Student Name

Honors Thesis Proposal

My thesis will examine the likelihood of inbreeding in American bison (*Bison bison*) herds managed for conservation. I plan to use behavioral data to set the parameters of a simulation model to determine the likelihood of a mating occurring between a bull and his daughter. I conducted my research and will make use of past research done on the Samuel H. Ordway, Jr. Memorial Preserve in Leola, South Dakota, where a herd of approximately 350 bison is being managed by The Nature Conservancy. Behavioral data are available for each mating season since 2005. Observations are collected twice each day during the mating season and include bull and cow tending pairs, observed and presumed matings, and interactions between bulls. This summer Cassidy Coats and I collected additional observations pertaining to cow mate choice, which entailed making focal observations on cow/bull tending pairs for 10-minute intervals. During a 10-minute period, we recorded the frequency of behaviors that indicated a cow was choosing or rejecting a bull.

Knowing the likelihood of inbreeding is relevant for conservationists managing bison herds with the goal of allowing the herd to function as naturally as possible while still avoiding behaviors that could be detrimental to the population. Inbreeding is likely a recently encountered risk for this species. When bison freely roamed the Great Plains, they crossed paths with millions of other bison. Today bison herds are confined to less than 1% of their pre-settlement range and are broken up into smaller herds that do not mingle (Hedrick 2009; Lott 2002). This increases the chance of inbreeding, as closely related bulls and cows remain on the same preserve rather than dispersing across a vast prairie. Inbreeding can have negative effects on the herd, including low natality, decreased resistance to disease and parasites, decreased ability to adapt to environmental change, high mortality of young calves, and sperm abnormalities, all of which result in little to no population growth (Hedrick 2009; Bradt 2014). Managers currently avoid inbreeding in their herds by removing bulls after they reach a particular age or reproductive potential. Knowing the likelihood of inbreeding would allow managers to most effectively weigh the costs and benefits of this management decision.

Inbreeding has been reported to influence traits related to fitness in a variety of species, and inbreeding avoidance has been observed in several vertebrate species. However, unlike species that evolved mechanisms to avoid inbreeding, bison evolved during a time when they were not restricted geographically and thus had little risk of inbreeding (Halbert et al. 2007). A study on reindeer, an ungulate species that evolved in conditions similar to that of bison, found females do not exhibit any behaviors that would aid them in avoiding mating with males they are closely related to (Holand et al. 2007).

While bison are unlikely to exhibit any behaviors that explicitly help to avoid inbreeding, the behaviors bulls and cows exhibit as they work to find a mate may impact the likelihood of inbreeding. My thesis aims to examine how bull and cow behaviors influence the likelihood of inbreeding in conservation herds. Bison are polygynous, so males must compete for access to as many females as possible to maximize their reproductive success. The more dominant a bull is, the more likely he is to be able to tend a cow until she is ready to mate (Holand et al. 2007; Wolff 1998). Past studies have found that bulls will tend and mate any cow in estrus regardless of her past reproductive success or age (Wolff 1998). However, Berger (1989) observed that bulls preferred barren cows to cows that were lactating. He proposed barren cows were in better condition, and therefore had higher reproductive potential. I will use behavioral data from this summer and past summers to determine if dominant bull(s) chose to tend cows of a particular age or prior reproductive success over others cows in estrus (also being tended) the same day. I will also use past behavioral data to find the probability of a bull of a particular age obtaining dominant status, the amount of time he is likely to hold this status, and the number of cows he is likely to mate with during that time.

