THE ECOLOGY OF BISON MOVEMENTS AND DISTRIBUTION IN AND BEYOND YELLOWSTONE NATIONAL PARK

A Critical Review
With Implications for Winter Use and Transboundary Population Management

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The history and enormity of issues leading to this study have touched the professional or personal lives of a broad spectrum of Americans, including federal and state civil servants and citizens who care passionately about the integrity of Yellowstone National Park, bison conservation, or protection of livestock against reinfection with a zoonotic organism nearing eradication in the industry. Given the strong polarization among interests involved in these environmental conflicts, the authors feel privileged to have been welcomed by key informants to engage in exploration of their knowledge and insights, and in many cases to have been provided with unpublished data contributing to our assessment and recommendations. Foremost among those we wish to acknowledge as contributing to the assessment is Dr. Mary Meagher, whose passionate concerns for the conservation of Yellowstone bison and the integrity of the Yellowstone Park ecosystem have been uncompromising. We encourage her to continue analyzing the as yet unrealized potential of a data set spanning more than 30 years, complimented by experience in the Yellowstone ecosystem exceeding the duration of most professional careers in wildlife management. In contrast, Rick Wallen, the current bison biologist with the National Park Service, is just beginning to develop a research and management program. We thank Rick for contributing information and his insights to the assessment and hope in return that the report contributes to the development of his program. We are grateful to both Rick Wallen and Dr. Doug Smith for the experience and insights we gained while riding the Mary Mountain Trail with them in October 2004. Finally, we wish to acknowledge the enormous contribution to the project by Traci Weller of Bozeman, Montana. Traci organized and scheduled the interviews and workshops, recorded the dialogue and prepared transcripts. Her competency and humor sustained us through the arduous interview schedule.

CONTENTS

4

HISTORY OF BISON MANAGEMENT IN YELLOWSTONE NATIONAL PARK

Yellowstone Bison in Prehistory

Bison were continuously distributed from eastern Beringia southward into central North America during the interstadial period before the Last Glacial Maximum (LGM, ca. 22 to 18 ky b.p.) (Shapiro et al 2004). The subsequent formation of the Laurentide (eastern) and Cordilleran (western) ice sheets created a barrier to north-south faunal exchange. The formation of an ice free area between the continental ice sheets around 14,000 b.p. provided a corridor for bison to disperse southward and northward from the respective glacial refugia. Southward dispersal of Beringian bison was more limited than movement of southern bison into the corridor. Evidence of temporal overlap of the two clades of bison exists only in the Peace River area in northeastern British Columbia ca. 10, 500 b.p. (Shapiro et al 2004). Grassland habitat rapidly diminished in the north, giving way to coniferous forests (Catto et al. 1996) and peatlands (Halsey et al. 1998) around 11,000 to 10,000 b.p. In the north, bison habitat remained as riparian meadows associated with seasonal inundation plains along river courses and other water bodies (Gates et al. 1992). However, the vast expanse of unsuitable habitat represented a barrier to interchange between northern and southern bison during the Holocene.

Yellowstone National Park is the only place in the lower 48 States where bison have existed in a wild state since prehistoric times. Bison occupied the region encompassing the park from shortly after recession of the last glaciers 10,000 to 12,000 years ago, until the 19th century when they came close to extirpation. *Bison bison antiquus* is represented at early Holocene archaeological sites. The Horner archaeological site southwest of Cody Wyoming yielded a date for a *B. b. antiquus* specimen of 10,000-11,000 b.p. (Frison and Todd 1987). The earliest date (8,000 b.p) for bison bones at an archaeological site north of Yellowstone National Park was obtained for the Meyers-Hindeman site south of Livingston (Lahren 1976). Recent archaeological work in 2003 near Gardiner Montana on the Yellowstone River (site 24YE353) yielded a radiocarbon date of 9,400 b.p. (Cody Complex material). Other bison bones were found at the same level at this site in 2004[1]. A Windlust-type point was found at a site in the Hellroaring area with a date of 9,500 – 10,700 b.p. (site 48YE1025); a right proximal metacarpal bison bone was also found at the site. In the interior of the park, a Cody Complex chert knife, dated to 9,000 b.p., was found at a site (48YE410) on the shore of Yellowstone Lake. Organic residue on the artifact, either blood or sinew, was determined to be of bovid origin (Cannon and Newman 1994). A corner-notched point found at an archaeological site near Tower Junction was 2,000-3,000 years old (Aaberg 1996: 48YE215). Materials at another nearby site were estimated to be 900 to 1,000 years old. Neonatal bison bones were found

[1] Interview with Ann Johnson, 28 July 2004.

at an archaeological site near the old Buffalo Ranch in the Lamar Valley; the site was dated at 400 to 500 years old (Sanders et al. 1997: 48YE168). Dates for bison bones sampled at the Meyers-Hindeman site south of Livingston ranged from 8,000 b.p. to 700 b.p. (Lahren 1976). In combination, archaeological evidence indicates a continuous association between bison and Native peoples in the Yellowstone area enduring more than 10 millennia.

The Lamar Valley and the Yellowstone River Valley north of the park (Figure 4.1) to Livingston and beyond was an important area for bison and Native peoples throughout the Holocene. This system can be considered the original Northern Range for Yellowstone bison[2], functioning as an ecological continuum of grasslands that likely supported seasonal migrations by bison as far south as the high elevation ranges in the Upper Lamar Valley. Davis and Zeier (1978:224) described the lower Yellowstone Valley as an exceptional area for Native people to gather, drive and kill bison. Eight bison jumps and three kill sites have been documented south of Livingston. The closest jump site to YNP is 25 km north of the park boundary. It was used during the late prehistoric period between 1,700 and 200 b.p. (Cannon 1992). There is evidence of a human use corridor from the Gallatin and Madison River drainages into the interior Yellowstone National Park. Several major bison kill sites are located in the Gallatin Valley outside of Bozeman Montana[3]. Archaeological sites in Fawn Pass provide evidence in support of the hypothesis that Native people moved between the Gallatin drainage and the interior of the park[4]. Chert and obsidian projectile points were found at the Fawn Pass site. The chert implements likely originated west of the park. The obsidian is being fingerprinted to determine its origin. Approximately half the projectile points were the Pelican Lake type, the most commonly represented prehistoric culture in YNP, dating from 1000 B.C. to A.D. 200. Other points were assigned to the McKean Complex, dating to around 3500 B.C. McKeean Complex sites are also quite common in the park. There is an obsidian source at Cougar meadows in west central Yellowstone Park. The material is inferior to the Obsidian Cliff source and was only used for making utility implements like knives and scrapers rather than projectile points. An obsidian artifact found at Yellowstone Lake was determined to be Cougar Creek Obsidian.

Based on the temporal frequency of dated archaeological sites and materials, it appears use of Yellowstone Park by prehistoric peoples increased over time from the early Holocene, reaching a peak between 3,000 and 1,500 b.p.[5] Thereafter, the abundance of dated archaeological materials diminishes, particularly during 600 to 400 years b.p. This period coincides in part with the Little Ice Age (ca. 1450 to 1850 A.D.) during which the severe climate of the park may have deterred human use, except for forays by work parties to acquire resources such as bighorn sheep and obsidian that were not available at lower elevations. Reduced use of the park during the Little Ice Age may also be attributable to a diminished wildlife population, which may have also been a response to severe winter conditions.

Europeans arrived in North America in 1492, bringing with them two significant forces of change for the aboriginal population and for bison: novel pathogens and horses.

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[2] Interview with Mary Meagher, 15 July 2004.
[3] Interview with Ann Johnson, 28 July 2004.
[4] Email from Ann Johnson, 5 September 2004.
[5] *Supra* note 4.

Smallpox, influenza, whooping cough, measles, and the common cold caused devastating epidemics that vastly reduced the immunologically naive indigenous human population (Crosby 1986). Before the arrival of the horse, the abundant bison population of the Great Plains provided part of the subsistence needs of both nomadic cultures living in the grasslands and village-dwelling Indians that migrated seasonally from nearby regions to hunt bison on foot (Isenberg 2000). Resource use was diverse for both traditions, involving gathering a variety food plants, pedestrian hunting of several wildlife species, and crop production in the case of village Indians in regions adjacent to the grasslands (Holder 1970, White 1983). The diversity of resources used and associated land use practices buffered these peoples from drought, fluctuations in wildlife abundance, and reduced the likelihood of overexploitation of resources (Isenberg 2000). Drought, the introduction of horses, and the emergence of a commercial market for wildlife products following European settlement changed the original economies of the Great Plains and contributed to the near extinction of the bison (Isenberg 2000:27, Flores 1996:16).

Horses did not reach the plains until the late seventeenth century, nearly 200 years after they were reintroduced by the Spanish. In the opening years of the 17th century, the Spanish in Mexico attempted to colonize Pueblo Indians in what is now New Mexico. In 1680, the Indians rebelled against oppressive treatment, forced about 2,000 Spaniards to flee, and seized their livestock (Spicer 1962 cited by Isenberg 2000). The ensuing intertribal trade in horses resulted in their rapid spread throughout the plains, reaching northern plains tribes by the 1730s to 1750s. Feral horses reestablished free ranging populations in the former grazing niche of the species. Flores (1996) estimated two million horses roamed below the Arkansas River and others ranged further north, competing with bison for forage. The Great Plains were opened to direct trade with Europeans beginning with the villages along the Missouri River in 1738 (Wood and Thiessen 1985). Located along the Missouri River in present day North Dakota, the Mandan/Hidatsa Indians traded horses, robes and furs to Canadian Fur Companies in return for guns and ammunition. In turn, they traded these goods for other commodities from various Northern Plains Indian Tribes, resulting in a technological revolution on the Great Plains. Beginning in about 1820, Euroamericans established a trade in native-tanned bison hides, soft pliable robes with the hair on. So began an insatiable demand for bison robes in the developed eastern United States and central Canada. By 1825, 25,000 robes were moved to market down the Missouri River. This increased to 85,000 to 100,000 raw hides traded annually at St Louis by the 1840s. Flores (1996) cites an unpublished reference by D. Wishart stating that the Hudson Bay Company trade reached a zenith of 73,278 robes traded in Canada between 1841 and 1845. By the time Euroamerican hide hunters arrived to engage in market hunting plains bison for their skins in the 1850s, the robe trade had been in place for a quarter of a century. Thereafter the extirpation of bison rapidly accelerated to near final conclusion in the mid 1880s. Bison were extirpated from the Snake River plains in Idaho by 1838 (Hornaday 1889). In 1880 the northern plains herd was estimated at 1.5 million animals; Euroamerican commercial hunters secured about 320,000 hides that year. The Blackfeet took 100,000 to 150,000 in 1881 and last hunted bison in 1883 when they took only six (Flores 1996). The last bison were extirpated from the prairies north and east of the Absaroka Mountains surrounding Yellowstone National Park by 1883 (Hornaday 1889). The last wild bison in

Wyoming outside of YNP was killed in 1889 (Blair 1987:27, cited by P. Schullery[6]). So it was that a population of about 30,000,000 or so plains bison present when Columbus arrived on the continent in 1492 (Shaw 1995) was reduced to near extinction at the close of the 19th century, the victim of a brief spasm of commercial exploitation.

Yellowstone National Park is the 8,983 km^2 center piece (Figure 4.1) of a large high elevation plateau, a caldera formed by volcanic eruptions, the most recent occurring 630,000 years ago (Smith and Siegel 2000). About 80% of the Yellowstone Plateau is covered by lodgepole pine forest (Despain 1990). Bison habitat (grasslands and meadows) occurs mainly in the Gardiner basin, Lamar River drainage, the Firehole, West Yellowstone to Hebgen Lake, and the Pelican, Hayden, upper Yellowstone River (Thorofare), and Bechler River Valleys (Figure 4.3). The combined area of winter forage producing communities on the Northern and Central ranges is less than 700 km^2, or less than 7% of the park and boundary areas used by bison today. In contrast, throughout most of the Holocene the extensive grasslands of the Great Plains, the eastern Columbia River Basin and intermountain grasslands of the Madison, Gallatin and Yellowstone River Valleys were the main grazing systems supporting an immense bison population that may have numbered 30,000,000 during pre-Columbian times (Shaw 1995, Isenberg 2000).

Prehistorically, YNP bison ranges were probably the "tips of the fingers" of seasonal migration from large source populations associated with expansive grasslands (Figure 4.1) lying to the north, west and southwest around the Yellowstone Plateau[7]. The high mountains on the east side of YNP and discontinuous habitat would likely not have supported bison migration. Historical accounts indicate that interior ranges also supported resident bison populations (Meagher 1973: Appendix II). Today, the bison of YNP are a source population with the potential to reoccupy surrounding grasslands systems if incompatible land uses and policies did not constrain expansion. There are no free-roaming bison populations in adjacent areas containing habitat contiguous with the park. The closest contemporary population is in the Jackson Valley, separated from YNP bison ranges by the Continental Divide and an expansive tract of coniferous forest.

