Ecosystem Services and Blue Carbon Workshop

Mission-Aransas NERR

Accounting for blue carbon in coastal wetlands, a new tool to promote ecological restoration to mitigate GHG pollution and adapt to sea level rise.

Tim Purinton & Nick Wildman
Mass Division of Ecological Restoration

Presentation Outline

- Who we are
- How we got into this
- What we have learned so far
- Blue Carbon Calculator
  - Origins & Policy implications
  - Mechanics & Limitations
  - Inputs
  - Example outputs
- What's next

Commonwealth of Massachusetts

Division of Ecological Restoration

Tim Purinton, Director

Invested in Nature and Community

Commonwealth of Massachusetts Department of Fish & Game

George Peterson, Commissioner

The mission of the Division of Ecological Restoration is to restore and protect the Commonwealth's rivers, wetlands and watersheds for the benefit of people and the environment.

Ecological Restoration

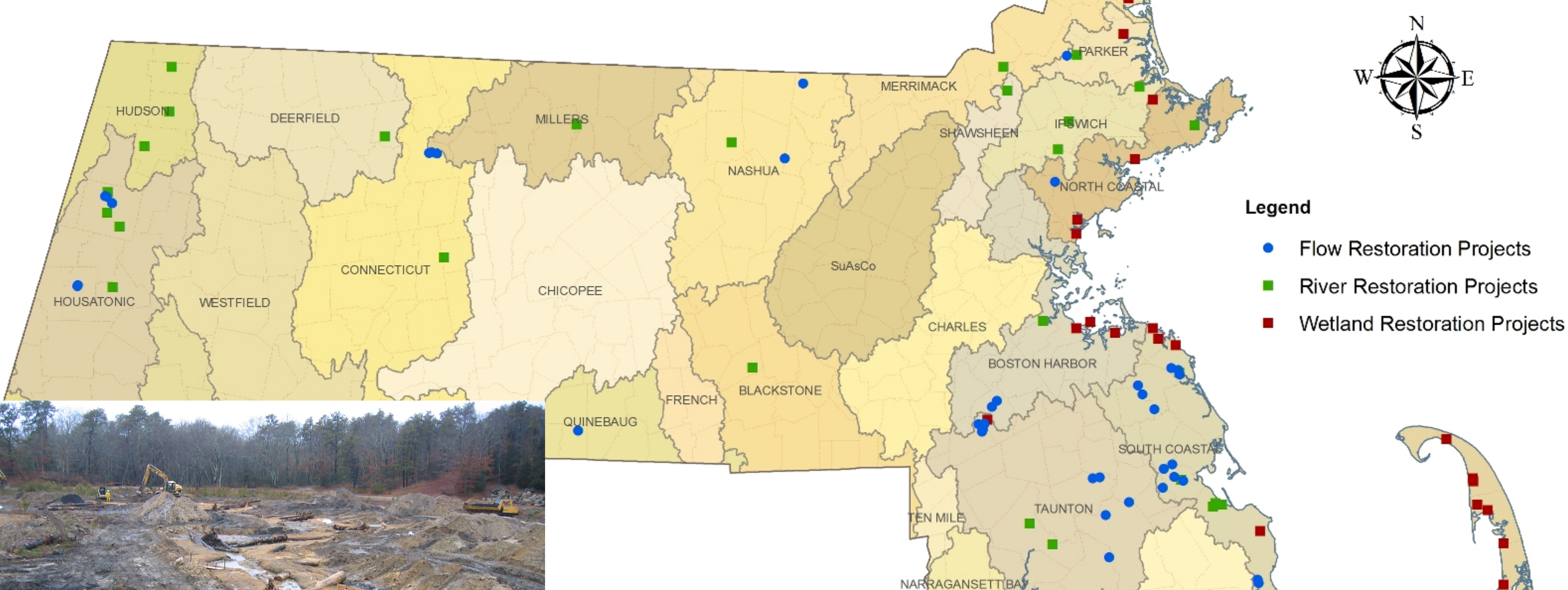
…activities that assist in the recovery of the natural processes of a aquatic ecosystem that have been

- **degraded,**
- **altered or**
- **destroyed**.

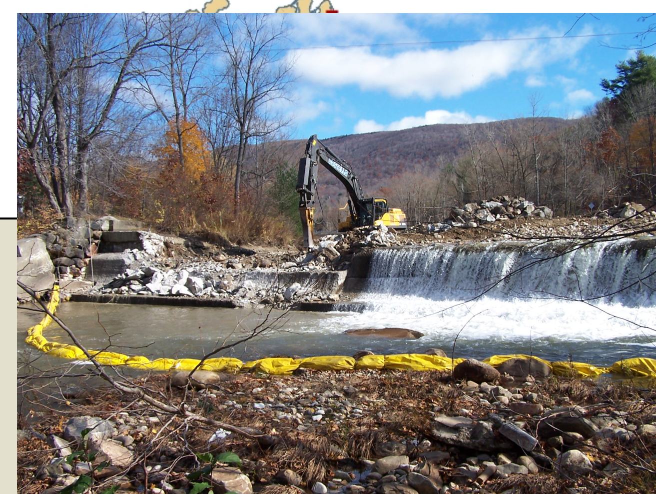
Such activities will

- **restore natural processes,**
- **remove ecosystem stressors,**
- **increase resilience of the ecosystem, &**
- **create no lasting harm.**

"Ecological restoration is an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and ***self-sustainability****."*


N
S
E
W
Legend
Flow Restoration Projects
River Restoration Projects
Wetland Restoration Projects
HUDSON
DEERFIELD
MILLERS
NASHUA
MERRIMACK
PARKER
SHAWSHEEN
IPSWICH
NORTH COASTAL
SuAsCo
CONNECTICUT
CHICOPEE
HOUSATONIC
WESTFIELD
CHARLES
BOSTON HARBOR
FRENCH
BLACKSTONE
QUINEBAUG
SOUTH COASTAL
TAUNTON
TEN MILE
NARRAGANSETT BAY
BUZZARDS BAY
CAPE COD





Accomplishments

- Over 60 completed projects (100 with WRP and Riverways)
- 2,000 acres of coastal wetland restored
- 40 dams removed
- 150 upstream river miles reconnected
- 60 active projects in planning and design
- Hundreds of volunteer hours logged

Economic Benefits of Restoration- What's Your Return on Investment?

- Benefits go well beyond restoring habitat
- Social, economic, and environmental
- Three recent studies of restoration value:
  - Short-term regional economic output
  - Ecosystem services
  - Cost savings for businesses and communities

Phase 1 – Regional Economics

Per $1 million investment

PROJECT	EMPLOYMENT DEMAND	LABOR INCOME	OUTPUT
Broad Meadows	12.9	$865,000	$1,830,000
Eel River	13.2	$781,000	$1,820,000
Stony Brook	11.8	$713,000	$1,630,000
North Hoosic River	12.2	$731,000	$1,720,000

Phase 2 – Ecosystem Services

<u>Herring River Restoration Project</u>
Wellfleet/ Truro
Ecosystem Service: Property Values
Over $10.4 Million Increase

<u>Damde Meadows & Broad Meadows Restoration Projects</u>
Quincy & Hingham
Ecosystem Service: Carbon Sequestration
Over $140,000 in Avoided Costs

<u>Muddy Creek Restoration Project</u>
Chatham/Harwich
Ecosystem Service: **Water Quality**
Over $14 Million in Savings

<u>Town Creek Restoration Project</u>
Salisbury
Ecosystem Service: **Flood Protection**
Over $2.5 Million in Avoided Costs

Phase 3 – Barrier Removal, Return on Investment

- **Culvert upgrades were less expensive than repairing and maintaining the structures at two of three sites**.
  - Up-front costs of culvert upgrades were greater than replacement.
  - However, long-term costs of the upgrade were less than replacement for *two of the culverts.*
- **Removing the dams was less expensive than repairing and maintaining them**.
  - Dam removal cost less
    - Up-front
    - Long-term
  - Costs of repair/maintenance ranged from 27% greater to more than 4 times the cost of removal.


