

ECCC Closing Remarks – RBT2 –DRAFT AUGUST 2 2019

Introduction

ECCC submits the following closing remarks to the Review Panel for the Roberts Bank Terminal 2 Project (the Project). ECCC's closing remarks provide a brief summary of ECCC's views with respect to the potential environmental effects and mitigation measures proposed by the Vancouver Fraser Port Authority (the Proponent) for the Project.

ECCC's closing remarks are focused on the topics that ECCC presented to the Review Panel at the public hearing, and include conclusions on the assessment of air quality, biofilm and shorebirds, and wetlands. Closing comments are also offered on species at risk.

The written submission for the public hearing provides a full description of ECCC's views and final recommendations with respect to the potential environmental effects of the Project in relation to its mandate (CEAR X).

1. Air Quality

ECCC conducted a science-based review of the Proponent's air quality predictions and associated assumptions for the Project. ECCC's technical review was focused on ensuring that the air quality predictions were developed based on appropriate emissions estimates, meteorology and baseline air quality.

1.1 Canadian Ambient Air Quality Standards

Federal, provincial and territorial governments are working collaboratively to improve air quality through the implementation of the Air Quality Management System (AQMS). The Canadian Ambient Air Quality Standards¹ (CAAQS) are a key element of the AQMS and are intended to be the drivers for air quality improvements across the country in order to further protect human health and the environment. Although the CAAQS are not legally binding, governments have agreed to work collaboratively to implement actions to improve air quality and to report on the improvement of the CAAQS on a regular basis. The CAAQS are based on air quality management levels that call for progressively more rigorous actions by jurisdictions as air quality approaches or exceeds the CAAQS.

As outlined in ECCC's written submission (CEAR X) and in the Proponent's response to IR14-04 (CEAR X), concentrations of 1-hour NO₂ is predicted to exceed the CAAQS over the majority of the study domain for both the expected and future conditions, and the annual NO₂ is predicted to be above the CAAQS in proximity to the Project (see Figure IR14-04-A4). These predictions indicate that management actions will be required for NO₂ in the Lower Fraser Valley air zone. Therefore, ECCC continues to recommend the Proponent participate in local and regional air quality management initiatives where applicable and take an adaptive approach to air quality management to prevent Project emissions from contributing to deteriorating air quality in the local and regional area.

1.2 Air Quality Modelling

ECCC's comments on the Proponent's air quality model, specifically the model domain size and inclusion of regional emission sources, are outlined in ECCC's public comment period #1 submission (CEAR X) and in the written submission (CEAR X). ECCC also provided comments on the air quality model in the first sufficiency review of the EIS and Marine Shipping Addendum in October 2016 (CEAR 581).

¹ The CAAQS are provided in Appendix 1 of ECCC's written submission (CEAR X).

ECCC remains of the view that a more rigorous modelling assessment is required for the Project, particularly given that predictions of NO₂ are above the CAAQS. ECCC advised that the methodology used by the Proponent in their air quality modelling study (adding one background value to represent regional sources) is a simplified method, and the inclusion of regional sources in the model domain would allow for an understanding of the potential interactions of those sources with those of the Project. ECCC maintains that conducting a sensitivity analysis using one point source in the center of the modelled domain does not capture all of the possible interactions the Project may have with existing and future regional emission sources.

ECCC concludes that the limited model domain size and representing all regional sources with one background value, as the Proponent has presented in the EIS and in responses to Information Requests, does not provide enough information to determine the full effect of the Project on regional air quality.

1.3 Marine shipping

1.4 Locomotive Emission Rates

ECCC's comments on locomotive emission rates are described in several submissions to the Panel (CEAR 1346, X).

The Proponent modelled locomotive emissions on the assumption that 100% of the switcher locomotives would meet Tier I emission standards by 2025. However, ECCC advised the Panel that there were no Tier I or higher yard switchers in Canada in 2015 according to the Railway Association of Canada.

ECCC advised that correctly accounting for NO₂ and other emissions is important for the determination of effects and identifying appropriate mitigation measures, particularly as it is unlikely that 100% of the switcher locomotives will meet Tier I in 2025.

During the Public Hearing session on air quality, the Proponent made reference that there is no difference in emissions between Tier 0 and Tier I locomotives. ECCC wishes to clarify for the Panel that the NO₂ emission factors for Tier 0+ are approximately 7% higher than for Tier 1 locomotives, whereas the difference between Tier 0 and Tier I is approximately 27%.

ECCC concludes that the locomotive emissions be reassessed using a more conservative assumption of Tier levels to reflect the current and expected near term (2025) fleet of yard switcher locomotives in Canada.

2. **Biofilm and Shorebirds**

Conservation values of Roberts Bank

Within the Fraser River Estuary and delta, Roberts Bank is the largest mudflat where the estuarine hydrological regime remains largely unmodified by water diversion structures, and, not coincidentally, the most important site on the delta for shorebirds during northward migration. Each spring, the global population of Western Sandpipers migrate from overwintering areas in Central and South America to their Arctic breeding grounds, refueling along the route at a chain of widely-separated estuarine stopover sites. Roberts Bank forms a critical link in the chain, providing food and nutrients for up to 42%–64% of the entire species of Western Sandpipers in a single season. The site also serves as important overwintering habitat for hundreds of thousands of waterfowl and other shorebirds.

Roberts Bank is internationally designated as a site of Hemispheric Importance under the Western Hemisphere Shorebird Reserve Network, a Ramsar Wetland of International Significance, and an Important Bird Area (IBA) through BirdLife International. Much of Roberts Bank lies within a provincial Wildlife Management Area created to provide critical habitat for shorebirds and other species.

3. A reconstituted mudflat of a similar scale, sediment characteristics and biofilm fatty acid productivity as the current upper intertidal area of Roberts Bank would have to be operational and tested prior to Project construction.

In summary, the ability to replicate a mudflat's ability to produce fatty acids on any scale has not been developed. Therefore, replacing mudflat habitat of the size and complexity of Roberts Bank would require development of novel restoration methods that would have uncertain success (with no interim options for meeting the needs of migrating Western Sandpipers).

Conclusions and Recommendation

Roberts Bank is a dynamic estuarine ecosystem supporting internationally significant populations of migratory shorebirds. Foraging on biofilm at Roberts Bank provides shorebirds with a rich supply of essential fatty acids. Predicted changes due to the Project include a substantial change in the salinity regime at Roberts Bank, particularly in those areas of highest importance to shorebirds. Average salinity is expected to decrease by 1 standard deviation in magnitude, accompanied by a reduction in the overall range of salinity by up to 10 PSU, nearly a third of the total variation. Substantial evidence exists linking this variability to the production of fatty acids by diatoms, both within existing literature and the Proponent's own studies (Salinity trigger). The best available evidence indicates that fatty acids are essential nutrients for long-distance flights of shorebirds during the critical northward migration period.

ECCC concludes that predicted Project-induced changes to Roberts Bank constitute an unmitigable species-level risk to Western Sandpipers, and shorebirds more generally. Accordingly, ECCC recommends that a Project redesign is needed to avoid changes to the geomorphological processes that would affect biofilm and shorebirds.

