Footnotes:

[1] Gates et al. (2010), p. 18.

[2] Sanderson et al. (2008).

[3] Popper and Popper (1987).

[4] The area partly depicted in Map 7.1 has no peer among locations in the USA with abundant federal land and good bison habitat, much already dedicated to wildlife. However, the areas depicted in Maps 7.2–7.6 are presented only as examples of many areas with abundant federal land that should be analyzed for possible plains bison restoration. Details are purposely omitted from these latter maps to avoid easy identification of anyone's private property.

[5] Manning (2009).

[6] News release of candidate Charles Schollenberger, June 25, 2010.

Chapter 8

Domestication of Plains Bison

In north-central Montana, the American Prairie Reserve is accumulating land and public grazing allotments to reestablish wild plains bison on native prairie. In 2011, APR had about 200 wild bison. During a recent cold winter, a local rancher accused APR of cruelty to animals. The rancher was providing supplementary hay to his cattle; whereas APR was not feeding hay to its bison. The rancher assumed the bison were starving; as his own cattle would have suffered without intervention. "But our bison were doing fine," said Jeff Hagener of APR. [1]

Similarly, on the Triple U Ranch in South Dakota, Roy Houck was unable to feed his stock, cattle and a few bison, for days during a severe snowstorm. When the storm finally ceased, many cattle were dead, but the bison were running and frolicking in the snow.[2]

These incidents illustrate one value of wildness in bison. They can take care of themselves, given adequate native forage and access to a diversity of natural habitat types. It also illustrates the common lack of awareness of the vast difference between wild and domestic animals and of the threat of domestication to wild plains bison.

Domestication can overtake bison just as it did the wild aurochs of the Old World.[3] Aurochs are ancestors of today's domestic cattle; but they no longer exist, except as pictographs in stone-age caves. The captive form of aurochs was altered and elaborated by human intervention, while the wild form was eliminated. At least 10 other species of large grazing mammals face this same demise. The Asian elephant, Dromedary and Bactrian camels, Yak, African wild ass, Asian wild horse, and four species of cattle (Zebu, Banteng, Gaur and Asian water buffalo) are numerous in domestication, but uncommon or rare in the wild (Fig. 8.1).

Control is a part of human nature. We try to control our environment; we try to control each other. Control brings safety, at least in the short term. Control brings the comfort of predictability. And so we domesticate what we can of the world's fauna and flora. We are on

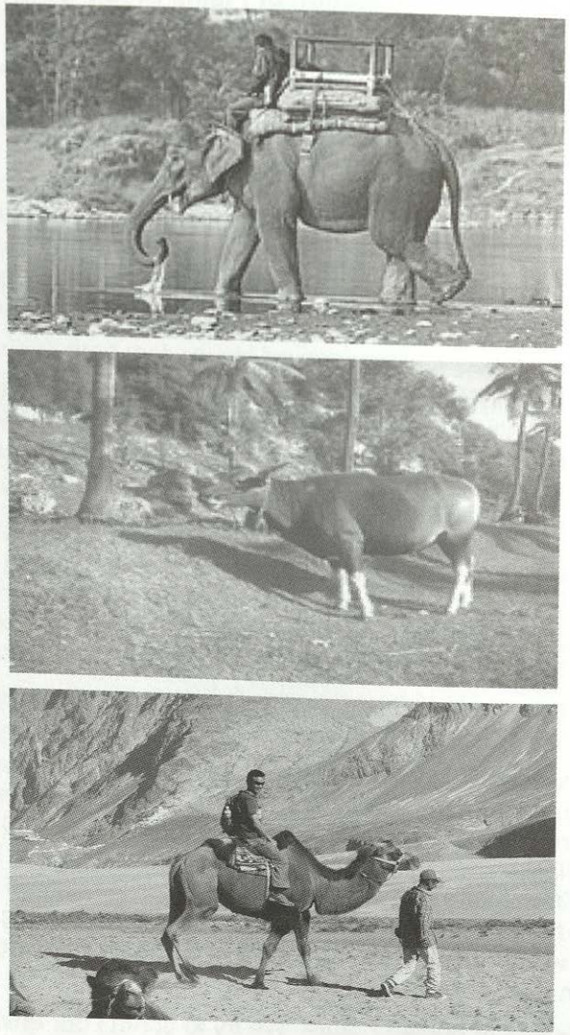

Fig. 8.1. Six of the 10 large grazing mammals that are abundant in domestication but uncommon or rare in the wild: Asian elephant, banteng, Bactrian camel ...

