IR2020-1.2 RBT2 Proposed Fish and Fish Habitat Offsetting Plan

Summary

The Vancouver Fraser Port Authority (the port authority) has developed a comprehensive suite of mitigation measures, including a fish and fish habitat offsetting plan, for the Roberts Bank Terminal 2 (RBT2) Project. The port authority has applied a mitigation hierarchy of first avoiding potential adverse effects, then reducing potential adverse effects that cannot be avoided, then compensating for or offsetting the effects that remain after the implementation of avoidance and reduction measures. The plan integrates the priorities and preferences of Indigenous groups and is based on a conservative and precautionary approach to calculating effects and applying avoidance, reduction, and offsetting measures. It uses multiple lines of evidence, accounts for all sources of potential uncertainty and temporal lag, proposes comprehensive follow-up monitoring, and includes adaptive management and potential contingency measures.

The plan proposed by the port authority fully offsets the effects of the project on juvenile salmon and counterbalances the effects to fish, and fish habitat. With mitigation, including offsetting, the project will result in a net gain in juvenile salmon habitat and productivity while disruption of juvenile salmon migration will be mitigated.

Avoidance and reduction measures

In response to the minister of environment and climate change's (the minister's) request, the port authority is advancing a number of additional avoidance and reduction measures to avoid or reduce potential project-related effects on fish (including juvenile salmon) and fish habitat, and further reduce required offsetting.

- As described in **IR2020-2.1**, the marine terminal footprint will be reduced by up to 10.3 hectares (ha) and the widened causeway by up to 4.1 ha, resulting in approximately 1.5 ha of juvenile salmon habitat being avoided.
- As described in **IR2020-2.2**, the port authority has identified implementation of a breach (i.e., fish passage for migrating juvenile salmon) as a new reduction measure that is expected to mitigate the potential for the project to disrupt juvenile salmon migration.

Offsetting

The port authority is advancing projects to restore and enhance up to 86 ha of fish habitat, including intertidal marsh and native eelgrass, in order to offset the potential adverse effects of the project, as described in the response to **IR2020-1.1**. This amounts to nearly three times the amount of habitat offsetting conceptually proposed in the environmental impact statement (EIS)[1], and 22 ha more than required to fully counterbalance the effects of the project that would remain after avoidance and reduction measures have been implemented. The additional 22 ha of offsetting provides greater confidence and assurance that gains will be realized for juvenile salmon, fish and fish habitat, and that uncertainty and temporal lag have been fully addressed.

Based on consultation with Indigenous groups and engagement with Fisheries and Oceans Canada (DFO), the offsetting plan integrates habitat bank credits, enhanced onsite offsetting, new offsite offsetting projects, including priority projects identified by Indigenous groups, and ongoing involvement of Indigenous groups in offsetting plan development, implementation, and monitoring.

[1] CIAR Document #181 Roberts Bank Terminal 2 Project - Environmental Impact Statement. https://iaac-aeic.gc.ca/050/evaluations/document/114311

The offsetting plan addresses effects of the project because of the following:

- Avoidance and reduction measures implemented prior to offsetting, including placing the terminal in deeper, lower productivity subtidal waters, and additional measures being advanced now, significantly reduce potential project impacts
- Lower productivity habitats impacted by the project are replaced by more productive eelgrass and marsh habitats
- Ecosystem modelling, supported by the review panel, demonstrates that the new RBT2 terminal will indirectly increase marsh and eelgrass productivity in the biophysical local assessment area (LAA)[2] due to changes behind the terminal in wave and current conditions, and that this habitat in turn will attract key species like juvenile Chinook salmon and Dungeness crab, resulting in 16 times more fish and fish habitat productivity than that lost due to the project footprint
- Even if indirect productivity gains are not considered, proposed offsetting projects alone will provide more than four times the productivity than that lost due to the project footprint (e.g., a 4:1 offsetting ratio)

In addition, to manage uncertainty in assessment predictions (for example, due to the use of forecasting modelling tools) and in response to input received from DFO, the port authority has undertaken extensive additional technical analyses to clearly identify and quantify uncertainty. Uncertainty was then accounted for to determine how the proposed offsetting plan fully offsets potential adverse effects of the project on juvenile Chinook salmon and counterbalances the effects to fish and fish habitat.

Follow-up program and adaptive management

As part of the project's follow-up program, the port authority is advancing planning and development of four follow-up program elements (i.e., marine vegetation, marine invertebrates, rockfish/lingcod, great blue heron) to evaluate ecosystem model outputs and in turn verify assessment predictions. In addition, the port authority will undertake effectiveness monitoring of all offsetting habitat projects to determine that they function as intended. The port authority will engage with DFO and consult with Indigenous groups during planning and development of these follow-up monitoring elements, including in relation to study design, monitoring frequency, monitoring metrics, and reporting. Consistent with the project's Adaptive Management Framework, should monitoring as part of these follow-up monitoring elements determine a departure from pre-determined action thresholds, adaptive measures will be identified, evaluated, and implemented in consultation with DFO and Indigenous groups.

Other available offsetting opportunities and potential contingency projects

In addition to the 86 ha of conventional offsetting currently being advanced, the port authority is also advancing other available offsetting opportunities, including a project identified by Tsawwassen First Nation (the Tsawwassen Marshlands Project) comprising several components, a complementary measure specific to identifying causes of local marsh recession, and the Non-Conventional Offsetting Program (NCOP). The NCOP would focus on offsetting projects that deliver the best conservation and enhancement outcomes for priority fish species (e.g., Chinook salmon). The port authority will continue to develop the NCOP as part of the offsetting plan, as per input from DFO. These additional offsetting opportunities have the potential to benefit productivity of fish (including juvenile salmon) and fish habitat and are anticipated to be included in the RBT2 *Fisheries Act* authorization in part or in whole (see **IR2020-1.1** for more details).

Potential onsite and offsite contingency projects (45 ha to 65 ha) are also available should proposed offsetting projects not perform as anticipated (see **IR2020-1.1** for more details). These potential contingency projects include additional onsite eelgrass and/or marsh habitat north of the proposed RBT2 terminal, additional onsite offsetting through a specific component of the Tsawwassen Marshlands Project (expansion of marsh habitat seaward of the outer dyke in the inter-causeway area) identified by Tsawwassen First Nation, future projects arising from the NCOP, and the next most technically well-developed and suitable offsetting project from the port

[2] CIAR Document #181 EIS Figures 11-1, 12-1, and 13-1.-F

authority's Habitat Enhancement Program (which would likely involve the restoration, enhancement, or creation of intertidal marsh habitat).

Background

In his letter of August 24, 2020,[3] the minister requested the port authority propose an offsetting plan that would address potential adverse effects from the project specifically for juvenile (Chinook) salmon, fish, and fish habitat. To provide context for the proposed offsetting plan, the following response first provides an overview of key assessment conclusions on juvenile salmon, fish and fish habitat presented in the project's EIS and describes the additional measures the port authority has investigated since the public hearing in order to further avoid, reduce, and offset project effects to juvenile salmon, fish, and fish habitat. It then sets out the proposed fish and fish habitat offsetting plan for RBT2. Background on how offsetting projects proposed in the EIS have been adapted since the public hearing is found in **IR2020-1.1**.

Juvenile Chinook salmon

As stated in the port authority's closing remarks,[4] without mitigation, the project has the potential to result in a minor decrease in juvenile salmon productivity by disrupting outmigration (i.e., altering habitat availability) and by changing the light environment. Mitigation proposed to address this minor decrease includes light management measures (such as reducing excess lighting during operation[5]) and creation of onsite offsetting habitats in the form of native eelgrass transplants and intertidal marsh planting (which would increase food supply, refuge habitat availability, and productivity of juvenile salmon).

Placement of the marine terminal in subtidal waters, away from more productive juvenile salmon habitat in the intertidal zone, is also predicted to increase productivity of juvenile salmon indirectly. Specifically, the configuration of the marine terminal is predicted to create a wave shadow effect immediately north of the terminal where physical conditions are predicted to become conducive to increases in juvenile salmon prey (macrofauna) and rearing habitat (intertidal marsh, native eelgrass).

With mitigation, including onsite offsetting, it was concluded in the EIS that changes in juvenile salmon productivity from potential project-related disruption to migration would be negligible. In its closing remarks, the port authority committed to enhancing offsetting (i.e., increasing the amount of offsetting described in the EIS) for priority species, such as Chinook salmon, and priority habitats, intertidal marsh and native eelgrass.[6] The port authority also committed to a follow-up program element for juvenile salmon[7] to verify assessment predictions and provide a mechanism for adaptive management.

Fish and fish habitat

The EIS assessed potential effects to fish and fish habitat through the following valued components: marine invertebrates and marine fish (fish), and marine vegetation (fish habitat). While minor residual effects, taking mitigation into account, were identified for some species (orange sea pens, Dungeness crab, infaunal bivalves, forage fish, and flatfish), residual adverse effects to these valued components would not be significant.

Assessment conclusions for marine vegetation accounted for predicted indirect increases in productivity with the project, pre-mitigation, and further increases in productivity following implementation of mitigation measures, including offsetting. Assessment conclusions also considered the high resiliency of marine invertebrate populations and high abundance of flatfish, the continued availability of suitable fish habitat at Roberts Bank

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[3] CIAR Document #2067 From the Minister of Environment and Climate Change to the Vancouver Fraser Port Authority re: Information Request. https://iaac-aeic.gc.ca/050/documents/p80054/135827E.pdf
[4] CIAR Document #2045 From the Vancouver Fraser Port Authority to the Review Panel re: Closing Remarks. https://iaac-aeic.gc.ca/050/evaluations/document/132548
[5] Commitment #24 in updated project commitments (CIAR Document #2001)
[6] Commitment #41 in updated project commitments (CIAR Document #2001)
[7] Commitment #81 in updated project commitments (CIAR Document #2001)

following project construction, as well as the commitment by the port authority to implement measures to avoid and reduce adverse effects to fish and fish habitat. Some of these measures are placing the terminal in subtidal waters effectively avoiding overlap with fish habitat in the intertidal zone; adherence to fisheries-sensitive windows that avoid sensitive life stages of fish and invertebrates, including juvenile salmon, herring, and Dungeness crab; as well as targeted measures such as salvaging Dungeness crab prior to project-related construction dredging activities and transplanting approximately 10% of the orange sea pen aggregation.

As indicated above, the port authority is enhancing offsetting (by increasing the amount) and focusing on priority species and habitats.[6] The port authority is also undertaking the development of several follow-up program elements for all marine vegetation representative species or groups (i.e., native and non-native eelgrass, intertidal marsh, *Ulva*, biomat, biofilm, and macroalgae), as well as for juvenile crab nursery habitat, reef fish, and infaunal macroinvertebrate communities (macrofauna and meiofauna) to verify assessment predictions and provide a mechanism for adaptive management.

Response

Minister's request: Provide a proposed fish and fish habitat offsetting plan for RBT2, including:

Part A: Propose an offsetting plan that would directly address the habitat loss and potential disruption of juvenile salmon migration that would be caused by the proposed Project.

The proposed offsetting plan directly addresses the habitat loss and potential disruption of juvenile Chinook salmon migration from the project. In fact, the project will result in a net gain in juvenile Chinook salmon habitat of 37.4 ha, and juvenile Chinook salmon migration disruption will be mitigated following application of avoidance, reduction, and offsetting measures.

As explained in the following sections, multiple lines of evidence indicate that up to 86 ha of offsetting presented in **IR2020-1.1** more than counterbalance the effects of the project on juvenile Chinook salmon, fish and fish habitat, even when discounting to account for uncertainty and potential delays in offsetting function. Potential uncertainty in offsetting predictions and function will be further managed by the provision of additional offsetting opportunities (such as complementary measures and the NCOP; the port authority will continue to develop the NCOP as part of the offsetting plan, as per input from DFO), potential contingency projects, rigorous monitoring, and adaptive management.

Part A of this response presents the approach taken in developing the offsetting plan (e.g., consultation with Indigenous groups, application of the mitigation hierarchy, focus on high productivity habitats and species of interest, leveraging previous experience, managing uncertainty, and precautionary approach), and how the plan fully offsets effects to juvenile Chinook salmon habitat and migration disruption. **Parts B** and **C** provide the analyses supporting the offsetting plan.

Approach to the offsetting plan

The approach taken to develop the proposed offsetting plan was informed by several guiding principles, summarized here and described in greater detail in the following sub-sections.

Consultation: Through the port authority's ongoing consultation with Indigenous groups, input to the project's proposed offsetting plan has been received and incorporated. Moreover, several offsetting projects of priority brought forward by Indigenous groups have been included in the offsetting plan (i.e., offsetting opportunities recently brought forward by Tsawwassen First Nation described in **IR2020-1.1**).

Mitigation hierarchy: In line with federal policy and the mitigation hierarchy of avoiding, reducing, and offsetting (described in greater detail below), a suite of expanded and enhanced avoidance, reduction, and offsetting measures is being proposed for the project. As examples, siting the marine terminal[8] in predominantly subtidal, lower productivity, waters (a key avoidance measure for the project) will effectively avoid sensitive, higher productivity, intertidal fish and fish habitat, and implementation of a breach will mitigate the potential effect of juvenile Chinook salmon migration (as described in **IR2020-2.2**).

High productivity and species of interest: Based on input from Indigenous groups and DFO, the proposed offsetting plan has purposefully targeted the construction of higher productivity fish habitat, with focus on priority species and habitats. For example, a large proportion of the proposed offsetting plan will provide intertidal marsh and native eelgrass habitats that are known to be important to juvenile Chinook salmon and Dungeness crab.

Leveraging previous experience building successful offsetting habitat: The proposed offsetting plan includes conventional (i.e., commonly constructed by the port authority with a high success rate of functioning as intended) offsetting projects that have already been constructed and are functioning (i.e., drawn from the port authority's habitat bank) and offsetting projects that have already undergone several years of substantial investigative work.

Managing uncertainty: The port authority has managed potential uncertainty in offsetting predictions and functioning. These include undertaking three lines of evidence to evaluate how proposed offsetting counterbalances the effects of the project, analyses and discounting to address potential uncertainty (in offsetting predictions and delays in functioning), additional offsetting opportunities, potential contingency projects (totaling 45 ha to 65 ha), robust follow-up monitoring, and adaptive management.

Conservative approach: The port authority took a conservative approach to developing the offsetting plan. As explained in **Parts B** and **C**, several examples of this conservative approach include assuming that it will take five years to build all offsetting projects (even when eelgrass transplanting, for example, will be productive after the first year), assuming that intertidal marsh offsetting projects require seven years to become fully functional (when it has been the port authority's experience that this is likely achieved in three to seven years), and, perhaps more notably, advancing 22 ha more conventional offsetting than is required to offset the effects of the project.

