6TH WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS

MAY 16 – 18, 2005
RENO, NEVADA

Heffelfinger

6th Western States and Provinces Deer and Elk Workshop Proceedings

Editor
Mike Cox, Nevada Department of Wildlife

Published by
Nevada Department of Wildlife, Reno

Organizing Committee

Mike Cox – Workshop Chair
Dawn Carter
Mark Smith
Janice Smith
Tony Wasley
Ken Gray
Carl Lackey
Kim Toulouse
Larry Gilbertson
Russell Woolstenhulme
Mike Podborny
Gregg Tanner

Chad Bishop – Wallmo Award Chair

Suggested Citation:
M. Cox, editor. 2007. Proceedings of the 6th Western States and Provinces Deer and Elk Workshop – 2005. Nevada Department of Wildlife, Reno. 78 pp.

The Western States and Provinces Deer and Elk Workshop is a biennial event sanctioned by the:

Western Association of Fish and Wildlife Agencies

The 2005 Western States and Provinces Deer and Elk Workshop was Sponsored by:

Rocky Mountain Elk Foundation
Nevada Bighorns Unlimited – Reno
Safari Club International, First for Hunters
Systems Consultants

SCI FIRST FOR HUNTERS

ROCKY MOUNTAIN ELK FOUNDATION Working for Wildlife

NEVADA BIGHORNS UNLIMITED RENO

Systems Consultants
www.sci-nevada.com

Donors contributing to the 2005 Deer and Elk Workshop were:

Desert – Las Vegas Chapter, Safari Club International
BASF
Pope and Young Club

BASF The Chemcial Company

DESERT-LAS VEGAS CHAPTER SCI FIRST FOR HUNTERS

POPE AND YOUNG CLUB

The 2005 Deer and Elk Workshop was Hosted by:

Nevada Department of Wildlife and the Mule Deer Foundation

NEVADA DEPARTMENT OF WILDLIFE

MULE DEER FOUNDATION

TABLE OF CONTENTS

HABITAT SYMPOSIUM

PAPERS AND PRESENTATIONS

CONSERVATION TOOLS FOR WILDLIFE HABITAT

COLLEEN E. HEMINGWAY, Trust for Public Land, PO Box 1097, Minden, NV 89423, USA, colleen.hemingway@tpl.org

Abstract: The American Farmland Trust estimates that 13 million acres of open land were converted to urban uses between 1982 and 1992. Across the country, states and communities are becoming creative and using several techniques to help keep farmland and ranchland in agriculture. In the West, communities are scrambling to protect land that supports the economic engines of ranching, tourism, and business growth. Natural open space supports fishing, hunting, and other wildlife-based tourism. In order to preserve open land, some farmland may be taxed at a special lower rate so long as it is used for farming. States and communities are also purchasing fee title to preserve valuable open space or purchasing just the development rights to agricultural land and restricting this land to farm, woodland, or other open space use. This technique allows the landowner to raise some money without losing control or ownership of the land itself and provides permanent protection of the landscape without the sometimes-controversial fee acquisition by the government or regulatory efforts to accomplish preservation. Other examples might be the remainder interest, a personal contract, license, or deed restriction/covenant/CC & R's.

Farm and ranch land not only provide scenic open space or wildlife habitat, but also economic stability. In 1997, American agriculture generated approximately $50 billion in farm income that was cycled through local communities. Across the nation, parks, protected rivers, scenic lands, wildlife habitat, and recreational open space help support a $502-billion tourism industry. Outdoor recreation represents one of the most vigorous growth areas in the U.S. economy. According to the Natural Resources Defense Council, the annual value of hunting, camping, fishing, and horseback riding on federal BLM lands is $376 million. Communities no longer need to choose between economic growth and open space protection. Open space protection is not only good for the economy, but also good for the community's health, beauty, and quality of life.

Some examples of conservation efforts in the West include Great Outdoors Colorado (GOCO), a grants program funded by state lottery revenues that supports wildlife preservation, recreation programs, and open space acquisition. Since 1992, GOCO in partnership with Gunnison Ranching Legacy Project has helped protect more than 60,000 acres of open space. These lands provide habitat for wildlife that attracts tourists, hunters, and anglers. Hunting and fishing alone contribute more than $62 million each year to the Gunnison County, Colorado economy. In 1991, Crested Butte began collecting a real estate transfer tax that has raised more than $1.5 million for open space conservation, and in 1997 county residents passed a dedicated sales tax to fund open space protection.

THE NATURE CONSERVANCY APPROACH TO LAND CONSERVATION

ROB J. SCANLAND, The Nature Conservancy, 1 East First Street, Reno, NV 89501, USA, rscanland@tnc.org

***Abstract*:** The Nature Conservancy (TNC) was founded in 1950 by a group of ecologists, earth scientists and local citizens who were concerned about protecting a single piece of property that was being threatened. From that humble beginning, The Nature Conservancy has grown to become a prominent voice in the conservation of lands and water around the world. The mission of The Nature Conservancy is to preserve the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive. The Conservancy, as of September 2004, has protected a total of 116,241,700 acres worldwide. TNC works in 28 countries. In the United States, TNC has an interest in 7,583,846 acres broken down as follows: owned - 3,004,123 acres; conservation easements - 2,933,361 acres; leases - 973,549 acres and management agreements - 672,813 acres. TNC is supported 34% by individuals, 16% by foundations, roughly 10% by corporations and the balance by government grants, investment income and contracts. Over the past 50+ years TNC has produced numerous other non-profit conservation organizations, who operate on local, national and global scale. The Conservancy has been innovative in it's scientific approach to conservation - Conservation by Design, Eco-Regional Planning and creation of the Natural Heritage Program, to name a few. TNC has also developed, employed and revised numerous land and water conservation tools. The Nature Conservancy has and continues to be non-confrontational, works in collaboration and partnership and continues to strive to accomplish, with your help, the mission which has been set before us.

The oral presentation touched on a few highlights of TNC's work in Nevada, highlighted a few tools that can be used to protect habitat, and provided cautions about some of the most commonly used conservation techniques.

CONSERVING WILDLIFE HABITAT WITH OLD TECHNIQUES AND NEW TOOLS

TOM TOMAN, Rocky Mountain Elk Foundation, 2291 West Broadway, Missoula, MT 59808, USA, tom@rmef.org

Abstract: The Rocky Mountain Elk Foundation (RMEF) has provided grants for wildlife habitat enhancement project for the past 18 years of our 20-year existence. These include prescribed burning, mechanical thinning, fertilization, seeding, planting, water developments and a variety of other techniques. Most have been very effective and have benefited not only elk, but also a wide variety of wildlife in various habitat types. As a result of the big wildfire season in summer of 1988, RMEF had an opportunity to begin land trust projects in addition to habitat enhancement projects. Our first land project was the acquisition of the Robb Creek Ranch on the Northern Yellowstone Elk Herd Winter Range. Since that time we have participated in 111 land acquisitions, 100 conservation easements, and received several land donations. Most of the acquisitions were conveyed to federal or state agencies to be managed as public land. Some of the new tools we are using include grazing allotment waivers, grass banks and forage reserves. We have developed new criteria for these types of wildlife habitat projects as we make every effort to think outside the box and encourage our wildlife and habitat professionals to join us.

CAN THE PRINCIPLES OF CONSERVATION BANKING AND RANGELAND TRUSTS APPLY TO DEER AND ELK HABITAT CONSERVATION?

RICH FLETCHER, 1568 Catalina Ct., Livermore, CA 94550, USA, richfletcher@sbcglobal.net
TIM KOOPMAN, California Rangeland Trust, Koopman Ranch, P.O. Box 177, Sunol, CA 94586, USA, tkoopman@sfwater.org

Abstract: Urban expansion into deer and elk habitat, especially winter range, is impacting many western herds. High-value real estate is an economic force that is depleting rangeland, farmland and other traditional big game winter habitats. The Endangered Species Act and California Environmental Quality Act provide authorizing legislation for Conservation Banking which has been used to reduce loss of critical habitat for threatened and endangered species in California. The Conservation Banking process identifies habitat for which compensation is created by setting aside habitat in other vital areas. For each acre of habitat lost to development, the developer pays to conserve up to 3 acres of similar habitat at a nearby appropriately designated location. Although habitat is diminished in the process, the impact of development is at least partially mitigated by the protection of other habitat that would otherwise remain exposed to future destruction. Is it possible that a similar conservation measure may be used to successfully mitigate losses of deer and elk habitat in western states?

The use of conservation easements for the perpetual conservation of open space, wildlife habitat, and working landscapes (continued ranching operations) has gained prominence in recent years. Conservation easements can provide a means of facilitating succession planning by providing cash payments to heirs that do not have an interest in continuing agricultural operations and may provide tax benefits for landowners who donate easements.

The California Cattlemen's Association established the California Rangeland Trust (CRT) in 1998-99 for the purpose of providing a landowner-based land trust. To date, CRT has secured easements on over 150,000 acres of rangeland in California, including the recent transaction that placed a permanent conservation easement on the 82,000 acre Hearst Ranch in San Luis Obispo County. Other easements held by CRT include the Dressler\Centennial Livestock Ranch (6,700+\- acres) in Bridgeport, Mono County, the Bar 1 Ranch in Sierra Valley (13,000 +\- acres) and the DS Ranch in Sierra Valley (8,000 +\- acres). Tim Koopman has personally executed two habitat conservation easements on his family ranch in Alameda County for habitat conservation for California Tiger Salamander and the Callipe Silver Spot Butterfly.

Tim Koopman's employment as a Watershed Resource Specialist with the City of San Francisco Water Department (SFWD) includes the management of 40,000 acres of watershed lands that includes a robust population of Black-tailed Deer and a small but growing herd of Tule Elk. The Tule elk herd on SFWD land began as a natural migration (9 elk) from the California Department of Fish and Game's transplant from the Owens Valley to Mount Hamilton. The herd now numbers about 156 animals including calves. Management practices for the Tule elk herd include the restriction of domestic livestock grazing on the known calving area and a reduction in domestic livestock grazing inventories from historic highs by 35%. The grazing tenants have accepted this reduction in cattle numbers as a reasonable land use as previous high inventories were inflated leading to overgrazing in average and below average forage production years.

PRIVATE LANDS AND RANCHING PARTNERSHIPS IN SOUTH TEXAS

FRED C. BRYANT, Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville, Kingsville, TX 78363, USA, kffcb00@tamuk.edu
DAVID G. HEWITT, Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville, Kingsville, TX 78363, USA, david.hewitt@tamuk.edu

Abstract: South Texas, a region of over 32 million acres, is 97 percent in private ownership. Partnerships with the ranching and wildlife recreation industry are a fruitful venture for both scientists and agencies for many reasons. Unique opportunities include (1) Landowner Associations whereby landowners form cooperatives and collectively manage wide ranging wildlife species such as white-tailed deer, Rio Grande turkeys and feral pigs; (2) tremendous financial resources and advanced management strategies that are ahead of the curve as we know it in the research world; (3) testing hypotheses about deer density impacts on habitat and population regulation; (4) resources to implement habitat management and restoration programs over vast areas; and (5) providing insight for researchers to test, regarding harvest strategies for deer. In one example, landowners actually donate financial resources to participate in research. All of these examples are models to engage landowners in research and science. Their participation is critical to successful conservation and stewardship practices.

PARTNERS IN HABITAT RESTORATION

SCOTT C. COOKE, Prineville District Bureau of Land Management, 3050 NE Third Street, Prineville, OR 97754, USA, Scott_Cooke@or.blm.gov
DON R. ZALUNARDO, Prineville District Bureau of Land Management, 3050 NE Third Street, Prineville, OR 97754, USA
JOHN L. CRAFTON, Oregon Hunter's Association, PO Box 267, Redmond, OR 97756, USA

Abstract: The Phillip W. Schneider Wildlife Area in Central Oregon encompasses over 43,000 acres of Bureau of Land Management (BLM), State, and Private Land. Public land is managed by the Prineville District BLM and the Oregon Department of Fish and Wildlife (ODFW). The area was formerly the Murderer's Creek Wildlife Area, renamed in 2002 to honor former State Game Director, Phillip W. Schneider. From 1929-33, the Murderer's Creek basin was a state refuge. At the end of that period, the largest deer population for the area was recorded, approximately 40,000. Heavy domestic livestock use during that time as well as a grasshopper infestation in the 1970's resulted in degraded range conditions, and large numbers of mule deer perished due to starvation. In 1972, large acres of deeded land were acquired by ODFW primarily to provide habitat for the wintering deer herd. Habitat conditions on several thousand acres of this crucial mule deer and elk winter range have never recovered. The shrub component is limited and in some areas non-existent. Medusahead rye (*Taeniatherum caput-medusa*), an aggressive exotic annual grass from the Mediterranean region of Eurasia, has also infested several thousand acres of crucial winter range. The area winters approximately 2,000 deer, 1,200 elk, 150 California bighorn sheep, and 100 pronghorn.

In 1993 Phase 1 of this habitat restoration project began. Medusahead rye was burned, experiments were tried with spraying, and approximately 2,000 acres were seeded to desirable perennial grasses and forbs over a 7-year period. Burning was conducted in the "soft dough" stage in an attempt to eliminate the current year's production of medusahead seed. Some areas were burned a second time and limited areas were sprayed with herbicides as a second treatment. Areas were then seeded in an attempt to compete with medusahead and restore this once productive winter range. In 2000, Phase 2 of the project was launched and involved planting shrubs to further the restoration effort. For the past 6 years, a total of 1,774 volunteers, donating 16,240 volunteer hours and 21,400 vehicle miles, have planted approximately 100,000 shrubs on 200 acres of BLM, State, and Private land. The 5-year average for shrub survival is 63% with 12 different species planted.

Multiple partners are involved in this project and include: Oregon Hunters Association (12 chapters statewide and led by the Redmond Chapter), Central Oregon Quail Unlimited, Oregon Department of Fish and Wildlife, National Fish and Wildlife Foundation's "Answer the Call" (National Quail Unlimited), Rocky Mountain Elk Foundation, Bureau of Land Management, Boy Scouts of America, National Wild Turkey Federation, and Pheasants Forever. The project has been recognized both locally and on a national level. Included in this recognition are articles in National Quail Unlimited magazine, the Bugle magazine produced by the Rocky Mountain Elk Foundation, the statewide Oregon Hunter's Association magazine, ODFW's statewide Access and Habitat Board News, and numerous local papers.

HABITAT TOOLS AND TREATMENT RESULTS FOR SAGEBRUSH STEPPE COMMUNITIES

KREIG RASMUSSEN, USDA Forest Service, Fishlake National Forest, 115 E. 900 N. Richfield, UT 84701, USA, kmrasmussen@fs.fed.us
LARRY GREENWOOD, BLM Richfield District, 150 East 900 North, Richfield UT 84701, USA
MACE CRANE, USDA Forest Service, Fishlake National Forest, 115 E. 900 N. Richfield, UT 84701, USA

Abstract: Habitat treatment tools being used in our area include chaining, Bullhog, Agri-ax, chainsaw, Bobcat Brushsaw, double and single drum Lawson aerator, Dixie Harrow, rangeland disc/drill, fire, and livestock. Once sagebrush sites reach 20% cover, the understory of grass and forbs decrease proportionately. Ideal rangeland should contain between 10-12 percent sagebrush. Many of the sites we target for treatment are over 25% and as high as 40%. If the understory is poor we will seed at the time of the treatment, otherwise, we will add seed only where needed. Sites that have a high percent of sagebrush cover also have a high percent of litter, bare ground and rocks. The inner spaces (between the brush) become almost barren of vegetation because of heavy grazing and trailing by cattle, elk, and deer. This creates high soil erosion potential on these sites. A sagebrush-dominant site can utilize 5-7 times more water than a grass-forb community. Old-age sagebrush that becomes decedent is not as palatable for deer compared to younger healthier sage. Our Dixie Harrow post treatment data shows, sagebrush averages 32.4% on untreated sites and 6.7% on treated sites. (These data reflect a "twice over" Dixie Harrow pattern to achieve a 90-95% initial reduction in sagebrush. A "once over" pattern will reduce sage 50-60%). The "twice over" pattern represents a 470% decrease of sagebrush on these sites. The grasses average 18.9% in the untreated sites and 40.5% on treated sites. This represents a 215% average increase in grass production post-treatment. The forbs average 4.5% in the untreated sites and 7.7% in the treated sites for a 170% increase. We see an increase of bare ground and litter the year immediately following the treatment. This soon changes as the vegetation increases and the litter melts down. With sagebrush reduced, grasses and forbs fill in the site and the percentage of bare ground is reduced dramatically. The treated sites reduce soil erosion greatly. A more natural flow of watershed function can occur than in a monoculture of sagebrush.

Other plants that respond well on our treated sites are bitterbrush and snowberry, 2 highly sought-after brush species by deer. The old decedent plants are removed by the treatment causing increased vigor to the remaining young plants. Bitterbrush sites that were Dixie Harrowed in "The Rocks" responded very positive. Forbs respond to a mechanical treatment almost like after a fire. Many wildlife species find the treatment areas very attractive for palatability and nutritional needs. We have to treat large amounts of acres to disperse grazing pressure on newly treated areas. Another positive aspect we see in the long-term is a "healing trend" in the untreated areas. As animals find the treatment areas more attractive, the adjacent untreated areas are receiving less pressure and are showing positive numbers in grass and forb production. This increases the size of the overall treatment area because of the affect the treatment has in the buffer areas.

The Dixie Harrow has been manufactured in 3 different sizes: 15 ft., 25 ft., and a 38 ft. The larger 2 harrows can be also used to treat sage in pinyon-juniper habitats and remove trees as well. We are also using the Bobcat Brush saw to cut re-growth of pinyon-juniper in old chainings. Maintenance of old chainings is an urgent issue. If we don't re-treat them before the understory starts to diminish again, the cost to reseed and re-treat will be 4 times greater. Mechanical treatments help set back the succession curve like fire. The Dixie Harrow is only one of the tools available to land managers today. We feel it is one of the best tools for sagebrush ecosystems. We have successfully treated and monitored thousands of acres with objectives in mind for deer, elk, and sage grouse and are finding positive results.

THE EFFECT OF ANCHOR-CHAINING ON WATERSHED VALUES, BIG GAME USE AND SMALL MAMMAL ABUNDANCE WITHIN A DEPLETED PINYON-JUNIPER WOODLAND IN CENTRAL UTAH

MARK E. FARMER[1], Brigham Young University, Provo, UT. 84604, USA
KIMBALL T. HARPER, Professor, (emeritus), Department of Integrated Biology, Brigham Young University, Provo, UT. 84604; USA
JAMES N. DAVIS, Division of Wildlife Resources, USDA Shrub Sciences Laboratory, 735 N 500 E, Provo, UT. 84606, USA
ASHLEY D GREEN, Brigham Young University, Provo, UT. 84604; USA

Abstract: Pinyon-juniper woodlands are an important rangeland type in the western United States where they cover up to 24 million ha (60 million acres). These woodlands have greatly expanded their distribution in the past 150 years due to effective fire control and heavy grazing by domestic livestock. Pinyon-juniper dominated landscapes offer little forage for wildlife and are prone to erosion. In 1990 the U.S. Forest Service anchor chained and seeded 121 hectares of juniper-pinyon woodland in Spanish Fork Canyon. Twenty 10-m^2 runoff-plots were established in 1991 to quantify the effect of anchor chaining on runoff and soil erosion. Plots were paired, one in the chained area and one on comparable terrain and soil type in the untreated juniper-pinyon woodland. Each enclosed runoff-plot channels runoff water and suspended sediments into collection containers. During five years of data collection, unchained plots produced 5.8 times more runoff and 9.2 times more sediment than chained plots. Ground cover values for runoff plots show that vegetation increased on chained plots from 27.1% in 1991 to 41.3% in 1995, while litter increased from 22.6% to 51.5% during the same time period. Vegetation cover on untreated plots varied from 7.5% in 1991 to 3.4% in 1995. Litter cover remained at nearly 15%. Results indicate that anchor chaining significantly reduced runoff and soil erosion by providing more protective ground cover.

Pellet group transects showed that deer and elk pellet groups were significantly more numerous in chained areas compared to unchained sites. Both deer and elk pellet group densities were greater on northern than on southern aspect control areas. Deer pellet groups were more numerous on south aspect treatment areas than on treatment areas of northerly aspect while elk pellet groups were similar for both aspects. Over the 4 years of data collection chained areas provided twice as many deer days use per hectare than unchained woodlands and 5 to 6 times more elk days use per hectare. These data show that anchor chaining can improve big game habitat and attract more animals to treated areas.

Small mammal snap trapping grids were setup on chained and unchained areas on the Spanish Fork chaining project during the summer of 1999. Trapping was conducted for 3 consecutive nights on 2 parallel, 150 m transects at two locations. Total abundance of small mammals was more than 2 fold higher in 2-way chained and seeded areas than in the unchained woodland. The abundance of deer mice (*Peromyscus maniculatus*), Great basin pocket mice (*Perognathus parvus*) and long tailed vole (*Microtus longicaudus*) were also significantly higher on chained and seeded sites. Least chipmunk (*Tamias minimus*) and pinyon mice (*Peromyscus truei*) were more abundant in the unchained woodland. Vegetation variables positively correlated to small mammal abundance included, heterogeneity of grasses and forbs at 1 and 2 m in height, total vegetation heterogeneity at 2 m in height, and woody plant cover. Pinyon-juniper density was the only variable that showed a significant negative correlation. Apparently, mechanically treated sites support higher numbers and more species of small mammals than untreated areas due to increases in herbaceous vegetation and litter which provide better habitat for forage, concealing cover, and nest building. Interspersing blocks of chained and unchained pinyon-juniper should increase small mammal abundance, richness, and diversity by providing more microhabitats for small mammal species.

---

[1]Present address: Utah Division of Wildlife Resources, 1115 North Main Street, Springville, UT 84663, USA, markfarmer@utah.gov

EFFECT OF ENHANCED NUTRITION OF FREE-RANGING MULE DEER ON POPULATION PERFORMANCE

CHAD J. BISHOP, Colorado Division of Wildlife, 317 West Prospect Road, Fort Collins, CO 80526, USA, chad.bishop@state.co.us
GARY C. WHITE, Colorado State University, Dept. of Fishery & Wildlife Biology, Fort Collins, CO 80523, USA
DAVID J. FREDDY, Colorado Division of Wildlife, 317 West Prospect Road, Fort Collins, CO 80526, USA
BRUCE E. WATKINS, Colorado Division of Wildlife, 2300 South Townsend Avenue, Montrose, CO 81401, USA

Abstract: We conducted a field experiment evaluating mule deer population responses to a nutrition enhancement treatment to further understand limiting factors of deer. The nutrition enhancement treatment represented optimum habitat conditions and was applied to free-ranging deer in a pinyon-juniper habitat complex. During November 2000 – June 2004, we radio-collared 810 deer evenly distributed among treatment and control units on the Uncompahgre Plateau in southwest Colorado. This included 293 adult females, 276 newborn fawns born from either treatment or control adult does, and 241 6-month-old fawns. We enhanced nutrition of deer in treatment units by providing supplemental feed daily from December through April each year. Control units did not receive any treatment. During 2002 – 2004, we measured pregnancy rates, fetus rates, late-winter body condition, fetus survival, neonate survival, and overwinter fawn survival among treatment and control deer. Fetus and neonate survival rates determined whether fawn production and survival increased as a result of enhanced nutrition of adult does. Estimated percent body fat of adult does during late February was higher ($F_{1,148} = 153.41$, $P < 0.001$) for treatment (9.8%, SE = 0.36, $n = 78$) than control (4.3%, SE = 0.26, $n = 76$) deer. Pregnancy and fetus rates were similar among treatment and control adult does. Overall pregnancy rate was 0.934 (SE = 0.019, $n = 167$) and overall fetus rate was 1.84 fetuses/doe (SE = 0.04, $n = 146$), which included yearlings. Using a continuous staggered entry survival process, we combined fetus, neonate, and winter fawn survival across years to evaluate the effect of the treatment on fawn production and survival to the adult age class (1 year old). Survival of fetuses to 1 year of age was higher ($\chi^2_1 = 13.201$, $P < 0.001$) for treatment deer ($S(t) = 0.458$, SE = 0.0309) than control deer ($S(t) = 0.276$, SE = 0.0256). The results reported here are based on preliminary analyses.

ECOLOGY OF CHEATGRASS

JAMES A. YOUNG, USDA, Agricultural Research Service, 920 Valley Road, Reno, NV 89512, USA, jayoung@scs.unr.edu
CHARLIE D. CLEMENTS, USDA, Agricultural Research Service, 920 Valley Road, Reno, NV 89512, USA

Abstract: Cheatgrass (*Bromus tectorum* L.) is an invasive, exotic annual grass that during the 20th century revolutionized the ecology of Intermountain Area rangelands. It accomplished this ecological revolution in two ways. First the seedlings of cheatgrass are extremely competitive for soil moisture. They out compete the seedlings of most native perennial plants and especially the seedlings of native perennial bunch grasses. Secondly, the early maturing, fine textured and occasionally very abundant herbage of cheatgrass increases the chance of ignition and the rate of spread of wildfires. These conditions prevail frequently enough among years that the return interval between wildfires is greatly shortened. This results in plant succession being truncated to continued dominance by cheatgrass and associated exotic annuals. The frequently occurring wildfires completely eliminate woody species from vast areas of rangeland. Even the non-sprouting, landscape characterizing big sagebrush (*Artemisia tridentata* Nutt.) has been eliminated in some areas by cheatgrass fueled fires. Cheatgrass provides the continuity of fuels to enhance the spread of fires from shrub to shrub. Native perennial grasses mature in late August and September. Cheatgrass matures in June, extending the wildfire season into the hottest months of the summer. In order to biologically suppress cheatgrass you must re-establish perennial grasses in the herbaceous layer. In order to establish such grasses some form of mechanical or herbicidal weed control is necessary. The seedlings of most native perennial grasses cannot compete with cheatgrass. Introduced grasses such as crested wheatgrass (*Agropyron desertorum* [Fisher] Schultz) have proven much more successful in revegetating areas infested with cheatgrass. Big sagebrush will invade crested wheatgrass seedings and eventually suppress or eliminate the perennial grass without recurrent fires.

