Clayton Lake Dinosaur Tracksite - Surface Hydrology Analysis
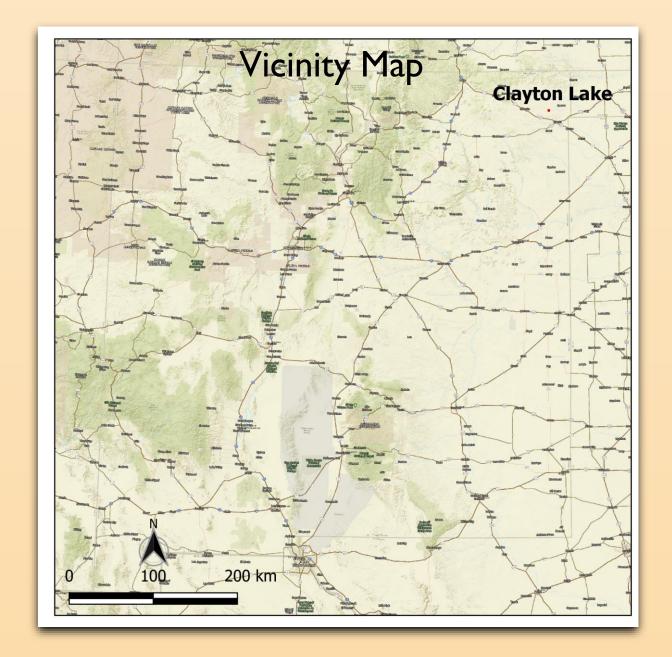## Establishing a baseline for studies of surface erosion

Background

About 100 million years ago, tall, bipedal herbivore dinosaurs in the ichnogenus *Caririchnium* roamed the area now known as Clayton Lake State Park, New Mexico[1].

Artwork by Karl Huber[10]

Source: Clayton Lake State Parks [11]

They left tracks in the mud. The mud hardened to rock, preserving the tracks in shale and underlying sandstone of the early Cretaceous Dakota Group. Layers of sediment covered the tracks over the eons[2]. In the early 1980's, a flood washed silt away from an earthen spillway above the mid-century constructed dam which created nearby Clayton Lake[1]. As water washed away the earth, bedrock dated to about 100 million years old was revealed. The rock contains pathways consisting of over five hundred dinosaur footprints[3]. Subsequently, an exhibit was established for people to study and view the tracks.
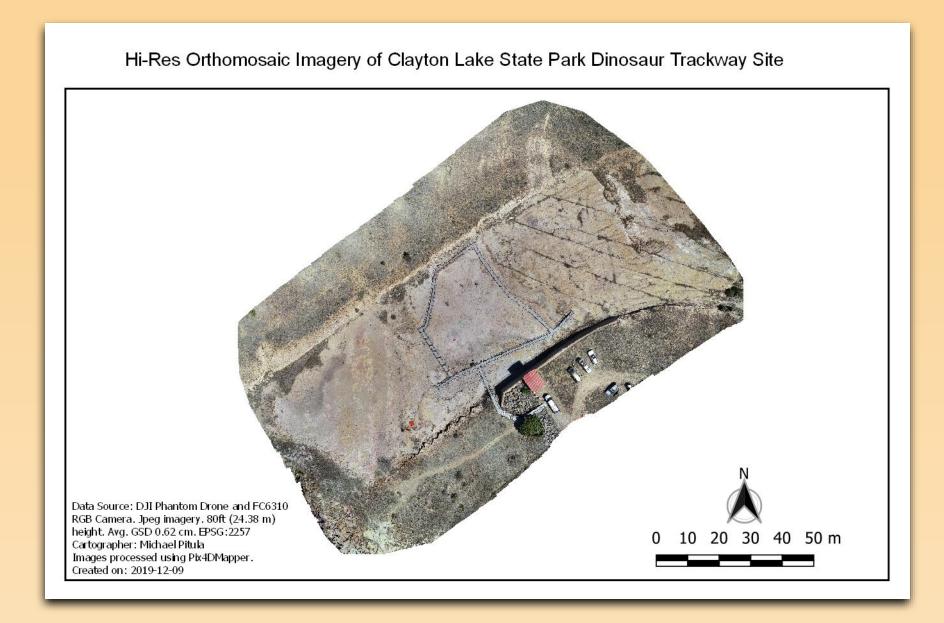

Vicinity Map

Problem & Purpose

Exemplary tracks in the bedrock of the spillway are exposed and vulnerable to the elements. The purpose of this project is to establish a baseline characterization of site surface hydrology in order to assess potential threats that flooding, weathering and erosion may present to ongoing preservation of tracks and traces.

