Lummi Intertidal Baseline Inventory

Appendix F: Petroleum Toxicity Baseline

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Executive Summary

Hydrocarbon and polycyclic aromatic hydrocarbon (PAH) concentrations in Manila clam tissues and intertidal sediments were assessed to determine baseline conditions of compounds associated with petroleum. This effort serves to characterize pre-spill conditions on the Lummi Indian Reservation tidelands and to clarify if these conditions have been influenced by non-point pollution sources. We sampled Manila clam tissues and sediment in Lummi Bay and in Portage Bay. Samples were composited within each of the three tidal elevations sampled at each location.

The PAH concentrations within the sediment samples were mainly below detection limits except for two PAH compounds at the topmost tidal elevation that was sampled in Lummi Bay. Hydrocarbon concentrations were also below detection limits within the sediments at both locations. Manila clam tissues did not have detectable PAH concentrations. In all, hydrocarbons and PAH concentrations were low and often below detection.

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1.0 Introduction

In the event of an oil spill, toxic organic chemical compounds are likely to contaminate tideland sediments and the tissues of organisms living on the tidelands. This contamination has potentially severe implications for survival and reproductive fitness of those organisms, and also for the health of other organisms and people who may ingest the affected organisms.

The two key metrics that are used to ascertain whether affected beaches can be reopened for shellfish harvest after an oil spill are: (1) a taste-test panel, which determines whether the shellfish is 'tainted', and (2) the evaluation of the concentrations of toxic organic compounds from petroleum and petroleum by-products in the tissues of harvestable species. Before shellfish beds can be re-opened, the concentrations of these compounds in shellfish tissues must return to levels that match pre-spill conditions (Yender *et al*. 2002). In the absence of pre-spill tissue data, reopening threshold values will be estimated from regional data for pristine beaches that are available in the published literature (Bob Woolrich, WA Dept. of Health, pers. comm.) However, many forms of petroleum compounds can originate from sources other than oil spills, such as urban run off, local oil dumping, and certain algal blooms. The Lummi Natural Resources Department (LNR) is also concerned that baseline concentrations of petroleum compounds and petroleum derivatives may be elevated from pristine conditions because of the close proximity of the Lummi Indian Reservation (Reservation) to two petroleum oil refineries and an aluminum smelter. This could mean that the reopening criteria used by public health agencies might be set at lower levels than the actual pre-spill baseline conditions warrant and thereby possibly prevent the shellfish beds from ever meeting the criteria to reopen.

The existing baseline information on toxic compounds in intertidal areas is limited. In coordination with the LNR, the Washington State Department of Ecology (Ecology) collected samples in 1998 and 2002 to analyze toxic compounds in sediments and biota tissues on Reservation tidelands (Partridge *et al*. 2005; Partridge 2007). However, these tissue samples were mixtures of multiple species. Since it is possible that different organisms may exhibit differing retention characteristics of polluting substances, this methodology may be inappropriate for assessing the public health risk for a single group of organisms. The LNR was seeking specific information about petroleum concentrations in Manila clam tissues because Manila clams provide a critically important commercial harvest to the Lummi Nation, and are also an important source of subsistence harvest. For this reason, information on PAH concentrations in Manila clams were collected in July 2008 as part of the LIBI project. This report summarizes the methodology and results of that investigation.

2.0 Methods

Lummi Natural Resources Department staff adapted the sample collection methods from the Draft Ephemeral Data and Sampling Collection Plan (Ephemeral Plan) for the BP Cherry Point Refinery and ConocoPhillips Ferndale Refinery (Cramer 2005). The Ephemeral Plan directs that nine sediment samples and tissue samples be collected at three transects and three tidal elevations in addition to three water samples. Water samples were not collected in this application of the sampling protocols in order to save on laboratory costs. This decision was justified because intertidal water bodies are transient and thus generally cannot store and accumulate these compounds over time, unlike sediments and animal tissues that remain in the area for prolonged periods of time. Accordingly, sediment samples and Manila clam tissue samples were collected at nine stations each at two sites. For each site, samples taken from the same tidal elevation on three separate transects were combined, resulting in 3 composited samples for each site: each representing a different tidal elevation. This procedure was chosen because tidal elevation determines the duration of time the sediments and organisms at a location are immersed in water that potentially contains toxic compounds during the tidal cycle. Combining samples from the same tidal elevation serves to integrate any along-shore variation in the samples, and reduces laboratory expenses at the cost of obtaining an explicit measure of variance. However, baseline conditions of petroleum products and PAH compounds concentrations were expected to be low, and along-shore variation in the samples was expected to be negligible accordingly.

