR Electronics EasyLog Data Loggers (EL-USB-1) will measure temperature in degrees Celsius (°C) at thirty minute intervals. The SOP for their deployment and use appears in Appendix B.

Detailed description of methods used to identify, count and determine the virulence of *Vibrio parahaemolyticus* can be found in the Sampling Procedures, Measurement Procedures, and Appendix B of WDOH (2012).

9.1.6 Sensitivity/Method Detection Limit (MDL)

±1 degree Celsius.

9.2 Sample preparation method(s)

Raw data (.csv) will be converted to Microsoft Excel format for data analysis.

9.3 Special method requirements

There are no special method requirements.

9.4 Field procedures table/field analysis table

There is no field analysis associated with this project.

9.5 Lab(s) accredited for method(s)

The Department of Health Public Health Lab is accredited by FDA for *Vibrio* methods used for analysis.

10.0 Quality Control (QC) Procedures

10.1 Table of lab and field QC required

Before re-deployment all data loggers must undergo a calibration check (Appendix B).

10.2 Corrective action processes

Data that fails to meet the measurement quality objectives may be rejected or qualified.

11.0 Data Management Procedures

11.1 Data recording/reporting requirements

Temperature data from loggers be downloaded as .cvs and be formatted and analyzed in Microsoft Excel. Standard summary statistics will be performed and temperature data will be overlaid with illness data by growing area to look for patterns. Other statistical methods (e.g., ANOVA, principle components analysis, Moran's *I*, Getis-Ord G_i^*) may also be used to explore relationships between temperature, substrate type, and presence of *Vibrio* in oysters and the presence of spatial patterns.

11.2 Lab data package requirements

See WDOH 2012.

11.3 Electronic transfer requirements

Data will be transferred electronically using the internal WDOH Shellfish Sample System database.

11.4 Acceptance criteria for existing data

This study will rely on data collected in the 2013 *Vibrio* control months. Illness data from 2013 will only be used if it meets the following criteria: a confirmed *V. parahaemolyticus*-associated gastroenteritis illness associated with a single growing area and harvest date.

11.5 EIM/STORET data upload procedures

Data will be formatted for entry into Ecology's EIM database for subsequent transfer to EPA's STORET.

12.0 Audits and Reports

12.1 Number, frequency, type, and schedule of audits

Field audits will be conducted on a monthly basis by the project manager. This will help to ensure that the proficiency of data collection is maintained.

12.2 Responsible personnel

Laura Wigand will be responsible for the field audits.

12.3 Frequency and distribution of report

Given the short timeframe of this study, interim reports will not be created.

12.4 Responsibility for reports

Laura Wigand will write the draft and final report for this project for review by exerts / peers as well as by the NEP QC.

13.0 Data Verification

13.1 Field data verification, requirements, and responsibilities

Data verification will be completed by Laura Wigand and will include ensuring that data logger calibration and accuracy checks are performed and documented, that site metadata sheets are complete for each deployment location, that each site meets minimum standards for temporal resolution (30 days), and that results are within the expected range (5-40°C).

13.2 Lab data verification

Existing program lab data verification will be completed.

13.3 Validation requirements, if necessary

Data validation will not be completed as part of this project.

14.0 Data Quality (Usability) Assessment

14.1 Process for determining whether project objectives have been met

Data will be used for all sites where data loggers are active for a minimum of 30 days. Sites where this temporal resolution is not met will be excluded from further analysis.

14.2 Data analysis and presentation methods

Data will be analyzed for the presence of trends and for associations with illness occurrence. This data will be presented in a final report and to the Vibrio Advisory Committee in Microsoft PowerPoint format. Data analysis will include standard summary statistics for temperature data. Data analysis will also include a comparison of illness occurrence and average temperature on associated date of harvest. Other statistical methods (e.g., ANOVA, principle components analysis, Moran's *I*, Getis-Ord G_i^*) may also be used to explore relationships between temperature, substrate type, and presence of *Vibrio* in oysters and the presence of spatial patterns.

14.3 Treatment of non-detects

Non-detects in temperature collection will be removed from further analysis and be attributed to a faulty data logger. Calibration of data loggers will be completed as outlined in section 6.0 Quality Objectives and Appendix A.

14.4 Sampling design evaluation

The sampling design evaluation will occur in the final report. The evaluation will include suggestions for improving the sampling design in future studies of this nature conducted by DOH.

14.5 Documentation of assessment

The documentation of assessment will occur in the final report.

