WEST VIRGINIA ELK MANAGEMENT PLAN

FY2016-FY2020

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INTRODUCTION

Eastern Elk (*Cervus elaphus canadensis*) were once common inhabitants of the eastern United States prior to European settlement. Elk roamed throughout what is now West Virginia, especially in the high mountain regions of the state. Historical records indicate elk were extirpated from West Virginia around 1875, and until recently free roaming elk have not been present in West Virginia. For the past several decades, elk have received protected status in the state. The West Virginia Natural Resources Law (§20-1-2) defines elk as a "big game" animal; however, there is currently no hunting season in West Virginia for this species.

In an effort to evaluate the feasibility of restoring elk to the state, the West Virginia Department of Natural Resources (now known as the West Virginia Division of Natural Resources) developed its first elk reintroduction feasibility study in 1972. More recently, the West Virginia Division of Natural Resources (WVDNR), in cooperation with the Rocky Mountain Foundation, conducted research in 2005 relating to the biological assessment of potential habitat and the social feasibility of restoring elk to the landscape in West Virginia.

The successful reintroduction of elk in Kentucky and the subsequent immigration of elk into West Virginia elevated the need to develop an effective, science-based elk management plan for West Virginia with the initial plan being drafted in 2011 and providing management direction during the period from 2011 to 2015. The purpose of this plan revision (FY2016-FY2020) is to provide guidance and direction to the WVDNR as elk pioneer unoccupied habitat in West Virginia and as the WVDNR embarks upon an active elk management program. The timeline associated with the development and implementation of the management strategies as outlined in this plan will be determined by the rate of population expansion and growth in the future, as well as the availability of elk for an active elk restoration effort in West Virginia. This plan will utilize an adaptive management approach and amendments to this document will be made as needed.

During the 2015 session of the West Virginia Legislative, enabling elk legislation was passed and went in effect on June 12, 2015 which tasked the WVDNR with the development of an active elk restoration program and the ability to promulgate rules to achieve the program objectives.

HISTORICAL OVERVIEW OF ELK IN WEST VIRGINIA

Historically, elk were common throughout most of the contiguous 48 states, including all of West Virginia. Large numbers were found in the Ohio and Kanawha river valleys and the higher mountain regions. Elk provided an important source for food, shelter and clothing for American Indians and early settlers. Evidence of their distribution throughout the state is illustrated by the widespread use of elk in place names. However, it should also be noted that early explorers often used the word "elk" to describe white-tailed deer (*Odocoileus virginianus*).

Elk population densities declined in West Virginia throughout the 1800s, as the state became home to European settlers. Subsistence hunting, market hunting and wide scale timbering all contributed to the decline of the elk population in West Virginia and the eastern United States. By the late 1800s, elk were completely eliminated from West Virginia, with the last native elk records being reported from the headwaters of the Cheat River in Pocahontas County in 1873 and the Webster Springs area of Webster County in 1875.

It is reported that in 1913, fifty (50) elk *(Cervus elaphus nelsonii)* were obtained from the Yellowstone National Park and transferred into an enclosure maintained by the Allegheny Sportsmen's Association at Minnehaha Springs in Pocahontas County. These animals were subsequently released into the wild, but this stocking proved to be unsuccessful in reestablishing elk into the state.

ELK BIOLOGY and LIFE HISTORY

Elk are gregarious, herding animals that feed primarily on grasses, forbs and other herbaceous matter during the spring, summer and fall seasons. During winter, elk feed on grasses when available but also utilize shrubs, twigs, tree bark and hard mast to meet their nutritional needs. Elk are primarily grazers and do not normally compete for food with white-tailed deer under ideal habitat conditions. However, the lack of quality grazing areas may intensify competition between elk and white-tailed deer for hard mast, browse and forage.

Male elk are called "bulls." Adult bulls stand 5 feet at the shoulder, are approximately 8 feet long and weigh around 700 pounds. Bulls have large antlers that can be five feet long, five feet across and have up to six or more points on a side, with yearling bulls typically having spikes. Female elk are called "cows." Adult cows stand 4 feet at the shoulder, are approximately 7 feet long and weigh around 500 pounds. Male elk typically reach sexual maturity between 3 and 4 years of age. Pelage varies from a deep copper to a light tan color. The rump patch is light beige, with the legs and neck being darker than the body. The rut, or mating season, takes place in late September and early October. Ovulation in females may begin as early as 1 ½ years of age with most cows breeding during their third year. Females give birth in late spring to a single calf (twins are rare), chestnut in color with cream colored spots and weighing about 35 pounds.

Predation on calves can be a limiting factor in the growth and expansion of elk populations in the eastern United States, as experienced in the restoration area within the Great Smoky Mountains National Park in North Carolina. A significant portion of the West Virginia Elk Management Area has a substantial black bear population, which may negatively impact future elk population growth if the bear population is maintained at present levels. The recently established elk population in bordering Kentucky has experienced high cow breeding and calf survival success rates.

Elk restored to the eastern United States have not displayed the migratory behavior that is common in the western states. As a result, elk home range sizes are significantly smaller in the eastern states. Elk in Kentucky have exhibited a preference for remaining close to their release sites and the associated reclaimed mined areas. Habitat quality in West Virginia is comparable to that found in Kentucky, and it is believed elk will respond similarly. Based upon this observation and the fact that female offspring often disperse and occupy adjacent and/or overlapping home ranges with their paternal parents, it is anticipated that a passive elk restoration approach will be a long term effort. To accelerate the establishment of a viable elk population in West Virginia, an elk translocation approach is proposed to be initiated during this planning period.

OVERVIEW OF 1972 ELK REINTRODUCTION FEASIBILITY REPORT

The feasibility of reintroducing elk into West Virginia was first studied in 1972. Previous elk restoration efforts in Virginia and Pennsylvania were reviewed and considered for applicability to conditions in West Virginia. The report presented conditions as they existed in the 1970s, evaluated the various limiting factors associated with elk reintroduction and subsequently determined the feasibility of elk reintroduction in West Virginia. The study concluded that before any effort is undertaken to reintroduce elk into West Virginia, several important factors should be considered:

- Availability of adequate habitat and range.
- Competition with other wildlife species.
- Potential for crop damage conflicts.
- Strong inherited migratory habit.
- Transmission and monitoring of parasites and disease.

The 1972 feasibility report concluded that many limiting factors (e.g., inadequate range, crop damage, competition with deer, brain worms, etc.) would negate the feasibility of reintroducing elk into West Virginia at that time. The report also concluded it would be unlikely that elk could be maintained in sufficient numbers to afford hunting and that the only logical criteria for supporting elk reintroduction would be aesthetics (i.e., to help preserve a beautiful and magnificent animal that once existed as part of West Virginia's natural fauna).

OVERVIEW OF 2005 BIOLOGICAL ASSESSMENT OF POTENTIAL HABITAT FOR ELK IN WEST VIRGINIA

Restoration efforts in Arkansas, Kentucky, Michigan, Missouri, Oklahoma, Pennsylvania, Tennessee, Virginia and Wisconsin have shown that elk can be restored to landscapes heavily impacted by human activity. In 2005, the WVDNR, Wildlife Resources Section contracted with the State University of New York, College of Environmental Science and Forestry to evaluate elk habitat suitability in West Virginia. Funding for the feasibility study was provided by the Rocky Mountain Elk Foundation,

and a report entitled “Biological Assessment of Potential Habitat for Elk in West Virginia” (Appendix A) was prepared. The report concluded there are three large core regions in West Virginia with the most potential for elk restoration (Figure 1). These areas are identified as: 1) Monongahela region in the eastern mountains of the state; 2) Ohio Hills region in west central West Virginia; and 3) Southern Coal Fields region that borders Kentucky. These regions were selected as having the highest potential based upon: 1) lower human densities; 2) limited road systems; 3) vicinity to existing populations; 4) lower amount of acreage in agricultural crops; and 5) habitat suitability based upon West Virginia GAP land cover analysis. The lack of open areas was identified as the primary limiting habitat factor in elk restoration.

The Ohio Hills region comprised the smallest area (4,049 sq. km.) of the three regions, but exhibited the highest percentage of high quality elk habitat. However, this region also had the highest road density compared to the other regions.

The Monongahela region is the largest region (13,957 sq. km.) and exhibits higher habitat quality when compared to the Southern Coal Fields region. However, conflict between elk and agricultural producers is a significant concern in this region due to the higher percentage of agricultural lands in this portion of the state.

The Southern Coal Fields region is the second largest region (4,633 sq. km.) but exhibits lower habitat quality due to the heavy forested area and poorer habitat diversity. Counties within the Southern Coal Fields region are heavily forested and subsequently open grassland habitat is the limiting cover type. However, mountaintop coal mining has converted large forested areas of steep, rugged terrain into plateaus of gently sloping low quality grasslands and adjacent forest fragments. The final report also concluded the close proximity of Kentucky’s elk restoration area made the Southern Coal Fields region a viable consideration for a passive elk restoration approach. Linking restoration areas in multiple states would recognize the mobile nature of elk and aid in natural population processes.

OVERVIEW OF 2005 SOCIAL FEASIBLITY OF RESTORING ELK TO WEST VIRGNIA

In 2005, the WVDNR, Wildlife Resources Section contracted with Cornell University, Department of Natural Resources to evaluate the social feasibility, cost and benefits associated with restoring elk in selected regions of West Virginia. For the purpose of the sociological assessment, only the Monongahela and Southern Coal Fields regions were evaluated. This social feasibility study was funded by the Rocky Mountain Elk Foundation and although considered a separate study was linked to the biological assessment study. A final report entitled “Social Feasibility of Restoring Elk to West Virginia” (Appendix B) was prepared.

A substantial majority (75%) of residents in the Southern Coal Fields region and 67% of residents in the Monongahela region had a positive attitude regarding the idea

of elk occurring in their respective regions. Most residents wanted to have elk for viewing, hunting or for the aesthetic pleasure of knowing elk are in West Virginia after years of absence. The report also concluded that the presence of elk would also have a positive impact on the public's perception of the agency. In addition, it was noted that local stakeholders in cooperation with WVDNR should be involved in the decision making and "co-management" of the elk resource. A small minority of respondents in the Southern Coal Fields region perceived there would be negative impacts associated with restoring elk to West Virginia. Residents in the Monongahela region had concerns regarding crop damage on farms and risk of collisions with vehicles. It was also identified that since communities in the Southern Coal Fields region had limited infrastructure, they might not have the ability to benefit economically from elk-associated tourism.

The feasibility report also concluded that the potential for human/elk conflicts were of concern to the public with an expanding elk population. Free ranging elk are capable of making long range movements and may appear in unsuitable areas resulting in intolerable levels of property and crop damage. Public information and education efforts will be critical in addressing real and perceived problems resulting from human/elk interactions. The impacts associated with the presence of elk will need to be monitored in order to properly address positive and/or detrimental experiences. The extent of these impacts will aid in determining the social carrying capacity in this region.

ELK RESTORATION EFFORTS AND CURRENT POPULATION STATUS IN SURROUNDING STATES

Pennsylvania has a remnant elk population that has remained stagnant in numbers until recent years. This population is a result of the Pennsylvania Game Commission's reintroduction of 177 Rocky Mountain elk (*Cervus elaphus nelsoni*) between 1913 and 1926. These elk were translocated from Yellowstone National Park, Wyoming to a 10-county area in north-central Pennsylvania (i.e., Blair, Cameron, Carbon, Centre, Clearfield, Clinton, Elk, Forest, Monroe and Potter counties). The Pennsylvania Game Commission opened hunting seasons for elk from 1923 through 1931. Elk were given total protection status after 1931 until recent years. In 1971, the elk population was reported to be around 38 animals and had retreated to the same section where the last native herd was found over 100 years earlier. At that time, it was concluded that Pennsylvania's elk experiment, though partially successful in the past, was doomed to failure. It was determined that the lack of undisturbed range would limit the ability of the species to engage in their usual nomadic wanderings without human harassment and interference. The current Elk Management Area in Pennsylvania, which encompasses 3,750 sq. mi., is located in the north-central portion of the state (i.e., in all or portions of Cameron, Centre, Clearfield, Clinton, Elk, Lycoming, McKean, Potter and Tioga counties) where 74% of the land is publicly owned. During the 5-year period from 2010 to 2014, between 50 and 110 elk licenses were issued annually which resulted in an elk harvest of between 40 and 88 elk. The current population density estimate for the Pennsylvania elk population is around 850-950 animals.

The Kentucky Department of Fish and Wildlife began the first of a series of elk releases into the wild in December 1997, and this reintroduction effort continued through the winter of 2002. Fifteen hundred fifty elk (*Cervus elaphus nelsonii*) were released at 8 different sites in a 16-county restoration zone which includes Bell, Breathitt, Clay, Floyd, Harlan, Johnson, Knott, Knox, Leslie, Letcher, Magoffin, Martin, McCreary, Perry, Pike, Whitley counties (Figure 2). Since these initial releases, elk have thrived in Kentucky. Studies indicate that Kentucky's elk population exhibits a 90% breeding success rate and a 92% calf survival rate. The original population target of 7,400 elk was achieved in 2008, approximately 11 years ahead of schedule. During the 2014-15 hunting season, 1,000 elk tags (as well as 50 dedicated special tags) were issued which resulted in an elk harvest of 469 elk within the elk management zone. Kentucky boasts the largest free ranging wild elk herd east of Montana with population models estimating the herd at over 10,000 animals. The Kentucky Department of Fish and Wildlife has served as the source herd for several elk restoration efforts in the east, including Missouri and Virginia, and is most recently working collaboratively with the Wisconsin Department of Natural Resources with the goal of establishing a free ranging elk herd in that state.

The Virginia Commission of Game and Inland Fisheries (now known as the Virginia Department of Game and Inland Fisheries) translocated between 140 and 150 Rocky Mountain elk from Yellowstone National Park in 1917 to 11 different locations in Virginia. An additional 193 elk were released between 1917 and 1935. Many of these releases occurred in unsuitable habitat and as a result most releases failed. A report prepared by R.K. Wood in 1943 concluded that a general elk restoration program in Virginia and in the eastern United States was not feasible, but that restoration in wilderness areas of 100,000 acres or more might be accomplished successfully. During 1971, a herd of 50 to 75 elk existed at the Peaks of Otter along the Blue Ridge Parkway, but this herd was extirpated years later.

The VDGIF established an elk restoration area (Figure 2) which consists of Buchanan, Dickenson and Wise counties. An elk release site was selected in Buchanan County and elk releases were conducted over a 3-year period during the springs of 2012-2014. A total of 71 elk were released with all animals originating from Kentucky's elk management area. The current population density estimate within the Virginia Elk Management Area is around 100 animals. Virginia currently allows elk to be harvested during any open deer hunting season utilizing weapons which are legal for that specific deer season, except for Buchanan, Dickenson and Wise counties, which are closed to elk hunting.

There are no free ranging wild elk known to exist in either Ohio or Maryland at the present time.

WEST VIRGINIA ELK MANAGEMENT PLAN

Goal: Establish and manage a healthy, free ranging elk population within **a seven-county region of southwestern West Virginia that is compatible with biological and sociological conditions and provides recreational opportunities and other benefits for the citizens of West Virginia.**

Objective A: Establish an Elk Management Area

Strategy 1: Designate an Elk Management Area with defined geographical boundaries based upon previous feasibility studies and a GIS-based evaluation of various biological and sociological parameters including land cover types, public lands, urban areas, highway systems and land ownership patterns (Table 1).

- The Elk Management Area includes seven (7) counties and/or portions thereof located in southern West Virginia. This area encompasses 2,845 square miles and is defined by the following geographical features: a portion of Boone County (south/west of SR 3); a portion of Lincoln County (south of CR 11 to Branchland, west of SR10 to Midkiff, south of CR 48 and CR 7 to Sias, south of CR 46 to Spurlockville, south of CR 62 to junction of SR 3 (Alkol), south of SR 3 to the Boone County border; Logan County; McDowell County; Mingo County; a portion of Wayne County (from Kentucky state line - south of CR 36 to Radnor, east of SR 152 to junction with CR 30, south of CR 30 and SR 37 (East Lynn), south of CR 25 to Nestlow, south of CR 21 to junction of CR 11 at Lincoln County line); Wyoming County (See Figures 3 & 4). Modifications to the boundaries of the Elk Management Area as identified in this section require legislative approval.

- The Elk Management Area is located within the Allegheny Plateau region which is dominated by the central hardwood forests and is characterized by dendritic stream patterns. The area is dominated (85%) by deciduous forests (e.g., cove hardwoods, mixed oak forests, etc.). Open land habitat, which includes agricultural areas and mineral extraction areas (e.g., mountain-top coal removal sites, other types of surface mining, etc.), comprise approximately 15% of the terrain. Public lands (e.g. Wildlife Management Areas and State Forests) comprise 154.2 square miles (5.4%) of the area.

- Propose modification to the Elk Management Area boundaries as needed to meet management goal. These boundaries should be evaluated on a 5 year basis in coordination with county planning commissions and other entities to address potential planned development conflicts.

Objective B: Implement an elk translocation program to compliment the natural movement of elk from the Kentucky and Virginia Elk Management Areas to populate the West Virginia Elk Management Area, and monitor population growth and expansion.

Strategy 1. Evaluate and garner public and legislative support for an active elk restoration effort.

- Two open house public meetings to gauge interest for trans-locating elk to West Virginia were held in Logan and Mingo counties on November 13, 2014 and December 4, 2014 respectively. In addition, a statewide voluntary on-line survey was conducted to reach out to citizens throughout the state which were unable to attend the public meetings. Results indicated overwhelming public support for restoring elk to the southern coal fields region of West Virginia. One thousand one-hundred thirty responses (1,130) from residents of 52 of 55 counties were 93% in favor of proceeding with active elk restoration in West Virginia.

- During the 2015 session of the West Virginia Legislative, enabling elk legislation was passed and went in effect on June 12, 2015 which tasked the WVDNR with the development of an elk restoration program and provided the agency with the ability to promulgate rules to achieve program objectives.

Strategy 2. Develop and implement an Elk Restoration Operational Plan which provides methodology and guidance associated with an elk translocation restoration approach (see Appendix C).

- Initiate communications with state fish and wildlife agencies to identify potential sources of free-ranging elk. Communications have been made with the Kentucky Department of Fish and Wildlife as well as the Virginia Department of Game and Inland Fisheries.

- Identify elk restoration focal areas based on GIS habitat and land ownership based analysis. Five focal areas have been identified as potential restoration areas (see Figure 5). These

regions will be targeted for enhanced public access (e.g., lease arrangement, fee and public access easement acquisition).

Strategy 3. Monitor elk population growth and range expansion and investigate the potential for developing population indices that accurately reflect herd status.

- During the plan period, WVDNR staff will record elk sightings, damage complaints, road kills, etc. from the public utilizing the West Virginia Elk Sighting Form (Table 2). Ground searching surveys by Wildlife Resources Section staff will also be conducted as needed.

- A link on the WVDNR's website will be available for the public to report elk sightings and/or nuisance elk problems.

- WVDNR will coordinate with the West Virginia Division of Highways to develop a notification system for reporting road killed elk.

- Elk sighting/bugling survey question will be incorporated into the West Virginia Bowhunter's Survey questionnaire.

- Population sampling techniques will be developed and implemented within the Elk Management Area to evaluate population distribution.

- Wildlife Resources Section and Law Enforcement Section personnel will coordinate with conservation organizations, state governmental agencies (e.g. West Virginia Department of Environmental Protection) and mineral extraction companies within the Elk Management Area to assist with monitoring efforts.

Strategy 4: Continue to retain a "protected status" on elk within the Elk Management Area until the population reaches a level that will support a limited permit hunting season.

Strategy 5: Initiate educational programs to address the following issues: elk herd establishment, population monitoring, elk viewing, research, and management and damage activities.

Strategy 6: Collaborate with surrounding state fish and wildlife agencies relating to elk research, management and monitoring protocol.

Strategy 7: Promulgate legislative rules or legislation to assure that an elk population does not become established outside of the Elk Management Area.

- Potential strategies include allowing properly licensed deer hunters to harvest either sex elk during the traditional deer archery, deer muzzleloader and deer firearms seasons in all regions of the state outside the Elk Management Area, or to issue an out-of-zone elk permit.

- Depredation permits will be issued when necessary to address elk crop damage problems.

Objective C: Manage a self-sustaining elk population within the Elk Management Area at biological and sociological levels which provides recreational opportunities (e.g. elk hunting and viewing) and other benefits for the state's citizens.

Strategy 1: The Elk Management Area's long-range elk population objective will be one (1) elk per square mile of elk range. This population objective will be re-evaluated every five years.

Strategy 2: Develop an elk harvest management strategy that will be used to set appropriate hunting regulations.

Strategy 3: Identify clearly defined parameters for use in establishing an elk harvest strategy.

Strategy 4: Coordinate efforts with the Law Enforcement Section to develop and implement appropriate natural resources laws and legislative rules.

- A new legislative rule (§58-74-1) entitled "Elk Restoration and Management Rule" which establishes guidelines and protocols relating to the WVDNR's elk management program has been submitted to the Legislature and will be taken up during the 2016 Legislative Session.

- Modify Legislative Rule Title 58, Series 45 (Hunting and Trapping Rules) to include an elk hunting season, daily bag limit and season limit when an elk season is approved by the Natural Resources Commission.

- Modify Legislative Rule Title 58, Series 50 (Deer Hunting Rules) to address caliber restrictions for elk, etc. or promulgate a new legislative rule to address all regulatory issues relating to the elk

hunting season. Language should include that it is illegal to bait and supplementally feed elk.

- Promulgate legislative rules that would allow for a non-refundable application fee to be collected by the WVDNR when applying for limited elk hunting permits. Also, explore the feasibility of a preference point draw system.

- Propose legislation to modify existing natural resources laws (Chapter 20-2-22: Tagging, removing, transporting and reporting deer and wild turkey) to include elk.

- Review, modify and/or propose other legislative rules and natural resources law (Chapter 20) relating to elk hunting regulations as deemed appropriate.

Strategy 5: Purchase (i.e., fee acquisition or public access conservation easements), lease, or secure management of additional elk habitat within the Elk Management Area in areas where there is limited public access.

Strategy 6: Develop programs designed to gain public access to private lands for elk hunting and elk viewing opportunities, which might otherwise be leased or restricted resulting in the privatization of the elk resource.

Strategy 7: Monitor elk harvest and recreational use and gather biological data required to make sound management decisions.

Strategy 8: Develop programs to promote the recreational opportunities associated with the state's elk population such as elk hunting and elk viewing opportunities.

Strategy 9: Work closely with large landholders (e.g., coal and timber companies) to promote habitat enhancement projects for elk, without increasing privatization of the elk resource within the Elk Management Area.

Strategy 10: Provide technical assistance to private landholders, conservation organizations and public entities interested in managing elk habitat and populations.

Strategy 11: Improve habitat conditions (e.g., develop herbaceous openings, etc.) for elk on the Wildlife Management Areas located within the Elk Management Area.

Strategy 12: Coordinate with Rocky Mountain Elk Foundation (RMEF) and other conservation partners on habitat enhancement projects within the Elk Management Area.

- RMEF to-date has contributed $97,500 toward habitat improvement projects and seed money for implementation of an elk restoration program in West Virginia.

Objective D: Minimize elk/human conflicts to sociological acceptable levels.

Strategy 1: Monitor crop and personal property damage complaints and provide technical assistance to private landowners relating to elk damage.

Strategy 2: Promulgate legislative rules pertaining to wildlife crop damage and implement recommendations accordingly.

Strategy 3: Wildlife Resources Section and Law Enforcement Section personnel will work with landowners to effectively address nuisance elk/human conflicts.

Strategy 4: Initiate educational programs to address elk/human conflicts (e.g. property damage, crop damage, etc.).

Strategy 5: Conduct human dimensions surveys with landowners and other residents within the Elk Management Area to evaluate public opinions relating to elk population levels and human/elk conflicts.

Strategy 6: Develop a survey protocol to measure elk browsing impacts on forest regeneration and plant communities.

Strategy 7: Allow for management of elk densities on sub-portions of the designated Elk Management Area.

Objective E: Promote public awareness of the elk resource.

Strategy 1: Develop educational programs and literature relating to the elk restoration program and elk ecology directed toward civic groups, landowners, governmental entities, businesses, schools and conservation organizations.

Strategy 2: Disseminate appropriate information relating to elk management through television and radio programs, magazines, newspapers and the WVDNR's website.

Strategy 3: Conduct public, open house meetings within WVDNR Districts IV and V to explain West Virginia's Elk Management Plan.

Strategy 4: Provide technical assistance to WVDNR - Parks Section in attracting elk and promoting public viewing of elk on State Parks in the designated Elk Management Area.

Objective F: Evaluate and monitor health conditions of the elk population.

[Note: Elk within the eastern United States have been surveyed for various pathogens; however, population health information is not extensive in this region of the country. Chronic wasting disease, bovine brucellosis, and bovine tuberculosis are high profile infectious diseases that have been recognized in captive and/or wild elk populations. Fortunately, these diseases have not been detected in free-ranging elk in the eastern United States].

Strategy 1: Develop standardized monitoring protocols to collect appropriate biological samples for disease and herd health testing from hunter harvested and non-seasonal elk mortalities.

Strategy 2: Monitor the health of the elk population working in close cooperation with the Southeastern Cooperative Wildlife Disease Study and other governmental entities.

Strategy 3: Continue to work collaboratively with other state fish and wildlife agencies regarding disease monitoring protocols and dissemination of disease testing results.

Strategy 4: Protect the health and genetic integrity of pioneering wild elk from illegally translocated elk on private lands. Lethal removal of all suspect and known translocated elk or red deer from the designated Elk Management Area will be carried out to protect the health and genetic integrity of the pioneering wild elk.

