promise of coastal blue carbon is not yet fully understood and will only be realized as we take bold steps forward. The authors in this issue are taking those steps and herein share their inspiration and the lessons they have learned.

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Carbon Sequestration Benefits of Peatland Restoration: Attracting New Partners to Restore National Wildlife Refuge Habitats

By Sara Ward and Scott Settelmyer

The U.S. Fish and Wildlife Service (FWS) is interested in attracting new partners in the delivery of quality biological carbon sequestration projects that produce real and measureable carbon dioxide (CO_2) reductions, while at the same time advancing our wildlife conservation mission. To date, FWS has collaborated with conservation organizations and other private entities on projects that have restored over 80,000 acres of bottomland hardwood forests and will sequester over 33 million tons of carbon. We are expanding our focus to include priority ecosystems beyond bottomland hardwoods, where the restoration need and carbon sequestration capacity is great. Peatlands, like those at the Pocosin Lakes National Wildlife Refuge (NWR), are one ecosystem where FWS is collaborating with an array of stakeholders to increase resiliency to climate change through restoring the hydrology of these carbon-rich wetlands.

Rewetting drained peatlands is a quantifiable approach to sequestering greenhouse gas (GHG) pollutants. Under normal saturated hydrologic conditions, decomposition in organic soils is minimized, allowing for accumulation of organic carbon (approximately 40% C content) in peatlands worldwide (Dolman & Buol 1967; Thompson et al. 2003). Peatland forests are gaining global recognition for their tremendous carbon sequestration potential (e.g., they cover only 3% of the world's land area, but contain the equivalent of twice the carbon stock of all forest biomass worldwide (Parish et al. 2008)). Reintroduction of wetland hydrology in peatlands stops the loss of carbon via peat oxidation while allowing carbon sequestration via soil accretion and biomass to resume. Peatland rewetting is achieved by installing water control structures to raise the water table, to encourage the more natural sheet flow (rather than channelized flow from the artificial ditches), and to attenuate runoff.

Millions of hectares of former peatlands in the United States have been drained and converted to agriculture and forestry. North Carolina's Albemarle-Pamlico Peninsula is the site of the greatest pocosin, or southeastern shrub peat bog, acreage in the United States (Richardson et al. 1981); however, 70% of pocosin habitat in North Carolina has been lost since the 1960s, and there is a significant restoration potential. For example, site-specific rewetting benefits at the Pocosin Lakes NWR are estimated at 1,080 metric tons of CO_2 equivalents (t CO_2-e) per acre over 100 years that will ultimately sequester over 21 million t CO_2-e for the roughly 20,000 acres of restoration collaboratively completed to date. A study to verify the carbon benefits is underway via a partnership with the Duke University Wetlands Center and The Nature Conservancy. With nearly one-half million acres of restorable peatlands in the Albemarle Sound region of North Carolina and Virginia (and 100,000 on FWS lands alone), refuges can substantially contribute to international targets for carbon sequestration through rewetting efforts while also providing important proof-of-concept examples for private landowners to follow.

In addition to the carbon benefits realized through peatland restoration, restoring hydrology conditions provides other important benefits to terrestrial and aquatic ecosystems, and human communities. Extensive drainage networks at the refuges, resulting from a land use legacy of agriculture and forestry, allow runoff to reach the Albemarle and Pamlico Sounds. The drainage canals that were historically constructed to artificially lower the water table enhance the off-site transport of soils and their constituents (Daniel 1980; 1981), remobilizing mercury (Lodenius et al. 1987) and nutrients (Brinson 1991). Extensive drainage also leaves FWS and surrounding private lands vulnerable to catastrophic fires and enhanced stormwater delivery during significant storms. Healthy pocosins require periodic fire, but lowered water tables render peatlands vulnerable to more frequent and severe fires. During such fires, losses of up to five feet of peat deposits have occurred, releasing approximately 20 million tons of carbon during four separate fires in 2008 and 2011 on North Carolina and Virginia NWRs (Mickler & Welch 2011; Mickler 2012). These fires result in abrupt habitat changes, massive carbon releases to the atmosphere, significant impacts to air quality and public health, vulnerability to sea-level rise, and massive financial costs for suppression. In low-elevation peatlands, the extensive network of ditches also allow the wind-tide-driven systems to jet brackish water much further into the interior resulting in accelerated shoreline erosion and peat decay. Restoring the hydrology is a fundamental climate change adaptation strategy as it allows the soil to reaccumulate by preventing incremental (via oxidation) and catastrophic (via burning) soil loss, limits saltwater intrusion, maintains necessary soil moisture and promotes carbon sequestration benefits, and helps mitigate impacts of flooding and storm events.

