

Status Report on the Yellowstone Bison Population to the Superintendent

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September 29, 2022

Summary

- There are about 6,013 animals in the Yellowstone bison population. Within the last year, the population ranged from about 5,472 animals in June 2021 to about 5,020 animals at the end of winter before increasing to its current level.
- The population continues to grow at an exponential rate of 14.5% in the absence of management removals. Removal of an average of 600 animals annually over the last decade stabilized the population around 5,100 animals.
- Few bison were removed over the past two winters when snow conditions were well below average, resulting in a 27% increase in numbers since 2020.
- Recent assessments suggest the park can sustain around 10,000 animals, including 5,000 bison in northern regions. Rangeland monitoring confirms that grassland areas continue to sustain ecosystem function with higher bison numbers. Genetic assessments indicate no loss of genetic diversity and or change in allele frequencies with higher numbers. Bison-related conflicts remain low despite the higher numbers.
- If bison move towards the northern park boundary during winter 2022-23, the NPS could capture animals in the bison facility to support the unique relationship among tribes and bison, reduce population growth, and respond to conflicts from bison exiting the park.
- The number of animals captured by the NPS should depend on the number of animals migrating to the northern park boundary, capacity for live transfer of animals, hunter success outside the park, and number of conflicts outside the park.
- If few bison migrate, the NPS could passively capture animals to enter program-eligible animals in the Bison Conservation Transfer Program and transfer ineligible animals to tribes for their meat and hides. Other bison in the area would be allowed to move towards park boundaries and support hunting opportunities. As numbers of animals migrating increases, more animals could be captured up to capacity of the Bison Conservation Transfer Program (about 400-600 animals). Thereafter, the NPS could move animals away from the facility. The NPS could resume capturing animals and transferring them to tribes for meat and hides if bison continue to migrate to winter areas in numbers exceeding tolerance for them. The NPS does not recommend removing more than 1,500 animals, including harvests outside the park.

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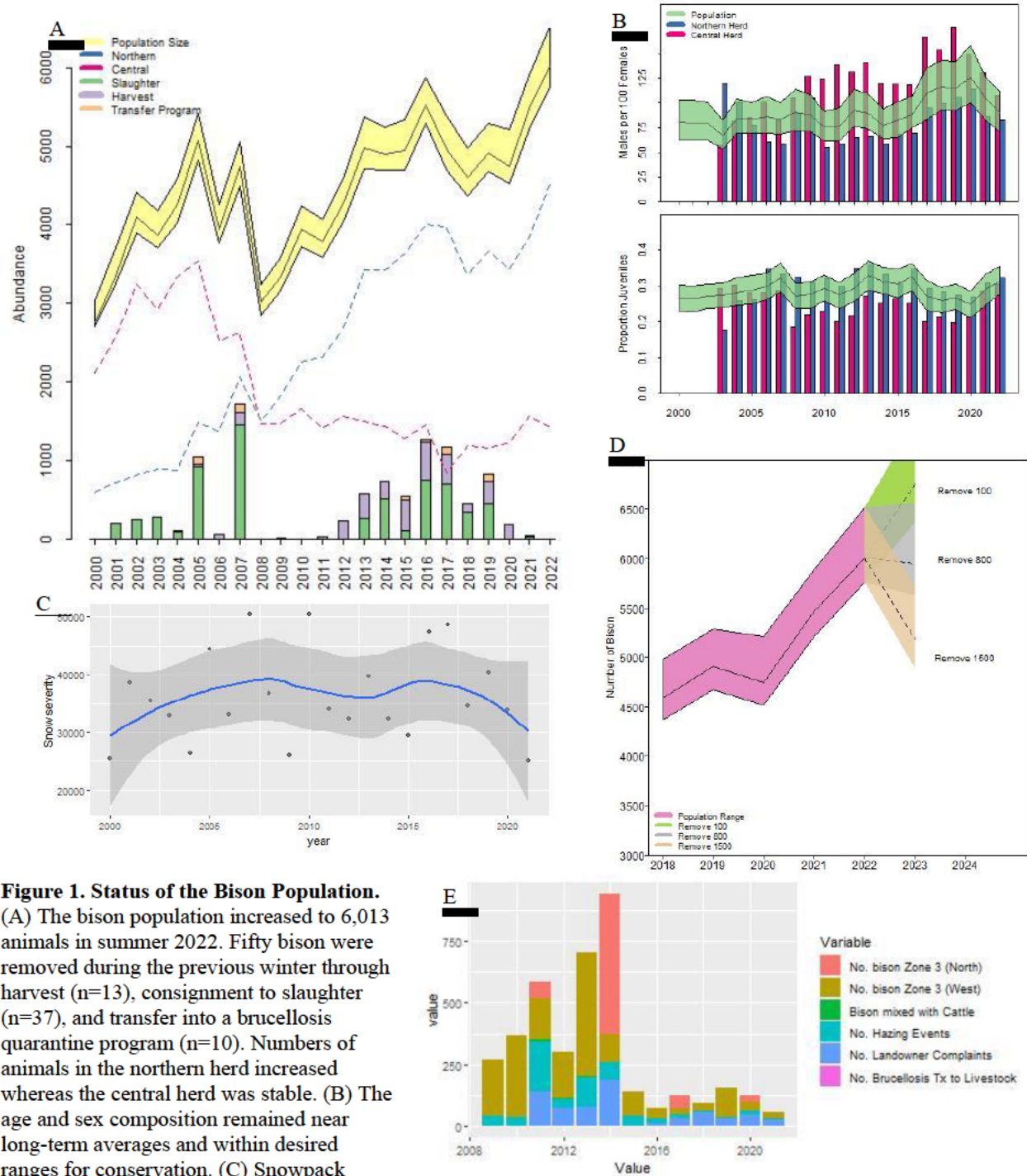


