Wetland Restoration: Carbon and Nitrogen Off-sets to Benefit Water Quality and Wildlife

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Overview

- Project history
- Off-set approach
  - Loading estimate
  - Off-set options considered
  - Off-set accounting
- Benefits of wetland restoration
- Project implications

Project History

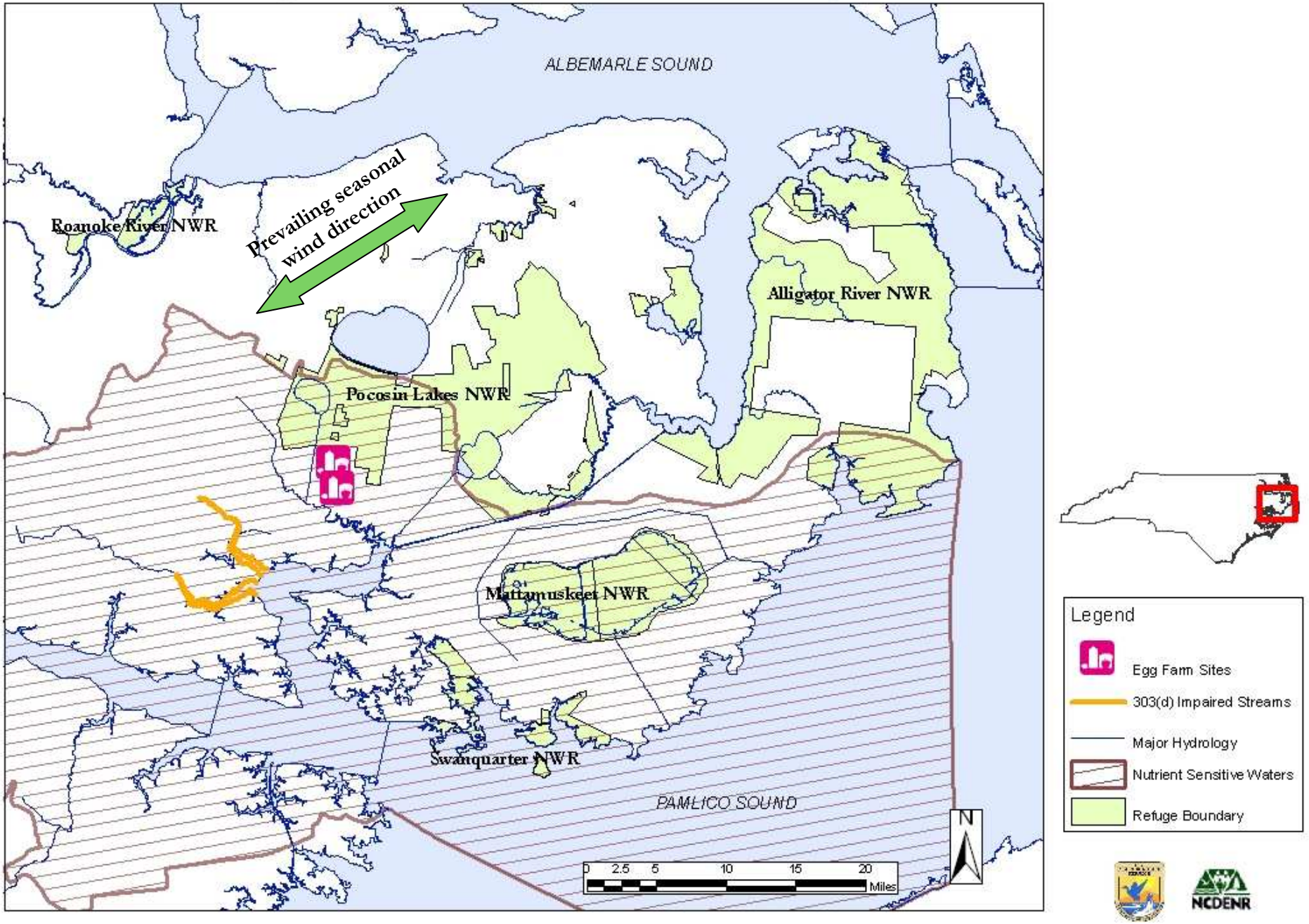
March 2003 – FWS reviewed plans for large new CAFO

