Briefing for PWSRCAC Board of Directors – January 2022

ACTION ITEM

Sponsor: Austin Love and the Scientific Advisory Committee

Project number and name or topic: 9510 – Long-Term Environmental Monitoring Program

1. **Description of agenda item:** This agenda item seeks Board acceptance of the report titled "Mussel Oiling and Genetic Response to the April 2020 Valdez Marine Terminal Spill: Executive Summary" by Lizabeth Bowen, William B. Driskell, James R. Payne, Austin Love, Eric Litman, and Brenda Ballachey. This brief report summarizes the work the Council conducted to monitor the environmental impacts of the April 12, 2020 oil spill from the Valdez Marine Terminal. Dr. Lizabeth Bowen, the lead author on the report, will provide a presentation of the key results of that monitoring and recommendations for further related work.

2. **Why is this item important to PWSRCAC:** The Long-Term Environmental Monitoring Program helps PWSRCAC fulfill one of its responsibilities detailed in the Oil Pollution Act of 1990 (OPA90). The Act instructs the PWSRCAC to "devise and manage a comprehensive program of monitoring the environmental impacts of the operations of terminal facilities and of crude oil tankers while operating in Prince William Sound." The work done under the Council's Long-Term Environmental Monitoring Program has been designed by the Scientific Advisory Committee to fulfill that responsibility mandated by OPA90t.

3. **Previous actions taken by the Board on this item:**

Meeting	Date	Action
Board	5/21/2020	Approval of FY2021 Contracts for Project 9510 LTEMP - The Board approved the following: Authorizing a contract negotiation with Payne Environmental Consultants Inc., for work to be performed under LTEMP, at an amount not to exceed $115,064. Authorizing a contract negotiation with Newfields Environmental Forensics Practice, for work to be performed under LTEMP, at an amount not to exceed $95,807. Authorizing a contract negotiation with the United States Geological Survey, for work to be performed under LTEMP, at an amount not to exceed $65,371. Authorizing a contract negotiation with Oregon State University, for work to be performed under LTEMP, at an amount not to exceed $22,030. Authorizing a contract to commence prior to the start of FY2021, as approximately $33,000 of these funds will need to be expended in May and June 2020.
Board	5/6/2021	The Board accepted the report titled "Long-Term Environmental Monitoring Program: 2020 Sampling Results and Interpretations," by Dr. James R. Payne and William B. Driskell, dated March 2021, as meeting the terms and conditions of contract number 951.21.04, and for distribution to the public. The Board accepted the report titled "Using Mussel Transcriptomics for Environmental Monitoring in Port Valdez, Alaska: 2019 and 2020 Pilot Study Results", dated

		February 17, 2021, as meeting the terms and conditions of contract number 951.21.06 and for distribution to the public.
Board	5/21/2021	Approval of FY2022 LTEMP Contracts for Project 9510: The Board Authorized individual contracts with Newfields Environmental Forensics Practice, Oregon State University, and the United States Geological Survey (USGS) with the aggregate total not to exceed the amount approved in the final FY2022 LTEMP budget ($147,720) for contract expenses, and delegated authority to the Executive Director to enter into individual contracts with the aforementioned consultants; and authorized that the contract work commence prior to the start of FY2022 as approximately $30,000 of these funds will need to be expended in May and June 2021.

4. **Summary of policy, issues, support or opposition:** This executive summary report is not the only report that has resulted from the Council's work to monitor the environmental impacts of the April 12, 2020 oil spill. A draft peer-reviewed journal length report has also been prepared by the same authors. Originally the plan was for only one Council-specific report to be generated in regards to monitoring the impacts of the April 2020 spill. However, as the report's authors analyzed and interpreted the information gained, they saw value in pursuing a submission to a peer-reviewed journal. During the July 13, 2021 Scientific Advisory Committee meeting, the decision was made to write two separate reports, a peer-reviewed journal-length report and the executive summary, tailored for the public audience. Since that July meeting, both reports were completed and submitted to the Council.