Although the exact nature of early historic period bison movements is a matter of conjecture, inferences can be drawn from knowledge of contemporary movement patterns and archaeological evidence. Mary Meagher[8] inferred that prehistorically, during the spring and early summer, bison would have moved into YNP following advancing plant phenology. Depending on snow conditions in the park, most would have moved out to lower elevation ranges during the fall and early winter. However, Meagher (1973:23) provided evidence that some bison wintered in the park in the Lamar, Pelican and Hayden Valleys.

What is now considered the Northern Range (Klein et al. 2002) used to extend from the Upper Lamar Valley to Livingston Montana and beyond. This larger area is considered the prehistoric annual range of northern herd, occupied continuously by bison for ca. 10,000 years. There are a dozen or so buffalo jumps documented between

[6] Draft manuscript provided by Paul Schullery: Schullery, P. and L. Whittlesey. Draft last revised 5-30-03. Greater Yellowstone bison distribution in the early historical period. This work, combined with Schullery and Whittlesey (1992) support, complement and expand on Meagher (1973), providing readers with the full geographical and historical context, and full citations unavailable in all earlier works.

[7] Interview with Mary Meagher, July 15, 2004.

[8] *Supra* note 7.

Yellowstone and Livingston, indicating the Yellowstone and Lamar Valleys were important for both bison and the original human occupants of the region.

The Gallatin and Madison Valleys and the Snake River Plain contain extensive grasslands that served as habitat for large numbers of bison (Figure 4.1), source populations for bison entering the park from the west. In 1880, Superintendent Norris commented on the presence of about 300 bison on the Madison Plateau and Madison River (Meagher 1973: 118). He speculated that the winter range of this population may have been outside the park. M. Meagher[9] inferred that bison would have migrated into the park from the west in the spring and summer by several routes: the chain of wet meadows along the Bechler River in the southwest corner of the park; diffuse movements across the Madison Plateau; and through Raynolds Pass and other low passes in the Continental Divide west of the Park. There is little available evidence for or against the possible use of the Madison River corridor during prehistoric or the early historic period. Meagher (1973:23) cites Raynolds (1867) who in 1860 saw "bison among the hills" while traveling from Henry's Lake to the Madison River west of the park. Bison were present in this corridor in the 1950's (Meagher 1973:23) and the corridor is heavily used by contemporary bison (Bjornlie and Garrott 2001).

A bison movement corridor (trail) across the Mirror Plateau was mapped by Superintendent Norris in 1880 (cited by Meagher 1973:25). Then as at the present time, the high country grasslands of the Mirror Plateau and upper Lamar drainage in the western slopes of the Absarokas were used as summer range. Bison left these areas to winter in the Lamar Valley south of Soda Butte Creek and in the Pelican Valley. Similarly, Mary Mountain trail connecting the Hayden Valley and the Firehole was recorded as an historic migration pathway (Meagher 1973:25).

M. Meagher[10] inferred although there are passes through the Absaroka Mountains along the northern and eastern boundaries of YNP there was likely little bison migration through them historically. The high elevation passes are characterized by steep terrain with little or no habitat for bison. The only documented contemporary movements of bison through the Absarokas occurs through Sylvan Pass where a few bulls move east of YNP to low elevation range in the North Fork of the Shoshone River basin in late summer/fall through the winter, then return to YNP for the summer where they participate in the rut[11]. R. Wallen[12] referred to a conversation with a long time Wyoming Game and Fish Department game warden, who told him that adult male bison periodically end up in the Sunlight Creek Basin in the Shohone National Forest east of Cache Creek ridge. When found, the bulls were shot to eliminate the risk of transmission of brucellosis to cattle in Wyoming.

Meagher (1973: 24) did not report any evidence of bison moving through the Sylvan Pass when the YNP population was small. Similarly, there is little historical evidence that bison used Two Ocean Pass to move over the Continental Divide, which separates grasslands in Teton National Forest from extensive meadows in the Thorofare area of the Upper Yellowstone River. Meagher (1973) referred to a bison skull found on Two Ocean

[9] *Supra* note 7.
[10] *Supra* note 7.
[11] Interview with R. Wallen, 23 July 2004.
[12] Email correspondence from R. Wallen, 29 March 2005.

Pass before 1925 (Fryxell 1926, cited by Meagher 1973). Snow is extremely deep in this high elevation pass of the Continental Divide.

The Bechler Meadows area in the southwest corner of the park (Figure 4.3) is characterized by very deep snow in winter (Meagher and Houston 1998:222) and high water in the meadows during the spring[13]. Meagher (1973:23, Fig. 11) illustrated the Bechler area as an historical migration corridor for bison spending summer in the interior of the park and returning to winter ranges on the Snake River Plains.

Yellowstone Bison in the Historic Period

Beginning prior to the establishment of Yellowstone National Park, then throughout its history, park wildlife management has changed with prevailing scientific theory, shifting cultural expectations, competition between ambitious people and agencies, varying levels of public involvement, and economic interests in the park and surrounding communities (Pritchard 1999).

The Early Historic Era 1840 to 1902

By 1840 intermountain bison populations were disappearing, a consequence of unregulated hunting. However, bison remained common in the Lamar and Yellowstone Valleys late into the 19th century. Meagher (1973) quotes an archival record (Potter 1962) of an observation made in 1867 for the Gardiner basin near Yankee Jim Canyon: "that whole flat would be covered with buffalo". Schullery and Whittlesey (1992) also reviewed the interview with Lena Potter and did not think that the context was clear enough to assign a single year date to the report, inferring that the year could have been anytime between 1867 and 1878. In June of 1870 Bart Henderson recorded seeing "thousands of buffalo quietly grazing" on a flat near Hell Roaring Creek (Meagher 1973: 116). This quotation is controversial; Schullery and Whittlesey (1992: 1.38-1.51) inferred from a comment by Henderson's travel partner, James A. Gourley, that hardly any bison survived in or near YNP.

Meagher (1973:118) cites the YNP Superintendent's report of 1880 in which the distribution and abundance of bison in YNP was described for three areas of the park. About 200 bison summered in the Lamar Valley, described as "the valleys of the Crevice, Hellroaring, and Slough Creeks and the mountain spurs between them". With the arrival of snow they moved to the "grassy valleys of the East Fork of the Yellowstone [Lamar] and Soda Butte". A second herd of over 100 bison "summer in the elevated and abruptly broken, little known section of the Park, extending from the Hoodoo region to the Grand Canyon, and from Amethyst Mountain to Pelican Creek, near the foot of the Yellowstone Lake, and winter occasionally upon the East Fork [Lamar] of the Yellowstone and on Pelican Creek". The Superintendent described a third herd numbering about 300 ranging in small groups on the Madison Plateau and along the "Little Madison River". A further comment made by the Superintendent that this herd probably wintered on the Pacific side of the Continental Divide "and if so, they are not permanent occupants of the Park, and are therefore likely to be slaughtered by advancing settlers". This comment reflected the pressure on large herbivore populations from

[13] *Supra* note 11.

unrestricted hunting outside the park. Poaching was also a serious problem within the park boundaries.

Market hunters discovered abundant wildlife remained in the Yellowstone Valley Northern Range. Although the 1872 act establishing Yellowstone National Park outlawed hunting "for the purposes of merchandise or profit", subsistence and sport hunting was still allowed. Hunters and poachers continued to kill bison and other big game in large numbers inside the park. Among them the Bottler brothers, who had settled about 50 km north of the park, participated in a profit-driven slaughter in 1874 - 1875 that Superintendent Norris claimed to have resulted in the taking of four thousand elk and large numbers of bighorn sheep, deer, antelope, moose, and bison, killed mostly for their tongues and hides. The kill was noted by George Bird Grinnell who accompanied the Colonel William Ludlow expedition to Yellowstone Park in 1875. His report expressed outrage against the slaughter. He initiated intense lobbying to protect wildlife remaining in the park and in so doing set the stage for public discourse on what a national park should represent. As editor (1876-1911) of the popular outdoors magazine *Forest and Stream*, he engaged in an editorial campaign to shape the purpose of Yellowstone National Park and to encourage a rational system of administration and management. George Bird Grinnell was also the founder of the Audubon Society and an organizer of the New York Zoological Society.

In 1880, the Secretary of the Interior (Carl Schurz) called for hunting to be outlawed in the park. General Philip H. Sheridan visited the park in the summer of 1882. He subsequently urged Congress to expand the park's northern boundary to prevent the slaughter of game (Haines 1997, Vol I: 252). In 1883, the new Secretary of the Interior (Henry Moore Teller) outlawed hunting for sport or subsistence, as well as continuing a ban on market hunting (Schullery 1997). Despite growing public concern over excessive hunting and declining numbers of bison, poachers based from Henry's Lake and Cooke City continued to operate in YNP[14].

Public pressure finally caused Congress to act in 1886. It assigned the U.S. Army to establish a command in the park to protect wildlife and geothermal features. Although the presence of the army reduced poaching, penalties were weak and were an inadequate deterrent. A new regional market for bison heads (scalps) had developed. Poachers travelled on skis into the park to take bison remaining on the Madison Plateau, in the Firehole, and as far east as the Pelican Valley. It took a well publicized incident in 1894 to precipitate a more substantial congressional mandate to enforce anti-poaching laws. That year army troops caught poacher Edgar Howell after he shot five bison near Pelican Creek. This flagrant violation of the law added pressure to enact more substantial legislation to protect wildlife. As Scout Felix Burgess and Sergeant Troike escorted Edgar Howell to the guardhouse at Fort Yellowstone, they happened upon the "Yellowstone National Park Game Expedition." Emerson Hough, a member of the expedition, promptly wrote an article for *Forest and Stream* magazine about poaching in YNP. George Bird Grinnell, by then a prominent conservationist and editor of the magazine, persuaded members of Congress of the serious threat to wildlife in the park. On March 26, 1894, Representative John Lacey of Iowa introduced H.R. 6442, "An act to protect the birds and animals in Yellowstone National Park, and to punish crimes in said park". President Grover Cleveland signed the bill into law on May 7, 1894. The 1894

[14] Interview with Mary Meagher, 15 July 2004

wildlife protection law gave sole jurisdiction over wildlife in Yellowstone to the federal government and prescribed fines of up to $1,000. Lacey introduced more general legislation to the House of Representatives in the spring of 1900. The Lacey Act, passed into law by President William McKinley on May 25 that year, prohibited trade in wildlife, fish and plants that have been illegally taken, possessed, transported or sold.

Despite increased protection, the park bison herd continued to dwindle in the closing years of the 19th century. In 1894, Edgar Hough, representing the publisher of *Field and Stream* Magazine, estimated that only 150 remained in the park. According to Albright (1925:3), Hough saw "85 to 100 wild bison in Hayden Valley and on Mary Mountain". In 1902 the Superintendent estimated only 22 bison remained in remote Pelican Valley (Albright 1925).

Concerned about saving some of the few animals remaining in the park, in 1895 the Smithsonian Institution recommended construction of an enclosure in the interior for native park bison (Schullery 1976, Haines 1977 Vol II). A fenced pasture was constructed on Alum Creek in the Hayden Valley to capture bison. Baiting failed to attract any into the enclosure and the effort was abandoned. Subsequently, in 1901, Acting Superintendent Captain John Pitcher asked Congress for money to buy bison that would be kept in a fenced enclosure in the park. Fifteen thousand dollars was appropriated for the purpose. C. J. Jones, also known as "Buffalo Jones," had developed a reputation as an expert on buffalo by capturing calves from a remnant herd in Colorado. He offered his services to the Secretary of the Interior, arriving in the park in 1902. Jones established a captive herd near Mammoth Hot Springs that included three bulls from the Goodnight herd of Texas and eighteen cows from Conrad Allard's herd in western Montana. Jones ended up at odds with Superintendent Pitcher and resigned in September 1905. The captive bison herd grew and the operation was moved to Rose Creek in the central Lamar Valley. This site became known as the 'Buffalo Ranch', where Lamar herd was managed until 1952.

The 21 bison imported from Montana and Texas and an indigenous population of approximately 22 animals in the Pelican Valley represented the founders of today's Yellowstone bison population.