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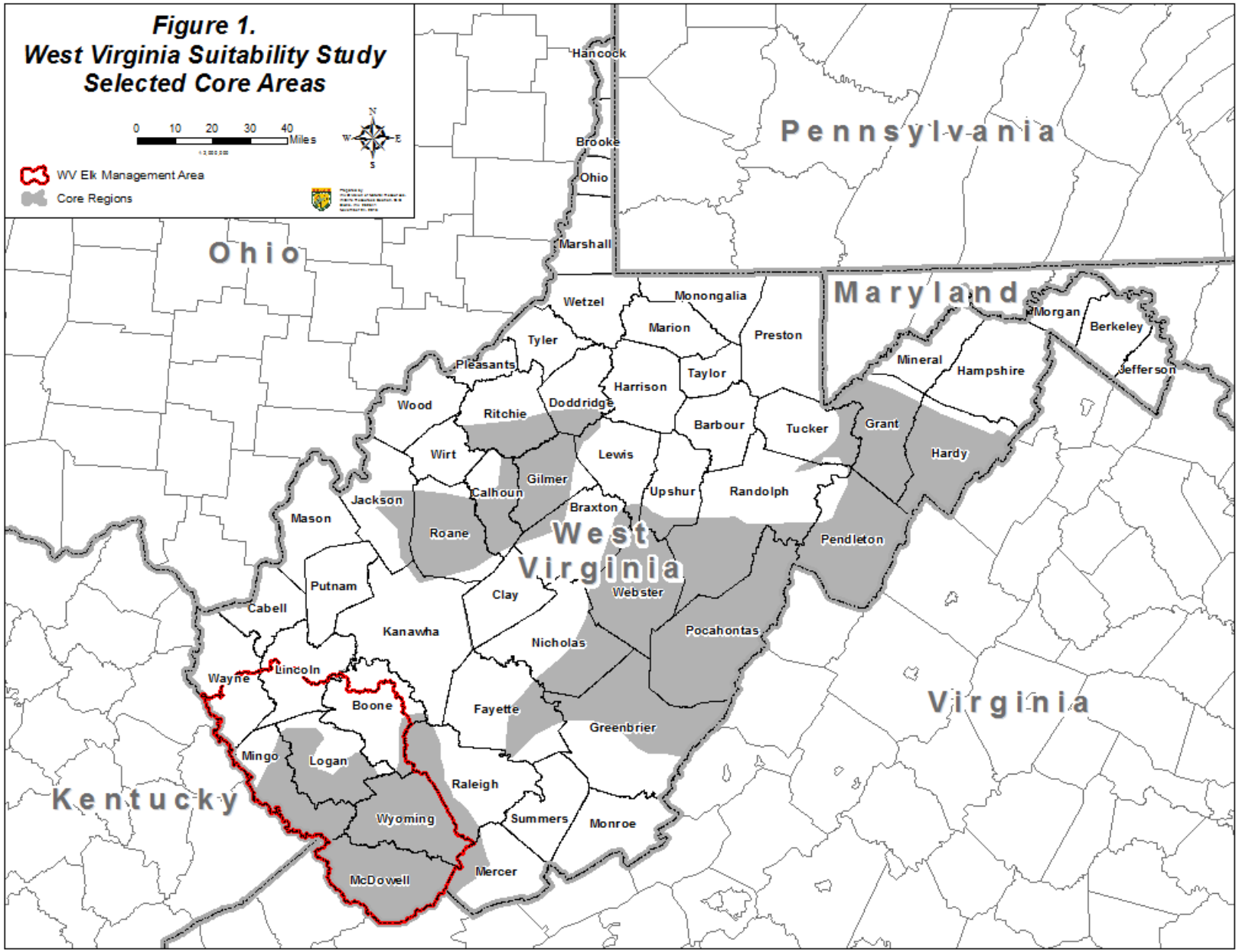


Figure 1.
West Virginia Suitability Study
Selected Core Areas
0 10 20 30 40 Miles
N
W E
S
WV Elk Management Area
Core Regions
Pennsylvania
Ohio
Maryland
Virginia
Kentucky
West Virginia
Hancock
Brooke
Ohio
Marshall
Wetzel
Monongalia
Marion
Preston
Tyler
Pleasants
Taylor
Harrison
Doddridge
Wood
Ritchie
Barbour
Tucker
Wirt
Lewis
Gilmer
Calhoun
Upshur
Randolph
Jackson
Braxton
Mason
Roane
Putnam
Clay
Webster
Cabell
Kanawha
Nicholas
Pocahontas
Wayne
Lincoln
Boone
Fayette
Greenbrier
Mingo
Logan
Raleigh
Wyoming
Summers
Monroe
McDowell
Mercer
Morgan
Berkeley
Mineral
Hampshire
Jefferson
Grant
Hardy
Pendleton

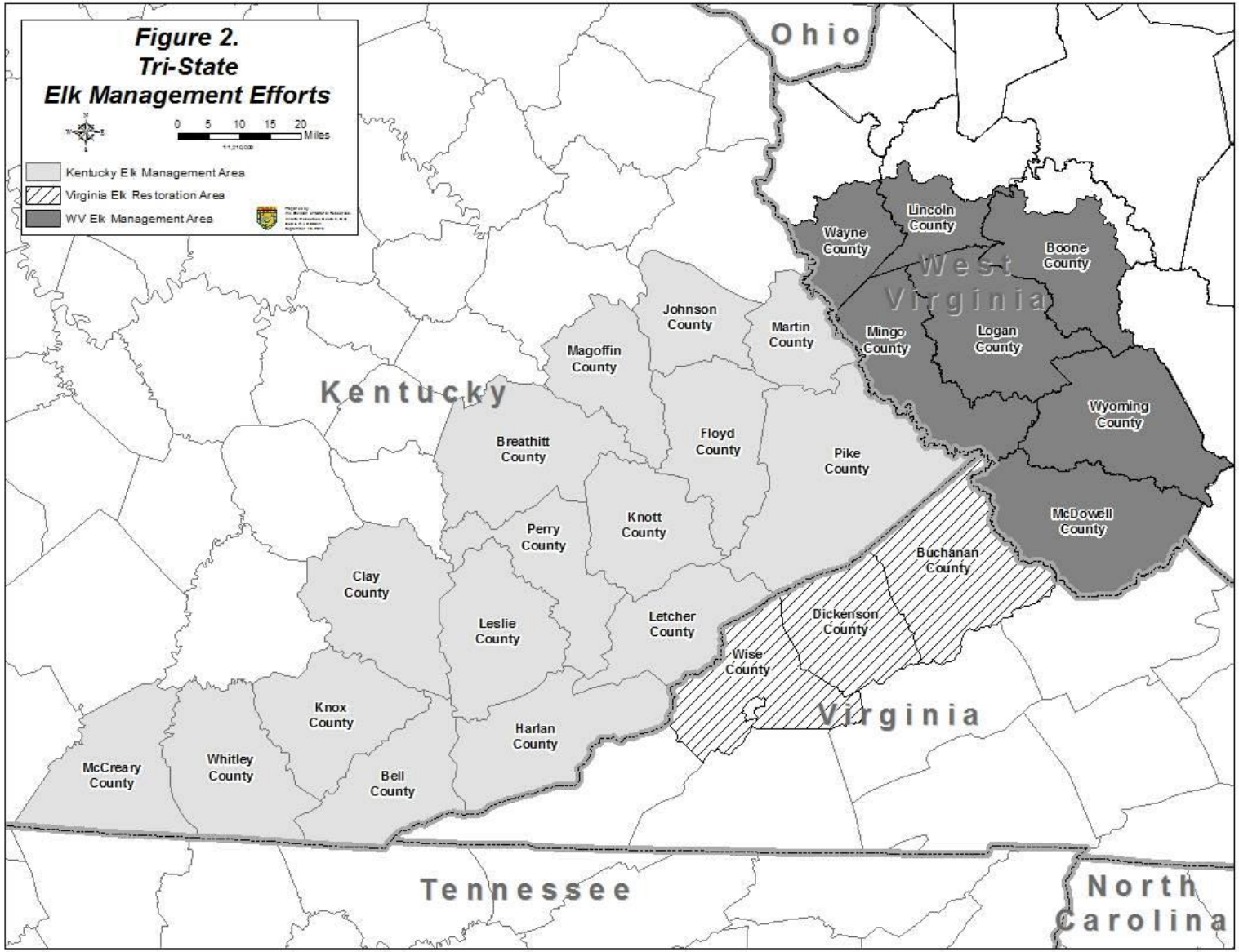


Figure 2.
Tri-State
Elk Management Efforts
0 5 10 15 20 Miles
Kentucky Elk Management Area
Virginia Elk Restoration Area
WV Elk Management Area
Ohio
West Virginia
Kentucky
Virginia
Tennessee
North Carolina
Lincoln County
Wayne County
Boone County
Johnson County
Martin County
Mingo County
Logan County
Magoffin County
Wyoming County
Floyd County
Breathitt County
Pike County
McDowell County
Knott County
Perry County
Buchanan County
Clay County
Dickenson County
Leslie County
Letcher County
Wise County
Knox County
Harlan County
McCreary County
Whitley County
Bell County

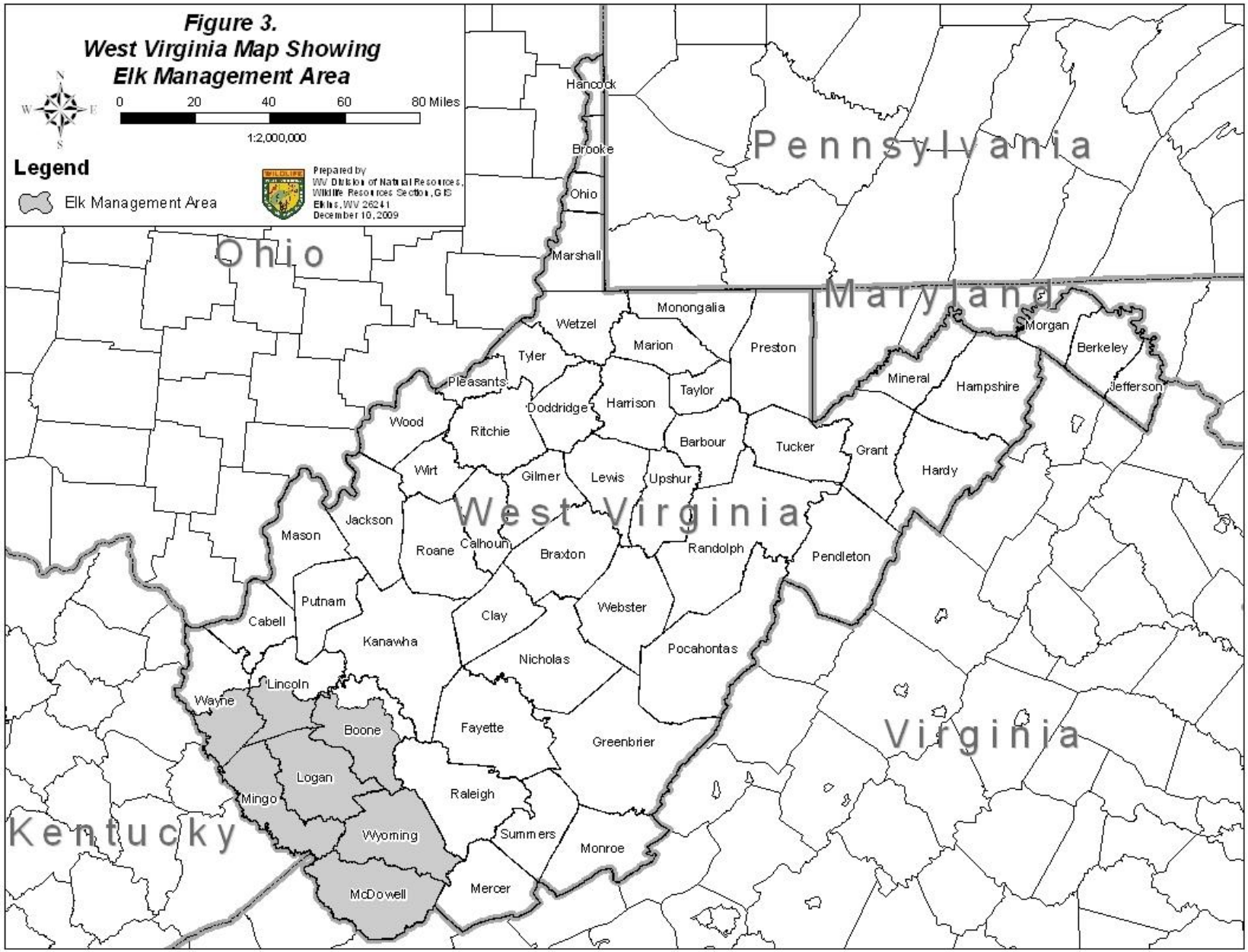
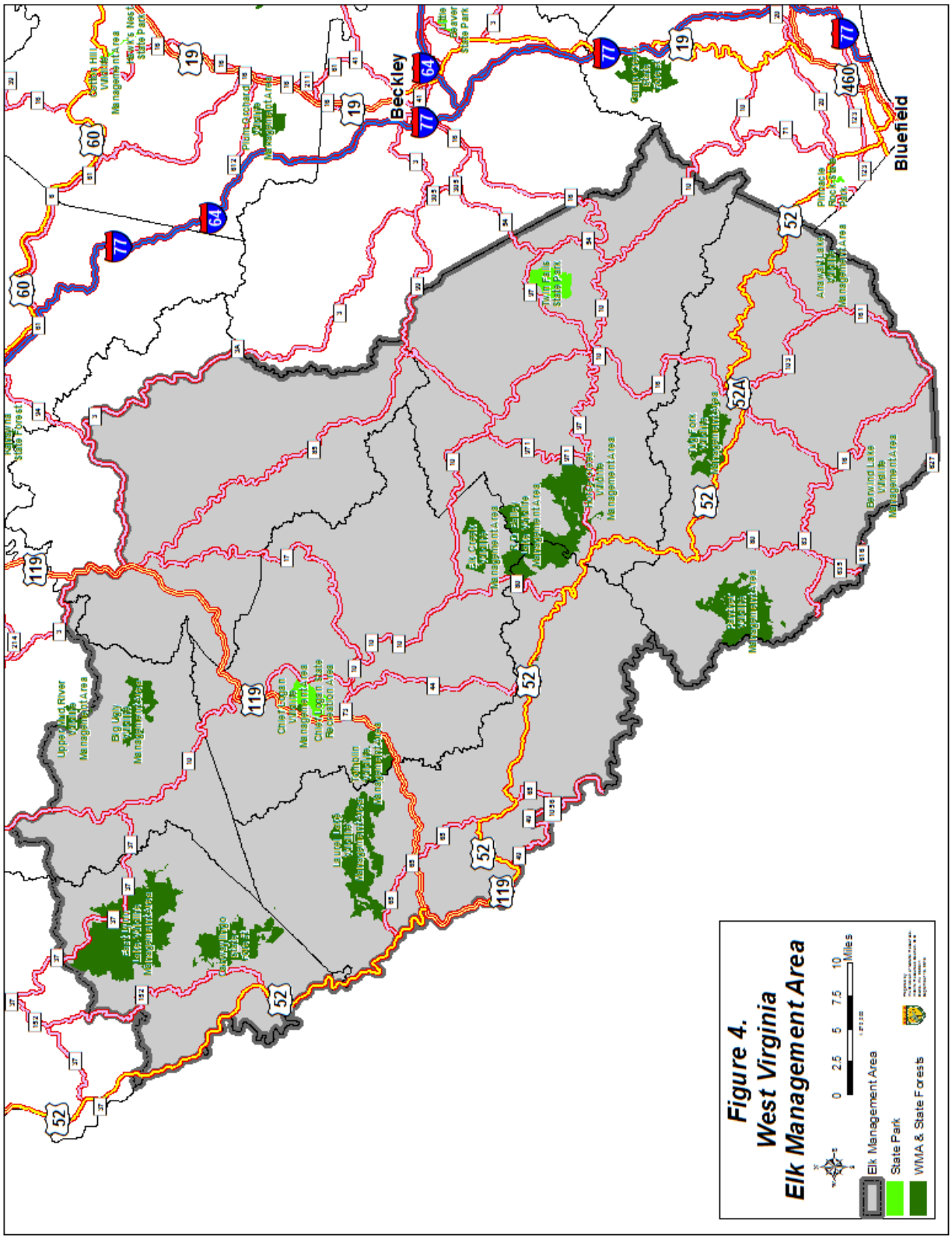


Figure 3.
West Virginia Map Showing
Elk Management Area
N
W
E
S
0 20 40 60 80 Miles
1:2,000,000
Legend
Elk Management Area
Prepared by
WV Division of Natural Resources,
Wildlife Resources Section, GIS
Elkins, WV 26241
December 10, 2009
Ohio
Pennsylvania
Maryland
Virginia
Kentucky
West Virginia
Hancock
Brooke
Ohio
Marshall
Wetzel
Monongalia
Marion
Preston
Tyler
Pleasants
Taylor
Doddridge
Harrison
Wood
Ritchie
Barbour
Tucker
Wirt
Gilmer
Lewis
Upshur
Randolph
Pendleton
Mason
Jackson
Roane
Calhoun
Braxton
Webster
Putnam
Cabell
Clay
Kanawha
Nicholas
Pocahontas
Wayne
Lincoln
Boone
Fayette
Greenbrier
Logan
Raleigh
Mingo
Wyoming
Summers
Monroe
McDowell
Mercer
Morgan
Berkeley
Jefferson
Mineral
Hampshire
Grant
Hardy


Beckley
Bluefield
Figure 4.
West Virginia
Elk Management Area
0 2.5 5 7.5 10
Miles
Elk Management Area
State Park
WMA & State Forests

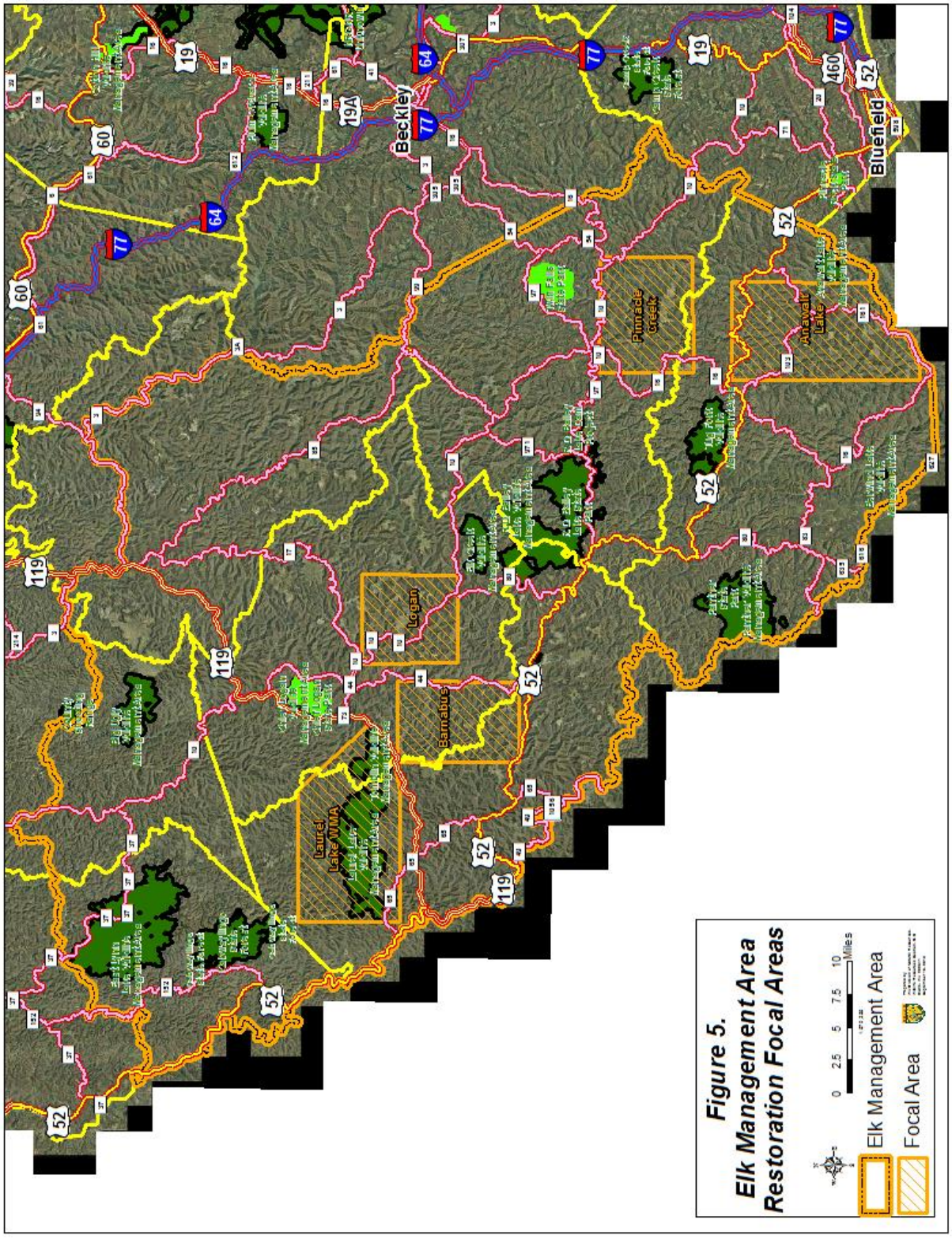

Beckley
Bluefield
Pinnacle Creek
Anawalt Lake
Logan
Barnabus
Laurel Lake WMA
Figure 5.
Elk Management Area
Restoration Focal Areas
0 2.5 5 7.5 10
Miles
Elk Management Area
Focal Area

TABLE 1.

HABITAT AND SOCIOLOGICAL PARAMETERS FOR COUNTIES WITHIN THE WEST VIRGINIA ELK MANAGEMENT AREA

County	Square Miles (Elk Range)	*Human Population (Per Sq. Mi.)	Forested Cover (%)	Openland Cover (%)	Large Landholdings (% >500 Acre Parcels)	**Public Lands (Sq. Mi.)
BOONE (portion)	366	47	84%	16%	63%	0
LINCOLN (portion)	310	49	84%	15%	8%	10.7
LOGAN	444	80	83%	17%	62%	14.7
MCDOWELL	486	38	88%	12%	65%	30.9
MINGO	403	61	83%	17%	53%	27.1
WAYNE (portion)	254	81	86%	14%	NA	48.8
WYOMING	495	45	86%	13%	67%	22.0
TOTALS	**2,845**	**57**	**85%**	**15%**	**56%**	**154.2**

*human population density for entire county land base (U.S. Census Bureau, 2014 data)
**includes Wildlife Management Areas and State Forests

WEST VIRGINIA ELK SIGHTING/BUGLING FORM

(PLEASE COMPLETE SHADED AREAS AND MAIL TO ADDRESS LISTED ON THE BOTTOM OF FORM)

DATE: _____	ELK OBSERVATION REPORTED BY: _____
COUNTY: _____	ADDRESS: _____ _____ PHONE #: _____ COMPANY/AGENCY NAME: _____

(CHECK ONE) ELK SIGHTING _____ OR ELK BUGLING _____

LOCATION DESCRIPTION:

UTM COORDINATES: Datum (Circle One): NAD27 or NAD 83 or WGS84 UTM Zone (Circle One): Zone 17 or 18 North: _ _ _ _ _ _ _ East: _ _ _ _ _ _ _	OR	LAT/LONG COORDINATES: LAT: _____ LONG: _____

TOTAL # OF ELK OBSERVED:	NUMBER OF BULLS:		NUMBER OF COWS:	NUMBER OF CALVES:
	ANTLER PTS: (L): (R):	ANTLER PTS: (L): (R):		
	ANTLER PTS: (L): (R):	ANTLER PTS: (L): (R):		

ELK OBSERVED ALIVE: (CHECK ONE)	GRAZING IN FIELD OR RECLAIMED MINE SITE:	SEEN ALONG ROAD WHILE DRIVING:	OBSERVED WHILE HUNTING:	OTHER (LIST):

ELK OBSERVED DEAD: (CHECK ONE)	ILLEGAL	ROADKILL	CROP DAMAGE	OTHER (LIST):
	WAS A DNR BIOLOGIST CONTACTED TO COLLECT BIOLOGICAL SAMPLES FROM THE DEAD ANIMAL: (Circle one): YES OR NO			

FORM COMPLETED BY: Name _____ Title_____ Date _____

COMMENTS:

Biological Assessment of Potential Habitat for Elk in West Virginia

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College of Environmental Science and Forestry
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Final Report
28 April 2005

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EXECUTIVE SUMMARY

The assessment of biological feasibility for restoring elk to the eastern landscape has seen increased support in recent years due to interest by the Rocky Mountain Elk Foundation. Feasibility projects have been completed for New York and Virginia and restoration has begun in a number of other states east of the Mississippi. We sought to provide an assessment of habitat suitability for restoration of elk in West Virginia. This report is the biological facet of a larger study that also includes analyses of social and economic conditions for elk restoration. Our objectives were to design a habitat assessment model to perform both course-filter elimination of portions of West Virginia that are unsuitable to elk, or where elk-human conflict would be great, and a fine-filter assessment of habitat quality where elk might be restored. In addition, we examined the sensitivity of the habitat assessment to underlying assumptions required by the model.

To achieve these objectives, we drew on a model developed for use with satellite imagery in New York. We adapted this model for application in West Virginia by comparing habitat assessments to habitat-use behavior displayed by elk in a recently restored population in eastern Kentucky. Findings show that there are 3 large regions in West Virginia that have the most potential as future sites for restoration: the Monongahela, Ohio Hills and Southern Coal Fields.

- The Monongahela region (13,597 km^2) ranks first because it contains the largest amount of highly suitable habitat (7,133 km^2) and is adjacent to the Shenandoah region of Virginia, an area identified as a suitable region in a previous feasibility study.

- The Ohio Hills (4,049 km^2) region contains the highest proportion of highly suitable habitat (73%), but its close proximity to major highways makes it less desirable than the Monongahela.

- The Southern Coal Fields region (4,633 km^2) contains the lowest relative amount of highly suitable habitat (839 km^2), but its close proximity to the border of eastern Kentucky where elk currently reside makes it a viable consideration.

- The habitat assessments are most sensitive to the inclusion of open area as a variable in the model. In all regions, open area is the limiting cover type. The assessments are less sensitive to the inclusion of roads in the model and to the geographic scale at which the model is run.

INTRODUCTION

Prior to European colonization of North America, elk (*Cervus elaphus*) numbers exceeded 10 million. Six subspecies occupied a variety of habitats reaching from the Atlantic Ocean to the Pacific Ocean and northern Mexico to sub-arctic Canada. During the period from 1500 to 1900, 2 subspecies were driven to extinction and the total number was reduced to below 100,000. Remaining individuals were confined to an isolated series of subpopulations scattered among 7 western states and 2 Canadian provinces (Christensen 1998). This decline was due to the combined effects of habitat loss, unrestricted hunting (private and commercial), and competition with domestic livestock (Bryant and Maser 1982). Modern management and conservation practices restored many populations and current abundance is estimated to be >1 million individuals (Long 1996, Christensen 1998). Restoration efforts in Arkansas, Kentucky, Michigan, Oklahoma, Pennsylvania, Tennessee, and Wisconsin show that elk are able to thrive on landscapes impacted by human activity (Didier and Porter 1999).