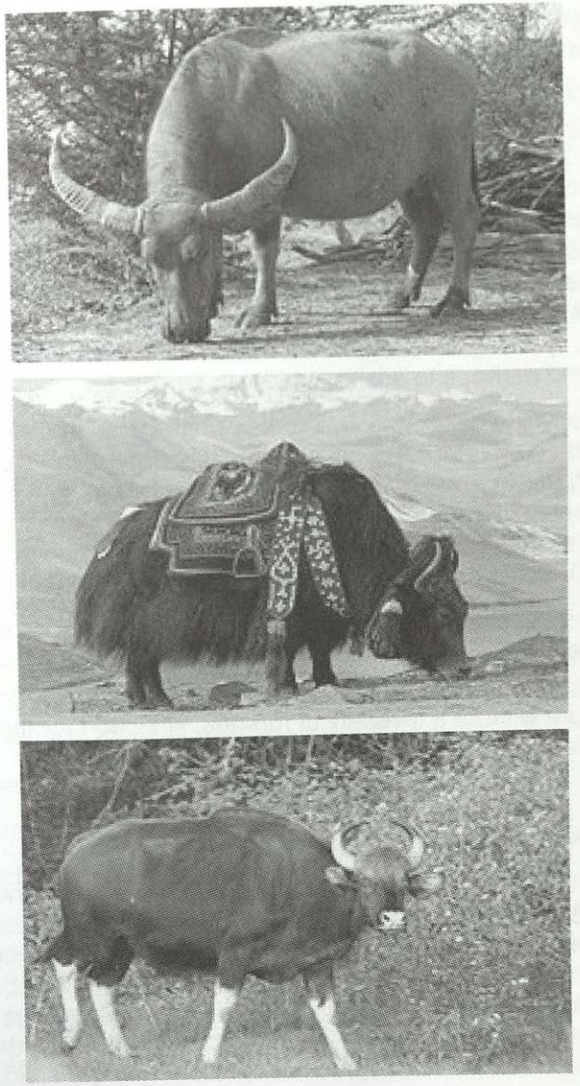

Fig. 8.1. continued: Asian water buffalo, yak and gaur.

our way to domesticating bison – to the extinction of wild bison, at least south of Canada.

Much of the difference between a wild and a domesticated animal is seen in comparing a Yellowstone bison to a domestic cow. We know that bison use upland areas and steeper slopes more than do cattle. But, just looking at bison and cattle, there is no comparison. The bison is designed by natural selection to be strong, mobile, agile, fast, independent, competitive and wary. The domestic cow is designed by human selection to be calm, slow, tractable, directing as much energy as possible to producing body tissue, rather than to activity, and dependent upon humans to provide emergency food, to control diseases and perhaps to assist at birthing time.

But these obvious differences fail to demonstrate all that is unique and valuable in wildness, as opposed to the domesticated state. In domestication, what will happen to bison's acuity of sight, hearing, taste and scent? Bison are not known to have sharp eyesight, but their other senses appear keen. Without predators, the value of and selection for acute senses will be diminished.

Foraging wild deer are known to use taste and smell to detect minute plant differences in amounts and types of volatile oils that would hinder digestion.[4] Bison likely have similar abilities. But, in a limited bison pasture without a diversity of forages, selection for this ability to discriminate will decline.

The Wildness – Domestication Continuum

Wildness is the opposite of domestication. There is a continuum of conditions between the extremes of totally wild and totally domesticated. The benchmark of domestication is the degree of replacement of natural selection by artificial selection. Artificial selection, a term used by Charles Darwin, occurs when human decisions, conscious or unconscious, directly or indirectly, determine which animals survive and reproduce to leave their genes in the next generation.

