

Pocosins and Carolina Bays Compared

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Carolina bays and pocosins are two distinct physiographic features found on the Atlantic Coastal Plain of the southeastern United States. Although pocosins have been identified in the literature for more than two hundred years and Carolina bays for more than one hundred, confusion frequently still exists pertaining to the definitions of both as they are often incorrectly assumed to be indistinguishable and the terms are used synonymously. This paper defines each term and illustrates how bays and pocosins differ. In some instances Carolina bays do possess pocosin-type vegetation, in fact, most if not all have at some time past possessed shrub bog or pocosin-type vegetation. The approach used in this paper shows that Carolina bays are landform features that now vary greatly in their land cover, while pocosins are unique ecological communities.

Atlantic Coastal Plain palustrine wetlands have long been the focus of geological, botanical and ecological studies (Ash, et. al.1983; Harper 1907; Richardson 1981; Ross 1987; Tooker 1899). The palustrine system includes all non-tidal wetlands dominated by trees, shrubs, persistent emergents and emergent mosses or lichens. These wetlands may occur as either *pocosins* or *Carolina bays* and are widespread in the Coastal Plain of the Carolinas. Pocosins and Carolina bays, however, exhibit distinctive geological and geographical differences. Because pocosins and Carolina bays occasionally occur in the same geographical areas and share soil types, floral and faunal species composition and other community attributes, many lay persons and some scholars are perplexed by the distinction and incorrectly use the terms as synonyms. *Shrub bogs*, which include all pocosin land and some Carolina bay land as well as other palustrine wetlands, are also briefly discussed as they pertain to the definitions of pocosins and Carolina bays.

Most pocosins occur chiefly in southern Virginia, the Carolinas and Georgia while Carolina bays have been identified along a broad band of the Atlantic Coastal Plain from southern Georgia to Delaware, and perhaps even to New Jersey. Troubled with the indiscriminate use by some scholars and writers of the term "pocosin" to

describe Carolina bays, Lide (1997) called upon scientists to be more precise in the designations applied to coastal wetlands, particularly of the Carolina bays. His call is supported by many whose focus of study and interest is in wetlands. In order to curtail confusion, and misinformation, scientists and journalists should use more precise terminology when communicating about coastal wetlands and minor landform features. For example, statements such as the following create the potential for confusion: "Carolina bays . . . are fragile and unique ecosystems; wetland habitats that exhibit a variety of vegetative components. Some bays are open water depressions dotted with . . . trees, . . . some are thick pocosins" (www.fs.fed.us/r8/fms/rec/bays). The problem here, of course, is that this broad definition absolutely ignores the significance of topography and geomorphological characteristics in establishing a definition for bays.

The purpose of this paper is to illustrate the distinction between pocosins and Carolina bays and to show the relationship of both to shrub bogs of the Atlantic Coastal Plain in order to provide definitions that are applicable to each of the terms, with particular emphasis upon making a clear distinction between pocosins and Carolina bays. It is hoped that the material provided here will clarify the appropriate usage for each term.

A major barrier to unequivocal definitions for pocosin and Carolina bays is that not all scholars apply the same identifying guidelines to the features being studied. Geographers, geologists, and other earth scientists are more likely to refer to a Carolina bay as a landform feature with an elliptical shape, roughly oriented northwest to southeast, sometimes bordered by a sand rim (Johnson 1942, Prouty 1952, Ross 1992, Lide 1997). Many botanists usually study only the bays that have evergreen shrub bog vegetation because vegetation is necessary for them to conduct their research; they then ignore most of the bays that have naturally in-filled with sediments and organic matter and those that have been artificially drained for agricultural and other uses (Sharitz and Gibbons 1982, Bennett and Nelson 1991, Richardson and Gibbons 1993). The implication in the publications of some botanists is that all Carolina bays must exhibit shrub bog-type vegetation ecosystems. This rationale apparently is based upon the fact that many of the places where they find shrub-bog plant communities just happen to occupy a geographic landform feature that scholars from other disciplines may call a Carolina bay. In other words, if that feature does not possess shrub-bog vegetation, some botanists do not consider it to be a Carolina bay, which could account for the relatively small numbers of bays identified in some botanical works (Bennett and Nelson 1991). Earth scientists, however, tend to aggregate all of the many forms of bays, including the dry, wet and shrub bog bays (Ross 1992, 1996, Lide 1997), and understand that bays embrace a wide continuum of land surface cover. In addition, many landform geographers,

