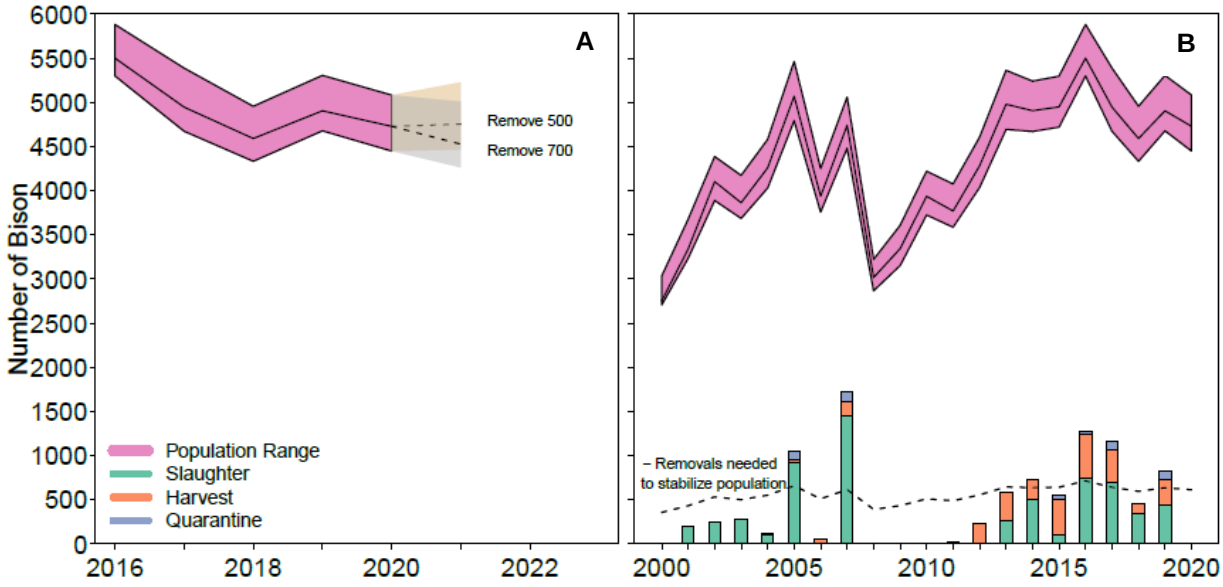
Status Report on the Yellowstone Bison Population

Chris Geremia[1] October 14, 2020

Summary

- There are currently about 4,730 animals in the Yellowstone bison population. Within the last year, the bison population ranged from a high of about 4,906 animals in June 2019 to low of about 3,992 in April 2020.
- Removing 500 to 700 bison during winter 2020-2021 should stabilize to slightly reduce the population to 3,850-4,040 at the end of winter and 4,500-4,730 animals after calving.
- Removals should only occur near the northern park boundary where animals from the central and northern herds intermix. Managers should track migrations and focus removals on the northern herd.
- If initial removal targets are met, up to 200 additional adult males could be harvested or captured in late winter.
- Certified quarantine facilities are at capacity precluding entering new animals in the conservation and transfer program until winter 2021-2022.



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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 partners[2] to inform their development of a consensus strategy for managing bison that migrate out of the park and into the State of Montana.

Management Recommendation

- Removal of 500 to 700 bison during winter 2020-2021 should stabilize or slightly reduce the population to 3,850-4,040 at the end of winter and 4,500-4,750 animals after calving.
- Removals should only occur near the northern park boundary where animals from the central and northern herds intermix. Migrations should be tracked to preferentially remove northern herd animals.
- Annual removals are biased towards juveniles and adult females, because they are more likely to migrate to wintering areas where they may be harvested or captured. To reduce skewing the age and sex structure, removals should target 135-189 calves, 80-112 yearlings, 189-259 adult females and 100-140 adult males. Such removals will likely increase the number of males from 127 to 133-137 males per 100 females and reduce the juvenile component to near 26%.
- Certified quarantine facilities in and near Yellowstone National Park are at capacity, which prevents entering new animals into the program during this winter. Removing more than 700 animals could reduce the number of animals available to enter quarantine in winter 2021-2022. The NPS is planning to expand its quarantine facility to accept up to 150 by winter 2021-2022.
- If initial removal targets are met, up to 200 additional adult males could be harvested or captured to balance the sex ratio and age structure. Such action would have minimal impact on quarantine intake in winter 2021-2022.

