Revisiting the age and development of Provincelands Hook, Cape Cod Massachusetts – a fresh look

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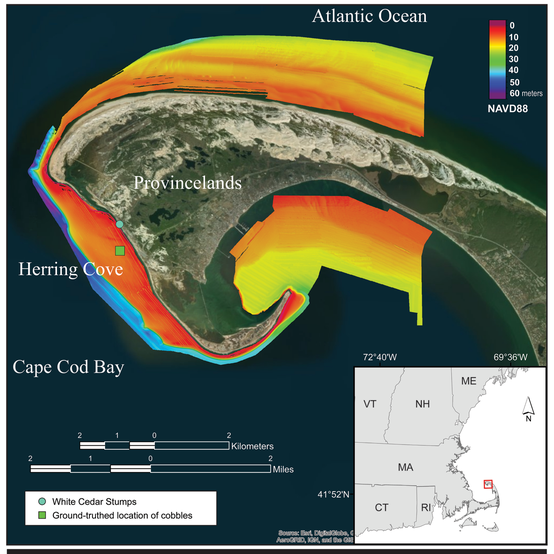
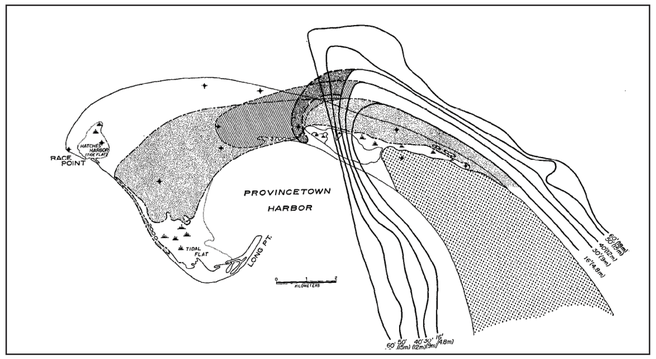
Introduction

Provincetown Hook, a 35 km² complex of barrier beaches, spits, dunes and wetlands is a major depocenter for sediment transported northward from the eroding bluffs of outer Cape Cod, Massachusetts.



Location map. Bathymetry and co-registered side scan (not shown) was collected by the Center for Coastal Studies in 2012, 2015 and 2017 for various projects.

The Hook was created by prograding barrier spits derived from the erosion of the Late Pleistocene glacial-fluvial deposits of Outer Cape Cod (Davis, 1896). Zeigler and others (1965) hypothesized that formation of the Hook was initiated around 6 kyr B.P. when offshore shoals became inundated by rising sea level, causing littoral transport to shift from southward to northward.



Provincelands Hook showing succesive positions of older shorelines. (Modified from Ziegler et al., 1965)

Growth was outward and slowly upward with rising sea level. Northward littoral currents carried material building the hook with mostly sand with zones of coarse gravels. The spits were built longitudinally and later hooked around enclosing lowland areas.

Uncovering new clues bearing on the development of the Hook

In 2017, the Center for Coastal Studies (CCS) conducted a series of acoustic surveys, which were part of an ongoing project funded by the National Park Service designed to study the effects of hydraulic clamming on the benthic environment. Preliminary analysis of the data revealed large scale sand sheets migrating over an unknown substrate. Subsequent ground – truthing confirmed that the unknown substrate consisted of coarse sand, cobbles, gravel and shell hash.

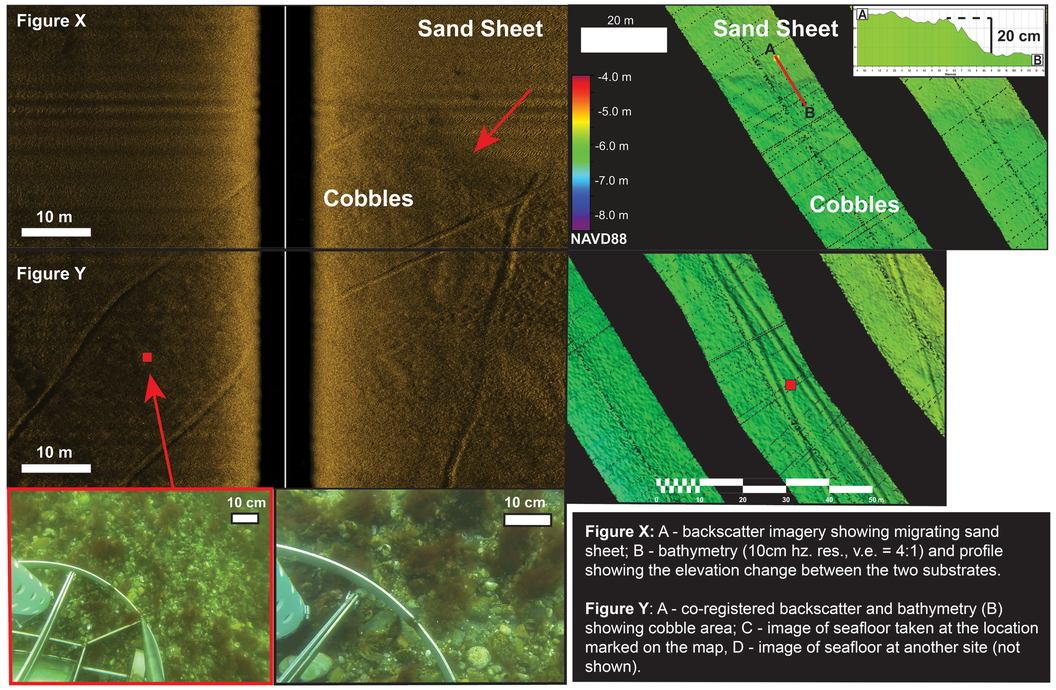
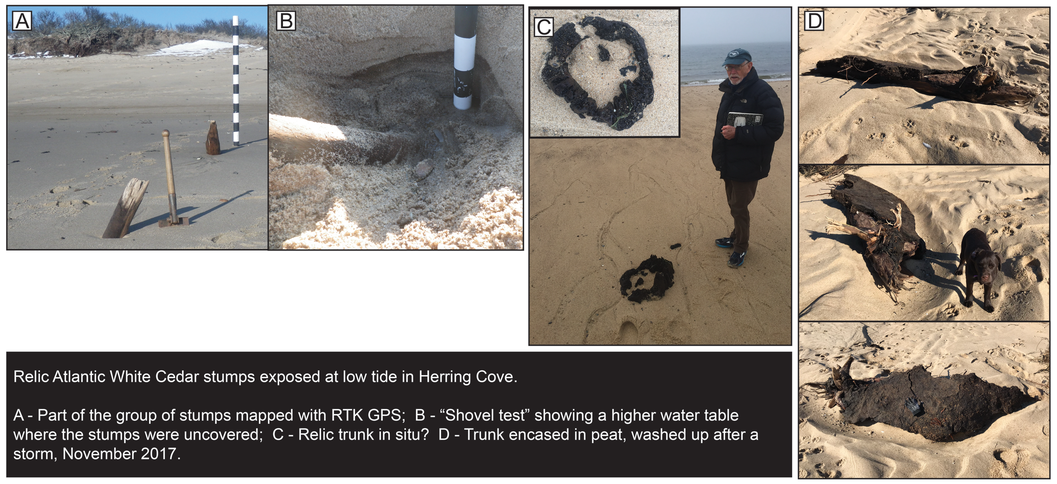


