Distribution of Upper Paleolithic human fossil footprints from White Sands National Park

David Bustos, U.S. National Park Service
Daniel Odess, University of Alaska Fairbanks
Matthew Bennett, Bournemouth University
Sally Reynolds, Bournemouth University
Jeffrey Pigati, U.S. Geological Survey
Kathleen Springer, U.S. Geological Survey
Tommy Urban, Cornell University
Vance Holliday, University of Arizona
The Position of Ice Before the Last Glacial Maximum
(Dalton et al. 2022 ESR)
Rich Pluvial Lake Systems and Modern Dry Wastelands
Help of our tribal partners

- Involving Tribal Youth in resource management
- Working with Tribes on new interpretation.
- Assistance with research and monitoring
Glimpses of the Past
Ice Age Fossil Prints from White Sands

Artwork by Karen Carr
Child and Adult prints from the last ice age
Six Print Types:
1. Clay, positive relief
2. Exposed, negative relief
3. Fine gray sand, no cap
4. Pale Fine Sand with cap
5. Dolomite, positive relief
6. Gary Coarse Sand with cap

Human Prints

Megafauna Prints
“Soil Moisture Visibly Dependent Prints”
Always Present, but not always seen

- Too wet
- Just right
- Too dry
Documenting and Locating with GPR
Great assemblage of human footprints (in area and number): New class of behavior data for archaeological sites
Tracks extend over great distances
Layers Range From 21,000 to 23,000 BP

Over 11 stratified layers of organics and fossil prints (6. shown below)

Defining the age of the prints

1. 2. 3. 4. 5. 6.
Fossilized Footprints Video - B roll - White Sands National Park (U.S. National Park Service) (nps.gov)
Nice prints, but where are the lithics ???

- Lithics found on same surface as prints
- Age unknown, could be the same age or younger
- Many large lithics, retouched edges, do not fit known typologies well
- No local stones present on salt flats
- Increased number of sites with lithics found on surface with trackways across 324 km (80,000 acres)
Large Tools Found Near Fossil Prints
Very large bifacial, uniface, and blades with retouched edges
New Ice Age Trail Exhibit

Footprints Tell Stories

Las Huellas Cuentan Historias

All Comes to An End

Todo Llega a Su Fin

One Print at a Time

Una Huella a La Vez
Human print in mammoth print
Tracks show interactions occurred

Footprints preserve terminal Pleistocene hunt?
Human-sloth interactions in North America.
Ground sloth and children prints
Erosion Exposes Tracks

Loss of Mammoth Trackway
2018

2020
Racing to capture the stories
One of many

- Large pluvial lakes common throughout the Americas
- Support for large migrations
- Rapid erosion is a common theme
- White Sands can serve as an analog for other playas where late Pleistocene trace fossils are present and being lost.
Thank you!
Defining the age of the prints

Human footprints at base of trench

Mammoth Print

Seed Layers

Human footprints at base of trench

Location of tracks at base of trench
New Trackways found on Westside

Mammoth Prints

Giant Ground Sloth Prints

Human Prints
Soft-sediment deformation

Camelops conidens


Two mile dolomite camel trackway
Longest known record human fossil trackway, over 1.5 kilometers

Tracks suggest interactions occurred

Testable hypothesis are generated, parameters can be based on future climate models, and management is informed by science.
Use of Satellite Imagery to Monitor Landscape Soil Moisture and Temperature Changes
Loss of Water = Loss of Sediment

2008 Drought, dunes become hotter and dryer than normal

2008 windstorm carries dust from WHSA to Oklahoma
Soil Erosion = Loss of Prints

Prints lost from 6 – 8 inch of sediment erosion

Recently exposed mammoth prints
Inventory & Monitoring

Use of magnetometry for detecting and documenting multi-species Pleistocene megafauna tracks. 

Defining the age of the prints
WATER PROVIDES GYPSYM DUNE STABILITY

February 28, 2012

March 14, 2008

02/26/2009

03/16/2010

05/26/2011

Mammoth Trackway
Ruppia cirrhosa
Overview of Work at Locality 2 Done in 2020
AMS Dates Constrain Ages of Track Horizons 2 to 5.

Older and Younger Horizons remain undated.
Preserving Trackways

Sloth tracks
Proboscidean Tracks
## WHSA CLIMATE PROJECTIONS (1950-1999 vs 2040)

<table>
<thead>
<tr>
<th></th>
<th>Warm/Rain-No Δ</th>
<th>Hot Wet</th>
<th>Hot Dry</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Warming</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common Across Scenarios</td>
<td>Warming in all seasons</td>
<td>Significant drop in days &lt;32 °F</td>
<td></td>
</tr>
<tr>
<td>Degree of warming</td>
<td>~ 1.5 °F</td>
<td>~ 4.1 °F</td>
<td>~ 4.1 °F</td>
</tr>
<tr>
<td></td>
<td>26 days &gt;100 °F (+6 days)</td>
<td>36 days &gt;100 °F (+16 days)</td>
<td>42 days &gt;100 °F (+22 days)</td>
</tr>
<tr>
<td><strong>Precipitation</strong></td>
<td>No change</td>
<td>2” annual decrease concentrated in Jul/Aug (↑~66%)</td>
<td>1.5” annual decrease evenly distributed across June-Dec</td>
</tr>
<tr>
<td><strong>Water Balance</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common Across Scenarios</td>
<td>Increases in soil moisture deficit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual soil moisture deficit increases 7%</td>
<td>Annual soil moisture deficit increases 12%</td>
<td>Annual soil moisture deficit increases 27%</td>
<td></td>
</tr>
</tbody>
</table>

Gregor Schuurman, NPS CCRP (2017)
Use of Lidar, Aerial, Imagery, and photogrammetry to detect prints and monitor erosion
Use of Lidar, Aerial, Imagery, and photogrammetry to detect prints and monitor erosion
Documenting and Locating with GPR
Eroding Tracks
Modern Day and Pleistocene Camelid
Modern Day and Pleistocene Proboscidean

WHSA Fossil Print

Modern Day Elephant