References

- Guglielmo, C.G. (2010). Move That Fatty Acid: Fuel Selection and Transport in Migratory Birds and Bats. *Integrative and Comparative Biology*, 50(3): 336–345.
- Hsu, W. C., Kuss, A., Ketron, T., Nguyen, A., Remar, A., Newcomer, M., & Angela Detweiler, M. S. (2011). Hyperspectral biofilm classification analysis for carrying capacity of migratory birds in the South Bay salt ponds. <http://www.asprs.org/pecora18/proceedings/Hsu.pdf>
- Kelly, J. P., & Condeso, T. E. (2017). Tidal marsh restoration stimulates the growth of winter shorebird populations in a temperate estuary. *Restoration Ecology*, 25(4), 640-649.
- Kuwaie, T., Beninger, P. G., Decottignies, P., Mathot, K. J., Lund, D. R., & Elner, R. W. (2008). Biofilm grazing in a higher vertebrate: the western sandpiper, *Calidris mauri*. *Ecology*, 89(3), 599-606.
- Kuwaie, T., Miyoshi, E., Hosokawa, S., Ichimi, K., Hosoya, J., Amano, T., Moriya T., Kondoh M., Ydenberg, R.C., and & Elner, R. W. (2012). Variable and complex food web structures revealed by exploring missing trophic links between birds and biofilm. *Ecology Letters*, 15(4), 347-356.
- Maillet, D., & Weber, J. M. (2006). Performance-enhancing role of dietary fatty acids in a long-distance migrant shorebird: the semipalmated sandpiper. *Journal of Experimental Biology*, 209(14), 2686-2695.
- Maillet, D., & Weber, J. M. (2007). Relationship between n-3 PUFA content and energy metabolism in the flight muscles of a migrating shorebird: evidence for natural doping. *Journal of Experimental Biology*, 210(3), 413-420.

Biofilm values of Roberts Bank

Intertidal biofilms are dynamic communities comprised of microorganisms, particularly diatoms, detritus and inorganic material within a mucus matrix of extracellular polymeric substances. Biofilm is now known to be a major food resource for shorebirds worldwide (Kuwae et al. 2012; Mathot et al. 2018). During their northward migration on Roberts Bank, Western Sandpipers depend on the availability of biofilm. A Western Sandpiper grazes biofilm directly from upper intertidal mudflats, and can consume 190g of biofilm per day. Biofilm is estimated to be 45-59% of the total diet, or 50% of their daily energy budget (Kuwae et al. 2008). The high nutritional value of this food to shorebirds during the migration period is linked to high production of fatty acids (particularly polyunsaturated fatty acids (PUFAs), e.g., Omega-3 and Omega-6 fatty acids) from marine-type diatoms in biofilm (Schnurr et al. 2019). These fatty acids provide the lightweight energy-dense fuel necessary for Western Sandpipers to fly long distances between widely-separated stopover sites. Further, PUFAs have been linked to migratory performance of shorebirds in a suite of studies (Maillet and Weber 2006, Maillet and Weber 2007, Guglielmo 2010, Young 2019). Migratory shorebirds have limited capacity to produce n-3 PUFA from precursors endogenously, and must access them directly either from diatoms in biofilm or indirectly from invertebrate prey that have consumed biofilm. The availability of PUFAs in biofilm thus links habitat quality to migratory performance, and potentially to breeding success.

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Project would reduce the quality and quantity of biofilm on Roberts Bank

In addition to direct biofilm habitat loss (2.5 ha) from the Project footprint, ECCC has identified four mechanisms by which Project-related changes to the salinity regime would impact the quality and quantity of biofilm available to shorebirds (CEAR 1775). These changes include: 1) disruption of the salinity trigger responsible for "shocking" marine-type diatoms into high fatty acid production, 2) changes in community composition of diatoms in biofilm from marine to freshwater types that may produce lower amounts of fatty acids, 3) an unfavorable spatial shift in the center of the distribution for biofilm towards sandier substrates where biofilm would be inaccessible for foraging Western Sandpipers due to tongue morphology, and 4) a reduction in the biomass of available biofilm, resulting in lower abundance of food for shorebirds during the critical northward migration period.

Absence of mitigation options for Roberts Bank

The Proponent's critique of ECCC's Written Submission (CEAR 1637) cited the presence of biofilm at restored sites in Japan and California. The examples provided are not evidence of the creation of new mudflats with equivalent values to Roberts Bank and therefore, in ECCC's view, mitigation remains a practical impossibility:

1. There are no alternate sites for the construction of a large mudflat on the Fraser River estuary. All alternate sites of an equivalent size within the Fraser River estuary and delta (Sturgeon Banks and Boundary Bay) have sandier substrates and/or different hydrological regimes, and they would not be suitable replacements for the loss of degradation of biofilm at Roberts Bank. Further, fatty acid productivity on a reconstituted mudflat would need to be subject to the same salinity-related considerations during the northward migration period, as previously described in ECCC's assessment of the Project's indirect effects.
2. None of the studies cited by the Proponent (CEAR# critique of our work) in California or Japan assessed the ability of restored habitats to provide fatty acids (particularly polyunsaturated fatty acids) during the northward migration of the Western Sandpipers. For example:
 - a. Kelly and Conseco (2017) explicitly state that they 'did not investigate this possible factor [biofilm] in shorebird responses to tidal restoration', although this study was cited by the Proponent as evidence of biofilm use at restored sites,
 - b. Hsu et al. (2011) mapped chlorophyll-a (a surrogate measure of biofilm biomass) following a large-scale restoration of salt ponds in South San Francisco Bay. High-density biofilm was primarily located in undisturbed sloughs and channels adjacent to the restored ponds, and not in 'restored' habitat.

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Schnurr, P. J., Drever, M. C., Kling, H. J., Elner, R. W., & Arts, M. T. (2019). Seasonal changes in fatty acid composition of estuarine intertidal biofilm: Implications for western sandpiper migration. *Estuarine, Coastal and Shelf Science*, 224, 94-107.

Young, K. G. (2019). Growth characteristics and lipid metabolism of cultured migratory bird skeletal muscle cells. University of Western Ontario, Ontario. M.Sc. Thesis, 99pp.

3. Wetlands and Wetland Functions

ECCC has described the ecological importance of wetlands, including intertidal and shallow subtidal flats of Roberts Bank, in several submissions to the Review Panel.

ECCC's comments have focused on the Proponent's predictions for future wetland productivity potentials for the with-Project future condition, and the performance of proposed wetland offsetting measures (productivity, functioning) (CEAR X, X). ECCC also highlighted the potential for cumulative environmental effects on wetlands, and recommended measures to improve the Wetland Functions Assessment in support of improving the likelihood of better offsetting outcomes.

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Overall, ECCC concluded that the wetland functions assessment did not adequately address potential direct and indirect effects to all wetland habitat types, and that potential remains for residual effects to the flora and associated functions for those wetland types.

Specifically, ECCC noted that there is uncertainty if future wetlands will provide the same productivity and range of functions as in the current baseline condition. Further, ECCC raised concern that habitat offsetting is not proposed for intertidal or shallow subtidal sand flats which support many taxa of coastal birds including shorebirds.

