Status Report on the Yellowstone Bison Population, August 2016

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Summary:

- The bison population is estimated near 5,500 (range = 5,200-5,800), which is an approximate 11% increase since summer 2015.
- Known culls and harvests during 2015-2016 totaled 552 bison and included 384 harvests, 18 wounded animals dispatched by rangers during hunts, 101 animals sent to meat processing facilities, and 49 animals held at Stephens Creek for possible quarantine.
- About 900 animals (70% adult, 10% yearlings, 20% calves; 60% females, and 40% males) would need to be removed during winter 2016-2017 to stabilize population growth. Removal of 1,400 animals, which is 25% of the current population, would lead to a forecasted bison population of 4,850 (95% range: 4,300-5,300) next summer.
- We recommend that population management actions during winter 2016-2017 substantially reduce the number of bison in northern Yellowstone (estimated at 4,000 animals).
- We recommend using harvests and culling at Stephens Creek through the winter to keep the number of bison migrating north of the park within a range that allows some migration while reducing brucellosis transmission risk and other potential conflicts in the local community. If migrations are large, we recommend removing less than 25% of the total summer population to reduce potential demographic effects.
- In the western management area, we recommend state and tribal harvests of bison through the winter.

Background: Bison management is a shared responsibility between the National Park Service and seven other partner agencies and tribes. We have shared interest among partners and interested constituents to preserve a wild and free-ranging bison population in Yellowstone National Park and the State of Montana; provide sustainable habitat for wildlife; recognize tribal treaty rights; maintain low risk of brucellosis transmission among bison and livestock; and reduce risk of human injury and property damage caused by bison. The Interagency Bison Management Plan that was created in 2000 and has since been adjusted through adaptive management provides a framework for meeting these shared responsibilities. Under the management plan, the bison population is supposed to be managed towards an end-of-winter target of 3,000 animals. Additionally, some partners want to maintain breeding herds of bison in the central and northern regions of the park; maintain similar proportions of males to females; maintain an age structure of about 70% adults and 30% juveniles; maintain the processes of migration and dispersal by bison; and use hunting in Montana as a primary management tool.[2]

Population Size: The bison population is estimated near 5,500 animals and within a range of 5,200-5,800 (95% credible interval; Figure 1). Despite the removal of at least 552 bison during winter 2015-2016, the population has increased by approximately 11% since summer 2015. These findings suggest bison were likely undercounted during at least the past two years.

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[2] We used methods described previously to estimate the status of the bison population. See Geremia, C., R.L. Wallen, and P.J. White. 2015. Population dynamics and adaptive management of Yellowstone bison. http://ibmp.info/Library/OpsPlans/2016_BisonRemovalRecommendations_NPS.pdf

Five aerial counts were completed during June-August 2016 (Table 1). Counts ranged between 3,152 and 4,042 animals in the northern herd and 1,451 and 1,639 in the central herd. We discarded an initial count of 4,494 in the northern herd, because thousands of bison were aggregated in one area of the Lamar Valley which made counting difficult. After that count, aerial observers began photographing groups larger than 50 animals to ensure counting accuracy. Also, ground observers simultaneously counted groups in some locations to confirm aerial counts. Using these comparisons, we determined that aerial observers undercounted the number of bison in groups that were encountered on both occasions when fewer than 3,200 animals were counted on the northern range. The discrepancy between aerial counts and photographs was +1% (e.g., air count 1% higher) when we counted 1,639 in the central herd and +2% when we counted 4,042 in the northern herd – suggesting these counts are reasonable approximations of the number of bison in each herd.

Age and Sex Structure: Composition data were collected during ground and aerial surveys in July (Table 2). The sex ratio of the bison population is about 84 males per 100 females (46% male; 54% female, Figure 2). Approximately 33% of the population is juvenile (less than 15 months old, Figure 2). We estimate that 1,050 calves survived through post-calving surveying in July. Additionally, the population is includes approximately 430 juvenile males, 320 juvenile females, 2,100 adult females, and 1,600 adult males.

Demographic Rates: Vital rates were estimated from bison fit with ratio telemetry devices and population age and sex surveys (Tables 2 and 5). We estimated adult female annual survival as 0.94 (standard deviation [SD] = 0.01) and adult male survival as 0.94 (SD = 0.04). Calf survival, which excluded neonate mortality occurring between calving and surveys in early July, was estimated as 0.88 (SD = 0.05). Fertility, defined as the number of calves born per adult female that survive until age and sex counts in early July, was 0.64 (SD = 0.03).

