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ACKNOWLEDGEMENT

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2019 - JCR Evaluation Form

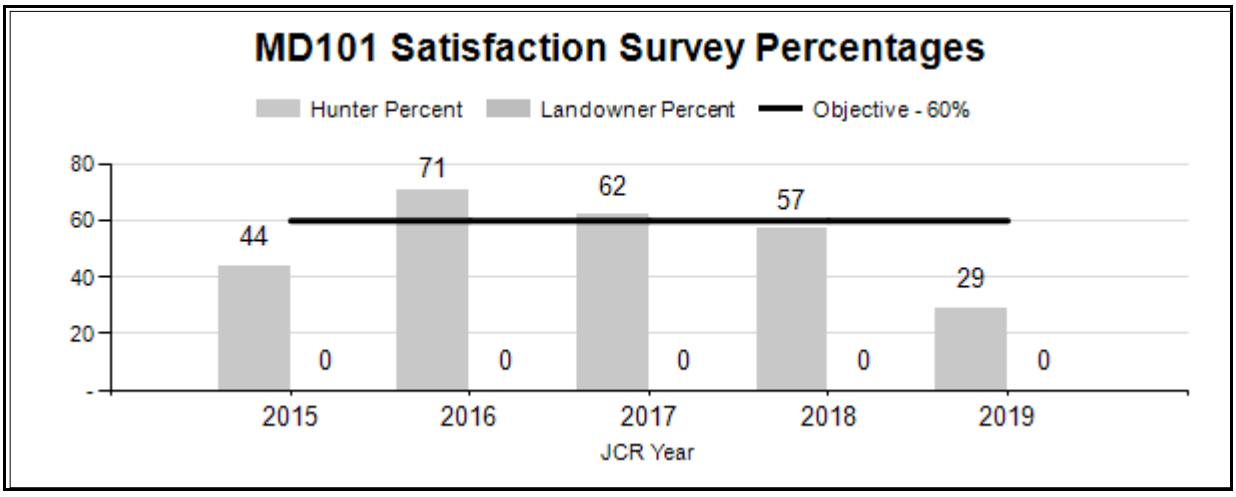
SPECIES: Mule Deer
PERIOD: 6/1/2019 - 5/31/2020

HERD: MD101 - TARGHEE

HUNT AREAS: 149
PREPARED BY: ALYSON COURTEMANCH

	2014 - 2018 Average	2019	2020 Proposed
Hunter Satisfaction Percent	56%	29%	60%
Landowner Satisfaction Percent	N/A	N/A	N/A
Harvest:	23	9	25
Hunters:	93	47	50
Hunter Success:	25%	19%	50%
Active Licenses:	93	47	50
Active License Success:	25%	19%	50%
Recreation Days:	467	235	400
Days Per Animal:	20.3	26.1	16
Males per 100 Females:	0	0	
Juveniles per 100 Females	0	0	

Satisfaction Based Objective	60%
Management Strategy:	Recreational
Percent population is above (+) or (-) objective:	N/A
Number of years population has been + or - objective in recent trend:	2



2020 HUNTING SEASONS
TARGHEE MULE DEER HERD (MD101)

Hunt Area	Hunt Type	Archery Dates		Season Dates		Quota	Limitations
		Opens	Closes	Opens	Closes		
149	Gen	Sep. 1	Sep. 14	Sep. 15	Oct. 6		Antlered mule deer or any white-tailed deer
148, 149, 150, 151, 152	3	Sep. 1	Sep. 14	Sep. 15	Nov. 30	25	Any white-tailed deer
149	8	Sep. 1	Sep. 14	Sep. 15	Nov. 30	25	Doe or fawn white-tailed deer

2020 Regional H nonresident quota: 600 licenses

2019 Hunter Satisfaction: 28.6% Satisfied, 64.3% Neutral, 7.1% Dissatisfied

2020 Management Summary

1.) **Hunting Season Evaluation:** Hunting opportunity in this herd unit is limited due to limited access points to public lands, steep terrain, and fall migration of mule deer to Idaho. Forty-seven hunters harvested 9 mule deer in this herd unit in 2019. Seventeen white-tailed deer were harvested. Hunter satisfaction was low in 2019 and did not meet the herd unit objective. Most hunters rated their satisfaction as “neutral” on the harvest survey, which likely reflect the low hunter success for mule deer. There were some small changes to the 2020 seasons. The antler point restriction was removed this year to match other hunt areas in Region H. Managers decreased the Type 8 licenses slightly in response to fewer white-tailed deer in the area. In 2020, the Type 3 license was combined with four other hunt areas in the Jackson Region to provide hunters more flexibility with where they can use this license and address areas where white-tailed deer numbers have been increasing.

2019 - JCR Evaluation Form

SPECIES: Mule Deer
PERIOD: 6/1/2019 - 5/31/2020

HERD: MD131 - WYOMING RANGE

HUNT AREAS: 134-135, 143-145
PREPARED BY: GARY FRALICK

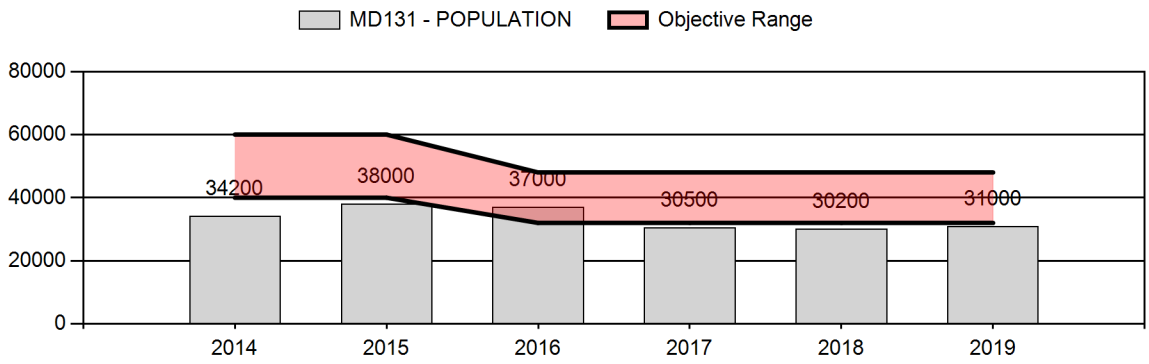
	2014 - 2018 Average	2019	2020 Proposed
Population:	33,980	31,000	28,100
Harvest:	2,512	1,490	1,525
Hunters:	5,772	4,971	5,100
Hunter Success:	44%	30%	30 %
Active Licenses:	5,772	4,971	5,100
Active License Success:	44%	30%	30 %
Recreation Days:	31,594	28,665	30,281
Days Per Animal:	12.6	19.2	19.9
Males per 100 Females	35	34	
Juveniles per 100 Females	61	59	

Population Objective (± 20%) :	40000 (32000 - 48000)
Management Strategy:	Special
Percent population is above (+) or below (-) objective:	-22.5%
Number of years population has been + or - objective in recent trend:	3
Model Date:	02/24/2020

Proposed harvest rates (percent of pre-season estimate for each sex/age group):

	JCR Year	Proposed
Females ≥ 1 year old:	8%	4%
Males ≥ 1 year old:	21%	23%
Total:	5%	5%
Proposed change in post-season population:	+2%	-9%

Population Size - Postseason



2020 HUNTING SEASONS
WYOMING RANGE MULE DEER HERD (MD131)

Hunt Area	Type	Archery Dates		Season Dates		Quota	Limitations
		Opens	Closes	Opens	Closes		
134	Gen	Sept. 1	Sept. 30	Oct. 1	Oct. 11		Antlered mule deer three (3) points or more on either antler or any white-tailed deer
135	Gen	Sept. 1	Sept. 30	Oct. 1	Oct. 11		Antlered mule deer or any white-tailed deer
143	Gen	Sept. 1	Sept. 14	Sept. 15	Oct. 6		Antlered mule deer or any white-tailed deer
144	Gen	Sept. 1	Sept. 14	Sept. 15	Oct. 6		Antlered mule deer or any white-tailed deer
145	Gen	Sept. 1	Sept. 14	Sept. 15	Oct. 6		Antlered mule deer-or any white-tailed deer
145	3	Sept. 1	Sept. 14	Sept. 15	Nov. 15	50	Any white-tailed deer
145	3			Nov. 16	Jan. 31		Antlerless white-tailed deer

2020 Region G nonresident quota: 400 licenses

2019 Hunter Satisfaction: 40% Satisfied, 24% Neutral, 36% Dissatisfied

2020 Management Summary

1.) **Hunting Season Evaluation:** The 3-point Antler Point Restriction (APR), which was adopted to protect yearling bucks from hunter harvest, was lifted in Hunt Areas 135 and 143-145 for the first time since 2016. The return to antlered only hunting in these areas was consistent with past management of the herd where antlered only hunting offered the hunting public less restrictions. Historically, yearling bucks have never been over-exploited (i.e. yearlings comprising $\geq 40\%$ of annual antlered harvest field checks) in this deer herd and a growing segment of the public called for discontinuing the 3-point APR and a return to any antlered deer hunting. Population growth will be achieved by continuing to restrict antlerless deer hunting. The number of days in all areas except Hunt Areas 134 and 135 remained unchanged. The closing dates in Areas 134 and 135 were Oct. 11 instead of October 14; Area 134 retained the 3-point APR, while Area 135 returned to any antlered deer hunting.

2.) Herd Unit Evaluation: Management strategies since 1993 have emphasized hunting antlered deer in an effort to promote population growth. Antlered deer hunts have occured in mid-September and early October throughout the herd unit. Hunting seasons have closed in the northern hunt areas prior to the onset of the annual fall migration in order to minimize vulnerability of bucks that migrate from subalpine summer ranges to sagebrush winter ranges in the Upper Green River Basin. Sustained population growth has been difficult because of the

frequency of high to extreme overwinter mortality every three years on crucial winter ranges. Over the last 27 years the population has remained stable at an annual average of approximately 33,000 deer. The only recent sustained, population growth occurred during the period from 2012 – 2016, which followed the winter of 2011 and prior to the 2017 winter. During the height of this period (2016) the population was estimated to be 38,000 deer.

During the period from 2012-2019, buck:doe ratios met or exceeded the special management objective of 30-45 bucks:100 does in the posthunt population in all years except 2017. Since 2017, moderate to high overwinter survival has ensured recruitment of 1.5+ year old bucks, throughout the herd unit in general, and on the LaBarge winter ranges specifically. On the LaBarge winter ranges, buck:doe ratios exceeded 40 bucks:100 from 2013 to 2015, with the highest buck ratio achieved in at least 20 years seen in 2013 when 46 bucks:100 does were observed. The high winter mortality observed during the 2017 and 2019 winters had a deleterious impact on buck:doe ratios herd unit-wide following those winters. The ratio of 29 bucks:100 does observed in 2017 was only the second time since 1993 that buck:doe ratios dropped below the management minimum of 30:100 does (Appendix A).

High winter survival was observed on the LaBarge winter ranges in 2019, and mitigated the high losses observed in Areas 134 and 135. As a result of the higher survival on the northern winter ranges near LaBarge, observed buck:doe ratios climbed to 41 bucks:100 does after the 2019 hunting season (Appendix A). Herd unit-wide buck:doe ratios are expected to return to the high 30s:100 does following the 2020 hunting seasons because of the relatively high over-winter survival observed throughout the herd unit in 2020.

3.) Harvest field checks have provided a relative indication of buck quality and, in addition to hunter comments received during the hunting season, have provided deer managers with the insight to assess hunter sentiment. A total of 150 bucks were field checked in 2019. Class 3 (≥26") bucks tallied 17% (n=26) of all antlered deer checked in the field. Area 144 tallied 69% (n=18) of the Class 3 bucks, while areas 134, 135, 143 and 145 accounted for 4%, 8%, 15%, and 4%, respectively, of the remaining 2019 sample size of Class 3 bucks that were field checked (Appendix B).

During the current year a total of 48 Class 2 (≥20" – 26") bucks were examined in the field. Areas 143 and 144 accounted for 27% (n=13) and 52% (n=25), respectively of the Class 2 bucks examined in 2019. The percentage of Class 2 bucks checked in Areas 134 and 135 accounted for 6% and 8%, respectively, of herd unit's field checked bucks (Appendix B).

4.) Hunter satisfaction is a metric that can be evaluated as an index of population performance prior to, and subsequent to, substantial winter mortality events. These ratings are determined based on a hunter response of ***Very Satisfied*** or ***Satisfied*** following the outcome of their deer hunt. There have been multiple winters since 2010 when above normal winter mortality has been documented throughout the herd unit. It was following the severe winters of 2011, 2017, and 2019 hunter satisfaction declined dramatically in this herd unit (Appendix C). During the period from 2012 – 2016 (following the 2011 severe winter) hunter satisfaction increased to some of the highest levels recorded in any deer population in Wyoming (Appendix C). Hunters reported satisfaction ratings that approached 80% in some hunt areas.

However, these high satisfaction ratings were reversed by the effects of what may be described as the highest mule deer winter mortality event observed in this deer herd since 1984. By all accounts, the aftermath of the 2017 winter resulted in a substantial population decline from the gains observed from 2012 - 2016. The decline in deer numbers following the 2017 winter was reflected in a reduction in herd unit wide hunter satisfaction following the 2017 hunting season.

What has complicated the rebound in deer numbers and consequently hunter satisfaction (at least in some hunt areas), was the high herd unit wide winter survival noted in 2018, which was then followed by another high winter mortality event on the southern (Cokeville, Kemmerer, and Evanston) winter ranges in 2019. In Areas 134 and 135 (which experienced two substantial winter mortality events in 2017 and 2019) hunter satisfaction was lower than the herd unit average. It was in these hunt areas where a substantial decline in hunter satisfaction was reported about the same in 2019 (40%) as in 2017 (41%). Conversely, in 2019 hunter satisfaction in Areas 143-145 was higher than the herd unit average because these northern areas did not experience the higher losses observed during the 2019 winter as the southern areas. (Appendix C).

5.) Antler Point Restrictions (APRs) have been a component of mule deer management in the state of Wyoming for many years. In the Jackson and Pinedale Regions, APRs (most notably the 4-point or better regulation) have been implemented periodically dating back to the 1970s, and were used in combination with general any and antlered only deer seasons. The last year the 4-point regulation was used in the Wyoming Range was in 1988.

It has been widely recognized that implementing APRs has been fraught with real and perceived benefits by the hunting public and deer managers alike. The debate over the efficacy and benefits of APRs has been widely reported in popular hunting literature, state wildlife agency white papers, professional journals, and more recently in a white paper published by the Wyoming Game and Fish Department entitled *A Critical Review of Mule Deer Antler Point Regulations and Their Application* (Appendix D).

In the Wyoming Range, APR hunting seasons had not been implemented in the northern hunt areas (Areas 143, 144, 145) since the period from 1977-1988. It was during one year, 1985, when the entire mule deer hunting season was administered by a 4-point or better regulation.

This has not been the case in the southern hunt areas (Areas 134 and 135) of the herd unit. Through most of the 1980s, 1990s and 2000s, APRs were not present in these areas. However, beginning in 2016, the 3-point or better regulation was adopted in Area 134 in response to hunter sentiments in southwest Wyoming. More recently, the Wyoming Game and Fish Commission directed the Department to implement a 3-point or better APR regulation in the Wyoming Range herd for the 2017 hunting season. The Commission acted on public input which requested a Department response to severe losses observed in the herd unit during the 2017 winter. The primary objective of the APR was to offer a degree of protection from hunter harvest for yearling bucks, which typically grow a spike or 2-points on each antler. The 2016 fawn cohort was the age class most impacted by the winter, and the surviving male individuals of this cohort entered

the 2017 hunt as yearlings. Concurrent with the adoption of the 3-point APR was a commitment to implement the APR for three consecutive hunting seasons from 2017 – 2019.

The Wyoming Range herd unit encompasses several areas where much of the hunting opportunity can be described as a "remote, road-less, and backcountry" hunting experience. These areas, notably Hunt Areas 143, 144, 145, and the northern portion of Area 135, offer the public the opportunity to hunt in areas away from extensive road systems that are typically found in at lower elevation sagebrush habitats and the sagebrush/aspen interface. Only Area 134 and the southern portion of Area 135 may be considered areas within the herd unit where a network of roads exist that provide a relatively high degree of motorized access unlike the northern three areas previously described.

An evaluation was conducted to see whether the 3-point APR achieved the desired objective of protecting yearling bucks (i.e. spikes and 2-point bucks) and increasing recruitment of yearlings into the 2+-year-old cohort over the 3-year APR period (2017-2019). This was done by determining the extent of yearling bucks represented in the historical harvest when the 3-point APR was not administered. Since yearling buck harvest is not surveyed during the annual hunter harvest survey, the only way to assess yearling buck harvest was to evaluate the percentage of yearling bucks examined during hunter harvest field checks each year. During the 26-year period from 1991-2016, the number and percentage of yearling bucks checked in the field annually in each hunt area were compiled and compared to total antlered harvest by hunt area (Appendix E). The percentage of yearling bucks reported represents the annual percentage of total antlered harvest for each respective hunt area.

During the report period, the annual percentage of yearling bucks checked in the field comprised 27%, 20%, 22%, 10%, and 20%, for Hunt Areas 134, 135, 143, 144, and 145, respectively, of the total hunt area's antlered harvest. These data were compelling and appeared to describe why yearling bucks have, historically, comprised a minor and inconsequential percentage of the annual antlered harvested in those areas during the years 1991-2016. Secondly, hunters that pursue mule deer in the Wyoming Range, especially the road-less and remote backcountry areas, are focused primarily on taking a buck older than a yearling (Appendix E). Moreover, because these areas are remote, difficult to access, and road-less, 80-90+% of all bucks harvested and subsequently field checked are typically 2+ years old (Appendix F). The Wyoming Range herd produces buck:doe ratios that typically exceed 40 bucks:100 does. Consequently, the preponderance of "trophy" class (≥ 24" antler width) bucks in the 2+-year old age classes provide little incentive for hunters to harvest yearlings. In summary, these are reasons why deer hunters have never been capable of, or interested in, over-exploiting the yearling buck cohort. These phenomena are compelling justifications why the 3-point APR, described herein as a regulation to protect yearling bucks, is unnecessary in the Wyoming Range herd.

6.) One metric that is essential in the management of male deer in the Wyoming Range herd is data associated with antler morphology and age at time of harvest (Appendix F). Since antler width, or spread, is perhaps the central component in determining the "trophy" status of harvested buck deer, the Department initiated an effort in 1989 to collect the outside spread and age at time of harvest during routine field checks.

These data have provided managers with an understanding of the growth form and size of antlers corresponding to the age of the buck at time of harvest. Average age, range of ages, oldest aged buck, and the corresponding antler width are metrics that are relevant to deer management in the Wyoming Range herd.

During the periods from 1989-2001 and 2012-2018, a total of 2118 antler measurements and incisiform teeth were collected from buck deer during routine field checks (Appendix F). Age of harvested deer was determined using cementum annuli aging methodology.

7.) The Wyoming Range Mule Deer Project was launched in March 2013. The overall goal of this research project was to address important research and management needs identified by the Wyoming Mule Deer Initiative and Wyoming Range Mule Deer Initiative.

An important aspect of this research was to investigate the nutritional relationships between mule deer population dynamics, energy development and disturbance, habitat conditions, and climate to provide a mechanistic approach to monitoring and management of mule deer (Appendix G). Integrating data on nutritional condition, forage production and utilization, and population performance to understand factors regulating Wyoming Range mule deer and the ability of the current habitat to support those deer, was a primary goal of this work.

In addition, secondary objectives were addressed, including nutritional contributions of winter and summer ranges, factors affecting reproduction, identification of habitats of nutritional and reproductive importance to mule deer, timing and delineation of important migration routes, and direct assessment of the effects of energy development on nutrition and survival of mule deer (Appendix H).

In March 2015 Phase II of the Wyoming Range Mule Deer Project was initiated. The Phase II segment of the project focused on measuring survival and cause-specific mortality of mule deer fawns to quantify the relative roles of habitat, nutrition, and predation on recruitment of young (Appendix I; 2017 Wyoming Range Mule Deer Job Completion Report, Jackson Region). Specific objectives of this project quantified the effects of predation and other mortality factors on survival of young mule deer, and provided a relative assessment of the effect of juvenile mortality on the annual population dynamic. A summary of annual fawn survival and mortality factors since inception of the project are reported in Appendix I.

In December 2018 Phase III of the Wyoming Range Mule Deer project was initiated to disentangle many of the factors that may regulate mule deer herds in Wyoming, but it was recognized that there was still a critical gap in understanding the ecology of this herd. Despite the fact that males are often the segment of the population most valued by the public, little information existed on how their ecology differs from females, and thus, how males may behave or respond differently from females to regulating or limiting factors (Appendix J; 2018 Wyoming Range Job Completion Report, Jackson Region). To better understand the ecology of male deer in the Wyoming Range, males were captured and radio-collared on LaBarge and Kemmerer/Evanston winter ranges in December 2018 and 2019, and January 2019 and 2020. At the time of writing this report, data associated with ecology of male deer is being analyzed and will be summarized and presented at a later date.

Appendix A. Wyoming Range Mule Deer Herd, posthunt herd composition data, 2012-2019.										
							Ratio:100 Females			
2012	Yrlng Males	Adult Males	Total Males	Does	Fawns	Total	Yrlng Males	Adult Males	Total Males	Fawns
HA134	55	103	158	635	404	1197	9	16	25	64
HA135	80	159	239	822	647	1708	10	19	29	79
HA143	116	177	293	799	505	1597	14	22	37	63
144/145	Survey conducted in February 2013					764				
TOTAL	251	439	690	2256	1556	5266	11	19	30	69
2013										
HA134	99	175	274	660	496	1430	15	26	41	75
HA135	145	203	348	913	672	1933	16	22	38	74
HA143	300	326	626	1373	897	2896	22	24	46	65
144/145	Survey conducted in March 2014					805				
TOTAL	544	704	1248	2946	2065	7064	18	24	42	70
2014										
HA134	100	138	238	565	466	1269	18	24	42	82
HA135	191	322	513	1386	1128	3027	14	23	37	81
HA143	291	271	562	1288	884	2734	22	21	43	68
144/145	Survey conducted in February 2015					1005				
TOTAL	582	731	1313	3239	2478	8035	18	22	40	76
2015										
HA134	81	173	254	737	406	1397	11	23	34	55
HA135	176	302	478	1188	828	2494	15	25	40	70
HA143	415	399	814	2005	1147	3966	21	20	41	57
144/145	Survey conducted in February 2016					440				
TOTAL	672	874	1546	3930	2381	8297	17	22	39	60
2016										
HA134	95	190	285	774	489	1549	12	24	36	63
HA135	182	380	562	1605	1008	3175	11	24	35	63
HA143	256	260	516	1430	723	2669	18	18	36	50
144/145	Survey conducted in February 2017					517				
TOTAL	533	830	1363	3809	2220	7910	14	22	36	58
2017*	Herd Unit Wide Antlered Deer, 3 points APR Hunt Season									
HA134	14	153	167	672	389	1228	2	23	25	58
HA135	47	282	329	1105	701	2135	4	25	30	63
HA143	111	348	459	1547	701	2707	7	22	30	45
144/145	Sightability Survey Conducted in February 2018					1405				
TOTAL	172	783	955	3324	1791	7475	5	23	29	54
2018*	Herd Unit Wide Antlered Deer, 3 points APR Hunt Season									
HA134	134	135	269	1223	721	2213	11	11	22	59
HA135	197	375	572	1752	1070	3394	11	21	33	61
HA143	178	239	417	1277	742	2436	14	19	33	58
144/145	Survey to be conducted in February 2019					823				
TOTAL	509	749	1258	4252	2533	8,866	12	18	30	59
2019*	Herd Unit Wide Antlered Deer, 3 points APR Hunt Season									
HA134	14	86	100	520	287	907	3	16	19	55
HA135	111	318	429	1346	730	2505	8	24	32	54
HA143	338	365	703	1706	1088	3497	20	21	41	64
144/145	Survey to be conducted in February 2020									
TOTAL	463	769	1232	3572	2105	6909	13	21	34	59

Appendix B

2010 - 2019 Harvest Age Structure by Hunt Area

for Mule Deer Herd MD131 - WYOMING RANGE - Hunt Area ALL

		MALES											FEMALES							
Year	Area	Juv	1	% 1	2+ C1	2+ C2	2+ C3	2+ UC	% 2+	Total Aged	Unk	**Total Chkd**	Juv	1	% 1	2+	% 2+	Total Aged	Unk	Total Chkd
2010	134	0	4	16%	0	0	0	21	84%	25	1	**26**	0	0	0%	0	0%	0	0	0
	135	0	13	10%	0	0	0	120	90%	133	0	**133**	0	0	0%	0	0%	0	0	0
	143	0	10	27%	0	0	0	27	73%	37	0	**37**	1	1	7%	12	86%	14	0	14
	144	0	8	6%	0	0	0	132	94%	140	0	**140**	2	1	8%	9	75%	12	0	12
	145	0	1	9%	0	0	0	10	91%	11	0	**11**	0	0	0%	0	0%	0	0	0
2011	134	0	0	0%	0	0	0	5	100%	5	0	**5**	0	0	0%	0	0%	0	0	0
	135	0	10	15%	0	0	0	56	85%	66	0	**66**	0	0	0%	1	100%	1	0	1
	143	0	1	5%	0	0	0	20	95%	21	0	**21**	0	0	0%	0	0%	0	0	0
	144	0	3	3%	0	0	0	101	97%	104	0	**104**	0	1	100%	0	0%	1	0	1
	145	0	0	0%	0	0	0	3	100%	3	0	**3**	0	0	0%	1	100%	1	0	1
2012	134	0	18	72%	0	0	0	3	28%	25	14	**39**	0	0	0%	1	100%	1	1	2
	135	0	20	35%	0	0	0	19	65%	57	21	**78**	0	1	33%	2	67%	3	3	6
	143	0	4	18%	0	0	0	16	82%	22	0	**22**	0	0	0%	0	0%	0	0	0
	144	0	7	6%	0	0	0	101	94%	108	1	**109**	0	0	0%	1	100%	1	0	1
	145	0	0	0%	0	0	0	8	100%	8	0	**8**	0	0	0%	0	0%	0	0	0
2013	134	0	1	50%	0	0	0	1	50%	2	0	**2**	0	0	0%	0	0%	0	0	0
	135	0	0	0%	0	0	0	7	100%	7	0	**7**	0	0	0%	1	100%	1	0	1
	143	0	4	44%	0	0	0	5	56%	9	0	**9**	0	0	0%	0	0%	0	0	0
	144	1	31	22%	0	0	0	107	77%	139	5	**144**	0	0	0%	3	100%	3	0	3
	145	0	4	22%	0	0	0	14	78%	18	4	**22**	0	0	0%	1	100%	1	0	1
2014	135	0	1	17%	2	1	0	2	83%	6	0	**6**	0	0	0%	3	100%	3	0	3
	143	0	7	41%	4	5	1	0	59%	17	0	**17**	0	0	0%	0	0%	0	0	0
	144	0	18	15%	1	0	0	100	85%	119	0	**119**	0	0	0%	3	100%	3	0	3
	145	0	0	0%	0	0	0	7	100%	7	0	**7**	0	0	0%	0	0%	0	0	0
2015	135	0	0	0%	0	0	0	0	100%	4	0	**4**	0	0	0%	0	0%	0	0	0
	144	13	0	0%	0	0	0	3	86%	96	0	**96**	0	0	0%	3	100%	3	0	3
	145	0	0	0%	0	0	0	1	100%	12	0	**12**	0	0	0%	2	100%	2	0	2
2016	144	1	10	8%	0	0	0	107	91%	118	1	**119**	0	0	0%	2	100%	2	1	3
	145	0	0	0%	0	0	0	12	100%	12	1	**13**	0	0	0%	0	0%	0	0	0

Appendix B (cont.)

2010 - 2019 Harvest Age Structure by Hunt Area																				
for Mule Deer Herd MD131 - WYOMING RANGE - Hunt Area ALL																				
		MALES											FEMALES							
Year	Area	Juv	1	% 1	2+ C1	2+ C2	2+ C3	2+ UC	% 2+	Total Aged	Unk	Total Chkd	Juv	1	% 1	2+	% 2+	Total Aged	Unk	Total Chkd
2017	134	0	5	11%	32	12	0	0	89%	45	0	**45**	0	0	0%	4	100%	4	1	5
	135	1	1	5%	8	9	3	0	91%	22	0	**22**	0	1	33%	2	67%	3	1	4
	143	0	0	0%	5	10	3	0	100%	19	0	**19**	0	0	0%	0	0%	0	0	0
	144	0	1	2%	7	24	7	0	98%	47	1	**48**	0	2	40%	3	60%	5	0	5
	145	0	0	0%	2	1	1	0	100%	6	0	**6**	0	0	0%	0	0%	0	0	0
2018	134	0	10	19%	27	16	0	0	81%	53	0	**53**	0	0	0%	1	100%	1	1	2
	135	2	17	17%	25	39	15	0	81%	98	0	**98**	0	0	0%	4	100%	4	0	4
	143	0	3	9%	5	20	6	0	91%	34	0	**34**	1	0	0%	1	50%	2	4	6
	144	0	3	7%	2	23	16	0	93%	44	0	**44**	0	0	0%	0	0%	0	2	2
	145	0	0	0%	0	2	0	0	100%	2	0	**2**	0	0	0%	0	0%	0	0	0
2019	134	0	3	15%	13	3	1	0	85%	20	1	**21**	0	0	0%	2	100%	2	2	4
	135	0	3	17%	9	4	2	0	83%	18	2	**20**	0	0	0%	1	100%	1	0	1
	143	0	6	21%	5	13	4	0	79%	28	7	**35**	0	0	0%	1	100%	1	0	1
	144	0	3	5%	14	25	18	0	95%	60	2	**62**	0	0	0%	1	100%	1	0	1
	145	0	1	8%	7	3	1	0	92%	12	0	**12**	0	0	0%	0	0%	0	0	0

A SUMMARY OF HUNTER SATISFACTION IN THE WYOMING RANGE MULE DEER HERD HUNT AREAS (AREAS 134, 135, 143-145) 2011 – 2019

Prepared by:

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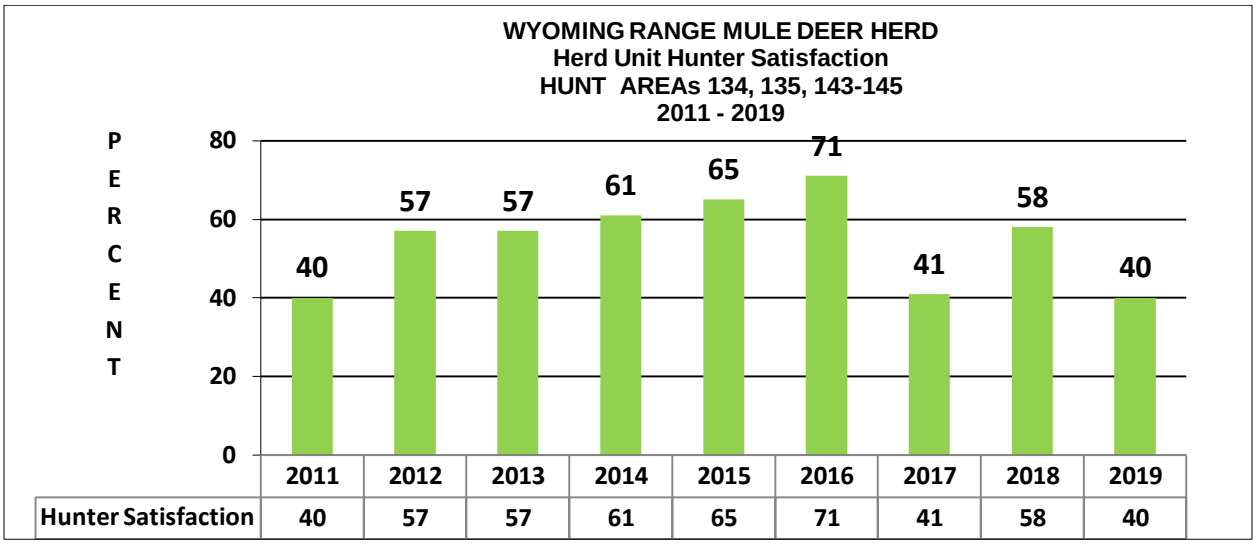
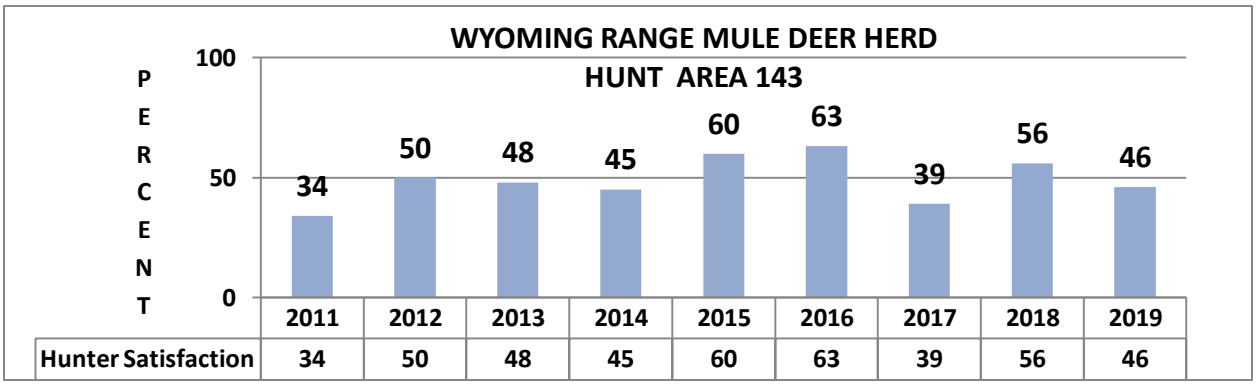
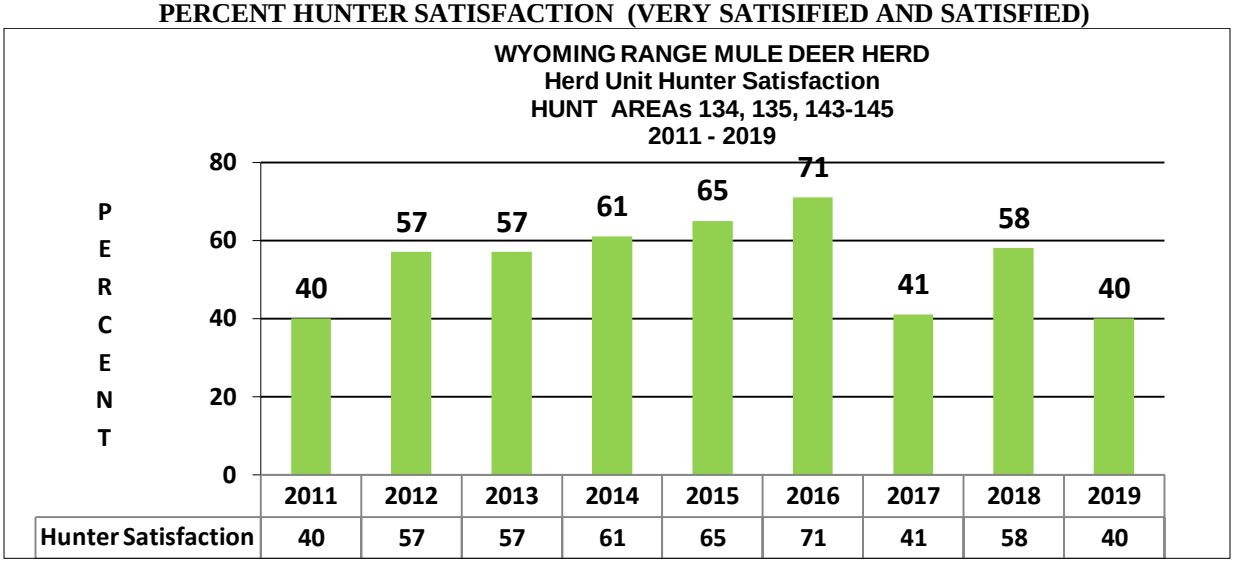
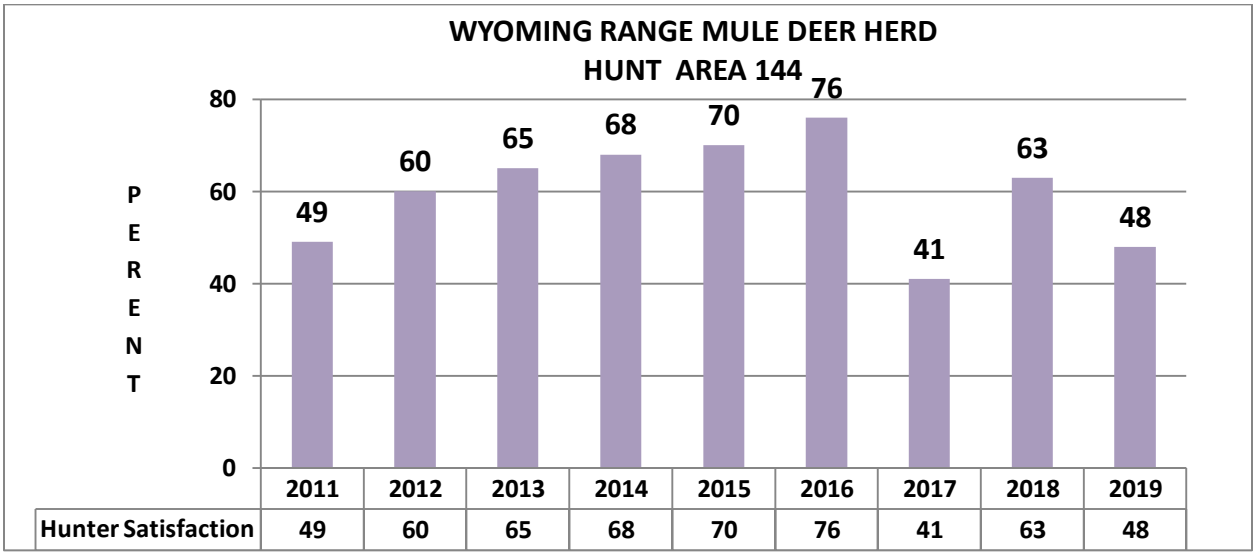
WYOMING RANGE MULE DEER HERD (HA 143)
PERCENT HUNTER SATISFACTION (VERY SATISIFIED AND SATISFIED)

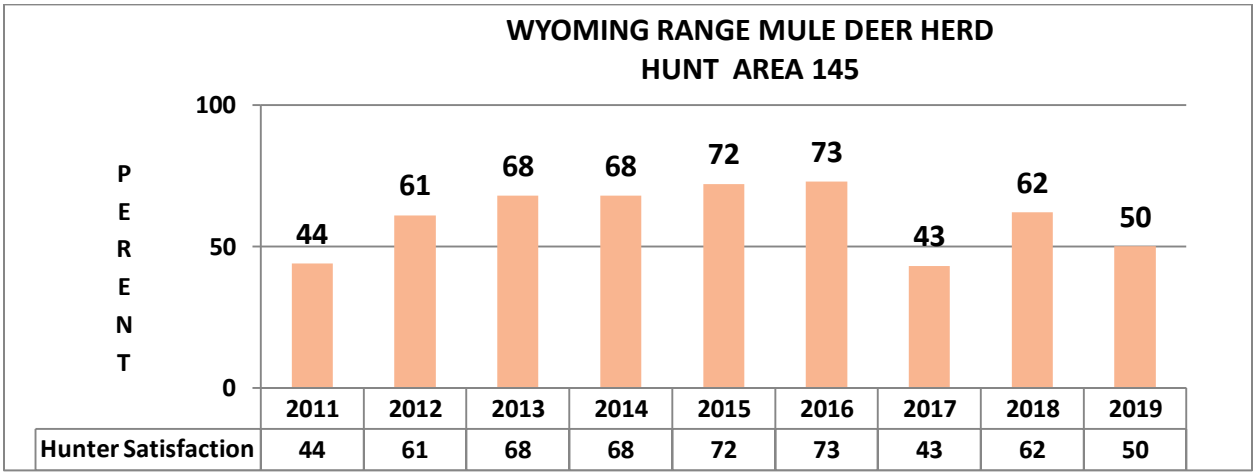




WYOMING RANGE MULE DEER HERD (HAs 144, 145)
PERCENT HUNTER SATISFACTION (VERY SATISIFIED AND SATISFIED)

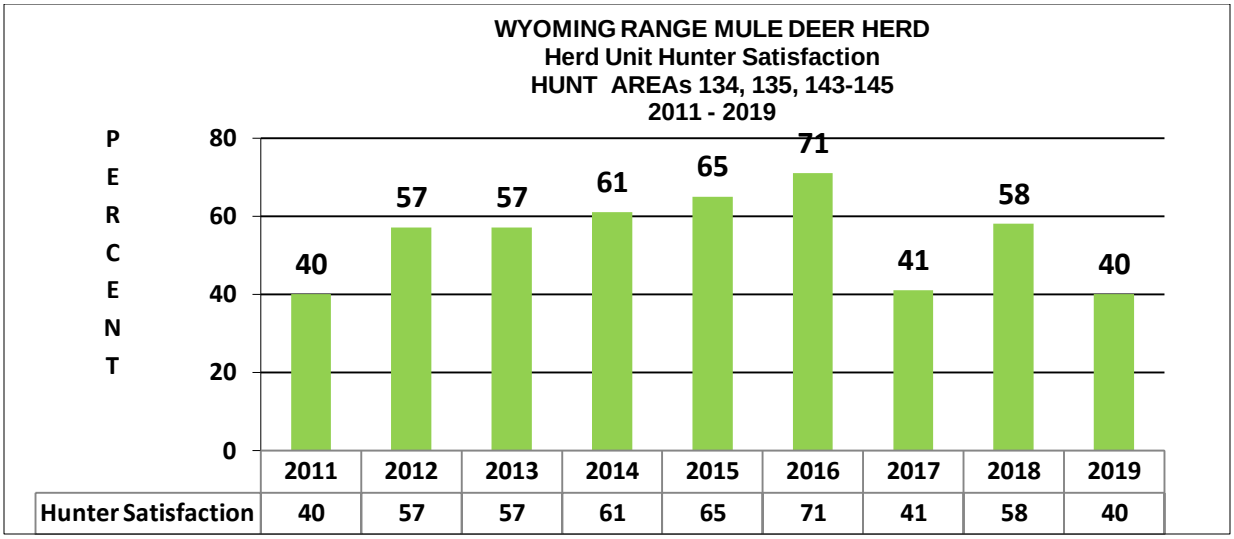




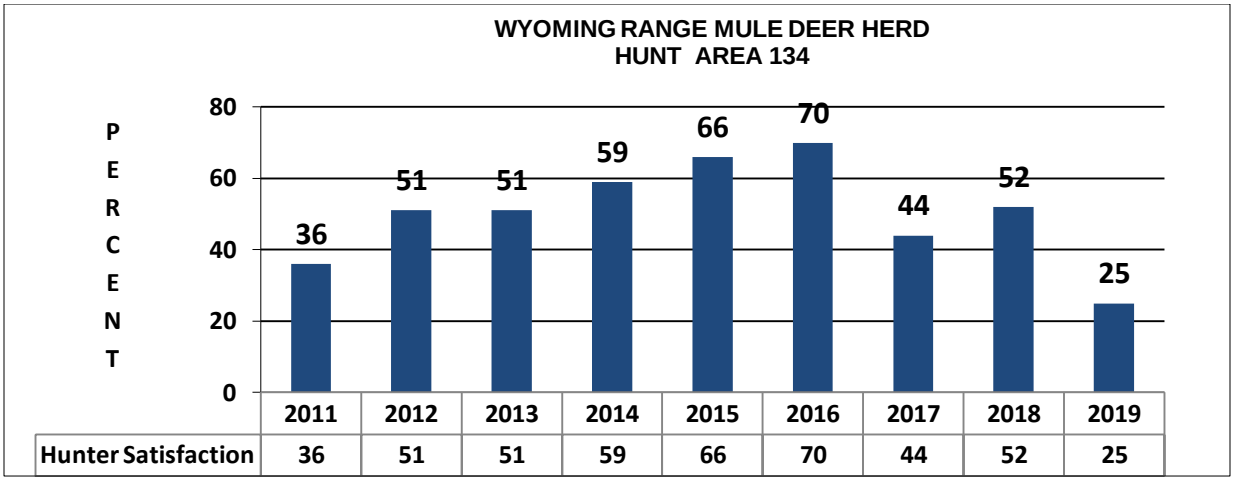


Appendix C

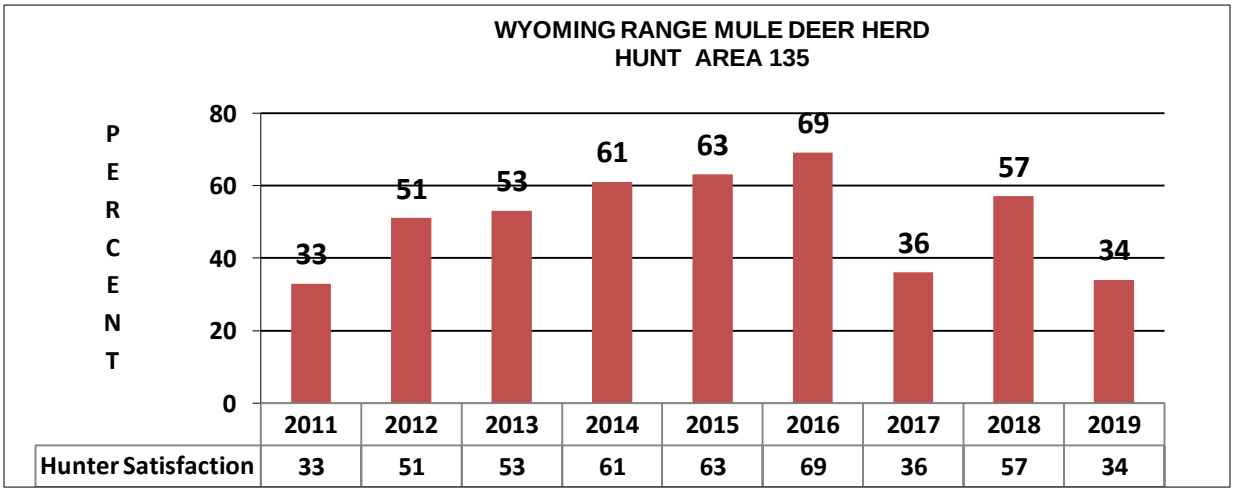
WYOMING RANGE MULE DEER HERD (HAs 134, 135)
PERCENT HUNTER SATISFACTION (VERY SATISIFIED AND SATISFIED)



	2011	2012	2013	2014	2015	2016	2017	2018	2019
Hunter Satisfaction	40	57	57	61	65	71	41	58	40



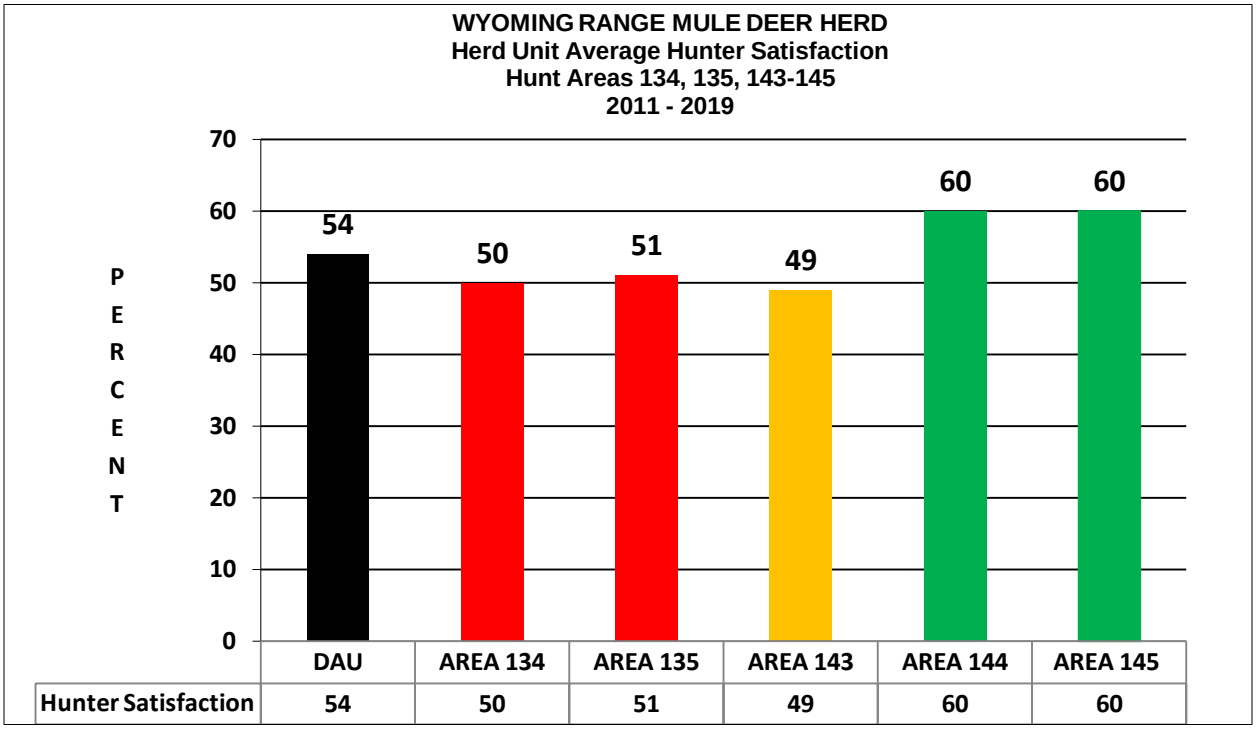
	2011	2012	2013	2014	2015	2016	2017	2018	2019
Hunter Satisfaction	36	51	51	59	66	70	44	52	25



	2011	2012	2013	2014	2015	2016	2017	2018	2019
Hunter Satisfaction	33	51	53	61	63	69	36	57	34

Appendix C

WYOMING RANGE MULE DEER HERD
AVERAGE HUNTER SATISFACTION (VERY SATISIFIED AND SATISFIED)
BY HUNT AREA
2011 - 2019



Appendix D

A CRITICAL REVIEW OF MULE DEER ANTLER POINT REGULATIONS AND THEIR APPLICATION

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Prepared: November 10, 2011

INTRODUCTION/BACKGROUND

Sportsmen and professional wildlife biologists throughout western North America are concerned about reduced numbers and declining trends in mule deer (deVos, et al. 2003). Range-wide declines in mule deer resulting from landscape level changes in habitats since the 1950s have resulted in recent and current concerns, with no jurisdiction being excluded from the decline (deVos, et al. 2003). During the post-1950s era, significant change occurred in both predator and hunter management, but declines in the quantity and quality of mule deer habitats are generally considered by leading mule deer biologists to be the major driving force leading to the range wide decline. Despite likely causes and limited ability to restore habitats to pre-1960 conditions, both hunters and managers continue to seek beneficial management strategies ranging from habitat treatments and predator management to varying deer harvest management schemes including antler point regulations. Too often, a simple solution is sought to what has been determined to be a very complex problem. It should be understood wildlife management agencies have "cycled through" varying management prescriptions for both deer and elk as long as the wildlife management profession has existed. This cycle continues with renewed implementation and ongoing evaluation.