However, to date the draft peer-reviewed journal article was kept from any public availability as the authors submitted it to two journals for possible publication – Environmental Science & Technology and the journal Marine Pollution Bulletin. Unfortunately, neither journal accepted the report for publication. Environmental Science & Technology found that draft article did not "offer sufficient novelty" while Marine Pollution Bulletin found "the paper is a limited snapshot with more work needed to more completely understand the transcriptomic response to oil exposure." However, it is planned that the draft peer-reviewed report will instead become a Council report, made available to the public; that decision will first be considered by the Scientific Advisory Committee before ultimately being considered by the Board of Directors for acceptance, likely during a future Executive Committee meeting. Additionally, after performing additional transcriptomic research, the authors plan to address the concerns voiced by these two journals and submit another peer-reviewed article for hopeful publication.

Lastly, it must be highlighted that the authors of both reports, especially Lizabeth Bowen, William B. Driskell, James R. Payne, Eric Litman, and Brenda Ballachey, went far beyond what was asked of them in any Council contract or agreement to produce these two reports, donating considerable time and effort to this work.

5. **Committee Recommendation:** During their October 1, 2021 meeting, the Scientific Advisory Committee passed a motion to move the April 2020 Oil Spill Report Executive Summary to the Board" for their acceptance.

6. **Relationship to LRP and Budget:** The Council's 9510 Long-Term Environmental Monitoring Program (LTEMP) is in the approved FY2022 budget and annual work plan.

9510—Long-Term Environmental Monitoring (LTEMP)

As of December 10, 2021

FY-2022 Budget	
Original	$154,980.00
Modifications	
Revised Budget	$154,980.00
Actual and Commitments	
Actual Year-to-Date	$37,906.65
Commitments (Professional Services)	$11,553.00
Actual + Commitments	$49,459.65
Amount Remaining	$105,520.35

7. **Action Requested of the Board of Directors:** Accept the report titled "Mussel Oiling and Genetic Response to the April 2020 Valdez Marine Terminal Spill: Executive Summary" by Lizabeth Bowen, William B. Driskell, James R. Payne, Austin Love, Eric Litman, and Brenda Ballachey, dated August 20, 2021, as meeting the terms and conditions of contract number 951.21.05 and research contribution number 951.21.07, and for distribution to the public.

8. **Alternatives:** Do not accept the report or accept the report with recommended revisions.

9. **Attachments:** Draft report titled "Mussel Oiling and Genetic Response to the April 2020 Valdez Marine Terminal Spill: Executive Summary" by Lizabeth Bowen, William B. Driskell, James R. Payne, Austin Love, Eric Litman, and Brenda Ballachey.

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Mussel Oiling and Genetic Response to the April 2020 Valdez Marine Terminal Spill: Executive Summary

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August 20, 2021

The full final report for this project has been prepared for publication in a peer-reviewed journal.

Prince William Sound Regional Citizens' Advisory Council Contract numbers: 951.21.05 & 951.21.07

EXECUTIVE SUMMARY

On April 12, 2020, a minor oil spill occurred at the Valdez Marine Terminal (Figure 1) whereby an estimated 1,400 gallons (~34 barrels) of Alaska North Slope (ANS) crude oil overflowed from a sump well and subsequently reached the shoreline, creating slicks and necessitating a full-scale marine response in Port Valdez, Alaska (Figure 2). Recognizing a spill-of-opportunity, the Prince William Sound Regional Citizens' Advisory Council's (PWSRCAC) Scientific Advisory Committee initiated a special project to measure oiling and genetic response of exposed mussels. Mussel samples were taken in a time series over a 7-week period, starting at 19 days post-spill. Most samples were collected at the spill site just outside the terminal's small boat harbor. Other mussels were collected for the Council's annual Long-Term Environmental Monitoring Program (LTEMP) at nearby terminal sites (Saw Island and Jackson Point) out to about 50 days post-spill. At about 50 days post-spill, mussels were also collected from remote unoiled sites in Jack Bay and Galena Bay (Figure 1). Those 2020 LTEMP mussels plus prior LTEMP mussels collected in 2019 serve both as oil spill recovery endpoints and for comparisons to historic background data.