Two locations were sampled that represent areas of particular importance to commercial clam harvests: Lummi Bay and Portage Bay. Samples were collected on August 28 and 29, 2008 respectively. Shore-perpendicular transects were established 130 feet (ft) apart and the three tidal elevations sampled were determined based on the known distribution of Manila clams from previous stock assessment surveys (Figure F.1). Upper tidal stations were located at the upper extent of Manila clam distribution, middle tidal stations were near the middle of the known distribution, and lower tidal stations were at the lower extent of the distribution (Figure F.2).

Date, time, and weather conditions were recorded for each station. Station locations were documented with a Global Positioning System (GPS) hand-held receiver with a horizontal accuracy of ± 10 ft. At each station, epibenthic species presence, vegetation coverage, and sediment descriptions were recorded.

Five sediment subsamples and 12 legal-size Manila clams were collected within a 1 meter-square quadrat at each station. Sediment subsamples were placed in a large stainless steel bowl and thoroughly mixed. Manila clams of at least 38 mm shell length were also collected within the quadrat. If fewer than 12 legal-size Manila clams were located within the sample quadrat, sampling continued outside the quadrat perimeter until 12 clams were collected. Manila clams were placed in the sample container provided by a contract laboratory. Once all samples were taken at the same tidal elevation, the collected sediments were mixed for 10 minutes to ensure a representative sample of all subsamples for analysis. The sample containers provided by a contract laboratory were filled with well-mixed sediment until they were 75% full. Once filled, sediment sample substrate composition was qualitatively assessed using the Wolman sediment classification system (Wolman 1954). All Manila clams collected were placed in the 32-ounce sample containers provided by a contract laboratory. After sample collection, samples were stored on ice in a cooler and then later transferred into a freezer.

Analytical Resources, Inc. (ARI), was contracted by LNR to analyze the collected samples. Analytical Resources, Inc. is a Washington State Department of Ecology and US Environmental Protection Agency (USEPA) accredited laboratory for total hydrocarbons, diesel range hydrocarbons, polynuclear aromatic hydrocarbons, lipids, and sediment grain size.