Before Removal


During Removal

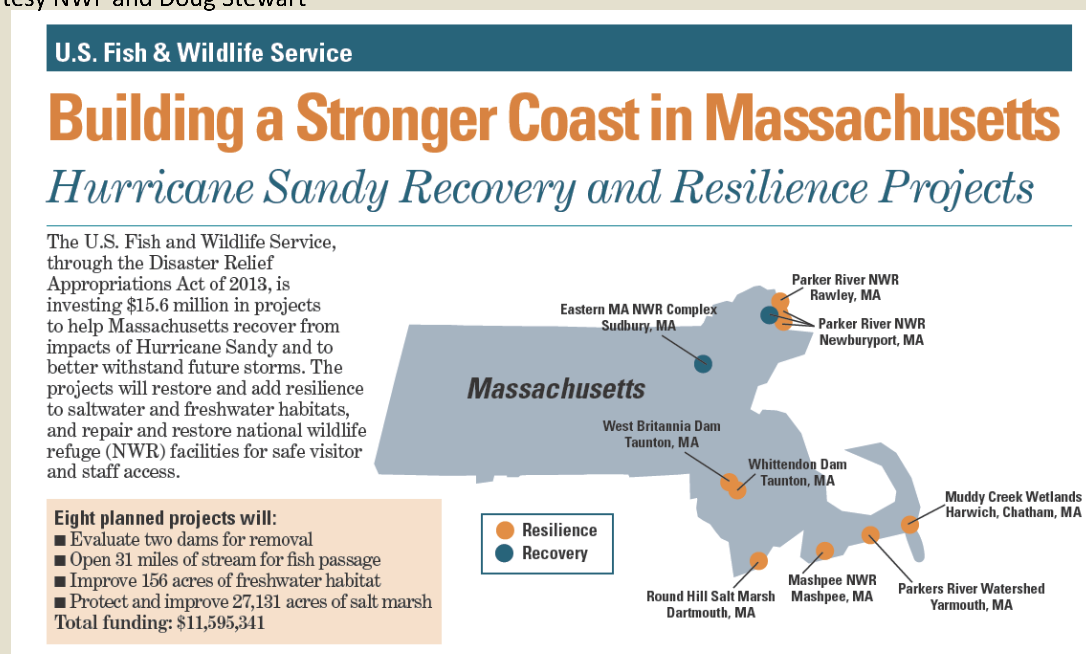

After Removal

Ecological Restoration & Adaptation

- Flood attenuation and mitigation
- Storm surge protection
- Water quality improvement
- Ability for salt marshes to migrate

Healthier marshes are more resilient

Courtesy NWF and Doug Stewart



U.S. Fish & Wildlife Service

Building a Stronger Coast in Massachusetts

Hurricane Sandy Recovery and Resilience Projects

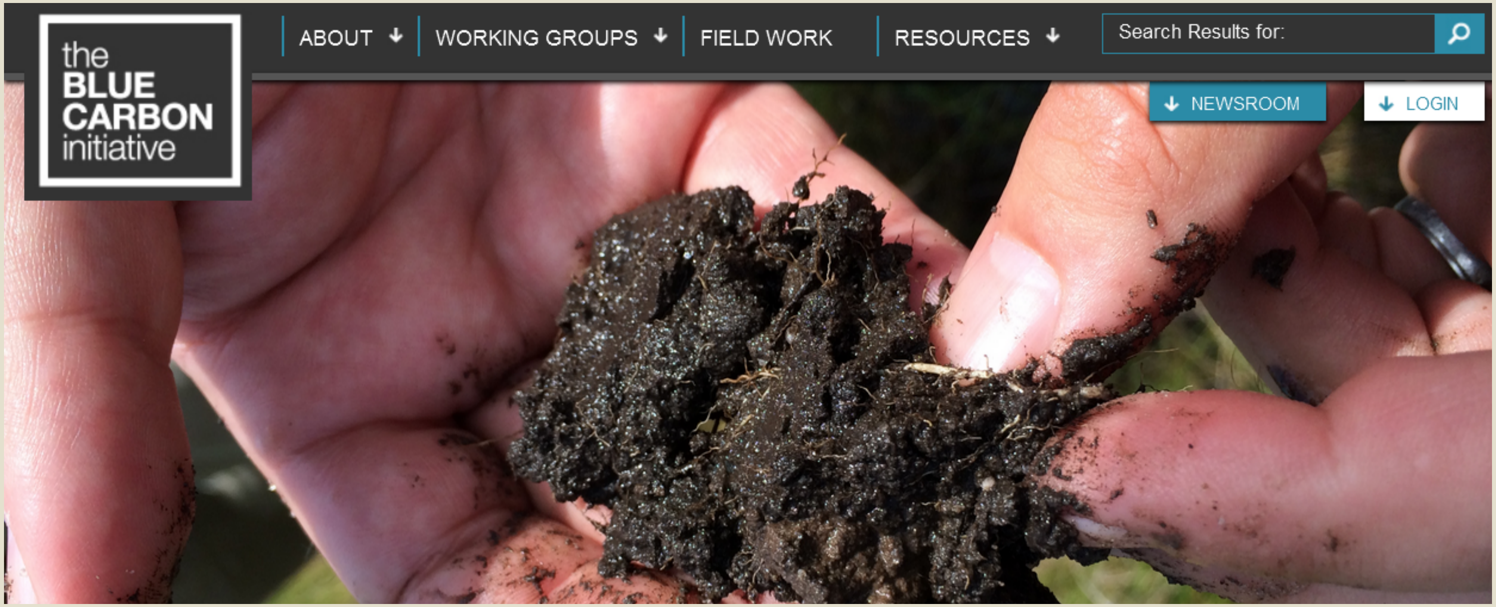
The U.S. Fish and Wildlife Service, through the Disaster Relief Appropriations Act of 2013, is investing $15.6 million in projects to help Massachusetts recover from impacts of Hurricane Sandy and to better withstand future storms. The projects will restore and add resilience to saltwater and freshwater habitats, and repair and restore national wildlife refuge (NWR) facilities for safe visitor and staff access.

Eight planned projects will:
- Evaluate two dams for removal
- Open 31 miles of stream for fish passage
- Improve 156 acres of freshwater habitat
- Protect and improve 27,131 acres of salt marsh

Total funding: $11,595,341

What is Blue Carbon?

- Blue Carbon (C): C stored in coastal and marine ecosystems
- Blue carbon sequesters C 100X faster than terrestrial forests
- Blue carbon is stored in peat and locked-in due to anoxic conditions
- Restoration of coastal habitats not only stores C, but reduces methane which has 25X more global warming potential than C



Policy Implications

- The application of carbon markets is a potential mechanism for funding wetland preservation and restoration.
- Blue Carbon can help meet GHG emission reduction targets
- GHG accounting can assist with project selection and prioritization
- Potential offset for GHG impacts associated with construction or other restoration activities
- Ecosystem service values of wetland restoration go beyond GHG mitigation, fulfilling multiple policy goals
- California includes wetlands within their climate change mitigation plans and funded 12 wetland restoration projects that will sequester GHGs