Research

Most of the tracks at this site are present in Dakota sandstone. The sandstone is susceptible to weathering and erosion. The area receives an average of less than 16" rainfall per year and about 28" snowfall[7]. Rain is infrequent but can be intense while runoff from snowmelt can also cause impacts.

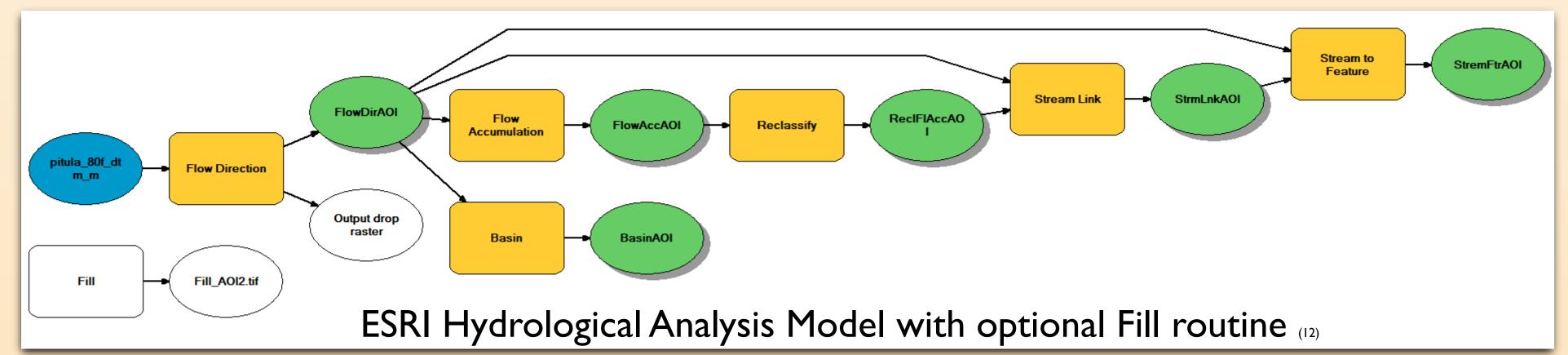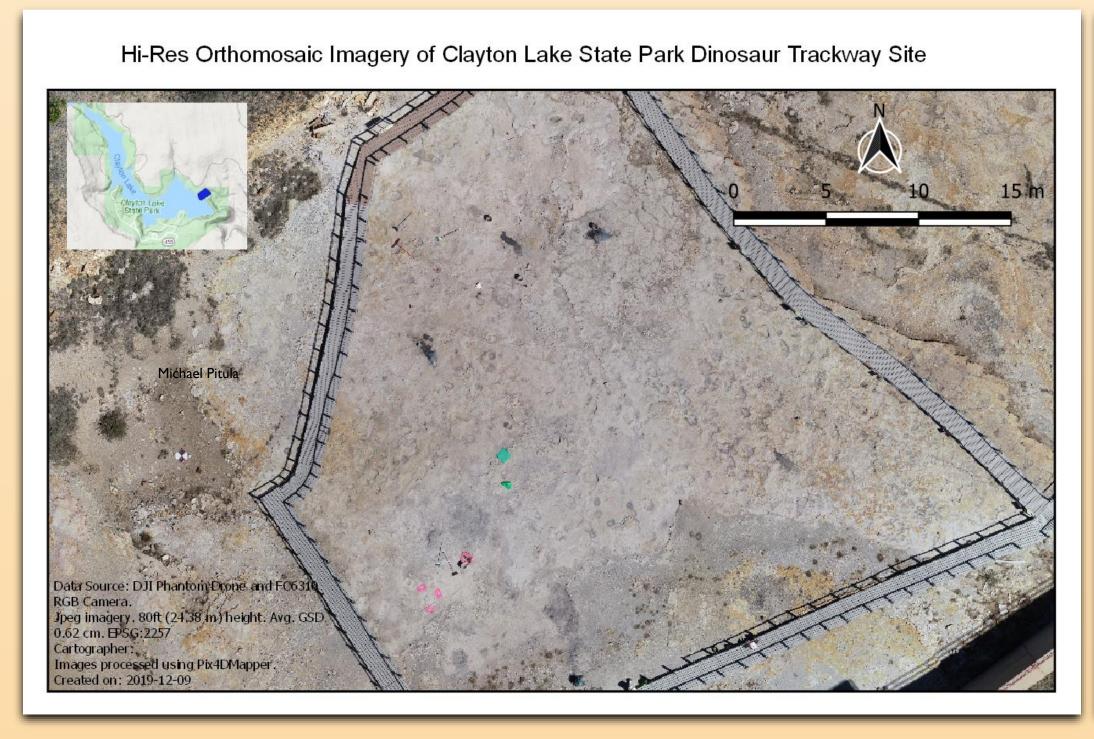Hi-Res Orthomosaic Imagery of Clayton Lake State Park Dinosaur Trackway Site
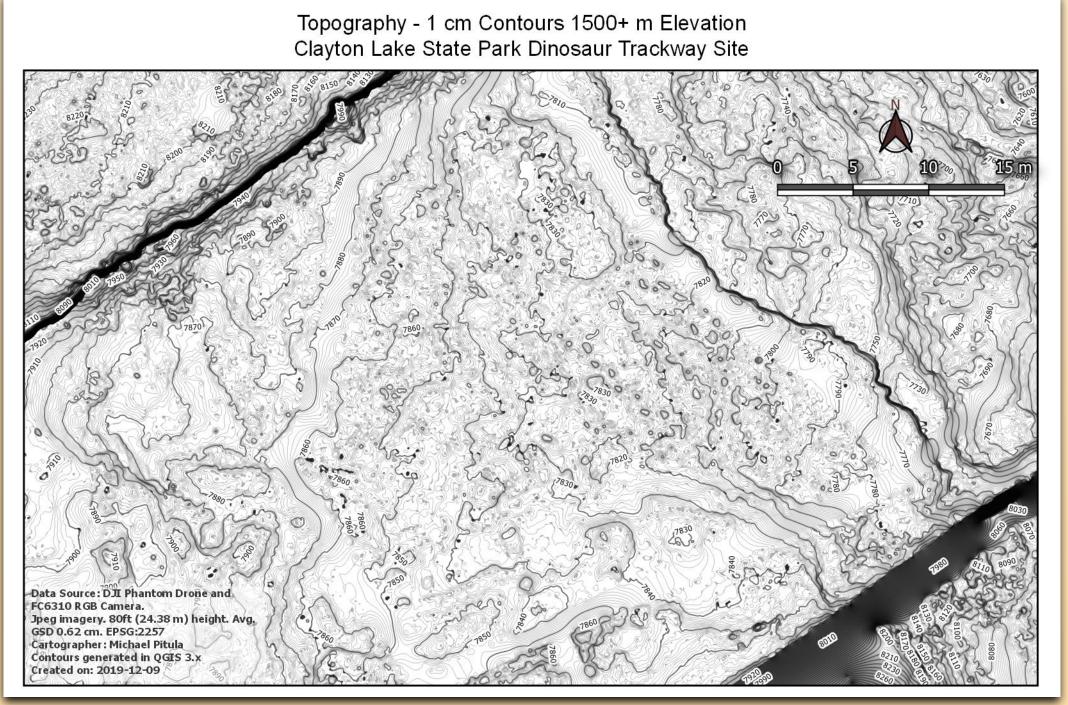
Data Compilation

In May 2019, CNM faculty and students performed the first ever digital survey of the site using terrestrial imagery, photogrammetry, high-resolution structured light scanning and lidar scanning[4]. UAS imagery was collected from heights of 40ft and 80ft, providing a GSD of 0.62 cm, superseding the spatial resolution of 10 m DEMs previously available for this site. Imagery from the 80 ft height was used for this project., consisting of over 350 images. Pix4DMapper was used to generate an Orthomosaic and DSM. Manual classification of the imagery allowed me to generate a DTM. A vector layer outlining the exemplary tracks identified by Dr. Spencer Lucas was obtained as well.

