

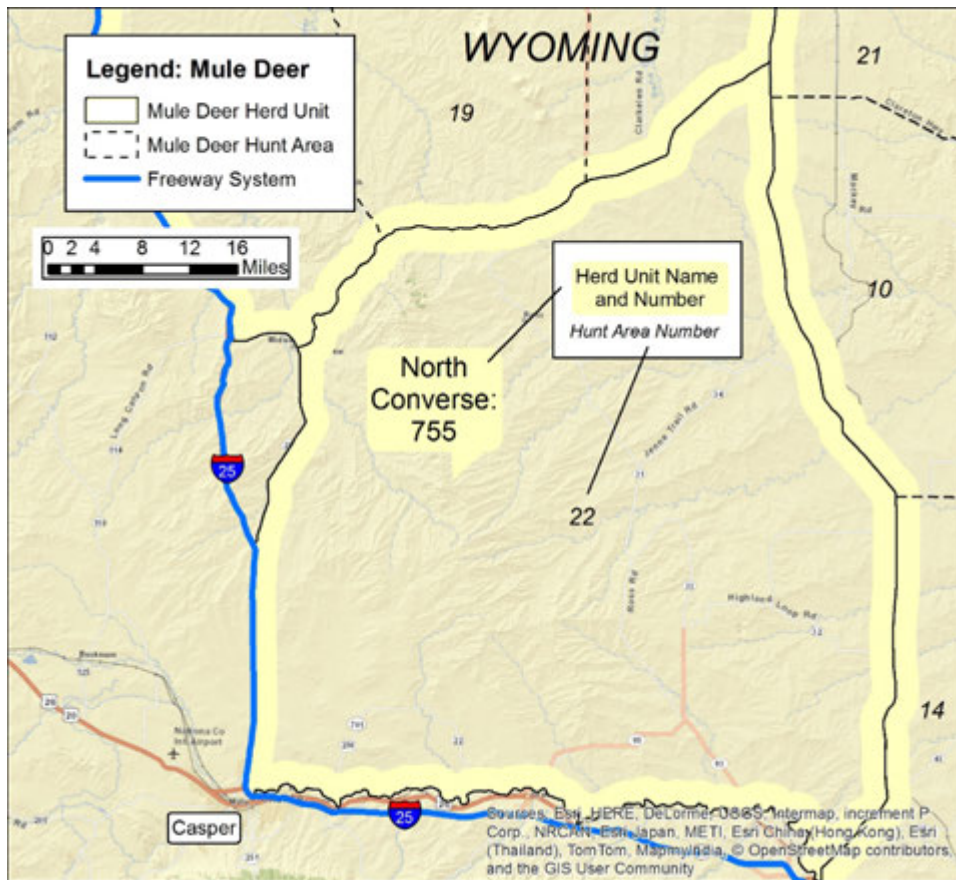


Fig. 97. Wyoming mule deer herd unit 755 (North Converse)

Land Ownership The herd unit contains a mixture of public and private lands. The distribution of land ownership includes 80% private, 10% BLM, 8% state, 1% Bankhead/Jones, 0.5% Department of Defense and 0.5% National Grassland (USFS) (WGFD 2014).

Land Use Primary land uses in this area include extensive oil and gas production, large-scale industrial wind generation, in-situ uranium production, and traditional cattle and sheep grazing. In recent years, expansion of oil shale development has dramatically increased the amount of land disturbed by human activity in the herd unit (WGFD 2013). Urban and sub-urban development includes the communities of Casper (pop. 55,316), Douglas (6,120), Glenrock (2,576), Midwest (404) and Edgerton (195). The remainder of the human population in the herd unit is located in small unincorporated towns, settlements or individual ranches or home sites (TWTER 2014).

Management Issues Management strategy for the herd unit is to limit licenses in order to maintain it as a trophy buck area, with the goal of trying to maintain post-season buck ratios at 30-45 bucks per 100 does. The objective and management strategy were last revised in 1997. The model for the herd unit is considered to be of medium quality based on model fit, although managers strongly concur with simulated population trend. Regardless, given consistently inadequate classification sample sizes, observed buck ratios may not be accurate. Public hunting access within the herd unit is poor, with only small tracts of accessible public land interspersed with predominantly private lands. High trespass fees and outfitting for mule deer are common on most ranches within this herd unit. As a result, licenses remain undersubscribed in years when issuance is elevated to increase harvest on an over-objective population. Habitat conditions in the unit are generally poor due to drought and continued heavy forage utilization by pronghorn antelope and domestic sheep (WGFD 2013).

Population Size This herd has fluctuated from year to year, presumably due to varying environmental conditions such as drought and severe winter conditions, but not as substantially as surrounding herds. As it is currently depicted, this mule deer population has fluctuated between a low of 4,050 animals in 1980 to a high of 11,686 animals in 2000. The mean value for population size for all years is 8,294 animals. The long-term trend for population size is increasing. The 2012 estimate for population size is 6,004 animals. The long-term population objective for this herd is 9,100 animals. This population objective was established in 1997.

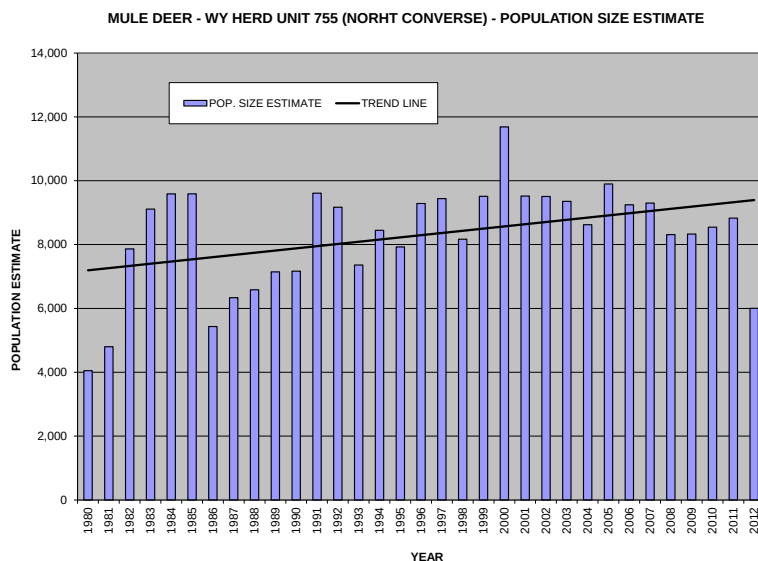


Fig. 98. Mule deer – Wyoming herd unit 755 (North Converse) – population size estimate

Age and Sex Composition Male/100 female ratios have varied from a low of 21 males/100 females in 1983 to a high of 53 males/100 females in 2008. The mean for all years of data 39 males/100 females. The overall trend for all years of data shows male/100 female ratios increasing

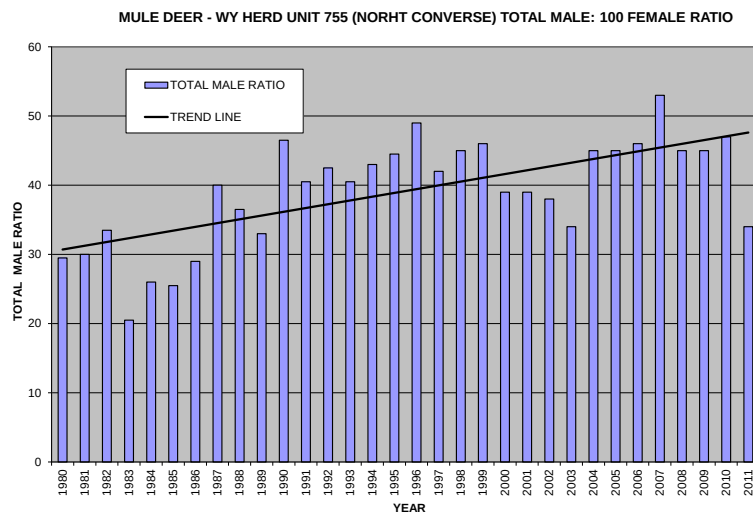


Fig. 99. Mule deer – Wyoming herd unit 755 (North Converse) – male/100 female ratios

Young/100 female ratios have varied from a high of 99 young/100 females in 1990 to a low of 53 young/100 females in 1983. The mean value for young/100 female ratios for all years of data is

75 fawns/100 females. The overall trend for young/100 female ratios for all years of data is decreasing.

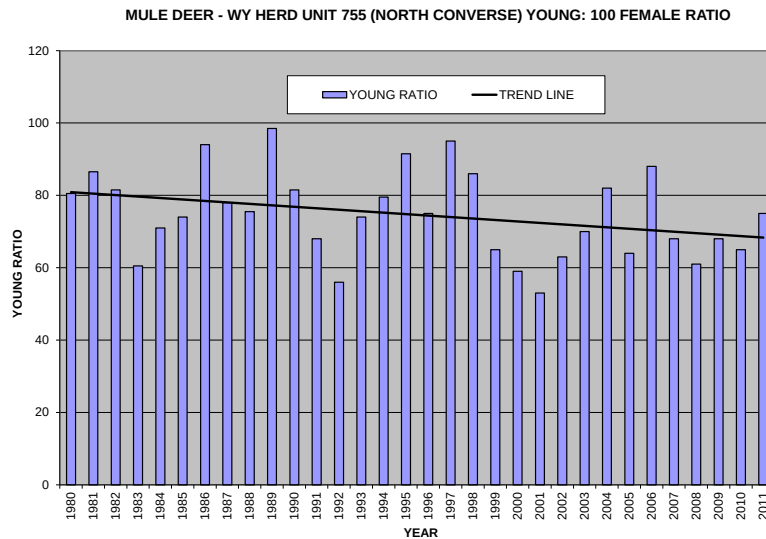


Fig. 100. Mule deer – Wyoming herd unit 755 (North Converse) – young/100 female ratios

Harvest Buck harvest in the herd unit has ranged from a high of 1,064 animals in 1982 to a low of 332 bucks in 2012. The average value for buck harvest in this herd unit is 568 animals. The long-term trend for buck harvest is declining. A review of buck harvest by decade shows that the average buck harvest by decade has declined from a high of 615 animals per year in the 1980s to a low of 419 animals harvested per year in the 2010s, only 68% of the harvest for the 1980s. Buck harvest in this herd unit hasn't equaled the average buck harvest for the unit since 2000.

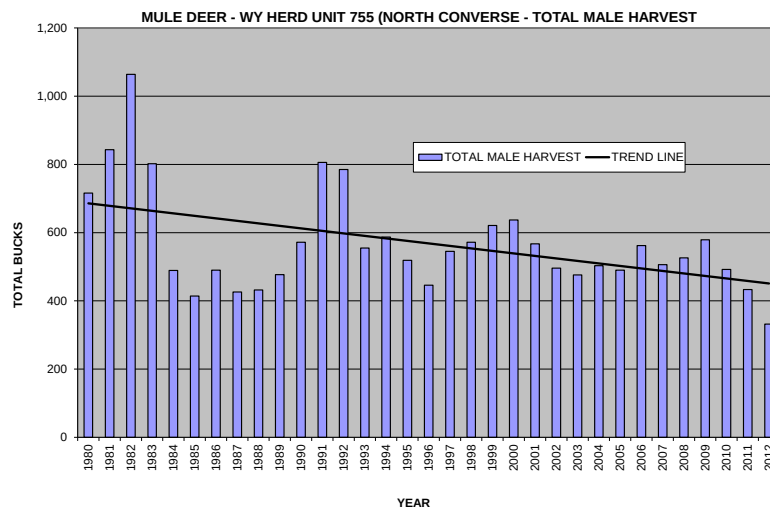


Fig. 101. Mule deer – Wyoming herd unit 755 (North Converse) – male harvest

Total harvest for all seasons and methods of take for this herd unit has varied from a high of 1,491 in 1992 to a low of 451 animals in 2012. The mean of total harvest for the period 1980 to 2012 is 827 deer. The long-term trend for harvest for all years of data for this herd unit is declining.

There have been two major peaks of harvest for this herd unit, one in the early 1980s and a second in 1991 and 1992. Other than those two periods of peak harvest, deer harvest has remained relatively constant, but is exhibiting a substantial decline in the last 3 years.

Harvest of antlerless deer has occurred in all years of the analysis. In some years antlerless harvest was substantial, equaling nearly 50% of the total harvest (1992), but for most years, antlerless harvest has been closer to 30% of the total harvest.

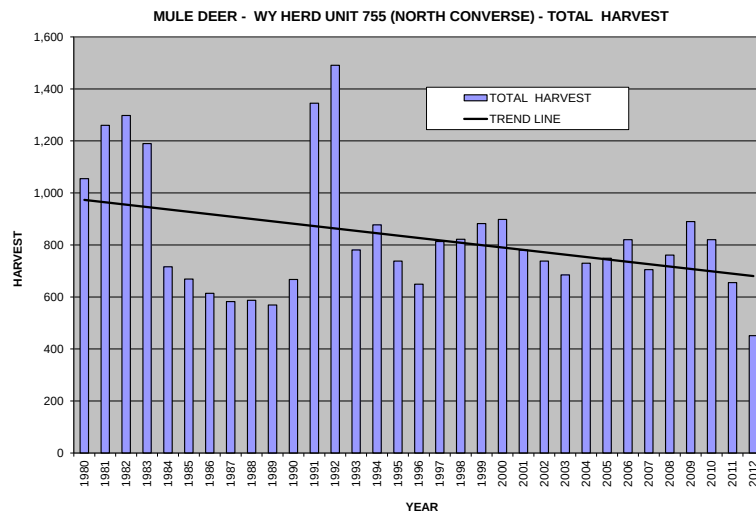


Fig. 102. Mule deer – Wyoming herd unit 755 (North Converse) – total harvest

Hunter Numbers and Success Rates Total hunting pressure for all seasons and methods of take has varied from a high of 2,165 hunters in 1980 to a low of 550 hunters in 2012. The mean value for hunting pressure for all years of the analysis is 1,057 hunters. The long-term trend for hunter numbers is decreasing. An examination of hunting pressure or hunter numbers by decade shows that the mean for hunter numbers in the 2010s is only 60% of the number of hunters supported by the unit in the 1980s.

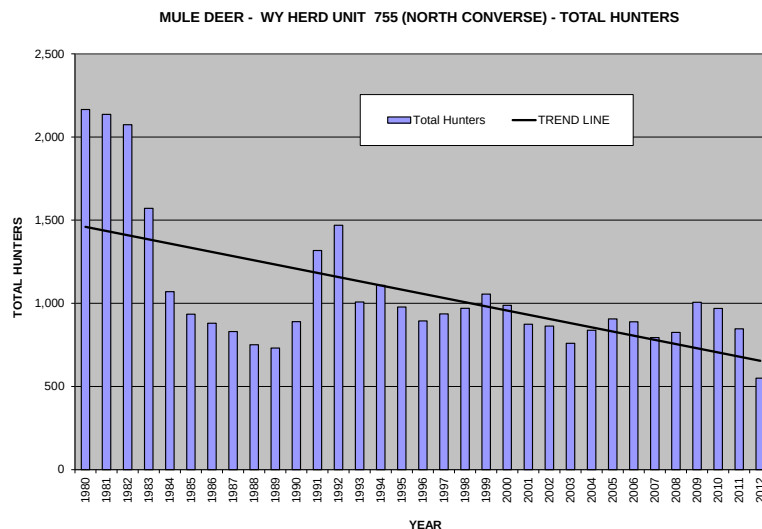


Fig. 103. Mule deer – Wyoming herd unit 755 (North Converse) – total hunters

Hunter success rates for all seasons and methods of take have varied from a low of 49% in 1980 to a high of 102% in 1991. The mean for hunter success rates for all years of the analysis is 80%. The overall trend for hunter success rates is increasing in this unit.

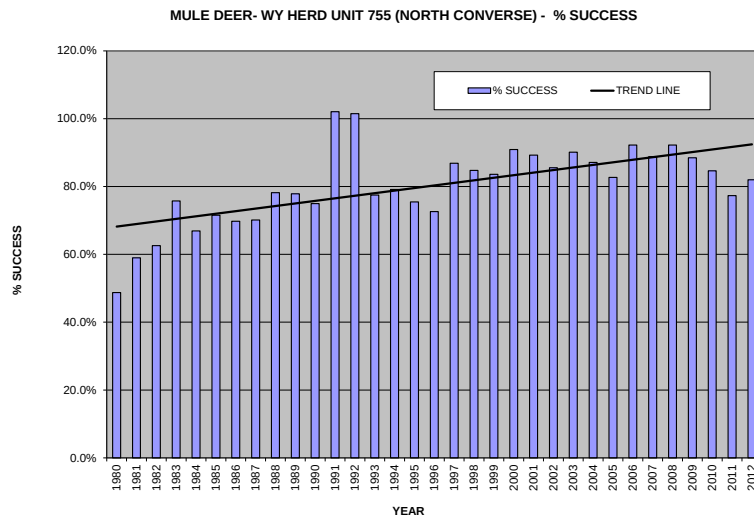


Fig. 104. Mule deer – Wyoming herd unit 755 (North Converse) – hunter success rates

Summary of Herd Vital Statistics and Management Implications

An evaluation of a variety of data for the mule deer herd in this herd unit indicates that it is not performing at an optimum level. According to an evaluation system that was developed for this project, the performance rating for this herd would be poor for the following reasons:

- The mule deer population in this herd unit is substantially below the long-term population objective set by the Wyoming Game and Fish Department (6,004 versus 9,100 animals). The last time this deer herd was at objective was 2007. This herd has been at objective or within 10% of the object for 9 of the past 10 years.
- The long-term trend for population size for the herd is increasing. However, in the short term (last 5 years) this population has declined. Even under the best of circumstances it will likely take a few years for this short-term trend to reverse itself and have the population begin to build back to the long-term population objective.
- The long-term trend for young/100 female ratios is decreasing. In addition, young/100 female ratios have only equaled or exceeded the mean value for young/100 female ratios (69:100) once in the last 5 years. If this short-term trend for young/100 female ratios continues there is only marginal potential for growth in the population.
- Another negative factor for this deer herd is a decreasing long-term trend for harvest. The total harvest of 451 animals in 2012 is the lowest harvest recorded in the 32 year period of this data analysis. Furthermore, in the last 10 years the annual harvest estimate has been below the long-term mean for harvest (827 animals) for this herd unit

The upshot all of this information is that even if current habitat conditions are maintained in the herd unit, and if the short-term trend for young/100 females continues, this deer herd is unlikely to show any improvement in population size and/or harvest. However, if habitat conditions deteriorate due to development or adverse natural environmental conditions, population size and harvest will likely decline further than the current situation.

A map of all the elk herd units in the Wyoming portion of the study area is included at this point to aid the reader in understanding how these isolated elk herds are distributed across the region.

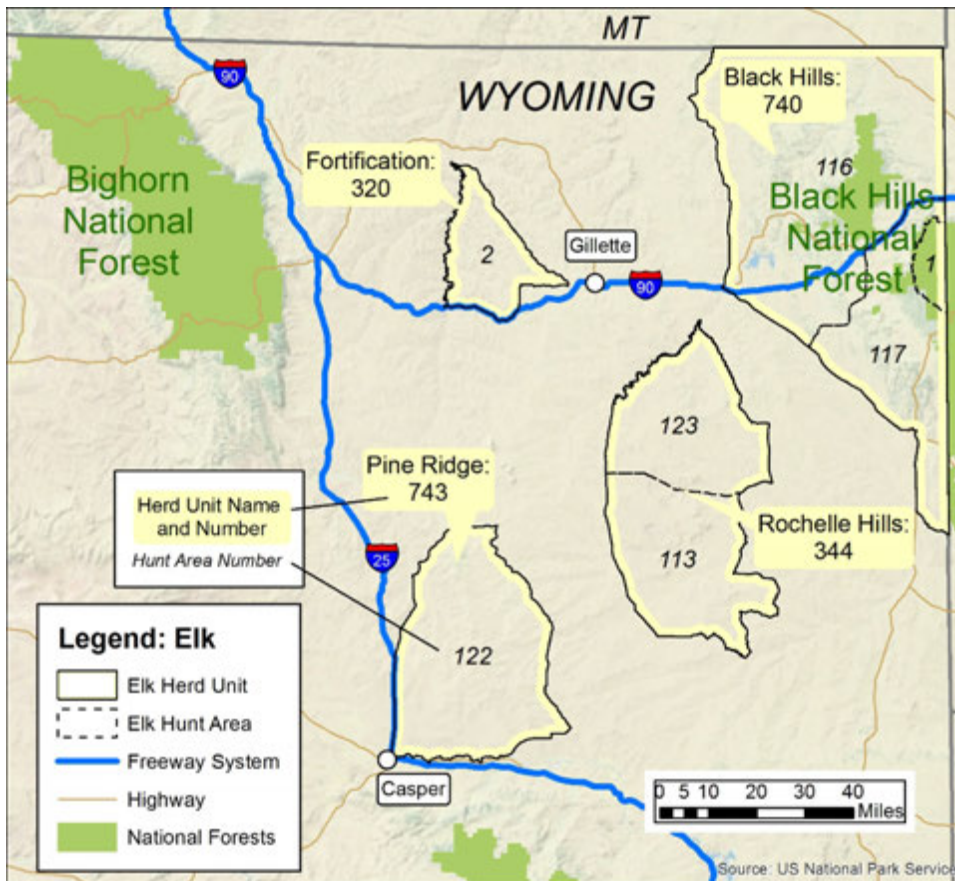


Fig. 105. Northeastern Wyoming elk herd units

FORTIFICATION, ELK HERD UNIT 320 (refer to appendix, table 12)

General Description Elk Herd Unit 320 is located in northeastern Wyoming near Interstate Highway 90 and is commonly referred to as the Fortification Herd Unit. The herd unit lies in portions of Sheridan, Johnson and Campbell counties and only contains Hunt Area 2. The herd unit is bounded on the north by Sheridan County Road 38 (Wild Horse Road); on the east by Sheridan County Road 293 and Campbell County Road 29 (Echeta Road); on the south by Campbell County Road 77 (Montgomery Road), Campbell County Road 63 (Kingsbury Road), and Interstate Highway 90; and on the west by the Powder River. The herd unit covers an area of approximately 398 square miles, of which 192 square miles are considered to be occupied habitat. Elevation in the herd unit varies from a high of 4,870 ft. at Crenshaw Hill west of Gillette to a low of approximately 3,900 ft. at the Powder River near Arvada. The topography of the herd unit consists of a rolling upland plain with low to moderate relief, broken by buttes, mesas, hill and ridges. The Powder River is the main drainage in the area forming the west boundary of the herd unit. Wildhorse Creek, Fortification Creek and Barber Creek are the main tributaries to the Powder River in the unit. Vegetation in the herd unit primarily includes shortgrass prairie, sagebrush shrubland, mixed grass prairie and other shrublands or scrub forest (Juniper spp.). These plant communities account for the majority of the land coverage in the herd unit (BLM 2003).

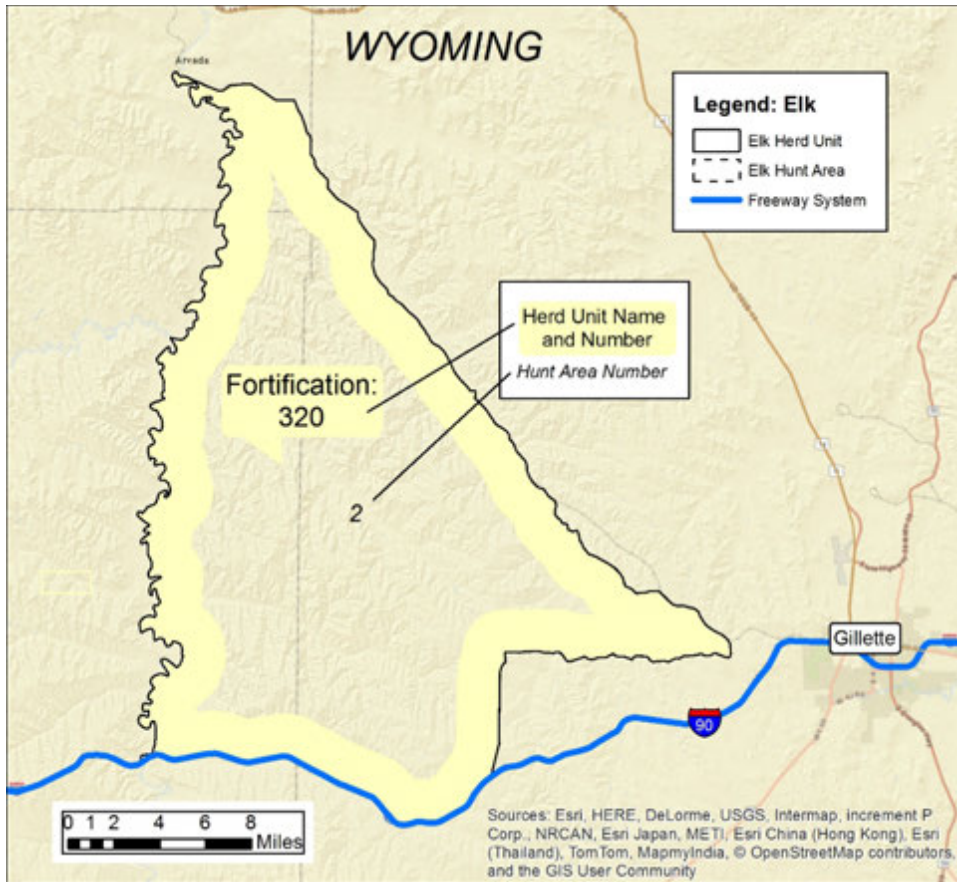


Fig. 106. Wyoming elk herd unit 320 (Fortification)

Land Ownership The herd unit contains a mixture of public and private lands. The distribution of land ownership in the herd unit is approximately 50% private, 44% Bureau of Land Management (federal government) and 6% state (WGFD 2014).

Land Use Much of the private and public land in the herd unit is used for livestock grazing, primarily cattle. Oil wells, conventional natural gas wells and coal-bed methane gas wells are common in the herd unit. There isn't any urban or sub-urban development in the herd unit, although the community of Gillette is located approximately 5 miles east of the southeast corner of the herd unit.

Management Issues This herd unit is managed under a recreational management strategy. Hunter access to the elk in the herd unit is a big issue. Although much of the habitat utilized by the elk is on public land, the public land is surrounded by private land which limits hunter access to the elk population in the area. This elk herd is already substantially over the population objective and the herd will likely continue to grow rapidly unless more public access can be acquired for hunters.

There is a high level of local interest in this elk herd. Thirty five cow elk were captured in 2011 and fitted with GPS radio collars in order to monitor elk movements. The animals were captured and collared in order to study the impacts of coal-bed methane development on herd movements and habitat utilization.

Population Size This elk population initially exhibited slow but steady growth, followed by a period of being static and recently has exhibited explosive growth. As the herd is currently

represented, the minimum population size was 100 animals in 1980 and the maximum population size is 500 animals in 2012, an estimate that Wyoming Game and Fish personnel feel may be overly optimistic. The mean value for population size for all years of the analysis is 244 animals. The long-term trend for population size is increasing. The long-term population objective for this herd is 150 animals.

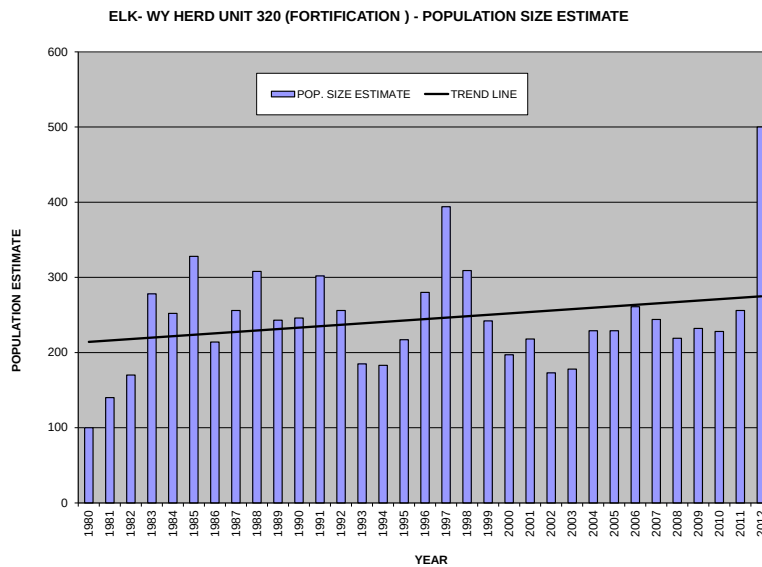


Fig. 107. Elk – Wyoming herd unit 320 (Fortification) – population size estimates

Age and Sex Composition Male/100 female ratios have been very erratic, making it difficult to forecast a reliable long-term trend. The variation in the observed ratios is likely a symptom of small sample sizes when biologists were attempting to classify animals in the herd unit. With the above items taken into account, male/female ratios have varied from a high of 105 males/100 females in 1989 to a low of 13 males/100 females in 1993. The mean for all years of data is 42 males/100 females. The overall trend for the data shows that male/100 female ratios are increasing.

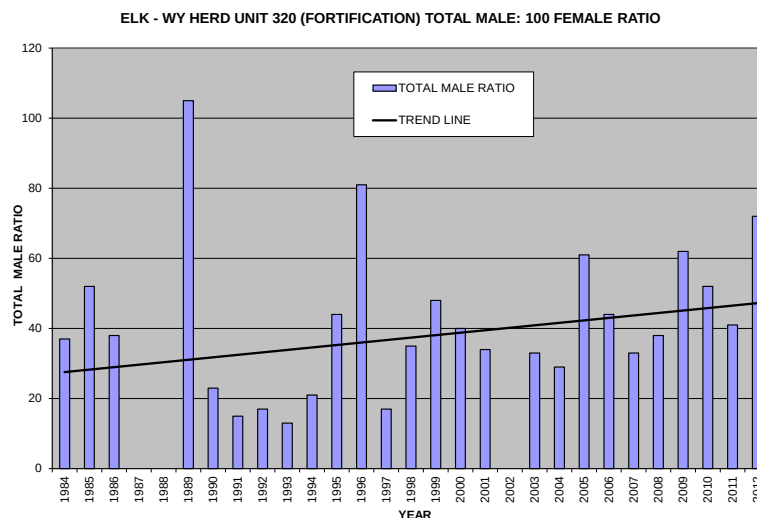


Fig. 108. Elk – Wyoming herd unit 320 (Fortification) – male/100 female ratios

Young/100 female ratios appear to be as erratic as male/100 female ratios and likely due to the same reason, small sample sizes. Young/100 female ratios have varied from a low of 29 young/100 females in 1998 to a high of 77 young/100 females in 2012. The overall trend for young/100 female ratios is increasing.

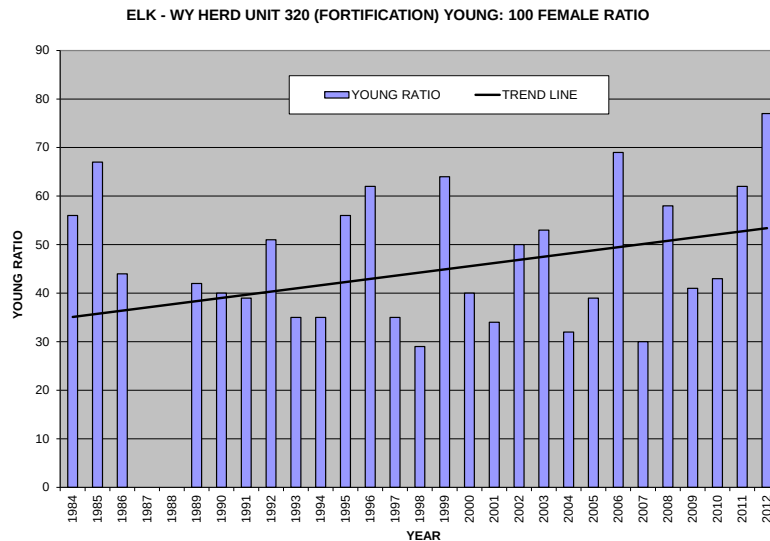


Fig. 109. Elk – Wyoming herd unit 320 (Fortification) – young/100 female ratios

Harvest Total male for this herd unit has varied from a low of 0 on 7 different occasions starting in 1985 to a high of 47 in 1999. The average for bull harvest for all years of the analysis (beginning in 1984) is 16 animals per year. The long-term trend for bull harvest is increasing.

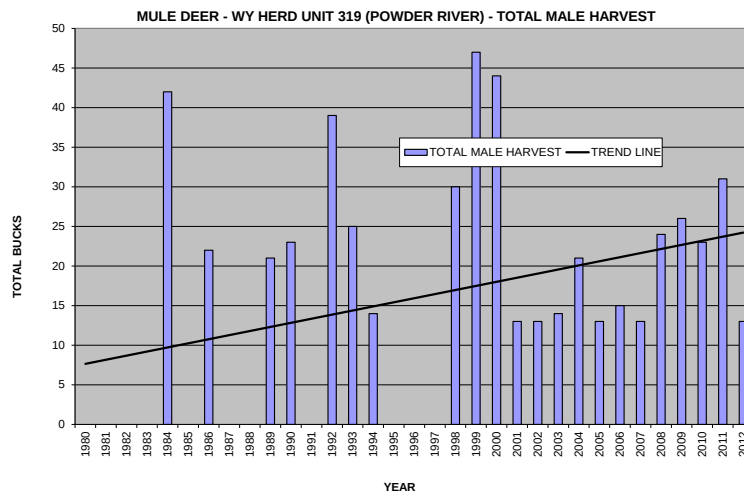


Fig. 110. Elk – Wyoming herd unit 320 (Fortification) – male harvest

Total harvest for this herd unit has varied from a low of 0 animals for 6 years between 1984 and 2012 to a high of 114 animals in 1999. The mean harvest for all years of data is 41 animals, and the long-term trend for harvest is increasing. It is unclear from Wyoming Game and Fish

Department information if years with no harvest is due to lack of hunter success or if it was due to the fact that a hunting season wasn't open in the herd unit for those years.

Antlerless (cow and calf) harvest was sporadic in the 1980s but has occurred every year except 3 since 1990. Antlerless harvest as a percentage of total harvest has been extremely variable through the years ranging from 0% in 1991, 1996 and 1997 to a high of 81% of total harvest in 2002.

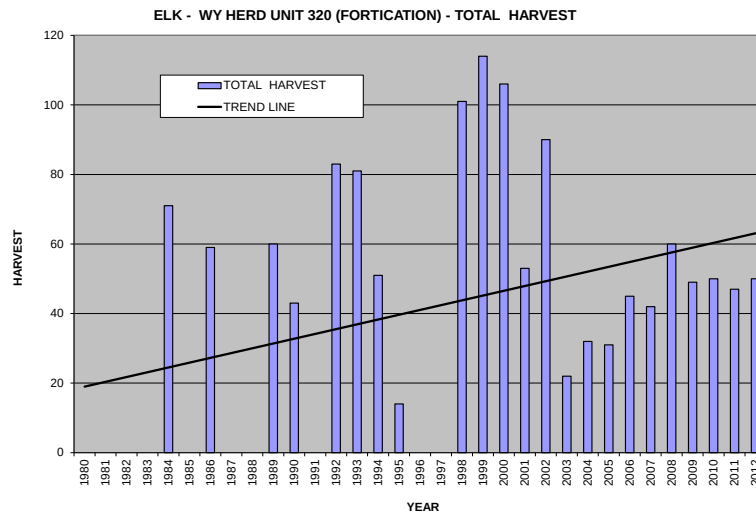


Fig. 111. Elk – Wyoming herd unit 320 (Fortification) – total harvest

Hunter Numbers and Success Rates Total hunting pressure for all seasons and methods of take has ranged from a high of 232 hunters in 1998 to a low of 43 hunters in 2003. The mean value for hunter numbers for all years of data is 71 (1984 through 2012 seasons). The long-term trend for numbers of hunters is increasing.

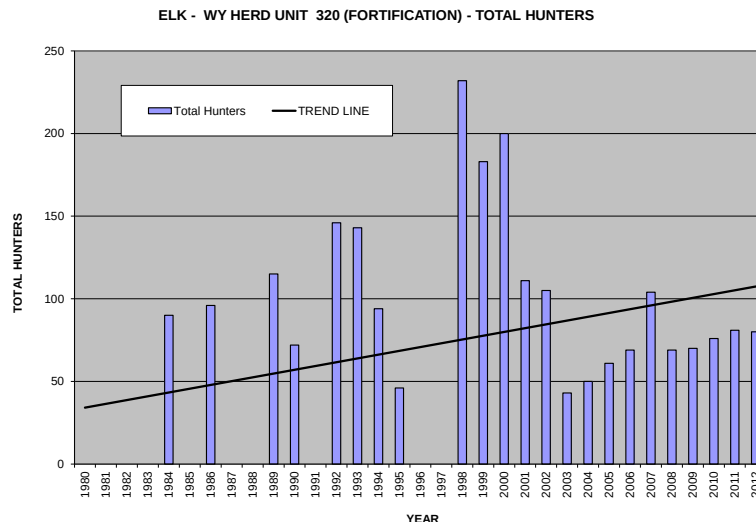


Fig. 112. Elk – Wyoming herd unit 320 (Fortification) – total hunters

Hunter success rates have varied from a low of 30.4% in 1995 to a high of 87% in 2008. The mean value for hunter success for all seasons and methods of take is 59%. The overall trend for hunter success is slightly increasing.

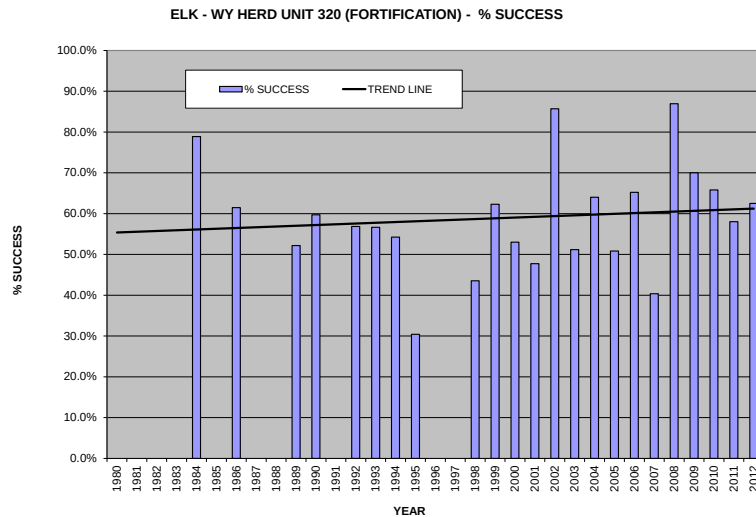


Fig. 113. Elk – Wyoming herd unit 320 (Fortification) – hunter success rates

Summary of Herd Vital Statistics and Management Implications An evaluation of an assortment of data for the elk herd in this herd unit indicates that it is performing well. According to a rating system that was developed for this project, the performance rating for this herd would be good for the following reasons:

- The elk population in this herd unit is substantially above the long term population objective set by the Wyoming Game and Fish Department (500 animals versus LTO of 150 animals). This elk herd has been at or above objective since 1982.
- The long-term trend for population size for the herd is increasing.
- The long-term trend for young/100 female ratios is increasing. Young/100 female ratios have equaled or exceeded the mean value for young/100 female ratios (48:100) for 3 of the last 5 years.
- Also, the long-term trend for harvest is increasing. Elk harvest in the unit for 2012 was 50 animals. Also, elk harvest in this herd unit has exceeded the long-term mean for harvest (41 animals) for 7 of the last 10 years.

The end result of all of this information is that if current habitat conditions are maintained and if current trends in population size, young/100 female ratios and harvest continue this elk herd is likely to display substantial growth. It is unknown at this time how much loss of habitat or habitat degradation would need to occur before this elk population would start to decline.

ROCHELLE HILLS ELK HERD UNIT 344 (refer to appendix, table 13)

General Description Elk Herd Unit 344 is located in northeastern Wyoming and is designated as the Rochelle Hills Herd Unit. The herd unit lies in portions of Campbell, Weston, Converse and Niobrara counties and contains 2 hunt areas, 113 and 123. The herd unit is bounded on the north by the Belle Fourche River; on the east by Raven Creek, Weston County Road 26 (North Raven Creek Road), Weston County Road 16 (Raven Creek Road), State Highway 116, State Highway 450, the Lynch Road (Weston County Road 7A and Converse County Road 39), Converse County Road 38, Niobrara County Road 14, Niobrara County Road 4, Niobrara County Road 3, Converse County Road 45, and Niobrara County Road 50; on the south by Converse County Road 43, Dry Creek, U.S.F.S. Road 958 and Converse County Road 38 (Dull Center Road); on the west by State Highway 59. This herd unit is approximately 1,628 square miles in size with 599 square miles of the herd unit considered to be occupied habitat. Elevation in the herd unit varies from a high of 5,175 feet at Rochelle Hill approximately 2.5 miles northwest of the intersection of the Campbell, Weston and Converse Counties to a low of approximately 4,200 feet

at the confluence of the Belle Fourche River and Raven Creek southwest of Moorcroft. Vegetation types or plant communities in the herd unit include shortgrass prairie, sagebrush shrubland, mixed grass prairie, coniferous forest and other shrublands. These 5 plant communities account for approximately 90% of the land coverage (BLM 2003).

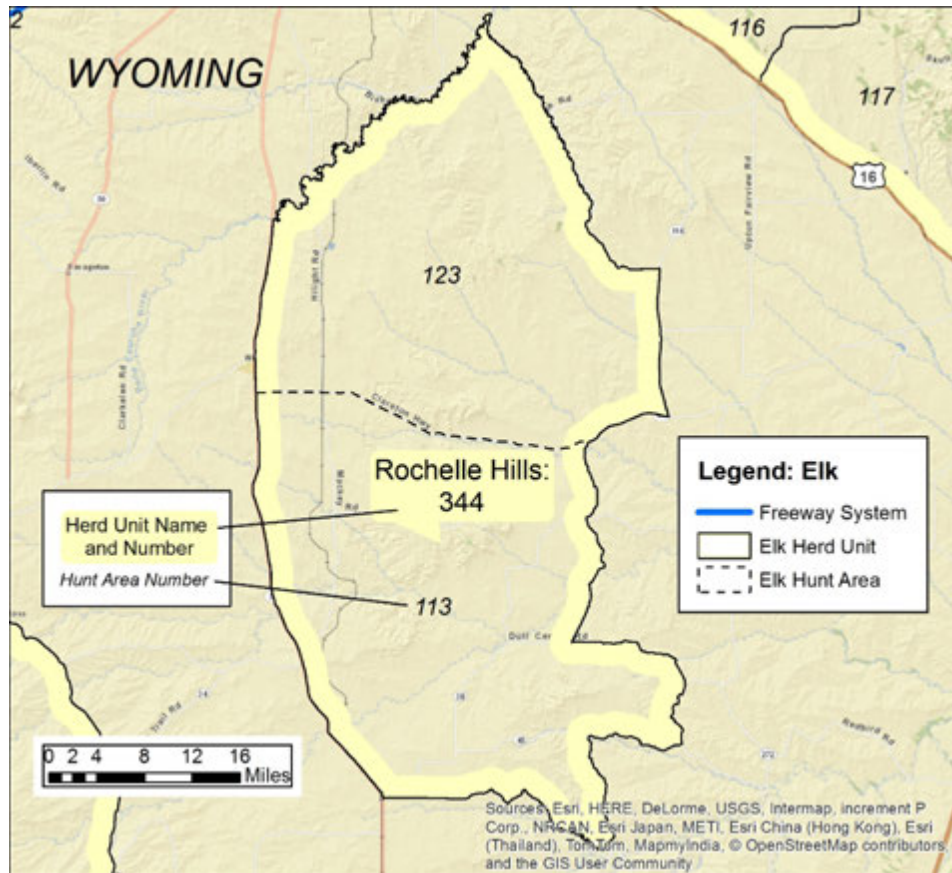


Fig. 114. Wyoming elk herd unit 344 (Rochelle Hills)

Land Ownership The herd units contains both private and public land, however habitat occupied by elk in the unit is primarily private land. The distribution of land ownership of occupied elk habitat is 49% private land, 28% U.S.F.S. (National Grassland), 12.4% Bankhead/Jones lands, and 4.7% Bureau of Land Management. The remainder of the public land (10.6%) is owned by a number of entities, none of which control more than 5% of occupied elk habitat (WGFD 2014).

Land Use Land use in this herd unit is similar to what occurs in mule deer herd unit 740 (Cheyenne River) as part of the northwest portion of the deer herd unit overlaps with this elk herd unit. Agriculture in the form of livestock grazing is a very prominent land use in the herd unit. Energy development is another prominent land use in the area. Oil and gas development occurs throughout the herd unit.

No large urban or suburban development occurs in the herd unit. The nearest town to the herd unit is Moorcraft (1,009) which lies approximately 8 miles northeast of the northern tip of the herd unit. The majority of the human population in the herd unit is rural in character, being dispersed in very small communities or individual ranches or farms throughout the area.

Management Issues The herd unit contains 2 hunt areas, 113 and 123. The majority of the elk in hunt area 123 are on private land and there isn't a consensus among landowners concerning

population objectives for the herd unit, resulting in a mixed bag concerning access for hunters. There is an adequate amount of public land in hunt area 113 to provide a substantial amount of public access. Historically, the elk population in this herd unit has only been hunted on an every third year or every other year basis in an effort to allow more bull escapement and which should result in more trophy bulls produced for the hunt. There isn't a working model for this elk herd (WGFD 2013).

Population Size The elk population in the Rochelle Hills Herd Unit appears to be increasing but there isn't a working model for this herd. Based on the current projection for the herd, a minimum population estimate for this herd was 60 animals in 1985. The maximum population estimate for the herd is 741 animals in 2011. The mean population estimate for all years is 368 animals. A population estimate isn't available for 2012. This population is not showing the fluctuations that occur in other populations but continues to exhibit strong growth. The long-term trend for the population is increasing. The long-term objective for this population is to maintain a combined landowner/hunter satisfaction rating of 60%. Currently the satisfaction rating for hunters is 70% and the rating for landowners is 60%.

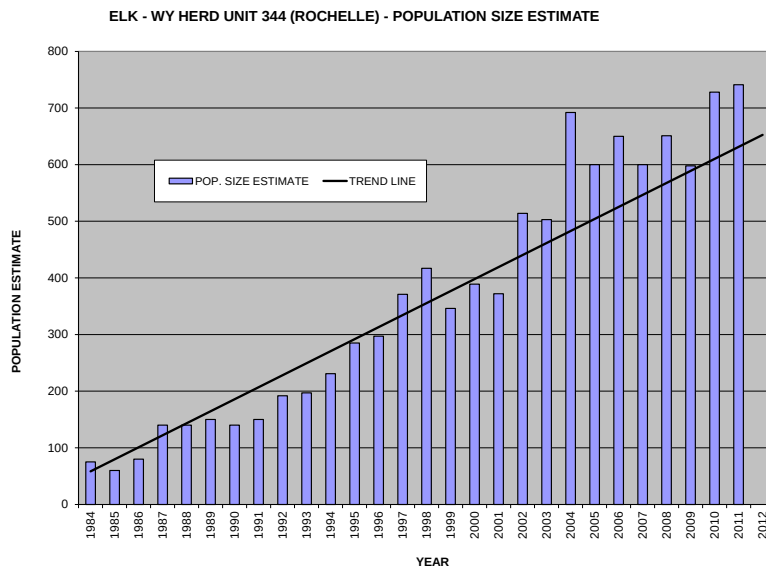


Fig. 115. Elk – Wyoming herd unit 344 (Rochelle Hills) – population size estimate

Age and Sex Composition Males/100 female ratios have varied from a low of 19 males/100 females in 1996 to a high of 96 males/100 females in 2002. The mean for all years of data is 50 males/100 females. The high amount of variation for this parameter may be due to small sample sizes instead of actual variation within the population. The overall trend for males/100 female ratios is increasing.

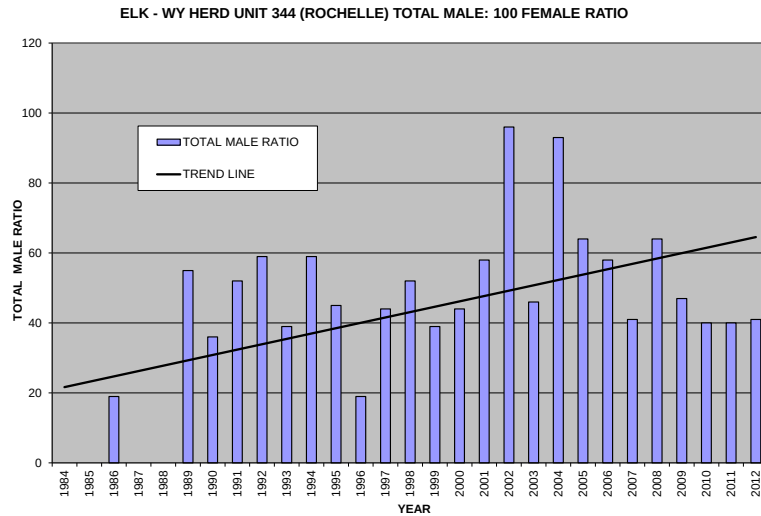


Fig. 116. Elk – Wyoming herd unit 344 (Rochelle Hills) – male/100 female ratios

Young /100 female ratios have varied from a low of 22 young/100 females in 1986 to a high of 67 young/100 females in 1998. The mean value for all years of data is 45 young/100 females. The long term trend for young/100 female ratios is increasing.

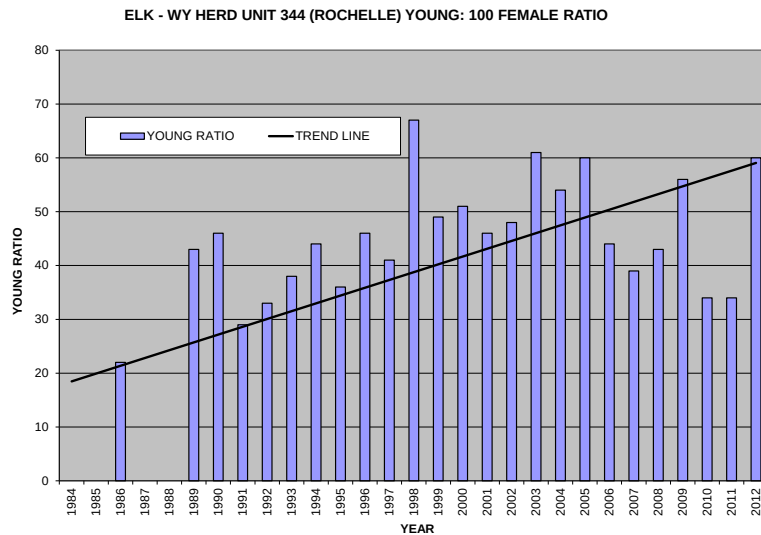


Fig. 117. Elk – Wyoming herd unit 344 (Rochelle Hills) – young/100 female ratios

Harvest Total male harvest has ranged from a low of 0 bulls harvested in 4 different years to a high of 53 bulls harvested in 2007. Average value for bull harvest for the unit is 17 animals. The long-term trend for total male harvest is increasing.

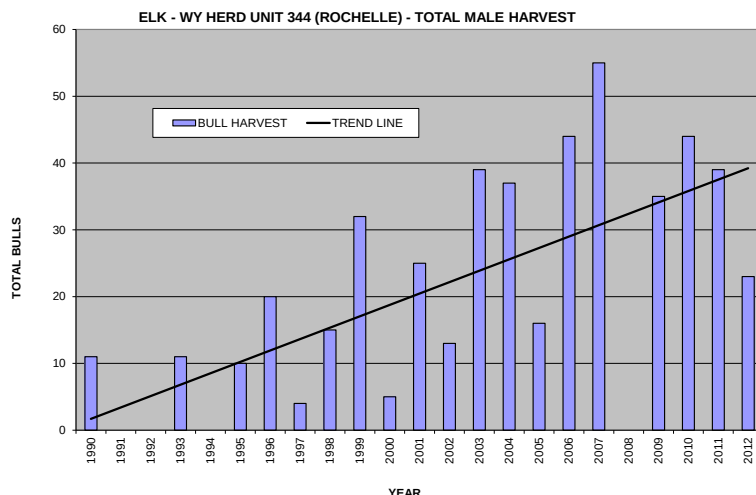


Fig. 118. Elk – Wyoming herd unit 344 (Rochelle Hills) – male harvest

Total harvest for this herd unit has ranged from a low of 0 animals harvested in 3 different years early in the history of the management of this unit to a high of 188 animals harvested in 2005. The mean harvest for all years of the analysis is 52 animals. The long-term trend for harvest is increasing. Looking at the average harvest by decade provides some insights into the history of the management of this elk herd. The mean harvest for the 1980s was 0 animals, for the 1990s 15 animals, for the 2000s 108 animals and for the 2010s 97 animals.

Antlerless harvest has made up a large percentage of the total harvest for all years of the analysis. Antlerless harvest has comprised $\geq 50\%$ of the total harvest for 12 of the 22 years that elk harvest has occurred in the herd unit.

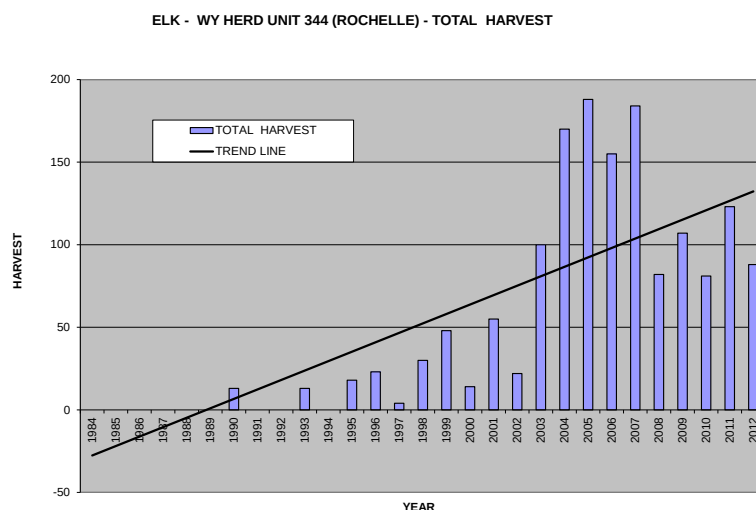


Fig. 119. Elk – Wyoming herd unit 344 (Rochelle Hills) – total harvest

Hunter Numbers and Success Rates Total hunting pressure (all seasons and methods of take) has varied from a low of 0 hunters for the nine years during the early period of management of this herd to a high of 265 hunters in 2006. The mean value for hunter numbers for all years of the analysis is 73. The long-term trend for total hunting pressure is increasing. All licenses for this herd unit are limited in number and only available through a lottery process.

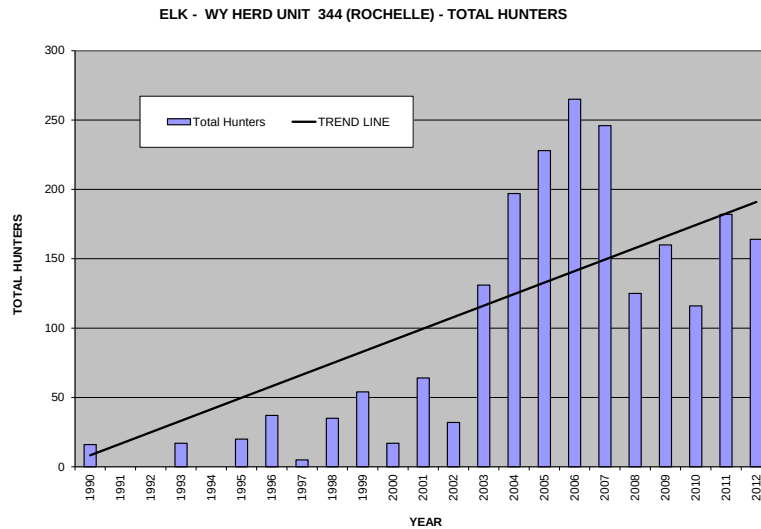


Fig. 120. Elk – Wyoming herd unit 344 (Rochelle Hills) – total hunters

Hunter success rates have been exceptionally high for this herd unit and varied from a high of 90% in 1995 to a low of 54% in 2012. The mean for success rates for all years of the analysis is 75%. The long term trend for hunter success rates is decreasing for this herd unit but shouldn't be cause for alarm as the highest success rates were posted during the early years of hunting in this herd unit when hunter numbers were very low and unusually high success rates were the norm instead of the exception. The mean of success rates by decade has decreased but even the lowest success rates are very high when compared to other hunt units in the state (1990s 81%, 2000s 75% and 2010s 64%).

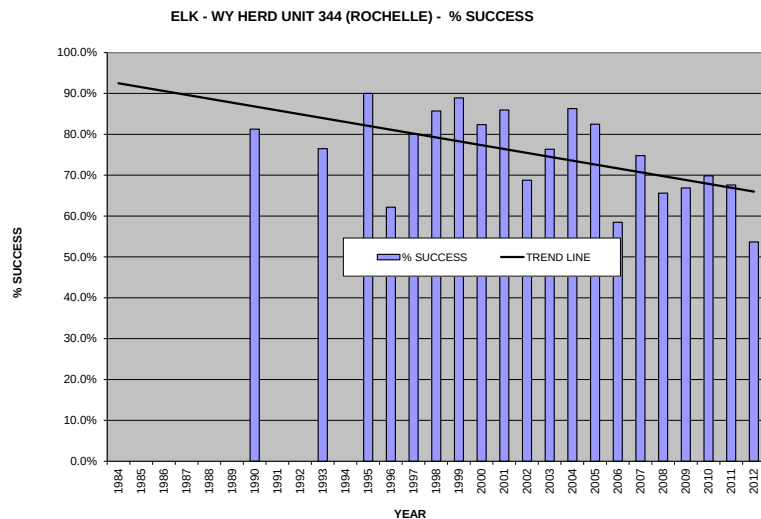


Fig. 121. Elk – Wyoming herd unit 344 (Rochelle Hills) – hunter success rates

Summary of Herd Vital Statistics and Management Implications An evaluation of an assortment of data for the elk herd in this herd unit indicates that it is performing well. According to an objective rating system that was developed for this project, the performance rating for this herd would be good for the following reasons:

- A numerical long-term population objective hasn't been established for this elk herd. Instead, an objective based on hunter and landowner satisfaction with the number of elk in the herd unit has been created. Essentially, the elk herd is at objective when 70% of sportsmen and 60% of landowners are satisfied with the size of the elk population in this

herd unit. Currently satisfaction expressed by hunters and landowners meets or exceeds the satisfaction levels set for this herd unit.

- The long-term trend for population size for the herd is increasing although it is based on field estimates instead of information from a population model.
- The long-term trend for young/100 female ratios is increasing. In addition, for the last 5 years, young/100 female ratios have been above the long-term mean value for young/100 female ratios (45:100) for 2 of 5 years.
- The long-term trend for harvest is increasing for this herd unit. In addition, elk harvest in this unit has been greater than the long-term mean value for harvest (52 animals) for all 5 years.

The end result of all of this information is that if current habitat conditions are maintained, and if the short-term trend for young/100 females continues, this elk herd is likely to continue to grow in size. However, at some point in time the carrying capacity of the habitat will be exceeded and the population will plateau and recruitment and survival will begin to decline. If habitat conditions deteriorate due to development or adverse natural environmental conditions, population size and harvest could decline. But at this point in time it would be difficult to speculate how much habitat would need to be lost or degraded before the elk population would begin to decline.

BLACK HILLS, ELK HERD UNIT 740 (refer to table 14 in the appendix)

General Description Elk Herd Unit 470 is located in northeastern Wyoming and is generally referred to as the Black Hills herd unit. This herd unit lies in portions of Campbell, Crook and Weston Counties and contains 3 hunt areas; 1, 116 and 117. The herd unit is bounded on the north by the Montana/Wyoming state line, on the east by the South Dakota/Wyoming state line; on the south and west by Weston County Road 2, U. S. Highway 85, U. S. Highway 16, Interstate Highway 90, Crook County Road 68 (D Road) and Rocky Point Road (Campbell County Road 85). The herd unit covers an area of approximately 3,100 sq. mi. of which 1,655 sq. mi. is considered to be occupied elk habitat (WGFD 2014). Elevation in the herd unit varies from a high of approximately 6,401 ft. at Mt. Pisgah, north of Newcastle to a low of approximately 3,348 ft. at Mud Butte near the northeast corner of the state. Ponderosa pine is the dominant overstory species on forested lands. Quaking aspen, paper birch, and bur oak stands are present. Important shrubs include big sagebrush and silver sage, Saskatoon serviceberry, Oregon grape, common chokecherry, spiraea, and true mountain mahogany. Many non-timbered lands in the herd unit are dominated by sagebrush or are used to produce agricultural crops such as winter wheat, alfalfa hay, and grass hay (WGFD 2013).

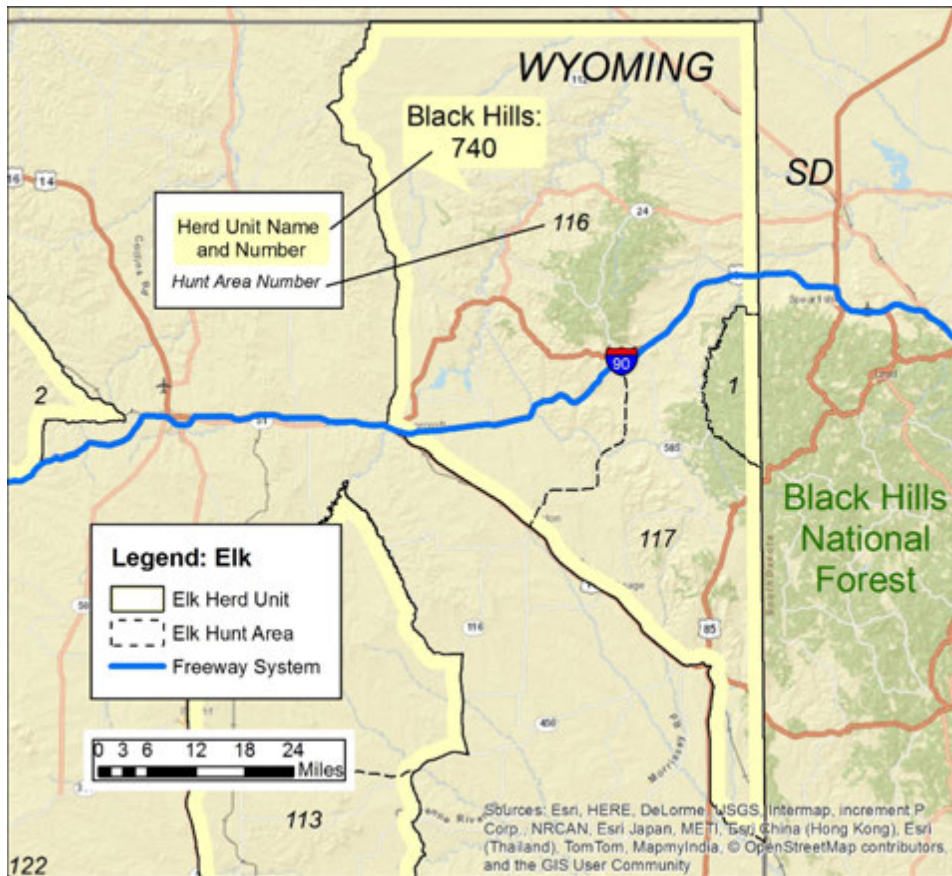


Fig. 122. Wyoming elk herd unit 740 (Black Hills)

Land Ownership The herd unit is predominantly private land with a mixture of public land owners. The distribution of land ownership in the herd unit is approximately 71% private, 16.5% U. S. Forest Service, 7.4% state land and 2.5% BLM land. These landowners account for more than 97% of the land ownership in the herd unit with Bankhead Jones lands, Army Corps of Engineers and National Grasslands (U. S. Forest Service) accounting for the remainder (WGFD 2014).

Land Use Livestock grazing on public and private lands is a major activity in this area. Urban and sub-urban development includes the communities of Newcastle (3,532), Sundance (1,182), Upton (1,100) and Moorcraft (1,009) and a number of smaller unincorporated towns and hamlets (TWTER 2014). The area provides ample opportunities for a variety of outdoor recreational activities. During the fall, hunting for small game and big game attracts a number of recreationists.

Management Issues This elk herd is managed under a private land management strategy in which satisfaction of private landowners in the area is a major consideration. Wyoming Game and Fish Department hasn't been able to collect usable age and sex composition data for the herd unit nor have they been able to construct a workable population model for this elk herd. There is substantial interstate movement of elk between Wyoming and South Dakota. Consequently, this elk herd is managed to provide ample recreational opportunity and address damage and depredation complaints (WGFD 2013).

Population Size Efforts to collect meaningful estimates of population size were suspended in 1994 as a result of difficulty in obtaining accurate information for this herd unit. As a result, the

normal analysis of population size will not be completed. While the stated population objective for this herd is 500 animals, field estimates of elk numbers in the unit place the current population size to be close to 3,000 animals.