Blue Carbon Calculator

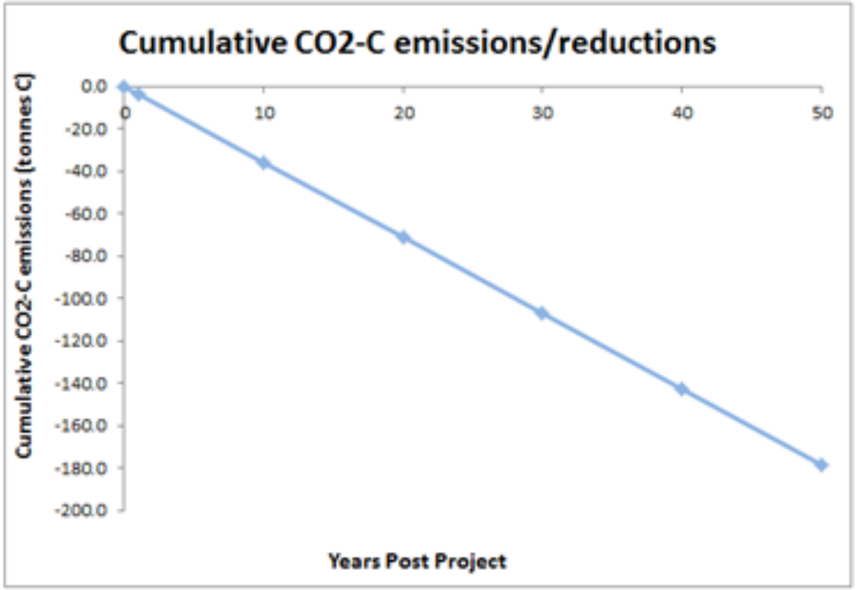
The Basics

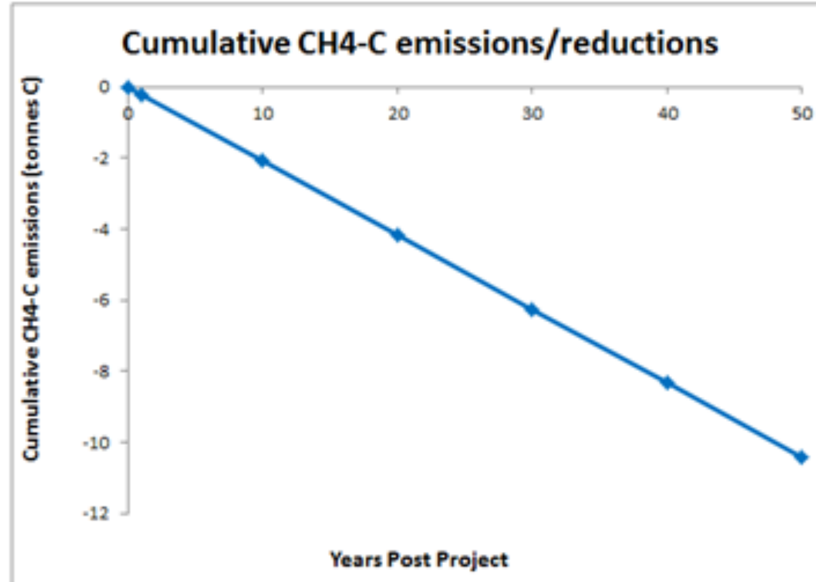
- User enters wetland change pre & post on the "Data Entry" worksheet.
- Annual emissions resulting from each activity are calculated on each activity's worksheet.
- Calculations are based on formulas provided by IPCC, where land area within each land cover class is X by the sum of emissions factors for that cover class.
- Annual emissions are summed and total emissions are applied for 1 to 50 yrs.
- Calculated emissions and removals:
  - Tonnes CO_2-C: mass of C (in tonnes) resulting from **CO_2 only**
  - Tonnes CH_4-C: mass of C (in tonnes) resulting from **CH_4 only**
  - Tonnes CO_2e: mass of CO_2 equivalents resulting from **CO_2 and CH_4** combined
  - Gallons of gasoline: Equivalent of CO_2 emissions from gas consumption

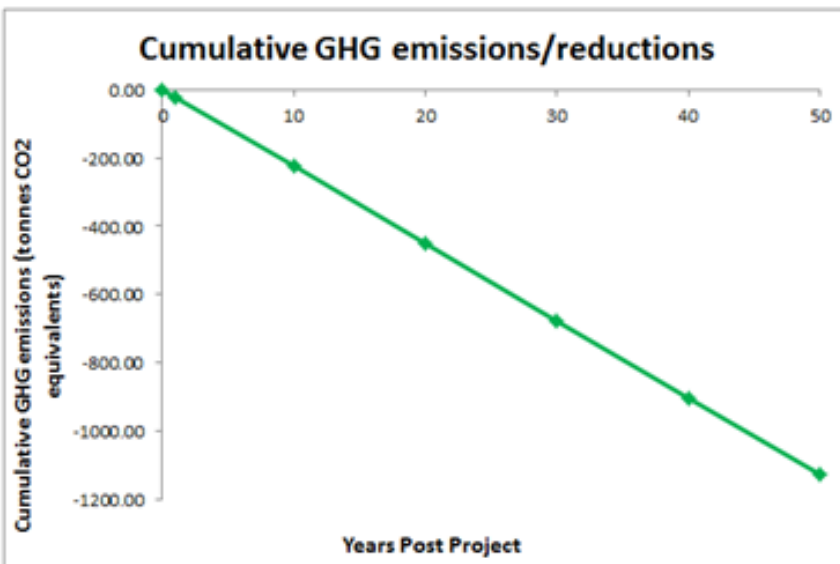
Mangrove v.3 - Microsoft Excel

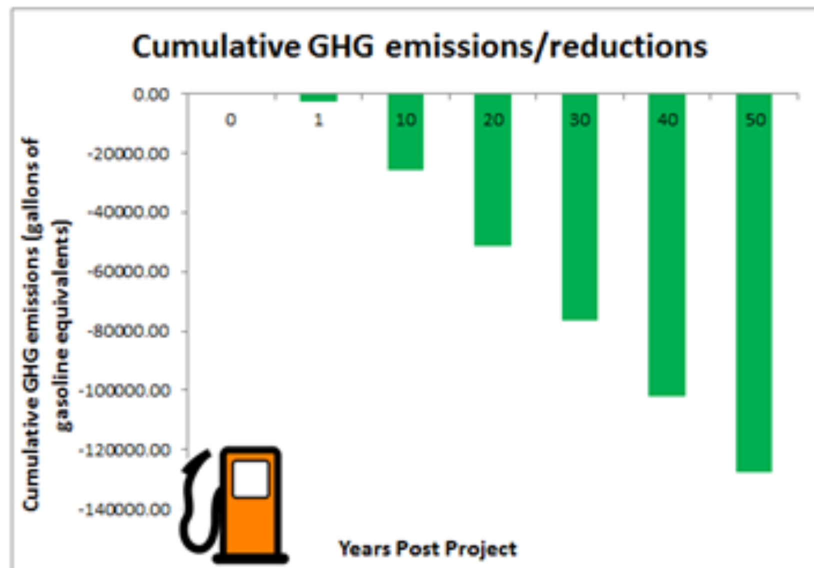
Location	Soil Type	MA DEP Wetland Category	Wetland Changes: Wetlands Destruction: Wetland area to be extracted (acres)	Wetlands Destruction: Wetland area to be drained (acres)	Wetlands Restoration: Rewetted wetland area (acres)	Wetlands Restoration: Wetlands Remaining Weltands: Saturated area prior to project (acres)	Wetlands Remaining Weltands: Saturated area post project (acres)	Calculator Land Use Category	Values for extraction calculator (ha)	Values for Drained Calculator (ha)	Values for Rewetting Calculator (ha)	Values for Conversion Calculator: Pre-Conversion Area (ha)	Values for Conversion Calculator: Post-Conversion Area (ha)
Inland Wetland	Organic	DEEP MARSH						FW Wetland	0.00	0.00	0.00	0.00	0.00
		SHALLOW MARSH, MEADOW, OR FEN											
		BOG											
		SHRUB SWAMP											
		WOODED SWAMP DECIDUOUS						FW Forested Wetland	0.00	0.00	0.00	0.00	0.00
		WOODED SWAMP CONIFEROUS											
		WOODED SWAMP MIXED TREES											
		FLOODPLAIN FOREST DECID											
		FLOODPLAIN FOREST CONIF											
		FLOODPLAIN FOREST MIX											
		OPEN WATER (FRESH)						Open water fresh	0.00	0.00	0.00	0.00	0.00
	Mineral	DEEP MARSH						FW Wetland	0.00	0.00	0.00	0.00	0.00
		SHALLOW MARSH, MEADOW, OR FEN											
		BOG											
		SHRUB SWAMP											
		WOODED SWAMP DECIDUOUS						FW Forested Wetland	0.00	0.00	0.00	0.00	0.00
		WOODED SWAMP CONIFEROUS											
		WOODED SWAMP MIXED TREES											
		FLOODPLAIN FOREST DECID											
		FLOODPLAIN FOREST CONIF											
		FLOODPLAIN FOREST MIX											
		OPEN WATER (FRESH)						Open water fresh	0.00	0.00	0.00	0.00	0.00
	Organic	MANGROVE					100	NA	0.00	0.00	0.00	0.00	44.62
		PHRAGMITES DOMINATED - WETLAND						Phragmites Wetland	0.00	0.00	0.00	0.00	0.00
		SALT MARSH - HIGH				50		SW/brackish Wetland	0.00	0.00	0.00	44.62	0.00
		SALT MARSH - LOW				50							
		BARRIER BEACH-BOG											
		BARRIER BEACH-SALT MARSH											
		BARRIER BEACH-DEEP MARSH											
		BARRIER BEACH-MARSH											
		BARRIER BEACH-SHRUB SWAMP						SW/brackish Forested Wetland	0.00	0.00	0.00	0.00	0.00
		BARRIER BEACH-WOODED SWAMP DECIDUOUS											
		BARRIER BEACH-WOODED SWAMP CONIFEROUS											

