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The restoration, conservation, or avoided loss of tidal wetlands carbon pools may help to mitigate climate change



Stephen Emmett-Mattox is Senior Director of Strategic Planning and Programs at Restore America's Estuaries.



Stephen Crooks is Director of Climate Change Services, ESA PWA.



Jette Findsen is Program Manager for Climate Change, Science Applications International Corporation.

Are tidal wetlands ready for the carbon markets? Nearly so. That is the conclusion of a national panel of experts convened in 2010 to identify and address the scientific, policy, and economic challenges of creating greenhouse gas offset credits through tidal wetlands restoration and management.

Tidal wetlands hold vast stores of carbon, some within standing biomass, but mostly within deep organic-bearing soils. These stores have built up over millennia and reflect significant pools of carbon dioxide transferred from the atmosphere and sequestered within roots and other organic material. The loss of wetland area, either through erosion or diking, eliminates its ongoing sequestration capacity, and draining wetlands releases within a few decades carbon that took centuries or millennia to accumulate.

The restoration, conservation, or avoided loss of tidal wetlands carbon pools may be attractive to those seeking to mitigate climate change. Questions arise: Can we halt the release of carbon from converted or eroding wetlands, and can we reverse these losses through wetlands restoration? Can the GHG mitigation value of these wetlands be quantified and internalized in financial markets at a rate that makes projects viable? Wetlands also offer well-recognized ecosystem benefits that are not fully captured in management decisionmaking. To the coastal conservation community, connecting wetlands restoration and management to the carbon market offers the attractive potential of a new and sustainable funding stream.

GHG offsets have long been promoted as an important element of a comprehensive climate change policy approach. By enabling offsets to be developed where the cost may be lower, offsets projects and programs can reduce the overall cost of achieving a given emissions reduction goal, a finding supported by economic analyses.¹ Furthermore, some offsets have the potential to deliver ecosystem sustainability co-benefits and to develop human and institutional capacity for reducing emissions in sectors and locations that are uncapped or otherwise unregulated under a cap-and-trade system or mandatory government policy.

There are challenges and concerns voiced by the financial, science, and conservation communities. While tidal wetlands do effectively sequester carbon, those in low salinity settings emit methane (CH₄) as well. CH₄ is approximately 21 times

more powerful as a GHG than CO₂, where even low emission rates can be significant. While CH₄ has a half-life in the atmosphere of only a few years, and carbon is in the ground for centuries to millennia, the short time frame needed to mitigate future climate change requires us to focus on clear and immediate near-term mitigation benefits.

Moreover, until very recently, the science, economics, and policy communities have not focused on incorporating tidal wetlands into the carbon market. As such, there is a need for focused and coordinated data collection and modeling activities to build comparable wetland GHG emissions budgets.

Some in the conservation community are also concerned that if wetlands were to be drawn into the financial market that focuses on carbon and not ecological functioning, then biodiversity-poor carbon farms would be built. Such concerns can be addressed in the frameworks used to establish GHG offset protocols to avoid detrimental impacts to coastal systems. And, in fact, it is our recommendation that a wetland GHG offset protocol requires wetlands projects to support the ecosystem restoration goals and ecological recovery of a region.

Drawn by the potential to bring new and sustainable financial resources to coastal habitat restoration, Restore America's Estuaries began an intensive effort 18 months ago to understand the linkages between GHG sequestration, tidal wetlands restoration, climate adaptation and mitigation, and GHG offset protocols and markets.

RAE asked:

- Does wetland science support the hope and expectation that tidal wetlands have net GHG sequestration rates comparable to, or better than, forests on a per acre basis?
- How do you ensure that tidal wetlands restoration projects undertaken for climate mitigation purposes also support ecological restoration and climate adaptation goals?

• What is the process for developing an offsets protocol, and how can we support it?

• Is the restoration community prepared to participate in the GHG markets through the creation of offsets credits?

The answers to these questions are encouraging, and in August 2010 we released the findings of the National Blue Ribbon Panel on the Development of a Greenhouse Gas Offset Protocol for Tidal Wetlands Restoration and Management, subtitled an Action Plan to Guide Protocol Development.

This was new territory for RAE, so we quickly began to build a partnership with experts in the field, including Philip Williams & Associates, now ESA PWA,² with expertise in wetland science, and Science Applications International Corporation, which has helped to develop several offset protocols in other sectors. The Environmental Defense Fund

and The Nature Conservancy, which are working to use carbon sequestration as a means to reverse decades of soil loss in the Sacramento Delta, and the California State Coastal Conservancy, which works on coastal conservation and policy responses for sea-level rise adaptation, also joined to form the project working group. Early in the effort, we also successfully sought participation from the Climate Action Reserve, a North American GHG registry that has developed several protocols.