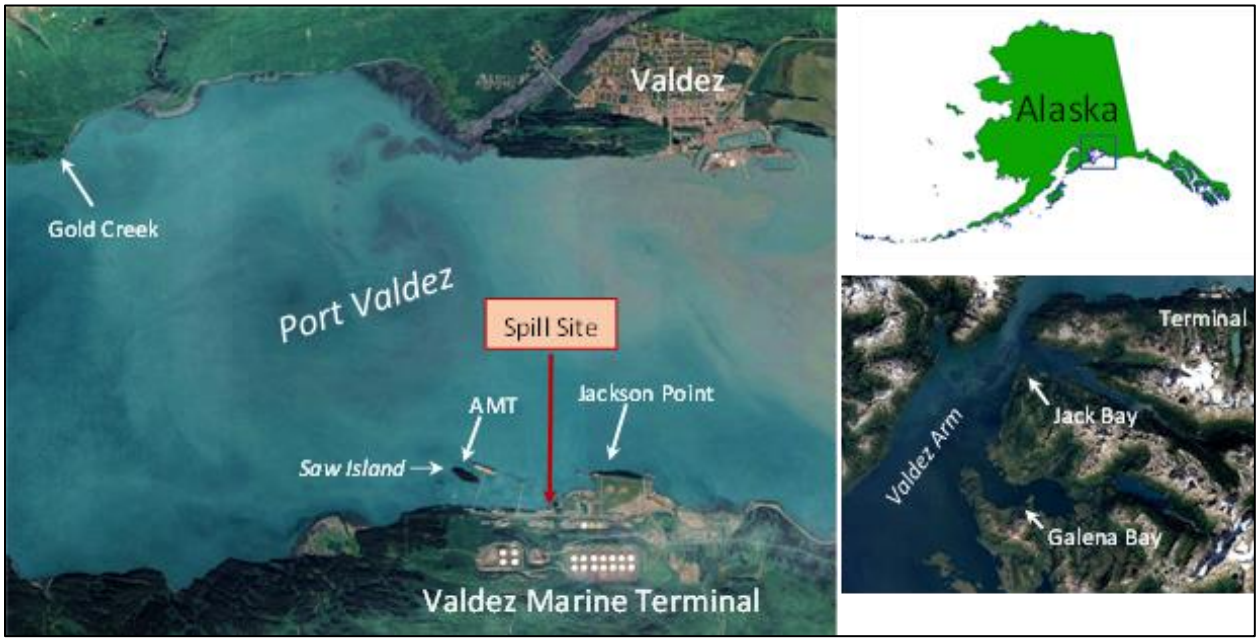

Figure 1. Overview of Port Valdez showing the April 12, 2020 intertidal spill location at the Valdez Marine Terminal. Mussels were sampled at the spill site, Jackson Point, Saw Island (AMT), and the control station at Gold Creek 6 km to the northwest. Regional background samples were also collected at Jack Bay and Galena Bay (lower right inset) on June 20, 2020.

Figure 2. Containment booms placed around the spill site and in adjacent waters. Saw Island in upper left background adjacent Berth 5 tanker. Image from Alyeska Pipeline Service Company.

Chemical analyses of mussels over time (Figure 3) showed the expected decrease of total hydrocarbons in tissue. Elapsed days in Figures 3 and 5 refers to days from this study's start, but it is important to note, sampling day 1 was 19 days post-spill. By the 40-day mid-point sampling, 2020 LTEMP mussels were approaching 2019 background levels but still held a trace of the spilt oil, while the spill site mussels were 1,000 times more contaminated. The extended deployment of containment booms at the spill site through October 2020 and increasingly weathered chemistry profiles suggest that continued low exposures from sheening continued through at least July, the time of the last mussel collections in this study. By late July when the last samples were collected, the spill site mussels were still 100 times above the 2019 background concentrations.

