Pacific NorthWest LNG Project
Marine Fish and Fish Habitat Survey Results: December 2014 to August 2015 Interim Data Report

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November 3, 2015

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Abbreviations

#	number
%	percent
°C	degrees celsius
µS/cm	microsiemens per centimetre
µg/L	micrograms per litre
CD	chart datum
CEA Agency	Canadian Environmental Assessment Agency
chl-*a*	chlorophyll *a*
CPUE	catch per unit effort
CRA	commercial, recreational and Aboriginal
CTD	conductivity-temperature-depth
DFO	Fisheries and Oceans Canada
DO	dissolved oxygen
EIS	Environmental Impact Statement
g	grams
GPS	global positioning system
LNG	liquefied natural gas
m	metre
mL/L	millilitres per litre
mm	millimetres

MOF	materials offloading facility
ms	milliseconds
MVBS	mean volume backscattering strength
n	sample size
NTU	Nephelometric Turbidity Units
PDA	Project Development Area
PNW LNG	Pacific NorthWest LNG Limited Partnership
PRPA	Prince Rupert Port Authority
SCOR	Scientific Committee on Oceanic Research
S_v	volume backscattering coefficient
TS	target strength
UTM	Universal Transverse Mercator

November 3, 2015

Acknowledgements

Stantec's team extends our appreciation for the input and participation of the technical survey team members from Gitxaala Nation, Kitselas First Nation, Kitsumkalum First Nation, and Gitga'at First Nation. Undertaking this Program would not be possible without their input, assistance, and ongoing support.

We also extend our thanks to the captains and crews of the Metlakatla vessel *Ocean Star*, the Lax Kw'alaams vessel *Freeport*, the *Ocean Royal*, the *Active Pass*, and their support vessels. Their assistance has been invaluable throughout the Program.

1.0 INTRODUCTION

Pacific NorthWest LNG Limited Partnership (PNW LNG) is proposing to construct and operate a liquefied natural gas (LNG) facility (the Project) on Lelu Island within the District of Port Edward, British Columbia and a marine terminal within Chatham Sound off Lelu Island. The Project would be located on federal lands and waters under the jurisdiction of the Prince Rupert Port Authority (PRPA). A Marine Fish and Fish Habitat Follow-up Monitoring Program (the Program) has been developed to meet the pre-construction information requirements for a follow-up program under the *Canadian Environmental Assessment Act, 2012*. The Program also addresses information requests from the Canadian Environmental Assessment Agency (CEA Agency) to provide additional information to support the Marine Resources Sections of the Environmental Impact Statement (EIS) for the Project (Stantec Consulting Ltd. 2014) and EIS Addendum (PNW LNG 2014).

The Program combines a series of marine fish and fish habitat surveys and techniques intended to provide a full year of pre-construction information on the spatial and temporal distribution of marine resources including commercial, recreational and Aboriginal (CRA) fish species and supporting fish species. The sampling methods included survey techniques and gear types to sample CRA fish species, if present in the study area, as well as environmental properties within the vicinity of the project development area (PDA, see Section 2.1).

1.1 PROGRAM OBJECTIVES

The Program has been developed in response to comments from the CEA Agency, Fisheries and Oceans Canada (DFO), the PNW LNG Working Group, and Tsimshian First Nations about existing marine biological conditions and fish and fish habitats in the potential project area. The objectives of the entire Program are to:

- Describe marine biophysical ocean environment in the survey area (water properties, zooplankton)
- Identify fish and invertebrate species present in the survey area
- Identify spatial patterns of distribution, abundance and biological characteristics for fish and invertebrate species in the survey area
- Identify temporal patterns of distribution, abundance and biological characteristics of fish and invertebrate species in the survey area.

1.2 INTERIM REPORT GOALS

The goals of this Marine Fish and Fish Habitat interim data report are to:

- Describe the methods used for the marine fish surveys
- Summarize sampling effort to date

- Summarize data collected to date
- Provide preliminary analysis of the results from December 2014 to August 2015 surveys.

This interim report follows and expands on the July 9, 2015 initial interim data report on fish and fish habitat. A comprehensive data analysis will be included in the final report when the Program is completed (November 2015). Submission of the final report is anticipated in early 2016.

1.3 SUMMARY OF EFFORT AND SURVEY SCHEDULE

The Program conducted multiple surveys over the past nine months (December 2014 to August 2015) to sample ocean water properties, phytoplankton, zooplankton, shellfish and fish species. The study design, gear and study area were based on PNW LNG, Stantec and Tsimshian First Nations site experience and understanding to sample across the range of biophysical conditions in the study area. This includes:

- Daytime Fish Surveys—Monthly or bimonthly daytime fish surveys using a variety of gear types suitable for different habitats across a full year to examine fish species presence, abundance and biological characteristics and ocean water properties including phytoplankton
- Nighttime Fish Surveys—Biweekly or weekly dusk/night fish surveys using a variety of gear types suitable for different habitats from April to July 2015, to examine fish species presence, abundance and biological characteristics, ocean water properties, and zooplankton.

Table 1 summarizes daytime and nighttime fish survey schedules and survey effort from December 2014 to August 2015.

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Table 1 Marine Fish and Fish Habitat Survey Summary

Survey	Number	Date
Monthly Fish/Fish Habitat	Daytime-01	December 15–20, 2014
Monthly Fish/Fish Habitat	Daytime-02	January 26–February 1, 2015
Monthly Fish/Fish Habitat	Daytime-03	February 18–23, 2015
Monthly Fish/Fish Habitat	Daytime-04	March 19–25, 2015
Monthly Fish/Fish Habitat	Daytime-05	April 23–27, 2015
Monthly Fish/Fish Habitat	Daytime-06	May 19–24, 2015
Bimonthly Fish/Fish Habitat	Daytime-07	June 7–15, 2015
Bimonthly Fish/Fish Habitat	Daytime-08	June 16–23, 2015
Bimonthly Fish/Fish Habitat	Daytime-09	July 1–9, 2015
Bimonthly Fish/Fish Habitat	Daytime-10	July 16–24, 2015
Monthly Fish/Fish Habitat	Daytime-11	August 12–16, 2015
Monthly Fish/Fish Habitat	Daytime-12	*September 13–17, 2015*
Pending	Daytime-13	*October 28–November 1, 2015*
Pending	Daytime-14	*November 27–December 1, 2015*
Biweekly Dusk/Night Fish	Nighttime-01	April 30–May 3, 2015[a]
Biweekly Dusk/Night Fish	Nighttime-02	May 12–16, 2015
Biweekly Dusk/Night Fish	Nighttime-03	May 25–29, 2015
Weekly Dusk/Night Fish	Nighttime-04	June 3–9, 2015
Weekly Dusk/Night Fish	Nighttime-05	June 9–15, 2015
Weekly Dusk/Night Fish	Nighttime-06	June 15–23, 2015
Weekly Dusk/Night Fish	Nighttime-07	June 24–30, 2015
Weekly Dusk/Night Fish	Nighttime-08	July 1–7, 2015
Weekly Dusk/Night Fish	Nighttime-09	July 8–15, 2015

NOTE:

[a] Nighttime were surveys completed in the morning of the final survey day

2.0 STUDY AREA AND PROGRAM RATIONALE

2.1 STUDY AREA

The spatial boundaries of the study area for the Program are consistent with the PDA as defined in the EIS (Stantec Consulting Ltd. 2014). The study area includes all the marine components of the project PNW LNG marine infrastructure for the suspension bridge anchor and tower blocks, marine jetty and berth areas on Agnew Bank, and the materials offloading facility (MOF) in Porpoise Channel on Lelu Island. The study area also includes marine waters adjacent to the proposed marine infrastructure in Porpoise Channel, the western edge of Lelu Island, and Flora, Agnew, and Horsey banks, and the deeper waters around the banks and the northern portions of Inverness Passage (Figure 1).

The spatial definitions of Flora Bank and the adjacent areas are defined by charts published by the Canadian Hydrographic Service. For Flora Bank itself, this encompasses the area defined by the -3.8 m bathymetric contour (chart datum) and is shown on Figure 2. Flora Bank is identified here as a specific physical marine form distinct from other physical and bathymetric features around the study area. The definition of Flora Bank has often been unclear or inconsistent among other studies conducted in this region of Chatham Sound.

2.2 PROGRAM RATIONALE

The Program was initially designed as two surveys scheduled over two months (December 2014 and January 2015). It was understood that these two surveys would be refined based on in-field experience in order to more fully scope the long term marine fish program. The program design considered important spatial, temporal, and environmental challenges, for example access to sites due to weather, sea state, bathymetry, intertidal shallows, or ebb and flood tidal currents.

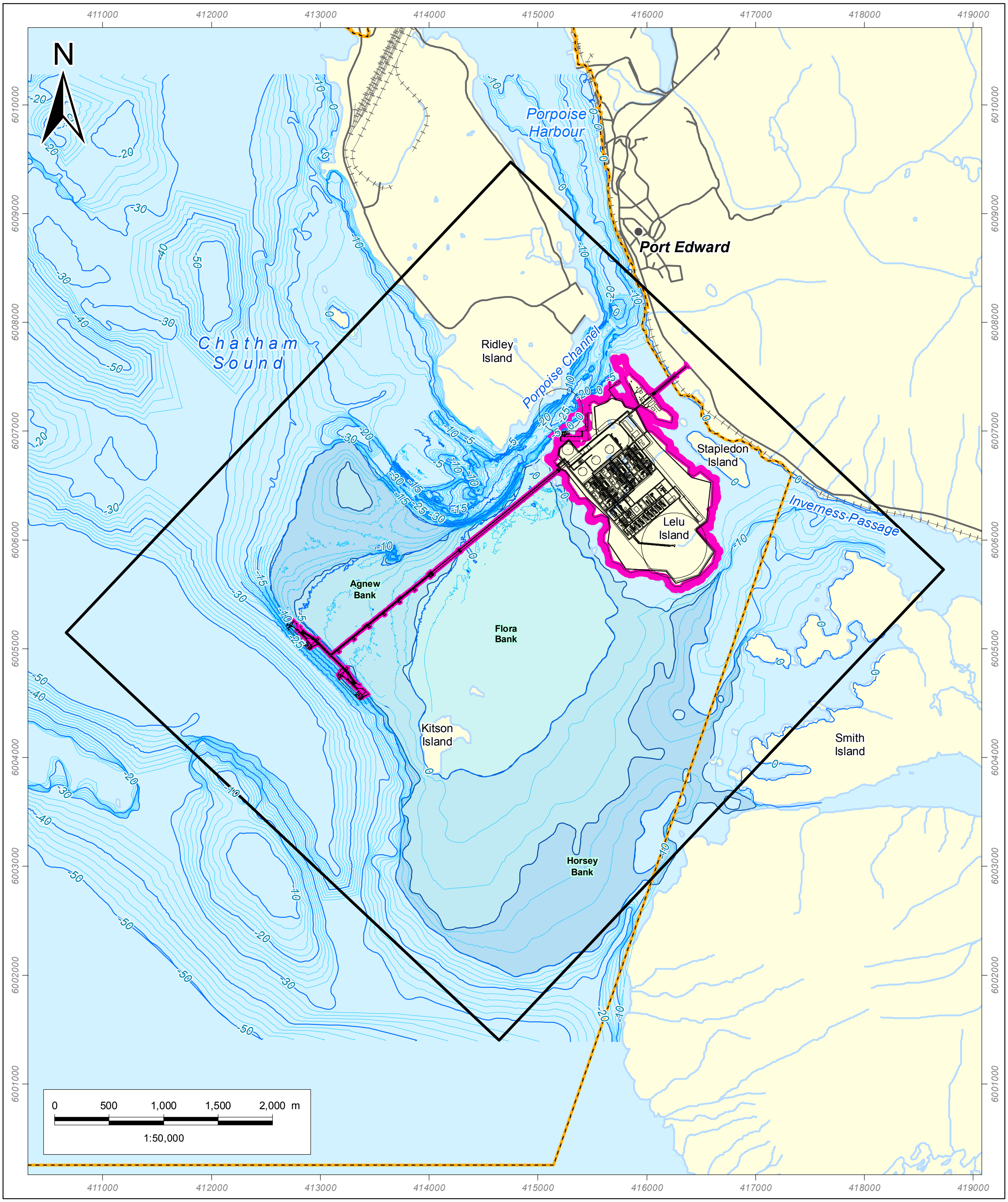
The initial study design and proposed methods were shared with the CEA Agency, Fisheries and Oceans Canada (DFO), the CEA Agency-PNW LNG Working Group, and the Tsimshian community in October of 2014. As a result of this input, the surveys were extended to cover a full year time series, with data collection planned through to at least the end of November 2015. At the same time, the study design included two specific surveys and sampling techniques:

- Daytime Fish Surveys—Monthly daytime surveys
- Nighttime Fish Surveys—Weekly dusk/night surveys from April to July 2015.

The rationale for each of the survey types was as follows:

- Daytime Fish—Monthly and bimonthly daytime surveys using a variety of fishing gear types (e.g., crab traps, trawls, beach seines, purse seine, fyke net) adapted for different habitats to examine fish spatial distribution across the different habitats in the study area over an individual survey period of 5 to 8 days across varying tide heights, tidal currents and directions (slack, ebb and flood tide).

- Nighttime Fish—Biweekly and weekly dusk/night surveys using trawl and hydroacoustic fishing gear paired with zooplankton vertical hauls to examine fish migratory or non-migratory spatial distribution and plankton forage supply. Surveys were scheduled during known periods of spring-summer salmon smolt movement patterns from freshwater to marine waters. The intent was to use nighttime sampling to capture fish during periods of potential lower spatial heterogeneity (reduced nighttime schooling behaviour) (Whitney 1969; Godin 1980; Soeda, et al. 1987). Surveys were conducted over periods of 4 to 6 days across varying tide heights, tidal currents and directions (slack, ebb and flood tide).



● City or Town	Waterbody	Marine Fish and Fish Habitat Program Survey Area
Project Component	Shoal	Project Development Area
Railway	Flora Bank	
Road	0 - 5 m Deep Shoal	
Secondary Road	5 - 10 m Deep Shoal	
Watercourse	Bathymetry (m)	
Prince Rupert Port Authority Boundary	Major Contour	
	Minor Contour	

Pacific NorthWest LNG

Marine Fish and Fish Habitat Program Survey Area: Lelu Island/Flora Bank

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

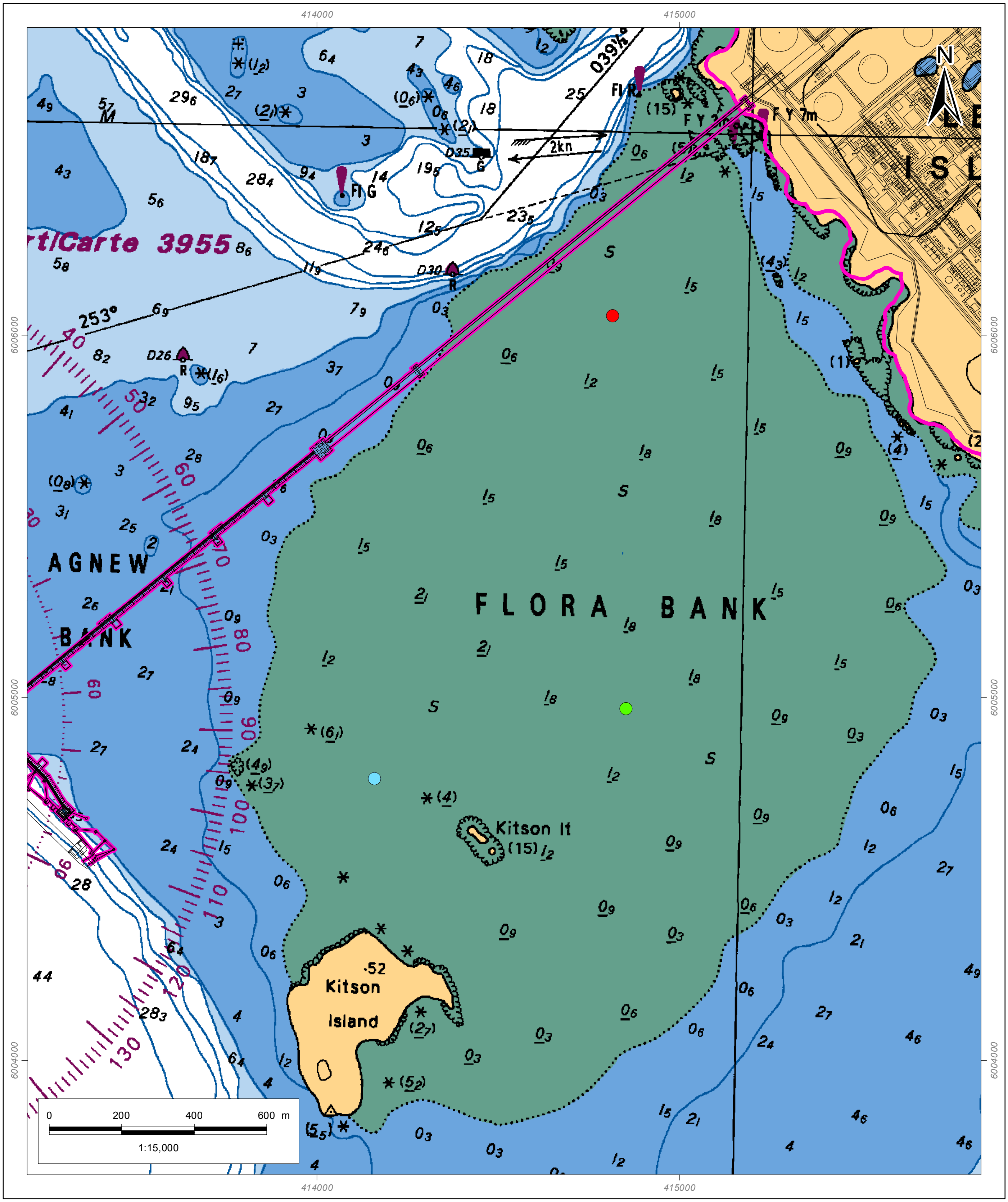
Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

DATE: 22-SEP-15	PROJECTION: UTM - ZONE 9
FIGURE ID: 123110537	DATUM: NAD 83
DRAWN BY: A. BOONE	CHECKED BY: M. JOHANNES

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **1**



- Reference Point 1: 54.195N, -130.305E
- Reference Point 2: 54.183N, -130.3153E
- Reference Point 3: 54.185N, -130.304E
- Project Component
- Project Development Area

Pacific NorthWest LNG

Flora Bank
2012 Bathymetry Chart

Sources: Government of British Columbia; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd. 3717 Canadian Hydrographic Service

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

DATE: 28-OCT-15	PROJECTION: UTM - ZONE 9
FIGURE ID: 123110537	DATUM: NAD 83
DRAWN BY: S. PARKER	CHECKED BY: M. JOHANNES

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **2**

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3.0 METHODS

To address the first program objective and describe the marine biophysical environment in the survey area (water properties, and zooplankton), several survey types were conducted: collection of marine water properties (Sections 3.1.1 and 3.2.1); and prey base surveys using zooplankton hauls (Section 3.2.2) and salmon stomach contents (Section 3.2.6).

To address the second program objective to identify fish species present in the survey area, a variety of fish sampling methods (beach seines, hydroacoustics, trawls, fyke nets, crab trapping, and purse seines) were used to capture fish during both daytime (Section 3.1) and nighttime (Section 3.2).

To address the third and fourth program objectives to identify spatial and temporal patterns of distribution, abundance and biological characteristics for fish and invertebrate species in the survey area, the Program used a variety of gear types to sample fish and invertebrates suitable for different habitats across a full year (Section 3.1and 3.2). To examine the biological characteristics of fish caught, the first 10 fish of each species caught from all catches were selected to be measured (Sections 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.2.3, 3.2.4, and 3.2.5).

3.1 DAYTIME MARINE FISH AND FISH HABITAT SURVEYS

Daytime fish surveys were conducted to identify fish species presence and spatial and temporal patterns of distribution, abundance and biological characteristics for those species in the survey area.

While the daytime fish surveys focused on standard sampling techniques for ocean water quality and fish and fish habitats, surveys were enhanced and expanded to include the use of additional non-destructive fishing gear (e.g., new purse seine and multiple beach seine nets) and additional sites (e.g., increased sampling effort on Flora Bank [fyke nets and trawls]). Improvements and adjustments to the Program were a direct reflection of in-field experience and understanding of the specific marine conditions in the survey area.

The purpose of the sampling approach was to examine the spatial and temporal distribution of fish species that support a CRA fishery and the forage fish that support these populations. Fish species captured include Pacific salmon, crab, Pacific herring (*Clupea pallasi*), eulachon (*Thaleichthys pacificus*) and flatfish (flounder, sole), surf smelt (*Hypomesus pretiosus*s), and sandlance (*Ammodytes hexapterus*); however, sampling methods used were not exclusive to these specific species. Due to the physical characteristics of the study area (tide heights, tidal currents, shoreline slopes, littoral and pelagic habitats, intertidal nature of Flora Bank, intertidal bays in Porpoise Channel and Lelu Island), sample techniques, location and intensity were adapted to local conditions throughout the daytime fish surveys. The initial study design implemented in December 2014 included the following sample techniques:

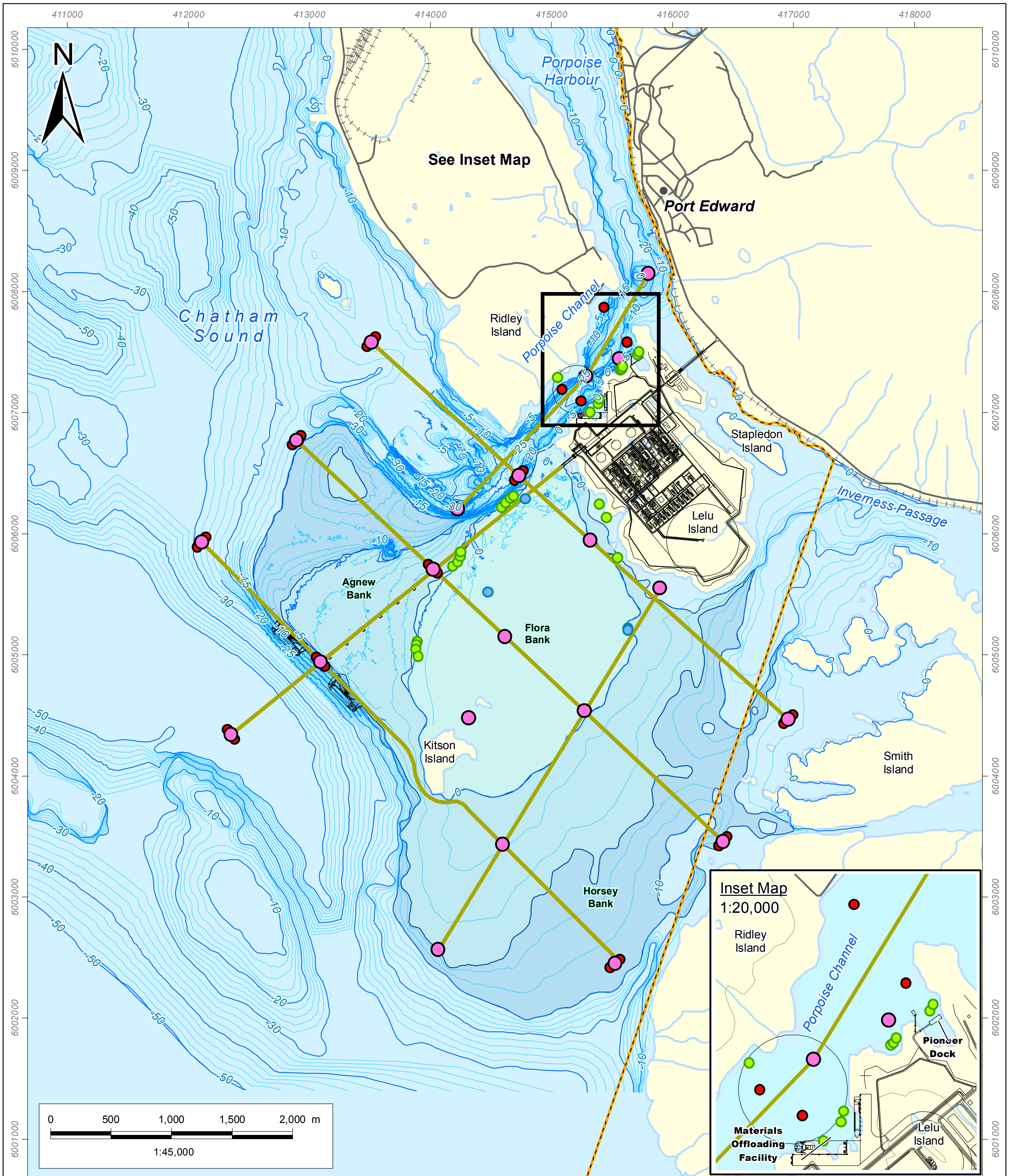
- Use of hydroacoustic and trawl surveys to assess and characterize the abundance and distribution of pelagic fish species
- Beach seining to assess and characterize the abundance and distribution nearshore fish
- Crab trapping surveys to assess and characterize the abundance and distribution of crab
- Oceanographic water property data collection to understand the extent of suitable physical, chemical and biological marine fish habitats and how they vary in space and time.

Refinements to the initial sampling methods were implemented throughout the study period to allow better spatial coverage and increase statistical power of analyses. These survey enhancements are listed below and discussed in detail for each of the gear/technique methods sections (see Section 5.4, Table 4 for a summary of methods by date):

- Expanded beach seine surveys with two different seine nets (12 m x 1.5 m and 22 m x 3 m) and increased number and locations of seine sites (February 2015)
- Increased number of hydroacoustic transects (from 4 to 6 transects) across the study area (May 2015)
- Expanded trawls with two different trawl nets (2 m x 2 m tucker trawl [February 2015] and 5 m x 4.6 m Otter trawl [April 2015])
- Addition of intertidal fyke net sampling on Flora Bank (March 2015)
- Addition of nighttime fish surveys (see Section 3.2; May 2015)
- Addition of monthly forage base surveys for benthic and zooplankton sampling (August, September, October, and November; analysis is not complete, data not discussed in this report, sampling underway).

Daytime fish sampling locations are shown in Figure 3.

The following sections provide a detailed discussion on the purpose, study design and methods for each survey components as part of the larger daytime fish surveys including: marine water properties, beach seine, hydroacoustic and trawls, fyke net, and crab trapping.



City or Town	Waterbody	CTD Site
Project Component	**Shoal**	Fyke Net
Railway	Flora Bank	Beach Seine Site
Road	0 - 5 m Deep Shoal	Crab Trap
Secondary Road	5 - 10 m Deep Shoal	Hydroacoustic and Trawl Transect
Watercourse	**Bathymetry (m)**	
Prince Rupert Port Authority Boundary	Major Contour	
	Minor Contour	

Pacific NorthWest LNG

Daytime Fish Survey Locations (2014 – 2015)

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

DATE: 28-OCT-15	PROJECTION: UTM - ZONE 9
FIGURE ID: 123110537	DATUM: NAD 83
DRAWN BY: T.McInnes	CHECKED BY: M. JOHANNES

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: 3

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3.1.1 Marine Water Properties

Purpose

Marine water properties contribute to the understanding and description of the biophysical habitat in the study area. Marine water properties have a strong influence on the distribution and production of aquatic taxa (Falkowski, et al. 1998) and marine ecosystems (Ware and Thompson 2005). Sampling marine water properties (e.g., temperature, salinity, chlorophyll *a* [chl-*a*], turbidity and dissolved oxygen [DO]) concurrently with fish distribution and abundance, provide the basis for understanding and identifying the requirements and extent of suitable physical, chemical and biological marine fish habitats and how they vary over space and time.

Sample Design

Marine water properties were sampled during daytime at 17 designated sites during each monthly daytime fish survey (Figure 3). Sample sites were distributed with established hydroacoustic and trawl transects, with one additional site placed within Porpoise Channel outside of the known marine traffic routes. These sites were selected in relation to the fish and crab sampling sites (e.g., often placed along transect lines) to allow future comparisons between water properties and fish distribution and habitat use. These comparisons are not provided in this interim report.

Methods

Water properties were collected by vertical water column profiling with a XR RBR 620 Conductivity-Temperature-Depth (CTD) instrument during daytime fish surveys in December 2014, January and February 2015. An ALEC CLW Infinity sensor combined with a RBR Concerto CTD was used for water column profiling in March 2015 through August 2015 for both the daytime fish surveys and the nighttime fish surveys. At each station, the instrument package was lowered to the seabed and retrieved vertically through the water column to the surface at a fixed rate of 1 m/s. The instruments employed for the water properties work were all leased from ASL Environmental Ltd. (Saanichton, BC) and sent back to ASL for regular maintenance and calibration checks.

Visual measurements of Secchi depth, an indicator of water clarity, were recorded during the monthly daytime fish surveys. A weighted Secchi disk was lowered through the water column with a marked line. The disk was lowered until just out of sight and raised again into view. The length of line out when the disk was once again visible was recorded as the Secchi depth in metres (m). Measurements were taken without sunglasses to avoid any error introduced through wearing polarized lenses. To the greatest extent possible, the disk was lowered in the shade of the vessel to reduce the effects of glare on the water.

Water quality parameters collected include:

- Turbidity (Nephelometric Turbidity Units [NTU])
- Temperature (degrees Celsius [°C])
- Conductivity (microsiemens per centimetre [µS/cm])
- Depth (m)
- DO concentration (millilitres per litre [mL/L])
- Chl-a concentration (micrograms per litre [µg/L])
- Secchi depth (m) (daytime only)

3.1.2 Beach Seine

Purpose

Beach seining was used to sample composition, abundance and distribution of fish species (Conlin and Tutty 1979; Johnson, et al. 2007) within nearshore habitats (intertidal, benthic and shallow subtidal habitats) during daytime fish surveys at sites on Flora Bank, Lelu Island and in Porpoise Channel.

Sample Design

The focus of the initial study design was to prioritize sample efforts and sites to areas adjacent to the proposed marine infrastructure. Based on Project infrastructure, substrate/sediment, hydrodynamic reported conditions (Sayao and Absalonsen 2014) and local experience, the western side of Flora Bank was identified as key area for nearshore fish sampling. The initial study design focused on sampling four areas: Porpoise Channel, the northwest corner of Flora Bank, central western side of Flora Bank, and southwest corner of Flora Bank (Figure 3). The selection of beach seine sites within each sampling area was largely based on available/effective shoreline sites and slopes to set and haul beach seines. Within the Porpoise Channel sample area nine sites were targeted during each monthly survey. Within each of the three Flora Bank sampling area, at least four beach seine sample sites were targeted during surveys. Therefore, a total of 21 monthly beach seine sites were targeted within the study area (Figure 3).

Beach seining within Porpoise Channel was often constrained by tide height. At high tides, the bottom type (large angular boulders) and shore complexity (roots, debris) resulted in snags or hang-up while setting the net, reducing the overall efficiency of seine sets. Similarly, at some very low tides the same issue presented itself at some sites. Consequently, beach seining activities in Porpoise Channel were completed by using multiple and varying local sites based on tide heights. A total of nine local beach seine sites were established within Porpoise Channel (Figure 3) and sampled regularly during monthly daytime surveys.

On Flora Bank, the flat/shallow bathymetry limited practical set and hauls using beach seines to the edge of the bank. As tide levels rose from 1.5 m to 1.9 m CD (chart datum), water levels rapidly covered Flora Bank. At tide levels greater than 1.9 m CD, it was not considered safe to work on Flora Bank and there was insufficient shoreline available to effectively set, haul and process beach seines (Flora Bank is 100% intertidal). As a result, beach seines in this area were typically carried out at tides below 1.5 m CD and it was not possible to sample the middle bank areas. Within each of the sample areas on the edge of Flora Bank, beach seine sites were shallow, flat, dominated by compact sands, and had limited structural complexity; these characteristics allowed for high sampling efficiency.

Four local beach seine sites were identified across three general areas sampled on Flora Bank (Figure 3). Site access was determined in the field based on safety and daytime access related to tides, weather and waves. Based on sampling constraints, including weather, tides and currents, a range of 6 to 13 beach seines were completed on Flora Bank each month.

In May 2015, beach seine was increased to include sites in the channel between Lelu Island and Flora Bank (Figure 3). These Lelu channel sites were added in order to examine salmon smolt migratory corridors and holding areas.

Methods

Two set and haul techniques were used depending on water depth:

1. Shallow set (≤ 1.2 m): A 12 m long by 1.5 m deep seine net with 6 mm mesh at the tow ends and 4 mm mesh at the bunt was used in water depths of 1.2 m or shallower, including all sites outside of the channel between Lelu Island and Flora Bank (approximately 85 % of all sites). Each beach seine was set by two fishers towing the net approximately 20 m along the shoreline and hauling the net to shore. Universal Transverse Mercator (UTM) coordinates (start point and finish point) and water depth (at the deepest point) were recorded for each set.
2. Deep set (>1.2 m): At the commencement of the fish surveys (December 2014, January 2015), a larger 22 m long by 3 m deep net (with 13 mm mesh at the tow ends and 6 mm mesh at the bunt) was tested at a number of shallow water sites; however, the net was too heavy to safely haul (with a crew of three) and many sites were too shallow to use a boat. Consequently, after January 2015 this larger net was limited to use at deep water sites (>1.2 m) and deployed with the aid of a skiff. Deeper sites included sites in the channel between Lelu Island and Flora Bank. The beach seine was deployed from an anchor on the shoreline and towed down-current (as currents within the channel were too strong to adequately haul and maneuver the skiff into the current). UTM coordinates and water depth were recorded similar to the shore sets.

All fish captured were identified and counted in the field to the lowest possible taxonomic level (ideally to species), measured (fork and total length in millimetres, depending on species), and assessed visually for injuries and abnormalities. In an effort to minimize fish handling and stress, 10 fish were selected to be measured from each species caught per set. Measured fish were chosen to represent the size distribution of each species caught. All fish were captured under DFO scientific collection permits and generally live-released at the location of capture. Some salmonids were retained for stomach content analysis (see Section 3.2.6); any other incidental mortalities were recorded.

3.1.3 Hydroacoustics and Trawls

Purpose

Hydroacoustic surveys, paired with surface trawls, were used to survey abundance and distribution of fish along defined transects. Trawling is a stand-alone survey method but also serves to identify acoustic targets (ground-truthing). Hydroacoustic and trawl fish data linked with marine water properties (Section 3.1.1) and bathymetry, can be used to gain insight into the linkages between habitats and fish distribution.

Hydroacoustic surveys use high frequency sound pulses ("pings") sent through the water column by an acoustic transducer. The transducer receives and characterizes the energy or echoes returning from objects in the water. The energy returning through a volume of water is termed the instantaneous volume backscattering coefficient (S_v) and is a metric used in hydroacoustics to estimate fish distribution. S_v values are presented in decibels (dB) as negative values. Numbers further from zero (larger negative numbers) indicate less relative biomass and numbers closer to zero (smaller negative numbers) indicate higher relative fish biomass. An S_v value of zero indicates that no fish backscattering energy was detected by the transducer and therefore no fish biomass was observed in the volume of water. Mean Volume Backscattering Strength (MVBS) is used a standardized measure for fish biomass during hydroacoustic surveys and uses S_v averaged over a range interval and unit distance. MVBS when integrated over the entire water column, can be used as a measure of relative fish biomass per unit volume or fish biomass density (Food and Agriculture Organization of the United Nations (FAO) 1983; Simmonds and MacLennan 2005).

MVBS was used for the analyses reported here because a defect in the DTX echosounder was detected during the course of hydroacoustic surveys conducted in April, May and June. This defect did not affect quantification of the echo intensity (MVBS) of the survey data, but did result in reduced split beam capacity for some of the surveys, leading to reduced accuracy in post data processing estimates derived for target strength (TS) based on the position of the target in the beam. This in turn prevented accurate TS estimates and limits analytical methods, such as echo integration, used to estimate fish numbers. In addition, target density was often too low to allow for accurate statistical methods for target strength estimation (i.e., conversion of MVBS into number of fish). Nonetheless, analysis of MVBS across all of the surveys conducted from January to mid-July allows for a standardized comparison between transects within a survey session, and across surveys to gain insight into spatial and temporal patterns of fish distribution. These results, however, do not allow for specific insight into the species composition.

Follow-up analyses will be carried out and presented in the final report that incorporate TS estimates made possible with the full functioning split-beam echosounder.

Note: Spatial patterns described below are preliminary and descriptive; follow-up analyses for the final report will be undertaken to describe the patterns seen with greater statistical rigor.

Sample Design

Hydroacoustic surveys were initially conducted with four transects in January 2015; a transect was added within Porpoise Channel in February 2015, and to the east of Flora Bank in May 2015 (Figure 3 and Table 4), to provide greater coverage of habitats surrounding the Project site. Survey design was to run parallel transects with sufficient resolution to allow for interpolation between transects, and estimate fish distribution across the entire study area. Transects were located to run co-linearly and across the proposed project's marine trestle and jetty alignment to examine fish presence along the proposed infrastructure, and provide context for the potential effects of placement of the infrastructure.

Methods

Trawls

Three different trawl nets were used to collect pelagic fish in open water along set transects. Different trawls were used as a result of various logistical constraints and adaptive field methods associated with local marine conditions. The three trawl nets included a modified Otter trawl net 18 m long with an opening 5 m wide and 4.6 m deep, a 2 m x 2 m Tucker trawl net, and a 1 m x 1 m Tucker trawl. The 1 m x 1 m Tucker trawl Tucker trawl net was used initially during daytime fish surveys until the 2 m x 2 m custom Tucker trawl was built for the project (it was only used on the second survey before being substituted). After evaluation of catch numbers with the 1 m x 1 m Tucker trawl, this net was deemed inefficient for fish sampling for the study area due to mesh size and capture efficiency and was removed from surveys in February 2015. The 2 m x 2 m trawl was used starting in February 2015 surveys and onwards. All trawl nets captured a range of fish taxa and sizes, including salmon smolts, surf smelt, and herring. The 5 m x 4.6 m modified Otter trawl is considered more effective at catching fish of all species when compared against catches from the smaller Tucker trawls (Schwinghamer, et al. 1998). However, use of the Otter trawl was limited to deeper waters (and could not be deployed over Flora Bank). The relative effectiveness and depth of the water fished with the different nets will be considered when using trawl information as a stand-alone survey method to provide information regarding fish distribution as well as to examine the identity of the fish targets observed with the hydroacoustic data for the final report.

The Otter trawl net fished waters from 0 m to 5 m depths, the 2 m x 2 m Tucker trawl net fished waters from 0.5 m to 3 m, and the 1 m x 1m Tucker trawl fished obliquely through the water column from 5 m to 20 m. The modified Otter trawl was constructed with a baffled holding box specifically designed for live capture, and was used on transects only in water deeper than 10 m (due to the draft requirements of the fishing vessel). The Tucker trawl nets were deployed from a 5.5 m aluminum skiff. Experience with these nets indicated that the most effective methods for trawling consisted of a combination of the Otter trawl used in deep water (>10 m depth) and the 2 m x 2 m Tucker trawl fished along the surface over Flora Bank and shallow waters (≤10 m depth).

Fish captured were processed as described in Section 3.1.2.

Hydroacoustics

Hydroacoustic surveys were conducted using a 120 kHz DT-X digital echosounder (Biosonics Inc., Seattle, WA) mounted to an aluminum pole attached over the side of the 5.5 m aluminum skiff. The echosounder was positioned downward looking through the water column while the boat travelled at 3 to 4 knots along each set transect.

An onboard deck unit was used to control the transducer via Biosonics Visual Acquisition 6.0 software. Prior to starting each transect, maximum water depth to be encountered along each transect (plus a 5 to 10 m safety margin) was entered to set the range for data collection. The acoustic system calibration was checked by sounding on a submerged standardized tungsten ball target, as per a calibration protocol instructions (and video) provided by the instrument manufacturer.

Acoustic transects were surveyed with the echograms viewed in real time and data stored on an onboard laptop. Latitude and longitude of each ping were also stored on the onboard GPS (global positioning system). The ping rate was typically five pings/second unless a false bottom (a reflection of the bottom that appears in the water column due the influence of surface reflectivity) was noted in which case the ping rate was reduced to four pings/second; the pulse width was at 0.4 milliseconds (ms). The threshold for data collection was -130 dB so that information regarding even acoustically faint targets was collected for possible use later.

In this study, only acoustic returns equal to or greater than -60 dB were imported into the hydroacoustics VISUAL ANALYSER software for analysis of fish biomass density. The -60 dB cut off was chosen to allow for maximum detection of smaller fishes. According to Love's equation (Love 1970), a fish of ~30 mm in length (e.g., the size of a pink salmon) will have a TS of -55 dB. Therefore -60 dB was used as the threshold for the data to be analyzed to account for as much as possible a reduction in echo intensity because of off center location of targets of interest in the beam, without incorporating non-fish background sound energy such that may be reflected from high density marine invertebrate swarms or detrital layers. The threshold of -60 dB also allows for the detection of newly emerged salmon smolts, and small adult eulachon (Gauthier and

Horne 2004), while excluding echoes from large zooplankton (Crawford, et al. 1992). In some instances, a zooplankton or detrital layer was so pronounced across a transect that it blocked accurate estimation of fish -only MVBS strength. The transect segments for which the pronounced zooplankton and/or detrital layers were detected are presented in the figures in Appendix B as a grey line.

Hydroacoustic data were analyzed with Visual Analyzer 4.3 software (BioSonics Inc.) to determine MVBS as a measure of fish biomass density. Mean in situ water column salinity and temperature data (Section 3.1.1) from each survey were entered to fine-tune calculations of sound transmission speed. Seafloor bottoms were defined by the software and then manually adjusted to exclude echoes from the bottom substrate and objects extending up from the seafloor. Any surface disturbance was also removed from the analysis of the echogram. Interpretation of the echograms was done in consultation with staff at Biosonics Inc. manufacturer of the echosounder. To facilitate visualization and interpretation of fish biomass density results, each transect was divided into approximately 500 m segments. The MVBS was calculated for 500 m sections along the transects and this section on the transect was colour-coded as -80 dB and less; -75 dB to - 80 dB; -70 dB to -75 dB; -65dB to -70dB; -60 dB to -65 dB; -55 dB to -60 dB; -55 dB and greater accordingly.

The hydroacoustic method selected has two limitations to be considered when interpreting patterns of fish detection over the shallow waters of the study area, including Flora Bank. First, the ability for downward-looking echosounders to detect targets is proportional to water depth; in shallow water, the cone-shaped acoustic beam is relatively narrow and is therefore less likely to pass over fish than in deeper water where the beam is wider; second, the use of mobile hydroacoustic surveys in shallow waters can result in fish avoidance of the vessel. Effort was made to survey the shallowest areas during the highest possible tide to minimize these depths limitations.

3.1.4 Fyke Net

Purpose

Fyke nets were used to sample the shallow intertidal areas on Flora Bank where other methods were constrained because of quickly fluctuating tidal height and currents. As discussed in Section 3.1.2, beach seines could not be safely or effectively used on most (90%) of the surface of Flora Bank (i.e., only the edges of the bank could be fished using beach seine techniques).

Method

Fyke net sets were implemented in daytime fish surveys in March 2015 to provide additional information on fish species presence, movement, and distribution across the shallow areas on Flora Bank. Fyke nets are an effective method for sampling migratory species in estuarine habitats. This form of passive live-fish sampling and capture is particularly effective over long duration sets and tidal cycles (6 to 10 hour sets) and across shallow and intertidal habitats such as Flora Bank (Conlin and Tutty 1979; Shreffler, et al. 1990; Portt, et al. 2006; Johnson, et al. 2007).

Fyke nets are constructed comprising a cone-shaped net bag mounted on a series of hoop rings (0.6 m diameter by 3.8 m long) mesh wings to direct fish into the net. At the front, the outside lead (7.3 m long) guide the fish towards the square opening of the net bag (0.76 m high by 0.86 m wide). A third central lead (14.6 m) also directs fish into the net (Photograph 1).

Photograph 1 Fyke Net Set on Flora Bank

In an effort to establish adequate spatial coverage across Flora Bank, the bank was divided into four sections; field teams aimed to set one net in each section every survey period. This approach was used because varying tidal heights between surveys exposed different parts of the bank such that exact sites had to be determined in situ based on local conditions, safe site access and gear transport, orientation of the fyke net opening into ebb or flood tidal currents during the next tidal cycle, and local habitat complexity (e.g., eelgrass presence, shallow dendritic channels) (Figure 3). The frequency of successful sampling ranged from zero to four net sets per survey (see results Section 5.4, Table 4 for details).

Nets were initially set at both high and low tides. However, setting nets at low tide became the method of choice due to the added effort required to ensure proper setup from a vessel during high water.

All fish caught were processed as described in Section 3.1.2.

3.1.5 Crab Trapping

Purpose

Crab traps were set to assess and characterize the distribution, relative abundance, sex ratio, and state of moulting for Dungeness crabs within the study area.

Sample Design

Crab trapping was conducted as a component of the monthly daytime fish surveys. Twenty-four crab trap sets were completed during each daytime fish survey: 20 crab traps were set at the beginning and end points of each daytime fish survey hydroacoustic/trawl transect, and four crab traps were set within Porpoise Channel (Figure 3). Deployment of crab traps directly on Flora Bank was not possible due to its intertidal nature and potential for crabs to be killed from prolonged exposure to air during low tide.

Methods

Commercial grade crab traps (0.91 m bottom ring, 0.86 m top ring, two 105 mm escape hatches, 25 mm weight bar, wrapped in standard mesh [0.05 m diamond weave]) were set using protocol established from DFO's *Manual for Dungeness Crab Surveys in British Columbia* (Dunham, et al. 2011). Traps were baited with herring and set to soak for 18 to 24 hours. Crab trap data included date, set and retrieval times, water depth, and UTM coordinates. Temperature was collected at each site, as part of the oceanographic data collection using the CTD (Section 3.1.1).

All crabs, invertebrates and fish captured were identified and counted in the field to the lowest possible taxonomic level (ideally to species), sexed when possible, measured (carapace point width in millimetres), weighed (grams [g]) and assessed visually for injuries and abnormalities (e.g., missing legs, cracked shell, etc.). Crabs were also assessed for reproductive status (i.e., berried or not) and moult stage (i.e., hard- or soft-shelled). All crabs were captured under DFO scientific collection permits and live-released.

3.2 NIGHTTIME FISH AND FISH HABITAT SURVEYS

Nighttime fish surveys were added to the Program to enhance the sampling effort during smolt out-migration (spring-early summer) period (e.g., when salmon smolts leave the Skeena River watershed and move to areas of open "green" [clear] marine waters), and to improve capture efficiency for fish species normally active during dusk, night and dawn time periods. The nighttime fish surveys were conducted to examine the spatial and temporal distribution of fish species that support a CRA fishery and the forage fish that support these populations.

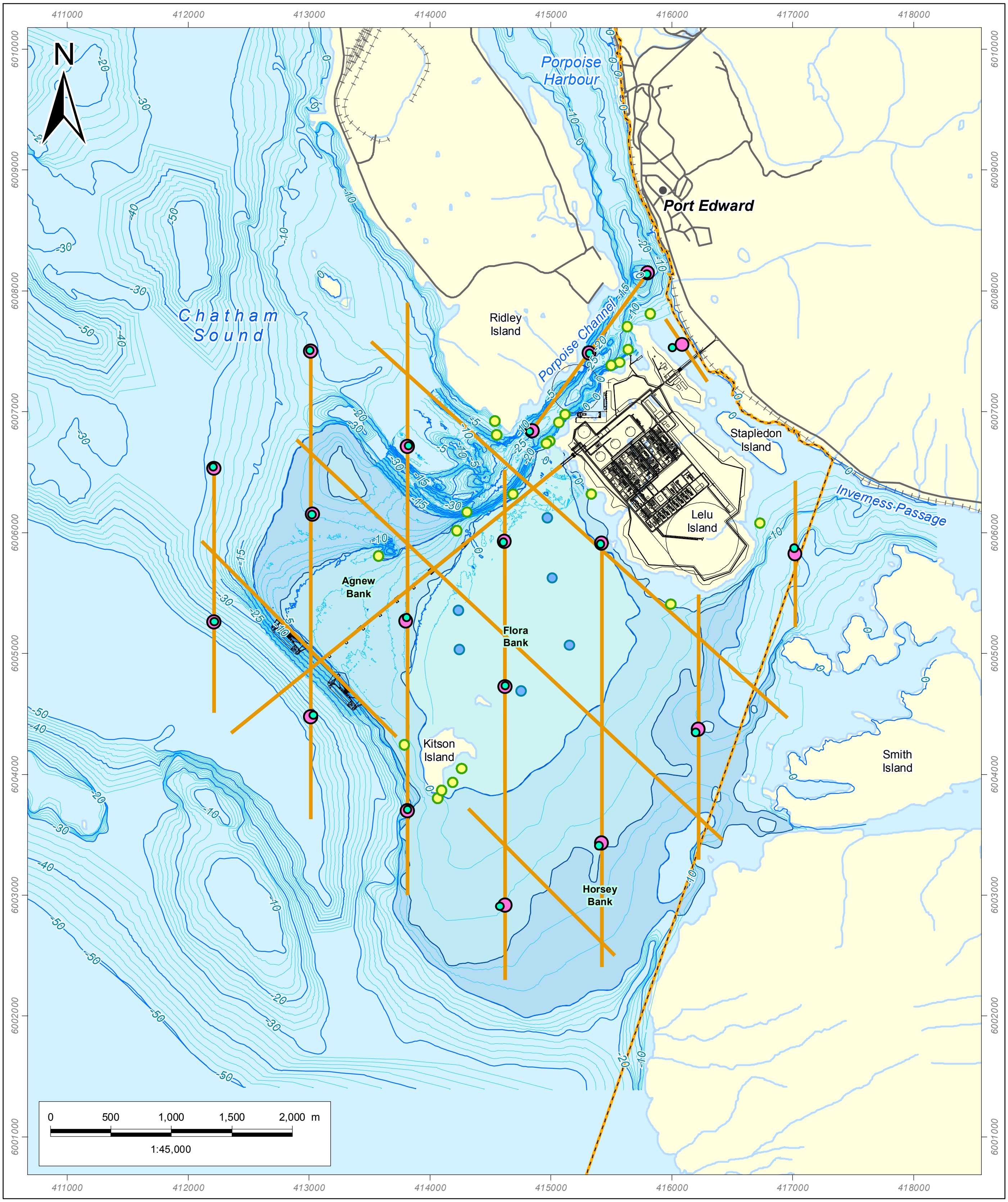
Consistent with the daytime fish surveys, an adaptive approach was used to conduct nighttime fish surveys to sample ocean water quality, fish and fish habitats around the study area reflective of in-field experience, site weather and marine conditions and challenges. Nighttime surveys included hydroacoustic and trawls, fyke netting, and purse seining, but did not include beach seining or crap trapping due to nighttime safe working conditions. Salmon were retained during nighttime surveys for stomach content analysis (and later on during daytime surveys) (see Section 5.3).

The study design included the following sample techniques:

- Oceanographic water property data collection to understand the extent of suitable physical, chemical and biological fish habitats and how they vary in space and time
- Zooplankton surveys to assess and characterize the abundance and distribution of planktonic fish and invertebrates
- Use of hydroacoustic and trawl surveys to assess and characterize the abundance and distribution of pelagic fish
- Fyke net sets to assess and characterize the abundance and distribution of intertidal fishes on Flora Bank
- Purse seining to assess and characterize the abundance and distribution of pelagic fishes
- Salmon smolt stomach sample collection and analysis to determine diets.

The following sections provide a detailed discussion on the purpose, study design and methods used for each nighttime survey components.

The location of sampling sites by gear type / method for the nighttime fish surveys is shown in Figure 4.



City or Town	Waterbody	CTD Site
Project Component	**Shoal**	Fyke Net
Railway	Flora Bank	Zooplankton Site
Road	0 - 5 m Deep Shoal	Purse Seine
Secondary Road	5 - 10 m Deep Shoal	Hydroacoustic and Trawl Transect
Watercourse	**Bathymetry (m)**	
Prince Rupert Port Authority Boundary	Major Contour	
	Minor Contour	

Pacific NorthWest LNG

Nighttime Fish Survey Locations (May – July 2015)

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

DATE: 28-OCT-15
FIGURE ID: 123110537
DRAWN BY: A. BOONE

PROJECTION: UTM - ZONE 9
DATUM: NAD 83
CHECKED BY: M. JOHANNES

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: 4

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3.2.1 Marine Water Properties

Purpose

Marine water properties are used to explore the interactions between the biological and physical systems and to potentially help identify species-specific habitat requirements (see Section 3.1.1 above).

Sample Design

Water properties stations for nighttime fish surveys were consistent with those sampled during daytime fish surveys. Three sites were added within Porpoise Channel (see Section 3.1.1) to support additional water sampling adjacent to the proposed MOF.

Methods

Water properties were collected across vertical profiles in the water column using ALEC CLW Infinity and RbR Concentro unit CTD probes and loggers from May 2015 through July 2015 for nighttime fish surveys. At each survey site, the CTD logger was lowered to the seabed and retrieved vertically through the water column to the surface with a rope/winch at a fixed rate of 1 m/s.

