

Appendix 2-D

2023 Muskrat Technical Data Report

Project Nujio'qonik: Amendment to the Environmental Impact Statement



**Project Nujio'qonik
2023 Muskrat Survey**

Final Report

January 25, 2024

Prepared for:

World Energy GH2 LP

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File: 121417575

PROJECT NUJIO'QONIK 2023 MUSKRAT SURVEY

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Executive Summary

World Energy GH2 LP (WEGH2) is proposing to develop Project Nujio'qonik (hereafter the “Project”) a commercial-scale, “green hydrogen” and ammonia production facility powered by renewable wind energy in western Newfoundland. The Project involves the development, construction, operation and maintenance, and eventual decommissioning and rehabilitation of two onshore wind farms (Port au Port and Codroy Wind Farms) and a hydrogen-ammonia facility, in Stephenville, powered by renewable wind energy. As part of the provincial environmental assessment (EA) requirements, WEGH2 was required to conduct baseline surveys of the terrestrial environment, including for muskrat (*Ondatra zibethicus*).

Stantec Consulting Ltd. (Stantec) was retained by WEGH 2 to conduct a survey in fall 2023 following provincial protocols for muskrat surveys (NLDFFA 2019). The objectives of the 2023 Muskrat Survey were to determine the presence/non-detection of muskrat in suitable habitat in Project area, quantify wetland habitat associated with muskrat use (relative abundance of muskrat sign based on sign/100m of surveyed), and to prepare a technical data report outlining the results of the muskrat survey (i.e., this document).

Surveys for muskrat were conducted over seven field days between September 16 and September 28, within the timing window from September 1 to November 1 identified by NLDFFA (2019) to conduct muskrat surveys. Survey methods consisted of a combination of habitat delineations (vegetation surveys) and surveying for muskrat sign (transect surveys). A total of 55 sites (ponds and wetlands) were visited, 74 habitat plots delineated, and 8,210.1 m of transects surveyed for evidence of muskrat.

Habitat at 16 sites was assessed as having a high potential to support muskrat, 12 as moderate potential, and 16 as having a low potential. Eleven other sites were assessed as having areas with a combination of low, moderate or high potential, depending on the area within the survey site. Evidence of muskrat was detected at 36.4% of the sites surveyed, with the highest percentage of sites with evidence of muskrat in the Stephenville (46.2%) and Codroy Wind Farm (55.0%) areas. Only two of the sites surveyed in the Port au Port Wind Farm area (13.3%) had evidence of muskrat, and only one site (20.0%) along the transmission line. Eighteen sites with evidence of muskrat were ponds and two were within a wetland. Muskrat sites consistently had sedges or grasses present on the shoreline, while sweet gale (*Myrica gale*) and rushes (*Juncus* spp. or *Schoenoplectus* spp.) were also relatively common among sites with muskrat. At sites with evidence of muskrat, muskrat sign ranged from 0.45 / 100m surveyed to 6.00 / 100m surveyed. Overall (i.e., all transects surveyed with and without muskrat sign), the abundance of muskrat sign was 0.66 / 100m surveyed.



Abbreviations

EA	Environmental Assessment
EIS	Environmental Impact Statement
kV	kilovolt
MW	megawatt
NL	Newfoundland and Labrador
NLDEEC	Newfoundland and Labrador Department of Environment and Climate Change
NLDFFA	Newfoundland and Labrador Department of Fisheries, Forestry and Agriculture
Project	Project Nujio'qonik
Stantec	Stantec Consulting Ltd.
WEGH2	World Energy GH2 LP

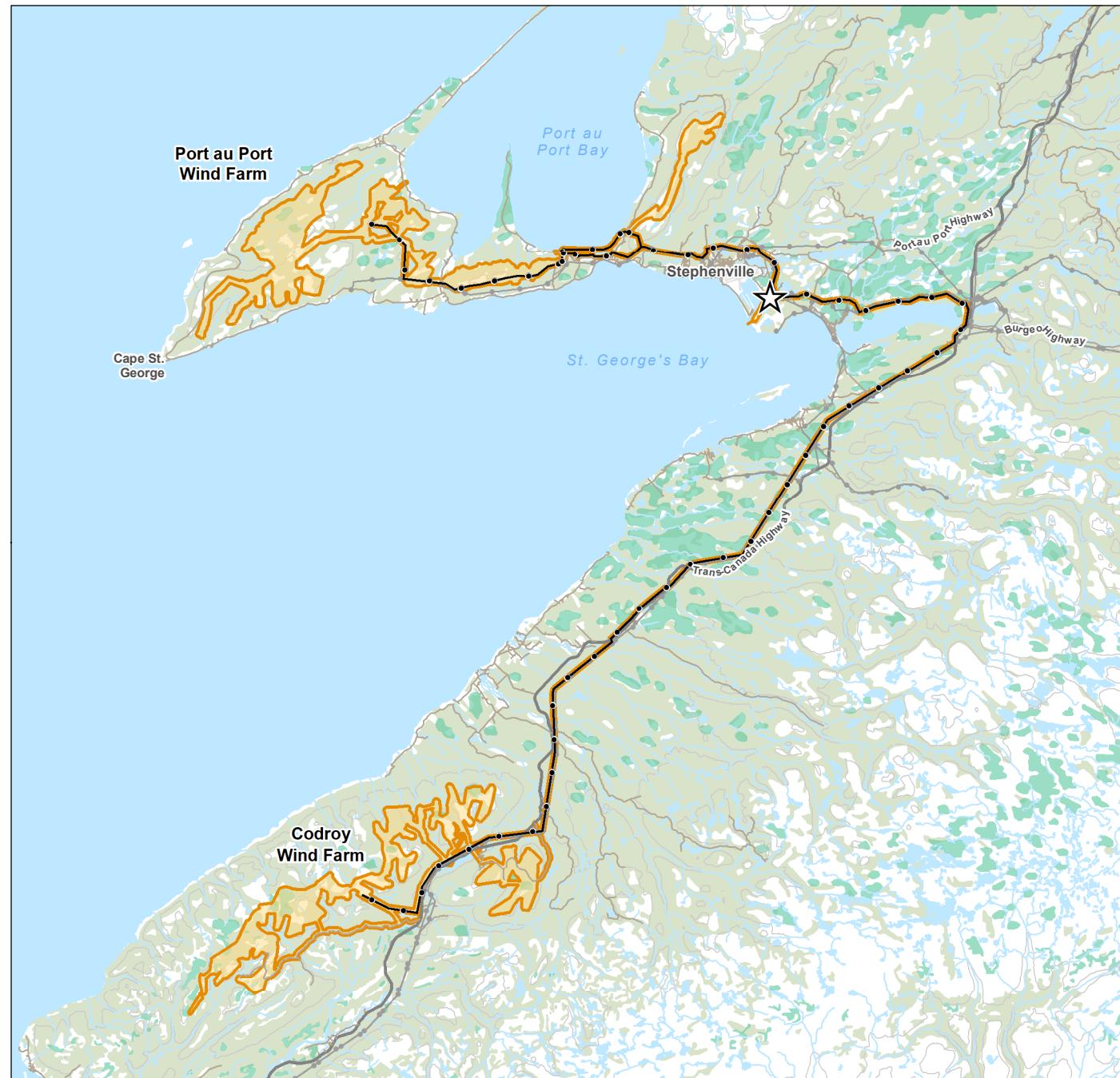


1.0 INTRODUCTION

World Energy GH2 Inc. (WEGH2) is proposing to develop a new hydrogen and ammonia production facility and wind farm (Project Nujo'qonik, (hereafter the “Project”) a commercial-scale, “green hydrogen” and ammonia production facility powered by renewable wind energy on the west coast of the island of Newfoundland, in the Province of Newfoundland and Labrador (NL) (Figure 1-1). The Project involves the development, construction, operation and maintenance, and eventual decommissioning and rehabilitation of two onshore wind farms and a hydrogen-ammonia production plant powered by renewable wind energy.

The Project is subject to provincial environmental assessment (EA) requirements under the NL *Environmental Protection Act* and associated *Environmental Assessment Regulations*. The NL Department of Environment and Climate Change (NLDECC) released the Final Environmental Impact Statement (EIS) Guidelines for the Project on December 1, 2022. The EIS Guidelines identify the information required to support the EA including baseline surveys of the terrestrial environment. As per section 4.3.3 (Terrestrial Environment) of the Guidelines, pre-construction baseline surveys for muskrat (*Ondatra zibethicus*) are required in suitable biophysical environments that could be affected by the Project. Stantec Consulting Ltd. (Stantec) was retained by World Energy to complete a fall 2023 pre-construction survey for muskrat. This document presents the findings of the 2023 muskrat survey.





Proposed Project Features

- Hydrogen / Ammonia Plant Location
- Transmission Line 230 kV
- Project Area

Other Features

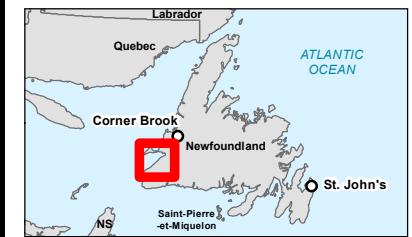
- Transmission Line, Existing
- Trans-Canada Highway
- Road
- Contour (100 m)
- Watercourse
- Waterbody
- Wetland
- Forested Area



0 10 Kilometres
(At original document size of 8.5x11)
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Notes

- Coordinate System: NAD 1983 CSRS UTM Zone 21N
- Data Sources: World Energy GH2, NRCan CanVec, OpenStreetMap
- Background: NRCan CanVec



Project Location: Stephenville, NL
Prepared by MB on 2023-06-30
QR by AW on 2023-07-06

Client/Project: World Energy GH2
Project Nujjo'qonik
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Figure No.: 1-1

Proposed Project Features and Location

1.1 BACKGROUND

1.1.1 Project Overview

Project Nujio'qonik involves the development, construction, operation and maintenance, and eventual decommissioning and rehabilitation of one of the first Canadian, commercial-scale, “green hydrogen” and ammonia production plants powered by renewable wind energy. Key components of the Project will include two onshore wind farms, situated on Crown lands in the Port au Port and Bay St. George South / Codroy areas of NL, and a hydrogen / ammonia facility, situated on a privately owned brownfield site at the Port of Stephenville (in the Town of Stephenville, NL) that is zoned for industrial use. The Project will have a maximum production of up to approximately 206,000 t of green hydrogen per year. The hydrogen produced by the Project will be converted into ammonia and the resulting 1.17 Mt of ammonia exported to international markets by ship.

