Genetic Adequacy of Yellowstone Bison

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

The wild character of Yellowstone bison is uniquely valuable. It is one of a few herds with no evidence of cattle genes from previous cross-breeding. Within the 48 states, no other conservation herd is challenged by effective predators and is allowed considerable natural mobility across a large and diverse habitat.

> About 95% of plains bison are being domesticated in private, commercial herds (Gates et al. 2010). However, much domestication also occurs in the 5% of plains bison that are in "conservation" herds (Bailey, 2013).

Yellowstone bison come from fewer than 70 animals present in the Park in 1902 (Meagher 1973).

> There were at least 23 counted Yellowstone bison, an unknown few that were not counted, plus 21 bison transplanted from northern Montana and Texas. Recent research (Forgacs et al. 2016) indicates that alleles from the original Yellowstone bison and from northern Montana bison persist in the herd. (Persistence of Texas bison genes has not been tested.)

The bison population grew to about 1000 animals in 1930 and was controlled somewhat below 1000 into the 1960s. In 1965-66, the herd was reduced to below 400. In 1969 a decision to "rewild" the bison allowed the herd to grow steadily to about 4000 in 1995, creating conflicts with Montana and causing another herd reduction to about 1900 bison. The herd regrew to about 5000 in 2006 when herd reductions were initiated under a federal/state Interagency Bison Management Plan (Plumb et al. 2009:Fig. 2, White et al. 2011:Table 4). Despite annual reductions with Montana and Native American hunting and capturing animals for slaughter, plus other removals, the herd stood above 5000 in 2016.

By 1917, Yellowstone bison became infected with *Brucella abortus*, causing the disease brucellosis (White et al. 2011). *B. abortus* is an alien, but naturalized species in the GYE. It is widespread in abundant bison, elk and other species. There is no evidence it will, or can, be eradicated. Wild bison should be allowed to continue evolving with and adapting to *B. abortus*, demonstrating nature's time-tested way of dealing with disease.

The full range of natural, unimpaired dynamics of Yellowstone bison in the GYE has not yet been allowed. Herd size was tightly controlled before 1969; and has never been allowed to reach natural limits. Although mobility is a primary evolved adaptation of *Bison bison*, the herd has been limited to areas within and near the Park, disallowing bison to respond naturally to a growing herd size, to variations in winter severity and phenology, and to other environmental variables. The herd's ultimate relationship with a relatively recently established population of wolves may yet evolve. Attempts to vaccinate bison against brucellosis may have interfered with their evolving accommodation with *Brucella*. Just outside the Park, research on methods for bison birth control threatens to generate new proposals for impairing the natural continuing evolution of this important herd.

Currently, under the Interagency Plan, Yellowstone bison would be limited to 2100-3000 animals, though that goal has been difficult to achieve. A new interagency plan is being developed. The Park Service has proposed allowing the herd to fluctuate between 2500 and 4500, controlling numbers with a management-induced dispersal "sink" to remove bison outside the Park. Removals will be at or near the Park boundary so long as Montana will not allow bison to roam far from the Park (Plumb et al. 2009:2385; White et al. 2015).

Are Yellowstone bison a genetically adequate herd? How well does management of Park bison limit inbreeding and genetic drift while maintaining a preponderance of natural selection over drift and artificial selection?

> Despite periodic bottlenecks, the Yellowstone herd has retained relatively high levels of genetic diversity and was cited as a "critical" bison genome resource (Halbert and Derr 2008). Inbreeding has not been an issue for Yellowstone bison since 1968 when the northern herd in the Park was controlled to about 80 animals.
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> With current population levels and lesser population goals, the significance of a gradual loss of alleles due to natural genetic drift is uncertain. A bison herd of 2000-3000 animals has been estimated to lose 5% of its alleles, due to drift, each 100 years. However, at important immune-system loci, and at other loci with relatively rare alleles, this loss may be at least 10% (Perez-Figueroa et al. 2010). We do not know what alleles or functions will be lost.
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> The most important concern for current genetic adequacy of Yellowstone bison is the replacement of much natural selection by hunting and by capture for slaughter and other removals. These practices contribute to drift for many alleles and replace much natural selection for post-juvenile animals.
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> In recent and current times, it appears that human-caused mortality has exceeded other mortality of Yellowstone bison by a factor of 2.6-3, at least in some years. In the severe winter of 1997, the herd declined from 3500 to 2000. Seventy-five % of the lost animals were shot, sent to slaughter or removed for research (White et al. 2011:2). Human-caused mortality was 3 times natural mortality. In 2017, at least 1300 bison were hunted

or removed following capture (Buffalo Field Campaign counts). Other, natural mortality may have been 9% of the herd (estimate based on White et al. 2015:90), or 495 of 5500 bison entering the winter. Human caused mortality is estimated as 2.6 times natural mortality in 2017.

While Park Service policies (Appendix 2) and its definition of wild bison (White et al. 2015:174 and elsewhere) emphasize animals “subject to” natural selection, there has been little evaluation of the effectiveness of natural selection compared to drift and artificial selection. That is, providing for a predominance of natural selection has not been addressed.

Human predation has been an important factor in the evolution of *Bison bison* (Bailey 2013) and, in this sense, can be considered “natural”. However, mobility has been a major evolutionary response of *B. bison* to human predation. Thus, for Yellowstone bison with their minimal allowed mobility, human predation becomes a less natural evolutionary process. For an unimpaired bison herd, solutions to this conundrum may involve:

maintaining a very large herd to (1) counteract genetic drift, (2) stimulate competition and other natural evolutionary processes associated with fluctuating ecological density, (3) provide a relatively large number of bison to mortality that is not human-caused; and (4) perhaps cause bison recruitment to decline in a density-dependent manner, thereby diminishing the number of animals that must be removed to maintain a given herd size;

allowing for natural mortalities other than human removals, including disease, predation and winter losses;

excluding management interventions, such as vaccinations and artificial birth control, that weaken or replace natural selection;

expanding the bison range to allow some mobile bison to escape human-caused mortality, while providing a more diverse environment with more diverse natural selection.

Effects of the comparative weakening of natural selection upon the wild bison genome will occur gradually over decades and may defy detection. But evolutionary theory predicts such negative effects upon wildness. For the nation’s only wild plains bison herd, extremely conservative prudence is justified. The ultimate goal should be to limit the effects of a preponderance of human-caused mortality and to maintain the irreplaceable wildness of Yellowstone bison. But the future of a truly wild Yellowstone bison herd depends largely upon Montana’s position on allowing bison outside the Park.

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2017
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