Bison bison

Mary Meagher


Stable URL:
http://links.jstor.org/sici?sici=0076-3519%2819860616%293%3A0%3A266%3C1%3ABB%3E2.0.CO%3B2-F

Mammalian Species is currently published by American Society of Mammalogists.

Your use of the JSTOR archive indicates your acceptance of JSTOR's Terms and Conditions of Use, available at http://www.jstor.org/about/terms.html. JSTOR's Terms and Conditions of Use provides, in part, that unless you have obtained prior permission, you may not download an entire issue of a journal or multiple copies of articles, and you may use content in the JSTOR archive only for your personal, non-commercial use.

Please contact the publisher regarding any further use of this work. Publisher contact information may be obtained at http://www.jstor.org/journals/asm.html.

Each copy of any part of a JSTOR transmission must contain the same copyright notice that appears on the screen or printed page of such transmission.

The JSTOR Archive is a trusted digital repository providing for long-term preservation and access to leading academic journals and scholarly literature from around the world. The Archive is supported by libraries, scholarly societies, publishers, and foundations. It is an initiative of JSTOR, a not-for-profit organization with a mission to help the scholarly community take advantage of advances in technology. For more information regarding JSTOR, please contact support@jstor.org.
MAMMALIAN SPECIES  No. 266, pp. 1–8, 4 figs.

Bison bison.  By Mary Meagher
Published 16 June 1986 by The American Society of Mammalogists

Bison (Hamilton-Smith, 1827)
Bison Hamilton-Smith, 1827:373. Type species Bison bison (Linnaeus, 1758). Proposed as subgenus Bison bison as genus by Knight, 1849:408.

CONTEXT AND CONTENT. Order Artiodactyla, Family Bovidae, Tribe Bovini. The genus Bison includes two extant species, B. bison, the European bison or wisent, and B. bison, the late Holocene bison of North America.

Bison bison (Linnaeus, 1758)
Bison


CONTEXT AND CONTENT. Context as given above. Two subspecies are recognized (McDonald, 1981; Skinner and Kaisen, 1947). Synonomy for both subspecies follows Skinner and Kaisen (1947).

B. b. athabascae Rhoads, 1897:498. Type locality, within 50 miles southwest of Fort Resolution, Mackenzie District, Northwest Territories, Canada (occidentalis Lucas, oregonus Bailey, and haningtoni Figgins are synonyms).

B. b. bison (Linnaeus, 1758). Type locality, see above (americanus Brisson, sylvestris Hay, pennsylvanicus Shoemaker, and septentrionalis Figgins are synonyms).

DIAGNOSIS. The following applies to the genus and species: horn cores in cross section at the base more or less triangular (males), protruding anterolaterally; nasals broad, short, triangular; in females, broad, flat, less (McDonald, 1981; Wilson, 1975). They have longer pelage on the forehead, chin, ventral mantle, and chaps of the forelegs, and a more pronounced line of demarcation between the longer hair of the forequarters and the shorter hair of flanks and rear.

B. b. athabascae and B. b. bison closely resemble each other. B. b. athabascae is generally larger but there is overlap. Selected measurements (in mm) for males are as follows: maximum length, 562 to 604, 500 to 583; spread of horn cores, 542 to 848, 510 to 778; least width at frontals between horn cores and orbits, 273 to 313, 237 to 318.

DISTRIBUTION. Bison formerly were widespread in North America from Alaska and western Canada across the United States and into narrow Mexico (Fig. 4). Occupation of marginal areas may have been intermittent (McDonald, 1981). McDonald (1981) believes the maximum geographic distribution of B. b. bison occurred in the late prehistoric period because of the many historical accounts of bison presence near the margins of the indicated maximum range (Christman, 1971; Reed, 1955; Roe, 1970; Rostland, 1960). The distribution of B. b. athabascae is less well known (McDonald, 1981). They apparently disappeared from Alaska before historic times but there are unfossilized specimens (Skinner and Kaisen, 1947).

