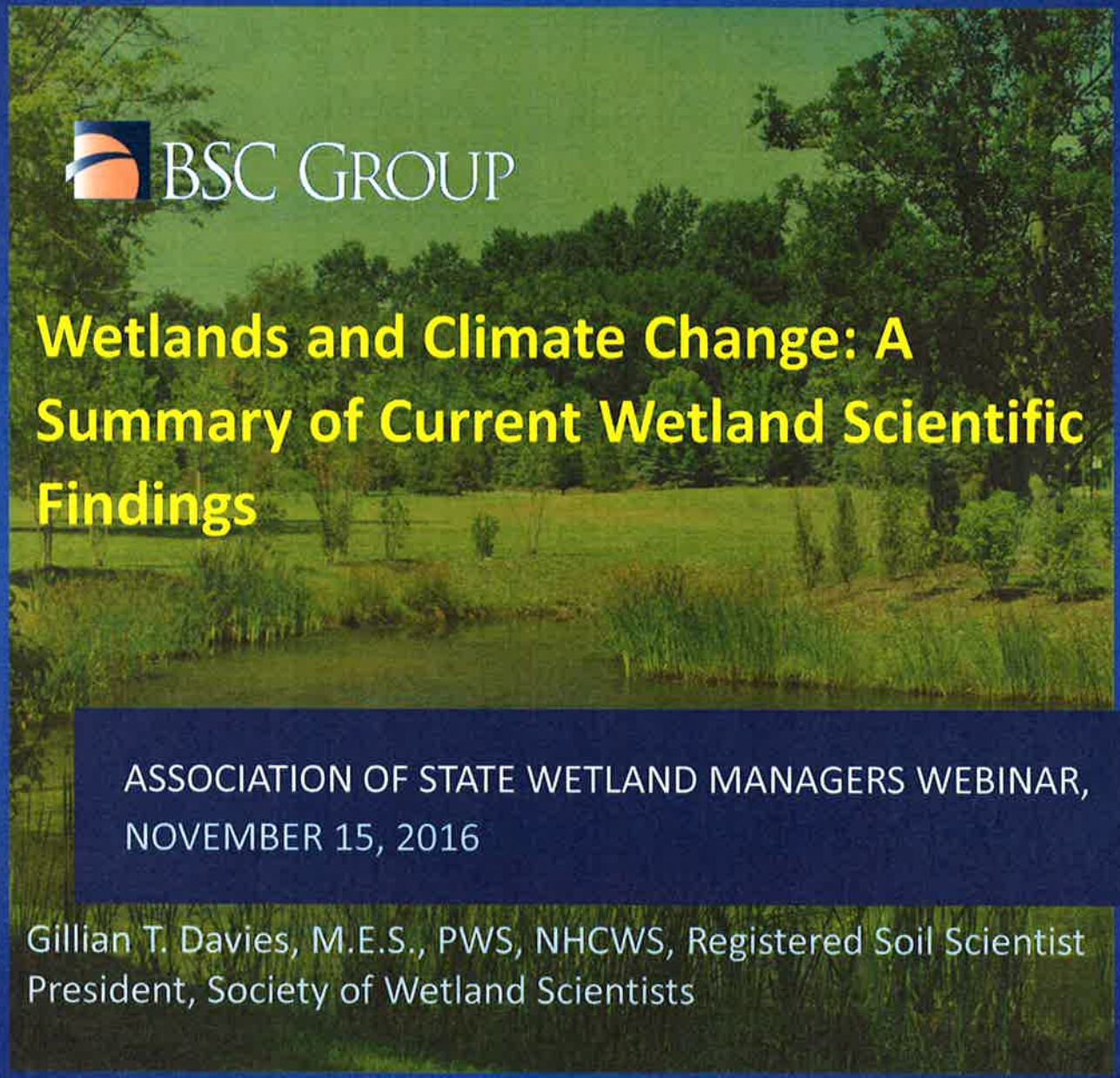


BSC GROUP

# Wetlands and Climate Change: A Summary of Current Wetland Scientific Findings

ASSOCIATION OF STATE WETLAND MANAGERS WEBINAR,
NOVEMBER 15, 2016

Gillian T. Davies, M.E.S., PWS, NHCWS, Registered Soil Scientist
President, Society of Wetland Scientists

