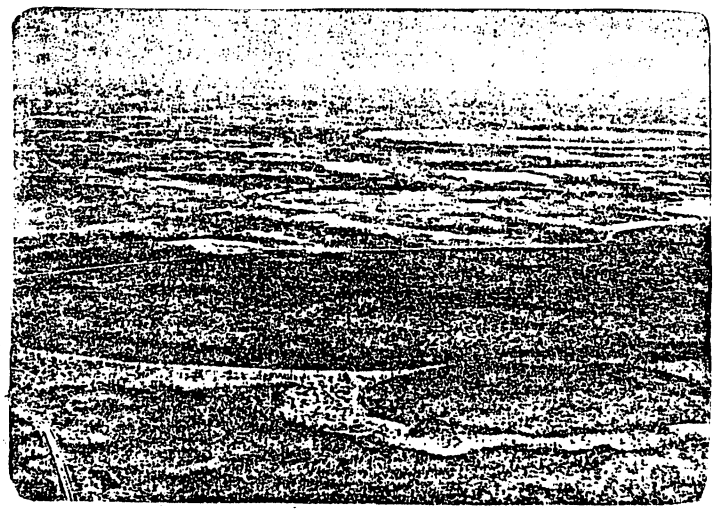
NCGS 80-1

North Carolina's Bay Lakes

The "Carolina Bays"

An Update on Their Origin and Character



Fred L. Beyer
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This report is preliminary and has not been edited or reviewed for conformity with North Carolina Geological Survey standards and nomenclature.

For more than one hundred years, the mysterious bay lakes, also called "Carolina Bays", have been a cause for study and debate. The bays were first discovered in North and South Carolina. Later, they were found to extend from New Jersey to Florida. The bays are generally elliptical in shape with shallow bottoms and low sandy rims. They are found only on the coastal plain where the surface is formed from loose and often sandy soil. The lakes generally line up with their long axes oriented northwest-southeast and have raised sandy rims. Often they form swampy areas raised very slightly above the surrounding land surface.

Seven and one-half minute orthophoto map of the White Lake area in Bladen County showing a large number of bays both water-filled and swampy.

While geologists agree that the lakes are found only where the sea recently covered the land, (the sea withdrew from the Carolina Coastal Plain between 9,000 and 7,000 years ago) they disagree on how the bays were formed. Most believe they were formed after the sea withdrew. When they were first discovered about 1800, the lakes were thought to be the result of a large meteor shower. Since then at least fifteen different hypotheses have been proposed for their origin.

Hypotheses Concerning Bay Origin

(1) Spring basins (Toumey, 1848, pp. 143, 144).
(2) Sand bar dams of drowned valleys (Glenn, 1895).
(3) Depressions dammed by giant sand ripples (Glenn, 1895, alternative).
(4) Craters of meteor swarm (Melton and Schriever, 1933). Supported by Prouty (1952) and associates, holding that weak magnetic anomalies showed buried magnetic meteorites southeast of individual Bays. Supported also by Wells and Boyce (1953). Peat in crater fill was burned out by Indians.
(5) Submarine scour by eddies, currents or undertow (Melton, 1934; alternative to No. 4).
(6) Segmentation of lagoons and formation of crescentic keys (Cooke, 1934). Original hollows at the foot of marine terraces and between dunes (Cooke, 1954, P.195).
(7) Lakes in sand elongated in direction of maximum wind velocity (Raisz, 1934).
(8) Solution depressions, with wind-drift sand forming the "rims" (Johnson, 19 ?).
(9) Solution depressions, with magnetic highs near Bays due to redeposition of iron compounds leached from basins (Lobeck, 1939 pp. 714, 715).
(10) Basins scoured out of confined gyroscopic eddies (Cooke, 1940, 1954). Schriever finds the hypothesis mathematically and physically insupportable (Schriever, 1965. Jones, 1956).
(11) Solution basins of artesian springs, with lee dunes. Johnson's (1942) "complex artesian-solution-lacustrine-aeolian" hypothesis.
(12) Fish nests made by giant schools of fish waving their fins in unison over submarine artesian springs (unnamed, see No. 15).
(13) Eolian (deflation) blowouts, reported by Prouty (1952 as suggested "by a number of scientists" (unnamed, see No. 15).
(14) Bays are sinks over limestone solution areas, streamlined by groundwater (LeGrand, 1953, Shockley et al., 1956). A modification of Johnson (1942, pp. 247-274) and Prouty (1952, pp. 194, 195).
(15) Oriented lakes of stabilized grassland inter-ridge swales of former beach plains and longitudinal dune fields, with some formed from basins in Pleistocene lagoons (Price, 1951, 1958). This is an elaboration of No. 13, here modified following Carson and Hussey's (1960, 1962) principle of orientation by wind waves of opposed wind systems. The basins are now in humid forest phase of Quarternary climatic oscillations and thus extinct, with the few having lakes now being senescent or nearly so.