During the Public Hearing session on wetlands and wetland functions, the Proponent noted that there are no data gaps in relation to the intertidal and shallow subtidal wetland areas. ECCC clarifies that the data gaps referenced in earlier submissions to the Panel on wetlands relate to the lower intertidal and shallow subtidal wetland areas. For additional clarity, ECCC refers the Panel to the following RBT2 Technical Data Reports² wherein the spatial locations of field sampling are presented.

ECCC concludes that ECCC's recommendations on wetlands outlined in several previous submissions to the Panel (CEAR XXX) remain applicable.

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4. Species at Risk

ECCC has responsibilities related to the conservation and protection of species listed on Schedule I of the *Species at Risk Act* (SARA). The ranges of nineteen species listed under SARA and four species assessed by the Committee on Endangered Wildlife in Canada (COSEWIC) overlap with the Project area. ECCC's comments and recommendations related to the assessment of these federally-listed species at risk were outlined in ECCC's written submission (CEAR X).

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² RBT2 Technical Data Report: Marine Vegetation – Intertidal Marsh, Foreshore Habitat and Invertebrate, Eelgrass, Ulva, and Biomat Survey Results (Prepared by Hemmera for Port Metro Vancouver, May 2014)

RBT2 Technical Data Report: Infaunal and Epifaunal Invertebrate Communities (Prepared by Hemmera for Port Metro Vancouver, December 2014)

Barn Owl is a SARA-listed species (threatened) found in nationally significant numbers in terrestrial habitats of the Fraser River estuary and is also subject to federal and provincial recovery planning.

ECCC highlighted concerns related to the survival and recovery of the Barn Owl, including risks of road mortality due to vehicle collisions, and decreasing habitat suitability, ~~such as~~ especially foraging habitat. ECCC has also stressed the importance of preserving roadside verge habitats, despite the risk of vehicle collision, as owls select roadside grass verges for foraging more than any other habitat types within their home ranges.

ECCC provided specific comments and recommendations on the mitigation measures proposed for Barn Owls in several submissions to the Panel (CEAR 1146, X). These recommendations included designing physical non-vegetated barriers to reduce the risk of vehicle collisions, and ensuring nest box mitigation is monitored for effectiveness. Further, ECCC recommended that mitigation measures be proposed within the regional assessment area, as Project-related effects to Barn Owl such as road mortality due to vehicle collisions are likely to occur beyond the local Project area.

The Proponent's updated Project commitments in relation to Barn Owl (CEAR X) include installation of five nest boxes during the first year of construction, two follow-up monitoring programs to monitor the Project's contribution to Barn Owl road mortality, and usage of nest boxes. The Proponent has also committed to working with a stewardship program to support the development of offset measures to benefit Barn Owls, such as contributing to grassland set aside programs.

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ECCC generally supports measures that would aid in addressing habitat loss for Barn Owls. In relation to road mortality mitigation and monitoring, ECCC affirms the importance of identifying high mortality zones, or hotspots, ~~to~~ inform the development of ~~in-developing~~ effective mitigation measures for road related effects to Barn Owl.

ECCC Closing Remarks – RBT2 – DRAFT AUGUST 7 2019

The written submission for the public hearing provides a full description of ECCC's views and final recommendations with respect to the potential environmental effects of the Project in relation to its mandate (CEAR 1637).

1.1 Marine shipping

In regard to the assessment of marine emissions from the Project, ECCC conducted a science-based review of the Proponent's air quality predictions and associated assumptions for the Project. ECCC's review was focused on ensuring that the air quality predictions were developed based on appropriate emissions estimates, meteorology and baseline air quality.

The Proponent provided updated estimates for the rate of introduction of Tier III vessels calling at Vancouver terminals at the Public Hearing (CEAR 1846) and concluded that 54% of new vessels will be Tier III in 2035. As described in ECCC's response to Undertaking #42 (CEAR 1970), ECCC is of the view that the new estimates could be overestimating the number of Tier III vessels compared to other jurisdictions such as the Ports of Los Angeles and Long Beach in California where projections for Tier III vessels in 2035 is 0% for all container ship vessel size categories (except for 15,000 – 18,000 TEU which are projected to be 26% Tier III in 2035).

The rate of introduction of Tier III affects the forecasted NO_x emission rates, and therefore, the predicted NO₂ concentrations. The predictions for NO₂ are particularly important as the 1-hour NO₂ exceeds the CAAQS over the majority of the study domain for the expected and future Project scenarios.

ECCC is currently updating our NO_x Tier III projections for Canadian ports, but concludes that the Proponent's new forecast could be overestimating the number of Tier III vessel calls compared to other jurisdictions, resulting in a likely underestimation of predicted concentrations of NO_x and NO₂ from marine vessels.

These predictions indicate that management actions ~~will be necessary~~ ~~would be advisable~~ ~~will be required~~ for NO₂ in the Lower Fraser Valley air zone. Therefore, ECCC continues to recommend the Proponent participate in local and regional air quality management initiatives where applicable, and take an adaptive approach to air quality management to prevent Project emissions from contributing to deteriorating air quality in the local and regional area.

Commented [M1]: I'd suggest that the WOG letter mention that departmental written submissions contain full summary of conclusions/recommendations.

Commented [M2]: The two points that are not included here are:

- That the new estimates (Mercator 2019) didn't include an updated effects assessment for marine emissions
- The larger ship scenario will have additional effects to be considered (longer berth times, larger auxiliary engines)

I am thinking that the opening discussion on Mercator or the new forecast more generally will touch on that it is not an updated effects assessment, and other effects from larger ships would need to be considered. If these points should be included in this section, please let me know and I can write something up. I thought it may be covered off in the TC opening...?

Commented [C3R2]: I agree I think it should be in the opening part of the whole of government piece and not our specific interest. I would like to propose language in the TC document that covers this - I think that might have been done.

Commented [C4]: Do we need to be clear here that this is based on the assumptions in the EIS and Marine piece? Or are we being broader to encompass the Mercator reports?

Commented [M5R4]: I view the definition of the Project to include all related studies to the EIS, so we don't need to define it here. Just my view.

Commented [C6]: Add a reference here to the undertaking where we discussed this.

Commented [C7]: Don't think we can say required as the CAAQS don't have a requirement but have suggestions for actions

Commented [M8R7]: In ECCC's written submission, we describe the NO₂ exceedances as indicating that NO₂ management actions will be required for the air zone. I think this was meant generally, and then the recommendation was for the Proponent to participate in local air quality management initiatives where applicable.

ECCC Closing Remarks – RBT2 – DRAFT AUGUST 7 2019

Shorebirds and Biofilm

Roberts Bank is a dynamic estuarine ecosystem supporting internationally significant populations of migratory shorebirds. Foraging on biofilm at Roberts Bank provides shorebirds with a rich supply of essential fatty acids. The best available evidence indicates that fatty acids are essential nutrients for long-distance flights of shorebirds during the critical northward migration period.

→ Predicted changes due to the Project include a substantial change in the salinity regime at Roberts Bank, particularly in those areas of highest importance to shorebirds.

Average salinity is expected to decrease by 1 standard deviation in magnitude, accompanied by a reduction in the overall range of salinity by up to 10 PSU, nearly a third of the total variation. As described in ECCC's written submission (CEAR 1637) and in ECCC's response to Undertaking #29 (CEAR 1947), substantial evidence exists linking this variability to the production of fatty acids by diatoms, both within existing literature and the Proponent's own studies (salinity trigger).

