
Harvest Strategies and Numbers of Elk (*Cervus elaphus*) in Oklahoma, 1987-2001

W. David Walter

Oklahoma Cooperative Fish and Wildlife Research Unit, 404 Life Sciences West, Oklahoma State University, Stillwater, OK 74078

David M. Leslie, Jr.

U.S.G.S. Biological Resources Division, Oklahoma Cooperative Fish and Wildlife Research Unit, 404 Life Sciences West, Oklahoma State University, Stillwater, OK 74078

Elk have persisted in Oklahoma for nearly a century challenging wildlife agencies to balance management objectives with constituent requests. We summarized harvest strategies and numbers of elk harvested in Wichita Mountains Wildlife Refuge (WMWR), Fort Sill Military Reservation (FS), Private Lands (PL) near WMWR, and Pushmataha, Cookson Hills, and Spavinaw wildlife management areas (WMA) from 1987 to 2001. A total of 2284 elk have been harvested in Oklahoma since 1987 with a majority of the harvest occurring at WMWR, FS, and PL. Limited harvests are available in WMA because disease, poaching, and lack of habitat are believed to limit population growth. Future elk management in Oklahoma will require a cooperative effort between state and federal wildlife agencies to alleviate potential conflicts with surrounding landowners. ©2002 Oklahoma Academy of Science

INTRODUCTION

Elk (*Cervus elaphus*) were once widespread in North America and occupied every major natural vegetation type (1). The public is usually surprised to learn that elk occur in Oklahoma, but as a game species several populations are relatively large and productive enough to sustain a restricted annual harvest. Merriam's elk (*C. e. merriami*) were native to Oklahoma prior to the 1900s, but the last known Merriam's elk was harvested on Rainy Mountain, Kiowa County, in 1881 (2). In 1908, a bull of unknown stock and origin was released into the Wichita Mountains Wildlife Refuge (WMWR), followed by five Rocky Mountain elk (*C. e. canadensis*; one bull, four cows) from Jackson Hole, Wyoming, in 1911 (1,2). Relocation efforts were successful, and the elk population in WMWR is maintained at about 500 through annual harvests (J. Kimball, WMWR Wildlife Biologist, personal communication). Elk have migrated from WMWR through fence-breaks south to the adjacent Fort Sill Military Reservation (FS) and north and west to adjacent private land (PL) outside WMWR

and FS. To further establish elk in eastern Oklahoma, elk from WMWR were introduced into Cherokee, Cookson, LeFlore, McCurtain, Pushmataha, and Spavinaw wildlife management areas (WMA) in the late 1960s (3).

Successful elk restoration has occurred in Pennsylvania and Michigan resulting in self-sustaining herds (4,5), causing other states to assess the feasibility of elk restoration (5-7). The Oklahoma Department of Wildlife Conservation (ODWC) has regulated elk harvests to control expanding elk herds on private lands and provides hunting opportunities for Oklahoma residents on wildlife management areas. We summarize harvest strategies and total harvest of elk in Oklahoma from 1987 to 2001.

STUDY AREA and METHODS

Wichita Mountains Wildlife Refuge: The WMWR is 23,879 ha in Comanche County in southwestern Oklahoma (8). During the

1960s, a 2.4-m fence of 80 km was erected to confine ungulates to WMWR (elk; bison, *Bos bison*; white-tailed deer, *Odocoileus virginianus*; longhorn cattle, *Bos taurus*). About two-thirds of the WMWR interior is enclosed by a 2.4-m fence to prevent human exploitation and is maintained as a natural resource area.

Fort Sill Military Reservation: The 38,164-ha FS borders WMWR to the south and also is surrounded by a 2.4-m fence. The FS is similar in topography and vegetation to WMWR and is an active military base with daily ground and air exercises.

Private Lands: The PL bordering WMWR to the north includes igneous mountains peaks and slopes (>25%) extending from the WMWR (9).

Wildlife Management Areas: From 1969 to 1972, 391 elk were transplanted to WMA and preserves in eastern Oklahoma (3). Elk were released into Cherokee, Cookson, LeFlore, McCurtain, Pushmataha, and Spavinaw wildlife management areas. Only Pushmataha (PWMA), Spavinaw (SWMA), and Cookson Hills (CHWMA) wildlife management areas have maintained an elk population.

The PWMA is 7390 ha located in Pushmataha County. The CHWMA is 5807 ha located in Cherokee and Adair counties (10). The SWMA is 5803 ha located in Delaware and Mayes counties. Cimarron County is located in the panhandle in northwestern Oklahoma. Elk in the County were believed to be migrants from Kansas because a drought in 1993 appeared to force elk to search for suitable forage (unpublished data, ODWC Federal Aid Annual Performance Reports).

