2015 Summary Report

Burrard Inlet-Indian Arm Eelgrass Mapping

SeaChange Marine Conservation Society
and
Tsleil-Waututh Nation

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Introduction

Human activity, including residential and port developments, dredging, marine transport and log storage in Burrard Inlet and Indian Arm have resulted in changes to coastal and marine areas, including losses of important habitats including eelgrass (*Zostera marina*) beds. Communities, in particular the Tsleil-Waututh First Nation who have relied on the area since time immemorial, have an interest in maintaining and restoring the health of the area to support traditional harvests and ecosystem integrity. With proposed increases in port activity, including proposals to significantly increase oil transport, it is more important than ever to understand the remaining habitats, compare to historical information and identify potential restoration areas. It has been known since at least the 1990s that eelgrass existed in Burrard Inlet, although detailed records were not available at the time of writing.

This report summarizes work done in 2015 to map eelgrass beds in eastern Burrard Inlet and Indian Arm. It also serves to provide background information for future eelgrass inventories and restoration projects, and to sound decisions that will affect the natural ecological health of the marine nearshore environments within Metro Vancouver.

Eelgrass is a vascular plant that grows in relatively shallow marine areas. Eelgrass provides a wide variety of ecosystem services, including food, shelter and refugia for invertebrates and fish – including Chinook, Coho, Pink, Chum, and Sockeye salmon, feeding habitat for birds such as Great Blue Herons and Brant geese, nutrient cycling, carbon sequestration and carbon storage. They provide surface area for epiphytic algae that serve as the base of the food web, stabilize shorelines and buffer wave energy. They also serve as excellent areas for science and education (Orth et al. 1984, Thompson 1994, Bostrom and Bonsdorff 2000, Duarte 2000, Molnar 2015). The rates at which eelgrass capture and store carbon can be up to 90 times that of forests (Campbell 2010) and continue for up to 40 years following restoration (Thom et al 2011). From an economic perspective, eelgrass meadows around the Lower Mainland provide $80,929 in ecosystem services per hectare per year (Molnar et al. 2012).

Limiting factors for eelgrass growth include temperature (0° to 30°C but ideally 10° - 20° C; Phillips 1984), light availability, depth, substrate (usually mud or sand), wave action (relatively low), salinity (20 - 32 ppt in the Salish Sea; Durance 2002) and pH.

There are a number of possible human impacts on eelgrass and other seagrasses including the following, many of which are found in Burrard Inlet and Indian Arm:

- dredging and filling associated with harbour and port construction, which is one of the primary reasons for loss of eelgrass beds (Levings and Thom 1994)
- turbidity, smothering and anoxia from woody debris generated by forestry activities such as log dumps and log booms (Phillips 1984, BC/Washington Marine Science Panel 1994)
- pollution, which is of particular concern in sheltered areas with poor circulation, and includes:
    - eutrophication in streams that provide needed freshwater and sediment input to eelgrass beds, which can result in reduced oxygen input for the beds (BC /Washington Science Panel 1994)
    - chemical pollution and road runoff which can affect sediment health (BC /Washington Science Panel 1994)
    - toxins such as heavy metals which can be taken up by eelgrass and have cascading effects through the food web (Lyngby and Brix 1989)
    - oil pollution which in late summer or winter can be retained and brought into the intertidal zone by mats of drifting eelgrass blades, and in spring can affect eelgrass seed production and viability (Beak Consultants 1975)
- shading, physical damage and disruption of water movement by overwater structures such as docks (DFO 2003)
- effects of boating, including damage by propellers, anchoring and bottom dragging by chains and poorly-affixed moorings

Climate change can be expected to change the extent of eelgrass beds. One of the expected effects of climate change is landward movement of nearshore habitats (Nicholls et al. 2007). Shoreline alteration that removes coastal habitat will impede this movement. Erosion and resulting sedimentation is an expected result of sea level rise. Depending on the extent of sedimentation this could either create habitat for or smother eelgrass beds. Erosion and coastal scouring are exacerbated by shoreline developments such as seawalls and other hard structures. The BC Ministry of Environment has produced a model showing relative sensitivity of areas of the BC shoreline to sea level rise (Biffard et al. 2014). Continuity of eelgrass beds and integrity of adjacent habitats will both protect the beds themselves over time, as well as limit the overall effects of climate change due to the shoreline stabilization and buffering effects of contiguous eelgrass beds.

Methods

The methodology used to map and characterize *Z. marina* beds was adapted from Durance (2002). The eelgrass inventory for this project entailed determining the presence or absence of *Zostera marina* using an underwater towed video camera (Deep Blue HD high definition SplashCam underwater video camera) and monitor, Garmin 60Cx handheld GPS unit and a power boat. The GPS hand held unit was used to record waypoints at approximately 10 m intervals. The GPS unit has a listed accuracy of +/- 10 m, however actual accuracy of the GPS readings was usually +/- 3 m, with field testing confirming this.

The field crew consisted of three individuals. A camera technician operated the underwater camera, made observations by seeing the display in the monitor and filling out the data sheets, took photographs of the shoreline and backshore at each eelgrass bed, and guided the boat driver and GPS technician with respect to presence or absence of eelgrass. A GPS technician recorded waypoints on the

handheld GPS unit and communicated with the camera technician and boat driver regarding appropriate spacing between waypoints. The boat driver was responsible for safe operation of the vessel and ensuring the boat remained within the appropriate depth range for eelgrass presence. GIS technicians created maps from the GPS coordinates following completion of the field survey.

The following characteristics were noted during the survey.

Presence
Waypoints were taken when eelgrass was present, recorded as either the edge or interior of a bed. Absence of eelgrass was only recorded in the event of a gap in the bed or exit from a bed, and in cases where conditions appeared suitable for eelgrass growth but eelgrass was not observed. The edge of a bed is generally when shoot density is less than one shoot per square metre (Durance 2002).

Distribution
Eelgrass distribution was recorded as being either patchy (containing isolated groups of plants) or continuous (the plants extend into a contiguous bed). Continuous beds may contain bare patches surrounded by eelgrass (Durance 2002).

Form
Eelgrass beds in this region tend to form as fringes, which are narrow bands limited by factors such as wind exposure, depth gradient or substrate, or flats, which are more expansive beds (Durance, 2002).

Sediment Types
Primary, secondary and tertiary occurrence of substrate types was recorded: sand, mud, shell, pebble and cobble. Sandy or muddy substrate would be more likely to support continuous eelgrass beds, whereas increased presence of large shells, cobble or rock could limit eelgrass extent and also support kelp growth which could shade out eelgrass.

Percent Cover
Percent cover was estimated in broad categories to increase accuracy of observation (<25%, 26-75%, >75%). Percent cover is an indicator of bed health, substrate and area suitability, and potential as donor or recipient sites for restoration efforts.

Tidal Fluctuations
Observations of whether tide was slack or running were recorded to help assess the accuracy of percent cover and substrate estimations. These estimations are more accurate at slack tide, when the substrate is more visible between eelgrass shoots.

Presence of Algae
Presence of broad or tuft-like algae were recorded for a better understanding of the substrate when substrate was not visible (e.g. presence of kelp indicates a cobble or rocky bottom), and potential limiting factors to eelgrass growth, both from substrate type and shading by algae, including the alien species *Sargassum muticum*.

Visibility
Visibility was rated as low, medium or high as an indicator of the accuracy of other observations. Glare, light quality and water quality can affect visibility.

Comments
Other details were recorded at each waypoint or for each eelgrass bed as applicable, including photograph number; potential threats to eelgrass in the area; backshore characteristics including shoreline developments; observations of Canada geese, which are a threat to eelgrass, and other wildlife; observations of *S. muticum*; human activities in the area including active or historical log booming or other industrial or recreational activities; whether the site looks suitable but eelgrass was not observed; and whether the site has potential for restoration.

