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USGS, NPS, and NASA Investigate Horse-Grazing Impacts on Assateague Island Dunes Using Airborne Lidar Surveys

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The U.S. Geological Survey (USGS), National Park Service (NPS), and National Aeronautics and Space Administration (NASA) are jointly investigating horse-grazing impacts on American beachgrass and resulting effects on natural dune establishment along Assateague Island National Seashore (ASIS). American beachgrass is a pioneer dune-building plant as well as a major staple in the feral horse diet at Assateague Island. Using NASA Airborne Topographic Mapper (ATM) elevation surveys, color-infrared photography, and field data, scientists are investigating the changes in topography and vegetation cover in experimental plots to determine the impacts of horse grazing on geomorphology at ASIS.

The horses (*Equus caballus* Linnaeus) of Assateague Island are a non-native species that have inhabited the barrier island for several centuries. Early colonial settlers introduced horses onto Assateague Island in 1669 to avoid the king's taxation on fencing and livestock by allowing the horses to graze freely (Bearrs, 1968). Today, the northern two-thirds of the 57-km-long island is managed by the NPS as Assateague Island National Seashore. Within its boundaries, the Maryland Department of Natural Resources manages a 3.2-km-long region as Assateague State Park. Upon the establishment of ASIS in 1965, the horses inhabiting the Maryland portion of the island have remained free roaming (Kirkpatrick, 1995). In 1965, the ASIS horse population consisted of 21 horses: nine stallions and 12 mares (Kirkpatrick, 1995). With no natural predators and despite the harsh environment, the ASIS herd had grown to 180 individuals by the spring of 2001.

Figure 2. American beachgrass colonizes bare sand and promotes natural dune development and stabilization.

Figure 1. Feral horses of Assateague Island National Seashore grazing on nearshore dune vegetation.

The significant growth in the feral-horse population has increased grazing pressure on native vegetation at ASIS. From April through September when insect populations flourish in the salt marshes and inland areas of the island, the horses migrate toward the beach to avoid the infestation. During these months, horses feed intensively on American beachgrass (*Ammophila breviligulata* Fernald) growing near the Atlantic shoreline (Figure 1).

American beachgrass colonizes bare sand and plays an important role in the natural bioengineering process of dune

Figure 3. 2001 field photograph of southernmost pair of experimental plots. In experimental areas of restricted and permitted horse grazing, dune development occurs where vegetation is undisturbed.

formation and stabilization (Figure 2). The root system of American beachgrass spreads horizontally, sending out rhizomes that produce new above-ground shoots and advance the plant. This horizontal root system provides an efficient means of moisture collection for plants inhabiting sediment that dries quickly. Concurrently, the extensive root system stabilizes sand and limits erosion. The plant shoots and leaves also trap wind-blown sediment, which contributes to dune development. Once the American beachgrass colonizes an area and dune development is underway, other plant and animal species succeed in colonizing the area as well. This robust, rapidly growing grass species is vital to the natural dune-building processes as well as to erosion prevention along Assateague Island National Seashore.

Figure 4. This 1995 field photograph of the southernmost fenced experimental plot displays less vegetation cover and topographic relief when compared to the 2001 field photograph in Figure 3.

When horses feed on American beachgrass, they may damage or destroy the plant, thereby disturbing dune development. To determine the impact of horse grazing on eolian dune-building processes, a team of scientists from the USGS, NPS, and NASA is investigating the differences in topography and vegetation cover between areas that are pastured by horses and areas that are protected from horse grazing (Figures 3 and 4).

Six pairs of experimental plots, remaining from a University of Delaware 1994 - 1996 vegetation study in ASIS (Seliskar, 1997), are being used to examine changes in topography and vegetation cover over a period from 1993 through 2001. Each plot pair consists of one 15- x 20-m fenced area that restricts horse grazing and one nearby unfenced area of the same size that permits horse grazing. The series of plot pairs established in 1994 were selected in areas of like morphology (Seliskar, 1997) with similar vegeation cover (D. Seliskar, oral commun., 2001). All plot pairs are located along the Atlantic shore of the Assateague Island National Seashore (Figure 5).

NASA ATM elevation surveys from 1996 through 2000 are being used to map topographic changes and color-infrared photography from 1993 and 1998 is being examined for vegetation cover change. Field data include a traditional GPS beach surface elevation survey taken in 2001 and vegetation cover estimates from 1994, 1995, and 2001 using the Daubenmire cover-scale method (Daubenmire, 1968) within each of the plot pairs.