- 4 million layer hens
- Estimated ammonia emissions of 4.8 million lbs/yr

Project History

- That's big!
  - Larger than any NC poultry operation
  - Ammonia emissions double the average large NC swine operation
- Proposed location
  - One mile south of Pocosin Lakes NWR
  - In watershed designated "nitrogen sensitive"
  - 15 mi of streams 303(d)-listed as "impaired" due to nitrogen enrichment from ag sources

Layer Operation Vicinity Map



The Problem

1) Existing nitrogen over-enrichment
2) Facility would add large new nitrogen load
3) New nitrogen loads from facility largely unregulated

Potential for nutrients and other wastes to impact fish and wildlife, water quality, and the refuge visitor experience

Photo: S.Ward, USFWS

The Fix: EC-Suggested BMPs

- Nitrogen reduction
  - Litter management to reduce ammonia volatilization
  - Exhaust air treatment to remove ammonia
  - Expanded stream setbacks for land application
- Monitoring
  - Emissions
  - Water quality
- Nitrogen load off-set

Photo: roseacre.com

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✓ Embraced by regulators during permitting

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✓ Embraced by environmental managers

Nitrogen Off-Set Approach

Goal: Prevent a net increase in local watershed nitrogen loads

Strategy: Implement reduction projects in basin to balance new nitrogen loads

Off-Set Approach: Loading Estimate

- Estimated emissions for planned operation

$$\text{Ammonia house emission rate (lb/yr/head)} = \text{manure nitrogen}_{\text{excreted}} \text{ (lb/yr/head)} \times EF \times (17\ NH_3/14\ N)$$

<u>data inputs (from USEPA 2002):</u>
layer animal weight (lbs) = 4.0
Nitrogen excreted (lb/day/1000 lb animal) for layer = 0.79
Emission factor (EF) for dry layer house (lb/yr/head) = 0.86

4.8 million lbs NH_3 / yr

Source: http://www.epa.gov/npdes/pubs/cafo_nonwaterquality.pdf

Off-Set Approach: Loading Estimate

- Verify emissions estimate
  - Review literature for similar operations
  - Compare to emissions from applicant's operation in IN

Photo: Iowa St. Univ., www3.abe.iastate.edu

Nitrogen Off-Set: Options Evaluated

- Local expertise
  - FWS - Partners Program, Migratory Bird Field Office, Refuges
  - NC Coastal Land Trust
  - NRCS
  - University Cooperative Extension
  - NC Natural Heritage Program
- GIS mapping exercise
  - Riparian condition
  - Land use 303(d) listed streams

Nutrient Off-Set Projects Considered

- Wetland restoration
- Stream buffer establishment / enhancement
- Land preservation

Nitrogen Off-Set Projects Considered

- Wetland restoration
  - Priority areas (protected lands, easements)
  - Suboptimal farmland
- Stream buffers
  - Impaired streams
  - Ag drainage receiving waters
- Land preservation
  - Natural Heritage Program priority areas
  - Lands vulnerable to nutrient loss

Wetland Restoration

Recommended expansion of restoration at Pocosin Lakes NWR

Why?