Elk harvests were summarized by area from Federal Aid Annual Performance Reports provided by the ODWC. We summarized available data from 1987 to 2001 because only limited data on harvest strategies and numbers in areas other than WMWR were available prior to 1987.

RESULTS and DISCUSSION

Although cattleguards prevent ungulates from leaving WMWR on state highways 49

and 115, elk movements between WMWR, FS, and PL have been observed. Vandalism, water run-off, and elk have caused breaks in the fence and permitted emigration from WMWR. To provide a re-entry, WMWR personnel have constructed six ramps that permit elk to return to WMWR but prevent dispersal to PL.

Elk in WMWR are harvested annually through lottery drawings administered by ODWC. A total of 1563 elk have been harvested in WMWR since 1987 (Table 1). Harvest quotas are set by the WMWR manager based on results of annual aerial/road surveys. If a minimum number of 250 elk is not observed, permits issued may be reduced to decrease harvest numbers. In the early 1990s, numerous elk emigrated from WMWR to FS and PL because of landowner vandalism of fencing and the draining of Lake Elmer Thomas (S. Waldstein, WMWR Supervising Manager, personal communication). This resulted in a reduction of permits issued by WMWR and a low overall harvest (<100) in Oklahoma in 1993 and 1995-1996, and no harvest in 1994 (Table 1).

The elk population on FS was originally from the WMWR herd and 12-15 Rocky Mountain elk transported from a captive herd in Ponca City, Oklahoma and released in 1979 (G. Wampler, Fort Sill Military Reservation Administrator/Game Warden, personal communication). Detailed harvest data were not collected before 1990 so exact numbers harvested and how long elk hunting has occurred at FS were difficult to determine. Prior to 1990, harvest season dates and number of permits issued were determined annually by FS personnel to increase recreational use of FS to military personnel and registered guests and when a harvest appeared warranted based on population assessments from spotlight counts (G. Wampler, personal communication). Based on the available data compiled, a total of 178 elk have been harvested on FS since 1987 (Table 1). Since 1990, a maximum of 36 elk could be harvested annually during the 9-d archery season in October or the 6-d firearms season in December. Elk in FS experience an addi-

TABLE 1. Annual harvest statistics for elk (*Cervus elaphus*) in Wichita Mountains Wildlife Refuge (WMWR), private lands (PL), Wildlife Management Areas (WMAs), and Fort Sill Military Reservation (FS), Oklahoma, from 1987 to 2001.

Year	Total permits	# hunters	Percent participation ^a	Success rate (%)	WMWR	FS	PL	WMAs	Total harvest
1987	285	251	88	67	149	7	NH ^b	13	169
1988	483	471	98	51	210	NH	6	23	239
1989	286	267	93	47	110	1	NH	15	126
1990	338	287	85	53	132	7	NH	12	151
1991	608	592	97	43	127	16	98	11	252
1992	606	582	96	33	115	8	66	4	193
1993	443	438	99	28	50	11	59	4	124
1994	52	45	87	38	NH	8	NH	9 ^c	17
1995	59	58	98	55	19	10	NH	3	32
1996	79	74	94	55	24	14	NH	3	41
1997	680	680	100	32	109	15	91	2	217
1998	236	223	94	65	126	18	NH	2	146
1999	236	164	69	80	113	17	NH	2	132
2000	581	555	96	42	115	24	92	2	233
2001	657	628	96	34	164	22	24	2	212
Total	5629	5315	94	43	1563	178	436	107	2284

^a PL and FS hunter participation is unknown; therefore, 100% hunter participation was assumed.

^b NH = no harvest occurred for that year.

^c Includes five elk harvested in Cimarron County.

tional unknown level of mortality through mortar and bomb explosions during standard military exercises (G. Wampler, personal communication).

The initiation of an elk harvest on PL resulted from wheat/alfalfa crop damage complaints by farmers and ranchers. A total of 436 elk have been harvested from PL since 1987, with 207 (47%) harvested in the past 5 y. From 1987 to 1993, hunters could harvest one elk of either sex in lieu of harvesting a deer. In response to several years of recurring complaints received from farmers, ODWC altered the harvest strategy on PL. In 1997, in an attempt to considerably reduce the elk herd on PL, hunters submitting proof of landowner permission to hunt the PL were issued a permit to harvest one elk of

either sex (R. Smith, ODWC Supervising Biologist, personal communication). To reduce the PL elk herd enough to prevent crop damage, no permit quota was set, although no research on population estimates or carrying capacity was conducted on PL. This new strategy permitted 4 d of hunting (2 in October, 2 in December) and resulted in 91 elk (51 male, 40 female) being harvested in 1997. As a result, no crop damage complaints were received in 1998-1999. After 2 y of no harvest, crop damage was again a concern of landowners, which prompted the ODWC to reopen the PL elk harvest in 2000.

