

**OBSERVATIONS ON DUNE BEHAVIOR AT GREAT SAND DUNES NATIONAL PARK, COLORADO.**

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**Introduction:** Dune migration measurements have been made by the National Park Service (NPS) at Great Sand Dunes, Colorado. The development of GPS satellites as a mapping tool in the 1990s has allowed the NPS to map the position of several index dunes on an annual basis. A time series of aerial imagery has also been used by the NPS and others [1] to measure dune movement from the 1930s to the present. There have also been periodic surveys with a total station to measure dune height on some of the larger dunes at Great Sand Dunes. In October 2011, Great Sand Dunes have been mapped by LiDAR. If that data becomes available, it will be included in the presentation and a comparison will be made of measuring dune heights with LiDAR vs. conventional surveying.

Great Sand Dunes, Colorado is the site of an aeolian system that varies along a topographic gradient [2], Figure 1. It originates at a playa system [3]

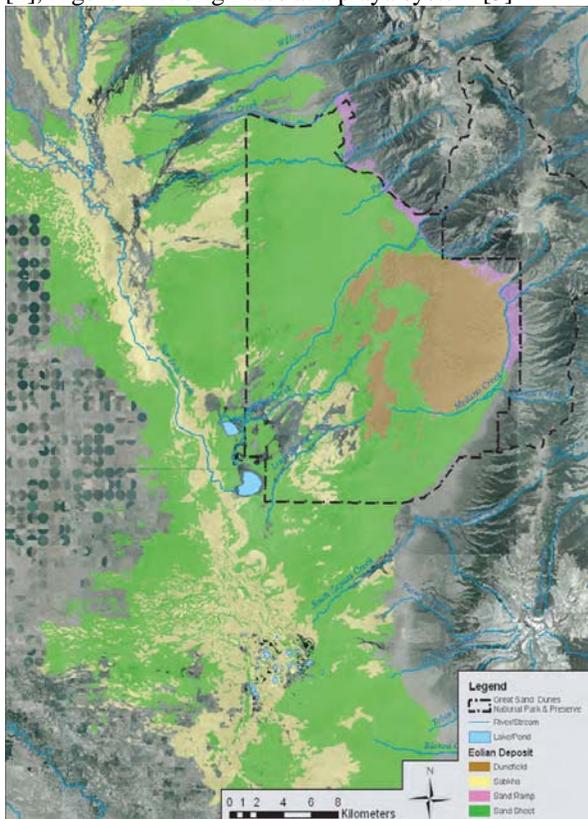


Figure 1: Aeolian Sand Deposits at Great Sand Dunes. The deposits consist of inland sabkhas (yellow), sand sheets (green), active dunefields (brown), and sand ramps (purple).

where sabkha deposits are found. As the land surface rises above the capillary fringe, sand sheets develop. Near the mountain front is the dunefield and along the mountain front are sand ramps. So the playa is the site of aqueous concentration of sand. Once exposed to wind, the sand is transported across the sand sheet. At the mountain front the wind regime changes and creates a depo-center where the dunefield is found. Because of variation in wind regime, sand supply, vegetation, and topography, a variety of dune types have developed [2], Figure 2.

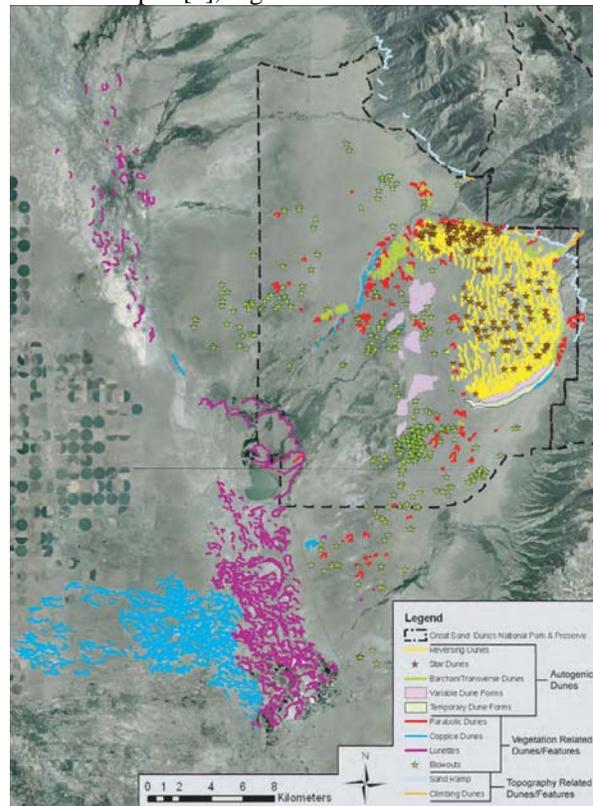


Figure 2. Dune types at Great Sand Dunes.