Additional information on the port authority's approach to developing the offsetting plan is provided below.

Consultation

A key objective of the proposed offsetting plan is to reflect feedback received through consultation and collaborative processes with Indigenous groups. Through the port authority's ongoing consultation activities, input has been incorporated into the project's proposed offsetting plan, including the advancement of several offsetting projects of priority brought forward by Indigenous groups as well as priority species of interest to Indigenous groups. Specifically, three offsetting projects (i.e., Tilbury Island Peninsula Enhancement Project, Finn Slough Enhancement Project, and Semiahmoo Bay-Little Campbell River Enhancement Project), ranging between 3.5 ha and 8 ha in areal extent (see **IR2020-1.1**, Table IR2020-1.1-1) have been brought forward by Indigenous groups as priority projects and are included in the current offsetting plan. Indigenous group input (including on the types of offsetting habitat and species of interest) has been sought and integrated into all offsetting projects comprising the proposed offsetting plan, which has been notably improved and enhanced since the EIS. All offsetting projects being considered by the port authority to counterbalance project-related effects to fish (including juvenile salmon) and fish habitat are described in detail in **IR2020-1.1**.

Consultation with Indigenous groups is ongoing and the port authority's commitment to this approach is being demonstrated in the current collaborations with many Indigenous groups. One example is the work with Tsawwassen First Nation where continued dialogue is focused on exploring the advancement of the Tsawwassen Marshlands Project. Additionally, this commitment is reflected in the offsetting plan's alignment with Musqueam's vision of creating a mosaic of habitat enhancement (for increased feeding, rearing, and refuge for a range of priority species and life stages throughout the Fraser River estuary). This aligns with Musqueam's responsibility to

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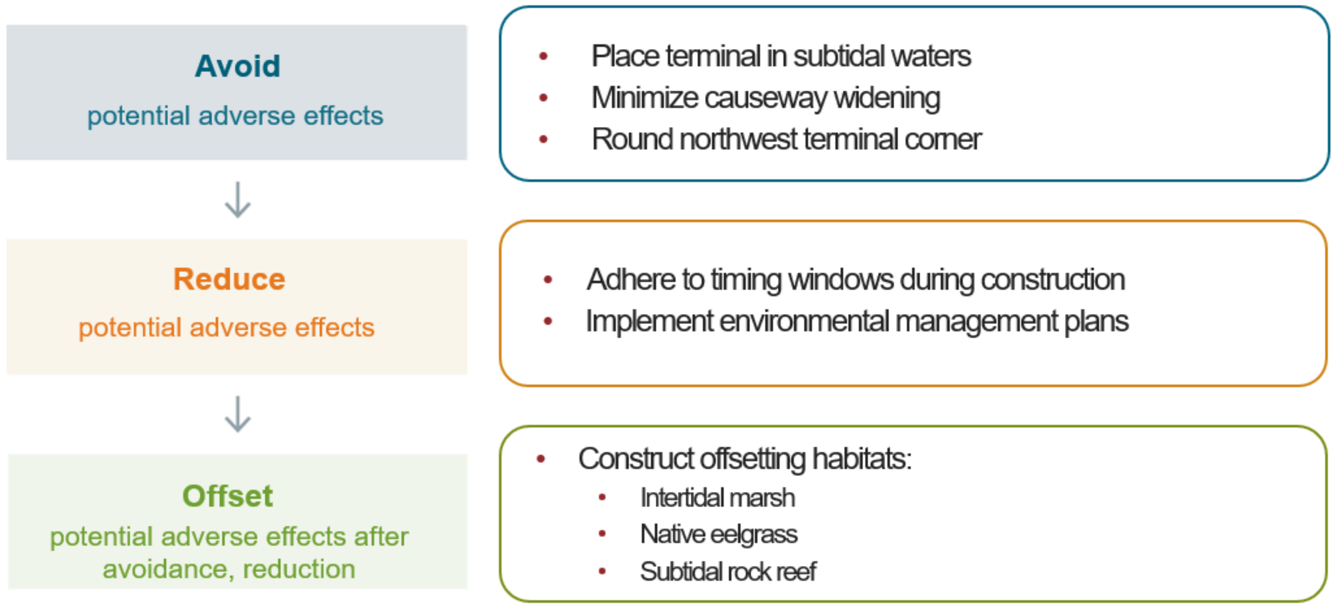
[8] CIAR Document #539 From the Review Panel Secretariat to the Review Panel re: Summary Report - Roberts Bank Terminal 2 Project Trade-Off Process and Output Document. https://iaac-aeic.gc.ca/050/documents/p80054/115548E.pdf

be stewards of their traditional territory and ensure there are adequate ecological and cultural resources to support the cultural continuity of future generations of Musqueam people.

Applying the mitigation hierarchy: avoid, reduce, offset

In the development of the offsetting plan and in line with federal policy the port authority has sought to first avoid then reduce potential adverse effects of the project on fish and fish habitat to minimize the amount of offsetting required. The mitigation hierarchy applied in developing the project's offsetting plan is shown in **Figure IR2020-1.2-1**.

Figure IR2020-1.2-1: Mitigation hierarchy the port authority has applied in developing the offsetting plan proposed for the Roberts Bank Terminal 2 Project. Examples are shown in open boxes of measures to first avoid potential adverse effects, second reduce potential adverse effects that cannot be avoided, and then offset potential adverse effects that remain after implementation of avoidance and reduction measures.



Feedback from Indigenous groups received on the draft **IR2020-1.1** indicated a preference for less focus on avoidance and reduction measures, in the offsetting plan. In response, previous detail on these measures has been moved into **Appendix IR2020-1.2-E** with a summary provided below.

Avoidance and reduction measures

A comprehensive suite of avoidance and reduction measures being advanced by the port authority to avoid or reduce potential project-related effects on fish (including juvenile salmon) and fish habitat is summarized in **Table IR2020-1.2-1** (see also **Appendix IR2020-1.2-E**, Table IR2020-1.2-E1 for further details on these measures). Since the public hearing, the port authority has undertaken additional work and has identified measures to further avoid or reduce potential project-related effects to fish (including juvenile salmon) and fish habitat. This work has been guided by input shared through ongoing consultation and collaboration processes with Indigenous groups and DFO. In **Table IR2020-1.2-1**, additional avoidance and reduction measures identified since the public hearing are shown as new, while avoidance and reduction measures that are described in the updated project commitments (CIAR Document #2001[9]) are also noted.

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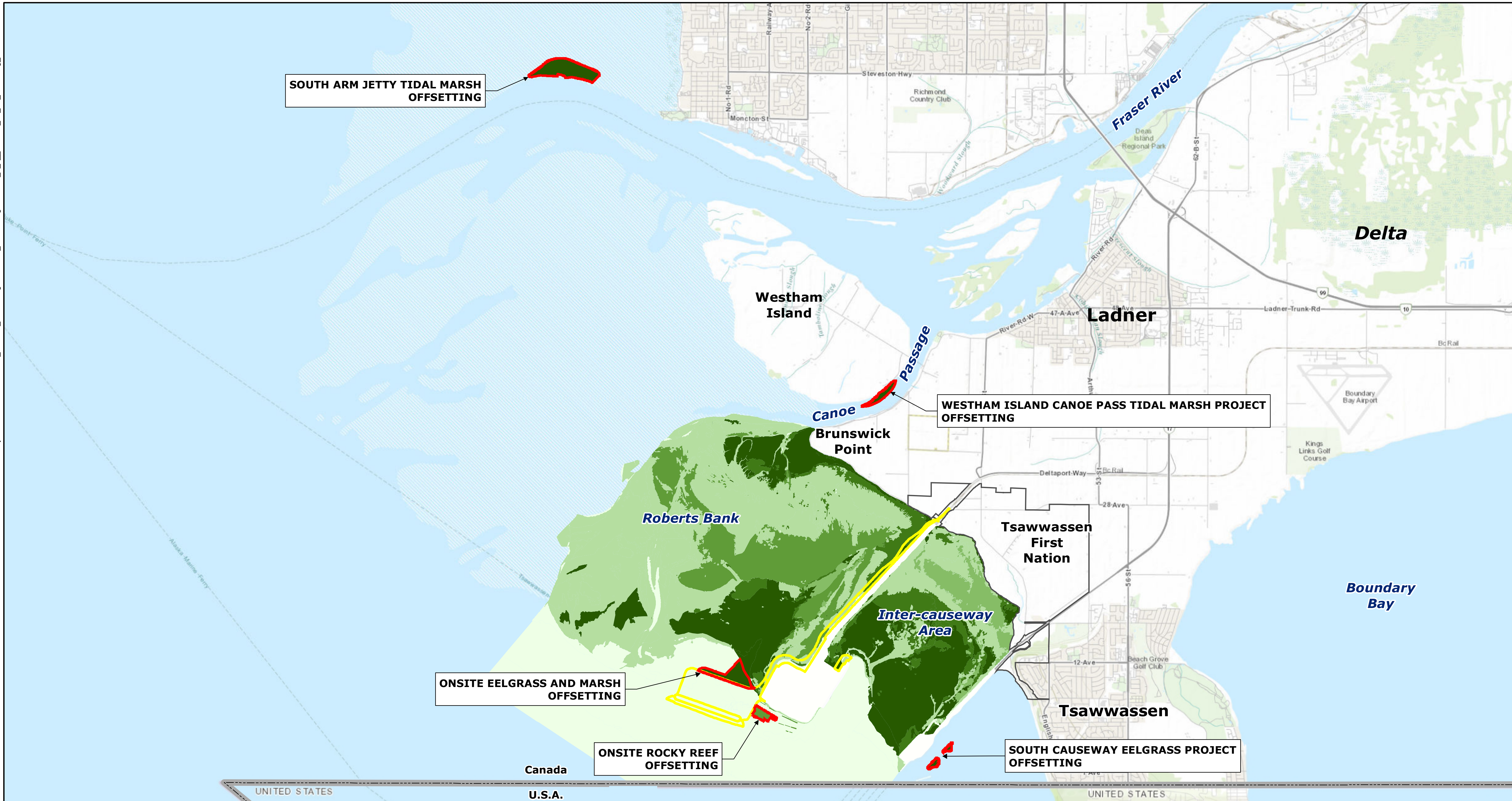
[9] CIAR Document #2001 From the Vancouver Fraser Port Authority to the Review Panel re: Updated Project Commitments (See Reference Documents #1738 and #1934). https://iaac-aeic.gc.ca/050/documents/p80054/130776E.pdf

Table IR2020-1.2-1: List of avoidance, reduction, and offsetting measures that are described in the updated project commitments (CIAR Document #2001) or have been proposed by the port authority after the public hearing (new) and are considered in IR2020-1.2 analysis of project effects on juvenile Chinook salmon, fish, and fish habitat, in support of the proposed offsetting plan for the Roberts Bank Terminal 2 Project

#	Source	Mitigation measure short title
Avoidance measures		
1	CIAR Document #2001	Placement of the marine terminal in subtidal waters
2	CIAR Document #2001	Tug basin expansion re-design
3	CIAR Document #2001	Widened causeway re-design
4	New, IR2020-2.1	Potential additional project footprint reduction
5	CIAR Document #2001	Containment dyke construction measures
6	CIAR Document #2001	Rounded northwest corner of marine terminal
Reduction measures		
7	New, IR2020-2.2	Potential breaching mitigation
8	CIAR Document #2001	Removal of the intermediate transfer pit
9	CIAR Document #2001	Marine Species Management Plan (timing windows)
10	CIAR Document #2001	Marine Species Management Plan (salvage)
11	CIAR Document #2001	Underwater Noise Management Plan
12	CIAR Document #2001	Light Management Plans
13	New, IR2020-2.2	Additional operational lighting mitigation
14	New, IR2020-2.2, IR2020-3	Additional operational mitigation for underwater noise
15	New, IR2020-2.2	Timing of maintenance dredging at the expanded tug basin
Offsetting measures		
16	New, IR2020-1.1	Offsetting projects to restore and enhance up to 86 ha of fish habitat
17	New, IR2020-1.1	Additional offsetting opportunities (complementary measures, recent projects brought forward by Indigenous groups, the Non-Conventional Offsetting Program)
18	New, IR2020-1.1	Potential contingency projects (45 ha to 65 ha)

As an example, siting the marine terminal in predominantly subtidal waters is a key avoidance measure for the project (measure 1 in **Table IR2020-1.2-1** and **Figure IR2020-1.2-2** below) as it avoids overlap with and has a direct footprint effect on more productive intertidal habitats, such as intertidal marsh and eelgrass, which provide food and refuge opportunities for juvenile salmon rearing at Roberts Bank. Placement of the marine terminal in predominantly subtidal waters is also predicted to indirectly increase the productivity of juvenile salmon due to environmental and physical changes behind the proposed terminal (see **Part B** in this response). Moreover, implementation of a breach (i.e., fish passage for migrating juvenile salmon) has been identified as a new reduction measure (measure 7 in **Table IR2020-1.2-1**) that is expected to mitigate potential project-related disruption to juvenile salmon migration (a description of potential breach locations and associated reduction in project-related effects to juvenile salmon is provided in **IR2020-2.2**).



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Legend

- BOUNDARY OF PROJECT AREA
- HABITAT OFFSETTING AREA
- U.S.A.-CANADA BORDER

RELATIVE RANKING

- HIGH
- GOOD
- MODERATE
- INTERMEDIATE
- FAIR
- POOR

0 1 2
Kilometres
1:75,000
NAD 1983 UTM Zone 10N

N

PORT of vancouver

ROBERTS BANK TERMINAL 2

RELATIVE VALUE OF JUVENILE CHINOOK SALMON HABITAT WITH THE PROJECT AND OFFSETTING

DATE:	FIG No.
08/09/2021	IR2020-1.2-2

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Offsetting measures

For those potential adverse effects on fish and fish habitat that remain following avoidance and reduction measures, the port authority is advancing offsetting projects to restore and enhance up to 86 ha of fish habitat, including intertidal marsh and native eelgrass (measure 16 in **Table IR2020-1.2-1**). This amounts to nearly three times the amount of habitat offsetting conceptually proposed in the EIS.