Data Entry | Extraction Calculator | Drainage Calculator | Rewetting Calculator | Wetlands-Wetlands Calculator | Results Summary | Lookup Table


Cumulative CO2-C emissions/reductions
Cumulative CO2-C emissions (tonnes C)
0.0
-20.0
-40.0
-60.0
-80.0
-100.0
-120.0
-140.0
-160.0
-180.0
-200.0
0
10
20
30
40
50
Years Post Project


Cumulative CH4-C emissions/reductions
Cumulative CH4-C emissions (tonnes C)
0
-2
-4
-6
-8
-10
-12
0
10
20
30
40
50
Years Post Project

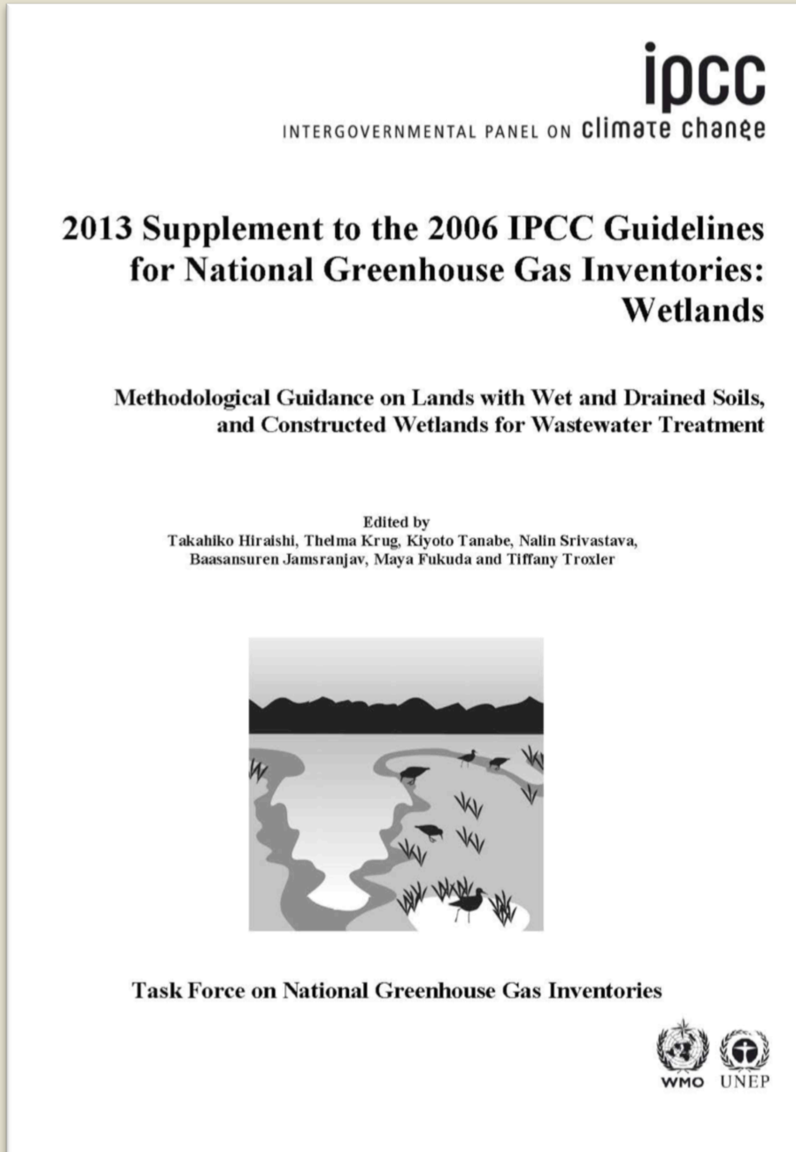

Cumulative GHG emissions/reductions
Cumulative GHG emissions (tonnes CO2 equivalents)
0.00
-200.00
-400.00
-600.00
-800.00
-1000.00
-1200.00
0
10
20
30
40
50
Years Post Project


Cumulative GHG emissions/reductions
Cumulative GHG emissions (gallons of gasoline equivalents)
0.00
-20000.00
-40000.00
-60000.00
-80000.00
-100000.00
-120000.00
-140000.00
0
1
10
20
30
40
50
Years Post Project

What it <u>doesn't</u> do

- Say anything about sequestration
- Account for biomass C
- Account for sea level rise*
- Account for N_2O emissions
- Be regionally- or locally-specific
- Give you a $ value

Where do the numbers come from?



ipcc

INTERGOVERNMENTAL PANEL ON climate change

2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands

Methodological Guidance on Lands with Wet and Drained Soils, and Constructed Wetlands for Wastewater Treatment

Edited by
Takahiko Hiraishi, Thelma Krug, Kiyoto Tanabe, Nalin Srivastava,
Baasansuren Jamsranjav, Maya Fukuda and Tiffany Troxler

Task Force on National Greenhouse Gas Inventories

WMO UNEP

The Massachusetts Clean Energy and Climate Plan: 2015 Update

Abt ASSOCIATES

Final Draft

October 15, 2015

Prepared for:

The Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs
100 Cambridge Street
Suite 900
Boston, MA 02114

IPCC's Three Tiered Guidance

The IPCC divides their guidance for analysis of GHG emissions from wetlands management activities into three 'tiers' which correspond to varying levels of accuracy and precision. While all tiers are designed to provide unbiased estimates of GHG emissions and removals, accuracy and precision are expected to improve with a move from Tier 1 to Tier 3.

***Tier 1:** The IPCC provides mathematical equations for estimating emissions/removals and default emissions factors to use in generating first-order estimates. Default values are a result of an extensive and exhaustive review of the literature on wetland GHG emissions worldwide. Emissions factors are disaggregated by wetland type, management activity and climate region.*

***Tier 2**: Available country-specific data and more regional-specific information such as climate sub-domain, nutrient status, and drainage/rewetting timescales, are used to estimate fluxes.*

***Tier 3:** The most robust analysis is conducted by modelling and/or empirical measurement of emissions at the geographic site under analysis.*