Today bison occur as geographically isolated population units in parks, preserves, and other public lands, and on private ranches and small holdings throughout and external to the maximum known geographic distribution (Fig. 4). Major free-ranging populations occur in Canada (Mackenzie Sanctuary, Wood Buffalo National Park and adjacent Slave River lowlands) and the United States (Yellowstone National Park); a few smaller units also exist (Reynolds et al., 1982). Altitude does not appear to have limited bison distribution. Evidence of past bison occupation was reported from about 3,903 m in Colorado (Beideman, 1955), from 2,897 m to about 3,659 m in Wyoming (Fryxell, 1928), and at approximately 3,200 m in Montana (Pattie and Verbeek, 1967).

FOSSIL RECORD. Although the time and place of origin of the ancestors of B. bison are obscure, the earliest dated remains of the genus occur from the late Pliocene of Central Asia, with possible early Pleistocene occurrences from northern India and northern China (McDonald, 1981). Bison seemingly were confined to temperate and upland east Asia until after the early Pleistocene. Thereafter they appeared in southeastern and central Europe, becoming relatively common as fossils and in later cave paintings throughout much of Europe. Bison reached northern Eurasia during the middle Pleistocene and spread across the Paleartic into Asia, but survived in northern Eurasia until the very late Pleistocene (McDonald, 1981). They first appeared in the fossil record south of Beringia in North America in early late Pleistocene faunas (Guthrie, 1980; McDonald, 1981). Most specimens of bison are known from the late Pleistocene of North America and higher latitude Eurasia, and the Holocene steppes and adjacent forests of Eurasia and North America (McDonald, 1981).

The evolutionary line leading to B. bison remains controversial although there seems to be general agreement on many elements. Proleptobos from the early Pliocene may be the ancestor of the
Re. 2. Dorsal, ventral, and lateral views of cranium of adult female bison (YNP 12050). Condylar length, 460 mm. Photographs by A. Vanderbilt.

*Bos*—*Bison* group of Bovini (McDonald, 1981). *Leptobos*, appearing later in the Pliocene and widely distributed in central and southern Eurasia during both the Pliocene and Pleistocene, may be either a common ancestor (Guthrie, 1980; McDonald, 1981) or a closely related taxon (McDonald, 1981). *B. sivalensis*, the earliest known species and possible ancestor of later lineages of bison, dispersed northward into Siberia by the middle Pleistocene or earlier (McDonald, 1981). This species and another poorly known early form, *B. paleosinensis*, seem to have been small bodied, small horned, and more cattle-like compared to later bison, and were probably adapted to a woodland–parkland environment (Guthrie, 1980).

Early in the middle Pleistocene the so-called steppe bison, *B. priscus* appeared (Guthrie, 1980). This larger bodied, larger horned bison apparently was the dominant form during the rest of the Pleistocene and may be ancestral to the North American forms (Guthrie, 1980; Wilson, 1975).

By the late Illinoian to early Sangamon the large steppe bison seems to have spread into the grasslands of central North America where they became even larger, with enormous horn cores reaching 2 m tip to tip (Guthrie, 1980). This form, *B. latifrons* or *B. priscus latifrons*, occurred in much of unglaciated North America but seems to have been most common from Alberta to Texas along the east front of the Rocky Mountains and the intermontane basins. Guthrie

---

**Fig. 1.** Dorsal, ventral, and lateral views of cranium and lateral view of mandible of adult male bison (YNP 11661) Condylar length, 519 mm. Photographs by A. Vanderbilt.

**Fig. 2.** Dorsal, ventral, and lateral views of cranium of adult female bison (YNP 12050). Condylar length, 460 mm. Photographs by A. Vanderbilt.
Fig. 3. Photographs of a fully mature male (top) during rut and female (bottom) bison showing contrast in head and horn shape. Photographs courtesy of A. Stephen Johnson.

Fig. 4. Map illustrating probable maximum distribution of B. bison during late prehistoric times with the north-south axis of the primary range coincident with the central North American grasslands. The maximum extent of the range of B. b. athabascae is not as well known as that of B. b. bison. Map is fig. 23 from McDonald (1981) courtesy of University of California Press (scale added).

(1980) and Wilson (1975) believed this line decreased in size during the Wisconsin, grading eventually into the smaller B. antiquus.