Offsetting projects that the port authority is currently advancing include predominantly onsite and offsite conventional offsetting projects, details of which and their approximate areal ranges are provided in **IR2020-1.1** (also refer to **Table IR2020-1.2-1** and **Appendix IR2020-1.2-E**, Table IR2020-1.2-E1). Of these conventional offsetting projects, approximately 8.3 ha (or ~10%) are banked offsetting habitat projects that are already functioning, have been accruing fish and fish habitat productivity since their establishment, and will continue to accrue fish and fish habitat productivity until project construction.

The following is a description of how conventional offsetting projects being advanced by the port authority will counterbalance project-related effects that remain after the implementation of the avoidance and reduction measures described above on fish (including juvenile salmon) and fish habitat (additional detail on these offsetting projects is provided in **IR2020-1.1**; details on how offsetting gains from offsetting habitats were calculated are provided in **Part B** (for juvenile salmon and their habitat) and **Part C** (for other fish and fish habitat) of this response):

- The Glenrose Tidal Marsh Project, Gladstone Park Tidal Marsh Project, Riverfront Park Tidal Marsh Project, and Timberland Basin Habitat Project in the port authority's habitat bank involved the creation of intertidal marsh habitat, an important habitat type for juvenile salmon (as well accepted in the scientific literature). Juvenile salmon, such as ocean-type Chinook salmon of the Harrison River and South Thompson River and chum salmon, use marsh habitats as they outmigrate from the lower Fraser River, through the Fraser River estuary, and into the marine environment, while acclimatizing to increasing salinity (e.g., Levy and Northcote 1982, Levings 2016, Chalifour et al. 2019); these habitat bank projects total approximately 8.3 ha and have been contributing productivity in the Fraser River estuary for up to approximately 30 years.
- The Salt Marsh Restoration Projects in the port authority's habitat bank involved the restoration of intertidal marsh habitat through removal of accumulated logs, the benefits of which to juvenile salmon are described above. Two of these projects are located at Tsawwassen First Nation, and Tsawwassen First Nation will play a key role in both the monitoring and stewardship of the sites. Tsawwassen First Nation's traditional knowledge and familiarity of the area will enhance the likelihood of success of the restoration projects and benefits to priority species.
- Optimized onsite offsetting currently being advanced includes the creation of intertidal marsh and subtidal native eelgrass habitat. In addition to the benefits of intertidal marsh habitat to juvenile salmon, described above, native eelgrass habitat provides important rearing opportunities to juvenile Chinook salmon that have adapted physiologically to higher salinities and are capable of transitioning to rearing habitats such as native eelgrass away from the river mouth, including north and south of the Roberts Bank causeway (e.g., MacDonald 1984, Bottom et al. 2005, Chalifour et al. 2019). Constructing intertidal marsh and native eelgrass habitats will therefore increase survival and growth of juvenile salmon and recruitment success to the parent stock. The importance of intertidal marsh and native eelgrass to priority species and life stages like juvenile salmon has been noted by Indigenous groups, including Tsawwassen First Nation, Musqueam Indian Band (Musqueam), Semiahmoo First Nation, T'suubaa-asatx First Nation, Malahat Nation, Cowichan Nation Alliance, and Tseycum First Nation, as well as organizations such as the Lower Fraser Fisheries Alliance.
- The South Arm Jetty Tidal Marsh Project involves the creation of intertidal marsh habitat. Along with the marsh benefits to juvenile salmon mentioned above, the network of tidal channels proposed as part of this offsetting project will provide accessible fish habitat over an even longer part of the tidal cycle and increase habitat complexity. In turn, this will increase rearing opportunities for juvenile salmon outmigrating from the Fraser River. Synergistic features such as removal of piles, logs, and other debris, as suggested by Indigenous groups will also be integrated, as appropriate, to further increase the value of this project to juvenile salmon and other fish.

- The South Causeway Eelgrass Project involves the creation of subtidal native eelgrass habitat. The habitat structure and complexity provided by eelgrass beds attracts diverse assemblages of marine invertebrates, including important prey for juvenile salmon (e.g., MacDonald 1984, Bottom et al. 2005, Knight et al. 2015, Kennedy et al. 2018), and offers refuge for fish species, including outmigrating juvenile salmon (e.g., Levings 2016). Eelgrass also supports species of cultural importance and priority to Indigenous groups (in particular, Pacific salmon species like Chinook and chum, and Dungeness crab), and so is an important part of the offsetting plan.
- The Westham Island Canoe Pass Tidal Marsh Project involves the creation of intertidal marsh habitat, as well as the restoration of intertidal marsh through the removal of accumulations of historically-deposited anthropogenic logs (i.e., saw-cut logs from the forestry sector). The removal of this material will increase marsh productivity by reversing vegetation smothering and soil compaction, reducing the risk of toxic chemical leaching from creosote-treated logs (if present), and preventing the clogging of tidal channels, all of which will benefit outmigrating juvenile salmon. This project will address concerns raised by Indigenous groups, such as Tsawwassen First Nation, Musqueam, Tsleil-Waututh Nation, Semiahmoo First Nation, T'suubaa-asatx First Nation, and Malahat Nation, who have noted concerns with chemical leaching (creosote). Numerous groups have expressed support for efforts to address log accumulation. Canoe Pass is considered a prime location for estuarine-rearing juvenile salmon to forage and acclimatize to increasing salinity (particularly Chinook and chum), hence offsetting here is anticipated to directly benefit juvenile salmon.
- The Tilbury Island Peninsula Enhancement Project includes the creation of intertidal marsh habitat and creation of interconnected off-channel habitat, both of which benefit juvenile salmon rearing and are relatively lacking in this part of the lower Fraser River. This offsetting project is considered to align with Musqueam's vision of creating a mosaic of habitat enhancement throughout the Fraser River estuary—to contribute to a "ladder" of increased feeding, rearing, and refuge opportunities for a range of priority species and life stages, including juvenile salmon. Musqueam has emphasized the importance of intertidal marsh for juvenile salmon and highlighted that this offsetting project will help restore an important link in the juvenile salmon rearing network in this area of the Fraser River. Tsawwassen First Nation shares this vision, noting interest in seeing a mosaic of salmon habitat extending through to the inter-causeway area.
- The Finn Slough Enhancement Project involves the restoration of intertidal marsh habitat through removal of accumulated logs, and the enhancement of tidal channel habitat and access through the reconnection of a slough channel. The location of this offsetting project in the south arm of the Fraser River is considered an ecologically important area for juvenile salmon, including by Musqueam, who brought this offsetting opportunity forward.
- The Semiahmoo Bay-Little Campbell River Enhancement Project, identified by Semiahmoo First Nation, includes the creation of intertidal marsh and the removal of creosote-treated wood, the benefits of which for juvenile salmon are described above. Additionally, this offsetting project involves the implementation of large woody debris complexes to encourage the formation of pool habitat, and provide cover and holding areas, for migratory fish like juvenile salmon, increasing the value of this project.

In addition to conventional offsetting projects, the port authority is proposing other available offsetting opportunities, including the following:

- Tsawwassen Marshlands Project: Tsawwassen First Nation recently brought forward an RBT2 offsetting opportunity—the Tsawwassen Marshlands Project—comprising several components targeting benefits to fish and fish habitat and juvenile salmon in particular. The port authority is committed to exploring and advancing this project in collaboration with Tsawwassen First Nation.
- A complementary measure specific to identifying causes of local marsh recession
- The NCOP: proposed as an innovative and enduring regional program to be advanced in conjunction with RBT2. The intent of the NCOP would be to deliver projects that benefit fish and fish habitat, with a particular focus on projects that deliver the best conservation and enhancement outcomes for priority species and habitats, by addressing limiting factors, bottlenecks, and emerging needs. The port authority

will continue to develop the NCOP as part of the offsetting plan, as per input from DFO; by design, the NCOP would be 'non-conventional' in nature and related projects may or may not be habitat focused

Potential contingency measures and projects, to be used in the unlikely event that any of the habitat developed for the offsetting plan does not function as intended, and remedial measures are unavailable or unsuccessful, have also been identified, including the following:

- Onsite contingency projects (including additional onsite native eelgrass and/or marsh habitat north of the proposed terminal and additional onsite offsetting through a specific component of the Tsawwassen Marshlands Project (expansion of marsh habitat seaward of the outer dyke in the inter-causeway area))
- NCOP projects (offsetting projects delivered through an operational (i.e., established) NCOP could be considered potential contingency projects)
- Offsite contingency projects (such as the Point Grey Tidal Marsh Project and McDonald Tidal Marsh Project[10])

A more detailed description of the other available offsetting opportunities and potential contingency projects is provided in **IR2020-1.1**.

Managing uncertainty

In reviewing earlier draft materials on the project's proposed offsetting plan, DFO commented that there is uncertainty in whether the proposed offsets would counterbalance potential adverse effects of the project (after avoidance and reduction measures) on invertebrates, fish, and their habitats. Sources of uncertainty identified by DFO included uncertainty regarding the updated Roberts Bank ecosystem model (updated RB model[11]; described in **Appendix IR2020-1.2-A**) and the time that may be required for predicted indirect gains in fish and fish habitat productivity to be realized (referred to in this response as temporal lag A), as well as uncertainty associated with the offsets meeting desired outcomes. Specifically, DFO commented that there is uncertainty regarding the extent to which proposed offsets counterbalance the direct versus the indirect effects of the project, the time required to construct offsetting habitats (referred to in this response as temporal lag B), and, once constructed, the time required for offsetting habitats to become functional (referred to in this response as temporal lag C). DFO also expressed uncertainty about the port authority's ability to secure the lands that will account for a large portion of the offsetting required.

In response to DFO comments, the port authority has undertaken extensive technical analyses to clearly identify and quantify uncertainty (described in detail in **Appendix IR2020-1.2-D**). Uncertainty was then incorporated in the calculations of net gain in fish and fish habitat productivity (with avoidance, reduction, and offsetting measures) presented in **Parts B** and **C** of this response to determine how the proposed offsetting plan counterbalances potential adverse effects of the project on juvenile Chinook salmon, fish, and fish habitat. Results of these new analyses confirm the findings presented in earlier draft materials that the project's proposed offsetting plan fully offsets effects of the project on juvenile Chinook salmon and counterbalances effects to fish and fish habitat; in fact there is net gain in juvenile Chinook salmon habitat of 37.4 ha and a net gain in fish and fish habitat productivity. The confidence of this finding is supported by two lines of independent analysis that the port authority conducted and that demonstrate (i) there will be a net gain with the project of habitats that are of higher relative importance to juvenile Chinook salmon, and (ii) offsetting productivity will conservatively result in approximately four times more fish and fish habitat productivity than lost by the footprint alone (productivity ratio of 4:1), or 16 times more productivity than lost by the footprint (productivity ratio of 16:1) when non-footprint-related (indirect) gains in fish and fish habitat productivity from RBT2 are also considered.

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[10] Any future development of the site would also require cooperation from Vancouver International Airport to ensure that the project is constructed in line with their wildlife management objectives.
[11] The RB model that was developed for the EIS was updated in 2020 to incorporate empirical data collected for the project in 2019 and reflect current (2019) existing conditions; it is referred to herein as the updated RB model (**Appendix IR2020-1.2-A**).

Additional information is provided below on how the port authority has managed uncertainty associated with the proposed offsetting plan and where applicable the calculations of net gain in fish and fish habitat productivity (with avoidance, reduction, and offsetting measures) presented in **Parts B** and **C** of this response.

Land tenure: Through a recent letter to the port authority (see **IR2020-1.1**, Appendix IR2020-1.1-D), the Province of B.C. has confirmed that, in the case of the largest proposed offsetting projects, the land tenure application review is well advanced, and that the port authority has addressed comments by Indigenous groups in the consultation process. The letter also confirms that the Ministry of Forests, Lands, Natural Resource Operations and Rural Development and the port authority are working to advance tenure decisions on all proposed offsetting projects on Provincial Crown land in a timely manner.

Technical analyses of uncertainty and temporal lag: The port authority undertook additional technical analyses to clearly identify and quantify uncertainty associated with the outputs of the updated RB model, as well as temporal lags A, B, and C. The methods used and results are presented in **Appendix IR2020-1.2-D** and summarized in **Parts B** and **C** of this response. In summary, consideration of uncertainty and temporal lags resulted in a total discounting of approximately 19.3%, or approximately 425 tonnes per year (t/year) less net gain in fish and fish habitat productivity relative to the net value presented in an earlier draft IR2020-1.2 response. Even when uncertainty and temporal lags are accounted for, implementation of avoidance, reduction, and 86 ha of offsetting currently being advanced will counterbalance effects in fish and fish habitat productivity with a net gain of 1,773 t/year.

Multiple lines of evidence: In response to comments by DFO, the port authority analyzed three lines of evidence to determine the sufficiency of the proposed 86 ha of offsetting in counterbalancing the effects of RBT2 on fish and fish habitat. Three separate lines of evidence indicate that 86 ha of proposed conventional offsetting, without complementary measures included, more than counterbalance the effects of RBT2 on juvenile Chinook salmon, fish, and fish habitat.

i) Productivity approach using the outputs of the updated RB model (see **Parts B** and **C** of this response): as indicated above, this analysis shows that even with the application of 19.3% discounting to account for uncertainty and temporal lags, the proposed 86 ha of offsetting will counterbalance effects of RBT2 on fish and fish habitat productivity with a net gain of 1,773 t/year (see **Parts B** and **C** of this response)

ii) Footprint vs. non-footprint effects approach (see **Part C** of this response): this analysis demonstrates that offsetting alone will create 4 times more productivity than that lost by the project footprint; when including forecasted non-footprint-related gains in fish and fish habitat productivity, the project will result in 16 times more productivity than lost by the footprint

iii) A juvenile Chinook salmon relative habitat values approach: this analysis demonstrates that within the biophysical LAA when the relative importance to juvenile Chinook salmon is considered for all habitat types that may be affected by the project, a net gain in juvenile Chinook salmon habitat of 37.4 ha is expected with avoidance, reduction, and offsetting measures.

Habitat bank projects: The offsetting plan presented in this response includes credit withdrawal from banked habitat projects, which reduces the potential for temporal lag and increases certainty of effectiveness. Current DFO offsetting policy now prioritizes the use of habitat bank credits as a measure to offset project-related adverse effects on fish and fish habitat that remain after avoidance and reduction measures are considered. One of the benefits of habitat banking is that the bank is established in advance of the adverse effects taking place. Consequently, there is less uncertainty related to the effectiveness of the offsetting measures or the time required for the offsetting measures to become functional.