The two Wind Farms (referred to herein as the “Port au Port Wind Farm” and the “Codroy Wind Farm”) will include up to 328 turbines and collectively produce approximately 2,000 megawatts (MW) of renewable electricity. The Port au Port Wind Farm is currently planned to include up to 164 wind turbines on the Port au Port Peninsula, NL, and adjacently on the Newfoundland “mainland” (i.e., northeast of the isthmus at Port au Port). The Codroy Wind Farm is also currently planned to consist of up to 164 wind turbines located on Crown land in the Anguille Mountains¹. Both Wind Farms will require a network of new and upgraded access roads for transportation of Project components and equipment, as well as interconnection of the wind turbine locations within the respective Wind Farm sites. An electrical collector system (i.e., a network of 34.5 kilovolt [kV] transmission lines) will interconnect the wind turbines at each of the Wind Farm sites to transformer substations owned by the Project.

The Project will initially be operated using the Port au Port Wind Farm as the primary power source. Civil works associated with the Port au Port Wind Farm are scheduled to start in 2024, with operations commencing in 2027. The operational life of the Project is currently modelled to be approximately 30 years.

On August 22, 2023, WEGH2 filed an EIS with the NLDECC assessing potential Project and cumulative effects of the Project.

¹ The modelling and assessment work is based on preliminary layouts for both Wind Farm sites. Final Wind Farm layouts will be dependent on results of the ongoing wind campaign and more detailed field investigations.



1.1.2 Newfoundland Muskrat

Muskrats are native to the Island of Newfoundland and are considered a distinct race that differ morphologically from muskrat in other areas (Rigby and Threlfall 1982). Muskrats are managed and trapped throughout much of NL (NLDFFA 2023) and are also a culturally important species to Indigenous communities in Newfoundland. Emerging data indicate muskrat across North America are in decline (Sadowski and Bowman 2021; Gregory et al. 2019; Ward and Gorelick 2018; Ahlers and Heske 2017) and, based on trends in trapping data, it is believed muskrat on the Island of Newfoundland may be undergoing a similar decline (NLDFFA 2019). The cause of muskrat decline in North America is unknown, though it is likely related to multiple factors, including wetland loss and alteration combined with predation, disease, and contaminants (Sadowski and Bowman 2021; Ganoe et al. 2020). Historical declines on the Island of Newfoundland have been attributed to predation from introduced mink (*Neogale vison*) (Soper and Payne 1997; Soper 1995).

Muskrats inhabit a variety of permanent wetlands and watercourses, including marshes, ponds, slough, lakes, and slow-moving creeks, and rivers; anthropogenic wetlands such as ditches and dugouts are also used (Boutin and Birkenholz 1987). Muskrats can occupy brackish water (e.g., estuaries) and have been observed in saltwater (Naughton 2012). In western Newfoundland, Soper (1995) found that sites consisted of marshy areas or bogs bordering deep ponds but noted that deep open water ponds provide only marginal habitat for muskrat. Cattails (e.g., *Typha latifolia*) are generally considered a preferred food source and building material for muskrat lodges; however, cattails are relatively rare on the Island of Newfoundland and have not been recorded as being used for muskrat lodges (per review comments provided by Newfoundland and Labrador Department of Fisheries, Forestry and Agriculture [NLDFFA] on the EIS [WEGH2 2024]). In western Newfoundland, sedge (*Carex* sp.), iris (*Iris versicolor*), horsetail (*Equisetum* sp.), pondweed, and rush (*Eleocharis* sp.) are considered the primary food source and lodge building material for muskrat (Soper 1995). Other emergent / shoreline vegetation used by muskrat include bullhead-lily (*Nuphar variegatum*), bulrush (*Schoenoplectus* spp.), broad leaf arrowhead (*Sagittaria latifolia*), buckbean (*Menyanthes trifoliate*), Canadian burnet (*Sanquisorba Canadensis*), goldenrod (*Solidago* spp.), American bur-reed (*Sparganium americanum*), sweet gale (*Myrica gale*), and moss and grass species (NLDFFA 2019).

During winter, muskrat remain active and den in bank burrows or lodges made from aquatic vegetation (Naughton 2012). Muskrat in Western Newfoundland tend to favor bank burrows for shelter (Lear 1952 in Soper 1995), which may make them more vulnerable to mink predation (NLDFFA 2019). Specialized “push-ups” with a central plunge hole and walls of mud and vegetation are also built by muskrat on the ice surface during winter, these features provide a protected location under the snow for resting and feeding (Naughton 2012).



1.1.3 Survey Objectives

The 2023 muskrat survey is based on provincial protocols provided by the NL Department of Fisheries, Forestry and Agriculture - Wildlife Division (NLDFFA - Wildlife Division) (NLDFFA 2019), that identified a primary goal to understand the current distribution and relative abundance of muskrat across the Island of Newfoundland. Based on the information provided in these protocols, the specific objectives of the 2023 muskrat survey were to:

- determine presence/non-detection of muskrat in the Project Area
- quantify wetland habitat associated with muskrat use (relative abundance of muskrat sign based on sign / 100m of surveyed)
- prepare a technical data report outlining the results of the muskrat survey

2.0 METHODS

Survey methods were based on provincial protocols provided by NLDFFA - Wildlife Division (NLDFFA 2019). A copy of the provincial muskrat survey protocols is provided in Appendix A.

2.1 SURVEY AREA

The survey area for the 2023 muskrat survey included the Project Area (Figure 1-1), but focused on potential muskrat habitat identified during pre-survey planning (described below).

2.2 PRE-SURVEY PLANNING

Provincial protocols base survey site selection on current or historic muskrat sites as identified by trappers, provincial officers, and other local knowledge. However, as those data were unavailable², the approach was to identify survey sites that provide suitable habitat for muskrat based on the available landcover data. Specifically, potential sampling locations were selected using the provincial forestry wetland layer, which included bogs, treed bogs, and wet bogs, and the provincial water polygon layer, which included larger rivers, ponds, and lakes. These habitats were assessed for their ability to support muskrat and preliminarily ranked using aerial imagery, based on the presence of the following features in an area or within a portion of a larger wetland or waterbody:

- 50-80% of water surface covered with emergent vegetation
- Presence of shoreline herbaceous vegetation within 10m of water's edge
- Water depth of 0.5 to 1.5m with stable seasonal water levels
- Slow flowing/standing water
- Burrow sites (soft high clay content, not rocky; slope $\geq 10^\circ$, minimum height 0.2 m)

²Land and Resource Use Survey Results identified five respondents from the Port au Port peninsula, nine in and around the Codroy valley and three near Stephenville who, or a member of their family, harvested muskrat, but details on muskrat sites were not included in the survey (Stantec 2023). There was no evidence of trapping activity observed during the 2023 Muskrat Survey.



Note that these features represent some of the ideal conditions for detecting the presence of muskrat, and targeted survey sites were not required to have all of the features listed.

Wetlands with no visible open water, such as the majority of treed bogs and many smaller bogs, were not considered as potential muskrat habitats. Open water areas, such as lakes and ponds, with no visible emergent vegetation and no adjacent wetland areas were considered to have low potential to support muskrat. Areas considered to have the highest habitat suitability include areas of open water with visible emergent vegetation adjacent to the wetland. Remaining areas were ranked as having moderate potential to support muskrat. Potential survey locations and their ranks were uploaded to ArcGIS Field Maps.

2.3 SURVEY METHODS

2.3.1 Survey Timing

As per provincial protocols, the muskrat survey was completed during the recommended timing window (September 1 and November 1), as fall surveys provide for the greatest opportunity for detection of fresh sign due to muskrat being at the highest population levels during this period.

2.3.2 Survey Site Selection

Targeted locations for surveys were determined in the field and prioritized by locations that were initially ranked (i.e., during the desktop assessment) as having high or moderate potential to support muskrat³, which included a visual assessment of emergent vegetation. For locations initially ranked as having a low potential for muskrat, particularly high-elevation wetlands in the Anguille Mountains, a subset of the sites were surveyed from the ground and additional sites visually assessed from the helicopter. If a site was considered suitable for muskrat based on the visual/aerial assessment, the site was targeted for a ground survey.

2.3.3 Ground Surveys

Ground surveys consisted of habitat delineations (survey plots) and surveys for muskrat sign (transect surveys). At each survey site, habitat delineations were completed within each discrete area with similar plant assemblages, as well as a minimum of one survey transect (resulting in a greater number of habitat delineations completed compared to transects). Data were recorded on printed data forms provided in the provincial protocols. Photographs and transect data were also digitally recorded using ArcGIS Field Maps.

³ Approximately 350 wetland areas were identified in the Project Area and vicinity during the initial desktop analysis, including locations with a low potential for muskrat.



2.3.3.1 Habitat Delineation (plots)

A 10 m X 10 m plot in each distinctive, suitable habitat was established. Water depth was estimated for each habitat delineated, based on visual inspection or depth when walking in the water. Common wetland species (as presented in Appendix B of the provincial protocols; NLDFFA 2019) were described and quantified using the Braun Blanquet scale (Table 2.2).

Table 2.1 Braun Blanquet Cover and Abundance Categories

Rating	Description of Cover
+	< 5 % and sparse
1	< 5 % and plentiful
2	5 – 25%
3	26 – 50%
4	51 – 75%
5	76 – 100%

Source: NLDFFA 2019

2.3.3.2 Transect Surveys for Muskrat Sign

At each survey site, one or both observers walked along the shoreline, recording muskrat sign including distinct groups of scat, clippings, burrows, trails, tracks, feed beds and houses. Sign found within each 1 m traveled was considered one distinct sign. The provincial protocols do not stipulate a shoreline distance to survey, but where possible the full extent of potential muskrat habitat at a given site was surveyed. The total observations and distance surveyed was tabulated for each delineated habitat, and an index of relative muskrat abundance (sign / 100 m) was calculated.



