Inclusion of Coastal Wetlands into the U.S. Inventory of GHG Emissions & Sinks

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Blue Carbon: Integrating Data Applied to IPCC Emissions Factors and Carbon Markets.

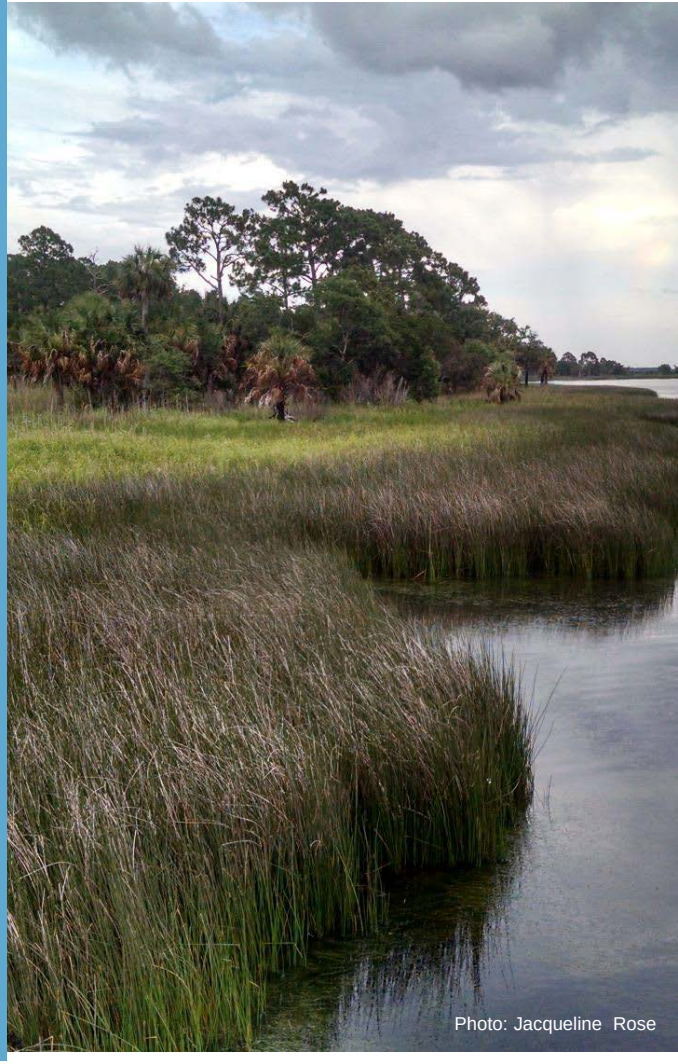
Photo: Jacqueline Rose

12th International Symposium
on Biogeochemistry of Wetlands
April, 25, 2018

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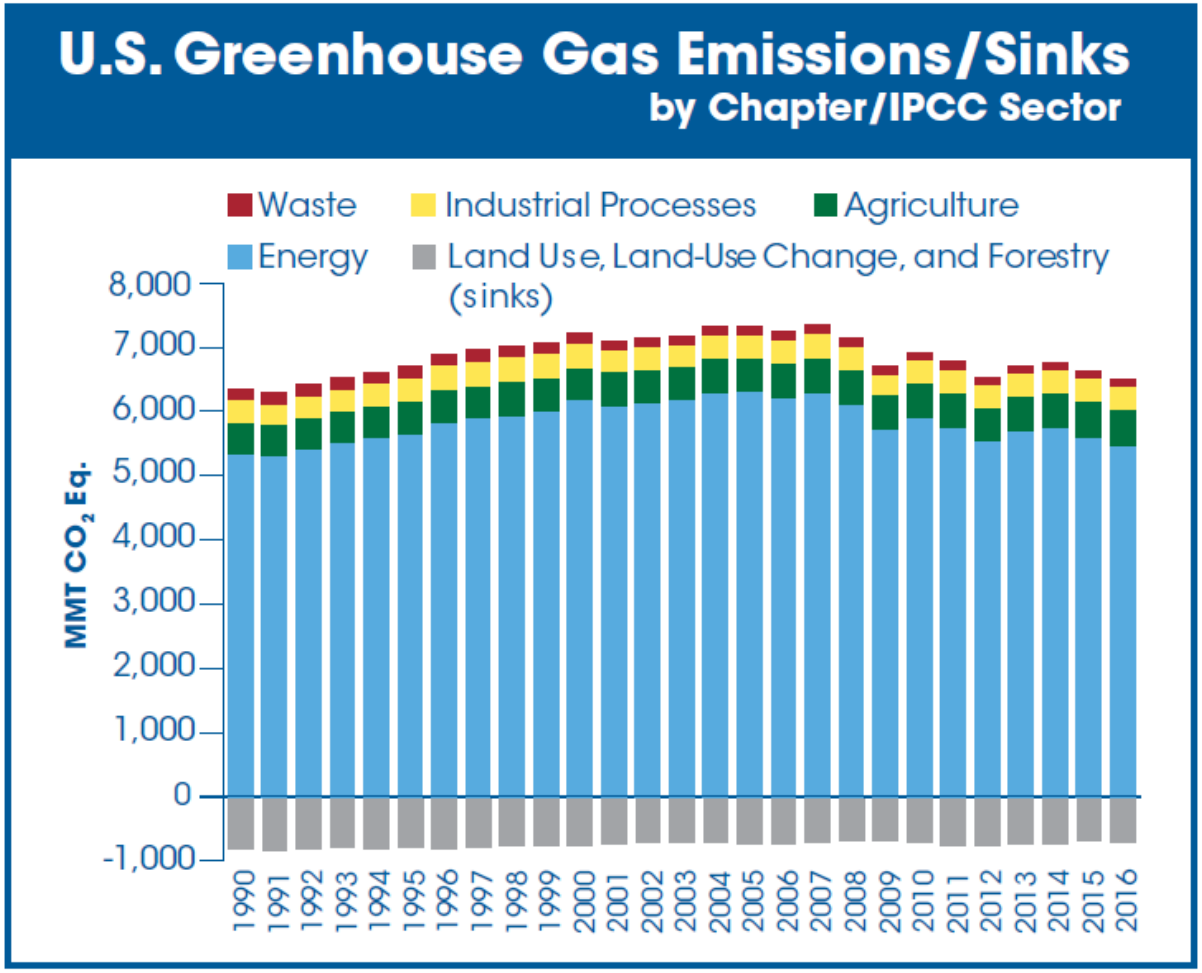