The Bison Protection, Ranching, and Range Management Eras: 1902-1968

Between 1907 and 1912, the imported captive herd was maintained in fenced pastures in the Rose Creek facility in the Lamar Valley. Activities at the ranch included irrigation, growing and feeding hay, roundups, culling, castration, and predator control. In 1913, the bison were released to graze freely in the surrounding areas during the day and brought back in at night. By 1915, the herd had increased to 259. Starting in 1915, bison were herded up the Lamar Valley to high elevation summer pastures then back again in the fall. This was done to reduce grazing pressure on the ranch during the summer. Seasonal herding was practiced until about 1930. In the early 1920s, a substantial log fence was built across the upper Lamar Valley to keep bison from returning prematurely to the hay fields. As the Lamar herd expanded its summer range, it mingled with the wild herd moving into the high country of the upper Lamar Valley from Pelican Valley. After 1932, there was no attempt to keep the two herds separate. They mixed with the wild herd in the

high country summer range. In an internal report dated January 17, 1934, Chief Ranger G. F. Baggley commented:

"The buffalo range during the grazing season from Junction Butte to Cache, Calfee, and Miller Creeks on the east to the head of the Lamar River on the south and Cold Creek on the west, also to some extent over the east part of the Mirror Plateau. In short, they occupy a considerable part of the Lamar River drainage, with a few getting over into Pelican Creek."

Early herding practices may explain much of the seasonal migration patterns observed in the Lamar bison population at the present time. The historical herding of bison into and out of seasonal habitats (winter and summer) was conducted to manage the distribution of bison in the park[15]. Although the Lamar herd was essentially wild by 1930, it was still fed hay during the winter months, a practice continued until 1952. Albright (1944:8) offered the following reason for winter feeding:

"... the Lamar River herd if not fed in periods of deep snow or under blizzard storm conditions will move down the valley and out of the park into towns and farms and in such drifts there is always the possibility of excessive losses of bison as well as great property damage by the restless hungry animals".

Cahalane (1944*a*) explained that when the park was established the boundary in the Gardiner basin was set to protect geophysical resources, hot springs and high mountain scenery. Lowlands in the Gardiner basin with agricultural potential had been excluded from the park, and with them, low elevation grasslands lying in a snow shadow that would otherwise serve as critical winter range for bison. Cahalane (1944*a*) argued for expanding the boundary to take in the Gardiner basin north to Yankee Jim Canyon. This was was done.

Neither subject to winter deprivation nor to predation the Lamar herd grew rapidly, reaching approximately 1100 by 1930 (Meagher 1973). The mean rate of population increase (r) between 1902 and 1930 (adjusted for removals) was 0.19 ± 0.09 (s.d.) (data source Meagher 1973: Appendix IV). The Park Service began culling to limit the size of the Lamar herd in 1919, but population objectives were not defined until the early 1930s. Authority for the sale or disposition of surplus bison was granted in the Appropriation Act of 1923. 737 bison were removed from the northern herd between 1919 and 1931 at an average rate of 56/yr. A policy developed in 1932 stipulated that ungulate populations in the park would be managed within the carrying capacity of the range by limiting their numbers[16]. The "average winter carrying capacity" on the northern range was calculated as 7,059 elk and 245 bison (Grimm 1939). Reductions increased during 1932 to 1936 during which time 979 bison were removed at an annual rate of 196/yr. In 1937, 488 bison remained on the northern range.

In 1942, the Director of the Park Service, Newton Drury, ordered a reduction of the Lamar herd; 193 bison were culled and 17 shipped from the park. The winter of 1943 was

[15] Interview with Keith Aune, 22 July 2004.
[16] Wayne B. Alcorn, "History of the bison in Yellowstone National Park", Supp. 1942-1951, cited by Franke *in press*.

harsh and despite reduction in the previous year, 160 bison moved down the valley and exited the northern boundary of the park. Cahalane (1944*b*) recorded that some of them traveled 50 km north to Carbella Flats and another was reported on a ranch 80 km from the park. He also reported 150 bison were observed in summer 1943 at Lake Abundance near the northeast corner of the park. Despite subsequent reductions of the northern herd (Figure 4.4), 68 of 313 bison on the Northern Range moved north of the park boundary into the Gardiner basin during the mild winter of 1948. Bison also exited the park in 1953 when a group wandered across the northern boundary of the park (Franke *in press*). The State of Montana authorized a hunt that year; three bison were taken. A second hunt was held in Montana 1954.

Mixed groups of bison (cows and juveniles) had not been seen in the Hayden Valley after 1895. In 1936, 71 bison were rounded up on the Northern Range and trucked to the Hayden Valley and Fountain Flats in the Firehole (Figure 4.3); about half of them were released in each area. Park Superintendent Edmund Burrell Rogers explained "This was done in an attempt to scatter the herd over a wider range and provide more opportunity for park visitors to see buffalo running free and wild" (Superintendent E. B. Rogers cited by Franke *in press*).

Before the translocation of bison to central YNP, there were two wintering populations, one in Lamar Valley and the other in the Pelican Valley (Meagher 1973: 31). While the Lamar herd originated from stock imported from captive herds in Montana and Texas (Chapter 4), the Pelican herd was indigenous. With effective protection, but no winter feeding and little management interference, the Pelican herd increased at an annual exponential rate of 0.056 between 1902 and 1954 reaching 461 that winter (Figure 4.5). The bison translocated to the Hayden Valley and the Firehole increased more rapidly than the Pelican herd ($r = 0.156$), reaching 858 by 1954 (Figure 4.6). Meagher (1971, 1974) explained that winter conditions in the Pelican Valley are the harshest in the park. The lower rate of increase in the Pelican Valley compared to the Mary Mountain population likely reflects the harsher conditions and the differences in resource availability between these ranges. As the Hayden Valley and the Firehole populations increased, movements were soon established between the Hayden Valley and the Firehole through the Mary Mountain corridor (Meagher 1973:31). During the 1950s and 1960s more animals were observed in the Hayden Valley than in the Firehole.

After the reintroduction to the interior ranges in 1936, bison were seen with increasing frequency in other areas of the park. Meagher (1973:33) cited ranger reports of bison on the Madison Plateau beginning in 1939. Bison had been absent from the Bechler Meadows for three decades after the early 1900s. Cahalane (1944*b*:138) saw a single bull in the Bechler Meadows in winter 1936. Meagher (1973) reported 3 bulls were there in February 1955 and a mixed herd was observed in winter 1962-63, then again during the next two winters. Forty to 50 bison wintered at the Cougar meadows in 1955-56 and bison were seen there again in 1959. Bison were occasionally reported in peripheral locations. Cahalane (1944*b*) reported a sighting in September 1943 of three bulls near Jackson Hole WY. Albright (1944:8) added the following comment on this sighting "...but they returned to the park or perished for they were not in sight this year [1944]", indicating he thought they were Yellowstone Park bison. Another unconfirmed sighting was relayed to the authors of a bull seen about 1945 near Two Ocean Pass outside the

southeast corner of YNP[17]. Schullery et al. (1998) reported that bison were observed moving beyond the boundaries of the park in 16 of 25 years from the early 1940s to 1967. Most of these movements occurred on the northern range.

Although removals to limit the size the Lamar herd began in 1919 and continued until the mid 1960s, it was not until the 1940s that attention was paid to the condition of bison ranges in central YNP. In 1939, the Department of the Interior issued a wildlife policy developed six years earlier in which it was recognized that ungulate populations would be kept within the carrying capacity of the range by limiting their size[18]. In 1943, the Director of the Park Service accepted a recommendation to maintain the northern range bison herd at 350 and the central population at 300. This objective remained in place until the mid 1960s. Sizeable reductions were carried out on the northern winter range about every second year; 1748 bison were removed from the northern range between 1944 and 1965 (Figure 4.4). In 1966, only 66 bison were counted in the Lamar Valley (Meagher 1973: 147).

Reductions were not implemented in the central ranges until the mid 1950s. However, the first significant loss recorded for the Mary Mountain herd was accidental. In February 1946, 38 bison plunged through the ice of the Yellowstone River (Beal 1950). Concerned about trampling damage by bison to geothermal features in the central park, and in keeping with the range management objectives established in the 1940s, the park administration began removals to reduce the central bison population beginning in 1954 (Figure 4.4).

Like bison, Yellowstone's northern range elk population was intensively managed to control population size in relation to perceived carrying capacity. In 1962, confronted with a public outcry against elk reductions on the northern range, the Secretary of the Interior appointed a panel of scientists under the direction of Starker Leopold to review elk population management. Published in 1963, the Leopold Report (Leopold et al. 1963) provided the impetus for a profound change in Park Service management policy. The Committee concluded:

> "As a primary goal, we would recommend that the biotic associations within each park be maintained, or where necessary recreated, as nearly as possible in the condition that prevailed when the area was first visited by the white man. A national park should represent a vignette of primitive America."

However, the report continued to call for managing ungulate populations at levels "that the range will carry in good health and without impairment to the soil, the vegetation, or to habitats of other animals". Recommended methods included natural predation, trapping and transplanting, shooting migrants outside the parks, shooting within the parks. Between 1964 and 1968, 1673 bison were removed from the central herds. Reductions were carried out in the Pelican Valley on two occasions only: 118 were removed in 1956 and 38 in 1965 (Meagher 1973:146,147). The remaining removals were from the Mary Mountain population. At the end of the range management era in 1968,

[17] Interview with Steve Cain, 11 August 2004.

[18] Wayne B. Alcorn, "History of the bison in Yellowstone National Park", Supp. 1942-1951, cited by Franke, M.A. *in press*. To save the wild bison, draft 10/15/04, University of Oklahoma Press to be published in Fall 2005.

160 bison were counted in the Pelican winter range and 188 in the Mary Mountain range (Meagher 1973: 147).

In 1964, the Secretary of the Interior instructed the Park Service to manage parks "toward maintaining, and where necessary reestablishing indigenous species" while "preserving the total environment"[19]. In the same year the "1964-65 Bison and Habitat Management Plan[20] ...", Yellowstone National Park prescribed removing 63 (34%) animals from the Lamar herd, 94 (34%) from the Pelican Valley herd, and 335 (67%) from the "Hayden-Valley-Nez Perce-Firehole Bison Herd". The plan was defined as a "reduction and brucellosis control program" whose intention was to allow for "range improvement" and reducing the prevalence of *B. abortus* infection.

A significant policy shift away from intensive management occurred in 1968 when the National Park Service issued a policy prescribing that national parks should be managed as ecological entities[21] providing for restoration, protection, and maintenance of native complexes "where practicable, at levels determined through historical and ecological research of plant-animal relationships". With the cessation of population management, elk and bison populations subsequently began to increase within the park.

Ecological Management Era: 1968 - present

Bison populations in the northern and central ranges increased dramatically during the three and a half decades after the end of the intensive management era in 1967, (Figure 4.4). The main influences on population growth were removals at the boundaries in the Gardiner basin and near West Yellowstone beginning in the mid 1980s, and natural mortality during a few harsh winters (Cheville et al. 1998, DelGuidice et al. 2001). The populations grew rapidly until the early 1980s. During the 20 year period between 1984 and 2004 the northern herd fluctuated between 300 and >1200 and the central range population varied between 1400 and >3300 (Figure 4.4). Ecological mechanisms influencing bison populations, range expansion, and migration to boundary ranges were evaluated by a National Research Council committee tasked with examining the epidemiology of brucellosis in bison, elk and other species, the potential for a wild animal vaccination program, and key factors for reducing the risk of transmission from wildlife to cattle (Cheville et al. 1998). Mechanisms of population ecology, movements and range expansion are explored in further detail in the next chapter of this report.

Since 1968, bison management in the YNP area has been dominated by two major linked controversies: 1) the risk of transmission of brucellosis to cattle on surrounding lands from bison moving across the boundary (Cheville et al. 1998); and 2) criticism of the effects of winter road grooming on bison population dynamics, movements and range expansion (Meagher 1993, Meagher et al. 2002). The evolution of these issues is reviewed below.

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[19] Memorandum from Secretary of the Interior, Stewart Udall, on Management of the National Park System to National Park Service Director, July 10, 1964, cited by Franke *in press*.

[20] YNP Bison Management Office, document entitled "Yellowstone National Park, Wyoming, 1964-65 BISON AND HABITAT MANAGEMENT PLAN FOR YELL...", recommended by John.S. McLaughlin, Superintendent, Yellowstone National Park, approved by Fred J. Novak, Acting Regional Director, Midwest Region.

[21] Administrative Policies for Natural Areas, 1968. Reprinted in America's National Park System: The Critical Documents, Lary M. Dilsaver (ed.). Rowman & Littlefield Publishers, 1994.