Figure 1. Status of the Bison Population.

(A) The bison population increased to 6,013 animals in summer 2022. Fifty bison were removed during the previous winter through harvest ($n=13$), consignment to slaughter ($n=37$), and transfer into a brucellosis quarantine program ($n=10$). Numbers of animals in the northern herd increased whereas the central herd was stable. (B) The age and sex composition remained near long-term averages and within desired ranges for conservation. (C) Snowpack severity progressively decreased over the last four years resulting in fewer numbers of animals exiting the park and removals. (E) Despite higher numbers, conflicts associated with bison moving outside the park remained low.

(D) Removing 800 animals during the 2022-23 winter would stabilize the population and cease current exponential growth.

Introduction

The National Park Service created an integrated population model to support science-based management of the Yellowstone bison population. The model uses current data to estimate the abundance and composition of the population and identify a reduction strategy that meets population conservation objectives. The National Park Service provides this recommendation to Interagency Bison Management Plan partners² to inform their efforts to manage bison that migrate out of the park and into the State of Montana.

Management Recommendations

- The NPS can manage bison migrating to park boundaries to support the unique relationship among tribes and bison, while reducing conflicts that occur when bison exit the park.
- The NPS can capture animals in the bison facility near the northern park boundary in ways that balance transferring live animals to tribal lands, providing meat and hides to tribes for food, supporting tribal hunting opportunities outside the park, lowering numbers of animals exiting the park, and reducing population growth.
- The number of animals captured by the NPS should depend on the number of animals migrating to the northern park boundary, capacity for live transfer of animals, hunter success outside the park, and level of conflicts outside the park.
- If few animals migrate, the NPS could passively capture animals throughout winter through baiting and rounding-up animals nearby the capture facility. Captured animals that qualify for brucellosis quarantine could be entered in the Bison Conservation Transfer Program for their eventual live release to tribes. Animals that don't qualify for the program could be given to tribes for their meat and hides. Other bison in the area would be allowed to move towards park boundaries and support hunting opportunities outside the park.
- If more animals migrate, the NPS could capture animals up to program capacity of the Bison Conservation Transfer Program, entering eligible animals and giving ineligible animals to tribes for their meat and hides (about 400-600 animals captured). Bison would be allowed to move past the facility throughout winter to support hunting opportunities outside the park. Once program capacity is met, bison could be hazed away from facility.
- If bison continue to migrate to wintering areas near the northern park boundary in numbers exceeding tolerance for them, additional animals could be captured to reduce numbers up to a total removal of 1,500 animals (25% of the population). Removing more than 25% of the population is not recommended due to unintended consequences on population conservation, reducing tribal hunting opportunities, and reducing future transfers of live bison to tribes.
- Removals should only occur near the northern park boundary where animals from the central and northern herds intermix.
- The age and sex structure of the population is near conservation objectives allowing nonselective removal.

Objective 1. Sustain a viable wild population.

- The estimate for the bison population in summer 2022 was 6,013 animals. Within the last year, the bison population ranged from about 5,472 in June 2021 to about 5,020 animals at the end of winter, before increasing to its current level.
- The population increased from around 4,594 since 2018 due to a series of progressively less severe winters with fewer animals exiting the park.
- Survival and birth rates remained high as numbers increased, with the population maintaining an annual growth rate of 14.5% when accounting for management removals.
- The population remains below the predicted capacity based on forage production of 5,000 in northern regions of the park and 10,000 across the entire park.
- Grasslands sustained ecosystem function with higher bison numbers. Monitoring during 2015-2022 confirmed soil organic matter was stable, unchanged under yearlong grazing exclusion, and within ranges supporting nutrient cycling, water holding potential, and physical structure. Grazed plant communities maintained primary production compared to yearlong grazing exclusion, although one area of the Lamar Valley shows a gradual decline in production over time.
- The larger numbers helped maintain existing genetic diversity without genetic exchange from other bison populations. Allelic diversity, allele frequencies, and inbreeding levels remained similar over more than two

² National Park Service, U.S. Forest Service, Animal and Plant Health Inspection Service, Montana Department of Livestock, Montana Fish, Wildlife and Parks, Confederated Salish and Kootenai Tribes, InterTribal Buffalo Council and Nez Perce Tribe.

decades based on 44 microsatellites across the bison genome. Also, bison from both the native and introduced lineages remain in the population in approximate equal distribution based on mitochondrial DNA.