Water quality parameters collected include:

- Turbidity (NTU)
- Temperature (°C)
- Conductivity (µS/cm)
- Depth (m)
- DO concentration (mL/L)
- Chl-*a* concentration (µg/L)

3.2.2 Zooplankton

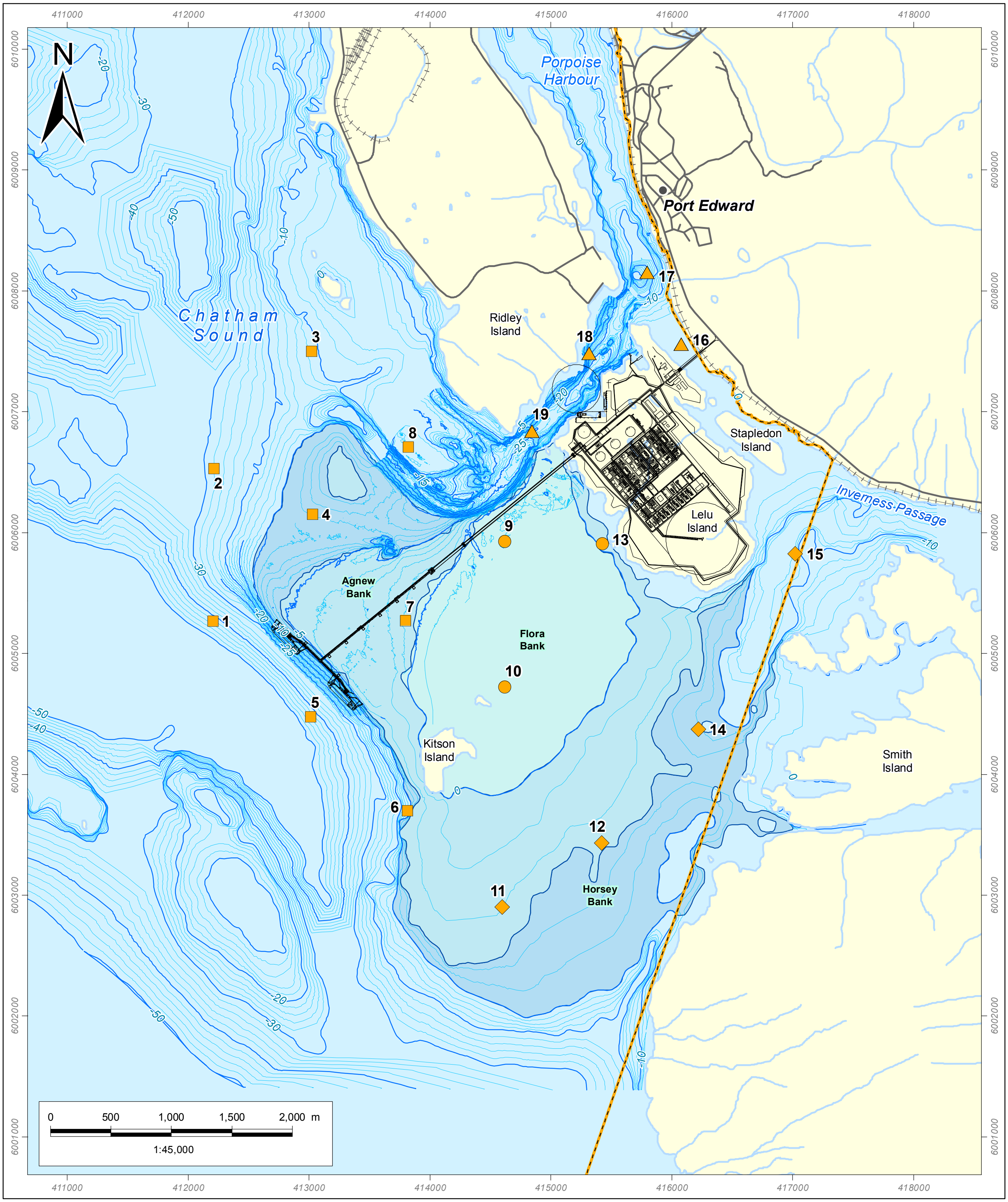
Purpose

Zooplankton are prey for many species of plankton-feeding fish (planktivores), are the primary herbivore in a marine food-web, and provide a link from nutrients and primary producers to higher trophic level consumers (Pomeroy 1974; Sheldon et al. 1977; Pauly and Christensen 1995, Schweigert et al. 2007). The relative abundance and density of known prey items can be used to predict potential fish productivity and potential feeding habitats used by pelagic planktivorous fish, including juvenile salmon, Pacific herring, surf smelt, sandlance and juvenile eulachon, among others (Manzer 1969; Brodeur 1990).

Zooplankton Sample Design

Eight nighttime fish surveys collected zooplankton samples across these 19 sites from May to July 2015. At the time of report writing, five surveys (which in total collected 94 samples) have been processed and analyzed. Results from samples from all eight surveys will be presented in the final report at the completion of the Program (see Section 3.2.1 and Figure 4). Zooplankton and CTD sampling were conducted at the same locations to have concurrent data (McCarter and Hay 2003).

Sampling stations were grouped into four locales within the study area based on their similarities of location and proximity, bathymetry, and exposure to outflow currents from Inverness Passage and Porpoise Channel. The groupings were designated: Northwest, Porpoise Channel, Southeast, and Flora Bank (Figure 5). For the purpose of this report, an initial analysis of zooplankton density was compared across locales.



Zooplankton Sampling Station: Flora Bank	City or Town	Prince Rupert Port Authority Boundary
Zooplankton Sampling Station: Northwest	Project Component	Waterbody
Zooplankton Sampling Station: Porpoise Channel	Railway	**Shoal**
Zooplankton Sampling Station: Southeast	Road	Flora Bank
	Secondary Road	0 - 5 m Deep Shoal
	Watercourse	5 - 10 m Deep Shoal
	Bathymetry (m)	
	Major Contour	
	Minor Contour	

Pacific NorthWest LNG

Nighttime Fish Survey Zooplankton Sampling Stations

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

DATE: 28-OCT-15	PROJECTION: UTM - ZONE 9
FIGURE ID: 123110537	DATUM: NAD 83
DRAWN BY: R. CAMPBELL	CHECKED BY: J. DIMITRIJEVIC

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: 5

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Methods

Zooplankton were collected from each station using a Scientific Committee on Oceanic Research (SCOR) vertical plankton net (diameter = 0.5 m, mesh = 333 microns; Hyatt, et al. 1984). The net was lowered close to the seafloor and then hauled vertically through the water column to the surface at approximately 1 m/s. A flow meter was attached to the net to verify calculation of the volume of water filtered (McQueen and Yan 1993). Samples were rinsed with filtered sea water and preserved in 10% formalin saturated with borax. Sample processing was subcontracted to Biologica Environmental Services Ltd.

Zooplankton and other organisms in the samples were sorted and identified to the lowest practical taxonomic level. All organisms observed in samples were grouped into taxonomic categories for ease of interpretation and comparison with existing literature (e.g., Gottesfeld, et al. 2008; Price, et al. 2013). The number of zooplankton was standardized per cubic metre (m^3) of water by estimating the haul vertical cylindrical volume of water for each sample and site based on net flow efficiency where possible.

3.2.3 Hydroacoustics and Trawls

Purpose

Refer to Section 3.1.3.

Hydroacoustics were paired with surface or midwater trawls, and were conducted to survey fish abundance and distribution along fixed transects located across the study area. These surveys were conducted from May to July 2015 to coincide with the out migration of salmon smolts from the Skeena River (Manzer 1956, Beacham et al. 2014). These data, when collected in conjunction with marine water properties (Section 3.2.1), zooplankton (Section 3.2.2) and bathymetry, can be used to examine relationships between habitat characteristics and fish distribution.

Method

Nighttime hydroacoustic transects were designed to systematically examine fish presence across the study area. The first two nighttime surveys, (late April to early May 2015 and mid-May 2015), were carried out using a transect grid pattern to cover the study area and was enhanced in later surveys with a slightly more intensive grid pattern.

The nighttime fish survey hydroacoustic and trawl transects followed the same fixed transect locations used for the daytime fish surveys. Eight transects were added to the nighttime fish surveys (April 30 to July 15, 2015), seven parallel transects running north-south approximately 800 m apart, and one transect in the slough north of Lelu Island (see Figure 4).

The intent of the additional eight transects was to increase hydroacoustic resolution and spatial coverage across the study area during the salmon smolt migration period. Transects were conducted north to south to minimize the effect of the outflow of the Skeena River while traveling along the transects. Additionally, starting with the third nighttime fish survey (May 25 to 29, 2015), a grid of eight transects was added directly over top of Flora Bank to increase hydroacoustics and trawl coverage in that area (Figure 4).

The 2 m x 2 m Tucker trawl net was towed 90 m behind the boat and fished 0.5 m to 2.5 m below the surface. The Otter trawl was not used at night because of safety considerations.

All fish caught were processed as described in Section 3.1.2.

3.2.4 Fyke Net

Purpose

See Section 3.1.4.

Sample Design

See Section 3.1.4.

Method

See Section 3.1.4.

During the nighttime fish surveys, field crews set up the fyke nets during low tide during dawn/ daylight conditions (usually at the end of the night shift). The nets were fitted with plywood doors that covered the entire opening of the fyke net so that they did not fish until the doors were removed. A line and float were attached to each door allowing the crew to remove the doors the following day during high tide from the vessel. The nets were left to fish passively until collection at the next low tide.

All fish caught were processed as described in Section 3.1.2.

3.2.5 Purse Seine

Purpose

Purse seining was used to sample offshore pelagic fish communities (Beamish, et al. 2003) during nighttime fish surveys. Purse seining was added as a component to the nighttime fish surveys beginning at the end of June 2015 with the intent to diversify the sampling methods and coverage used in the Program. Sites fished included areas over Flora Bank, near Kitson and Lelu islands, and in Porpoise Channel (Figure 4).

Methods

Purse seine sites were chosen based on field conditions associated with tide height for site depths, tidal currents and weather (i.e., they were not fixed) and provided a broad spatial coverage across the entire survey area (e.g., Porpoise Channel, western Flora/Agnew banks, northern Flora Bank adjacent to Lelu Island, eastern Flora/Horsey banks, and central Flora Bank were fished using the purse seine; Figure 4).

The purse seine was 50 m in length and 6 m deep with a mesh size of 11 mm. The net was pursed using a perimeter line drawn through a set of rings along the entire vertical and bottom horizontal panels of the net. The purse seine was set from a boat and hauled straight for approximately 10 m to confirm no twists or tangles were present in the set (specifically that lead lines did not cross the float line). Once the net was set in the water, the boat circled back to the opposite end of the purse seine to retrieve the net lead to complete full circle of net in the water. The lead and purse line of the seine net was pulled in to close the net bottom to prevent fish from escaping. Once pursed, the net was hauled up and into the boat. Fish were left in the water before being collected for processing. UTM coordinates were record for seine set start points, and water depths were recorded at the deepest point of the set.

All fish caught were processed as described in Section 3.1.2.

3.2.6 Salmon Smolt Stomach Sampling

Purpose

Salmon smolts were retained for stomach contents to examine diet and prey selection.

Methods

Salmon smolts were retained from nighttime surveys from May to July 2015 and from daytime fish surveys during July and August 2015. Juvenile salmon were euthanized using clove oil and flash frozen on dry ice. Whole fish were submitted to Biologica Environmental Services for positive species identification, measurement of biological characteristics and count of stomach contents and prey items.

Frozen and thawed fork lengths of juvenile salmon were measured (±1.0 mm). Frozen stomachs were extracted and immediately measured for frozen and wet thawed weight. Stomach contents were characterized by assessing fullness, digested condition of prey, and identification and number of prey taxa in each stomach. Fullness was estimated based on a scale of 0–100%, with 0 being empty, 10% trace of prey, 50–75% full, and 100% distended. Digestive condition of individual prey items was assessed on a scale of 0–100%, with 0% being an intact full prey and 100% being a fully digested, often unrecognizable, prey taxa. Prey was identified to lowest possible taxon, enumerated, and wet thawed weighed (±0.0001 g).

Stomach content results reported here include an initial summary analysis of the counted number of individual prey in each stomach expressed as a percentage of the total number of prey in the stomach sample for each salmon species. Stomach contents were also expressed as the frequency of occurrence from number of stomachs in which each prey was counted and expressed as a percentage of the total stomach analyzed per salmon species.

Stomach content analysis is underway and results are not fully available at the time of writing this report. An analysis of the complete stomach content data, diet preference, and index of relative importance (Hyslop 1980) will be included in the final report.

The DFO sample permit was pending during the first night survey (April 30 to May 4, 2015), so no fish were retained during this period.

4.0 QUALITY CONTROL/QUALITY ASSURANCE

A series of protocols were implemented to promote high-quality data collection, analysis and interpretation during the Program.

Routine Field Equipment Inspection and Calibration

- All fishing gear was inspected for tears and rips prior to field use. If wear or damage was identified, the net was mended by field crews (minor repairs, e.g., small holes) and/or professionally repaired (large rips or tears requiring stitching) as required.
- Hydroacoustics data analysis was calibrated using in situ salinity and temperature conditions within the study area at the time of each survey. In addition, a calibrated check was conducted with a tungsten-carbide sphere at the start of each survey so that any calibration offsets could be incorporated in the post collection processing of the hydroacoustic data.
- CTD sensors used to sample marine water properties were rented in good working order from ASL Environmental Sciences. CTD equipment was maintained and calibrated by ASL on a routine basis.
- All crab traps and lines were inspected for obstructions (e.g., faulty doors) prior to field use.

Data Checks

- Quality control checks were routinely scheduled and performed to review data during the field program.
- Data was reviewed and approved by a second biologist within the timing of the field surveys to confirm data accuracy and completeness.
- Data forms were photographed for inventory purposes and to prevent data loss.
- Photographs were downloaded from cameras, sorted, and labelled at the end of each day.
- Data files were uploaded for storage during each field survey as possible using a secure Stantec server.
- Data review and approval was routinely performed by a biologist.

Data Analysis

- Data review was conducted by a series of biologists, including experienced fisheries scientists, and included careful scrutiny of data, review for outliers, and post-hoc addition of variables (e.g., specifying spatial groupings).
- Initial analyses included:
  - Creation of summary tables of total survey effort and species caught
  - Plotting salmon catch and size, by species, over time
  - Plotting raw data as size frequency histograms across space and time, for select CRA species.

November 3, 2015

Report Preparation and Review

- All Stantec reports are subject to a rigorous quality control review process that includes review by Quality (Technical) Reviewer, and Independent Review by qualified staff, in accordance with the project requirements of Stantec's ISO 9001 Quality Management System.

5.0 INTERIM RESULTS

5.1 PHYSICAL AND BIOLOGICAL SETTING

Results for each survey described in Section 3.0 are presented as follows: water properties (Section 5.2); prey base sampling using zooplankton tows (Section 5.3) and stomach contents (Section 5.6).

5.2 WATER PROPERTIES

Section plots of turbidity, temperature, salinity, dissolved oxygen (DO), and chlorophyll *a* (chl-*a*) data are presented in Appendix A (Figure A-1 through Figure A-19). The water property plots are organized by month and transect, with each plot displaying the parameters measured with depth across horizontal transects.

Results from daytime fish surveys from December 2014 to August 2015 present a consistent transition from winter conditions, with colder surface waters and lower primary productivity (chl-*a*), to warmer more productive summer seasonal marine conditions (Figure A-1 to Figure A-19). In December 2014 (Figure A-1 to A-4) the average ocean temperature in the survey area was 8.7°C, with a range across the entire water column of 5.8°C to 9.9°C (with surface water being relatively colder). Chl-*a* ranged from 0 to 0.43 µg/L (Figures A-1 to A-4). Relatively colder surface waters, above warmer sub-surface water, were observed until the May 19, 2015 survey (Figures A-5 to A-9) along with a small but detectable increase in water column chl-*a*. Notable increases in chl-*a* concentrations were not seen in the surface waters until the June 2015 surveys, consistent with observed stronger water column thermal stratification (Figures A-10 to A-14). The highest concentrations of water-column chl-*a* were observed in the June 18, 2015 survey; these concentrations had decreased by the July 2015 surveys (Figures A-15 to A-19). Higher chl-*a* concentrations were observed at greater depths in the water column in July 2015 relative to earlier in the season.

Additional water properties will be discussed in the final report when all data has been collected.

Measurements of Secchi depth were used to estimate water clarity in the study area. Secchi depth estimates were collected December 2014 to August 2015 daytime fish surveys with the exception of March, May and June 2015 surveys (Table 2). Secchi depth observations indicate that water clarity was clearer during winter months and declined with the transition to periods of seasonal phytoplankton growth (e.g., chl-*a*: Figures A-15 to A-19) and potentially linked to increasing Skeena River discharge and higher local total suspended sediment concentrations (PNW LNG 2015). Observed Secchi depths were smaller (indicating greater turbidity) at the outflow of Inverness Passage, and greater at areas in Porpoise Channel and Porpoise Harbour (Table 2).

Table 2 Study Area Site Maximum Water Depth and Observed Secchi Depth (Water Clarity)

Site ID (Direction, Area) [Appendix A]	Secchi Depth (m)																					
	2014		2015																			
	December		January		February		March		April		May		June (early)		June (mid)		July (early)		July (mid)		August	
	Max Water Depth (m)	Secchi Depth (m)	Max Water Depth (m)	Secchi Depth (m)	Max Water Depth (m)	Secchi Depth (m)	Max Water Depth (m)	Secchi Depth (m)	Max Water Depth (m)	Secchi Depth (m)	Max Water Depth (m)	Secchi Depth (m)	Max Water Depth (m)	Secchi Depth (m)	Max Water Depth (m)	Secchi Depth (m)	Max Water Depth (m)	Secchi Depth (m)	Max Water Depth (m)	Secchi Depth (m)	Max Water Depth (m)	Secchi Depth (m)
CTD1 (SW, Agnew)	-	5	68	3.5	72.6	3.5	-	-	70	4.1	-	-	-	-	-	-	68.8	2.0	71.3	4.1	74	3.2
CTD2 (W, Agnew)	-	5	10	3.5	11.0	5.0	-	-	9.5	4.1	-	-	-	-	-	-	9.6	1.7	11.3	2.9	12	3.4
CTD3 (Agnew)	-	4	3.2	2.5	6.3	4.2	-	-	5.7	4.1	-	-	-	-	-	-	2.5	0.5	6.1	2.7	5	3.5
CTD4 (E, Agnew)	-	5	23	3	26.0	4.0	-	-	9.8	3	-	-	-	-	-	-	22.6	1.1	23.0	2.8	23	2.9
CTD5 (N, Agnew)	-	6	29	3.5	35.5	5.2	-	-	32.2	4	-	-	-	-	-	-	29.6	3.8	32.0	2.4	34	3.5
CTD6 (S, Horsey)	-	8	8	2.5	11.7	4.0	-	-	11.1	3.6	-	-	-	-	-	-	8.4	1.5	10.9	4.5	10	3
CTD7 (N, Agnew)	-	5	14.2	2.7	17.3	4.1	-	-	16.8	2.9	-	-	-	-	-	-	13.1	3.2	15.9	2.5	17	3
CTD8 (S, Horsey)	-	5	2.8	2.5	6.4	5.0	-	-	5.6	2.3	-	-	-	-	-	-	3.1	2.1	5.8	2.7	5	2.5
CTD9 (W, Ridley)	-	5	9.5	3.2	12.4	3.1[b]	-	-	7.1	3	-	-	-	-	-	-	8.0	3.0	11.0	2.5	11	3.1
CTD10 (N, Inverness)	-	3	2	2	5.7	3.5	-	-	4.7	2.6	-	-	-	-	-	-	5.0	1.5	5.1	2.1	4	2.6
CTD11 (Porpoise)	-	4.5	19.1	2.5	19.8	3.0	-	-	24.6	2.9	-	-	-	-	-	-	19.4	2.0	25.0	2.0	20	2.6
CTD12 (Flora)	-	-	1	1	4.5	4.4	-	-	4	3.4	-	-	-	-	-	-	2.0	2.0	4.0	3.8	3	3.2
CTD13 (Flora)	-	-	1	1	4.5	4.4	-	-	3.9	3.1	-	-	-	-	-	-	2.0	1.0	3.9	3.6	3	3.4
CTD14 (E, Flora)	-	-	2	1.9	5.3	5.0	-	-	4.6	3.2	-	-	-	-	-	-	3.7	2.0	4.8	2.4	4	3
CTD15 (E, Porpoise)	-	-	26	2.5	29.2	3.0	-	-	28.7	3.2	-	-	-	-	-	-	24.6	2.5	29.2	1.8	27	2.2
CTD16 (Porpoise)	-	-	27	3	30.9	3.0	-	-	31.3	3.3	-	-	-	-	-	-	24.9	2.3	30.7	2.8	30	2.7
CTD17 (W, Porpoise)	-	-	34	3	36.0	4.5	-	-	34.8	3	-	-	-	-	-	-	34.0	1.0	35.0	2.3	35	3
CTD18 (Lelu Channel)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.6	1.0	4.0	1.6	3	2.4
CTD19 (S, Flora)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.8	0.8	5.2	3.0	5	2.5

Table 2 Study Area Site Maximum Water Depth and Observed Secchi Depth (Water Clarity)

Site ID (Direction, Area) [Appendix A]	Secchi Depth (m)																					
	2014		2015																			
	December		January		February		March		April		May		June (early)		June (mid)		July (early)		July (mid)		August	
	Max Water Depth (m)	Secchi Depth (m)	Max Water Depth (m)	Secchi Depth (m)	Max Water Depth (m)	Secchi Depth (m)	Max Water Depth (m)	Secchi Depth (m)	Max Water Depth (m)	Secchi Depth (m)	Max Water Depth (m)	Secchi Depth (m)	Max Water Depth (m)	Secchi Depth (m)	Max Water Depth (m)	Secchi Depth (m)	Max Water Depth (m)	Secchi Depth (m)	Max Water Depth (m)	Secchi Depth (m)	Max Water Depth (m)	Secchi Depth (m)
CTD20 (Horsey)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.3	0.8	6.5	3.8	6	3.2
CTD21 (SW, Horsey)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.4	1.0	8.8	5.5	9	4

NOTES:

[a] Eleven CTD stations were initially planned. More stations were added on subsequent surveys with the addition of paired hydracoustic and trawl transects.

[b] CTD site moved ~50 m south to avoid rock.

- Secchi Disk measurements were not completed.

ND No Data

5.3 ZOOPLANKTON

5.3.1 Zooplankton Density

The analysis of zooplankton density was completed for five of the eight sampling periods (i.e., the nighttime fish surveys from May to July 2015). In total, 94 out of 151 samples were available for presentation in this interim report. The remaining samples from three surveys (n = 57) are being analyzed, and will be included in the final report.

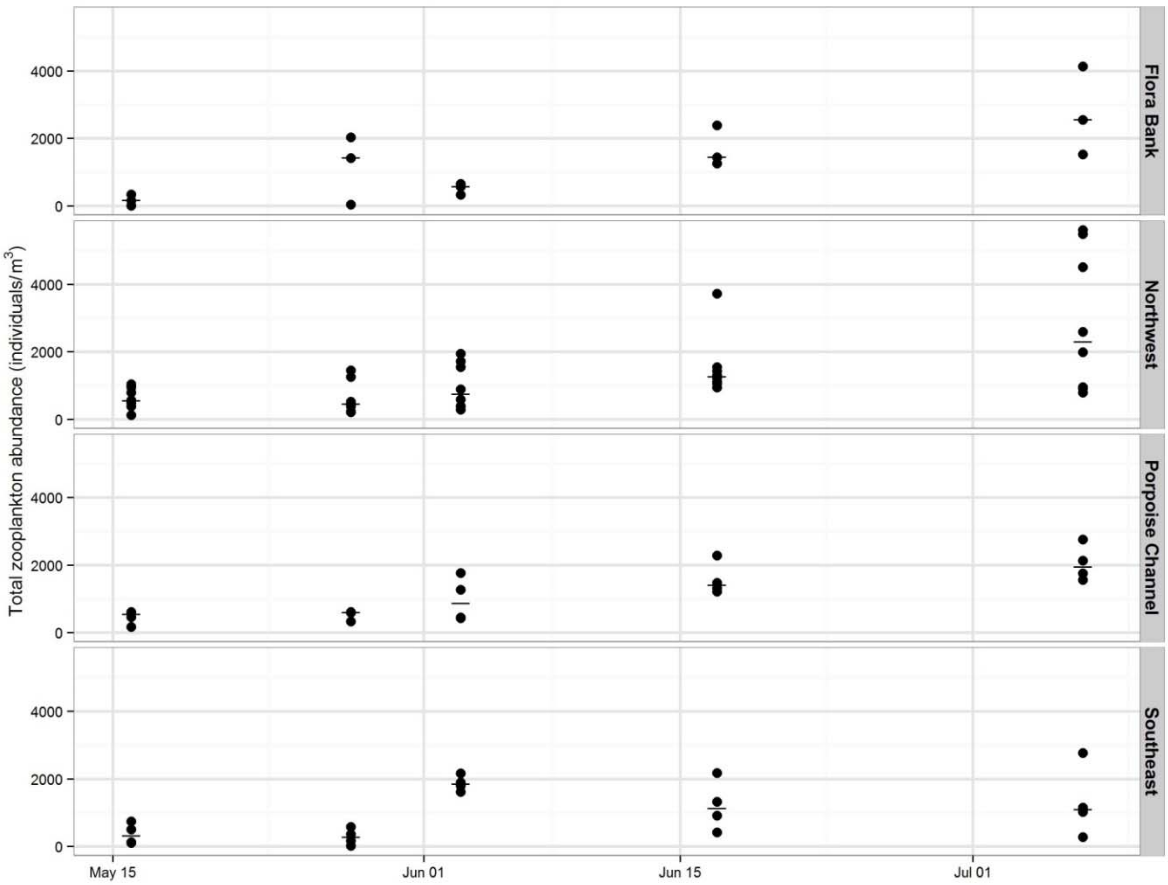
Estimates of zooplankton density (#/m^3) were pooled for all species and are presented as median estimates across sampling sites and grouped across four broad areas of shallow and deeper offshore sites (Figure 5).

Zooplankton density showed a high degree of variability among all sites and between grouped shallow (Flora Bank and *Southeast* sites) and deeper offshore (Northwest and Porpoise Channel sites) areas (sites numbers are shown on Figure 7) and ranged from 0 to above 4,000 individuals per m^3 (Figure 6, Figure 7).

Median estimates of zooplankton density showed a trend similar to patterns identified for chlorophyll *a* concentrations (Section 5.2 and Appendix A) consistent with enhanced productivity in spring to summer and declines in July 2015 (Figure 6). Variability was high among sites within each sampling period, particularly in June and July 2015. The zooplankton density observed in the four *Southeast* sites showed a general pattern of lower density relative to more northerly sites (Figure 7).

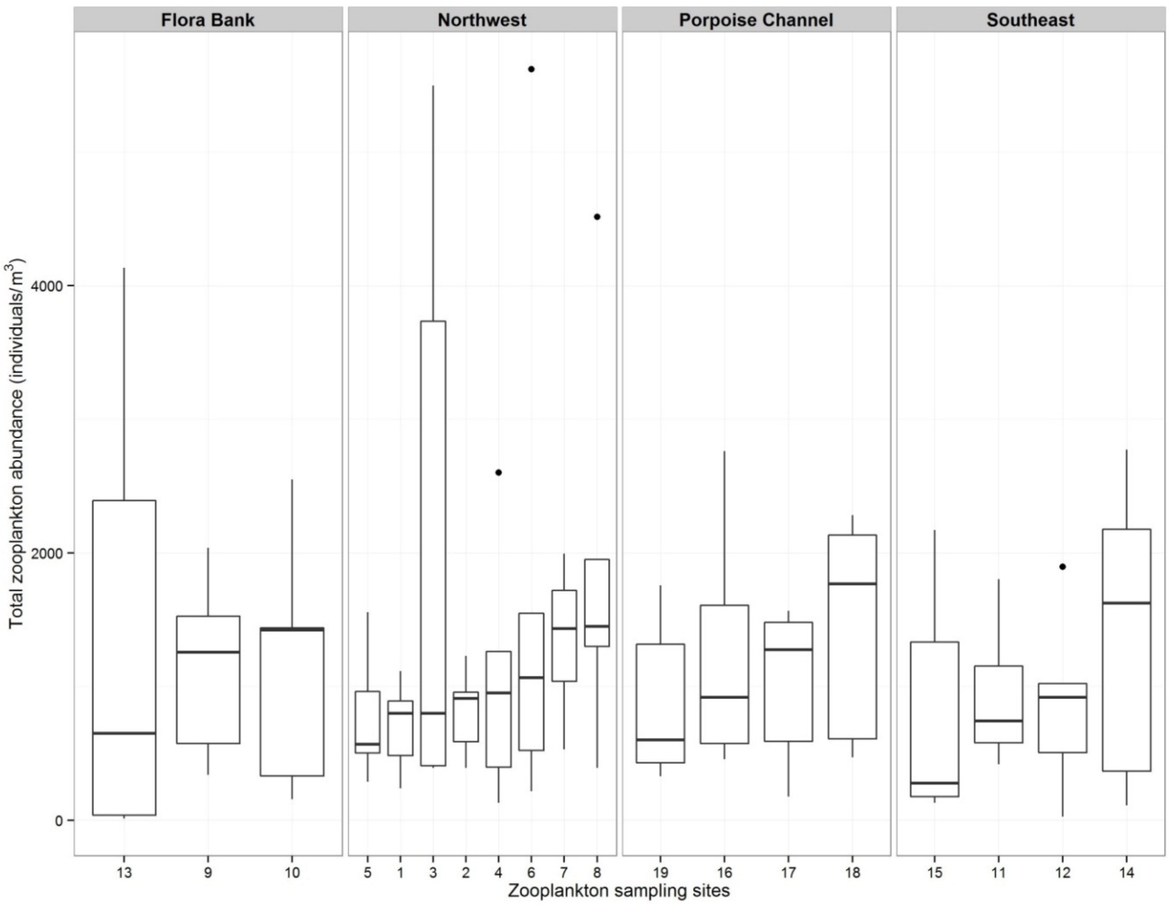
Total zooplankton abundance observed on Flora Bank showed lower variability than observed in deeper offshore sites, possibly reflecting lower sample sizes at Flora Bank. Total zooplankton abundance observed in the seven grouped *Northwest* offshore sites showed higher variability than the other grouped sites.

Additional analysis of zooplankton spatial and temporal patterns of density, taxonomy, and distribution will be presented in the final report once all samples have been analyzed.



NOTES: Dots represent zooplankton density values of individual sites; bars represent median values across sites for each survey date.

Figure 6 Zooplankton Density by Over Time Grouped within General Sampling Areas (Zooplankton sample site numbers: Flora Bank – 13, 9, 14; Northwest – 5, 1, 3, 2, 4, 6, 7, 8; Porpoise Channel – 19, 16, 17, 18; Southeast – 15, 11, 12, 14).



NOTE: Lower and upper limits of the box = IQR (i.e., the 25th and 75th percentiles respectively); solid horizontal lines = median; vertical lines ('whiskers') = IQR ± 1.5 * IQR. Points shown fall beyond these whiskers and are outliers.

Figure 7 Zooplankton Abundance (Density) between Sites across all Sample Periods

5.3.2 Zooplankton Taxonomic Groups

Median relative abundance of zooplankton taxa observed across all 94 samples expressed a percent and inter-quartile range (IQR) are presented in Table 3. Twenty-two taxonomic groups of zooplankton and organisms were identified across all five sampling periods (May to July 2015).

These median values reflect the associated species' typical representation in a sample; note, that these statistics do not sum to 100% across species. Copepods dominated observed zooplankton communities during all sampling periods, followed by cirripeds, decapods, gastropods, appendicularids, and euphausiids respectively; the remaining community composition was comprised of a suite of rare and variable species (defined as <1% mean relative abundance, RA) (Table 3). Taxonomic groups that appeared at less than 0.1% RA across zooplankton tows (indicating low availability as prey) were removed from Table 3: Asteroidea, Bryozoa, Mysidacea, Nemertea, Scyphozoa, Sipuncula, and unidentified terrestrial organisms.

Table 3 Median Relative Abundance (%) of Organisms in All Zooplankton Hauls (May to July 2015)

Taxon	Zooplankton Taxa (%) (Inter-quartile Range)
Crustacea–Copepoda	53.5 (50.8–76.8)
Crustacea–Cirripedia	17.9 (15.8–26.3)
Crustacea- Decapoda	2.0 (1.1–2.5)
Mollusca–Gastropoda	1.5 (1.1–2.2)
Larvacea–Appendicularia	1.2 (0.8–1.4)
Crustacea–Euphausiacea	1.1 (0.7–3.3)
Crustacea–Cladocera	0.7 (0.5–5.6)
Cnidaria (indeterminate)	0.4 (0.2–0.5)
Unidentified benthic	0.3 (0.3–0.5)
Unidentified organism	0.3 (0.2–0.4)
Crustacea (indeterminate)	0.2 (0.1–1.6)
Chaetognatha	0.2 (0.2–0.3)
Pisces (fish)	0.2 (0.0–0.3)
Polychaeta (indeterminate)	0.2 (0.1–0.4)
Ctenophora	0.2 (0.2–0.2)
Mollusca–Bivalvia	0.1 (0.1–0.2)
Echinodermata–Echinoidea	0.1 (0.1–0.1)
Polychaeta–Sedentaria	0.1 (0.0–0.3)
Crustacea–Ostracoda	0.1 (0.0–0.1)
Cnidaria–Hydrozoa	0.1 (0.0–0.1)
Echinodermata–Ophiuroidea	0.0 (0.0–0.1)
Crustacea–Isopoda	0.0 (0.0–0.1)

5.4 MARINE FISH CATCH

Eleven daytime and nine nighttime fish surveys were completed from December 2014 to August 2015 during the Program (Table 4).

Daytime and nighttime surveys completed (Table 4) a total of:

- 226 beach seines
- 151 zooplankton hauls
- 241 hydroacoustic transects
- 317 trawls
- 25 fyke net sets
- 36 purse seines
- 234 crab trap sets

A total of 46,773 individual fish and invertebrates were captured across all gear types within the study area, including 35,404 fish and 11,369 invertebrates from at least 82 identified taxa (61 fish species, 21 invertebrates) (Table 5).

Seventeen fish groups were not identified to species and accounted for 12,984 (27.8%) individual fish and invertebrates in the total captures. For example, 6,950 larval crab, 3,580 larval fish and 1,257 shrimp were captured in predominantly beach seines and trawls but not identified to the species. Larval species and some shrimp are difficult to efficiently identify during the course of field sampling and would require specimens to be retained, preserved, and later identified using genetic analysis.

Anadromous Pacific salmon smolts comprised 3.1% of the total fish caught (n = 1,099) and included 626 pink, 228 chum, 102 sockeye, 90 coho, 36 Chinook salmon and 17 Dolly Varden char. Salmon ranged in size from 30 to 46 mm for pink, 38 to 87 mm for chum, 49 to 138 mm for sockeye, 47 to 162 mm for coho, and 56 to 143 mm for Chinook salmon. Dolly Varden ranged in size from 135 to 401 mm.

Surf smelt, Pacific herring and shiner perch comprised 29.2% (n = 10,350; 20–108 mm), 17.6% (n = 6,227; 30–257 mm) and 15.9% (n = 5,637; 11–240 mm) of all fish captured respectively. Flounder and sole fish species comprised 6.5% of the fish captured.

Table 4 Fish and Fish Habitat Sample Effort (December 2014 – August 2015)

Survey Number	Effort (Days)	1 m x 1 m trawl	2 m x 2 m trawl	6 m x 5 m Otter Trawl	Hydroacoustic Passes	Beach Seine 12 m x 1.5 m	Beach seine 22 m x 3 m	Purse Seine	Fyke Net	Crab Traps	Zooplankton
Daytime-01	5	0	0	0	0	5	4	0	0	29	0
Daytime-02	5	5	0	0	5	14	4	0	0	24	0
Daytime-03	6	0	6	0	6	22	0	0	0	22	0
Daytime-04	6	0	5	0	5	22	0	0	4	22	0
Daytime-05	7	0	1	4	1	15	0	0	2	23	0
Daytime-06	6	0	9	0	10	16	6	0	3	24	0
Daytime-07	5	0	6	0	0	22	0	0	0	18	0
Daytime-08	6	0	6	3	0	20	3	0	2	18	0
Daytime-09	7	0	6	0	6	21	3	0	0	18	0
Daytime-10	4	0	6	0	6	21	3	0	0	18	0
Daytime-11	6	0	5	0	5	22	3	0	0	18	0
Nighttime-01	5	0	13	0	13	0	0	0	1	0	0
Nighttime-02	4	0	18	0	19	0	0	0	3	0	19
Nighttime-03	6	0	34	0	34	0	0	0	3	0	18
Nighttime-04	6	0	33	0	33	0	0	0	0	0	19
Nighttime-05	3	0	26	0	0	0	0	0	0	0	19
Nighttime-06	9	0	34	0	0	0	0	7	3	0	19
Nighttime-07	7	0	31	0	32	0	0	3	4	0	19
Nighttime-08	8	0	32	0	32	0	0	16	0	0	19
Nighttime-09	4	0	34	0	34	0	0	10	0	0	19
Total	**115**	**5**	**305**	**7**	**241**	**200**	**26**	**36**	**25**	**234**	**151**

Table 5 Marine Species, Number of Individuals, and Size Range Captured in All Gear Types: December 2014 to August 2015

Species		Method											Percent of Catch
		Beach Seine		Tucker Trawl		Otter Trawl	Fyke Net	Purse Seine	Crab Trap	Size Range (mm)		Total	
		12 m x 1.5 m	22 m x 3 m	1 m x 1 m	2 m x 2 m	6 m x 5 m	15 m x 1 m	50 m x 6 m		Min	Max		
Fish Species													
Bay Pipefish	*Syngnathus leptorhyncus*	10	21	0	1	0	0	0	0	106	266	32	0.09
Big Skate	*Raja binoculata*	29	1	0	3	0	1	0	0	184	370	34	0.10
Buffalo Sculpin	*Enophrys bison*	22	125	0	0	0	1	3	0	99	303	151	0.43
Cabezon	*Scorpaenicthys marmoratus*	0	0	0	0	0	0	0	2	400	450	2	0.006
Chinook Salmon	*Oncorhynchus tshawytscha*	13	11	0	11	0	0	1	0	56	143	36	0.10
Chum Salmon	*Oncorhynchus keta*	217	3	0	8	0	0	0	0	38	87	228	0.64
Coho Salmon	*Oncorhynchus kisutch*	20	16	0	41	0	0	13	0	47	162	90	0.25
Crescent Gunnel	*Pholis laeta*	188	441	0	3	0	7	1	0	39	206	640	1.81
Dolly Varden	*Salvelinus malma*	11	5	0	1	0	0	0	0	135	401	17	0.048
English Sole	*Parophrys vetelus*	394	104	0	2	0	7	0	1	32	315	508	1.44
Fish Larvae	*Chordata* spp.	326	0	1	3,123	0	0	130	0	20	75	3,580	10.1
Flatfish spp.	*Pleuronectiformes* spp.	640	43	0	66	0	14	0	2	20	330	765	2.2
Gadid spp.	*Gadidae* spp.	0	0	0	11	0	0	0	0	20	68	11	0.03
Giant Wrymouth	*Delolepis gigantea*	0	0	0	0	0	0	0	1	1,090	1,090	1	0.003
Great Sculpin	*Myoxocephalus polyacanthocephalus*	6	53	0	0	0	0	0	0	60	235	59	0.17
Gunnel spp.	*Pholidae* spp.	24	33	0	0	0	0	0	0	59	194	57	0.16
Hybrid Sole	*Soleidae* spp.	3	0	0	0	0	0	0	0	163	225	3	0.008
Kelp Greenling	*Hexagrammos decagrammus*	0	2	0	0	0	0	0	0	48	136	2	0.006
Lingcod	*Ophiodon elongatus*	0	1	0	0	0	0	0	0	92	92	1	0.003
Longfin Smelt	*Spirinchus thaleichthys*	1	0	0	4	0	0	0	0	67	93	5	0.014
Lump Sucker	*Cyclopteridae* spp.	0	0	0	1	0	0	0	0	80	80	1	0.003
Northern Spearnose Poacher	*Agonopsis vulsa*	0	0	0	3	0	0	0	0	130	161	3	0.008
Pacific Cod	*Gadus macrocephalus*	4	0	0	0	0	2	1	0	171	248	7	0.02
Pacific Herring	*Clupea pallasi*	824	59	0	435	2,205	4	2,645	0	30	257	6,172	17.4
Pacific Herring Larvae	*Clupea pallasi*	55	0	0	0	0	0	0	0	-	-	55	0.16
Pacific Lamprey	*Lampetra tridentatus*	1	1	0	16	1	0	0	0	140	233	19	0.054
Pacific Sanddab	*Citharichthys sordidus*	89	3	0	0	0	0	0	0	40	235	92	0.26
Pacific Sandfish	*Trichodon trichodon*	4	0	0	78	1	3	62	0	4	215	148	0.418
Pacific Sandlance	*Ammodytes hexapterus*	28	0	0	72	0	0	0	0	38	149	100	0.28
Pacific Snake Prickleback	*Lumpenus sagitta*	687	252	0	24	0	3	1	0	11	400	967	2.7
Pacific Staghorn Sculpin	*Leptocottus armatus*	1,173	306	0	18	0	72	0	0	20	379	1,569	4.4

Table 5 Marine Species, Number of Individuals, and Size Range Captured in All Gear Types: December 2014 to August 2015

Species		Method											Percent of Catch
		Beach Seine		Tucker Trawl		Otter Trawl	Fyke Net	Purse Seine	Crab Trap	Size Range (mm)		Total	
		12 m x 1.5 m	22 m x 3 m	1 m x 1 m	2 m x 2 m	6 m x 5 m	15 m x 1 m	50 m x 6 m		Min	Max		
Pacific Tomcod	*Microgadus proximus*	8	14	0	0	0	0	0	0	142	247	22	0.062
Penpoint Gunnel	*Apodichthys flavidus*	0	2	0	0	0	0	0	0	130	205	2	0.006
Pink Salmon	*Oncorhynchus gorbuscha*	618	0	0	8	0	0	0	0	30	46	626	1.77
Poacher spp.	*Agonidae* spp.	0	0	0	2	0	0	0	0	99	120	2	0.006
Prowfish	*Zaprora silenus*	0	0	0	1	0	0	0	0	95	95	1	0.003
Quillfish	*Ptilichthys goodei*	0	0	0	1	0	0	0	0	160	160	1	0.003
Red Irish Lord	*Hemilepidotus hemilepidoyus*	0	1	0	0	0	0	0	2	199	340	3	0.008
Rock Greenling	*Hexagrommos lagocephalus*	2	4	0	0	0	2	0	0	55	270	8	0.023
Rock Sole	*Lepidopsetta bilineata*	279	17	0	0	0	39	0	0	40	410	335	0.95
Sand Sole	*Psettichthys melanostictus*	734	66	0	1	0	5	3	1	23	425	810	2.29
Sanddab spp.	*Citharichthys* spp.	1	0	0	0	0	0	0	0	82	82	1	0.003
Sculpin spp.	*Cottoidea* spp.	477	118	0	5	0	7	0	0	1	340	607	1.71
Shiner Perch	*Cymatogaster aggregata*	3,128	2,103	0	22	0	167	217	0	11	240	5,637	15.9
Slender Dab	*Limanda* spp.	1	0	0	0	0	0	0	0	131	131	1	0.003
Slender Sole	*Lyopsetta exilis*	7	0	0	0	0	0	0	0	57	135	7	0.02
Slimy Sculpin	*Cottus cognatus*	1	0	0	0	0	0	0	0	139	139	1	0.003
Sockeye Salmon	*Oncorhynchus nerka*	20	6	0	67	1	0	8	0	49	138	102	0.29
Soft Sculpin	*Psychrolutes sigalutes*	0	0	0	5	0	0	0	0	5	45	5	0.014
Speckled Sanddab	*Citharichthys stigmaeus*	1	0	0	0	0	0	0	0	185	185	1	0.003
Spotted Snailfish	*Liparis callyodon*	0	0	0	0	0	1	0	0	116	116	1	0.003
Starry Flounder	*Platichthys stellatus*	800	103	0	48	3	5	2	1	21	511	962	2.72
Striped Surf Perch	*Embiotoca lateralis*	0	0	0	6	0	1	0	0	113	155	7	0.02
Sturgeon Poacher	*Podothecus accipenserinus*	2	0	0	0	0	0	0	0	101	125	2	0.006
Surf Smelt	*Hypomesus pretiosus*	8,413	347	0	954	56	2	578	0	20	208	10,350	29.2
Threespine Stickleback	*Gasterosteus aculeatus*	5	1	0	0	0	1	0	0	54	66	7	0.02
Tidepool Sculpin	*Oligocottus maculatus*	28	19	0	0	0	0	0	0	44	145	47	0.13
Tubesnout	*Aulorhynchus flavidus*	417	46	0	0	0	25	0	0	4	237	488	1.38
Walleye Pollock	*Gadus chalcogrammus*	0	0	0	1	0	0	1	0	134	184	2	0.006
Whitespotted Greenling	*Hexagrammos stelleri*	3	0	0	0	0	1	0	0	71	305	4	0.011
Yellowfin Flounder	*Pleuronectes ferruginea*	0	0	0	1	0	0	0	6	190	280	7	0.02
Total Fish Individuals		**19,714**	**4,327**	**1**	**5,043**	**2,267**	**370**	**3,666**	**16**	**-**	**-**	**35,404**	-

Table 5 Marine Species, Number of Individuals, and Size Range Captured in All Gear Types: December 2014 to August 2015

Species		Method											Percent of Catch
		Beach Seine		Tucker Trawl		Otter Trawl	Fyke Net	Purse Seine	Crab Trap	Size Range (mm)		Total	
		12 m x 1.5 m	22 m x 3 m	1 m x 1 m	2 m x 2 m	6 m x 5 m	15 m x 1 m	50 m x 6 m		Min	Max		
Invertebrates													
Brittle Star	*Ophiuroidea* spp.	0	0	0	1	0	0	0	0	-	-	1	0.009
Coonstripe Shrimp	*Pandalus danae*	8	0	0	0	0	0	1	0	29	85	9	0.08
Crab Larvae	*Malacostraca* spp.	0	0	0	6,945	0	0	5	0	2	20	6,950	61.1
Decorator Crab	*Majidae*	35	0	0	0	0	1	0	2	32	32	38	0.33
Dungeness Crab	*Metacarcinus magister*	97	96	0	36	0	67	3	1,836	29	221	2,135	18.8
Graceful Crab	*Metacarcinus gracilis*	1	0	0	0	0	0	0	0	53	53	1	0.009
Hermit Crab spp.	*Pagarus* spp.	4	0	0	30	0	0	0	0	-	-	34	0.3
Humpback Shrimp	*Pandalus hypsinotus*	824	0	0	0	0	0	0	0	21	44	9	0.1
Isopod spp.	*Idotea* spp.	2	0	0	9	0	0	0	0	30	30	11	7.9
Jelly spp. (Translucent)	*Medusozoa* spp.	105	0	0	722	70	0	0	0	10	30	897	0.026
Krill spp.	*Euphausiacea* spp.	0	0	0	3	0	0	0	0	-	-	3	0.12
Nereid Worm spp.	*Nereidae* spp.	0	0	0	14	0	0	0	0	7	40	14	0.009
Nudibranch spp.	*Nudibranchia* spp.	0	0	0	1	0	0	0	0	30	30	1	0.018
Polychaete Worm spp.	*Polychaeta* spp.	0	0	0	2	0	0	0	0	-	-	2	0.035
Prawn/Shrimp Larvae	*Decapoda* spp.	0	0	0	4	0	0	0	0	5	5	4	0.39
Sea Pen spp.	*Pennatulacea* spp.	0	0	0	1	0	0	0	0	-	-	1	0.009
Sea Star spp.	*Asteroidea* spp.	1	0	0	0	0	0	0	0	-	-	1	0.009
Shrimp (Crangon spp.)	*Crangon* spp.	575	130	0	491	0	18	43	0	10	72	1,257	10.7
Sidestripe Shrimp	*Pandalopsis dispar*	1	0	0	3	0	0	0	0	65	65	4	0.035
Stubby Squid	*Rossia pacifica*	0	0	0	5	0	0	0	0	2	10	5	0.044
Tanner Crab	*Chionoecetes bairdi*	0	0	0	0	0	0	0	1	78	78	1	0.009
Total Invertebrate Individuals		**829**	**226**	**0**	**8,267**	**70**	**86**	**52**	**1,839**	**-**	**-**	**11,369**	-
Total Catch (Fish and Invertebrates)		**20,543**	**4,553**	**1**	**13,310**	**2,337**	**456**	**3,718**	**1,855**	**-**	**-**	**46,773**	-

5.5 MARINE FISH

Preliminary December 2014 to August 2015 survey results for the fish distribution are presented in the following sections: (a) general spatial patterns of fish density identified from hydroacoustic surveys; and, (b) select CRA fish species size frequency distribution combined from beach seine, purse seine, trawl, and trap gear. Although only select species are discussed here, additional CRA species will be discussed in the final report.

5.5.1 Hydroacoustics Spatial Patterns

Hydroacoustic data were analyzed as depth integrated mean volume backscatter strength (MVBS) and used to examine the general spatial and temporal patterns of fish biomass density during daytime and nighttime fish surveys. The results for each survey are presented as figures shown in Appendix B (Figures B-1 to B-15) and illustrate estimated fish density, colour coded by grouped estimates of MVBS for individual 500 m sections along each of the transects surveyed during daytime and nighttime fish surveys. Example echograms are show as insets on each of the figures in Appendix B.

Note: Spatial patterns described below are preliminary and descriptive. Follow-up analyses will be undertaken to describe the patterns seen with greater statistical rigor and will be reported in 2016 when the Program is completed. The results presented in this final report will examine the patterns seen in terms of fish biomass per unit volume based on more in-depth information regarding the targets detected by use and examination of target strength (TS) from surveys when echosounder was fully functional. Hydroacoustic TS estimates will be integrated with trawl catch data for each survey, to provide a more detailed examination of fish spatial and temporal distribution.

5.5.1.1 Hydroacoustics: Daytime Fish Surveys

The results of eight daytime hydroacoustic surveys are reported here (data collected from January to July 2015). In the January 2015 survey, which had a median MVBS across all segments of -120 dB, the majority of the 500 m transect segments had a MVBS of -80 dB or less (as per Section 3.1.3, a cut off of -60 dB was chosen to allow for maximum detection of smaller fishes), with localized areas of higher densities seen in the waters just southwest off Lelu Island and north of the proposed berths (see Figure B-1).

The highest densities were observed near the northern and southern ends of Porpoise Channel, the southeast edge of Flora Bank and Smith Island near Inverness Passage (see Figure B-2 and Figure B-3). The higher densities observed in January 2015 near the southwest corner of Lelu Island, were not observed in the February 2015 survey.

Relatively higher fish densities were not observed in and near Porpoise Channel in April 2015, but higher densities were again seen near the proposed berth and on the southeast edge of Flora Bank. Relatively higher densities seen in this survey were also seen south of Kitson Island (see Figure B-4).

The median MVBS for the May 2015 daytime survey (see Figure B-5) was -80 dB, with the highest densities observed again near the proposed berth, southeast and central Flora Bank and near Kitson Island.

The highest fish densities in June were observed southwest of Kitson Island and southwest of Lelu Island and along northern margins of Flora Bank, including the previously noted area of higher density along southeast Flora Bank (see Figure B-6).

The early July 2015 daytime fish survey showed an overall MVBS of -65 dB, with the highest densities observed southwest of Kitson Island and on central Flora Bank, the northern margins of Flora Bank, including the previously noted area of higher density along southeast Flora Bank, and along the proposed berth (see Figure B-7). In late July 2015 daytime fish survey, the highest densities were observed near the proposed berth, in deep water northwest of Agnew Bank, southwest of Kitson Island, northern margins of Flora Bank, including the previously noted area of higher density along southeast Flora Bank and west of Smith Island.

5.5.1.2 Hydroacoustics: Nighttime Fish Surveys

The results of seven nighttime fish hydroacoustic surveys carried out from May to July 2015 are reported in this interim report.

Median MVBS for May 2015 surveys was -74 dB, but the spatial distribution of fish densities differed between early and mid-May 2015. The highest densities for the early May 2015 survey were seen near the proposed berth and south of Kitson Island, while for the mid-May 2015 survey the highest densities were seen on Flora Bank just west of Kitson Island (see Figures B-9 and B-10). Overall median MVBS cannot be easily compared between the May nighttime surveys and subsequent nighttime surveys since the areal coverage and number of transects per survey increased substantially from the first two surveys to later surveys from late May 2015 onwards. The median MVBS for the nighttime survey carried out in late May 2015 was -70 dB. Notable increases in density were detected ranging from the proposed berth, northeast towards Porpoise Channel, as well as the west and northwest margins of Flora Bank and west of Smith Island (see Figure B-11). High fish densities (MVBS -55 to -60 dB) were also seen on Flora Bank.

Overall median MVBS decreased slightly from the late May 2015 to early June 2015 nighttime survey (-70 and -72 dB respectively). For the early June 2015 nighttime survey, the highest densities were observed west and south of Kitson Island and on the southeastern corner of Flora Bank (see Figure B-12).

5.5.2 Hydroacoustics Temporal Patterns

Hydroacoustic data were analyzed as depth integrated mean volume backscatter strength (MVBS) and used to examine the general temporal patterns of fish biomass density during daytime and nighttime fish surveys. The results are presented as figures for each survey period, Figures B-1 through B-15, and illustrate estimated fish biomass density, colour coded by grouped estimates of MVBS for individual 500 m sections along each of the transects surveyed during daytime and nighttime fish surveys. Example echograms are show as insets on each of the figures in Appendix B.

Consistent with the spatial discussion on hydroacoustic results as shown in Figure 8, the range and median value for each 500 m segment of hydroacoustic transect surveyed and shows changes in observed fish biomass density over the entire survey area over time.

These results give no specific insight into the fish species underlying the temporal patterns observed. Follow up analyses will use target strength within hydroacoustic data to interpret the temporal and spatial patterns presented in this interim report.

Figure 8 across shows the distribution of data for each 500 m segment of hydroacoustic transect surveyed and shows changes observed in fish density across the entire study area over time. Figure 8 will be referenced in the following descriptions as showing the variation of median MVBS of sum total on the 500 m segments of the transects across the entire survey session.