In a wild population, natural selection in a natural environment is the preponderant mechanism determining which animals survive and reproduce. The more we intervene to manage wild populations, the more artificial selection will occur. Populations will adapt to us rather than to a wild, natural environment. They will be pushed along the continuum from wildness toward domestication.

Conservation biologists have recognized this continuum of wildness to domestication. They suggest five population "stages" to illustrate the continuum: 1) self-sustaining, 2) conservation dependent, 3) lightly managed, 4) intensively managed, and 5) captive managed.[5]

Human Interventions Leading to Domestication

Human interventions, replacing or weakening natural selection and resulting in domestication of wild bison, are listed below.

- Small herd sizes.
- Small herd ranges with little habitat diversity.
- Rotation through seasonal pastures.
- Intensive range/habitat manipulation.
- Provision of artificial waters.
- Supplementary feed during winter or drought.
- Annual roundups and selective culling (Figs. 8.2, 8.3).
- Selection of bulls for breeding.
- Control of breeding season by separating bulls and cows.
- Early, forced weaning of calves.
- Assistance in calving.
- Maintaining stable herd sizes well below ecological carrying capacity.

- Maintaining herds with unnaturally young age distributions.
- Maintaining an unnaturally low bull/cow ratio.
- Culling feisty, excitable, intractable bison.
- Unintentional injuries and deaths of excitable bison during handling (Fig. 8.4).
- Use of vaccinations, vermicides and antibiotics.
- No effective predators.

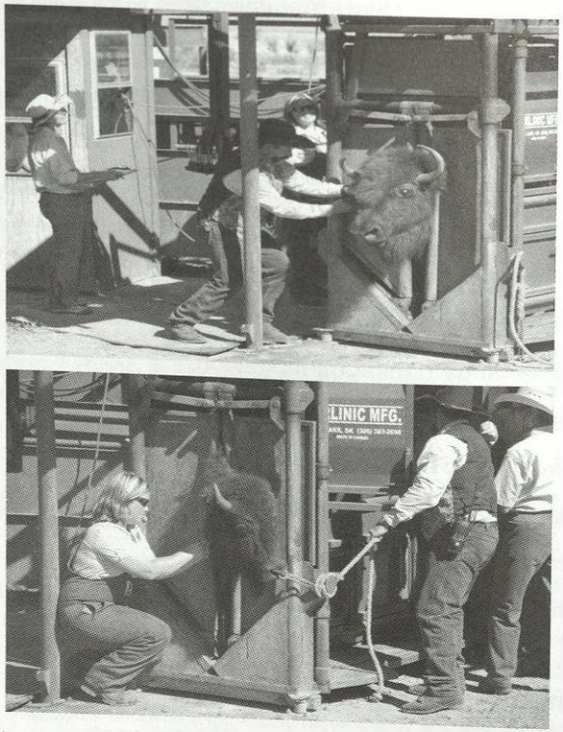

Fig. 8.2. Bison being processed during the annual roundup, Custer State Park, SD.

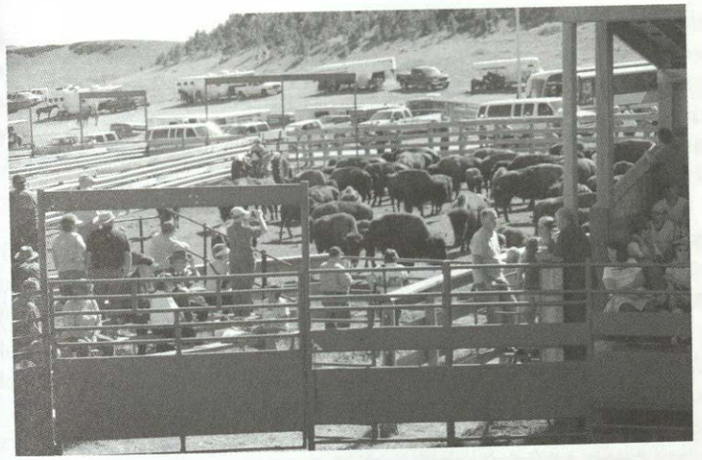

Fig. 8.3 The Custer State Park conservation herd of bison is rounded up and processed for handling and culling annually.