Cross-walk to State GIS Classes

MassGIS/MassDEP Land Use Category	IPCC Method and Source	Land Use Category in Calculator's Look-up Table
	Coastal Wetland	
PHRAGMITES DOMINATED - WETLAND	Organic and Mineral: *Wetlands Supplement* Chapter 4	Phragmites Wetland
SALT MARSH - HIGH	Organic and Mineral: *Wetlands Supplement* Chapter 4	Saline/brackish Wetland
SALT MARSH - LOW		
BARRIER BEACH-BOG		
BARRIER BEACH-SALT MARSH		
BARRIER BEACH-DEEP MARSH		
BARRIER BEACH-MARSH		
BARRIER BEACH-SHRUB SWAMP	Organic and Mineral: *Wetlands Supplement* Chapter 4	Saline/brackish Forested Wetland
BARRIER BEACH-WOODED SWAMP DECIDUOUS		
BARRIER BEACH-WOODED SWAMP CONIFEROUS		
BARRIER BEACH-WOODED SWAMP MIXED TREES		
TIDAL FLAT	NA	No guidance- Assumed that no emissions or reductions are associated with these land cover types
COASTAL BEACH		
COASTAL DUNE		
BARRIER BEACH SYSTEM		
ROCKY INTERTIDAL SHORE		
COASTAL BANK BLUFF OR SEA CLIFF		
BARRIER BEACH-COASTAL BEACH		
BARRIER BEACH-COASTAL DUNE		
OPEN WATER (SALT)	Organic and Mineral: Kroeger and Crooks (in prep)	Open water (salt)
BARRIER BEACH-OPEN WATER		
GRASSLAND UPLAND		

English

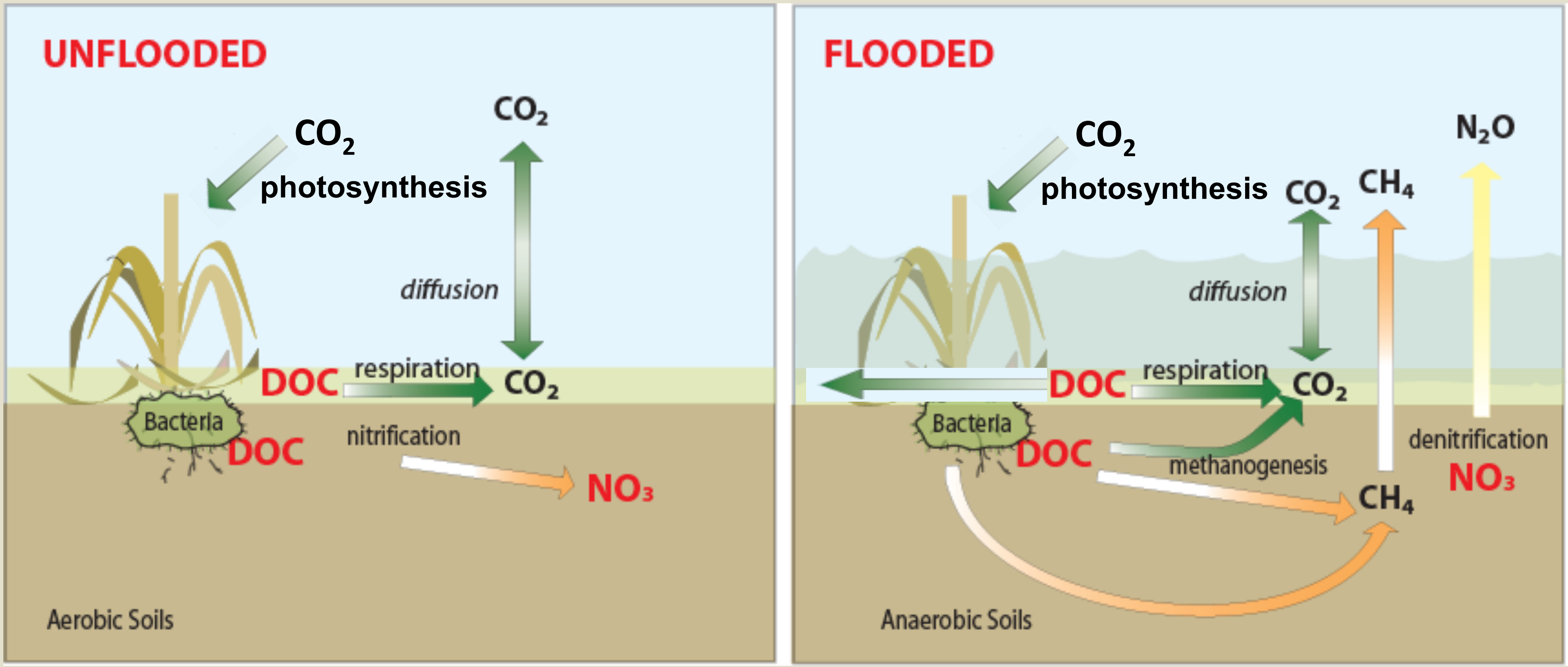
Metric

What do I need to know?

Inputs:

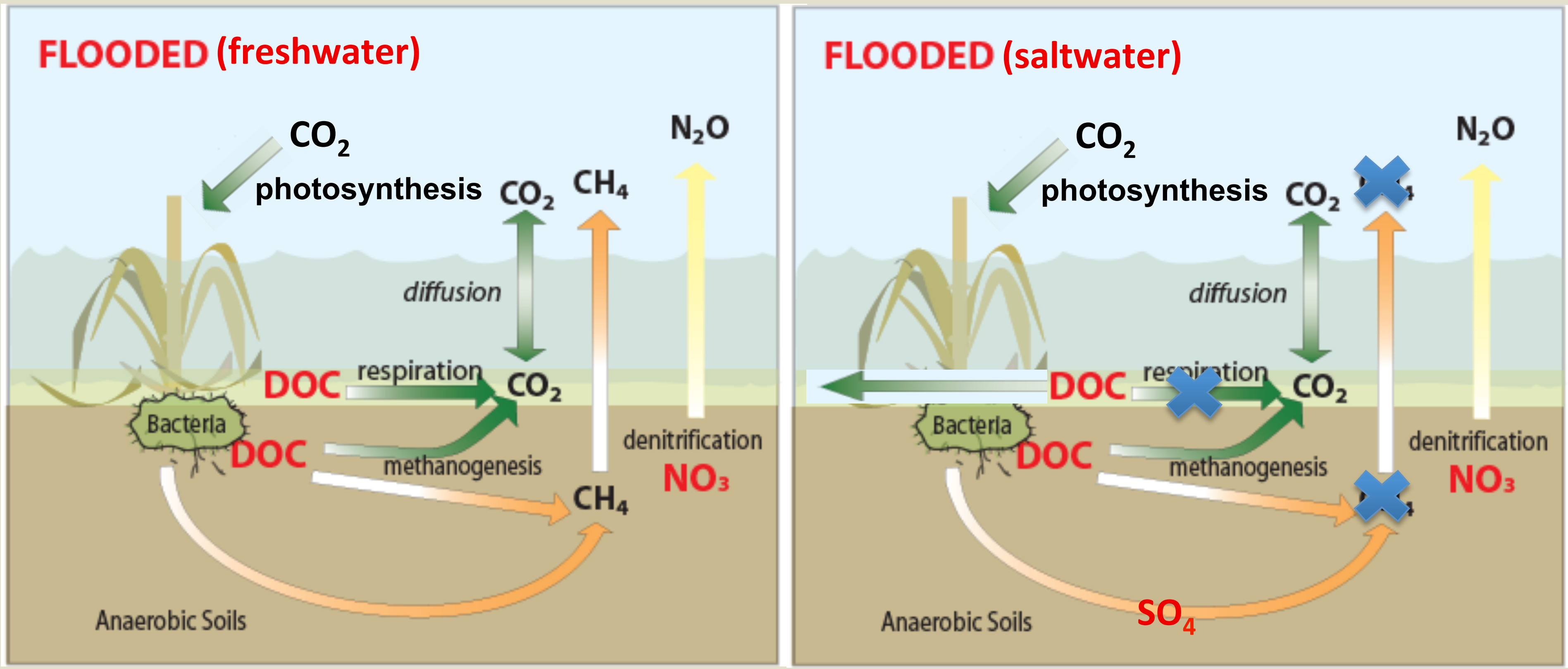
- Salinity
- Activity type
- Acreage of cover type
- Soils organic or mineral
- Nutrient-rich or nutrient-poor?