Study Area

All areas deemed to have potentially suitable bathymetry and substrate for eelgrass growth were surveyed in Indian Arm (see Figure 1). Much of Indian Arm is deep fjord and therefore unsuitable for eelgrass growth; these areas were not surveyed. Survey efforts in Burrard Inlet were limited by presence of industrial activities and large terminals.

Figure 1. Study area. Areas covered are demarcated in blue (includes all accessible areas deemed feasible as potential eelgrass habitat)

Results and Discussion

The observed characteristics of all surveyed sites are described below, along with assessments of potential for eelgrass restoration and above-water photographs of locations where eelgrass was observed. Sites are presented in the order in which they were surveyed: Bedwell Bay, Strathcona Park, Barnet Park, Belcarra, Whey-ah-Wichen (Cates Park), Dollarton Highway to IR #3, Maplewood, Port Moody Arm, Indian River estuary, Bishop Creek, Granite Falls, Buntzen Bay, Camp Jubilee, Farrer Cove, Second Narrows Bridge to Westridge Terminal and Deep Cove.

Observed eelgrass locations are presented in Figure 2, with detailed versions of each site presented in Appendix 1. Although the survey extended northward to the Indian River estuary, eelgrass beds were not observed north of Deep Cove.

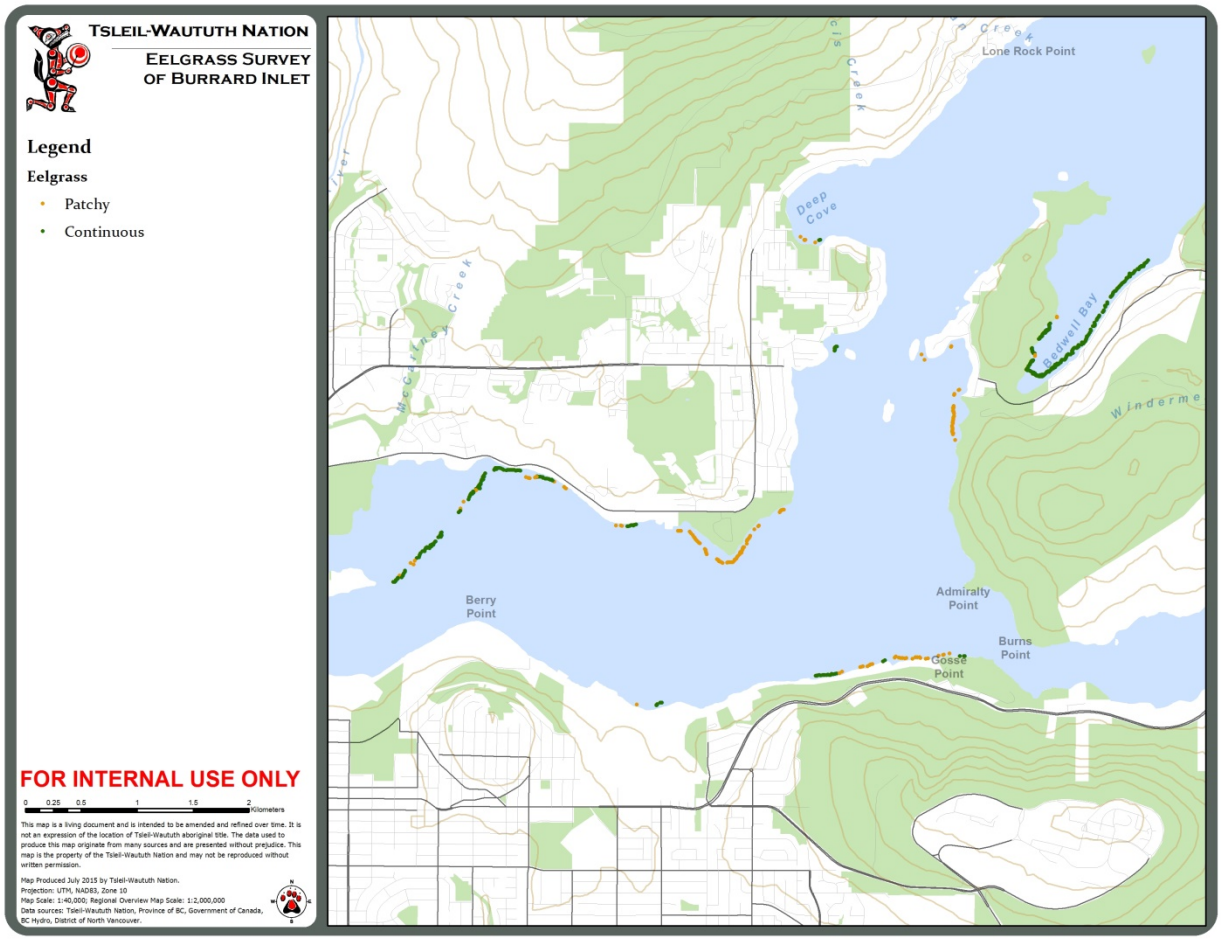

Figure 2. Observed eelgrass locations in Burrard Inlet and Indian Arm

Bedwell Bay (surveyed 26 May):

Eelgrass was known to occur intertidally in the head of the bay from traditional knowledge, recent field work by TWN and photographs. During the 2015 survey a continuous eelgrass bed was found subtidally throughout the bay, beginning as fringing beds and developing into a flat towards the head of the bay

(Figure 3). Density was low. At least one boat was anchored in the eelgrass bed, and several moorings were also near the bed. Several adjacent private docks on the east side of the bay extend over the bed, with a gap in the bed beneath at least one dock. Of the various sites mapped in Burrard Inlet and Indian Arm, the eelgrass bed at Bedwell Bay was likely the most extensive and continuous. It is potentially the only location surveyed as part of this study where the bed was extensive enough to be a source location for eelgrass transplants for restoration purposes, although density was still never greater than 25%.