Numerous attempts to restore elk in the East were made, beginning in the early 20th century. Early efforts in 10 eastern states, including Indiana, New Hampshire, Virginia, Wisconsin, and New York were unsuccessful (Bryant and Maser 1982, McClafferty and Parkhurst 2001, Larkin et al. 2003). Elk were effectively restored to Pennsylvania and Michigan (1913 and 1915, respectively; Bryant and Maser 1982). Recent restorations in Wisconsin, Kentucky, Tennessee, and Arkansas have been successful, generating public support and interest by neighboring states.

Both New York and Virginia have assessed the suitability of potential habitat in their respective states. In New York, suitable habitat was identified in the western peripheral Adirondacks, the Catskills, and a portion of the Alleghenies (Didier 1998). Suitable habitat in Virginia was identified in the Shenandoah mountain region, the southern Piedmont region and a section in the southwest corner of the state (McClafferty and Parkhurst 2001). The Shenandoah and southwest regions are in close proximity to the West Virginia border. In addition, the designated counties in eastern Kentucky are adjacent to the borders of West Virginia and Virginia (J. Larkin, personal communication).

In 1999, West Virginia began considering elk restoration. Eastern elk (*Cervus elaphus canadensis*) were historically common throughout West Virginia, particularly in the higher mountain regions (Brooks 1911, Hale 1886, Audubon and Bachman 1854, Brooks 1932, Shoemaker 1939). Accounts of extirpation vary throughout the state, with the last reported sighting in 1875. We sought to provide a statewide assessment of the potential for elk restoration in West Virginia by drawing on the capabilities of satellite imagery and geographic information system tools. Similar assessments have been conducted recently for New York and Virginia using models derived from published literature and, to a limited extent, research conducted on the small eastern populations of elk. Although scientifically grounded, the habitat suitability models produced from these efforts have not been tested against elk populations living on the eastern landscape. Our specific objectives were to: (1) develop models to provide both course-filter and fine-

filter assessment of habitat quality for elk in West Virginia, and (2) identify the areas of West Virginia that have the greatest potential for supporting an elk population. Development of the models required a series of assumptions and, consequently, a secondary objective was to test the sensitivity of the model to those assumptions, and the implications of that sensitivity to the identification of potential elk habitat.

STUDY AREA

West Virginia is approximately 66,000 km^2 in size. Major physiographic regions in West Virginia include the Northern Ridge and Valley province to the east, the Allegheny Mountains and the Cumberland Plateau in the center, and the Southern Unglaciated Allegheny Plateau in the western half of the state. Included in the Allegheny Mountain province is the 3,678 km^2 Monongahela National Forest, which consists primarily of northern hardwoods. The remaining deposits of easily accessible coal exist in the Cumberland Plateau and large-scale surface mining operations are currently present in the southwest region. Mountaintop excavation of coal and the subsequent remediation processes has converted large areas of rugged, steep topography and dense forests into plateaus of gently sloping grasslands and adjacent forest fragments.

Nearly 73% of the state is forested while only 3% of land cover resides in cropland (West Virginia Tables 2002). The dominant forest type in the state is diverse mixed mesophytic forest (38% of WV's area; Strager and Yuill 2002) (Figure 1). Common herbaceous plants in the reclaimed surface mine openings include Kentucky-31 tall fescue (*Festuca arundinacea*), bush clover (*Lespedeza* spp.), perennial ryegrass (*Lolium perenne*), and orchardgrass (*Dactylis glomerata*; Larkin et al. 2003). Due to extreme topography, agriculture is not a major component of land-cover.

The human population in West Virginia is approximately 1.8 million people (U.S. Census Bureau 2004). The northern and eastern panhandle regions are heavily populated. The capital city of Charleston is a major urban epicenter with substantial commercial and suburban development. The majority of the state consists of small, unincorporated towns and undeveloped areas owned by the federal government, the state, or private natural resource corporations.

METHODS

To develop models for assessing habitat quality in West Virginia, we followed procedures developed in New York by Didier and Porter (1999). We formulated models that were similar to those in New York and then refined these models by comparing their output to actual observed use of habitat by elk in eastern Kentucky. The refined models were then used to produce the coarse-filter elimination of areas deemed completely unsuitable for elk restoration, and fine-filter classification of the suitability of habitat in the remaining regions.

Developing the Coarse Filter Model

To identify and evaluate the potential for elk restoration, we first developed a coarse filter that would enable us to eliminate all areas that would be unsuitable. This assessment was based on a large-scale, low-resolution analysis of the entire state and inputs to the model were data summarized at the county level. Elimination criteria were (1) counties that contained >15% area in cropland, (2) counties defined as Metropolitan Statistical Areas (MSA; US Census Bureau 2003a), (3) areas within 8 km of 4-lane highways, and (4) areas remaining after steps 1-3 that were smaller than 500 km^2. An MSA is a core area containing a substantial population nucleus, together with adjacent communities having a high degree of economic and social integration with that core (U.S. Census Bureau 2003b).

Developing the Fine Filter Model

To assess the relative suitability of habitat in areas remaining after the elimination by the coarse filter, we developed a fine-filter assessment model modified from Didier and Porter (1999). We designed the model to be applied to classified, 30 m resolution land cover data provided by the GAP analysis program (Figure 1; West Virginia GIS Technical Center 2000 and Kentucky GIS 2004). Land cover data were reclassified to include 10 different cover types (Table 1). All analyses were conducted using ArcView 3.3, ArcView Spatial Analyst, and ArcAvenue (ESRI, Inc.). Habitat suitability was calculated using 4 variables considered important for reproduction and survival of elk: food, cover, habitat diversity, and road density.

Food and Cover.-- Specific suitability values were adapted from Beyer (1986), Van Deelen et al. (1997), and Didier and Porter (1999). To include the degree of interspersion between food resources and cover in the model, we multiplied food suitability values for each pixel by a distance-to-cover modifier (Figure 2) and cover suitability values for each pixel by a distance-to-food modifier (Figure 3). We based these modifiers on the movement behavior of elk in Kentucky (Wichrowski 2001) and the seasonal movements of elk as summarized by Didier (1998).

In the unadjusted model, each land cover type was assigned a suitability value for quality of food (SV_{FD}) and cover (SV_{CV}; Table 1). The minimum habitat suitability index for either food or cover was considered limiting to elk and was assigned as the food and cover suitability value for each pixel ($\min SV_{FD \text{ and } CV}$). The HSI values ascribed to each pixel reflected the food and cover values from the surrounding landscape. This was accomplished by moving a circular assessment window across the satellite image and calculating the mean minimum suitability value for food and cover of all the pixels within a pre-determined radius following procedures described by Didier and Porter (1999).

The adjusted model considered each cover type as food, cover, both, or none (Table 2), but assigned an HSI value based solely on the corresponding distance modifier ($SV_{FD \text{ or } CV}$). If a pixel was considered both food and cover, its suitability was automatically 1. Food and cover HSI values were not averaged across the landscape with the adjusted model.

Habitat Diversity.-- We used the assessment window to incorporate a measure of habitat diversity into the HSI value assigned to each pixel. The HSI value was based on the proportion of each respective cover type that fell within the radius. A minimum proportion of each of 3 cover types was required for optimal habitat: 40% forest ($SV_{\%F}$), 10% open area ($SV_{\%O}$), and 15% successional forest or shrubland ($SV_{\%Sh}$; Figure 4).

Road Density.-- To include the potential influence of roads on habitat quality, we calculated road density in West Virginia based on a 55 km^2 grid. This was the average home range of adult elk in Kentucky (Wichrowski 2001). This calculation included interstate highways, town, city, village, and county roads, state routes, and state highways. We assigned suitability values for road density (SV_{RD}) to each pixel based on the HSI curve from Didier (1998; Figure 5).

Unadjusted Final Suitability.-- The New York-based model was originally applied to Kentucky where final suitability values (FSV) were compared against elk telemetry locations using the following equation:

$$FSV = (\text{mean}(\text{min}SV_{FD \text{ and } CV}) * SV_{\%F} * SV_{\%O} * SV_{\%Sh})^{1/4},$$

Where $\text{min}SV_{FD \text{ and } CV}$ is the minimum suitability value for food *and* cover,
$SV_{\%F}$ is the suitability value for proportion of area in forest,
$SV_{\%O}$ is the suitability value for proportion of area in open,
$SV_{\%Sh}$ is the suitability value for proportion of area in shrub.

Adjusted Final Suitability.-- Final suitability values following model adjustment in Kentucky were calculated without the influence roads ($FSV_{w/oRD}$) and with the influence of roads (FSV_{RD}) using the following equations:

$$FSV_{w/oRD} = (SV_{FD \text{ or } CV} * SV_{\%F} * SV_{\%O} * SV_{\%Sh})^{1/4},$$

$$FSV_{RD} = (SV_{FD \text{ or } CV} * SV_{\%F} * SV_{\%O} * SV_{\%Sh} * SV_{RD})^{1/5},$$

Where $SV_{FD \text{ or } CV}$ is the suitability value for food *or* cover,
SV_{RD} is the suitability value for roads.

A geometric mean was applied, in contrast to an arithmetic mean, to ensure that a low suitability value for any single variable would cause the corresponding pixel to be assigned a low final suitability. The equation produced final suitability values that ranged from 0 (not suitable) to 1 (highly suitable). To simplify results, final suitability values were placed into 4 categories: unsuitable (0-0.25), low suitability (0.25-0.50), moderate suitability (0.50-0.75) and high suitability (0.75-1.0).

Refining the Models

We refined both coarse filter and fine-filter models by applying them to eastern Kentucky, where an elk herd was established during 1997-2000 (Larkin et al. 2001). We compared the habitat suitability predictions from our models to empirical observations of habitat use by elk in Kentucky based on 16,000 observations (i.e., telemetry fixes) of elk (J. Larkin, University of Kentucky, personal communication). We adjusted the model to maximize fit between predicted suitability and observed use.

Evaluating Sensitivity of the Model

To evaluate the sensitivity of our assessment models we examined the influence of each habitat variable in the model and the effects of varying the size of the assessment window. To determine the sensitivity of each variable, we ran a series of habitat assessments that successively omitted each individual variable. To test the sensitivity of the analysis to the scale of assessment we conducted another series of assessments with window radii of 1 km, 2.34 km, and 3.68 km. The 2.34 km radius represented the average home range for an elk in Kentucky, while the 1 km and 3.68 km radii represented upper and lower limits (Wichrowski 2001). In each case, we compared the changes in proportional amounts and spatial patterns of the habitat suitability within each of the 3 assessment classes.

RESULTS

Refining the Model in Kentucky

Coarse Filter.-- There were 35 counties that were eliminated because they were MSA in Kentucky. The majority were located in the northern portion of the state with the exception of Christian, Edmonson, Trigg, and Warren in the southwestern region of the state. There were 95 counties eliminated because they contained > 15% of land cover in agriculture. A total of 31 counties met both criteria (Figure 6). The 16-county elk management zone in the eastern portion of Kentucky met course filter criteria as potential elk habitat (Figure 7), so no adjustments were made to the course-filter model. Four-lane highways in eastern Kentucky were buffered by 8 km on either side, removing 1900 km^2 from further analysis. Approximately 55% of the telemetry points were located within the remaining areas > 500 km^2 that were present after elimination of MSA counties, agricultural counties and buffered 4-lane highways. The remaining 45% of the telemetry points occurred outside of the remaining areas (Figure 8).

Fine Filter.-- Application of the unadjusted habitat model to eastern Kentucky identified the majority of the land cover as unsuitable (71%), while low, moderate, and highly suitable habitat were not as well represented (15%, 6%, and 8%, respectively) (Table 3; Figure 9). The majority of telemetry points also fell within habitat identified as unsuitable (66%), while few fell within moderate or highly suitable habitat (3% and 4%; Table 3).

The model was adjusted by altering the suitability values assigned to various cover types (Table 1 versus Table 2). Application of the adjusted model resulted in 8% of the land being classified as unsuitable, 36% as moderate and 35% as highly suitable (Table 3, Figure 10). After adjustment, only 6% of the telemetry points fell within habitat identified as unsuitable, with higher proportions located within moderate or highly suitable habitat (25% and 56%, respectively; Table 3).

Applying the Model to West Virginia

A total of 21 counties were eliminated by the course-filter assessment. Only Jefferson County, located in the easternmost tip of the state had > 15% agriculture (Table 4). After Jefferson, those counties with the highest proportion of agriculture were Berkeley (5%), Mason (3%), and Hardy (2%). The remaining counties were at or below 1% in agricultural land cover. Twenty-one counties, including Jefferson, were classified as MSA's (U.S Census Bureau 2003b) and eliminated (Table 4; Figure 11).

In the remaining counties, an 8 km geographic buffer zone was placed around 4-lane highways. There were 22,951 km^2 that were eliminated because they fell within these buffer zones (Figure 12). Those remaining areas > 500 km^2 were presented to WVDNR in July 2003 (Figure 13) and with their concurrence, the 3 largest were selected for fine-filter analysis. These areas can be described as the Monongahela National Forest (13,597 km^2), Ohio Hills (4,049 km^2), and Southern Coal Fields (4,633 km^2; Figure 14).

Evaluating the Sensitivity of the Model

The assessment was most sensitive to the proportion of open area. Removing the variable for open area had a large positive impact on high-suitability habitat in all 3 areas (135% increase for Ohio Hills, 187% increase for Monongahela, and a 550 % increase for Southern Coal Fields). The removal of any of the other variables had less of an impact on the amount of high-suitability habitat, particularly in the Ohio Hills and Monongahela regions, where the greatest difference was 10-11%. The removal of the variable shrubland had a 29% positive impact on the Southern Coal Fields region.

The assessment was also sensitive to road density. Excluding the effects of road density with the 1 km assessment window, the Monongahela region had the largest amount of highly suitable habitat (7,133 km^2), but ranked second in proportion of highly suitable habitat (51%). However, the northeast portion of the Monongahela region contained a large proportion of highly suitable habitat (Figures 15a and 16). The Ohio Hills region ranked second (2,961 km^2), but had the greatest proportion of highly suitable habitat (73%). The Southern Coal Fields ranked third with the lowest proportion (18%) and amount of suitable habitat (839 km^2).

The highest road density in these 3 areas was 2 – 5 km/km^2 (Figure 17). In all 3 regions, the amount of area in the high suitability category decreased by 3 – 8% when road density was included, while the amount of area in the moderate suitability category increased by 5 – 9% (Figure 16 versus Figure 18). Road density had the greatest negative

impact on the Ohio Hills region (8% decrease in highly suitable habitat. However, the amount of nonsuitable habitat in the Ohio Hills remained at 2% with the inclusion of roads (Figure 15a versus 19a).

Road density had the greatest negative impact on the Ohio Hills region decreasing the amount of highly suitable area by 10% with the 2.34 km (Figures 19b and 20) and 3.68 km assessment windows (Figures 19c and 21). The majority of this difference in the Ohio Hills was in the moderately suitable category (17% versus 30%). The Monongahela and the Southern Coal Fields regions were less affected by road density (Figure 15b,c versus Figure 19b,c).

The size of the assessment window affected the proportion of the area in each of the suitability classes, with overall suitability generally declining with increased radius of the assessment window. At the 1 km assessment radius, the Monongahela region had the most area in the high suitability category, and the Ohio Hills region had the greatest proportion of its habitat that was considered highly suitable habitat (73% versus 51%). A large amount of area in the Monongahela region was identified as moderately suitably (3031 km^2), resulting in a total of 10,164 km^2 (73 %) of the region identified as moderate or highly suitable. On a smaller scale, 3,800 km^2 (94%) of the Ohio Hills was either moderate or highly suitable. Only 18% of the Southern Coal Fields was identified as highly suitable, while the majority of this area fell in the low to moderate suitability categories (Figures 15a and 16).

Overall, suitability decreased with the 2.34 km radius when compared to the 1 km assessment window radius. The Monongahela region had the most area in the high suitability category, followed by the Ohio Hills region. The majority of the Southern Coal Fields region fell in the nonsuitable category (56%), a decrease of 40% from the 1 km window size (Figures 15b and 22). The proportion of the Ohio Hills that was highly suitable decreased when compared to the 1 km assessment window radius (58% versus 73%), but it was still the highest proportion of the 3 regions. The amount of highly suitable area in the Monongahela region fell by 1,640 km^2, while the amount of nonsuitable habitat in the same area increased by 2,751 km^2. To a lesser extent, this occurred in the other 2 areas as well (Figure 15a versus Figure 15b).

The differences between areas in each of the suitability categories were slight when the 3.68 km radius was compared to the 2.34 km assessment window radius. Across all 4 suitability categories, the greatest difference was 2%. At 3.68 km, the Monongahela region had the most high suitability habitat, while the Ohio Hills had the greatest proportion of high suitability habitat. Combing the moderate and high suitability categories, the Ohio Hills had 74% of its landcover included, while the Monongahela region had 54% (7,510 km^2). Approximately 4% of the Southern Coal Fields region fell within the high suitability category (Figures 15c and 23).

DISCUSSION

Suitable Areas in West Virginia

While course filter analysis eliminated much of state from consideration for an elk restoration, 3 large areas contain significant amounts of suitable habitat and appear to have good potential to support an elk population. Fine-filter assessments show that the Monongahela region contains the largest aggregate area of highly suitable habitat. Small abandoned strip-mine sites throughout the region provide the necessary open habitat. Shrubland is present on commercial forest lands, particularly in the southwestern portion of the region. In combination with areas of more mature forest, these areas of open area and shrubland cover produce high suitability scores for food, cover and habitat diversity. The northeastern section of this region contains the highest concentration of high-suitability habitat. Less suitable habitat is concentrated in the central portion of the region and reflects a lack open habitat in this area (Figure 15).

A possible conflict to elk in the Monongahela region is the presence of cattle farming along Route 219/55, which follows a major valley in a north/south direction. Along this highway, small farming operations maintain open hayfields and pastures which may be appealing to elk.

The Ohio Hills region has the greatest proportion of high-quality habitat and very little unsuitable or low-suitability habitat. The region contains an optimal mix of open areas, shrubland, and forested habitat. This area was ranked second because although it contains a high proportion of highly suitable habitat, it does not contain as much total area of suitable habitat as the Monongahela region. Road density is highest in this region, indicating an increased potential for vehicular conflicts.

The Southern Coal Fields has the lowest amount of moderate and highly suitable habitat. This is largely due to the size and configuration of open areas. Many of the openings in the Southern Coal Fields are a result of large abandoned mountaintop removal mining operations and their large size reduces their suitability.

While the focus of attention for restoration is on these 3 areas, it is important to view them within the larger landscape. Other portions of the state contain suitable habitat, but were eliminated in the course-filter assessment because of the high potential for conflict between elk and humans. Where areas of suitable habitat occur immediately adjacent to one of the 3 designated regions, there is a high probability that they will attract elk. This is especially likely in the areas immediately adjacent to the Ohio Hills. Much of the area to the north of Ohio Hills is highly suitable habitat and may become a destination for elk that migrate seasonally or that disperse.

The landscape context is also important because of the potential to link regions of suitable habitat together to form larger management areas. The Monongahela region is adjacent to the Shenandoah region in Virginia, an area identified as being suitable by the Virginia feasibility study (McClafferty and Parkhurst 2001). Similarly, the Monongahela

region could be viewed in conjunction with the Ohio Hills to create a potential restoration area that encompasses approximately 18,000 km^2. Realistically, the Shenandoah, Monogahela, and Ohio Hills regions could be combined into one contiguous management area. A key concern is the interstate highway corridor created by I-79. This highway separates the Monongahela and Ohio Hills regions, and represents an important source of potential conflict between elk and humans. The implications of the corridor on behavioral and population processes, such as seasonal migration and dispersal, would depend on the ease with which elk learn to cross it and motorists learn to avoid collisions with elk.

Viewing the habitat assessment in a larger context may also change the evaluation of the Southern Coal Fields. This region is just east of the elk herd already present in adjacent regions of Kentucky. Recent sightings of elk in the Southern Coal Fields are most likely dispersing individuals from Kentucky. This region is also adjacent to the southwest region of Virginia, another area identified as suitable (McClafferty and Parkhurst 2001).

Model Considerations

As with any assessment of habitat suitability, our evaluation of potential elk habitat in West Virginia is built on a series of assumptions. We worked to understand the sensitivity of our models to these assumptions, and to minimize their impact where possible. Three assumptions are key to the assessment: the accuracy of the classified satellite imagery data, the selection of habitat variables, and the geographic scale of the assessment.

Accuracy of GAP Data.-- Land cover in West Virginia was primarily mapped from classification of Landsat TM imagery acquired from 1992 – 1994. Classification was augmented with aerial videography from 1994 – 1996 as well as ground sampling throughout the state. Twenty-six different land-cover categories were mapped. The minimum mapping unit (MMU) was approximately 1 ha. The final land cover map was the result of filtering 30 m pixel data. Strager and Yuill (2002) conducted an assessment of WV-GAP accuracy. The basis for their assessment was a comparison of the West Virginia land cover dataset to 2 existing and 2 new datasets on a pixel basis. Datasets used for comparison were (1) USDA Forest Service Inventory and Analysis (FIA) datapoints, (2) WV-GAP field plots, (3) Digital Ortho-quarter Quadrangle (DOQQ) photo-interpretation, and (4) WV-GAP videography points.

Simple comparison of WV-GAP to FIA plots yielded a 69% correspondence between the 2 data sets. Comparing WV-GAP field plots to the nearest or most comparable WV-GAP alliance group yielded a correspondence of 77%. There was an 83% correspondence between the photo-interpretation results and the associated WV-GAP land cover categories.

Comparison of videography interpretation to WV-GAP classifications was broken down by producer accuracy and user accuracy with assessment across 3 general land cover classes: forested, agriculture, and urban/developed (Strager and Yuill 2002).

Producer accuracy is a measure of how accurately the image data are classified by category. The producer's accuracy details errors of omission that result when a pixel is incorrectly classified into another category, excluding it from its correct class. User accuracy is a measure of how closely the map classification represents that category on the ground. The user's accuracy details errors of commission, which results when a pixel is incorrectly included in a class (Story and Congalton 1986).

Producer's accuracy comparison between the WV-GAP land cover superclasses and videography points were as follows: forested - 91.0%, agriculture – 76.1%, developed – 72.2%. User's accuracy comparison between the WV-GAP land cover superclasses and videography points were as follows: forested – 91.4%, agriculture – 81.8%, developed – 59.3%.

Classification difficulties encountered with mapping land cover in WV were primarily the result of mountainous terrain and patchy forest distribution. The mosaic of forest types (8 different forest types were noted) contributed to accuracy challenges (Strager and Yuill 2002). Classification errors in the land cover of other states have been attributed to narrow class definitions and heterogeneous landscapes, but the identification of major land cover types (forest, developed, agriculture) was generally acceptable (Zhu et al. 2000). We collapsed the 26 different WV-GAP land cover types into 10 general categories. By generalizing land cover classifications and relying on major land cover types, error propagation throughout the suitability model is reduced (Fleming et al. 2004).

Both WV-GAP and NLCD were created from Landsat TM imagery that was purchased as part of the Multi-Resolution Land Characteristics Consortium (MRLC). We selected WV-GAP because both leaf-on and leaf-off TM scenes were used for classification, while the MRLC/NLCD data were classified using leaf-off data (Strager and Yuill 2000). Accurate classification of the transitional barren class was difficult in the leaf-off data in the MRLC/NLCD, particularly because fresh clear-cuts appeared similar to row crops (WV NLCD Metadata 2000). As a result, MRLC/NLCD land cover data tended to overestimate the area of row crops in the state (Strager and Yuill 2000). In addition, there was some confusion between clear-cuts, regrowth in clear-cuts, forested areas, and shrublands, so deciduous shrublands were classified as deciduous forest (WV NLCD Metadata 2000).

We chose to use WV-GAP land cover data for habitat modeling because 2 main components in the elk habitat suitability model for West Virginia were shrubland and row crops. The admitted limitations of these classifications in the MRLC/NLCD dataset led us to favor the WV-GAP dataset for our analyses.

Selection of Habitat Variables.-- To minimize concerns about the assumptions underlying our habitat assessment models, we began with a model that had been used in New York and refined it through comparison with telemetry data for in Kentucky.
We included food and cover, and then emphasized the importance of proximity of food and cover by modifying food variables by their distance to cover, and cover variables by

their distance to food. Areas that contained a large amount of edge habitat between food and cover sources received higher suitability values than those that lacked edge habitat.

Any food source within 150 m of a cover source received a value of 1, with suitability rapidly declining thereafter (Figure 2). In contrast, cover sources received a suitability value of 1 when food was within 5,000 m because some food is available within most forested cover in openings too small to be discerned by the classification of the satellite imagery (Figure 3). We placed additional emphasis on the proximity of food and cover by requiring that forest, open and shrub cover types all occur within each assessment window. This conforms to the observation that elk in Kentucky tended to congregate near the edges of large open areas, close to forested habitat, particularly during daylight hours (Wichrowski 2001).

The adjustments we made to the model based on the comparison with the Kentucky telemetry data produced several important improvements to the model. The New York-based model fails to consistently identify habitat used by elk in Kentucky because of the way the suitability values are assigned. Many cover types used by elk receive low scores because the New York-based model emphasizes the need for both cover and food within each pixel. We adapted the model to reflect the idea that a pixel with good food but poor cover value would still be valuable to elk if there was good cover in close proximity.

We assumed that at 3 years post-release, elk in Kentucky would be using habitat that should be classified as moderate to highly suitable. While the unadjusted model suggested 93% of telemetry locations occurred in unsuitable or low-suitability habitat, the adjusted model showed 81% of the telemetry locations in moderate or high-suitability habitat.

Despite their differences, both unadjusted and adjusted models performed similarly in the areas in Kentucky that had the highest suitability. Although the percentage of high and moderately suitable habitat in Kentucky under the unadjusted model was relatively low (Table 6), those areas that scored highest also scored highest with the adjusted model. However, the numerical value assigned by the unadjusted model was typically much lower. Thus, the adjustment was valuable because it helped to ensure that suitable habitat was not overlooked.

To increase our understanding of the sensitivity of our assessments of habitat suitability to variables in the model, and the HSI curves, we looked at how habitat assessments changed when we excluded individual variables. This analysis shows that open cover type is limiting to elk. Given the large relative dominance of the region by forest, the importance of open areas is understandable. In the Ohio Hills and Monongahela regions, the removal of other variables had less than an 11% impact on highly suitable habitat in all cases. The amount of highly suitable habitat in Southern Coal Fields was impacted positively by 29% with the removal of the shrubland variable. This indicates that in addition to the severe limitations caused by the lack of open area, the Southern Coal Fields are also lacking in the presence of shrubland habitat when compared to the other 2 regions. The relative deficiency of shrubland and open areas in

the Southern Coal Fields is most likely the reason it received low values for habitat suitability when compared to the other 2 regions.