Follow-up monitoring and adaptive management: The port authority will implement four rigorous follow-up program elements to evaluate ecosystem model predictions for marine vegetation, marine infaunal invertebrates, rockfish/lingcod, and great blue heron.[12] In addition, the port authority will undertake effectiveness monitoring of all offsetting habitat projects to determine that they function as intended.[11] The port authority will engage with DFO

[12] Commitment #81 in updated project commitments (CIAR Document #2001)

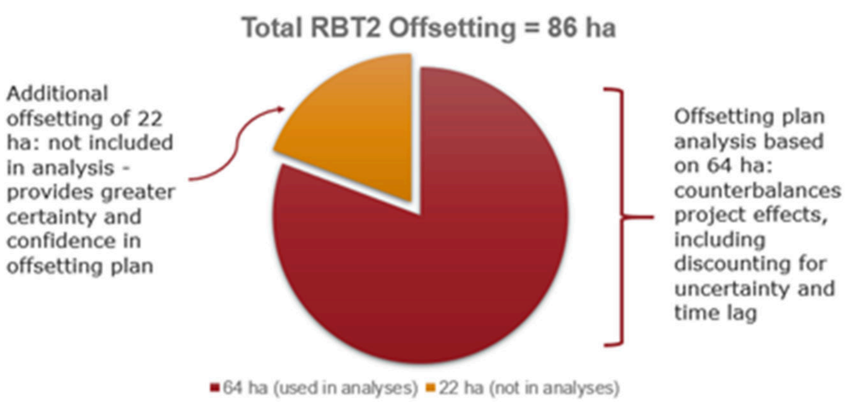
and consult with Indigenous groups during planning and development of these follow-up program elements, including in relation to study design, monitoring frequency, monitoring metrics, and reporting. Consistent with the project's Adaptive Management Framework, should monitoring as part of these follow-up program elements determine a departure from ecosystem model predictions based on pre-determined action thresholds, adaptive measures will be identified, evaluated, and implemented (in consultation with DFO and Indigenous groups).

Other available offsetting opportunities and potential contingency measures: The other available offsetting opportunities and potential contingency measures summarized above (and presented in more detail in **IR2020-1.1**) will effectively manage uncertainty in the offsetting plan. For example, in the unlikely event the follow-up monitoring program determines that proposed conventional offsetting habitat is not functioning as predicted, and remedial measures are not available or have not been successful, then additional offsetting measures or potential contingency projects could be used (in an adaptive management approach). Further details on the approach to potentially using contingency projects is included as **Appendix IR2020-1.2-C**.

Conservative approach

Analyses undertaken in **Parts B** and **C** indicate that while 64 ha of offsetting will counterbalance the remaining effects of the project and result in net gains in fish and fish habitat productivity, the port authority's offsetting plan actually includes advancing 86 ha of offsetting, as described in the response to **IR2020-1.1**. Hence the port authority's approach to the offsetting plan is conservative in that more offsetting has been proposed than required to counterbalance the effects of the project. As described in the following figure, an additional 22 ha of offsetting provides greater confidence and assurance that gains will be realized for juvenile salmon, fish and fish habitat, and that uncertainty and temporal lag have been fully addressed.

Figure IR2020-1.2-3: Total amount of offsetting proposed as part of the RBT2 offsetting plan (offsetting projects are described in IR2020-1.1)



How the offsetting plan directly addresses habitat loss caused by the proposed project

In summary, taking mitigation (including avoidance, reduction, and offsetting measures) into account, the project will result in a net increase in habitat used by juvenile Chinook salmon by a total of 959 t/year (intertidal marsh: 786 t/year, native eelgrass: 173 t/year) and by 37.4 ha in terms of areal extent (as described in **Part B** of the response). For fish and fish habitat overall, the project will result in a net gain in productivity by 1,773 t/year. Net productivity calculations account for uncertainty and temporal lags and are conservative as the analysis is based on 64 ha of the 86 ha of offsetting currently being advanced by the port authority. Additional information on the calculations is provided in **Part B** of the response, and additional technical information is provided in **Appendices IR2020-1.2-A, IR2020-1.2-B**, and **IR2020-1.2-D**.

How the plan will address potential project-related disruption to juvenile salmon

In summary, taking mitigation (including avoidance, reduction, and offsetting measures) into account, the project will result in a net increase in juvenile Chinook salmon productivity by 0.1 t/year. In other words, taking mitigation into account, including offsetting, the productive potential of Roberts Bank is estimated to increase such that it can sustain on average an additional approximately 65,000 outmigrating juvenile Chinook salmon annually (range of approximately 50,000 to 100,000 individuals per year).[13] Also, implementation of a breach (fish passage) would mitigate potential migration disruption of juvenile salmon, and depending on the location, a breach would also restore habitat by facilitating access between north and south of the inter-causeway area. As indicated above, net productivity calculations account for uncertainty and temporal lags and are conservative as the analysis is based on 64 ha of the 86 ha of offsetting proposed by the port authority. Additional information on the calculations is provided in **Part B** of the response, and additional technical information is provided in **Appendices IR2020-1.2-A** and **IR2020-1.2-D**.

Therefore, potential adverse effects on juvenile Chinook salmon, habitat, and migration will be fully mitigated (i.e., no residual adverse effect will remain, taking mitigation, including offsetting, into account). This conclusion is conservative and precautionary as it is based on only 64 ha of the total 86 ha offsetting, discounting to account for uncertainty and potential temporal lag has been included in the 64 ha, the additional 22 ha of offsetting provides greater certainty that the offsetting overall will be a net gain and additional offsetting opportunities have been proposed (e.g., the NCOP). In addition, the port authority has proposed a robust follow-up monitoring program to verify the predicted effects and effectiveness of mitigation, including offsetting, triggering adaptive management and implementation of potential contingency measures if and as required.

Part B: Identify and provide an analysis of how Project impacts to juvenile Chinook salmon habitat and migration will be fully offset.

The following provides two separate analyses (or lines of evidence) of how potential project effects to juvenile Chinook salmon habitat and migration are fully offset (following implementation of avoidance, reduction, and offsetting measures discussed in **Part A** of this response).

As a general conclusion, the analyses described in this part of the response demonstrate a net gain in juvenile Chinook salmon habitat (of 959 t/year in productivity and 37.4 ha in areal extent), that potential disruption to juvenile Chinook salmon migration has been mitigated (see measure 7 – breaching mitigation in **Table IR2020-1.2-1**), and that juvenile Chinook salmon productivity will increase by a net 0.1 t/year following avoidance, reduction, and offsetting measures.

In other words, taking mitigation into account, including offsetting, the productive potential of Roberts Bank is estimated to increase such that it can sustain on average an additional approximately 65,000 outmigrating juvenile Chinook salmon annually (range of approximately 50,000 to 100,000 individuals per year).[15] Therefore, following avoidance, reduction, and offsetting measures, potential adverse effects of the project on juvenile Chinook salmon habitat and migration will be fully mitigated, with no adverse residual effects. This is consistent with the conclusions of the biophysical effects assessment presented in the EIS. In fact, a net gain is expected to result for this species of interest.

Further, these results conservatively under-represent the net gains anticipated for juvenile Chinook salmon habitat and migration on the following basis:

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[13] Calculation of number of individual juvenile Chinook salmon uses body size data collected during empirical surveys undertaken for the project's juvenile salmon follow-up program element in 2020; average value assumes an average body size of juvenile Chinook salmon of 1.55 grams (based on the geometric mean) and calculation of values range assumes the first (i.e., 1.00 gram) and third (i.e., 2.13 grams) quartile of body size of juvenile Chinook salmon recorded in 2020.

- As explained below, the analysis of offsetting productivity gains was based on 64 ha of the 86 ha of offsetting habitat the port authority is currently advancing; the remaining 22 ha (86 ha minus 64 ha) of offsetting will provide additional benefits to juvenile Chinook salmon habitat and productivity
- Indirect productivity gains (with avoidance and reduction measures and before offsetting) forecasted by the updated RB model were discounted to account for uncertainty in the model as well as for time that may be required for indirect productivity gains to be realized following project construction (more detail is provided below and in **Appendix IR2020-1.2-D**)
- Offsetting productivity gains were discounted assuming that five years are required to construct offsetting habitats, even though several of the offsetting projects that comprise the project's proposed offsetting plan will be constructed sooner than that (more detail is provided below and in **Appendix IR2020-1.2-D**)
- Offsetting productivity gains were further discounted (in addition to the discounting referred to in the previous bullet) assuming that seven, three, and one year is required respectively for intertidal marsh, native eelgrass, and subtidal rock reef to become functional once constructed (more detail is provided below and in **Appendix IR2020-1.2-D**)
- Approximately 8.3 ha (or ~10%) of offsetting habitat included in the project's proposed offsetting plan comprises banked habitat projects that are already functioning and contributing productivity to juvenile salmon. Productivity gains that have been accruing since establishment of these banked habitat projects, and will continue to accrue until project construction, are not included in the calculations of net gains in juvenile Chinook salmon productivity.
- Potential offsetting gains in productivity of juvenile Chinook salmon and their habitat associated with the Tsawwassen Marshlands Project brought forward by Tsawwassen First Nation, as well as complementary measures and the NCOP described in **Part A** of the response, are not included in productivity estimates presented above. As described earlier, the Tsawwassen Marshlands Project is being explored further collaboratively between the port authority and Tsawwassen First Nation, and complementary measures and the NCOP are subject to further engagement with DFO and Indigenous groups.

Of the 86 ha of conventional offsetting habitat that the port authority is advancing, a total of 64 ha of offsetting habitat (50 ha of intertidal marsh, 10 ha of native eelgrass, 4 ha of subtidal rock reef[14]) was accounted for in calculating project effects to fish (including juvenile Chinook salmon) and fish habitat. The analysis demonstrates that the potential adverse effects would be effectively counterbalanced (including avoidance, reduction, and offsetting measures). This approach was taken to be conservative (so that gains from offsetting would be higher, when the offsetting is constructed, than estimated in the analysis) and to accommodate the range of the amount of offsetting being proposed by the port authority (consistent with typical design iterations as well as potential design refinements to reflect input from Indigenous groups and regulators; see **IR2020-1.1** for additional details).

Effects analysis results are provided below first for juvenile Chinook salmon habitat and second for juvenile Chinook salmon.

Effects analysis results for juvenile Chinook salmon habitat

The analysis regarding net change (after avoidance, reduction, and offsetting measures) in juvenile Chinook salmon habitat is described below using two equivalency analyses approaches as lines of evidence, specifically one that is based on productivity (in t/year) and a second one that is based on areal extent (in ha).

Line of evidence 1 – Productivity approach

In summary, the productivity approach conservatively shows a net gain in juvenile Chinook salmon habitat productivity (of 959 t/year), even after accounting for potential uncertainty and potential delays in offsetting function. The following presents the methods used, which avoidance, reduction, and offsetting measures were

[14] Analyses specific to juvenile salmon do not include the 4 ha of subtidal rock reef offsetting, as this habitat type is not typically used by juvenile salmon.

included in the analyses, how discounting for uncertainty and offsetting function were included, and the results of the analysis.

The analysis of net change in the productivity of habitats used by juvenile Chinook salmon focused on intertidal marsh and native eelgrass, the two marine vegetative habitat types that are of highest relative importance to juvenile Chinook salmon given the rearing opportunities they provide (see ‘Line of evidence 2 – Relative Values Approach’ below, which demonstrates how all potential habitats used by juvenile Chinook salmon may be affected by the project and proposed mitigation).

Intertidal marsh and native eelgrass are the two habitat types that juvenile Chinook salmon preferentially use when rearing at Roberts Bank. Intertidal marsh offers less physiologically stressful and more sheltered habitat than the outer flats of the estuary and has been shown to provide rearing opportunities, including food and refuge, to juvenile Chinook salmon (e.g., Levings 2016, Chalifour et al. 2019, 2020). As they grow, juvenile Chinook salmon have adapted to higher salinities and are capable of transitioning to rearing habitats such as native eelgrass away from the river mouth, including north and south of the Roberts Bank causeway (e.g., Levings 2016, Chalifour et al. 2019, 2020).

Mitigation measures that were considered in the calculation of net change in the productivity of habitat used by juvenile Chinook salmon, including rationale for their consideration, are listed in **Appendix IR2020-1.2-E**, Table IR2020-1.2-E2, and summarized in **Table IR2020-1.2-2**.

Table IR2020-1.2-2: Juvenile Chinook salmon habitat – productivity; avoidance, reduction, and offsetting measures considered in IR2020-1.2 analysis in support of the proposed offsetting plan for the Roberts Bank Terminal 2 Project

#	Mitigation measure	Analysis of project effects (juvenile Chinook salmon habitat, productivity)
Avoidance measures		
1	Placement of the marine terminal in subtidal waters	✓
2	Tug basin expansion re-design	✓
3	Widened causeway re-design	✓
4 (new)	Potential additional project footprint reduction	●
5	Containment dyke construction measures	●
6	Rounded northwest corner of marine terminal	✓
Reduction measures		
7 (new)	Potential breaching mitigation	●
8	Removal of the intermediate transfer pit	●
9	Marine Species Management Plan (timing windows)	×
10	Marine Species Management Plan (salvage)	×
11	Underwater Noise Management Plan	×
12	Light Management Plans	×
13 (new)	Additional operational lighting mitigation	×
14 (new)	Additional operational mitigation for underwater noise	×
15 (new)	Timing of maintenance dredging at the expanded tug basin	×
Offsetting measures		
16 (new)	Offsetting project to restore and enhance up to 86 ha of fish habitat[15]	✓

Notes:

– number of mitigation measures corresponds to numbered list presented in **Table IR2020-1.2-1**
✓ – considered quantitatively in the analysis
● – considered qualitatively in the analysis (empirical data not available)
× – does not apply to juvenile Chinook salmon habitat as no interaction with RBT2 and no pathway of effect has been identified in the EIS; measure is directly relevant to and has been considered in the analysis for juvenile Chinook salmon (see **Table IR2020-1.2-4** and **Appendix IR2020-1.2-E**, Table IR2020-1.2-E3 for rationale)

With avoidance, reduction, and offsetting measures, productivity of habitats in the biophysical LAA used by juvenile Chinook salmon are forecasted to increase by a total of 959 t/year. This consists of a potential net gain in intertidal marsh productivity by 786 t/year and a potential net gain in native eelgrass productivity by 173 t/year (**Table IR2020-1.2-3**). Net gain in productivity of intertidal marsh and native eelgrass was calculated by subtracting from the direct and indirect productivity changes (forecasted by the updated RB model) losses in

[15] As described earlier, analytics included 64 ha of the total 86 ha proposed by the port authority.

productivity associated with the expansion of the tug basin, and then adding productivity gains associated with proposed offsetting. Additional information on the calculations is provided below, and additional technical information is provided in **Appendices IR2020-1.2-A, IR2020-1.2-B**, and **IR2020-1.2-D**.