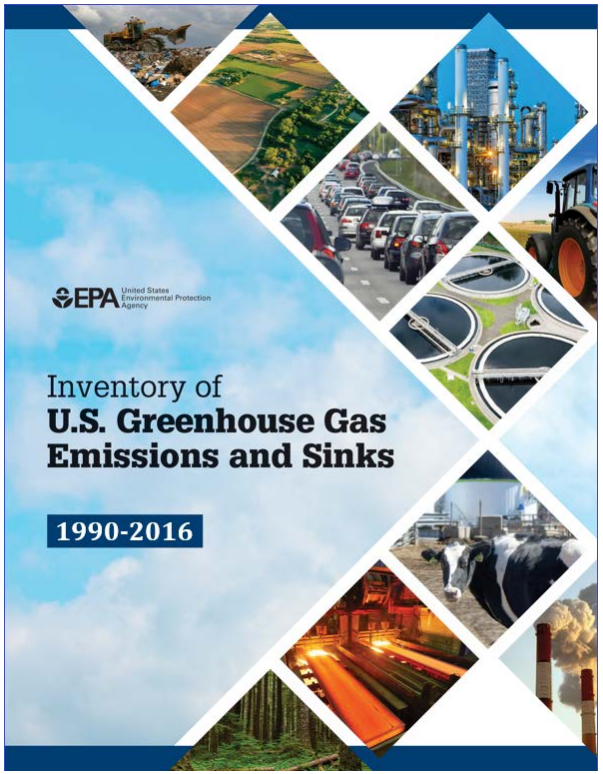

In 2016 gross US GHG emissions were 6,511 MMT CO2e. An increase of 2.4% above 1990 and a drop of 1.9% below 2015.

LULUCF Sector net sink of 717 MMTCO2e Coastal Wetlands net sink of 8.5 MMtCO2e

https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2016

U.S. Coastal Wetland Carbon Working Group

U.S. National Oceanic and Atmospheric Administration (Coastal Management, Habitat Conservation, International), U.S. Environmental Protection Agency (Climate Change, Wetlands), U.S. Geological Survey, U.S Forestry Service, Environmental Science Associates, Florida International University, Smithsonian Environmental Research Center, Restore America's Estuaries, Colorado State University, Pennsylvania State University, Texas A & M.

"Blue" Carbon Monitoring System

Linking soil and satellite data to reduce uncertainty in coastal wetland carbon burial: a policy-relevant, cross-disciplinary, national-scale approach

Lisamarie Windham-Myers (18 Science PIs; October 2014-17)

Federal		Non Federal	
USGS	Brian Bergamaschi	U. South Carolina	Jim Morris
	Kristin Byrd	U. Maryland/NOAA	Ariana Sutton-Grier
	Judith Drexler	U. San Francisco	John Callaway
	Kevin Kroeger	Florida Intl. U.	Tiffany Troxler
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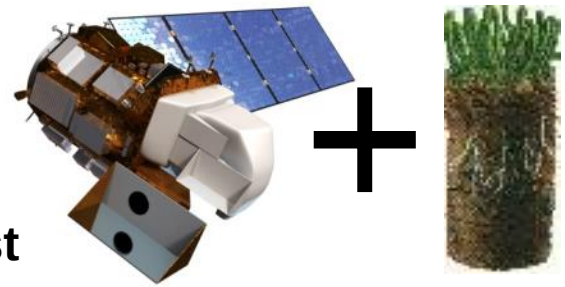
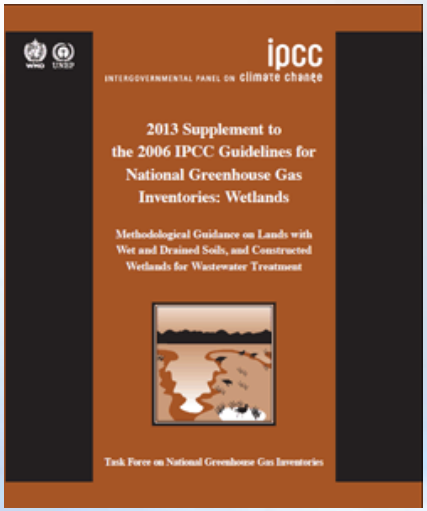
Postdoc:	Meagan Gonneea		
NOAA-NERR	Matt Ferner		
Smithsonian	Pat Megonigal		
	Don Weller		
	Lisa Schile		
Postdoc:	**James Holmquist**		
NASA-JPL	Marc Simard		