Geographic Scale.-- Overall suitability was negatively correlated to the size of the assessment window. As the size of the assessment window increased, more land area was included in the final suitability to the center pixel. The sensitivity of the model to changes in scale is important because habitat models are best applied at the scale of the species' home range (Didier and Porter 1999). The home range of elk has been shown to vary widely regionally. The 3 different circular assessment window radii to address the variability of home range area, 1 km, 2.34 km and 3.68 km, served to (1) address variability in home range size and the area that elk perceive their environment, (2) identify and compare potential restoration areas, and (3) identify habitat within potential restoration areas and outside them that may attract dispersing individuals.

The smallest assessment window (1 km radius) was also chosen because the small window size permits the model to analyze a large amount of habitat in a relatively short period of time. As the size of the assessment window increases, the amount of time the model takes to complete each function is greatly increased because the number of surrounding pixels that are included in each calculation is exponentially increased. The medium-sized window (2.34 km radius) was chosen because it was similar to the home range of elk observed in other eastern states. The largest assessment window (3.68 km radius) represented the upper end of home ranges reported in the east (Beyer 1987, Larkin et al. 2003). We attempted to include an assessment window with a radius of 5.68 km to further test sensitivity to scale, but the amount of time required to complete calculations for each variable within the model made further investigation impractical.

Road Density Sensitivity.-- Road density tended to have a minimal impact on the habitat assessment. This indicated that road density throughout all 3 of the remaining regions was low. This is likely due to the effectiveness of the coarse filter elimination process. A positive aspect of the coarse filter elimination criteria is that it excluded urbanized counties and areas in close proximity to 4-lane highways. Developed areas were selected against, so remaining areas were predisposed to a relatively low road density. The only region visibly affected was the Ohio Hills, but even with the presence of road density in the equation, this area still achieves the highest proportion of highly suitable habitat.

Management Implications

It is important to keep in mind that habitat suitability is a relative concept. Elk will seek the best habitat they can find, even if it is less than ideal. Our assessment provides an objective and quantitative assessment of the habitat suitability that is most useful in comparing one area to another. For example, there is more high suitability habitat in the Monongahela region than in the Southern Coal Fields region. This does not indicate that high-suitability habitat is necessarily optimal, but rather that it is better than moderately suitable habitat.

In a management context, the assessment identifies areas that include minimum amounts of a variety of important factors and bases suitability on the proximity of these variables to each other; primarily food sources and covers sources. The assumption was that elk would prefer areas where they do not have to travel great distances to satisfy their daily needs and would be less likely to leave areas selected as release sites and come into conflict with humans.

The coarse filter, large-scale analysis was designed to eliminate areas of the state that would be unfavorable for reasons other than biological suitability. The coarse filter eliminated areas that possessed a high likelihood of social conflict, should elk be present. This does not necessarily indicate that an area cannot biologically support elk. Rather, it suggests that the probability of social conflict in this area is too high to warrant consideration.

The fine-filter, small scale model assessed habitat suitability on a pixel-by-pixel basis. The purpose of this step was to identify habitat requirements and examine conditions elk are likely to experience on the ground. Conducting this small scale analysis on a regional, statewide level permitted us to compare the relative suitability of those areas remaining after coarse filter elimination. It is important to conduct fine-filter habitat suitability analysis in the areas eliminated by the coarse filter because if they contain highly suitable habitat, elk may disperse there following release. By identifying likely dispersal areas, managers can be made aware of them and plan accordingly to alleviate any conflicts that may occur in areas that are biologically suitable but socially unsuitable.

Many states east of the Mississippi have expressed interest in determining the feasibility of restoring elk to their natural range. As identified in West Virginia, there may be merit to the idea of delineating restoration areas that link multiple states together. Such an approach would recognize the mobile nature of elk, aiding normal population processes. The ability to easily run a biological suitability model for elk on multiple states and assess management opportunities at a regional level would prove useful. The ability to map out suitable habitat on a regional level will also bring us further along in the attempt to link isolated populations by corridors of suitable habitat.

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Table 1. Food and cover HSI values for land cover types of the unadjusted model for Kentucky in 2004.

Cover Type	HSI Food	HSI Cover
Deciduous	0.5	0.5
Coniferous	0.2	1
Mixed Deciduous/Coniferous	0.35	0.75
Shrub/Successional	1	0.5
Open	1	0
Urban	0	0
Barren	0	0
Water	0	0
Wetland	0	0
Other	0	0

Table 2. Food and cover HSI values for land cover types for the adjusted model in 2004.

Cover Type	HSI Food	HSI Cover
Deciduous	0	1
Coniferous	0	1
Mixed Deciduous/Coniferous	0	1
Shrub/Successional	1	1
Open	1	0
Urban	0	0
Barren	0	0
Water	0	0
Wetland	0	0
Other	0	0

Table 3. Comparison of percentage (%) of suitable habitat and telemetry point locations in Kentucky identified using the unadjusted model and the adjusted model in 2004.

Habitat Suitability	**Unsuitable**	**Low**	**Moderate**	**High**
Percent Landcover Unadjusted Model	71	15	6	8
Percent Telemetry Points Unadjusted Model	66	27	3	4
Percent Landcover Adjusted Model	8	21	36	35
Percent Telemetry Points Adjusted Model	6	13	25	56

Table 4. West Virginia counties eliminated due to Metropolitan Statistical Area (MSA) status or > 15% agriculture in 2004.

MSA Counties		**> 15% Agriculture**
Berkeley	Mineral	Jefferson (19)
Boone	Monongalia	
Brooke	Morgan	
Cabell	Ohio	
Clay	Pleasants	
Hampshire	Preston	
Hancock	Putnam	
Jefferson	Wayne	
Kanawha	Wirt	
Lincoln	Wood	
Marshall		

Figure 1. GAP land cover data for West Virginia, 2004.

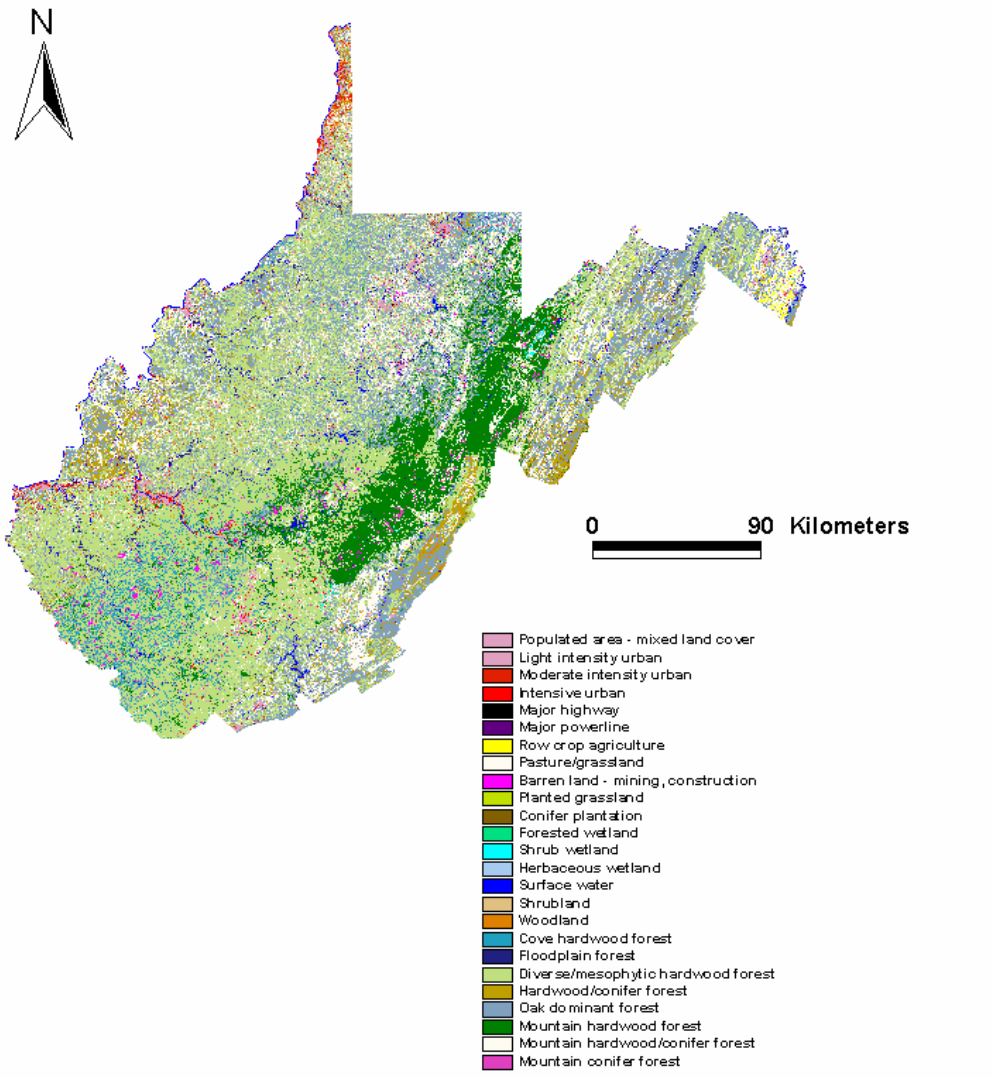


Figure 2. Distance to cover modifier used to adjust the suitability values for food in the HSI model for elk in West Virginia, 2004. Food sources included deciduous, deciduous/coniferous mix, shrubland, and open areas.

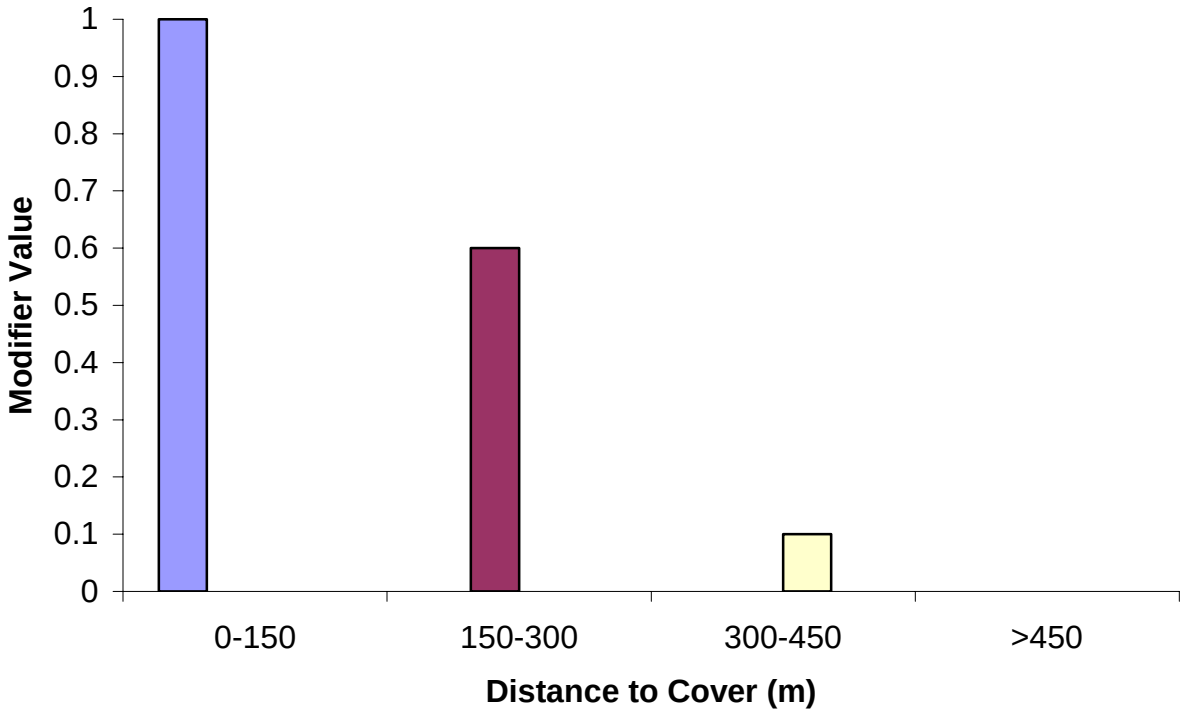


Figure 3. Distance to food modifier used to adjust the suitability values for cover in the HSI model for elk in West Virginia, 2004. Cover included all forest types and shrubland.

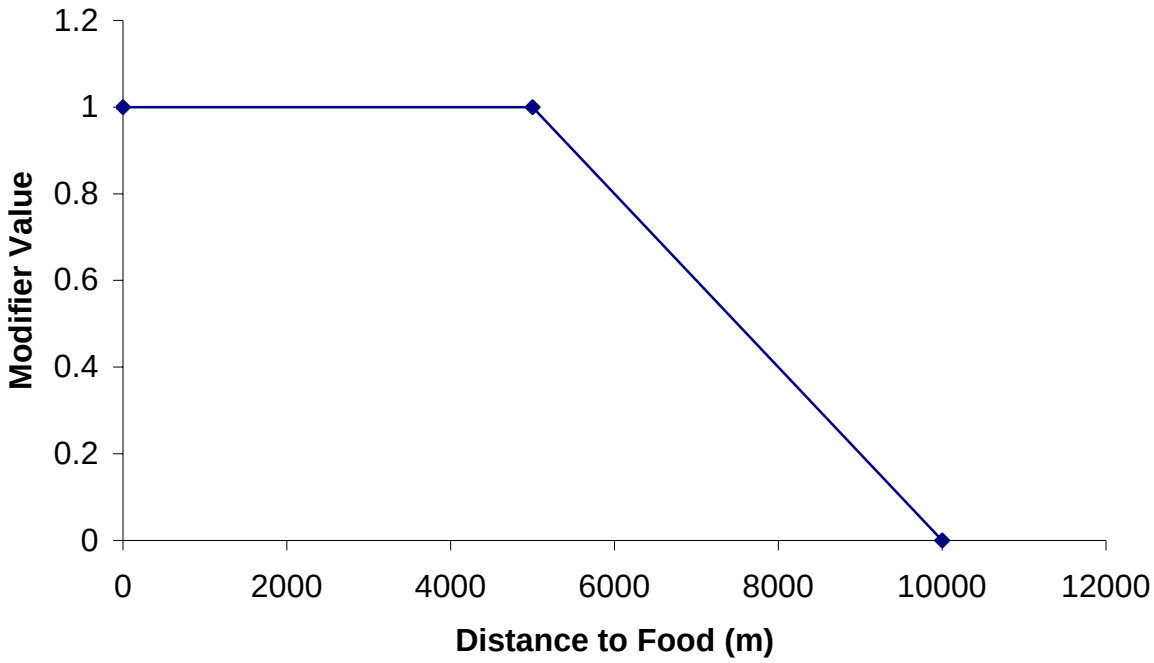


Figure 4. The suitability curves used to determine the life requisite value for habitat diversity in the habitat suitability model for elk in West Virginia, 2004.

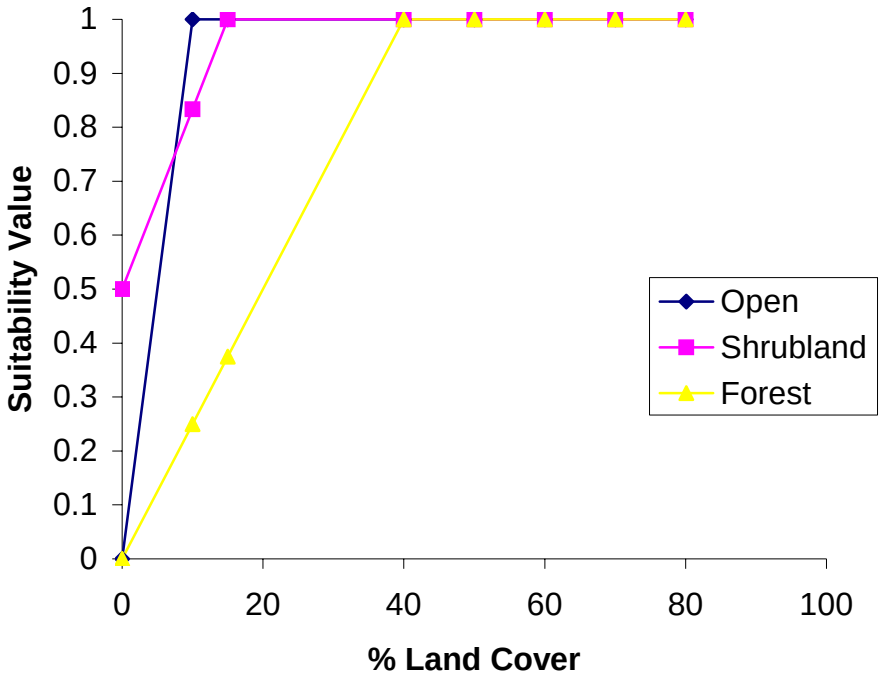


Figure 5. Road density suitability for elk habitat adapted from Lyon (1984).

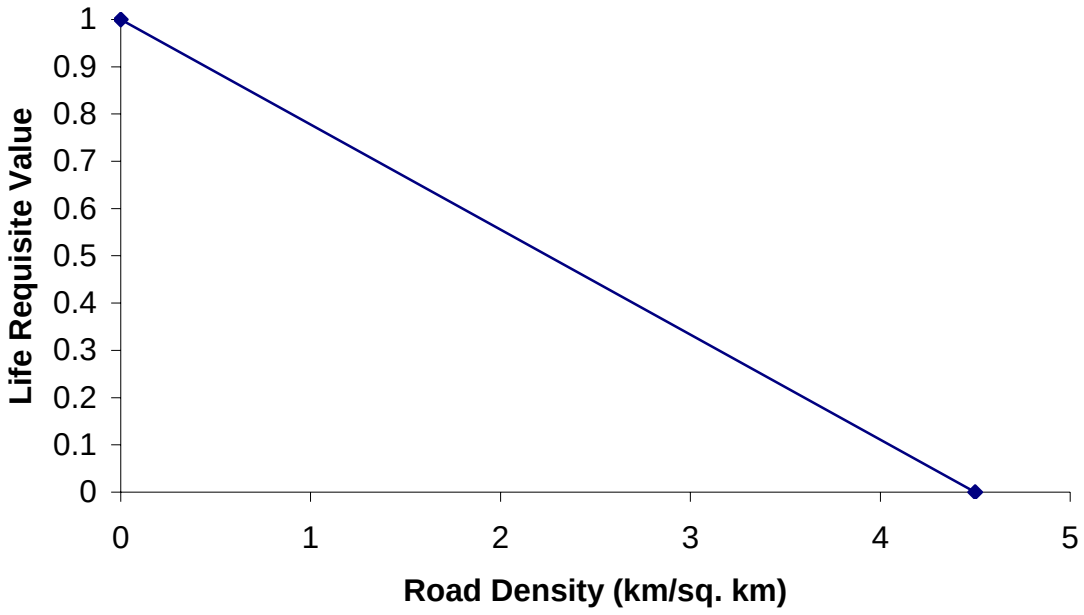


Figure 6. Two of the three criteria used for Stage 1 coarse screening in Kentucky. Counties that had a high proportion of cropland or were defined as MSA's were eliminated from further analysis.

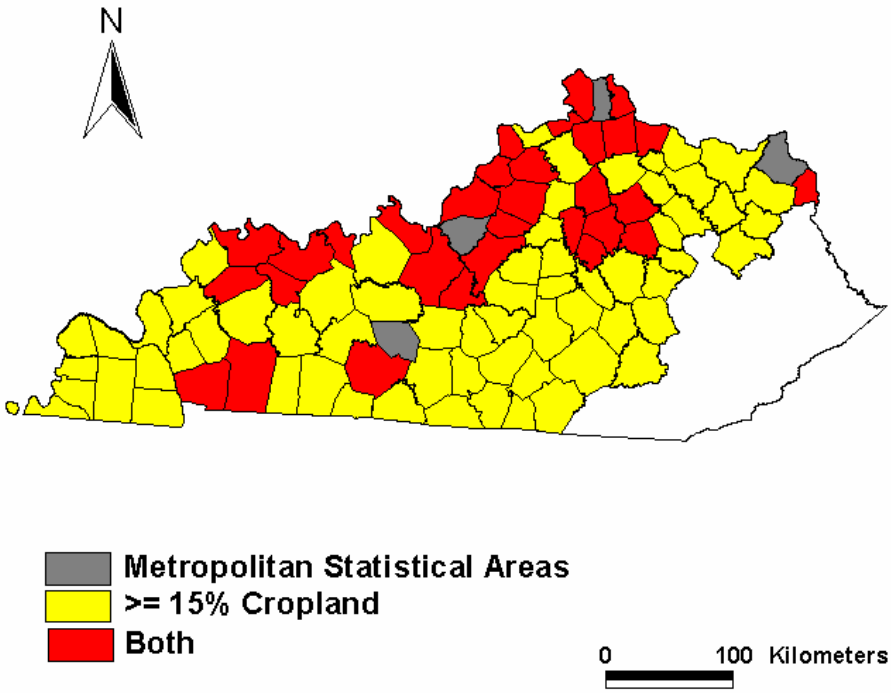


Figure 7. Counties in Kentucky designated as elk management areas.

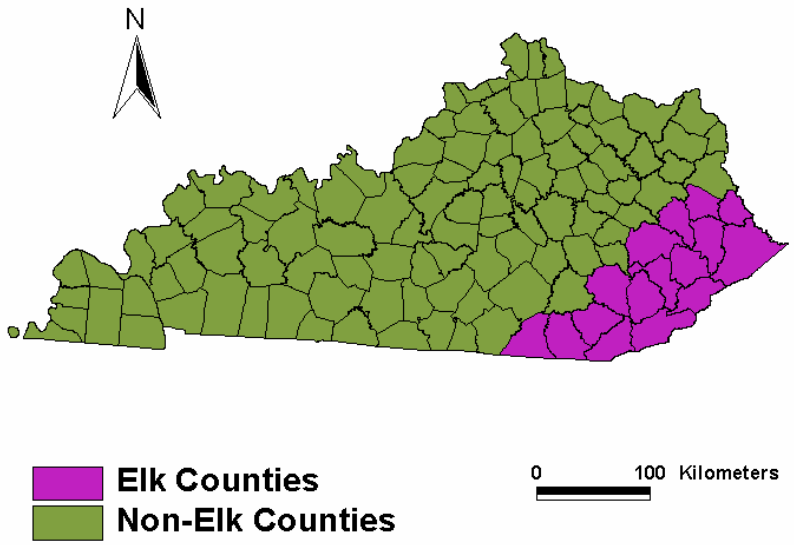


Figure 8. Areas remaining after Stage 1 screening of Kentucky. The area (km^2) is reported for each of the individual sections. Telemetry points were included to show that they occur outside of the Stage 1 remaining areas, requiring most of eastern Kentucky to be included for Stage 2 model validation.

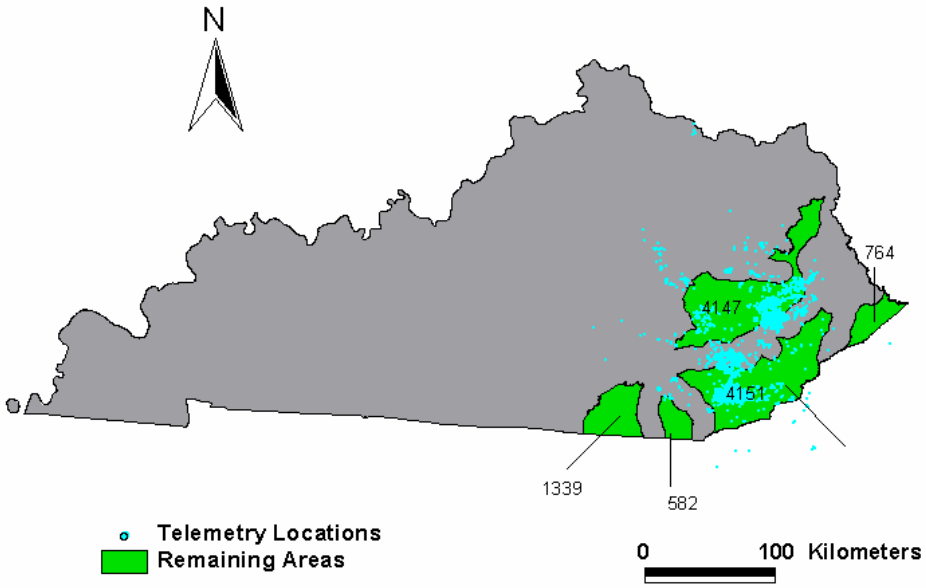


Figure 9. Unadjusted model habitat suitability results excluding road density using a 1 km radius assessment window in Kentucky, 2004.

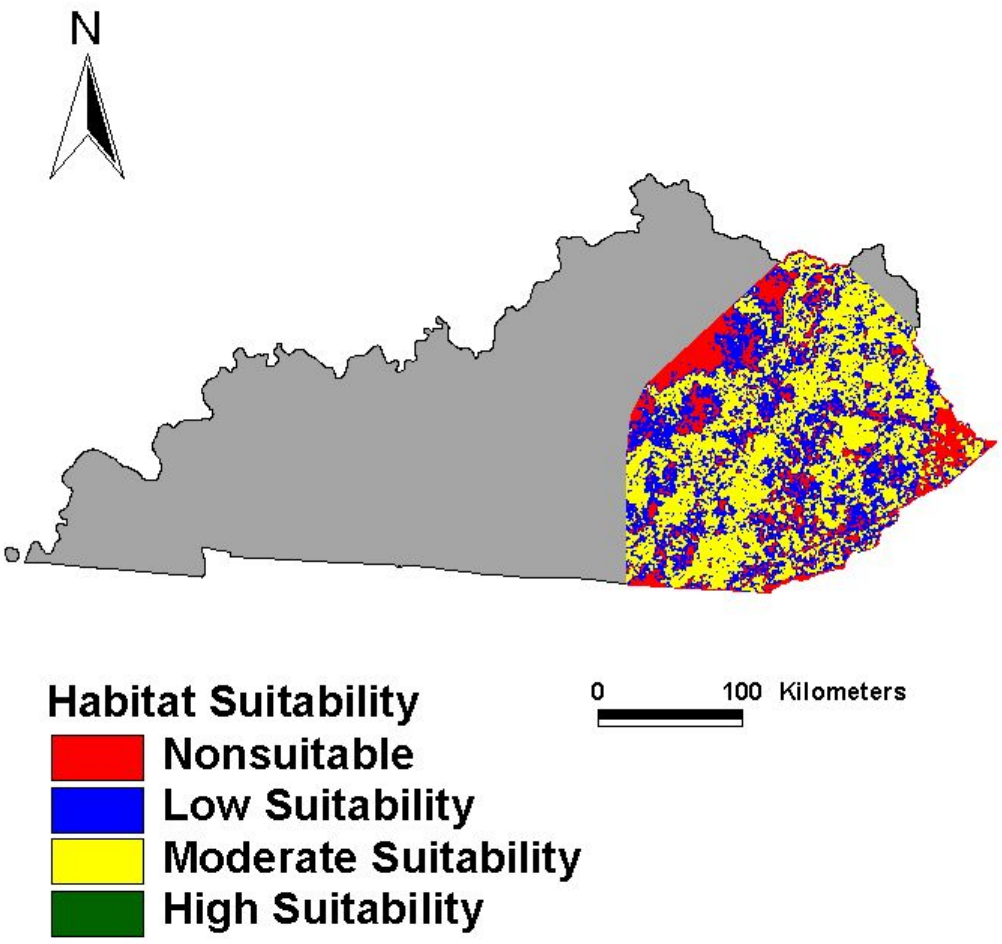


Figure 10. Adjusted model habitat suitability results excluding road density using a 1 km radius assessment window in Kentucky, 2004.