RESTORING ANTELOPE BITTERBRUSH COMMUNITIES

CHARLIE D. CLEMENTS, USDA, Agricultural Research Service, 920 Valley Road, Reno, NV 89512, USA, charlie@scs.unr.edu
JAMES A. YOUNG, USDA, Agricultural Research Service, 920 Valley Road, Reno, NV 89512, USA

Abstract: Antelope bitterbrush (*Purshia tridentata* Pursh. DC) is a critical browse species to native and domestic ungulates. The lack of adequate seedling recruitment has resulted in old decadent stands that provide little nutritional value. In addition, wildfires have increasingly consumed important browse communities, and with each passing wildfire season more and more important browse communities are lost for the near future, and in many cases converted to cheatgrass (*Bromus tectorum* L.) dominated rangelands. Mule deer (*Odocoileus hemoinus*) are the only declining big game species in North America, the further degradation of these important browse communities only exacerbates the struggle that many mule deer herds face. It is very disturbing that antelope bitterbrush is often passed over as a candidate species in restoration efforts, the presence of antelope bitterbrush as a productive component of shrub communities is beneficial to mule deer and other wildlife species. This paper points out the importance of antelope bitterbrush as a browse species and some optimism in restoring this *key* browse species back into these critical habitats.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 6:12-16

Key Words: antelope bitterbrush, cheatgrass, mule deer, restoration, seed caching, seeding, transplanting, wildfires

---

The restoration of important browse species is a critical element in implementing successful wildlife management practices. Antelope bitterbrush (*Purshia tridentata* Pursh. DC) is the most important browse species on many western mule deer ranges. Because of this recognition, state, federal, and other interested parties have put forth tremendous efforts in the attempt to restore antelope bitterbrush communities throughout the western United States. Antelope bitterbrush occurs from British Columbia to Montana and south to New Mexico.

In 1924, Arthur W. Sampson, one of the fathers of range management, reported antelope bitterbrush as an important browse species to deer (*Odocoileus spp*), elk (*Cervus elaphus*) and antelope (*Antilocarpa americana*). Another early researcher, Joseph Dixon, studied the food habits of deer in different regions of California in the 1920s and early 1930s and reported the importance of antelope bitterbrush to deer. This research led to the recognition of antelope bitterbrush as a critical browse species to many mule and black-tailed deer. This critical status is supported by the nutritional value provided by antelope bitterbrush. Protein for body maintenance is often considered the most important dietary nutrient. Even a slight deficiency can adversely affect reproduction, lactation, and growth. About 7% crude protein is needed for mule deer maintenance, antelope bitterbrush provides from 8-14% crude protein through the various seasons of the year and represents as much as 60% of the mule deer diet.

Antelope bitterbrush communities have not been successful in establishing enough seedlings to sustain their population from such losses as old age, diseases, and wildfires (Figure 1). Lack of natural seedling recruitment requires artificial establishment of this valuable shrub by direct seeding or transplanting. We report on some hard learned experiences of successes and failures of restoring antelope bitterbrush.

Antelope bitterbrush flowers on second year wood, that is twigs produced the previous year. To have good seed production the plant must have considerable leader length that survives browsing pressure (Figure 2). The number of bright yellow flowers you see on antelope bitterbrush plants in the spring is directly proportional to the quality of growing conditions the *previous* spring and the browsing pressure the previous winter. Even with good flowering, seed production is not assured. As a spring flowering plant, antelope bitterbrush seed production can be severely damaged by late frost and insects. We investigated these 2 seed mortality factors and found that frost damage was very low at 1-2% over a 2 year period, compared to insect damage which ranged from 47%-52% over the same period. This level can have significant effects on seed dispersal and subsequent sprouting of seedlings.

Figure 1. Catastrophic wildfires are increasingly burning whole mountain ranges in the Great Basin including critical mule deer winter habitats that once supported sagebrush and bitterbrush plant communities.

Once seeds are successfully produced they must be dispersed. The seeds are much too heavy and lack the aerodynamic shape for wind dispersal. The natural dispersal of antelope bitterbrush seeds is closely related to the seed caching activities of granivorous (seed eating) rodents such as chipmunks, kangaroo rats, and pocket mice. Many of these rodent species have external, fur lined cheek pouches that aid in the collection and transportation of seeds. Rodents benefit antelope bitterbrush by dispersing the seed through their collecting and caching behavior. "Scatter hoard" caching (caching seeds in shallow depressions) by rodents has been found to be very important in the recruitment of antelope bitterbrush seedlings. A. W. Adam's research in Oregon reported that natural mortality in a bitterbrush community of about 500 bitterbrush plants/acre only required the recruitment of 7 new antelope bitterbrush seedlings/year to sustain the population. This particular mule deer range had been recruiting less than 1 antelope bitterbrush seedling/year for the previous 50 years. This leads to old, decadent, unproductive, and less nutritional antelope bitterbrush communities.

Figure 2. Antelope bitterbrush shrub severely browsed with little seed production (left) versus excellent seed production on a moderately browsed, healthier antelope bitterbrush shrub.

We conducted research at three separate antelope bitterbrush communities in northeastern California and northwestern Nevada in which we aged antelope bitterbrush shrubs. The average plants in 2 of the 3 sites were over 80 years of age (83 and 98 years of age). The peak age for seed production is 60 years.

The younger site, 33 years, produced 18 times as much seed as the site that averaged 83 years, and 128 times as much seed as the site that averaged 98 years of age. The more seed produced, the more seed dispersed and cached, the greater the chance of seedling recruitment.

Seeding Antelope Bitterbrush

For various reasons, resource managers have experienced very limited success in their efforts to artificially seed antelope bitterbrush. Failure to establish antelope bitterbrush stands through direct seeding has been attributed to poor seed quality, predation of seeds and seedlings, and competition for moisture from exotic weeds such as cheatgrass (*Bromus tectorum* L.). This lack of success has resulted in antelope bitterbrush taking a back seat to other plant species in various seed mixtures used in restoration projects. The decision to not seed antelope bitterbrush on rangelands contributes to the decline of this critical browse species. This decline ultimately reduces plant species diversity as well as forage and cover for mule deer and other wildlife species.

The first criteria to be examined in efforts to restore antelope bitterbrush, is whether the site was formerly occupied by antelope bitterbrush. If the site was void of antelope bitterbrush, then it may not have the biological potential to support the shrub in the first place. A site that has antelope bitterbrush present or formerly supported an antelope bitterbrush population is a good candidate for antelope bitterbrush restoration. If the habitat is not excessively steep and rocky, the planting of antelope bitterbrush seed into the ground with a rangeland drill or no-till drill can produce very favorable results. Rangeland drills serve the same functions as grain drills do in farmlands. The rangeland drill is constructed on a heavy duty frame which allows it to seed over rocks, stumps, and uneven topography. No-till drills are not as sturdy. We conducted two separate seeding efforts in northwestern Nevada and northeastern California in which we drill seeded antelope bitterbrush seed with both the widely used rangeland drill and no-till drill onto burned

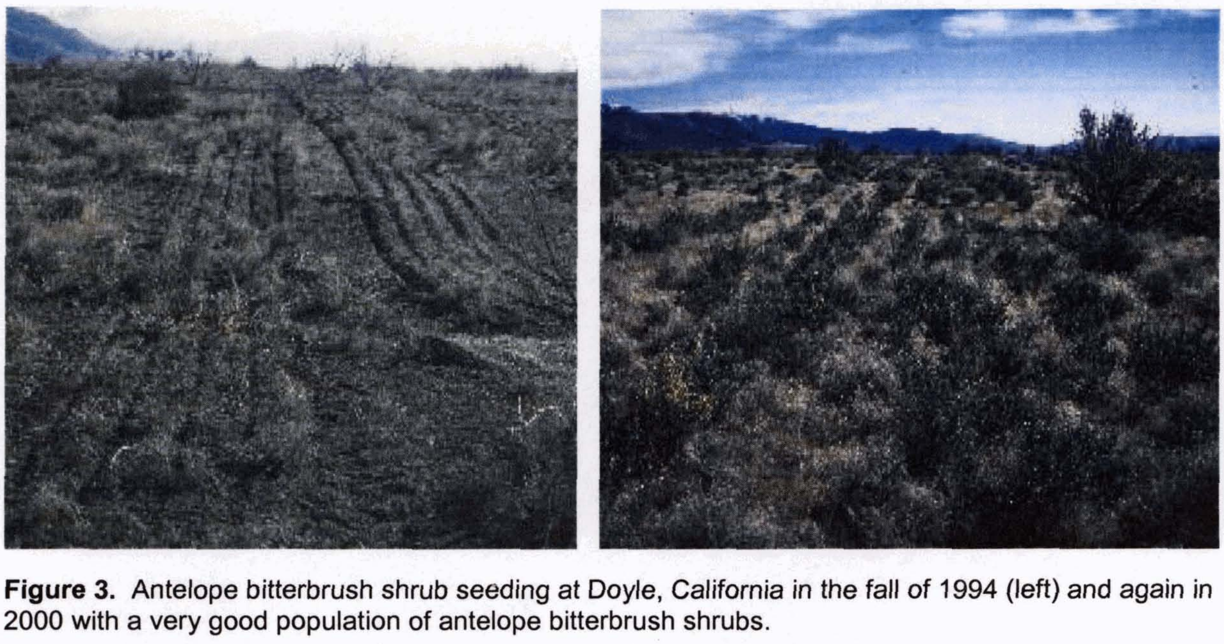


Figure 3. Antelope bitterbrush shrub seeding at Doyle, California in the fall of 1994 (left) and again in 2000 with a very good population of antelope bitterbrush shrubs.

antelope bitterbrush communities. At the first site, Doyle, California, we drill seeded at a rate of 3 lbs./acre (Figure 3). At the time of seeding, the site supported 10 antelope bitterbrush shrubs/acre, even though prior to the habitat burning in 1985 the site supported 250 antelope bitterbrush shrubs/acre. The density in the fall of 2000 was 2,500 shrubs/acre with the use of the rangeland drill (Figure 3) and 7,800 shrubs/acre with the use of the no-till drill. The seedling density acquired by the no-till drill method was greater than the potential of the site to support seedlings, therefore the shrubs are less vigorous as they are out competing each other for limited resources. The second site, located in the Sand Hills area of northwestern Nevada, was also drill seeded at 3 lbs./acre rate. The site had formerly supported 27 antelope bitterbrush shrubs/acre, yet following this restoration effort the site had a density of over 2,200 shrubs/acre by the fall 2000 using a rangeland drill. We highly recommend that these seeding efforts take place the first fall following the wildfire before the highly competitive invasive annual weed cheatgrass invades the site. If you do not seed immediately following the wildfire, cheatgrass will most likely invade the site. Once cheatgrass invades a site, as little as 4 cheatgrass plants per square foot can cause the death of native seedlings through moisture competition. It is not uncommon to have cheatgrass densities at hundreds/ft^2.

Transplanting Antelope Bitterbrush

Transplanting of antelope bitterbrush seedlings is one of the most popular and widely used methods in restoring antelope bitterbrush communities. The California Department of Fish and Game (CDFG) contacted us in the mid 1990s to research the lack of success they had been experiencing with their transplanting efforts in a critical mule deer wintering area. Field studies were located on the historic Evans Ranch in Sierra County, California. The CDFG in cooperation with the Mule Deer Foundation (MDF) had transplanted 79,000 antelope bitterbrush seedlings between 1993 and 1995. A biologist with the CDFG estimated that perhaps 5 transplanted seedlings had survived, but no one person had seen all 5 (Figure 4). We conducted an experiment using the same seedling supplier they had previously used as well as transplanted seedlings using the same methodology they had used as a control method (simply digging a shallow hole burying the roots). We also added different treatments; 1) spraying herbicides to control weeds and herbaceous vegetation for moisture competition, 2) disking to reduce competition from weeds, and 3) inoculating the transplants. In the inoculation method we collected soil from an adjacent bitterbrush community from beneath the shrubs and placed about 1 tablespoon of the soil in the hole with the transplants. This is important because antelope bitterbrush plants are known to fix nitrogen through a symbiotic relation with a microorganism known as *Frankia* that forms nodules on the roots. Experiments were also replicated inside a big game exclosure to see what effect if any the local mule deer herd had on predation of these young seedlings (the land is owned and operated by the CDFG and no livestock were permitted as of that time).

Figure 4. Following the transplanting of 79,000 antelope bitterbrush seedlings at this site, it is apparent that this method was unsuccessful.

We experienced the same results that the CDFG had experienced when using the control method, which was 0% success. However, inside the mule deer exclosure we experienced a 6% success rate. Outside the mule deer exclosure, the other methods resulted in significantly higher success; herbicide application 8%, disking 15%, and soil inoculation 15%. Success rates for seedling establishment inside the exclosure with the various treatments included: spraying 25%, disking 25%, and soil inoculation 27%. Obviously, more intense methods yield higher results; the burning question is whether those individuals in charge of these transplanting efforts are willing to put in the added effort to increase the success of transplanting.

The initial cost of these seedlings was $1.10 each. If a resource managers goal was to establish 200 seedlings/acre, and 25% success could be attained, this would still cost over $1,000/acre and this cost goes up as success goes down ($7,000/acre at 5% success). The extra effort put forth to ensure added success surely must be looked at more seriously. Transplanting of antelope bitterbrush must be monitored to fully understand exactly what level of success is being experienced. Far too often naturally recruited seedlings from rodent caches are counted as successful transplants.

Achieving Success

Many antelope bitterbrush habitats that have burned are infested with the invasive weed cheatgrass. The factor that most limits the establishment of antelope bitterbrush seedlings in the arid west is the competition for moisture from cheatgrass. If a big sagebrush/antelope bitterbrush community with an understory of cheatgrass burns with a good density of these woody shrubs, the fire will burn hot enough to raise the temperatures high enough to kill many of the cheatgrass seeds. Repeated wildfires that eliminate most of the woody plant material and result in a fast burns do not significantly reduce the cheatgrass seed banks (the reserve of cheatgrass seeds in the soil). Some form of weed control is needed before seeding antelope bitterbrush. To successfully seed into these higher cheatgrass areas, even after an active weed control program, the seeding of perennial grasses is critical in combating against cheatgrass invasion. We seeded crested wheatgrass at 4 lbs./acre with 2 lbs./acre rate of antelope bitterbrush and yielded 18,000 crested whreatgrass plants/acre and 1,500 antelope bitterbrush shrubs/acre, well above our goal of 250 bitterbrush shrubs/acre.

Direct seeding of antelope bitterbrush is a preferred method compared to transplanting if the seeding equipment can traverse the site. When we compare the direct seeding with the widely used rangeland drill, and the success we reported previously at the Doyle site, the success we achieved cost $54.00/acre plus labor. Transplanting would cost $1,000 - $7,000/acre to achieve a significantly lower density of antelope bitterbrush plants and over $15,000/acre to achieve similar results. Perhaps using volunteers to artificially cache antelope bitterbrush seeds to resemble rodent seed caches could be implemented in place of or adjacent to a transplanting programs to see if better success could be reached, in rough terrain, and at the same time decreasing costs (bitterbrush seed ranges from $15-$25/lb., and remember there are more than 16,000 seeds/lb.).

Antelope bitterbrush is an important browse species to mule deer and other wildlife and therefore should be used in restoration activities. The lack of success that resource managers have experienced or heard of second hand can cloud their views towards using this species in restoration efforts. The failure to restore antelope bitterbrush communities has added to the decline of this critical browse species. Far too often we are informed of the effort or process of restoration activities, and seldom are we made aware of the success of these activities or lack of success for that matter. There has truly been a lot of research concerning mule deer and antelope bitterbrush. This research, as well as extensive field experience, provides resource managers and other concerned organizations and individuals with much information on managing our mule deer herds and their habitat. If our goal is to reverse the continued decline of many of our mule deer herds, then the approach of assessing the importance of all habitats with the passion of restoring these critical browse species must be done with the perspective of the past as well as the technology of the present.

RESTORATION OF ASPEN HABITATS: PART OF A COMPLEX ISSUE

DAVID BURTON, Aspen Delineation Project; 2070 Orange Dr, Penryn, CA 95663, USA, peregrines@prodigy.net
MIKE PODBORNY, Nevada Department of Wildlife; P.O. Box 592, Eureka, NV 89316, USA, mpodborny@mwpower.net
DAN STROUD, Wyoming Game and Fish Department; 118 S. Sublette, Pinedale, WY 82941, USA, dan.stroud@wgf.state.wy.us
FLOYD ROADIFER, Wyoming Game and Fish Department; 227 S. Sublette, Pinedale, WY82941, USA, floyd.roadifer@wgf.state.wy.us
STEVE KILPATRICK, Wyoming Game and Fish Department, P.O. Box 67, Jackson, WY 83001, USA
KEVIN SPENCE, Wyoming Game and Fish Department, 351 Astle, Green River, WY 82935, USA,

Abstract: State and Federal game, fish, and land management agencies are being asked to take a far more active role in the conservation of an ever broadening range of wildlife species, many of which are considered to be at risk. However, conserving these species one species at a time is often impractical and unsustainable. Thus, there is an increasing awareness that management, preservation and restoration of habitat are critical for long-term sustainable management of wildlife populations. To address this challenge effectively, resource managers, who have historically often operated under conflicting management objectives, are beginning to realize a need to be collaboratively involved in a complex web of habitat-related decisions.

This presentation will focus on issues relating to aspen habitat restoration, but the presenters hope the lessons learned from discussing the complexity of managing this ecologically diverse habitat can be applied to other key habitats.

Presenters will discuss how to navigate the challenges of effective adaptive management, given wide-ranging and often polarized public and agency opinions about the management of wild and domestic ungulates and their relationship to habitat restoration.

The presenters will offer case studies examining successful approaches as well as pitfalls in the interaction of interdisciplinary teams, multiple agencies, and public stakeholders as these groups begin to address critical management issues.

The case studies will examine (1) steps taken toward designing and implementing strategic wildlife and habitat planning, (2) the evolution and value of monitoring in the development of effective management decisions; and (3) how collaboration between stakeholders moves issues away from impasse.

GENERAL SESSION

PAPERS AND PRESENTATIONS

WINTER HABITAT SELECTION OF MULE DEER BEFORE AND DURING DEVELOPMENT OF A NATURAL GAS FIELD

HALL SAWYER, Western Ecosystems Technology, Inc., 2003 Central Ave., Cheyenne, WY 82001, USA, hsawyer@west-inc.com
RYAN M. NIELSON, Western Ecosystems Technology, Inc., 2003 Central Ave., Cheyenne, WY 82001, USA.
FRED LINDZEY, United States Geological Survey (USGS), Wyoming Cooperative Fish and Wildlife Research Unit, Box 3166, Laramie, WY 82071, USA.
LYMAN MCDONALD, Western Ecosystems Technology, Inc., 2003 Central Ave., Cheyenne, WY 82001, USA.

Abstract: Increased levels of natural gas exploration, development, and production across the Intermountain West have created a variety of concerns for mule deer (*Odocoileus hemionus*) populations, including direct habitat loss to road and well pad construction and indirect habitat losses that may occur if deer use declines near roads or well pads. We examined winter habitat selection patterns of adult female mule deer prior to and during the first 3 years of development in a natural gas field in western Wyoming. We used global positioning system (GPS) locations collected from a sample of adult female mule deer to model relative frequency, or probability of use as a function of habitat variables. Model coefficients and predictive maps suggested mule deer were less likely to occupy areas in close proximity to well pads than those farther away. Changes in mule deer habitat selection appeared to be immediate (i.e., Year 1 of development) and no evidence of well pad acclimation occurred through the course of the study, rather mule deer selected areas farther from well pads as development progressed. Lower predicted probabilities of deer use within 2.7 to 3.7 km of well pads suggested indirect habitat losses may be substantially larger than direct habitat losses. Additionally, some areas classified as high probability of use by mule deer before gas field development changed to areas of low use following development and others originally classified as low probability of use were used more frequently as the field developed. If areas with high probability of deer use before development were those preferred by the deer, observed shifts in their distribution as development progressed were toward less preferred and presumably less suitable habitats.

CONTROLLING CHEATGRASS IN WINTER RANGE TO RESTORE HABITAT AND ENDEMIC FIRE

JOSEPH G. VOLLMER, BASF Corporation, 26 Davis Dr., Research Triangle Park, NC 27709 USA, vollmej@basf.com
JENNIFER L. VOLLMER, BASF Corporation, 26 Davis Dr., Research Triangle Park, NC 27709, USA
KEITH SCHOUP, Wyoming Game and Fish Department, 3030 Energy Lane, Suite 100, Casper, WY 82604, USA
RYAN AMUNDSON, Wyoming Game and Fish Department, 302A 16th Street, Wheatland, WY 82201, USA

Abstract. Cheatgrass (*Bromus spp.*), an introduced, invasive, annual grass of the Western rangelands, increases both fire frequency and intensity, competes with native species for water, space and nutrients, and is a primary cause for loss of habitat quality on elk and deer winter ranges. Studies indicate that rangeland with a 5% cheatgrass composition can become dominated by cheatgrass after a fire. When fire enters a landscape, cheatgrass is the first species to colonize after the burn, utilizing moisture before most native vegetation breaks dormancy. Cheatgrass evolved with and responds well to fire, enabling land to burn annually, increasing cheatgrass density. Cheatgrass litter build-up increases fire intensity, temperatures and frequency causing loss of fire tolerant native vegetation. The importance of removing cheatgrass, especially from crucial winter range, is emphasized by death of native shrubs from excessive fire intensity, inability of native species to compete with cheatgrass, and the subsequent rapid cheatgrass domination of the burn area. Four successful scenarios have been devised remove cheatgrass using fire and Plateau® herbicide: 1) Apply fire - wait one growing season - apply Plateau. This scenario generally produces poor conditions for desirable vegetation recovery. Cheatgrass quickly reoccupies the site out competing native plants, and provides the poorest conditions to apply the herbicide. 2) Apply fire - apply Plateau in the same growing season, results in best recovery of existing native vegetation and/or seedbed preparation for revegetation. 3) Apply Plateau - no fire. This scenario is best when cheatgrass litter fuel would cause fire to reach temperatures causing mortality of native species, impeding native plant re-colonization of the site. 4) Apply fire – apply Plateau – revegetate. This scenario is effective when reclaiming cheatgrass monocultures and the area requires replanting of desirable species. By removing cheatgrass prior to or after a burn, crucial winter range species, like true mountain mahogany (*Cercocarpus montanus*), antelope bitterbrush (*Purshia tridentata*), shadscale/Four wing saltbush (*Atriplex spp.*) and sagebrush (*Artemisia spp.*) species can more efficiently and vigorously re-occupy the site or survive the burn. Native grasses and forbs produce 3 to 8 times more biomass with cheatgrass removal. Critical plant inter-space is restored, reducing fire frequency, size and intensity. This information can be used by wildlife/resource managers throughout Western North America to prevent further decline and improve both winter and summer range. Habitat managers can better prepare a program for prescribed burns and wildfire management, to produce maximum forage biomass. For areas consisting of monoculture stands of cheatgrass, this information can be used to re-establish wildlife friendly vegetation (grass, forbs or brush species) into annual grass monocultures, creating sustainable habitat for wildlife summer or winter range.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 6:20-24

Key words: Artemisia, Atriplex, bitterbrush, Bromus, Cercocarpus, cheatgrass, fire, habitat, mahogany, Purshia, rangeland, sagebrush, shadscale, imazapic

---

Fine fire fuel management programs are being implemented by Wyoming Game and Fish Department to reduce loss of big game winter range. Prescribed fire has been an important tool to regenerate brush, improving winter browse. However, severe drought during the late 1990s and early 2000s have favored annual brome species (*Bromus* spp.) and allowed this invasive weed to influence burn area recovery. Critical big game winter range in Wyoming have had an increase of annual brome, such as cheatgrass (*Bromus tectorum*), after wildfire, resulting in decreased desirable vegetation including grass, shrubs and forbs. These results have prompted Wyoming Game and Fish to evaluate areas prior to a prescribed burn to determine if an annual brome component is present and if likelihood of habitat degradation, rather than improvement, may occur. If the site has potential of degradation due to annual brome release, Plateau® herbicide, imazapic, is incorporated into the winter range improvement plan for pre-emergence control of cheatgrass.

Increasing use of the herbicide Plateau, imazapic, for selective control of annual brome in Western wildlands has dictated the need for increased knowledge of tolerant brush species. Western bunchgrass and forb tolerance trials have shown Plateau to be an acceptable tool for release of desirable plant species and renovation of annual brome infested areas[1] (Foy 2003, Rayda 2003). In general, Plateau is not effective at control of brush; however, some brush species exhibit unacceptable injury. Brush tolerance to Plateau is key when considering use of this herbicide for selective control of annual brome prior to a prescribed burn for critical winter range brush regeneration.

In addition, Plateau is gaining recognition and use as a tool to produce aesthetically acceptable fuel breaks and green strips. Plateau can selectively remove the fine annual brome fuel from more fire resistant bunch grasses and shrubs. Removal of the annual brome helps eliminate an ignition fuel as well as eliminating the main fire carrier. Fire modeling of Plateau treated areas utilizing the BehavePlus fire model has shown significant reduction of flammable biomass as well as decreasing flame height and length (Kury 2003). Applications of Plateau are typically broadcast, applied over the top of brush remaining in the green strip for aesthetic, moisture catching or soil stabilizing purposes. Brush tolerance is an important aspect when considering the use of Plateau for enhancing green strips and fuel breaks, as well as an additional tool for habitat improvement.