Salinity



Source: Figure adapted from http://ca.water.usgs.gov/projects/2009-05.html

Salinity



Source: Figure adapted from http://ca.water.usgs.gov/projects/2009-05.html

Activity Type

- Drainage
- Extraction
- Rewetting

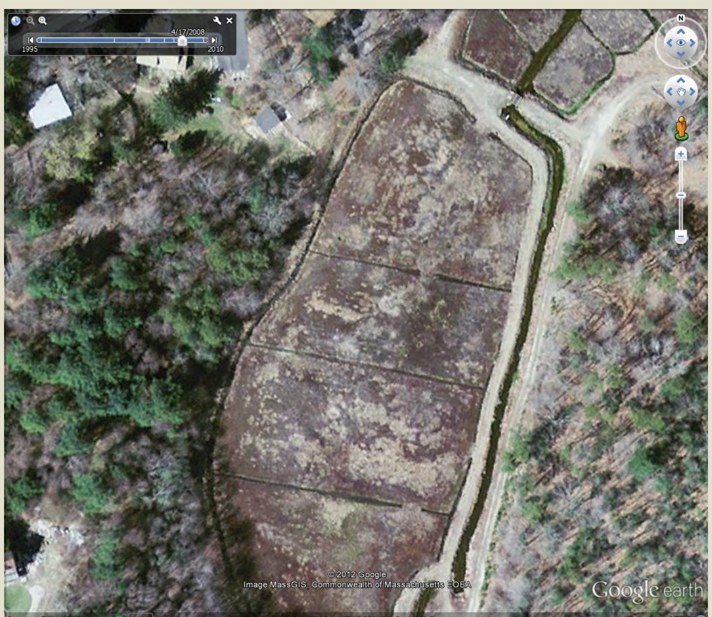
We added:

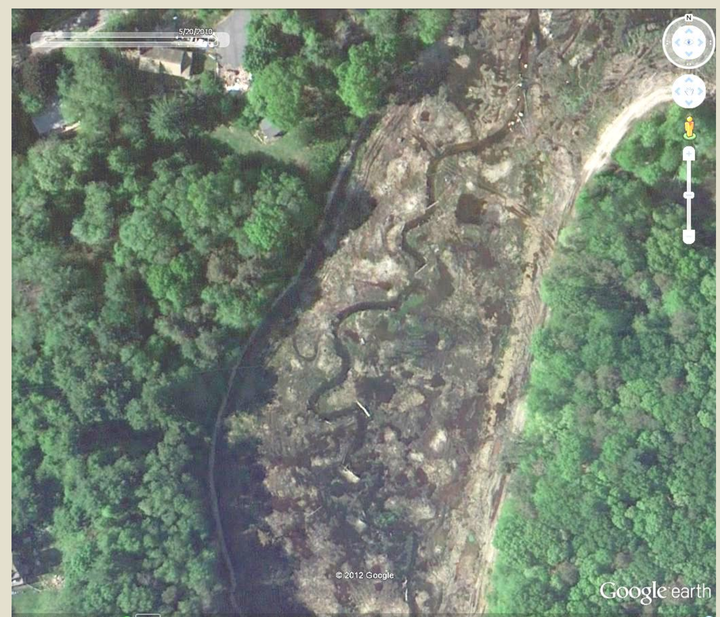
- "wetlands remaining wetlands"

Could be anthropogenic or "natural"
(i.e. climate change effects)

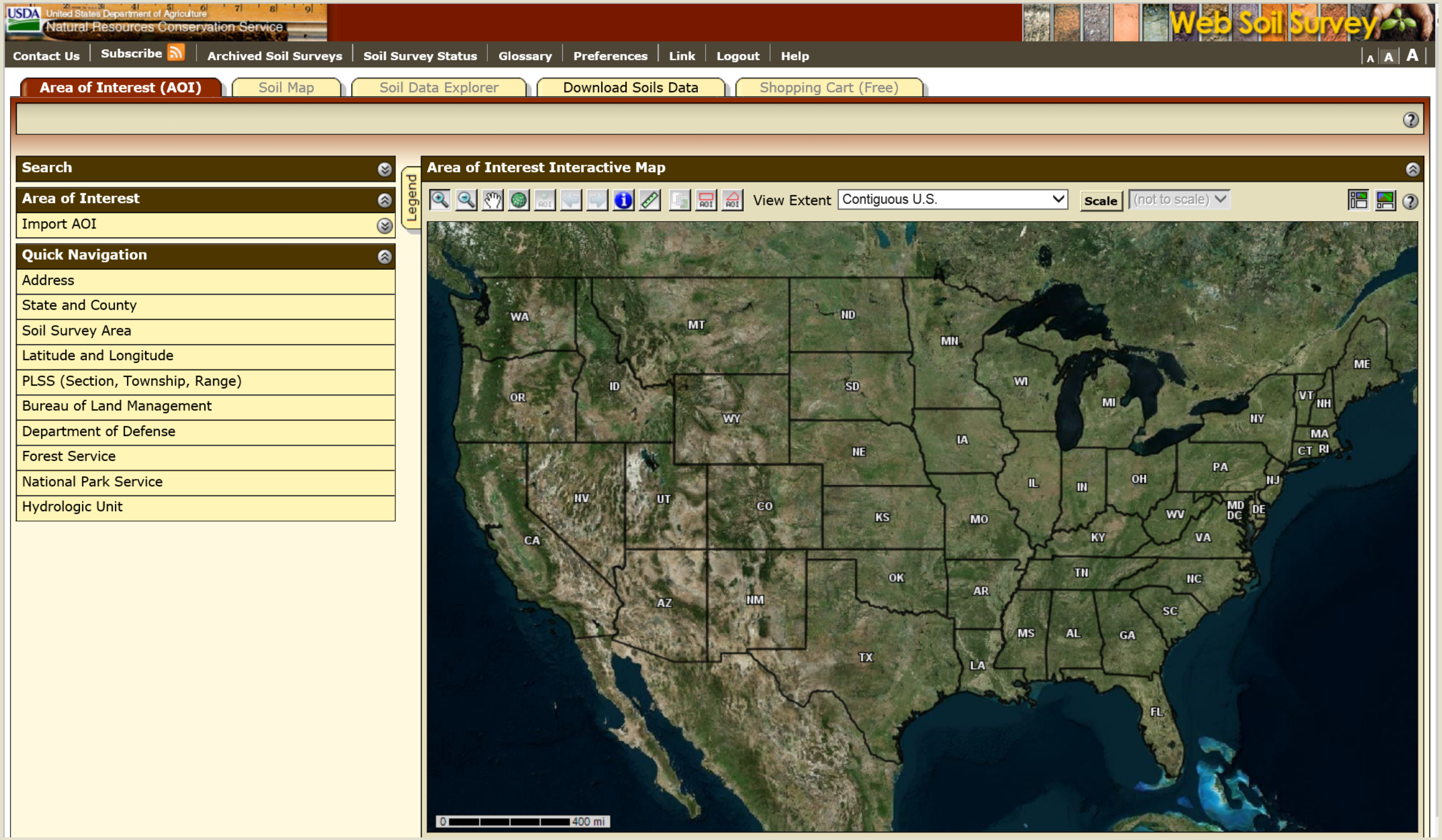
Acreage of Cover Type

- Drainage
- Extraction
- Rewetting
- “wetlands remaining wetlands”