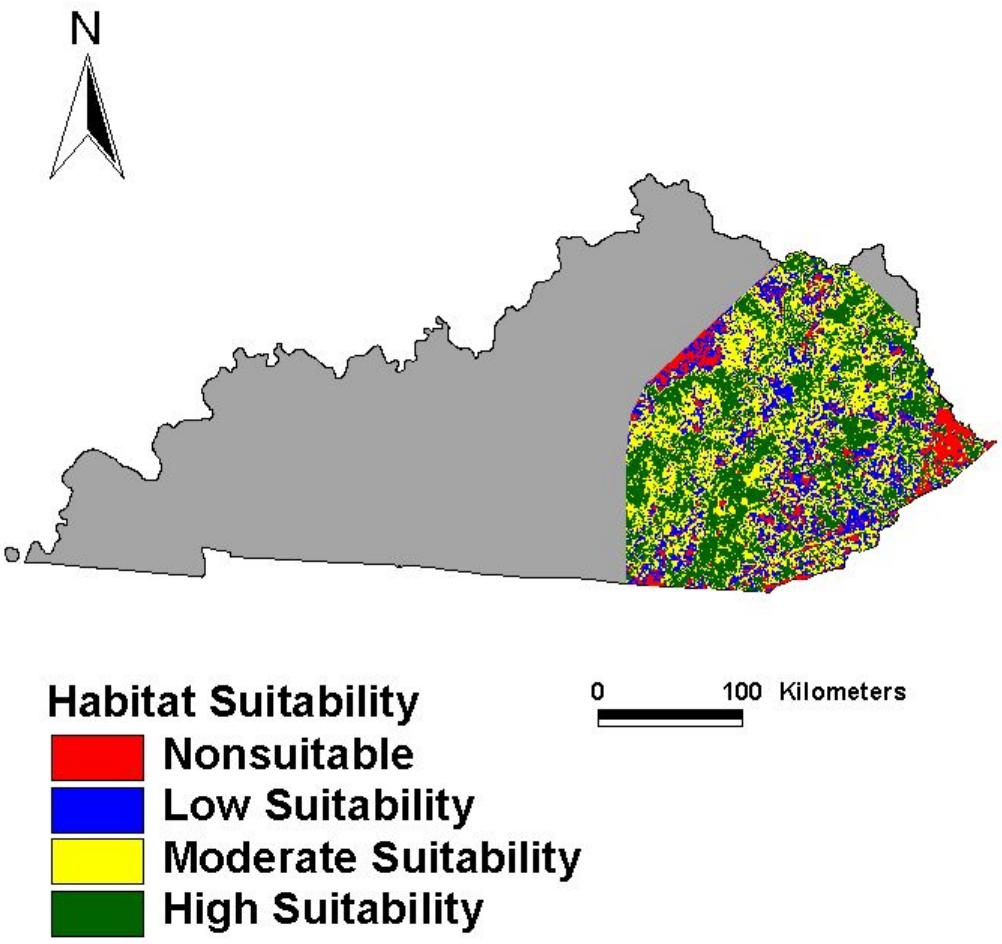


Figure 11. Two of the 4 criteria used in Stage 1 screening of West Virginia for potential elk habitat. Counties that had a high proportion of cropland or were defined as MSA's were eliminated from further analysis.

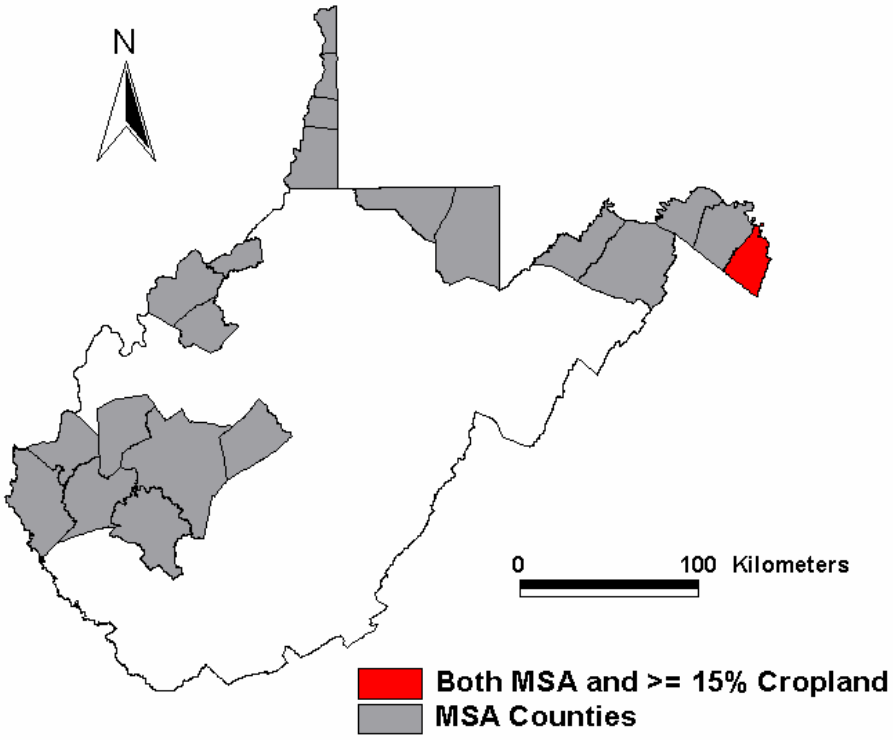


Figure 12. Areas within 8 km of 4-lane divided highways were eliminated in step 3 of Stage 1 analysis.

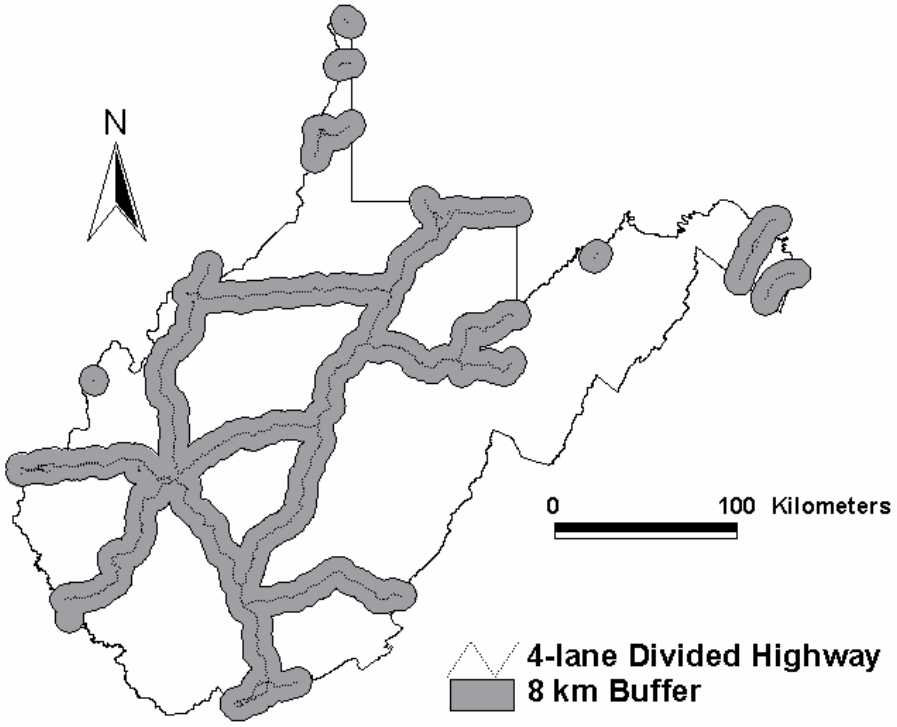


Figure 13. Areas $\geq$ 500 km^2 remaining after elimination criteria 1-3 have been met. Area (km^2) is included for each section. These areas were presented to WVDNR and RMEF in July 2003.

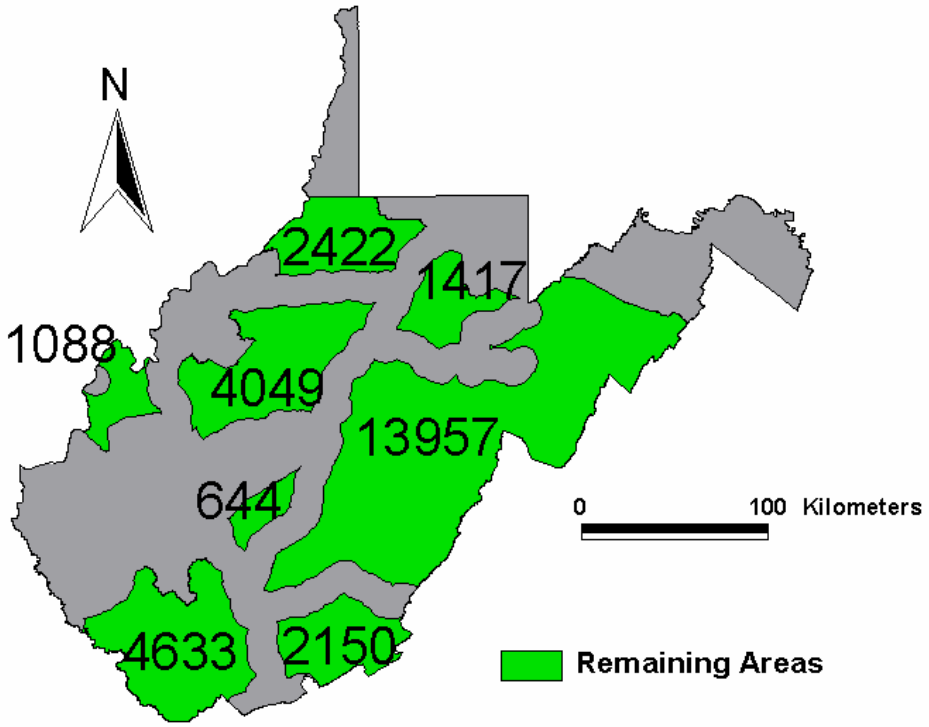


Figure 14. Three areas selected by WVDNR for Stage 2 habitat analysis and social feasibility.

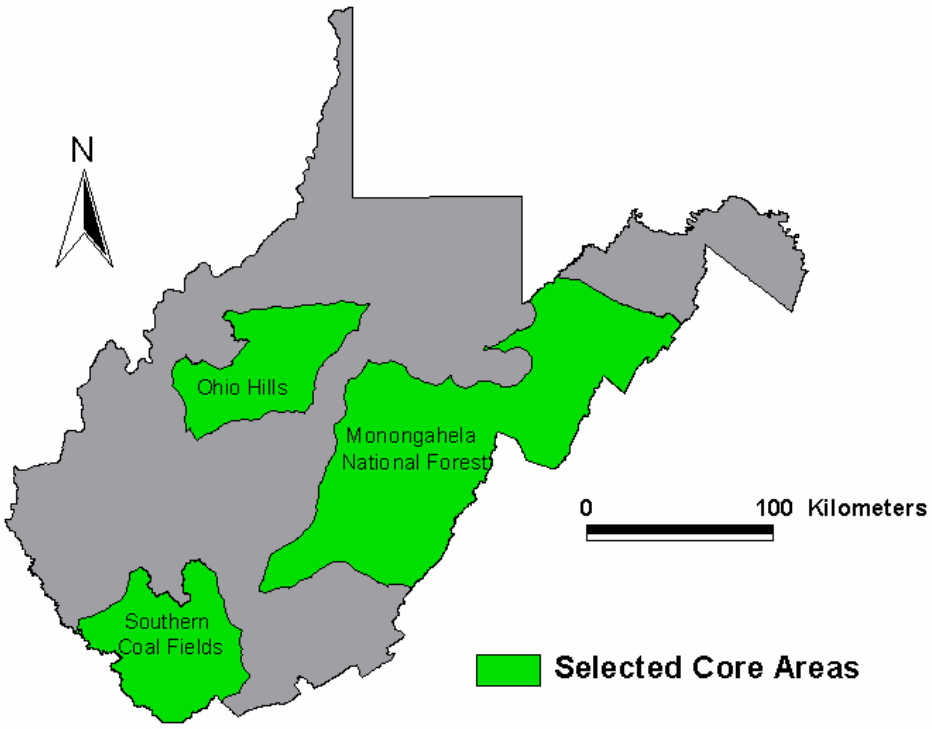
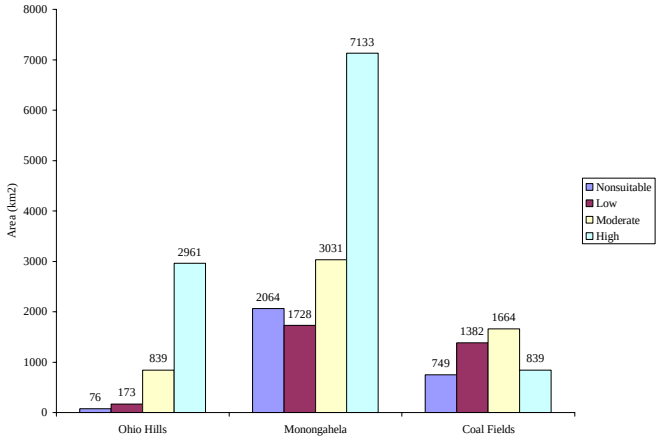
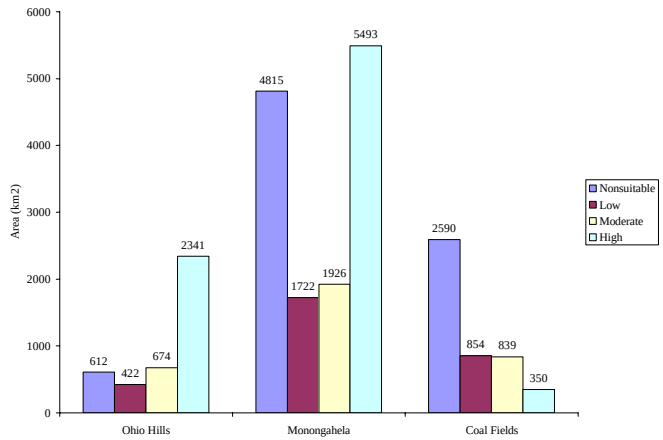


Figure 15. The amount of suitable land cover in each of the remaining areas excluding the effects of road density with an assessment window radius of a) 1 km, b) 2.34 km, and c)3.68 km.

a)



b)



c)

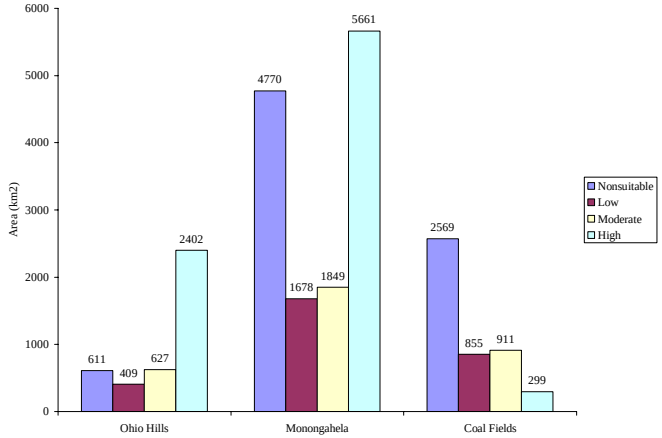


Figure 16. Habitat suitability results excluding road density using a 1 km radius assessment window in West Virginia, 2004.

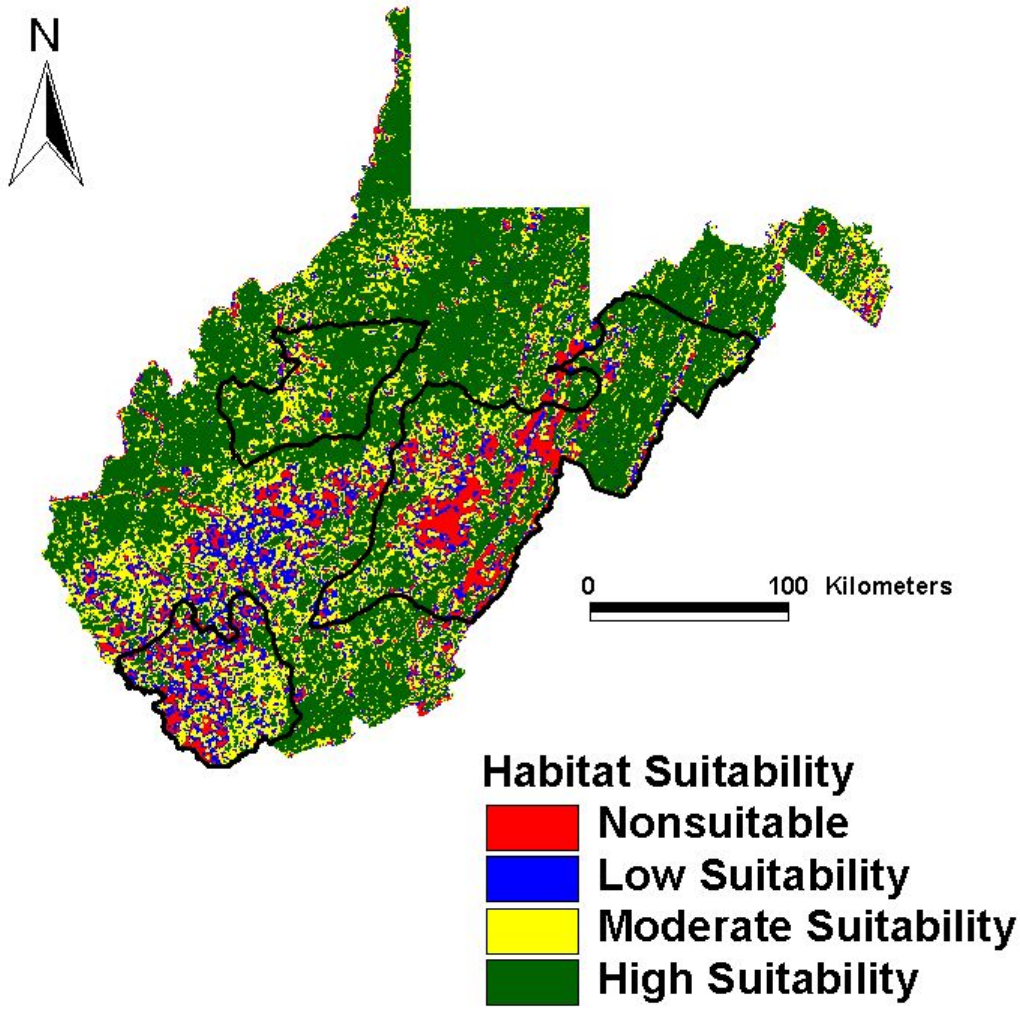


Figure 17. Road densities for a random grid in West Virginia in 2004. A 55 km^2 grid size was used because of the prevalence of unincorporated townships in West Virginia, so most municipal data is only available at the county level. 55 km^2 was the average home range of male and female elk in Kentucky.

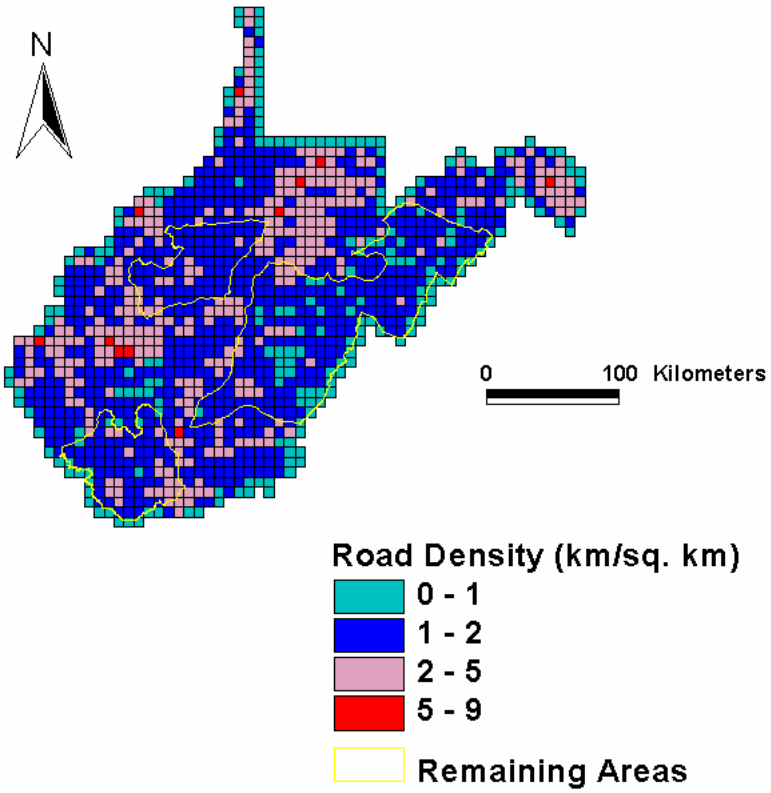


Figure 18. Habitat suitability results with road density using a 1 km radius assessment window in West Virginia, 2004.

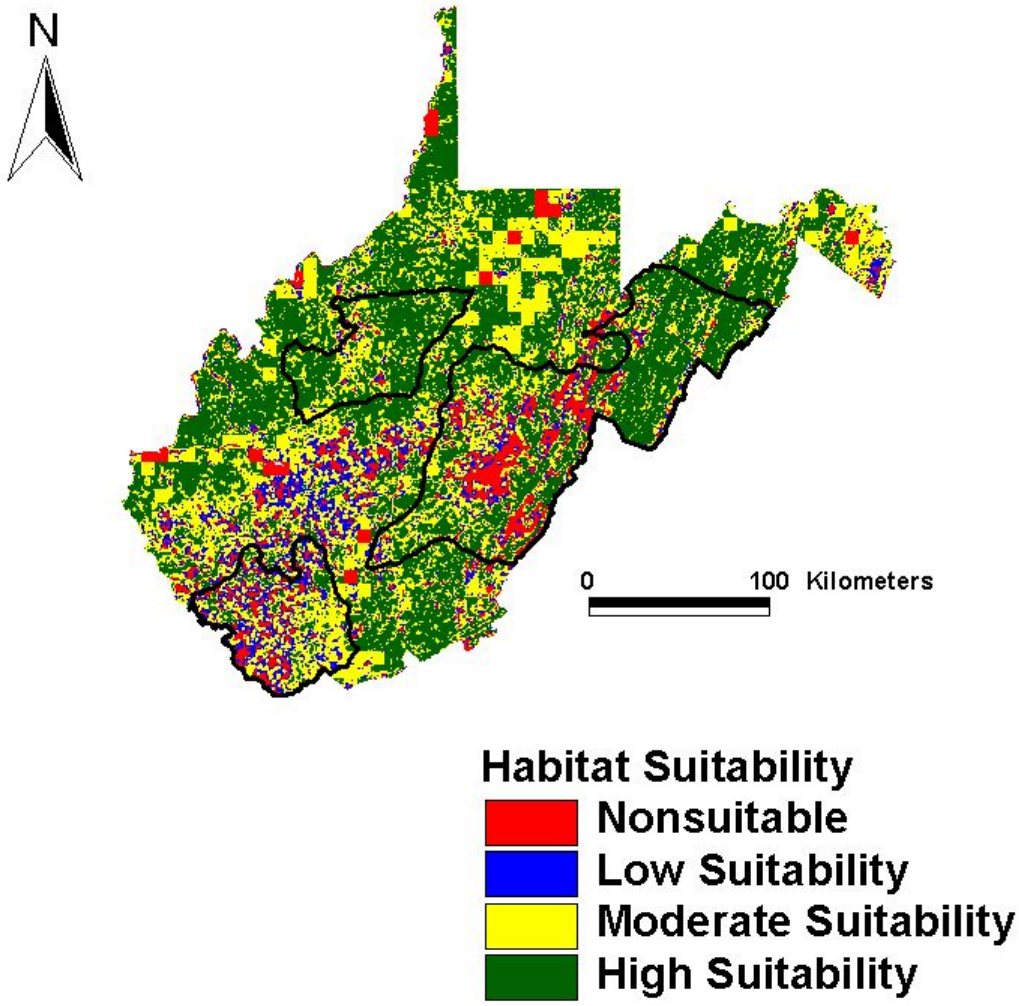
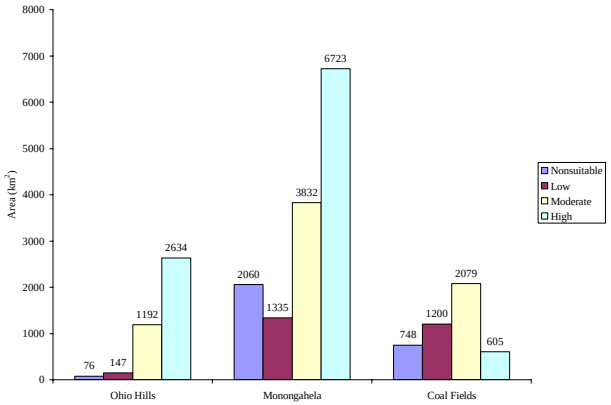
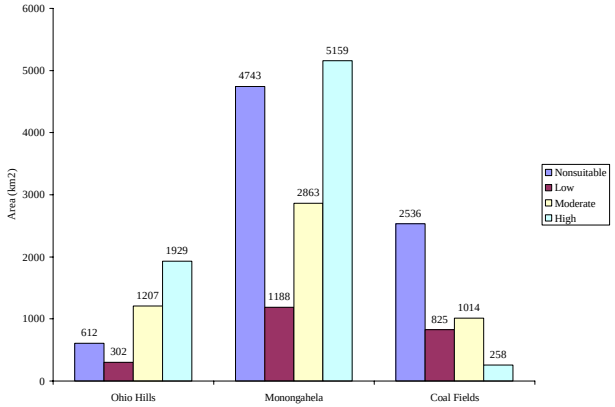


Figure 19. The amount of suitable land cover in each of the remaining areas including the effects of road density with an assessment window radius of a) 1 km, b) 2.34 km, and c)3.68 kfm.

a)



b)



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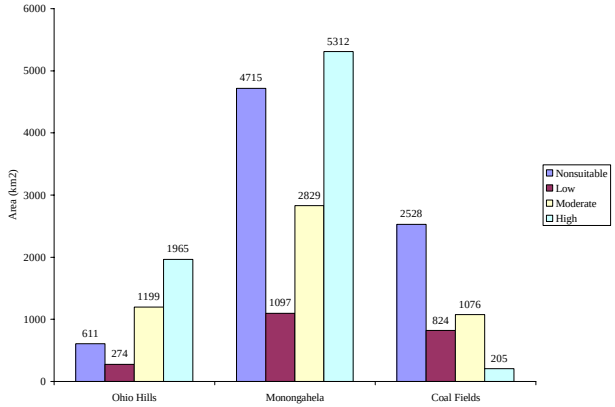


Figure 20. Habitat suitability results with road density using a 2.34 km radius assessment window in West Virginia, 2004.