Tolerance Mechanism

Plateau herbicide, imazapic, is a member of the imidazolinone family. The active ingredient of an imidazolinone herbicide controls susceptible plants by binding to the acetohydroxyacid synthase (AHAS) enzyme and preventing production of three essential amino acids. Plant tolerance to imidazolinones can be due to inherent differences in the AHAS enzyme itself and/or differences in the stability of the enzyme. Some species, such as legumes, tolerance to imidazolinones is contributed to their ability to metabolize the herbicide active ingredient. Mature tissues in plants appear to be relatively unaffected by inhibition of the AHAS enzyme (Shaner 1991). This accounts for the higher susceptibility of annual versus perennial plants, since perennial plants would have a higher percentage of mature tissue. After direct treatment with an imidazolinone herbicide, mature leaves of perennial susceptible plants will remain green for a long period of time, several months, prior to desiccation. Leaves continue to photosynthesis, although amino acid production is arrested. In treated susceptible species, photosynthesis translocation can be disrupted, depriving roots of an energy supply (Shaner 1991). Susceptibility of well-established shrubs may take up to two years to determine.

Results and Discussion

True Mountain Mahogany Tolerance

True mountain mahogany (*Cercocarpus montanus*) trials were conducted on a post-burn site in Douglas, WY. At one year after a wildfire, further loss of mountain mahogany was threatened by competition and additional fine fuel buildup of cheatgrass, tumble mustard (*Sisymbrium altissimum*) and thistle (*Cirsium* spp.) invasion. Plateau treatments were broadcast applied 4 September 2002, prior to cheatgrass emergence. The trial had 7 treatments; 6, 9, and 12 oz of Plateau per acre, with and without methylated seed oil (MSO) surfactant at 1 qt/acre, compared to a non-treated plot. Plot size included 7 to 10 bushes in a 10 x 50 foot area replicated 3 times. The same treatments were conducted on an adjacent area in spring 2003. Treatment goals were to reduce the fine fuel load to prevent further loss of the remaining mountain mahogany population in the event of a wildfire. Data was to be used to aid in plans to prepare similar sites for a prescribed burn.

The spring after application, all fall 2002 treatments showed delayed leaf expansion with some yellowing during the first growing season. This response increased as the Plateau rate increased, with a greater negative response from treatments that included the MSO surfactant. All plots were evaluated the first full growing season after applications on 10 August 2004. Fall treated plots at the typical cheatgrass

---

® Registered Trademark of BASF Corporation

[1] Data on file with BASF Corporation, J.L. Vollmer, Laramie, WY, as "GRASS AND FORB TOLERANCE TO PLATEAU® HERBICIDE – Update July 26, 2006.

recommended application rates of Plateau at 6 or 9 oz/acre and Plateau at 6 oz + MSO had no adverse effects on the true mountain mahogany. Addition of MSO to the Plateau at 9 oz/acre simulated a burn response by stimulating new shoot growth from the base of the plant. The Plateau at 9oz/acre plus MSO treatment could be used to simulate a prescribed burn for habitat enhancement when the cheatgrass population is high enough to threaten mahogany mortality during a wildfire or prescribed burn.

Spring applications showed greater variability in response between plants within a treatment. Plateau at 6oz/acre was the only treatment resulting in mahogany growth similar to the non-treated plot. Plateau at 12 oz/acre + MSO applied in the spring resulted in initial unacceptable stunting of new growth. The observed stunting was viewed as unacceptable due to the decreased amount of vegetation that could be utilized as browse.

New basal growth was evaluated for all treatments as an important source of mahogany regeneration. New basal growth was acceptable for all fall treatments except the Plateau 12oz/acre + MSO. Results suggest that this treatment affected the overall plant system, inhibiting the ability of the plant to recover. For spring-applied treatments, new basal growth, at 16 months after treatment, was not affected by Plateau at the 6 or 12 oz rate or MSO plus Plateau at 9 or 12 oz rate. All other treatments had individual plants that elicited variable shoot growth. Differences in basal growth may be due to individual plant genetics or microclimate including soil type and/or depth.

Fall pre-emergence Plateau treatments without surfactant provided the needed cheatgrass control. The addition of MSO was not needed to achieve adequate cheatgrass control to reduce competition and fire hazard. *Spring treatments required the addition of MSO to control the cheatgrass post emergence,* but spring treatment is not recommended due to variation in brush response and annual brome efficacy.

Antelope Bitterbrush Tolerance

The antelope bitterbrush (*Purshia tridentata*) tolerance research was conducted on a site prior to a prescribed burn, at 8000 feet east of Laramie, WY. Plateau treatments were broadcast applied 30 September 2003, prior to cheatgrass emergence. The trial had 9 treatments; Plateau at 6, 8, 10 and 12 oz/acre, Plateau at 6 and 8 oz/acre plus non-ionic surfactant (NIS) at 0.25% v/v, and Plateau at 10 and 12oz/acre with MSO surfactant at 1 qt/acre, all compared to a non-treated plot. Plot size included 10 bitterbrush plants in a 10 x 50 foot area replicated three times. Treatment goals were to prevent cheatgrass domination after a prescribed burn.

At the beginning of the first growing season after application, 24 June 2004, bitterbrush showed little response from most treatments. Exceptions were Plateau at 12 oz/acre alone and Plateau 10 and 12 oz/acre plus MSO. The response elicited by these herbicide treatments was a delay in leaf expansion, smaller mature leaves and shortened internodes of new stems (typical imidazolinone symptomology). First year results indicated that later ratings were needed to evaluate long-term herbicide effect on bitterbrush.

At 2.5 years after treatment, 23 May 2006, bitterbrush mortality was evaluated. The 6 and 8 oz/acre rates of Plateau with and without surfactant had no mortality and no evidence of treatment effect (Table 1). The two high rates of Plateau with surfactant resulted in 28% to 43% mortality.

Table 1. Antelope bitterbrush tolerance, leaf expansion and mortality after treatment of Plateau with associated additives.

	Evaluation June 24, 2004	Evaluation May 23, 2006
Treatment	% Injury by leaf Expansion Reduction[a]	% Mortality[a]
Plateau 6oz + NIS	7	0
Plateau 8oz + NIS	8	0
Plateau 10oz + MSO	90	28
Plateau 12oz + MSO	90	43
Plateau 6oz	0	0
Plateau 8oz	0	0
Plateau 10oz	0	27[b]
Plateau 12oz	22	33[b]
Non-treated	0	0

[a]Average over 3 replications
[b] First replication, located on slope with drought tendency had 80% mortality

Surviving plants had no new stem growth and spring leaf growth was severely delayed with the few new leaves displaying typical imidazolinone symptomology, indicating these plants were still under severe stress from the Plateau herbicide. The second and third replications of 10 and 12 oz/acre rate of Plateau without surfactant, showed little to no injury on recovered plants. However, the first replication, located on a drought prone slope, had mortality of 80% for both treatments. This response to adverse environmental factors in combination with a Plateau treatment indicates marginal tolerance of bitterbrush to Plateau at high rates. Of the recovering plants in the second and third replications, first year growth after application was a fifth of the second year growth. Wildlife managers would need to assess bitterbrush recovery potential and browsing demands on these plants to determine if high rates of Plateau were acceptable for their program goals. Rates of 10 and 12 oz of Plateau per acre is rarely needed to achieve acceptable cheatgrass control, allowing managers to adjust rates to achieve antelope bitterbrush selectivity.

Sagebrush Species Tolerance

Sagebrush (*Artemisia* spp.) steppe communities have been severely impacted by fire carried by annual brome species. Restoration of fire-scarred land can be unsuccessful due to competition from annual brome; therefore, a selective herbicide that can be used to preserve remaining sagebrush steppes as well as aid in restoration is very important. Plateau herbicide has been applied over the top of several sage species through research and commercial applications. Table 2 is a summary of tolerance research results and commercial observations made across the western Unites States sagebrush steppe areas.

Table 2. Tolerance summary of sage species to Plateau herbicide at 2 to 12 oz/acre with or without MSO.

Silver Sagebrush (*A. cana*)[a]	no injury
Fringed Sagebrush (*A frigida*)[a]	no injury, new growth greater than in non-treated areas, possibly due to elimination of annual brome competition
Wyoming Big Sage (*A. tridentata*)	
spring applied	no injury
fall applied	no injury, new leader growth often increased compared to non-treated areas, possibly due to elimination of annual brome competition
Seedling Wyoming Big Sage[a]	no injury

[a] Fall applied Plateau herbicide treatment

Sagebrush Case Study

The Johnson Creek Unit of Sybille Canyon, WY suffered the loss of critical bighorn sheep winter habitat in August 2001. An escaped campfire resulted in a 448-acre wildfire. During the fall 2001 cheatgrass dominated the area, out-competing the native vegetation. A rescue/release treatment of Plateau at 8 oz/acre plus MSO was applied in August 2002. Prior to treatment, 100 foot transects were installed on the Wyoming Game and Fish treated area and on an adjacent non-herbicide-treated, burned Bureau of Land Management section. In 2003, post application, belt density transects and nested frequency quadrants were added. Measuring relative cover at 1 year after treatment, cheatgrass increased by 8% in the non-treated area to 75%, while native vegetation decreased a corresponding amount to 25% of the cover (Table 3). In the Plateau treated area, cheatgrass decreased from 84% to 0% with a corresponding increase in native vegetation to 100%.

Table 3. Percent Relative Cover of the Johnson Creek Unit at Sybille Canyon, WY[a]

	Bromus tectorum		Native flora	
Treatment	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
Non-treated area	67%	75%	33%	25%
Plateau 8oz/acre + MSO	84%	0%	16%	100%

[a]Preliminary data compiled by Wyoming Game and Fish Department[2]

Conclusion

Fall Plateau treatment, prior to cheatgrass emergence, remains the best program for true mountain mahogany tolerance in addition to best cheatgrass control at the lowest herbicide rates. Results indicated that an alternative to fire for mahogany regeneration is Plateau at 9oz/acre plus MSO. This treatment would give wildlife managers a treatment option when annual brome populations prohibit burning due to the increased fire temperatures threatening mahogany survival. A cheatgrass control program in an antelope bitterbrush community should not exceed Plateau at 8oz/acre with or without surfactant. Higher rates can increase the possibility of unacceptable injury to bitterbrush. *Artemisia* spp. exhibited the greatest tolerance with no negative treatment response to the highest label rate of Plateau with or without surfactant.

Plateau has proven to be an effective fire mitigation, release and restoration tool for grass/shrub landscapes. The selective ability of the product gives wildlife and land managers options for improving shrub communities. Specific species tolerance to Plateau is important when choosing rate, timing and additive.

Special Thanks: BASF wishes to acknowledge and thank Ryan Amundson and Keith Schoup, biologists for Wyoming Game and Fish, for bringing the research need of Plateau brush tolerance to our attention, and helping us determine injury acceptability limits dependant on anticipated wildlife utilization.

Literature Cited

Foy, Lise P., Whitson, Thomas D. and Stevens, Bart W. 2003. Establishment of Native Wildflowers and Grasses for Roadside Re-vegetation Using Imazapic. Western Society of Weed Science Proceedings 25 pp

Kury, Brenda and Vollmer, Jennifer L. 2003. "Data Collection and Fire Modeling Determine the Potential for the use of Plateau ® Herbicide to Establish Fuel Breaks in *Bromus tectorum* - Dominated Rangelands." Western Society of Weed Science Proceedings 24 pp

Rayda, Margaret M. and Miller, Stephen D. 2003. Effect of Imazapic on Crop, Weed and Native Legumes. Western Society of Weed Science Proceedings 77 pp

Shaner, Dale L. and O'Conner, Susan L. 1991. The Imidazolinone Herbicides. CRC Press, Inc. (80, 135 pp)

[2] Data on file with the Wyoming Game and Fish Department, Casper, WY

CHARACTERISTICS OF UNGULATE BEHAVIOR AND MORTALITY ASSOCIATED WITH WIRE FENCES

JUSTIN HARRINGTON, Utah State University, Department of Forest, Range, and Wildlife Sciences, Logan, UT 84322-5230, USA, jlharrington@cc.usu.edu

MICHAEL R. CONOVER, Utah State University, Department of Forest, Range, and Wildlife Sciences, Logan, UT 84322-5230, USA, conover@cc.usu.edu

Abstract: We studied the characteristics of fence mortality in pronghorn antelope (*Antilocapra americana*), mule deer (*Odocoileus hemionus*), and elk (*Cervus elaphus*) along roads in northwestern Colorado and northeastern Utah from June to December 2004. We found that mule deer and pronghorn antelope were similar in their methods used to cross fences (i.e. jumping over, crawling through, or crawling under). Mule deer suffered higher mortality rates from getting caught in wire fences than elk or pronghorn antelope because they are more likely to cross fences and feed in the right-of-way ($P<0.001$). Juveniles of all species were 8 times more likely to die in fences than adults ($P<0.001$). Woven wire & 1-strand barbed wire was significantly more lethal to ungulates than woven wire & 2-strand, and 4-strand barbed wire types ($P<0.001$). The highest mortality frequencies for ungulates occurred during the month of August, which coincides with weaning of fawns. There was a strong relationship between the frequency of fence-mortalities and the animal densities along the right-of-way ($P<0.001$). Both mortality frequencies ($P<0.001$) and right-of-way presence ($P<0.001$) have a negative relationship with traffic loads.

ELK, ROADS AND PEOPLE IN THE BLACK HILLS, SOUTH DAKOTA

MARK A. RUMBLE, USDA Forest Service, Rocky Mountain Research Station, 1730 Samco Road, Rapid City, SD 57702, USA, mrumble@fs.fed.us
R. SCOTT GAMO, Idaho Department of Fish and Game, P.O. Box 428, Jerome, ID 83338 USA
L. BENKOBI, Department of Forest, Rangeland and Watershed Stewardship, Colorado State University, Fort Collins, CO 80523-1472, USA

***Abstract*:** Biologists have known for >20 years that roads are a major factor influencing the distribution of elk. Most studies of elk and roads had road densities <1.2 km/km^2 (2 mi/mi^2). We studied elk habitat and distribution in the Black Hills of South Dakota and Wyoming where the road density was 2.3 km/km^2 (3.7 mi/mi^2). Analyses of: home ranges, elk distribution relative to roads and forage-cover edges, hourly movement patterns, and habitat selection patterns at two scales all showed effects of roads on elk. Home ranges for elk were larger ($P \leq 0.10$) in areas with greater road density. Home ranges of elk and road densities in the central Black Hills were both larger than home ranges and road densities in Custer State Park in the southeastern Black Hills. The effects of primary and secondary roads extended 350 m and 240 m, respectively. After removing effects of primary and secondary roads elk used areas adjacent to primitive roads randomly. However, this may be a result of sporadic disturbance or high road density. The average distance of elk with GPS telemetry collars during fall hunting seasons to primitive roads ranged from 160m to 234 m. But the average distance from random points to primitive roads was 145 $\pm$ 35 m. For an animal with daily movements up to 3 km/day, limited opportunities exist to avoid roads at these road densities. Increased movements by elk were evident on days of high human disturbance and for 10-day intervals associated with hunting seasons ($P \leq 0.05$). To compensate for energy expended in these movements, elk had to forage an extra 30-45 minutes/day. During late fall and winter physiological limitations on elk prevent them from foraging long enough to maintain an energy balance to obtain adequate forage. Disturbance from hunters altered habitat selection leading elk to avoid meadows during daylight hours. Area of habitat not bisected by a road was positively correlated ($P \leq 0.01$) with elk use. Contrary to other studies, elk avoided edges of cover adjacent to forage for 200-300 m. Most large meadows had gravel roads in them and the avoidance cover-forage edges coincided with the effects of primary and secondary roads. More than 20 years has passed since the negative effects of roads on elk were published. In 2003, Forest Service Chief Bosworth articulated concern of off-road recreation as 1 of 4 threats to the nation's National Forests. ATV and snowmobile sales and use have increased dramatically in the past 10 years. It is time for resource managers to implement comprehensive travel management plans that consider wildlife.

WAFWA MULE DEER WORKING GROUP—MULE DEER MAP

TODD A. BLACK, Community Based Conservation Extension Specialists, Utah State University, 5230 Old Main Hill, Hyrum, UT 84319, USA, tblack@cc.usu.edu
JIM DEVOS, Arizona Game and Fish Department, 2222 W. Greenway Road, Phoenix, AZ 85023 jdevos@gf.state.az.us
R. DOUG RAMSEY, Remote Sensing/GIS Laboratory, Utah State University. doug.ramsey@usu.edu
JOHN H. LOWRY, Remote Sensing/GIS Laboratory, Utah State University. jlowry@gis.usu.edu

Abstract: In 2002, the Western Association of Fisheries and Wildlife Agencies (WAFWA) Mule Deer Working Group (MDWG) were tasked to map and classify mule and black-tailed deer habitat and identify limiting factors that are adversely affecting this habitat across their range in North America. The grouped adopted 6 different habitat types and limiting factors identified herein. The Delpi approach (expert opinion) was used as the primary approach to identify habitat and areas of concern. This information was then put into a single Geographical Information System (GIS) database.

To accomplish this task, regional MDWG representatives solicited information from state-provincial-tribal, national experts and local wildlife biologist in mule deer habitat to not only identify habitat but to classify and rank it as well. This information was then was put into a spatial database using the Remote Sensing/GIS Laboratory at Utah State University. This database identifies mule deer presence in 6 different habitat types. The classified and attributed polygons identify a minimum of 3 limiting factors applicable to each polygon. This database can be used to assist in management programs such as habitat restorations that cross administrative boundaries.

PROGRESS AND STATUS OF THE WESTERN ASSOCIATION OF FISH AND WILDLIFE AGENCIES MULE DEER WORKING GROUP

BRIAN WAKELING, on behalf of the WAFWA Mule Deer Working Group, Arizona Game and Fish Department, Game Branch, 2221 West Greenway Road, Phoenix, AZ 85023, USA, Bwakeling@gf.state.az.us

Abstract: The Western States and Provinces Mule Deer Working Group (MDWG) was established at the midwinter meeting of the Western Association of Fish and Wildlife Agencies (WAFWA) in Tucson, Arizona in January 1998. Agency Directors at this meeting established the working group as an official full committee of WAFWA for this effort. Each State and Province was requested to assign one person to this committee. In addition, a representative from the Wildlife Management Institute was appointed to serve as a technical adviser. The mission of the MDWG is "To find solutions to our common mule deer management problems and to optimize cooperative research and management in the Western states and provinces." There are three primary purposes for the MDWG: (1) begin to develop strategies to assist in management of mule deer populations throughout the West; (2) improve communication among mule deer biologists throughout the West, improve communication between biologists and agency administrators, and develop a mechanism to formalize communications with all entities interested in management of mule deer populations; and (3) provide a forum, in addition to the WAFWA-sanctioned biennial deer/elk workshop, to respond to information needs from agency administration. This would include, but not be limited to, developing regional-based briefing documents, position papers, and reviewing research/management proposals. The working group meets at least twice annually, with one of the meetings held at the annual summer meeting of WAFWA.

MDWG has developed a several products to assist biologists and wildlife managers in understanding mule deer relationships. A popular publication entitled "Mule Deer: Changing Landscapes, Changing Perspectives" was developed and disseminated for use by the public. This popular publication was based on the technical book "Mule Deer Conservation: Issues and Management Strategies" published in 2003. After the book was released, the need for habitat management guidelines became evident. Habitat management guidelines should be structured around mule deer distributional maps indicating where problems might be effectively addressed. MDWG believed that until we were able to implement large-scale habitat restoration programs, we would never be able to achieve sustained increases in mule deer numbers. Recognizing the diversity of habitat in which mule deer are found, the Working Group began discussing how we could prioritize areas to begin restoration treatments that would have the highest return for the investment. Although most states and provinces had existing maps of mule deer habitat, there were essentially no mapping efforts that crossed state-provincial boundaries; therefore, the goal of large-scale restoration was hampered. Further, we found that maps were completed at different scales and with different mapping conventions, which made them difficult to use. Few of the existing maps actually identified what factors imposed limitations on the quality of the mule deer habitat. The "Mule Deer Map" was recently completed. MDWG is currently working to complete the "Mule Deer Habitat Management Guidelines" for each ecoregion. An implementation timeline has been developed to complete the project by July 2006.

INCREASING THE EFFICACY OF CHRONIC WASTING DISEASE DETECTION VIA SELECTIVE AND TARGETED SAMPLING

MARY M. CONNER, Utah State University, Department of Forest, Range, and Wildlife Sciences; UMC 5230, Logan, UT 84322, USA, mconner@cc.usu.edu

CAROLINE E. KRUMM[1], Colorado Division of Wildlife, Wildlife Research Center, 317 West Prospect Road, Fort Collins, Colorado 80526-2097, USA.

MICHAEL W. MILLER, Colorado Division of Wildlife, Wildlife Research Center, 317 West Prospect Road, Fort Collins, Colorado 80526-2097, USA.

Abstract: Controlling chronic wasting disease (CWD) becomes more difficult as prevalence rises in deer (*Odocoileus* spp.) or elk (*Cervus elaphus*) populations. Although detecting new foci of CWD when prevalence is still low (e.g., 1% or less) is clearly important to increase the likelihood of management success, detecting the occurrence of CWD when it is rare can be difficult and expensive. Using data collected by the Colorado Division of Wildlife since 1996, we compared harvest-based (random), selective (i.e., biased sampling approaches like vehicle-kills), and targeted (i.e., sampling "sick" cervids) surveillance approaches for detecting CWD. We found that the sampling effort required to detect at least one case of CWD with ≥ 99% detection probability can be reduced by using selective or targeted surveillance. For example, we found that sampling vehicle-killed mule deer reduced the required number of samples by 34–96% compared to random sampling; these reductions were especially dramatic in low prevalence areas. Targeted surveillance samples should provide similar gains in efficiency, as evidenced by the fact that nearly half of the CWD-infected populations in Colorado have been detected by this method. We also describe strategies for exploiting demographic influences on prevalence to further reduce sampling effort aimed at detecting CWD.

---

[1]Present address: Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, Colorado 80523, USA.

REVIEW AND UPDATE ON CHRONIC WASTING DISEASE IN THE UNITED STATES AND CANADA

TOM GIDLEWSKI, USDA, Animal, Plant and Health Inspection Service, Ames, IA 50010, tgidlewski@aphis.usda.gov

Abstract: A review of Chronic Wasting Disease (CWD) in the United States and Canada to include:

- History and transmission of the disease;
  - First identified in a free-ranging deer in 1981.
  - No evidence of natural infection of any non-cervid species.
  - Transmission via the environment has now been proven - may play an important role. Vertical transmission does not appear to be important
  - Minimum incubation period 15 months (mule deer) and 12 months (elk) in experimental infections Maximum incubation period unknown – 25 (mule deer) to 34 months (elk) in high dose oral inoculation - ??

- Appropriate sample collection and submission to laboratories.

- Diagnostics
  - Though clinical signs and gross lesions may appear similar to conditions caused by other disease processes, the histopathology is definitive and unmistakable in diagnosing CWD. "Gold standard" for diagnostics is Immunohistochemistry (IHC). IHC high in sensitivity and specificity. Allows visualization of staining in association with specific tissue architecture – confidence. Four ELISA-based test kits are currently licensed for use in wild cervids

- Differences in prion^{cwd} distribution between deer and elk and how differential prion distribution affects testing.
-
- Federal CWD funding for wildlife management agencies.
-
- Current distribution of the disease
  - CWD has been detected in wild cervids in 8 states: Colorado, Illinois, Nebraska, New Mexico, South Dakota, Utah, Wisconsin, and Wyoming and 1 province – Saskatchewan
  - CWD has been detected in 39 farmed cervid herds in 9 states: Colorado, Kansas, Minnesota, Montana, Nebraska, Oklahoma, South Dakota, Wisconsin, and New York and 2 provinces Saskatchewan and Alberta
  - Currently 6 known positive captive herds: 4 Colorado elk herds and 2 Wisconsin white-tailed deer herds
  - Summarize the status of CWD in states where it has been detected in wild cervid populations including testing history, sample numbers and geographic distribution of positives.

COMPARATIVE MATING SUCCESS OF MALE WHITE-TAILED DEER IN RELATION TO AGE AND PERCEIVED QUALITY

DONNIE FRELS, Texas Parks and Wildlife Department, Kerr Wildlife Management Area, 2625 FM 1340, Hunt, TX 78024, USA, dfrels@ktc.com
JAMES OTT, Texas State University, Department of Biology, 601 University Drive, San Marcos, TX 78666, USA, jo05@Academia.swt.edu

Abstract: Current interest in "genetic improvement" of free-ranging white-tailed deer (*Odocoileus virginianus*) through selective harvest of bucks perceived to be of "low quality" (in relation to body size and antler configuration) and/or the introduction of bucks perceived to be of "superior quality" is at an all time high in Texas. The effect of selective removal of yearling bucks, and/or the introduction of superior bucks on the genetic composition of a free-ranging population can not, at present, be adequately addressed without detailed information on the breeding success of males in relation to body size, antler characteristics, and age. In addition, much of the controversy surrounding the management and harvest strategy of yearling bucks (spike bucks in particular) is fueled by the lack of information on the breeding success of males of this age class.

The goal of this research project is to provide wildlife managers and deer breeders with baseline information on the relative breeding success of individual males within medium-sized captive populations representative of typical high fence conditions. This information can be used to understand the probable effects of selective harvest and management techniques and better design breeding trials.

