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Age Determination of the Remaining Peat in the Sacramento–San Joaquin Delta, California, USA

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Introduction

The Sacramento–San Joaquin Delta of California was once a 1,400 square kilometer (km^2) tidal marsh, which contained a vast layer of peat ranging up to 15 meters (m) thick (Atwater and Belknap, 1980). Because of its favorable climate and highly fertile peat soils, the majority of the Delta was drained and reclaimed for agriculture during the late 1800s and early 1900s. Drainage of the peat soils changed the conditions in the surface layers of peat from anaerobic (having no free oxygen present) to aerobic (exposed to the atmosphere). This change in conditions greatly increased the decomposition rate of the peat, which consists largely of organic (plant) matter. Thus began the process of land-surface subsidence, which initially was a result of peat shrinkage and compaction, and later largely was a result of oxidation by which organic carbon in the peat essentially vaporized to carbon dioxide (Deverel and others, 1998; Ingebritsen and Ikehara, 1999). Because of subsidence, the land-surface elevation on farmed islands in the Delta has decreased from a few meters to as much as 8 m below local mean sea level (California Department of Water Resources, 1995; Steve Deverel, Hydrofocus, Inc., written commun., 2007).

The USGS, in collaboration with the University of California at Davis, and Hydrofocus Inc. of Davis, California, has been studying the formation of the Delta and the impact of wetland reclamation on the peat column as part of a project called Rates and Evolution of Peat Accretion through Time (REPEAT). The purpose of this report is to provide results on the age of the remaining peat soils on four farmed islands in the Delta.

Age Determination of the Peat

In the summer of 2005, peat cores were collected using a Livingstone corer from Sherman Island, Webb Tract, Venice Island, and Bacon Island in the Sacramento–San Joaquin Delta, as well as four relatively undisturbed Delta marsh islands. The farmed islands currently are being used to produce corn, safflower, wheat, alfalfa, and pasture. Bulrush seeds and charcoal samples found throughout the peat cores were sent for radiocarbon age determination (for example Byrne and others, 2001; Watson, 2004) to the Center for Accelerated Mass Spectrometry, Lawrence Livermore National Laboratories, Livermore, California.

Results from radiocarbon age determination showed that the bottom of the peat column dates back to nearly 7,000 years ago, indicating that the Delta started forming at about this time. In addition, the uppermost layer of intact peat that has not been physically disturbed by plowing or disking and has not been exposed to the atmosphere is mostly between 4,100 and 4,800 years old on Sherman Island, Webb Tract, and Venice Island, and 4,900 to 5,300 years old on Bacon Island (fig. 1). These dates refer to peat situated in the center of the islands, which are much more subsided than the perimeter of the islands (Mount and Twiss, 2005). Ages of peat along the perimeter of the islands are younger, except on Webb Tract where the coring location was near the island drain. This location most likely was subject to greater oxidation of peat than usually occurs near a levee. Therefore, the age of peat along the perimeter of Webb Tract may be somewhat younger in areas distant from the drain.

At the farmed island sites, there was no peat younger than approximately 3,000 years old, because the younger peat layers have already been lost through subsidence processes. In fact, most of the peat from these sites was over 4,000 years old (fig. 1). In contrast, peat cores collected from the unfarmed marsh islands, which are also being analyzed as part of the REPEAT project, contained peat that dated to within the past 100 years (not shown). These results indicate that, since reclamation, agricultural practices on the four farmed islands have largely consumed peat formed between approximately 150 to 4,000 years ago. Because the four farmed islands studied for this project are similar in land use and water management to other islands in the central and western Delta region, it is highly likely that a similar pattern of peat consumption pertains to this entire part of the Delta. As farming continues in the Delta, land-surface subsidence will consume older and older layers of peat, mainly through the process of oxidation, unless the practice of keeping an aerobic root zone is discontinued.