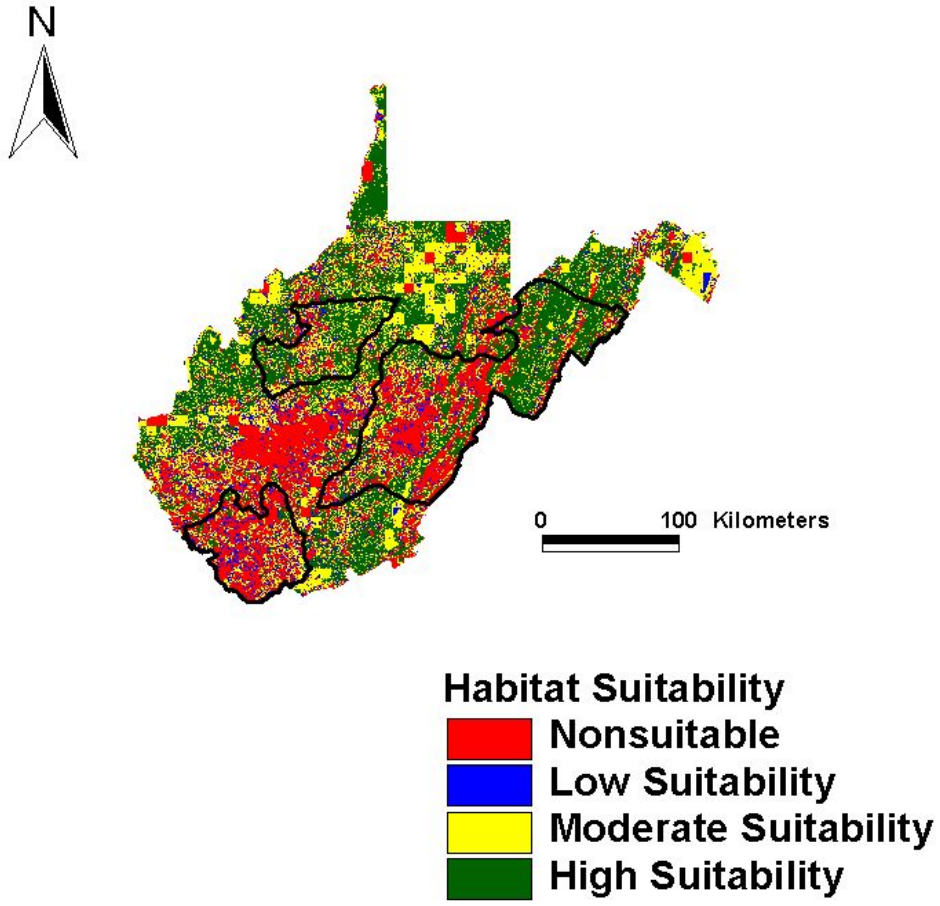


Figure 21. Habitat suitability results with road density using a 3.68 km radius assessment window in West Virginia, 2004.

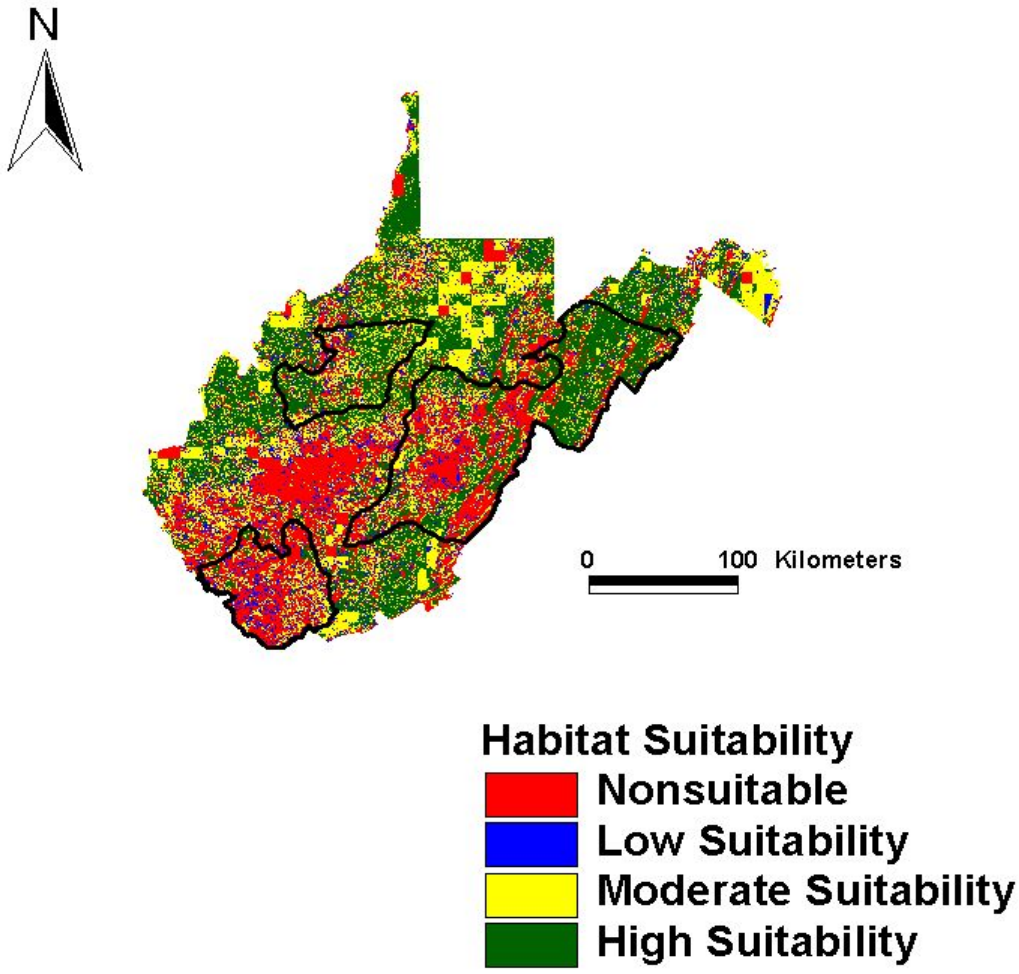


Figure 22. Habitat suitability results excluding road density using a 2.34 km radius assessment window in West Virginia, 2004.

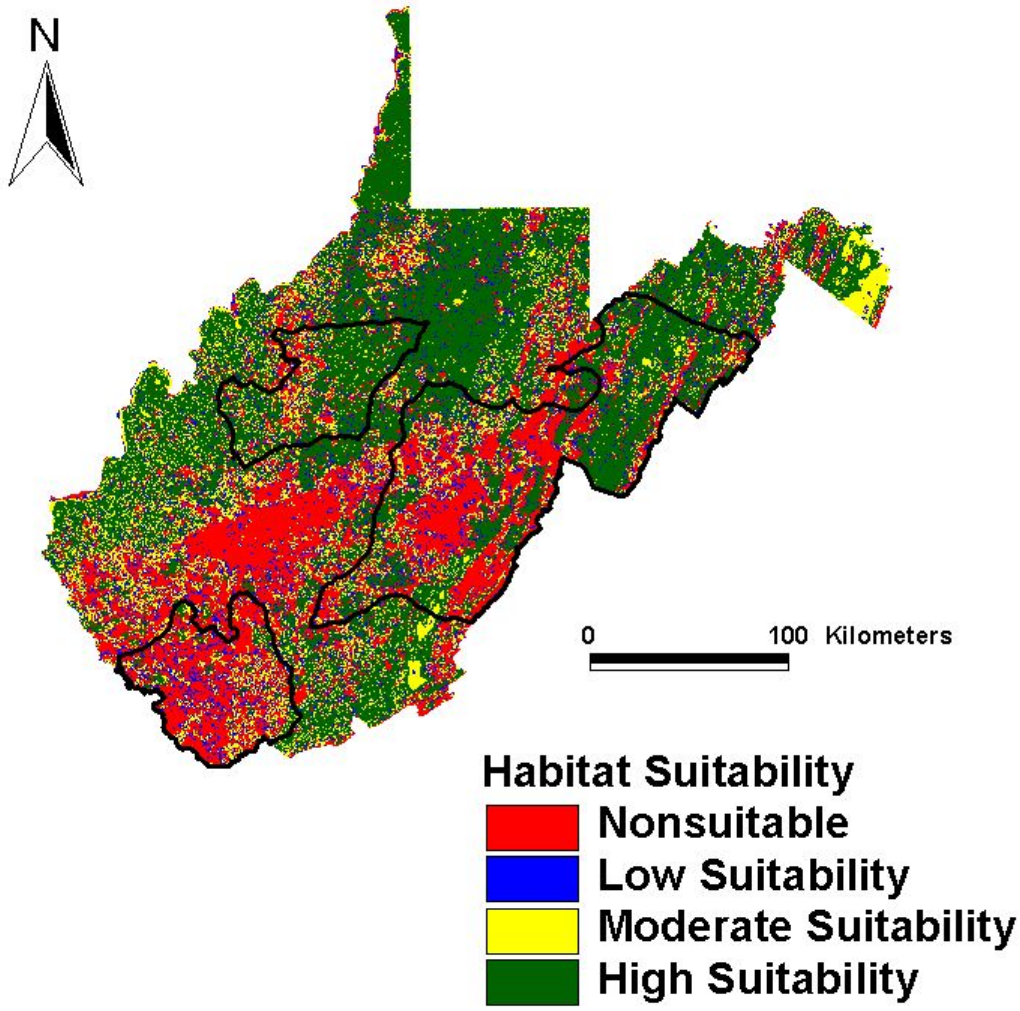
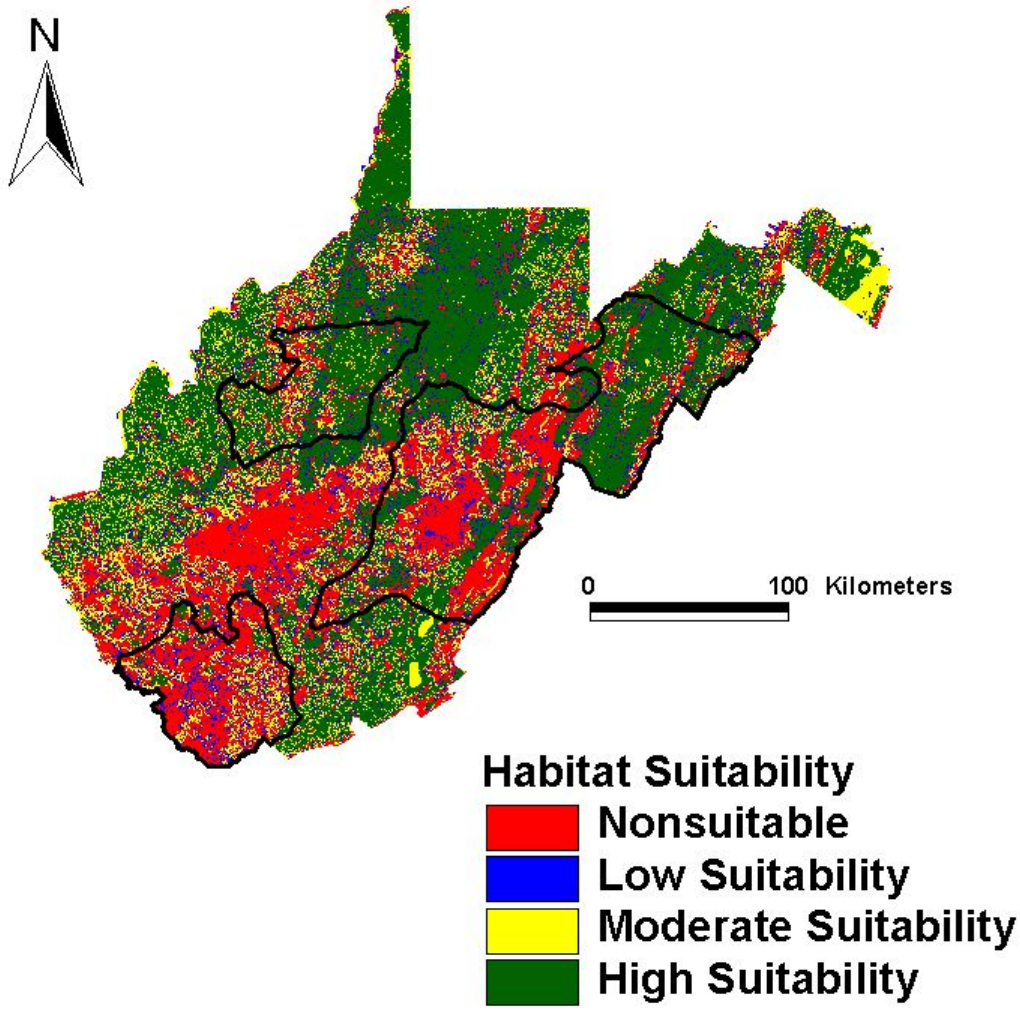
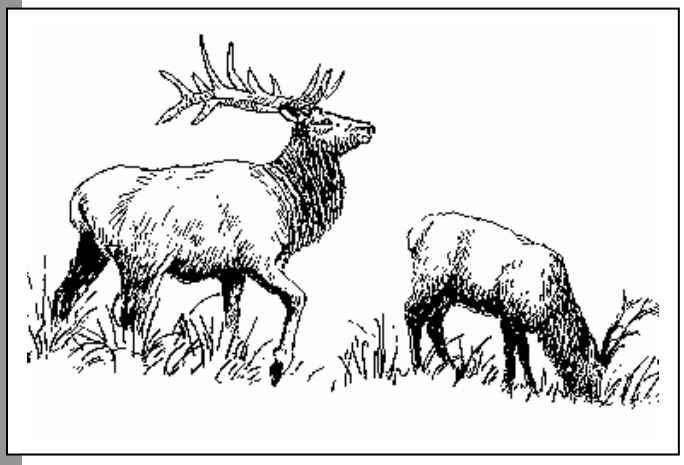


Figure 23. Habitat suitability results excluding road density using a 3.68 km radius assessment window in West Virginia, 2004.



Social Feasibility of Restoring Elk to West Virginia



November 2005

HDRU Series No 05-3

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EXECUTIVE SUMMARY

This report describes the potential social feasibility and agency-related costs and benefits of restoring elk to West Virginia, and is a companion to a report by Zyzik and Porter (2005) that describes biological feasibility. Zyzik and Porter identify eight geographic areas >500km^2 that include all or parts of 34 counties. These 34 counties are the basis for our assessment of potential social feasibility. It should be noted that the context for our work is best described as a preliminary study. Should it be shown that biological and social feasibility exist at suitable for the West Virginia DNR to consider restoration, a specific restoration proposal likely would be brought forth, perhaps containing one or more alternatives. The social and economic impacts of those specific proposals would need further study and public input. The actual process of determining whether restoration should proceed will occur under appropriate guidelines developed by the West Virginia DNR.

Assessment of Potential Social Feasibility

We used a multiple-methods approach for assessing potential social feasibility. First, we applied a combination of six social and economic variables to determine a social feasibility index (SFI) for each county. SFI provides a relative (not absolute) assessment of each county's potential capacity to identify and take advantage of possible restoration-related benefits and/or identify and overcome possible restoration-related problems. Thus, the SFI provides a context for understanding the social context within which elk restoration might be considered at the local level by residents who would be most likely to experience any positive or negative impacts of elk restoration. Counties with various SFI designations were distributed differently throughout the three largest areas (>4,000km^2). In consultation with staff from the West Virginia DNR and using SFI designations to help in the decision, we selected the eastern area (with a mix of SFI designations from low to high) and the southern area (with all but one of the counties having a moderate SFI) as study sites within which we mailed surveys to 600 randomly selected households to assess public attitudes toward elk restoration.

Social and demographic variables revealed that respondents from both areas reflected a broad cross-section of the public as expected based on our sampling strategy. Overall, respondents in both areas have some misperceptions about both elk and deer, and many respondents indicated they did not know answers to specific questions assessing their objective knowledge about deer and elk. Nonetheless, we found substantial correspondence for both study areas between people's experiences with deer in their counties and their desire for future deer population size. Those evaluating deer as mostly a problem for people in their county wanted a substantial decrease in the deer population, whereas those evaluating deer as mostly beneficial wanted either no change or a slight increase in deer. Further, respondents based their expectations of possible experiences with elk on their current experiences with deer. Apparently, many respondents used their real experiences with deer as a foundation for developing expectations about whether elk would be beneficial or problematic in their county.

A substantial majority of respondents in both areas have a positive attitude about the idea of elk restoration occurring in their county. About three-quarters of respondents in the southern area have a positive attitude toward restoration, and about two-thirds of respondents in the

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eastern area support restoration. When asked to evaluate each of 10 possible impacts of elk restoration, in terms of whether those impacts would be good or bad, and whether they were likely to occur or not, >75% of respondents in both areas evaluated the possible impacts positively. That is, even if they believed some impacts would be bad, they did not believe they would happen, and thus would not be a concern in their county. The major exceptions were that respondents in the eastern area believed that two impacts – drivers paying for repairs from elk-car accidents and elk damaging crops on farms – would be bad and were likely to occur. Only small minorities of respondents in the southern area evaluated negatively any of the ten possible impacts we examined.

In both study areas, most respondents believed that three impacts would be good and likely to occur: (1) increase in tourism, (2) preservation of elk as a species, and (3) return of a missing component of wilderness. The latter two beliefs certainly are not surprising and are reflective of values expressed broadly by the American public. That an increase in tourism was evaluated positively by respondents in both areas likely reflects a desire for economic diversification in those areas. However, the belief that an increase in tourism would occur in both areas may not reflect reality given the different SFI designations in the two areas, indicating differential capacity to reap the benefits of restoration and to deal with restoration-related problems. Correspondence analysis comparing SFI and attitude toward restoration showed that respondents in the eastern area may be more realistic in their expectations for taking advantage of possible benefits and dealing with possible problems, compared to respondents from the southern area.

Assessment of Costs and Benefits to WV DNR

Assumptions guiding this assessment were to consider: (1) only economic costs and benefits to West Virginia DNR, not to individuals or communities; (2) a 20-year time horizon, (3) an active restoration scenario in the eastern study area (i.e., translocation of source animals from another state or province) but a passive restoration scenario in the southern study because of its nearness to an elk population in Kentucky, and (4) identification of basic categories of costs and benefits based on experiences of other states and provinces where elk restoration had occurred, given that exact costs and benefits are impossible to determine.

Categories of costs for active restoration include: capturing elk in donor states or provinces, disease assessment and inoculation, transporting elk, establishing release sites, post-release monitoring, public communication efforts, and hunting-related activities. Categories of costs for passive restoration include at least: monitoring of elk moving into the state, public communication efforts pertaining to those elk, and hunting-related costs. Categories of tangible, economic benefits to WV DNR would be similar under either restoration scenario: revenue from sale of hunting permits, and the opportunity to leverage additional funds for wildlife conservation.

Virtually all the key informants interviewed from states and provinces that have restored elk made it clear that elk restoration (like all other wildlife management activities) had higher short- and long-term costs compared to economic benefits (i.e., revenue). However, informants also unanimously mentioned the importance of intangible benefits to the state wildlife agency in

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terms of public relations and goodwill. They stressed the importance of communicating with the public about restoration efforts, and the need to help the public develop realistic expectations about potential positive and negative impacts of having elk in the state.

Study Conclusions

- Although public attitudes toward elk and the possibility of elk restoration in West Virginia generally were positive in both eastern and southern study areas, attitude data should not be mistaken as a vote for or against restoration with any degree of finality. Rather the findings indicate how people thought about the issue at the time they were surveyed.

- Factors affecting public attitudes toward elk restoration that were identified through regression analyses seemed logical and reflected factors identified in other studies of public attitudes toward wildlife restoration, especially whether respondents' liked or did not like elk as an animal. However, some of the factors may be of concern because they reflect respondents' overall low objective knowledge about elk as well as questionable perceptions about whether particular restoration-related impacts they evaluated as being "good" or "bad" for their county were likely or not to occur in their county.

- The degree to which respondents' beliefs about possible impacts of elk restoration reflect what actually would happen if elk were restored is uncertain, in part, because of differences among counties in the two study areas in terms of their of "potential community capacity" to take advantage of possible elk-related benefits and address possible elk-related problems, as determined through a county-level social and economic variables combined into a social feasibility index (SFI) with four levels: low, moderate worsening, moderate improving, and high.

- In general, counties with high SFI likely have the greatest potential capacity to identify and prevent/mitigate negative impacts, and to identify and realize positive impacts. Counties with low SFI are least likely to benefit from wildlife restoration, and most likely to experience, with little ability to mitigate, negative consequences of restoration. However, **a designation of high SFI does not guarantee that a county will benefit or that possible benefits will be consistent with local goals, nor does it indicate that a county will desire restoration. Further, a designation of moderate or even low SFI does not preclude a county from benefiting, comparing restoration consequences and local goals, or pursuing the idea of restoration.** Rather, SFI provides insights into the social and institutional context within which counties can discuss how restoration might affect them and decide whether they may want to request WV DNR to pursue elk restoration.

- Five of six counties in the southern study area were designated with moderate worsening SFI, and one was designated with high SFI. Strong support for elk restoration among respondents from that area may be based on unrealistic expectations about their capacity to address possible elk-related problems and to experience possible elk-related benefits. They generally believed that possible problems from elk restoration would not occur in

their county, and that possible benefits – especially an increase in tourism – were likely to occur. However, counties in the southern area have relatively limited infrastructure in place to realize tangible, economic benefits from tourism.

- The eastern study area contained the full spectrum of SFI designations (i.e., low, moderate worsening, moderate improving, and high). If respondents from the southern area were possibly over-optimistic about their capacity to experience benefits and address problems, respondents from the eastern area may have been somewhat pessimistic, especially in counties designated with high SFI. Respondents from those counties were split in terms of their attitudes toward elk restoration. Those with a negative attitude generally believed that any impacts of elk restoration would be negative and that most would occur in their county, including an increase in tourism, preservation of elk as a species, and return of a missing component of wilderness. Despite their high potential capacity to address problems, their negative attitude toward restoration may have reflected a perception that they would be overwhelmed with problems. Those with positive attitudes evaluated some possible impacts as benefits and some as problems, and generally believed that positive impacts were more likely to occur than negative ones.

- Overall social feasibility is higher in the eastern study area than in the southern study area, given high levels of public support for elk restoration and the designation of many counties in the eastern area as having "moderate improving" or "high" SFI. However, because no counties in the southern area were designated with "low" SFI and public support for restoration was even higher there than in the eastern area, **social feasibility is sufficient in both study areas for WV DNR to discuss and make a decision about elk restoration with local residents.**

- Such community-based discussions would provide an opportunity to explore the validity of respondents' evaluations of possible elk-related impacts, particularly in light of the differential SFI designations. Support was high in both study areas for local residents to share with WV DNR responsibility for providing input and making a decision about restoration, and for WV DNR to take the greatest responsibility for implementing management actions stemming from a decision.

- These findings support the concept of "co-management" in which wildlife management professionals work in tandem with local stakeholders to make decisions about issues that are likely to affect the local area. Taking an inquisitive approach to decision making by surveying people about their attitudes and beliefs regarding restoration provides invaluable information to the wildlife agency. However, because attitudes can change quickly if residents believe a decision is being "imposed on them by outside forces," even greater benefit to the wildlife agency can result from engaging in a co-management approach to making decisions about restoration in areas that have the highest potential capacity to do so.

- A co-management approach to decisions about whether and/or how to restore elk (e.g., passive vs. active) may be necessary given the potentially high economic cost/benefit ratio for WV DNR. Other state and provincial wildlife agencies contacted for this study

indicated that economic costs usually far outpaced economic benefits, particularly in the short-term (e.g., <20 years after restoration). Even after elk were well-enough established to support revenue-generating hunting opportunities, substantial annual costs were incurred for communicating about and addressing elk-related problems that typically accompanied an expanding elk population.

- Two other important economic considerations were identified as germane to a wildlife agency's decision to restore elk actively or to passively allow elk to expand to new areas. First, various conservation organizations, especially the Rocky Mountain Elk Foundation (RMEF), had made substantial financial and logistical contributions to elk restoration in other states and provinces. Direct economic costs of restoration were too great for any wildlife agency to bear without the considerable help of RMEF and other groups. Second, the more-intangible, public relations benefits to the agency of restoring elk were substantial although hard to document in terms of direct economic benefits.

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ACKNOWLEDGMENTS

We greatly appreciate the support and guidance of various staff from WV DNR, including, Jim Crum, Jim Evans, Dick Hall, and Paul Johansen. Jim Crum, in particular, provided invaluable assistance in making contacts with key people on the project, showing the senior author key areas in the eastern study area, providing insights about wildlife management regulations and policies in West Virginia, obtaining access to a flight over study areas, and reviewing parts of this report.

Several staff and volunteers from Rocky Mountain Elk Foundation provided feedback, assistance with the contract, and insights about elk restoration in other parts of the country. Staff who provided assistance included John Mechler, Dale Nolan, Tom Toman, and Ron White. West Virginia volunteers included Brian Satterfield, Dale Smith, and Jeffrey Sperry.

William F. Porter, Jonathan Zyzik, collaborators from SUNY-ESF, were instrumental in helping to secure the grant, conducting the preliminary coarse screening to identify potential study sites, and sharing data and insights.