15.0 References

Adams, M. 2013. Protocol for Placement and Retrieval of Temperature Data Loggers in Idaho Streams Water Quality Monitoring Protocols—Report No. 10. Idaho Department of Environmental Quality, Water Quality Division.

Danieldon, T. 2006. Protocols for Measuring Continuous Water Temperature Using an Onset Data Logger. Maine Department of Environmental Protection. Bureau of Land and Water Quality, Division of Environmental Assessment, Biomonitoring Program.

Nordstrom, J.L.; Kaysner, C.A.; Blackstone, G.M.; Vickery, M.C.L.; Bowers, J.C.; DePaola, A. 2004. Effect of Intertidal Exposure on *Vibrio parahaemolyticus* Levels in Pacific Northwest Oysters. *Journal of Food Protection*. 67:10.

Oberbeckmann, S; Fuchs, B.M.; Meiners, M.; Wichels, A.; Wiltshire, K.H.; Gerdts, G. 2012. Seasonal dynamics and modeling of a *Vibrio* community in coastal waters of the North Sea. *Environmental Microbiology*. 63.

Washington Administrative Code 246-282-006.

Washington Department of Health, 2012. Quality Assurance Project Plan for Possible Inoculation of Wet Stored Shellfish in Penn Cove, Whidbey Basin, with Endemic *Vibrio parahaemolyticus.*

16.0 Figures

17.0 Tables

18.0 Appendices

18.0 Appendices

Appendix A – Data Logger Accuracy and Calibration Form

Temperature Data Logger Accuracy Check and Calibration Form				
Data Logger Number				
Manufacturer Specifications ^{o}C Accuracy:				±1 ^{o}C
PRE-DEPLOYMENT Accuracy Check Performed by:				
Date and Time	**Dial Stick Thermometer Temp**	**Data Logger Temp**	**Difference**	**Pass/Fail**
		Average Difference		
		Drift		
POST-RETRIEVAL Accuracy Check Performed by:				
Date and Time	**Dial Stick Thermometer Temp**	**Data Logger Temp**	**Difference**	**Pass/Fail**
		Average Difference		
		Drift		

Appendix B – Field Collection SOP

Standard Operating Procedure
Bureau of Land and Water Quality
Date: December 20, 2006
Doc num: DEPLW0700

Bureau of Land and Water Quality
Division of Environmental Assessment
Biomonitoring Program

Standard Operating Procedure
Protocols for Measuring Continuous Water Temperature
Using an Onset Data Logger

1. **Applicability.** This standard operating procedure (SOP) applies to the collection and analysis of continuous water temperature data from wadeable rivers and streams in Maine using a HOBO Water Temp Pro logger from Onset Computer Corporation.

2. **Purpose.** The purpose of this SOP is to provide standardized methods for collecting and processing continuous water temperature data from wadeable rivers and streams in Maine.

3. **Definition.** Continuous water temperature data are those that are collected at certain time intervals (e.g., every 10 or 30 minutes) for an extended period of time (e.g., 4-6 weeks) using an electronic temperature logger deployed in a river or stream.

4. **Responsibilities**

   A. Training. It is the responsibility of the task manager for whose project temperature data are collected to ensure that the individual(s) using the loggers are familiar with this SOP.

   B. Tracking of temperature logger usage. It is the responsibility of the individual launching, deploying, or retrieving a logger to note these activities on the relevant tracking forms and/or field sheet; this is especially important if a logger is to be deployed and retrieved by different groups (i.e., algae *versus* macroinvertebrate staff). It is the responsibility of the task manager to place completed tracking forms and/or field sheet in the appropriate folder located in the Biomonitoring staff area.

   C. Data retrieval and processing. It is the responsibility of the task manager or the staff member retrieving/processing the data to note these activities on the relevant tracking forms. When all data have been processed, these forms will be printed out and included in the Biomonitoring unit's QAPP folder.

5. Guidelines and Procedures

A. Measurement period. In the majority of cases, temperature data will be collected concurrently with the sampling of algae and/or macroinvertebrates during the summer low flow period.

B. Materials
   (1) Launched temperature logger, labeled with deployment location.
   (2) Cable ties, nylon (not cotton) rope, steel cable, and rebar where appropriate, to anchor logger in deployment location.
   (3) Lengths of PVC pipe (~6 inches) to shade and protect logger. PVC pipe has 2 holes drilled at one end to allow it to be secured to the logger with cable ties.
   (4) Appropriate field sheet to note deployment/retrieval of logger.
   (5) Color-coded flagging tape to mark logger location.