Numerous management strategies have been employed to combat declining mule deer trends and the desire for more and larger bucks. One of the more popular strategies among sportsmen is the use of antler point regulations (APRs), wherein a segment of the male population is legally protected from harvest. The Wyoming Game and Fish Department and most other western state's wildlife agencies have conducted numerous evaluations of antler point regulations for cervids (primarily mule deer and elk) since the 1960s. Sportsmen generally believe APRs for mule deer produce more total bucks and larger bucks based on relative vulnerability of older-age mule deer. The application of APRs to reduce hunting pressure and to temporarily increase buck:doe ratios has been shown to be effective.

A recent resurrection of interest in antler point restrictions among members of southwestern Wyoming hunting public has resulted in this latest effort to evaluate the use of

APRs to benefit mule deer and improve buck deer hunting. These regulations have generally been supported by sportsmen and some wildlife professionals as a way of boosting male:female ratios and as a mechanism to increase the number of "trophy" or older-aged males. In premise, the thinking is limiting the harvest by reducing hunter participation and protecting specific age group(s) of deer will protect that group and allow for achievement of maximum age, size (trophy status), and number of bucks in the population. This paper is intended to provide a critical and current review of the use of APRs as they apply to mule deer and may be useful to managers and the public.

REVIEW OF ANTLER POINT REGULATION USE

APRs have been used by Western states for mule deer, black-tailed deer, white-tailed deer and/or elk in two general forms: 1) restrictions that protect younger age classes, and 2) restrictions that protect older aged males during general hunts. For mule deer, "three point or better" (≥3 points used by Colorado, Utah, Montana, Idaho, Washington, and Wyoming) or "four points or better" (≥4 points) seasons are an example of the first form. Seasons that restrict general license hunters to deer with ≤ 2 points, coupled with limited quota for deer > 2 points are an example of the latter form (e.g. this type of season is used in portions of both Idaho and Montana).

All APRs evaluated, regardless of method, resulted in short term increases in male ratios. The APRs evaluated were eventually followed by a return to pre-APR male:female levels after varying lengths of time, regardless of continued use of the APR**.** Most western states have concluded improved buck:doe ratios combined with increases in the number of mature bucks can only be accomplished through either: 1) a dramatic decrease in total buck harvest through limited quota in addition to doe harvest (Bender 2011) or 2) very conservative season length.

deVos et al. (2003) suggested that while APRs have been shown to increase total buck ratios, the number of adult (mature) bucks have never been shown to increase substantially. Additionally, these increases in buck ratio have never been shown empirically to improve either herd production or population size (deVos et al. 2003; Bishop et al. 2005), despite public perception this may occur.

USE OF ANTLER POINT REGULATIONS FOR MULE DEER BY STATE

COLORADO - Colorado implemented antler point restrictions for mule deer on a statewide basis for six years, and for a seven year period in a number of Game Management Units (GMU). These seasons resulted in a shift of hunting pressure on all age classes of bucks (primarily yearlings) to bucks ≥2. Colorado documented a marked increase in illegal or accidental harvest of yearling bucks during this period. The number and ratio of mature bucks did not increase during these 6 or 7 year periods.

IDAHO - Idaho implemented ≤2 point seasons (combined with limited quota seasons for bucks with ≥3 points) to reduce hunting pressure on older bucks and improve post-season total buck:doe ratios. Over the long term, these ≤2 point APR seasons did not improve total buck:doe post-season ratios. However, there were temporary (2-4 years) improvements in post-season

adult buck ratios following initiation of this type of APR. Following several consecutive years of increased general pressure solely on yearling males, adult buck ratios returned to pre-treatment (or worse) levels in the face of this regulation. This reduction of adult bucks following several years of increased pressure on yearlings was the result of dramatically reduced recruitment of yearlings into the adult buck classes.

Idaho also used a ≥4 point season in big game management unit 73 in the early 2000s in an effort to reduce hunter participation and crowding in this area. The regulation was strongly backed by the public and resulted in increased total buck:doe ratios. However, following several years of APR use, the public became concerned about increasing number of large adult males with 3 point antlers. Complaints about hunter crowding remained during APR use and the area was eventually converted to an "unlimited controlled hunt structure" (hunters selecting to hunt in this area are precluded from hunting in other "general" areas, but "permits" were not limited) in an effort to limit hunter participation.

UTAH - Utah used both ≥3 and ≥4 point over a number of years in numerous GMUs. The Utah Division of Wildlife abandoned mule deer APRs after five years due to significant (>35%) illegal harvest of yearling males, reduced total harvest, reduced hunter participation, shifting hunter distribution, and a reduction in harvestable mature bucks.

MONTANA – Montana has used APR seasons that protect both adult males (≤2 points only legal for a portion of the general season) and seasons that protect yearlings. In the former seasons, results were similar to those in Idaho; a temporary increase in mature bucks followed by a return to pre-APR ratios. Conversely, attempts to increase the number of mature bucks and total buck:doe ratios using ≥4 point seasons in Montana reduced total buck harvest by 28%, and increased illegal harvest of bucks with ≤3 points by nearly 40%. However, harvest of legal bucks having ≥4 points increased when compared to areas without APR, but personnel believed this was unsustainable. Montana personnel suggested this season structure could be detrimental to total buck ratios in areas with limited mule deer security habitats (e.g. areas with extensive road networks).

WASHINGTON - Washington used APRs in select units for mule deer, black-tailed deer, and/or white-tailed deer (WDFW 2010). During APR use, which they continue to employ in select units, Washington experienced a smaller total harvest of mule deer bucks, a switch in some harvest from mule deer to white-tailed deer, and no increase in the number of mature mule deer bucks. They did experience an increase in total buck:doe ratios as the result of lower total mule deer buck harvest. However, fawn recruitment in these areas also increased at this same time due to improved precipitation and habitat, complicating the analysis. WDFW concludes in their analyses that APRs work to increase buck "escapement" from harvest when combined with short season length.

OREGON – Oregon used an APR regulation for mule deer for a number of consecutive years in the popular Steens Mountain herd, and other wildlife management units. ODFW abandoned this regulation when both the number of older bucks and total buck:doe ratios decreased following 12 consecutive years of APR (≥4 point). They documented significant illegal harvest of bucks ≤3 points and a reduction of 30% of bucks ≥4 points observed following

the hunting season. Additionally, legal harvest declined by over 50%. Since APRs did not achieve public desires for more and larger bucks, Oregon has since moved to limited quota to meet post-season buck ratio management objectives in these areas (ODFW 2003).

HISTORY AND STATUS OF APRS FOR MULE DEER IN WYOMING

Wyoming has used APRs as a harvest management tool several times over the past 40+ years. APRs have been used in different parts of the state as a tool to increase total buck:doe ratios in herds that fail to meet management objectives. For mule deer, the harvest strategy was put in place to increase buck survival by limiting the segment of bucks allowable for legal harvest. The following examples are the main areas where APRs have been used for mule deer management in Wyoming.

WGFD Cody Region

The Cody Region has a long history of ≥4 point APR use in mule deer seasons. This season structure was used for a 12 year period in the Meeteetse area during the general season (November general season) where total buck:doe ratios were below management objectives. Initially, this season increased total buck:doe ratios. However, the regulation was removed following this 12-year period due to reduced total buck:doe ratios and an increase in prevalence of older-aged 3 point deer. Misidentification and illegal harvest of ≤3 point males was also considered to be an issue. The Cody Region also used this season on a private ranch in the Ten Sleep area to accomplish the same goals. The Orchard Ranch used the regulation for several decades before coming to the same conclusion it was not maintaining higher overall ratios and was promoting survival of older aged “inferior” bucks (Kevin Hurley pers. comm.).

APRs have also been used extensively in the Upper Shoshone (McWhirter 2006a) and Clarks Fork (McWhirter 2006b) herd units near Cody on a periodic basis to address low total buck:doe ratios. In the Upper Shoshone, a ≥4 point APR was used most recently from 2003-05. Yearling ratios did not respond favorably the first year due to poor fawn recruitment from 2002. However, yearling buck ratios improved the following year since 2003 fawn recruitment was much better. Cody personnel did not observe an increase in adult bucks:100 does during this period, while total bucks:100 does did increase. Protection of yearling males shifted all hunting pressure to 2+ year-old bucks, and the ratio of mature bucks fell during the use of APR.

Use of the ≥4 point APR regulation in the Clarks Fork herd yielded similar results to those seen in the Upper Shoshone. While yearling male ratios increased during the period the APR was employed, mature buck ratios declined, and the regulation resulted in no increase in total buck ratios. Following removal of the APR, total buck ratios were maintained by shortening the general season length. However, personnel recognized more conservative season

structures (i.e. limited quota) were most likely necessary to meet mature buck management objectives and public desires regarding this herd.

The Cody Region also used ≥4 point APR restrictions in the former Nowood Mule Deer Herd Unit (Hunt Areas 35 and 39; now a portion of Southwest Bighorns Mule Deer) in combination with antlerless deer seasons from 1984-1989 (Harju 1987; need JCR reference 1989) due to public concerns for low buck:doe ratios. Prior to 1984, this herd was hunted under a general antlered deer season and 150-300 antlerless deer licenses. The goal of the ≥4 point APR season was to increase total buck ratios. As has been documented in a number of states and other locations in Wyoming, the APR season resulted in a dramatic decline in both hunter numbers and buck harvest. In the Nowood herd, total and mature buck:doe ratios initially dropped after APR implementation but improved as hunter participation dropped and success remained low. Season structure was changed back to an "any deer" season in 1990.

WGFD Lander Region

The Lander Region used ≥4-point APRs in Hunt Areas 91-97 and Hunt Area 160 (South Wind River and Sweetwater Herd Units) in 2004 and 2005. This was a 2-year effort to increase total buck ratios that had declined below objective following several years of severe drought and concurrent declines in fawn recruitment. Fawn recruitment reached a low of 37:100 does in 2001. Results suggest the use of APR season worked well in both cases and the management objective of increasing total buck ratios were achieved. As expected, yearling buck:doe ratios showed marked improvement during both years, which later translated into improved adult buck ratios. APR use resulted in significantly fewer hunters and harvest, possibly due to concerns over buck numbers or regulation complexity. Mature buck:doe ratios also benefitted from reduced hunter numbers and harvest. Fawn/doe ratios increased during these years due to better environmental and habitat conditions, which led to even greater yearling recruitment/survival due to larger numbers of buck fawns reaching age 1+ post-season. Following two years of ≥4 points APR in the South Wind River and Sweetwater herd units, coupled with vastly improved fawn recruitment, total buck ratios more than doubled from lows of 13 and 14 bucks:100 does in 2002, up to 29 and 31 bucks:100 does in 2005, respectively.

During the APR season structure in these two herds, personnel documented a few ≤3 point bucks killed and abandoned, or at check stations. Overall, personnel considered regulation compliance to be good. As expected, most of the 2004 and 2005 harvest consisted of younger aged ≥4 point bucks (2 and 3 year olds). Personnel also noted an increase in older aged class males in both herd units following the improved habitat conditions and reduced hunting pressure and harvest. Total buck harvest in 2009 was nearly quadruple of that observed in 2004. Total buck:doe ratios have remained in the mid to upper 20s:100 does without APR since 2005.

However, it should be noted the **combination** of APR, improved fawn production/recruitment, and reduced total buck harvest yielded the results achieved in the Lander Region.

WGFD Green River Region

The Green River Region has used APRs in two herds. In the South Rock Springs Herd APRs were implemented in the 1970s. However, little information is recorded on their use from that era. According to communications with past managers the regulation was concurrent with low overall hunter numbers and done during a time of significant more deer security habitat and lower hunter mobility in those areas due to fewer roads and no modern ORV vehicles to travel the area. Hunting was reportedly very good during those years but it is unclear whether the presence of APR had any impact.

In the Green River Region, APR regulations have been used most recently in the Uinta Deer Herd, specifically in Hunt Area 132. The xeric area has low habitat productivity and is extremely heavily roaded, with very limited mule deer security habitat. The APR regulation was initiated in 2007 as a ≥4 point regulation and remained that way in 2008. In 2009 the regulation was modified to a ≥3 point regulation. This hunt area is currently the only area in Wyoming with an APR for mule deer. Criteria for length of time the APR would be used and specific buck ratio objectives were established during the initial year of the regulation, but were unacceptable to a vocal local public, including some influential landowners. Under WGFD recreational management guidelines, the target range for post-season buck:doe ratios is 20-29 bucks:100 does. Personnel proposed the season return to an antlered deer general season once observed ratios met or exceeded 25:100 for two consecutive years. Conversely, if Hunt Area 132 buck:doe ratios were below the midpoint (25:100) for two consecutive years, the point restriction would be reinstated.

Results from Area 132 are not as clean as those from some areas in Wyoming. A relatively significant shift in hunt area boundaries occurred during the middle of the APR period (2009), which makes direct comparison of the data somewhat problematic. Additionally, classification sample size has been inadequate during most years (most collected from the ground) prior to 2007 where increased flight budget allowed for additional data collection in this area. Both hunter participation and harvest fell significantly by 30% and 45%, respectively the year APR was initiated (2007), which is consistent with other areas. Since then, both harvest and hunter numbers may have rebounded to pre-APR levels, but the addition of more mesic areas along the Blacks Fork River and Bigelow Bench likely contribute significantly to this. Personnel are not seeing a dramatic increase in either participation or harvest on the ground in the area of concern east of Highway 414. The first year of APR implementation coincided with the first decent fawn production this hunt area had seen for a number of years. Yearling buck ratios appear to have increased during the years with improved fawn production the prior year, but total

buck ratios appear to be similar to pre-APR years. Fawn production has varied, but generally fallen since the first year of the APR.

Wyoming Summary

Clearly, Wyoming has significant experience with the use of APRs for mule deer management. The following excerpt is from page 18 of the Wyoming Mule Deer Initiative plan and notes some of the key issues with APR (specifically ≥4-point regulations; WGFD Mule Deer Working Group. 2007)

"A harvest strategy sometimes employed to improve depressed buck:doe ratios is a "four-point or better" hunting season. It may seem counterintuitive, but antler point restrictions do not necessarily produce more large bucks. In a ≥4 point season, the hunter is restricted to harvesting bucks with 4 points or more on either antler. Consequently, all harvest pressure is redirected to the largest deer in the population, which reduces their number. Since most yearlings and some 2-year old bucks are protected until they become small 4-point deer, the overall ratio of bucks to does will increase somewhat as a result of having more young bucks in the population. However, harvest is merely delayed until a buck grows its first set of 4-point antlers. The maximum benefit of a 4-point season is typically realized after the season has been in place 2 or 3 years, at which time most 4-point bucks are being harvested. Thereafter, the buck:doe ratio does not continue to increase and fewer bucks actually survive to grow truly large antlers. Over the long-term, persistently targeting large bucks may also eliminate desirable genetics (the ability to grow large antlers) from the population. If the objective is to produce more large deer, the 4-point restriction must be lifted after 2 years so harvest is once again spread over more age classes. This allows more of the incoming cohort of 4-point bucks to survive to an older age and potentially grow much larger antlers. Should the overall buck:doe ratio again decline to an unacceptably low level, the ≥4 point season can be reinstated for another 2-3 years to augment the number of bucks in the population, and the process is repeated. Permanent ≥4 point seasons do not produce more large bucks and actually reduce the harvestable surplus because some of the younger bucks that could have been harvested will die from other causes before they grow 4-point antlers. In addition, some small bucks are mistaken for legal bucks and are illegally killed and abandoned. Those deer represent a resource that is lost from the population and impact hunter opportunity in future years."

CONCLUSION

Point regulations have been referred to as a prescription for ailing deer and elk management, without a clear understanding of the disease (Carpenter and Gill, 1987). As is typical with most wildlife management, simple solutions are often sought for a very complex problem, one in which our ability (or understanding of all consequences) to influence direction may be limited.

Appendix D

Here are the main points from our analysis of APR use from Wyoming and throughout the west:

- APRs **DO** increase total buck ratios; **however** results varied and were usually temporary.
- APRs are very popular with the hunting public. However public understanding of the pros and cons appears to be limited, and is complicated by popular literature concerning APRs.
- Most benefits occur in ≤ 3 years; use of APRs beyond this often appear to result in negative impacts to both total buck ratios and mature buck ratios. Continued long term use of APRs (≥3-4 years) may result in lower total male:female ratios.
- No APR evaluated resulted in a long-term increase in adult (mature) male:female ratios, or an increase in the number of adult bucks, except in cases where hunter participation falls off significantly, coupled with good fawn production.
- For improvements in total buck:doe ratios, temporary use of APRs are most effective following a year of high fawn production and recruitment or in years doe harvest is increased.
- Mule deer managers (and the data) generally agree only dramatic reductions in harvest pressure on males ≥2 years of age (through conservative seasons such as limited quota or very short season length) will increase adult buck:doe ratios in herds where adult male ratios are chronically low.
- APRs often appear to reduce the number and quality of mature bucks over time.
- Long–term use of APRs may target younger animals with high antler growth potential while protecting animals with low antler growth potential. While this is a concern among wildlife professionals and the public, no research has occurred to validate these concerns.
- APRs may dramatically reduce hunter numbers, hunter success, and total harvest.
- APRs can increase the number of deer shot and illegally left in the field; this can be significant as documented in Wyoming, Colorado, Utah, and Montana.
- APRS do not increase fawn production or population size. Even when buck ratios are in single digits, pregnancy rates are well over 90%. Dramatic increases in buck ratios result in relatively few additional fawns (White et al. 2001). Discussions concerning the influence of total and adult buck:doe ratios on timing of conception (and corresponding fawn recruitment/survival) continues among wildlife professionals and the public in Wyoming and other Western states, and is a topic for additional evaluation.
- Some APRs place all the hunting pressure on older age class bucks, gradually eroding that portion of the buck population. Others reduce yearling recruitment potential to older age classes by placing most harvest pressure on yearling males.
- Use of APRs may decrease interest in hunting among "meat" hunters.
- Use of APRs suggests harvest may become more difficult for beginning and young hunters in both locating and identifying legal deer.
- Long-term use of APRs in areas with limited mule deer security habitats is potentially detrimental to maintenance of acceptable total or adult buck:doe ratios.
- No empirical study of APR regulations or results has occurred for mule deer. We recommend this be a priority topic of research for WAFWA.

- Use of APRs should be viewed as a legitimate management tool to be used temporarily in areas with chronically low male:female ratios. Managers and the public are cautioned that review of the available information suggests APRs result in no long term increase either adult buck ratios nor total deer populations.

While the data suggests APRs definitely increase **total** buck ratios, at least temporarily, they **do not** appear to increase the number or ratio of adult bucks in the population, quite the contrary when used over a long period of time. They may increase mature bucks only when hunter participation falls significantly enough to dramatically reduce overall buck harvest, similar to that seen under a conservative limited quota scenario. Long-term APR use has also been shown to reduce the percentage of Class II (20-25") and Class III (>25") bucks in the population. APRs typically reduce hunter participation, harvest, and hunter success, sometimes dramatically. The harvest data from Wyoming's Area 132 contradicts other harvest data sets from areas with APRs given continued increases in hunter participation, harvest, and success, and reduced hunter effort. However, as mentioned above, addition of a significant and more productive area to Hunt Area 132 may have resulted in these observed increases in hunter statistics.

Part of the belief these regulations will work among sportsmen is linked to an assumed reduced vulnerability of older-aged males to harvest. While reduced vulnerability to harvest definitely occurs at some level, the data suggests it is not enough to prevent reductions in these age classes under most scenarios evaluated. Also, heavily roaded hunt areas may not provide security habitats necessary for older aged mule deer to escape harvest, despite increased experience. Additionally, there is a misperception that an APR won't allow for younger aged animals to be harvested, when in fact many young-aged cervids (often the "best" genetically) meet the minimum restriction for number of points and can be legally harvested.

Appendix D

TABLE 1. Use of APR restrictions, APR type and results, western U.S.

STATE	APR TYPE	TOTAL BUCK RATIOS?	MATURE BUCK RATIOS?	HUNTER NUMBERS	TOTAL HARVEST	TOTAL POPULATION INCREASE FROM APR?	HUNTER COMPLIANCE
Colorado	≥4 points	Temp increase	No improvement	Unknown	Decrease	No	Poor
Idaho [a]	≤2 points + LQ for ≥3 points males	Long term no improvement	Temporary improvement followed by decreased adult buck ratios	Decrease	Decrease	No	Unknown
Idaho [b]	≥4 points	Temporary increase	Regulation resulted in promotion of older aged 3 point deer	Neutral	Decrease	No	Unknown
Utah	Variable, ≥3 points or ≥4 points	No long term improvement	Decrease	Decrease	Decrease	No	Poor ≥35% illegal harvest
Montana [a]	≤2 points last two weeks of five week season	Long term no improvement	Temporary increase followed by pre APR adult buck ratios	Decrease	Decrease	No	Poor to Fair
Montana [b]	≥4 points	Temporary increase	Decrease	Decrease	Decrease in total harvest by 28% but increase in mature buck harvest	No	Poor 31-42% reported increase in illegal harvest

TABLE 1. Continued.

STATE	APR TYPE	TOTAL BUCK RATIOS?	MATURE BUCK RATIOS?	HUNTER NUMBERS	TOTAL HARVEST	TOTAL POPULATION INCREASE FROM APR?	HUNTER COMPLIANCE
Washington	≥3 points	Increase	No improvement	Neutral; significant switch to white-tailed deer hunting	Decrease in mule deer harvest	No	Unknown
Oregon	≥4 points	Decrease	Decrease	Decrease	Decrease by 50%	No	Poor – illegal harvest was "significant"
Wyoming – Meeteetse	≥4 points	Temporary increase, then reduction	No improvement; personnel believed promoted genetic "worsening" of antler form (selecting for older 3 points)	Decrease	Decrease	No	Poor
Wyoming – Nowood Mule Deer	≥4 points	Initial decrease then increase	Initial decrease then increase	Decrease	Decrease	No	Fair
Wyoming – Upper Shoshone Mule Deer	≥4 points	Temporary increase	Decrease	Decrease	Decrease	No	Unknown
Wyoming – Clarks Fork Mule Deer	≥4 points	Temporary increase	Decrease	Decrease	Decrease	No	Unknown
Wyoming – Sweetwater Mule Deer	≥4 points (2 years)	Temporary increase	Temporary improvement	Decrease	Decrease	No	Fair

TABLE 1. Continued.

STATE	APR TYPE	TOTAL BUCK RATIOS?	MATURE BUCK RATIOS?	HUNTER NUMBERS	TOTAL HARVEST	TOTAL POPULATION INCREASE FROM APR?	HUNTER COMPLIANCE
Wyoming – South Wind River Mule Deer	≥4 points (2 years)	Temporary increase	Temporary improvement	Decrease	Decrease	No	Fair
Wyoming – Uinta Mule Deer (Area 132)	≥4 points (two years) followed by ≥3 points (two years)	Increase, temporary? Ongoing use.	Increase, but so did adjacent areas without APR	Initial decrease – see discussion	Initial decrease – see discussion	No	Fair

Appendix D

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Appendix E

A summary of field check hunter-harvested yearling bucks, Hunt Areas 134,135, 143-145, Wyoming Range deer herd, 1991 - 2016.

	Hunt Area 134		Hunt Area 135		Hunt Area 143		Hunt Area 144		Hunt Area 145	
	N	Percent	N	Percent	N	Percent	N	Percent	N	Percent
Year	1	%	1	%	1	%	1	%	1	%
1991	12	33%	49	30%	34	28%	45	23%	0	0%
1992	0	0%	22	18%	9	11%	17	12%	0	0%
1993	1	5%	0	0%	2	5%	1	2%	0	0%
1994	9	56%	10	27%	1	5%	5	4%	NA	NA
1995	8	18%	19	14%	17	24%	23	11%	NA	NA
1996	1	7%	20	18%	7	18%	15	14%	NA	NA
1997	0	0%	13	18%	3	19%	3	5%	NA	NA
1998	2	8%	26	28%	2	10%	9	10%	1	100%
1999	42	59%	39	38%	7	32%	13	10%	0	0%
2000	25	36%	26	23%	22	45%	28	13%	3	60%
2001	21	24%	19	22%	15	31%	23	16%	1	100%
2002	3	16%	10	15%	0	0%	19	10%	0	0%
2003	13	17%	53	39%	2	17%	4	4%	2	40%
2004	6	9%	11	20%	0	0%	3	3%	0	0%
2005	7	29%	19	31%	7	33%	7	8%	6	46%
2006	17	29%	8	21%	10	33%	12	11%	2	18%
2007	4	11%	37	30%	9	33%	13	11%	5	33%
2008	8	21%	26	28%	4	13%	12	13%	1	6%
2009	2	100%	0	0%	5	29%	11	9%	0	0%
2010	4	16%	13	10%	10	27%	8	6%	1	9%
2011	0	0%	10	15%	1	5%	3	3%	0	0%
2012	18	72%	20	35%	4	18%	7	6%	0	0%
2013	1	50%	0	0%	4	44%	31	22%	4	22%
2014	NA	NA	1	17%	7	41%	18	15%	0	0%
2015	NA	NA	0	0%	NA	NA	0	0%	0	0%
2016	NA	NA	NA	NA	NA	NA	10	8%	0	0%
Total	**204**		**469**		**182**		**340**		**26**	

Annual	Hunt Area 134		Hunt Area 135		Hunt Area 143		Hunt Area 144		Hunt Area 145	
AVG	9	27%	18	20%	8	22%	13	10%	1	20%

Appendix F

WYOMING RANGE MULE DEER HERD

	1989 - 1995 N=781 Heads Measured				1996 - 2001; N=914 Heads Measured				2012 - 2018; N=423 Heads Measured			
	7 Years				6 Years				7 Years			
Spread	No. Heads	Average	Range of	Heads Measuring	No.Heads	Average	Range of	Heads Measuring	No.Heads	Average	Range of	Heads Measuring
(inches)	Measured	Age	Ages	Less (%)	Measured	Age	Ages	Less (%)	Measured	Age	Ages	Less (%)
8	1	2	2	0	1	1	1	0	1	1	1	0
9	1	2	2	<1%	2	1	1	<1%	2	2	2	<1%
10	0	N/A	N/A	<1%	3	1	1	<1%	0	N/A	N/A	<1%
11	4	1	1 - 2	<1%	9	1	1 - 3	<1%	0	N/A	N/A	<1%
12	8	2	1 - 3	<1%	5	1	1	2%	6	2	2 - 3	<1%
13	13	2	1 - 3	2%	18	2	1 - 3	2%	0	N/A	N/A	2%
14	23	2	1 - 3	3%	16	2	1 - 6	3%	6	3	1 - 4	2%
15	42	2	1 - 4	6%	22	2	1 - 3	4%	5	3	2 - 4	3%
16	54	2	1 - 4	12%	37	3	1 - 6	7%	14	3	2 - 5	5%
17	53	3	2 - 5	19%	52	2	2 - 5	11%	10	3	2 - 4	8%
18	63	3	2 - 4	25%	51	3	2 - 5	17%	18	3	2 - 4	10%
19	43	3	2 - 6	33%	46	3	2 - 7	23%	18	3	2 - 5	15%
20	55	3	2 - 9	39%	51	3	2 - 6	28%	23	4	3 - 5	19%
21	53	3	2 - 7	46%	57	3	2 - 10	33%	24	4	3 - 6	24%
22	67	4	2 - 10	53%	82	4	2 - 9	40%	32	4	3 - 9	30%
23	55	4	3 - 8	61%	53	4	2 - 8	49%	49	5	3 - 8	37%
24	49	4	3 - 8	68%	86	4	2 - 9	54%	40	5	3 - 8	49%
25	51	4	3 - 10	75%	79	5	2 - 9	64%	43	5	3 - 9	59%
26	44	4	3 - 9	81%	55	5	3 - 9	73%	32	5	3 - 8	69%
27	40	4	3 - 9	87%	62	5	3 - 9	79%	27	6	4 - 9	76%
28	24	4	2 - 9	92%	42	5	3 - 9	86%	30	5	4 - 7	83%
29	14	4	3 - 6	95%	27	5	3 - 8	91%	21	6	3 - 10	90%
30	12	5	4 - 9	97%	20	5	3 - 8	94%	8	6	4 - 7	95%
31	6	5	4 - 6	98%	16	5	3 - 8	96%	7	5	4 - 6	97%
32	4	5	3 - 8	99%	11	4	3 - 7	98%	4	6	4 - 7	98%
33	0	N/A	N/A	N/A	5	6	5 - 8	99%	3	6	5 - 6	99%
34	0	N/A	N/A	N/A	2	4	4 - 5	99.30%	0	N/A	N/A	100.00%
35	2	6	5 - 7	99.70%	1	7	7	99.50%	0	N/A	N/A	100.00%
≥36	0	N/A	N/A	100%	3	6	5 - 6	99.70%	0	N/A	N/A	100.00%

APPENDIX G

Nutritional carrying capacity and factors limiting population growth of mule deer in the Wyoming Range

Wyoming Cooperative Fish and Wildlife Research Unit
Wyoming Game and Fish Department
University of Wyoming
2013

APPENDIX G

PROJECT TITLE
Nutritional carrying capacity and factors limiting population growth of mule deer in the Wyoming Range

PRINCIPLE INVESTIGATORS
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Wyoming Game and Fish Department
Pinedale, WY

DURATION: 1 July 2012 – 30 June 2016

INTRODUCTION

Concerns over population performance and factors limiting population growth have heightened in recent decades in response to near ubiquitous declines in the abundance of mule deer (*Odocoileus hemionus*) throughout much of the West. Factors responsible for such declines remain largely speculative and controversial (deVos et al. 2003); however, recent comprehensive research has identified habitat quality and winter severity as important factors that are currently limiting mule deer in the Intermountain West (Bishop et al. 2009, Hurley et al. 2011). In response to concerns of mule deer populations in Wyoming, in 2007, the Wyoming Game and Fish Commission adopted the *Wyoming Mule Deer Initiative* (MDI) with the intent to develop individual management plans or strategies for key herd units based on overarching goals and objectives. Separately, the Mule Deer Working Group (2007) recognized that the *"Success and implementation of these plans will depend upon our ability to identify limiting factors to mule deer populations and their habitats"*.

Of particular concern is the Wyoming Range mule deer herd in western-central Wyoming- one of the largest mule deer herds in the state and a premier destination for mule deer hunting in the country. The Wyoming Range mule deer population (MD131) has undergone dynamic changes in recent decades from a population high of >50,000 in the late 1980s, to a sustained population of ~30,000 during the last decade. Prior to the acceptance of the MDI, the Wyoming Range mule deer herd was a top priority for the development of a management plan according to the MDI. The first of the herd-specific management plans, the *Wyoming Range Mule Deer Initiative* (WRMDI), was finalized in 2011 following a collaborative public input process. The proposed research we describe here stems directly from research and management issues identified by the Mule Deer Working Group in the WRMDI, and we have proposed to conduct this research on Wyoming Range mule deer because of its priority status and controversy behind its population dynamics.

The marked decline of this deer population following the 1992-93 winter, and the near absence of any substantial recovery, has engaged the WGFD in controversy regarding management and herd unit objectives. Despite conservative harvest focused on the antlered portion of the population with limited to no harvest of females, the population has failed to recover to the herd unit objective of 50,000 animals. Given current population trends, severity of winters, and deteriorating range conditions, it has become apparent that

the habitat is not capable of supporting the current herd unit objective. Nevertheless, identifying the current capacity of the habitat to support mule deer in the Wyoming Range has been a persistent management challenge. Habitat conditions on both winter and summer range occupied by Wyoming Range mule deer have been deteriorating as a result of both drought and land-use practices. Declines in snowpack and rising spring temperatures have been pronounced in recent decades across much of the Rocky Mountains (Westerling et al. 2006, Pederson et al. 2011); both of which have a negative effect on forage quality and abundance, thereby influencing carrying capacity.

PRIMARY OBJECTIVE

The overall goal of this research project is to address important research and management needs indentified by the MDI and WRMDI. **Overall, we seek to investigate the nutritional relationships between mule deer population dynamics, energy development and disturbance, habitat conditions, and climate to provide a mechanistic approach to monitoring and management of mule deer.** Our approach is to mesh data on nutritional condition, forage production and utilization, and population performance to understand factors regulating Wyoming Range mule deer and the ability of the current habitat to support mule deer. In addition, we have the opportunity to address secondary objectives including nutritional contributions of winter and summer ranges, factors affecting reproduction, identification of habitats of nutritional and reproductive importance to mule deer, timing and delineation of important migration routes, and direct assessment of the effects of energy development on nutrition and survival of mule deer.

BENEFITS

The impetus behind this project follows from questions underlying the population dynamics of the Wyoming Range mule deer herd, and was formulated to meet multiple objectives outlined by the Mule Deer Working Group in the *Wyoming Mule Deer Initiative*, and the herd-unit specific *Wyoming Range Mule Deer Initiative* (WRMDI). Our proposed study will meet objectives under 5 of the 6 management issues identified in the WRMDI which was finalized in 2011, including but not limited to:

• Estimate the nutritional capacity of existing habitat available to mule deer in the Wyoming Range to evaluate whether revision of the current population objective of 50,000 wintering mule deer is warranted.

• Characterize existing habitat conditions with respect to population density by implementing a nutritionally based approach to estimating carrying capacity that could be applied to other herd units in Wyoming.

• Link habitat use with vital rates and nutritional processes will help identify vegetation communities and habitat treatments most beneficial for mule deer to enhance mule deer populations as wells as identifying effective mitigation strategies.

• Assess the nutritional capacity for survival and reproduction will help characterize the potential effects of predation on mule deer, as well as the benefits of predator control efforts already in place.

• Evaluate patterns of mule deer migration will delineate important mule deer migration corridors, and provide predictive models for timing of seasonal migration to identify critical migration periods.

• Evaluate the physiological effects of oil and gas development will help to quantify the direct and indirect effects of habitat loss and disturbance on mule deer in the Wyoming Range, as well as identifying habitat manipulations that are likely to be most effective in mitigating the effects of energy development.

• Results of this research project will be presented in public forums in conjunction with the public input process, and by way of other venues to inform the public and stakeholders of issues facing Wyoming Range mule deer as well as management strategies likely to be most beneficial to the mule deer population.

Wyoming Range Mule Deer Project

Summer 2019 Update

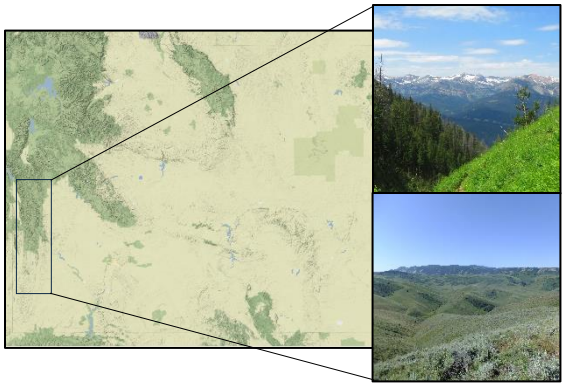
MONTEITH SHOP
HAUB SCHOOL OF ENVIRONMENT & NATURAL RESOURCES
WYOMING COOPERATIVE FISH & WILDLIFE RESEARCH UNIT

WYOMING GAME & FISH DEPARTMENT

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

UNIVERSITY OF WYOMING

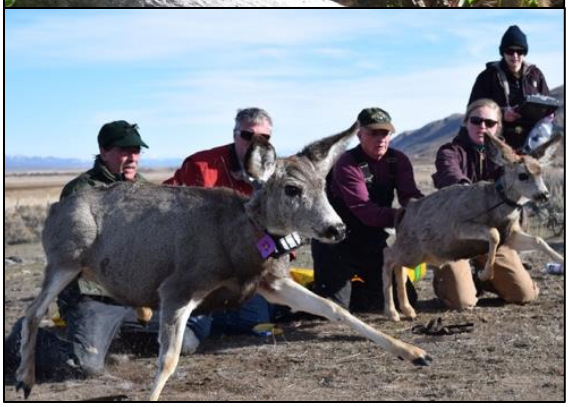
Appendix H



Above: The Wyoming Range, highlighted in the black inset, is a remarkable landscape full of wildlife, forests. Locals and non-residents alike use this area to hunt and recreate in.

Below: Male mule deer in the Wyoming Range are venerated throughout the western US and are highly sought-after by hunters.

The Wyoming Range is home to breathtaking landscapes, abundant wildlife, lush wildflowers, and ample recreation opportunities. Of all the remarkable landscape characteristics in the Wyoming Range, the mule deer are held in especially high regard. Many in the public are intensely invested in the well-being of this herd of mule deer, and the Wyoming Game and Fish Department has worked to ensure that this population remains robust enough to support sufficient hunting opportunities while protecting the herd overall. Yet, despite substantial efforts to increase mule deer abundance, this populations has historically experienced instances of dramatic declines, followed by moderate recovery. Further, since the most notable decline in the mid-1990s, the Wyoming Range mule deer population has remained stagnant or declined. These concerning trends have motivated inquiry into the factors that regulate this cherished herd.



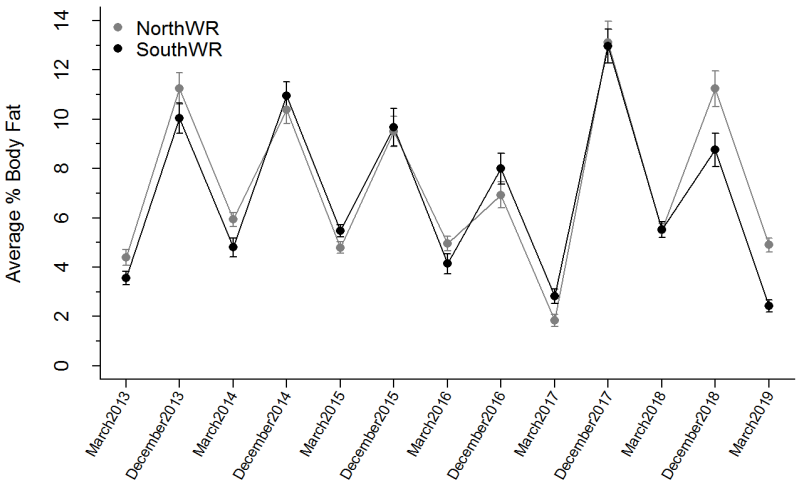
Above: This cross-generational study, which starts with the birth of a fawn, gives us a detailed view into the factors affecting the Wyoming Range mule deer herd. We then monitor individuals throughout their lives, allowing us to assess factors such as nutritional condition, reproduction, and behavior throughout multiple life stages and seasons.

We at the Monteith Shop have been working to understand myriad aspects of mule deer ecology to inform on-the-ground management, conservation, and policy of Wyoming Range mule deer since 2013. Our work primarily centers on tracking mule deer throughout their lives, while assessing their nutritional condition, movement, habitat use, and survival, among other elements. The Wyoming Range Mule Deer research encompasses multiple projects to provide solutions for immediate management concerns, as well as answer foundational questions in wildlife ecology. Through these efforts, we are uncovering previously unknown aspects of mule deer behavior, life history, and population dynamics that have direct implications for the conservation of mule deer in the Wyoming Range and beyond.

A Longitudinal look at mule deer in Wyoming

Fawns must grow enough to survive their first winter, yearlings must establish home ranges, adult males fight for the chance to mate, and adult females raise offspring; even this simplistic representation of the demands a deer faces throughout their life suggests that different factors will be important to an animal depending upon where they are in life. Yet, there is a common thread that fuels all of these demands: food.

Over the past 6 years, we have been taking a longitudinal look at the factors influencing the Wyoming Range mule deer herd, using a nutritional ecology framework. Through longitudinal research, we are able to assess how the factors that are most influential might change throughout an animal's life, as well as across generations. This long-term look allows us to identify trends and relationships that shorter studies may have missed. Through the nutritional ecology framework, we evaluate how resources such as food affect individuals, and eventually populations. Using this unique approach, we have begun to develop a comprehensive understanding of how the connections individual deer have with their environments influences population dynamics. This long-term research project has allowed researchers, scientists, and managers to answer on-the-ground management questions and better understand broad ecological phenomena.



Above: Average percent of body fat of adult, female mule deer in the Wyoming Range from March 2013 to March 2019. Long term study of this population has allowed us to document significant crashes in condition of animals during harsh winters.

Each year, we recapture animals each spring and autumn with helicopter netgunning to evaluate their condition as they leave seasonal ranges. Each capture event, we fit an animal with a GPS collar and use ultrasonography to evaluate percent body fat and pregnancy. By capturing animals multiple times throughout their life, we can link various life-history characteristics with behaviors and habitat conditions of individual animals.

Above: At each capture event, we collect a suite of different data points, including measurements of body size, pregnancy and nutritional condition, and biological samples such as blood and fecal samples.

The following pages include updates on the projects we are working on!

How do fawns fare over summer?

Over the past 5 summers, we have collared neonatal mule deer that belong to collared females to monitor survival and determine cause-specific mortality of the most vulnerable segment of the population. Since 2015, we have successfully tracked 341 fawns and have been continually monitoring their survival.

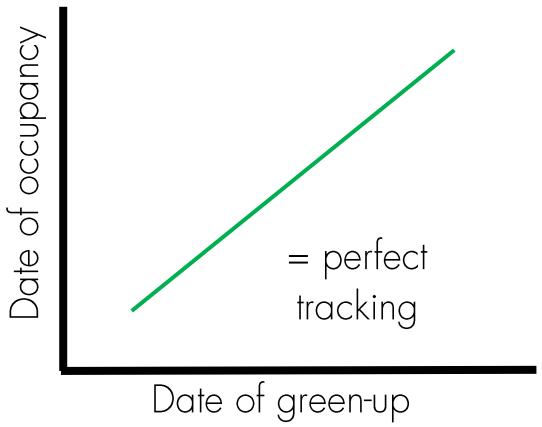
Above: WY Game and Fish biologist, Gary Fralick, collars a fawn during the summer of 2015.

Fawn survival over the past five summers has been variable, and leading cause of mortalities differs from year to year. In 2015, disease was the leading cause of death in fawns over summer. Following a particularly harsh winter in 2016-2017, stillbirths were the leading cause of death in fawns the following summer. This component of the project is still ongoing, but so far we have detected a breadth of various causes for fawn mortality including predation, disease, malnutrition, drowning, hypothermia, vehicle-collision, and just being caught in vegetation.

Above: A male fawn collared in June 2018. He survived his first summer and migrated with his brother and their mom to their winter range near Calpet during the fall of 2018.

What do mule deer eat while migrating?

Migration is a complex phenomenon that allows animals to use high-quality resources available on one seasonal range (e.g., summer ranges), while avoiding resource deficiencies on the other (e.g. winter ranges). Until recently, little has been known about how animals behave along their migration routes, and the potential benefits animals might gain by using different paths at different times. To understand this process better, we evaluated how well animals can match their movement to emerging vegetation. Emerging vegetation provides high quality food during an important period of the year for these animals and might play an important role on their ability to recruit offspring into the population, and ultimately survive.



Above: An animal that is a 'perfect surfer' matches the date that they use an area on the landscape perfectly with the date that area has the highest quality of resources (or 'green-up').

We found that animals were able to match their movements closely with newly emergent, high-quality forage along elevational gradients on their migration routes. The ability for animals to match their movement to high quality food allows them to maximize the resources on their way to summer range.

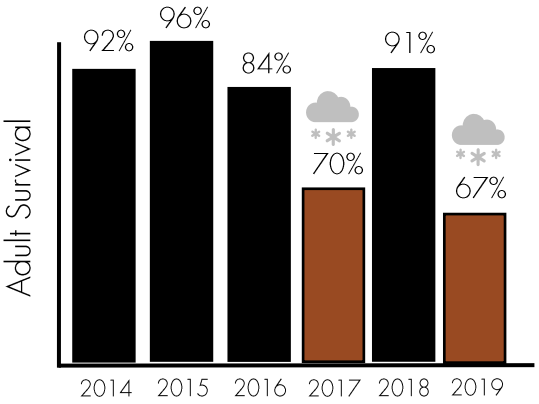
This research is published!

Aikens, E.O., M. J. Kauffman, J. A. Merkle, S. P. H. Dwinnell, G. L. Fralick, and K. L. Monteith. 2017. The greenscape shapes surfing of resource waves in a large migratory herbivore. *Ecology Letters* 20:741-750.

How do mule deer recover from harsh winters?

Winters in the Wyoming Range can be extremely harsh, which can cause dramatic dips in over-winter survival and may have long-term effects on population dynamics. We are working to understand the consequences of harsh winter conditions and the associated recovery from severe winters.

Above: Mule deer in Whitney Canyon, WY migrating towards winter range during December 2018.

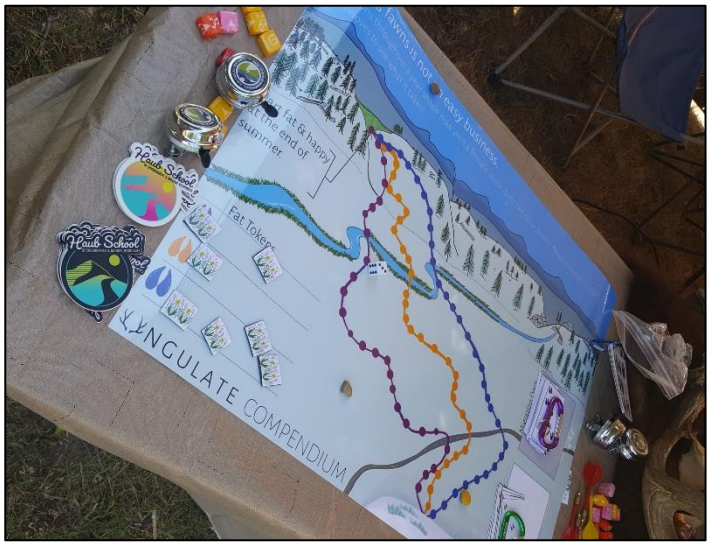


Above: Overwinter survival of adult, female mule deer in the Wyoming Range.

In 2016 – 2017, the Wyoming Range mule deer herd experienced one of the worst winters on record, and survival of adults was very low compared to years with average winter conditions. Only two years later during the 2018 – 2019 winter, winter conditions again were extremely harsh, and overwinter survival of adults dropped even lower than what we detected in 2016 – 2017. Understanding how animals cope with severe winter conditions and how they survive and reproduce successfully during extreme weather may help to manage populations better under increasingly stochastic and harsh winter conditions.

What does the public think about mule deer ecology?

Effective wildlife management hinges on decisions grounded in science, as well as public support of issues relating to wildlife. Lack of public support can cause members of the public to resist, and potentially prevent, management actions from being implemented. To increase public support, many wildlife scientists have increasingly shared their findings and the importance of their work with members of the public. Scientists rarely, however, stop to evaluate whether they are presenting information in the most effective way. To improve communication with members of the public, we are examining how multiple stakeholder groups think about the issues affecting mule deer populations in Wyoming. Results from this research will help to shape future communication strategies, towards the goal of preventing more effective science outreach.

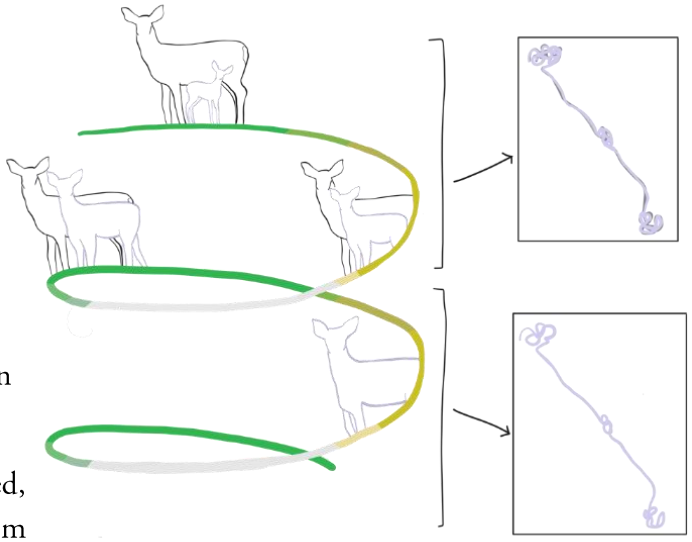


Above: A board game developed by the Monteith Shop to teach the public about the costs and benefits of migration. Using multiple media to interact with different members of the public can be an effective tool in both outreach and education about wildlife in Wyoming.

How is mule deer migration established?

Each year, millions of ungulates migrate across seasonally changing landscapes to access forage that is only available during certain times of the year, to reduce risk of predation and disease, or to escape harsh climactic conditions. These migrations are rarely spontaneous movements, but instead are continuations of behaviors that have been in place for years. Individual mule deer, for example, are extremely faithful to their migratory routes year after year, and rarely deviate from their migratory paths. Despite the high degree of faithfulness scientists have observed, how these behaviors are established in the first place still remains a mystery.

To better understand how migratory behaviors are established, we are evaluating whether migratory behaviors are learned from an animal's mother during the first year of their life. By understanding how migratory behaviors are established, our efforts will aid management seeking to protect migratory behaviors into the future.



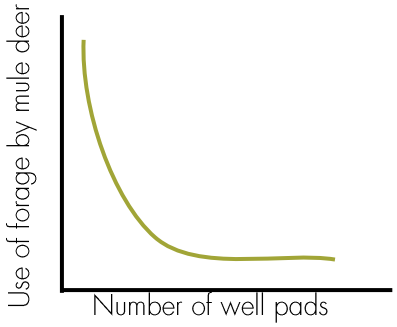
Above: After daughters are born (top center of spiral), we suspect that they migrate with their mother for their first fall migration (right side of spiral) and their first spring migration (left side of spiral). During that first year, mother and daughter will likely migrate together (top right). If migratory behaviors are established during that first year of life, daughters will continue along that same route later in life (bottom right).