ESRI Hydrological Analysis Model with optional Fill routine [12]

Hi-Res Orthomosaic Imagery of Clayton Lake State Park Dinosaur Trackway Site

Digital Surface and Digital Terrain Models
Clayton Lake State Park Dinosaur Trackway Site

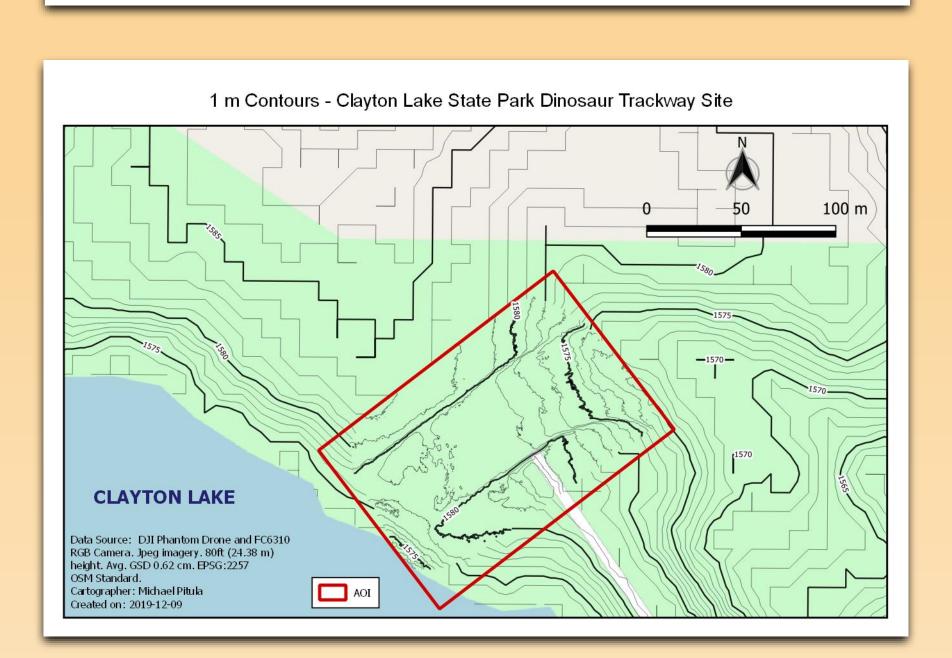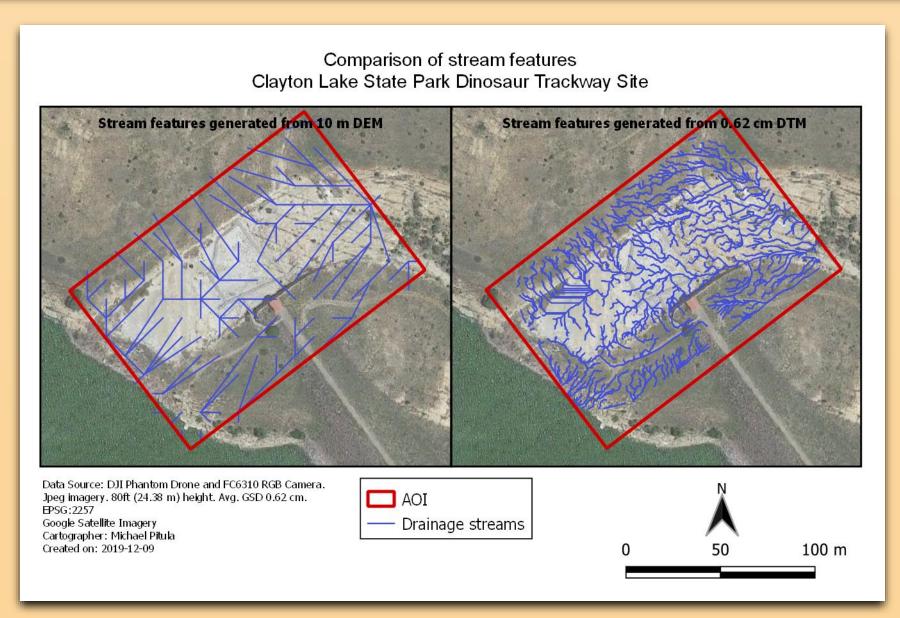1 m Contours - Clayton Lake State Park Dinosaur Trackway Site

Analysis

ESRI ArcMap 10.6 Modelbuilder and QGIS 3.x were used to conduct a hydrological analysis of the site topography based on the DTM. This process generated feature classes for basins, contours and ephemeral microstream features. These were then intersected with the microstreams with the exemplary tracks. These tracks are potentially the most impacted by surface runoff because velocity of runoff is higher in the relatively narrow channels.

