PORT of vancouver | Vancouver Fraser Port Authority

# Roberts Bank Terminal 2 Follow-up Program

## A collaborative and approporiately designed approach to protect western sandpipers

November 14, 2022

Canada

# Contents



# List of Appendices

# A collaborative and appropriately designed approach to protect western sandpiper

## Response to comments of Environment and Climate Change Canada

## 1. Introduction

In this submission, the Vancouver Fraser Port Authority (port authority) synthesizes the available information related to the assessment of potential effects of the Roberts Bank Terminal 2 project (the project) on western sandpiper to support decision-making. This submission comprises the port authority's response to the submission of Environment and Climate Change Canada (ECCC), dated October 26, 2022[1] (referred to hereafter as 'ECCC's submission'). ECCC's submission was made in response to the port authority's submission dated June 10, 2022[2] (referred to hereafter as 'June submission'). In brief, the information provided in this submission demonstrates that the comprehensive approach proposed by the port authority, including mitigation measures and follow-up programs to be developed collaboratively with ECCC, experts with relevant expertise in biofilm and related disciplines, and Indigenous groups, will effectively address the potential risk and mitigate potential adverse environmental effects on western sandpipers due to project-induced salinity changes.

As explained in this submission, the information provided since the Minister of Environment and Climate Change (the minister) issued the information request (IR) demonstrates that, taking mitigation into account, the project is *not likely* to cause a significant adverse effect on western sandpiper. The proposed follow-up programs will be appropriately designed to verify this predicted outcome. The port authority has proposed, through the precautionary construction approach follow-up program (described further in Section 2), that if early signals demonstrate that an immediate population-level effect on western sandpiper is likely to occur if construction proceeds, adaptive management measures will be implemented, which may include the extraordinary backstop measure of deconstructing the marine terminal if required.

The planned consultation and collaboration with ECCC, alongside internationally recognized experts and Indigenous groups in a multi-party approach to the development of the follow-up programs which is consistent with the federal conditions of approval, should give the Government of Canada confidence that the approach will be appropriately designed to effectively address any potential risk of the project to the western sandpiper population.

### 1.1 Background and context for this response

The independent review panel appointed to conduct the federal environmental assessment of the project considered the potential environmental effects of the project on salinity, biofilm, and western sandpiper. In its report, the review panel concluded that the project would result in only minor changes in salinity in the local assessment area (LAA).[3] The review panel also concluded that the project "would not result in an adverse effect on biofilm productivity or composition and diatom assemblages at Roberts Bank" and that "the Proponent demonstrated that fatty acid production did not vary across the salinity gradient currently experienced at Roberts Bank in the area where shorebirds forage during northward migration at the end of April to early May".[4]

[1] CIAR #3557, Environment and Climate Change Canada (ECCC) Response to the Proponent's Public Comment Period Submissions.
[2] CIAR #3553, Vancouver Fraser Port Authority to Impact Assessment Agency of Canada re: Part two of response to draft conditions and public comment period submissions - biofilm and western sandpipers.
[3] CIAR #2062, Federal Review Panel Report for the Roberts Bank Terminal 2 Project, p. 109.
[4] Ibid. p. 150.

The review panel also concluded that the project would not result in an adverse effect on invertebrates (another important prey source for western sandpiper that can comprise up to 55% of its diet in the LAA[5,6])[7]. However, the review panel was unable to conclude with certainty that the project would result in an adverse effect on polyunsaturated fatty acid production by biofilm.[8] As a result of this uncertainty, the review panel said that it was unable to determine whether the project would or would not have any effect on western sandpiper:

> "Due to the uncertainty with respect to fatty acid production in biofilm, the Panel is unable to conclude with reasonable confidence that the Project would or would not have an adverse effect on the Western sandpiper."[9]

Since the review panel issued its report, the minister issued an additional IR regarding the potential effect of the project on salinity, biofilm, and western sandpiper. Additional information has been provided by the port authority, including site- and project-specific data and analysis. Further information has also been provided by ECCC and other parties during the public consultation period on the port authority's response to the minister's IR and on the draft potential conditions, and by the port authority in response to the draft conditions and the submissions of other parties. In its June 2022 submission, the port authority summarized information relevant to the assessment of whether the project would have any effect on western sandpiper, including information that was considered by the review panel and additional information developed since the review panel issued its report. It also described the suite of measures proposed to address a potential project effect on western sandpiper. The additional information provided by the port authority directly addresses the uncertainty identified by the review panel regarding the potential for the project to cause an effect on western sandpiper due to changes in salinity.

Most recently, ECCC has made a submission (dated October 26, 2022) in response to the port authority's June submission, providing feedback on the approach proposed by the port authority. It now remains for the minister, based on the review panel's findings and the additional information provided, to reach a conclusion where the review panel did not: that is, to determine whether, as a result of potential changes in polyunsaturated fatty acid production that may be caused by predicted changes in salinity at Roberts Bank, the project is likely or unlikely to have a significant adverse environmental effect on western sandpiper.

## 1.2 Overview and structure of this submission

This submission provides a synthesis of the available information for the Impact Assessment Agency of Canada (IAAC) to take into account in fulfilling its mandate of preparing advice for the minister to support decision-making. In doing so, the port authority addresses several important matters raised by ECCC in its recent submission.

**Section 2** of this submission describes how the matters raised in ECCC's response are addressed by the full scope of the port authority's proposed approach to address the potential risk to the western sandpiper population hypothesized by ECCC. That approach includes a suite of mitigation measures and follow-up programs.

**Section 3** then characterizes the potential residual environmental effect on western sandpiper, considering the key criteria of magnitude, extent, timing, duration, frequency, and reversibility. It also describes the potential significance of a residual effect, should one occur, and, if so, its likelihood. This characterization is completed as a synthesis of the available site- and project-specific evidence, together with ECCC's recent feedback.

---

[5] Kuwae, Tomohiro, Peter G. Beninger, Priscilla Decottignies, Kimberley J. Mathot, Dieta R. Lund, and Robert W. Elner. "Biofilm grazing in a higher vertebrate: the western sandpiper, Calidris mauri." *Ecology* 89, no. 3 (2008): 599-606.
[6] Jardine, Catherine, B., Alexander L. Bond, Peter J. A. Davidson, Robert W. Butler, Tomohiro Kuwae. 2015. "Biofilm Consumption and Variable Diet Composition of Western Sandpipers (Calidris mauri) during Migratory Stopover". *PLoS ONE* 10(4): e0124164. doi:10.1371/journal.pone.0124164.
[7] CIAR #2062, supra note 3 at p. 165.
[8] Ibid. p. 151.
[9] Ibid. p. 243.

The main body of the submission is supported by the following appendices:

**Appendix A** includes clarifications in response to the feedback provided by ECCC. In its submission, ECCC summarized various aspects of the port authority's proposed approach to address the potential risk to western sandpiper. Some of ECCC's characterization of the information provided previously by the port authority is incomplete or misconceives the information, and warrants a response to ensure the material on the record is accurate.

**Appendix B** includes additional details related to the precautionary construction approach follow-up program. In its submission, ECCC indicated that additional details related to the precautionary construction approach follow-up program would be helpful to support decision making. The port authority has provided additional detail as requested.

**Appendix C** comprises a figure showing western sandpiper northward migration sites along the Pacific coast of the Americas, to the breeding grounds and associated peak migration period.

**Appendix D** includes the port authority's response to suggested edits of ECCC on draft conditions. In its submission, ECCC made comments and suggested edits on several draft conditions related to wetlands, biofilm, and the precautionary construction approach.

## 2. A comprehensive approach

ECCC acknowledges that "an appropriately designed phased approach could help reduce the likelihood that the species-level impact to the Western Sandpiper identified by ECCC experts would occur".[10] The port authority agrees. The port authority has proposed a comprehensive approach – to be developed in collaboration with ECCC, relevant experts, and Indigenous groups - to addressing potential effects of the project-induced changes to salinity predicted to occur.[11] ECCC's recent submission focuses largely on just one aspect – the precautionary construction approach follow-up program – of the port authority's comprehensive approach. However, as described in the port authority's June submission, the port authority has proposed to implement a much broader suite of important measures, including but not limited to the following:

- **Biofilm habitat creation:** The port authority proposes to proactively undertake biofilm habitat creation even though an adverse effect on polyunsaturated fatty acid production in biofilm is not likely to occur. This work would build on examples of successful biofilm habitat creation elsewhere, including a large-scale project in San Francisco Bay and other successful examples referenced by experts at ECCC[12], and would be incorporated into a proposed new follow-up program to verify the effectiveness of the created habitat.[13] Planning for this initiative is being undertaken collaboratively with Indigenous groups; their ongoing participation and knowledge will support effective biofilm creation.
- **Long-term verification of salinity predictions:** A multi-year follow-up program–developed in consultation with ECCC, Fisheries and Oceans Canada, and Indigenous groups–to verify predicted changes in salinity has been proposed to be implemented, building on the port authority's existing multi-year baseline dataset.[14]

[10] CIAR #3557, supra note 1 at p. 1 and 7.
[11] The mitigation measures and follow-up programs proposed by the port authority are reflected in the version of the draft conditions that were released for public comment on December 15, 2021 (CIAR #2086) with revisions and new conditions suggested by the port authority in its June submission (CIAR #3553).
[12] Kuwae, Tomohiro, Robert W. Elner, Tatsuya Amano, and Mark C. Drever. "Seven ecological and technical attributes for biofilm-based recovery of shorebird populations in intertidal flat ecosystems." *Ecological Solutions and Evidence* 2, no. 4 (2021): e12114., as referenced in ECCC's submission CIAR #3557.
[13] As reflected in the new draft conditions previously proposed by the port authority.
[14] As reflected in the public consultation version of the draft conditions, with revisions previously suggested by the port authority.