As the PL elk harvest developed, landowners began leasing land strictly for elk hunting. Land leases, for elk hunting

only, were \geq \$3,000; some landowners provided guides and lodging to individuals willing to pay \$7,500. To provide additional hunting opportunities, the ODWC also opened a 5-d archery season preceding the 2-d firearm hunt in October and December 2001. Prior to 2000, no regulation on bulls was imposed during PL harvests because objectives were a population reduction of the entire PL herd. In response to the larger than expected harvest of bulls in 1997, a minimum of four points on one side in 2000 and a minimum of five points on one side in 2001 were required to harvest bulls.

Harvest permits for elk on state wildlife management areas and special circumstance hunts (Cimarron County) are included in the statewide lottery system that selects hunters for WMWR. Annual harvest quotas are determined annually by ODWC personnel based on annual road surveys and trends in population size observed for each area.

About 80 elk are on CHWMA and a harvest has occurred annually since 1987 (R. Justice, ODWC Wildlife Biologist, personal communication). Initially, males and females were harvested on an annual basis, with 69 elk harvested prior to 1997. Trends revealed the elk population size in CHWMA was similar each year in the mid-1990s because mortality from poaching and potentially meningeal worm (*Parelaphostrongylus tenuis*) removed 8-10 elk/y (10, 11, R. Justice, personal communication). Lack of genetic diversity also has been speculated to cause low reproductive rates because the herd has been genetically isolated since the last introduction in 1971. Only one bull permit was issued from 1997 to 2001 to provide some elk hunting opportunities in eastern Oklahoma.

An elk herd established in SWMA provided a total harvest of 11 (5 males, 6 females) from 1987 to 1991. A harvest has not been implemented since 1991 because low reproductive rates and occasional mortality from meningeal worm and poaching have limited the population to 20-30 elk (S. Perry, ODWC Wildlife Biologist, personal communication). Although no detailed research has been conducted, low reproductive rates are believed to be a result

of poor genetic diversity and limited forage (S. Perry, ODWC Wildlife Biologist, personal communication). Elk use adjacent hay fields and meadows on private lands, suggesting preferred grazing habitat is limited at SWMA.

Elk numbers were estimated at 40 prior to the first harvest in PWMA in 1994 (J. Waymire, ODWC Wildlife Biologist, personal communication). Currently, there are about 50 elk in PWMA with 8 (3 males, 5 females) released in 2002 from a captive herd in Cushing, Oklahoma, to increase the genetic diversity of the original herd. In March 2002, 6 of the 8 elk (2 males, 4 females) were radiocollared before being released and are monitored weekly to determine the movements on PWMA (Jack Waymire, ODWC Wildlife Biologist, personal communication). Only one bull elk permit has been issued each year since 1994 to provide hunting opportunities in south-eastern Oklahoma.

Elk were harvested in 1994 in Cimarron County in response to crop damage complaints from farmers and ranchers. Elk in the county were believed to be migrants from Kansas and permitted a single harvest opportunity in northwestern Oklahoma in 1994. The effort resulted in a total harvest of 5 elk (2 male, 3 female) out of the 24 permits issued through the lottery system with no future crop damage complaints experienced in the area.

Wildlife managers are challenged with managing elk as population dynamics and sociological aspects change. Transplanted elk fall victim to disease (6), migrate onto private lands causing crop damage (13), or become a revenue for landowners causing state agencies to change harvest goals and objectives. Hunting pressure on established herds can cause changes in elk movements and timing of migration (12), if applicable, and use of crops on private land or refuges (13,14). Elk harvests can be further complicated when managers restrict hunting for several years creating a surplus of animals. Prior to 1997, the last PL hunt was in 1993 because crop damage was believed to be minimal in 1994-1996. From 1994 to 1996, WMWR reduced the number of harvest

permits by 66%. By 1997, the PL elk population had expanded, causing crop damage complaints and the reestablishment of the PL harvest. Although elk densities and movements in WMWR and PL were not investigated, it is possible that the increase of the PL elk herd was a direct effect of the decrease in the annual harvest on WMWR from >115 elk to <50 elk removed annually. Elk management can be complicated by different management objectives of state and federal agencies, as is the case between WMWR and PL.

