Ducks Unlimited Canada

Soil Organic Carbon Estimates in the Fisher River Cree Nation Conservation Areas Initiative Study Area

April 2021

Updated February 2022

Prepared for CPAWS Manitoba and Fisher River Cree Nation
by
Ducks Unlimited Canada

1.0 Purpose

Ducks Unlimited Canada (DUC) was contracted by the Canadian Parks and Wilderness Society (CPAWS) Manitoba Branch to calculate estimates of soil organic carbon mass stored in the watersheds of the Fisher River Cree Nation Conservation Areas Initiative Study Area. The following presents the data and procedures used, along with the results of the analysis.

2.0 List of Acronyms

AAFC	Agriculture and Agri-Food Canada
CanVec	Canada Vector Dataset
CPAWS	Canadian Parks and Wilderness Society
DUC	Ducks Unlimited Canada
EOSD	Earth Observation for Sustainable Development
HWL	Hybrid Wetland Layer
POC	Peatlands of Canada Dataset
SOCC	Soil Organic Carbon of Canada Digital Dataset
USEPA	United States Environmental Protection Agency

3.0 Study Area

The Fisher River Cree Nation identified the Study Area as an area of importance. It is situated in the interlake region of Manitoba nestled along a 150 km stretch of the southwestern coast of Lake Winnipeg (within 50.9° to 52.3° latitude and -96.5° to -97.9° longitude). It is on Treaty 2 land and encompasses the Fisher River Cree Nation along with the Kinonjeoshtegon and Peguis First Nations. It falls entirely within the Boreal Plains Ecozone between the Prairie and the Canadian Shield Ecozones. The soil organic carbon analysis was conducted on the 11 watersheds used by CPAWS as comment zones (Figure 1), that overlap the Notice Area. These 11 watershed comment zones are composed of the Manitoba Gross Watersheds (2005) while the smaller watersheds within comment zones 7 and 10 were grouped together to create two larger comment zones rather than 12 smaller ones. These gross watersheds are based on Agriculture and Agri-Food Canada's (AAFC) hydrometric gauging stations and their gross drainage area boundaries.

4.0 Data

AAFC has developed some national scale datasets for estimating soil organic carbon. The first is the Soil Organic Carbon of Canada (SOCC), which was developed on their Soil Landscapes of Canada polygons. It includes soil organic carbon densities from both mineral and organic soils averaged across the land portion of a polygon. The second dataset, the Peatlands of Canada (POC), is an update the peatland portion of the previous. In this dataset peatland soil profiles are used and the proportion of each polygon covered by bog, fen, marsh, and swamp is reported. This dataset doesn't account for mineral wetland soils or upland soils as the SOCC dataset does.

When it comes to national scale wetland cover, the Hybrid Wetland Layer (HWL) is the most comprehensive wetland dataset within DUC. It uses the Earth Observation for Sustainable Development

(EOSD) land cover dataset for Canada and overlays in the Canada Vector (CanVec) Waterbodies from Natural Resources Canada. The resulting raster dataset represents open water bodies, wetlands, and uplands. This dataset covers the entire boreal zone of Canada.

Given that peatlands have deep carbon rich soils compared to mineral soils (Tarnocai and Lacelle 1996, Zoltai et al., 2000), the peatland portion of the carbon estimate is the primary focus of this report. Therefore, DUC chose to use the POC polygons with the peatland percent and peatland carbon densities as the main inputs for the carbon estimates. The open water and mineral wetland cover from the HWL was summarized into the POC polygons to estimate the remaining mineral wetland carbon stocks. This combined soil organic carbon layer is referred to as the Hybrid Carbon Layer.

5.0 Methods

All work was performed in ArcGIS 10.7 with the Canada Albers Equal Area Conic NAD83 projection. The spatial framework of the Hybrid Carbon Layer consists of the POC polygons. Using the POC and the HWL, the total area of each POC polygon was split into 9 cover classes (Table 1). The 'Tabulate Area' tool was used to calculate the area of the open water and wetland classes from the HWL within each POC polygon, which was then converted to a proportion of the total polygon. The four POC peatland classes and a rock cover (bare earth) class were already present in the polygons of the dataset.