Direct and indirect productivity changes: Direct and indirect productivity changes for intertidal marsh and native eelgrass were forecasted using the updated RB model. They are attributed to quiescent conditions that are predicted to establish behind the proposed marine terminal; quiescent conditions are conducive to growth of intertidal marsh and native eelgrass (described in **Appendix IR2020-1.2-A**). Forecasts of the updated RB model consider mitigation measures 1, 3, and 6 as part of the current project footprint (defined in the project construction update[16]) used as input into the updated RB model. In response to comments received by DFO, these forecasted changes in the productivity of intertidal marsh and native eelgrass were discounted to account for uncertainty in the outputs of the updated RB model and temporal lag A (details on the methodology are provided in **Appendix IR2020-1.2-D**). After discounting, and before offsetting, intertidal marsh and native eelgrass are forecasted to increase in productivity by 777 t/year and 177 t/year, respectively, for a total of 954 t/year (**Table IR2020-1.2-3**).

Tug basin expansion productivity changes: Dredging proposed as part of construction to expand the existing tug basin will result in the permanent alteration of intertidal mudflat to subtidal habitat and the potential loss in 5.5 t of native eelgrass productivity (**Table IR2020-1.2-3**) due to the removal during dredging of patches of dense native eelgrass. Technical information on the calculation of productivity losses associated with construction for the expansion of the tug basin is provided in **Appendix IR2020-1.2-B**. Calculations of losses in the productivity of juvenile Chinook salmon habitat from tug basin expansion take into account the re-design of the expanded tug basin (measure 2 in **Table IR2020-1.2-1**).

Offsetting productivity gains: As part of the project's offsetting plan, the port authority is proposing up to 86 ha of conventional offsetting habitats, including intertidal marsh and native eelgrass. Productivity gains associated with offsetting habitats were calculated using a simple method recommended by DFO[17] whereby the production of a species or group[18] associated with each offsetting habitat is calculated with the areal extent of the habitat proposed to be constructed. Habitat-specific production estimates were quantified using local abundance data (and not the outputs of the updated RB model) for as many species or groups as possible, collected during empirical surveys undertaken for the project in 2012, 2013, and 2019. As pointed out by DFO, this approach is conservative as it may underestimate productivity of created habitats, given that it reflects existing conditions of fish populations that may be depressed and does not fully reflect the improved capacity of the created habitat (details on the method used to estimate production of offsetting habitats is provided in **Appendix IR2020-1.2-A**).

In response to DFO comments, offsetting productivity gains were discounted to account for the productivity of existing habitat underlying the proposed offsetting habitat, and to account for two types of temporal lag (i.e., temporal lags B and C; **Appendix IR2020-1.2-D**). Discounting was not applied to projects that will be withdrawn from the habitat bank (amounting to approximately 8.3 ha or 10% of the offsetting plan; see **IR2020-1.1**, Table IR2020-1.1-1) as they are already constructed and functioning.

As described earlier, for the purposes of this analysis, the creation of 50 ha of offsetting intertidal marsh and 10 ha of offsetting native eelgrass was conservatively assumed, even though the port authority is proposing up to 86 ha of conventional offsetting habitats.

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[16] CIAR Document #1210 From the Vancouver Fraser Port Authority to the Review Panel re: Project Construction Update. https://iaac-aeic.gc.ca/050/documents/p80054/122934E.pdf

[17] CIAR Document #1630 From Fisheries and Oceans Canada to the Review Panel re: Written Submission for the Roberts Bank Terminal 2 Public Hearing (Note: Updated May 16, 2019). https://iaac-aeic.gc.ca/050/documents/p80054/129340E.pdf

[18] Species or groups associated with each habitat type are consistent with the habitat specific food webs presented in the port authority's response to IR7-26 (CIAR Document #934). They include juvenile and adult life stages for Pacific salmon and Dungeness crab.

Assuming the creation of 50 ha of intertidal marsh offsetting habitat, gains of intertidal marsh productivity were calculated to be 8.8 t/year (**Table IR2020-1.2-3**). This estimate includes discounting to account for the productivity of underlying intertidal mudflat. Furthermore, a 3% discount rate (Bradford 2017) has been applied to this estimate assuming a temporal lag B of five years, as well as temporal lag C of an additional seven years (increased by two years compared to temporal lag C of five year considered in draft response materials, based on DFO input).

Temporal lag B of five years is appropriate given that the preliminary RBT2 offsetting construction schedule involves construction completion for all proposed offsetting projects within five years of RBT2 construction commencement. This approach is conservative given that construction completion of a number of proposed offsetting projects is anticipated to occur substantially earlier than five years. For example, the South Causeway Eelgrass Project (formerly known as the Tsawwassen Eelgrass Project), the Westham Island Canoe Pass Tidal Marsh Project, the Finn Slough Enhancement Project, the Tilbury Island Peninsula Enhancement Project, and the Semiahmoo Bay-Little Campbell River Enhancement Project are all anticipated to be completed within three years of RBT2 construction commencement.

The port authority stands by its original estimate that intertidal marsh will conservatively take five years to establish based on experience and precedent (see Table IR7-28-1 in the response to IR7-28).[19] However, given feedback from DFO, the port authority increased temporal lag C to seven years for intertidal marsh.

Assuming the creation of 10 ha of native eelgrass offsetting habitat, gains of native eelgrass productivity were calculated to be 1.4 t/year (**Table IR2020-1.2-3**). This estimate includes discounting to account for the productivity of underlying subtidal sand. Furthermore, a 3% discount rate (Bradford 2017) has been applied to this estimate assuming five years for temporal lag B and three years for temporal lag C. As described above, temporal lag B of five years is considered appropriate, and conservative, given that a number of projects, including the South Causeway Eelgrass Project, are anticipated to be constructed earlier than five years. Also, a temporal lag C of three years for native eelgrass is considered appropriate based on effectiveness monitoring of native eelgrass transplantation projects in B.C. (see Table IR7-29-1 in the response to IR7-29).[19]

In total, the creation of 50 ha of intertidal marsh and 10 ha of native eelgrass offsetting habitat is estimated to result in gains of juvenile Chinook salmon habitat productivity by 10.2 t/year (**Table IR2020-1.2-3**).

The calculation presented in **Table IR2020-1.2-3** of net gain in the productivity of juvenile Chinook salmon habitat is considered conservative, because of conservative discounting assumptions made to account for temporal lags B and C (as described above) and because it does not take into account the following:

- <u>Potential additional project footprint reduction</u>: The port authority has evaluated additional project design options to further reduce effects on juvenile Chinook salmon habitat (described in **IR2020-2.1**). A potential reduction of the current project footprint by up to 14.4 ha (measure 4 in **Table IR2020-1.2-1**) will avoid the loss of combined intertidal marsh and native eelgrass productivity of approximately 0.001 t/year (see **Appendix IR2020-2.1-A**, Table 4-1). Such potential reduction in direct loss of juvenile Chinook salmon habitat productivity is small relative to productivity gains forecasted by the updated RB model. Hence, benefits to the productivity of intertidal marsh and native eelgrass associated with a potential additional reduction in the current project footprint are not considered in the overall productivity calculations for juvenile Chinook salmon habitat, making those calculations more conservative.
- <u>22 ha of additional offsetting</u>: Potential additional habitat productivity gains associated with 22 ha of conventional offsetting projects the port authority is currently advancing are anticipated in addition to the 64 ha of conventional offsetting habitats considered in the analysis. As a result, actual offsetting productivity gains in juvenile Chinook salmon habitat to be realized with the project are anticipated to be even greater.

[19] CIAR Document #934 From the Vancouver Fraser Port Authority to the Review Panel re: Compilation of the Review Panel's Information Requests and the Vancouver Fraser Port Authority's Responses (Note: Updated February 15, 2019). https://iaac-aeic.gc.ca/050/evaluations/document/128131

In conclusion, with mitigation, including offsetting, project-related losses in the productivity of habitats used by juvenile Chinook salmon will be fully mitigated and no adverse residual effect will remain.

Table IR2020-1.2-3: RBT2 net gains in the productivity (tonnes (t) per year) of habitats used by juvenile Chinook salmon (intertidal marsh, native eelgrass) with mitigation, including offsetting

Juvenile Chinook salmon habitat	Direct and indirect project effects with avoidance and reduction measures (with – without project; t/year)[a]	Effects from tug basin expansion with avoidance and reduction measures (t/year)[b]	Offsetting (t/year)	Net productivity gain (t/year)
Intertidal marsh	777.3	0.0	8.8[c]	786.1
Native eelgrass	177.0	-5.5	1.4[d]	172.9
Total	**954.3**	**-5.5**	**10.2**	**959.0**

Notes:

- Negative numbers indicate loss in productivity of fish and fish habitat.

a. Calculated using the RB model developed using Ecopath with Ecosim and Ecospace for the EIS and updated in 2020 to reflect current (2019) existing conditions (see **Appendix IR2020-1.2-A**). Discounted to account for uncertainty in the updated RB model and temporal lag A. Avoidance measures taken into account include measures 1, 2, 3 and 6 in **Table IR2020-1.2-1**.

b. Technical information on the analysis of effects to juvenile Chinook salmon habitat from the tug basin expansion is provided in **Appendix IR2020-1.2-B**. Measure 4 in **Table IR2020-1.2-1** is taken into account in the calculation.

c. Offsetting productivity gains assume the creation of 50 ha of intertidal marsh, discounted by the productivity of underlying intertidal mudflat (**Appendix IR2020-1.2-A**), temporal lag B and C of five and seven years, respectively (**Appendix IR2020-1.2-D**).

d. Offsetting productivity gains assume the creation of 10 ha of native eelgrass, discounted by the productivity of underlying subtidal sand (**Appendix IR2020-1.2-A**), and temporal lags B and C of five and three years, respectively (**Appendix IR2020-1.2-D**).

Line of evidence 2 – Relative values approach

In summary, the relative values approach conservatively shows a net gain in juvenile Chinook salmon habitat (of 37.4 ha) when all potential habitats are considered. The following presents how the relative ranking was determined, which avoidance, reduction, and offsetting measures were included in the analyses, the methods that were used to apply the ranking, and the results of the analysis.

In the analysis of project-related effects to habitats used by juvenile Chinook salmon, and in response to DFO input, the port authority undertook an alternate equivalency analysis (to quantify how offsetting projects address the effects of the project). This alternative analysis considered all habitat types at Roberts Bank that will be directly affected by the project and their relative importance to juvenile Chinook salmon. Technical information on the analysis is provided in **Appendix IR2020-1.2-D**. Based on the habitat map developed for the project and updated with empirical data collected in 2019 (**Appendix IR2020-1.2-A**, Figure 2-1), the habitat types at Roberts Bank that juvenile Chinook salmon encounter when rearing at Roberts Bank are intertidal marsh, native and non-native eelgrass, kelp (canopy-forming macroalgal communities), mud- and sandflats, open water offshore waters along the delta foreslope, and rocky shorelines.

Habitat types at Roberts Bank were ranked based on opportunities (in terms of food and refuge) they provide for juvenile Chinook salmon rearing. Rankings were based on professional opinion and informed by scientific literature and ranged from good and high relative importance for intertidal marsh and native eelgrass, given the rearing opportunities they provide for juvenile Chinook salmon (as explained above); fair to moderate for non-native eelgrass and kelp; fair for intertidal mud and sand; and poor for subtidal offshore habitat. Rationale for the ranking of relative importance is provided in **Appendix IR2020-1.2-D**, Table IR2020-1.2-D4; the relative importance of habitat used by juvenile Chinook salmon is shown in **Appendix IR2020-1.2-D**, Figure IR2020-1.2-D1.

Mitigation measures that were considered in the calculation of net change in areal extent of habitat used by juvenile Chinook salmon, including rationale for their consideration, are listed in **Appendix IR2020-1.2-E**, Table IR2020-1.2-E3, and summarized in **Table IR2020-1.2-4**.

Table IR2020-1.2-4: Juvenile Chinook salmon habitat – area; avoidance, reduction, and offsetting measures considered in IR2020-1.2 analysis in support of the proposed offsetting plan for the Roberts Bank Terminal 2 Project

#	Mitigation measure	Analysis of project effects (juvenile Chinook salmon habitat, area)
Avoidance measures		
1	Placement of the marine terminal in subtidal waters	✓
2	Tug basin expansion re-design	✓
3	Widened causeway re-design	✓
4 (new)	Potential additional project footprint reduction	✓
5	Containment dyke construction measures	●
6	Rounded northwest corner of marine terminal	✓
Reduction measures		
7 (new)	Potential breaching mitigation	●
8	Removal of the intermediate transfer pit	●
9	Marine Species Management Plan (timing windows)	×
10	Marine Species Management Plan (salvage)	×
11	Underwater Noise Management Plan	×
12	Light Management Plans	×
13 (new)	Additional operational lighting mitigation	×
14 (new)	Additional operational mitigation for underwater noise	×
15 (new)	Timing of maintenance dredging at the expanded tug basin	×
Offsetting measures		
16 (new)	Offsetting project to restore and enhance up to 86 ha of fish habitat[20]	✓

Notes:

– number of mitigation measures corresponds to numbered list presented in **Table IR2020-1.2-1**
✓ – considered quantitatively in the analysis
● – considered qualitatively in the analysis (empirical data not available)
× – does not apply to juvenile Chinook salmon habitat as no interaction with RBT2 and no pathway of effect has been identified in the EIS; measure is directly relevant to and has been considered in the analysis for juvenile Chinook salmon (see **Table IR2020-1.2-4** and **Appendix IR2020-1.2-E**, Table IR2020-1.2-E3 for rationale)

Direct footprint effects: The current project footprint overlaps with and will result in the permanent loss of 28.1 ha of habitat, weighted based on its relative importance to juvenile Chinook salmon (**Table IR2020-1.2-5**). This direct

[20] As described earlier, analytics included 64 ha of the total 86 ha proposed by the port authority.

footprint effect on habitats used by juvenile Chinook salmon was calculated by overlaying the current project footprint on the 2019 Roberts Bank habitat map developed following surveys undertaken for the project in 2019 (**Appendix IR2020-1.2-A**, Figure 2-1). This effect calculation considers that approximately 72%[21] of the project footprint is proposed to be constructed in subtidal waters (measure 1 in **Part A** of the response), and considers other avoidance measures (measures 2, 3, and 6 in **Part A** of this response) that are integrated into the current project footprint.

