Carbon In, Methane Out: The Greenhouse Gas Balance of North American Wetlands

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State of the North American Carbon Cycle

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THE CARBON BALANCE OF NORTH AMERICAN WETLANDS

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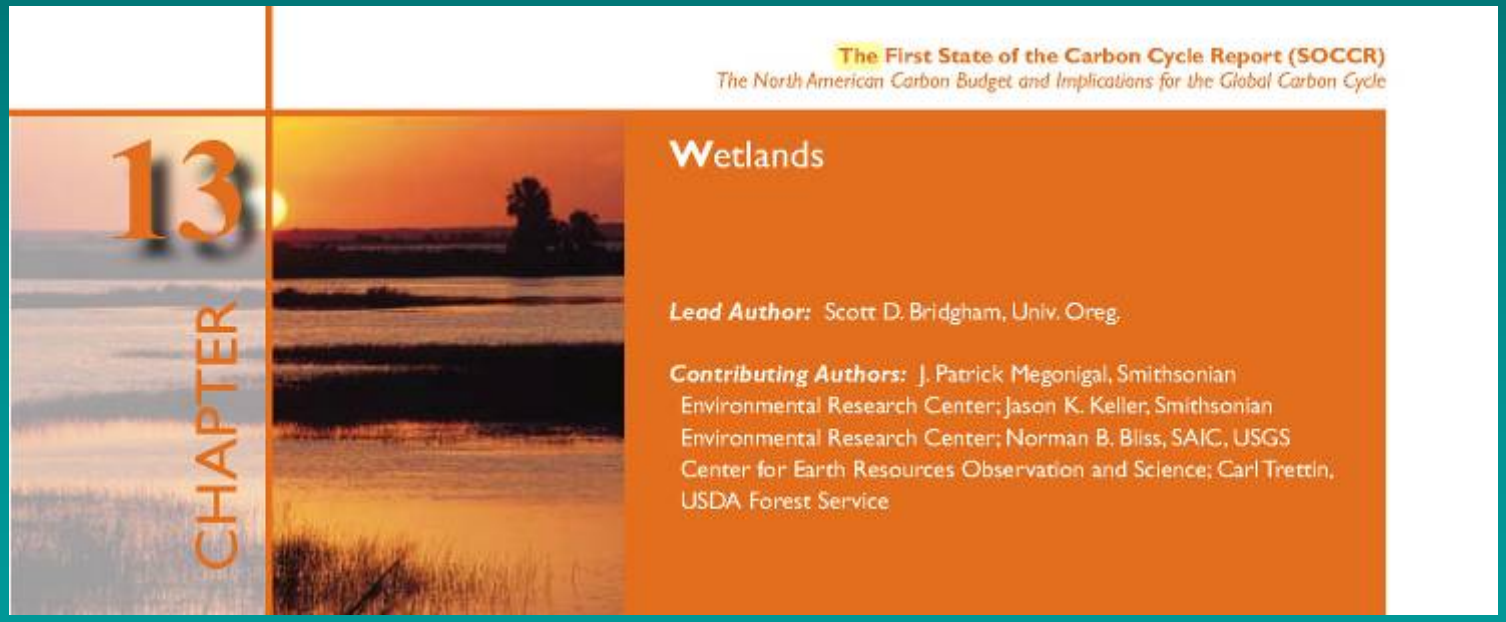
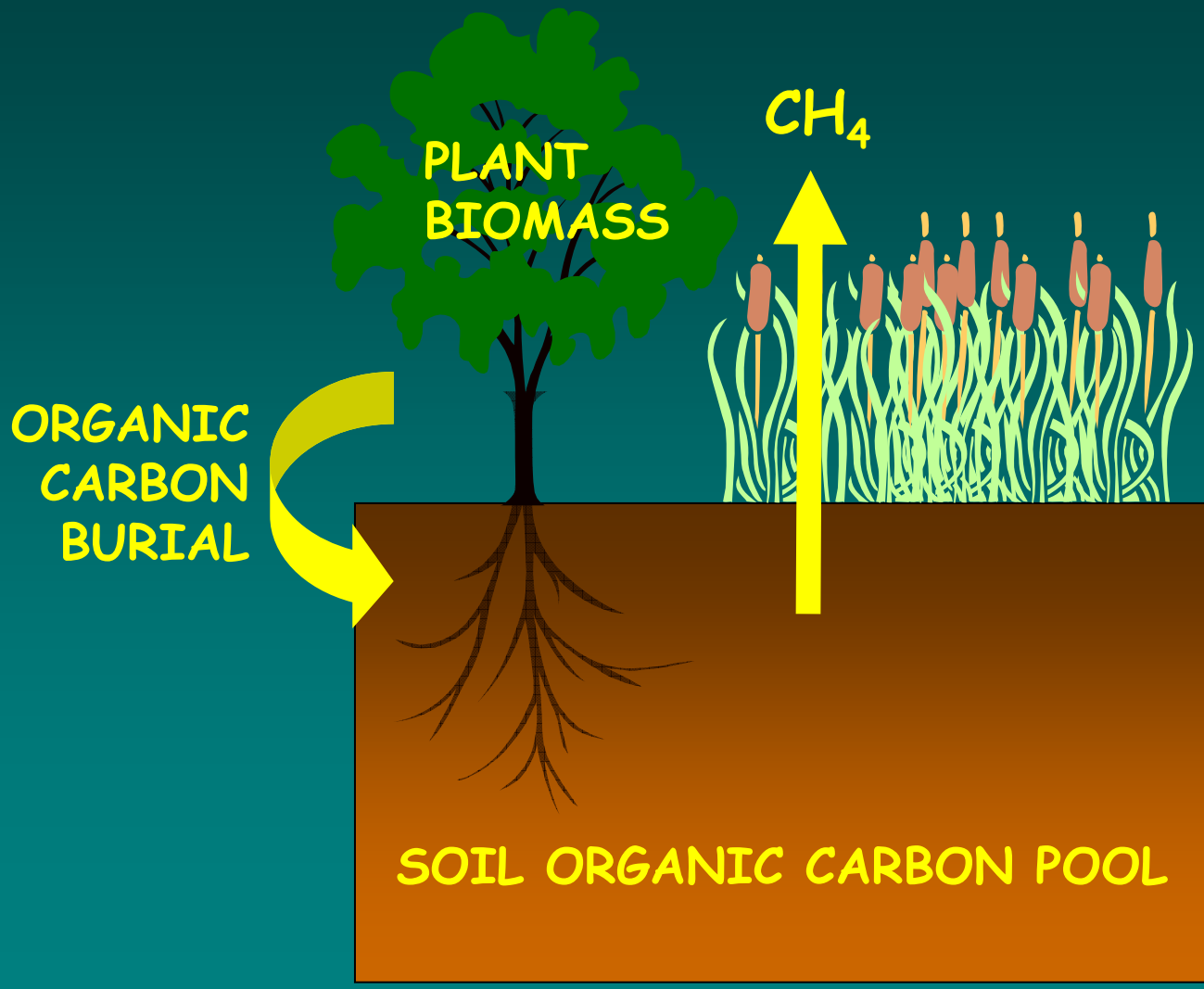