Table 1: Cover Class Data Sources. The nine cover classes of the Hybrid Carbon Layer and the dataset used to derive the percent area and carbon content.

Cover Class	Total Area Derived From:	Carbon Densities Derived From:
Open Water	HWL	Brigham et al. 2006
Fen Peatlands	POC	POC
Bog Peatlands	POC	POC
Marsh Peatlands	POC	POC
Swamp Peatlands	POC	POC
Mineral Wetland	HWL	Brigham et al. 2006
Rock (Bare Earth)	POC	N/A
Upland	Remaining	Badiou and Witherly, 2015

It is expected that using the total percent of each cover class as shown in Table 1 would produce a total polygon percent larger than 100 since the methods used to estimate the cover classes in the two datasets differ (i.e. one dataset may estimate more wetlands than another). To adjust for the difference in dataset cover estimates, an additive approach was used, starting with the proportion of the class we have the highest confidence in and adding the class with the next greatest importance to the carbon estimate one at a time until 100% of the polygon was reached.

Of all the cover classes, Open Water is the easiest to map due to its optical properties in the source imagery, and therefore is the most reliable cover estimate within each polygon. The analysis started by assigning the Open Water cover proportion as calculated from the HWL to each polygon. Then the total proportion of the four peatland classes were added, as these are typically the most significant landscape carbon stocks. The next class added was Mineral Wetlands. Since the HWL wetland class includes both peatland and mineral wetlands in one general wetland class, the total peatland percent of the POC was subtracted from the wetland class of the HWL to estimate total extent of mineral wetlands remaining. The resulting mineral wetland area estimates were added to the polygon total. If the total polygon area was exceeded, mineral wetland area was estimated by subtracting the sum of open water and peatland areas from the total polygon area and assumed the remainder represented mineral wetlands. The next class added was the rock cover from the POC. If the total polygon area was exceeded, then the total cover from all wetland types was subtracted from the polygon area and the remainder was classified as rock. All remaining polygon area was classified as upland.

Soil organic carbon densities for each cover class was used from a combination of data sources as described in Table 1. The POC dataset had soil profiles associated with each peatland type in each polygon. To calculate the total density, depth was multiplied by, bulk density and organic carbon percent of each horizon and all horizons were added for the full soil core. The resulting densities were applied to the peatland class for that polygon. The open water and mineral wetland classes received a general mineral wetland carbon density of 289 tonnes/ha based on sampled freshwater mineral soils average in Brigham et al. 2006. As for upland soils, a general carbon density of 157.85 tonnes/ha was used based on mean upland soil carbon estimates for Canada in Badiou and Witherly 2015.

Using the total hectares of each cover class multiplied by the soil organic carbon density of the cover class in each polygon, the total mass was calculated in tonnes of carbon for each polygon. We converted the mass of carbon to carbon dioxide using the standard conversion factor of 3.666. Carbon dioxide was further converted into the number of standard passenger vehicles annual emissions equivalent assuming that a typical passenger vehicle emits 4.6 metric tonnes of carbon dioxide per year (USEPA, 2018).

6.0 Results

The Fisher River Cree Nation Conservation Areas Initiative Study Area watershed comment zones contain an estimated combined 360.7 million tonnes of soil organic carbon, which is equivalent to the emissions of 287.4 million typical passenger vehicles annually (Table 2). Bogs contribute the most carbon with 112.6 million tonnes followed by 104.3 million tonnes from fens, 67.5 million tonnes from uplands, 61.6 million tonnes from mineral wetlands, and 14.6 million tonnes from open water bodies (Table 3). Out of the 11 watershed comment zones, zone 1 has the highest soil organic carbon density of 622 tonnes/ha followed by zone 2 and 3 at 583 and 557 tonnes/ha respectively (Table 2). Zones 7, 10, and 11 have the lowest soil organic carbon density at 304, 233, and 263 tonnes/ha respectively (Table 2).

Table 2: Watershed Soil Organic Carbon and Equivalents.