Unlike bulls, female bison will only have one calf each year and therefore benefit from being selective and choosing the highest quality mate (Holand et al. 2007; Lott 2002; Wolff 1998). Dominant bulls are likely to pass on dominant traits, which increase the mother and her calf's future reproductive success (Lott 2002). A variety of behaviors have been observed, which indicate a cow does have some choice in her mate. A cow being tended may walk away from her bull towards another or take off and run through the herd to catch the attention of other bulls. In both of these situations, the cow is more likely to mate with a higher-ranking bull than the one previously tending her. (Wolff

1998; Lott 2002). The focal observations Cassidy and I collected this summer will be used to examine this aspect of inbreeding likelihood. The behaviors being recorded in our focal observations were walking away from a bull, running from a bull, dodging a bull, and rejecting a bull's chin (an advance made by a bull to test a cow's readiness to mate). I will analyze the frequency of behaviors observed during these focal observations in relation to the age, dominance, and body condition of the tending bull, the age of the cow, and the amount of time before the cow was mated. I will also use past behavioral data to determine what percentage of cows under two years of age mate and the percentage of cows three years and older that mate.

Data are available on the Ordway bison herd for each mating season since 2005. Every bison in the herd is identified using a color-coded tag with a unique number. Tag color corresponds to year of birth. Bulls older than 4 years are the primary focus of the available observations and are given names to facilitate quick identification. Field workers have recorded interactions, such as displacements or contests, between bulls each season. Knowing the winners and losers of these interactions allows me to determine the dominance hierarchy of bulls in the herd for a particular time period. Hierarchies can be used to determine the probability of a bull of a particular age obtaining dominant status and the amount of time he is able to hold on to this status. Records are also kept on which cows a bull tends. Hierarchies can be used with tending records to assign matings to a bull based on how long he tended a cow, his dominant status, and the dominant status of other bulls that tended the cow. DNA analyses done for calves born in 2006 and 2008 found that this method of assigning matings gives an accurate number of matings per bull per season. Therefore, assigned matings can be used to determine the number of cows bulls at various ranks in the hierarchy are likely to mate with. Assigned matings also allow me to determine the percentage of cows in particular age groups that mate during a season. Tending records show which cows were being tended, or approaching estrus, on a particular day. This gives me the necessary information to determine if dominant bulls prefer cows of a particular age or prior reproductive success. Records are kept each year of which cows have calves from the previous summer, which can be used to determine previous reproductive success.

I will use the long-term behavioral data to create a simulation model and determine the likelihood of inbreeding in the bison herd being managed at the Samuel H. Ordway, Jr. Memorial Preserve. In 2013-2014 Dan Bradt examined the potential for inbreeding in conservation bison herds using data from the Ordway bison herd. As part of his analysis, he created a rough model of the probability of a bull mating with his daughter using information from Junior, a relatively successful bull (Figure1). I plan to use the data described above to create a more sophisticated model incorporating data from many bulls of varying dominance rankings.