geomorphologists and geologists are less concerned with the existence of specific vegetation communities, but are more interested in the patterns of vegetation differences among the several types of bays, as well as the soils, shapes, and patterns of occurrence of the bays themselves (Figure 1).

The definition problem has been addressed previously by several scholars from diverse academic disciplines. The most thorough studies, however, have been conducted by scientists primarily concerned with wetland vegetation communities. For example, Sharitz and Gibbons (1982) provide an excellent background to coastal wetlands and subsequently the definition problem, but their study has not been widely disseminated throughout the scientific community. Subsequently, Richardson and

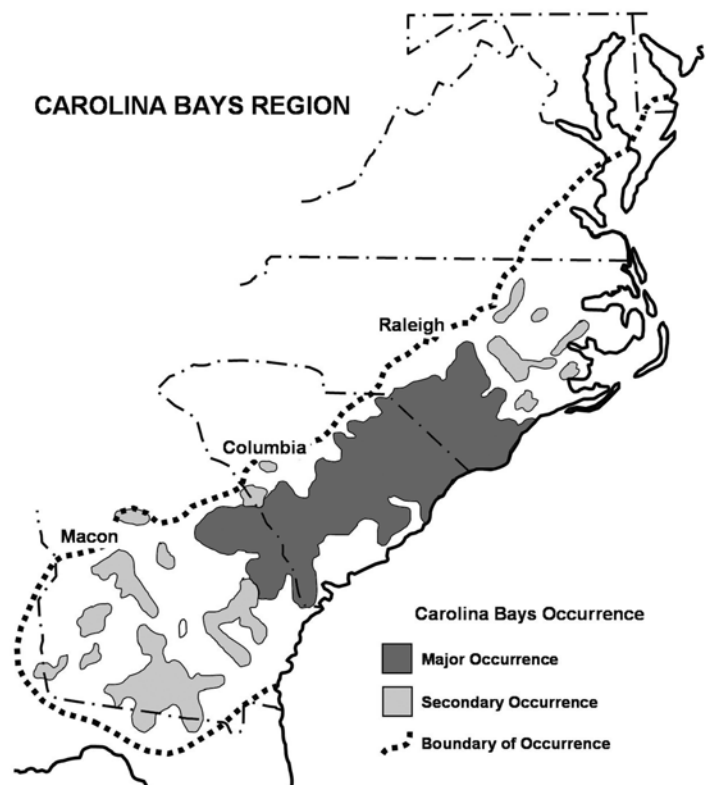


Figure 1. Carolina bays on the Atlantic Coastal Plain. The bays are concentrated in southeastern North Carolina and northeastern South Carolina, but occur as far south as northern Florida and north into Delaware, albeit in a more scattered pattern.

Gibbons (1993) examined the definition and classification problem with considerable elaboration upon the physical characteristics of pocosins and bays, and in a much more accessible medium than that of Sharitz and Gibbons (1982).

Too few scholars specializing in Carolina bays investigations have provided detailed studies of the differences between bays and pocosins, however. Johnson (1942), Prouty (1952), and Melton and Schriever (1933) have all made valuable contributions in the study, and definition, of Carolina bays and have mentioned that some bays have a pocosin-type vegetation while most do not. But the absence of significant elaboration upon the distinction between bays and pocosins in their publications only exacerbated the confusion.

In the following discussion, shrub bogs, pocosins, and Carolina bays will be described and defined. This clarification should enable scholars and others who study and write about coastal plain wetlands and Carolina bays to be more precise in their use of terminology.