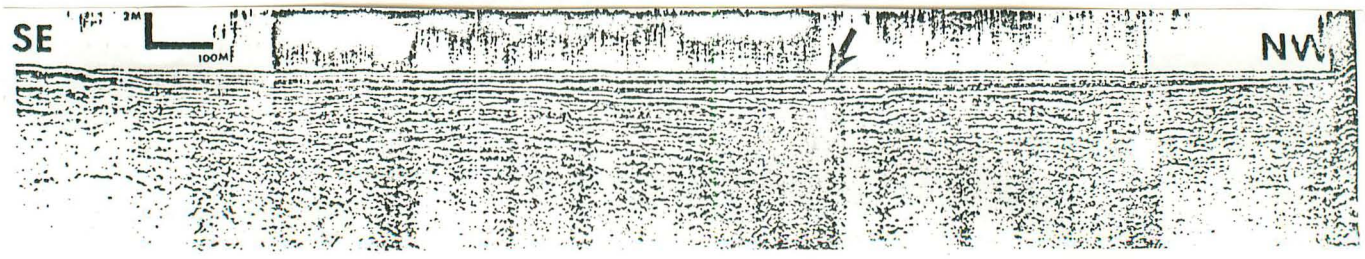
(Abstracted from Price; 1968, P.103.)

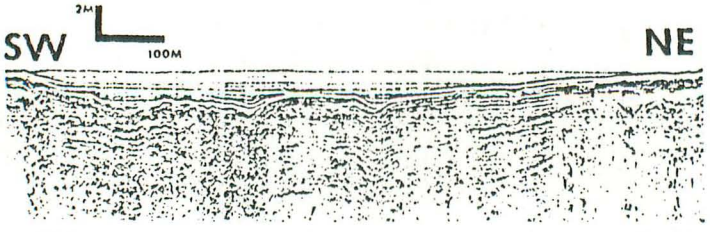
Obviously there was plenty of speculation concerning the origin of the lakes but unfortunately there was also little field research to back up the ideas. Virtually the only scientists carrying out scientific field work were the botanists. They were able to show a series of plant successions in the lakes and developed an excellent catalog of plants found in the lakes. One of the most common plants in the evergreen community found growing in the lakes was the "Bay" as a result the lakes came to be called "Carolina Bays".

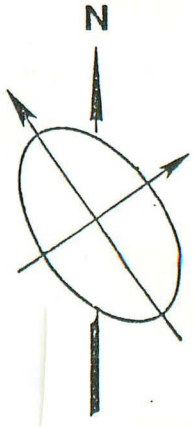
Carolina Bays have now been recognized on the coastal plain of Alaska, on the Llanno Estacado in Texas and in Terra Del Fuego, Chile, near the southern tip of South America as well as along the Atlantic Coast. During the last five years, geologists at the University of South Carolina have studied the bays in all four areas. Their studies revealed several interesting things:

1. No trace of a magnetic field or large dense rock was found beneath the bays. Such evidence would support meteors as an explanation for their origin. Calculations based on magnetic surveys suggest that the "average" meteor size would have to have been about 165 meters in diameter. The largest known meteorite in the world is slightly less than five meters long.

2. Profiles (seismic) of lake bottoms show flat bottoms with no evidence of the kind of impact that would be caused by a meteor's crashing to earth.

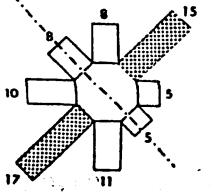




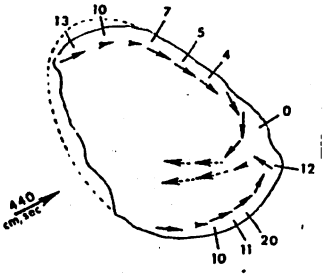


Seismic profiles of the long and short axes in Singletary Lake. A water filled Carolina Bay. (Abstracted from Kaezorowski; 1977, p. 34.)

Winds and currents studies suggest that prevailing winds in the areas where bays form tend to blow primarily from one or two directions. Where they blow from two directions the winds most often oppose one another.



Wind directions in % of time. Dotten line shows average longitudinal bay axis direction in the Carolina's.



Current velocities in a typical bay with wind measured in cm/sec. as shown by arrow.

(Abstracted from Kaczorowski; 1977, p. 76 & 79.)

4. Wind tunnel studies show that wind can generate currents in an irregular lake which will change its shape to an ellipse with its long axis at right angles to the wind directions.