- **Long-term verification of prey (including biofilm) availability to migrating western sandpipers:** A multi-year follow-up program, developed in consultation with ECCC and Indigenous groups and reviewed by independent experts, has been proposed to be implemented[15] to evaluate the capability of the LAA to support western sandpiper populations due to potential alterations to distribution, abundance, and quality of biofilm and invertebrate prey, including:
  - Monitoring and analysis of lipids and fatty acids and other key parameters in biofilm
  - Further analysis of any potential effect of predicted salinity changes on polyunsaturated fatty acids in biofilm
  - Identification and implementation, if necessary, of adaptive management measures (consistent with all follow-up programs)
- **Precautionary monitoring of early signals of population-level effect on western sandpiper:** The proposed precautionary construction approach follow-up program, to be appropriately designed with advice from ECCC, recognized experts, and Indigenous groups, would monitor for early signals of an immediate population-level project effect on western sandpiper and would identify and, if necessary (based on pre-established thresholds in the follow-up program), implement *additional* mitigation *before* such a significant adverse environmental effect manifests.

  Additional mitigation would include adaptive management measures that may include offsetting, habitat enhancements, and, as proposed, an extraordinary measure of deconstruction of the east basin of the marine terminal as a backstop in the unlikely event that monitoring early in the construction phase demonstrates on a scientific basis that an immediate population-level effect on western sandpiper is likely to occur if construction continues, as hypothesized by ECCC in several submissions.[16] [17] [18] [19] This backstop measure, considered together with the full suite of actions required under the draft potential conditions that would be imposed in a decision statement, demonstrates that any risk to the western sandpiper population attributable to changes in salinity caused by the project will be mitigated.

Additional details on relevant mitigation measures are provided in Section 2.1, and additional details on follow-up programs are provided in Section 2.2.

## 2.1 Mitigation

### 2.1.1 Measures to be implemented by the port authority

#### Project design measures

The mitigation measures described in Section 3 of the port authority's June submission remain relevant to the minister's decision-making pursuant to section 52 of the *Canadian Environmental Assessment Act, 2012* (CEAA 2012). Those measures include, but are not limited to, avoidance of intertidal habitats, re-design of the terminal land mass, and reduction of the footprint of the marine terminal and causeway. These measures reflect the port authority's precautionary approach to protecting biofilm habitats since early in project design. Other project re-design measures, which have further reduced effects to the marine environment, include re-design of the tug basin, re-design to eliminate the intermediate transfer pit, reduction in dredging requirements, and a commitment to implement a breach (as contemplated in draft condition 7.1) (see the June submission for further detail).

[15] As reflected in the public consultation version of the draft conditions, with revisions previously suggested by the port authority.
[16] CIAR #1637, Environment and Climate Change Canada to the Review Panel re: Written Submission for the Roberts Bank Terminal 2 Public Hearing, p. 35.
[17] CIAR #1818, Hearing Transcript volume 11: May 27, 2019, p. 2678.
[18] CIAR #2062, supra note 3 at p. 242.
[19] CIAR #2212, Environment and Climate Change Canada Review of Information Request 2020-4: Biofilm and Effects to Migratory Birds, and Appendix IR2020-4-A, p. 6.

### Biofilm habitat creation

As noted above, the port authority proposed a condition requiring it to proactively undertake biofilm habitat creation to support migrating western sandpipers even if no adverse effect on western sandpiper due to project-induced changes in salinity occurs. During the review panel process, ECCC expressed concern that mudflat creation was an unproven mitigation measure.[20] In its report, the review panel accepted that view and concluded that mudflat [i.e., biofilm habitat] creation at Roberts Bank "...cannot be considered feasible until best practices can be developed" [emphasis added].[21] In this regard, the draft conditions (with revisions suggested by the port authority) include a requirement to document methods and best practices for biofilm habitat creation.

As described in Section 3.1 of its June submission, the port authority has, with input from ECCC, technical experts, including individuals with expertise in biofilm science and restoration techniques who have co-authored papers with ECCC staff, and Indigenous groups, proactively developed a biofilm habitat creation manual in anticipation of this condition, documenting methods and best practices for biofilm habitat creation. The manual, which continues to be updated to incorporate emerging experience from across the globe, includes methods and best practices drawn from successful biofilm habitat creation projects at a range of scales. The manual, approximately 175 pages in length, is a technical volume written to guide practitioners in creating, restoring, and enhancing biofilm habitat.

The biofilm habitat creation project to be undertaken by the port authority will provide an opportunity to apply the methods and best practices included in the manual. The port authority has suggested revisions to the draft conditions that would not only *require* the port authority to proceed with the biofilm habitat creation project but would require it to use the methods and best practices outlined in the manual. This approach is consistent with the review panel findings.

The port authority is also already proactively advancing the biofilm habitat creation initiative in collaboration with Indigenous groups: work to identify selection criteria and candidate sites was undertaken in 2021, and site evaluation with Indigenous groups, involving site visits and ongoing engagement, has continued in 2022. The remaining candidate sites are all within the Fraser River estuary and would enhance biofilm productivity within the same larger stopover area used by western sandpipers in the LAA. The goal would be to initiate the biofilm habitat creation project *prior* to project construction, pending confirmation through ongoing consultation with Indigenous groups. In addition, as discussed below, the feasibility of biofilm creation is being demonstrated.

## 2.1.2 **Response to ECCC comments on biofilm creation**

The port authority continues to closely monitor developments in biofilm science and best practices, including to inform its continual update of the biofilm habitat creation manual. In its most recent submission, ECCC continues to assert that “considerable uncertainty” remains with respect to the viability of biofilm habitat creation. ECCC does not account for the documentation of several new examples and increased understanding of successful biofilm habitat creation projects that are supporting shorebirds. The port authority’s responses to ECCC’s comments are provided below.

### Scale of biofilm habitat creation projects

The scale of habitat restoration projects resulting in biofilm creation continues to expand, as demonstrated in the successful biofilm restoration project in San Francisco Bay recently featured as a case study within a biofilm symposium at the Western Hemisphere Shorebird Group conference that was organized by ECCC staff in September 2022. ECCC asserts there are no examples of large-scale biofilm restoration, despite sites in Japan and California providing examples of restored habitat on the scale of hundreds of hectares; in fact, the port authority’s biofilm habitat creation manual includes methods and best practices drawn from successful biofilm habitat creation projects at a range of scales up to well over 500 hectares.[22]

[20] CIAR #1637, supra note 16.
[21] CIAR #2062, supra note 3 at p. 151.
[22] Kuwae et al., supra note 12.

ECCC also asserts that the manual proposes remediation in multiple smaller areas in the estuary. This is a mischaracterization, as the manual does not propose this. The manual documents methods and best practices, but does not propose specific biofilm habitat creation projects in the project area. ECCC goes on to state that such small-scale biofilm habitat creation would be insufficient to provide "the large-scale biofilm habitat creation that would be required for the RBT2 Project"; however, as noted above, the manual includes examples of successful biofilm habitat creation up to over 500 hectares in size.

For context, the scale of biofilm that has been successfully created in recent projects is up to an order of magnitude greater than the limited area where short-term >10 PSU[23] compression of the salinity range is predicted to be induced by the project (on average ~10% of biofilm habitat area available or 63 ha; see discussion of extent in Section 3.2 below).

Further, to be clear, the spatial extent of the short-term and temporary salinity range compressions predicted to occur as a result of the terminal land mass is limited and has not been proven to cause any change in polyunsaturated fatty acid production in biofilm that would require offsetting.

## Effectiveness of biofilm habitat creation

The feasibility of biofilm habitat creation is acknowledged by ECCC scientists as co-authors of the recent study titled '*Seven ecological and technical attributes for biofilm-based recovery of shorebird populations in intertidal flat ecosystems'*.[24] The authors stated "[w]e propose that effective human intervention [i.e., biofilm habitat creation and enhancement] in intertidal flat ecosystems can be developed through mirroring the needs of small-bodied shorebirds" [emphasis added] and went on to outline seven criteria necessary to create effective high-quality shorebird (biofilm) habitat. The authors do *not identify* polyunsaturated fatty acids as necessary. In fact, the authors do not mention polyunsaturated fatty acids at all, and the term "fatty acid" appears only once. Instead, Kuwae et al. (2021)[25] noted that maximizing energy available in biofilm for foraging shorebirds was the primary goal of biofilm habitat restoration. Energy availability has been a key metric used by the port authority since the initial effects assessment (based on input from the Technical Advisory Group[26], which included participants from ECCC); the assessment demonstrated that biofilm on Roberts Bank will be able to support more than 1 million western sandpipers in a single day with the project in place.[27]

The development of the proactive biofilm habitat creation to be undertaken by the port authority would be guided by the example described by Kuwae et al. (2021) and other examples, including the San Francisco Bay example. The growing body of literature regarding biofilm habitat creation continues to improve confidence in the effectiveness of this mitigation measure.