The project is designed to: 1) estimate the comparative mating success of yearling white-tailed bucks in competition with mature bucks and 2) determine whether variation in relative antler quality and body weight within each age class affects mating success.

Mating success will be assessed by performing paternity analyses on all offspring sired within two replicate captive herds on the Mason Mountain Wildlife Management Area in Mason County, Texas. To establish the experimental populations, resident deer were removed in the fall 1999 from two 500-acre high fenced enclosures. The pastures were then stocked with selected white-tailed deer culled from 320 native deer trapped throughout the Edwards Plateau during winter 1999. The experimental herds were established in January and February 2000 at a sex ratio (1 buck:2.5 does) and density (1 deer/7 acres) representative of the Hill Country. The following classes of WTD were introduced into the enclosures and allowed to acclimate until the 2001 breeding season: does $\geq$1.5 years old, bucks $\geq$ 3.5 years old of high and low antler quality, and 0.5 year old buck fawns. DNA samples were collected prior to release of all deer. Following the 2001 breeding season, deer were collected and adults and fetuses were typed at $\leq$13 microsatellite loci. The computer program "Cervus" used hand-matching to assign paternity.

The results indicated that reproductive success differed significantly between mature and yearling males. In both study areas mature bucks tend to garner a disproportionate amount of matings when compared to their yearling counterparts. Antler quality among mature males did not influence reproductive success to the same extent. Mature bucks of high antler quality were disproportionately successful in one study area but mature bucks of low antler quality proved to be significant breeders in the other. Additionally, multiple paternity of 16% to 28% was observed. These results provide the first estimates of single-season male reproductive success and multiple paternity in field populations of white-tailed deer.

MULE DEER SURVIVAL AND POPULATION RESPONSE TO EXPERIMENTAL REDUCTION OF COYOTES AND MOUNTAIN LIONS

MARK A. HURLEY, Idaho Department of Fish and Game, P. O. Box 1336, Salmon, ID 83467, USA, mhurley@idfg.idaho.gov
JAMES W. UNSWORTH, Idaho Department of Fish and Game, P. O. Box 25, Boise, ID, 83707, USA
PETE ZAGER, Idaho Department of Fish and Game, 1540 Warner Ave., Lewiston, ID 83501, USA
EDWARD O. GARTON, Department of Fish and Wildlife Resources, University of Idaho, Moscow, ID, 83844, USA
DEBRA M. MONTGOMERY, Department of Fish and Wildlife Resources, University of Idaho, Moscow, ID, 83844, USA

Abstract: We tested the response of mule deer (*Odocoileus hemionus*) populations to coyote (*Canis latrans*) and mountain lion (*Puma concolor*) removal in 8 game management units (GMU) in southern Idaho 1997-2002. Each GMU was assigned to a treatment under a 2X2 factorial design (coyote removal, mountain lion removal) with 2 replicates of each treatment/control combination. Small mammal and lagomorph numbers were indexed each year to provide an estimate of staple and alternate prey. Mule deer populations were surveyed using a helicopter for fawn/doe ratios in December and total population size in March with estimates corrected for visibility bias. To determine survival and mortality cause, 250 neonate fawns, 284 6-month-old fawns and 521 adult does were monitored with radio telemetry in 2 intensive study GMUs, one with coyote and lion removal and one without. Cox's proportional hazards survival models were ranked with AIC to determine the best competing models. Pregnancy rates, fawn-at-heel ratios, population rates of increase, and previous population levels suggest these populations were below nutritional carrying capacity at the onset of the research. Important factors influencing survival of neonate fawns were small mammal and lagomorph abundance, coyote removal, and weather conditions. Coyote removal did not influence the survival of 6-month-old fawns or adults. Mountain lion removal increased the survival of adult females in the winter season. Weather variables were the most significant factor in the majority of the competing survival models for all age classes of mule deer. Fawn:doe ratios were significantly influenced by mountain lion removal across all study units ($P=0.065$), but coyote removal had no significant effect on fawn:doe ratios ($P=0.628$). No significant effect was found with coyote or mountain lion removal on total population trend of mule deer, although populations with increased mountain lion removal indicated positive population trends. A regression analysis of actual removal rate of predators with deer population rate of increase was not significant ($P=0.2$). The addition of a weather severity index to the model produced a significant model ($P=0.007$) to explain population rates of increase. The lack of fawn:doe ratio or population response indicates that increased neonate survival due to coyote removal is partially compensatory. The combinations of staple prey populations and weather conditions required for coyote removal to increase fawn survival are dynamic, suggesting annual coyote removal programs will not be a cost effective method to increase mule deer populations. Mountain lion removal increased deer survival, fawn:doe ratios, and populations slightly at higher levels of removal.

ELK CALF SURVIVAL IN THE CLEARWATER DRAINAGE OF NORTHCENTRAL IDAHO

CRAIG G. WHITE, Idaho Department of Fish and Game, 3101 S. Powerline Road, Nampa, ID 83686, USA, cwhite@idfg.idaho.gov
PETE ZAGER, Idaho Department of Fish and Game, 3316 16th Street, Lewiston, ID 83501, USA, pzager@idfg.idaho.gov

Abstract: Elk (*Cervus elaphus*) populations have declined dramatically in several important Game Management Units (GMUs) in Idaho since the late 1980s. We evaluated the survival rates and cause-specific mortality of elk calves on 2 contrasting study areas in north central Idaho from 1997 through 2004. Annual calf survival varied between 0.06 – 0.46 on the "low recruitment study area" and 0.18 - 0.57 on the "good recruitment study area". Predation by black bears (*Ursus americanus*) and mountain lions (*Puma concolor*) was the primary proximate cause of calf mortality in both study areas. We examined the effects of landscape structure, predator harvest levels, and biological factors on calf survival. Our preliminary model suggests that the percentage of forest with 33-66% canopy cover, percentage of forest with >66% canopy cover, and percentage of grassland cover type within 500 m of calf locations were positively related to calf survival. Further, older calves and male calves experienced better survival. We experimentally manipulated bear and lion densities on portions of each study area and demonstrated that calf survival was also related to the level of bear and lion harvest. We demonstrate that different levels of predator harvest can affect calf survival and subsequent elk recruitment. We also demonstrate the importance of landscape features on calf survival. Experimental manipulation of cover types is needed to more fully understand how the current landscape affects calf survival. Over the short term, predator harvest levels influenced survival, but large-scale habitat manipulation is needed to improve elk recruitment in the Clearwater drainage over the long-term.

REDUCING RELIANCE ON SUPPLEMENTAL WINTER FEEDING IN ELK: AN APPLIED MANAGEMENT EXPERIMENT AT DESERET LAND AND LIVESTOCK RANCH

DAX L. MANGUS, Department of Forest, Range, and Wildlife Sciences, Utah State University, 5230 Old Main Hill, Logan, UT 84322-5230, USA, dax@cc.usu.edu
FREDRICK D. PROVENZA, Department of Forest, Range, and Wildlife Sciences, Utah State University, 5230 Old Main Hill, Logan, UT 84322-5230, USA,
RICK E. DANVIR, Deseret Land & Livestock, P.O. Box 250, Woodruff, UT 84086, USA

Abstract: Wildlife managers have been feeding elk (*Cervus elaphus*) in North America for nearly 100 years. Giving supplemental winter feed to elk can compensate for a shortage of natural winter range and may boost elk populations while also helping to prevent commingling with livestock and depredation of winter feed intended for livestock. However, elk herds that winter on feeding grounds have a significantly higher prevalence of brucellosis than elk that winter "out". Research suggests that winter feed grounds may also facilitate the spread of Chronic Wasting Disease. Many see the discontinuation of winter feeding programs as a necessary step to decrease the risk of disease outbreaks. Our research is focused on using an understanding of elk behavior to develop methods to reduce reliance on supplemental winter feeding in elk without massive population reductions and while keeping human wildlife conflicts at a minimum. We will test the effectiveness of range improvements, strategic cattle grazing, dispersed supplemental feeding, hunting, and herding as tools to distribute and hold elk in desired areas during the winter. We anticipate that through our efforts we can decrease dependence on supplemental winter feeding and reduce the risks of disease while keeping human wildlife conflicts at a minimum. This research will allow wildlife managers to keep elk populations at or near their current size, while constraining disease outbreak and transmission risks to "acceptable" levels. It will also provide a more complete understanding of winter feeding behavior in large ungulates and may provide assistance in development of winter feeding practices and policies for elk, mule deer, and pronghorn in the west.

WILDLIFE MANAGEMENT DECISIONS AND TYPE I AND TYPE II ERRORS

BRIAN F. WAKELING, Arizona Game and Fish Department, Game Branch, 2221 West Greenway Road, Phoenix, AZ 85023, USA, Bwakeling@gf.state.az.us

Abstract: Hypotheses and scientific approaches have received substantial attention in the literature. Some authors (e.g., Cherry 1998, Johnson 1999) have suggested traditional hypothesis testing is often unnecessary, gratuitous, capricious, and incorrectly interpreted. Several alternate approaches have been suggested, but I believe that most, if not all, management decisions are still informally viewed in the traditional hypothesis testing approach. Specifically, a proposed management action is viewed subjectively from the perspective that its implementation may have no effect toward achieving the goal for which it is intended (null hypothesis). This hypothesis is rejected and the action implemented, or not rejected and not implemented, based on public input, administrative direction, and biological data. Managers often implicitly focus on the probabilities of committing a Type I error, in that they attempt to minimize the chances for no effect following implementation. I believe that managers often omit the evaluation of implicit Type II errors and the corresponding chances not achieving the desired effect if they don't implement the action. For instance, when planning a prescribed fire, managers try to guard against implementation failures like inadvertent burning of undesired areas or combustion at temperatures too great to yield the desired future vegetative conditions (Type I errors). Managers may not fully weigh the outcome of avoiding ignition of the fire on a population of wildlife that is dependent on earlier seral stages of vegetation. The risks of lost population growth, public recreational opportunity, and possible population extirpation because an action was not implemented are also real implementation failures (Type II errors). In a phrase, at times managers are so concerned about the implications of doing something wrong that they don't do anything at all, with greater consequences. Managers need to consciously consider the implications of tradeoffs between Type I and Type II errors when deciding on management action implementation. In instances when rare species or impacts to humans are involved, it may be appropriate to avoid Type I errors. An example whereby antlerless deer harvests are recommended in Arizona will be used to illustrate this relationship.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 6:35-42

Key words: Arizona, deer, hypothesis testing, management, statistical inference

---

Traditional hypothesis testing in research design has received substantial scrutiny in use recently (e.g., Cherry 1998, Johnson 1999), but this criticism is far from new (e.g., Berkson 1938, Bakan 1966, Carver 1978). The application of traditional hypothesis testing has been criticized by these authors as being often unnecessary, gratuitous, capricious, and incorrectly interpreted. From a research design perspective, these arguments are salient. For managers deciding to implement management actions, they are equally important and relevant. Johnson (1999) suggests several alternatives to traditional hypothesis testing, including decision theory, model selection, and Bayesian approaches. These alternatives, in the form of many informal mental algorithms, are generally used to evaluate the host of available alternatives and ultimately select one for possible application. I believe that the subsequent decision to implement or not implement that action is ultimately decided on informal traditional hypothesis testing.

I believe that regardless of how an individual preferred management action is arrived at, the ultimate decision to implement that action is a result of an implicit traditional hypothesis test that the action will have no effect. The decision to implement is based on the mental test of the null hypothesis. If the mental test results in a rejection of the null hypothesis (no effect), the action is implemented. Although there is generally no formal α (probability of a Type I error) established or P value calculated, we have mentally engaged in the testing process. Occasionally, the mental test also regards consideration of β (probability of a Type II error) and $1-\beta$ (power of test). However, most managers do not recognize the implicit hypothesis testing in which decisions are made nor the implications of Type I and II errors.

Type I and II errors are predicated on the ability to correctly reject the null hypothesis. A Type I error occurs when a null hypothesis is rejected when it is indeed true, and a Type II error occurs when a null hypothesis in not rejected when it is indeed false (Table 1; Zar 1984:44). Although inversely related, the probability of a Type II error is rarely known, although power analyses can provide insight into the likely magnitude of this probability.

Table 1. Illustration of the two types of errors in traditional hypothesis testing (Zar 1984:44)

	If H_0 is true	If H_0 is false
If H_0 is rejected:	Type I error	No error
If H_0 is not rejected:	No error	Type II error

When drawing inferences from a population, we routinely assume some underlying distribution. In simplest terms, we generally assume a normal distribution around a point of central tendency. We can then assign an arbitrary α, beyond which we assume a reasonable chance that a sample statistic coming from this area is sufficiently distant that it is unlikely to represent the population. We recognize that whatever value we assign to α is also the probability that we will, if we meet all the assumptions of the test we are using, make a Type I error (Figure 1).

Conversely, β is the probability of incorrectly inferring that no effect will occur, when we cannot detect the effect through our test (Figure 2). Although β is inversely related to α, without a true knowledge of the distribution of the second distribution from which we sample, it impossible to determine what the probability of making a Type II error really is. Decision makers must decide what the implications of making these errors are prior to committing the decision. These implications include probability and degree of impact, and should be done through explicit rather than implicit thought processes.

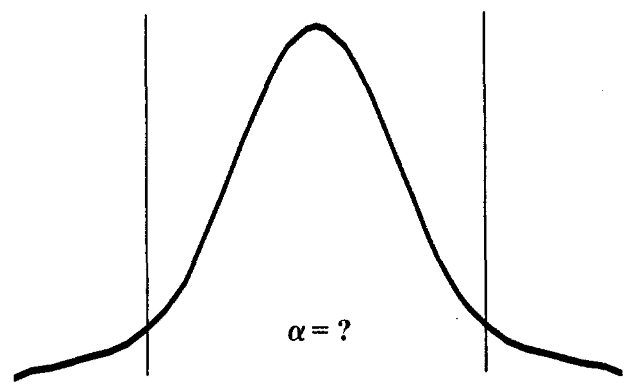


Figure 1. Graphic representation of the classic assignment of α in traditional hypothesis testing

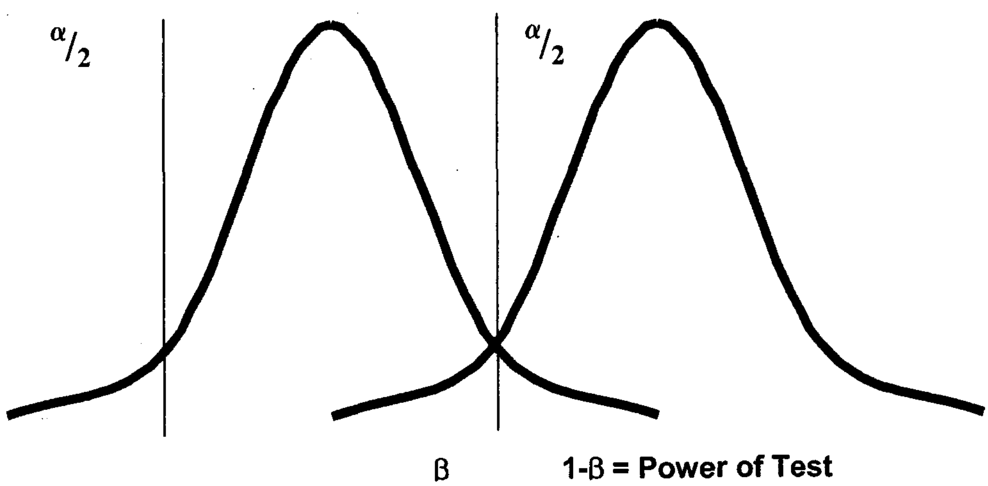


Figure 2. Graphic representation of the relationship among α, β, and 1 - β in traditional hypothesis testing.

An Arizona Example: Antlerless Deer Harvest

Antlerless deer harvests are generally employed only in situations where deer density is deemed greater than desired. Mule deer in Arizona's North Kaibab (Units 12A and 12B) are managed under alternative management guidelines that target a higher quality hunting experience (lower hunter densities and higher probability for harvesting trophy bucks). This management structure also allows for the harvest of antlerless deer based on winter range cliffrose (*Cowania mexicana*) transects that are measured annually to determine the level of forage use. The decision to implement antlerless harvests, and the number of permits authorized, rests ultimately with the Arizona Game and Fish Commission. The Commission must decide if they will authorize recommendations for harvest provided by the Arizona Game and Fish Department in an open public meeting, where many vocal hunters and wildlife enthusiasts have the opportunity to voice their opinions. Public opinions are based on personal experience, observation, and data provided by the Department or collected personally. Department recommendations regarding removal of female deer are generally not embraced by the public that recall periods when deer where much more abundant.

Population demographics are measured and season structure or permit numbers are adjusted annually. The demographics measured include yearling buck weight at a mandatory check station, buck to doe and fawn to doe ratios obtained through December ground surveys, monitoring of cliffrose browse use in February and April, and hunt success. Although not a direct factor influencing management decisions, modeled population size has been used by the Department to infer the impact of harvests on the population. That model has not been verified with a population estimate derived from surveys.

Because the public expressed concern regarding the lack of population model verification in Unit 12AW, the Department conducted winter surveys during December 2004 using the simultaneous double-count approach (Magnusson et al. 1978, Rivest et al. 1995) to test the estimates derived from the model. Historically, Unit 12A population estimates have ranged widely (Table 2).

Table 2. Post-hunt adult population estimates in Units 12AE and 12AW based on the Department's population models.

Year	Unit 12AE	Unit 12AW
1983	3,255	7,539
1984	4,092	9,480
1985	5,045	11,686
1986	4,997	11,576
1987	4,270	9,891
1988	4,043	9,367
1989	3,722	8,622
1990	2,853	7,344
1991	2,918	6,760
1992	3,066	7,103
1993	3,070	7,113
1994	3,089	7,156
1995	3,546	8,214
1996	3,532	8,182
1997	3,683	8,533
1998	4,238	9,819
1999	3,993	9,251
2000	3,730	8,642
2001	3,297	7,638
2002	2,914	6,750
2003	3,428	7,941
2004	4,268	9,886

Selection of Techniques

One of the advantages of aerial sampling over other sampling approaches is the easy addition of a formal sampling design to the survey. Many surveyors sample deer by convenience sampling; that is, selecting samples that are easy to access or convenient (Rabe et al. 2002). Road surveys are an example of convenience sampling (Thompson et al. 1998). In aerial survey, high grading, or flying to where the most deer can be seen in the least amount of time is another example of this type of sampling. Convenience sampling may seem efficient because it often maximizes the number of deer seen per hour, but convenience sampling decreases precision (or makes real estimation of precision impossible), inflates biases, and limits inference to the sampled units only (Thompson et al. 1998). Rabe et al. (2002) further stated, "accurate information about a few populations is preferable to inaccurate information about many." Techniques employing simultaneous double-count methodologies currently present the best opportunities for implementation on a unit specific basis (Magnusson et al. 1978, Rivest et al. 1995)

Several formalized sampling designs are possible with aerial survey. Colorado uses a technique whereby some blocks are surveyed each year and used to calculate abundance indices (Rabe et al. 2002). A modification of this method, where select sets of blocks are surveyed each year and another set of random blocks is also surveyed, is the method currently used in Montana

The purposes of the Arizona survey were to derive sighting probabilities for helicopter mule deer surveys in pinyon-juniper and grassland cover (winter range), calculate mule deer densities for Units 12AW, 12AE, and 12B, and provide a minimum population estimate for mule deer on these ranges.

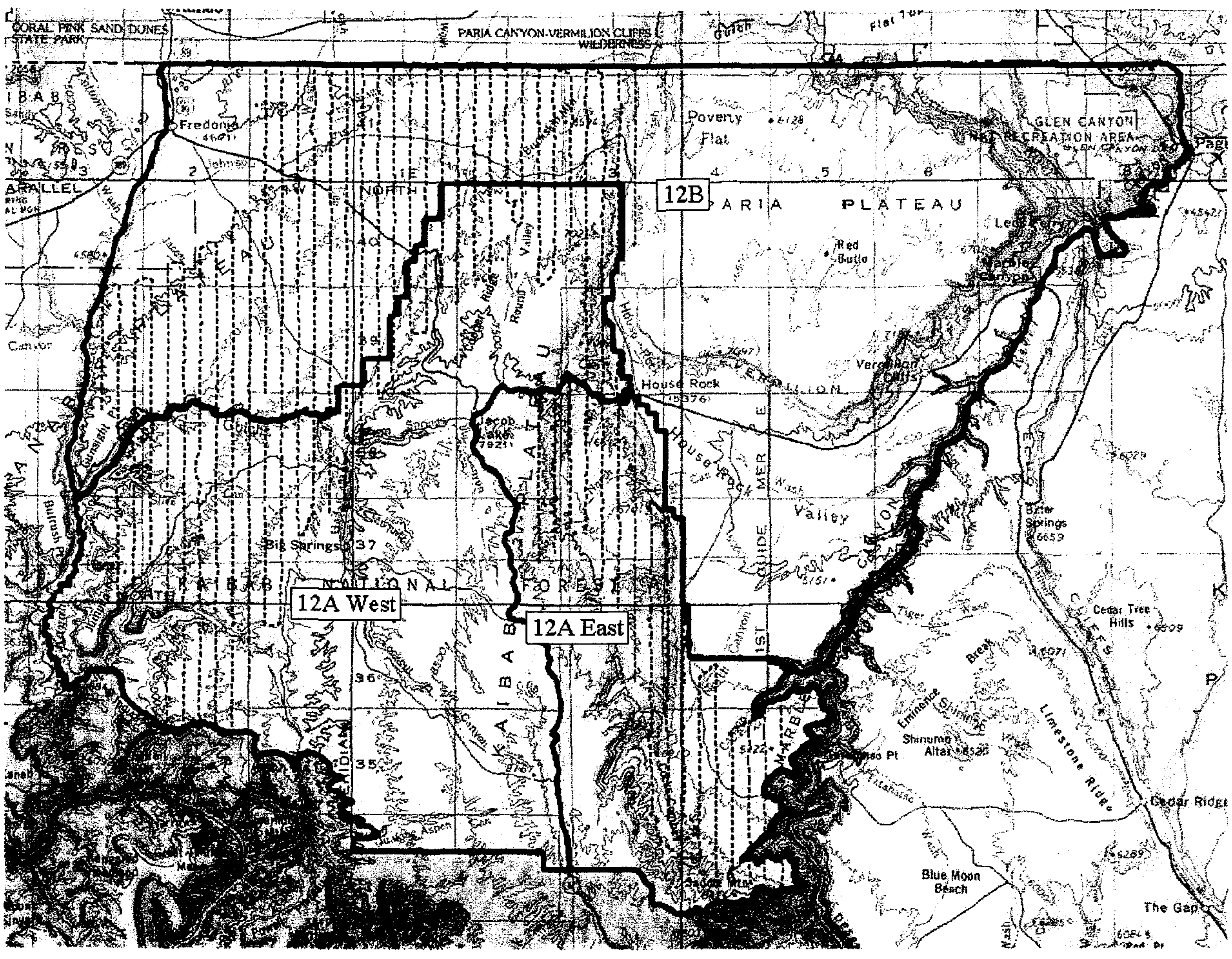


Figure 3. Unit 12 survey transects from GPS track logs, 29 November – 3 December, 2004.

Methods

During 29 November – 3 December 2004, Department personnel surveyed winter range in Units 12AW, 12AE, and 12B using helicopters and simultaneous double-count survey methodologies (Magnusson et al. 1978, Rivest et al. 1995). Surveys were flown along each minute of longitude along a north-south bearing, and grid lines were surveyed from low elevation to high elevation until no deer had been observed for 2 consecutive lines (Figure 3). In Units 12B and 12AE, north-south grid lines were surveyed beginning at an elevation that ensured at least 2 grids would be completed before any deer were observed. Department personnel that participated in these surveys included at least 1 person who had experience in the technique and some that had not participated in this type of survey before so that average sighting probabilities could be established.

Surveys were flown 30-60 m above ground level at a speed of 100-135 kph with 2 observers on the left side of the helicopter. Observations were recorded out to 200 m from the survey line. These ranges were calibrated periodically using a laser rangefinder. Assumptions of the methodology include that a standard observation width is maintained and sighting probability is equal throughout the swath. We tested this assumption following the second survey by calculating the distance between each observation north-south survey grid line (approximate location within tracklog circles and grid line). A GPS tracklog was kept on each survey to determine actual survey distance flown. Each location was logged as a waypoint. The observer on the right side of the helicopter, seated immediately behind the pilot, served as the recorder. Observations made by the recorder were not included in the population estimate calculation because the observation rate differed and was influenced by the recording and GPS waypointing responsibilities.

Estimating Sighting Probabilities and Abundance

Sighting probabilities are used to estimate the proportion of visible animals that are seen by observers. The numbers of animals that are not visible (e.g., those under trees that do not move) are not estimated, which makes all calculations of density and abundance conservative estimates and likely underestimates population size. Some animals may be observed twice on adjacent transects and may not be recognized as duplicate counts; this was unlikely because the distance between consecutive transect grids was about 1 mile.

Sighting probabilities were pooled across all surveys. Pooled observation rates are superior statistically to those derived from a single survey and are not influenced to the same degree by one superior or inferior observer (Rivest et al. 1995). To estimate abundance and population size, total area surveyed was calculated and an estimate of the number of animals in this area. The 200-m wide transect serves as the basis for calculating the amount of land covered during the survey. The entire flight path including the north-south transects and the time between the individual transects are considered a single transect and the length of that transect can be taken from the GPS unit after the flight (this assumes flight time between transects was spent in survey mode). The distance of the circling to classify groups can be eliminated using. The number of animals in the survey area was the number seen on transect (<200 m on left side) divided by the sighting probability (proportion of animals seen). The number of animals in the surveyed area divided by the survey area is the average abundance of animals.