Palustrine wetlands include shrub bogs, pocosins, and some Carolina bays. *Shrub bog* is a collective term applicable to wetlands in which the primary plant species are evergreen broad-leaved shrubs. In the southeastern United States, shrub bogs are found in areas with poorly developed internal drainage and usually have highly developed organic or peaty, acidic soils. Pocosins and some, but not all, Carolina bays are types or subclasses of shrub bogs that exhibit these attributes.

The precise formation mechanism of shrub bogs, pocosins, and Carolina bays is not known, but several factors combine to create a pocosin ecosystem exemplified by broad-leaved evergreen shrub vegetation such as titi (*Cyrilla racemiflora*), red bay (*Persea borbonia*), sweet bay (*Magnolia virginiana*), loblolly bay (*Gordonia lasianthus*), bitter gallberry (*Ilex glabra*), and wax myrtle (*Myrica cerifera*) overtopped by pond pine (*Pinus serotina*). The bays may indeed possess shrub bog plant communities, but they are not restricted to shrub bog. Some bays exhibit other successional stages of wetland vegetation while others include open water, or if drainage systems have been constructed, upland plants and animals.

The Venn Diagram in Figure 2 points out the overlapping nature of bogs, pocosins and Carolina bays as components of a broader palustrine wetland which may include additional vegetation communities, such as evergreen and deciduous bay forests, pine flatwoods and swamp forests. Although a simplified depiction of a highly complex phenomenon, the diagram illustrates that some Carolina bays contain two classes of pocosin-type vegetation: scrub-shrub pocosins and forested pocosins. The diagram also at the same time shows the significant differences that exist between the Carolina bays and pocosins.

Pocosins

Pocosins have historically been described as extremely poorly drained areas of highly organic soils (peaty) supporting pond pines with an understory composed mostly of broad-leaved evergreen shrubs, found mostly on the Atlantic Coastal Plain from southern Virginia to northern Florida (Ash et al. 1983). These freshwater wetland

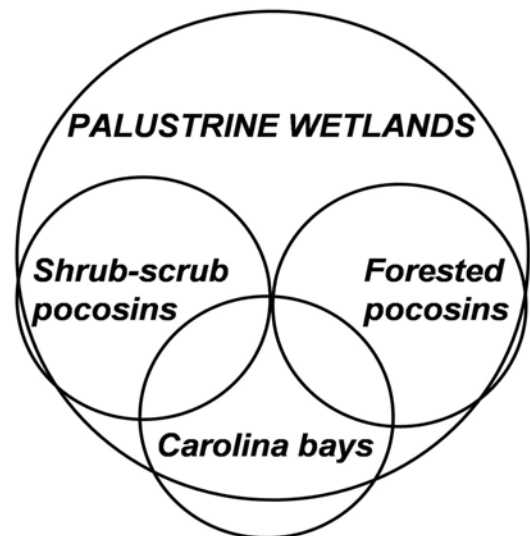


Figure 2. Carolina bays on the Atlantic Coastal Plain. The bays are concentrated in southeastern North Carolina and northeastern South Carolina, but occur as far south as northern Florida and north into Delaware, albeit in a more scattered pattern.

ecosystems occur predominately in wide shallow stream basins or on broad flat upland areas where long hydroperiods occur. Other characteristics include temporary or intermittent standing water, peat or muck fires and soils of sandy humus (Wells 1928).

Unlike Carolina bays, the origin of pocosins is somewhat more understood. It is generally accepted in the academic community that pocosin development and survival are closely related to climate and the lay of the land, or topography, of the region in which pocosins occur. Brinson (1991) demonstrated that climate and topography are both important in the development of pocosins. Climate is the variable that plays a major role in "the exchange of matter and thermal energy between pocosins and the atmosphere" (Brinson 1991). For the most part, the exchange occurs in the form of water. The bulk of the precipitation received by pocosins is eliminated through evapotranspiration. The large volume of heat consumed through evapotranspiration of the pocosins, then, impacts upon local climatic conditions. In terms of topography, Brinson contends that topography "is a consequence of the inherited landscape upon which pocosins formed. While the muted topographic relief . . . is probably the main contributor to pocosin formation, the feedback between climate and topography is likely essential." He concludes that the position of the water table, as determined by topographic position, and "the local hydrology seem to be vital controls whether due to the original landscape in which peat development was initiated or to the impeded drainage created by tertiary mire formations."