- The larger numbers conserved improved visitor experience by providing an unparalleled opportunity to view large herds of free-roaming bison.
- IBMP managers made consensus decisions about population targets since 2013 that led to a bison population averaging near 5,100 animals after calving. Managers agreed to these numbers, because of increased tolerance for bison outside the park, balancing hunting outside the park with capturing animals for slaughter inside the park, developing a transfer program to rehome bison to tribes, and continued success limiting bison-related conflicts outside the park.

Objective 2. Remove fewer than 25% of the population and less than 1,000 animals when possible.

- Managers removed 50 bison (<1% of the population) during winter 2021-2022. State and tribal hunters harvested 13 bison outside the park in the State of Montana. National Park Service captured 38 animals using the bison facility located near the northern park boundary. Captured bison were transferred to tribes for meat and hides (27), entered in brucellosis quarantine for their eventual live transfer to tribes (10), or released back into the park (1).
- Most (88%) removals occurred near the northern park boundary.
- Removals included 20% adult male, 56% adult female, 12% yearling, and 12% calf.
- Removals during the last five years (2018-2022) were biased towards juveniles and adult females and altered population composition. During this time, managers averaged removing 35% of annual calf cohorts prior to their reaching two years of age and about 1.9 adult females to each adult male.
- Removing less than 25% of the population reduces the chances of altering population composition and reducing genetic diversity.

Objective 3. Maintain more than 1,000 bison in northern and central herds.

- Aerial surveys in August 2022 counted 4,420 and 4,507 bison in the northern herd (5-year average 3,760), and 1,284 and 1,432 bison in the central herd (5-year average 1,318).
- Bison breed in northern or central geographic regions of the park with some interchange of animals between breeding areas among years. The founding maternal lineages of the population are found in both breeding areas. Between two and five groups of related alleles based on neutral markers exist across the park. Maintaining more than 1,000 bison in each breeding area helps to protect any existing unique diversity or rare alleles. It also allows bison to be a meaningful component of the food web influencing energy and nutrient transfer throughout the ecosystem across a broad geographic area of the park.

Objective 4. Maintain a balanced sex ratio.

- The proportion of females in the population increased over the last year with 91 males per 100 females (excluding calves). Over the last five years, the sex ratio averaged 52% males and 48% females.
- Males outnumbered females in the central herd with 108 males per 100 females (5-year average of 144:100) and females outnumbered males in the northern herd with 83 males per 100 females (5-year average 98:100).
- A balanced sex ratio supports mate competition allowing natural selection to affect population genetics.

Objective 5. Maintain an age structure of about 70% adults and 30% juveniles.

- The population consisted of 31% juvenile animals (0 to 16 months of age), including 45 calves per 100 adult females and 39 yearlings per 100 adult females. Over the past five years, the age composition averaged 28% juveniles and 72% adults.
- Juveniles made up 30% of animals in the central herd (5-year average 24%) compared to 32% in the northern breeding area (5-year average 29%).
- An age structure of about 70% adults and 30% juveniles is based on the expected population composition based on age-specific birth and survival rates.

Appendix A: Summaries of Counts, Classifications, and Removals during 2000-2022

Table A1. Aerial counts of the Yellowstone bison population completed during 2000 to 2022^a.

		Park Total	Central Herd			Northern Herd		
			Total	Adults	Calves	Total	Adults	Calves
2000	June 4, 2000	2,613	2,060	1,734	326	553	460	93
	July 13, 2000	2,432	1,924			508		
	August 31, 2000	2,708	2,118			590		
2001	June 21, 2001	3,256	2,595	2,126	469	661	557	104
	July 24-25, 2001	2,859	2,564			719		
2002	June 25, 2002	3,648	3,100	2,560	540	548	477	71
	July 29, 2002	3,715	2,902			812		
	August 22, 2002	4,045	3,240			805		
2003	July 10, 2003	3,778	2,900	2,466	434	878	753	125
	August 8, 2003	3,811	2,923			888		
	August 28, 2003	3,766	2,770			996		
2004	July 21, 2004	4,148	2,811	2,310	501	1,337		
	July 28, 2004	3,995	3,027			968		
	August 4, 2004	4,215	3,339			876		
2005	July 19, 2005	4,819	3,553			1,266		
	July 26, 2005	4,747	3,394			1,353		
	August 1, 2005	5,015	3,531			1,484		
2006	July 19, 2006	3,713	2,430	2,146	284	1,283		
	July 26, 2006	3,889	2,512			1,377		
	August 2, 2006	3,775	2,496			1,279		
2007	June 14, 2007	4,554	2,734	2,385	349	1,820	1,499	321
	July 30, 2007	3,959	2,390			1,569		
	August 6, 2007	4,694	2,624			2,070		
2008	June 14, 2008	2,943	1,150	1,047	103	1,793	1,468	325
	July 8, 2008	2,881	1,540			1,341		
	July 15, 2008	2,969	1,469			1,500		
2009	June 12, 2009	3,301	1,464	1,295	169	1,837	1,518	319
	July 9, 2009	2,977	1,544			1,433		
	July 16, 2009	3,183	1,535			1,648		
2010	June 14, 2010	3,898	1,652	1,425	227	2,246	1,891	355
	July 8, 2010	3,715	1,730			1,985		
	July 22, 2010	3,563	1,708			1,855		
2011	June 21, 2011	3,651	976	880	96	2,675	2,188	487
	July 12, 2011					2,288		
	July 18, 2011	3,720	1,406			2,314		
	July 25, 2011	3,485	1,330			2,155		
2012	June 21, 2012	3,885	1,395	1,194	201	2,490	2,097	393
	July 8, 2012	4,171	1,640			2,531		

