Blue Carbon Losses With Salt Marsh Drainage

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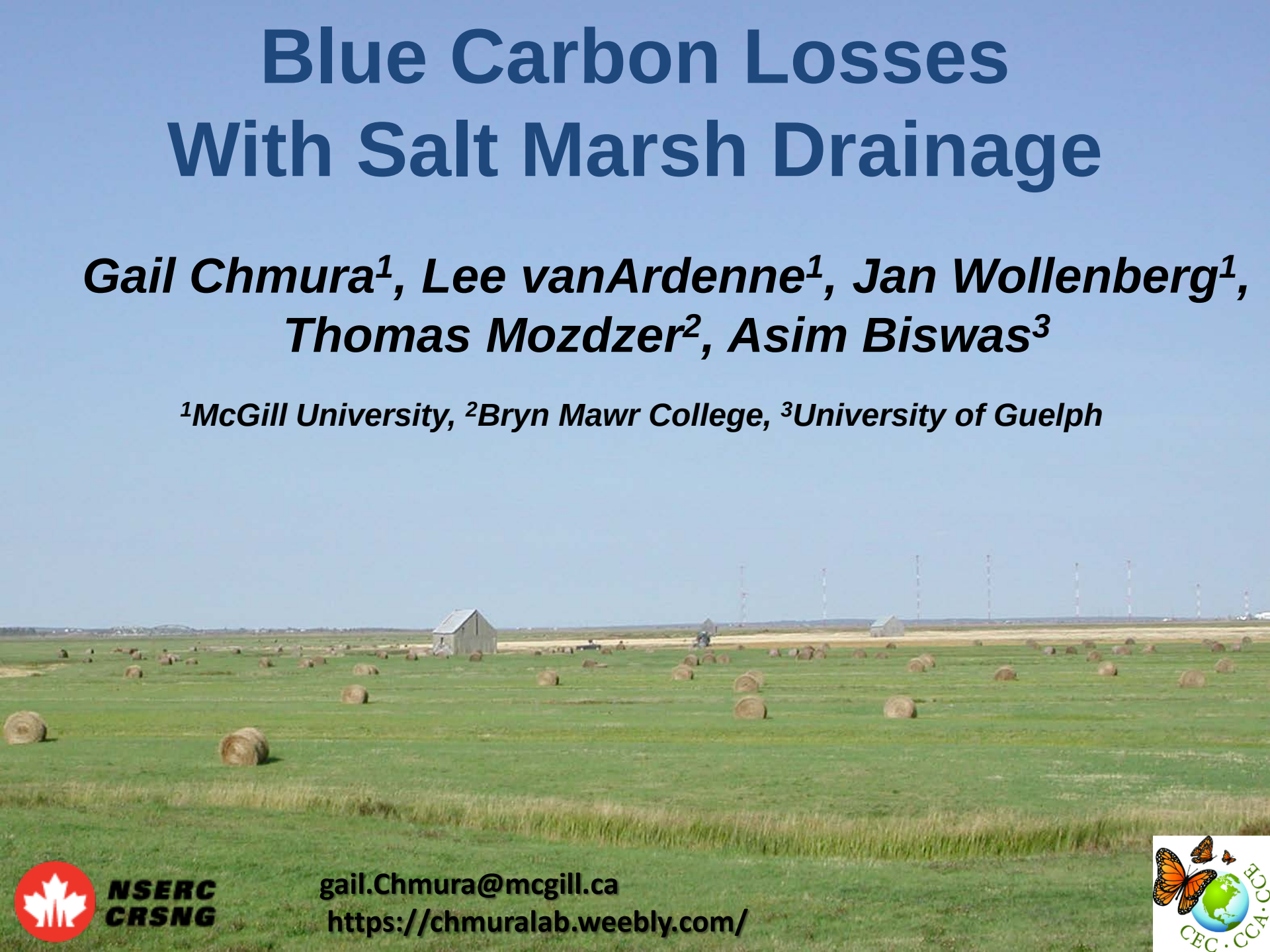