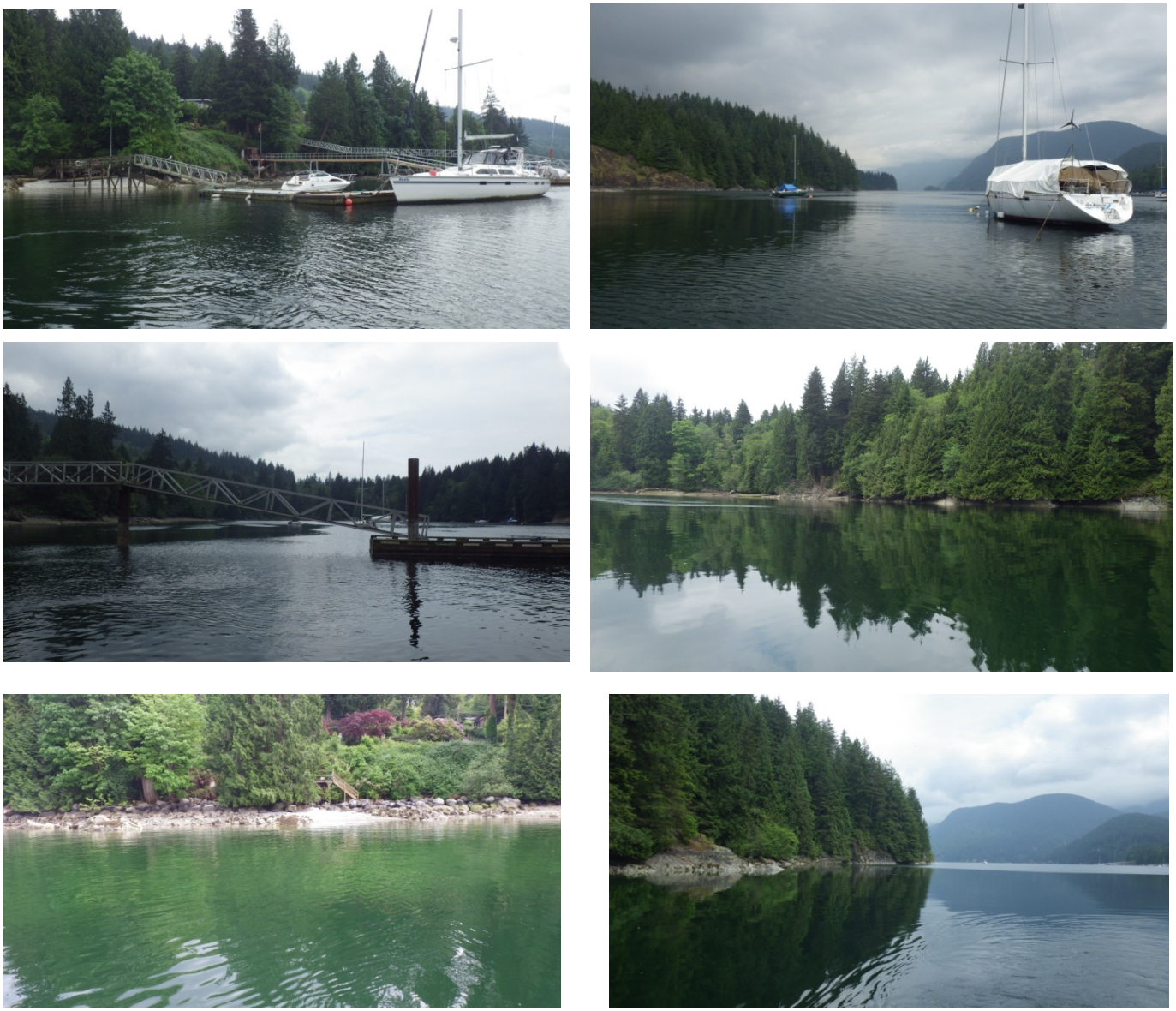

Figure 3. Eelgrass locations in Bedwell Bay

Strathcona Park, Deep Cove (surveyed 26 May):

There are many docks on either side of this park. Eelgrass was observed in the subtidal area immediately in front of the park and cobble beach, where there were no docks (Figure 4).

Figure 4. Eelgrass location in Strathcona Park

Barnet Park (surveyed 28 May):

Eelgrass patches were observed along much of the length of this park (Figure 5), which borders the east side of the Kinder Morgan terminal. Several old pilings are still in the water within eelgrass depth. Eelgrass observed in some locations was denser than in the beds observed at Cates Park, however the eelgrass observed also included a series of patches. Natural limitations on eelgrass growth in this area could include exposure due to the fetch from Indian Arm and Burrard Inlet west. Although this site was considered for possible eelgrass restoration, maintenance dredging may limit eelgrass survival.

Figure 5. Eelgrass locations in Barnet Park

Belcarra (surveyed 28 and 29 May):

No eelgrass was observed from Admiralty Point to the point just south of the picnic area. Much of this area was rocky and steep, and likely exposed to the westward fetch from Burrard Inlet. A continuous eelgrass bed was observed in front of the beach at the park picnic area (Figure 6). Eelgrass patches were observed among some of the docks north of the park. The survey extended to the reef that connects the lighthouse to the privately-owned island. Adult and juvenile Canada geese were present along the shore in many locations where eelgrass was observed. High levels of human activity in summer, including kayaking and crabbing off the dock, could make this site unsuitable for restoration.

Figure 6. Eelgrass locations in Belcarra

Whey-ah-Wichen/Cates Park (surveyed 28 May):

Eelgrass beds were observed from east of the Polygon development site around the point towards Deep Cove (Figure 7). Closer to the Polygon site the substrate included woody debris. The bed became more dense further east of the Polygon site. There is considerable erosion at the shoreline around Roche point, so east of the point could be a potential restoration site. Eelgrass restoration could complement the existence and conservation of sand lance and surf smelt beaches in the area. The observed gap in eelgrass beds or patches may be due to the presence of a rocky outcrop.

Figure 7. Eelgrass locations in Whey-a-Wichen (Cates Park)

Dollarton Highway (#3785) to, and including, IR #3 (surveyed 29 May):

The coast was surveyed westward from the Polygon development site, although that development site was not surveyed due to active changes in the area. A fringing, and at times patchy, eelgrass bed was observed along portions of the coastline, often in the intertidal zone (Figure 8). This bed could be exposed at low tides. Although there is suitable substrate along this coastline, much of the bathymetry is very steep. The marine area in front of IR#3 (the primary Tsleil-Waututh reserve) could potentially be a restoration site, although limitations include regular and mostly intertidal harvesting of crabs and clams by Tsleil-Waututh community members at low tide, and the historical use of some areas for log storage. The bed in some cases existed quite far from shore. Eelgrass was sparse in certain sections of the bed. A community-based restoration project may be possible if efforts would improve harvests and were arranged in a way that harvesting activities would not disturb the beds. In particular, restoration activities could take place at a depth beyond which crabbing activities take place. An area in front of two likely supportive individuals' houses was identified as a start point, from which restoration activities could extend into Maplewood (see next section). Historically, eelgrass beds extended in front of the entire reserve.

Figure 8. Eelgrass locations from Polygon Site to IR #3

Maplewood (surveyed 29 May and 8 June):

A patchy, fringing bed was observed east of the mudflats and old pilings, and continued to just west of the pilings (Figure 9). Natural limitations to eelgrass growth include the steep bathymetry and shifting sediment due to tides and currents. The shipping channel toward the centre of Burrard Inlet is dredged, leading to steep drop-offs on the sea floor. Current pilings are made of creosote but purple martin boxes have been installed on them and were observed to be actively used at the time of the survey, meaning that piling removal has the potential to disturb the birds. There were areas containing potential eelgrass habitat

and appropriate depth range closer to shore than the area surveyed, but they were inaccessible by boat due to the presence of shallow mudflats between the surveyed area and the shore. Those potential shoreward areas are potential site to conduct a snorkel/kayak survey at a later date. The overall Maplewood area consists of an old log sort area dredged into a lagoon. Eelgrass is known to exist there[1], and Port Metro Vancouver was considering the area for a habitat banking project. Tsleil-Waututh Nation has plans for removal of creosote pilings, restoration of functional bathymetry, restoration and invasive plant removal at the mouth of McCartney Creek. Eelgrass restoration would fit in with Tsleil-Waututh Nation's broader restoration plans in the area, potentially in 2016 spring or fall after other benthic restoration activities and piling removal have been completed.