- Peatland restoration allows substantive nitrogen sequestration benefits
- Refuge habitat improvement
- Planning complete; accelerates priority project
- Proximity to new facility loads

Pocosin restoration = ideal off-set

- Nutrients and carbon accumulate in deep organic soils
- Drained in the 70s for ag and peat mining
- Drainage promoted organic matter decomposition and loss of nitrogen and carbon to atmosphere
- Drainage networks enhance delivery to downstream waters
- Restoration stops loss of soil constituents

Nitrogen and Carbon Sequestration: Accounting

Drained Condition

N, C and Hg loss via oxidation

(SOURCE)

Restored Condition

nitrogen, C and Hg sequestration

(SINK)

Components of estimate:

1) amount retained that would otherwise be lost without restoration
2) amount retained in peat as soil genesis is re-established
3) amount retained in above ground biomass

1) Amount retained that would be lost without restoration (stop loss)

Rate of peat loss (ft/yr)	X	Bulk density (kg/ft^3)	X	Peat N or C content (%)	X	CF	=	lb/ac/yr sequestered

where CF = conversion factors for ft^2/ac and lb/kg

- Rate of peat loss when drained 0.03 ft/yr
- Bulk density 0.2 g/cm^3
- Peat nitrogen content 1.35%
- Peat carbon content 43%

= 190 lb N/ac/yr and 6100 lb C/ac/yr

2) Amount retained in peat as soil genesis is re-established

Bulk density (kg/ft^3)	X	Peat depth (ft)	X	Peat age (yr)	X	Peat N or C content (%)	X	CF	=	lb/ac/yr sequestered

where CF = conversion factors for ft^2/ac and lb/kg

- Peat depth northwest of Pungo Lake = 7.6 ft
- Peat age northwest of Pungo Lake = 7500 yr
- Soil property info as on previous slide

= 7 lb N/ac/yr and 230 lb C/ac/yr

3) Amount retained in above ground biomass

Above ground biomass (lb/ac)	X	Biomass N or C content (%)	X	Age of mature vegetation (yr)	=	lb/ac/yr sequestered

- Above ground biomass in tall pocosin 3300 g/m2 (29,000 lb/ac)
- Biomass N content 0.09% (mid-range reported for shrub pocosins)
- Biomass C content 1.0%

= 0.6 lb N/ac/yr and 140 lb C/ac/yr

Off-Set Accounting

Components of estimate:	Sequestration (lb/ac/yr) Nitrogen	Carbon
1) amount retained that would otherwise be lost without hydrology restoration	190	6100
2) amount retained in peat as soil genesis is re-established	7	230
3) amount retained in the above ground biomass	0.6	140
TOTAL:	200	6500

Benefits of Restoration

- 16,000 acres drastically altered peatlands targeted for restoration on Pocosin Lakes NWR
- State funds expand and accelerate restoration; with Coastal Program and Refuges will restore 7,500 acres

Nitrogen Retained (lbs/ year)	Carbon Retained (lbs/ year)
1,500,000	48,000,000

- When complete, 95% of the new CAFO nitrogen deposition will be offset
- Ongoing restoration will more than balance the remaining load

Benefits of Restoration: Carbon

Carbon sequestration estimate (6500 lb C/ac/yr) indicates restoration project will sequester the carbon in ~82,000 tons of CO_2/yr

Project Implications

- EC Program can help achieve the Service's wetland/riparian restoration goals with pollutant offset projects
- Wetland restoration offers nutrient and carbon sequestration
- Sequestration potential not limited to peatlands