Age and Sex Composition Efforts to obtain adequate sample sizes for age and sex composition of the elk herd were suspended in the middle 1990s. As a result, any meaningful analysis of data isn't possible.

Harvest Total male for this herd unit has varied from a low of 14 bulls harvested in 1980 to a high of 258 bulls harvested in 2007. Average bull harvest for all years of the analysis is 97 animals per year. The long-term trend for bull harvest is increasing.

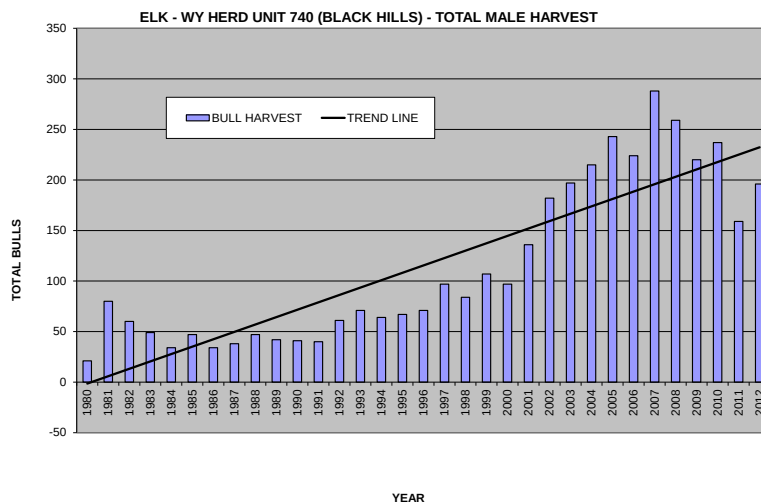


Fig. 123. Elk – Wyoming herd unit 740 (Black Hills) – male harvest

Total harvest for the herd unit has varied from a low of 42 animals in 1980 to a high of 601 animals in 2011. The mean of total harvest for the period 1980 through 2012 is 249 animals. The long-term trend of harvest for all years of data is increasing.

Antlerless elk harvest has ranged from a low of 21 (50% of total harvest) animals in 1980 to a high of 442 (73% of total harvest) animals in 2011. Antlerless elk harvest has accounted for 30% or more of the total harvest for nearly all years of the analysis.

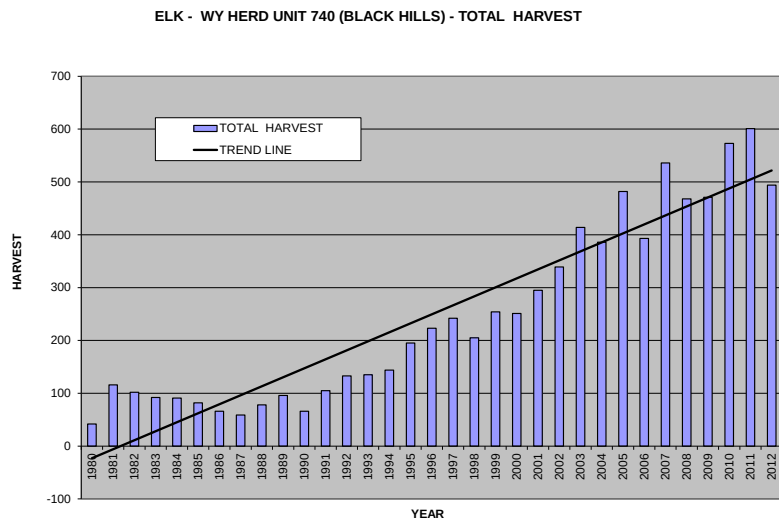


Fig. 124. Elk – Wyoming herd unit 740 (Black Hills) – total harvest

Hunter Numbers and Success Rates Total hunting pressure (all seasons and methods of take) has ranged from a low of 74 hunters in 1980 to a high of 1,416 hunters in 2011. This herd unit has supported an average of 586 hunters a year for all years of data. The overall trend for hunter numbers is increasing. A review of mean hunting pressure by decade shows the 1980s and 1990s with relatively low hunter numbers. However in the 2000s and 2010s, the mean number of hunters has increased dramatically.

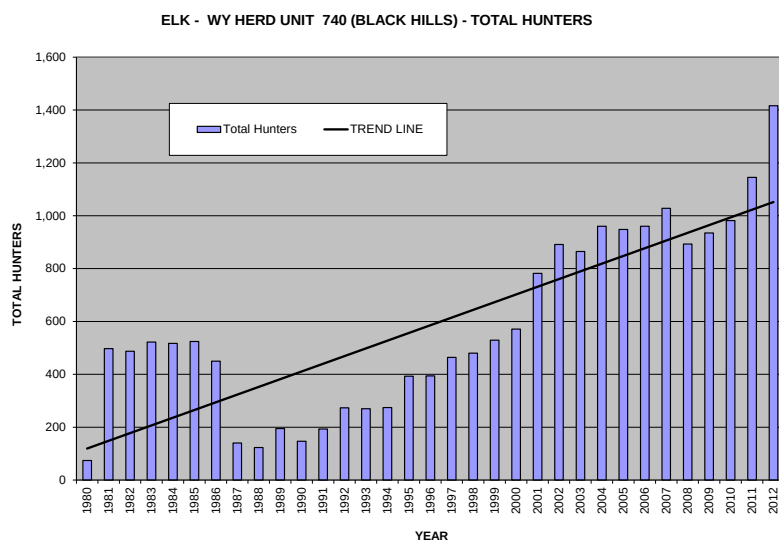


Fig. 125. Elk – Wyoming herd unit 740 (Black Hills) – total hunters

Hunter success rates for all seasons and methods of take have ranged from a low of 14.7% in 1986 to a high of 63.4% in 1988. The mean for success rates for all years of data is 43.1% success. Reviewing hunter success rates by decade shows the 1990s with the highest success rate at 50%, with subsequent decades displaying slight decreases in success rates (2000s-45.5% and 2010s-48.6%).

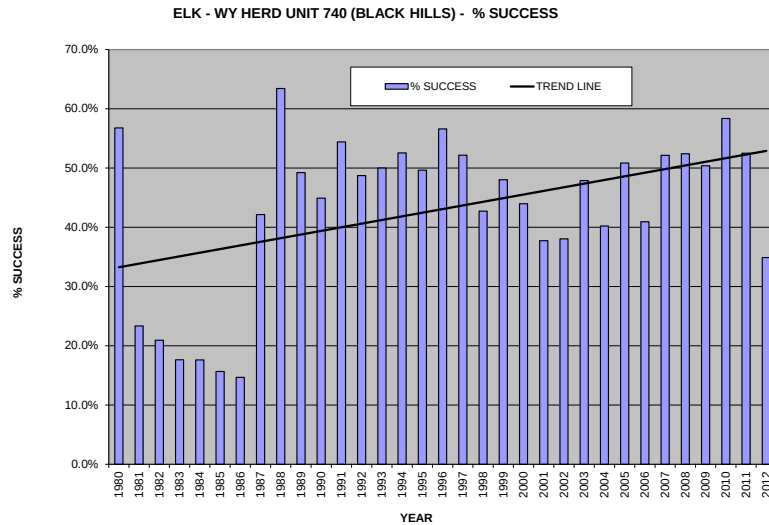


Fig. 126. Elk – Wyoming herd unit 740 (Black Hills) – hunter success rates

Summary of Herd Vital Statistics and Implications for Management

The Wyoming Game and Fish Department suspended efforts to collect inventory data on this elk herd in 1994. Since the data set for this elk herd is incomplete no attempt will be made to categorize whether this herd is performing at the good, poor or fair level.

PINE RIDGE, ELK HERD UNIT 743 (refer to table 15 in the appendix)

General Description Elk Herd Unit 743 is located in east-central Wyoming and is commonly referred to as the Pine Ridge Herd Unit. The herd unit lies in portions of Johnson, Campbell, Natrona and Converse counties and contains one hunt area, 122. The herd unit is bounded on the north by State Highway 387, on the east by Ross Road (County Road 31 in Converse County), on the south by Converse County Road 95 and the North Platte River and on the west by Interstate Highway 25 and State Highway 259. The herd unit covers an area of approximately 1,274 sq. mi. with only 151 sq. mi. considered to be occupied habitat (WGFD 2014). Elevation in the herd unit varies from a high of 6,090 ft. at Blue Hill north of Parkerton to a low of 5,157 ft. at Monkey Hill near Glenrock. Vegetation in the herd unit is Mixed-grass prairie dominated by blue grama, western wheatgrass, junegrass, Sandberg bluegrass, needle-and-thread grass, rabbitbrush, fringed sage, and other forbs, shrubs and grasses (Chapman et al. 2004).

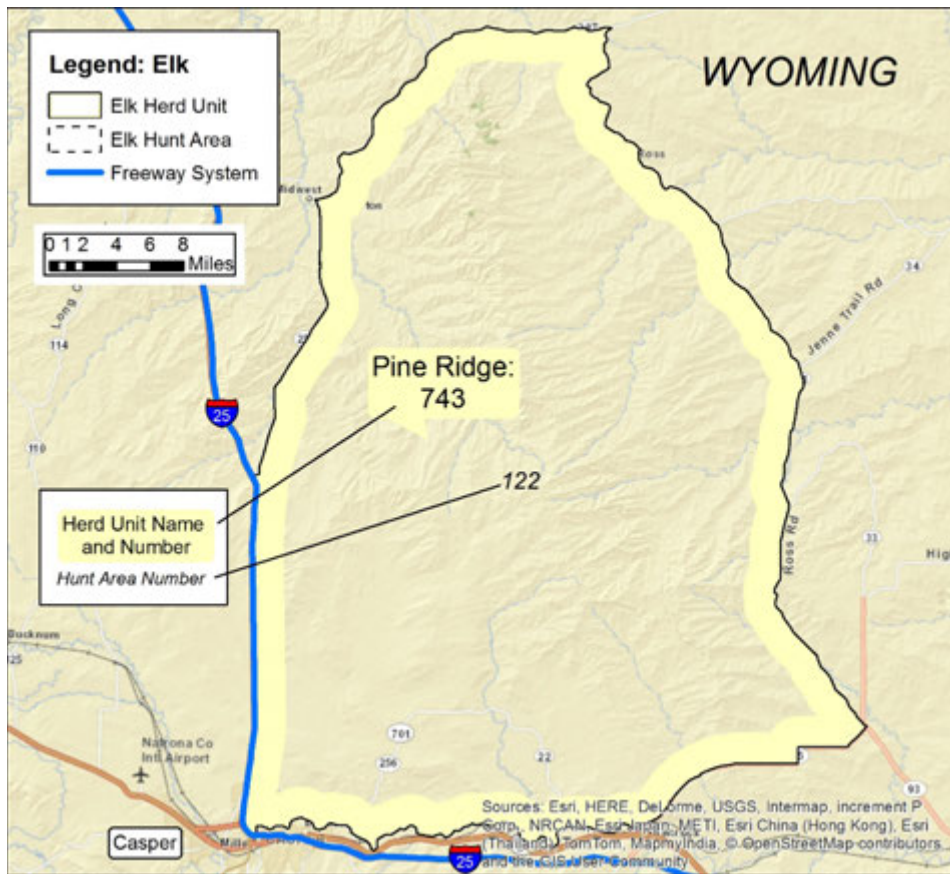


Fig. 127. Wyoming elk herd unit 743 (Pine Ridge)

Land Ownership This herd unit contains a mixture of private and public lands but most land in the unit is in private ownership. The distribution of land ownership in the herd unit is approximately 70.2% private land, 23% Bureau of Land Management Land and 6.8% state land (WGFD 2014).

Land Use Primary land uses in this area include extensive oil and gas production, large-scale industrial wind generation, in-situ uranium production, and traditional cattle and sheep grazing. In recent years, expansion of oil shale development has dramatically increased the amount of land disturbed by human activity in the herd unit (WGFD 2013).

Urban and sub-urban development in the herd unit includes the communities of Casper (55,316), Glenrock (2,576), Midwest (404) and Edgerton (195). The remainder of the human population in the herd unit is located in unincorporated towns, small settlements and individual ranches or home sites (TWTER 2014).

Management Issues Virtually all the elk in this herd unit can be found along the Pine Ridge escarpment in the north-central portion of the herd unit. Access to elk hunting in the unit is tightly controlled by private landowners and obtaining adequate harvest in order to control herd growth is difficult (WGF 2012). The Wyoming Game and Fish Department has declined to spend a lot of time, money and effort managing the elk herd in this unit because of land ownership and access issues that prevent them from effectively managing the elk population (WGFD 2013).

Population Size Population estimates for this herd have been very unreliable. No population model exists for this herd. Trend count surveys conducted in previous years have provided some information but surveys have been conducted sporadically and in less than ideal counting

conditions. Trend count surveys conducted in 2009 and 2010 showed a minimum of 350 and 150 elk respectively. A winter trend conducted under optimum conditions in December 2012 revealed a minimum of 840 elk present in the unit which was a substantially larger number of elk than what landowners and field personnel thought were in the herd unit (WGF, 2013). The long-term trend for population size presented in the chart below is inaccurate and is based on incomplete data. No population objective has been established for this herd as the management philosophy for the herd is based on landowner and hunter satisfaction rates instead of population size.

Age and Sex Composition The most recent surveys to estimate age and sex composition of the elk herd in this unit were conducted in 1999 and as such are woefully out of date. Considering the recent trend count information gathered for this herd unit in 2009, age and sex composition information would likely show a much different picture than what was portrayed during the 1980s and 1990s.

Harvest Total male harvest for this herd unit has varied from a low of 1 bull in 1993 to a high of 38 bulls in 2001. The mean value for male harvest for all years of the analysis is 15 bulls. The long-term trend for bull harvest is increasing.

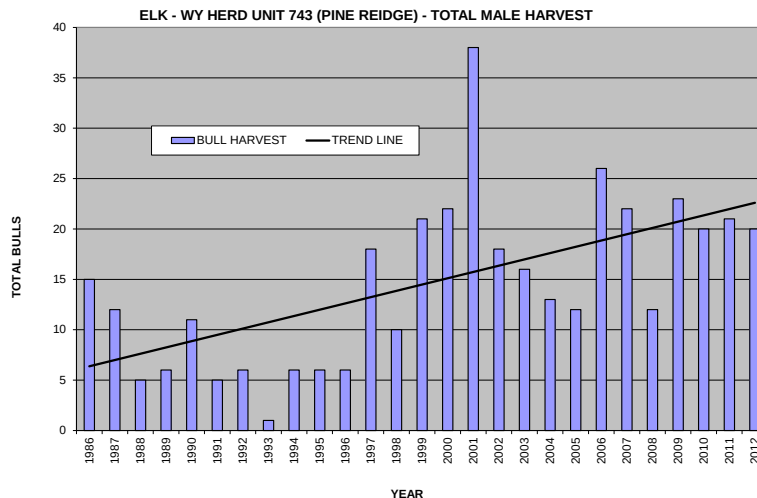


Fig. 128. Elk – Wyoming herd unit 743 (Pine Ridge) – male harvest

Total harvest for this herd unit has ranged from a low of 6 animals in 1996 to a high of 59 animals in 2004. The mean harvest for all years of data is 33 animals. The long-term trend for harvest for all years of data is increasing.

Antlerless harvest (cows and calves) has ranged from a low of 0 animals harvested in 1996 to a high of 46 (78% of total harvest) animals in 2004. The average antlerless harvest for all years of the analysis is 18 animals. With the exception of 1996, antlerless harvest has accounted for at least 14% of the total harvest in all other years of the analysis.

Again, hunter access to this herd unit is tightly controlled by private landowners and increases and decreases in numbers of animals harvest are more likely an artifact of hunter access than an indirect indicator of increases or decreases in the elk population in the herd unit.

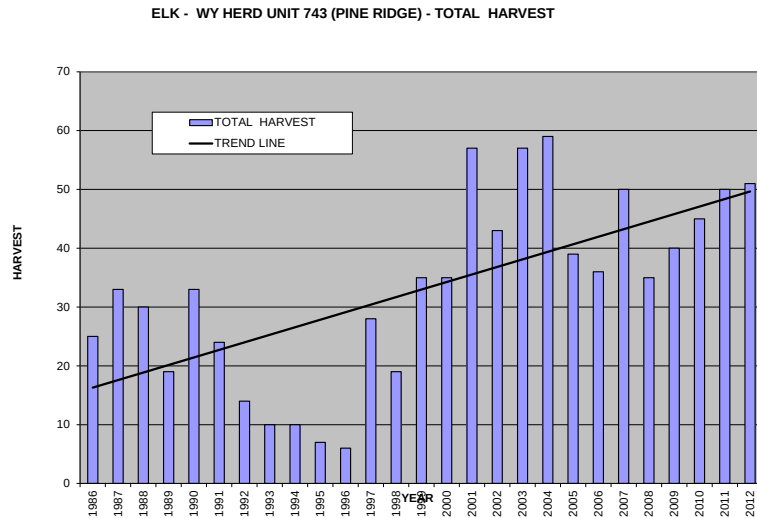


Fig. 129. Elk – Wyoming herd unit 743 (Pine Ridge) – total harvest

Hunter Numbers and Success Rates

Total hunting pressure has fluctuated from a low of 11 hunters in 1996 to a high of 87 hunters in 2003. The herd unit has supported an average of 52 hunters per year for all the years of the analysis. The long-term trend for hunter numbers is increasing.

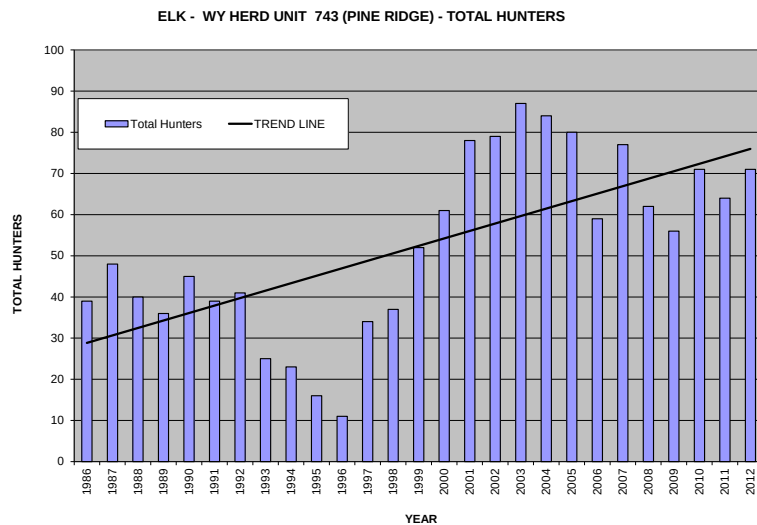


Fig. 130. Elk – Wyoming herd unit 743 (Pine Ridge) – total hunters

Hunter success rates have varied from a low of 34% success in 1992 to a high of 82% success in 1997. The mean for hunter success is 16%. The long-term trend for hunter success is increasing slightly.

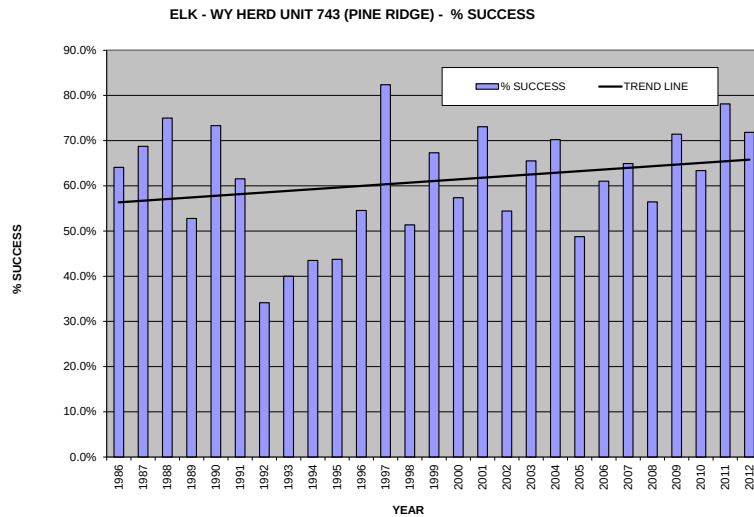


Fig. 131. Elk – Wyoming herd unit 743 (Pine Ridge) – hunter success rates

Summary of Herd Vital Statistics and Management Implications

The Wyoming Game and Fish Department suspended efforts to collect inventory data on this elk herd in 1999. Since the data set for this elk herd is incomplete no attempt will be made to categorize whether this herd is performing at the good, poor or fair level.

A map of all the pronghorn herd units in the Wyoming portion of the study area is included at this point to aid the reader in understanding how the various herd units are distributed across this portion of the state.



Fig. 132. Northeastern Wyoming Pronghorn Herd Units

CLEARMONT, PRONGHORN HERD UNIT 308 (refer to table 16 in the appendix)

General Description Pronghorn Herd Unit 308 is located in northeastern Wyoming is commonly referred to as the Clearmont Herd Unit. The herd unit lies in portions of Sheridan and Campbell counties and contains hunt area 15. The herd unit is bounded on the north by the Montana/Wyoming state line, on the east by the Powder River, on the south by U. S. Highway 14, and on the west by Interstate Highway 25. This herd unit covers an area of approximately 1,142 sq. mi. with 1,057 sq. mi. of the unit considered to be occupied habitat (WGFD 2014). Topography of the herd unit consists of a rolling upland plain with low to moderate relief, broken by buttes, mesas, hills and ridges. Vegetation is characteristic of the Powder River basin sub-region of the northwestern Great Plains which consists of mixed-grass prairie dominated by blue grama, western wheatgrass, junegrass, Sandberg bluegrass, needle-and-thread grass, rabbitbrush, fringed sage, and other forbs, shrubs and grasses (BLM 2003).

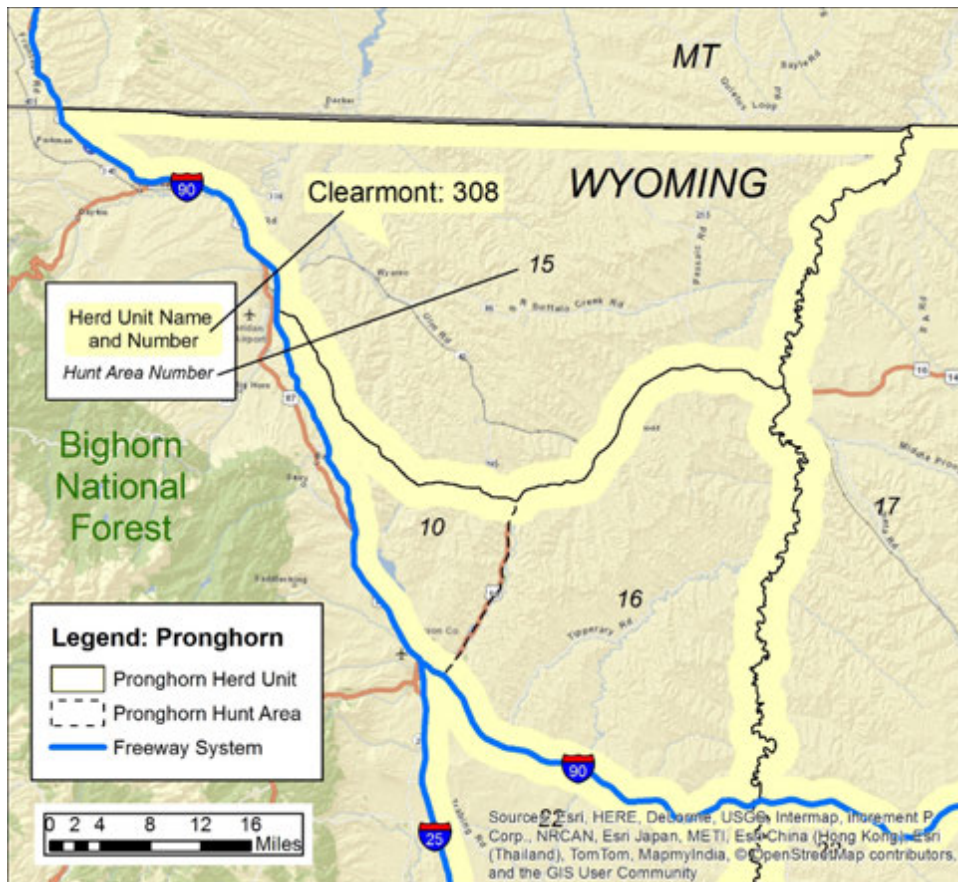


Fig. 133. Wyoming pronghorn herd unit 308 (Clearmont)

Land Ownership The herd unit contain a mixture of public and private lands. The distribution of land ownership in the herd unit is approximately 84% private land, 11% state land and 5% Bureau of Land Management (BLM) land (WGFD 2014).

Land Use Much of the private and public land in the herd unit is used for livestock grazing, primarily cattle. Oil and gas development are examples of mineral development and extraction that have occurred throughout the herd unit. Oil wells, conventional natural gas wells and coal-bed natural gas wells are numerous in the herd unit (BLM 2003).

Urban and sub-urban development includes the communities of Sheridan (17,444) and Ranchester (855). The distribution of the remainder of the human population in the area is rural in character being dispersed in small unincorporated communities, settlements or individual ranches or home sites throughout the herd unit (TWTER 2014).

The area provides ample opportunities for a variety of outdoor recreational activities. During the fall, hunting for small game and big game attracts large numbers of outdoor enthusiasts.

Management Issues Industrial scale oil and gas development and outfitting in the herd unit have resulted in restricted hunting access to some private lands. There are very few public land hunting opportunities in this herd unit. The restricted access has made it difficult to attain adequate harvest in portions of the herd (WGFD 2013).

Population Size The pronghorn population in herd unit 308 has fluctuated substantially likely due to a variety of factors. As the unit is currently represented, the minimum population estimate for the herd is 2,300 animals in 1981 and the maximum population size is 8,750 animals in 2008. The mean value for population size for all years of the analysis is 4,500 animals. The population

estimate for 2012 is 4,300 animals. A review of the mean population estimates by decade also provides some insight to what has occurred with this population. The mean population size for the 1980s is 3,008 animals, for the 1990s 4,344 animals, for the 2000s 6,088 animals and for the 2010s 4,703 animals. The long-term trend for population size is increasing for this herd unit. The long-term population objective for this herd unit is 3,000 animals.

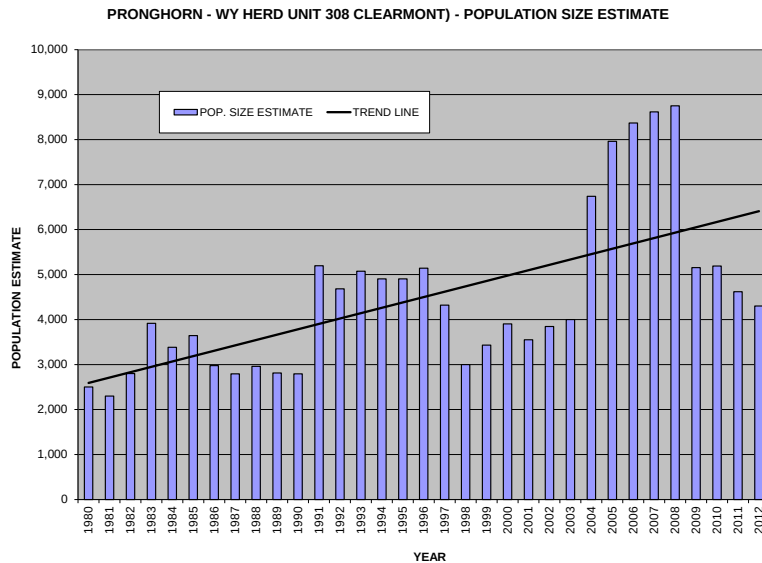


Fig. 134. Pronghorn – Wyoming herd unit 308 (Clearmont) – population size estimate

Age and Sex Composition Male/100 female ratios have varied from a high of 75 males/100 females in 1980 to a low of 27 males/100 females in 1982. The mean for male/female ratios is 43 males/100 females for all years of the analysis. The long-term trend for male/female ratios is increasing.

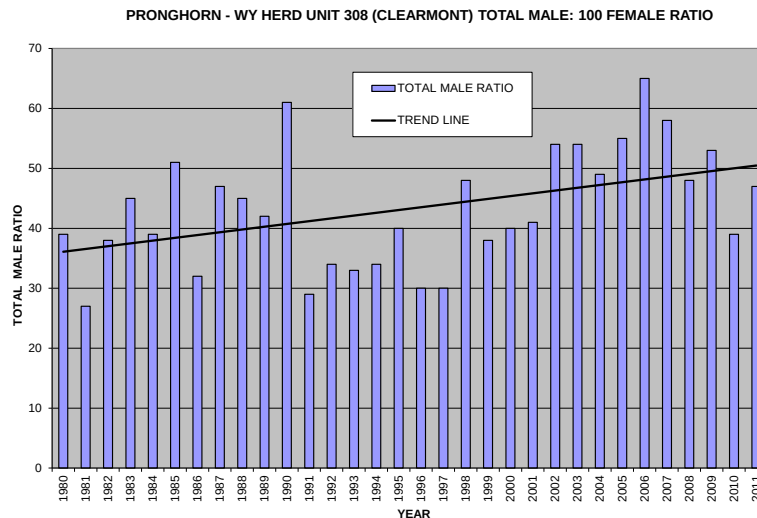


Fig. 135. Pronghorn – Wyoming herd unit 308 (Clearmont) – male/100 female ratios

Young/100 female ratios have fluctuated from a high of 110 young/100 females in 1983 to a low of 36 young/100 females in 1997. The mean value for young/100 female ratios for all years of the analysis is 66 young/100 females. The long-term trend for young/100 females is decreasing.

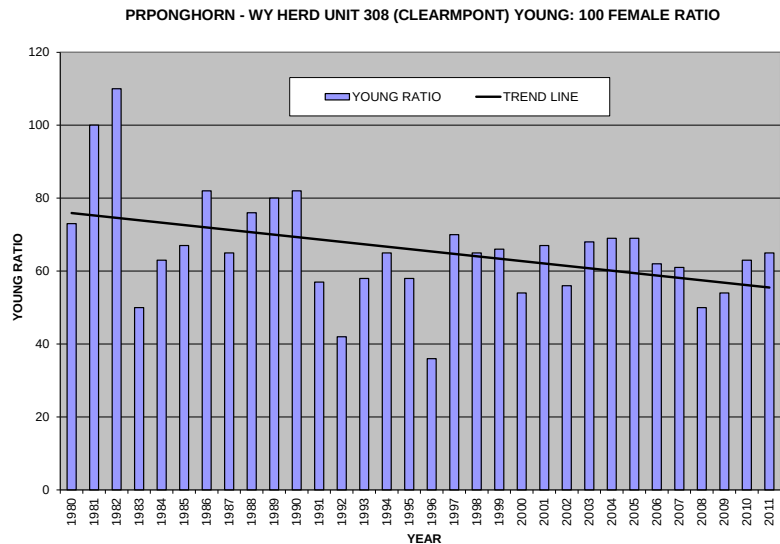


Fig. 136. Pronghorn – Wyoming herd unit 308 (Clearmont) – young/100 female ratios

Harvest Total male harvest for this herd unit has varied from a high of 500 bucks harvested in 1985 to a low of 152 bucks harvested in 1999. Average buck harvest for all years of the analysis is 354 animals. The long-term trend for buck harvest is decreasing. Buck harvest for 2012 was 244 animals. A review of average buck harvest by decade shows that average harvest has declined from a high of 440 animals in the 1980s to a low of 284 animals in the 2000s and a small increase back to 300 animals in the 2010s. Despite the modest increase in the 2010s, buck harvest has been below the average harvest of 354 animals since 2009.

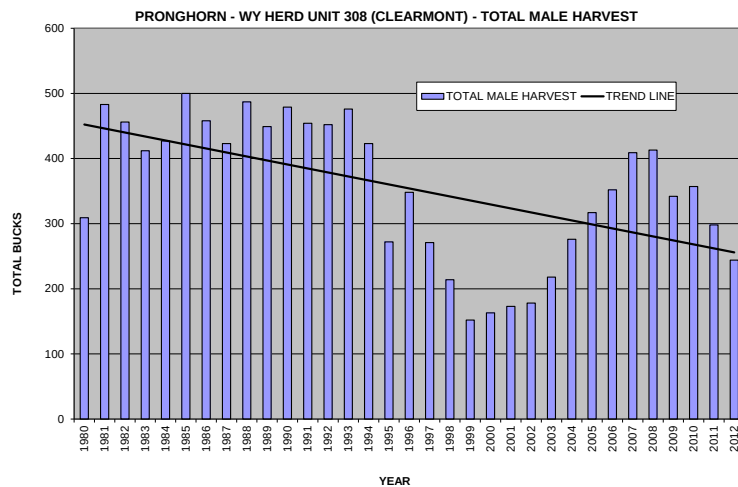


Fig. 137. Pronghorn – Wyoming herd unit 308 (Clearmont) – male harvest

Total harvest of animals for the herd unit has ranged from a high 898 animals in 1985 to a low of 172 animals in 1999. The mean value for total harvest for all years of the analysis is 552 animals. The long-term trend for harvest is decreasing. Total harvest of animals for this population dropped below the mean for harvest for a 10 year period of time from 1996 through 2005 and has dropped below the mean again in 2011 and 2012.

Harvest of females and young has accounted for a substantial proportion of the harvest for all years of the analysis except for the time period from 1996 to 2004 when female and young harvest accounted for less than 25% of the total harvest. In the late 1980s and early 1990s, female and young harvest accounted for as much as 58% of the total harvest.

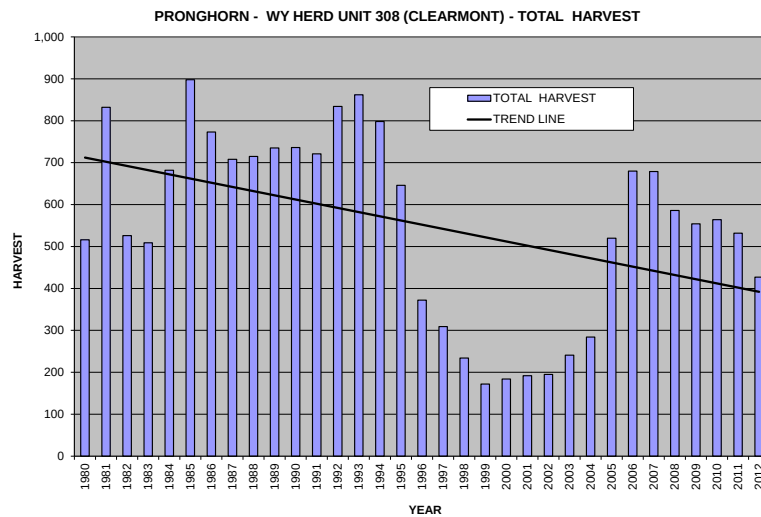


Fig. 138. Pronghorn – Wyoming herd unit 308 (Clearmont) – total harvest

Hunter Numbers and Success Rates Total hunting pressure (all seasons and methods of take) has varied from a high of 981 hunters in 1981 to a low of 250 hunters in 2001. The mean for total hunting pressure for all years of the analysis is 588 hunters. The long-term trend for hunting pressure is decreasing. The total number of hunters dipped below the mean number of hunters for a 10 year period of time from 1996 through 2005.

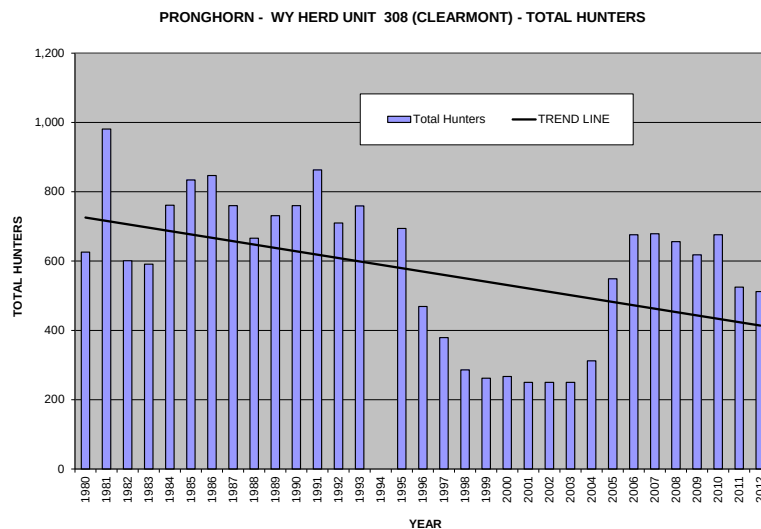


Fig. 139. Pronghorn – Wyoming herd unit 308 (Clearmont) – total hunters

Hunter success rates for all seasons and methods of take have ranged from a high of 117.5% success in 1992 to a low of 65.6% in 1999. The mean value for hunter success rates is 90.5%. The long-term trend for hunter success rates is level to very slightly decreasing.

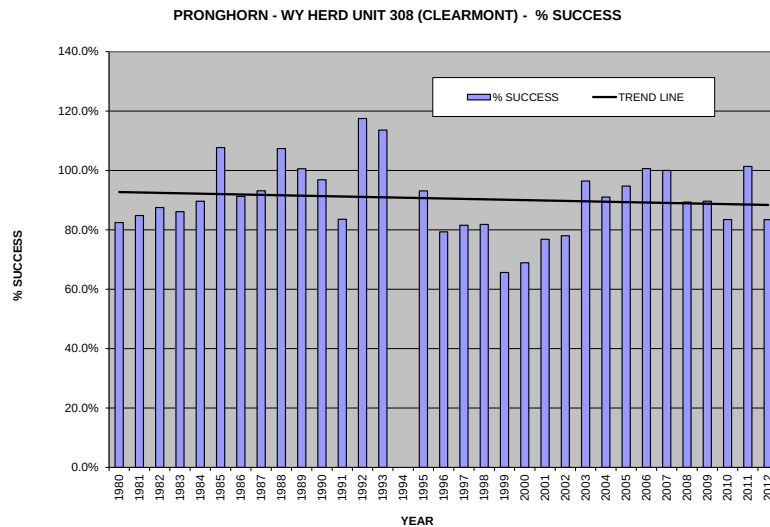


Fig. 140. Pronghorn – Wyoming herd unit 308 (Clearmont) – hunter success rates

Summary of Herd Vital Statistics and Management Implications An evaluation of an assortment of data for the pronghorn herd in this herd unit indicates that it is not performing at an optimum level. According to an evaluation system that was developed for this project, the performance rating for this herd would be fair for the following reasons:

- The pronghorn population in this herd unit is at or above the long term population objective set by the Wyoming Game and Fish Department (4,300 versus an LTO of 3,000 animals). This herd has been at objective or within 10% of the object for the past 10 years.
- The long-term trend for population size for the herd is increasing. However, this herd has been decreasing for the last 5 years but it is still above the current long-term objective.
- The long-term trend for young/100 female ratios is decreasing. In addition, young/100 female ratios for the last 5 years have been below the mean value for young/100 female ratios (66:100) for this herd. Since this population is above the stated long-term objective for population size this short-term trend for young/100 female ratios isn't a big issue. However, it is expected that young/100 female ratios will eventually rebound as animal density decreases.
- A negative factor for this pronghorn herd is a decreasing long-term trend for harvest. The total harvest of 427 animals in 2012 is substantially lower than the mean value for harvest (552 animals per year). From 1996 to 2005 this herd endured a 10 year period of low harvest. The mean harvest for this 10 year period was 270 animals per year which is substantially below the long-term mean value for harvest (552 animals per year). Without this 10 year period of low harvest the long-term trend for harvest would likely have been stable instead of declining which would have moved the herd unit from the fair to good category of performance.

The end result of all of this information is that if current habitat conditions are maintained, and if the young/100 female ratios stay at the current level, this population will likely be able to maintain the population at near the current level. However, if habitat conditions deteriorate due to development or adverse natural environmental conditions, population size and harvest will likely decline further than the current situation.

PUMPKIN BUTTES, PRONGHORN HERD UNIT 309 (refer to table 17 in the appendix)

General Description Pronghorn antelope herd unit 309 is located in northeastern Wyoming and is generally referred to as the Pumpkin Buttes Herd Unit. The herd unit lies in portions of

Campbell and Johnson counties and contains hunt area 23. The herd unit is bounded on the north by Interstate 90, on the east by state highway 59, on the south by state highway 387 and on the west by state highway 192 and the Powder River. The herd unit covers an area of approximately 1,542 sq. mi. with 1,473 sq. mi. considered to be occupied habitat (WGFD 2014). The topography of the area consists of a rolling upland plain with low to moderate relief. A major river drainage is the Powder River on the west boundary of the herd unit. Vegetation in the herd unit is characteristic of the northwestern Great Plains, consisting of mixed-grass prairie dominated by blue grama, western wheatgrass, junegrass, Sandberg bluegrass, needle-and-thread grass, rabbitbrush, fringed sage, and other forbs, shrubs and grasses (BLM 2003).

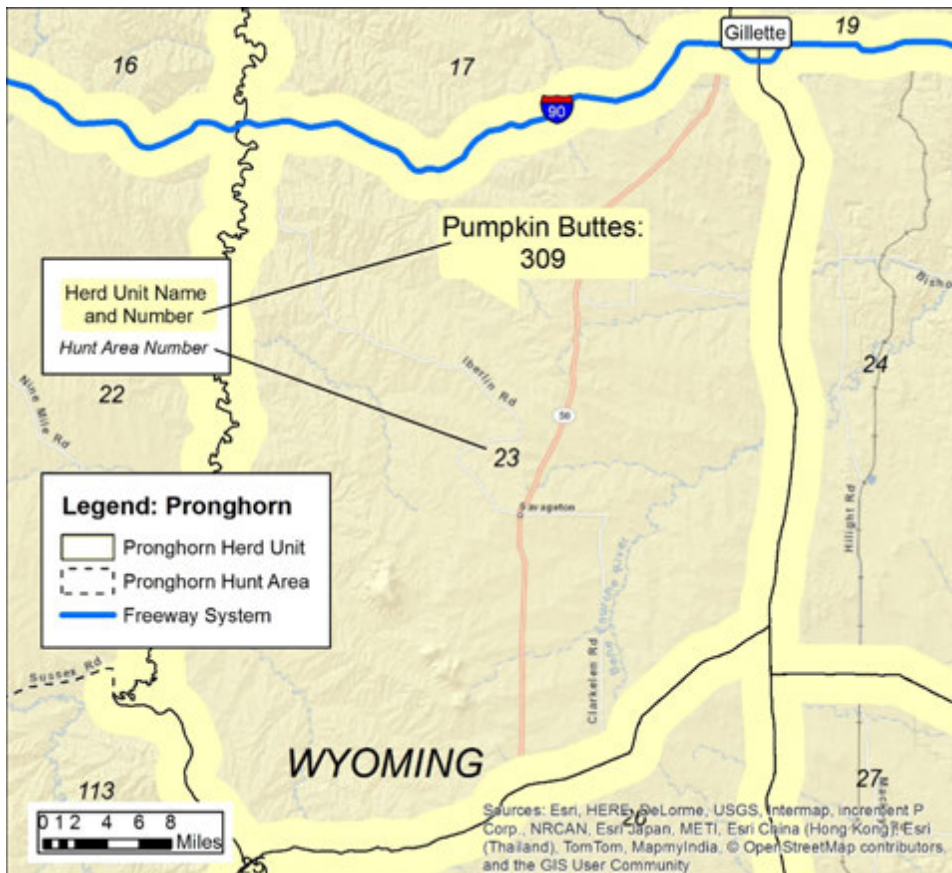


Fig. 141. Wyoming pronghorn herd unit 309 (Pumpkin Buttes)

Land Ownership This herd unit is comprised of a mixture of public and private lands. The distribution of land ownership is approximately 88% private, 7% BLM and 5% private (WGFD 2014).

Land Use Livestock grazing for cattle occurs on much of the private and public land in the herd unit. Extraction of natural resource for energy development is a major activity in this herd unit. There are a number of large coal strip mines in the east portion of the herd unit. Drilling for oil, natural gas and coal-bed methane is another large industry in this area with numerous wells, processing and compressor plants, pipelines and service roads existing in the unit (BLM 2003).

Urban and sub-urban development consist of the community of Gillette (29,087) and numerous unincorporated towns, settlements or individual farms and ranches.

Management Issues There has been extensive coal bed methane development in this herd unit. This has resulted in a network of roads and infrastructure that has interfered with hunting in the past but seems to have declined in recent years (WGF, 2013). Reclamation of wells will be a high priority as drilling and development activity subsides. Access is a very big issue in this herd unit as a substantial number of animals are found on private land (WGFD 2013).

Population Size The pronghorn population in this herd unit has been gradually increasing due to recent, mild winter conditions and the difficulty in getting adequate harvest due to private land access issues. As it is currently represented the minimum population estimate for this herd was 11,806 animals in 1981. The maximum population estimate for the herd was 36,482 animals in 2006. The mean value for population size for all years of the analysis is 22,670 animals. The long-term trend for population size is increasing. The population estimate for 2012 is 35,500 animals. The long-term objective for this population is 18,000 animals. Since the long-term objective was established in 1989, this population has been over objective for 21 of 24 years.

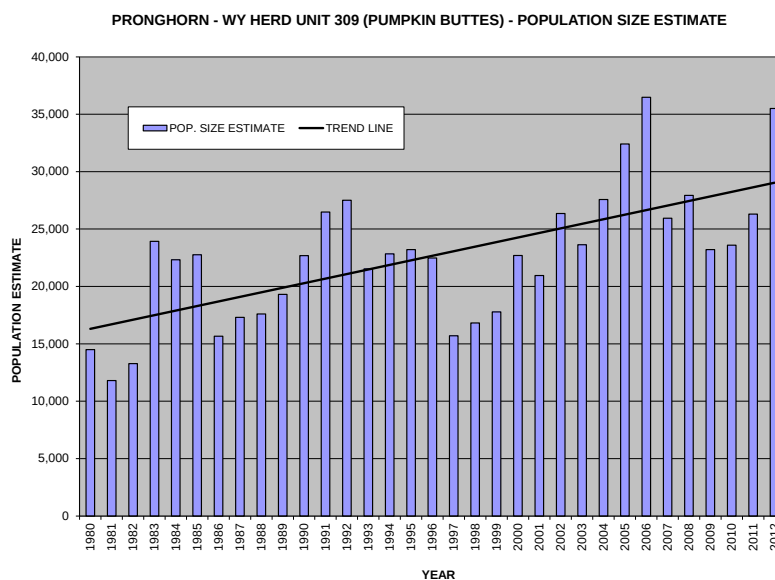


Fig. 142. Pronghorn – Wyoming herd unit 309 (Pumpkin Buttes) – population size estimate

Age and Sex Composition Male/100 female ratios have ranged from a high of 68 males/100 females in 1987 to a low of 41 males/100 females in 2006. The mean value for male/100 female ratios for all years of the analysis is 54 males/100 females. The long-term trend for male/100 female ratios is level is increasing slightly.

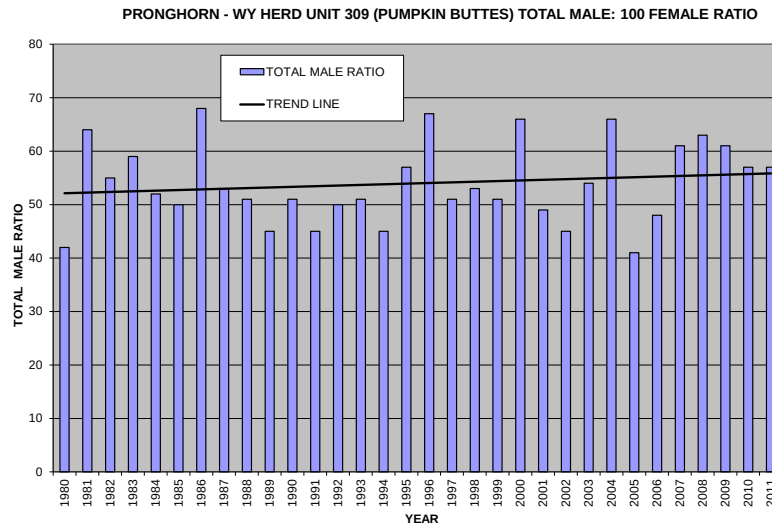


Fig. 143. Pronghorn – Wyoming herd unit 309 (Pumpkin Buttes) – male/100 female ratios

Young/100 female ratios have ranged from a high of 109 young/100 females in 1986 to a low of 64 young/100 females in 1993. The mean value for young/100 females for all years of the analysis is 83 young/100 females. The long-term trend for young/100 females is decreasing.

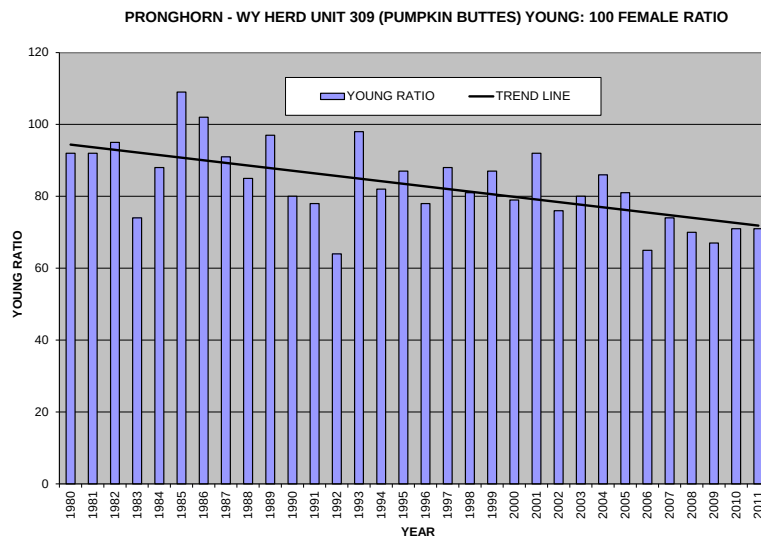


Fig. 144. Pronghorn – Wyoming herd unit 309 (Pumpkin Buttes) – young/100 female ratios

Harvest Total male harvest for this herd unit has ranged from a low of 973 animals in 1980 to a high of 2,184 animals in 1994. The mean value for buck harvest for all years of the analysis is 1,361 animals. The long term trend for harvest is decreasing. Buck harvest for 2012 was 1,479 animals. A review of average buck harvest by decade shows that the highest average harvest occurred in the 1980s, declined through the 1990s and 2000s and increased very slightly in the 2010s. The 2012 buck harvest of 1,479 animals is above the long-term average harvest of 1,361 animals.

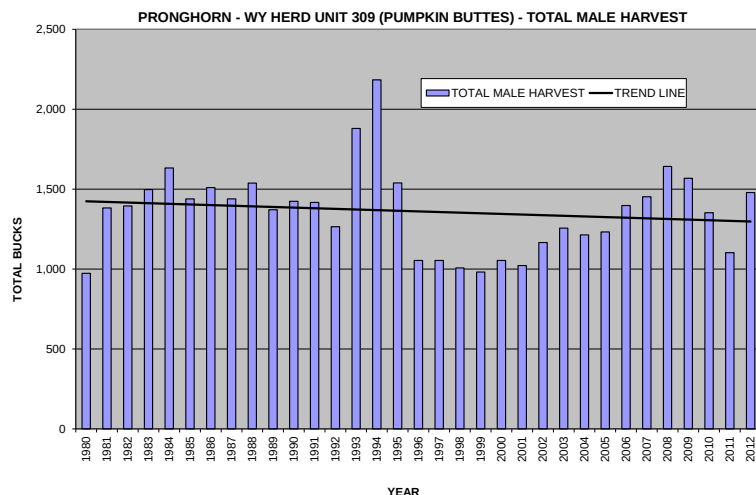


Fig. 145. Pronghorn – Wyoming herd unit 309 (Pumpkin Buttes) – male harvest

Total harvest for all seasons and methods of take has fluctuated from a high of 4,526 animals in 1994 to a low of 1,051 animals in 1999. The mean value for harvest for all years of the analysis is 2,297 animals. The long-term trend for harvest for all years of data is decreasing. With the exception of 1998 and 1999, doe and fawn harvest has always made up a significant portion of the total harvest.

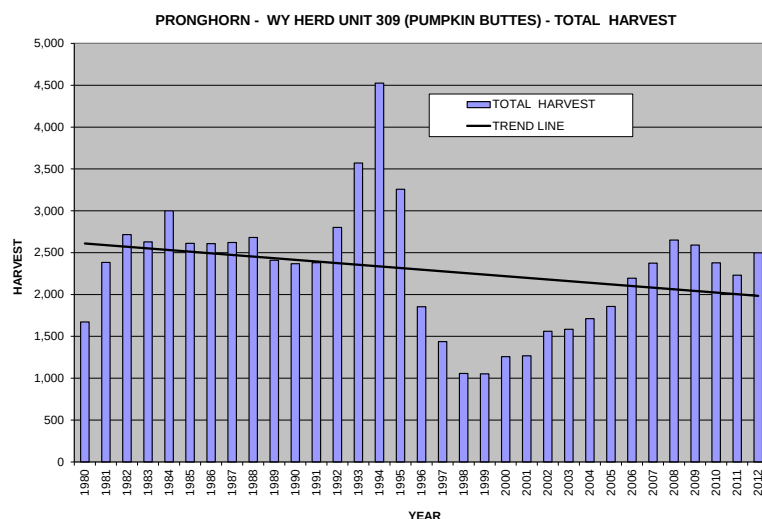


Fig. 146. Pronghorn – Wyoming herd unit 309 (Pumpkin Buttes) – total harvest

Hunter Numbers and Success Rates Hunter numbers have fluctuated fairly dramatically in this herd unit. Total hunting pressure (all seasons and methods of take) has ranged from a high of 3,191 in 1984 to a low of 983 in 1989. This herd unit has supported an average of 2,105 hunters per year for all years of the analysis. The long-term trend for hunter numbers is level. The cause for the large fluctuations of hunter numbers over the years is difficult to pinpoint since numbers of pronghorn in the population and recruitment of young haven't demonstrated changes anywhere near the change in hunter numbers.

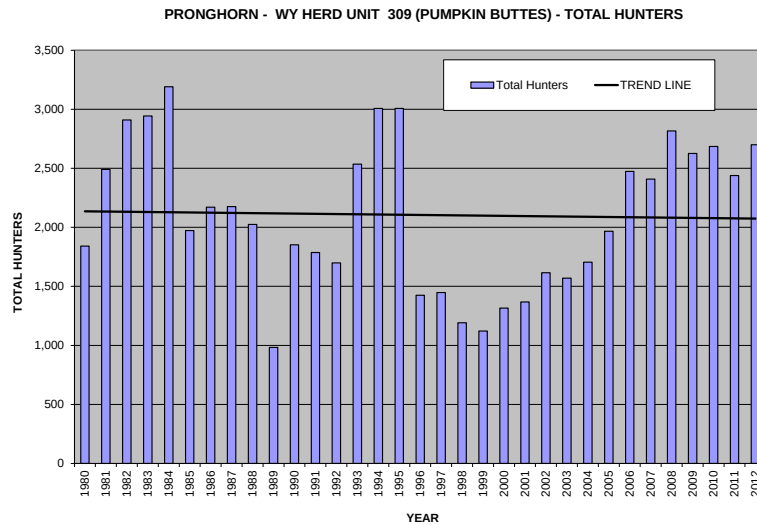


Fig. 147. Pronghorn – Wyoming herd unit 309 (Pumpkin Buttes) – total hunters

Hunter success rates, with the exception of 1989, have remained fairly constant over the years. The high success rate documented for that year especially, and eleven other years, would have necessitated hunting seasons that allowed hunters to have more than one license and/or harvest more than one animal in a single season. Hunter success rates have ranged from a high of 245% in 1989 to a low of 88.6% in 2010. The mean for hunter success rates for all years of the analysis is 111.7%. Even though the long-term trend for hunter success rates is shown as only decreasing slightly, there is a 30 percentage point difference between average success rates for the 1980s and the 2010s.

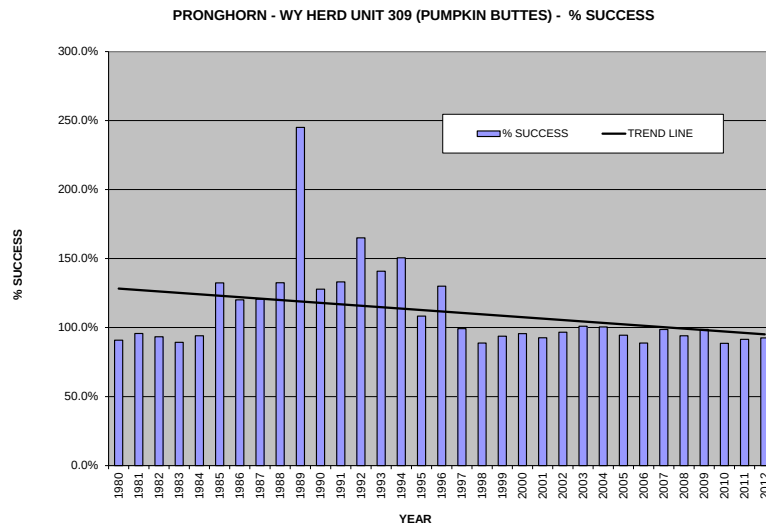


Fig. 148. Pronghorn – Wyoming herd unit 309 (Pumpkin Buttes) - hunter success rates

Summary of Herd Vital Statistics and Management Implications An evaluation of an assortment of data for the pronghorn herd for this herd unit indicates that it is performing well. According to an evaluation system that was developed for this project, the performance rating for this herd would be good for the following reasons:

- The pronghorn population in this herd unit is substantially above the long term population objective set by the Wyoming Game and Fish Department (35,500 versus 18,000 animals). This herd has been at objective or within 10% of the object for the past 13 years.

- The long-term trend for population size for the herd is increasing. This herd has been increasing in recent years as well.
- The long-term trend for young/100 female ratios is decreasing. In addition, young/100 female ratios for the last 5 years have been below the mean value for young/100 female ratios (83:100). The short-term trend for young/100 female ratios of 70.6/100 should be sufficient to maintain the population if not achieve minor increases.
- A negative factor for this pronghorn herd is a decreasing long-term trend for harvest. However, the total harvest of 2,498 animals in 2012 is above the long-term mean for harvest (2,297 animals) for this herd unit. From 1996 to 2006 this herd endured an 11 year period of low harvest. The mean harvest for this 11 year period was 1,531 animals per year which is substantially below the long-term mean value for harvest (2,297 animals per year). Without this 11 year period of low harvest the long-term trend for harvest would likely have been stable instead of declining.

The end result of all of this information is that if current habitat conditions are maintained, and if the short-term trend for young/100 females continues, this pronghorn herd may be able to maintain the current population size. However, if habitat conditions deteriorate due to development or adverse natural environmental conditions, harvest and hunting opportunity will likely decline further than the current situation.

HIGHLIGHT, PRONGHORN HERD UNIT 316 (refer to table 18 in the appendix)

General Description Pronghorn Antelope Herd Unit 316 is located in northeastern Wyoming is referred to as the Highlight Herd Unit. The herd unit lies in portions of Crook, Weston and Campbell counties and contains hunt area 24. The herd unit is bounded on the north by Interstate 90, on the east by the Belle Fourche River, the Horse Creek/Raven Creek divide, the Belle Fourche River/Cheyenne River divide, the Newel Prong, Bacon Creek, Black Thunder Creek and the Keeline Road; on the south by Wyoming Highway 450 and on the west by Wyoming Highway 59. This herd unit covers an area of approximately 851 sq. mi. with 721 sq. mi. considered to be occupied habitat WGFD 2014).



Fig. 149. Wyoming pronghorn herd unit 316 (Highlight)

Vegetation in the herd unit is composed of 2 eco-regions; the Powder River Basin and Pine Scoria Hills of the Northwestern Great Plains. Vegetation for the first eco-region is consists of mixed-grass prairie dominated by blue grama, western wheatgrass, junegrass, Sandberg bluegrass, needle-and-thread grass, rabbitbrush, fringed sage, and other forbs, shrubs and grasses. Vegetation for the second eco-region consists of Ponderosa pine-Rocky Mountain juniper forest or ponderosa pine savanna with understory of grasses, forbs, and shrubs. Species include little bluestem, bluebunch wheatgrass, western wheatgrass, blue grama, and Sandberg bluegrass, Idaho fescue, and needle-and-thread. Skunkbush sumac and western snowberry are common shrubs (Chapman et al. 2004).

Land Ownership This herd unit contains a mixture of public and private lands. The distribution of land ownership in the herd unit is approximately 85% private, 7% state, 4% BLM and 4% National Grasslands (WGFD 2014).

Land Use Agriculture in the form of livestock grazing is a very prominent land use in the herd unit. Agricultural crops grown in the area include winter wheat, grass and alfalfa hay but account for only a small percentage of the total area of the herd unit. Croplands are localized and found primarily southeast of Gillette and near Moorcroft. Energy development is another prominent land use in the area. There are several large surface coal mines along the west boundary of the herd unit which create a high level of disturbance. In addition, coal bed methane development over a large portion of the herd unit is expected to continue to increase disturbance (Wyoming Game and Fish 2013). Urban and suburban development include the communities of Gillette (29,087) and Moorcroft (1,009). The remainder of the human population in the herd unit is rural in character, being dispersed in very small communities or individual ranches or farms throughout the area.

Management Issues One of the major issues with this herd unit is that of achieving an adequate harvest when needed as many of the pronghorn are on private land. Confidence in the model is low (poor model). There is the possibility that this herd unit has some immigration and emigration on the eastern boundary, which could be the cause for widely fluctuating buck ratios and the potential inaccuracy of this model (WGFD 2013).

Population Size As currently represented, the pronghorn population in the Highlight herd unit has fluctuated from a low of 7,626 animals in 1980 to a high of 16,489 animals in 1983. The mean value for population size for all years of the analysis is 11,527 animals. The long-term trend for population size is stable or only decreasing slightly. The population estimate for 2012 is 10,000 animals. The long-term population objective for the herd unit is 11,000 animals. The current population model does not do a good job of representing what likely happened with the population in the early years (1980s). Wyoming Game and Fish personnel state that they have low confidence that the model accurately depicts what is happening with the population in the early years of the analysis (WGF 2013).

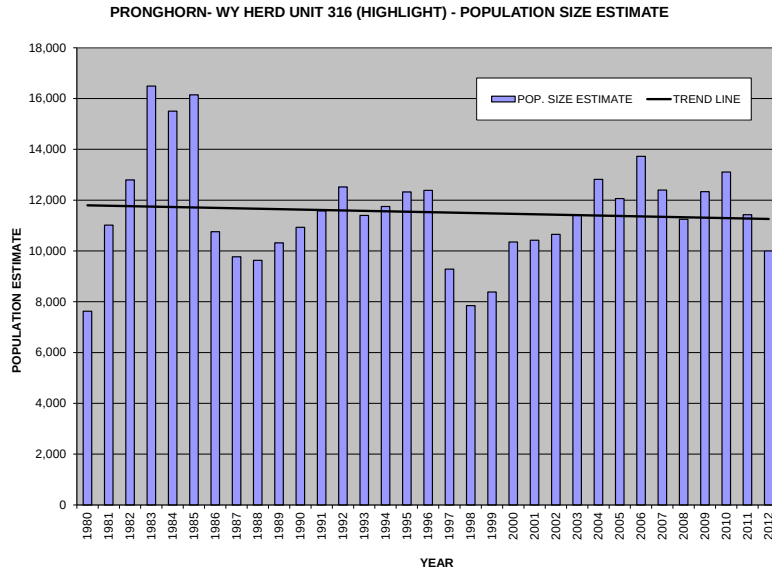


Fig. 150. Pronghorn – Wyoming herd unit 316 (Highlight) – population size estimate

Age and Sex Composition Male/100 female ratios have varied from a low of 33 males/100 females in 1998 to a high of 74 males/100 females in 2008. The mean value for all years of data is 56 males/100 females. The long-term trend for male/100 female ratios is increasing.

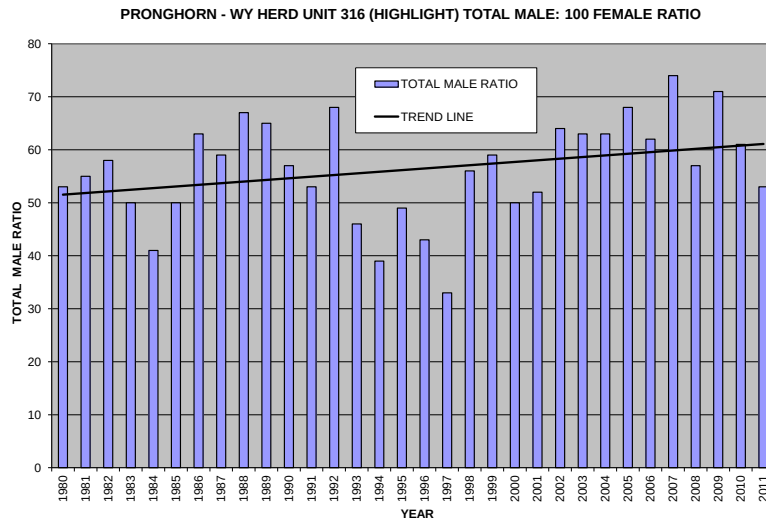


Fig. 151. Pronghorn – Wyoming herd unit 316 (Highlight) – male/100 female ratios

Young/100 female ratios have ranged from a high of 97 young/100 females in 1981 and 1988 to a low of 47 young/100 females in 2012. The mean value for all years of data is 77 young/100 females. The long-term trend for young/100 females is decreasing.