Figure 9. Eelgrass locations at Maplewood

Port Moody Arm (surveyed 8 and 9 June):

Mapping was undertaken from Admiralty Point to Barnet Park. No eelgrass was found throughout Port Moody Arm in the areas mapped. The northwestern area was mostly rocky, then when the substrate became more suitable, the shoreline became steep. One area on the north shore was identified as having suitable substrate and no obvious threats, but no eelgrass was observed. The substrate towards the Ioco (Imperial Oil/Esso) dock and marina was composed of mud, sand and many empty clam shells, all covered in epiphytic algae; no eelgrass was observed - research is required to determine whether this was an old log storage area. Eelgrass was not observed in the subtidal mudflats that make up the head of Port Moody Arm. The mudflat at the very head of the arm dries out at low tide, and was not surveyed. The substrate in some areas may shift frequently. A large subtidal area toward the head of the arm consisted of appropriate substrate and depth, but no eelgrass was observed; more than 30 boats and moorings were located in the area. Portions of the southern shore had to be bypassed due to docks and industrial activity (e.g. Pacific Coast Terminals, Reed Point Marina and Petro-Canada/Suncor terminals). Areas currently occupied with industrial activities such as log sorts and oil terminals could have been suitable habitat for eelgrass if these activities were not present. Old creosote pilings in Schoolhouse Creek are also a pollution source in the area. Pacific Coast Terminals plan to dump dredgeate from their activities into Port Moody Arm with the argument that it will create eelgrass habitat. The substrate in Port Moody Arm is likely currently toxic due to industrial activity.

[1] Based on information from Doug Swanston.

Indian River estuary (surveyed 10 June)

The Indian River estuary (Figure 10) was surveyed from the north side of the working dock on the eastern portion to the north side of the yacht club out station on the western portion. No eelgrass was observed. The substrate was suitable throughout the area, however it was covered with woody debris, including small bark fragments scattered throughout and many tree branches. Woody debris washes from the river into the estuary annually with winter stream flow. There are many sunken logs and navigational hazards on the northeast side of the estuary. The adjacent area, south of the TWN/BC Parks dock, is also a log booming site associated with a woodlot operation owned by TWN. Tsleil-Waututh Nation plans to remove creosote pilings over the next few years to improve ecosystem health in the area. Traditional knowledge records indicate that eelgrass was historically present in the area. Many factors may currently be preventing eelgrass growth. A better understanding of the limiting factors and current threats is necessary to determine whether the site could be suitable for eelgrass restoration.

Figure 10. Indian River estuary

Bishop Creek North and South (surveyed 10 June)

No eelgrass was observed. The bathymetry was predominantly steep. Sandy areas were sparse and mostly deeper than ideal eelgrass depth. One location was noted as potentially suitable, but the substrate also contained woody debris, potentially washed out from the creek.

Granite Falls (surveyed 10 June)

No eelgrass was observed at Granite Falls. The area was steep and rocky, so was likely naturally not favourable for eelgrass growth. A second cove south of Granite Falls was also surveyed; eelgrass was not observed there either.

Buntzen Bay (surveyed 10 June)

No eelgrass was observed at Buntzen Bay.

Camp Jubilee (surveyed 10 June)

No eelgrass was observed in front of Camp Jubilee. It was necessary to go around several docks in the area. The substrate in the areas surveyed was mostly composed of cobble and the bathymetry consisted of steep drop-offs.

Farrer Cove (surveyed 11 June)

No eelgrass was observed growing at the subtidal eelgrass depth range surveyed at Farrer Cove, but many floating blades were observed on the water's surface. The substrate and conditions appeared

suitable. These observations may indicate the presence of an intertidal eelgrass bed. The intertidal area could be examined with a snorkel/kayak survey. A treated sewage outflow line associated with Camp Howdy enters the area.

Second Narrows (Ironworkers Memorial) Bridge to Westridge Terminal (surveyed 11 June):

At the eastern start point of the survey area it was necessary to go around bull kelp beds. The area east of the Stanovan (Chevron) terminal was sandy, flat and a suitable depth but no eelgrass was observed. It was necessary to go around the Island Trader docks and large ships that were docked. Eelgrass patches were observed west of the Shellburn (Shell) dock (see Figure 11). This could be a potential restoration site through the augmentation of existing patches. The shoreline was industrially used, but the coastal bank is treed. It was necessary to go around another long industrial dock (potentially also belonging to Shell?). Similar suitable habitat (sand and mud flats at suitable depth) was observed west of the Westridge (Kinder Morgan) Terminal, which was the location of the 2007 Kinder Morgan oil spill (Figure 12), with some live kelp (*Laminaria sp.*), *Ulva sp.*, sea cucumbers and crabs present; no eelgrass was observed in this area, however. It was necessary to go around the Westridge terminal docks, crab traps and booms, as well as other industry terminals and booms so those areas within eelgrass depth range could not be surveyed.

Figure 11. Eelgrass locations west of Shellburn dock

Figure 12. Location of 2007 Kinder Morgan oil spill

Deep Cove (surveyed 11 June):
Small eelgrass beds were observed at the south side of the cove. The area is heavily used for recreation, including a yacht club, marina and canoe/kayak rental centre in addition to residences. There may be additional eelgrass beds or patches in the cordoned-off swimming area west of the yacht club that had no boat access – this area would require a snorkel survey.

Other observations
Large moon jelly (*Aurelia labiata*) blooms were observed at each site surveyed in Indian Arm. This is a common phenomenon that has been observed by Tsleil-Waututh Nation field staff in other years; moon jellies seem to bloom or aggregate at sites in Indian Arm where there is freshwater outflow.

Comparison with historical information
Further research is required to compare the results of this survey with traditional knowledge or other historical records of eelgrass in Burrard Inlet and Indian Arm. This comparison will help to determine additional potential restoration sites and identify threats in the area that need to be addressed to enable eelgrass habitat restoration.

Conclusion

This survey provides valuable information about the current extent and health of eelgrass beds in Burrard Inlet and Indian Arm in relation to human activities. This information will help with understanding the effects of current and historical activities on eelgrass habitat, provision of input into proposed activities in the area and restoration planning. It will also help identify areas that are important to conserve and restore in the interest of maintaining and improving salmon habitat and migration corridors.