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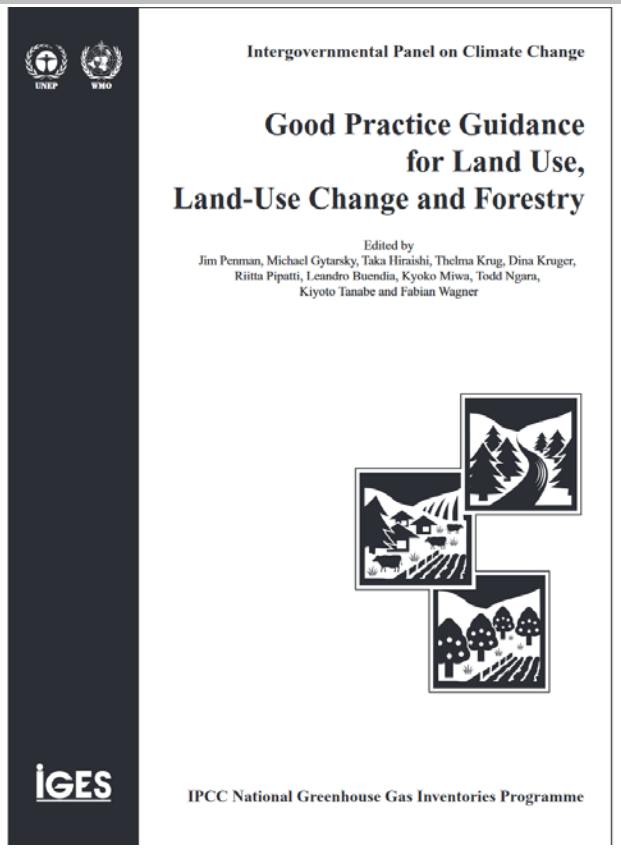
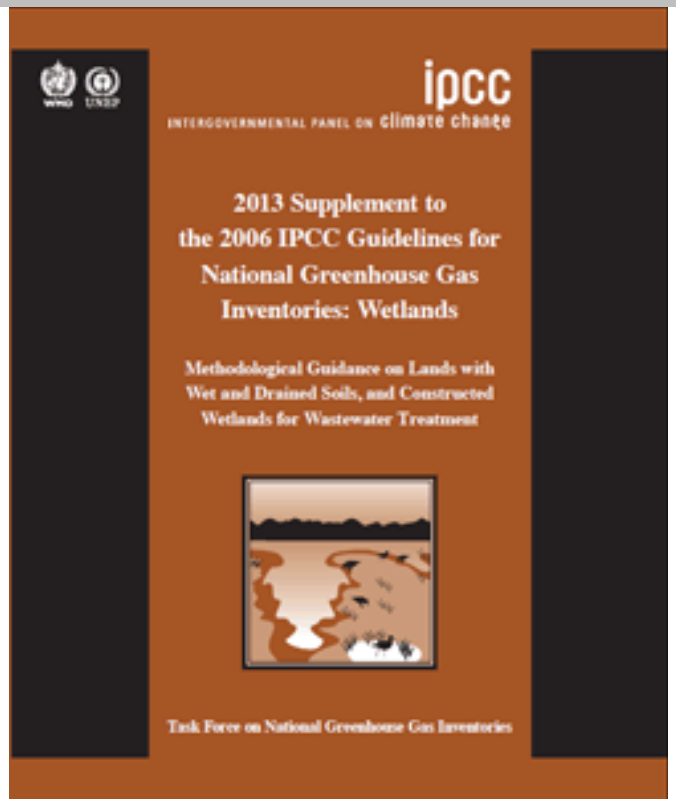
NSERC CRSNG

CEC · CCA · CCE

Emission factors produced for land use change



2006 revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories then the 2013 Supplement on Wetlands



One chapter was on wetlands.

Chapters
1 Introduction
Chapter 2 Drained Inland Organic Soils
Chapter 3 Rewetted Organic Soils
Chapter 4 Coastal Wetlands
Chapter 5 Inland Wetland Mineral Soils
Chapter 6 Constructed Wetlands for Wastewater Treatment
Chapter 7 Cross-cutting Issues and Reporting

www.IPCC.ch –
see publications/methodologies

Source of IPCC emission factors for drainage

C loss assumed to extend to 1 m.
Emissions persist for as long as it takes soil OC (organic matter) to be oxidized (that is until loss is equivalent to stocks reported in earlier tables).

TABLE 4.13 ANNUAL EMISSION FACTORS (EF_{DR}) ASSOCIATED DRAINAGE (EF_{DR}) ON AGGREGATED ORGANIC AND MINERAL SOILS (TONNES C HA^{-1} YR^{-1})

Ecosystem	EF_{DR}	95% CI	Range	N
Tidal marshes and mangroves	7.9[1]	5.2, 11.8	1.2 – 43.9	22

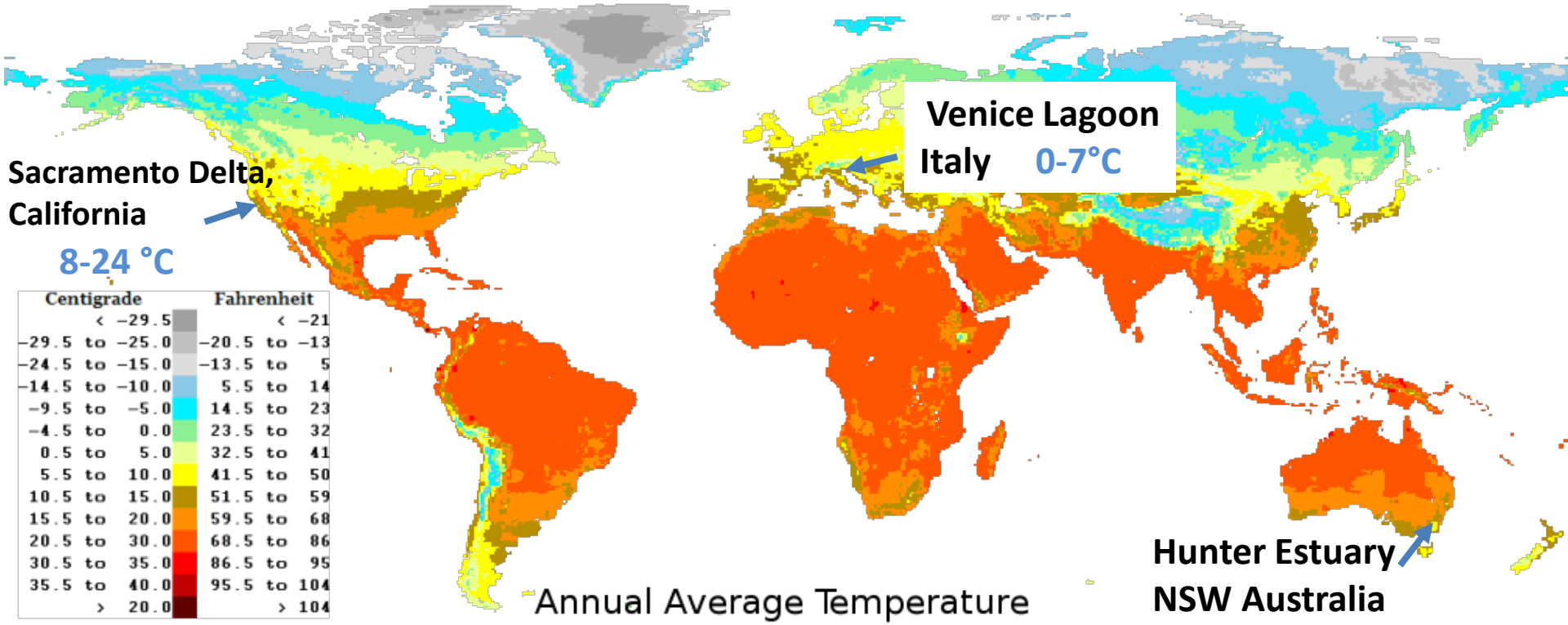
[1] Camporese et al. (2008), Deverel & Leighton (2010), Hatala et al. (2012), Howe et al. (2009), Rojstaczer & Deverel (1993)