SOCCR Wetland Carbon Budget



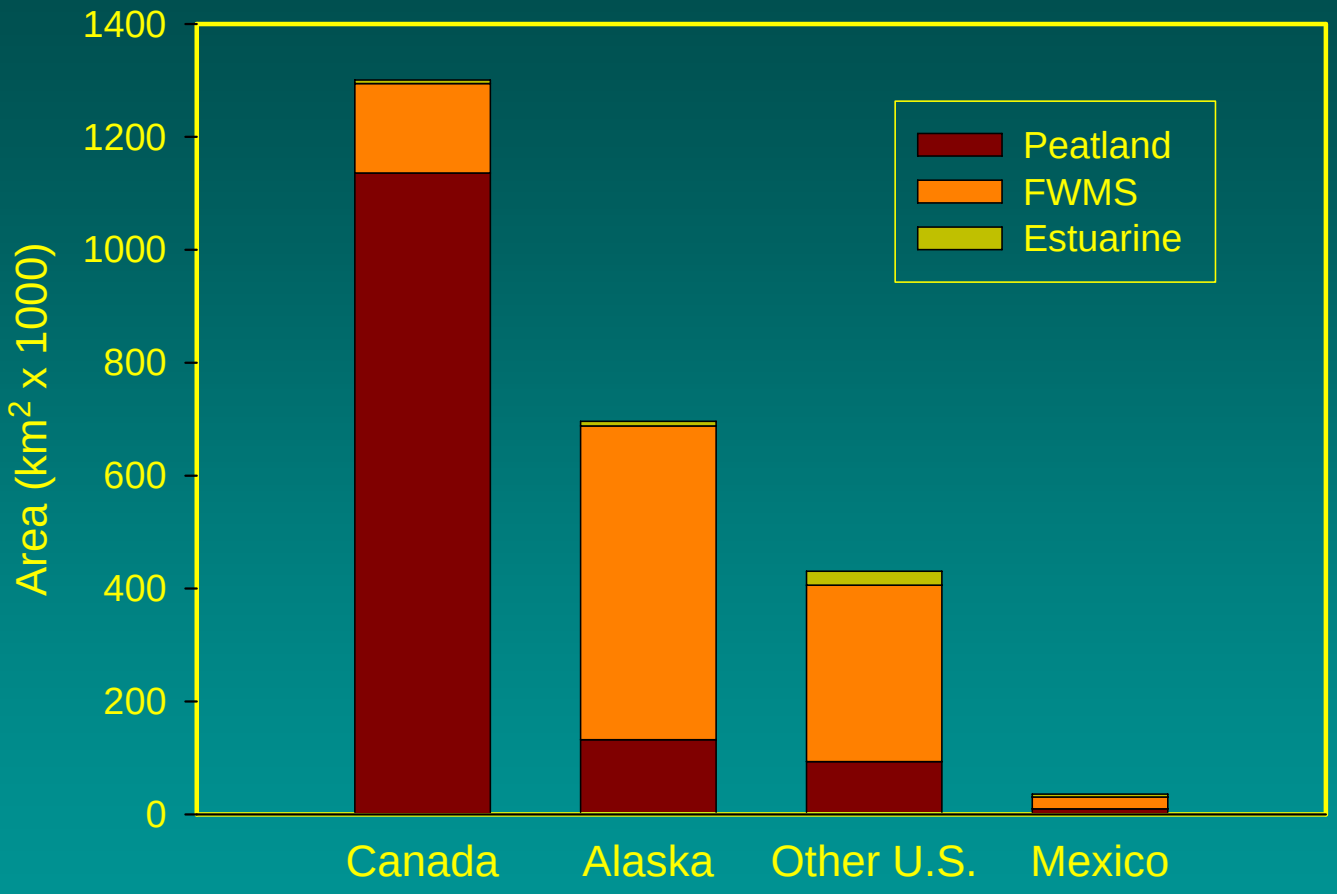
Methods Overview

- Literature on wetland area, losses, and C pools and fluxes.
- Synthesis of published CH_4 fluxes in conterminous US.
- Used USDA soil datasets for peatland area and US soil C densities.
- Used 'best professional judgment' to provide uncertainty estimates.

Wetland Types

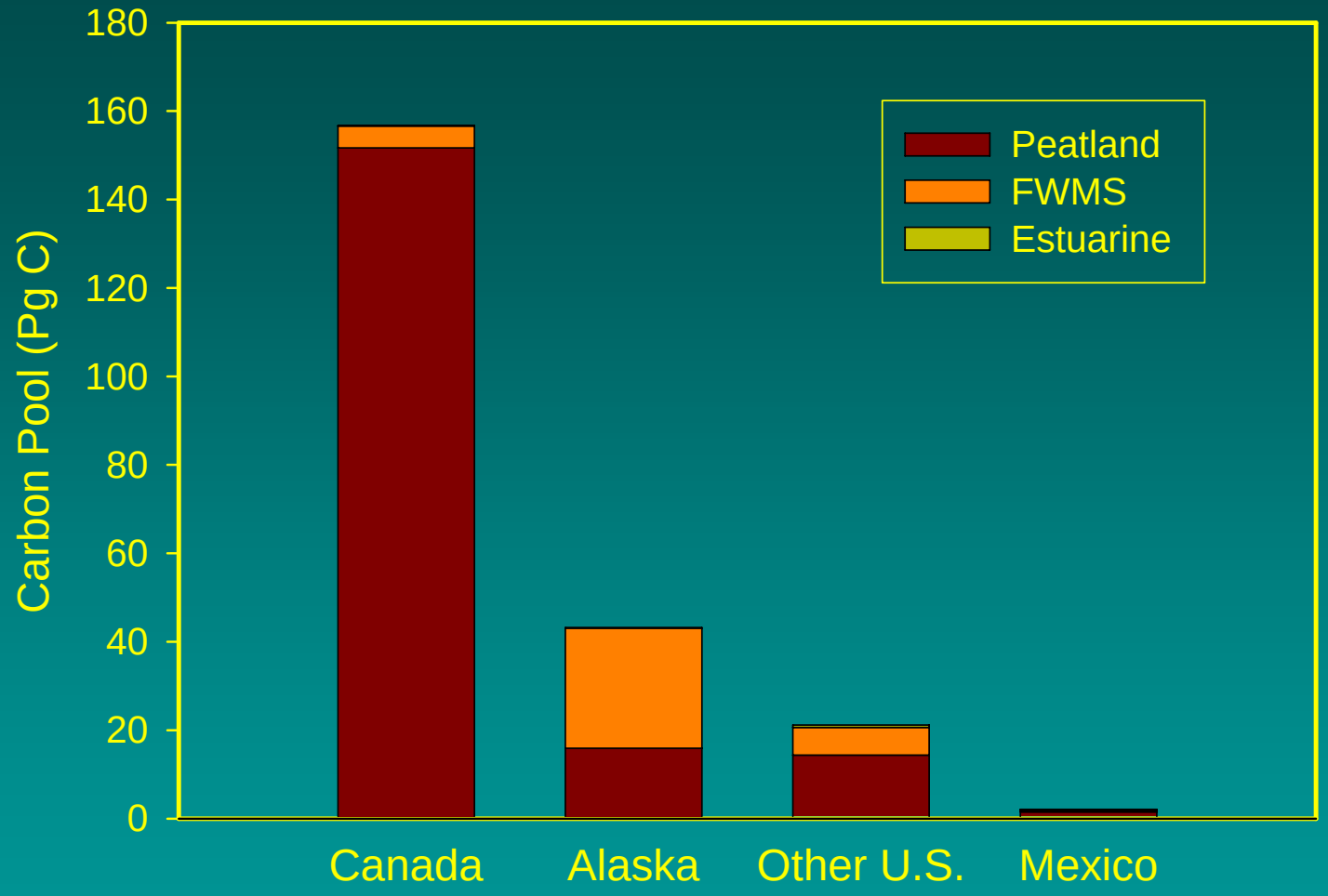
	Freshwater	Saltwater
Mineral Soils	 freshwater mineral soils (FWMS)	 estuarine
Organic Soils	 peatlands	 estuarine

North American Wetland Area



5% of North American Continent
41% of global wetland area

North American Wetland Carbon Pool



total pool = 223 Pg C
43% of global wetland pool

Peatland soils are rich in organic carbon because of slow decay rates due to wet and cold soil conditions

