# B2D2 Project

## Lynn Creek Estuary Fish and Fish Habitat Existing Conditions Report

REP-B2D2-0002

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# ACRONYMS AND DEFINITIONS

| ACRONYM | DEFINITION |
|---|---|
| B2 | Berth 2 |
| BC | British Columbia |
| BCIT | British Columbia Institute of Technology |
| BIEAP | Burrard Inlet Environmental Action Program |
| CD | Chart Datum |
| CDC | Conservation Data Centre |
| CEMP | Construction Environmental Management Plan |
| CNV | City of North Vancouver |
| COSEWIC | Committee on the Status of Endangered Wildlife in Canada |
| DFO | Fisheries and Oceans Canada |
| DNV | District of North Vancouver |
| FAA | *Fisheries Act* Authorization |
| FREMP | Fraser River Estuary Management Program |
| HADD | Harmful alteration, disruption or destruction of fish habitat |
| Hatfield | Hatfield Consultants LLP |
| IBA | Important Bird Area |
| LCE | Lynn Creek Estuary |
| LCE Study Area | Lynn Creek Estuary Study Area |
| NBT | Neptune Bulk Terminals (CANADA) Ltd. |
| NHC | Northwest Hydraulic Consultants Ltd. |
| NSSK | North Shore Streamkeepers |
| KWL | Kerr Wood Leidal Associates Ltd. |
| PER | Project and Environmental Review |
| the Port Authority | Vancouver Fraser Port Authority |
| ROV | Remotely Operated Vehicle |
| SARA | *Species at Risk Act* |
| Tsleil-Waututh | Tsleil-Waututh Nation |
| VanPile | Vancouver Pile Driving Ltd. |

# 1 INTRODUCTION

Neptune Bulk Terminals (CANADA) Ltd. (NBT) proposes a habitat enhancement project in Lynn Creek Estuary (the Lynn Creek Estuary [LCE] Offset Project). The LCE Offset Project is designed to offset the harmful alteration, disruption, or destruction (HADD) of fish habitat associated with the NBT Berth 2 (B2) Project. Hatfield Consultants LLP (Hatfield) has conducted field surveys and has developed this Existing Conditions Report to characterize the habitat in the LCE. Northwest Hydraulics Consultants Ltd. (NHC) and Vancouver Pile Driving Ltd. (VanPile) have conducted additional physical surveys in the LCE. This report follows the Vancouver Fraser Port Authority (the Port Authority) Project and Environmental Review (PER) Guidelines for Habitat Assessment (2015) and fulfills the requirements of the *Fisheries Act* Authorization (FAA) application of the "Description of Fish and Fish Habitat in the Offsetting Area".

## 1.1 Supporting Documents

The following documents were reviewed and used as guidance in the development of this report.

- Lynn Creek Estuary Enhancement (KWL, 2022) – This is a North Shore Streamkeepers (NSSK) document that was developed by Kerr Wood Leidal Associates Ltd. (KWL) in 2022 outlining and evaluating potential enhancement projects that could be undertaken in Lynn Creek.
- Project and Environmental Review Guidelines for Habitat Assessment (Port Authority, 2015) – This document provides guidance to Port Authority tenants in assessing potential habitat and wildlife impacts associated with projects proposed on Port Authority-managed lands.
- Tsleil-Waututh Nation Construction Environmental Management Plan Requirements (Tsleil-Waututh, 2022) – This document identifies Tsleil-Waututh Nation's (Tsleil-Waututh) minimum requirements to include in a Construction Environmental Management Plan (CEMP), including requirements for offsetting plans.
- Burrard Inlet Action Plan (KWL, 2017) – This document was developed by KWL on behalf of Tsleil-Waututh, and is a founding guidance document for a new science-based, First Nations-led initiative to improve the health of Burrard Inlet by 2025.

## 1.2 Berth 2 Existing Conditions Report

B2 Marine Fish and Fish Habitat Existing Conditions Report (NBT, 2023) – This report provides details of the existing physical and biological conditions at B2. A broader summary and literature review of Burrard Inlet is provided in the B2 Existing Conditions Report and thus not further discussed in this report.

## 1.3 Study and Survey Areas

The LCE Study Area is the area that was included in field surveys and the desktop review for this report. Within the LCE Study Area, a portion of the estuary near the proposed LCE Offset Project was surveyed in greater detail using a Remotely Operated Vehicle (ROV) (i.e., the ROV Survey Area).

### 1.3.1 Lynn Creek Estuary Study Area

The LCE Study Area is located at approximately 49°17.963'N, 123° 2.406'W. It is west of the Ironworkers Bridge in Burrard Inlet, and it is situated between the VanPile work yard and Lynnterm Terminal, near Harbourview Park (Figure 1-1, Photo 1-1). The depth of the LCE Study Area ranges from approximately -8 m to + 5 m chart datum (CD). The LCE Study Area was selected based on the footprint of the LCE Offset Project that will be designed to support the offsetting requirements for the B2 Project, and includes a buffer of at least 50 m on either side, to understand the subtidal habitat and species presence in the vicinity of the footprint. The LCE Offset Project is currently in the preliminary design phase.

### 1.3.2 Remote Operated Vehicle Survey Area

The ROV Survey Area is located at the southern portion of the LCE Study Area. This area encompasses the LCE Offset Project footprint and was surveyed using a ROV. The depth of the ROV Survey Area ranges from approximately -8 m to +2 m CD.


LEGEND:

- ROV Survey Area
- LCE Offset Project
- Port Authority Conservation Area
- B2 Project Footprint

**Depth**

- 5.0 m Contour

SOURCE / NOTE:

a) ROV survey area, LCE study area, Hatfield 2022.
b) Contours generated using depth points provided by Neptune Terminals in December 2022, Hatfield 2022. Contours have been adjusted to chart datum using a +3.0 m offset.
c) Conservation area, VFPA 2023.
d) B2 project footprint, digitized by Hatfield (2023) using Drawing No. 20230328-002, Rev: A "Berth 2 and Lynn Creek Estuary Project Location and Footprint", Neptune Bulk Terminals, March 2023.
e) Background, Orthophoto 10 cm, 13 April 2021, Esri Online Service.

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ISSUES/REVISIONS

VENDOR: Hatfield

ISSUED AS RECORD COPY (YES/NO) NO

Neptune TERMINALS



TITLE:

# Overview map and Lynn Creek Estuary Study Area

Figure 1-1

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**Photo 1-1: Aerial Photo of the Lynn Creek Estuary Study Area at Low Tide**

Source: ShoreZone (2017)

## 1.4 Lynn Creek Neighbours

### 1.4.1 Vancouver Pile Driving

VanPile is a multi-discipline construction company located to the west of the LCE Study Area. In 1956 VanPile leased 5.3 hectares of waterfront land adjacent to Lynn Creek. An inland harbour extending 92 m wide by 153 m long was dredged in the intertidal flats at the mouth of Lynn Creek. Upon flooding of this new inland harbour in the following winter, VanPile constructed a rock wall spit near the boundary between their waterlot and Lynn Creek (Figure 1-2). The rock wall spit was originally wide enough for vehicles to drive on, but much of the rock wall spit has eroded since its initial construction.

VanPile conducts regular maintenance dredging immediately west of the LCE Study Area to remove sediment to maintain vessel access.

### 1.4.2 Lynnterm Terminal

Lynnterm Terminal is a consolidation centre for forest products, steel, and break-bulk cargo, and is located to the east and south of the LCE Study Area (Figure 1-2). The portion of the terminal that is immediately south of the LCE Study Area is comprised of a platform several metres above the water that is supported by many steel piles.


