Using GPR, GPS and Close-Range Photography to Map and Characterize Dinosaur Tracks in the Connecticut River Valley

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Abstract:

Fossil trackways can provide information about environmental conditions, group behavior, as well as body size and speed, though the connections between track-size-to-body size and stride-to-speed has recently been challenged (Bobo and Rainforth, 2010). Much of this information can be extracted from photographs and maps of trackways. By georeferencing the data within a digital database, we can extract more information and ask new questions about animal behavior and environment. Our efforts aim to move studies of fossil trackways toward such a digitized georeferenced environment.

While dinosaur skeletal remains are rare, numerous trackways exist in the eastern United States. We chose a well-exposed set of trackways on sedimentary bedding planes in the Connecticut River valley, previously mapped by Ostrom (1972). We used differential GPS to record the location of each track. We took close range oriented photographs to determine the orientation, size and morphology of individual tracks. We precisely located an oriented scale object in each photograph with a reflectorless total station, and used this data to georeference the photographs in GIS software (Global Mapper). We measured dinosaur track characteristics within this georeferenced environment, including size, shape, and bearing. The trackways occur in thinly bedded ripple-marked sandstone, so we suspected that additional tracks existed in the subsurface. We explored the ability of ground penetrating radar (GPR) to identify buried trackways.

We present here our initial results. We found it difficult to compare our trackways with Ostrom (1972). We found many more tracks. In addition, GPR revealed disruptions in the subsurface of the same scale as exposed tracks, leading us to conclude that radar could detect the buried tracks. A major goal of our effort aims at integrating a variety of spatial data and sharing this data with the scientific community for further investigation. Our study highlights the value of combining GPS, GPR, and digital images in the study of dinosaur tracks.

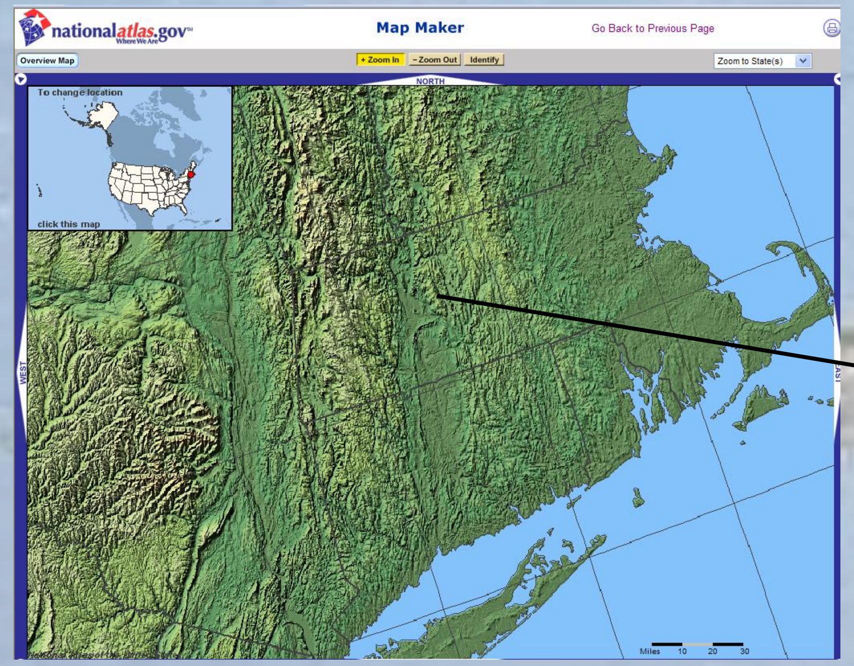

Figure 1: Map of NE USA showing the approximate location of our field site in Holyoke, MA. Map was created using the National Atlas.

Figure 2: Photograph showing our research site. Image is taken facing approximately South.