5.5.2.1 Hydroacoustics: Daytime Fish Surveys

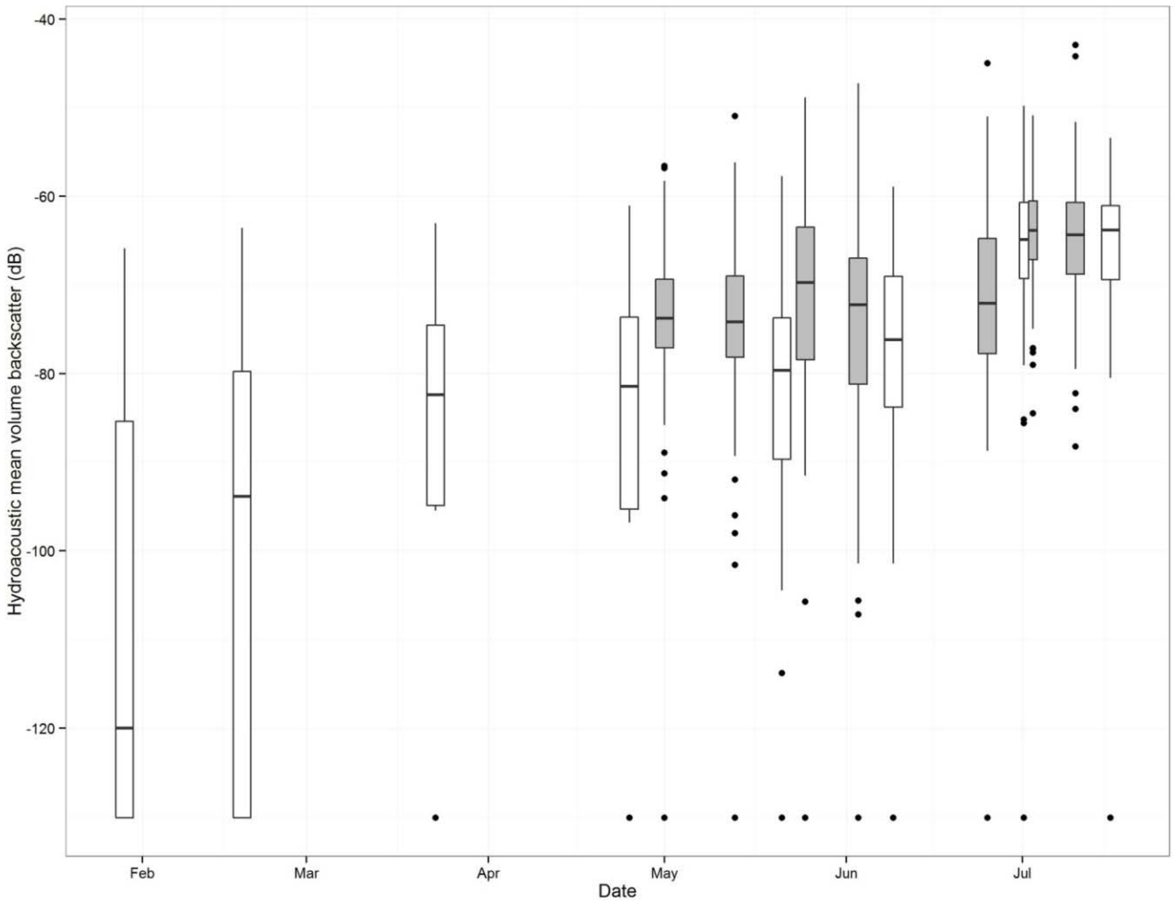
Inspection of the spatial pattern of MVBS, as well as plotting of MVBS over time, shows that overall fish densities increased over the survey period from January to July 2015 surveys (Figure 8), with the most notable increase between February and April). In the winter season (January and February, 2015) densities are relatively low increasing in the spring months of March, April and May, 2015, and then again into June and July, 2015. Spatial patterns embedded in these overall patterns of fish density increases throughout the year are described in Section 5.5.1.1.

5.5.2.2 Hydroacoustics: Nighttime Fish Surveys

For the nighttime surveys, the temporal record is not as long, but the pattern of increasing fish densities over the course of the sampling period is similar to that observed in the daytime surveys, with densities becoming notably higher in July, 2015. Spatial patterns embedded in these overall patterns of fish density increases throughout the year are described in Section 5.5.1.2.

Due to the need for hydroacoustic instrument repairs, the next nighttime survey was not conducted until late June 2015. Median MVBS for late June 2015 was -72 dB, the same as the survey conducted in late May 2015; however, the pattern of density distribution was different, with higher densities reported on Flora Bank in the late June 2015 survey as compared to the survey in late May 2015 (see Figure B-13).

The median MVBS for both the nighttime surveys carried out in early and mid-July 2015 was -64 dB, which showed an increase in fish biomass density from the -72 dB median MVBS observed in late June 2015. Increased density was noted across the entire study area from June to July 2015. For the early July 2015 survey, the highest densities were seen on and to the west of Flora Bank (see Figure B-14). A similar pattern of distribution of fish densities were seen in mid-July 2015 survey, except density increases noted near Smith Island, at the site of the proposed berth in the deep water northwest of Agnew Bank (see Figure B-15).



NOTE: White boxes denote daytime surveys and grey boxes indicate nighttime surveys. Each individual box plot represents the interquartile range (IQR) and median of each of the MVBS for each 500 m segment of hydroacoustic transect. Lower and upper limits of the box = IQR (i.e., the 25th and 75th percentiles respectively); solid horizontal lines = median; vertical lines ('whiskers') = IQR ± 1.5 * IQR. Points shown fall beyond these whiskers and are outliers.

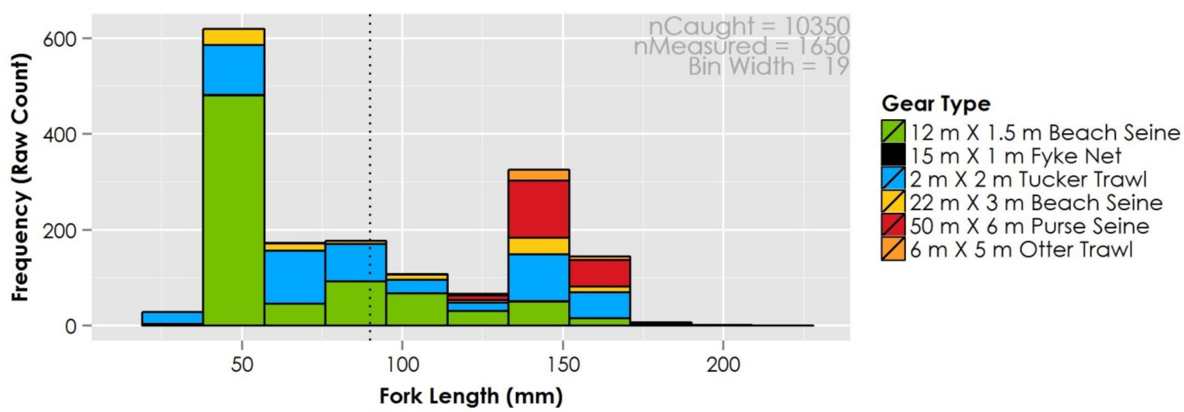
Figure 8 Depth Integrated Mean Volume Backscatter Strength (MVBS) per 500 m Segment

5.5.3 Select Fish Species

Catch data collected for select fish species, including salmon, Pacific herring, surf smelt, fish larvae and Dungeness crab, from December 2014 to August 2015 are presented below to examine the size frequency distribution of fauna occurring in the survey area. Data from all gear types were combined to generate the size frequency distributions (see Table 5 for more details on catch by gear type). Daytime and nighttime survey data are presented separately, with the total number of individuals caught, measured, and bin width shown on each figure.

5.5.3.1 Surf Smelt

Surf smelt were the most abundant fish species caught (n = 10,350), comprising approximately 29% of the total fish catch. Surf smelt caught ranged in size (fork length) from 20 mm to 208 mm (n = 1,650) (Figure 9). Based on established life-history characteristics, two distinct life-history stages (immature and sexually mature fish, where length at 50% maturity = 90 mm; see dotted vertical line in Figure 9; FishBase 2015c) were observed in the survey area. Surf smelt were sampled by most gear types but were caught in the highest number using beach seine gear (Figure 9 and Table 5).

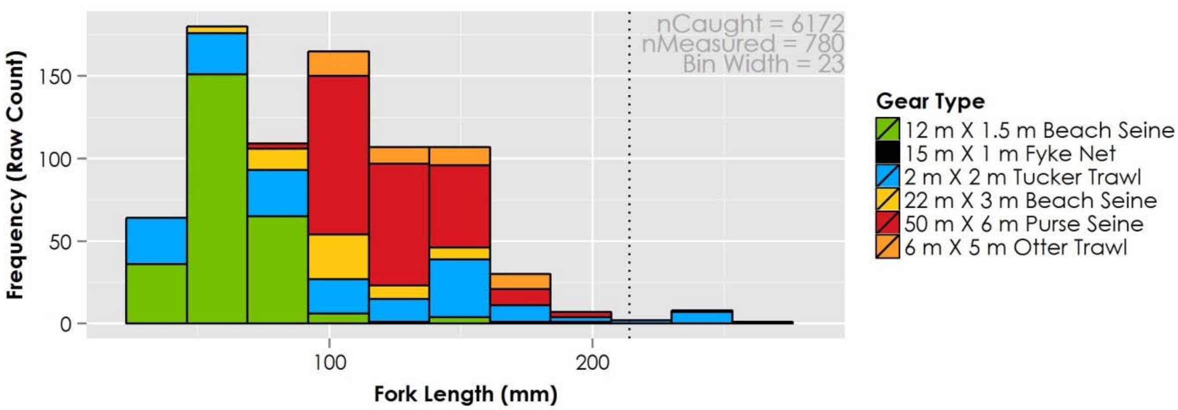


NOTE: Dotted vertical line shows size at 50% maturity

Figure 9 Length Frequency for Surf Smelt Caught Using All Gear Types

5.5.3.2 Pacific Herring

Pacific Herring were the second most abundant fish species caught (n = 6,172), and comprised approximately 17% of the total fish catch. Pacific herring ranged in size (fork length) from 30 mm to 257 mm (n = 780) (Note: Dotted vertical line shows size at 50% maturity, Figure 10). Based on established life history characteristics, at least two life history stages of Pacific herring were caught, including sexually mature and immature fish (length at 50% maturity = 214 mm; dotted line in Figure 10) (Lassuy and Moran 1989; FishBase 2015b); however, relatively few mature herring were caught in the survey area. Pacific herring were sampled by most gear types but were caught in the highest numbers using purse and beach seines (Figure 10 and Table 5).



NOTE: Dotted vertical line shows size at 50% maturity

Figure 10 Length Frequency for Pacific Herring Caught Using All Gear Types

5.5.3.3 Fish Larvae

Fish larvae were the fourth most abundant fish group caught (n = 3,580), and comprised approximately 10% of the total fish catch (by numerical abundance). Larval fish ranged in size (fork length) from 20 mm to 75 mm (n = 45). Larval fish captured that were less than 40 mm in size were translucent and often indistinct as vertebrate fish species. Consequently, most could not be identified to species in the field; however, one sample of larvae collected in June was sent to a laboratory for species identification. These results indicate three species were present in the June 2015 sample including: surf smelt (n = 46; size range [total length] 20 mm to 31 mm), Pacific herring (n = 10; size range [total length] 16 mm to 31 mm), and one prickly sculpin (total length = 10 mm). Fish larvae were sampled by most gear types but were caught in the highest number using trawl gear (Figure 11 and Table 5).

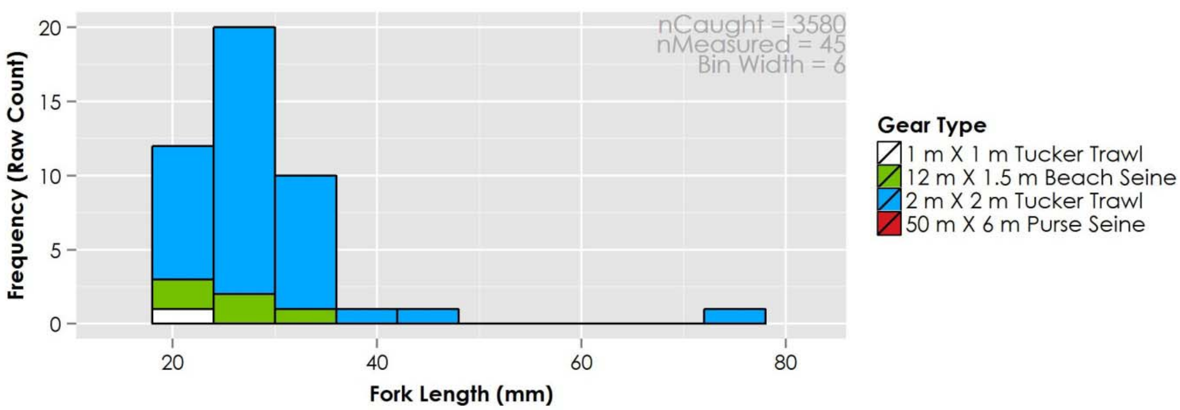


Figure 11 Length Frequency for Fish Larvae Caught Using All Gear Types

5.5.3.4 Pink Salmon

Pink salmon were the most commonly caught salmon species (n = 626) and comprised approximately 1.7% of the total fish catch. Pink salmon ranged in size (fork length) from 30 mm to 46 mm (n = 127), but most were 40 mm or less. Considering salmon size and location where they were caught (suggesting the onset of characteristic downstream migration behaviour), these fish are all considered salmon smolts (McPhail 2007; Quinn 2005). Pinks were caught in the highest number using beach seine gear (Figure 12 and Table 5).

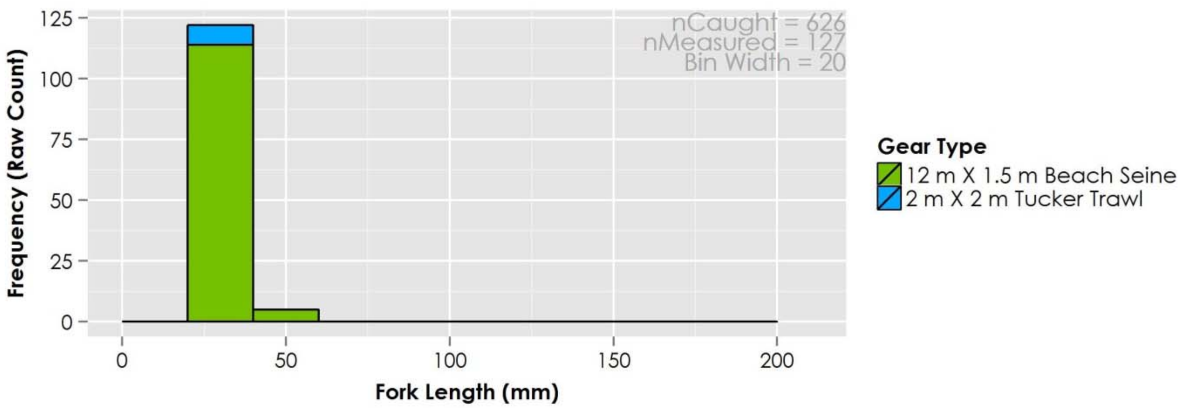


Figure 12 Length Frequency for Pink Salmon Caught Using All Gear Types

5.5.3.5 Chum Salmon

Chum salmon were the second most commonly caught salmon species (n = 228) and comprised approximately 0.6% of the total fish catch. Chum salmon ranged in size (fork length) from 38 mm to 87 mm (n = 136), but most were smaller than 60 mm. Considering salmon size and location where they were caught (suggesting the onset of characteristic downstream migration behaviour), these fish are all considered salmon smolts (FishBase 2015a; Lamb and Edgell 2010; McPhail 2007; Quinn 2005). Chum salmon were sampled by several gear types but were caught in the highest number using beach seine gear (Figure 13 and Table 5).

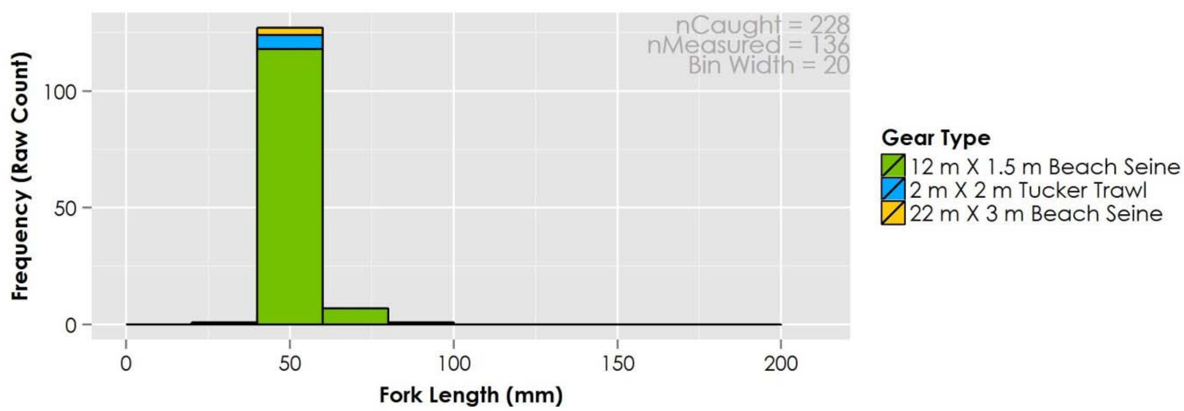


Figure 13 Length Frequency for Chum Salmon Caught Using All Gear Types

5.5.3.6 Sockeye Salmon

Sockeye salmon were the third most commonly caught salmon species (n = 102), and comprised approximately 0.3% of the total fish catch. Sockeye salmon ranged in size (fork length) from 49 mm to 138 mm (n = 98), with most being 80 to 100 mm. Considering salmon size and location where they were caught (suggesting the onset of characteristic downstream migration behaviour), these fish are all considered salmon smolts (McPhail 2007; Quinn 2005). Sockeye salmon were sampled by most gear types but were caught in the highest number using trawl gear (Figure 14 and Table 5).

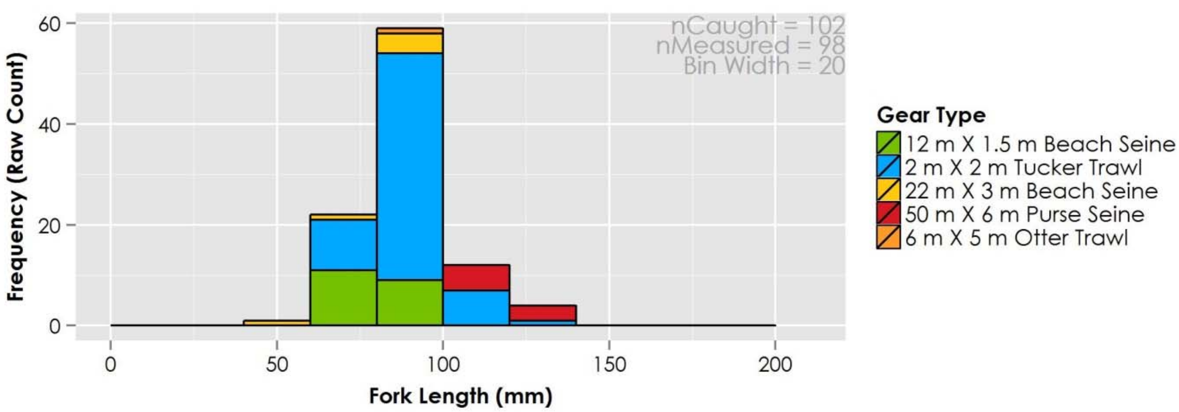
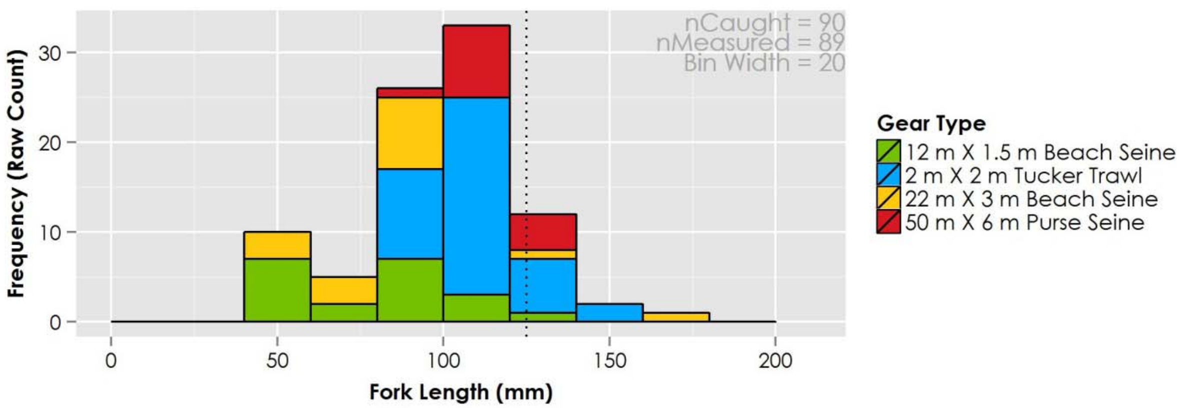


Figure 14 Length Frequency for Sockeye Salmon Caught Using All Gear Types

5.5.3.7 Coho Salmon

Coho salmon were the fourth most commonly caught salmon species (n = 90), and comprised less than 0.3% of the total fish catch). Coho salmon ranged in size (fork length) from 47 mm to 162 mm (n = 89), but most were smaller than 120 mm. Considering salmon size and location where they were caught (suggesting the onset of characteristic downstream migration behaviour), these fish are all are considered salmon smolts (McPhail 2007; Quinn 2005). However, a second life history stage (yearling smolts, ranging in size [fork length] from 100 mm to 150 mm), may have also been caught (the vertical dotted line draw at 125 mm in Figure 15 indicates the median threshold for one year smolts; McPhail 2007; Quinn 2005). Coho salmon were sampled by most gear types but were caught in the highest number using trawl gear (Figure 15 and Table 5).

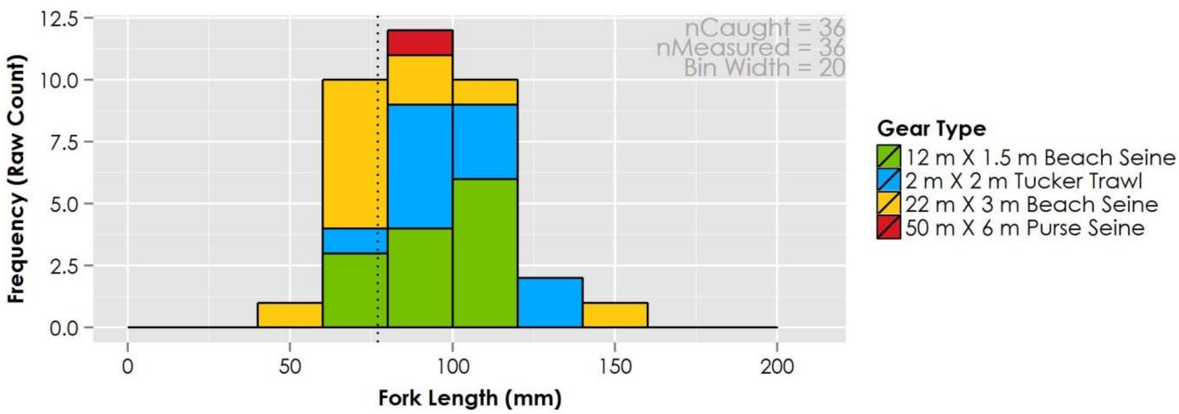


NOTE: The vertical dotted line indicates the median threshold for one year smolts.

Figure 15 Length Frequency for Coho Salmon Caught Using All Gear Types

5.5.3.8 Chinook Salmon

Chinook salmon were the least abundant salmon species in catches (n = 36), and comprised approximately 0.1% of the total fish catch). Chinook salmon ranged in size (fork length) from 56 mm to 143 mm (n = 36), but most were smaller than 120 mm. Considering salmon size and location where they were caught (suggesting the onset of characteristic downstream migration behaviour), most of these fish are all are considered salmon smolts. However, a second life history stage (yearling smolts, ranging in size [fork length] from 45 mm to 110 mm), was also caught (see dotted line in Figure 16 at 77 mm indicating median threshold for one year smolts; McPhail 2007; Quinn 2005). Chinook salmon were sampled approximately evenly by beach seine and trawl gear (Figure 16 and Table 5).

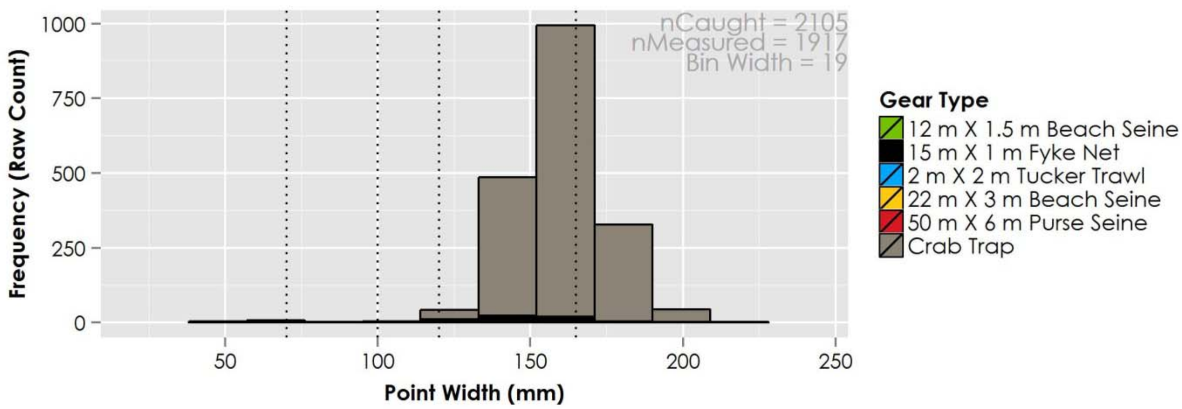


NOTE The vertical dotted line indicates the median threshold for one year smolts.

Figure 16 Length Frequency for Chinook Salmon Caught Using All Gear Types

5.5.3.9 Dungeness Crab

Dungeness crab were the second most abundant invertebrate species caught (n = 2,106), and comprised approximately 18% of the total invertebrate catch). Dungeness crab ranged in size (point width) from 29 mm to 221 mm (n = 1,918), but most were between 152 mm to 171 mm (i.e., the tallest single bin) (Figure 17). Based on established life history characteristics, multiple life history stages of Dungeness crab were caught. These included juveniles (< 70 mm; see dotted lines), sub-adults (> 70 but < than 100 or 120 mm for females and males respectively), and mature individuals (> 100 or 120 for females and males respectively (Dunham, et al. 2011). A vertical dotted line at 165 mm shows the legal size limit for male Dungeness crabs. Dungeness crab were caught in the highest number using trap gear (Figure 17 and Table 5).



NOTE: Dotted vertical lines represent (from left to right) size at transition to subadult, subadult female, subadult male, and legal catch size limit for males.

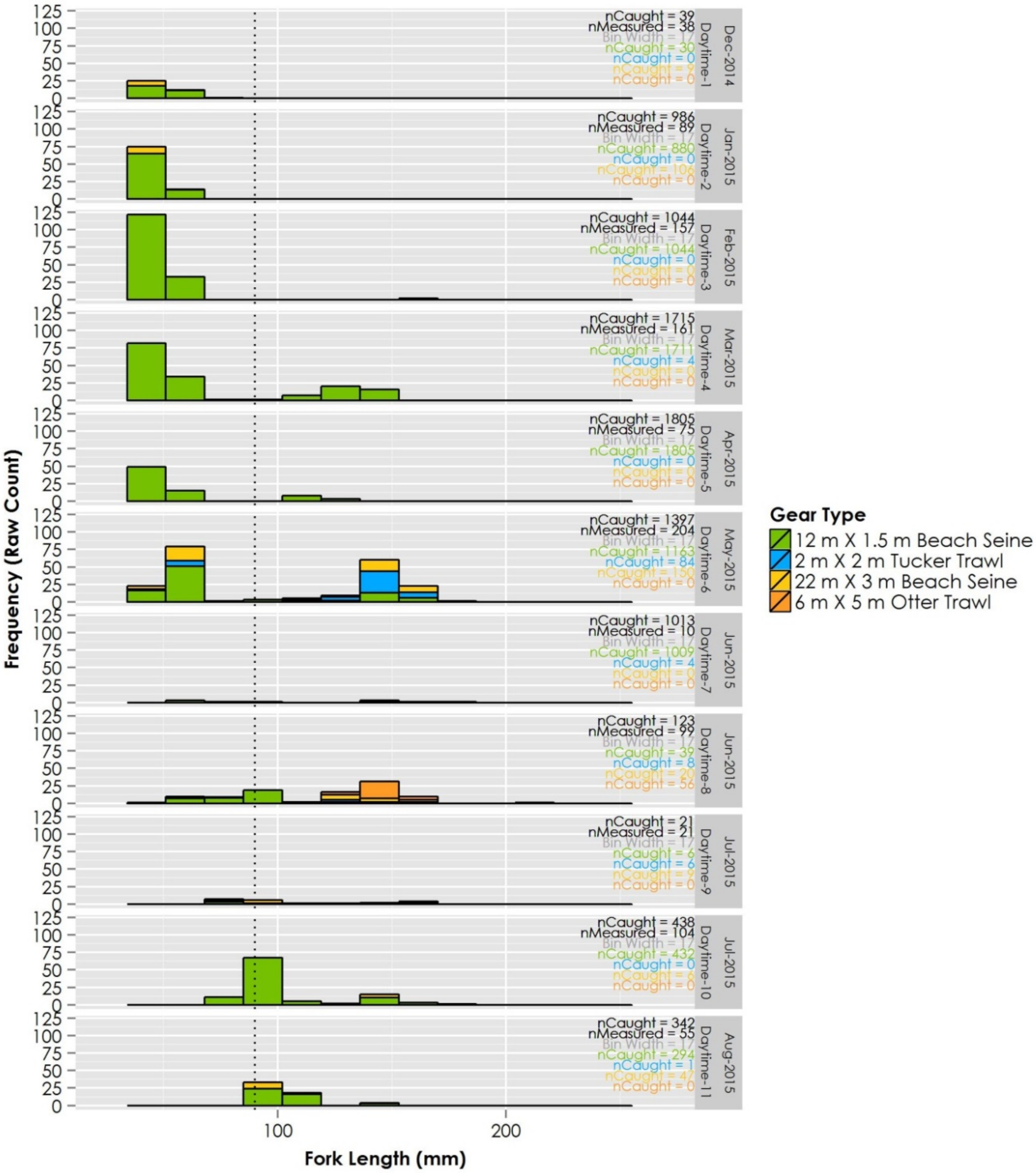
Figure 17 Length Frequency for Dungeness Crab Caught Using All Gear Types

5.5.4 Select Fish Species Temporal Distribution

Catch data collected for select fish species, including salmon, Pacific herring, surf smelt, fish larvae and Dungeness crab, from December 2014 to August 2015 are presented to examine the size frequency distribution of fauna occurring in the survey area over time. Data from all gear types were combined to generate the size frequency distributions (see Table 5 for more details on catch by gear type). Daytime and nighttime survey data are presented separately, with the total number of individuals caught, measured, and bin width shown on each figure.

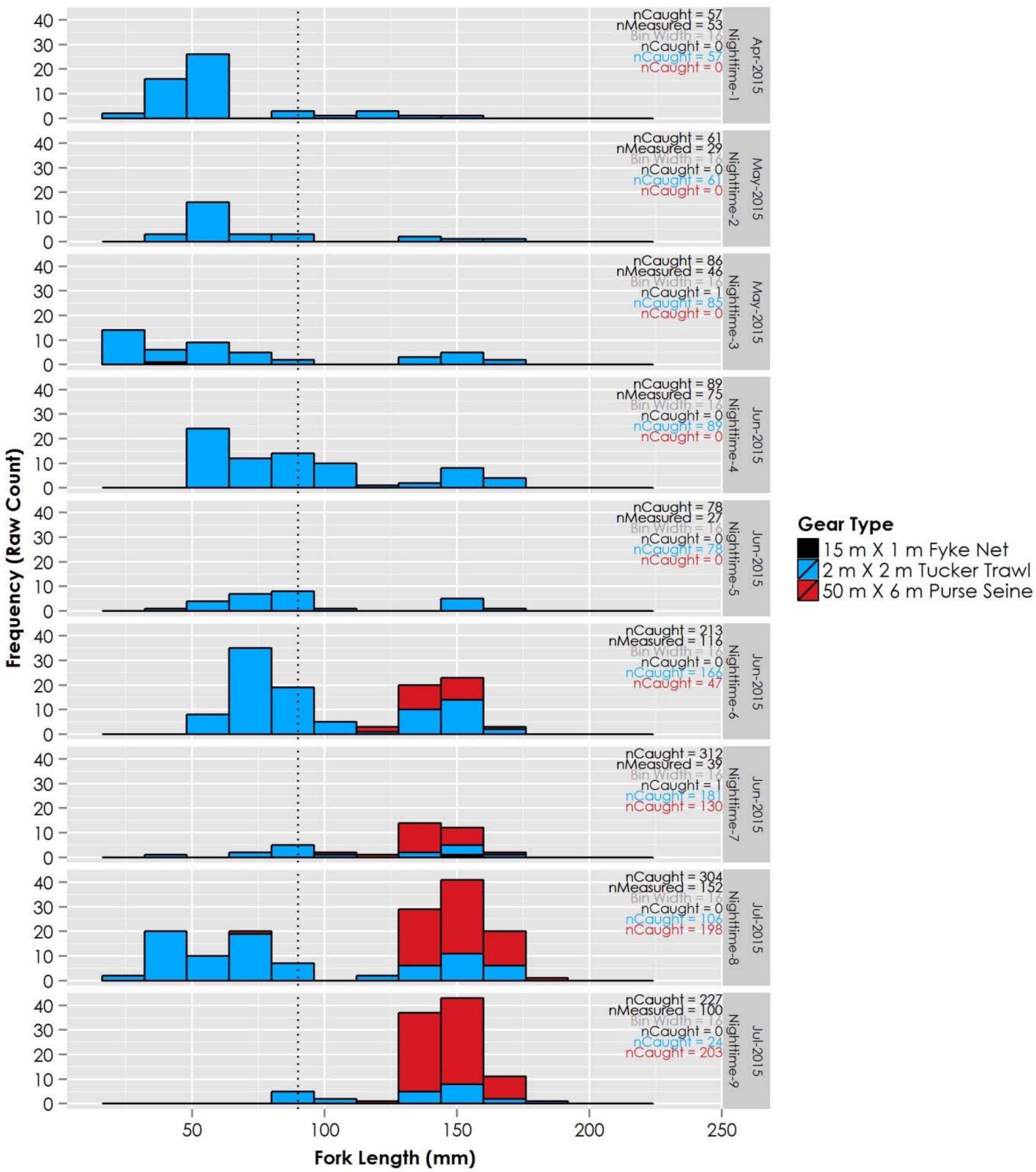
5.5.4.1 Surf Smelt

Surf smelt were caught during every survey and were present in the survey area from December 2014 through August 2015. Larger surf smelt were caught in higher numbers during summer months. Based on established life history characteristics, two distinct life history stages (immature and sexually mature fish: length at 50%maturity = 90 mm; FishBase 2015c) were detected and present in the survey area throughout the duration of surveys (Figure 18 and Figure 19).



NOTE: Annotations show the total number of fish caught and measured (black text), histogram bin width (mm; grey text), and number of fish caught for each gear type (coloured text). Dotted vertical line shows size at 50% maturity.

Figure 18 Daytime Length Frequency for Surf Smelt Caught Using All Gear Types

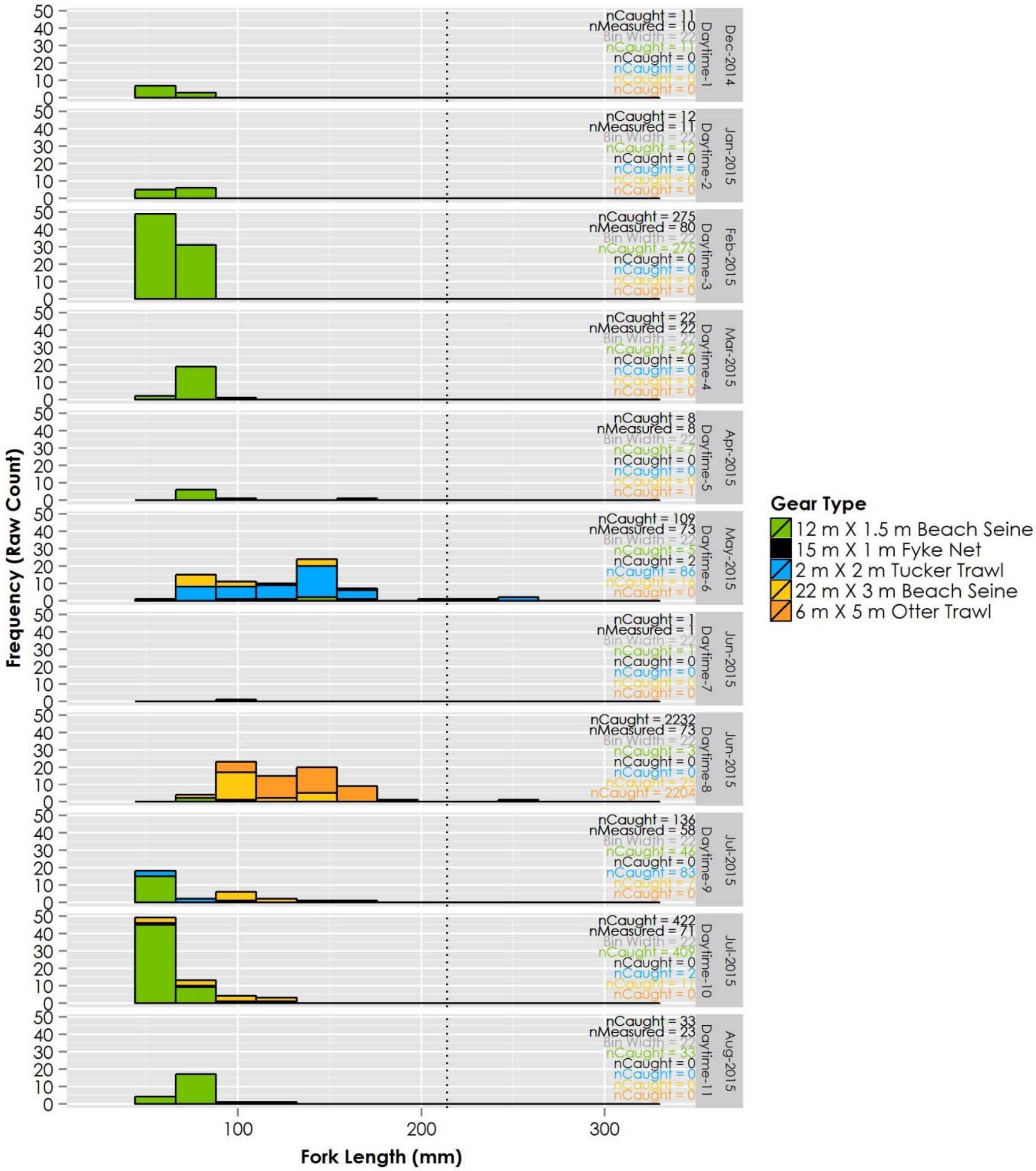


NOTE: Annotations show the total number of fish caught and measured (black text), histogram bin width (mm; grey text), and number of fish caught for each gear type (coloured text). Dotted vertical line shows size at 50% maturity

Figure 19 Nighttime Length Frequency for Surf Smelt Caught Using All Gear Types

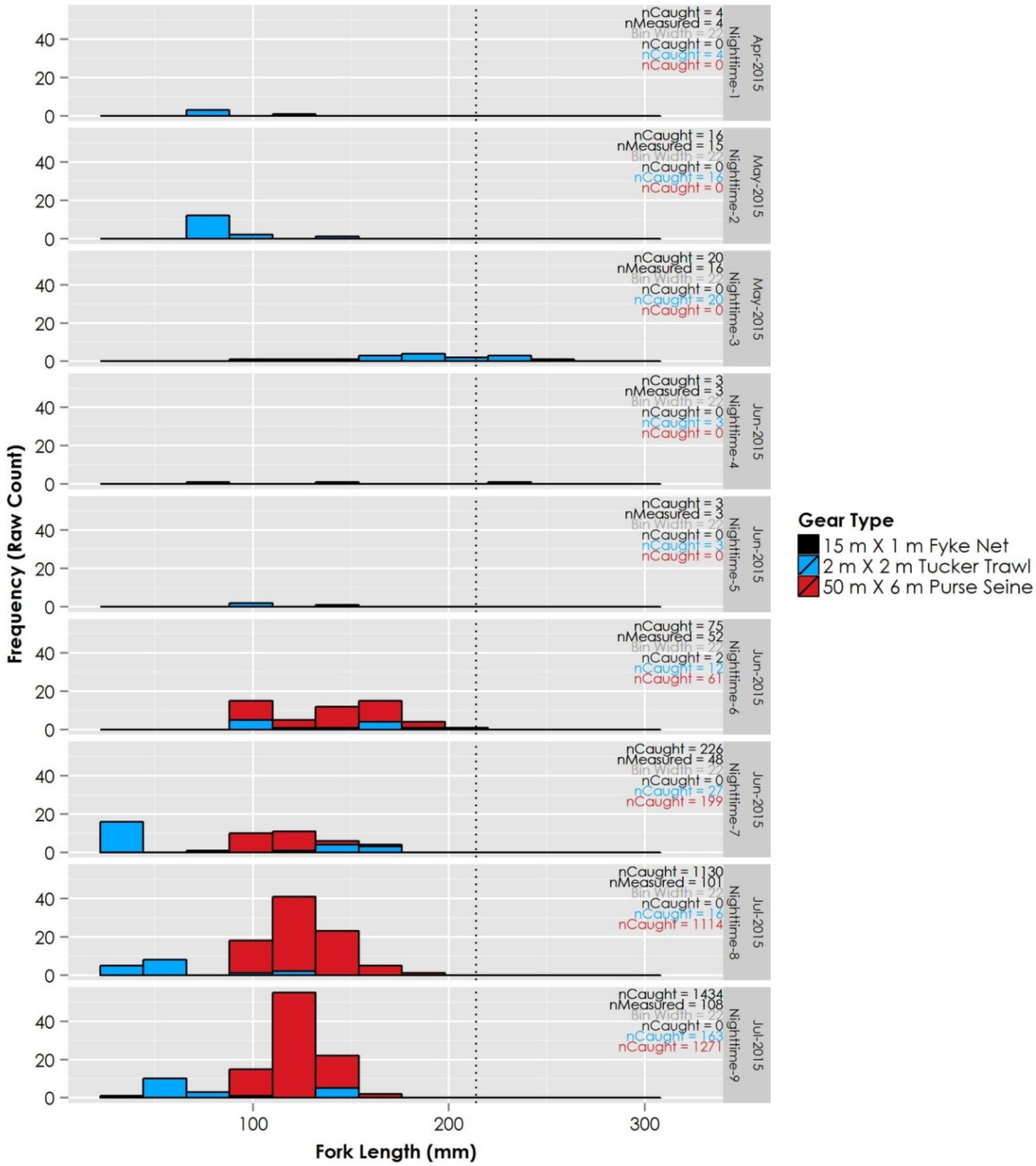
5.5.4.2 Pacific Herring

Pacific herring were caught during every survey and were present in the survey area from December 2014 through August 2015 (Figure 20 and Figure 21). Based on established life history characteristics, multiple life history stages of Pacific herring were caught, including sexually mature and immature fish (length at 50% maturity = 214 mm) (Lassuy and Moran 1989; FishBase 2015b), with sexually mature individuals caught predominantly during summer months. It is unclear whether or not larger, potentially reproductive adults, are present in the survey area year round.



NOTE: Annotations show the total number of fish caught and measured (black text), histogram bin width (mm; grey text), and number of fish caught for each gear type (coloured text). Dotted vertical line shows size at 50% maturity

Figure 20 Daytime Length Frequency for Pacific Herring Caught Using All Gear Types

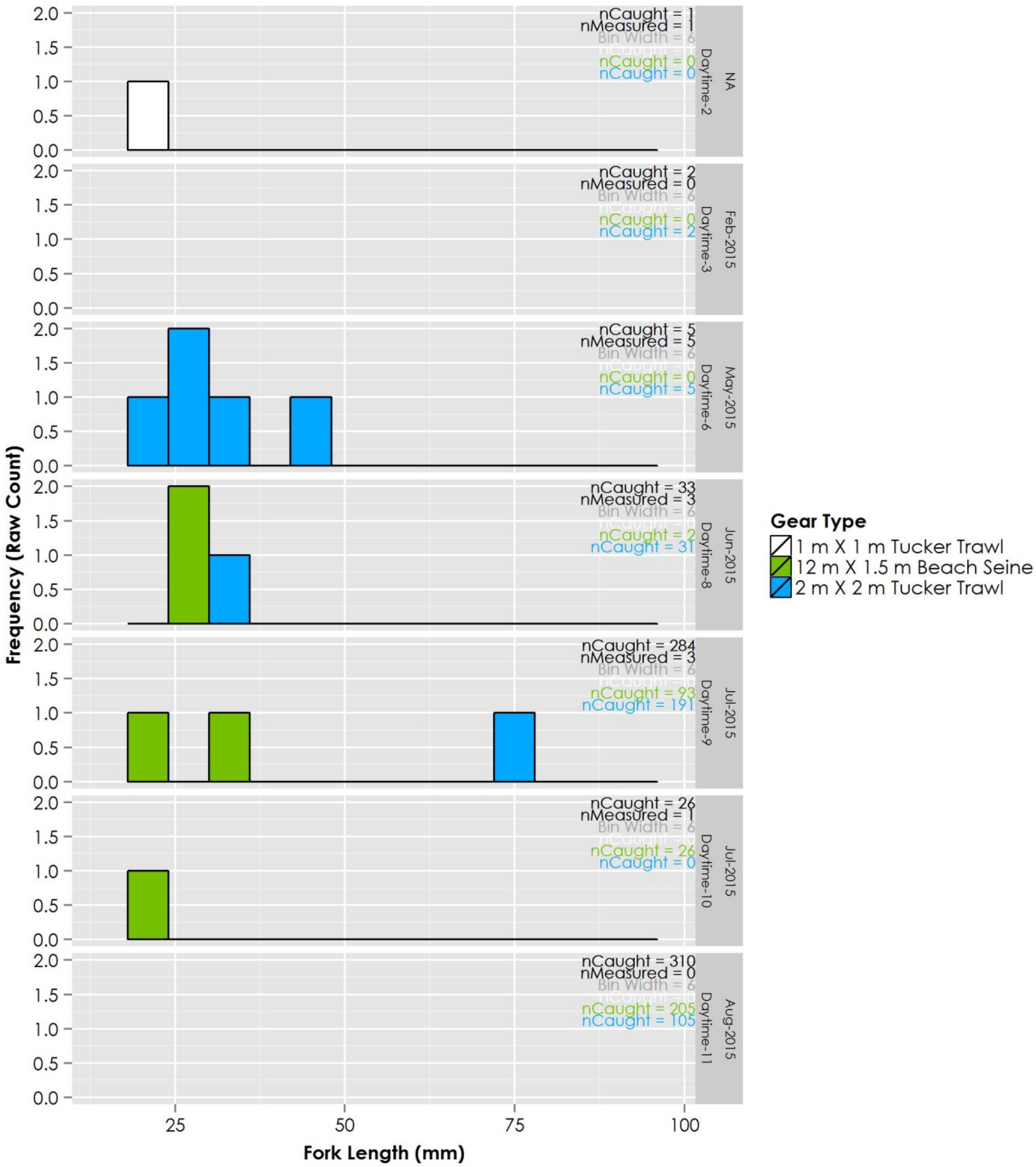


NOTE: Annotations show the total number of fish caught and measured (black text), histogram bin width (mm; grey text), and number of fish caught for each gear type (coloured text). Dotted vertical line shows size at 50% maturity

Figure 21 Nighttime Length Frequency for Pacific Herring Caught Using All Gear Types

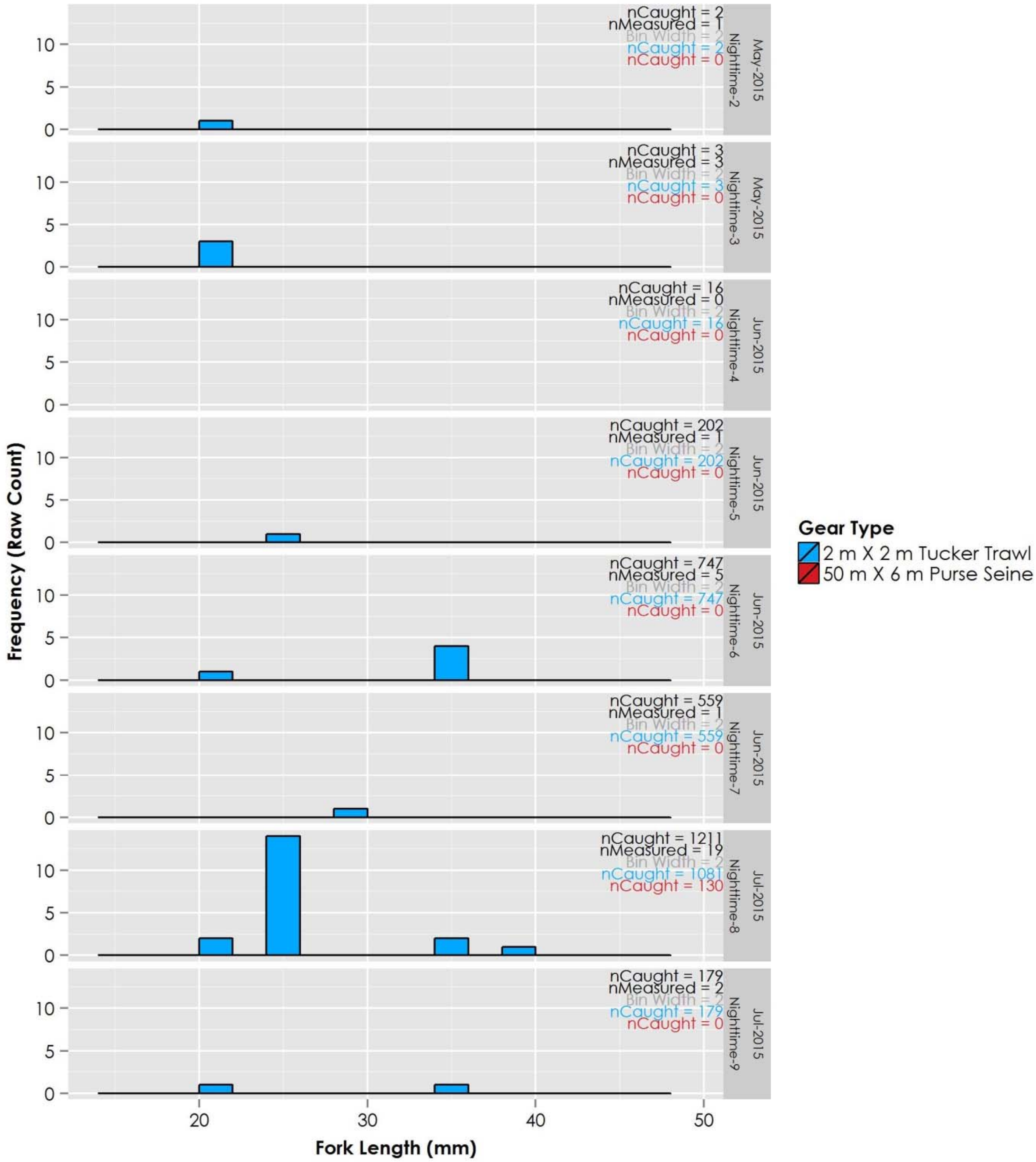
5.5.4.3 Fish Larvae

Fish larvae were caught during multiple surveys between December 2014 and August 2015, but were caught in highest numbers during summer months and at night (Figure 22 and Figure 23). Taxonomic analysis indicated three fish species in the representative sample collected in June, 2015 (see Section 5.5.3.3), but it is possible other larval fish are also present in the survey area.



NOTE: Annotations show the total number of fish caught and measured (black text), histogram bin width (mm; grey text), and number of fish caught for each gear type (coloured text).

Figure 22 Daytime Length Frequency for Fish Larvae Caught Using All Gear Types



NOTE: Annotations show the total number of fish caught and measured (black text), histogram bin width (mm; grey text), and number of fish caught for each gear type (coloured text).

Figure 23 Nighttime Length Frequency for Fish Larvae Caught Using All Gear Types

5.5.4.4 Salmon Species

Pink salmon, and to a lesser extent chum salmon, had the highest relative abundance in catches compared to other species of salmon over December 2014 to August 2015 daytime and nighttime surveys (Figure 24). This pattern was largely driven by large beach seine catches of both salmon species in April 2015 in nearshore areas. Pink salmon were not caught beyond May 2015, while chum salmon were not seen after June 2015. Sockeye salmon were observed May through July 2015, while Chinook salmon and coho salmon were caught from May through August 2015.