The rate of increase in the bison population, after adjusting for bison that were removed from the population through culling and harvest, was 24% during July 2015 to July 2016. This increase was substantially higher than the 15-year average of 14% and suggests that the bison population is undergoing exponential growth – characteristic of a population that has not reached carrying capacity. This increase also suggests that we underestimated the number of bison in the population last year.

Summary of Removals during Winter 2015-2016: Known culls and harvests during winter 2015-2016 totaled 552, which excludes up to 30 additional animals that were wounded during hunts and returned into the park. In the northern management area, known removals included 360 harvests, 18 wounded animals that were dispatched by rangers during hunts, 101 animals consigned to tribes for meat processing, and 49 animals held for possible quarantine. Twenty-four bison were harvested in the western management area. Age and sex composition of removals included 175 adult and juvenile males, 227 adult and juvenile females, 146 calves, and 4 unclassified animals (Tables 3 and 4).

Forecasts of the Bison Population Under Management: We forecasted the bison population during July 2017 under different management alternatives that removed between 0 and 1,500 bison during winter 2016-2017. In each scenario, we removed 70% adults, 10% yearlings, and

20% calves, including 60% females and 40% males. We chose these removal ratios because they would maintain the age and sex structure of the population within desired conditions.

Forecasts revealed that removal of approximately 900 bison under the assumed removal ratios would be necessary to stabilize population growth (Figure 3). Removal of 1,400 bison, which is approximately 25% of the current population size, would result in a smaller population of 4,850 bison (95% range 4,300-5,300) next summer. In contrast, removal of zero individuals would ensure a larger population of 6,500 bison (95% range 5,800-7,200) next summer.

Recommendations for Winter 2016-2017: During 2013-2016, we provided recommendations that specified objectives for annual removals aimed to gradually reduce the bison population. This approach was unsuccessful because numbers of animals migrating outside of the park varied, we were unable to balance hunting and culling to remove targeted numbers of animals and, as a result, the bison population continued to increase. Rather than providing a removal objective, we recommend the following guidelines that balance conservation objectives and conflict resolution constraints for managing bison that exit the park:

Focus population management reductions on the northern herd. Under severe weather conditions, we anticipate a large migration of bison into the northern management area that could exceed 2,000 animals[3]. A mass migration could challenge our ability to meet shared goals of maintaining low transmission risk of brucellosis among bison and livestock. Also, breeding herds larger than 3,000 animals have been associated with high grazing intensities on summer ranges that may not be sustainable over time. There are currently nearly 4,000 animals in the northern herd and we recommend reducing the northern herd towards 3,000 animals.

Maintain approximately 200-450 animals north of Mammoth Hot Springs and within the existing out-of-park conservation area to Yankee Jim Canyon. This approach would support state and tribal harvests – daily harvests rates averaged about 3 bison per day during winters 2013-2015 when 200-450 bison were north of Mammoth Hot Springs. This approach would also limit the number of bison exiting northern Yellowstone and reduce potential conflicts (human safety, property damage) in the local community.

Capture bison at the Stephen's Creek facility throughout winter and during state and tribal hunts. Capture of bison at the Stephens Creek facility can be used to maintain the number of bison north of Mammoth Hot Springs within the range of 200 to 450 animals. Capture-and-slaughter should be implemented throughout the winter with relatively small numbers of animals removed weekly during January through March. If winter is severe, with large numbers of animals rapidly moving into the basin, more animals could be captured weekly.

Remove more animals when winter is severe and large numbers of animals migrate outside the park. Repeated removal of more than 20% of the population as occurred during 2006 and 2008 (Table 3) may have had negative effects on the bison population, such as altering subpopulation and age and sex structure. Therefore, we recommend removing more bison when large numbers of bison exit the park, but removing less than 25% of the preceding summer population at one time. If bison continue to migrate into the northern management area and more than 25% of the population has been removed, we recommend holding animals for release back into the park during spring.

