GENETIC ADEQUACY of JACKSON HOLE BISON[1]

(The Introduction to “Endangered Genes of Yellowstone” should be read before this section.)

The Jackson Hole bison herd began in 1968 with a limited diversity of alleles in only 11 founders from a small herd that had been isolated from natural selection and had endured bouts of inbreeding for 20 years. After 1968, many half-siblings must have been produced for a few years. Resulting additional inbreeding by these related bison should have limited reproduction, survival and population growth. (The herd added only 7 animals over 7 years until 1975.) However, inbreeding during this time would also have exposed and purged deleterious recessive alleles from the herd, allowing for eventual population growth.

Once the bison discovered and began to use artificial winter feed at the National Elk Refuge, rapid population growth ensued. There were 600 bison in 2000; but their genetic diversity was less than diversities of 8 of 11 other federal bison herds (Halbert and Derr 2008). There were about 1100 bison in 2006.

With the growing herd in its limited and much developed range, diverse conflicts developed. In 2007, a joint management plan committed to reducing and maintaining the herd at 500 animals. This goal has been nearly achieved by 2017. About 270 bison were harvested in 2016. The smaller herd is well below ecological carrying capacity of the range, and continues to access artificial winter feed.

> With a base herd of 500 bison, average annual recruitment of calves likely will be around 100 animals, requiring a harvest of 100 bison each year to maintain the herd. More than 100 calves may be conceived each year. Some die due to brucellosis disease; and probably a few are predated by wolves or bears. Aside from human harvest, there is very

little mortality of adult bison. Thus, losses from conception through survival of very young calves amount to most of the natural selection affecting this herd's genome.

Jackson bison exhibit an unusual, perhaps increasing, amount of asynchronous breeding and calving. Many calves are born very late and most survive through the winter. Synchronous breeding/calving are evolved adaptations to (1) coordinate reproduction with local plant phenology, ensuring maximum nutrition for nursing cows and growing calves; (2) allow calves to reach body masses necessary for winter survival; and (3) "swamp" predators with the availability of more young calves than predators will kill during a short period of calf vulnerability.

For Jackson Hole bison, the initially limited sample of the allelic diversity bequeathed from past evolution in wild environments is being diminished and rearranged by genetic drift and by a weakening and replacement of natural selection.

With only 500 animals, a small but persistent level of inbreeding will diminish the reproduction and survival of some animals, limiting or replacing the role of natural selection in determining their contributions to future generations. (Inbreeding replaces natural selection by the environment.)

With 500 animals, there is a gradual loss of alleles from the population due to drift as random factors influence the transfer of alleles during meiosis and influence the survival of alleles during individual lifetimes. (In a modelling effort, Giglio et al. 2016 estimated a loss of 17% for average alleles per locus, each 100 years, for a randomly culled herd of 350 bison. With 500 bison in Jackson Valley, allele loss will be slower, but still substantial.)

With the population maintained below the ecological carrying capacity of the range, and being fed in winter, natural selection for competiveness, foraging efficiency, energy efficiency and winter survival is greatly diminished. The genome becomes increasingly dependent on winter feeding.

Natural selection to retain genetic influences on synchronous breeding/calving is diminished by many months with high availability of excellent nutrition due to the low ecological density of the population; by winter feeding; and by having few predators in the valley, with the few wolves concentrating mostly on elk.

Aside from the maternal reproductive process and early calf survival, almost all mortality is human-caused, replacing natural selection. Human harvests are expected to be random with respect to most alleles in the population genome, thus contributing to drift.

With diminished natural selection, the prevalence of some alleles that are valuable in a diverse, fluctuating and wild environment is allowed to fluctuate randomly. Some valuable alleles become rare and subject to extinction from the herd. Also, the number of animals with the best combinations of alleles for surviving and reproducing in wild conditions will decline.

The Jackson Hole bison herd, which spends some of its time within Grand Teton National Park, certainly is not an "unimpaired" population. It is a semi-domestic bison herd with limited, slowly declining and compromised genetic diversity. We should recognize and admit this limitation, required by the Jackson Hole environment.

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