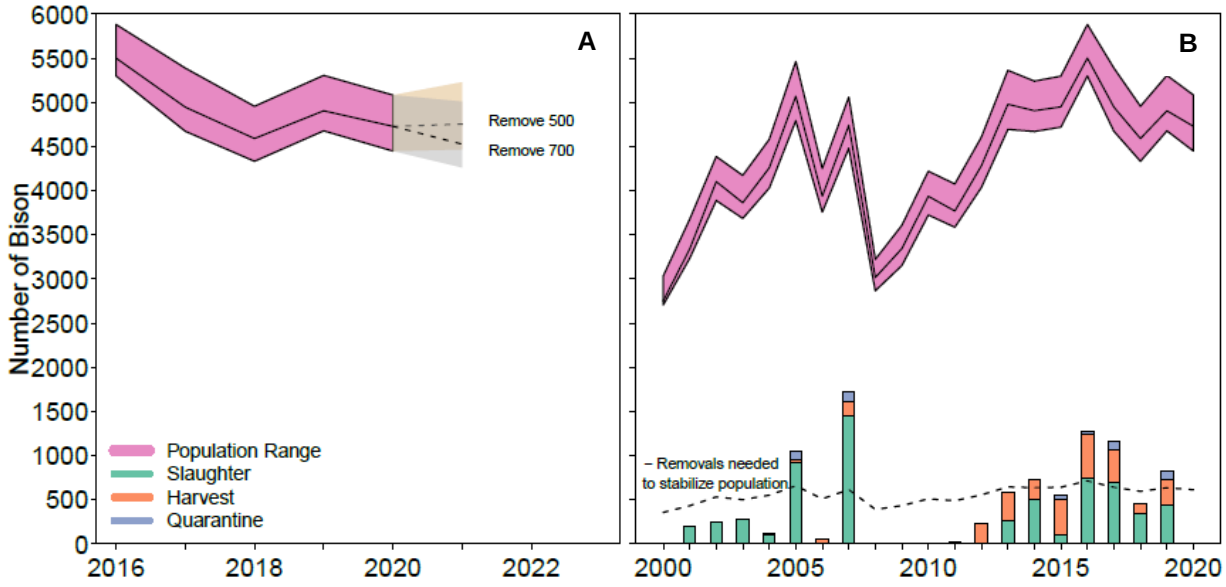

Figure 1. Removal Recommendation for winter 2020-2021
(A) Removal of 500-700 bison during winter 2020-2021 should stabilize to slightly reduce the population. **(B)** It takes a bison population of at least 3,800 at the end-of-winter or 4,500 after calving for the number of animals migrating to wintering areas to equal or exceed the number of animals that must be removed to stop exponential growth and stabilize the population. In **A-B**, purple polygons represent the 95% confidence range of the population after spring calving. In **B**, colored bars show numbers of bison rounded up and transferred to slaughter, harvested by state and tribal hunters or entered in the conservation and transfer program.

[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.

Objective 1. Sustain a viable wild population.

- The most likely estimate for the bison population at the end of calving in June 2020 was 4,730 animals. Within the last year, the population ranged from a high of 4,906 animals in June 2019 to 3,992 animals at the end of winter.
- Managers reached consensus agreement on removal targets since 2013. During that time, the bison population averaged near 4,100 at the end-of-winter and 4,900 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.
- Current data shows that the bison population has the potential to grow exponentially. The number of animals moving to wintering areas surrounding park boundaries increases with population size. It takes a bison population of at least 3,800 at the end-of-winter or 4,500 after calving for the number of animals migrating to wintering areas to equal or exceed the number of animals that must be removed to stop exponential growth and stabilize the population. Bison that migrate to wintering areas can be removed through hunting outside the park or capture for slaughter or transfer.
- The larger numbers conserved since 2013 supported bison as a meaningful component of the food web influencing energy and nutrient transfer throughout the ecosystem; improved visitor experience by providing an unparalleled opportunity to view large herds of free-roaming bison; and ensured gene flow and conservation of existing genetic diversity.