[2]95%CI of the geometric mean

Data from 3 sites:

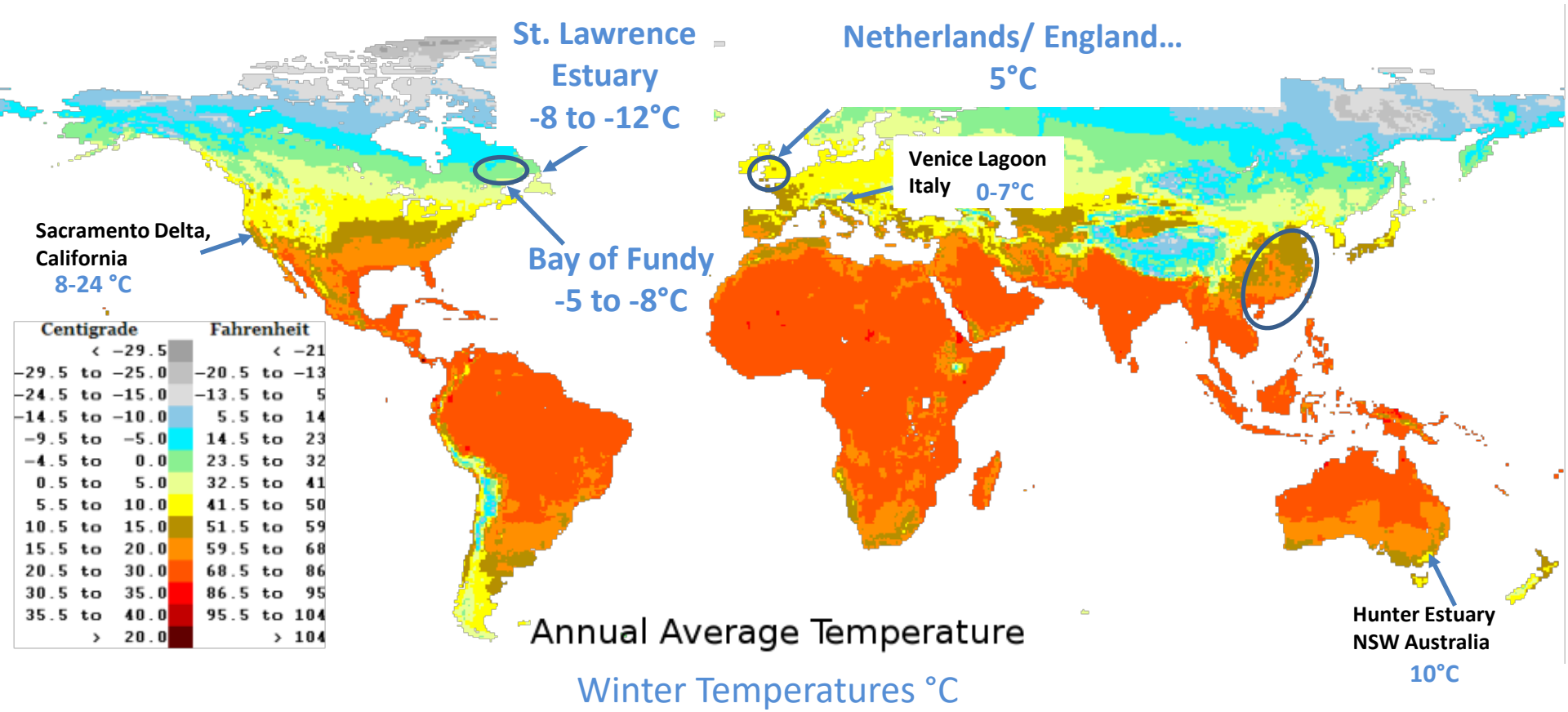
- **Camporese et al. - a drained cropped peatland south of Venice, Italy (was a *Phragmites* site)**
- **Deverel & Leighton, Hatala et al., Rojstaczer & Deverel - Sacramento-San Joaquin Delta, California, USA, freshwater tidal**
- **Howe et al. - Hunter Estuary, Australia (mangroves and salt marsh)**