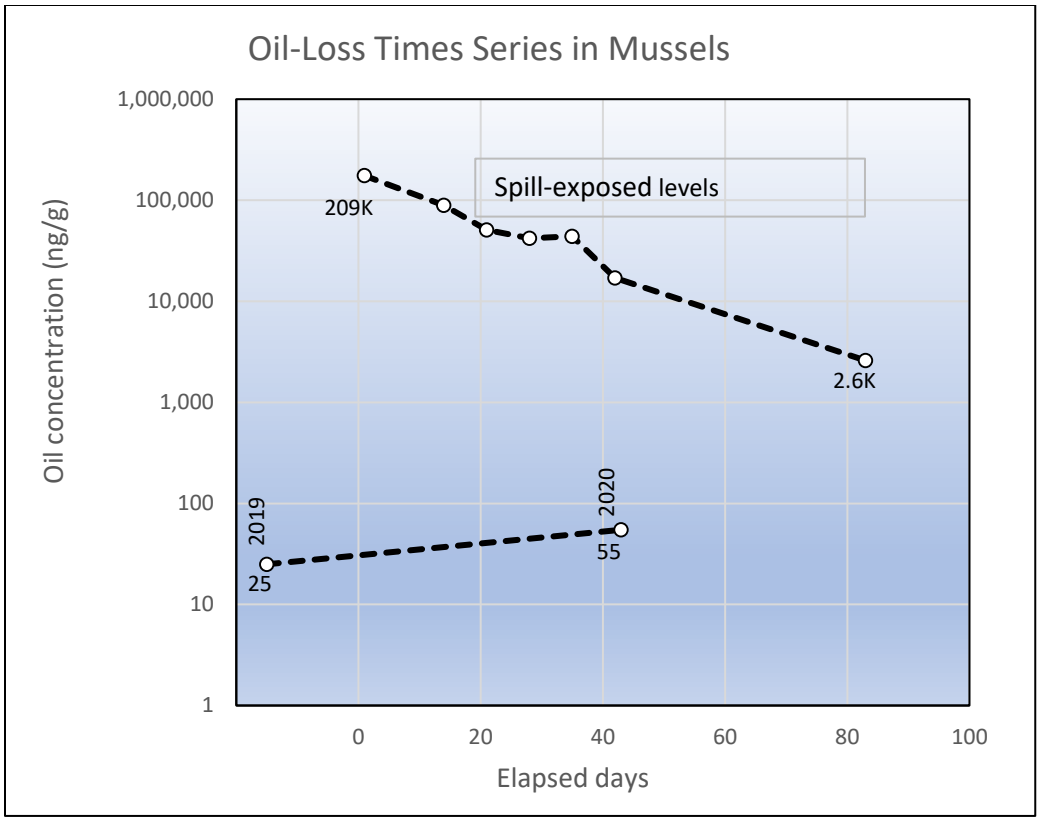

Figure 3. Mussel oiling or chemistry shows consistent 100-fold decrease during the sampling period at the spill site but did not reach background levels of 2019 or 2020 LTEMP samples.

When a mussel is exposed to a toxic foreign substance (oil), the animal must somehow deal with it. To survive, the mussel will modify various physiological processes to reduce stresses and mitigate or eliminate the toxin. Exposure to oil is physiologically stressful, with effects including hypoxia (low oxygen), inflammation and immunity issues, and balancing energy needs while detoxifying and eliminating the foreign compounds. Each physiological need requires regulating specific gene activity by boosting or dampening the conversion of a gene's DNA message into protein (transcription). In this project, we measured the transcription of 14 genes, including five directly linked with detoxification processes (Figure 4), and found alterations associated with oil exposure.

Relevant gene activity showed a general trend, with increased transcription lagging behind tissue hydrocarbon concentrations (Figure 5). Transcription levels peaked after the hydrocarbon levels were partially depleted. These results were consistent with other studies where gene transcription was initially inhibited following contaminant exposure. This suggests that the mussels were unable to initially maximize transcription for detoxifying the oil. In addition, by the study's end, with oil still evident in the tissues,

gene transcription had not yet completely returned to background levels seen in LTEMP mussels sampled in 2019.

Gene	Biological Process	Environmental Interaction
Metallothionein 20 (MT20)	Detoxification	Contaminants - metals
Caspase 8 (CASP8)	Programmed Cell Death, Necrosis, Inflammation	Pathogens, Contaminants
Heat shock protein 90 (HSP90)	Thermal Stress	Temperature, Pathogens, Contaminants
Cytochrome P450, family 3 (Cyp3)	Detoxification	Contaminants
Tumor protein 53 (P53)	Programmed Cell Death	Contaminants

Figure 4. Five genes linked to detoxification processes (related to oil exposure), the primary biological processes they are associated with, and what types of environmental interactions are known to affect their transcription.

