“Space use of American bison at Fort Niobrara National Wildlife Refuge”

For the 6th consecutive summer, our research team spent 10 weeks studying the bison herd at Fort Niobrara National Wildlife Refuge in the Sandhills of Nebraska. Our team this year consisted of one returning veteran (Stefanie) and two ‘newbies’ (Danielle and Seth). This summer marked a year of transition for the bison research program, as we finished collecting the final year of genetic data for our 5-year paternity analysis of bull reproductive success and began a new pilot project exploring the movement patterns of the herd. To finish off our genetic dataset, we collected tissue samples from all the calves in the herd via biopsy darting. These samples were frozen for storage and later sent to the Veterinary Genetics Lab at UC Davis, where the identity of the sires was established through microsatellite analysis. The paternity data can then be matched with our observations of reproductive behavior during the 2007 breeding season, when the 2008 calves were conceived. We also continued to track the breeding behavior of the herd, although our dataset was limited this year because the breeding season, or rut, started 10 days later than usual (Fig. 1).

Having now completed 5 full seasons of data collection, we are in a position to examine long term trends in breeding behavior. Our data indicates, for example, that the vast majority of reproductive behavior occurs within the first 3 weeks of the breeding season, representing an extraordinary concentration of reproductive effort (Figs. 2-3).
Our new project involves collecting data on herd movements using a combination of GPS (global positioning systems) and GIS (geographical information systems) to build a geodatabase containing information on herd location, size, and composition at different times throughout the day and season. This information will assist the refuge in improved management of the herd through better understanding of how the bison use resources. In addition, we hope to gain new insights into how a species that historically migrated hundreds of miles per year has adjusted to the much smaller semi-captive environments of national parks and wildlife refuges in which nearly all bison conservation herds are now restricted.

The students spent hundreds of hours in the field following and recording the spatial location of the herd. Because the herd is rotated through 11 grazing units throughout the summer, our research is designed to examine movement patterns within each unit in relation to time of year (before or during breeding), weather (temperature, humidity), topography (elevation, slope), forage quality of plant community, and other factors of interest (e.g., location of fence and gates). Between June 9 and August 7, we collected data on the compass bearings and distance of animals on the perimeter of the groups in relation to a GPS reference point, and sketched the approximate locations of the herd subgroups at various times of day on paper maps. At the same time, we collected data on group size, composition, and activity budgets. These variables will later be analyzed in relation to habitat factors such as vegetation, soil, slope, and so forth. In total, we produced 186 maps (herd sweeps) on 44 days in 9 grazing units. Although for the pilot study we recorded data into notebooks and paper maps (which later had to be entered into the ArcGIS software), next summer we plan to use a rugged tablet PC to record spatial information directly into ArcGIS. The team worked hard and played hard. As always, we enjoyed the flora and fauna of the Sandhills, canoed and kayaked on the river, and praised God for his glorious creation and the privilege to be able to study it. The team met weekly for Bible study, journal discussions, and community meals.

Students Involved in Bison GPS Analysis and Directed by Mike Mooring
Lane Votapka (Fallbrook, CA), Audra Evoy (San Diego, CA), Kemper Ruth (San Diego, CA), Jake Minich (Elliotsburg, PA)

“Using GPS to Analyze Space use of American bison”

Following the collection of the herd movement data at Fort Niobrara National Wildlife Refuge over the summer, the GPS team at PLNU began the task of spatial analysis over the Fall and Spring semesters. The team started out by converting the field data collected over the summer (in the form of paper maps and spreadsheet data) to polygons and attribute tables embedded in the ArcGIS 9.2 software system (Fig. 1). ArcGIS is the gold standard of GIS, but also has a considerable learning curve. Undaunted, the team (Lane, Audra, Kemper, and Jake) mastered the use of two components within ArcGIS. They used ArcPad (a field data collection system) to bring the herd location data into ArcMap (a full system with sophisticated data analysis tools not available in ArcPad) (Fig. 2, 3). In both these systems, the herd spatial locations were converted into
polygons on a map layer, with data on herd size, composition, and activity budgets entered into linked attribute tables. This dataset is archived in the form of a geodatabase, which was completed by the end of the Fall semester. The GIS team is now shifting gears to analyze the geodatabase using a powerful arsenal of analytical tools (Spatial Analyst, Animal Movement, and Hawthes Tools). The first goal is to characterize the herd locations using home range analysis, which will enable us to see whether the herd is moving randomly through the grazing units or selectively using some areas more than others. If the analysis indicates the latter, the next step will be to perform analyses that examine space use in relation to the location of geographic features (fences, gates), elevation, soil type, vegetation community, temperature, and hydrology. Knowledge of the factors that influence herd space use may then provide insights into how to better manage the herd by maximizing resource utilization within the refuge carrying capacity. Preliminary analysis suggest that the bison herd shifts their grazing and movement patterns during the rut in July and August, when the previously fragmented groups aggregate to form one or several very large groups. If herd grazing and movements are significantly different during rut, this will imply the need to manage the herd differently during the rut months.

This study has the potential to address two important points in bison conservation. Can we assume that bison (1) behave like cattle terms of their feeding ecology, and (2) behave the same as historical bison that migrated hundreds of miles each year? Overall, this research will increase our current understanding of bison habitat use and carrying capacity in the national wildlife refuge system.
Faculty Presentations, Publications, and Grants

Journal Articles


Grants

Research and Special Projects Grant, “Using a rugged tablet PC for field collection of bison space use data”, $1500.

Student Presentations

Daniel Sullivan*, Stefanie Eick*, and Mike Mooring. “Role of progesterone in the estrous cycle of bison females”, presented by Daniel Sullivan and Stefanie Eick at the 33rd Annual West Coast Biological Sciences Undergraduate Research Conference at Point Loma Nazarene University in San Diego, California, April 12, 2008.


Rachel Bettes*, Mike Mooring, and Dennis Siegfried. “Tending effort and age in relation to reproductive success in bison bulls”, presented by Rachel Bettes at the 33rd Annual West Coast Biological Sciences Undergraduate Research Conference at Point Loma Nazarene University in San Diego, California, April 12, 2008.

Peer Reviews

“Seasonal variations in group size dependent association between food profitability and spatial distribution of bison” by Fortin D, Fortin M-E.

“Trade-offs in primate grooming reciprocation: behavioural flexibility and correlated evolution” by Schino G and Aureli F.

“Social status and cortisol levels in singing rock hyraxes” by Koren L, Mokady O, Geffen E.
“Programmed versus stimulus-driven anti-parasitic grooming in a desert rodent” by Hawlena.

“Sex-specific responses of North American elk to fuels reduction” by Long RA, Rachlow JL, Kie JG.

“Determinants and life-history consequences of social dominance in bighorn ewes” by Favre M, Martin JGA, Festa-Bianchet M.

“Does the maternal grooming of cow clean the bacteria on the coast of calves?” by Anonymous.

“Rut-induced hypophagia in male bighorn sheep and mountain goats: foraging under time budget constraints” by Pelletier F, Mainguy J, Cote SD.