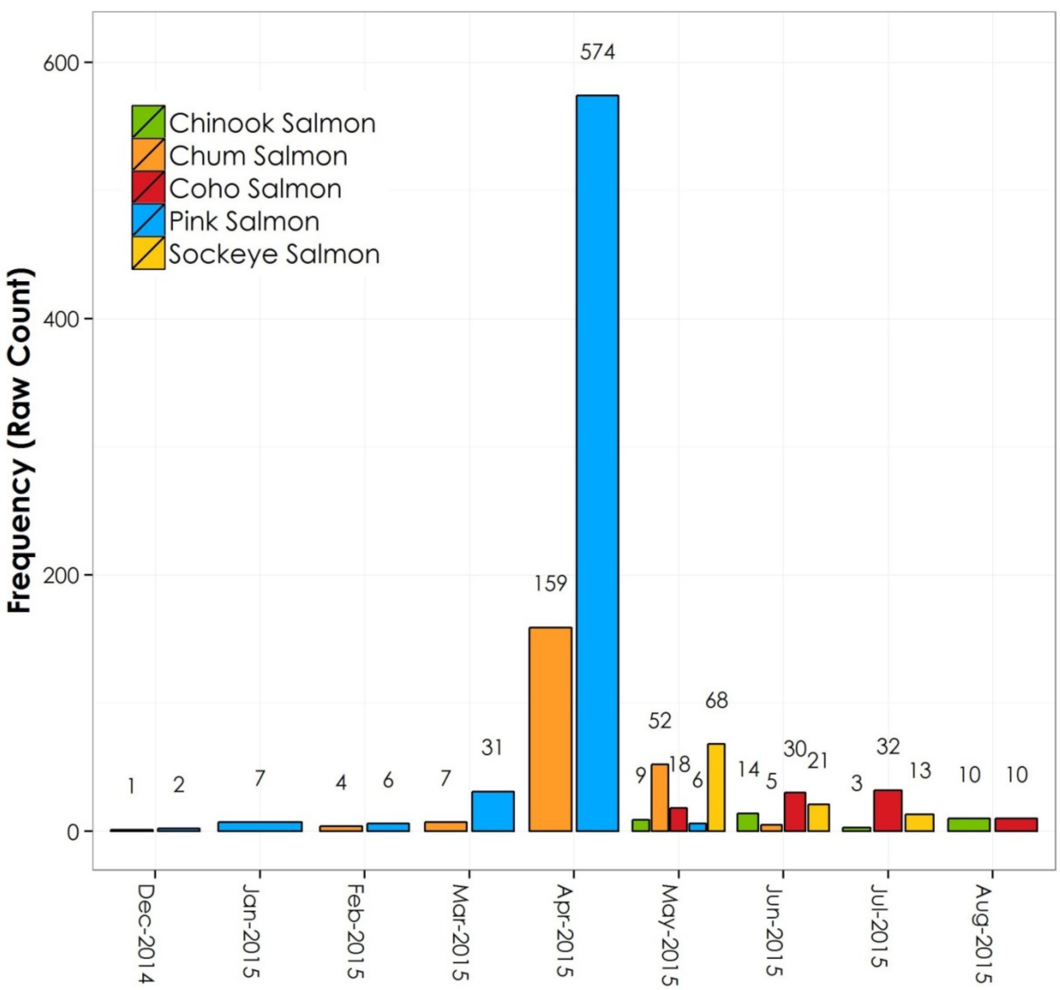
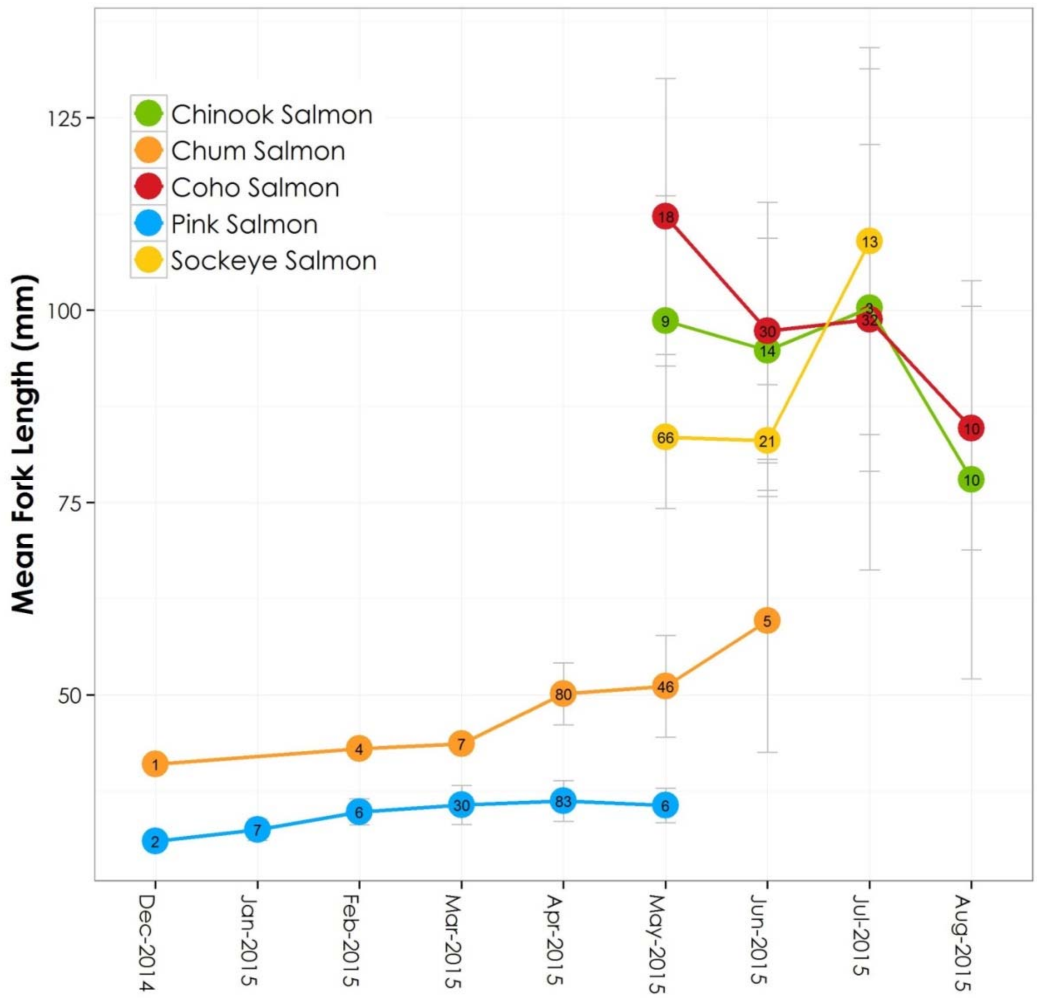


Figure 24 Salmon Catches Using All Gear Types Daytime and Nighttime (December 2014 to August 2015)

Pink and chum salmon, while being the most frequent species caught, had the lowest observed sizes compared to other species of salmon over December 2014 to August 2015 daytime and nighttime surveys (Figure 25). Coho, Chinook and sockeye salmon had greater sizes, but occurred in the study area later in the season. Sizes of salmon captured varied greatly over the extent of the completed surveys. Pink and chum salmon showed an increase in size during the spring. No distinct trend in size was observed for coho, Chinook and sockeye salmon based on low numbers captured and over large variation in sizes.

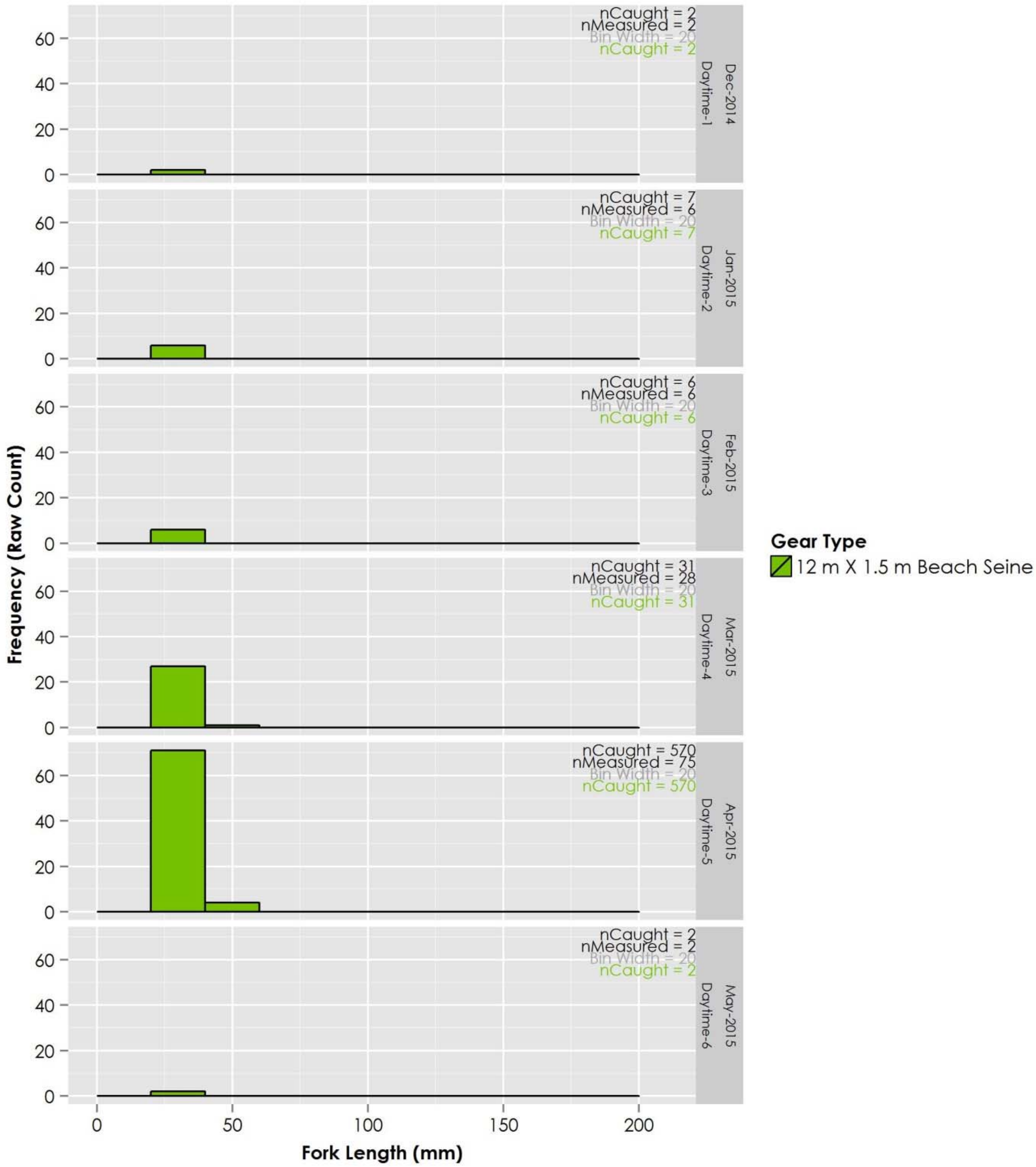


NOTE: Numbers in the points indicate sample size.

Figure 25 Mean Salmon Fork Length Using All Gear Types Daytime and Nighttime (December 2014 to August 2015), numbers in dots represent sample sizes

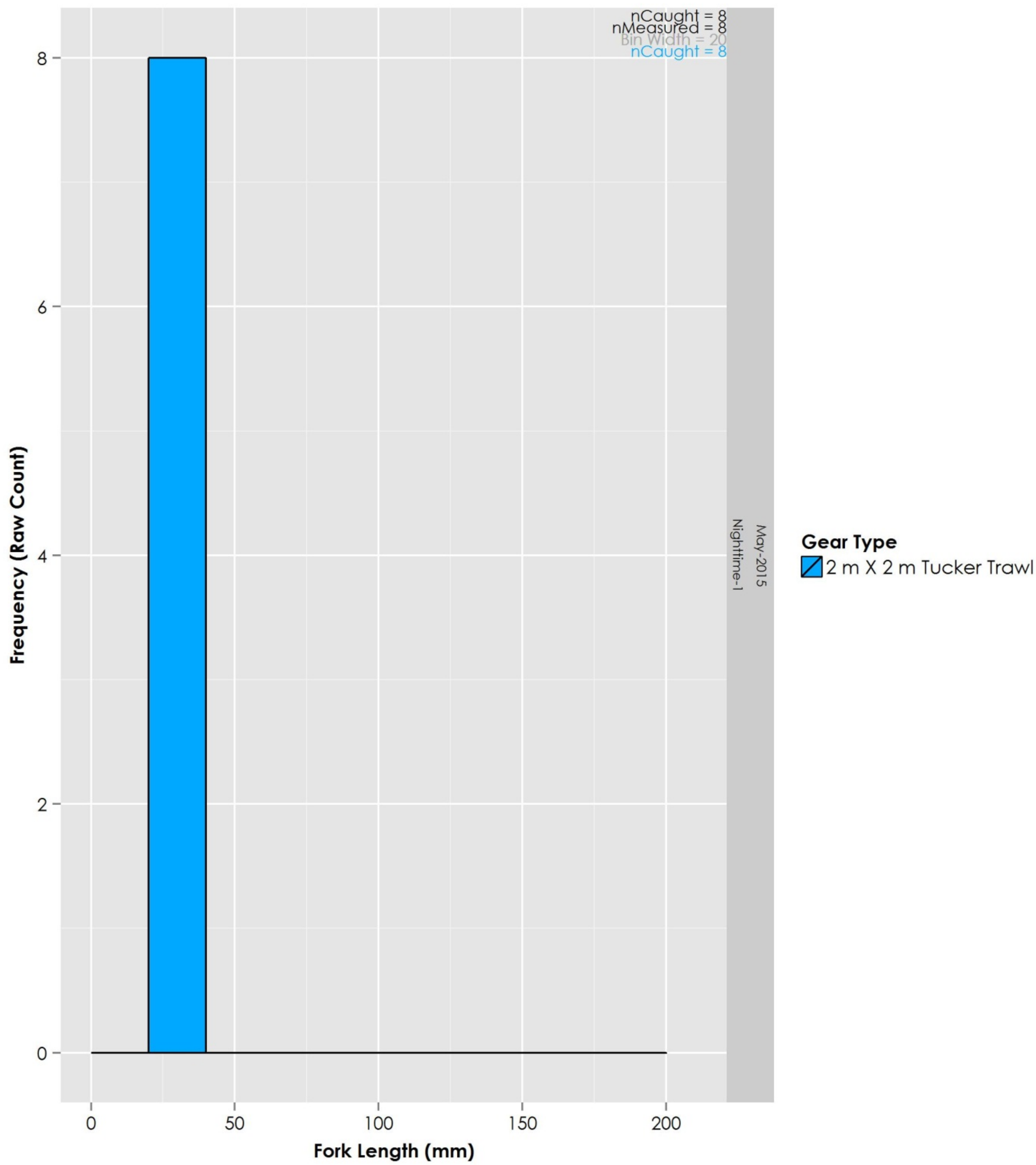
5.5.4.5 Pink Salmon

Pink salmon were caught from December 2014 through to May 2015, and were caught in highest numbers in March and April (Figure 26 and Figure 27). Across all sampling periods, fish ranged in size (fork length) from 20 mm to 40 mm, with a few pink salmon being upwards of 50 to 60 mm. Considering salmon size and location where they were caught (suggesting the onset of characteristic downstream migration behaviour), these fish are all are considered salmon smolts (McPhail 2007; Quinn 2005). Pink salmon smolts were not caught in daytime or nighttime fish surveys after May 2015.



NOTE: Annotations show the total number of fish caught and measured (black text), histogram bin width (mm; grey text), and number of fish caught for each gear type (coloured text).

Figure 26 Daytime Length Frequency for Pink Salmon Caught Using All Gear Types

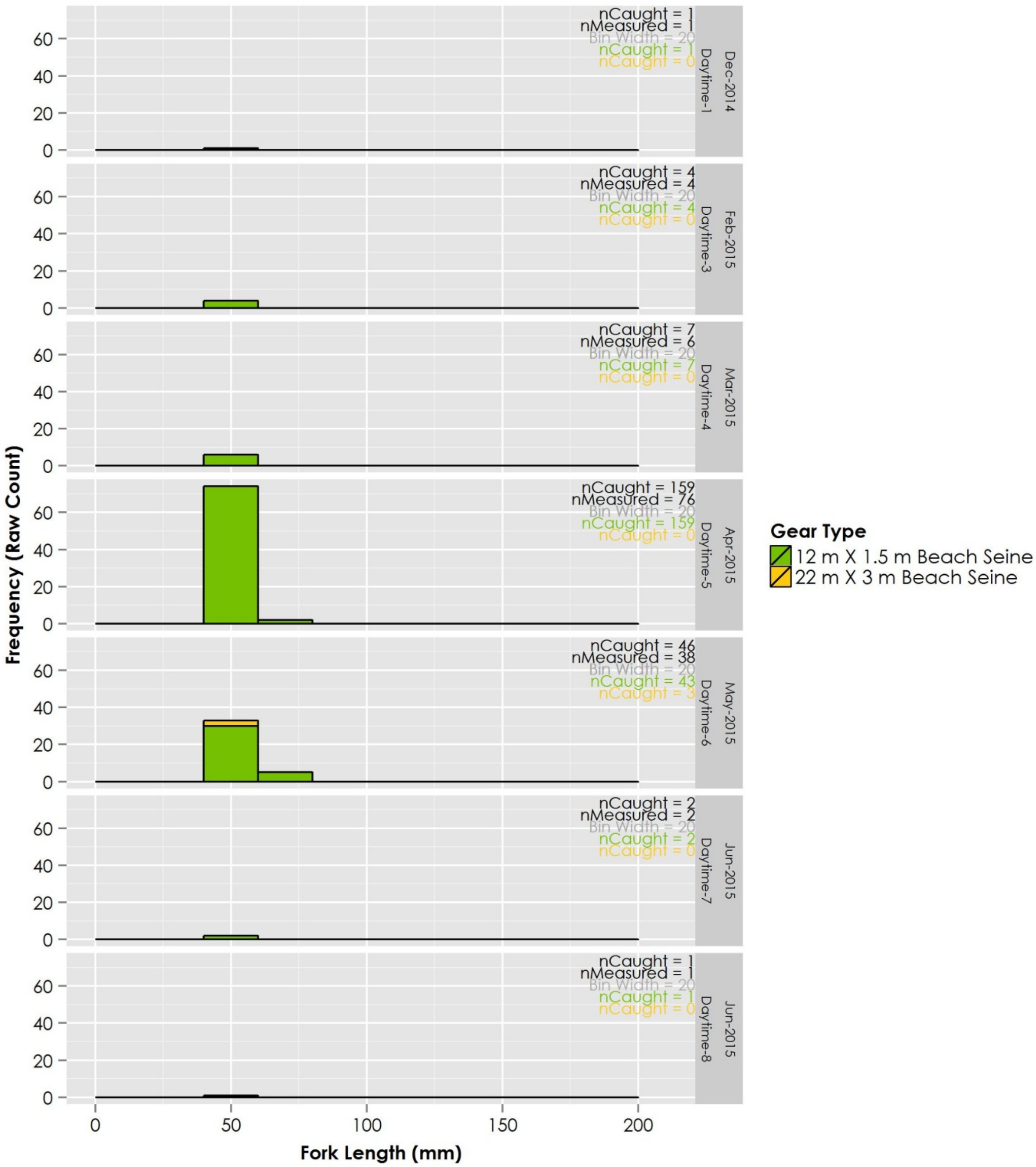


NOTE Annotations show the total number of fish caught and measured (black text), histogram bin width (mm; grey text), and number of fish caught for each gear type (coloured text).

Figure 27 Nighttime Length Frequency for Pink Salmon Caught Using All Gear Types

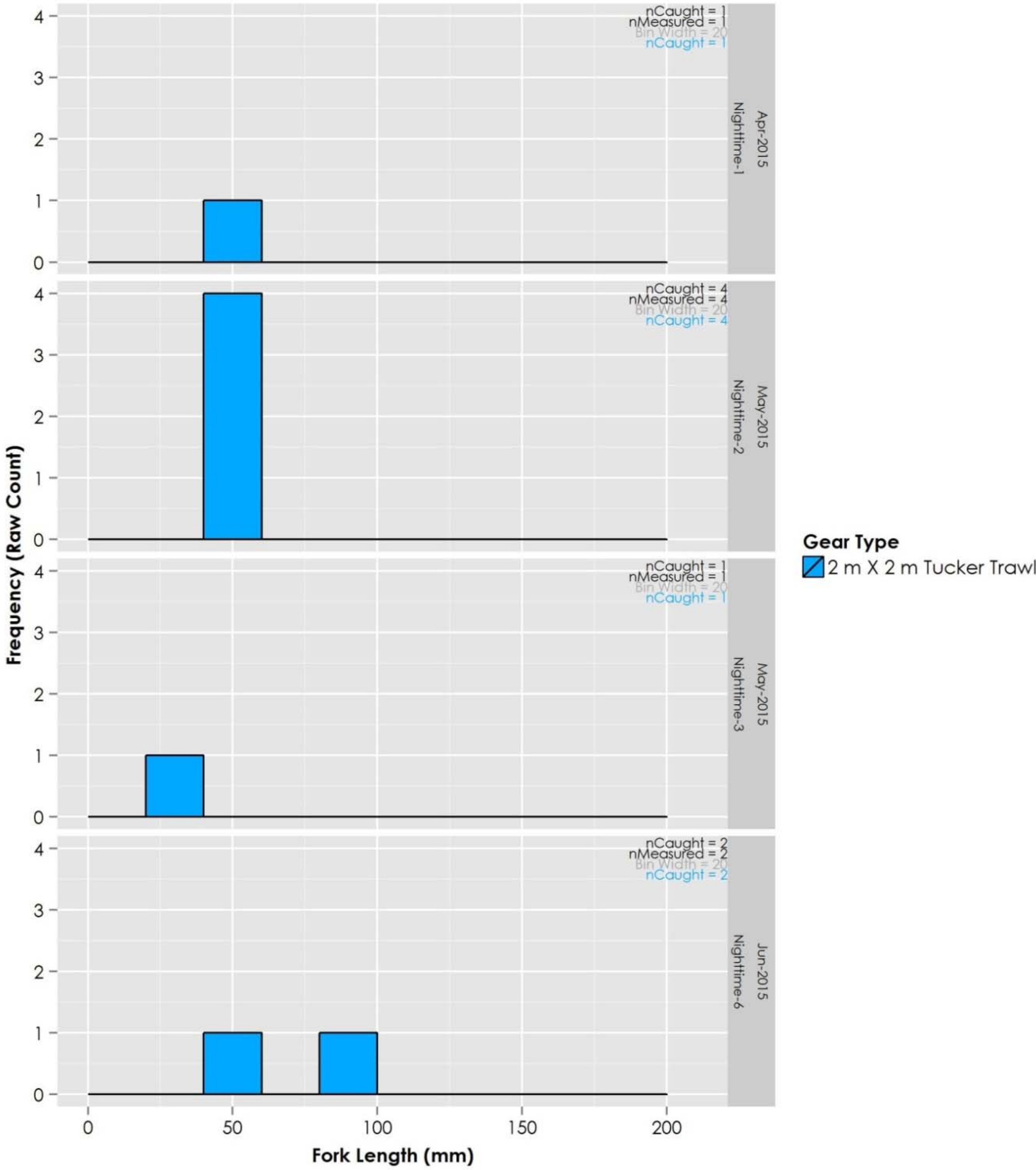
5.5.4.6 Chum Salmon

Chum salmon were caught from December 2014 through to June 2015, and in highest numbers in April and May (Figure 28 and Figure 29). Chum salmon sampled were mostly 40 mm to 60 mm in size (fork length). Considering salmon size and location where they were caught (suggesting the onset of characteristic downstream migration behaviour), these fish are all are considered salmon smolts (FishBase 2015a; Lamb and Edgell 2010; McPhail 2007; Quinn 2005). Chum salmon smolts were not caught in daytime or nighttime fish surveys after May 2015.



NOTE: Annotations show the total number of fish caught and measured (black text), histogram bin width (mm; grey text), and number of fish caught for each gear type (coloured text).

Figure 28 Daytime Length Frequency for Chum Salmon Caught Using All Gear Types

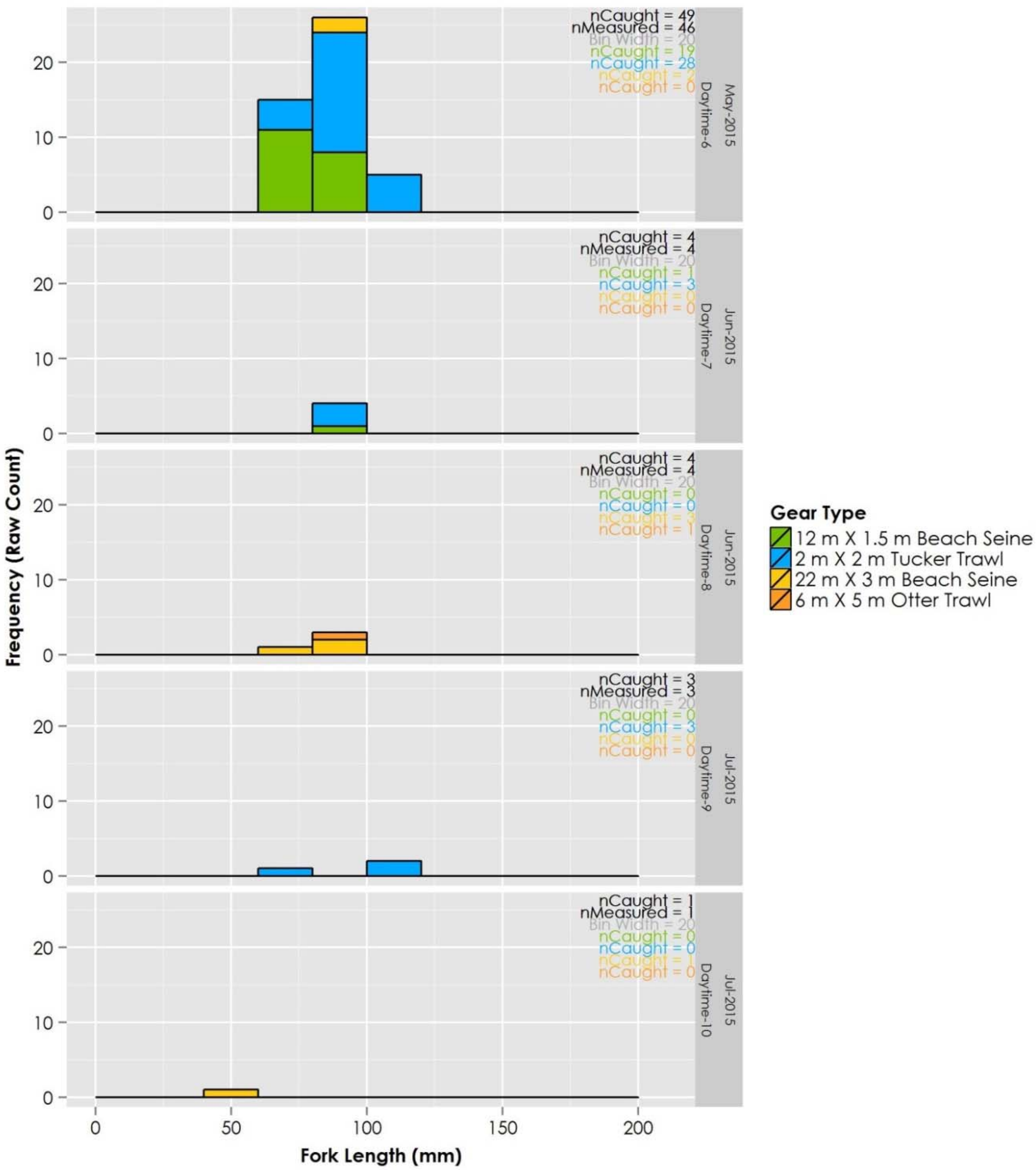


NOTE: Annotations show the total number of fish caught and measured (black text), histogram bin width (mm; grey text), and number of fish caught for each gear type (coloured text).

Figure 29 Nighttime Length Frequency for Chum Salmon Caught Using All Gear Types

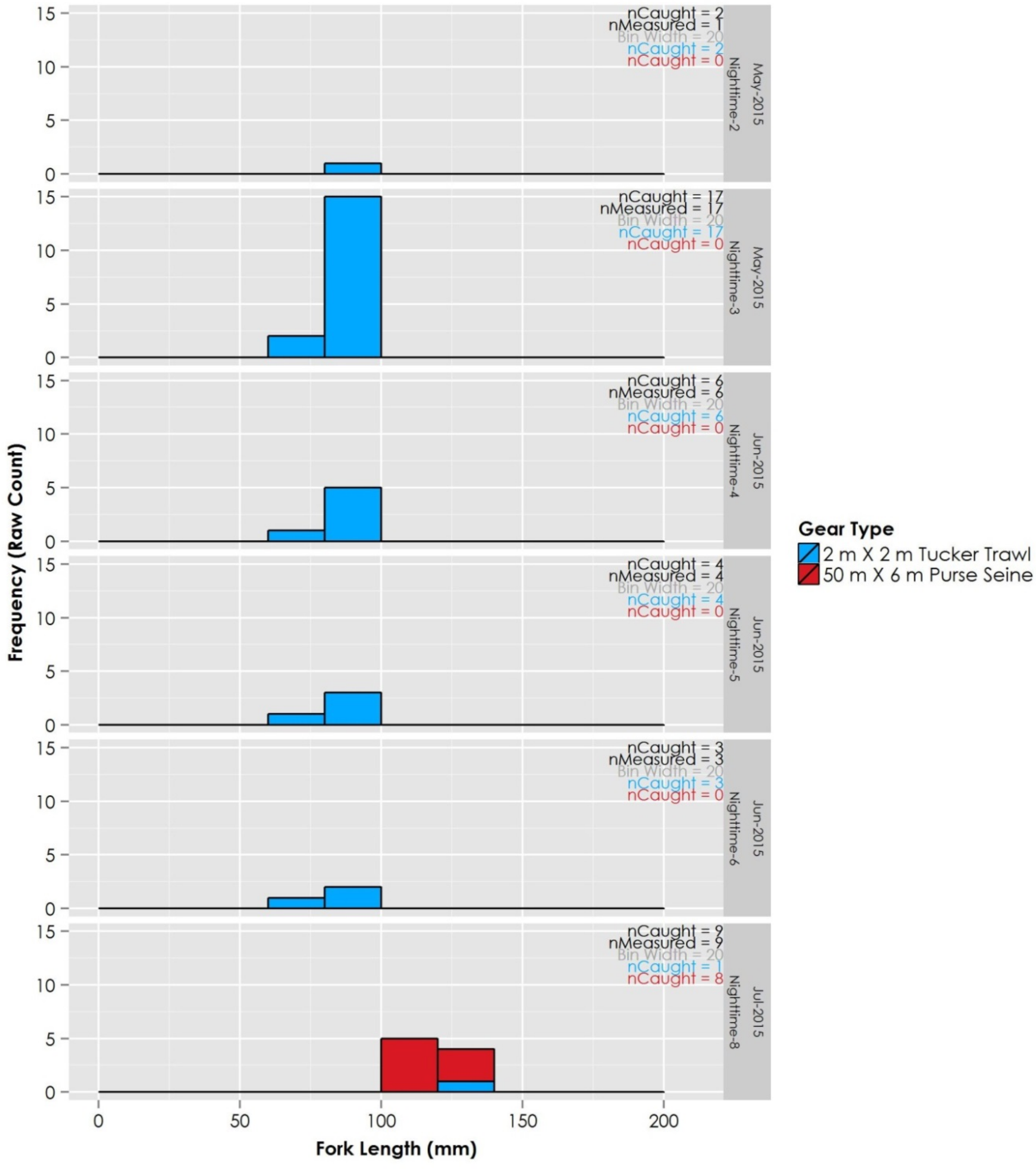
5.5.4.7 Sockeye Salmon

Sockeye salmon were caught in May through July 2015, with catches being the highest and lowest at the beginning and end of this period, respectively (Figure 30 and Figure 31). The size (fork length) of most sockeye salmon sampled ranged from 80 mm to 120 mm. Considering salmon size and location where they were caught (suggesting the onset of characteristic downstream migration behaviour), these fish are all are considered salmon smolts (McPhail 2007; Quinn 2005). Sockeye salmon smolts were not caught in the August 2015 daytime fish survey.



NOTE: Annotations show the total number of fish caught and measured (black text), histogram bin width (mm; grey text), and number of fish caught for each gear type (coloured text).

Figure 30 Daytime Length Frequency for Sockeye Salmon Caught Using All Gear Types

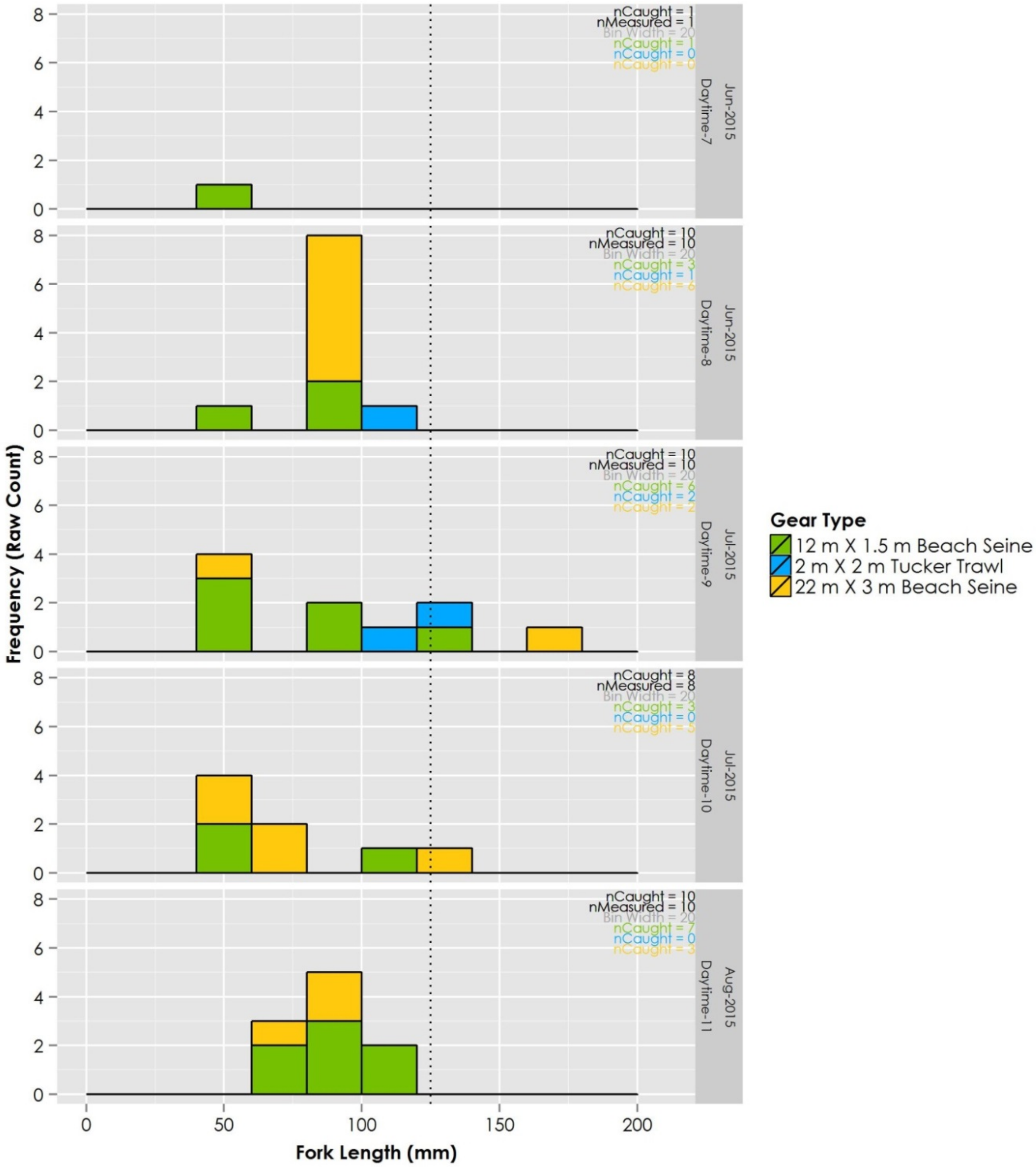


NOTE: Annotations show the total number of fish caught and measured (black text), histogram bin width (mm; grey text), and number of fish caught for each gear type (coloured text).

Figure 31 Nighttime Length Frequency for Sockeye Salmon Caught Using All Gear Types

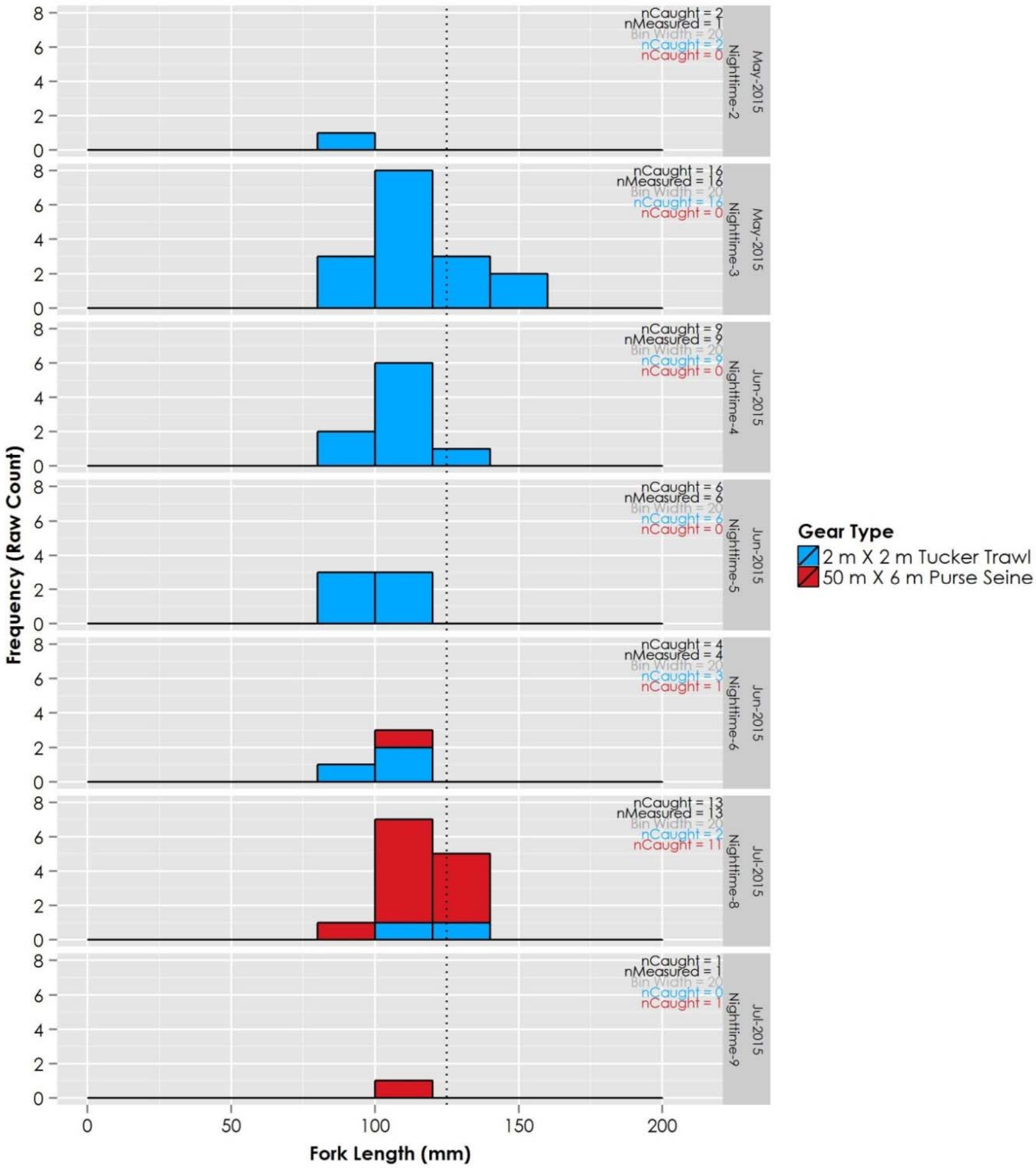
5.5.4.8 Coho Salmon

Coho salmon were caught from May through August 2015 (Figure 32 and Figure 33). The size (fork length) of coho sampled remained relatively consistent through this period, with most fish between 80 mm and 120 mm. Considering salmon size and location where they were caught (suggesting the onset of characteristic downstream migration behaviour), these fish are all are considered salmon smolts (McPhail 2007; Quinn 2005). However, a second life history stage (yearling smolts, ranging in size [fork length] from 100 mm to 150 mm; McPhail 2007), may have also been detected in July (when the largest coho salmon was caught) and other months.



NOTE: Annotations show the total number of fish caught and measured (black text), histogram bin width (mm; grey text), and number of fish caught for each gear type (coloured text). Dotted vertical line indicates size at 50% maturity.

Figure 32 Daytime Length Frequency for Coho Salmon Caught Using All Gear Types

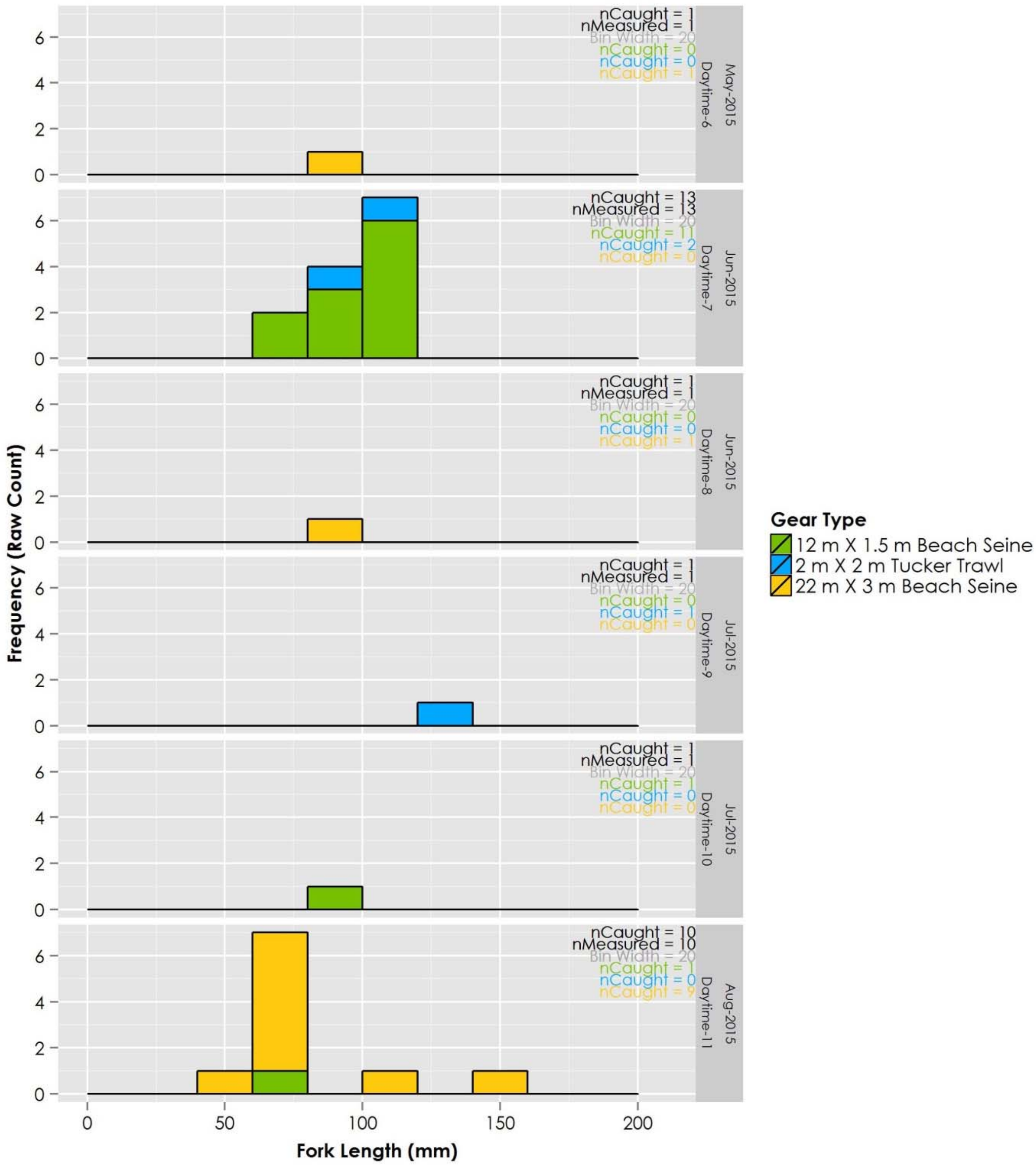


NOTE: Annotations show the total number of fish caught and measured (black text), histogram bin width (mm; grey text), and number of fish caught for each gear type (coloured text). Dotted vertical line indicates size at 50% maturity.

Figure 33 Nighttime Length Frequency for Coho Salmon Caught Using All Gear Types

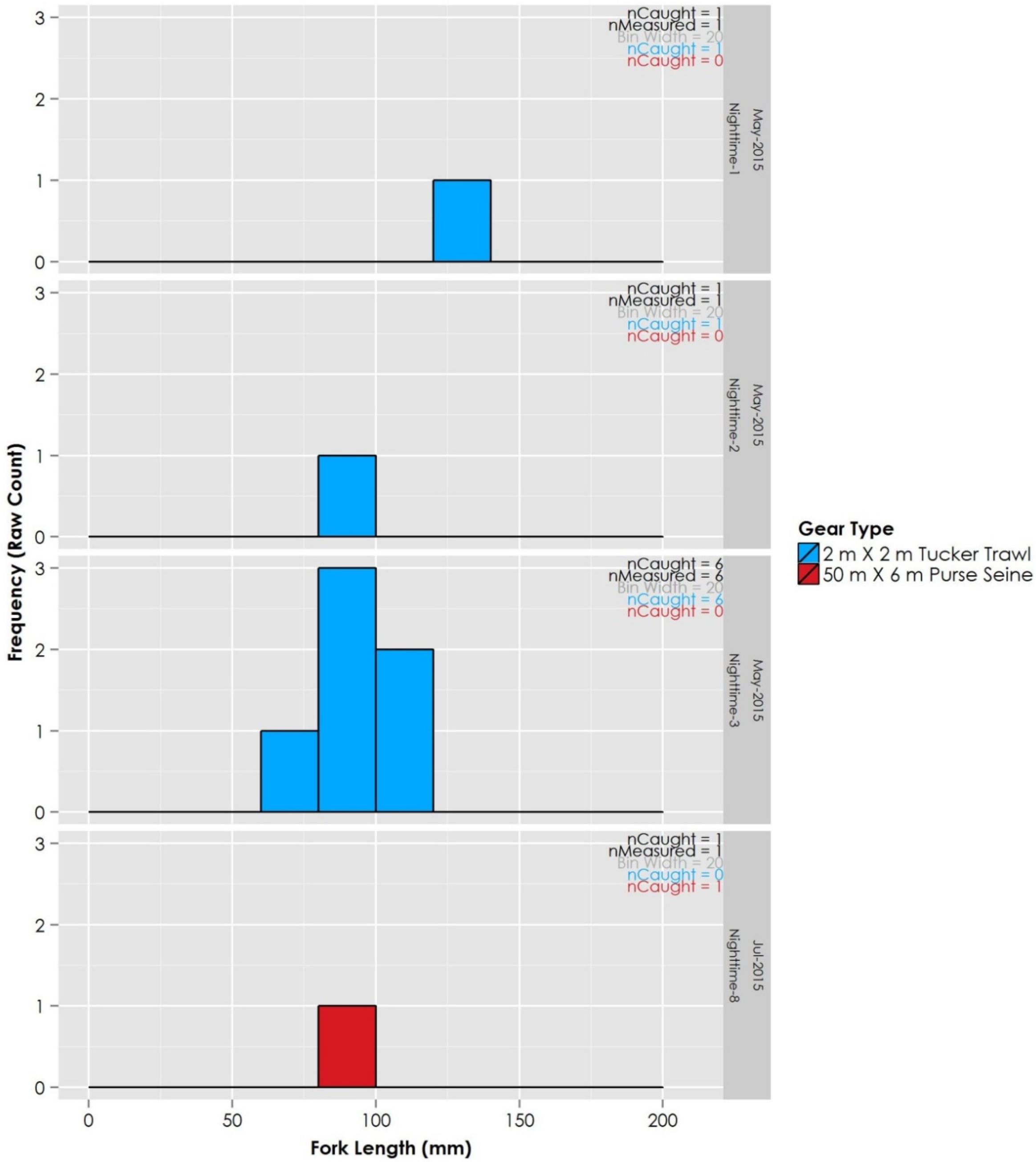
5.5.4.9 Chinook Salmon

Chinook salmon were caught from May to August 2015 in lower numbers compared to other salmon species (Figure 34 and Figure 35). The size (fork length) of Chinook salmon sampled remained relatively consistent, with most fish between 80 mm and 120 mm. Considering salmon size and location where they were caught (suggesting the onset of characteristic downstream migration behaviour), these fish are all are considered salmon smolts (McPhail 2007; Quinn 2005).



NOTE: Annotations show the total number of fish caught and measured (black text), histogram bin width (mm; grey text), and number of fish caught for each gear type (coloured text).

Figure 34 Daytime Length Frequency for Chinook Salmon Caught Using All Gear Types

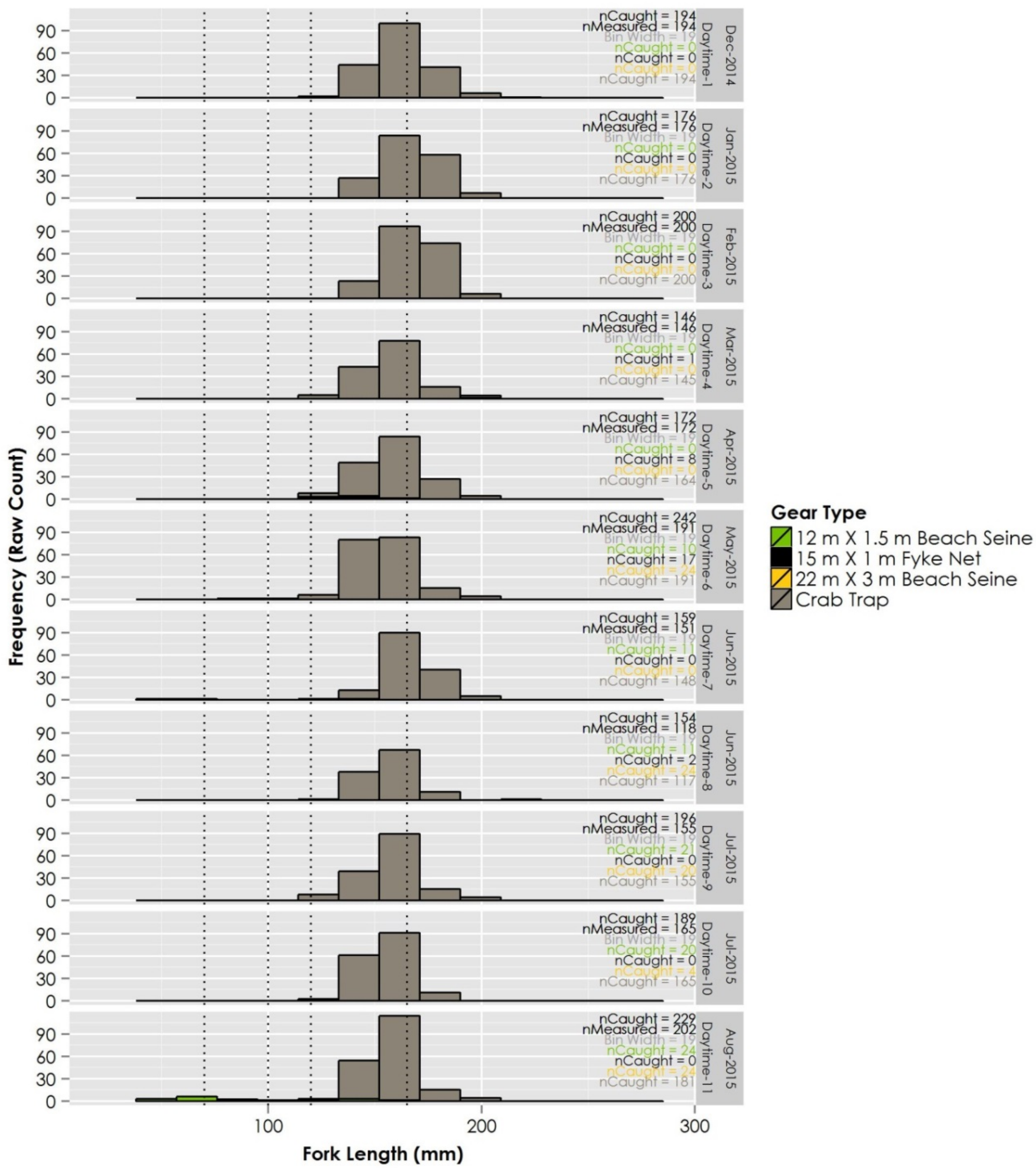


NOTE: Annotations show the total number of fish caught and measured (black text), histogram bin width (mm; grey text), and number of fish caught for each gear type (coloured text).