Acknowledgements

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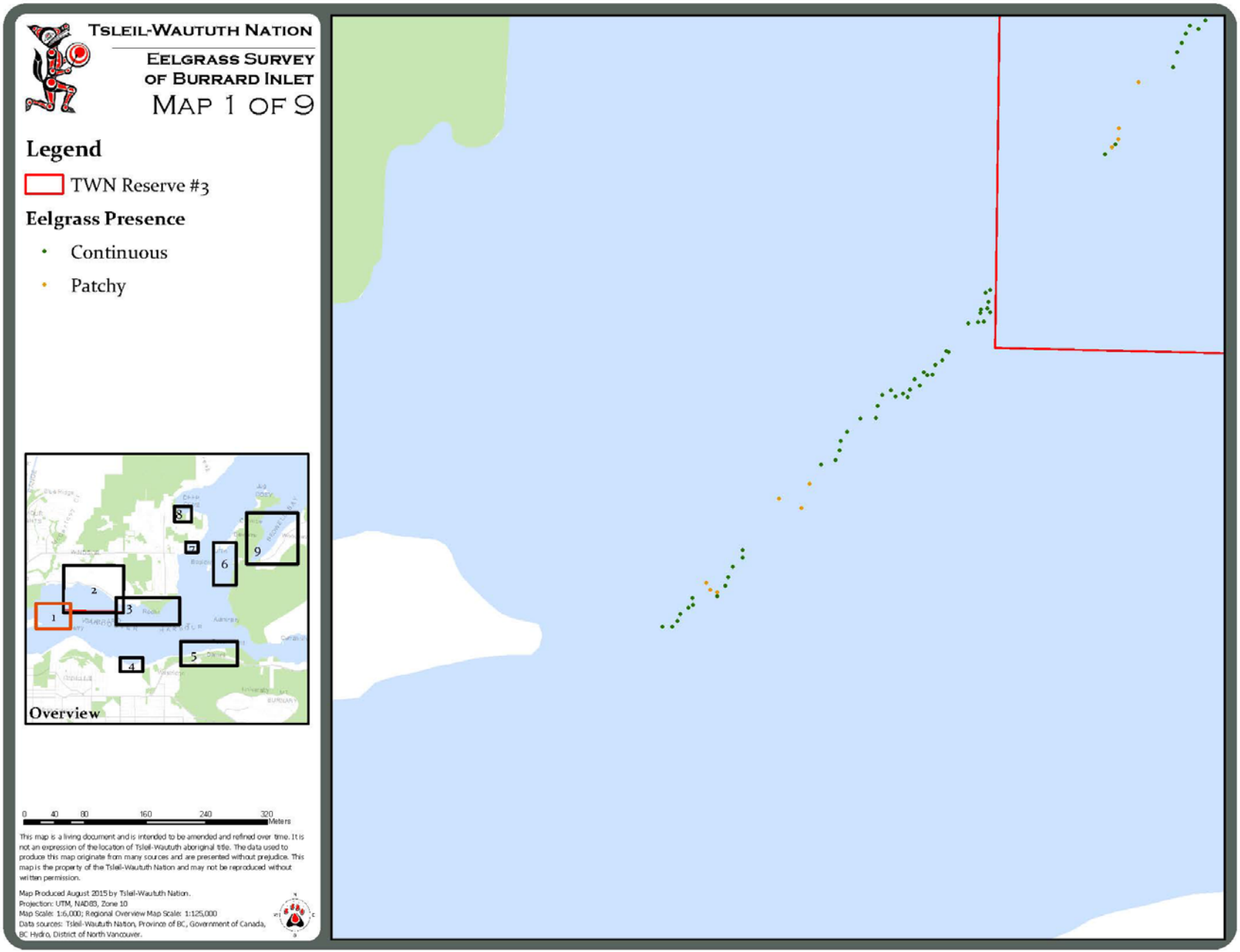
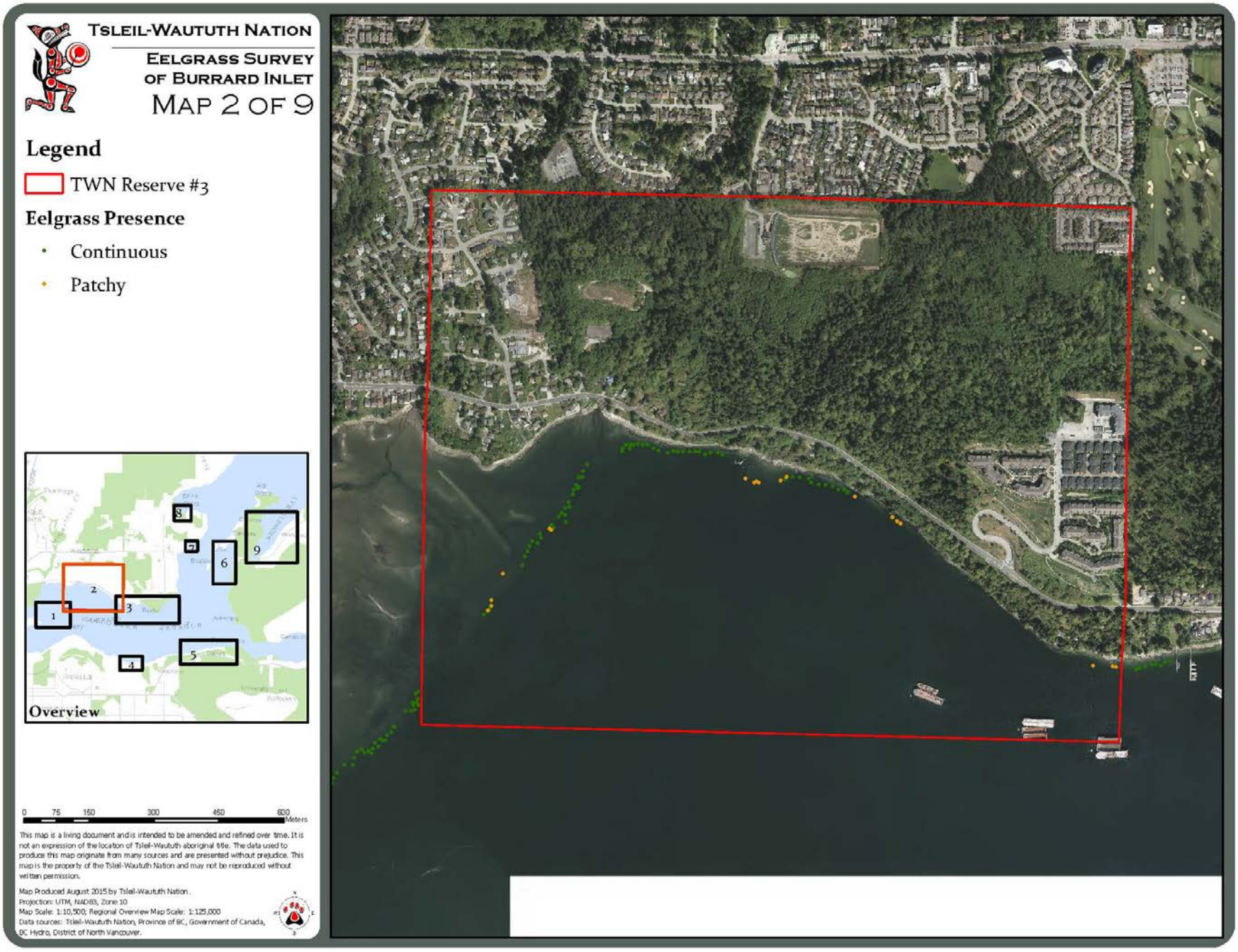
Appendix 1: Detailed maps of eelgrass presence