	July 22, 2012	4,230	1,561			2,669		
2013	June 6, 2013	4,492	1,327	1,159	168	3,165	2,631	534
	July 15, 2013	4,924	1,504			3,420		
	July 22, 2013	4,565	1,334			3,231		
2014	June 20, 2014	4,857	1,340	1,192	148	3,517	2,926	591
	July 18, 2014	4,386	1,444			2,942		
	July 25, 2014	4,865	1,441			3,424		
2015	June 13-14, 2015	4,910	1,282	1,113	169	3,628	2,997	631
	July 12, 2015	4,616	1,291			3,325		
	July 19-20, 2015	4,764	1,323			3,441		
2016	June 18 & 28, 2016	5,459	1,451	1,280	171	4,008	3,312	696
	July 18, 2016	4,736	1,584			3,152		
	July 25, 2016	4,809	1,638			3,171		
	August 8, 2016		NA			4,042		
2017	August 03, 2017					3,619		
	August 4-5, 2017	4,816	847			3,969		
2018	June 4-5, 2018	4,401	758	679	79	3,643	2,994	649
	August 4-5, 2018	4,527	1,190			3,337		
	September 2-3, 2018	4,372	1,162			3,210		
2019	June 12-13, 2019	4,829	1,162	1,013	149	3,667	2,995	672
	July 29-30, 2019	4,664	1,124			3,540		
2020	August 21-22, 2020	4,680	1,243			3,437		
	August 23-24, 2020	4,658	1,251			3,407		
2021	August 24-25, 2021	5,394	1,564			3,830		
	August 26-28, 2021	4,922	1,299			3,623		
2022	August 26-29, 2022	5,704	1,284			4,420		
	August 30-31, 2022	5,939	1,432			4,507		

^aWe reevaluated flight totals during summer 2017 using updated count areas for each herd based on an improved understanding of bison movements.

Table A2. Composition surveys of the Yellowstone bison population during 2003 to 2022. Numbers in parentheses show results from repeated counts.

Year	Herd	Classified in Mixed Gender Groups					Air Count	
		Male>1	Male1	Female>1	Female1	Calf	Bachelor	Mixed
2003	C	438	150	1,426	241	498	379	2,521
	N	159 (133)	23 (11)	176 (227)	12 (15)	46 (110)	83	795
2004	C	638 (523)	179 (125)	1,082 (932)	126 (131)	497 (397)	217	2,594
	N	247 (232)	35 (26)	331 (458)	33 (49)	164 (145)	127	1,210
2005	C	500 (674)	178 (175)	1,098 (1,060)	162 (148)	430 (443)		
	N	276 (205)	63 (49)	441 (324)	51 (37)	153 (97)		
2006	C	368 (386)	141 (152)	654 (757)	101 (111)	258 (301)	352	2,078
	N	102	27	202	40	103		
2007	C	375 (555)	100 (119)	709 (805)	109 (106)	342 (305)		
	N	300 (173)	139 (28)	637 (366)	101 (28)	339 (169)		
2008	C	116	36	387	50	110	439	1,101