About 13,000–12,000 BP, a gradual diminution in size of B. priscus seems to have occurred in the far north (Guthrie, 1980) leading to B. occidentalis (Guthrie, 1980; Wilson, 1975). At the end of the Wisconsin, this northern line of B. occidentalis may have invaded the grasslands of the Great Plains to contact and interbreed with the more southern line of B. antiquus (Wilson, 1975). At this time the two lines may have been similar in size although somewhat different in cranial and horn-core morphology (Guthrie, 1980). During the Holocene, North American bison seemingly continued to diminish in body size while at the same time increase in numbers (Guthrie, 1980).

Guthrie (1980) pointed out that the rapid rate of bison evolution led to a bewildering assortment of taxonomic designations. The trend in recent years has been to synonymity (Guthrie, 1980; McDonald, 1981; Skinner and Kaisen, 1947; Wilson, 1975), but temporal and spatial trends seem to warrant subspecific status for resulting differences of form. In this view, then, the evolution of North American bison led to two Holocene species, the earlier B. priscus, and the extant B. bison, with their subspecies (Guthrie, 1980; Wilson, 1975).

FORM AND FUNCTION. The annual pelage molt begins late winter to early spring. Tattered patches of bleached winter hair may cling to the forequarters well into August. New growth is short, somewhat stiff, and nearly black. By late fall the winter coat of wooly underfur with overlying coarse guard hairs is essentially full grown. Head, underparts, flanks, and rear are dark brown, appearing black at a distance. The long wooly hair across the forequarters commonly lightens to bleached tan, most pronounced on older bulls. Usually there is a dark streak down the front of the hump, suggesting a mane, although the hair is scarcely longer than that over the shoulders.

Length of hair (in mm) has been estimated as follows: flanks and rear, 25; rump and hips, 50 to 90; shoulders and hump, 65 to 160; chaps, 150 to 190; and beard, 300 mm (Meagher, 1973; Soper, 1941). On bulls, the hair of the forehead may be 150 to
210 mm, which may compact into a frizzy mat 100 to 130 mm thick at eye level (Lott, 1974). Peters and Slen (1964) found an average density of hair fibers per cm² at the midrib of bison calves to be about 2,992 for females and 2,182 for males. The winter pelage of bison showed a greater weight, coarseness, and amount of hair per unit area compared with that of three breeds of cattle (Peters and Slen, 1964). These pelage characteristics provide high quality insulation, contributing to the observed ability of bison to winter at temperatures well below zero and in areas swept by strong winds (Meagher, 1973, 1976). Christopherson et al. (1979) attributed the observed cold tolerance of 6-month-old bison calves to their heavy coat. The bison metabolic rate in still air at −30°C was maintained or reduced, apparently because of decreased physical activity. However, with the addition of wind at −30°C a lower thermally critical zone was reached with a metabolic rate increase from 700 KJ/kg to 950 KJ/kg. In winter, the upper critical temperature apparently was exceeded at 10°C (Christopherson et al., 1979).

The upper limits of physiological heat tolerance in summer apparently have not been determined. However, the historical presence of modern bison in Texas and Mexico (Reed, 1955) suggests that temperatures may not have imposed geographic limits where forage and water were suitable. In Texas, bison to 120 to 130 mm in diameter (Murie, 1954) and 133.5 cm³ insole area (Telfer and Kelsall, 1979). Tongue, lips, and rhinarium are black. Bison have 31 vertebrae exclusive of the caudals: the atlas, axis, and 5 other cervicals, 14 thoracics, 5 lumbarS, and 5 sacrals, which are fused into a composite bone. There are 14 pairs of ribs. The neural processes of the second and third thoracic vertebrae are the longest; in large bulls these may extend 450 to 500 mm (Olsen, 1960).