IPCC Land Classification

Forest land

- All woody vegetation according to national definitions

Cropland

- Crops including rice and agro-forestry not included above

Grassland

- All rangelands and pastures not included above

Settlements

Wetlands

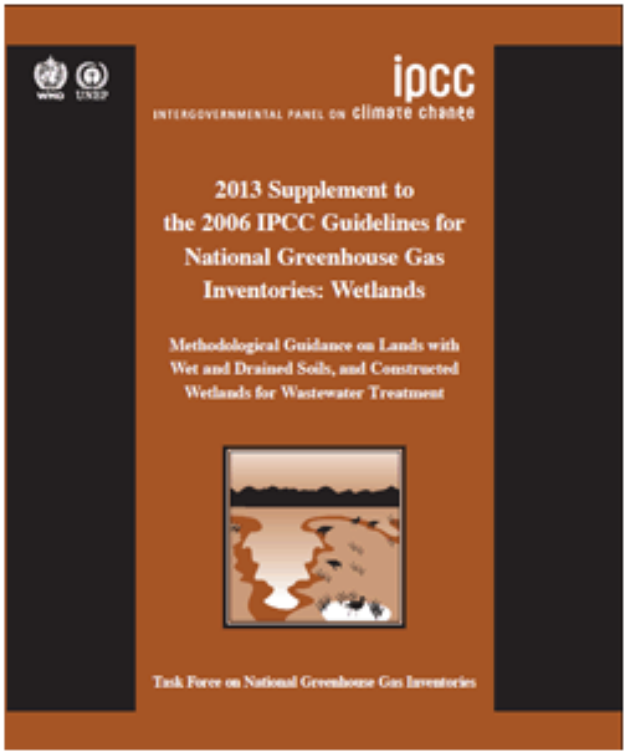
- Wetlands not included above (peat use and flooded lands)

Other Lands

- Includes bare soil, rock, ice and lands not included above

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

1. Introduction
2. Cross cutting guidance on organic soils
3. Rewetting and restoration of organic soils
4. **Coastal wetlands**
5. Other freshwater wetlands
6. Constructed wetlands
7. Good practice and implications for reporting

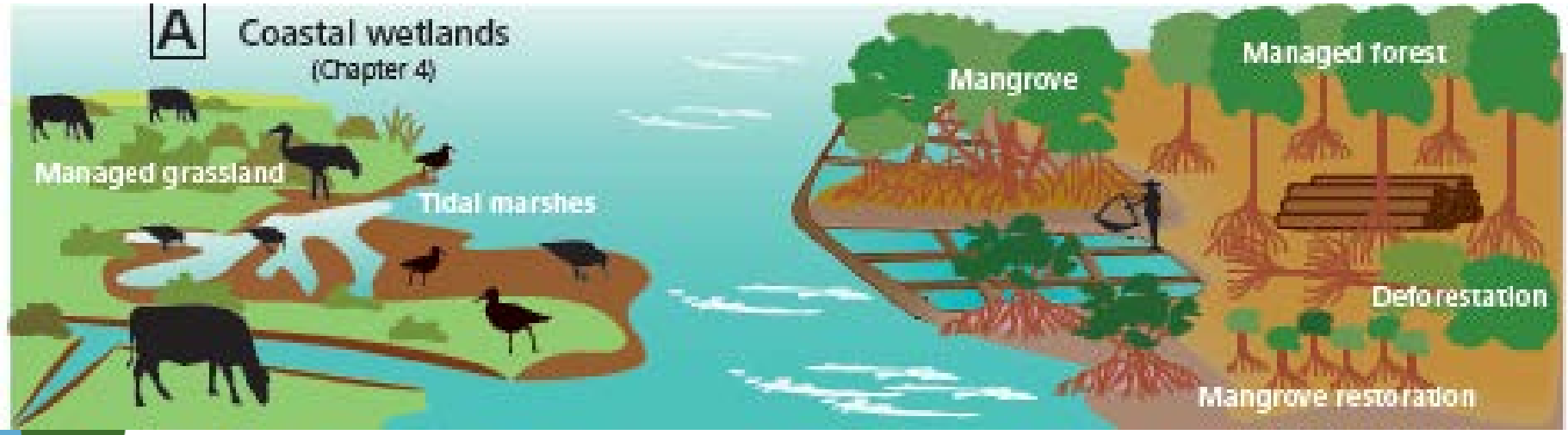


Adopted by IPCC Oct 2013, Published Feb 2014

- http://www.ipcc-nggip.iges.or.jp/

Chapter 4: Coastal Wetlands of the *2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands*

- Updated default data for estimation of C stock changes in mangrove living biomass and dead wood pools
- New generic methodological guidance and data on:
  - CO_2 emissions and removals on coastal wetlands on organic and mineral soils for specific management activities
  - N_2O emissions during aquaculture use
  - CH_4 emissions from rewetted soils and creation of mangroves and tidal marshes