Watershed Comment Zones	Area	Soil Organic Carbon	Soil Organic Carbon Density	CO_2 Equivalent	Annual Emissions Equivalent	Emissions Over 20 Years Equivalent
	Hectares	Tonnes	Tonnes/Hectare	Tonnes	Number of Cars	Number of Cars
1	18,094	11,259,421	622	41,277,036	8,973,269	448,663
2	40,196	23,452,691	583	85,977,564	18,690,775	934,539
3	23,419	13,050,221	557	47,842,109	10,400,458	520,023
4	114,753	49,877,050	435	182,849,265	39,749,840	1,987,492
5	104,897	48,594,760	463	178,148,389	38,727,911	1,936,396
6	30,617	14,059,632	459	51,542,612	11,204,916	560,246
7	223,270	67,763,202	304	248,419,899	54,004,326	2,700,216
8	95,346	41,523,579	436	152,225,439	33,092,487	1,654,624
9	127,829	54,700,636	428	200,532,531	43,594,029	2,179,701
10	148,741	34,613,810	233	126,894,227	27,585,702	1,379,285
11	7,018	1,847,492	263	6,772,904	1,472,370	73,619
Combined Total	**934,180**	**360,742,492**	**386**	**1,322,481,974**	**287,496,081**	**14,374,804**

Table 3: Watershed Soil Organic Carbon by Wetland Type.

Watershed Comment Zones	Tonnes of Soil Organic Carbon				
	Bog	Fen	Open Water	Mineral Wetland	Upland
1	3,992,817	4,811,268	220,237	1,322,353	912,746
2	15,278,537	1,849,733	1,009,389	3,467,139	1,847,893
3	8,552,199	856,322	738,273	1,815,133	1,088,293
4	13,189,809	16,568,960	1,148,850	14,634,859	4,334,571
5	19,616,355	12,290,946	3,327,630	8,881,635	4,478,193
6	7,835,982	1,109,777	1,873,502	1,920,531	1,319,839
7	6,817,799	27,345,703	1,474,856	11,145,823	20,979,021
8	15,488,327	12,587,024	1,868,955	7,101,327	4,477,945
9	19,991,980	17,053,743	1,834,534	8,525,552	7,294,828
10	1,511,991	9,486,233	920,569	2,801,349	19,893,668
11	386,767	360,403	183,412	43,590	873,319
Combined Total	**112,662,563**	**104,320,112**	**14,600,207**	**61,659,293**	**67,500,317**