The starting point for this effort was the Greenhouse Gas Mitigation Typology Issues Paper: Tidal Wetlands Restoration, prepared for the Climate Action Reserve, in early 2009 (PWA & SAIC 2009), which identified several obstacles to protocol development. It became clear that a national panel populated by experts from a diverse range of backgrounds was needed to establish broad consensus on the potential of wetlands to be incorporated into the carbon market, and to set in motion a process to develop the necessary science and policy to achieve this.

RAE recruited panel members with expertise in wetlands management, carbon sequestration, GHG accounting, and offsets protocols and markets. Pan-



el members are:

- Stephen Crooks, ESA PWA, Panel Chair
- Tim Dillingham, American Littoral Society
- Abe Doherty, California Coastal Conservancy and Ocean Protection Council
- Jette Findsen, Science Applications International Corporation
- Kathryn Goldman, Climate Action Reserve
- Patrick Megonigal, Smithsonian Environmental Research Center
- Ken Newcombe, C-Quest Capital
- Lydia Olander, Nicholas Institute for Environmental Policy Solutions, Duke University
- Brad Raffle, formerly of Conservation Capital, LLC
- Debbie Reed, DRD Associates
- Diane Ross-Leech, Pacific Gas & Electric Company
- Eric T. Sundquist, U.S. Geological Survey
- Robert Twilley, Louisiana Office of Coastal Protection and Restoration
- Michael Wara, Stanford Law School

The panel was tasked with determining an action plan to guide protocol development for tidal wetlands. An offset protocol provides the necessary guidance to calculate, report, and verify GHG emission reductions associated with offset projects. It provides a reliable framework for implementing tidal wetlands projects to create offset credits that are likely to be recognized by current climate markets and registries, and under emerging climate change laws and regulations.

A national protocol is the critical next step in bringing tidal wetlands into the carbon markets. An offset protocol is a set of requirements and procedures, adopted by registries and markets, that enables the creation of and accounting for offset credits from a specific project. GHG offset registries and markets have varying standards and required elements for offset protocols, but share many commonalities.

Essentially, a protocol is the means to ensure that offsets projects are suitable for receiving credits before credits are issued. For tidal wetlands, an offsets protocol can require that projects are ecologically appropriate, additional, permanent, and verified by an independent third party. A national tidal wetlands protocol would provide standardized criteria, methodologies, and tests that remove the burden from each individual project having to prove that a wetlands project merits offset credits.

Some protocols take a bottom-up approach, while others take a top-down approach. A bottom-

up approach requires each project to demonstrate that the project will deliver net GHG sequestration benefits. A top-down approach is a standardized methodology and set of criteria that allows any project to fit. Projects still must meet specific standards, but the burden on each project is lessened by providing an umbrella under which it can generate offset credits. Our approach has been to develop a top-down national protocol utilizing standardized methodologies and criteria.

The CAR, and several other registries, look to screen and then address a number of questions both before and during protocol development:

- Does the project lend itself to a performance standard-based approach?
- Can the project demonstrate that carbon sequestered will be additional; i.e., would not have occurred without carbon financing?
- Can GHG emissions budgets be quantified for existing land uses and for the project?
- Is the reduction potential significant?
- Can the project boundary and GHG fluxes across that boundary be clearly defined?
- Can ownership be unambiguously determined?
- Can leakage be assessed; i.e., will secondary carbon losses occur external to the project boundary because of the project?
- Can risk to carbon storage permanence be assessed and mitigated?

The issues paper drafted for the CAR explored these questions. To tackle outstanding issues, the panel recommended a broad programmatic approach involving four foundational working groups to tackle nationwide technical science, economic, and policy questions, and three high-priority case study-based working groups to test proof-of-concept.

The first question that arises in a developing protocol is which projects are eligible. A clear project definition is needed to guide project developers and others. Tidal wetlands are complex systems, and restoration, management, and avoided loss of tidal wetlands can quickly create complicated scenarios. The panel defined a tidal wetlands GHG offset project as a planned set of activities to remove, reduce, or prevent GHGs in the atmosphere by conserving and/or increasing wetlands carbon stock and/or lowering GHG emissions. Project activities that could be included in a protocol encompass four management approaches to wetlands:

Avoided Wetlands Loss. Conserving and avoiding loss of existing wetlands carbon stocks that would otherwise be at risk of CO₂ release by erosion and/or human impacts.

Wetlands Restoration. Actions taken in a converted former wetland or degraded natural wetland that result in the reestablishment of ecological processes, functions, and biotic and abiotic linkages, and lead to a persistent, resilient, and integrated system.