**Climate Change is a land use change and ecosystem change problem, as well as a carbon emissions problem.**

West Haven, CT

Photo: West Haven Dept. of Planning & Development

**"Climate Change is a global issue that manifests itself locally." –**

Dr. William Moomaw, Tufts University and IPCC author

Taiwan

Photo: G. Davies

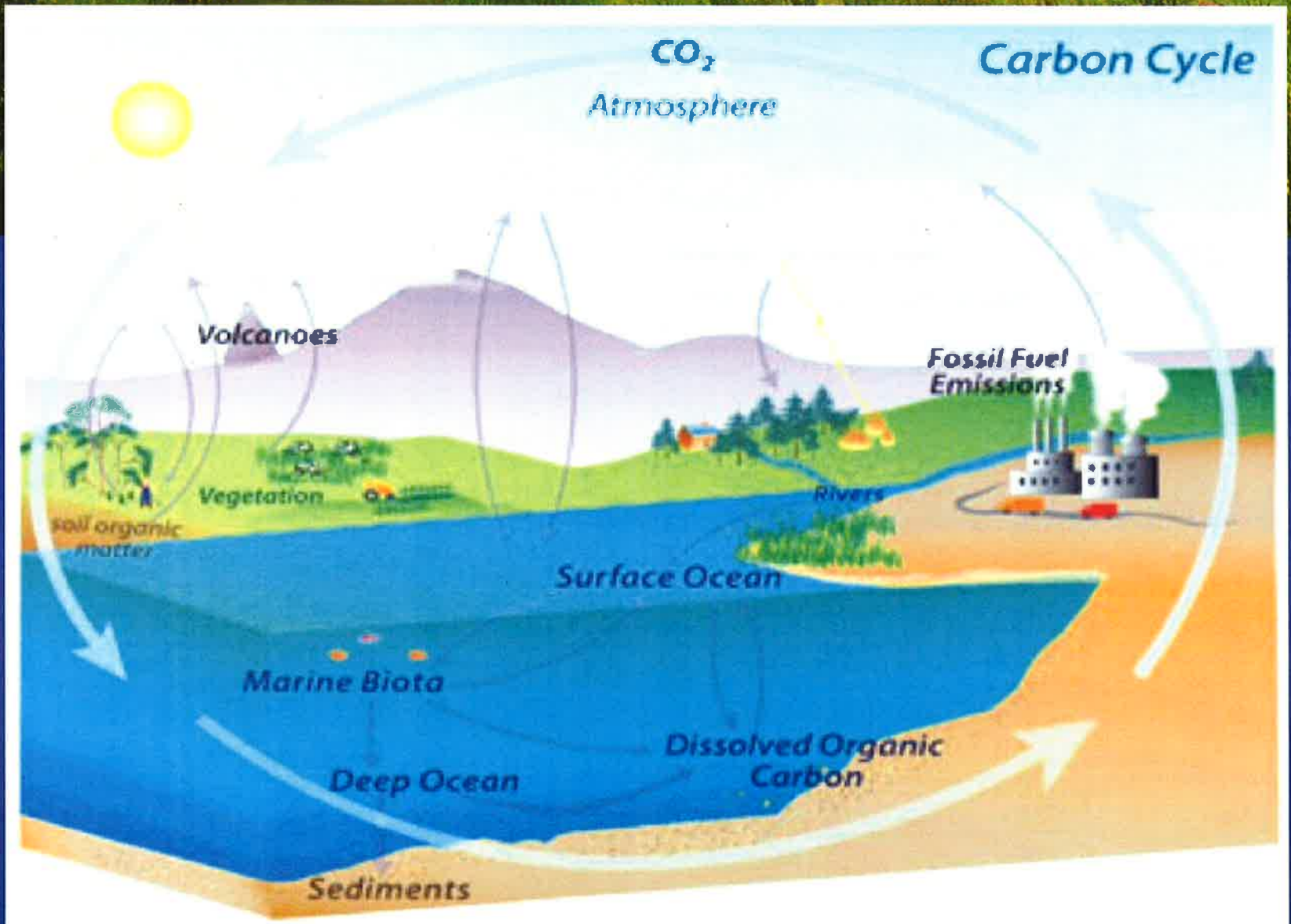



Image: Biocycle.atmos.colostate.edu

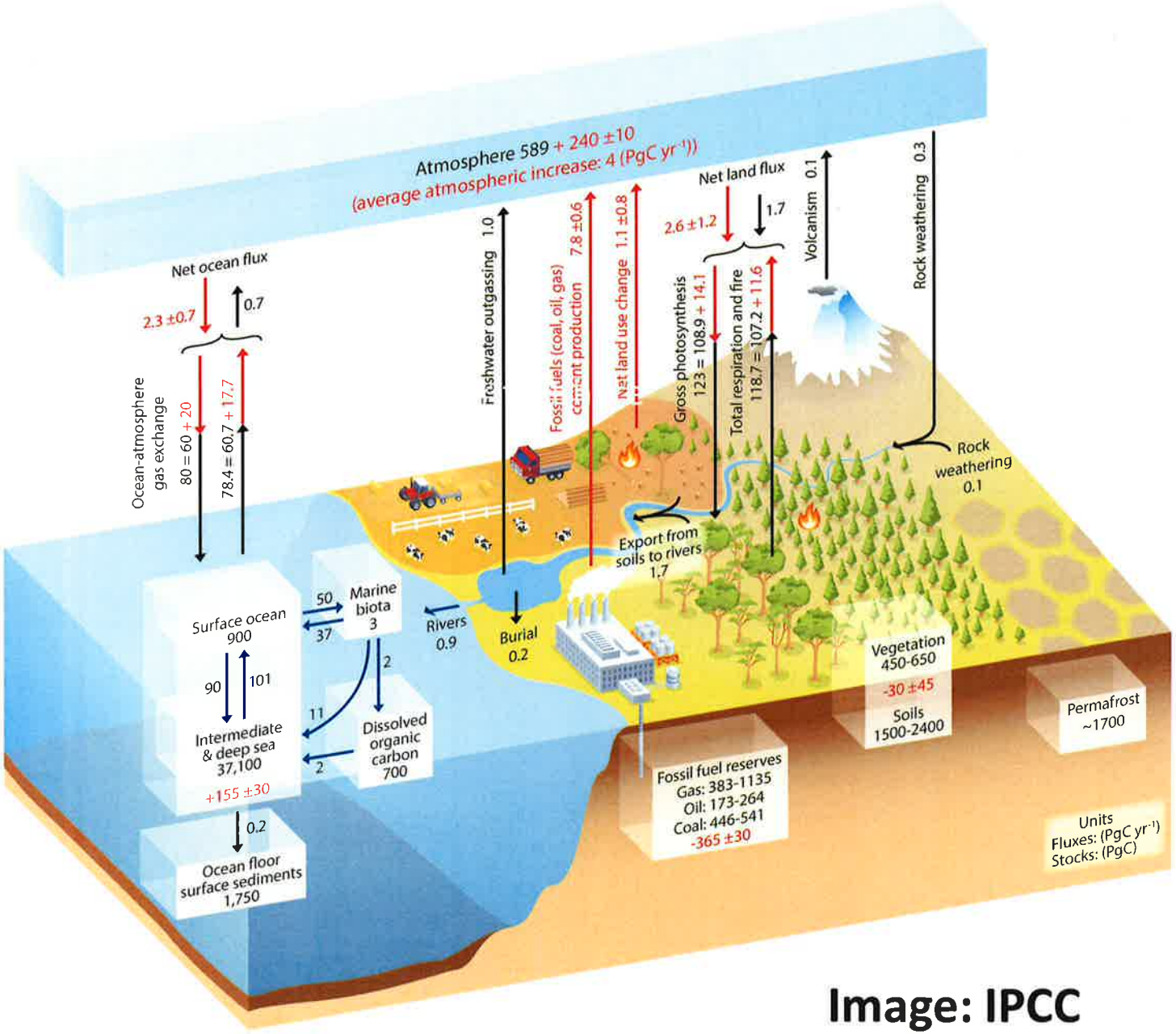

Atmosphere 589 + 240 ±10
(average atmospheric increase: 4 (PgC yr⁻¹))
Net ocean flux
2.3 ±0.7
0.7
Ocean-atmosphere gas exchange
80 = 60 + 20
78.4 = 60.7 + 17.7
Freshwater outgassing 1.0
Fossil fuels (coal, oil, gas) cement production 7.8 ±0.6
Net land use change 1.1 ±0.8
Net land flux
2.6 ±1.2
1.7
Gross photosynthesis 123 = 108.9 + 14.1
Total respiration and fire 118.7 = 107.2 + 11.6
Volcanism 0.1
Rock weathering 0.3
Rock weathering 0.1
Export from soils to rivers 1.7
Surface ocean 900
50
37
Marine biota 3
Rivers 0.9
Burial 0.2
90
101
2
11
2
Intermediate & deep sea 37,100
+155 ±30
Dissolved organic carbon 700
0.2
Ocean floor surface sediments 1,750
Vegetation 450-650
-30 ±45
Soils 1500-2400
Permafrost ~1700
Fossil fuel reserves
Gas: 383-1135
Oil: 173-264
Coal: 446-541
-365 ±30
Units
Fluxes: (PgC yr⁻¹)
Stocks: (PgC)