<u>Reduced direct footprint effects from potential footprint reduction (described in **IR2020-2.1**):</u> A potential further reduction of the current project footprint by up to 14.4 ha would further reduce direct effects to habitat. When the relative importance to juvenile Chinook salmon is considered, this reduction of direct effects to habitat amounts to 3.2 ha (**Table IR2020-1.2-5**).

<u>Offsetting gains:</u> When the relative importance to juvenile Chinook salmon is considered, 64 ha of offsetting habitat amount to areal gains of habitats used by juvenile Chinook salmon of 62.4 ha (intertidal marsh: 50 ha, native eelgrass: 10 ha, kelp canopy: 2.4 ha; see **Appendix IR2020-1.2-D**).

In summary, with avoidance, reduction, and offsetting measures, the project will result in a net areal gain of 37.4 ha of juvenile Chinook salmon habitat. This result accounts for gains of high value intertidal marsh (40.1 ha), native eelgrass (6.3 ha), and kelp canopy (2.4 ha), minus direct (footprint) losses of lower value non-native eelgrass (5 ha) and intertidal and subtidal mud- and sandflat (6.3 ha) (**Table IR2020-1.2-5**, and **Appendix IR2020-1.2-D** for additional technical details).

Net gains in juvenile Chinook salmon habitat presented in **Table IR2020-1.2-5** are conservative because they do not consider potential additional habitat gains associated with 22 ha of additional offsetting habitats the port authority is currently advancing in addition to the 64 ha of conventional offsetting habitats considered here (see earlier discussion explaining why only 64 ha of the 86 ha were used in this analysis). As a result, actual offsetting areal gains in juvenile Chinook salmon habitat to be realized with the project are anticipated to be greater.

In conclusion, with mitigation, including offsetting, project-related loss to juvenile Chinook salmon habitat will be fully mitigated, and no residual adverse effects will remain.

[21] Approximately 126.3 ha out of 175.5 ha of the current project footprint overlapping with the wetted environment at Roberts Bank are proposed to be located below 0 m CD (i.e., the mean lower low water that defines the seaward boundary of the intertidal zone).

Table IR2020-1.2-5: Net gain, with mitigation, including avoidance, reduction, and offsetting measures, in area (hectares; ha) of juvenile Chinook salmon habitat before and after applying the relative importance of habitat to juvenile Chinook salmon

Juvenile Chinook salmon habitat	Overlap with current project footprint with avoidance measures (ha)[a]	Weighted[b] overlap with current project footprint with avoidance measures (ha)	Avoided habitat loss with potential additional footprint reduction (ha; IR2020-2.1)[c]	Weighted avoided habitat loss with potential additional footprint reduction (ha)	Offsetting (ha; IR2020-1.1)[d]	Net habitat change (ha)	Weighted net habitat change (ha)
Intertidal marsh	-13.1	-11.2	1.5	1.3	50.0	38.4	40.1
Native eelgrass	-4.7	-4.4	0.7	0.6	10.0	6.0	6.3
Subtotal	***-17.8***	***-15.5***	***2.2***	***1.9***	***60.0***	***44.4***	***46.3***
Non-native eelgrass	-20.5	-5.8	2.4	0.8	0.0	-18.1	-5.0
Native/non-native eelgrass	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kelp	0.0	0.0	0.0	0.0	4.0	4.0	2.4
Mud/sand	-128.2	-6.8	9.7	0.5	0.0	-118.5	-6.3
Gravel/cobble	-5.9	0.0	0.0	0.0	0.0	-5.9	0.0
Rock	-2.2	0.0	0.0	0.0	0.0	-2.2	0.0
TOTAL	**-174.6**	**-28.1**	**14.4**	**3.2**	**64.0**	**-96.2**	**37.4**

Notes:

- Negative numbers indicate loss in areal extent of juvenile Chinook salmon habitat.

a. Overlap of proposed project footprint defined in the project construction update with habitat types at Roberts Bank mapped in 2019 during surveys undertaken for the project (**Appendix IR2020-1.2-A**, Figure 2-1). Avoidance measures taken into account include measures 1, 2, 3, and 6 described in **Part A** of the response.
b. Weighting was undertaken using a scale of 0 to 1 (poor to high) to reflect the relative importance to juvenile Chinook salmon of habitat types at Roberts Bank based on the association of juvenile Chinook salmon with these habitat types and opportunities they provide for juvenile Chinook salmon rearing (see **Appendix IR2020-1.2-D**, Table IR2020-1.2-D4).
c. Considers measure 4 described in **Part A** of the response.
d. For the purpose of this analysis, calculations conservatively assumed the creation of 50 ha of intertidal marsh, 10 ha of native eelgrass, and 4.0 ha of subtidal rock reef offsetting habitats, even though the port authority is advancing up to 86 ha of conventional offsetting habitats (see response for more details on this approach).

Effects analysis results for juvenile Chinook salmon

In summary, with avoidance, reduction, and offsetting measures, the project will conservatively result in a net gain in the productivity of juvenile Chinook salmon by a total of 0.1 t/year (**Table IR2020-1.2-7**). In other words, taking mitigation into account, including offsetting, the productive potential of Roberts Bank is estimated to increase such that it can sustain on average an additional approximately 65,000 outmigrating juvenile Chinook salmon annually (range of approximately 50,000 to 100,000 individuals per year).[15] Conservatism in this calculation is explained below. Additional information on the calculations is provided below and in **Appendices IR2020-1.2-A, IR2020-1.2-B**, and **IR2020-1.2-D**.

This section provides an analysis of net change (after avoidance, reduction, and offsetting measures) in the productivity of juvenile Chinook salmon. Mitigation measures that were considered in this analysis, including rationale for their consideration, are listed in **Appendix IR2020-1.2-E**, Table IR2020-1.2-E4, and summarized in **Table IR2020-1.2-6**.

Table IR2020-1.2-6: Juvenile Chinook salmon – productivity; avoidance, reduction, and offsetting measures considered in IR2020-1.2 analysis in support of the proposed offsetting plan for the Roberts Bank Terminal 2 Project

#	Mitigation measure	Analysis of project effects (juvenile Chinook salmon, productivity)
Avoidance measures		
1	Placement of the marine terminal in subtidal waters	✓
2	Tug basin expansion re-design	●
3	Widened causeway re-design	✓
4 (new)	Potential additional project footprint reduction	●
5	Containment dyke construction measures	●
6	Rounded northwest corner of marine terminal	✓
Reduction measures		
7 (new)	Potential breaching mitigation	✓
8	Removal of the intermediate transfer pit	●
9	Marine Species Management Plan (timing windows)	●
10	Marine Species Management Plan (salvage)	●
11	Underwater Noise Management Plan	●
12	Light Management Plans	●
13 (new)	Additional operational lighting mitigation	●
14 (new)	Additional operational mitigation for underwater noise	●
15 (new)	Timing of maintenance dredging at the expanded tug basin	●
Offsetting measures		
16 (new)	Offsetting project to restore and enhance up to 86 ha of fish habitat[22]	✓

Notes:

– number of mitigation measures corresponds to numbered list presented in **Table IR2020-1.2-1**
✓ – considered quantitatively in the analysis
● – considered qualitatively in the analysis (empirical data not available)

[22] As described earlier, analytics included 64 ha of the total 86 ha proposed by the port authority.

Direct and indirect productivity changes: Direct and indirect productivity changes resulting from the project were calculated for juvenile Chinook salmon using the outputs of the updated RB model (see also **Appendix IR2020-1.2-A** for technical information on the updated RB model). After discounting for uncertainty in the updated RB model and temporal lag A, forecasted gains in juvenile Chinook salmon productivity amount to 0.005 t/year (**Table IR2020-1.2-2**; see also **Appendix IR2020-1.2-D**). Productivity gains forecasted for juvenile Chinook salmon are attributed to food web linkages, as the productivity of macrofauna, preyed upon by juvenile Chinook salmon, is also forecasted to increase. Measures 1, 3, and 6 described in **Part A** of the response are reflected in the discounted outputs of the updated RB model as they were incorporated in the current project footprint which was used as input into the updated RB model.

Potential breaching mitigation: As described in the port authority's closing remarks, placement of the marine terminal in predominantly subtidal waters, while avoiding and thereby minimizing the loss of high value juvenile salmon habitat, has the potential to disrupt the migration of juvenile Chinook salmon. In the EIS, changes in productivity of juvenile Chinook salmon from a potential project-related disruption to migration were qualitatively predicted to be minor[23] before mitigation. Since the public hearing, additional analysis has been undertaken (using modelling technology that was not available at the time of EIS submission) that enabled the port authority to quantify potential effects on the productivity of juvenile Chinook salmon from a potential disruption to migration. This quantification analysis confirmed that the effect would be minor and that the project has the potential to divert away from the inter-causeway area approximately 0.002 t/year to 0.004 t/year of juvenile Chinook salmon (**Table IR2020-1.2-7**). In other words, the project has the potential to divert approximately 35 to 70 juvenile Chinook salmon per day,[24] representing approximately 7% to 14% of the proportion of juvenile Chinook salmon that would have accessed the inter-causeway area without the project (**IR2020-2.2** and **Appendix IR2020-2.2-E**). This disruption (and apparent effect) is unlikely to result in a loss of juvenile Chinook salmon productivity because those individuals diverted from the inter-causeway area will either remain north of the causeway, where they will benefit from the increased productivity in new offsetting habitats and increases with the project in native eelgrass and intertidal marsh forecasted by the updated RB model, and/or they will migrate and successfully rear in offshore and other nearshore habitats in the estuary.

The port authority has evaluated breaching (i.e., fish passage) mitigation at four potential locations, one at the east end of the proposed marine terminal, and three locations along the Roberts Bank causeway (Measure 7 in **Part A** of the response; see also **IR2020-2.2**, Figure IR2020-2.2-1). As currently designed, all four breach location options are considered effective in facilitating movements of juvenile Chinook salmon between north and south of the project. Breaching mitigation at a causeway location would also provide direct access from the north side of the causeway to the inter-causeway area. Thus, implementation of breaching mitigation would avoid a potential project-related disruption of juvenile Chinook salmon migration equivalent to approximately 7% to 14% (or approximately of 0.002 t/year to 0.004 t/year; **Table IR2020-1.2-7**) of juvenile Chinook salmon that would have accessed the inter-causeway area without the project. For additional information on the evaluation of breaching mitigation effectiveness, refer to **IR2020-2.2**.

Offsetting gains: As indicated earlier, the port authority is currently advancing up to 86 ha of conventional offsetting habitat for the project, including intertidal marsh and native eelgrass, the two habitat types preferentially used by juvenile Chinook salmon. Conservatively assuming the creation of 50 ha of intertidal marsh and 10 ha of native eelgrass, offsetting gains in the productivity of juvenile Chinook salmon were calculated to be 0.105 t/year, for a net gain in juvenile Chinook salmon productivity of 0.110 t/year (**Table IR2020-1.2-7**). In other words, with offsetting, the productive potential of Roberts Bank is estimated to increase such that it can sustain on average an additional approximately 65,000 outmigrating juvenile Chinook salmon annually (range of approximately 50,000 to 100,000 individuals per year).[15]

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[23] In the EIS, the minor effect category was defined as a productivity change ranging between 6% and 30% (see also IR-7.31.15-07, CIAR Document #314).

[24] Calculation is based on an average body weight of 1.85 grams, measured during field surveys undertaken for the project in spring and summer 2020, and a 30-day period to account for a full-moon cycle that influences the tides at Roberts Bank and thus movements of rearing juvenile salmon.

The approach to calculating productivity gains from offsetting habitats, including accounting for the productivity of underlying habitat as well as discounting for temporal lags B and C, is summarized above for juvenile Chinook salmon habitat and additional technical information is provided in **Appendices IR2020-1.2-A** and **IR2020-1.2-D**.

The calculation presented in **Table IR2020-1.2-7** of net gain in the productivity of juvenile Chinook salmon is considered conservative because it does not take into account the following:

- Potential additional project footprint reduction: The portion of the project footprint that was incorporated in the updated RB model does not account for potential additional footprint reductions by up to 14.4 ha. Potential reduction in footprint-related effects to the productivity of juvenile Chinook salmon should this potential additional footprint reduction be implemented are described qualitatively in **IR2020-2.1**. Therefore, direct and indirect effects of the project forecasted by the updated RB model presented in **Table IR2020-1.2-7** are considered conservative.

  In addition to the reduction measures discussed above, the port authority is currently evaluating the technical and economic feasibility of complexing intermittently some portions of the existing rocky perimeter on the marine terminal's west side, to provide food and refuge to juvenile salmon individuals that migrate along the west marine terminal perimeter. Preliminary interest in learning more about this concept has been expressed by several Indigenous groups, in particular Semiahmoo First Nation and T'suubaa-asatx First Nation. This potential additional mitigation measure and associated benefits to juvenile Chinook salmon productivity are not included in the calculation shown in **Table IR2020-1.2-7** and further consultation and evaluation will occur during the project's permitting phase, as described in **IR2020-2.2**.

- 22 ha of additional offsetting: As indicated in **Part A** of the response, the port authority is currently advancing up to 86 ha of conventional offsetting habitats; however, not all offsetting projects were considered in the calculations shown in **Table IR2020-1.2-7**. As a result, actual offsetting gains in the productivity of juvenile Chinook salmon to be realized with the project are anticipated to be greater.

In conclusion, with mitigation including offsetting, project-related effects to the productivity of juvenile Chinook salmon, including from a potential project-related disruption to migration, will be fully mitigated and no adverse residual effects will remain.

Table IR2020-1.2-7: RBT2 net change in productivity (tonnes (t) per year) of juvenile Chinook salmon with mitigation, including avoidance, reduction, and offsetting measures

Direct and indirect project effects with avoidance and reduction measures (with – without project; t/year)[a]	Potential migration disruption without mitigation[b] (t/year)	Breaching mitigation (t/year)[c]	Offsetting (t/year)[d]	Net productivity change (t/year)
0.005	-0.002 to -0 004	0.002 to 0 004	0.105	0.110

Notes:

- Negative numbers indicate loss in productivity of fish and fish habitat.

a. Calculated using the RB model developed using Ecopath with Ecosim and Ecospace for the EIS and updated in 2020 to reflect current (2019) existing conditions (see **Appendix IR2020-1.2-A**). Discounted to account for uncertainty in the updated RB model and temporal lag A. Avoidance and reduction measures taken into account include measures 1, 3, and 6 described in **Part A** of the response.
b. Quantification of juvenile Chinook salmon productivity losses from a potential project-related disruption to migration is described in **Appendix IR2020-2.2-E**.
c. Measure 7 in **Part A** of the response was taken into account in the calculation.
d. Offsetting productivity gains assume the creation of 50 ha of intertidal marsh and 10 ha of native eelgrass, discounted by the productivity of underlying habitat, temporal lag B of five years for both offsetting habitat types, and temporal lag C of seven and three years for intertidal marsh and native eelgrass, respectively (**Appendices IR2020-1.2-A** and **IR2020-1.2-D**).