Carbon Pools

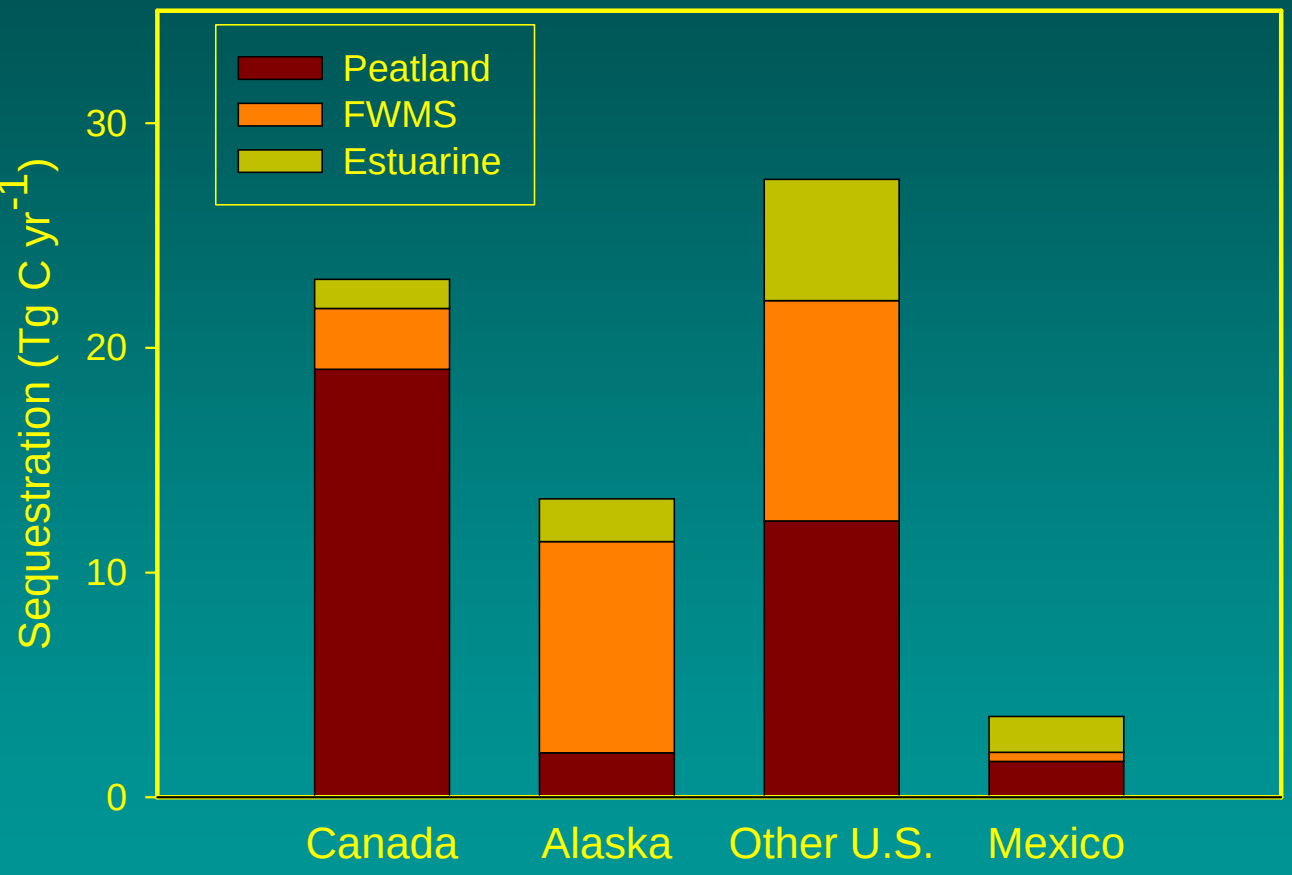
Table 3.3 Carbon stocks in North America in billions of tons, (see Box 3.1 for uncertainty conventions).

	United States	Canada	Mexico	North America
Forest	67[a,***]	86[a,***]	19[d,**]	171***
Cropland	14[b,****]	4[b,****]	1[b,**]	19****
Grazing lands	33[b,***]	12[b,***]	10[b,***]	55***
Wetlands	64[c,***]	157[c,***]	2[c,*]	223***
Total	178***	259***	33**	468***

First State of the Carbon Cycle Report (2007)

Carbon Fluxes

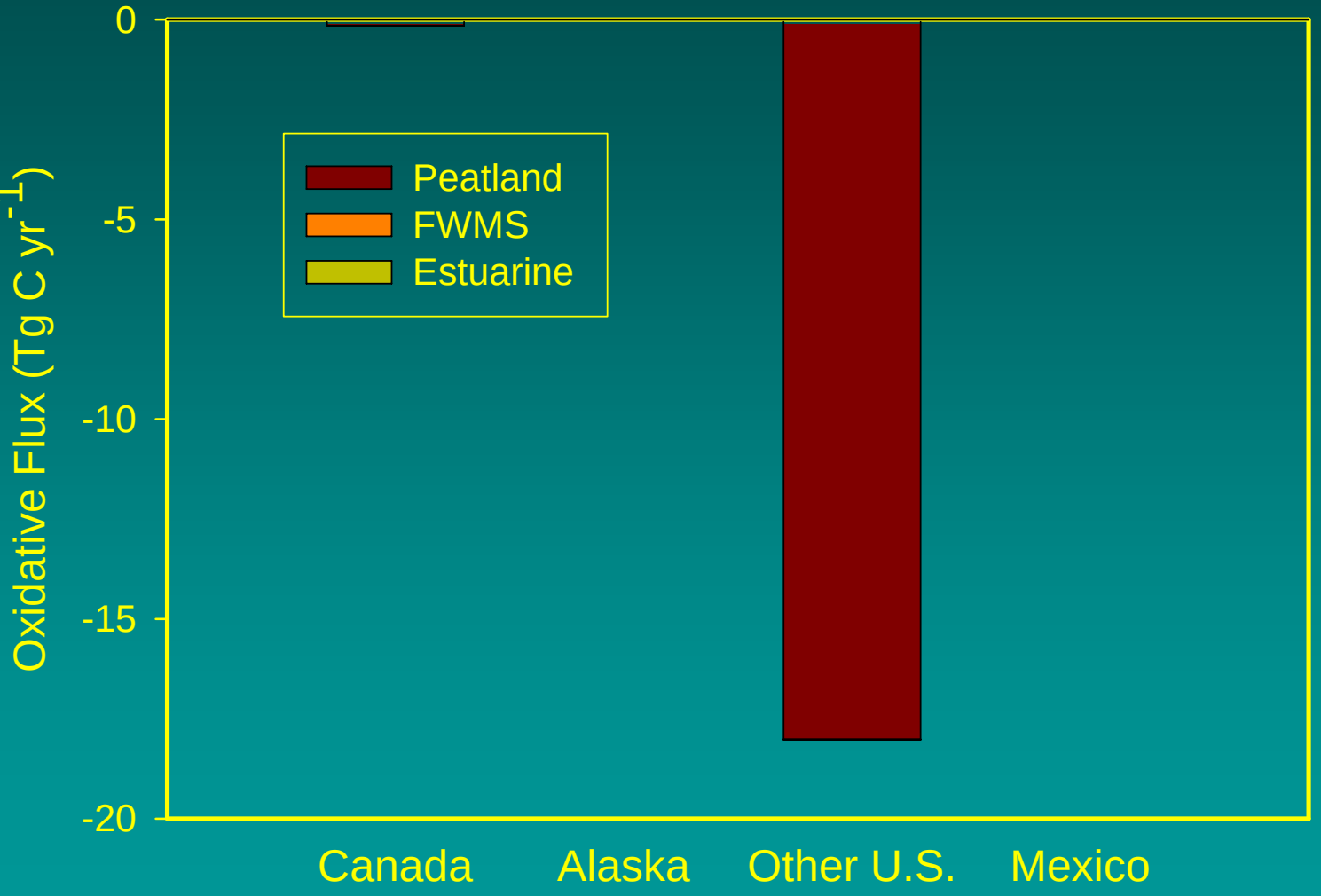
N.A. Wetland Carbon Sequestration in Extant Wetlands (Plants + Soil)



Total sequestration = 67 Tg C yr^{-1} (but estimate has very low confidence).