Climate of these sites

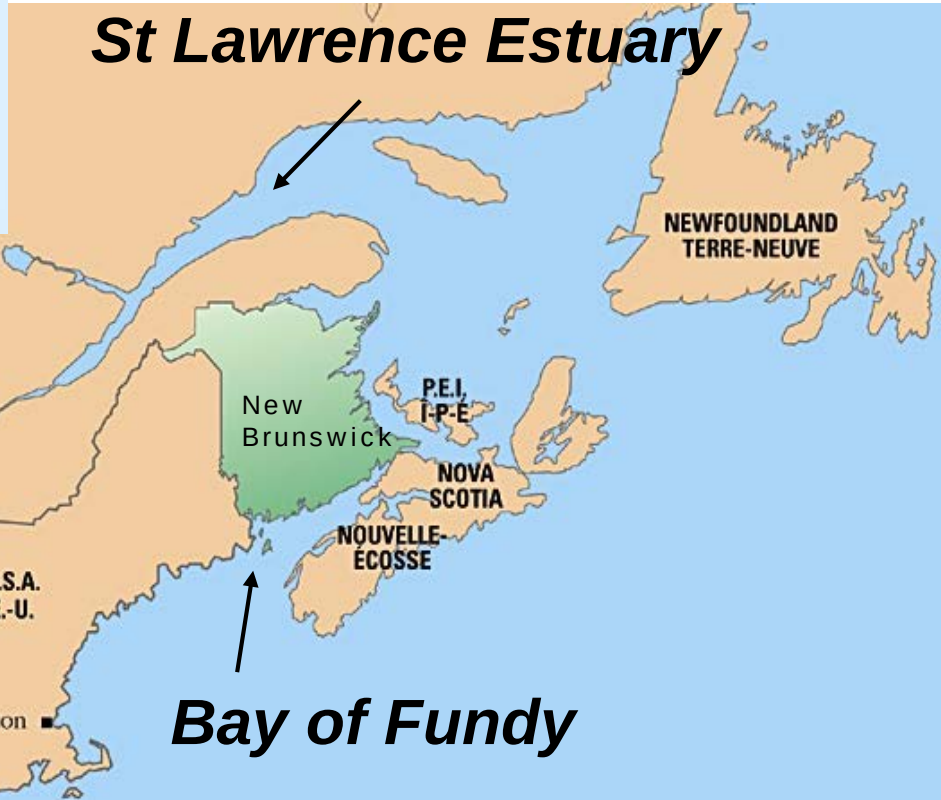


Centigrade	Fahrenheit
< −29.5	< −21
−29.5 to −25.0	−20.5 to −13
−24.5 to −15.0	−13.5 to 5
−14.5 to −10.0	5.5 to 14
−9.5 to −5.0	14.5 to 23
−4.5 to 0.0	23.5 to 32
0.5 to 5.0	32.5 to 41
5.5 to 10.0	41.5 to 50
10.5 to 15.0	51.5 to 59
15.5 to 20.0	59.5 to 68
20.5 to 30.0	68.5 to 86
30.5 to 35.0	86.5 to 95
35.5 to 40.0	95.5 to 104
> 20.0	> 104

Compare IPCC sources to climate of other sites where drainage has been prevalent & in some cases continues to occur



Marsh "reclamation" or dyking & drainage has been extensive on Canada's east coast, particularly the mesotidal St. Lawrence (2-3 m) & macrotidal Bay of Fundy (6-11 m)



dyking on St. Lawrence Estuary 1859 Fundy mid 17th century

Methods –
Decomposition bag study in marsh and farm
Aboveground on soil surface
Belowground material at 15 cm soil depth

van Ardenne et al. in preparation

Results –

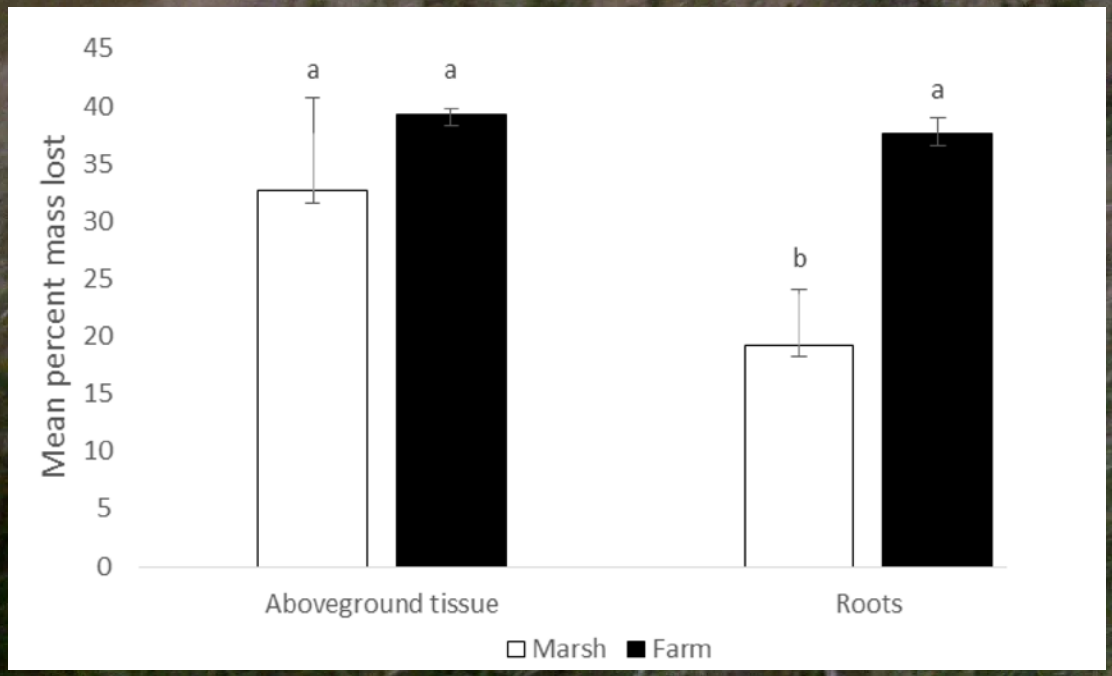
Decomposition bag study in marsh and farm