Numerous colleagues from the Human Dimensions Research Unit in the Department of Natural Resources at Cornell University provided assistance with the project. Nancy Connelly helped with survey sampling and supervised implementation. Karlene Smith collected social and economic data to develop the social feasibility index, and implemented the mail surveys. Margie Peech helped with reports and slide presentations. Marisa Adler and Jolene Tam conducted telephone interviews with non-respondents to the mail survey.

Insights and data about costs/benefits of elk restoration to wildlife agencies were provided by the following individuals: Tom Barnes, Jonathan Day, and Jeff Larkin (Kentucky); Dean Beyer (Michigan); Josef Hamr (Ontario); Lisa Muller (Tennessee); and Keith Warnke (Wisconsin).

Funding for this study was provided by the Rocky Mountain Elk Foundation through the West Virginia Division of Natural Resources.

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INTRODUCTION

Historically, the eastern subspecies of elk (*Cervus elaphus canadensis)* occurred in what is now the eastern U.S., including West Virginia, at the time of European colonization. Increased harvest of elk for private and commercial use, along with habitat alteration, resulted in extirpation of populations east of the Mississippi River by the late 1800's (Bryant and Maser 1982). In West Virginia, elk apparently were most abundant in the higher mountain regions. Shoemaker (1939) reported that elk were found near the headwaters of the Tygart and Greenbriar rivers as late as 1875. These animals probably were the last survivors. No elk restoration programs have been initiated in West Virginia historically. As of the time of this study (2003-2005), a very small number of elk are known to have entered southwestern West Virginia from the elk restoration program in neighboring Kentucky.

As with any wildlife species in West Virginia, final decisions about management of elk (including decisions about whether elk can or should be restored) rest with the West Virginia Division of Natural Resources (DNR). The Rocky Mountain Elk Foundation (RMEF) and West Virginia DNR personnel worked closely to ensure that pertinent information needed to make a decision about restoration of elk in West Virginia was obtained. Specifically, these organizations provided insights about elk management and restoration across the nation as well as state-specific policy guidelines for a multi-phase, step-wise assessment of the biological and social feasibility.

The context for our work is best described as a preliminary study. Should it be shown that biological and social feasibility exist at suitable for the West Virginia DNR to consider restoration, a specific restoration proposal likely would be brought forth, perhaps containing one or more alternatives. The social and economic impacts of those specific proposals would need further study and public input. The actual process of determining whether restoration should proceed will occur under appropriate guidelines developed by the West Virginia DNR. That process likely would require input at the local level that is beyond the scope of this feasibility study. This project should not be seen as a substitute for that process. Rather, this research will help communities, decision makers, and the public understand the likely general biological, social and economic impacts of elk restoration and set the stage for further discussion and perhaps, specific restoration proposals.

Study Objectives

1. Assess the social feasibility of elk restoration using a multi-stage approach including profiles of the social infrastructure in counties within potentially suitable areas of West Virginia and public surveys of attitudes about the possibility of elk restoration.

2. Conduct a cost-benefit analysis with an itemized accounting of cost and benefit variables, including in-depth analysis of long-term management costs to the West Virginia DNR, assuming restoration efforts were undertaken and successful.

Organization of This Report

The remainder of this report is organized around these objectives. A methods section follows, and specific methods pertaining to each objective is described in a subsection. Study findings are similarly presented in subsections within a results section.

METHODS

Social Feasibility Objective

Information pertaining to public attitudes, including preferences and concerns related to elk restoration, ultimately will be an important part of decision making, perhaps at several levels (e.g., local communities, counties, West Virginia DNR, other stakeholder groups). Toward that end, some survey work was conducted as part of this effort. Indeed, assessments of public attitudes toward restoration of a particular species have been used widely by wildlife agency decision makers to assess the degree to which wildlife restoration is socially feasible (e.g., Parker 1990, Reading and Kellert 1993, Lohr et al. 1996, Pate et al. 1996, Schoenecker and Shaw 1997, Merrill et al. 1997, McClafferty and Parkhurst 2001, and Bowman et al. 2004). Level of support or opposition for restoration is used as an index to feasibility, and factors affecting attitudes usually are identified. Attitudinal data may be particularly useful when restoration of an endangered species is mandated by law and biological feasibility is high only in a limited geographic range (Griffith et al. 1989). In those situations, knowledge of factors affecting stakeholders' attitudes about restoration can be applied to communication and education programs to enhance support for the idea of restoration or for management actions needed to implement restoration successfully (e.g., Kellert 1991, Clarke et al. 2000).

Rationale for Using a Combination of Approaches:

Several issues diminish the utility of public attitudes about restoration as a sole index of social feasibility. First, public attitudes reflect respondents' feelings at a particular point in time, but can change substantially from one time period to another (e.g., Heberlein 1976, Responsive Management 1996, Enck and Brown 2002). Second, attitude data by themselves do not determine feasibility. Is 75% support adequate, is 55%, or even 33% if communication and education actions are used to increase support? Decision makers need contextual information to understand the relationship between attitude data and feasibility (Enck and Bath 2001, MacDonald et al. 2002).

Another issue that diminishes the utility of attitudinal data as a sole index of social feasibility is that respondents' attitudes about restoration may be based on faulty information or misperceptions pertaining to hypothetical impacts, rather than direct experiences *in that location* with the species to be restored (Lauber and Knuth 1998). For example, the probability may be low that wolves will prey on livestock (Thompson 1993) or that moose will cause vehicle accidents (Hicks and McGowan 1992). Yet, levels of concern about those issues may be quite high (e.g., Bath 1989, Lauber and Knuth 1998, respectively). To provide better insight into stakeholders' perceptions, evaluative beliefs have been assessed whereby respondents are asked about the likelihood of various impacts occurring and about whether those impacts would be good or bad. This is an improvement over simple measures of level of support versus opposition

because respondents consider not only how much they might fear or desire a potential impact, but also whether they expect the impact to occur (Pate et al. 1996, Bright and Manfredo 1996). Even with this approach, survey respondents lack a foundation for assessing how realistic it might be for a particular impact to occur; the evaluation is based on respondents' perceptions, which may either accurately mirror or greatly differ from reality.

A potential way of addressing these challenges, and for developing a more reliable index of social feasibility is to frame decision making within the context of actual experiences of local residents. That is, social feasibility can be related to respondents' history of living with change in the local area. Residents of any locality have experiences every day identifying opportunities and challenges associated with change in a variety of dimensions of community life. Sometimes change occurs slowly (e.g., loss of tax base due to successive industrial plant closings). Other changes may occur suddenly or unexpectedly (e.g., natural disasters).

Restoration of elk, if it occurs, could bring various changes to people living in the area. For example, restoration of elk could result in herbivory on agricultural, ornamental, or commercially important forest tree species. Restoration also could bring new visitors who want to view or listen to elk. To local residents, visitors have the potential to be either a new source of revenue or an added burden (e.g., in terms of needed services, crowding, and soil and vegetation trampling). Specific kinds of positive or negative impacts probably would not be known until they occurred, but restoration undoubtedly would bring change.

Communities at the local municipal level (i.e., counties in West Virginia), rather than individuals, are a useful scale at which to consider the potential impacts and changes that could be associated with elk restoration. Although impacts from elk restoration would be felt across the area where elk were restored, possible impacts associated with those changes would not be experienced the same way by all counties. Each county has its own leadership, budget, vision for the future, and unique social characteristics.

The unique social and economic situations in the various counties provide each with a different capacity to respond to change. This capacity has been referred to variously as community resiliency (Harris et al. 1996), vitality (McNamara and Deaton 1996), or well-being (Eberts and Khawaga 1988). Regardless of the name, community capacity is an index if the degree to which a county can anticipate and deal with impacts related to change (Swanson 1996). When compared among a set of counties, this capacity can indicate the relative capacity of the county to use wildlife restoration to its advantage. Assessment of this capacity can provide the context and foundation for exploring attitudes and beliefs about restoration (Enck et al. 1998, Enck and Brown 2002).

Profiling Communities to Create a Social Feasibility Index (SFI):

To identify geographic areas of West Virginia to consider for the feasibility assessment, Zyzik and Porter (2005) applied a coarse-screen filter to the state following a procedure described in Didier and Porter (1999). They eliminated from consideration all counties having $\geq$15% of their land area devoted to agriculture, and all counties designated by the U.S. Census Bureau as "metropolitan" (census.gov/population/www/estimates/metrodef.html). We then

profiled the social infrastructure (Enck et al. 1998) of the 34 remaining counties. We chose county as the most appropriate level local government because sub-county entities (e.g., towns or townships) do not occur in West Virginia.

To determine each county's relative capacity to identify and take advantage of possible restoration-related benefits and/or identify and overcome possible restoration-related problems, we obtained social and economic data for the 34 counties under consideration. Then we applied these data in a 3-stage key developed by Enck et al. (1998) to compare current and recent trend in social infrastructure for all communities (Figure 1).

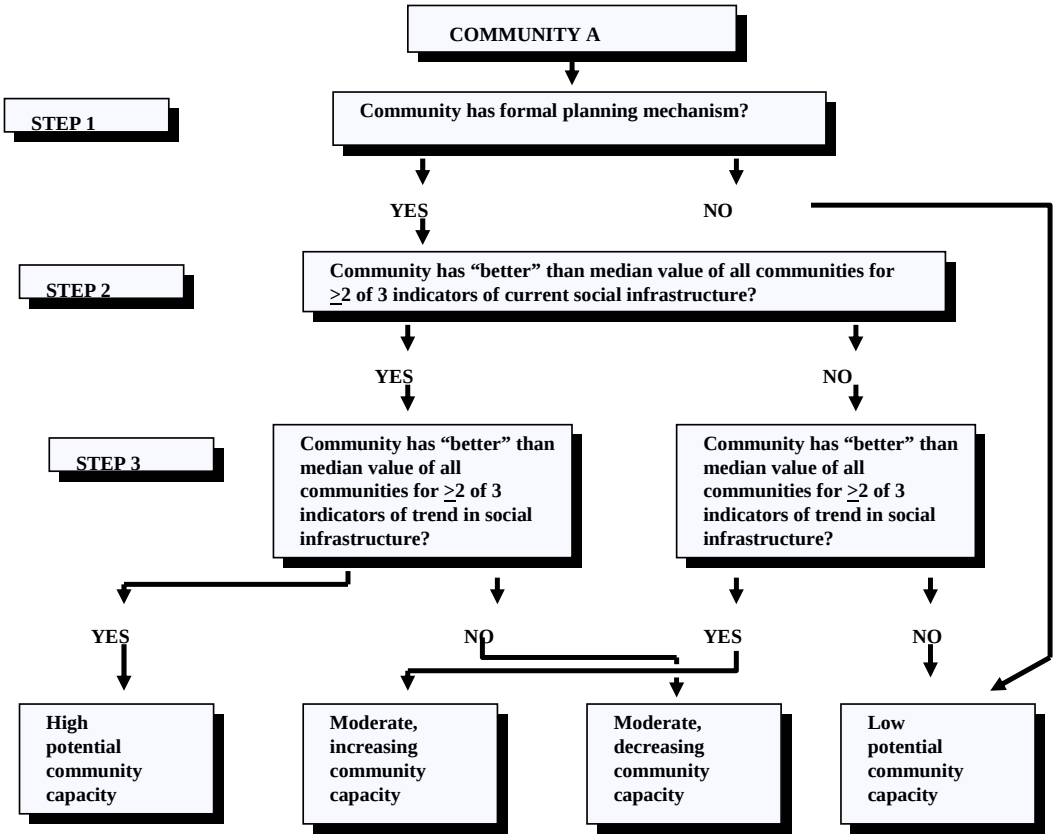

Figure 1. Three-step key for determining a community's social feasibility index (SFI), or relative potential capacity for responding to or taking advantage of elk restoration.

The first step in the key is intended to distinguish between counties with a well-defined, legal mechanism for making decisions about their futures (i.e., a comprehensive plan) versus counties lacking such a mechanism. Counties with a comprehensive plan hypothetically are better able to take advantage of restoration-related opportunities (Enck et al. 1998). Conversely, communities that have not carefully considered their futures and how they want to manage those futures hypothetically are more likely to experience possible negative consequences of

restoration and be less likely to experience positive consequences. We eliminated this step from the methodology developed by Enck et al. (1998) because no counties had had time to fully develop a comprehensive plan since the passage of a state law in 2002 calling for each county to develop a plan.

Our profiling effort started with step two in the key, which identified counties that have demonstrated some success in achieving relatively high levels of well-being compared to other counties (Eberts and Khawaga 1988). We used a combination of three indicators for this step – Dependency Ratio (McNamara and Deaton 1996), per capita baseline expenditures, and per pupil education expenditures – because no single available indicator would adequately measure well-being. This second stage examines the "current condition" of a county's social infrastructure. Here, "current" pertains to the most recent point in time for which data are available. The three variables indicate the degree to which the social services in a county are strained (Dependency Ratio) and the degree to which people in the county invest in their own future (through baseline and education expenditures), relative to other counties.

The third stage in the key determined whether counties experienced improving or worsening trends in their social infrastructure. We used three variables – 1990-2000 trend in Dependency Ratio, trend in total population (census.gov/main/www/cen2000.htmls), and trend in property values (State of West Virginia 1997 and 2003). Both trend in Dependency Ratio and trend in total population indicate whether people are being retained in or attracted to the county. Trend in property values is an indicator of the extent to which people express confidence in the county by investing in property located there.

Interpretation of quantitative data for variables pertaining to Dependency Ratio, expenditures, and trends required the intermediate step of calculating a median value for each variable. For each of these six variables, we compared data for each county to the median values of the six variables for all 34 counties. Counties with "better" social infrastructures (and thus greater levels of potential social feasibility) are those which have values "better" than the median value. Greater potential social feasibility is associated with values above the overall median for baseline expenditures and education expenditures, but below the overall median for Dependency Ratio.

We converted trend data to percent change over time to standardize the data among counties. Then we compared percent change over time for each county with the median percent change for all counties. Thus, greater potential social feasibility was indicated by values above the median change in trend for total population, Dependency Ratio, and property values.

For the second and third stages, we determined the degree of consistency among the combined variables. Situational factors may affect the outcome for any of the variables used (e.g., counties containing a college may have a relatively high Dependency Ratio without contributing excessive strain on the county). For our analysis, an acceptable degree of consistency among variables existed if at least two of the three variables had values “better” than the median value. Which two of three variables were “better” than the median did not matter because all three variables were weighted equally.

Counties having a both a "better" current situation and a "better" recent trend compared to other counties were designated as having high potential social feasibility (Table 1). These counties have the greatest relative potential to realize benefits from restoration and deal with problems. Counties having both a "worse" current condition and a "worse" recent trend in their social infrastructures were designated as having low potential social feasibility. These counties are least likely to benefit from restoration, but are most likely (compared to other counties) to experience negative consequences from restoration because they likely lack capacity for mitigation.

Table 1. Relationship between (a) current condition of social infrastructure, (b) recent trends in condition of social infrastructure, and (c) level of community capacity as an index to potential social feasibility.

Current Condition of Social Infrastructure	Recent Trend in Social Infrastructure	
	Positive	Inconsistent or Negative
Strong	High potential social feasibility	Moderate but decreasing potential social feasibility
Weak	Moderate but increasing potential social feasibility	Low potential social feasibility

Counties designated as having moderate potential feasibility have demonstrated that they have some capacity to benefit from some local change such as restoration. However, several important barriers likely exist in these counties that negatively affect whether they could identify and take advantage of restoration-related benefits without important changes in social infrastructure. Also, counties with moderate potential are less likely than those with high potential feasibility designations to be able to address and successfully mitigate most negative consequences that may be associated with restoration.

A designation of high potential social feasibility does not guarantee that a county will benefit or that possible benefits will be consistent with goals, nor does it indicate that a county will desire restoration. Further, a designation of moderate potential or even low potential feasibility does not preclude a county from benefiting, comparing consequences and goals, or pursuing the idea of restoration. This research simply provides insights into the social and institutional context that presents the opportunity for counties to best discuss how restoration might affect them and decide whether they may want to pursue restoration.

Surveying Households to Assess Public Attitudes Toward Elk Restoration:

We developed a self-administered, mail-back questionnaire to assess public attitudes toward elk and the idea of elk restoration, and factors affecting those attitudes. We mailed questionnaires to a random sample of households in both the eastern (n = 600) and southern areas (n = 600), stratified by census block within each of those areas. We implemented the surveys beginning on 28 October 2003, using a 4-wave procedure similar to that described by Dillman (2000). Instructions sent with the questionnaires asked that the survey be completed by the adult who had had the most recent birthday in the household. To determine whether nonrespondents differed from respondents for attitude or belief questions, we completed telephone interviews with 50 nonrespondents to the mail survey from each of the two areas. The nonrespondent follow-up was conducted between 15 and 30 March 2004.

Attitudes and beliefs. We assessed attitudes toward elk restoration (RESTATT) using three questions: (1) Do you approve or disapprove of restoring elk to the county where you live in West Virginia; (2) Do you like or dislike the prospect of elk being restored to West Virginia; and (3) Is the idea of restoring elk to West Virginia a good idea or a bad idea? Each question had seven possible response categories ranging from +3 to -3, including 0 for "neither." We averaged responses to the three items to create a single 7-point index (Azjen and Fishbein 1980) that was highly reliable (Chronbach's $\alpha = 0.98$ and 0.95 for east and south areas, respectively.

We determined evaluative beliefs (Azjen and Fishbein 1980) about possible impacts of elk restoration in the mail survey through a series of ten items adapted from Enck and Brown (2000). For each possible impact, we asked subjects the extent to which they agreed or disagreed that each impact would happen in their county (i.e., belief strength). Then we asked them to consider whether each impact would be extremely, moderately, slightly, or neither good nor bad for their community (i.e., outcome evaluation). We developed a belief evaluation index (BELIEF1 to BELIEF10) by multiplying belief strength by outcome evaluation for each impact (Enck and Brown 2000).

For each respondent, the belief evaluation index could be either positive or negative for each impact. A positive index resulted if (1) the respondent agreed the impact would happen in his/her county and would be good, or (2) if the impact would be bad but the respondent disagreed that it would happen in his/her county. A negative index resulted if (1) the respondent believed the impact would be bad and agreed it would happen in his/her county, or (2) if the respondent disagreed that a good impact would happen locally.

Knowledge and issue importance. We determined objective knowledge in both the mail survey and nonrespondent follow-up by asking 8 “yes or no” questions about elk (with which they have no experience in West Virginia) and white-tailed deer ([*Odocoileus virginianus*] with which they have experience). Four of the questions focused on deer, and four focused on elk. For each ungulate, two correct responses were “yes,” and two correct responses were “no.” We created a knowledge index (KNOW) by summing the number of correct answers for each respondent. In addition, we evaluated respondents’ experiences with deer by asking them to indicate which of the following best described how deer currently affected their county: (a) “we benefit from deer and can deal with most problems deer cause,” (b) “we benefit to some degree

from having deer around, but we still experience some big problems from deer," or (c) "we experience more problems than benefits from deer." We determined respondents' expectations if elk restoration were to proceed by asking them which of the following best described what they though would happen: (a) 'we would benefit from elk and would be able to deal with most problems elk might cause," (b) "we would benefit to some degree, but we would still experience some big problems from elk," or (c) "we probably would experience more problems than benefits." Finally, we assessed importance of the issue of elk restoration, to respondents personally (PERSIMP) and to the well-being of their county (CNTYIMP) using 4-point scales, where 0 = not at all important and 3 = extremely important.

Perceptions of potential community capacity. We developed a self-assessment of community capacity in the mail survey by asking respondents to rate how their county compared to most other counties around it with respect to: (1) "amount of involvement by community groups in making your county a better place to live," (2) "quality of education for students in your county," and (3) "quality of basic services and facilities in your county." Each of the three questions was scaled from 1 (much lower) to 3 (about the same) to 5 (much higher). We summed responses to the three items to create a single index (COMCAP) that was highly reliable (Chronbach's $\alpha = 0.70$ and 0.61 for east and south areas, respectively).

Perceptions about level of co-management responsibility. The process of decision-making in the context of wildlife management involves several components including (a) having input from all potentially affected stakeholders, (b) having a mechanism for actually making the decision(s), and (c) having a way to carry out actions related to the decision(s). Responsibility for these components of the decision-making process could be taken on by one stakeholder group or shared among several.

We developed a question about each of these three components, and for each, asked respondents to the mail survey how much responsibility they believed should be taken by: (1) residents of your county, (2) local elected officials in your county, (3) offices of the WV DNR, (4) officials of nongovernmental conservation groups, and (5) WV residents living outside their county. Possible responses ranged from "no responsibility" to "a great deal of responsibility". Respondents also could indicate that they did not know how much responsibility a stakeholder group should take for a particular component of co-management.

Demographic and wildlife-related characteristics of respondents. We asked respondents to indicate their gender and the year in which they were born, which we subtracted from 2003 to determine their age. We also asked how many years they had lived in West Virginia, and to indicate the type of area in which they lived from a list of five possible categories (farm, rural-not a farm, village with <25,000 residents, small city with 25,000 to 49,999 residents, or large city with $\geq$50,000 residents). On both mail and telephone surveys we asked about participation in nine types of outdoor recreation. We used two questions in the mail survey to assess West Virginia residents' desired changes in local populations of deer (DEERPOP) and coyotes (COYPOP), from greatly decrease (-3), to no change (0), to greatly increase (+3).

We used two separate questions to assess respondents' (1) evaluations of their current experiences with deer in their county (DEEREVAL), and (2) expectations about likely

experiences with elk in their county if restoration were to proceed (ELKEVAL). Three response choices were offered for each of these two questions, with slight word changes to reflect current experiences with deer and what respondents thought *would* happen if elk were restored. "We benefit from deer and can deal with most problems deer cause" (would benefit from elk). "We benefit to some degree from having deer around, but we still experience some big problems from deer." "We experience more problems than benefits from deer."

Analyzing Data for Social Feasibility Objective:

We analyzed survey data using SPSS-X (SPSS, Inc. 1994), and used P=0.05 as the significance threshold for all analyses. We used descriptive statistics to determine means and standard errors, and to determine whether respondents from the two study areas differed in terms of their characteristics and experiences. We used stepwise multiple regression to assess factors affecting RESTATT. Because regression examines patterns of relationships among variables associated with individual respondents, we used data unadjusted for nonresponse bias. We selected P-in=0.05 and P-out=0.10; P-in must be less than P-out to prevent the same variable from being repeatedly entered and removed (SPSS, Inc. 1994).

We assessed whether untransformed data violated assumptions associated with linear multiple regression following procedures outlined by Neter et al. (1996). To examine whether multicollinearity existed among possible explanatory variables, we examined correlation coefficients and included no variables in the analysis with $r>0.5$. We assessed appropriateness of the linear regression function by plotting z-residuals against z-predicted values for all significant explanatory variables, and found no observable relationships. We also used plots of residuals and predicted values to assess equality of variance. Because we had no time-series data, we did not assess independence of error. We assessed normality by visually examining normal probability plots for all explanatory variables.

We used correspondence analysis to validate SFI as an index to "potential community capacity." Correspondence analysis examines relationship between $\geq$2 categorical variables, identifies underlying patterns that might not be evident through crosstabs procedures or regular Chi-square analyses, and plots those relationships graphically in a multi-dimensional space (Carroll et al. 1986). For all correspondence analyses, we used symmetrical normalization, which allows interpretation of distances between plotted points as Chi-square distances. We did not constraint the number of dimensions identified in the data.

The validation involved multiple steps, and was based on the important assumption that DEEREVAL reflected "*experienced* community capacity" or the capacity of persons living in a given county to take advantage of possible benefits and address possible problems faced by the county – not limited to, but certainly including those benefits and problems that could be related to restoration of a large ungulate. First, we examined the consistency of relationships between response categories for the variables DEEREVAL and DEERPOP to determine whether DEEREVAL was a reasonable measure of respondents' real experiences with a large ungulate. Next, we examined relationships between DEEREVAL and both COMCAP and SFI to determine if either of these indices to "*potential* community capacity" reflected respondents' experiences with deer. We used the combined data from both study areas for these analyses.

Cost-benefit Objective

In conjunction with J. Crum of the West Virginia DNR, we identified four basic assumptions to guide our cost-benefit assessment:

1. The assessment should focus on economic costs and benefits to West Virginia DNR only, not to individual landowners or communities;

2. We should use a 20-year time horizon for the assessment;

3. We should consider two different restoration scenarios because restoration in an eastern study area would require "active restoration" (i.e., translocation of source animals from another state or province), whereas restoration in a southern study area adjacent to an extant elk population in Kentucky might occur as "passive restoration" (i.e., as the elk population in Kentucky expands naturally).

4. The assessment should include identification of basic categories of costs and benefits based on experiences of other states and provinces where elk restoration had occurred, and should include "ball-park" costs and benefits, given that exact costs and benefits are impossible to determine.

To develop categories of costs and benefits based on experiences with other states and provinces, telephone interviews were conducted with staff from state/provincial wildlife agencies and researchers at universities in Kentucky, Michigan, Tennessee, Wisconsin, and Ontario.

RESULTS

Profiling Communities to Create a Social Feasibility Index (SFI)

Eliminating metropolitan and agricultural counties, and establishing an 8km buffer zone around 4-lane highways resulted in 8 areas >500km^2 (Figure 2). These areas included all or parts of 34 counties. Profiling of these 34 counties identified seven counties with high potential social feasibility, eight counties with moderate and increasing potential social feasibility, 11 with moderate but decreasing potential feasibility, eight counties with low potential feasibility (Figure 3). As noted previously, these measures compare each county against other counties in a relative sense. These results do not identify absolute measures of potential social feasibility. A county's designation of potential social feasibility could possibly change if a different set of counties were used in the comparison. Thus, a county identified as having high potential social feasibility in this instance may have a lower designation in a comparison with a different set of counties.