	N	198	87	433	61	232	183	1,158
2009	C	145 (161)	63 (62)	427 (498)	73 (47)	158 (186)	481	1,063
	N	244 (224)	84 (83)	414 (391)	53 (53)	237 (179)	194	1,239
2010	C	340 (369)	72 (82)	517 (537)	57 (81)	219 (228)	338	1,370
	N	228 (298)	126 (150)	934 (679)	140 (121)	391 (344)	230	1,755
2011	C	118 (163)	58 (53)	323 (309)	37 (40)	105 (106)	444	962
	N	303	131	915	99	361	185	2,103
2012	C	282 (420)	68 (80)	493 (477)	41 (55)	173 (216)	398 (212)	1,242 (1,349)
	N	375 (405)	187 (114)	876 (698)	165 (84)	466 (288)	80 (50)	2,451 (2,619)
2013	C	287 (372)	101 (102)	415 (401)	82 (77)	197 (191)	342 (186)	1,162 (1,148)
	N	457 (608)	231 (249)	1,061 (1,149)	191 (198)	528 (538)	145 (80)	3,275 (3,151)
2014	C	275 (296)	113 (71)	565 (380)	69 (63)	206 (145)	276 (282)	1,168 (1,159)
	N	310 (565)	155 (266)	1,023 (1,314)	126 (259)	422 (612)	145 (261)	2,797 (3,163)
2015	C	187 (310)	43 (58)	301 (364)	42 (58)	165 (166)	240 (166)	1,051 (1,157)
	N	651 (738)	219 (192)	1,499 (1,144)	203 (141)	689 (507)	149 (69)	3,176 (3,372)
2016	C	350 (327)	106 (37)	457 (316)	79 (25)	185 (95)	169 (142)	1,415 (1,496)
	N	770 (839)	316 (304)	1,510 (1,570)	248 (200)	763 (766)	123 (56)	3,029 (3,115)
2017	C	388	44	275	39	106	88	759
	N	1,167	221	1,279	231	585	59	3,910
2018	C	405	59	324	34	126	105	1,085
	N	983	179	1,065	134	512	35	3,302
2019	C	317	37	213	27	84	106	1,018
	N	1,065	192	1,140	195	500	175	3,365
2020	C	174	37	153	19	71	151	1,092
	N	296	44	283	37	140	100	3,337
2021	C	346	79	372	72	198	208	1,356
	N	898	251	1,273	224	556	159	3,671
2022	C	331	78	348	76	158	90	1,182
	N	767	217	1,091	189	515	118	4,302

Table A3. Numbers of bison removed from Yellowstone National Park or nearby areas of Montana during winters from 1970 to 2022.

Winter	Maximum No. Bison Counted Previous June-August ^b			Sent to Slaughter/Management Culls		Hunter Harvest ^a		Sent to Quarantine Research		Total	Age and Gender Composition of Culls/Harvests			
	North	Central	Total	N	W	N	W	N	W		M	F	C	Unk
1970-84				0	0	13	0	0	0	13	4	7	0	2
1984-85	695	1,552	2,247	0	0	88	0	0	0	88	42	37	8	1

1985-86	742	1,609	2,351	0	0	41	16	0	0	57	42	15	0	0
1986-87	998	1,778	2,776	0	0	0	7	0	0	7	5	2	0	0
1987-88	940	2,036	2,976	0	0	2	37	0	0	39	27	7	0	5
1988-89	1,058 ^h	2,089 ^h	3,147 ^h	0	0	567	2	0	0	569	295	221	53	0
1989-90	432 ^h	2,075 ^h	2,507 ^h	0	0	1	3	0	0	4	0	0	0	4
1990-91	818	2,203	3,021	0	0	0	14	0	0	14	0	0	0	14
1991-92	822	2,290	3,112	249	22	0	0	0	0	271	113	95	41	22
1992-93	681	2,676	3,357	0	79	0	0	0	0	79	9	8	9	53
1993-94	636 ^h	2693 ^h	3329 ^h	0	5	0	0	0	0	5	0	0	0	5
1994-95	1,140	2,974	4,114	307	119	0	0	0	0	426	77	66	31	252
1995-96	866	3,062	3,928	26	344	0	0	0	0	370 ^c	100	71	10	189
1996-97	860 ^h	2,724 ^h	3,584 ^h	725	358	0	0	0	0	1,083 ^d	329	330	144	280
1997-98	455	1,715	2,170	0	11	0	0	0	0	11	0	0	0	11
1998-99	489 ^h	1,622 ^h	2,111 ^h	0	94	0	0	0	0	94	44	49	1	0
1999-00	540	1,904	2,444	0	0	0	0	0	0	0	0	0	0	0
2000-01	590 ^h	2,118 ^h	2,708 ^h	0	6	0	0	0	0	6	6	0	0	0
2001-02	719	2,564	3,283	0	202	0	0	0	0	202	60	42	16	84
2002-03	805 ^h	3,240 ^h	4,045	231	13	0	0	0	0	244	75	98	43	28
2003-04	888	2,923	3,811	267	15	0	0	0	0	282	58	179	23	22
2004-05	876	3,339	4,215	1	96	0	0	0	17	114	23	54	20	17
2005-06	1,484	3,531	5,015	861	56	32	8	87	0	1,044	205	513	245	81
2006-07	1,377	2,512	3,889	0	4	47	12	0	0	63	53	6	0	4
2007-08	2,070	2,624	4,694	1,288	160	59	107	112	0	1,726	516	632	332	246
2008-09	1,500	1,469	2,969	0	4	1	0	0	0	5	5	0	0	0
2009-10	1,837 ^h	1,464 ^h	3,301 ^h	3	0	4	0	0	0	7	7	0	0	0
2010-11	2,246 ^h	1,652 ^h	3,898 ^h	6	0	Unk	Unk	53	0	260	106	102	52	0
2011-12	2,314	1,406	3,720	0	0	15	13	0	0	28 ^e	14	12	2	0
2012-13	2,669	1,561	4,230	0	0	148	81	0	0	250 ^f	116	85	28	0
2013-14	3,420	1,504	4,924	258	0	258	69	60	0	645 ^g	202	287	152	4
2014-15	3,424 ^h	1441 ^h	4,865	511	0	201	18	7	0	737	276	297	161	3
2015-16	3,627 ^h	1,282 ^h	4,910 ^h	101	0	378	24	49	0	552	175	227	146	4
2016-17	4,008	1,451	5,459	753	0	389	97	35	0	1,274	311	585	342	36
2017-18	3,969	847	4,816	697	0	285	90	99	0	1,171	300	491	288	92
2018-19	3,337	1,190	4,527	348	0	109	3	0	0	460	97	159	204	0
2019-20	3,667	1,162	4,829	445	0	221	63	105	0	834	180	328	193	133
2020-21	3,427	1,243	4,670	0	0	153	34	0	0	187	64	57	42	24
2021-22	3,830	1,564	5,394	27	0	6	7	10	0	50	15	29	6	0