Part of this research is published!

Jakopak, R. P., T. N. LaSharr, S. P. H. Dwinnell, G. L. Fralick, and K. L. Monteith. 2019. Rapid acquisition of memory in a complex landscape by a mule deer. *Ecology. In press.*

How do mule deer respond to energy development?

Oil and natural gas are a crucial part of Wyoming's economy, but energy development often co-occurs with wildlife habitat. Understanding how mule deer respond to energy development is critical to the successful management of many of the herds across the state. We evaluated how varying levels energy development on critical winter range affected feeding behavior of mule deer.



Above: As wellpads increased, mule deer tended to forage less.

Disturbance on winter ranges prompts avoidance, resulting in a loss of otherwise available food—revealing a missing link to population level consequences of behavioral avoidance of disturbance. Animals avoided human disturbance from energy development at both the home range and winter range scales, resulting in indirect habitat loss that was 4.6x greater than the habitat loss from infrastructure, roads, and well pads alone. This work shows that increased energy development on critical winter range has limiting effects on populations.

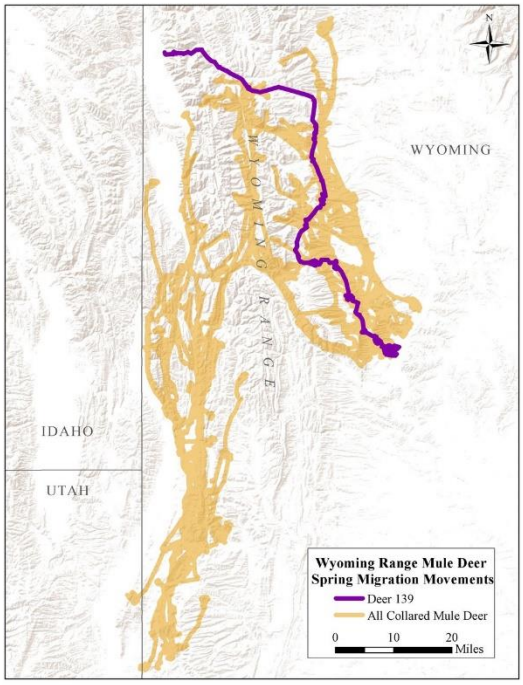
This research is published!

Dwinnell S. P. H., H. Sawyer, J. E. Randall, J. L. Beck, J. S. Forbey, G. L. Fralick, and K. Monteith. 2019. Where to forage when afraid: Does perceived risk impair use of the foodscape? *Ecological Applications. In press.*

Deer 139 Film

To highlight the intimate connection between wildlife and their environment, we are creating a film that follows 3 women as they hike, ski, and paddle the migratory route of one of the Wyoming Range mule deer, Deer 139. Sam Dwinnell has been involved with the Wyoming Range Mule Deer project since the beginning, and during the spring of 2018, she along with an all-women team of fellow adventurers and naturalists followed Deer 139's migration trail for 85 miles. The team travelled from Deer 139's winter range in the sagebrush steppe outside LaBarge, Wyoming, up into and over the Wyoming Range, across the Greys River, to an alpine cirque in the Salt River Range, to see first-hand this long, complex, and, until now, largely invisible journey.

The overall objectives with this film was to illuminate the mysteries of long-distance migration, demonstrate the toughness of a seemingly ordinary species like mule deer, and draw in a broad audience by highlighting an all-women team of adventurers and scientists.



Above: Deer 139's spring migration (purple) and migrations of all other collared mule deer (yellow).

This film is coming soon!
This film will be available for viewing in the fall of 2019!

Does the ecology of male and female mule deer differ?

Above: Until recently, we have assumed that males migrate in the same way females do. Our work will help to elucidate the differences between male and female migration in the Wyoming Range.

The Wyoming Range mule deer herd is revered by locals and many across the West, in large part because of the ample opportunities to harvest high-quality males. Wyoming Range bucks are highly sought-after and ensuring that populations are managed in a way that promotes hunting opportunities for future generations hinges on management practices that are rooted in science.

Surprisingly, we know relatively little about the ecology of males, including their migratory behaviors, dispersal, and vulnerability to harvest. We are exploring the ecology of male mule deer to yield greater context to their presence and management. In particular, we aim to address questions related to migration, habitat selection, and harvest. Males and females differ dramatically in the stressors they face: females expend the most energy in rearing offspring, whereas males focus on obtaining mating opportunities. To date, however, most research concerning the management of mule deer has focused primarily on females because of their role in driving population dynamics; yet, this singular focus renders a weaker understanding of the ecology of the male segment of our deer populations.

Future Directions

The overall goal of our continued work in the Wyoming Range will be to build on our understanding of the nutritional and population ecology of this herd. As before, our overall approach will continue to weave data on nutritional condition, habitat condition, migration, and population performance together to understand factors regulating Wyoming Range mule deer and the ability of the current habitat to support mule deer. With a distinct reduction in density following the several harsh winters this herd has experienced, habitat and density-dependent feedbacks onto the population should illuminate even more so than previously. Our approach will allow us to continue to elucidate the relative roles of habitat, nutrition, predation, and disease on the regulation of deer in western Wyoming, and fully grasp the magnitude and extent of the effects of the transient, but clearly regulatory role of winter.

Our Team

The Wyoming Range Mule Deer project is conducted in collaboration with Wyoming Game and Fish, BLM, and the USFS. This project is led by Principal Investigator Dr. Kevin Monteith, along with master's students, doctoral students, and research associates at the University of Wyoming.


Ellen


Rhiannon


Tayler


Samantha


Kevin

Partners

The Wyoming Range Deer Project is a collaborative partnership in inception, development, operations, and funding. Without all the active partners, this work would not be possible. Funds have been provided by the Wyoming Game and Fish Department, Wyoming Game and Fish Commission, Wyoming Wildlife and Natural Resource Trust, Muley Fanatic Foundation, Bureau of Land Management, Knobloch Family Foundation, U.S. Geological Survey, National Science Foundation, Wyoming Governor's Big Game License Coalition, Boone and Crockett Club, Animal Damage Management Board, Ridgeline Energy Atlantic Power, Bowhunters of Wyoming, and the Wyoming Outfitters and Guides Association. Special thanks to the Wyoming Game and Fish Department, Bureau of Land Management, and Wyoming State Veterinary Lab for assistance with logistics, lab analyses, and fieldwork. Also, thanks to the Cokeville Meadows National Wildlife Refuge and U.S. Forest Service for providing field housing.

Appendix H

Monteith Shop
Bim Kendall House
804 E Fremont Street
Laramie, Wyoming 82071

Appendix I

Wyoming Range Mule Deer Survival

Above: A collared fawn hides in foliage in the Wyoming Range. Photo: Mark Gocke.

The mule deer of the Wyoming Range are part of one of the most cherished herds in the West, and ensuring the health of this population is of utmost importance to the public, wildlife managers, and scientists. Beginning in 2013, the Wyoming Range Mule Deer project set out to understand better what factors are influencing the size of this population, and to identify the influence of nutrition, disease, environment, and predation. Given the harsh and variable climate in Wyoming, the effects of winter on this population has been a key focus of the study.

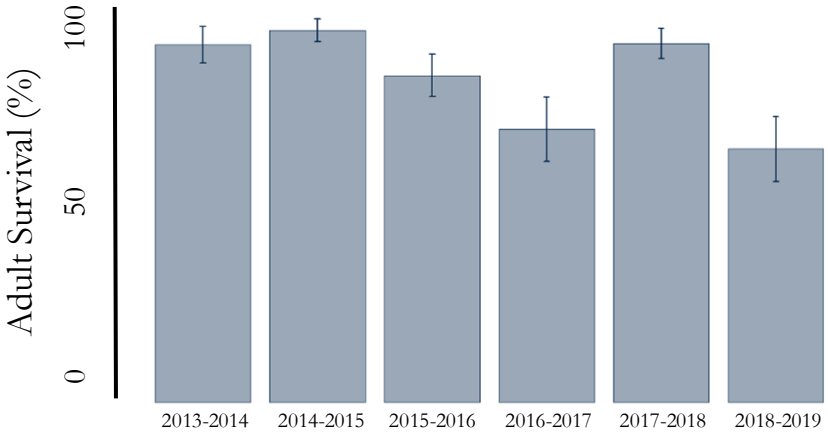
The Wyoming Range experienced particularly harsh winters in 2016 – 2017 and 2018 – 2019, which dramatically affected mule deer survival. In 2016, survival of adults was much lower than is typical for big game species, and none of the collared fawns survived to the following summer. Only 2 years later, the Wyoming Range herd again was subjected to severe winter conditions, and adult survival fell even lower than what occurred in 2016.

The harsh winters impacted populations beyond directly affecting mortality. Animals that were able to survive those two bad winters entered into summer with almost no fat, and many produced fawns that were small and underdeveloped. One of the overarching goals of this project is to understand how these winters are affecting fawn survival, and if the effects of severe winter conditions carries over for multiple years.

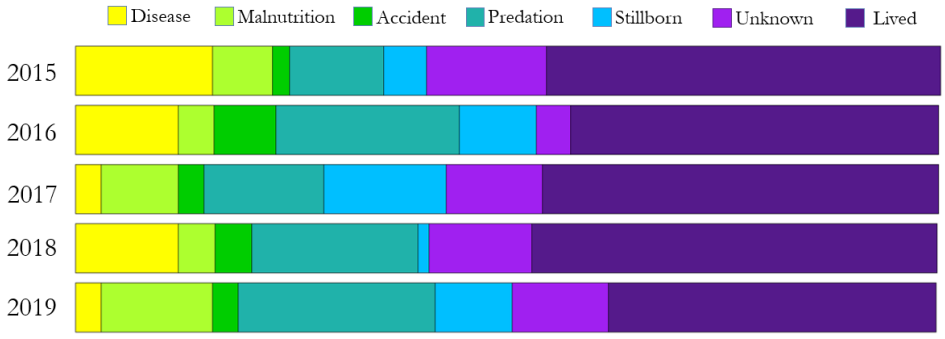
	2015	2016	2017	2018	2019
Number of Fawns Tracked	58	70	67	83	65
Median Birthdate	June 10	June 13	June 17	June 11	June 15
Average Birthweight	7.9 lb	7.5 lb	6.7 lb	7.6 lb	6.7 lb
Fawn Summer Mortality	46%	57%	52%	53%	63%
Fawn Winter Mortality	9%	43%	7%	41%	–
Total Mortality	55%	100%	59%	94%	–

Above: Beginning in 2015, we began collaring fawns to track survival and determine the leading causes of death for young animals. In a typical year, ~50% of fawns die over the summer. Birthweights of fawns following the 2016 – 2017 and 2018 – 2019 winters were lower than the average weights of fawns in other years, indicating that the condition of a mom may have important implications for fawn weight, and subsequently, fawn survival. Summer mortality is monitored from birth to Dec 1. Winter mortality is monitored from Dec 1 to May 1.

SURVIVAL OF MULE DEER IN THE WYOMING RANGE



Above: Winter survival of adult mule deer in the Wyoming Range has been variable over the past 6 years. During the two harsh winters this population experienced, overwinter survival dropped sustainably—to 70% survival over the 2016-2017 winter and 65% survival over the 2018-2019 winter. This is a stark contrast to the survival rates of ~90% that are typical for adult mule deer, both in the Wyoming Range and in other systems across the West. Most overwinter mortality has resulted from starvation.



Above: Fawn survival over summer. Typical survival for fawns is around 50%, and the causes of fawn mortality over the past 5 summers has been variable. In 2015, disease was the leading cause of death for fawns in the Wyoming Range, with over 15% of all collared fawns succumbing to disease. Following the particularly bad winter in 2016 – 2017, stillbirths were tied with predation as the leading cause of death for fawns. Fat levels of females following a poor winter may have serious implications for fawn survival. If females do not start summer with enough resources to devote to raising their offspring, the chance of that fawn making it through the summer is low.

MONTEITH SHOP
HAUB SCHOOL OF ENVIRONMENT & NATURAL RESOURCES
WYOMING COOPERATIVE FISH & WILDLIFE RESEARCH UNIT

UNIVERSITY OF WYOMING

For more information,
please contact
wyomingrangedeer@gmail.com.

Appendix J

Ecology of Male Mule Deer in the Wyoming Range

Above: A male mule deer collared near Calpet, WY. Mule deer are an icon throughout the West, and hunting opportunities for males is a cherished aspect of the Wyoming Range herd.

We at the Monteith Shop are working to understand the ecology of mule deer by addressing questions related to how male mule deer differs from females, with a specific eye towards characterizing seasonal behavior, migration, survival, vulnerability to harvest, and growth and recruitment. Given the long-term and ongoing research associated with the Wyoming Range Mule Deer Project, we have a unique opportunity to build a fuller picture of the factors that influence this valuable herd and within the context of the highly revered male segment. Indeed, it is those males that are providing valuable wildlife viewing and hunting opportunity that is at the core of our outdoor heritage in Wyoming.

The Wyoming Range mule deer herd is revered by locals and many across the West, in large part because of the ample opportunities to harvest high-quality males. Wyoming Range bucks are highly sought-after and ensuring that populations are managed in a way that promotes hunting opportunities for future generations hinges on management practices that are rooted in science. Males and females differ dramatically in the stressors they face: females expend the most energy in rearing offspring, whereas males focus on obtaining mating opportunities. To date, however, most research concerning the management of mule deer has focused primarily on females because of their role in driving population dynamics; yet, this singular focus renders a weaker understanding of the ecology of the male segment of our deer populations.

Above: High elevation summer ranges provide important habitat and high-quality food for mule deer during the summer months in the Wyoming Range. Yet, we don't know why males use these areas, nor how they come to occupy them in the first place.

Appendix J

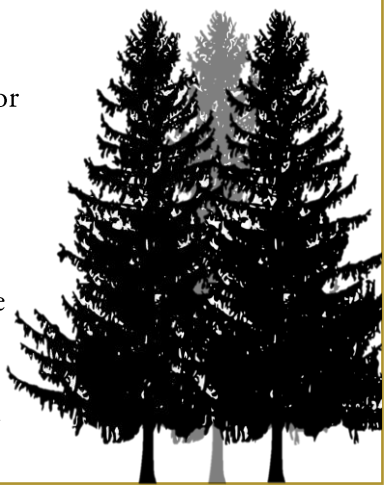
Ongoing Work

Does migration differ between males and females?

Female mule deer that are migrating tend to match their movements with the emergence of high-quality, fresh vegetation. Because male mule deer have different constraints in their lives—such as directing resources to growing antlers instead of into raising fawns—it is unclear if male mule deer track resources in the same way. We hope to identify migratory routes and evaluate what factors influence the timing of migration in males. Gaining a more detailed understanding of migratory behaviors within mule deer will further help to protect this important behavior.

Do males and females key in on different habitat variables?

Because the physiological demands on males and females differ dramatically, males and females might use habitat and the resources therein in different ways. We will evaluate how selection for habitat variables such as cover, topography, and food availability differs between males and females on winter and summer range. Consequently, habitat management practices may differ markedly in the benefits they provide to males and females. As such, knowing which segment of the population our efforts may benefit is important for designing sound habitat management plans.



How does harvest influence males?

Harvesting animals sustainably—a primary goal of wildlife agencies—requires implementing practices that will allow harvesting into the future. To ensure that harvest is not negatively impacting the entire male segment of deer population, managers need to understand how harvest influences males. We aim to evaluate the vulnerability of male mule deer to harvest as a function of age, behavior, and size.

We will also examine whether hunting influences how males move. Hunting pressures may cause animals to occupy parts of a landscape they might not otherwise inhabit.

Monteith Shop

UW Haub School of Environment and Natural Resources

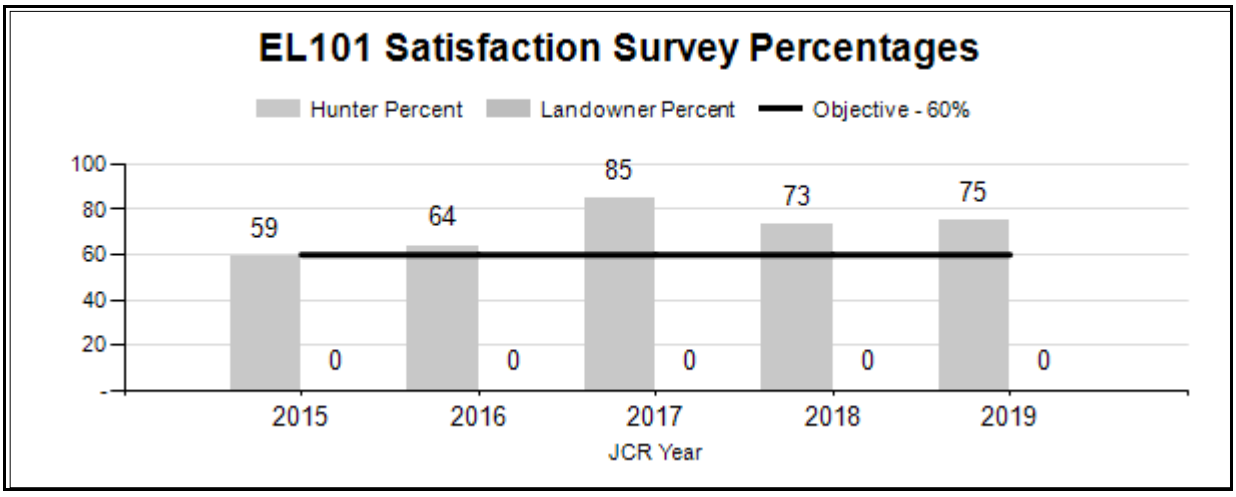
For more information, please contact kevin.monteith@uwyo.edu.

2019 - JCR Evaluation Form

SPECIES: Elk
PERIOD: 6/1/2019 - 5/31/2020
HERD: EL101 - TARGHEE
HUNT AREAS: 73
PREPARED BY: ALYSON COURTEMANCH

	2014 - 2018 Average	2019	2020 Proposed
Hunter Satisfaction Percent	68%	75%	75%
Landowner Satisfaction Percent	N/A	N/A	N/A
Harvest:	36	43	50
Hunters:	101	108	110
Hunter Success:	36%	40%	45 %
Active Licenses:	104	114	115
Active License Success:	35%	38%	43 %
Recreation Days:	646	768	650
Days Per Animal:	17.9	17.9	13
Males per 100 Females:			
Juveniles per 100 Females			

Satisfaction Based Objective	60%
Management Strategy:	Recreational
Percent population is above (+) or (-) objective:	N/A
Number of years population has been + or - objective in recent trend:	4



2020 HUNTING SEASONS
TARGHEE ELK HERD (EL101)

Hunt Area	Hunt Type	Archery Dates		Season Dates		Quota	Limitations
		Opens	Closes	Opens	Closes		
73	Gen	Sep. 1	Sep. 19				Any elk
73	Gen			Sep. 20	Oct. 25		Antlered elk, spikes excluded
73	6	Sep. 1	Sep. 19				Cow or calf valid in the entire area
73	6			Aug. 15	Jan. 31	35	Cow or calf valid on private land

2019 Hunter Satisfaction: 75% Satisfied, 11.1% Neutral, 13.9% Dissatisfied

2020 Management Summary

1.) **Hunting Season Explanation:** The 2020 season structure remains similar to previous years. Hunting opportunity in this herd unit is limited due to limited access points to public lands, steep terrain, and fall migration of elk to Idaho. Despite relatively low overall harvest numbers (35 elk harvested with a general license), hunter satisfaction in this herd unit is high and the herd is meeting its hunter satisfaction objective. Managers increased the Type 6 licenses slightly to continue to address elk damage on private lands near Alta, Wyoming.

2.) Elk were GPS-collared for the first time in this herd unit in 2018 and 2019. A total of 30 elk were collared on winter ranges in Idaho adjacent to the Targhee Herd Unit. The collars will collect location data for approximately 3 years before dropping off. Over half of the collared elk migrated into Wyoming during the spring and summer, however many do not move far past the state line. Many of these elk migrated back into Idaho either before or very early in the hunting season. The collared elk that migrated into Wyoming spent the summer in the southwest corner of Yellowstone National Park, the Squirrel Meadows area, Conant Creek, Bitch Creek, Teton Canyon, and Teton Pass area. Final data summaries will be completed in 2021.

2019 - JCR Evaluation Form

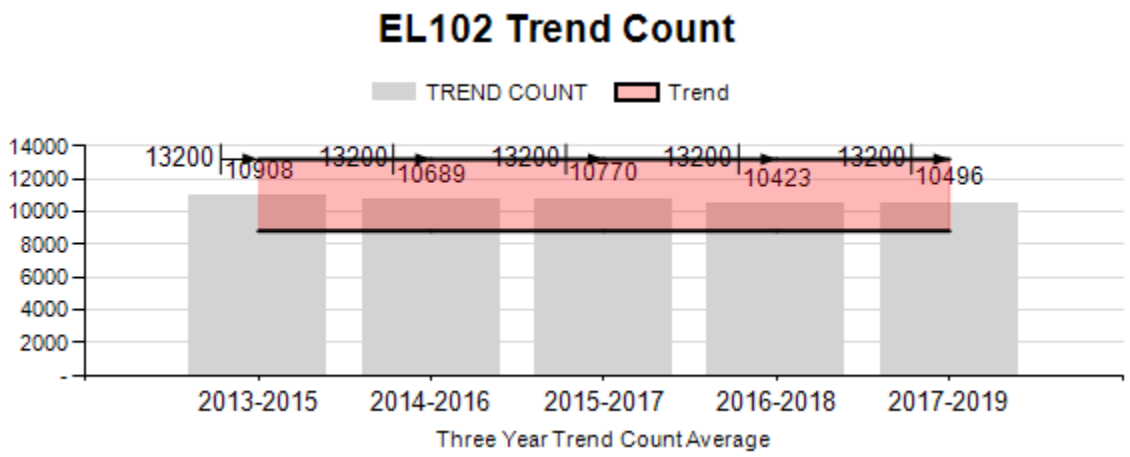
SPECIES: Elk
PERIOD: 6/1/2019 - 5/31/2020

HERD: EL102 - JACKSON

HUNT AREAS: 70-72, 75, 77-83
PREPARED BY: ALYSON COURTEMANCH

	2014 - 2018 Average	2019	2020 Proposed
Trend Count:	10,514	10,985	11,000
Harvest:	1,404	791	1,400
Hunters:	3,123	2,403	3,100
Hunter Success:	45%	33%	45 %
Active Licenses:	3,258	2,544	3,100
Active License Success	43%	31%	45 %
Recreation Days:	20,755	16,313	20,000
Days Per Animal:	14.8	20.6	14.3
Males per 100 Females:	35	31	
Juveniles per 100 Females	20	20	

Trend Based Objective (± 20%)	11,000 (8800 - 13200)
Management Strategy:	Recreational
Percent population is above (+) or (-) objective:	-0.1%
Number of years population has been + or - objective in recent trend:	0



2020 HUNTING SEASONS
JACKSON ELK HERD (EL102)

Hunt Area	Hunt Type	Archery Dates		Season Dates		Quota	Limitations
		Opens	Closes	Opens	Closes		
70	Gen	Sep. 1	Sep. 19				Any elk
70	Gen			Sep. 20	Oct. 31		Antlered elk, spikes excluded
71	Gen	Sep. 1	Sep. 19				Any elk
71	Gen			Sep. 20	Oct. 31		Antlered elk, spikes excluded
72							Closed
75	4			Nov. 7	Nov. 22	50	Antlerless elk; the Snake River Bottom portion shall be closed, also valid in that portion of Area 81 west of the Shadow Mountain Loop Road (U.S.F.S. Road 30340)
75	4			Nov. 23	Dec. 13		Antlerless elk; the Snake River Bottom and Antelope Flats portions shall be closed
75	6			Nov. 7	Nov. 22	500	Cow or calf; the Snake River Bottom portion shall be closed
75	6			Nov. 23	Dec. 13		Cow or calf; the Snake River Bottom and Antelope Flats portions shall be closed
77				Oct. 13	Oct. 26		General license and unused limited quota licenses, excluding limited quota cow or calf licenses, valid for any elk
77				Oct. 27	Nov. 25		General license and unused limited quota licenses; antlerless elk
77	Youth only			Nov. 26	Nov. 28		National Elk Refuge permits shall be issued only for those in possession of a full

							price youth elk license, any elk; youth only
77				Nov. 29	Dec. 13		General license and unused limited quota licenses, antlerless elk
78	Gen	Sep. 1	Sep. 25				Any elk valid in the entire area
78	Gen			Aug. 15	Oct. 31		Antlerless elk valid on private land
78	1			Aug. 15	Sep. 25	50	Any elk valid off national forest
78	1			Sep. 26	Jan. 31		Any elk valid in the entire area
78	2			Aug. 15	Oct. 31	50	Any elk valid on private land
78	6			Aug. 15	Sep. 25	175	Cow or calf valid off national forest
78	6			Sep. 26	Jan. 31		Cow or calf valid in the entire area
79							Closed
80	Gen	Sep. 1	Sep. 25	Sep. 26	Oct. 31		Any elk
80	6	Sep. 1	Sep. 25	Oct. 13	Nov. 15	300	Cow or calf
80	6			Nov. 16	Nov. 30		Cow or calf valid south of the Curtis Canyon and Sheep Creek Roads (U.S.F.S. Road 30440 and 30445)
81	Gen	Sep. 1	Sep. 25				Any elk
81	Gen			Sep. 26	Oct. 25		Antlered elk, spikes excluded
82	Gen	Sep. 1	Sep. 25				Any elk
82	Gen			Sep. 26	Oct. 25		Antlered elk, spikes excluded
82	4	Sep. 1	Sep. 9	Sep. 10	Nov. 15	25	Antlerless elk
83	Gen	Sep. 1	Sep. 30				Any elk
83	Gen			Oct. 1	Oct. 25		Antlered elk, spikes excluded

2019 Hunter Satisfaction: 61.2% Satisfied, 19.8% Neutral, 18.9% Dissatisfied

2020 Management Summary:

1.) **Hunting Season Evaluation:** The 2020 season structure remained similar to recent years and continues to focus antlerless harvest on short-distance migratory herd segments and more conservative, antlered-only harvest on long-distance migratory and Gros Ventre herd segments. The current hunting season structure has succeeded in stabilizing the herd to within a very small margin of the 11,000 mid-winter trend count objective. In 2020, hunting seasons in Hunt Area 78 focused on continuing to address damage to private lands through a variety of license types and early opening and late closing dates. Quotas were reduced slightly for some license types due to reduced access to some private lands. In 2019, quotas for Hunt Area 75 Type 4 and Type 6 licenses were significantly reduced due to a low mid-winter trend count caused by unusual winter conditions with many elk on native winter range. A more typical mid-winter trend count in 2019 resulted in these quotas being increased for the 2020 hunting season. The main continuing challenges for management of the Jackson Elk Herd are 1) controlling short-distance migratory elk numbers through cow harvest, while protecting long-distance migratory elk from overharvest, 2) monitoring and adapting to recent changes in elk winter distribution, and 3) working with the multiple agencies and landowners involved in elk population, habitat, and disease management.

2.) **Herd Unit Evaluation:** A total of 10,985 elk were classified in February 2020 with a calf:cow ratio of 20 calves per 100 cows, adult bull to cow ratio of 23, and yearling bull to cow ratio of 8. A total of 8,095 elk were classified on National Elk Refuge (NER) feedlines, 109 on native winter ranges on the NER, 329 at Patrol Cabin Feedground, 1402 at Fish Creek Feedground, 401 on native winter range in the Gros Ventre drainage, and the remaining 649 on other native winter ranges (mainly Buffalo Valley, Elk Ranch, Spread Creek, and east of the NER. This included 204 elk that were being fed on a private feedline in the Buffalo Valley (this feeding action was not approved by the WGFD in winter 2019/2020).

3.) Managers became concerned in winter 2017/2018 when the number of elk wintering in the Gros Ventre drainage decreased dramatically to only 86 elk (from 1,243 in 2016 and over 3,000 in 2012). The small sample size of collared Gros Ventre elk at the time suggested that elk that had traditionally wintered on the Gros Ventre feedgrounds had shifted to other winter ranges, including the NER, Buffalo Valley, Dubois area, and Upper Green. In order to better understand Gros Ventre elk movements and survival, 20 GPS satellite collars were deployed in fall 2018 and an additional 15 in fall 2019 on Gros Ventre cow elk. On average, 75% of the collared elk have stayed in the Gros Ventre and 25% moved to the NER during the past two winters, but all returned to the Gros Ventre for the spring, summer, and fall. Local managers have also established remote cameras on the primary elk movement path between Gros Ventre winter ranges and the NER. So far, two of the 35 collared elk have died (1 from mountain lion predation and 1 from unknown causes). The collars will collect data for another 1-2 years. The number of elk wintering in the Gros Ventre increased during the past two years to 2,136 in 2018 and 2,132 in 2019. Post-season calf ratios also increased to 26 calves per 100 cows in 2018 and 29 in 2019. Based on collared Gros Ventre elk movements and remote camera data collection, managers estimate that there are approximately 2,800 elk from the Jackson Elk Herd that spend the summer and fall in the Gros Ventre area. A graduate student at the University of California at Berkeley is currently working on a research project evaluating the interactions of elk, wolves, weather (i.e. snow), human activity, and other factors in the Jackson Elk Herd, including the

Gros Ventre drainage. This research will help managers assess the relative influence of these factors on changing elk winter distributions.

4.) In 2020, the U.S. Fish and Wildlife Service began its implementation of the Bison and Elk Management Step-Down Plan: a Structured Framework for Reducing Reliance on Supplemental Winter Feeding (2019) on the NER. Feeding initiation criteria (based on measurements of forage availability and snow conditions) remained the same as in previous years and the NER began feeding on February 1, 2020. Based on the Step-Down Plan direction, the NER ceased feeding approximately 1 week earlier in the spring than traditionally done during past years with similar snow conditions. That resulted in cessation of feeding during the first week of April. Per the Step-Down Plan direction, there were no other changes to feeding operations in 2020 except for the earlier end-date.

5.) In 2018 the Jackson Hole Cooperative Elk Studies Technical Committee decided to repeat a previous cow elk harvest availability analysis that used GPS collar data to evaluate the amount and timing of use of open hunt areas by cow elk belonging to different summering segments of the Jackson Elk Herd. The report, titled "Harvest and Use of Open Hunt Areas by Female Elk Wintering on the National Elk Refuge 2016-2019" was completed by Carson Butler (term biologist at Grand Teton National Park) in February 2020 (attached). A key finding of the analysis was that elk from various herd segments use Hunt Areas 75, 77, and 80 simultaneously and there is significant annual variability in each segment's timing of use, which makes it very difficult, if not impossible, to structure hunting seasons in these areas to strategically harvest one segment and not another. Hunt Area 79 has significant use by long-distance migrants during the hunting season and Hunt Area 78 is used exclusively by short-distance migrants. This report supports the decision made in 2019 close Hunt Area 79 to protect long-distance migrants, and continuing efforts to direct harvest at the productive segment of short-distance migrants in Hunt Area 78.

Appendix A.

Harvest and Use of Open Hunt Areas by Female Elk Wintering on the National Elk Refuge 2016-2019

Carson Butler

Division of Science and Resource Management

Grand Teton National Park

Summary

State and Federal wildlife management agencies currently use antlerless elk harvest to achieve their management objectives for the Jackson Elk Herd. The Jackson Elk Herd (JEH) as a whole is at a population size where harvest is still used to achieve objectives; however, some segments of the JEH are growing while others appear to have declined and managers strive to minimize harvest of the reduced segments and focus harvest on the growing segments. Cow elk that winter on the National Elk Refuge were captured and instrumented with GPS-collars each winter 2016-2019. This study used GPS collar data from 78 individual elk across four hunting seasons (2016-2019) to evaluate availability of antlerless elk from four recognized summer segments for harvest in five hunt areas. Key findings include:

1. The overall use of most hunt areas (while they were open to harvest) by GPS collared elk was strongly correlated with annual harvest in the hunt areas, indicating the utility of this approach to assess harvest availability of antlerless elk in the Jackson Elk Herd. This was not the case for Hunt Area 78, which may be explained by the many private land sanctuaries in the hunt area and/or little variability in harvest across years.

2. Two thirds (66%) of 2016-2019 antlerless harvest in the Jackson Elk Herd occurred in Hunt Areas 75 and 77. Due to limited season dates, very little antlerless harvest occurred in Hunt Area 79. Antlerless harvest in Hunt Area 78 was very consistent across years (approximately 100 harvests per season) while harvest in the other hunt areas varied greatly across seasons.

3. The previously described trend of a declining proportion of elk wintering on the National Elk Refuge which are long-distance migrants appears to have leveled off as the proportion of animals in this study that were long distance migrants is similar to the proportion reported in 2012 (by Cole et al 2015).

4. Based on the GPS collar data, different summer segments are most available for harvest in different hunt areas. Some hunt areas provide harvest opportunities for specific segments while all segments are available for harvest in others. For example, Hunt Area 78 provides opportunity to harvest almost exclusively the Wilson to Beaver Creek segment (i.e. Short Distance Migrants) while Hunt Area 79 provides opportunity to almost exclusively harvest Yellowstone and Teton Wilderness elk (i.e. Long Distance Migrants). In contrast, Hunt Areas 75, 77, and 80 provide opportunity to harvest multiple population segments.

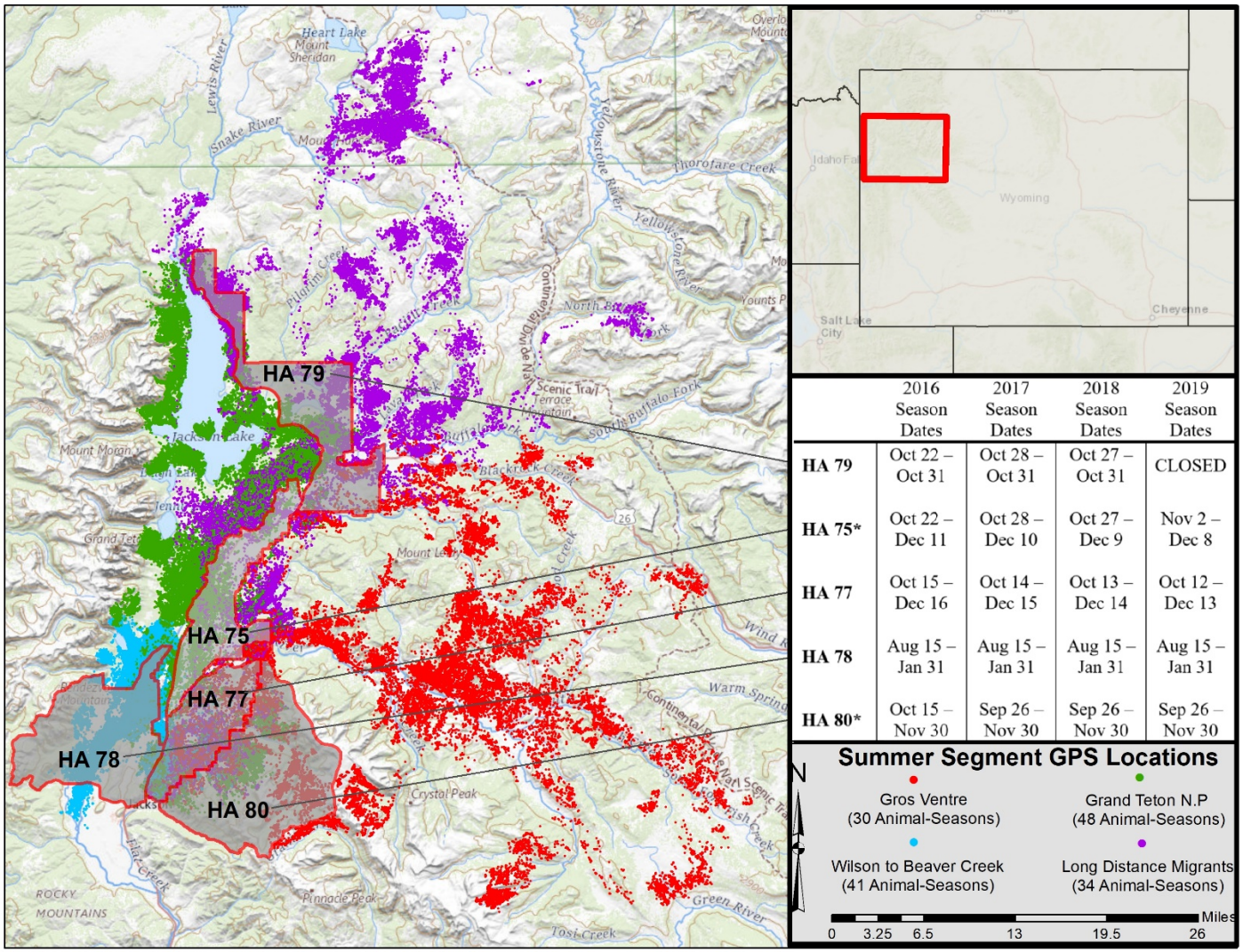
5. Simultaneous use of Hunt Areas 75, 77, and 80 by multiple summer segments and annual variability in the timing of use of the different hunt areas by different segments corroborates previous conclusions that simultaneously increasing harvest availability of some segments while minimizing availability of others by strategically altering hunt season dates may not be possible.

6. Any elk harvested in Hunt Area 78 is most likely a short distance migrant (i.e. Wilson to Beaver Creek segment). The extended hunting season in this unit which results in the consistent harvest of approximately 100 antlerless elk may play an important role in limiting the growth of the Wilson to Beaver Creek population segment.

7. Harvest of study animals suggests that antlerless elk which summer in the Teton Wilderness and Yellowstone National Park (a segment managers are trying to limit harvest of) are less likely to be harvested than those from other population segments. If a goal of management agencies is to minimize harvest of this segment, recent management approaches that close or severely limit hunting opportunities in Hunt Area 79 help achieve this goal as any elk harvested in this unit is likely a Long Distance Migrant.

Problem Statement

The population objective for the Jackson Elk Herd (JEH) is 11,000 total elk, with 5,000 wintering on the National Elk Refuge (NER; 2007 National Elk Refuge and Grand Teton National Park Bison and Elk Management Plan). While the JEH has declined to reach the objective of 11,000 total elk, the proportion of elk wintering on the National Elk Refuge has increased and is commonly above the objective of 5,000 elk. Managers have identified four summering segments of the JEH including: Short distance migrants that generally summer west of the Snake River and south of Beaver Creek, WY (Wilson to Beaver Creek); Long distance migrants that generally summer in Yellowstone National Park or the Teton Wilderness; elk that summer in Grand Teton National Park (GTNP); and elk that generally migrate up the the Gros Ventre River drainage to summer in the Gros Ventre Mountains, Togwotee Pass area, or the Mt. Leidy Highlands areas (modified after Smith and Robbins 1989; Figure 1). The proportion of the JEH belonging to these different summer segments has shifted over time (Cole et al. 2015). Most notably, the proportion of long-distance migrants has declined while the proportion of short distance migrants has increased. Cole et al. (2015) determined this shift was likely attributed to differences in calf recruitment between the segments. Additionally, the increase in elk wintering on NER has been partially driven by elk that previously wintered in the Gros Ventre drainage switching winter ranges to NER in recent years (2016-Present). Antlerless elk harvest is used to drive the JEH closer to management objectives and the current aim is to reduce the number of elk wintering on NER to approximately 5,000. Although there are not official objectives explicitly related to the different summering segments, managers do take their apparent abundance into account when determining hunting season dates and regulations. Specifically, there is an aim to focus harvest on the burgeoning short distant migrant segment that spends a significant amount of time on private lands while minimizing harvest on the diminished long-distance migrant segment. Traditionally, female elk wintering on NER have been targeted for harvest by permitting antlerless elk harvest in five hunt-areas including Hunt Area 79, Hunt Area 75, Hunt Area 78, Hunt Area 77, and Hunt Area 80 (Figure 1). A previous analysis used GPS collar data collected from cow elk 2006-2012 to investigate whether hunting season dates and regulations could be altered to increase availability of short distance migrants for harvest while decreasing vulnerability of long-distance migrants to harvest. The study determined that modifying season dates or sub-unit boundaries of hunt areas in Jackson Hole would not be an effective strategy to reduce elk wintering on NER while protecting long distance migrants. However, there have been observed changes in behavior and distribution for some parts of the JEH since 2012 (e.g. elk switching winter range from the Gros Ventre drainage to NER) and there have been changes in hunt area season dates and boundaries since 2012 (e.g. the season length and areas open to hunting in Hunt Area 79 was dramatically reduced, some areas of Hunt Area 75 were closed to hunting, and harvest in Hunt Areas 75 and 79 was restricted to antlerless only). As such, there is value in re-assessing the harvest-availability of the JEH summer segments across the different hunt-areas that target cow elk wintering on NER.



	2016 Season Dates	2017 Season Dates	2018 Season Dates	2019 Season Dates
HA 79	Oct 22 – Oct 31	Oct 28 – Oct 31	Oct 27 – Oct 31	CLOSED
HA 75*	Oct 22 – Dec 11	Oct 28 – Dec 10	Oct 27 – Dec 9	Nov 2 – Dec 8
HA 77	Oct 15 – Dec 16	Oct 14 – Dec 15	Oct 13 – Dec 14	Oct 12 – Dec 13
HA 78	Aug 15 – Jan 31	Aug 15 – Jan 31	Aug 15 – Jan 31	Aug 15 – Jan 31
HA 80*	Oct 15 – Nov 30	Sep 26 – Nov 30	Sep 26 – Nov 30	Sep 26 – Nov 30

*Figure 1. Elk GPS-collar locations and Wyoming Game Fish Department hunt areas used in analysis. Locations shown range from Aug 15 – Jan 31 each hunting season from 2016-17 to 2019-20 and include only animal-seasons where the animal wintered on the National Elk Refuge. * Hunt areas with asterisks have sub-units that close earlier than the main units' dates.*

Methods

Capture, instrumentation, and summer range assignment

During late fall and winter 2016-2019, NER and Wyoming Game and Fish Department (WGFD) staff captured and fit GPS radio-collars to cow elk on NER and in the Gros Ventre Drainage. Collar makes and models included Telonics Iridium, Telonics Recon, and ATS. GPS data were censored to exclude data within twenty-four hours of capture and after animals died. Telonics collar data were censored to exclude fix locations with horizontal error >60m and ATS collar data were censored to exclude fix locations with horizontal dilution of precision (HDOP) >10. Dates of GPS collar fixes were set to local time. Individual animals were assigned to a summer segment each year by calculating the centroid of each animal's July-September GPS locations and overlaying the centroid with summer range polygons. The data for analysis were limited from August 15 – January 31st each season, which corresponds with the annual dates that Hunt Area 78 was open to female elk harvest. Data from animal-years where the animal did not winter on NER were excluded from the analysis.

Use of Hunt Areas

GPS locations in the analysis dataset were overlaid with polygons showing areas open to hunting (based on management agency regulations and not accounting for private lands) in each of the five hunt areas of interest to assign a hunt area to each GPS location. Locations that did not fall within hunt areas were classified as "Out". Locations located within hunt-areas but in specific areas that were closed to hunting were also classified as "Out". If a GPS location was located within an area open to hunting between the area's opening and closing dates of season, the animal was considered available for harvest at that point in space and time.

Several summaries were calculated to evaluate animals from different summering segments availability for harvest. As the most general evaluation of harvest availability, the proportion of Oct 15th – Dec 20th locations that each animal was in an open hunt area was calculated for each animal each hunting season and visually displayed using boxplots. Second, for each hunt area, the proportion of animals from each summer segment with at least one GPS point in the hunt area was calculated. Finally, for each hunt area, the proportion of GPS points from each animal located in the hunt area was calculated for each day and the daily proportion of points in the hunt area for all animals in each summer segment was calculated. For Hunt Area 75 and Hunt Area 80, which have sub-units with earlier closing dates, these same daily proportions were calculated for the different sub-units.

Harvest

The relative rate of harvest for the different summer segments was assessed by comparing harvest of collared animals from each segment to the number of animal-years each segment was represented by. Annual harvest statistics for Hunt Area 78, Hunt Area 77, and Hunt Area 80 were gathered from Wyoming Game and Fish Department's annual harvest reports. Harvest statistics for Hunt Area 79 and Hunt Area 75 were gathered from Grand Teton National Park internal records. The number of active antlerless elk hunters in each hunt area each year

was obtained from Wyoming Game and Fish Department's annual harvest reports. To test whether use of the open hunt areas by collared individuals was predictive of annual harvest in each hunt area, generalized linear models regressing the number of annual antlerless harvests, corrected for number of active hunters, against several indices of overall elk use (ignoring summer segments) of the open hunt areas were ranked. The indices of elk-use that were compared in these models were number of days of open hunt season with use by at least one collared elk (H_0: The number of elk in a hunt area is less important to annual harvest than simply some elk being in the hunt area on a given day), cumulative daily proportion of elk using the hunt area (H_0: The number of elk-days of use of a hunt area is most important to season harvest but the amount of time elk spend in hunt areas is less important), and cumulative daily proportion of GPS locations (H_0: The total amount of time elk spend in hunt areas is most important to determining annual harvest). Due to the extremely limited number of open days and harvest numbers, Hunt Area 79 was excluded from the harvest vs. GPS collar data regressions.

Results

General summaries

Data

GPS data from 153 elk-seasons (from 78 individual elk) were used in the analysis. Of 74 animals that were collared on the National Elk Refuge and whose summer range could be determined, 27% (n=20) were short distance migrants (Wilson to Beaver Creek) and 73% were medium- or long-distance migrants (all other summer segments). The Gros Ventre summer segment was represented with 30 elk-seasons of data, the Grand Teton summer segment was represented with 48 elk-seasons, the Wilson to Beaver Creek summer segment was represented with 41 elk-seasons, and the Long Distance Migrants (including animals summering in Yellowstone National Park and the Teton Wilderness) were represented with 34 elk seasons of data (Figure 2). The overall fix success was 97% and there were 343,250 GPS locations used in the analysis.

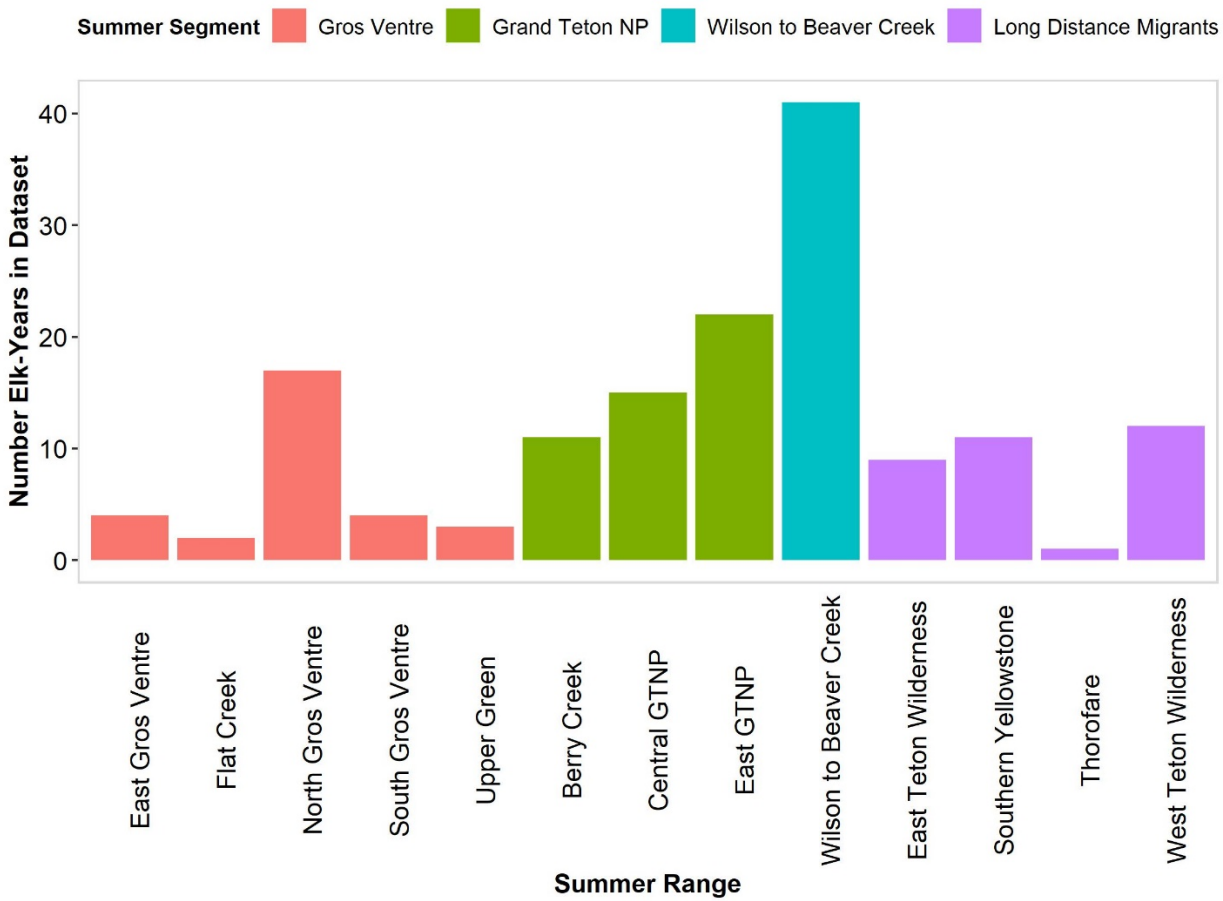


Figure 2. Number of elk-years in dataset assigned to animals migrating from different summer ranges

Harvest numbers by hunt area and year

The majority of antlerless elk harvest occurred in Hunt Area 77 and Hunt Area 75, with 66% of total 2016-2019 antlerless harvest occurring in these two hunt areas (Table 1). Negligible antlerless harvest occurred in Hunt Area 79 and 18% and 16% of antlerless harvest occurred in Hunt Area 78 and Hunt Area 80, respectively. Harvest varied considerably across years for most hunt areas, except for Hunt Area 78 which was very similar across years (Table 1).

Table 1. Antlerless elk harvest and active antlerless hunters (in parentheses) in the hunt areas and seasons investigated in this analysis.

Hunt Area	***Season***				
	2016	***2017***	***2018***	***2019***	***Total***
79	6 (26)	2 (15)	3 (12)	0 (0)	11
75	132 (500)	242 (460)	186 (475)	58 (289)	618
78*	109 (166)	97 (152)	93 (208)	102 (192)	401
77	285 (529)	154 (429)	323 (554)	43 (350)	805
80*	78 (422)	167 (472)	84 (220)	8 (215)	337
Total	610	662	689	211	

*Type 1 and Type 2 permit holders were not counted towards number of active antlerless hunters but general license holders were counted towards number of active antlerless hunters.