LEGEND:

**Depth**

- 5.0 m Contour
- 0.5 m Contour
- ROV Survey Area
- LCE Offset Project
- Port Authority Conservation Area
- Habitat Restoration (2014 - 2016)
- Approximate Lynn Creek Estuary Offset Project Location
- Boulder Augmentation (2020)

SOURCE / NOTE:
a) ROV survey area, study area, Hatfield 2022.
b) Contours generated using depth points provided by Neptune Terminals in December 2022, Hatfield 2022. Contours have been adjusted to chart datum using a +3.0 m offset.
c) Conservation area, VFPA 2023.
d) Habitat restoration, created from "Restoring fish habitat in the Lynn Creek Estuary" District of Vancouver, Hatfield 2023.
e) Approximate Lynn Creek Estuary Offsetting Location, boulder augmentation, NHC 2023.
f) Background, Orthophoto 10 cm, 13 April 2021, Esri Online Service.

| REV | YYYY-MM-DD | DESCRIPTION | DRAWN | APPROVED |
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ISSUES/REVISIONS

VENDOR: Hatfield

ISSUED AS RECORD COPY (YES/NO) NO

Neptune TERMINALS



TITLE:
Lynn Creek Estuary Study Area

Figure 1-2

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## 1.5 Supporting Field Programs

The following field programs were undertaken for the design and options assessment for the offsetting plan:

- Subtidal ROV survey and intertidal/riparian assessments of the LCE Study Area – conducted by Hatfield in December 2022 and described in this report.
- Bathymetric survey of the LCE Study Area – conducted by VanPile in December 2022.
- Orthoimagery/drone flight of the LCE Study Area – conducted by NHC in December 2022.

## 1.6 Lynn Creek Estuary History and Urbanization

Historical maps of the area show that intertidal mudflat and marsh habitat existed in the LCE Study Area in the 1920s (Figure 1-3, Photo 1-2). Today, much of Lynn Creek is channelized due to urbanization. Only 1% remains of the LCE (K. Ashley, *pers. comm.*).


**Figure 1-3: Comparison Map of the Lynn Creek Estuary Study Area from 1929 and 2022**

Source (left): West Vancouver Archives

Note: Map from 1929 (left) showing the extent of salt marsh (light blue hashed area), with the approximate LCE Study Area compared with 2022 (right). The green rectangle highlights approximately the same area on each map.


**Photo 1-2: Aerial photo from 1970 showing the mouth of Lynn Creek (bottom right)**

Source: North Vancouver Archives (Inventory Number 16513)

## 1.7 North Shore Streamkeepers

North Shore Streamkeepers is a volunteer-led non-profit group focused on monitoring and improving streams and waterways along the North Shore. North Shore Streamkeepers is a stakeholder in the LCE Offset Project since the LCE Offset Project location is in the LCE. They have supported the classification of Lynn Creek as a Conservation Area by the Port Authority, and they have initiated a feasibility study of potential restoration projects in Lynn Creek (KWL, 2022). NBT is working together with NSSK in the development of the LCE Offset Project.

## 1.8 Past Restoration Projects in Lynn Creek

### 1.8.1 Habitat Restoration (2014-2016)

Restoration and habitat creation works have occurred in recent years in the LCE. In 2014-2016, fish habitat restoration works were implemented by British Columbia Institute of Technology (BCIT) Rivers Institute and Tsleil-Waututh, supported by the District of North Vancouver (DNV). As part of this project, the main gravel bars were reconstructed to retain more natural debris, large wood debris was secured on the gravel bars, and the intertidal islands at the head of the bar were reconstructed to support more plant life (DNV, 2016). Additionally, creosote-treated

wooden structures and invasive plants were removed, intertidal and riparian planting occurred, and eelgrass (*Zostera marina*) was transplanted. The eelgrass transplants did not survive (NSSK *pers. comm.*).

### 1.8.2 Boulder Habitat Augmentation (2020)

In 2020, a boulder reef was created in the LCE, led by the NSSK (Photo 1-1) between 0 m and +1.2 m CD. The boulder reef was created to provide additional macroalgae habitat (i.e., fish habitat) for juvenile salmonids outmigrating the LCE. Assessment of the boulder reef in 2021 and 2022 revealed that at least 22 invertebrate species and 10 algae species, including sugar kelp, have colonized the boulders (see Photo 5-5 for demonstration) (Seacology, 2021, 2022).

## 1.9 Desktop Review

A desktop review of existing publicly available information was conducted for the LCE Study Area (Figure 1-1) and Lynn Creek to inform and support the subsequent field assessment. A review of Burrard Inlet is provided in the B2 Existing Conditions Report (NBT, 2023). The information was assembled to characterize known marine habitat features, potential species presence, and potential migratory, refuge or spawning areas, including species-at-risk and wildlife of potential conservation concern. Data sources reviewed and evaluated included:

- British Columbia (BC) Conservation Data Centre (CDC).
  - BC Species & Ecosystems Explorer (BC CDC, 2023).
  - CDC iMap (Government of British Columbia, 2023).
- DFO (Fisheries and Oceans Canada), Aquatic Invasive Species (DFO, 2018).
- DFO, Pacific Herring Spawning Records – Strait of Georgia (DFO, 2016).
- DFO, Pacific Ocean, Aquatic Species at Risk Map (DFO, 2023).
- Fish Inventories Data Queries (FIDQ) (BC ENV, 2020).
- Fraser River Estuary Mmanagement Program (FREMP)–Burrard Inlet Environmental Action Program (BIEAP) Habitat Atlas (FREMP, 2022).
- Habitat Wizard Provincial Database (Government of British Columbia, 2022).
- Important Bird Areas (IBAs) (IBA Canada, 2021).
- Sensitive Habitat Information Mapping (SHIM) (SHIM, 2021).
- Species at Risk Registry: The Public Registry for species at risk in Canada (Government of Canada, 2023a).

# 2 FISH HABITAT

Fish habitat in the LCE Study Area includes various species of algae, rocky substrates such as cobble and gravel, and large woody debris. These habitats provide refuge from predators, foraging and spawning areas, and protection from temperature change and desiccation in the intertidal (KWL, 2017).

## 2.1 Physical Conditions

Lynn Creek originates in the protected Lynn Headwaters Regional Park and is bordered by the Seymour River and Mosquito Creek watersheds. It is 18 km long and has a watershed area of 55 $km^2$ (Pacific Streamkeepers Federation, 2015). Lynn Creek is a salmon-bearing watercourse and is the third-largest salmon-bearing river on the North Shore. Lynn Creek has been classified as endangered in the lower two-thirds of the watershed due to riparian removal, urbanization, culverting, and degraded water quality (DFO, 1998).

The LCE is a semi-enclosed body of water where freshwater from Lynn Creek meets the saltwater from Burrard Inlet. Typically, in estuaries, nutrients and sediment become trapped and constant mixing of the nutrients creates the opportunity for productive and diverse ecosystems. In Lynn Creek, the morphology has been simplified to plane bed runs (flat cobble streambeds with uniform water depth and velocity) and riffles with straight armoured edges, due to dredging and the confinement of the channel using riprap slopes. The artificially channelized flow may be leading to increased flow velocity.

Kerr Wood Leidal collected specific conductivity and temperature measurements within the main creek channel in May 2021. These parameters were found to not be limiting to fish or other aquatic life; however, water temperatures within side channel pools that hug the eastern shoreline of the creek, were observed at the general upper extent of the zone of preference for salmonids at low tide (Sullivan *et al.*, 2000). The observed temperatures were 18.2°C and 18.3°C (KWL, 2022), and the zone of preference for salmonids is between 13°C and 20°C (Sullivan *et al.*, 2000). Kerr Wood Leidal noted that there is potential for temperatures within these side channel pools to increase beyond the upper extent of the zone of preference during the summer months at low tide (KWL, 2022).

Large woody debris installations took place in the LCE in 2016 for the creation of fish habitat (DNV, 2016); Photo 5-4). Large woody debris provides a cover refuge and foraging habitat for juvenile and adult salmonids and promotes upstream sediment deposition by decreasing flow velocity (Davidson & Eaton, 2015). The LCE is relatively linear and contains a single main channel, which leads to relatively deep and fast-flowing water. This type of river structure does not provide ideal salmonid habitat, as salmonids need a variety of structures (e.g., pools and riffles) in which to rest, spawn and feed (Swales & Levings, 1989). The gravel bars in the LCE were also altered during the 2014-2016 restoration works to include riffle, pool, and run sequences, providing habitat properties that allow fish to thrive (Photo 5-4). Riffles are fast-flowing shallow parts of the stream used by fish as a feeding location, as they rest downstream of a fast-flowing riffle to wait for food. A pool is deeper and slows the rate of the flow. It is used by fish to rest, where they can use the organic matter present to hide. A run has deep fast flowing water, in a uniform flow.

## 2.2 Algae

Red, green, and brown algae species are present in the LCE, including sea lettuce (*Ulva* sp.), rockweed (*Fucus distichus*), and sugar kelp (*Saccharina latissima*). These algae species provide habitat, food, shelter and nursery environments for fish, invertebrates,

and some other algae. Their biomass also provides oxygen to nearshore food webs through primary productivity (Bates, 2004).