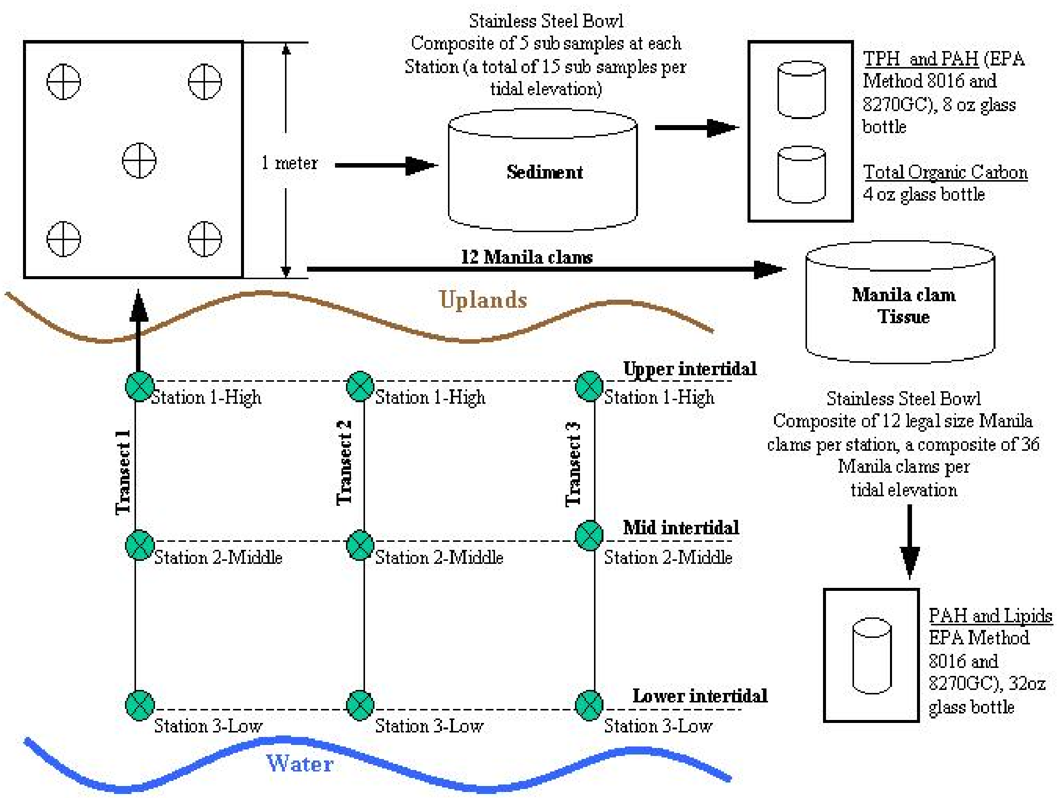

Figure F.1. Schematic Site Layout for Sediment and Manila Clam Sample Collection

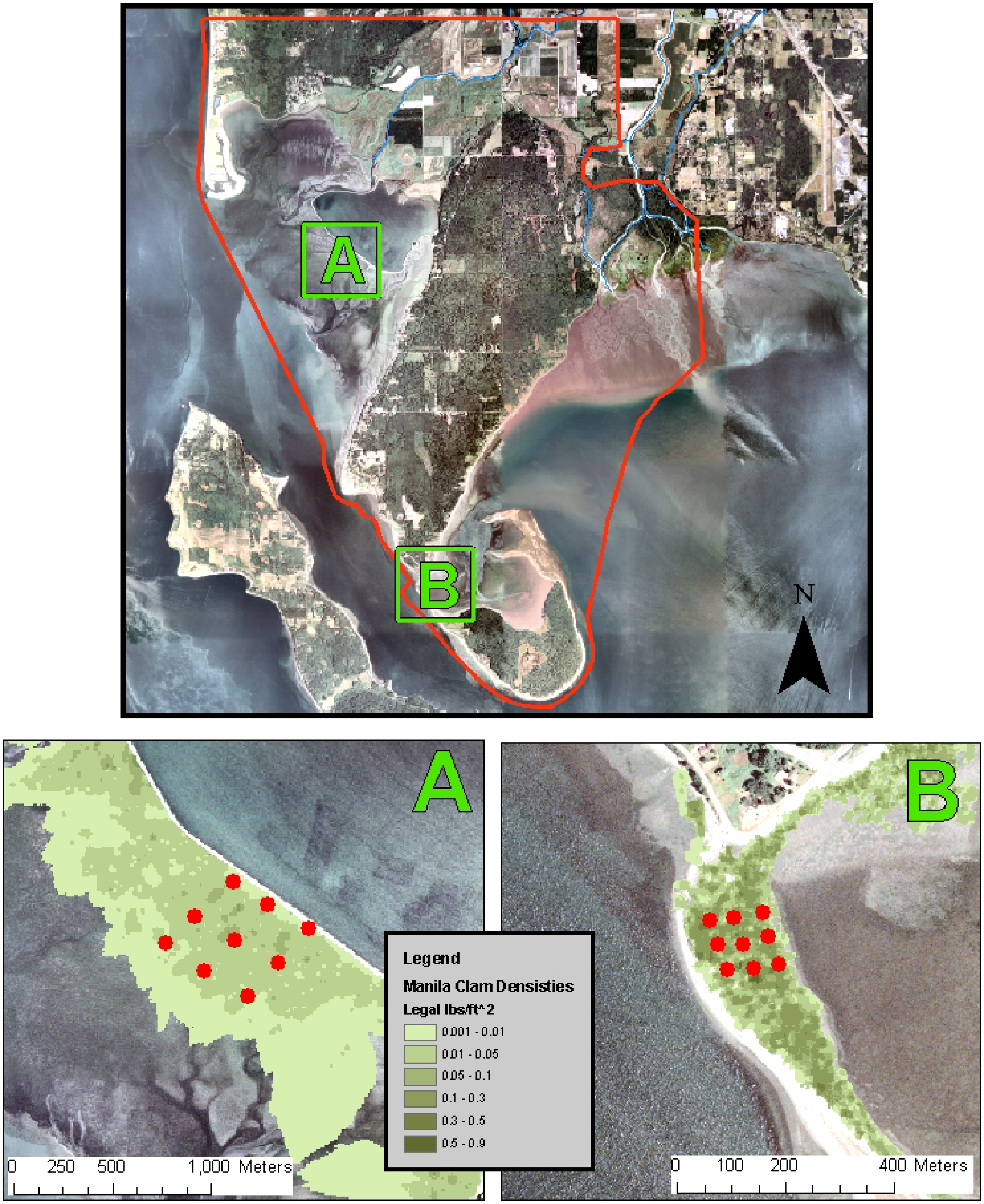

Figure F.2. Petroleum and PAH Compound Sampling Locations and Sub-sampling Locations

LNR staff compared the results with the USEPA and LNR standards for human and environmental health.

3.0 Results

Sediment samples from both Lummi and Portage Bays contained very low concentrations of polycyclic aromatic hydrocarbons (PAH) (Table F.1). These concentrations were generally below the detection limits of the analysis methods used by the laboratory. The only PAH concentrations above the detection limits were Napthalene and Phenathrene. However, these compounds were present only at relatively low concentrations. Hydrocarbon concentrations within the sediments were also below detection limits in the two sampling locations (Table F.2).

Manila clam tissues were analyzed for PAH and found to be below the analysis method detection limits at both Lummi Bay and Portage Bay (Table F.3).

Table F.1. Polycyclic Aromatic Hydrocarbon Concentrations Found in Sediment at Two Locations on the Lummi Reservation Tidelands, Reported as Parts Per Billion