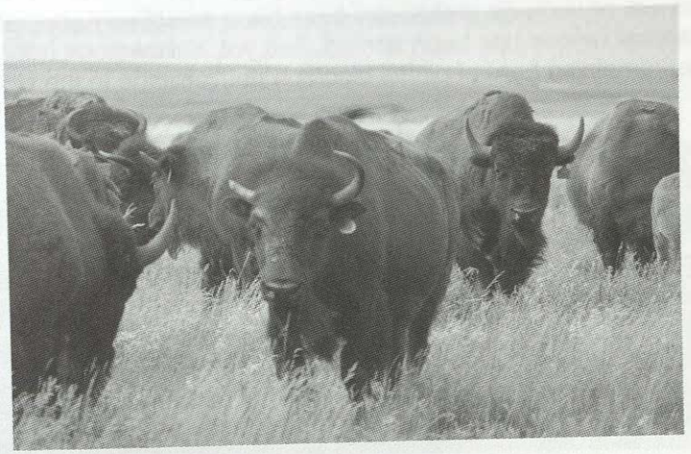

Fig. 8.4. Ear tags diminish esthetic value of wild bison. Broken and deformed horns are a common result from frequent handling of bison in pens and chutes. Effects of such deformities on dominance behavior of bison are uncertain.

The degree and rate of domestication will depend upon the number of these interventions being applied to a bison herd. Interventions will be most active in replacing natural selection when applied to young breeding-age animals, before natural selection has been allowed to operate. (But see section on Public Hunting in Chapter 12 for more on this complex topic.)

Perhaps no herd, not even the most commercial private herd, is subject to all these practices. But most bison herds, including those in the care of our state and federal wildlife agencies, are affected by many of these activities.[6] Even the bison of Yellowstone National Park, under the Interagency Bison Management Plan, are impacted by several interventions. Yellowstone bison are culled in a non-random manner. Herd size is limited. The average age of Yellowstone bison has been artificially reduced. Yellowstone bison have been vaccinated. During the winter of 2011, about 700 bison were held and fed in crowded pens for up to 4 months (Fig 8.5). Some of the most aggressive or nomadic individuals have been selectively shot. Access to seasonal ranges has been denied. And yet, Yellowstone has the wildest remaining herd of plains bison on native range in the USA!

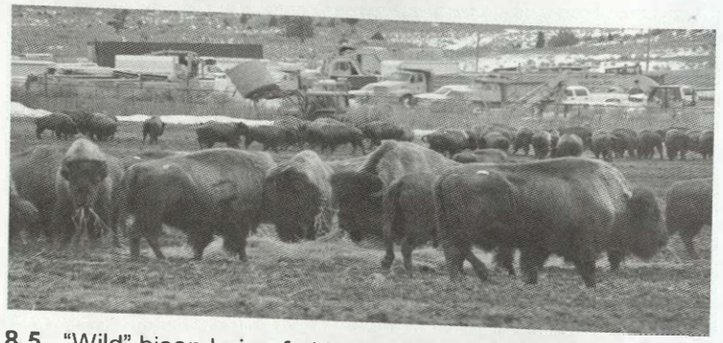

Fig. 8.5. "Wild" bison being fed in holding pens within Yellowstone National Park during 2011 when up to 700 bison were retained for up to 4 months to prevent them from leaving the Park. (Buffalo Field Campaign photo)

Results of Human Interventions in Domesticating Bison

Domestication causes a slow dismantling of the adaptive syndrome that is wild bison. Genetic and some non-genetic impacts of domestication upon wild bison may include those listed below, although this list must underestimate effects.[7]

- Inbreeding, with negative effects on survival and reproduction.
- Loss of genetic diversity and ability to evolve and adapt to changing environments.
- Altered body size, smaller or larger, depending upon selection.
- Reduced skull and brain size.
- Diminished dominance behavior.
- Reduced nutritional and energetic efficiencies.
- Reduced maternal behavior, lower milk quality.
- Diminished ease of calving.
- Decline of precociousness in calves.
- Reduced synchrony of breeding and calving.
- Lethargy, less aggressiveness, reduced mobility and agility.
- Diminished disease resistance/accommodation.
- Reduced acuity of senses.
- Diminished ability to survive in the wild.