## Adaptive management

The port authority has also proposed a precautionary construction approach and adaptive management measures as discussed above.

In its submission, ECCC asserts that "[t]he only mitigation measures identified in the [port authority's] Part 2 submission involve the discontinuation or deconstruction of the Project." That is not accurate. As noted above, in its June submission, the port authority describes a suite of mitigation measures, including measures that had previously been considered by the review panel and additional measures proposed since (See Section 2.1.1). These mitigation measures serve to reduce the magnitude and extent of any potential effect on western sandpipers that stop over at Roberts Bank that could be affected by changes in polyunsaturated fatty acid production in biofilm (if the salinity trigger hypothesis were to be correct (See **Appendix A**).

[23] Practical salinity units.
[24] Kuwae et al., supra note 12.
[25] Ibid.
[26] The role of the Technical Advisory Group in providing expert advice in relation to the environmental assessment is described in the EIS (CIAR #181).
[27] CIAR #181, Environmental Impact Statement, p. 15-2.

Further, if an investigation conducted under the follow-up program demonstrates that an immediate adverse population-level effect on western sandpiper would likely occur without further mitigation, the port authority would implement feasible adaptive management measures. The applicable follow-up programs would be developed in consultation with ECCC, internationally recognized experts, and Indigenous groups.

To be clear, the proposed biofilm habitat creation and other mitigation measures that have been proposed and either will be or, through the implementation of follow-up programs, could be implemented if necessary, will mitigate, that is, avoid, reduce, or offset, any species-level effect of the project on western sandpiper.

## 2.2 Follow-up: the importance of an appropriately designed approach

As noted above, ECCC acknowledges that "an appropriately designed phased approach could help reduce the likelihood that the species-level impact to the Western Sandpiper identified by ECCC experts would occur".[28] As previously described in the port authority's June submission, careful study design is important in the development of measures to protect western sandpiper.

In its report, the review panel recommended follow-up to address the uncertainty it identified with respect to polyunsaturated fatty acid production in biofilm[29]. The follow-up programs proposed by the port authority and reflected in the draft conditions are consistent with those recommendations.

### 2.2.1 Consultative approach to incorporate Indigenous and scientific advice

The port authority emphasizes that the follow-up programs related to salinity, biofilm, and western sandpiper, including the methods and monitoring parameters to be used and the thresholds for adaptive management action, would be designed in consultation with ECCC, as well as with recognized experts and Indigenous groups. This is a standard aspect of follow-up program development and is a fundamental requirement of all follow-up programs, as reflected in the general draft conditions 2.5 to 2.9. The application of this standard approach ensures feedback provided by ECCC will be taken into account in further developing the precautionary and comprehensive approach proposed by the port authority.

The port authority has experience working successfully with ECCC to resolve uncertain and hypothesized effects related to other development projects in the Roberts Bank area and Lower Mainland, such as the Deltaport Third Berth Project. This experience demonstrates that an appropriately designed monitoring program can be developed through ongoing consultation with ECCC. All of the follow-up programs proposed by the port authority and reflected in the draft conditions would be developed with this consultative approach.

In its submission, ECCC commented (in relation to draft condition 10.14.5) on the need for an independent and transparent review process; the port authority agrees and has addressed the comment on independent review in its proposed revisions to the draft conditions.

### 2.2.2 Reliance on leading indicators

In its response regarding the precautionary construction approach, ECCC states that it "…does not recommend reliance on any approach that would use a measurable decrease in the population of a species as an appropriate mitigation...". The port authority concurs. The port authority has proposed a follow-up program that would be focused on monitoring *leading* indicators (discussed further below and in **Appendix B** of this submission) that would allow early signals of an immediate population-level effect on western sandpiper to be detected and adaptive management action to be taken *before* such a significant adverse environmental effect could manifest.

ECCC notes that additional information will be needed regarding the indicators that would be used to determine effects and identifies specific indicators it considers should be included, such as "salinity, biofilm community composition, fatty acid content of biofilm, western sandpiper abundance and distribution." As described in **Appendix B**, the port authority identified these and other candidate monitoring parameters, which include indicators of migration success, western sandpiper condition and diet while foraging in the

[28] CIAR #3557, supra note 1 at p. 1 and 7.
[29] See Recommendations 19, pp151-152, CIAR #2062).

Fraser River estuary, and indicators of breeding success for the population (e.g., common breeding vital rates). The availability of multiple years for baseline data, including the unparalleled amount of salinity, biofilm, and western sandpiper data collected by the port authority at Roberts Bank (as described further below), will provide the robust dataset that will enable the identification of early signals of a population-level effect on western sandpipers, if one were to occur, immediately following construction of the east basin containment dyke.

The port authority looks forward to working with ECCC, internationally recognized experts, and Indigenous groups to select appropriate monitoring parameters to achieve the goals of the western sandpiper follow-up programs.

### 2.2.3 Robust baseline

In its submission, ECCC also notes that a robust baseline for the western sandpiper precautionary construction approach follow-up program would be required, taking into account inter-annual variability of Fraser River discharge, salinity, biofilm, and western sandpiper. The port authority agrees. In addition to continuing to gather relevant baseline data for key parameters, including salinity, biofilm, and western sandpiper, as it has for years already, the port authority has proposed new draft conditions to require the establishment of robust multi-year baseline information for key western sandpiper-related parameters. This will capture variability and facilitate the identification of an early indication of the potential for a population-level effect, if one were to occur (**Appendix B** and the port authority's June submission). The robust baseline information of key parameters, as well as monitoring at selected control site(s) and in the project area prior to and during northward migration, would also facilitate determination of whether any observed change, if one were to occur, can be attributed to the project.

The precautionary construction approach follow-up program will, as noted above, be complemented with other long-term monitoring related to western sandpiper population integrity and is just one aspect of a comprehensive approach to address the potential risk to the western sandpiper population.

### 2.2.4 Science-based adaptive management thresholds

The port authority also anticipates that ECCC, alongside internationally recognized experts and Indigenous groups, would provide expert advice on the thresholds of environmental change that would trigger adaptive management actions, including a threshold beyond which a significant adverse environmental effect on western sandpiper is expected to occur. Again, this is a standard requirement of all follow-up programs, as reflected in draft condition 2.5.4, which contemplates modified or additional mitigation measures, including "instances where the Proponent may require Designated Project activities causing the environmental change to be stopped".

## 3. Characterization of residual effect on western sandpiper

This section of the port authority's submission synthesizes the available information, including ECCC's recent feedback, to characterize the potential residual effect on the western sandpiper population due to the predicted project-induced changes in salinity and the potential changes they may cause in polyunsaturated fatty acid production in biofilm. This characterization considers the key criteria of magnitude, extent, timing, duration, frequency, and reversibility, as well as significance and likelihood, as per IAAC's Operational Policy Statement "*Determining Whether a Designated Project is Likely to Cause Significant Adverse Environmental Effects under CEAA 2012*".[30] This summary of environmental assessment outcomes is provided for IAAC to take into account in fulfilling its mandate of preparing advice for the minister to support decision-making.

[30] IAAC's Operational Policy Statement, accessed Nov 22 at: https://www.canada.ca/en/impact-assessment-agency/services/policy-guidance/determining-whether-designated-project-is-likely-cause-significant-adverse-environmental-effects-under-ceaa-2012.html.

The characterizations of the potential project effect on the total western sandpiper population provided below consider the mitigation measures described in Section 2 except for the port authority's proposed proactive biofilm habitat creation or adaptive measures that could be implemented if needed. These measures would further mitigate (and indeed avoid or reverse) any potential population-level effect on western sandpiper.

## 3.1 Magnitude

Three factors are considered in the characterization of magnitude of an effect of the project on western sandpiper: 1) percentage of the population foraging near the project,[31] and length of stay during migratory stopover; 2) the production of fatty acids across the salinity gradient, and 3) the composition of western sandpiper diet.

ECCC's response refers to the proportion of shorebirds observed in the LAA (which they refer to as Brunswick Point) relative to the entire Fraser River estuary. However, it is important to note that, on average, only 17% of the total western sandpiper population stop over at the mudflats near the project[32] during spring migration in any given year, and individual western sandpipers forage for up to four days.[33] (See figure in **Appendix C**) Further, only a portion of those will feed in the area predicted to experience a modified salinity regime. Thus, in an average year, more than 83% of the total western sandpiper population cannot be affected by the project in any way.

In any given year, the predicted salinity range compressions will be short-term, temporary, and would impact only a portion of the biofilm habitat area at Roberts Bank. This means that even if salinity changes adversely affect polyunsaturated fatty acid production, only a portion of the individual western sandpipers stopping over at Roberts Bank (which encompass only a portion of the total population) foraging in those areas might be potentially affected.