Figure X: A - backscatter imagery showing migrating sand sheet; B - bathymetry (10cm hz. res., v.e. = 4:1) and profile showing the elevation change between the two substrates.

Figure Y: A - co-registered backscatter and bathymetry (B) showing cobble area; C - image of seafloor taken at the location marked on the map, D - image of seafloor at another site (not shown).

Several major extra-tropical cyclones in 2015 - 2017 eroded the dunes at Herring Cove, revealing a stand of buried tree stumps presumed to be Atlantic White Cedar, once "luxuriously" common in the great freshwater bogs of Cape Cod (Alpeter, 1937). Shovel tests confirmed that the stumps were overtop an impermeable surface (i.e. trapping the water table), suggesting that the stumps were emplaced in a layer of peat.



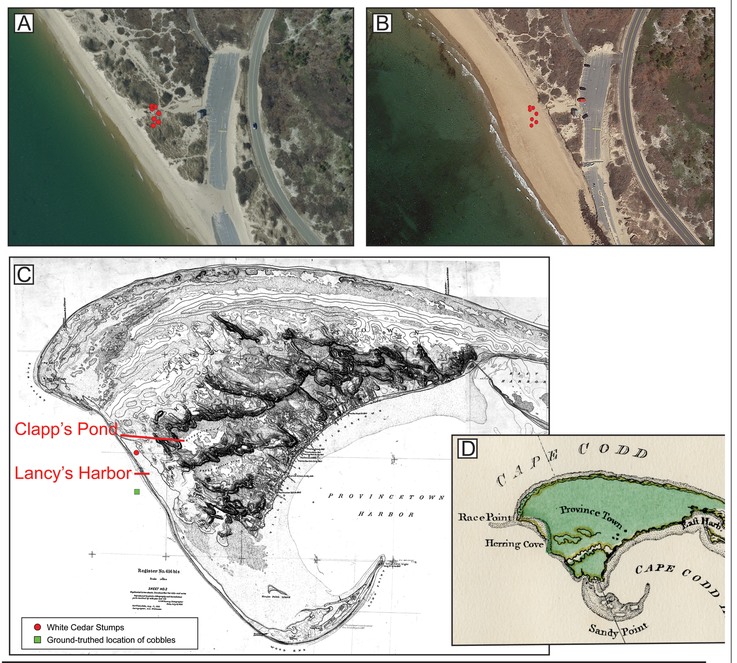
Relic Atlantic White Cedar stumps exposed at low tide in Herring Cove.

A - Part of the group of stumps mapped with RTK GPS; B - "Shovel test" showing a higher water table where the stumps were uncovered; C - Relic trunk in situ? D - Trunk encased in peat, washed up after a storm, November 2017.

Implications for future research

Although not confirmed by ground truthing, it is estimated that the cobble surface is at least 2 km². The depth of the cobble "terrace" is 6.2 m NAVD88 (4.6 m MLW). If the terrace represents a relic shoreline, applying the concept introduced by Ziegler and others (1965), it could be ~3,000 years old.

Peat and the remnants of a White Cedar stand indicate that there were freshwater wetlands further west than previously known.



A - GPS locations of the Atlantic White Cedar trunks overlaying 2014 orthophotos. Note that the for-dune is intact.
B - GPS locations overlaying 2017 aerial images (Google Earth). The fore dune is gone, and the parking lot to the east is severely eroded.
C - GPS locations overlaying 1836 geo-rectified map. Showing the stand in the center of a salt water lagoon! (Lancy's Harbor).
D -1778 DesBarres map of Herring Cove.

Until recently, there hasn't been a lot of data to speculate as to how far west the hook extended. Given these new insights, what questions can we ask? Is the gravel – cobble terrace relic swash zone deposits? What is the true extent of the deposit?

A deeper understanding of the littoral processes of Herring Cove can be gained by further exploring the development of the Hook as new data are uncovered, and new technologies enhance our ability to detect what was previously hidden from view.

References

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