Some relationships between above human interventions and results in the bison genome are easy to comprehend. Others are more complex.

Traits are not always inherited independently. Those that tend to be inherited together are termed linked traits. For example, in a classic experiment, Russian scientist Dimitri Balyaev selectively removed

animals from normally uniformly colored silver foxes in a fur farm. He culled the most aggressive animals and saved the tamest. In a few generations, Balyaev had, not only tame foxes, but animals with mottled fur, floppy ears and shorter tails!.[8]

In culling bison to limit herd sizes, managers often select aggressive, hard-to-handle animals for removal. Some managers, especially of commercial herds, also select smaller bison for sale, retaining the larger bison for breeding. Those that have grown most rapidly during their early years may be especially desired for subsequent breeding. This is exactly the process that has produced commercial, domestic cattle. Less excitable, more lethargic, less mobile and agile animals can divert more of their digested nutrients away from activity and into growth. This is a little recognized danger of selective culling in bison herds. Many characteristics of domestic animals can increase simultaneously as an unintended consequence.

Implications of non-random culling are seldom recognized. Often, the first bison to come through the handling chutes are chosen for removal. A Canadian study has shown that this approach emphasized removal of the largest animals.[9] Other bison traits probably are linked to body size and were being artificially selected unknowingly.

Even random culling of bison will weaken natural selection. Random removal of animals treats the most fit and least fit bison equally, whereas natural selection would favor survival and reproduction of bison most suited for wild conditions.

The role of disease control in wild bison is a difficult and controversial issue. Simplistically, we want our wild bison to be "healthy", yet wild ecosystems are anything but simple. The absence of pathogens in an ecosystem would be as unnatural as the absence of predators. However, several diseases of bison may be transmitted to domestic livestock.[10] These diseases are unwelcome threats to private interests, however small or manageable the threats may be. Adding to the difficulty and controversy, 1) a few diseases that may infect bison and other hoofed animals are rarely transmitted to humans; 2)

some diseases are not native to North America so that bison and other wildlife have had relatively little evolutionary history with these pathogens; 3) some pathogens may persist undetectably in bison for years before becoming transmittable; and 4) several diseases that may infect bison are highly regulated by government agencies at all levels. Government pathologists often presume that methods of disease control developed with domestic livestock are appropriately and effectively applied to wildlife. Both presumptions are questionable.

At the extremes, there are two models for disease management for humans, for our domestic animals including livestock, and for our wildlife. These and their important characteristics, especially for wildlife management, are:

1. Intensive intervention and management of disease.

- Comparatively simple interventions with quarantines, culling infected animals, vaccinations, vermicides and antibiotics to produce quick, short-term benefits.
- When public issues are involved, interventions are especially attractive to political interests that are, by nature, short-term.
- Interventions may treat the most and least disease-resistant animals equally, thereby weakening any natural selection for resistance.
- Interventions create long-term commitments because animals fail to evolve resistance while pathogens evolve and adapt to the interventions, requiring constant development of new vaccines, antibiotics and other intervention techniques.
- Pharmaceutical and veterinary industries develop a strong financial and lobbying system for research and continued responsive intervention.

2. Mother Nature's time-tested model.

- Time-tested by centuries of evolution; animals develop resistance and evolve accommodation with pathogens that also evolve toward reduced virulence. (The rapid evolution of European hares and the myxoma virus in Australia exemplifies this coevolution.)
- May be costly in the short-term; much less costly in the long-term.
- Brutal system: animals die of disease as natural selection operates. However, some predators are skilled at detecting and quickly removing infected animals. Disease-debilitated animals are selectively disadvantaged as inferior competitors for resources and breeding.
- Relatively little public understanding of evolution and the complexities of animal physiology. ("Take a pill and call me in the morning." is so much easier to grasp!)
- Consequently, there is rather little public support for systems of natural regulation, as illustrated by the difficulty that our National Park Service has had in applying this approach.