Further, fatty acid production will continue. Even in the limited areas of biofilm (See Section 3.2) that may experience intermittent compression of the salinity range (described in Section 3.2 of the port authority's June submission), biofilm would still produce fatty acids during any brief periods of compression even if the salinity trigger hypothesis were to be correct. Existing data show fatty acids, including polyunsaturated fatty acids , are continually produced under varying salinity regimes.[34] [35] [36] Three years of study demonstrate that biofilm produces fatty acids and polyunsaturated fatty acids under all salinity conditions.[37] [38] [39] The review panel concurred, finding that "the Proponent demonstrated that fatty acid production did not vary across the salinity gradient currently experienced at Roberts Bank in the area where shorebirds forage

---

[31] 'mudflats near the project' defined as north of the Roberts Bank causeway to Canoe Pass, as per (Drever et al. 2014 (see note 50)).

[32] Percentage based on a population of 3.5M western sandpiper (Bishop et al. 2000, and Morrison et al. 2001) and an annual estimate of 600K western using the LAA (Brunswick Point; Drever et al. 2014).

[33] As cited in:

- Iverson, George C., Sarah E. Warnock, Robert W. Butler, Mary Anne Bishop, and Nils Warnock. "Spring migration of western sandpipers along the Pacific coast of North America: a telemetry study." *The Condor* 98, no. 1 (1996): 10-21.
- Warnock, Nils, and Mary Anne Bishop. "Spring stopover ecology of migrant Western Sandpipers." *The Condor* 100, no. 3 (1998): 456-467.
- Warnock, N. I. L. S., Mary Anne Bishop, John Y. Takekawa, and Tony D. Williams. "Pacific Flyway Shorebird Migration Program: Spring Western Sandpiper Migration, Northern Baja California, Mexico to Alaska, Final Report 2004." *Unpublished Progress Report. PRBO Conservation Science, Stinson Beach, CA, USA* (2004).

[34] CIAR #1100, British Columbia Ministry of Forests, Lands, Natural Resource Operations and Rural Development to the Review Panel re: Response to Information Requests issued by the Review Panel on September 27, 2017.

[35] CIAR# 1322, Vancouver Fraser Port Authority to the Review Panel re: Response to Information Requests IR9-01 to IR9-04, IR10-01, IR10-27, IR10-28, IR11-06, IR11-24, IR12-08, and IR12-12.

[36] CIAR #1385, Vancouver Fraser Port Authority to the Review Panel re: Additional Information in Response to Information Request IR8-04 – 2018 Biofilm Dynamics Data Report (See Reference Documents #1071, #1110 and #1215).

[37] CIAR #1100, supra note 34.

[38] CIAR# 1322, supra note 35.

[39] CIAR #1385, supra note 36.

during northward migration at the end of April to early May".[40] In areas where the project may increase the salinity range, polyunsaturated fatty acid production would be expected to *increase* if the salinity trigger hypothesis were to be correct, helping to offset any decreases that could be occurring elsewhere. Fatty acid production at other times and locations would be unchanged. Thus, the magnitude of a change in total fatty acid production in biofilm across Roberts Bank, if any such change occurred due to project-induced changes in salinity range, would also be low.

Another factor relevant to the consideration of the magnitude of a potential effect on western sandpiper is that biofilm provides only a portion of western sandpipers' diet while they are at Roberts Bank. The remainder of their diet comprises invertebrate prey, which account for approximately half of the diet of western sandpiper.[41] The review panel concluded that the project would not result in an adverse effect on invertebrates.[42] Thus, the proportion of the western sandpiper diet that could be affected by short-term and temporary compressions >10 PSU in salinity range, if the salinity trigger hypothesis were to be correct, is low (i.e., of about half of its diet, on average only about 10% of the biofilm habitat area on some days (see discussion on extent below)).

The available evidence therefore indicates that the magnitude of a potential effect on the total western sandpiper population would be low.

## 3.2 Extent

The port authority noted in its June submission that the area potentially experiencing a compression in the range of salinity of >10 PSU would be limited to on average only about 10% (i.e., ~63 ha) of the available biofilm habitat on only some days during the stopover period. In its response, ECCC did not dispute this fact. Previously, ECCC had suggested to the review panel that the potentially affected biofilm habitat area could be as much as 558 ha.[43] The port authority's clarification of the limited extent of the biofilm habitat area potentially experiencing predicted salinity range compressions greatly reduces the uncertainty that the review panel highlighted in its report.

ECCC did comment on the "patchiness" of fatty acid distribution in biofilm; however, it is unlikely that the limited areas in which the salinity range would be occasionally and temporarily compressed would consistently occur in or disproportionally affect patches of high fatty acid concentration, which are present over vast areas across the mudflat near the project (north of the causeway to Canoe Pass).[44] Further, ECCC's response did not acknowledge that the analysis provided by the port authority demonstrates that large, polyunsaturated fatty acid-rich areas of high use by western sandpiper and other shorebirds would be unaffected by the salinity changes caused by the project.

It is also worth reiterating that the majority of the western sandpiper population (83%), on average, do not forage at the mudflats near the project[45] on their northward migration, stopping over at other sites (See figure in **Appendix C**). When considering the extent of a potential effect on the western sandpiper population, the limited extent of the potentially affected area at Roberts Bank must be considered relative to the total area used by the western sandpiper population during their northward migration.

The available evidence therefore indicates that the spatial extent of a potential effect of the project on biofilm and the total western sandpiper population would be limited.

[40] CIAR #2062, supra note 3 at p. 150.
[41] CIAR #1385, supra note 36.
[42] CIAR #2062, supra note 3 at p. 165.
[43] CIAR #2212, supra note 19.
[44] CIAR #181, supra note 27 at figure 11-7.
[45] Only on average 17% of total western sandpiper population stop at the mudflats near the project, north of the Roberts Bank causeway to Canoe Pass (Drever et al. 2014); supra note 31.

## 3.3 Timing, duration, and frequency

The timing, duration, and frequency of the predicted changes in salinity were described in the port authority's June submission. For example, based on the 2012 assessment year, the largest magnitude changes in salinity will occur relatively infrequently within the western sandpiper stopover period (8 out of 26 days). In the upper intertidal area (important to western sandpiper), there are several days within the stopover period when the predicted reduction would not exceed 10 PSU in *any* area. Most of the time within the stopover period (22 of the 26 days), there is no part of the Canoe Pass biofilm area (the other area important to western sandpiper) that will experience a salinity range decrease by more than 8 PSU. In short, the project-induced changes in salinity (compression in salinity range > 20-25 PSU as hypothesized by ECCC[46] that would be needed to constrain polyunsaturated fatty acid production in biofilm, as hypothesized by ECCC, would be of short duration, occurring only in limited areas (as explained above) across Roberts Bank and varying from day to day.

In its submission, ECCC did not acknowledge that the duration of predicted project-induced salinity changes at any given point in the biofilm habitat area at Roberts Bank is shorter than both the lifecycle of a diatom (approximately 6 days on average)[47] and the duration of stopover by western sandpiper (up to four days). Thus, if the salinity trigger hypothesis were to be correct, diatoms that experience a salinity range compression in any given tidal cycle may still be exposed to higher salinity ranges during their life cycle. Further, as noted above, even diatoms exposed to a compressed salinity range would continue to produce fatty acids. These factors make it much less likely that polyunsaturated fatty acid production in biofilm at any given location would be consistently or persistently constrained over a relevant period of time or that any western sandpiper would not be able to meet its total energy intake requirements during its stopover.

It is also important to note that western sandpipers stopping over at Roberts Bank do so over an approximately three to four-week period (April 15 to May 10), with individual birds stopping for up to four days. The predicted changes in salinity will not be consistent or persistent throughout this time, varying in location, extent, duration, and frequency, such that, if the salinity trigger hypothesis were to be correct and polyunsaturated fatty acid production is curtailed in some biofilm in limited areas for a short period of time, only some individual western sandpipers could be affected.

With regard to frequency of a potential effect, if the salinity trigger hypothesis were to be correct and the salinity range compressions predicted to occur, for a limited period in some areas, cause polyunsaturated fatty acid production in biofilm to be temporarily curtailed, some individual western sandpipers present at that time and feeding in the affected area may not be able to meet their energy requirements, according to ECCC's hypothesis. If that were to occur, based on ECCC's hypothesis, those affected individual western sandpipers would then suffer an immediate energy deficiency that would impact their remaining migration and subsequent breeding in that season. Given the high temporal and spatial variability of the predicted salinity changes over the stopover period, it is not likely that the same individuals, if they return to the mudflats near the project in subsequent years, would necessarily be adversely affected by curtailed polyunsaturated fatty acid production again.

## 3.4 Reversibility

In its submission, ECCC stated that it "needs to understand the reversibility of any impacts" and asserted that "reversibility of impacts is unknown." In fact, there is information available to the minister regarding the reversibility of the predicted salinity changes and of the potential effects on biofilm and western sandpiper that may ensue, if the salinity trigger hypothesis were to be correct.

[46] CIAR #1947, Undertaking #29: From Environment and Climate Change Canada – Salinity trigger linked to biofilm.
[47] D'Alelio, Domenico, Maurizio Ribera d'Alcala, Laurent Dubroca, Adriana Zingone, and Marina Montresor. "The time for sex: a biennial life cycle in a marine planktonic diatom." *Limnology and Oceanography* 55, no. 1 (2010): 106-114.

