NJ Department of Environmental Protection
Division of Science and Research

A factsheet:
Last Millennium Relative Sea-level Change on the Western Coast of Southern New Jersey

December 2024

Report Authors and affiliation:
Jennifer Walker, Ph.D.
Rowan University

Factsheet Prepared by:
Mihaela Enache, Ph.D., Division of Science and Research

What was the purpose of the study?

The main goal of this study was to figure out how sea levels changed over the last 1,000 years on the western coast of southern New Jersey along the Delaware Bay shore. The researchers used techniques to study the historic environment by evaluating sediment cores to get detailed information about sea levels and land sinking, known as subsidence, at Dennis Creek during this time. They analyzed the distribution of tiny sea creatures called foraminifera changes in sediment chemistry, and other features of the sediment cores. By using radiocarbon dating and pollution markers, they determined the rates of subsidence and sea level rise. They also looked at changes in the numbers of fossil foraminifera in the cores to track sea level changes over time.

What was the general approach to the study?

In Fall 2022, scientists began a study at Dennis Creek by taking nine deep samples of the ground, called sediment cores, to understand the layers of the wetlands and their history (Figure 1). They found different types of peat and silt in these layers, but foraminifera, tiny sea creatures important for studying past sea levels, were mostly missing below 60 cm (about two feet), so identification of a new location where foraminifera were found at depth was needed. The investigators collected 30 surface samples at the original locations to help understand the relationship between elevation and the presence of foraminifera and carbon isotopes. In Spring 2023, they returned to the study site to explore more of the wetland and identified a more representative location with thick salt-marsh layers. They took two new cores for analysis and collected 15 more surface samples to get a full picture of the environment. By Spring 2024, they went back to collect additional cores from the same spot. These were analyzed for organic content and density to adjust for natural ground settling, which helps them accurately reconstruct how sea levels have changed over the past 1,000 years.

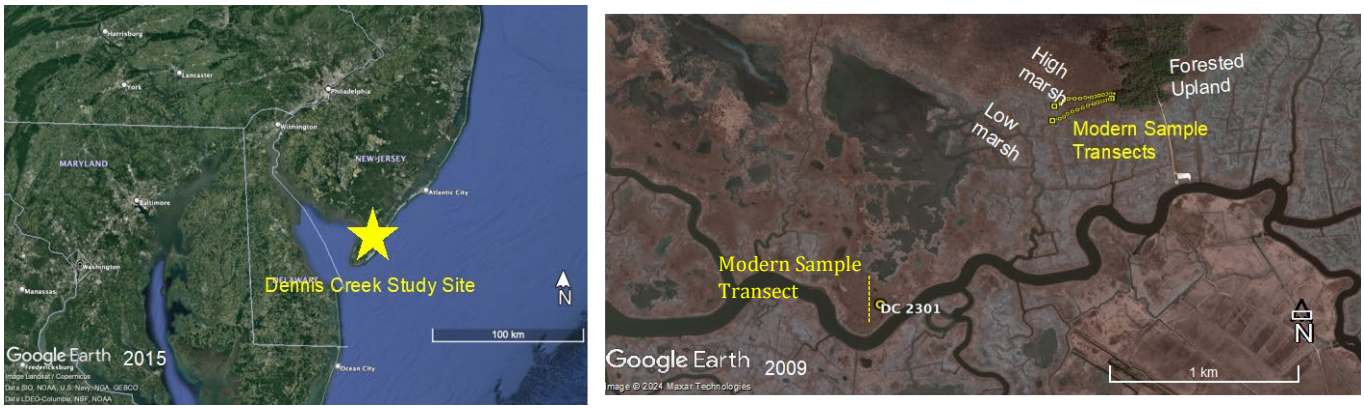


Figure 1. Left: Location of Dennis Creek study site in southern New Jersey. Right: Location of two original modern sample transects and an additional modern sample transect from fieldwork in spring 2023. DC 2301 is the location of the sampled sediment core for analysis (39.1728 N -74.8698 W).

The 30 samples of surface sediment from Fall 2022 were analyzed for foraminifera. A special technique was used to sieve the sediments to separate particles by size and then scientists counted and identified 100 foraminifera from each sample using a microscope. For the 2023 sediment core, they identified foraminifera throughout the core in 1-cm thick slices cut at every 10-cm interval down to 160 cm deep.