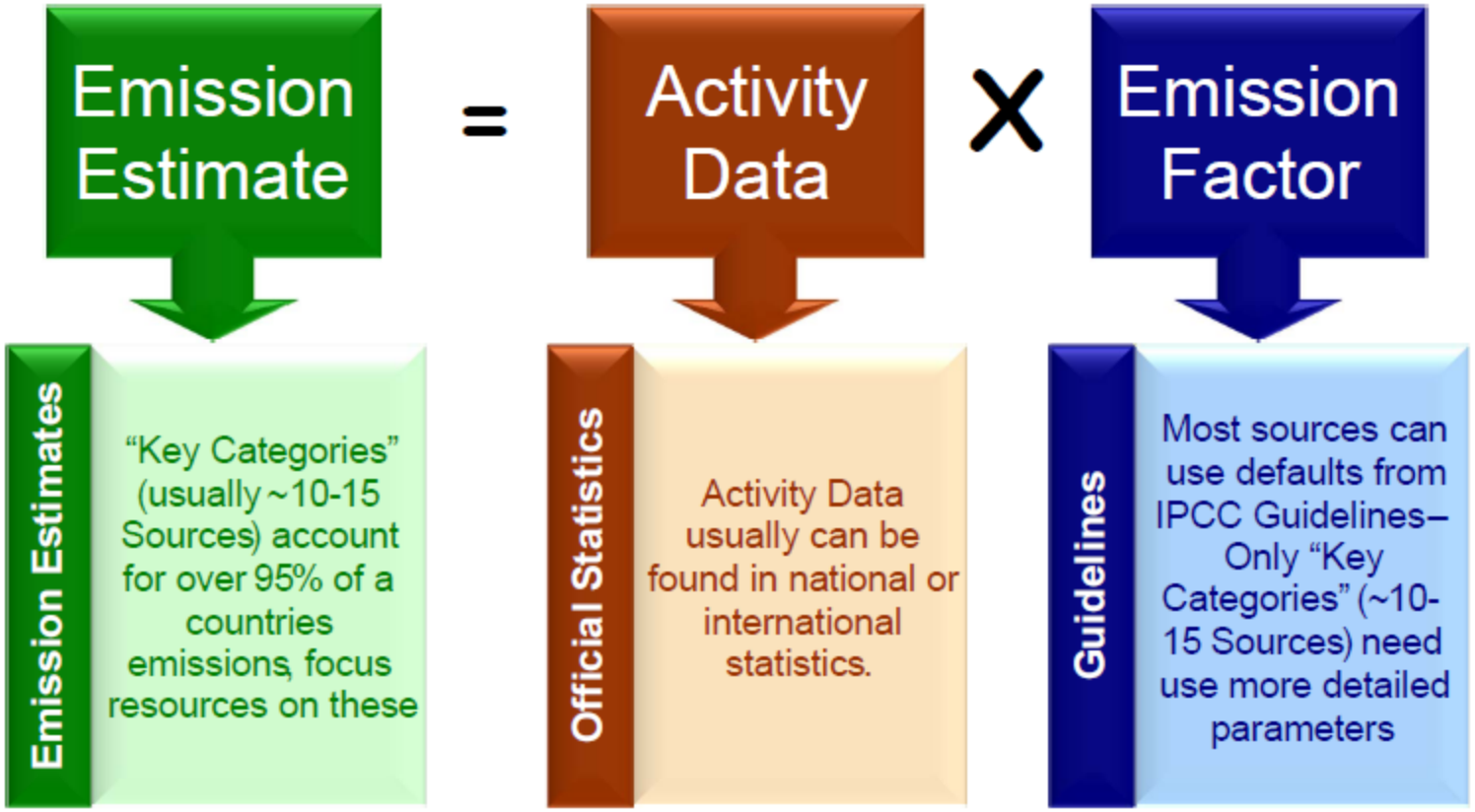


Guidance to Estimate CO_2, CH_4 and N_2O Fluxes from Management Activities in Coastal Wetlands – Consistent with 2006 GLs but also captures E/R that fall outside of land base