Topography - 1 cm Contours 1500+ m Elevation
Clayton Lake State Park Dinosaur Trackway Site

Comparison of stream features
Clayton Lake State Park Dinosaur Trackway Site

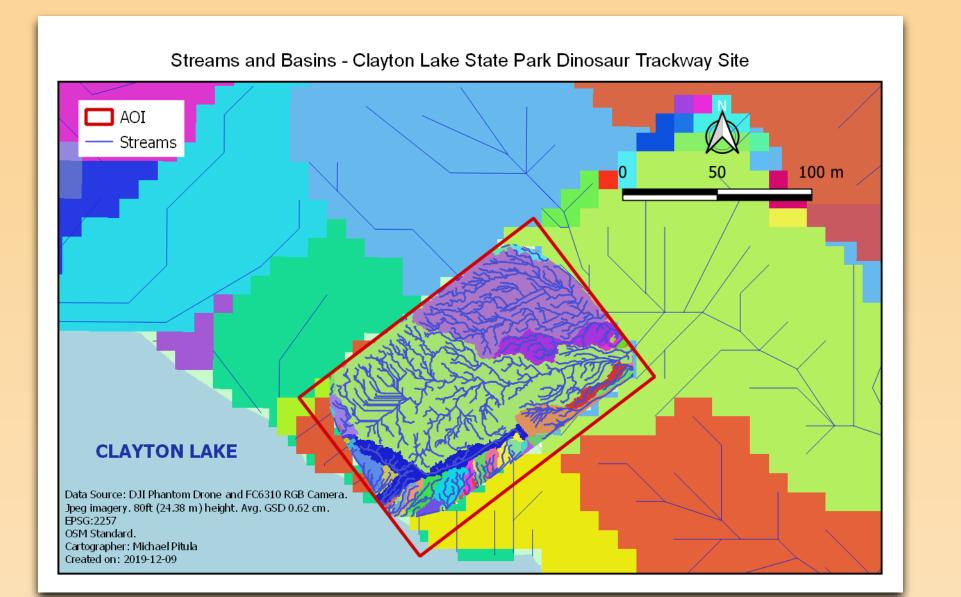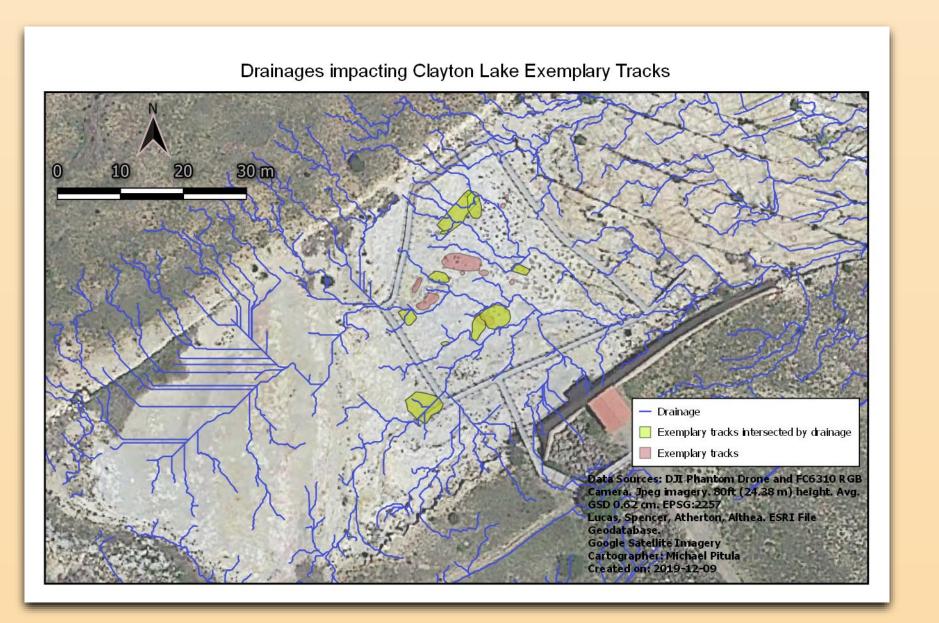Streams and Basins - Clayton Lake State Park Dinosaur Trackway Site