Wetlands Management. Manipulating one or more functions performed by an existing degraded wetland beyond baseline conditions of existing practice.

Wetlands Creation. Conversion of a non-wetland (terrestrial upland or unvegetated water) to a vegetated wetland where no wetland previously existed.

Each of these project activities has parallels with principles of wetland science and with principles established for existing national and international forestry GHG offset protocols and methodologies. The panel recognized as important an initial step to develop clear and overarching definitions that categorize near-term and potential future project activities. There is a concern that piecemeal bottom-up project development can lead to contradicting or misaligned use of terminology as protocols and policies develop. For example, wetland enhancement and management do not necessarily mean the same to negotiators developing global GHG mitigation policy as they do wetland scientists. Establishing clear definitions for project activities is needed now as GHG offset frameworks are being developed at both national and international levels.

The panel also noted the likelihood that a single large wetlands project may include several of the above project activities, opening the possibility that it could be subject to several types of eligibility tests and quantification procedures. Because of this complexity in wetlands projects, it may be difficult to fit such projects within some offset program approaches, particularly those that rely on standardized eligibility tests. As a result, further work will be needed to better define and categorize relevant project activities, based on common practices and functionalities related to the restoration and management of tidal wetlands, in a way that best enables protocol standardization.

Once a project definition is agreed upon, the next key issue that arises is additionality. A chief concern of any offset project is that it produces GHG emission reductions/net sequestration beyond those that would have occurred otherwise, under business-as-usual practices. Only projects that are truly additional should receive credit and be used to meet emission targets or offset other emissions. For example, where tidal wetlands projects are required

for mitigation purposes, net GHG sequestration resulting from the project is not additional, because it would have occurred already. Voluntary restoration or management activities more easily meet an additionality test. The panel recommends a working group address several key considerations.

To determine what is truly additional, we must first determine to what extent restoration and management activities are already occurring and considered business as usual. This effort may involve collecting survey data on the opportunity for tidal wetlands projects nationally and regionally, current tidal wetlands projects, typical restoration or management practices, the funding decisions that led to the implementation of the projects, and the level of participation by local, state, and federal agencies in the projects.

Guidance is needed to determine the relevance of public ownership, management, and funding to project eligibility. The panel recommends that projects on public lands and with public funding not be ruled ineligible.

More research is needed to address the question of whether financial incentives can be stacked to fund a project. Opinions differ. Given the current value of carbon is not high, would a project have happened anyway if larger funds for, say, flood management benefits bring a project to fruition? This question must be addressed in concert with consideration of other biological GHG offset protocols.

The next issue is permanence. A protocol provides procedures for assessing and managing the risk of reversal of GHG reductions or removals. The panel recommends that a working group examine issues related to ensuring the permanence of GHG reductions and removals, and credits generated from tidal wetlands projects. For tidal wetlands, GHG offset projects may be at risk due to such factors as change of environmental policies; project manager financial failure; engineering failure, e.g., collapse of structures, such as levees; vegetation eradication to manage invasive species; disruptive impacts of large natural events; progressive impacts of sea-level rise and climate change; and human-induced disruption to upstream water and sediment supply. A working group must examine the potential for such reversals to occur, as well as methods for managing and reducing risk.

The key calculation in issuing GHG offset credits is the net GHG sequestration resulting from a project, beyond what would have happened if the project had not occurred. While measurement technologies are available to quantify carbon storage and GHG emissions, the scientific utilization of

these technologies has not been focused on building datasets to support detailed and cost-effective GHG budgeting for tidal wetlands projects. There is a need to establish cost-effective, rigorous, and replicable standardized approaches for quantifying baseline and project GHG benefits.

A number of activities are moving forward on this front that future and parallel activities should build upon. Foremost, a scientific working group sponsored by the National Center for Ecological Analysis and Synthesis, or NCEAS, has drawn together wetland scientists to develop a carbon sequestration and GHG emissions model for salt marshes.³ This approach builds on models developed for projecting rates of soil elevation change in tidal wetlands.⁴

Modeling the processes that produce CH₄ and also nitrous oxide (N₂O) is more challenging. This NCEAS working group and other groups are poised to test process-driven models that illuminate biogeochemical processes in freshwater wetlands. For example, the denitrification decomposition model is being tested on rice fields and is proposed as a leading candidate for detailed simulation of GHG (CO₂, CH₄, and N₂O) emissions for agricultural baseline conditions,^{5,6} as well as mangrove systems.⁷ This approach may potentially extend to simulating restoration of managed tidal freshwater wetlands and salt marshes.

Once the capacity to model soil biogeochemistry of GHG production and storage exists, processes will be needed to establish simple landscape-level assessment approaches; i.e., the establishment of regional look-up tables of GHG budgets by wetland class, and to develop simple field testing to track project performance. The science is ready, but the work needs to be done, and in a coordinated manner using standardized approaches.