Based on ECCC's review of the scientific literature Project-related changes to the salinity regime would impact the quality and quantity of biofilm available to shorebirds. These changes include:

- the disruption of the salinity trigger responsible for "shocking" marine-type diatoms into high fatty acid production;
- changes in community composition of diatoms in biofilm from marine to freshwater types that may produce lower amounts of fatty acids;
- an unfavorable spatial shift in the center of the distribution for biofilm towards sandier substrates where biofilm would be inaccessible for foraging Western Sandpipers due to tongue morphology; and,
- a reduction in the biomass of available biofilm, resulting in lower abundance of food for shorebirds during the critical northward migration period.

The best available evidence indicates that fatty acids are essential nutrients for long-distance flights of shorebirds during the critical northward migration period.

Absence of mitigation options for Roberts Bank

The Proponent's response to ECCC's written submission (CEAR 1705) cited the presence of biofilm at restored sites in Japan and California. The examples outlined by the Proponent do not provide evidence of the creation of new mudflats with equivalent values to Roberts Bank. Based on ECCC's review of the current scientific literature, including the studies undertaken by the Proponent, ECCC remains concerned that there are no practical mitigation measures available to address the potential large-scale impacts of changes to biofilm at Roberts Bank. There are no alternate sites for the construction of a large mudflat on the Fraser River estuary. All alternate sites of an equivalent size within the Fraser River estuary and delta (Sturgeon Banks and Boundary Bay) have sandier substrates and/or different hydrological regimes, and would not be suitable replacements for the loss or degradation of biofilm at Roberts Bank. Further, none of the studies cited by the Proponent (CEAR 1705) in California or Japan assessed the ability of restored habitats to provide fatty acids (particularly polyunsaturated fatty acids) necessary for during the northward migration of the Western Sandpipers and other shorebirds. For example, Kelly and Conesco (2017) explicitly state that they 'did not investigate this possible factor [biofilm] in shorebird responses to tidal restoration', although this study was cited by the Proponent as evidence of biofilm use s at restored sites. In addition, Hsu et al. (2011) mapped chlorophyll-a (a

Commented [C1]: Could we add a link here to the pieces of evidence on the record that included all of these scientific evidence- I would guess our submission and our response to the undertaking would be the 2 key pieces.

Commented [M2]: The term biofilm use is more correct than used.

surrogate measure of biofilm biomass) following a large-scale restoration of salt ponds in South San Francisco Bay. High-density biofilm was primarily located in undisturbed sloughs and channels adjacent to the restored ponds, and not in 'restored' habitat.

[As previously discussed in ECCC's written submission \(CEAR 1637\), ECCC is of the view that it is not currently possible to recreate a mudflat with similar sediment characteristics and biofilm fatty acid productivity as the Roberts Bank area.](#)

[A reconstituted mudflat of a similar scale and with similar sediment characteristics and biofilm fatty acid productivity as the current upper intertidal area of Roberts Bank would have to be operational and tested prior to Project construction.](#)

ECCC continues to conclude that predicted Project-induced changes to Roberts Bank constitute an unmitigable species-level risk to Western Sandpipers, and shorebirds more generally. ECCC recommends that only a Project redesign would avoid changes to the geomorphological processes that would affect biofilm and shorebirds.

References

- Guglielmo, C.G. (2010). Move That Fatty Acid: Fuel Selection and Transport in Migratory Birds and Bats. *Integrative and Comparative Biology*, 50(3): 336–345.
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- Young, K. G. (2019). Growth characteristics and lipid metabolism of cultured migratory bird skeletal muscle cells. University of Western Ontario, Ontario. M.Sc. Thesis, 99pp.

Commented [C3]: This statement continues to confuse me as we are clearly saying we don't think that a similar size mudflat with the appropriate characteristics is possible within the area. Is there a reason why we need to say it would need to be operational and tested prior to construction? I am wondering if the following would be an appropriate addition:

"If the proponent wanted to explore a reconstituted mudflat option as a mitigation it would need to be operational and tested prior to project construction. ECCC as previously noted does not see evidence that a site with similar sediment characteristics and biofilm fatty acid productivity is plausible within the Roberts Bank area"

Commented [M4R3]: I have consulted S&T (Mark Drever) about a revision here. Hope this works. We had a paragraph in the written submission that discussed this issue.

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ECCC Closing Remarks – RBT2 – DRAFT AUGUST 7 2019

Shorebirds and Biofilm

ECCC presented evidence about the expected likely impacts of the project on the quality and quantity of biofilm available to migrating shorebirds in the Roberts bank area, about the likely consequences to migrating shorebirds of that decline in quantity and quality of biofilm, about the absence of equivalent other sources of biofilm that shorebirds can access, and about the low possibility of being able to mitigate these issues by creating or enhancing alternative sites.

The importance of biofilm at Roberts bank to migrating birds and the likely Project impacts on that biofilm

Roberts Bank is a dynamic estuarine ecosystem supporting internationally significant populations of migratory shorebirds. Foraging on biofilm at Roberts Bank provides shorebirds with a rich supply of essential fatty acids. The best available evidence indicates that fatty acids are essential nutrients for long-distance flights of shorebirds during the critical northward migration period. Predicted changes due to the Project include a substantial change in the salinity regime at Roberts Bank, particularly in those areas of highest importance to shorebirds. Average salinity is expected to decrease by 1 standard deviation in magnitude, accompanied by a reduction in the overall range of salinity by up to 10 PSU, nearly a third of the total variation. As described in ECCC's written submission (CEAR 1637) and in ECCC's response to Undertaking #29 (CEAR 1947), substantial evidence exists linking this variability to the production of fatty acids by diatoms, both within existing literature and the Proponent's own studies (salinity trigger).

Based on ECCC's review of the scientific literature, Project-related changes to the salinity regime would impact the quality and quantity of biofilm available to shorebirds. These changes are likely to include would include are likely to include:

- the disruption of the salinity trigger responsible for "shocking" marine-type diatoms into high fatty acid production;
- changes in community composition of diatoms in biofilm from marine to freshwater types that may produce lower amounts of fatty acids;
- an unfavorable spatial shift in the center of the distribution for biofilm towards sandier substrates where biofilm would be inaccessible for foraging Western Sandpipers due to tongue morphology; and,
- Together, these changes are likely to a reduction reduction in the biomass of available biofilm, resulting in lower abundance of food for shorebirds during the critical northward migration period.

Absence of mitigation options for Roberts Bank

The Proponent's response to ECCC's written submission (CEAR 1705) cited the presence of biofilm at restored sites in Japan and California. The examples outlined by the Proponent do not provide evidence of the creation of new mudflats with equivalent values to Roberts Bank. Based on ECCC's review of the current scientific literature, including the studies undertaken by the Proponent, ECCC remains concerned that there are no practical mitigation measures available to address the potential large-scale impacts of changes to biofilm at Roberts Bank. There are no alternate sites for the construction of a large mudflat on the Fraser River estuary. All alternate sites of an equivalent size within the Fraser River estuary and delta (Sturgeon Banks and Boundary Bay) have sandier substrates and/or different hydrological regimes, and as such are not likely to be able to provide alternative sources of food? nutrients that could compensate fully for would not be suitable replacements for the loss or degradation of biofilm at Roberts Bank.