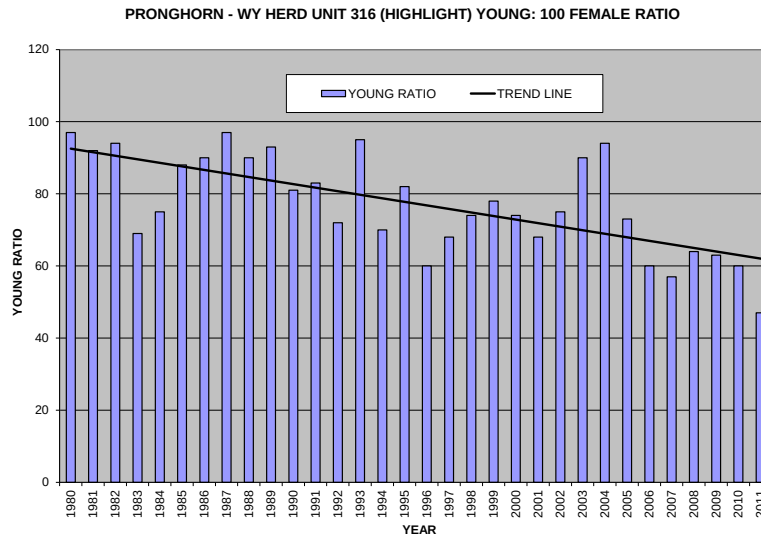


Fig. 152. Pronghorn – Wyoming herd unit 316 (Highlight) – young/100 female ratios

Harvest Total male harvest for this herd unit has ranged from a high of 935 bucks in 1984 to a low of 114 bucks in 2000. The average buck harvest for all years of the analysis is 532 animals. The long-term trend for harvest is decreasing. Buck harvest for 2012 was 528 animals which is slightly above the average harvest for the herd unit. A review of the average harvest of bucks by decade shows that average harvest has declined from a high of 671 animals per year in the 1980s to 464 in the 1990s, 435 in the 2000s and then climbed back to 617 animals in 2010s which is near the high average harvest from the 1980s.

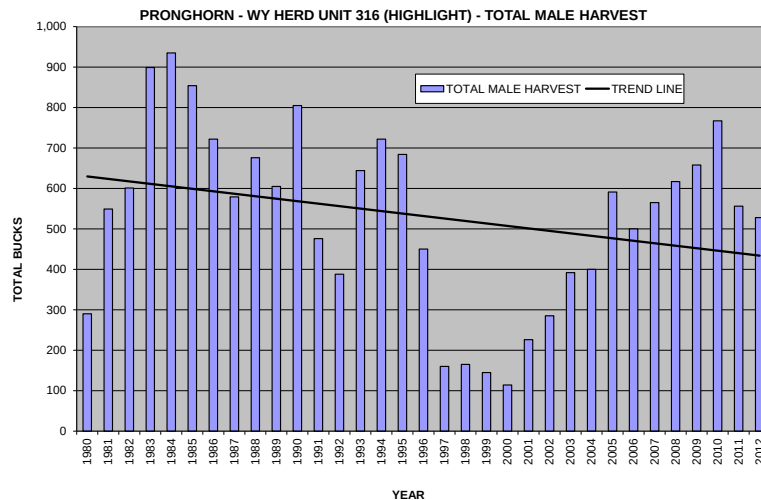


Fig. 153. Pronghorn – Wyoming herd unit 316 (Highlight) – male harvest

Total harvest for this herd unit has varied from a high of 2,752 animals in 1983 to a low of 162 animals in 1999. The mean for total harvest for all years of the analysis is 1,046 animals. The long-term trend for harvest is decreasing. Harvest started out very high in the early 1980s and then experienced a steady decline till 1999 when the harvest of 162 animals was less than 6% of the total harvest in 1983. Since that time harvest has climbed back to 1,319 animals in 2010 but has decreased again to 884 animals harvested in 2012.

Doe and fawn harvest has occurred in all years of this analysis. In the mid-1980s, doe and fawn harvest accounted for as much as 57% of the total harvest. Doe and fawn harvest declined dramatically in the late 1990s and early 2000s but is again accounting for at least 35% of the total harvest in the last 7 years.

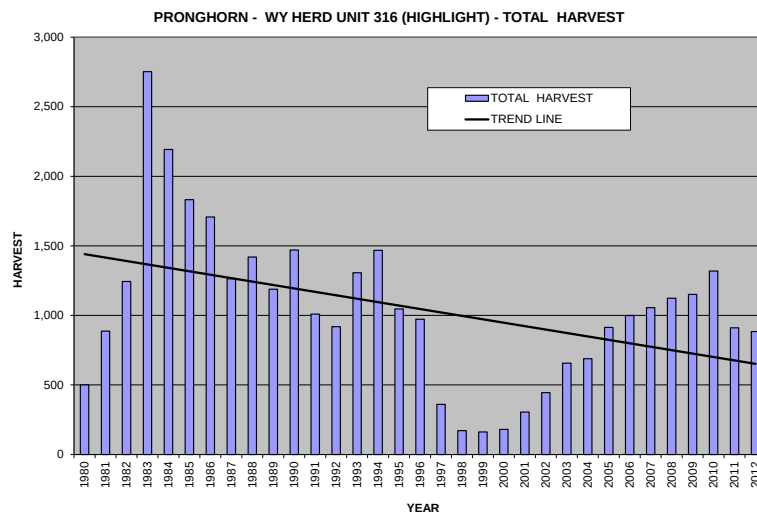


Fig. 154. Pronghorn – Wyoming herd unit 316 (Highlight) – total harvest

Hunter Numbers and Success Rates Total hunter pressure is a virtual mirror image of harvest with hunter numbers peaking at 2,870 in 1983 and then declining to 178 hunters in 1999. The mean value for total hunters for all years of the analysis is 963. The long-term trend for hunter numbers is decreasing.

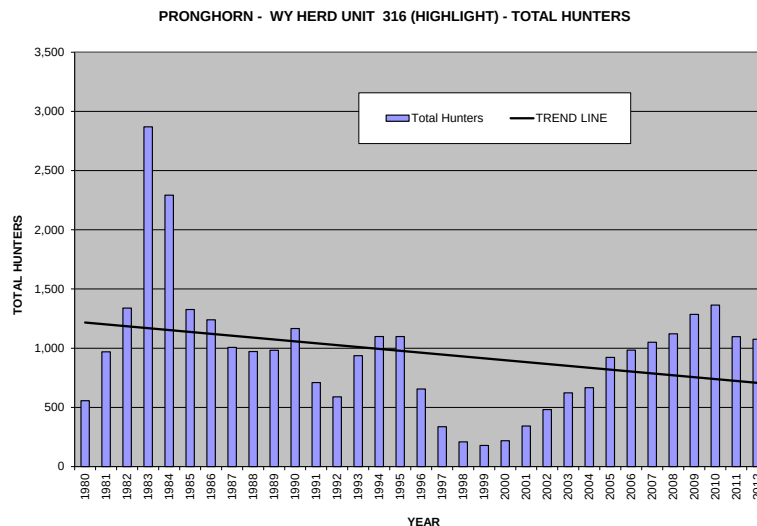


Fig. 155. Pronghorn – Wyoming herd unit 316 (Highlight) – total hunters

Hunter success rates for all methods of take have varied from a high of 156% in 1992 to a low of 81.8% in 1998. The mean for hunter success rates for all years that were evaluated is 108.5%. The long-term trend for hunter success rates for the unit is decreasing. Hunter success rates greater than 100% equates to multiple licenses per hunter or a situation where more than one animal can be harvested per license.

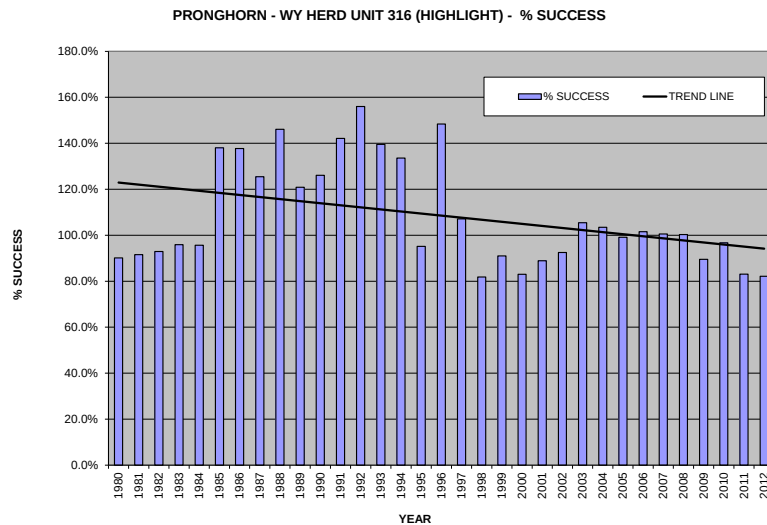


Fig. 156. Pronghorn – Wyoming herd unit 316 (Highlight) – hunter success rates

Summary of Herd Vital Statistics and Management Implications An evaluation of an assortment of data for the pronghorn herd in this herd unit indicates that it is not performing at an optimum level. According to an evaluation system that was developed for this project, the performance rating for this herd would be fair for the following reasons:

- The pronghorn population in this herd unit is within 90% of the long-term population objective set by the Wyoming Game and Fish Department (10,000 versus LTO of 11,000 animals). The last time this pronghorn herd was at objective was 2011, but the population has been at objective or within 10% of the LTO for the last 10 years.
- The long-term trend for population size for the herd is stable.
- The long-term trend for young/100 female ratios is decreasing. The young/100 female ratio for 2012 is the lowest value ever reported for this herd. In addition, young/100 female ratios have been below the long-term mean value for young/100 female ratios (77:100) for 8 years. If this short-term trend for young/100 female ratios continues there is low potential for growth in the population.
- Another negative factor for this pronghorn herd is a decreasing long-term trend for harvest. The total harvest of 884 animals in 2012 is below the long-term mean for harvest (1,046 animals) for this herd unit. In addition, from 1996 through 2006 this herd endured an 11 year period of low harvest. The mean harvest for this 11 year period was 532 animals per year which is substantially below the long-term mean value for harvest (1,046 animals per year). Without this 11 year period of low harvest the long-term trend for harvest would likely have been stable instead of declining.

The upshot of all of this information is that even if current habitat conditions are maintained, and if the short-term trend for young/100 females continues, this pronghorn herd is unlikely to show any improvement in population size and harvest. However, if habitat conditions deteriorate due to development or adverse natural environmental conditions, population size and harvest will likely decline further than the current situation.

CRAZY WOMAN, PRONGHORN HERD UNIT 318 (refer to table 19 in the appendix)

General Description Pronghorn antelope herd unit 318 is located in northeastern Wyoming and is commonly known as the Crazy Woman Herd Unit. The herd unit lies in portions of Johnson and Natrona counties and contains 2 hunt areas; 22 and 113. The herd unit is bounded on the north by Interstate Highway 90, on the east by the Powder River and state highway 192, on the south by U. S. Highway 387 and on the west by Interstate 25. The herd unit covers an area of approximately 1,170 sq. mi. with 1,154 sq. mi. considered to be occupied habitat (WGFD 2014).



Fig. 157. Wyoming pronghorn herd unit 318 (Crazy Woman)

The area consists of a rolling upland plain with low to moderate relief, broken by buttes, mesas, hills and ridges. Topography of the area has been shaped mostly by erosion by water. Minor drainages dissecting the area are incised, typically are ephemeral or intermittent, and do not normally provide permanent or year-around sources of water along their entirety. A major river valley in the herd unit, the Powder River has a wide and flat floodplain. Vegetation in the herd unit is characteristic of the Powder River Basin eco-region of the northwestern Great Plains and consists of mixed-grass prairie dominated by blue grama, western wheatgrass, junegrass, Sandberg bluegrass, needle-and-thread grass, rabbitbrush, fringed sage, and other forbs, shrubs and grasses (Chapman et al. 2004)

Land Ownership The herd unit is comprised of both public and private land. The distribution of land ownership is approximately 75% private, 18% BLM and 7% state (WGFD 2014).

Land Use Livestock grazing is a major land use in the area while only a small portion of the area is plowed or planted to crops such as alfalfa, grass hay or winter wheat. Extraction of natural resource for energy development is a major activity in this herd unit. Drilling for oil, natural gas and coal-bed methane is another large industry in this area with numerous wells, processing and compressor plants, pipelines and service roads existing in the unit. Communities in the herd unit include Buffalo (4,585), Midwest (404), Kaycee (203) and Edgerton (201). The distribution of the remainder of the human population in the herd unit is rural in character being dispersed in very small communities, settlements or individual ranches or farms (TWTER 2014).

Management Issues The Crazy Woman Pronghorn Herd Unit post-season population objective is 7,000 pronghorn. The management strategy is recreational management. The objective and management strategy were last revised in 1988 but was scheduled to be reviewed in 2014. Area 22 is largely private land with limited public land hunting opportunities. Therefore, access to hunt

is largely determined by landowners. Increased outfitter leasing of ranches typically results in more restrictive access. Area 113 contains a large amount of inaccessible public land. A cooperative agreement between private landowners, the BLM and the WGFD ended in 2008 when one of the remaining two landowners withdrew from the program. In 2012, the Mieke Ranch sold most of its property which is expected to significantly reduce hunter access. Even with the expansive outfitting industry, at the herd unit level increasing numbers of hunters are finding hunting opportunity. This past hunting season both buck harvest and total harvest rivaled highs set in 1982, 1,143 and 2,048, respectively (WGFD 2013).

Population Size The pronghorn population in herd unit 318 has fluctuated substantially for the entire period of the analysis. The minimum population estimate for the herd was 3,599 animals and occurred in 1980. The maximum population estimate was 15,868 animals and occurred in 2011. The mean value for population size for all years of the analysis is 8,842 animals. The long-term trend for population size is increasing. The population estimate for 2012 is 12,100 animals. The long-term objective for population size is 7,000 animals. The population has expanded and declined twice in the past 20 years. Since that time the population has grown to a record high of 15,868 animals and managers appear to be unable to control the population or maintain it near the current long-term objective of 7,000 animals with the current season structure and issues with hunter access.

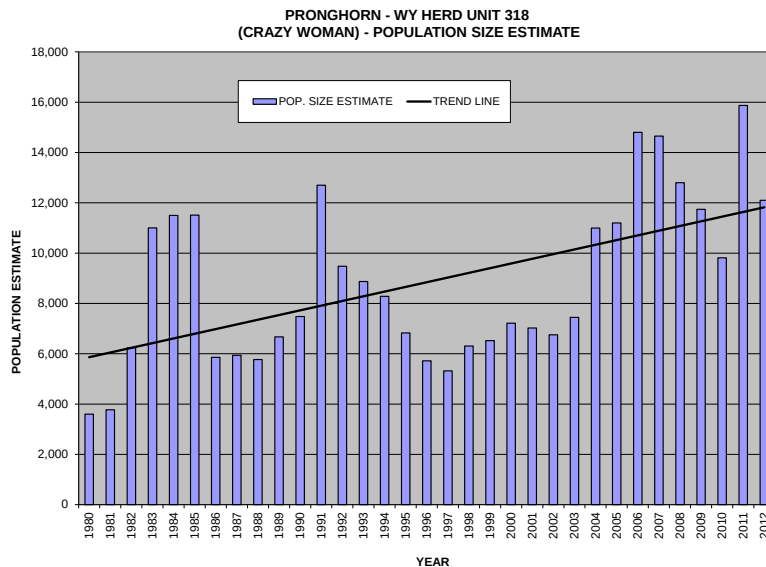


Fig. 158. Pronghorn – Wyoming herd unit 318 (Crazy Woman) – population size estimate

Age and Sex Composition Male/100 female ratios have varied from a low of 32 males/100 females in 1986 to a high of 71 males/100 females in 2009. The mean value for all years of the analysis is 53 males/100 females. The long-term trend for male/100 female ratios is increasing for this herd unit.

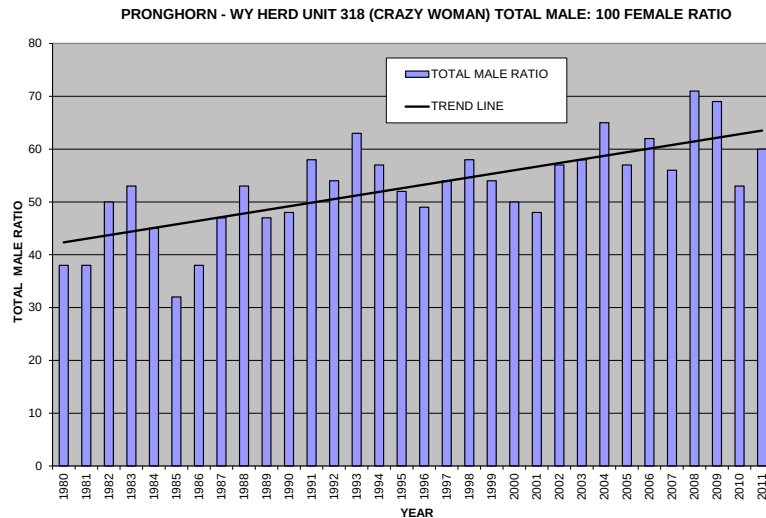


Fig. 159. Pronghorn – Wyoming herd unit 318 (Crazy Woman) – male/100 female ratios

Young/100 female ratios have ranged from a high of 102 young/100 females in 1987 to a low of 59 young/100 females in 1993. The mean value for all years of the analysis is 84 young/100 females. The long-term trend for young/100 females is declining.

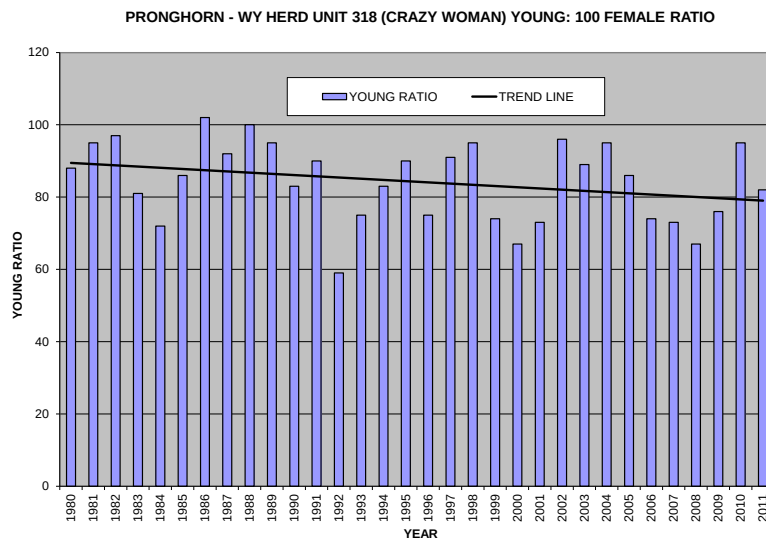


Fig. 160. Pronghorn – Wyoming herd unit 318 (Crazy Woman) – young/100 female ratios

Harvest Total male harvest for the Crazy Woman herd unit has varied from a high of 1,177 bucks in 1984 to a low of 341 bucks in 1989. The mean value for buck harvest for all years of the analysis is 719 animals. The long-term trend for buck harvest is declining slightly. Total buck harvest for 2012 was 1,086 animals which is well above the long-term average harvest. A review of male harvest by decade shows that the 2010s have the highest average buck harvest for all decades of the analysis at 1,012 animals.

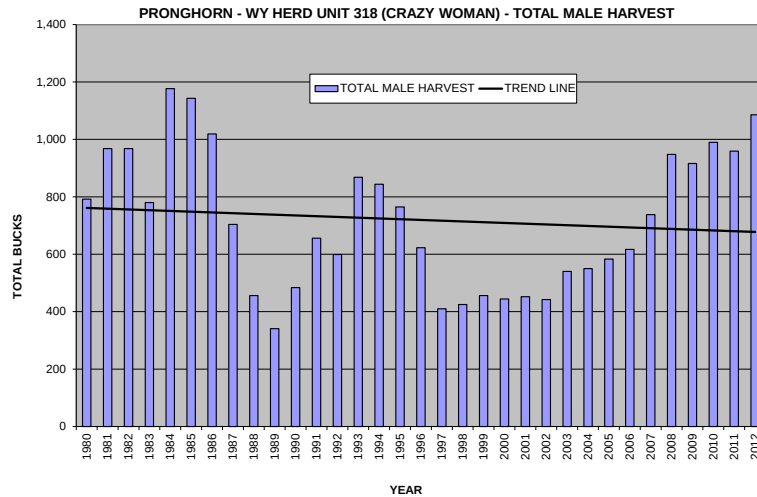


Fig. 161. Pronghorn – Wyoming herd unit 318 (Crazy Woman) – male harvest

Total pronghorn harvest in this herd unit has fluctuated dramatically over the years. The maximum harvest of 2,098 animals occurred in 1984 and the minimum harvest of 421 animals occurred in 1989. The mean value for harvest for all years of the analysis is 1,163 animals. The long-term trend for harvest is declining weakly. Total harvest for 2012, 1,987 animals, is substantially above the average harvest of 1,163 animals.

Doe and fawn harvest has occurred in all years of this analysis. In the mid-1980s, doe and fawn harvest accounted for as much as 35% of the total harvest. Doe and fawn harvest declined dramatically in the late 1990s and early 2000s but is again accounting for a larger proportion of total harvest and accounted for 45% of the total harvest in 2012.

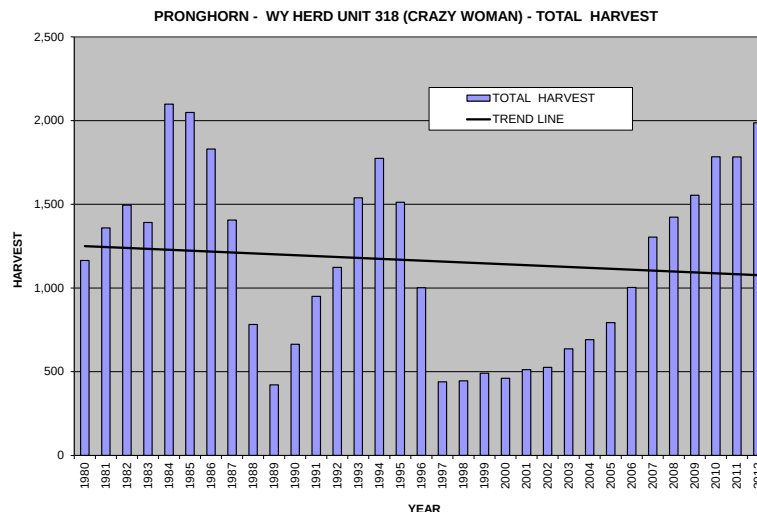


Fig. 162. Pronghorn – Wyoming herd unit 318 (Crazy Woman) – total harvest

Hunter Numbers and Success Rates

As in other herd units in northeast Wyoming, hunter numbers have followed harvest rates very closely. Total hunting pressure for all seasons and methods of take has ranged from a high of 2,198 hunters in 1984 to a low of 448 hunters in 1989. The mean for hunting pressure for all years of the analysis is 1,094 hunters. The long-term trend for hunter numbers is declining.

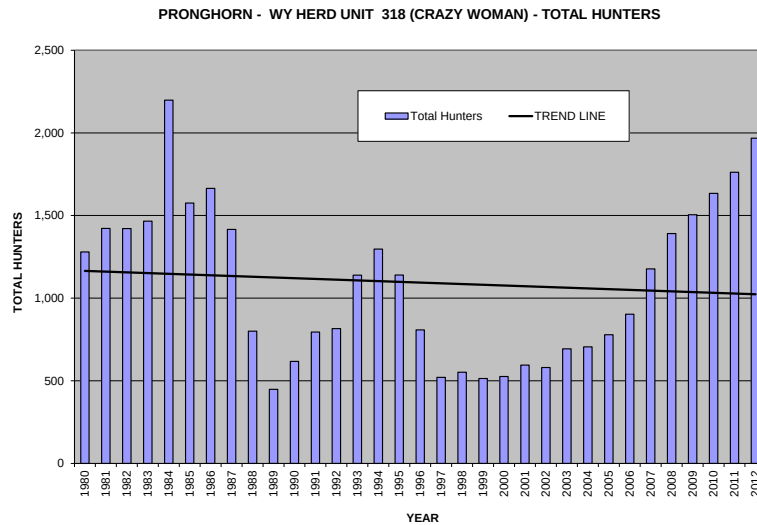


Fig. 163. Pronghorn – Wyoming herd unit 318 (Crazy Woman) – total hunters

Hunter success rates have been variable but not to the extent of what has occurred with harvest. Success rates have varied from a high of 137.6% in 1992 to a low of 80.6% in 1999. The mean value for hunter success for all years included in the review is 104.9%. The long-term trend for hunter success is stable or only slightly decreasing.

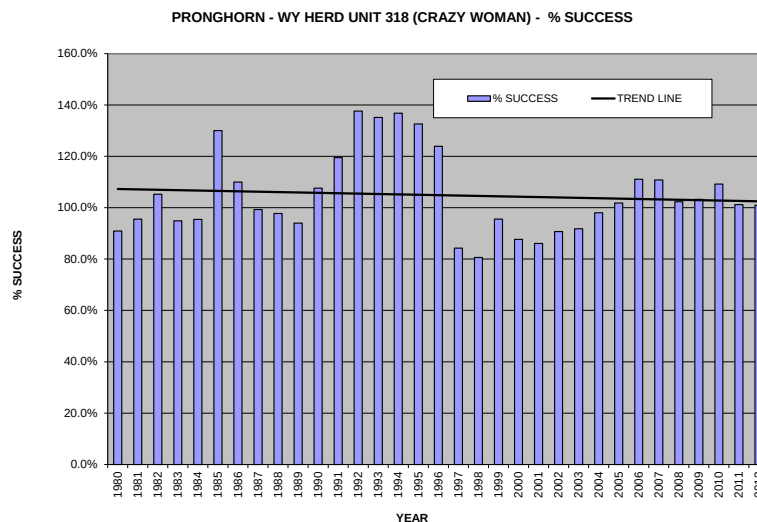


Fig. 164. Pronghorn – Wyoming herd unit 318 (Crazy Woman) – hunter success rates

Summary of Herd Vital Statistics and Implications for Management

An evaluation of a variety of data for the pronghorn herd in this herd unit indicates that it is not performing at an optimum level. According to an evaluation system that was developed for this project, the performance rating for this herd would be fair for the following reasons:

- The pronghorn population in this herd unit is above the long term population objective set by the Wyoming Game and Fish Department (12,000 versus 7,000 animals LTO). This herd has been at objective or within 10% of the object for the last 13 years.
- The long-term trend for population size for the herd is increasing.
- The long-term trend for young/100 female ratios is decreasing. Young/100 female ratios have only exceeded the mean value for young/100 female ratios (84:100) once in the

last 5 years. However, the fawn/doe ratios for the last 5 years for this heard unit are sufficient to maintain the population if not produce a slow rate of population growth.

- A negative factor for this pronghorn herd is a decreasing long-term trend for harvest. The total harvest of 1,987 animals in 2012 is above the long-term mean value (1,163 animals) for harvest. In addition, from 1996 through 2006 this herd endured an 11 year period of low harvest. The mean harvest for this 11 year period was 636 animals per year which is substantially below the long-term mean value for harvest (1,163 animals per year). Without this 11 year period of low harvest the long-term trend for harvest would likely have been stable instead of declining.

The end result of all of this information is that if current habitat conditions are maintained, and if the short-term trend for young/100 females continues, this pronghorn herd is likely to show improvements in population size and harvest. However, if habitat conditions deteriorate due to development or adverse natural environmental conditions, population size and harvest will likely decline further than the current situation.

NORTH BLACK HILLS, PRONGHORN HERD UNIT 339 (refer to table 20 in the appendix)

General Description Pronghorn antelope herd unit 339 is located in extreme northeastern Wyoming and is referred to as the North Black Hills Herd Unit. The herd unit lies in portions of Crook and Campbell counties and contains 5 hunt area; 1, 2, 3, 18 and 19. The unit is bounded on the north by the Montana state line, on the east by the South Dakota state line, on the south by Interstate 90 and on the west by state highways 14, 16 and 59. Herd unit 339 covers an area of approximately 3,005 sq. mi. with approximately 2,007 sq. mi. considered to be occupied habitat (WGFD 2014). The topography for this herd unit is very diverse. It ranges from the Black Hills foothills and plateau to the sagebrush steppe, Pierre Shale plains, pine scoria hills and the Powder River Basin. As a result of the varied topography, vegetation is equally diverse. It ranges from ponderosa pine forests and savannas in the Black Hills plateau and foothills and pine scoria hills with their understories of grasses and shrubs to the open steppes and plains that are more characteristic of the northwestern Great Plains. In the Black Hills and pine scoria regions ponderosa pine is the dominant overstory species. Common grasses in these areas are western wheatgrass, needle-and-thread, little bluestem, buffalo grass and blue gramma. These eco-regions also contain areas of aspen, eastern boxelder, paper birch and some white spruce. Common shrubs include burr oak, Rocky Mountain juniper, snowberry, bearberry and russet buffaloberry. In the northern Great Plains sub-regions vegetation ranges from the various sagebrushes of the sagebrush steppe to the regions that have grasses as the more dominant species and shrubs being less common. Grass species range from western wheatgrass, green needlegrass, blue grama, Sandberg bluegrass, buffalograss, bluebunch wheatgrass, needle-and-thread grass and junegrass. Shrub species include rabbitbrush and fringed sage (Chapman et al. 2004).



Fig. 165. Wyoming pronghorn herd unit 339 (North Black Hills)

Land Ownership The herd unit contains a mixture of public and private land. The distribution of land ownership is approximately 79% private land, 9% BLM land, 7% state land, 2.5% Bankhead Jones Land and 2.5% other federal agencies (WGFD 2014).

Land Use Livestock grazing on public and private lands is a major activity in this area. Urban and sub-urban development includes the communities of Newcastle (3,532), Sundance (1,182), Upton (1,100) and Moorcraft (1,009) and a number of smaller unincorporated towns and hamlets (TWTER 2014). The area provides ample opportunities for a variety of outdoor recreational activities. During the fall, hunting for small game and big game attracts a number of outdoor recreationists.

Management Issues The management objective for the North Black Hills Herd Unit is a post-season population objective of 14,000 pronghorn. The management strategy is recreational management. The objective and management strategy were last revised in 1994. The 2012 post-season population estimate was about 12,500. Since 2006, this population has been declining. Currently, the population is estimated to be below the management objective. Issues related to adverse winter and spring weather, and low fawn production have been observed in this herd over the past few seasons. The winters of 2008 to 2010 appeared to have taken a toll on this herd in the form of increased winter mortality and decreased fawn recruitment. Heavy spring snows and cold spring temperatures in 2009 & 2010 likely reduced fawn survival, particularly in Areas 18 and 19. Pronghorn in Areas 18 and 19 are still not rebounding yet and numbers do not warrant issuing more licenses. The last line transect survey was conducted in this herd unit was in June 2012 (WGFD 2013).

Population Size Population size in Herd Unit 339 has fluctuated substantially in past years. The minimum population estimate for this herd unit was 6,500 animals in 1980 and the maximum population estimate was 22,769 animals in 2006. The mean value for population size for all years of the analysis is 13,746 animals. The long-term trend for population size is increasing. The population estimate for 2012 is 12,500 animals. The long-term objective for population size 14,000 animals.

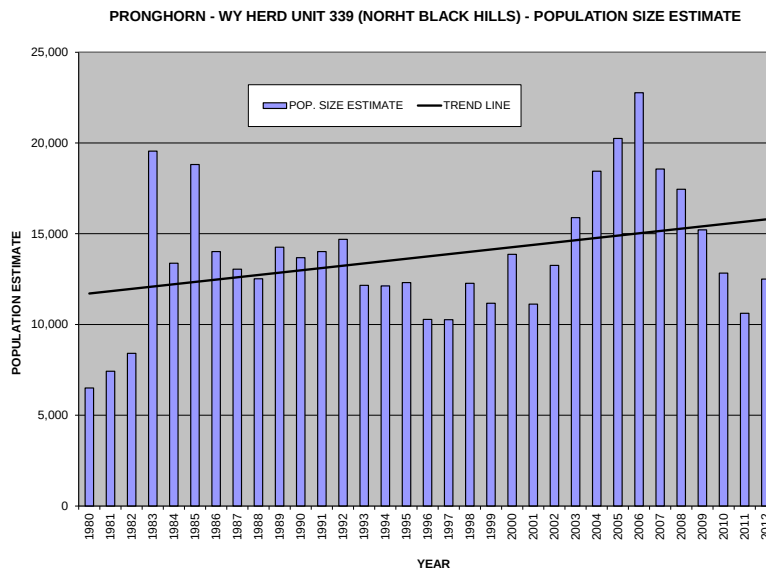


Fig. 166. Pronghorn – Wyoming herd unit 339 (North Black Hills) – population size estimate

Age and Sex Composition Male/100 female ratios have ranged from a high of 62 males/100 females in 2003 to a low of 32 males/100 females in 2011. The mean value for all years of this analysis is 49 males/100 females. The long-term trend for all years of data is decreasing slightly.

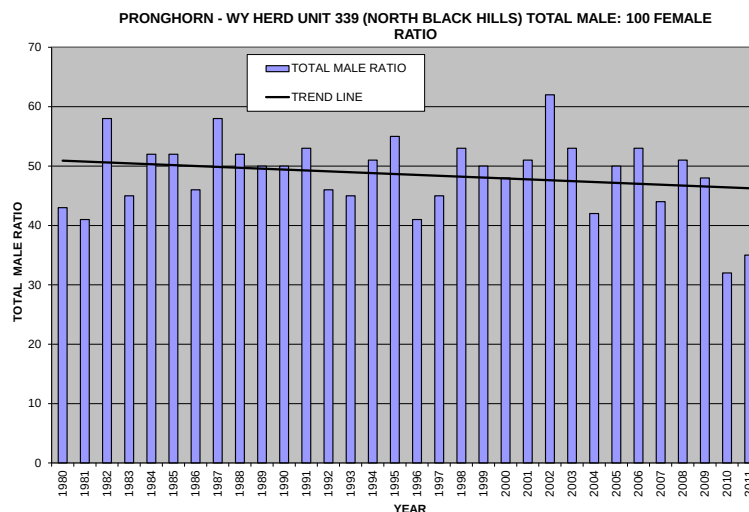


Fig. 167. Pronghorn – Wyoming herd unit 339 (North Black Hills) – male/100 female ratios

Young/100 female ratios have ranged from a high of 120 young/100 females in 1987 to a low of 57 young/100 females in 2009. The mean value for all years is 83 fawns/100 females. The long-term trend for all years of data is decreasing.

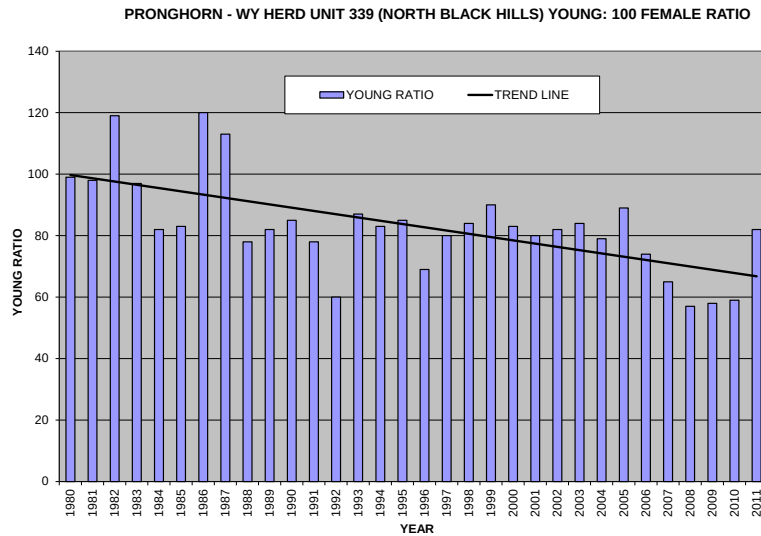


Fig. 168. Pronghorn – Wyoming herd unit 339 (North Black Hills) – young/100 female ratios

Harvest Total male harvest for this herd unit has ranged from a low of 356 bucks harvest in 1980 to a high of 1,576 bucks harvested in 1990. Average buck harvest for all years of the analysis is 971 animals. The long-term trend for male harvest is declining. Buck harvest for 2012 was 415 animals which is only 43% of the average male harvest for this herd unit. A review of average buck harvest by decade shows that the 1990s had the highest average harvest with 1065 animals. Since that time the average buck harvest by decade has declined to the lowest level in the 2010s at 602 animals per year.

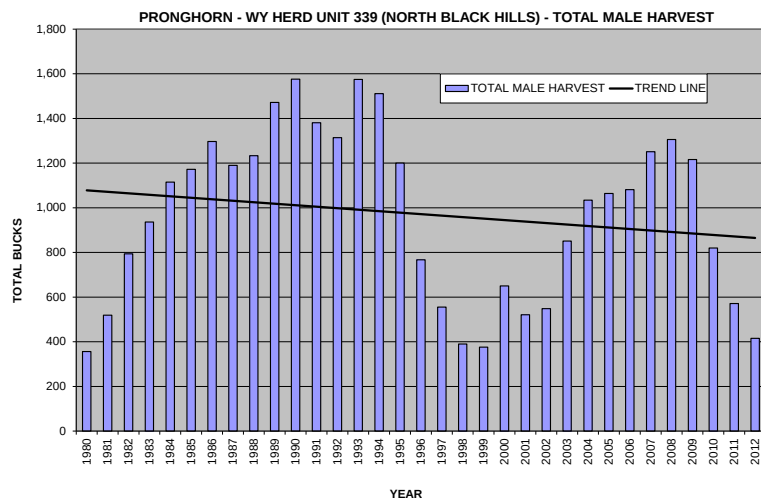


Fig. 169. Pronghorn – Wyoming herd unit 339 (North Black Hills) – male harvest

Total harvest for this herd unit has fluctuated dramatically, especially since the mid-1990s. The values for harvest have varied from a low of 479 animals in 1980 to a high of 3,192 animals in 1993. The mean value for total harvest is 1,623 animals. The long-term trend for harvest is decreasing. In addition to the very low harvest that occurred in 1980, total harvest has approached that value again in 1998 and 2012 when total harvest was 487 and 595 animals respectively. Doe and fawn harvest has taken place all years of the evaluation and has approached or exceeded 50% of the total harvest in 1992, 1993 and 1994.

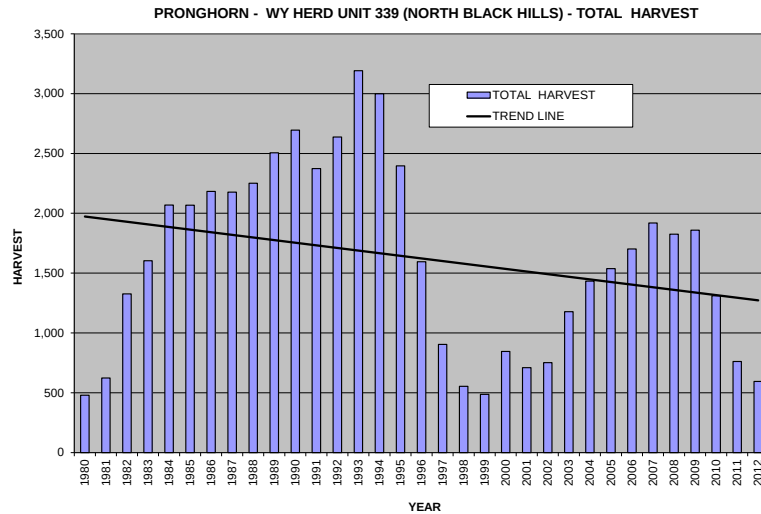


Fig. 170. Pronghorn – Wyoming herd unit 339 (North Black Hills) – total harvest

Hunter Numbers and Success Rates Total hunting pressure (all seasons and methods of take) has varied from a low of 551 hunters in 1980 to a high of 2,271 hunters in 1984. The mean for hunting pressure for all years of the analysis is 1,516 hunters. The long-term trend for hunting pressure is decreasing.

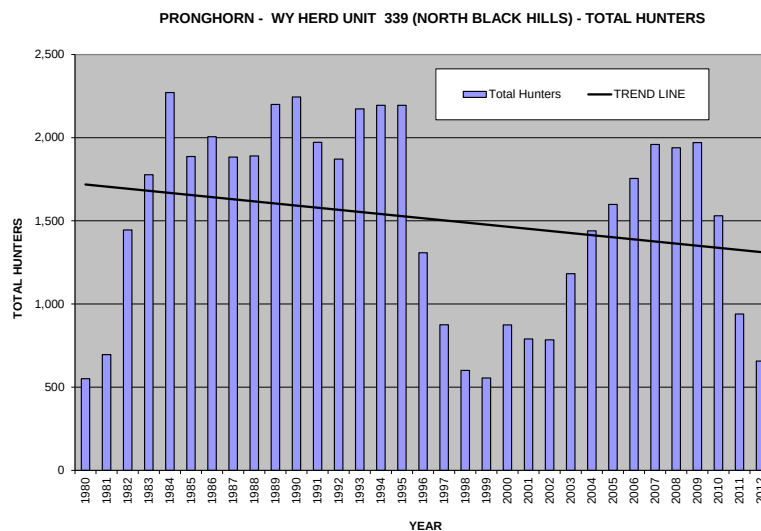


Fig. 171. Pronghorn – Wyoming herd unit 339 (North Black Hills) – total hunters

Hunter success rates have remained relatively stable for all of the years of the analysis with the exception of 13 year period from 1985 to 1997 when hunter success rates continually exceeded 100%. The variation in hunter success rates has ranged from a high of 146.9% in 1993 to a low of 81.1% in 2011. The mean value for hunter success rates is 103.5%. The long-term trend for hunter success is decreasing slightly.

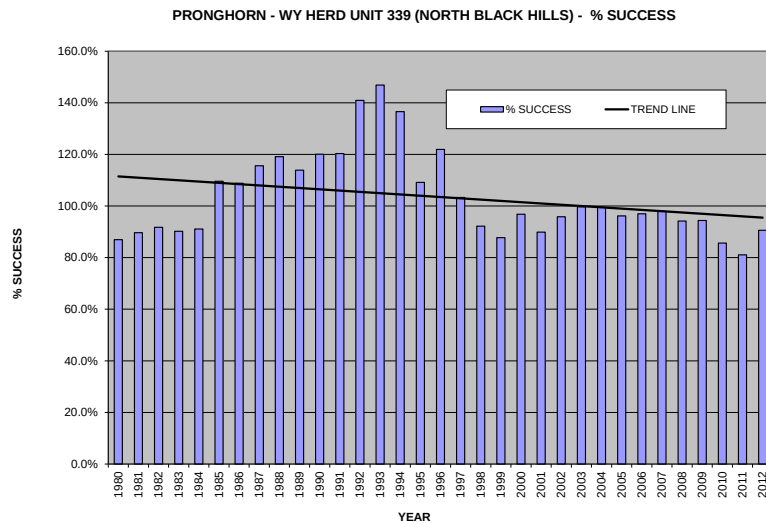


Fig. 172. Pronghorn – Wyoming herd unit 339 (North Black Hills) – hunter success rates

Review of Herd Vital Statistics and Management Implications An evaluation of an assortment of data for the pronghorn herd in this herd unit indicates that it is not performing at an optimum level. According to an evaluation system that was developed for this project, the performance rating for this herd would be poor for the following reasons:

- The pronghorn population in this herd unit is currently below the long term population objective set by the Wyoming Game and Fish Department (12,500 versus 14,000 animals LTO). The last time this pronghorn herd was at objective was 2009. This herd has been at objective or within 10% of the object for 8 of the past 10 years.
- The long-term trend for population size for the herd is increasing. However, in the short term (last 3 years) this population has declined. This population is currently very close to objective
- The long-term trend for young/100 female ratios is decreasing. Young/100 female ratios have been below the mean value for young/100 female ratios (83:100) for the last 6 years. If this short-term trend for young/100 female ratios continues there is low potential for growth in the population.
- A negative factor for this pronghorn herd is a decreasing long-term trend for harvest. The total harvest of 595 animals in 2012 is the fourth lowest harvest recorded in the 32 year period of this data analysis. In addition, from 1996 through 2005 this herd endured a 10 year period of low harvest. The mean harvest for this 10 year period was 1,000 animals per year which is substantially below the long-term mean value for harvest (1,623 animals per year). Without this 11 year period of low harvest the long-term trend for harvest would likely have been stable instead of declining.

The end result of all of this information is that if current habitat conditions are maintained, and if the short-term trend for young/100 females continues, this pronghorn herd may show improvement in population size and harvest. However, if habitat conditions deteriorate due to development or adverse natural environmental conditions, population size and harvest will likely decline further than the current situation.

GILLETTE, PRONGHORN HERD UNIT 351 (refer to table 21 in the appendix)

General Description Pronghorn antelope herd unit 351 is located in northeastern Wyoming and generally referred to as the Gillette herd unit. The herd unit lies in portions of Campbell, Johnson and Sheridan counties and contains hunt area 17. The herd unit is bounded on the north by the Montana state line, on the east by state highways 59, 14 and 16, on the south by Interstate 90

and on the west by the Powder River. The herd unit covers an area of approximately 1,779 sq. mi. with 1,333 considered to be occupied habitat (WGFD 2014).

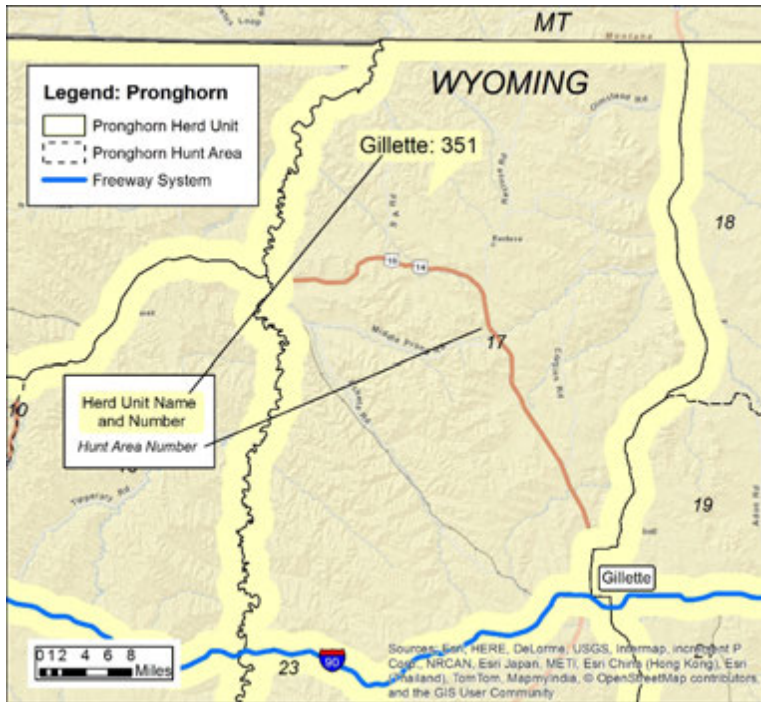


Fig. 173. Wyoming pronghorn herd unit 351 (Gillette)

Habitat in this herd unit includes 2 eco-regions, the Powder River basin in the western and central portion of the herd unit and the pine scoria foothills eco-region along the eastern edge of the herd unit. The Powder River basin eco-region is characterized by mixed-grass prairie dominated by blue grama, western wheatgrass, junegrass, Sandberg bluegrass, needle-and-thread grass, rabbitbrush, fringed sage, and other forbs, shrubs and grasses. The pine scoria eco-region consists of ponderosa pine-Rocky Mountain juniper forest or ponderosa pine savanna with understory of grasses, forbs, and shrubs. Species include little bluestem, bluebunch wheatgrass, western wheatgrass, blue grama, and Sandberg bluegrass, Idaho fescue, and needle-and-thread. Skunkbush sumac and western snowberry are common shrubs (Chapman et al. 2004).

Land Ownership The herd unit is comprised of a mixture of public and private land. The distribution of land ownership in the herd unit is approximately 84% private, 9% BLM and 7% state (WGFD 2014).

Land Use Much of the private and public land in the Herd Unit is used to graze livestock, primarily cattle. A relatively small portion of the area is plowed or planted to crops, primarily alfalfa, grass hay and winter wheat. Oil and gas development and coal mining are examples of mineral development and extraction that have occurred throughout the herd unit. Some of the largest coal strip mines in northeast Wyoming are located in the unit. Oil wells, conventional natural gas wells and coal-bed natural gas wells are numerous in the herd unit and are concentrated in the portion of the unit north and west of Gillette in the Little Powder River drainage. Urban and sub-urban development includes the community of Gillette (29,087). The distribution of the remainder of the human population in the area is rural in character being dispersed in very small communities, settlements or individual ranches or home sites throughout the Herd Unit (TWTER 2014).

Management Issues The postseason population objective for the Gillette Pronghorn Herd Unit is 11,000 pronghorn. The management strategy is recreational management. The objective and management strategy were last revised in 1994. The largest issue with achieving adequate harvest in this herd is access, as most of the pronghorn are found on private lands. Extensive coal bed methane development has occurred in the herd unit and has resulted in a network of roads and other development associated with the infrastructure required to support coal bed methane extraction. The increased traffic was an issue with hunting in the past, however in recent years, development and activity has tapered off substantially. The more pressing issue in this herd unit will be proper reclamation as these wells are abandoned (WGFD 2013).

Population Size The pronghorn population in this herd unit has varied substantially over the years but not to the extreme that has been exhibited in other pronghorn herd units in the vicinity of northeastern Wyoming. The minimum population estimate for this herd was 7,349 animals in 1985 and the maximum population estimate was 18,530 animals in 2006. The mean value for population size is 12,509 animals. The long-term trend for population size is increasing. The population estimate for 2012 is 10,300 animals. The long-term objective for population size for this herd unit is 11,000 animals.

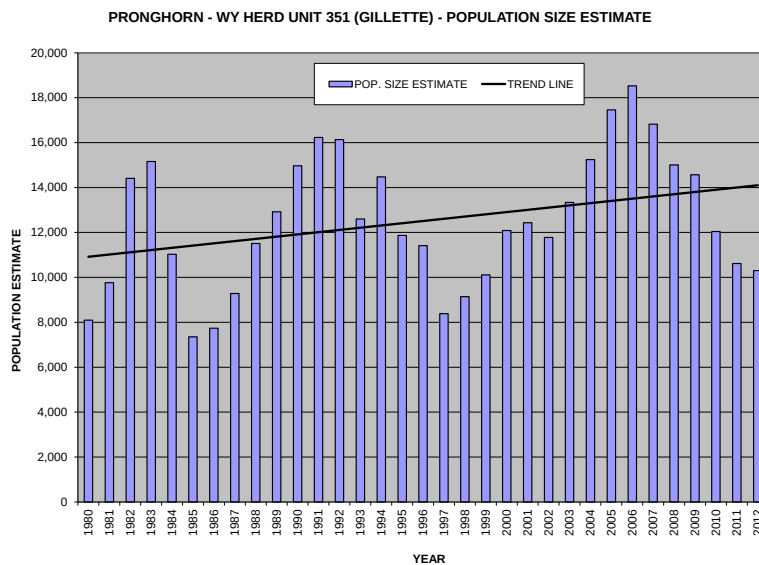


Fig. 174. Pronghorn – Wyoming herd unit 351 (Gillette) – population size estimate

Age and Sex Composition Male/100 female ratios have ranged from a high of 65 males/100 females in 1983 to a low of 28 males/100 females in 1999. The mean value for male/100 female ratios is 47. The long term trend for male/100 female ratios is increasing.

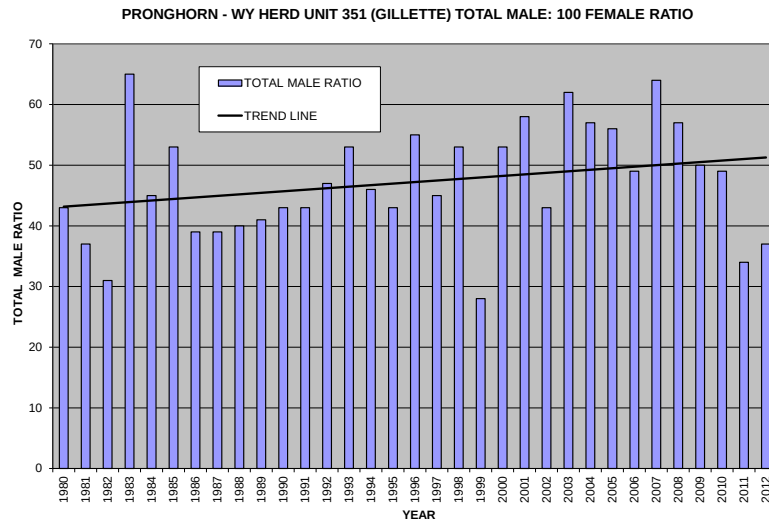


Fig. 175. Pronghorn – Wyoming herd unit 351 (Gillette) – males/100 female ratios

Young/100 female ratios have ranged from a low of 37 young/100 females in 1993 to a high of 107 young/100 females in 2006. The mean value for young/100 female ratios for all years of the analysis is 65. The long-term trend for young/100 females is decreasing.

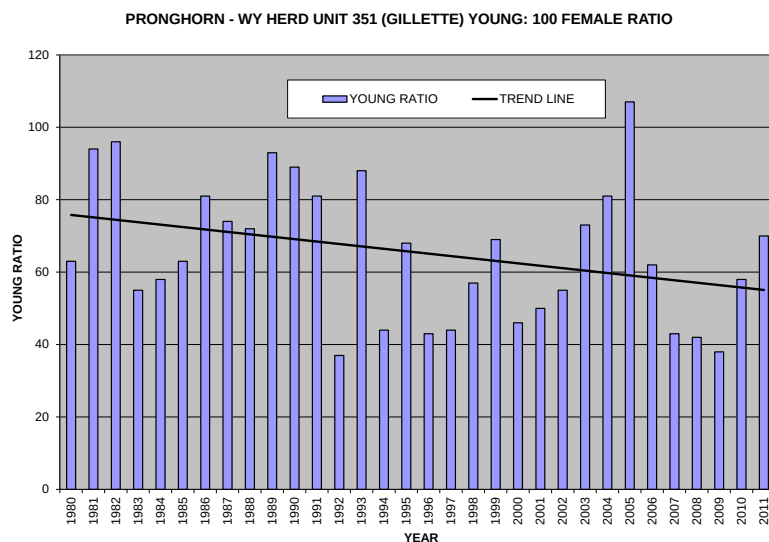


Fig. 176. Pronghorn – Wyoming herd unit 351(Gillette) – young/100 female ratios

Harvest Total male harvest for the Gillette herd unit has varied from a high of 995 bucks harvested in 1995 to a low of 363 bucks harvested in 1999. The average for buck harvest for all years of the analysis is 709 animals. The long-term trend for buck harvest is increasing slightly. Buck harvest for 2012 was 794 animals which is more than 10% above the long-term average buck harvest of 709 animals. A review of average buck harvest by decade shows that the 2010s have the highest average buck harvest for the period of the analysis at 777 animals, although average buck harvest by decade hasn't fluctuated a great deal over the years.

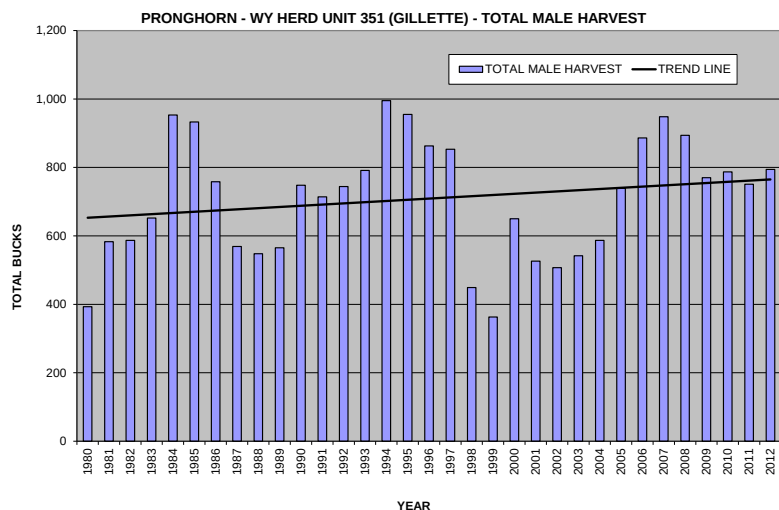


Fig. 177. Pronghorn – Wyoming herd unit 351 (Gillette) – male harvest

Total harvest for this herd unit has ranged from a high of 2,059 animals in 1995 to a low of 384 animals in 1999. The mean of total harvest for all years of the analysis is 1,047 animals. The long-term trend for harvest is level to increasing slightly. There have been 3 peaks of harvest over the 33 years of the analysis, 1984, 1995 and 2008. The peak in 1995 is probably the most interesting as it is followed 4 years later by the smallest amount of harvest in the herd unit for any one year. Total harvest for 2012 is 991 animals which is approximately 5% below the average harvest for the herd unit which is 1,047 animals.

Doe and fawn harvest has occurred in all years during the period of this analysis and has ranged from a high of 1,104 animals in 1995 to a low of only 15 animals only 3 years later in 1998. In some years, doe and fawn harvest have accounted for more than 50% of the total harvest.

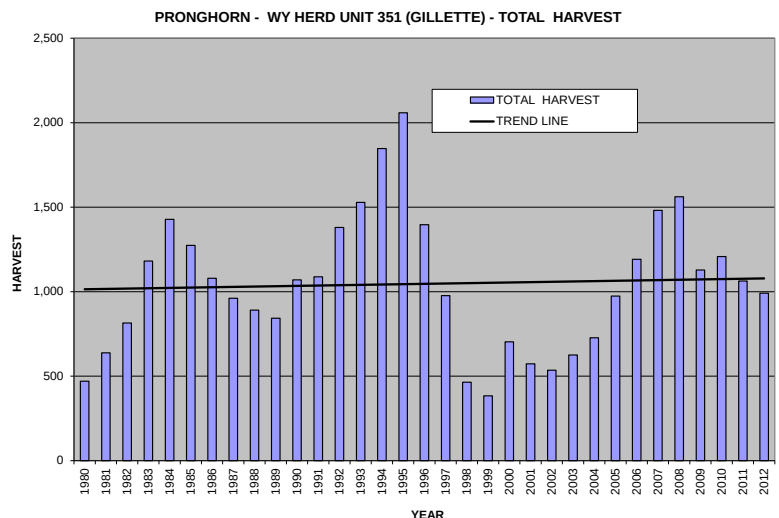


Fig. 178. Pronghorn – Wyoming herd unit 351 (Gillette) – total harvest

Hunter Numbers and Success Rates Total hunting pressure (all seasons and methods of take) has ranged from a low of 421 hunters in 1999 to a high of 1,628 hunters in 2008. The mean value for hunting pressure for all years of the analysis is 1,028 hunters. The long-term trend for hunting pressure is increasing slightly.

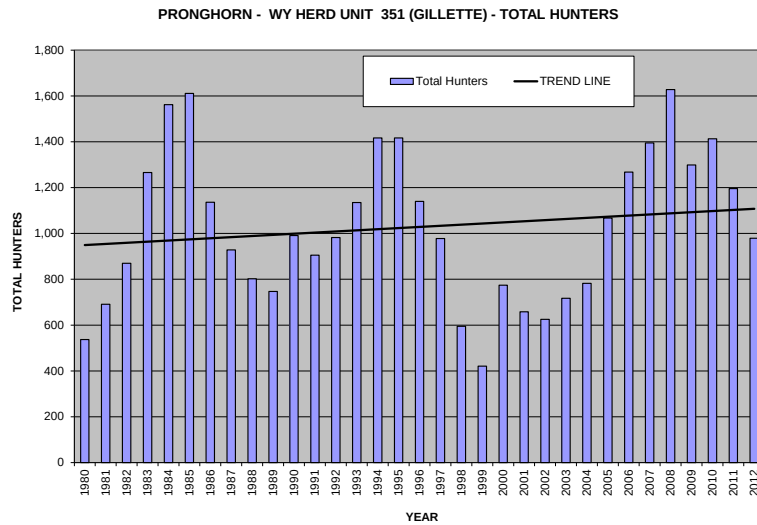


Fig. 179. Pronghorn – Wyoming herd unit 351 (Gillette) – total hunters

Hunter success rates for all methods of take have varied from a high of 145.3% in 1995 to a low of 78% in 1998. The mean for hunter success rates is 100.7%. The long-term trend for hunter success rates is decreasing slightly.

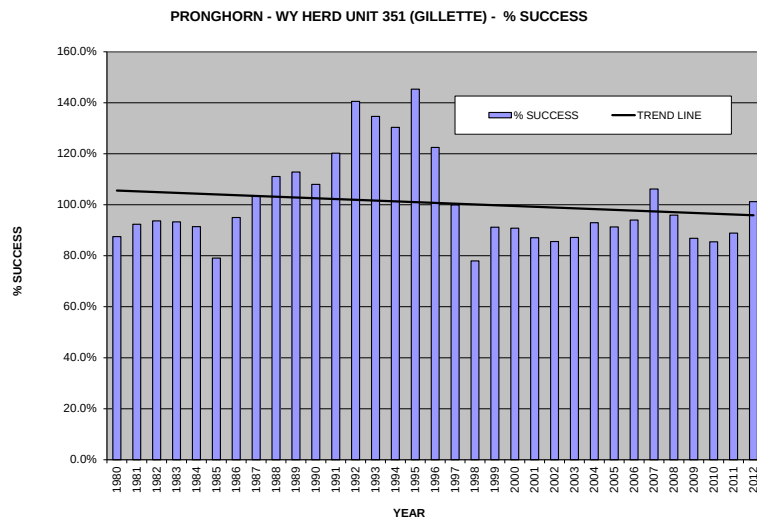


Fig. 180. Pronghorn – Wyoming herd unit 351 (Gillette) – hunter success rates

Summary of Herd Vital Statistics and Management Implications An evaluation of an assortment of data for the pronghorn herd in this herd unit indicates that it is not performing at an optimum level. According to an evaluation system that was developed for this project, the performance rating for this herd is fair for the following reasons:

- The pronghorn population in this herd unit is within 90% of the long term population objective set by the Wyoming Game and Fish Department (10,300 versus 11,000 animals LTO). This herd has been at objective or within 10% of the object for the past 10 years.
- The long-term trend for population size for the herd is increasing. However, in the short term (last 3 years) this population has declined.
- The long-term trend for young/100 female ratios is decreasing. In addition, young/100 female ratios have been below the long-term mean value for young/100 female ratios

(65:100) for 5 of the last 10 years. If this short-term trend for young/100 female ratios continues, potential for population growth is limited or unlikely.

- This pronghorn herd is displaying a stable long-term trend for harvest. However, from 1997 through 2006 this herd endured a 10 year period of low harvest. The mean harvest for this 10 year period was 715 animals per year which is substantially below the long-term mean value for harvest (1,047 animals per year). Without this 10 year period of low harvest the long-term trend for harvest would likely have been increasing instead of stable.

The end result of all of this information is that if current habitat conditions are maintained, and if the short-term trend for young/100 females continues, this pronghorn herd will not likely show improvement in population size and harvest. If habitat conditions deteriorate due to development or adverse natural environmental conditions, population size and harvest will likely decline further than the current situation.

UCROSS, PRONGHORN HERD UNIT 353 (refer to table 22 in the appendix)

General Description Pronghorn antelope herd unit 353 is located in northeastern Wyoming is commonly referred to as Ucross Herd Unit. The herd unit lies in portions of Sheridan and Johnson counties and contains hunt areas 10 and 16. The herd unit is bounded on the north by U. S. Highways 14 and 16, on the east by the Powder River and on the south and west by Interstate 90. This herd unit covers an area of approximately 842 sq. mi. with 819 sq. mi. considered to be occupied habitat (WGFD 2014). Topography in the herd unit consists of a rolling upland plain with low to moderate relief, broken by buttes, mesas, hills and ridges (BLM 2003). Vegetation in the area is characteristic of the Powder River basin eco-region of the northwestern Great Plains. It consists of a mixed-grass prairie dominated by blue grama, western wheatgrass, junegrass, Sandberg bluegrass, needle-and-thread grass, rabbitbrush, fringed sage, and other forbs, shrubs and grasses (Chapman et al. 2004).



Fig. 181. Wyoming pronghorn herd unit 353 (Ucross)

Land Ownership The herd unit contains a mixture of public and private land. The distribution of land ownership in the herd unit is approximately 74% private, 16% BLM and 10% state (WGFD 2014).