TSLEIL-WAUTUTH NATION
EELGRASS SURVEY OF BURRARD INLET
MAP 2 OF 9
Legend
TWN Reserve #3
Eelgrass Presence
Continuous
Patchy
Overview
1
2
3
4
5
6
8
9
0 75 150 300 450 600
Meters
This map is a living document and is intended to be amended and refined over time. It is not an expression of the location of Tsleil-Waututh aboriginal title. The data used to produce this map originate from many sources and are presented without prejudice. This map is the property of the Tsleil-Waututh Nation and may not be reproduced without written permission.
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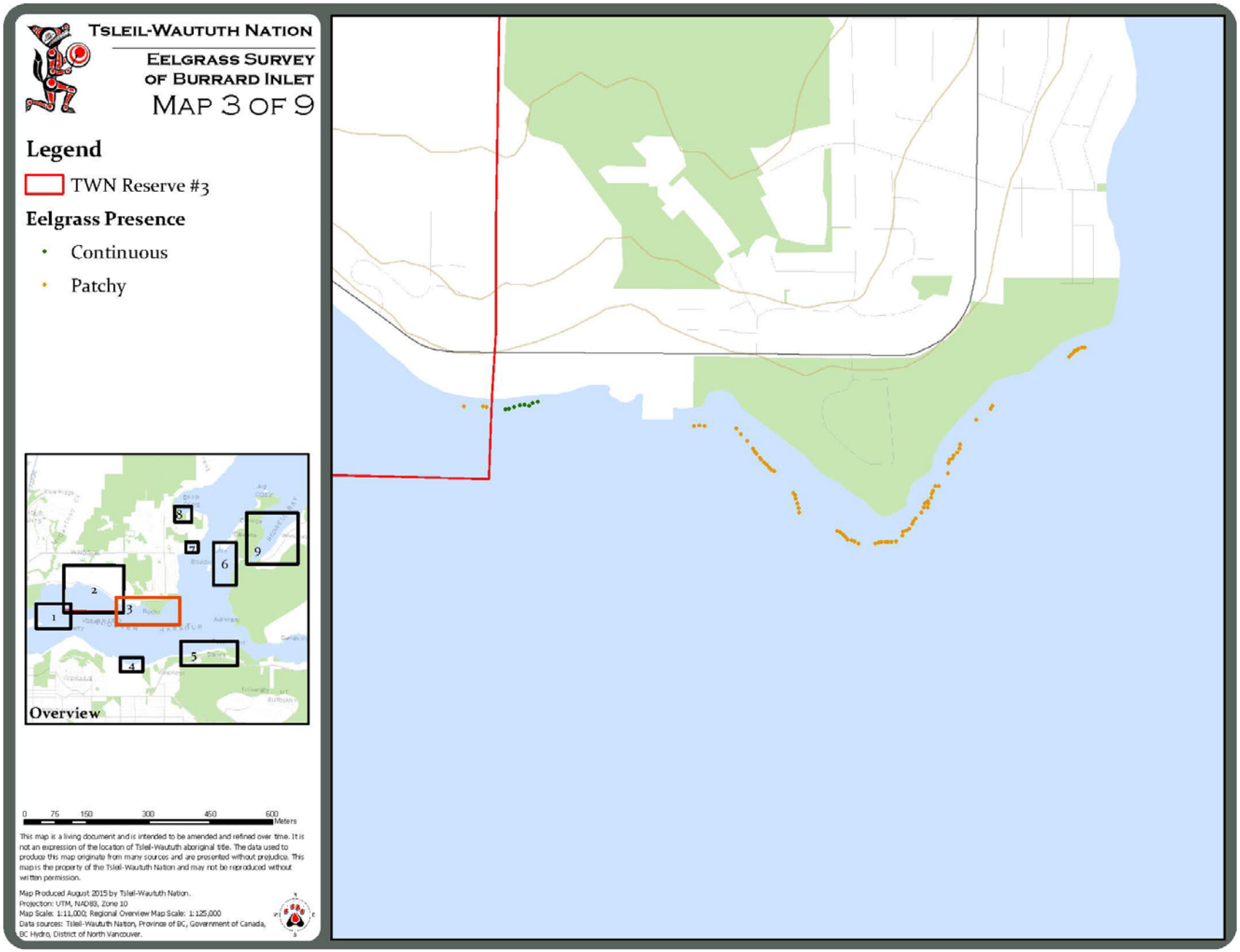
Data sources: Tsleil-Waututh Nation, Province of BC, Government of Canada, BC Hydro, District of North Vancouver.


TSLEIL-WAUTUTH NATION
EELGRASS SURVEY OF BURRARD INLET
MAP 3 OF 9
Legend
TWN Reserve #3
Eelgrass Presence
Continuous
Patchy
Overview
1
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TSLEIL-WAUTUTH NATION

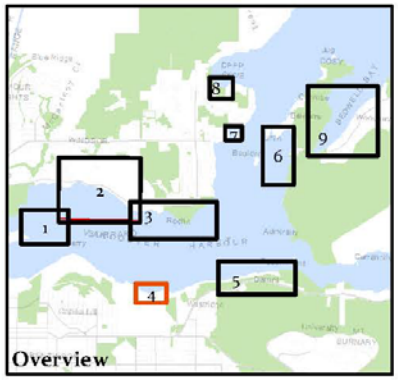
EELGRASS SURVEY OF BURRARD INLET

MAP 4 OF 9

Legend

Eelgrass Presence

- Continuous
- Patchy



0 25 50 100 150 200 Meters

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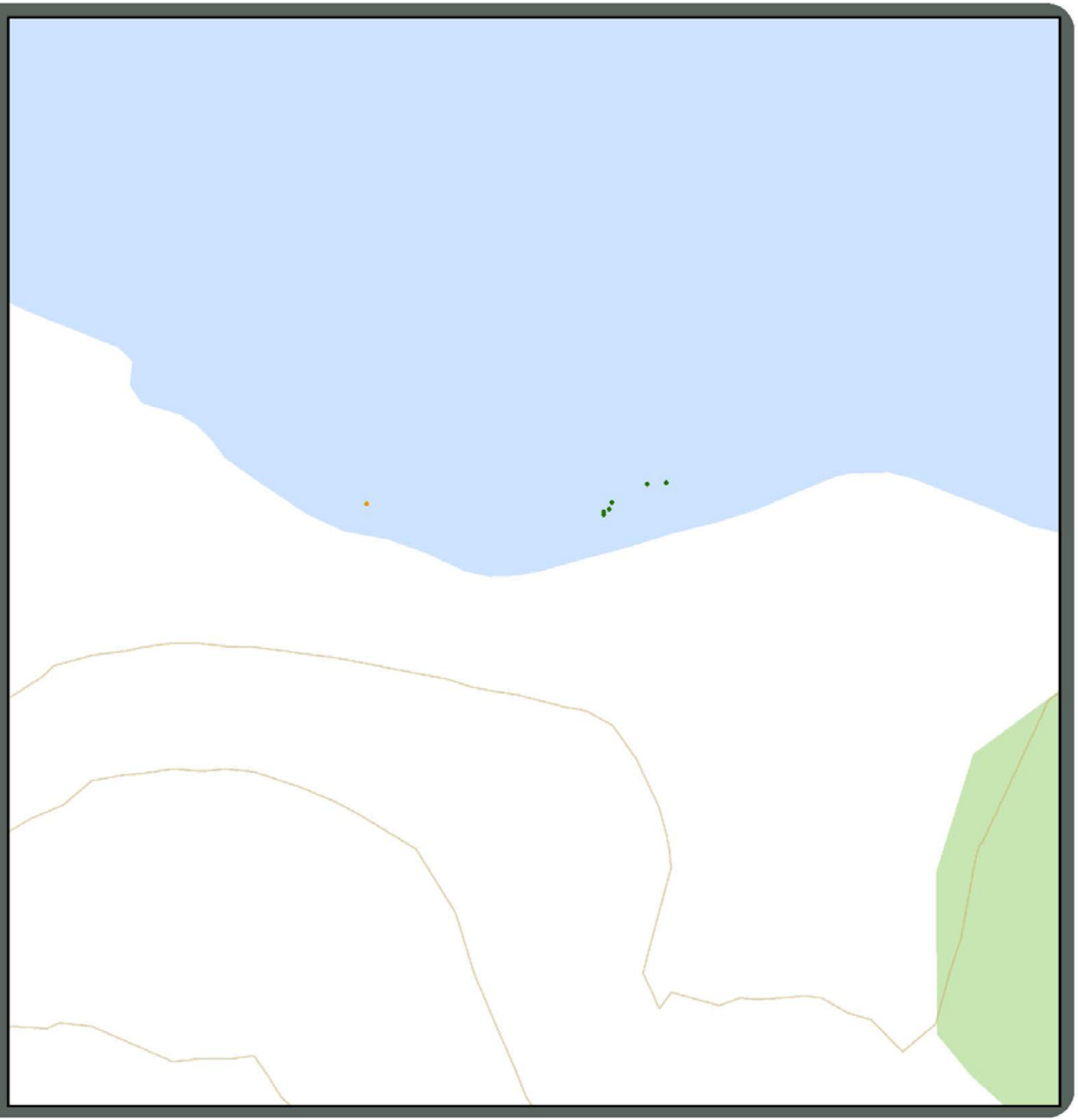
Projection: UTM, NAD83, Zone 10
Map Scale: 1:4,000; Regional Overview Map Scale: 1:125,000
Data sources: Tsleil-Waututh Nation, Province of BC, Government of Canada, BC Hydro, District of North Vancouver.