Discussion

Access to subcentimeter spatial resolution imagery greatly enhanced our perspective on this site. Drainage is now characterized with much greater accuracy, which is crucial in relation to the scale of these trackways. The surface runoff flows across the spillway toward the northeast, away from the lake, whereas flow direction modelling based on 10m DEM's indicated a greater degree of flow back into the lake. The analysis determined that about half of the exemplary trackways are intersected by emphemeral microstreams. Many of these are simply grazed by the microstreams but about 3-4 of them are squarely intersected by drainages that accumulate from significant upstream areas within the watershed. These are tracks that should be prioritized for protection.

Further Studies

This initial study provides a very preliminary baseline for understanding the surficial hydrology of this site. Geological studies could be conducted to create quantitative modeling of weathering and erosion of the bedrock. These should incorporate slope and aspect for the drainage channels. Engineering studies could investigate the impact of installing check dams to divert runoff around tracks and traces that are prioritized for protection.

Drainages impacting Clayton Lake Exemplary Tracks

Citations

1) "Clayton Lake State Park Dinosaur Tracksite, Clayton, NM." 2017. *Allosaurus Roar* (blog). April 4, 2017. https://allosaurusroar.com/clayton-lake-state-park-dinosaur-tracksite-clayton-nm/.

2) "Geologic Tour: Clayton Lake State Park." n.d. Accessed October 6, 2019. https://geoinfo.nmt.edu/tour/state/clayton_lake/home.html.

3) "Clayton Lake, New Mexico." n.d. Accessed October 6, 2019. https://ucmp.berkeley.edu/mesozoic/cretaceous/clayton.html.

4) "CNM Students Play Large Role in Mapping Clayton Lake Dinosaur Tracksite." n.d. CNM. Accessed October 6, 2019. https://www.cnm.edu/news/cnm-students-to-play-large-role-in-mapping-clayton-lake-dinosaur-tracksite.

5) "Clayton Lake State Park New Mexico." n.d. Accessed December 9, 2019. http://www.emnrd.state.nm.us/SPD/claytonlakestatepark.html.

6) Kappus, Eric & Lucas, Spencer & Langford, Richard. (2011). The Cerro de Cristo Rey Cretaceous Dinosaur tracksites, Sunland Park, New Mexico, USA, and Chihuahua, Mexico. 53. 272-288.

7) "Climate Clayton - New Mexico and Weather Averages Clayton." n.d. Accessed December 9, 2019. https://www.usclimatedata.com/climate/clayton/new-mexico/united-states/usnm0065/2019/7.

8) Watson, Rick P., Beltran, John and CNM Students. Summer 2019 Field Work Photos Collected with a DJI Phantom Drone and FC6310 RGB Camera. Jpeg imagery. 80 ft (24.38 m) height. Avg GSD 0.62 cm. EPSG: 2257. Central New Mexico Community College, 2019.

9) Lucas, Spencer, Atherton, Althea, ESRI File Geodatabase, polygon outlines of exemplary ichnological samples. Nov. 18, 2019.

10) Artwork by Huber, Karl, cited in Kappus, Eric & Lucas, Spencer & Langford, Richard. (2011). The Cerro de Cristo Rey Cretaceous Dinosaur tracksites, Sunland Park, New Mexico, USA, and Chihuahua, Mexico. 53. 272-288.

11) "Clayton Lake State Park New Mexico." n.d. Accessed December 9, 2019. http://www.emnrd.state.nm.us/SPD/claytonlakestatepark.html.

12) Watson, Theresa. GIS 2001 Lab M: Surface Hydrology and Tools. Fall 2018. Central New Mexico Community College, 2019.

GIS 2030   Michael Pitula   Fall 2019