**Image: IPCC**

# Biological Carbon Sequestration

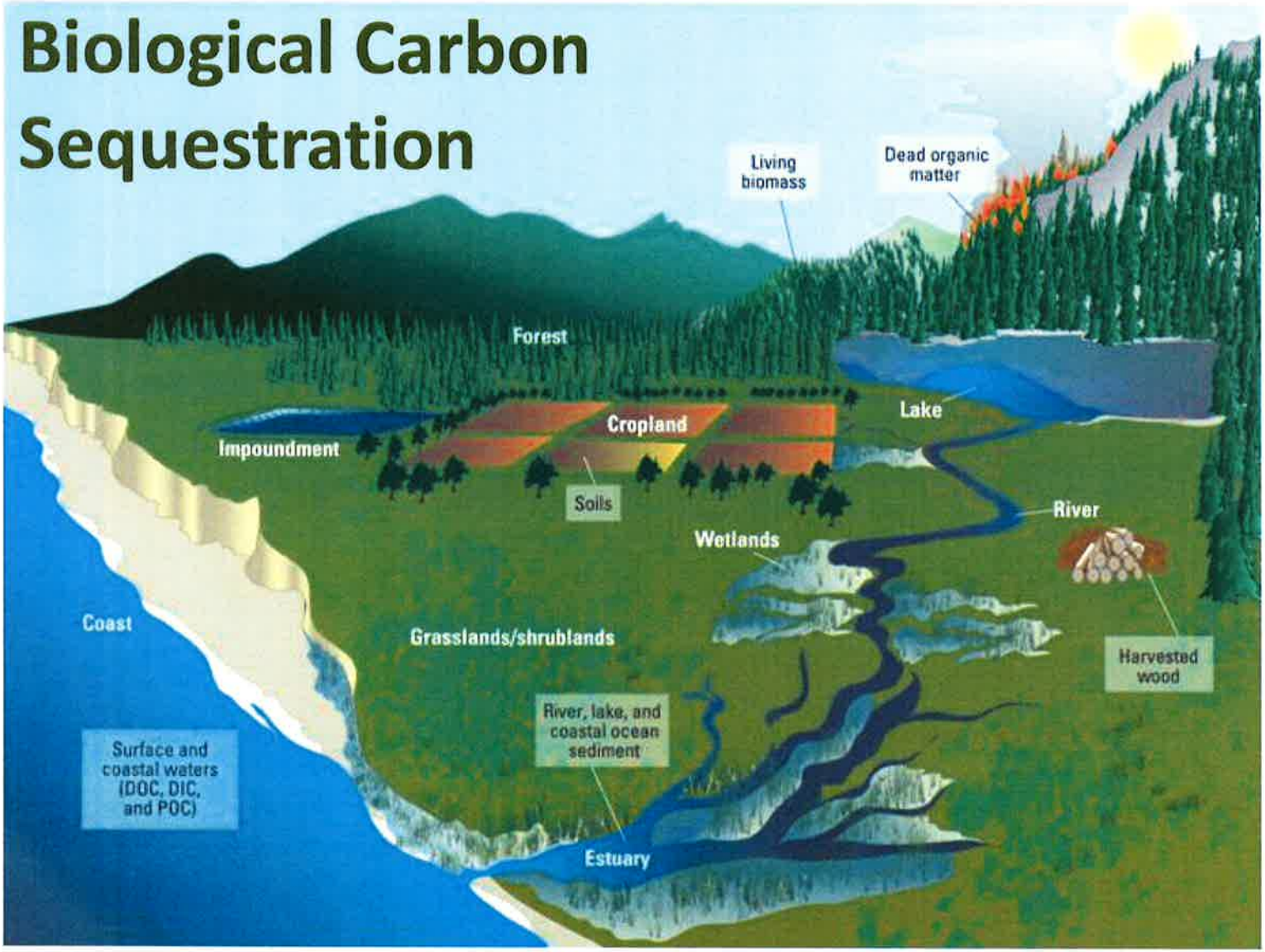
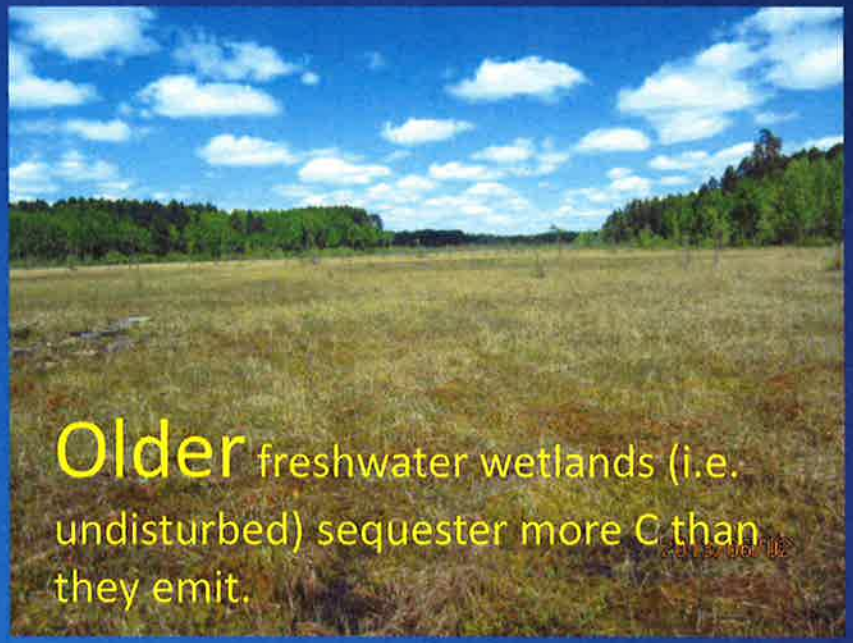