Shows considerable carbon can be lost in the first year

Discount role of temperature:

a 3-6% increase in decay rate per °C (Kirwan et al. 2014)

Farm soil was ~1 °C higher = 6% increase in decay



We assume wherever drainage has occurred, a minimum of 37.6% blue carbon lost in the 1st yr .

Methods-
Compare stocks in marshes to drained sites

Cored to basal marine clay in farm and marsh, controlling for compaction, measuring bulk density and OC by LOI.

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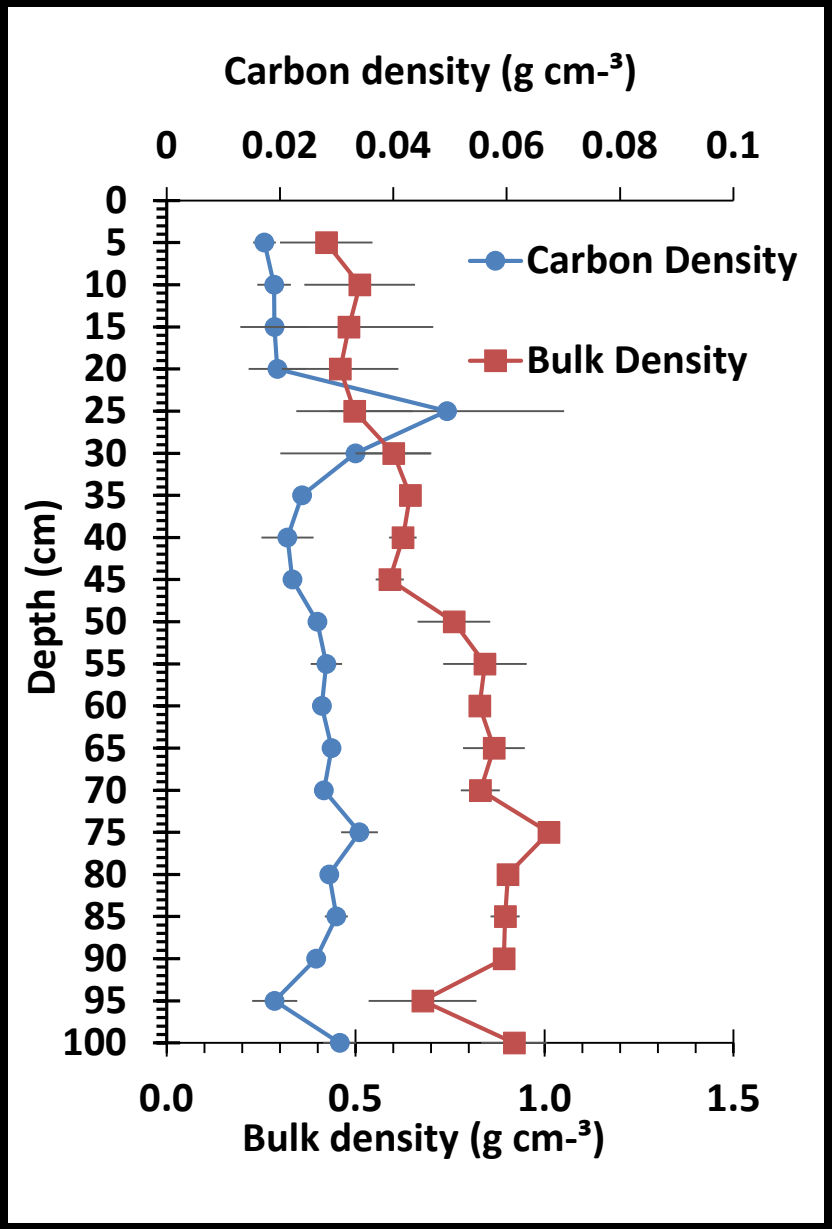
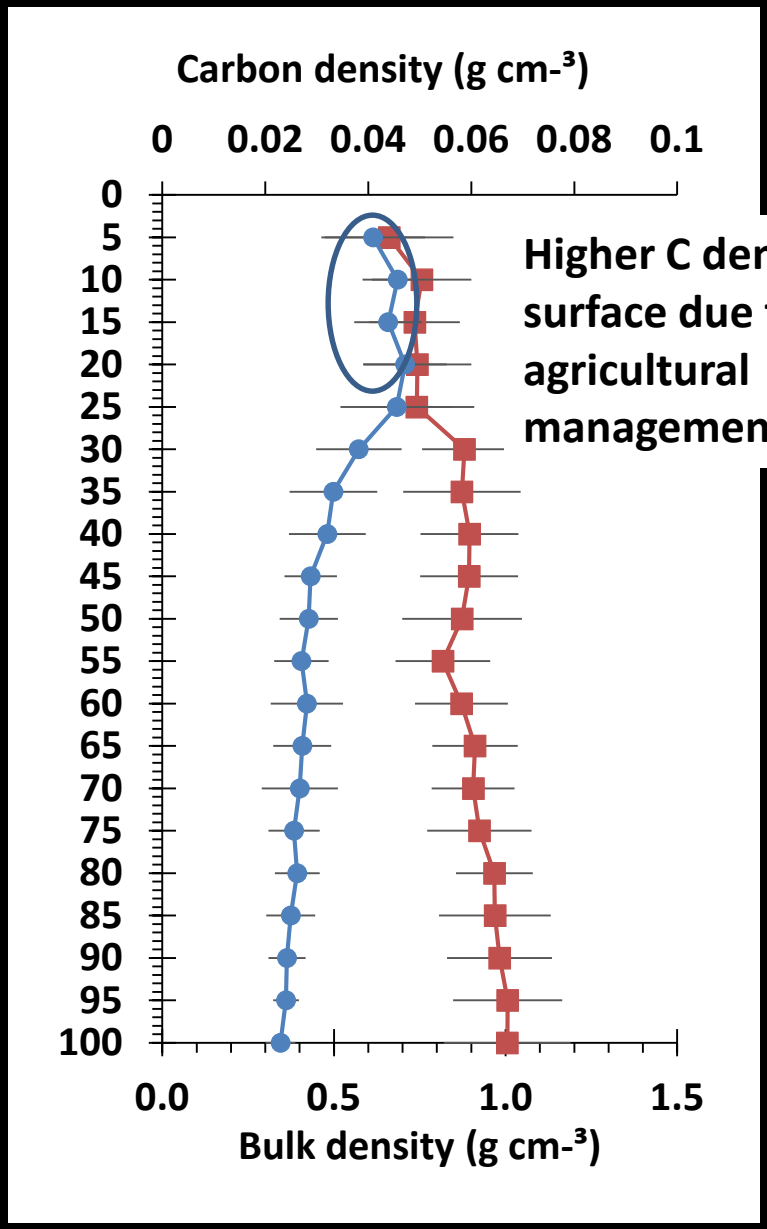
Flooded marsh
(3 cores)