Given the scale of peatland rewetting need, the magnitude of the estimated carbon sequestration benefits, and significant ecosystem co-benefits (FWS 2010), there is an opportunity to expand this type of restoration to other peatlands throughout the United States and globally. Project development is presently limited by the lack of approved methodologies for quantifying the GHG benefits of peatland restoration (CAR 2013), and maybe more importantly, by the relatively limited demand in the voluntary carbon market. To date, there are two peatland rewetting methodologies that have been developed in the voluntary carbon market under the Verified Carbon Standard and that are currently in the process of independent validation (Winrock Int'l 2011; Silvestrum 2011). One of these methodologies is globally applicable and can be applied using local or regionally appropriate research data on GHG emission relationships with proxy variables such as water levels or vegetation (Silvestrum 2011). While this methodology lays out a practical and robust approach to measuring GHG emissions, there is limited experience with applying it to proof-of-concept projects (e.g., no projects have been advanced in the United States to date). These projects are critical to demonstrating the technical feasibility of peatland rewetting methodologies to regulatory agencies such as the California Air Resources Board (CARB), who could in turn approve peatland carbon offsets for use in California's GHG cap-and-trade program and create a more robust compliance market demand to support investment in peatland rewetting efforts.

The development of a proof-of-concept project is also of particular interest to FWS as a means to address any legal and institutional issues that may limit the potential eligibility of carbon projects implemented on federal lands to receive compliance credits. The Climate Action Reserve (CAR) has released a white paper regarding the basis of concerns that rendered forest offset projects on federal lands ineligible for regulatory crediting by CARB (CAR 2012). The white paper outlines an approach acceptable to the CAR for federal land management agency participation on compliance carbon projects (e.g., projects are implemented on private lands and ultimately transferred, with carbon rights retained by a private entity, to federal ownership for long-term stewardship) and identifies potential future opportunities to address policy and legal hurdles that could expand projects on federal lands in the future.

There is a tremendous opportunity to reduce GHG emissions, to restore natural hydrological processes, to reduce costly fires, and to improve ecosystem resilience to climate change by rewetting peatlands in the United States, including on FWS lands. The development of carbon market incentives to rewet peatlands could provide significant funding and attract new partners to undertake peatland restoration activities. However, funding to undertake these activities at scale will require strong carbon market incentives, based on deep compliance markets such as the California GHG program. It is therefore critical at this point to develop proof-of-concept projects using voluntary carbon market standards in order to demonstrate to regulators that the GHG benefits of peatland rewetting can be credibly quantified, undertaken at scale on federal lands with appropriate legal and policy tools to satisfy regulatory eligibility requirements, and meaningfully contribute to achieving GHG emission reduction targets.

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Making Blue Carbon Real: Five Recommendations for Project Developers

By Dr. Igino Emmer and Dr. Moritz von Unger

Blue carbon is a relatively recent phenomenon, but carbon projects in the land use sector have existed for some time. They were first developed in the early 1990s by foresters, with tree-planting programs pioneering certification, and with in-house greenhouse gas (GHG) verification services by certification companies. The Clean Development Mechanism (CDM) followed a decade later with its afforestation and reforestation (A/R) project category, for which to date more than 10 GHG accounting methodologies have been developed, all consolidated into four methodologies for wetlands and non-wetlands, large-scale and small-scale, and with 51 A/R CDM projects registered. Other carbon standards—operating in the voluntary carbon markets—have subsequently covered the vast, unexplored ground left by the CDM. Since its launch in 2007, the Verified Carbon Standard (VCS) initiated projects and methodologies for forest conservation, improved forest management, agricultural land management, and, more recently, wetlands restoration and conservation. In the land use category, the VCS has approved more than 10 methodologies and a myriad of modules for specific accounting procedures, as well as more than 30 individual projects. Four peatland-related methodologies (three for tropical regions and one for temperate climates) and one tidal wetland methodology for Louisiana are currently under validation by the VCS. The American Carbon Registry (ACR) recently approved a wetlands restoration methodology for the Mississippi Delta (for more on this, see Sarah Mack's sidebar on page 17).

Considerable expertise and technical knowledge have been built up over the years that can serve current and future blue carbon initiatives. This expertise has been captured in various guidance books,[1] the development of standardized approaches for certain aspects of baseline setting and carbon accounting (e.g., the VCS), public access to various models for contractual arrangements, such as purchase agreements,[2] and the development of methodological modules (VCS and ACR).

But while many projects reached completion and have often proved perfectly resilient long after the intervention took place, many other initiatives have never moved beyond the design or test phase. The reasons are numerous. Sometimes, project proponents found out (too late) that certain mandatory carbon requirements were not met. Sometimes, necessary seed financing was not in place. Sometimes, land access and control could not be secured (and maintained). Sometimes, the political context was not favorable. In many cases, the development of a dedicated carbon project served as a secondary goal and only received attention when the project was too far along in the design and implementation process to make necessary amendments. Unfortunately, factors that lead to the failure or deferral of carbon projects are not usually shared with the public or other project developers, and therefore newcomers will often not benefit from lessons learned.

What most of the failed or troubled projects have in common is that the proponents did not make the right prioritizations from the start. Land use and coastal use-related projects