C. Precautions and limitations. The HOBO Water Temp Pro is only suitable for measurements in the range of 32°F to 122°F (0°C to 50°C).

D. Procedures
   (1) Pre-deployment logger precision test. Prior to each sampling season, all temperature loggers must be tested for precision according to the procedures outlined in the Protocols for Testing Temperature Logger Precision (App. A).
   (2) Pre-deployment logger launch
      (a) Connect IR Base station to a host computer that has the BoxCar software installed using the appropriate interface cable and align communication window on base station with communication window on logger.
      (b) Open BoxCar software program and go to Logger > HOBO Water Temp Pro > Launch. Update the description (i.e., planned deployment location) and measurements units (degrees Celsius). Make sure stealth mode is NOT selected. Select 'Launch Immediately' and logger should begin recording data, LED will blink every 5 seconds during logging.
      (c) Enter logger type and number and launch info (start date and time, name of MDEP staff who launched logger, measurement interval, planned deployment location) in the logger tracking file [H:L&W/WATERSHED/Monitoring & Assessment/Program/ Biomonitoring/SOP-QAPP/ Tracking temp loggers] (App. B). Using tape, label temperature logger with planned deployment location, i.e. waterbody name, town, station number or 'new (station)', descriptor such as 'above' or 'below' if necessary.
   (3) Logger deployment
      (a) Determine a suitable site for deployment in line with the program's objectives. In general, the logger should be deployed near the sample location in an area that is likely to stay inundated throughout the sampling period.

(b) Attach logger (with the sensor end down) with a cable tie, nylon (not cotton) rope, or steel cable to a suitable deployment point, for example:
   i. a sturdy structure such as a large tree root;
   ii. a rebar stake driven into the stream bed;
   iii. one of the sampling devices (e.g., rock bag). This is the preferred method if the site is being sampled for macroinvertebrates.
   If options (i) – (iii) are not applicable, the task manager should use his/her best judgment to find a suitable attachment point.

(c) If the deployment location is in a sunny area, the logger should be secured within a length of PVC pipe or shaded in some other way.

(d) The Hobo Water Temp Pro loggers tend to float and steps must be taken to ensure the logger remains completely submerged throughout the sampling period. For example, the logger could be placed under a boulder or within a length of PVC pipe with both ends secured so one end doesn't float.

(e) To aid in logger retrieval, make a drawing on the field sheet indicating logger location and note location (e.g., attached to rock bag). If deemed necessary, the area of deployment can also be flagged or marked with color-coded flagging tape, or the GPS coordinates of the location, if available, can be recorded.

(f) Check box 'Temperature Probe deployed' on the field sheet and note logger number. Make sure to note if the logger was deployed in a different location than planned. Back at the MDEP office, enter deployment information in the temperature logger tracking file (App. B).

(4) Logger retrieval

(a) Locate the logger utilizing drawing, notes, flagging, marking, or GPS coordinates as available/necessary. Retrieve logger and check box 'Temperature Probe retrieved' on the field sheet. Back at the MDEP office, enter retrieval information in the logger tracking file (App. B).

(b) Keep logger in a safe location and return it to the MDEP office for data retrieval and processing.

(5) Data retrieval

(a) Connect IR Base station to a host computer that has the BoxCar software installed using the appropriate interface cable.

(b) Open BoxCar software program and go to Logger > HOBO Water Temp Pro > Readout.

(c) Once logger has appeared in window, select 'Stop Search' and 'Readout'. Next, click 'Stop Logging and Off-load Data'.

(d) Select location to save data [H:L&W/WATERSHED/Monitoring & Assessment/Program/Biomonitoring/STREAM DATA/H2OTEMPS/ (appropriate year)/dtf files/] and rename file as appropriate [e.g., 'Pretty_Brook_S###_PrettyTown.dtf'; if station (S) number has not yet been assigned, say 'Snew' and add descriptor, e.g., 'upstream' or 'below_POTW' if necessary]. In window 'Data off-load successful', click OK, then click OK for Series 'Temperature (C)' and 'Select time offset

from UTC (GMT) = -4'. This will create a graph of all data records collected.

(e) Enter retrieval information in temperature logger tracking file (App. B).