Image: USGS


Undisturbed North American peatlands sequester approximately 32 million tons of C per year. - Bridgham et al., 2006
Globally, wetlands store approximately 300 – 700 billion tons of carbon. – Bridgham et al., 2006
2013/06/02
Don't buy peat moss!
Photo: G. Davies

**Saltwater** wetlands/estuarine environments sequester $CO_2$ efficiently and emit relatively little $CH_4$.



**Older** freshwater wetlands (i.e. undisturbed) sequester more C than they emit.

**Forested** wetlands - sequester large amounts of C in tree biomass.

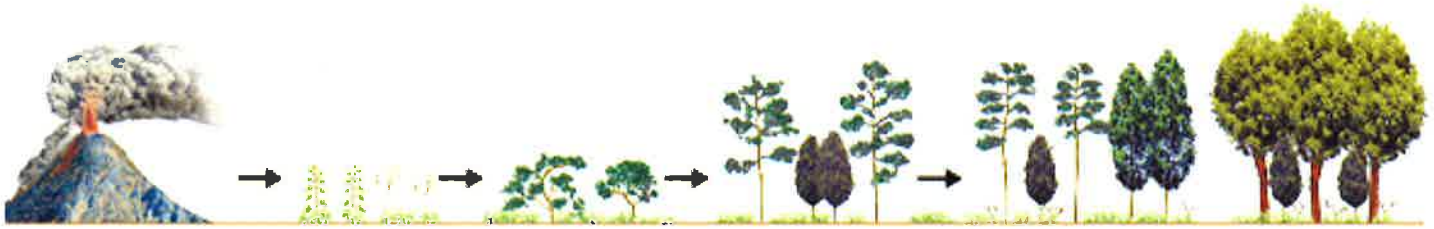
**Younger** freshwater wetlands and disturbed wetlands can be net C emitters until switchover time, when they then become net C sequesterers.

Photos: G. Davies

# REFERENCES


- Bridgham SD, Megonigal JP, Keller JK, Bliss NB, Trettin CC. 2006. The carbon balance of North American wetlands. Wetlands 26:889–916.
- Bridgham, S, Moore TR, Richardson, CJ, Roulet, NT. 2014. Errors in greenhouse forcing and soil carbon sequestration estimates in freshwater wetlands: A comment on Mitsch et al. (2013). *Landscape Ecology*, online at link.springer.com. Doi: 10.1007/s10980-014-0067-2.
- Neubauer SC. 2014. On the challenges of modeling the net radiative forcing of wetlands: Reconsidering Mitsch and others (2013). Landscape Ecol 29:571–7. doi:10.1007/s10980-014-9986-1.
- Neubauer, SC and Megonigal, JP. 2015. Moving beyond global warming potentials to quantify the climatic role of ecosystems. Ecosystems. Doi:10/1007/s10021-015-9879-4.