Soils



USDA United States Department of Agriculture
Natural Resources Conservation Service
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Glossary
Preferences
Link
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Help
Area of Interest (AOI)
Soil Map
Soil Data Explorer
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Search
Area of Interest
Import AOI
Quick Navigation
Address
State and County
Soil Survey Area
Latitude and Longitude
PLSS (Section, Township, Range)
Bureau of Land Management
Department of Defense
Forest Service
National Park Service
Hydrologic Unit
Legend
Area of Interest Interactive Map
View Extent
Contiguous U.S.
Scale
(not to scale)
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MN
OR
ID
SD
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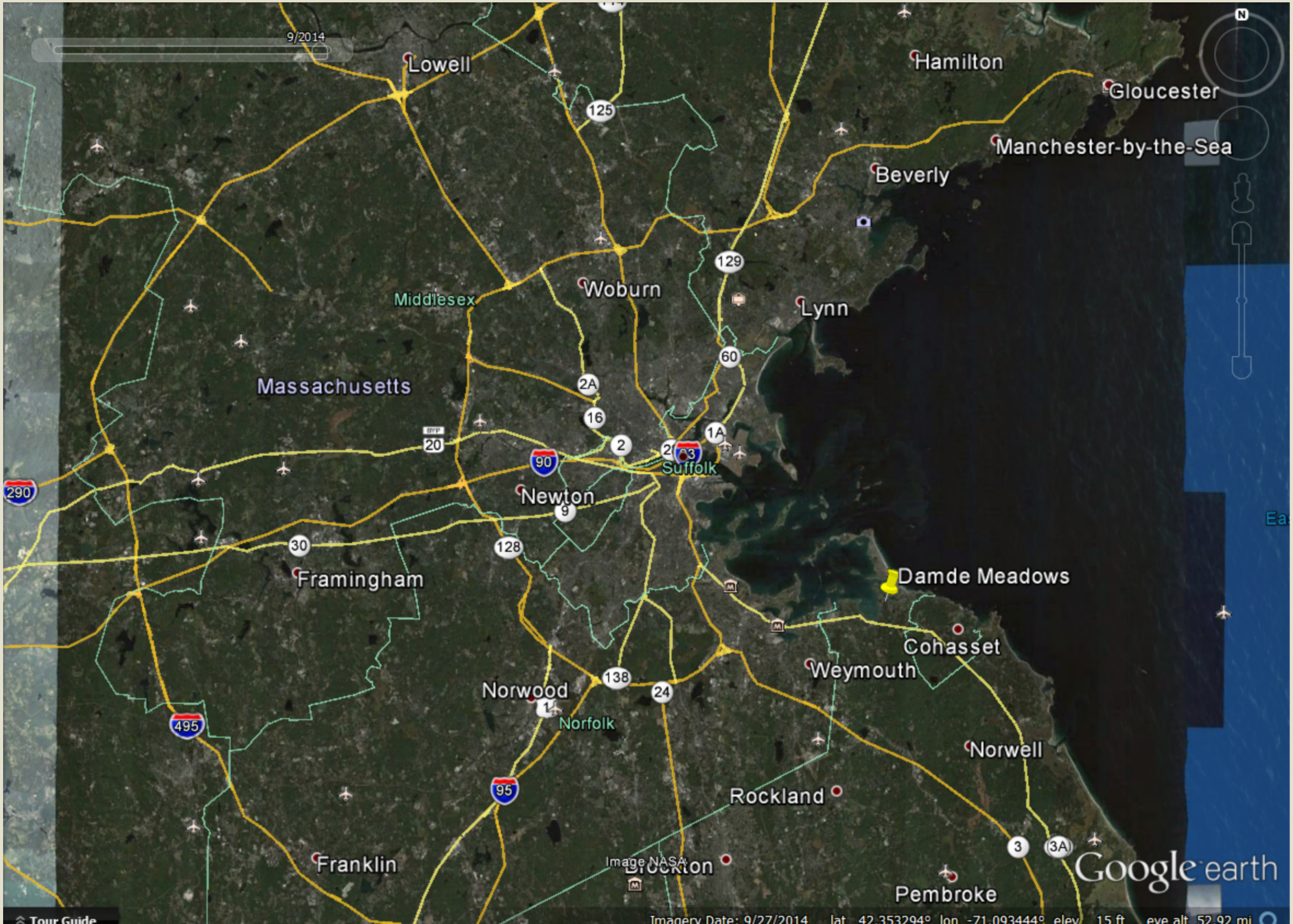
Nutrients

- Emission factors for CO_2 from inland organic wetlands vary with nutrient status. These wetlands sequester CO_2 when lacking in nutrients, and are a source of CO_2 when rich in nutrients.
- Default to “nutrient-rich”