But……

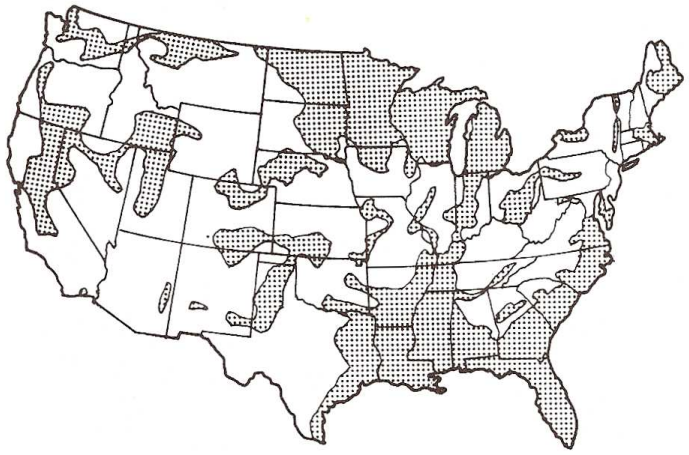
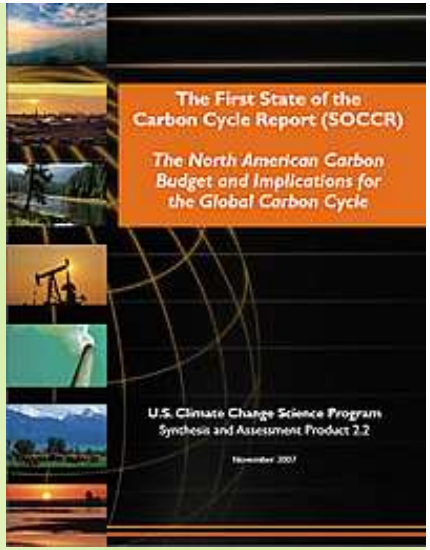


Figure 3-8. Distribution of wetlands in conterminous United States as adapted from Shaw and Fredine (1956). The Shaw and Fredine map emphasized wetlands that were important to waterfowl, so many major wetland areas may be missing from this map. *(After Office of Technology Assessment, 1984, p. 26)*

USDA-NRCS Histosols distribution map
http://soils.usda.gov/technical/classification/orders/histosols_map.html

Not all wetlands are created (or re-created) equal….



	Area[a] (km^2)	Carbon Pool[b] (Gt C)	Net Carbon Balance[c] (Mt C/yr)	Historical Loss in Sequestration Capacity (Mt C/yr)	Methane Flux (Mt CH_4/yr)
Alaska					
Peatland	132,196	15.9	-2.0	0.0	0.3
Freshwater mineral	555,629	27.1	-9.4	0.0	1.4
Estuarine	8,400	0.1	-1.9	0.0	0.0
Total	696,224	43.2	-13.0	0.0	1.7
Conterminous United States					
Peatland	93,477	14.4	5.7	1.2	0.7
Freshwater mineral	312,193	6.2	-9.8	7.6	2.4
Estuarine	25,000	0.6	-5.4	0.5	0.0
Total	430,670	21.2	-9.5	9.4	3.1
U.S. TOTAL[d]	1,126,895*****	64.3**	-23*	9.4*	4.8**

[a] Estuarine includes salt marsh, mangove, and mudflat.

[b] Includes soil carbon and plant carbon, but overall soil carbon in 98% of total pool.

[c] Includes soil carbon sequestration, plant carbon sequestration, and loss of carbon due to wetland drainage. Plant carbon sequestration and soil oxidative flux due to drainage are either unkonwn or negligible for North American wetlands except for the c

[d] Uncertainty conventions. ***** (95% certain that value is within 10% of reported estimate), ** (95% certain that value is within 100% of reported estimate), * (uncertainty greater than 100%).

Project Implications: Climate Change

- Wetland restoration projects may be attractive source of credits (EC program can provide technical leadership) in emerging carbon markets
- Carbon exchange projects largely do not address habitat restoration (opportunity for Service to steer trading to benefit trust resources)


Photo: S.Ward, USFWS

Summary

1) Off-setting new pollutant loads with equivalent local pollutant reduction is a sound approach; an achievable pollution prevention outcome (try it!)
2) Peatland restoration is attractive as offset
   - Sequestration
   - Habitat benefits
3) Restoring other wetlands also provides sequestration benefits (check into it!)
4) Potential for similar restoration projects to be important in carbon markets
5) Service being challenged to address climate change - example of what we in EC can do; quantifiable and reportable in acres restored an pounds of pollutants sequestered

Acknowledgements

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Thanks!