The Proponent's response to ECCC's written submission (CEAR 1705) cited the presence of biofilm at restored sites in Japan and California. However, the examples outlined by the Proponent do not provide evidence of the creation of new mudflats with equivalent functional values to Roberts Bank. Further, particularly with respect to the biofilm

Commented [D[1]: This phrasing would not be consistent with our previous submissions and presentation to the Panel. Can we rewrite to: ECCC presented evidence about expected impacts of the project on the quality and quantity of biofilm available to migrating shorebirds in the Roberts Bank area, about the consequences to migrating shorebirds of that decline in quantity and quality of biofilm, about the absence of equivalent other sources of biofilm that shorebirds can access, and about the current absence of options to mitigate these issues by creating or enhancing alternative sites.

Commented [D[2]: We have argued that there is no current technology to develop large mudflats that furnish essential fatty acids during April/May. As such, there is an absence of mitigation options.

Commented [M[3]: Can we qualify this – "are likely to" "almost certainly will" "may"???

Commented [S[4]: I would suggest "are likely to"

Commented [D[5R4]: We have been using the qualifier 'would' to capture the uncertainty. Ending with 'include' keeps the phrasing intact.

Commented [M[6]: Would it be appropriate to turn this into a concluding sentence, rather than a final bullet? For example, "Together, these changes [impacts?] are likely[?] to reduce the biomass of..., resulting in lower ..."

Commented [D[7R6]: I understand the motivation here, as it does read like a concluding statement, but there is a nuance here about 'biomass', as measured by chlorophyll-a and presented in the Proponent's own studies. This nuance merits keeping this as separate bullet that distinguishes between changes in quality (fatty acids) and changes in quantity (biomass). These bullets also mirror the 4 slides with our concerns, as presented to the Panel. I suggest keeping the original text.

Commented [M[8]: What kind of values? Nutrient? Energy? ???

Commented [K[9]: I think issue is SCALE and HABITAT QUALITY Does this work?

Commented [D[10R9]: yes

community. Further, in particular, none of the studies cited by the Proponent (CEAR 1705) in California or Japan assessed the ability of restored habitats to provide the fatty acids (particularly polyunsaturated fatty acids) necessary for the northward migration of the Western Sandpipers and other shorebirds. For example, Kelly and Conesco (2017) explicitly state that they 'did not investigate this possible factor [biofilm] in shorebird responses to tidal restoration', although this study was cited by the Proponent as evidence of biofilm use at restored sites. In addition, Hsu et al. (2011) mapped chlorophyll-a (a surrogate measure of biofilm biomass) following a large-scale restoration of salt ponds in South San Francisco Bay. However, that study found that the high-density biofilm was primarily located in undisturbed sloughs and channels adjacent to the restored ponds, and not in 'restored' habitat.

As previously discussed in ECCC's written submission (CEAR 1637), ECCC is of the view that it is not currently possible to recreate a mudflat with similar sediment characteristics and biofilm fatty acid productivity as the Roberts Bank area.

ECCC continues to conclude that predicted Project-induced changes to Roberts Bank constitute an unmitigable species-level risk to Western Sandpipers, and shorebirds more generally, and that therefore the only way to be confident of avoiding the impacts on biofilm and shorebirds from these predicted geomorphological processes is with ECCC recommends that only a Project redesign would avoid changes to the geomorphological processes that would affect biofilm and shorebirds.

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ECCC Closing Remarks – RBT2 – DRAFT AUGUST 16 2019

Shorebirds and Biofilm

ECCC presented evidence about the expected impacts of the project on the quality and quantity of biofilm available to migrating shorebirds in the Roberts bank area, about the likely consequences to migrating shorebirds of that decline in quantity and quality of biofilm, about the absence of equivalent other sources of biofilm that shorebirds can access, and about the current absence of options to mitigate these issues by creating or enhancing alternative sites.

The importance of biofilm at Roberts bank to migrating birds and the likely Project impacts on that biofilm

Roberts Bank is a dynamic estuarine ecosystem supporting internationally significant populations of migratory shorebirds. Foraging on biofilm at Roberts Bank provides shorebirds with a rich supply of essential fatty acids. The best available evidence indicates that fatty acids are essential nutrients for long-distance flights of shorebirds during the critical northward migration period. Predicted changes due to the Project include a substantial change in the salinity regime at Roberts Bank, particularly in those areas of highest importance to shorebirds. Average salinity is expected to decrease by 1 standard deviation in magnitude, accompanied by a reduction in the overall range of salinity by up to 10 PSU, nearly a third of the total variation. As described in ECCC's written submission (CEAR 1637) and in ECCC's response to Undertaking #29 (CEAR 1947), substantial evidence exists linking this variability to the production of fatty acids by diatoms, both within existing literature and the Proponent's own studies (salinity trigger).

Based on ECCC's review of the scientific literature, Project-related changes to the salinity regime would impact the quality and quantity of biofilm available to shorebirds. These changes are likely to include

- the disruption of the salinity trigger responsible for "shocking" marine-type diatoms into high fatty acid production;
- changes in community composition of diatoms in biofilm from marine to freshwater types that may produce lower amounts of fatty acids;
- an unfavorable spatial shift in the center of the distribution for biofilm towards sandier substrates where biofilm would be inaccessible for foraging Western Sandpipers due to tongue morphology; and
- a reduction in the biomass of available biofilm, resulting in lower abundance of food for shorebirds during the critical northward migration period.

Absence of mitigation options for Roberts Bank

Based on ECCC's review of the current scientific literature, including the studies undertaken by the Proponent, ECCC remains concerned that there are no practical mitigation measures available to address the potential large-scale impacts of changes to biofilm at Roberts Bank. There are no alternate sites for the construction of a large mudflat on the Fraser River estuary. All alternate sites of an equivalent size within the Fraser River estuary and delta (Sturgeon Banks and Boundary Bay) have sandier substrates and/or different hydrological regimes, and as such are not likely to be able to provide alternative sources of nutrients that could compensate for the loss or degradation of biofilm at Roberts Bank.

The Proponent's response to ECCC's written submission (CEAR 1705) cited the presence of biofilm at restored sites in Japan and California. However, the examples outlined by the Proponent do not provide evidence of the creation of new mudflats with equivalent functional values to Roberts Bank, particularly with respect to the biofilm community. None of the studies cited by the Proponent in California or Japan assessed the ability of restored habitats to provide the fatty acids (particularly polyunsaturated fatty acids) necessary for the northward migration of the Western Sandpipers and other shorebirds. For example, Kelly and Conesco (2017) explicitly state that they 'did not investigate

this possible factor [biofilm] in shorebird responses to tidal restoration', although this study was cited by the Proponent as evidence of biofilm use at restored sites. In addition, Hsu et al. (2011) mapped chlorophyll-a (a surrogate measure of biofilm biomass) following a large-scale restoration of salt ponds in South San Francisco Bay. However, that study found that the high-density biofilm was primarily located in undisturbed sloughs and channels adjacent to the restored ponds, and not in 'restored' habitat.

As previously discussed in ECCC's written submission (CEAR 1637), ECCC is of the view that it is not currently possible to recreate a mudflat with similar sediment characteristics and biofilm fatty acid productivity as the Roberts Bank area.