Sugar kelp is a common brown macroalga that grows on rocks in the low intertidal and shallow subtidal zone, along protected to semi-protected shorelines (Fretwell, 2016), including the LCE Study Area. The presence of this species in the subtidal may suggest an intermittently disturbed area (Guiry, 2021). Sugar kelp is an ecologically important species as it is a primary producer and provides food and shelter for fish, shellfish, invertebrates, and other algae (Bates, 2004; Christie *et al.*, 2009).

Rockweed is common in the upper to lower intertidal zone of sheltered to semi-exposed shorelines around Burrard Inlet and within the marine portion of the LCE Study Area (Mathieson *et al.*, 2014). Distribution is typically restricted to a narrow band in the mid intertidal zone. Rockweed creates a short canopy that plays an integral role within the intertidal community by providing invertebrates with a food source and shelter to protect invertebrates from wave action, dessication, freezing, and predators (Mathieson *et al.*, 2014; University of Puget Sound, 2019).

Red algae are common along the coastline of Burrard Inlet, including the LCE Study Area, and are found in two structural forms: bladed (i.e., broad and leafy) and filamentous. Splendid iridescent seaweed (*Mazzaella splendens*) is a common bladed red alga recognized by its iridescent sheen. It grows on rock substrate in the mid to low intertidal and upper subtidal zones in semi-protected to exposed habitats (Bates, 2004; Meschkat *et al.*, 2014). Succulent seaweed (*Sarcodiotheca gaudichaudii*) is an example of a filamentous red alga that is finely branched and grows in clusters. Bladed red algae were observed in the ROV footage.

Sea lettuce is a common green macroalga that grows throughout the intertidal zone in protected and semi-protected habitats (Proudfoot & Fretwell, 2015; University of Puget Sound, 2019) including the LCE Study Area. The species is often found attached to various types of substrates including gravel, cobble, boulders, shells, and wood habitats (Proudfoot & Fretwell, 2015; University of Puget Sound, 2019). Sea lettuce is fed upon by several intertidal organisms including polychaete worms, amphipods, crabs, snails, and sea urchins (University of Puget Sound, 2019).

# 3 MARINE ORGANISMS

## 3.1 Fish

The LCE is used for rearing and migration by five salmonid species: chinook (*Oncorhynchus tshawytscha*), chum (*O. keta*), coho (*O. kisutch*), pink (*O. gorbuscha*), and cutthroat trout (*O. clarki*) (BC ENV, 2020; Government of British Columbia, 2022; Haggarty, 2001; SHIM, 2021). A summary of pacific salmon biology and life stages is in Table 3-1.

The Morten Creek Salmon Enhancement Program manages a hatchery upstream of the LCE and volunteers with the program also participate in stream care (Morten Creek PSKF, 2012). The program releases coho and chum salmon fry into Lynn Creek and its tributaries, with a target of 30,000 chum fry per year (Morten Creek PSKF, 2012). Smolts

from the creeks and rivers to the east of the LCE, including the Seymour River where a large hatchery is located, preferentially use the North Vancouver shoreline beyond the LCE Study Area for out-migration to the ocean (NHC, 2019).

The local salmon populations in Lynn Creek are relatively small but still important. Much effort has been made by Indigenous Groups, NSSK, and other interested parties to increase these salmon stocks. The timing of salmon spawning migrations in Lynn Creek is presented in Table 3-1. Pink salmon prefer to spawn close to the ocean and in estuaries, and juveniles do not spend an extended period of time in freshwater. Similarly, juvenile chum also migrate out of freshwater environments soon after hatching (DFO, 2022a). Coho typically spawn in small streams and are likely passing through the LCE Study Area to streams further up LCE, where they then spend one to two years in freshwater (DFO, 2022a).

Four species of salmon have been identified to historically be supported by Lynn Creek and are listed in Table 3-2. Besides salmon, species include: Dolly varden (*Salvelinus malma*), prickly sculpin (*Cottus asper*), and threespine stickleback (*Gasterosteus aculeatus*).

**Table 3-1: Summary of general biological and life history characteristics of four species of Pacific salmon**

| LIFE HISTORY CHARACTERISTIC | COHO (*O. KISUTCH*) | PINK (*O. GORBUSCHA*) | CHUM (*O. KETA*) | CHINOOK (*O. TSAWYTSCHA*) |
|---|---|---|---|---|
| Season when eggs hatch | Spring | Spring | Spring | Spring |
| Length of stay in freshwater | 1-2 years; 1 year is common | Virtually none; often straight to ocean | Virtually none; often straight to ocean | Ocean-type: 60-150 days<br>Stream-type: 1-2 years |
| Primary rearing habitat | Stream | Estuary | Estuary | Stream/Ocean |
| Size at ocean migration | 10 cm or more | About 3.3 cm | 2.8 to 5.5 cm | 5 to 15 cm |
| Ocean voyage | 4 to 18 months | 18 months | 2 to 5 years | 4 months to 5 years |
| Age at return to freshwater | During 2nd to 4th year | During 2nd year | During 3rd to 5th year | During 2nd to 6th year |
| Season/month of return | Late summer to January | July to September | July to October | Spring to fall; some rivers support more than one run |
| Number of eggs/female | 2,000-3,000 | 1,200-2,000 | 2,000-3,000 | 2,000-17,000; (generally 5,000-6,000) |
| Preferred spawning area | Small streams | Close to ocean | Above turbulent areas or upwellings | Very broad tolerances |

| LIFE HISTORY CHARACTERISTIC | COHO (*O. KISUTCH*) | PINK (*O. GORBUSCHA*) | CHUM (*O. KETA*) | CHINOOK (*O. TSAWYTSCHA*) |
|---|---|---|---|---|
| Timing of salmon spawning migrations in Lynn Creek | June to late December | Early September to late October | Early October to late November | Mid-October to mid-November |

Note: Sockeye (*O. nerka*) is not included as Lynn Creek is unlikely to support its life characteristics and sockeye have historically not been observed to use Lynn Creek for rearing or spawning.
Source: DFO (2022a)

**Table 3-2: Historically documented fish species observed in Lynn Creek and Lynn Creek Estuary**

| COMMON NAME | SCIENTIFIC NAME | SHIM (2001) | FIDQ (2019) | HAGGARTY (2001) | BC HABITAT WIZARD (2021) | THIS REPORT |
|---|---|---|---|---|---|---|
| Chinook salmon | *O. tshawytscha* | X | X | | | |
| Chum salmon | *O. keta* | X | X | X | X | |
| Coho salmon | *O. kisutch* | X | X | X | X | |
| Cutthroat trout | *O. clarkii* | | X | X | X | |
| Dolly Varden | *S. malma* | | X | X | X | |
| Pink salmon | *O. gorbuscha* | | X | X | X | |
| Prickly sculpin | *C. asper* | | X | | X | |
| Rainbow trout | *O. mykiss* | | X | | X | |
| Starry flounder | *P. stellatus* | | | | | X |
| Steelhead trout | *O. mykiss* | X | X | X | X | |
| Threespine stickleback | *G. aculeatus* | | X | | X | |

Sources: BC ENV (2020); Government of British Columbia (2022); Haggarty (2001); SHIM (2021)

## 3.2 Invertebrates

Invertebrates play an important role in the marine ecosystem. They may seek refuge and graze on the macroalgae present, and they also process the particulate, organic materials (detritus and small organisms) that are deposited on the seafloor or that are suspended within reach of the organisms (Burd *et al.*, 2008). Invertebrates use a wide range of feeding strategies including deposit-feeding, suspension-feeding, filter-feeding, or scavenging. Benthic invertebrates may also be predators and herbivores and provide food for fish, birds, and marine mammals. Invertebrates are also useful as indicators of human activities, such as aquaculture.

## 3.3 Marine Mammals

Several marine mammals have been observed in Burrard Inlet, and therefore have the potential to occur in the LCE Study Area, including Pacific harbour seals (*Phoca vitulina richardii*), Steller sea lions (*Eumetopias jubatus*), and California sea lions (*Zalophus californianus*). The most likely marine mammal to enter the LCE Study Area is the harbour seal. The harbour seal diet consists primarily of crustaceans and molluscs, which are likely to occur in the LCE Study Area.