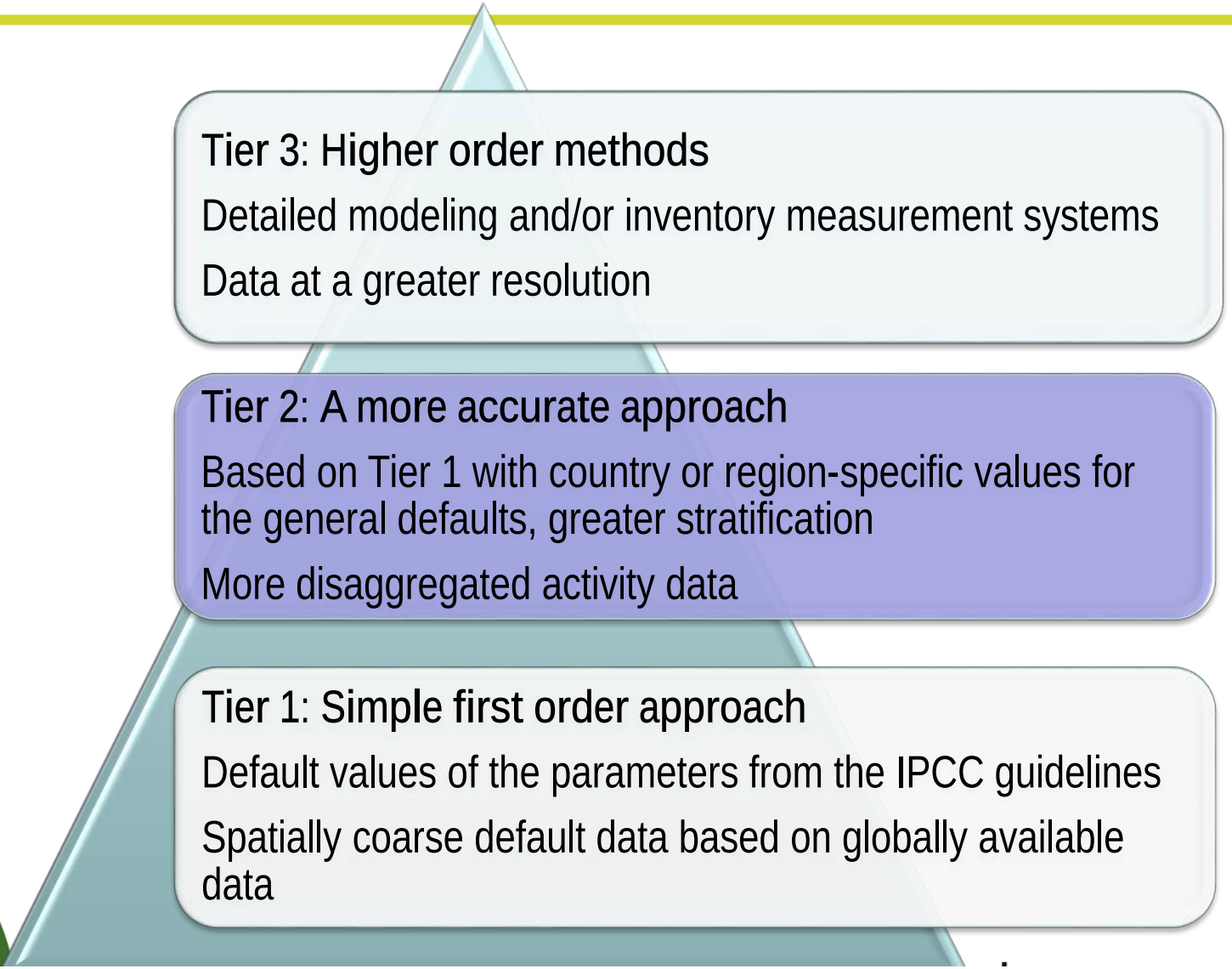
Activity	Coastal Vegetation Types Affected*	Sub-Activity	New/Updated Guidance or Data Provided in Coastal Wetlands Chapter of the Wetlands Supplement
Activities Relevant to CO_2 Emissions and Removals			
Forest Management	M	Planting, thinning, harvest, wood removal, fuelwood removal and charcoal production. Including conversion to or from Forest Land	Updates to 2006 GLs default data for estimation of C stock changes in biomass , dead organic matter and soil C pools
Extraction	M, TM, SGM	Excavation to construct port, harbor or marina; filling or dredging to raise elevation of land	New guidance , data and EFs provided for estimation of CO_2 emissions and removals from biomass, dead organic matter and organic/mineral soils
	M, TM	Construction of aquaculture facilities	
	M, TM	Construction of salt production facilities	
Drainage	M, TM	Agriculture, forestry, mosquito control	
Rewetting, revegetation and creation	M, TM	Conversion from drained to saturated soils by restoring hydrology and vegetation	
Revegetation	SGM	Reestablishment of vegetation on undrained soils	
Activities Relevant to non-CO_2 Emissions			
Aquaculture (use)	M, TM, SGM	N_2O emissions from aquaculture use	New methodological guidance and EFs for estimating N_2O emissions from aquaculture use
Rewetting, revegetation, and creation	M, TM, SGM	CH_4 emissions from rewetting, revegetation and creation of wetlands	New methodological guidance and EFs for estimating CH_4 emissions from rewetting, revegetation and creation of M, TM, SGM