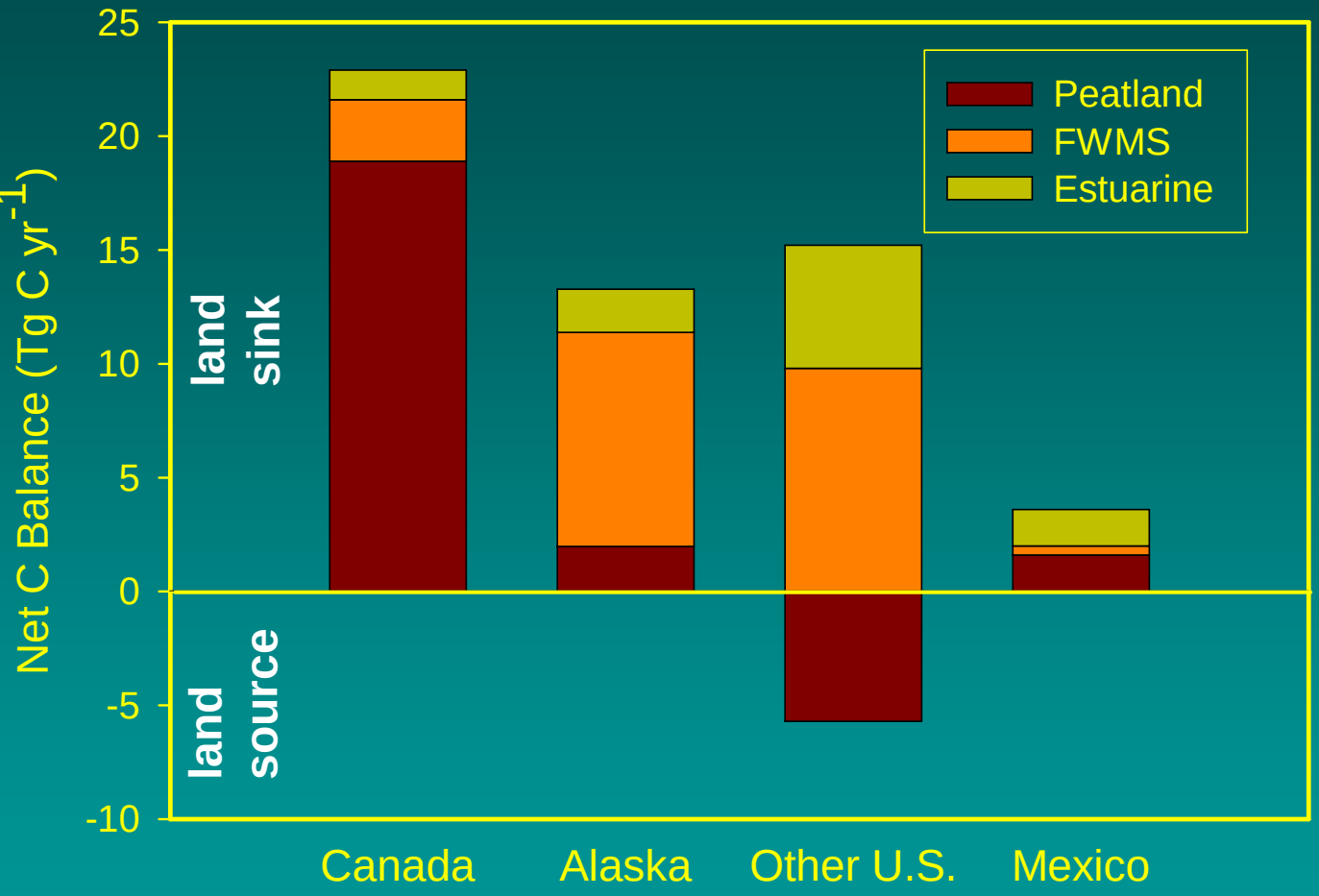
Drainage causes rapid oxidation that continues for decades.

North American Wetland Current Oxidative Flux



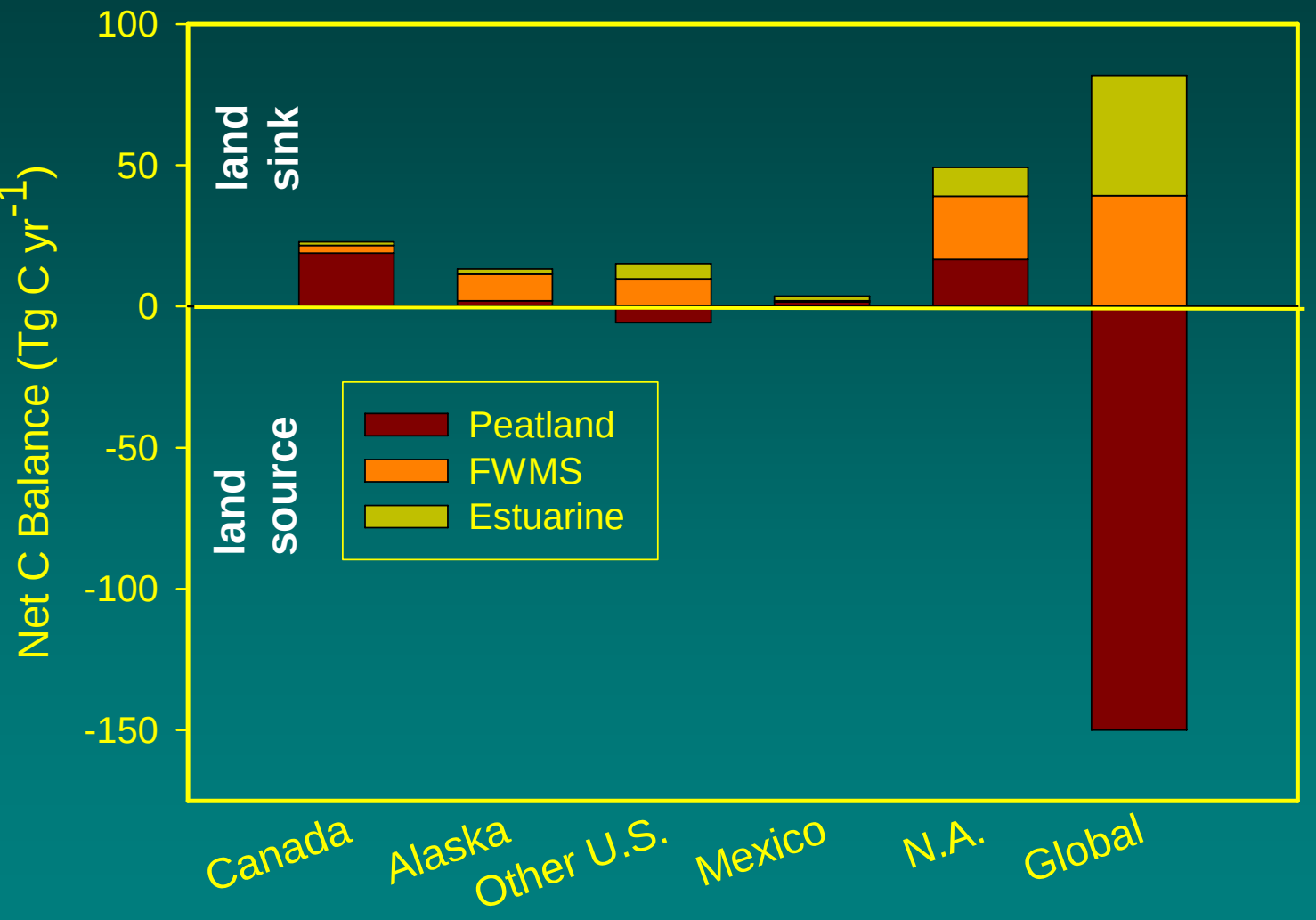
Note: Negative number = net flux from wetland to atmosphere.