Once animal abundance in the area surveyed is estimated, an estimate for the entire unit or area with similar vegetation associations was calculated. The number of animals per unit area multiplied by the area of occupied deer habitat yields a population estimate for the defined area. Confidence intervals surrounding these estimates were derived using variance estimates from the mark-recapture probabilities described (Magnusson et al. 1978). We selected a 95% confidence interval for our estimate of population size.

Results

Assumption of Standard Transect Width

Observations were highest in the 50-100 m range and decreased beyond that distance (Figure 4). This distribution indicates that surveyed deer were within the transect width and animal detection was largely equal across the survey transect.

Calculation of Sighting Probabilities and Population Estimates

The overall sighting probability was 0.92. In 12AW, we estimated 6,872 deer in 709 km^2 of deer habitat (9.7 deer/km^2), whereas in 12AE we estimated 1,098 deer in 502 km^2 (2.2 deer/km^2). In Unit 12B, we estimated 1,373 deer in 663 km^2 (2.1 deer/ km^2). About 9,343 deer were estimated to inhabit the North Kaibab based on these early winter surveys (Table 3).

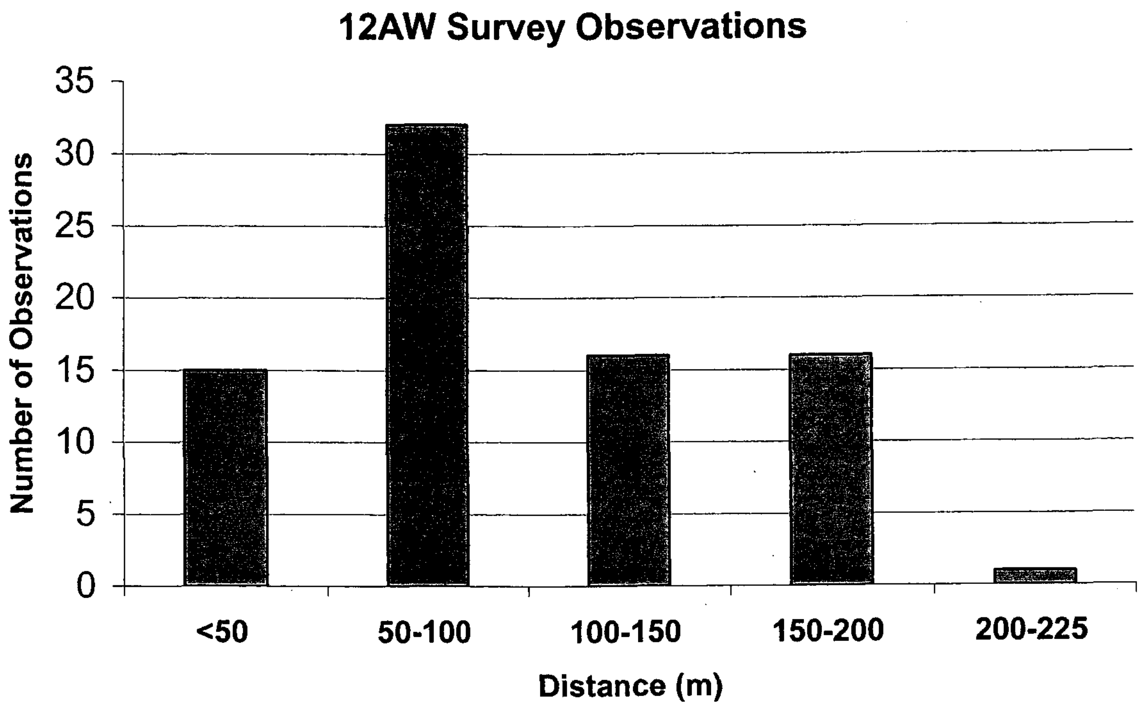


Figure 4. Histogram of frequency of observation distance from transect midline during the second survey of Unit 12AW, 13 – 14 December 2005.

Table 3. Population estimates and 95% confidence intervals for surveys in Units 12AW, 12AE, and 12B, 2004.

Unit	12AW	12AE	12B
Estimated population	6,872	1,098	1,373
95% confidence interval	6,373-7,371	1,036-1,159	1,297-1,449

Discussion

Population estimates from the simultaneous double-count surveys differ somewhat from estimates derived from population modeling. In 2004, the Unit 12AE population model suggested that about 4 times as many deer inhabit the unit than did the survey, whereas in Unit 12AW the model suggests that 1.4 - 2.6 times as many deer occupy the area as did the surveys. In contrast, the public perception was that the double-count estimate was still far greater than the deer they believed inhabited the area. There exist a host of reasons why the double-count estimate is necessarily conservative and probably yields a minimum estimate of the deer population, however trying to explain these issues to the public further undermines the credibility of the agency in the public view.

By using measured fawn to doe (103:100) and buck to doe (34:100) ratios, population estimates were partitioned into sex and age segments. The population model was calibrated with the population estimate derived from the double-count sightability survey. Cliffrose browse use was examined to determine level of use. An antlerless permit recommendation was developed and provided to the Arizona Game and Fish Commission for consideration.

In 2005, the Commission, in a mental test, ultimately falsified the null hypothesis that antlerless harvest would have no effect on the population and authorized the permits recommended by the Department. Had they failed to falsify the null hypothesis, Type I error outcomes were numerous. Projected population growth of the deer herd could have been sufficient to result in greater winter range degradation. Although the probability of this outcome is likely, the implication of that degradation is not likely to have been extreme. Projected population growth could have been so great as to result in lower yearling buck weights, lower adult and fawn survival, and herd reduction from lack of nutrition. Although yearling buck weights may have declined, survival and herd reduction were not nearly as likely to occur. Hence, the implications of this error were not likely to be severe either. On the other end of a two-tailed test, projected population growth may have been lower than projected (which is a portion of the concern from the public). This was very unlikely based on the biological data collected, yet plausible. The implications of this error were likely to be that the Commission would have lost credibility with agency biologists.

Conversely, the Commission may have committed a Type II error with many outcomes as well because they had falsified the null hypothesis. Again, the population growth may have increased despite the antlerless harvest. The likelihood is low, yet plausible if the population was severely underestimated. The implications of such an error were limited because herd growth must be predicated at least in part on available resources, although increased winter range degradation was possible. Or the population may have declined dramatically, in which case the public would have lost trust in the Department and Commission, which may have been the most severe implication.

In this instance, the Commission chose to risk a Type II error, which may have held greater political implications, in lieu of a Type I error, with potentially greater biological implications, because of the data presented and the collaborative process by which the data was developed. The implications of making either of these errors from a biological perspective were likely to be relatively small because hunt recommendations are made annually, and errors made during a given year may be corrected in a subsequent cycle. Cumulative errors can allow egregious errors, such as the irruptions for which the North Kaibab deer herd is famous and the subsequent forage overexploitation (e.g., Swank 1998, but also see caution in interpretation by Hall 1988).

Implications of management decisions regarding what we do versus what we choose not to do can at times be more severe when dealing with situations of human health and safety or small populations. The decisions to not euthanize a bear (*Ursus americana*) causing human conflicts can result in human injury or death (Type II error). The repeated removal of many problems bears may jeopardize the continued existence of a bear population if it is small and isolated (Type I error). Bear populations may be reestablished, but injuries may not be reversed. Federally listed endangered species, such as the Sonoran pronghorn (*Antilocapra americana sonoriensis*), may be precluded from intervention efforts such as captive breeding or forage enhancement until numbers dwindle to extremely low numbers (Wilson et al. 2006) by ESA requirements or federal refuge process limitations, when earlier intervention may have reversed declines (Type II error). Intervening at an earlier point may have had detrimental effects on a population already in jeopardy (Type I error).

Management decisions regarding wildlife involve pubic input and processes mandated by federal and state laws and rules. Rarely are these decisions made solely on biological data and considerations. A situation similar to the Arizona deer management scenario I described in this manuscript was described by Freddy et al. (2004) within Colorado. A county administrator that was asked to discuss conflict resolution at an Arizona Chapter of The Wildlife Society winter meeting sums up the process of public involvement, "Collaboration is messy, but generally yields better outcomes." A former Arizona Game Branch Chief also pointed out when in a subsequent year the Commission chose not to follow a Department antlerless hunt recommendation, "This is why we do this every year. It is difficult to screw things up so badly in 1 year that it cannot be corrected next year." Colorado's collaborative efforts cost about $100,000 (Freddy et al. 2004), whereas ours necessitated additional surveys, analyses, and consultants which are estimated to total $250,000.

Decision makers need to be provided with accurate assessments of the implications of implementing an action versus not implementing that action. Accurate information instills trust and credibility. It also helps resource managers understand the true impacts of our recommendations. If an action is truly essential, clear concise data must be provided to the decision makers. If it is simply the best biological recommendation, there tends to be far broader sideboards on biological constraints than on social constraints. By providing the best information to decision makers, while acknowledging aspects for which we don't have clear answers (e.g., Porter 1997), we can retain credibility and remain focused on the important long-term goals of wildlife management. When it really counts, we don't want to be so concerned about doing something wrong, that we fail to do something right. Explicitly viewing the tradeoffs during informal hypothesis testing can help decision makers make the best decision possible.

Literature Cited

Bakan, D. 1966. The test of significance in psychological research. Psychological Bulletin 66:423-437.

Berkson, J. 1938. Some difficulties of interpretation encountered in the application of the chi-square test. Journal of the American Statistical Association 33:526-542.

Carver, R. P. 1978. The case against statistical significance testing. Harvard Educational Review 48:378-399.

Cherry, S. 1998. Statistical tests in publications of The Wildlife Society. Wildlife Society Bulletin 26:947-953.

Freddy, D. J., G. C. White, M. C. Kneeland, R. H. Kahn, J. W. Unsworth, W. J. deVergie, V. K. Graham, J. H. Ellenberger, and C. H. Wagner. 2004. How many mule deer are there? Challenges of credibility in Colorado. Wildlife Society Bulletin 32:916-927.

Hall, C. A. S. 1988. An assessment of several of the historically most influential theoretical models used in ecology and of the data provided in their support. Ecological Modeling 43:5-31.

Johnson, D. H. 1999. The insignificance of statistical significance testing. Journal of Wildlife Management 63:763-772.

Magnusson, W. E., G. J. Caughley, and G. C. Grigg. 1978. A double-survey estimate of population size from incomplete counts. Journal of Wildlife Management 42:174-176.

Porter, W. F. 1997. Ignorance, arrogance, and the process of managing overabundant deer. Wildlife Society Bulletin 25:408-412.

Rabe, M. J., S. S. Rosenstock, and J. C. deVos, Jr. 2002. Review of big-game survey methods used by wildlife agencies of the western United States. Wildlife Society Bulletin 30:46-52.

Rivest, L., F. Potvin, H. Creqeau, and G. Daigle. 1995. Statistical methods for aerial surveys using the double-count technique to correct visibility bias. Biometrics 51:461-470.

Swank, W. G. 1978. History of the Kaibab deer herd, beginning in 1968. Pages 14-23 *in* J. C. deVos, Jr., editor. Proceedings of the 1997 Deer/Elk Wrokshop, Rio Rico, Arizona. Arizona Game and Fish Department, Phoenix.

Thompson, W. L., G. C. White, and C. Gowan. 1998. Monitoring vertebrate populations. Academic Press, San Diego, California, USA.

Wilson, R. R., P. R. Krausman, and J. R. Morgart. 2006. Recovery efforts for the Sonoran pronghorn in the United States. Pages 67-77 *in* J. W. Cain III and P. R. Krausman, editors. Managing Wildlife in the Southwest. Southwest Section of The Wildlife Society, Tucson, Arizona.

Zar, J. H. 1984. Biostatistical Analysis. Second Edition. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

ELK SIGHTABILITY AND STRATIFIED SURVEYS WITH RESOURCE SELECTION FUNCTIONS

JAMES R. ALLEN, Alberta Fish and Wildlife, PO Box 1720, 2nd floor Provincial Building, 4919-51 st., Rocky Mountain House, AB T4T 1B3, CANADA, James.Allen@gov.ab.ca
EVELYN H. MERRILL, Department of Biological Sciences, University of Alberta, Edmonton AB, T6G 2E9, CANADA, Emerrill@ualberta.ca
L.E. MCINENLEY, Department of Biological Sciences, University of Alberta, Edmonton, AB, T6G 2E9, CANADA
M.S. BOYCE, Department of Biological Sciences, University of Alberta, Edmonton, AB, T6G 2E9, CANADA

Abstract: As part of the Central East Slopes Elk Study (CESES), this project was meant to provide meaningful elk population estimates to enhance current wildlife management. Using radio collared elk, a sightability model was developed to correct for elk missed during aerial surveys. During trials, if a radio collared elk was observed, 11 factors were recorded: light intensity, aspect, activity, topography, percent vegetation screening, vegetation class, percent snow cover, elk group size precipitation, temperature and observer experience. If the elk was not observed, the survey crew used telemetry receivers to locate the elk and record the same factors. A logistic regression approach was used to develop a correction based on environmental factors that affected sightability. Significant variables affecting sightability were, elk group size, percent vegetation screening, elk activity, percent snow cover and light intensity. Survey design can also increase precision of population estimates. When there is high spatial variation in animal numbers, spatial stratification is one approach by which the precision of estimates can be increased. This study compared a typical stratified random sample design using tree canopy for stratification to an improved stratification approach with refined strata using GIS-based covariates. This approach assumes that sample units with similar environmental covariates will have similar elk densities. GIS- based covariates were used to develop a winter elk resource selection function (RSF). The mean RSF value in each survey cell was used to stratify the survey cells for improved precision of the population estimate.

SIGHTABILITY SURVEYS FOR ELK AND DEER: THE NEW MEXICO EXPERIENCE

STEPHAN G. KOHLMANN, New Mexico Department of Game and Fish, 01 Wildlife Way, Santa Fe, NM 87507, USA, skohlmann@state.nm.us
BARRY HALE, New Mexico Department of Game and Fish, 01 Wildlife Way, Santa Fe, NM 87507, USA
DARREL L. WEYBRIGHT, New Mexico Department of Game and Fish, 01 Wildlife Way, Santa Fe, NM 87507, USA

***Abstract*:** New Mexico's elk (*Cervus elaphus*) population is thriving and sustaining a multi-million dollar recreational industry. In contrast, mule deer (*Odocoileus hemionus*) have declined dramatically throughout the West since the latter part of the last century. The high economic value attached to elk and their use of private and public grazing lands have moved elk to the center of public attention in many counties. Similarly, deer hunters and conservationists are concerned with current deer population trends. As a consequence, the New Mexico Department of Game and Fish is frequently challenged about the validity of elk and deer population data. Since 1998, the Department has employed a randomized, stratified sightability survey approach to estimate population parameters. We present a summary of survey and stratification techniques and document the relationship between sampling effort and precision and provide estimates of fiscal impact of this intensive sampling. We discuss the utility of spatial survey data for management and public information in a litigious society. We also point out difficulties in applying the Idaho sightability model (Samuel et al. 1987) in New Mexico for elk and deer and discuss possible remedies.

POSTER PRESENTATIONS

PAPERS AND POSTERS

COOPERATIVE MULE DEER MONITORING PROJECT IN THE HD MOUNTAINS, SOUTHWEST COLORADO

ARAN S. JOHNSON, Southern Ute Division of Wildlife Resource Management, P.O. Box 737 Ignacio, CO 81137, USA, ajohnson@southern-ute.nsn.us

Abstract: In 2004 the Southern Ute Division of Wildlife Resource Management (DWRM) and the Colorado Division of Wildlife (CDOW) began a cooperative mule deer monitoring project in the HD Mountains of southwestern Colorado. Initially the DWRM deployed 7 GPS collars on mule deer around the HDs. Data from the collars suggest that mule deer migrate seasonally from winter ranges within the exterior boundary of the reservation to summer ranges north on the San Juan and Rio Grande National Forests. Migration routes tended to follow major river drainages and deer traced the same routes to and from winter ranges. Collared mule deer traveled between 19 and 46 air miles between winter and summer ranges. Arial extent of winter and summer ranges were calculated using the Kernel Homerange function in Arc View and showed bucks used significantly larger areas for winter range than does.

In 2005 the DWRM collared eleven more mule deer in the HDs with GPS units to continue to investigate migration and winter range habitat use on reservation lands. In conjunction the CDOW deployed 30 VHF collars on mule deer does across HDs winter ranges to begin investigating survival of the herd. Ultimately both agencies plan to continue to work together to investigate possible impacts of large-scale coalbed methane development planned for the HDs.

ESTIMATES OF ROOSEVELT ELK SURVIVAL AND ANNUAL HUMAN-INDUCED LOSSES IN THE CLEARWATER GMU

WARREN A. MICHAELIS, Washington Department of Fish and Wildlife, 48 Devonshire Road, Montesano, WA, USA, michawam@dfw.wa.gov
JACK L. SMITH, Washington Department of Fish and Wildlife, 48 Devonshire Road, Montesano, WA, USA, smithjls@dfw.wa.gov
H. MAX ZAHN, Washington Department of Fish and Wildlife, 48 Devonshire Road, Montesano, WA, USA, ZAHNHMZ@dfw.wa.gov

Abstract: Hunted Roosevelt elk populations on the Olympic Peninsula occur generally on highly accessible forest and agricultural lands. Reliable information on human-induced mortality (poaching and wounding) and significant non-reported hunter harvest of elk can be parameters difficult to obtain. Population model predictions are most sensitive to survival rates. Historically, harvest of antlered elk in the Clearwater Game Management Unit (GMU 615) ranked as one of the highest in western Washington. In the spring of 1996, WDFW conducted a mark-recapture estimate and subsequent population reconstruction that identified missing antlered bull harvest. Objectives of this study were to estimate survival, mortality sources, and estimate numbers of elk being removed annually as a result of human-induced mortality sources. From July 1999 through June 2003, 47 bulls and 50 cows were helicopter darted, radio-marked, and monitored. 79% of instrumented elk were outfitted with internal rumen transmitters. Cow survival rates (0.893 SE 0.06) were comparable with other Roosevelt cow elk survival data.

In addition, branched bull survival rates (0.534 SE 0.07) were comparable with other branched bull survival data and represent an accessible, highly-exploited bull sub-population. We identified a new mortality classification Human Unknown as a result from this study. Telemetry data estimates on the average annual number of branched bulls harvested by state hunters was identical with the estimated two-year mean (2001 and 2002) using a mandatory reporting system. With this same method, we estimated a substantial number of bulls (spikes and branched combined) likely harvested by treaty tribes and not being reported. 25% of branched bull tribal harvest occurred prior to annual WDFW fall composition flights. Continued cooperation and increased sharing of harvest data between the tribes is needed to develop better harvest information to more effectively monitor elk populations and management action.

CHEATGRASS INVASION AND MULE DEER HABITAT

CHARLIE D. CLEMENTS, USDA, Agricultural Research Service, 920 Valley Road, NV 89512, USA, charlie@scs.unr
KEN GRAY, Nevada Department of Wildlife, 60 Youth Center Road, Elko, NV 89801, USA
JAMES A. YOUNG, USDA, Agricultural Research Service, 820 Valley Road, Reno, NV 89512, USA

Abstract: Cheatgrass (*Bromus tectorum*) provides a fine textured early maturing fuel that increases the chance, rate, spread and season of wildfire. In 1964 a firestorm swept through Elko County in northeastern Nevada burning 300,000 acres. Most of the burned habitat was converted from big sagebrush (*Artemisia tridentata*)/bunchgrass to cheatgrass dominance. Subsequently, recurring wildfires at increasingly short intervals has spread and maintained cheatgrass dominance. With each wildfire comes further loss of important browse communities. Historical fire intervals are believed to have been 80 to 110 years, cheatgrass has caused wildfire intervals to increase every 5-10 years, simply too short of an interval to allow for the return and productivity of important browse species. Before the 1964 wildfire, the Independence Range mule deer (*Odocoileus hemionus*) herd was estimated at 38,000 animals. In 1999, 1.8 million acres of northern Nevada rangelands burned, largely fueled by cheatgrass invasions. The Independence Range mule deer herd has decreased to an estimated 9,000 animals as a result of these wildfires burning critical browse communities. This scenario holds true for many mule deer herds throughout the western United States. Active and aggressive management of cheatgrass along with the restoration of native shrub communities is critical in decreasing the frequency and intensity of wildfires, and providing critical browse habitats to mule deer and many other wildlife species.

THE USE OF MICRO-NUTRIENT SEED TREATMENT IN RANGE RESTORATION EFFORTS

CHARLIE D. CLEMENTS, USDA, Agricultural Research Service, 920 Valley Road, NV 89512, USA, charlie@scs.unr

JAMES A. YOUNG, USDA, Agricultural Research Service, 820 Valley Road, Reno, NV 89512, USA

Abstract: Restoration of disturbed sites to mitigate environmental degradation is consuming an increasingly amount of natural resource managers time. In semi-arid and arid environments, restoration seedings are often very difficult to establish. Managers who have become frustrated with seeding failures using conventional methods are experimenting with non-conventional, often propriety seed treatments (either nutrient enrichment or inoculated micro-organisms) in an attempt to enhance seedling establishment. Managers sometime report excellent seedling establishment using these products, but the lack of experimental designs containing replications, data collection, and the use of control treatments makes it impossible to assign cause and effect with any level of statistical precision. We evaluated the micro-nutrient seed treatment GERM-N-8® on seedling emergence and establishment of 8 native perennial grass, 1 introduced perennial grass, 4 native shrubs, and 1 introduced shrub species at 2 locations in northwestern Nevada. The product is a suspension of nutrients (nitrogen 2%, phosphorus 14%, and potassium 3%) applied to dry seeds. The locations were a degraded basin big sagebrush (*Artemisia tridentata ssp. tridentata*)/Thurber's needlegrass (*Achnatherum thurberianum*)-needle and thread grass (*Hesperostipa comata*) site and a degraded mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*)/Thurber's needlegrass site. A randomized block design with 3 replications was used. Seedling emergence, growth and persistence were followed for 2 years after seeding. One site showed initial emergence of the grass seedlings to be higher with the propriety seed treatment but after 2 years there was no difference in seedling establishment or persistence at either site. The treatment of GERM-N-8® on the shrub species monitored was not beneficial in the establishment of more shrubs in this study. If such treatments are to be used, scientific data should be collected to determine their true performance in enhancing seedling establishment.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 6:49-51

Key words: perennial grass, micro-nutrient enrichment, range restoration, seedling establishment, shrubs

---

The effort to restore disturbed sites to mitigate environmental degradation consumes an increasing amount of natural resource manager's time. In arid and semi-arid environments, restoration seedings are often very difficult to establish. Resource managers are frustrated with the lack of seedling success after using conventional methodologies and have started using non-conventional methodologies such as propriety seed treatments. The exact nature of these propriety products is often confidential, but they generally consist of either nutrient or micro-nutrient enrichment or inoculation with unspecified micro-organisms. One of the more popular propriety seed treatments used in Nevada is known as GERM-N-8®. This product is a suspension of nutrients (14% phosphorous, 3% potassium, 2% nitrogen) applied to dry seed at a rate of 6.5 oz. per 100 lbs. of seed. The cost of using this product can range depending on the contract, but estimates run in the neighborhood of 10 cents per lb. of seed if you apply the product yourself to 20 cents per lb. of seed if they apply the product.

Nevada experienced extreme fire conditions in 1999 in which 1.8 million acres of rangelands burned. The most extensive restoration/revegtation effort in history began with 60 million dollars being obligated over a 2 year period in Nevada alone. Within these 1.8 million acres of charred rangeland was over 1,100 separate fires that burned more than 140,000 acres of sage grouse habitat that consisted of nearly 40 sage grouse leks, and another 700,000 acres of mule deer and antelope habitat. More than 1,500 wild horses were removed from the burned rangeland and livestock operations were faced with the hard reality of finding grazing resources away from these decimated rangelands that would be closed from grazing for at least 2 years. This massive restoration/revegetation effort resulted in the purchase of 4.8 million pounds of native and non-native seed (1.4 million lbs of native seed at an average of $7.75/lb, and

3.4 million lbs. of non-native seed at an average of $1.99/lb.) to be seeded on approximately 800,000 acres. In the fall 2000 and the spring 2001, the Winnemucca District of the Bureau of Land Management, U.S. Department of Interior, seeded more than 900,000 lbs. of grass, forb, and shrub seed treated with GERM-N-8® at an added cost of more than $190,000. Success of using this propriety product varies greatly among resource managers: some report excellent success, some report initial success with no long term benefit, and others report no success. The lack of experimental design makes it impossible to assign cause and effect of such successes and failures.

Perennial Grass Emergence and Establishment

We tested the propriety product GERM-N-8® on the emergence and establishment of 8 native and 1 non-native perennial grass at 2 locations in northwestern Nevada. The native perennial grass species tested were big bluegrass, Idaho fescue, thickspike wheatgrass, squirreltail, western wheatgrass, needle-and-threadgrass, Indian ricegrass, and bluebunch wheatgrass (Table 1). Crested wheatgrass was the non-native species tested (Table 1). Dry seed of these species were treated with GERM-N-8® at the recommended rate of 6.3 ounces per 100 pounds of seed. Treated and untreated seed of each species was seeded by hand in October 2001 at a rate of 12 seeds per foot and replicated 3 times at each location. The first location is known as Beddell Flat, 30 miles north of Reno, Nevada, at 5,080 feet elevation. The site received an average of 8.5 inches of precipitation as indicated by a rain gauge at the study site. The site is dominated by Wyoming sagebrush, Nevada ephedra, and an understory of Thurber's needlegrass. The other location is also located about 30 miles north of Reno and is known as Granite Peak. The site is at a higher elevation of 5,840 feet, received an average of 10.6 inches of precipitation, and is dominated by mountain big sagebrush and antelope bitterbrush, with an understory of Thurber's needlegrass (*Achnatherum thuberianum*), Idaho fescue, and squirreltail. Treatments were sampled monthly from November 2001 through August 2003 as initial sprouting, mortality, and persistent establishment were recorded. The initial sprouting of squirreltail, thickspike wheatgrass, Indian ricegrass and bluebunch wheatgrass showed increased success at the Beddell Flat site when treated with GERM-N-8®, while this only held true for squirreltail and Indian ricegrass at the Granite Peak site. After 2 years, the persistent establishment of seeds treated was less than that of the seeds not treated, except for Indian ricegrass at the Granite Peak site. The conversion of initial sprouting to establishment when comparing the treated seeds to the untreated seeds was very interesting, but most apparent with thickspike wheatgrass at the Beddell Flat site. The initial sprouting of treated thickspike wheatgrass was 5.8 per foot compared to 4.1 of the untreated seed, yet the establishment was 0.6 per foot when treated compared to 1.6 per foot when not treated. Again, using the propriety seed treatment product GERM-N-8® benefited initial sprouting of some perennial grass species over those untreated, but the establishment of these perennial grass species did not benefit from this treatment at these study sites.