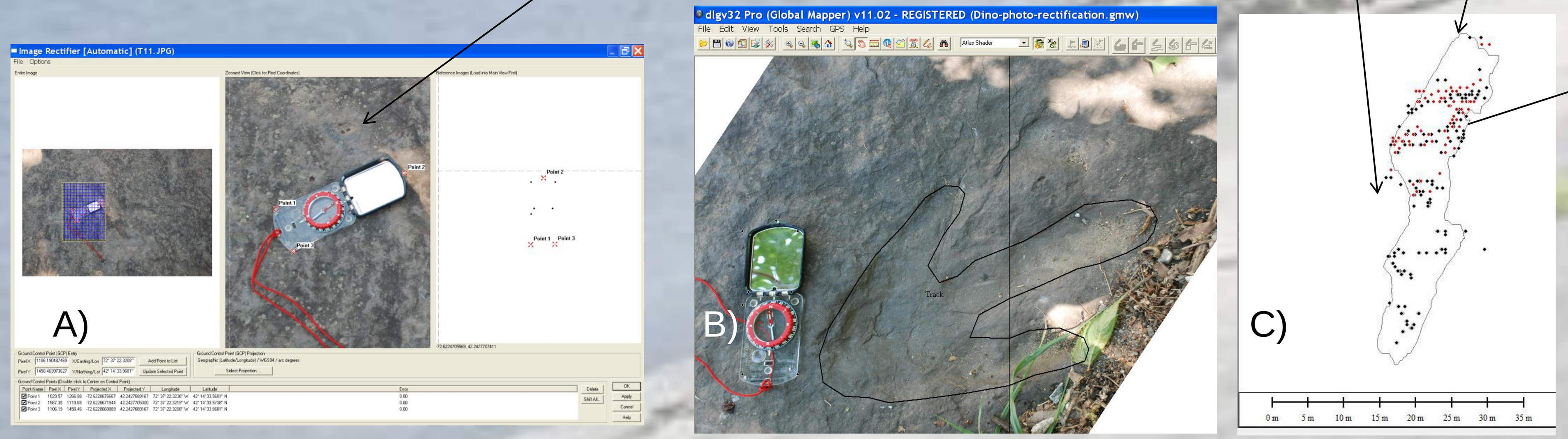

Figure 3: A) Image showing the rectifying process. We used the total station to record a point on the compass which we placed facing North in each photograph. We then plotted the translated control points in the GIS software so we could rectify the images. A total of three points were used on each photograph.

- Project Goal 1: Measure dinosaur footprints and trackways to:
  - Better characterize morphology of footprints
  - Better characterize group behavior
  - Test hypotheses of trackway patterns (shore parallel paths?)
- Project Goal 2: Create a georeferenced data set to:
  - Tie field observations into a global reference frame
  - Simplify feature measurements and manage data
  - Readily share data with other researchers

- Data Collection
  - Hand held photographs
  - Differential GPS of track locations
  - Survey control points for photographs
  - Ground penetrating radar survey
- Data Processing
  - Georeferencing photographs

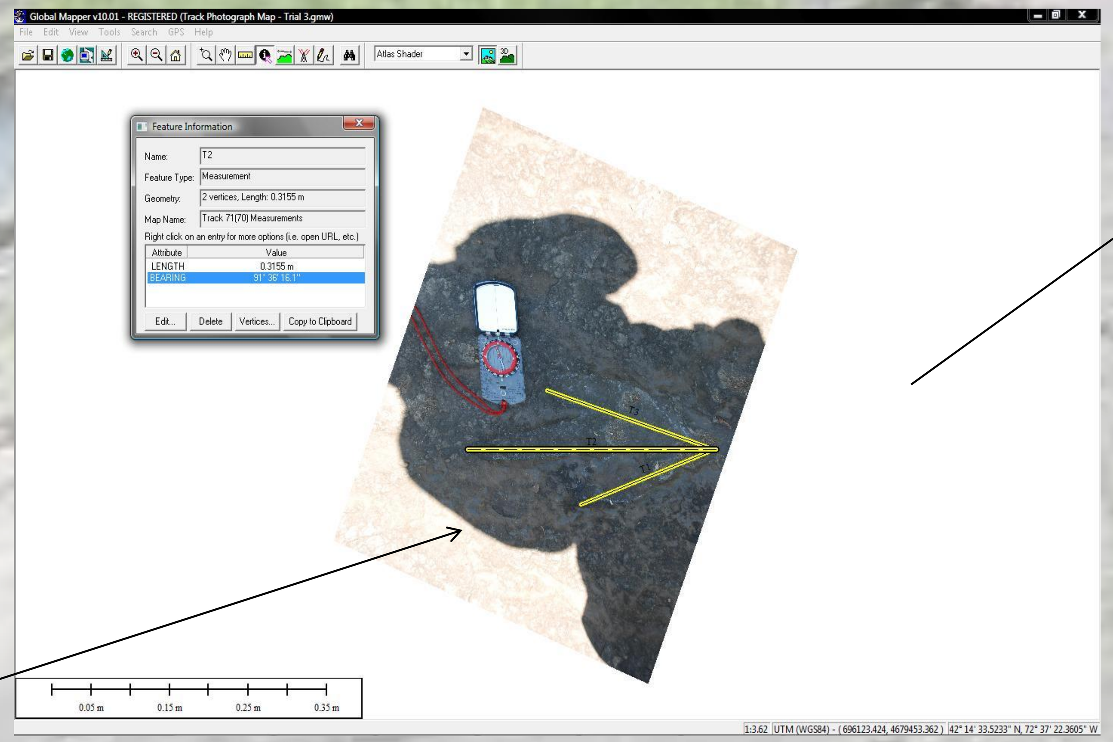

Figure 4: Close up view of Track-70. We measured various lengths of the tracks as well as the bearing. Measurements can be saved as separate layers and turned on and off at will. This is a very useful aspect of GIS—data storage and retrieval is part of the package.

