

# Quaternary Climate Change and Paleoecology, Bladen County, NC

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## Introduction

Students analyze a Quaternary pollen diagram from lakes in Bladen County, NC. This diagram contains (from the top down) the current deglaciation, the last glacial, and the previous interglacial. These lakes occur in Carolina Bays (see below) and students also evaluate a proposal that meteorite impact 12.9 ka BP created the Bays.

### Objectives

- 1) Student analysis using local real data via an approach used in the scientific literature.
- 2) Recognize significant Quaternary paleoecologic and climatic changes even in unglaciated areas
- 3) Interpret and synthesize multivariate data
- 4) Evaluation of a proposed origin for Carolina Bays

What follows in Roman is information or questions for the students. My answers/comments are in *italics*.

Figure 1. Location of Bladen County on NC Coastal Plain. UNC-Pembroke is located in the next county to the west.



Figure 2. Aerial photo-lidar composite of Singletary Lake, the principal sampling location of Frey (1953). Note that the lake is smaller than the oval outline of the bay itself. The striations on the lake surface are a processing artifact.



## Taphonomy

Plants produce pollen in different volumes depending on their pollination mechanism. Thus, there is a bias in records toward plants that produce and disperse maximum pollen, namely wind-pollinated taxa like *Pinus*.

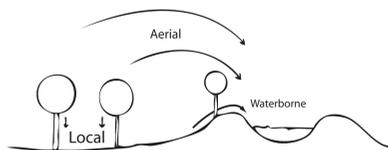


Figure 3. Pollen transport mechanisms.

Pollen can reach a depositional site by dropping directly out of vegetation, by wind transport, and by water transport by overwash or streams and rivers (Fig. 3). In many settings, stream transport is clearly the most effective. Wind transport is limited in the trunk space of a forest and can be blocked by a continuous forest canopy. Most Carolina Bays, however, do not have significant stream input today and Singletary Lake is several hundred meters across. Briefly interpret the likely transport mechanisms for pollen reaching the Bay.

*Transport mechanisms are most likely directly from vegetation and wind. Wind can carry some pollen over treetops into the open water of the bay. Probably most pollen comes from plants growing in or near the edge of the bays (e.g., bald cypress will grow in standing water).*

Uses Figure 11 from Frey 1953.

Figure 4. Pollen diagram from Frey (1953). The student exercise includes a list of common names for these taxa.

## Paleoecology and Climate Change

Above is a pollen diagram summarized from several cores in Carolina Bay lakes in Bladen County, principally Singletary Lake in Singletary Lake State Park. In contrast to more northern sites which have only deglaciation records, eastern North Carolina was never glaciated, so we can consider longer term questions.

Keep in mind that the last glacial maximum (LGM) occurred about 23,000 years ago.

Identify major intervals in the pollen record. Are there any taxa indicative of colder climates than we have today in this area? Make tentative correlations to climate.

*The record shows the latest deglaciation (or interglacial) from roughly 6 feet to the surface, the vegetation of the last glacial from about 11 feet to 6 feet, and a previous interglacial below 11 feet.*

**Picea* and *Tsuga* are cold climate taxa. *Isoetes* (the lycopod quillwort) could also be put in this category, although most students wouldn't know this except from a note in the exercise.*

*Frey interpreted much of the *Pinus* as transported from farther afield than the bay's edge, especially during the glacial. Note also the nearly complete disappearance of tree pollen during the glacial, particularly those tree taxa common in or at the lake's edge today (*Taxodium*, *Liquidambar*, *Nyssa*). This suggests that the area around the bays was much more open than at present. *Pinus* could increase in relative abundance even if it was less common in such a setting.*

What does the increase of Compositae in the youngest part of the core indicate?

*The increase in Compositae is an indicator of human land disturbance after European settlement. Ragweed in particular thrives in disturbed areas between cultivated fields and forest.*

*This is valuable to show students that human impacts can be recognized in records like this. In addition, the ragweed increase is commonly used as an absolute age marker (calibrated to local time of European settlement) for the youngest interval of time.*

What does the change in pollen record below about 11 feet depth represent?

*The record shows the latest deglaciation (or interglacial) from roughly 6 feet to the surface, the vegetation of the last glacial from about 11 feet to 6 feet, and a previous interglacial below 11 feet.*

What can we say about the constancy of the vegetation of this region over the time period represented by this pollen record? Does an equilibrium state ever seem to be reached?

*Clearly, the vegetation has not been constant. Students could argue for or against equilibrium vegetation: perhaps argue that an equilibrium occurs in the assemblage just before European settlement (i.e., below the ragweed spike at the top) at least for interglacials, but it could also be argued that no true equilibrium developed.*

Uses Murray Springs figure from Dalton 2007.

Figure 5. Black layer at Murray Springs, Arizona at the position of supposed impact 12.9 ka BP. From Dalton (2007)

## The 12.9 ka Impact and Origin of the Bays

The origin of Carolina Bays has been attributed to a number of causes (e.g., schools of whales flapping their tails, meteorite impacts, groundwater sapping, interaction of groundwater and prevailing winds), some more far-fetched than others. It would be fair to say that the exact mechanism is not well understood. Recently, Firestone et al. (2007a and news story in Nature: Dalton, 2007) suggested that an extraterrestrial impact about 12,900 years ago had catastrophic effects across North America including large animal extinctions. In addition, this impact was supposed to have produced the Carolina Bays from fallout of debris. Describe what evidence Frey's pollen record provides on this mechanism for the origin of the Bays.

*As Frey's pollen record clearly shows vegetation of the most recent glacial and the interglacial before it, the Bay's sedimentary fill has existed much longer than 12.9 ky. Therefore, an extraterrestrial impact at that time could not have formed the Bays.*

What additional evidence would be helpful in confirming your interpretation?

*Frey got a radiocarbon date of >38,000 years or greater about 6 feet above the bottom of the Singletary Lake fill. More recent data suggests that many Bays formed at least 100 ky ago. By the time the meteorite impact hypothesis for 12,900 yrs BP appeared as a paper (Firestone, et al., 2007b), the authors had discovered Frey's work (although this is hardly the only work on the age of the bays) and no longer attributed formation of the Bays to the impact.*

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### References

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- Frey, D.G., 1953, Regional Aspects of the Late-Glacial and Post-Glacial Pollen Succession of Southeastern North Carolina: Ecological Monographs, vol. 23 (3), p. 289-313.