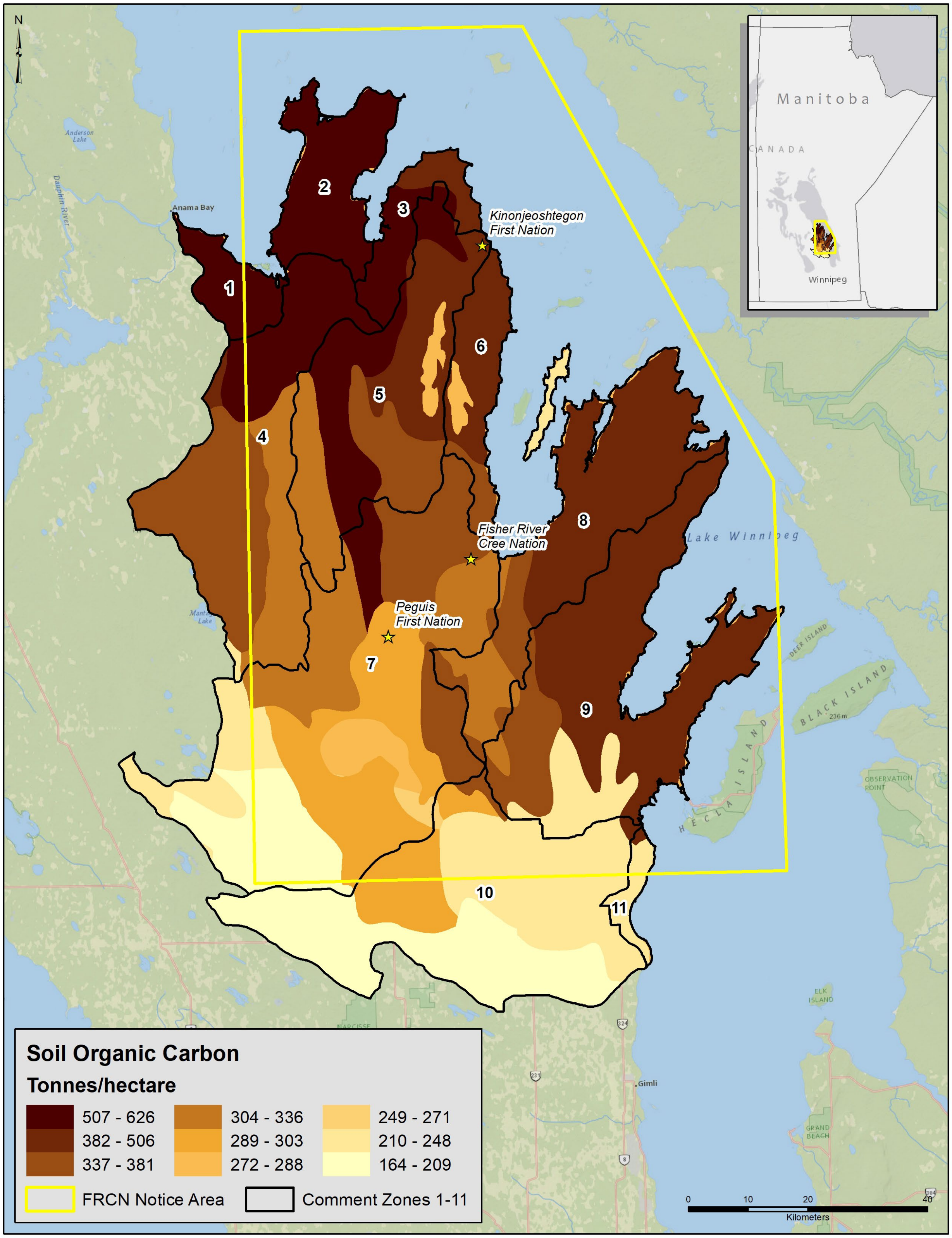

Figure 1: Soil organic carbon density in the eleven Fisher River Cree Nation Conservation Areas Initiative Study Area comment zones.

References

Badiou, P. and Witherly, S. 2015. Manitoba Boreal Wetland Carbon Inventory. A report prepared for the Government of Manitoba, Department of Conservation and Water Stewardships. 15 pp.

Bridgham, S. D., Megonigal, J. P., Keller, J. K., Bliss, N. B., & Trettin, C. (2006). The carbon balance of North American wetlands. *Wetlands, 17*(2), 889-916.

Ducks Unlimited Canada. May 2011. Hybrid Wetland Layer User Guide. 18 pp. Hybrid Wetland Layer Version 2.1.1 Ducks Unlimited Canada, Edmonton, Alberta.

Manitoba Gross Watersheds (hp14_mb). 2005. Winnipeg, MB: Bob Harrison, Manitoba Water Stewardship. Available: Manitoba Land Initiative http://web2.gov.mb.ca/mli

Tarnocai, C., Kettles, I.M., and Lacelle, B. 2011. Peatlands of Canada; Geological Survey of Canada, Open File 6561 (digital database). Available: Government of Canada https://sis.agr.gc.ca/cansis/interpretations/carbon/index.html

Tarnocai, C., and Lacelle, B. 1996. Soil Organic Carbon Digital Database of Canada. Ottawa, ON: Eastern Cereal and Oilseed Research Center, Research Branch, Agricultutre and Agri-Food Canada. Available: Government of Canada https://sis.agr.gc.ca/cansis/interpretations/carbon/index.html

U.S. Environmental Protection Agency (EPA). 2018. Greenhouse Gas Emissions from a Typical Passenger Vehicle: Questions and Answers. Office of Transportation and Air Quality. Retrieved from https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100U8YT.pdf

Zoltai, S., Siltanen R., Johnson, J. 2000. A Wetland Data Base for the Western Boreal, Subarctic, and Arctic Regions of Canada. Information Report NOR-X-368. Northern Forestry Center, Edmonton, Alberta.