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

- Managers removed 834 (17% of the population) bison during winter 2019-2020, which was within the range of 600 to 900 agreed to by managers. Removals included 548 bison captured at the Stephens Creek facility with 105 entered in brucellosis-quarantine for transfer to the Fort Peck Tribes, 442 sent to slaughter and 1 bison dying during handling; 284 bison harvested outside the park in Montana; and 2 bison shot outside the conservation area.
- Removals were biased to adult females and younger animals, including 51% adults (68% females and 32% males) and 49% juveniles (43% yearlings and 57% calves). Over the last five years, managers averaged removing 50% 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 age and sex composition and reducing genetic diversity.

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

- Aerial surveys in August 2020 counted 3,437 and 3,407 bison in the northern herd (5-year average 3,688) and 1,243 and 1,251 bison in the central herd (5-year average 1,179).
- 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 each breeding area. Maintaining more than 1,000 bison in each breeding area helps to protect any existing unique diversity or rare alleles (genes) within each breeding area. 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 sex ratio was 127 males per 100 females (excluding calves). Over the last five years, the sex ratio averaged 53% male and 47% female and became overrepresented by males.
- Males were overrepresented more so in the central herd with 149 males per 100 females (5-year average of 153:100) compared to 114 males per 100 females in the northern herd (5-year average 97:100).
- 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.

- About 25% of the population was composed of juvenile animals (0 to 16 months of age), which included 48 calves per 100 adult females and 28 yearlings per 100 adult females. Over the past five years, the age composition averaged 27% juveniles and 73% adults.

- Older animals were overrepresented more so in the central herd with juveniles making up 21% of animals in the breeding area (5-year average 22%) compared to 27% 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.

