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Using Assisted Reproductive Technologies to Mitigate Disease and Preserve Genetic Variation in Bison

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Assisted reproductive technologies (ART) refers to interventions into the reproductive process of a person or animal intended to result in pregnancy or to preserve fertility. They include procedures such as in vitro fertilization, artificial insemination, and embryo transfer. For decades these techniques have been used to promote reproduction in livestock, wildlife, and humans. What has this to do with bison, an animal whose annual natural breeding rates can exceed 80% in healthy herds (Fuller et al. 2007)? Bison are not endangered, but when it comes to disease management or movement of valuable genetics, reproductive technologies provide some clear potential benefits.

Reproductive techniques currently applied to bison have been modeled after routine procedures used in cattle worldwide. Embryo transfer, the collection of an embryo from the uterus of one female prior to implantation and placement of that embryo into the uterus of another female, is done in hundreds of thousands of cattle annually. Embryos may be collected and transferred to another female immediately or frozen for transfer at a later date. Semen can be collected from live males or even post-mortem and preserved for use in artificial insemination or production of embryos in vitro. Eggs from females are typically used to make embryos that are frozen and stored. Once they are frozen, reproductive cells and embryos can theoretically remain viable if kept in liquid nitrogen for hundreds of years, providing some genetic insurance for the species.

The direct relevance of these techniques for bison conservation is in the movement of genetics between herds, especially when there are associated disease risks. The best example of this is brucellosis in bison from Yellowstone National Park. Accessing the genomes of these animals, which have no cattle genes and are highly desired by many bison herd managers has been difficult because of the fear of bringing brucellosis along. This is where reproductive technologies may prove to be a valuable tool in the conservation story of bison.

Citation: Weber, Samantha, ed. 2017. *Connections Across People, Place, and Time: Proceedings of the 2017 George Wright Society Conference on Parks, Protected Areas, and Cultural Sites*. Hancock, Michigan: George Wright Society.

The assisted reproductive technologies described above can be performed on bison that have brucellosis. The embryos collected from brucellosis positive females can be washed to prevent the transfer of the bacterium that causes the disease to the female that will receive the embryo and give birth to the offspring. This washing technique is not novel; it is required for all cattle embryos that cross international borders (Stringfellow 2010). Additionally, semen can be "cleaned" by separating the sperm cells from the fluid portion of an ejaculate via centrifugation and collection through a device called a ProInsert (Nidacon). Following this wash procedure, sperm can be frozen using standard cattle semen freezing protocols. Disease-free bison calves have been produced in our laboratory from washed embryos and washed semen.

This is an exciting time in bison conservation with the establishment of new herds and a more concerted effort to manage herds for genetic variation. Many of the challenges associated with building or augmenting herds can be addressed by these assisted reproductive technologies. For example, even though one may know which genetics they want to augment their herd, locating and obtaining animals with those genetics may be difficult for a variety of reasons. The animals may be in very distant locations so that transport is difficult or the owner of the desired animals may not be willing to move any of their animals. While owners may not be willing to part with a bull, they may be amenable to collecting semen from that bull to be used for artificial insemination of females in another herd.

Just as the shipping of semen may provide solutions to moving genetics, so can movement of embryos. It is far easier to send a small tank with frozen semen or embryos across the country or across borders (though this can be complicated by customs and international regulations), than to ship live animals. Anytime a bison is put on a trailer, there is the risk of injury to the animal or to personnel moving the animal. Long hauls are stressful for bison as bison are not easily loaded and off loaded from trailers for overnight stops for rest and feeding/watering. Depending on time of year, weather during transport can also be a significant concern.

When moving bison from herd to herd, there is also the risk of exposing animals to new diseases. If a bison is coming from a herd known to be potentially exposed to a specific disease or is from a region where a disease is prevalent, it can be difficult to ensure that the bison being shipped is not a carrier without extensive testing or quarantine, which is costly, time consuming, and laborious for managers. Shipping embryos and semen that have been treated as described above can minimize or eliminate those concerns.

Lastly, one complication that has been expressed anecdotally by a number of bison managers is failure of a new animal to integrate into a herd. Even if you do find the bison with the genetics you want, there is no guarantee that that animal will breed in your herd. Moving young bison (one- or two-year-olds) seems to prevent some of these dynamics but does not guarantee acceptance of new animals. When you artificially inseminate a female or transfer an embryo with the genetics that you desire, that offspring will grow up as a member of the herd, even though genetically it may be unrelated, avoiding the acceptance problem.

Reproductive technologies can play an important role in bison conservation from the perspective of genetic preservation, genetic movement, and disease mitigation. While these techniques may not be appropriate for all herds and in all situations, they are valuable tools that can be integrated into management strategies that previously posed significant challenges, particularly when it comes to disease management. At the least, preservation of genetics from all herds in the form of

frozen semen and embryos could protect against unpredicted loss of animals to environmental conditions or unexpected disease outbreaks. Bison have already survived one population bottleneck. Assisted reproductive technologies can be a safety net preventing another.

References

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