^a Total includes bison harvested by game wardens and State of Montana hunters during 1973 through 1991, and state and tribal hunters after 2000.

^c The Final Environmental Impact Statement reported 433 bison, but records maintained by Yellowstone National Park only indicate 370 bison.

^d Total does not include an unknown number of bison captured at the north boundary and consigned to a research facility at Texas A&M University (about 100 bison).

^e There is a report of 29 removals with differences owing to reported harvests.

^f There is a report of 260 removals with differences owing to reported harvests.

^g There is a report of 650 removals with differences owing to reported harvests.

^h We reevaluated flight totals during summer 2017 using updated count areas for each herd and including flights occurring June 1-August 31.

Table A4. Bison related conflicts reported by Yellowstone National Park, State of Montana, U.S. Forest Service, and Animal and Plant Health Inspection Service during 2009-2021.

Winter	No. Bison Zone 3N	Hazing Events (N)	Bison-Cattle (N)	No. Bison Zone 3W	Hazing Events (W)	Bison-Cattle (W)	Brucellosis Tx to Livestock	State of MT Management Requests	People Injured (YNP)	Bison Related Motor Vehicle Accidents (YNP/MT)
2009	0	13	0	228	30	1	0	NA	NA	4
2010	0	7	0	330	28	1	0	NA	NA	3
2011	65	174	9	168	25	1	0	142	NA	6
2012	0	1	2	190	33	2	0	75	NA	5
2013	1	81	6	500	37	1	0	77	NA	14
2014	569	42	0	110	30	0	0	189	NA	4
2015	0	5	0	100	37	0	0	NA	5	3
2016	0	11	0	40	10	0	0	13	3	3
2017	50	3	0	25	12	0	0	33	2	2
2018	0	0	0	30	4	0	0	58	4	13
2019	0	0	0	115	6	0	0	33	3	11
2020	25	3	0	40	12	0	0	46	2	19
2021	0	0	0	24	3	0	0	29	3	12

Table A5. Net aboveground herbaceous production (g m^{-2}) in sites monitored across Yellowstone National Park.

Site	Region	2015	2016	2017	2018	2019	2020	2021	2022
Lamar	L1	290	301	417	292	394	331	327	338
Valley	L2	214	141	290	264	115	149	89	116
	L3	213	202	348					
	L4	263	193						
	L5			202					
	L6		178	278					
	L7								380
Slough	S1	58	57	107	79	101	96		104
Creek	S2	224	188	344		142	152		223
	S3				48				
	S4			52	101				
	S5				118				
	S6								244
Hellroaring	H1	100	62	115	114	94			100
	H2	165	77						
	H3	116	96						
Blacktail	B1	85	62	90	68	59			70
	B2	66	35						
Gardiner	G1	62							
	G2	74	160						
	G3			106					
Hayden	H1	321	265	304					
Valley	H2	213	201						
	H3	147							
	H4		164						
Firehole	F1	206	130						

Valley	F2	140	109
Madison	M1	414	278
Valley	M2	114	91
	M3	367	227

Table A6. Percent soil organic matter in top 10cm of soil in sites monitored across Yellowstone National Park.

Site	Region	2015	2016	2017	2018	2019	2020	2021	2022
Lamar	L1	10.1	9.3	10.6	9.0	11.0	13.2	12.7	
Valley	L2	11.8	12.6	13.9	14.3	17.0	12.9	12.5	
	L3	18.9	20.4	25.0		24.1	17.9	20.9	
	L4	18.5	20.1				17.3	19.0	
Slough	S1	7.0	5.8	6.7	6.8	6.2	5.5		
Creek	S2	14.3	13.6	13.7		13.0	13.7		
Hellroaring	H1	13.5	11.9	13.0	12.2	15.2			
Blacktail	B1		12.6	9.6	9.0	12.9			
Hayden	H1	13.9	17.5	14.8	16.9	13.8			
Valley									

Table A7. Population genetic measures of Yellowstone bison monitored during 2016-2021 (n=189) based on 44 microsatellites located across the bison genome.