Land Use Much of the private and public land in the Herd Unit is used for livestock grazing, primarily cattle. A relatively small portion of the area is plowed or planted to crops, primarily alfalfa, grass hay and winter wheat. Oil and gas development and coal mining are examples of mineral development and extraction that have occurred throughout the herd unit. Oil wells, conventional natural gas wells and coal-bed natural gas wells are numerous in the herd unit (BLM 2003). Urban and sub-urban development includes the communities of Sheridan (17,444) and Buffalo (4,585) (TWTER 2014). The distribution of the remainder of the human population in the area is rural in character being dispersed in very small communities, settlements or individual ranches or home sites throughout the Herd Unit (TWTER 2014).

Management Issues The management objective for the Ucross Pronghorn Herd Unit is a post-season population objective of 2,500 pronghorn. The management strategy is recreational management. The objective and management strategy were last revised in 1996. Industrial scale oil and gas development and outfitting in the herd unit have resulted in restricted hunting access to some private lands. There are very little public land hunting opportunities in this herd unit. The restricted access has made it difficult to attain adequate harvest in portions of the herd (WGFD 2013).

Population Size The pronghorn population in the Ucross Herd Unit has fluctuated substantially over the years. As currently modeled, the lowest estimate for the population was 1,500 animals in 1998 and the highest estimate was 10,047 in 2008. The mean value for population size is 4,833 animals. The long-term trend for the population is increasing. The population estimate for 2012 is 7,400 animals. The long-term population objective for the herd unit is 2,500 animals.

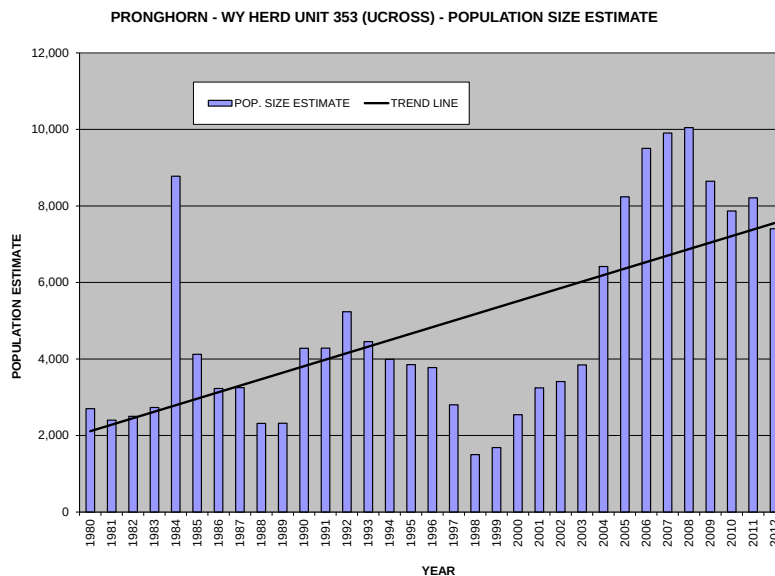


Fig.182. Pronghorn – Wyoming herd unit 353 (Ucross) – population size estimate

Age and Sex Composition Males/100 female ratios have been variable but not to the extent that has been observed in other herd units in the area. Male/100 female ratios have ranged from a low of 41 males/100 females in 1999 to a high of 88 males/100 females in 2006. The mean value for male/female ratios in the herd unit is 68 males/100 females. The long-term trend for male/100 female ratios is decreasing.

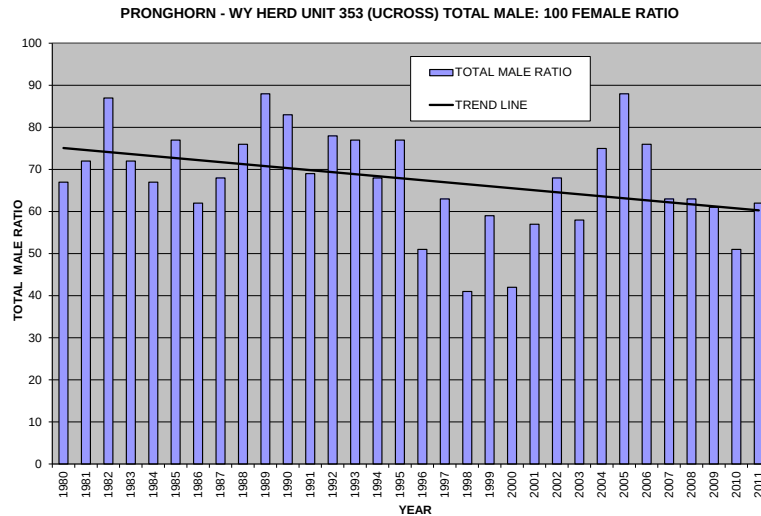


Fig. 183. Pronghorn – Wyoming herd unit 353 (Ucross) – Males/100 female ratios

Young/100 female ratios in this herd unit have varied from a high of 98 young/100 females in 1981 to a low of 50 young/100 females in 1994 and again in 2009. The mean value for young/100 females for this unit is 74. The long-term trend for young/100 females is decreasing.

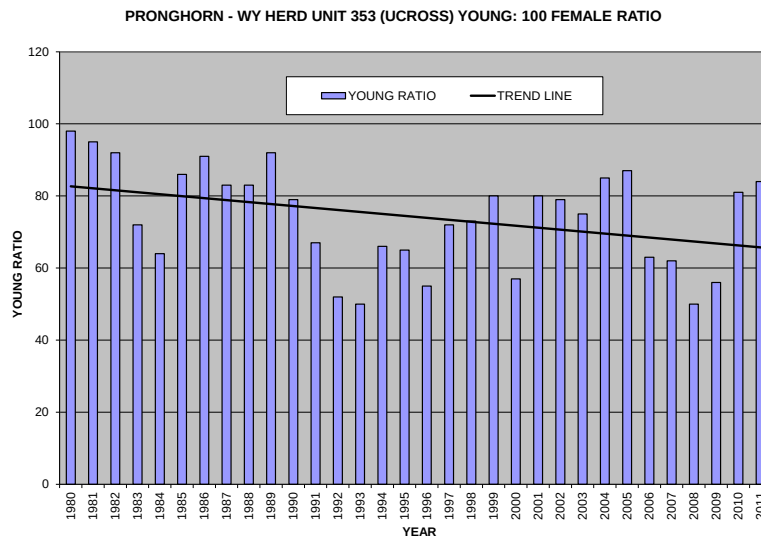


Fig. 184. Pronghorn – Wyoming herd unit 353 (Ucross) – young/100 female ratios

Harvest Total male harvest in the Ucross herd unit has varied from a low of 146 bucks harvested in 2001 to a high of 505 bucks harvested in 2008. The mean value for buck harvest for all years of the analysis is 308 animals. The long-term trend for buck harvest is level or increasing slightly. Buck harvest for 2012 was 459 animals which is 49% above the long-term average of 308 animals. A review of information on average buck harvest by decade shows the 2010s are the decade with the highest average buck harvest.

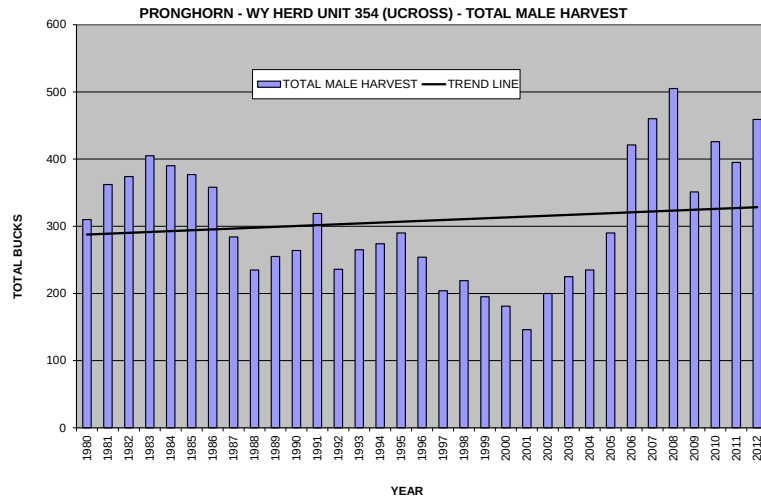


Fig. 185. Pronghorn – Wyoming herd unit 353 (Ucross) – male harvest

Total harvest for this herd unit has ranged from a low of 163 animals in 2001 to a high of 787 animals 2008. The mean value for harvest is 476 animals. The long-term trend for harvest is virtually level. A comparison of harvest by decade shows that there was a peak of harvest in the 1980s (557), followed by a decline in the 1990s (377) and then increasing harvest in the 2000s (430) and 2010s (687). Doe and fawn harvest has been a significant component of total harvest for all years except the late 1990s and early 2000s.

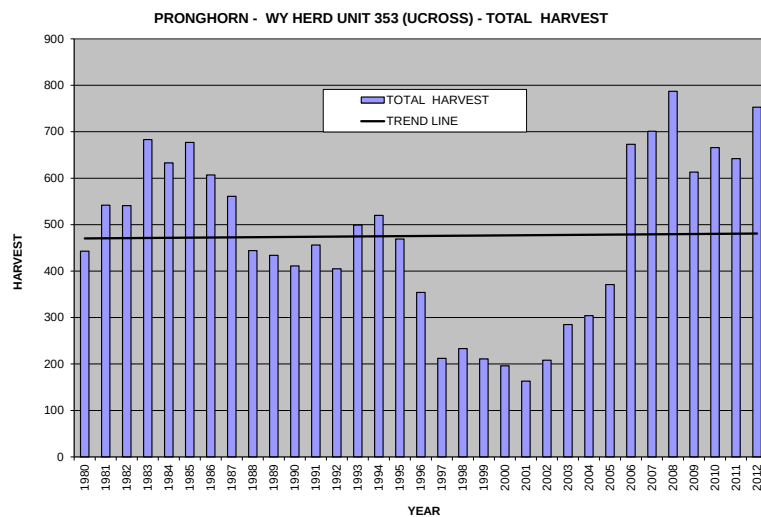


Fig. 186. Pronghorn – Wyoming herd unit 353 (Ucross) – total harvest

Hunter Numbers and Success Rates Total hunting pressure (all seasons and methods of take) has ranged from a low of 198 hunters in 2001 to a high of 802 hunters in 2012. The mean value for hunting pressure is 488 hunters. The long-term trend for hunting pressure is level or only decreasing very slightly.

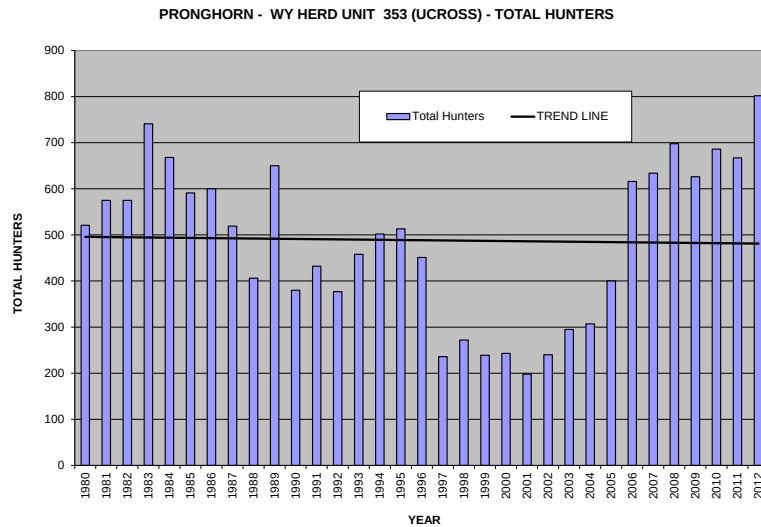


Fig. 187. Pronghorn – Wyoming herd unit 353 (Ucross) – total hunters

Hunter success rates for all methods of take has varied from a high of 114.6% in 1985 to a low of 66.8% in 1989. The mean value for hunter success rates is 96.5%. The long-term trend for success rates is level.

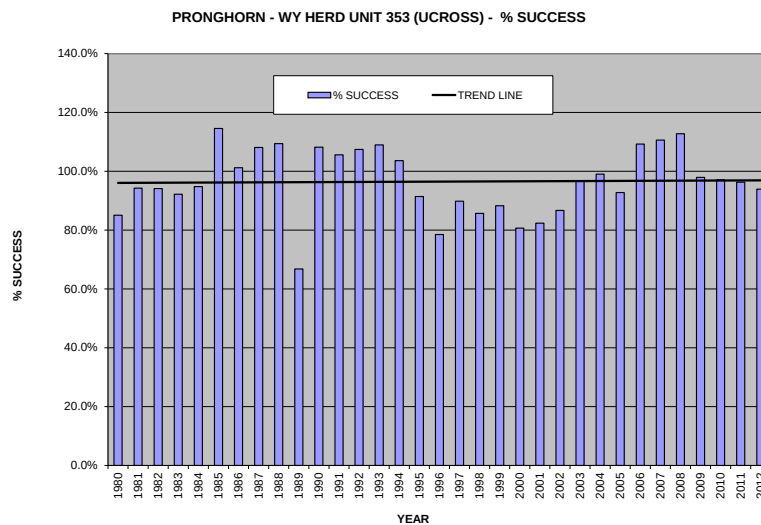


Fig. 188. Pronghorn – Wyoming herd unit 353 (Ucross) – hunter success rates

Summary of Herd Vital Statistics and Management Implications An evaluation of an assortment of data for the pronghorn herd in this herd unit indicates that it is performing well. According to an evaluation system that was developed for this project, the performance rating for this herd is good for the following reasons:

- The pronghorn population in this herd unit is at or above the long term population objective set by the Wyoming Game and Fish Department (7,400 versus 2,500 animals LTO).
- The long-term trend for population size for the herd is increasing. However, in the short term (last 4 years) this population has declined
- The long-term trend for young/100 female ratios is decreasing. However, young/100 female ratios for the last 5 years have equaled or exceeded the mean value for

- young/100 female ratios (74:100) for 2 out of 5 years. If this short-term trend for young/100 female ratios continues there is little potential for growth in the population.
- The long-term trend for harvest is stable. However, from 1996 through 2005 this herd endured a 10 year period of low harvest. The mean harvest for this 10 year period was 254 animals per year which is substantially below the long-term mean value for harvest (476 animals per year). Without this 10 year period of low harvest the long-term trend for harvest would likely have been increasing instead of stable.

The upshot of all of this information is that if current habitat conditions are maintained, and if the short-term trend for young/100 females continues, this pronghorn herd will likely maintain the current level of population size and harvest, if not improve slightly. However, if habitat conditions deteriorate due to development or adverse natural environmental conditions, population size and harvest will likely decline further than the current situation.

PRONGHORN HERD UNIT 740 (Cheyenne River) (refer to table 23 in the appendix)

General Description Pronghorn antelope herd unit 740 is located in eastern Wyoming and is referred to as the Cheyenne River herd unit. The herd unit lies in portions of Crook, Weston, Niobrara, Converse and Campbell counties and contains hunt areas 4, 5, 6, 7, 8, 9, 27 and 29. The herd unit is bounded on the north by Interstate 90, on the east by the South Dakota state line, on the south by U. S. Highway 20 and Interstate Highway 25 and on the west by the Belle Fourche River, the Horse Creek/Raven Creek divide, the Belle Fourche River/Cheyenne River divide, Newel Prong, Bacon Creek, Black Thunder Creek and Keeline Road; on the south by Wyoming Highway 450 and on the west by Wyoming Highway 59. This herd unit covers an area of approximately 6,671 sq. mi., likely the largest pronghorn herd unit in the state. Approximately 6,371 sq. mi. is considered to be occupied habitat (WG&FD 2014).

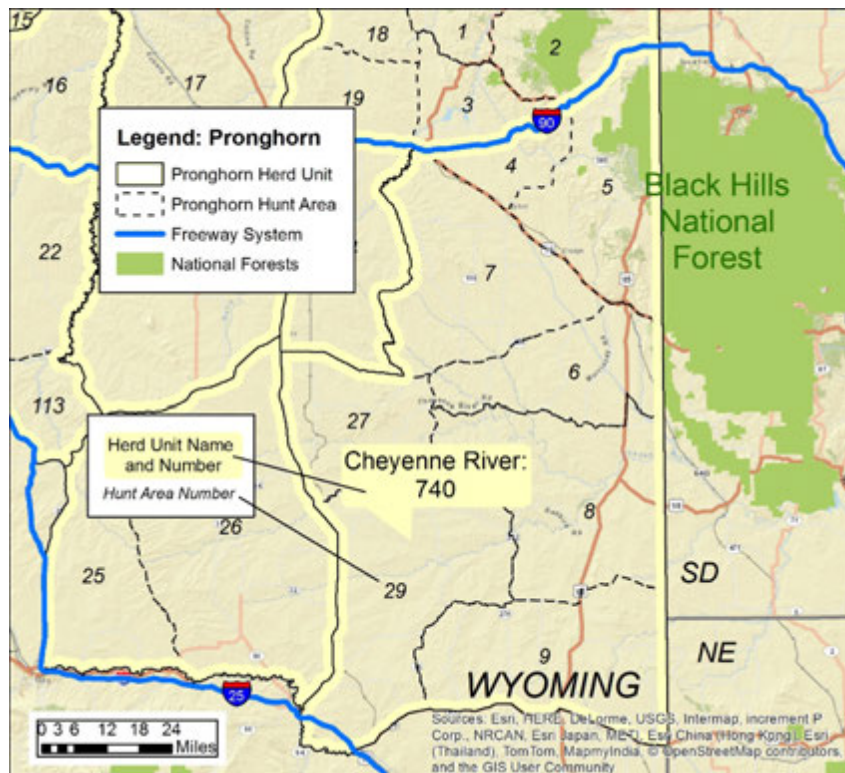


Fig. 189. Wyoming pronghorn herd unit 740 (Cheyenne River)

Topographically, this is a diverse unit ranging from the Black Hills foothills and plateau in the north to the pine scoria hills in the northwestern part of the herd unit and near Lusk to the Powder River basin plains. Vegetation varies from ponderosa pine forests in the Black Hills plateau and foothills to the more open ponderosa pine savannas of the pine scoria hills. The Powder River basin plains consist of mixed-grass prairie dominated by blue grama, western wheatgrass, junegrass, Sandberg bluegrass, needle-and-thread grass, rabbitbrush, fringed sage, and other forbs, shrubs and grasses (Chapman et al. 2004).

Land Ownership

The herd unit contains a mixture of public and private lands. The distribution of land ownership is 76% private, 8% state, 6% Bankhead Jones lands, 5% BLM and 5% National Grasslands (USFS) (WGFD 2013).

Land Use

Major land uses in this herd unit include livestock grazing, oil and gas production, timber harvest, and farming. There are several oil and gas fields which occur primarily in Hunt Areas 6, 7, 8, and 29, and development pressure has increased in recent years in Hunt Areas 8 and 29. Two surface coal mines represent a substantial land use within Hunt Area 27. Farming generally occurs in the southern most portion of the herd unit, but there are a number of wheat, oat, and alfalfa fields near Sundance and Upton. When pronghorn numbers are high, damage to growing alfalfa can become an issue (WG&FD 2013). Urban and sub-urban development in the herd unit include the communities of Douglas (6,120), Newcastle (3,532), Lusk (1,567), Sundance (1,182) and Moorcraft (1,009) (TWTER 2014). The remainder of the human population in the area is rural in character being dispersed in small, unincorporated communities, settlements or individual ranches or home sites throughout the Herd Unit.

Management Issues

This herd unit was created by combining the South Black Hills and Lance Creek herd units in 1998. The management objective for the new Cheyenne River Pronghorn Herd Unit is for an estimated post-season population of 38,000 pronghorn. This herd is managed under the recreational management strategy. The population objective and management strategy were set in 1999. Approximately 77% of this herd unit is private land. Public lands in the herd unit includes lands managed by the United States Forest Service (USFS), the Bureau of Land Management (BLM), and the State of Wyoming. Most of the USFS lands are part of the Thunder Basin National Grassland (TBNG) and located in Hunt Areas 5, 6, 7, 27, and 29. The State of Wyoming owns a large parcel of land in Hunt Area 9. Remaining public lands are scattered throughout the herd unit, and most are accessible only by crossing private lands. Access fees for hunting are common on private land, and many landowners have leased their property to outfitters. Therefore, accessible public lands are subjected to heavy hunting pressure (WG&FD 2013).

Population Size

The pronghorn population in this herd unit has fluctuated substantially over the period of this analysis. The maximum population estimate of 56,198 occurred in 1983 and the minimum population estimate for this herd was 15,031 animals in 1988 and. The mean value for the population for all the years of the analysis is 31,140 animals. The long-term trend for the population is increasing. The population estimate for 2012 is 31,065 animals. The long-term objective for population size is 38,000 animals.

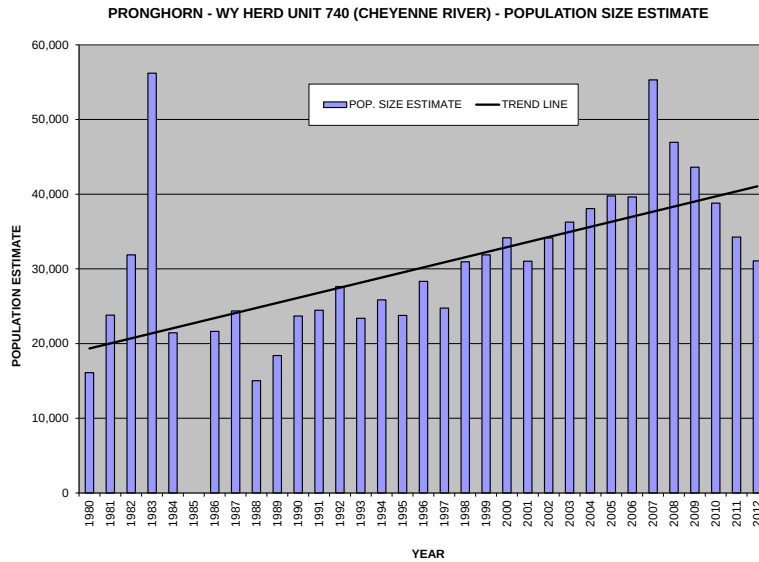


Fig. 190. Pronghorn – Wyoming herd unit 740 (Cheyenne River) – population size estimate

Age and Sex Composition

The Cheyenne River herd unit was created when the South Black Hills and Lance Creek herd units were combined in 1998. From 1980 through 1997, the male/100 female ratios and young /100 female ratios that are used in the analysis are an average of the ratios from the 2 herd units. From 1998 on the ratios are from the data collected for the entire unit and averaging wasn't used to produce the estimates for various ratios.

Male/100 female ratios have ranged from a low of 23 males/100 females in 1986 to a high of 66 males/100 females in 1993. The mean value for males/100 females is 50. The long-term trend for males/100 females is increasing.

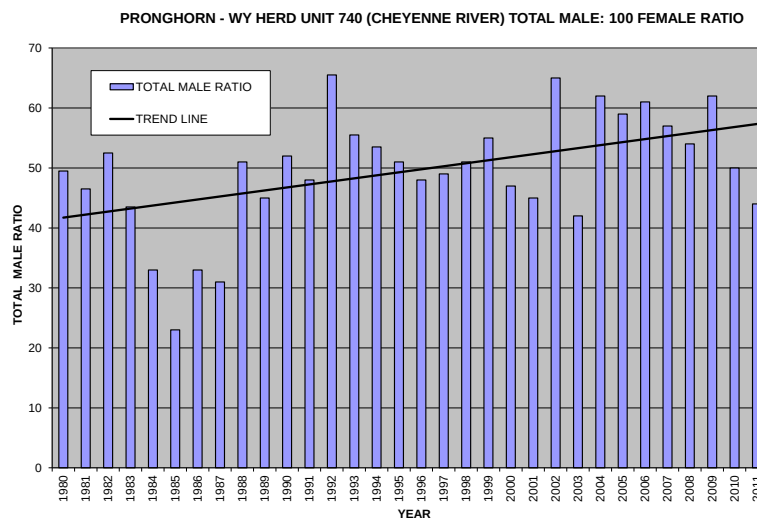


Fig.191. Pronghorn – Wyoming herd unit 740 (Cheyenne River) – males/100 female ratios

Young/100 female ratios have varied from a high of 106 young/100 females in 1987 to a low of 55 young/100 females in 2008. The mean value for young/100 females is 78. The long-term trend for young/100 females is decreasing.

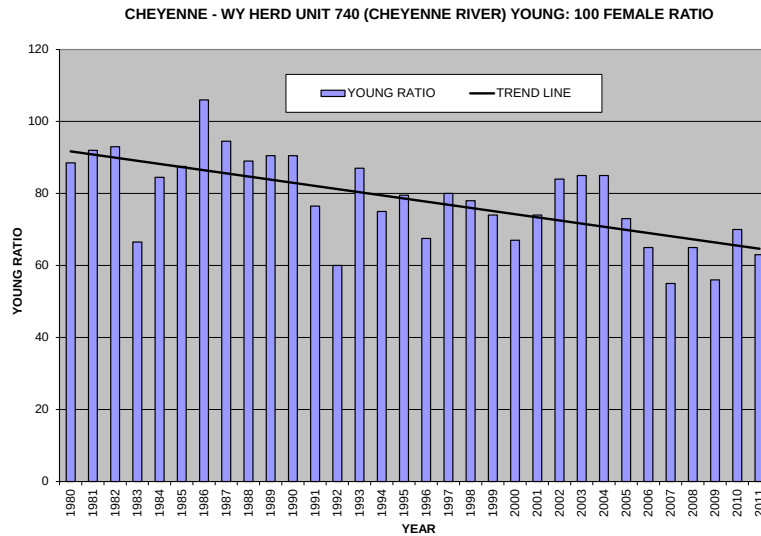


Fig. 192. Pronghorn – Wyoming herd unit 740 (Cheyenne River) – young/100 female ratios

Harvest

Total male for this herd unit has ranged from a high of 4,775 bucks in 1983 to a low of 1,416 bucks in 1989. The mean value for buck harvest for all years of the analysis is 2,667 animals. The long-term trend for buck harvest is stable. Buck harvest for this herd unit in 2012 was 2,512 animals which is only 6% below the long term average for buck harvest for this herd unit. A review of average buck harvest by decade shows that the 2010s have the highest average buck harvest of all decades in the analysis at 3,018 animals.

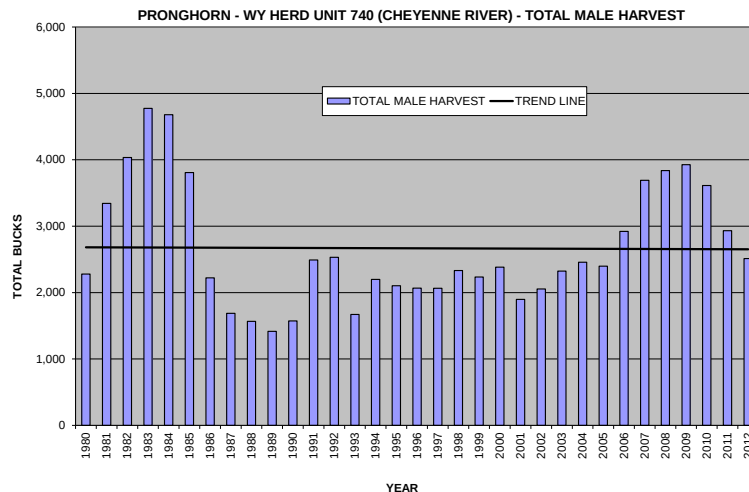


Fig. 193. Pronghorn – Wyoming herd unit 740 (Cheyenne River) – male harvest

Total harvest for this herd unit has ranged from a high of 9,750 animals in 1983 to a low of 2,425 animals in 2001. The mean value for harvest is 4,369 animals. The long-term trend for total pronghorn harvest for the unit is decreasing. The variation in average harvest by decade provides a convenient way to review harvest data. The average harvest by decade is as follows; for the 1980s, 5,475 animals, the 1990s, 3,169 animals, the 2000s, 4,149 animals and the 2010s, 5,421 animals.

Doe and fawn harvest has been a major component of total harvest for all years of the analysis. During the 1980s and early 1990s, doe and fawn harvest made up approximately 40% of the total harvest. When populations declined in the mid-1990s and early 2000s, the percent of does and fawns in the harvest declined to as low as 15% of the total harvest. Since 2006, the pronghorn population in the unit has recovered from the decline it suffered in the 1990s and early 2000s. Doe and fawn harvest has again increased and accounts for more than 40% of the total harvest in most years.

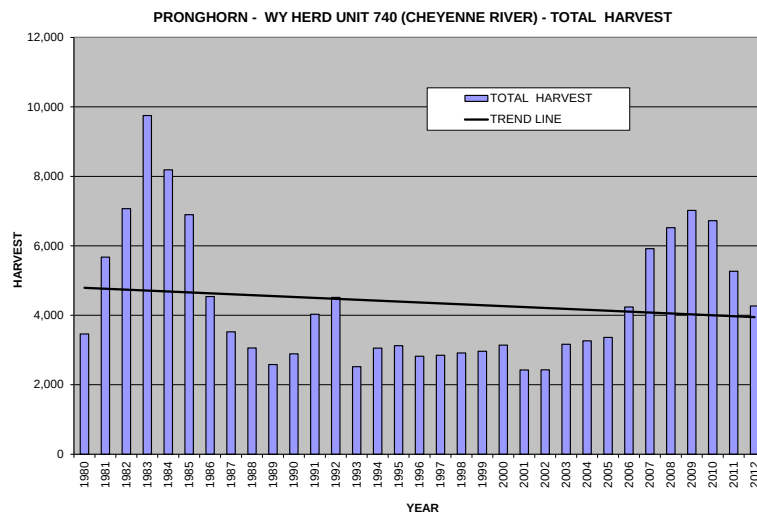


Fig. 194. Pronghorn – Wyoming herd unit 740 (Cheyenne River) – total harvest

Hunter Numbers and Success Rates

Total hunting pressure for all seasons and methods of take has varied from a high of 11,180 hunters in 1983 to a low of 2,285 hunters in 1993. The mean value for hunting pressure for all years of the analysis is 4,492 hunters. The long-term trend for hunting pressure is decreasing slightly.

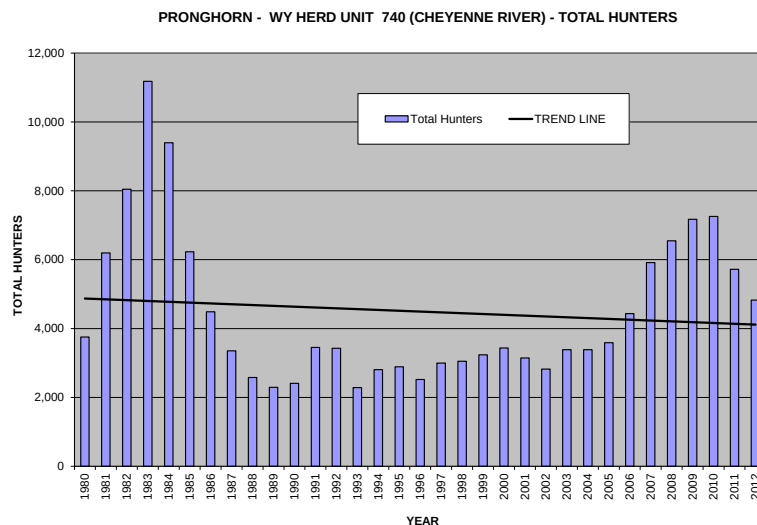


Fig. 195. Pronghorn – Wyoming herd unit 740 (Cheyenne River) – total hunters

Hunter success rates for all seasons and methods of take have varied from a high of 131.8% in 1992 to a low of 77.1% in 2001. The mean value for hunter success is 99.7%. The long-term trend for hunter success rates is decreasing slightly.

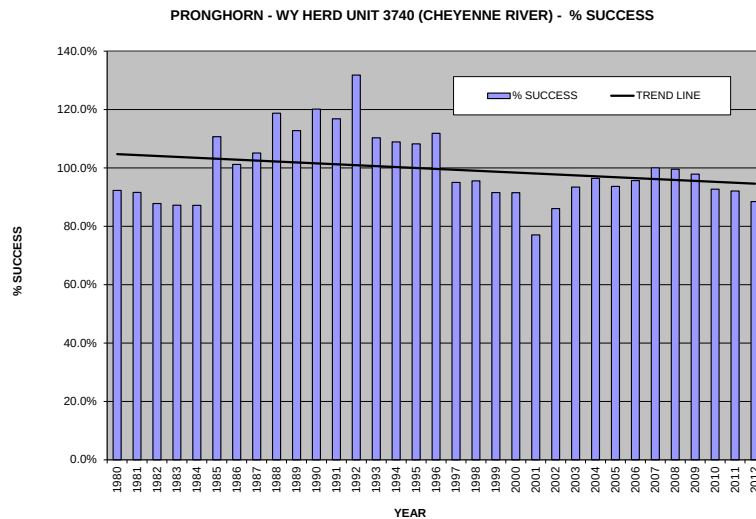


Fig. 196. Pronghorn – Wyoming herd unit 740 (Cheyenne River) – hunter success rates

Summary of Herd Vital Statistics and Management Implications

An evaluation of an assortment of data for the pronghorn herd in this herd unit indicates that it is not performing at an optimum level. According to an evaluation system that was developed for this project, the performance rating for this herd is fair for the following reasons:

- The pronghorn population in this herd unit is substantially below the long term population objective set by the Wyoming Game and Fish Department (31,065 versus 38,000 animals). The last time this pronghorn herd was at objective was 2010. This herd has been at objective or within 10% of the object for 8 of the past 10 years.
- The long-term trend for population size for the herd is increasing. However, in the short term (last 2 years) this population has declined.
- The long-term trend for young/100 female ratios is decreasing. In addition, young/100 female ratios have been below the mean value for young/100 female ratios (78:100) for the last 7 years. If this short-term trend for young/100 female ratios continues there isn't much potential for growth in the population.
- A negative factor for this pronghorn herd is a slightly decreasing long-term trend for harvest. In addition, this herd endured a 15 year period of low harvest from 1993 through 2006. The mean harvest for this 10 year period was 3,019 animals per year which is substantially below the long-term mean value for harvest (4,369 animals per year). Without this 10 year period of low harvest the long-term trend for harvest would likely have been stable instead of decreasing.

The end result of all of this information is that if current habitat conditions are maintained, and if the short-term trend for young/100 females continues, this pronghorn herd is unlikely to show any improvement in population size and harvest. However, if habitat conditions deteriorate due to development or adverse natural environmental conditions, population size and harvest will likely decline further than the current situation.

NORTH CONVERSE, PRONGHORN HERD UNIT 748 (refer to table 24 in the appendix)

General Description Pronghorn antelope herd unit 748 is located in eastern Wyoming and is commonly referred to as the North Converse Herd Unit. The herd unit lies in portions of Converse, Natrona, Campbell and Johnson counties and contains hunt areas 25 and 26. The

herd unit is bounded on the north by State Highway 387, on the east by State Highway 59, on the south by the North Platte River and on the west by Interstate 25 and State Highway 259. This herd unit covers an area of approximately 2,539 sq. mi. and approximately 2,531 sq. mi. is considered to be occupied habitat (WG&FD 2014). Topography in the area is characteristic of the Powder River basin consisting of a rolling upland plain with low to moderate relief, broken by buttes, mesas, hill and ridges. Vegetation is characteristic of the Powder River basin portion of the northwestern Great Plains consisting of a mixed-grass prairie dominated by blue grama, western wheatgrass, junegrass, Sandberg bluegrass, needle-and-thread grass, rabbitbrush, fringed sage, and other forbs, shrubs and grasses (Chapman et al. 2004).

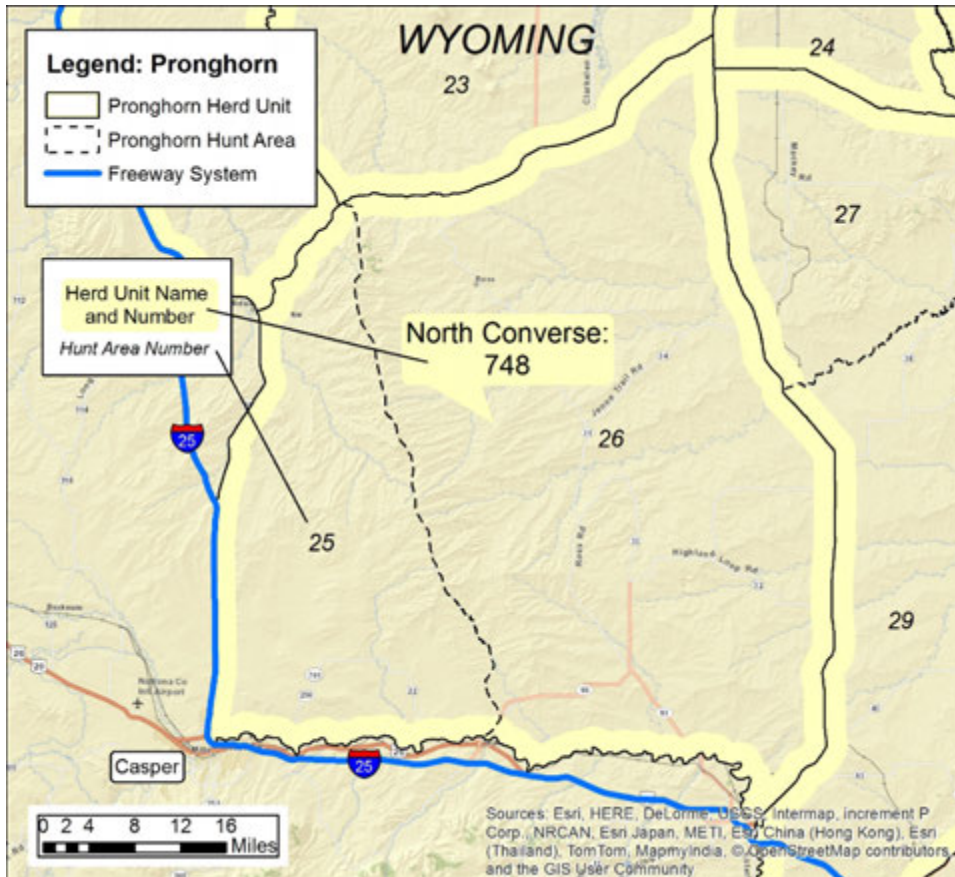


Fig. 197. Wyoming pronghorn herd unit 748 (North Converse)

Land Ownership This herd unit contains a mixture of public and private lands. The distribution of land ownership is approximately 80% private, 10% BLM, 7% state, with another 3% comprised of a combination of Bankhead Jones Lands, Department of Defense and National Grasslands (USFS) (WG&FD 2014).

Land Use Primary land uses in this herd unit include extensive oil and gas production, large-scale industrial wind generation, In-Situ uranium production, and traditional cattle and sheep grazing. In recent years, expansion of oil shale development has dramatically escalated anthropogenic disturbance throughout this herd unit. Urban and sub-urban development includes the communities of Casper (55,316), Douglas (6,120), Glenrock (2,576), Midwest (404) and Edgerton (195) (TWTER 2014). The remainder of the human population in the area is rural in character being dispersed in small, unincorporated communities, settlements or individual ranches or home sites throughout the herd unit.

Management Issues The boundary of the North Converse herd unit has changed and evolved over the years. In 1985, the Sage Creek herd and North Converse herd units were combined and renamed the North Converse herd unit. A similar action occurred again in 1997 when the Omsby and North Converse herd units were combined and renamed the North Converse herd unit.

The management objective for the North Converse Pronghorn Herd Unit is a post-season population objective of 28,000 pronghorn. This herd is managed under the recreational management strategy, with a goal of maintaining preseason buck ratios between 30-59 bucks per 100 does. The objective and management strategy were last revised in 1989. Public hunting access within the herd unit is poor, with only small tracts of accessible public land interspersed with predominantly private lands. Two Walk-In Areas provide some additional hunting opportunity, although they are relatively small in size (WGFD 2013).

Population Size The pronghorn population in this herd unit has fluctuated substantially over the years. As it is currently configured, the minimum population estimate was 17,000 animals in 1980 and the maximum population estimate for the herd unit was 41,909 animals in 1983. The mean value for population size is 27,150 pronghorn. The long-term trend for the population is increasing. The population estimate for 2012 is 20,432 animals. The long-term population objective for the combined population is 28,000 animals.

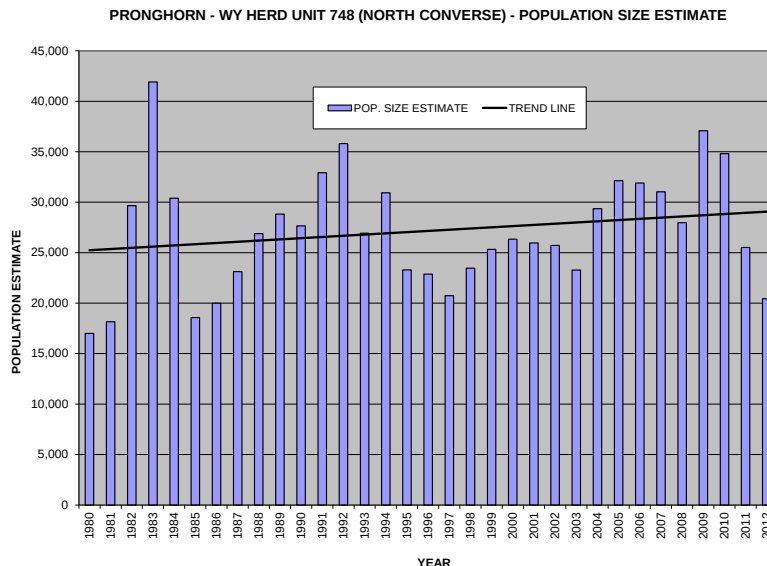


Fig. 198. Pronghorn – Wyoming herd unit 748 (North Converse) – population size estimate

Age and Sex Composition As noted in the management issues section of the discussion of this herd unit, the North Converse herd unit has been combined with 2 other herd units over the years. As a result of this consolidation of herd units, male/100 female ratios and young/100 female ratios reported for 1980 through 1997 are an average of the ratios collected for the separate units (North Converse, Sage Creek and Omsby). From 1998 on the ratios listed are the values collected for the newly realigned North Converse herd unit. Male/100 female ratios have varied from a low of 42 males/100 females in 1986 to a high of 79 males/100 females in 2010. The mean value for males/100 females for all years of data is 60. The long-term trend for male/100 female ratios is increasing.

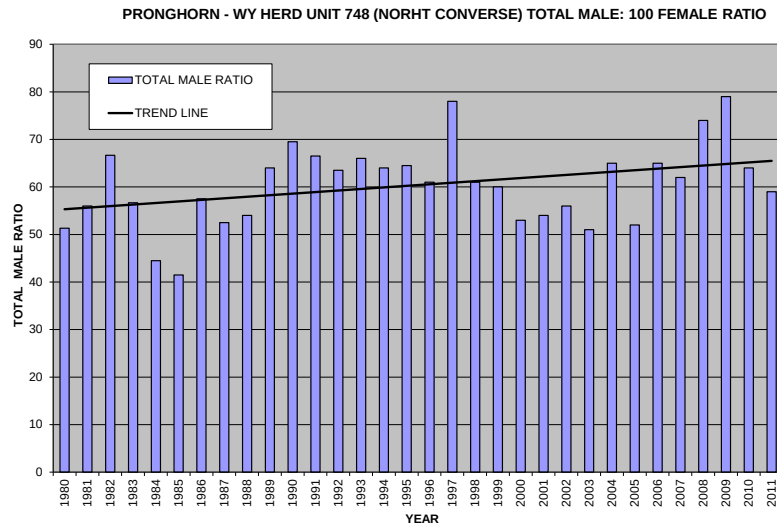


Fig. 199. Pronghorn – Wyoming herd unit 748 (North Converse) – Males/100 female ratios

Young/100 female ratios have varied from a low of 51 young/100 females in 1993 to a high of 104 young/100 females in 1996. The mean value for young/100 female ratios for all years of the analysis is 83. The long-term trend for young/100 females is decreasing.

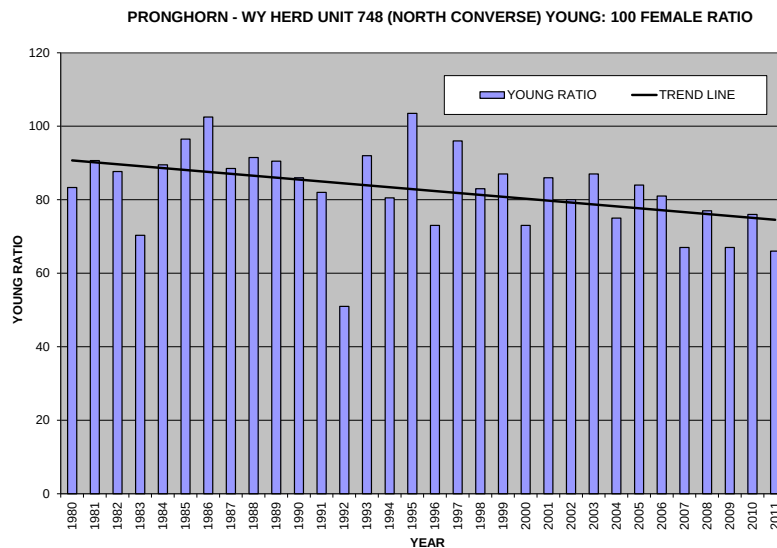


Fig. 200. Pronghorn – Wyoming herd unit 748 (North Converse) – young/100 female ratios

Harvest Total male harvest for this herd unit has varied from a high of 3,630 bucks harvested in 1983 to a low of 1,173 bucks harvested in 1998. Average buck harvest for all years of the analysis is 1,944 animals. The long-term trend for buck harvest is declining. Buck harvest for 2012 was 1,759 animals which is 90% of the average buck harvest for the herd unit. A review of the average buck harvest by decade shows that the highest average buck harvest occurred in the 1980s with an average of 2,591 bucks harvested per year. Average buck harvest per decade decreased in the 1990s (1,865) and 2000s (1,381) but increased to 1,928 animals harvested per year in the 2010s, although this harvest level is slightly below the long-term average harvest for the herd unit which is 1,944 animals per year.

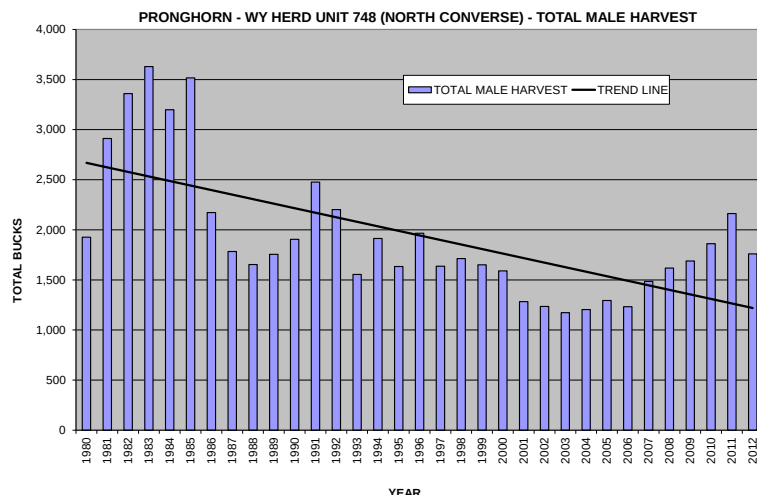


Fig. 201. Pronghorn – Wyoming herd unit 748 (North Converse) – male harvest

Total harvest for the North Converse Herd Unit has varied from a high of 7,016 animals in 1983 to a low of 1,573 animals in 2003. The mean value for harvest is 3,200 animals. The long-term trend for harvest is decreasing. Total harvest for the herd unit in 2012 was 3,169 animals which is only slightly below the long term average harvest of 3,200 animals. An evaluation of total harvest by decade illustrates that harvest has declined substantially from the 1980s and has only begun to show improvement in the 2010s.

Again, as in other pronghorn herd units in the northeastern part of the state, doe and fawn harvest comprise a substantial portion of total harvest. In the 1980s and early 1990s, doe and fawn harvest made up as much as 53% of the total harvest. From 1995 to 2009, declined to a lower percentage, as low as 15% of the total harvest. Since 2010 doe and fawn harvest have again increase to 37 to 44% of the total harvest.

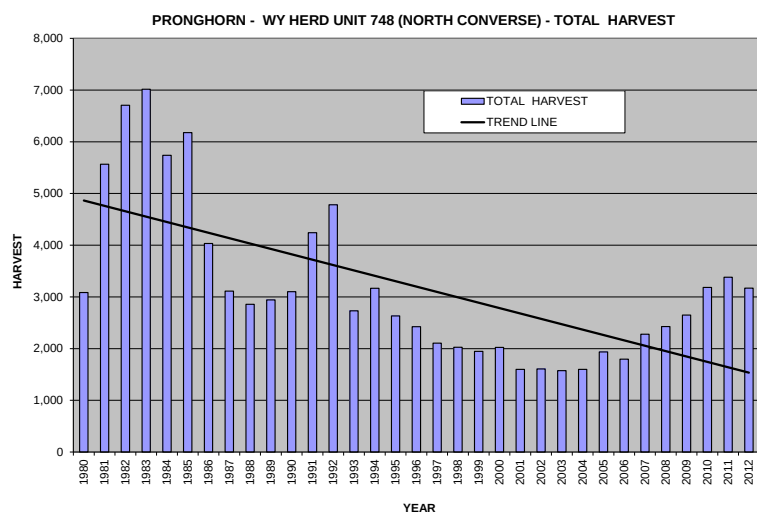


Fig. 202. Pronghorn – Wyoming herd unit 748 (North Converse) – total harvest

Hunter Numbers and Success Rates Total hunting pressure for all seasons and methods of take has ranged from a high of 7,385 hunters in 1983 to a low of 1,655 hunters in 2004 for this unit.

The mean value for hunter pressure for all years of the analysis is 3,072 hunters. The long-term trend for hunting pressure is decreasing.

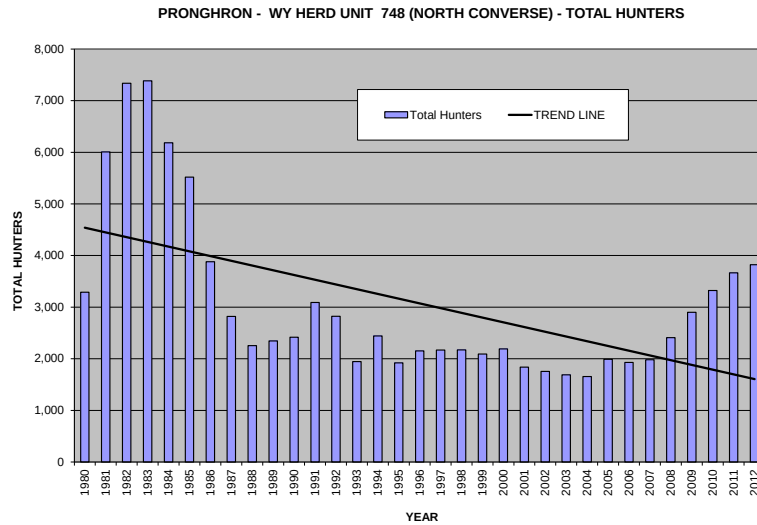


Fig. 203. Pronghorn – Wyoming herd unit 748 (North Converse) – total hunters

Hunter success rates for all seasons and methods of take has ranged from a high of 169.4% in 1992 to a low of 82.9% in 2012. The mean value for success rates for all years of data is 106.4%. The long-term trend for hunter success rates is decreasing.

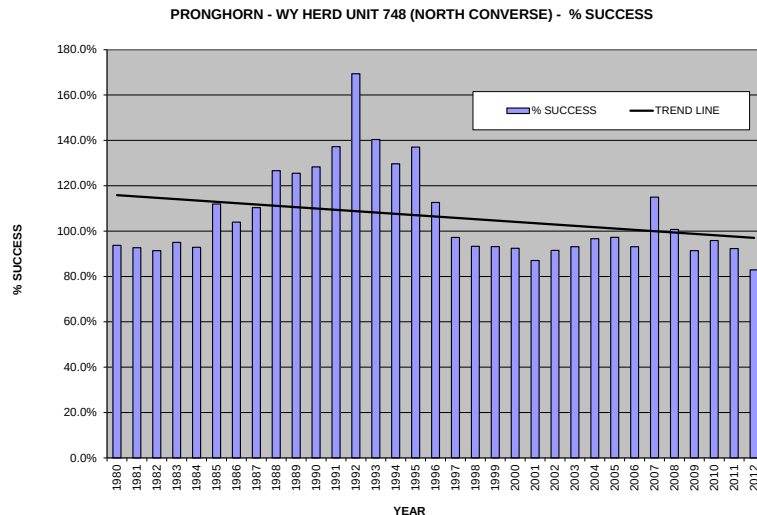


Fig. 204. Pronghorn – Wyoming herd unit 748 (North Converse) – hunter success rates

Summary of Herd Vital Statistics and Management Implications An evaluation of an assortment of data for the pronghorn herd in this herd unit indicates that it is not performing at an optimum level. According to an evaluation system that was developed for this project, the performance rating for this herd is poor for the following reasons:

- The pronghorn population in this herd unit is substantially below the long term population objective set by the Wyoming Game and Fish Department (20,432 versus 28,000 animals LTO). The last time this pronghorn herd was at objective was 2010. This herd has been at objective or within 10% of the object for 8 of the past 10 years.

- The long-term trend for population size for the herd is increasing. However, in the short term (last 3 years) this population has declined.
- The long-term trend for young/100 female ratios is decreasing. In addition, young/100 female ratios have only equaled or exceeded the mean value for young/100 female ratios (83:100) for 2 of the last 10 years. If this short-term trend for young/100 female ratios continues there is only slight potential for growth in the population.
- A negative factor for this pronghorn herd is a decreasing long-term trend for harvest.

The upshot of all of this information is that if current habitat conditions are maintained, and if the short-term trend for young/100 females continues, this pronghorn herd is unlikely to show substantial improvement in population size and harvest. In addition, if habitat conditions deteriorate due to development or adverse natural environmental conditions, population size and harvest will likely decline further than the current situation.

SECTION V

GREATER SAGE-GROUSE DATA AND ANALYSIS – MONTANA

Lek Counts

Foster et al. (ND) studied sage grouse in the in the core area of SE corner of Montana. The core areas support the highest densities of sage grouse and are the highest conservation priority. Pre-1980 historic lek data is not available for the core area. The lek data for this area since 1980 indicates that the area has not exhibited a long term decline and the peak population actually occurred in the mid-2000's. This was followed by a decline that was probably a result of a West Nile virus (Foster et al ND).

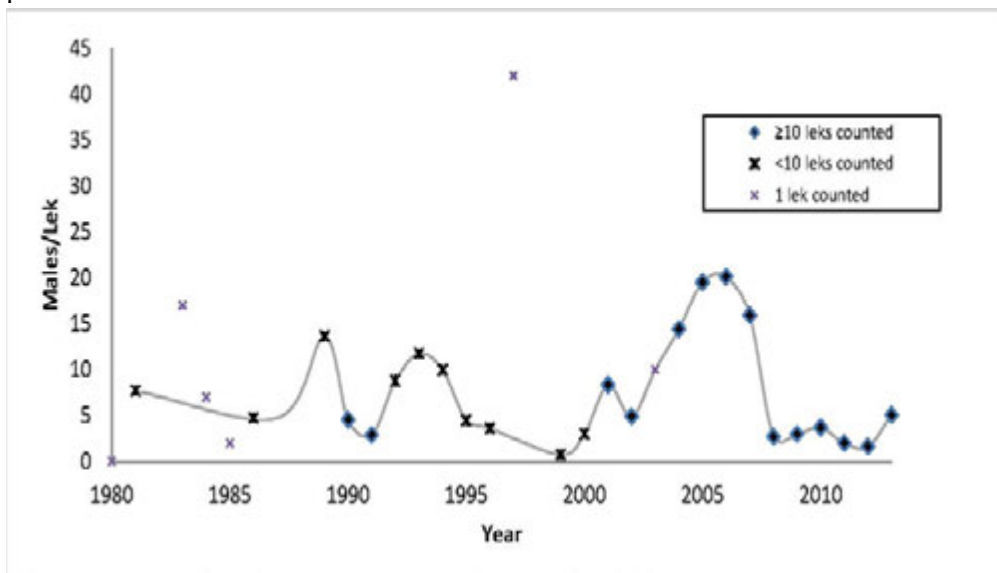


Fig. 205. Graph of the average number of greater sage grouse males per lek in Carter County, MT 1980-2013. (Foster et al ND)

Region 7 of the MFWP also conducts lek counts in four sage grouse lek trend areas. These are counted annually. The four trend areas have a combined total of 80 potential sage grouse leks and samples from these leks are counted annually. The total males counted in these trend areas peaked in 2006 with 988 males (988 males counted on 56 leks = avg 17.6 males).

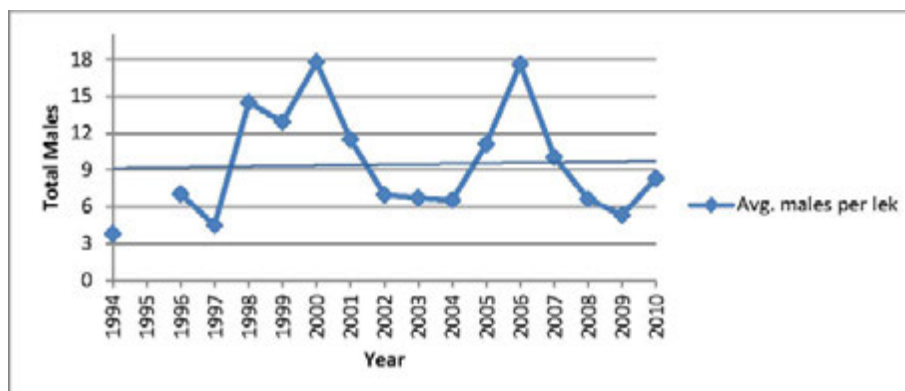


Fig. 206. Graph of the average number of males counted in 4 GRSG lek trend areas in Reg. 7 of MFWP from 1994-2010.

From 2007 through 2009 the average number of males counted on trend areas were declining. Then in 2010 numbers increased to an average of 8.3 males (465 total males counted on 56 leks). The overall trend for the sage grouse trend areas appears to be stable (Beyer et al 2010).

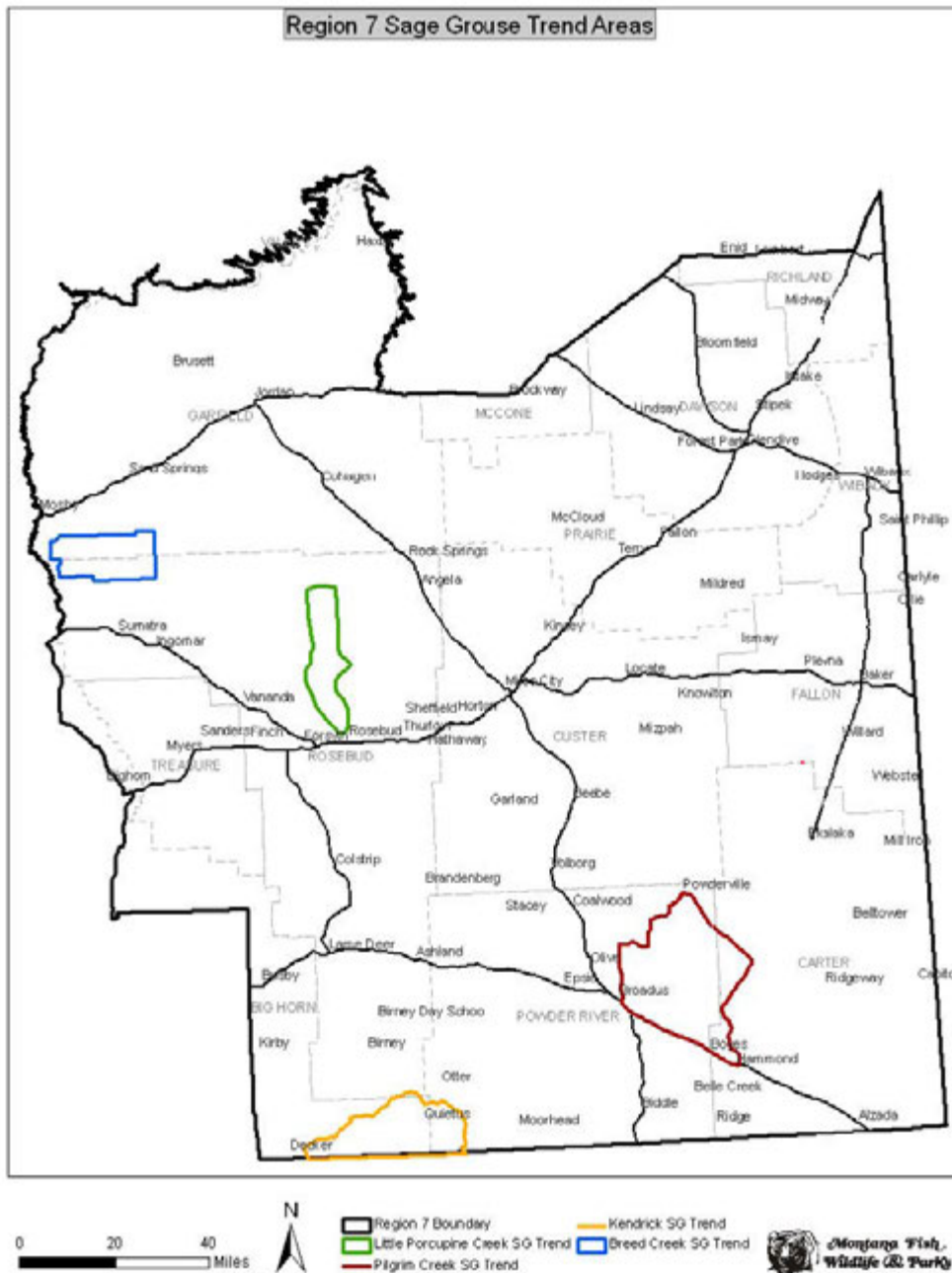


Fig. 207. Map showing the location of the 4 greater sage grouse trend count areas for Region 7, MFWP (Beyer et al 2010).

MFWP Region 7 also conducts sage grouse lek surveys in 22 Adaptive Harvest Management (AHM) leks. These leks are surveyed annually and the information is used to adjust the sage grouse hunting season quotas as necessary. Unlike the trend area leks the AHM leks do not show an increase in the total males counted. The total males counted on these AHM leks peaked in 2001 with 528 males counted. The males decreased until 2005 and 2006 when they had

another increase to 497 and 449 males counted, respectively. However from 2007 through 2010 there were declining numbers of males counted on the AHM leks ending at 209 total males counted in 2010. This trend can also be seen in graph below which shows the average number of males per lek peaking in 2001 then declining from 2007-10. The overall trend for the sage grouse AHM leks is decreasing (Beyer et al 2010).

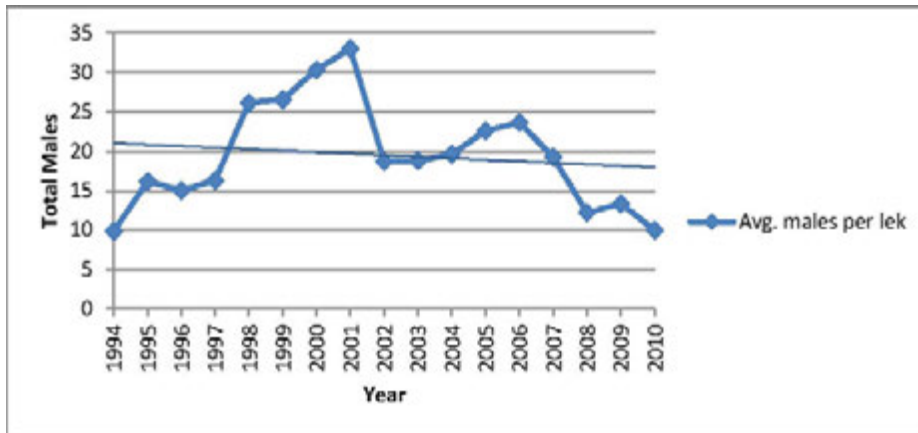


Fig. 208. Graph showing the summary of average males per lek for greater sage grouse surveyed from the Adaptive Harvest Management areas (AHM) leks (n=22) for 1994-2010 (Beyer et al 2010).



Fig. 209. Map showing the general location of greater sage grouse leks for SE Montana (September 2014).

Hunting and Harvest

Sage grouse hunting is still allowed in Montana. Hunting regulations have changed a few times since 1990. In 1994 the bag limit on sage grouse changed from 4 to 3 per day and the possession limit changed from 16 to 12. In 1996, the bag limit changed again to 2 sage grouse per day with a possession limit of 6. The bag limit increased to 3 sage grouse per day in 2000, but the possession limit stayed at 6. In 2005, the bag limit changed from 3 to 2 sage grouse per day and the possession limit decreased from 6 to 4. The hunting season length on sage grouse also decreased during this time. From 1990-95 the season dates were Sep.1-Dec.15, and then in 1996 the season was shortened to Sep. 1-Nov.1, which is the current hunting season structure. Harvest information indicates a declining sage grouse harvest from approximately 1,000 in 2003 to 386 in 2009. Sage grouse hunter days were sporadic ranging from approximately 850 to 1,400 hunter days annually from 2007-09. Current hunter days are similar to sage grouse hunter days from 2004-06 which ranged from approximately 900 to 1,300 hunter days annually (Beyer et al 2010).