The NASA scanning laser altimeter accumulates dense topographic data during airborne surveys. The

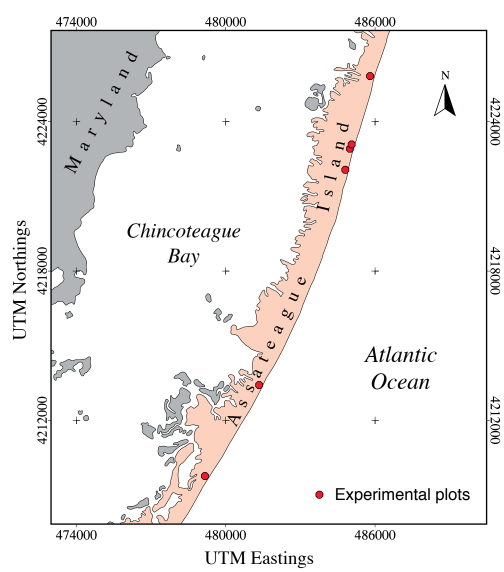

Figure 5. Location of experimental plots.

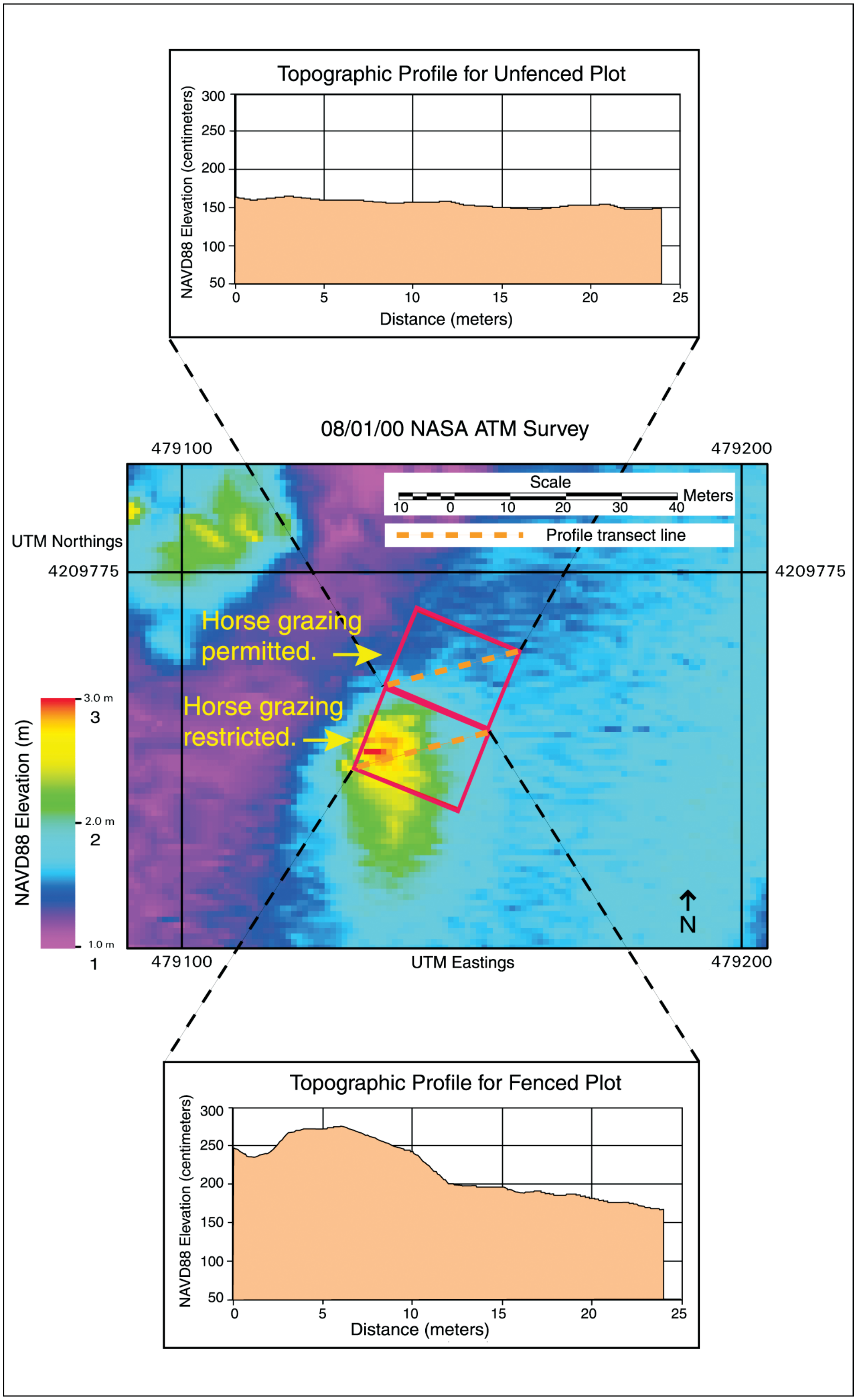

Figure 6. August 1, 2000, NASA ATM survey of southernmost experimental plots. Diagonal profiles of each plot reveal topographic difference between areas where horse grazing is permitted and restricted.

topographic or point elevation data are converted into digital elevation models (DEM) at 1-m grid cell resolution (Figures 6 and 7). In a NASA-NOAA-USGS feasibility study of lidar beach mapping, the ATM methodology was found to have a vertical accuracy of 14 cm (Sallenger, 1999). ATM data is being used to track 1996 to 2001 topographic change at six pairs of experimental plots along Assateague Island National Seashore (Figure 5).