Loci	Expected Heterozygosity	Inbreeding Coefficient	Allelic Richness
AGLA232	0.6546	-0.0049	5
BL1036	0.6512	-0.0265	4
BM1225	0.7022	0.01	5
BM1706	0.4172	-0.0253	5
BM17132	0.7216	-0.082	5
BM1824	0.7506	-0.0188	6
BM1862	0.6873	-0.0659	5
BM2113	0.5486	-0.082	4
BM2830	0.8084	-0.0584	9
BM4028	0.6716	0.0207	4
BM4107	0.5868	0.0157	5
BM4311	0.7404	-0.0544	6
BM4440	0.6261	0.0519	5
BM47	0.2383	-0.0323	5
BM711	0.5129	0.0199	4
BM720	0.7964	-0.0139	6
BM757	0.5623	-0.008	5
BMC4214	0.7461	-0.0106	5
BMS1001	0.6832	-0.002	5
BMS1074	0.6464	0.0156	4
BMS1117	0.6176	-0.0391	3
BMS1172	0.5646	-0.023	5
BMS1315	0.6376	-0.0399	4
BMS1355	0.3336	-0.0579	3
BMS1675	0.4135	-0.0734	3

BMS1716	0.3749	-0.0556	4
BMS1747	0.7184	0.0174	4
BMS1857	0.7995	0.0047	6
BMS2258	0.7456	0.0245	5
BMS2639	0.6633	-0.0319	4
BMS410	0.6623	0.0149	4
BMS510	0.6658	-0.004	4
BMS527	0.6847	0.0237	6
BMS528	0.7592	-0.0425	5
BMS812	0.6436	0.0528	5
BMS941	0.5088	0.075	3
HUJ246	0.5416	-0.0169	4
IL4	0.7267	-0.0155	8
ILSTS102	0.6183	0.0314	3
INRA037	0.6361	0.0247	4
INRA194	0.6367	0.0425	5
TGLA122	0.7584	0.0057	5
TGLA44	0.6651	-0.0211	6
TGLA53	0.5184	-0.1098	3

Table A8. Allele frequencies of Yellowstone bison monitored during 1997-2003 (n=661) and 2016-2021 (n=189) based on 44 microsatellites located across the bison genome.

Loci	Allele	Frequency		Loci	Allele	Frequency		Loci	Allele	Frequency	
		1996-2003	2016-2021			1996-2003	2016-2021			1996-2003	2016-2021
AGLA232	159	0.20%	0.00%	BM47	102	0.00%	1.87%	BMS2258	127	18.20%	15.78%
	161	30.80%	36.36%		103	87.80%	86.63%		140	40.30%	39.30%
	165	53.00%	44.92%		104	0.00%	0.53%		142	17.90%	21.39%
	167	3.20%	5.08%		105	11.70%	10.70%		146	0.10%	0.00%
	169	4.30%	4.28%		107	0.50%	0.27%		148	13.80%	16.04%
BL1036	173	8.60%	9.36%	BM711	161	62.30%	65.78%	BMS2639	150	9.70%	7.49%
	177	18.50%	22.99%		165	8.40%	5.08%		168	18.00%	20.32%
	179	2.60%	2.67%		167	23.10%	21.93%		170	35.90%	33.96%
	181	27.50%	27.01%		175	6.20%	7.22%		172	41.70%	42.51%
	191	51.40%	47.33%	BM720	213	15.50%	10.70%		186	4.40%	3.21%
BM1225	241	41.20%	39.04%		225	14.80%	11.76%	BMS410	83	45.50%	37.70%
	249	0.80%	0.27%		227	0.20%	0.00%		89	22.40%	25.13%
	253	20.00%	18.45%		229	23.90%	21.93%		95	0.40%	0.53%
	269	8.90%	10.16%		231	33.40%	32.09%		97	31.80%	36.63%
	271	29.20%	32.09%		233	3.00%	8.82%	BMS510	91	39.60%	42.25%
BM1706	232	6.50%	5.61%	BM757	235	9.20%	14.71%		92	30.60%	36.36%
	238	75.50%	74.33%		188	0.10%	0.27%		94	7.00%	7.22%
	250	0.40%	1.07%		190	0.80%	1.34%		95	22.80%	14.17%
	252	15.10%	16.58%		192	1.10%	0.00%	BMS527	163	4.80%	2.41%