** General license holders counted towards number of active antlerless hunters in 2016 and 2017 but were not counted after regulations changes beginning in 2018.

Relationships between metrics of availability of GPS-collared elk and annual harvest

The three indices of hunt-area use by GPS-collared elk (days of open season with at least one GPS-collared elk in a hunt area; scaled elk-use days in a hunt area during open season; average proportion of GPS locations in a hunt area during open season) were highly correlated. The correlation coefficient for all three pairwise correlations were >0.90. Scatterplots between these variables and annual harvest in each hunt area revealed a strong pattern between them and annual harvest in all the hunt areas except for Hunt Area 78 (Figure 3). Therefore, Hunt Area 78 (in addition to Hunt Area 79) was excluded from the regressions to test the ability of GPS collar data to predict annual harvest.

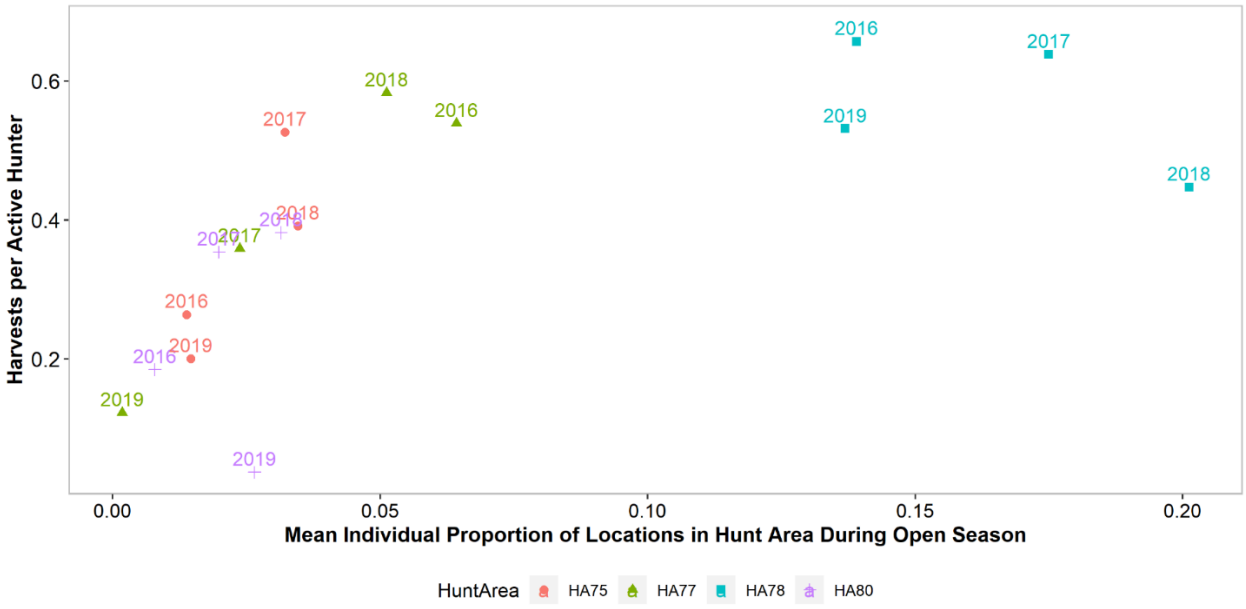


Figure 3. Annual antlerless elk harvest rates (harvests per active hunter) in Hunt Areas 75, 77, 78, and 80 relative to the mean proportion of GPS-collared cow elk locations in the hunt area while it was open to harvest. Hunt Area 79 was not included due to low levels of harvest and a very short season length during this study.

AICc model ranking determined that the average proportion of GPS collar location in a given hunt area during open season was the best predictor of annual harvest among the three variables (Table 2). This model had a pseudo R^2 of 0.94 indicating it described variability in annual harvest among the hunt areas extremely well (1 is highest possible).

Table 2. Rankings of models testing relationship between different metric of annual use of hunt areas by GPS-collared cow elk and annual harvest rates in Hunt Areas 75, 77, and 80.

Model	AICc	ΔAICc	Psuedo-R^2 *
Annual Harvest Rate ~ Avg. Proportion GPS Locations in Hunt Area	**251.79**	**0**	**0.94**
Annual Harvest Rate ~ Scaled Elk-Days in Hunt Area	257.57	5.78	0.94
Annual Harvest Rate ~ Days with Elk in Hunt Area	464.01	212.22	0.65

*R^2 cannot be used for generalized linear models. Pseudo-R^2 does not indicate 'proportion of variation explained' as with R^2. Possible values for Psuedo R^2 range 0-1, with 0 indicating poor model fit and 1 indicating perfect model fit.

Harvest of GPS-collared elk relative to collar-seasons for summering segments.

Nineteen of the GPS-collared animals in the dataset were harvested by hunters. Proportionally, 21% of harvests were from the Gros Ventre summer segment, 37% of harvests were from the Grand Teton National Park summer segment, 37% of harvest were from the Wilson to Beaver Creek summer segment, and 5% of harvests were from the Long Distance Migrants summer segment. For comparison, 20% of elk-seasons in the analysis dataset were from the Gros Ventre summering segment, 31% were from the Grand Teton National Park segment, 27% were from the Wilson to Beaver Creek segment, and 22% were from the Long Distance Migrants segment. A chi-square test did not find strong evidence that the relative number of harvested GPS-collared elk from the summer segments differed from what would be expected based on the number animal-seasons from each segment in the dataset (p=0.34). However, it is worth noting that Long Distance Migrants in the dataset appear to be harvested less than would be expected based on their representation in the dataset (Figure 4).

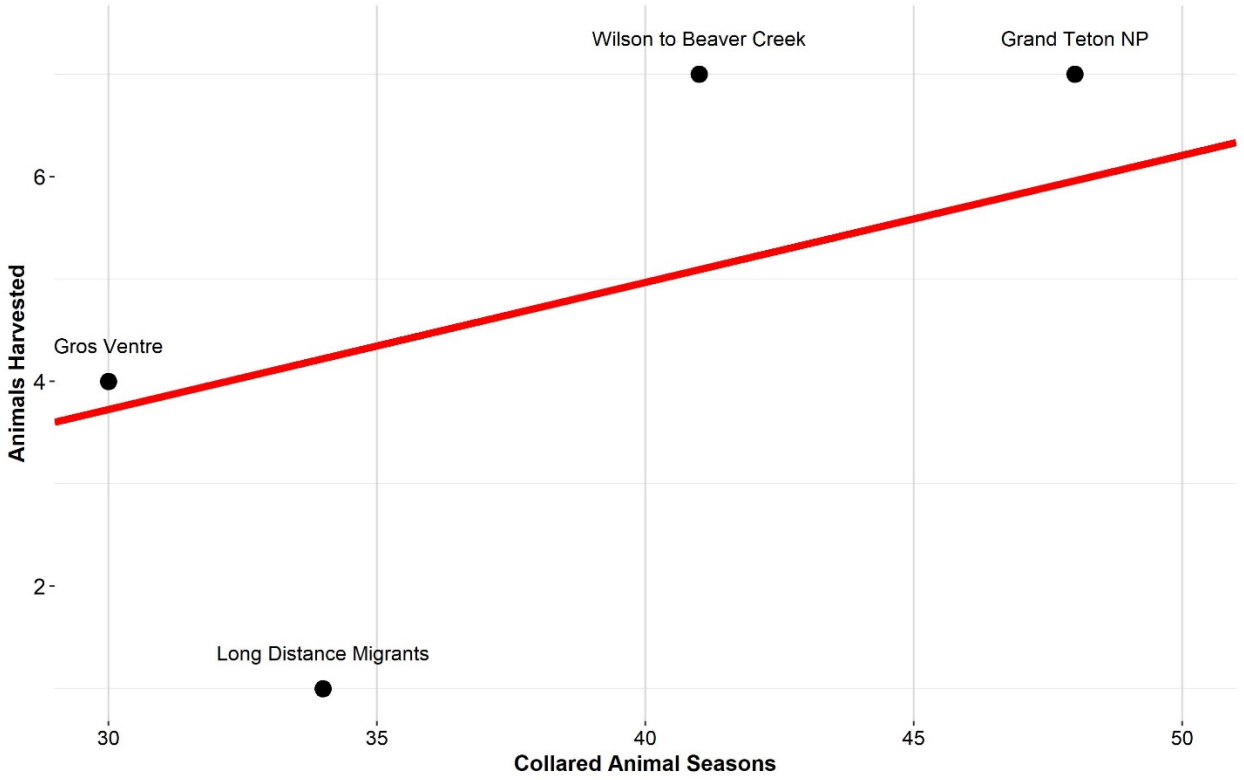


Figure 4. Harvest of collared cow elk belonging to each summer segment relative to number of animal-seasons in dataset. The red line represents harvest numbers in perfect proportion to the number of collared animal-years assigned to that summering segment. Points above the red line represent harvest levels greater than in proportion to animal-years and points below represent harvest levels less than in proportion to animal-years.

Availability of Different Segments

Across all seasons, individuals from the Wilson to Beaver Creek summer segment had a substantially higher proportion of GPS locations in an area open to hunting than individuals from other segments (Figure 5). From October 15th – December 20th the median proportion of locations in an open hunt area (availability) for individuals from the Wilson to Beaver Creek Segment ranged from 72% to 80% across the four seasons. Median 'availability' of individual elk from other segments during this time period each season ranged from 0% to 18% and varied more across seasons (Figure 5). Individuals from the Grand Teton National Park segment were the next most 'available' elk on average, with median availability varying between 3% in 2019 to 18% in 2018. The Gros Ventre and Long Distance migrants were similarly available on average; median availability ranged from 0% (2018 & 2019) to 9% for the Gros Ventre segment and ranged from 1% (2019) to 9% (2017) for the Long Distance Migrant segment.

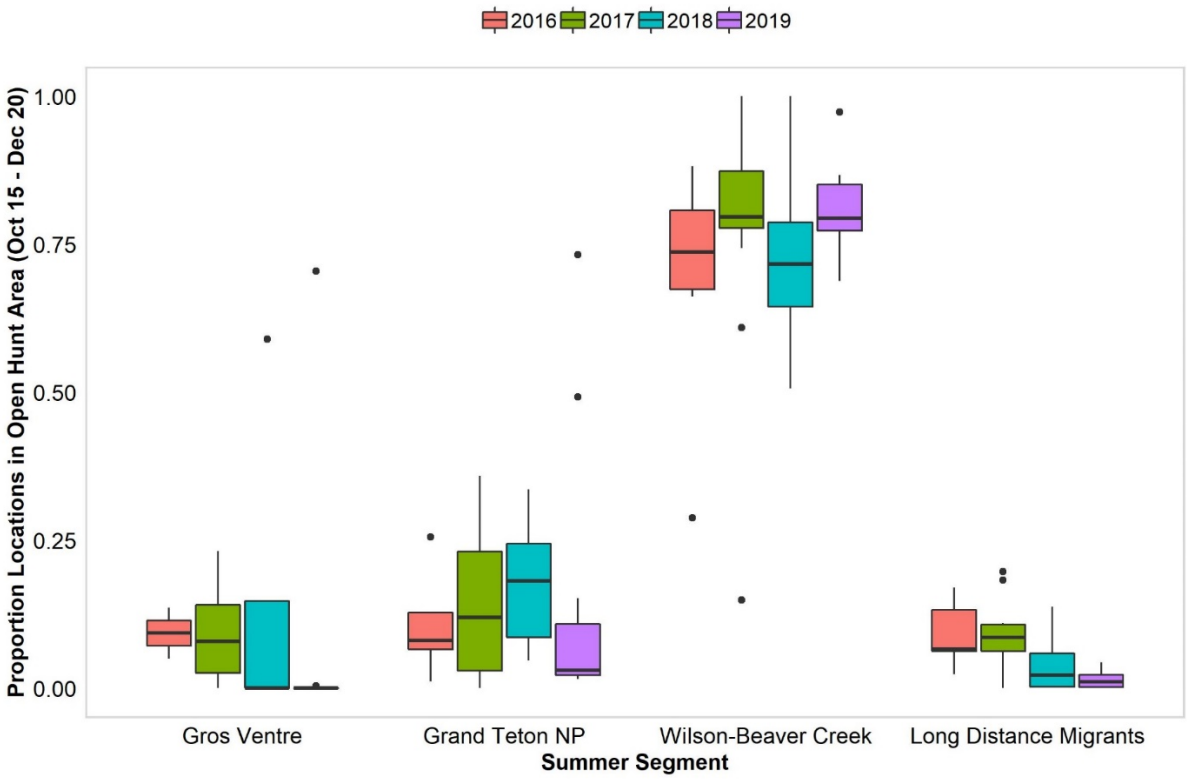


Figure 5. Proportions of cow elk GPS-collar locations (October 15 – December 20) located in a hunt area while the hunt area is open to antlerless elk harvest. Boxplots show distribution of proportions for individual animals belonging to different summer segments in different years.

Use of Hunt Areas by Segment

Wilson to Beaver Creek

Collared animals from the Wilson to Beaver Creek segment were available to harvest almost exclusively in Hunt Area 78 and Hunt Area 77. Across years, the highest animal presence in Hunt Area 78 (proportion of animals with at least a single GPS location in the open hunt area in a given day) appears to peak in November with most animals present in the hunt area on most days (Figure 6D). Presence of Wilson to Beaver Creek animals in Hunt Area 78 begins to decline between late November and late December depending on the year. The decline in use of Hunt Area 78 occurs as animals increase their presence in Hunt Areas 77 and, to a lesser extent, Hunt Area 80. In 2016 and 2018 GPS-collared Wilson to Beaver Creek animals started using Hunt Area 77 at the beginning of December, and the majority of animals were present in the Hunt Area by the 1st week in December. In 2017 and 2019 GPS-collared animals didn't use Hunt Area 77 until late December, after it was closed to harvest (Figure 6C). Wilson to Beaver Creek animals were present in Hunt Area 80 to varying degrees across the years, but were never present in the Hunt Area before the season was closed (Figure 6E). The Wilson to Beaver Creek animals use of Hunt Area 80 is almost entirely confined to the southern sub-unit (Figure 8). The proportion of GPS locations from Wilson to Beaver Creek animals in the hunt areas they used was similar to the proportion of animals spending any time in the hunt areas, suggesting that this segment does not frequently move in and out of the hunt areas (Figure 7).

Grand Teton

Collared animals from the Grand Teton segment were available for harvest primarily in Hunt Area 75, Hunt Area 77, and Hunt Area 80. Across years, timing of peak presence of Grand Teton animals in Hunt Area 75 fluctuated between the first week of December (2016 & 2019) and mid-November (2017 & 2018). Across years, GPS-collared Grand Teton animals were rarely present in Hunt Area 75 prior to the first week of November (Figure 6B), but peak presence in the hunt area occurred while the area was open to hunting every season. The proportion of total GPS locations from the Grand Teton segment in Hunt Area 75 followed the same temporal pattern as proportion of animals present, but was notably lower, indicating that during the days when animals from this segment used the hunt area, they did not spend most of their time in the hunt area.

The timing of use of Hunt Area 77 by the Grand Teton segment varied across years. In 2016 and 2018, over 50% of collared elk from this segment were present in the hunt area by the first week of December, in 2017 a low percentage of elk were present in the hunt area while it was open to harvest, and in 2019 there was essentially no presence in the hunt area until the last days it was open to harvest (Figure 6C). The daily proportion of total GPS locations from the Grand Teton segment in Hunt Area 77 closely followed the temporal pattern of proportion of Grand Teton animals present in the hunt area, but was slightly lower, indicating the animals are not spending all their time in this Hunt Area once they start using it for the season (Figure 7C).

The pattern and timing of use of Hunt Area 80 by the Grand Teton segment also varied across years (Figure 6E). Overall, a small proportion of this segment was present in Hunt Area

80 while the area was open to harvest, and more animals typically used the area after it was closed for harvest each season. There was some presence of collared elk from this segment in Hunt Area 80 2016-2018, but not in 2019. Like this segment's use of Hunt Area 77, the temporal pattern of proportion of GPS locations in Hunt Area 80 closely followed the temporal pattern of presence in the hunt area but was slightly lower.

Long Distance Migrants

Collared animals from the Long Distance Migrants segment were available for harvest in all hunt areas except Hunt Area 78. Long Distance Migrants' use of Hunt Area 79 was relatively prolonged most years, but only a small proportion of collared animals were typically present in the Hunt Area on a given day (Figure 6A). The proportion of total GPS locations from the Long Distance Migrants in Hunt Area 79 closely mirrored the pattern of proportion of animals present in the hunt area (Figure 7A).

Long Distance Migrants were present in Hunt Area 75 while the area was open to harvest each year since 2016. The timing of peak use of Hunt Area 75 by Long Distance Migrants varied from mid November in 2017 to mid December (after Hunt Area 75 closed to harvest). Peak presence in Hunt Area 75 was around 50% of the collared animals each year (Figure 6B). The proportion of total GPS locations from the Long Distance Migrants in Hunt Area 75 matched the temporal pattern of proportion of animals present in the hunt area (Figure 7B). However, in contrast to peak presence, the peak proportion of GPS points in the hunt area was 0.25 or less each year suggesting that during periods when animals from this segment used Hunt Area 75, they spent a substantial amount of time outside of the hunt area.

The presence of collared Long Distance Migrants in Hunt Area 77 while the area was open to harvest declined each year from 2016 to 2019 (Figure 6C). In 2016, nearly all collared Long Distance Migrants were present in Hunt Area 77 before it closed to harvest and in 2018 and 2019 there was extremely little use of the hunt area before it closed to harvest. The proportion of GPS locations in Hunt Area 77 matched the pattern of animal presence in the hunt area but the daily proportion of locations in the area while it was open to harvest was notably lower than the proportion of animals present in the area, suggesting that Long Distance Migrants moved in and out of this hunt area once they started using it for the season (Figure 7C).

Hunt Area 80 was most heavily used by collared Long Distance Migrants after it closed to harvest each season (Figure 6E, Figure 7E), however Long Distance Migrants did use the hunt area while it was open to harvest in 2016 and 2017. Collared Long Distance Migrants heavily used the northern sub-unit of Hunt Area 80 in 2016 and 2017 while the subunit was closed and Hunt Area 77 was open. In most years, the collared Long Distance Migrants used the northern sub-unit more heavily than the southern sub-unit of Hunt Area 80 (Figure 8).

Gros Ventre

Collared animals from the Gros Ventre summer segment were most present in Hunt Area 77 and Hunt Area 80, but they also used Hunt Area 75 to some extent. In 2016 and 2018 there were only two and five collared animals, respectively, from the Gros Ventre segment, limiting

inference in those years. The only season collared Gros Ventre animals had a regular presence in Hunt Area 75 was 2017, when a low proportion of animals were periodically in the hunt area from mid-November until mid-December (Figure 6B, Figure 7B).

Collared animals from the Gros Ventre segment were present in Hunt Area 77 while it was open to harvest in most seasons. Like Long Distance Migrants, the presence of collared Gros Ventre animals in Hunt Area 77 while it was open to harvest appears to have declined from 2016 to 2019, with a relatively high proportion of individuals using the hunt area during open season in 2016 and 2017 and few to none using the hunt area during open season in 2018 and 2019 (Figure 6C).

Generally, collared Gros Ventre animals were not present in Hunt Area 80 while it was open to harvest; most use occurred after the area was closed (Figure 6E, Figure 7E). The period of consistent use in 2018 and 2019 is driven by a single collared individual whose summer and fall home range included upper Flat Creek, which is in Hunt Area 80 but not easily accessible for hunters. In three of four seasons (2016-2018) Gros Ventre animals used the northern subunit of Hunt Area 80 during the period it was closed to harvest and the southern subunit was open to harvest (Figure 8).

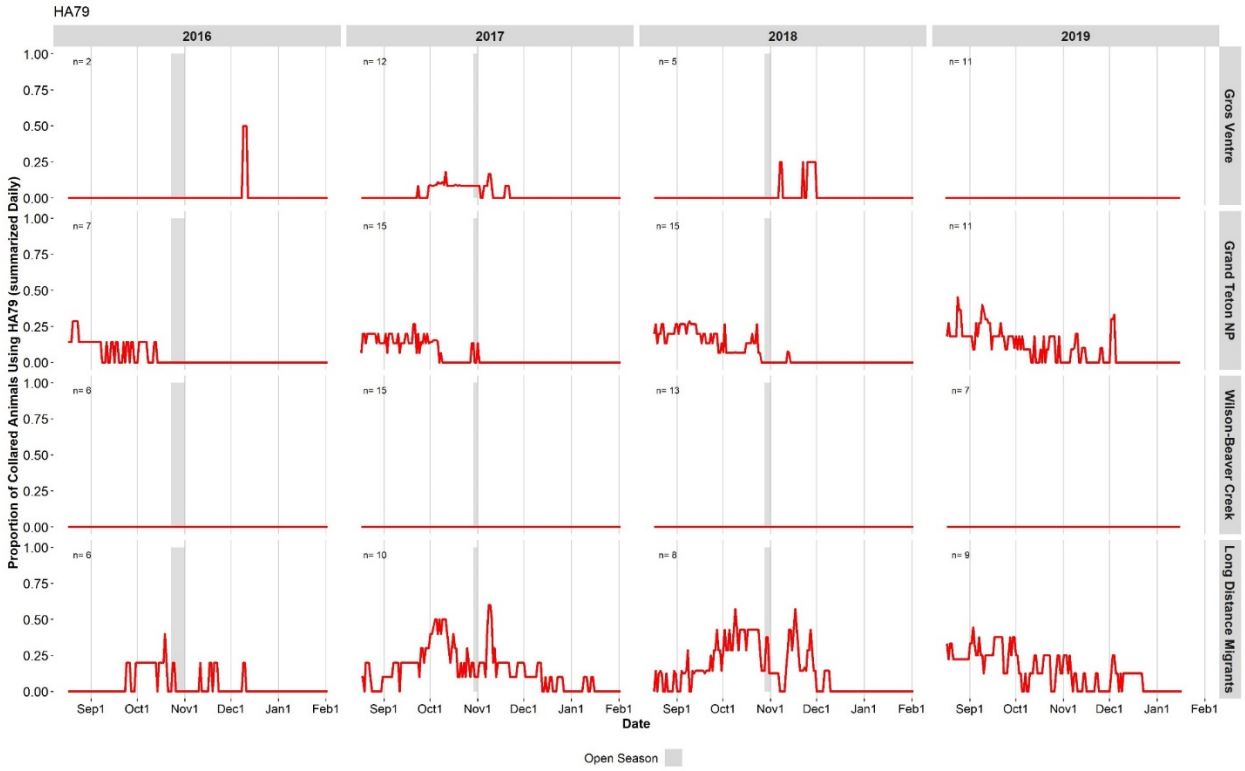


Figure 6A. Daily proportion of cow elk from each summering segment with at least one GPS-collar location in the specified hunt area, relative to when the hunt areas are open to antlerless elk harvest. Gray boxes in panels illustrate when the specified hunt area is open to antlerless elk harvest. Hunt Area 79.

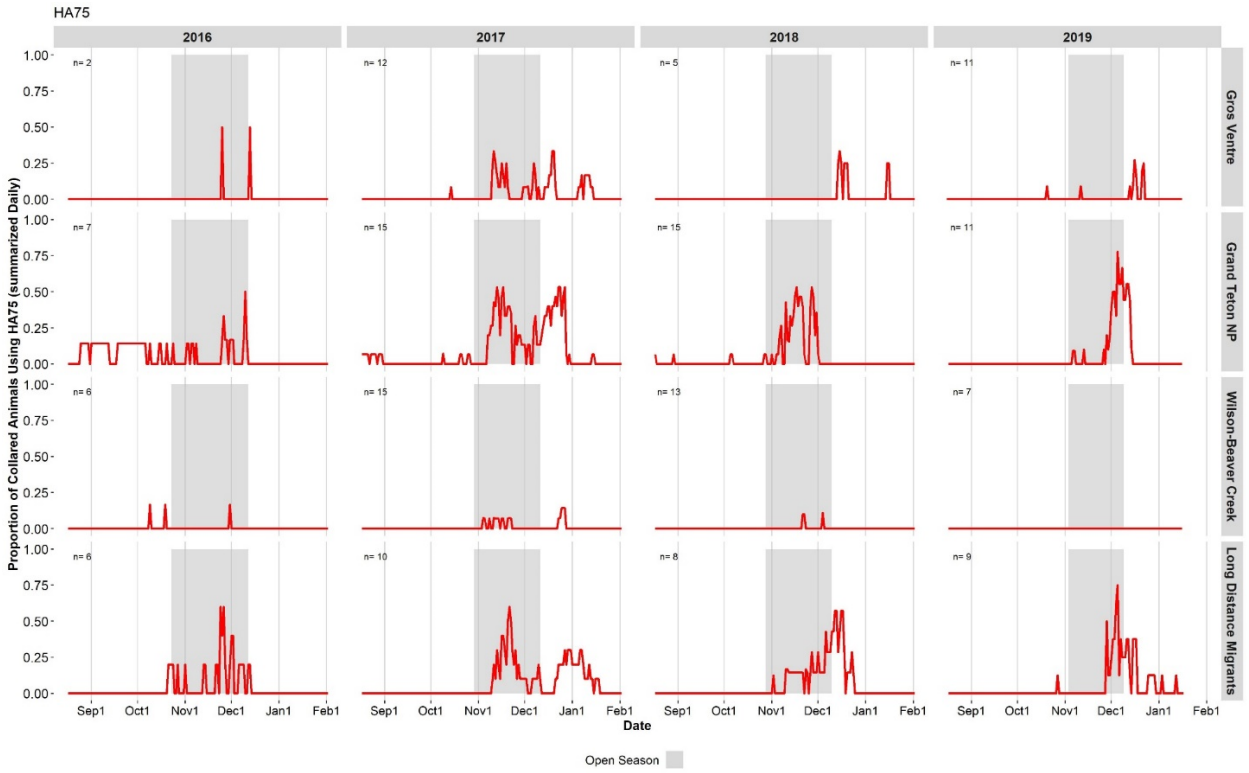


Figure 6B. Hunt Area 75. See 6A for complete figure legend.

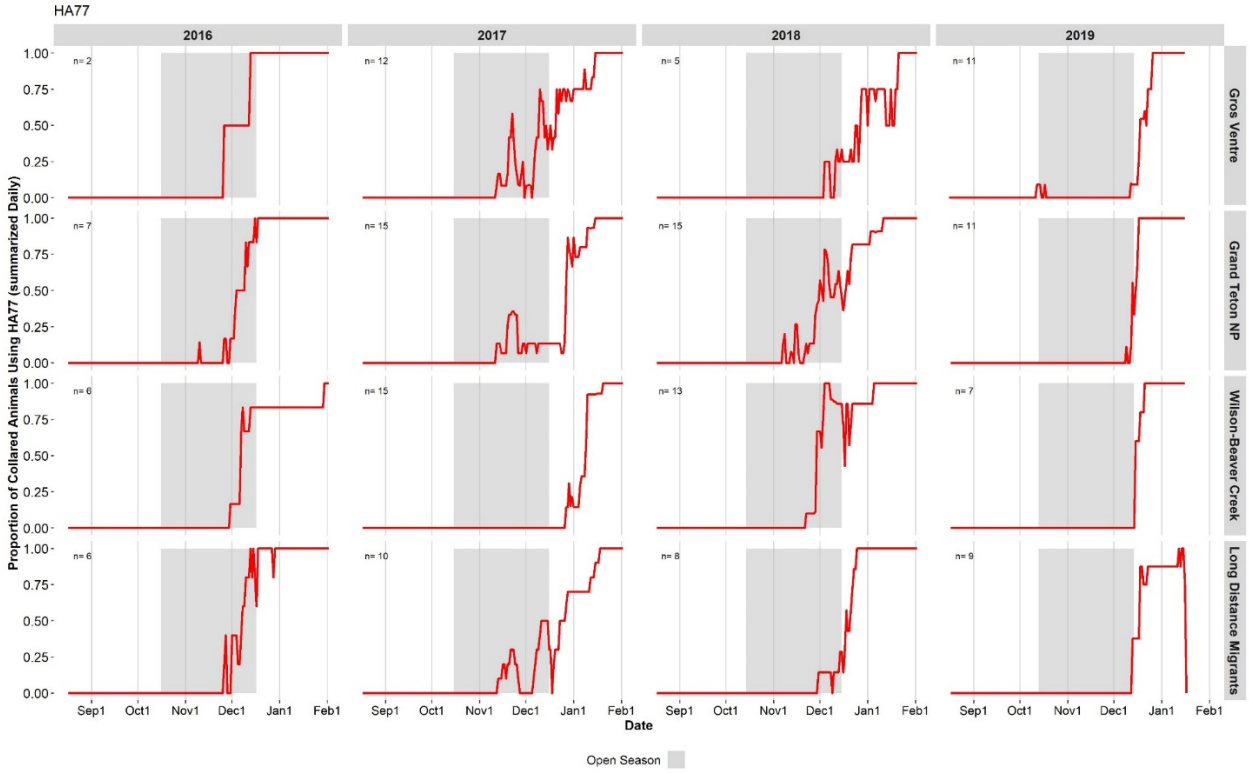


Figure 6C. Hunt Area 77. See 6A for complete figure legend.

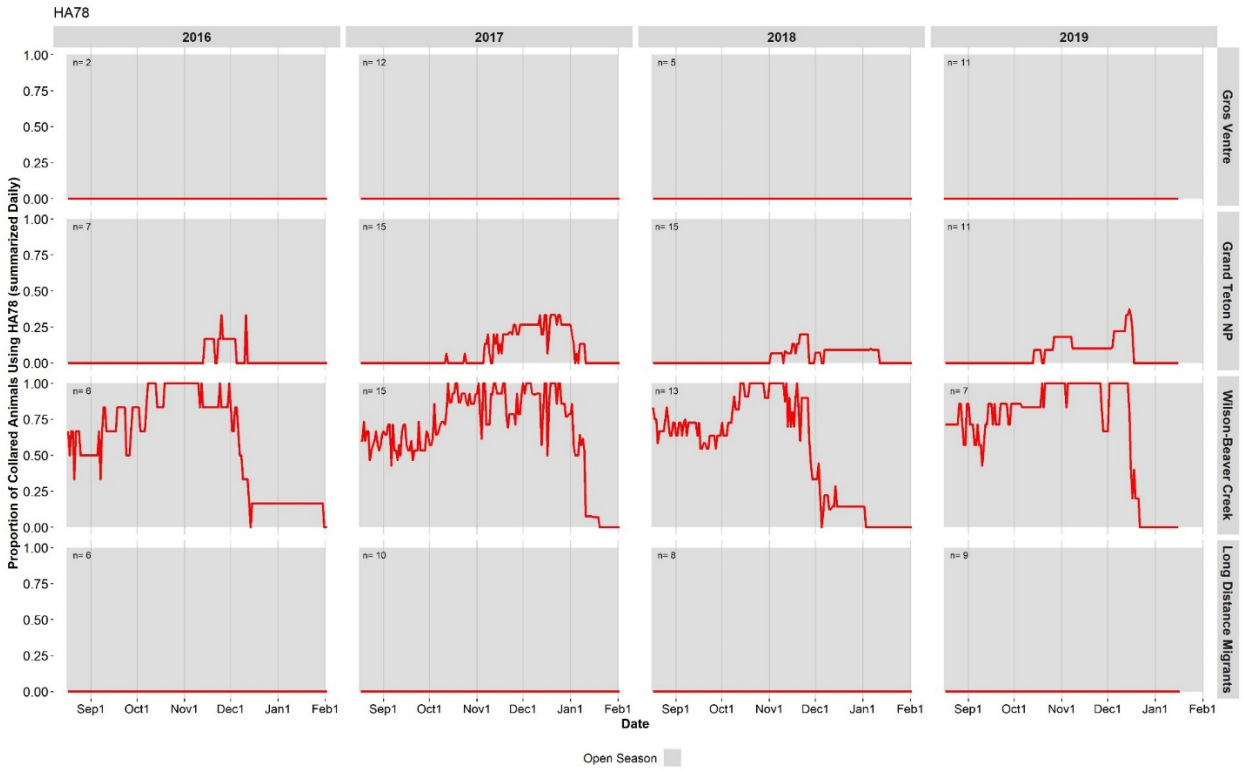


Figure 6D. Hunt Area 78. See 6A for complete figure legend.

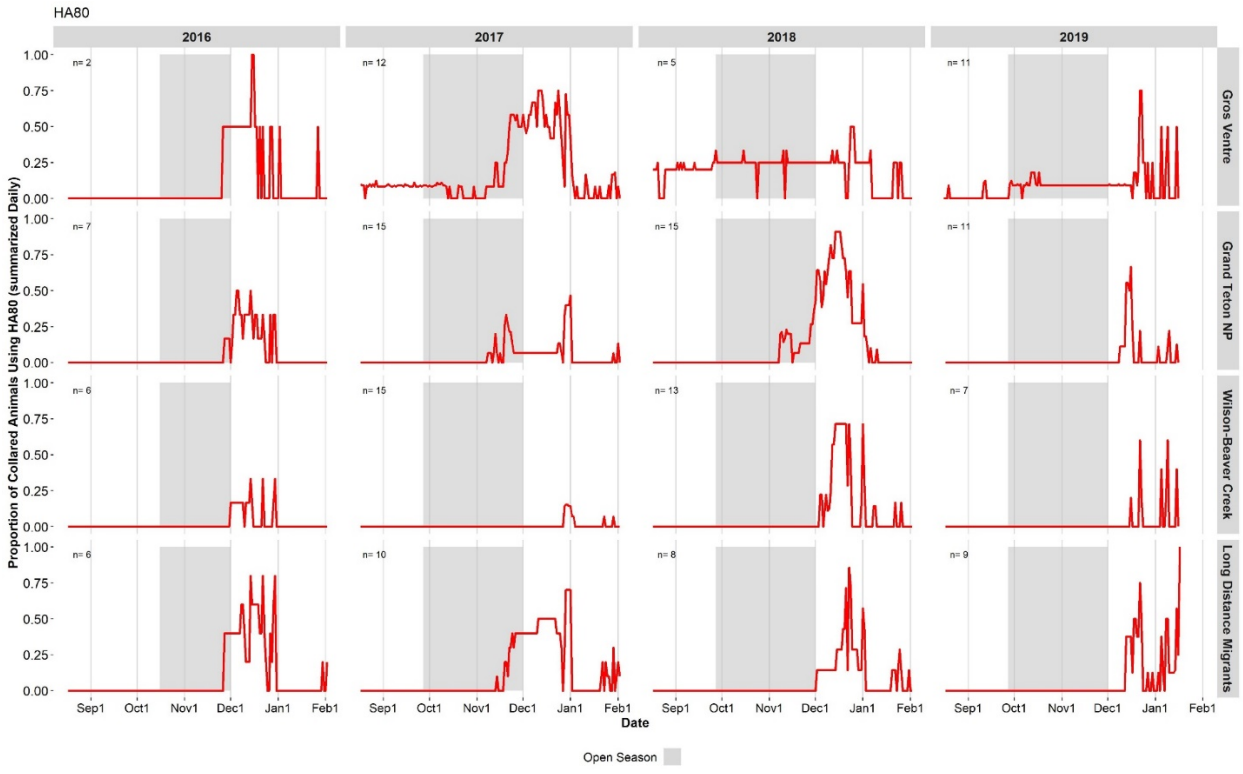


Figure 6E. Hunt Area 80. See 6A for complete figure legend.

Use by Hunt Area

Hunt Area 79

Hunt Area 79 was most heavily used by collared Long Distance Migrants, though there was some use by collared animals from the northernmost Gros Ventre and Grand Teton segments. Long Distance Migrants as well as the Grand Teton segment used the hunt area as early as September in most seasons and use by Long Distance Migrants lasted longer most seasons (Figure 7A).

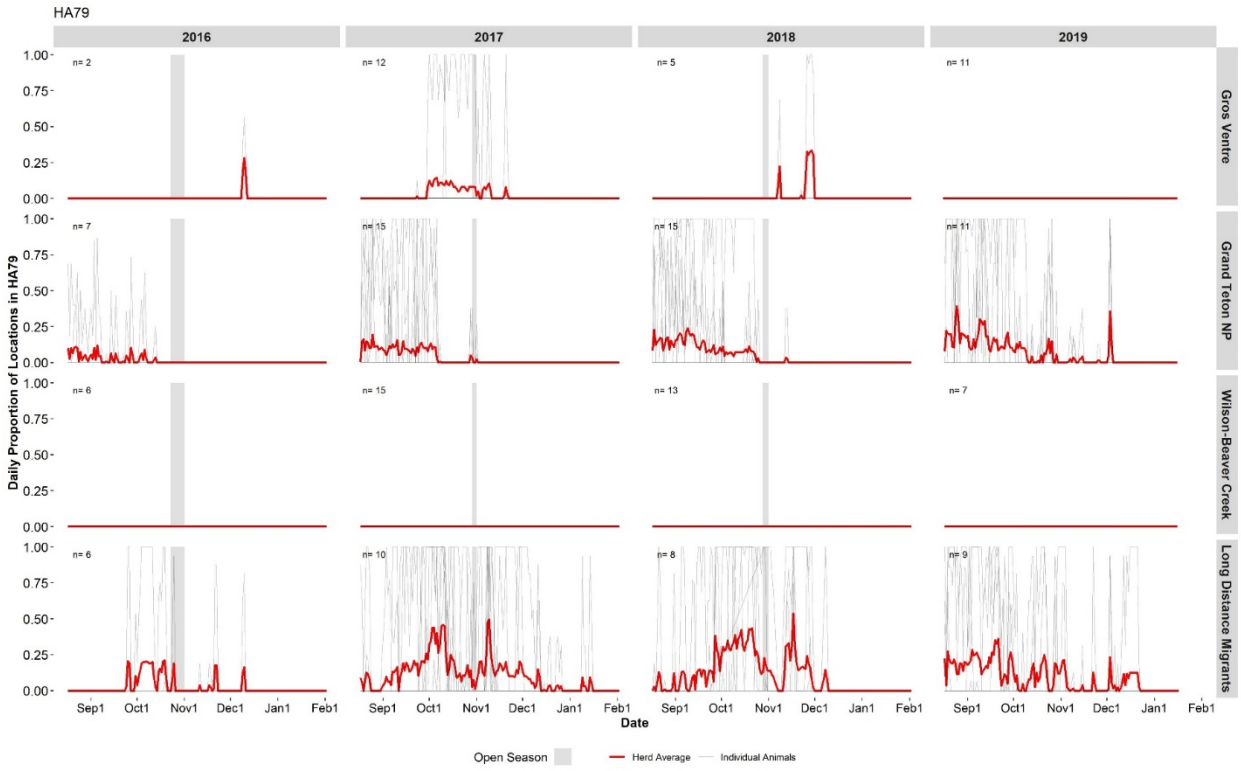


Figure 7A. Daily proportion of cow elk GPS-collar locations from each summering segment in the specified hunt area relative to when the hunt areas are open to antlerless elk harvest. Gray boxes in panels illustrate when the specified hunt area is open to antlerless elk harvest. The red line represents herd average and light gray lines indicate the daily proportion of locations from individual animals in the hunt unit. Hunt Area 79.

Hunt Area 75

Hunt Areas 75 was used most heavily by collared animals from the Grand Teton segment, followed relatively closely by animals from the Long Distance Migrant segment. The timing of use by these two segments was similar each year and often overlapped with the dates the hunt area was open to harvest (Figure 7B). The hunt area was also used by collared animals from the Gros Ventre segment but to a lesser extent and less often while the area was open to harvest.

Hunt Area 75 contains two smaller subunits whose closing dates for harvest vary from the main unit (Figure 8); the Antelope Flats and State Piece subunits. Antelope Flats is used most commonly by the Grand Teton Segment, followed by Long Distance Migrants. During the time period when Antelope Flats is closed to harvest and the main unit is open to harvest, Antelope Flats typically receives some, but a small amount of, use by these segments. The State Piece receives little use overall, though in 2017 collared animals from the Gros Ventre segment were present in the subunit in early November.

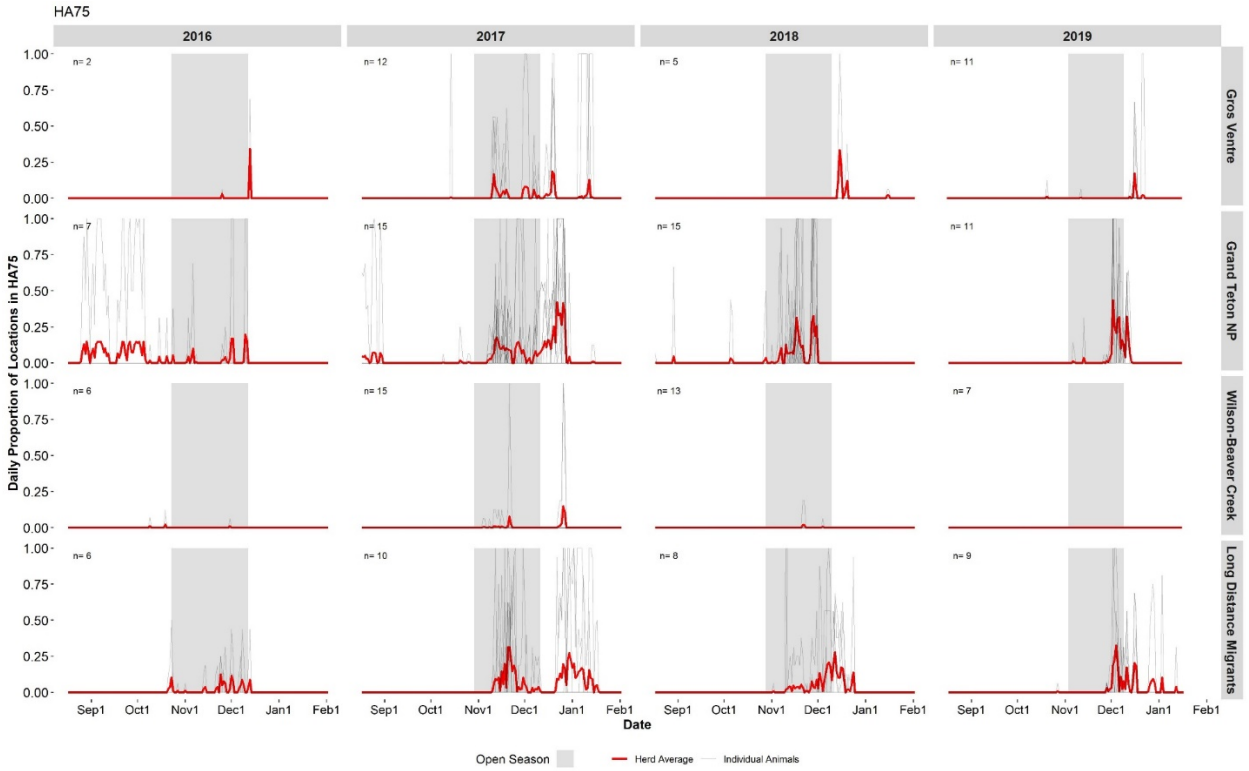


Figure 7B. Hunt Area 75. See 7A for complete figure legend.

Hunt Area 77

Collared animals from each summer segment use Hunt Area 77, but the timing of use varies by segment and year such that each year different segments use the hunt area most heavily while it is open to harvest (Figure 7C). In 2016, collared animals from each segment used the hunt area to similar extents when it was open to harvest. In 2017, collared animals from the Gros Ventre and Long Distance Migrants segments were in Hunt Area 77 most commonly, followed by Grand Teton animals, and no collared animals from the Wilson to Beaver Creek segment used the hunt area while it was open to harvest. In 2018, collared animals from the Grand Teton and Wilson to Beaver Creek segments used the hunt area most heavily while it was open, but Gros Ventre and Long Distance Migrants did use the hunt area to a lesser degree. In 2019, there was essentially no use of Hunt Area 77 by collared animals from any segment until the final days of open season.

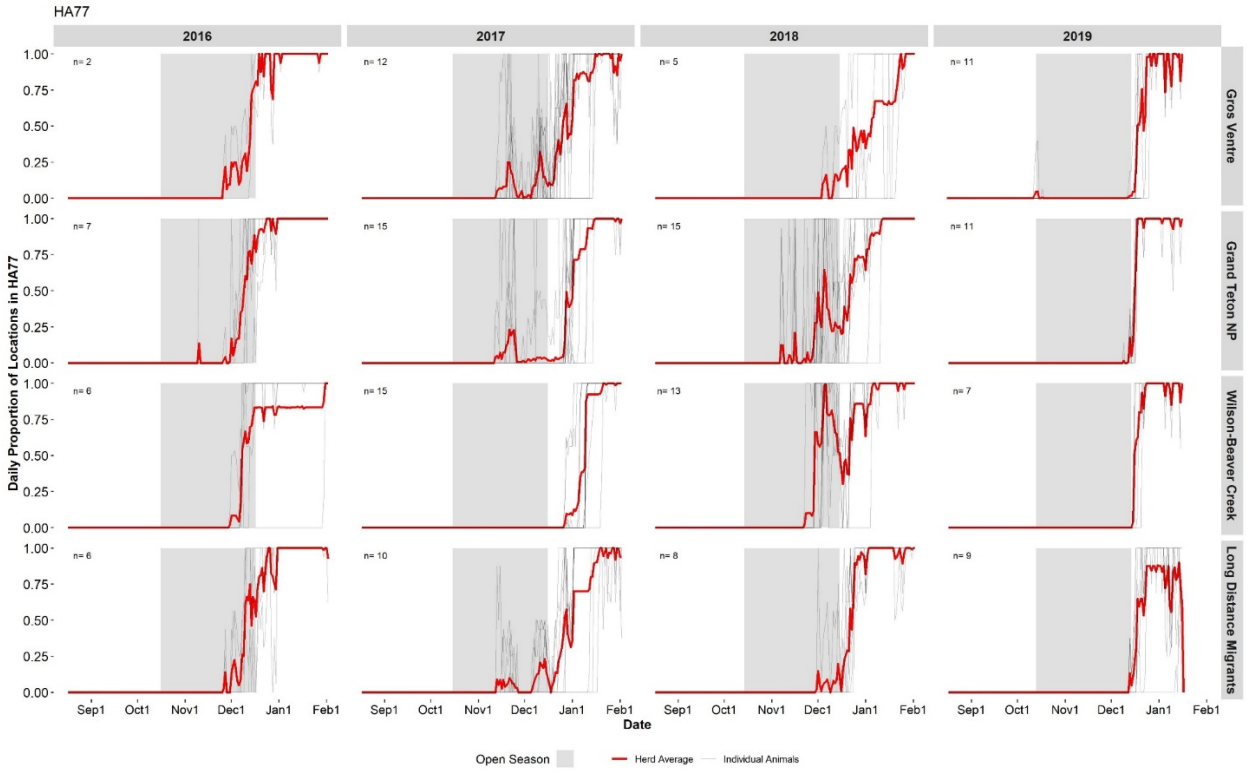


Figure 7C. Hunt Area 77. See 7A for complete figure legend.

Hunt Area 78

Hunt Area 78 was used most heavily by collared animals from the Wilson to Beaver Creek segment, with limited use by collared animals from the Grand Teton segment (Figure 7D). Collared animals were present in the hunt area throughout most of the time period it is open to harvest, with most collared animals departing the area by January each year.

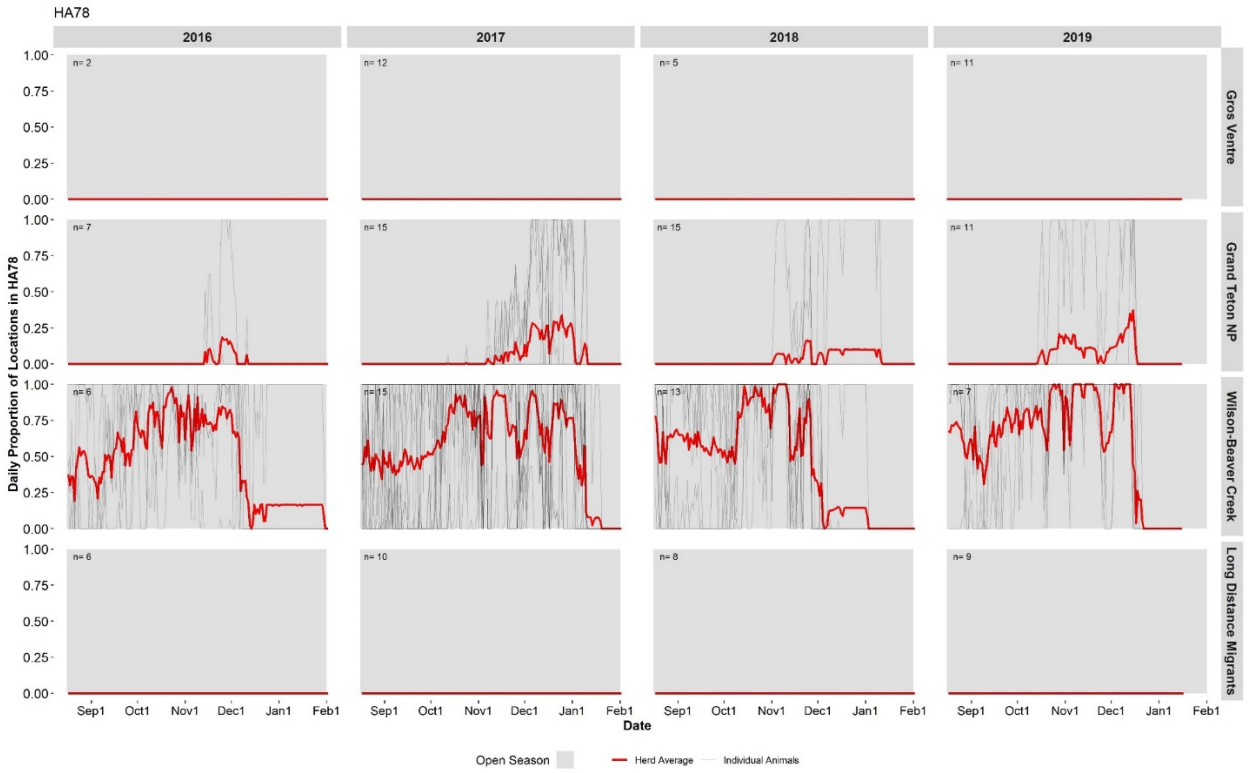


Figure 7D. Hunt Area 78. See 7A for complete figure legend.