North American Wetland Net Carbon Balance



Total net C balance = 49 Tg C yr^{-1} (but estimate has very low confidence).

Wetland Net Carbon Balance



Note: Positive number = net flux into wetland, negative number = net flux from wetland

Carbon Fluxes

Table 3.1 Annual net emissions (source = positive) or uptake (land sink = negative) of carbon in millions of tons circa 2003 (see Box 3.1 for uncertainty conventions).

Source (positive) or Sink (negative)	United States	Canada	Mexico	N. America
Fossil source (positive)				
Fossil fuel (oil, gas, coal)	1582[a,*****] (681, 328, 573)	164[a,*****] (75, 48, 40)	110[a,*****] (71, 29, 11)	1856***** (828, 405, 624)
Non-fossil carbon sink (negative) or source (positive)				
Forest	−256[b,***]	−28[c,***]	+52[d,**]	−233***
Wood products	−57[e,***]	−11[f,***]	ND	−68***
Woody encroachment	−120[g,*]	ND	ND	−120*
Agricultural soils	−8[h,***]	−2[h,***]	ND	−10[h,***]
Wetlands	−23[i,*]	−23[i,*]	−4[i,*]	−49*
Rivers and reservoirs	−25[j,**]	ND	ND	−25*
Total carbon source or sink	−489***	−64**	48*	−505***
Net carbon source (positive)	1093****	100***	158***	1351****

First State of the Carbon Cycle Report (2007)

Wetlands contribute 10% of North American Sinks

Wetland Soils Sequester Carbon In Sediments

Carbon Sequestered By Sediment Deposition

FW Mineral Soil Wetlands

- sequestration rate = 17 g C m^{-2} yr^{-1}

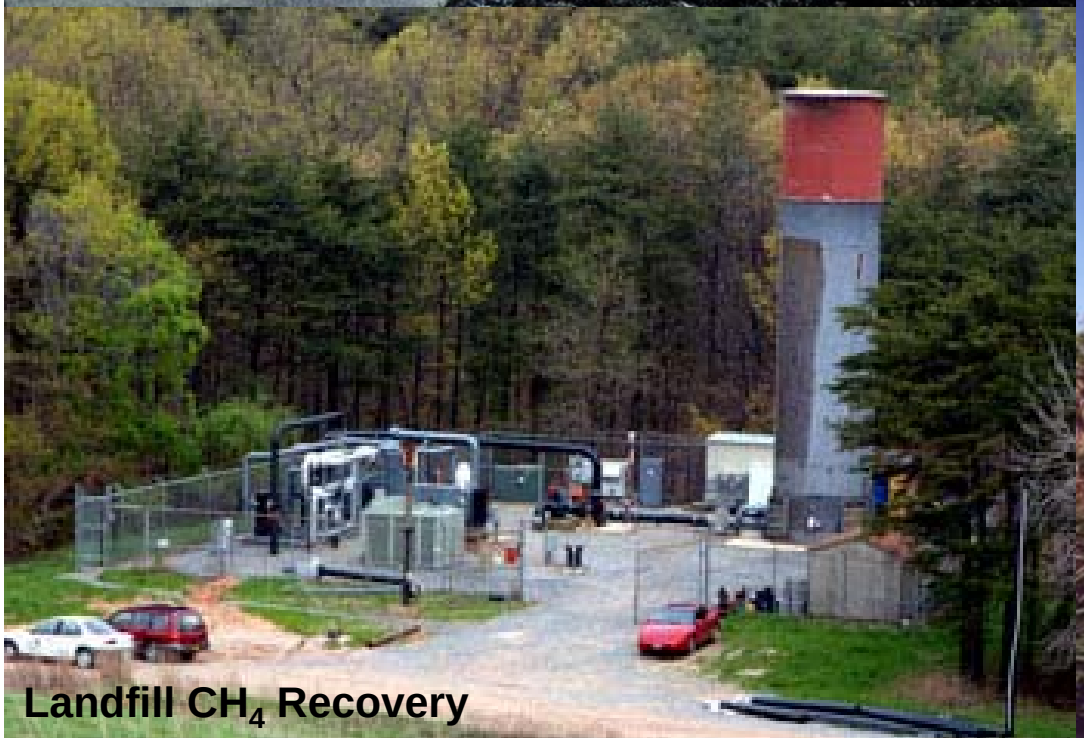
Estuarine Wetlands

- sequestration rate = 180-330 g C m^{-2} yr^{-1}

Sedimentation Rates Are Highly Uncertain

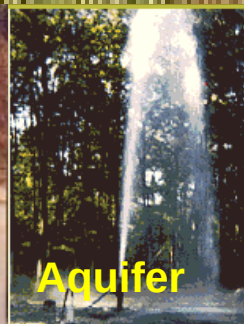
- Are estimates representative?
- What portion is autochthonous?
- Do decomposition rates decrease?