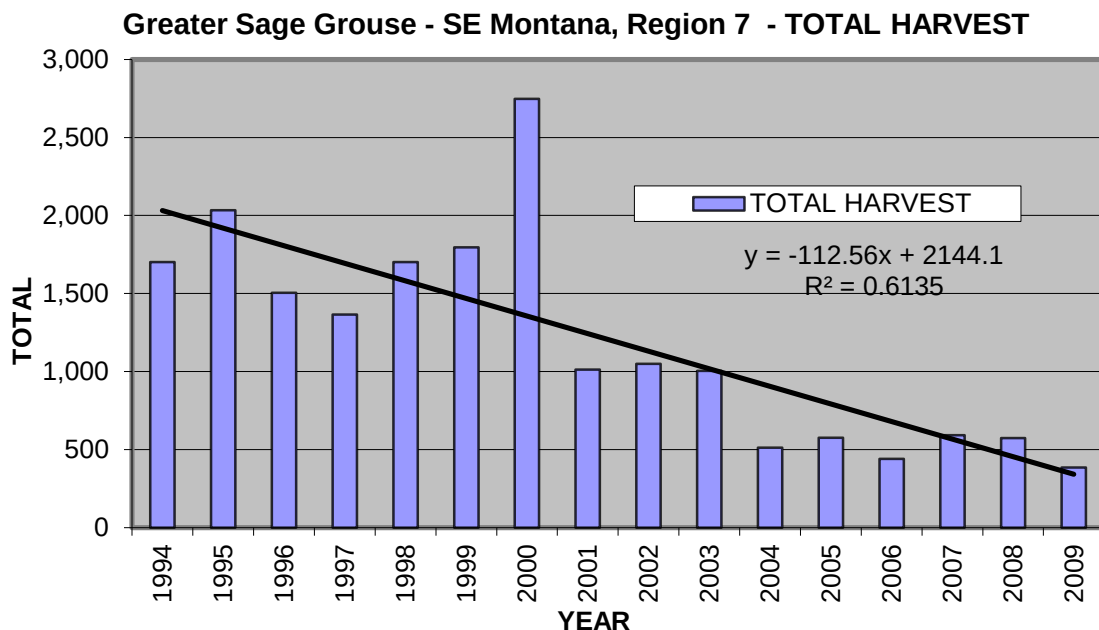


Fig. 210. Greater sage-grouse, southeast Montana – region 7 – total harvest

MT Conservation Strategy

Executive Order (Sage Grouse Core Areas) Montana has followed Wyoming's lead in developing a sage grouse conservation program based upon the core area principles. The program was initiated on Sept. 9, 2014 when Gov. Steve Bullock signed Montana Executive Order Number 10-2014. Montana has the second largest GSG population among the western states. Their plan closely mirrors the Wyoming executive order and plan. As stated earlier, the USFWS has already given their blessing to this type of strategy. Montana's plan differs from Wyoming's by the method of oversight.

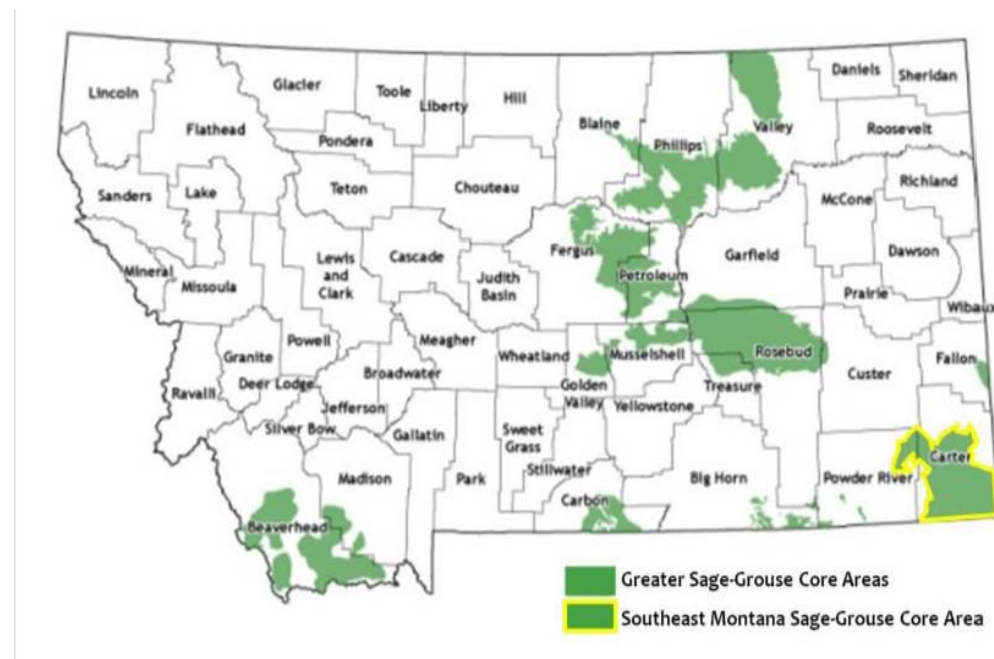


Fig. 211. Montana – Greater sage-grouse GrSG core areas and SE Montana GrSG core areas

Montana has set up a Sage Grouse Oversight Team (MSGOT) while the WY plan relies on the Wyoming Fish and Game to provide the plan oversight. The initial composition of MSGOT shall include the Directors of the Departments of Fish, Wildlife and Parks, Environmental Quality, Natural Resources and Conservation, and transportation, the Executive Director of the Montana Board of Oil and Gas Conservation, a representative of the rangeland Resources Committee, and a member of the Governor's Office. The MSGOT will oversee the administration of the Montana Sage Grouse Habitat Conservation Program (referred to as the Program). This will include, among other tasks: supervision of the Program Manager, staying abreast of emerging science and developing appropriate guidance, reviewing and troubleshooting the consultation process, providing input to funding requests for research and land management projects, and recommending to the Governor further improvements to the Program.

The Program will give priority to the maintenance and enhancement of sage grouse habitats in the Core Population and Connectivity Areas. The program also state that the Core Population Areas (Core Areas) should not be altered for at least 5 years and incentives shall be developed to encourage new land uses and activities in the general habitat areas to occur in a manner that minimizes impacts to sage grouse populations and habitats. The Program has a role of consultation, recommendation, and facilitation, and has no authority to either approve or deny a project.

The plan calls for new land uses or activities in core areas shall be avoided when possible while existing land uses and activities shall be recognized and respected by state agencies, and those existing prior to the effective date of the Program will not be managed under the stipulations of this Conservation Strategy. Examples of existing activities include oil and gas, mining, agriculture, processing facilities, power lines, housing, operations and maintenance.

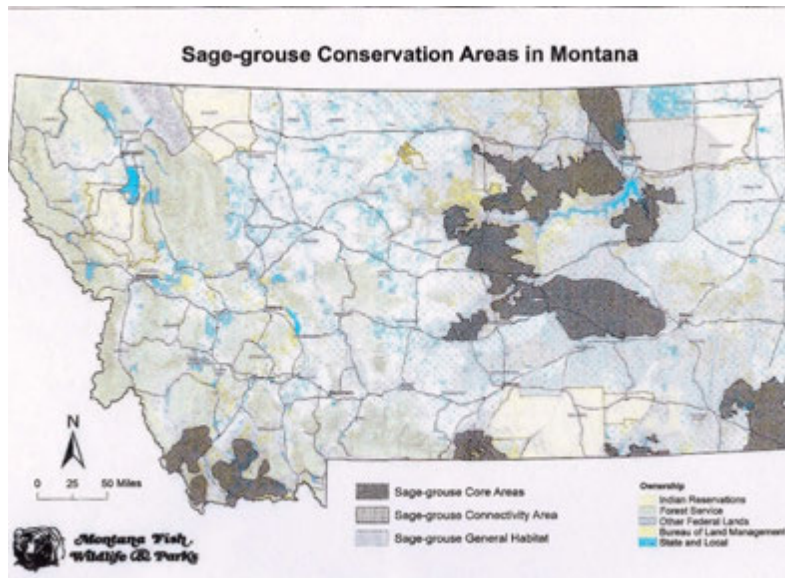


Fig. 212. Montana - core sage-grouse areas established by the Executive Order No. 10-2014.

The Executive Order contains 7 appendixes:

- 1) Predators;
- 2) Wildlife fire prevention and rehabilitation;
- 3) Stipulations for uses and activities in the core area and those that involve oil and gas, mining, coal mining and wind energy as well as general habitat stipulation, including sage grouse connectivity linkage areas;
- 4) Special management areas;
- 5) Exempt activities;
- 6) Recommendations for range and disease management;
- 7) Definitions.

Key core area stipulations call for surface disturbances to be limited to 5% of the suitable sage-grouse habitat averaged across the area affected by the project. Unsuitable habitat shall be factored out of this analysis. Surface occupancy stipulations require that there will not be any surface occupancy within 0.6 mi. of an active sage grouse lek. Uses and activities in Core Areas will be evaluated within the context of maximum allowable disturbance (disturbance percentages, location and number of disturbances) of suitable sage grouse habitat within the area affected by the project. The maximum disturbance allowed will be analyzed via a **Density/Disturbance Calculation Tool (DDCT)** process, similar to that currently utilized by the State of Wyoming. Unsuitable habitat occurring within the project area will not be included in the disturbance cap calculations. Existing disturbances shall be included.

Conclusion: WMCA concurs with the USFWS about the value of the core area strategy conservation program to preserve and protect the remaining greater sage grouse. The states of Wyoming and Montana are to be commended for taking this important step and the authors encourage the remaining western states that have GRSG to adopt similar programs to protect and preserve the remaining populations and habitats in their respective states.

SECTION VI

GREATER SAGE-GROUSE DATA AND ANALYSIS – WYOMING

The state of Wyoming has completed a statewide conservation plan (WGFD 2003) and 8 local working group plans. For the purpose of this report, the Northeast Wyoming Plan Local Working Group plan (NEWLWG 2006 & 2014) will be discussed. While these local working groups do not have statutory management authority, the working group members represent their particular interests and provide liaison with the groups they represent and they bring a cohesive, cooperative approach to sage-grouse management. The purpose of local working groups are to develop local conservation plans, design projects that benefit sage grouse and other sagebrush obligate species, and to implement on-the-ground habitat and population related projects for the species.

The Wyoming Sage-grouse Conservation Plan was finalized in 2003 (WGFD 2003). The state was divided up into eight local working groups to develop their respective local plans. The Northeast Wyoming Sage-grouse Working Group Plan was finalized in August 2006. Since that time, a significant amount of new information has been gathered through research and subsequent conservation strategies have been developed. An addendum to this plan was completed in Feb. 2014. The addendum updates the Northeast Wyoming Sage-grouse Conservation Plan with the latest information and identifies strategies the Working Group will undertake in upcoming years.

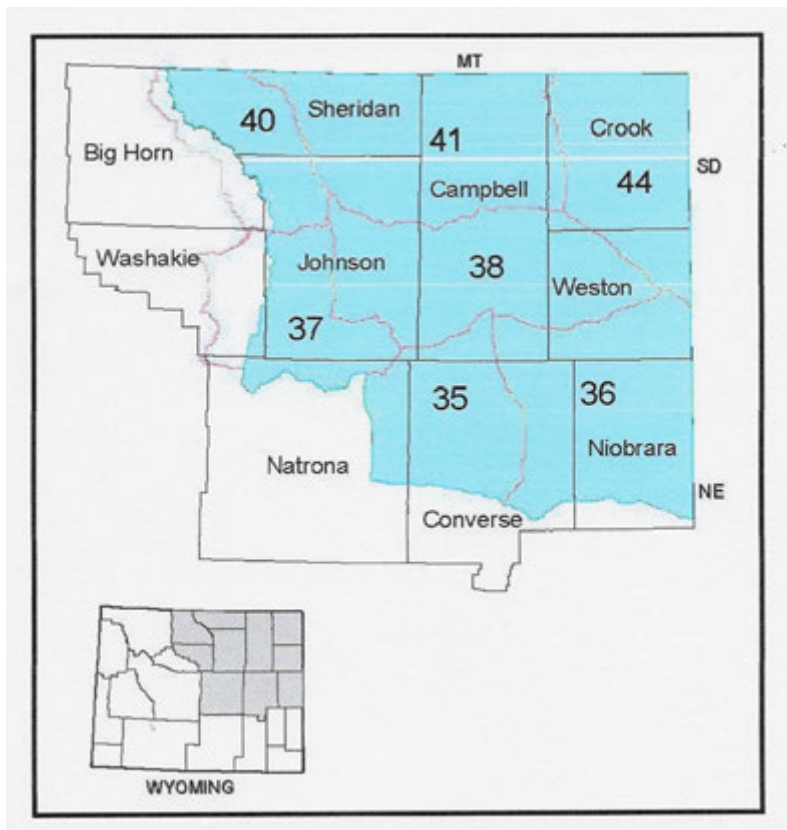


Fig. 213. NE Wyoming sage-grouse local working group area showing WGFD upland game management units and counties.

NE Wyoming Current Sage Grouse Population Status

Sage-grouse Trends (NEWLWG 2014) Northeast Wyoming Working Group Male Sage-grouse Lek Attendance 1967- 2013.

As discussed earlier, the trend of males per active lek continues to be the most reliable indicator of sage-grouse abundance. Since the working group's plan was completed in 2006, sage-grouse numbers have declined significantly. The current decreasing trend could be a combination of cyclic nature of sage-grouse populations combined with documented influences from fire, land conversion, West Nile virus and energy development in the Powder River Basin. The last peak occurred in 2006 and 2007 which actually exceeded the previous peak which occurred in 2000. The highest level was over 50 males per lek in 1979.

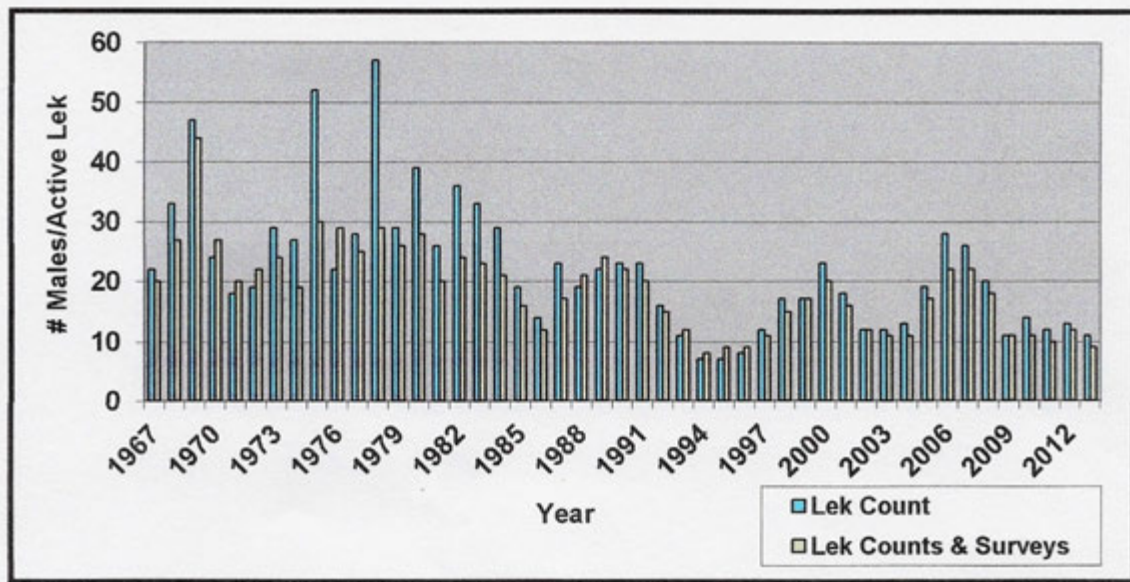


Fig. 214. Wyoming - Average number of male GrSG per active lek in the NEWLWG area from 1967-2012.

Another index to sage grouse populations is the number of active leks vs. inactive leks. The level of lek activity can correspond to either population increases or increased lek monitoring effort (lek counts and surveys), both of which have occurred in the working group area over the last 15 years. The number of leks monitored annually has remained relatively stable since 2006, which was the last peak in the male lek attendance cycle. Since then, both the average number of males per active lek and the percentage of active leks have decreased significantly, suggesting a notable decrease in the population. This decrease in northeast Wyoming has been greater than that observed for the other working group areas while similar population trends have occurred in other areas of the state.

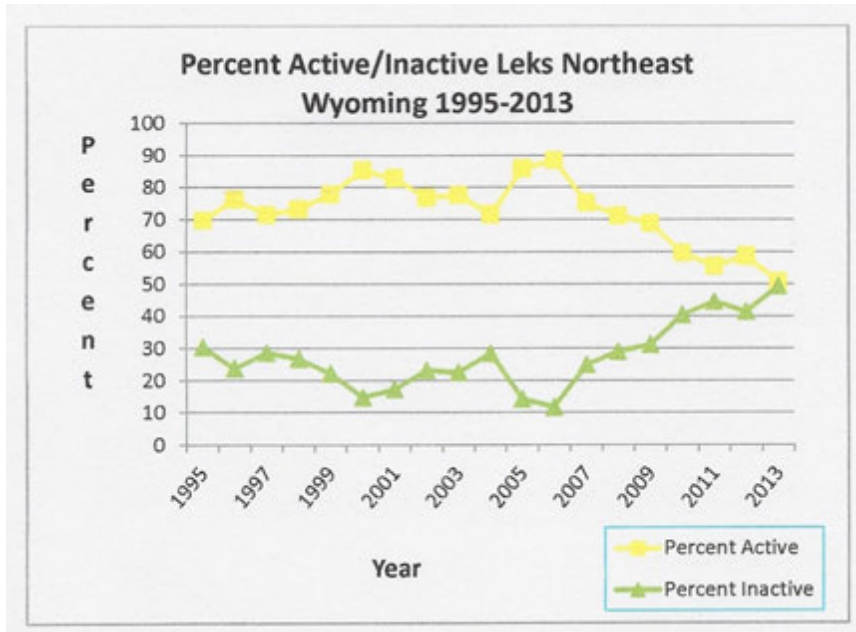


Fig. 215. Greater sage-grouse – northeast Wyoming – percent active versus inactive leks – 1995-2013

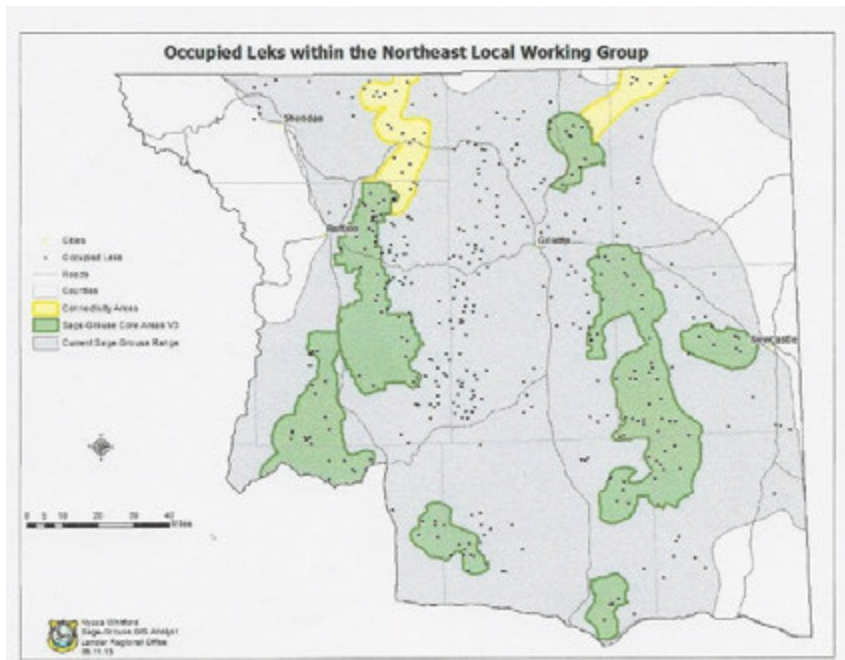


Fig. 216. Wyoming – Greater sage-grouse occupied leks in Northeastern Local Working Group Area

Vegetation communities within the working group area are naturally fragmented as they represent a transition between the intermountain basin sagebrush communities to the west and the prairie communities to the east. Northeast Wyoming is also near the eastern edge of greater sage-grouse range. The spatial extent and quality of sagebrush habitat on the landscape corresponds

to the abundance of sage-grouse. Estimated sagebrush coverage in the Powder River Basin is estimated to be 35% with an average patch size of less than 300 acres whereas the Upper Green River Basin has sagebrush coverage of 58% with an average patch size greater than 1,200 acres (Rowland et al. 2005). The Powder River Basin patch size has decreased by more than 63% in forty years, from 820 acre patches and an overall coverage of 41% in 1964 (Rowland et al. 2005).

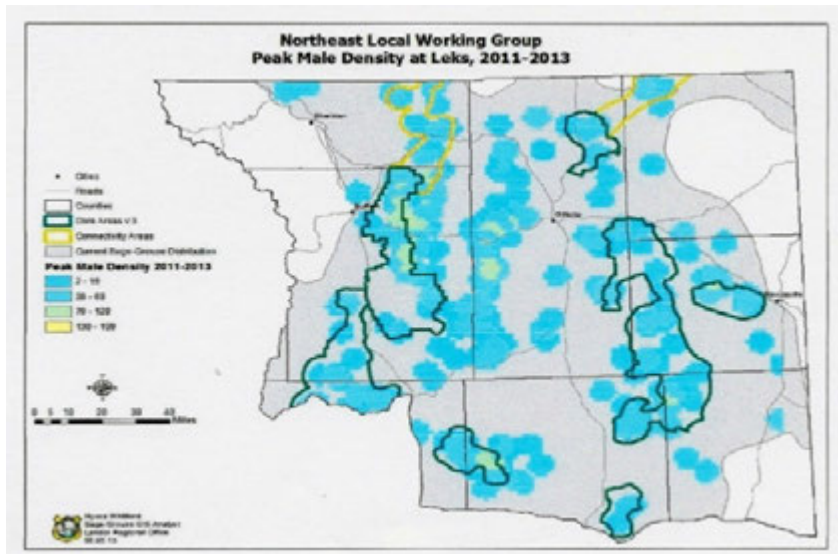


Fig. 217. Wyoming – Northeast Local Working Group – peak of male GrSG at leks, 2011-2013

Since 1995, northeast Wyoming has the lowest average peak male lek attendance in the state, averaging 9 males per active lek in 2013 compared to the statewide average of 17 males per active lek. Male lek attendance for the other working group areas averaged from 10 to 35 males per active lek. Most leks in northeast Wyoming are small with less than 20 males observed at the peak male count. In years when grouse are at the peak of their cycle, less than 10% of leks have greater than 50 males at peak count. In 2013 only one lek exceeded a peak male attendance of 50 males, the Kaufman Draw Lek with 53 males.

WY Sage Grouse Harvest and Hunting Seasons (NEWLWG 2006)

From 1937 to 1947 the hunting seasons in WY were closed because of concern over low populations of sage-grouse. Since 1948 GrSG have since been hunted annually under regulation of the WGFD. Sage-grouse hunting provides recreational, cultural and economic values plus the biological data from the harvested birds provide via harvest surveys and wing collections serve as important indicators of population status and trend.

Sage Grouse Seasons

Sage-grouse hunting seasons within the Northeast Wyoming Sage-Grouse Working Group Area are managed concurrently with other open areas in the state. Prior to 1995, the statewide hunting season opened September 1 and closed September 30. Concerns with decreasing sage-grouse populations and the impact of hunting adult hens in early September initiated changes to more conservative hunting seasons. Beginning in 1995, the opening date was moved to the third Saturday in September with hunting seasons lasting 14 – 17 days. Bag and possession limits were 3 birds per day and 6 birds in possession. More conservative hunting seasons were enacted in 2002 when the opening day was moved to the fourth Saturday in September and the closing date to the first Sunday in October resulting in a 9 day season. The bag and possession limits were reduced to 2 and 4 birds, respectively. A Wyoming Game and Fish Commission

Emergency Order was approved in 2003 to close the hunting season in Sheridan, Johnson and Campbell Counties due to documented loss of sage-grouse to West Nile virus. This area included portions of Management Areas 35 – 38 and 40 – 41. The hunting season was resumed in this area for 2004 because increased monitoring of radio collared birds indicated that West Nile virus, while still present, had not caused a statistically significant population decline.

Harvest

Over the past 15 years, sage-grouse harvest for the Northeast Wyoming Sage-grouse Working Group area has ranged from a high of 2,515 birds in 2000 to a low of 104 birds in 2003 when Sheridan, Johnson and Campbell Counties were closed to hunting. Only 120 birds were harvested in 2002 when more conservative season dates and bag/possession limits were enacted. Hunter numbers have generally mirrored harvest, with more hunters going afield when populations are high. Such was the case in 1999 and 2000 when more than 2,500 birds were harvested annually.

The sage-grouse population in northeast Wyoming greatly exceeds the recommended minimum population size of 300 birds to allow recreational hunting (Connelly et al. 2000). Continued monitoring of lek attendance and harvest provides indicators of population status and trend. Hunting season data (harvest, hunter numbers, and hunter effort) provide indications of fall sage-grouse population status and sage-grouse wings collected from hunter-harvested grouse have been used to test for exposure to West Nile virus.

WY Conservation Strategies

Core Area Strategy

In July 2007 Wyoming Governor Freudenthal convened a sage-grouse summit and created an implementation team to develop a conservation strategy to manage sage-grouse to prevent listing under the Endangered Species Act and retain State authority in management decisions. The Wyoming Core Population Area strategy was developed by the Wyoming Governor's Sage-grouse Implementation Team. The strategy identified the most important sage-grouse habitat in Wyoming using a lek density map which showed areas of the state which supported the highest densities of breeding activity from 2005 thru 2007. The initial mapping effort identified areas of "core" habitat which supported 80% of the state's breeding sage-grouse. This area amounted to approximately 15 million acres or about 24% of the state. In northeast Wyoming, concessions were made to account for areas that were already leased for energy development in the Powder River Basin as the coalbed natural gas (CBNG) play was in full development. This eliminated significant areas of key habitat from inclusion into core area protection. A number of northeast Wyoming core area boundaries were subsequently revised, most notably the East Buffalo Core Area, to follow legal boundaries which accounted for oil and gas leases as identified by BLM "focus areas". Focus areas were BLM's version of core habitat.

The Governor issued Executive Order 2008-2 in August 2008 outlining the core area strategy with 21 recommendations that conserve Wyoming's most important sage-grouse habitats while allowing for natural resource development outside core areas. Statewide, core areas accounted for approximately 34% of the current sage-grouse range while including leks where 81% of males were counted during peak periods of attendance in 2008. However, within a three county area of the Powder River Basin (Campbell, Johnson and Sheridan Counties), core areas were designated based on CBNG development patterns along with lek density data thereby encompassing leks where only 28% of males were counted during peak periods of attendance in 2008.

Following the March 2010 listing decision of "warranted, but precluded" by the U.S. Fish and Wildlife Service, Governor Freudenthal asked the Sage-grouse Implementation Team to revisit Wyoming's sage-grouse management strategy. The group's three tasks were:

- 1) Review core area boundaries,
- 2) Review development guidelines inside and outside core habitats, and
- 3) Identify connectivity areas to ensure movement corridors between populations to preserve genetic integrity.

At the direction of the Sage-grouse Implementation Team, the eight local working groups held meetings to review core area boundaries and make adjustments based on existing and planned development, unsuitable habitat and connectivity between core areas. In addition, the Northeast Wyoming Local Working Group (NEWLWG) identified two areas of connectivity habitat which link Wyoming core areas and core habitat in Montana based on large leks in close proximity to other large leks. The NEWLWG also developed recommendations for managing connectivity habitat. The NEWLWG provided recommendations to the Sage-grouse Implementation Team on core area boundary revisions, connectivity area designation and connectivity corridor development recommendations.

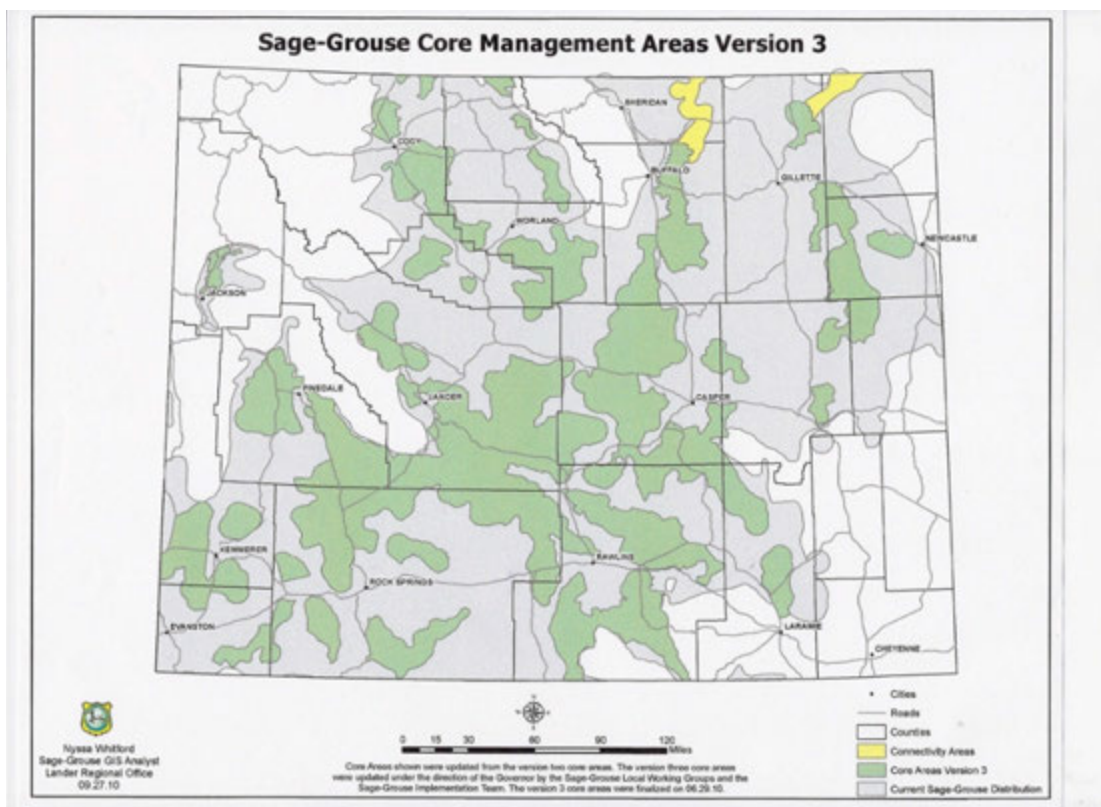


Fig. 218. Map of Wyoming Core Areas and Connectivity Areas (version 3).

The Northeast Wyoming working group area encompasses 23,024 square miles of which 3,281 square miles are in core areas which amounts to 14.3% of the LWG area. In 2013 there were 417 occupied leks in the LWG area of which 157 are located in core areas with an additional 25 occupied leks in areas of connectivity. Therefore, 38% of occupied leks occur in core habitat and 44% of occupied leks occur in core and connectivity habitat. Using 2011-2013 peak male lek attendance to calculate peak male density resulted in a total of 2,913 males in the LWG area. Fifty-one percent of those were in core areas (1,470 males) whereas 58% were in core and connectivity combined (1,470 and 208 males in core and connectivity, respectively). These figures are adjusted for 17 leks for which a portion of their 6/10 mile buffer falls outside of the core area boundary. For these leks only 50% of their peak male count was used in the calculations.

Subsequent to the 2010 Wyoming gubernatorial election, Governor Mead signed a 2011 version of the Executive Order that reiterated and clarified the Wyoming Core Area Strategy. In June 2011, the U.S. Fish and Wildlife Service wrote in a letter to Governor Mead, "In summary, the Service believes the greater Sage-grouse Core Area Protection provides an excellent model for meaningful conservation of sage-grouse if fully supported and implemented. We believe that when fully realized, this effort could ameliorate many threats to the Greater sage-grouse in Wyoming." On April 5, 2013, Governor Mead issued Executive Order 2013-3, *Greater Sage-grouse Core Area – Grazing Adjustments*, which addressed livestock grazing and sage-grouse as well as coordination between the state and federal agencies in managing Wyoming's federal rangelands.

Wyoming's core area policy focuses sage-grouse management on maintenance and enhancement of habitat, populations and connectivity areas identified in Executive Order 2011-5. Although extensive monitoring of populations continues through lek monitoring, brood surveys and hunter harvest wing barrels, obtaining accurate population estimates remains difficult. Monitoring population trends through male lek attendance remains the best option to track population trends. The option to establish population objectives at the statewide and local working group scales should be considered when information to make reliable estimates exists.

The Sage-grouse Implementation Team continues to be active in implementing Wyoming's core area policy. The NEWLWG will continue to coordinate and assist the Sage-grouse Implementation Team when requested.

National Conservation Objectives Team (COT) Report 2013

In December 2011, Wyoming Governor Matt Mead and Secretary of the Interior Ken Salazar co-hosted a meeting to address coordinated conservation of the Greater sage-grouse (sage-grouse) across its range. Ten states within the range of the sage-grouse were represented, as were the U.S. Forest Service (FS), the Natural Resources Conservation Service (NRCS), and the Department of the Interior (DOI) which oversees the Bureau of Land Management (BLM) and U.S. Fish and Wildlife Service (USFWS). The primary outcome of the meeting was the creation of a **Sage-Grouse Task Force (Task Force)** chaired by Governors Mead (WY) and Hickenlooper (CO) and acting Director of the BLM Mike Pool. The Task Force was directed to develop recommendations on how to best move forward with a coordinated, multi-state, range-wide effort to conserve the sage-grouse, including the identification of conservation objectives to ensure the long-term viability of the species. Recognizing that state wildlife agencies have management expertise and retain management authority for this species; the USFWS created a **Conservation Objectives Team (COT)** of state and USFWS representatives to accomplish this task. Each member was selected by his or her state or agency. Bob Budd was the Wyoming representative to the COT and Rick Northrup is the representative from Montana. The purpose of the COT was to develop conservation objectives by defining the degree to which the threats need to be reduced or ameliorated to conserve the sage-grouse so that it is no longer in danger of extinction or likely to become in danger of extinction.

In summary, the report prepared by the COT (U.S. Fish and Wildlife Service 2013) listed energy development, infrastructure, improper livestock and/or wildlife grazing practices, weeds and annual grasses, mining and recreation as broad scale threats to sage-grouse in the Powder River Basin portions (NELWG area plus a small section of Montana) of the Great Plains Management Zone with localized threats being sagebrush elimination, fire, conifer encroachment, and urbanization. The report estimated a 16.5% probability of the subpopulation of breeding birds being below 500 by 2037 and an 86.2% probability of the subpopulation of breeding birds declining below 500 by 2107. This relatively high probability of continued population declines is a concern and this Conservation Plan as updated in 2013, and the Wyoming Core Area Strategy (described below) have implemented management actions and projects designed to address the issues.

The General Conservation Objectives identified by the COT are:

1. Stop population declines and habitat loss.
2. Implement targeted habitat management and restoration.
3. Develop and implement state and federal sage-grouse conservation strategies and associated incentive-based conservation actions and regulatory mechanisms.
4. Develop and implement proactive, voluntary conservation actions.
5. Develop and implement monitoring plans to track the success of state and federal conservation strategies and voluntary conservation actions.
6. Prioritize, fund and implement research to address existing uncertainties.

Additionally the report identified many Specific Conservation Objectives relative to identifying “Priority Areas for Conservation” (synonymous with Wyoming “Core Areas”) as well as threat reduction objectives and conservation measures to accomplish those reductions. The Northeast LWG has sought to make this conservation plan revision consistent with these general and specific objectives.

SECTION VII

SUMMARY

Throughout this report we have demonstrated the vulnerability of deer, pronghorn and greater sage-grouse populations and to a lesser extent elk to stochastic events such as severe winters and drought. As human development causes additional impacts to wildlife habitat these populations are forced to exist on less habitat or lower quality habitat than they have existed on in the past.

Analysis of data for 27 big game herd units or hunting districts was completed for this project, 8 mule deer, 7 elk and 12 pronghorn. In addition, a review of information and data was completed for 2 greater sage-grouse management areas, one each in Montana and Wyoming.

For big game we used information from the literature and our professional experience and opinions to evaluate the status of the big game herds (Bender 2006, Caughley 1977 and Unsworth 1999).

Criteria that we evaluated for each herd unit (Wyoming) and hunting district (Montana) included the following:

- 2012 values for young/100 female ratios and a comparison to the long-term average for young /100 female ratios.
- Long-term trend for young/100 female ratios.
- 2012 values for male harvest and a comparison to the long-term average for male harvest.
- Long-term trend for male harvest.
- 2012 values for total hunters and a comparison to the long-term average for total hunters.
- Long term trend for total hunters.
- To a lesser extent, estimates for population size were also assessed and were compared to established population objectives for each herd, when available.

Of the big game species addressed in this analysis, mule deer and pronghorn appear to be the most vulnerable. Deer and pronghorn populations analyzed during the 32 year interval covered in this report have either shown declines in population size or productivity or both. Such declines have direct impacts on hunters and hunting opportunity in the form of lower hunter success rates, decreased harvest, decreases in trophy quality of animals harvested and more conservative hunting seasons. We have significant concerns that losses of habitat due to development will result in further reductions in populations and productivity of the deer and pronghorn herds in question, resulting in increasingly conservative hunting seasons and lower numbers of available licenses.

We believe that elk are not as vulnerable as mule deer and pronghorn to habitat loss or degradation due to development. This is most probably due to their broader food habits and adaptability (Hanley and Hanley 1982 and Thompson and Henderson 1998). However, a likely result of development on public lands will be displacement of elk from seasonal ranges or shifts in periods of use of these seasonal ranges. Displacement of animals will likely result in increased use of private lands by elk resulting in increasing levels of conflict. Increased conflicts often results in increases in game damage or more demands for reductions in elk populations by private land owners which will, in the long run, mean less hunting opportunity.

Mule Deer

Eight mule deer herds were examined in this analysis, 3 in Montana and 5 in Wyoming. From information based on the long term average for young/100 female ratios, 3 herds had ratios that are indicative of an increasing deer herd. The remaining 5 herds had ratios that were indicative of a stable population (no growth or loss). However, 2012 young /100 female ratios indicated a

slightly different situation with 4 herds with ratios that were indicative of a growing herd, 2 that were stable and 2 that were decreasing). The long-term trends for young/100 female ratios indicates 2 herds had increasing ratios while 6 had decreasing ratios.

Young /100 female ratios (recruitment rates) provide information about the general condition of the various mule deer herds. When combined with estimates for survival for young and adults they can provide an explicit estimate of rate of increase or decrease for big game herds (Unsworth et al. 1999), but survival rate information wasn't available for any of the mule deer herds in this analysis. Without survival rate information only general observations can be made about the impact of recruitment rates on big game herd performance. Ratios of 70 or more young/100 females likely indicates that deer herds are increasing. Recruitment rates of around 60 young/100 females indicates that populations are likely stable, displaying little or no growth. Mule deer populations with recruitment rates of less than 60 young/100 females likely indicates that populations are declining.

In the analysis of harvest, harvest estimates for 2012 were lower than the long-term average for male harvest for all herds. In comparing 2012 male harvest of these herds to their respective long-term averages for harvest, the best herd was at 81% of the long-term average while the worst herd was at 58% of the long-term average. In addition, the long-term trend for male harvest is decreasing in all herds.

Numbers of hunters for 2012 are lower than the long-term average for hunters for all of the deer herds. The herd displaying the smallest decrease in numbers of hunters is at 96% of the long-term average for hunters while the herd with the worst scenario only supports 52% of the long-term average for numbers of hunters. In addition, 7 of the 8 herds evaluated showed declining long-term trends for numbers of hunters.

Analysis of population size for the 8 deer herds isn't totally comparable because Montana doesn't establish long-term population objectives for their deer herds. In addition, Montana doesn't use unit wide census methods or modeling to provide annual estimates of population size for the deer herds in question. Instead, they conduct surveys of trend count areas that produce a density estimate for the trend count area that is extrapolated to the entire hunting district to produce a population estimate.

For Wyoming, 2012 estimates for population size were all lower than the long-term average. In addition, the 2012 estimates for population size were all lower than the established long-term population objectives for each herd unit.

With the preceding caveats in mind, the long-term trends for population size for the 8 deer herds in the analysis indicated 5 herds were increasing, 2 herds were stable and 1 decreasing. This can be somewhat misleading, especially if estimates for population size were substantially smaller in the 1980s and 1990s. Also, the long-term trend covers a period of up to 32 years in this analysis and may not be sensitive to short-term trends for the last 5 to 10 years.

Of the 8 herds evaluated only 1 was judged to be in good condition, Wyoming herd unit 751 (Black Hills). Five herds were judged to be in fair condition; Montana hunting districts 702 (Yellowstone Pine Hills), 704 (Powder Pine Hills) and Montana hunting district 705 (Prairie Pine-Juniper Breaks) and Wyoming herd units 319 and 755. Wyoming herd units 320 (Pumpkin Buttes) and 740 (Cheyenne River) were judged to be in poor condition. Three herds had additional problems or issues. Wyoming deer herd units 319 (Powder River), 320 (Pumpkin Buttes) and 740 Cheyenne River) had short-term trends of 3-5 years of recent declines in population size along with long-term declines for recruitment (young/100 females). These populations are especially vulnerable to additional habitat loss or degradation. If habitat loss or degradation occurs within these 3 herd units, increases in population size are unlikely or will be very slow to occur.

Table 4. Summary of mule deer population data and trends

Unit	Pop. Obj.	2012 Pop. Size	Avg. Pop. Size	Pop. Trend	2012 Yng./100 Fem.	Avg. Yng./100 Fem.	Yng./100 Fem. Trend	2012 Male Harvest	Avg. Male Harvest	Male Harvest Trend	2012 Total Hunters	Ave. Total Hunters	Total Hunter Trend	Herd Rating
M-MD-702	NA	105	153	D	84	68	I	877	1,083	D	2,416*	2,656	D	F
M-MD-704	NA	538	524	S	63	69	D	1,574	2,238	D	4,695*	4,841	I	F
M-MD-705	NA	492	447	I	56	66	D	1,553	1,937	D	4,141*	5,008	D	F
W-MD-319	52,000	36,300	45,490	I	75	68	D	2,036	3,191	D	3,602	5,826	D	F
W-MD-320	13,000	9,600	11,117	S	64	69	D	633	729	D	1,046	1,467	D	P
W-MD-740	38,000	17,367	29,150	I	44	74	D	1,255	2,339	D	2,511	4,719	D	P
W-MD-751	20,000	19,505	20,040	I	76	74	I	1,253	1,917	D	3,569	5,845	D	G
W-MD-755	9,100	6,004	8,294	I	75	75	D	332	568	D	550	1,057	D	F
Unit explanation - M-MD-702 = Montana mule deer hunting district 702														
W-MD-319 = Wyoming mule deer, herd unit 319														
Trend: I - increasing, S - stable, D - decreasing														
Herd Rating: G - good, F - fair, P - poor														
NA - not applicable														
ND - no data														
* 2011 data														
Population estimates are for a Montana trend count area that is smaller in size than														
a hunting district														

Elk

Seven elk herds were examined in this analysis, 3 in Montana and 4 in Wyoming. From information based on the long-term average for young/100 females, the 3 herds that had recruitment information available had rates that are indicative of increasing elk herds. The 2012 young/100 female ratios indicated a similar if not better situation as ratios for 2012 were higher than the long-term average ratios. Information from long-term trends for young/100 female ratios indicates 2 herds had increasing ratios and 1 has decreasing ratios (limited data).

In the analysis of harvest data, harvest estimates for 2012 were higher than the long-term average for male harvest in 6 of the 7 herds. In addition, the long-term trend for male harvest is increasing for all herds.

Numbers of hunters for 2012 are greater than the long-term average for hunters for all of the elk herds. In addition all of the herds evaluated exhibited increasing long-term trends for hunters.

Five of the 7 elk herds didn't receive a rating due to incomplete data. Readers that are interested in these hunting districts or herd units should refer to the detailed evaluations for each of them in the body of the report and tables for each herd unit in the appendix. Both Wyoming elk herd unit 320 (Fortification) and elk herd unit 344 (New Rochelle) were rated in the good category. The situation for elk seems to be almost exactly opposite of what is occurring for mule deer and pronghorn. However, there is significant concern that additional habitat loss or degradation due to development, prolonged drought or severe winters may displace elk populations, causing increased game damage problems on private lands. Such issues will likely result in demands for further reduction in long term population objectives for elk. If long-term population objectives for elk are reduced, it will eventually result in further decreases in harvest and hunter opportunity.

Table 5. Summary of 2012 elk population data and trends

Unit	Pop. Obj.	2012 Pop. Size	Avg. Pop. Size	Pop. Trend	2012 Yng./100 Fem.	Avg. Yng./100 Fem.	Yng./100 Fem. Trend	2012 Male Harvest	Avg. Male Harvest	Male Harvest Trend	2012 Total Hunters	Avg. Total Hunters	Total Hunters Trend	Herd Rating
M-E-702	NA	ND	NA	ND	71	NA	NA	23	14	I	523	277	I	NA
M-E-704	NA	1,070	NA	ND	44	43	D	54	33	I	719	656	I	NA
M-E-705	NA	ND	NA	NA	53	NA	NA	26	17	I	277	212	I	NA
W-E-320	150	500	244	I	77	48	I	13	16	I	80	71	I	G
W-E-344	NA	741*	368	I	60	45	I	22	16	I	164	73	I	G
W-E-740	500	ND	NA	I	ND	NA	NA	171	97	I	1,416	586	I	NA
W-E-743	NA	ND	NA	NA	NA	NA	NA	20	14	I	71	52	I	NA
Unit explanation - M-E-702 = Montana elk hunting district 702														
W-E-320 = Wyoming elk herd unit 320														
Trend: I - increasing, S - stable, D - decreasing														
Herd Rating: G - good, F - fair, P - poor														
NA - not applicable														
ND - no data														
* 2011 data														

Pronghorn

Twelve pronghorn herds were examined in this analysis, 3 in Montana and 9 in Wyoming, however 1 herd in Montana wasn't rated due to lack of data. From information based on the long term average for young/100 female ratios, 8 herds had ratios that are indicative of an increasing herd, 2 herds had ratios indicative of a stable herd and 1 had ratios indicative of a declining herd. Recruitment rates for 2012 exhibited a slightly different situation with 6 herds in the increasing category, 3 in the stable category and 2 decreasing. Long-term trends for recruitment showed all herds had declining ratios (please refer to the comments on young/adult ratios [recruitment rates] in the section on mule deer on page 197 for more information).

For the analysis of harvest, estimates for 2012 showed 7 herds were below the long-term average for harvest and the remainder, 5, were greater than the long-term average. In comparing 2012 male harvest of these herds to their respective long-term averages for harvest, the best herd was 151% of the average while the worst herd was 30% of the long-term average. In addition the long-term trend for harvest is decreasing for 8 herds, stable for 1 herd and increasing for 3.

Hunter numbers for 2012 are lower than the long-term average for hunters for 6 of the 12 herds. Again, hunter numbers for 2012 ranged from a low of 26% of the hunters to a high of 180% of the average number of hunters. Eight of the 12 herds show a long-term decline in the number of hunters while 3 herds have stable numbers of hunters and 1 herd shows numbers of hunters are increasing.

Again, analysis of population size for the 12 pronghorn herds isn't totally comparable because Montana doesn't establish long-term population objectives for their pronghorn herds. Also, Montana doesn't use models nor does it attempt to census all of their hunting districts in order to determine the total number of animals in the respective hunting districts. Instead they use a trend

count technique that provides a density estimate for a relatively small area that is then projected to all suitable pronghorn habitat in the hunting district. With the above mentioned issues in mind, the long-term trends for population size for the 12 pronghorn herds indicate 10 are increasing, 1 is stable and 1 is decreasing. For Wyoming, which sets long-term population objectives and uses computer modeling to assess their pronghorn populations, 2012 estimates of population size were less than the long-term average for 5 herds and 4 were greater than the long-term average.

Of the twelve pronghorn herds evaluated in the analysis, only 1 of the herds didn't receive a rating due to incomplete data, Montana hunting district 702 (Yellowstone Pine Hills). Three pronghorn herds received a good rating; Wyoming herd units 309 (Pumpkin Buttes), 318 (Crazy Woman) and 353 (Ucross). Seven units received a fair rating; Montana hunting district 705 (Prairie Pines-Juniper Breaks), Wyoming herd units 308 (Clearmont), 316 (Highlight), 339 (North Black Hills), 351 (Gillette), 740 (Cheyenne River) and 748 (North Converse). One unit received a poor rating, Montana hunting district 704 (Powder Pine Hills). In addition, Wyoming pronghorn herd units 740 (Cheyenne River) and 748 (North Converse) have short-term trends of 2-3 years of recent declines in population size along with long-term declines of productivity (young/100 female ratios) that make these herds especially vulnerable to loss of habitat. If habitat loss or degradation occurs with these 2 herd units, increases in population size are going to be very slow or unlikely.

Table 6. Summary of 2012 pronghorn population data and trends

Unit	Pop. Obj.	2012 Pop. Size	Avg. Pop. Size	Pop. Trend	2012 Yng./100 Fem.	Avg. Yng./100 Fem.	Yng./100 Fem. Trend	2012 Male Harvest	Avg. Male Harvest	Male Harvest Trend	2012 Total Hunters	Avg. Total Hunters	Total Hunters Trend	Herd Rating
M-PH-702	NA	2,097	2,932	D	ND	NA	I	98	244	I	198	518	S	NA
M-PH-704	NA	1,079	936	I	35	29	D	190	623	D	328	1,234	D	P
M-PH-705	NA	604*	1,211	I	86	93	D	315	1,081	D	550	2,119	D	F
W-PH-308	3,000	4,300	4,500	I	65	66	D	244	354	D	512	588	D	F
W-PH-309	18,000	35,500	22,670	I	71	83	D	1,479	1,361	D	2,699	2,105	S	G
W-PH-316	11,000	10,000	11,527	S	47	77	D	528	532	D	1,076	963	D	F
W-PH-318	7,000	12,100	8,842	I	82	84	D	1,086	719	D	1,968	1,094	D	G
W-PH-339	14,000	12,500	13,746	I	82	83	D	415	971	D	657	1,516	D	F
W-PH-351	11,000	10,300	12,509	I	70	65	D	794	709	I	979	1,028	I	F
W-PH-353	2,500	7,400	4,833	I	84	74	D	459	308	I	802	488	S	G
W-PH-740	38,000	31,065	31,140	I	63	78	D	2,512	2,667	S	4,826	4,492	D	F
W-PH-748	28,000	20,432	27,150	I	66	83	D	1,759	1,944	D	3,822	3,072	D	F
Unit explanation - M-PH-702 = Montana pronghorn hunting district 702														
W-PH-308 = Wyoming pronghorn herd unit 308														
Trend: I - increasing, S - stable, D - decreasing														
Herd Ratings: G - good, F - fair, P - poor														
NA - not applicable														
ND - no data														
Population estimates are for a Montana trend count area that is smaller in size than a hunting district														

Greater sage-grouse

Northern sage-grouse populations have experienced periodic fluctuations in southeastern Montana and northeastern Wyoming over the years. Trends for the average number of males per lek and the trend of the percentage of occupied leks versus unoccupied leks seem to be the best indicators of sage grouse abundance.

Lek data for the core area of southeastern Montana indicates that the sage-grouse populations in the area have not exhibited a long term decline and the peak population actually occurred in the mid-2000s. This was followed by a decline that was probably a result of West Nile virus (Foster et al ND). However, pre-1980 historic lek data is not available for the core area. As a result, a claim that 2002 was the peak for northern sage-grouse populations in the core area needs to be considered cautiously.

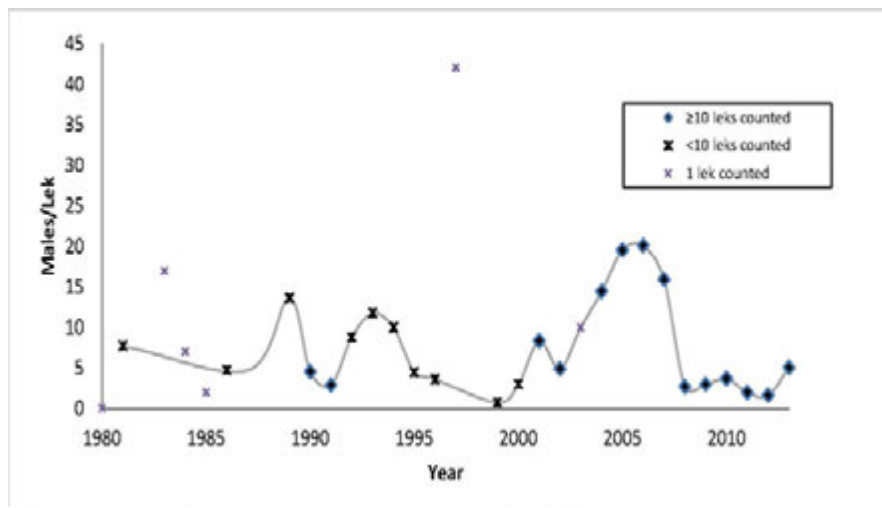


Fig. 219. Average number of GrSG males per lek in Carter County, MT 1980-2013. (Foster et al ND)

Trends for sage-grouse populations in northeastern Wyoming appear to be substantially different. Since 2006, sage-grouse numbers have declined significantly. The current decreasing trend could be a combination of the cyclic nature of sage-grouse populations combined with documented influences from fire, land conversion, West Nile virus and energy development in the Powder River Basin. The last peak occurred in 2006 and 2007 (> 30 males per lek) which actually exceeded the previous peak which occurred in 2000. The highest level was over 50 males per lek in 1979.

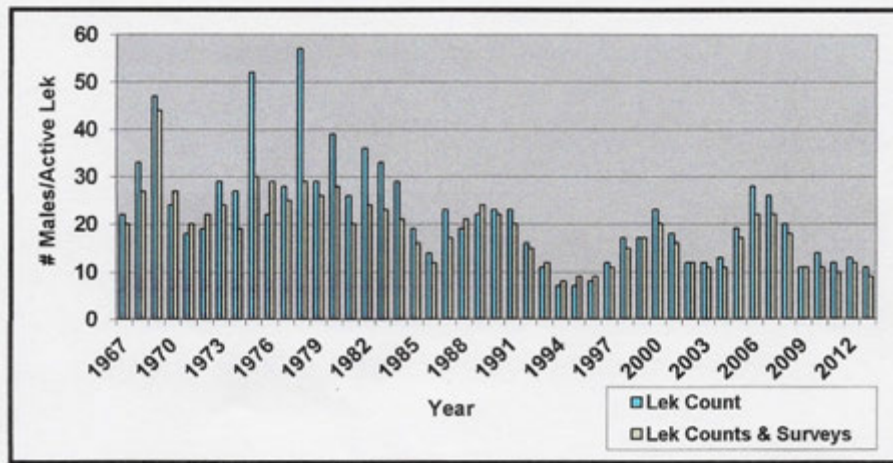


Fig. 220. Wyoming - Average number of male GrSG per active lek in the NEWLWG area from 1967-2012.

Hunting and Harvest

Sage-grouse hunting seasons in both states have become more conservative with shorter seasons and smaller bag and possession limits as populations have fluctuated.

Hunting regulations in Montana have changed a few times since 1990. In 1994 the bag limit on sage grouse changed from 4 to 3 per day and the possession limit changed from 16 to 12. In 1996, the bag limit changed again to 2 sage grouse per day with a possession limit of 6. The bag limit increased to 3 sage grouse per day in 2000, but the possession limit stayed at 6. In 2005, the bag limit changed from 3 to 2 sage grouse per day and the possession limit decreased from 6 to 4. The hunting season length on sage grouse also decreased during this time. From 1990-95 the season dates were Sep.1-Dec.15, and then in 1996 the season was shortened to Sep. 1-Nov.1, which is the current hunting season structure. Harvest information indicates a declining sage grouse harvest from approximately 1,000 in 2003 to 386 in 2009. Sage grouse hunter days were sporadic ranging from approximately 850 to 1,400 hunter days annually from 2007-09. Current hunter days are similar to sage grouse hunter days from 2004-06 which ranged from approximately 900 to 1,300 hunter days annually (Beyer et al 2010).

Sage-grouse hunting seasons within the Northeast Wyoming Sage-Grouse Working Group Area are managed concurrently with other open areas in the state. Prior to 1995, the statewide hunting season opened September 1 and closed September 30. Concerns with decreasing sage-grouse populations and the impact of hunting adult hens in early September initiated changes to more conservative hunting seasons. Beginning in 1995, the opening date was moved to the third Saturday in September with hunting seasons lasting 14 – 17 days. Bag and possession limits were 3 birds per day and 6 birds in possession. More conservative hunting seasons were enacted in 2002 when the opening day was moved to the fourth Saturday in September and the closing date to the first Sunday in October resulting in a 9 day season. The bag and possession limits were reduced to 2 and 4 birds, respectively. A Wyoming Game and Fish Commission Emergency Order was approved in 2003 to close the hunting season in Sheridan, Johnson and Campbell Counties due to documented loss of sage-grouse to West Nile virus. This area included portions of Management Areas 35 – 38 and 40 – 41. The hunting season was resumed in this area for 2004 because increased monitoring of radio collared birds indicated that West Nile virus, while still present, had not caused a statistically significant population decline.

Over the last ten years, sage-grouse harvest for the Northeast Wyoming Sage-grouse Working Group area has ranged from a high of 2,515 birds in 2000 to a low of 104 birds in 2003 when

Sheridan, Johnson and Campbell Counties were closed to hunting. Only 120 birds were harvested in 2002 when more conservative season dates and bag/possession limits were enacted. Hunter numbers have generally reflected harvest, with more hunters going afield when populations are high. Such was the case in 1999 and 2000 when more than 2,500 birds were harvested annually.

Conservation Strategies

Wyoming and Montana have both implemented core area strategies in an attempt to better protect sage-grouse and their habitat. In July 2007 Wyoming Governor Freudenthal convened a sage-grouse summit and created an implementation team to develop a conservation strategy to manage sage-grouse to prevent listing under the Endangered Species Act and retain State authority in management decisions. The strategy identified the most important sage-grouse habitat in Wyoming using a lek density map which showed areas of the state which supported the highest densities of breeding activity from 2005 thru 2007. The initial mapping effort identified areas of "core" habitat which supported 80% of the state's breeding sage-grouse. This area amounted to approximately 15 million acres or about 24% of the state. However, in northeast Wyoming, concessions were made to account for areas that were already leased for energy development in the Powder River Basin as the coalbed natural gas (CBNG) play was in full development. This eliminated significant areas of key habitat from inclusion into core area protection.

The Governor issued Executive Order 2008-2 in August 2008 outlining the core area strategy with 21 recommendations that conserve Wyoming's most important sage-grouse habitats while allowing for natural resource development outside core areas. Statewide, core areas accounted for approximately 34% of the current sage-grouse range while including leks where 81% of males were counted during peak periods of attendance in 2008. However, within a three county area of the Powder River Basin (Campbell, Johnson and Sheridan Counties), core areas were designated based on CBNG development patterns along with lek density data thereby encompassing leks where only 28% of males were counted during peak periods of attendance in 2008.

Subsequent to the 2010 Wyoming gubernatorial election, Governor Mead signed a 2011 version of the Executive Order that reiterated and clarified the Wyoming Core Area Strategy. In June 2011, the U.S. Fish and Wildlife Service wrote in a letter to Governor Mead, "In summary, the Service believes the greater Sage-grouse Core Area Protection provides an excellent model for meaningful conservation of sage-grouse if fully supported and implemented. We believe that when fully realized, this effort could ameliorate many threats to the Greater sage-grouse in Wyoming." On April 5, 2013, Governor Mead issued Executive Order 2013-3, *Greater Sage-grouse Core Area – Grazing Adjustments*, which addressed livestock grazing and sage-grouse as well as coordination between the state and federal agencies in managing Wyoming's federal rangelands.

In December 2011, Wyoming Governor Matt Mead and Secretary of the Interior Ken Salazar co-hosted a meeting to address coordinated conservation of the Greater sage-grouse (sage-grouse) across its range. The primary outcome of the meeting was the creation of a **Sage-Grouse Task Force (Task Force)** chaired by Governors Mead (WY) and Hickenlooper (CO) and acting Director of the BLM Mike Pool. The Task Force was directed to develop recommendations on how to best move forward with a coordinated, multi-state, range-wide effort to conserve the sage-grouse, including the identification of conservation objectives to ensure the long-term viability of the species. Recognizing that state wildlife agencies have management expertise and retain management authority for this species; the USFWS created a **Conservation Objectives Team (COT)** of state and USFWS representatives to accomplish this task. The purpose of the **COT** was to develop conservation objectives by defining the degree to which the threats need to be reduced or ameliorated to conserve the sage-grouse so that it is no longer in danger of extinction or likely to become in danger of extinction.

Montana has followed Wyoming's lead in developing a sage grouse conservation program based upon the core area principles. The program was initiated on Sept. 9, 2014 when Gov. Steve Bullock signed Montana Executive Order Number 10-2014. Montana has the second largest GSG population among the western states. Their plan closely mirrors the Wyoming executive order and plan. As stated earlier, the USFWS has already given their blessing to this type of strategy. Montana plan differs from Wyoming's by the method of oversight.

The Montana Program will give priority to the maintenance and enhancement of sage grouse habitats in the Core Population and Connectivity Areas. The Program also states that the Core Population Areas (Core Areas) should not be altered for at least 5 years and incentives shall be developed to encourage new land uses and activities in the general habitat areas to occur in a manner that minimizes impacts to sage grouse populations and habitats. The Program has a role of consultation, recommendation, and facilitation, and has no authority to either approve or deny projects.

In addition, new land uses or activities in core areas shall be avoided when possible while existing land uses and activities shall be recognized and respected by state agencies, and those existing prior to the effective date of the Program will not be managed under the stipulations of this Conservation Strategy. Examples of existing activities include oil and gas production, mining, agriculture, processing facilities, power lines, housing, operations and maintenance.

While the "Core Area Strategy" concept is a step in the right direction and should provide additional protection for sage-grouse habitat in the future for both states, a report issued by the Conservation Objectives Team (**COT**), a part of the Sage Grouse Task Force mentioned above, paints a bleak picture for the future of sage-grouse in northeastern Wyoming and to lesser extent, southeastern Montana. In summary, the report prepared by the **COT** (U.S. Fish and Wildlife Service 2013) listed energy development, infrastructure, improper livestock and/or wildlife grazing practices, weeds and annual grasses, mining and recreation as broad scale threats to sage-grouse in the Powder River Basin portions (NEWLWG area plus a small section of Montana) of the Great Plains Management Zone with localized threats being sagebrush elimination, fire, conifer encroachment, and urbanization. **The report estimated a 16.5% probability of the subpopulation of breeding birds being below 500 by 2037 and an 86.2% probability of the subpopulation of breeding birds declining below 500 by 2107.**

WMCA concurs with the USFWS about the value of the core area strategy conservation program to preserve and protect the remaining greater sage grouse. The states of Wyoming and Montana are to be commended for taking this important step and the authors encourage the remaining western states that have GRS to adopt similar programs to protect and preserve the remaining populations and habitats in their respective states.

Additional Reference Material for Greater Sage Grouse

Due to the decline in GrSG and the potential to have them listed under the Endangered Species Act, much effort has been directed toward the conservation and recovery effort for this species by the western states, the federal government and many individuals and NGOs. Range-wide, state and local working group conservation plans have been completed for many areas. These plans provide an abundance of data and information about this species. Many of the plans are readily available on the internet. People who are interested in learning more about these species can find these reports at the following websites:

Range-wide Conservation Strategy: <http://wildlife.state.co.us/NR/ronlyres/16844D7D-634D-4F0D-A3B6-7CB676CA099D/0/GreaterSagegrouseNationalConservationStrategy.pdf>

Wyoming Statewide and LWG plans: http://gf.state.wy.us/wildlife/wildlife_management/sagegrouse/index.asp

Wyoming NE Sage Grouse Plan:

http://wgfd.wyo.gov/web2011/Departments/Wildlife/pdfs/SG_NE_CONSERVPLAN0005525.pdf

20__ GSG WY Executive Order:

(http://wgfd.wyo.gov/web2011/Departments/Wildlife/pdfs/SAGEGROUSE_EO_COREPROTECTION0000651.pdf)

Conservation Objectives Team (COT) report:

<http://www.fws.gov/mountain-prairie/species/birds/sagegrouse/COT/COT-Report-with-Dear-Interested-Reader-Letter.pdf>.