5. Field studies have confirmed that such currents do indeed form in modern lakes such as White Lake and Singletary Lake. The effect of wave action does not appear to be significant because of the shallow nature of the bays (maximum depths do not exceed 3 meters) prevent the formation of large wave forms.

Perhaps the best explanation for the origin of the bay lakes based on the presently available evidence is described by the following sequence of events. As sea level fell following the last glacial retreat, the North Carolina Coastal Plain was exposed as an almost flat plain. Water collecting in irregularly shaped depressions on the old ocean floor formed lakes of various shapes and sizes. Winds blowing across the lakes caused the water to move forming currents. Because the winds blew from two opposing directions most of the time, the currents began changing the shape of the lakes into eliptical forms with their long axes at right angles to the direction of the prevailing winds. The currents moved sand from the lake bottoms depositing the larger grains in the shallow waters near their edges and building raised sandy rims around many lakes. Changes in the water table in various areas allowed some lakes to drain while others developed into swampy evergreen shrub bogs or pocosins. In a few lakes springs maintained high water conditions resulting in clear water bays such as White Lake.

Today's bays are obvious features when seen from the air. On the ground their most obvious characteristic is the dense evergreen vegetation which grows in the swampy soils of the bays. A typical assemblage of plants in a modern Carolina Bay might include the: Angle-Stem Fetter Bush (Pieis nitida), Bamboo Brier (Smilax laurifolia), Bog Dog-Laurel (Leucothoa axillaris, Cane (Arundinaria teeth), Choke Cherry (Aronia arbutifolia), Lablolly Bay (Gordonia lasianthus), Pepper bush (Clethru alnifolia), Pocosin Pine (Pinus serotina), Sweet Bay (Magnolia virginiana) and Wax Myrtle (Myrica cerifera and M. Carolinense) among othes.

While all the answers concerning questions about the origin of the Carolina Bays have not been answered, much progress has been made in the past ten years. There is still a need for selected kinds of research to confirm the recently discovered facts about the bays and to find the answers to remaining questions. In the meantime, the Carolina Bays offer an intriguing phenomenon from the recent geologic past for geologists and students to ponder.

BIBLIOGRAPHY

Colquhoun, D.J. 1969, Geomorphology of the Lower Coastal Plain of South Carolina: S.C. State Development Board, Geol. Div., Map Series 15 w/text, p. 36.

Frey, David G., 1949, Morphometry and hydrography of some natural lakes in the North Carolina Coastal Plain; the bay lake as a morphometric type: Elisha Mitchell Sci. Soc. Jour., Vol. 85, No. 1, p. 1-37.

Frey, David G., 1950, Carolina Bays in relation to the North Carolina Coastal Plain: Elisha Mitchell Sci. Soc. Jour., Vol. 66, No. 1, p. 44-52.

Frey, David G., 1951, Pollen Succession in the sediments of Singletary Lake, North Carolina: Ecology, Vol. 32, No. 3, p. 518-533.

Frey, David G., 1954, Evidence for the recent enlargement of the "bay" lakes of North Carolina: Ecology, Vol. 35, No. 1, p. 78-88.

Frey, David G., 1956, Stages in the ontogeny of the Carolina Bays: Internat. Assoc. theoretical and applied limonology Cong. (Great) Britian, Prosc., Vol. 12, p. 660-668.

Frink, John W. and Murray, Grover E. Jr., 1937, Eliptical "Bays" or "Craters" of Southeastern United States: Compass, Vol. 17, No. 4, p. 227-233.

Gohn, G.S., Higgins, B.B., Owens, J.P., Schneider, R. and Hess, 1976, Lithostratigraphy of the Clubhouse Crossroads core: Charleston project, South Carolina (abs.): N.E. & S.E. Sect., Geol. Soc. Amer., Vol. 8, No. 2, p. 314.

Gilbert, G.K., 1895, Lake basins created by wind erosion: Journal of Geology, Vol. 3, p. 47-49.

Gamble, Earling E., Daniels, R.B. and Wheeler, Walter H., 1977, Primary and Secondary rims of Carolina Bays: Southeastern Geology, Vol. 18, No. 4, p. 199-212.

Grant, Chapman, 1948, Meteoritic origin of the "Carolina Bays" questioned: Pop. Astron., Vol. 56, No. 10, p. 511-527.

Grant, Chapman, 1945, A biological explanation of the Carolina Bays: Sci. Monthly, Vol. 61, No. 3, p. 443-450.

Grant, Chapman, 1945, "When the Comet struck America" vs. "Neptune's race tracks" (Carolina Bays origin): Sci. Monthly, Vol. 61, No. 3, p. 243.

Hutchinson, George E., 1944, Carolina Bays: Am. Sci., Vol. 32, No. 1, p. 80.