Track the age and sex composition of removals throughout winter to use capture-and-slaughter to offset demographic effects of preferential harvest. Do not selectively remove bison

[3] Geremia C, P. J. White, R. L. Wallen, R. L., F. G. Watson, J. J. Treanor, et al. 2011. Predicting bison migration out of Yellowstone National Park using Bayesian models. PLoS one, *6*(2), e16848

based on their brucellosis exposure status. Removal of relatively small, entire groups of bison gathered through weekly efforts should mimic random culling, which is a preferable alternative for conservation. Management culling is the dominant source of mortality for Yellowstone bison. Random removal, in contrast to selective removal based on brucellosis exposure, avoids artificially allowing brucellosis to act as a key selective force on the bison population.

Figure 1. Estimated size of the Yellowstone bison population since the inception of the Interagency Bison Management Plan. Bold lines indicate mean abundance, gray shaded area shows the 95% range of the population, and gray boxes are observed aerial counts.

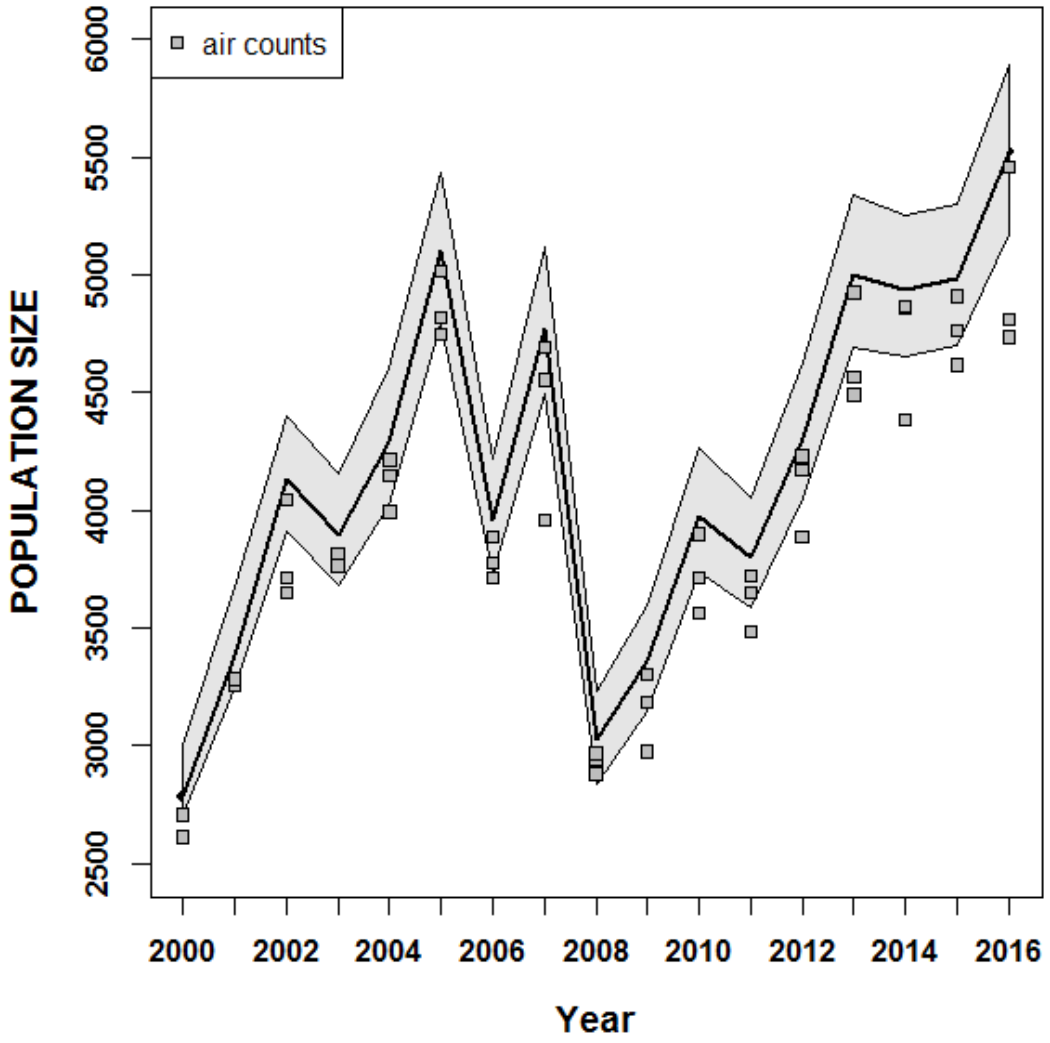
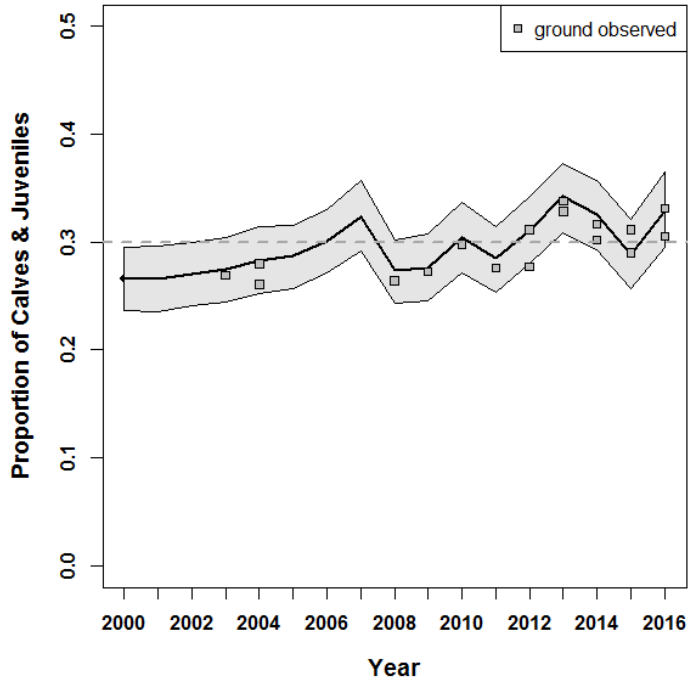