MT Statewide GrSG Plan:

<http://fwp.mt.gov/fishAndWildlife/management/sageGrouse/>

MT SE Montana Local Working Group Plan:

<http://fwp.mt.gov/fishAndWildlife/management/sageGrouse/>

MT Core Habitat Executive Order:

http://governor.mt.gov/Portals/16/docs/2014EOs/EO_10_2014_SageGrouse.pdf

SECTION VIII

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APPENDIX

SECTION IX

Table 7. Mule deer harvest, sex and age ratio and population data - WY Herd Unit 319 (Powder River).

YEAR	HARVEST DATA					HUNTER DATA		AGE & SEX RATIO		POP Size Estimate
	Total Males	Total Females	Total Young	Total Antlerless	Total Harvest	Total Hunters	Hunter Suc.	Total M /100 F	Young /100 F	
1980	4,083	464	0	464	4,547	7,054	64.5%	19	87	27,609
1981	4,201	852	0	852	5,053	6,792	74.4%	27	101	29,224
1982	5,253	1,783	122	1,905	7,158	9,478	75.5%	24	89	42,194
1983	5,477	2,807	179	2,986	8,463	10,980	77.1%	26	93	42,340
1984	4,071	1,876	94	1,970	6,041	8,517	70.9%	28	77	27,910
1985	4,107	2,291	69	2,360	6,467	8,769	73.7%	24	55	37,361
1986	3,047	1,325	44	1,369	4,416	7,525	58.7%	21	43	27,262
1987	2,028	0	0	0	2,028	4,172	48.6%	19	83	38,326
1988	2,414	267	23	290	2,704	4,141	65.3%	24	70	46,602
1989	2,866	760	24	784	3,650	4,866	75.0%	34	68	51,477
1990	3,273	1,138	72	1,210	4,483	5,460	82.1%	32	84	58,061
1991	3,983	1,949	122	2,071	6,054	6,450	93.9%	42	71	66,513
1992	4,291	2,767	232	2,999	7,290	7,601	95.9%	37	64	65,482
1993	3,464	2,414	257	2,671	6,135	7,124	86.1%	28	54	40,357
1994	2,697	482	28	510	3,207	5,366	59.8%	31	62	44,569
1995	2,954	409	3	412	3,366	4,958	67.9%	29	77	48,587
1996	2,521	378	32	410	2,931	5,824	50.3%	36	64	52,635
1997	2,862	73	0	73	2,935	3,819	76.9%	34	45	40,711
1998	2,815	10	0	10	2,825	4,538	62.3%	32	65	47,904
1999	3,057	61	4	65	3,122	4,783	65.3%	27	66	47,761
2000	3,327	218	7	225	3,552	4,959	71.6%	27	57	51,081
2001	3,310	227	14	241	3,551	5,494	64.6%	32	43	43,560
2002	3,210	267	9	276	3,486	5,385	64.7%	29	47	47,242
2003	3,337	344	13	357	3,694	5,365	68.9%	28	69	51,401
2004	3,241	608	51	659	3,900	5,368	72.7%	34	56	51,678
2005	2,597	710	54	764	3,361	4,868	69.0%	32	76	54,495
2006	3,372	852	23	875	4,247	5,784	73.4%	43	65	52,716
2007	2,590	1,076	44	1,120	3,710	5,167	71.8%	39	65	49,560
2008	2,507	1,054	65	1,119	3,626	5,051	71.8%	40	69	52,396
2009	2,488	894	94	988	3,476	4,835	71.9%	39	55	50,450
2010	2,105	803	17	820	2,925	4,519	64.7%	34	62	40,196
2011	1,716	420	39	459	2,175	3,653	59.5%	34	73	38,210
2012	2,036	502	3	505	2,541	3,602	70.5%	41	75	35,300
Total	105,300	30,081	1,738	31,819	137,119	192,267				
Average	3,191	912	53	964	4,155	5,826	70.3%	31	68	45,490
1980's AVG	3,755	1,243	56	1,298	5,053	7,229	68.4%	25	77	37,031
1990's AVG	3,192	968	75	1,043	4,235	5,592	74.0%	33	65	51,258
2000's AVG	2,998	625	37	662	3,660	5,228	70.0%	34	60	50,458
2010's AVG	1,952	575	20	595	2,547	3,925	64.9%	36	70	37,902
Minimum	1,716	0	0	0	2,028	3,602	48.6%	19	43	27,262
Maximum	5,477	2,807	257	2,999	8,463	10,980	95.9%	43	101	66,513

Table 8. Mule deer harvest, sex and age ratio and population data - WY Herd Unit 320 (Pumpkin Buttes).

YEAR	HARVEST DATA					HUNTER DATA		AGE & SEX RATIO		POP Size Estimate
	Total Males	Total Females	Total Young	Total Antlerless	Total Harvest	Total Hunters	Hunter Suc.	Total M /100 F	Young /100 F	
1980	701	283	0	283	984	2,017	48.8%	22	86	11,319
1981	806	135	0	135	941	1,754	53.6%	18	76	11,854
1982	949	180	0	180	1,129	1,831	61.7%	23	75	15,723
1983	1,229	96	9	105	1,334	1,995	66.9%	25	85	11,905
1984	1,000	427	57	484	1,484	2,464	60.2%	25	69	9,800
1985	740	227	0	227	967	1,682	57.5%	22	74	15,710
1986	518	210	17	227	745	1,690	44.1%	23	64	7,419
1987	326	101	0	101	427	1,184	36.1%	27	104	6,713
1988	432	81	3	84	516	835	61.8%	34	77	8,166
1989	628	73	10	83	711	1,125	63.2%	28	78	8,157
1990	851	120	12	132	983	1,243	79.1%	34	83	10,972
1991	872	236	5	241	1,113	1,468	75.8%	37	79	12,965
1992	875	454	17	471	1,346	1,773	75.9%	36	68	12,370
1993	831	393	49	442	1,273	1,804	70.6%	28	56	9,194
1994	674	161	20	181	855	1,444	59.2%	32	62	10,054
1995	803	265	24	289	1,092	1,671	65.4%	23	69	9,224
1996	493	54	0	54	547	1,480	37.0%	34	72	10,819
1997	666	77	14	91	757	1,026	73.8%	28	60	10,662
1998	827	82	12	94	921	1,464	62.9%	39	75	10,393
1999	1,053	129	4	133	1,186	1,663	71.3%	32	68	12,455
2000	965	88	5	93	1,058	1,508	70.2%	37	52	12,938
2001	790	139	10	149	939	1,659	56.6%	37	36	12,669
2002	745	157	16	173	918	1,560	58.8%	30	44	12,052
2003	773	101	38	139	912	1,438	63.4%	28	75	14,282
2004	665	176	22	198	863	1,294	66.7%	29	53	10,557
2005	656	245	42	287	943	1,367	69.0%	35	80	10,350
2006	684	295	4	299	983	1,408	69.8%	45	66	12,350
2007	613	220	14	234	847	1,209	70.1%	45	60	10,850
2008	609	259	27	286	895	1,162	77.0%	51	72	12,850
2009	613	188	17	205	818	1,162	70.4%	53	61	12,108
2010	486	109	10	119	605	975	62.1%	41	72	10,782
2011	546	63	4	67	613	1,009	60.8%	38	69	9,604
2012	633	156	19	175	808	1,046	77.2%	41	64	9,600
Total	24,052	5,980	481	6,461	30,513	48,410				
Average	729	181	15	196	925	1,467	63.5%	33	69	11,117
1980's AVG	733	181	10	191	924	1,658	55.4%	25	79	10,677
1990's AVG	795	197	16	213	1,007	1,504	67.1%	32	69	10,911
2000's AVG	711	187	20	206	918	1,377	67.2%	39	60	12,101
2010's AVG	555	109	11	120	675	1,010	66.7%	40	68	9,995
Minimum	326	54	0	54	427	835	36.1%	18	36	6,713
Maximum	1,229	454	57	484	1,484	2,464	79.1%	53	104	15,723

Table 9. Mule deer harvest, sex and age ratio and population data - WY Herd Unit 740 (Cheyenne River).
The Thunder Basin and Lance Creek herd units were combined in 2010 to form the Cheyenne River unit.
Age and sex ratio data from 1980-2009 is an average between the Thunder basin and Lance Creek herd units.

YEAR	HARVEST DATA					HUNTER DATA		AGE & SEX RATIO		POP Size Estimate
	Total Males	Total Females	Total Young	Total Antlerless	Total Harvest	Total Hunters	Hunter Suc.	Total M /100 F	Young /100 F	
1980	2,445	929	0	929	3,374	4,996	67.5%	27	87	18,350
1981	3,532	1,474	0	1,474	5,006	6,630	75.5%	20	101	21,900
1982	3,588	1,148	160	1,308	4,896	6,554	74.7%	22	99	24,703
1983	3,929	1,454	120	1,574	5,503	7,472	73.6%	25	95	37,703
1984	2,986	2,132	150	2,282	5,268	7,727	68.2%	17	63	23,917
1985	2,285	2,182	110	2,292	4,577	7,016	65.2%	18	76	NA
1986	1,376	1,406	88	1,494	2,870	5,311	54.0%	15	60	14,600
1987	1,126	164	12	176	1,302	2,774	46.9%	19	97	19,632
1988	1,805	228	10	238	2,043	2,853	71.6%	29	86	23,536
1989	1,791	415	22	437	2,228	3,169	70.3%	26	88	21,921
1990	2,158	500	7	507	2,665	3,479	76.6%	29	102	27,596
1991	3,665	1,501	207	1,708	5,373	5,826	92.2%	36	82	35,836
1992	4,582	2,358	187	2,545	7,127	7,302	97.6%	34	71	35,428
1993	2,539	1,128	73	1,201	3,740	5,387	69.4%	33	57	26,678
1994	1,807	676	18	694	2,501	4,119	60.7%	29	74	24,917
1995	1,973	693	82	775	2,748	4,257	64.6%	28	80	27,894
1996	2,024	541	28	569	2,593	4,340	59.7%	34	91	32,910
1997	2,139	579	49	628	2,767	3,381	81.8%	29	72	29,988
1998	2,569	476	39	515	3,084	5,216	59.1%	30	83	38,298
1999	3,145	854	55	909	4,054	6,009	67.5%	28	86	38,854
2000	3,144	794	54	848	3,992	5,641	70.8%	39	73	42,311
2001	2,713	828	79	907	3,620	5,665	63.9%	28	50	33,394
2002	2,484	773	60	833	3,317	5,228	63.4%	25	52	32,965
2003	2,170	789	86	875	3,045	4,618	65.9%	25	73	34,060
2004	1,956	635	50	685	2,641	4,067	64.9%	29	66	34,006
2005	1,821	677	94	771	2,592	3,909	66.3%	32	72	33,266
2006	1,970	715	31	746	2,716	3,676	73.9%	42	67	40,082
2007	1,949	773	43	816	2,765	3,856	71.7%	45	66	39,922
2008	1,758	545	36	581	2,339	3,462	67.6%	36	58	27,755
2009	1,807	548	44	592	2,399	3,452	69.5%	38	59	26,930
2010	1,459	315	43	358	1,817	3,152	57.6%	33	54	23,963
2011	1,237	219	33	252	1,489	2,688	55.4%	34	62	22,102
2012	1,255	84	7	91	1,346	2,511	53.6%	33	44	17,367
Total	77,187	28,533	2,077	30,610	107,797	155,743				
Average	2,339	865	63	928	3,267	4,719	67.9%	29	74	29,150
1980's AVG	2,486	1,153	67	1,220	3,707	5,450	66.8%	21	85	22,918
1990's AVG	2,660	931	75	1,005	3,665	4,932	72.9%	31	79	31,840
2000's AVG	2,177	708	58	765	2,943	4,357	67.8%	34	63	34,469
2010's AVG	1,317	206	28	234	1,551	2,784	55.5%	33	53	21,144
Minimum	1,126	84	0	91	1,302	2,511	46.9%	15	44	14,600
Maximum	4,582	2,358	207	2,545	7,127	7,727	97.6%	45	102	42,311

Table10. Mule deer harvest, sex and age ratio and population data - WY Herd Unit 751 (Black Hills).

YEAR	HARVEST DATA					HUNTER DATA		AGE & SEX RATIO		POP Size Estimate
	Total Males	Total Females	Total Young	Total Antlerless	Total Harvest	Total Hunters	Hunter Suc.	Total M /100 F	Young /100 F	
1980	1,658	483	0	483	2,141	3,979	53.8%	NA	NA	12,500
1981	1,962	727	0	727	2,689	13,686	19.6%	NA	NA	14,000
1982	1,739	726	137	863	2,602	11,308	23.0%	NA	NA	16,425
1983	2,483	880	87	967	3,450	5,705	60.5%	20	91	17,500
1984	2,322	1,437	69	1,506	3,828	7,518	50.9%	11	73	16,874
1985	2,091	1,346	105	1,451	3,542	6,096	58.1%	11	64	NA
1986	1,799	1,203	178	1,381	3,180	6,421	49.5%	19	79	13,919
1987	1,504	158	11	169	1,673	4,914	34.0%	10	99	15,922
1988	1,857	227	0	227	2,084	3,920	53.2%	23	94	19,406
1989	2,412	610	44	654	3,066	5,145	59.6%	23	77	19,546
1990	2,671	1,325	159	1,484	4,155	6,357	65.4%	24	87	24,280
1991	2,562	1,287	98	1,385	3,947	6,226	63.4%	21	82	23,225
1992	2,756	2,738	298	3,036	5,792	7,670	75.5%	19	68	18,987
1993	1,925	2,004	325	2,329	4,254	7,237	58.8%	17	72	14,515
1994	1,310	366	22	388	1,698	4,635	36.6%	21	80	16,156
1995	1,793	524	57	581	2,374	4,308	55.1%	24	80	19,551
1996	1,372	189	15	204	1,576	3,811	41.4%	24	76	21,592
1997	1,413	310	32	342	1,755	3,998	43.9%	12	49	15,351
1998	1,403	208	30	238	1,641	3,755	43.7%	16	83	19,995
1999	1,710	185	12	197	1,907	3,782	50.4%	24	83	21,900
2000	1,817	284	19	303	2,120	4,385	48.3%	34	66	25,381
2001	1,982	309	44	353	2,335	4,908	47.6%	25	54	20,333
2002	1,828	320	34	354	2,182	4,893	44.6%	22	68	24,282
2003	2,205	517	67	584	2,789	5,949	46.9%	14	64	22,911
2004	2,500	698	56	754	3,254	6,203	52.5%	25	71	27,606
2005	2,476	798	63	861	3,337	6,982	47.8%	23	67	28,282
2006	2,333	823	90	913	3,246	6,887	47.1%	26	83	32,431
2007	2,175	1,136	61	1,197	3,372	6,917	48.7%	21	73	28,856
2008	1,894	929	96	1,025	2,919	6,773	43.1%	16	74	22,399
2009	1,688	1,104	48	1,152	2,840	6,650	42.7%	19	68	18,589
2010	1,238	434	51	485	1,723	4,539	38.0%	17	64	16,092
2011	1,128	208	43	251	1,379	3,746	36.8%	18	62	12,973
2012	1,253	166	23	189	1,442	3,569	40.4%	16	76	19,505
Total	63,259	24,659	2,374	27,033	90,292	192,872				
Average	1,917	747	72	819	2,736	5,845	47.9%	20	74	20,040
1980's AVG	1,983	780	63	843	2,826	6,869	46.2%	17	82	16,232
1990's AVG	1,892	914	105	1,018	2,910	5,178	53.4%	20	76	19,555
2000's AVG	2,090	692	58	750	2,839	6,055	46.9%	23	69	25,107
2010's AVG	1,206	269	39	308	1,515	3,951	38.4%	17	67	16,190
Minimum	1,128	158	0	169	1,379	3,569	19.6%	10	49	12,500
Maximum	2,756	2,738	325	3,036	5,792	13,686	75.5%	34	99	32,431

Table 11. Mule Deer harvest, sex and age ratio and population data - WY Herd Unit 755 (North Converse). North Converse and Bill mule deer herd units were combined in 1997 to form North Converse unit. Age and sex ratio data from 1980-1996 is an average between North Converse and Bill

Year	HARVEST DATA					HUNTER DATA		AGE & SEX RATIO		POP Size Estimate
	Total Males	Total Females	Total Young	Total Antlerless	Total Harvest	Total Hunters	Hunter Suc.	Total M /100 F	Young /100 F	
1980	716	339	0	339	1,055	2,165	48.7%	23	65	4,050
1981	843	417	0	417	1,260	2,136	59.0%	30	81	4,800
1982	1,064	189	45	234	1,298	2,074	62.6%	30	87	7,861
1983	802	362	26	388	1,190	1,571	75.7%	34	82	9,112
1984	489	207	20	227	716	1,070	66.9%	21	61	9,586
1985	414	236	19	255	669	935	71.6%	26	71	9,586
1986	490	114	10	124	614	880	69.8%	26	74	5,434
1987	426	146	10	156	582	830	70.1%	29	94	6,335
1988	432	155	0	155	587	751	78.2%	40	78	6,581
1989	477	92	0	92	569	731	77.8%	37	76	7,143
1990	572	89	6	95	667	890	74.9%	33	99	7,167
1991	806	504	35	539	1,345	1,318	102.0%	47	82	9,611
1992	785	688	18	706	1,491	1,469	101.5%	41	68	9,169
1993	555	216	10	226	781	1,008	77.5%	43	56	7,359
1994	587	263	27	290	877	1,108	79.2%	41	74	8,447
1995	519	196	23	219	738	978	75.5%	43	80	7,925
1996	446	194	9	203	649	894	72.6%	45	92	9,288
1997	545	214	54	268	813	936	86.9%	49	75	9,440
1998	572	200	50	250	822	970	84.7%	42	95	8,167
1999	621	242	19	261	882	1,055	83.6%	45	86	9,510
2000	637	236	25	261	898	988	90.9%	46	65	11,686
2001	567	199	14	213	780	874	89.2%	39	59	9,518
2002	496	224	18	242	738	863	85.5%	39	53	9,505
2003	476	190	19	209	685	760	90.1%	38	63	9,353
2004	503	219	8	227	730	838	87.1%	34	70	8,621
2005	490	244	15	259	749	906	82.7%	45	82	9,899
2006	562	252	6	258	820	889	92.2%	45	64	9,244
2007	506	186	13	199	705	794	88.8%	46	88	9,300
2008	526	218	17	235	761	825	92.2%	53	68	8,311
2009	579	292	19	311	890	1,006	88.5%	45	61	8,328
2010	492	287	41	328	820	969	84.6%	45	68	8,546
2011	433	159	63	222	655	847	77.3%	47	65	8,829
2012	332	99	20	119	451	550	82.0%	34	75	6,004
Total	18,760	7,868	659	8,527	27,287	34,878				
Average	568	238	20	258	827	1,057	80.3%	39	75	8,294
1980's AVG	615	226	13	239	854	1,314	68.0%	30	78	7,049
1990's AVG	601	281	25	306	907	1,063	83.8%	43	81	8,608
2000's AVG	534	226	15	241	776	874	88.7%	43	67	9,377
2010's AVG	419	182	41	223	642	789	81.3%	42	69	7,793
Minimum	332	89	0	92	451	550	48.7%	21	53	4,050
Maximum	1,064	688	63	706	1,491	2,165	102.0%	53	99	11,686

Table 12. Elk harvest, sex and age ratio and population data - WY Herd Unit 320 (Fortification).

YEAR	HARVEST DATA							HUNTER DATA		AGE & SEX RATIO		POP Size Estimate
	Adult Males	Yearling Males	Total Females	Total Young	Total Males	Total Antlerless	Total Harvest	Total Hunters	Hunter Suc.	Total M /100 F	Young /100 F	
1980	0	0	0	0	0	0	0	0				100
1981	0	0	0	0	0	0	0	0				140
1982	0	0	0	0	0	0	0	0				170
1983	0	0	0	0	0	0	0	0				278
1984	42	10	16	3	52	19	71	90	78.9%	37	56	252
1985	0	0	0	0	0	0	0	0		52	67	328
1986	22	0	31	6	22	37	59	96	61.5%	38	44	214
1987	0	0	0	0	0	0	0	0		NA	NA	256
1988	0	0	0	0	0	0	0	0		NA	NA	308
1989	21	4	30	5	25	35	60	115	52.2%	105	42	243
1990	23	4	10	6	27	16	43	72	59.7%	23	40	246
1991	0	0	0	0	0	0	0	0		15	39	302
1992	39	16	22	6	55	28	83	146	56.8%	17	51	256
1993	25	23	27	6	48	33	81	143	56.6%	13	35	185
1994	14	12	20	5	26	25	51	94	54.3%	21	35	183
1995	0	0	13	1	0	14	14	46	30.4%	44	56	217
1996	0	0	0	0	0	0	0	0		81	62	280
1997	0	0	0	0	0	0	0	0		17	35	394
1998	30	0	47	24	30	71	101	232	43.5%	35	29	309
1999	47	3	47	17	50	64	114	183	62.3%	48	64	242
2000	44	9	45	8	53	53	106	200	53.0%	40	40	197
2001	13	5	31	4	18	35	53	111	47.7%	34	34	218
2002	13	4	58	15	17	73	90	105	85.7%	NA	50	173
2003	14	0	7	1	14	8	22	43	51.2%	33	53	178
2004	21	3	8	0	24	8	32	50	64.0%	29	32	229
2005	13	2	12	4	15	16	31	61	50.8%	61	39	229
2006	15	1	18	11	16	29	45	69	65.2%	44	69	261
2007	13	2	26	1	15	27	42	104	40.4%	33	30	244
2008	24	0	26	10	24	36	60	69	87.0%	38	58	219
2009	26	2	17	4	28	21	49	70	70.0%	62	41	232
2010	23	2	21	4	25	25	50	76	65.8%	52	43	228
2011	31	2	12	2	33	14	47	81	58.0%	41	62	256
2012	13	2	22	13	15	35	50	80	62.5%	72	77	500
Total	526	106	566	156	632	722	1,354	2,336				
Average	16	3	17	5	19	22	41	71	59.0%	42	48	244
1980's AVG	9	1	8	1	10	9	19	30	64.2%	51	50	229
1990's AVG	18	6	19	7	24	25	49	92	52.0%	33	45	261
2000's AVG	20	3	25	6	22	31	53	88	61.5%	43	45	218
2010's AVG	22	2	18	6	24	25	49	79	62.1%	57	70	328
Minimum	0	0	0	0	0	0	0	0	30.4%	13	29	100
Maximum	47	23	58	24	55	73	114	232	87.0%	105	77	500

Table 13. Elk harvest, sex and age ratio and population data - WY Herd Unit 344 (Rochelle).

YEAR	HARVEST DATA							HUNTER DATA		AGE & SEX RATIO		POP Size Estimate
	Adult Males	Yearling Males	Total Females	Total Young	Total Males	Total Antlerless	Total Harvest	Total Hunters	Hunter Suc.	Total M /100 F	Young /100 F	
1984	0	0	0	0	0	0	0	0		NA	NA	75
1985	0	0	0	0	0	0	0	0		NA	NA	60
1986	0	0	0	0	0	0	0	0		19	22	80
1987	0	0	0	0	0	0	0	0		NA	NA	140
1988	0	0	0	0	0	0	0	0		NA	NA	140
1989	0	0	0	0	0	0	0	0		55	43	150
1990	11	0	2	0	11	2	13	16	81.3%	36	46	140
1991	0	0	0	0	0	0	0	0		52	29	150
1992	0	0	0	0	0	0	0	0		59	33	192
1993	10	1	2	0	11	2	13	17	76.5%	39	38	197
1994	0	0	0	0	0	0	0	0		59	44	231
1995	10	0	7	1	10	8	18	20	90.0%	45	36	285
1996	20	0	0	3	20	3	23	37	62.2%	19	46	297
1997	3	1	0	0	4	0	4	5	80.0%	44	41	371
1998	13	2	15	0	15	15	30	35	85.7%	52	67	417
1999	30	2	15	1	32	16	48	54	88.9%	39	49	346
2000	1	4	9	0	5	9	14	17	82.4%	44	51	389
2001	25	0	26	4	25	30	55	64	85.9%	58	46	372
2002	13	0	8	1	13	9	22	32	68.8%	96	48	514
2003	35	4	54	7	39	61	100	131	76.3%	46	61	503
2004	35	2	128	5	37	133	170	197	86.3%	93	54	692
2005	16	0	149	23	16	172	188	228	82.5%	64	60	600
2006	44	0	91	20	44	111	155	265	58.5%	58	44	650
2007	53	2	111	18	55	129	184	246	74.8%	41	39	600
2008	0	0	73	9	0	82	82	125	65.6%	64	43	651
2009	33	2	57	15	35	72	107	160	66.9%	47	56	598
2010	44	0	31	6	44	37	81	116	69.8%	40	34	728
2011	39	0	74	10	39	84	123	182	67.6%	40	34	741
2012	22	1	59	6	23	65	88	164	53.7%	41	60	NA
Total	457	21	911	129	478	1,040	1,518	2,111				
Average	16	1	31	4	16	36	52	73	75.2%	50	45	368
1980's AVG	0	0	0	0	0	0	0	0	#DIV/0!	37	37	108
1990's AVG	10	1	4	1	10	5	15	18	80.6%	45	43	263
2000's AVG	26	1	71	10	27	81	108	147	74.8%	61	49	557
2010's AVG	35	0	55	7	35	62	97	154	63.7%	41	47	735
Minimum	0	0	0	0	0	0	0	0	53.7%	19	22	60
Maximum	53	4	149	23	55	172	188	265	90.0%	96	67	741

Table 14. Elk harvest, sex and age ratio and population data - WY Herd Unit 740 (Black Hills).

YEAR	HARVEST DATA							HUNTER DATA		AGE & SEX RATIO		POP Size Estimate
	Adult Males	Yearling Males	Total Females	Total Young	Total Males	Total Antlerless	Total Harvest	Total Hunters	Hunter Suc.	Total M /100 F	Young /100 F	
1980	14	7	16	5	21	21	42	74	56.8%	NA	NA	400
1981	46	34	29	7	80	36	116	497	23.3%	NA	NA	400
1982	37	23	33	9	60	42	102	487	20.9%	5	53	400
1983	28	21	40	3	49	43	92	522	17.6%	NA	NA	400
1984	17	17	43	14	34	57	91	517	17.6%	NA	NA	375
1985	32	15	33	2	47	35	82	524	15.6%	7	36	NA
1986	14	20	29	3	34	32	66	450	14.7%	5	73	375
1987	24	14	19	2	38	21	59	140	42.1%	38	76	374
1988	30	17	28	3	47	31	78	123	63.4%	NA	NA	559
1989	27	15	46	8	42	54	96	195	49.2%	39	58	342
1990	21	20	19	6	41	25	66	147	44.9%	31	63	342
1991	26	14	47	18	40	65	105	193	54.4%	60	67	533
1992	32	29	67	5	61	72	133	273	48.7%	18	50	479
1993	55	16	53	11	71	64	135	270	50.0%	NA	NA	438
1994	47	17	71	9	64	80	144	274	52.6%	18	48	NA
1995	44	23	100	28	67	128	195	393	49.6%	33	44	NA
1996	50	21	117	35	71	152	223	394	56.6%	NA	NA	NA
1997	90	7	114	31	97	145	242	464	52.2%	NA	NA	NA
1998	76	8	105	16	84	121	205	480	42.7%	NA	NA	NA
1999	89	18	105	42	107	147	254	529	48.0%	NA	NA	NA
2000	79	18	120	34	97	154	251	571	44.0%	NA	NA	NA
2001	119	17	117	42	136	159	295	782	37.7%	NA	NA	NA
2002	170	12	119	38	182	157	339	891	38.0%	NA	NA	NA
2003	173	24	173	44	197	217	414	865	47.9%	50	47	NA
2004	204	11	141	30	215	171	386	960	40.2%	NA	NA	NA
2005	208	35	193	46	243	239	482	948	50.8%	NA	NA	NA
2006	211	13	147	22	224	169	393	960	40.9%	NA	NA	NA
2007	258	30	225	23	288	248	536	1,028	52.1%	NA	NA	NA
2008	241	18	176	33	259	209	468	893	52.4%	NA	NA	NA
2009	212	8	216	35	220	251	471	935	50.4%	NA	NA	NA
2010	219	18	287	49	237	336	573	982	58.4%	NA	NA	NA
2011	147	12	350	92	159	442	601	1,145	52.5%	NA	NA	NA
2012	171	25	254	44	196	298	494	1,416	34.9%	NA	NA	NA
Total	3,211	597	3,632	789		4,421	8,229	19,322				
Average	97	18	110	24		134	249	586	43.1%	28	56	417
1980's AVG	27	18	32	6		37	82	353	32.1%	21	60	403
1990's AVG	53	17	80	20		100	170	342	50.0%	32	52	448
2000's AVG	188	19	163	35		197	404	883	45.5%	50	47	
2010's AVG	179	18	297	62		359	556	1,181	48.6%			
Minimum	14	7	16	2		21	42	74	14.7%	5	36	342
Maximum	258	35	350	92		442	601	1,416	63.4%	60	76	559

Table 15. Elk harvest, sex and age ratio and population data - WY Herd Unit 743 (Pine Ridge).

YEAR	HARVEST DATA							HUNTER DATA		AGE & SEX RATIO		POP Size Estimate
	Adult Males	Yearling Males	Total Females	Total Young	Total Males	Total Antlerless	Total Harvest	Total Hunters	Hunter Suc.	Total M /100 F	Young /100 F	
1986	13	2	10	0	15	10	25	39	64%	17	56	NA
1987	11	1	16	5	12	21	33	48	69%	69	81	NA
1988	4	1	21	4	5	25	30	40	75%	54	43	144
1989	6	0	9	4	6	13	19	36	53%	56	47	100
1990	11	0	17	5	11	22	33	45	73%	39	65	108
1991	3	2	13	6	5	19	24	39	62%	129	100	NA
1992	6	0	8	0	6	8	14	41	34%	75	75	NA
1993	1	0	7	2	1	9	10	25	40%	NA	NA	NA
1994	6	0	4	0	6	4	10	23	43%	NA	NA	100
1995	5	1	1	0	6	1	7	16	44%	NA	NA	NA
1996	6	0	0	0	6	0	6	11	55%	43	74	NA
1997	18	0	10	0	18	10	28	34	82%	53	60	NA
1998	10	0	7	2	10	9	19	37	51%	NA	NA	NA
1999	21	0	12	2	21	14	35	52	67%	58	58	NA
2000	22	0	11	2	22	13	35	61	57%	NA	NA	NA
2001	33	5	12	7	38	19	57	78	73%	NA	NA	NA
2002	18	0	21	4	18	25	43	79	54%	NA	NA	NA
2003	14	2	25	16	16	41	57	87	66%	NA	NA	NA
2004	13	0	46	0	13	46	59	84	70%	NA	NA	NA
2005	12	0	20	7	12	27	39	80	49%	NA	NA	NA
2006	26	0	10	0	26	10	36	59	61%	NA	NA	NA
2007	22	0	23	5	22	28	50	77	65%	NA	NA	NA
2008	12	0	20	3	12	23	35	62	56%	NA	NA	NA
2009	21	2	11	6	23	17	40	56	71%	NA	NA	NA
2010	20	0	23	2	20	25	45	71	63%	NA	NA	NA
2011	12	9	26	3	21	29	50	64	78%	NA	NA	NA
2012	20	0	30	1	20	31	51	71	72%	NA	NA	NA
Total	366	25	413	86	391	499	890	1,415				
Average	14	1	15	3	14	18	33	52	61%	59	66	113
1980's AVG	9	1	14	3	10	17	27	41		47	58	122
1990's AVG	9	0	8	2	9	10	19	32	55%	72	73	104
2000's AVG	19	1	20	5	20	25	45	72	62%			
2010's AVG	17	3	26	2	20	28	49	69	71%			
Minimum	1	0	0	0	1	0	6	11		17	43	100
Maximum	33	9	46	16	38	46	59	87		129	100	144

Table 16. Pronghorn harvest, sex and age ratio and population data - WY Herd Unit 308 (Clearmont).

YEAR	HARVEST DATA					HUNTER DATA		AGE & SEX RATIO		POP Size Estimate
	Total Males	Total Females	Total Young	Total Antlerless	Total Harvest	Total Hunters	Hunter Suc.	Total M /100 F	Young /100 F	
1980	309	180	27	207	516	626	82.4%	75	87	2,500
1981	483	287	62	349	832	981	84.8%	39	73	2,300
1982	456	61	9	70	526	601	87.5%	27	100	2,800
1983	412	85	12	97	509	591	86.1%	38	110	3,917
1984	427	231	24	255	682	761	89.6%	45	50	3,382
1985	500	370	28	398	898	834	107.7%	39	63	3,642
1986	458	298	17	315	773	847	91.3%	51	67	2,975
1987	423	255	30	285	708	760	93.2%	32	82	2,792
1988	487	208	20	228	715	666	107.4%	47	65	2,960
1989	449	254	32	286	735	731	100.5%	45	76	2,812
1990	479	220	37	257	736	760	96.8%	42	80	2,792
1991	454	218	49	267	721	863	83.5%	61	82	5,196
1992	452	338	44	382	834	710	117.5%	29	57	4,682
1993	476	345	41	386	862	759	113.6%	34	42	5,074
1994	423	338	37	375	798	NA		33	58	4,903
1995	272	302	72	374	646	694	93.1%	34	65	4,904
1996	348	24	0	24	372	469	79.3%	40	58	5,140
1997	271	38	0	38	309	379	81.5%	30	36	4,320
1998	214	20	0	20	234	286	81.8%	30	70	3,000
1999	152	20	0	20	172	262	65.6%	48	65	3,430
2000	163	21	0	21	184	267	68.9%	38	66	3,903
2001	173	13	6	19	192	250	76.8%	40	54	3,549
2002	178	17	0	17	195	250	78.0%	41	67	3,844
2003	218	23	0	23	241	250	96.4%	54	56	4,000
2004	276	8	0	8	284	312	91.0%	54	68	6,738
2005	317	185	18	203	520	549	94.7%	49	69	7,962
2006	352	302	26	328	680	676	100.6%	55	69	8,369
2007	409	235	35	270	679	679	100.0%	65	62	8,616
2008	413	163	10	173	586	656	89.3%	58	61	8,750
2009	342	187	25	212	554	618	89.6%	48	50	5,153
2010	357	195	12	207	564	676	83.4%	53	54	5,188
2011	298	225	9	234	532	525	101.3%	39	63	4,620
2012	244	183	0	183	427	512	83.4%	47	65	4,300
Total	11,685	5,849	682	6,531	18,216	18,800				
Average	354	177	21	198	552	588	90.5%	43	66	4,500
1980's AVG	440	223	26	249	689	740	93.1%	40	76	3,008
1990's AVG	354	186	28	214	568	576	90.3%	38	61	4,344
2000's AVG	284	115	12	127	412	451	88.5%	50	62	6,088
2010's AVG	300	201	7	208	508	571	89.4%	46	61	4,703
Minimum	152	8	0	8	172	250	65.6%	27	36	2,300
Maximum	500	370	72	398	898	981	117.5%	65	110	8,750

Table 17. Pronghorn harvest, sex and age ratio and population data - WY Herd Unit 309 (Pumpkin Buttes).

YEAR	HARVEST DATA					HUNTER DATA		AGE & SEX RATIO		POP Size Estimate
	Total Males	Total Females	Total Young	Total Antlerless	Total Harvest	Total Hunters	Hunter Suc.	Total M /100 F	Young /100 F	
1980	973	571	128	699	1,672	1,841	90.8%	40	107	14,500
1981	1,382	812	189	1,001	2,383	2,490	95.7%	42	92	11,806
1982	1,395	1,161	160	1,321	2,716	2,909	93.4%	64	92	13,273
1983	1,497	993	138	1,131	2,628	2,943	89.3%	55	95	23,922
1984	1,632	1,182	186	1,368	3,000	3,191	94.0%	59	74	22,327
1985	1,439	1,049	123	1,172	2,611	1,972	132.4%	52	88	22,758
1986	1,510	834	263	1,097	2,607	2,171	120.1%	50	109	15,669
1987	1,439	1,082	101	1,183	2,622	2,175	120.6%	68	102	17,311
1988	1,538	955	189	1,144	2,682	2,024	132.5%	53	91	17,607
1989	1,371	934	104	1,038	2,409	983	245.1%	51	85	19,306
1990	1,424	742	202	944	2,368	1,852	127.9%	45	97	22,689
1991	1,417	788	174	962	2,379	1,787	133.1%	51	80	26,478
1992	1,265	1,350	186	1,536	2,801	1,698	165.0%	45	78	27,514
1993	1,880	1,402	288	1,690	3,570	2,535	140.8%	50	64	21,528
1994	2,184	2,002	340	2,342	4,526	3,007	150.5%	51	98	22,837
1995	1,539	1,407	311	1,718	3,257	3,007	108.3%	45	82	23,210
1996	1,054	695	104	799	1,853	1,425	130.0%	57	87	22,484
1997	1,054	359	24	383	1,437	1,448	99.2%	67	78	15,699
1998	1,007	46	4	50	1,057	1,191	88.7%	51	88	16,823
1999	981	58	12	70	1,051	1,121	93.8%	53	81	17,776
2000	1,054	178	26	204	1,258	1,316	95.6%	51	87	22,696
2001	1,022	213	32	245	1,267	1,368	92.6%	66	79	20,951
2002	1,166	376	19	395	1,561	1,615	96.7%	49	92	26,358
2003	1,256	301	28	329	1,585	1,569	101.0%	45	76	23,639
2004	1,214	463	34	497	1,711	1,704	100.4%	54	80	27,570
2005	1,232	542	84	626	1,858	1,966	94.5%	66	86	32,405
2006	1,397	765	33	798	2,195	2,473	88.8%	41	81	36,482
2007	1,452	870	52	922	2,374	2,408	98.6%	48	65	25,944
2008	1,642	944	64	1,008	2,650	2,816	94.1%	61	74	27,933
2009	1,568	914	109	1,023	2,591	2,626	98.7%	63	70	23,206
2010	1,352	966	60	1,026	2,378	2,685	88.6%	61	67	23,593
2011	1,102	980	148	1,128	2,230	2,438	91.5%	57	71	26,304
2012	1,479	932	87	1,019	2,498	2,699	92.6%	57	71	35,500
Total	44,917	26,866	4,002	30,868	75,785	69,453				
Average	1,361	814	121	935	2,297	2,105	111.7%	54	83	22,670
1980's AVG	1,418	957	158	1,115	2,533	2,270	121.4%	55	92	17,848
1990's AVG	1,381	885	165	1,049	2,430	1,907	123.7%	52	83	21,704
2000's AVG	1,300	557	48	605	1,905	1,986	96.1%	54	79	26,718
2010's AVG	1,311	959	98	1,058	2,369	2,607	90.9%	58	70	28,466
Minimum	973	46	4	50	1,051	983	88.6%	41	64	11,806
Maximum	2,184	2,002	340	2,342	4,526	3,191	245.1%	68	109	36,482

Table 18. Pronghorn harvest, sex and age ratio and population data - WY Herd Unit 316 (Highlight).

YEAR	HARVEST DATA					HUNTER DATA		AGE & SEX RATIO		POP Size Estimate
	Total Males	Total Females	Total Young	Total Antlerless	Total Harvest	Total Hunters	Hunter Suc.	Total M /100 F	Young /100 F	
1980	290	200	11	211	501	556	90.1%	40	87	7,626
1981	549	283	55	338	887	969	91.5%	53	97	11,014
1982	601	574	69	643	1,244	1,339	92.9%	55	92	12,796
1983	899	1,626	227	1,853	2,752	2,870	95.9%	58	94	16,489
1984	935	1,150	108	1,258	2,193	2,292	95.7%	50	69	15,500
1985	854	869	109	978	1,832	1,327	138.1%	41	75	16,141
1986	722	811	175	986	1,708	1,240	137.7%	50	88	10,758
1987	579	577	107	684	1,263	1,007	125.4%	63	90	9,766
1988	676	604	140	744	1,420	972	146.1%	59	97	9,631
1989	605	513	70	583	1,188	983	120.9%	67	90	10,319
1990	805	637	28	665	1,470	1,166	126.1%	65	93	10,929
1991	476	482	51	533	1,009	710	142.1%	57	81	11,577
1992	388	495	36	531	919	589	156.0%	53	83	12,520
1993	644	592	71	663	1,307	937	139.5%	68	72	11,395
1994	722	623	123	746	1,468	1,099	133.6%	46	95	11,750
1995	684	330	32	362	1,046	1,099	95.2%	39	70	12,322
1996	450	469	53	522	972	655	148.4%	49	82	12,387
1997	160	186	15	201	361	337	107.1%	43	60	9,281
1998	165	6	0	6	171	209	81.8%	33	68	7,846
1999	145	13	4	17	162	178	91.0%	56	74	8,384
2000	114	58	9	67	181	218	83.0%	59	78	10,352
2001	226	70	9	79	305	343	88.9%	50	74	10,420
2002	285	153	7	160	445	481	92.5%	52	68	10,651
2003	392	248	17	265	657	623	105.5%	64	75	11,416
2004	400	266	23	289	689	666	103.5%	63	90	12,816
2005	591	273	50	323	914	922	99.1%	63	94	12,061
2006	500	449	50	499	999	984	101.5%	68	73	13,725
2007	565	482	9	491	1,056	1,050	100.6%	62	60	12,397
2008	617	467	40	507	1,124	1,121	100.3%	74	57	11,249
2009	658	462	31	493	1,151	1,286	89.5%	57	64	12,331
2010	767	516	36	552	1,319	1,364	96.7%	71	63	13,108
2011	556	313	42	355	911	1,097	83.0%	61	60	11,426
2012	528	348	8	356	884	1,076	82.2%	53	47	10,000
Total	17,548	15,145	1,815	16,960	34,508	31,765				
Average	532	459	55	514	1,046	963	108.5%	56	77	11,527
1980's AVG	671	721	107	828	1,499	1,356	113.4%	55	88	12,004
1990's AVG	464	383	41	425	889	698	122.1%	51	78	10,839
2000's AVG	435	293	25	317	752	769	96.4%	61	73	11,742
2010's AVG	617	392	29	421	1,038	1,179	87.3%	62	57	11,511
Minimum	114	6	0	6	162	178	81.8%	33	47	7,626
Maximum	935	1,626	227	1,853	2,752	2,870	156.0%	74	97	16,489

Table 19. Pronghorn harvest, sex and age ratio and population data - WY Herd Unit 318 (Crazy Woman).

YEAR	HARVEST DATA					HUNTER DATA		AGE & SEX RATIO		POP Size Estimate
	Total Males	Total Females	Total Young	Total Antlerless	Total Harvest	Total Hunters	Hunter Suc.	Total M /100 F	Young /100 F	
1980	792	316	56	372	1,164	1,280	90.9%	61	87	3,599
1981	968	335	56	391	1,359	1,422	95.6%	38	88	3,770
1982	968	440	87	527	1,495	1,421	105.2%	38	95	6,239
1983	780	543	68	611	1,391	1,466	94.9%	50	97	11,003
1984	1,177	739	182	921	2,098	2,198	95.5%	53	81	11,500
1985	1,143	833	72	905	2,048	1,575	130.0%	45	72	11,513
1986	1,019	721	90	811	1,830	1,664	110.0%	32	86	5,855
1987	704	608	94	702	1,406	1,416	99.3%	38	102	5,939
1988	456	285	41	326	782	800	97.8%	47	92	5,768
1989	341	69	11	80	421	448	94.0%	53	100	6,671
1990	484	155	25	180	664	617	107.6%	47	95	7,481
1991	656	270	24	294	950	795	119.5%	48	83	12,700
1992	599	475	49	524	1,123	816	137.6%	58	90	9,479
1993	868	611	60	671	1,539	1,139	135.1%	54	59	8,870
1994	844	798	132	930	1,774	1,297	136.8%	63	75	8,282
1995	765	600	147	747	1,512	1,140	132.6%	57	83	6,829
1996	623	326	52	378	1,001	808	123.9%	52	90	5,718
1997	410	29	0	29	439	521	84.3%	49	75	5,322
1998	425	12	8	20	445	552	80.6%	54	91	6,310
1999	456	23	12	35	491	514	95.5%	58	95	6,524
2000	444	17	0	17	461	526	87.6%	54	74	7,217
2001	452	60	0	60	512	595	86.1%	50	67	7,023
2002	442	72	12	84	526	580	90.7%	48	73	6,755
2003	540	82	14	96	636	693	91.8%	57	96	7,446
2004	550	123	18	141	691	705	98.0%	58	89	10,994
2005	583	177	33	210	793	779	101.8%	65	95	11,200
2006	617	375	11	386	1,003	903	111.1%	57	86	14,800
2007	738	523	43	566	1,304	1,177	110.8%	62	74	14,650
2008	948	453	22	475	1,423	1,391	102.3%	56	73	12,800
2009	916	625	13	638	1,554	1,505	103.3%	71	67	11,743
2010	990	722	72	794	1,784	1,634	109.2%	69	76	9,811
2011	959	749	75	824	1,783	1,762	101.2%	53	95	15,868
2012	1,086	755	146	901	1,987	1,968	101.0%	60	82	12,100
Total	23,743	12,921	1,725	14,646	38,389	36,107				
Average	719	392	52	444	1,163	1,094	104.9%	53	84	8,842
1980's AVG	835	489	76	565	1,399	1,369	101.3%	44	90	7,186
1990's AVG	613	330	51	381	994	820	115.4%	54	84	7,752
2000's AVG	623	251	17	267	890	885	98.3%	58	79	10,463
2010's AVG	1,012	742	98	840	1,851	1,788	103.8%	61	84	12,593
Minimum	341	12	0	17	421	448	80.6%	32	59	3,599
Maximum	1,177	833	182	930	2,098	2,198	137.6%	71	102	15,868

Table 20. Pronghorn harvest, sex and age ratio and population data - WY Herd Unit 339 (North Black Hills).

YEAR	HARVEST DATA					HUNTER DATA		AGE & SEX RATIO		POP Size Estimate
	Total Males	Total Females	Total Young	Total Antlerless	Total Harvest	Total Hunters	Hunter Suc.	Total M /100 F	Young /100 F	
1980	356	107	16	123	479	551	86.9%	36	88	6,500
1981	519	98	7	105	624	696	89.7%	43	99	7,420
1982	794	440	92	532	1,326	1,445	91.8%	41	98	8,410
1983	936	610	57	667	1,603	1,777	90.2%	58	119	19,548
1984	1,115	872	82	954	2,069	2,271	91.1%	45	97	13,375
1985	1,172	844	52	896	2,068	1,887	109.6%	52	82	18,811
1986	1,297	774	112	886	2,183	2,006	108.8%	52	83	14,013
1987	1,190	882	105	987	2,177	1,883	115.6%	46	120	13,049
1988	1,233	932	86	1,018	2,251	1,890	119.1%	58	113	12,513
1989	1,472	863	170	1,033	2,505	2,200	113.9%	52	78	14,254
1990	1,576	949	170	1,119	2,695	2,245	120.0%	50	82	13,677
1991	1,381	837	155	992	2,373	1,972	120.3%	50	85	14,016
1992	1,314	1,188	135	1,323	2,637	1,871	140.9%	53	78	14,690
1993	1,575	1,457	160	1,617	3,192	2,173	146.9%	46	60	12,156
1994	1,511	1,284	203	1,487	2,998	2,195	136.6%	45	87	12,127
1995	1,200	993	203	1,196	2,396	2,195	109.2%	51	83	12,307
1996	767	732	96	828	1,595	1,308	121.9%	55	85	10,277
1997	555	315	34	349	904	875	103.3%	41	69	10,265
1998	390	150	14	164	554	601	92.2%	45	80	12,272
1999	376	89	22	111	487	555	87.7%	53	84	11,169
2000	650	156	40	196	846	874	96.8%	50	90	13,865
2001	521	159	30	189	710	790	89.9%	48	83	11,121
2002	548	184	20	204	752	785	95.8%	51	80	13,251
2003	851	286	41	327	1,178	1,182	99.7%	62	82	15,883
2004	1,034	348	51	399	1,433	1,440	99.5%	53	84	18,446
2005	1,064	385	88	473	1,537	1,599	96.1%	42	79	20,245
2006	1,081	560	61	621	1,702	1,755	97.0%	50	89	22,769
2007	1,251	603	65	668	1,919	1,959	98.0%	53	74	18,565
2008	1,306	466	54	520	1,826	1,939	94.2%	44	65	17,452
2009	1,216	585	58	643	1,859	1,970	94.4%	51	57	15,210
2010	820	420	71	491	1,311	1,531	85.6%	48	58	12,832
2011	571	164	27	191	762	940	81.1%	32	59	10,617
2012	415	158	22	180	595	657	90.6%	35	82	12,500
Total	32,057	18,890	2,599	21,489	53,546	50,017				
Average	971	572	79	651	1,623	1,516	103.5%	49	83	13,746
1980's AVG	1,008	642	78	720	1,729	1,661	101.7%	50	99	12,789
1990's AVG	1,065	799	119	919	1,983	1,599	117.9%	49	79	12,296
2000's AVG	952	373	51	424	1,376	1,429	96.1%	50	78	16,681
2010's AVG	602	247	40	287	889	1,043	85.8%	38	66	11,983
Minimum	356	89	7	105	479	551	81.1%	32	57	6,500
Maximum	1,576	1,457	203	1,617	3,192	2,271	146.9%	62	120	22,769

Table 21. Pronghorn harvest, sex and age ratio and population data - WY Herd Unit 351 (Gillette).

YEAR	HARVEST DATA					HUNTER DATA		AGE & SEX RATIO		POP Size Estimate
	Total Males	Total Females	Total Young	Total Antlerless	Total Harvest	Total Hunters	Hunter Suc.	Total M /100 F	Young /100 F	
1980	393	66	11	77	470	537	87.5%	43	83	8,096
1981	583	48	7	55	638	691	92.3%	37	63	9,764
1982	587	207	21	228	815	870	93.7%	31	94	14,407
1983	652	450	79	529	1,181	1,266	93.3%	65	96	15,162
1984	953	429	46	475	1,428	1,562	91.4%	45	55	11,024
1985	933	322	19	341	1,274	1,611	79.1%	53	58	7,349
1986	758	298	23	321	1,079	1,136	95.0%	39	63	7,733
1987	569	372	20	392	961	928	103.6%	39	81	9,285
1988	548	321	22	343	891	802	111.1%	40	74	11,507
1989	565	243	35	278	843	747	112.9%	41	72	12,922
1990	748	289	33	322	1,070	991	108.0%	43	93	14,964
1991	714	351	23	374	1,088	905	120.2%	43	89	16,228
1992	744	595	41	636	1,380	982	140.5%	47	81	16,134
1993	791	698	39	737	1,528	1,135	134.6%	53	37	12,601
1994	995	771	81	852	1,847	1,417	130.3%	46	88	14,472
1995	955	954	150	1,104	2,059	1,417	145.3%	43	44	11,867
1996	863	460	73	533	1,396	1,140	122.5%	55	68	11,413
1997	853	98	26	124	977	978	99.9%	45	43	8,386
1998	449	15	0	15	464	595	78.0%	53	44	9,144
1999	363	21	0	21	384	421	91.2%	28	57	10,108
2000	650	46	7	53	703	774	90.8%	53	69	12,087
2001	526	43	4	47	573	658	87.1%	58	46	12,435
2002	507	26	2	28	535	625	85.6%	43	50	11,775
2003	542	78	5	83	625	717	87.2%	62	55	13,339
2004	587	120	20	140	727	782	93.0%	57	73	15,240
2005	739	226	9	235	974	1,067	91.3%	56	81	17,457
2006	886	274	32	306	1,192	1,268	94.0%	49	107	18,530
2007	948	533	0	533	1,481	1,395	106.2%	64	62	16,823
2008	894	563	105	668	1,562	1,628	95.9%	57	43	15,005
2009	770	358	0	358	1,128	1,299	86.8%	50	42	14,570
2010	787	413	8	421	1,208	1,413	85.5%	49	38	12,038
2011	751	312	0	312	1,063	1,196	88.9%	34	58	10,618
2012	794	174	23	197	991	979	101.2%	37	70	10,300
Total	23,397	10,174	964	11,138	34,535	33,932				
Average	709	308	29	338	1,047	1,028	100.7%	47	65	12,509
1980's AVG	654	276	28	304	958	1,015	96.0%	43	73	10,725
1990's AVG	748	425	47	472	1,219	998	117.1%	46	64	12,532
2000's AVG	705	227	18	245	950	1,021	91.8%	55	63	14,726
2010's AVG	777	300	10	310	1,087	1,196	91.9%	40	55	10,985
Minimum	363	15	0	15	384	421	78.0%	28	37	7,349
Maximum	995	954	150	1,104	2,059	1,628	145.3%	65	107	18,530

Table 22. Pronghorn harvest, sex and age ratio and population data - WY Herd Unit 353 (Ucross).

YEAR	HARVEST DATA					HUNTER DATA		AGE & SEX RATIO		POP Size Estimate
	Total Males	Total Females	Total Young	Total Antlerless	Total Harvest	Total Hunters	Hunter Suc.	Total M /100 F	Young /100 F	
1980	310	119	14	133	443	521	85.0%	64	96	2,700
1981	362	161	19	180	542	575	94.3%	67	98	2,400
1982	374	150	17	167	541	575	94.1%	72	95	2,500
1983	405	264	14	278	683	741	92.2%	87	92	2,731
1984	390	232	11	243	633	668	94.8%	72	72	8,777
1985	377	290	10	300	677	591	114.6%	67	64	4,123
1986	358	230	19	249	607	600	101.2%	77	86	3,230
1987	284	255	22	277	561	519	108.1%	62	91	3,250
1988	235	209	0	209	444	406	109.4%	68	83	2,315
1989	255	153	26	179	434	650	66.8%	76	83	2,322
1990	264	136	11	147	411	380	108.2%	88	92	4,278
1991	319	134	3	137	456	432	105.6%	83	79	4,285
1992	236	151	18	169	405	377	107.4%	69	67	5,235
1993	265	210	24	234	499	458	109.0%	78	52	4,452
1994	274	237	9	246	520	502	103.6%	77	50	3,990
1995	290	149	30	179	469	513	91.4%	68	66	3,851
1996	254	90	10	100	354	451	78.5%	77	65	3,776
1997	204	4	4	8	212	236	89.8%	51	55	2,800
1998	219	14	0	14	233	272	85.7%	63	72	1,500
1999	195	14	2	16	211	239	88.3%	41	73	1,685
2000	181	15	0	15	196	243	80.7%	59	80	2,543
2001	146	15	2	17	163	198	82.3%	42	57	3,244
2002	200	8	0	8	208	240	86.7%	57	80	3,410
2003	225	57	3	60	285	295	96.6%	68	79	3,845
2004	235	59	10	69	304	307	99.0%	58	75	6,416
2005	290	58	23	81	371	400	92.8%	75	85	8,238
2006	421	207	45	252	673	616	109.3%	88	87	9,504
2007	460	225	16	241	701	634	110.6%	76	63	9,905
2008	505	270	12	282	787	698	112.8%	63	62	10,047
2009	351	256	6	262	613	626	97.9%	63	50	8,645
2010	426	222	18	240	666	686	97.1%	61	56	7,866
2011	395	220	27	247	642	667	96.3%	51	81	8,211
2012	459	277	17	294	753	802	93.9%	62	84	7,400
Total	10,164	5,091	442	5,533	15,697	16,118				
Average	308	154	13	168	476	488	96.5%	68	74	4,833
1980's AVG	335	206	15	222	557	585	96.0%	72	85	3,435
1990's AVG	252	114	11	125	377	386	96.7%	70	67	3,585
2000's AVG	301	117	12	129	430	426	96.9%	65	72	6,580
2010's AVG	427	240	21	260	687	718	95.7%	58	74	7,826
Minimum	146	4	0	8	163	198	66.8%	41	50	1,500
Maximum	505	290	45	300	787	802	114.6%	88	98	10,047

Table 23. Pronghorn harvest, sex and age ratio and population data - WY Herd Unit 740 (Chyenne River).
South Black Hills & Lance Creek herd units were combined in 1998 to form the Cheyenne River herd unit
Age and sex ratio data from 1980-1997 is an average between S. Black Hill and Lance Cr. herd units.

YEAR	HARVEST DATA					HUNTER DATA		AGE & SEX RATIO		POP Size Estimate
	Total Males	Total Females	Total Young	Total Antlerless	Total Harvest	Total Hunters	Hunter Suc.	Total M /100 F	Young /100 F	
1980	2,280	1,018	166	1,184	3,464	3,755	92.3%	40	88	16,100
1981	3,343	1,976	357	2,333	5,676	6,197	91.6%	50	89	23,800
1982	4,035	2,490	542	3,032	7,067	8,048	87.8%	47	92	31,875
1983	4,775	4,289	686	4,975	9,750	11,180	87.2%	53	93	56,198
1984	4,678	3,025	484	3,509	8,187	9,395	87.1%	44	67	21,444
1985	3,808	2,670	418	3,088	6,896	6,231	110.7%	33	85	NA
1986	2,222	1,989	329	2,318	4,540	4,487	101.2%	23	88	21,630
1987	1,687	1,542	295	1,837	3,524	3,354	105.1%	33	106	24,369
1988	1,567	1,244	250	1,494	3,061	2,578	118.7%	31	95	15,031
1989	1,416	992	175	1,167	2,583	2,291	112.7%	51	89	18,403
1990	1,574	1,131	186	1,317	2,891	2,407	120.1%	45	91	23,688
1991	2,491	1,350	190	1,540	4,031	3,451	116.8%	52	91	24,455
1992	2,531	1,757	228	1,985	4,516	3,427	131.8%	48	77	27,633
1993	1,670	755	95	850	2,520	2,285	110.3%	66	60	23,378
1994	2,198	772	84	856	3,054	2,805	108.9%	56	87	25,840
1995	2,102	893	131	1,024	3,126	2,889	108.2%	54	75	23,768
1996	2,067	692	61	753	2,820	2,522	111.8%	51	80	28,325
1997	2,064	727	58	785	2,849	2,998	95.0%	48	68	24,754
1998	2,332	508	74	582	2,914	3,049	95.6%	49	80	30,945
1999	2,234	629	102	731	2,965	3,238	91.6%	51	78	31,869
2000	2,383	658	102	760	3,143	3,434	91.5%	55	74	34,161
2001	1,897	443	85	528	2,425	3,147	77.1%	47	67	31,023
2002	2,054	312	63	375	2,429	2,823	86.0%	45	74	34,146
2003	2,324	718	122	840	3,164	3,386	93.4%	65	84	36,253
2004	2,458	693	114	807	3,265	3,387	96.4%	42	85	38,059
2005	2,397	822	143	965	3,362	3,590	93.6%	62	85	39,752
2006	2,922	1,186	133	1,319	4,241	4,434	95.6%	59	73	39,621
2007	3,691	1,999	227	2,226	5,917	5,915	100.0%	61	65	55,287
2008	3,838	2,412	271	2,683	6,521	6,549	99.6%	57	55	46,949
2009	3,926	2,731	363	3,094	7,020	7,173	97.9%	54	65	43,611
2010	3,612	2,736	377	3,113	6,725	7,254	92.7%	62	56	38,795
2011	2,931	1,978	359	2,337	5,268	5,722	92.1%	50	70	34,253
2012	2,512	1,481	276	1,757	4,269	4,826	88.5%	44	63	31,065
Total	88,019	48,618	7,546	56,164	144,183	148,227				
Average	2,667	1,473	229	1,702	4,369	4,492	99.7%	50	78	31,140
1980's AVG	2,981	2,124	370	2,494	5,475	5,752	99.4%	40	89	25,428
1990's AVG	2,126	921	121	1,042	3,169	2,907	109.0%	52	78	26,466
2000's AVG	2,789	1,197	162	1,360	4,149	4,384	93.1%	55	73	39,886
2010's AVG	3,018	2,065	337	2,402	5,421	5,934	91.1%	52	63	34,704
Minimum	1,416	312	58	375	2,425	2,285	77.1%	23	55	15,031
Maximum	4,775	4,289	686	4,975	9,750	11,180	131.8%	66	106	56,198

**Table 24. Pronghorn harvest, sex and age ratio and population data - WY Herd Unit 748 (North Converse). Sage Creek herd unit was combined with N. Converse in 1985.
The Omsby herd unit was combined with N. Converse in 1997
Age and sex ratio data from 1980-1997 is an average between Sage Creek and Omsby herd units.**

YEAR	HARVEST DATA					HUNTER DATA		AGE & SEX RATIO		POP Size Estimate
	Total Males	Total Females	Total Young	Total Antlerless	Total Harvest	Total Hunters	Hunter Suc.	Total M /100 F	Young /100 F	
1980	1,926	984	174	1,158	3,084	3,290	93.7%	48	103	17,000
1981	2,912	2,476	178	2,654	5,566	6,007	92.7%	51	83	18,150
1982	3,359	2,920	427	3,347	6,706	7,338	91.4%	56	91	29,654
1983	3,630	2,978	408	3,386	7,016	7,385	95.0%	67	88	41,909
1984	3,198	2,213	329	2,542	5,740	6,183	92.8%	57	70	30,401
1985	3,517	2,283	378	2,661	6,178	5,520	111.9%	45	90	18,573
1986	2,172	1,590	270	1,860	4,032	3,879	103.9%	42	97	19,981
1987	1,784	1,123	205	1,328	3,112	2,821	110.3%	58	103	23,122
1988	1,653	1,040	163	1,203	2,856	2,255	126.7%	53	89	26,888
1989	1,756	964	223	1,187	2,943	2,345	125.5%	54	92	28,820
1990	1,905	1,053	142	1,195	3,100	2,416	128.3%	64	91	27,646
1991	2,476	1,556	209	1,765	4,241	3,090	137.2%	70	86	32,927
1992	2,202	2,334	245	2,579	4,781	2,823	169.4%	67	82	35,807
1993	1,555	1,093	82	1,175	2,730	1,945	140.4%	64	51	26,925
1994	1,914	1,077	176	1,253	3,167	2,442	129.7%	66	92	30,931
1995	1,634	831	166	997	2,631	1,920	137.0%	64	81	23,299
1996	1,966	401	56	457	2,423	2,151	112.6%	65	104	22,879
1997	1,636	424	47	471	2,107	2,168	97.2%	61	73	20,735
1998	1,713	285	28	313	2,026	2,171	93.3%	78	96	23,461
1999	1,651	257	40	297	1,948	2,091	93.2%	61	83	25,330
2000	1,590	400	35	435	2,025	2,191	92.4%	60	87	26,341
2001	1,284	278	38	316	1,600	1,838	87.1%	53	73	25,970
2002	1,235	353	18	371	1,606	1,755	91.5%	54	86	25,715
2003	1,173	334	66	400	1,573	1,689	93.1%	56	80	23,272
2004	1,204	334	61	395	1,599	1,655	96.6%	51	87	29,356
2005	1,295	555	85	640	1,935	1,990	97.2%	65	75	32,133
2006	1,233	525	38	563	1,796	1,929	93.1%	52	84	31,891
2007	1,486	708	84	792	2,278	1,981	115.0%	65	81	31,028
2008	1,618	711	99	810	2,428	2,410	100.7%	62	67	27,967
2009	1,689	926	35	961	2,650	2,901	91.3%	74	77	37,083
2010	1,861	1,188	135	1,323	3,184	3,323	95.8%	79	67	34,808
2011	2,163	1,113	105	1,218	3,381	3,663	92.3%	64	76	25,521
2012	1,759	1,260	150	1,410	3,169	3,822	82.9%	59	66	20,432
Total	64,149	36,567	4,895	41,462	105,611	101,387				
Average	1,944	1,108	148	1,256	3,200	3,072	106.4%	60	83	27,150
1980's AVG	2,591	1,857	276	2,133	4,723	4,702	104.4%	53	89	25,450
1990's AVG	1,865	931	119	1,050	2,915	2,322	123.8%	66	84	26,994
2000's AVG	1,381	512	56	568	1,949	2,034	95.8%	59	80	29,076
2010's AVG	1,928	1,187	130	1,317	3,245	3,603	90.3%	67	70	26,920
Minimum	1,173	257	18	297	1,573	1,655	82.9%	42	51	17,000
Maximum	3,630	2,978	427	3,386	7,016	7,385	169.4%	79	104	41,909

Table 25. Pronghorn harvest, sex and age ratio and population data - MT Hunting District 702.