*M=Mangroves, TM= Tidal Marsh, SGM=Sea Grass Meadows

Basic Method



Methodological Tiers*

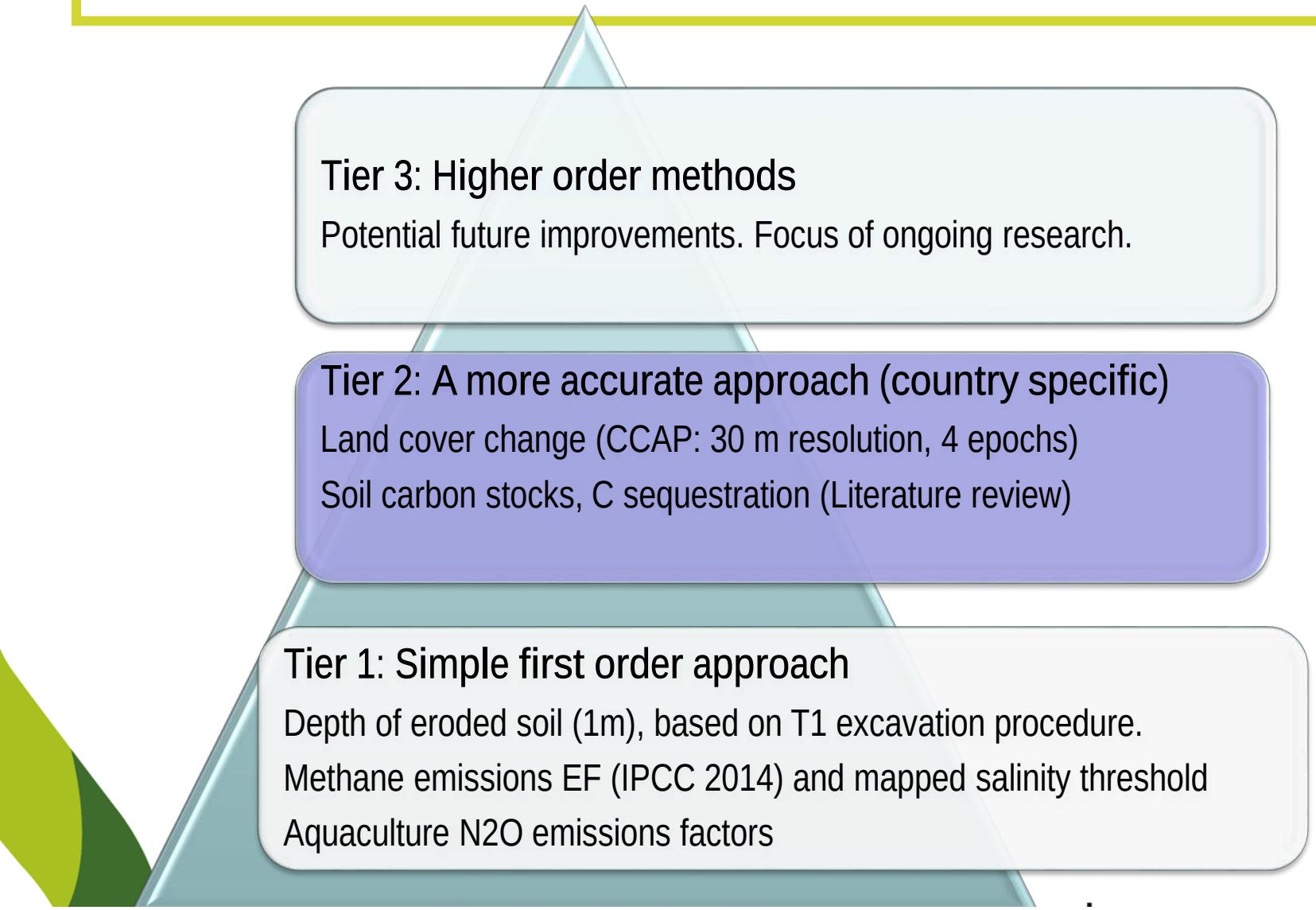


* Different tiers can be applied to different C pools, if all data do not support the highest tier approach

United States: Emissions of Interest

- Emissions and removals of CO_2 and CH_4 on intact and restoring wetlands.
- Drainage and excavation activities
- Conversion of wetlands to open water
- Forestry activities on wetland soils
- CH_4 emissions from impounded waters
- Aquaculture

U.S. Analysis: Methodological Tiers*



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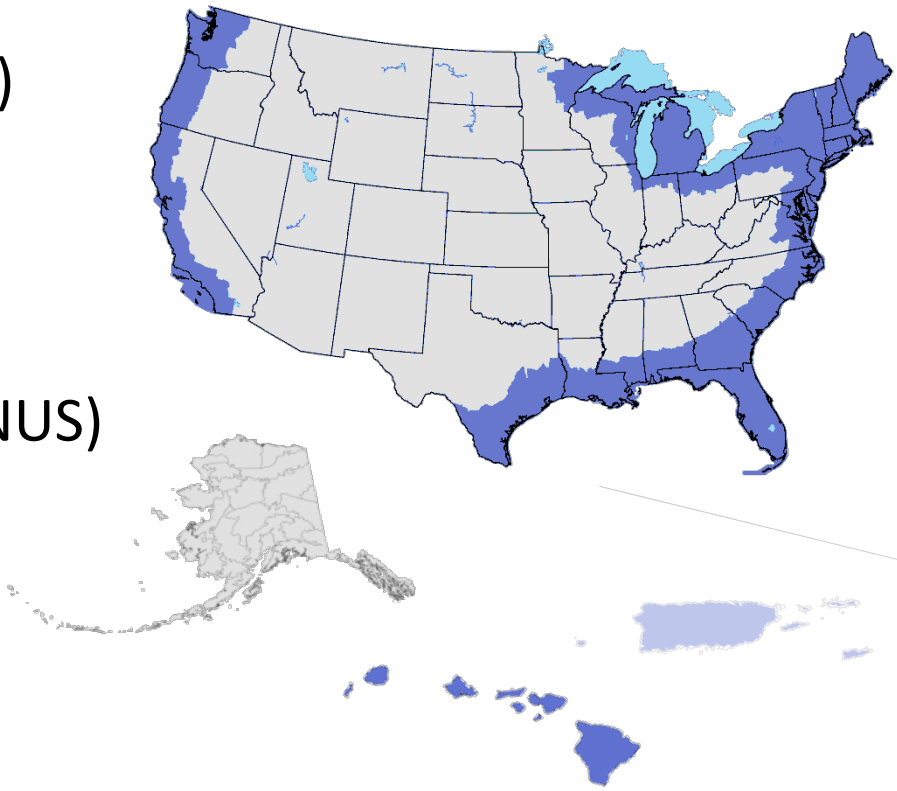
C-CAP Regional Land Cover and Change