Problems with rectification

1. Developing ground coordinates for the compass—we used Excel, then read the control points into Global Mapper
2. Global Mapper version 10 and lower could not rectify the close range photos; v11 worked!

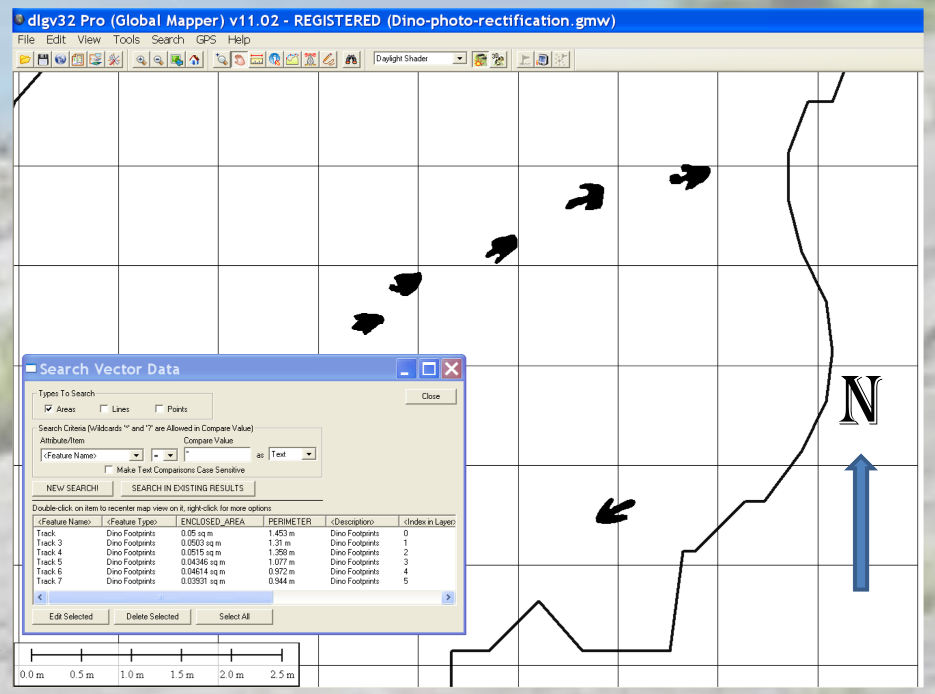

Figure 5: Tracks can be outlined and filled as areas, which allows for better visualization of the tracks. More importantly, tracks can be measured. The photograph layer can be turned off to allow the tracks to be seen clearly. Here we can obtain measurements of stride and identify paths. Visualizing tracks in this way also provides a sense of track quality.