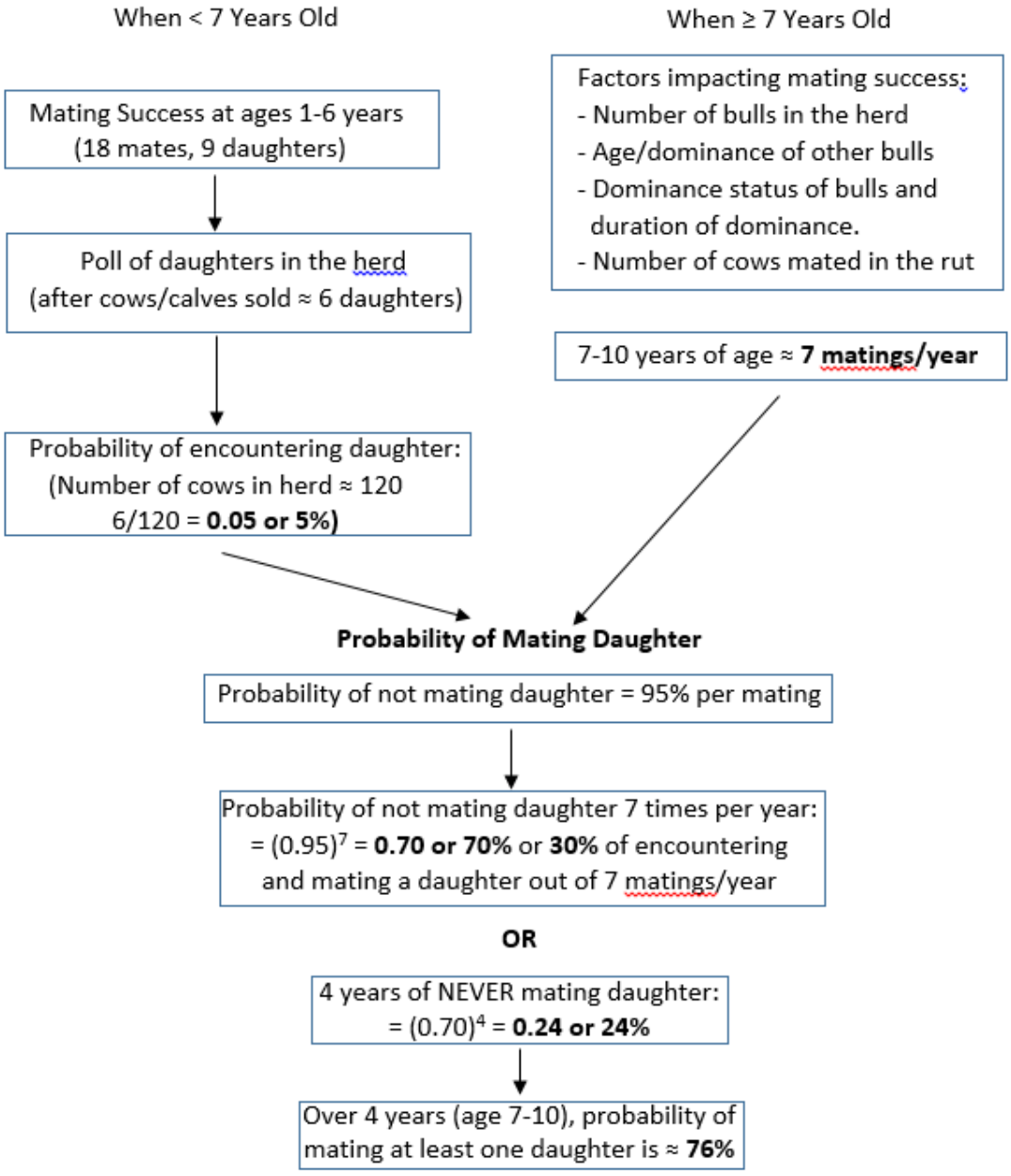

Figure 1- From Bradt 2014. Model that roughly examines the probability of a bull mating with his daughter based on data from a relatively successful bull, Junior.

This past summer, data were collected from July 15th to August 20th. Prior to the start of the academic year, I drafted the Introduction and Methods sections of my thesis paper. During Fall 2016, I will analyze data and draft the Results and Discussion sections of my paper. In Spring 2017, I will compile my drafts and finalize my paper. I will also complete my public presentation, oral exam, and thesis summary in the spring (Table 1).

I am very excited about the prospect of completing an Honors Thesis and believe this will be an incredible opportunity for me to explore my interests in animal behavior and gain research skills for the future. In completing this thesis, I will see firsthand how research and management practices interact, as well as the many objectives conservation managers must consider in their work. I will also gain valuable experience completing research more similar to what is being done by graduate students and professionals. Thank you for considering my proposal.

Table 1. Timeline of completed work and work to be done.

July 15- August 20th	Data collection
August 24th	Leave Samuel H. Ordway, Jr. Memorial Preserve
August 24th – September 6th	Draft Introduction and Methods
Early September	Submit final proposal to the Gustavus Biology Department for review
Fall 2016	Analysis of data, draft Results and Discussion
Spring 2017	Compile drafts, complete thesis, public presentation, oral exam, thesis summary

Literature Cited

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