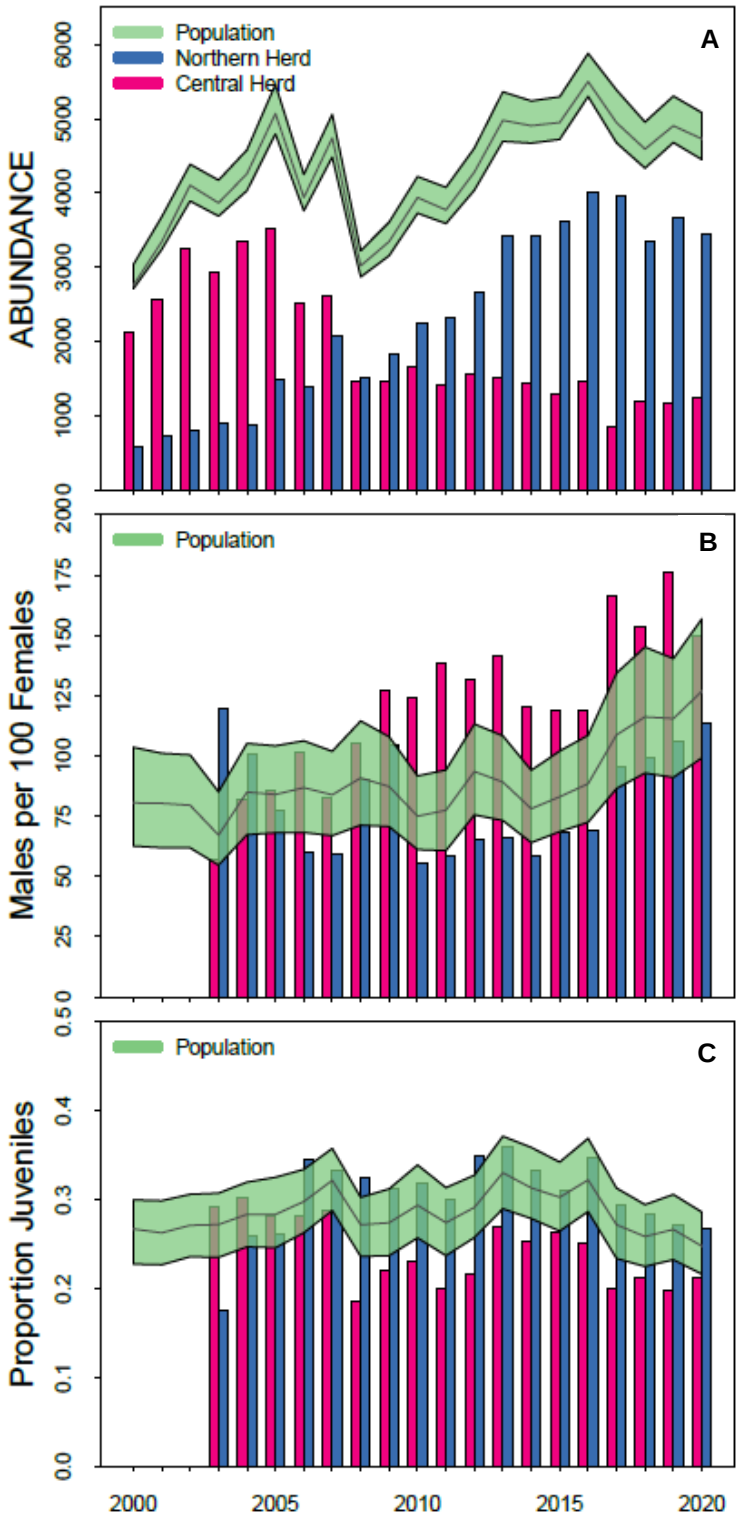

Figure 2. Abundance, Age and Sex Structure.

(A) Post-calving abundances, **(B)** sex ratios and **(C)** age structures of the Yellowstone bison population. In **A-C**, the green polygons represent the 95% confidence range. Estimates were generated using an integrated population model. The colored bars show annual counts of the northern and central herds.

Appendix A: Population Modeling Methods

We (i.e., National Park Service) use the hierarchical Bayesian state-space modeling approach to build models suitable for incorporating multiple sources of uncertainty and comparing forecasted outcomes of a system under management. This approach supports adaptive management by incorporating new data as it becomes available and revising future predictions based on outcomes of management. We begin by estimating the initial conditions of the bison population, including the number of bison in age and sex stages, which we sum to identify total herd and population sizes. Next, we predict the bison population during the next year based on survival, birth, and winter removals. These quantities, called states, are unobserved, meaning we never know their exact value. As the year passes, we collect data on the bison population through aerial counting, completing age and sex composition surveys, and monitoring radio-collared animals. We compare these data to model predictions made before collecting the data to refine estimation. These data are imperfect because we cannot count or track every single individual. Therefore, even after data are collected, we still do not know the exact values of the states of interest. We repeat this process of forecasting the state of the bison population during the next year and collecting data to check and improve our predictions. Over time, predictions improve because repeating these comparisons each year improves our understanding of the system.

We created five life-cycle stages for bison. We estimated the number of bison in these stages during June each year since 2000. Life cycle stages were newborn calves, pre-reproductive (one-year-old) female or male bison, and reproductive ($\geq$2-year-old) female or male bison. We assumed there were three different survival rates. Calf survival was the rate for the first year, from June until the next June, and excluded mortality occurring immediately after birth. We assigned the same survival rate to pre-reproductive and reproductive-aged animals. However, male survival varied from female survival. We assumed all reproductive-aged females exhibited similar birth rates. Birth rate included offsets due to neonate mortality occurring between birth and June 1. Bison could produce up to one calf each year. We assumed birth rates were unaffected by population size; thus, we used an exponential growth model. That is, the rate of population growth could not decrease as the bison population increased in size.

We used a Bayesian matrix model to estimate bison population growth. We began by estimating the numbers of bison in each life-cycle stage during June 2000. Each ensuing year, we estimated the number of bison based on survival, reproduction, and winter removals. Statistically, we represented the bison population as $\mathbf{Z}_t = \mathbf{A}(\mathbf{Z}_{t-1}-\mathbf{H}_t)+\varepsilon_1$ using a lognormal model. In this equation, $\mathbf{Z}_t$ is the number of bison in each life-cycle stage during the current year, $\mathbf{Z}_{t-1}$ is the number of bison in each life-cycle stage during the previous year, **A** is a matrix of survival and reproduction rates, and $\mathbf{H}_t$ is the number of bison removed during winter harvests and culls. The term ε_1 accounts for types of uncertainty about the natural processes of population growth that we overlooked, such as different survival rates among bison in northern and central Yellowstone and age-effects on reproduction. The matrix **A** included survival and reproduction rates. We estimated survival rates using the logistic model where $s=invlogit(s_0 + s_1 + s_2 + \varepsilon_2)$. The elements of **s** were survival coefficients for age and sex classes and the term ε_2 accounted for other sources of uncertainty (e.g., weather effects) in annual survival that we overlooked. Similarly, we used a logistic model to estimate reproduction rate.