Figure 2. Estimated proportion of juveniles (*left*) and male to female ratio (*right*) of the Yellowstone bison population since the inception of the Interagency Bison Management Plan. Bold lines indicate mean values, gray shaded areas show the 95% range, and gray boxes are observed counts. The dotted lines show objective compositions.



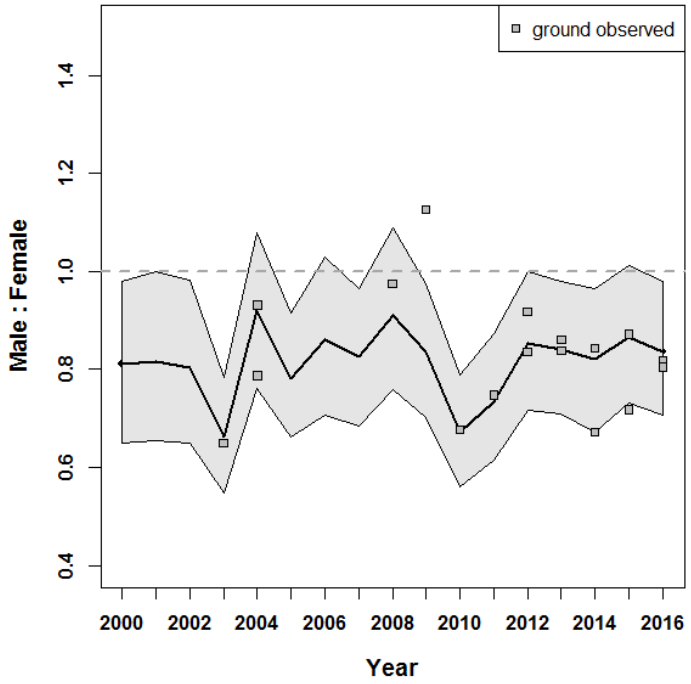


Figure 3. Forecasted size of the bison population during July 2017 considering management removals of up to 1,500 animals. Forecasts were made assuming the removal composition was 20% calf, 48% female, and 32% male.

