



# The Periglacial Legacy of the New Jersey Pine Barrens, USA: Climate History and Geomorphic Heritage as a Land-Use Management Tool

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## I. ABSTRACT

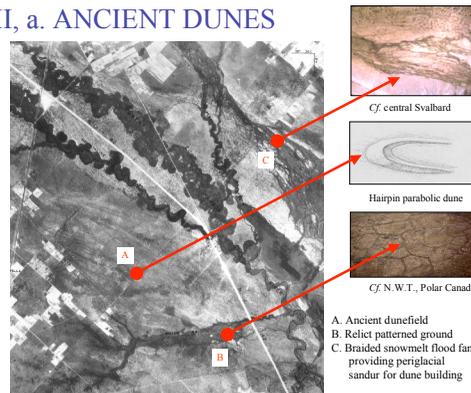
The wetlands of the Pinelands National Reserve in New Jersey provide valuable geographic clues concerning the region's cold, dry, and windy ice-age past. Studying the relationships between humans and unusual landforms known locally as *spungs*, *cripples*, *blue holes*, and *savannahs* yields important insight into the effects of 200,000 years of global climate change, and how regional environmental dynamics relate to human ecology.

The debate about the periglacial/permafrost origins of Pine Barrens landforms has been spirited and controversial. Recent contributions to paleoenvironmental reconstruction in the region provide strong support for the interpretation that cold, non-glacial processes left distinctive marks on the region's landscapes. Unusual "periglacial" wetland features were linked by ancient trails, woven together in a geographic tapestry of interactions between society and nature. In the absence of a long-term scientific monitoring program, historical records and local knowledge were used to document recent changes in these wetland environments, which are drying up. This process threatens life-supporting systems that are fundamental elements in this internationally important ecological region. It is hoped that wider understanding of the Pinelands National Reserve's natural and human history will spur greater efforts to protect near-surface and surficial water resources. The shallow aquifers are the lifeblood of the Pine Barrens.

## II. METHODOLOGY

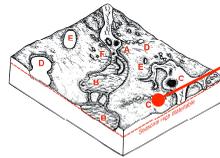
The research described here involves an attempt to link the characteristics of a Pleistocene permafrost landscape with contemporary cultural and environmental dynamics in the region. Information derived from the Quaternary stratigraphy of the Pine Barrens provides a view of changes in the nature and intensity of climatic and surficial processes. Ultimately, this information may be of value for efforts to conserve and preserve southern New Jersey's natural landscapes.

## III, a. ANCIENT DUNES



Traces of broad, shallow, and braided Pleistocene-aged stream channels are common within the Pine Barrens. These ancient patterns reflect high-energy seasonal flow (*i.e.*, snowmelt derived) passing over frozen ground. Modern (Holocene-aged) waterways are underfit, indicating that a much lower hydraulic gradient exists today than during cold intervals. In this photo, both the Hospitality Branch and Great Egg Harbor River (left to right) form tight meanders as they pass through an ancient dune field. Above and upwind of the eolian bedform, the Penny Pot Branch (right) remained braided without sand-choking (1931 aerial photomosaic).

## III, b. SPUNGS

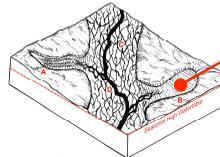


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|-----------------------------|---------------------------|
| <b>Riverine Environment</b> | <b>Upland Environment</b> |
| A. Blue hole                | C. Round pond             |
| B. Icing pond               | D. Irregular pond         |
| C. Round pond               | E. Oval pond              |
| D. Irregular pond           | F. Furrows                |

• Diagrammatic illustration of some topographic relationships for pond types typically found in the New Jersey Pine Barrens.

*Spungs* are enclosed wetland basins, created by katabatic wind deflation under cold, non-glacial (*i.e.*, periglacial) conditions. These pockets of water served as oasis-like watering places for wildlife and ambulant peoples over a period of 12,000 years, and loci of early European settlement. Spungs are a northern variant of the Carolina Bays, considered by many to be among North America's most provocative geologic enigmas. Within the wetlands are many of the region's rare, threatened and endangered species of flora and fauna. They are not isolated basins, but complex regional water-table features.

## III, c. CRIPPLES

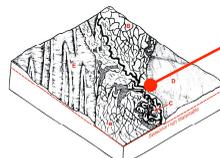


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|---------------------------------------|
| A. V-headed round-bottomed cripple    |
| B. Round-headed flat-bottomed cripple |
| C. Broad paleochannel                 |
| D. Modern underfit stream             |

• Diagrammatic illustration of some topographical relationships of generalized cripples types found in the New Jersey Pine Barrens.

*Cripples* are short, broad, and damp valleys lacking modern stream incision. Surface wash over frozen ground and wind action were the primary geomorphic agents responsible for shaping these valleys. These are the equivalent of Europe's *dells*, which are widely considered relicts of former periglacial conditions. Cripple recognition fills an important gap in the characterization and protection of Pinelands ephemeral wetlands. Little is known of their numbers, their extent outside the Pinelands, their age, or their importance concerning threatened or endangered plants and animals.