3.0 RESULTS

3.1 SURVEY EFFORT

The 2023 muskrat survey was completed during seven field days between September 16 and September 28, 2023. A total of 55 sites (ponds and wetlands) were visited, which included an assessment of 74 habitat plots and 65 transects (Table 3.1). Approximately 30 additional sites were assessed (e.g., from helicopter) as having a low potential to support muskrat and were not targeted for ground-based surveys.

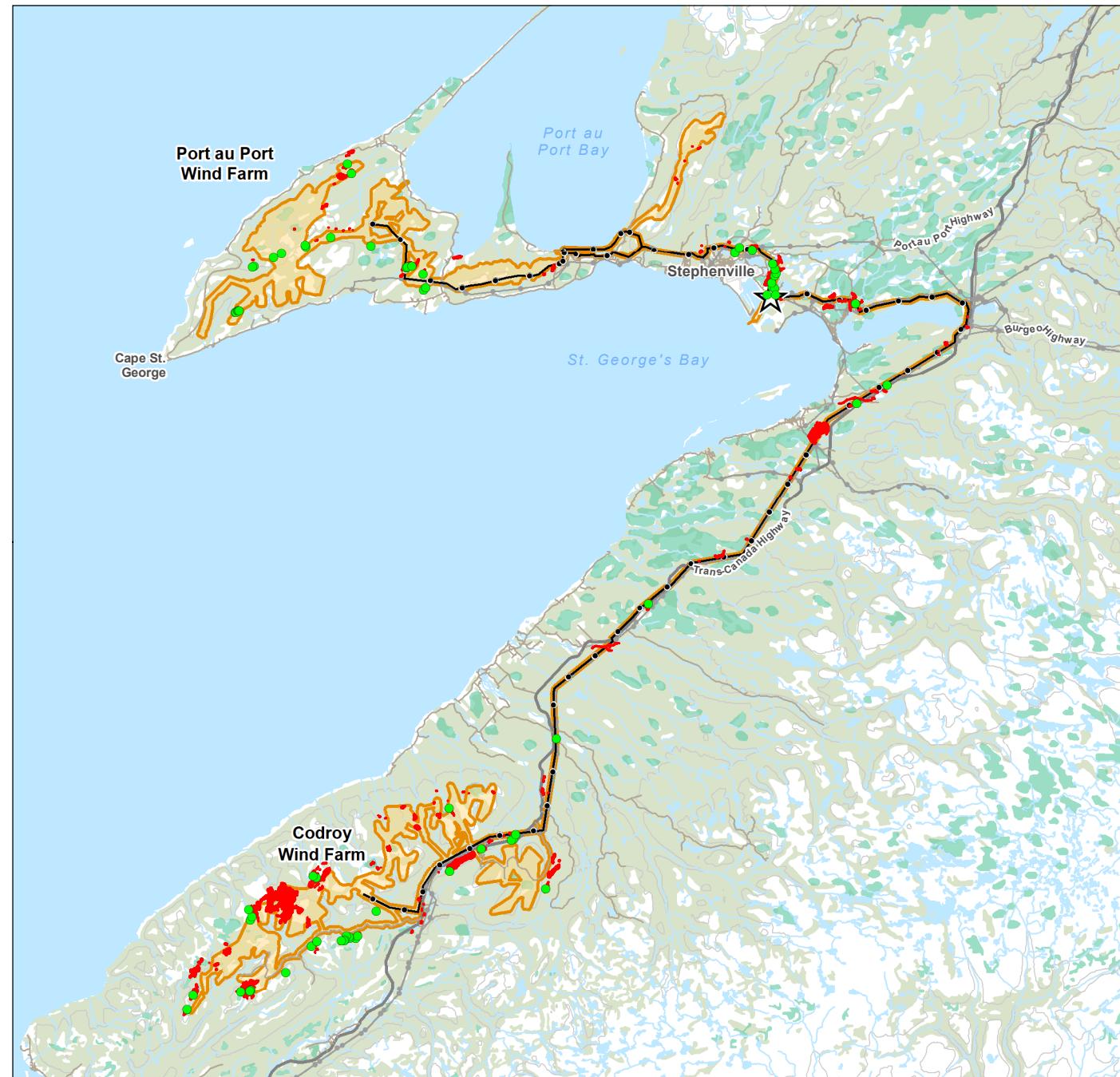
Table 3.1 Survey Effort during the 2023 Muskrat Survey

Project Area	Survey Effort		
	# Sites	# Habitat Plots	# Transects
Port au Port Wind Farm	15	26	24
Stephenville	13	17	12
Codroy Wind Farm	20	24	22
Transmission Line	5	5	5
Codroy Wind Farm / Transmission Line	2	2	2
Total	55	74	65

Survey sites were located in or adjacent to the footprint of the proposed Port au Port (15 sites) and Codroy (20 sites) Wind Farms, infrastructure associated with the hydrogen / ammonia facility in Stephenville (13 sites), the transmission line right-of-way (5 sites), and sites proximate to both the Codroy Wind Farm and transmission line (2 sites) (Table 3.1 and Figure 3-1). The total distance covered among the survey transects was 8,210 m (average 126 m per transect; range 32 m to 406 m).

Survey locations, including coordinates for each site visited during the 2023 muskrat survey, are provided in Table B-1 of Appendix B.





Stantec

● Visited Site
■ Interpreted as Potential Muskrat Site

Proposed Project Features

- Hydrogen / Ammonia Plant Location
- Transmission Line 230 kV
- Project Area

Other Features

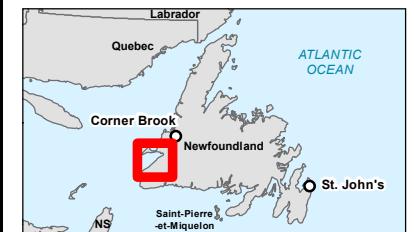
- Transmission Line, Existing
- Trans-Canada Highway
- Road
- Contour (100 m)
- Watercourse
- Waterbody
- Wetland
- Forested Area



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 (At original document size of 8.5x11)
 1:550,000

Notes

1. Coordinate System: NAD 1983 CSRS UTM Zone 21N
2. Data Sources: World Energy GH2, NRCan CanVec, OpenStreetMap
3. Background: NRCan CanVec



Project Location
 Stephenville
 NL

Prepared by MB on 2023-11-20

Client/Project
 World Energy GH2
 Project Nujo'qonik

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Figure No.
 3-1

Sampling Locations during the 2023 Muskrat Survey

3.2 MUSKRAT HABITAT POTENTIAL

Habitat at 16 sites was assessed as having a high potential to support muskrat, 12 as moderate potential, and 16 as having a low potential (Table 3.2). Eleven other sites were assessed as having areas with a combination of low, moderate or high potential, depending on the area within the survey site (e.g., two ends of a pond, two open water areas within a wetland complex). Including these locations, an additional eight sites had at least one area with habitat that was assessed as having a high potential to support muskrat.

Table 3.2 Habitat Potential of Surveyed Sites

Project Area	Habitat Potential of Surveyed Sites				
	Low	Moderate	High	Mixed ^A	Total
Port au Port Wind Farm	8	2	1	4	15
Stephenville	2	3	7	1	13
Codroy Wind Farm	3	5	8	4	20
Transmission Line	3	-	-	2	5
Codroy Wind Farm / Transmission Line	-	2	-	-	2
Total	16	12	16	11	55

Notes:

A. Refers to sites containing areas of low and moderate, low and high, or moderate and high habitat potential for muskrat.

B. Includes one site where muskrat was incidentally confirmed (visual observation) during another field program.

The assessment of habitat potential while in the field was based on a combination of visible emergent vegetation, standing water depth, slope characteristics, and shoreline vegetation. Examples of habitats ranked as low, moderate and high potential to support muskrat are shown in Figures 3-2 to 3-4, respectively. In the examples provided, Site 813 (Figure 3-2) was visually assessed as low potential habitat for muskrat and additional surveys were not conducted (i.e., habitat delineation and transect survey). Site 829 (Figure 3-3), while having abundant emergent vegetation and herbaceous shoreline vegetation, was estimated to have a water depth <0.5 m throughout and was ranked as moderate habitat. There was also no evidence of muskrat found at this site during the transect survey. Site 860 (Figure 3-4) was assessed as having a high potential for muskrat, based on the presence of aquatic and herbaceous vegetation, standing water depths ranging from 0.5 m to 1.5 m, and suitable habitat for burrow sites. Muskrat was incidentally confirmed using this site during avifauna surveys in July 2023, however, no evidence of muskrat was found in the area surveyed via transect (106 m length) in October 2023.





Figure 3-2 Example of a Site Assessed as Low Potential for Muskrat (Site 813/814A)





Figure 3-3 Example of a Site Assessed as Moderate Potential for Muskrat (Site 829A)





Figure 3-4 Example of a Site Assessed as High Potential for Muskrat (Site 860A)

3.3 MUSKRAT SIGN

Overall, muskrat sign was detected at 36.4% of the sites surveyed (Table 3.3). The highest percentage of sites with evidence of muskrat was in the Stephenville (46.2%) and Codroy Wind Farm (55.0%) areas (Figure 3-5 and 3-6, respectively). Only two of the sites surveyed in the Port au Port Wind Farm area (13.3%) had evidence of muskrat (Figure 3-7), and only one site (20.0%) along the transmission line (Figure 3-6). Of the 20 sites with muskrat sign, 15 were ranked as having at least one area of high potential habitat for muskrat, while the five remaining sites were ranked as moderate or low-moderate muskrat habitat (Table B.1 in Appendix B).