Damde Meadows, Hingham

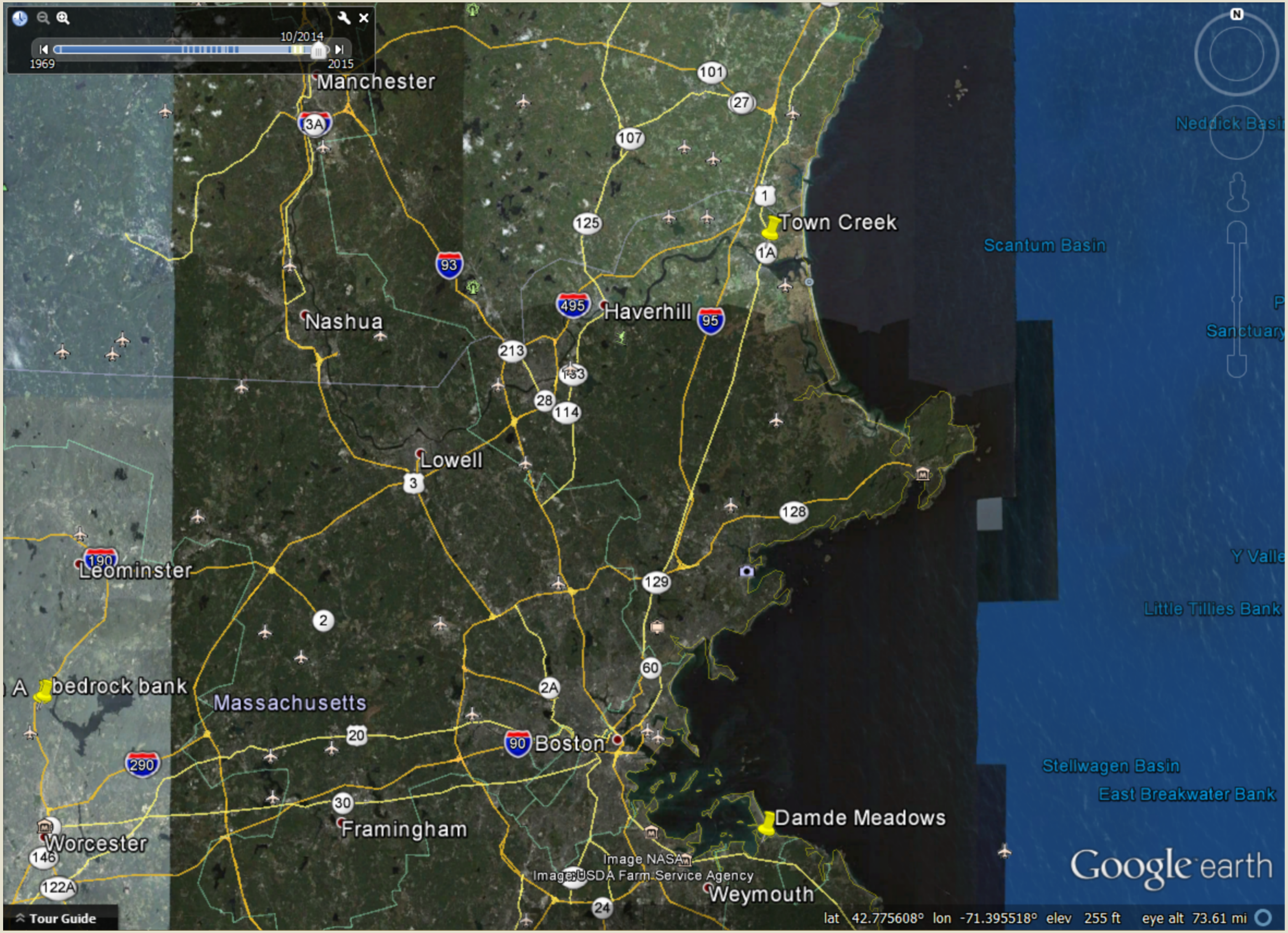


Damde Meadows, Hingham

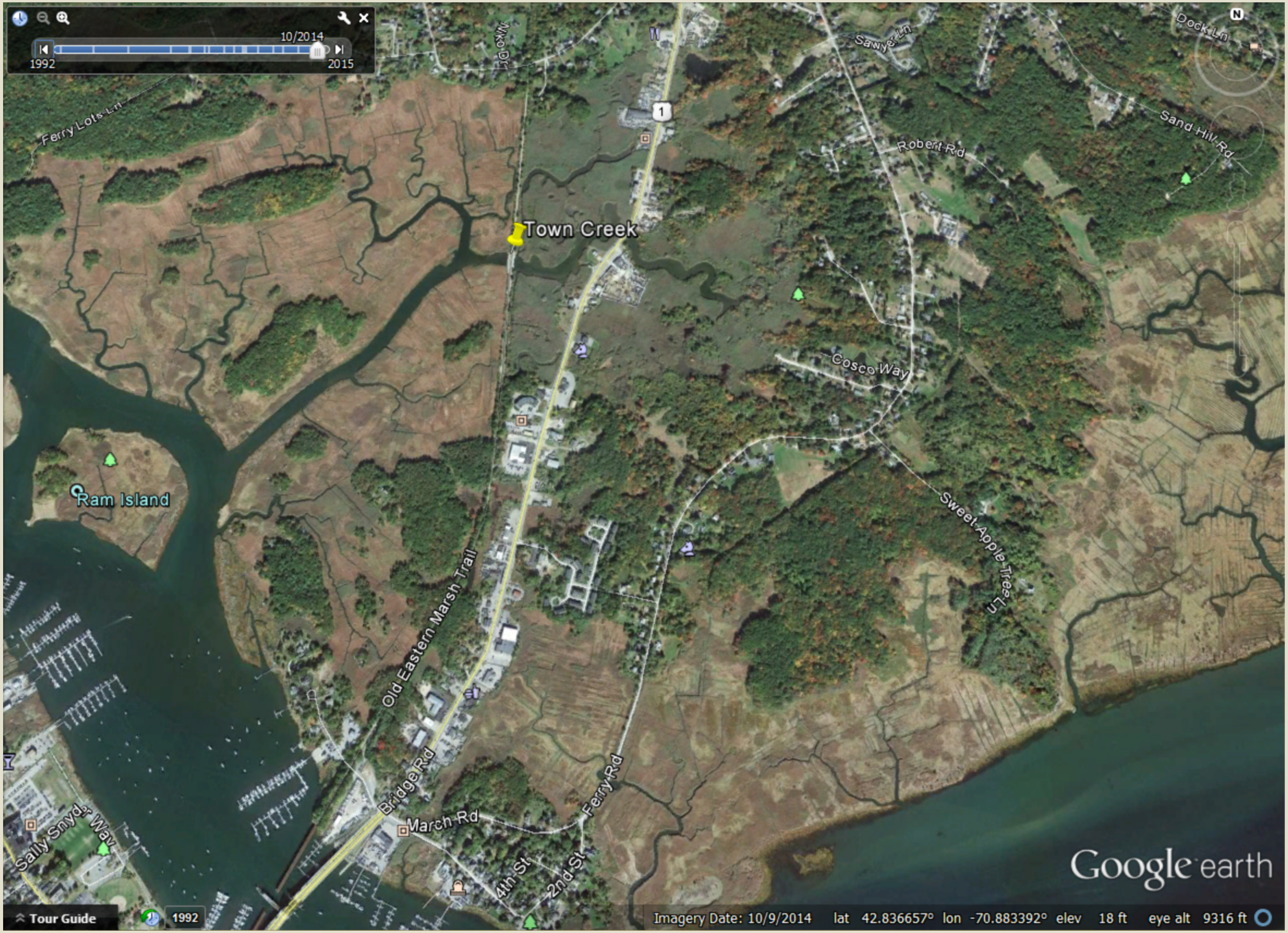
Damde Meadows, Hingham

- Restoration produces a net benefit in CO_2 and CH_4 emissions\reductions
- CO_2 sequestration associated with an increase in wetland area, from 3.2 acres of phragmites dominated wetland to 3.2 acres high saltmarsh and 8.8 acres low salt marsh
- Converting from phragmites to salt marsh results in a reduction of CH_4 emissions
- Over 50 years, this project results in 902 fewer tonnes of CO_2 equivalents in the atmosphere, = to combustion of 101,937 fewer gallons of gasoline

Town Creek, Salisbury



Town Creek, Salisbury



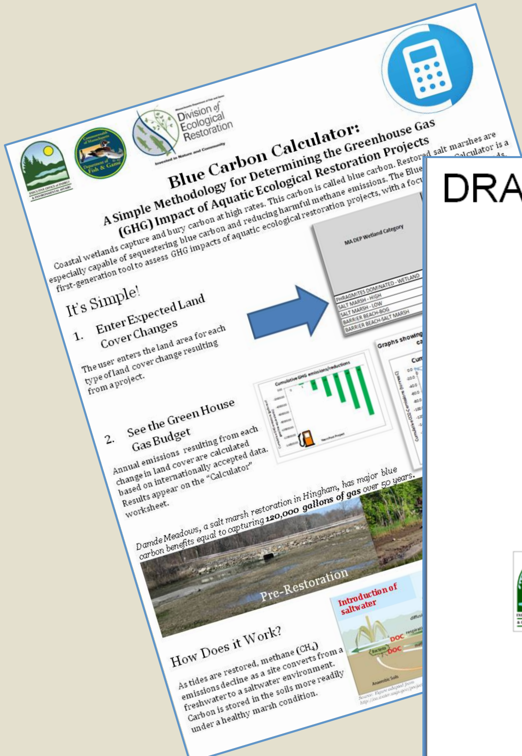
Town Creek, Salisbury

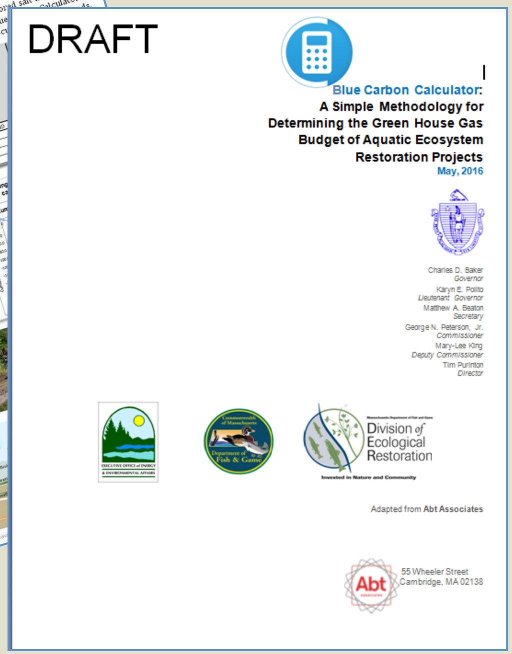
•Restoration produces a net benefit in CO_2 and CH_4 emissions\reductions.
•CO_2 sequestration associated with a decrease in freshwater wetlands to saltmarsh.
•Converting from phragmites to salt marsh results in a reduction of CH_4 emissions
•Over 50 years, this project results in 12,494 fewer tonnes of CO_2 equivalents in the atmosphere, = to combustion of 1,144,884 fewer gallons of gasoline

Summary

- This is only one ecosystem benefit from our projects
- Can be built upon with site specific data
- Herring River evaluation will help reveal market possibilities of blue carbon
- Definite room for improvements
  - Continued use/ testing
  - Better factor for open water emissions
  - Advancement to Tier II or Tier III?

Outreach Materials




DRAFT

Blue Carbon Calculator: A Simple Methodology for Determining the Green House Gas Budget of Aquatic Ecosystem Restoration Projects

May, 2016

Charles D. Baker
Governor
Karyn E. Polito
Lieutenant Governor
Matthew A. Beaton
Secretary
George N. Peterson, Jr.
Commissioner
Mary-Lee King
Deputy Commissioner
Tim Purinton
Director

Division of Ecological Restoration
Invested in Nature and Community

Adapted from Abt Associates

Abt Associates
55 Wheeler Street
Cambridge, MA 02138

- Factsheet
- Methodology Report
- Excel Spreadsheet Calculator

Nick

- OK let’s take a test drive….