There are various aspects of reversibility to consider when evaluating the potential effect of project-induced salinity changes on western sandpiper. First, the data show that magnitude and extent of project-induced salinity changes vary greatly from one day to the next such that salinity conditions at most areas of the biofilm zone are only altered from what would have occurred under existing conditions for periods as short as one day. Further, the data show that biofilm is highly resilient to its dynamic environment, as evidenced by its rapid re-establishment following other kinds of physical disturbance.[48]

The lifespan of individual diatoms is approximately just 6 days on average, so that even if polyunsaturated fatty acid production in some diatoms is briefly constrained over a tidal cycle (an effect that is only hypothetical and not supported by any available site- and project-specific evidence), other diatoms in that location could continue to produce polyunsaturated fatty acids in subsequent tidal cycles that exhibit different salinity conditions over the three to four-week long western sandpiper stopover period. Further, diatom regeneration is continuous. Diatoms replicate (asexually reproduce) at the rate of 0.5 (i.e., twice in one day) to 10 days, so any diatom cohort may not be exposed to any salinity range compression. In addition, new diatoms settle from the water column in each tidal cycle, “seeding” the mudflats and contributing to biofilm productivity.

Biofilm in the LAA is composed of a diverse suite of diatoms that create a robust community, insulating itself against change and allowing it to be extremely adaptable. The spring biofilm community present during the western sandpiper northward migration comprises a mixture of estuarine diatoms, freshwater diatoms from the Fraser River, and marine diatoms from the Strait of Georgia. The community is made up of hundreds (if not thousands) of species, all adapted to different environmental conditions, including varying salinity conditions. The diverse community of diatoms are reproducing (replicating themselves) growing in abundance or being continually replenished by the recruitment of individuals from the different water sources. All diatoms produce and store an abundance of energy in the form of carbohydrates and fatty acids (including polyunsaturated fatty acids). Biofilm species diversity likely makes the community resilient and robust to changing salinity conditions.

In addition, the shorebird foraging opportunity model[49] shows there will be enough biofilm on the mudflats near the project (north of the causeway to Canoe Pass) to support one million sandpipers in a single day with the project in place. Typically, the peak number of foraging shorebirds on a given day during a northward migration stopover is 150,000 birds.[50] Moreover, biofilm grows and replaces itself daily following foraging by western sandpipers.[51]

Further, deconstruction, which would be implemented early in the construction phase if determined to be required, would re-establish existing salinity conditions at Roberts Bank. Finally, as noted previously, about 83% of the total western sandpiper population does not stop over at the mudflats near the project,[52] and would be completely unaffected by the project. Of those that do stop over (17% on average), some would not feed in the limited areas experiencing changes in the salinity regime. Thus, most of the population would be unaffected, if the salinity trigger hypothesis were to be correct, and would therefore be available to contribute to population recruitment in future years. Thus, at each step of the effect pathway, the predicted salinity changes and the potential effect that could result should be considered reversible.

It is also worth reiterating that western sandpiper is not a listed species of conservation concern either federally or provincially and available evidence indicates the population (3.5 million individuals) is trending upwards (see **Appendix A** for more detail).[53]

---

[48] CIAR #1329, Vancouver Fraser Port Authority to the Review Panel re: Panel request for Technical Data Report Biofilm Regeneration Study.
[49] CIAR #181, supra note 27.
[50] Drever, Mark C., Moira JF Lemon, Robert W. Butler, and Rhonda L. Millikin. "Monitoring populations of western sandpipers and Pacific dunlins during northward migration on the Fraser River Delta, British Columbia, 1991–2013." *Journal of Field Ornithology* 85, no. 1 (2014): 10-22.
[51] Canham, Rachel. "Slime, safety and shorebirds: Biofilm production and grazing by migrating western sandpipers (Calidris mauri)." PhD diss., Science: Biological Sciences Department, 2019.
[52] Supra note 31.
[53] Weiser, Emily L., Richard B. Lanctot, Stephen C. Brown, H. River Gates, Joël Bêty, Megan L. Boldenow, Rodney W. Brook et al. "Annual adult survival drives trends in Arctic-breeding shorebirds but knowledge gaps in other vital rates remain." The Condor 122, no. 3 (2020): duaa026.

## 3.5 Significance

The characteristics of the potential effect of the project-induced changes in salinity on biofilm and the total western sandpiper population are summarized in the following table.

**Table 1 Summary of effect characterization**

| Key criterion | Evaluation based on synthesis of available evidence |
|---|---|
| Magnitude | **Low:**<br>· Small proportion of biofilm habitat area experiencing salinity range compression of >10 PSU; most areas experience low magnitude changes in salinity (see extent below)<br>· Fatty acid production would still continue in affected areas, as existing data show fatty acids, including polyunsaturated fatty acids, are continually produced under varying salinity regimes<br>· No effect on biofilm productivity or composition or diatom assemblages<br>· Invertebrate prey unaffected (comprises about half of western sandpiper diet)<br>· Only a portion (17% on average) of total western sandpiper population stop over at mudflats by the project[54], and only a portion of those could be affected by a change in polyunsaturated fatty acid production, if one were to occur |
| Extent | **Limited:**<br>· Site selection and re-design (including but not limited to footprint reductions) avoid and reduce the extent of changes to salinity and potential effects on biofilm habitat area<br>· Salinity range compressions of >10 PSU limited to ~10% on average (i.e., 63 ha) of the biofilm habitat area available in the LAA on some days during the northward migration period<br>· Salinity range increases also predicted to occur (helping to offset)<br>· Fatty acid production would still continue in areas experiencing changes in the salinity regime, as existing data show fatty acids, including polyunsaturated fatty acids, are continually produced under varying salinity regimes<br>· Invertebrate prey unaffected<br>· Biofilm habitat creation proposed to mitigate<br>· Roberts Bank stopover site only one of several used by migrating western sandpipers |
| Timing, Duration, and Frequency | **Short-term and temporary:**<br>· Predicted salinity range compressions at any given point would be short-term, varying from day to day<br>· Salinity range compression would not be consistent or persistent at any given point, so polyunsaturated fatty acid production would not necessarily be consistently or persistently constrained, if salinity trigger hypothesis were correct<br>**Change shorter than relevant life stages**<br>· Duration of salinity range compression shorter than diatom lifecycle and typical western sandpiper stopover duration |

[54] North of the Roberts Bank causeway to Canoe Pass (Drever et al. 2014).

| Key criterion | Evaluation based on synthesis of available evidence |
|---|---|
| | · Natural salinity range conditions will continue to occur over most areas throughout the three to four-week western sandpiper northward migration period<br>· Effect on western sandpiper individuals, if any, would be reflected in success of remaining migration and breeding in first season after exposure |
| Reversibility | **Reversible:**<br>· Salinity range conditions vary with every tidal cycle (twice daily), reverting to unaffected conditions frequently<br>· Diatom regeneration is continuous; diatoms replicate (asexually reproduce) at the rate of 0.5 (i.e., twice in one day) to 10 days, any diatom cohort may not be exposed to any salinity range compression<br>· Recruitment - new diatoms settle from water column in each tidal cycle "seeding" the mudflats and contributing to biofilm productivity<br>· Biofilm demonstrably resilient, re-establishes in three to nine days after complete physical removal<br>· Biofilm grows and replaces itself daily from foraging by western sandpipers<br>· Deconstruction of marine terminal land mass would restore existing salinity conditions<br>· Majority (~83%) of western sandpiper population use alternate stopover sites and do not stop near the project during northward migration and are thus unaffected by the project. |

Taking into consideration the key criteria of magnitude, extent, duration, frequency, and reversibility, described above based on the available site- and project-specific evidence, in addition to the input provided by ECCC, and taking into account the implementation of the available and appropriate mitigation measures, the residual project effect, if any, on the western sandpiper population would not be significant. That is, the project would not cause a change in the species abundance or density of the western sandpiper population.

## 3.6 Likelihood

Even if the minister were to determine that the residual project effect on the western sandpiper population would be significant, that effect cannot be considered likely.

While the project is expected to cause changes in salinity *(i.e*., a likely environmental change), those changes are *not likely* to create consistent and persistent conditions that would consistently or persistently constrain diatoms in biofilm from producing levels of fatty acids, including polyunsaturated fatty acids, comparable with what they produce today.

Further, the likely project-induced changes in salinity are *not likely* to cause all or even many western sandpipers stopping over at Roberts Bank to be unable to meet their total energy intake requirements to support successful migration and breeding. Invertebrate prey, which make up about half of the western sandpiper diet, will be unaffected by the project. Only a limited area (~10% on average) of the total biofilm habitat area available could experience short-term and temporary predicted salinity range compressions >10 PSU, and biofilm in those areas would still produce fatty acids, including polyunsaturated fatty acids, as existing data show fatty acids, including polyunsaturated acids, are continually produced under varying salinity regimes across the LAA. The individual western sandpipers that may feed in areas experiencing salinity changes during their stopover would still be obtaining energy from biofilm, as well as from invertebrates. Moreover, the data show that there will be large areas within the LAA containing productive, nutritious biofilm available to foraging shorebirds to support western sandpipers.

Finally, even if, in the unlikely event that the predicted short-term salinity changes did cause a temporary decline in polyunsaturated fatty acid production in some biofilm at Roberts Bank that was not offset by project-induced increases in polyunsaturated fatty acid in other biofilm at Roberts Bank *and* that decline affected the ability of some western sandpipers stopping over at Roberts Bank to meet their total energy intake requirements *and* that reduced ability resulted in compromised migration or breeding success of those individuals, it is *not likely* that the integrity of the total western sandpiper population would be compromised, given that, on average, 83% of western sandpiper do not stop over at the mudflats near the project and would be completely unaffected by the project and that only some of the remaining 17% could be affected.