Drained marsh
(14 cores)



Mean ±sd

Results –

Despite the surface C enrichment due to agriculture…

The deposit above the marine clay in the undrained marshes is thicker & stores 265 - 642 tonne C ha^{-1}

farm soil deposit stores 47 - 461 tonne C ha^{-1}

Average Rate of loss

4.91 tonnes C ha^{-1} yr^{-1}

IPCC average

7.9 tonnes C ha^{-1} yr^{-1}

van Ardenne et al. in preparation

As much as 39% of the original C stock has been lost.

Farms may still be loosing C and we can regain carbon by restoring them
– but we have to convince the agriculture community.

van Ardenne et al. in preparation

Thanks!

Acknowledgements

Kamouraska farmers for access, particularly Dr. Parent

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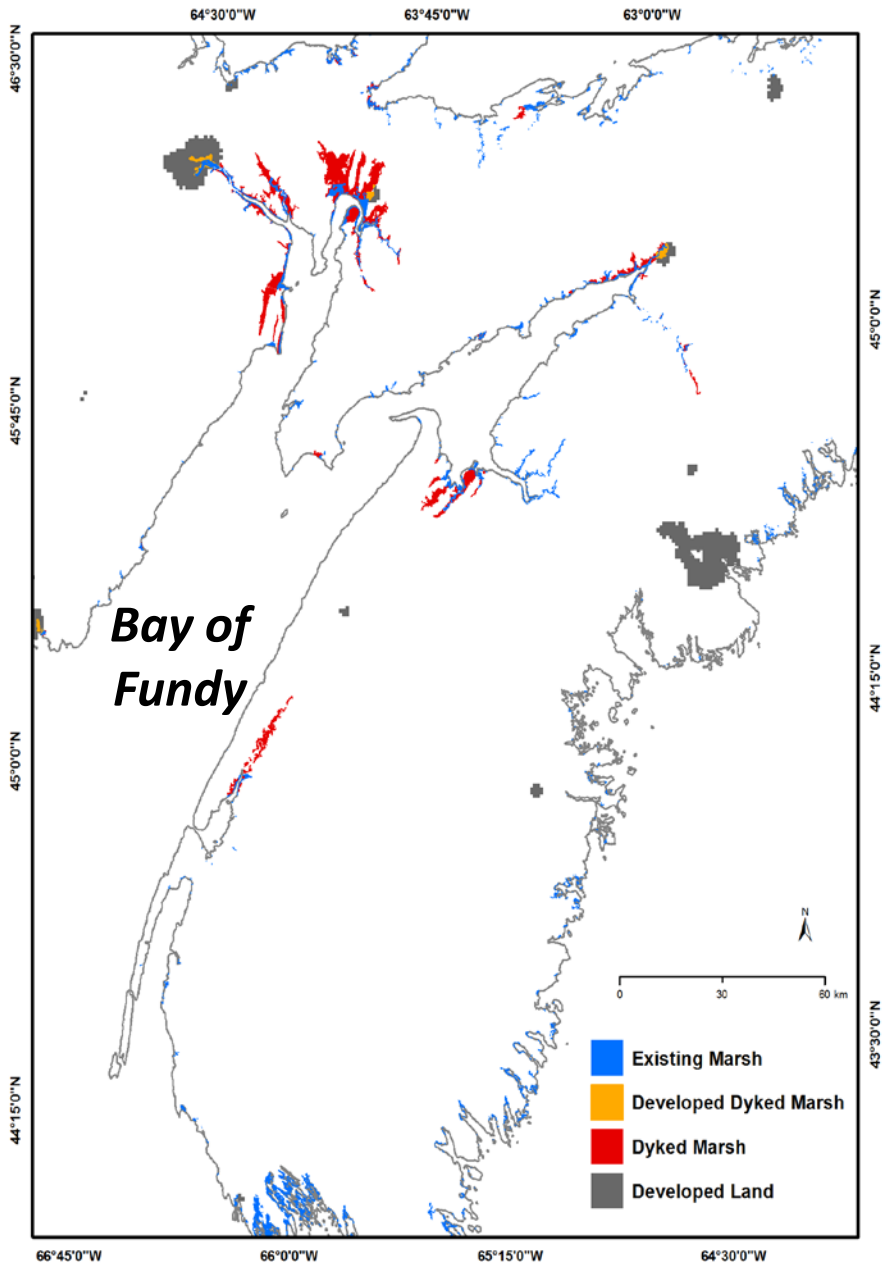
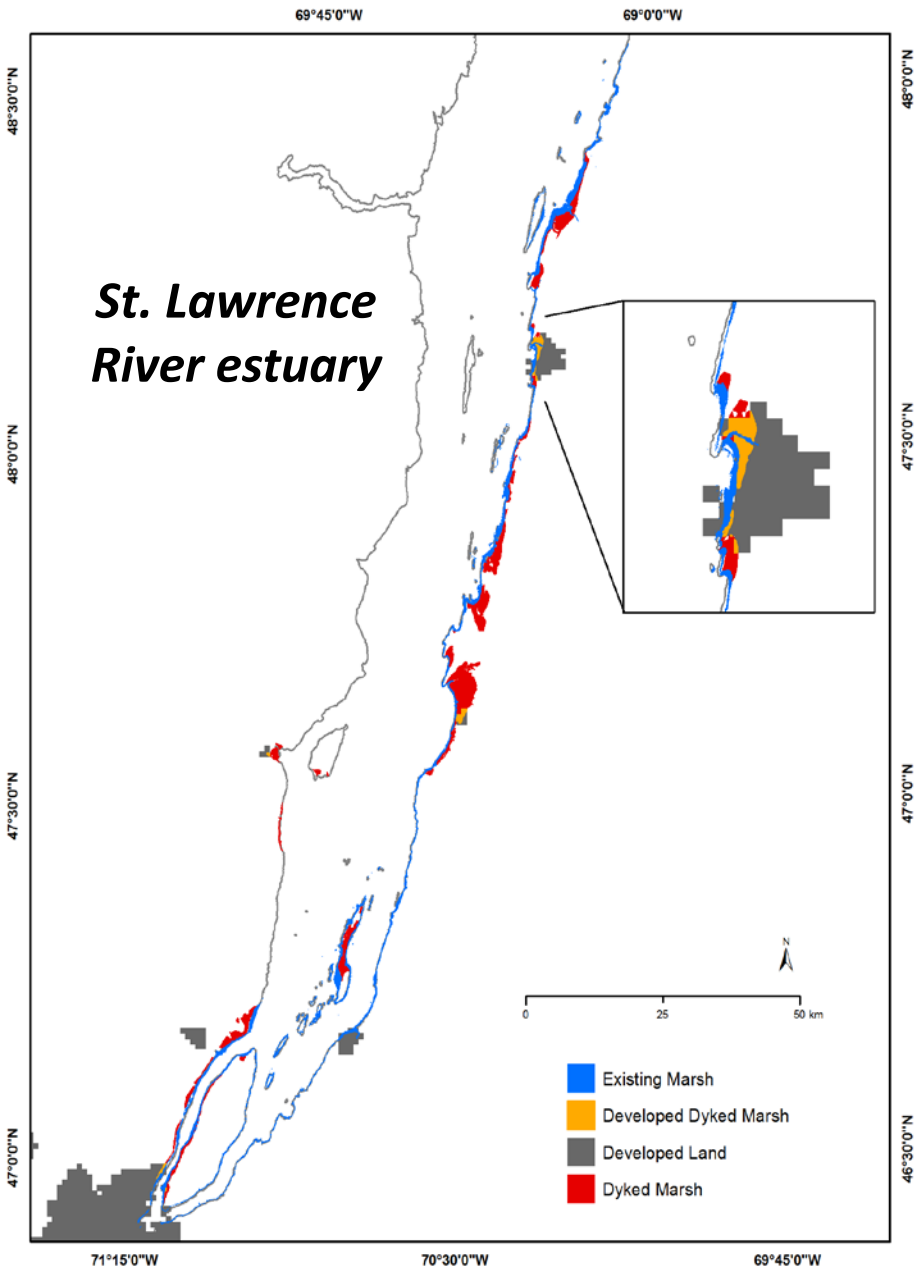
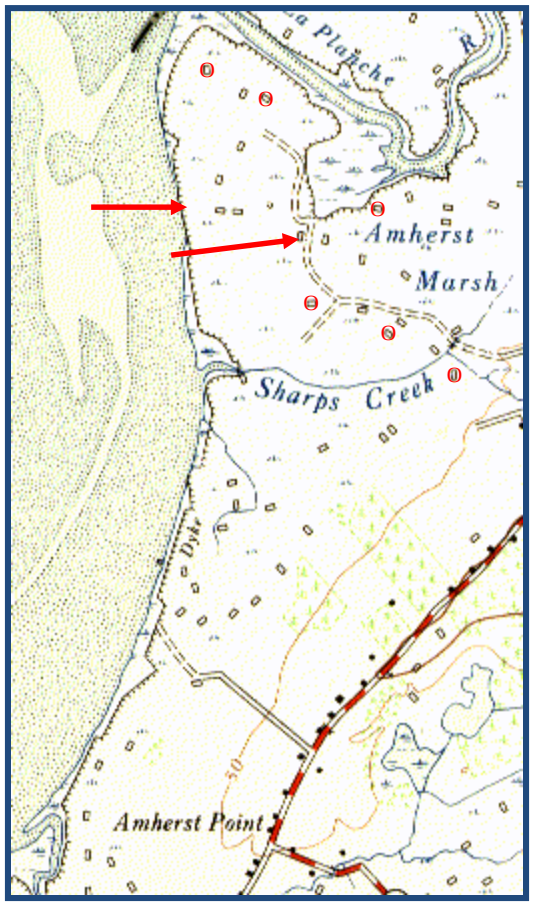