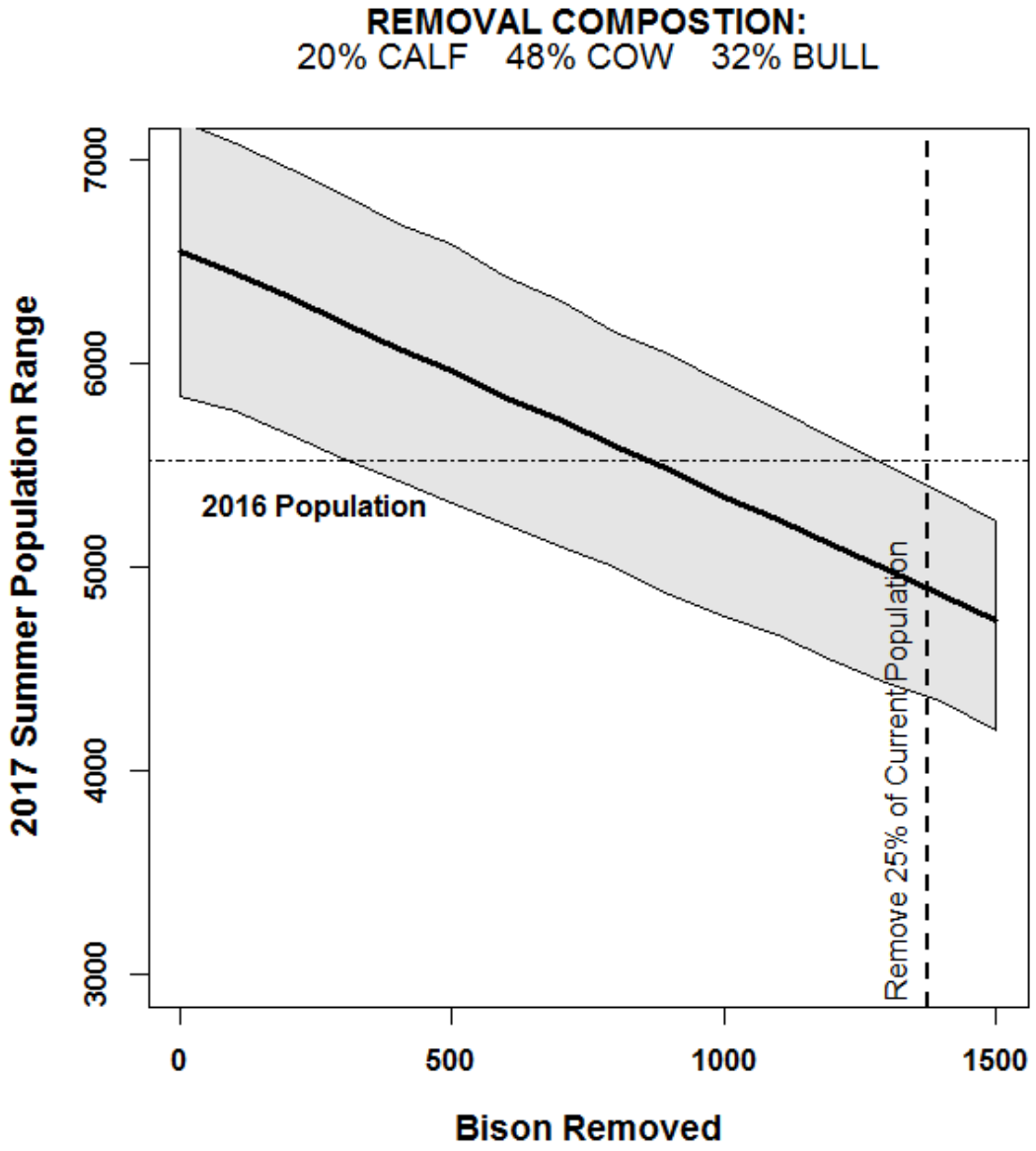


Table 1. Aerial counts of the Yellowstone bison population completed during June-July, 2000-2015.

		Central Herd			Northern Herd		
		Total	Adults	Calves	Total	Adults	Calves
2000	June 4, 2000	2,060	1,734	326	553	460	93
	July 13, 2000	2,118			590		
	August 31, 2000	2,084			529		
2001	June 21, 2001	2,599	2,190	469	657	553	104
	July 25, 2001	2,564			719		
2002	June 25, 2002	3,100	2,560	540	548	477	71
	July 29, 2002	2,901			813		
	August 22, 2002	3,238			807		
2003	July 10, 2003	2,905	2,471	434	873	748	125
	August 8, 2003	2,923			888		
	August 28, 2003	2,772			994		
2004	July 21, 2004	2,811	2,310	501	1,337		
	July 28, 2004	3,027			968		
	August 4, 2004	3,339			876		
2005	July 19, 2005	3,553			1,266		
	July 26, 2005	3,394			1,353		
	August 1, 2005	3,531			1,484		
2006	July 19, 2006	2,430	2,146	284	1,283		
	July 26, 2006	2,512			1,377		
	August 2, 2006	2,496			1,279		
2007	June 14, 2007	2,734	2,385	349	1,820	1,499	321
	July 30, 2007	2,390			1,569		
	August 6, 2007	2,624			2,070		
2008	June 14, 2008	1,115	1,052	103	1,788	1,463	325
	July 8, 2008	1,540			1,341		
	July 15, 2008	1,469			1,500		