The dental formula is: i 0/3, c 0/1, p 3/3, m 3/3, total 32 (Hall, 1981). Molariform teeth are hypsodont and selenodont. At birth all deciduous teeth are present and covered by a semitransparent membrane that sloughs off during the first days of life (Fuller, 1959). The first permanent tooth, ml, erupts during the first year; by age 5 all teeth are permanent (Fuller, 1959). Age estimates based on wear thereat are approximate and subjective. Four inguinal mammas are present. Milk analysis showed 8.9% nonfat solids, 6.3% protein, 2.9% anhydrous lactose, 6.3% fat, 0.3% calcium (Hebring, 1983).

Bison bulls yielded dressed carcass weights (without hide, head, and entrails) of 52 to 54%, adult cows yielded 54 to 58% (Halloran, 1957). Analysis of muscle from various body parts showed 28 to 35% protein and 0.8 to 5% fat (Johnson and Deethardt, 1980). Values for selected cellular constituents of adult bison blood (n = 163) were: hemoglobin, 16.99 ± 1.43 g% hematocrit (packed cell volume) 46.62 ± 6.06%; erythrocytes, 10.98 ± 1.45 × 10¹²/mm³; and leucocytes, 8.03 ± 1.41 × 10⁹/mm³ (Mehrer, 1976). The leucocyte component varied according to diet and season (Keith et al., 1978), and was significantly different between bison under 2 years of age and adults (Marler, 1975). Oxygen-carrying capacity for seven adult bison was 22.2 ml/100 ml; oxygen tension at half saturation (P,O₂) was 32 mm at pH 7.4 and 37°C (Haines et al., 1978). Schaefer et al. (1978) found mean plasma T₁ and T₃ levels of 11.2 to 20.0 ± 8.8/minute. Actual breeding is more strongly seasonal. Lott (1981) reported that sperm in the epididymis as yearlings; by age 3 most males and 19 August with a peak about 1 August. In the north, at Wood Buffalo National Park, breeding activity may begin later (Soper, 1941) and peak between 10 and 20 August (Fuller, 1962). Gestation, was estimated at 285 days (Haugen, 1974). The calving season generally extends from mid-April through May with births often concentrated from the end of April through the first two weeks of May (Lott and Galland, 1985; McHugh, 1958; Meagher, 1973; Rutberg, 1984; Shult, 1972). Out-of-season births are as much as 50% within 30 sec (Hawley and Peden, 1982). Mean body temperature was 38.7°C (Hawley and Peden, 1982). Christopherson et al. (1979) recorded mean respiration rates that ranged from 11.2 ± 2.9 to 20.0 ± 8.8/minute. Digestion has the rumen microorganisms including eight species of ciliate protozoa and five morphological types of bacteria, with average total counts of 0.58 × 10¹¹/ml and 7.14 × 10¹⁰/ml, respectively. Rumen content from 4, 16, 17, 22, and 33%, respectively, of monoglycerides, triglycerides, sterols, phospholipids, and nonesterified fatty acids (Evans, 1964). Apparent digestibility in percent of a hay diet was: dry matter, 51.3; crude protein, 38.3; crude fat, 64.2; neutral detergent fiber, 54.7; acid detergent fiber, 47.0; hemicellulose, 67.1; lignin, 25.2; and gross energy, 50.6 (Hawley et al., 1981a). On this diet, bison showed an average daily gain in kg/day of 0.42 and 0.04 for summer and winter, respectively. When compared with cattle, digestibility coefficients for all nutrients were higher in bison. Macronutrient digestibility coefficients for various native forages (Hawley et al., 1981b). Rumen ammonia concentrations and urinary urea levels appeared to be proportional to dietary N levels (Keith et al., 1981). Apparent absorption of N from the gastrointestinal tract was 3.50 g/100 g of dry matter; retention time of digesta in feeding trials was 78.8 h (Schaefer et al., 1978).

Droppings are similar to those of cattle. On succulent feed, a flat mass of 30 cm diameter is common; with drier feed a more rounded, layered mass forms (Murie, 1954). Defecation rates of approximately once per h were observed in bulls (Herrig and Haugen, 1969).

The mean brain weight for four subadult males and two mature females was 458 g. Mean forebrain measurements (in mm) were: length, 114.3; width, 93.3; height, 64.1. Mean cerebellum measurements were: length, 44.8; height, 38.7 (Harper and Masner, 1976).