Part C: Provide an analysis of how the proposed offsetting plan will counterbalance residual effects of the Project on fish and fish habitat.

Two separate analyses (or lines of evidence) are provided that show how the proposed offsetting will counterbalance effects of the project on fish and fish habitat that remain after avoidance and reduction measures.

As a general conclusion, with mitigation, including offsetting, both lines of evidence conservatively indicate that the project, with offsetting, counterbalances the effects to fish and fish habitat. A net gain in fish and fish habitat productivity (of 1,773 t/year) is conservatively predicted with the project, even when discounting is applied to account for uncertainty in the updated RB model and potential delays in offsetting function. Moreover, offsetting will conservatively contribute four times more productivity than that lost by the footprint. Inclusion of indirect gains in productivity (due to the quiescent conditions predicted to be developed behind the terminal) and offsetting gains indicate a gain of up to 16 times the productivity (than that lost by the footprint alone). Consistent with EIS findings, residual adverse effects are predicted for forage fish (including herring), flatfish (including starry flounder), infaunal bivalves, and orange sea pens; these residual adverse effects are considered not significant and are discussed below.

Estimates of net productivity change following application of avoidance, reduction, and offsetting measures are considered conservative for the following reasons:

- Offsetting gains in fish and fish habitat productivity were based on 64 ha of offsetting, and not the full 86 ha of offsetting that the port authority is currently advancing. Consequently, greater gains in offsetting productivity from an additional 22 ha of offsetting are anticipated.
- Offsetting projects proposed to be withdrawn from the habitat bank are already functioning, have been accruing fish and fish habitat productivity since their establishment, and will continue to accrue fish and fish habitat productivity until project construction. These gains in productivity that will have contributed to the system prior to project construction are not included in the calculations presented in this part of the response.
- Temporal lag B of five years was conservatively assumed in the calculation of offsetting productivity gains even though several offsetting projects are anticipated to be constructed substantially earlier than five years (e.g., three years for some offsetting projects; habitat banking credit will be withdrawn earlier than five years; see **Part B** of the response for details).
- Reduction in direct (footprint) effects to fish and fish habitat from a potential reduction in the current project footprint (described in **IR2020-2.1**) are not considered in the net productivity calculations for fish and fish habitat (as explained in **Part B** of the response).

For clarity, ‘fish’[25] in this response encapsulate the representative species or groups of marine fish and marine invertebrates selected to structure the biophysical effects assessment presented in the EIS. Representative species or groups of marine vegetation assessed in the EIS comprise ‘fish habitat’[26] in this response.

Effects analysis results for fish and fish habitat

The analysis regarding net gain in productivity of fish and fish habitat (after avoidance, reduction, and offsetting measures) is described below using two lines of evidence: (i) one that looks at net changes in fish and fish habitat productivity across the LAA, called the ‘productivity approach’, and (ii) a second one that looks separately at net

[25] Representative species or groups that were selected for the biophysical effects assessment presented in the EIS and are referred to as ‘fish’ in this response include (i) marine fish: Chinook and chum salmon (adults, juveniles), forage fish, including Pacific herring, Pacific sand lance, shiner perch, surf smelt, English sole, starry flounder, rockfish, lingcod, large and small demersal fish, and (ii) marine invertebrates: Dungeness crab (adults, juveniles), infaunal bivalves, macrofauna, meiofauna, and orange sea pens.
[26] Marine vegetation representative species or groups selected for the biophysical effects assessment presented in the EIS are referred to as ‘fish habitat’ in this response and include brown algae, native and non-native eelgrass, and intertidal marsh.

changes in fish and fish habitat productivity that are direct (footprint-related) and indirect (i.e., occurring outside the project footprint (non-footprint-related)), called the ‘footprint vs. non-footprint approach’.

Line of evidence 1 – Productivity approach

This section provides an analysis of net change in the productivity of fish and fish habitat (with avoidance, reduction, and offsetting measures). Mitigation measures that were considered in this analysis quantitatively or qualitatively, including rationale for their consideration, are listed in **Appendix IR2020-1.2-E**, Table IR2020-1.2-E5 and summarized in **Table IR2020-1.2-8**.

Table IR2020-1.2-8: Fish and fish habitat – productivity; avoidance, reduction, and offsetting measures considered in IR2020-1.2 analysis in support of the proposed offsetting plan for the Roberts Bank Terminal 2 Project

#	Mitigation measure	Analysis of project effects (juvenile Chinook salmon, productivity)
Avoidance measures		
1	Placement of the marine terminal in subtidal waters	✓
2	Tug basin expansion re-design	✓
3	Widened causeway re-design	✓
4 (new)	Potential additional project footprint reduction	●
5	Containment dyke construction measures	●
6	Rounded northwest corner of marine terminal	✓
Reduction measures		
7 (new)	Potential breaching mitigation	✓
8	Removal of the intermediate transfer pit	●
9	Marine Species Management Plan (timing windows)	●
10	Marine Species Management Plan (salvage)	●
11	Underwater Noise Management Plan	✓
12	Light Management Plans	●
13 (new)	Additional operational lighting mitigation	●
14 (new)	Additional operational mitigation for underwater noise	●
15 (new)	Timing of maintenance dredging at the expanded tug basin	●
Offsetting measures		
16 (new)	Offsetting project to restore and enhance up to 86 ha of fish habitat[27]	✓

Notes:

– number of mitigation measures corresponds to numbered list presented in **Table IR2020-1.2-1**
✓ – considered quantitatively in the analysis
● – considered qualitatively in the analysis (empirical data not available)

[27] As described earlier, analytics included 64 ha of the total 86 ha proposed by the port authority.

With all mitigation measures (**Table IR2020-1.2-8**) and 19.3% discounting to account for uncertainty and potential delays in offsetting functioning (see **Appendix IR2020-1.2-D**) the project has the potential to result in a net gain in productivity of the Roberts Bank ecosystem by a total of 1,773 t/year (**Table IR2020-1.2-9**). This value is predominantly influenced by net gains in marine vegetation by 1,334 t/year (or by 75%) with the project. This model outcome aligns with literature which supports that lower trophic level groups, including marine vegetation, make up the largest proportion of existing biomass in the Roberts Bank ecosystem (CIAR Document #934, Package 3 response). The ecosystem model was validated using local empirical data to understand its ability to predict lower trophic level groups, including marine vegetation. Validation shows a relatively high degree of accuracy (greater than 85%; see EIS Appendix 10-C, Section 3.4)[1] between model forecasts and local empirical distribution of vegetative habitats at Roberts Bank. On this basis, the review panel concluded that the model provides credible results for lower trophic levels such as marine vegetation and invertebrates.

For marine fish, productivity is predicted to increase by a net 3.2 t/year (or by 0.2%) with the project, while for marine invertebrates, productivity is predicted to increase by a net 435 t/year (or by 25%) with the project.

Net gain in fish and fish habitat productivity was calculated by subtracting from the direct and indirect productivity changes (forecasted by the updated RB model and after discounting for uncertainty and temporal lag A) losses in productivity associated with the expansion of the tug basin and changes in the acoustic environment, and then adding productivity gains associated with proposed offsetting. Additional information on the calculations is provided in **Appendices IR2020-1.2-A**, **IR2020-1.2-B**, and **IR2020-1.2-D**.

For those potential project effects to fish and fish habitat that remain following avoidance and reduction measures, the port authority is advancing up to 86 ha of offsetting habitats as part of the offsetting plan (summarized in **Part A** of the response and presented in detail in **IR2020-1.1**). While the port authority is advancing 86 ha of offsetting habitat, the analysis of offsetting productivity gains is based only on 64 ha of offsetting habitat (intertidal marsh: 50 ha; native eelgrass: 10 ha; subtidal rock reef: 4 ha[28]). Consequently, when the additional 22 ha of offsetting habitat (that the port authority will be advancing above the 64 ha analyzed here) is taken into account, the results presented here will be conservative compared to the additional gains from offsetting that are anticipated.

With the development of 50 ha of intertidal marsh, 10 ha of native eelgrass, and 4 ha of subtidal rock reef (as described above), offsetting gains in the productivity of fish and fish habitat were calculated to be 474 t/year (**Table IR2020-1.2-9**). Marine vegetation contributes to this value by 93%. Offsetting gains of 474 t/year are discounted to account for the productivity of underlying habitat (see **Appendix IR2020-1.2-A**) and temporal lags B and C (see **Appendix IR2020-1.2-D**).

<u>Residual effects</u>

Overall, with mitigation (avoidance, reduction and offsetting), and discounting (to account for uncertainty and potential delays in offsetting function), a net gain in productivity is estimated for fish (including species that rely on intertidal habitats to perform life functions) and fish habitat.

Species with a net gain in productivity include juvenile stages of Chinook and chum salmon, reef fish, forage fish, Dungeness crab, as well as other demersal species.[29] These species and juvenile stages seek food and refuge in intertidal and shallow subtidal habitats at Roberts Bank to perform life functions. Net productivity gains for such

[28] The amount of proposed subtidal rock reef offsetting habitat was recently decreased to 3 ha to 4 ha by the port authority, based on input from Indigenous groups (see **IR2020-1.1** for more details). Hence, offsetting productivity gains of representative species or groups associated with the subtidal rock reef offsetting habitat, such as rockfish and lingcod, may be overestimated. Additional calculations for the final size of the subtidal rock reef offsetting habitat will be undertaken to incorporate in the final offsetting plan as part of the project's application for a *Species at Risk Act*-compliant *Fisheries Act* authorization.
[29] Although a net loss in the productivity of small demersal fish is shown in **Table IR2020-1.2-9**, additional productivity gains from the 22 ha of offsetting habitat not included in the calculation will counterbalance project effects to the productivity of small demersal fish.

juvenile life stages translate into net productivity gains of adult life stages due to recruitment to the parental stock. Overall, placement of the marine terminal in subtidal waters avoids direct footprint effects on sensitive intertidal habitats (such as intertidal marsh and native eelgrass; see **Appendix IR2020-1.2-D**, Figure IR2020-1.2-D1) and enhances their productivity indirectly through changes in coastal geomorphic conditions. With the project, intertidal habitats will continue to provide rearing opportunities and enhance the productivity of juvenile life stages of marine species at Roberts Bank. Therefore, no residual adverse effects remain on these species/groups taking into account mitigation (including avoidance, reduction, and offsetting).

Consistent with assessment conclusions presented in the EIS, with avoidance, reduction, and offsetting measures, a residual adverse effect is predicted for forage fish (including herring), flatfish (including starry flounder), infaunal bivalves, and orange sea pens, predominantly due to placement of the marine terminal over subtidal sand (**Table IR2020-1.2-9**). This predicted residual adverse effect is assessed to be not significant for reasons discussed below. The not significant residual adverse effects to these species or groups are likely to remain after the consideration of the additional 22 ha of offsetting habitat that was not included in the analyses here (as described above). This is because these species are generally marine pelagic or benthic occurring in the subtidal zone, whereas the additional 22 ha of offsetting are located in the intertidal zone.

Groups such as flatfish and bivalves are ubiquitous, widespread, and abundant in the LAA and subtidal sand habitat is expansive within and beyond the boundaries of the LAA in the Salish Sea. Also, they possess life history characteristics (such as high fecundity) that make them resilient to physical and environmental change. Productivity loss of these species from the project will likely be counterbalanced over a relatively short period of time by natural recovery (i.e., recruitment, immigration) and populations are expected to re-establish in subtidal sand surrounding the terminal footprint and beyond. Conventional offsetting projects specific to flatfish are unknown though, as stated above, juvenile species of flatfish are anticipated to gain in productivity from the creation of native eelgrass offsetting habitat. As described in **IR2020-1.1**, the port authority is collaborating with Tsawwassen First Nation on the Tsawwassen Marshlands Project and the potential exists for bivalve habitat enhancement to be included as a component of this opportunity, hence residual losses to infaunal bivalves from the terminal footprint may be partially offset. Similarly the port authority is supporting several Indigenous group projects that will promote use of bivalves. While there are no known orange sea pen offsetting measures, translocation of orange sea pens (measure 9 in **Part A** of this response) will also aid in the recovery of orange sea pen aggregations at Roberts Bank by ensuring availability of a parent stock for recruitment.

For pelagic species, such as Pacific herring and other forage fish, the terminal footprint effect forecasted by the updated RB model over-emphasizes loss of productive habitat,[30] and thus the output is considered conservative (i.e., the actual effect would be less than forecasted). Pelagic species such as herring primarily use the water column more widely at Roberts Bank and are not restricted in the water column within the terminal footprint. They also rely for food on resources such as zooplankton that are widely distributed and available within the water column at Roberts Bank and surrounding areas of the Salish Sea and thus are not limiting. Herring are wide ranging in the Salish Sea with spawning activity largely concentrated to the east coast of Vancouver Island (well beyond the boundaries of the LAA); some spawning, however infrequent, has also been documented in the inter-causeway area (see the port authority's response to the review panel's IR4-18 (CIAR Document #934)). Herring larvae and juveniles are also pelagic and distributed in the water column across the Salish Sea, as such, their presence in the LAA is not anticipated to change with the project. Disturbed areas at Roberts Bank will likely be re-colonized quickly and pelagic herring larvae will continue to drift seasonally to Roberts Bank from spawning locations in the Salish Sea, such as the east coast of Vancouver Island or Point Roberts (e.g., Gordon and Levings 1984).

With respect to mitigation (including offsetting), the fisheries-sensitive timing window for juvenile salmon will also protect sensitive life history stages of herring that are present in the intertidal zone during that time, such as herring spawn and rearing juvenile herring; therefore, measure 9 in **Table IR2020-1.2-1** will be effective at reducing effects to herring during construction. Moreover, in addition to productivity gains of Pacific herring and forage fish anticipated with the creation of native eelgrass, this habitat type is also expected to provide structural

[30] The model results are considered an overestimate for Pacific herring because the assumptions used in the model to describe their movement under-represented their pelagic and transitory nature.

complexity as refuge habitat for rearing juveniles, as well as substrate for spawning by adult Pacific herring. Also, the Semiahmoo Bay-Little Campbell River Enhancement Project, identified by Semiahmoo First Nation, includes enhancement of forage fish spawning habitat, which is expected to further enhance the net productivity of forage fish. The port authority has committed funding of $500k to support advancement of Musqueum/Tsawwassen First Nation led research and priority initiatives for eulachon (a forage fish species).