BM17132	254	2.50%	2.41%	BMC4214	194	58.00%	60.43%	BMS528	165	1.60%	0.27%
	85	39.60%	33.96%		196	15.70%	16.04%		167	4.40%	9.63%
	87	16.00%	14.97%		200	24.30%	21.93%		173	22.30%	23.26%
	89	27.50%	35.03%		175	19.10%	18.72%		175	50.50%	47.33%
BM1824	91	3.70%	2.14%	BMS1001	179	2.70%	4.28%	BMS812	177	16.50%	17.11%
	95	13.20%	13.90%		181	10.20%	14.44%		140	27.60%	20.32%
	180	39.30%	38.50%		185	34.60%	27.81%		146	19.50%	24.60%
	184	17.30%	18.98%		187	33.40%	34.76%		148	36.40%	34.22%
BM1862	190	5.30%	9.09%	BMS1074	107	1.20%	0.80%	BMS941	150	9.90%	13.64%
	192	8.70%	8.02%		108	0.00%	35.83%		152	6.70%	7.22%
	196	3.70%	2.67%		109	35.80%	0.00%		90	11.20%	11.76%
	198	25.80%	22.73%		110	0.00%	3.48%		106	49.60%	51.60%
BM2113	201	1.10%	0.27%	BMS1117	111	1.70%	0.00%	HUJ246	108	29.30%	27.01%
	202	3.60%	4.28%		113	24.90%	22.99%		110	4.80%	3.21%
	205	38.40%	39.04%		115	36.50%	36.90%		112	5.00%	6.42%
	207	28.40%	25.94%		154	12.80%	12.57%		81	36.20%	45.45%
BM2830	211	28.50%	30.48%	BMS1172	156	14.90%	23.80%	IL4	83	62.80%	53.48%
	129	24.40%	24.06%		158	14.10%	11.76%		85	1.10%	1.07%
	133	9.20%	5.61%		160	58.30%	51.87%		258	26.00%	29.41%
	143	59.60%	62.03%		89	25.40%	27.54%		260	7.10%	4.81%
BM4028	149	6.80%	8.29%	BMS1315	91	21.40%	21.12%	ILSTS102	262	61.50%	60.70%
	140	16.50%	10.96%		93	53.10%	51.34%		264	5.40%	5.08%
	146	5.30%	5.88%		88	3.10%	4.55%		83	4.00%	5.61%
	148	3.80%	1.07%		90	63.10%	61.50%		89	34.80%	44.65%
BM4107	150	6.50%	6.42%	BMS1355	100	1.50%	2.41%	INRA037	91	0.20%	0.00%
	152	30.10%	30.75%		102	21.60%	21.39%		93	3.00%	2.14%
	156	1.00%	0.53%		104	10.70%	10.16%		97	14.40%	16.31%
	158	21.30%	21.66%		135	53.10%	53.48%		99	8.10%	6.95%
BM4311	160	0.20%	0.00%	BMS1675	137	16.60%	16.58%	INRA194	101	0.10%	0.53%
	162	6.20%	5.61%		141	20.20%	20.32%		103	30.80%	19.79%
	164	9.20%	17.11%		147	10.10%	9.63%		105	4.70%	4.01%
	108	12.20%	13.10%		146	79.00%	80.48%		143	48.60%	51.34%
BM4311	114	14.60%	9.36%	BMS1716	148	13.50%	11.23%	TGLA122	145	23.50%	27.01%
	116	33.10%	34.49%		150	7.50%	8.29%		147	27.80%	21.66%
	118	40.10%	43.05%		87	71.90%	74.33%		120	8.90%	9.36%
	165	51.40%	60.16%		89	10.30%	9.63%		122	41.10%	42.25%
BM4311	179	17.30%	14.44%	BMS1747	91	17.80%	16.04%	TGLA122	124	45.30%	41.71%
	181	8.90%	9.36%		189	14.30%	10.16%		132	4.70%	6.68%
	183	21.00%	15.24%		191	75.90%	77.54%		144	10.90%	7.49%
	185	1.40%	0.80%		193	0.60%	0.27%		154	47.20%	50.53%
BM4311	90	6.40%	4.81%	BMS1747	195	9.20%	12.03%	TGLA122	156	33.20%	31.28%
	92	7.60%	8.82%		95	28.50%	29.68%		158	7.50%	6.95%
	96	9.50%	9.63%		99	33.60%	32.62%		160	1.20%	3.74%
	98	36.80%	39.30%		101	30.20%	28.34%		136	4.40%	5.08%
BM4311	102	9.30%	9.36%	BMS1747	103	7.80%	9.36%		140	20.60%	17.91%

BM4440	104	30.40%	28.07%	BMS1857	0	0.00%	0.53%	TGLA44	142	18.00%	17.38%
	106	0.10%	0.00%		142	13.50%	0.00%		144	0.10%	0.00%
	123	4.90%	5.35%		143	0.00%	9.09%		148	31.20%	32.09%
	125	53.80%	54.81%		150	17.50%	0.00%		150	25.70%	27.54%
	127	25.30%	22.19%		151	0.00%	18.18%		149	11.10%	10.70%
	129	14.70%	14.97%		156	11.00%	0.00%		151	3.20%	2.41%
	131	1.20%	2.67%		158	26.30%	15.24%		153	30.70%	33.16%
					160	25.30%	20.05%	TGLA53	155	43.50%	45.99%
					161	0.00%	30.21%		157	3.30%	2.94%
					170	6.30%	6.68%		159	8.20%	4.81%
									134	46.70%	36.90%
									136	51.00%	58.29%
									140	2.40%	4.28%