Table 3.3 Summary of Muskrat Sign in the Project Area

Project Area	Sites Surveyed ^A			Transect Surveys		
	Total Sites	# Sites with Muskrat Sign	% of Sites Surveyed	Total Distance (m) ^B	Total Sign	Muskrat Sign / 100 m
Port au Port Wind Farm	15	2	13.3%	3,682	5	0.14
Stephenville	13	6 ^C	46.2%	1,364	14	1.03
Codroy Wind Farm	20	11 ^D	55.0%	2,561.1	32	1.25
Transmission Line	5	1	20.0%	409	2	0.49
Codroy Wind Farm / Transmission Line	2	- ^E	-	194	1	0.52
Total	55	20	36.4%	8,210.1	54	0.66

Notes:

A. Refer to Table 3.2 (above) and Table B.1 (Appendix B) for details regarding the assessed habitat potential of surveyed sites.
B. Total distance includes all transects (i.e., sites with and without evidence of muskrat).
C. Includes one site where muskrat was incidentally confirmed (visual observation) during another field program.
D. At two sites, two transects had evidence of muskrat (i.e., 13 transects total across 11 sites).
E. “-” indicates no observations.

Most (76.8%) muskrat sign observed was in the form of trails (Table 3.4 and Figure 3-5). There was also one set of tracks recorded (Figure 3-6) and six potential burrow sites and houses (Table 3.4). One of the burrow sites had clippings near the entrance, suggesting the site was actively used by muskrat (Figure 3-7). Clippings were also noted at five other sites (Table 3.4). While evidence of muskrat was not recorded during the transect survey at Site 860, a muskrat was incidentally observed swimming in the pond during other surveys related to the Project, in July 2023 (Table 3.4). Excluding this observation of a muskrat, muskrat sign at sites with evidence of muskrat ranged from 0.45/100m surveyed at Site 813/814B to 6.00/100m surveyed at Site 837B (Table 3.4). Overall (i.e., all transects surveyed with and without muskrat sign), the abundance of muskrat surveyed was 0.66/100m surveyed.

Sites with evidence of muskrat consistently had sedges or grasses present on the shoreline, usually both (Table 3.4). Sweet gale (*Myrica gale*) and rushes (*Juncus* spp. or *Schoenoplectus* spp.) were also relatively common among sites with muskrat (Table 3.4). Cattail was present at eight of the sites visited with muskrat sign (Table 3.4). Of the common wetland vegetation identified in the provincial muskrat survey protocols (NLDFFA 2019) the only species not observed during the survey was broadleaf arrowhead (*Sagittaria latifolia*). One other species, buckbean (*Menyanthes trifoliata*), as well as moss were only recorded at sites where muskrat evidence was not recorded. Habitat characteristics at surveyed sites with and without evidence of muskrat use are presented in Table 3.2 (below) and Table B.1 (Appendix B), respectively.





Muskrat Sign Present at Site

- yes
- no

Proposed Project Features



Other Features

- Substation, Existing
- Electrical Generation, Existing
- Transmission Line, Existing
- Trans-Canada Highway
- Road
- Resource Road / Trail
- Contour (100 m)
- Watercourse
- Waterbody
- Wetland
- Forested Area



0
4.5 Kilometres
(At original document size of 8.5x11)
1:200,000

Notes

1. Coordinate System: NAD 1983 CSRS UTM Zone 21N
2. Data Sources: World Energy GH2, NRCan CanVec, OpenStreetMap
3. Background: NRCan CanVec



Project Location
Stephenville
NL

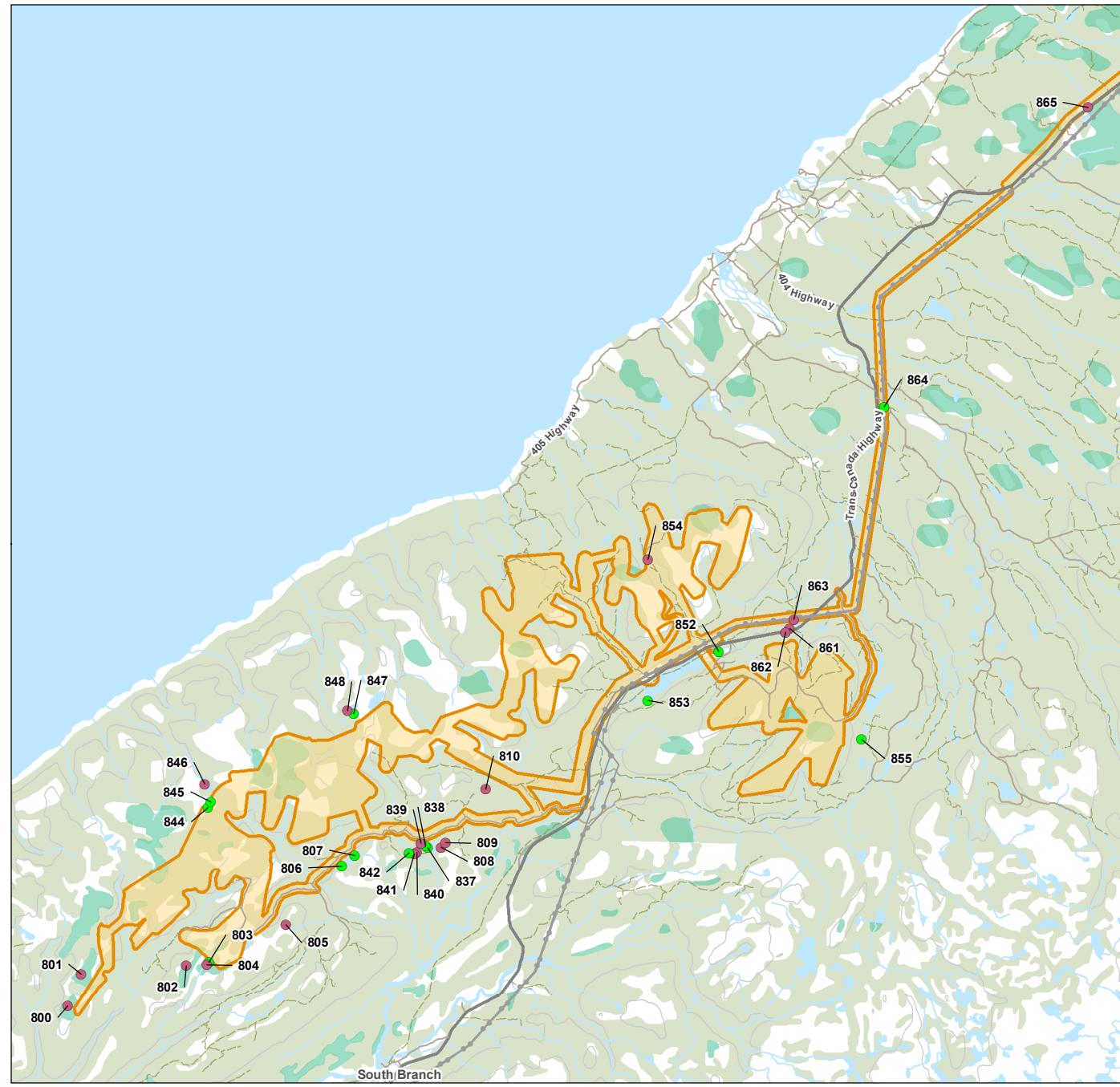
Prepared by MB on 2023-12-18

Client/Project
World Energy GH2
Project Nujo'qonik

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Figure No.
3-5

Locations with Muskrat Sign in the
Stephenville Area



 Stantec

Muskrat Sign Present at Site		Other Features
yes		Transmission Line, Existing
no		Trans-Canada Highway
Proposed Project Features		Road
 Project Area		Resource Road / Trail
		Contour (100 m)
		Watercourse
		Waterbody
		Wetland
		Forested Area



0 5.5 Kilometres
(At original document size of 8.5x11)
1:250,000

Notes

- Coordinate System: NAD 1983 CSRS UTM Zone 21N
- Data Sources: World Energy GH2, NRCan CanVec, OpenStreetMap
- Background: NRCan CanVec