ECCC continues to conclude that predicted Project-induced changes to Roberts Bank constitute an unmitigable species-level risk to Western Sandpipers, and shorebirds more generally, and that therefore the only way to be confident of avoiding the impacts on biofilm and shorebirds from these predicted geomorphological processes is with a Project redesign.

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August 26, 2019

Jocelyne Beaudet, Panel Chair;
David Levy, Panel Member; Douw Steyn, Panel Member;
c/o Cindy Parker, Panel Manager
Canadian Environmental Assessment Agency
160 Elgin Street, Ottawa, ON K1A 0H3
Sent by email to: CEAA.PanelRBT2-CommissionRBT2.ACEE@canada.ca

Dear Ms. Beaudet et al:

Subject: Closing Remarks for the Roberts Bank Terminal 2 Project

Transport Canada (TC), Environment and Climate Change Canada (ECCC), Fisheries and Oceans Canada (DFO) and the Canadian Coast Guard (CCG), and the Canadian Environmental Assessment Agency (CEAA), collectively the Federal Authorities, put forward this closing remarks submission. Thank you for the opportunity to summarize our final positions related to the potential environmental effects of the Project as it relates to our mandates and areas of technical expertise. Our collective positions are organized by topic below.

Marine Vessel Traffic

As the Review Panel is aware, the Vancouver Fraser Port Authority (VFPA) does not anticipate an increase in containership traffic in the Marine Shipping Area as a result of the proposed Roberts Bank Terminal 2 project, as described in the container traffic trends and marine forecast findings prepared by Mercator International in November 2018 (CEAR [1362](#)).

Economic forecasting for global container demand and associated marine traffic comprises a number of factors and complexities that inherently involve some level of uncertainty. That said, TC is of the view that the VFPA's conclusions based on the Mercator report findings are generally consistent with our understanding of container traffic trends, as outlined in our January 30, 2019 presentation to the Review Panel (CEAR [1404](#), slide 8).

The Government of Canada recognises concerns, including those raised by Indigenous groups, regarding the cumulative effects associated with marine shipping and the potential increase of marine shipping in the Salish Sea. Consistent with the principles of adaptive management, and as detailed in our various submissions and presentations to the Review Panel, the Government of Canada is committed to the continuous improvement of Canada's marine safety and security system through a number of measures and initiatives including the Oceans Protection Plan (CEAR [954](#), [1133](#), [1618](#), [1771](#)) and the Whales Initiative (CEAR [1224](#), [1618](#), [1749](#)).

In addition, the VFPA's updated summary of Project commitments (CEAR [2001](#), pg. 10-11 and Table B-3) included details on additional measures - 16 new recommendations and 6 new marine focused accommodation measures - that outline how the Government of Canada is looking beyond project specific concerns to broader issues of marine shipping within the Salish Sea. These measures, in response to the Trans Mountain Expansion Project approved in June 2019 by the Government of Canada, will be applicable within the same marine shipping route as any vessels proposed to call at the proposed RBT2 Project. Notably, these measures

include a marine birds monitoring plan, the development and implementation of a cumulative effects management plan for the Salish Sea and a long-term strategy for managing and monitoring cumulative effects. These measures and initiatives are applicable to all marine vessels and will deliver overall enhancements to the marine safety system and respond directly to marine shipping-related concerns, including those raised by Indigenous groups.

Air Emissions from Marine Vessels

Various factors can contribute to air emission projections, such as size of ships, duration at port, tier level of engines, and equipment used for loading cargo. A consideration for the air pollution emissions from marine shipping associated with the Project is the predicted rate of introduction of Tier III vessels. At the Public Hearing, the Proponent provided updated estimates for the rate of introduction of Tier III vessels likely to call at Vancouver terminals (CEAR [1846](#)), and concluded that 54% of new vessels will be Tier III in 2035.

ECCC highlighted at the Public Hearings some potential underestimation of the NO_x and NO₂ emissions from marine vessels, given that the number of keels laid globally for Tier III vessels has been less than expected since 2016, and that the number of Tier III vessels projected for some other major Pacific terminals is lower than the proponent predicts for Roberts Bank Terminal 2 (CEAR [1795](#) and [1970](#)). These complexities contribute to uncertainty around the Proponent's predictions, and ECCC remains of the view that the Proponent's predictions may underestimate NO_x and NO₂ emissions. Predictions for NO₂ from Project-related shipping are particularly important because of existing high NO₂ concentrations in the region.

In turn, this suggests that management actions may be necessary for NO₂ in the Lower Fraser Valley air zone under the national Air Quality Management System. Therefore, ECCC continues to recommend that the Proponent participate in local and regional air quality management initiatives where applicable, and take an adaptive approach to prevent Project emissions from contributing to deteriorating air quality in the local and regional area.

Shorebirds and Biofilm

ECCC presented information about the expected impacts of the project on the quality and quantity of biofilm available to migrating shorebirds in the Roberts bank area, about the likely consequences to migrating shorebirds of that decline in quantity and quality of biofilm, about the absence of equivalent other sources of biofilm that shorebirds can access, and about the current absence of options to mitigate these issues by creating or enhancing alternative sites.

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production of fatty acids by diatoms, both within existing literature and the Proponent's own studies (salinity trigger).

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- the disruption of the salinity trigger responsible for "shocking" marine-type diatoms into high fatty acid production;
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¹ Kelly, J. P., & Condeso, T. E. (2017). Tidal marsh restoration stimulates the growth of winter shorebird populations in a temperate estuary. *Restoration Ecology*, 25(4), 640-649.

² Hsu, W. C., Kuss, A., Ketron, T., Nguyen, A., Remar, A., Newcomer, M., & Angela Detweiler, M. S. (2011). Hyperspectral biofilm classification analysis for carrying capacity of migratory birds in the South Bay salt ponds. <http://www.asprs.org/pecora18/proceedings/Hsu.pdf>

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[Other Topics as Requested by FAs]

Thank you again for the opportunity to participate in this process.

Sincerely,

[Signatory to be discussed as part of August 20th ADM Major Ports Project Steering Committee]

DRAFT FOR DISCUSSION

ECCC Closing Remarks – RBT2 –~~DRAFT~~ AUGUST 7, 2019

Introduction

ECCC submits the following closing remarks to the Review Panel for the Roberts Bank Terminal 2 Project (the Project). ECCC's closing remarks provide a brief summary of ECCC's views with respect to the potential environmental effects and mitigation measures proposed by the Vancouver Fraser Port Authority (the Proponent) for the Project.

ECCC's closing remarks are focused on the topics that ECCC presented to the Review Panel at the public hearing, and include conclusions on the assessment of air quality, and biofilm and shorebirds.

The written submission for the public hearing provides a full description of ECCC's views and final recommendations with respect to the potential environmental effects of the Project in relation to its mandate (CEAR 1637).

1. Air Quality

ECCC conducted a science-based review of the Proponent's air quality predictions and associated assumptions for the Project. ECCC's review was focused on ensuring that the air quality predictions were developed based on appropriate emissions estimates, meteorology and baseline air quality.