Although each of the plot-pairs were originally selected to be as equivalent as possible in relief and vegetation cover, after 7 years all cases of fenced and unfenced plot-pairs are now distinctly different in both topography and vegetation cover. These preliminary observations suggest that by analyzing the time series of lidar and photographic surveys aquired over the fenced and unfenced plots, we will be able to learn more about dune development processes at Assateague Island National Seashore.

In 1976, Congress amended the legislative 1965 Assateague Act to mandate protection of natural ecosystems. Processes such as dune establishment and growth are integral functions of the natural ecosystems of ASIS. Quantifying topographic and vegetation cover change in a temporal study such as this assists park personnel in implementing the restoration of natural coastal processes, protection of ecosystems, and management of the horse population in Assateague Island National Seashore. By investigating the horse-grazing impacts on natural dune establishment, this study supports the Congressional directive. Results from this study may be used to develop computer models for simulating the likely consequences of various horse-management strategies at Assateague Island National Seashore.

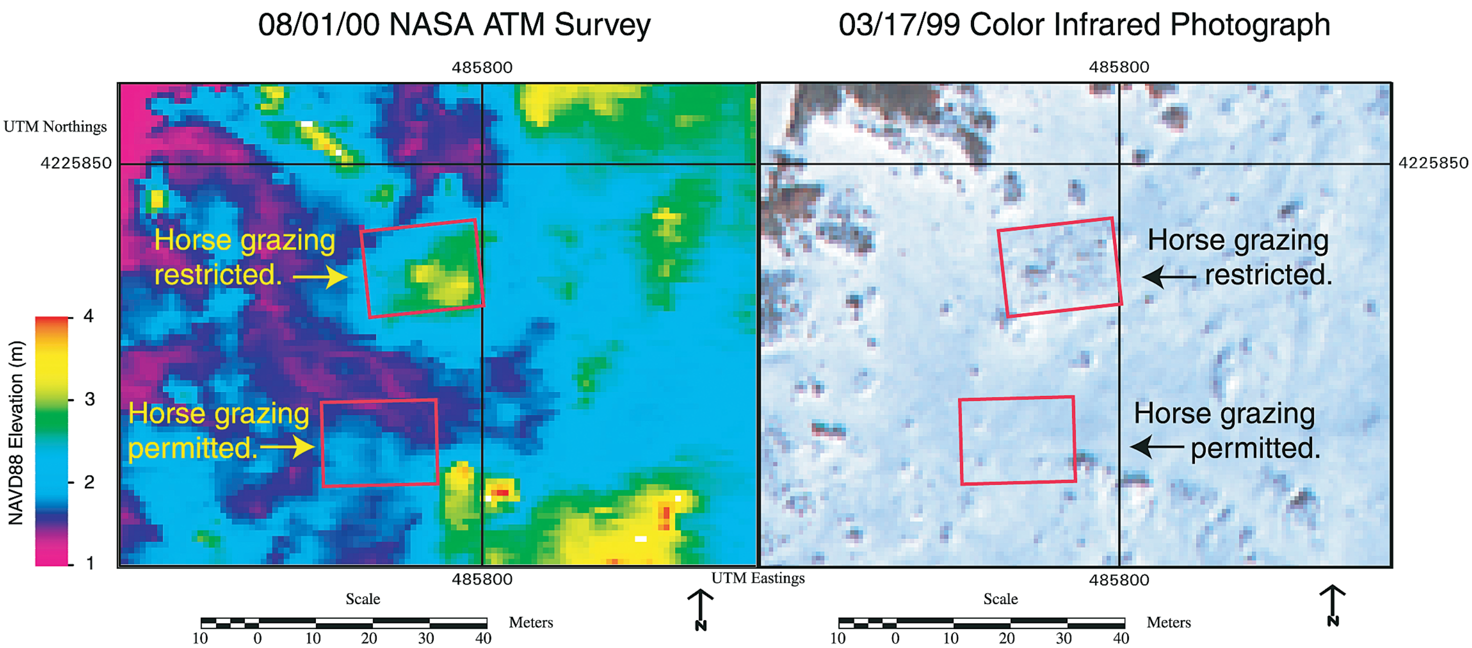

Figure 7. August 1, 2000, NASA ATM survey and March 17, 1999, color-infrared photograph of the northernmost pair of experimental plots. Topographic difference is about 1 to 2 m with significant vegetation cover difference between fenced and unfenced plots.

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