May 20, 2007

Notes on Carbon Sequestration and Tidal Salt Marsh Restoration

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Summary:
From the standpoint of habitat restoration, recent research shows that restoring tidal salt marshes is one of the most effective measures for sequestering carbon that we can take. While people often look to planting trees as a way to take carbon from the atmosphere, marsh restoration may be even more efficient, per unit area, at removing carbon. Tidal marshes are extremely productive habitats that remove significant amounts of carbon from the atmosphere, large amounts of which are stored in marsh soils. Unlike many freshwater wetlands, saltwater tidal marshes release only negligible amounts of methane, a powerful greenhouse gas; therefore, the carbon storage benefits of tidal salt marshes are not reduced by methane production. In addition, as sea levels rise, tidal marsh plains continue to build up to match the rise in water level, if suspended sediments are adequate, continually pulling carbon dioxide out of the air in the process. While specific research is needed to quantify the carbon sequestration capacity of San Francisco Bay tidal marshes, in general, restoring tidal marshes is certainly an effective method for removing carbon dioxide from the atmosphere. Marsh restoration should be actively pursued as a method to sequester carbon. Some literature supporting this summary is given below.

Literature Information:

- Salt marshes are widely recognized as some of the most productive ecosystems on earth, with primary productivity that rivals industrialized agriculture (Mitch and Gosselink, 2000).
- Tidal marshes can produce up to 8000 metric tons of plant material per year (Mitch and Gosselink 2000), a process by which plants continually remove CO_2 from the atmosphere and convert it to plant material. Marsh grasses and other macrophytes, microalgae on the mud surface, and phytoplankton are the three primary components of the natural community that remove CO_2. While some of this annual productivity will be consumed or decompose, substantial amounts of carbon accumulate in tidal marsh soils, especially from belowground plant production.
- In central and southern California tidal salt marshes, macrophytes produce about 450 g of carbon per square meter per year and the algae productivity adds an additional 340 to 630 g of carbon per square meter per year (Zedler 1980). Within San Francisco Bay, Mahall and Park (1976) estimated annual primary productivity for *Spartina foliosa* ranging from 270 to 690 g/m^2 yr, and 550 to 960 g/m^2 yr for *Sarcocornia pacifica* (formerly *Salicornia virginica*). In comparison, Atwater et al. (1979) did not estimate annual productivity but found end-of-year biomass ranging from 300 to 1700 g/m^2 for *S. foliosa* and 500 to 1200 g/m^2 for *S. pacifica* (J. Callaway, pers. comm.).
- The carbon compounds in marsh organisms have a variety of fates, one of which is storage in the soil. When stored in the soil, the carbon is primarily taken out of the

system as decomposition rates under anaerobic conditions are low. As a result, wetland soils are well-known as major carbon-storing ecosystems (Chmura, et al. 2003).

- The Intergovernmental Panel on Climate Change (nd) specifically discusses restoration of former wetlands as a strategy to sequester carbon from the atmosphere. The Panel states that restoration of former wetlands will remove CO_2 from the air and increase storage in soils. Thus, they recommend wetland restoration as a carbon sequestration strategy.
- One concern with wetland restoration is that many freshwater wetlands emit methane (CH_4), a powerful greenhouse gas. Thus, the carbon storage benefit from freshwater wetlands can be negated by wetland methane production. However, salt marshes release "negligible amounts of greenhouse gases and store much more carbon per unit area" (Chmura, et al. 2003) due to salt water soil processes. Thus, the benefits of salt marsh restoration for carbon sequestration are great.
- In fact, Choi, et al. (2001) found that as sea levels rise, the marsh plains continue to build up (accrete) and, as they do, they continually store carbon in the process. Thus, not only do tidal marshes help protect uplands from storm events, but they continue to take carbon from the atmosphere as sea levels rise, as long as there a large enough input of mineral sediments to build marsh soil and keep pace with sea-level rise. Choi, et al. (2004) conclude that, "Because of higher rates of C sequestration and lower CH_4 emissions, coastal wetlands could be more valuable C sinks per unit area than other ecosystem in a warmer world".
- It is important to note that when wetlands are drained the once anaerobic soils become exposed to the air. Increased rates of aerobic decomposition in these drained soils will release stored carbon back into the atmosphere as carbon dioxide.

Citations

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