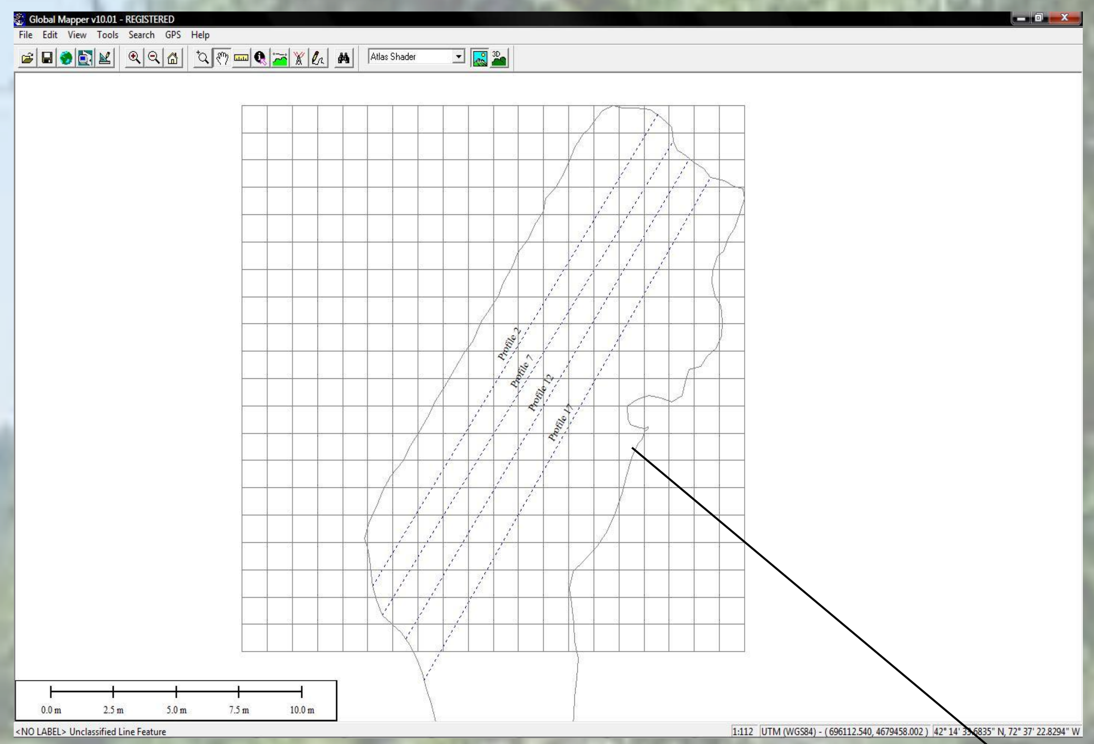

Figure 6: GPR profiles run parallel to the wall visible in Figure 2. We ran 17 profiles with a 500 MHz antenna. The profiles were run at 20 cm intervals.

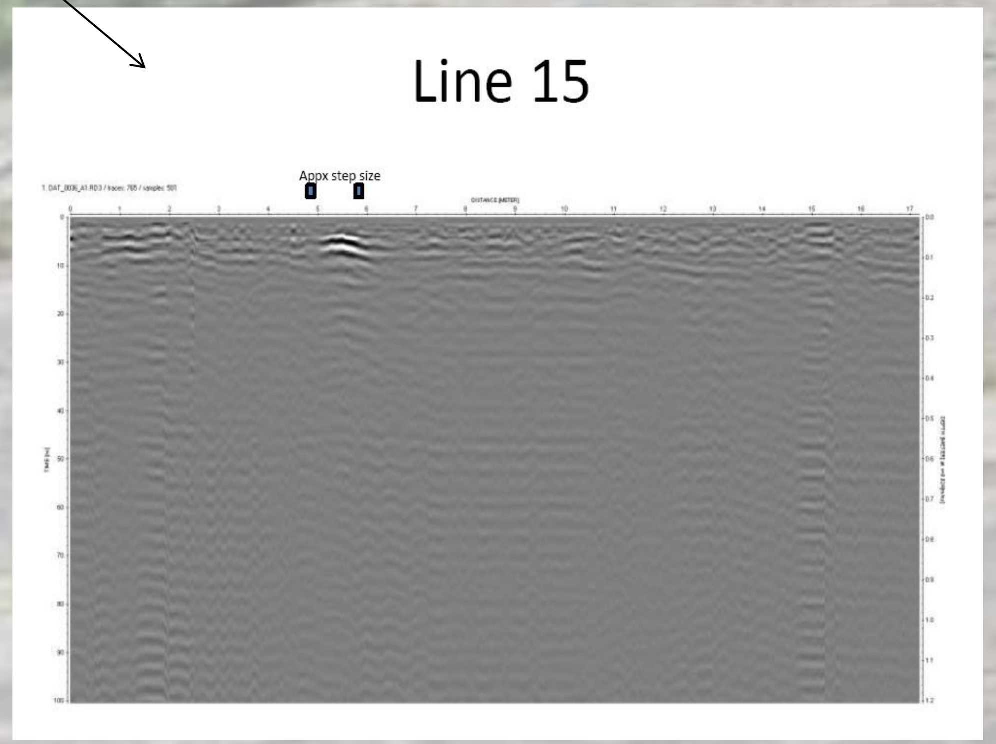

Figure 7: Sample of a GPR profile. The purpose of our GPR work was to see if we could identify tracks in the subsurface. We hypothesized that concentrations of mica would increase within the tracks and as a result, would register on the GPR. Results provided hints of tracks, but work needs to be done. Red arrow points to a disturbance similar in size to the tracks found at the site. Future attempts will look to run profiles as much smaller intervals.

Discussion:

The primary problems we encountered derive from:

1. Booking errors when recording survey data.
2. Poor imaging conditions for photographs (can't see the footprints clearly)
3. Difficulty defining a footprint during replicate surveys
4. GPR should be collected at a higher data density to adequately capture disruptions that could be tracks in the subsurface.

We like using a compass for control points for photos: it's oriented and scaled!

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