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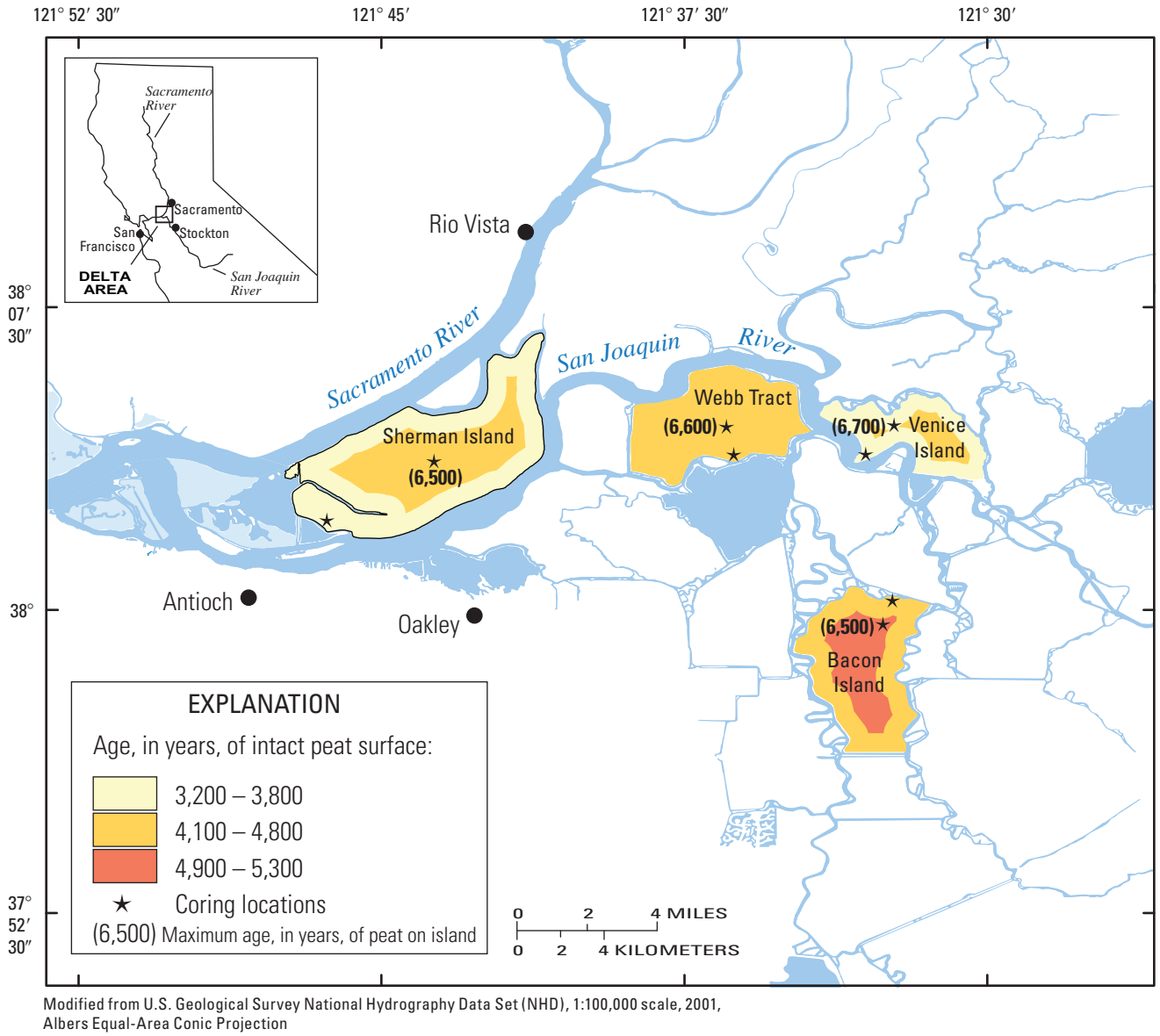

Modified from U.S. Geological Survey National Hydrography Data Set (NHD), 1:100,000 scale, 2001, Albers Equal-Area Conic Projection

Figure 1. Estimated age of the surface of the intact peat that underlies the physically disturbed and oxidized soil layer currently being farmed in the Sacramento–San Joaquin Delta, California. Marsh island sites are not shown.

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