Hunt Area 80

Similar to Hunt Area 77, collared animals from each summer segment use Hunt Area 80 with timing of use varying by year and segment. In general, Hunt Area 80 was used little by collared animals until after it is closed to harvest; only in 2017 and 2018 was there notable use of the hunt area while it was open to harvest (Figure 7E). Use of Hunt Area 80 during open season by the Gros Ventre segment in 2018 and 2019 was almost exclusively from a single individual whose fall home range was in upper Flat Creek.

Considering the different subunits of Hunt Area 80, there are different patterns of use by collared individuals of different segments. The northern subunit, which typically closes in early November, was most used by collared animals from the Long Distance Migrants, Grand Teton, and Gros Ventre summer segments, and far less by collared animals from the Wilson to Beaver Creek segment (Figure 8). In most years, use of the northern subunit increased after it closed to harvest and before the southern subunit closed. The southern subunit of Hunt Area 80 was used by collared animals from all segments but animals from the Wilson to Beaver Creek segment very rarely used the subunit while it was open to harvest.

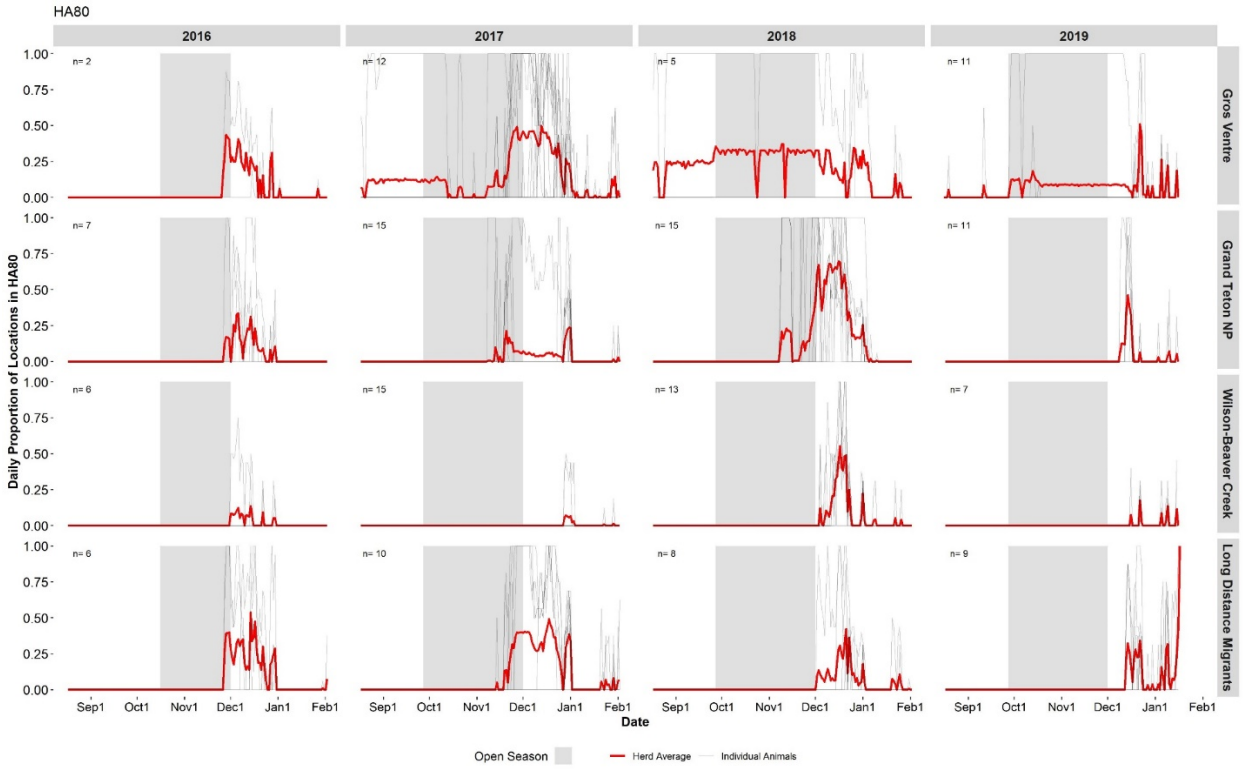


Figure 7E. Hunt Area 80. See 7A for complete figure legend.

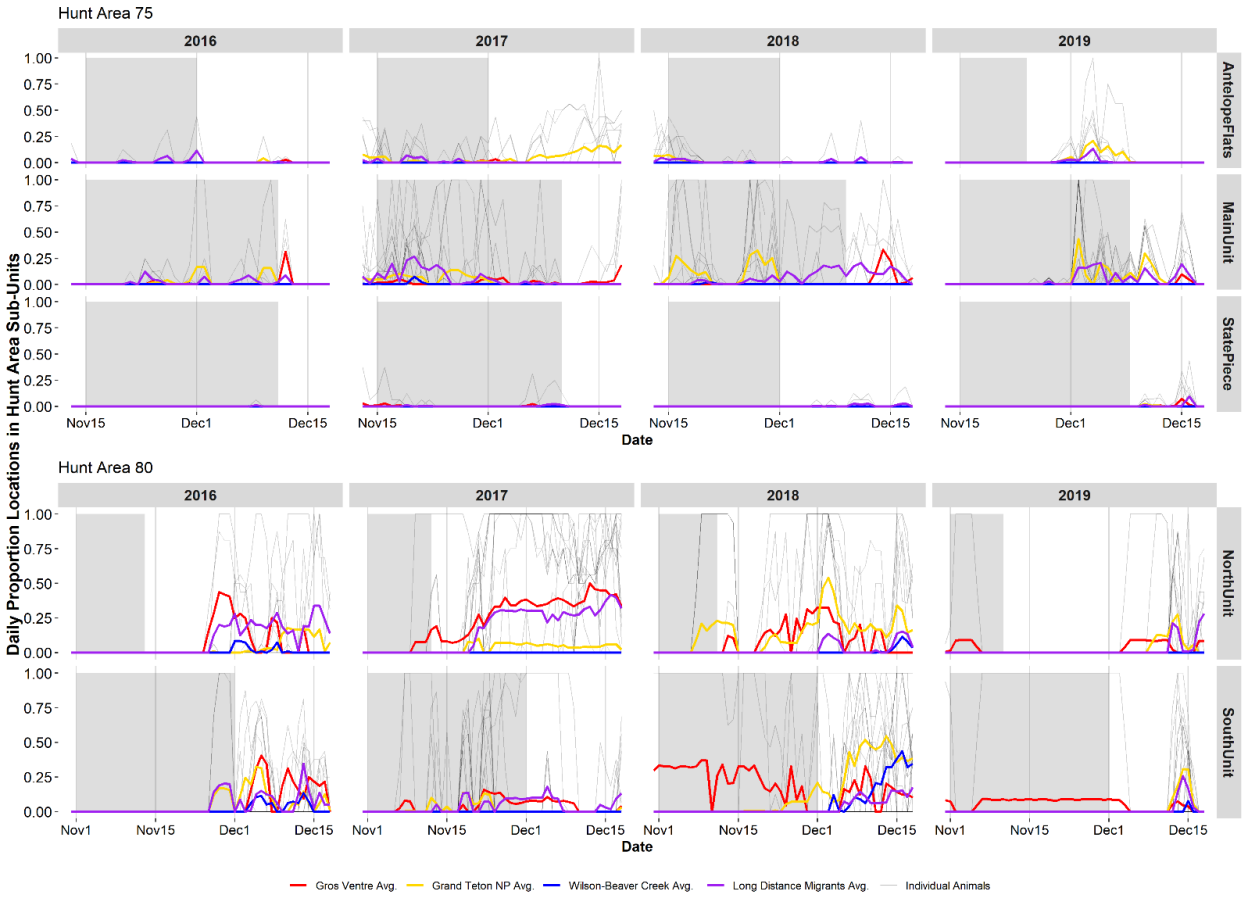


Figure 8. Daily proportion of cow elk GPS-collar locations from each summering segment in the specified sub-units of Hunt Area 75 (top) and Hunt Area 80 (bottom), relative to when the sub-units are open to antlerless elk harvest. Gray boxes in panels illustrate when the specified hunt area is open to antlerless elk harvest. Gray lines indicate the daily proportion of locations from individual animals in the hunt unit.

Discussion

This analysis corroborates the main finding of the previous analysis completed by Foley et al. in 2013. The use of the hunt areas, particularly Hunt Area 75 and Hunt Area 77, by the collared Long Distance Migrants temporally overlaps with use by other segments which managers would like to target for harvest. This suggests there is not a simple way for managers to time the dates of hunting seasons for the hunt areas to simultaneously maintain or increase availability of animals in the Grand Teton and Wilson to Beaver Creek segments for harvest while reducing vulnerability of Long Distance Migrants to harvest. Annual variability in the timing of when the different segments use Hunt Area 75, Hunt Area 77, and Hunt Area 80 adds to the challenge of setting season dates that focus harvest on certain segments. However, the low relative harvest of collared Long Distance Migrants provides some evidence that the current hunting prescription for the hunt areas used by this segment (Hunt Area 79, Hunt Area 75, Hunt Area 77, and Hunt Area 80) minimizes harvest of Long Distance Migrants for reasons that are not elucidated by this analysis. However, the short season length and subsequent closure of Hunt Area 79 certainly contributed to low harvest of Long Distance Migrants.

The utility of using GPS data as an index of harvest availability in the Jackson Elk Herd was supported by the strong correlation between annual harvest rates of antlerless elk in Hunt Areas 75, 77, and 80 and the average proportion of collared cow elk GPS locations in these hunt areas each season (Figure 3). This correlation suggests that the use of open hunt areas by this sample of elk for harvest is representative of antlerless elk in the Jackson Elk Herd and that availability of elk in these hunt areas is a key determinate of annual variability in harvest. However, it would be valuable to validate this pattern with additional years of GPS-collar monitoring. Hunt Area 78 clearly did not fit the same pattern and there are a couple differences between Hunt Area 78 and the hunt areas that make this unsurprising. Whereas Hunt Areas 75, 77 and 80 have pulses of elk migrate onto them throughout the fall and early winter, there are usually many resident elk in Hunt Area 78 throughout its long season. The frequent use of private land by elk in Hunt Area 78 is another key difference between this hunt area and the others. Many private lands within this hunt area are accessible to few or no hunters and this analysis did not distinguish areas where elk hunting is allowed and where it is not. Thus, many elk locations in Hunt Area 78 considered to be available for harvest in this analysis were truly not available because they were on private land that did not allow hunting. Additionally, a high number of resident elk in Hunt Area 78 likely creates a situation where there's never a shortage of elk for hunters to pursue. Given a long hunting season and high numbers of elk in the hunt area, a relatively high percentage of hunters consistently encounter and harvest elk on lands they have permission or are entitled to hunt on. Finally, unlike other hunt areas, Hunt Area 78 was used almost exclusively by a single summer segment. Due to this, there is more of a chance that annual variability in overall proportion of GPS locations in Hunt Area 78 (for all animals in the dataset) is partially driven by the annual changes in the proportion of collared animals that belong to the Wilson to Beaver Creek segment (as new animals are collared and added to the dataset each year).

This analysis' finding that Hunt Area 78 is heavily used by the Wilson to Beaver Creek segment throughout the hunting season and scarcely used by other segments is consistent with previously findings of Foley et al. (2013). Thus, animals harvested in Hunt Area 78 very likely belong to the Wilson to Beaver Creek segment. During the hunting seasons examined in this analysis, antlerless harvest in Hunt Area 78 was very consistent and averaged 100 antlerless (cows or calves) animals harvested per season. Thus, Hunt Area 78 alone contributes to the reduction of approximately 100 animals from the Wilson to Beaver Creek segment each season. Most collared Wilson to Beaver Creek animals do not use Hunt Area 75, suggesting that most of the segment moves directly from Hunt Area 78 to Hunt Area 77. Assuming the hunting seasons examined in this analysis are not anomalous, the Wilson to Beaver Creek segment is not always available for significant levels of harvest in Hunt Area 77 and is rarely available for significant levels of harvest in Hunt Area 80. However, the collared animals may not capture the entire range of movements of the segment in terms of space or time and more animals are likely available for harvest than the collared animals indicate.

The GPS collar data suggest that the segments most available for harvest in Hunt Area 75 are Grand Teton segment animals and Long Distance Migrants, which in turn suggests most animals harvested in Hunt Area 75 belong to these segments. In contrast to Hunt Area 75 and Hunt Area 78, the segments that appear to be most available for harvest in Hunt Area 77 and Hunt Area 80 changed from year to year as different segments arrived while the areas were open to harvest each year. This suggests that although it is a challenge to focus or avoid harvest on any particular segment in these hunt areas, long-term harvest (assuming current patterns continue) may be well distributed across the summer segments.

The simplest explanation for annual variability in the timing and magnitude of use of hunt areas by collared animals from different summer segments is the timing and amount of snow on the segments' summer and transition ranges each year. However, some of the variability may be explained by the turnover of collared animals belonging to each summer segment. The areas that define some summer segments are rather large and elk occupying different parts of the segment's range may have different summer ranges and migration patterns. For example, the consistent low-level use of Hunt Area 80 by Gros Ventre segment animals throughout October and November in 2018 and 2019 is attributable to a single newly instrumented animal whose late summer range is in Hunt Area 80 and the subtle decline in use between 2018 and 2019 is due to additional Gros Ventre animals being added to the dataset, diluting the contribution of this single animal to the segment's average. While this is a clear example, this same situation may impact other segments in less clearly visible ways.

In the last decade the arrival of elk onto Hunt Area 77 appears to have been delayed. From 2006-2012, the majority GPS locations from collared elk were in Hunt Area 77 when the area closed to harvest in mid-December (Foley et al. 2013). In three out of fours years of this study, most GPS locations from collared elk were not in Hunt Area 77 until after the season closed. Climate change is a plausible explanation given general predictions of delayed onset of winter conditions which would make spending more time on summer and fall transition ranges a more successful strategy than it historically was. Other factors (e.g. changes in hunting

regulations and areas open to hunting, changes in predation risk, summer range forage quality, etc.) may also contribute to this pattern, however. If the pattern of delayed arrival to Hunt Area 77 continues, harvest would likely decline without changes to hunting season structure.

The proportion of elk which were captured on the National Elk refuge in this study that were in the Wilson to Beaver Creek (short distance migrants) segment (27%) is lower than found by Cole et al. in 2012 (41%). This suggests that the decline in the proportion of elk wintering on the National Elk Refuge which are medium or long-distance migrants that Cole et al. described may have leveled off in recent years. One relevant change is that a segment of migrant elk which historically wintered in the Gros Ventre drainage has begun to winter more frequently on the National Elk Refuge since 2012. This influx of migrants may explain the increase in the probability that an elk captured on the National Elk Refuge is not a short distance migrant. If animals from the Gros Ventre summer segment are excluded, 34% of animals collared on NER in this study were short distance migrants, which still suggests the pattern of declining migrants has leveled off.

Additional research may provide more insight. One prospect would be to define movement corridors of the different segments as they migrate to winter range. This may better reveal specific areas where segments are most vulnerable to harvest. More specific information on timing and location of harvests could be incorporated to highlight higher-risk hunt areas (see Cole et al. 2015) or high-risk areas within hunt areas. Additionally, identifying which areas in Hunt Area 78 are open to hunting and which are *de facto* closed to hunting would help better understand availability of elk in that unit. An analysis that accounts for whether GPS locations are during 'shooting hours' would also provide better accuracy of an individual's true availability for harvest. Investigation of if and how elk movement patterns respond to changes in hunting regulations may also provide useful information about long-term efficacy of hunting regulation changes aimed at promoting or diminishing harvest of particular segments. Investigating the relationship between snowfall and timing of elk migration may help management agencies better anticipate the typical timing of migration, and hence harvest availability, in the Jackson Elk Herd in future years. Lastly, the interchange between elk wintering in the Gros Ventre drainage and the National Elk Refuge is a recent and dynamic trend that warrants additional attention as it has implications for the satisfaction of the 2007 Bison and Elk Management Plan. A similar analysis that focuses exclusively on elk which summer in the Gros Ventre drainage (regardless of winter range) may provide useful insights relative to this management issue.

Conclusions:

1. The overall use of most hunt areas (while they were open to harvest) by GPS collared elk was strongly correlated with annual harvest in the hunt areas, indicating the utility of this approach to assess harvest availability of antlerless elk in the Jackson Elk Herd. This was not the case for Hunt Area 78, which may be explained by the many private land sanctuaries in the hunt area and/or little variability in harvest across years.

2. Two thirds (66%) of 2016-2019 antlerless harvest in the Jackson Elk Herd occurred in Hunt Areas 75 and 77. Due to limited season dates, very little antlerless harvest occurred in Hunt Area 79. Antlerless harvest in Hunt Area 78 was very consistent across years (approximately 100 harvests per season) while harvest in the other hunt areas varied greatly across seasons.

3. The previously described trend of a declining proportion of elk wintering on the National Elk Refuge which are long-distance migrants appears to have leveled off as the proportion of animals in this study that were long distance migrants is similar to the proportion reported in 2012 (by Cole et al 2015).

4. Based on the GPS collar data, different summer segments are most available for harvest in different hunt areas. Some hunt areas provide harvest opportunities for specific segments while all segments are available for harvest in others. For example, Hunt Area 78 provides opportunity to harvest almost exclusively the Wilson to Beaver Creek segment (i.e. Short Distance Migrants) while Hunt Area 79 provides opportunity to almost exclusively harvest Yellowstone and Teton Wilderness elk (i.e. Long Distance Migrants). In contrast, Hunt Areas 75, 77, and 80 provide opportunity to harvest multiple population segments.

5. Simultaneous use of Hunt Areas 75, 77, and 80 by multiple summer segments and annual variability in the timing of use of the different hunt areas by different segments corroborates previous conclusions that simultaneously increasing harvest availability of some segments while minimizing availability of others by strategically altering hunt season dates may not be possible.

6. Any elk harvested in Hunt Area 78 is most likely a short distance migrant (i.e. Wilson to Beaver Creek segment). The extended hunting season in this unit which results in the consistent harvest of approximately 100 antlerless elk may play an important role in limiting the growth of the Wilson to Beaver Creek population segment.

7. Harvest of study animals suggests that antlerless elk which summer in the Teton Wilderness and Yellowstone National Park (a segment managers are trying to limit harvest of) are less likely to be harvested than those from other population segments. If a goal of management agencies is to minimize harvest of this segment, recent management approaches that close or severely limit hunting opportunities in Hunt Area 79 help achieve this goal as any elk harvested in this unit is likely a Long Distance Migrant.

8. There are avenues of additional research that could provide managers additional and more nuanced understanding of harvest availability of antlerless elk in the

Jackson Elk Herd in future years. These avenues include assessing elk use of hunt areas with respect to daylight hours, a more precise definition of areas open to hunting in Hunt Area 78, evaluating whether elk-use patterns change following changing in hunting regulations, determining if and how annual weather patterns influence timing of fall migration, and completing a more detailed investigation of elk belonging to the Gros Ventre summer and winter segments.

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2019 - JCR Evaluation Form

SPECIES: Elk
HERD: EL103 - FALL CREEK
HUNT AREAS: 84-85

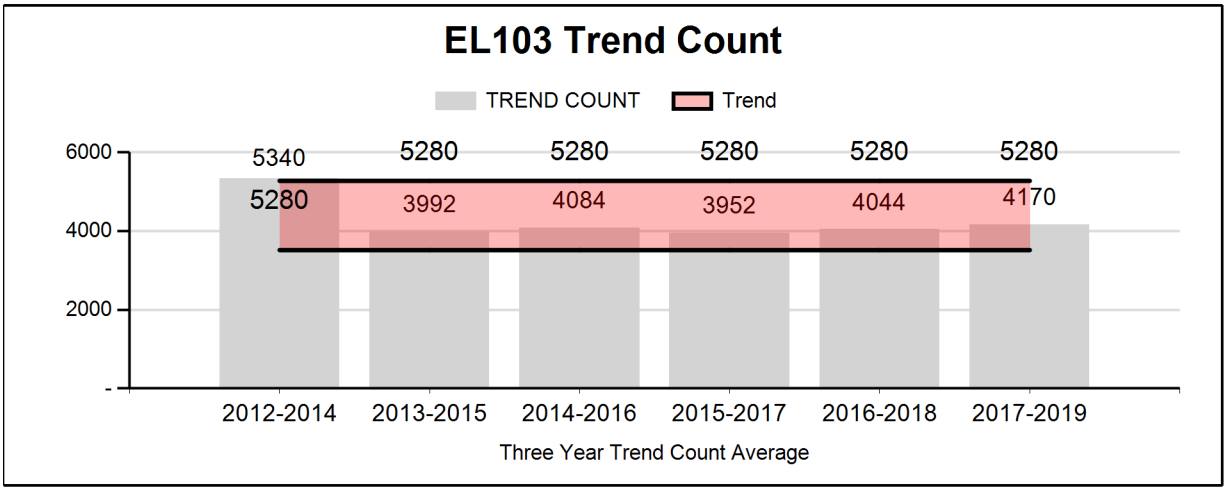
PERIOD: 6/1/2019 - 5/31/2020
PREPARED BY: GARY FRALICK

	2014 - 2018 Average	2019	2020 Proposed
Trend Count:	4,019	4,665	4,300
Harvest:	484	481	558
Hunters:	1,637	1,380	1,421
Hunter Success:	30%	35%	39 %
Active Licenses:	1,677	1,478	1,421
Active License Success	29%	33%	39 %
Recreation Days:	10,383	9,111	9,765
Days Per Animal:	21.5	18.9	17.5
Males per 100 Females:	22	19	
Juveniles per 100 Females	28	30	

Trend Based Objective (± 20%)	4,400 (3520 - 5280)
Management Strategy:	Recreational
Percent population is above (+) or (-) objective:	6%
Number of years population has been + or - objective in recent trend:	1

Proposed harvest rates (percent of pre-season estimate for each sex/age group):

	JCR Year	Proposed
Females ≥ 1 year old:	NA%	NA%
Males ≥ 1 year old:	NA%	NA%
Juveniles (< 1 year old):	NA%	NA%



2020 HUNTING SEASONS
FALL CREEK ELK HERD (EL103)

Hunt Area	Type	Archery Dates		Season Dates		Quota	Limitations
		Opens	Closes	Opens	Closes		
84	Gen	Sept. 1	Sept.25				Any elk
84	Gen			Sept.26	Oct.31		Any elk, spikes excluded
84	1	Sept. 1	Sept. 25				Any elk
84	1			Nov. 1	Jan.31	20	Any elk valid on private land west of U.S. Highway 191 and north and east of the Snake River starting at the South Park Bridge
84	6	Sept. 1	Sept. 25	Sept.26	Nov.20	75	Cow or calf; that portion of Area 84 east and south of Granite Creek to the Hoback River shall be closed after October 31
84,85	7			Aug. 15	Jan. 15	200	Cow or calf valid on private land in Area 84; also valid in that portion of Area 85 on or within 200 yards of irrigated land north of Fall Creek
85	Gen	Sept. 1	Sept. 25				Any elk
85	Gen			Sept.26	Oct. 31		Any elk, spikes excluded
85	6	Sept. 1	Sept. 25	Sept.26	Oct. 31	75	Cow or calf

2019 Hunter Satisfaction: 69% Satisfied, 17% Neutral, 14% Dissatisfied

2020 Management Summary

1.) **Hunting Season Evaluation:** The 2020 hunting season structure was designed to promote any elk hunting, spikes excluded opportunity from September 26 to October 31 because of a substantial increase in the annual postseason trend count. Public sentiment, primarily from resident hunters, supported more opportunity to harvest antlerless elk in this herd. Type 6 licenses in Area 84 were increased from 50 licenses to 75 licenses. Type 7 licenses have been popular with the hunting public and as a result, the number of limited quota licenses was increased from 175 to 200 licenses. These late season hunts have been popular with the public, and also minimize elk damage to privately stored crops and comingling with livestock.

2.) **Herd Unit Evaluation**: The number of elk counted during postseason surveys increased from 4100 elk in 2018 to 4660 elk in 2019 (Appendix A). Consistent with the increase in trend count was a reduction in hunter numbers and participation, which may have played a role in the increased number of elk counted. Bull:cow ratios continued to remain below management minimums in spite of 7 years of spikes excluded general license hunting.

In general, management over the last eight years has been successful at maintaining bull:cow ratios at or higher than the management goal of 20 bulls:100 cows. Bull:cow ratios in 2014 – 2016 were observed at some of the highest levels (≥24 bulls:100 cows) in 10 years, and were likely a result of warm temperatures which encouraged elk to remain at higher, inaccessible elevations, absence of weather during the October portion of the hunting season, and a shorter general license any elk portion of the season which likely discouraged hunter participation. However, total bull:cow ratios observed during the 2017 and 2018 trend counts were 16 bulls:100 cows and 15 bulls:100 cows, respectively, which is attributed to the fewer bulls being counted on native winter ranges. The observed bull:cow ratio in 2019 was 18 bulls:100 cows (Appendix A).

3.) Concurrent with lower than desired trend counts from 2012 -2018 has been a pervasive public dissatisfaction with bull numbers and ratios, and specifically, with yearling bull ratios. Consequently, segments of the public voiced support for spikes excluded seasons which were incorporated into the management strategy in 2013. The prevailing public perception was hunting pressure would increase in this area if spikes excluded seasons were not adopted. The spikes excluded regulation has been in place each hunting season since that time.

Management in the last two years has focused on a transition away from spikes excluded hunting. The spikes excluded season has been supported by a relatively small segment of the hunting public. Since 2013 spikes excluded hunting has precluded yearling bulls from the harvest, and placed hunting pressure on 2+year olds, many of which are branched-antlered bulls (Appendix B). Prior to the initiation of spikes excluded seasons in 2013, and during the period from 1995-2012, the yearling male cohort comprised 11% of the total annual herd unit harvest, and approximately 23% of the total antlered elk harvest. These metrics showed the annual antlered harvest was comprised primarily of branch antlered males 2+ years of age, and indicated the yearling bull cohort was not overexploited by hunters (Appendix C).

A summary of spikes excluded hunting seasons from 2013 – 2018 were reported in a previous Job Completion Report (2018 Fall Creek JCR, Wyoming Game and Fish Department, Jackson Region). These findings concluded that there was no substantial increase in recruitment of yearling bulls after the hunting seasons, or into the 2+ year old cohort of the population, nor was there a sustained, observed increase in the yearling bull:cow ratio (Appendix D).

4.) Despite relatively conservative hunting seasons since 2012, population growth has been suppressed by several issues believed to be associated with disease, primarily the necrotic stomatitus pathogen, emigration into adjacent herd units (Jackson, Afton, and Hoback herds), and predation. Since that time, antlerless elk hunting by general and limited quota cow/calf license holders has been eliminated or greatly reduced. Consequently, trend counts have reflected those

lower numbers and maintained the population within 20% of the population based trend objective.

5.) Another substantial change in management direction occurred in 2019, and was directed at minimizing elk damage to privately stored crops and comingling with domestic livestock. For the first time in the management history of the herd, limited quota antlerless elk late season hunts were valid on private property in the entirety of Hunt Area 84, and in a portion north of Fall Creek in Area 85. Prior to 2019, late season depredation-oriented hunts occurred only in a portion of Hunt Area 84 and north of Butler Creek in Area 85. Both of these changes received positive support by the public and the desired effect of minimizing damage and depredation to private property were largely achieved. This management strategy was continued in 2020.

Appendix A. Fall Creek Elk Herd, posthunt herd composition data, 2014-2019.										
							Ratio:100 Females			
2014	Adult Males	Yrlng Males	Total Males	Cows	Calves	Total	Adult Males	Yrlng Males	Total Males	Calves
84 HCFG	160	48	208	1096	178	1482				
84 CCGF	24	15	39	184	97	320				
84 SPFG	128	107	235	626	202	1063				
84 NR	54	24	78	149	57(3)	287				
85 DCFG	65	52	117	579	119	815				
85 NR	21	15	36	58	29(62)	185				
TOTAL	452	261	713	2692	682	4152	17	9	26	25
2015										
84 HCFG	101	18	119	384	74	577				
84 CCGF	51	21	72	847	242	1161				
84 SPFG	120	46	166	603	214	983				
84 NR	6	5	11	7	19(68)	105				
85 DCFG	76	35	111	569	212	892				
85 NR	6	6	12	36	7(41)	96				
TOTAL	360	130	490	2446	768(109)	3813	15	5	20	31
2016										
84 HCFG	116	76	192	833	281	1306				
84 CCGF	37	46	83	485	118	686				
84 SPFG	117	90	207	647	250	1104				
84 NR	25	3	28	19	9(92)	148				
85 DCFG	72	57	129	627	240	996				
85 NR	9	1	10	1	0(35)	46				
TOTAL	376	273	649	2612	898(127)	4286	14	10	24	34
2017										
84 HCFG	115	52	167	787	148	1102				
84 CCGF	5	12	17	446	47	510				
84 SPFG	73	42	115	609	218	942				
84 NR	24	7	31	64	25(59)	179				
85 DCFG	23	30	53	551	85	689				
85 NR	11	15	26	44	24(240)	334				
TOTAL	251	158	409	2501	547(299)	3756	10	6	16	22
2018										
84 HCFG	78	50	128	927	203	1258				
84 CCGF	11	28	39	512	157	708				
84 SPFG	74	42	116	513	167(50)	846				
84 NR	22	9	31	61	36(110)	238				
85 DCFG	48	29	77	595	201	873				
85 NR	8	8	16	111	25(15)	167				
TOTAL	241	166	407	2719	789(175)	4090	9	6	15	29
2019										
84 HCFG	181	89	270	1194	314	1778				
84 CCGF	10	27	37	563	201	801				
84 SPFG	88	45	133	553	185	871				
84 NR	18	13	31	46	29(56)	162				
85 DCFG	54	39	93	705	177	975				
85 NR	2	5	7	12	14(45)	78				
TOTAL	353	218	571	3073	920(101)	4665	11	7	18	30

Appendix B

2006 - 2019 Harvest Summary																		
Emphasis on Spikes Excluded, 2013-2019																		
for Elk Herd EL103 - FALL CREEK																		
	HUNTERS					**HARVEST**									**SUCCESS**			
Year	**Res Htrs**	**NRes Htrs**	**% NRes**	**Total Htrs**	**Act Lic**	**Ylg Male**	**Adult Male**	**Total Male**	**% Male**	**Fem**	**% Fem**	**Juv**	**% Juv**	**Tot Harv**	**Hntrs**	**Act Lic**	**Hntr Days**	**Days to Harv**
2006	1,810	692	28%	2,502	2,624	109	323	432	46%	382	41%	124	13%	938	37%	36%	16,472	17.6
2007	1,777	695	28%	2,472	2,544	102	361	463	50%	377	40%	94	10%	934	38%	37%	17,020	18.2
2008	1,924	824	30%	2,748	2,883	55	347	402	42%	445	46%	116	12%	963	35%	33%	21,949	22.8
2009	2,022	804	28%	2,826	2,972	98	305	403	38%	555	53%	91	9%	1,049	37%	35%	23,602	22.5
2010	2,037	711	26%	2,748	2,913	86	350	436	30%	772	54%	223	16%	1,431	52%	49%	22,262	15.6
2011	1,948	812	29%	2,760	2,879	62	330	392	45%	414	48%	61	7%	867	31%	30%	21,958	25.3
2012	1,594	562	26%	2,156	2,269	70	353	423	51%	345	41%	66	8%	834	39%	37%	16,943	20.3
2013	**1,632**	**491**	**23%**	**2,123**	**2,231**	**8**	**307**	**315**	**43%**	**338**	**47%**	**73**	**10%**	**726**	**34%**	**33%**	**15,271**	**21**
2014	**1,469**	**461**	**24%**	**1,930**	**1,982**	**0**	**291**	**291**	**51%**	**226**	**40%**	**49**	**9%**	**566**	**29%**	**29%**	**12,749**	**22.5**
2015	**1,336**	**350**	**21%**	**1,686**	**1,714**	**3**	**275**	**278**	**66%**	**118**	**28%**	**24**	**6%**	**420**	**25%**	**25%**	**10,154**	**24.2**
2016	**1,173**	**317**	**21%**	**1,490**	**1,518**	**4**	**347**	**351**	**70%**	**133**	**26%**	**20**	**4%**	**504**	**34%**	**33%**	**8,778**	**17.4**
2017	**1,226**	**296**	**19%**	**1,522**	**1,575**	**3**	**268**	**271**	**65%**	**118**	**28%**	**27**	**6%**	**416**	**27%**	**26%**	**9,928**	**23.9**
2018	**1,215**	**341**	**22%**	**1,556**	**1,598**	**0**	**310**	**310**	**60%**	**169**	**33%**	**34**	**7%**	**513**	**33%**	**32%**	**10,304**	**20.1**
2019	**1,091**	**289**	**21%**	**1,380**	**1,478**	**3**	**302**	**305**	**63%**	**169**	**35%**	**7**	**1%**	**481**	**35%**	**33%**	**9,111**	**18.9**

*** 2013 - 2019 Spikes Excluded Seasons**

Appendix C

1995 - 2012 Harvest Summary

Emphasis on Percent Yearling Males Harvest

for Elk Herd EL103 - FALL CREEK

	HUNTERS					HARVEST										SUCCESS			
Year	Res Htrs	NRes Htrs	% NRes	Total Htrs	Act Lic	Ylg Male	% Ylg	Adult Male	Total Male	% Male	Fem	% Fem	Juv	% Juv	Tot Harv	Hntrs	Act Lic	Hntr Days	Days to Harv
1995	2,113	804	28%	2,917	2,917	147	17%	305	452	51%	388	44%	39	4%	879	30%	30%	15,759	17.9
1996	1,762	517	23%	2,279	2,279	71	8%	288	359	40%	416	46%	120	13%	895	39%	39%	14,968	16.7
1997	1,516	712	32%	2,228	2,228	114	13%	348	462	51%	383	42%	59	7%	904	41%	41%	13,717	15.2
1998	1,513	1,007	40%	2,520	2,520	97	15%	328	425	64%	198	30%	37	6%	660	26%	26%	14,108	21.4
1999	2,071	580	22%	2,651	2,651	142	16%	325	467	52%	341	38%	92	10%	900	34%	34%	16,064	17.8
2000	1,453	546	27%	1,999	1,999	89	12%	327	416	59%	240	34%	53	7%	709	35%	35%	11,469	16.2
2001	1,577	467	23%	2,044	2,044	149	21%	272	421	60%	244	35%	38	5%	703	34%	34%	12,091	17.2
2002	1,812	478	21%	2,290	2,294	70	11%	221	291	45%	313	49%	40	6%	644	28%	28%	12,750	19.8
2003	1,525	568	27%	2,093	2,095	78	10%	352	430	54%	305	39%	56	7%	791	38%	38%	12,436	15.7
2004	1,774	649	27%	2,423	2,465	139	12%	395	534	45%	534	45%	120	10%	1,188	49%	48%	14,718	12.4
2005	1,506	707	32%	2,213	2,285	79	11%	366	445	60%	255	34%	43	6%	743	34%	33%	14,929	20.1
2006	1,810	692	28%	2,502	2,624	109	12%	323	432	46%	382	41%	124	13%	938	37%	36%	16,472	17.6
2007	1,777	695	28%	2,472	2,544	102	11%	361	463	50%	377	40%	94	10%	934	38%	37%	17,020	18.2
2008	1,924	824	30%	2,748	2,883	55	6%	347	402	42%	445	46%	116	12%	963	35%	33%	21,949	22.8
2009	2,022	804	28%	2,826	2,972	98	9%	305	403	38%	555	53%	91	9%	1,049	37%	35%	23,602	22.5
2010	2,037	711	26%	2,748	2,913	86	6%	350	436	30%	772	54%	223	16%	1,431	52%	49%	22,262	15.6
2011	1,948	812	29%	2,760	2,879	62	7%	330	392	45%	414	48%	61	7%	867	31%	30%	21,958	25.3
2012	1,594	562	26%	2,156	2,269	70	8%	353	423	51%	345	41%	66	8%	834	39%	37%	16,943	20.3

APPENDIX D

A 6-YEAR SUMMARY OF SPIKES EXCLUDED HUNTING IN THE FALL CREEK ELK HERD HUNT AREAS 84, 85 2013 – 2018

Prepared by:

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March 1, 2019

A 6-YEAR SUMMARY OF SPIKES EXCLUDED HUNTING
IN THE FALL CREEK ELK HERD
2013 - 2108

The reduction in yearling harvest because of the spikes excluded regulation has not resulted in the sustained or desired increase in recruitment of the yearling cohort. From 2013 - 2015 the number of yearling bulls documented in the herd composition surveys has exhibited an annual, incremental decrease (Figure 1).

The number (Figure 1) and proportion (Figure 2) of yearling bulls in the current year's postseason trend count declined dramatically in 2017, and did not respond to the conservative management actions that were designed to promulgated yearling recruitment in 2018. In general, yearling bull ratios have exhibited a sustained suppression in comparison to those years in which the spike excluded season were not in place.

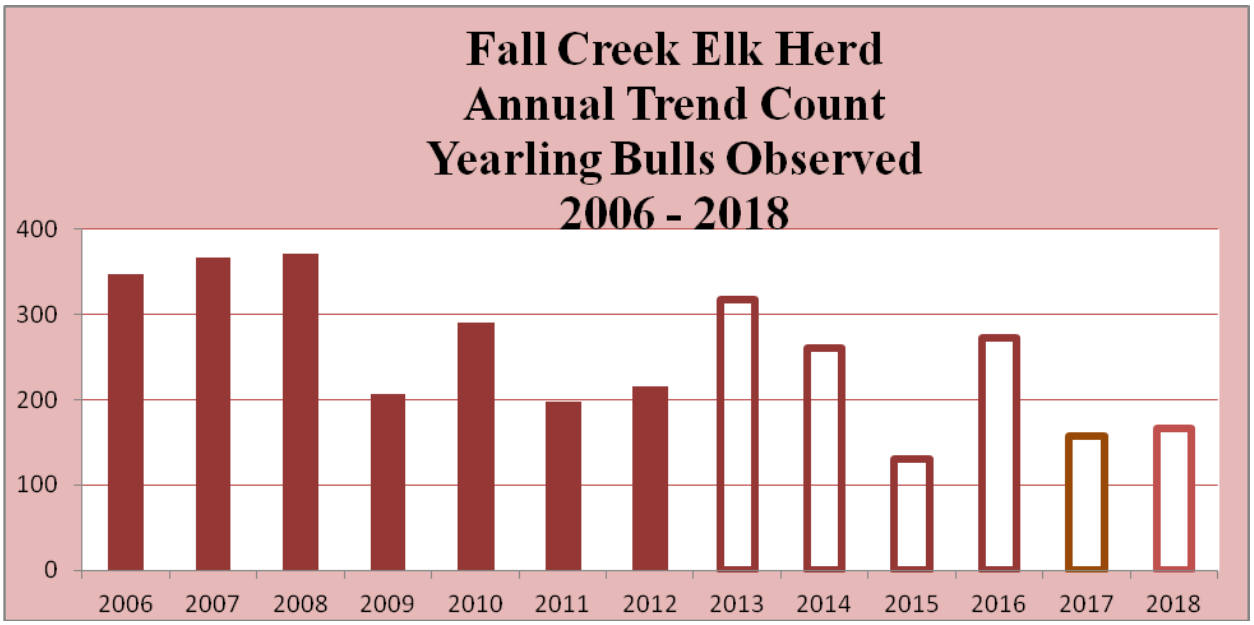


Figure 1. A depiction of the number of yearling bulls counted during the annual trend count during years of general license, any elk hunting seasons (2006-2012) versus general license, any elk spikes excluded hunting seasons (2013-2018).

In 2015, the observed ratio of 5 yearling bulls:100 cows was the lowest yearling bull ratio observed since spikes excluded hunting was first implemented in 2013. Since that time yearling bull ratios have exhibited annual declines from 13 yearling bulls:100 cows in 2013, to 9, 5, and 10 yearling bulls:100 cows from 2014 - 2016, respectively.

A total of 6 yearling bulls:100 cows were observed during the 2017 and 2018 postseason herd unit surveys, respectively.

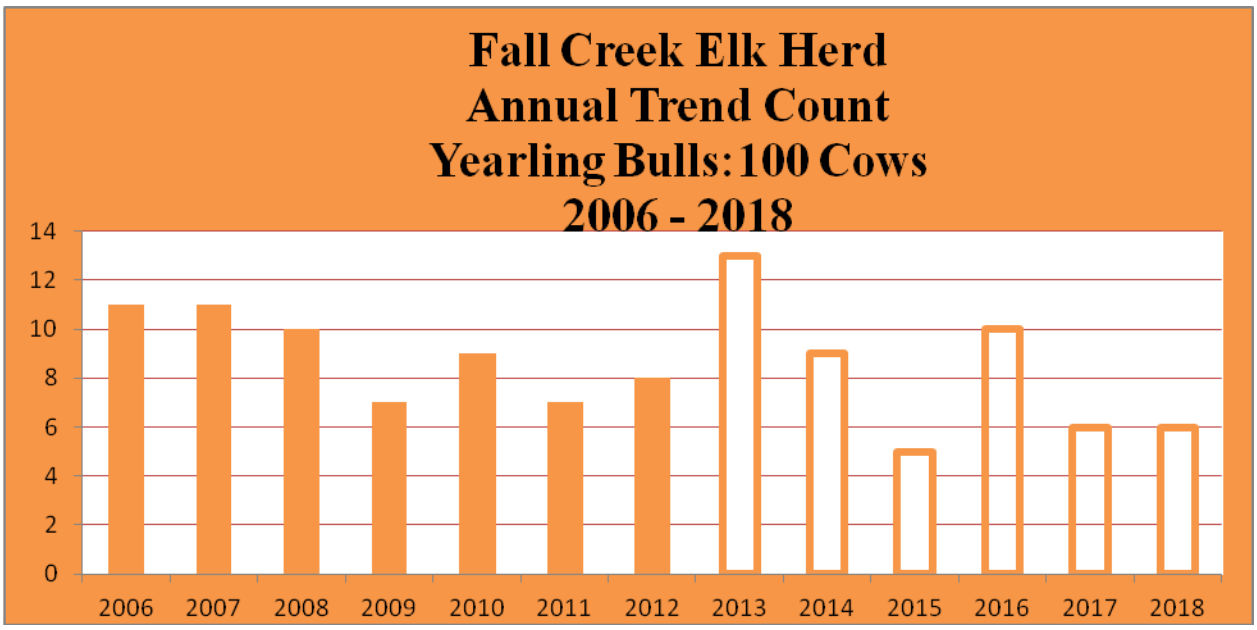


Figure 2. A depiction of the yearling bulls:100 cows ratio observed during the annual trend count during years of general license, any elk hunting seasons (2006-2012) versus general license, any elk spikes excluded hunting seasons (2013-2018).

2019 - JCR Evaluation Form

SPECIES: Elk
HERD: EL105 - AFTON
HUNT AREAS: 88-91

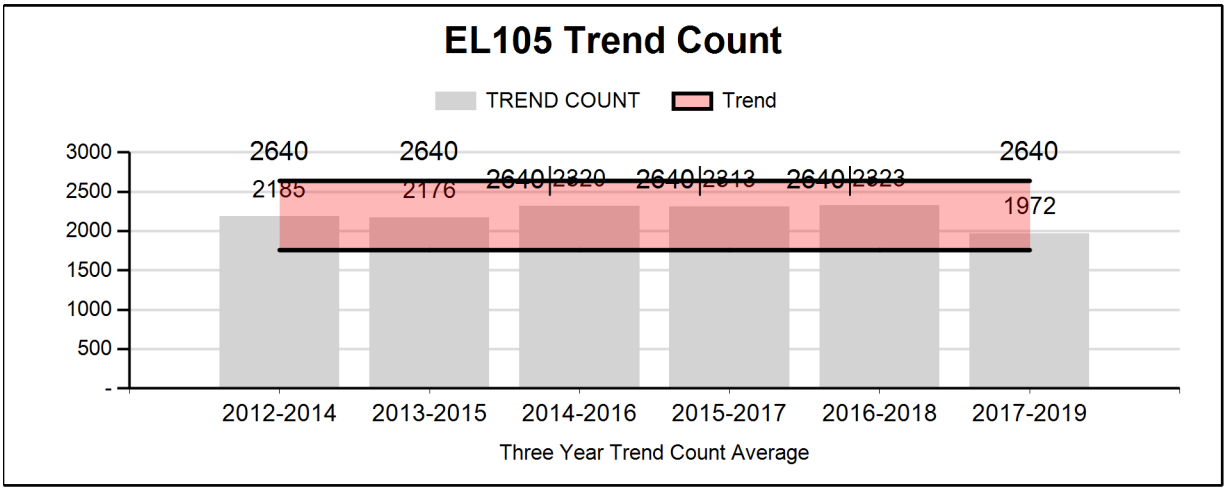
PERIOD: 6/1/2019 - 5/31/2020
PREPARED BY: GARY FRALICK

	2014 - 2018 Average	2019	2020 Proposed
Trend Count:	2,248	1,636	1,900
Harvest:	853	852	700
Hunters:	2,595	2,418	2,370
Hunter Success:	33%	35%	30 %
Active Licenses:	2,693	2,508	2,370
Active License Success	32%	34%	30 %
Recreation Days:	17,552	15,282	14,891
Days Per Animal:	20.6	17.9	21.3
Males per 100 Females:	18	17	
Juveniles per 100 Females	36	36	

Trend Based Objective (± 20%)	2,200 (1760 - 2640)
Management Strategy:	Recreational
Percent population is above (+) or (-) objective:	-25.6%
Number of years population has been + or - objective in recent trend:	2

Proposed harvest rates (percent of pre-season estimate for each sex/age group):

	JCR Year	Proposed
Females ≥ 1 year old:	NA%	NA%
Males ≥ 1 year old:	NA%	NA%
Juveniles (< 1 year old):	NA%	NA%



2020 HUNTING SEASONS
AFTON ELK HERD (EL105)

Hunt Area	Type	Archery Dates		Season Dates		Quota	Limitations
		Opens	Closes	Opens	Closes		
88	1	Sept.1	Sept. 30	Oct. 1	Oct. 31	40	Any elk
	1			Nov. 1	Jan. 31		Antlerless elk valid south of Peterson Lane and south and west of the Greys River Wildlife Habitat Management Area Elk Fence
89	Gen	Sept. 1	Sept. 30	Oct.15	Oct.17		Any elk
89	Gen			Oct. 18	Oct. 31		Antlered elk
90	Gen	Sept. 1	Sept.30	Oct. 15	Oct. 31		Any elk
90	Gen			Nov. 1	Nov. 10		Antlerless elk
90	6	Sept. 1	Sept.30	Oct. 15	Nov.10	125	Cow or calf
91	Gen	Sept. 1	Sept. 30	Oct.15	Oct. 31		Any elk
91	1	Sept. 1	Sept.30	Oct. 1	Oct. 31	100	Any elk
91	1			Nov. 1	Dec. 31		Antlerless elk
91	1			Jan. 1	Jan. 31		Antlerless elk valid in the entire area. Archery, muzzleloading firearm or shotgun only in that portion of Area 91 south of Cedar Creek and east of Muddy String Road (Lincoln County Road 117), north of Lost Creek Road (Lincoln County Road 120), and north of Lost Creek, off national forest
91	6	Sept. 1	Sept. 30	Oct. 1	Dec.31	200	Cow or calf
91	6			Jan. 1	Jan. 31		Cow or calf valid in the entire area. Archery, muzzle loading firearm or shotgun only in that portion of Area 91 south of Cedar Creek and east of Muddy String Road (Lincoln County Road 117), north of Lost Creek Road (Lincoln County Road 120), and north of Lost Creek off national forest

2019 Hunter Satisfaction: 66% Satisfied, 21% Neutral, 13% Dissatisfied

2020 Management Summary

1.) **Hunting Season Evaluation:** The 2020 hunting season was designed to maintain the population within the parameters of the mid-winter trend objective of 2200 elk (+/-20%). In Area 90, the November season was shortened and Type 6 licenses were reduced in order to promote an increase in elk numbers in the upper Greys River. Seasons were extended into January in Area 88 licenses and limited quota licenses targeted at antlerless elk into January in Area 91 were increased to focus on minimizing elk damage to private property and comingling with livestock in Salt River watershed.

2.) **Herd Unit Evaluation**: Elk numbers in the Afton elk herd were within the 20%± threshold of the population trend count objective of 2200 elk. Hunting seasons have been designed to maintain harvest on the antlerless segment of the population over the last 10 years in Areas 90 and 91 because of higher than desired numbers in the Areas 90 and depredation issues in Area 91.

A total of 1636 elk were counted during a postseason trend count in February (Appendix A). Bull:cow ratios were slightly below the management minimum of 20 bulls:100 cows. The number of elk on feedgrounds accounted for 60% of the current year's trend count, and as a result, elk numbers on the Greys River and Forest Park feedgrounds are below Commission-established quotas of 1000 and 750 elk, respectively. In response to the lower trend count, antlerless harvest in Area 89 has been reduced to maintain and/or increase elk numbers on native winter ranges in Greys River and on the Greys River feedground. Area 90 limited quota type 6 licenses were reduced to promote an increase in elk numbers in the upper Greys River elk and on the Forest Park feedground next winter.

3.) The Department initiated supplemental feeding programs along the west boundary of Areas 91 and the Idaho-Wyoming Stateline to alleviate damage to stored crops and prevent elk from comingling with livestock. During one of the most severe winters noted in 1996-97 approximately 525 elk were fed in the Spring Creek and Crow Creek drainages in the southwest portion of Area 91. Other locations where supplemental feeding operations have occurred along the west slope of the Salt Range in Areas 91 are east of Etna and north of Afton. During the current winter approximately 80-110 elk were provided supplemental feed at the confluence of Lee and Wolfley Canyons east of Etna, and near Afton in the eastern portion of Area 91 and near Crow Creek where approximately 80-100 elk were supplemental fed.

4.) Over the last 20 years substantial changes have occurred in the number of elk documented on feedgrounds and native winter ranges (Appendix B). The number of elk counted during trend counts typically exceeds the minimum required sample size of approximately 700-900 elk. During the late 1990s and early 2000s, approximately 85-95% of the number of elk counted were documented on feedgrounds, while only 5%-15% of all elk were counted on native winter ranges.