Project Location
Stephenville
NL

Prepared by MB on 2023-12-18

Client/Project
World Energy GH2
Project Nujo'qonik

121417233_304

Figure No.
3-6

Locations with Muskrat Sign in the Codroy Wind Farm and Transmission Line Areas

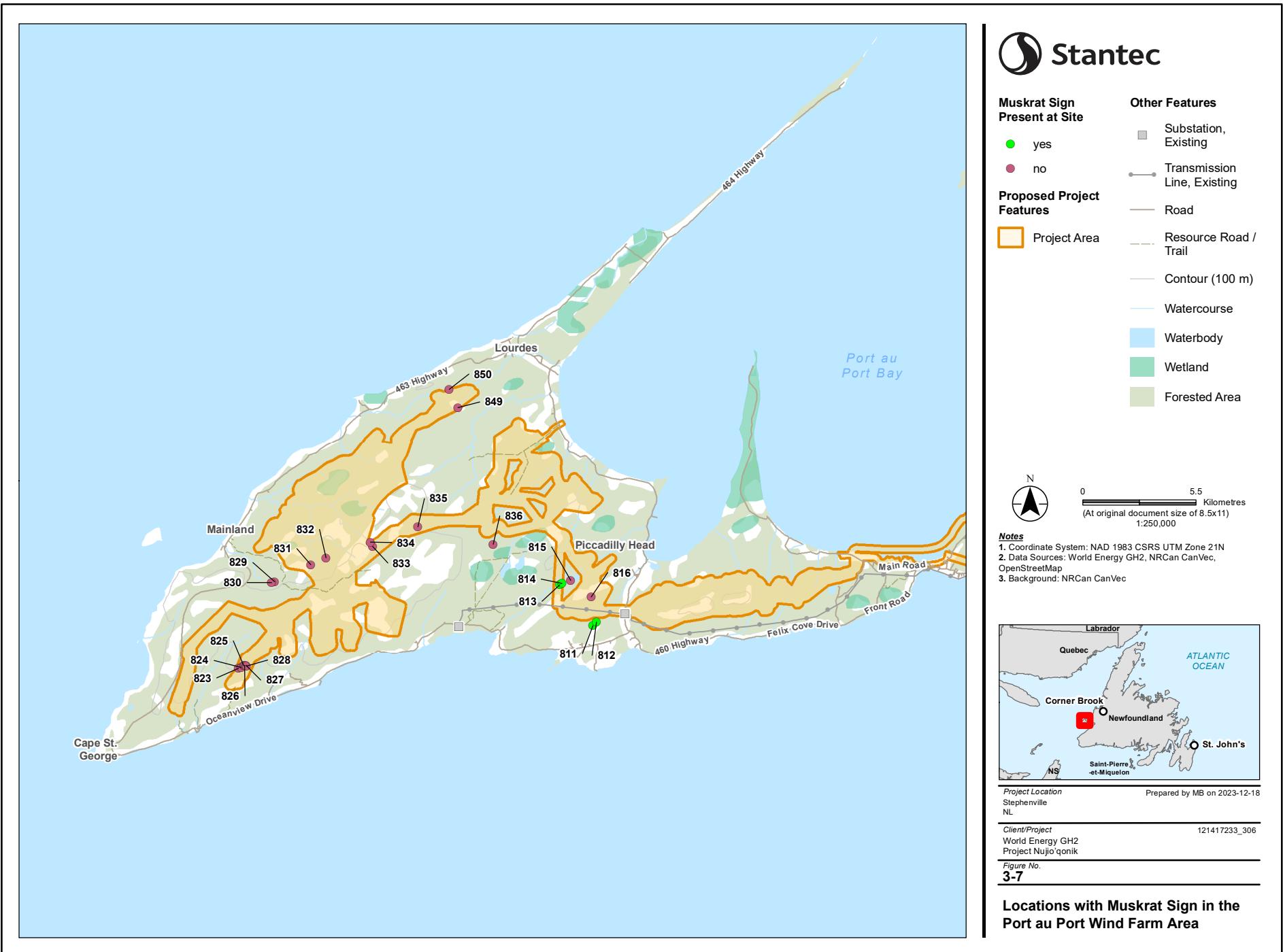


Table 3.4 Summary of Muskrat Sign and Habitat Characteristics at Survey Sites with Evidence of Muskrat Use

Site	Approx. Water Depth (m)	General Habitat	Transect Survey Observations (Counts of Muskrat Sign)										Abundance of Common Wetland Vegetation ^A														
			Transect Distance (m)	scats	clippings	burrows	trails	tracks	feed beds	houses	other	total sign	Muskrat sign / 100 m	sedges	grasses	bullhead-lily	pondweed	sweet gale	bulrush / rushes	water horsetail	Canadian burnet	goldenrod	blue flag iris	cattail	American bur-reed	moss	Total Species
PORT AU PORT WIND FARM																											
811/812B	0.5-1.0	WL	248		2	1	1					4	1.61	3		4		2	2								4
813/814B	0.25-0.3	pond	220					1				1	0.45	+	5			2	1		2						5
Total^B			468	0	2	1	1	1				5	1.07	2	1	1		2	2		1						6
STEPHENVILLE																											
817A	0.5-1.5	pond	129				1					1	0.78	+	+	+	+	+	+	4		1		3			9
818A	1.5	pond	100			1				1		2	2.00		1		4		1			1		3			5
822A	0.5-1.5	pond	101				1					1	0.99	2	3	1		3	2					3			6
851B	0.5-1.5	pond	105				4					4	3.81	4	4			1		+	2						5
856A	0.5-1.5	pond	105				2					2	1.90	4	4			3	2	1	1		+	2			8
860A	0.5-1.5	pond	106	Muskrat presence confirmed incidentally ^C								1	1.55	5	6	2	3	4	5	3	2	2	1	5			5
Total^B			646			1	8			1		10		5	6	2	3	4	5	3	2	2	1	5			11
CODROY WIND FARM																											
803A	1.0-1.5	pond	190		2		3					5	2.63	2	3			2		+	1	+	3		+	3	9
803B	1.0	pond	106			2	1					3	2.83	2	3			3							3		4
806/807A	0.5-0.75	pond	125				1					1	0.80	3	4				3				+				4
837A	0.5-1.0+	pond	110		1		2					3	2.73	1	4	2	2	1									5
837B	0.5-1.0	pond	100			1	5					6	6.00	1	3	2	3	1	+								6
838A	0.5-1.5	pond	80				1					1	1.25	4	1	+	1	1	+		+		+			8	
842A	0.5-1.0	pond	100				2					2	2.00	+	4				1					+			4
844A	0.5-1.5	pond	105				3					3	2.86		4	1	+	2			1						5
845A	0.25-0.75	pond	100				1					1	1.00	1	1	2		2									4
847A	0.5-1.0	pond	115				4					4	3.48	+	4	2			2			1					5
852A	0-1.5	WL	108				2					2	1.85	3	5	+	2	2	2	+			1			8	
853A	1.0-2.0	pond	101				2					2	1.98	3	5		1		2	1		+	1			7	
855A	1.0	pond	211		1							1	0.47	4	4	+		3	3	1	2						7
Total^B			1,551		4	3	27					34	2.19	12	13	8	6	9	8	4	5	1	5	2	1	2	13



Table 3.4 Summary of Muskrat Sign and Habitat Characteristics at Survey Sites with Evidence of Muskrat Use

Site	Approx. Water Depth (m)	General Habitat	Transect Survey Observations (Counts of Muskrat Sign)										Abundance of Common Wetland Vegetation ^A														
			Transect Distance (m)	scats	clippings	burrows	trails	tracks	feed beds	houses	other	total sign	Muskrat sign / 100 m	sedges	grasses	bullhead- lily	pondweed	sweet gale	bulrush / rushes	water horsetail	Canadian burnet	goldenrod	blue flag iris	cattail	American bur-reed	moss	Total Species
TRANSMISION LINE																											
864A	0.5-2.0+	pond	159				5					5	3.14		4		1	2	1				3			5	
OVERALL TOTAL			2,824	-	6	5	41	1	-	1	-	54	1.91	19	21	11	10	16	16	7	8	3	6	8	1	2	

Notes:

A. Common wetland species identified were based on guidance provided in provincial muskrat survey protocols (NLDFFA 2019). Wetland species were quantified using the Braun Blanquet Scale (refer to Table 2.2). A copy of the muskrat survey protocols, including Latin names of the wetland species, is provided in Appendix A.

B. Total is for sites with muskrat sign only (i.e., does not include surveyed transects or habitat plots with no evidence of muskrat)

C. Muskrat was incidentally confirmed (visual observation) at this site during the avifauna field program in July 2023.





Figure 3-8 Presumed Muskrat Trails Observed at Site 851 (top left), Site 817 (top right) and Site 803 (bottom)





Figure 3-9 Muskrat Tracks Observed at Site 814



PROJECT NUJIO'QONIK 2023 MUSKRAT SURVEY



Figure 3-10 Bank Burrow (above) with Clippings (below) Observed at Site 812/813



4.0 SUMMARY AND DISCUSSION

The 2023 muskrat survey was designed to gather information on the current distribution and relative abundance of muskrat in the Project Area. A total of 55 sites (ponds and wetlands) were visited in the Project Area, which included 74 habitat plots, and a total of 8,210 m of transects surveyed for evidence of muskrat. Evidence of muskrat was found at 36.4% of the sites surveyed including 11 sites surveyed in the Codroy Wind Farm area, six in the Stephenville (hydrogen / ammonia facility) area, two in the Port au Port Wind Farm area, and one along the transmission line. Overall, the abundance of muskrat sign was 0.66/100m surveyed. While there are no comparable indices for muskrat in the Project Area (B. Rodrigues, pers. comm.), trends in trapping data suggest the population on the island of NL is likely low and in decline (NLDFFA 2019), consistent with trends across much of North America (e.g., Sadowski and Bowman 2021; Gregory et al. 2019; Ward and Gorelick 2018; Ahlers and Heske 2017).

Cattails are generally considered a preferred food source and building material for muskrat lodges. However, cattails are relatively rare in NL, and this has been associated with reduced habitat quality and increased susceptibility to predation on the island (Soper and Payne 1997). As expected, cattails were relatively uncommon among the sites visited during this survey (found in only 14, or 25% of the sites visited and generally associated with the Stephenville area). Given the paucity of cattail, sedge, iris, horsetail, pondweed, and rush have instead been identified as primary food sources and lodge building materials for muskrat in western Newfoundland (Soper 1995). Soper and Payne (1997) also suggest that bank burrows (vs. houses) are used almost exclusive by muskrat in NL. Five bank burrows and one old (inactive) house were observed in the survey area that are believed to be associated with muskrat. Sedges, rushes and pondweed were relatively common in the areas surveyed, while horsetail and iris and were found less frequently (with the latter absent from surveyed areas on the Port au Port peninsula). In general, habitat assessed as having a high potential for muskrat, based on a combination of visible emergent vegetation, standing water depth, slope characteristics, and shoreline vegetation, were more common in the Codroy Wind Farm and Stephenville areas, compared to assessed habitats associated with either the Port au Port Wind Farm or transmission line (Table 3.2). Of the 55 sites surveyed, muskrat sign was found at 15 sites ranked as having high potential for muskrat (or a combination thereof [i.e., low-high or moderate-high]) and five sites were ranked as having moderate or low-moderate potential for muskrat; None of the sites ranked as having a low potential for muskrat showed evidence of muskrat use.

The findings from the 2023 Muskrat Survey provide baseline information on muskrat in the Project Area. WEGH2 has committed to work with the NLDFFA - Wildlife Division to manage potential interactions with sensitive wildlife areas, including for muskrat.



5.0 REFERENCES

Ahlers, A. A., and E. J. Heske. 2017. Empirical evidence for declines in muskrat populations across the United States. *Journal of Wildlife Management* 81: 1408–1416.

Boutin, S. and D. E. Birkenholz. 1987. Muskrat and round-tailed Muskrat. In M. Novak, J. A. Baker, M. E. Obbard, & B. Malloch (Eds.), *Wild furbearer management and conservation in North America* (pp. 315–325). Ontario Ministry of Natural Resources.