Shrub Emergence and Establishment

When we first started indicating our preliminary results of the perennial grass experiments, comments arose and confirmed that the success of using GERM-N-8® referred to by the resource managers previously was for shrub seeds such as sagebrush and 'Immigrant' forage kochia. Therefore, at the same two sites in northwestern Nevada that we researched perennial grass emergence and establishment, we tested the application of GERM-N-8® on 5 species of shrubs. The 3 common sagebrush species: mountain, Wyoming, and basin big sagebrush were tested as well as the commonly used 'Immigrant' forage kochia and the critical browse species antelope bitterbrush (Table 1.). Dry seed of these species were treated with the recommended rate of GERM-N-8® and seeded in October 2003. The sagebrush species and forage kochia were seeded at a rate of 20 seeds per foot, while antelope bitterbrush was seeded at a rate of 12 seeds per foot and replicated 3 times at each location. The Beddell Flat site received an average of 10 inches of precipitation over the 2 years (2003-2004 and 2004-2005) while the Granite Peak study site received an average of 13.6 inches. There was no significant difference in initial emergence of shrubs between treatments other than with Wyoming big sagebrush which was twice as dense when treated with GERM-N-8® at the Beddell Flat site, 0.04 compared to 0.02 per foot, and 3 times as dense at the Granite Peak site, 0.33 compared to 0.10 per foot. "Immigrant' forage kochia had good initial emergence at the Granite Peak site, 0.40 untreated and 0.33 treated per foot, but significantly reduced over the summer to 0.06 per foot for both treated and untreated plots. Overall, the shrub seeding at the Beddell Flat site was a complete failure as the only established plants after 2 years was the untreated Wyoming big sagebrush, 0.003 per foot, and the treated and untreated mountain big sagebrush, 0.01 per foot. The Granite Peak site experienced better success as all species treated and untreated established in the plots. Mountain big sagebrush experienced the best success with the establishment of 0.19 untreated and 0.13 treated per foot.

Remember, shrubs are naturally spaced further apart than are herbaceous grass species so it is important to look at the plant community as a whole to get a better picture of just how our seeding compares to that of the adjacent, already established plants. For example, at the Granite Peak site the adjacent community has a density of 130,680 perennial grasses per acre. Our seeded perennial grasses have a density of 35,930 per acre. The shrub density at Granite Peak in the adjacent community, mainly mountain big sagebrush and antelope bitterbrush, is 7,380 per acre compared to our seeding that resulted in 305 shrubs per acre. The adjacent plant communities are made up of plants of various ages, whereas our plots are made up of plants on their second year. Over time these established plants produce seed for the recruitment of plants in future years and therefor are very important in the restoration process of plant communities. Far too often plant communities lost in wildfires are not seeded and in the case of big sagebrush the seed source is absent and there is no hope of shrubs to get established.

The treatment of GERM-N-8® on these shrub species was not beneficial in the establishment of more shrubs in this study. Resource managers need to realize that the added costs of using such propriety products may not increase their success in restoration efforts, but if they are going to use such treatments they should scientifically collect data and maintain records that allow them to make informed decisions in the future.

Table 1. Common and Scientific names of plant species tested.

Common	Scientific
Big bluegrass	*Poa secunda*
Bluebunch wheatgrass	*Psuedoroegneria spicata*
Crested wheatgrass	*Agropyron desertorum*
Idaho fescue	*Fetuca idahoensis*
Indian ricegrass	*Achnatherum hymeniodes*
Needle-and-Threadgrass	*Hesperostipa comata*
Squirreltail	*Elymus elymoides*
Thickspike wheatgrass	*Elymus lanceolatus*
Western wheatgrass	*Pascopyrom smithii*
Antelope bitterbrush	*Purshia tridentata*
Basin big sagebrush	*Artemisia tridentata* ssp. *tridentata*
'Immigrant' Forage kochia	*Kochia prostrata*
Mountain big sagebrush	*Artemisia tridentata* ssp. *vaseyana*
Wyoming big sagebrush	*Artemisia tridentata* ssp. *wyomingensis*

THE INFLUENCE OF ANCHOR-CHAINING ON WATERSHED HEALTH IN A DEPLETED JUNIPER-PINYON WOODLAND IN CENTRAL UTAH

MARK E. FARMER[1], Brigham Young University, Provo, UT. 84604, USA
KIMBALL T. HARPER, Department of Integrated Biology, Brigham Young University, Provo, UT. 84604, USA
JAMES N. DAVIS, Range Trend Coordinator, Division of Wildlife Resources, USDA Shrub Sciences Laboratory, 735 N 500 E, Provo, UT. 84606; USA

Abstract: Large-scale successional changes in the last 150 years have been observed throughout the juniper-pinyon woodlands of the West. With the increase in tree cover, there is a corresponding decrease in understory cover, diversity, and resilience. With this loss of protective understory cover, soils are more susceptible to erosion from high intensity storms. Soil loss is a crucial factor effecting productivity and site potential of these woodland sites. In 1990 the U.S. Forest Service anchor chained and seeded 121 ha of Juniper-Pinyon woodland in Spanish Fork Canyon. Twenty, $10m^2$ runoff-plots were established in 1991, to quantify the effect of anchor chaining on runoff and soil erosion. Plots were paired, one in the chained area and one on comparable terrain and soil type in the untreated juniper-pinyon woodland. Each enclosed runoff-plot channels runoff water and suspended sediments into collection containers. During five years of data collection, unchained plots produced on average 5.8 times more runoff and 9.2 times more sediment than chained plots. Ground cover values for runoff plots show that vegetation increased on chained plots from 27.1% in 1991 to 41.3% in 1995, while litter increased from 22.6% to 51.5% during the same time period. Vegetation cover on untreated plots varied from 7.5% in 1991 to 3.4% in 1995. Litter cover remained at nearly 18%. Results indicate that anchor chaining significantly reduced runoff and soil erosion by providing more protective ground cover.

---

[1]Present address: Utah Division of Wildlife Resources, 1115 North Main Street, Springville, UT 84663, USA, markfarmer@utah.gov

A NICHE-BASED FRAMEWORK FOR EVALUATING SPECIES- AND SEX-SPECIFIC RESPONSES OF ELK AND MULE DEER TO FOREST FUELS REDUCTION

RYAN A. LONG, Department of Fish and Wildlife Resources, University of Idaho, Moscow, ID 83844, USA, long7842@uidaho.edu
JANET L. RACHLOW, Department of Fish and Wildlife Resources, University of Idaho, Moscow, ID 83844, USA
JOHN G. KIE, USDA Forest Service, Pacific Northwest Research Station, La Grande, OR 97850, USA
MARTIN VAVRA, USDA Forest Service, Pacific Northwest Research Station, La Grande, OR 97850, USA

Abstract: Over the past century, strict fire exclusion policies have dramatically altered natural fire regimes across North America. The ecological consequences of prolonged and highly efficient fire suppression are varied, but include the accumulation of high fuel loads and an associated increase in the occurrence of high-severity fires. Recognition of these effects has led to the integration of fuels reduction programs into forest management strategies. Nevertheless, empirical research on the effects of fuels reduction techniques on wildlife is limited. A recently completed fuels reduction program at the Starkey Experimental Forest and Range (Starkey) in northeastern Oregon, however, has provided an ideal opportunity to study the responses of two commonly sympatric ungulate species, elk (*Cervus elaphus*) and mule deer (*Odocoileus hemionus*), to fuels reduction in a relatively controlled setting. Between 2001 and 2003, roughly 30 stands of true fir (*Abies sp.*) and Douglas fir (*Pseudostuga menziesii*) at Starkey that suffered high rates of mortality from a spruce budworm outbreak in the late 1980's were mechanically thinned and then burned to reduce fuel loadings. An equal number of similar stands were left untreated to serve as experimental controls. We propose a niche-based framework for evaluating responses of elk and mule deer to fuels reduction. Telemetry data from 3 years pre-treatment to 3 years post-treatment (1998-2006) will be used to test a variety of hypotheses about: 1) selection of treatment versus control stands by elk and mule deer over time; 2) influence of different habitat components (i.e. slope, elevation, distance to roads, and dominant vegetative cover type) and patch and landscape characteristics (i.e. size, shape, and arrangement of patches) on resource selection; and 3) effects of habitat alteration on sexual segregation in elk. Results will be used to evaluate current fuels reduction programs, and to suggest management strategies that consider habitat use and selection by both ungulates.

TRANSMISSION OF HAIR-LOSS SYNDROME FROM AFFECTED COLUMBIAN BLACKTAIL DEER (ODOCOILEUS HEMIONUS COLUMBIANUS) TO ROCKY MOUNTAIN MULE DEER (ODOCOILEUS HEMIONUS HEMIONUS)

JASON A. ROBISON, Oregon State University Department of Fisheries and Wildlife, 104 Nash Hall Corvallis OR 97330, USA, Jason.Robison@oregonstate.edu

Abstract: Hair loss syndrome (HLS) or "Hair Slip" is a new affliction affecting Columbian black-tailed deer (*Odocoileus hemionus columbianus*) and potentially Rocky Mountain mule deer (Odocoileus hemionus hemionus) in Oregon and Washington (USA). It is believed that an invasive species of louse in the genus *Damalinia*, subgenus *Cervicola* is causing a hypersensitive reaction resulting in pruritic grooming behavior leading to the removal of pelage. The potential transmission of *D. (Cervicola) sp.* from affected black-tailed deer to mule deer is unknown. In order to answer this question, six mule deer were experimentally infested with *D. (Cervicola) sp.*, and six mule deer were held in direct contact with six infested black-tailed deer at EE-Wilson Wildlife area, near Corvallis, Oregon. Grooming behavior, lice numbers, and clinical signs (darkening of hair coat, yellow discoloration, hair-loss, raw skin) were recorded. Both experimentally infested deer and those held in direct contact with infested blacktail deer showed marked increases in grooming behavior within three weeks of exposure. Lice counts doubled following exposure in both groups and lice samples taken from mule deer held in direct contact with black-tailed deer were identified as *D. (Cervicola) sp.* Small patches of groomed hair were recorded in exposed mule deer, however no extreme hair loss was observed. On the basis of these data, the potential for mule deer to develop hair- loss syndrome is high when in direct contact with affected black-tailed deer, or other modes of *D. (Cervicola) sp.* contact.

DESERT VEGETATION DECREASES GENE FLOW AMONG COUES WHITE-TAILED DEER POPULATIONS IN THE SOUTHWEST

ROY LOPEZ, USDA, Forest Service, Rocky Mountain Research Station and School of Forestry, Northern Arizona University, 2500 S. Pine Knoll Drive Flagstaff, AZ 86001, USA, rglopez@fs.fed.us
PAUL BEIER, Northern Arizona University, Flagstaff, AZ 86001, USA, paul.beier@nau.edu

Abstract: We used microsatellite allele frequencies to examine spatial patterns of genetic relatedness for Coues white-tailed deer (*Odocoileus virginianus couesi*) in Arizona and New Mexico in naturally fragmented habitats (Sky Islands) and in relatively continuous habitats (Mogollon Rim). Because these deer are associated with oak woodland and oak-pine woodlands, we expected greater gene flow along the Mogollon Rim where no habitat barriers to movement exist. Conversely, gene flow should be restricted in areas where habitat discontinuities exist as among the Sky Island region of SE Arizona and SW New Mexico, which is characterized by basin and range topography with desert grasslands separating mountains. We determined genotype (allele frequencies at 12 microsatellite markers) for 358 Coues white-tailed deer from the Sky Islands of Southeastern Arizona and Southwest New Mexico and from along and below the Mogollon Rim from southwest of Flagstaff Arizona to the Black Range of New Mexico. As expected, the Sky Islands showed a stronger pattern of isolation by distance than did deer populations along the Mogollon Rim. Both population and individual statistics indicated genetic differentiation between a "mainland" (Mogollon Rim) subpopulation and a Sky Island subpopulation. We also found evidence for unexpectedly low gene flow limited between some pairs of neighboring sampling units which may reflect a combination of habitat and anthropogenic barriers.

STATUS AND TREND OF POPULATION AND HARVEST FOR DEER AND ELK IN WESTERN NORTH AMERICA, 1970 – 2003

MIKE COX, Nevada Department of Wildlife, 1100 Valley Road, Reno, NV 89512, USA, mcox@ndow.org
TONY WASLEY, Nevada Department of Wildlife, 60 Youth Center Road, Elko, NV 89801, USA,
JASON COPPER, Nevada Department of Wildlife, 1100 Valley Road, Reno, NV 89512, USA

Abstract: We surveyed the 23 states and provinces belonging to the Western Association of Fish and Wildlife Agencies (WAFWA) to determine the status and trend of populations and harvest of deer (*Odocoileus spp.*) and elk (*Cervus spp.*) from 2003. The main objective of this survey and previous ones is to collect and synthesize long-term demographic data for deer and elk in western North America. Responses were received from 22 of the 23 WAFWA members surveyed. Data from 2003 for fawn, calf, buck, and bull ratios; population estimates; harvest; and hunter effort were appended to previous years' survey information (1970, 1985, 1995, 2000, and 2001) in a Microsoft Access® database. Most current year values and long-term trends by species for population estimates and total harvest were spatially summarized. Over the long-term, with the exception of Colorado, the data depicts a decreasing trend in mule deer fawn ratios across the west, though short-term most states have shown a slight increase in fawn ratios. The combined mule deer and black-tailed deer population estimate for all western states and provinces was approximately 4.9 million in 2003. For states that provided data back to 1970, Rocky Mountain elk herds in the west grew 235% through 2003. The 2003 total west-wide Rocky Mountain elk population for all states and provinces was 980,000.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 6:56-76

Key Words: deer, elk, harvest, population, provinces, ratios, status, survey, states, trends

---

Continuing with the direction provided by the Mule Deer Working Group as supported by the Western Association of Fish and Wildlife Agencies (WAFWA), the host state for the biennial Deer and Elk Workshop is responsible for collecting and compiling status surveys on population and harvest data for both deer and elk herds from the 23 states and provinces in western North America. Nevada Department of Wildlife (NDOW) worked with System Consultants, Inc., to develop an online data entry process for all survey data via a webpage for deer and elk biologists to enter data directly into a single Microsoft Access® database.

The main objective of this survey is to collect and synthesize long-term demographic data for white-tailed, black-tailed, and mule deer and Rocky Mountain, Roosevelt, and Tule elk in western North America. It is an extension of a survey initiated by the Oregon Department of Fish and Wildlife for the 2001 Western States Deer and Elk Workshop and continued by Wyoming Game and Fish in 2003. In 2005, responses were received from 22 of the 23 WAFWA members surveyed. All 18 member states responded to the survey and 4 of 5 Canadian Provinces responded. The 2005 survey asked states and provinces for data from the 2003 biological and harvest years for fawn, calf, buck, and bull ratios; population estimates and objectives; harvest by weapon class; and hunter effort. As part of the 2005 survey, NDOW also appended the 2003 data to previous years' survey information (1970, 1985, 1995, 2000, and 2001) in a Microsoft Access® database.

Results and Discussion

All states and provinces where mule or black-tailed deer populations exist provided 2003 estimates to the survey except Oklahoma (Table 1, Figure 1). The combined mule deer and black-tailed deer population estimate summed across all western states (including Alaska) and provinces was approximately 4.9 million in 2003. A separate west-wide mule deer population estimate assuming more than half of the deer in California are black-tailed deer, was approximately 3.6 million in 2003 (excluding Oklahoma).

Mule deer population trends seemed to be mixed across the west since 1985 (Table 1, Figure 2). Alberta, Colorado, and Wyoming had increasing population trends; Oregon's trend was stable, and Arizona, California, New Mexico, Nevada, and Utah showed declining mule deer estimates. Lack of black-tailed and white-tailed population estimates prior to 2000 in most states and provinces preclude long-term population trends (Table 2, Figure 5).

Short-term data (2000 – 2003) show stable to slight increasing trends in post-season mule deer fawn/100 doe ratios with the exception of New Mexico and Oregon (Table 3). Unfortunately in the long-term, with the exception of Colorado, the data depicts a decreasing trend in fawn ratios across the west. The west-wide weighted (population size) fawn ratio was 66 fawns/100 does in 1970 and 1985, dipped to 52 in 1995 and rose to 62 in 2003. Only Oregon has long-term black-tailed deer fawn ratios (Table 3). Stable fawn production existed from 1970 – 2001 with the exception of 1995 and a 24% drop in 2003 compared to the long-term average fawn ratio. Conversely, white-tailed deer fawn ratios remain stable over the long-term across the west (Table 3).

Figure 3 displays the 2003 black-tailed and mule deer harvest totals for reporting states and provinces. For long-term mule deer harvest trends, except for Alberta and Montana, all states who reported mule deer harvest since 1985 are showing a decline (Table 4, Figure 4). This ranges from an 11% decline in Nebraska to a 79% decline in Arizona. States adjacent to Arizona also showed large declines in mule deer harvest since 1985: Nevada – 69%, New Mexico – 66%, and Utah – 77%. Long-term black-tailed deer harvest trends for Alaska are stable since 1985 (Table 4). Other than Alaska, only Oregon and Washington have harvest data back to 1985 for black-tailed deer separate from mule deer. Both states combined showed a 40% reduction in total black-tailed deer harvest between 1985 and 2003. Conversely, long-term white-tailed deer harvest trends are up for those western states and provinces that provided harvest data since 1985 (Table 5, Figure 6).

Long-term Rocky Mountain elk population trends are up in all reporting states and provinces (Table 8). For states that provided data back to 1970, elk herds grew 235% through 2003. The 2003 total west-wide Rocky Mountain elk population summed across all states and provinces (all western states and provinces reported an estimate) was 980,000 (Figure 7). This west-wide population growth was fueled by strong calf ratios prior to 2000 with a decline in calf recruitment over the last few years (Table 9). The west-wide weighted (population size) average for the calf/100 cow ratio was 48 in 1970 and 1985, dropped slightly to 45 in 1995, showed a major decline to 34 in 2001 and then elevated slightly to 38 in 2003.

All states and provinces with Roosevelt elk herds reported a combined population of 108,000 elk in 2003 (Table 8). Oregon, which made up approximately 60% of this west-wide population, showed a 45% increase in its Roosevelt elk population since 1985. Tule elk which only exist in California showed a remarkable increase from 500 in 1970 to 3,700 in 2003 (Table 8).

Figure 8 displays the 2003 elk harvest totals for reporting states and provinces. Long-term elk (all subspecies) harvest trends are up in all reporting states except Washington (Table 10).

For both deer and elk, as one might expect, hunter days followed the same general trend as harvest for that species. However, in many states and provinces there appears to be an increase in hunter days for primitive weapons relative to rifle hunts.

Although missing data values and lack of consistent data parameters among states and provinces exist, we found great utility in elucidating broad landscape scale trends in the demographics of deer and elk in Western North America. A few thoughts are provided on limitations of the data provided. Not all states conduct surveys at the same time of the year, which may create incomparable results if sightability differs especially for bucks and bulls. Also, it may be difficult to accurately compare fawn ratios among states if some surveys occur in early fall vs. others that occur in January where fawns have experienced partial winter mortality. Several states with tags or permits for 2 species/subspecies of deer or elk do not separate hunter numbers by species/subspecies, especially for primitive weapons. Though not extremely critical, if harvest is reported by species/subspecies, this proportion of harvest along with making a few assumptions can be used to partition the hunters and hunter effort by species/subspecies. A much more critical issue is those states and provinces that do not separate harvest by species/subspecies regardless of weapon class. It is important especially for white-tailed vs mule deer population management for states to devise guidelines and criteria to institute requirements of hunters to identify harvest by species or subspecies. Lastly, after reviewing the magnitude of deer harvest to a state's or province's population estimates and recruitment rates, it most probable that a few are overly liberal in estimating their deer numbers and a few are very conservative compared to the majority of states or provinces. This could lead to serious credibility issues among wildlife agencies in the face of ever critical publics and the ability to document true population changes. However, despite these shortcomings, these data represent the most comprehensive and current demographic dataset for deer and elk in western North America. As the database grows with each successive year's data, so will its utility and strength as an analytical tool.

TABLE 1. 1970 – 2003 black-tailed and mule deer population estimates reported by states and provinces in western North America.

		Year					
Species	State	1970	1985	1995	2000	2001	2003
Black-tailed Deer[a]	Alaska			355,000	315,000		400,000
	British Columbia						157,500
	California	combined with Mule Deer					
	Oregon		432,234	376,500			320,000
	Washington						120,000
Mule Deer	Alberta		86,000		120,000	145,000	157,000
	Arizona	130,000	155,000	110,000	105,000	111,500	110,000
	British Columbia						140,000
	California[b]	1,000,000	850,000	760,000	677,000		521,944
	Colorado		465,000	530,370	548,200		603,000
	Idaho						300,000
	Kansas						10,000
	Manitoba						400
	Montana						327,000
	Nebraska						50,000
	Nevada	75,000	156,000	118,000	133,000	108,000	109,000
	New Mexico	300,000	250,000	200,000	150,000		70,000
	North Dakota						25,500
	Oregon		251,200	235,300	257,068	282,930	246,400
	Saskatchewan					36,461	39,525
	South Dakota				83,000	70,000	75,000
	Texas					184,405	210,215
	Utah	350,000	360,000	254,964	319,720	310,000	268,000
	Washington				320,000		120,000
	Wyoming		423,000	429,000	535,000	488,809	499,978
	Yukon	150			700	650	800
Total reported - black-tailed and mule deer							4,881,262

[a]Black-tailed deer occur in Hawaii but no estimate was provided.

[b]Estimate includes both black-tailed and mule deer in California.

TABLE 2. 1970 – 2003 white-tailed deer population estimates reported by states and provinces in western North America.

		Year					
Species	State	1970	1985	1995	2000	2001	2003
White-tailed Deer	Alberta		115,000	150,000	200,000	230,000	245,000
	Arizona	40,000	85,000	80,000	80,000	83,000	86,000
	Colorado				8,780		
	Idaho						200,000
	Kansas						250,000
	Manitoba						180,000
	Montana						237,700
	Nebraska						225,000
	New Mexico				10,000		
	Oklahoma						475,000
	Oregon						12,000
	Saskatchewan					277,500	374,691
	South Dakota				175,000		210,000
	Texas					3,776,052	4,007,748
	Washington						80,000
	Wyoming		48,000	37,000	58,100	41,500	
	Yukon		15		40	100	
	Total reported						6,583,139

TABLE 3. 1970 – 2003 post-season deer fawn/100 doe ratios reported by states and provinces in western North America.

		Year					
Species	State	1970	1985	1995	2000	2001	2003
Black-tailed Deer	California						47
	Oregon	54	57	42	51	51	39
	Washington[a]					53	52
Mule Deer	Alberta[b]				79		79
	Arizona	48	54	33	44	41	41
	California[b]			47	58	40	
	Colorado		67	52	49		69
	Idaho						60
	Kansas						76
	Montana					62	50
	Nevada	68	68	58	54	53	55
	New Mexico	62	42	40	47		31
	North Dakota					100	88
	Oregon	64	54	58	51	51	35
	Saskatchewan					79	87
	South Dakota				150	98	101
	Texas					54	67
	Utah	75	80	63	58	56	66
	Washington					62	
	Wyoming[b]		76	61	76	54	66
Weighted Average (based on population estimate)		66	66	52	59	55	62
White-tailed Deer	Alberta[b]				73		73
	Arizona	31	50	26	36	37	35
	Idaho						60
	Kansas						79
	Montana[b]				55	50	76
	Oklahoma						60
	Saskatchewan					96	95
	South Dakota				131	112	125
	Texas					48	49
	Washington					59	
	Wyoming[b]		76	61	75	81	75

[a]Fawn ratio based on fawns/100 adults.

[b]Fawn ratio based on average of low and high values provided; no statewide average provided.

TABLE 4. 1970 – 2003 black-tailed and mule deer harvest by all weapon classes reported by states and provinces in western North America.