		Central Herd			Northern Herd		
		Total	Adults	Calves	Total	Adults	Calves
2009	June 12, 2009	1,462	1,293	169	1,839	1,520	319
	July 9, 2009	1,544			1,433		
	July 16, 2009	1,535			1,648		
2010	June 14, 2010	1,653	1,426	227	2,245	1,890	355
	July 8, 2010	1,735			1,980		
	July 22, 2010	1,713			1,850		
2011	June 21, 2011	976	880	96	2,675	2,188	487
	July 18, 2011	1,406			2,314		
	July 25, 2011	1,335			2,150		
2012	June 21, 2012	1,389	1,188	201	2,496	2,103	393
	July 8, 2012	1,640			2,531		
	July 22, 2012	1,561			2,669		
2013	June 6, 2013	1,338	1170	168	3,154	2,620	534
	July 15, 2013	1,504			3,420		
	July 22, 2013	1,337			3,228		
2014	June 20 ,2014	1,338	1,190	148	3,519	2,928	591
	July 18, 2014	1,448			2,938		
	July 25.2014	1,444			3,421		
2015	June 13-14, 2015	1,283	1,114	169	3,627	2,996	631
	July 12, 2015	1,291			3,325		
	July19-20, 2015	1,323			3,441		
2016	June 18 & 28, 2016	1,451	1,280	171	4,008	3,312	696
	July 18, 2015	1,584			3,152		
	July 25, 2016	1,639			3,170		
	August 8, 2016	NA			4,042		

Table 2. Composition surveys of the Yellowstone bison population during June-July, 2003-2015.

Date		Classified in Mixed Gender Groups					Air Count		Classified in Mixed Gender Groups					Air Count	
		Male>1	Male1	Female>1	Female1	Calf	Bachelor	Mixed	Male>1	Male1	Female>1	Female1	Calf	Bachelor	Mixed
July 7-15, 2003	*central*	438	150	1,426	241	498	380	2,521							
	northern	159	23	176	12	46	77	795	133	11	227	15	110		
July 14-18, 2004	*central*	638	179	1,082	126	497	284	2,594	523	125	932	131	397		
	northern	247	35	331	33	164	125	1,145	232	26	458	49	145		
July 6-15, 2005	*central*	500	178	1,098	162	430			674	175	1,060	148	443		
	northern	276	63	441	51	153			205	49	324	37	97		
July 11-13, 2006	*central*	368	141	654	101	258	518	2,078	386	152	757	111	301		
	northern	102	27	202	40	103									
July 10-17, 2007	*central*	375	100	709	109	342			555	119	805	106	305		
	northern	300	139	637	101	339			173	28	366	28	169		
July 8-11, 2008	*central*	116	36	387	50	110	444	1,101							
	northern	198	87	433	61	232	178	1,158							
July 6-16, 2009	*central*	145	63	427	73	158	480	1,063	161	62	498	47	186		
	northern	244	84	414	53	237	191	1,239	224	83	391	53	179		
July 6-20, 2010	*central*	340	72	517	57	219	342	1,370	369	82	537	81	228		
	northern	228	126	934	140	391	20	1,755	298	150	679	121	344		
July 7-19, 2011	*central*	118	58	323	37	105	413	1,407	163	53	309	40	106		
	northern	303	131	915	99	361	185	2,103							
July 9-29, 2012	*central*	282	68	493	41	173	398	1,242	420	80	477	55	216	212	1,349
	northern	375	187	876	165	466	80	2,451	405	114	698	84	288	50	2,619
July 15-25, 2013	*central*	287	101	415	82	197	342	1,162	372	102	401	77	191	189	1,148
	northern	457	231	1,061	191	528	145	3,275	608	249	1,149	198	538	77	3,151
July 14-25, 2014	*central*	275	113	565	69	206	280	1,168	296	71	380	63	145	285	1,159
	northern	310	155	1,023	126	422	141	2,797	565	266	1,314	259	612	261	3,163
July 13-23, 2015	*central*	187	43	301	42	165	240	1,051	310	58	364	58	166	166	1,157
	northern	651	219	1,499	203	689	149	3,176	738	192	1,144	141	507	69	3,372
July 18-29, 2016	*central*	350	106	457	79	185	169	1,415	327	37	316	25	95	143	1,496
	northern	770	316	1,510	248	763	123	3,029	839	304	1,570	200	766	55	3,115