In 4.5-year-old bison the mean chest height for males (n = 95) was 677 ± 3.3 mm and for females (n = 23) was 643 ± 7.0 mm; the mean foot load, in gm/cm², was 884.1 ± 8.02 and 672.4 ± 9.47 for males and females, respectively (Telfer and Kelsall, 1979). These authors suggested that males might cope more successfully with increased snow depth, but that females might have a greater advantage when walking on hard or dense snow. The musculature of the neck and shoulders allows bison to forage by swinging the head and neck upward as much as 50% within 30 sec (Hawley and Peden, 1982). Mean heart rate for bison was 89 beats/min; rate fluctuated approximately once per h were observed in bulls (Herrig and Haugen, 1969).

ONTOGENY AND REPRODUCTION. A few precocious female bison first conceive as yearlings but sexual maturity most commonly occurs at 2 to 4 years of age (Fuller, 1962; Halloran, 1968; Meagher, 1973). Sexual maturity in males is similar. A few show sperm in the epididymis as yearlings; by age 3 most males are sexually mature (Fuller, 1962; Shult, 1972). Although Halloran (1968) reported that about 90% of copulations occurred in a 2-week period following the birth of a calf, males might perform effectively as sires in the absence of older males, bulls usually do not breed cows until age 6 (Herrig and Haugen, 1969; Lott, 1981; McHugh, 1958). The breeding season may extend from late June or early July through September (McHugh, 1958; Meagher, 1973; Shult, 1972) but actual breeding is more strongly seasonal. Lott (1981) reported that about 90% of copulations occurred in a 2-week period following the birth of a calf, males might perform effectively as sires in the absence of older males, bulls usually do not breed cows until age 6 (Herrig and Haugen, 1969; Lott, 1981; McHugh, 1958). The breeding season may extend from late June or early July through September (McHugh, 1958; Meagher, 1973; Shult, 1972) but actual breeding is more strongly seasonal. Lott (1981) reported that about 90% of copulations occurred in a 2-week period following the birth of a calf, males might perform effectively as sires in the absence of older males, bulls usually do not breed cows until age 6 (Herrig and Haugen, 1969; Lott, 1981; McHugh, 1958). The breeding season may extend from late June or early July through September (McHugh, 1958; Meagher, 1973; Shult, 1972) but actual breeding is more strongly seasonal. Lott (1981) reported that about 90% of copulations occurred in a 2-week period following the birth of a calf, males might perform effectively as sires in the absence of older males, bulls usually do not breed cows until age 6 (Herrig and Haugen, 1969; Lott, 1981; McHugh, 1958).
recorded in most herds, usually later in summer (Fuller, 1962; Lott and Galland, 1985; McHugh, 1958; Meagher, 1973).

Bison cows have one calf; twins are known but are rare (Engelhard, 1970; Fuller, 1962; Halloran, 1968, Haugen, 1974; McHugh, 1958; Roe, 1970). At birth, the calf may weigh 15 to 25 kg (Rutberg, 1984). The fetal sex ratio usually favors males (Fuller, 1962; Haugen, 1974; McHugh, 1958; Meagher, 1973).

Calves are usually bright reddish tan, although Engelhard (1970) recorded some calves with atypical dark streaking and areas of gray. Calves begin to darken to a brownish black at about 2.5 months (McHugh, 1958). Darker hair appears first on the head, then the shoulders and back, but calves are not uniformly dark until 4 months (Engelhard, 1970). Sexes are alike in appearance at birth, with no apparent hump. There is a tendency for males to develop slightly larger body size, larger hump, and longer more conical horns by the end of the first year (Engelhard, 1970). Calves usually weigh between 135 and 180 kg by 8 to 9 months of age; yearlings (20 to 22 months) weigh between 225 and 315 kg (Meagher, 1973).