Brucellosis Management

Brucellosis is primarily a disease of the reproductive organs caused by bacteria in the genus *Brucella*; the causative agent in bovids and elk is *B. abortus*. Pathology in bison includes abortion, endometritus, retained placenta, orchitis and joint inflammation (Tessaro 1989, Rhyan et al. 2001). The primary route of transmission is contact with oropharyngeal tissues of susceptible individuals by touching, licking or ingestion of contaminated fluids and tissues associated with abortion or birth (Cheville et al. 1998). The organism is not native to North America and was likely introduced with infected European cattle (Meagher and Meyer 1994, Whittlesey 1994-95). Brucellosis was first diagnosed in Yellowstone's northern bison herd in 1917 (Mohler 1917, cited by Tunnicliff and Marsh 1935). The most likely source of infection of Yellowstone bison was domestic cattle. After 1915, bison were pastured with cattle near the Lamar Valley ranch providing the opportunity for transmission from infected cattle to bison. Bovine brucellosis is a zoonosis; it is a regulated disease because of its ability to infect humans. A national program to eradicate the disease from cattle was established by the U.S. Department of Agriculture in 1934. Since then, several billion dollars in federal, state and private funds have been spent on the program. The Animal Plant Health Inspection Service of USDA certifies states as brucellosis-free, class A, B, or C, depending on the frequency of occurrence of infected cattle herds in the state. The State of Montana worked aggressively to eradicate brucellosis from its cattle herds beginning in 1952. It attained brucellosis free status in 1985 after an expenditure of more than $30 million by the industry[22].

YNP was engaged with the U.S. Department of Agriculture on brucellosis testing and management in the bison herd since the early days of the national brucellosis eradication program[23]. Activities were limited to testing bison until the 1940s when it was expanded to include calfhood vaccination and slaughter of reactors in the Lamar herd. The program ceased when the ranching operation was abandoned in 1952. Testing was carried out again in 1961-62, when 143 were removed from the Lamar herd, then again in 1964-65 when some bison in the Mary Mountain herd were rounded up by helicopter. Brucellosis testing and herd reductions were not conducted in the park after the winter of 1965-66[24].

In 1967, State veterinarians from Montana, Idaho, and Wyoming expressed concern to the Department of the Interior about the potential for the YNP bison population to increase in the absence of reductions in the park, leading to greater numbers moving into surrounding areas where cattle were grazed[25]. YNP instituted a boundary control program the next year. Park personnel were authorized to shoot bison approaching the boundary in the Gardiner basin and near West Yellowstone. Only five bison were killed [by park personnel] under this program; park rangers shot three bulls in 1974 and one cow and one bull in 1978 (Meagher 1989*a*). Control actions were also undertaken by the State of Montana. The winter of 1975/1976 was harsh. Early winter storms interspersed with

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[22] Montana Department of Livestock web site: www.discoveringmontana.com/liv/animalhealth/bison/BRUCEINFO//bsnisu3.asp

[23] Barmore, W.J. 1968. Bison and brucellosis in Yellowstone Natonal Park: A problem analysis. Internal report. Yellowstone National Park Archives.

[24] Ibid.

[25] Montana Department of Livestock, *supra* note 21.

thaws locked up the northern range under a layer of ice. In January 1976, eight bison exited the park near Gardiner. They were killed by Montana State personnel[26]. A few weeks later, 84 bison were seen moving downstream along the Yellowstone River toward the northern boundary. The movement was viewed unlikely to be repeated, so managers decided to prevent the animals from leaving the park with drift fences and hazing rather than shooting such a large number (Meagher 1989*a*). In 1978, the Secretary of the Interior rescinded authorization for park personnel to shoot bison in the park.

Annual use of the Mammoth-Gardiner area by bison continued to increase after 1976. Mixed herds began to cross the boundary at Reese Creek in winter 1982-83 (Meagher 1989*b*). About 250 bison foraged in the Gardiner area in the winters of 1985-1986 and 1986-1987. Unable to use lethal methods to prevent bison from exiting the park, YNP managers decided to evaluate non-lethal techniques including ground-based (on foot or horseback) and aerial hazing, noise makers, tape-recorded wolf howls, barrier fences, cattle guards on roads, aversive conditioning (bird shot and rubber bullets), baiting with hay and scattering charcoal to increase snow melt (Meagher 1989*a*). Although some methods temporarily deterred bison, no method or combination proved effective in attenuating the drive by bison to use boundary areas with which they had recently become familiar. During the winter of 1984-1985 Montana State personnel removed 88 bison that wandered beyond the northern boundary. The Montana State legislature designated bison as a game animal and authorized a hunting season; 57 bison were taken in the Reese Creek area near the YNP north boundary in winter 1985-1986. In protest, the Fund for Animals sued the National Park Service for allowing bison to move into Montana where they could be killed; the Fund lost the suit (Cromley 2002). Authorized public hunting continued in Montana until 1991 when the Montana State legislature rescinded the authority for a hunting season in response to a strong national outcry against hunting bison exiting the park. Hunters had taken approximately 675 bison on lands adjacent to the park during the intervening six year period while hunting was permitted[27]. Thereafter, agency officials were tasked with removing bison wandering out of the park.

Interagency planning to address bison management in YNP and adjacent Montana began in 1985. This first effort failed because of conflicting agency mandates (Cromley 2002). By 1989, state and federal agencies recognized that conflicts could best be reconciled by coordinated development of a joint bison management plan. So began an eleven year effort among agencies at two levels of government that culminated with a Record of Decision dated December 20, 2000 (U.S. Department of the Interior and U.S. Department of Agriculture 2000). The cooperating agencies included the Department of the Interior (National Park Service), the U.S. Department of Agriculture (Forest Service and Animal and Plant Health Inspection Service), and the State of Montana (Department of Livestock and Department of Fish, Wildlife, and Parks).

In 1989, the State of Montana entered into an agreement with the NPS and the USDA Forest Service to develop a long term management plan and a requisite EIS for actions to manage bison migrating from the park into Montana. Montana required a plan that provided for protection of property, human safety, and the state's brucellosis class-free

[26] Franke, M.A. *in press*. To save the wild bison, draft 10/15/04. To be published by the University of Oklahoma Press in Fall 2005..
[27] Montana Department of Livestock, *supra* note 21.

status. NPS completed an environmental assessment in 1990 providing for limited actions in and near the park including hazing and monitoring bison. Park personnel were allowed to participate in shooting bison outside the park boundaries under the authority of the Montana Department of Fish, Wildlife and Parks. Another similar environmental assessment was completed in 1992. Activities described in the 1990 and 1992 EAs have continued to the present.

In 1995, the State of Montana legislature changed the primary authority for managing bison originating in YNP from the Department of Fish, Wildlife and Parks (DFWP) to the Department of Livestock (DOL), an agency without experience in wildlife management whose mandate is "to protect the health and well-being of the livestock industry and economic well-being of ranchers". The move was seen as ascendancy of commercial agriculture (brucellosis-free status) over the value of bison as free-ranging wildlife (Cromley 2002). It also reflected tensions among and between state and federal agencies caused by substantial differences in mandates and institutional cultures. Under pressure from veterinarians from other states, APHIS threatened to revoke Montana's brucellosis-free status. Out of frustration, the State of Montana filed a complaint in U.S. federal court in January 1995 against the federal government, claiming Department of the Interior policies caused diseased and disease-exposed bison to enter Montana, and U.S. Department of Agriculture policies might result in revocation of its brucellosis class-free status because of the presence of diseased wild bison in the state.

A settlement agreement was reached in November 1995 in which the NPS and State of Montana agreed to prepare an environmental assessment for actions prescribed in Interim Bison Management Operating Procedures. Actions described in the settlement were: capture and removal of bison moving north of the park boundary at Reese Creek; construction of capture facilities at Stephen Creek inside the park; all bison captured at the facility would be sent to slaughter; bison moving outside the park at West Yellowstone would be captured in facilities outside the park; all testing positive for exposure to *B. abortus* and pregnant females would be shipped to slaughter; test negative bison would be marked and released; Bison moving into the areas north of the park in Eagle Creek/Bear Creek, Hellroaring Creek and Slough Creek drainages and those moving into the Lee Metcalf Wilderness and Cabin Creek Recreation and Wildlife Management area west of the Park would be monitored. The settlement agreement also established that the long term bison management plan and draft EIS would be completed by late 1996 and a final EIS would be due by May 1997. APHIS agreed not to downgrade Montana's brucellosis class-free status if it complied with the Interim Bison Management Procedures.

The 2000 Joint Management Plan was the product of mediated negotiations between federal and state agencies following a decision of the federal court that the federal agencies could terminate a 1992 Memorandum of Understanding (MOU); the 1992 MOU formalized terms of reference for interagency negotiations on completion of a long-term bison management plan. The federal agencies wanted to issue a final EIS without Montana, citing the State's "unreasonable objections" to a federal proposal to increase tolerance for bison outside of the Park (Cromley 2002:140). At the request of Judge Charles Lovell, who had presided over the 1995 settlement agreement directing the agencies, the agencies agreed to mediated negotiations. The mediation was informed by the draft and final environmental impact statements, public comments submitted on both

documents, other relevant documents in the administrative record, and negotiations with the State of Montana.

The Final EIS was a product of the Department of the Interior (National Park Service) and the U.S. Department of Agriculture (U.S. Forest Service and Animal and Plant Health Inspection Service). The State of Montana issued a separate Final EIS under Montana law that incorporated the federal agencies' final EIS by reference. The Records of Decision committed the National Park Service, U.S. Forest Service, and Animal and Plant Health Inspection Service to manage the risk of transmission of brucellosis from bison to cattle, to conserve free-ranging bison, and to work with agencies of the State of Montana in implementing the "Joint Management Plan". The following are highlights of the three step plan (the reader is referred to the original document for details):

- The plan provides for actions in Yellowstone National Park, the Gallatin National Forest, and private lands on the north and west boundaries of Yellowstone National Park.
- The primary tool is the spatial and temporal separation of cattle and bison.
- The number of bison will be limited in the boundary areas in the Gardiner basin and near West Yellowstone.
- The intensity of management will increase as bison move toward the edges of management Zone 2 (zone nearest the park in Montana in each boundary area).
- In the spring the agencies will haze bison back into the park when snow and weather typically allow bison to move back into the interior of the park.
- If hazing is unsuccessful, bison that do not return to the park will be captured or shot.
- Capture, test, and slaughter of seropositive bison in the Reese Creek and West Yellowstone areas in steps one and two,
- Hazing, capture, test and slaughter operations, or quarantine of bison that remain outside the park in these areas after specified haze-back dates.
- Vaccination of bison and cattle (including remote delivery) will be used to reduce risk and to work toward the eventual elimination of brucellosis in bison. The delivery system and development of a safe and effective vaccine require further research.
- Untested bison will be allowed to occupy the Eagle Creek/Bear Creek area, Cabin Creek Recreation and Wildlife Management Area, and the Monument Mountain Unit of the Lee Metcalf Wilderness year-round without agency interference because these areas do not have cattle grazing within them or nearby.

Given the difficult and lengthy negotiations that culminated in a judicially mediated agreement defined in the 2000 Record of Decision, it would be difficult to argue that there is a high level of satisfaction among the agencies in the outcome, or that their interests were served. In a critical review of the decision process for bison management, Cromley (2002) pointed to fractured governance structures and a low level of public involvement as the factors accounting for the failure to securely represent the common interest in a long-term management policy for bison. It was apparent from interviews and workshops conducted by us in July, August and October 2005 that agency personnel continue to protect their specialized mandates and policies from interference by

competing agencies, and the affected publics feel disenfranchised from the decision process because of the low level of involvement provided for through the EIS review process under NEPA rules, i.e. limited term public comment on documents filed in the Federal Register. Requirements for public involvement associated with preparation of environmental impact statements or their equivalents cause agencies to ask "What are the legal requirements for public involvement?" rather than "What level of public participation is needed to achieve our objectives?" (Creighton 1999).

Optimism was expressed that working relationships between agency representatives on the Greater Yellowstone Interagency Brucellosis Committee (GYIBC) have gradually improved over the 14 year history of that committee[28]. However, the mission of the GYIBC is limited "to facilitate the development and implementation of brucellosis management plans for elk and bison in the GYA" and its main activities are focused on research on brucellosis epidemiology, pathobiology and on disease risk management, not on bison conservation. The GYIBC primarily serves the function of coordinating information on brucellosis research and keeping members agencies informed of the activities of other agencies[29]. Cromley (2002:146) claimed the GYIBC excludes representatives of the public from the committee because the Federal Advisory Committee Act prohibits public representation. The public may attend meetings but is restricted to providing comment during a designated time at the end of the agenda and is not allowed to participate in deliberations of the committee. In the absence of facilitated debate, there is limited potential for shared learning of values, interests and knowledge within the committee, for resolution of conflicts, or agreement on common interests.

The decision process followed by federal and state agencies to develop the Joint Management Plan appeared a divisive, deeply-rooted power-balancing struggle among agencies to protect fragmented and overlapping jurisdictions and avoid risk. Each interest committed resources to control the issue, which was blocked by competing interests, with little to show for the effort but increasing frustration. Outside (judicial) mediation was necessary to define a solution.