About three million acres of the Atlantic Coastal Plain, from southern Virginia to northern Florida, were once pocosin ecosystems (Richardson and Gibbons 1993). Some pocosins also are found in coastal Alabama. No detailed map showing the distribution of pocosins has been developed for the whole region; in fact, most states have not mapped their pocosin lands. The most complete mapping of pocosins has been accomplished by North Carolina (Wilson 1962; Richardson 1981). Based on that comprehensive undertaking, it is estimated

that about 70 percent of the United States' pocosins are in North Carolina and that more than 50 percent of North Carolina's freshwater wetlands are pocosins (Richardson and Gibbons 1993).

Pocosins occur in irregularly shaped tracts varying in size from less than 20 acres to several thousands of acres. They are most commonly found on interfluvies between rivers and sounds on the Atlantic Coastal Plain. Most pocosin communities thrive in the organic soil that has formed over clay-based soils in these depressions. The exact origin of the pocosin is not fully understood, but the most widely held hypothesis is that the milder climate of the interglacial period following the Wisconsin Ice Age (18,000 BP) resulted in a combination of factors (rising sea levels, peat formation and sediment build-up) that interfered with the many freshwater streams flowing across the Coastal Plain into the sounds of the Atlantic Ocean (Whitehead 1972, 1981; Richardson and Gibbons 1993). These changes were responsible for the conversion of the boreal forest of the Ice Age to wetland forests and evergreen shrub bog communities that eventually spread over the Atlantic Coastal Plain of the southeastern United States.

Daniel (1981), using carbon-14 dating, estimated the age of basal peats in the Dismal Swamp to be between 10,340 BP $\pm$ 130 years and 8,135 BP $\pm$ 160 years. Conversely, Richardson and Gibbons (1993) reported that "radiocarbon dates from much of the peat forest present today in the Dismal Swamp indicate ages under 3500 years." The difference in the two estimates is attributed to "fluctuations in peat oxidation and accumulation rates, the occurrence of extensive fires in pocosin peatlands, and a dynamic peat development history" (Richardson and Gibbons 1993).

A precise, universally accepted definition of "pocosin" is difficult to establish because several academic disciplines have developed terminologies unique to their individual discipline. Sharitz and Gibbons (1982) addressed this issue when they wrote "pine-dominated flatwoods occurring in areas with prolonged hydroperiods may be included in a forester's definition, whereas a hydrologist might consider only those shrub bogs

occurring in broad, undrained interstream areas to be true pocosins.”

So what is a working definition of a pocosin? Most scholars could probably be comfortable with the following: a coastal plain wetland area of variable shape and size in an area of poor surface drainage whose vegetation is mostly broadleaved evergreen trees and pond pine growing on very organic or peaty soils.

Carolina bays

Carolina bays are shallow, elliptical depressions with generally parallel major axes oriented northwest-southeast on the Atlantic Coastal Plain. Reportedly found from southeastern New Jersey to northern Florida, most are concentrated in southern North Carolina and northern South Carolina (Johnson 1942, Prouty 1952) (Refer to Figure 1). Although the vast majority of bays possess a near uniform shape, they vary greatly in size, from less than 75 feet along the long northwest-southeast axis to more than seven miles. Estimates of the total number of bays has ranged from approximately 500,000 (Prouty 1952) to fewer than 20,000 (Bennett and Nelson 1991).

The elliptical depressions were brought to the attention of scholars in 1848 when Michael Toumey made a brief mention of them in his *Report on the Geology of South Carolina*. The first reference to “bays” in a scholarly journal was by L. C. Glenn (1895). According to Glenn:

... to the lake-like expanses the term ‘bay’ is usually applied, and by it is meant a perfectly flat, clayey area with a surface some two to four feet below the general level of the country and varying from a few acres in size to stretches a mile or two long and a half mile or more in width; the smaller ones being much more numerous and having usually an area of 20 to 30 acres. They are in some cases approximately round in shape, though they are usually ovoid or elliptical, and are covered with vegetation-stained water from a few inches to a foot or two deep, according to the season.