Methane Emissions



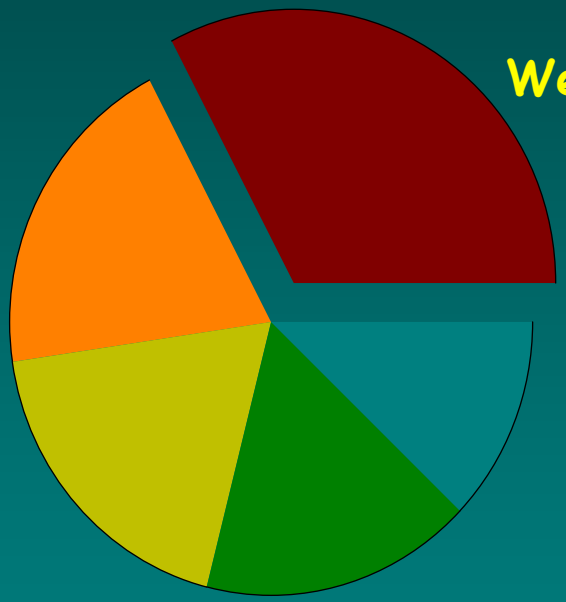
Landfill CH_4 Recovery

Termite Mound



Aquifer

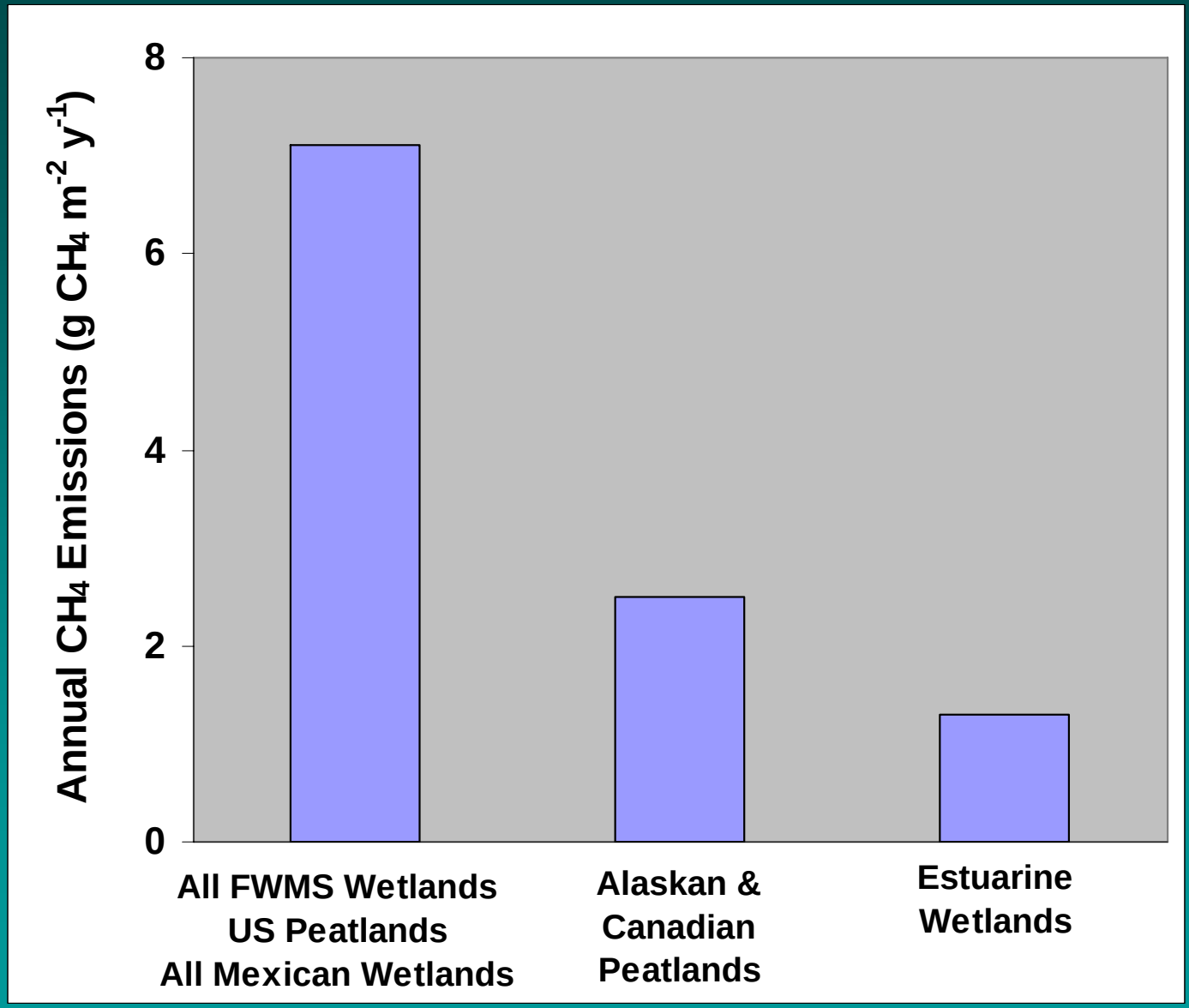
Wetlands Emit Methane



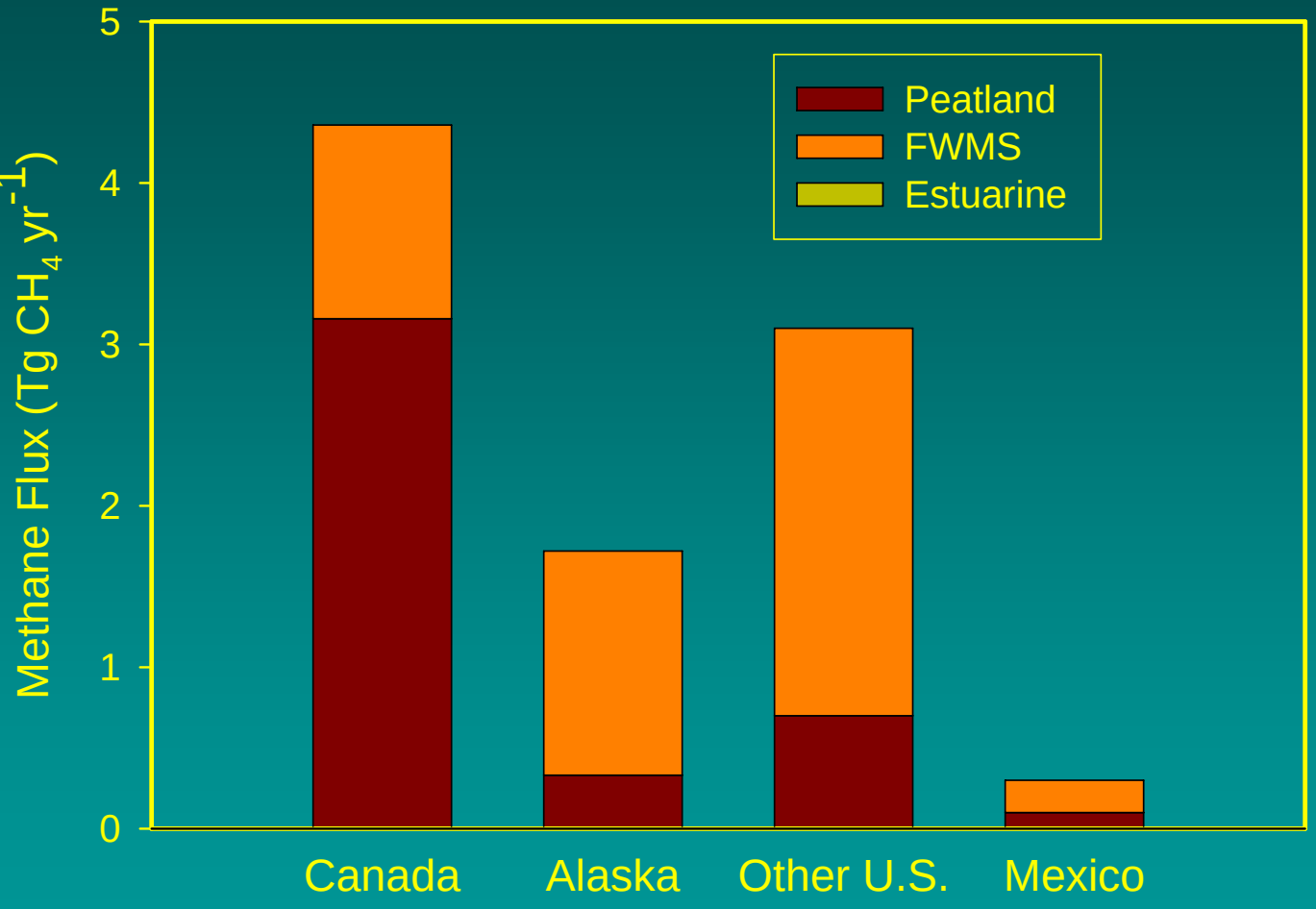
Global Methane Sources

- Methane is 20% of Global Warming
- Wetlands are 40% of sources

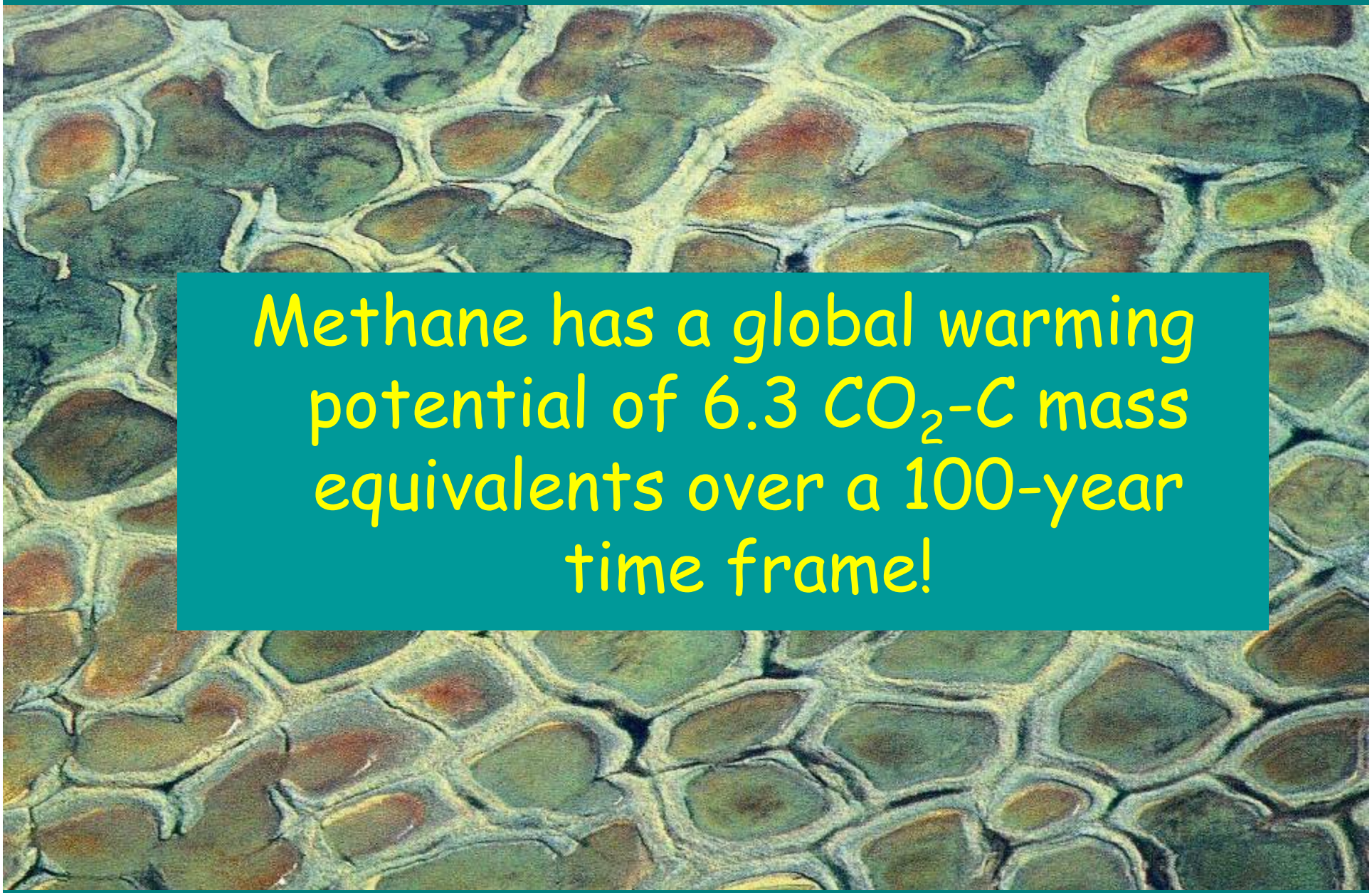
Methane Emissions



North American Wetland Methane Flux