# Disturbance: Resetting the Carbon Clock



| Bare land<br>lava plateau | Herbaceous plants | Shrubs | Shade-intolerant trees | Shade-intolerant and tolerant trees | Shade-tolerant trees (climax) |
|---|---|---|---|---|---|
| Plant: mosses<br>lichens | Japanese knotweed<br>Japanese pampas grass | *Alnus sieboldiana*<br>*Weigela coraeensis*<br>*Hydrangea macrophylla*<br>*Rubus trifidus*<br>*Eurya japonica* | *Pinus densiflora*<br>*Prunus jamasakura*<br>*Zanthoxylum ailanthoides*<br>*Stachyurus praecox*<br>*Styrax japonica*<br>*Ligustrum ovalifolium*<br>*Mallotus japonicus* | *Mallotus japonicus*<br>*Pinus densiflora*<br>*Ligustrum ovalifolium*<br>*Styrax japonica*<br>*Castanopsis sieboldi*<br>*Machilus thunbergii* | *Castanopsis sieboldi*<br>*Machilus thunbergii*<br>*Dendropanax trifidus*<br>*Camellia japonica* |

ZOOM

Image: www.BeyondtheBeauty.com

**CARBON CYCLE & MICROBIAL PROCESSES DIFFER AT DIFFERENT STAGES OF SUCCESSION.**

50 years
BSC GROUP
1965-2015

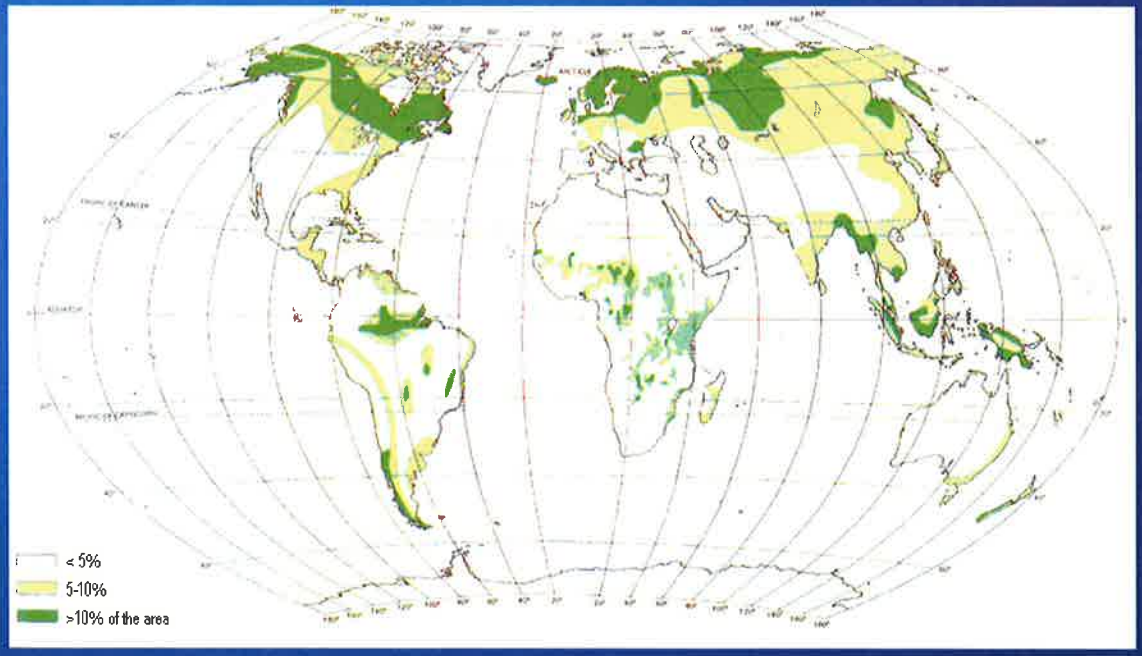
# Can We Unscramble the Eggs?

**Carbon sequestration function is not always replicable after disturbance (within decades to thousands of years).**

Photos: G. Davies.