We collected data on the bison population through aerial counting, completing age and sex composition surveys, monitoring radio-collared animals, and testing for previous brucellosis exposure of bison at capture facilities. We used these data to refine estimation of survival and birth rates, and numbers of bison in each life-cycle stage over time. Biologists completed 56 aerial surveys during June through August from 2000 to 2019 to count bison in the population. We assumed the bison population did not change during the summer count interval. In other words, we assumed no bison were born or died between counts. We assumed aerial counts were nearly a census with every single individual counted. Bison are highly visible during the summer and congregate in large groups in open areas. However, we expected some differences among counts and actual abundance due to observer error, such as missing groups that moved out of survey units or into timbered areas. As a result, observers could under-count the bison population, but could not over-count the bison population. We related counts to the model predicted population size using a beta-binomial model $Y1_t = p\mathbf{Z}_t + \sigma_1$ where $Y1_t$ was a population count, $\mathbf{Z}_t$ was the number of bison in each age and sex class, p was a sighting parameter, and σ_1 was error. We assumed the sighting parameter p was not a single value (e.g., 0.97). Instead, p represented a range of values described by a mean and standard deviation (e.g., 0.97, 0.92 – 0.99).

We completed aerial and ground composition surveys during July or August. Bison segregate into mixed age and gender and adult male only (e.g., bachelor) groups during summer. Aerial counts determined the number of bison found in mixed gender and bachelor groups. We used a beta-binomial model to estimate the annual proportion of

bison found within bachelor groups m, $Y2_t = mN2_t + \sigma_2$ where $Y2_t$ was the number of animals found in mixed groups and $N2_t$ was the total aerial count. Ground counts determined the number of calves, juvenile males and females, and adult males and females found within mixed groups. We used the proportion of bison found in mixed gender groups to correct ground count observations for bulls because ground counts were restricted to mixed gender groups. We used the beta-binomial model to relate our ground counts to model-predicted numbers of bison in each age and sex class. For female and young, $Y3_{t,i} = c_i N3_t / m + \sigma_3$ where c_i was the model-predicted proportion of bison in the i^{th} age and sex class, $Y3_{t,i}$ was the number of bison in the given age and sex class counted in mixed groups, and $N3_t$ was the total number of bison counted in mixed groups. For adult males, $Y3_{t,i} = mc_i / (1 - mc_i) N3_t + \sigma_3$.

Managers removed bison through roundups and harvest. We treated total removals as known quantities for each winter. However, the age and sex class of some removals were unknown during some years. We estimated these unknown removals as the product of total removals for each year and the age and sex proportions identified from the subset of known removals.

Model parameters and latent quantities were estimated using Markov chain Monte Carlo techniques. All analyses were completed using program R. We assessed the ability of our model to make predictions using posterior predictive checking and out-of-sample prediction. Posterior predictive checks evaluate the ability of the model to simulate data that resembles the data that were actually collected. Out-of-sample prediction compares data not used to fit the model to new data collected during monitoring. We found that annual aerial calf counts of the population systematically undercounted the likely number of calves in the population. In addition, we monitored whether adult females fit with radio-collars produced calves each year and determined that the calf to female ratio from these data was much higher than population averages estimated in June. Therefore, we did not use these data sources in model fitting.

Appendix B: Summaries of Counts, Classifications, and Removals during 2000-2019

Table B1. Aerial counts of the Yellowstone bison population completed during June-July, 2000 to 2019[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		
	July19-20, 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, 2015	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	4829	1,162	1013	149	3,667	2995	672
	July 29-30, 2019	4664	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		

[a] We reevaluated flight totals during summer 2017 using updated count areas for each herd based on an improved understanding of bison movements.

Table B2. Composition surveys of the Yellowstone bison population during June-August, 2003 to 2019. Numbers in parentheses show results from repeated counts.

		Classified in Mixed Gender Groups					Air Count	
Year	Herd	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

Table B3. Numbers of bison removed from Yellowstone National Park or nearby areas of Montana during winters from 1970 to 2019.

		Maximum No. Bison Counted Previous June-August[h]		Sent to Slaughter/ Management Culls		Hunter Harvest[a]		Sent to Quarantine Research		Total	Age and Gender Composition of Culls/Harvests			
Winter	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	3,437	1,243	4,829	445	0	221	63	105	0	834	180	328	193	133

[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.