	Lummi Bay			Portage Bay		
	Lower	Middle	**Higher**	Lower	Middle	Higher
Naphthalene	< 4.7	< 4.8	**15**	< 4.6	< 4.5	< 4.6
2-Methylnaphthanlene	< 4.7	< 4.8	< 4.6	< 4.6	< 4.5	< 4.6
1-Methylnaphthanlene	< 4.7	< 4.8	< 4.6	< 4.6	< 4.5	< 4.6
Acenapthylene	< 4.7	< 4.8	< 4.6	< 4.6	< 4.5	< 4.6
Acenaphthene	< 4.7	< 4.8	< 4.6	< 4.6	< 4.5	< 4.6
Fluorene	< 4.7	< 4.8	< 4.6	< 4.6	< 4.5	< 4.6
Phenanthrene	< 4.7	< 4.8	**6.0**	< 4.6	< 4.5	< 4.6
Anthracene	< 4.7	< 4.8	< 4.6	< 4.6	< 4.5	< 4.6
Fluoranthene	< 4.7	< 4.8	< 4.6	< 4.6	< 4.5	< 4.6
Pyrene	< 4.7	< 4.8	< 4.6	< 4.6	< 4.5	< 4.6
Benzo (a) anthracene	< 4.7	< 4.8	< 4.6	< 4.6	< 4.5	< 4.6
Chrysene	< 4.7	< 4.8	< 4.6	< 4.6	< 4.5	< 4.6
Benzo (b) fluoranthene	< 4.7	< 4.8	< 4.6	< 4.6	< 4.5	< 4.6
Benzo (k) fluoranthene	< 4.7	< 4.8	< 4.6	< 4.6	< 4.5	< 4.6
Benzo (a) pyrene	< 4.7	< 4.8	< 4.6	< 4.6	< 4.5	< 4.6
Indeno (1,2,3-cd) pyrene	< 4.7	< 4.8	< 4.6	< 4.6	< 4.5	< 4.6
Dibenz(a,h) anthracene	< 4.7	< 4.8	< 4.6	< 4.6	< 4.5	< 4.6
Benzo (g,h,I) perylene	< 4.7	< 4.8	< 4.6	< 4.6	< 4.5	< 4.6
Dibenzofuran	< 4.7	< 4.8	< 4.6	< 4.6	< 4.5	< 4.6

Table F.2. Hydrocarbon Concentrations Found In Sediment at Two Locations on The Lummi Reservation Tidelands, Reported as Parts Per Million