We are clearly committed to intensive medical intervention for managing human disease, though not without setbacks including serious epidemics of Spanish, Hong Kong, Asian and bird flu and the recent rise of antibiotic-resistant bacteria. We are also committed to this model for our domestic animals and livestock, at considerable perpetual cost. Success in these two arenas has caused us to presume that the intervention model is also best for our wildlife. There has been too little discussion of the wisdom of this presumption and of the costs in lost values of wildness.

Intervention with selective culling, vaccines, antibiotics and vermicides may prevent, reduce or delay disease problems in wild bison. However, effects of these interventions may not be limited simply to one target pathogen and its host. All mammals carry hundreds of competing and synergistic species and strains of bacteria, viruses and other potential pathogens. These interact complexly with several biochemical and cell-mediated mechanisms of

disease resistance. It seems unlikely that we can change one part of this complex micro-system without causing compensatory changes in other parts of the system.[11] With disease control, we are interfering with evolved and evolving mechanisms of resistance and accommodation between bison and their pathogens. We do not fully understand the implications of wildlife disease control; and we will not learn what they are unless we retain at least a few wild populations without disease control, as a basis for comparison.

Under natural selection, bison with the least disease resistance, or bison carrying the most virulent, debilitating strains of a pathogen, will experience relatively low rates of reproduction and/or survival. In this coevolving system, natural selection favors persistence of disease resistant bison and of less virulent strains of pathogens. The result is disease accommodation.[12] In reality, a sick animal is a natural component of a "healthy", evolving ecosystem.

In contrast, intervention with vaccines, antibiotics and vermicides can impede natural selection for resistance and accommodation. It may also cause loss of whatever disease resistance bison already carry. Intervention will be a commitment to continued human management to maintain susceptible bison that are obligated to humans for disease control. Disease management is domestication. Unfortunately, a recent review of principles for managing bison diseases ignored these issues and assumed that failure to intervene with bison diseases would be an "inappropriate management strategy".[13]

The issue of disease, especially of brucellosis, is exaggerated in public discussions of possible bison restoration. It is a serious issue because brucellosis and a few other diseases transmittable between bison and livestock may be economic burdens for the livestock industry. However, brucellosis has been used to prevent bison restoration by overstating the risks of transmission to livestock, even when uninfected bison are involved. This politically successful tactic has been used to avoid the embarrassing argument that public bison will compete with private livestock for public forage on public land. In

contrast, a fair-minded approach would 1) consider the biological realities of bison/*Brucella* ecology; 2) equally recognize private property rights and public property rights; and 3) equally disclose and consider both public and private costs and benefits of any proposed bison restoration.

Predation has been a major selective force creating wild bison. Today, only two plains bison herds on native range in the USA – both in the Yellowstone area – live with effective predators. Removal of predators allows individuals with less acute senses to survive and reproduce. Without predators, there is less advantage for synchronous breeding and calving, for ease of calving, for precocious calves and for high-density milk to support rapid calf growth. Likewise, there is less selective pressure favoring mobility and agility and less selective removal of individuals that fail to develop adaptations for disease resistance.

Mate selection, with the dominance of large, agile bulls has been another major selective force in bison. In wild bison herds, most breeding is accomplished by bulls that are 8 or more years old. Dominant bulls have proven their abilities to survive, to resist debilitating diseases, to forage effectively and to digest forages efficiently in order to outcompete other bulls. Years of natural selection are represented in each dominant breeding bull. In many managed plains bison herds, this selection is lost as most bulls are culled at an early age based on human decisions, and bull competition is largely eliminated by maintaining a herd sex ratio of 1 bull per 10 or more adult cows (Chapter 11).

Moreover, there is evidence that female mammals, using the scent of prospective breeding males, can detect and consent to breed with males having different alleles from their own. This behavior thwarts inbreeding and enhances valuable genetic diversity in offspring. In bison, the common practice of running small herds with relatively few breeding-age males, or of selecting bulls for breeding, must obstruct this valuable component of natural sexual selection.