## III, d. BLUE HOLES

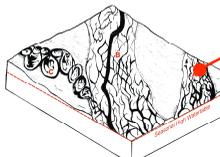


- |                              |
|------------------------------|
| A. Strong spring             |
| B. Braided paleochannel      |
| C. Cusped/meandering channel |
| D. Gravelly siltent          |
| E. Dunes                     |

• Diagrammatic illustration of the Inskeeps Blue Hole (*Piney Hollow, N.J.*), showing topographical relationships often shared by other blue holes of the Pine Barrens.

*Blue holes* are deep, strong springs found in present-day river channels or, occasionally, on the broad paleochannels bordering watercourses. During frozen epochs, such springs could have been the source of thick, tabular masses of ice called "icings." Until recent investigations, blue holes remained in the realm of Pinelands legend and folklore, mythical locales replete with fantastic stories. Ancient trails linked these upwellings with other "periglacial" features. Current studies indicate the turquoise-blue hue may be caused by unusual microflora.

## III, e. SAVANNAHS



- |   |
|---|
| A. Savannah within a braided Pleistocene paleochannel that lacks a dominant modern channel      |
| B. Savannah along an incised river-channel floodplain   |
| C. Savannah present within stream meanders that developed in response to windblown sand-choking |

• Diagrammatic illustration of topographic relationships for three types of savannah habitat in the New Jersey Pine Barrens.

*Savannahs* are flat stretches of sedgey, grassy, and sparsely wooded meadow occupying abandoned Pleistocene river channels. Ancient aboriginal trails often pass along savannah, which are prime hunting grounds. The term "savannah," as used here, is from its proper Caribbean Indian derivation for treeless, open, and marshy plains of tropical America. According to early accounts, cattle were raised in these wet meadows of the Pine Barrens. Dunes, associated with savannah microtopography, form critical botanical habitat.

## IV. DISCUSSION

The Mid-Atlantic region of the USA is experiencing unprecedented development, with rapid expansion of low-density housing and commercial functions into previously forested and agricultural rural areas. In New Jersey, development pressures are extreme—land developed between 1986 and 1995 in New Jersey consumes double the per-capita acreage of that developed prior to 1986. Recognition and understanding of periglacial landforms may help to address broader issues concerning the Mid-Atlantic region, and can add insight across a range of disciplines beyond geomorphology. Heightened appreciation for the natural history of a region can provide a basis for the preservation of extensive preserves and heritage sites, such as the Ice Age Scientific Reserve in Wisconsin.

- To the *biologist*, the legacy of periglacial features provides critical habitat for many of the rare, threatened and endangered plants and animals.
- To the *climatologist*, periglacial phenomena can be used to reconstruct Late Glacial to Holocene conditions with respect to temperature, precipitation, and wind patterns important to climate-change modeling.
- To the *archeologist*, relict landforms are noteworthy as sites where relicts of the Pinelands' earliest cultures can be found.
- To the *historian*, relict landforms can mark places of Colonial settlement, the locus of early roads, and are places of timberland and frontier commerce.
- To the *hydrologist*, these shallow wetlands are windows into the region's groundwater, where accurate records of shallow aquifer levels in the Pine Barrens are scanty, episodic and of insufficient duration to document long term trends in ground water base level.
- To the *land-use planner*, recognition of periglacial landforms will provide geotopes and biotopes worthy of preservation and information useful in their struggles to control sprawl and create healthy, livable communities.

## V. CONCLUSIONS

Development pressures are extreme in New Jersey. Valued landscapes usually go to the highest bidder, and their fate is all too often decided by economic rather than scientific concerns, such as climate-change impacts. Associated problems range from the ecological patchworks created by low-intensity exurban and recreational housing to unsustainable drawdown of groundwater reserves in the New Jersey Pinelands. Problems compound as the Pinelands Commission's planning power decentralizes and shifts to facilitate local entrepreneurial interests. Municipal, county, and state governments can become advocates and sponsors of development, weakening or ignoring the environmental oversight they were entrusted with, even at the imperilment of a globally significant biosphere. Our efforts to publicize the Pine Barrens' legacy of climate change and periglacial conditions indicate that some potentially destructive land-use decisions can be mitigated when local inhabitants and officials become familiar with the unusual natural history of their region.

## VI. REFERENCES

- Demitroff M. 2007. *Pine Barrens Wetlands: Geographical Reflections of South Jersey's Periglacial Legacy*. MS thesis, University of Delaware, Newark, DE, 244 pp.
- French, H.M. & Demitroff, M. 2001. Cold-climate origin of the enclosed depressions and wetlands ("spungs") of the Pine Barrens, southern New Jersey, USA. *Permafrost and Periglacial Processes* 12: 337-350.
- French, H.M., Demitroff M., Forman, S.L. & Newell, W.L. 2007. A chronology of Late Pleistocene permafrost events in southern New Jersey, Eastern USA. *Permafrost and Periglacial Processes* 18: 49-59.