YEAR	HARVEST DATA					HUNTER DATA		PRESEASON A & S RATIO		POP Size Estimate (1)
	Total Males	Total Females	Total Young	Total Antlerless	Total Harvest	Total Hunters	Hunter Suc.	Total M /100 F	Young /100 F	
1980										
1981										
1982										
1983										
1984	13	65		65	78	86	90.7%			
1985	69	35		35	104	171	60.8%			
1986	125	74		74	199	247	80.6%			
1987	209	198		198	407	474	85.9%			
1988	351	282		282	633	715	88.5%			
1989	286	182		182	468	675	69.3%			
1990	322	152		152	474	628	75.5%			
1991	211	100		100	311	498	62.4%			
1992	302	229		229	531	682	77.9%			
1993	297	150		150	447	645	69.3%			
1994	289	297		297	586	797	73.5%			
1995	446	238		238	684	761	89.9%			
1996	304	128		128	432	642	67.3%			
1997										
1998										
1999										1,914
2000	318	166		166	484	620	78.1%			2,903
2001										3,146
2002	242	112		112	354	470	75.3%			1,942
2003	316	219		219	535	638	83.9%			2,622
2004										3,788
2005	213	229		229	442	442	100.0%			4,198
2006	279	164		164	443	473	93.7%			3,746
2007	244	320		320	564	718	78.6%			4,654
2008	286	145		145	431	537	80.3%			3,980
2009	294	203		203	497	596	83.4%			3,481
2010	243	78		78	321	454	70.7%			2,137
2011	110	29		29	139	256	54.3%			1,062
2012	98	12		12	110	198	55.6%			2,097
2013										2,314
Total	5,867	3,807		3,807	9,674	12,423	1845.3%			
Average	244	159		159	403	518	76.9%			2,932
1980's AVG	176	139		139	315	395	79.3%			
1990's AVG	310	185		185	495	665	73.7%			1,914
2000's AVG	274	195		195	469	562	84.1%			3,446
2010's AVG	150	40		40	190	303	60.2%			1,903
Minimum	13	12		12	78	86	54.3%			1,062
Maximum	446	320		320	684	797	100.0%			4,654

1) Population size estimate is based upon combined density estimate (PH/sq. mi.) X estimated size of the occupied habitat (grassland & sagebrush = ~1,808 sq mi) in HD702.

Table 26. Pronghorn harvest, sex and age ratio and population data - MT Hunting District 704.

YEAR	HARVEST DATA					HUNTER DATA		PRESEASON A & S RATIO (1)		POP Size Estimate (2)	Population Trend (3) A&S Sample Size
	Total Males	Total Females	Total Young	Total Antlerless	Total Harvest	Total Hunters	Hunter Suc.	Total M /100 F	Young /100 F		
1980											
1981											
1982											
1983											
1984	403	710		710	1,113	1,209	92.1%				
1985	640	579		579	1,219	1,145	106.5%				
1986	585	397		397	982	996	98.6%				
1987	593	531		531	1,124	1,141	98.5%				
1988	720	546		546	1,266	1,349	93.8%				
1989	665	332		332	997	1,344	74.2%				
1990	870	540		540	1,410	1,565	90.1%				
1991	887	576		576	1,463	1,680	87.1%				
1992	909	623		623	1,532	1,731	88.5%				
1993	1,060	726		726	1,786	1,954	91.4%				
1994	901	899		899	1,800	2,171	82.9%				
1995	770	734		734	1,504	1,908	78.8%				
1996	662	243		243	905	1,410	64.2%				
1997											
1998											
1999										3,453	
2000	423	262		262	685	866	79.1%			4,460	
2001										4,854	
2002	500	255		255	755	888	85.0%			4,158	
2003	482	305		305	787	890	88.4%			3,799	
2004										5,846	
2005	462	372		372	834	861	96.9%			7,931	
2006	578	417		417	995	901	110.4%			8,112	
2007	765	599		599	1,364	1,441	94.7%			7,182	
2008	578	340		340	918	1,211	75.8%	57	38	6,142	1,392
2009	607	415		415	1,022	1,217	84.0%	40	28	5,372	853
2010	406	144		144	550	795	69.2%	45	19	3,297	639
2011	304	40		40	344	605	56.9%	42	26	1,638	719
2012	190	32		32	222	328	67.7%	29	35	6,034	1,079
2013										10,386	
Total	14,960	10,617		10,617	25,577	29,606					
Average	623	442		442	1,066	1,234	85.6%	43	29	5,511	936
1980's AVG	601	516		516	1,117	1,197	93.9%				
1990's AVG	866	620		620	1,486	1,774	83.3%			3,453	
2000's AVG	549	371		371	920	1,034	89.3%	49	33	5,786	1,123
2010's AVG	300	72		72	372	576	64.6%	39	27	5,339	812
Minimum	190	32		32	222	328	56.9%	29	19	1,638	639
Maximum	1,060	899		899	1,800	2,171	110.4%	57	38	10,386	1,392

1) Preseason age and sex ratio based upon Powder R. basin trend study area only (655 sq. mi.).

2) Population size estimate is based upon combined density estimate (PH/sq. mi.) X estimated size of the occupied habitat (grassland & sagebrush = 3,657 sq mi) in HD704

3) Population trend is based upon the age and sex ratio sample size for the Powder River Basin trend area.

Table 27. Pronghorn harvest, sex and age ratio and population data - MT Hunting District 705.

YEAR	HARVEST DATA					HUNTER DATA		PRESEASON A & S RATIO (1)		POP Size Estimate (3)	Population Trend (2) A&S Sample Size
	Total Males	Total Females	Total Young	Total Antlerless	Total Harvest	Total Hunters	Hunter Suc.	Total M /100 F	Young /100 F		
1980								19	45		
1981								56	96		
1982											
1983								63	106		
1984	883	2,777		2,777	3,660	3,922	93.3%	48	47		
1985	1,164	601		601	1,765	2,513	70.2%	59.3	81.5		1,741
1986	692	415		415	1,107	1,073	103.2%	55.6	100.0		1,452
1987	611	543		543	1,154	1,263	91.4%	50.0	112.6		
1988	998	948		948	1,946	1,897	102.6%	58.3	98.4		
1989	1,266	969		969	2,235	2,434	91.8%	64.8	109.8		1,348
1990	1,452	1,118		1,118	2,570	2,458	104.6%	51.8	104.8		1,601
1991	1,216	924		924	2,140	2,332	91.8%	57.2	104.8		
1992	1,698	1,360		1,360	3,058	3,060	99.9%	49.0	103.7		
1993	1,571	1,331		1,331	2,902	2,955	98.2%				
1994	1,450	2,429		2,429	3,879	3,552	109.2%	59.0	114.5		2,245
1995	1,559	1,623		1,623	3,182	3,635	87.5%	51.9	98.7		1,501
1996	1,154	505		505	1,659	2,139	77.6%	49.8	96.7		1,035
1997								48.0	107.2		888
1998								51.1	113.1		806
1999								97.5	107.5	6,553	366
2000	938	696		696	1,634	1,675	97.6%	101.2	120.8	6,447	541
2001								58.1	77.1	10,511	882
2002	953	585		585	1,538	1,498	102.7%	56.9	97.1	8,295	696
2003	1,165	803		803	1,968	1,894	103.9%	61.1	93.3	13,491	1,132
2004								64.2	88.2	11,834	987
2005	810	920		920	1,730	1,525	113.4%	83.1	81.7	15,743	1,316
2006	1,252	1,199		1,199	2,451	1,786	137.2%	61.6	82.6	17,364	1,458
2007	1,496	1,391		1,391	2,887	2,474	116.7%	76.7	83.2	23,347	1,959
2008	1,115	1,006		1,006	2,121	2,148	98.7%	79.7	70.8	21,130	1,773
2009	948	892		892	1,840	2,051	89.7%	55.8	82.6	15,767	1,218
2010	749	206		206	955	1,212	78.8%	61.1	90.7	13,002	1,088
2011	477	91		91	568	806	70.5%	57.4	72.2	7,198	604
2012	315	46		46	361	550	65.6%	59.8	85.8	10,333	
2013								70.3	90.3	13,188	
Total	25,932	23,378		23,378	49,310	50,852					
Average	1,081	974		974	2,055	2,119	95.7%	61	93	12,947	1,211
1980's AVG	936	1,042		1,042	1,978	2,184	92.1%	53	88		
1990's AVG	1,443	1,327		1,327	2,770	2,876	95.5%	57	106	6,553	1,206
2000's AVG	1,085	937		937	2,021	1,881	107.5%	70	88	14,393	1,196
2010's AVG	514	114		114	628	856	71.6%	62	85	10,930	846
Minimum	315	46		46	361	550	65.6%	19	45	6,447	366
Maximum	1,698	2,777		2,777	3,879	3,922	137.2%	101	121	23,347	2,245

1) Age and sex ratio is the summary from S. Deadboy, Thompson Cr. and Medicine Rocks trend areas (see Table 21A).
All three trend areas were reduced in size starting in 1984.

2) Population trend is based upon the combined age and sex ratio sample size when all three trend areas were flown for the particular since 1984 year.

3) Population size estimate is based upon combined density estimate (PH/sq mi) X estimated size of the occupied habitat (grassland & sagebrush) in HD705

Table 27A. MT HD 705 - Pronghorn preseason Age & Sex Ratio data from trend areas.

S Deadboy A&S					Thompson Cr. A&S				Medicine Rocks A&S				Total HD 705			Combined (1)		Combined	
YEAR	Bucks	Doe	Fawn	Total	Bucks	Doe	Fawn	Total	Bucks	Doe	Fawn	Total	Bucks	Doe	Fawn	Sample Size (Trend)	Buck Ratio	Fawn Ratio	
1984	200	214	199	613	425	445	413	1283											
1985	146	222	214	582	237	398	304	939	46	103	71	220	429	723	589	1,741	59.3	81.5	
1986	80	181	203	464	181	285	263	729	55	102	102	259	316	568	568	1,452	55.6	100.0	
1987	169	298	363	830	117	274	281	672					286	572	644	1,502	50.0	112.6	
1988	110	253	213	576	144	183	216	543					254	436	429	1,119	58.3	98.4	
1989	159	234	255	648	81	183	187	451	78	74	97	249	318	491	539	1,348	64.8	109.8	
1990	143	309	345	797	132	215	211	558	48	100	98	246	323	624	654	1,601	51.8	104.8	
1991	186	262	283	731	184	385	395	964					370	647	678	1,695	57.2	104.8	
1992	241	351	355	947	186	521	549	1256					427	872	904	2,203	49.0	103.7	
1993																0			
1994	199	317	368	884	197	329	400	926	88	175	172	435	484	821	940	2,245	59.0	114.5	
1995	142	250	244	636	116	220	237	573	53	129	110	292	311	599	591	1,501	51.9	98.7	
1996	69	119	135	323	106	189	176	471	34	112	95	241	209	420	406	1,035	49.8	96.7	
1997	24	51	70	145	98	209	231	538	45	88	72	205	167	348	373	888	48.0	107.2	
1998	28	87	114	229	65	100	130	295	63	118	101	282	156	305	345	806	51.1	113.1	
1999	42	54	70	166				0	75	66	59	200	117	120	129	366	97.5	107.5	
2000	49	52	71	172	107	75	95	277	14	41	37	92	170	168	203	541	101.2	120.8	
2001	68	92	66	226	81	199	164	444	69	84	59	212	218	375	289	882	58.1	77.1	
2002	19	74	81	174	99	149	148	396	38	51	37	126	156	274	266	696	56.9	97.1	
2003	65	146	123	334	129	194	204	527	78	105	88	271	272	445	415	1,132	61.1	93.3	
2004	96	157	163	416	98	171	136	405	57	63	46	166	251	391	345	987	64.2	88.2	
2005	153	153	127	433	195	280	237	712	65	64	42	171	413	497	406	1,316	83.1	81.7	
2006	142	204	198	544	191	318	244	753	35	75	51	161	368	597	493	1,458	61.6	82.6	
2007	294	338	284	916	198	254	242	694	86	162	101	349	578	754	627	1,959	76.7	83.2	
2008	337	367	280	984	160	247	193	600	67	94	28	189	564	708	501	1,773	79.7	70.8	
2009	142	257	237	636	115	213	177	505	28	41	8	77	285	511	422	1,218	55.8	82.6	
2010	124	219	202	545	112	170	159	441	28	43	31	102	264	432	392	1,088	61.1	90.7	
2011	69	103	95	267	63	99	74	236	19	61	21	101	151	263	190	604	57.4	72.2	
2012	79	137	120	336	75	98	99	272	23	61	35	119	177	296	254	727	59.8	85.8	
2013	83	121	110	314	113	158	142	413					196	279	252	727	70.3	90.3	
2014	75	94	105	274	117	198	161	476					192	292	266	750	65.8	91.1	

(1) Bold = all three trend areas were flown in a the same year and can be used as a population trend data point

Table 28. Elk harvest, sex and age ratio and population data - MT Hunting District 702.

YEAR	HARVEST DATA					HUNTER DATA		PRESEASON A & S RATIO		POP Size Estimate (1)
	Total Males	Total Females	Total Young	Total Antlerless	Total Harvest	Total Hunters	Hunter Suc.	Total M /100 F	Young /100 F	
1980										
1981										
1982										
1983										
1984										
1985										
1986										
1987										
1988										
1989										
1990										
1991										
1992	3	0		0	3					
1993	10	0		0	10					
1994	1	0		0	1					
1995	3	0		0	3					
1996	0	0		0	0					
1997	0	0		0	0					
1998	1	0		0	1					
1999	5	2		2	7					
2000	15	5		5	20					
2001	13	35		35	48					
2002	16	31		31	47					
2003	6	11		11	17					
2004	13	22		22	35	198	17.7%			
2005	9	27		27	36	150	24.0%			
2006	7	22		22	29	180	16.1%			
2007	21	24		24	45	226	19.9%			
2008	26	24		24	50	254	19.7%			
2009	35	8		8	43	275	15.6%			
2010	34	47		47	81	326	24.8%			
2011	38	43		43	81	363	22.3%			
2012	23	105		105	128	523	24.5%	78	71	
2013	29	74		74	103					
2014										1,174
Total	308	480	0	480	788	2,495				
Average	14	22		22	36	277	21%	78	71	1,174
1980's AVG										
1990's AVG	3	0		0	3					
2000's AVG	16	21		21	37	214	19%			
2010's AVG	31	67		67	98	404	24%	78	71	1,174
Minimum	0	0	0	0	0	150	16%	78	71	1,174
Maximum	38	105	0	105	128	523	25%	78	71	1,174

Table 29. Elk harvest, sex and age ratio and population data - MT Hunting District 704.

YEAR	HARVEST DATA					HUNTER DATA		A & S RATIO (1)		POP Size Estimate (2)
	Total Males	Total Females	Total Young	Total Antlerless	Total Harvest	Total Hunters	Hunter Suc.	Total M /100 F	Young /100 F	
1980										
1981										
1982										
1983										
1984										
1985										
1986										
1987										
1988										
1989										
1990										
1991										
1992	4	2		2	6					
1993	6	0		0	6					
1994	6	0		0	6					
1995	16	0		0	16					
1996	0	0		0	0					
1997	0	0		0	0					
1998	5	5		5	10					
1999	9	6		6	15					
2000	18	12		12	30					
2001	32	16		16	48					
2002	31	54		54	85					
2003	24	52		52	76					
2004	34	52		52	86	535	16.1%			
2005	44	49		49	93	533	17.4%			
2006	44	65		65	109	458	23.8%	19	48	
2007	52	44		44	96	577	16.6%			
2008	73	77		77	150	678	22.1%	25	53	
2009	69	74		74	143	840	17.0%	28	28	
2010	55	85		85	140	745	18.8%	34	46	
2011	54	121		121	175	817	21.4%	19	40	
2012	54	94		94	148	719	20.6%	17	44	1,070
2013	92	122		122	214					
2014										
Total	722	930	0	930	1,652	5,902				
Average	33	42		42	75	656	19%	24	43	1,070
1980's AVG										
1990's AVG	6	2		2	7					
2000's AVG	42	50		50	92	604	19%	24	43	
2010's AVG	64	106		106	169	760	20%	23	43	1,070
Minimum	0	0	0	0	0	458	16%	17	28	1,070
Maximum	92	122	0	122	214	840	24%	34	53	1,070

1) All data is post-hunting season age and sex ratio data. 2009 & 2010 from Powder R. area. 2006, 2008, 2011 is from Custer National Forest. 2012 is a combined survey of 856 elk (see Table 1 from Waltree 2013)

2) Full coverage survey assuming 80% of the elk were observed

Table 30. Elk harvest, sex and age ratio and population data - MT Hunting District 705.

YEAR	HARVEST DATA					HUNTER DATA		POSTSEASON A & S RATIO		POP Size Estimate (1)
	Total Males	Total Females	Total Young	Total Antlerless	Total Harvest	Total Hunters	Hunter Suc.	Total M /100 F	Young /100 F	
1980										
1981										
1982										
1983										
1984										
1985										
1986										
1987										
1988										
1989										
1990										
1991										
1992										
1993										
1994										
1995										
1996										
1997										
1998										
1999	6	0		0	6					
2000	7	0		0	7					
2001	0	0		0	0					
2002	2	11		11	13					
2003	3	10		10	13					
2004	9	15		15	24	147	16.3%			
2005	21	41		41	62	209	29.7%			
2006	28	24		24	52	206	25.2%			
2007	24	29		29	53	193	27.5%			
2008	15	18		18	33	186	17.7%			
2009	20	15		15	35	180	19.4%			
2010	28	23		23	51	239	21.3%			
2011	27	35		35	62	274	22.6%			
2012	26	23		23	49	277	17.7%	41	53	
2013	35	23		23	58					432
2014										
Total	251	267		267	518	1,911				
Average	17	18		18	35	212	22%	41	53	432
1980's AVG										
1990's AVG	6	0		0	6					
2000's AVG	13	16		16	29	187	23%			
2010's AVG	29	26		26	55	263	21%	41	53	432
Minimum	0	0		0	0	147	16%	41	53	432
Maximum	35	41		41	62	277	30%	41	53	432

Table 31. Mule deer harvest, sex and age ratio and population data - MT Hunting District 702.

YEAR	HARVEST DATA					HUNTER DATA (1)		POST-SEASON A & S RATIO (2)		POP Size Trend (3)
	Total Males	Total Females	Total Young	Total Antlerless	Total Harvest	Total Hunters	Hunter Suc.	Total M /100 F	Young /100 F	
1980	1,056	0		0	1,056	2,308	46%			
1981	480	156		156	636	1,071	59%			
1982	893	307		307	1,200	2,033	59%			
1983	1,855	1525		1,525	3,380	3,977	85%			
1984	1,542	3865		3,865	5,407	6,059	89%			
1985	878	1189		1,189	2,067	4,082	51%	31.8	45.5	82
1986	923	196		196	1,119	2,178	51%			
1987	1,028	391		391	1,419	2,452	58%			
1988	1,027	461		461	1,488	2,437	61%			
1989	1,135	635		635	1,770	2,380	74%			
1990	1,283	923		923	2,206	2,702	82%			
1991	1,213	784		784	1,997	2,575	78%			
1992	1,557	969		969	2,526	3,205	79%			
1993	1,432	1002		1,002	2,434	3,078	79%			
1994	1,402	1226		1,226	2,628	3,214	82%			
1995	1,279	884		884	2,163	3,108	70%			
1996	1,106	702		702	1,808	2,673	68%			
1997	900	425		425	1,325	2,718	49%			
1998	786	381		381	1,167	2,298	51%			
1999	856	249		249	1,105	2,454	45%	17.2	71.3	164
2000	829	459		459	1,288	2,162	60%	13.2	53.3	325
2001	981	398		398	1,379	2,283	60%			
2002	1,186	540		540	1,726	2,525	68%	14.7	50.7	124
2003	1,190	801		801	1,991	2,587	77%	24.7	71.9	175
2004	1,246	778	18	796	2,042	2,626	78%	40.0	65.7	144
2005	966	388	17	405	1,371	2,076	66%	25.4	90.5	136
2006	1,033	645	11	656	1,689	1,824	93%	31.2	83.0	302
2007	1,041	762	10	772	1,813	2,284	79%	33.3	47.3	168
2008	909	585	15	600	1,509	2,269	67%			
2009	1,042	589	12	601	1,643	2,508	66%	25.4	64.4	112
2010	859	413	0	413	1,272	2,439	52%			
2011	936	283	4	287	1,223	2,416	51%	12.5	45.8	76
2012	877	161	4	165	1,042			48.9	84.4	105
2013								36.7	106.7	73
Total	35,726	23,072	91	23,163	58,889	85,001				
Average	1,083	699	10	702	1,785	2,656	67%	27	68	153
1980's AVG	1,082	873		873	1,954	2,898	63%	32	45	82
1990's AVG	1,181	755		755	1,936	2,803	68%	17	71	164
2000's AVG	1,042	595	14	603	1,645	2,314	71%	26	66	186
2010's AVG	891	286	3	288	1,179	2,428	51%	33	79	85
Minimum	480	0	0	0	636	1,071	45%	13	45	73
Maximum	1,855	3,865	18	3,865	5,407	6,059	93%	49	107	325

(1) Hunters include whitetail deer hunters

(2) Age and sex ratio surveys are based upon a post-hunt sample from the Sarpy trend area only - see table 25A.

(3) Winter or post-hunt trend count only for Sarpy survey area in HD 702 (see Table 25A.)

Table 31A . Mule deer posthunt age and sex ratio data for Hunt District 702.

Survey Area	Year	Female	Male	Young	Total	M:100F	Y:100F
Sarpy	1980-81						
Sarpy	1981-82						
Sarpy	1982-83						
Sarpy	1983-84						
Sarpy	1984-85						
Sarpy	1985-86	44	14	20	82	31.8	45.5
Sarpy	1986-87						
Sarpy	1987-88						
Sarpy	1988-89						
Sarpy	1989-90						
Sarpy	1990-91						
Sarpy	1991-92						
Sarpy	1992-93						
Sarpy	1993-94						
Sarpy	1994-95						
Sarpy	1995-96						
Sarpy	1996-97						
Sarpy	1997-98						
Sarpy	1998-99						
Sarpy	1999-00	87	15	62	164	17.2	71.3
Sarpy	2000-01	197	26	105	325	13.2	53.3
Sarpy	2001-02						
Sarpy	2002-03	75	11	38	124	14.7	50.7
Sarpy	2003-04	89	22	64	175	24.7	71.9
Sarpy	2004-05	70	28	46	144	40.0	65.7
Sarpy	2005-06	63	16	57	136	25.4	90.5
Sarpy	2006-07	141	44	117	302	31.2	83.0
Sarpy	2007-08	93	31	44	168	33.3	47.3
Sarpy	2008-09						
Sarpy	2009-10	59	15	38	112	25.4	64.4
Sarpy	2010-11						
Sarpy	2011-12	48	6	22	76	12.5	45.8
Sarpy	2012-13	45	22	38	105	48.9	84.4
Sarpy	2013-14	30	11	32	73	36.7	106.7

Table 32. Mule deer harvest, sex and age ratio and population data - MT Hunting District 704.

YEAR	HARVEST DATA					HUNTER DATA (1)		POSTSEASON A & S RATIO (2)		POP Size Trend (3)
	Total Males	Total Females	Total Young	Total Antlerless	Total Harvest	Total Hunters	Hunter Suc.	Total M /100 F	Young /100 F	
1980	1,846	14		14	1,860	3,693	50%			
1981	1,310	79		79	1,389	1,955	71%			
1982	1,802	844		844	2,646	3,595	74%			
1983	3,129	2,510		2,510	5,639	6,690	84%			
1984	2,274	4,221		4,221	6,495	7,084	92%			
1985	1,468	853		853	2,321	4,600	50%	32.8	21.3	
1986	1,662	241		241	1,903	3,298	58%			
1987	1,691	411		411	2,102	3,291	64%			
1988	2,084	362		362	2,446	3,454	71%			
1989	2,210	1,358		1,358	3,568	4,233	84%			
1990	2,865	1,738		1,738	4,603	5,065	91%			
1991	2,438	1,813		1,813	4,251	4,816	88%			
1992	3,298	2,174		2,174	5,472	6,239	88%			
1993	3,090	2,043		2,043	5,133	6,238	82%			
1994	3,277	2,663		2,663	5,940	6,678	89%			
1995	3,191	2,470		2,470	5,661	7,189	79%			
1996	2,737	1,450		1,450	4,187	5,900	71%	49.5	58.9	446
1997	2,296	947		947	3,243	5,654	57%	39.8	109.4	
1998	1,889	827		827	2,716	4,806	57%	20.8	125.5	
1999	2,487	576		576	3,063	5,070	60%	22.7	104.1	610
2000	2,052	883		883	2,935	4,400	67%	0.0	77.4	
2001	2,540	1,019		1,019	3,559	5,168	69%	18.3	63.4	338
2002	2,552	1,037		1,037	3,589	5,040	71%			
2003	2,272	1,138		1,138	3,410	4,829	71%			
2004	2,495	1,449	50	1,499	3,994	5,105	78%	21.5	80.0	
2005	2,264	882	35	917	3,181	4,486	71%	41.0	82.8	
2006	1,815	1,030	10	1,040	2,855	3,353	85%	54.5	55.8	1062
2007	2,059	1,312	15	1,327	3,386	4,233	80%	48.4	53.2	629
2008	2,071	1,202	23	1,225	3,296	4,394	75%	43.4	54.7	210
2009	1,972	1,160	29	1,189	3,161	4,898	65%	37.5	44.7	530
2010	1,752	740	14	754	2,506	4,918	51%	33.0	50.8	362
2011	1,807	416	8	424	2,231	4,695	48%	30.4	52.9	471
2012	1,574	247	3	250	1,824			32.2	62.7	538
2013	1,829	213	8	221	2,050	4,692	44%	23.4	73.4	571
Total	76,098	40,322	195	40,517	116,615	159,759				
Average	2,238	1,186	20	1,192	3,430	4,841	71%	32	69	524
1980's AVG	1,948	1,089		1,089	3,037	4,189	70%	33	21	
1990's AVG	2,757	1,670		1,670	4,427	5,766	76%	33	99	528
2000's AVG	2,209	1,111	27	1,127	3,337	4,591	73%	33	64	554
2010's AVG	1,741	404	8	412	2,153	4,768	47%	30	60	486
Minimum	1,310	14	3	14	1,389	1,955	44%	0	21	210
Maximum	3,298	4,221	50	4,221	6,495	7,189	92%	54	126	1,062

(1) Total hunters includes whitetailed deer hunters

(2) Age and sex ratio data is the combined totals of the Olive and Otter trend survey areas (see Table 26A).

(3) Trend count only for the years when both Olive and Otter trend areas were surveyed (see Table 26A).

Table 32A. MT HD 704 - Mule Deer postseason age & sex ratio data from the Olive and Otter trend areas.

Trend Area	Olive				Otter				Grand Total				Combined A & S		Pop Trend Total			
YEAR	Bucks	Doe	Fawn	Total	Bucks	Doe	Fawn	Total	Bucks	Doe	Fawn	Bucks	Doe	Fawn	Total	Buck Ratio	Fawn Ratio	Both Areas*
1980																		
1981																		
1982																		
1982																		
1984																		
1985					20	61	13	94				20	61	13		32.8	21.3	
1986																		
1987																		
1988																		
1989																		
1990																		
1991																		
1992																		
1993																		
1994																		
1995																		
1996	53	107	63	223	53	107	63	223				106	214	126	446	49.5	58.9	446
1997	68	171	187	426								68	171	187		39.8	109.4	
1998	31	149	187	367								31	149	187		20.8	125.5	
1999	61	238	256	555	0	31	24	55				61	269	280	610	22.7	104.1	610
2000				0	0	31	24	55				0	31	24		0.0	77.4	
2001	31	160	105	296	3	26	13	42				34	186	118	338	18.3	63.4	338
2002				0														
2003				0														
2004	14	65	52	131								14	65	52		21.5	80.0	
2005	176	429	355	960								176	429	355		41.0	82.8	
2006	242	439	243	924	33	66	39	138				275	505	282	1062	54.5	55.8	1062
2007	132	282	141	555	19	30	25	74				151	312	166	629	48.4	53.2	629
2008	39	77	38	154	7	29	20	56				46	106	58	210	43.4	54.7	210
2009	96	246	112	454	13	45	18	76				109	291	130	530	37.5	44.7	530
2010	62	177	91	330	3	20	9	32				65	197	100	362	33.0	50.8	362
2011	65	221	114	400	13	36	22	71				78	257	136	471	30.4	52.9	471
2012	84	248	164	496	5	28	9	42				89	276	173	538	32.2	62.7	538
2013	61	228	167	456	7	62	46	115				68	290	213	571	23.4	73.4	571
2014																		

* Pop trend is only computed when both trend areas were surveyed (see the last column).

Table 33. Mule deer harvest, sex and age ratio and population data - MT Hunting District 705.

YEAR	HARVEST DATA					HUNTER DATA (1)		POSTSEASON A & S RATIO (2)		POP Size Trend (3)
	Total Males	Total Females	Total Young	Total Antlerless	Total Harvest	Total Hunters	Hunter Suc.	Total M /100 F	Young /100 F	
1980	1,569	75		75	1,644	3,567	46%			
1981	1,878	506		506	2,384	4,434	54%			
1982	2,299	3,391		3,391	5,690	6,512	87%			
1983	3,290	4,659		4,659	7,949	10,407	76%			
1984	2,976	7,059		7,059	10,035	11,306	89%			
1985	1,316	1,974		1,974	3,290	6,344	52%			
1986	1,002	225		225	1,227	3103	40%			
1987	958	323		323	1,281	2,771	46%			
1988	1,457	347		347	1,804	2,943	61%			
1989	1,856	1,478		1,478	3,334	3,941	85%			
1990	1,927	1,431		1,431	3,358	3,847	87%			
1991	1,828	1,485		1,485	3,313	3,736	89%			
1992	1,958	2,328		2,328	4,286	4,977	86%			
1993	2,243	1,978		1,978	4,221	5,045	84%			
1994	2,193	2,730		2,730	4,923	6,060	81%			
1995	2,169	2,587		2,587	4,756	6,328	75%			
1996	1,847	1,214		1,214	3,061	4,746	64%			
1997	1,720	1,219		1,219	2,939	4,860	60%	28.3	74.5	215
1998	1,729	1,053		1,053	2,782	4,328	64%	26.8	73.2	
1999	2,127	250		250	2,377	4,440	54%	21.6	82.4	416
2000	1,818	906		906	2,724	4,233	64%	27.5	56.4	
2001	2,566	1,101		1,101	3,667	5,414	68%	47.0	65.2	
2002	2,362	1,238		1,238	3,600	5,019	72%	27.1	76.1	
2003	2,620	1,518		1,518	4,138	5,453	76%	16.4	61.2	
2004	2,416	1,359	86	1,445	3,861	5,178	75%	28.9	56.1	
2005	2,086	830	30	860	2,946	4,458	66%	19.3	67.3	474
2006	1,800	1,304	26	1,330	3,130	4,211	74%	31.2	72.4	627
2007	2,183	1,317	24	1,341	3,524	5,033	70%	46.6	83.6	647
2008	1,765	1,351	35	1,386	3,151	4,726	67%	30.2	68.1	
2009	1,789	1,185	22	1,207	2,996	4,763	63%	30.8	60.0	477
2010	1,512	594	25	619	2,131	4,678	46%	18.9	32.4	
2011	1,400	261	3	264	1,664	4,141	40%	25.1	58.6	351
2012	1,553	128	7	135	1,688			33.1	56.2	492
2013	1,651	135	6	141	1,792	4,274	42%	17.0	77.6	321
Total	65,863	49,539	264	49,803	115,666	165,276				
Average	1,937	1,457	26	1,465	3,402	5,008	67%	28	66	447
1980's AVG	1,860	2,004		2,004	3,864	5,533	64%			
1990's AVG	1,974	1,628		1,628	3,602	4,837	74%	26	77	316
2000's AVG	2,141	1,211	37	1,233	3,374	4,849	69%	31	67	556
2010's AVG	1,529	280	10	290	1,819	4,364	43%	24	56	388
Minimum	958	75	3	75	1,227	2,771	40%	16	32	215
Maximum	3,290	7,059	86	7,059	10,035	11,306	89%	47	84	647

(1) Total hunters includes whitetailed deer hunters.

(2) Age and sex ratio surveys are based upon post-hunt sample size for the combined totals of the Harding, Horse Creek and Tie Creek trend areas - (Table 27A)

(3) Trend count only for the combined totals of the Harding, Horse Creek and Tie Creek survey areas in HD 705 when all three trend areas were surveyed (see Table 27A).

Table 33A. MT HD 705 - Mule Deer postseason Age & Sex Ratio data from trend areas.

Trend Area	Harding				Horse Creek				Tie Creek				Grand Total				Combined A & S		Pop Trend total
YEAR	Bucks	Doe	Fawn	Total	Bucks	Doe	Fawn	Total	Bucks	Doe	Fawn	Total	Bucks	Doe	Fawn	Total	Buck Ratio	Fawn Ratio	All Three Areas *
1980																			
1981																			
1982																			
1982																			
1984																			
1985																			
1986																			
1987																			
1988																			
1989																			
1990																			
1991																			
1992																			
1993																			
1994																			
1995																			
1996																			
1997	19	57	42	118	1	30	20	51	10	19	17	46	30	106	79	215	28.3	74.5	215
1998	19	71	52	142				0				0	19	71	52	142	26.8	73.2	
1999	38	136	106	280	4	58	45	107	2	10	17	29	44	204	168	416	21.6	82.4	416
2000	44	189	111	344	40	116	61	217				0	84	305	172	561	27.5	56.4	
2001	48	112	76	236	14	20	10	44				0	62	132	86	280	47.0	65.2	
2002	17	78	63	158	34	110	80	224				0	51	188	143	382	27.1	76.1	
2003	11	67	41	119				0				0	11	67	41	119	16.4	61.2	
2004	45	139	80	264				0	9	48	25	82	54	187	105	346	28.9	56.1	
2005	20	97	76	193	8	56	36	100	21	101	59	181	49	254	171	474	19.3	67.3	474
2006	32	187	144	363	37	70	48	155	27	51	31	109	96	308	223	627	31.2	72.4	627
2007	63	178	147	388	48	65	60	173	20	38	28	86	131	281	235	647	46.6	83.6	647
2008	33	147	96	276	42	101	73	216				0	75	248	169	492	30.2	68.1	
2009	41	146	92	279	29	79	46	154	7	25	12	44	77	250	150	477	30.8	60.0	477
2010				0					7	37	12	56	7	37	12	56	18.9	32.4	
2011	18	92	43	153	15	63	51	129	15	36	18	69	48	191	112	351	25.1	58.6	351
2012	50	160	82	292	24	59	41	124	12	41	23	76	86	260	146	492	33.1	56.2	492
2013	14	92	71	177	12	51	36	99	2	22	21	45	28	165	128	321	17.0	77.6	321
2014																			

*Pop trend is only considered when all three trend areas were surveyed (see last column).

Table 34. Comparison of mule deer and whitetailed deer harvest for HD 702, 704 & 705 (1980-2003)

HD	702			704			705			All HD		
Year	MD Tot	WT Tot	Both Total	MD Tot	WT Tot	Both Total	MD Tot	WT Tot	Both Total	Tot MD	Tot WTD	Grand Tot
1980	1,056	159	1,215	1,860	282	2,142	1,644	728	2,372	4,560	1,169	5,729
1981	552	105	657	1,389	379	1,768	2,384	986	3,370	4,325	1,470	5,795
1982	934	250	1,184	2,646	236	2,882	5,690	898	5,742	9,270	1,384	10,654
1983	1,925	359	2,284	5,639	761	6,400	7,949	3,304	11,253	15,513	4,424	19,937
1984	1,631	608	2,239	6,495	711	7,206	10,035	2,238	12,273	18,161	3,557	21,718
1985	964	547	1,511	2,321	388	2,709	3,290	1,705	23,526	6,575	2,640	9,215
1986	923	380	1,303	1,903	312	2,215	1,227	1,160	2,387	4,053	1,852	5,905
1987	1,073	364	1,437	2,102	212	2,314	1,281	995	2,276	4,456	1,571	6,027
1988	1,027	317	1,344	2,446	246	2,692	1,804	783	4,663	5,277	1,346	6,623
1989	1,195	238	1,433	3,568	202	3,770	3,334	780	4,114	8,097	1,220	9,317
1990	1,342	269	1,611	4,603	257	4,860	3,358	730	4,088	9,303	1,256	10,559
1991	1,294	181	1,475	4,251	398	4,649	3,313	599	8,202	8,858	1,178	10,036
1992	1,627	314	1,941	5,472	458	5,930	4,286	1,142	5,428	11,385	1,914	13,299
1993	1,510	270	1,780	5,133	493	5,626	4,221	1,187	5,408	10,864	1,950	12,814
1994	1,482	329	1,811	5,940	632	6,572	4,923	1,805	10,836	12,345	2,766	15,111
1995	1,357	355	1,712	5,661	632	6,293	4,756	1,301	6,057	11,774	2,288	14,062
1996	1,106	428	1,534	4,187	833	5,020	3,061	1,376	4,437	8,354	2,637	10,991
1997	900	387	1,287	3,243	481	3,724	2,939	1,057	10,494	7,082	1,925	9,007
1998	828	317	1,145	2,716	385	3,101	2,782	874	3,656	6,326	1,576	7,902
1999	883	383	1,266	3,063	508	3,571	2,377	1,090	3,467	6,323	1,981	8,304
2000	862	340	1,202	2,935	625	3,560	2,724	1,194	7,123	6,521	2,159	8,680
2001	1,029	242	1,271	3,559	309	3,868	3,667	862	4,529	8,255	1,413	9,668
2002	1,186	323	1,509	3,589	294	3,883	3,600	963	4,563	8,375	1,580	9,955
2003	1,242	379	1,621	3,410	429	3,839	4,138	1,116	9,092	8,790	1,924	10,714
Total	27,928	7,844	35,772	88,131	10,463	98,594	88,783	28,873	117,656	204,842	47,180	252,022
% Harv	78%	22%		89%	11%		75%	25%		81%	19%	

Table 35. Greater sage-grouse harvest - Montana

YEAR	Harvest
1994	1,701
1995	2,034
1996	1,504
1997	1,365
1998	1,702
1999	1,795
2000	2,747
2001	1,013
2002	1,050
2003	1,004
2004	512
2005	576
2006	441
2007	593
2008	573
2009	386
Total	18,996
Average	1,187
1990's AVG	1,684
2000's AVG	890
Minimum	386
Maximum	2,747

Exhibit 21

***ENVIRONMENTAL ASSESSMENT
FOR SPRING CREEK COAL LEASE BY APPLICATION
MTM94378
EA# MT-020-2007-34***

Prepared by:

The United States Department of the Interior
Bureau of Land Management
Miles City Field Office

In Cooperation with

Montana Department of Environmental Quality
and
Office of Surface Mining Reclamation and Enforcement

November 2006

TABLE OF CONTENTS

ABBREVIATIONS AND ACRONYMS USED IN THIS REPORT	v
1.0 INTRODUCTION	1
1.1 Background	1
1.2 Purpose and Need	4
1.3 Regulatory Authority and Responsibility	4
1.4 Relationship to BLM Policies, Plans, and Programs	5
1.5 Conformance with Land Use Plan	5
1.6 Consultation and Coordination	9
2.0 PROPOSED ACTION AND ALTERNATIVES.....	11
2.1 Proposed Action.....	11
2.2 Alternative 1 - Proposed Action Less Acres Classified as Unsuitable	18
2.3 Alternative 2 - Proposed Action with Changes Based on Unsuitability Status	18
2.4 Alternative 3 - No Action Alternative.....	20
2.5 Relevant Regional Activity.....	20
2.5.1 Relevant Past and Present Actions.....	20
2.5.2 Reasonably Foreseeable Future Actions	22
2.5.3 Potential Future Actions	22
2.6 Comparison of Alternatives	23
3.0 AFFECTED ENVIRONMENT	27
3.1 General Setting.....	27
3.2 Topography and Physiography	27
3.3 Geology, Mineral Resources, and Paleontology	28
3.4 Air Quality	33
3.4.1 Background.....	33
3.4.2 Particulate Emissions.....	36
3.4.3 Blasting Emissions.....	36
3.4.4 Emission Control Techniques	36
3.4.5 Visibility	38
3.4.6 Acidification of Lakes.....	38
3.5 Water Resources	40
3.5.1 Groundwater	40
3.5.2 Surface Water	40
3.6 Alluvial Valley Floors.....	42
3.7 Wetlands	42
3.8 Soils	42
3.9 Vegetation.....	44
3.10 Wildlife	53
3.10.1 Big Game	53
3.10.2 Other Mammals	54
3.10.3 Raptors	55
3.10.4 Upland Game Birds.....	55
3.10.5 Other Birds.....	59
3.10.6 Amphibians and Reptiles, and Aquatic Species.....	59
3.10.7 Threatened or Endangered Species and Other Species of High Federal or State Interest	59
3.11 Ownership and Use of Land	60
3.12 Cultural Resources	60
3.12.1 Native American Consultation.....	66
3.13 Visual Resources.....	67
3.14 Noise	68
3.15 Transportation Facilities	70

3.16 Hazardous and Solid Waste	70
3.17 Socioeconomics	70
3.17.1 Local Economy	70
3.17.2 Population	71
3.17.3 Employment	72
3.17.4 Housing	72
3.17.5 Local Government Facilities and Services	73
3.17.6 Environmental Justice	73
4.0 ENVIRONMENTAL CONSEQUENCES	75
4.0.1 Mitigation	75
4.0.2 Direct and Indirect Effects Common to All Alternatives	75
4.0.3 Cumulative Effects Common to All Alternatives	75
4.1 Effects From Proposed Action	77
4.1.1 Topography and Physiography	77
4.1.2 Geology, Mineral Resources, and Paleontology	78
4.1.3 Air Quality	80
4.1.4 Water Resources	81
4.1.5 Alluvial Valley Floors	85
4.1.6 Wetlands	85
4.1.7 Soils	85
4.1.8 Vegetation	86
4.1.9 Wildlife	89
4.1.10 Land Use	94
4.1.11 Cultural Resources	96
4.1.12 Visual Resources	98
4.1.13 Noise	98
4.1.14 Transportation Facilities	99
4.1.15 Hazardous and Solid Waste	99
4.1.16 Socioeconomics	99
4.2 Effects From Alternative 1 – Removing All Unsuitable Without Exception Areas From Consideration	100
4.3 Effects From Alternative 2 – Removing Prairie Falcon Nest Site From Consideration	101
4.4 Effects From Alternative 3 - No Action	102
5.0 CONSULTATION AND COORDINATION	103
6.0 REFERENCES	104

particular, treatment of haul roads and stockpiles, covering of conveyors, and more rapid revegetation of disturbed areas have become the norm rather than just being used in special cases.

The nearest Class I area is located approximately 19 miles north of the proposed tracts at the Northern Cheyenne Indian Reservation. Should surface inversion occur in the northern portion of the Powder River Basin, cumulative impacts on air quality could be high in the short term in this area due to coal mining activities. This would be temporary, lasting only during the inversion. Air quality impacts would cease to occur after mining and reclamation are complete.

Air quality impacts related to oil and gas development would occur during construction (due to potential surface disturbance by earth-moving equipment, vehicle traffic fugitive dust, well testing, as well as drilling rig and vehicle engine exhaust) and production (including non-CBNG well production equipment, booster [field] and pipeline [sales] compression engine exhausts). The amount of air pollutant emissions during construction would be controlled by watering disturbed soils and by air pollutant emission limitations imposed by applicable air quality regulatory agencies. Maximum construction impacts from fugitive dust (24 hour PM₁₀) are estimated to be 55 µg/m³, about one third of the applicable MAAQS. Actual air quality impacts depend on the amount, duration, location, and emission characteristics of potential emissions sources, as well as meteorological conditions (wind speed and direction, precipitation, relative humidity, etc.). For additional information about the cumulative impact analyses and assumptions used in the cumulative air quality impact assessment, refer to the Wyoming Oil and Gas Project EIS (BLM 2003a), the Montana Final Statewide Oil and Gas EIS (BLM 2003b) and the Air Quality Impact Assessment Technical Support Document (Argonne 2002).

4.1.4 Water Resources

It is generally recognized that surface coal mining impacts local hydrology, including both the surface and groundwater systems. As a result, the analysis and mitigation of hydrologic impacts is carefully planned during the preparation of mining

permit application documents and is reviewed during the mining permit process.

4.1.4.1 Groundwater

Direct and Indirect Effects: The general impacts to groundwater as a result of surface coal mining include the following:

- Removal of the coal aquifer and any overburden and alluvial aquifers within the areas that are mined, and replacement of these aquifers with backfilled overburden material. Should any overburden or alluvial aquifer be critical to the area's hydrologic balance, and restoration of the essential hydrologic functions can only be achieved by reestablishment of the aquifer, these materials may be selectively salvaged and replaced.
- A lowering of static water levels in the coal and overburden aquifers around the mine due to dewatering associated with removal of these aquifers within the mine boundaries. This reduction in static water levels would not be permanent, and recharge to the backfill and adjacent undisturbed aquifers would occur as mined areas are reclaimed.
- Other groundwater impacts, which may or may not occur, or which may occur only at specific locations, include changes in water quality (usually deterioration) outside the area that is mined and reclaimed as a result of communication between the reclaimed aquifer and the unmined aquifer, and changes in recharge-discharge conditions and/or groundwater flow patterns.

The overburden and the A/D coal aquifer would be removed from the proposed LBA tracts during the mining process. These aquifers would be replaced with backfilled overburden and interburden materials. The physical characteristics of the reclaimed backfill material are dependent upon mining methods and premining overburden lithology. Overall, the permeability and porosity of the spoils at the proposed LBA tracts are expected to be greater than the original material. The reclaimed spoil aquifer could provide adequate water quantity for stock wells. The reclaimed spoil aquifer may be sufficient to support groundwater flow patterns that are similar to premining patterns, allowing for the fact that one aquifer (the reclaimed backfill aquifer) would

replace the original aquifer systems in the areas that are mined and reclaimed.

After mining and reclamation, groundwater discharges from the backfill aquifer could alter the water quality of the down gradient aquifers. The overburden is highly fractured by blasting and dragline removal, and the newly exposed particle surfaces contain quantities of leachable minerals and salts that dissolve in the invading groundwater as the mine backfill resaturates. According to a previous study (Clark 1995), the groundwater is moving from an upgradient coal aquifer to the backfill aquifer in the Spring Creek Mine area. As water moves from coal aquifer to the recently backfilled overburden, dissolved concentrations of sulfate, sodium, and bicarbonate ions have apparently increased, and thus the groundwater from the backfill aquifer has a higher TDS concentration than the water in the coal. The increased concentrations of sulfate and sodium in the backfill aquifer most likely results from the dissolution of gypsum, followed by the ionic exchange of calcium and magnesium ions in solution for sodium ions on the smectite clays in the backfill aquifer. The increase in bicarbonate concentration is likely due to the dissolution of calcite or dolomite. Under typical conditions at the Spring Creek Mine area, groundwater from the backfill will move downgradient the adjacent, unmined coal aquifer, which crops beneath the reservoir. The water in Tongue River Reservoir would dilute these constituents in solution, and therefore the elevated levels of TDS are expected to have no discernible effect on the use of the reservoir or its water. The reservoir has recently been enlarged, which further reduces the effect of the elevated TDS in the backfill aquifer discharges. The coal decreases the sulfate concentration level through sulfate reduction, and the water becomes less concentrated in sodium and bicarbonate. As a result, a reduction in the TDS concentration would occur.

Cumulative Effects: The cumulative impacts to groundwater as a result of surface coal mining and CBNG production are discussed as follows:

- The effect of the removal of the coal aquifer and any overburden aquifers within the mine area, and replacement of these aquifers with backfill material.

- The extent of the temporary lowering of static water levels in the aquifers around the mine due to dewatering associated with removal of these aquifers within the mine boundaries and CBNG production around the area.
- Changes in water quality as a result of mining.

The effects of replacing the coal and overburden aquifers with backfilled overburden are the foremost groundwater concern. Mining of the LBA tracts would increase the cumulative size of the backfill area in the Tongue River drainage basin.

Recharge to the backfill aquifer in the Spring Creek Mine is primarily by infiltration of direct precipitation on nearby scoria outcrops. Not all scoria is saturated, however. Some of the clinker is mined for road surfacing and railroad ballast, but saturated clinker is not generally mined since abundant clinker exists above the water table and does not present the mining problems that would result from mining saturated clinker. Therefore, no cumulative impacts to groundwater recharge areas would occur as a result of mining the tracts.

The second major groundwater issue is the extent of water level drawdown in the coal and shallower aquifers in the area surrounding the mines. The groundwater impacts that would be expected as a result of CBNG production and mining the LBA tracts would be the simultaneous pumping to release CBNG and dewater the active mine pits. Where the effects of pumping from mines (e.g., Spring Creek, North, West and East Decker mines) and CBNG production overlap, additional water level declines result from concurrent operations. The deeper coal aquifers are areally more continuous, and a possibility exists that the areas influenced by pumping related to CBNG production and pumping at the Spring Creek and Decker mines could locally overlap. Should this overlap occur, the decline in water levels in wells adversely affected would be the sum of the declines caused by dewatering in the nearby mines and pumping in the local CBNG fields. Domestic and stock wells that are completed in a coal seam near a producing CBNG field or located near active mines, are therefore within the potential drawdown area and anticipated to have decreased yields as a result of CBNG and mining related

drawdown. Springs that emit from the developed coal seam and are located within the potential drawdown area would also be anticipated to have decreased yields as a result of CBNG and mining related drawdown. The greater the magnitude of drawdown (such as that within producing fields and near active mine pits), the greater the decreases in yield would be. Only those wells completed within the dewatered coal seam would be affected by the CBNG pumping and/or mine dewatering since the coal seams are confined aquifers. Similarly, only the springs that emit from the developed coal seam would be affected.

Shallow coal aquifers located in the Tongue River Member of the Fort Union Formation stratigraphically above the A/D coal seam should not experience cumulative declines because these aquifers lack hydraulic continuity between the four existing mines and CBNG does not typically tap these shallow coal aquifers.

Fidelity Exploration & Production estimates the extent of the 20-year, 20-foot drawdown zone from the edge of the nearest proposed CBNG well field, which adjacent to the southernmost LBA tract, would be approximately 2.7 miles. Based on the three-dimensional groundwater modeling conducted for the MT FEIS, it was estimated that after 20 years of pumping, the 20-foot drawdown contour would likely extend 2.5 to 4.2 miles from well fields, unless limited by faulting or other hydrogeologic boundaries (BLM 2005). The exact radius of the drawdown cone, and the time required for the head to recover, would depend on the site specific aquifer properties, the precise timing of the pumping of each of the wells, and the overall nature of CBNG development in this region. After more than 5 years of CBNG production, drawdown of up to 20 feet has been measured in the coal seams at a distance of roughly 1 mile outside the production areas, close to, but slightly less than, the drawdown predicted (Montana Bureau of Mines and Geology 2005).

The third issue of concern with groundwater is the effect of CBNG production and mining on the water quality. Since all surface coal mines within the regional study area reclaim the active pits with backfill material, the concentration of dissolved solids and sulfates are expected to be higher in water from backfill aquifers than in water from undisturbed overburden or coal aquifers. This is

expected because blasting and movement of overburden materials exposes more mineral surface area to water, increasing the rate of dissolution of soluble materials. The spread of the dissolved solutes discharging from reclaimed areas would be difficult to predict. However, Montana State regulations require surface coal mine permittees to replace any groundwater supply for domestic, agricultural, industrial, or any other legitimate use if such a supply is diminished, interrupted, or contaminated, to the extent of precluding use of the water, as a result of mining.

Changes have occurred in the quality of water in shallow (i.e. alluvial) aquifers, in response to infiltrated CBNG produced water. TDS concentrations increased initially and are now being observed to decrease as the available salts are flushed from the systems. The trend of decreasing TDS concentration is expected to continue.

4.1.4.2 Surface Water

Direct and Indirect Effects: General impacts to surface water resulting from surface coal mining include the following:

- Disruption of the surface drainage system (stream channels and their watershed areas) during mining, requiring replacement of these systems during reclamation.
- Changes in streamflow patterns during mining caused by the regulatory requirement to store runoff and settle out solids; by construction of flood control reservoirs or diversion systems needed to prevent unacceptable levels of runoff from entering the pit; and by discharges of pit inflows to streams or other sources of water in excess of the mine's water requirements.
- Possible changes in runoff rates due to changes in precipitation infiltration rates on restored land.
- Changes in surface water quality.

The incremental impacts to the surface drainage system caused by mining the proposed LBA tracts would be minimal. Flow in Spring Creek is currently stored in reservoirs within the existing Spring Creek Mine and upstream of the nearby Decker Mine. Additional reservoirs upstream of the Spring Creek Mine on North and South Forks

Spring Creek reduce the volume of water reaching these lower reservoirs. These drainages have been diverted to prevent floodwaters from entering the pits and to store runoff and settle out solids. Loss of this water from the annual flow volume in the Tongue River and Tongue River Reservoir should have no measurable effect on downstream water resources.

Postmining Spring Creek, North Fork Spring Creek, and South Fork Spring Creek streamflows could be somewhat reduced from premining flows due to the reclaimed topography being more subdued and regular than the premining topography. As a result, more precipitation may be absorbed by the soil, and postmining runoff volumes and peak flows may be slightly lower than premining values. While impossible to quantify with accuracy, mine permit documents indicate that pre- and postmining peak discharges in stream channels that would be disturbed by mining compare favorably. The reduction in postmining runoff quantities due to topographic moderation may be offset somewhat by the fact that infiltration rates are initially smaller on reclaimed lands (for the first few years) than on unmined lands. Over time however, the postmining infiltration rates recover to premining levels (Martin, et al. 1988).

Spring Creek, North Fork Spring Creek, and South Fork Spring Creek are currently being impacted by ongoing mining activities. Following reclamation these ephemeral streams will be restored according to a reclamation plan approved by MDEQ.

Surface water quality should not be significantly affected as a result of mining the proposed LBA tracts. Although reclaimed soils may have lower infiltration rates and be more erosive for the first few years after reclamation, sediment yield should not increase in area streams. The larger sediment production would probably not be delivered to area streams due to sediment deposition as a result of flatter slopes on the restored lands and sediment trapping by authorized sedimentation ponds. Sediment yields to the Tongue River Reservoir would have minimal impact during the life of the mine because impoundments placed on streams and utilized for flood and sediment control must be permitted with MDEQ and must meet effluent standards or store the design event, in which case

they are dewatered following major runoff events to provide storage space for the subsequent event. Once vegetation growth and density on reclaimed areas becomes sufficiently reestablished, many of the erosion sediment controls would no longer be necessary and would then be removed and reclaimed.

Surface water resources will be affected under the Proposed Action and Action Alternatives as discussed above. Portions of all four tracts will be disturbed even under the No Action Alternative. The disturbance to the land surface, and consequently to the surface water regime under the No Action Alternative, has already been approved by MDEQ. If the tracts are leased, the revised reclamation and mine plan, including restoration of the essential hydrologic function, will be subject to MDEQ approval.

Cumulative Effects: There are three potential issues relating to cumulative surface water impacts:

- Possible changes in surface runoff rates due to changes in precipitation infiltration rates.
- Possible changes in surface water quality.
- Possible changes in water quality of the Tongue River Reservoir.

Some studies indicate that soil infiltration rates are lower on reclaimed lands than on premining lands due to changes in drainage patterns and surface disturbance. However, the reduction in slope after reclamation will provide enhanced opportunity for infiltration of precipitation and will likely more than offset this temporary decrease in soil infiltration rates.

Sediment yield should not increase in streams as a result of mining. Although reclaimed soils may be more erosive for a few years after reclamation, the larger sediment production would not be delivered to streams due to sediment deposition as a result of flatter slopes on restored lands and sediment trapping by mandated sedimentation ponds. Sediment yield associated with CBNG production may increase due to runoff from the disturbance related to access roads and utility corridors. Surface disturbance is proving to be less than projected in the MT FEIS as a result of increased well spacing (reducing the number of wells drilled

Exhibit 22

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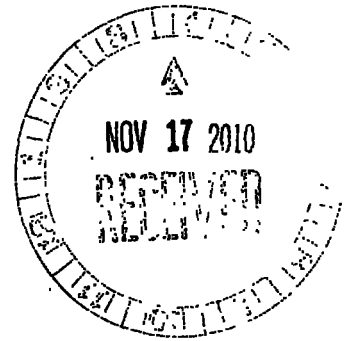
Part of
Public Record

November 17, 2010

VIA HAND DELIVERY

Ms. Cynthia Brown
Chief, Section of Administration
Office of Proceedings
Surface Transportation Board
395 E Street, SW
Washington, DC 20423-0001

228 267



Re: *Petition of Arkansas Electric Cooperative Corporation for a Declaratory Order,*
STB Finance Docket 35305

Dear Ms. Brown:

As requested by Board staff, enclosed are two hard copies of the PowerPoint slides that BNSF Railway Company presented during oral argument in the above-referenced case on July 29, 2010, and two copies of the videos clips that were shown in the PowerPoint presentation.

Please address any questions concerning these materials to the undersigned.

Sincerely,

Samuel M. Sipe (KG)
Samuel M. Sipe, Jr.
Counsel for BNSF Railway Company

cc: Parties of Record (with enclosures)

BNSF Railway

STB Docket No. 35305

Petition of Arkansas Electric Cooperative Corporation

July 29, 2010



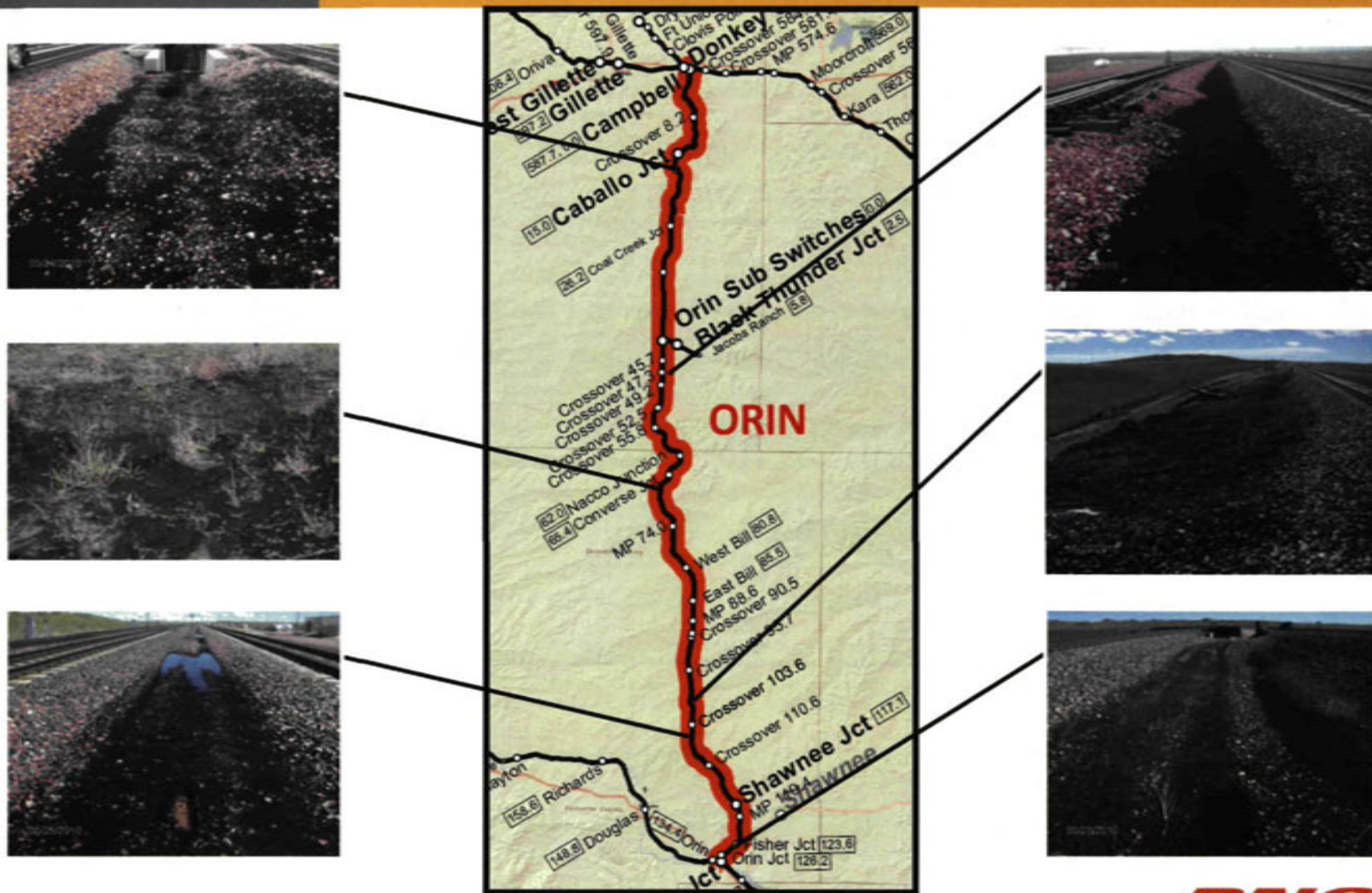
The Board Should Conclude:

- 1) It is necessary to keep coal dust from blowing off of loaded trains in transit.**
- 2) BNSF has the authority to issue reasonable operating rules that will curtail coal dust emissions.**
- 3) The specific standards at issue here are reasonable.**



**COAL DUST EMISSIONS MUST
BE SUBSTANTIALLY
ELIMINATED**

Coal dust fouling is extensive



BNSF

Coal dust fouling is extensive

Milepost 20.6

05/24/2010

BNSF

Coal dust fouling is extensive

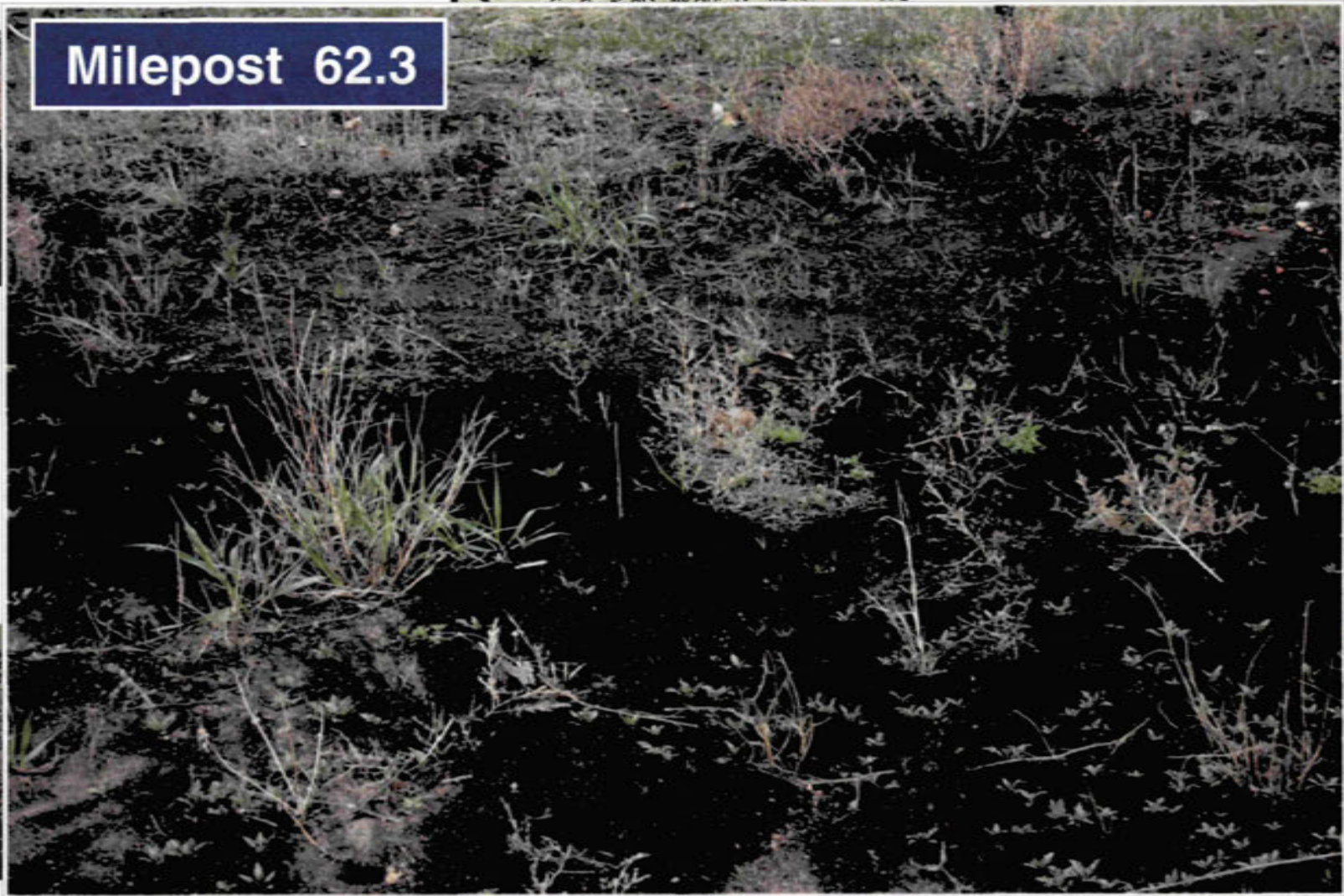
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05/24/2010

BNSF

Coal dust fouling is extensive

Milepost 62.3



BNSF

Coal dust fouling is extensive

Milepost 96.3

05/25/2010

BNSF

Coal dust fouling is extensive

Milepost 103.6

05/25/2010

BNSF

Coal dust fouling is extensive

Milepost 126.63

05/25/2010

BNSF

Coal dust is found on all PRB rail lines



BNSF

Coal dust is blown off the top of loaded cars in transit



Large amounts of coal are lost from the tops of cars

Coal loss
caused by
wind erosion
in transit



Exhibit 23



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

SEP 30 2014

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

MEMORANDUM

SUBJECT: Clarification on the Use of AERMOD Dispersion Modeling for Demonstrating Compliance with the NO₂ National Ambient Air Quality Standard

FROM: R. Chris Owen and Roger Brode *R. Chris Owen*
Air Quality Modeling Group, C439-01 *Roger Brode*

TO: Regional Dispersion Modeling Contacts

1. Introduction

On January 22, 2010, the U.S. Environmental Protection Agency (EPA) announced a new 1-hour nitrogen dioxide (NO₂) National Ambient Air Quality Standard (1-hour NO₂ NAAQS or 1-hour NO₂ standard). The new standard specifies attainment at a monitor when the 3-year average of the 98th-percentile of the annual distribution of daily maximum 1-hour concentrations is less than or equal to 100 ppb. The final rule for the new 1-hour NO₂ NAAQS was published in the Federal Register on February 9, 2010 (75 FR 6474-6537), and the standard became effective on April 2, 2010 (EPA, 2010a).

