Environmental Impacts of Bison on the North Rim of Grand Canyon National Park

Victoria Coraci[1], Cynthia Valle[1], Benjamin Tobin[1], Jennifer Reeder[1], Gregory Holm[1]

[1]Grand Canyon Science and Resource Management
Contact Victoria with questions via cellular phone at (954)774-1489 or email at victoria_coraci@partner.nps.gov

Introduction

The purpose of this study is to determine the impacts of American bison, an introduced ungulate, on the Boreal Forest ecosystem of the North Rim of Grand Canyon National Park. The study measures the effects of bison on the soil surrounding grazing locations, the water quality of springs and sinkholes, vegetation richness, and herpetofauna concentration/densities. Site locations were based on a stratified random sampling of sinkholes classified on bison use level. The variables tested in this study are infiltration capacity, presence of E.coli, inventory of species of vegetation, and a habitat assessment for herpetofauna. In 2012, a synthesis paper titled "History and Implications of the House Rock Valley Bison Herd" assessed information influencing the management decisions effecting the bison on the North Rim of the Grand Canyon. This paper calls for ecological data to "further quantify impacts to ecological resources from bison presence in GCNP" (NPS, 2012). Bison have been shown to impact the presence and distribution of exotic plants on the Rainbow Plateau. Large ungulate grazing has been reported to expedite exotic species transmission (Constible et al 2005, Loeser et al 2007). The exotic species of the north rim ecosystem favor areas of disturbed or eroded exposed soil (Crawford et al 2001). A 2012 study indicates that bison significantly reduced vegetative cover, increased exposed soil, and decreased vegetation height across forb, grass, and sedge functional groups, indicating that bison may be the primary cause of ecosystem change (Reimondo 2012.) Habitats of herpetofaunal, especially riparian herpetofaunal communities are extremely sensitive to ecosystem change, local extinctions have been observed even in areas with only light grazing (ε ~ 0.7) (Larson, 2015.) This study quantifies the ecological impacts of bison on the North Rim and influence future management decisions.

Questions

- Does bison use increase percolation time?
- How does bison grazing effect water quality?
- Does bison use lead to bacteria in standing water?
- Does bison use impact herpetofauna habitat?
- Is vegetation biodiversity effected by bison use?
- Are bison increasing the spread of non-native plant species?

Methods

Infiltration Capacity

- PVC Pipes were placed in the ground 6 inches.
- 5 gallons of water were poured into the pipe to saturate the soil.
- Another 5 gallons were placed in the PVC.
- Time of required for percolation was recorded.

Water Quality

- Water was incubated using 3M petri filmstrips for 24 hours. Sites were tested twice.
- A hand held multi-parameter meter was used to measure pH, TDS and Temperature.

Herpetofauna Habitat

- A habitat assessment was conducted at each site and indicate qualities such as pH, vegetation cover at water level, aerial vegetation cover, water temperature, water depth, pool size and flow of water.

Biodiversity of Vegetation

- Vegetation was identified in the field, unknown species were collected for identification.

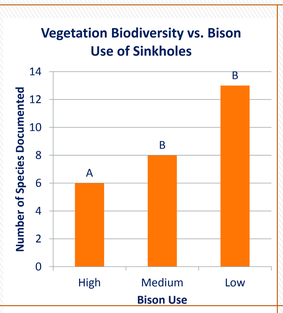
Bison in in Field. Photo by Eric Hope

Results

Biodiversity of Vegetation in Sinkholes

The biodiversity of the vegetation within the sinkholes appears to be impacted by the level of bison use.

Bison Use	Native Species Present
Low	13
Medium	8
High	6



Herpetofauna Habitat in Springs

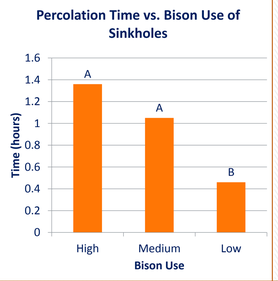
Only if all parameters were within sufficient range for amphibian habitats was a site deemed good quality.

Bison Use	Habitat Quality
Low	Good
Medium	Poor
High	Poor

Percolation Time in Sinkholes

The soil compaction from bison use resulted in longer percolation times.