TSLEIL-WAUTUTH NATION

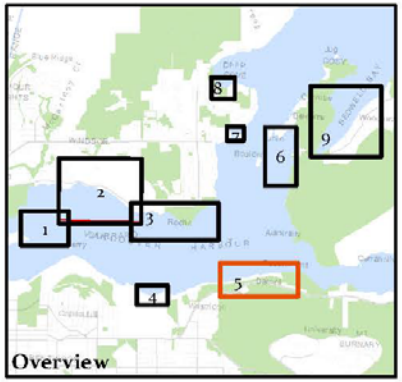
EELGRASS SURVEY OF BURRARD INLET

MAP 5 OF 9

Legend

Eelgrass Presence

- Continuous
- Patchy



0 70 140 280 420 560 Meters

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Map Produced August 2015 by Tsleil-Waututh Nation.
Projection: UTM, NAD83, Zone 10
Map Scale: 1:10,000; Regional Overview Map Scale: 1:125,000
Data sources: Tsleil-Waututh Nation, Province of BC, Government of Canada, BC Hydro, District of North Vancouver.

TSLEIL-WAUTUTH NATION

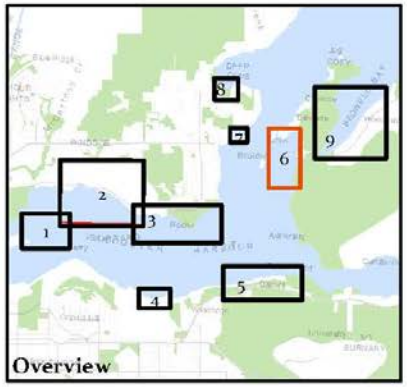
EELGRASS SURVEY OF BURRARD INLET

MAP 6 OF 9

Legend

Eelgrass Presence

- Patchy



0 50 100 200 300 400 Meters

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Map Scale: 1:7,000; Regional Overview Map Scale: 1:125,000
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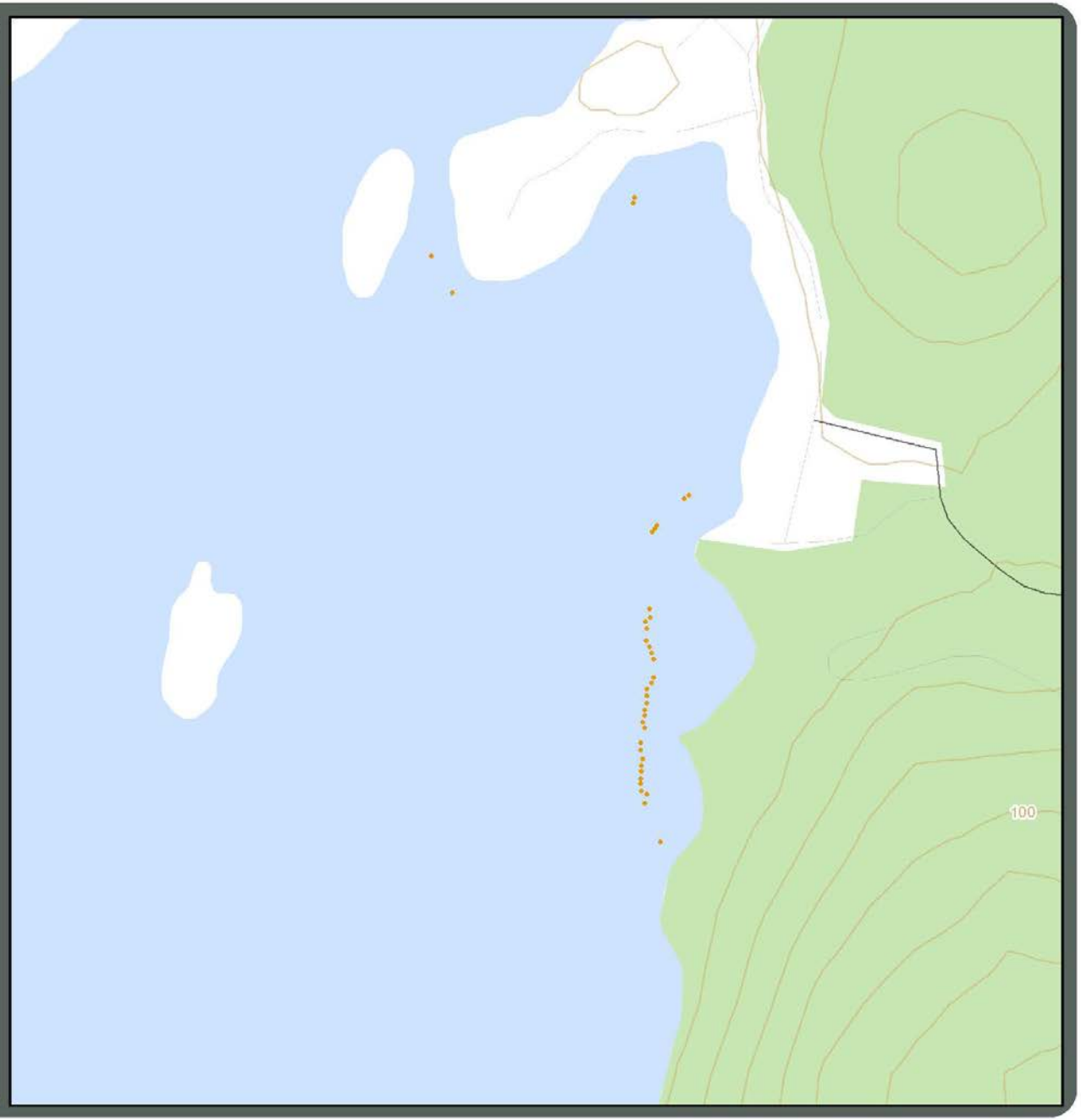