**Problem Statement:** The NPS manages Great Sand Dunes and is interested in understanding the behavior of the sand dunes and how the aeolian system works. Essential to that is monitoring dune movement and growth. There are areas with a unimodal wind regime where migratory dunes form and areas with bi-modal and complex wind regimes where vertically growing dunes form.

Great Sand Dunes is known for having the tallest dunes in North America, so understanding the vertical

growth component is also important. Elevation changes have been tracked and field observations have also led to ideas about how the vertical growth occurs.

**Results:** The dunes with the longest period of measure are a barchan/parabolic dune known as the escape dune and the tallest dune in the park known as the star dune. Up-to-date data is available, but Figure 3 shows that from 1992 to 2006, the escape dune has migrated more than 120 meters toward the northeast. That is an average of 8.6 meters/year. Much of the migration is during the spring where migration as high as 6 meters in 40 days have been measured.

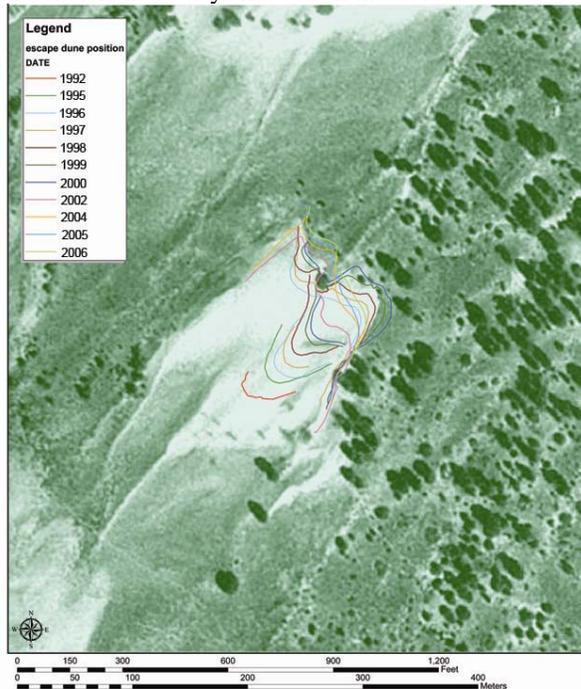


Figure 3. 1992 to 2006 locations of the “escape dune” at Great Sand Dunes, Colorado.

The star dune is in a bi-modal wind regime and its position tends to oscillate with some net migration toward the northeast. Elevation measurements suggest that when the dune’s crest migrated toward the northeast, the crest elevation drops. When the crest migrates back toward the southwest, it gains elevation.

Data from other dunes would also be presented.

**Conclusions:** The unimodal dune forms are smaller and have shown more migration, but all show a net migration toward the northeast. Vertical growth on large dunes requires an input of new sand.

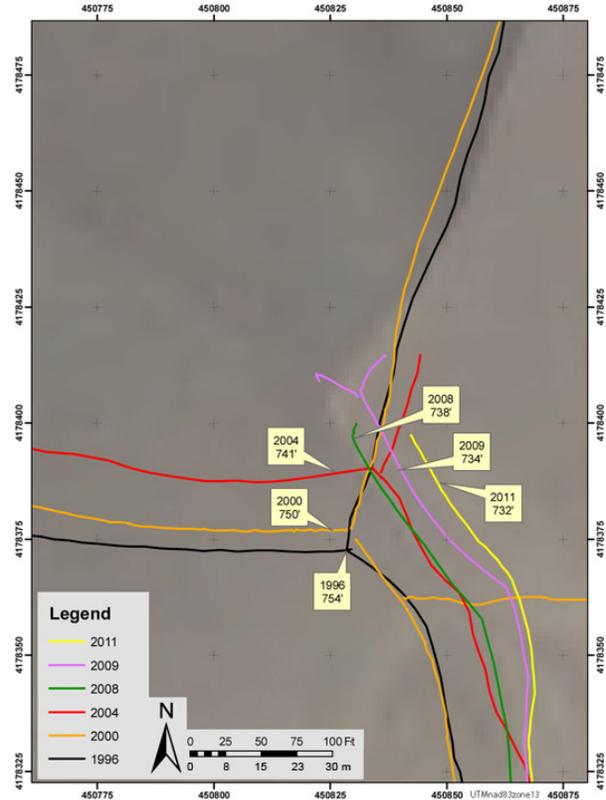


Figure 4. 1996 to 2011 locations and heights of the “star dune” at Great Sand Dunes, Colorado.

**References:** [1] Foreman, S. L., Episodic Late Holocene dune movements on the sandsheet area, Great Sand Dunes National Park and Preserve, San Luis Valley, Colorado, USA. *Quaternary Research* 66 p 97–108, 2006

[2] Valdez, A. D., Development and Eolian Geomorphology of Great Sand Dunes in Quaternary Geology of Great Sand Dunes, USGS Open File Report 2007-1193 p 7-10, 2007

[3] Madole, R. F., On the origin and age of the Great Sand Dunes, Colorado, *Geomorphology* 99 p 99-119, 2008