	Lummi Bay			Portage Bay		
	Lower	Middle	Higher	Lower	Middle	Higher
Diesel	< 6.3	< 6.4	< 6.4	< 6.0	< 5.6	< 7.0
Motor oil	< 13	< 13	< 13	< 12	< 11	< 14
o-Terphenyl	74.2%	79.8%	78.2%	78.0%	76.0%	77.8%

Table F.3. Polycyclic Aromatic Hydrocarbon Concentrations Found in Manila Clam Tissue at Two Locations on the Lummi Reservation Tidelands, Reported as Parts Per Billion

	Lummi Bay			Portage Bay		
	Lower	Middle	Higher	Lower	Middle	Higher
Naphthalene	< 5.0	< 4.9	< 5.0	< 4.9	< 5.0	< 5.0
2-Methylnaphthanlene	< 5.0	< 4.9	< 5.0	< 4.9	< 5.0	< 5.0
1-Methylnaphthanlene	< 5.0	< 4.9	< 5.0	< 4.9	< 5.0	< 5.0
Acenapthylene	< 5.0	< 4.9	< 5.0	< 4.9	< 5.0	< 5.0
Acenaphthene	< 5.0	< 4.9	< 5.0	< 4.9	< 5.0	< 5.0
Fluorene	< 5.0	< 4.9	< 5.0	< 4.9	< 5.0	< 5.0
Phenanthrene	< 5.0	< 4.9	< 5.0	< 4.9	< 5.0	< 5.0
Anthracene	< 5.0	< 4.9	< 5.0	< 4.9	< 5.0	< 5.0
Fluoranthene	< 5.0	< 4.9	< 5.0	< 4.9	< 5.0	< 5.0
Pyrene	< 5.0	< 4.9	< 5.0	< 4.9	< 5.0	< 5.0
Benzo (a) anthracene	< 5.0	< 4.9	< 5.0	< 4.9	< 5.0	< 5.0
Chrysene	< 5.0	< 4.9	< 5.0	< 4.9	< 5.0	< 5.0
Benzo (b) fluoranthene	< 5.0	< 4.9	< 5.0	< 4.9	< 5.0	< 5.0
Benzo (k) fluoranthene	< 5.0	< 4.9	< 5.0	< 4.9	< 5.0	< 5.0
Benzo (a) pyrene	< 5.0	< 4.9	< 5.0	< 4.9	< 5.0	< 5.0
Indeno (1,2,3-cd) pyrene	< 5.0	< 4.9	< 5.0	< 4.9	< 5.0	< 5.0
Dibenz(a,h) anthracene	< 5.0	< 4.9	< 5.0	< 4.9	< 5.0	< 5.0
Benzo (g,h,I) perylene	< 5.0	< 4.9	< 5.0	< 4.9	< 5.0	< 5.0
Dibenzofuran	< 5.0	< 4.9	< 5.0	< 4.9	< 5.0	< 5.0

4.0 Discussion

Hydrocarbons and PAH levels in sediments and Manila clam tissues were consistently low at both of the sites surveyed. The Manila clam tissue results show that there is no current public health risk arising from PAH or hydrocarbon contamination of Manila clams on the Reservation tidelands. Conditions on the Reservation tidelands are generally similar to the results from Neptune Beach that were obtained in the multi-agency Puget Sound Ambient Monitoring Program (PSAMP). The results differed from the PSAMP results obtained at Bellingham Bay, which can be explained by the fact that the Bellingham Bay site was located near an industrial effluent source (Llanso *et al*. 1998; Partridge *et al*. 2005; Partridge 2007).

Sediments and bivalves are known to retain hydrocarbons and PAH for prolonged periods of time. Hardshell clams can take months to years to excrete PAH compounds making them ideal candidates to address chronic trends in petroleum exposure (Fukuyama *et al*. 2000). Since PAH were not observed in high concentrations, it can be assumed that the Reservation tidelands are currently pristine in nature and not affected by potential point and/or non-point sources.

With increased human population growth in the surrounding area, hydrocarbon and PAH levels should be periodically reassessed to ensure that there have been no increases in the baseline conditions in the future.

5.0 References

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