Cetaceans are unlikely to occur in the LCE Study Area; they are infrequent visitors to Burrard Inlet (Haggarty, 2001) and are unlikely to enter the LCE Study Area because of the shallow water depths.

## 3.4 Designated Species

The Species at Risk (SAR) Public Registry, BC Ecosystem Explorer, CDC and DFO aquatic species at risk maps were reviewed to identify aquatic species at risk with a range that covers the LCE Study Area. Based on habitat characteristics present in the LCE Study Area and known ranges of various at-risk species, the only aquatic species at risk with the potential to occur in the LCE Study Area is the Steller sea lion. However, Steller sea lions are infrequent visitors to Burrard Inlet (KWL, 2017).

Based on the DFO Aquatic SAR map, there are other species that have the potential to occur within 1 km of the LCE Study Area including those species listed in Table 3-3. However, the presence of these species in the LCE Study Area, besides Steller sea lions, is highly unlikely due to the shallow water depth in the LCE Study Area.

**Table 3-3: Fisheries and Oceans Aquatic Species at Risk with the potential to occur within one km of the Lynn Creek Estuary Study Area**

| COMMON NAME | SCIENTIFIC NAME | BC LIST | COSEWIC STATUS | SARA STATUS |
|---|---|---|---|---|
| Basking shark | *Cetorhinus maximus* | No status | E | E |
| Bluntnose sixgill shark | *Hexanchus griseus* | No status | SC | SC |
| Green sturgeon | *Acipenser medirostris* | B | SC | SC |
| Grey whale | *Eschrichtius robustus* | B | Non-active | SC |
| Harbour porpoise | *Phocoena phocoena vomerina* | B | SC | SC |
| Humpback whale | *Megaptera novaeangliae* | B | SC | SC |
| Killer whale | *Orcinus orca, resident* | R | E | E |
| Killer whale | *Orcinus orca, transient* | R | T | T |
| Leatherback sea turtle | *Dermochelys coriacea* | R | E | E |
| Longspine thornyhead | *Sebastolobus altivelis* | No status | SC | SC |
| Northern abalone | *Haliotis kamtschatkana* | R | E | E |

| COMMON NAME | SCIENTIFIC NAME | BC LIST | COSEWIC STATUS | SARA STATUS |
|---|---|---|---|---|
| Rougheye rockfish Type I and II | *Sebastes sp.* | No status | SC | SC |
| Steller sea lion | *Eumetopias jubatus* | B | SC | SC |
| Tope shark | *Galeorhinus galeus* | No status | SC | SC |
| Yelloweye rockfish | *Sebastes ruberrimus* | No status | T | SC |

Note: Reviewed January 2023

Source: Species at Risk Public Registry (Government of Canada, 2023a), Pacific Ocean, Aquatic SAR maps (DFO, 2023), BC Species Ecosystem Explorer (BC CDC, 2023)

Definitions: R = red, B = blue; T = threatened, E = endangered, SC = special concern

Acronyms: SARA = *Species at Risk Act* , COSEWIC = Committee on the Status of Endangered Wildlife in Canada

### 3.5 Invasive Species

Invasive species with the potential to occur in the Pacific North Coast waters as per DFO's Aquatic Invasive Species website (DFO, 2018) are listed below:

- Soft shell clams (*Mya arenaria*).
- Manila clams (*Lajonkairia lajonkairii*).
- Japanese wireweed (*Sargassum muticum*).
- Pacific oysters (*Magallana gigas*).
- European green crab (*Carcinus maenas*).
- Boring sponges (*Cliona* sp., *Sycon* spp.).
- Three byozoans and ascidians.
- Japanese skeleton shrimp (*Caprella mutica*).
- America shad (*Alosa sapodissima*).

The most likely invasive species to occur in the LCE Study Area is Japanese wireweed.

## 4 RIPARIAN VEGETATION

The LCE Study Area is located within the dry Coastal Western Hemlock biogeoclimatic zone. This zone is characterized by warm, relatively dry summers and moist, mild winters with little snowfall, where growing seasons are long and feature only minor water deficits on zonal sites (Green & Klinka, 1994). Located in an industrialized section of Burrard Inlet, which has experienced high levels of commercial and industrial activity since the 1930s, the LCE Study Area is relatively flat with low topography relief and superficial materials that are predominantly composed of imported infill. The terrestrial habitat has been highly modified from its pre-development setting and continues to be used for recreational and industrial purposes. Riparian vegetation surrounds waterways and rivers, including the banks of the LCE. It serves as bank stabilization, reduces erosion, and aids with flood control (Khan *et al.*, 2022).

During the 2014-2016 habitat restoration project in the LCE, soil amender was added, 680 native shrubs and trees were planted, and clover and wildflower seeds were sown. However, there was a notable vertical and horizontal separation between vegetation and the wetted channel due to the presence of riprap armouring and minimal areas where vegetation overhangs the channel (KWL, 2022). This limits the potential access for terrestrial invertebrates and limits the utilization of the canopy for cover by fish during high water tide levels (KWL, 2022).

Invasive plants are non-native to an area (usually spread by humans) and have a negative effect on local ecosystems. They may prevent other plants from growing and may not provide food for local wildlife. The invasive Himalayan blackberry (*Rubus armeniacus*) is widespread across BC. It displaces native vegetation, degrades local habitats, and contributes to river and stream bank erosion in riparian areas. Scotch broom (*Cytisus scoparius*) was originally introduced as an ornamental plant due to its bright yellow flower, which blooms in the early summer months. Scotch broom growth has increased due to favourable conditions brought about by climate change. It is found throughout disturbed sites and outcompetes native plant species that provide habitat for local wildlife. During the 2014-2016 habitat restoration project in the LCE, invasive plant species such as Himalayan blackberry, Scotch broom, ivy (*Hedera helix*) and holly (*Ilex* sp.) were removed from the LCE Study Area.

# 5 FIELD PROGRAM

Hatfield conducted an existing conditions assessment, including an ROV survey and a land-based upper intertidal/riparian assessment of the LCE Study Area.

## 5.1 Methodology

The methods for the survey and the characterization of habitat and biota are described in this section.

### 5.1.1 Survey Techniques

#### 5.1.1.1 Subtidal (Remote Operated Vehicle) Survey

The ROV survey was conducted within the ROV Survey Area on November 24, 2022. Four transects, approximately 100 m long and spaced approximately 20 m apart, were surveyed (Figure 1-1, ROV Survey Area). The depth of the ROV Survey Area was -8 m to +2 m CD. The pilot navigated in a straight heading along each transect using both video and imaging sonar. Imagery of the seabed and aquatic fauna and flora was collected for the entire length of each transect.

#### 5.1.1.2 Upper Intertidal-Riparian Survey

A land-based survey of the upper intertidal and riparian areas within the LCE Study Area was conducted on November 25, 2022 (Photo 5-2). The survey was conducted by traversing the riparian and upper intertidal areas of the LCE Study Area, and recording notes and taking photographs of all observed substrates, algae, marine invertebrates, and riparian vegetation. Due to the lack of adequate daytime low tides at the time of investigation (i.e., late November 2022; Figure 5-1), the upper intertidal area of Lynn Creek was not assessed. However, a recent assessment of these areas was conducted by KWL during low tide in May 2021 (KWL, 2022).