coast.noaa.gov/digitalcoast/data/ccapregional

- National Coastal Land Cover Monitoring Program
  - Updated every five years since 1996
- Based on Landsat imagery (30m)
  - Regional to county scale in scope
- Consistent, Accurate Products
  - FGDC National Geospatial Data Asset
- 25% of the contiguous U.S. (CONUS)
  - Coastal expression of the NLCD
- Additional Coastal Detail
  - Focus on wetland categories
  - More dates / longer time series



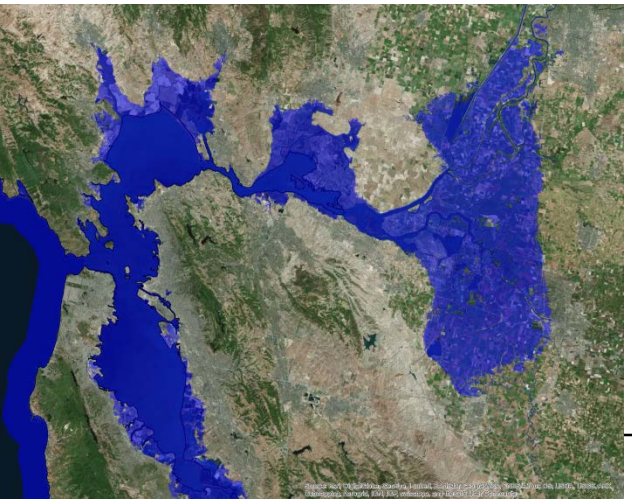
Methodology

- Define Coastal Land Area based upon extent of tides and US Land Representation.
- Quantify land use within Coastal Land Area based upon CCAP
- Quantify land use change 1990-2015.
- Ascribe a CO_2 and CH_4 emissions factor for land use change based upon lit review of C stocks, stock change and CH_4 flux.
- Estimate N_2O emissions from aquaculture based upon T1 emissions factor and annual survey of aqua. production.
- Calculate annual emissions and removals:
  - Coastal Vegetated Wetlands Remaining Coastal Vegetated Wetlands
  - Coastal Vegetated Wetlands converted to Coastal Wetlands Open Water
  - Lands Converted to Coastal Wetlands.

Extent of Coastal Land Area

OFFICE FOR COASTAL MANAGEMENT
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Tide data
Lidar surface
C-CAP land cover