Ganoe L.S., J.D. Brown, M.J. Yabsley, M.J. Lovallo and W.D. Walter. 2020. A review of pathogens, diseases, and contaminants of muskrats (*Ondatra zibethicus*) in North America. *Frontiers in Veterinary Science* 7:1-13.

Gregory, G. J., R. Dibblee, P-Y. Daoust and M.R. Van Den Heuvel. 2019. Declines in Muskrat (*Ondatra zibethicus*) Population Density in Prince Edward Island, Canada. *Canadian Wildlife Biology and Management* 8: 46-60.

Lear, E. 1952. Some observations on the summer food of muskrat in Newfoundland. Unpub. prog. rep., National Res. Counc., WLR 21, Ottawa. 112pp.

Naughton, D. 2012. The natural history of Canadian mammals. Canadian Museum of Nature and the University of Toronto Press.

NLDFFA (Newfoundland and Labrador Ministry of Fisheries, Forestry and Agriculture). 2019. Newfoundland muskrat distribution and population survey. Newfoundland and Labrador Ministry of Fisheries, Forestry and Agriculture survey protocol, revised August 23, 2019. 13 pp.

NLDFFA. 2023. Furbearer Management in Newfoundland and Labrador. Available at: <https://www.gov.nl.ca/ffa/wildlife/wildlife-research/furbearers/> Accessed March 21, 2023.

Rigby, M. D. and Threlfall, W. 1982. A morphological comparison of muskrats (*ondatra zibethicus*) from Newfoundland and New Brunswick. *Canadian Journal of Zoology*, 60(9), 2235-2238.

Sadowski, C. and J. Bowman. 2021. Historical surveys reveal a long-term decline in muskrat populations. *Ecology and Evolution* 11:7557-7568.

Soper, L. R. 1995. Influence of Introduced Mink on Newfoundland Muskrat. University of Wisconsin. College of Natural Resources. MSc. Thesis. 142 pp.

Soper, L. R. and N. F. Payne. 1997. Relationship of introduced mink, an island race of muskrat, and marginal habitat. *Annales Zoologici Fennici* 34(4):251-258

Stantec (Stantec Consulting Ltd.). 2023. Land and Resource Use Survey. Final Report prepared for World Energy GH2. 122 pp. + Appendices.

Ward, E. M. and S.M. Gorelick. 2018. Drying drives decline in muskrat population in the Peace-Athabasca Delta, Canada. *Environmental Research Letters* 13, 124026.

WEGH2 (World Energy GH2 Inc.). 2024. Project Nujo'qonik: Amendment to the Environmental Impact Statement.



APPENDIX A

Provincial Muskrat Survey Protocols

BACKGROUND:

Muskrat (*Ondatra zibethicus*) are considered one of the most valuable semi-aquatic furbearers and continues to be the most harvested pelt in North America. Canadian statistics for 2014-15 showed muskrat's overall value at \$1.7 million with 314,000 pelts harvested. They are an important prey source for native and introduced species in Newfoundland as well as significantly affecting wetland vegetation.

Typically, muskrat use the most available wetland plant species. In other parts of North America cattails (*Typha latifolia*) has often been identified as one of the most important sources for food and structural material but the presence of cattails is limited on the Island. In Newfoundland, muskrat have fewer plant species available for house building and may rely more heavily on burrows for dwellings. Exclusive use of burrows may make muskrat more vulnerable to mink predation. Soper (1988) found sites on the Northern Peninsula were shallow ponds or slow-moving brooks, while the other study areas in Western Newfoundland consisted of marshy areas or bogs bordering deep ponds.

On the Island of Newfoundland, trapper opinion has indicated that muskrat populations have been declining and disappearing from many areas in their historic range. Trapper opinion from Labrador suggests the population there has remained stable over time. Historical declines on the Island have been attributed to the introduction of mink, possibly accentuated due to marginal muskrat habitat available on the Island and predator naivety. While mink may still be a factor in declines, current threats have not been properly quantified and larger factors may be at play with muskrat declines reported across N.E. North America.

While efforts in N.E. North America are looking at causes of decline, on the Island a good understanding of muskrat distribution and abundance is necessary in order to support appropriate management strategies and determine further monitoring/research needs.

GOAL:

To understand the current distribution and relative abundance of muskrat across the Island of Newfoundland.

OBJECTIVES:

- 1) Conduct yearly muskrat surveys across Newfoundland in appropriate habitat for this species.
- 2) Provide for longterm (10 year minimum) data to evaluate current population size and distribution of muskrat on the Island
- 3) Quantify wetland habitat associated with muskrat on the Island.

METHODOLOGY:

Equipment:

*Canoe	Datasheets
*Paddles	Clipboard
*Lifejackets	Camera
*Canoe safety gear	(Chest) waders
10m measuring tape	Measuring string with weight
*site dependent	

Site Selection:

Survey site selection will be based on current or historic muskrat sites as identified by trappers, FLR officers, and through other local knowledge. Historically surveyed sites will be of particular importance. As accessibility, time, and staff availability allow; other sites deemed suitable for muskrat can also be surveyed. Appropriate sites could be a portion of a larger wetland or waterbody. Ideal habitat would typically include some/all of the following features.

- 50-80% of water surface covered with emergent vegetation
- Presence of shoreline herbaceous vegetation within 10m of water's edge
- Water depth of 0.5 to 1.5m with stable seasonal water levels
- Slow flowing/standing water
- Burrow sites:
 - Soft high clay content, not rocky
 - slope $\geq 10^\circ$, minimum ht. 0.2m

Survey timing:

The survey window is from **September 1 to November 1**. Fall counts provide for the greatest opportunity for detection of fresh sign due to muskrat being at the highest population levels at this time. Sites should not be visited right after extensive rainfall which can disturb or interfere with the detection of sign.

Delineating Habitat and Quantifying Emergent Vegetation

While the priority is to determine presence/non-detection and relative abundance of muskrat, habitat should also be classified for each site visited.

- 1) Enter all data on the datasheet (see Appendix A and example in Figure 2).
- 2) Print out a Google Earth map of each wetland to be surveyed (Fig.1).
- 3) At the site, delineate uniform wetland habitat boundaries on the site map. Distinct habitat boundaries are decided by a visual inspection to determine discrete areas with similar species assemblages. Label each habitat 'A', 'B', 'C', etc. (Fig.1). Include unsuitable areas, such as open water in mapping, even if not surveyed.

Newfoundland Muskrat Distribution and Population survey



Figure 1: Example of survey site habitat delineation

- 2) Based on surveyor opinion, establish a 10mX10m plot in each distinctive, but suitable, habitat. **This plot is for habitat classification purposes only.** Mark the plot location with an 'X' on the map provided. Given habitat boundaries may change over time, plot location will be decided yearly based on the surveyors visual examination of the site. It is not necessary to use the same plot location each year, but is recommended when habitat boundaries have not changed significantly. Extent of survey area will be limited to areas considered appropriate for detection of muskrat sign. Survey areas do not need to include portions with deep open water or fast running streams. In the example above only 'A' and 'B' may need surveying.
- 3) Estimate water depth for each habitat. A weighted string or canoe paddle can be helpful for estimating.
- 4) If present, identify all common wetland species described in Appendix B and quantify using the Braun Blanquet scale (Table 1). **Note: most species will be in various stages of senescence and not flowering at the time of the survey.** If possible, categorize all other identifiable species. If a species cannot be identified, particularly if it is highly represented, it should be photographed or a sample taken for further identification. Unknowns will still be classified using the Braun Blanquet scale and labeled as 'Unknown1', 'Unknown2', etc.

Table 1: Braun Blanquest cover and abundance categories

Rating	Description of cover
+	< 5 % and sparse
1	< 5 % and plentiful
2	5 – 25%
3	26 – 50%
4	51 – 75%
5	76 – 100%

Newfoundland Muskrat Distribution and Population survey

MUSKRAT SURVEY FORM (2018 version)										Page 1 of 1																																				
Site name: Plum Point Pond 2					Date: October 19, 2017																																									
Coordinates: 51.058139N 56.851083W					Name of Surveyors: D. Chambers, B. Rodrigues																																									
General Habitat Description (pond, ditch, fen, bog, bank composition, stream, shoreline vegetation etc.):																																														
Pond beside main road, mainly open water. Shallow, rocky bank bordered by ericaceous vegetation and spruce forest																																														
Average Water depth (m):																																														
Plot A		Plot B		Plot C		Plot D		Plot E																																						
0.4m		0.3m		5m		-		-																																						
Emergent plant species assemblage:																																														
<table border="1"> <thead> <tr> <th rowspan="2">Plant Species</th> <th colspan="5">Abundance rating (see scale below)</th> <th rowspan="2">Comments</th> </tr> <tr> <th>Plot A</th> <th>Plot B</th> <th>Plot C</th> <th>Plot D</th> <th>Plot E</th> </tr> </thead> <tbody> <tr> <td>Sedge (<i>Carex spp.</i>)</td> <td>5</td> <td>4</td> <td></td> <td></td> <td></td> <td rowspan="4">Seed pods and stalks, plus leaves present Pic 1437, pink stem. Whorled, toothed leaves, 1m <u>ht</u>, on shoreline</td> </tr> <tr> <td>Horsetail (<i>Equisetum</i>)</td> <td>2</td> <td>2</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Blue Flag (<i>Iris versicolor</i>)</td> <td>1</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Unknown1</td> <td></td> <td>+</td> <td></td> <td></td> <td></td> </tr> </tbody> </table>										Plant Species	Abundance rating (see scale below)					Comments	Plot A	Plot B	Plot C	Plot D	Plot E	Sedge (<i>Carex spp.</i>)	5	4				Seed pods and stalks, plus leaves present Pic 1437, pink stem. Whorled, toothed leaves, 1m <u>ht</u> , on shoreline	Horsetail (<i>Equisetum</i>)	2	2				Blue Flag (<i>Iris versicolor</i>)	1					Unknown1		+			
Plant Species	Abundance rating (see scale below)					Comments																																								
	Plot A	Plot B	Plot C	Plot D	Plot E																																									
Sedge (<i>Carex spp.</i>)	5	4				Seed pods and stalks, plus leaves present Pic 1437, pink stem. Whorled, toothed leaves, 1m <u>ht</u> , on shoreline																																								
Horsetail (<i>Equisetum</i>)	2	2																																												
Blue Flag (<i>Iris versicolor</i>)	1																																													
Unknown1		+																																												

Figure 2: example of habitat data entry

Surveying for Muskrat Sign:

1. At each site, an observer will travel along the shoreline, either on foot or in watercraft- site conditions determining the most appropriate means of transport.