50 years
BSC GROUP
1965-2015

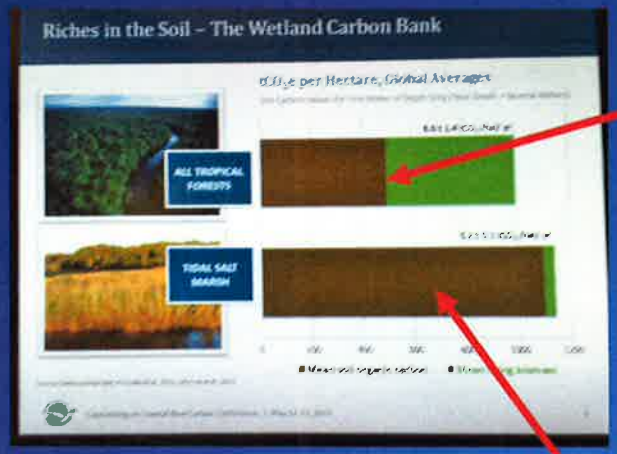

Global carbon storage in terrestrial ecosystems




Global extent of peatlands

http://www.grida.no/publications/rr/natural-fix/page/3724.aspx

# High Carbon Ecosystems




ALL TROPICAL FORESTS

TIDAL SALT MARSH

Photos: G. Davies

CARBON!

## COASTAL WETLANDS

- salt marshes
- sea grass beds
- mangrove swamps

Waquoit Bay National Estuarine Research Reserve, Falmouth, MA

# Forests


Photos: G. Davies

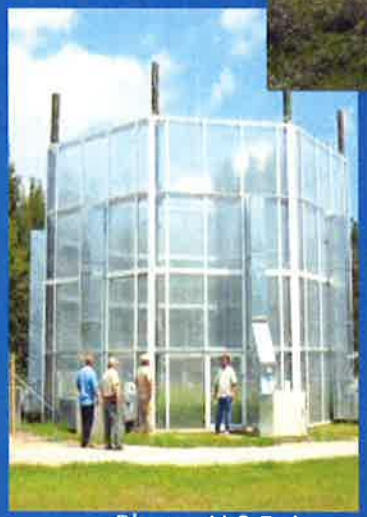


Photo: U.S.D.A.
S.P.R.U.C.E. Project



**Spruce and Peatland Responses Under Climatic and Environmental Change (S.P.R.U.C.E.) Project**

Oak Ridge National Laboratory operated by UT-Battelle, LLC
U.S. Forest Service, Northern Research Station,
Marcell Experimental Forest.

# High Carbon Ecosystems

INLAND PERMANENTLY FLOODED WETLANDS

TROPICAL PEATLANDS

UNDERWATER BIOMASS

GRASSLANDS

LAKES

Photos: G. Davies

Photo: Saint John's River Water Management District

Photo: G. Davies

# Climate Resiliency & Adaptation: Wetland Ecosystem Services

- If 10% - 20% of watershed is wetland/lake, you see 60% reduction in peak flow of big storm events *(Kolka, 2013)*. (*flood storage, storm damage prevention, water quality, habitat protection, water supply protection*)

- Peatland can be small percentage of watershed, but produce 50% of streamflow *(Kolka, 2013)*. (*water supply, water quality, habitat*)

# Climate Resiliency and Adaptation: Wetland Ecosystem Services

- Wetlands store water, & can help offset loss of snowpack, increased drought, buffer adjacent areas from heavy precipitation and severe storms (*water quality & quantity, habitat*)

- Wetlands function as air conditioners on the landscape, keeping air and water temperatures down. (*human health, habitat*)

- Coastal & estuarine wetlands provide wave attenuation & erosion control (*storm damage prevention, habitat, SLR protection*)

# How are wetlands being impacted by our changing climate?

Photos: G. Davies

# Ecosystem "Distress Syndrome"

- Reduced biodiversity.
- Reduced nutrient cycling.
- Increased prevalence of diseases.
- Increased dominance of invaders.
- Altered primary and secondary productivity, altered ecosystem processes.
- Predominance of shorter-lived opportunistic species.

*- K. Erwin, 2009*

50 years
BSC GROUP
1965-2015

# CARBON MITIGATION STRATEGIES

Protect large carbon banks.

Photos: G. Davies

Accelerate carbon sequestration: Plant trees.

Decelerate carbon Emissions: Ecosystem services instead of gray infrastructure.

Photo: G. Davies

Protect water tables, especially in permanently flooded wetlands.

RESILIENCY STRATEGIES

Manage hydrologic systems, including wetlands, in ways that minimize climate impacts.

Soil, Water, Land Conservation

Reforestation

Photos: G. Davies

RESILIENCY STRATEGIES

Prevention of forest degradation

# RESILIENCY STRATEGIES

Increase buffers to allow for ecosystem migrations.