The term “bay” was applied to these depressions because of the presence of the numerous bay trees found in and around them. Sweet bay, loblolly bay, and red bay trees make up a significant portion of the plants associated with bays.

Glenn also provided some details about the sand ridges found on some bays, the effects of artificial drainage of the bays themselves, and also offered the first theory of how they were formed (see Table 1).

The origin theory of Carolina bays drew no further discussion in the scientific literature until Melton and Schriever (1933), after examination of aerial photographs taken by Fairchild Aviation in coastal South Carolina, claimed that they were meteorite scars (Figure 3). As shown in Table 1, many theories have been introduced to explain the origin, development and maintenance of these most intriguing geomorphic features. Johnson (1942) reviewed and rejected the numerous theories of origin present at the time, while making a strong case for his terrestrial- water-wind theory, which was elaborated upon by Kaczorowski (1977). Most earth scientists today reject the hypotheses that meteorites, comets, or antimatter played any role in the origins of Carolina bays. Instead, they accept that a combination of physical, earthbound physiographic factors triggered the process of development. The most widely accepted theory today is one that Kaczorowski developed after Douglas Johnson’s water and wind theory. Kaczorowski argued that lakes on the Coastal Plain sediments were subjected to winds blowing from the northwest and that this created the elliptical and oriented pattern of bays. The winds were also responsible for the development of the sand rims found on many bays, most of which are higher and wider along the southeast end of the bay.

Although the literature about bays is relatively abundant, their origin remains a mystery, but many scientists accept the hypothesis that they are ancient lakebeds, most of which have dried up during the past several thousand years (Ross 1987, 2000). During periods of heavy precipitation, however, most bays collect runoff water that is ponded for several hours or days above the water table and zone of saturation (Ross 1996). Only a few bays, such as

Table 1. Some Theories of Carolina Bays Origin

<u>THEORY</u>	<u>AUTHOR</u>	<u>DATE</u>
Spring basins	Tourney	1848
Sand bar dams of drowned valleys	Glenn	1895
Depressions dammed by giant sand ripples	Glenn	1895
Leaching of aluminum and iron in low spots on surface	Smith	1931
Craters of meteor swarm	Melton/ Shriever	1933
Submarine scour by eddies, currents and undertow	Melton	1933
Segmentation of lagoons, formation of crescentic keys	Cook	1934
Lakes in sand elongated in direction of maximum wind	Raisz	1934
Solution depressions, with wind drift forming rims	Johnson	1936
Solution basins of artesian springs	Johnson	1942
Fishnests made by fish waving fins over artesian springs	Grant	1945
Sinks over limestone solution areas streamlined by groundwater	Grant	1945
Original hollows at the foot of marine terraces	Cooke	1954
Wind action on water bodies	Thom	1970
Blackhole striking Hudson Bay, throwing ice onto coastal plain	Davis	1971
Shockwaves from cometary fragments exploding above surface	Eyton/ Parkhurst	1975
Wind and wave action on unconsolidated sediments	Kaczorowski	1977
Impact of antimatter striking the earth	Baxter/ Atkins	1978
Extended drought, fire in peat deposits, followed by eolian activity	Ross	1986
Dropping water table, geochemical weathering and silica-karst development	May/ Warne	1999

Sources: Ross, T. E. 2000. *Carolina Bays: An Annotated and Comprehensive Bibliography 1844-2000*, Southern Pines, N.C.:Carolinas Press; and Price, W. A. 1958. Carolina Bays. In *Encyclopedia of Geomorphology*. Pp. 102-108, edited by R. W. Fairbanks. New York: Reinhold Book Corporation.