Calves are precocious; average times for 10 calves to first stand and first nurse were 10.9 min and 32.2 min, respectively (Lott and Galland, 1985). They may try to graze by 5 days of age (Shult, 1972) and will drink water after the first week (Engelhard, 1970; Fuller, 1962; Halloran, 1973; McHugh, 1958). Calves with partly digested grass in the abomasum; calves orphaned at 7 to 8 weeks of age have survived (Shult, 1972). Cows nurse their calves for at least 7 to 8 months (McHugh, 1958), but most calves apparently are weaned by the end of the first year (Halloran, 1968; McHugh, 1958; Shult, 1972; Van Vuren, 1979).

Females may be seasonally polyoestrus, with a cycle of approximately 3 weeks (Fuller, 1962). Estrus may last from 9 to 28 h (Haugen, 1974). Average longevity in bison has not been documented. Fuller (1959, 1962) placed the onset of old age at 12 to 15 years. In the wild, a few bison apparently survive more than 20 years (Meagher, 1973); records of a few known-age cows of 40+ years were cited by McHugh (1958).

ECOLOGY. An estimated 30 million bison inhabited North America about the time modern man arrived (McHugh, 1972). Subsequently, bison nearly were exterminated through overhunting. Various writers have chronicled this exploitation (Dary, 1974; Haines, 1970; McHugh, 1972; Roe, 1970). By 1903, a known 1,644 bison existed (Garretson, 1938), mostly in zoos and privately owned herds. They survived near extermination as a wild species in two areas: Wood Buffalo National Park, Canada (Soper, 1941), and Yellowstone National Park, Wyoming (Meagher, 1973). Through establishment of additional public preserves and privately owned herds, bison numbered an estimated 75,000 in 1983 (Jennings and Hebbring, 1983).

Prehistoric distribution occurred primarily on the central grasslands and northern parklands of North America, but bison habitats used ranged from semidesert to boreal forest where suitable grazing was available (McDonald, 1981). Bison are grazers at all seasons, taking mostly grasses and sedges (Carex spp.). Use of warm season grasses predominated in shortgrass pasture (Peden et al., 1974); cool season grasses including some sedges composed 79 to 96% of the diet of bison on montane pastures (Coppock et al., 1983). Among four species of ungulates on a shortgrass pasture, bison were the least selective and ingested the lowest quality forage (Rice et al., 1974; Schwartz and Ellis, 1981). In montane habitat in winter, bison appeared more restricted than elk (Cervus elaphus) to highly productive wet meadows where they could forage in deeper snow while obtaining a large quantity of food (Houstou, 1982). In boreal forest-aspen–meadows of Elk Island National Park, elk and bison in winter overlapped most in habitat use but least in food habits, the reverse was true in summer (Telfer and Cairns, 1979). Telfer and Kelsall (1984) developed a morphological index in combination with behavioral information to evaluate snow-coping ability of eight species of ungulates; bison ranked below all but pronghorn (Antilocapra americana).

Use of forested areas appears limited except occasionally for shade, for escape from insects and other disturbances (Fuller, 1962; Halloran, 1968, 1973; McHugh, 1958), and for protection from snowstorms (Fuller, 1962; Soper, 1941). Foraging in more open forest may be relatively frequent (Fuller, 1962; Soper, 1941) or incidental (Meagher, 1973). Extensive forests were traversed between open foraging areas and on seasonal migrations (Fuller, 1962; McHugh, 1958; Meagher, 1973; Soper, 1941).
Mortality in most herds is man-caused through commercial and sport harvest, or subsistence hunting. The wolf (Canis lupus) is apparently a competent predator of free-ranging bison. Bison contributed about 65% to the winter diet of wolves in Wood Buffalo National Park. Bison predation did not appear to have a negative impact on the bison population (Fuller, 1962). However, wolf and human predation may be additive. On the Slave River lowlands a severe winter weather combined with the combined predation apparently triggered a decline in bison numbers from 1,900 to 1,200; bison declined further to about 750 (Reynolds et al., 1982). Bison separated from herds appeared to be the primary targets of attack (Haynes, 1982).

Periodically, severe winter weather is the primary mortality agent in Yellowstone Park; winterkill to some degree occurs every year with differential mortality among age and sex classes (Meagher, 1973). Unusually severe spring storms may cause both high calf mortality and increase adult mortality (Meagher, 1976). Winterkill also occurs frequently in and adjacent to Wood Buffalo National Park (Reynolds et al., 1982). Accidents are usually insignificant but several thousand bison have drowned in single occurrences (Reynolds et al., 1982).