2. Count the total number of distinct groups of scat, clippings, burrows, trails, tracks, feed beds and houses. Consider each type of sign found in each 1 meter traveled as one distinct sign. For example, if 10 clippings are clustered within a 1 meter section, it is just still just counted as one observation. See Appendix C for examples. There is no set criteria for size of wetland or distance of shoreline to survey. If feasible, cover the full extent of potential muskrat habitat at a given site.
3. Tabulate observations and total distance surveyed by delineated habitat (eg. A, B and C). Enter all information on the data form (Appendix A). An example of entered data is found in Figure 3.
4. An index of relative muskrat abundance of sign/100m of shoreline covered, can then be calculated by distinct habitat and site

Habitat	distance surveyed (m)	Scats/latrines	clippings	burrows	trails	tracks	Feed beds	houses	*Other:	sign/100m =(sign/dist)*100
A	220m	2	4	0	3	0	1	1	-	5

Figure 3: example of datasheet entry of muskrat sign

Newfoundland Muskrat Distribution and Population survey

Appendix A: Datasheet example

MUSKRAT SURVEY FORM (2018 version)

Page 1 of 2

Site name:

Date:

Coordinates:

Name of Surveyors:

General Habitat Description (pond, ditch, fen, bog, bank composition, stream, shoreline vegetation etc.):

Average Water depth (m):

Plot A	Plot B	Plot C	Plot D	Plot E

Emergent plant species assemblage:

List each species (or lowest practical taxa) on a separate line. Use as many sheets as necessary.

Rating	Description of abundance
+	< 5 % and sparse
1	< 5 % and plentiful
2	5 – 25%
3	26 – 50%
4	51 – 75%
5	76 – 100%

MUSKRAT SURVEY FORM (2018 version)

Page 2 of 2

Site name:

Date:

Coordinates

Name of Surveyors:

Count of Muskrat sign:

*Comments/ Other Observations:

Appendix B: Common emergent/shoreline vegetation used by muskrat

Differentiating sedges, grasses and rushes:

Sedges: Solid, triangular stems ("sedges have edges") with some exceptions; leaves 3-ranked; fruit a nutlet subtended by a scale

• **Grasses:** Hollow (between the nodes), round stems; leaves 2-ranked; fruit a grain covered by two papery scales

• **Rushes:** Solid, round stems; leaves few; fruit a several to many-seeded capsule surrounded by 6 scale-like structures

Sedges (*Carex spp.*):



Rush (*Juncus spp.*)



Grass spp.



Moss:



Newfoundland Muskrat Distribution and Population survey

Water horsetail (*Equisetum fluviatile*):



Blue Flag (*Iris versicolor*)



Bullhead-lily (*Nuphar variegatum*):



Pond weed (*Potamogeton* spp.)



Bulrush (*Schoenoplectus* spp.):



Cattail (*Typha latifolia*)



Newfoundland Muskrat Distribution and Population survey

Broad leaf Arrowhead (*Sagittaria latifolia*)



Buckbean (*Menyanthes trifoliata*)



Canadian burnet (*Sanquisorba Canadensis*)



Goldenrod (*Solidago spp.*)



American Bur-reed (*Sparganium americanum*)



Sweet Gale (*Myrica gale*)



Wetland Plant Identification References:

websites:

http://www.ducks.ca/assets/2016/01/wetlandcare_v8.pdf

<https://www.ducks.ca/assets/2015/03/field-guide-new.pdf>

<http://fernhillns.ca/fernhillnsWP/wp-content/uploads/2017/05/PeatlandGuideDRAFT.pdf>

<http://www.bwsr.state.mn.us/wetlands/training/PlantID-sedges.pdf>

books:

Wetland Plants of Ontario Paperback – Feb 26 1997 by Steven Newmaster (Author), Alan Harris (Author), Linda Kershaw (Author)

Aquatic and Wetland Plants of Northeastern North America, Volume II: A Revised and Enlarged Edition of Norman C. Fassett's A Manual of Aquatic Plants, Volume II: Angiosperms: Monocotyledons Paperback – Feb 10 2006 by Garrett E. Crow (Author), C. Barre Hellquist (Author)

Hotchkiss, Neil. 1972. Common Marsh, Underwater & Floating-leaved Plants of the United States and Canada.

Photo credits:

Sedge: By Kristian Peters -- Fabelfroh 16:01, 13 July 2006 (UTC) [GFDL (<http://www.gnu.org/copyleft/fdl.html>) or CC-BY-SA-3.0 (<http://creativecommons.org/licenses/by-sa/3.0/>)], from Wikimedia Commons

Grass: Photo: Tom Koerner/USFWS (bluejoint grass)

Bullrush: By Jerry Oldenettel, <https://www.flickr.com/photos/7457894@N04/1527128096>

Bullhead lily: By Cephas - Own work, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=15970887>

Broad leaf Arrowhead: CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=539878>

Buckbean: By H. Zell - Own work, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=10684516>

Canada Burnet: By Donald Cameron. Copyright © 2018 Donald Cameron

Sweet Gale: CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=204817>

Tradescant Aster: By Donald Cameron (S.tradescantii). Copyright © 2018 Donald Cameron

Water plantain: By Matt Lavin - Flickr: Alisma triviale, CC BY-SA 2.0, <https://commons.wikimedia.org/w/index.php?curid=16901224>

Floating Heart: By Jomegat - Own work, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=6959221>

Mermaid weed: By Choess - Own work, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=11454845>

American Bur-reed: by Jill Lee, <https://www.flickr.com/photos/jilllybean/20083090940/>

Appendix C: Description of sign

1) houses: >30cm above water surface: with fresh activity=active, lacking fresh activity =inactive



2) Feed beds: An accumulation of herbaceous material, clipped off, sometimes found under bank cover (see picture under 'burrows')

3) Burrows: best observed in clear water, typically found just under surface to about 3ft depth. Can have multiple entrances



4) Scat/latrine: usually found on rocks, dirt mounds, or logs projecting out of the water

Newfoundland Muskrat Distribution and Population survey



5) Trails: paths through aquatic vegetation or along shore frequented by muskrat

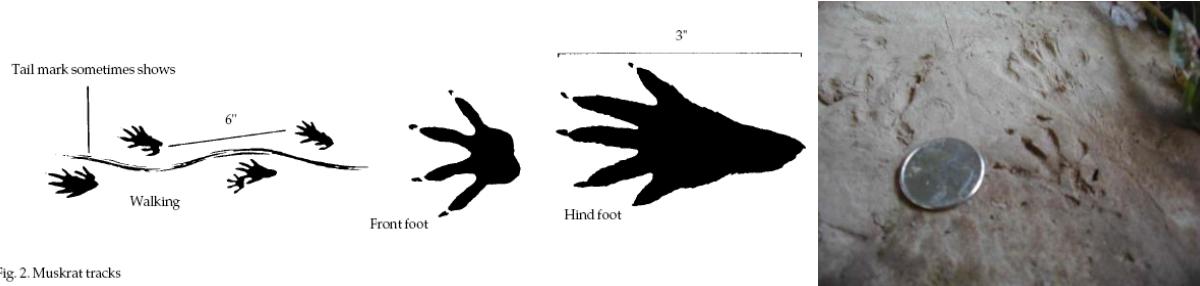


6) Clippings: bitten off herbaceous vegetation often floating in water



7) Tracks:

Newfoundland Muskrat Distribution and Population survey



8) Other: eg. Fresh shells (along shoreline), animal seen, presence of mink, etc.



Newfoundland Muskrat Distribution and Population survey

Rare wetland plants to look out for (optional). Take photos and coordinates:

Sweetflag (*Acorus americanus*)



mermaidweed (*Proserpinaca pectinata*)



Tradescant's aster (*Symphyotrichum tradescantii*)



waterplantain (*Allisma triviale*)



Wild calla (*calla palustris*)



floatingheart (*Nymphoides cordata*)



APPENDIX B

Survey Results

PROJECT NUJIO'QONIK 2023 MUSKRAT SURVEY

Table B.1 Sites Visited during the 2023 Musrat Survey

Site	Location ^B		Project Area Location ^A	General Habitat ^A	# Survey Plots	# Survey Transects	Habitat Potential	Muskrat Sign Observed
	Latitude	Longitude						
801	47.9451	59.2026	Codroy	WL	1	1	low	no
803	47.9507	59.1321	Codroy	pond	2	2	high	yes
808	47.9957	59.0057	Codroy	pond	1	1	high	no
809	47.9975	59.0032	Codroy	pond	1	1	high	no
815	48.5478	58.7580	PAP	pond	3	1	moderate-high	no
816	48.5408	58.9441	PAP	WL	1	1	low	no
817	48.5305	58.5194	Stephenville	pond	1	1	high	yes
818	48.5368	58.5133	Stephenville	pond	1	1	high	yes
819	48.5361	58.5100	Stephenville	pond	1	1	low	no
820	48.5402	58.5138	Stephenville	pond	2	1	moderate	no
821	48.5466	58.5102	Stephenville	pond	2	1	moderate	no
822	48.5482	58.5085	Stephenville	pond	1	1	moderate	yes
823	48.5055	59.1750	PAP	pond	1	1	low	no
829	48.5439	59.1529	PAP	pond	1	1	moderate	no
831	48.5516	59.1293	PAP	WL	2	2	low	no
832	48.5548	59.1196	PAP	WL	1	1	low	no
833	48.5603	59.0889	PAP	pond	1	1	low	no
834	48.5622	59.0903	PAP	pond	1	1	low	no
835	48.5695	59.0595	PAP	pond	1	1	moderate	no
836	48.5628	59.0095	PAP	WL	2	2	low-moderate	no
837	48.9955	59.0132	Codroy	pond	2	2	moderate-high	yes
838	47.996	59.0143	Codroy	pond	1	1	high	yes
839	47.997	59.0171	Codroy	pond	1	1	moderate	no
840	47.9955	59.0190	Codroy	pond	1	1	low	no
841	47.9931	59.0205	Codroy	small steady	1	0	low	no
842	47.9933	59.0232	Codroy	pond	1	1	low-moderate	yes
843	48.5514	58.5099	Stephenville	pond	1	0	low	no
844	48.008	59.1351	Codroy	pond	1	1	moderate	yes
845	48.0103	59.1335	Codroy	pond	1	1	low-moderate	yes
846	48.0167	59.1372	Codroy	pond	1	1	moderate	no
847	48.0444	59.0561	Codroy	pond	1	1	moderate	yes
848	48.0455	59.0595	Codroy	pond	1	1	moderate	no
849	48.6220	59.0354	PAP	pond / WL	1	1	low	no