In its submission, ECCC acknowledges that "an appropriately designed phased approach could help reduce the likelihood that the species-level impact to the Western Sandpiper identified by ECCC experts would occur." The port authority agrees.

# Appendix A Clarifications related to ECCC's submission

In its submission dated October 26, 2022[55] ECCC summarizes various aspects of the information provided in the port authority's June submission[56]. In doing so, ECCC has mischaracterized aspects of the information, data and analysis that could be misleading, and these warrant clarification to ensure the information considered by IAAC and the minister is accurate. Clarifications of key mischaracterizations are provided below; the port authority has not corrected every mischaracterization or error.

## Population status of western sandpiper

In its submission, ECCC reiterates their view that the western sandpiper population at Roberts Bank is declining based on site-specific census data, referencing Canham et al. (2021)[57]. It is worth nothing that the decrease cited in the publication is not statistically significant, as 95% confidence interval spans zero (i.e., 0.032 to -0.3, a positive value represents an increase). ECCC expresses their view despite evidence in Weiser et al. (2020)[58], which was co-authored by staff at ECCC, indicating a statistically significant increase in the western sandpiper population.

Studies have demonstrated that shorebird censuses (i.e., count or abundance data) are not a good indicator of a species' population trend. Further, shorebird censuses at single stopover sites have also been noted as an unreliable indicator of overall population trend, including for shorebirds. Bart et al. (2007)[59] compiled over 32,000 shorebird surveys for 30 species from 168 sites in two regions in North America. The authors concluded that census data are noisy, inconsistent, and don't support firm conclusions concerning population trends. Rieter et al. (2020)[60], which ECCC staff co-authored, found that shorebird counts, including western sandpipers, from a single location are not reliable to indicate a population trend. That paper emphasizes the need for standardized shorebird abundance data from multiple sites to provide "insight on whether fluctuations at one location represent real changes in abundance". In addition, Ydenberg et al. (2004)[61] found that shorebird "abundance" counts at a stopover site are not a reliable indicator of overall population status as data are strongly affected by shorebird behaviour. In investigating western sandpiper count data (1992-2001) at Sidney Island[62], B.C., the authors determined that the 18% annual per year decline was entirely attributable to a shortening length of stay (i.e., a change in shorebird behaviour) and not an indicator of a declining population (Figure 1). The authors concluded that behavioural changes in migratory shorebirds may be "contributing to the widespread census declines reported in North America" (Ydenberg et al. 2004).

[55] CIAR #3557, supra note 1.
[56] CIAR #3553, supra note 2.
[57] Canham, Rachel, Scott A. Flemming, David D. Hope, and Mark C. Drever. "Sandpipers go with the flow: Correlations between estuarine conditions and shorebird abundance at an important stopover on the Pacific Flyway." *Ecology and evolution* 11, no. 6 (2021): 2828-2841.
[58] Weiser et al., supra note 53.
[59] Bart, Jonathan, Stephen Brown, Brian Harrington, and R. I. Guy Morrison. "Survey trends of North American shorebirds: Population declines or shifting distributions?." *Journal of Avian Biology* 38, no. 1 (2007): 73-82.
[60] Reiter, Matthew, Eduardo Palacios, Diana Eusse-Gonzalez, Richard Johnston González, Pete Davidson, David Bradley, Rob Clay et al. "A monitoring framework for assessing threats to nonbreeding shorebirds on the Pacific Coast of the Americas." *Avian Conservation and Ecology* 15, no. 2 (2020).
[61] Ydenberg, Ronald C., Robert W. Butler, David B. Lank, Barry D. Smith, and John Ireland. "Western sandpipers have altered migration tactics as peregrine falcon populations have recovered." *Proceedings of the Royal Society of London. Series B: Biological Sciences* 271, no. 1545 (2004): 1263-1269.
[62] Sidney Island, B.C., is located in the Salish Sea approximate ~ 65 km from Roberts Bank.

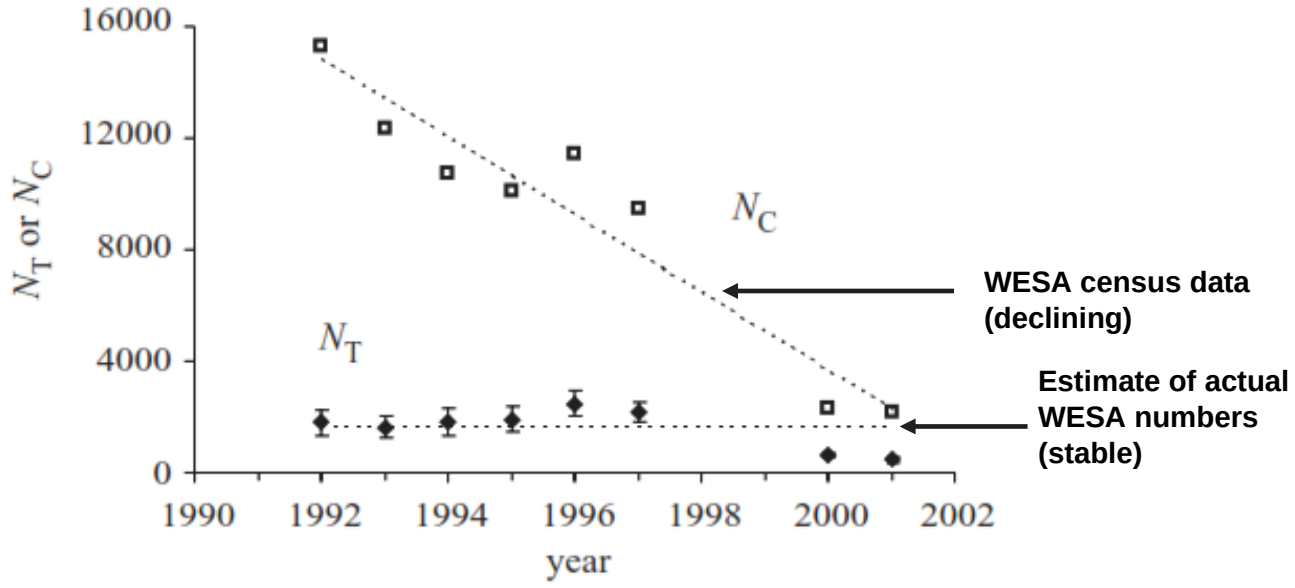



**Figure 1** **Replication[63] of Figure 4 of Ydenberg et al. (2004) illustrating the comparison of annual cumulative daily counts ($N_C$) of western sandpipers stopping over at Sidney Island between 1992 and 2001, with estimates of the true number ($N_T$). Estimate of $N_T$ report and standard error of the mean associated with the uncertainty in estimating length of stay (LOS). The values for $N_C$ indicate a significantly declining trend of ca. 18% per year. By contrast, estimates of $N^T$ indicate no significant decline (p=0.24). The method for estimating $N_T$ is explained in Ydenberg et al. (2004).**

Count data from a stopover site provides different information than results from a demographic model, which is founded on more developed population theory. The population dynamics approach applied by Weiser et al. (2020) is considered to be a more scientifically robust approach to identify a species population trend, as population models are more complete, founded on population theory and better understood. Hence, the results from the Weiser et al. (2020) demographic model and analysis cited by the port authority continue to be the scientifically defensible evidence regarding the upward western sandpiper population trend. As noted in the port authority's June submission, the study concluded that the western sandpiper population is increasing. It is also worth noting that the western sandpiper is listed as 'secure' provincially[64] and not identified as at risk federally.[65]

## Evidence of salinity trigger

In its submission, ECCC asserts that the project "remains likely to lead to reductions in biofilm quantity and quality" and bases this assertion on their view that the data provided by the port authority is consistent with and demonstrates the salinity trigger hypothesis; it does not.

ECCC refers to the Canham et al. (2021) study in their submission and notes that western sandpipers' use of Roberts Bank during spring migration is negatively correlated with freshwater discharge from the Fraser River. Canham et al. (2021), which was co-authored by staff at ECCC, concludes that "this correlational study cannot disentangle the underlying mechanisms surrounding growth and productivity in intertidal biofilm, but highlights the complexity of estuarine systems where the influence of freshwater incursion on shorebird abundance requires further study". The port authority agrees that estuarine ecosystems, such as

[63] Labels adapted for clarity, with permission of the author.
[64] B.C. Conservation Data Centre. 2022. BC Species and Ecosystems Explorer. B.C. Minist. of Environ. Victoria, B.C. Available at https://a100.gov.bc.ca/pub/eswp/.
[65] https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html.

the Fraser River estuary, are complex systems, comprising robust and dynamic environments exposed to regular natural variability. Species that occupy and rely on estuarine habitats are adapted to dynamic and ever-changing environmental conditions. Further, the Canham et al. (2021) study also found a correlation in yearly western sandpiper counts with tidal amplitude, as the size of tides influences the amount of mudflat habitat available to foraging shorebirds during their stopover.