The port authority recognizes the importance of flatfish, forage fish, Pacific herring, infaunal bivalves, and orange sea pens to a healthy marine ecosystem and to Indigenous group stewardship of fish and fish habitat. The port authority acknowledges the challenges that Indigenous groups have faced with declining fish stocks and the lack of access to traditional foods that have sustained Indigenous groups for millennia and will continue to consult closely with Indigenous groups, in relation to all five of these species and/or groups through the relevant follow-up programs. Over the course of consultation on the proposed project, the port authority has heard from several Indigenous groups about the particular importance of Pacific herring and infaunal bivalves to their traditional diet and the restrictions that have been in place for decades that have limited the ability of Indigenous groups to harvest and consume these resources.

In response to Tsleil-Waututh Nation’s concerns about the residual effects to several fish species and acknowledging the opportunity to support Indigenous-led food security initiatives, the port authority notes the possibility exists to focus potential NCOP projects on several of these fish species and groups for which the current proposed RBT2 offsetting plan would not result in a net productivity gain (NCOP; see **IR2020-1.1**, Section 6.2). The port authority will continue to work with Indigenous groups to explore potential opportunities and initiatives.

Line of evidence 2 – Footprint-related vs. non-footprint-related effects approach

During their review of the draft **IR2020-1.2** response, DFO commented that they found it difficult to determine the extent to which proposed offsets counterbalance the direct versus indirect effects of the project. To respond to DFO’s comment, an alternative equivalency analysis was undertaken to distinguish between forecasted changes in fish and fish habitat productivity within and outside the proposed project footprint.[31] This alternative equivalency analysis used the outputs of the updated RB model key run (described in **Appendix IR2020-1.2-A**) by extracting the productivity of fish and fish habitat for those grid cells that overlap with the proposed project footprint.

In total, the proposed project footprint overlaps with and will adversely affect approximately 119 t/year of fish (marine fish: 13 t/year; marine invertebrates: 106 t/year) and fish habitat (marine vegetation: <0.1 t/year; **Appendix IR2020-1.2-D**, Table IR2020-1.2-D1). Footprint-related productivity losses are attributed predominantly to infaunal bivalves (82%), which inhabit subtidal sand that overlaps with the marine terminal footprint, followed by forage fish and Pacific herring (10%), which are seasonally present in the water column of the subtidal area where the marine terminal is proposed to be constructed.

Forecasted changes in fish and fish habitat productivity outside the proposed project footprint were calculated by subtracting the footprint-related productivity losses from the updated RB model key run, after discounting for uncertainty and temporal lag A. Outside the project footprint, the project is forecasted to result in an overall gain in the productivity of fish and fish habitat at Roberts Bank by a total of 1,430 t/year (marine fish: -3 t/year; marine invertebrates: 537 t/year; marine vegetation: 897 t/year; **Appendix IR2020-1.2-D**, Table IR2020-1.2-D1).

When only footprint-related losses of approximately 119 t/year in the productivity of fish and fish habitat are considered, offsetting productivity gains of approximately 474 t/year are four times the productivity amount forecasted to be lost, or a 4:1 ratio, which is double the amount of offsetting DFO typically requires. When gains in fish and fish habitat productivity outside the proposed project footprint are considered alongside offsetting gains,

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[31] Note that the proposed project footprint considered in this analysis does not account for an additional reduction of up to 14.4 ha described and evaluated in **IR2020-2.1**. Given that the potential footprint reduction evaluated reduces the marine terminal width and not the overall length, no appreciable changes are anticipated in the magnitude of project-related coastal geomorphic changes (described in **IR2020-4**), and in turn the changes in fish and fish habitat productivity forecasted by the updated RB model.

then the ratio is 16:1. In other words, with offsetting the project is forecasted to result in 16 times more fish and fish habitat productivity than that forecasted to be lost due to the project footprint. Both these ratios are conservative for reasons described earlier, including consideration in the offsetting calculation of only 64 ha of the 86 ha the port authority is advancing, and a conservative assumption of five years for temporal lag B. Non-footprint-related (indirect) gains in the productivity of fish and fish habitat that will result once the project landmass is constructed are important and should be accounted for in determining the project's offsetting requirements (in accordance with the productivity approach (line of evidence 1) described in **Part C** of this response) for the following reasons:

- The updated RB model was developed by top modelling experts from the University of British Columbia (UBC) and developers of the Ecopath with Ecosim and Ecospace software. The model has been peer-reviewed extensively, including by UBC academics and DFO scientists.[32] During the RB model's update in 2020, the port authority proceeded to revise aspects of the model to incorporate feedback received by DFO during their technical review of the project's environmental assessment of ecosystem productivity[36] (see **Appendix IR2020-1.2-A**).
- Indirect productivity gains forecasted by the updated RB model (due to changes in physical conditions: wave height, depth, salinity, current velocity) are attributed predominantly to lower trophic level groups, such as marine vegetation (primary producers) and marine invertebrates (primary consumers). These lower trophic level groups make up the largest proportion of existing biomass (96% of total system biomass)[33] in the Roberts Bank ecosystem. This is characteristic of a highly productive estuarine system where nutrients become available to marine vegetation and marine invertebrates and make their way up the food web to consumers through bottom-up processes. For example, increased productivity of macrofauna will increase prey density for juvenile Chinook salmon, thereby increasing growth and survival and in turn productivity in key habitats used by juvenile Chinook salmon during the critical life history phase of this species. The review panel evaluated the RB model and concluded that it provides credible results for lower trophic levels such as marine vegetation, invertebrates and stationary, habitat forming groups.[34]
- The updated RB model is rooted on local empirical information which was collected during empirical studies undertaken for the project in 2012, 2013, and 2019. Validation of the model was also undertaken focusing on habitat forming groups and using four different methods and local empirical data. Results of this analysis revealed a very good agreement between existing distribution (based on empirical information) of habitat forming groups and productivity changes forecasted by the RB model (see EIS Appendix 10-C[1] and the port authority's response to review panel's IR3-21 (CIAR Document #934)).
- As part of the project's follow-up program, the port authority is advancing planning and development of four follow-up program elements (i.e., marine vegetation, marine invertebrates, rockfish/lingcod, great blue heron) to evaluate the outputs of the updated RB model and in turn verify assessment predictions[9]. The port authority will engage with DFO and consult with Indigenous groups during planning and development of these follow-up monitoring elements, including in relation to study design, monitoring frequency, monitoring metrics, and reporting. Consistent with the project's Adaptive Management Framework, should monitoring as part of these follow-up monitoring elements determine a departure from ecosystem model predictions based on pre-determined action thresholds, adaptive measures will be identified, evaluated, and implemented in consultation with DFO and Indigenous groups.

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[32] CIAR Document #900 From the Review Panel Secretariat to the Review Panel re: Technical Review of Roberts Bank Terminal 2 Environmental Assessment: Section 10.3 - Assessing Ecosystem Productivity - by Fisheries and Oceans Canada. https://iaac-aeic.gc.ca/050/documents/p80054/116596E.pdf

[33] This value was calculated as the sum of the biomass of functional groups with trophic levels lower than 3 over the total Roberts Bank system biomass (see response to the review panel's IR3-24; CIAR Document #984).

[34] CIAR Document #2062 Report of the Review Panel, Vancouver Fraser Port Authority Roberts Bank Terminal 2 Project. https://iaac-aeic.gc.ca/050/documents/p80054/134506E.pdf

Table IR2020-1.2-9: RBT2 net productivity change (in tonnes (t) per year) by representative species or group of fish and fish habitat after mitigation measures (avoidance, reduction and offsetting) and discounting to account for uncertainty and potential delays in offsetting function

Representative species or group	Direct and indirect project effects with avoidance and reduction measures (with – without project; t/year)[a]	Effects from tug basin expansion with avoidance and reduction measures (t/year)[b]	Underwater noise effects (t/year)[c]		Offsetting (t/year)[d]	Net productivity change (t/year)[e]
			Without reduction measures	With reduction measures		
Chinook (adult)	0.01	0.00	0.00	0.00	0.07	0.08
Chinook (juvenile)	0.00	<0.01	0.00	0.00	0.11	0.11
Chum (adult)	-0.03	0.00	0.00	0.00	0.07	0.04
Chum (juvenile)	0.02	<0.01	0.00	0.00	0.13	0.15
Flatfish	-0.45	-0.01	-0.02	-0.02	-0.14	-0.62
Forage fish	-13.61	-0.35	-0.33	-0.13	-0.41	-14.49
Pacific herring	-0.39	-0.08	-1.87	-1.81	0.42	-1.86
Large demersal fish	-0.54	-0.01	-0.01	0.00	0.58	0.03
Lingcod	-0.58	0.00	-0.01	-0.01	1.16	0.57
Rockfish	-0.75	0.00	-0.01	0.00	1.02	0.26
Pacific sand lance	0.01	-0.01	-0.01	-0.01	0.01	0.00
Shiner perch	0.79	-0.02	0.00	0.00	18.41	19.18
Small demersal fish	-0.42	-0.01	0.00	0.00	0.27	-0.16
Starry flounder	-0.13	-0.01	0.00	0.00	0.04	-0.10
Marine fish subtotal	*-16.07*	*-0.50*	*-2.27*	*-1.98*	*21.74*	*3.19*
Dungeness crab (adult)	-1.11	0.00	0.00	0.00	1.62	0.51
Dungeness crab (juvenile)	0.70	-0.03	0.00	0.00	0.21	0.89
Infaunal bivalves	-394.63	-0.61	0.00	0.00	-2.28	-397.51
Macrofauna	520.95	-3.76	0.00	0.00	6.42	523.61
Meiofauna	307.81	-0.28	0.00	0.00	3.24	310.78
Orange sea pen	-2.92	0.00	0.00	0.00	0.00	-2.92

Representative species or group	Direct and indirect project effects with avoidance and reduction measures (with – without project; t/year)[a]	Effects from tug basin expansion with avoidance and reduction measures (t/year)[b]	Underwater noise effects (t/year)[c]		Offsetting (t/year)[d]	Net productivity change (t/year)[e]
			Without reduction measures	With reduction measures		
Marine invertebrates subtotal	*430.81*	*-4.66*	*0.00*	*0.00*	*9.21*	*435.35*
Brown algae	-61.71	0.00	0.00	0.00	432.74	371.04
Native eelgrass	177.02	-5.53	0.00	0.00	1.36	172.86
Non-native eelgrass	4.02	-0.07	0.00	0.00	0.00	3.95
Intertidal marsh	777.29	0.00	0.00	0.00	8.84	786.13
Marine vegetation subtotal	*896.62*	*-5.60*	*0.00*	*0.00*	*442.89*	*1,333.97*
Total	**1,311.36**	**-10.76**	**-2.27**	**-1.98**	**473.89**	**1,772.51**

Notes:

- Negative numbers indicate loss in productivity of fish and fish habitat.

a. Calculated using the RB model developed using Ecopath with Ecosim and Ecospace for the EIS and updated in 2020 to reflect current (2019) existing conditions. Numbers in column account for uncertainty in the forecasts of the updated RB model and temporal lag A (see **Appendix IR2020-1.2-D**). Avoidance and reduction measures taken into account include measures 1, 3, and 6 in **Table IR2020-1.2-1**.

b. Technical information on the analysis of effects to fish and fish habitat from the tug basin expansion is provided in **Appendix IR2020-1.2-B**. Measure 2 in **Table IR2020-1.2-1** is taken into account.

c. Technical information on the analysis of effects to fish from underwater noise with and without reduction measures is provided in **Appendix IR2020-1.2-A**. Avoidance and reduction measures taken into account include measure 11 in **Table IR2020-1.2-1**.

d. Productivity gains from offsetting assume the creation of 64 ha of offsetting habitat (see accompanying text and **Appendices IR2020-1.2-A** and **IR2020-1.2-D**):
   - 50 ha of intertidal marsh, discounted by the productivity of underlying intertidal mudflat, and temporal lags B and C each of five years
   - 10 ha of native eelgrass, discounted by the productivity of underlying subtidal sand, and temporal lags B and C of five and three years, respectively
   - 4 ha of subtidal rock reef, discounted by the productivity of underlying subtidal sand, and temporal lags B and C of five and one year, respectively

   Thus, net productivity changes presented here are considered underestimates given that greater gains in productivity are anticipated when the additional 22 ha are considered.

e. While numerous avoidance and reduction measures have been proposed by the port authority only those shown in this table have been quantified; therefore, all net productivity changes are underestimates (when considering qualitatively the remaining avoidance and reduction measures that were not included here quantitatively; see also **Appendix IR2020-1.2-E**, Table IR2020-1.2-E4).

Conclusion

Three lines of scientific evidence all indicate that the 86 ha of conventional offsetting proposed by the port authority fully offsets effects to juvenile Chinook salmon and counterbalances the effects of the project to fish and fish habitat, even after additional discounting to account for uncertainty and potential delays in offsetting function. Additional offsetting opportunities, potential contingency measures, multi-year robust monitoring, and adaptive management provide even greater assurance that potential uncertainty in offsetting effectiveness will be managed.

Potential effects to juvenile Chinook salmon have largely been avoided (by the siting of the marine terminal in deeper habitat that provides lower productivity for juvenile salmon) and have been more than offset. In fact, the project, with offsetting, will result in a net gain of 37.4 ha of juvenile Chinook salmon habitat and the implementation of a breach effectively mitigates potential disruption to juvenile Chinook salmon migration.

The port authority's approach to developing the offsetting plan is conservative, incorporates input and projects from Indigenous groups, leverages the notable experience held by the port authority in developing successful offsetting projects, includes input from DFO, and is aligned with federal offsetting policy.

Appendices

Appendix IR2020-1.2-A Roberts Bank Terminal 2 Draft Report – Roberts Bank Ecosystem Model Update

Appendix IR2020-1.2-B Tug Basin Expansion Effects to Fish and Fish Habitat

Appendix IR2020-1.2-C Contingency Measure Approach

Appendix IR2020-1.2-D RBT2 Proposed fish and fish habitat offsetting plan – additional technical analysis

Appendix IR2020-1.2-E Avoidance, reduction, and offsetting measures considered in the analysis of project effects on juvenile Chinook salmon, fish and fish habitat, in support of the proposed RBT2 offsetting plan

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