Martha's Vineyard

Photos: G. Davies

Minimize impacts from other stressors.

# RESILIENCY STRATEGIES

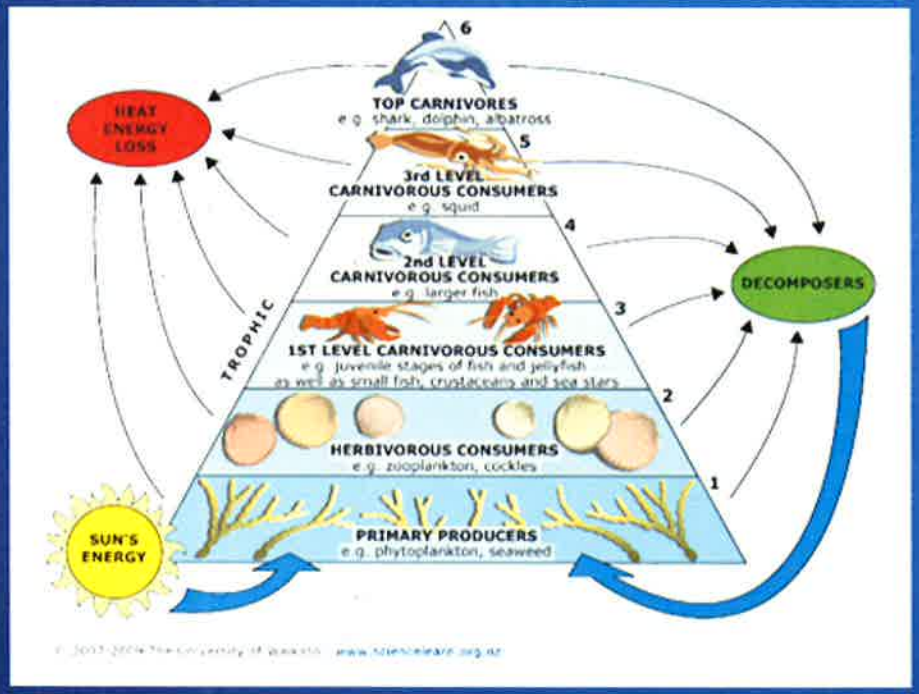
Protect large, undisturbed ecosystems.

Maximize connectivity.

Photos: G. Davies

# Resiliency Strategies

- Focus on protection, maintenance, health and restoration of ecosystem *processes and function.*




www.ecobiomes.weebly.com

Artist: A. Low

Changing species assemblages?

# RESILIENCY STRATEGIES

Plan ecosystem management, restoration & creation at watershed/landscape scales.

Photo: G. Davies

# Wetlands Protection, Restoration & Creation is a 3-for-1 Deal:

- Traditional ecosystem services/functions/values
- Climate adaptation/resiliency
- Carbon sequestration, emission reduction & long-term storage (climate mitigation)

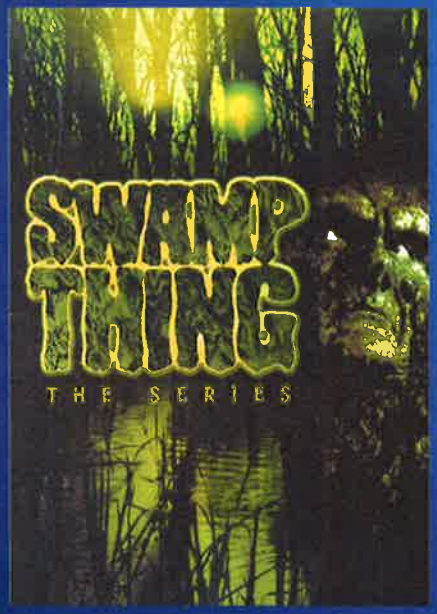



Image: dvdempire.com

Photo: G. Davies

Society of Wetland Scientists Annual Meeting

SWS2017 Puerto Rico June 5-8

Celebrating Wetland Diversity Across the Landscape: Mountains to Mangroves

# Ideas to Ponder

- Ecosystem functioning and ecosystem services will change as a result of changes in species composition, increases in invasive species, and ecosystem disassembly and re-organization that result from climate changes.

- Urbanization and climate change affect ecosystem processes in similar ways.

- Positive feedbacks: increased drought/drying of floodplains, peatlands, wetlands, which leads to increased C releases.

Photo: G. Davies