Since 1987, the changing management of elk populations by federal and state agencies has resulted in annual variations in the total elk harvests across Oklahoma. Currently, research efforts through a cooperative effort between Oklahoma State University, the Rocky Mountain Elk Foundation, Nature Works, and the ODWC are underway to understand elk populations on PL near WMWR and to determine the most effective harvest strategy. With only about 500 permits issued annually to 50,000 applicants, elk management requires balancing concerns of farmers, ranchers, hunters, and outdoor enthusiasts. The ODWC, like other wildlife management agencies in several states considering reintroduction of elk, are incorporating concerns of numerous constituent groups in several areas across Oklahoma to manage elk populations. Similar to reintroduced elk in Kentucky (6), elk populations in eastern Oklahoma are susceptible to meningeal worm (11). Further reintroductions in the eastern US should consider the effects of meningeal worm and habitat management practices that may limit occurrence of this neurologic disease (10). Cooperation with federal agencies also is necessary because elk herds established on fenced (i.e., WMWR, FS) or unfenced (12,14) federal property will inevitably use private lands and potentially cause conflict.

ACKNOWLEDGMENTS

We thank, R. Bryant, S. Hodge, R. Justice, C. Kimball, J. Kimball, S. Perry, M. Shaw, R. Smith, G. Wampler, S. Waldstein, and J. Waymire for providing input on harvest

results and strategies. Financial support was provided by the Rocky Mountain Elk Foundation, Nature Works, and the Federal Aid, Pittman-Robertson Wildlife Restoration Act under Project W-148-R of the Oklahoma Department of Wildlife Conservation and Oklahoma State University. This research was conducted under the auspices of the Oklahoma Cooperative Fish and Wildlife Research Unit (Oklahoma Department of Wildlife Conservation, Oklahoma State University, U.S.G.S. Biological Resources Division, and Wildlife Management Institute cooperating).

REFERENCES

1. Bryant LD, Maser C. Classification and distribution. In: Thomas JW, Toweill DE, editors. Elk of North America ecology and management. Harrisburg (PA): Stackpole Books; 1964. 698 p.
2. Caire W, Tyler JD, Glass BP, Mares MA. Mammals of Oklahoma. Norman (OK): University of Oklahoma Press; 1989. 567 p.
3. Stout GG, Lowry FC, Carlisle F. The status of elk transplants in eastern Oklahoma. Proceedings of the 26th Annual Conference of the Southeast Association of Game and Fish Agencies 1972;26:202-203.
4. Cogan RD, Diefenbach DR. Effect of undercounting and model selection on a sightability-adjustment estimator for elk. J Wildlife Management 1998; 62:269-279.
5. Larkin JL, Grimes RA, Cornicelli L, Cox JJ, Maehr DS. Returning elk to Appalachia: foiling Murphy's Law. In: Maehr DS, Noss RF, Larkin JL, editors. Large mammal restoration: ecological and sociological challenges in the 21st century. Washington DC: Island Press; 2001; p 101-117.
6. Maehr DS, Grimes R, Larkin JL. Initiating elk restoration: the Kentucky case study. Proceedings of the Annual Conference of Southeastern Fish and Wildlife Agencies 1999;53:380-363.
7. McClafferty JA, Parkhurst JA. Using public surveys and GIS to determine the feasibility of restoring elk to

- Virginia. In: Maehr DS, Noss RF, Larkin JL, editors. Large Mammal Restoration: ecological and sociological challenges in the 21st century. Washington DC : Island Press; 2001. p 83-100.
8. Waldrip GP. Elk habitat use during calving season with possible effects on white-tailed deer at the Wichita Mountains National Wildlife Refuge [MS thesis]. Stillwater (OK): Oklahoma State University; 1977. 80 p. Available from: OSU Library.
 9. Buck P. Relationships of the woody vegetation of the Wichita Mountains Wildlife Refuge to geological formations and soil types. *Ecology* 1964;45:336-344.
 10. Raskevitz RF, Kocan AA, Shaw JH. Gastropod availability and habitat utilization by wapiti and white-tailed deer sympatric on range enzootic for meningeal worm. *J Wildlife Diseases* 1991;92-101.
 11. Carpenter JW, Jordan HE, Ward BC. Neurologic disease in wapiti naturally infected with meningeal worms. *J Wildlife Diseases* 1973;9:148-153.
 12. Conner MM, White GC, Freddy DJ. Elk movement in response to early-season hunting in northwest Colorado. *J Wildlife Management* 2001;65:926-940.
 13. Brelsford MJ, Peek JM, Murray GA. Effects of grazing by wapiti on winter wheat in northern Idaho. *Wildlife Soc Bull* 1998;26:203-208.
 14. Burcham M, Edge WD, Marcum CL. Elk use of private land refuges. *Wildlife Soc Bull* 1999;27:833-839.

Received: June 6, 2002; Accepted: September 3, 2002