Johnson, Douglas W., 1940, Mysterious craters of the Carolina coast, a study in methods of research: Sci. in Progress, 2nd. Ser., V. 2, pp. 78-106, Yale Univ. Press: 1944, Am. Sci. Vol 32, No. 1, p. 1-22.

Johnson, Douglas W., 1941, New light on the origin of the Carolina "Bays" (abs.): Sci. Vol. 93, No. 2420, p. 463.

Johnson, Douglas W., 1942, Rotary currents and the Carolina Bays: Jour. of Geomorphology, Vol. 4, No. 4, p. 307-321, Vol. 5, No. 1, p. 59-72.

Johnson, Douglas W., 1942, The origin of the Carolina Bays: New York, Columbia Univ. Press, 341 p.

Johnson, Douglas W., 1944, Role of artesian wates in forming the Carolina Bays: Sci. M.S. Vol. 86, No. 2229, p. 255-258.

Johnson, W. Ray Jr., Straley, H.W. and Straley, H.W. IV, 1950, Depth to anomaly source for Carolina Bays: Ga. Geol. Survey Bull., No. 60, p. 125-130.

Kaczorowskt, Raymond T., 1977, The Carolina Bays: a comparison with modern oriented lakes: Coastal Research Div., Dept. of Geol., Univ. of S.C., Columbia, 124 p.

Legrand, Harry M., 1953, Streamlining of the Carolina Bays (abs.): Jour. Geol., Vol. 61, No. 3, p. 263-274.

MacCarthy, Gerald R., 1937, The Carolina Bays: Geol. Soc. Amer. Bull., Vol 43, No. 9, p. 1211-1225.

MacCarthy, Gerald R., 1936, Meteors and the Carolina Bays (abs.): Elisha Mitchell Sci. Soc. Jour., Vol. 50, No. 1-1, p. 211.

MacCarthy, Gerald R., 1936, Magnetic anomalies and their geologic structures of the Carolina Coastal Plain: Jour. Geol., Vol. 44, No. 3, p. 396-406.

McCambell, John C., 1944, An evaluation of the artesian hypothesis or origin of the Carolina Bays: Elisha Mitchell Sci. Soc. Jour., Vol. 60, No. 2, p. 183-185.

McCambell, John C., 1945, Meteorites and the "Carolina Bays": Pop. Astron., Vol. 50, No. 8, p. 388-392.

McCambell, John C., 1945, A Geomagnetic study of some Bladen County, North Carolina, "Carolina Bays": Jour. Geol., Vol. 53, No. 1, p. 66-67.

Melton, Frank A., 1950, The Carolina "Bays": Jour. Geol., Vol. 53, No. 2, p. 123-134.

Odum H.T., 1952, The Carolina Bays and the Pleistocene weather map: Amer. Jour. Sci., Vol. 250, p. 263-270.

Preston, C.D. and Brown, C.Q., 1964, Geologic section of a Carolina Bay, Sumter County, South Carolina: Southeastern Geology, Vol. 6, p. 21-29.

Price, W.A., 1968, Carolina Bays: in Fairbridge, R.W. ed., The Encyclopedia of Geomorphology: New York, Reinhold Book Corp., p. 102-109.

Prouty, William F., 1934, Carolina Bays and eliptical-like basins: Jour. Geol., Vol. 34, No. 2, p. 200-207.

Prouty, William F., 1934, Carolina Bays (abs.): Elisha Mitchell Sci. Soc. Jour., Vol. 50. No. 1 - 2, p. 59-60.

Prouty, William F., 1948, Heart-shaped Carolina Bays (abs.): Geol. Soc. Amer. Bull. Vol. 59, No. 12, Pt. 2, p. 1345.

Prouty, William F., 1943, The Carolina Bays: Compass, Vol. 23, No. 4, p. 236-244.

Prouty, William F., 1950, Origin of the Carolina Bays: Pop. Astron., Vol. 58, No. 1, p. 17-21.

Sass, Herbert R., 1944, When the Comet Struck (Carolina Bays): Saturday Evening Post, Vol. 217, No. 11, p. 12-13, 10-, 107.

Thom, B.G., 1970, Carolina Bay, genesis, age: Geol. Soc. Amer. Bull. Vol. 81, No. 3, p. 783-813.

Wells, Bertram W. and Bryce, Steve G., 1953, Why the "Whiteness" of White Lake, Bladen Co., N.C. (abs.): Elisha Mitchell Sci. Soc. Jour., Vol. 69, No. 2, p. 90.

Wells, Bertram W., 1944, Origin of the Carolina Bays; evidence from peat profiles (abs): Elisha Mitchell Sci. Soc. Jour., Vol. 60, No. 2, p. 129-134.

Wells, B.W., 1932, Natural Gardens of North Carolina: Chapel Hill, University of North Carolina Press, p. 458.