Figure 35 Nighttime Length Frequency for Chinook salmon Caught Using All Gear Types

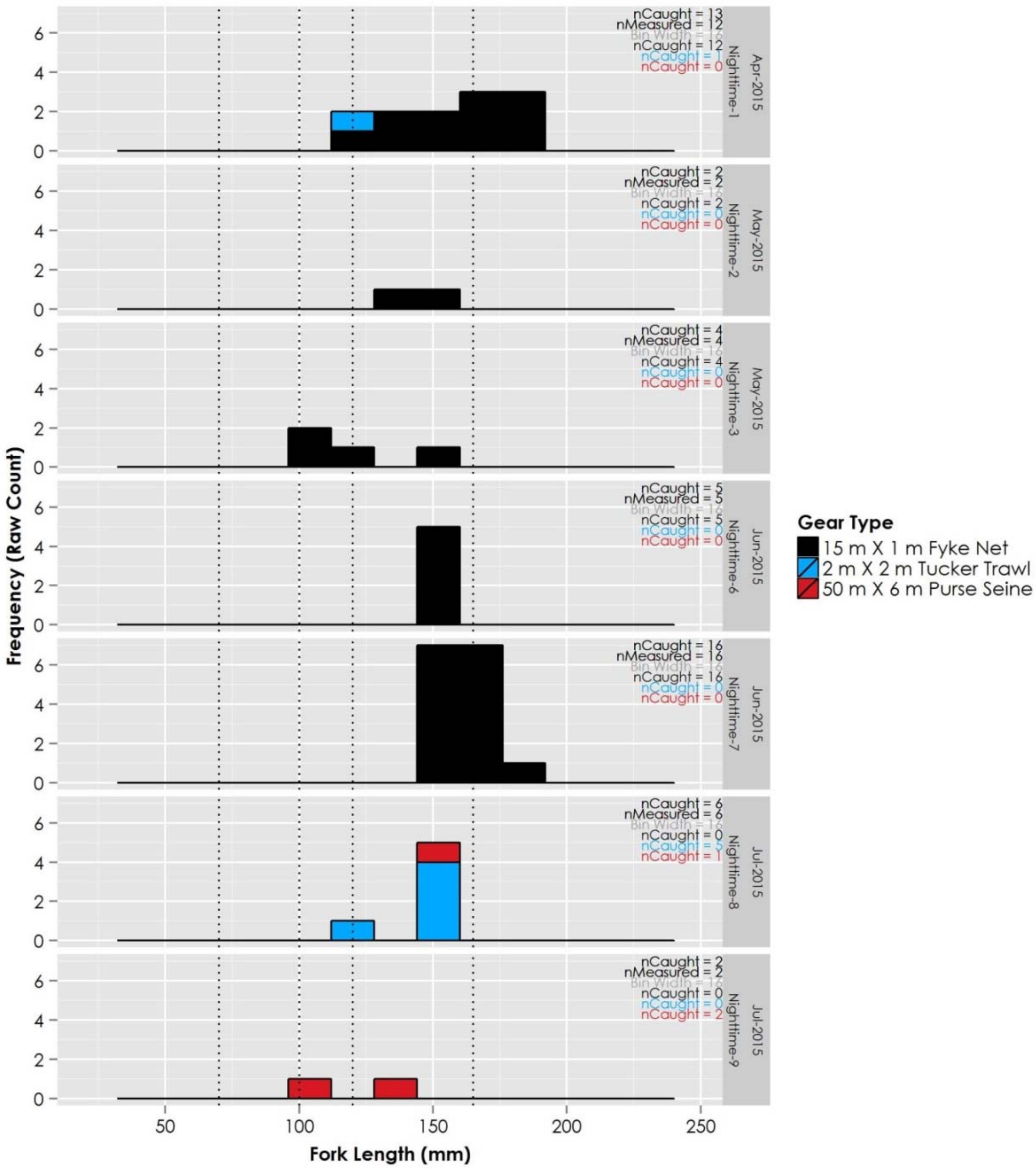
5.5.4.10 Dungeness Crab

Dungeness crab were caught consistently in all survey periods (Figure 36 and Figure 37). Nighttime surveys did not target crab; all catches reported in Figure 37 are incidental catches. The dominant size class of crabs caught was 152 mm to 171 mm. No obvious trends with respect to the size or abundance of crabs caught are apparent based on these data. Based on established life history characteristics, multiple life history stages of Dungeness crab were caught. These included juveniles (< 70 mm; see dotted lines), sub-adults (> 70 but < than 100 or 120 mm for females and males respectively), and mature individuals (> 100 or 120 for females and males respectively (Dunham, et al. 2011). A vertical dotted line at 165 mm shows the legal size limit for male Dungeness crabs.



NOTE: Annotations show the total number of fish caught and measured (black text), histogram bin width (mm; grey text), and number of fish caught for each gear type (coloured text).

Figure 36 Daytime Length Frequency for Dungeness Crab Caught Using All Gear Types



NOTE: Annotations show the total number of fish caught and measured (black text), histogram bin width (mm; grey text), and number of fish caught for each gear type (coloured text). Dotted vertical lines represent (from left to right) size at transition to subadult, subadult female, subadult male, and legal catchsize limit for males.

Figure 37 Nighttime Length Frequency for Dungeness Crab Caught Using All Gear Types

5.6 SALMON STOMACH SAMPLE ANALYSIS

Two hundred and twenty salmon smolts (127 coho, 54 sockeye, 32 Chinook and 7 chum) collected during daytime and nighttime surveys have been analyzed to date for stomach contents (Table 6). Empty stomachs comprised 9.5 % of the 220 fish stomachs analyzed (15 coho, 5 sockeye, and 1 Chinook). The majority of the salmon smolts were observed with at least 50% stomach fullness, with greater than 75% digested material in stomachs.

A preliminary review of the stomach content results suggest that crustacean planktonic (euphausiids, copepods, cladoceran), crustacean benthic prey (Cumacea, Cirripedia, Amphipoda and Isopoda), and terrestrial insects comprised a high proportion of numeric prey abundance and high frequency of presence in stomach contents for all four species of salmon smolts collected (Table 6). Terrestrial insects comprised a high proportion of contents in stomachs of chum and coho salmon, and were found frequently in stomachs of all four salmon species. Terrestrial insects, nearshore benthic (amphipod) and larger sized zooplankton (euphausiids, copepods) were numerically abundant in Chinook salmon stomachs. Fish prey were frequently found in Chinook salmon stomachs and less frequent in coho and sockeye salmon stomachs. Chum salmon fed primarily on terrestrial insects and less frequently on copepods, cumacea, and amphipods. Coho salmon showed the greatest diversity in prey types across benthic and planktonic crustaceans, nearshore benthic crustaceans, terrestrial insects, and small fish. Sockeye salmon also showed a great diversity of prey types with a primary focus on surface and pelagic crustacean plankton species including cladocerans, euphausiids and planktonic cirripedia (barnacles). Sockeye salmon had the largest number of prey per fish stomach relative to the other three species of salmon.

Table 6 Percent by Number (% N) of Prey Organisms and Percent Frequency of Occurrence (% F) in Juvenile Salmon Stomach Contents (May to July 2015)

Stomach Content Prey Taxa	Salmon Smolts									
	Pink		Chinook		Chum		Coho		Sockeye	
	% N	% F	% N	% F	% N	% F	% N	% F	% N	% F
Crustacea (Planktonic)										
Euphausiacea	-	-	50.3	18.8	0	0	0.1	2.4	11.3	14.8
Copepoda	-	-	16.9	25.0	0.4	30	1.5	7.1	2.7	44.4
Cladocera	-	-	0	0	0	0	<0.1	0.8	62.6	16.7
Decapoda	-	-	2.7	18.8	0	0	4.7	17.3	<0.1	5.6
Crustacea (Benthic/Planktonic)										
Cumacea	-	-	0.1	6.3	6.0	20	19.9	22.0	0	0
Cirripedia	-	-	4.5	15.6	0	0	3.4	5.5	12.0	37.0
Amphipoda/Isopoda	-	-	0.8	12.5	1.4	30	1.2	18.1	<0.1	3.7
Unknown Crustacea	-	-	0	0	3.3	20	0	0	0	0
Insects/Arachnids	-	-	8.82	46.9	88.2	50	41.2	73.2	5.5	38.9
Pisces (fish)	-	-	2.0	56.3	0	0	3.2	16.5	0.8	16.7
Mollusca/Gastropoda	-	-	0	0	0	0	3.7	1.6	<0.1	5.6
Non-food items	-	-	0.2	15.6	0.4	10	0.8	13.3	0.3	24.1
Undetermined materials	-	-	13.7	-	0.3	-	20.3	-	4.8	-
% Fullness (Median)	-		80		55		50		50	
% Digested (Median)	-		77.5		80		75		77.5	
Total prey items counted	-		3,128		927		2,748		16,042	
Prey items per fish	-		39.1		132.4		21.6		296.7	
Empty stomachs (%)	-		**3.1**		**0**		**11.8**		**9.3**	
Total stomachs (#)	0		**32**		**7**		**127**		**54**	

6.0 INTERIM REPORT SUMMARY

This interim report is built around the objectives of the entire Marine Fish and Fish Habitat Follow-up Monitoring Program to:

- Describe marine biophysical environment in the survey area (water properties, zooplankton)
- Identify fish species present in the survey area (Section 5.4)
- Identify spatial patterns of distribution (Section 5.5.1), abundance (Catch per Unit Effort [CPUE] to be completed for final report) and biological characteristics (Section 5.5.3) for fish and invertebrate species in the survey area
- Identify temporal patterns of distribution (Section 5.5.2), abundance (CPUE to be completed for final report) and biological characteristics (Section 5.5.4) of fish and invertebrate species in the survey area.

The Program was expanded in early January 2015 based on in-field experience and technical advice from agency and partners. The Program now consists of two component surveys conducted in the study area scheduled across at least a full year. The component surveys include: daytime and nighttime fish.

The results presented herein support the goals outlined in Section 1.2 including:

- An update on marine fish survey methods (Section 3.0)
- A summary of sampling effort to date (Section 1.3)
- A summary of data collected to date (Section 5.1 to 5.6)
- A preliminary description of survey results completed between December 2014 and August 2015 (Section 5.5).

The frequency and efforts of surveys completed from December 2014 to August 2015 involved:

- Eleven monthly and bimonthly daytime fish and marine field surveys using a variety of gear types suitable for different habitats
- Nine biweekly and weekly nighttime fish and marine field surveys using a variety of gear types suitable for sampling different nighttime habitats conducted during the spring/summer Skeena River salmon smolt migration timing window.

The Program has conducted 115 survey days of effort over of approximately 250 days of the year to date and completed 550 trawls and hydroacoustic transects, 225 beach seines, 35 purse seines, 20 fyke net sets, 150 CTD samples, 90 zooplankton samples, and 155 salmon smolt stomachs collected. The program results to date are summarized below with each section directly tied to a program objective.

6.1 PHYSICAL AND BIOLOGICAL SETTING

Water Properties

Both vertical and horizontal structure of the water column in the study area influence habitat characteristics used by a variety of marine species. Water properties, including primary productivity, in the study area showed variation associated in changes in seasons from winter, spring to summer. Warmer surface waters were observed in early May 2015 corresponding to seasonal daylight and a detectable increase in phytoplankton concentrations as measured by chlorophyll *a*. Phytoplankton concentrations peaked in June 2015 and showed a decline in July 2015.

Zooplankton

Zooplankton total abundance increased from May to June 2015, with slight decline in July 2015 potentially associated with the decline in phytoplankton. This is consistent with spring to summer patterns of warming surface water and increasing and varying chlorophyll *a* concentrations. Copepods dominated the 22 zooplankton taxa identified in the samples.

6.2 MARINE FISH SPECIES

Daytime and nighttime marine fish and fish habitat surveys (December 2014 to August 2015) captured a total of 46,773 individual fish and invertebrates. Eighty-two species (or groups) were caught (61 fish and 21 invertebrates), using a variety of gear types suitable for different habitats.

Surf smelt, followed by Pacific herring and shiner perch, were the most commonly caught fish. Five of six species of anadromous salmon were also caught and made up 3.1% of the total fish catch. All salmon captured were determined to be smolts.

Several CRA species were notably absent from catches during all surveys including eulachon, northern abalone (*Haliotis kamtschatkana*), and Pacific halibut (*Hippolglossus stenolepis*). Larval eulachon are found primarily in estuaries, or adjacent to rivers, in near shore marine waters (McCarter 2003). While the Program resulted in catches of larval fish (10.1% of total fish captured), those that have been identified from a single June sample included surf smelt and Pacific herring, but did not include eulachon larvae. Targeted surveys for larval eulachon (i.e., river and bongo net trawls) at the appropriate time of year (McCarter and Hay 2003) were not conducted within the local study area as part of this Program.

Surveys targeted for abalone were not used (e.g., SCUBA divers), and so it is not surprising that abalone were not observed. Northern abalone are typically distributed in rocky, subtidal habitat at depths of less than 10 m in areas of high salinity (Sloan and Breen 1988; Davies, et al. 2006; DFO 2015b). These conditions are not present in the study area.

Pacific halibut are primarily observed on mixed bottom substrates, at depths up to 1,000 m (Lamb and Edgell 2010, Loher and Seitz 2008) and spawn and rear at depths greater than 50 to 100 m in locations outside the proposed project area (St.-Pierre 1984, Valero and Webster 2011). Halibut are often captured with long line or bottom trawl gear (DFO 2015a). These gear types generally result in destructive sampling (i.e., fish are killed and marine habitats can be damaged) and were not used during the Program. Given the gear types employed in this Program, the known distribution of halibut and the habitats observed in the study area, it is not surprising that no halibut were caught.

6.3 MARINE FISH DISTRIBUTION

Hydroacoustic daytime fish survey results indicated that fish density increased from January to July 2015 in the study area. Early in the season (January to May 2015) higher fish densities were noted in or near Porpoise Channel, in deeper areas near the proposed berthing facility, south of Kitson Island, southwest of Lelu Island, off southeast Flora Bank, and in the deep waters northwest of Agnew Bank. In June and July 2015, higher densities of fish were found more widely distributed with notable increases along the northern margin and central Flora Bank and west of Smith Island.

Daytime hydroacoustic results were corroborated by nighttime survey, which also indicated that fish density increased throughout the survey period, particularly from late June into July 2015. The surveys conducted in July 2015 detected highest fish density across the study area, particularly on Flora Bank during high tides and to the west of Flora Bank.

6.4 FINAL REPORT

The broader objectives for the Program will be further explored in the final report, which will be available in early 2016 after the first year of surveys are completed. The final report will include a summary of data from the entire Program, specifically:

- Results from identification of zooplankton taxa
- Results from identification of prey in stomach contents
- Results from water properties with discussion on characteristics (e.g., chlorophyll *a*, temperature, salinity, turbidity)
- Results from hydroacoustics data, including TS, were possible
- Ground-truthing results from hydroacoustics using trawl data
- Analysis of CPUE.

Other analyses may be presented based on results of further data exploration.

7.0 CLOSURE

We trust that the above information meets with PNW LNG requirements. Should you have any further questions or require further information, please contact Ben Byrd at 604-678-9307.

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8.0 REFERENCES

Beacham, T.D., R.J. Beamish, J.R. Candy, C. Wallace, S. Tucker, J.H. Moss and M. Trudel. 2014. Stock-Specific Migration Pathways of Juvenile Sockeye Salmon in British Columbia Waters and in the Gulf of Alaska, Transactions of the American Fisheries Society, 143:6, 1386-1403.

Beamish, R.J., I.A. Pearsall, and M.C. Healey. 2003. A history of the research on the early marine life of Pacific salmon off Canada’s Pacific coast. North Pacific Anadromous Fish Commission Bulletin 3: 1–40.

Brodeur, R.D. 1990. *A Synthesis of the Food Habits and Feeding Ecology of Salmonids in Marine Waters of the North Pacific.* (INPFC Doc.) FRI-UW-9016. Fish. Res. Inst., Univ. Washington, Seattle. 38 pp.

Burril, S.E., Zimmerman, C.E., Finn, J.E., and Gilikin, D. 2009. Abundance, Timing of Migration, and Egg-to-Smolt Survival of Juvenile Chum Salmon, Kwethluk River, Alaska. Prepared for Arctic-Yukon-Kuskowim Sustainable Salmon Initiative. Project 619. US Geological Survey.

Chapman, E.D., Hearn, A.R., Michel, C.J., Ammann, A.J., Lindley, S.T., Thomas, M.J., Sandstrom, P.T., Singer, G.P., Peterson, M.L., MacFarlane, R.B., Klimley, A.P. 2012. Diel movements of out-migrating Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead trout (*Oncorhynchus mykiss*) smolts in the Sacramento/San Joaquin watershed. Environmental Biology of Fish.

Conlin, K. and B.D. Tutty. 1979. Juvenile Salmonid Field Trapping Manual. Habitat Protection Division, Department of Fisheries and Oceans. Vancouver, BC. Available: http://www.dfo-mpo.gc.ca/Library/74138.pdf Accessed: June 2015.

Crawford, R.E., Hudon, C., Parsons, D.G. 1992. An acoustic study of shrimp (*Pandalus montagui*) distribution near Resolution Island (eastern Hudson Strait). Canadian Journal of Fisheries and Aquatic Sciences 49:842-856.

Davies, K., M. Atkins and J. Lessard. 2006. Survey of Northern Abalone, *Haliotis kamtschatkana*, Populations in Queen Charlotte and Johnstone Straits, British Columbia, May 2004. Fisheries and Oceans Canada. Nanaimo, British Columbia.

Dunham, J.S., A. Phillips, J. Morrison and G. Jorgensen. 2011. A Manual for Dungeness Crab Surveys in British Columbia. Canadian Technical Report of Fisheries and Aquatic Sciences 2964. Fisheries and Oceans Canada.

Falkowski, P.G., Barber, R.T., and Smetacek V. 1998. Biogeochemical controls and feedbacks on ocean primary production. Science 281, 200–206.

FishBase. 2015a. *Oncorhynchus keta (Walbaum, 1792) Chum salmon.* Available at: http://www.fishbase.ca/Summary/SpeciesSummary.php?ID=241&AT=chum+salmon. Accessed: September 11, 2015.

FishBase. 2015b. *Clupea pallasii pallasii (Valenciennes, 1847) Pacific herring.* Available at: http://www.fishbase.ca/Summary/speciesSummary.php?ID=1520&AT=pacific+herring. Accessed: September 11, 2015.

FishBase. 2015c. *Hypomesus pretiosus (Girard, 1854) Surf smelt.* Available at: http://www.fishbase.ca/Summary/speciesSummary.php?ID=255&AT=surf+smelt. Accessed: September 11, 2015.

Fisheries and Oceans Canada (DFO). 2015a, March 6 2015. Pacific Halibut. Available at: http://www.dfo-mpo.gc.ca/fm-gp/sustainable-durable/fisheries-peches/halibut-fletan-eng.htm. Accessed: September 29 2015, 2015.

Fisheries and Oceans Canada (DFO). 2015b, August 14 2015. Northern Abalone. Fisheries and Oceans Canada. Available at: http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=603. Accessed: September 29 2015, 2015.

Food and Agriculture Organization of the United Nations (FAO) 1983. Fisheries Acoustics – A Practical Manual for Aquatic Biomass Estimation. FAO Fisheries Technical Paper 240 FIRM/T240. By K.A. Johannesson, MIOA and R.B. Mitson, FIOA. Accessed September 2015. Available at: www.fao.org/docrep/x5818e/x5818e00.HTM

Gauthier, S. and Horne, J. 2004. Potential acoustic discrimination within boreal fish assemblage. ICES Journal of Marine Science 61 (5): 836-845. doi: 10.1016/j.icesjms.2004.03.03.

Godin, J.G.J. 1980. Ontogenetic changes in the daily rhythms of swimming activity and of vertical distribution in juvenile pink salmon (*Oncorhynchus gorbuscha*, Walbaum). Canadian Journal of Zoology 58(5):745-753.

Gottesfeld, A.S., C. Carr-Harris, B. Proctor and D. Rolston. 2008. Sockeye salmon juveniles in Chatham Sound 2007. Report to Pacific Salmon Forum. 33 pp.

Hyatt, K. D., D. Rutherford, T. Gjernes, P. Rankin and T. Cone. 1984. Lake Enrichment Program: Juvenile Sockeye Unit survey guidelines. Canadian Manuscript Report of Fisheries and Aquatic Sciences. No. 1976: 84 pp.

Hyslop, E.J. 1980. Stomach contents analysis: a review of methods and their application. J. fish. Biol. 17:411-429

Johnson, D.H., Shrier, B.M., O'Neal, J.S., Knutzen, J.A., Augerot, X., O'Neil, T.A. and T.N. Pearsons. 2007. *Salmonid Field Protocols Handbook: Techniques for Assessing Status and Trends in Salmon and Trout Populations.* American Fisheries Society. Bethesda, Maryland. 478 pp. Available: http://www.stateofthesalmon.org/fieldprotocols/ Accessed: June 2015.

Lamb, A. and P. Edgell 2010. *Coastal fishes of the Pacific Northwest*. Harbour Publishing Company. Madeira Park, BC.

Lassuy, D.R. and Moran, D. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest)---Pacific herring. *U.S. Fish and Wildlife Service Biological Reports* 82 (11.126). U.S. Army Corps of Engineers, TR-EL-82-4.

Loher, T., and A. Seitz. 2008. Characterization of active spawning season and depth for eastern Pacific halibut (*Hippoglossus stenolepis*), and evidence of probable skipped spawning. J. Northw. Atl. Fish. Sci., 41: 23–36.

Love, R. H. 1970. Dorsal-aspect target strength of an individual fish. Journal of Acoustic Society of America. 49:816–823.

Manzer, J.I. 1956. *Distribution and Movement of Young Pacific Salmon During Early Ocean Residence*. Fisheries Research Board of Canada Progress Reports. No. 106: 24-28.

Manzer, J.I. 1969. Food and Feeding of Juvenile Pacific Salmon in Chatham Sound and Adjacent Waters. Fisheries Research Board of Canada, Manuscript Report Series No. 1020. 23 pp.

McCarter, P.B. and D. E. Hay. 2003. *Eulachon Embryonic Egg and Larval Outdrift Sampling Manual for Ocean and River Surveys*. Canadian Technical Report of Fisheries and Aquatic Sciences 2451. Fisheries and Oceans Canada Science Branch, Pacific Region. Pacific Biological Station. Nanaimo, BC.

McQueen, D.J. and N.D. Yan. 1993. Metering filtration efficiency of freshwater zooplankton hauls: reminders from the past. Journal of Plankton Research 15:57-65.

McPhail, J.D. 2007. *Freshwater Fishes of British Columbia* Vol. 6. University of Alberta.

Pacific NorthWest LNG Limited Partnership (PNW LNG). 2014. Pacific NorthWest LNG - Addendum to the Environmental Impact Statement. Prepared for the Canadian Environmental Assessment Agency. December 12, 2014. Available at: http://www.ceaa-acee.gc.ca/050/document-eng.cfm?document=100767

Pacific NorthWest LNG Limited Partnership (PNW LNG). 2015. Report on Water Clarity – Baseline Characterization of the Water Clarity, Total Suspended Solids, and Turbidity on Flora Bank and Adjacent Habitats. Prepared for the Canadian Environmental Assessment Agency. May 4, 2014.

Pauly, D., and V. Christensen. 1995. Primary production required to sustain global fisheries. *Nature*: 374: 255-257.

Pomeroy L. R. 1974. The ocean's food web, a changing paradigm. *BioScience* 24:499–504.

Portt, C.B., Coker, G.A., Ming, D.L. and R.G. Randall. 2006. A review of fish sampling methods commonly used in Canadian freshwater habitats. Canadian Technical Report of Fisheries and Aquatic Sciences 2604. Fisheries and Oceans Canada. Available; http://www.dfo-mpo.gc.ca/Library/324435.pdf Accessed: June 2015.

Price, M.H.H., B.W. Glickman and J.D. Reynolds. 2013. Prey selectivity of Fraser River sockeye salmon during early marine migration in British Columbia. *Transactions of the American Fisheries Society*. 142:4, 1126-1133.

Prince Rupert Port Authority (PRPA). 2015. Shoreline Habitat, ShoreZone Imaging Survey. Available at: http://www.rupertport.com/port-authority/sustainability/shoreline-habitat. Accessed August 31, 2015.

Quinn, T.P. 2005. *The behaviour and ecology of Pacific salmon and Trout*. University of Washington Press. Seattle, Washington.

Sayao, O. and L. Absalonsen. 2014. *Potential Impacts of the Marine Terminal Structures on the Hydrodynamics and Sedimentation Patterns*. Project memo prepared for Capt. David Kyle of Pacific NorthWest LNG Limited Partnership by Hatch Ltd. Project Memo H345670. December 11, 2014. Available at: http://www.ceaa-acee.gc.ca/050/documents/p80032/100814E.pdf.

Schweigert, J., McCarter, B., Therriault, T., Flostrand, L., Hrabok, C., Winchell, P., and Johannessen, D. 2007. Appendix H: Pelagics. In Ecosystem overview: Pacific North Coast Integrated Management Area (PNCIMA). Edited by Lucas, B.G., Verrin, S., and Brown, R. Canadian Technical Report on Fisheries and Aquatic Sciences 2667: iv + 35 pp.

Schwinghamer, P., Gordon, D. C., Rowell, T. W., Prena, J., McKeown, D. L., Sonnichsen, G. and Guigné, J. Y. 1998. Effects of Experimental Otter Trawling on Surficial Sediment Properties of a Sandy-Bottom Ecosystem on the Grand Banks of Newfoundland. Conservation Biology, 12: 1215–1222. doi: 10.1046/j.1523-1739.1998.0120061215.x

Sheldon, R. W., W. H. Sutcliffe, Jr., and M. A. Paranjape. 1977. Structure of pelagic food chain and relationship between plankton and fish production. *Journal of the Fisheries Research Board of Canada* 34:2344–2353.

Shreffler, D.K., Simenstad, C.A. and R.M. Thom. 1990. Temporary residence by juvenile salmon in a restored estuarine wetland. Canadian Journal of Fisheries and Aquatic Sciences 47: 2079-2084.

Simmonds, J. and D.N. MacLennan. 2005. Fisheries Acoustics: Theory and Practice, 2nd Ed. Blackwell Publishing, Iowa, USA. ISBN: 978-0-632-05994-2

Sloan, N.A. and P.A. Breen. 1988. Northern Abalone, *Haliotis kamtschatkana*, in British Columbia: Fisheries and Synopsis of Life History Information. Fisheries and Oceans Canada. Ottawa.

Soeda, H., Yoza, K., T. Shimamura, and E. Hasegawa. 1987. On the swimming behavior of chum salmon in early migratory season off the coast of Hokkaido, Okhotsu Sea. Bull. lap. Soc. Sci. Fish. 53(10): 1827-1833.

St-Pierre, G. 1984. Spawning locations and season for for Pacific halibut. International Pacific Halibut Commission, Scientific Report 70: 46p.

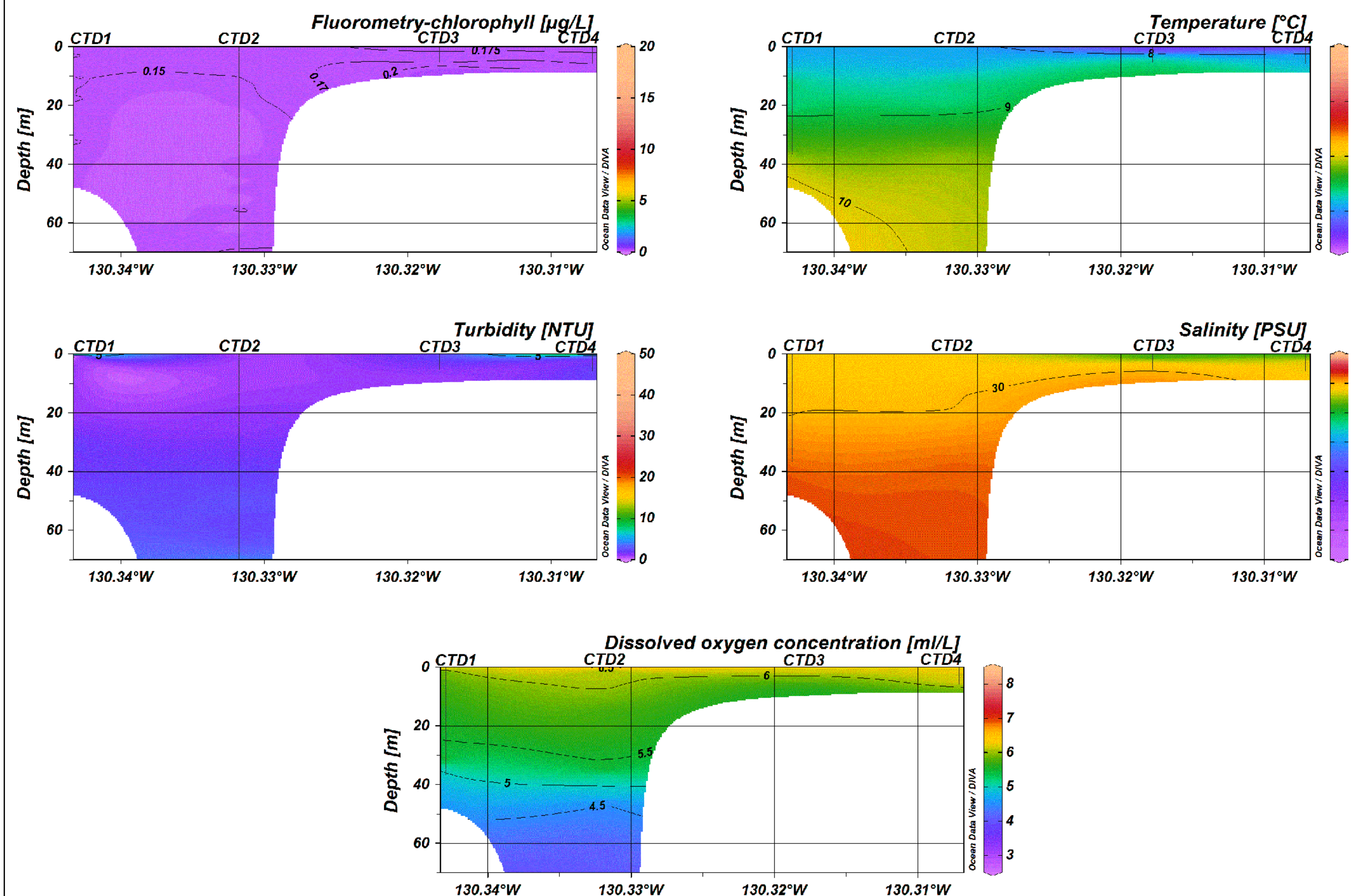
Stantec Consulting Ltd. 2014. Pacific NorthWest LNG - Port Edward, BC. Environmental Impact Statement and Environmental Assessment Certificate Application. Prepared for Pacific NorthWest LNG Limited Partnership. February 24, 2014. Available at: http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_document_396_37423.html

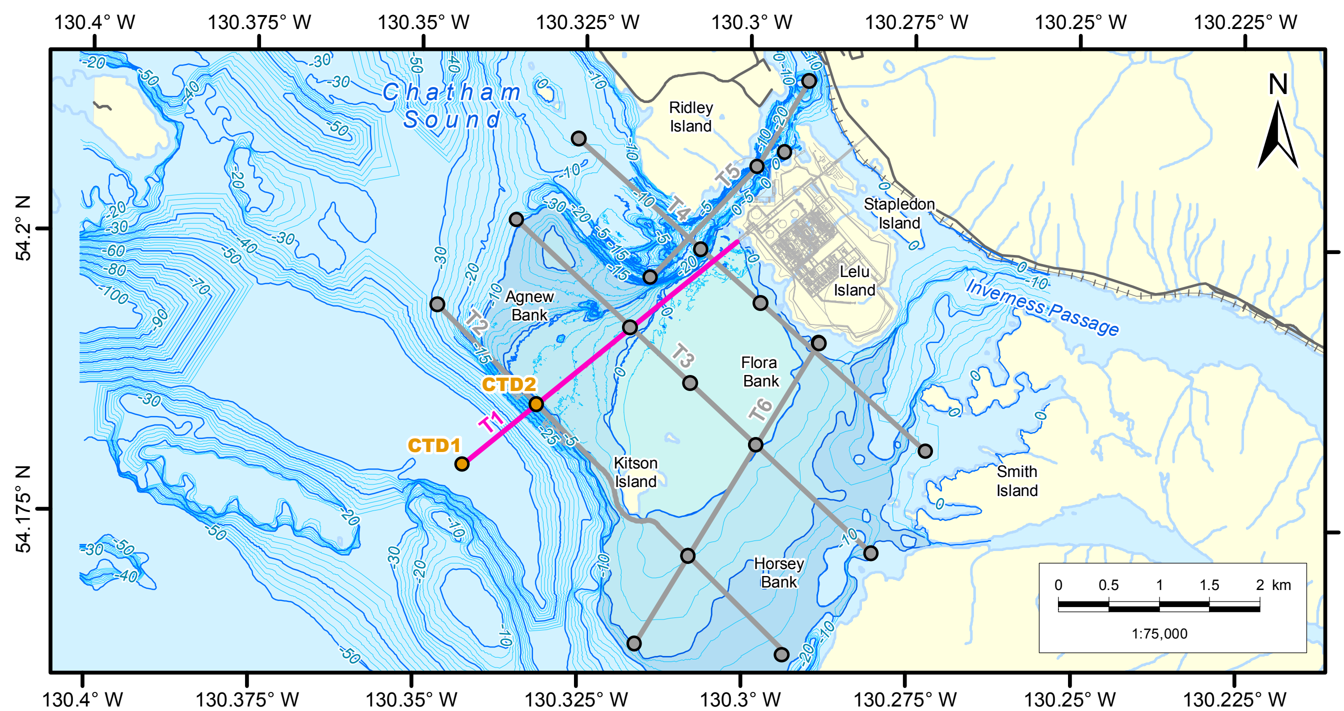
Valero, J.L. and R.A. Webster. 2011. Current understanding of Pacific halibut migration patterns. International Pacific Halibut Commission, Report of Assessment and Research Activities 2011. p.341-380.

Ware, D.M. and R.E. Thomson. 2005. Bottom-up Ecosystem Trophic Dynamics Determine Fish Productivity in the Northeast Pacific. *Science* 308: 1280-1284.

Whitney, R.R. 1969. Schooling of fishes relative to available light. Transactions of the American Fisheries Society 98(3):497-504.

APPENDIX A
WATER PROPERTIES FIGURES





Illustrated Oceanographic Site
Other Oceanographic Site
Illustrated Transect
Other Transect
Project Component

Bathymetry (m)
Major Contour
Minor Contour
Railway
Road
Secondary Road
Watercourse

Waterbody
Shoal
Flora Bank
0 - 5 m Deep Shoal
5 - 10 m Deep Shoal

Pacific NorthWest LNG

Daytime Fish Survey Marine Water Column Profiling: Transect 1 (December 18, 2014)

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

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FIGURE ID: 123110537
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PROJECTION: UTM - ZONE 9
DATUM: NAD 83
CHECKED BY: S. O'REGAN

PREPARED BY: Stantec
PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **A- 1**

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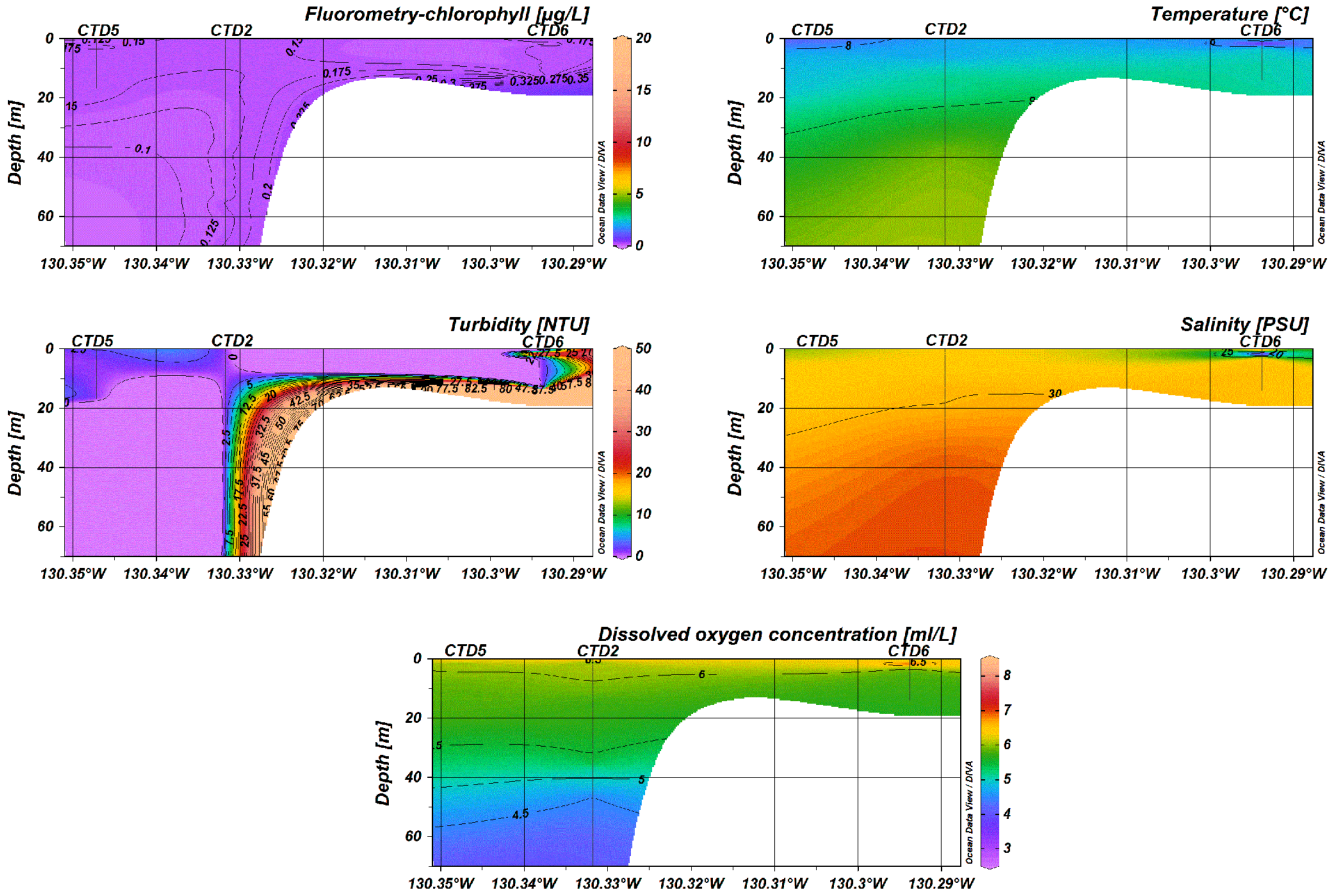

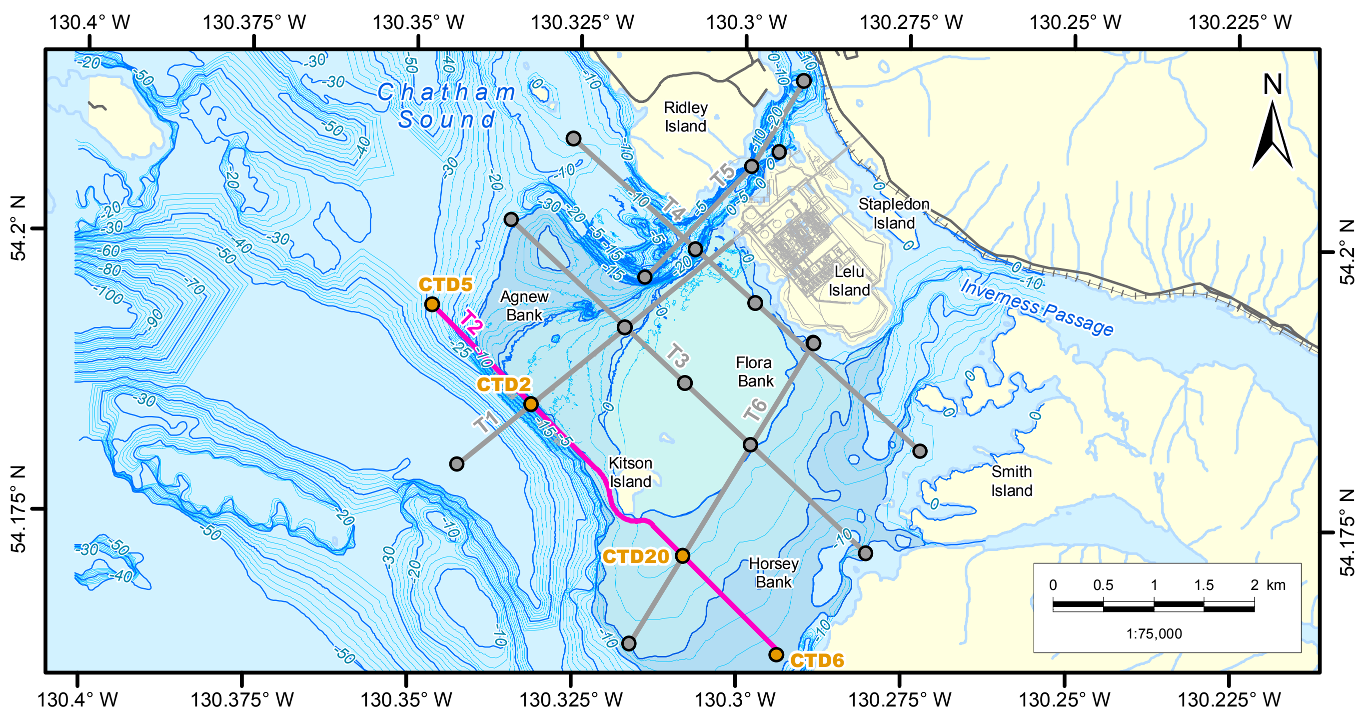

Legend

- Illustrated Oceanographic Site
- Other Oceanographic Site
- Illustrated Transect
- Other Transect
- Project Component

Bathymetry (m)

- Major Contour
- Minor Contour
- Railway
- Road
- Secondary Road
- Watercourse

- Waterbody

Shoal

- Flora Bank
- 0 - 5 m Deep Shoal
- 5 - 10 m Deep Shoal

Pacific NorthWest LNG

Daytime Fish Survey Marine Water Column Profiling: Transect 2 (December 18, 2014)

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

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DATE: 01-OCT-15	PROJECTION: UTM - ZONE 9
FIGURE ID: 123110537	DATUM: NAD 83
DRAWN BY: R. CAMPBELL	CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **A- 2**

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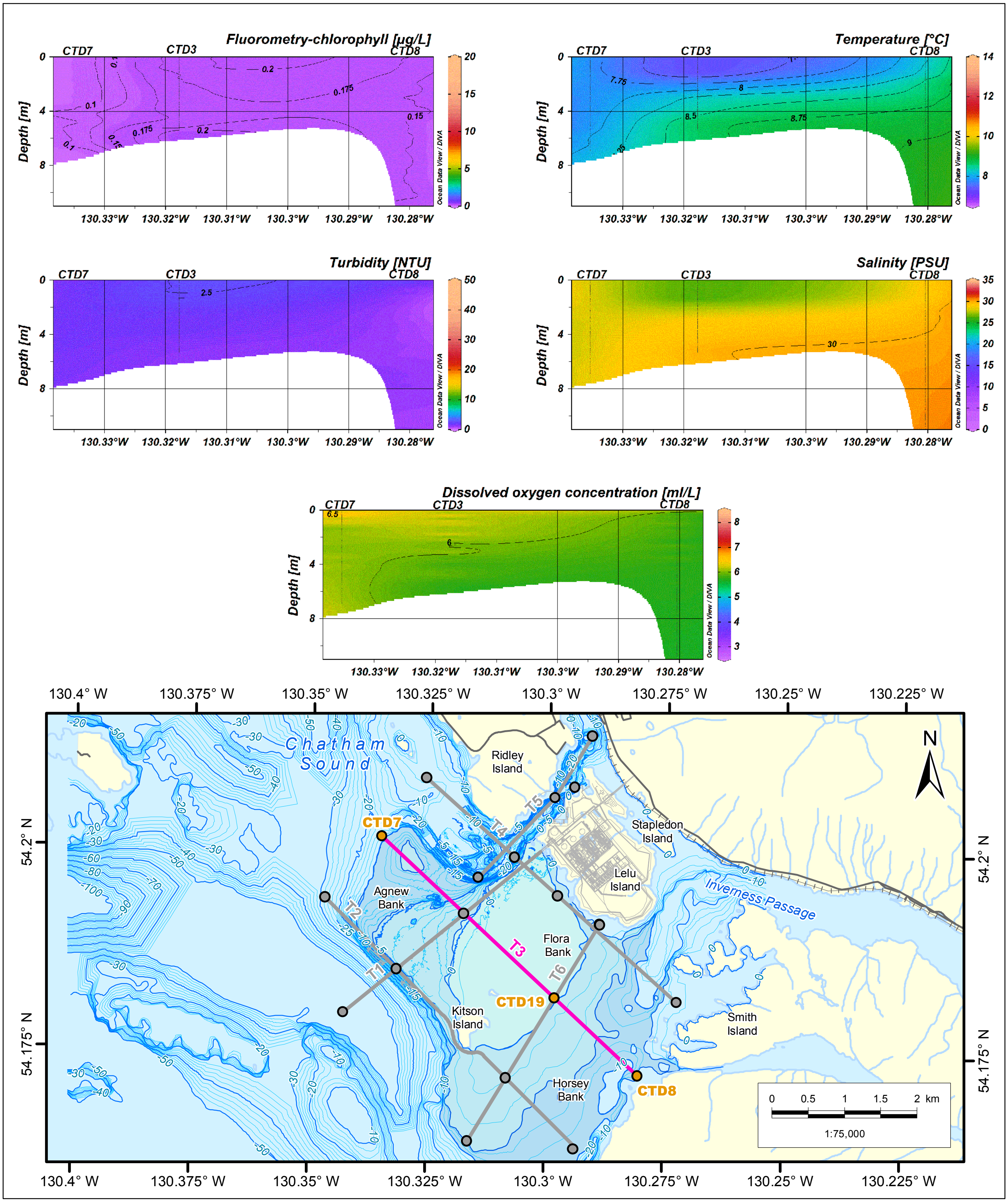

- Illustrated Oceanographic Site
- Other Oceanographic Site
- Illustrated Transect
- Other Transect
- Project Component

Bathymetry (m)

- Major Contour
- Minor Contour
- Railway
- Road
- Secondary Road
- Watercourse

- Waterbody

Shoal

- Flora Bank
- 0 - 5 m Deep Shoal
- 5 - 10 m Deep Shoal

Pacific NorthWest LNG

Daytime Fish Survey Marine Water Column Profiling: Transect 3 (December 18, 2014)

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

DATE: 01-OCT-15	PROJECTION: UTM - ZONE 9
FIGURE ID: 123110537	DATUM: NAD 83
DRAWN BY: R. CAMPBELL	CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO:

A- 3

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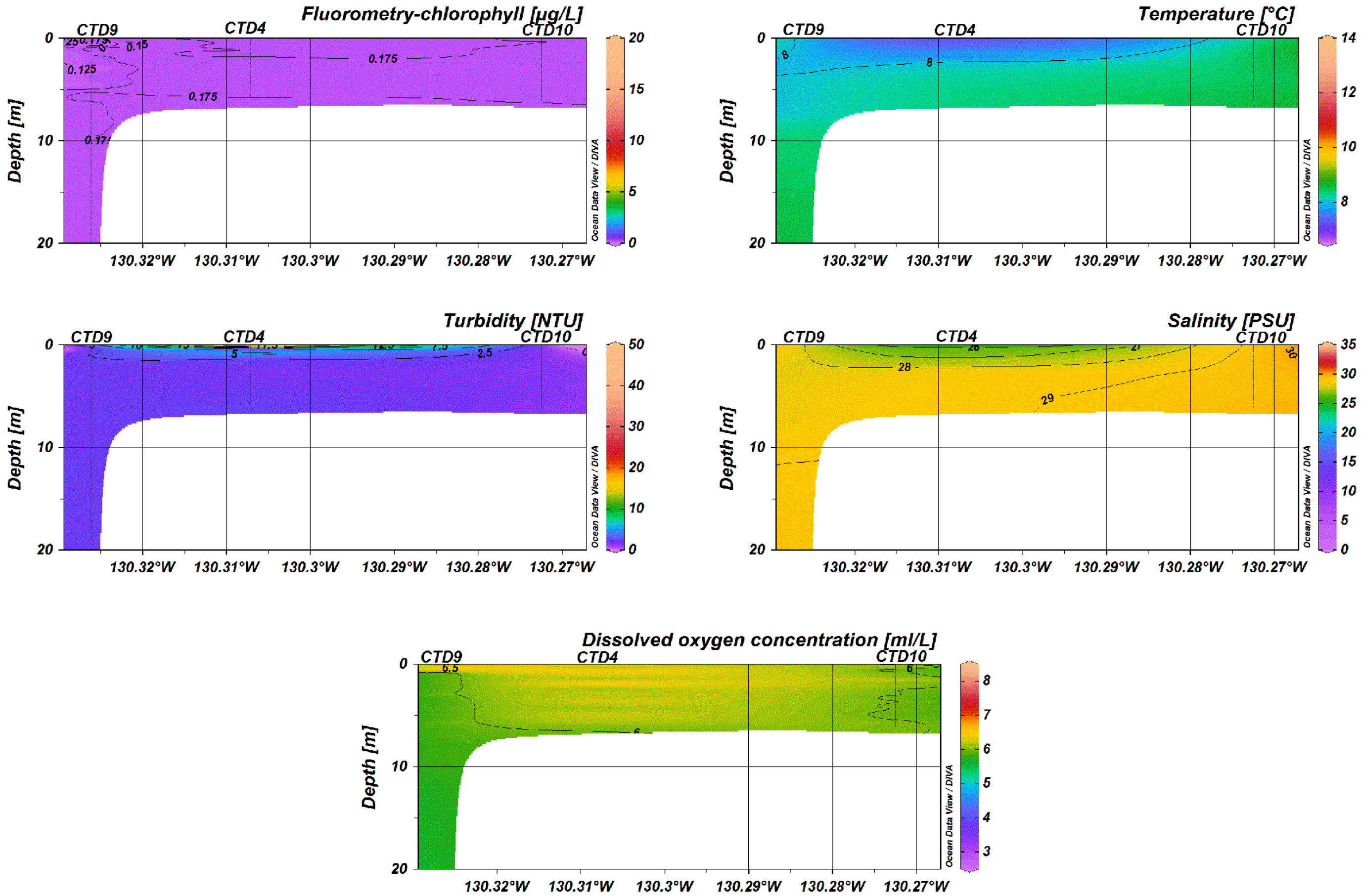

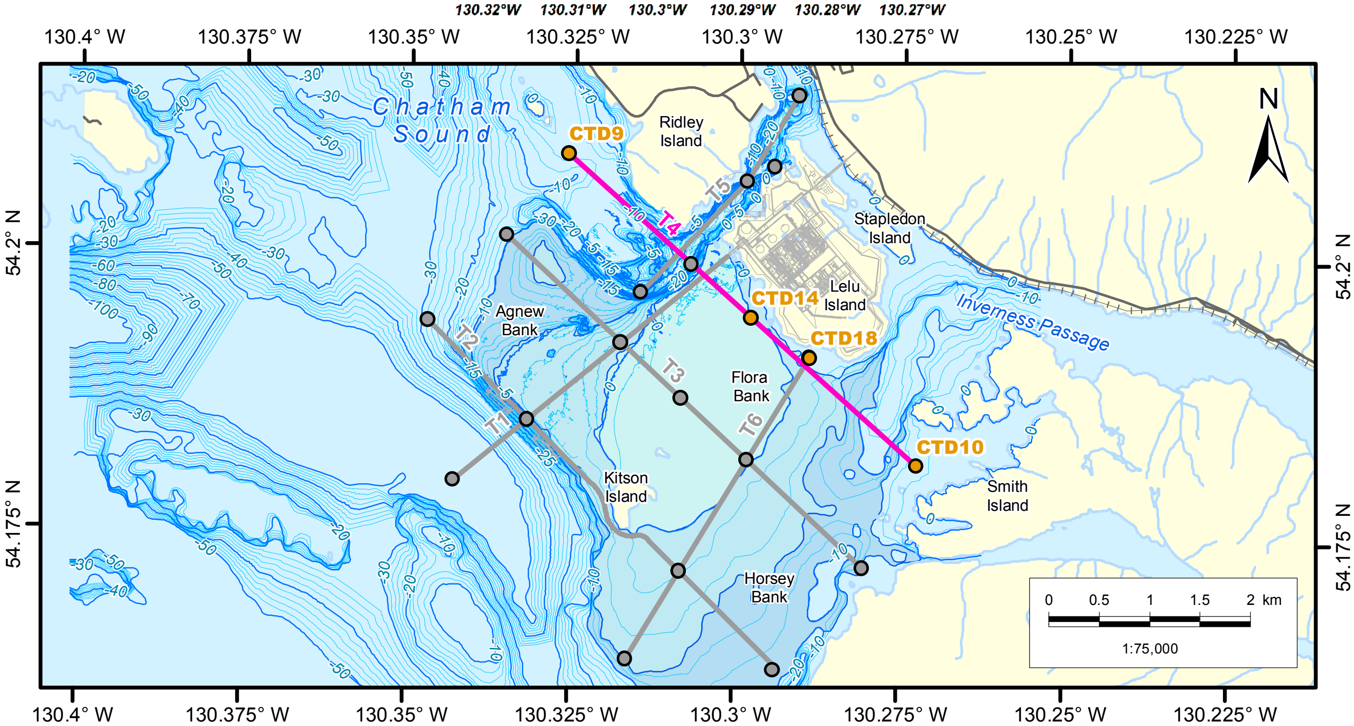

Illustrated Oceanographic Site	
Other Oceanographic Site	
Illustrated Transect	
Other Transect	
Project Component	

Bathymetry (m)
- Major Contour
- Minor Contour
- Railway
- Road
- Secondary Road
- Watercourse

Waterbody

Shoal
- Flora Bank
- 0 - 5 m Deep Shoal
- 5 - 10 m Deep Shoal

Pacific NorthWest LNG

Daytime Fish Survey Marine Water Column Profiling: Transect 4 (December 18, 2014)