Despite the broad mission of the GYIBC "to facilitate the development and implementation of brucellosis management plans for elk and bison in the GYA"[30], the committee has no authority and its composition reflects a balance of power among the agencies. As one participant said:

> "The GYIBC was never designed as a decision making body; it has no enforcement or regulatory authority. The GYIBC was designed specifically not to usurp or abrogate any individual agency's management authority or responsibility. The only incentive to buy into a GYIBC recommended action is through peer pressure or if the action is self-serving, that's about it."[31]

It is noteworthy to comment on bison management in Wyoming. A management plan was developed in 1994 for bison leaving Yellowstone National Park through Sylvan Pass into the North Fork of the Shoshone River west of Cody, Wyoming. The plan allows for

[28] Interview with Keith Aune, August 10, 2004, Corwin Springs, MT.
[29] Interview with T. Roffe, 22 July, 2004, Bozeman, MT.
[30] www.nps.gov/gyibs/home.htm
[31] Interview with Tom Roffe, 22 July 2004, Bozeman, MT.

up to 15 bulls in the area, but cows are not tolerated to prevent establishment of a breeding population. When more bison move out of YNP than the target population, a hunt is authorized and hunters who have obtained a permit are notified. Twelve bull bison were harvested in winter 1995-96 and 14 bulls and a cow and calf were taken in 1996-97. Wyoming also established a regulated hunt in the Jackson area. The first hunt was in 1989. In 1990, the Legal Action for Animals sued over noncompliance with the NEPA; the hunt was being conducted on federal land. The hunt was shut down because of the complaint. Legal requirements were addressed and hunting resumed on private land, state land and in the Bridger-Teton National Forest. A regular hunting season has been in place every year since 1998. In 2005, the season ran September 1 to November 30; tags were issued for 25 bulls and 50 cows or calves[32]. Unlike the Montana/YNP bison management planning process, Wyoming "went to great lengths" to involve local conservation groups and local communities in direct dialogue on bison management, and unlike the YNP/Montana boundary bison control situation, there have been no disputes in the field in Wyoming[33].

The National Park Service (NPS) and the U.S. Fish and Wildlife Service (USFWS) are developing a plan for managing elk and bison in the National Elk Refuge (NER) and Grand Teton National Park (GTNP). Bison management is being addressed jointly by these agencies because the population has become habituated to the feed provided to elk on the National Elk Refuge in winter. There approximately 14,000 elk and 800 bison in the area in winter. The bison herd moves among several jurisdictions including the National Elk Range, Grand Teton National Park, Bridger-Teton National Forest, Bureau of Land Management resource areas, and Wyoming state and private lands. Inter-population movements are rare between the YNP and Jackson herds[34]. A management plan and environmental assessment was prepared in September 1996 (Grand Teton National Park et al. 1996). It called for hunting to limit the size of the Jackson herd to a range of 200 to 250 bison. A lawsuit filed in 1998 resulted in a court order dictating that bison could not be destroyed in the NER or in GTNP to control the population until the USFWS and NPS assessed bison management and the winter feeding program[35]. Before initiating a comprehensive management plan process for the Jackson bison and elk herds, the two federal agencies, with the support of the U.S. Forest Service and the Wyoming Game and Fish Department, invited the U.S. Institute for Environmental Conflict Resolution (U.S. IECR et al. 2000) to conduct a situation assessment to provide guidance on devising a public involvement strategy and an assessment of the range of interests and

[32] Billings Gazette, January 27, 2005, Montana outdoors: Wyoming offers well-run bison hunt by Mark Henckel.

[33] Comment attributed to Mark Gocke, regional information specialist for Wyoming Game and Fish at Jackson, Woming, *supra* note 31.

[34] In winter 1995/96, 3 bulls from the Hayden Valley and wintered in the vicinity of Polecat Creek; they were captured and radio collared. For several years after that they returned each year to Hayden Valley during the rut then back to the Jackson Lake area to spend the winter. During the harsh winter of 1996-97 a mixed group of 3 cows and 3 juveniles followed the road from YNP through the south gate and spent winter in the same area as the 3 bulls. Then they moved south and joined the Jackson herd; this mixed group did not return to YNP. Source: Interview with Steven Cain, 11 August 2004.

[35] Homepage for the National Elk Refuge and Grand Teton National Park Bison and elk management plan/EIS, http://bisonandelkplan.fws.gov, February 2, 2005)

concerns about the management of the Jackson bison and elk herds (U.S. IECR et al. 2000). The issues included optimal herd size, disease management, artificial feeding, and other management tools such as hunting, increasing forage by irrigation, controlled burning, agency jurisdiction and perceptions of poor working relationships between and within the agencies.

The U.S. IECR et al. (2000) defined common interests among groups, including: "a shared vision of healthy herds of elk and bison, well-nourished, free of disease, and more in balance with their natural habitat; a general understanding of the importance of the herds to the Jackson area economy and way of life; a recognition of the national, perhaps international, significance of the herds; a desire for change, both in the way the agencies manage the herds and how the agencies work with each other; and finally, a strong desire for more and better information, especially scientific data, upon which to base management decisions". They recommended a three body planning structure comprised of an interagency planning team, a multistakeholder working group advising the planning team, and a science council.

Winter Use of YNP and Perceived Effects on Bison

Grooming of snow covered roads and winter use of the park by large numbers of oversnow vehicles has been a significant and often controversial matter for Yellowstone National Park management since the 1940s (Table 4.1). The first published comment we discerned on the influence of roads on winter movements of bison was by Meagher (1989*b*). Reference was made to the influence of the plowed road through the northern range. The following statements are particularly relevant to understanding the beginning of concerns about the influence of roads on winter bison movements (Meagher 1989*b*:673,674):

- "After daily road plowing between Tower and Mammoth began in the 1940s (B. Hape, pers. comm.), a few males sometimes traveled this route, but mixed herds did not until 1975-76."
- "The bison used two major travel routes (Fig.1), the natural topographic route along the Yellowstone River from Tower to Gardiner was the primary route initially (Table 1). In 1982-1983, the plowed road became the primary route".
- "When human interference precluded use of the primary routes, the bison detoured across steep terrain, or traveled along tributary drainages"
- "Use of the plowed road for relatively easy and energy-efficient travel probably facilitated learning and a rapid increase in numbers."

The last statement in particular foreshadowed a more elaborate explanation of the influence of packed winter roads on population growth and range expansion by bison in the central ranges of the park. In 1993, Meagher (1993) published an internal report reviewing, in depth, the history of movement and distribution patterns and inferred the influence of groomed roads on winter movements of bison in the central ranges. The notions were put forth that grooming and high volumes of snowmobile traffic on roads in the central ranges created hard packed surfaces used by bison for "energy efficient travel that resulted in energy saving within traditional foraging areas, range expansion, major

shifts among previously semi-isolated populations, and a mitigation of winterkill and enhancement of calf survival". In 2001, the Fund for Animals argued further that use of packed roads by bison facilitates emigration from the park where they are harassed and killed in the State of Montana[36]. We examine the ecological bases for these claims in the next two chapters. Here we wish to comment on the evolution of the issue surfacing during the extreme winter of 1996/97 when large numbers of bison were culled at the Park boundaries in Montana.

The winter of 1996-1997 was the most severe on record (Figure 3.9 and 3.10) with heavy snow and "snow crusting" that created a thick layer of ice early in the winter. Bison had great difficulty cratering through snow to obtain forage; > 1,000 left the park. Concern by the ranching community over spread of brucellosis from migrating bison to cattle resulted in APHIS, the State of Montana and Yellowstone Park culling about 1100 of them at the Park boundaries. This produced a great controversy (Peacock 1997*a*,*b*) and renewed the debate on brucellosis risk to the livestock industry. In 1997, the Fund for Animals and other groups sued the NPS for violating the Endangered Species Act and the National Environmental Policy Act (Yochim 1998*a*). The Fund for Animals requested NPS prepare an Environmental Impact Statement (EIS) concerning winter use, and evaluate the effects of road grooming on wildlife and other park resources (Yochim 1998*a*). The argument for an EIS under NEPA was based on the substantial and unpredicted increase in winter use visitation that had occurred since the first winter use management plan was released in 1990 (Figure 3.13) and that new information had come forward suggesting bison use of groomed roads during the winter had substantially changed their population dynamics and distribution. The NPS settled the lawsuit with the plaintiffs by agreeing to conduct an EIS to address a full range of alternatives for winter use and to conduct an EA on a proposal to close a road segment during the winter to study the effects of groomed roads on bison. Subsequent actions are noted in Table 4.1.

Protection of the park environment represents one set of interests in the debate over winter use; recreation and business interests are another. Since 1949, the public has had the opportunity visit the park with over snow vehicles. A substantial winter recreation industry has developed around OSV access to the park. Threatened by the proposed closure of the park to snowmobile access, the International Snowmobile Manufacturers Association (ISMA) and others filed a claim in federal court alleging that NPS violated the Administrative Procedure Act, NEPA, the NPS Organic Act and other laws in the 2000 NPS Record of Decision. ISMA agreed to settle with NPS when it committed to conduct a supplemental EIS considering new information and technology. Complaints by each side of the debate (environmental protection, and recreation and economics) have been addressed in federal courts in Washington D.C and Wyoming. Resolution of the battle between values and world views remains uncertain.

Like the bison/cattle/brucellosis issue, the winter use issue is a highly charged conflict with public interests having no mechanism for meaningful participation apart from the process prescribed by NEPA for public comment on EAs and EISs and that required by the Administrative Procedure Act for rulemaking. And, like the bison/cattle/brucellosis issue, the affected publics use the media or courts to be heard, or in some cases pursue more radical activism. The result is ongoing conflict, substantial

[36] Statement of The Fund for Animals in Response to the Settlement Agreement in International Snowmobile Manufacturers Association et al. v. Norton 7/05/2001.

annual and incremental costs for the agencies in time and resources (Cromley 2002), and promoting the notion that more science, more information, will somehow result in a wiser outcomes.

New Paradigm for Bison Management

The methods by which value conflicts have been dealt with by affected interests, including agencies and conservation advocacy groups, escalated to what Mary Meagher refers to as "the bison wars"[37]. Clearly, the governance systems and public involvement mechanisms in place for dealing with the complex issues described herein suffer from jurisdictional fragmentation and hierarchical decision-making. They appear grounded in the outdated precepts of "sufficiency of science" and "expert-authority" (Riley et al. 2002). The sufficiency of science precept is a belief that insights or reliable knowledge gained through science provides the exclusive keys to best management decisions (Decker et al. 1987). Expert-authority (Ludwig 2001) holds that experts (e.g. biologists and veterinarians), by virtue of their training, education and experience, are best qualified to make resource management decisions. Policy processes based on power and dominance are inefficient and incapable of defining the common interest. New foundations are being defined for resource management that are integrative, inclusive of diverse values and interests, more democratic, and more likely to define the common interest than command and control approaches to policy development. These emerging resource management approaches are also more likely to engage society in a better understanding of the real issues influencing decisions.

The Park was established in 1872 with the aspiration to manage its resources in the common interest, "for all people"; this has not changed (Cromley 2002). The challenge is to design a new way of dealing with complex issues that will reduce conflict, improve policy stability and achieve wise outcomes for society, conservation of ecosystem values, while respecting people who are a part of the Greater Yellowstone Ecosystem. Advancements in integrative approaches to management are being made under the rubrics of ecosystem management (Knight and Meffee 1997), collaborative resource management (Wondolleck and Yaffee 2000), coordinated resource management (Hicks et al. 1996), conservation biology (Meffee and Viederman 1995), conservation ecology (Shindler and Cheek 1999), citizen science (Light et al. 1998), integrated environmental management (Margerum 1999), and community-based natural resource management (Michaelidou et al. 2002, Virtanen 2003). Common aspects of these approaches as applied in successful resolution of environmental conflicts include: legitimacy (Mascarenhas and Scarce 2004); integrative problem solving and decision-making; shared learning (Schusler et al 2003); and value-based judgments informed by, but distinguished from, scientific judgments (Decker et al. 1991).