PROJECT NUJIO'QONIK 2023 MUSKRAT SURVEY

Table B.1 Sites Visited during the 2023 Musrat Survey

Site	Location ^B		Project Area Location ^A	General Habitat ^A	# Survey Plots	# Survey Transects	Habitat Potential	Muskrat Sign Observed
	Latitude	Longitude						
850	48.6300	59.0412	PAP	pond	1	1	high	no
851	48.5243	58.4098	Stephenville	pond	2	2	high	yes
852	48.0709	58.8549	Codroy	WL	1	1	high	yes
853	48.0522	58.9340	Codroy	pond	1	1	high	yes
854	48.1044	58.8954	Codroy	pond	1	1	high	no
855	48.0394	58.7749	Codroy	pond	2	1	moderate-high	yes
856	48.5649	58.5010	Stephenville	pond	1	1	high	yes
857	48.5686	58.5542	Stephenville	pond	1	0	moderate-high	no
858	48.5671	58.5388	Stephenville	pond	1	1	high	no
859	48.556	58.5133	Stephenville	pond	2	1	high	no
860	48.5307	58.5087	Stephenville	pond	1	1	high	yes ^C
861	48.0800	58.8161	Codroy / TL	pond	1	1	moderate	no
862	48.0786	58.8184	Codroy / TL	pond	1	1	moderate	no
863	48.0836	58.8139	TL	pond	1	1	moderate-high	no
864	48.1631	58.7666	TL	pond	1	1	moderate-high	yes
865	48.2757	58.6572	TL	pond	1	1	low	no
866	48.4429	58.4057	TL	pond	1	1	low	no
867	48.4583	58.3691	TL	pond	1	1	low	no
806/ 807	47.9877	59.0601	Codroy	pond	2	2	high	yes
811/ 812	48.5283	58.9428	PAP	WL	3	3	low-high	yes
813/ 814	48.5458	58.9650	PAP	pond	2	2	low-high	yes
824- 828	48.5060	59.1728	PAP	WL	5	5	low	No

Notes:

A. PAP – Port au Port Wind Farm; TL – Transmission Line; WL – wetland / wetland complex

B. WGS84

C. Muskrat was incidentally confirmed (visual observation) at this site during avifauna surveys in July 2023.



PROJECT NUJIO'QONIK 2023 MUSKRAT SURVEY

Table B.2 Habitat Characteristics and Distance Surveyed at Sites without Muskrat Sign

Site	Habitat Potential	Water Depth (m)	Habitat Type ^A	Abundance of Common Wetland Vegetation ^B													Transect Distance (m)		
				sedges	grasses	bulrush / lily	pondweed	sweet gale	bulrush / rushes	water horsetail	Canadian burnet	goldenrod	Blue flag iris	cattail	buckbean	American bur-reed	Total Plant Species		
806/807B	high	1.0-1.5	pond	3	4	+	1		2				2				6	125.1	
808A	high	1.0	pond	2		2	3	3	3				2				6	62	
809A	high	1.0-1.5	pond	1	5	4		2	2				1				6	100	
811/ 812A	low-high	1.0-1.5	WL	1		1		1	2								4	151	
811/ 812C	low-high	0.25-0.4	WL	3		1		1	2								4	51	
813/ 814A	low-high	1.0-1.5	pond	1	2	3		2			3						5	117	
815A	moderate-high	0.5-1.5	pond	1	3	1	2	3	1		1						7	183	
815B	moderate-high	1.0-1.5	pond	+	2				2	1	5	1					6	0	
815C	moderate-high	0.5-1.5	pond	+	3				2	4	4	1	+				7	0	
816A	low	0.25-0.5	WL		1	3		3	3		2	+					6	300	
819A	low	2.0+	pond	1	5								2				3	99	
820A	moderate	1.0-1.5	pond	2	2	+	+	2		5	+						7	106	
820B	moderate	1.0-1.5	pond	2	4	3		3									4	0	
821A	moderate	0.5-1	pond	2	3			2	1								2	5	142
821B	moderate	1.0	pond	2	2			2	1				5				1	6	0
823A	low	0.5-1.0	pond	2	3	1	1	+		+	+						7	106	



PROJECT NUJO'QONIK 2023 MUSKRAT SURVEY

Table B.2 Habitat Characteristics and Distance Surveyed at Sites without Muskrat Sign

Site	Habitat Potential	Water Depth (m)	Habitat Type ^A	Abundance of Common Wetland Vegetation ^B												Transect Distance (m)	
				sedges	grasses	bulrush / lily	pondweed	sweet gale	bulrush / rushes	water horsetail	Canadian burnet	goldenrod	Blue flag iris	cattail	buckbean	American bur-reed	
824-828A	low	0.5-0.75	WL		3	+	+									3	183
824-828B	low	0.5-1.0	WL	4	3	+	+									4	117
824-828C	low	1.0	WL	3	3	1	+									4	40
824-828D	low	0.5-0.5	WL	2	3	+	+									4	102
824-828E	low	0.5-0.75	WL	1	2	+	+									4	88
829A	moderate	0.5-0.5	pond	2	2	2	3	1			+					6	155
831A	low	0.75-0.75	WL		4	+		+								3	101
831B	low	1.0-1.5	WL		4	+		+								3	81
832A	low	0.25-0.25	WL	+	2			+								3	52
833A	low	1.0	pond	2	1			1		4	+					5	121
834B	low	0.5-0.75	pond	+	2	+		+		1	1					6	124
835A	moderate	0.5-1.0	pond	+	3	1	1	+								5	194
836A	low-moderate	0.5-1.5	WL	+	2	+		+								4	325
836B	low-moderate	0.5-1.5	WL	+	2	+		1								4	406
839A	moderate	0.5-1.0	pond	1	2		+									3	109
840A	low	0.5-0.75	pond	+	1											2	103



PROJECT NUJIO'QONIK 2023 MUSKRAT SURVEY

Table B.2 Habitat Characteristics and Distance Surveyed at Sites without Muskrat Sign

Site	Habitat Potential	Water Depth (m)	Habitat Type ^A	Abundance of Common Wetland Vegetation ^B												Transect Distance (m)		
				sedges	grasses	bulrush-lily	pondweed	sweet gale	bulrush / rushes	water horsetail	Canadian burnet	goldenrod	Blue flag iris	cattail	buckbean	American bur-reed		
841A	low	0.5-0.5	small steady	+	2											2	0	
843A	low	1.0+	pond			+		2	2							3	0	
846A	moderate	0.5-1.5	pond	1	3	2		1								4	100	
848A	moderate	0.5-1.0	pond		4	3		1			+					4	87	
849A	low	0.5-0.5	pond / WL	4	3			2								3	110	
850A	high	0.5-1.5	pond	4	4	1	1	1		2	1					7	107	
851A	high	0.5-0.5	pond	5	4	2		2		1	1					6	106	
854A	high	0.5-2.0	pond	2	3		3	3		1	1					6	105	
855B	moderate-high	0.5-0.75	pond	5	4	1	1	2		+	1					7	211	
857A	moderate-high	1.0-2.0	pond					4		+						2	0	
858A	high	0.5-1.5	pond	3	4	+							+	2		2	7	106
859A	high	0.5-1.5	pond	2	3	3	3	1	1		+		+	2	1	10	32	
859B	high	1.0-2.0	pond	4	2	3	3	+					+	2	+	8	0	
861A	moderate	0.5-1.0	pond		3	2	2		+	1				4		6	65	
862A	moderate	0.5-1.0	pond		4		2							3		3	101	



PROJECT NUJIO'QONIK 2023 MUSKRAT SURVEY

Table B.2 Habitat Characteristics and Distance Surveyed at Sites without Muskrat Sign

Site	Habitat Potential	Water Depth (m)	Habitat Type ^A	Abundance of Common Wetland Vegetation ^B													Transect Distance (m)	
				sedges	grasses	bulrush / lily	pondweed	sweet gale	bulrush / rushes	water horsetail	Canadian burnet	goldenrod	Blue flag iris	cattail	buckbean	American bur-reed	Total Plant Species	
863A	moderate-high	0.25-1.0	pond		2	1	1	4	5							5	103	
865A	low	0.5-2	pond			3			2				1	3		4	90	
866A	low	0.5-1	pond		4	2	2									3	102	
867A	low	0.5-1.5	pond		3	+		4	1							4	104	
Total Sites with Species and Total Distance Surveyed				38	45	37	23	35	18	11	16	3	7	7	2	3	51	5,372.1

Notes:

A. WL – wetland / wetland complex

B. Common wetland species were based on provincial muskrat survey protocols (NLDFFA 2019). Quantification of common wetland vegetation used the Braun Blanquet scale: "+" = <5% and sparse; 1 = <5% and plentiful; 2 = 5-20%; 3 = 26-50%; 4 = 51-75%; 5 = 76-100% coverage.