1.1 Canadian Ambient Air Quality Standards

Federal, provincial and territorial governments are working collaboratively to improve air quality through the implementation of the Air Quality Management System (AQMS). The Canadian Ambient Air Quality Standards¹ (CAAQS) are a key element of the AQMS and are intended to be the drivers for air quality improvements across the country in order to further protect human health and the environment. Although the CAAQS are not legally binding, governments have agreed to work collaboratively to implement actions to improve air quality and to report on the improvement of the CAAQS on a regular basis. The CAAQS are based on air quality management levels that call for progressively more rigorous actions by jurisdictions as air quality approaches or exceeds the CAAQS.

As outlined in ECCC's written submission and in the Proponent's response to IR14-04 (CEAR 1465), concentrations of 1-hour NO₂ is predicted to exceed the CAAQS over the majority of the study domain for both the expected and future conditions, and concentrations of annual NO₂ is predicted to be above the CAAQS in proximity to the Project (see Figure IR14-04-A4). These predictions indicate that management actions will be required for NO₂ in the Lower Fraser Valley air zone. Therefore, ECCC continues to recommend the Proponent participate in local and regional air quality management initiatives where applicable and take an adaptive approach to air quality management to prevent Project emissions from contributing to deteriorating air quality in the local and regional area.

1.2 Air Quality Modelling

ECCC's comments on the Proponent's air quality model, specifically the model domain size and inclusion of regional emission sources, are outlined in ECCC's public comment period #1 submission (CEAR 1346) and in ECCC's written submission. ECCC also provided comments on the air quality model in the first sufficiency review of the EIS and Marine Shipping Addendum in October 2016 (CEAR 581).

ECCC remains of the view that a more rigorous modelling assessment is required for the Project, particularly given that predictions of NO₂ are above the CAAQS. ECCC advised that the methodology used by the Proponent in their air

¹ The CAAQS are provided in Appendix 1 of ECCC's written submission (CEAR 1637).

quality modelling study (adding one background value to represent regional sources) is a simplified method, and the inclusion of regional sources in the model domain would allow for an understanding of the potential interactions of those sources with those of the Project. ECCC maintains that conducting a sensitivity analysis using one point source in the center of the modelled domain does not capture all of the possible interactions the Project may have with existing and future regional emission sources.

ECCC concludes that the limited model domain size and representing all regional sources with one background value, as the Proponent has presented in the EIS and in responses to Information Requests, does not provide enough information to determine the full effect of the Project on regional air quality.

1.3 Marine shipping

ECCC provided comments on the assessment of marine shipping associated with the Project in several submissions to the Panel (CEAR 1637, CEAR 1346).

During the Public Hearing session on air quality, the Proponent presented new estimates for the rate of introduction of Tier III vessels calling at Vancouver terminals (CEAR 1846) and concluded that 54% of new vessels will be Tier III in 2035. An updated air quality effects assessment was not included with the new estimates provided by the Proponent. However, based on ECCC's analysis of the information, ECCC concluded that the Proponent's new estimates could be overestimating the number of Tier III vessels compared to other jurisdictions. The rate of introduction of Tier III affects the forecasted NO_x emission rates, and therefore, the predicted NO₂ concentrations. The predictions for NO₂ are particularly important as the 1-hour NO₂ exceeds the CAAQS over the majority of the study domain for the expected and future Project scenarios.

As described in the *San Pedro Bay Ports Clean Air Action Plan 2017*, the two largest ports in North America (for container volume), the Ports of Los Angeles and Long Beach in California, are projecting 0% Tier III ship calls in 2035 for all container ship vessel size categories (except for 15,000 – 18,000 TEU, which are projected to be 26% Tier III in 2035). Based on the Proponent's new ship call estimates (where 2/15 per week are in the 15,000-18,000 TEU category) and applying the California ports' projections, the proportion of vessel calls meeting Tier III in 2035 would be 3.5%. ECCC is still in the process of updating our NO_x Tier III projections for Canadian ports, but concludes that the Proponent's new forecast could be overestimating the number of Tier III vessel calls compared to other jurisdictions. Therefore, the NO_x emissions from marine vessels are likely underestimated for the Project, and the associated predictions for NO₂ are likely underestimated as well.

1.4 Locomotive Emission Rates

ECCC's comments on locomotive emission rates are described in several submissions to the Panel (CEAR 1637, CEAR 1346).

The Proponent modelled locomotive emissions on the assumption that 100% of the switcher locomotives would meet Tier I emission standards by 2025. However, ECCC advised the Panel that there were no Tier I or higher yard switchers in Canada in 2015 according to the Railway Association of Canada.

ECCC advised that correctly accounting for NO₂ and other emissions is important for the determination of effects and identifying appropriate mitigation measures, particularly as it is unlikely that 100% of the switcher locomotives will meet Tier I in 2025.

During the Public Hearing session on air quality, the Proponent made reference that there is no difference in emissions between Tier 0 and Tier I locomotives. ECCC wishes to clarify for the Panel that the NO₂ emission factors for

Tier 0+ are approximately 7% higher than for Tier 1 locomotives, whereas the difference between Tier 0 and Tier I is approximately 27%.

ECCC recommends that that new Tier IV switcher locomotives be used for the Project to mitigate for emissions, particularly as NO₂ is predicted to exceed the CAAQS.

2. Biofilm and Shorebirds

2.1 Conservation values of Roberts Bank

Within the Fraser River Estuary and delta, Roberts Bank is the largest mudflat where the estuarine hydrological regime remains largely unmodified by water diversion structures, and, not coincidentally, the most important site on the delta for shorebirds during northward migration. Each spring, the global population of Western Sandpipers migrate from overwintering areas in Central and South America to their Arctic breeding grounds, refueling along the route at a chain of widely-separated estuarine stopover sites. Roberts Bank forms a critical link in the chain, providing food and nutrients for up to 42%–64% of the entire species of Western Sandpipers in a single season. The site also serves as important overwintering habitat for hundreds of thousands of waterfowl and other shorebirds.

Roberts Bank is internationally designated as a site of Hemispheric Importance under the Western Hemisphere Shorebird Reserve Network, a Ramsar Wetland of International Significance, and an Important Bird Area (IBA) through BirdLife International. Much of Roberts Bank lies within a provincial Wildlife Management Area created to provide critical habitat for shorebirds and other species.

2.2 Biofilm values of Roberts Bank

Intertidal biofilms are dynamic communities comprised of microorganisms, particularly diatoms, detritus and inorganic material within a mucus matrix of extracellular polymeric substances. Biofilm is now known to be a major food resource for shorebirds worldwide (Kuwaie et al. 2012; Mathot et al. 2018). During their northward migration on Roberts Bank, Western Sandpipers depend on the availability of biofilm. A Western Sandpiper grazes biofilm directly from upper intertidal mudflats, and can consume 190g of biofilm per day. Biofilm is estimated to be 45-59% of the total diet, or 50% of their daily energy budget (Kuwaie et al. 2008). The high nutritional value of this food to shorebirds during the migration period is linked to high production of fatty acids (particularly polyunsaturated fatty acids (PUFAs), e.g., Omega-3 and Omega-6 fatty acids) from marine-type diatoms in biofilm (Schnurr et al. 2019). These fatty acids provide the lightweight energy-dense fuel necessary for Western Sandpipers to fly long distances between widely-separated stopover sites. Further, PUFAs have been linked to migratory performance of shorebirds in a suite of studies (Maillet and Weber 2006, Maillet and Weber 2007, Guglielmo 2010, Young 2019). Migratory shorebirds have limited capacity to produce n-3 PUFA from precursors endogenously, and must access them directly either from diatoms in biofilm or indirectly from invertebrate prey that have consumed biofilm. The availability of PUFAs in biofilm thus links habitat quality to migratory performance, and potentially to breeding success.