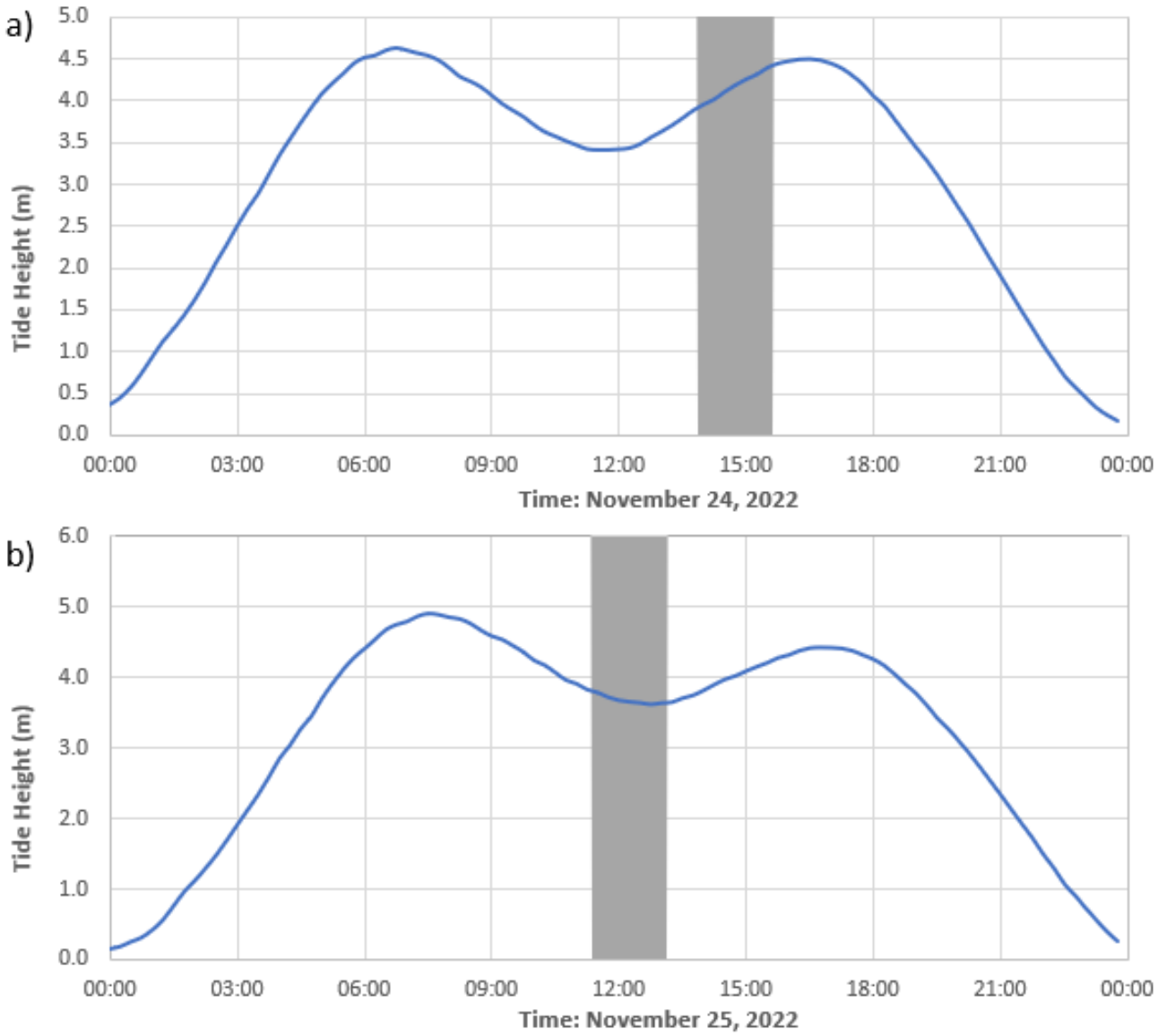



**Figure 5-1: Tide charts during the Remote Operated Vehicle survey (panel (a) Nov 24 14:00-15:30), and the intertidal/riparian survey (panel (b) Nov 25 11:30-13:30)**

Source: Government of Canada (2023b)

### 5.1.2 Habitat and Biota Characteristics

Following the ROV survey, video footage was analyzed by a Hatfield biologist to identify and summate observed organisms, habitats, and substrates. Fish, invertebrates and algae were identified and the location was defined in order to generate habitat maps. The dominant substrate was identified and locations of substrate transitions were defined. Physical substrate characteristics observed are described according to the categories presented in Figure 5-1.

**Table 5-1: Substrate categories used for the Remote Operated Vehicle survey**

| SUBSTRATE | DEFINITION | SIZE |
|---|---|---|
| Fines: Silt, clay, mud | Loose sedimentary deposit | <0.0625 |
| Sand | Loose granular material | 0.0625 – 2 |
| Gravel | Loose fragments of rock | 2 – 64 |
| Cobble | Loose stone larger than gravel, smaller than a boulder | 64 – 256 |
| Boulder | Detached mass of rock | >256 |
| Shell Hash | Surface substrate layers are dominated by loose shell accumulations | 2 – 64 |
| Plant Debris | Leaves and sticks from terrestrial vegetation obstructing view of substrate below | any |

## 5.2 Results

### 5.2.1 Sediment

The LCE is comprised of bars made up of cobble, gravel, and sand (Photo 5-1, Photo 5-2). Some of the rocky material in the LCE Study Area has been placed to armour Lynn Creek, such as the VanPile rock wall spit to the west and the riprap armouring to the east at the base of the walking trail, and some of the material has accumulated naturally such as the sand bars (Photo 5-1, Photo 5-2). The video analysis of the ROV Survey Area showed the main substrate in the ROV Survey Area was cobble (56%), followed by sand (30%), gravel (8%) and boulder (<0.1%) (Table 5-2, Photo 5-2).

Cobble was generally more abundant in the shallower areas closer to shore (i.e., T3 and T4) and sand was more abundant in the deeper transects to the west (i.e., T1 and T2). Plant and wood debris were dense in some areas, making it difficult to identify the substrate below (Photo 5-2). This was most likely due to the time of the year (late autumn/winter), as most of the plant debris was composed of leaves from deciduous trees.

There was what appeared to be silt cover in some areas on the transects. This silt cover is typical of estuary environments. Silt build-up can be harmful to benthic organisms such as oysters and mussels, as these species are filter feeders and can become smothered by the silt.

**Table 5-2: Substate cover observed along the transects during the Remote Operated Vehicle Survey, November 2022**

| TRANSECT | SUBSTRATE (%) | | | | |
|---|---|---|---|---|---|
| | Boulder | Cobble | Gravel | Sand | Plant Debris |
| 1 | 0 | 45 | 0 | 41 | 14 |
| 2 | 0.1 | 30 | 0 | 70 | 0 |
| 3 | 0 | 56 | 0 | 21 | 23 |
| 4 | 0 | 71 | 22 | 7 | 0 |
| Entire ROV Survey Area | <0.1 | 56 | 8 | 30 | 6 |

**Photo 5-1: Substrate in Lynn Creek Estuary at Low Tide, June 2016**

Source: Doug Swanston (Seacology, 2020)

Panel 1: Cobble – north end of Transect 4.

Panel 2: Sand – centre of Transect 3.

Panel 3: Plant debris – north end of Transect 2.

Panel 4: Gravel – south end of Transect 1.