Periodic severe winters and droughts have always tested wild bison,

selecting for energetic and digestive efficiencies. Persistence of these adaptations is compromised by supplemental feeding, pasture rotation, habitat/forage enhancement, and by maintaining bison herd sizes well below the ecological carrying capacities of their ranges. If no bison are dying on the ranges, natural selection is not working.

Relationships among human interventions that generate artificial selection and alter the bison genome are more complex and interrelated than these few obvious examples suggest. Reduced natural selection for aggressiveness and dominance behavior may result from at least 11 of the 18 interventions listed above. In turn, dominance enhances or mediates several other results of human interventions.

Many of these impacts, and others we do not expect, must be occurring in plains bison. While natural selection usually proceeds slowly, domestication in combination with genetic drift may cause rapid changes in the genetic composition of a population. How many generations are required for loss of wild characteristics to be obvious? We do not know; but it will depend on the intensity of human intervention into the natural-selection process. This intervention has begun. Almost all our plains bison have been under some level of domestication, mostly in small herds, for more than 100 years. Some impacts should be measurable already, if we would look carefully.

How far this may go is demonstrated by the very many breeds of domestic cattle and domestic dogs. Aurochs, the progenitor of cattle is extinct. However, wolves, the source of domestic dogs, continued in the wild on a separate evolutionary track while we were domesticating and selectively breeding dogs. Will wild plains bison go the way of aurochs, or of wolves? Knowingly or not, we are making that decision in bison management today.

Empirical evidence of domestication

Currently, the Yellowstone National Park bison are our only standard

of wildness of plains bison. Only in Yellowstone have some plains bison persisted always as wild animals. Only in Yellowstone do significant numbers of bison live with large predators on native range. If we are to measure effects of domestication, or semi-domestication, upon bison – now or in the future – we must retain wildness in the Yellowstone herd as a basis for comparison.

Yet Yellowstone bison can provide a sample size of only one herd; and the Park is not the best possible habitat for retaining a sample of wild bison. Originally, this upper Yellowstone area supported a backwater population on the periphery of better plains bison habitat. It is a harsh habitat, at least at some seasons, for plains bison today. If we are to preserve examples of wild bison, we should do so in more than one place, and in some places with better bison habitat than Yellowstone National Park.

References:

[1] Personal communication, Jeff Hagener was executive director of the American Prairie Reserve during 2011.

[2] The Triple U Ranch experience was related at livestockrus.com.

[3] Gates et al. (2010) discuss the threat of domestication to conservation of the wild character and genome of bison.

[4] I participated in this research on forage selection by mule deer at Colorado State University.

[5] Redford et al. (2011).

[6] At the American Bison Society's conference in Tulsa, Oklahoma in 2011, biologists concluded "Artificial selection due to the way bison are managed has in various ways replaced natural selection among the vast majority of bison herds in North America, including herds managed primarily for conservation purposes."

[7] Effects of captivity and domestication on animals are summarized by Clutton-Brock(1999), O'Regan and Kitchener (2005) and references therein. The latter paper emphasizes effects of captivity in

cages, zoos and relatively small pens. In contrast, most bison herds in the USA live in pens of at least a few square miles. However, for bison, a species that evolved to be highly mobile and to use a diversity of habitats, we should expect the pen-size effects of captivity to be exacerbated.

[8] The Belyaev experiment is described by O'Regan and Kitchener (2005) and on line.

[9] Personal communication, Wes Olson, wildlife biologist, Grasslands National Park, Saskatchewan.

[10] Gates et al. (2010) review diseases that may infect bison. However, the website of the National Bison Association, an organization of commercial bison producers, touts the superior (to cattle) disease resistance of bison.

[11] Woolhouse et al. (2002) provide a useful review of many interrelated processes in coevolution of pathogens and their hosts.

[12] Meyer (1992) noted greater resistance of wild bison to *Brucella abortus*, causative agent of brucellosis, compared to resistance in domestic cattle. Seabury et al. (2005) detected evidence of a genetic basis for this resistance in Yellowstone bison. Either the resistance of bison to *Brucella* is a case of "preadaptation" or some resistance and accommodation evolved during about 10 generations of bison since first exposure of the Yellowstone herd.

[13] Nishi (2010).