The questions of leakage fall under both permanence and quantification working groups. Approaches will need to be developed to assess whether project activities will lead to secondary GHG emissions beyond the project boundary.

In addition to these fundamental issues, the panel recommended several geographic case studies to demonstrate proof-of-concept and address information gaps for relevant activities and specific wetlands classes. Case studies should be designed to address specific issues that will be encountered in protocol development.

Potentially, the biggest carbon sequestration bang for the buck can be found through two project activities: first, protecting existing wetlands from

drainage, because carbon-rich soils release CO₂ rapidly when water tables are lowered and, second, restoring freshwater tidal wetlands associated with water management and subsidence reversal of subsided lands through organic soil buildup.

In the latter case, the panel recommends supporting the established science community in the Sacramento–San Joaquin Delta. Here, the U.S. Geological Survey and others have been exploring subsidence reversal and carbon sequestration for more than 10 years. The potential for high carbon sequestration, even taking into account CH₄ emissions, has been demonstrated, but further testing of water management to optimize carbon sequestration against CH₄ emissions is needed.

The panel also recommended a case study in a highly saline marsh where sea-level rise drives continual sequestration of soil carbon through burial, and the high sulfate content of sea water suppresses CH₄ emissions. One of the main challenges in bringing salt marshes into carbon markets is the ability to quantify the risks to permanence, particularly associated with sediment management and sea-level rise.

Finally, the panel recommended considering a large deltaic coastal wetland system; e.g., the Mississippi Delta, in which several different baseline conditions may exist, but where restoration or management would need to be highly coordinated. It is important that results from these case studies be coordinated and integrated with the efforts to address the foundation issues.

The panel discussed these issues and more in-depth during a two-day intensive workshop in April 2010. The panel recommended the creation of several working groups described earlier to address specific action items required for protocol development. In August 2010, RAE released these recommendations in the Findings of the National Blue Ribbon Panel on the Development of a Greenhouse Gas Offset Protocol for Tidal Wetlands Restoration and Management: Action Plan to Guide Protocol Development.⁸

Since undertaking this initiative, national and international interest in tidal wetlands as potential generators of GHG offsets has grown tremendously. As one example, the Kerry-Lieberman climate legislation introduced in the U.S. Senate in May 2010 specifically identified “projects to restore or prevent the conversion, loss, or degradation of vegetated marine coastal habitats”⁹ as eligible climate offset project types. The economic, ecological, and climate mitigation potential of tidal wetlands GHG offset projects is very strong. There is a critical need for a coordinated effort that combines an emphasis

on central issues with site-specific case studies. RAE and its many partners are committed to working to address the panel's recommendations to achieve timely development of a protocol that is effective, transparent, rigorous, cost-effective, and broadly applicable to the requirements of registries and resource managers.

We look forward to making the connections between climate change adaptation and mitigation and coastal wetlands restoration and management that can result in healthy, resilient, and sustainable coastal ecosystems. •

Notes

1. Kollmus, Anja, et al., *Handbook of Carbon Offset Programs: Trading Systems, Funds, Protocols and Standards* (Earthscan 2010).
2. Now known as ESA PWA.
3. See <http://www.nceas.ucsb.edu/featured/callaway>.
4. Morris, James T. et al., Responses of Coastal Wetlands to Rising Sea Level, 83 *ECOLOGY* 2869-77 (2002).
5. Fumoto, Tamon et al., Revising a Process-Based Biogeochemistry Model (DNDC) to Simulate Methane Emission From Rice Paddy Fields Under Various Residue Management and Fertilizer Regimes, 14 *Global Change Biology* 382-402 (2008).
6. Qiu, Jianjun et al., Modeling Impacts of Carbon Sequestration on Net Greenhouse Gas Emissions From Agricultural Soils in China, 23 *Global Biogeochemical Cycles* 1007 (2009).
7. World Bank, Project Appraisal Document on a Proposed Purchase of Emission Reductions by the Biocarbon Fund and Other Carbon Funds, Report No. 45642-TT, Trinidad and Tobago, Nariva Wetland Restoration and Carbon Sequestration Project (2008).
8. Crooks, Stephen, et al., Findings of the National Blue Ribbon Panel on the Development of a Greenhouse Gas Offset Protocol for Tidal Wetlands Restoration and Management (Restore America's Estuaries, Philip Williams & Associates, Ltd., and Science Applications International Corporation 2010), available at <https://www.estuaries.org/climate-change.html>.
9. S. 1733, The Clean Energy Jobs and American Power Act, 111th Cong., discussion draft, 388