In its submission, ECCC states that the correlation "establishes a clear link" between western sandpipers and salinity conditions at Roberts Bank with reference to data provided by the port authority for the years 2016 to 2018, and that "low variation in salinity and low fatty acid production by diatoms may have resulted in reduced shorebird use". ECCC also asserts that the "changes to the hydrological regime arising from the Project would result in a lower abundance of sandpipers and exacerbate their ongoing long-term population decline."

As noted by the review panel, 'the Proponent undertook biofilm studies in 2016, 2017 and 2018 to address the information gaps and respond to the concerns identified by ECCC".[66] Based on these studies, the review panel found "that the Proponent demonstrated that fatty acid production did not vary across the salinity gradient currently experienced at Roberts Bank in the area where shorebirds forage during northward migration at the end of April to early May".[67] As previously described, the range of Fraser River discharge captured by the port authority studies (2016-2018) are within the range of typical Fraser River flows during most of the northward migration period, as well as on the higher end of the range for some portions of this period.[68] The port authority indeed demonstrated that the range in salinity did not reach the trigger under either typical conditions or high flow conditions (large amplitude salinity oscillations within a tidal cycle between 20-25 PSU) hypothesized by ECCC to be required to induce polyunsaturated fatty acid production in biofilm.[69] [70] Given that flow conditions in these years of study include typical conditions, there continues to be no direct empirical evidence supporting the salinity trigger hypothesis or the reliance of western sandpipers on higher polyunsaturated fatty acid levels hypothesized to be induced by high salinity ranges. In turn, it cannot be inferred that the low counts of western sandpipers in the three years of study (2016-2018) is due to a lack of a salinity trigger, as cited by ECCC. This line of argument would suggest that salinity trigger was present in almost all other years, for which there is no evidence. It is evident, however, as noted above, that census data for a stopover site is variable, as observed in the count data presented in Figure 3 of ECCC's submission. For example, in 2019, western sandpiper numbers were higher, near the upper 95% confidence interval of the median count. Western sandpiper data has been variable over the count period as western sandpipers stop over at multiple sites during their northward migration to breeding grounds (see figure in **Appendix C**).

The idea that a change in salinity can shock diatoms to produce fatty acids is imported from laboratory studies conducted by the biotechnology sector for biofuels, as noted in ECCC's Undertaking #29.[71] There is also no direct empirical evidence from other studies of a salinity trigger in natural ecosystems, including considering recently published papers, as clarified in the port authority's response to the minister's IR.[72] There is also no evidence that fatty acid production was low during 2016, 2017 and 2018, as suggested by ECCC. The port authority studies do not show reduced fatty acid production in those years.

For the sake of argument, assuming the salinity trigger hypothesis is correct and that western sandpipers rely on a salinity trigger to induce higher polyunsaturated fatty acid production in biofilm, one would surmise that an immediate population-level effect should be observable if there was a lack of a salinity trigger as hypothesized by ECCC. Following three years of no salinity trigger in 2016, 2017 or 2018, a notable population level effect would be expected, which would require multiple years for the WESA population to rebound, if the salinity trigger hypothesis were correct. Thus, if there was a population-level reliance on a salinity trigger one would anticipate observing a population level decrease in 2019. However, western sandpiper use of Roberts Bank actually increased in 2019 and was in fact near the upper 95% confidence interval of the median count, as shown in Figure 3 of ECCC's submission.

---

[66] CIAR #2062, supra note 3 at p. 149.
[67] Ibid. p 150.
[68] CIAR #3553, supra note 2 at figure A-1.
[69] CIAR #1947, supra note 46.
[70] CIAR #2062, supra note 3.
[71] CIAR #1947, supra note 46.
[72] CIAR #2083, Vancouver Fraser Port Authority to Impact Assessment Agency of Canada re: Response to Information Requests, Appendix IR2020-4-A.

As noted above, census data for a stopover site is not a reliable index of population trend but is known to be influenced by bird behaviour. Western sandpipers stop over at multiple sites during their northward migration to breeding grounds (see figure in **Appendix C**). With the understanding that annually approximately 83% of western sandpipers typically do not stop over near the project, it would be reasonable to conclude that more western sandpipers selected alternate migratory stopover sites in 2016 to 2018 or stayed for a shorter time, as observed in the Ydenberg et al. (2004) study. In 2019, western sandpiper numbers were higher, near the upper 95% confidence interval of the median count, reflecting increased use (abundance or length of stay) (see Figure 3 of ECCC's submission).

To conclude, there is no empirical evidence of a salinity trigger, an existing consistent observable pattern of large, rapid salinity change. In turn, there is no evidence that the project is likely to lead to a population-level effect on western sandpipers.

# Appendix B Additional information requested by ECCC

In its submission dated October 26, 2022[73], ECCC indicated that additional details related to the precautionary construction approach follow-up program condition would be helpful to support decision-making. In response the port authority provides additional detail, summarized below and reflected in suggested edits to the proposed draft condition provided in the port authority's June submission**.**

The scientific investigations required under the proposed precautionary construction approach follow-up program would be designed to detect early signals of an immediate population-level effect on western sandpipers, attributable to the project, following east basin containment dyke construction.

The western sandpiper precautionary construction approach follow-up program will be scientifically defensible and be developed to verify the predicted effect, specifically that project-induced salinity changes would not result in an immediate population-level effect on western sandpipers. This follow-up program will require monitoring and development of scientifically defensible action threshold(s) to trigger adaptive management measures.

The western sandpiper precautionary construction approach follow-up program will be founded on multiple years of baseline data including data gathered during the assessment and in the pre-construction period, for the selected parameters. The port authority has collected an unparalleled amount of salinity, biofilm, and western sandpiper data for Roberts Bank during the decade of research completed to date. This foundation of robust existing data will ensure the development of strong baseline datasets that can be used to understand the temporal variability in salinity, biofilm, and western sandpiper migration, and support the identification of robust and scientifically defensible action threshold(s). The baseline data will also assist in the ongoing efforts to fill the knowledge gaps and support enhanced understanding of the salinity trigger hypothesis.

The western sandpiper precautionary construction approach follow-up program will require:

- **Additional modelling**

  The port authority proposes updating the salinity modelling (using the model used in the environmental assessment) to identify the anticipated changes in salinity during the early stages of construction, which in turn will support monitoring design (sample size, location, and frequency).

- **Monitoring**

  The follow-up program will require monitoring, including direct data collection, and could use data collected from ongoing third-party monitoring programs. The monitoring program will include a suite of monitoring parameters, which will be selected in consultation with ECCC, Indigenous groups, and scientific experts. In addition to parameters related to salinity and fatty acids in biofilm, the parameters may include western sandpiper foraging intensity and spatial use in the Fraser River estuary, success of western sandpiper northward migration (including tracking individuals at other stopover sites), western sandpiper condition and diet while foraging in the Fraser River estuary, and overall indicators of breeding success for the population.

  The monitoring program design will include selection of control sites and sample sizes and locations sufficient to detect the predicted changes. The western sandpiper precautionary construction approach follow-up program will also rely on data collected through the existing (and ongoing) salinity, biofilm, and western sandpiper field studies developed for the project's environmental assessment.

[73] CIAR #3557, supra note 1.

- **Analysis**

  The follow-up program will require the identification of an analytical framework, in consultation with ECCC, Indigenous groups, and scientific experts, to support appropriate analysis of the monitoring data collected prior to, during, and immediately after the construction of the east basin.

  Baseline data collected prior to construction will be analyzed to update the existing conditions of the suite of monitoring parameters selected. The data will also be analyzed to determine the range of temporal variability, which will inform the selection of scientifically defensible action threshold(s).

  As data is collected and received in the months following east basin construction, analyses will be undertaken to determine if any of the action threshold(s) are exceeded, thus requiring adaptive management. Scientific evidence will be relied upon when drawing conclusions with regard to changes in key monitoring parameters relative to defined threshold(s).

  The analytical methods for the western sandpiper precautionary construction approach follow-up program will be developed in consultation with ECCC, Indigenous groups, and scientific experts and may include tools and approaches like analysis for before-after-control-impact studies.

- **Adaptive management**

  The follow-up program will include scientifically-based and defensible action threshold(s) for determining whether the project is likely to cause an immediate population level impact to western sandpipers due to changes in polyunsaturated fatty acid production in biofilm caused by project-induced salinity changes.

  - Action threshold(s) represent the value or level of the selected and relevant monitoring parameter(s) that indicates an adverse effect, which, if not addressed through adaptive management measures, could be unacceptable
  - Action threshold(s) will account for variability determined through multiple years of baseline data collection
  - Thresholds will be developed in consultation with ECCC, Indigenous groups, and scientific experts

  The follow-up program will include identification of potential and feasible adaptive management measures.

  The follow-up program will also include the development of an action plan describing the process to be followed in selecting and implementing adaptive management measures if one or more action thresholds are exceeded.