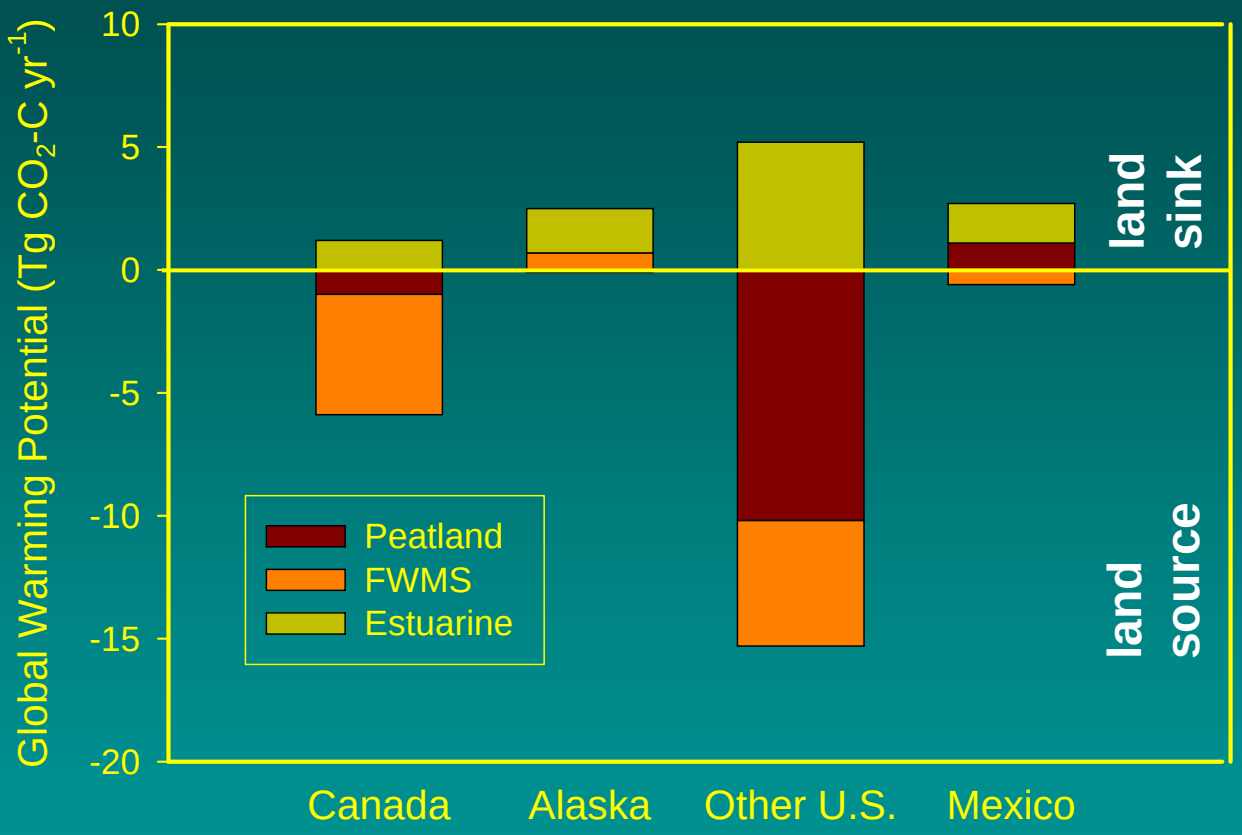


total net flux = 9 Tg CH_4 yr^{-1}
(about 20% of CO_2 sequestration by mass)


Methane has a global warming potential of 6.3 CO_2-C mass equivalents over a 100-year time frame!

Radiative balance refers to the static radiative effect of a substance.

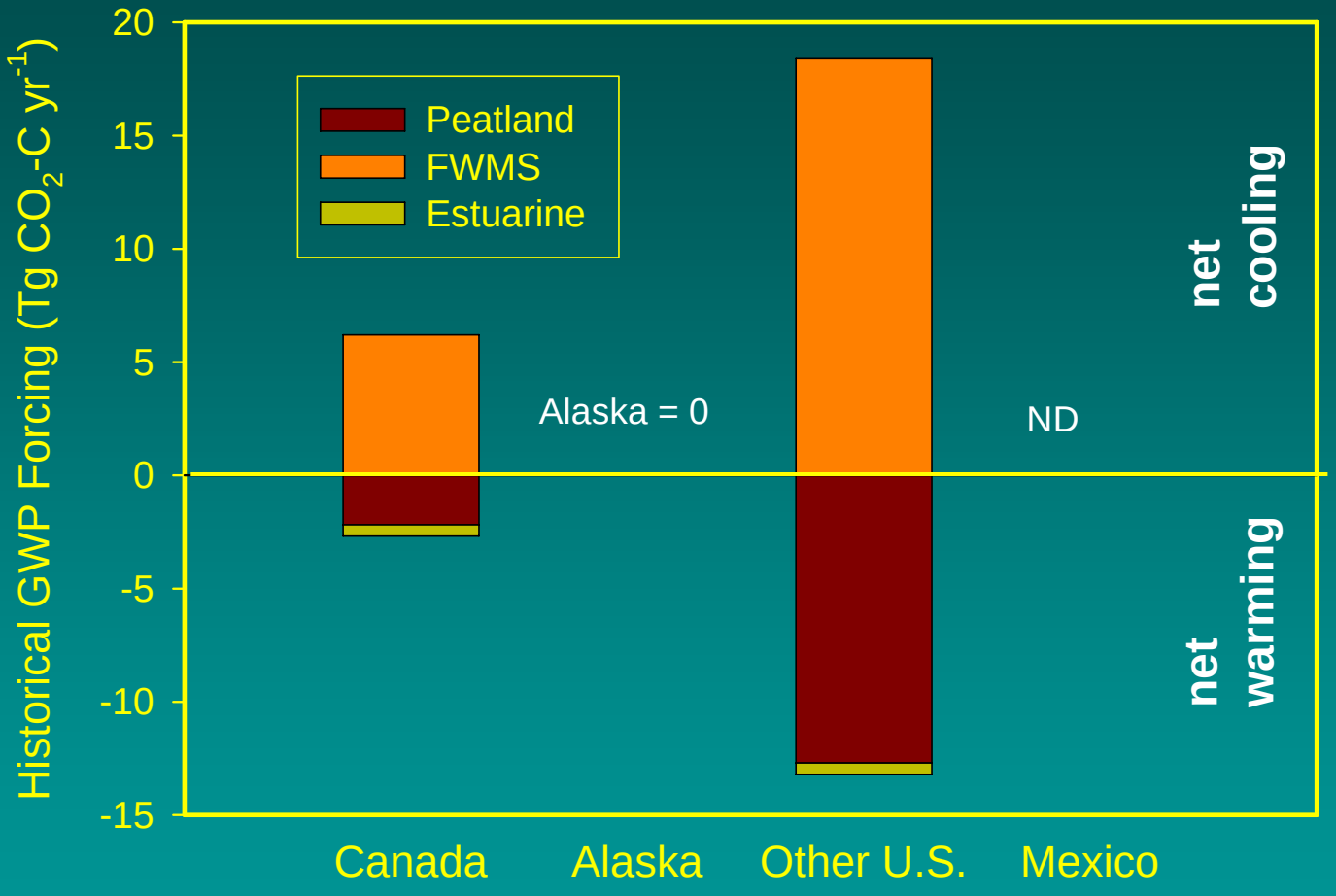
Current Global Warming Balance in North American Wetland