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

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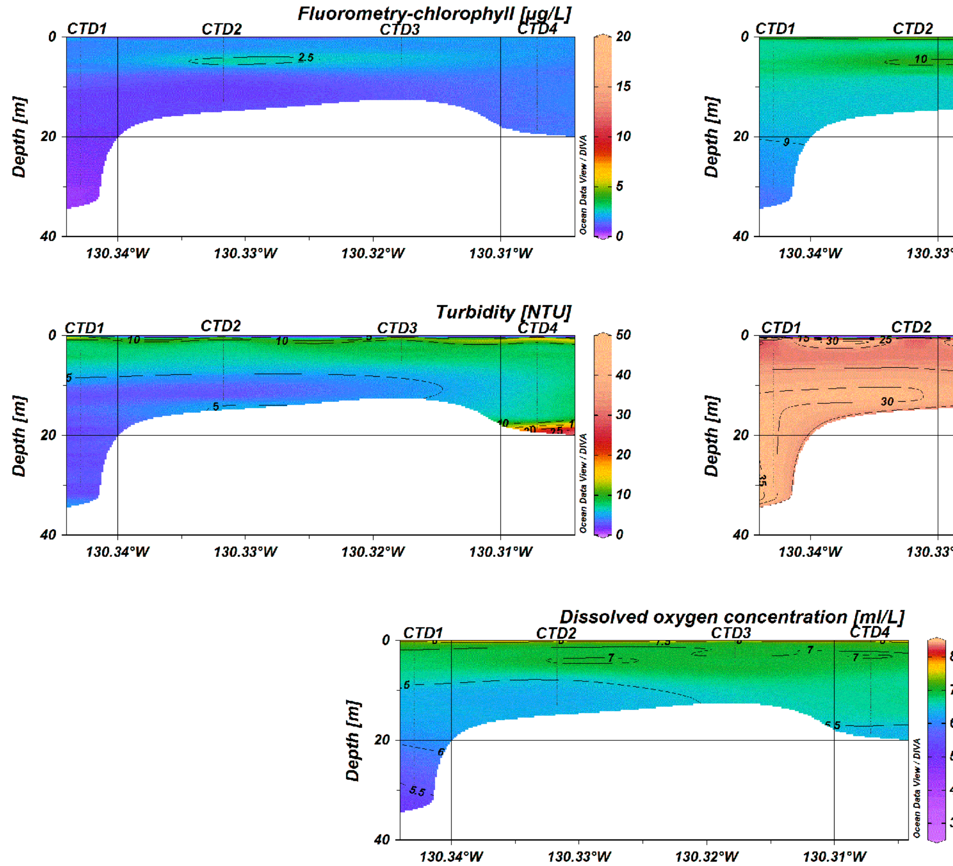
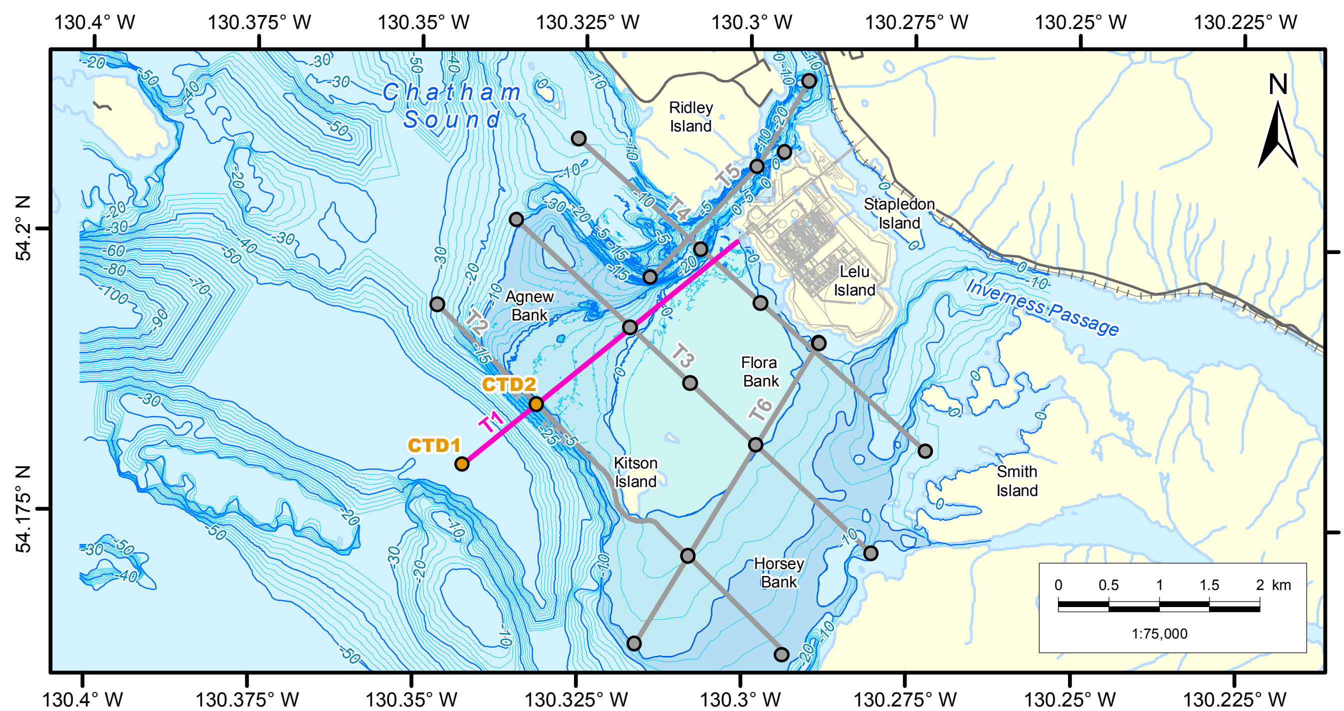
DRAWN BY: R. CAMPBELL
PROJECTION: UTM - ZONE 9
DATUM: NAD 83
CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **A- 4**





Legend		
Illustrated Oceanographic Site	**Bathymetry (m)**	Waterbody
Other Oceanographic Site	Major Contour	**Shoal**
Illustrated Transect	Minor Contour	Flora Bank
Other Transect	Railway	0 - 5 m Deep Shoal
Project Component	Road	5 - 10 m Deep Shoal
	Secondary Road	
	Watercourse	

Pacific NorthWest LNG

Daytime Fish Survey Marine Water Column Profiling: Transect 1 (May 19, 2015)

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

DATE: 01-OCT-15	PROJECTION: UTM - ZONE 9
FIGURE ID: 123110537	DATUM: NAD 83
DRAWN BY: R. CAMPBELL	CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **A- 5**

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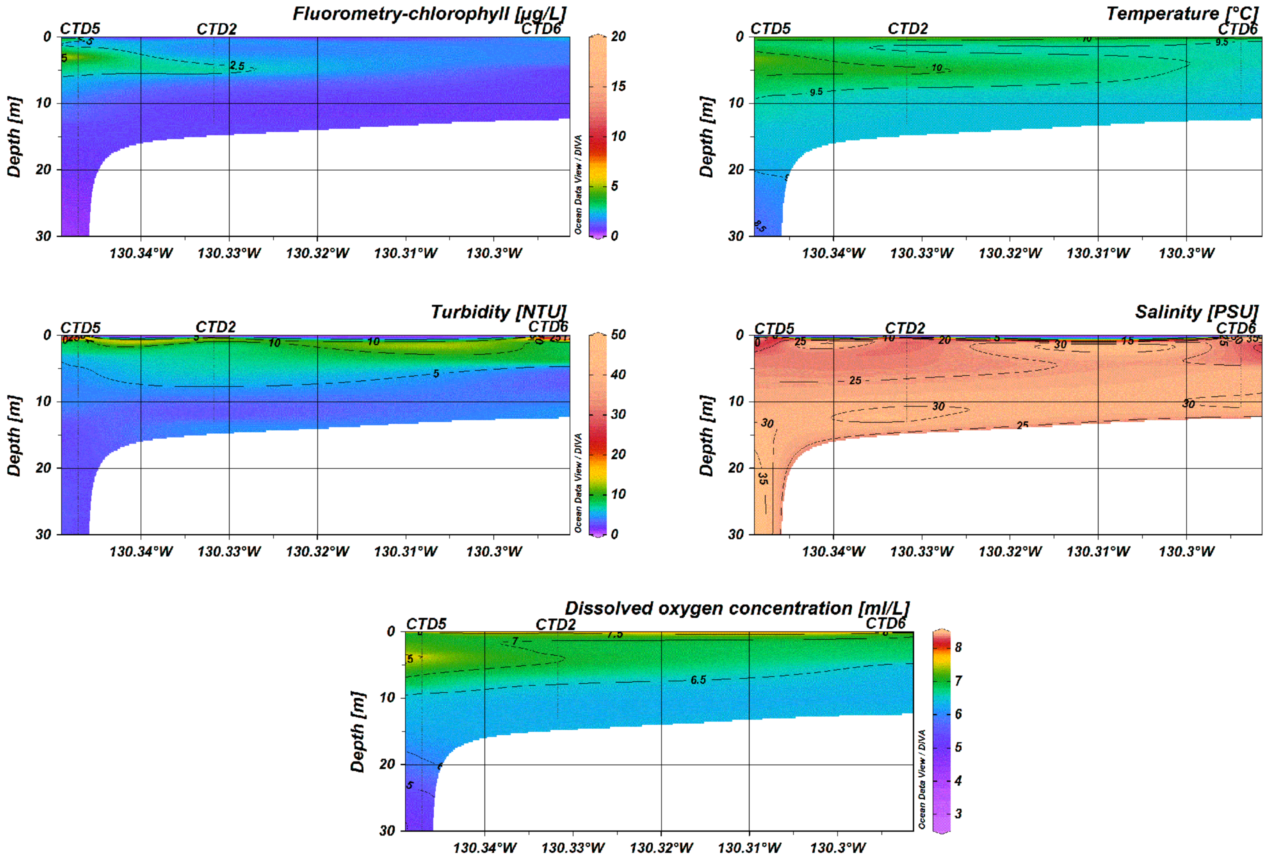

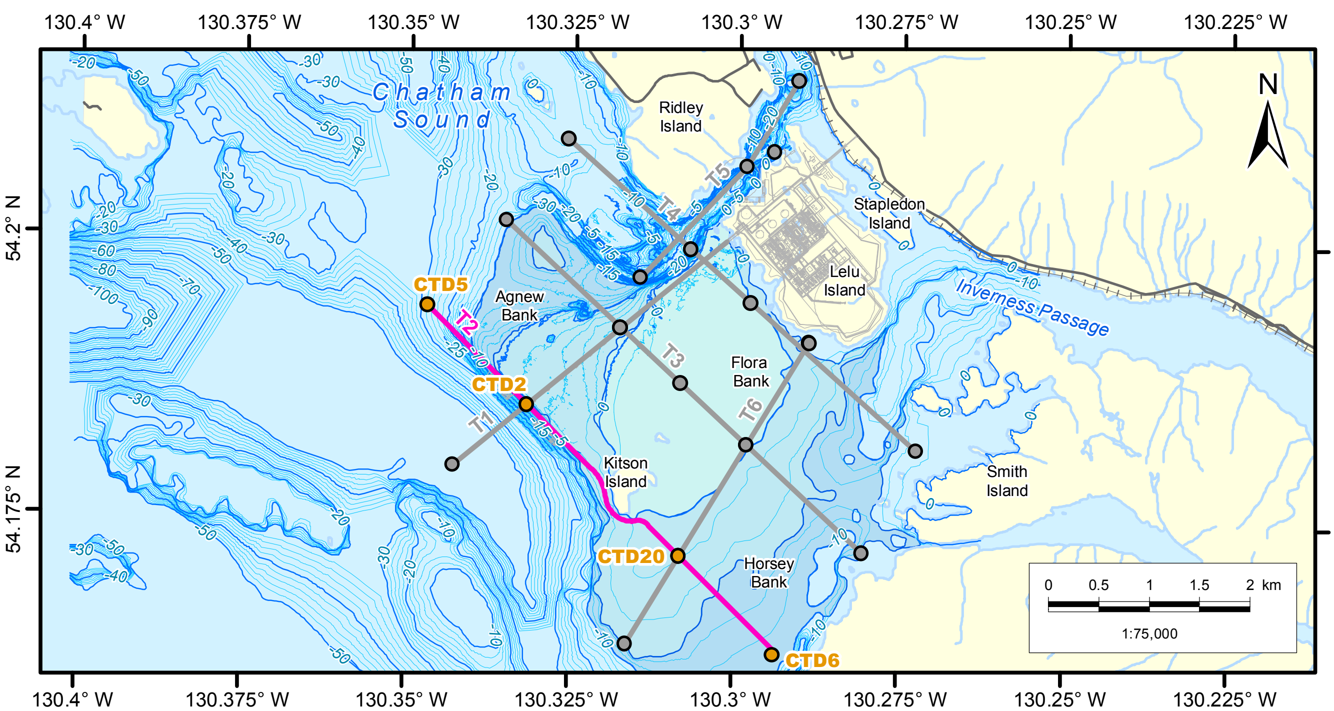

Illustrated Oceanographic Site
Other Oceanographic Site
Illustrated Transect
Other Transect
Project Component

Bathymetry (m)
Major Contour
Minor Contour
Railway
Road
Secondary Road
Watercourse

Waterbody
Shoal
Flora Bank
0 - 5 m Deep Shoal
5 - 10 m Deep Shoal

Pacific NorthWest LNG

Daytime Fish Survey Marine Water Column Profiling: Transect 2 (May 19, 2015)

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

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DATE: 01-OCT-15
FIGURE ID: 123110537
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PROJECTION: UTM - ZONE 9
DATUM: NAD 83
CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO:
A- 6

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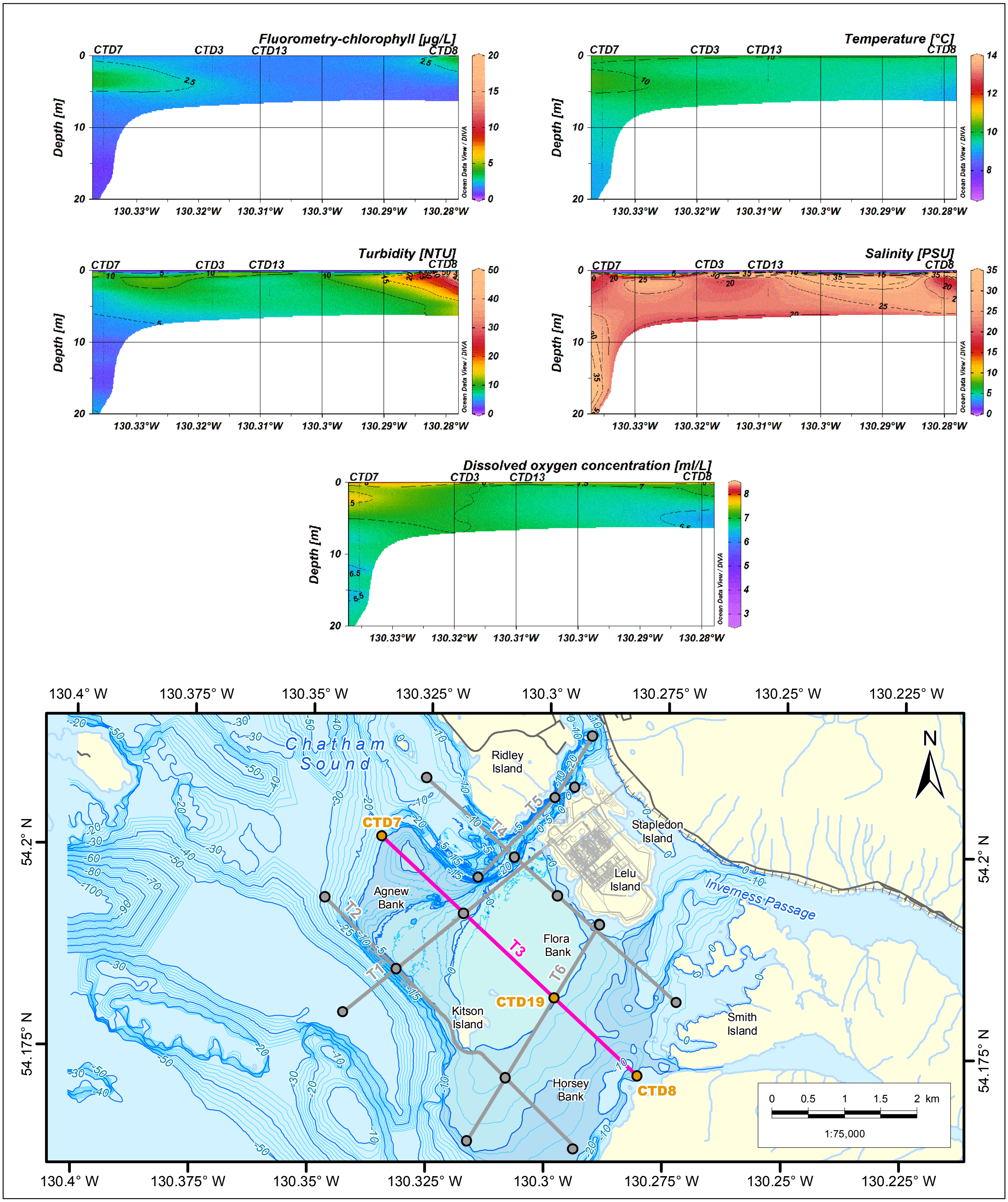


Illustrated Oceanographic Site	**Bathymetry (m)**	Waterbody
Other Oceanographic Site	Major Contour	**Shoal**
Illustrated Transect	Minor Contour	Flora Bank
Other Transect	Railway	0 - 5 m Deep Shoal
Project Component	Road	5 - 10 m Deep Shoal
	Secondary Road	
	Watercourse	

Pacific NorthWest LNG

Daytime Fish Survey Marine Water Column Profiling: Transect 3 (May 19, 2015)

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

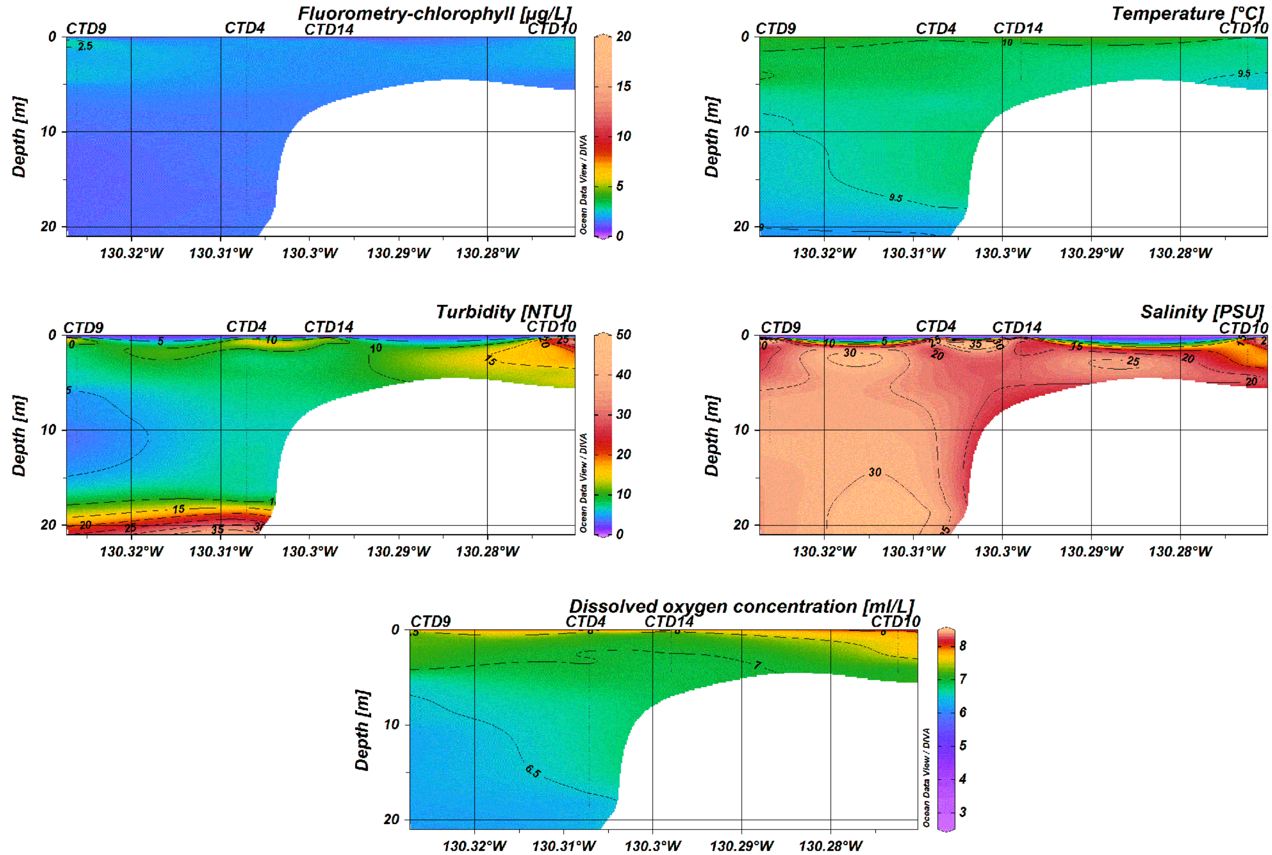
Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

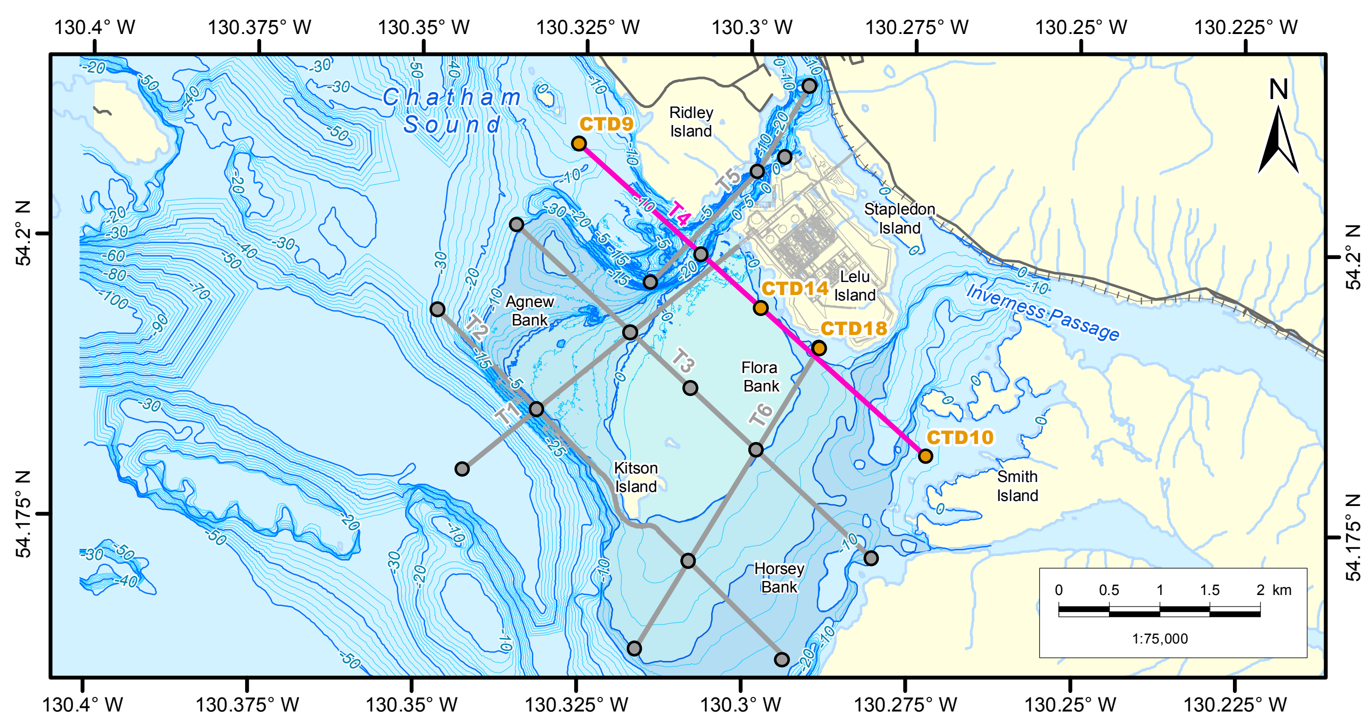
DATE: 01-OCT-15	PROJECTION: UTM - ZONE 9
FIGURE ID: 123110537	DATUM: NAD 83
DRAWN BY: R. CAMPBELL	CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **A- 7**





Illustrated Oceanographic Site

Other Oceanographic Site

Illustrated Transect

Other Transect

Project Component

Bathymetry (m)

Major Contour

Minor Contour

Railway

Road

Secondary Road

Watercourse

Waterbody

Shoal

Flora Bank

0 - 5 m Deep Shoal

5 - 10 m Deep Shoal

Pacific NorthWest LNG

Daytime Fish Survey Marine Water Column Profiling: Transect 4 (May 19, 2015)

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

DATE: 01-OCT-15
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PROJECTION: UTM - ZONE 9
DATUM: NAD 83
CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO:

A- 8

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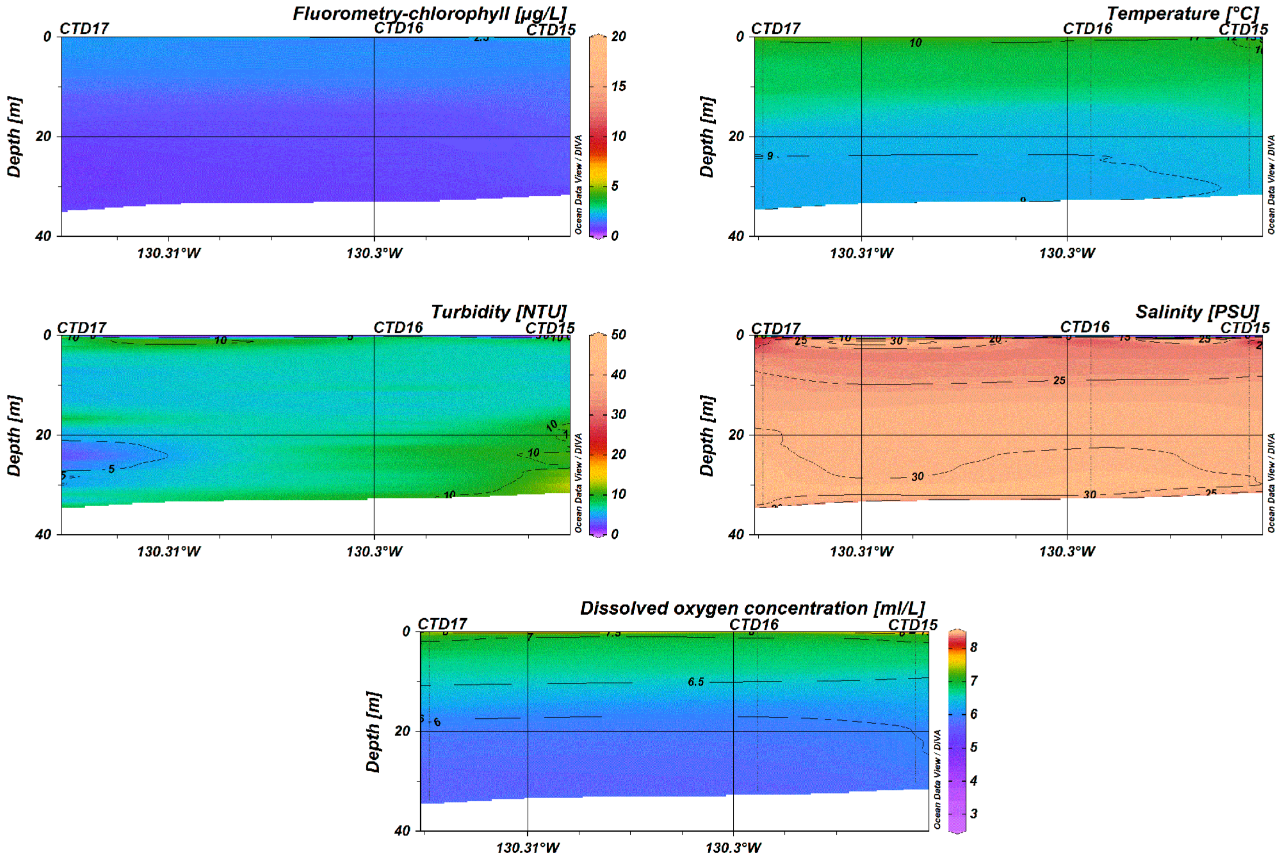

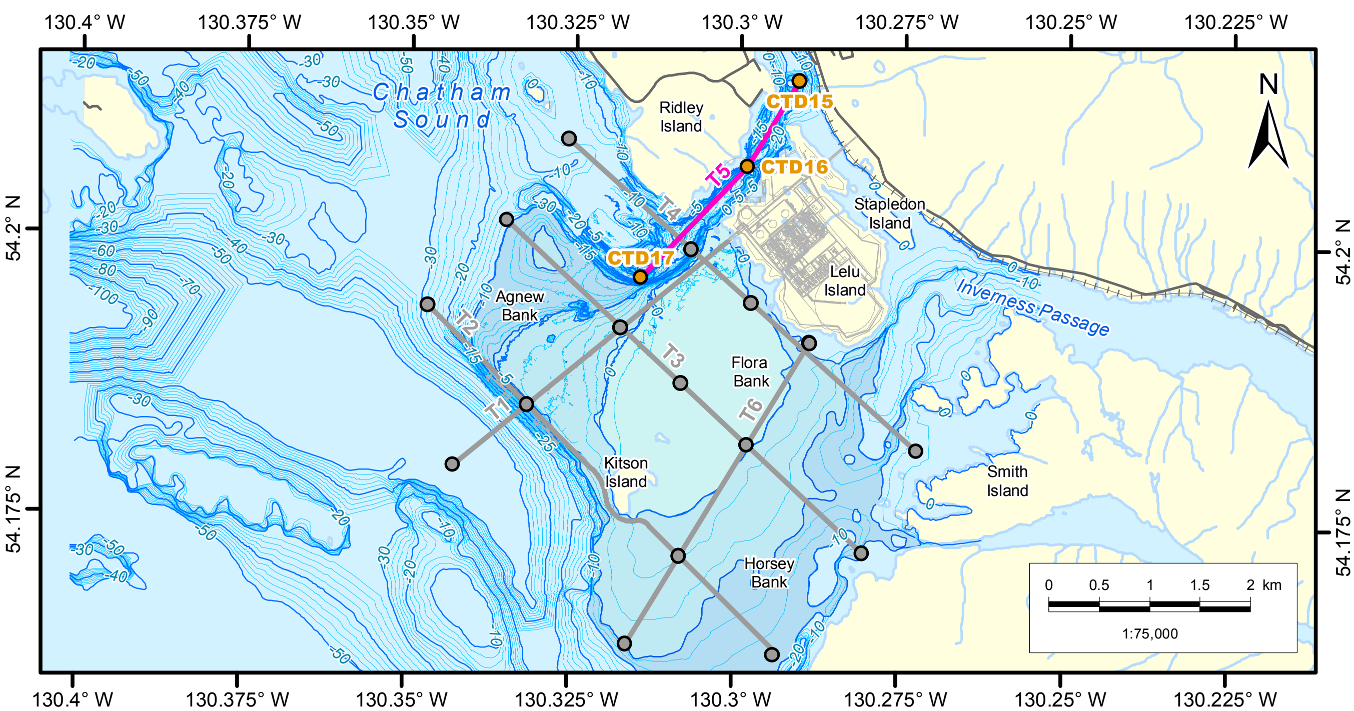

Illustrated Oceanographic Site	**Bathymetry (m)**	Waterbody	
Other Oceanographic Site	Major Contour	**Shoal**	
Illustrated Transect	Minor Contour	Flora Bank	
Other Transect	Railway	0 - 5 m Deep Shoal	
Project Component	Road	5 - 10 m Deep Shoal	
	Secondary Road		
	Watercourse		

Pacific NorthWest LNG

Daytime Fish Survey Marine Water Column Profiling: Transect 5 (May 19, 2015)

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

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DATE: 01-OCT-15
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DRAWN BY: R. CAMPBELL

PROJECTION: UTM - ZONE 9
DATUM: NAD 83
CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **A- 9**

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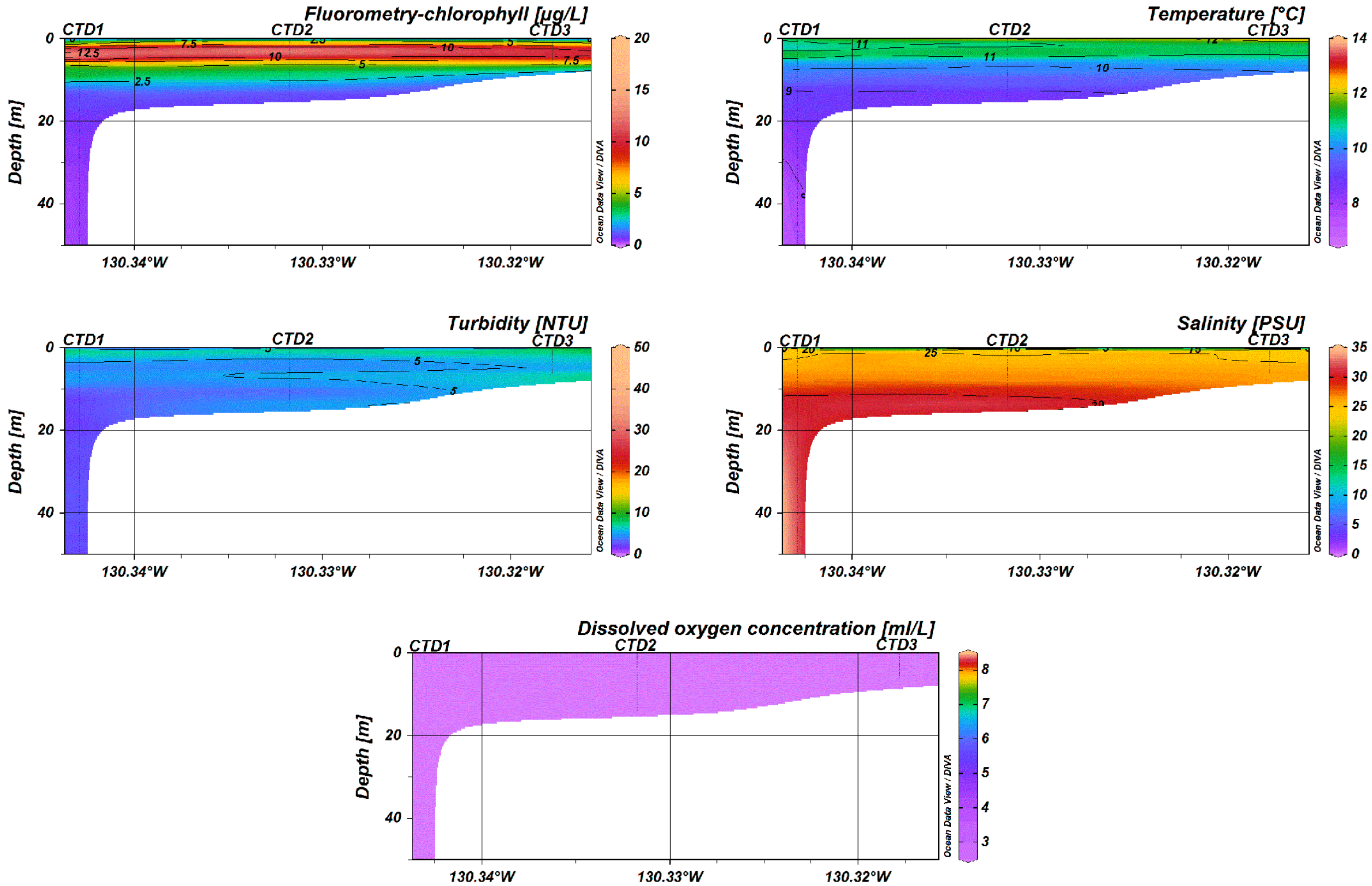

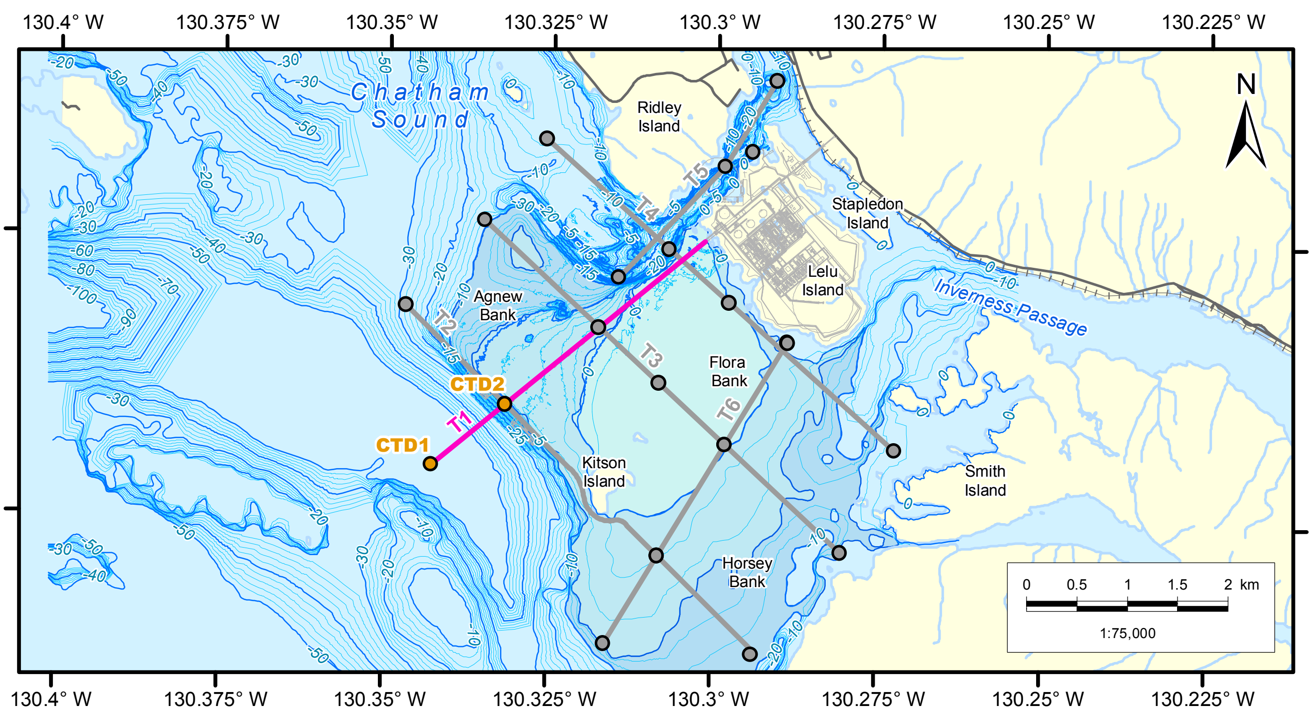

Illustrated Oceanographic Site

Other Oceanographic Site

Illustrated Transect

Other Transect

Project Component

Bathymetry (m)

Major Contour

Minor Contour

Railway

Road

Secondary Road

Watercourse

Waterbody

Shoal

Flora Bank

0 - 5 m Deep Shoal

5 - 10 m Deep Shoal

Pacific NorthWest LNG

Daytime Fish Survey Marine Water Column Profiling: Transect 1 (June 18, 2015)

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

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DATE: 01-OCT-15
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DRAWN BY: R. CAMPBELL

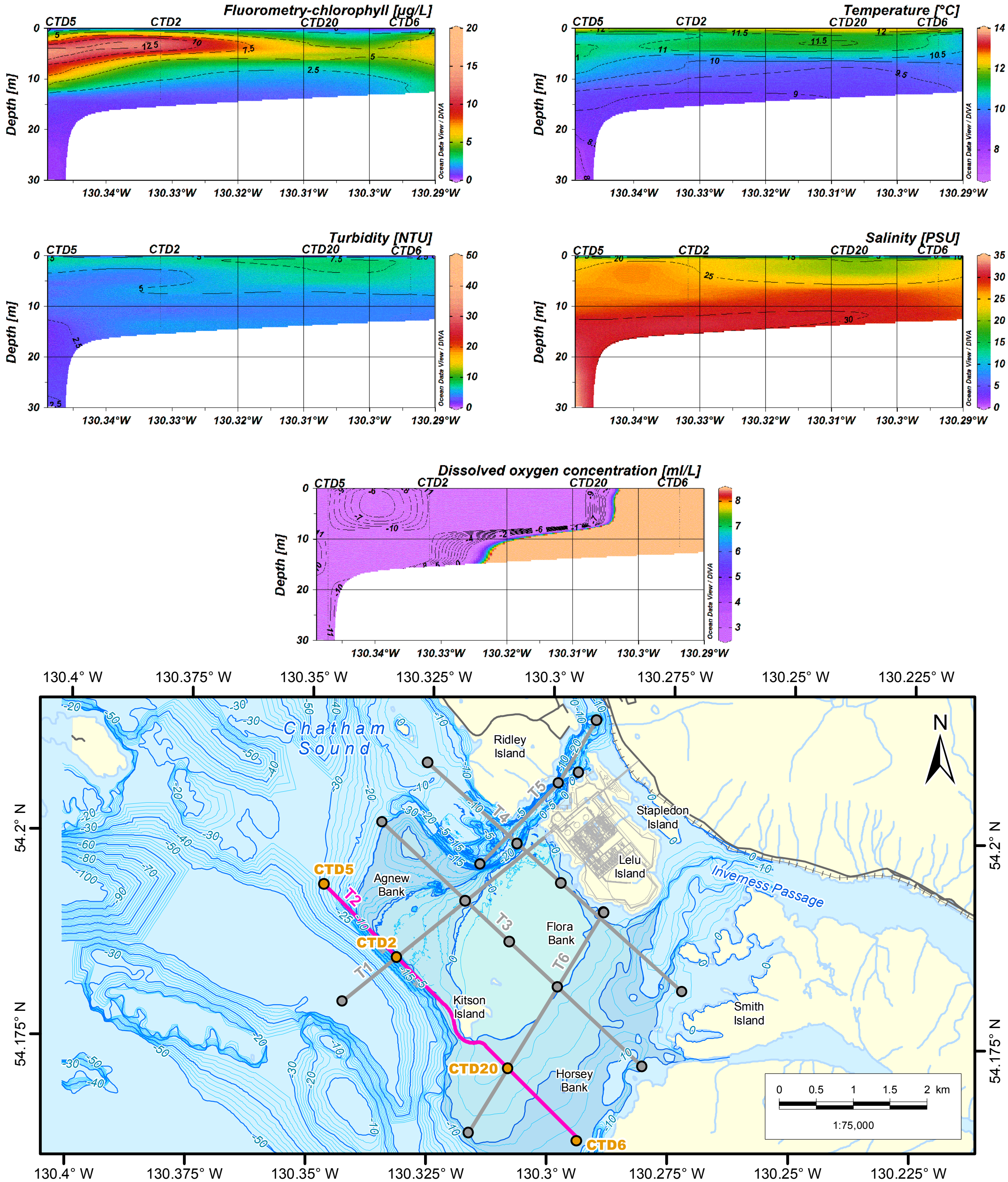
PROJECTION: UTM - ZONE 9
DATUM: NAD 83
CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO:

A- 10



Illustrated Oceanographic Site	Bathymetry (m)
Other Oceanographic Site	Major Contour
Illustrated Transect	Minor Contour
Other Transect	Railway
Project Component	Road
	Secondary Road
	Watercourse

Waterbody

Shoal

- Flora Bank
- 0 - 5 m Deep Shoal
- 5 - 10 m Deep Shoal

Pacific NorthWest LNG

Daytime Fish Survey Marine Water Column Profiling: Transect 2 (June 18, 2015)

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

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DATE: 01-OCT-15
FIGURE ID: 123110537
DRAWN BY: R. CAMPBELL

PROJECTION: UTM - ZONE 9
DATUM: NAD 83
CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO:

A- 11

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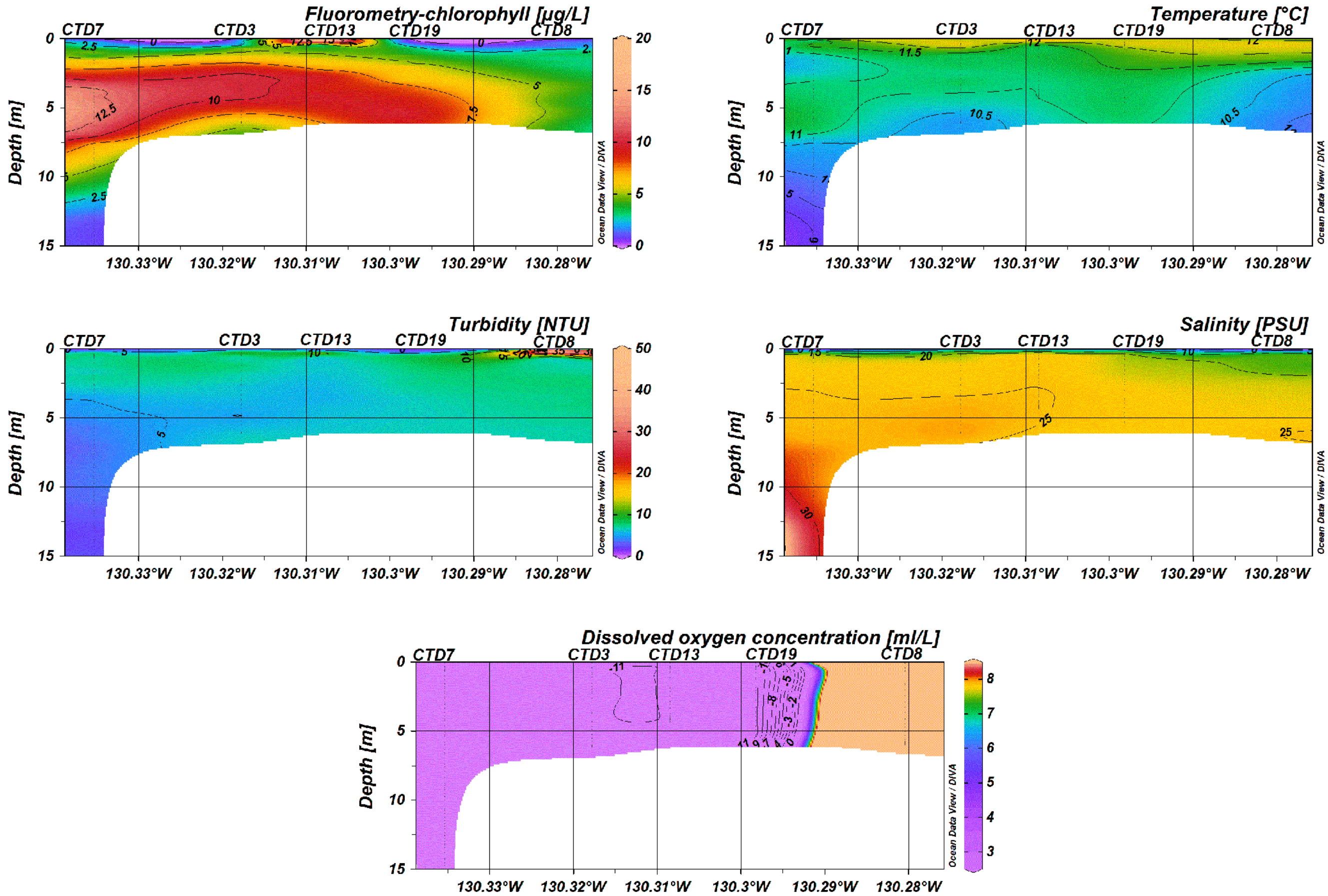

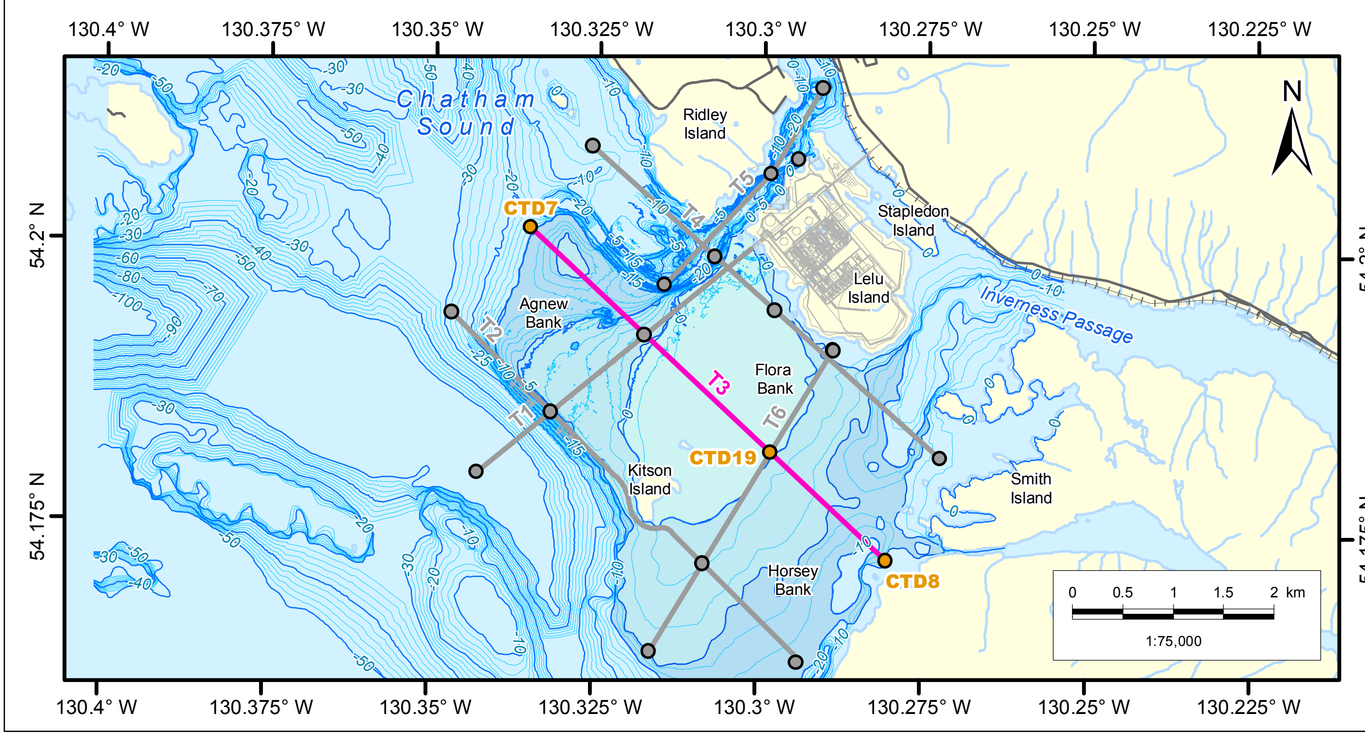

Illustrated Oceanographic Site

Other Oceanographic Site

Illustrated Transect

Other Transect

Project Component

Bathymetry (m)

Major Contour

Minor Contour

Railway

Road

Secondary Road

Watercourse

Waterbody

Shoal

Flora Bank

0 - 5 m Deep Shoal

5 - 10 m Deep Shoal

Pacific NorthWest LNG

Daytime Fish Survey Marine Water Column Profiling: Transect 3 (June 18, 2015)

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

DATE: 01-OCT-15
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DRAWN BY: R. CAMPBELL

PROJECTION: UTM - ZONE 9
DATUM: NAD 83
CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO:

A- 12

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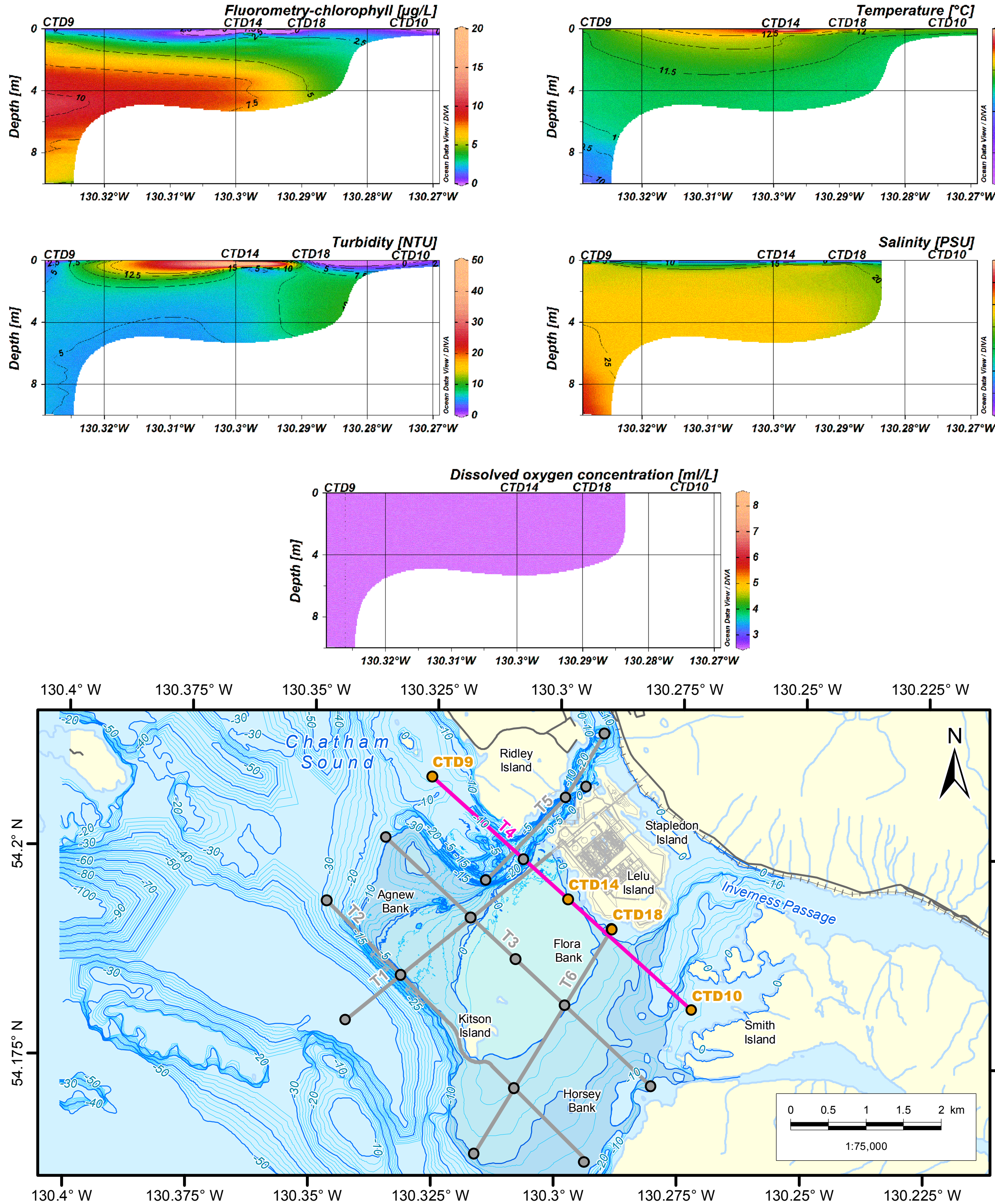