It is not the intent of this report to provide a full review of the natural resource policy literature. However, some key points are worth noting. We believe it would be beneficial to those engaged in the bison movements and brucellosis issues to redefine the structures and processes used to address them by taking an integrative policy-orientation approach (Clark 2002), which encourages integration of natural and social sciences to aid

[37] Interview with Mary Meagher, July 15, 2005, Gardiner, MT.

managers, leaders, and the affected publics to make sound choices and effectively solve problems. Secondly, it is important to more clearly understand the nature of value dynamics underlying the conflicts. Base values are the things people desire, strive for, or demand (Lasswell 1971). Lasswell and McDougal (1992) provided a system of value analysis based on the belief that human dignity is the central goal of all people. Living with dignity means having adequate power, enlightenment, wealth, well-being, skill, affection and rectitude (Clark and Wallace 2002). Inadequate amounts of any of these values can generate conflict. In the current context, as lead agencies carry out federal or state ESA policy or work to satisfy specialized mandates, their personnel expect to wield a certain amount of power, use their knowledge (enlightenment) and skill to achieve the mission of their agency, and have the respect of other agencies and the public. Furthermore, they believe their service is justified by the legislated mandate of their agency, which in turn gives them the right to serve one or more public interests (rectitude). Those with more power, resources or knowledge may treat other stakeholders in ways that do not offer them dignity, leading to a loss of cooperation or more radical challenges, ineffective policies and inefficient programs.

The emphasis placed by stakeholders (agencies and conservation advocacy organizations) on technical knowledge and the natural sciences in the Yellowstone bison conflicts indicates how highly enlightenment is ranked. However, little attention has been paid to the importance of the social sciences, in particular policy process and organization theory in decision making. Formal assessments (Cheville et al. 1998, Klein et al. 2002) and environmental assessments (various EA and EIS) grounded in the natural sciences add information, address scientific information gaps and advance careers, but have not improved decision-making or cooperation (Cromley 2002). Indeed studies commissioned to date persist in focusing on technical details and call for further research to address scientific uncertainties; they have paid scant attention to improving the policy processes or organizational structures necessary for achieving wise and enduring solutions acceptable to the broadest possible range of stakeholders. Dery (1984; cited by Clark and Wallace 2002) commented that people's behavior cannot be changed merely by bringing "new information" to their attention. Dispensing more or better knowledge without an effective policy process and organizational structures within which knowledge can be used to inform value-based decisions, is not an effective means to achieve lasting solutions. Win-win solutions are accomplished through a process that offers dignity to everyone involved (Clark and Wallace 1999). To be effective and successful, an integrative policy process requires appropriate structures for organizing people to work together (team work), acknowledgements of legal constraints and authorities, interdisciplinary skills and knowledge, pragmatism, and procedural rationality (Clark and Wallace 2002).

The 1998 National Parks Omnibus Management Act authorizes and directs the Secretary of the Interior "to assure that management of units of the National Park System is enhanced by the availability and utilization of a broad program of the highest quality science and information." The role of science in supporting high quality decisions canot be overemphasized, but on its own scientific knowledge is insufficient for making effective decisions. Establishing the organizational structures and processes to link science to value-based decision-making is perhaps more challenging than conducting research.

There are significant research efforts being undertaken or supported by various institutions and individuals on bison ecology and brucellosis epidemiology. The US Geological Survey – Biological Research Division (USGS-BRD) website lists 16 projects funded by that organization. The GYIBC web site (www.nps.gov/gyibc/research.htm) lists 26 projects of which 11 are funded in whole or in part by the USGS-BRD. A group of three principal investigators (affiliations: Montana State University Department of Ecology, Yellowstone National Park, California State University Monteray Bay) has developed a research program focusing on detailed characterization of the landscape in the west central Yellowstone Park, the role of climatic variation in influencing ecological processes including plant productivity and phenology, snowpack dynamics, and linking climatic variation with both the spatial dynamics and population dynamics of the primary large mammals that inhabit the region: elk, bison, and wolves (www.homepage.montana.edu/~rgarrott/centralyellowstone/index.htm). The web site lists 22 separate projects: 6 projects on bison, 3 on wolf-ungulate dynamics, 6 on biophysical research, 2 on winter recreation impacts on bison and elk, 3 on spatial and population dynamics of elk, a project on geochemical cascades and another on plant productivity and phenology.

We could not find a current comprehensive list of projects on YNP bison or evidence of current comprehensive coordination of research efforts by NPS and other agencies. A recent effort to provide coordination was terminated in November 2003. Gogan et al. (2002) described the initiative by the USGS-BRD to coordinate research among various institutions, which began in the fall of 1995 when biologists from the park's Yellowstone Center for Resources contacted their counterparts in the USGS-BRD to discuss research needs on the ecology of bison in Yellowstone. The program was conceived as a joint cooperative effort between management and research biologists. It was intended to enhance the understanding of bison ecology, integrate past research and the results of new research into a predictive model of the role of bison in the GYA. Key elements of the program were extensive and continuous communication between management biologists and research biologists, and extensive planning and review of study designs to maximize the effectiveness of the research. Ecological studies supported under the initiative focused on forage availability, habitat use, and bison population dynamics. Brucellosis research included examining the risk of transmission of the disease from wildlife to cattle, identification of exposed animals in the field, and the safety of vaccines to wildlife species. We inferred from key informant interviews with some of the investigators involved in the program that competition has to a significant extent replaced the original intention of ongoing collaboration. Indeed, we found it difficult to obtain or get permission to use current data on bison ecology from several researchers and inferred that data were not shared to protect publication rights or to reduce competition for limited research funding.

Informed by key informant interviews and workshops held with various groups and individuals during July, August and October 2004, and by review of documents, we provide the following observations concerning the nature of the brucellosis and winter use conflicts and governance mechanisms being used to address them:

- There is strong competition and in some cases antagonism among some scientists and research groups which impedes data sharing, collaboration and coordination.

- There remains a strong sense of competition between agencies for influence over bison management based on individual agency mandates, disciplinary biases, and differences in institutional cultures.
- State and federal livestock agencies remain deeply committed to eradication of brucellosis from wildlife, and elimination of all risk to the livestock industry.
- The singular focus on bison as a vector of brucellosis is poorly understood by the public, which sees a much larger reservoir in elk associated with feed grounds in Wyoming and inconsistent policies by which the State of Montana deals with bison emigrating from the park.
- Many publics are frustrated with the low level of opportunity for involvement in decision processes and are willing to collaborate with government agencies.[38]
- There is a strong tension within some agencies over increasing public involvement in decision-making on bison management.
- The agency-based planning process used for these issues, and the low level of public involvement required under NEPA have generated conflict and reduced public trust in governance.

No organization yet exists to deal with the broad matter of regional bison conservation and management (including disease management at the boundary and winter use in YNP), or that provides for a level of public involvement higher than solicitation of individual commentary on agency plans or actions. We advise a thorough assessment is needed of the nature of the conflicts, including base values and biases, the potential for defining common interests, and the nature of current and historic decision processes and structures. The assessment should focus on designing new organizational structures and processes that can more effectively and efficiently deal with the ongoing and unresolved linked conflicts of bison/brucellosis/cattle and winter use/bison movements.

Finally, the definition (below) of wildlife management offered by Riley et al. (2002) represents recognition of the requirement for interdisciplinarity and the increasing demand for democratization of natural resource conservation now being experienced worldwide:

> Wildlife management is “the guidance of decision-making processes and the implementation of practices to purposefully influence interactions among and between people, wildlife, and habitats to achieve impacts valued by stakeholders”.

Conclusions

The two major issues associated with Yellowstone National Park bison management are primarily a consequence of the successful recovery and expansion of bison as a wildlife species and value conflicts resulting from the arbitrary location of the park boundary within a large ecosystem in which people live and derive their livelihoods. In

[38] 13 environmental non-government organizations attended a workshop hosted on October 29, 2005, at Livingston Montana. The systems model (Chapter 6) was reviewed. The overwhelming response we received was one of gratitude for being invited to be involved in dialogue and exploration of the issues in the formal context of the model. Participants invited and those attending are listed in the Appendix.

the early historical period, bison ranged widely in large numbers throughout the Great Plains, Snake River Plains, and intermountain regions, including the Yellowstone Plateau and valleys connected to it. Market and subsistence hunting during the mid 1800s reduced the bison population to a few hundred individuals at the time Yellowstone National Park was established in 1872. Subsistence hunting and poaching continued for three more decades, reducing the indigenous population to 23 survivors in the remote Pelican Valley. Concern about the persistence of bison in the park, and indeed in America, resulted in a captive breeding program being established on the northern range in 1902. It was managed by the military until 1916 when taken over by the newly formed National Park Service.

YNP Bison were managed through five decades under an agricultural paradigm necessitating periodic culling to keep them in balance with range 'carrying capacity'. Throughout this period, egress from the park was frequent on the northern range in the Gardiner basin where a climatic gradient creates low snow cover and attractive winter range conditions relative to harsher environmental conditions in the higher elevation Lamar Valley. Park managers have long recognized the Gardiner basin as an integral part of the northern winter range for bison and elk. Movements out of the park increased following cessation of winter feeding in the Lamar Valley in 1952. Movement out of the park from central bison ranges was uncommon over the range of population sizes present between 1902 and 1967. Park policy then changed to one of minimum interference in ecological processes. The number of bison increased and, like the elk population, expanded their range, and pushed out from the central ranges to boundary areas. Initial concerns of the livestock sector about contact between migrating brucellosis-infected bison and susceptible cattle increased after 1967 with implementation of ecological management. Boundary culls increased after 1985, heightening conflict between bison conservation interests and livestock protection interests. Starting in the late 1980s, winter use management, specifically packing of snow on roads by grooming equipment and recreational over snow vehicles, was claimed to influence bison movements, range expansion, enhance reproduction and survival, leading to increasing egress from the park where animals were subject to culling.

Efforts to deal with the linked problems of bison/brucellosis/cattle and winter use/bison movements have suffered fractured government jurisdiction, inadequate policy process and low levels of public involvement, leading to intense conflict. Recent advancements in natural resource policy processes offer promise for dealing with complex problems such as bison management in the Greater Yellowstone Area. A pragmatic, procedurally rational integrative policy-oriented process is needed for organizing agencies and citizens to work together to use multidisciplinary knowledge for integrative decision-making.

Table 4.1. Chronology of winter use policy development in Yellowstone National Park.

Year	Action	Outcome
1940	Senator Joseph O'Mahoney of Wyoming pressured the National Park Service (NPS) to plow Yellowstone National Park (YNP) roads in winter.	NPS denies request because of concerns about safety and costs.
1949	Yellowstone National Park (YNP) administrators allow first Over Snow Vehicle's (OSV) into the park.	OSV use increases steadily, but remains relatively low (<650 users in winter of 1954-55).
1949	Big Horn Basin Clubs (group of commercial clubs in Wyoming) renew pressure to plow YNP roads in winter.	U.S. Bureau of Public Roads winter use feasibility study determines that YNP roads are unsuited to plowing, buildings of park are not winterized and plowing would be too hazardous.
1956	MISSION 66 implemented; encourages and provides for infrastructure for winter use in National Parks.	Committee of representatives from NPS, regional highway departments, American Automobile Association and Yellowstone Park Committee recommend year round operation of YNP is feasible but not practical; park continues to allow OSV use.
1967	Congressional hearing held in Jackson, Wyoming to address public pressure to plow YNP roads in winter.	NPS concludes that roads will not be plowed; summer season will not be extended but YNP will remain open to OSV's.
1967-1971	Creation of first official NPS OSV policy and regulations.	Allow OSV use on roads only, road grooming began; Old Faithful snowlodge opened.
1971-1983	Promotion of winter use in YNP.	1971 overnight accommodation available at Old Faithful; encouragement of tours in YNP; grooming program expanded to be more consistent and to include east entrance road; warming huts built and Mammoth Hot Springs Hotel opened in winter; gas become available at Canyon in 1977 and daily grooming of east entrance road began; by late 70s all roads were used in winter except Tower to Canyon across Mt. Washburn.
1983-1990	NPS recognizes growing winter use in YNP.	1984 formal winter use planning begins; NPS develops winter use plans for YNP. Meagher (1989*b*) comments on the influence of plowed roads on bison movements on the northern range.
1990	Winter Use Plan completed for YNP, Grand Teton National Park and John D. Rockefeller Jr. Memorial Parkway.	First environmental compliance on winter use policy for YNP.
1993	NPS notes earlier than expected increase in winter use in YNP.	NPS agrees to evaluate winter use across the GYE in conjunction with the United States Forest Service (USFS). First published mention of winter

		recreation-induced changes in bison numbers and distribution Meagher (1993).
1994	Greater Yellowstone Coordinating Committee (GYCC; National Park Superintendents and National Forest Service Supervisors) evaluate increasing winter use.	Chartered interagency team to perform an analysis of winter use in the Greater Yellowstone Area (GYA).
1996	The Biodiversity Legal Foundation (BLF) send letter to NPS stating intent to sue for violating NEPA and the Endangered Species Act in YNP winter use policy	
Winter of 1996-1997	Most severe winter on record (e.g. deep, hard snow) triggers migration of bison from the park.	Results in controversial culling of 1,084 bison at park boundaries to prevent brucellosis transmission from bison to cattle.
1997	Draft released - Winter Use Management: A Multi-Agency Assessment	
1997	Fund for animals et al. (including the BLF) sue NPS.	Alleged failure of winter use plan to consult United States Fish and Wildlife Service (USFWS) on impacts of winter use on threatened or endangered species, and adhere to the National Environmental Policy Act (NEPA). Request NPS prepare an Environmental Impact Statement (EIS) concerning winter use, and evaluate the effects of grooming on wildlife and other park resources.
1997	Fund for animals et al. agree to a settlement with NPS	NPS commits to write an EIS and new winter use plan; requests formal consultation with USFWS and evaluates possible road closure in YNP
1998	Environmental Assessment (EA) released on the possibility of closing road segments during the winter in YNP.	Alternative road closures proposed for EIS; YNP continues grooming until EIS completed.
1999	NPS releases final publication of Winter Use Management: A Multi-Agency Assessment.	Identifies desired conditions for the GYA, current areas of conflict, issues and concerns and possible ways to address them
1999	Draft winter use EIS released.	
2000	Final winter use EIS released.	Preferred alternative is phase out of snowmobiles by winter 2002-03, to be replaced by NPS managed snowcoach transportation system.
2000	Record of Decision (ROD) regarding winter use EIS is signed.	Preferred alternative from EIS implemented.
2000	International Snowmobile Manufacturers Association (ISMA) et al. file suit against the Secretary of the Interior et al.	Allege that NPS have violated the Administrative Procedure Act (APA), NEPA, NPS Organic Act and other laws in the 2000 ROD.