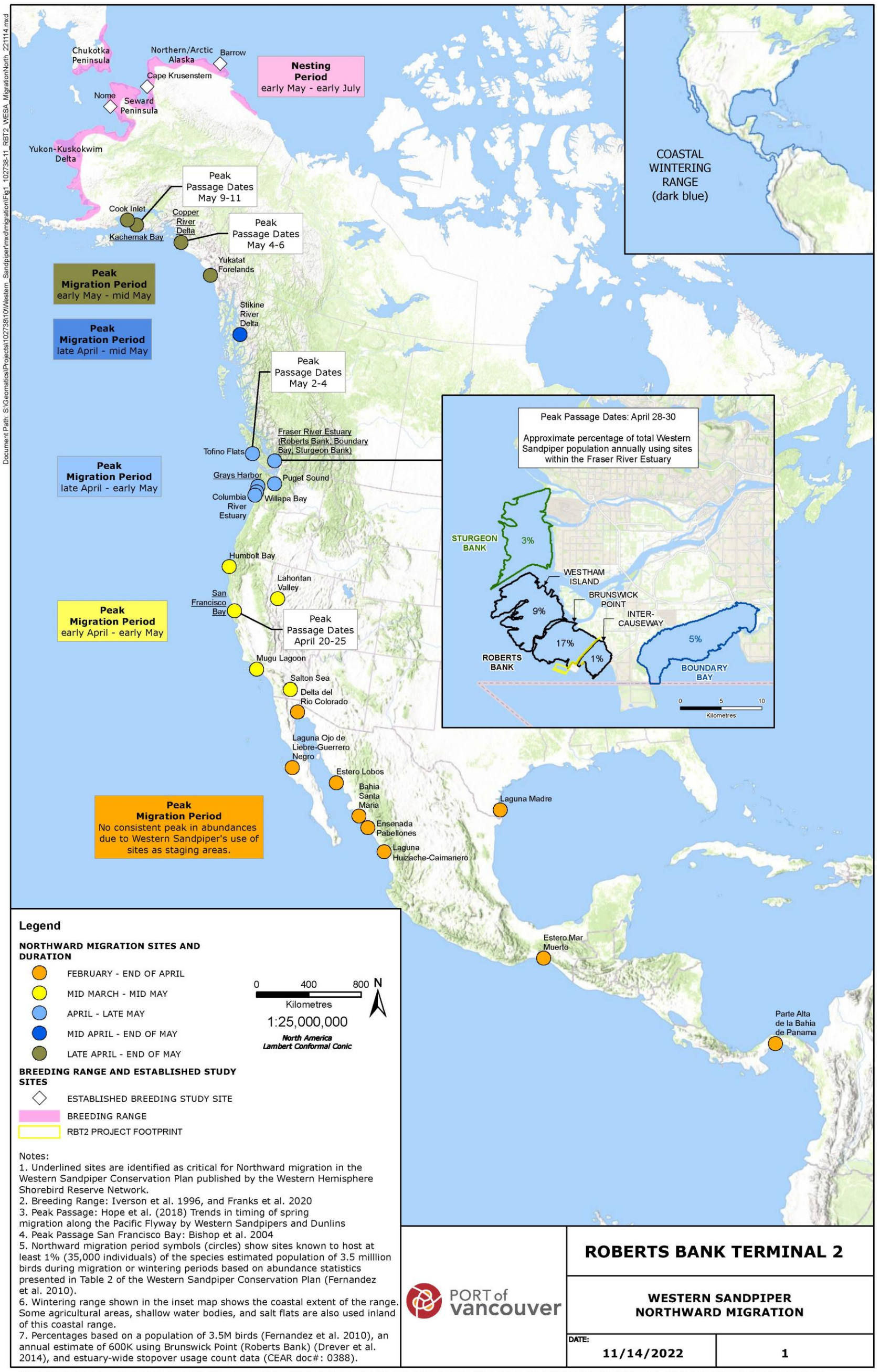
- **Reporting**

  As with all follow-up programs, the western sandpiper precautionary construction approach follow-up program will involve regular reporting of results that must be shared with Indigenous groups, ECCC and IAAC.

The information described above is reflected in suggested edits to the draft conditions provided by the port authority in its June submission.

## Appendix C Figure: Western sandpiper northward migration sites

**Western sandpiper northward migration sites, along the Pacific coast of the Americas, to the breeding grounds and associated peak migration period.**



# Appendix D – Port authority feedback on edits to draft conditions suggested by ECCC

**Table 1** **Response to comments of ECCC** Posted October 26, 2022. Link: CIAR #3557

| Original condition | ECCC Comment and suggested amendment | | | Port authority response |
|---|---|---|---|---|
| | **VFPA Comment/Suggested Change to Draft Conditions**<br>(VFPA's proposed additions reflected in bold and italicized text and deletions in strikethrough) | **ECCC Comment/Suggested Change to Draft Conditions**<br>(ECCC's proposed additions reflected by bold text and deletions in strikethrough) | **ECCC Comment on Proponent Response/Suggested Change to Draft Conditions** | |
| 10.14.2 – collect, during the northern migration period of the Western sandpiper (*Calidris mauri*) prior to and throughout construction and the first three years of operation, fatty acids and carbohydrates of invertebrate prey and biofilm and chlorophyll for biofilm, and record and report as both concentration (measure per $m^2$) and content (measure per gram of dry sediment); | 'collect, during the northern migration period of the Western sandpiper (*Calidris mauri*) prior to and ~~throughout~~ ~~construction~~, ***following completion of the construction of the marine terminal containment dykes***, and the first three years of operation, fatty acids and carbohydrates of invertebrate prey and biofilm and chlorophyll***-a*** for biofilm, and record and report as both concentration (measure per m2) and content (measure per gram of dry sediment);' | Collect, during the northern migration period of the Western sandpiper (*Calidris mauri*) prior to and throughout construction and the first three years of operation, fatty acids, **lipids,** and carbohydrates of invertebrate prey and biofilm, and **taxonomic composition and chlorophyll-a** for biofilm, and record and report as both concentration (measure per m2) and content (measure per gram of dry sediment); | ECCC's proposed additions to Condition 10.14.2 supports consistency between future monitoring and the baseline studies already conducted by the Proponent, as specified in Condition 10.14.<br>Further, community composition of biofilm is a strong driver of the fatty acid content. Without this information, the Proponent will not be able to identify the specific species that should be targeted in restoration/remediation efforts. This correction maintains consistency with Condition 10.14.3, which specifically indicates measuring lipids in the collected samples.<br>The proposed change by the Proponent would restrict monitoring to a specific period in the construction phase, which would lessen the probability of detecting an effect on biofilm that could occur during other phases in the construction, e.g., during an accidental spill. ECCC recommends retaining monitoring for the full construction period (i.e., retaining 'throughout construction'). | The port authority has no concern with respect to the addition of lipids to the condition.<br>The suggested reference to chlorophyll-a is consistent with the port authority's previous feedback.<br>The port authority notes that the review panel concluded that the project would not result in an adverse effect on biofilm productivity or composition and diatom assemblages at Roberts Bank (page 150, CIAR #2062). The review panel did not recommend any follow-up with respect to biofilm composition. Monitoring of taxonomic composition, which is not expected to be adversely affected by the project, is therefore not warranted. |
| 10.2.1 and 10.2.2 - new condition proposed on applying the lessons learned in the biofilm manual (see next column for proposed text by VFPA) | ***10.2.1: In designing and implementing any biofilm habitat creation or enhancement, including any biofilm habitat creation or enhancement included in any wetland compensation plan developed pursuant to condition 9.2 and any biofilm habitat creation or enhancement implemented as a mitigation measure pursuant to condition 2.5.5 or 9.4.4, the Proponent shall apply the methods and best practices documented pursuant to condition 10.2.*** | N/A | This proposed condition describes detailed reporting on the implementation of wetland compensation/biofilm remediation. Condition 10.2.2 appears to indicate that the Proponent is not necessarily beholden to apply the best practices as long as the reasons are detailed in a response to the Agency, Indigenous groups (Roberts Bank), and Environment and Climate Change Canada. | The port authority has proposed to proactively implement biofilm habitat creation. The port authority intends to apply best practices, which will apply lessons learned described in the biofilm manual (pursuant to draft condition 10.2), and will also consider developments in the continually growing body of literature regarding biofilm habitat creation, restoration, and enhancement.<br>The port authority proposed these new conditions to clarify this intent and to recognize that the methods and best practices that would be implemented at the time may be other than those documented in the manual. The port authority notes that it has also |

| Original condition | ECCC Comment and suggested amendment | | | Port authority response |
|---|---|---|---|---|
| | **VFPA Comment/Suggested Change to Draft Conditions**<br>(VFPA's proposed additions reflected in bold and italicized text and deletions in strikethrough) | **ECCC Comment/Suggested Change to Draft Conditions**<br>(ECCC's proposed additions reflected by bold text and deletions in strikethrough) | **ECCC Comment on Proponent Response/Suggested Change to Draft Conditions** | **Port authority response** |
| | ***10.2.2: If the methods and best practices documented pursuant to condition 10.2 cannot be applied to biofilm habitat creation or enhancement undertaken by the Proponent, the Proponent shall document the reasons and the alternative methods or practices applied. The Proponent shall provide the reasons and the alternative methods or practices applied to the Agency, Indigenous groups (Roberts Bank), and Environment and Climate Change Canada.*** | | | proposed revisions to draft condition 10.2 that would require any emerging knowledge and science, including knowledge and science developed as part of the design and implementation of any biofilm habitat creation and Indigenous knowledge, to be incorporated into the biofilm habitat creation manual.<br>The port authority suggests no further changes to the draft conditions it previously proposed. |