GWP Balance = - 10 Tg CO_2-C Equivalents yr^{-1}

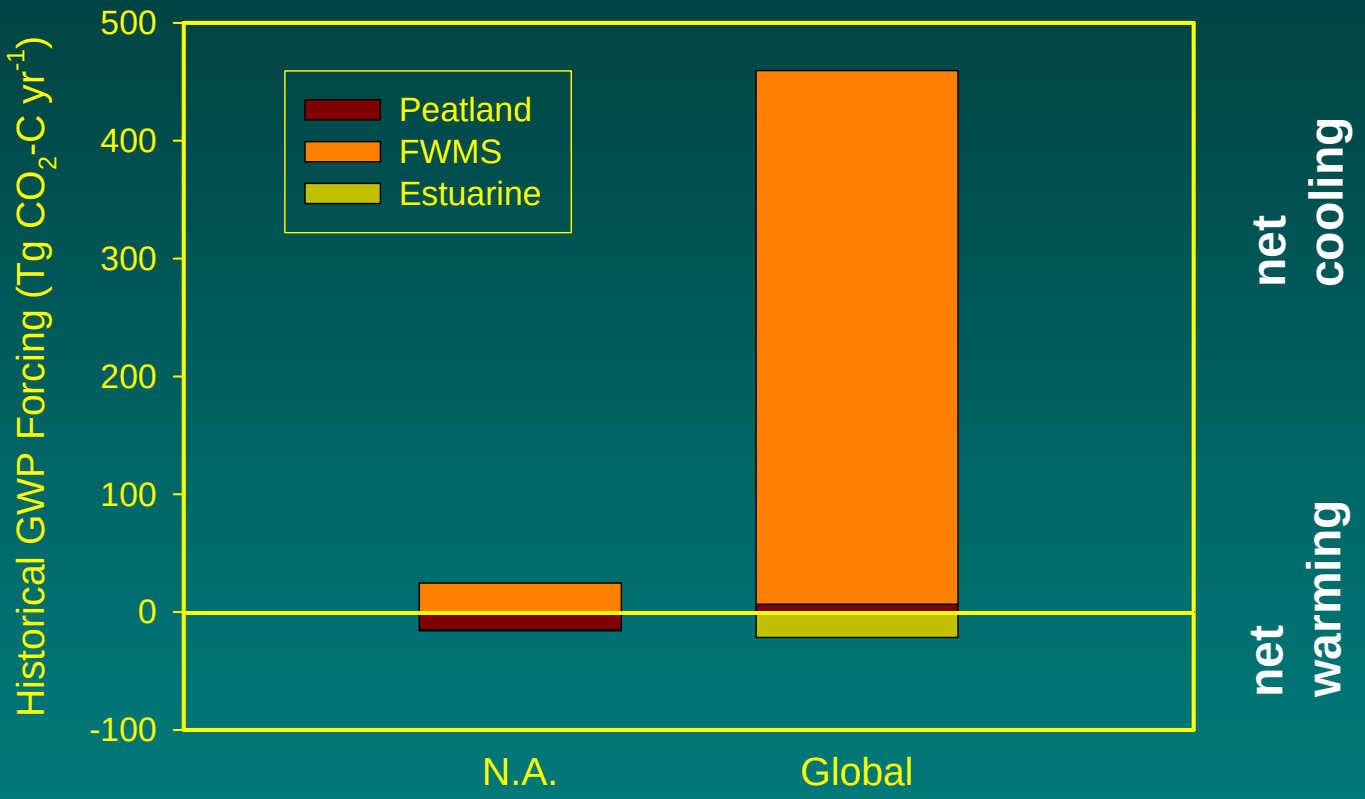
Radiative forcing refers to an external perturbation in the radiative balance.

Historical GWP Forcing in North American Wetlands



Historical GWP Forcing = 9 Tg CO_2-C Equivalents yr^{-1}

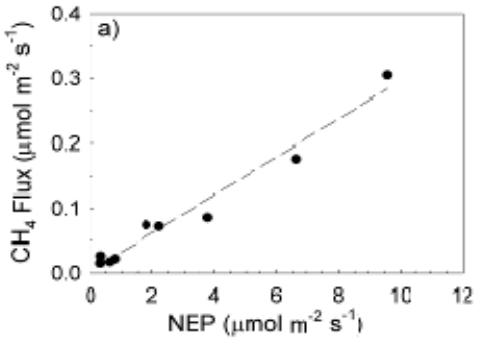
Historical GWP Forcing in Wetlands in N.A. and the Globe



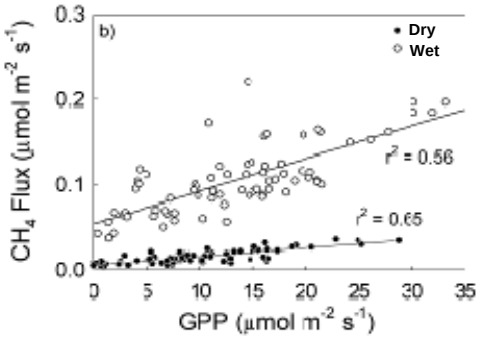
Total Historical Global GWP Forcing = 438 Tg CO_2-C yr^{-1}

Implications for Wetland Management

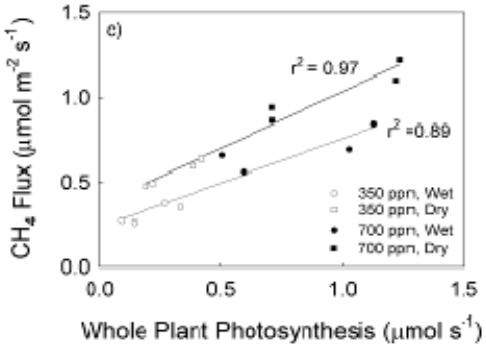
Carbon Dioxide In, Methane Out



Northern Hemisphere Wetlands (Whiting and Chanton 1993)



Northern Peatland (Updergraff et al. 2001)



Elevated CO_2 Effects (Vann and Megonigal 2003)

Megonigal, Hines and Vissher (2004)

Conclusions

- NA wetlands are a large carbon pool, but a small to moderate CO_2 sink.
- CH_4 largely offsets the benefits of C sequestration.

Conclusions

- Protecting FWMS wetlands for carbon sequestration is questionable.

- Protecting peatlands and estuarine wetlands for carbon sequestration is more promising.


Thank
You!!