Since 2014 the number of elk documented on native winter ranges has increased to levels not observed in at least 20 years, especially in the Greys River. This winter range is located in Hunt Area 89 and encompasses the area from Deadman Creek northward to the confluence of Greys River and Snake River. The number of elk documented on this winter range from the mid-1990s ranged from 50 to 350 elk. During the last 5 years the average number of elk documented on this winter range was 337 elk. The highest number of elk ever document on native winter ranges in the lower Greys River was 625 elk in January 2018.

As elk numbers declined on the Greys River feedground at Alpine, elk numbers increased on native winter ranges in Area 89, with the most notable increases in 2014 and 2018. The importance of this native winter range is essential to long-term maintenance of elk that spend the summer and fall in the lower Greys River. The number of elk that spend the winter on native winter ranges in the lower Greys River accounts for, in part, the decline in the number of elk counted on the Greys River feedground at Alpine. During open and relatively snow-free winters, many elk spend the winter on Greys River winter ranges instead of migrating to the Greys River feedground at Alpine, and has accounted for a substantial percentage of the annual Afton elk herd trend count.

5.) A total of 136 elk were examined in the field during annual hunter check stations and field checks. Interestingly, 95% of all male elk examined were at least 2 years old or older. Only 5 yearling bulls, or 5% of the antlered field check harvest was comprised of yearlings. Cows and calves comprised 29% of the total 2019 field checks. Hunters reported seeing bulls specifically, and elk in general, during their trips afield during the archery and general seasons. These hunter observations support the hunter satisfaction statistic reported previously in this document.

As recently as 25 years ago the number of elk checked in the field tallied 377 elk (Appendix C), and since that time the percentage of harvested elk examined in the field has decreased. This can be explained largely due to unfavorable weather and declining resident hunters (Appendix D). During the period from 1995-1999 the average number of hunters recorded was 3125 hunters compared to the most recent 5-year average of approximately 2600 hunters, with the largest decline observed in resident hunters. From 1995-1999 an average of 2400 resident hunters participated in the annual Afton elk hunt, but has declined since that time to an average of approximately 1860 residents in the last 5 years (2015-2019). This represents a 22% decline in resident hunter participation from the mid-1990s to the current 5-year average.

Appendix A. Afton Elk Herd, posthunt herd composition data, 2015-2019.										
							Ratio:100 Females			
Year	Adult Males	Yrlng Males	Total Males	Cows	Calves	Total	Adult Males	Yrlng Males	Total Males	Calves
2015										
88 GRFG	43	24	67	441	152	660				
88 NR	0	0	0	1	0	1				
89 NR	6	6	12	101	57 (24)	194				
90 FPFG	59	18	77	476	188	741				
90 NR	0	0	0	0	0	0				
91 NR	13	5	18	26	14(183)	241				
TOTAL	121	53	174	1045	411(207)	1837	11	5	17	39
2016										
88 GRFG	43	13	56	532	144	732				
88 NR	0	1	1	3	1(5)	10				
89 NR	4	3	7	88	44(52)	191				
90 FPFG	61	48	109	507	198	814				
90 NR	0	2	2	2	2(1)	7				
91 NR	41	33	74	148	122((592)	936				
TOTAL	149	100	249	1280	511(650)	2690	11	8	19	40
2017										
88 GRFG	29	7	36	358	82	476				
88 NR	0	0	0	0	0	0				
89 NR	7	4	11	37	15(562)	625				
90 FPFG	66	25	91	409	79	579				
90 NR	0	1	1	0	0(8)	9				
91 NR	57	1	58	8	0(658)	724				
TOTAL	159	38	197	812	176(1228)	2413	19	5	24	22
2018										
88 GRFG	18	13	31	378	110	519				
88 NR	0	0	0	0	0	NS				
89 NR	1	12	13	111	85(108)	317				
90 FPFG	36	11	47	326	94	467				
90 NR	0	0	0	0	0	NS				
91 NR	49	21	70	227	90(177)	564				
TOTAL	104	57	161	1042	379(285)	1867	10	5	15	36
2019										
88 GRFG	22	13	35	343	110	488				
88 NR	0	1	1	3	1	5				
89 NR	15	10	25	187	82 (63)	357				
90 FPFG	36	25	61	318	108 (2)	489				
90 NR	3	0	3	6	4	13				
91 NR	20	7	27	18	9 (230)	284				
TOTAL	96	56	152	875	314(295)	1636	11	6	17	36

WYOMING
GAME AND FISH DEPARTMENT
Dave Freudenthal, Governor — Terry Cleveland, Director
"Conserving Wildlife - Serving People"

APPENDIX B

Number of elk counted on feedgrounds and on native range during annual herd unit trend counts for four elk herds in the South Jackson Wildlife Biologist District, 1988-2005.

	FALL CREEK		HOBACK		AFTON		PINEY	
YEAR	ON FEED	ON NATIVE RANGE	ON FEED	ON NATIVE RANGE	ON FEED	ON NATIVE RANGE*	ON FEED	ON NATIVE RANGE
1988	4878	478	1159	39	1890	579	2415	472
1989	4006	556	1199	62	1820	303	1916	297
1990	3687	665	1000	89	1822	398	1919	271
1991	4168	668	929	54	1759	647	1788	201
1992	4281	768	1044	119	1869	792	1971	305
1993	3548	715	799	106	1638	221	1875	482
1994	3561	735	743	81	1839	420	1578	657
1995	3528	940	893	40	1679	518	2032	787
1996	4116	262	869	53	1793	545	2263	675
1997	3481	450	433	48	1756	519	2154	681
1998	3859	355	652	44	1969	448	2221	741
1999	3844	192	660	70	1846	246	2193	777
2000	4160	172	745	22	1666	261	2208	301
2001	4768	125	800	48	1689	248	2109	354
2002	4087	299	673	144	1394	551	2135	263
2003	4965	203	1010	36	1611	332	2294	336
2004**	4293	401	858	13	1421	608	2167	53
2005**	4993	192	1036	6	1576	369	2614	494
AVG.	**4123**	**454**	**861**	**60**	**1724**	**445**	**2103**	**453**
%	**90%**	**10%**	**94%**	**6%**	**80%**	**20%**	**82%**	**18%**
POP. OBJ.	**4392** Hunt Areas 84,85		**1100** Hunt Areas 86,87		**2200** Hunt Areas 88-91		**2424** Hunt Areas 92,94	

* Afton Elk Herd- Numbers of elk counted on Native Range during years 1994-2005 reflect those elk counted in Areas 88-90, and only on the eastern portion of Area 91.
** 2004 Hoback Elk Herd - 70 elk counted on private horse feedline.
** 2005 Hoback Elk Herd - 60 elk counted on private horse feedline.

Appendix C

1995 - 2019 Harvest Age Structure																			
for Elk Herd EL105 - AFTON																			
	Males									Females									Herd
Year	Juv	1	% *	2 ^	% **	Tot Aged ++	Not Aged +++	Unk	Tot Chkd	Juv	1	% *	2 ^	% **	Tot Aged ++	Not Aged +++	Unk	Tot Chkd	Tot
1995	17	53	31%	19	26%	89	101	0	190	21	13	8%	27	68%	61	126	0	187	377
1996	25	36	22%	50	58%	111	76	0	187	26	8	6%	20	71%	54	116	0	170	357
1997	16	44	32%	23	34%	83	72	0	155	26	0	0%	21	100%	47	106	0	153	308
1998	12	22	24%	23	51%	57	48	0	105	15	6	5%	15	71%	36	93	0	129	234
1999	4	31	21%	45	59%	80	69	0	149	2	22	21%	16	42%	40	69	0	109	258
2000	8	30	22%	38	56%	76	71	0	147	14	8	7%	24	75%	46	84	0	130	277
2001	3	29	24%	37	56%	69	55	0	124	16	1	1%	6	86%	23	76	0	99	223
2002	3	10	8%	0	0%	13	119	0	132	7	2	2%	0	0%	9	104	0	113	245
2003	2	6	5%	0	0%	8	123	0	131	3	2	2%	0	0%	5	86	0	91	222
2004	0	5	3%	0	0%	5	138	0	143	0	2	2%	0	0%	2	89	0	91	234
2005	7	26	26%	74	74%	107	0	2	109	8	3	5%	57	95%	68	0	0	68	177
2006	4	14	18%	62	82%	80	0	0	80	5	1	2%	55	98%	61	0	0	61	141
2007	3	17	18%	79	82%	99	0	0	99	8	1	2%	63	98%	72	0	0	72	171
2008	1	9	12%	6	40%	16	60	11	87	3	5	9%	0	0%	8	48	4	60	147

1995 - 2019 Harvest Age Structure																			
for Elk Herd EL105 - AFTON																			
	Males									Females									Herd
Year	Juv	1	% *	2 ^	% **	Tot Aged ++	Not Aged +++	Unk	Tot Chkd	Juv	1	% *	2 ^	% **	Tot Aged ++	Not Aged +++	Unk	Tot Chkd	Tot
2010	11	30	26%	86	74%	127	0	0	127	5	1	2%	53	98%	59	0	0	59	186
2011	2	7	10%	66	90%	75	0	0	75	0	9	21%	33	79%	42	0	0	42	117
2012	2	11	11%	90	89%	103	0	0	103	5	2	4%	48	96%	55	0	0	55	158
2013	3	18	26%	50	74%	71	0	4	75	8	2	7%	26	93%	36	0	9	45	120
2014	7	13	15%	75	85%	95	0	0	95	4	2	4%	49	96%	55	0	7	62	157
2015	3	11	16%	2	15%	16	57	0	73	0	3	6%	0	0%	3	45	0	48	121
2016	0	10	11%	78	89%	88	0	0	88	3	0	0%	21	100%	24	0	14	38	126
2017	0	2	4%	44	96%	46	0	1	47	2	3	13%	20	87%	25	0	0	25	72
2018	3	8	14%	50	86%	61	0	0	61	2	2	9%	20	91%	24	0	1	25	86
2019	4	5	5%	87	95%	96	0	0	96	8	2	6%	30	94%	40	0	0	40	136

*	Percent of aged animals (including unaged adults but excluding juveniles) 1 1/2 years old
^	Number of animals two years old and older. Animals aged older than two (excluding unaged adults) are lumped into this two plus category
**	Percent of aged animals (not including juveniles or unaged adults) two years old or older
++	includes juveniles
+++	Unaged adults - unaged animals older than yearlings

Appendix D

1995 - 2019 Harvest Summary

for Elk Herd EL105 - AFTON

Year	HUNTERS					HARVEST									SUCCESS			
	Res Htrs	NRes Htrs	% NRes	Total Htrs	Act Lic	Ylg Male	Adult Male	Total Male	% Male	Fem	% Fem	Juv	% Juv	Tot Harv	Hntrs	Act Lic	Hntr Days	Days to Harv
1995	2,479	570	19%	3,049	3,049	123	323	446	48%	393	42%	94	10%	933	31%	31%	15,601	16.7
1996	2,254	460	17%	2,714	2,714	69	197	266	36%	379	52%	88	12%	733	27%	27%	18,043	24.6
1997	2,403	897	27%	3,300	3,300	113	428	541	57%	367	39%	41	4%	949	29%	29%	20,182	21.3
1998	2,120	911	30%	3,031	3,031	118	322	440	50%	381	43%	67	8%	888	29%	29%	17,509	19.7
1999	2,731	798	23%	3,529	3,529	110	403	513	53%	373	38%	87	9%	973	28%	28%	22,103	22.7
2000	1,855	743	29%	2,598	2,598	97	333	430	50%	348	40%	86	10%	864	33%	33%	16,348	18.9
2001	2,441	634	21%	3,075	3,075	111	334	445	48%	419	45%	71	8%	935	30%	30%	20,884	22.3
2002	2,261	656	22%	2,917	2,917	85	326	411	48%	368	43%	70	8%	849	29%	29%	17,730	20.9
2003	2,062	666	24%	2,728	2,728	72	325	397	52%	321	42%	46	6%	764	28%	28%	17,257	22.6
2004	1,858	730	28%	2,588	2,588	85	422	507	54%	323	34%	107	11%	937	36%	36%	15,694	16.7
2005	1,706	538	24%	2,244	2,244	80	311	391	57%	253	37%	46	7%	690	31%	31%	14,217	20.6
2006	1,762	527	23%	2,289	2,301	60	314	374	52%	257	36%	85	12%	716	31%	31%	13,505	18.9
2007	1,913	570	23%	2,483	2,535	56	361	417	53%	321	40%	56	7%	794	32%	31%	16,410	20.7
2008	1,746	598	26%	2,344	2,409	74	281	355	53%	241	36%	74	11%	670	29%	28%	15,643	23.3
2009	1,733	625	27%	2,358	2,431	74	370	444	58%	287	37%	37	5%	768	33%	32%	16,340	21.3
2010	1,643	598	27%	2,241	2,311	88	348	436	50%	329	38%	99	11%	864	39%	37%	14,449	16.7

Appendix D (cont.)

1995 - 2019 Harvest Summary

for Elk Herd EL105 - AFTON

Year	HUNTERS					HARVEST									SUCCESS			
	Res Htrs	NRes Htrs	% NRes	Total Htrs	Act Lic	Ylg Male	Adult Male	Total Male	% Male	Fem	% Fem	Juv	% Juv	Tot Harv	Hntrs	Act Lic	Hntr Days	Days To Harv
2011	1,631	634	28%	2,265	2,343	50	299	349	57%	216	35%	47	8%	612	27%	26%	16,064	26.2
2012	1,644	634	28%	2,278	2,363	54	350	404	57%	244	34%	65	9%	713	31%	30%	15,197	21.3
2013	1,766	679	28%	2,445	2,540	67	342	409	50%	299	37%	105	13%	813	33%	32%	15,975	19.6
2014	1,755	605	26%	2,360	2,449	57	384	441	58%	245	32%	71	9%	757	32%	31%	19,082	25.2
2015	1,869	668	26%	2,537	2,626	62	419	481	56%	306	36%	74	9%	861	34%	33%	16,469	19.1
2016	2,083	847	29%	2,930	3,007	100	521	621	59%	361	35%	62	6%	1,044	36%	35%	17,749	17
2017	1,877	807	30%	2,684	2,796	33	367	400	56%	278	39%	41	6%	719	27%	26%	18,187	25.3
2018	1,782	684	28%	2,466	2,587	56	403	459	52%	347	39%	78	9%	884	36%	34%	16,273	18.4
2019	1,705	713	29%	2,418	2,508	53	502	555	65%	240	28%	57	7%	852	35%	34%	15,282	17.9

2019 - JCR Evaluation Form

SPECIES: Moose

PERIOD: 6/1/2019 - 5/31/2020

HERD: MO101 - TARGHEE

HUNT AREAS: 16, 37

PREPARED BY: ALYSON COURTEMANCH

	2014 - 2018 Average	2019	2020 Proposed
Population:		N/A	N/A
Harvest:	4	5	5
Hunters:	5	5	5
Hunter Success:	80%	100%	100 %
Active Licenses:	5	5	5
Active License Success:	80%	100%	100 %
Recreation Days:	36	46	45
Days Per Animal:	9	9.2	9

Limited Opportunity Objective:

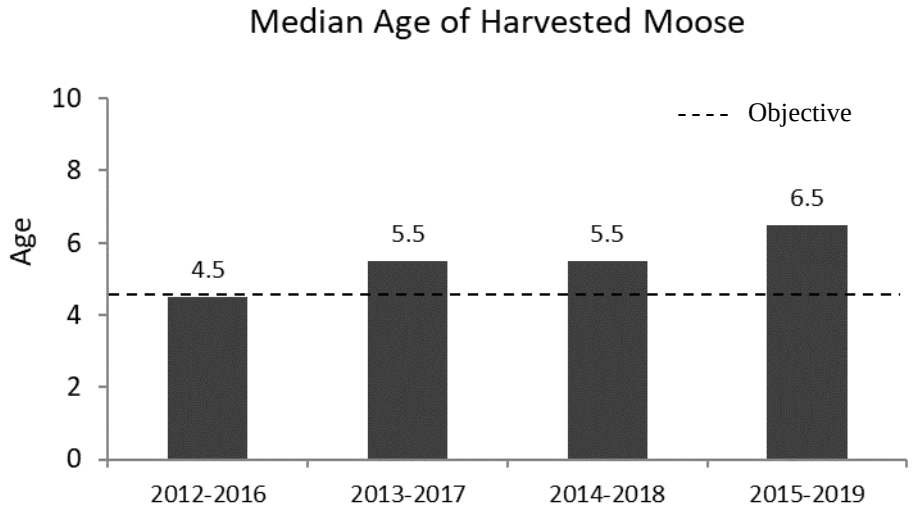
5-year median age of > 4.5 years for harvested moose

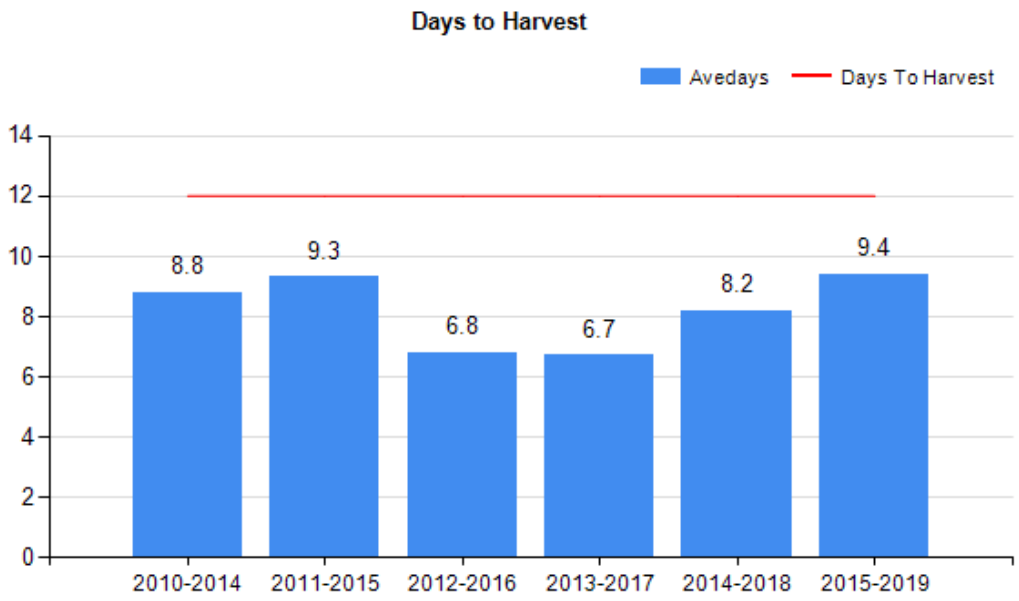
5-year average of <= 12 days/animal to harvest

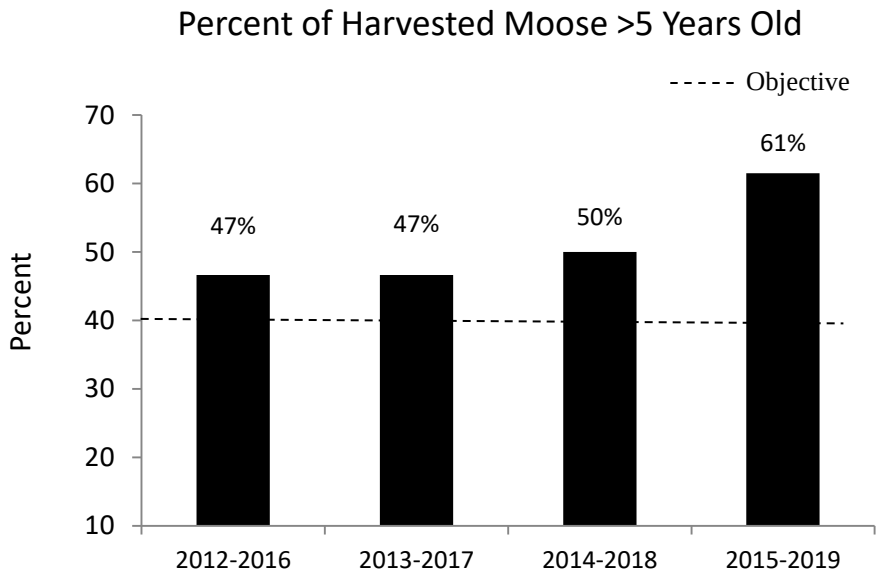
Secondary Objective:

5-year average of 40% of harvested moose are > 5 years of age

Management Strategy: Special




Days to Harvest
Avedays
Days To Harvest
14
12
10
8
6
4
2
0
8.8
9.3
6.8
6.7
8.2
9.4
2010-2014
2011-2015
2012-2016
2013-2017
2014-2018
2015-2019


Percent of Harvested Moose >5 Years Old
Objective
Percent
70
60
50
40
30
20
10
47%
47%
50%
61%
2012-2016
2013-2017
2014-2018
2015-2019

2020 HUNTING SEASONS
TARGHEE MOOSE HERD (MO101)

Hunt Area	Hunt Type	Archery Dates		Season Dates		Quota	Limitations
		Opens	Closes	Opens	Closes		
16, 37	1	Sep. 1	Sep. 14	Sep. 15	Nov. 15	5	Antlered moose

2020 Management Summary

1.) **Hunting Season Evaluation:** This herd is meeting its limited opportunity objectives, which are based on harvest data. In 2019, one of 5 hunters submitted teeth for aging (7 years old). In 2019, moose hunters continued to have good success in this herd unit (100%) and days to harvest remained relatively low (average = 9). This herd was not surveyed from the air due to its interstate nature (many moose migrate to Idaho for the winter) and winter ranges in Wyoming have poor aerial moose sightability due to tree cover. The 2020 hunting seasons were unchanged from 2019.

2019 - JCR Evaluation Form

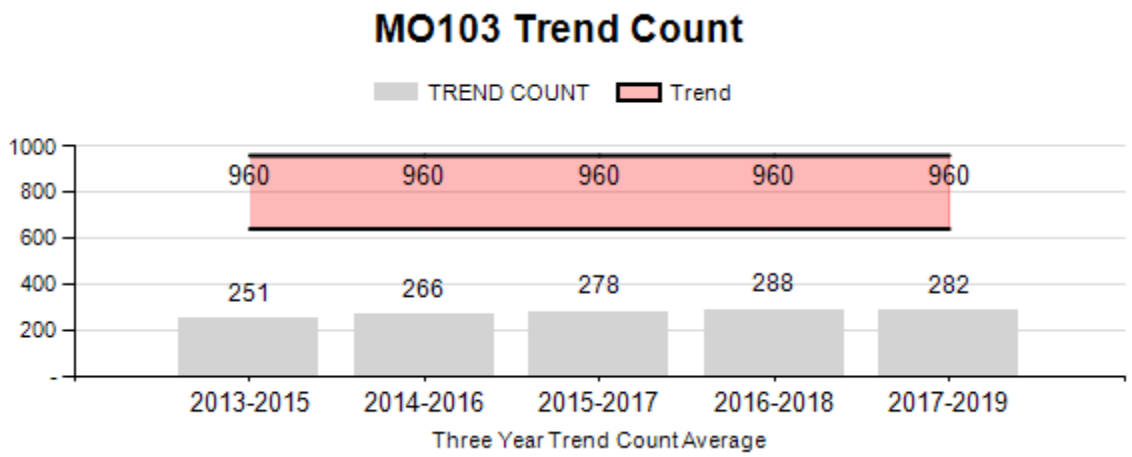
SPECIES: Moose
PERIOD: 6/1/2019 - 5/31/2020

HERD: MO103 - JACKSON

HUNT AREAS: 7, 14-15, 17-19, 28, 32
PREPARED BY: ALYSON COURTEMANCH

	2014 - 2018 Average	2019	2020 Proposed
Trend Count:	267	313	350
Harvest:	10	8	10
Hunters:	10	9	10
Hunter Success:	100%	89%	100 %
Active Licenses:	10	9	10
Active License Success	100%	89%	100 %
Recreation Days:	81	87	80
Days Per Animal:	8.1	10.9	8
Males per 100 Females:	84	71	
Juveniles per 100 Females	43	50	

Trend Based Objective (± 20%)	800 (640 - 960)
Management Strategy:	Special
Percent population is above (+) or (-) objective:	-60.9%
Number of years population has been + or - objective in recent trend:	20



2020 HUNTING SEASONS
JACKSON MOOSE HERD (MO103)

Hunt Area	Hunt Type	Archery Dates		Season Dates		Quota	Limitations
		Opens	Closes	Opens	Closes		
7, 14, 15, 19, 32							CLOSED
17, 28	1	Sep. 1	Sep. 14	Sep. 15	Oct. 31	5	Antlered moose
18	1	Sep. 1	Sep. 30	Oct. 1	Oct. 31	5	Antlered moose

2020 Management Summary

1.) **Hunting Season Evaluation:** The 2020 seasons remained the same as previous years. Even though the herd continues to be below objective with 313 moose counted in February 2020, limited antlered moose hunting in some areas is still sustainable. Harvest success was 89% in 2019 with average days to harvest at 10.9. Bull ratios were relatively high again during the 2019 post-season classification at 70 bulls per 100 cows. The calf ratio was 50 calves per 100 cows. Hunt areas 7, 14, 15, 19, and 32 remained closed in 2020. We received clear feedback from the hunting public that they do not support opening these areas at this time.

2.) **Management Objective Review:** In 2020, managers reviewed the past five years of population, harvest, habitat, and disease data to determine whether the current population objective of a mid-winter trend count of 800 moose for the Jackson Moose Herd is still appropriate. The population has been about 60% below this objective for the past 5 years and overall numbers from the mid-winter trend counts have been relatively flat (min of 231 and max of 346). The last time the mid-winter trend count was over 800 moose was in 2000. Managers recognized that a population objective of 800 moose is likely not attainable in the near future, but felt this is a number to strive for. It is clear that the public also desires to have more moose in the herd than current numbers.

3.) **Herd Unit Evaluation:** Even though overall numbers remain low, the population is not declining further and calf:cow ratios have been higher in recent years. In 2009, the calf:cow ratio was 15 calves per 100 cows. Since then, it has been increasing and the average ratio during the past 5 years has been 46 calves per 100 cows. Bull ratios in the herd have remained relatively high at an average of 80 bulls per 100 cows during the past 5 years.

4.) Managers initiated a moose GPS-collaring project in collaboration with Wyoming Department of Transportation (WYDOT) in the southern end of the herd unit and northern end of the Sublette Moose Herd Unit in winter 2019 to evaluate moose movements around roadways in relation to moose-vehicle collisions. The areas surrounding the Snake River Bridge on Highway 22 have the highest rate of moose-vehicle collisions in Teton County. For that reason, wildlife underpasses have been incorporated into the planning design for a bridge replacement project planned for 2021. In 2019, WYDOT provided funding to WGFD to collar 10 moose within a 1 mile radius of the Snake River Bridge to gather data on the seasonality, frequency, locations, and time of day when moose cross roads in the area. This is the first time that moose have been collared in this area near the towns of Jackson and Wilson. In March 2019, WGFD biologists

darted 10 cow moose from the ground and deployed satellite GPS collars on them. The collars were programmed to collect a GPS location of the moose every 30 minutes for 2.5 years, at which point they will automatically drop off of the moose. Since March 2019, additional funding support has been secured from Teton Conservation District, Greater Yellowstone Coalition, U.S. Geological Survey at Montana State University, Veterinary Initiative for Endangered Wildlife, and Teton County Commission to collar additional moose. An additional 6 collars were deployed on cow moose in March 2020. This project will aid managers in assessing moose habitat use, movements, road crossings, reproduction, survival, and disease in the southern end of the Jackson Herd Unit.

2019 - JCR Evaluation Form

SPECIES: Bighorn Sheep

PERIOD: 6/1/2019 - 5/31/2020

HERD: BS106 - TARGHEE

HUNT AREAS: 6

PREPARED BY: ALYSON COURTEMANCH

	2014 - 2018 Average	2019	2020 Proposed
Population:		N/A	N/A
Harvest:	1	1	1
Hunters:	1	1	1
Hunter Success:	100%	100%	100 %
Active Licenses:	1	1	1
Active License Success:	100%	100%	100 %
Recreation Days:	29	17	15
Days Per Animal:	29	17	15

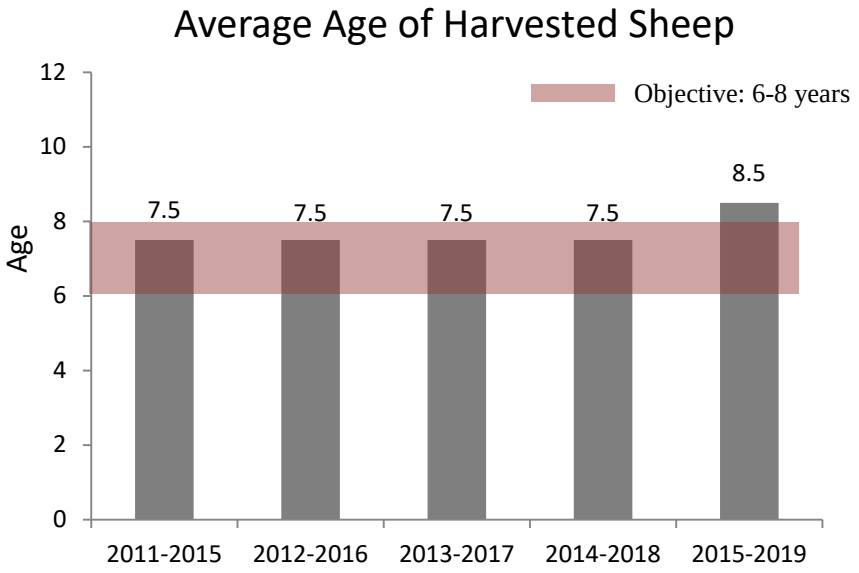
Limited Opportunity Objective:

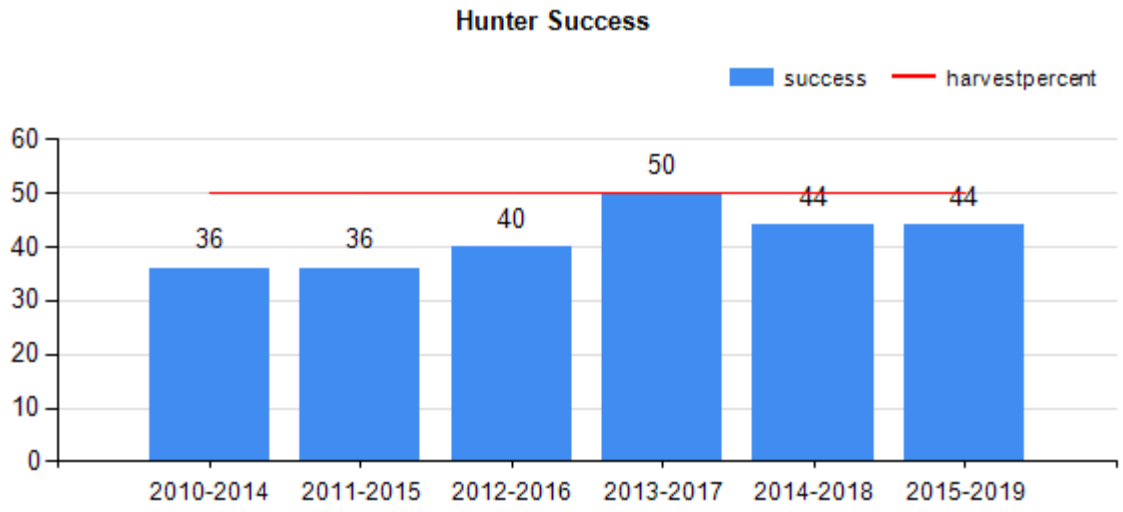
5-year average harvest age of 6-8 years

5-year average hunter success of >= 50%

Secondary Objective:

Management Strategy: Special





2020 HUNTING SEASONS
TARGHEE SHEEP HERD (BS106)

Hunt Area	Hunt Type	Archery Dates		Season Dates		Quota	Limitations
		Opens	Closes	Opens	Closes		
6	1	Aug. 1	Aug. 14	Aug 15.	Oct. 31	1	Any ram (1 resident)

2020 Management Summary

1.) **Hunting Season Evaluation:** The 2020 hunting season remained the same as 2019. The herd is currently exceeding its age of harvested sheep objective with a 5-year average of 8.5 years old. However, the herd is not meeting its objective of a 5-year average of at least 50% hunter success. Managers reduced the license quota from 2 to 1 beginning in 2018 because overall herd numbers and mature ram numbers were low. One hunter harvested a 7-year old ram in 2019. During the 2019 post-season trend count, a total of 100 sheep were classified (60 sheep in the north herd segment and 40 sheep in the south). Only five rams with three-quarter curls were observed in the southern herd segment. During the past 20 years, all bighorn sheep harvest in Hunt Area 6 has occurred in the southern herd segment. This is likely due to relatively easier access and ram availability in the southern portion of the hunt area. Managers will continue to monitor population trends in the herd and evaluate the feasibility of increasing licenses again in the future.

2.) The Teton Range Bighorn Sheep Working Group was very active during the past year. The working group includes representatives from WGFD, Grand Teton National Park, Bridger-Teton National Forest, Caribou-Targhee National Forest, Wyoming Wild Sheep Foundation, and Northern Rockies Conservation Collaborative (retired biologist who studied the herd in the 1970s). The working group convened a panel of 8 bighorn sheep experts from around the West and Alaska in March 2019. The purpose of the panel was to review data and information from

the Targhee Bighorn Sheep Herd and assist the working group in prioritizing research approaches and management actions to conserve this herd. The main recommendations from the panel are included in the "Teton Bighorn Sheep Herd Situation Assessment" (Appendix A). One of the recommendations from the expert panel was to prioritize protecting the herd's remaining high elevation winter habitat and avoid disturbing sheep during the winter. As a result, the working group initiated the Teton Sheep and Recreation Community Collaborative Process in winter 2019/2020 to address the impacts of backcountry skiing on this herd. The working group hired Dr. Jessica Western from the University of Wyoming's Ruckelshaus Institute to facilitate a series of four collaborative learning workshops with the public. The purpose of these workshops was, 1) build community awareness about the Targhee Herd and impacts from winter recreation, and 2) identify community-supported solutions that would balance bighorn sheep habitat needs with recreation access. A total of 158 people attended at least one of the workshops, and many people attended multiple sessions. Attendees were from the backcountry skiing community, commercial guiding companies, ski resorts staff, conservation non-profit organizations, recreation advocacy non-profit organizations, hunting outfitters, Teton County commissioners, and the general public. Final results of this collaborative process will be summarized in fall 2020. Funding was provided by Community Foundation of Jackson Hole, Wyoming Wild Sheep Foundation, U.S. Forest Service, Grand Teton Park Association, and Winter Wildlands Alliance.

3.) The WGFD implemented a new mountain goat hunt area (Hunt Area 4) that overlaps with Bighorn Sheep Hunt Area 6 in fall 2019. The purpose of this new hunt area was to reduce the mountain goat population in this area to alleviate potential impacts to the Targhee Herd (transmission of respiratory disease pathogens and competition for limited winter habitat). A total of 48 Type A licenses were issued for this hunt area in 2019 and 23 hunters successfully harvested a goat, which greatly exceeded the expectations of local managers. Hunters enjoyed this new hunt area and the opportunity to harvest a goat, even though goat densities were low. Type A licenses do not count against a hunter's once-in-a-lifetime mountain goat license. Details about this hunt area for 2020 can be found in the Palisades Mountain Goat Herd Job Completion Report.

Appendix A.

Teton Range Bighorn Sheep Herd Situation Assessment

January 2020

Photo: A. Courtemanch

Compiled by:
Teton Range Bighorn Sheep Working Group

Table of Contents

EXECUTIVE SUMMARY

Introduction and Overview

The Teton Range Bighorn Sheep Working Group (hereafter Working Group), comprised of wildlife biologists from the land and wildlife management agencies (Bridger-Teton National Forest, Caribou-Targhee National Forest, Grand Teton National Park, and Wyoming Game and Fish Department) responsible for the management of the bighorn sheep population and their habitat and several other non-agency biologists with a long history of working with the Teton Range bighorn bheep population has been working together for close to 30 years to conserve the Teton Range bighorn sheep population. Over the last several years the Working Group has become increasingly concerned about the status of the Teton Range bighorn sheep population and its long-term prospects for persistence. The Working Group considers the population to be at a breaking point where the management agencies must take conservation actions soon or risk losing the population. To this end, the Working Group recently undertook two initiatives aimed at obtaining technical input on current research and management and assessing the perspective of the local winter backcountry community with respect to bighorn sheep and winter backcountry recreation. These efforts included: 1) convening an expert panel to review and provide feedback on current management, research, and issues facing the bighorn sheep population, and 2) and an outreach effort to build awareness of and support for the Teton Range bighorn sheep population and obtain feedback from the public.

This document summarizes the bighorn sheep data and information compiled for the expert panel review, the discussion between the expert panel members and the bighorn sheep managers, the recommendations made by the panel, and the key messages that emerged from conversations with community members.

Assessment Process

In March of 2019, the Working Group convened a panel of scientists with expertise in various aspects of bighorn sheep ecology, disease, demography, genetics, habitat/nutrition, or management. In preparation for the panel discussion, the Working Group compiled a document that summarized the current state of knowledge for the Teton Range bighorn sheep population and provided the document to the expert panel for review prior to their arrival. The panel of technical experts met with the management agencies for a full day and in the evening participated in a public meeting sharing information from the daytime session.

In a separate effort, members of the Working Group met with community members one-on-one or in small groups for "coffee-cup" conversations over the past two years. These conversations were designed to:

- inform participants about the status of the Teton Range bighorn sheep population and the concerns about impacts to sheep from backcountry winter recreation to build community awareness; and
- learn the perspectives of community members and assess general willingness to participate in a broader community engagement process around this issue.

The goal of these conversations was to share information about the status of the Teton Range bighorn sheep population and to listen to the perspectives, opinions, and concerns of the public about the issue and ideas about possible solutions.

Key Findings: Research Summary and Expert Panel
The information provided to the expert panel for review is summarized later in this document. The panel, consisting, of nationally recognized experts in ecology, demographics, genetics, habitat, nutrition, and management of bighorn sheep and epidemiology of wildlife diseases and etiology of pneumonia in bighorn sheep, offered a number of recommendations related to the specific issues facing the Teton Range bighorn sheep population. Below is a condensed summary of the action items the expert panel suggested that the agencies consider based on their review of population data/information and discussion with the managers:

General

- Focus on preserving the existing bighorn sheep population and occupied habitat and actively manage the threats. Identify items the Working Group can address positively in the near term.

Habitat and Nutrition

- Enhance population and health monitoring. Specifically, assess nutritional status of the population (consider early winter captures to assess body condition or a study to assess forage quality).
- Work with fire management personnel to identify wildland and prescribed fire opportunities to restore important bighorn sheep habitats.
- Actively manage (remove) mountain goats to minimize impacts to bighorn sheep.
- Consider the cumulative effects of climate change on winter mortality and quality of summer habitats.

Limited Winter Range

- Coordinate with appropriate resource specialists to restore fire to the landscape.
- Reduce human disturbance on crucial bighorn sheep winter ranges.

Domestic Sheep Grazing

- Conduct a disease risk assessment (specific to hobby sheep/goat flocks).

Disease

- Prevent transmission of respiratory pathogens from mountain goats and neighboring bighorn sheep herds.
- Address the risk of pathogen transmission from pack goats.
- Actively manage (remove) mountain goats to minimize impacts to bighorn sheep.
- Continue disease surveillance efforts.
- Consider collaring young bighorn sheep rams to understand movements and potential for exposure to pneumonia pathogens.

Hunting

- Consider closing the bighorn sheep hunt in the Teton Range. Identify trigger points for when hunt should occur.

Demographics

- Enhance population monitoring. Several specific suggestions for tools or techniques were offered, including population estimation using mark-resight or genetic capture-recapture, intensive lamb surveys to monitor survival and recruitment, and recount from photos during aerial surveys.

Genetics

- Reassess the genetic status of the Teton Range bighorn sheep population.

- Identify trigger points for when intensive management actions [e.g. moving pregnant females or young males, augmentation with other sheep (not currently recommended)], would be necessary to address genetic concerns.

Predation/Mortality

- Continue to monitor mortality causes.

Key Findings: Community Outreach Efforts

Over the last 2 years, members of the Working Group met one-on-one or in small groups with community members interested in the issue surrounding Teton Range bighorn sheep and backcountry winter recreation. Below are some key themes and thoughts that emerged from those discussions.

- There is a lot of community interest in this topic/issue.
- Backcountry winter recreation, especially skiing, is very important to the local community and has a long and rich history here.
- Most people were supportive of working with the agencies to identify possible solutions to this issue.
- Many people were not aware of the issue or thought that the community as a whole may not be aware that the bighorn sheep population is struggling.
- There is concern about losing access and freedom and winter backcountry users feel they are singled out.
- Some thought that wildlife managers are moving too slow.
- Community members had ideas for solutions that they wanted to share.
- Community members expressed concern for the bighorn sheep population and wanted to be part of the process to address the issue.

Action Items

Based on the feedback from the expert panel and our community conversations, the Working Group identified several actions to advance conservation of the Teton Range bighorn sheep population:

1. Expert Panel - Expert Panel - In the short term, move forward with high priority expert panel identified actions, strategies, or recommendations including mountain goat removal, engaging the public to address human disturbance on bighorn sheep winter ranges, and enhancing the quality of demographic data collection. In the longer-term, update the Teton Range Bighorn Sheep Working Group strategic plan to incorporate new data and information and the expert panel recommendations. In the longer-term, update the Teton Range Bighorn Sheep Working Group strategic plan to incorporate new data and information and the expert panel recommendations.

2. Community Conversation - Engage the public in a collaborative learning process specially focused on the issue of backcountry winter recreation and Teton Range bighorn sheep. This process is not intended to be a decision making (or NEPA) process but rather a series of public workshops where the public and agency managers learn from each other about the issue and collaboratively develop possible solutions to reduce impacts on bighorn sheep

from backcountry winter recreation. Key elements of the process include the following: open to all, shared learning, transparent, and collaborative development of community-supported possible solutions that meet agency policies.

INTRODUCTION AND BACKGROUND

Purpose of this Assessment

This Situation Assessment is intended to summarize the results of two initiatives undertaken by the Teton Range Bighorn Sheep Working Group to obtain technical input from a committee of scientists with expertise in bighorn sheep management and research and an effort to better understand perceptions of local residents regarding the bighorn sheep population and the issue around backcountry winter recreation.

Background

Bighorn sheep have occupied the Teton Mountain Range for thousands of years, but today this native population is small and at risk of local extinction. The Teton Range bighorn sheep population ranges within Grand Teton National Park (GRTE) on the east slope and the Caribou-Targhee (CTNF) and Bridger-Teton National Forests (BTNF) on the west slope. Management of the herd and its habitat is coordinated between the National Park Service, Wyoming Game and Fish Department (WGFD), and the US Forest Service. The sheep are considered a core native herd by the State of Wyoming, which means they have never been extirpated or augmented with transplanted sheep. WGFD also considers bighorn sheep as a Species of Greatest Conservation Need. Bighorn sheep are designated a sensitive species on the BTNF and the Targhee portion of the CTNF. Sensitive species are those for which population viability is a concern. These species are given special management emphasis.

With concern for the sustainability of the Teton Range's bighorn sheep population, the Teton Range Bighorn Sheep Working Group was formed in the early-1990s and includes biologists from GRTE, WGFD, BTNF, CTNF as well as several local sheep experts. In 1996, the Working Group finalized a strategic plan to address threats to population survival. Since then, significant research and field work led by the GRTE and WGFD has addressed many of the identified threats, but much more work remains to be done to ensure the persistence of this iconic bighorn sheep population.

ASSESSMENT APPROACH

PART 1: Research Summary and Expert Panel

In March 2019, the Working Group convened a panel of scientists from around the western United States with expertise in the ecology, demographics, genetics, habitat, nutrition, and management of bighorn sheep and epidemiology of wildlife diseases and etiology of pneumonia in bighorn sheep. The Working Group provided the expert panel with a Teton Range Bighorn Sheep Research Summary as background and asked them to do the following:

- Review existing research, state of knowledge, current management strategies and conservation initiatives of the herd;
- Identify critical data gaps in need of attention/improvement;
- Recommend and prioritize management/conservation actions, research and other strategies to improve population resilience; and
- Share expertise and thoughts with the public through a panel discussion.

The expert panel members included:

Dr. Tom Besser – Professor, Department of Veterinary Microbiology and Pathology, Washington State University
Dr. Clinton Epps – Associate Professor in Mammalian Ecology and Population Genetics, Oregon State University
Dr. Bob Garrott – Professor, Department of Ecology, Montana State University
Dr. Tom Lohuis – Regional Research Coordinator, Alaska Department of Fish and Game
Hollie Miyasaki – Staff Biologist, Idaho Department of Fish and Game
Dr. Tom Stephenson – Sierra Nevada Bighorn Sheep Recovery Coordinator, California Department of Fish and Wildlife
Dr. Peri Wolff – Wildlife Veterinarian, Nevada Department of Wildlife

In preparation for the expert panel, the Working Group summarized the state of knowledge and current situation for the Teton Range bighorn sheep population and provided this background document and relevant papers and reports to the panel for review prior to meeting. The Working Group met with the expert panel for a full day and discussed a range of topics. In the evening, the expert panel attended a public meeting and discussed the results of the daylong session with the managers and the recommended action items for the bighorn sheep population. The background material for each major topic followed by a summary of the expert panel discussion and recommendations is below.

Key Findings: Research Summary and Expert Panel

Herd History and Distribution

Background - Through extensive review of archaeological, historical, and agency records and many interviews with long-time residents of nearby valleys, Whitfield (1983) developed a historical perspective of bighorn sheep in the Teton Range. Bighorn sheep and aboriginal humans interacted in the Tetons for over 6,000 years. Early Euro-American visitors to the region found bighorn sheep to be numerous and widely distributed in areas in and around the Tetons. Given abundant high quality summer range in the Tetons and access to lower elevation winter ranges, the Teton Range bighorn sheep population was likely much larger than it is today. Human activities post settlement in nearby mountain valleys greatly reduced bighorn sheep numbers, altered distributions and reduced habitat quality. Migration routes to lower elevation winter ranges, some of which were likely at some distance from the Tetons, were lost. Extirpation of bighorn sheep populations from the adjoining Snake River and Big Hole ranges and a break in connections to the Gros Ventre population led to genetic isolation of Teton sheep by the mid-1900s. Major stressors to the Teton bighorn sheep were domestic livestock grazing and associated diseases, excessive hunting, loss of seasonal migrations and winter ranges, loss of genetic connectivity with other bighorn sheep populations, and curtailment of natural wildfire.

Whitfield (1983) documented the current distribution of bighorn sheep in the Tetons through direct field observation and annotation of agency observation records. Cain and Reid (1997), and Courtemanch (2014) substantiated and refined these seasonal distributions through radio telemetry and GPS-collar data. Further, Courtemanch (2014) confirmed bighorn sheep were using areas in the southern end of the Tetons that were not known to be occupied in recent times. Today's Teton Range bighorn sheep are grouped into two subpopulations in the northern

Tetons and southern Tetons, with few sheep seen in the central Tetons. Teton bighorn sheep are generally found at or near tree-line in all seasons but spring when most sheep descend to low elevations to follow green-up and fall when sheep descend to mid-elevations during the rut. Most winter ranges are found on isolated patches of windswept alpine tundra or snow free krummholz ridges at high elevation. Teton Range bighorn sheep primarily winter at high elevations where conditions are harsh and food is scarce. Avalanches have been found to be an important mortality source for Teton Range bighorn sheep (Cain and Reid 1997, Courtemanch 2014).

Expert Discussion - The Teton Range sheep population has not changed dramatically since the 1970s-1980s, although there appears to have been a decline in numbers in the past few years. Over that time winter closures on some of the most significant winter ranges, elimination of domestic sheep grazing throughout the Tetons, and small scale prescribed burns may have contributed to sustaining the population, but it does appear to be on the edge. The Teton herd is a native population that has adapted to wintering at high elevation and is regarded as of high value as an iconic symbol of a resilient, genetically unique population. The relevant agencies are committed to sustaining this sensitive and vulnerable population. Although there is some interest in re-establishment of some of the pre-settlement migration routes used by Teton Range bighorn sheep, there are currently substantial risks associated with such movements, most notably exposure to disease and conflict with human activity and other wildlife populations.

Recommendations:

- Focus first on preserving the population and occupied habitat and actively manage the threats.
- Identify items the Working Group can address positively in the near term.

Habitat and Nutrition

Background - The Teton Range bighorn sheep appear to have ample high quality summer forage. Bighorn sheep summer ranges in the Tetons are characterized by notably abundant and diverse forb species (Whitfield 1983) which provide bighorn sheep with high quality forage (Courtemanch 2014). By contrast, winter ranges are severely limited.

Expert Discussion - The experts suggested there needs to be better population health and habitat monitoring in all seasons.

Recommendations:

- Enhance population and health monitoring
  - Consider assessing body condition using remote cameras or other methods in conjunction with continued captures;
  - Consider placing remote cameras on winter range to monitor sheep and public interaction/effectiveness of outreach;
  - The condition of bighorn sheep going into winter is not well understood. Fall captures of a small number of bighorn sheep to assess body condition could provide the best measure of summer nutrition and an index of summer range condition.

- Place greater emphasis on monitoring lamb survival and recruitment, particularly during bottleneck periods (e.g. winter starvation). Concentrated lamb surveys in the spring and fall could address this.
- Assess the impact of research captures on bighorn sheep.

- Cooperate and coordinate with federal fire personnel and land managers to identify and implement management action (e.g. prescribed fire, wildland fire use) to enhance bighorn sheep ranges and migration habitats, where possible and appropriate.
- Consider a summertime nutritional study to understand how quality of summer range affects the sheep herd or alternately conduct captures earlier (i.e. October) to assess nutritional condition and track summer range quality. Quality of summer range is particularly important for sheep that winter in high elevations and depend upon stored body fat.

Limited Winter Range - Access to Lower Elevation Winter Ranges

Background - Winter habitat is a limiting factor for this population. Human development and disturbances/pressures in the valleys flanking the Tetons isolated the herd from traditional low-elevation winter range and from neighboring sheep herds (Whitfield 1983). Long-term fire suppression has also affected habitat quality and blocked access to some low elevation winter ranges. After migration to low elevation winter ranges ceased in the early to mid-1900s, most sheep within the herd spend the winter at high elevation (9,000-11,000 feet) on windswept ridgelines and slopes in the Teton Range. Occupied winter habitat occurs in relatively small, disconnected patches and it is difficult for sheep to move between patches due to canyons and deep snow (Cain and Reid 1997, Courtemanch 2014).