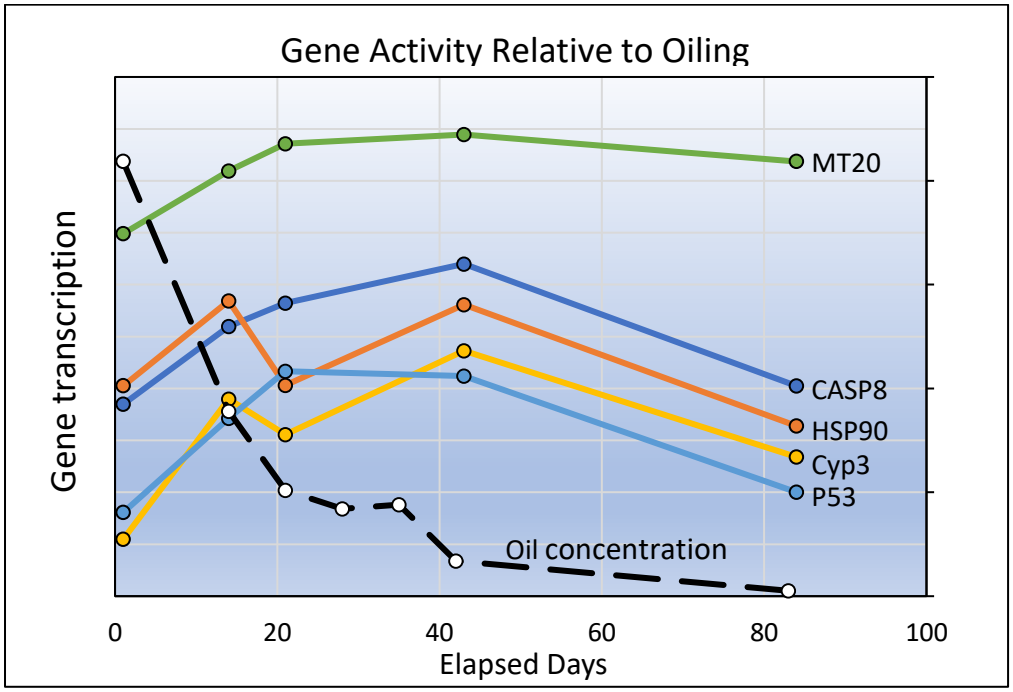

Figure 5. Transcription levels in 5 genes, directly linked to detoxification (solid-colored lines), in mussels from the spill site. Tissue chemistry (dashed line) diminished throughout the study. Note the lag in gene response, with transcription initially low, then peaking mid-study and subsequently dropping off, whereas oil in tissues consistently decreased.

This study has provided a unique opportunity to relate mussel hydrocarbon burdens with gene transcription profiles. In previous years, only the hydrocarbon levels would have been reported and, if elevated, assessed against theoretical toxic-effects levels. However, the addition of gene transcription allows detection of physiological effects in the mussels weeks after hydrocarbon levels have dropped. Our novel findings demonstrate the merits of combining chemistry and genetics to evaluate the extent and persistence of spill effects.

In consideration of the advances made and insights gained, we feel further analyses are warranted. In this project, gene transcription provided a significant advance in our understanding of spill effects. However, this approach needs further development. Specifically, our archived mussel samples can be re-analyzed to obtain the full suite of transcribed genes (transcriptome), quantifying approximately 10,000 genes in contrast to the panel of 14 genes used in this study. Our findings would help to design improved monitoring programs and to better assess spill impacts. We also note that these data are not just applicable to Alaska marine environments. Publishing these methods and interpretations has the potential to globally inform other researchers and regulators regarding contaminant impacts and study designs for discharge or spill assessment programs.

Recommendations for future monitoring and spill response

- The archived oiled and unoiled mussels should be analyzed for the full transcriptome (i.e., the complete suite of genes transcribed by the organism). Only 14 genes were considered in this study but there are many others that could be analyzed. Comparing exposed versus unexposed mussel response would identify the most appropriate genes for monitoring future oil spills.
- Chemical and genetic methods should be used in future assessments of acute and chronic oil pollution. Monitoring programs which include both body burdens of chemicals and gene transcription of mussels show tremendous benefit as an oil spill, damage assessment approach.
- Additional samples collected from the spill location in 2021 should be analyzed to determine if contamination and transcription levels have returned to normal background levels for Port Valdez.
- A pilot study of seasonal transcription assays would be useful to understand normal baseline expression for monitoring programs, prior to spill events.