2.3 Project would reduce the quality and quantity of biofilm on Roberts Bank

In addition to direct biofilm habitat loss (2.5 ha) from the Project footprint, ECCC has identified four mechanisms by which Project-related changes to the salinity regime would impact the quality and quantity of biofilm available to shorebirds (CEAR 1775). These changes include: 1) disruption of the salinity trigger responsible for "shocking" marine-type diatoms into high fatty acid production, 2) changes in community composition of diatoms in biofilm from marine to freshwater types that may produce lower amounts of fatty acids, 3) an unfavorable spatial shift in the center of the distribution for biofilm towards sandier substrates where biofilm would be inaccessible for foraging Western

Sandpipers due to tongue morphology, and 4) a reduction in the biomass of available biofilm, resulting in lower abundance of food for shorebirds during the critical northward migration period.

2.4 Absence of mitigation options for Roberts Bank

The Proponent's response to ECCC's written submission (CEAR 1705) cited the presence of biofilm at restored sites in Japan and California. The examples provided are not evidence of the creation of new mudflats with equivalent values to Roberts Bank and therefore, in ECCC's view, mitigation remains a practical impossibility.

1. There are no alternate sites for the construction of a large mudflat on the Fraser River estuary. All alternate sites of an equivalent size within the Fraser River estuary and delta (Sturgeon Banks and Boundary Bay) have sandier substrates and/or different hydrological regimes, and would not be suitable replacements for the loss or degradation of biofilm at Roberts Bank. Further, fatty acid productivity on a reconstituted mudflat would need to be subject to the same salinity-related considerations during the northward migration period, as previously described in ECCC's assessment of the Project's indirect effects (CEAR 1637).
2. None of the studies cited by the Proponent (CEAR 1705) in California or Japan assessed the ability of restored habitats to provide fatty acids (particularly polyunsaturated fatty acids) during the northward migration of the Western Sandpipers. For example:
 - a. Kelly and Conesco (2017) explicitly state that they 'did not investigate this possible factor [biofilm] in shorebird responses to tidal restoration', although this study was cited by the Proponent as evidence of biofilm use at restored sites.
 - b. Hsu et al. (2011) mapped chlorophyll-a (a surrogate measure of biofilm biomass) following a large-scale restoration of salt ponds in South San Francisco Bay. High-density biofilm was primarily located in undisturbed sloughs and channels adjacent to the restored ponds, and not in 'restored' habitat.
3. A reconstituted mudflat of a similar scale, sediment characteristics and biofilm fatty acid productivity as the current upper intertidal area of Roberts Bank would have to be operational and tested prior to Project construction.

In summary, the ability to replicate a mudflat's ability to produce fatty acids on any scale has not been developed. Therefore, replacing mudflat habitat of the size and complexity of Roberts Bank would require development of novel restoration methods that would have uncertain success (with no interim options for meeting the needs of migrating Western Sandpipers).

2.5 ECCC Conclusions and Recommendation

Roberts Bank is a dynamic estuarine ecosystem supporting internationally significant populations of migratory shorebirds. Foraging on biofilm at Roberts Bank provides shorebirds with a rich supply of essential fatty acids. Predicted changes due to the Project include a substantial change in the salinity regime at Roberts Bank, particularly in those areas of highest importance to shorebirds. Average salinity is expected to decrease by 1 standard deviation in magnitude, accompanied by a reduction in the overall range of salinity by up to 10 PSU, nearly a third of the total variation. Substantial evidence exists linking this variability to the production of fatty acids by diatoms, both within existing literature and the Proponent's own studies (salinity trigger). The best available evidence indicates that fatty acids are essential nutrients for long-distance flights of shorebirds during the critical northward migration period.

ECCC concludes that predicted Project-induced changes to Roberts Bank constitute an unmitigable species-level risk to Western Sandpipers, and shorebirds more generally. Accordingly, ECCC recommends that a Project redesign is needed to avoid changes to the geomorphological processes that would affect biofilm and shorebirds.

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HYPERSPECTRAL BIOFILM CLASSIFICATION ANALYSIS FOR CARRYING CAPACITY OF MIGRATORY BIRDS IN THE SOUTH BAY SALT PONDS

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ABSTRACT

Highly productive tidal marshes provide ecosystem support for migratory birds and often contain biofilm, a substantial food source for the community. In this study, biofilms were analyzed based on taxonomic classification, population density, and spectral signatures. These techniques were then applied to remotely sensed images to map biofilm populations in the South Bay Salt Ponds and predict the carrying capacity of these newly restored ponds for migratory birds. The GER-1500 spectroradiometer was used to obtain *in situ* spectral signatures for each density-class of biofilm. The spectral variation and taxonomic classification between high, medium, and low density biofilm cover types was mapped using in-situ spectral measurements and classification of EO-1 Hyperion and Landsat TM 5 images. Biofilm samples were also collected in the field to perform laboratory analyses to determine chlorophyll *a* content, taxonomic classifications, and energy content. Comparison of the spectral signatures between the three density groups shows distinct variations useful for hyperspectral classification. Also, analyses of chlorophyll *a* concentrations show statistically significant differences between each density group, using the Tukey-Kramer test at an alpha level of 0.05. The potential carrying capacity in South Bay Salt Ponds, an area of approximately 15,000 acres (6,070 hectares), is estimated to be 250,000 birds.

INTRODUCTION

Development of over 90% of the South San Francisco Bay estuary in the past century, from a natural wetland environment to agricultural and salt production ponds, has lowered biodiversity while weakening the ability for this ecosystem to aid in flood protection and pollution control (Philip Williams & Associates Ltd. and Faber, 2004). In an effort to restore 15,000 acres of this land, the South Bay Salt Pond Restoration Project (SBSRP) has applied an adaptive management strategy for wetland restoration (Trulio et al., 2007). The SBSRP is managed collaboratively by the California State Coastal Conservancy (CSCC), the U.S. Fish and Wildlife Service (FWS), and the California Department of Fish and Game (DFG) (Trulio et al., 2007; South Bay Salt Pond Restoration, 2010).

Tidal marshes are highly productive ecosystems, providing habitat for birds, breeding grounds for fish and crabs, flood protection, and improved water quality through pollutant filtration (Kelly and Tuxen, 2009). The South Bay salt ponds, located at the southern end of San Francisco Bay, lie on the Pacific Flyway, which provides good roosting and over-wintering sites for migratory bird species and also a rich supply of nutrients on the mudflats. The shallow open water, mudflats, and salt marshes are utilized by various waterfowl, shorebirds, and mammals (Siegel and Bachand, 2002). It was estimated that over 500,000 birds utilize the habitat each year in the San Francisco Bay Salt Ponds (Harrington and Perry, 1995). Many small shorebirds use seasonal managed ponds throughout the year, with highest usage during spring, fall, and winter period (Brand et al., 2011).

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