In general, we suspect that these sheep have access to relatively low quality winter habitat that results in inadequate winter nutrition, which could limit reproduction or survival. Although we have not measured it directly, we believe that high quality summer forage and ample habitat allows sheep to successfully gain enough body fat to support lambs and go into the winter with enough fat reserves to survive in very limited winter habitat.

Expert Discussion - The experts discussed the potential of reestablishing bighorn sheep use of the historic low elevation winter ranges that are still deemed suitable habitat. Two scenarios were discussed, 1) prescribed burning to open up historical winter ranges or 2) try to reestablish longer range migrations into Jackson Hole and Idaho. Prescribed burns have been attempted without great success on the west slope, CTNF. Reestablishment of migration patterns would likely require larger catastrophic fires originating at lower elevation and moving into summer habitats. Longer migrations into Idaho are problematic due to disease risks and competition with other wildlife populations.

It appears that Teton Range bighorn sheep are enduring the winter by limiting their movements on high elevation winter ranges. As such, these sheep should not be disturbed in these habitats.

Recommendations

- Work with appropriate specialists (e.g. social scientist, fire ecologist, silviculturalist, recreation staff, etc.) to identify areas and develop a mechanism to allow for natural fire

ignitions in bighorn sheep habitat. Consider the use of prescribed fire to improve winter range conditions, where appropriate.
- Reduce human disturbance on crucial bighorn sheep winter ranges.

Domestic Sheep Grazing

Background - Whitfield (1983) reviewed numerous historical records to document domestic sheep grazing in the Tetons. During the late 1800's and early 1900's, large numbers of domestic sheep grazed throughout the entire Teton Range. Prior to establishment of Forest Reserves and subsequent National Forests to only later be followed by the funds needed to administer them, domestic sheep herds from as far away as Utah were trailed to the Tetons in an unregulated summer long race to exploit forage resources. Even after grazing control began to be administered around 1910, Forest Service allotment records indicate that over 25,000 permitted sheep still grazed the west slope of the Tetons between Coal Creek and Bitch Creek throughout the summer. Domestic herds often grazed in Teton Range bighorn sheep habitat. Significant damage to vegetation and subsequent soil erosion, direct disturbance to wild sheep from herders and dogs, and introduction of diseases likely led to severe declines in the bighorn sheep population. Gradually domestic herd reductions and administrative closures of bighorn sheep habitats reduced these impacts. The revision of the CTNF Forest Plan (1997) set goals to maintain and enhance the integrity of wild sheep habitats. Efforts to separate domestic sheep from bighorn sheep culminated in the voluntary buyout of grazing rights of the remaining domestic sheep grazing allotments on the west slope by the Wyoming Wild Sheep Foundation (WY-WSF, previously WY FNAWS) and the National Wildlife Federation (NWF) from 2001-2003. CTNF subsequently closed domestic sheep allotments, and the remaining domestic grazing in the CTNF is by cattle.

Expert Discussion - Domestic sheep in the general region remain as a potential source of disease transmission to bighorn sheep. The visiting experts asked if private land farms with domestic sheep and goats in the area had been fully assessed, and what the potential impact of these operations might be to Teton Range bighorn sheep. It was noted that there are a few small domestic sheep operations on private lands adjacent to the west slope of the Tetons, and that there is still domestic sheep grazing on Forest Service allotments in the Snake River Range where the likely source mountain goat population is found (GRTE unpublished data). Bighorn sheep are occasionally seen in the Snake River Range as well. Domestic sheep also still graze under permit in the Big Hole Mountains.

Recommendations.
- Conduct a disease risk assessment for areas around the Tetons with specific focus on domestic herds (e.g. hobby flocks) on private lands bordering the Tetons and those grazing in adjacent mountain ranges.

Disease

Background - There have been no confirmed disease die-offs in the Teton Range bighorn sheep population, although precipitous declines of Teton Range bighorn population by the early 1900s suggest die-offs may have occurred. Whitfield (1983) recorded an old-timer's observation of the remains of many bighorn sheep south of Rendezvous Mountain in the 1940s. Pneumonia is the

disease of most concern for bighorn sheep and the primary pathogens associated with it include several species of bacteria in the *Pasteurella* family and *Mycoplasma ovipneumoniae*. In recent study (Butler et al. 2018, GRTE unpublished data), a total of 20 animals were tested for *Mycoplasma ovipneumoniae* and *Pasteurellas* (nasal and tonsil swabs collected) using the Wyoming Game and Fish Wildlife Health Lab (6 animals January 2017, 12 animals December 2017, 2 animals December 2018). Samples were tested using a combination of culture and PCR. Leukotoxigenic bacteria in the *Mannheimia* genus (unidentified species that are not *M. haemolytica or M. glucosida*) were detected in 11 of the 20 animals and *Pasteurella multocida* was detected in one (1) of the 20 animals. *Mycoplasma ovipneumoniae, Mannheimia haemolytica, Mannheimia glucosida, and leukotoxigenic Bibersteinia trehalosi* were not detected. However, *Mannheimia haemolytica* was detected in Teton Range bighorn sheep in 2008 (Courtemanch 2014)

Mountain goats in the Teton Range are known to carry several *Pasteurella* species associated with polymicrobial pneumonia die-offs although the 14 sampled animals tested negative for *Mycoplasma ovipneumoniae* (a key component of polymicrobial pneumonia). The likely source population of mountain goats in the Teton Range, the Palisades/Snake River Range population, carry *Mycoplasma ovipneumoniae* and the *Pasteurella* species associated with pneumonia (Lowrey et al. 2018). Given the small number of mountain goats sampled in the Tetons and the pathogens carried by their likely source population, those pathogens that have yet to be detected in the Tetons may very well be present. Recent studies have documented the two-way transmission of pneumonia pathogens, with corresponding disease die-offs, between overlapping bighorn sheep and mountain goat populations (Wolff et al 2019).

Expert Discussion – The best available information does not indicate that the Teton Range bighorn sheep are currently facing notable disease issues. Nevertheless, a threat of pathogen transmission from neighboring bighorn sheep or mountain goat populations exists. Domestic sheep generally represent a reservoir of very high disease threat to bighorn sheep.

Recommendations:

- Prevent respiratory disease transmission to Teton Range bighorn sheep, with particular reference to keeping bighorn sheep for the Jackson herd and Snake River Range mountain goats from coming to the Tetons.
- Remove mountain goats from the Teton Range.
- Develop mechanisms to remove newly arrived mountain goats in the Tetons quickly.
- Conduct a disease risk assessment for areas around the Tetons with specific focus on domestic herds (e.g. hobby flocks) on private lands bordering the Tetons and those grazing in adjacent mountain ranges.
- Collar Jackson herd bighorn rams to identify risk of movements into the Tetons.
- Address the issue of pack goats on the National Forest in the Tetons.
- Continue to surveil disease occurrence in Teton Range bighorn sheep and mountain goats.

Hunting

Background - Excessive, unregulated hunting of bighorn sheep for meat and horns was a major factor in the decline of wild sheep in many of their former ranges. M. Whitfield (1983) recorded many records of legal and illegal hunting of bighorn sheep in the Tetons beginning pre-

settlement. Poaching of wild sheep in the Tetons remained a concern into much more recent times (Murie 1956). Although early hunting may not have had a large overall impact on the pre-settlement Teton Range bighorn sheep population, a more significant effect of over hunting may have been elimination of bighorn sheep that used lower elevation winter ranges and longer seasonal migrations. Currently WGFD administers a Teton Range hunt outside of GRTE with an allowance of 1 license for any age ram each year.

Expert Discussion - The experts asked if it is sustainable to remove 1 ram every 1-2 years, and how selective hunters have been in hunting for larger rams. WGFD responded that the hunters have been selective but have not always harvested rams of greater than ¾ curl. It was noted that given the demographics, the southern Teton's population is of greater concern. In the past 15 years, 15 rams have been taken, all from the southern subsegment. Recent flights have not detected many rams in the southern Tetons. With recognition that managers always have to assess the value of bighorn hunting in this area, it might be of value to direct the hunt to the northern Tetons population.

Recommendations:

- Consider eliminating of the Teton Range bighorn sheep hunting season with particular concern for the southern subpopulation. Identify trigger points for when a hunt should occur.
- When hunting occurs, balance harvest between the north and south segments.

Demographics--Small population size

Background - Over the past forty years until recently, the total Teton Range bighorn sheep population size was estimated to be around 125 with a static or declining population trend (Whitfield 1983). The minimum number of individuals identified through recent genetic sampling was 97; 40 unique individuals in the south and 57 in the north (GRTE unpublished data).

Expert Discussion - The general concern is that the Teton bighorn sheep population could persist for some time at these low numbers, but given its isolation from other populations, if a number of stressors happened all at once the population could die out quickly without any chance of rescue. As such, it is important to obtain and maintain accurate population estimates. The experts discussed the efficacy of photographic mark recapture (resight) techniques, particularly with remote cameras at mineral licks. GRTE has been exploring this approach and believes that it could be successful with a greater proportion of marked animals.

Recommendations:

- Obtain a more rigorous estimate of population size and demographic parameters. Mark-resight and/or genetic capture-recapture techniques may prove to be helpful. Consider new genetics methodologies (see below).
- Consider taking photographs during aerial surveys to aid in follow-up herd classification.
- Consider focused lamb surveys in the spring (winter survival) and fall. Improved monitoring of lamb survival and recruitment is important.
- Consider using remote cameras at mineral licks or along movement corridors to monitor lamb ratios/numbers;

- Consider developing a citizen science project to assist with bighorn sheep monitoring;

Genetics

Background - Research on the herd's genetic status indicates low genetic diversity, geographic isolation from neighboring herds, and genetic differentiation between the northern and southern segments of the Teton Range bighorn sheep population. An early study using gel electrophoresis methodology noted that the Teton Range bighorn sheep population was characterized by a relatively high inbreeding coefficient (F = 0.014) and low heterozygosity (Fitzimmons et al 1995). A follow-up 1997 pilot study provided genetic evidence (i.e. very low variability in mitochondrial DNA haplotypes) which supported biologists' suspicions that the Teton Range bighorn sheep population is isolated from other populations (Ramey 2006). A more recent study found that, genetic variation was lower in the northern and southern Teton sub-populations than in the Jackson herd. Tests for population bottlenecks suggest the Northern Teton sub-population had recently suffered a reduction in size and/or increased isolation (i.e. reduced gene flow). Results indicate substantial genetic differentiation between bighorn sheep in the Jackson herd and the Teton Range (FST = 0.18) and between the northern and southern sub-populations within the Teton Range (FST = 0.12) (Kardos et al 2010). This study recommended management actions to increase gene flow within the Teton Range population or from outside populations that use high elevation habitats like the Tetons sheep, but with careful consideration of disease risks. The study further recommended that the northern and southern bighorn sheep sub-populations be managed as distinct population units for conservation purposes owing to their genetic isolation from one another.

Expert Discussion - The current lack of connectivity with other bighorn populations' means that it is unlikely that the Teton Range bighorn sheep would be rescued naturally if locally extirpated. Experts asked if there is a source of clean sheep that behave similarly to the Teton Range bighorn sheep in wintering at high elevation. It was noted that the disease risk is too high to move bighorn sheep from the Absaroka area into the Teton area even though those sheep are also wintering at high elevation.

Recommendations:

- Fully assess the current genetic status of the Teton Range bighorn Sheep population.
  - Update herd level information on genetic connectivity and gene flow
  - Reassess measures of genetic drift
  - Obtain information on paternity (numbers of breeders and age structure)
- Consider using fecal DNA monitoring techniques to gain information on gene flow, population size, survival and recruitment, sex ratios etc. GRTE is now investing considerable resources to investigate this low impact means of population monitoring.
- Identify trigger points for when intensive conservation actions (e.g. genetic augmentation through moving pregnant females or young males among sub-populations within the Range or augmentation from outside the Range) are warranted.
- Augmentation of the Teton Range bighorn sheep population with bighorn sheep from other areas is not recommended at this time. Translocating bighorn sheep between the north and south sub-segments is also not recommended at this time.

Mountain Goats

Background - Mountain goats were introduced to the Snake River Range south of the Tetons in the late 1960s and early 1970s (Hayden 1989). This population expanded very rapidly in the 1980s and early 1990s and began to expand its range as habitats in the original areas declined in quality. It is thought that most of the movement into the Tetons occurred in this period. Observations of mountain goats in the Tetons were first documented in the late 1970s, but such reports were sporadic and thought to be transient individuals. A breeding population became established in the Tetons around the mid- to late- 2000s (GRTE unpublished data). Survival of radio-collared adults has been nearly 100%. There is currently insufficient data to quantify the Teton Range mountain goat population growth rate although all available information suggests the population is growing rapidly. The goat population is currently estimated at about 100 individuals. A recent modeling effort (DeVoe et al. 2015) predicted the amount of suitable habitat in the Tetons could support 4 times the number of goats currently present. A primary concern is that these non-native goats could transmit pathogens to Teton sheep and compete with and/or displace bighorn sheep on very limited winter ranges or optimal summer habitat. Snake River Range mountain goats, the likely source of Teton mountain goats, tested positive for a suite of pathogens that could lead to pneumonia if transmitted to the Teton Range bighorn sheep population. Genetic and pathogen data suggests that there is not currently much movement of Snake River Range goats into the Tetons (GRTE unpublished data). The chance of an expanding mountain goat population having an impact on bighorn sheep, whether from disease, competition, or displacement, is high. Grand Teton National Park released a management plan for public comment in December 2018. The preferred alternative calls for removing goats from the park using non-lethal (translocation) and lethal means.

To increase hunting harvest of mountain goats in the portion of the Tetons outside the park, the WGFD, established a new hunt area (HA 4). Beginning in 2019, the Department offered a limited quota Type A license (any mountain goat) that is not restricted by the once-in-a-lifetime draw.

Expert Discussion - Bob Garrott's student published a resource selection study of GPS-collared bighorn sheep and mountain goats in the northeast Greater Yellowstone area that demonstrated that there was almost no niche separation between resident bighorn sheep and mountain goats (Lowrey eta l. 2018). When direct competition for limited resources occurs, mountain goats usually displace bighorn sheep (Chadwick 1983, Reed 2001). Thus, on shared high elevation winter range displacement of bighorn sheep by mountain goats is expected. Goats can do better than sheep with challenging nutritional situations as they are more inclined to use browse. Experts also asked if the goat movement from the original reintroduction site into the Tetons is still occurring. This is not known. There is evidence that the very rapid expansion of the mountain goats at the original introduction sites in Palisades Creek led to habitat degradation and enhanced movement of goats into other areas in the 1980s (Hayden 1989). Mountain goat numbers in the Palisades/Big Elk areas of the Snake River Range have declined in more recent years. Evidence from recent history of mountain goats and bighorn sheep that cohabit ranges in Nevada strongly suggests passage of pathogens from mountain goats to bighorn sheep (Wolff et al. 2019). The experts also discussed the potential use of contraception for the Teton goats, but there are limited effective options and delivery in the wild would be very difficult.

Recommendations:

- Support removal of mountain goats from the Tetons.
- Develop a mechanism to quickly remove newly arrived goats from the Tetons.
- Improve understanding of how goats are using Teton Range habitats given their rapid expansion at a time when the native bighorn sheep are not faring as well.

Predation

Background - Several potential predators occur in the range including: mountain lions, wolves, grizzly and black bears, coyotes, wolverine, and golden eagles. No studies have been conducted to look specifically at predation of Teton Range bighorn sheep, although when possible studies of radio collared individuals followed-up on mortalities to determine cause of death. With limited data, it does not appear that predation is a major source of mortality.

Expert Discussion - Mountain lions have created severe predation issues in some vulnerable bighorn sheep populations.

Recommendations:
- Predation does not currently appear to be a significant issue in the Tetons. Continue to monitor mortality causes.

Human Recreation

Background - Teton Range bighorn sheep are, with a few exceptions, extremely sensitive to human activity in winter habitats. In the 1970s-1990s the primary concern for recreational conflict with Teton bighorn sheep was snowmobile use as advances in snow machine technology allowed people to access Teton Range bighorn sheep winter ranges. Extensive public outreach led by Mary Maj of the Targhee National Forest and increased acceptance of Wilderness regulations mitigated most of this concern. In recent years, backcountry skiing has become more of a concern as newer ski technology and increased recreation numbers have led to more use of high elevations in winter. Backcountry skiing is very popular in the southern Tetons on the BTNF and in the Park. Many skiers exit Jackson Hole Mountain Resort to ski outside the resort boundary in the backcountry. Courtemanch (2014) completed extensive research into human and bighorn sheep interactions on winter ranges in the Tetons. Courtemanch found bighorn sheep avoid high quality winter habitat that is heavily used by winter recreationists. In her habitat modeling, Courtemanch (2014) noted up to a 30 percent reduction in high quality winter habitat for some individuals in areas of high recreation activity due to their avoidance of areas of backcountry recreation. Further, Courtemanch found sheep wintering in areas with high recreation activity have higher daily movement rates, larger home ranges, and, therefore, expend more energy, than sheep wintering in areas with little to no recreation.

There are two long standing winter closures in Grand Teton National Park to all human entry in bighorn sheep winter range in the south-central portion of the Range. There are no closures in the northern Tetons although this area is gaining in popularity for backcountry skiers. The skier community generally respects these closures, but large amounts of winter range remain unprotected.

Expert Discussion - Other work has shown that ungulates can habituate to predictable types of disturbances (e.g. vehicles on roads or trails), but struggle to habituate to backcountry skier behavior as it is less predictable in space and time. The experts spoke of examples from Nevada and California where sheep are habituated to humans. There may be opportunities in the Tetons for the skiers to access high quality ski terrain in ways that are predictable to wintering bighorn sheep while also avoiding important bighorn sheep winter ranges.

Recommendations:

- Engage the public in shared ownership of planning to ensure responsible recreational activity in sensitive wildlife habitats. Consider focusing skier activity for more predictable backcountry use. Build support for any changes.
- Examine the impacts of summer recreation on the Teton Range bighorn sheep population and their lambing ranges.
- Update and improve recreation use monitoring in all seasons to provide a baseline.

Climate change

Background -- The duration and depth of snow cover, which are strongly correlated with mean temperature and precipitation, are key factors controlling alpine ecosystems (Beniston 2003). Snow cover provides frost protection for alpine plants in the winter, as well as the water supply in spring. Reduced snowpack with warming is likely to cause major changes in alpine plant communities (Gottfried et al. 2012). The duration of time that high quality forage is available may decline in mountainous habitats where warmer springs encourage faster green-up (Pettorelli et al. 2007; Wagner and Peek 2006).

Expert Discussion -- Climate change can result in a high likelihood of rain on-snow events in mid-winter with consequent "locking up" of winter forage. Climate change appears to be reducing the nutritional quality of summer ranges of Dall sheep (*Ovis dalli*) in Alaska.

Recommendations:

- There is a need to more fully consider the cumulative effects of climate change on winter mortality and quality of summer habitats.

PART 2: Community Outreach Efforts

In the fall of 2017, with the assistance of a communications specialist, the Working Group developed a strategy to help frame the narrative around bighorn sheep conservation, specifically related to winter habitat needs of the bighorn sheep. The document also identified key audiences and messages and tools for getting the message out. One of the tools identified was to meet with people one-on-one or in small groups to share the information and data about the bighorn sheep, but also to understand their perspectives. Between December 2017 and November 2019, the Working Group engaged in more than 45 one-on-one or small group conversations with about 80 individuals from the winter backcountry community. The purpose of these conversations was to gauge community awareness of the plight of Teton Range bighorn sheep and learn the perspective and concerns of community members on the issue of bighorn sheep winter habitat needs and winter backcountry access in the Tetons.

The goal of the community conversations was simply to share information and learn the perspectives of community members. There was no attempt to reach consensus or agreement, rather the purpose was to elicit a range of opinions, concerns, and the participants' ideas for possible solutions and ways to engage the broader backcountry community. The themes summarized below represent the views of the individuals contacted, not necessarily those of the backcountry community as a whole. However, they do help managers better understand the range of concerns and values that may be important to individuals and the broader community. Those we talked to were generous with their time and candid and open with their feedback. The feedback was helpful in identifying parts of the issue that are not well understood, where the Working Group can focus efforts to promote greater awareness and a deeper understanding of the complexity of the issue.

Key Findings: Community Outreach Efforts
Below is a summary of the general themes and thoughts that emerged from the community conversations.

Theme 1: People are not aware of the issue

- There is high-turnover in winter backcountry users in the community. Bighorn sheep managers need to do more education and outreach.
- Many individuals expressed that they did not know Teton Range bighorn sheep were in trouble.
- Biologists need to better demonstrate the direct connection between bighorn sheep decline and backcountry skier increase
- Biologists need to better articulate and share how recreation affects the bighorn sheep population. In general backcountry recreationists view their sport as very low impact. More education is needed to describe how these activities can disturb wildlife.
- Many observed that bighorn sheep that winter at the National Elk Refuge near Miller Butte seem okay with people in close proximity and lick their cars and asked why those sheep are not negatively impacted.
- People see bighorn sheep hanging out near the top of the Tram at the Jackson Hole Mountain Resort with no apparent issues. Why aren't these sheep disturbed?
- We need to remind our community what is at stake – extinction of a native population.
- Are there impacts to sheep everywhere in the Tetons or just certain places? Where are those places?
- Some people want more research/studies before decisions are made.

Theme 2: Concern about access and freedom

- There is an extremely rich history and strong culture (both locally and globally) of backcountry skiing in the Tetons.
- Winter backcountry users expressed concerns about:
    - losing access to specific area/places;
    - complete closure of larger geographic areas;
    - complete closure of massive landscapes (i.e. all of the Tetons); and
    - additional closures could result in the loss of "aspirational terrain" (extreme skiing routes where few people go, but others dream of going there one day). Some of these areas are important for ski guiding businesses because they have

return clients that work on improving and honing their skills every year in order to ski them some day.

- There was some support expressed for the following:
    - closures in certain areas, but recreationists want to be a part of the conversation; and
    - closures with designated routes through them
- A few individuals expressed sentiment along the lines of *the sheep have had their day, it's our day now.*
- Some winter backcountry users like the idea of responsible recreation – i.e. where wildlife disturbance is minimized/eliminated.
- Some winter backcountry users expressed frustration that a few vocal individuals are driving this conversation and making the ski community as a whole "look bad". At the same time, they are apathetic that their opinion will mean anything because they aren't part of the "cool crowd".

Theme 3: Skiers feel singled out

- There is some skepticism among winter backcountry users that have a negative impact on bighorn sheep.
- Some winter backcountry users thought there were bigger issues affecting the sheep like mountain goats, ski resort development, or predators. Some skiers feel that their impact is relatively low compared to other things.
- Some winter backcountry users expressed the need better explain why bighorn sheep on the National Elk Refuge are not afraid of cars yet skiers have a disturbance effect in the Tetons.
- Most people recognize that the numbers and reach of backcountry use has increased substantially during the past several decades, but a minority of people claim backcountry use is not increasing.
- Need to illustrate it is not just skiers that have been or are being asked to sacrifice for these sheep – domestic sheep grazing is gone, there are restrictions on resort development/backcountry access, reduced hunting tags and hunting opportunities, snowmobile use is restricted due to Wilderness, many winter closures for other ungulates in lower elevations – why not sheep in these higher elevations?
- Some backcountry winter users were interested to know:
    - If winter is so hard on the sheep, why don't wildlife managers feed them?
    - Even if we make a lot of changes, isn't the herd so small that it will go extinct anyway?
    - Why don't agencies transplant sheep from elsewhere into the Tetons to the help the herd?

Theme 4: Wildlife managers are moving too slow

- A lack of information and decisions causes people to stew and stir, uncertainty adds to the rumor mill.
- Some backcountry winter users are unaware of how policy evolves across multiple federal agencies. It does move slowly and folks are burning out on the bighorn sheep issue because of the lack of policy implementation. What will agency managers support, what are they thinking?

- Some individuals were curious why agency decision makers were not present at the numerous public meetings, what their position was on the issue, and whether they would support the biologist and expert panel recommendations.
- Give us a timeline, how long will this really take?
- Some people feel that the agencies have already made their decisions, so it's pointless to participate in public meetings.
- Confusion over the multiple agencies involved and their roles.
- It is confusing for the public that there are so many different people speaking to this issue- there is no one leader.
- Many individuals and organizations have been confused by the different type of process we are embarking on for this issue instead of typical NEPA process. This has created confusion and frustration.

Themes 5: Skier Ideas

- Voluntary self-regulation seems to work, maybe use this model (e.g. no one snowmobiles at the top of Teton Pass)
- Incentives or trade-offs (e.g. allow uphill traffic at JHMR, plot routes through habitat areas)
- Plow road to Jenny Lake to facilitate access to central portion of the range.
- Develop route specific "rule sets"
- Find ways to make skiers more predictable
- Identify routes through important bighorn sheep winter ranges
- No closures
- Create a list of "responsible recreation" guidelines – recreate without disturbing the wildlife
- Increase education and awareness in the ski community about disturbance to wildlife and to "turn around" if you see wildlife that you might disturb
- Desire for more tools that people can use to do the right thing, such as an app on your phone showing the existing closures and your location
- Collar at least one sheep in every group and share location data in real-time so that skiers can know where they are and avoid them
- Develop a bighorn sheep reporting system (similar to how avalanches can be reported). This would allow people to check where sheep have been observed recently and avoid those areas.

Themes 6: Concern for the herd

- Elected officials are interested in this issue and have asked how they can help.
- There is local and national interest from bighorn sheep conservation groups.
- Need to remind people what is at stake for this herd – local population extinction.
- The majority of skiers we talked to are conservationists at heart and don't want their actions to hurt bighorn sheep.
- People recognize that bighorn sheep are an iconic species of the Tetons and don't want to lose them.
- Some people in the ski community have voiced that "we have many places we can ski, but the sheep only have these few areas to survive", so we can go other places.

SUMMARY

Backcountry winter recreation, especially skiing is very important to the identity of Jackson Hole and there is a long and rich history of backcountry skiing in the Teton Range. Through our conversations with community members we learned that there is a lot of interest in this topic/issue and we heard loud and clear that people are very concerned about losing access. At the same time, many of the people we talked to are conservation oriented, expressed concern for the sheep, and were supportive of being part of an effort to identify possible solutions that balance conservation of Teton Range bighorn sheep and backcountry winter recreation.

RECOMMENDATIONS

Based on the technical feedback from the expert panel and our community conversations, the Working Group identified several actions to advance conservation of the Teton Range bighorn sheep population:

Expert Panel Recommendations

In the short term, move forward with high priority expert panel identified actions, strategies, or recommendations including mountain goat removal, addressing human disturbance on bighorn sheep winter ranges, and enhancing the quality of demographic data collection. In the longer-term, update the Teton Range Bighorn Sheep Working Group strategic plan to incorporate new data and information and the expert panel recommendations.

Collaborative Learning Process

In the short-term, members of the Working Group recommend that the group collectively move forward with a collaborative learning process on the topic of backcountry winter recreation and bighorn sheep.

1. Engage the public in a structured, collaborative learning process. This process would consist of a series of evening public workshops, facilitated by a neutral party and open to all interested participants with clear guidelines, objectives, and process. The Teton Range Bighorn Sheep Working Group would host the meetings. Key elements of the process include the following: open to all, shared learning, transparent, and collaborative development of community-supported possible solutions that meet agency policies. The meetings would be structured as follows:
    a. **Meeting 1:** Laying the foundation -- Explore expert knowledge (from bighorn sheep and backcountry skiing experts) and ask the community to identify interests, issues, and values.
    b. **Meeting 2:** Conceptual solutions -- Brainstorm possible solutions to this issue. What are broad ideas/solutions that could be considered?
    c. **Meeting 3:** Geographical solutions -- Build off of conceptual solutions from last meeting and identify on-the-ground, site-specific solutions with the help of maps.
    d. **Meeting 4:** Report back to the public -- Report back to the community explaining which suggestion can be carried forward and why.

2. Convene an interagency meeting. In addition to these public workshops, Dr. Western will meet with representatives from government agencies to review the draft list of suggestions that are developed through this process. Each suggestion from the community will receive a response as to why it can or cannot be considered for implementation by the agencies, based

on legality, jurisdiction, feasibility, cost, etc. These responses will be shared with the community during workshop #4.

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APPENDIX A
Expert Panel Recommendations

General: Action Items
Focus on preserving the bighorn population and occupied habitat that we now have and actively manage the threats.
Identify concerns/issues the working group can address positively in the near term.
Habitat/Nutrition: Action Items
Enhance population and health monitoring • Consider assessing body condition using remote cameras or other methods in conjunction with continued captures; • Consider placing remote cameras on winter range to monitor sheep and public interaction and effectiveness of outreach; • The condition of bighorn sheep going into winter is not well understood. Fall captures of a small number of bighorn sheep to assess body condition could provide the best measure of summer nutrition and an index of summer range condition; • Place greater emphasis on monitoring lamb survival and recruitment, particularly during bottleneck periods (e.g. winter starvation). Concentrated lamb surveys in the spring and fall could address this; • Assess the impact of research captures on bighorn sheep.
Cooperate and coordinate with federal fire personnel and land managers to identify and implement management action (e.g. prescribed fire, wildland fire use) to enhance bighorn sheep ranges and migration habitats, where possible and appropriate.
Consider a summertime nutritional study to understand how quality of summer range affects the sheep herd or alternately conduct captures earlier (i.e. October) to assess nutritional condition and track summer range quality. Quality of summer range is particularly important for sheep that winter in high elevations and depend upon stored body fat.
Limited Winter Range—Access to lower elevations: Action Items
Work with appropriate specialists (e.g. social scientist, fire ecologist, silviculturalist, recreation staff, etc.) to identify areas and develop a mechanism to allow for natural fire ignitions in bighorn sheep habitat. Consider the use of prescribed fire to improve winter range conditions, where appropriate.
Reduce disturbance to sheep on priority winter ranges.
Domestic Sheep Grazing: Action Items
Conduct a disease risk assessment for areas around the Tetons with specific focus on domestic herds (e.g. hobby flocks) on private lands bordering the Tetons and those grazing in adjacent mountain ranges.
Disease: Action Items
Prevent respiratory disease transmission to Teton Range bighorn sheep, with particular reference to keeping bighorn sheep from the Jackson herd and Snake River Range mountain goats from coming to the Tetons.
Remove mountain goats from the Teton Range.
Develop mechanisms to remove newly arrived mountain goats in the Tetons quickly.
Conduct a disease risk assessment for areas around the Tetons with specific focus on domestic herds (e.g. hobby flocks) on private lands bordering the Tetons and those grazing in adjacent mountain ranges.
Collar Jackson herd bighorn rams to identify risk of movements into the Tetons.
Address the issue of pack goats on the National Forest in the Tetons.
Continue to surveil disease occurrence in Teton Range bighorn sheep and mountain goats.
Hunting: Action Items
Consider eliminating of the Teton Range bighorn sheep hunting season with particular concern for the southern subpopulation. Identify trigger points for when a hunt should occur.

When hunting occurs, balance harvest between the north and south subsegments.
Demographics—Small Population Size: Action Items
Obtain a more rigorous estimate of population size and demographic parameters. Mark-resight or genetic capture-recapture techniques may prove to be helpful. Consider new genetics methodologies (see below).
Consider taking photographs during aerial surveys to aid in follow-up herd classification.
Consider focused lamb surveys in the spring (winter survival) and fall. Improved monitoring of lamb survival and recruitment is important.
Consider using remote cameras at mineral licks or along movement corridors to monitor lamb ratios/numbers;
Consider developing a citizen science project to monitor bighorn sheep;
Genetics: Action Items
Fully assess the current genetic status of the Teton Range bighorn Sheep population. • Update herd level information on genetic connectivity and gene flow • Reassess measures of genetic drift • Obtain information on paternity (numbers of breeders and age structure)
Consider using fecal DNA monitoring techniques to gain information on gene flow, population size, survival and recruitment, sex ratios etc. GRTE is now investing considerable resources to investigate this low impact means of population monitoring.
Identify trigger points for when intensive conservation actions (e.g. genetic augmentation through moving pregnant females or young males among sub-populations within the Range or augmentation from outside the Range) are warranted.
Augmentation of the Teton population with sheep from other areas is not recommended at this time. Translocating bighorn sheep between the north and south sub-segments is also not recommended at this time.
Mountain Goats: Action Items
Support removal of mountain goats from the Tetons.
Develop a mechanism to quickly remove newly arrived goats from the Tetons.
Improve understanding of how goats are using Teton Range habitats given their rapid expansion at a time when the native bighorn sheep are not faring as well.
Predation: Action Items
Predation does not currently appear to be a significant issue in the Tetons. Continue to monitor mortality causes.
Human Recreation: Action Items
Engage the public in shared ownership of planning to ensure responsible recreational activity in sensitive wildlife habitats. Consider focusing skier activity for more predictable backcountry use. Build support for any changes.
Examine the impacts of summer recreation on the Teton Range bighorn sheep population and their lambing ranges.
Update and improve recreation use monitoring in all seasons to provide a baseline.
Climate Change: Action Items
There is a need to more fully consider the cumulative effects of climate change on winter mortality and quality of summer habitats.

APPENDIX B
Management Agency Policy/Sideboards, Roles, and Responsibilities

Growing recognition of the tenuous status of the Teton Range bighorn sheep population and the need for interagency cooperation in managing the population and its habitat led to the formation of the Teton Range bighorn sheep working group in 1990. Representatives from the park, WGFD, BTNF, CTNF, and several NGOs comprise the current working group. The purpose of the working group is to provide technical information to agency personnel responsible for managing the Teton Range bighorn sheep population and its habitat.

National Park Service – Grand Teton National Park

National Park Service Mission
The National Park Service preserves unimpaired the natural and cultural resources and values of the National Park Service System for the enjoyment, education, and inspiration of this and future generations. The Park Service cooperates with partners to extend the benefits of natural and cultural resource conservation and outdoor recreation throughout this country and the world.

National Park Service Management Direction and Policies
Management of national parks is guided by the NPS Organic Act (1916), the NPS Management Policies (2006), and other laws, executive orders, and regulations. As outlined in the Organic Act the NPS . . . *shall promote and regulate the use of the . . . areas … by such means and measures as conform to the fundamental purpose … to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations*.

The NPS Management Policies (2006) provide guidance for managing NPS units. These policies are based on laws, Executive orders, proclamations, regulations, etc. that govern NPS as well as departmental policies and longstanding NPS practices. Several key sections related to impairment and wildlife management are highlighted below.

Section 1.4.2 of the NPS management Policies concludes that both the term "unimpaired" in the 1916 Organic Act and the term "derogation" in the 1978 Redwoods Amendment are used to describe a "single standard" of "what the National Park Service must avoid" in managing park resources and values.

Section 1.4.3 explains how the Park Service should both conserve resources and values and provide for their enjoyment, but also declares that "when there is a conflict between conserving resources and values and providing for enjoyment of them, conservation is to predominant."

Section 1.4.4 identifies the impairment prohibition—separate from the above conservation mandate—as the "cornerstone of the Organic Act."

Section 1.4.6 defines "what constitutes park resources and values" with a comprehensive list, including tangible resources of every kind from individual to landscape in scope; "the ecological, biological, and physical processes that created the park and continue to act upon it"; sensory experiences like visibility, natural soundscapes, and smells, with both tangible and

intangible aspects; "appropriate opportunities to experience enjoyment" of all the listed resources, but "without impairing them"; the park's contribution to the values of the National Park System; and any additional specific attributes of the particular park.

Section 4.4.1 states that the NPS will *maintain as parts of the natural ecosystems of parks all plants and animals native to park ecosystems*.

Section 4.4.1.1 directs the NPS to cooperate with states, tribal governments, federal agencies, and other land managers to conserve species populations and habitats.

Native species are defined in Section 4.4.1.3 as those that have occurred, now occur, or may occur as a result of natural processes on NPS system lands.

National Park Service Role
The NPS is responsible for managing wildlife and visitor activities within the park.

US Forest Service - Bridger-Teton and Caribou-Targhee National Forests

US Forest Service Mission
The mission of the Forest Service is to sustain the health, diversity, and productivity of the nation's forests and grasslands to meet the needs of present and future generations.

US Forest Service Management Direction and Policies
Bighorn sheep are designated as a Sensitive Species by Region 4 of the USFS on the BTNF and CTNF. Sensitive species are those plant and animal species identified by the Regional Forester for which population viability is a concern, as evidenced by significant current or predicted downward trends in population numbers or density and a significant current or predicted downward trend in habitat capability that would reduce species' existing distribution (FS Manual 2670). Sensitive species of native plant and animal species receive special management emphasis to ensure their viability. Specific USFS policies and requirements apply to the management of sensitive species. These include objectives to 1) develop and implement management practices to ensure that species do not become threatened or endangered because of Forest Service actions, 2) maintain viable populations of all native and desired nonnative wildlife, fish, and plant species in habitats distributed throughout their geographic range on National Forest System land, and 3) establish management objectives in cooperation with the States when projects on National Forest System lands may have a significant effect on sensitive species population numbers or distribution.

Aligning with the above Sensitive Species objectives, the Secretary of Agriculture's Policy on Fish and Wildlife, Department Regulation 9500-4 (DR 9500-4), directs the Forest Service to, 1) manage habitats for all existing native and desired non-native plants, fish, and wildlife species in order to maintain at least viable populations of such species, and 2) habitat must be provided for the number and distribution of reproductive individuals to ensure the continued existence of a species generally throughout its current geographic range. Within these parameters, the US Forest Service is a partner in finding ways to integrate recreation demands with the federal requirement to provide suitable habitat for the Teton Range bighorn sheep population.

In addition, the Targhee portion of the CTNF has specific provisions in the 1997 Revised Forest Plan that guide habitat management for this herd. These include an objective to identify opportunities to improve bighorn sheep habitat through fire management for the Teton Range herd and a goal of coordinating with GRTE and the WGFD in the management of the bighorn sheep population and habitat (TNF Revised Forest Plan p. 111-156). This forest plan also directed the Forest to phase out domestic Sheep allotments on the Teton Range subsection of the Teton Basin Ranger District to separate domestic and bighorn sheep and reduce disease transmission risk to bighorn sheep, which has been completed.

US Forest Service Role
The primary role of the FS is as a habitat manager, although as noted above the Forests are also responsible for ensuring that viable populations of wildlife species are maintained. Habitat management for the bighorn sheep population is shared between the respective land management agencies, with each agency responsible for managing the lands within its jurisdiction. Both forests coordinate with and seek input from WGFD in habitat management efforts for bighorn sheep and other species.

<u>Wyoming Game and Fish Department</u>

Wyoming Game and Fish Department Mission
Conserving wildlife -- serving people.

Wyoming Game and Fish Department Management Direction and Policies
The WGFD considers bighorn sheep to be a Species of Greatest Conservation Need due to their constricted range and susceptibility to large population die-offs due to pneumonia from domestic sheep. There are three levels of conservation priority for bighorn sheep herds in the state, as described in the Statewide Bighorn/Domestic Sheep Interaction Working Group Plan (2004), which is now Wyoming Statute 11-19-604 (2015).

The Teton Range bighorn sheep population is considered a "Core Native Herd", which is the highest priority level. There are only four such herds in the state and they receive this designation because they have never been extirpated (gone extinct) or been augmented through management transplants of sheep. For these reasons, the WGFD is committed to ensuring the future sustainability of the Teton Range bighorn sheep herd.

Wyoming Game and Fish Department Role
WGFD is charged with managing wildlife species in the state for the benefit of the citizens of Wyoming. Management follows the North American Model of Wildlife Conservation, the core tenets of which include: 1) wildlife is a public resource that is managed by the government on behalf of all citizens, and 2) long-term sustainability of wildlife populations will be ensured by using science-based decision-making and policy. The WGFD places a heavy emphasis on public participation and input in wildlife management decisions.

In simple terms, the WGFD is responsible for managing wildlife population numbers and health, whereas federal land management agencies such as the USFS are responsible for managing the land and habitat that these animals depend on. Likewise, the federal land management agencies are in charge of managing human activities such as camping,

motorized/non-motorized trail use, etc. An exception to this is that WGFD manages hunting and fishing through licenses and seasons. Due to these different responsibilities and the fact that many of these roles are intertwined, federal and state agencies work very closely together to collaborate on wildlife, habitat, and human activity decisions. The WGFD is responsible for managing the Teton Range bighorn sheep when they reside on BTNF or CTNF lands.

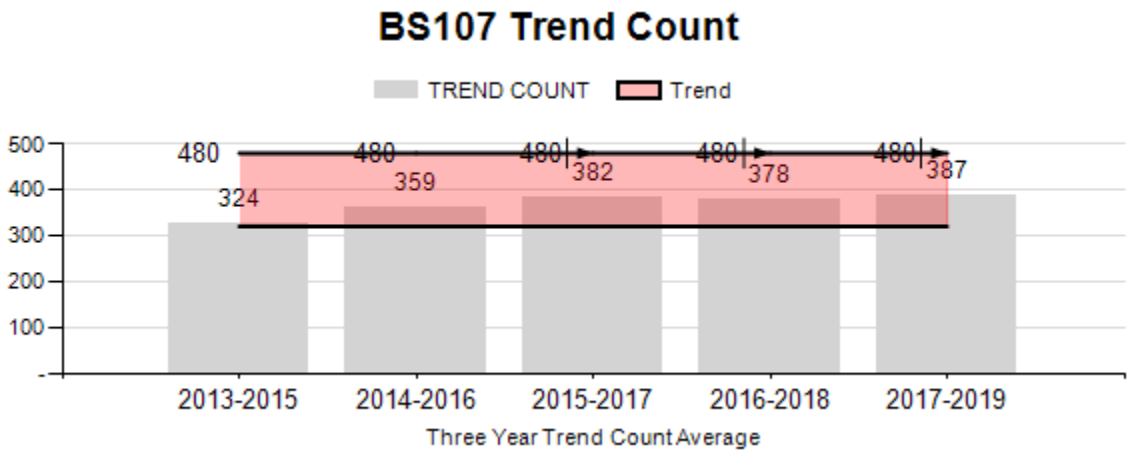
2019 - JCR Evaluation Form

SPECIES: Bighorn Sheep
HERD: BS107 - JACKSON
HUNT AREAS: 7

PERIOD: 6/1/2019 - 5/31/2020
PREPARED BY: ALYSON COURTEMANCH

	2014 - 2018 Average	2019	2020 Proposed
Trend Count:	368	398	400
Harvest:	9	10	12
Hunters:	11	12	12
Hunter Success:	82%	83%	100%
Active Licenses:	11	12	12
Active License Success	82%	83%	100%
Recreation Days:	114	139	144
Days Per Animal:	12.7	13.9	12
Males per 100 Females:	42	32	
Juveniles per 100 Females	37	34	

Trend Based Objective (± 20%)	400 (320 - 480)
Management Strategy:	Special
Percent population is above (+) or (-) objective:	-0.5%
Number of years population has been + or - objective in recent trend:	0



2020 HUNTING SEASONS
JACKSON SHEEP HERD (BS107)

Hunt Area	Hunt Type	Archery Dates		Season Dates		Quota	Limitations
		Opens	Closes	Opens	Closes		
7	1	Aug. 15	Aug. 31	Sep. 1	Oct. 31	12	Any bighorn sheep

2020 Management Summary

1.) **Hunting Season Evaluation:** There were no changes for the 2020 hunting season. The Jackson Bighorn Sheep Herd has been at objective for the past 5 years. A total of 398 sheep were counted during the 2019 post-season mid-winter trend count. The lamb:ewe ratio was 34:100 and the ram:ewe ratio was 32:100. Hunters had an 83% success rate during the 2019 season and average age of harvested sheep was 8 years old. Overall herd numbers and ram numbers have plateaued in recent years, therefore managers did not recommend a license quota increase for 2020.

2.) **Management Objective Review:** In 2020, managers reviewed the past five years of population, harvest, and disease data to determine whether the current population objective of a mid-winter trend count of 400 bighorn sheep for the Jackson Bighorn Sheep Herd is still appropriate. The herd underwent a pneumonia die-off in 2012 when the population dropped to 243 sheep, but recovered to approximately 400 sheep within 3 years. For the past 5 years, the population has plateaued at about 400 sheep. Based on the recent population dynamics, managers believe that 400 sheep remains an appropriate population objective. The age of harvested sheep remains relatively high in this herd and the 12 licenses issued each year provides hunters with opportunity.

3.) For the past 5 years, WGFD has collaborated with the University of Wyoming on a research project investigating bighorn sheep nutrition, disease, reproduction, and causes of lamb mortality in the Jackson, Whiskey, and Absaroka Herds. Results from this research in the next few years will provide additional insight into the nutritional carrying capacity of the herds within the context of respiratory disease. These results will help inform the next population objective review in 2025. Preliminary results from this research are attached (Appendix A).

Appendix A.
Wyoming Bighorn Sheep Research Project

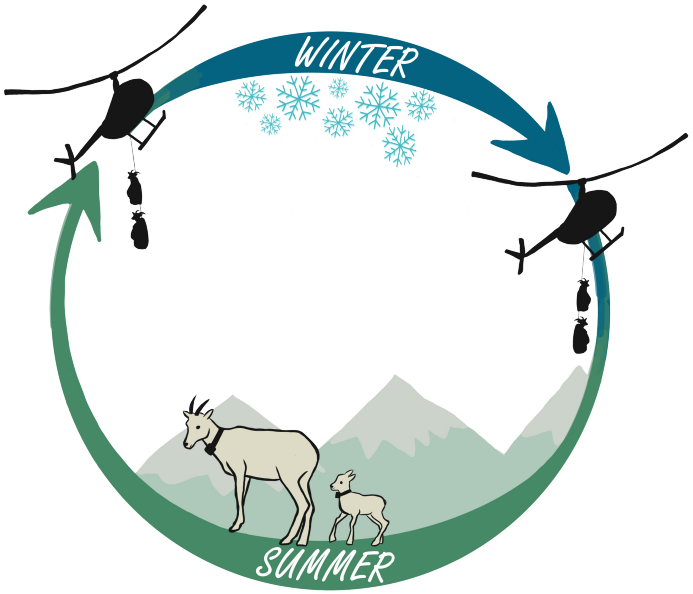
The persistence of pneumonia poses a risk to bighorn sheep herds throughout their range, as it is often the culprit for massive population crashes. Following a crash, pneumonia can remain in the herd long after its initial introduction. Infected herds can experience very different population trends - some continue to decline, some undergo crash-recovery cycles, and some are able to tolerate it without significant mortality. It remains unknown why some herds can recover from the disease while others cannot, but this suggests ecological or environmental factors may be at play to influence population trends in the context of disease.

Wyoming's bighorn sheep herds have experienced pneumonia die-offs throughout the state, to which there has been variability in recovery. Once the largest Rocky Mountain bighorn sheep herd, the Whiskey Mountain herd experienced a pneumonia die-off in the early 1990's and has continued to decline with abysmal lamb survival ever since. Still, there are other herds nearby that have experienced similar die-offs but have not faced the long-lasting population decline affecting the Whiskey herd. The differences in trends across populations with the same pneumonia related pathogens motivates our investigation into the factors that influence population dynamics in the presence of disease.

OUR APPROACH

We seek to identify how nutrition and disease interact to influence population dynamics. Our work focuses on the Whiskey Mountain, Gros Ventre, and Absoroka bighorn sheep herds, which all hold the same bacterial pathogens associated with pneumonia but have much different population trends. We aim to look beyond the disease itself and identify factors that influence the ability of sheep to tolerate or succumb to pneumonia.

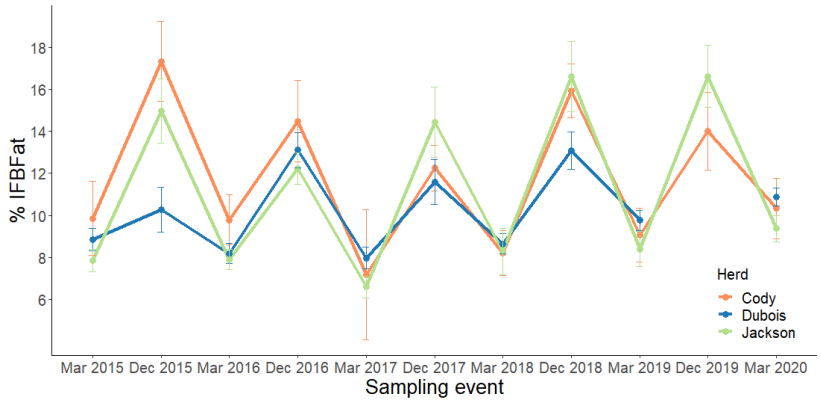
Through our longitudinal study (i.e., monitoring the same animals through time), we are tracking pathogens presence, nutritional condition, reproduction, adult and lamb survival, mortality causes, and forage conditions of individuals over time. We aim to disentangle the relative roles of each of those components in crashes and recoveries of bighorn sheep populations. Identifying how disease and nutrition interact to influence population dynamics is critical to improving our understanding of pneumonia, developing management options for bighorn sheep, and ultimately, mountain sheep conservation.



Above: We capture bighorn sheep twice a year to track how individuals, and ultimately populations, farein the face of pneumonia and environmental stressors.

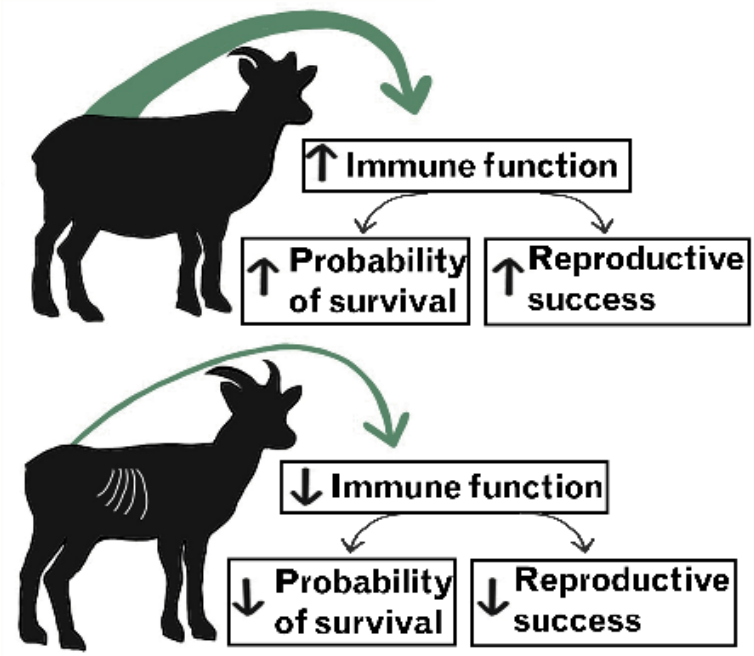
HOW DO BIGHORN SHEEP FINANCE SURVIVAL, REPRODUCTION, AND IMMUNE FUNCTION?