64°30'0"W
63°45'0"W
63°0'0"W
46°30'0"N
45°45'0"N
45°0'0"N
44°15'0"N
43°30'0"N
45°0'0"N
44°15'0"N
Bay of Fundy
N
0
30
60 km
Existing Marsh
Developed Dyked Marsh
Dyked Marsh
Developed Land
66°45'0"W
66°0'0"W
65°15'0"W
64°30'0"W

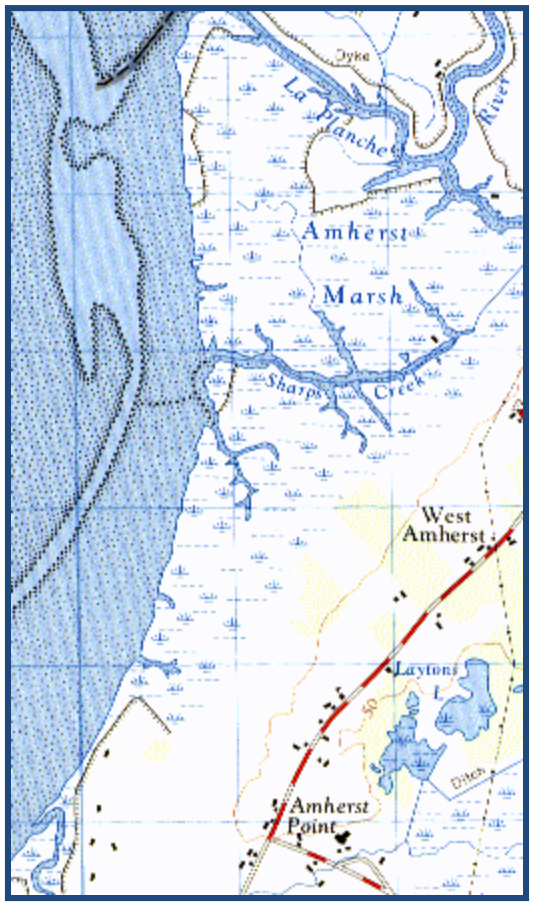

69°45'0"W
69°0'0"W
48°30'0"N
48°0'0"N
47°30'0"N
47°0'0"N
48°0'0"N
47°30'0"N
47°0'0"N
46°30'0"N
St. Lawrence River estuary
N
0
25
50 km
Existing Marsh
Developed Dyked Marsh
Developed Land
Dyked Marsh
71°15'0"W
70°30'0"W
69°45'0"W

Recent History of Lusby Marsh

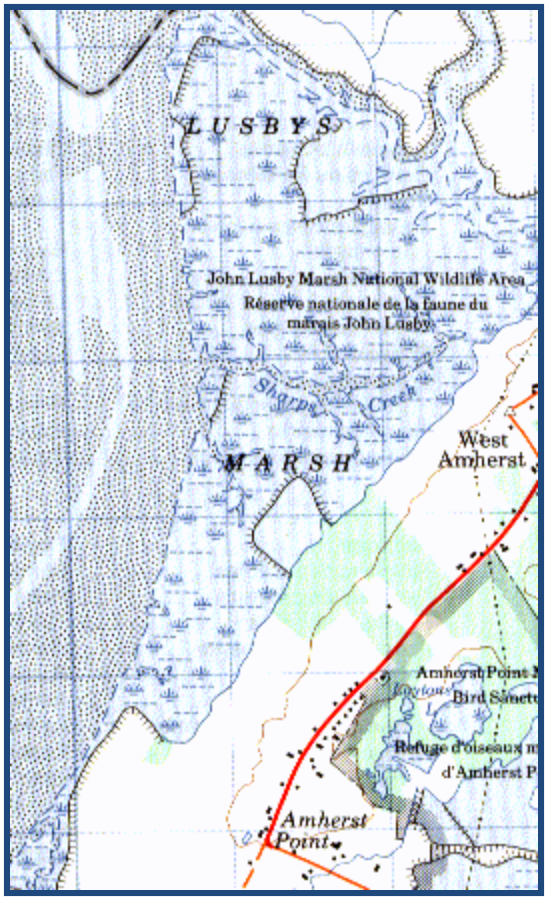
1935



1959



1979



Filling the gaps: Return of ecosystem services