2001	Final rule published in federal register implementing the ROD of 2000.	
2001	ISMA agrees to settlement with NPS.	NPS commits to conduct a supplemental EIS (SEIS) considering new information and technology and allowing for additional public participation.
2001	USFS, states of Montana, Idaho and Wyoming, Fremont county in Idaho, Gallatin and Park counties in Montana, Park and Teton counties in Wyoming, and Environmental Protection Agency (EPA) participate in SEIS.	Purpose of SEIS is to further the purposes of NEPA, solicit more public comment on earlier winter use decisions, consider additional information from ISMA and any other new or updated information not available at time of earlier decisions.
2002	NPS publish proposed rule in federal register to delay for one year the phase-out of snowmobiles.	Additional time needed to complete SEIS.
2003	NPS issue SEIS and supplemental ROD.	NPS chooses alternative that would allow 950 snowmobiles into YNP/day; subject to specific requirements to mitigate impacts to park resources.
2003	NPS issue regulations implementing the 2003 ROD.	
2003	Fund for animals et al. challenge the 2003 ROD in Washington, D.C. federal court.	Allege that NPS did not address trail grooming in manner required by NEPA, the 1997 Settlement and other federal laws. Ask the court to enjoin NPS to close all roads to grooming except South Entrance to Old Faithful.
2003	US federal court, District of Columbia sets aside the 2003 ROD and regulations.	Concludes, in part, that NPS did not address the impacts of groomed roads on wildlife in YNP and that NPS violated NEPA's provision for addressing a full range of alternatives. Concludes NPS in violation of the APA (i.e. concludes that a drastic change of policy requires documentation above & beyond the norm). Concludes that prior ruling to phase out snowmobiles will remain in effect; NPS allows 493 snowmobiles/day into YNP.
2003	Wyoming and ISMA re-open their lawsuit challenging the 2000 EIS and 2001 regulations in Wyoming federal court	
2004	Federal court, Wyoming, issues preliminary injunction against original EIS.	Orders YNP to issue new rules that are "fair & equitable" to all parties. Rules that 2000 EIS was inconsistent with NEPA and the APA. Concludes that snowmobile limits should be increased for the remainder of the current winter season. NPS increases snowmobile limit to 780 snowmobiles per day midway through

		winter 2003-2004.
2004	NPS issues a Draft Temporary Winter Use Plan EA that considers several winter use alternatives for next 3 years. NPS issues a draft Finding of No Significant Impact (FONSI).	Preferred alternative allows 720 snowmobiles/day for next 3 winters. NPS contracts independent researcher to produce a report about what is known on road grooming and dispersal.
2004	NPS publishes proposed rule to implement preferred alternative from the draft EA and draft FONSI.	The Final Rule was published in the Federal Register on November 10, 2004.
2004	NPS issues final 2004 FONSI and Final Rule.	The Final Rule was published in the Federal Register on November 10, 2004. NPS decide to groom all roads for next 3 seasons and permit 720 snowmobiles/day. Announce will not be preparing an EIS on the temporary use plan for next 3 winters but will prepare an EIS for a long-term winter management plan.
2004	U.S. Congress passes an amendment to the Interior Appropriations Act requiring the temporary winter use plan be implemented during the 2004-2005 winter season.	
2004	Fund for Animals et al., State of Wyoming; Wyoming Lodging & Restaurant Association, and the GYC challenge NPS 2004 FONSI and final rule in federal court.	

Sources: Meagher 1993; Yochim 1998*a*; 2003 YNP Winter Use Plans Record of Decision; Fund for Animals et al. Complaint 2004; M. Yochim (YNP planner, NPS) and K. Schneider (YNP planner, NPS), reviewed the table (Yochim's email response January 27, 2005; Schneider's email response January 29, 2005).

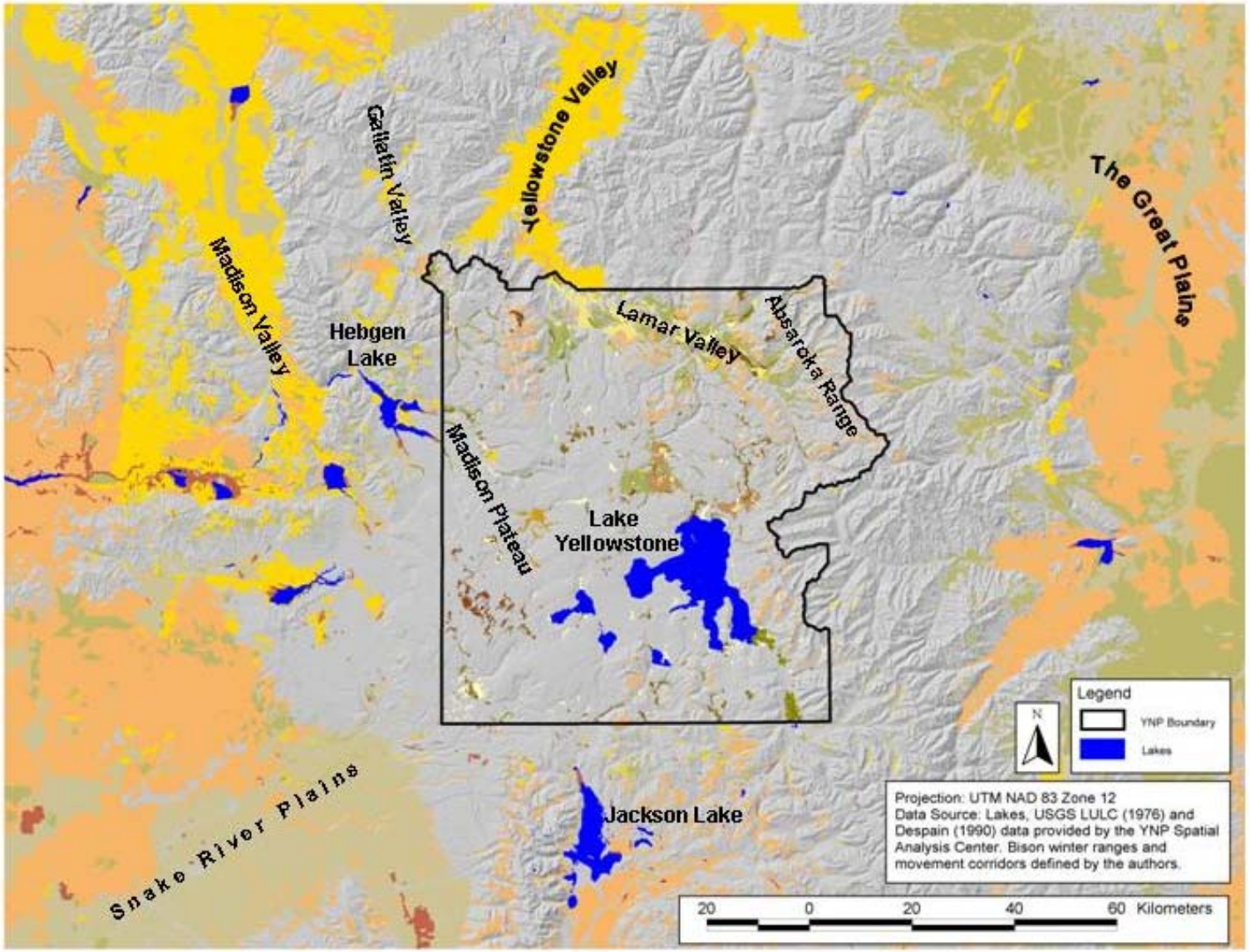

Figure 4.1. Potential bison habitat in the Greater Yellowstone Area (GYA). Habitat class color codes are described in Figure 4.2.

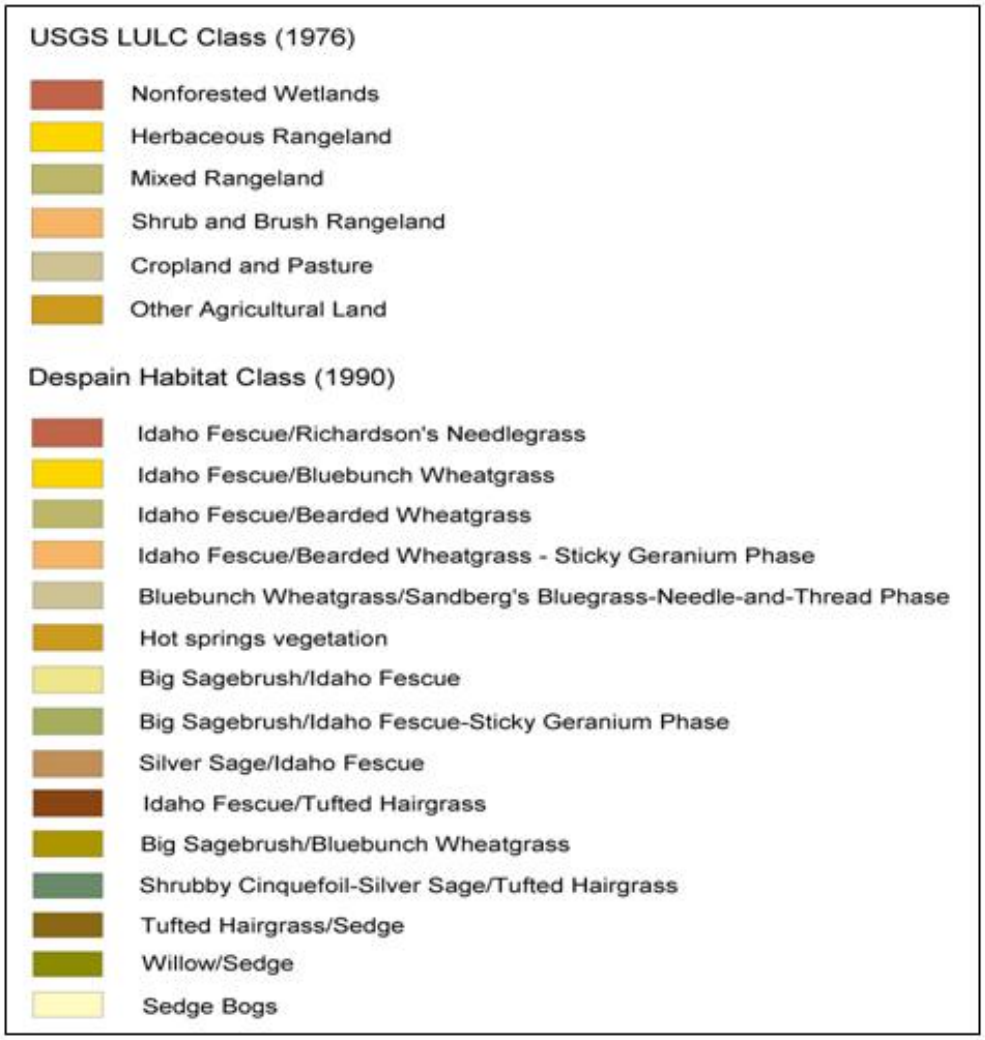

Figure 4.2. Habitat class color codes used in Figure 4.1 and Figure 4.3.