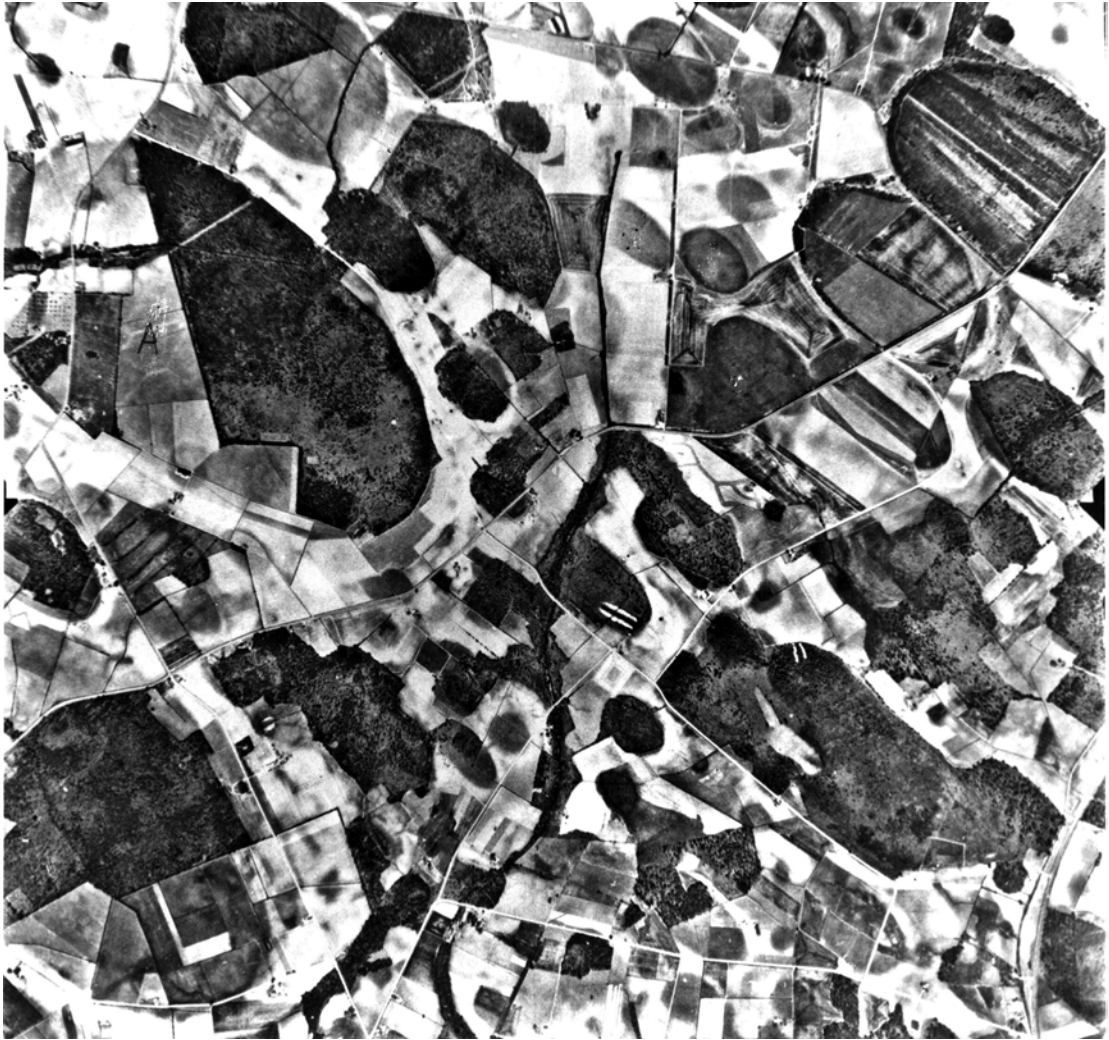


Figure 3. Aerial photograph of Carolina bays in Robeson County, NC. Observe the ellipticity, parallelism and north-west-southeast orientation of these depressions. All of the dark areas are bays. Some in this photography have been drained and cleared, others remain forested.