TSLEIL-WAUTUTH NATION

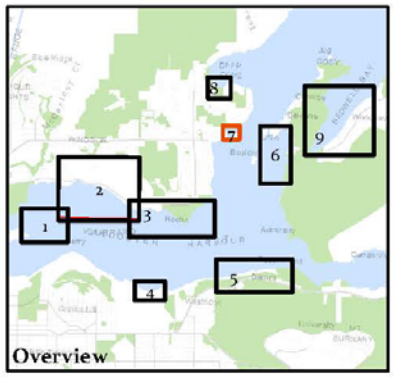
EELGRASS SURVEY OF BURRARD INLET

MAP 7 OF 9

Legend

Eelgrass Presence

- Continuous



0 12.5 25 50 75 100 Meters

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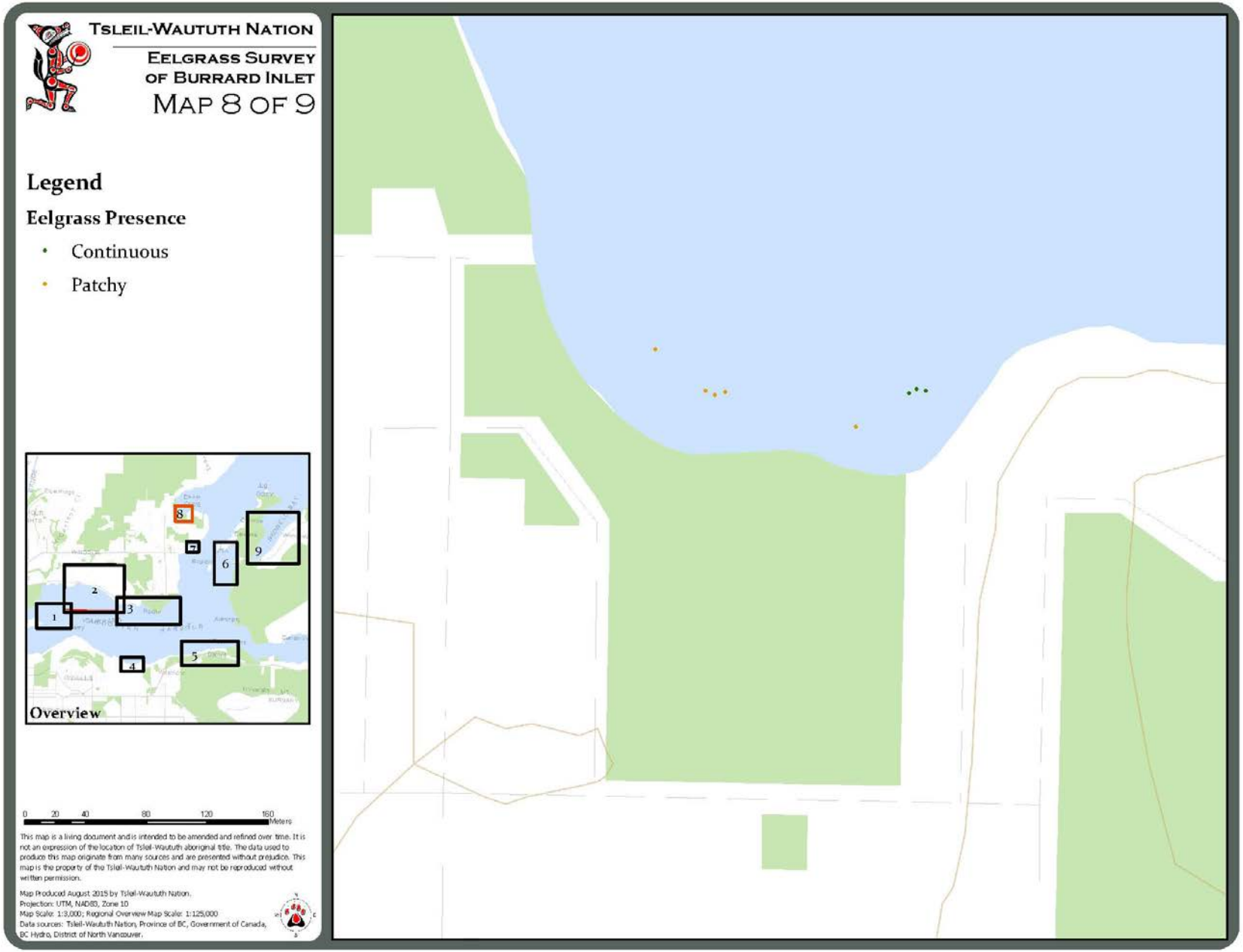
Projection: UTM, NAD83, Zone 10
Map Scale: 1:2,000; Regional Overview Map Scale: 1:125,000
Data sources: Tsleil-Waututh Nation, Province of BC, Government of Canada, BC Hydro, District of North Vancouver.


Tsleil-Waututh Nation
Eelgrass Survey of Burrard Inlet
Map 8 of 9
Legend
Eelgrass Presence
Continuous
Patchy
1
2
3
4
5
6
8
9
Overview
0 20 40 80 120 160
Meters
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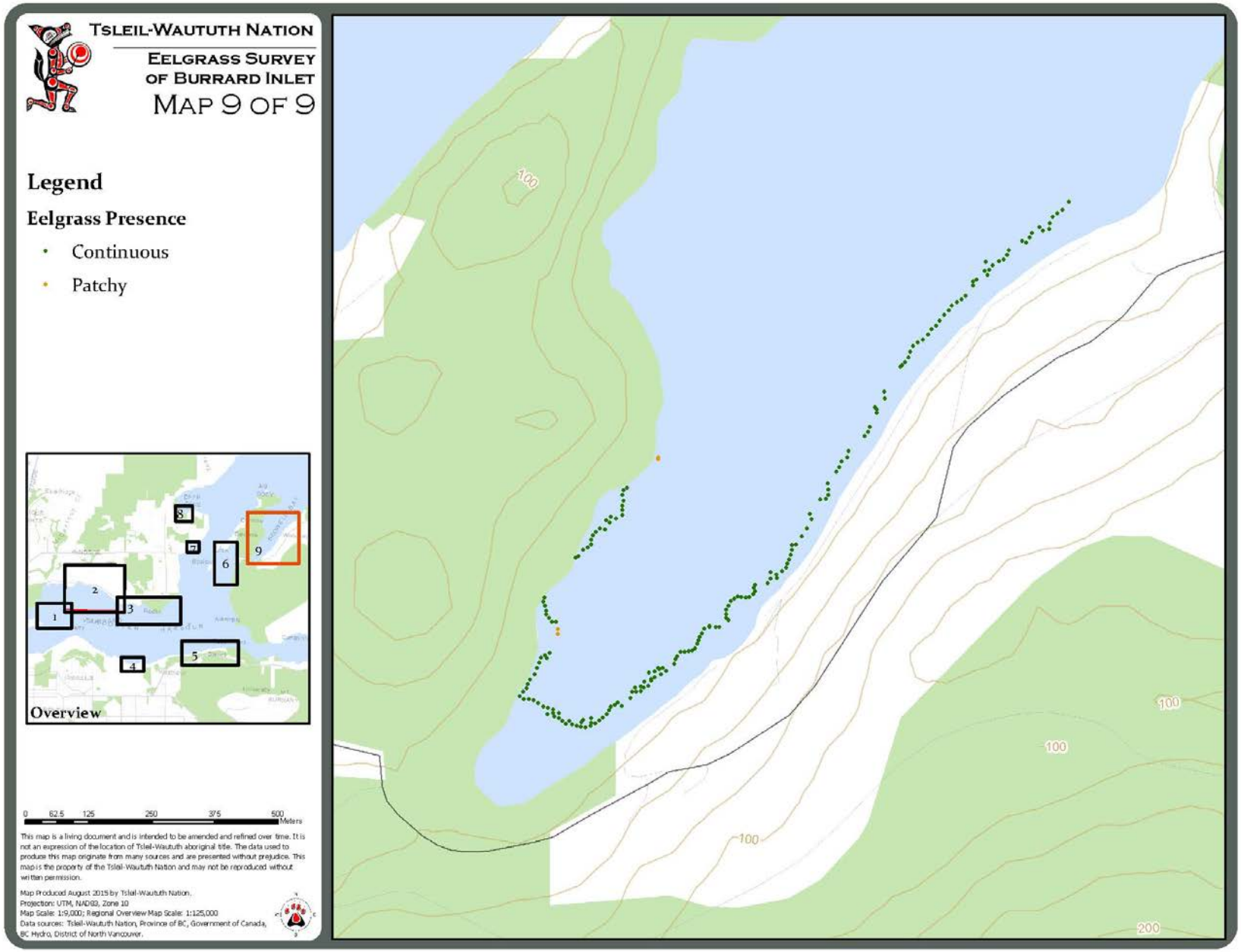
Projection: UTM, NAD83, Zone 10
Map Scale: 1:3,000; Regional Overview Map Scale: 1:125,000
Data sources: Tsleil-Waututh Nation, Province of BC, Government of Canada, BC Hydro, District of North Vancouver.


TSLEIL-WAUTUTH NATION
EELGRASS SURVEY OF BURRARD INLET
MAP 9 OF 9
Legend
Eelgrass Presence
Continuous
Patchy
Overview
1
2
3
4
5
6
7
8
9
100
100
100
200
0 62.5 125 250 375 500 Meters
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Projection: UTM, NAD83, Zone 10
Map Scale: 1:9,000; Regional Overview Map Scale: 1:125,000
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