Bighorn sheep live in extreme environments where they experience seasonal fluctuations in resource availability. They accumulate fat reserves over summer, when forage is lush and abundant, for later use to meet energetic demands over winter. Burning through these fat reserves is the main way sheep finance their own maintenance, raise a lamb, and mount an immune response. An overarching goal of the project is to understand environmental factors that affect an individual's ability to gain fat as well as understand how they balance investing their fat reserves between these three needs. We measure percent ingesta-free body fat (IFBFat) each March and December using ultrasonography.



Above: Average percent of body fat of adult, female mule deer in the Wyoming Range from March 2013 to December 2019. Long term study of this population has allowed us to document significant crashes in condition of animals during harsh winters. Below: A mule deer in the Wyoming Range. Habitat conditions can play an important role in nutrition.

HOW DOES MOM'S NUTRITIONAL CONDITION INTERACT WITH IMMUNE FUNCTION, PNEUMONIA, AND REPRODUCTION?



Because lamb survival is often the limiting factor to bighorn sheep population growth, we want to understand what allows a mother to successfully raise a lamb. Mothers' give their lambs energy to grow, passive immunity to help defend against disease, and potentially the pathogens that she carries. We want to understand how maternal factors such as age, nutritional condition, disease state, and immune function work together to influence her ability to successfully raise a lamb, particularly in the face of pneumonia. Understanding in what ways mother's contribute to lamb survival will help us to better understand where potential vulnerabilities lie, and which individuals will be most successful in raising lambs.

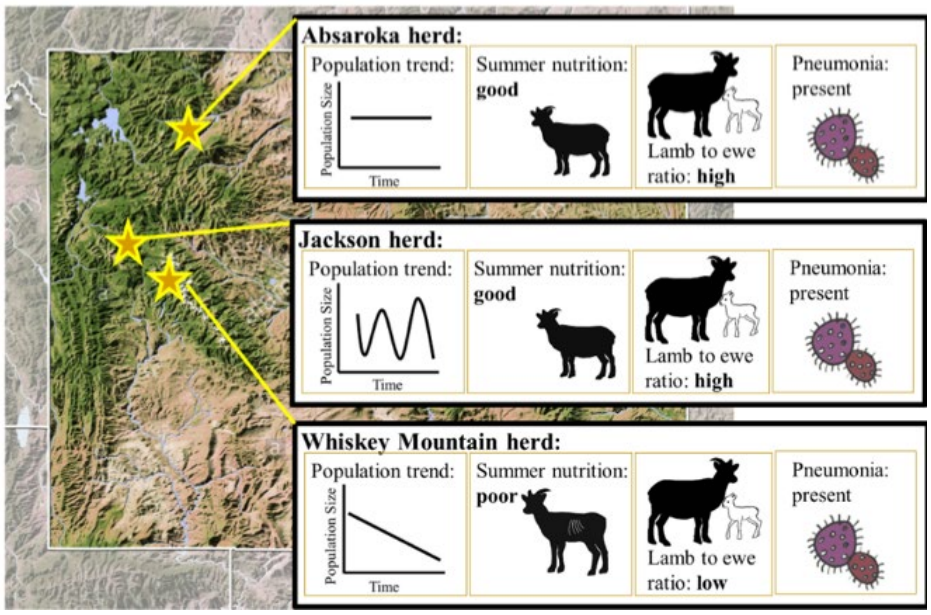
Above: Potential relationship between nutritional condition, immune function, survival, and reproductive success.

HOW DOES HABITAT QUALITY INFLUENCE THE ABILITY OF SHEEP TO TOLERATE PNEUMONIA?

A bighorn sheep's nutritional condition (how much fat it has) is likely indicative of the quality of its habitat. There are apparent differences in nutritional condition in the three herds, particularly noticeable in the fall, after they have migrated off summer range. Individuals in the Whiskey Mountain herd consistently come off summer range in poorer condition than those in the Jackson and Cody herds. We are studying the summer ranges of the Whiskey Mountain and Jackson herds from the ground up to identify why the Whiskey Mountain herd seems to have poorer summer nutrition than the Jackson herd. To do so, we are piecing together the diet composition and quality of each sheep by analyzing fecal samples to identify the plants in their diet and quantifying the digestibility and quality of the species.

Above: Vegetation data collection on summer range of the Gros Ventre herd.

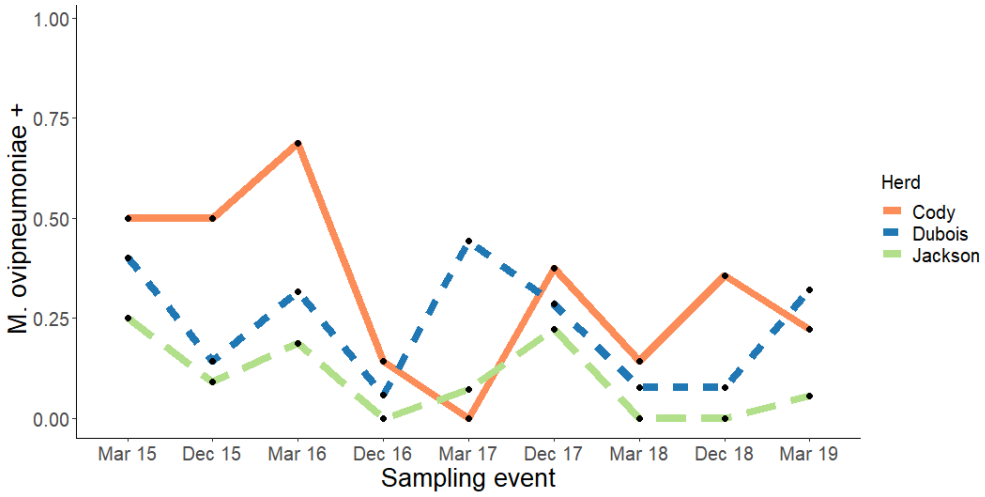
HOW DO SHEEP ALLOCATE RESOURCES IN THE CONTEXT OF DISEASE?



Immune function is just one of the many energetic costs that a bighorn sheep incurs. In the context of pneumonia, it is unknown how much an adult will invest in her own immune function to either suppress pathogens or attempt to clear them. Whether an animal is positioned to tolerate a pathogen, or mount an immune response to suppress or clear the pathogen, can have severe consequences for an animal's fate. Consequently, we want to investigate the relative cost of immune function and how energetic investment in immune function influences survival, and how immune function and nutritional condition may interact to influence the ability of a female to provision her offspring.

WHY DO WE SEE SEASONAL CHANGES IN PATHOGEN PRESENCE?

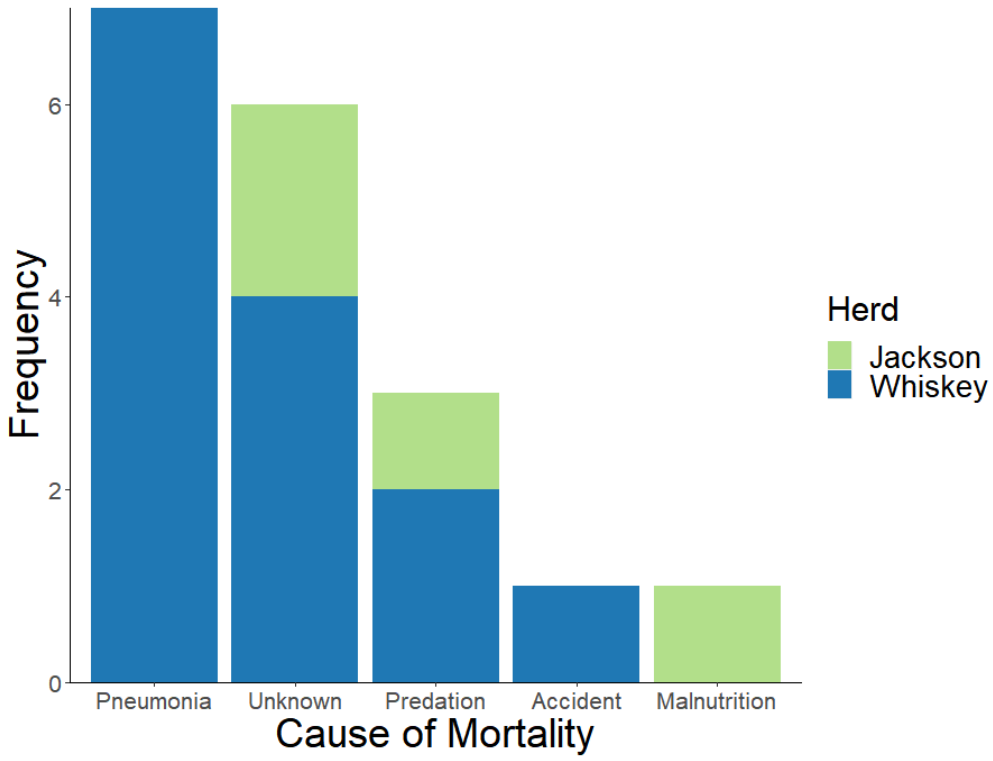
It is currently believed that Mycoplasma ovipneumoniae (M. ovi) is one of the most important pathogens associated with pneumonia in bighorn sheep and is often present when dieoffs occur. Every December and March, we test individuals for pathogens associated with pneumonia. Often, we observe a higher presence of M. ovi in March than in December. Seasonal changes may correspond with the period when animals are also in poorer nutritional condition, and potentially living in larger groups in smaller ranges. We aim to determine the relative importance of the social dynamics of bighorn sheep and nutrition for the susceptibility of disease and identify the time of year we should be testing bighorn sheep for disease surveillance.



Left: M. ovi prevalence in three bighorn sheep herds from March 2015 – March 2019.

WHAT IS THE LEADING CAUSE OF LAMB MORTALITY?

We captured 18 lambs (14 in Dubois and 4 in Jackson) during the 2019 summer. Early in the summer there were a few predation events (one mountain lion and one coyote), accidents, and unknown mortalities, however most of the mortalities thereafter were associated with pneumonia. After the first pneumonia death in late June, that was the only cause of mortality we observed until November. The last lamb died of an unknown predation in February but had symptomatic pneumonia as well. Pasturella multocida has been associated with most of the pneumonia deaths.



PROJECT ADVANCEMENT

Although disease dynamics of bighorn sheep have been studied extensively, the underlying principles of population dynamics have often been discounted. For example, even in the presence of disease, populations are still subject to limitations of forage as populations grow or habitats change. Further, interactions may exist among growing populations, nutrition, predation, and disease. Indeed, immune function and nutrition may well be tightly linked and thereby, may lend some ecological and environmental context to when pneumonia dieoffs may occur in chronically infected herds. Understanding how nutrition, disease, predation, and recruitment in female bighorn sheep interact to influence population dynamics is critical in developing management plans to maintain healthy populations of one of our most cherished ungulate species.

We will continue intensive summer habitat work and monitoring lamb survival in the Whiskey Mountain and Gros Ventre herds through 2021. Looking forward, we hope to include an additional segment of the Whiskey herd that are high-elevation residents in our study. This segment of the Whiskey herd stays at high elevations year-round, instead of migrating to a lower elevation in the winter like the rest of the herd. Based on herd composition surveys done by Wyoming Game and Fish, the high elevation residents have much rates of lamb survival than the elevational migrants. Consequently, the story of the sheep that remain at high elevations may hold powerful insight into understanding how disease, nutrition, or predation dynamics affect this segment of the herd. Such understanding could shed light into potential solutions for the Whiskey Mountain herd. Indeed, to fully comprehend population dynamics and the interaction among density, nutrition, disease and migration in the Whiskey Mountain herd, we must capture and include animals from the segments of the population that seem to have better performance.

OUR TEAM

This project is led by master's students Brittany Wagler and Rachel Smiley.

Brittany

Rachel

PARTNERS & COLLABORATORS

The Northwest Wyoming Bighorn Sheep Project benefits from being highly collaborative in development, operations, and funding. We at the University of Wyoming are fortunate to partner with the Wyoming Game and Fish Department and the Wyoming State Veterinary Laboratory, a collaboration through which we can pull expertise from managers, disease specialists, and ecologists. Funds have been provided by the Wyoming Game and Fish Department, Wyoming Game and Fish Commission, Wyoming Wildlife and Natural Resource Trust, National Wild Sheep Foundation, Wyoming Wild Sheep Foundation, Wyoming Governor's Big Game License Coalition, Bureau of Land Management, Wyoming Animal Damage Management Board, Wyoming Wildlife Livestock Disease Research Partnership, and Bowhunters of Wyoming Inc. Special thanks to the Wyoming Game and Fish Department, United States Forest Service, and Wyoming State Veterinary Lab for assistance with logistics, lab analyses, field housing, and fieldwork.

2019 - JCR Evaluation Form

SPECIES: Mountain Goat
HERD: MG101 - PALISADES
HUNT AREAS: 2, 4

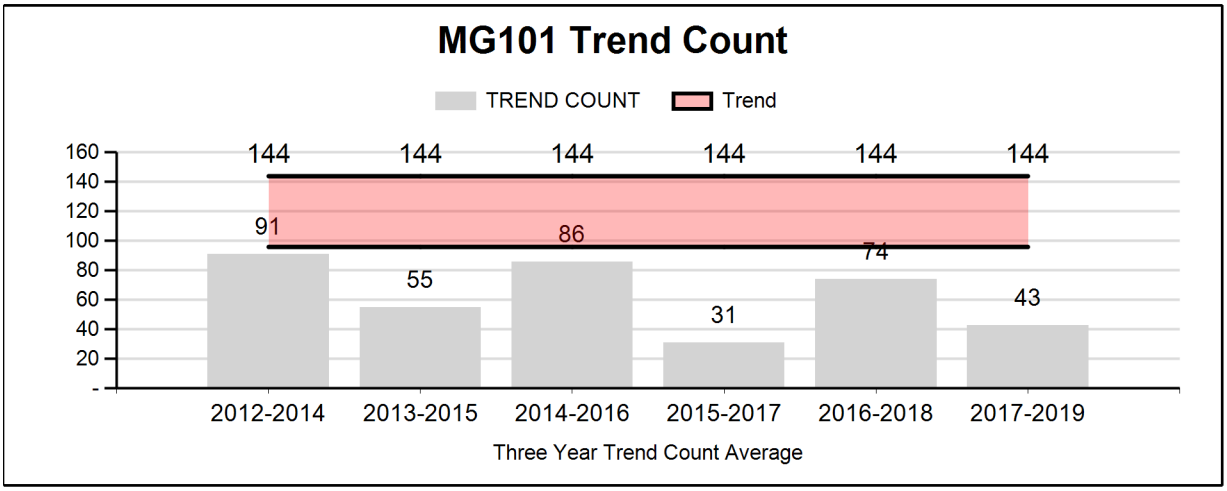
PERIOD: 6/1/2019 - 5/31/2020
PREPARED BY: GARY FRALICK

	2014 - 2018 Average	2019	2020 Proposed
Trend Count:	129	0	110
Harvest:	9	32	8
Hunters:	10	50	8
Hunter Success:	90%	64%	100 %
Active Licenses:	10	50	8
Active License Success	90%	64%	100 %
Recreation Days:	49	264	40
Days Per Animal:	5.4	8.2	5
Males per 100 Females:	0	0	
Juveniles per 100 Females	24	0	

Trend Based Objective (± 20%)	120 (96 - 144)
Management Strategy:	Special
Percent population is above (+) or (-) objective:	N/A%
Number of years population has been + or - objective in recent trend:	1

Proposed harvest rates (percent of pre-season estimate for each sex/age group):

	JCR Year	Proposed
Females ≥ 1 year old:	NA%	NA%
Males ≥ 1 year old:	NA%	NA%
Juveniles (< 1 year old):	NA%	NA%



2020 HUNTING SEASONS
PALISADES MOUNTAIN GOAT HERD (MG101)

Hunt		Archery Dates		Season Dates			
Area	Type	Opens	Closes	Opens	Closes	Quota	Limitations
2	1	Aug. 15	Aug. 31	Sept. 1	Oct.31	8	Any mountain goat
4	A	Aug. 1	Aug. 14	Aug. 15	Nov.15	48	Any mountain goat

2020 Management Summary

1.) **Hunting Season Evaluation**: In Area 2 a total of eight (8) licenses, valid for any goat, will be issued in 2020. The season will run September 1 – October 31. The number of licenses issued will be similar to levels issued in 2017 and 2018 and reflects a population dynamic that remains within the management trend count threshold of 120 (+/- 20%) mountain goats. Management emphasis in Hunt Area 4 will remain the elimination of mountain goats from the Teton Mountain Range. Licenses issuance will remain similar to 2019 levels. A total of 48 licenses were issued.

2.) Management Objective Review: The Palisades mountain goat mid-summer trend count objective is 120 goats, and was established by the Wyoming Game and Fish Commission in 2015. In 2020, managers reviewed the past five years of population, harvest, habitat, and disease data and determined the current mid-summer trend count objective is still appropriate. Current management has resulted in a high degree of hunter satisfaction, exceptionally high hunter success, low days/animal harvest, and trophy class males being taken in most years since the hunt was initiated in 1999. The most recent trend count (August 2018 = 129) was essentially at the objective, as well as the average of the last three trend count surveys (2014, 2016, 2018 average = 129).

3.) **Herd Unit Evaluation**: Since hunting seasons were initiated in 1999, the Palisades herd has offered hunters the opportunity to harvest trophy class billies that are typically 5 years old, or older, and experience a high degree of hunter satisfaction and success, and low days/animal harvested. Midsummer trend counts are conducted in collaboration with the Idaho Department of Fish and Game every other year and are scheduled for August 2020.

The 2019 hunting season was the 21th year that goats have been hunted in Area 2. A total of nine (9) licenses were issued, and nine goats were harvested (eight billies, one nanny). Since 1999, a total of 143 mountain goats (122 billies, 22 nannies) have been harvested in Hunt Area 2, and 85% and 15% of the total harvest has been comprised of billies and nannies, respectively.

In 2019 Hunt Area 4 was created and incorporated into the Palisades herd unit. The management objective in Area 4 has been the dramatic reduction or elimination of mountain goats from lands located outside of Grand Teton Nation Park in Wyoming (GTNP). The first hunting season in Area 4 was initiated in 2019, with a total of 48 limited quota licenses issued. A total of 41 hunters harvested 23 mountain goats (14 billies, nine nannies). Hunter success in Area 4 was reported at 56%.

Since 1996, Wyoming has conducted August aerial surveys in Hunt Area 2 (Appendix A). These surveys are in association with the Idaho Department of Fish and Game, and are a collaborative effort to assess herd composition, distribution, and population status.

During the intervening years since the initial 1996 mid-summer trend count, opportunistic mid-winter surveys were attempted in conjunction with big game surveys which were dependent upon weather conditions that allowed safe flying conditions and adequate funding. The effect of these surveys was to document the location of crucial winter ranges and provide a relative assessment of any changes in herd dynamics. The most relevant mid-winter surveys occurred in February 2017 and 2018, respectively, in conjunction with annual elk and moose surveys. In February 2017 and January 2018 a total of 80 and 70 mountain goats were observed, respectively, in Hunt Area 2. The observed mid-winter kid:adult ratios were 8 kids:100 adults during both surveys (Appendix A). The January 2018 survey was followed in August by the regularly scheduled mid-summer survey. A total of 129 mountain goats were counted during that survey. A substantial increase in the number of kids observed was documented, and was reflected in an observed kid:100 adults ratio of 33:100 (Appendix A).

4.) A substantial and unprecedented effort to understand population dynamics, movements and distribution, and disease ecology in this mountain goat population occurred in 2013 when the Department initiated a collaborative research project with Montana State University and the Greater Yellowstone Area Mountain Ungulate Project. Over the course of 4 years, a total of 24 mountain goats were captured and monitored for seasonal movements, distribution, and dispersal into surrounding mountain ranges. Of the 24 goats captured, 18 were radio-collared. The primary goal of radio-collaring mountain goats was to assess productivity, determine the prevalence of respiratory pathogens, document daily and seasonal movements, and identify dispersal mechanisms into surround mountain ranges. Since the capture efforts were initiated in 2013, the subsequent findings and results of the Palisades mountain goat research initiative have been reported in the 2014, 2015, 2016 and 2019 Job Completion Reports, Palisades mountain goat herd (Wyoming Game and Fish Department, Jackson Region).

5.) During winter 2019–2020 Grand Teton National Park (GTNP) finalized and subsequently implemented a program designed to employ lethal and non-lethal methods to remove mountain goats that reside inside GTNP. The lethal removal operation (using trained marksmen from a helicopter) was launched on February 21, 2020 and resulted in 36 mountain goats killed before the operation was halted by the U.S. Secretary of the Interior at the request of the Governor of Wyoming. Plans are being developed to conduct further lethal removal operations using skilled volunteers in ground-based efforts.

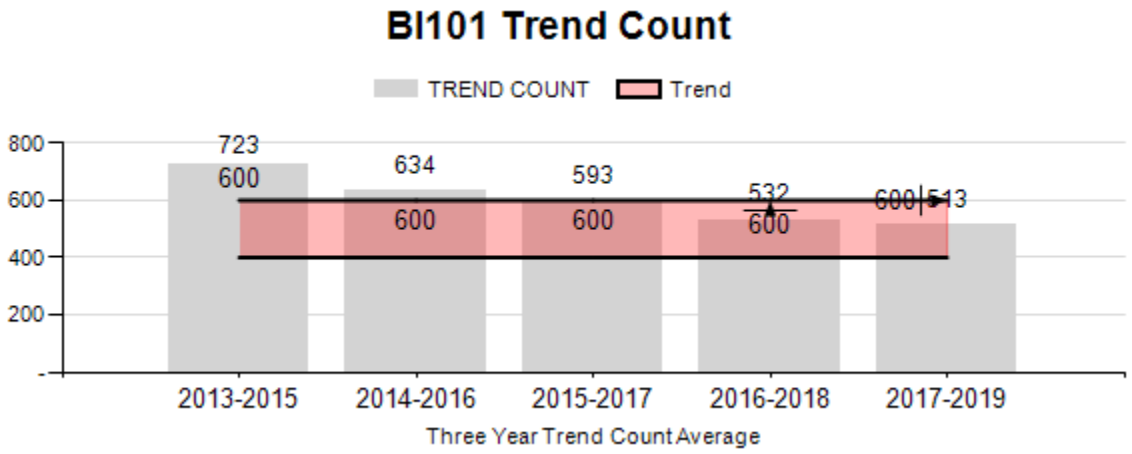
2019 - JCR Evaluation Form

SPECIES: Bison
HERD: BI101 - JACKSON
HUNT AREAS: 2

PERIOD: 6/1/2019 - 5/31/2020
PREPARED BY: ALYSON COURTEMANCH

	2014 - 2018 Average	2019	2020 Proposed
Trend Count:	591	488	500
Harvest:	188	92	125
Hunters:	237	146	175
Hunter Success:	79%	63%	71%
Active Licenses:	237	146	175
Active License Success	79%	63%	71 %
Recreation Days:	1,384	1,427	1,000
Days Per Animal:	7.4	15.5	8
Males per 100 Females:	101	88	
Juveniles per 100 Females	51	39	

Trend Based Objective (± 20%)	500 (400 - 600)
Management Strategy:	Recreational
Percent population is above (+) or (-) objective:	-2.4%
Number of years population has been + or - objective in recent trend:	0



2020 HUNTING SEASONS
JACKSON BISON HERD (BI101)

Hunt Area	Type	Archery Dates		Season Dates		Quota	Limitations
		Opens	Closes	Opens	Closes		
2	1			Aug. 15	Jan. 1	125	Any wild bison; also valid in Area 1 within the Clark's Fork River and Soda Butte Creek drainages. Valid in other portions of Area 1 upon notification and authorization by the Department
2	1			Jan. 2	Jan. 31		Any wild bison. Limited alternate permits for the National Elk Refuge may be available through the Department's Jackson Regional Office on a first-come first-served basis until the season closes or forage/weather conditions dictate that supplemental feeding is necessary
2	4			Aug. 15	Jan. 1	50	Any female or calf wild bison; also valid in Area 1 within the Clark's Fork River and Soda Butte Creek drainages. Valid in other portions of Area 1 upon notification and authorization by the Department
2	4			Jan. 2	Jan. 31		Any female or calf wild bison. Limited alternate permits for the National Elk Refuge may be available through the Department's Jackson Regional Office on a first-come first-served basis until the season closes or forage/weather conditions dictate that supplemental feeding is necessary

2020 Management Summary

1.) **Hunting Season Evaluation:** The 2020 hunting season remained the same as 2019. Four hundred and eighty-eight (488) bison were classified during the 2019 mid-winter trend count. A large proportion of the herd was on native winter ranges in Grand Teton National Park (GTNP) and in forested areas, which made sightability difficult. Based on previous classification and harvest numbers, managers estimate that there were approximately 550 bison in the herd post-season 2019. Calf recruitment in recent years has been estimated at approximately 100 calves, meaning that an annual harvest of about 100 bison will hold this population stable. Annual harvest over the past 3 years has been 92 bison (2019), 91 (2018), and 70 (2017).

2.) **Herd Unit Evaluation:** When the Jackson Bison Herd was above objective, hunter success was commonly 80-98% success. During the past three years when the herd has been close to the 500 bison objective, hunter success has been lower (50-63% success). This is because the majority of bison harvest (and nearly all of the cow/calf harvest) occurs when bison migrate to

the National Elk Refuge. For the past three years, this migration has happened very late (the last few days of January). This uncertainty of the timing of the migration has been frustrating for hunters. However, managers have limited options to increase hunter opportunity due to the majority of the herd residing longer within GTNP during the season. Managers increased the number of Type 1 licenses in 2019 to allow hunters to take any bison and worked with GTNP in 2020 to allow additional bison retrieval routes from the open hunt area on Bridger-Teton National Forest to parking areas in GTNP. Although the unpredictability of bison in the open hunt area has been frustrating for hunters, recent harvest levels have been sufficient to prevent the population from increasing.

2019 – Jackson Region Disease Monitoring

PREPARED BY: BEN WISE PERIOD: 6/1/2019 - 5/31/2020

Wildlife disease surveillance, management and mitigation are an integral part of wildlife management in the Jackson Region of the Wyoming Game and Fish Department (WGFD). Several significant diseases are routinely monitored, and in some cases complicated by supplemental feeding of elk and bison. Disease management is not only a wildlife issue in the Jackson Region, but often involves potential pathogen transmission concerns with domestic livestock. It is the intent of managers in the Jackson Region to understand disease dynamics and attempt to limit disease transmission, morbidity and mortality in wildlife, while at the same time addressing statutory obligations to address big game damage to stored crops and prevent commingling with domestic livestock (specifically elk/bison/cattle).

Brucellosis

Brucella abortus, a gram negative bacterial infection, is the causative agent for the disease Brucellosis. Brucellosis is a mammalian bacterial disease that has been endemic in the Greater Yellowstone Ecosystem (GYE) since the early 1900's. The main route of transmission of this disease is via physical contact with infected reproductive materials (aborted fetuses, placenta, amniotic fluids, live born fetuses, etc.) during the transmission period (February 15-June 1). Both the primary transmission route and transmission period were determined and validated through work that was partially undertaken by the WGFD's Brucellosis-Feedground-Habitat (BFH) section from the mid 1980's through 2018. Along with the information that was collected on what transmission in the environment looks like, several Best Management Practices (BMPs) were developed in an effort to slow the rate of transmission of brucellosis in feedground settings. Due to the increased risk of disease proliferation in the feedground systems of western Wyoming, several of these practices have been adopted (referred to as the "Target Feedground Plan") at various levels of success in an effort to reduce and control communicable diseases both within wildlife and among livestock populations in the region. For the 2019-2020 feeding season, the following brucellosis (and overall wildlife disease) management efforts were implemented.

Brucellosis Surveillance

During the winter of 2019-2020, Jackson Region personnel (and U.S. Fish & Wildlife personnel on the National Elk Refuge) captured elk using both chemical immobilization and corral traps at feedgrounds to deploy Global Positioning System (GPS) collars to continue long term brucellosis seroprevalence trend data and for additional brucellosis-related investigations. Early winter conditions in the Jackson Region were mild, but followed by record snowfall amounts in

January, which increased feedground attendance in the Fall Creek and Jackson Elk Herds and resulted in emergency feedground initiation in the Star Valley due to wildlife/livestock comingling concerns. As part of regional surveillance plans, the Fall Creek Elk Herd was the priority surveillance herd for 2020. This effort included trapping elk at South Park (last statistically significant sample effort in 2010) and Horse Creek feedgrounds (last statistically significant sampling effort in 2000). Overall, 402 elk were handled this winter, including 347 animals trapped on the Fish Creek, South Park, and Horse Creek feedgrounds, 35 elk chemically immobilized on the National Elk Refuge, Camp Creek, Dog Creek, and Forest Park feedgrounds, and 23 adult female elk helicopter net-gunned on native range in the Fall Creek and Jackson Herd Units. GPS collars were placed on all elk chemically immobilized, as well as those helicopter net-gunned. Sampling results from this past winter are given in Table 1.

Table 1. Brucellosis sampling for elk in the Jackson Region, 2019-2020.

Feedground	Sampling Method	# Animals Captured	19-20 Sero (Total Tested)	Long Term Sero (Total Tested)
Fish Creek	Trap	81	31% (35)	32% (361)
Horse Creek	Trap	177	47% (47)	43% (83)
South Park	Trap	89	23% (40)	32% (228)
NER	Dart	25	20% (25)	34% (2037)
Camp Creek	Dart	3	33% (3)	44% (82)
Dog Creek	Dart	2	50% (2)	54% (61)
Forest Park	Dart	2	50% (2)	25% (326)
Fall Creek (NWR)	Helicopter	8	38% (8)	41% (17)
Gros Ventre (NWR)	Helicopter	15	27% (15)	32%(34)

Target Feedground Plan

- Low Density Feeding: Low Density (LD) Feeding is a technique that was developed and validated by the BFH crew in the late 2000's in an effort to reduce contact (and subsequent transmission risk) between elk on supplemental feed. This technique has been shown to reduce contacts with aborted fetuses by 66-75% and is a cost effective method to directly reduce brucellosis prevalence among elk attending feedgrounds, and indirectly reduce risk of brucellosis spillover into livestock. The basic idea behind this technique is to distribute the hay in a uniform pattern across the feeding area, which reduces the linear travel of elk on feedlines. When done correctly the feedground looks similar to a checkerboard, allowing an individual animal up to eight potential paths of travel to move between hay piles as opposed to a linear feeding (traditional) system where there are only two directions of travel on the feed lines. Where feasible, the Jackson Region has implemented LD feeding and where utilized effectively, has been shown to decrease brucellosis seroprevalence.

- Early End Dates: In conjunction with LD feeding, early supplemental feeding end dates has been shown to reduce brucellosis transmission on feedgrounds (and subsequently reduce brucellosis infection rates among attending elk). Research by the WGFD has found that the rate of elk abortion due to brucellosis on feedgrounds peaks in March, April and May, so the earlier in spring that managers can encourage elk to disperse onto native ranges, the less the chance for elk to become exposed to the disease while on densely occupied feedgrounds. However, to end feeding as early as possible there must be sufficient native forage available so elk remain in good health, and the risk of elk causing damage to stored crops or co-mingling with cattle remains very low. Based on 65 years of WGFD feedground data (Cross et. al., 2007), over 50% of the variation in brucellosis seroprevalence among elk attending feedgrounds can be explained by the end date of the feeding season (the later into spring a feedground operates, the higher brucellosis prevalence is), therefore truncating feeding seasons, where possible and if successful, should lead to long term decreases in brucellosis prevalence over time.

Necrotic Pododermatitis (Hoof-rot)/Necrotic Stomatitis (Mouth-rot)

During the 2019-2020 feeding season, a mortality event was documented at the Horse Creek/Camp Creek Feedground complex south of Jackson. Based on visual and necropsy observations, this prolonged morbidity/mortality event was determined to be from a buildup of *Fusobacterium necrophorum,* an anaerobic bacteria commonly found in the mammalian digestive tract. Based on past documentation, these outbreaks typically occur when animal densities are high and animals cannot adequately spread out and utilize clean feeding areas. Typically these mortality events occur later in the feeding season (spring) as temperatures moderate and daily freeze-thaw cycles allow the proliferation of the anaerobic bacteria in the feeding areas. The combination of high densities of elk, limited ability to spread animals out on clean feeding areas, and the accumulation of feces throughout the feeding season results in an increased risk of this disease.

Typically this disease presents itself as either infectious necrotic pododermatitis (Hoof-rot) or Necrotic Stomatitis (mouth-rot), and occurs due to either inter-digital or inter-oral injury combined with subsequent infection of *F. necrophorum* from the environment. The majority of the mortality attributed to this disease on elk feedgrounds occurs in calves. It is speculated this is due in part to their small size, limited energy reserves and inability to adequately deal with the systemic infection that often accompanies a severe *F. necrophorum* infection. If infected individuals are able to survive a *F. necrophorum* infection often there will be lifelong morbidity (deformed hooves, necrosis of the jaw, etc.) in the afflicted areas due to the infection.

Based on past experience, elk that are fed a diet consisting of predominantly alfalfa or alfalfa/grass mix hay, fed at high densities (based on overall feedground size and attendance), and fed later into the spring (after loss of persistent snow cover on feedgrounds) tend to be at a higher risk of *F. necrophorum* outbreaks. Based on a combination of feedground classification survey results and limited options to adjust feeding practices available at the Horse Creek Feedground, it was predicted there would be a *F. necrophorum* outbreak during the spring of 2020.

In early March, WGFD began receiving reports from the feeder that calves were becoming lame and lethargic on Horse Creek Feedground, which resulted in an increased focus on monitoring animal health at this feedground. Between March 5 and April 11, 2020 a total of 56 calf mortalities were documented, with 36 occurring either on or directly adjacent to the feeding areas, with many euthanized due to inability to move at time of discovery. An additional 20 calves were documented to the west of the feedground along the elk exclusionary fence and based on scavenging patterns, locations, age and timing of mortality it is assumed that these individuals are highly likely to have been infected as well. The documented mortality on this feedground accounts for over 18% of the calves that were classified in this location in 2020. Mortality events like this further support proper feedground management practices (reducing densities of elk on feedgrounds through managing populations to maintain feedground objectives) and the need for continued monitoring and research into feedground related diseases in order to reduce the risk of large scale transmission events and subsequent increased mortality.

Chronic Wasting Disease

The WGFD conducted Chronic Wasting Disease (CWD) surveillance in the Jackson elk herd and adjacent elk, deer, and moose herds during the 2019 hunting seasons. Additional funds were provided by the Teton Conservation District (TCD) through a generous grant to extend the available technician hours to enhance sampling effort. The funding was used by the WGFD to hire one temporary CWD technician from mid-October through March 2020. The WGFD technician logged 600 hours and 6,773 miles, mostly while conducting field contacts with hunters and collecting samples (medial retropharyngeal lymph nodes) from carcasses. Having additional funding for the CWD technician position allowed field presence nearly every day of open hunting seasons in the Jackson area as well as considerable time to work with feeders and collect CWD samples at state operated feedgrounds throughout the winter. This strategy helped maximize the number of samples collected from all species throughout the Jackson Region.

The highest yielding method of collecting elk samples for subsequent CWD testing in the Jackson Region comes from partnerships with local meat processors as well as hunter contacts in the field, especially those within Grand Teton National Park (GTNP) and the National Elk Refuge (NER). Hunter contacts are made throughout the fall in an effort to increase sample size and participation, and to educate hunters on CWD. NER parking areas and highly used locations in GTNP, such as the Kelly Hayfields and Blacktail Butte, are reliable places to make hunter contacts and collect samples. Frequent communication among NER/GTNP law enforcement, GTNP biological staff, elk retrieval operators and other WGFD personnel is essential for locating successful hunters soon after they've harvested their elk.

Successful hunters whose animals are not sampled in the field are requested to deposit heads with attached harvest information in bear-proof containers placed at Moose and Moran Junctions within GTNP in the same locations as tooth and permit drops. Another container is stationed at Kelly Warm Springs, mostly for use by hunters returning from the Gros Ventre drainage, and more head-drop containers are placed at three of the hunter parking areas on the NER. An additional collection barrel was located at the WGFD office in Jackson,

Many samples are obtained though the cooperation of the local game meat processor (Matts Meats – Jackson). Employees save heads along with harvest date, location, and hunter contact information, which are retrieved by CWD technicians daily. CWD samples are also collected from road-killed and "targeted" (euthanized due to illness) animals throughout the year. In addition, GTNP personnel make a concerted effort to sample road-killed and hunter harvested animals within the Park. With increased interest in CWD testing over the last several years in the Jackson Region, a concerted effort has been made to educate and train the hunting public how to collect and submit samples collect from their own harvested animals. This educational effort includes providing public wildlife disease workshops in the region including sampling demonstrations, training interested individuals on a one-on-one basis and distributing sampling supplies to individuals upon request.

Personnel at the WGFD Wildlife Health Laboratory use the IDEXX enzyme-linked immunosorbent assay (ELISA) to analyze lymph node samples for CWD. Any IDEXX-positive samples would then be confirmed with the Bio-Rad ELISA. Samples positive on both ELISAs would be confirmed by immunohistochemistry. Results are reported to hunters typically within three weeks of sample submission. Hunters can obtain results by accessing the Department's web site, and hunters that submit a positive sample are personally notified via phone and letter.

The WGFD collected and tested a total of 447 lymph nodes from 346 elk, 96 deer, and 5 moose for CWD within the Department's Jackson region in 2019 (Appendices A, B, C). We did detect one new CWD case in the Jackson Region during the 2019 hunting season. An adult male mule deer was harvested by a hunter in the Willow Creek drainage of Deer Hunt Area 152 in October, and subsequently sampled at the Alpine Check Station by WGFD personnel. Detailed sampling efforts from specific geographic areas follow.

Jackson Elk Herd/Sublette Deer (North Jackson)

During calendar year 2019, WGFD collected 180 lymph nodes from elk sampled within the Jackson Elk Herd (HAs 70-83; Table 2, Appendix A). Hunt Areas 75 and 77 comprised the majority of samples, and the most effective means of sample collection was through field contacts (i.e., approaching hunters with downed animals and removing lymph nodes in the field; Figure 1). The high proportion of samples obtained via field contacts emphasizes the importance of having trained personnel in the field every day during hunting seasons. Head-drop barrels were only moderately successful in gathering samples; many hunters make use of the barrels only if they have been contacted previously in the field by WGFD personnel. An additional 30 samples from the Jackson herd were collected from targeted elk or feedground mortalities, the majority of which were collected on the NER during feeding operations January-March 2020.

A total of 21 samples were collected from deer within the area encompassed by the Jackson elk herd (Appendix B). A substantial proportion of the contributions to the overall deer sample size came from road killed mule deer collected by WGFD staff. The majority of deer harvested in this area are typically bucks killed in backcountry areas. Whole carcasses and intact heads are rarely encountered during field checks, limiting opportunities for collecting testable lymph nodes.

Table 2. CWD samples collected from elk within the Jackson elk herd by year, with corresponding population and harvest estimates.

Year	Sample Size	Population Estimate	% of Est. Pop Sampled	# Harvested	% of Harvest Sampled
1997	243	16463	1.48%	3290	7.39%
1998	317	17641	1.80%	3159	10.03%
2000	197	16385	1.20%	2350	8.38%
2002	234	13457	1.74%	2253	10.39%
2004	187	12610	1.48%	1818	10.29%
2005	189	12855	1.47%	1776	10.64%
2006	184	12904	1.43%	1678	10.97%
2007	116	12795	0.91%	1689	6.87%
2008	301	12935	2.33%	1316	22.87%
2009	434	13349	3.25%	1486	29.21%
2010	414	11976	3.46%	1414	29.28%
2011	275	11962	2.30%	1146	24.00%
2012	241	11051	2.18%	1037	23.24%
2013	300	11423	2.63%	1437	20.88%
2014	247	11,000	2.25%	1768	13.97%
2015	301	11,200	2.69%	1183	25.44%
2016	558	10,766	5.18%	1482	37.65%
2017	394	10,877	3.58%	1144	34.44%
2018	365	9,627	3.97%	1336	27.32%
2019	180*	10,985	1.64%	791*	22.76%*

* does not include samples collected and submitted by GTNP staff

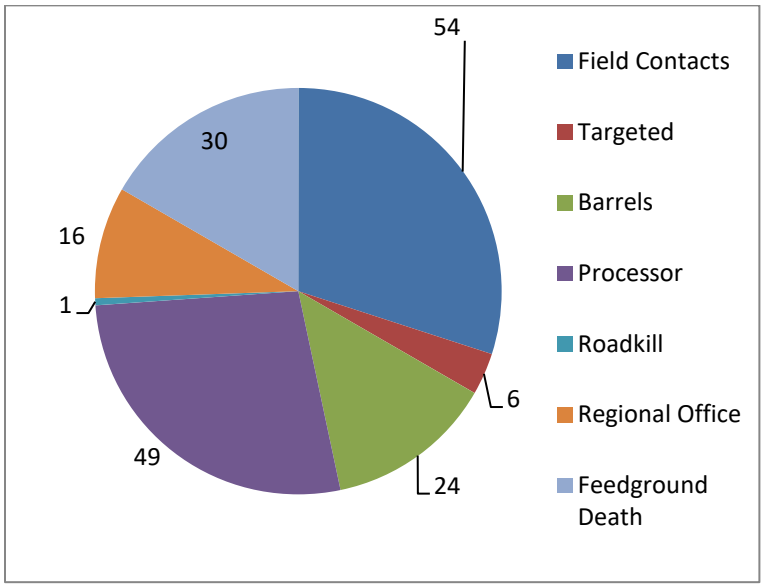


Figure 1. Collection method of 180 total elk CWD samples obtained in the Jackson elk herd, 2019.

Fall Creek Elk Herd, Sublette Deer Herd (South Jackson)

Elk HAs 84 and 85, covering the Snake River Range and much of the lower Hoback River Basin, make up the Fall Creek Elk Herd (Appendix A). Samples were collected from 94 elk in this herd, the majority of which came from hunter-killed animals and feedground related deaths. Deer HAs 151 and 152 correspond to the area covered by the Fall Creek Elk Herd. In 2019, we collected 25 total CWD samples from deer in these areas (Appendix B). A significant proportion of samples came from opportunistically sampling road-killed animals and collecting samples from local area processors.

Afton Elk Herd, Wyoming Range Deer Herd (Salt and Greys Rivers)

Elk HAs 88, 89, 90, and 91 comprise the Afton elk herd. In 2019, the Afton Elk Herd was identified as a priority CWD sampling herd by the internal CWD Management Team, with the goal of collecting at least 200 CWD samples from the herd in order to more accurately analyze disease data (can be collected over multiple years). A total of 72 samples were collected this year, primarily from hunter-killed animals collected at the Alpine Check Station (Appendix A). Jackson wild game processors, taxidermists and field checks also contributed in attaining these samples. Deer HAs 144 and 145 correspond to the area covered by the Afton elk herd. The majority of samples obtained from these areas were pulled from carcasses that came through the hunter check station set up on the Greys River road in Alpine. The check station was attended by WGFD personnel during approximately 10 days of anticipated heavy hunter-traffic. A total of 50 samples were collected in deer HAs 144 and 145 in 2019 (Appendix B).

Targhee, Jackson, Sublette Moose Herds (Hunt Areas 16, 17, 18, 20, 21, 23, 37)

A total of 5 moose were sampled in the Jackson Region during 2019 (Appendix C). Two moose samples were obtained in 2019 from HA 23, considered "CWD endemic" because of a single positive moose euthanized there in 2008. Forty percent of all moose samples (2 of 5) this year were obtained from road-killed animals. Two hunter-harvested moose samples from the Sublette Moose herd were collected and zero (0) from the Jackson Moose Herd, reflective of the reduced number of tags issued in these herds due to declining populations. One moose was removed by WGFD personnel due to injury/illness during 2019.

Research Projects

Jackson Moose Disease Project

Funding was obtained in 2019 to deploy GPS collars on exurban moose in the vicinity of the proposed Highway 22/390-Snake River Bridge Reconstruction Project in order to determine need and placement of wildlife crossing structures. Due to numerous cases of apparently healthy moose mortalities in the recent past, a disease component was added to already planned capture and monitoring protocols associated with this ongoing work in 2020.

The disease component is being led by Montana State University, with assistance from many collaborators that will assist in the design, implementation, analysis and/or collection of disease-related information. These collaborators include;

Troy Koser: PhD student with an emphasis in moose/winter tick interactions from Montana State University, Bozeman MT.
Kennan Oyen: Physiological Ecologist from the University of Cincinnati, Cincinnati OH.
Catherine Haase: Climate and Wildlife Interactions researcher from the National Climate Adaptation Science Center, USGS, Reston VA.
Laura Thompson: Thermal Ecologist and assistant professor from Austin Peay State University, Clarksville TN.
Paul Cross: Ecologist, specializes in infectious wildlife disease and quantitative methods, USGS Bozeman MT.
Sarah Dewey: Lead wildlife biologist at Grand Teton National Park, where she oversees the parks' ungulate monitoring, research, and management program, Moose WY.
Alyson Courtemanch: Wildlife Biologist, Wyoming Game and Fish Department, Jackson WY.
Ben Wise: Regional Wildlife Disease Biologist, Wyoming Game and Fish Department, Jackson WY.
Deborah McCauley and Virginia Stout: Wildlife veterinarians with Veterinary Initiative for Endangered Wildlife (VIEW), Bozeman MT.

In the spring of 2020, collars were deployed on four moose in the general vicinity of Highway 22 and Highway 390 near Wilson WY. In addition to deploying GPS collars for movement data, environmental and wildlife health information and biological samples were gathered, and body condition, presence of meningeal worms (*Elaeophora schneideri* via ultrasound), and extensive tick surveys were conducted on anesthetized animals. Data from these sampling efforts are being analyzed at present time and a synthesis of the captured animal conditions is not currently available. The data gathered from this project will be used to test several research questions pertaining to tick/*Elaeophora schneideri* distribution in relation to migratory movements/home ranges, effects of winter severity and persistence of snow pack on tick survival and questing, effects of home range selection on highway mortality and spring/summer moose microsite selection and subsequent tick presence/absence.

Bighorn Sheep Nutrition-Disease Relationships

For the past 5 years, WGFD has collaborated with the University of Wyoming on a research project investigating bighorn sheep nutrition, disease, reproduction, and causes of lamb mortality in the Jackson, Whiskey, and Absaroka Herds. Results from this research in the next few years will provide additional insight into the nutritional carrying capacity of the herds within the context of respiratory disease. These results will help inform the next population objective review in 2025. Preliminary results

from this research are attached with the Jackson Bighorn Sheep Job Completion Report.

Miscellaneous Necropsies

Field necropsies are often conducted in order to determine cause of death, disease, body condition and physiological trauma. The majority of these necropsies are done in an expedited fashion, especially when the biologist that is conducting the necropsy is monitoring an ongoing mortality event (i.e. *F. necrophorum* outbreaks on feedgrounds, urban mule deer spring mortalities). In cases where cause of morbidity or mortality are not known, a more rigorous necropsy occurs in an effort to provide wildlife managers, researchers and the general public with information as can be determined in a field necropsy (gross morbidity vs. histology). Due in part to cost as well as logistics, often many of the samples collected during field necropsies are not submitted to the Wyoming Wildlife Health Center unless findings are particularly interesting or samples collected are part of an ongoing wildlife disease sampling effort (i.e. CWD surveillance, big horn sheep nasal tumors, *Elaeophora schneideri* surveillance). Table 3 represents field necropsies conducted by the Jackson Wildlife Disease Biologist for 2019-2020. In 2020 a local veterinarian associated with VIEW received grant funding from Teton Conservation District to assist in necropsying deceased moose in the Jackson Region. This funding and assistance is integral in being able to conduct through, consistent and timely necropsies on moose in the Jackson Region.

Table 3. Wildlife Necropsies Conducted in Jackson Region WGFD 2019-2020

	Male	Female	Juvenile	**Total**
Moose	0	1	3	**4**
Elk	2	4	25	**31**
Mule Dee	1	3	6	**10**

* Moose Necropsies Conducted by VIEW in collaboration with WGFD

Appendix A. Elk samples tested for CWD collected in the Jackson Region, 2019.

Elk	**Hunt Area**	**Hunter-Killed**	**Targeted**	**Feedground Death**	**Roadkill**	**Total**
Jackson Elk Herd	70	8				8
	71					0
	72					0
	73					0
	74					0
	75	4				4
	77	94	1	25		120
	78	22			1	24
	80		4			4
	81	9		5		14
	82	6	1			6
	83					0
	Total	**143**	**6**	**30**	**1**	180
Fall Creek Elk Herd	84	48	4	9	4	65
	85	24		3	2	29
	Total	**72**	**4**	**12**	**6**	**94**
Afton Elk Herd	88		1	8		9
	89	38				38
	90	10				10
	91	13	1		1	15
	Total	**61**	**2**	**8**	**1**	**72**
Grand Total		**276**	**12**	**50**	**8**	**346**

Appendix B. Deer samples (mule and white-tail) tested for CWD in the Jackson Region, 2019.

Deer	**Hunt Area**	**Hunter-Killed**	**Targeted**	**Roadkill**	**Total**
Sublette Deer Herd (North Jackson)	148	1			1
	150	1	1	9	11
	155	4			4
	156	5			5
	GTNP				0
	Total	**11**	**1**	**9**	**21**
Sublette Deer Herd (South Jackson)	151	3		4	7
	152	11	2	5	18
	Total	**14**	**2**	**9**	**25**
Wyoming Range Deer Herd (Salt and Greys River)	144	31			31
	145	7	2	10	19
	Total	**38**	**2**	**10**	**50**
Grand Total		**63**	**5**	**28**	**96**

Appendix C. Moose samples tested for CWD in the Jackson Region, 2019.

Moose	**Hunt Area**	**Hunter-Killed**	**Targeted**	**Roadkill**	**Total**
Targhee Moose	16				0
	37				0
	Total	**0**	**0**	**0**	**0**
Jackson Moose	7				0
	14				0
	15				0
	17				0
	19				0
	28				0
	32				0
	GTNP				0
	Total	**0**	**0**	**0**	**0**
Sublette Moose	10				0
	20			2	2
	21	1			1
	23	1	1		2
	Total	**2**	**1**	**2**	**5**
Grand Total		**2**	**1**	**2**	**5**