At least 31 endoparasites have been reported from bison, mostly from captive herds where confinement may enhance occurrence. Effects in wild bison appear insignificant; only 2 of 26 species were reported from free-ranging bison (Meagher et al., 1982). Toxocosis is prevalent in geothermally active parts of Yellowstone National Park, which is probably a result of grazing conditions and habitat. Females of all ages, calves, most males 2 to 3 years old, and one to a few older males form mixed (sometimes called cow) groups throughout the year (Fuller, 1960; McHugh, 1958). Older males join these groups in increasing numbers as rut approaches (McHugh, 1958), but are afterwards found singly, or in bull groups containing as many as 30 individuals (Fuller, 1960). Mixed herds are fluid and variable. Herd size tends to be large during rut (Lott, 1981) and in more open habitat (Van Vuren, 1983). In spring, cows with calves tend to cluster (Rutberg, 1984). Solitary bulls sometimes remain with rider at about 1 km, and moving objects at nearly 2 km (McHugh, 1958). Vocalizations heard: the long, low bellow, the distinctive roar or bellow of rutting bulls may carry nearly 5 km (McHugh, 1958).

**GENETICS.** The diploid number is 60; there are 29 pairs of acrocentric autosomes, a metacentric X- and a small acrocentric Y-chromosome (Basrur and Moon, 1967; Bhamiani and Kuspira, 1969). Ying and Peden (1977) indicated that at least 20 pairs of autosomes and the sex chromosomes of B. b. athabascae and B. b. bison are homologous. The autosomes and the X-chromosome of B. bison are indistinguishable from those of Bos taurus. Cross-breeding experiments between bison and cattle date back apparently to the 1700's (Dary, 1974; Haines, 1970; McHugh, 1972; Roe, 1970) and continue to the present. Bison bull matings with cattle females generally result in fatalities to cow and calf because of excess amniotic fluid. Female hybrids are fertile, males are not. Albinism occurs in bull, but rarely (McHugh, 1958; Roe, 1970).

**BEHAVIOR.** Bison are gregarious, forming herds according to sex, age, season, foraging conditions, and habitat. Females of all ages, calves, most males 2 to 3 years old, and one to a few older males form mixed (sometimes called cow) groups throughout the year (Fuller, 1960; McHugh, 1958). Older males join these groups in increasing numbers as rut approaches (McHugh, 1958), but are afterwards found singly, or in bull groups containing as many as 30 individuals (Fuller, 1960). Mixed herds are fluid and variable. Herd size tends to be large during rut (Lott, 1981) and in more open habitat (Van Vuren, 1983). In spring, cows with calves tend to cluster (Rutberg, 1984). Solitary bulls sometimes remain with rider at about 1 km, and moving objects at nearly 2 km (McHugh, 1958). Vocalizations heard: the long, low bellow, the distinctive roar or bellow of rutting bulls may carry nearly 5 km (McHugh, 1958).

**DESCRIPTION.** The taxonomic status of B. b. athabascae and B. b. bison remains somewhat controversial. The differences in shape and pelage described by Geist and Karsten (1977) may be modified as larger samples are compared. Studies of chromosomes (Ying and Peden, 1977) and blood characteristics (Peden and Kraay, 1979) have not resolved the question. Additional research needs on bison include further anatomical and physiological descriptions and comparisons with wisent and cattle, further studies of adaptive strategies and interspecific relationships, and long-term analyses of the population dynamics and factors that naturally regulate the different free-ranging populations. Additional behavioral studies that compare various populations would be useful. Researchers and non-researchers alike would benefit from further studies of the evolutionary history and more recent forms of bison that might allow a consensus on nomenclature and the species and subspecies represented.

I thank Mrs. V. Black for interlibrary loans, the research office staff for manuscript preparation, and several reviewers for their helpful comments.