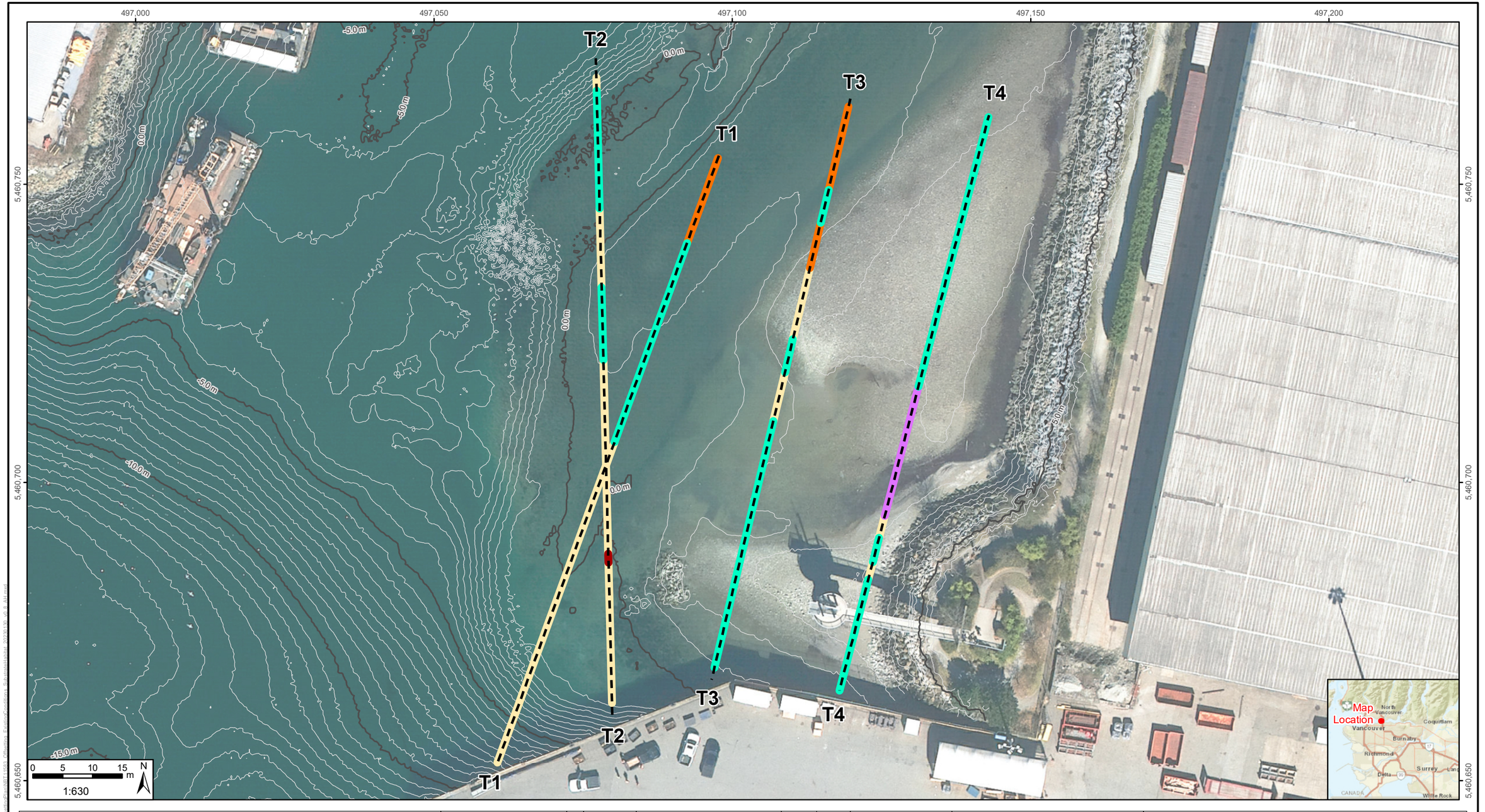
Panel 5: Boulder – south end of Transect 2.

Panel 6: Light silt – Transect 4.


Panel 7: Riprap slope – south end of LCE Study Area, looking south.


Panel 8: Riprap and cobbles – VanPile rock wall spit, looking south.

**Photo 5-2: Representative photos of substrate observed in the Lynn Creek Estuary Study Area during the ROV survey and the intertidal survey conducted in November 2022**




LEGEND:

- Transect

**Depth**

- 5.0 m Contour
- 0.5 m Contour

**Substrate**

- Cobble
- Plant Debris
- Gravel
- Sand
- Boulder

SOURCE / NOTE:
a) Transects, substrates, Hatfield 2022.
b) Contours generated using depth points provided by Neptune Terminals in December 2022, Hatfield 2022. Contours have been adjusted to chart datum using a +3.0 m offset.
c) Background, Orthophoto 10 cm, 13 April 2021, Esri Online Service.

| REV | YYYY-MM-DD | DESCRIPTION | DRAWN | APPROVED |
|---|---|---|---|---|
| | | | | |

ISSUES/REVISIONS

VENDOR: Hatfield

ISSUED AS RECORD COPY (YES/NO) NO

Neptune TERMINALS



TITLE:
Lynn Creek Estuary 2022 Remotely Operated Vehicle Survey - Substrate Observations

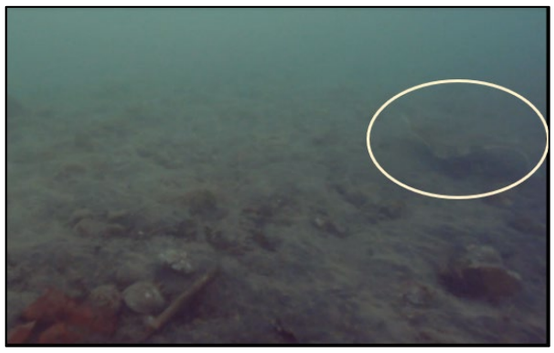
Figure 5-2

| SCALE: | SHEET | OF | DRAWING NO. | REV: |
|---|---|---|---|---|
| | 1 | 1 | | A |

### 5.2.2 Fish

Starry flounders (*Platichthys stellatus*) were observed twice during the ROV survey (Photo 5-3). Starry flounder is a flat fish with distinctive black to orange colour bars on the dorsal and anal fins. It is an inshore fish, inhabiting estuaries and freshwater habitats (Ralston, 2005). They feed on a variety of benthic invertebrates. Starry flounders are abundant and widespread globally and are not a provincially or federally listed species. Starry flounder was the only fish species observed during the November 2022 field surveys, likely due to the timing of the surveys.

**Panel 1: Starry flounder and Dungeness crab - south end of Transect 1.**



**Panel 2: Starry flounder - approximately midway through Transect 2.**

**Photo 5-3: Starry Flounder observed during the Remote Operated Vehicle survey, November 2022**

### 5.2.3 Algae and macrophytes

Red, green and brown algal species were identified primarily around rocky substrates in the LCE Study Area (Table 5-3). Rockweed was the most abundant algae observed during the land-based survey and it was observed throughout the riprap slopes (Photo 5-4). Within the ROV Survey Area, algae abundance was associated with substrate type; 86% of the area surveyed contained no algae and was typically linked with cobble and sand substrate (Figure 5-3; Table 5-3). Sea lettuce covered approximately 12% of the survey area (Photo 5-4). However, sea lettuce appears to be more abundant in summer months based on ShoreZone aerial imagery (Photo 1-1) and associated with sandy substrate (Photo 5-1; Table 5-3). Sugar kelp (*Saccharina latissima*) and red-bladed algae (phylum Rhodophyta) were observed during the ROV survey, primarily growing on cobble substrate and covering 0.1% and 2.0% of the survey area, respectively (Photo 5-4). These macroalgal species also tend to be more abundant in the summer. Boulders installed in 2020 to form a rock reef (Figure 5-3) have been colonized by sugar kelp, red algae, and sea lettuce (Seacology, 2020, 2022). There was no eelgrass observed in the LCE Study Area. Although eelgrass was transplanted as part of the 2014-2016 restoration works, the eelgrass translocation efforts were not successful (NSSK *pers. comm.*)

**Table 5-3: Algae observed along the transects during the Remote Operated Vehicle survey, November 2022**

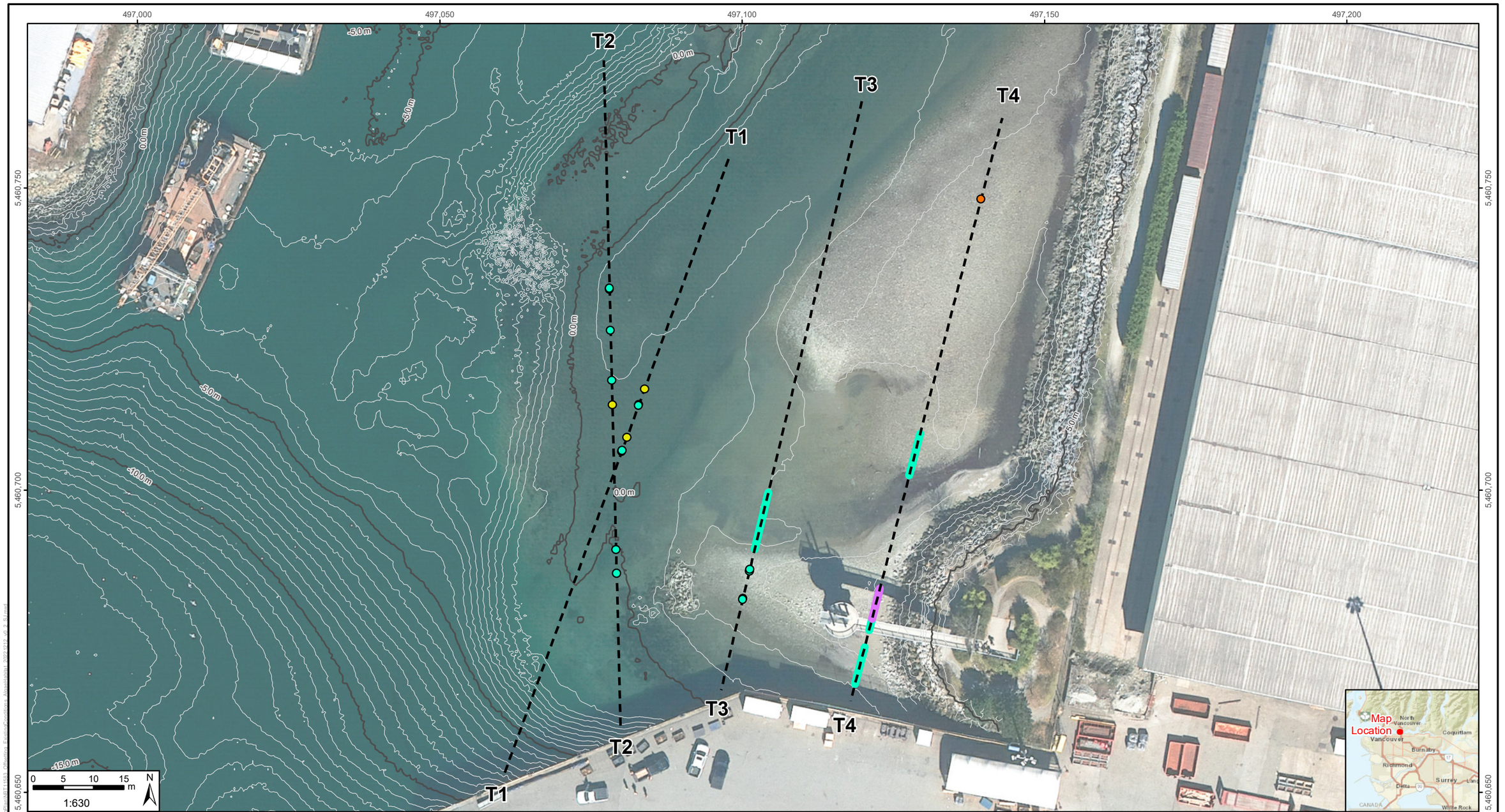
| SPECIES | PERCENT COVER |
|---|---|
| Sea lettuce | 12% |
| Sugar kelp | 0.1% |
| Red bladed algae | 2% |
| No algae cover | 86% |