Illustrated Oceanographic Site

Other Oceanographic Site

Illustrated Transect

Other Transect

Project Component

Bathymetry (m)

Major Contour

Minor Contour

Railway

Road

Secondary Road

Watercourse

Waterbody

Shoal

Flora Bank

0 - 5 m Deep Shoal

5 - 10 m Deep Shoal

Pacific NorthWest LNG

Daytime Fish Survey Marine Water Column Profiling: Transect 4 (June 18, 2015)

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

DATE: 01-OCT-15
FIGURE ID: 123110537
DRAWN BY: R. CAMPBELL

PROJECTION: UTM - ZONE 9
DATUM: NAD 83
CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **A- 13**

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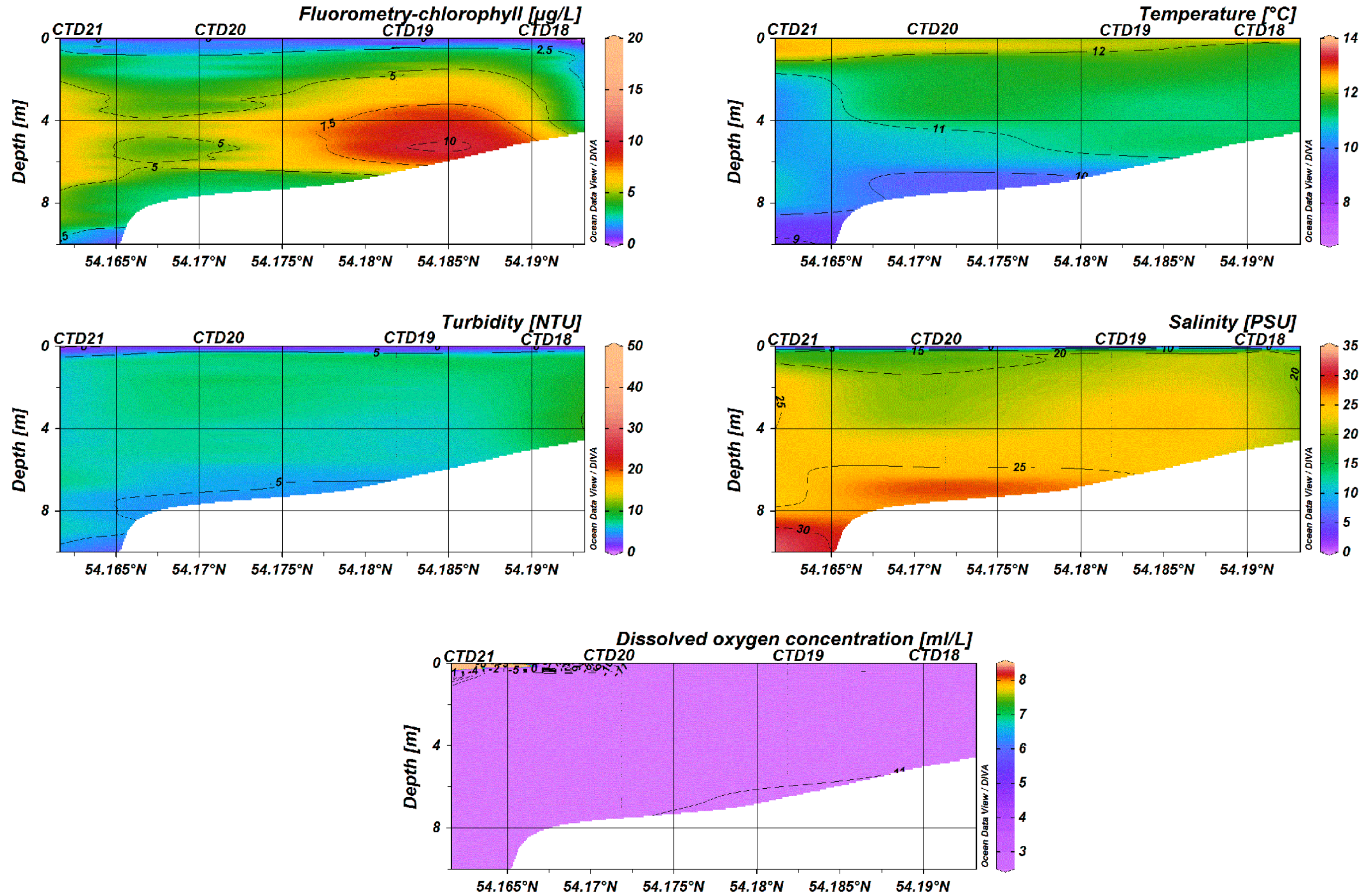
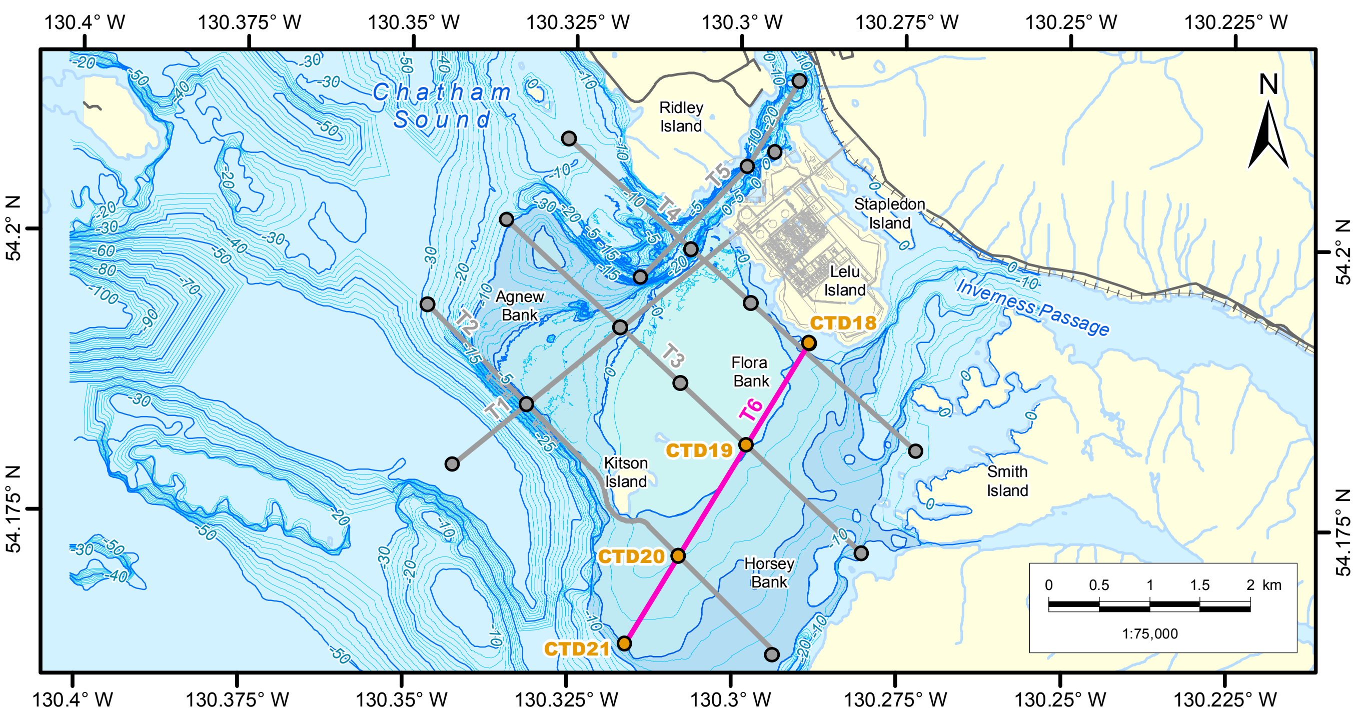




Illustrated Oceanographic Site
Other Oceanographic Site
Illustrated Transect
Other Transect
Project Component

Bathymetry (m)
Major Contour
Minor Contour
Railway
Road
Secondary Road
Watercourse

Waterbody
Shoal
Flora Bank
0 - 5 m Deep Shoal
5 - 10 m Deep Shoal

Pacific NorthWest LNG

Daytime Fish Survey Marine Water Column Profiling: Transect 6 (June 18, 2015)

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

DATE: 01-OCT-15
FIGURE ID: 123110537
DRAWN BY: R. CAMPBELL

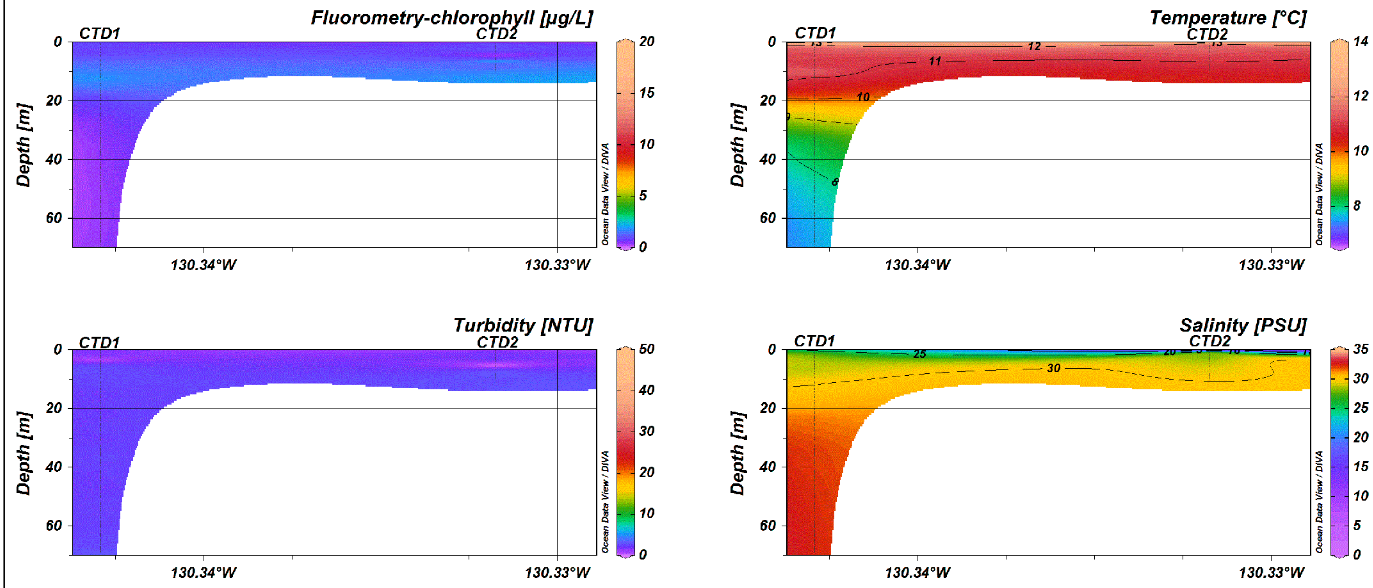
PROJECTION: UTM - ZONE 9
DATUM: NAD 83
CHECKED BY: S. O'REGAN

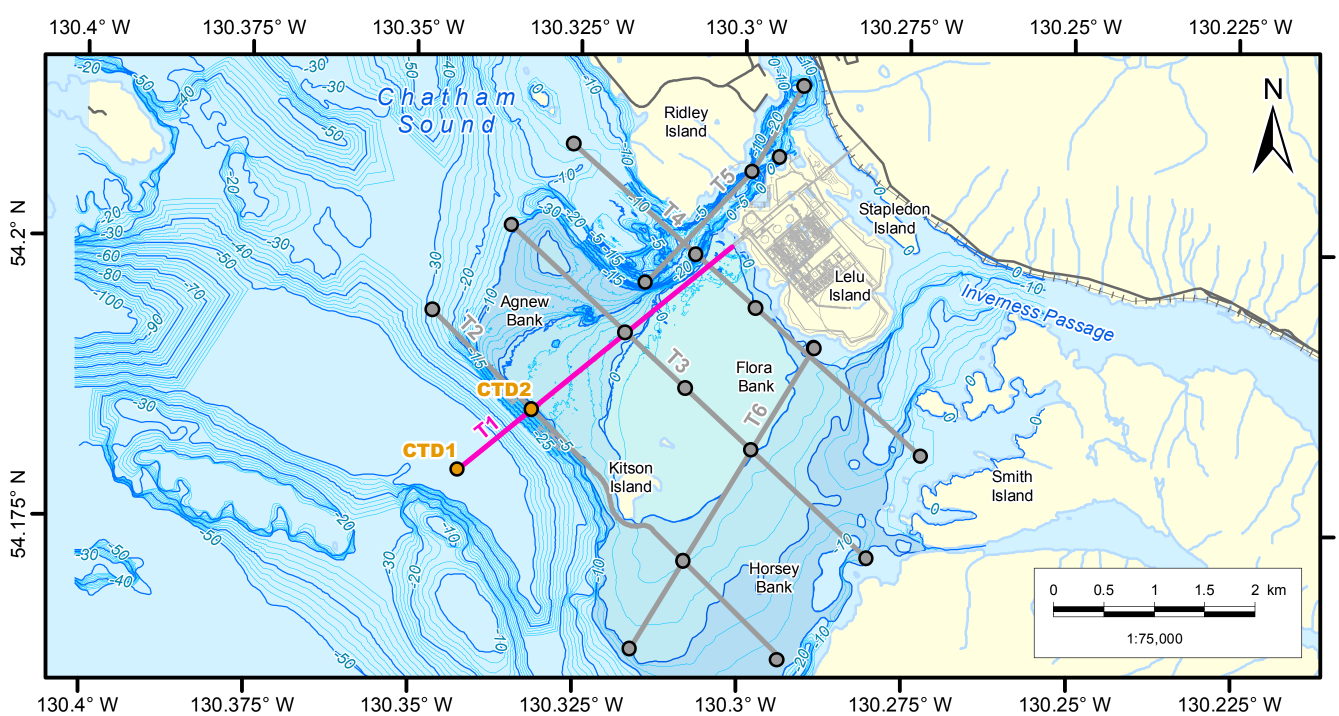
PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO:
A- 14

10/1/2015 - 3:48:54 PM \\cd1186-f04\workgroup\active\123110537\gis\figures\Interim_Report_2_Figures\Appendix_A\fig_123110537-905_gen_marine_010_Marfish_CTD_Section_Plot_Mapbook.mxd





Illustrated Oceanographic Site
Other Oceanographic Site
Illustrated Transect
Other Transect
Project Component

Bathymetry (m)
Major Contour
Minor Contour
Railway
Road
Secondary Road
Watercourse

Waterbody
Shoal
Flora Bank
0 - 5 m Deep Shoal
5 - 10 m Deep Shoal

Pacific NorthWest LNG

Daytime Fish Survey Marine Water Column Profiling: Transect 1 (July 19, 2015)

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

DATE: 01-OCT-15
FIGURE ID: 123110537
DRAWN BY: R. CAMPBELL

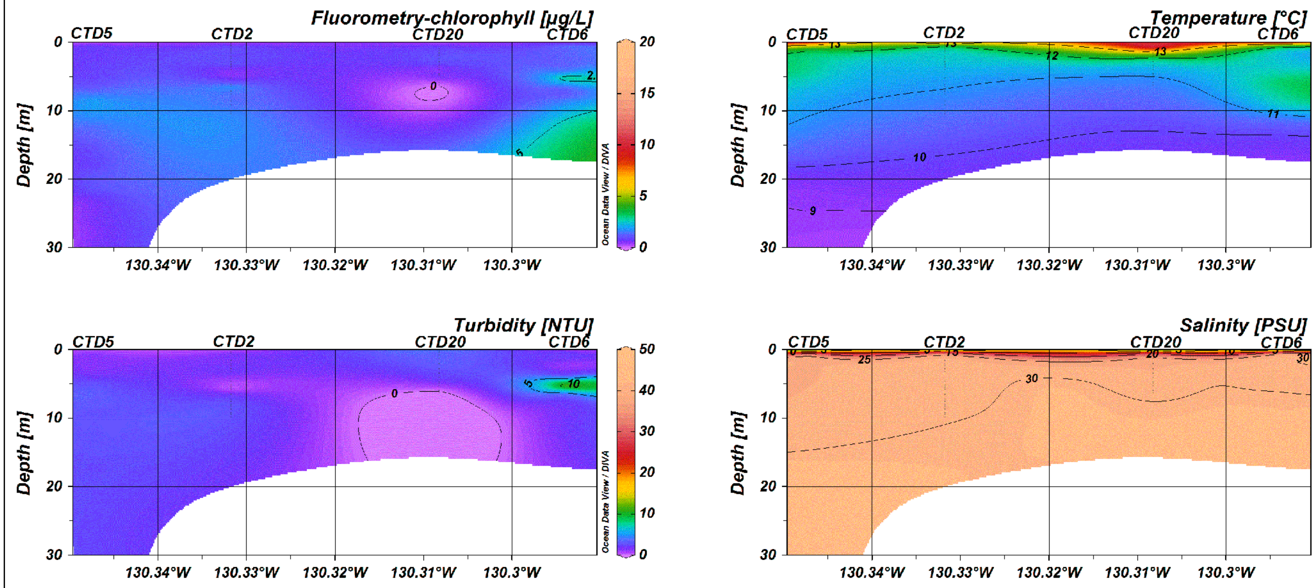
PROJECTION: UTM - ZONE 9
DATUM: NAD 83
CHECKED BY: S. O'REGAN

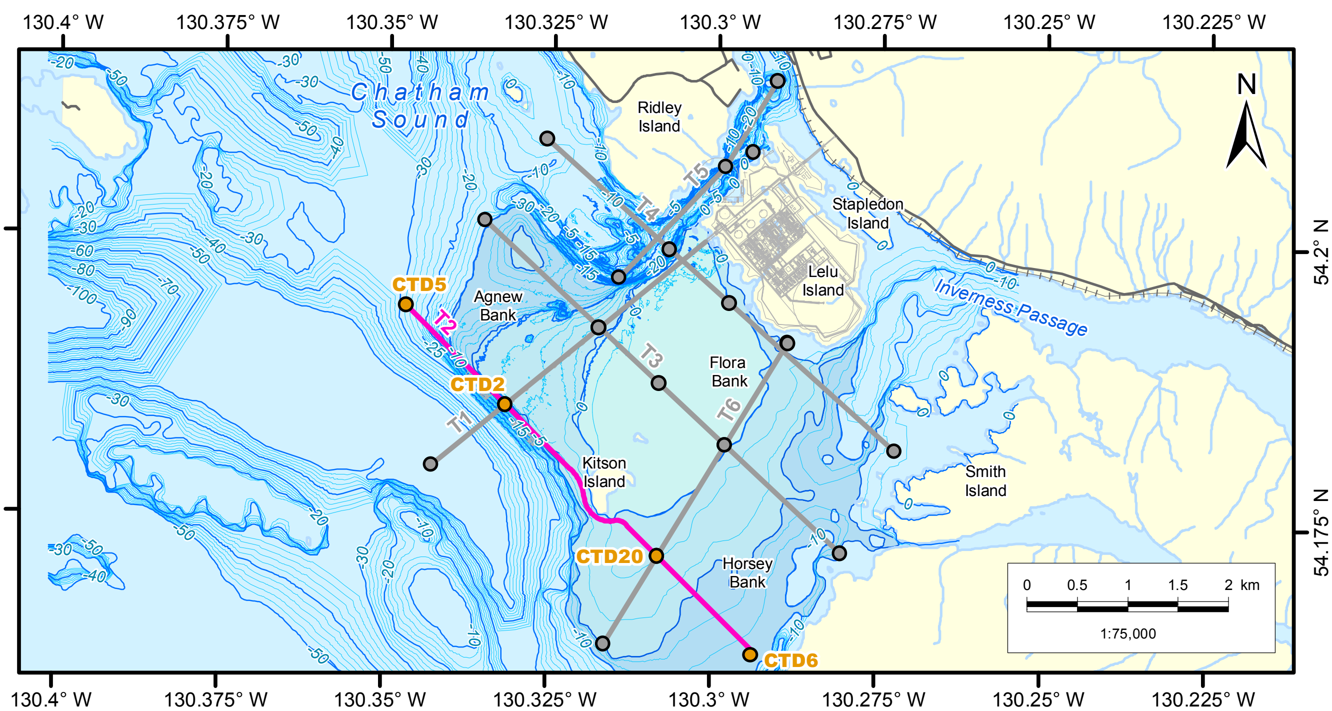
PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **A- 15**

10/1/2015 - 3:48:58 PM \\cd1186-f04\workgroup\active\123110537\gis\figures\Interim_Report_2_Figures\Appendix_A\fig_123110537-905_gen_marine_010_Marfish_CTD_Section_Plot_Mapbook.mxd





●	Illustrated Oceanographic Site
●	Other Oceanographic Site
—	Illustrated Transect
—	Other Transect
—	Project Component

Bathymetry (m)

- Major Contour
- Minor Contour
- Railway
- Road
- Secondary Road
- Watercourse

Waterbody

Shoal

- Flora Bank
- 0 - 5 m Deep Shoal
- 5 - 10 m Deep Shoal

Pacific NorthWest LNG

Daytime Fish Survey Marine Water Column Profiling: Transect 2 (July 19, 2015)

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

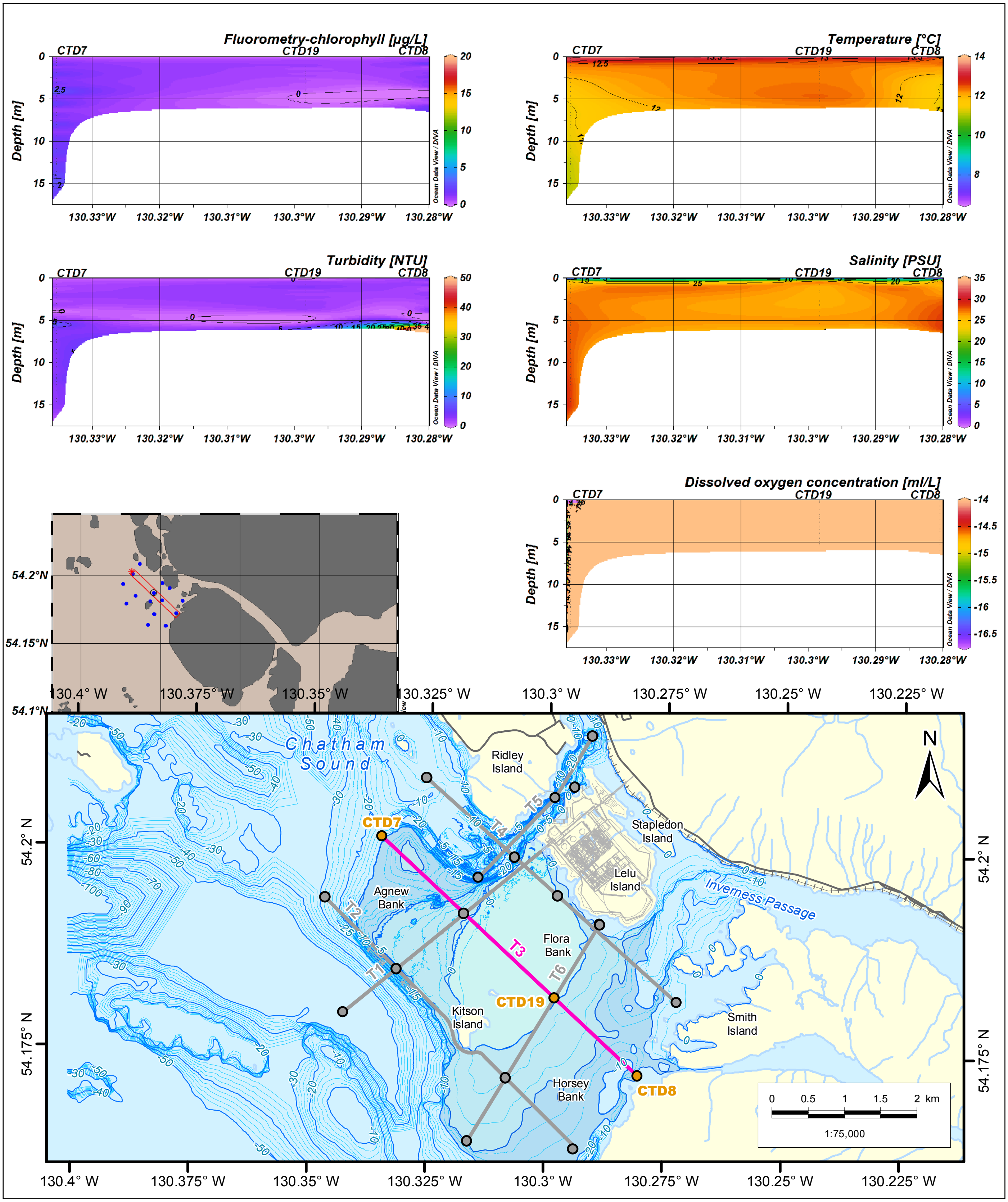
Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

DATE: 01-OCT-15	PROJECTION: UTM - ZONE 9
FIGURE ID: 123110537	DATUM: NAD 83
DRAWN BY: R. CAMPBELL	CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **A- 16**



Illustrated Oceanographic Site	**Bathymetry (m)**	Waterbody
Other Oceanographic Site	Major Contour	**Shoal**
Illustrated Transect	Minor Contour	Flora Bank
Other Transect	Railway	0 - 5 m Deep Shoal
Project Component	Road	5 - 10 m Deep Shoal
	Secondary Road	
	Watercourse	

Pacific NorthWest LNG

Daytime Fish Survey Marine Water Column Profiling: Transect 3 (July 19, 2015)

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

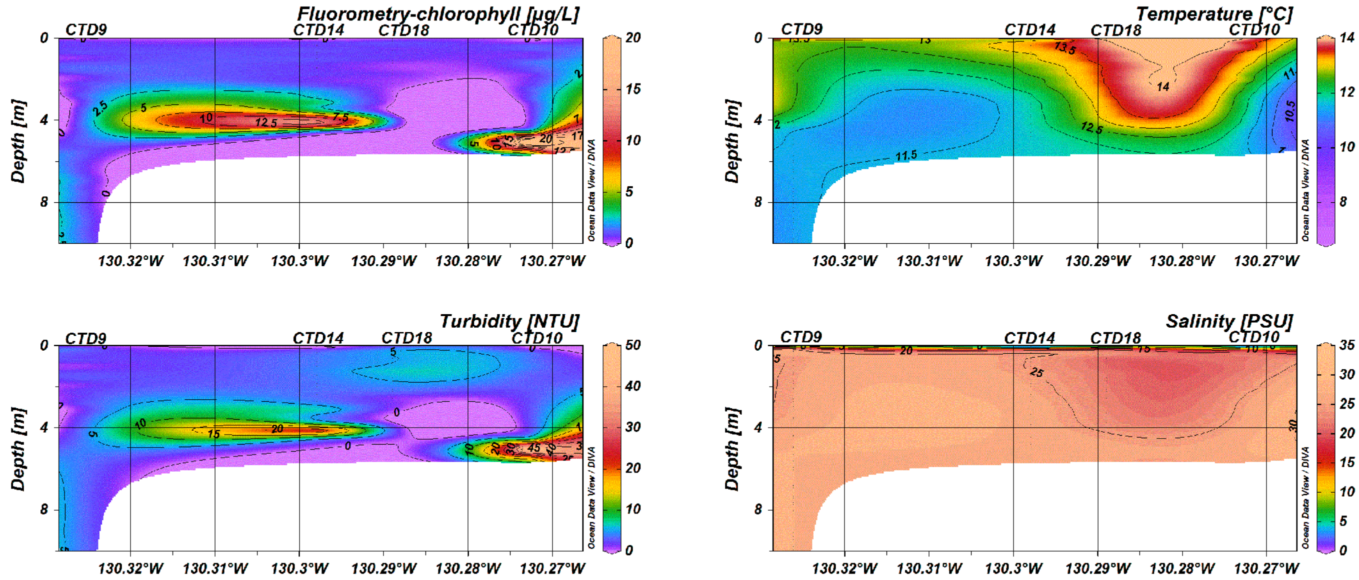
Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

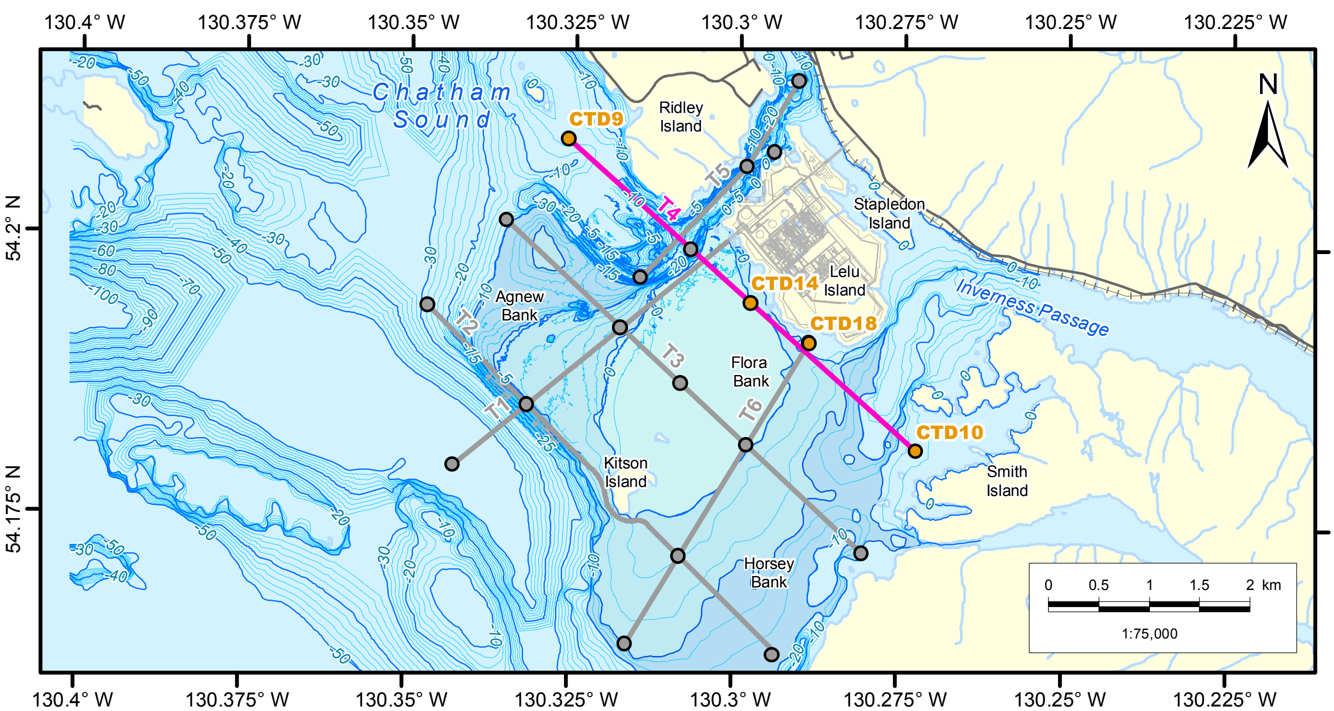
DATE: 01-OCT-15	PROJECTION: UTM - ZONE 9
FIGURE ID: 123110537	DATUM: NAD 83
DRAWN BY: R. CAMPBELL	CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **A- 17**





Illustrated Oceanographic Site	**Bathymetry (m)**	Waterbody
Other Oceanographic Site	Major Contour	**Shoal**
Illustrated Transect	Minor Contour	Flora Bank
Other Transect	Railway	0 - 5 m Deep Shoal
Project Component	Road	5 - 10 m Deep Shoal
	Secondary Road	
	Watercourse	

Pacific NorthWest LNG

Daytime Fish Survey Marine Water Column Profiling: Transect 4 (July 19, 2015)

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

DATE: 01-OCT-15
FIGURE ID: 123110537
DRAWN BY: R. CAMPBELL

PROJECTION: UTM - ZONE 9
DATUM: NAD 83
CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO:

A- 18

\\cd1186-f04\workgroup\active\123110537\gis\figures\Interim_Report_2_Figures\Appendix_A\fig_123110537-905_gen_marine_010_Marfish_CTD_Section_Plot_Mapbook.mxd
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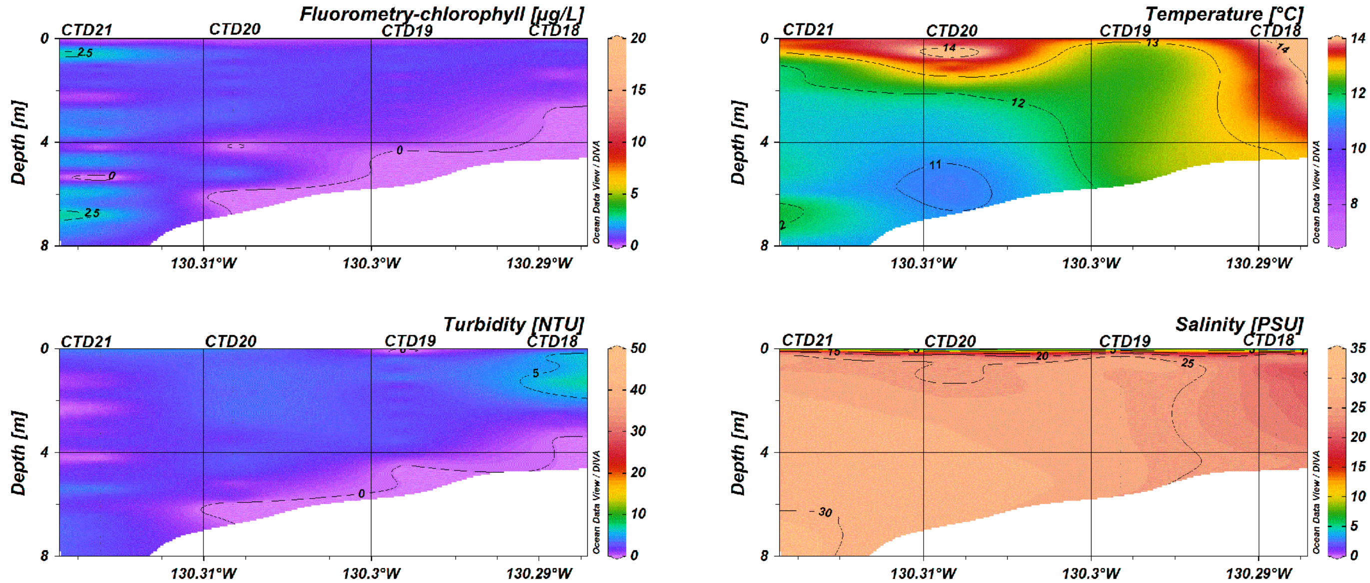
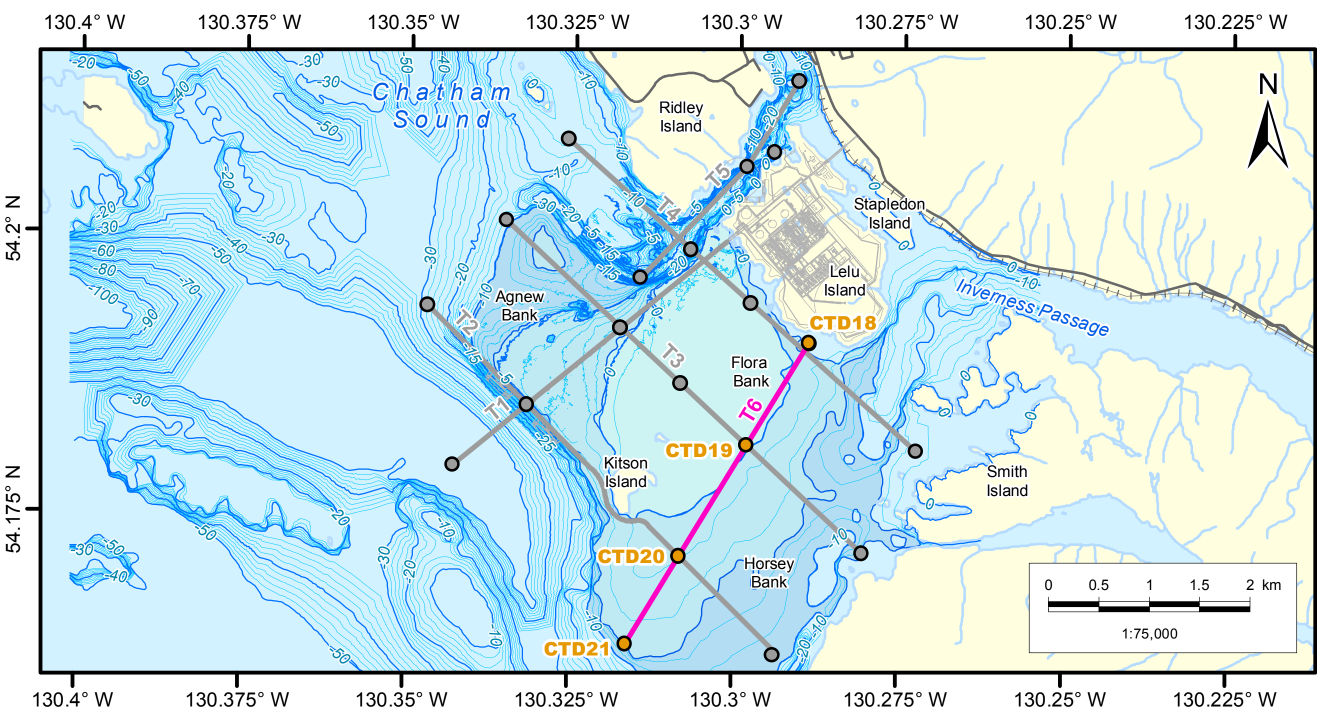




Legend		
Illustrated Oceanographic Site	**Bathymetry (m)**	Waterbody
Other Oceanographic Site	Major Contour	**Shoal**
Illustrated Transect	Minor Contour	Flora Bank
Other Transect	Railway	0 - 5 m Deep Shoal
Project Component	Road	5 - 10 m Deep Shoal
	Secondary Road	
	Watercourse	

Pacific NorthWest LNG

Daytime Fish Survey Marine Water Column Profiling: Transect 6 (July 19, 2015)

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

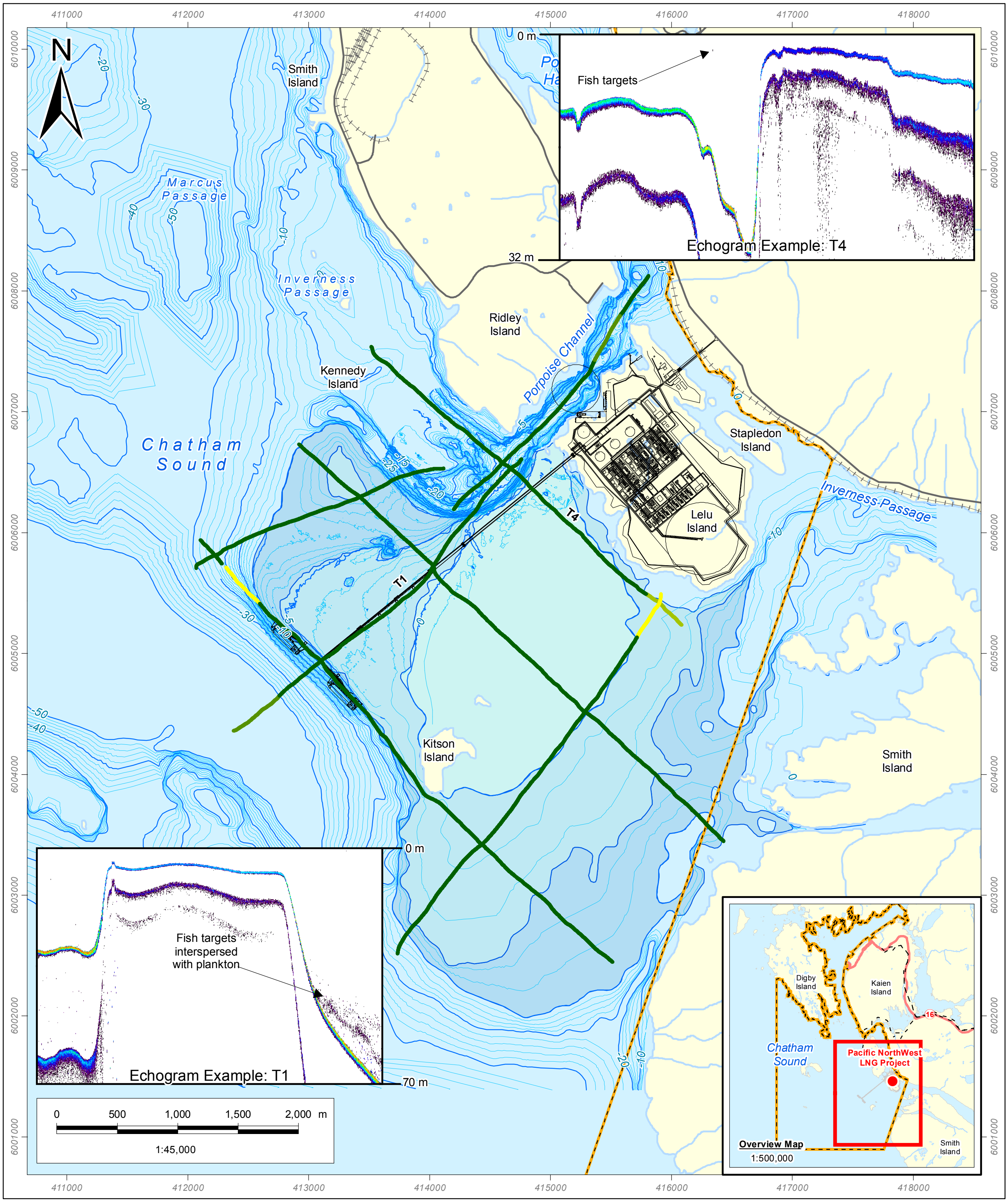
DATE: 01-OCT-15	PROJECTION: UTM - ZONE 9
FIGURE ID: 123110537	DATUM: NAD 83
DRAWN BY: R. CAMPBELL	CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **A- 19**

APPENDIX B
HYDROACOUSTICS FIGURES



Mean Volume Backscatter (MVBS) (dB)

- -80 and less
- -75 to -80
- -70 to -75
- -65 to -70
- -60 to -65
- -55 to -60
- -55 and greater

Project Component

Bathymetry (m)

- Major Contour
- Minor Contour
- Railway
- Secondary Road
- Watercourse

Prince Rupert Port Authority Boundary

Waterbody

Shoal

- Flora Bank
- 0 - 5 m Deep Shoal
- 5 - 10 m Deep Shoal

Pacific NorthWest LNG

Daytime Fish Hydroacoustic Survey 2, January 29 - 31, 2015

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

Although there is no reason to believe that there are any errors associated with the data used to produce this product or in the product itself, users of these data are advised that errors in the data may be present.

DATE: 14-OCT-15
FIGURE ID: 123110537
DRAWN BY: R. CAMPBELL

PROJECTION: UTM - ZONE 9
DATUM: NAD 83
CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **B-1**

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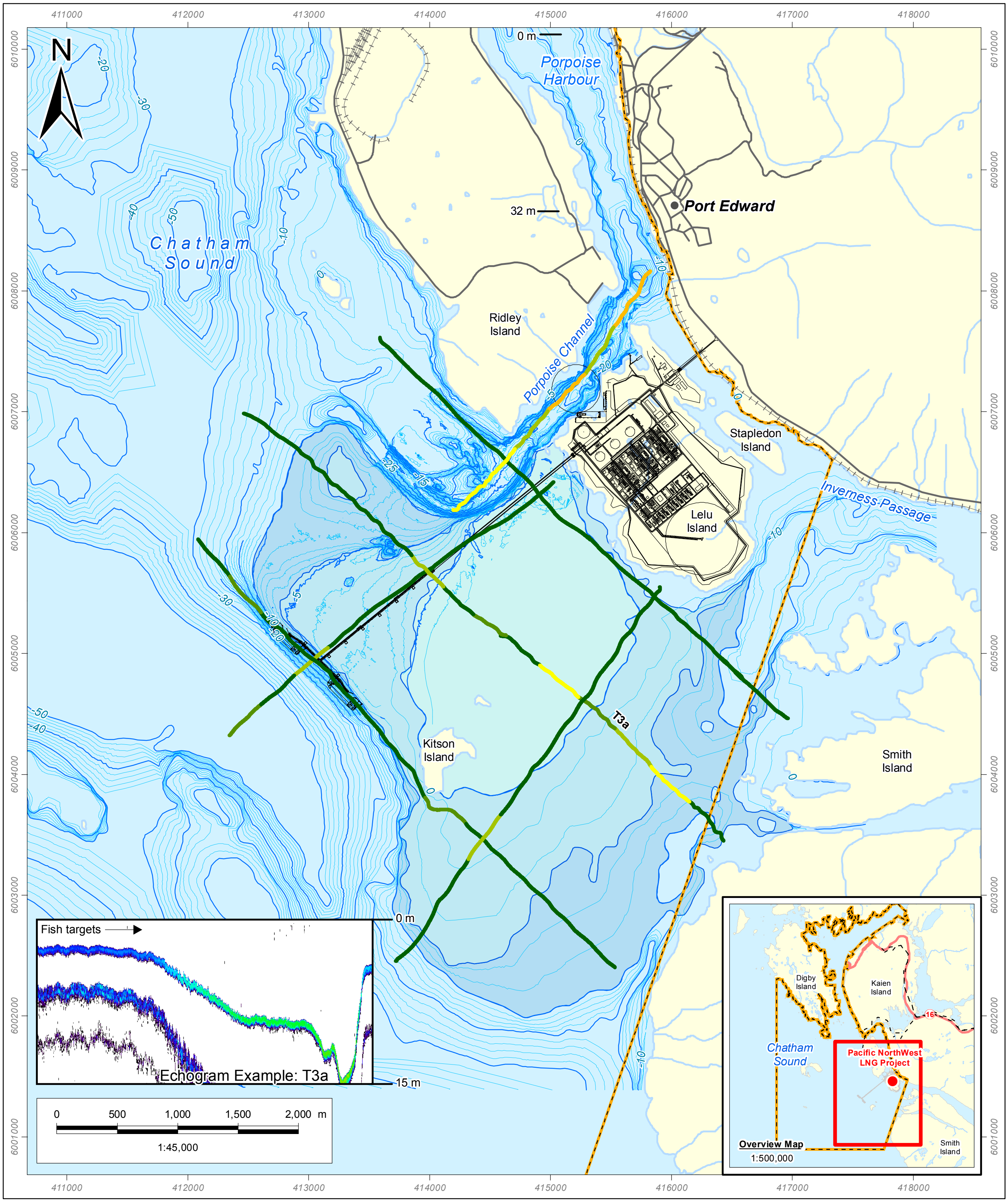


Mean Volume Backscatter (MVBS) (dB)

- -80 and less
- -75 to -80
- -70 to -75
- -65 to -70
- -60 to -65
- -55 to -60
- -55 and greater

Project Component

Bathymetry (m)

- Major Contour
- Minor Contour
- Railway
- Secondary Road
- Watercourse

Prince Rupert Port Authority Boundary

Waterbody

Shoal

- Flora Bank
- 0 - 5 m Deep Shoal
- 5 - 10 m Deep Shoal

Pacific NorthWest LNG

Daytime Fish Hydroacoustic Survey 3, February 18 - 21, 2015

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

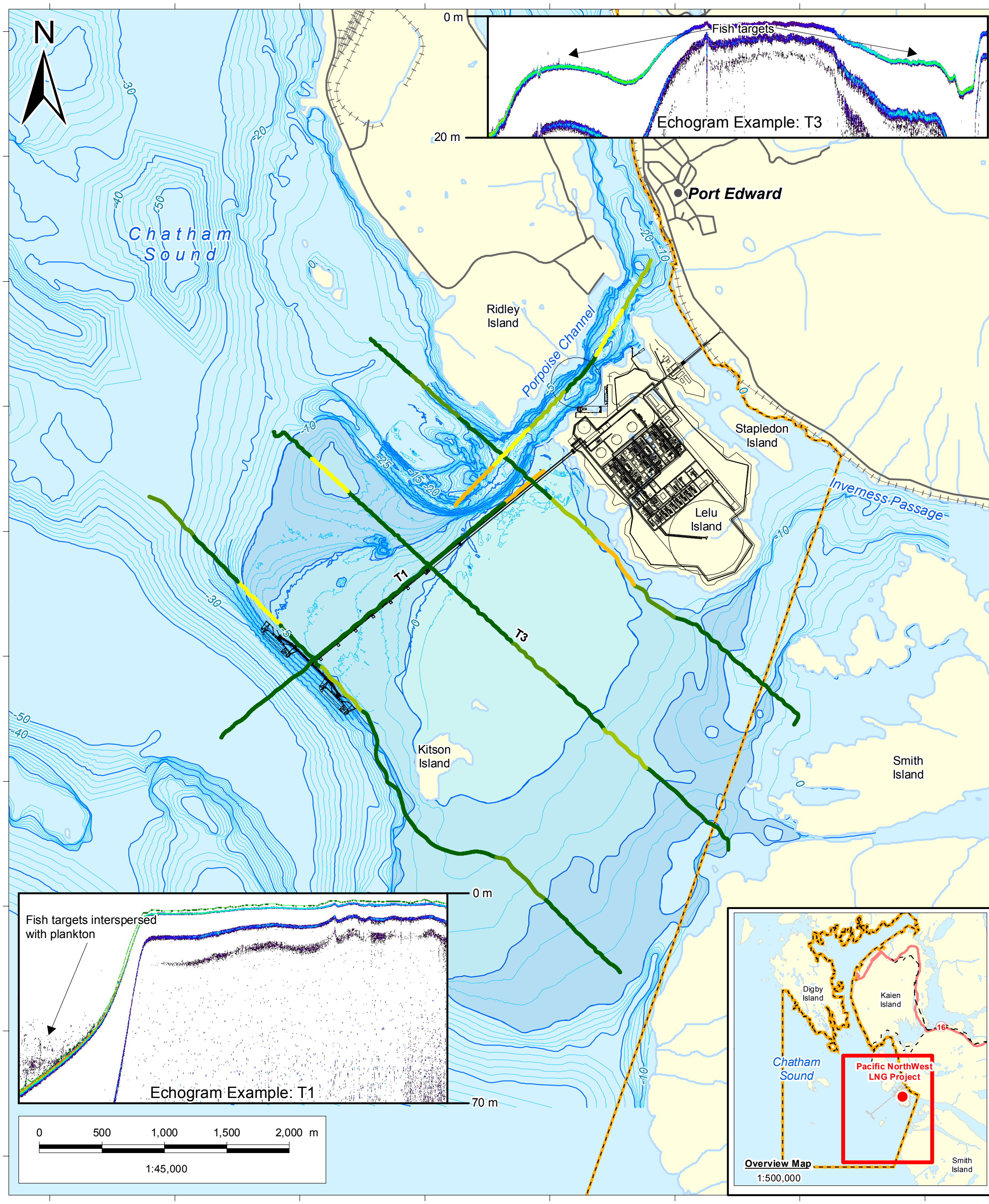
DATE: 29-SEP-15
FIGURE ID: 123110537
DRAWN BY: R. CAMPBELL

PROJECTION: UTM - ZONE 9
DATUM: NAD 83
CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **B-2**



Mean Volume Backscatter (MVBS) (dB)
- -80 and less
- -75 to -80
- -70 to -75
- -65 to -70
- -60 to -65
- -55 to -60
- -55 and greater

Project Component

Bathymetry (m)
- Major Contour
- Minor Contour

Railway
Secondary Road
Watercourse
Prince Rupert Port Authority Boundary
Waterbody

Shoal
- Flora Bank
- 0 - 5 m Deep Shoal
- 5 - 10 m Deep Shoal

Pacific NorthWest LNG

Daytime Fish Hydroacoustic Survey 4, March 23 - 24, 2015

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

DATE: 29-SEP-15
FIGURE ID: 123110537
DRAWN BY: R. CAMPBELL
PROJECTION: UTM - ZONE 9
DATUM: NAD 83
CHECKED BY: S. O'REGAN

PREPARED BY: Stantec
PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **B-3**