(6) Data processing

(a) Export data into a text file:

i. With desired BoxCar Pro graph (.dtf file type) open, go to File > Export > Custom > Preferences. Set the Date Style to 'Month and Day (Incl. Year)', the Date/Time Separator to 'Space ()', the Time Style to 'Hr. Min.' and the Data Separator to 'Comma (,)', click OK.

ii. Click on Export and select location to save text file [H:L&W/ WATERSHED/ Monitoring & Assessment/Program/ Biomonitoring/STREAM DATA/ H2OTEMPS/(appropriate year)/text files/] and rename as appropriate [see (5) (d), above, but use file extension 'txt').

iii. Enter processing information in temperature logger tracking file (App. B).

(b) Convert text file to an Excel file:

i. In Excel, open desired text file from location noted in (6) (a) (ii), above.

ii. Select 'Delimited' data file type and click Next. Select 'Tab' and 'Comma' as Delimiters. Click Finish.

iii. Save file as a Microsoft Excel Workbook in desired location [H:L&W/WATERSHED/Monitoring & Assessment/Program/ Biomonitoring/STREAM DATA/ H2OTEMPS/ (appropriate year)/Excel files/] and rename as appropriate [see (5) (d), above, but use file extension 'xls').

iv. Enter processing information in temperature logger tracking file (App. B).

(c) For use of temperature data in the biomonitoring portion of the annual SWAT report please see Protocols for creating Temperature graphs and transferring them into a Word file for the SWAT report (App. C).

6. Care and Maintenance

A. After use, clean the loggers using non-abrasive, mild, antibacterial soap and warm water with a non-scratching sponge or cloth. Any scratches on a logger's communication window may impair downloading of data. If necessary a plastic polish may be used for tougher cleaning jobs.

B. Be sure to keep the logger free from dirt and dust when not in use.

Appendix C – Locality Documentation and Logger Information Metadata Sheet

Locality Documentation and Logger Information Metadata Sheet			
Location Information			
Water Body Name:		Site ID:	
Site address:		Site Bed Elevation:	
Latitude/Longitude:		Datum:	WGS84
Site Map:			
Narrative description of data logger and site marker location:			
Logger Information			
Manufacturer:	LASCAR	Model:	EL-USB-1
Data Logger Number:			
Pre-deployment accuracy check performed?		Post-retrieval accuracy check performed?	
Y / N (circle one)		Y / N (circle one)	
Raw Data File Name(s)		Raw Data File Location(s)	
Start Type:	launched in field / triggered / delayed (circle one)		
Collection Interval (minutes):			
Measurement Type:	single / multiple (circle one)		
Deployment Date:		Deployment Time:	
Field audits performed?	Y / N (circle one)		

Appendix D – Glossary, Acronyms, and Abbreviations

Quality Assurance Glossary

Accuracy - the degree to which a measured value agrees with the true value of the measured property. USEPA recommends that this term not be used, and that the terms precision and bias be used to convey the information associated with the term accuracy. (USGS, 1998)

Analyte - An element, ion, compound, or chemical moiety (pH, alkalinity) which is to be determined. The definition can be expanded to include organisms, e. g. fecal coliform, Klebsiella, etc. (Kammin, 2010)

Bias - The difference between the population mean and the true value. Bias usually describes a systematic difference reproducible over time, and is characteristic of both the measurement system, and the analyte(s) being measured. Bias is a commonly used data quality indicator (DQI). (Kammin, 2010; Ecology, 2004)

Calibration - The process of establishing the relationship between the response of a measurement system and the concentration of the parameter being measured. (Ecology, 2004)

Comparability - The degree to which different methods, data sets and/or decisions agree or can be represented as similar; a data quality indicator. (USEPA, 1997)

Completeness - The amount of valid data obtained from a data collection project compared to the planned amount. Completeness is usually expressed as a percentage. A data quality indicator. (USEPA, 1997)

Data Quality Indicators (DQI) - Data Quality Indicators (DQIs) are commonly used measures of acceptability for environmental data. The principal DQIs are precision, bias, representativeness, comparability, completeness, sensitivity, and integrity. (USEPA, 2006)

Dataset - A grouping of samples, usually organized by date, time and/or analyte. (Kammin, 2010)

Measurement Quality Objectives (MQOs) - Performance or acceptance criteria for individual data quality indicators, usually including precision, bias, sensitivity, completeness, comparability, and representativeness. (USEPA, 2006)

Measurement result - A value obtained by performing the procedure described in a method. (Ecology, 2004)

Method - A formalized group of procedures and techniques for performing an activity (e.g., sampling, chemical analysis, data analysis), systematically presented in the order in which they are to be executed. (EPA, 1997)