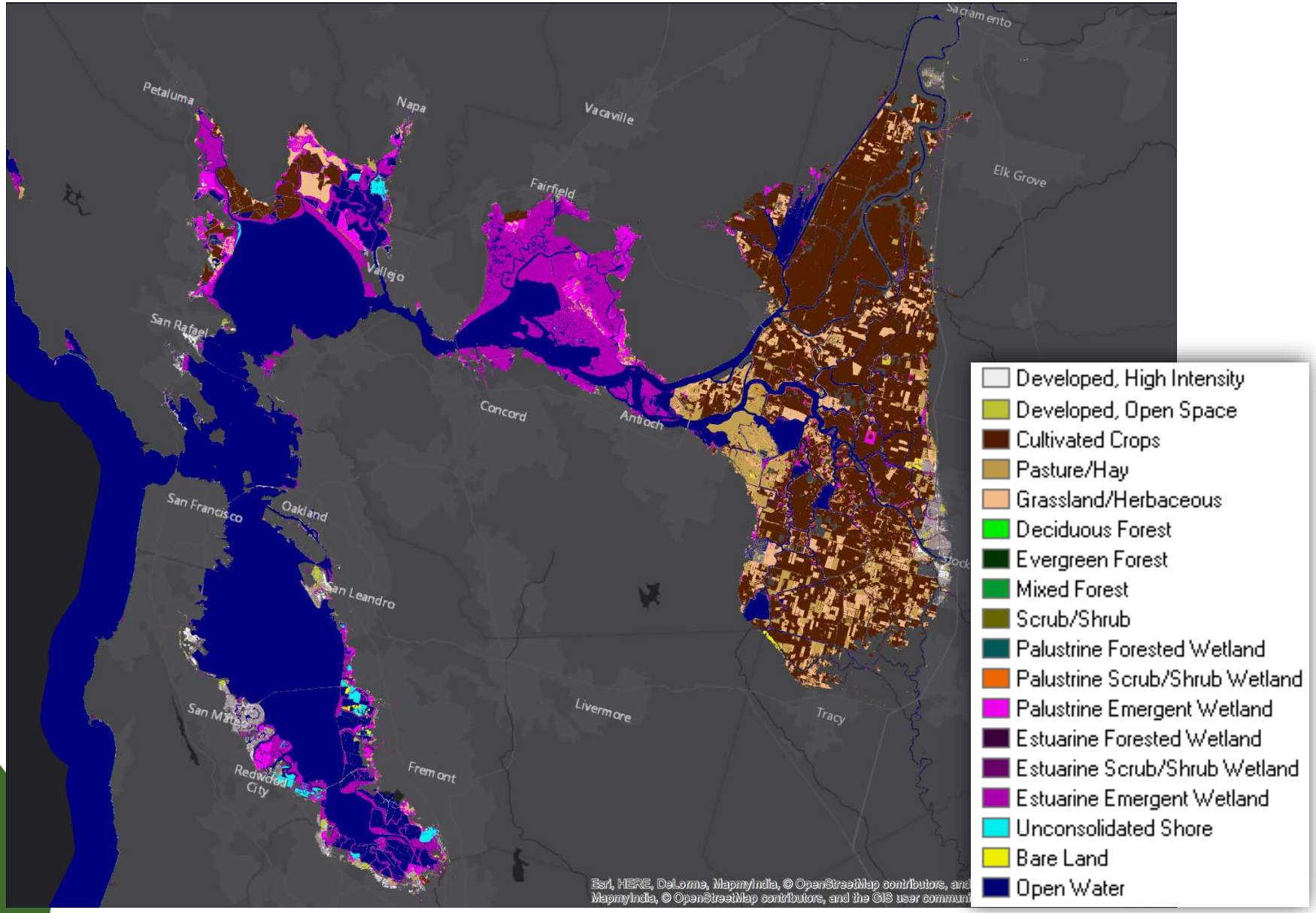


San Francisco Bay – San Joaquin River, CA

New Orleans – Mississippi River, LA

Chesapeake Bay – Blackwater National Wildlife Refuge, MD

San Francisco Estuary, CA



CONUS Coastal Land Area: Land Use and Soils

Land Use Category	Total Area	Organic Soil		Mineral Soil	
	(Ha)	Area (ha)	Area (%)	Area (ha)	Area (%)
Developed Land	151,304	37,667	24.9	113,637	75.1
Cultivated Land	267,137	114,567	42.9	152,571	57.1
Grassland (inc Scrub)	65,909	17,499	26.5	48,410	73.5
Forest Land (Dry)	45,401	5,358	11.8	40,042	88.2
Palustrine F, SS & EM	1,607,306	984,454	61.2	622,852	38.8
Estuarine F, SS & EM	2,188,624	1,064,223	48.6	1,124,400	51.4

Total coastal land area: 4,325,681 ha

Soil data from Soil Survey Geographic Database

Settlement or dry drained agro-forestry: 13%

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Annual emissions from drained organic former wetland soils:5,071,805 tCO_2

Wetlands Remaining Wetlands (2016)

Annual emissions and removals (parentheses)

Land Cover	Total Area (Ha)	C Sequest tCO_2 / yr	CH_4 emissions t CO_2e/yr	Total removal t CO_2e/yr
Palustrine Forest	873,340	NA	NA	NA
Palustrine S Shrub	138,749	(687,394)	675,900	(11,494)
Palustrine E Marsh	599,146	(3,458,534)	2,901,425	(899,393)
Estuarine Forest	191,550	(681,471)	-	(681,471)
Estuarine S Shrub	97,099	(350,224)	-	(350,224)
Estuarine E Marsh	1,852,842	(6,902,298)	-	(6,902,298)
Total	**3,795,930**	**(12,079,921)**	**3,577,325**	**(8,502,596)**

Wetland Conversions (1990-2016)

Land Use Change	Net Emission $MMtCO_2$ / yr
Wetland to Open Water	1.27-7.19
Wetland Drainage	0.70-1.92
Wetland Restoration	0.015-0.025

Summary: Considerations for Management

- Coastal Wetlands sequester net **8.5 MMTCO$_2$e/yr.**
- Preventing new drainage would avoid **0.7 – 1.9 MMTCO$_2$e/yr**.
- Restoring wetlands on drained organic soils (non developed) would avoid emissions of **4 MMTCO$_2$e/yr**.
- Restoring tidal connection to hundreds of small scale impounded waters would avoid reduce of **1-3 MMTCO$_2$e/yr.**
- Wetlands erosion releases **1-7 MMTCO$_2$e/yr.**
- Current restoration accounts for only **0.02 MMTCO$_2$e/yr** of new carbon sequestration

Main Sources of Error

- Small data set for Palustrine wetlands (C stocks, stock change and CH_4).
- Trend changes: extrapolation from 4 CCAP data points 1996, 2001, 2006, 2010. (2015 to be released this year)
- Methane: estuarine / palustrine delineated by 5 ppt salinity. Emissions factors by 18 ppt.
- Soil C erosion losses: based upon Tier 1 assumption of 1 m depth of soil erosion.
- Fate of C: 100% of eroded C returns to atmosphere. (Standard across inventory.)

Planned and Potential Improvements

Planned

- Inclusion of biomass (2019)
- Refined dataset and database on soil carbon stocks (2019)
- Refined uncertainty analysis (2019)
- Inclusion of CCAP 2015 in trend analysis (2020)
- Refined tidal boundary (2020)
- Further integration with NRI and FIA datasets

Potential

- Inclusion of seagrass meadows
- Improved C and CH_4 fluxes from palustrine wetlands
- Improved quantification of fluxes from impounded water
- Impacts of forestry activities on wetland soils
- Inclusion of wetlands above the Coastal Land Area.

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Qwuloolt tidal Wetland Restoration
(Image: Tulalip Tribes)