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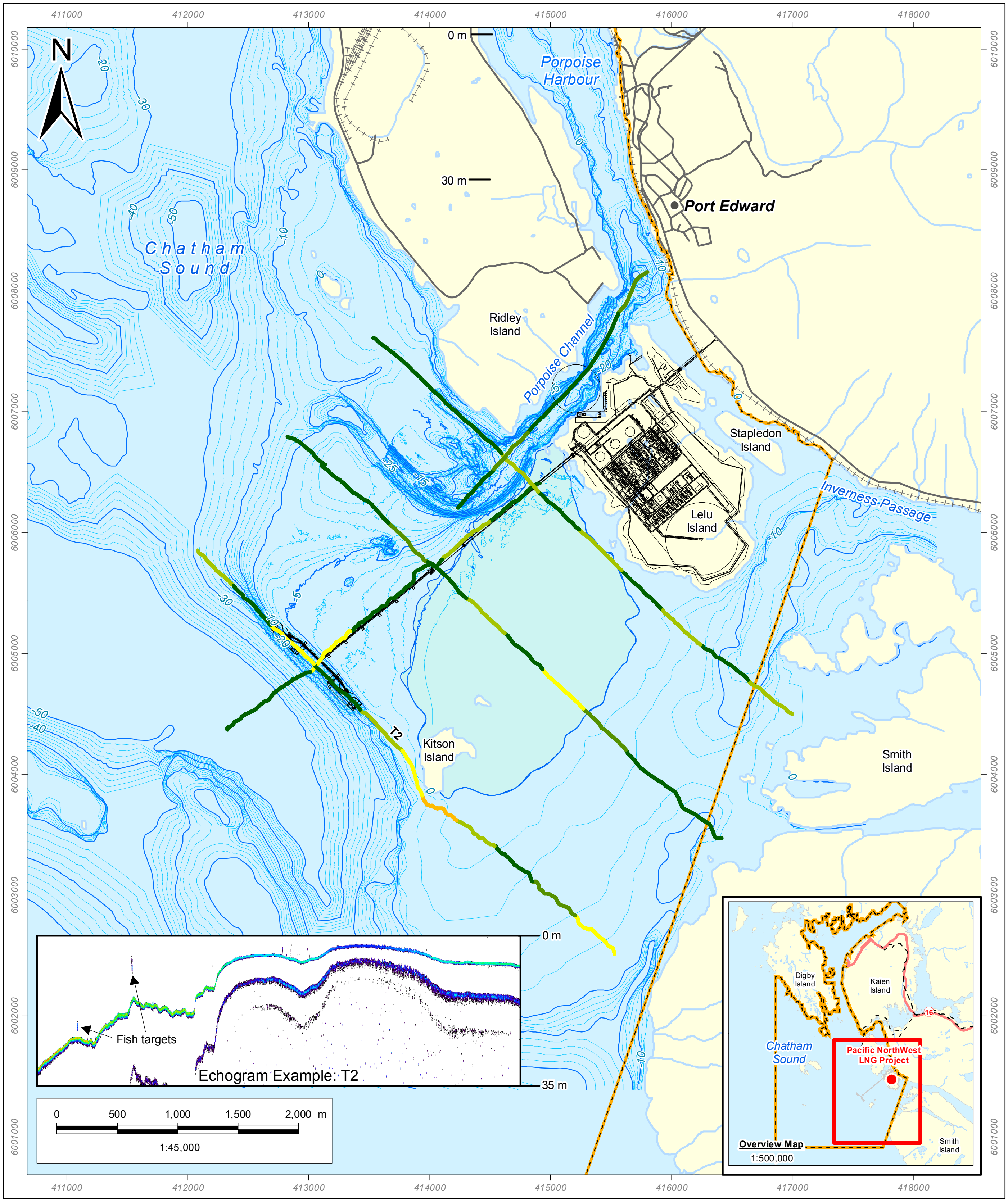


Mean Volume Backscatter (MVBS) (dB)

- -80 and less
- -75 to -80
- -70 to -75
- -65 to -70
- -60 to -65
- -55 to -60
- -55 and greater

Project Component

Bathymetry (m)

- Major Contour
- Minor Contour
- Railway
- Secondary Road
- Watercourse

Prince Rupert Port Authority Boundary

Waterbody

Shoal

- Agnew Bank
- Flora Bank
- Horsey Bank

Pacific NorthWest LNG

Daytime Fish Hydroacoustic Survey 5, April 26 - 27, 2015

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

DATE: 29-SEP-15
FIGURE ID: 123110537
DRAWN BY: R. CAMPBELL

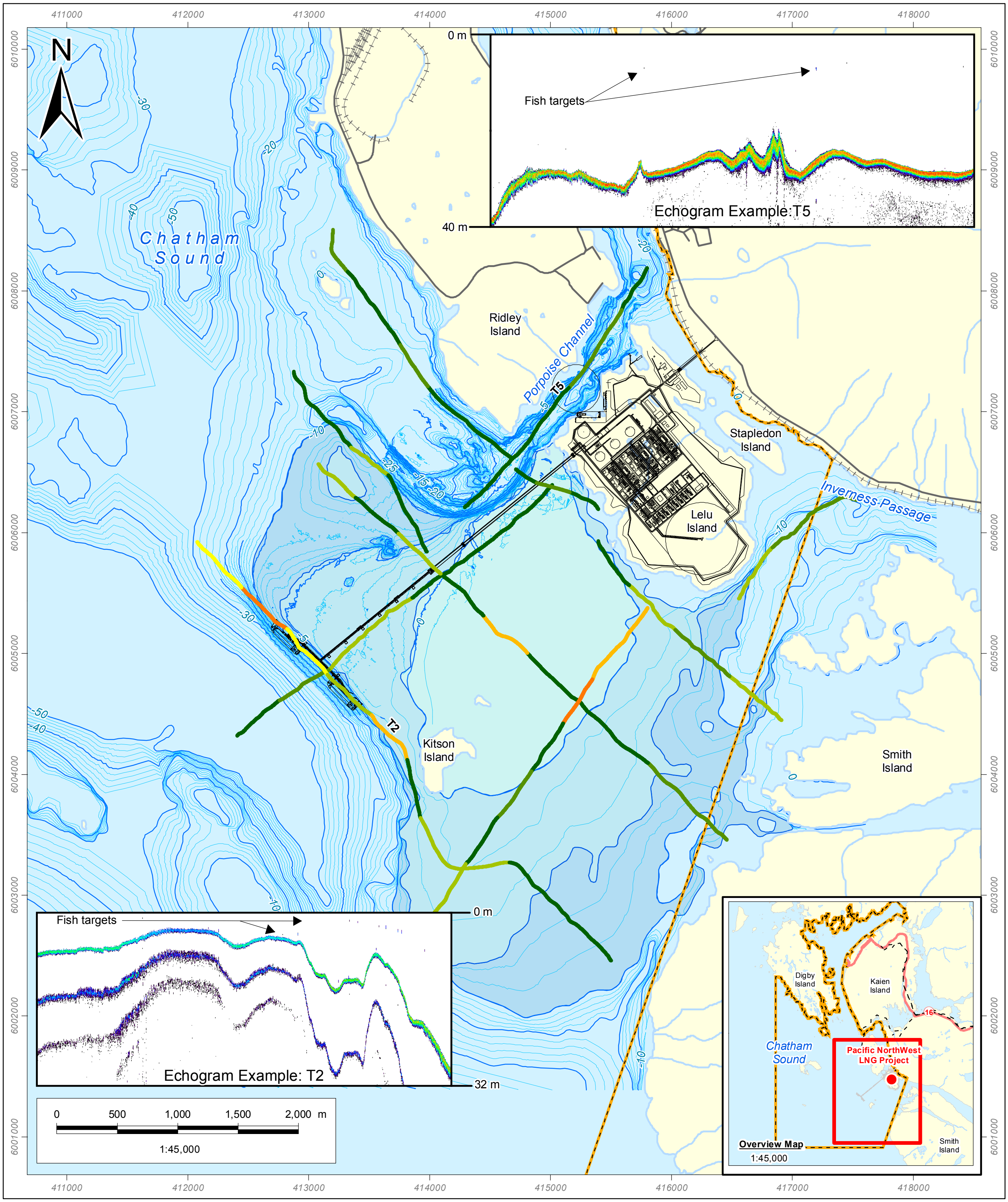
PROJECTION: UTM - ZONE 9
DATUM: NAD 83
CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **B-4**

9/29/2015 - 3:06:09 PM \\cd1186-f04\workgroup\active\123110537\gis\figures\Interim_Report_2_Figures\Appendix_B\fig_b-4_123110537_marine_12_Hydroacoustic_Survey_marfish_05.mxd



Mean Volume Backscatter (MVBS) (dB)

- -80 and less
- -75 to -80
- -70 to -75
- -65 to -70
- -60 to -65
- -55 to -60
- -55 and greater

Project Component

Bathymetry (m)

- Major Contour
- Minor Contour

Railway

Secondary Road

Watercourse

Prince Rupert Port Authority Boundary

Waterbody

Shoal

- Flora Bank
- 0 - 5 m Deep Shoal
- 5 - 10 m Deep Shoal

Pacific NorthWest LNG

Daytime Fish Hydroacoustic Survey 6, May 21 - 23, 2015

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

DATE: 29-SEP-15	PROJECTION: UTM - ZONE 9
FIGURE ID: 123110537	DATUM: NAD 83
DRAWN BY: R. CAMPBELL	CHECKED BY: S. O'REGAN

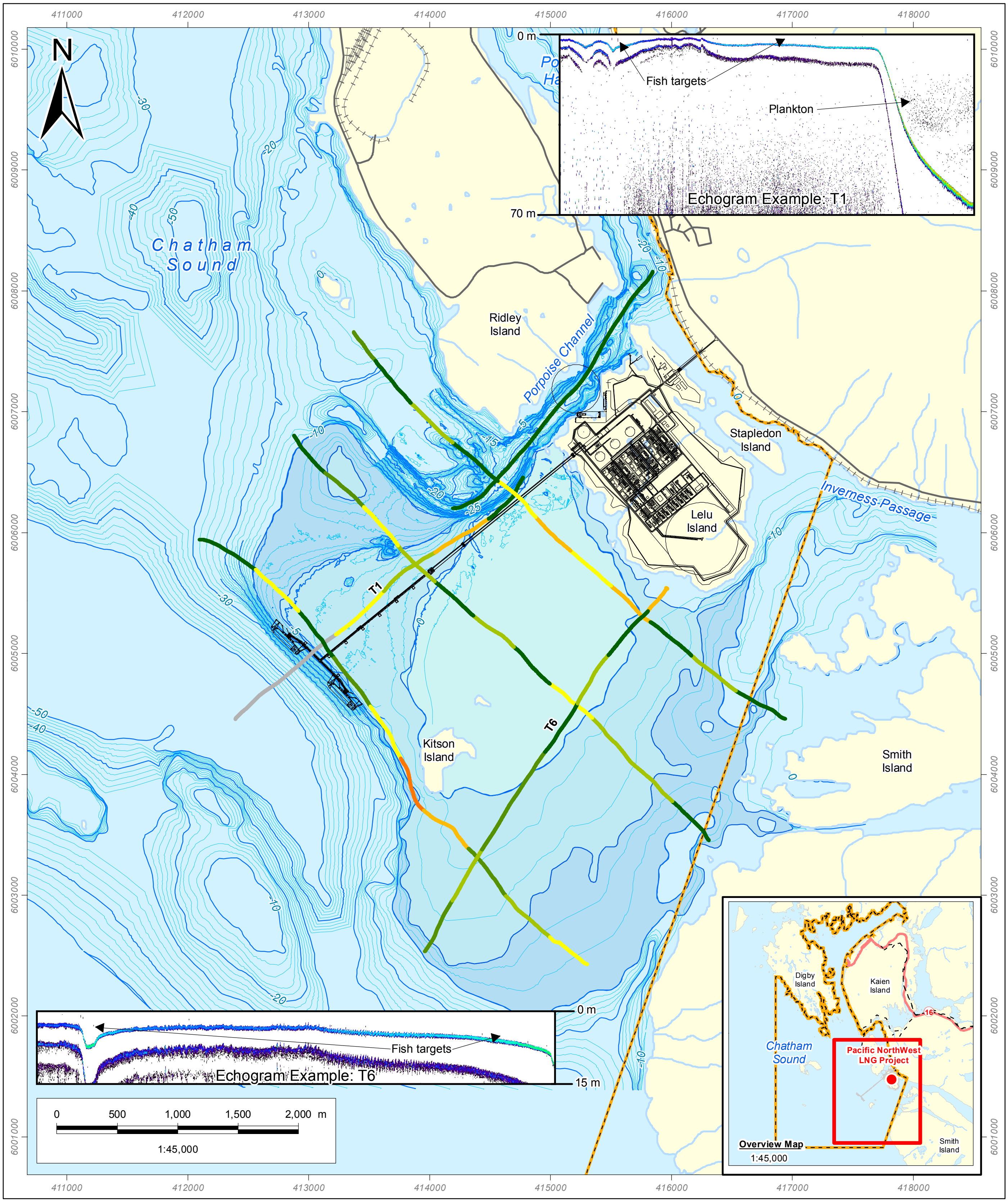
PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO:

B-5

9/29/2015 - 3:05:46 PM \\cd1186-f04\workgroup\active\123110537\gis\figures\Interim_Report_2_Figures\Appendix_B\fig_b-5_123110537_marine_13_Hydroacoustic_Survey_marfish_06.mxd



Mean Volume Backscatter (MVBS) (dB)

- -80 and less
- -75 to -80
- -70 to -75
- -65 to -70
- -60 to -65
- -55 to -60
- -55 and greater
- Substantial Zooplankton

Project Component

Bathymetry (m)

- Major Contour
- Minor Contour
- Railway
- Secondary Road
- Watercourse

Prince Rupert Port Authority Boundary

Waterbody

Shoal

- Flora Bank
- 0 - 5 m Deep Shoal
- 5 - 10 m Deep Shoal

Pacific NorthWest LNG

Daytime Fish Hydroacoustic Survey 7, June 9 - 10, 2015

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

DATE: 14-OCT-15
FIGURE ID: 123110537
DRAWN BY: R. CAMPBELL

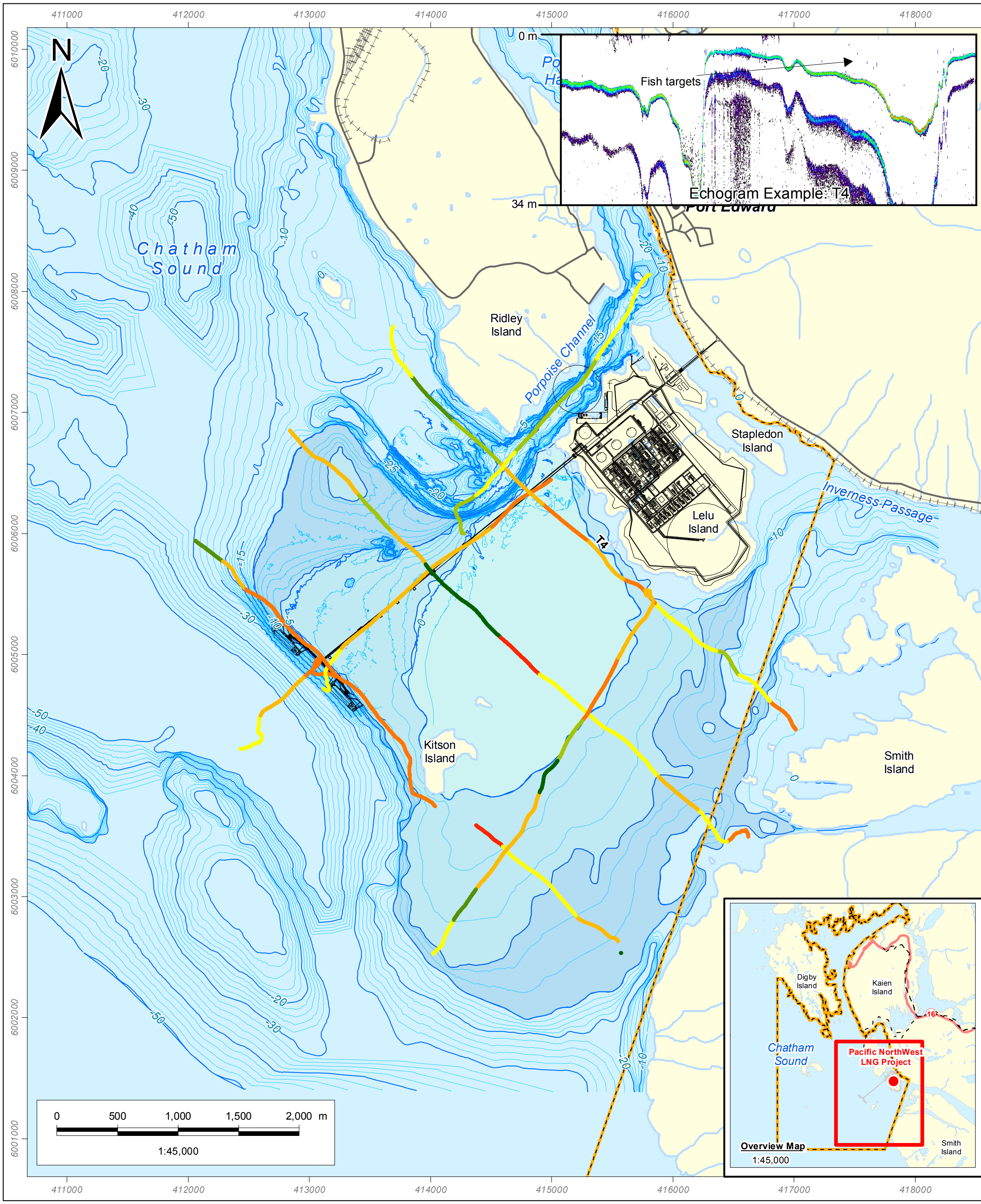
PROJECTION: UTM - ZONE 9
DATUM: NAD 83
CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **B-6**

10/14/2015 - 11:30:38 AM \\cd1186-f04\workgroup\active\123110537\gis\figures\Interim_Report_2_Figures\Appendix_B\fig_b-6_123110537_marine_14_Hydroacoustic_Survey_marfish_07.mxd



Mean Volume Backscatter (MVBS) (dB)

- -80 and less
- -75 to -80
- -70 to -75
- -65 to -70
- -60 to -65
- -55 to -60
- -55 and greater
- Substantial Zooplankton

Project Component

Bathymetry (m)

- Major Contour
- Minor Contour
- Railway
- Secondary Road
- Watercourse

Prince Rupert Port Authority Boundary

Waterbody

Shoal

- Flora Bank
- 0 - 5 m Deep Shoal
- 5 - 10 m Deep Shoal

Pacific NorthWest LNG

Daytime Fish Hydroacoustic Survey 9, July 2 - 8, 2015

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

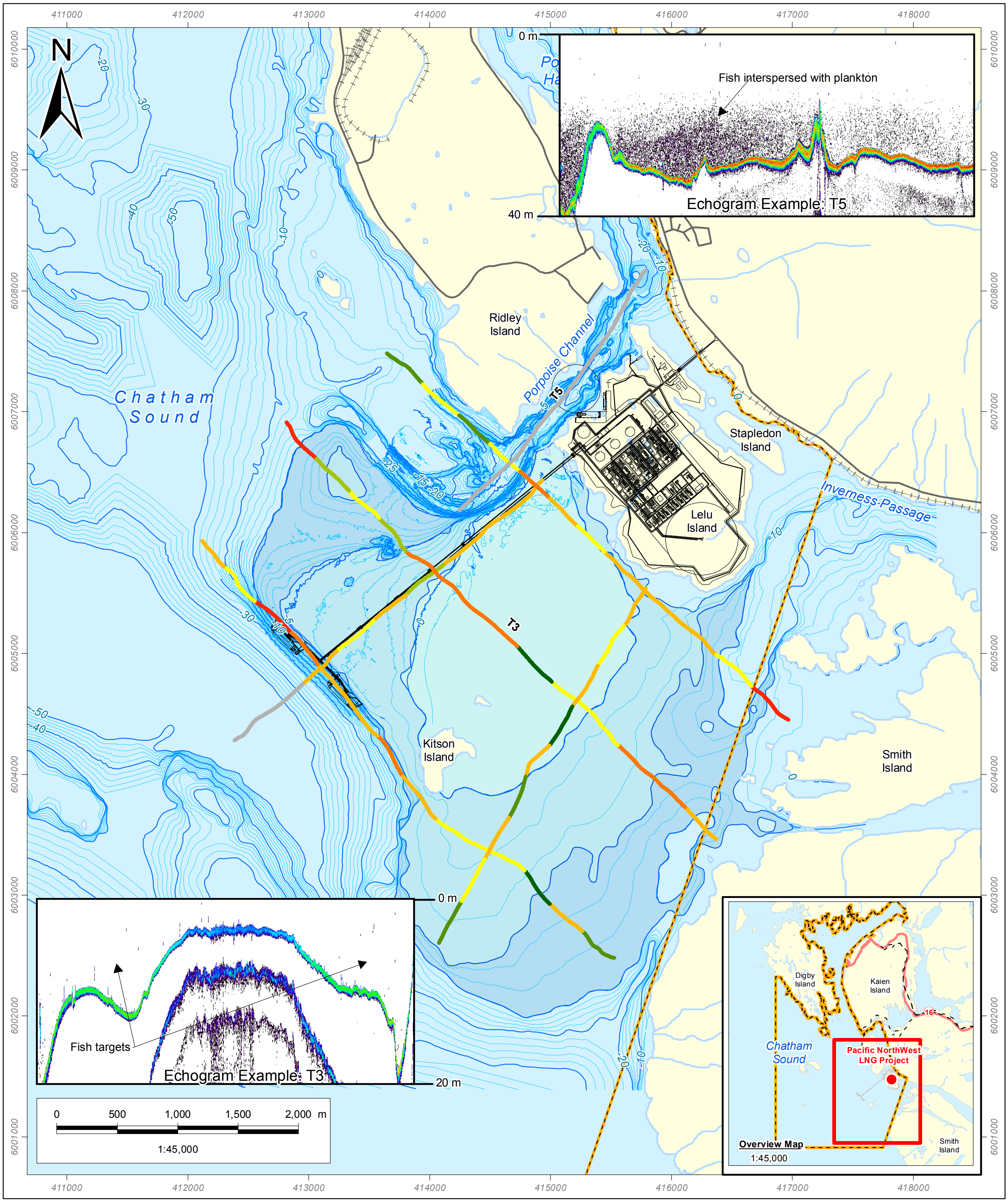
DATE: 29-SEP-15
FIGURE ID: 123110537
DRAWN BY: R. CAMPBELL

PROJECTION: UTM - ZONE 9
DATUM: NAD 83
CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **B-7**



Mean Volume Backscatter (MVBS) (dB)

- -80 and less
- -75 to -80
- -70 to -75
- -65 to -70
- -60 to -65
- -55 to -60
- -55 and greater
- Substantial Zooplankton

- Project Component

Bathymetry (m)

- Major Contour
- Minor Contour
- Railway
- Secondary Road
- Watercourse

- Prince Rupert Port Authority Boundary
- Waterbody

Shoal

- Flora Bank
- 0 - 5 m Deep Shoal
- 5 - 10 m Deep Shoal

Pacific NorthWest LNG

Daytime Fish Hydroacoustic Survey 10, July 16 - 23, 2015

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

DATE: 29-SEP-15	PROJECTION: UTM - ZONE 9
FIGURE ID: 123110537	DATUM: NAD 83
DRAWN BY: R. CAMPBELL	CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **B-8**

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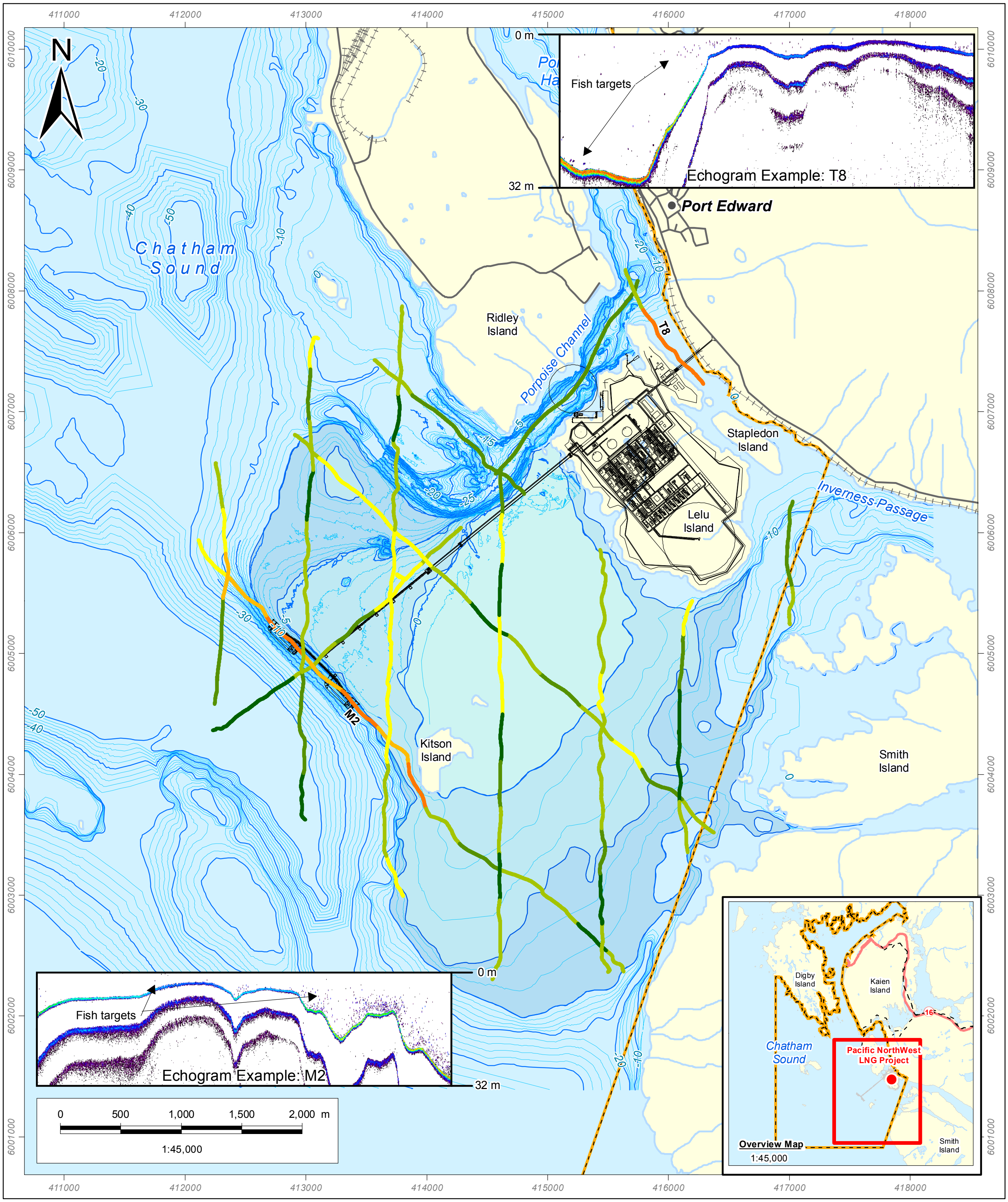


Mean Volume Backscatter (MVBS) (dB)

- -80 and less
- -75 to -80
- -70 to -75
- -65 to -70
- -60 to -65
- -55 to -60
- -55 and greater

Project Component

Bathymetry (m)

- Major Contour
- Minor Contour
- Railway
- Secondary Road
- Watercourse

Prince Rupert Port Authority Boundary

Waterbody

Shoal

- Flora Bank
- 0 - 5 m Deep Shoal
- 5 - 10 m Deep Shoal

Pacific NorthWest LNG

Nighttime Fish Hydroacoustic Survey 1, May 1 - 3, 2015

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

DATE: 29-SEP-15
FIGURE ID: 123110537
DRAWN BY: R. CAMPBELL

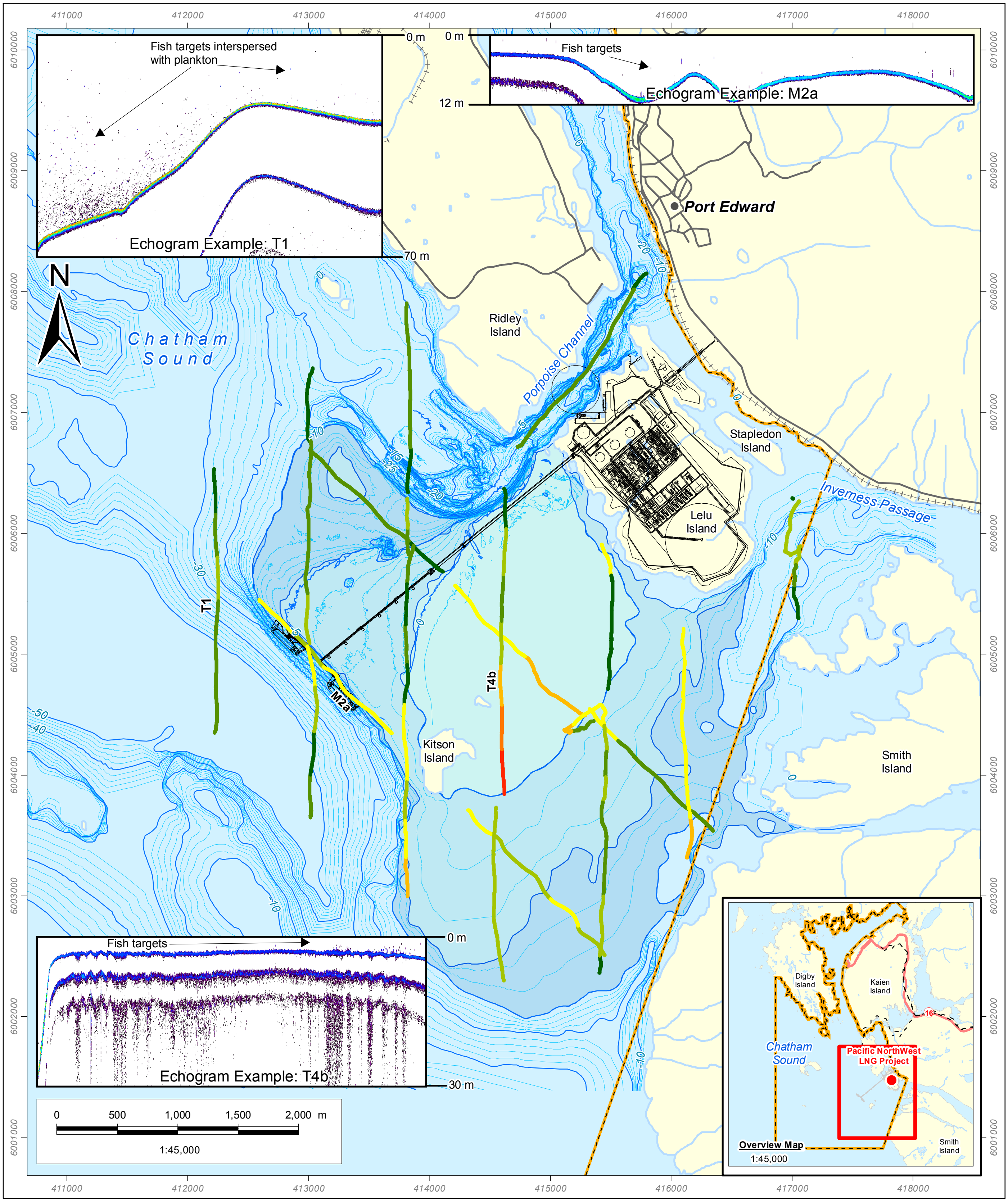
PROJECTION: UTM - ZONE 9
DATUM: NAD 83
CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **B-9**

9/29/2015 - 3:07:40 PM \\cd1186-f04\workgroup\active\123110537\gis\figures\Interim_Report_2_Figures\Appendix_B\fig_b-9_123110537_marine_01_Hydroacoustic_Survey_Smolt_01.mxd



Mean Volume Backscatter (MVBS) (dB)
- -80 and less
- -75 to -80
- -70 to -75
- -65 to -70
- -60 to -65
- -55 to -60
- -55 and greater

Project Component

Bathymetry (m)
- Major Contour
- Minor Contour

Railway

Secondary Road

Watercourse

Prince Rupert Port Authority Boundary

Waterbody

Shoal
- Flora Bank
- 0 - 5 m Deep Shoal
- 5 - 10 m Deep Shoal

Pacific NorthWest LNG

Nighttime Fish Hydroacoustic Survey 2, May 12 - 14, 2015

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

DATE: 14-OCT-15	PROJECTION: UTM - ZONE 9
FIGURE ID: 123110537	DATUM: NAD 83
DRAWN BY: R. CAMPBELL	CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **B-10**

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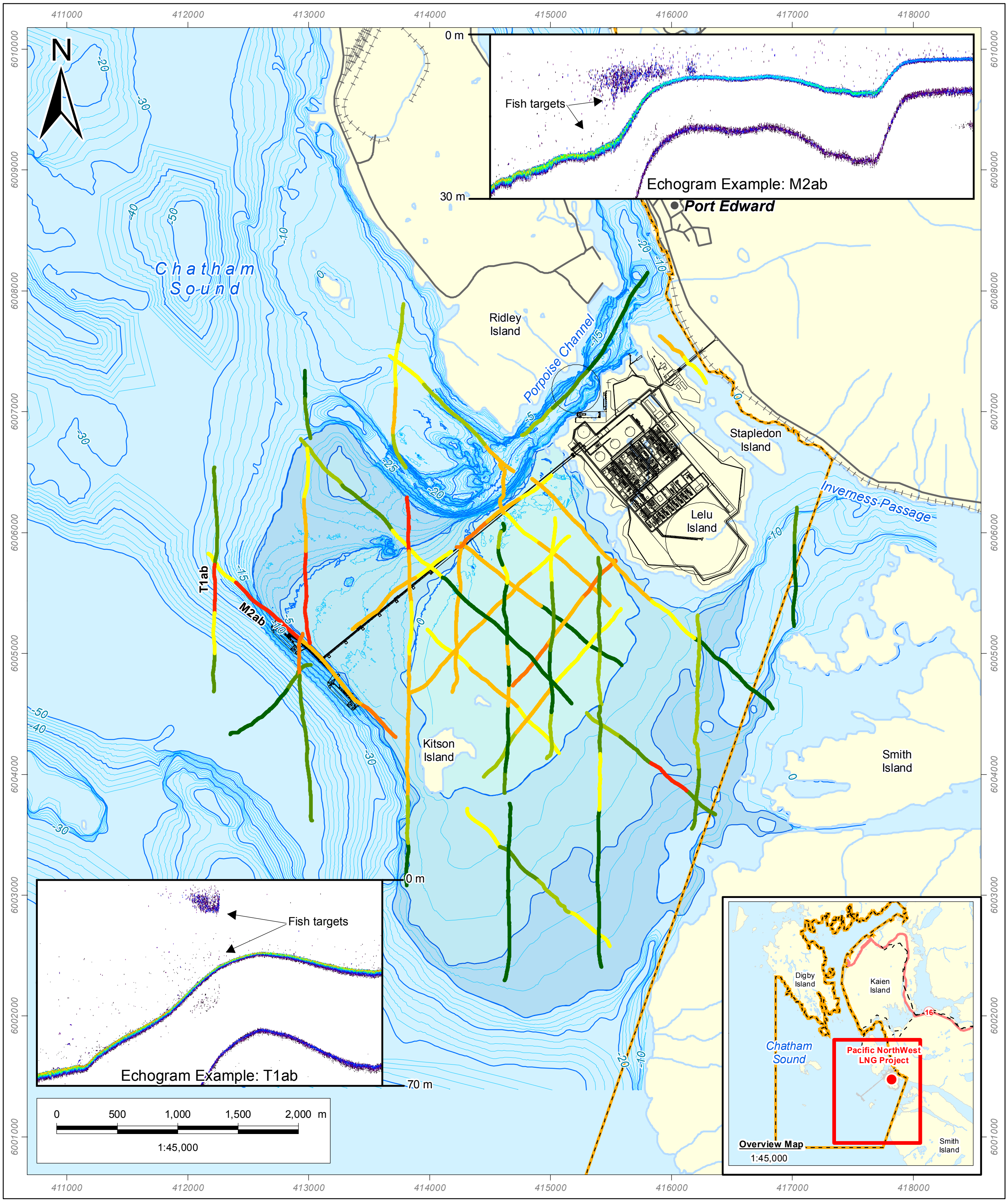


Mean Volume Backscatter (MVBS) (dB)
- -80 and less
- -75 to -80
- -70 to -75
- -65 to -70
- -60 to -65
- -55 to -60
- -55 and greater

Project Component

Bathymetry (m)
- Major Contour
- Minor Contour

Railway
Secondary Road
Watercourse

Prince Rupert Port Authority Boundary
Waterbody

Shoal
- Flora Bank
- 0 - 5 m Deep Shoal
- 5 - 10 m Deep Shoal

Pacific NorthWest LNG

Nighttime Fish Hydroacoustic Survey 3, May 25 - 29, 2015

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

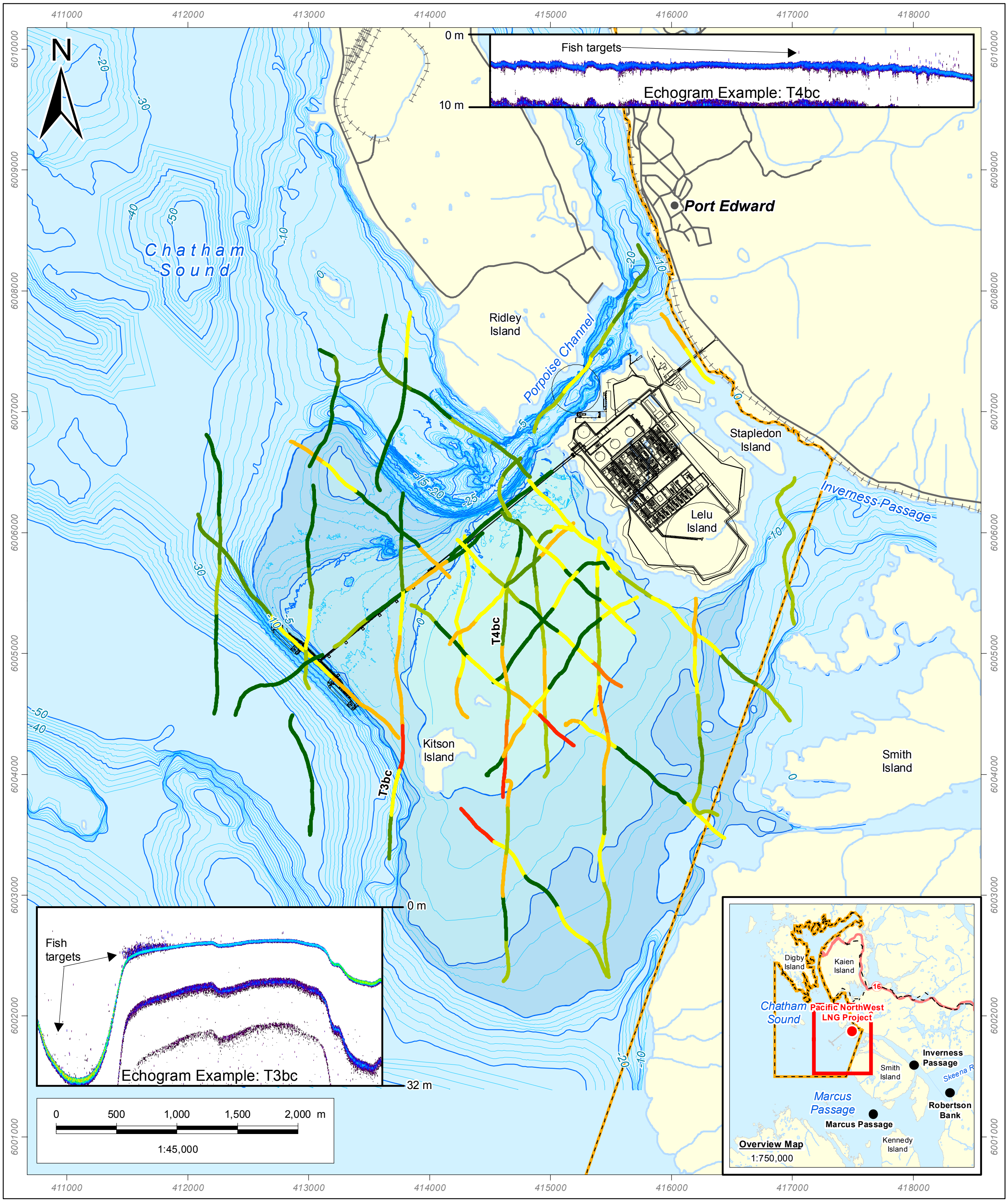
Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

DATE: 29-SEP-15	PROJECTION: UTM - ZONE 9
FIGURE ID: 123110537	DATUM: NAD 83
DRAWN BY: R. CAMPBELL	CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **B-11**



Mean Volume Backscatter (MVBS) (dB)

- -80 and less
- -75 to -80
- -70 to -75
- -65 to -70
- -60 to -65
- -55 to -60
- -55 and greater

Project Component

Bathymetry (m)

- Major Contour
- Minor Contour

Railway

Secondary Road

Watercourse

Prince Rupert Port Authority Boundary

Waterbody

Shoal

- Flora Bank
- 0 - 5 m Deep Shoal
- 5 - 10 m Deep Shoal

Pacific NorthWest LNG

Nighttime Fish Hydroacoustic Survey 4, June 3 - 6, 2015

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

Although there is no reason to believe that there are any errors associated with the data used to produce this product or in the product itself, users of these data are advised that errors in the data may be present.

DATE: 29-SEP-15
FIGURE ID: 123110537
DRAWN BY: R. CAMPBELL

PROJECTION: UTM - ZONE 9
DATUM: NAD 83
CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **B-12**

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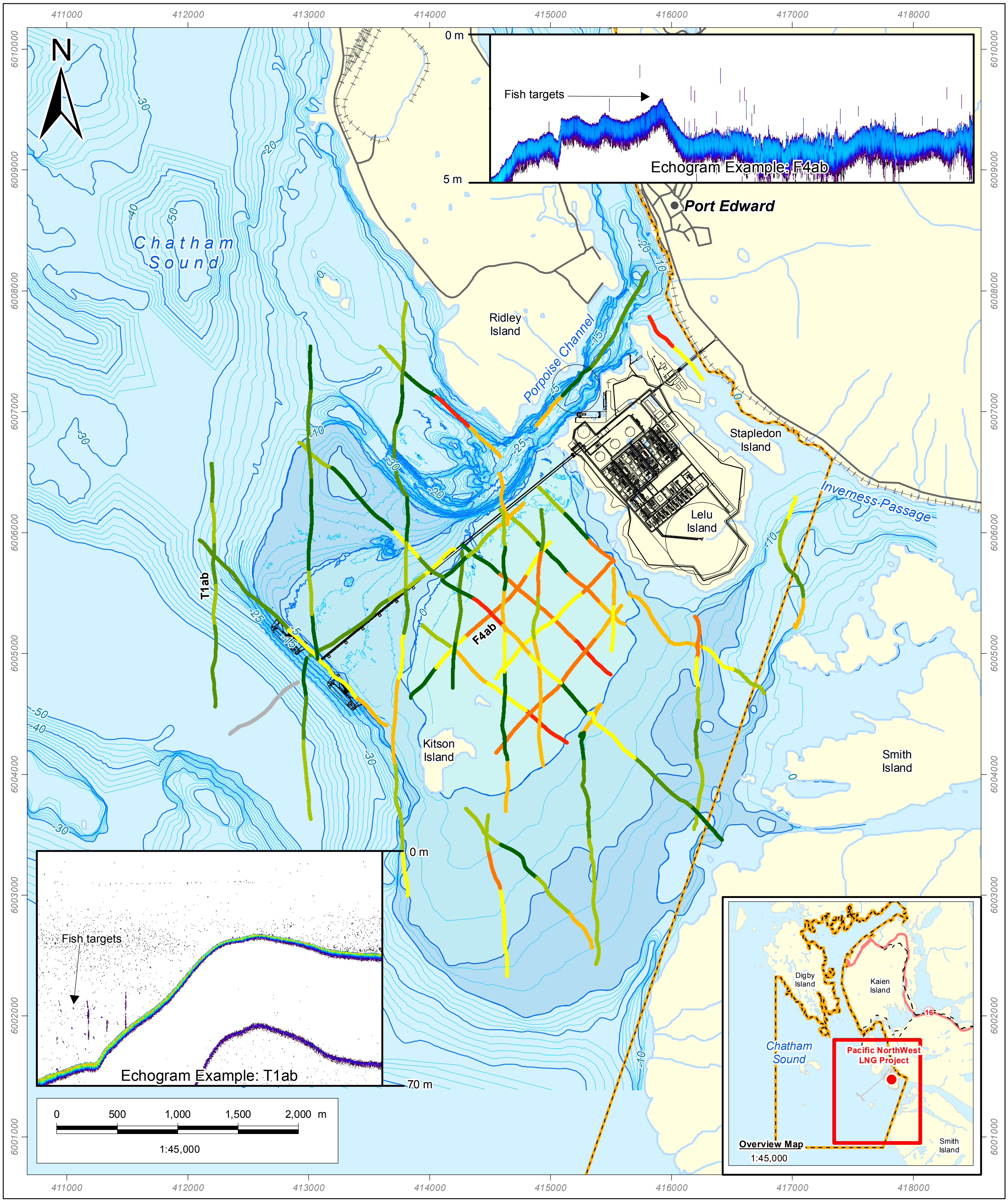

Mean Volume Backscatter (MVBS) (dB)

- -80 and less
- -75 to -80
- -70 to -75
- -65 to -70
- -60 to -65
- -55 to -60
- -55 and greater
- Substantial Zooplankton

Project Component

Bathymetry (m)

- Major Contour
- Minor Contour
- Railway
- Secondary Road
- Watercourse

Prince Rupert Port Authority Boundary

Waterbody

Shoal

- Flora Bank
- 0 - 5 m Deep Shoal
- 5 - 10 m Deep Shoal

Pacific NorthWest LNG

Nighttime Fish Hydroacoustic Survey 7, June 24 - 28, 2015

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

DATE: 29-SEP-15
FIGURE ID: 123110537
DRAWN BY: R. CAMPBELL

PROJECTION: UTM - ZONE 9
DATUM: NAD 83
CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO:

B-13

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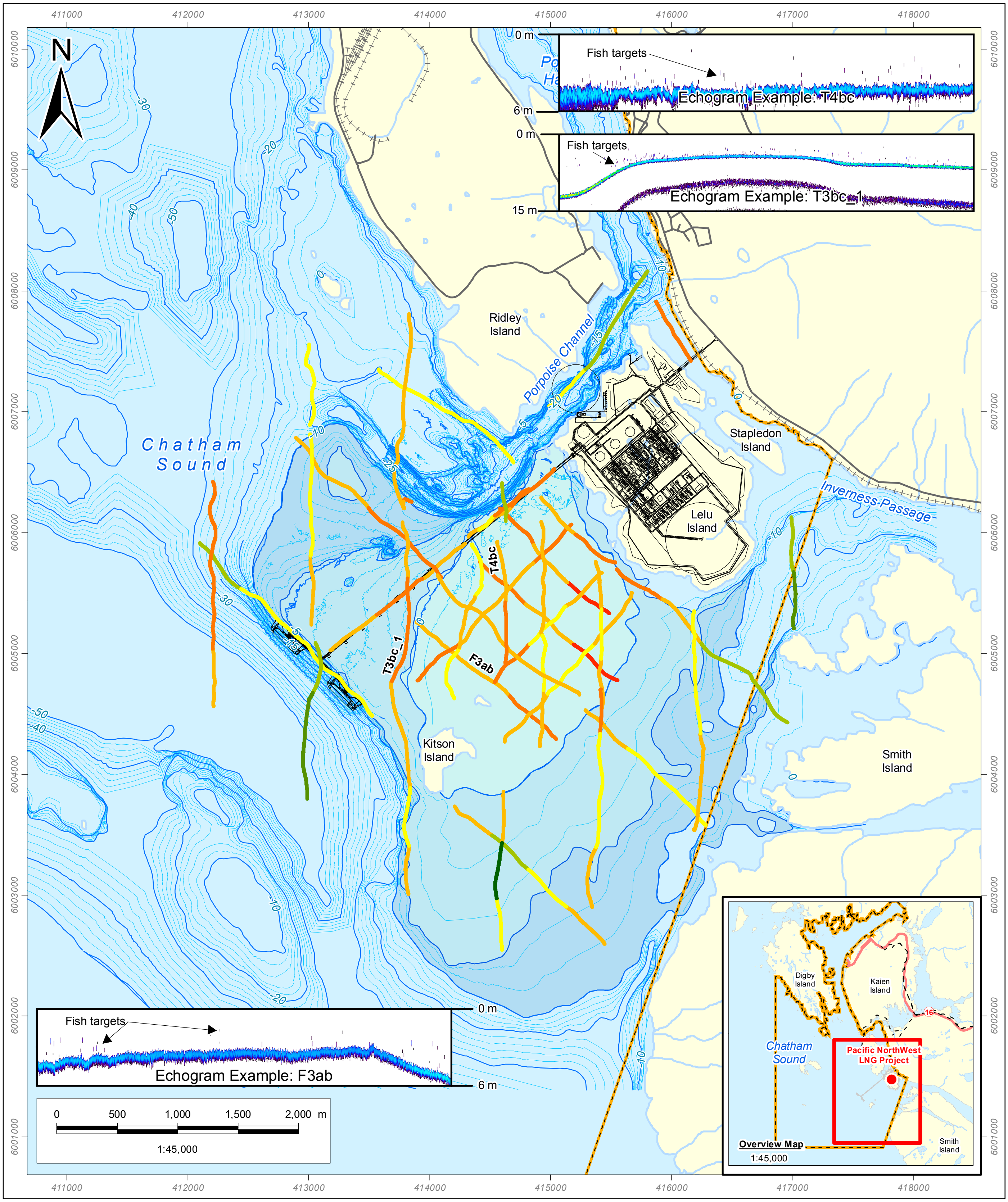

Mean Volume Backscatter (MVBS) (dB)
- -80 and less
- -75 to -80
- -70 to -75
- -65 to -70
- -60 to -65
- -55 to -60
- -55 and greater

Project Component

Bathymetry (m)
- Major Contour
- Minor Contour
- Railway
- Secondary Road
- Watercourse

Prince Rupert Port Authority Boundary

Waterbody

Shoal
- Flora Bank
- 0 - 5 m Deep Shoal
- 5 - 10 m Deep Shoal

Pacific NorthWest LNG

Nighttime Fish Hydroacoustic Survey 8, July 2 - 8, 2015

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

DATE: 29-SEP-15
FIGURE ID: 123110537
DRAWN BY: R. CAMPBELL

PROJECTION: UTM - ZONE 9
DATUM: NAD 83
CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **B-14**

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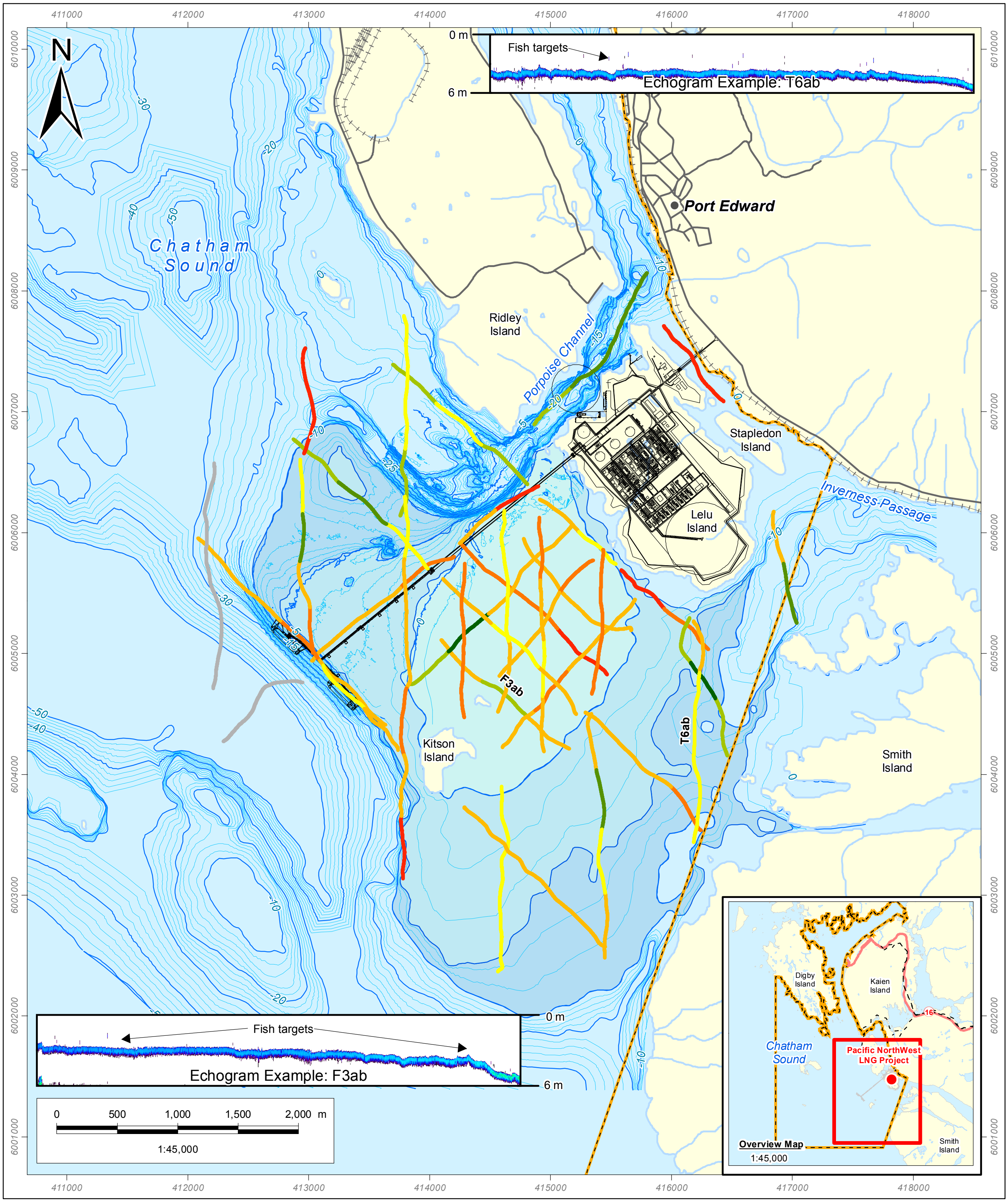

Mean Volume Backscatter (MVBS) (dB)
- -80 and less
- -75 to -80
- -70 to -75
- -65 to -70
- -60 to -65
- -55 to -60
- -55 and greater
- Substantial Zooplankton

Project Component

Bathymetry (m)
- Major Contour
- Minor Contour
- Railway
- Secondary Road
- Watercourse

Prince Rupert Port Authority Boundary

Waterbody

Shoal
- Flora Bank
- 0 - 5 m Deep Shoal
- 5 - 10 m Deep Shoal

Pacific NorthWest LNG

Nighttime Fish Hydroacoustic Survey 9, July 10 - 14, 2015

Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

DATE: 14-OCT-15
FIGURE ID: 123110537
DRAWN BY: R. CAMPBELL
PROJECTION: UTM - ZONE 9
DATUM: NAD 83
CHECKED BY: S. O'REGAN

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **B-15**

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