White, Jones, Singletary, Baytree, and Waccamaw Lakes, possess a natural, constant source of water. A dozen or so other bays are permanently ponded, while many others exhibit wetland areas that only intermittently contain water (Figure 4).

The North Carolina Heritage Program has developed the following classification for Carolina bays: (1) bays with clay-based substrata found typically in the Inner Coastal Plain; (2) “humate” bays or bays

with a sandy soil, perched water table, and spodic soil horizon; (3) peat-filled bays with shrubby vegetation; and (4) water-filled bays or bay lakes (Richardson and Gibbons 1993). Using this classification system, it is apparent that vegetation cover is not a major determinant factor in what most persons call a Carolina bay. Rather, it is the geologic and geomorphic characteristics that are used to define the bays. The large majority of the papers published on Carolina



Figure 4. A normally “dry” bay filled with water during the El Nino of the late 1990s. This is an example of a ponded bay.

bays during the past 150 years (Ross 2000) emphasize the physical characteristics, as presented in Table 2.

The variations in geographic location, soil, depth and size all help to account for the fact that no single characteristic vegetation type is associated with Carolina bays. These vegetation types run the gamut from herbaceous marshes to forests of pond and loblolly pine communities. Thus, the depressions that are called Carolina bays contain a variety of ecosystems, ranging from those associated with shallow lakes, swamps and marshes to that of cultivated cropland on bays that have been ditched and drained for agricultural, commercial, and residential use (Ross 1992).

In summary, Carolina bays are unique geomorphic features of the Atlantic Coastal Plain that are defined as shallow depressions varying in size from about 1,000 square feet to more than 7,000 acres, with an elliptical to ovoid shape generally oriented along a northwest-southeast axis, that for the most part parallels other bays. The most important components of their formation include the presence of natural lakes on a mostly flat, sandy

Coastal Plain that were subjected to winds blowing over the lakes. The photograph in Figure 3 shows the parallelism, orientation, and elliptical shape of the bays, which are all factors thought related to the direction of the prevailing winds.

Conclusion

The complexity of the definition issue is compounded because both Carolina bays and pocosins are located on the Coastal Plain and manifest similar soil types and plant and animal communities. They differ in their geological formation and present geomorphometry. Thus, Carolina bays are unique elliptical, shallow, and oriented depressions of the Atlantic Coastal Plain. Pocosins, on the other hand, are found in a wide array of geologic situations where water does not freely drain. Thus, pocosins and Carolina bays are separate and distinct ecological communities, but the terms pocosin and shrub bog are frequently interchangeable. If a particular Carolina bay contains floral and faunal characteristics associated with a pocosin, then it too can be referred as a pocosin,

Table 2. Physical characteristics of bays

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- Most of the bays in the Carolinas are elliptical, in Georgia most are oval.
 - Some bays are highly irregular in outline.
 - All gradations in form exist, from bays of the most regular outline to the highly irregular.
 - Oval bays have axial trends almost always directed between south and east, most of them ranging between S 10 degrees E and S 55 degrees E.
 - There are wide departures from the prevailing direction; elliptical bays are the most consistent in trend, with axes directed more or less nearly southeast; ovoid bays are most variable in trend, but as a rule have axial directions more nearly southward, their narrow ends pointing in this direction.
 - Bays vary in size: some are less than 50 feet long, many are one or two miles, and some six or seven miles in longest diameter.
 - The bays are remarkably shallow in comparison with their great area extent.
 - The bays descend below the level of the surrounding plain and below the bases of their bordering rims, as if they were depressions caused by removal of part of the Coastal Plain material.
 - Bays sometimes occur in systematic groups, with a distinct group pattern apparently determined by some preexisting topography or structure.
 - Many bays are bordered by rims of sand, but many bays, similar in all other respects, have no rims associated with them.
 - The rims, when present, rarely completely surround a bay; incomplete rims are sometimes erratically distributed but normally are highest and broadest about the southeastern quadrants of the depressions.
 - Multiple rims, nearly but not quite concentric, and from two or three up to eight and possibly more in number, occur about some bays.
 - Such multiple rims tend to be developed and farthest apart toward the southeastern ends of oval or ovoid bays, converging or merging or disappearing toward the northwestern ends. In some cases the multiple rims are chiefly confined to the eastern sides rather than the southeastern ends of the depressions.
 - A wide space sometimes intervenes between an outer rim or series of rims and an inner rim or series within the same bay; this distribution pattern may be repeated in adjacent bays.
 - The rims are of relatively insignificant size, the volume of material contained in them being but a small fraction of the material removed to form the bays.
 - The convergence of multiple rims of the same bay and the junction of contiguous rims of adjacent bays do not give rise to combined rims of unusually large size. On the contrary, such combined rims may be unusually small and may locally disappear.
 - There is not systematic relation between the size of the bays and the size of their bordering rims. Large bays may have small rims or none, and small bays may have large rims.
 - Many rims are relatively flat-topped or broadly rounded in cross section, frequently with steeper slopes inward toward the depression and outward toward the adjacent plain.
 - The composition of the rims is remarkably uniform, the material consisting for the most part of clean, fairly coarse white or buff quartz sand.
 - Material composing the Coastal Plain sediments in which the bays are “excavated” is often strikingly dissimilar to the material composing the rims.
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Source: Summarized from Douglas Johnson. *The Origin of the Carolina Bays*. New York: Columbia University Press. 1942.