Bison Use	Percolation Time (hours)
Low	0.4677
Medium	1.0550
High	1.3612



Exotic Vegetation Presence in Sinkholes

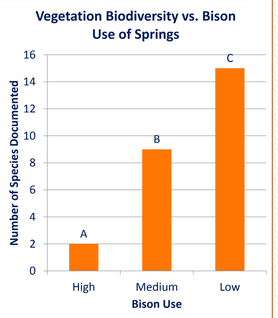
The most common exotic species found were Mullin and Dandelion

Bison Use	Exotic Species Present
Low	No
Medium	Yes
High	Yes

Biodiversity of Vegetation at Springs

The biodiversity of the Vegetation within and surrounding the springs appears to be impacted by lower biodiversity correlating to higher bison use.

Bison Use	Native Species Present
Low	15
Medium	9
High	2



Exotic Vegetation Presence in Springs

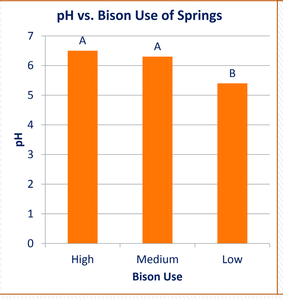
The most common exotic species found were Mullin. It did not appear to be correlated to Bison use as it was found at every study site.

Bison Use	Exotic Species Present
Low	Yes
Medium	Yes
High	Yes

Water Quality

Although not statistically significant, this can be detrimental to amphibians that cannot survive after 6.0. Lack of statistical significance may be due to sample size.

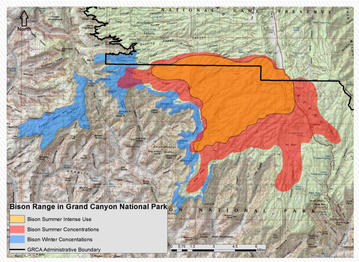
Bison Use	pH
Low	5.450
Medium	6.340
High	6.504



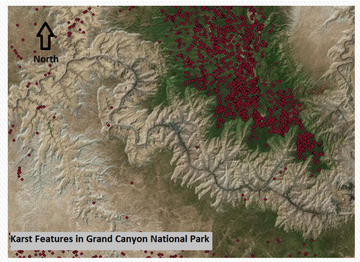
Presence of E Coli. in Springs

3m Test strips were used to incubate the E.coli bacteria and sites were tested twice, if sites tested positive twice it was concluded that they were contaminated.

Bison Use	Presence of E Coli.
Low	No
Medium	Yes
High	Yes

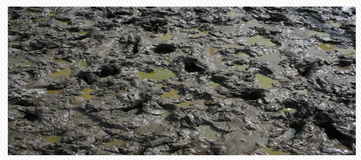


Bison Stampeding



Bison Wallow

Protected Vegetation



Bison Hoof Prints Near Spring

Conclusions

Springs

- Amphibian presence could not be compared because there were no standing bodies of water large enough to sustain an amphibian habitat that were non-impacted.
- The water tested in medium and high bison impact areas have a pH of above 6.0 which would cause damage to the intestinal epithelium of Northern Leopard Frogs.
- The vegetation decreases in biodiversity may be related to why species that had been common (such as the Mule Deer) are now mainly reported in areas of low bison use.

Sinkholes

- In sinks bison are prolonging percolation by soil compaction from grazing and wallowing near the sinks.
- A bison can consume up to 10 gallons of water in a watering session and heard sizes on the North Rim range from 6 to 300 bison.
- Of the sinkholes visited very few had standing water and the water present tested positive for E Coli.
- The compaction of the soil near the sinkholes can lead to the formation of lakes and can increase the potential for flooding, however this impact was not observed do to the rapid water consumption of the bison.

Meadows

- Although meadows were not studied they appear to be most impacted.
- Bison use creates wallows which alter the natural flow of water.
- Grazing areas show visible soil compaction and this can also lead to flooding.

Data Analysis

- Data was analyzed using an analysis of variance function.
- An aggregate was calculated from the data for each level of bison use, these are the values seen in the graphs.
- Impact was most different between areas of low and high bison use, as opposed to between the areas of low to medium bison use or medium to high bison use.

Future Studies

- This study should be continued to increase the sample sizes.
- This data will then be applied to the groundwater models of the canyon to determine the larger effects of the bison, if any, using data from a karst vulnerability study to determine the potential impacts of the Bison on the contamination of the aquifer.
- This data can also be correlated to the die Trace Study to determine sites to test for E Coli. Contamination to see if the E. Coli is being filtered out or is remaining in the water.

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High Bison Use Sinkhole