Table 3. Numbers of bison removed from Yellowstone National Park or nearby areas of Montana during winters from 1970-2014.

	Maximum No. Bison Counted Previous July-August			Sent to Slaughter/ Management Culls		Hunter Harvest[a]		Sent to Quarantine		Total	Age and Gender Composition of Culls/Harvests			
Winter	**North**	**Central**	**Total**	**North**	**West**	**North**	**West**	**North**	**West**		**Male**	**Female**	**Calf**	**Unknown**
1970-84				0	0	13	0	0	0	13	4	7	0	2
1985	695	1,552	2,247	0	0	88	0	0	0	88	42	37	8	1
1986	742	1,609	2,351	0	0	41	16	0	0	57	42	15	0	0
1987	998	1,778	2,776	0	0	0	7	0	0	7	5	2	0	0
1988	940	2,036	2,976	0	0	2	37	0	0	39	27	7	0	5
1989	NA[b]	NA[b]	NA[b]	0	0	567	2	0	0	569	295	221	53	0
1990	592	1,885	2,477	0	0	1	3	0	0	4	0	0	0	4
1991	818	2,203	3,021	0	0	0	14	0	0	14	0	0	0	14
1992	822	2,290	3,112	249	22	0	0	0	0	271	113	95	41	22
1993	681	2,676	3,357	0	79	0	0	0	0	79	9	8	9	53
1994	686	2,635	3,321	0	5	0	0	0	0	5	0	0	0	5
1995	1,140	2,974	4,114	307	119	0	0	0	0	426	77	66	31	252
1996	866	3,062	3,928	26	344	0	0	0	0	370[c]	100	71	10	189
1997	785	2,593	3,378	725	358	0	0	0	0	1,083[d]	329	330	144	280
1998	455	1,715	2,170	0	11	0	0	0	0	11	0	0	0	11
1999	493	1,399	1,892	0	94	0	0	0	0	94	44	49	1	0
2000	540	1,904	2,444	0	0	0	0	0	0	0	0	0	0	0
2001	508	1,924	2,432	0	6	0	0	0	0	6	6	0	0	0
2002	719	2,564	3,283	0	202	0	0	0	0	202	60	42	16	84
2003	813	2,902	3,715	231	13	0	0	0	0	244	75	98	43	28
2004	888	2,923	3,811	267	15	0	0	0	0	282	58	179	23	22
2005	876	3,339	4,215	1	96	0	0	0	17	114	23	54	20	17
2006	1,484	3,531	5,015	861	56	32	8	87	0	1,044	205	513	245	81
2007	1,377	2,512	3,889	0	4	47	12	0	0	63	53	6	0	4
2008	2,070	2,624	4,694	1,288	160	59	107	112	0	1,726	516	632	332	246
2009	1,500	1,469	2,969	0	4	1	0	0	0	5	5	0	0	0

2010	1,839	1,462	3,301	3	0	4	0	0	0	7	7	0	0	0
2011	2,245	1,653	3,898	6	0	Unk	Unk	53	0	260	106	102	52	0
2012	2,314	1,406	3,720	0	0	15	13	0	0	28	14	12	2	0
2013	2,669	1,561	4,230	0	0	148	81	0	0	250	116	85	28	0
2014	3,420	1,504	4,924	258	0	258	69	60	0	645	202	287	152	4
2015	3,421	1,444	4,865	511	0	201	18	7	0	737	276	297	161	3
2016	3,627	1,283	4,910	101	0	378	24	49	0	552	175	227	146	4

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

[b] - Aerial survey data not available during summer survey period (July-August).

[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 (less than 100) captured at the north boundary and consigned to a research facility at Texas A&M University.

Table 4. Brucellosis exposure status and disposition of bison tested at boundary management facilities in and near Yellowstone National Park.

