

A Hydrologic and Restoration-Feasibility Study of a Carolina Bay in Aiken and Barnwell Counties, South Carolina

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Carolina bays are shallow wetland depressions characterized by an elliptical shape oriented in a northwest-southeast direction. These depressions are unique geometric features of the Atlantic Coastal Plain, occurring from New Jersey to northern Florida but heavily concentrated in North and South Carolina (Sharitz and Gibbons, 1982). Carolina bays vary in size from thousands of acres to less than 1 acre, and their hydrologic regimes can range from permanently flooded to frequently dry. As wetland systems, Carolina bays may have one or more associated wetland functions such as water storage, wildlife habitat, biodiversity conservation, or nutrient cycling (Lugo and others, 1990; U.S. Environmental Protection Agency, 1993; Sharitz and Gresham, 1998; Whigham and Jordan, 2003). Approximately 97 percent of Carolina bays in South Carolina have been disturbed (Bennett and Nelson, 1991). Main disturbances include conversion to agriculture or silviculture, where bays are often ditched and drained. The alteration of bay hydrology in these systems has degraded habitat for many plant and animal species.

The Heritage Trust Program, currently administered by the South Carolina Department of Natural Resources, has highlighted the need to preserve and/or restore these unique ecosystems and has identified a Carolina bay at Ditch Pond Heritage Preserve as a site suitable for preservation and possible restoration. Ditch Pond Bay (DPB) is a 25-acre Carolina bay on the border of Aiken and Barnwell Counties near Williston, S.C., and is a prominent feature of the Ditch Pond Heritage Preserve, which was acquired for preservation in December 2002. Water levels in the bay may be below normal because of a shallow ditch that extends from the bay to a drainage culvert north of the bay. A larger ditch, which drains an adjacent Carolina bay (White Pond Bay) just west of DPB, may be impacting the water levels by altering the local water table. DPB is relatively undisturbed as compared to most Carolina bays in South Carolina; however, the degree to which the hydrology at DPB has been altered from its natural state is uncertain.

A study of the bay was initiated in 2006 to determine the impacts of the ditches, the current water budget of the bay and the feasibility of restoration. Physical characteristics of the ditches (depths, bed elevations, local of plugs, etc.) were determined to help assess any current impacts to the bay's water levels. Surface-water levels in DPB were monitored by a staff gage and an automatic data recorder installed within the bay. A network of 23 monitoring wells and piezometers were also installed across the site to assess any potential ground-water recharge or discharge to the bay and to assess any drainage impacts from the ditches. Soil samples were collected during each well installation and at several additional boreholes to identify the presence of any semi-impermeable layers which may influence the ground water regime within and surrounding the bay. Automatic data recorders were installed in three well sites to record hourly ground water levels, and manual measurements were made on a bi-monthly to monthly basis.

A monthly water budget was used to assess the ground-water component of the bay. Rainfall, a major input to the bay, was measured by an onsite automatic rain gage, and evapotranspiration (ET), a major output, was estimated using temperature and evaporation pan data from a nearby, long-term weather station. A bathymetry study was also conducted to determine the volume of water in the bay as a function of surface water elevation and to compute changes in storage from month to month. Differences in monthly rainfall and ET were compared to changes in storage to determine the magnitude of the groundwater component, if any. Data were measured or estimated over a four-year period from the spring of 2006 through the summer of 2010.

The period of record was dominated by below normal rainfall conditions and included the severe drought of 2007 and 2008. Rainfall for the April-December period in 2006 was below normal by nearly 5 inches, while rainfall totals for 2007 and 2008 were approximately 12 inches and 6 inches below normal, respectively. Drought conditions ended during 2009 and rainfall amounts were two inches above normal. After a wet 2009-2010 winter period, rainfall deficits had reached approximately 5 inches by June 2010. Surface-water levels generally followed

rainfall patterns and were highest in the spring of 2006 with ponded depths of over 4 feet. The bay had completely dried out by the fall of 2007 in response to well below normal rainfall conditions. Water levels varied seasonally over the next three years with limited ponding occurring during the winter and spring periods (maximum depths of approximately 1 ft) and no surface ponding during the late summer and fall periods. However, due to above normal rainfall conditions during the winter of 2009-2010, surface-water levels increased to within 1 ft of pre-drought levels.

Results of the water budget suggest that ground-water inflow and outflow is a significant component of the bay's water budget. During the drying out periods in 2006 and 2007, changes in the bay's storage could not be accounted for solely by differences in rainfall and ET. Similarly, differences in rainfall and ET during the winter of 2009-2010 could not explain the filling of the bay to within 1 ft of its highest level since the spring of 2006. Hydraulic gradients, computed from ground-water data from wells along the perimeter of the bay, generally supported the results of the water budget. These results show the potential importance of the surrounding ground-water regime to Carolina Bay hydrology and highlight the need for adequate upland buffers with undisturbed ground-water hydrology.

No flow was observed in the DPB ditch during the period of record and several plugs along the ditch were effective in preventing surface outflow. The location and bed elevation of the WPB ditch along with ground-water levels between the WPB ditch and DPB suggest that the WPB ditch has had little to no impact on the water levels in DPB. The study has shown that DPB is a hydrologically intact Carolina Bay system that is not currently impacted by the existing ditch network during dry to normal rainfall conditions. Additional data should be collected for wetter climate patterns and higher water tables to assess the impacts of the ditches during these conditions.

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