		Year					
Species	State	1970	1985	1995	2000	2001	2003
Black-tailed Deer	Alaska		15,177	20,196	13,510		16,166
	British Columbia			17,000			4,001
	California[c]					8,850	30,027
	Hawaii[a]	2	18	46	72		
	Oregon[b]	29,400	43,381	36,192	29,103	26,835	22,743
	Washington		18,090	16,874	13,165	13,654	13,933
Mule Deer	Alberta		17,932	20,027	18,757	16,220	17,911
	Arizona	13,825	24,826	10,231	5,329	7,870	5,133
	British Columbia			22,850			15,818
	California[c]	40,718	33,089	17,771	21,482	9,480	
	Colorado	71,795	57,831	81,899	35,634		36,822
	Idaho	78,100	36,450	19,875	31,050	26,250	28,300
	Kansas						2,658
	Montana	441	72,899	79,115	49,616	64,425	69,687
	Nebraska	8,505	10,232	11,022	10,152	10,604	9,053
	Nevada	14,587	19,520	8,114	12,437	9,795	6,072
	New Mexico	38,188	25,931	12,918	18,014		8,692
	North Dakota[b]	3,826	6,248	7,935	3,620	3,969	4,566
	Oregon[b]	68,860	35,273	26,994	31,704	32,480	26,864
	Saskatchewan[b]					5,422	21,402
	South Dakota[b]				6,275	8,245	9,989
	Texas[b]					3,183	4,622
	Utah	101,761	102,685	26,794	34,852	38,299	23,675
	Washington		3,682	16,976	14,054	16,576	13,273
	Wyoming	96,889	51,318	31,353	41,801	36,975	35,382
Total reported - black-tailed and mule deer							426,789

[a]Harvest includes both axis and black-tailed deer in Hawaii.

[b]Harvest by muzzleloader and archery partitioned by species based on rifle harvest proportions by species where state did not provide separate muzzleloader and archery harvest values by species or subspecies.

[c]2003 harvest listed under Black-tailed Deer includes both black-tailed and mule deer in California.

TABLE 5. 1970 – 2003 white-tailed deer harvest by all weapon classes reported by states and provinces in western North America.

Species	State	Year 1970	1985	1995	2000	2001	2003
White-tailed Deer	Alberta		20,505	35,019	36,637	36,000	39,179
	Arizona	2,242	6,902	4,894	4,204	3,416	4,216
	Colorado						
	Idaho		12,300	28,500	13,700	17,800	21,350
	Kansas						62,787
	Montana	24,929	42,949	60,795	44,796	36,219	60,437
	Nebraska	7,250	25,733	34,814	50,665	49,749	43,413
	New Mexico						
	North Dakota[a]	22,265	50,633	56,420	56,240	66,707	93,357
	Oklahoma						100,602
	Oregon[a]			700	1,025	1,382	1,052
	Saskatchewan[a]					35,722	30,609
	South Dakota[a]				24,500	44,968	50,136
	Texas[a]					394,016	434,341
	Washington			9,735	13,191	10,784	13,560
	Wyoming	9,878	8,967	6,959	10,605	9,267	10,328
	Total reported						965,367

[a]Harvest by muzzleloader and archery partitioned by species based on rifle harvest proportions by species where state did not provide separate muzzleloader and archery harvest values by species or subspecies.

TABLE 6. 1970 – 2003 black-tailed and mule deer rifle hunters reported by states and provinces in western North America (neither muzzeloader or archery hunters were included due to the inabilities of many states to track muzzleloader and archery hunters by species/subspecies).

		Year					
Species	State	1970	1985	1995	2000	2001	2003
Black-tailed Deer	Alaska		8,500	12,405	11,196		7,755
	British Columbia						6,898
	California						142,000
	Hawaii	99	1,033	1,224	1,949		
	Oregon	100,870	155,669	135,291	116,861	111,732	88,552
	Washington[a]						108,678
Mule Deer	Alberta		58,099	45,916	38,660	34,000	34,897
	Arizona	97,257	84,809	58,980	42,811	30,745	33,905
	British Columbia						37,529
	California	392,000	314,810	198,053	189,675		
	Colorado	171,731	146,515	144,425	69,843		71,982
	Idaho[b]	197,900	98,600	60,500		112,300	115,000
	Kansas						6,604
	Montana[b]	136,903	190,935	177,919	138,318	168,926	153,255
	Nebraska[b]						66,593
	Nevada	23,781	30,846	16,420	22,628	20,522	12,308
	New Mexico	97,000	87,025	54,259	53,840		32,118
	North Dakota	9,721	6,956	9,015	3,971	5,150	5,225
	Oregon	166,350	100,387	66,127	69,605	74,267	65,008
	Saskatchewan					5,484	14,146
	South Dakota					20,971	10,583
	Texas					14,976	15,810
	Utah	178,005	235,484	77,959	71,819	79,320	61,599
	Washington[a]						108,678
	Wyoming	126,189	87,794	62,981	67,509	66,448	65,714

[a] Includes black-tailed, mule, and white-tailed deer hunters

[b] Includes both white-tailed and mule deer hunters

TABLE 7. 1970 – 2003 white-tailed deer rifle hunters reported by states and provinces in western North America (neither muzzeloader or archery hunters were included due to the inabilities of many states to track muzzleloader and archery hunters by species/subspecies).

		Year					
Species	State	1970	1985	1995	2000	2001	2003
White-tailed Deer	Alberta		79,819	74,511	81,795	74,000	85,599
	Arizona					15,838	33,905
	Colorado						
	Idaho[a]		38,000	79,300		45,000	115,000
	Kansas						68,689
	Montana[a]						153,255
	Nebraska[a]						66,593
	New Mexico						
	North Dakota	37,610	60,024	75,187	80,800	102,100	111,000
	Oklahoma						155,628
	Oregon					16,329	472
	Saskatchewan					45,615	41,937
	South Dakota					46,419	53,102
	Texas					491,822	445,752
	Washington[b]						108,678
	Wyoming		21,389	17,841	21,965	21,081	20,994

[a]Includes both white-tailed and mule deer hunters

[b]Includes black-tailed, mule, and white-tailed deer hunters

TABLE 8. 1970 – 2003 elk population estimates reported by states and provinces in western North America.

		Year					
	State	1970	1985	1995	2000	2001	2003
Rocky Mountain Elk[a]	Alberta			25,000		28,000	28,000
	Arizona	10,500	19,000	20,000	25,000	24,000	23,000
	British Columbia						43,750
	California	1,000	1,000	1,250	1,250	1,250	2,000
	Colorado	80,000	132,500	203,000	263,300		278,000
	Idaho					123,000	125,000
	Kansas						160
	Manitoba						7,000
	Montana			93,401	99,627	180,000	138,500
	Nebraska						700
	Nevada	100	1,400	3,300	5,700	6,600	7,200
	New Mexico	30,000	45,000	62,500	71,500		72,000
	North Dakota						150
	Oklahoma						1,500
	Oregon		52,250	64,003	60,934	65,555	60,350
	Saskatchewan					14,500	15,086
	South Dakota				5,200	9,000	7,600
	Utah	7,500	30,000	59,355	62,635	62,000	58,000
	Washington					25,180	19,050
	Wyoming		70,300	110,000	99,000	96,115	92,293
	Yukon		70		100	175	300
	Total reported						979,639
Roosevelt Elk	Alaska			1,600	1,240		1,250
	British Columbia						3,800
	California	2,000	3,000	3,500	4,000	4,250	3,000
	Oregon		42,800	55,700	62,752	62,000	62,200
	Washington					29,570	37,400
	Total reported						107,650
Tule Elk	California	500	1,470	2,900	3,600	3,700	3,700

[a]Rocky Mountain elk occur in Alaska but no estimate was provided.

TABLE 9. 1970 – 2003 post-season elk calf/100 cow ratios reported by states and provinces in western North America.

		Year					
Species	State	1970	1985	1995	2000	2001	2003
Rocky Mountain Elk	Alberta		37				
	Arizona	55	44	41	45	28	34
	British Columbia						
	California						37
	Colorado		50	50	48		45
	Idaho					26	32
	Kansas						60
	Montana					35	35
	Nebraska						
	Nevada		56	46	46	42	37
	New Mexico	59	50	37	41		37
	North Dakota						
	Oklahoma						50
	Oregon	47	39	38	31	29	26
	Saskatchewan					50	
	South Dakota				55		50
	Utah		51			50	40
	Washington					34	23
	Wyoming						39
	Yukon						51
Weighted Average (based on population estimate)		48	48	45	44	34	38
Roosevelt Elk	Alaska			22	19		
	British Columbia						
	California						37
	Oregon	37	33	33	30	46	35
	Washington					28	
Tule Elk	California						34

TABLE 10. 1970 – 2003 elk harvest by all weapon classes reported by states and provinces in western North America.

		Year					
Species	State	1970	1985	1995	2000	2001	2003
Elk	Alberta		3,104	2,281	3,281	3,035	4,440
	Alaska[a]			96	81		104
	Arizona	1,426	6,657	10,125	10,500	10,448	7,503
	British Columbia[a]			3,800			2,557
	California[b]	21		131	306	226	173
	Colorado	17,236	23,342	36,171	60,120		57,331
	Idaho	14,150	15,550	22,435	19,875	17,900	22,050
	Kansas						20
	Montana	19,287	18,596	23,202	19,479	21,588	29,913
	Nebraska						33
	Nevada	6	82	183	804	669	1,056
	New Mexico	1,584	2,919	10,521	12,100		15,524
	North Dakota		2	30	94	106	123
	Oklahoma						194
	Oregon[a]	12,680	19,770	23,463	20,262	21,121	18,575
	Saskatchewan					2,276	2,915
	South Dakota				698	756	1,226
	Utah	1,995	5,872	8,372	6,164	13,733	10,467
	Washington[a]		10,363	8,371	8,670	5,470	8,705
	Wyoming	18,030	13,809	17,695	22,782	21,276	21,365
	Total reported						204,274

[a]Includes harvest of Rocky Mountain and Roosevelt elk subspecies.
[b]Includes harvest of Rocky Mountain, Roosevelt and Tule elk subspecies.

TABLE 11. 1970 – 2003 elk rifle hunters reported by states and provinces in western North America.

		Year					
Species	State	1970	1985	1995	2000	2001	2003
Rocky Mountain Elk	Alberta		37,412	19,701	27,113	22,500	25,520
	Alaska						
	Arizona	5,677	10,323	14,713	16,113	19,655	12,983
	British Columbia						10,388
	California			5	5	12	10
	Colorado	84,595	122,597	185,382	192,629		201,831
	Idaho	72,800	67,200	101,500		62,500	69,000
	Kansas						42
	Montana	77,819	89,182	109,860	99,921	109,383	115,476
	North Dakota		5	51	167	194	232
	Nebraska						79
	New Mexico	6,577	8,086	17,921	17,400		22,545
	Nevada	15	95	232	1,047	910	1,597
	Oklahoma						300
	Oregon	52,190	76,075	70,674	59,687	59,694	51,550
	South Dakota				1,024	1,124	1,831
	Saskatchewan					6,259	6,718
	Utah	10,354	24,751	33,964	26,729	41,121	36,910
	Washington						25,855
	Wyoming	40,251	45,809	53,041	51,944	53,548	53,600
	Total reported						636,467
Roosevelt Elk	Alaska			490			
	British Columbia						194
	California	100		40	130	134	135
	Oregon	21,370	52,126	46,846	44,718	44,850	40,353
	Washington						21,911
	Total reported						62,593
Tule Elk	California			73	157	215	120

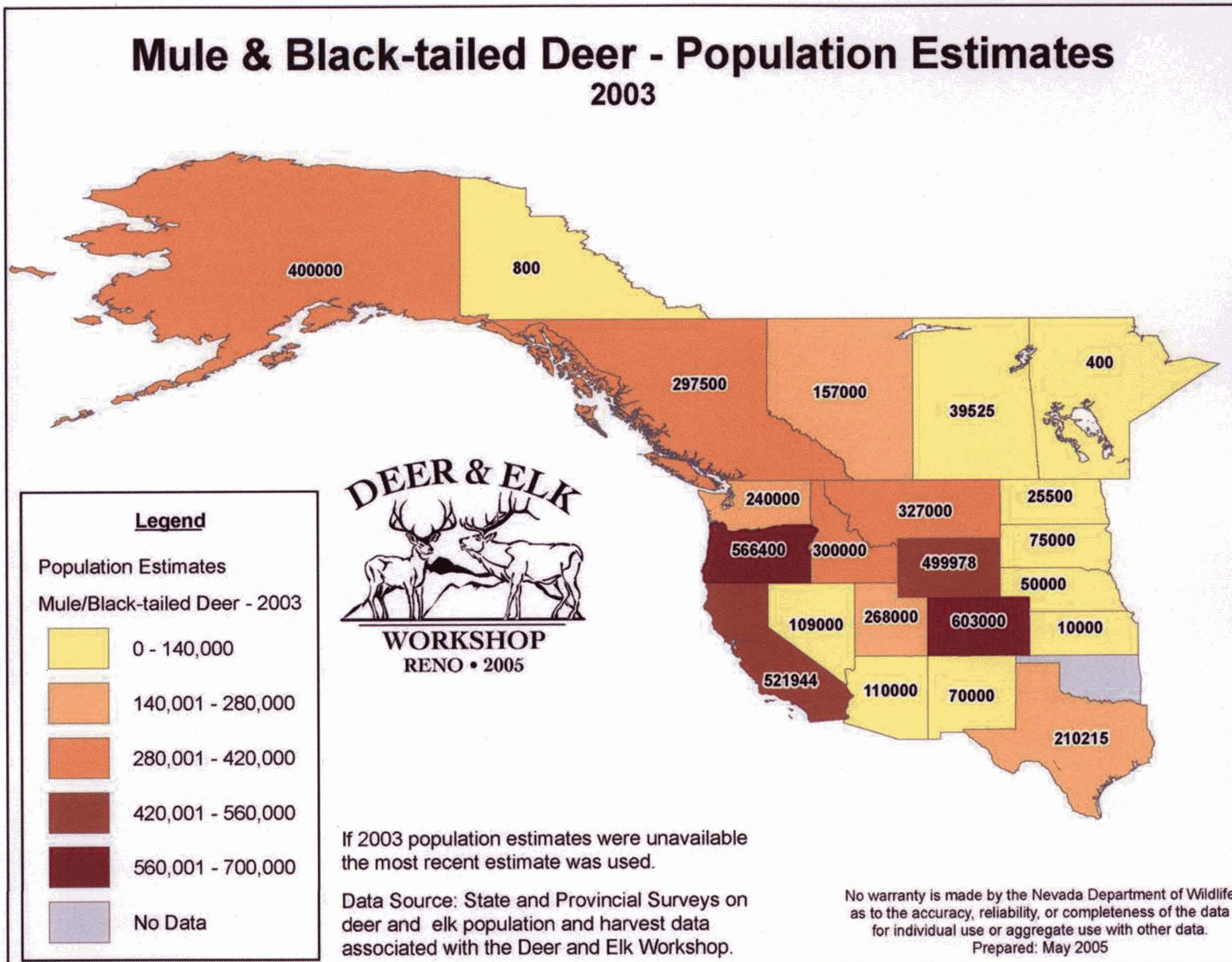

Mule & Black-tailed Deer - Population Estimates
2003
400000
800
297500
157000
39525
400
240000
327000
25500
566400
300000
499978
75000
50000
109000
268000
603000
10000
521944
110000
70000
210215
DEER & ELK
WORKSHOP
RENO • 2005
Legend
Population Estimates
Mule/Black-tailed Deer - 2003
0 - 140,000
140,001 - 280,000
280,001 - 420,000
420,001 - 560,000
560,001 - 700,000
No Data
If 2003 population estimates were unavailable the most recent estimate was used.
Data Source: State and Provincial Surveys on deer and elk population and harvest data associated with the Deer and Elk Workshop.
No warranty is made by the Nevada Department of Wildlife as to the accuracy, reliability, or completeness of the data for individual use or aggregate use with other data.
Prepared: May 2005

FIGURE 1.

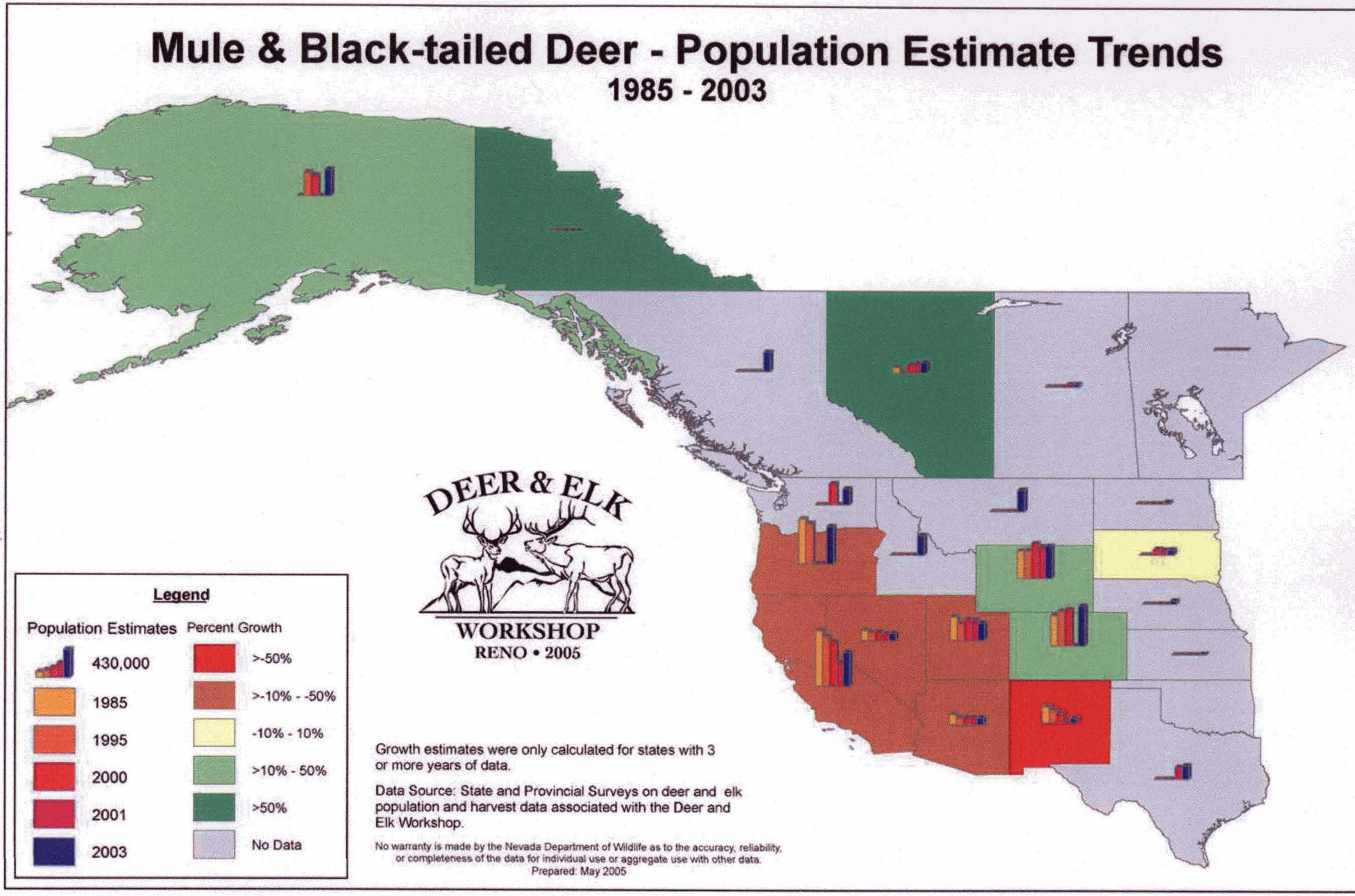

Mule & Black-tailed Deer - Population Estimate Trends
1985 - 2003
DEER & ELK
WORKSHOP
RENO • 2005
Legend
Population Estimates
430,000
1985
1995
2000
2001
2003
Percent Growth
>-50%
>-10% - -50%
-10% - 10%
>10% - 50%
>50%
No Data
Growth estimates were only calculated for states with 3 or more years of data.
Data Source: State and Provincial Surveys on deer and elk population and harvest data associated with the Deer and Elk Workshop.
No warranty is made by the Nevada Department of Wildlife as to the accuracy, reliability, or completeness of the data for individual use or aggregate use with other data.
Prepared: May 2005

FIGURE 2.

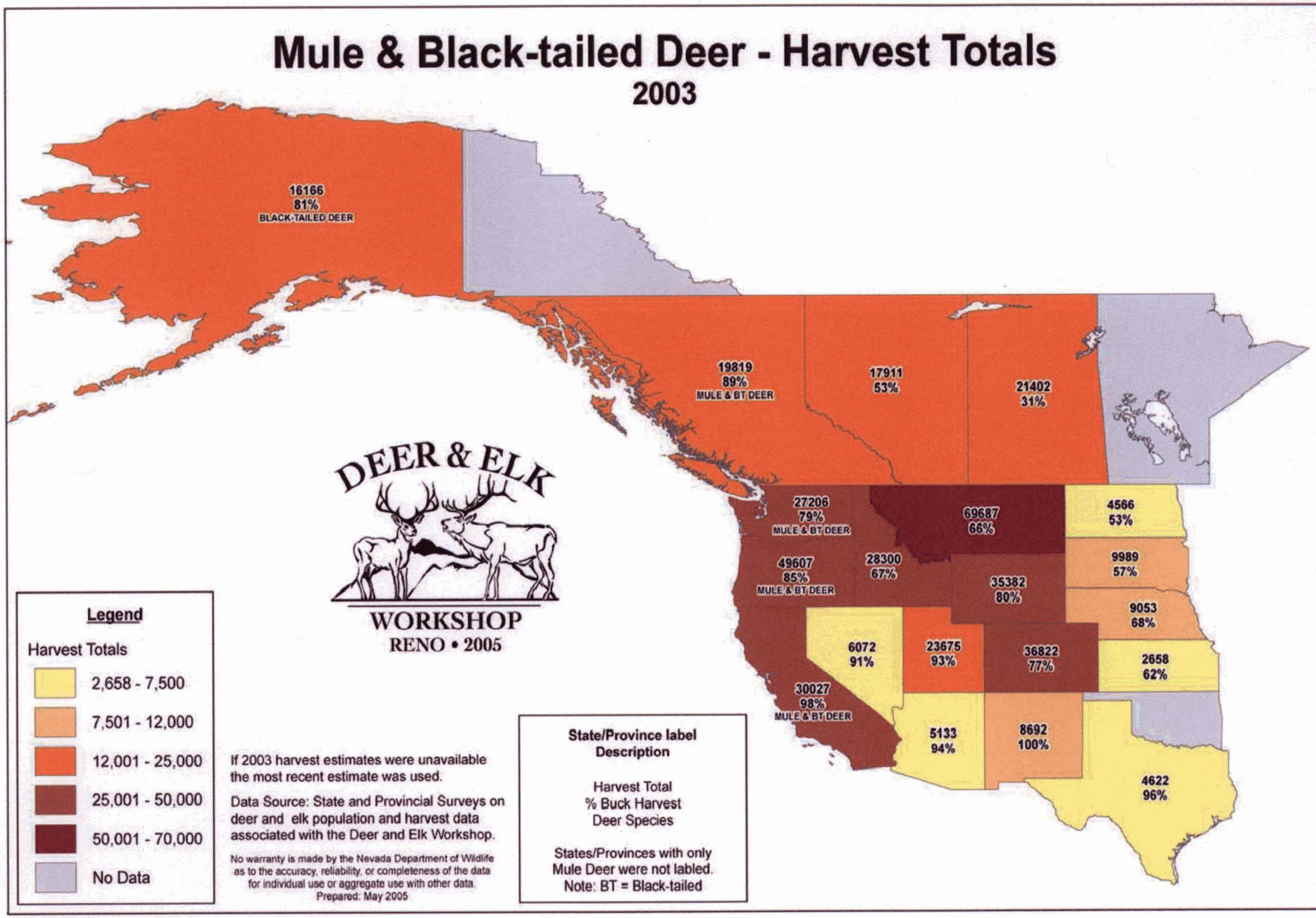

Mule & Black-tailed Deer - Harvest Totals
2003
16166
81%
BLACK-TAILED DEER
19819
89%
MULE & BT DEER
17911
53%
21402
31%
27206
79%
MULE & BT DEER
69687
66%
4566
53%
49607
85%
MULE & BT DEER
28300
67%
35382
80%
9989
57%
9053
68%
6072
91%
23675
93%
36822
77%
2658
62%
30027
98%
MULE & BT DEER
5133
94%
8692
100%
4622
96%
DEER & ELK
WORKSHOP
RENO • 2005
Legend
Harvest Totals
2,658 - 7,500
7,501 - 12,000
12,001 - 25,000
25,001 - 50,000
50,001 - 70,000
No Data
If 2003 harvest estimates were unavailable the most recent estimate was used.
Data Source: State and Provincial Surveys on deer and elk population and harvest data associated with the Deer and Elk Workshop.
No warranty is made by the Nevada Department of Wildlife as to the accuracy, reliability, or completeness of the data for individual use or aggregate use with other data.
Prepared: May 2005
State/Province label Description
Harvest Total
% Buck Harvest
Deer Species
States/Provinces with only Mule Deer were not labled.
Note: BT = Black-tailed

FIGURE 3.