| Panel 1: Sea lettuce – south end of Transect 4. | Panel 2: Rockweed – south end of the east bank. |
|---|---|
| Panel 3: Red bladed algae – south end of Transect 4. | Panel 4: Kelp – centre of Transect 1. |

**Photo 5-4: Representative Photos of marine algae observed in the Lynn Creek Estuary Study Area during the Remote Operated Vehicle survey and the intertidal survey conducted in November 2022**

**Photo 5-5: Marine life (barnacles, sea lettuce, sugar kelp) that colonized boulders placed in the Lynn Creek Estuary by North Shore Streamkeepers in winter 2020**

Source: Doug Swanston (in winter) 2022 (Seacology, 2022)




LEGEND:

- Transect

**Depth**

- 5.0 m Contour
- 0.5 m Contour

**Algae**

- Red Bladed Algae
- Sea Lettuce
- Sugar Kelp
- Sea Lettuce
- Red Bladed Algae and Sea Lettuce

SOURCE / NOTE:

a) Transects and algae, Hatfield 2022.
b) Contours generated using depth points provided by Neptune Terminals in December 2022, Hatfield 2022. Contours have been adjusted to chart datum using a +3.0 m offset.
c) Background, Orthophoto 10 cm, 13 April 2021, Esri Online Service.

| REV | YYYY-MM-DD | DESCRIPTION | DRAWN | APPROVED |
|---|---|---|---|---|
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ISSUES/REVISIONS

VENDOR: Hatfield

ISSUED AS RECORD COPY (YES/NO) NO

Neptune TERMINALS



TITLE:

# Lynn Creek Estuary 2022 Remotely Operated Vehicle Survey - Algae Observations

Figure 5-3

| SCALE: | SHEET | OF | DRAWING NO. | REV: |
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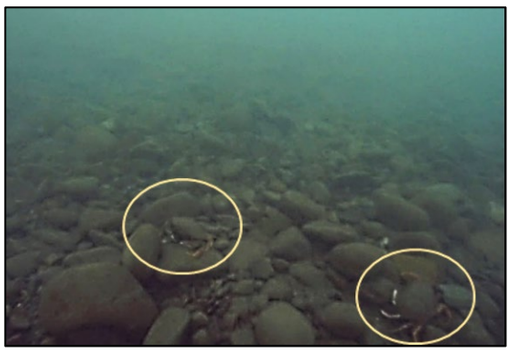
| | 1 | 1 | | A |

### 5.2.4 Marine Invertebrates

Five species of marine invertebrates were observed in the LCE Study Area during the subtidal and intertidal habitat assessment. Invertebrates observed during the ROV survey and the land-based intertidal survey included Dungeness crabs (*Metacarcinus magister*), Pacific oysters, acorn barnacles (*Balanus glandula*), mask limpets (*Lottia persona*), and sponges. A total of 52 Dungeness crabs were observed, with the majority observed on ROV Transect 4, the transect closest to the shoreline. Acorn barnacles were observed on the cobble in the ROV survey and on the riprap during the intertidal survey. Pacific oysters were observed in the cobbled north end of ROV Transect 4 (Photo 5-6), which is not unusual in estuaries (DFO, 2022b; Troost, 2010). The small red sponge observed in Transect 4 was on the base of a pile, it was not possible to identify the sponge species from the video footage.


**Panel 1: Acorn barnacles – south end of the east bank in the LCE Study Area.**

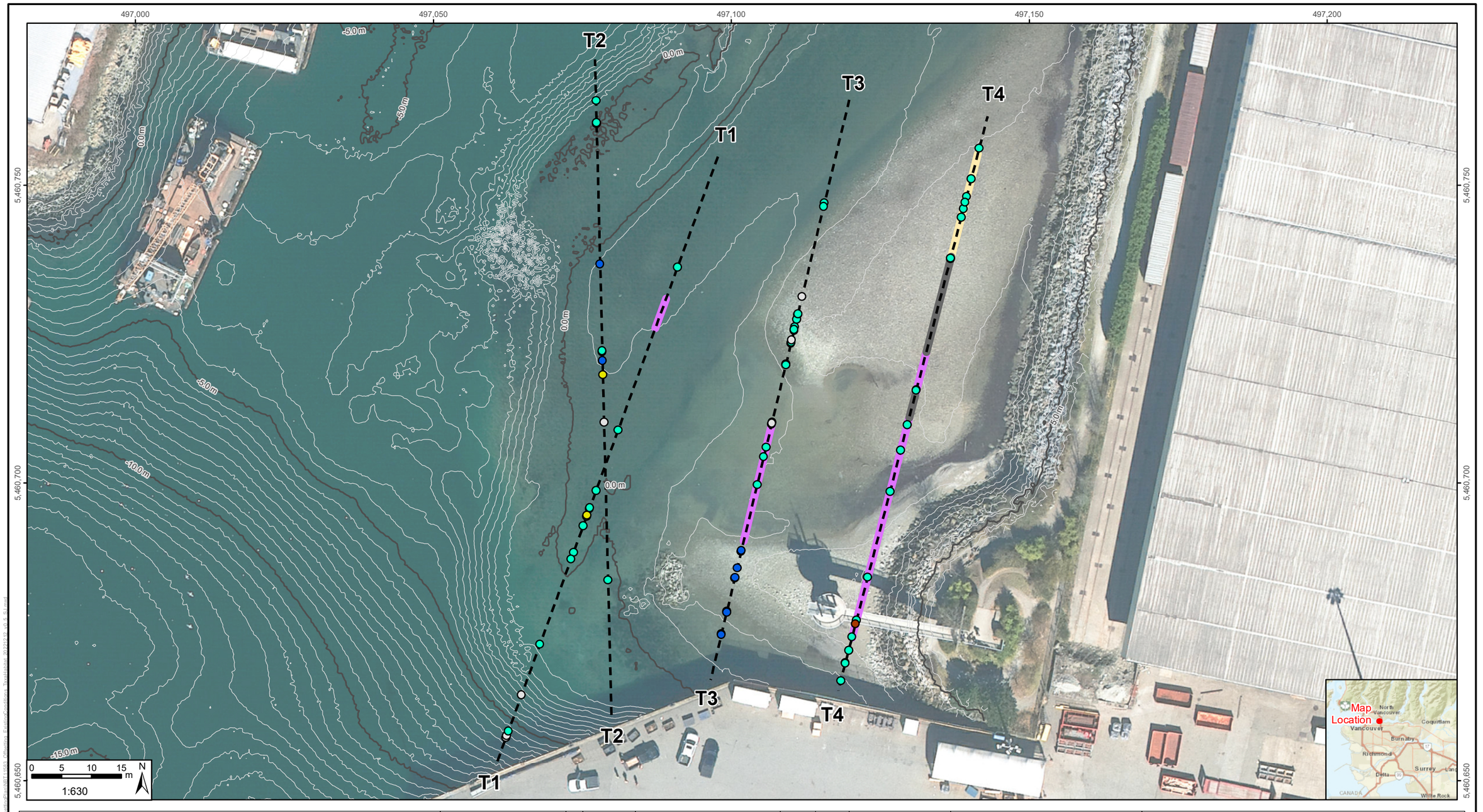

**Panel 2: Mask limpet – west side of the rock wall spit near the VanPile yard.**



**Panel 3: Dungeness crabs – north end of Transect 2.**

**Panel 4: Pacific oysters – north end of Transect 4.**

**Photo 5-6: Representative photos of marine invertebrates observed during the Remote Operated Vehicle survey and the intertidal survey in November 2022**