but as a whole Carolina bays do not have a distinctive vegetation type.

Pocosins and Carolina bays, therefore, are two distinctly different natural features; the former is a type of vegetation community or ecosystem while the latter are a geomorphic feature. Confusion in usage of the two terms is most frequently related to the occurrence of a "pocosin" or evergreen broad-leaved shrub bog vegetation type in *some* Carolina bays. The overwhelming majority of scholars who specialize in Carolina bay research and who are very familiar with Carolina bays' characteristics know that bays contain a variety of landcover, ranging from water to cultivated crops. They also understand that only a small proportion of the thousands of bays that dot the Atlantic Coastal Plain include pocosin-type vegetation. These same scholars also understand that it is the shape and location of the shallow geomorphic feature that makes it a bay, not the presence or absence of any type of vegetation ecosystem. But even those very familiar with bays sometimes confuse the issue. For example, in an internet paper entitled "Carolina bays fact sheet" released by the University of Georgia (www.uga.edu/srel/bays.html) the definition of bays was given as "isolated wetlands in natural shallow depressions that are largely fed by rain and shallow groundwater." In this definition, the wetlands are the bays, not the depressions. Statements such as this are at the heart of the problem.

What are some factors that contribute to the confusion? First, young scholars who are novices in Carolina bay research sometimes plunge into the subject without a thorough knowledge of the literature, accepting journalists' and the general public's interpretations and definitions as accurate, or perhaps scrutinizing only a narrow range of literature. Secondly, some scholars have established their own limited criteria for what a Carolina bay really is—most of this group consist of those who insist that vegetation is the primary factor. Thus, according to these scientists, the elliptical, shallow depressions that have been drained for agricultural or other uses and are devoid of vegetation are not really Carolina bays. At most, they may be called "ghost" or "relict" bays, contrary to the argument by many geographers and other earth scientists that they are bays regardless of the lack of vegetation.

In conclusion, it is very important to make an accurate distinction between Carolina bays and pocosins, especially in terms of ecological/environmental impact. A pocosin is a naturally wet feature that serves several ecological functions. It is a wildlife habitat, a home for distinctive plant life, and its wetland functions include flood and erosion control as well as a feature in which water can be cleansed by processing nutrients, suspended materials and other pollutants. A Carolina bay, conversely, if it is a dry or drained bay, has none of these functions and its uses by humans would probably have negligible impacts upon the environment. The same could not be claimed, however, for a Carolina bay that contains wetlands. The wetland portion would be in the same environmental category as the pocosin. These are valid reasons for insisting upon a distinctive definition for both pocosins and Carolina bays that would enable scholars and environmental planners to better manage the uses to which bays are subjected.

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