**LITERATURE CITED**


genase in the American buffalo (Bison bison), Biochem. Ge-

Olsen, S. J. 1960. Post-cranial skeletal characters of Bison and 
Pattie, D. L., and N. A. M. Verleek. 1967. Alpine mammals of 

Pearson, N. A. 1967. Rumen microorganisms in buffalo from 
characteristics in plains bison, wood bison, and their hybrids. 
1974. The trophic ecology of Bison bison L. on shortgrass 
Peters, H. F., and S. B. Slen. 1964. Hair coat characteristics of 
bison, domestic × bison hybrids, cattalo, and certain 
57.
Popp, J. 1980. Range ecology of bison on mixed grass prairie at 

Reed, E. K. 1955. Bison beyond the Pecos. Texas J. Sci., 7: 
130–135.

Bison. Pp. 972–1007, in Wild mammals of North America: 
biology, management, and economics (J. A. Chapman and G. 
A. Feldhamer, eds.) Johns Hopkins Univ. Press, Baltimore, 
1,147 pp.

Reynolds, H. W., R. M. Hansen, and D. G. Peden. 1978. Diets of 
the Slave River lowland bison herd, Northwest Territories, 

Riggs, S. N. 1897. Notes on living and extinct species of North 
483–502.

and sheep dietary quality and food intake. J. Anim. Sci., 38: 
1332. (Abstract)

Comparison of forage intake and digestibility by American 

Toronto Press, 991 pp.

Rostland, E. 1960. The geographic range of the historic bison 

Ruberg, A. T. 1983. Factors influencing dominance status in 
American bison cows (Bison bison). Z. Tierpsychol., 63:202– 
212.

———. 1984. Birth synchrony in American bison (Bison bison): 
response to predation or season? J. Mamm., 65:418– 
423.

Sartore, G., C. Stormont, B. G. Morris, and A. A. Grunder. 
1969. Multiple electrophoretic forms of carbonic anhydrase 
in red cells of domestic cattle (Bos taurus) and American 
bison (Bison bison). Genetics, 61:823–831.

Ration digestion and retention times of digesta in domestic 
cattle (Bos taurus), American bison (Bison bison), and Ti-

Schwartz, C. C., and J. E. Ellis. 1981. Feeding ecology and 
niche separation in some native and domestic ungulates on 

Seton, E. T. 1929. Lives of game animals. Doubleday, Doran 

Shult, M. J. 1972. American bison behavior patterns at Wind 

Fluoride toxicity in wild ungulates. J. Amer. Vet. Med. As-
soc., 185:1295–1300.

Skinner, M. F., and O. C. Kaizen. 1947. The fossil Bison of 

Smith, C. H. 1827. Supplement to the order Ruminantia in The 
animal kingdom arranged in conformity with its organization, 

Soper, J. D. 1941. History, range, and home life of the northern 

Telfer, E. S., and A. Cairns. 1979. Bison–wapiti interrelations-
ships in Elk Island National Park, Alberta. Pp. 114–121, in 
North American elk: ecology, behavior and management (M. 
S. Boyce and L. D. Hayden-Wing, eds.) Univ. Wyoming, 
Laramie, 294 pp.

Telfer, E. S., and J. P. Kelsall. 1979. Studies of morphological 
parameters affecting ungulate locomotion in snow. Canadian 

———. 1984. Adaptation of some large North American mam-

Thomas, O. 1911. The mammals of the tenth edition of Linnaeus; 
an attempt to fix the types of the genera and the exact bases 
120–156.

van Vuren, D. 1979. Ecology and behavior of bison in the 
Univ., Corvallis, 39 pp.

———. 1983. Group dynamics and summer home range of 

———. 1984. Summer diets of bison and cattle in southern 

Wilson, M. 1975. Holocene fossil bison from Wyoming and 
adjacent areas. Unpubl. M.A. thesis, Univ. Wyoming, 
Laramie, 276 pp.

relationships in Wind Cave National Park. J. Wildl. Mgmt., 

1762.

Editors of this account were B. J.Verts and Sydney Anderson. 
Managing editor was Timothy E. Lawlor.

M. Meagher, NATIONAL PARK SERVICE, YELLOWSTONE NATIONAL 
PARK, WYOMING 82190.