	No. captured[a]		Tested[b]		Positives slaughtered[c]		Negatives slaughtered[c]		Untested slaughtered		Consigned to quarantine		Negatives		Positives released		Untested		Capture pen mortalities		Management shootings	
Winter	**W**	**N**	**W**	**N**	**W**	**N**	**W**	**N**	**W**	**N**	**W**	**N**	**W**	**N**	**W**	**N**	**W**	**N**	**W**	**N**	**W**	**N**
2001	14[d]	0	14[d]	0	5	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	1	0
2002	251[d]	0	118[d]	0	113	0	41	0	45	0	0	0	52	0	0	0	0	0	0	0	3	0
2003	20[d]	231	16[d]	0	8	105	4	104	0	22	0	0	8	0	0	0	0	0	0	0	1	0
2004	21	463	18	407	10	227	0	31	3	6	0	0	8	198[e]	0	0	0	0	0	1	2	2
2005	186[d]	0	168[d]	0	79	0	0	0	17	0	17	0	73	0	0	0	0	0	0	0	0	1
2006	59	1,253	0	98	0	384	0	451	50	14	0	87	0	0	0	0	9	308[f]	0	9[g]	6	3
2007	56	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	52[h]	0	0	0	0
2008	158	1,647	0	539	0	711	0	560	158	5	0	112	0	191	0	18[i]	0	44[j]	0	6[g]	2	6
2009	3	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
2011	0	797	0	694	0	0	0	0	0	0	0	53	0	392	0	249	0	100[k]	0	3	0	3
2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2014	0	353	0	353	0	145	0	113	0	0	0	60	0	21	0	14	0	0	0	0	0	0
2015	0	519	0	481	0	181	0	293	0	33	0	7	0	0	0	0	0	1	0	4	0	0
2016	0	150	0	144	0	72	0	23	0	6	0	49	0	0	0	0	0	0	0	0	0	0

a - Captures include bison gathered into capture facilities, but exclude management shootings.

b - Field testing occurred during handling at capture facilities.

c - Disease exposure status determined during handling at capture or processing at slaughter facilities.

d -Totals may be incorrect due to inconsistencies in agency reports concerning individual animals captured and tested multiple times.

e - Twenty-eight animals retested at the Montana Department of Livestock diagnostic laboratory tested positive for disease exposure status..

f - Total excludes two untested newborn calves born within containment facilities during holding.

g - Total excludes four failed births that occurred within containment facilities during holding.

h - Fifty-two mixed age and gender bison were captured nearby the western park boundary during June and released at the Stephen's Creek Facility.

i – These seropositive bison were released back into the park because managers did not want to send females late in the third trimester of pregnancy to slaughter.

j - Total excludes 80 untested newborn calves born within containment facilities during holding.

k - Total excludes 169 untested newborn calves born within containment facilities during holding.

Table 5. Survival and reproduction of radio-collared, adult, female bison in and near Yellowstone National Park. These numbers do not reflect animals that were removed through management actions: two northern and one central herd animals were culled or harvested during 2015-16.

Survival					**Birth**				
	Central		**Northern**			**Central**		**Northern**	
year	lived	total	lived	total	year	birthed	total	birthed	total
1996	0	0	10	10	1996	0	0	3	3
1997	0	0	19	20	1997	2	2	6	8
1998	16	16	21	22	1998	3	7	9	14
1999	11	13	17	20	1999	9	15	10	14
2000	14	14	17	19	2000	7	10	8	13
2001	9	9	14	15	2001	5	8	9	13
2002	2	2	1	2	2002	0	0	0	0
2003	6	6	1	1	2003	3	4	0	0
2004	6	6	1	1	2004	14	17	0	0
2005	21	21	1	1	2005	15	25	0	0
2006	33	36	1	1	2006	11	19	0	0
2007	36	39	1	1	2007	19	29	8	10
2008	31	33	11	11	2008	14	23	18	27
2009	22	28	43	44	2009	8	14	14	19
2010	19	20	43	45	2010	11	13	15	18
2011	15	19	33	34	2011	7	10	17	19
2012	15	15	31	31	2012	9	14	15	17
2013	16	17	27	28	2013	10	14	11	16
2014	14	14	27	29	2014	8	12	9	14
2015	9	9	22	22	2015	4	9	12	17