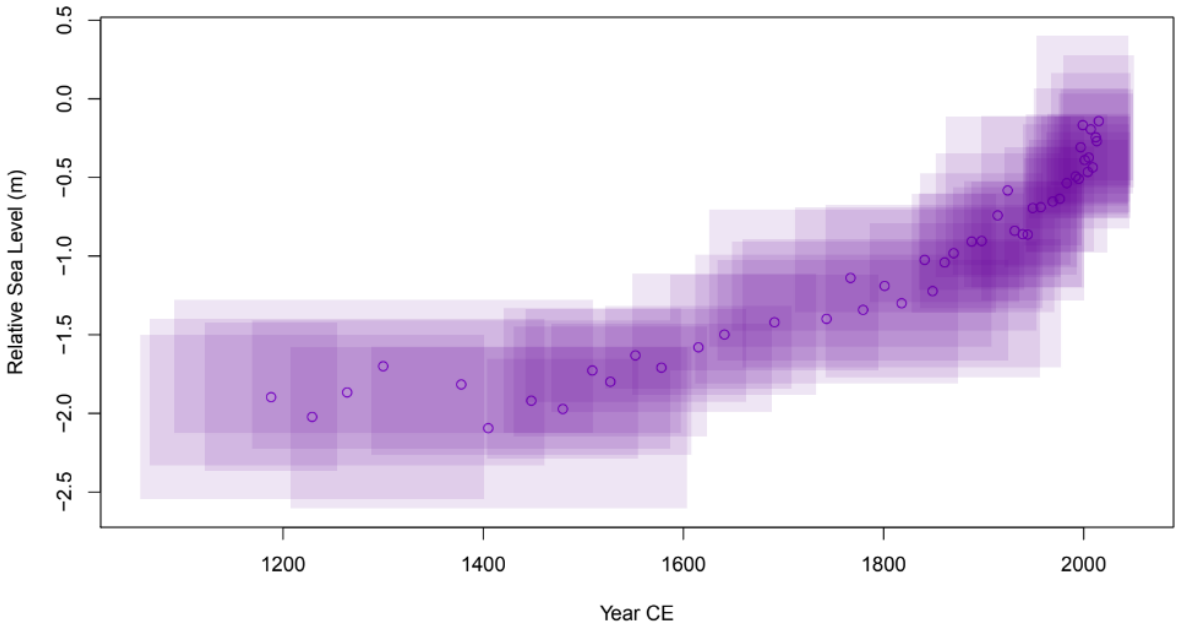
The investigators also studied stable carbon isotopes in the 2022 transect sediment samples which were used as a secondary proxy to foraminifera in sea-level reconstructions. This was done by analyzing the types of carbon found in marsh plants to distinguish between plants that are primarily living on land or are aquatic plants. For the 2023 core, they looked at carbon isotopes every 5 cm down to 300 cm. To date the upper 80 cm of the 2023 core, the presence of metals at different depths was linked to the start of their release during known pollution events. Below 80 cm, radiocarbon dating on plant fossils was used to determine the age of the sediment.
To understand how compacted the sediment was, they analyzed every other cm down to 300 cm in the core for something called loss-on-ignition and bulk density, which involved heating samples and measuring changes in organic and mineral matter content. The compaction was important for calculating wetland sediment accumulation rates and core chronology.

Overall, what did the study show?

In this study, scientists used the presence of different types of foraminifera, fossils of tiny sea creatures, to indicate the type of marsh environments present through time. For example, specific species are found more in low or high marsh areas (areas of the marsh that are more or less frequently flooded by tides) and foraminifera are not found above the tidal elevations in uplands. By analyzing the sediment core from 2023, they discovered that the area transitioned from upland to tidal marsh in the early 1500s. The carbon isotope data confirmed these findings, showing changes in plant life consistent with marsh conditions. They also measured how much organic material and density changed with depth, which helped them understand how the ground settled over time. By

looking at metal pollution levels and radiocarbon dating plant fossils in the sediment core, they created a timeline showing that the core covers the last 1,500 years. Using special models, they estimated that sea levels at Dennis Creek have risen about 1.5 meters since 1200, with the rate of rise increasing over time (Figure 2). In the last few hundred years, the rate of sea-level rise has sped up, matching patterns seen in nearby Cape May Courthouse, but slightly faster at Dennis Creek.

Figure 2. Relative sea-level record from Dennis Creek over the last 800 years. Each purple rectangle represents wetland age and uncertainties, with the midpoint shown by the circle.



For example, at Cape May Courthouse, relative sea-level rise likely reached a rate of 2 mm/yr by the 1700s and 3 mm/yr by 1900 CE; at Dennis Creek, relative sea-level rise reached a rate of 2 mm/yr by the mid-1600s and 3 mm/yr by 1800 CE. In the 20th century, relative sea-level rise was approximately 3.6 mm/yr at Cape May Courthouse, but 4.2 mm/yr at Dennis Creek (Table 1).

Table 1. Rates of sea-level change (mm/yr) over various time intervals at Dennis Creek (this study) compared to Cape May Courthouse (Kemp et al., 2013). *Note that the Cape May reconstruction stops at 2008 when the sediment core was collected restricting the comparison after this year.*

	Rate (mm/yr)	
Time Interval (year Common Era)	**Dennis Creek (this study)**	**Cape May Courthouse (Kemp et al., 2013)**
Entire study period (1188-2008)	1.8 ± 0.2	1.8 ± 0.2
Rates per century		
1508-1608	1.4 ± 0.3	1.4 ± 0.3
1608-1708	2.1 ± 0.2	1.9 ± 0.3
1708-1808	2.8 ± 0.2	2.5 ± 0.2
1808-1908	3.6 ± 0.2	3.1 ± 0.3
1908-2008	4.2 ± 0.4	3.6 ± 0.5
Rate for last decade		
1998-2008	4.5 ± 0.5	3.8 ± 0.6

How will DEP use the data?

The study at Dennis Creek gives us a local view of how sea levels have changed over time in the Delaware Bay area of New Jersey. When compared to similar studies from the Atlantic coast of New Jersey, it shows that sea levels at Dennis Creek started rising faster and earlier. These differences highlight the importance of understanding local factors that affect sea-level changes. This is crucial for accurately predicting future sea-level changes and understanding how different coastlines may respond.

Please review the full report for more detailed information at:
https://hdl.handle.net/10929/141967

Funding for this study was provided by NJDEP and managed under NJ DEP contract DR11173-004.

For more information, please contact Mihaela Enache at mihaela.enache@dep.nj.gov.

References:

Kemp, Andrew C., Benjamin P. Horton, Christopher H. Vane, Christopher E. Bernhardt, D. Reide Corbett, Simon E. Engelhart, Shimon C. Anisfeld, Andrew C. Parnell, and Niamh Cahill. 2013. "Sea-Level Change during the Last 2500 Years in New Jersey, USA." Quaternary Science Reviews 81 (December): 90–104. https://doi.org/10.1016/j.quascirev.2013.09.024.

This factsheet was written with assistance from the NJ AI Assistant (https://ai-assistant.nj.gov/) and thoroughly edited by DSR.