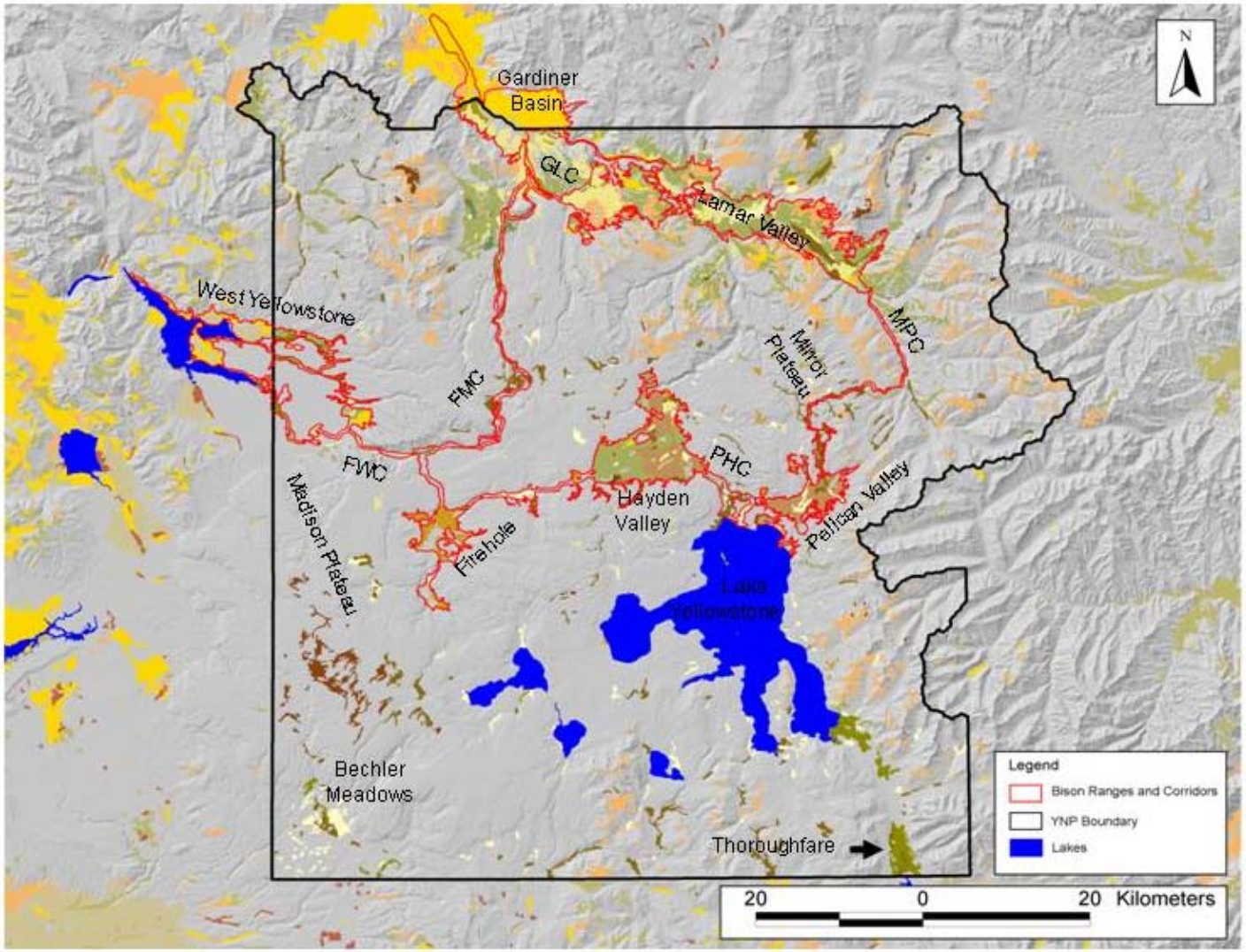

Figure 4.3. Location of bison winter ranges and winter movement corridors in Yellowstone National Park. Habitat class color codes are described in Figure 4.2. Ranges and corridors were mapped based on data from key informant interviews in July and August 2004.

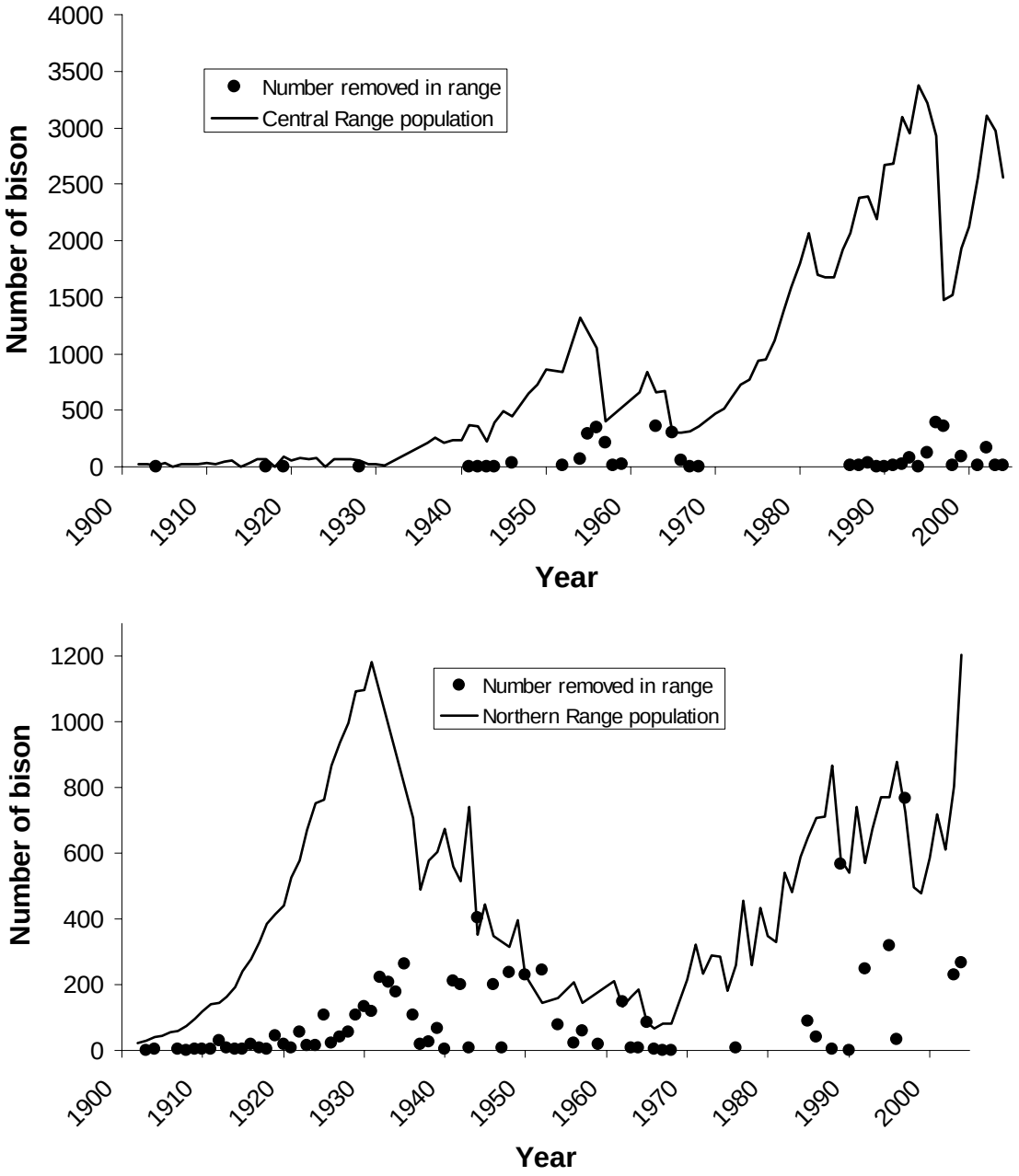

Figure 4.4. Population estimates and number of bison removed from the Central (top) and Northern (bottom) Yellowstone Bison Ranges between 1902 and 2004. Note: the Y-axis scales are different in each graph. Data sources: Meagher (1973) for 1902-1968, M. Meagher pers comm. for corrections to number of removals; M. Meagher, M. Taper, and C. Jerde for populations estimates 1970-1997; R. Wallen for population estimates 1998-2004.

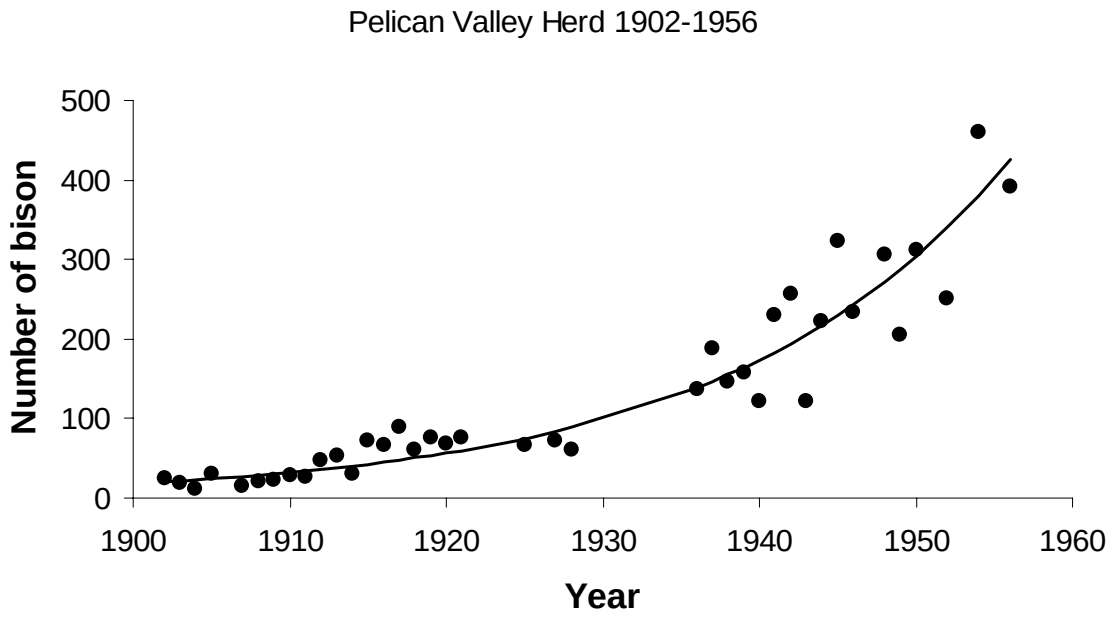

Figure 4.5. Growth of the Pelican Valley herd during 1902 – 1956 based on winter count data provided in Meagher (1973).

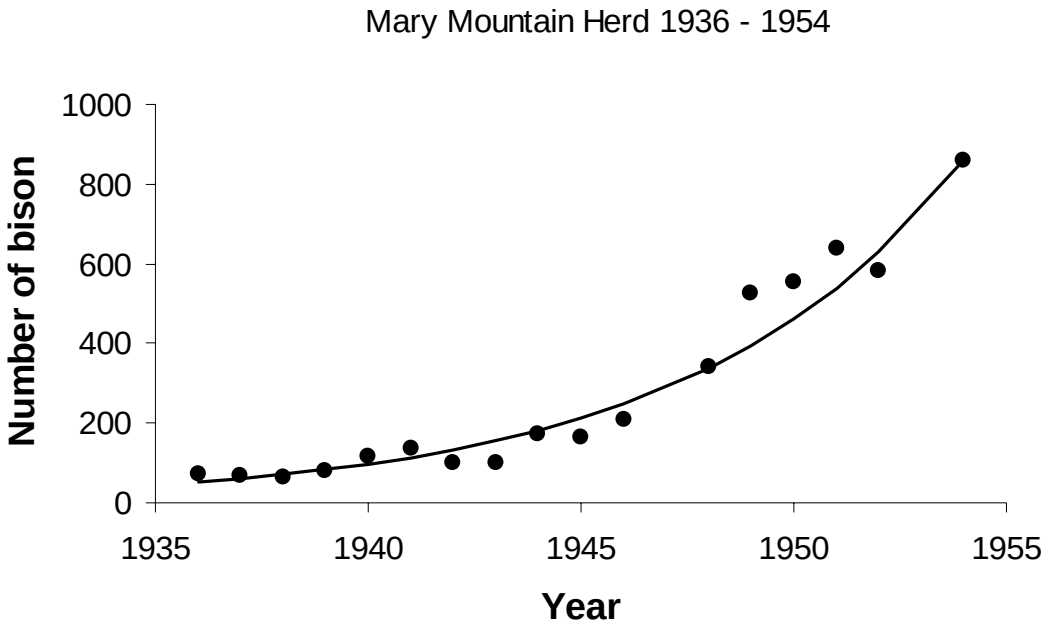

Figure 4.6. Growth of the Mary Mountain herd during 1902 – 1954 based on winter count data provided in Meagher (1973) with corrections by M. Meagher (pers. comm. October 2005).