This memorandum clarifies the applicability of current guidance in the *Guideline on Air Quality Models* (40 CFR Part 51, Appendix W, generally referred to simply as Appendix W, U.S. EPA, 2005) for modeling NO₂ impacts in accordance with the Prevention of Significant Deterioration (PSD) permit requirements to demonstrate compliance with the new 1-hour NO₂ standard and the existing annual standard. The guidance provided here supplements the June 28, 2010 (U.S. EPA, 2010b) and March 1, 2011 (U.S. EPA, 2011) guidance memorandums by providing further clarification and guidance on the application of Appendix W for the 1-hour NO₂ standard. The topics clarified in this memorandum include:

- Tier 2 methods - The status of the Ambient Ratio Method (ARM) and Ambient Ratio Method 2 (ARM2) Tier 2 modeling approaches for demonstrating NAAQS compliance under the PSD program.

- NO₂/NO_x in-stack ratio – The selection and application of the NO₂/NO_x in-stack ratio for use in Tier 3 NO₂ modeling applications.
- Tier 3 methods - The appropriate applications for the Ozone Limiting Method (OLM) and Plume Volume Molar Ratio Method (PVMRM) Tier 3 NO₂ modeling schemes.
- Background sources – The treatment of background sources and monitoring data in compliance demonstrations.

2. Summary of Current Guidance

Though the NAAQS is based on NO₂ concentrations, the majority of nitrogen oxides (NO_x) emissions are in the form of nitric oxide (NO) rather than NO₂. As noted in Section 5.1.j of the Appendix W, the resultant NO₂ concentrations are largely driven by the ambient chemical environment (i.e., the reaction of NO with ambient ozone to form NO₂) and the initial NO₂/NO_x ratio of the emissions (i.e., the in-stack ratio or ISR). As a result, Section 5.2.4 of Appendix W outlines a three tiered approach to estimating modeled NO₂ concentrations. We note that these sections of Appendix W were written when there was only an annual NO₂ standard, which necessitated U.S. EPA, 2010b and U.S. EPA, 2011 to clarify their application in the context of the new 1-hour standard. The current recommended tiered methods are:

- Tier 1 – assume full conversion of NO to NO₂, where total NO_x concentrations are computed with a refined modeling technique specified in Section 4.2.2 of Appendix W.
- Tier 2 – multiply Tier 1 results by empirically derived NO₂/NO_x ratios, with 0.75 as the national default ratio for annual NO₂ (Chu and Meyer, 1991) and 0.80 as the national default ratio for hourly NO₂ (Want, et al, 2011; Janssen, et al, 1991), as recommended in U.S. EPA, 2011.
- Tier 3 – detailed screening methods may be used on a case-by-cases basis. At this time, OLM (Cole and Summerhays, 1979) and the PVMRM (Hanrahan, 1999) are considered to be appropriate as detailed screening techniques.

As for EPA preferred models for NO₂ modeling, AERMOD is specified as the preferred model for regulatory applications in Section 4.2.2 of Appendix W. It should also be noted that all three tiers of NO₂ modeling are classified as screening techniques, and as such, negative emission rates should not be used to account for emission reductions when conducting dispersion modeling to determine net ambient impacts associated with emission changes for comparison to SILs, for NAAQS compliance demonstrations, nor for annual increment analysis. Questions regarding the application of the tiered approach for NO₂ modeling for any specific permit action should be addressed to the appropriate permitting authority and EPA Regional Office modeling staff.

3. Tier 2 Methods

3.1 ARM

The Tier 2 Ambient Ratio Method (ARM) applies a national default NO_2/NO_x ratio of 0.75 for the calculation of the annual standard and, as specified in U.S. EPA, 2011, 0.80 for the calculation of the hourly standard. Additionally, regional NO_2/NO_x ratios representative of area wide quasi-equilibrium conditions may be applied as default ratios under Tier 2, provided that the ambient data meets the guidelines specified in Sections 5.2.4.c and 5.2.4.d of Appendix W. The ratios should be applied only to the modeled concentrations, and the monitored NO_2 background levels should be added to the modeled concentrations to compute the design value. Prior to AERMOD version 13350, the application of the ARM method required the user to post-process the model data and monitored background to compute the design value. However, the ARM method has been incorporated into the AERMOD model code (version 13350 and later), such that monitored background data and ARM adjusted modeled NO_2 are combined within the model in order to eliminate the need for post-processing to compute the annual and hourly modeled design values. These options are invoked through the CO MODELOPT ARM and the CO ARMRATIO keywords and requires that BACKGRND is included in the SRCGROUP ALL specification. More details about these options can be found in the AERMOD User's Guide Addendum (U.S. EPA, 2014).

3.2 ARM2

AERMOD version 13350 introduced a new Tier 2 method, the Ambient Ratio Method 2 (ARM2), which is based on an evaluation of the ratios of NO_2/NO_x from the EPA's Air Quality System (AQS) record of ambient air quality data. The ARM2 development report (API, 2013) specifies that ARM2 was developed by binning all the AQS data into bins of 10 ppb increments for NO_x values less than 200 ppb and into bins of 20 ppb for NO_x in the range of 200-600 ppb. From each bin, the 98th percentile NO_2/NO_x ratio was determined and finally, a sixth-order polynomial regression was generated based on the 98th percentile ratios from each bin to obtain the ARM2 equation, which is used to compute a NO_2/NO_x ratio based on the total NO_x levels. The ARM2 report presents three basic evaluations: (1) an overview of the temporal and spatial trends in the NO_2/NO_x ratio data, (2) a model intercomparison based on three field studies, and (3) model sensitivity tests based on hypothetical case studies, all of which are briefly summarized below.

3.2.1 Spatial and Temporal Variation

While the ARM2 development is based on the 98th percentile of binned NO_2/NO_x ratios from the nation-wide AQS data from 2001-2010, the ARM2 development report compares these ratios to

equivalent ratios based on regional and temporal subsets of the data. In most cases, the regional 98th percentile NO₂/NO_x ratio was more conservative than the one based on the nation-wide ratios. The most significant deviation from this occurred in the Midwest in the range of 420-480 ppb of NO_x, where the regional 98th percentile was 4-14% higher. The temporal analysis, which compared data from multiple time periods (i.e., 2001-2003, 2004-2007, and 2008-2010) to the 10-year average, generally found that NO₂/NO_x ratios have been decreasing over time. The 2001-2003 ratios were on average 6.8% higher than the 10-year average and 2008-2010 ratios 1.2% were lower on average. However, all three temporal subsets showed a higher 98th percentile in the highest NO_x bins. The higher 98th percentiles in the temporal subset bins and in the Midwest can generally be attributed to the relatively small number of samples and does not immediately indicate any issues with the broad application of the method across the U.S.

3.2.2 Field Measurement Based Model Evaluation

The ARM2 report also presents several model performance evaluations, comparing modeled versus monitored NO₂ concentrations based on ARM, ARM2, PVMRM and OLM for three field studies: the Empire Abo gas plant in New Mexico, the Palaau Generating station in Hawaii, and a small power plant in Wainwright, Alaska. The evaluations considered the data from several aspects, including comparing the modeled and monitored concentrations paired in time and space, evaluations based on the ranked data (i.e., Q-Q plots and comparisons of the robust highest concentrations) and an evaluation of the behavior of the modeled and monitored NO₂/NO_x ratios as a function of the total NO_x concentration (i.e., an evaluation similar to the fundamental development of ARM2). The evaluations demonstrated that ARM2 is generally less conservative than full conversion and ARM and generally more conservative than PVMRM and OLM when considering the highest concentrations (i.e., those most relevant for regulatory purposes).

3.2.3 Sensitivity Case Studies

The report also includes the ARM2 results from sensitivity tests comparing hypothetical applications of the Tier 3 methods of OLM and PVMRM for a variety of source types (MACTEC, 2004, API, 2012). The sensitivity studies presented in the report generally indicate that ARM2 results are similar with or conservative relative to OLM and PVMRM. However, there are cases when the Tier 3 methods are known to be unrealistic as a screening tool due to an over estimation of the available ozone for NO conversion, resulting in an over-estimation of the total NO₂ and in cases where the Tier 3 methods were more conservative than ARM2.

3.2.4 EPA Analysis of ARM2

EPA believes that the evaluations indicate that the results from ARM2 are generally more conservative relative to the Tier 3 methods of OLM and PVMRM which is consistent with the tiered screening approach currently recommended in Appendix W for NO₂. Additionally, section 5.2.4c of Appendix W, which addresses the Tier 2 methods, provides for the consideration of “alternative default NO₂/NO_x ratios” as an additional Tier 2 NO₂ modeling method, as long as the NO₂ and NO_x data are considered accurate “within the range of typically measured values,” though this language was developed for an annual rather than an hourly standard. Given that the AQS data are used for NAAQS designations, this data should generally be considered to be accurate and covers all ranges of measured values, not just those that are “typical”. Thus, EPA finds that the application of ARM2 is generally supported by the current language in Appendix W and the model performance evaluations and other comparisons presented in the ARM2 development report make a strong case for broad acceptance of ARM2 as a Tier 2 method, with a few important exceptions:

1. It is not clear that the AQS data represent the direct impact from any specific source, much less the direct impact from any major NO₂ sources that have relatively high ISRs, as the AQS monitors are usually placed to determine the general background levels of air quality in an area. Thus, the AQS data alone does not necessarily represent the highest impacts that might occur near a major NO_x source. As a result, ARM2 may not represent the behavior of these impacts. Unfortunately, an extensive analysis of the locations of the AQS monitors, major point sources, and transportation and other area sources would be required to better understand the representativeness of the AQS data in this respect.
2. The field evaluation databases and case studies were based on sources with a relatively low ISR (0.1-0.2), so the results from these evaluations do not show what types of impacts may be expected near a source that has a higher ISR (e.g., 0.5, the current default ISR specified for Tier 3 modeling). Fortunately, additional modeling studies can be completed to gain a better understanding of the ability of ARM2 to determine maximum, near-source impacts from sources with higher ISRs.

Attachment A of this memorandum details additional testing completed by the EPA to explore the relative impact of sources with ISRs greater than 0.2 on ARM2, OLM, and PVMRM modeling results. The general findings from this analysis show that the ISR can have a significant impact on the NO₂/NO_x ratios such that ARM2 is no longer conservative relative to the Tier 3 methods and could potentially underestimate the true NO₂/NO_x ratios and NO₂ concentrations. However, as described below, the analysis did indicate ranges of total NO_x in which ARM2 is conservative relative to the Tier 3 methods and likely to produce more accurate NO₂/NO_x ratios as well.

3.2.5 Current implementation of ARM2

ARM2 is available as a non-DEFAULT BETA option in AERMOD, similar to the current OLM and PVMRM Tier 3 NO₂ screening options. As a result of their non-regulatory-default status, pursuant to Sections 3.1.2.c, 3.2.2.a, and A.1.a(2) of Appendix W, application of AERMOD with ARM2 is not a “preferred model” and, therefore, requires justification and approval by the Regional Office on a case-by-case basis. While EPA is continuing to evaluate the ARM2 option within AERMOD for use in compliance demonstrations for the 1-hour NO₂ standard, the analysis conducted by the EPA and information presented in the ARM2 documentation generally indicate that ARM2 is appropriate in many cases when the application of the ARM method is appropriate, with some potential exceptions as described below.

The implementation of ARM2 within AERMOD applies the ARM2 ratios to the modeled NO_x concentration to determine the total modeled NO₂. For a cumulative analysis, monitored NO₂ background levels should not be adjusted by the ARM2 ratio, but should be added to the modeled NO₂, which can be done directly in the AERMOD simulation. The ARM2 method includes a default maximum NO₂/NO_x ratio of 0.9 at very low levels of NO_x and a default minimum ratio of 0.2 at very high levels of NO_x. The implementation of ARM2 in AERMOD allows the user to set the maximum and minimum ratios, when such a change is determined appropriate, through the use of the CO MODELOPT ARM2 and the CO ARMRATIO keywords. See the AERMOD User’s Guide Addendum (EPA, 2014) for more details on these options. Note that the CO ARMRATIO keyword is used in both the ARM and ARM2 MODELOPT keywords, specifying the maximum and minimum ratios for ARM2 and the 1-hour and annual ratios for ARM.

3.2.6 Approval of ARM2

The tests conducted by the EPA indicated two cases where application of ARM2 may not be appropriate, specifically when the NO₂/NO_x ISR of the source is relatively high and when there is remarkably high background ozone (leading to more complete and more rapid conversion of NO to NO₂). Thus, the EPA recommends that the appropriate reviewing authorities (State/Local/Tribal Permitting authority and appropriate EPA Regional Office representatives) consider the follow conditions prior to approving the use of ARM2:

1. The Tier 1, total conversion, results from modeling the primary source can be used to determine if the primary source is likely to have ambient impacts that are appropriately conservative when using ARM2 regardless of the ISR of the primary source. The EPA sensitivity study indicates that this threshold is around 150-200 ppb of total modeled NO_x concentrations. Given the role of ozone in the EPA tests, the lower end of the threshold (150 ppb NO_x) would be appropriate in areas with higher background ozone concentrations and the higher end of the threshold (200 ppb NO_x) may be appropriate in

areas with lower background ozone concentrations. In such a case, no documentation of the source's ISR would need to be provided, though it would be preferred.

2. If the total predicted NO_x from a Tier 1, total conversion, analysis exceeds the 150-200 ppb threshold recommended above, then the representative background NO_2 concentration may also be considered to justify a higher NO_x threshold. If representative background NO_2 levels are generally low (less than about 20-30 ppb), then it may be appropriate to consider a higher NO_x threshold to justify use of ARM2. Details on this approach are provided in Attachment A of this memorandum.
3. If the total NO_x from a Tier 1, total conversion analysis exceeds the 150-200 ppb threshold outlined above, then the NO_2/NO_x ISR of the primary source should be considered. If an adequate demonstration can be provided that the primary source has ISRs that are all below 0.2, then ARM2 should be appropriately conservative for a Tier 2 analysis. If the source has a known ISR greater than 0.2, then ARM2 may be used, but the minimum ARM2 ratio should be adjusted to match the source's ISR. If a source has multiple stacks with varying ISRs, then nominally, the minimum ARM2 ratio should be set to the maximum source ISR. However, the sensitivity tests indicate that there could be some leeway with the minimum ARM2 ratio based on the relative locations of the stacks and the receptors with the maximum modeled impact and the prevailing wind directions. This last approach would require a time consuming analysis of the incremental contribution of each stack to the receptors with the maximum modeled impact, so an applicant may find it easier to pursue Tier 3 modeling.
 - a. The EPA's preference for an adequate demonstration of a source's ISR is stack testing results from the actual source. However, this is not an option for new sources and may be burdensome for sources that do not already perform stack testing. In these cases, an adequate demonstration of a source's ISR may include, but is not limited to, use of source manufacturer test data, state or local agency guidance, data available through EPA's ISR database or other public database.
 - b. The EPA recommends that if stack test data is to be used for this demonstration, then the permitting agency should request that the source submit the data to the EPA's ISR database as part of the documentation process.
4. The EPA analysis indicated that particularly high background ozone concentrations could result in higher predicted NO_2/NO_x ratios even for sources that had an ISR of 0.2. While the background ozone was generally secondary to the ISR in terms of determining the estimated NO_2/NO_x ratios, it was nonetheless significant and thus the background ozone should be considered. The sensitivity tests indicated that background ozone concentrations of 80-90 ppb was an approximate threshold to determine when background ozone could cause Tier 3 and actual NO_2/NO_x ratios to exceed the ARM2

ratios. Thus, nominally, if there are frequently multiple days (e.g., more than 7) with hourly ozone greater than 80-90 ppb during a typical year, then caution should be used when applying ARM2. However, if additional analysis shows that these high ozone days or hours are not coincident with the maximum modeled NO_x impacts, then the background ozone should not hinder the approval of ARM2.

4. NO₂/NO_x In-Stack Ratios (ISR)

The Tier 3 NO₂ screening methods, OLM and PVMRM, require the ISR as an input to the model. U.S. EPA, 2010b outlined scenarios where the ISR could potentially be the controlling factor in the speciation of NO_x as NO₂, particularly when considering maximum 1-hour concentrations. Thus, the overwhelming preference is for source-specific data. However, given the paucity of NO₂/NO_x ISR data, U.S. EPA, 2011 established a general acceptance of 0.5 as a default NO₂/NO_x in-stack ratio for usage with OLM and PVMRM when source-specific data or data from similar source types are not available. In order to address the need for additional NO₂/NO_x ISR data, in August, 2012, the EPA initiated an effort to formally collect source-test data. Submission of data is voluntary and open to all members of the community, including regulators, industry, equipment manufacturers, and environmental groups. Currently, there have been over two thousand records submitted, though they cover a fairly small range of source types. Additional details on the NO₂/NO_x in-stack ratio database can be found on the SCRAM website (http://www.epa.gov/ttn/scram/no2_isr_database.htm).

For compliance demonstrations of the 1-hour NO₂ standard in the context of the Tier 2 or 3 approaches, it is important to consider the cases which lead to the highest concentrations of NO₂. U.S. EPA, 2010b identified the following two scenarios which may lead to high NO_x concentrations:

- In the first scenario, a low-level source experiencing low wind speeds and limited vertical mixing was identified as a case that would most likely lead to high levels of surface NO_x. In this case, mixing with ozone is expected to be limited, also limiting the conversion of NO to NO₂. If the ISR of NO₂/NO_x is low, then the Tier 2 approaches are expected to be conservative, as most of the NO_x will be in the form of NO. However, if the ISR is high, then ARM2 may not be conservative, as a larger percentage of the total NO_x is already present as NO₂. Based on evaluations of potential ambient NO₂/NO_x ratios for cases like these, as outlined above, EPA is currently recommending that some applications of ARM2 include a demonstration that the source's ISR is less than 0.2 for approval of ARM2.
- In the second scenario, a plume from an elevated source in flat terrain, during daytime convective conditions, would experience significant entrainment of ozone (for conversion of NO to NO₂) as well as sufficient vertical mixing to bring the plume down to the surface. In this case, ARM2 may also not be conservative regardless of the NO₂/NO_x in-

stack-ratio, as there might be sufficient ozone to convert NO to NO₂ or there may already be a higher percentage of NO₂ if the NO₂/NO_x ISR is high.

Thus, even though the NO₂/NO_x ISR is not a required modeling input for the Tier 2 methods, it should still be considered when applying the ARM2 Tier 2 method, particularly when the NO₂/NO_x ISR is expected to be high or in the types of cases outlined above.

In the context of Tier 3 NO₂ screening, the NO₂/NO_x ISR is a required model input and must always be supplied for both the primary source and all nearby sources included in the modeling. As outlined above, when no source-specific data and no data for similar sources are available, a default ISR of 0.5 may be used for PVMRM and OLM. However, since there may be cases when the ISR is the controlling factor in the speciation of NO_x as NO₂, having accurate source-specific data is advantageous in accurately determining a source's impact. Since the receptors most affected by the scenarios where the ISR is most important are generally closest to the source, the importance of the ISR on the NO_x partitioning will generally diminish with larger transport times and greater transport distances. There may be exceptions to this when there are other large sources that are close to one another and significantly impact the cumulative concentration gradients. Thus, the greatest need for accurate ISR, or when lacking source-specific data, the need for appropriately conservative ISR, is for the primary source and other large nearby sources rather than the smaller nearby and more distant sources included in cumulative modeling.

Given that the greatest impact of the NO₂/NO_x in-stack ratio is typically on the closest/closer receptors to the source and that the highest modeled impact also generally is close to the source, it is reasonable to consider a less conservative default ISR for sources more distant from the primary source. Thus, for cumulative modeling, the new EPA recommendation for default ISR is to use 0.5 as a default for the primary source and any sources in the immediate vicinity of the primary source, when source-specific data is not available, and 0.2 as a default for the more distant nearby sources. The EPA believes that the sources that can use a default of 0.2 will generally be greater than 1-3 km away from the primary source, with the distance dependent upon the relative strength of the primary and background sources as well as the relative location of the background sources with respect to the prominent wind direction and location of expected maximum impacts from the primary source. With EPA's effort to collect additional source test data, we hope that over time the range of source categories for which ISR information is readily available will increase and that the quality of such information will improve, at which time, additional recommendations may be made.

5. Tier 3 Methods

Appendix W discusses the use of OLM and PVMRM as Tier 3 methods for point sources and though much of the historical documentation for these Tier 3 methods mentions only point

sources, the EPA supports the usage of both Tier 3 methods for non-point sources, as discussed below and in U.S. EPA, 2011. Both of these methods are based on the same basic chemical assumptions, the titration of NO by ozone to form NO₂. Both use the NO₂/NO_x ISR and information about the ambient ozone in the determination of the amount of titration that will occur in the plume. However, there are important differences that should be considered when determining which method is most appropriate for a particular modeling scenario. The primary difference between the two methods is the way in which the amount of ozone available for conversion of NO to NO₂ is determined. OLM assumes that all the ambient ozone is available for NO titration (i.e., instantaneous complete mixing with background air), regardless of the source or plume characteristics. In contrast, PVMRM determines the amount of ozone within the plume volume (computed from the source to the receptor) and limits the conversion of NO to NO₂ based on the ozone entrained in the plume. The calculation of the plume volume is done for an individual source or group of sources and on an hourly basis for each source/receptor combination, taking into account the plume dispersion for that hour.

In many respects, PVMRM represents a more accurate representation of the potential titration of NO by ozone and for certain modeling scenarios, PVMRM has a number of advantages over OLM. By accounting for the ozone available within the plume volume, PVMRM can more accurately determine the amount of NO titration, particularly near the source. Additionally, PVMRM more readily accounts for conversion limitations when plumes overlap by computing a merged plume volume, rather than assuming NO titration computations on an individual plume basis. However, the method for estimating the plume volume can be problematic in certain scenarios. When considering multiple plumes, the plume volume at each receptor is computed by first identifying the primary source contributing to the NO_x at the receptor. Then, all additional sources contributing at least half of the amount of NO_x as the primary contributing source are identified as “major contributing sources.” Third, the maximum width between the major contributing sources is found. Finally, the maximum width found in the third step is added to the width of the primary contributing plume to determine the combined plume width. The approach to determine a combined plume width potentially incorporates a significant amount of empty space between the major contributing sources and thus could overestimate the plume size, the amount of available ozone, and the amount of NO titration. Similarly, for area sources, PVMRM uses the projected width of the area source as part of determining the combined plume width, which can exacerbate the problem of overestimating the plume volume and the amount of ozone available for NO titration. A similar effect occurs with sources at or near the surface because PVMRM does not account for ground reflection in the plume volume, again resulting in an over-prediction of the amount of ozone available for NO titration.

Therefore, PVMRM is not recommended for use with area (or line) sources or with near-surface releases or for groups of sources with moderate distances between them. U.S. EPA, 2011 suggests that roadway sources, which are often modeled as elongated area sources, may be better

modeled as a series of volume sources when using PVMRM. While PVMRM may be used for roadway sources, due to the issues with estimating plume volumes with PVMRM for near-surface releases, OLM may be the best option for modeling roadways. OLM with the OLMGROUP ALL has been used by the EPA for roadway sources to site near-road NO₂ monitors (Watkins & Baldauf, 2012) and has also been shown to provide generally good model performance for roadway sources as applied in the NO₂ Risk and Exposure Analysis (REA, U.S. EPA, 2008). In general, the OLMGROUP ALL option was recommended in U.S. EPA, 2010b as the best approach for using OLM in AERMOD, as the OLMGROUP ALL option allows for some competition for ozone when there are overlapping plumes.

6. Background Sources of NO₂ and Ambient Ozone Concentrations

Each of the tiered NO_x modeling methods require the identification of nearby NO_x sources to include in cumulative modeling, a background NO₂ monitor to add to the modeled NO₂ for compliance demonstrations to account for natural background and non-modeled sources, and in the Tier 3 cases, a background ozone monitor for use in the NO titration schemes. U.S. EPA, 2010b briefly discusses the inclusion of nearby sources and the representativeness of ambient air quality data, while U.S. EPA, 2011 provides a significantly more detailed discussion. With respect to the number of nearby sources to be included in cumulative modeling, both memorandums cite Section 8.2.3 of Appendix W, which states “the number of such [nearby] sources is expected to be small except in unusual situations” and point to the “significant concentration gradient in the vicinity of the source” as the primary criterion for selection of these nearby sources. While the selection of nearby sources should also include a consideration of the representativeness of the available ambient monitoring data, including minimizing the potential double-counting of the modeled source impacts on the monitoring data. Here we reaffirm the previous guidance by reiterating that, in most cases, the number of nearby sources needed in cumulative modeling is expected to be far fewer than the past practice following section IV.C.1 of the EPA’s draft New Source Review manual, which specified an inventory that included all sources within the radius of influence plus 50 km (U.S. EPA, 1990). We also reemphasize that the determination will require sound professional judgment by the permit applicant and we recommend early consultation with the appropriate reviewing authorities.

Once the appropriate nearby sources and a representative background monitor have been identified, there are a number of ways that the background data can be combined with the cumulative modeling to determine compliance. U.S. EPA, 2010b outlines a “first tier” approach for demonstrating compliance with the 1-hr NO₂ standard, which combines the overall highest 1-hour background NO₂ concentration to the modeled design value. The EPA recognized that for many cases, this approach is too conservative and thus revised the “first tier” approach in U.S. EPA, 2011 with the recommendation that the monitored design value from the most recent three years of monitored data should be combined with the modeled design value, based on 5 years of

modeling. U.S. EPA, 2011 goes on to add a “second tier” approach, with more refined temporal pairing. The recommended refined method uses “multiyear averages of the 98th-percentile of the available background concentrations by season and hour-of-day, excluding periods when the source in question is expected to impact the monitored concentration.” When mobile sources are expected to significantly impact the monitor, the day-of-week variability may also be an appropriate consideration. It should also be noted that when determining the 98th percentile value, the ambient monitoring requirements (Appendix S to 40 CFR Part 50) specify the second-high value, given the number of values expected to be available for each season hour-of-day (90 to 92). However, the EPA recommends using the third-highest value in each season hour-of-day for modeling, which excludes the highest 8 values from the analysis rather than the highest 4 and thus more closely mimics the standard, which excludes the highest 7 values. U.S. EPA, 2011 provides an extensive discussion and supporting data for this “second tier” approach.

Based on the experience of the EPA since U.S. EPA, 2011 was issued, the EPA continues to support this “second tier” approach and generally recommends that it should be routinely accepted by the permitting authority, provided that an adequate demonstration of the appropriateness of the monitoring data has been provided. However, the EPA maintains that pairing the monitoring data on an hourly basis with modeled data paired in time (i.e., the “paired sums” approach) is not appropriate for the majority of modeling applications.

Whether using the first or second “tier” approach for combining monitoring data with modeled concentrations, it is important to insure that the monitoring data is adequately representative. Section 8.2.2b of Appendix W specifies for an Isolated Single Source analysis that the monitor should exclude “values when the source in question is impacting the monitor.” For an hourly standard and where there are 2 monitors in the vicinity of the Isolated Single Source, this may mean selectively using data from the monitor that is upwind of the source at each hour. This could be accomplished by manually editing the background file to splice together a wind-direction dependent monitored value. However, starting with version 13350, AERMOD includes the option to specify multiple background files, based on their geographic relation to the monitor and AERMOD will automatically apply the monitoring data from the appropriate downwind monitor on an hourly basis. This is implemented with the SO BGSECTOR keyword, which determines the applicable sector based on the flow vector (i.e. downwind direction) derived from the wind direction in the hourly surface meteorological file. While the BGSECTOR option is generally applicable to all pollutants, a similar NO₂-specific option has also been incorporated in AERMOD (beginning with version 13350) for supplying background ozone concentrations for Tier 3 NO₂ assessments. The CO O3SECTOR keyword allows the specification of multiple background ozone files, which are also selected based on the flow vector. However, it should be noted that the implementation in AERMOD of the selection of the background monitor (i.e., specifying the flow vector) is not meant to imply that the downwind monitor should always be used for either ozone or NO₂. U.S. EPA, 2011 provides various examples of when an upwind

versus downwind monitor should be used. The example provided here, when a monitor is impacted by an existing isolated source's emissions, is a scenario when the upwind monitor would be preferred and thus the user-specified sectors should be adjusted by 180 degrees, such that the upwind monitor would be selected. Modeling a new source that does not include nearby sources in the cumulative modeling is an example of a scenario when the downwind monitor might be the preferred option.

7. Summary

The primary purpose of this memorandum was to provide an assessment of the appropriateness of the new ARM2 NO_x speciation method and to provide guidance on its application and acceptance as an alternative Tier 2 modeling approach under Appendix W. A number of other NO₂-related modeling issues for regulatory purposes with the AERMOD air quality model were also addressed. In summary, the recommendations and findings presented in this memorandum include:

- The EPA testing and evaluation of the ARM2 method indicates that ARM2 appears to be an appropriate Tier 2 NO₂ modeling method in some cases and should be approved for usage as an alternative modeling option in these cases. These cases are:
 1. The primary source/facility has made a demonstration that the source/facility has a NO₂/NO_x in-stack ratio (ISR) of less than 0.2 (for 95% or more of the short-term NO_x emissions).
 2. The primary source/facility has made a demonstration that the total modeled NO_x from the source/facility is less than 150-200 ppb.
 3. The background ozone is not persistently above approximately 80-90 ppb.

If these conditions are not met, then ARM2 may underestimate ambient NO₂/NO_x ratios and so either a Tier III approach should be utilized or ARM2 should be applied with additional caution/considerations.

- The NO₂/NO_x ISR is an important input to the OLM and PVMRM Tier 3 methods and should also be considered in determining the appropriateness of application of the Tier 2 ARM2 method. Site or source specific values of the ISR are the preferred input and to facilitate the increased availability of more representative ISRs, the EPA launched a voluntary effort to collect and make available ISRs from a wide variety of sources. However, when site or source specific values are not available, a default ISR of 0.5 may be used for the primary source and a default ISR of 0.2 may be used for more distant sources (greater than 1-3 km) in the cumulative modeling applications of OLM and PVMRM.

- Both PVMRM and OLM Tier 3 methods may be used for non-point sources, including roadways. However, PVMRM is most appropriate with relatively isolated and elevated sources, while OLM is more appropriate for area sources, near-surface releases, or scenarios with multiple sources where plume overlap is likely to occur. In these cases, the OLMGROUP ALL option is recommended to better account for competition of ozone.
- AERMOD now includes directional-varying background options for both the primary pollutant (e.g., NO₂) and ozone in the Tier 3 methods. The general recommendation is that background data located downwind of the isolated source and near the receptor should be used for new sources and background data upwind of the isolated source should be used for non-nearby existing sources in order to minimize double-counting the impact of the existing source on the background data. U.S. EPA, 2011 provides a more comprehensive discussion of the selection and treatment of background monitoring data and should also be consulted.

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ATTACHMENT A. – EPA EVALUATION OF ARM2 PERFORMANCE

To address these potential limitations of the ARM2 evaluation, the EPA has conducted additional testing to inform the application and approval of ARM2. Specifically, the EPA has considered theoretical maximum concentrations of NO₂ based on combinations of chemical pathways for NO₂. The first is based on the simple, but total titration of NO to NO₂ by ozone (TT). The second is based on the partial titration of NO considering the “pseudo-steady state” of NO, NO₂, and ozone (PSS). The third is based on a theoretical Lagrangian plume that combines complete TT and PSS for NO titration, but also takes into account the volume of the plume and mixing with background air (PV). Additionally, the EPA has conducted modeling sensitivity tests based on a modifications of the ARM2 development report case studies, with a higher ISR, higher default background ozone, and with various receptor heights, including placing the receptors at stack height in order to capture the impacts closer to the plume centerline.

1. Theoretical Applications of Total Titration and the Pseudo-Steady State Approximation

For these evaluations, the EPA considered a wide range of ambient conditions to determine the potential maximum NO₂ concentrations resulting from various NO_x levels based on two fundamental assumptions about NO conversion to NO₂ by ozone. The first assumption is total titration of NO by ozone, which assumes that all available ozone is consumed for NO conversion, where availability is considered on the basis of ambient mixing ratios, ignoring plume volumes. The second assumption is based on the pseudo-steady state assumption, which determines an equilibrium ratio between ozone, NO and NO₂. This equilibrium is driven by the NO_x and ozone concentrations as well as ambient temperature, solar zenith angle (SZA), and cloud cover. The PSS equation is normally used to evaluate ozone formation and is formulated to determine ozone levels based on the speciation of NO and NO₂. For the purposes of the tests conducted here, the PSS equation was rearranged to use constant ozone and determine the NO and NO₂ speciation instead. The result of this assumption is that NO titration is never ozone limited and can thus overestimate the NO₂/NO_x ratio when the total NO_x is greater than the ozone concentration. To mitigate this aspect of the PSS approach, when evaluating a specific range of NO_x with accompanying ozone and meteorological conditions, the PSS assumption was used to determine the NO₂/NO_x ratio when the total NO_x was less than the ozone concentration and the TT assumption was used when the total NO_x was greater than the ozone concentration. Because of the combination of assumptions listed above, plus an assumption of complete mixing of the plume with background, the computed NO₂/NO_x ratios likely overestimate typical NO₂/NO_x ratios. However, this approach is attractive as it allows for a conservative assessment of theoretical NO₂/NO_x ratios across a wide range of ambient conditions. While the EPA considered many meteorological and emissions scenarios for this evaluation, only small subset are presented here, with the specific plume and meteorological assumptions for each scenario detailed in Table 1.

Scenario	ISR	Ozone (ppb)	Temperature (F)	Solar zenith angle (SZA, degrees)	Cloud cover	NO _x conversion
U.S. extreme,ST	0.0	150 ¹	97 ²	25 (Texas or Florida)	0%	TT/PSS
U.S. mean, ST	0.0	30 ³	56 ⁴	37.5 (e.g., Kansas)	50%	TT/PSS
U.S. high, ST	0.0	84 ⁵	76 ⁶	37.5 (e.g., Kansas)	50%	TT/PSS
PV, 0.2 high	0.2	84	76	37.5 (e.g., Kansas)	50%	Mixing volumes with TT/PSS
PV, 0.2 mean	0.2	30	76	37.5 (e.g., Kansas)	50%	Mixing volumes with TT/PSS
PV, 0.5 mean	0.5	30	76	37.5 (e.g., Kansas)	50%	Mixing volumes with TT/PSS
PV, 0.5 high	0.5	84	76	37.5 (e.g., Kansas)	50%	Mixing volumes with TT/PSS
PVMRM, 0.5 max/DV	0.5	Actual (85) ⁷	Actual ⁷	NA	Actual ⁷	PVMRM
PVMRM, 0.2 max/DV	0.2	Actual (85) ⁷	Actual ⁷	NA	Actual ⁷	PVMRM

Table 1: Ambient conditions and source configurations for EPA test cases

Figure 1 shows the results from the three scenarios using the combined PSS/TT approach, based on a source with pure NO emissions (i.e., an ISR of 0). The scenario “U.S. extreme, ST” shows the NO₂/NO_x ratios from NO_x concentrations determined from the most extreme conditions for the U.S. and thus indicate the highest 1-hr NO₂/NO_x ratios possible for a source of this type. The results from this extreme scenario give higher NO₂ concentrations at basically all NO_x levels than ARM2 and indicate that there could be times when a source with only NO emissions could produce NO₂ concentrations larger than ARM2. In contrast to these extreme conditions, the scenarios, “U.S. high, ST” and “U.S. mean, ST” consider less extreme values, using roughly maximum and mean monthly summertime temperatures for the continental U.S., and mean and more representative maximum ozone from AQS. The mean conditions produce NO₂/NO_x ratios notably lower than ARM2, which is expected, as ARM2 uses the highest NO₂/NO_x ratios from each NO_x bin rather than the mean ratios from each bin. The “U.S. high, ST” scenario gives NO₂/NO_x ratios that are closer to the ARM ratios, with the ratios from the “high” scenario less than the ARM2 ratios in the higher NO_x levels (above 300 ppb of NO_x).

¹ Roughly the maximum ozone from AQS data from 2008-2012

² Maximum monthly mean maximum summertime temperature from Austin, TX

³ Mean ozone concentrations from AQS from 2008-2012, including nighttime and daytime samples.

⁴ Mean temperature in July for the contiguous U.S.

⁵ Mean ozone concentration plus 3 standard deviations of the mean from AQS from 2008-2012

⁶ Mean maximum temperature in July for the contiguous U.S.

⁷ Actual ozone and meteorological data from Anchorage, AK from 1991-1995, with 85 ppb used to fill missing hours.

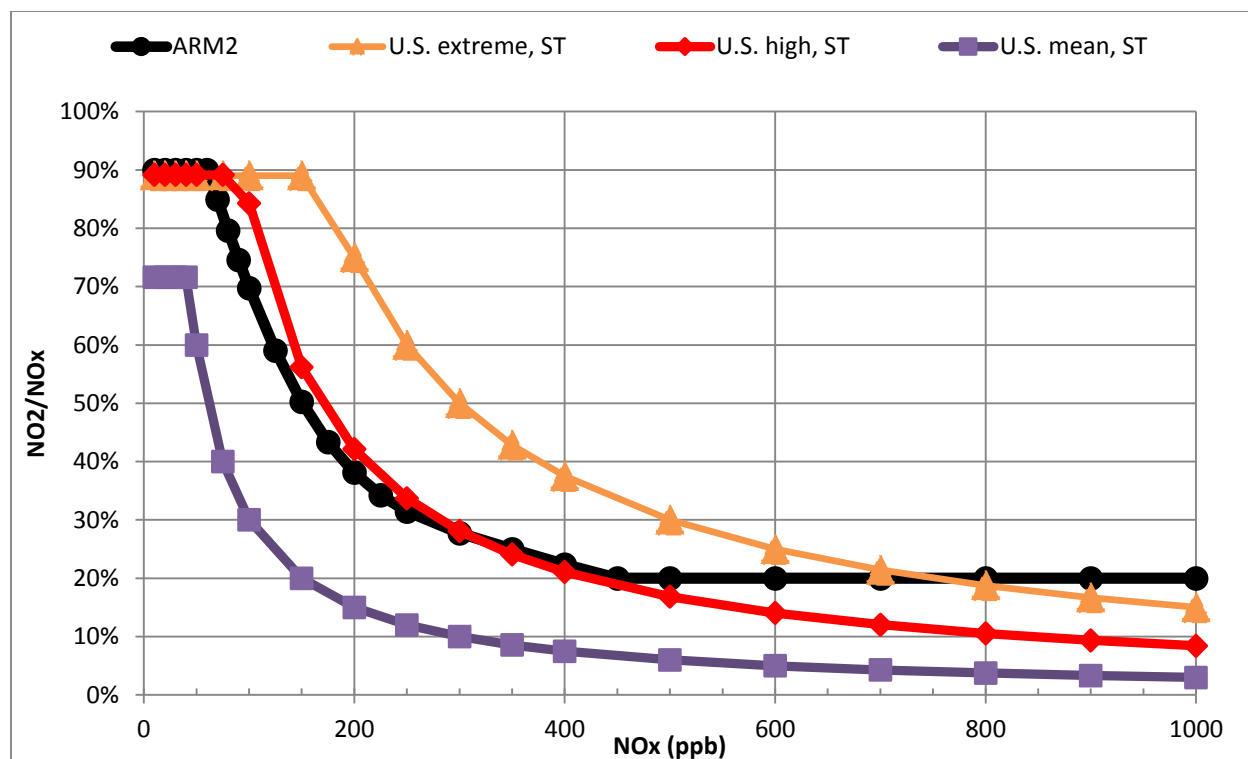


Figure 1: NO₂/NO_x ratios for ARM2 and the EPA PSS/TT sensitivity studies

It should be noted that while the “high” scenario is close to the ARM2 values in the range of 50–300 ppb NO_x, the curves are very steep in this range, such that at any specific NO_x level, the difference between the two curves can still be large (e.g., ARM2 indicates 70 ppb of NO₂ at 100 ppb of NO_x while the “U.S. high, ST” curve indicates 84 ppb of NO₂). Thus, the “high” scenario also indicates that there are times when a source with only NO emissions could produce NO₂ concentrations larger than ARM2. It should also be noted that surface ozone typically has a strong diurnal pattern, with higher ozone levels during the day, when photochemistry produces ozone, and lower ozone levels at night, when scavenging by NO tends to dominate ozone chemistry. The ozone levels include both nighttime and daytime measurements, which certainly affect the average and standard deviations computed for the dataset used here. Background ozone concentrations are typically assumed to be closer to 40 ppb for the continental US rather than the 30 used here. While 40 ppb of ozone would increase the NO₂/NO_x ratios for the “mean” scenario, the ratios would still be substantially less than the ARM2 ratios. Furthermore, while using only the daytime ozone data would provide a higher mean concentration, it would also give a lower standard deviation, which is likely to result in concentrations for a “high” scenario on the order of 80–90 ppb. Thus, it is not likely that the inclusion of nighttime and daytime ozone in the computations here will have a significant impact on the findings.

In order to account for the ISR of NO₂/NO_x and a more realistic consideration of ozone availability, another set of scenarios were constructed that use the TT and PSS assumptions but also uses a hypothetical ISR to initially proportion the total NO_x according to the ISR. These

plume volume scenarios (PV) take into account ozone availability, by using an initial plume volume, which mixes with background air as the plume volume increases, limiting the amount of ozone available to react with the remaining NO. This approach is similar to PVMRM in that the initial NO₂ remains as NO₂ and only the initial NO is available for titration and that ozone availability is considered. This assumption simplifies the calculation by using the mixing ratios of the plume and background air, rather than computing the moles of NO_x and ozone. This approach also assumes a uniform puff, rather than a Gaussian plume, as would be used in PVMRM.

For this analysis, four PV scenarios are shown in Figure 2, two with an ISR of 0.2 and two with an ISR of 0.5. For each ISR, “mean” and “high” ozone scenarios are examined, with 30 and 84 ppb of ozone, matching the PSS/TT scenarios above. In contrast to the PSS/TT scenarios, the NO₂/NO_x ratios from the PV tests are generally higher than those from ARM2, with the major exception occurring in the 0.2 ISR PV scenario with mean ozone, where ARM2 has higher ratios up until 300 ppb NO_x. Without the inclusion of the initial NO₂, these curves would closely match the TT/PSS cases discussed above when equivalent ambient conditions are used. The addition of the ISR clearly has a significant impact on the resulting NO₂/NO_x ratios, such that the NO₂/NO_x ISR is the controlling factor rather than the ambient conditions on the maximum potential impacts. It is important to keep in mind that the PSS/TT approach used in these scenarios are near theoretical maximum and presents a conservative assessment of theoretical NO₂/NO_x ratios.

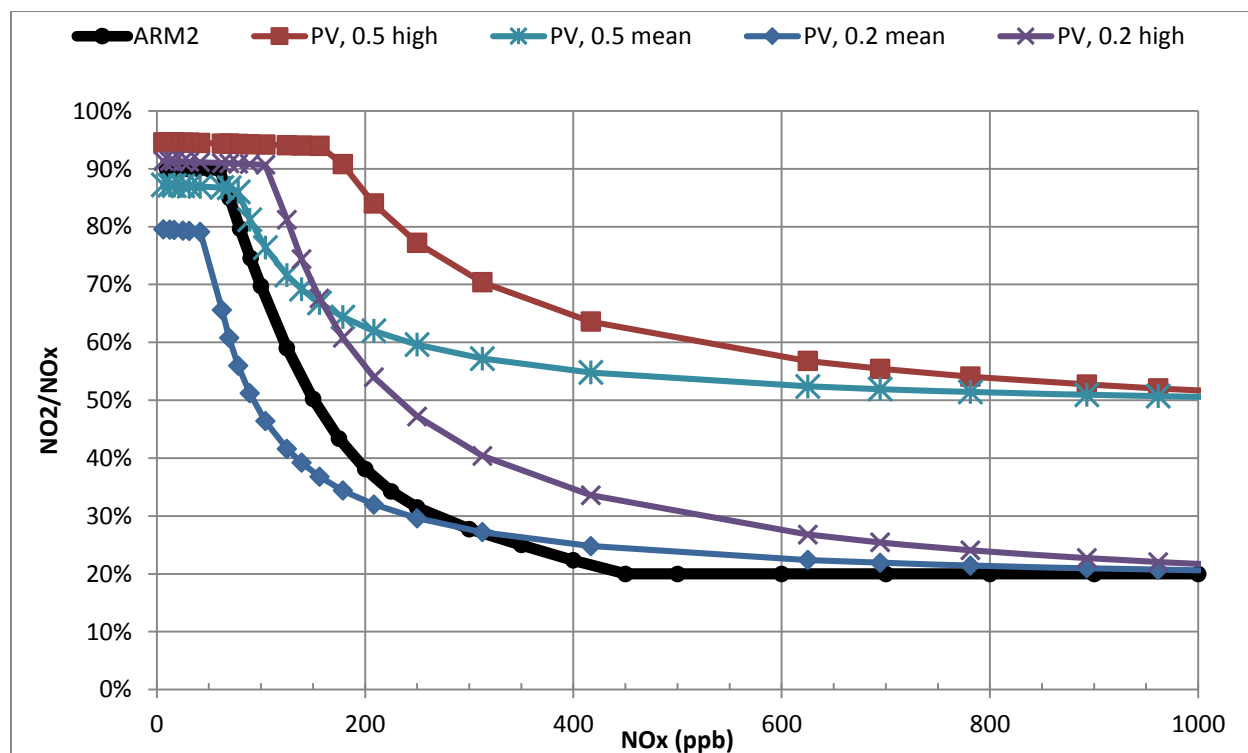


Figure 2: NO₂/NO_x ratios for ARM2 and the EPA PV sensitivity studies

2. Expanded Single-Source PVMRM Case Study

Since the theoretical “PV” tests conducted by the EPA indicate that a high NO_2/NO_x ISR can produce NO_2/NO_x ratios well above those determined from ARM2 and the API (2013) ARM2 cases all included a relatively low ISR or 0.1-0.2, one of the single-source cases from the ARM2 development report was modified for further investigation. The case includes a single point source, with a stack height of 35 m, an emission rate of 50 g/s, and an ISR of 0.1. The source was modified to have an ISR of 0.5 and 0.2, the receptor grid was raised from ground level to 35 m, in order to sample closer to the plume centerline, and the closest receptor was placed 1 m from the source.

The four sets of results from two full 5-year model simulations are shown in Figure 3. The resulting design values (5-year average of the 98th percentile daily 1-hour maximum at each receptor) and maximum (5-year average of the highest daily 1-hour maximum at each receptor) are shown. The design values from an OLM model simulation of the 0.5 ISR source are also included for additional reference. While the ambient ratios of the PVMRM design values (e.g., 98th percentile) for the 0.2 and 0.5 ISR sources are notably lower than the ambient ratios for the maximum impacts, all three simulations have NO_2/NO_x ratios at the highest NO_x levels that approach the ISR for each source. The result of the minimum NO_2/NO_x ratio being equal to the ISR is similar to the hypothetical results from the PV scenarios and is not a particularly surprising result – a source with a high ISR will have near-source, maximum impacts that heavily reflect the initial partitioning of NO and NO_2 . Even when the plume becomes diluted, the generic assumption for NO_2 modeling is that NO titration is irreversible and the NO_2/NO_x ratio can only increase as the plume becomes mixed with background air providing more ozone for NO titration. The differences between the OLM and PVMRM results are interesting and informative. Though the OLM results more closely reflect the results from the PV scenarios presented above, as outlined in the memorandum, the expectation is that PVMRM more accurately represents NO titration by accounting for the actual volume of the plume. The fact that the PVMRM ratios are lower than the OLM ratios indicate that the plume volume is limiting more ozone entrainment than would be inferred from OLM conversion based solely on the ambient mixing ratio, though the truth is likely somewhere in between the two model results. Nonetheless, these PVMRM results indicate that ARM2 could potentially underestimate the maximum 1-hour impacts from a source with an ISR above 0.2 and that ARM2 is likely not conservative for a 1-hour standard relative to PVMRM in such a scenario.

While the PVMRM results presented above are from a source with a high, but not unrealistic, NO_x emission rate, the receptor placement is clearly not appropriate for a typical NSR/PSD application (unless plume impaction on nearby terrain occurs). Thus, we have repeated the two PVMRM runs, but with a receptor height of 1.8 meters, to capture impacts closer to the ground. These results are not shown, but there is not surprisingly a major difference in the calculated

total NO_x and NO_2 concentrations, with the maximum NO_x impact reduced by several orders of magnitude from the 35 m receptors to the 1.8 m receptors. Since the maximum NO_x impacts are much lower, the NO_2/NO_x ratios for these 1.8 m receptors are in the range where the ARM2 ratios are higher than the PVMRM ratios. For both sources, the average ARM2 ratio for the design values at 1.8 m is 0.9 versus an average ratio of 0.63 for the 0.5 ISR source and 0.37 for the 0.2 ISR source from PVMRM. The implication for the difference in the 35 m and 1.8 m receptor results is that a source with a high ISR can be modeled with ARM2 and the resulting concentrations can be conservative relative to PVMRM and OLM. However, there is a clear dividing line where ARM2 becomes less conservative than PVMRM. For the 0.5 ISR source, this occurs around 150-200 ppb of total NO_x , indicating that if the impacts for the source are less than this threshold, then ARM2 will be likely be conservative relative to PVMRM, regardless of the ISR of the source (assuming a maximum default ISR of 0.5, as specified for Tier 3 sources). While the expectation is not that ARM2 should always be conservative relative to either of the Tier 3 methods, this particular modeling scenario is one in which PVMRM is expected to perform particularly well, indicating that any under prediction of ARM2 relative to PVMRM for these cases likely indicates ARM2 would also under predict a similar source's true impacts.

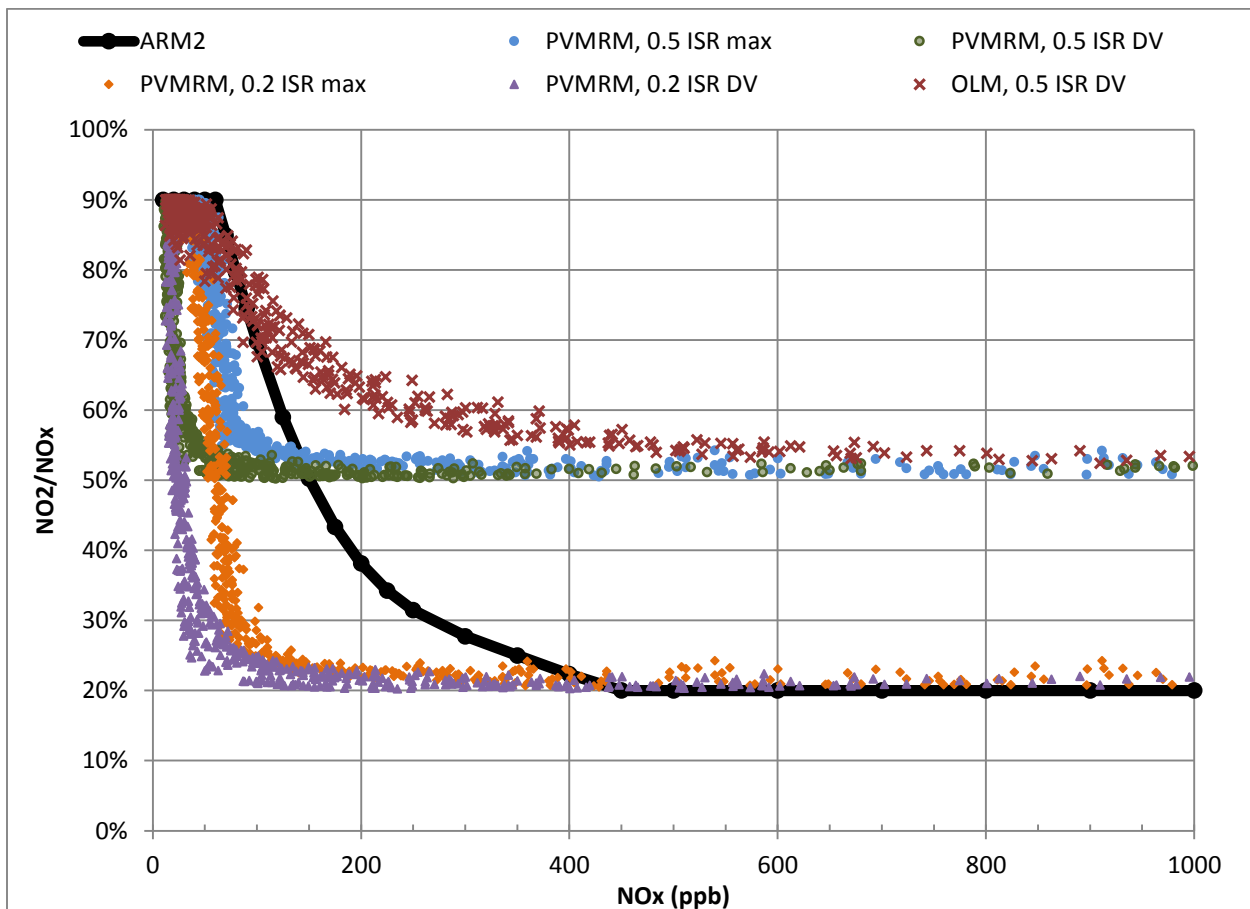


Figure 3: NO_2/NO_x ratios for ARM2 and the EPA PVMRM sensitivity studies

3.0 Multi-Source Scenarios

Given the potential importance of the ISR on the modeling results, the EPA also conducted some limited testing of multi-source scenarios. There was one multi-source scenario included in the ARM2 development report, based on oil and gas sampling in Alaska and originally included 64 sources, some of which experienced downwash, and all had an ISR of 0.1. In order to gauge the effect of multiple sources and varying ISRs, additional testing was done with a modified version of this multi-source scenario. For the testing done here, the scenario was scaled down to only 4 of the larger sources, all of which included downwash influences, and also covered the general extent of the original project area. The test results shown in Figure 4 are based on modifying two of the four sources to have an ISR of 0.5, such that there were 2 simulations with 1 source with an ISR of 0.5 and 1 simulation with 2 sources with an ISR of 0.5.

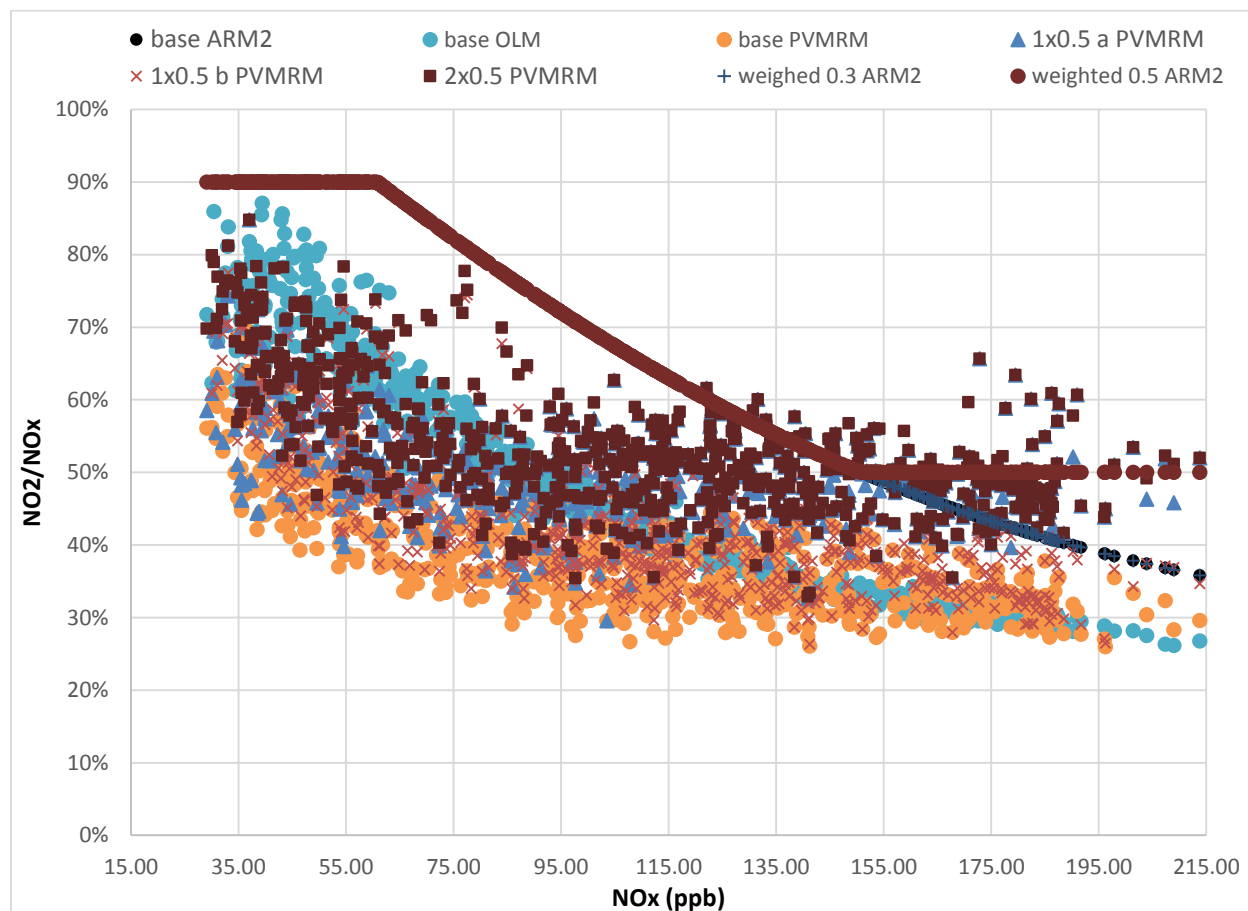


Figure 4: NO₂/NO_x ratios for the multi-source scenario sensitivity studies

These tests provide several interesting results. First, there is once again a NO_x threshold where ARM2 becomes less conservative than the Tier 3 methods occurring around 150 ppb of NO_x. Second, the two scenarios based on increasing the ISR to 0.5 for one of the sources are remarkably different, with the “1x0.5 b” case results more similar to the base case than the

“1x0.5 a” case. Similarly, the “1x0.5 a” case results are more similar to the “2x0.5” scenario that has 2 sources with an ISR of 0.5. These findings are due to the relative location of the receptors with the maximum concentrations to the 0.5 ISR source and the predominant wind conditions. The 0.5 ISR source in the “1x0.5 a” scenario is closer to and immediately upwind of the receptors with the maximum concentrations, while the 0.5 ISR source in the “1x0.5 b” scenario is farther upwind from these receptors. Ultimately, the results clearly demonstrate that when one source in a multi-source scenario has an ISR above the minimum ARM2 NO₂/NO_x ratio, then the ARM2 results may still be less conservative relative the Tier 3 methods.

Since the implementation of ARM2 in AERMOD allows the user to specify the minimum and maximum NO₂/NO_x ratio, the ARM2 settings can be adjusted to eliminate the NO₂/NO_x ratio under prediction when sources with an ISR greater than 0.2 are included in the modeling scenario. To explore this possibility, two additional scenarios were considered. For these simulations the minimum ARM2 ratio was adjusted to match the emission-weighted mean ISR from the four sources included (resulting in an ISR of 0.3066) and the maximum ISR from all sources (0.5). The results from these two additional ARM2-based runs are shown in Figure 4. Since the modified ARM2 runs do not change the source properties, the ARM2 results in the lower NO_x levels are identical in all three ARM2 runs. For the base case and weighted ARM2 case, the NO₂/NO_x ratios are identical at all NO_x levels because the minimum modeled NO₂/NO_x ratio from the base case (0.36) was greater than the emission weighted minimum ratio of 0.3066. In contrast, the “0.5” ARM2 run has substantially higher NO₂/NO_x ratios at the higher NO_x levels. However, the maximum Tier 3 results have higher NO₂/NO_x ratios than the “0.5” ARM2 run. These additional tests demonstrate that simply adjusting the minimum ARM2 ratio does not insure that the ARM2 NO₂/NO_x ratio will be conservative relative to the Tier 3 methods.

4.0 Conclusions of Additional EPA ARM2 Analysis

The additional EPA analysis of the ARM2 method expands considerably on the evaluation provided in the ARM2 development report, specifically highlighting when true ambient NO₂/NO_x ratios may be well above those computed by ARM2. While the ARM2 development report focused on modeled design values (i.e., 98th percentiles), the EPA analysis also considered single, high NO_x values to target the highest potential NO₂/NO_x ratios from a variety of scenarios. The EPA analysis indicates that there are several scenarios where ARM2 may not be appropriate or should be applied with caution. The first case is when there may be very high ozone present in the area of the project source. The second case, and biggest shortcoming of ARM2, is when one or more sources have ISRs greater than 0.2. This deficiency was highlighted in theoretical PV tests and the single and multi-source Tier 3 modeling results. Unfortunately, these findings complicate the implementation of ARM2 as a Tier 2 screening technique by requiring more consideration to justify for its usage than the existing ARM. However, there is a strong indication that below a certain total NO_x threshold, in the range of 150-200 ppb of NO_x,

ARM2 is likely to be conservative relative to the Tier 3 methods regardless of the source's ISR and therefore may be used as a safe harbor for the application of ARM2. It thus stands to reason that if a source or group of sources has a maximum modeled design value from the Tier 1 full conversion assumption below this threshold, then there should be no reason to restrict the usage of ARM2 or require a demonstration of the source's ISR.

When performing cumulative modeling, a similar threshold consideration could be made when background is added. Since the goal of the Tier 2 screening method is to determine if a violation will occur, the impact of the addition of the background NO₂ can also be considered. For example, in order to model a NO₂ concentration above the 1-hour standard with ARM2 absent any background, the total modeled NO_x would have to be 500 ppb (at 500 ppb NO_x, the ARM2 ratio is 0.2, giving a NO₂ concentration of 100 ppb). In contrast, if the background level of NO₂ is 35 ppb, then the total modeled NO_x needed to exceed the 1-hour NAAQS would only have to be 85 ppb (the ARM2 ratio at 85 ppb of NO_x is 0.77, giving a NO₂ concentration of 65, for a cumulative NO₂ concentration of 100 ppb). For the ARM2 "approval threshold" of about 150 ppb of NO_x, the resultant NO₂ concentration is 75 ppb and the background needed to produce a violation is only 25 ppb. Table 2 outlines benchmarks for modeling a violation for a number of background levels of NO₂. Based on the values in this table, it could reasonably be expected that a model violation would correctly be identified if the total NO_x of the 98th percentile values is below the level corresponding to the background values provided. For example, if the background NO₂ is 15 ppb, then the threshold for violation-identification would be 320 ppb NO_x, implying that ARM2 might be appropriate for use regardless of the ISR as long as the full conversion modeled design value (98th percentile) at any receptor is below this threshold.

NO _x	ARM2 NO ₂ /NO _x	NO ₂	Background	Cumulative NO ₂
105	67%	70.81	30	100.81
145	52%	75.17	25	100.17
270	30%	80.33	20	100.33
320	27%	85.14	15	100.14
455	20%	91.00	10	101.00
500	19%	100.00	0	100.00

Table 2: Modeled violation thresholds for various background levels of NO₂ and NO₂/NO_x ratios

There are also indications that when ozone levels are particularly high, ARM2 may underestimate NO₂ concentrations even when the source has a low ISR. The threshold for ozone effects being important appears to be approximately 90 ppb. When ozone levels are this high, the PV and PSS/TT tests indicated high NO₂/NO_x ratios could occur even when the source has no direct NO₂ emissions. PVMRM tests of a single source indicate a source with an ISR of 0.2 and 90 ppb of background ozone will model higher NO₂ than ARM2 when the total NO_x is above 250 ppb. Tests also indicate that lower ozone would produce PVMRM NO₂ results less than ARM2 NO₂ results up until 500 ppb of NO_x, above which, PVMRM and ARM2 would have

roughly equal NO_2/NO_x ratios. Thus, areas that regularly experience exceptionally high hourly ozone levels should use ARM2 with caution.