Parameter - A specified characteristic of a population or sample. Also, an analyte or grouping of analytes. Benzene, nitrate+nitrite, and anions are all "parameters". (Kammin, 2010; Ecology, 2004)

Population - The hypothetical set of all possible observations of the type being investigated. (Ecology, 2004)

Precision - The extent of random variability among replicate measurements of the same property; a data quality indicator. (USGS, 1998)

Quality Assurance (QA) - A set of activities designed to establish and document the reliability and usability of measurement data. (Kammin, 2010)

Quality Assurance Project Plan (QAPP) - A document that describes the objectives of a project, and the processes and activities necessary to develop data that will support those objectives. (Kammin, 2010; Ecology, 2004)

Quality Control (QC) - The routine application of measurement and statistical procedures to assess the accuracy of measurement data. (Ecology, 2004)

Representativeness - The degree to which a sample reflects the population from which it is taken; a data quality indicator. (USGS, 1998)

Sample (field) – A portion of a population (environmental entity) that is measured and assumed to represent the entire population. (USGS, 1998)

Sample (statistical) – A finite part or subset of a statistical population. (USEPA, 1997)

Sensitivity - In general, denotes the rate at which the analytical response (e.g., absorbance, volume, meter reading) varies with the concentration of the parameter being determined. In a specialized sense, it has the same meaning as the detection limit. (Ecology, 2004)

Standard Operating Procedure (SOP) – A document which describes in detail a reproducible and repeatable organized activity. (Kammin, 2010)

Systematic planning - A step-wise process which develops a clear description of the goals and objectives of a project, and produces decisions on the type, quantity, and quality of data that will be needed to meet those goals and objectives. The DQO process is a specialized type of systematic planning. (USEPA, 2006)

References

Ecology, 2004. Guidance for the Preparation of Quality Assurance Project Plans for Environmental Studies. http://www.ecy.wa.gov/biblio/0403030.html

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Kammin, 2010. Definition developed or extensively edited by William Kammin, 2010.

USGS, 1998. Principles and Practices for Quality Assurance and Quality Control. Open-File Report 98-636. http://ma.water.usgs.gov/fhwa/products/ofr98-636.pdf

Glossary – General Terms

Ambient: Background or away from point sources of contamination.

Outbreak: Two or more unrelated illnesses epidemiologically-linked to a single harvest area (WAC 246-282-006).

Parameter: A physical chemical or biological property whose values determine environmental characteristics or behavior.

Pathogen: Disease-causing microorganisms such as bacteria, protozoa, viruses.

Pathogenic: Capable of producing disease.

Sporadic illness: Single illness unrelated to any other illness in time and place (WAC 246-282-006).

***Vibrio parahaemolyticus*:** A bacterium that lives in brackish saltwater and causes gastrointestinal illness in humans. *V. parahaemolyticus* naturally inhabits coastal waters in the United States and Canada and is present in higher concentrations during summer; it is a halophilic, or salt-requiring organism (CDC, 2009).

***V. parahaemolyticus*-associated gastroenteritis:** Illness associated with *V. parahaemolyticus*. May include diarrhea, abdominal cramps, nausea, vomiting, headache, fever, and chills. The illness is usually mild or moderate, although some cases may require hospitalization. The median duration of the illness is 2.5 days. The incubation period is 4-96 hours after the ingestion of the organism, with a mean of 15 hours (FDA, 2013).

References

CDC. 2009. National Center for Emerging and Zoonotic Infectious Diseases: *Vibrio parahaemolyticus*. http://www.cdc.gov/nczved/divisions/dfbmd/diseases/vibriop/technical.html

FDA. 2013. Bad Bug Book: Foodborne Pathogenic Microorganisms and Natural Toxins Handbook: *Vibrio parahaemolyticus*. http://www.fda.gov/Food/FoodborneIllnessContaminants/CausesOfIllnessBadBugBook/ucm070452.htm

Washington Administrative Code 246-282-006.

Acronyms and Abbreviations

Following are acronyms and abbreviations used frequently in this report.

CDC	Centers for Disease Control and Prevention
DOH	Washington State Department of Health
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management database
EPA	U.S. Environmental Protection Agency
et al.	And others
FDA	United States Food and Drug Administration
MQO	Measurement quality objective
NOAA	National Oceanographic and Atmospheric Administration
QA	Quality assurance
SOP	Standard operating procedures
USGS	U.S. Geological Survey
Vibrio	*Vibrio parahaemolyticus*
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife

Units of Measurement

°C	degrees centigrade