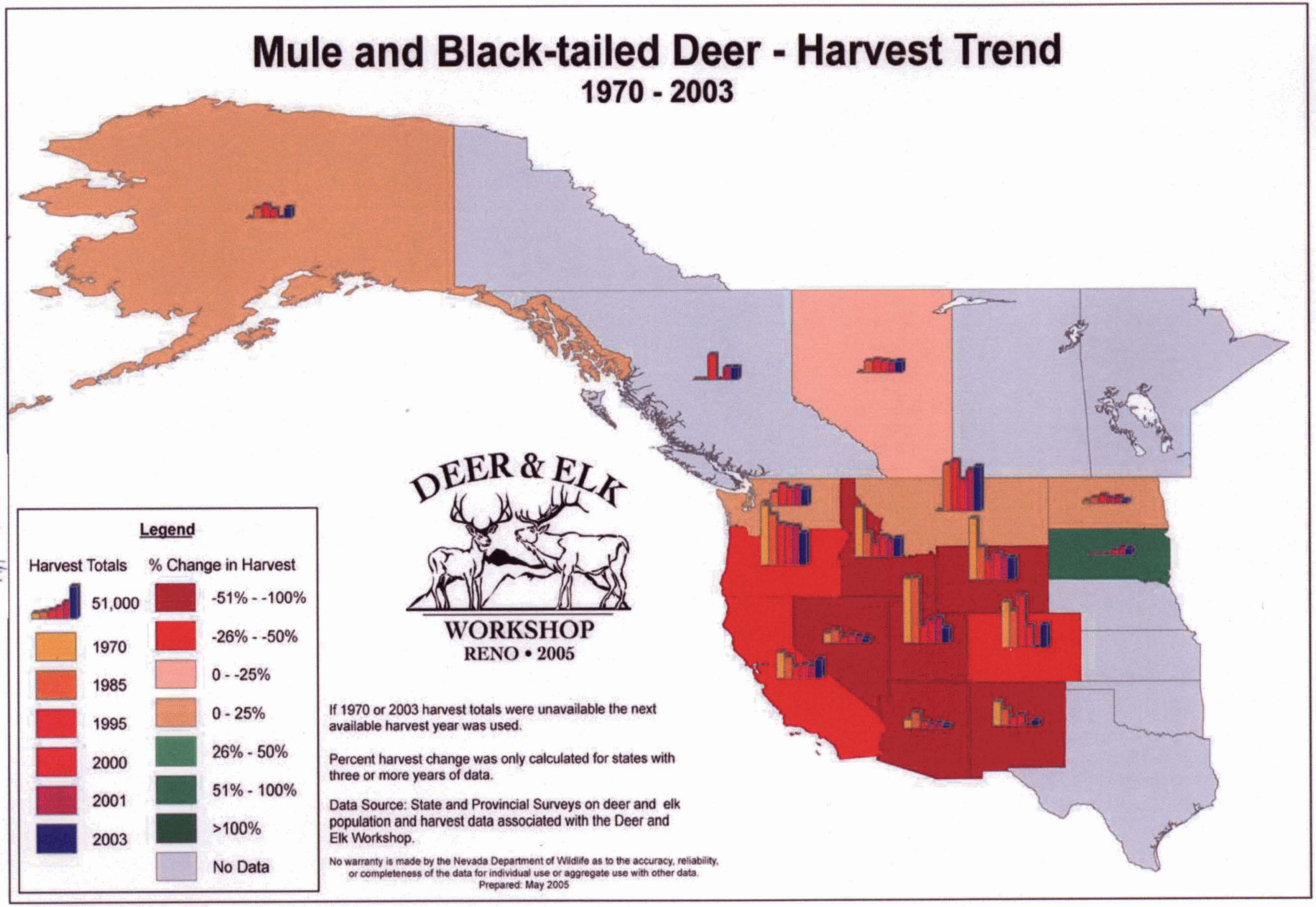

Mule and Black-tailed Deer - Harvest Trend
1970 - 2003
DEER & ELK
WORKSHOP
RENO • 2005
Legend
Harvest Totals
% Change in Harvest
51,000
1970
1985
1995
2000
2001
2003
-51% - -100%
-26% - -50%
0 - -25%
0 - 25%
26% - 50%
51% - 100%
>100%
No Data
If 1970 or 2003 harvest totals were unavailable the next available harvest year was used.
Percent harvest change was only calculated for states with three or more years of data.
Data Source: State and Provincial Surveys on deer and elk population and harvest data associated with the Deer and Elk Workshop.
No warranty is made by the Nevada Department of Wildlife as to the accuracy, reliability, or completeness of the data for individual use or aggregate use with other data.
Prepared: May 2005

FIGURE 4.

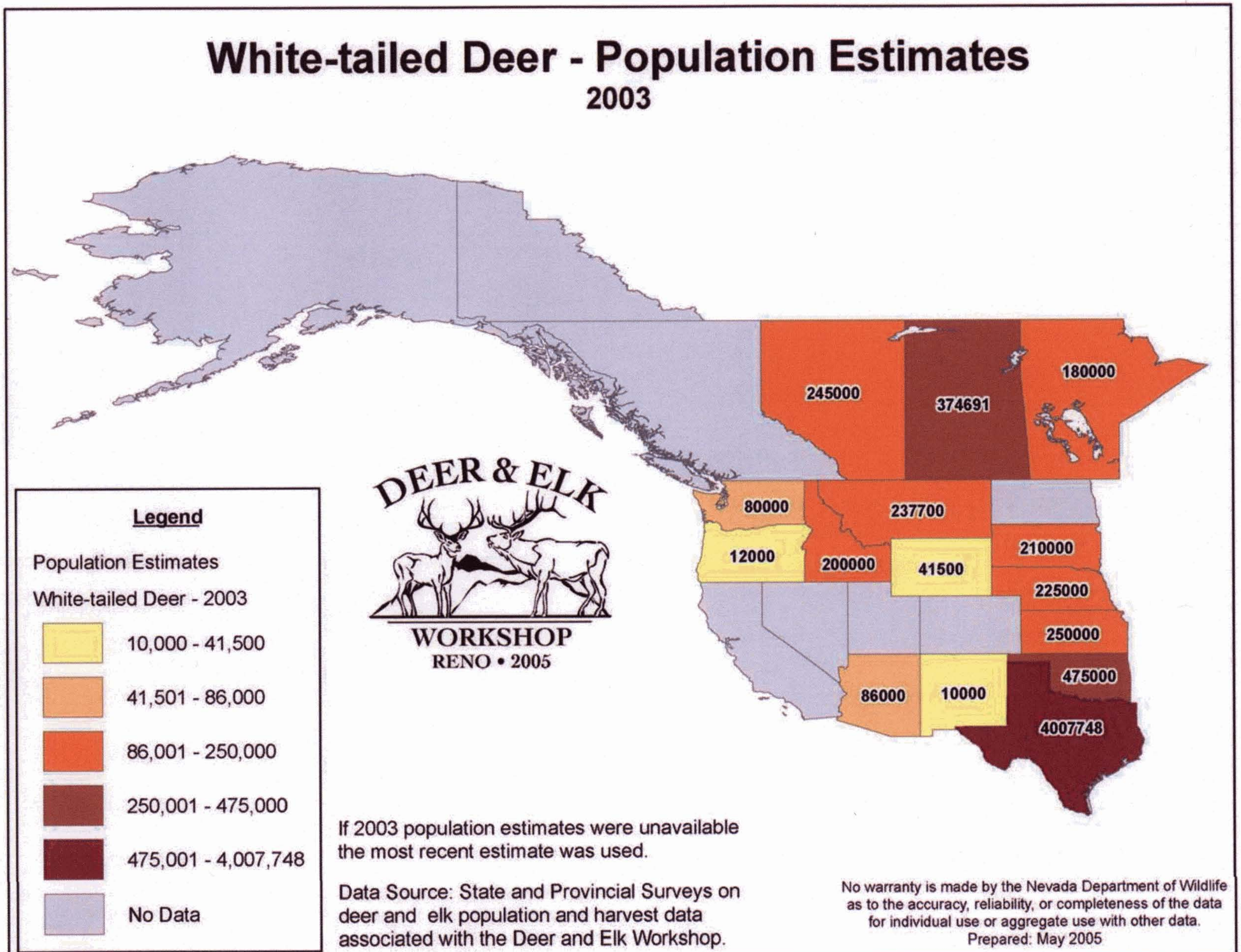
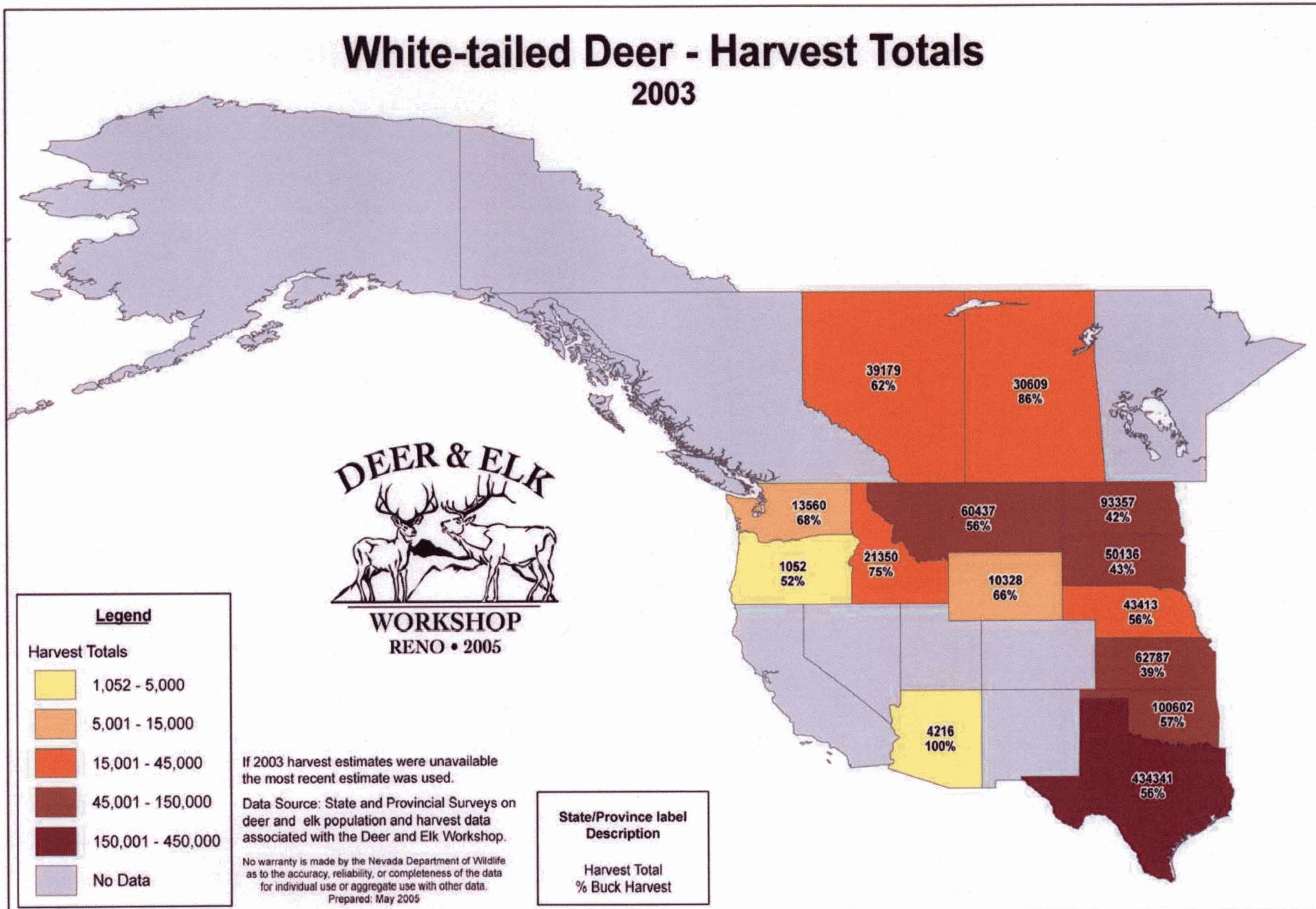

White-tailed Deer - Population Estimates
2003
245000
374691
180000
80000
237700
12000
200000
41500
210000
225000
250000
475000
86000
10000
4007748
DEER & ELK
WORKSHOP
RENO • 2005
Legend
Population Estimates
White-tailed Deer - 2003
10,000 - 41,500
41,501 - 86,000
86,001 - 250,000
250,001 - 475,000
475,001 - 4,007,748
No Data
If 2003 population estimates were unavailable the most recent estimate was used.
Data Source: State and Provincial Surveys on deer and elk population and harvest data associated with the Deer and Elk Workshop.
No warranty is made by the Nevada Department of Wildlife as to the accuracy, reliability, or completeness of the data for individual use or aggregate use with other data.
Prepared: May 2005

FIGURE 5.



White-tailed Deer - Harvest Totals
2003
DEER & ELK
WORKSHOP
RENO • 2005
39179
62%
30609
86%
13560
68%
60437
56%
93357
42%
1052
52%
21350
75%
10328
66%
50136
43%
43413
56%
62787
39%
100602
57%
4216
100%
434341
56%
Legend
Harvest Totals
1,052 - 5,000
5,001 - 15,000
15,001 - 45,000
45,001 - 150,000
150,001 - 450,000
No Data
If 2003 harvest estimates were unavailable the most recent estimate was used.
Data Source: State and Provincial Surveys on deer and elk population and harvest data associated with the Deer and Elk Workshop.
No warranty is made by the Nevada Department of Wildlife as to the accuracy, reliability, or completeness of the data for individual use or aggregate use with other data.
Prepared: May 2005
State/Province label Description
Harvest Total
% Buck Harvest

FIGURE 6.

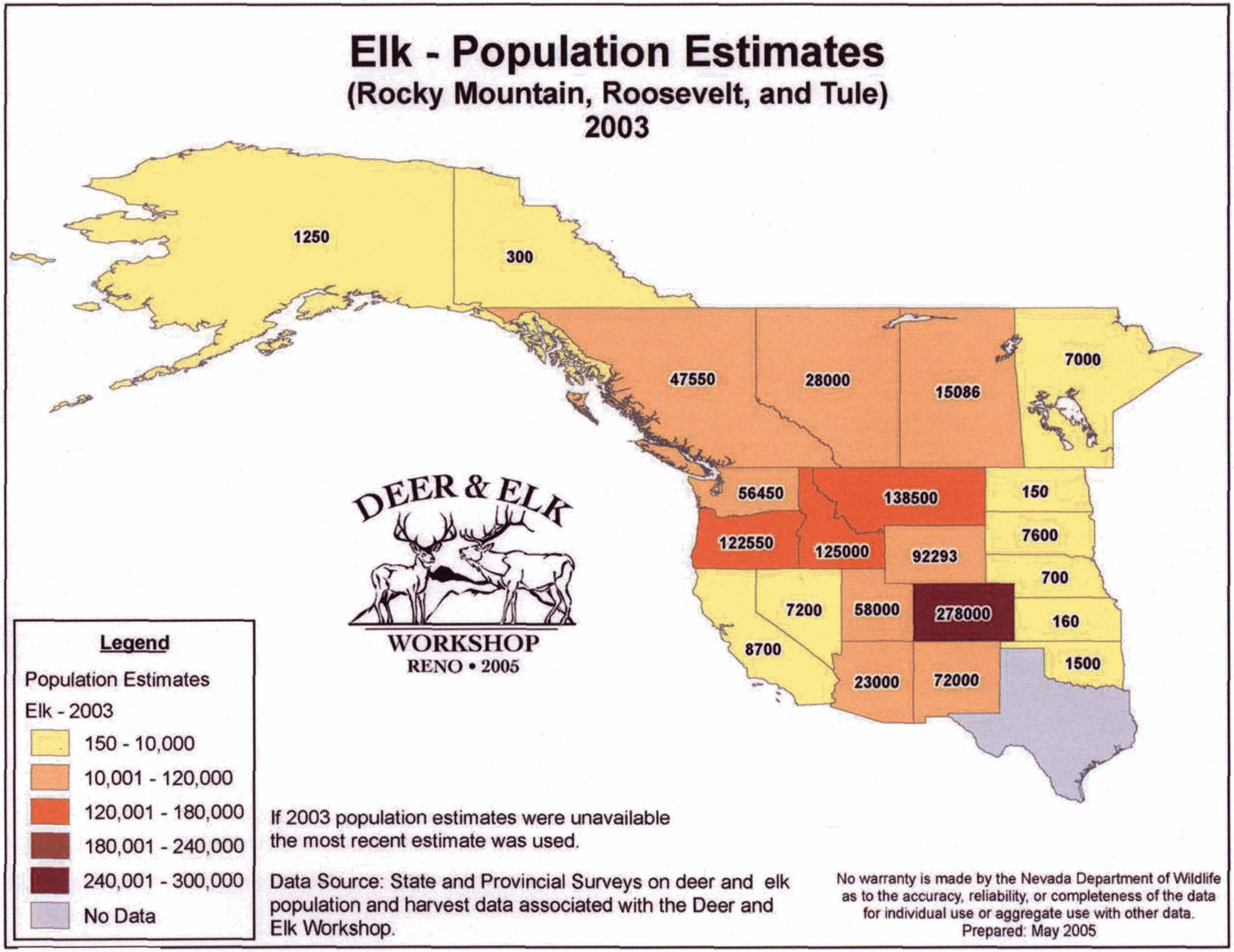

Elk - Population Estimates
(Rocky Mountain, Roosevelt, and Tule)
2003
1250
300
47550
28000
15086
7000
56450
138500
150
122550
125000
92293
7600
700
7200
58000
278000
160
8700
1500
23000
72000
DEER & ELK
WORKSHOP
RENO • 2005
Legend
Population Estimates
Elk - 2003
150 - 10,000
10,001 - 120,000
120,001 - 180,000
180,001 - 240,000
240,001 - 300,000
No Data
If 2003 population estimates were unavailable the most recent estimate was used.
Data Source: State and Provincial Surveys on deer and elk population and harvest data associated with the Deer and Elk Workshop.
No warranty is made by the Nevada Department of Wildlife as to the accuracy, reliability, or completeness of the data for individual use or aggregate use with other data.
Prepared: May 2005

FIGURE 7.

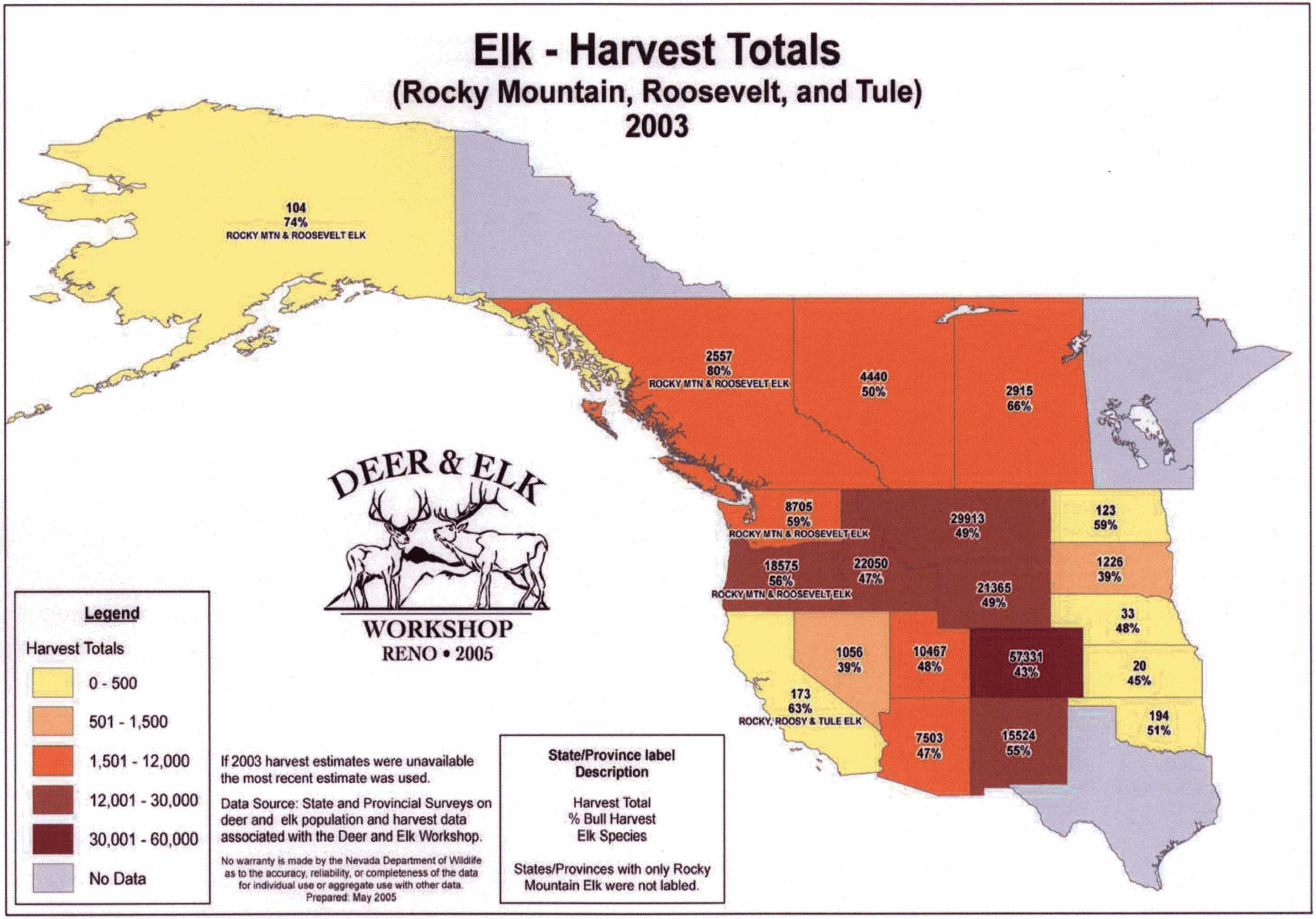

Elk - Harvest Totals
(Rocky Mountain, Roosevelt, and Tule)
2003
104
74%
ROCKY MTN & ROOSEVELT ELK
2557
80%
ROCKY MTN & ROOSEVELT ELK
4440
50%
2915
66%
8705
59%
ROCKY MTN & ROOSEVELT ELK
29913
49%
123
59%
18575
56%
ROCKY MTN & ROOSEVELT ELK
22050
47%
21365
49%
1226
39%
33
48%
1056
39%
10467
48%
57331
43%
20
45%
173
63%
ROCKY, ROOSY & TULE ELK
7503
47%
15524
55%
194
51%
DEER & ELK
WORKSHOP
RENO • 2005
Legend
Harvest Totals
0 - 500
501 - 1,500
1,501 - 12,000
12,001 - 30,000
30,001 - 60,000
No Data
If 2003 harvest estimates were unavailable the most recent estimate was used.
Data Source: State and Provincial Surveys on deer and elk population and harvest data associated with the Deer and Elk Workshop.
No warranty is made by the Nevada Department of Wildlife as to the accuracy, reliability, or completeness of the data for individual use or aggregate use with other data.
Prepared: May 2005
State/Province label Description
Harvest Total
% Bull Harvest
Elk Species
States/Provinces with only Rocky Mountain Elk were not labled.

FIGURE 8.

PAST DEER AND ELK WORSHOPS

MULE DEER

1970 Bianca, Colorado
Mule Deer Workshop

1972 Elko, Nevada, January 11-12
Mule Deer Workshop

1974 Laramie, Wyoming, Jan 22-23
Mule Deer Workshop

1975 Silver City, New Mexico, February 18-20
Mule Deer Workshop

1976 Boise, Idaho, February 19-21
Mule Deer Workshop

1976 Logan, Utah, April
Mule Deer Decline in the West Symposium

1978 Logan, Utah, February 21-23
Mule Deer Workshop

1980 Bend, Oregon, March 5-6
Mule Deer Workshop

1983 Spokane, Washington, April 11-12
Western Deer Workshop

1985 Bozeman, Montana, March 3-6
Western Deer Workshop

1987 Pingree Park, Colorado, August 4-7
Western Deer Workshop

1989 Albuquerque, New Mexico, August 23-25
Western Deer Workshop

1991 Monterey, California, August 27-30
Western Deer Workshop

1993 Vancouver, British Columbia, August 10-13
Western States and Provinces Deer Workshop

ELK

1977 Estes Park, Jan 31 - Feb 2
Western States Elk Workshop

1980 Cranbrook, British Columbia, Feb 27-28
Western States Elk Workshop

1982 Flagstaff, Arizona, February 22-24
Western States Elk Workshop

1984 Edmonton, Alberta, April 17-19
Western States and Provinces Elk Workshop

1986 Coos Bay, Oregon, March 17-19
Western States and Provinces Elk Workshop

1988 Wenatchee, Washington, July 13-15
Western States and Provinces Elk Workshop

1990 Eureka, California, May 15-17
Western States and Provinces Elk Workshop

1993 Bozeman, Montana, May 19-21
Western States and Provinces Elk Workshop

Western States and Provinces Deer and Elk Workshops

1995 Sun Valley, Idaho, May 23-25

1997 Rio Rico, Arizona, May 21-23

1999 Salt Lake City, Utah, March 3-5

2001 Wilsonville, Oregon, August 1-4

2003 Jackon Hole, Wyoming, May 21-23

2005 Reno, Nevada, May 16-18
Ungulate Data Gathering, Analysis and Use Workshop, May 19

Recipient and Nomination History for the O.C. "Charlie" Wallmo Award

Year	Award Recipient	Other Nominees
1987	Richard D. Taber	Kenneth L. Hamlin, William Longhurst, Fred Bunnell, Les Robinette, R. Bruce Gill, Richard M. Bartmann
1989	Richard Mackie	John Schoen, Richard M. Bartmann, Fred Bunnell, William Longhurst, Les Robinette
1991	Les Robinette	Richard M. Bartmann, Phillip Urness, Ian McTaggart-Cowan, John Schoen, Samuel Beasom, Fred Bunnell, William Longhurst, Dale McCullough
1993	Ian McTaggart-Cowan	Phillip Urness, David R. Klein, Richard M. Bartmann
1995	Phillip Urness	David R. Klein
1997	Fred Bunnell	Paul R. Krausman, David R. Klein
1999	Paul R. Krausman	William Longhurst, Richard M. Bartmann.
2001	John Kie	Richard M. Bartmann, Matthew Kirchoff, Ken Gray, William Longhurst.
2003	William Longhurst	Richard M. Bartmann, Len Carpenter, Dale McCullough, David Pac
2005	Richard M. Bartmann	Len Carpenter, Dale McCullough, David Pac, Elizabeth Williams