LEGEND:

- Transect
- **Depth**
  - 5.0 m Contour
  - 0.5 m Contour
- **Taxa**
  - Acorn Barnacles
  - Dungeness Crab
  - Pacific Oyster
  - Sponge
  - Starry Flounder
  - Barnacles
  - Oysters
  - Barnacles and Oysters

SOURCE / NOTE:
a) Transects and taxa, Hatfield 2022.
b) Contours generated using depth points provided by Neptune Terminals in December 2022, Hatfield 2022. Contours have been adjusted to chart datum using a +3.0 m offset.
c) Background, Orthophoto 10 cm, 13 April 2021, Esri Online Service.

| REV | YYYY-MM-DD | DESCRIPTION | DRAWN | APPROVED |
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| | | | | |

ISSUES/REVISIONS

VENDOR: Hatfield

ISSUED AS RECORD COPY (YES/NO) NO

Neptune TERMINALS



TITLE:
Lynn Creek Estuary 2022 Remotely Operated Vehicle Survey - Fish and Invertebrate Observations

Figure 5-4

| SCALE: | SHEET | OF | DRAWING NO. | REV: |
|---|---|---|---|---|
| | 1 | 1 | | A |

### 5.2.5 Birds

Bird species observed during the field survey included: Glaucous-winged gull (*Larus glaucescens*), Canada goose (*Branta canadensis*), great blue heron (*Ardea herodias*), bald eagle (*Haliaeetus leucocephalus*), mallard (*Anas platyrhynchos*), and other dabbling duck species, too distant to identify. There are signs indicative of waterfowl roosting on the rock wall spit on the west of the LCE Study Area (Photo 5-7; e.g., depressed grasses and bird feces), although no birds were observed in this area during the survey.

**Panel 1: Mallard ducks – northwest side of the LCE Study Area.**


**Panel 2: Great blue heron and mallard ducks along the rock wall spit – west side of the LCE Study Area.**

**Panel 3: Canada geese in the centre of the LCE Study Area, with a great blue heron in the back left of the photograph.**


**Panel 4: Potential bird roost site on the rock wall spit – west side of the LCE Study Area.**

**Photo 5-7: Bird species observed in the Lynn Creek Estuary Study Area, November 2022**

### 5.2.6 Riparian Vegetation

Patches of dunegrass (*Leymus mollis*) were observed on the rock wall spit on the west side of the LCE Study Area (Photo 5-8). Dunegrass provides soil stabilization, which is essential in areas that would be prone to erosion like the riverbank in the LCE Study Area (Schwendiman, 1977). There is little potential to extend these dunegrass patches further down the rock wall spit, because the soil becomes minimal due to the steep riprap walls. Due to the time of year when the field survey was conducted (November), it was difficult to identify all plant species, as many plants go dormant in the winter (Table 5-4).

The banks of the LCE Study Area have been disturbed by human use, which allows invasive species to thrive. Disturbed habitat leaves openings for invasive species to establish through natural colonization or through the accidental transfer of seeds (Photo 5-8). The riparian vegetation in the LCE Study Area includes many invasive plant species, mostly on the west rock wall spit (Table 5-4). Two invasive species were prominent on the rock wall spit on the west side of the LCE Study Area: Himalayan blackberry and Scotch broom (Table 5-4).

**Table 5-4: Riparian vegetation observed in the Lynn Creek Estuary Study Area, November 2022**

| COMMON NAME | SCIENTIFIC NAME | STATUS/BC LIST* |
|---|---|---|
| **Shrubs** | | |
| English ivy | *Hedera helix* | Exotic |
| Himalayan blackberry | *Rubus armeniacus* | Exotic |
| Rose spp. | *Rosa* spp. | - |
| Salmonberry | *Rubus spectabilis* | Yellow |
| Scotch broom | *Cytisus scoparius* | Exotic |
| Snow berry | *Symphoricarpos* spp. | - |
| **Herbaceous** | | |
| Dunegrass | *Leymus mollis* | Yellow |
| Sea plantain | *Plantago maritimia* | Yellow |
| Common tansy | *Tanacetum vulgare* | Exotic |
| Vetches | *Vicia* spp. | - |

Note: *BC List status not provided since plants were not identified to species level.
Source: BC CDC (2023)


Panel 1: Rose – east side of the LCE Study Area.


Panel 2: Dunegrass on the rock wall spit – west side of the LCE Study Area.


Panel 3: Common tansy on the rock wall spit – west side of the LCE Study Area.

Panel 4: English Ivy – east rock wall spit of the LCE Study Area.


Panel 5: Scotch broom on the rock wall spit – west side of the LCE Study Area.


Panel 6: Himalayan blackberry on the rock wall spit – east side of the LCE Study Area.

**Photo 5-8: Representative photos of riparian vegetation observed in the Lynn Creek Estuary Study Area, November 2022**

# 6 SUMMARY AND CONCLUSIONS

Hatfield has developed this Existing Conditions Report for the LCE Study Area in the LCE by assessing the subtidal, intertidal, and riparian environments using a ROV and a land-based field survey. Hatfield has summarized the existing conditions from the survey results and reviewed available databases and literature for the LCE, including a recent KWL (2022) report.

The LCE has been modified from its original state, mainly due to industrial development in the surrounding area. Since the habitat in the LCE Study Area is disturbed, invasive plants are abundant in the riparian zone, especially on the rock wall spit at the west end of the LCE Study Area. Artificially channelized flows due to riprap armouring and dredging are likely leading to increased uniform flows that may hinder fish migrations.

The fish habitat includes cobble, gravel and sand substrate, riprap slopes, a rock reef placed in 2020, and anchored large woody debris. Algae covered only 14% of the ROV Survey Area, but it is known to be more abundant in the summer, particularly on intertidal sandy substrates, which become colonized by sea lettuce. Rockweed was abundant in the upper intertidal area from the southern end of the west rock wall spit to 250 m upstream, where salinity decreases. Algae and invertebrates communities observed during the surveys were similar to those observed by Seacology (2022) on the subtidal boulders. The local salmon populations in Lynn Creek are relatively small, but still important, and include chum, coho, chinook and pink salmon (BC ENV, 2020; Government of British Columbia, 2022; Haggarty, 2001; SHIM, 2021). Salmon may be using LCE for spawning migration anytime between June and December of a given year.

There are limitations to habitat restoration options in Lynn Creek due to the limited space from industrial development, historical channelization and riprap armouring. Restoration works in the LCE conducted between 2014 and 2020 appear to have made some limited improvements to fish habitat (e.g., through side channel excavations, anchoring of large woody debris, and the installation of a rock reef). However, additional restoration works would provide value to improve fish habitat in LCE. Examples of restoration activities that may prove beneficial for fish and fish habitat include reducing the vertical separation between vegetation and the wetted channel to allow for more vegetation overhang for fish, modifying the stream to create more sections with riffles and pools, and increasing habitat complexity and habitat islands.

# 7 CONTRIBUTORS/CLOSURE

Regulatory professionals from Hatfield and NBT (through Dynamic Ocean) have contributed to developing supporting documents specific to *Fisheries Act* compliance.

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