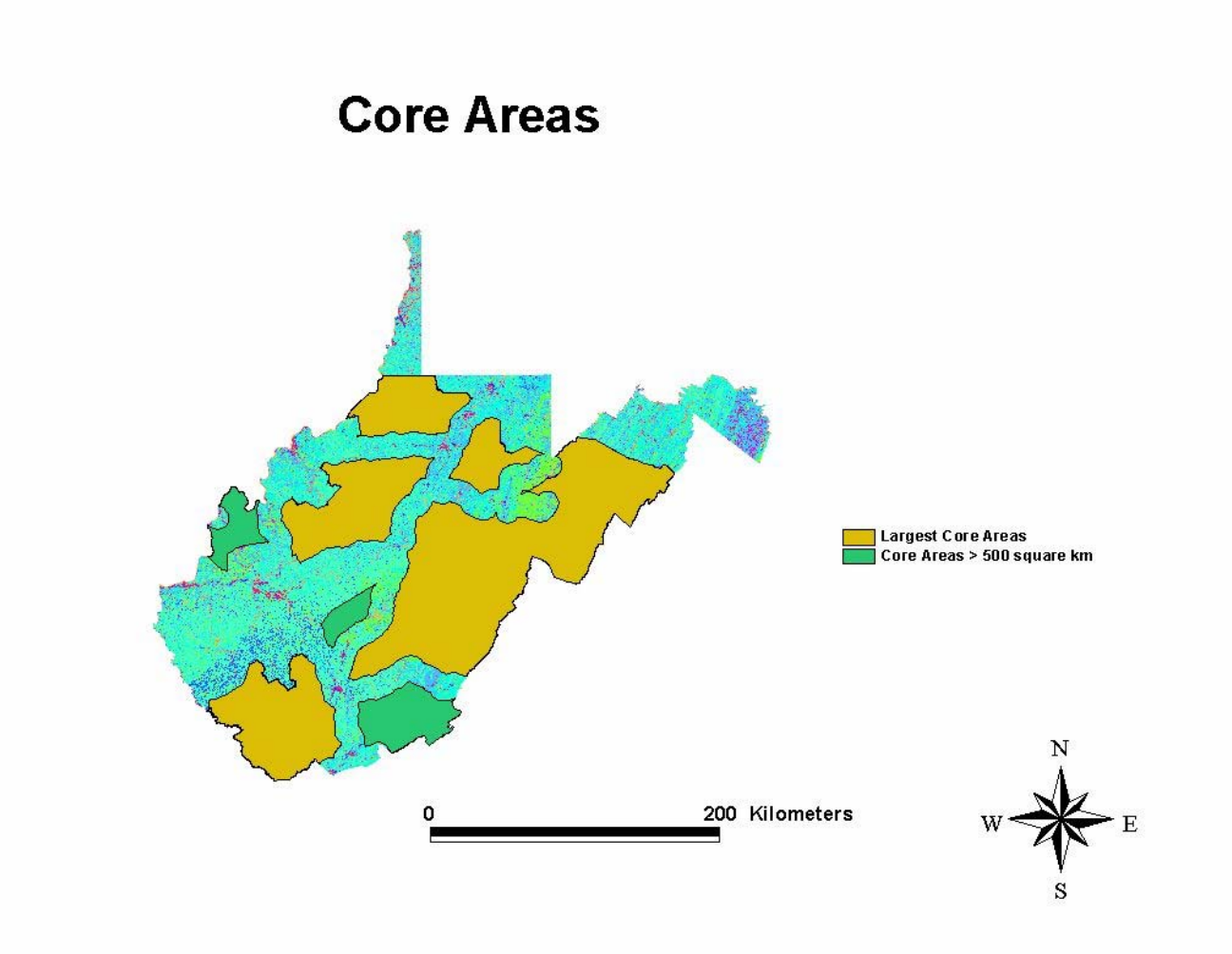

Figure 2. Geographic areas of West Virginia considered in an assessment of biological and social feasibility for restoring elk to the state in 2003-2005.

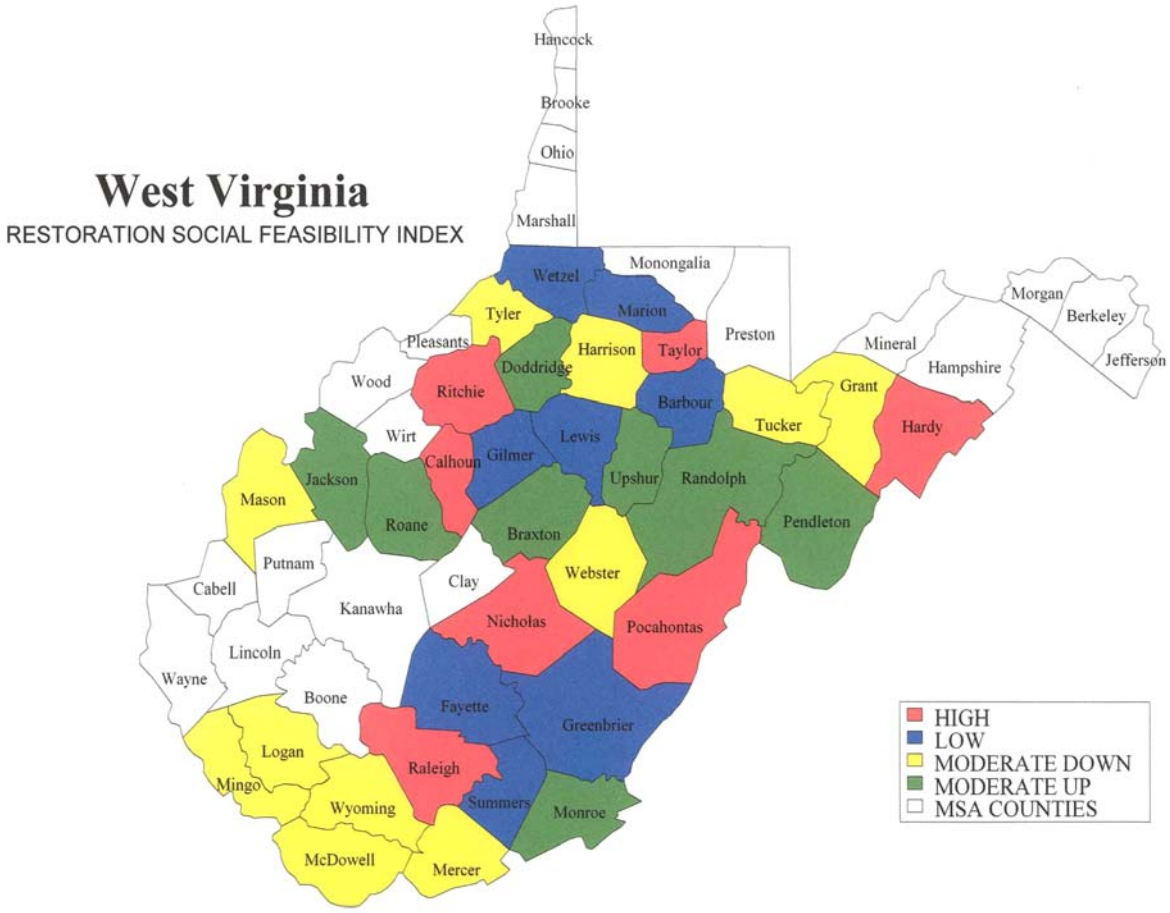

Figure 3. Social feasibility index (SFI) designations for 34 West Virginia counties being considered in an assessment of the social feasibility of restoring elk to the state, based on social and economic data in 2003.

Counties with various SFI designations were distributed differently throughout the three largest areas (Figure 4). The northern area was characterized by SFI designations of moderate and improving (three partial counties) and high (two partial counties), with only about 20% of the land area designated as low (two partial counties). The southern area was characterized mostly by SFI indices of moderate but worsening (five partial counties), with only about 15% of the land area designated as high (one partial county). The eastern area was the most diverse, with three partial or entire counties designated with a high SFI, four with moderate and improving, three with moderate but worsening, and three with low.

In consultation with staff from the West Virginia DNR, we selected the eastern and southern areas as study sites within which we would implement the mail survey to assess public attitudes toward elk restoration. The eastern area was the largest of the three areas, had the greatest amount of public land (National Forest), and was adjacent to public land (additional

National Forest land) across the state line in Virginia. Within the eastern area, 35% of the human population lived in areas we designated as having a high SFI, 37% moderate, and 28% low (census.gov/main/www/cen2000.htmls). The southern area is near the elk restoration zone across the state line in Kentucky and has similar land use patterns with the Kentucky area – in terms of timbering and mountain top removal mining. In this southern area, 81% of the human population lived in areas we designated as having a moderate SFI, and the remaining 19% lived in high SFI areas (census.gov/main/www/cen2000.htmls).

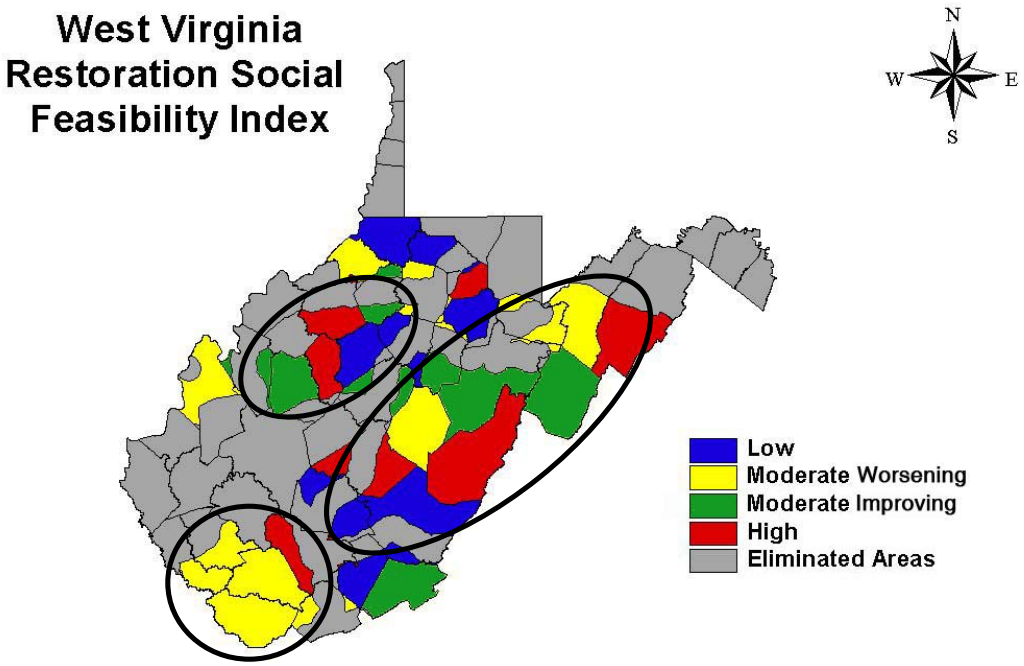

Figure 4. Identification of potential study areas for assessing the social feasibility of restoring elk to West Virginia, showing social feasibility index (SFI) designations for whole and partial counties within each area in 2003, based on county-level social and economic data.

Surveying Households to Assess Public Attitudes Toward Elk Restoration

Response to the mail survey. In the eastern area, the initial sample of 600 households resulted in 528 deliverable questionnaires and 232 useable returns (43.9% response rate). Fewer people responded from the southern area where the initial sample of 600 households resulted in 517 deliverable questionnaires and 169 useable returns (32.7%). Despite these relatively low response rates, the accuracy of our findings is sufficient to provide meaningful insights for decision making.

We make this statement because all studies of human behavioral characteristics and attitudes that involve sampling from a large population have a margin of error associated with them. This margin of error varies according to sample size, and the percentage of respondents giving a particular answer to each question (Cochran 1977). In this study, the maximum expected margin of error at the 95% confidence level for any question with dichotomous responses was ±6.6% for the eastern study area and ±7.7% for the southern study area (Table 2). That is, if 100 different samples of the same size were taken from the population of households in each study area, 95 times out of 100 the results obtained would vary no more than ±7.7 percentage points from the results that would be obtained if the entire population of households answered the question.

Table 2. Margins of error associated with dichotomous variables from mail surveys assessing public attitudes about restoring elk in eastern and southern study areas of West Virginia in 2003.

	Margin of error for	
Response percentage[a]	Eastern area	Southern area
10% or 90%	± 3.9%	± 4.6%
20% or 80%	± 5.2%	± 6.2%
30% or 70%	± 6.0%	± 6.7%
40% or 60%	± 6.4%	± 7.5%
50% or 50%	± 6.6%	± 7.7%

[a]Example: If 76.5% of respondents said they approved of elk restoration in the southern study area, the margin of error is no more than 6.2% (i.e., the estimate is that 70.3% to 82.7% of households approved of restoration).

We selected a random sample of 250 households that did not respond to the mail survey in each of the two areas to assess whether nonresponse bias existed in our findings. We called each household up to five times. From this sample, we completed 50 telephone interviews in each area.

We found no differences between respondents and nonrespondents on either study area with respect to attitudes toward elk or attitudes toward elk restoration. However, the issue of elk restoration was more important personally to respondents than to nonrespondetns in both the east area ($t = 2.19$, $df = 272$, $P<0.05$) and the south area ($t = 1.72$, $df = 216$, $P<0.05$).

Characteristics of respondents to the mail survey. Respondents from both areas reflected a broad cross-section of the public (Table 3). They reported a wide range in ages, years lived in West Virginia, and residential types. Females accounted for only about one-fifth to one-quarter of respondents from either area. Many respondents from both areas participated in a wide variety of wildlife-related and outdoor activities, including hunting, fishing, hiking, camping, wildlife feeding, and identification of wildlife species around their homes. Almost one-half of respondents on both areas took trips >1 mile from their homes to view wildlife, and those who did averaged 15-19 trips in the 12 months prior to the survey.

Objective knowledge about elk and deer. Overall, respondents from both areas had some misperceptions about both elk and deer, and many respondents indicated they did not know answers to specific questions (Table 4). Few respondents ($\leq$8.1%) in either study area knew that deer cause more economic damage to the forest industry than to agriculture in West Virginia each year. Relatively few ($\leq$28.5%) in either area knew that human injuries from deer-vehicle accidents usually are no more severe than human injuries from elk-vehicle accidents, in states with both elk and deer. A majority of respondents from the southern area were "not sure" about their responses to 4 of the 8 questions, including whether elk used to occur in West Virginia. In the eastern area, majorities were unsure about their responses to 2 of the 8 questions.

Summed knowledge scores were slightly higher for respondents in the eastern area (mean ELKKNOW = 4.4/8, range 0-7), compared to the southern area (mean ELKKNOW = 3.5/8, range = 0-7). For the four questions focused specifically on deer, respondents from the southern area (mean = 1.8/4, range = 0-4) were about as knowledgeable as respondents from the eastern area (mean = 2.1/4, range = 0-4).

Experiences with deer and expectations about elk. A majority of respondents from both study areas evaluated their experiences with deer positively, although more respondents from the southern area than from the eastern area said deer mostly were beneficial to their county. In both areas, respondents' evaluations of deer were reflected in their desired change for the deer population in their county. Three-quarters (76.5%) of respondents in the south said deer were mostly beneficial to their county, while 11.4% said deer were mostly a problem. The remainder said deer they benefited to some degree from deer but still experienced some big problems.

More than one-half (53.0%) of southern respondents wanted an increase in deer (23.5% desired a large increase), and 20.5% wanted a decrease (8.4% said a large decrease). The remainder wanted no change in the deer population. A vast majority (92.4%) of southern respondents who wanted an increase in deer numbers thought deer mostly were a benefit to their county. A slight majority (55.6%) of those who considered deer mostly to be a problem for their county wanted a decrease in the deer population while 36.7% wanted no change in deer numbers.

In the east, 57.5% evaluated deer as a benefit, and 12.8% thought deer were a problem. The remainder said deer were a benefit but caused some problems. One-quarter (25.7%) of respondents in the eastern area wanted an increase in the deer population (6.8% said a large increase), and 47.7% wanted a decrease (14.4% said a large decrease). The remainder wanted no change in the deer population. Overall, 90.9% of eastern respondents who wanted an increase in

Table 3. Characteristics of respondents from eastern and southern study areas of West Virginia in a study assessing public attitudes about potential elk restoration, based on a mail survey of households in 2003.

Characteristic	Eastern area n	%	Southern area n	%
Gender				
Percent female	231	24.7	167	22.2
Age	Mean = 54.5 SE = 1.05 Range = 19-94		Mean = 53.3 S.E. = 1.15 Range 18-88	
Years lived in WV	218 Mean = 44.6 S.E. = 1.36 Range = 2-93		163 Mean = 49.7 S.E. = 1.30 Range = 2-88	
Residence category				
Farm	221	20.8	160	4.4
Rural, not a farm		53.8		73.1
Village (<25,000)		22.6		18.1
Small city (<50,000)		2.7		4.4
Large city (≥50,000)		0.0		0.0
Participation in the following wildlife-related and outdoor activities:				
Fed wildlife near home	225	57.3	168	50.0
Photographed wildlife		42.2		29.2
Identified wildlife		60.0		42.3
Picked nuts and berries		52.4		52.4
Fished		50.7		58.9
Hunted		62.2		58.3
Camped in a tent		25.3		20.8
Hiked on a trail		53.8		46.4
Number of non-residential trips to view wildlife	97	46.4% of total	75	47.5% of total
	Mean = 18.6 S.E. = 1.90 Range = 1-75		Mean = 14.6 S.E. = 1.56 Range = 1-52	

Table 4. Number and percentage of respondents from eastern and southern study areas in West Virginia who either answered correctly or indicated "don't know" to knowledge questions about elk and deer, based on a mail survey of households in 2003.

	Eastern study area				Southern study area			
	Correct responses		Don't know responses		Correct responses		Don't know responses	
Question	n	%	n	%	n	%	n	%
Does the opportunity to hunt deer attract thousands of people from out if state to West Virginia each year? (Yes[a])	208	92.9	13	5.8	128	77.6	27	16.4
Are adult deer usually about the same size as adult elk? (No)	197	87.9	24	10.7	117	71.8	36	22.1
Did elk live in West Virginia in the past? (Yes)	141	62.9	71	31.7	62	37.8	93	56.7
Does the opportunity to see or hear elk attract large numbers of tourists to states where elk live? (Yes)	133	59.1	76	33.8	105	63.3	50	30.1
Are elk usually aggressive toward people? (No)	131	59.0	86	38.7	71	43.0	83	50.3
Do elk transmit disease to large numbers of livestock in places where elk live close to farms? (No)	83	37.4	130	58.6	44	26.7	116	70.3
In states with both elk and deer, are human injuries from deer-car collisions usually more severe than injuries from elk-car collisions? (No)	50	22.2	142	63.1	47	28.5	99	60.0
Do deer usually cause a lot more economic damage to the forest industry than to agriculture each year in West Virginia? (Yes)	18	8.1	49	22.0	6	3.7	40	24.5

[a]Correct answer is in parentheses.

the deer population considered deer to be a benefit to their county. In addition, 82.8% of those who thought deer mostly were a problem for their county desired a decrease in deer numbers.

Respondents in both areas apparently used their real experiences with deer as a basis for their expectations about elk, with a slight decrease in the percentage who thought elk would be a benefit (compared to deer) and a slight increase in the percentage who expected elk to be a problem. In the eastern area, 52.7% expected elk to be mostly a benefit and 27.2% expected elk to be a mostly a problem. In the southern area, 73.1% thought elk would be a benefit and 11.4% expected elk to be a problem.

Importance of the issue of elk restoration. Despite the relatively low knowledge levels of respondents from both study areas, the issue of elk restoration generally was deemed important. Slightly more respondents from the southern area (69%) compared to the eastern area (60%) rated the issue of elk restoration as moderately to very important personally. A substantially higher percentage of respondents from the southern area (61%) compared to the eastern area (47%) indicated the issue was moderately to very important to the well-being of their county.

Beliefs about possible impacts of elk restoration. Overall, about three-quarters of respondents in both study areas (75% in eastern area, 78% in southern area) held positive belief evaluations about the set of 10 possible impacts of elk restoration that we examined. Positive evaluations could result if a respondent (a) agreed that a possible impact would happen and believed that the impact would be good, or (b) believed that a possible impact would be bad but disagreed that it would happen. With this interpretation, respondents who believe that bad impacts may happen someplace, but not in their county, have positive perceptions about those possible impacts. Negative evaluations could result if a respondent (a) agreed that a possible impact would happen and believed that it would be bad, or (b) believed that a possible impact would be good, but disagreed that it would happen.

In the eastern area, a majority of respondents held positive perceptions about five possible impacts of restoring elk to their counties (Table 5), and a plurality held positive beliefs about a sixth possible impact. For the remaining four possible impacts of elk restoration, a plurality of respondents held neutral perceptions. Only for two possible impacts – drivers pay for repairs from elk-car accidents and elk damaging crops on farms – did more respondents hold negative beliefs compared to positive beliefs.

We found similar perceptions among residents in the southern study area (Table 6). A majority of residents held positive perceptions about four possible impacts of restoring elk to their counties, and a plurality held positive beliefs about a fifth possible impact. These were the same five impacts about which respondents from the eastern area held positive beliefs. For the remaining five possible impacts we examined, southern respondents generally held either neutral or positive beliefs. No more than 18% of southern respondents held negative perceptions about any of the ten possible impacts we examined.

Table 5. Numbers and percentages of respondents with either neutral or positive perceptions about possible impacts of restoring elk to their county in eastern West Virginia, and reasons for positive perceptions, based on a mail survey of households in 2003.

Possible impacts if elk were restored to respondent's county	Those with neutral perception		Those with positive perception		Of those with positive perceptions… Likely to occur, would be good		Would be bad, but unlikely to occur		x evaluation belief product
	n	%	n	%	n	%	n	%	
Increase tourism	58	26.4	145	65.9	130	59.1	15	6.8	3.5
Return wilderness component	69	31.5	139	63.5	113	51.6	26	11.9	3.4
Increase coyote population	81	37.9	118	55.1	15	7.0	103	48.1	3.0
Preserve elk as a species	90	40.9	118	53.6	87	39.5	31	14.1	2.7
Result in people killing elk because they do not like elk	78	35.2	106	47.9	15	6.8	91	41.1	1.8
Reduce local deer population	88	40.6	85	39.2	23	10.6	62	28.6	1.0
Result in landowners restricting activities on private property	108	49.1	80	36.4	33	15.0	47	21.4	0.9
Result in govt. restricting activities on private property	85	38.8	72	32.9	34	15.5	38	17.4	0.2
Result in drivers paying for repairs from elk-car accidents	80	36.4	71	32.3	25	11.4	46	20.9	-0.1
Result in elk damaging crops on farms	101	45.7	46	20.8	12	5.4	34	15.4	-0.6

Table 6. Numbers and percentages of respondents who held either neutral or positive perceptions about possible impacts of restoring elk to their county in southern West Virginia, and reasons for positive perceptions, based on a mail survey of households in 2003.

Possible impacts if elk were restored to respondent's county	Those with neutral perception		Those with positive perception		Of those with positive perceptions… Likely to occur, would be good		Would be bad, but unlikely to occur		x evaluation belief product
	n	%	n	%	n	%	n	%	
Increase tourism	30	18.6	121	75.2	113	70.2	8	5.0	4.5
Return wilderness component	46	28.2	81	66.2	98	60.1	10	6.1	4.4
Increase coyote population	53	32.7	92	56.6	12	7.4	78	49.2	3.1
Result in people killing elk because they do not like elk	58	35.8	90	55.5	8	4.9	82	50.6	3.0
Preserve elk as a species	58	35.8	87	53.7	80	49.4	7	4.3	2.9
Reduce local deer population	61	37.9	77	47.9	13	8.1	64	39.8	1.7
Result in drivers paying for repairs from elk-car accidents	73	45.3	64	39.7	11	6.8	53	32.9	1.4
Result in govt. restricting activities on private property	72	44.4	64	39.5	30	18.5	34	21.0	1.2
Result in landowners restricting activities on private property	72	43.9	63	38.5	26	15.9	37	22.6	1.1
Result in elk damaging crops on farms	93	57.4	49	30.3	5	3.1	44	27.2	0.8

Attitudes and beliefs about elk and elk restoration. A majority of respondents in both areas had positive attitudes toward elk and about elk restoration. In the southern area, 74.3% had a positive attitude toward elk and only 9.0% a negative attitude, compared to 64.2% positive and 20.1% negative in the eastern area. In the southern area, 76.6% approved of elk restoration, 76.6% liked the idea of elk restoration, and 78.6% thought elk restoration was a good idea. In the eastern area, 63.8% approved of elk restoration, 65.8% like the idea of elk restoration, and 62.6% thought elk restoration was a good idea.

Factors affecting attitude toward elk restoration. We used the 3-question, averaged index of attitude towards elk restoration as the basis for understanding reasons why respondents felt the way they did about elk restoration. This index was highly reliable for both study areas (Chronbach's alpha = 0.98 and 0.95 in the eastern and southern areas, respectively), indicating that all three questions contributed meaningfully to the measurement of respondents' attitudes.

In the eastern area, attitude toward elk restoration was explained by a combination of four variables that explained 83% of the variance in attitude. The strongest explanatory variable was attitude toward elk, which by itself explained about 80% of the variance. Another positive predictor was the belief that restoration would help preserve elk as a species in their county. Two negative predictors were beliefs that (1) elk would be killed by people in the county who did not like elk and (2) elk restoration would result in government restrictions on private land to protect elk from disturbance. Respondents who believed these latter two outcomes would not happen in their county were supportive of restoration whereas respondents who believed these latter two outcomes probably would happen had negative attitudes towards restoration.

Attitude toward elk as an animal was explained by a combination of seven variables that explained about 67% of the variance, for respondents in the eastern study area. The strongest positive predictor was the belief that restoration would return a missing symbol of wilderness to their county (explaining about 48% of the variance in attitude toward elk). Beliefs that elk would (1) cause crop damage on a large number of farms in their county, and (2) transmit disease to large numbers of livestock in areas where elk and livestock occur together both contributed to negative attitudes toward elk, and explained about 9% and 4% of the variance, respectively. Beliefs that elk would (1) increase tourism in the county, and (2) preserve an important species contributed to positive attitudes towards elk (each explaining about 2% of the variance). Unexpectedly, the more responsibility that respondents thought non-governmental conservation groups should take for gathering input toward, making, and implementing wildlife management decisions, the more negative their attitude toward elk as an animal. Finally, the belief that human injuries associated with deer-vehicle accidents usually are worse than human injuries from elk-vehicles accidents contributed to a positive attitude toward elk.

In the southern area, attitude toward elk restoration was predicted by a combination of five variables that explained 85% of the variance in attitude toward restoration. The strongest predictor was attitude toward elk, which by itself explained about 79% of the variance. Level of responsibility WVDNR should take for gathering input toward, making, and implementing wildlife management decisions, explained 3% of the variance in attitude toward restoration. The belief that elk restoration would add a missing part of wilderness to the county explained about 1% of the variance. The remaining 2% of the variance was explained by beliefs that restoration

would result in (1) drivers paying for repairs from elk-vehicle accidents, and (2) damage to crops on a large number of farms in their county. Both of these latter two beliefs were negative predictors of attitude toward restoration.

Attitude toward elk as an animal in the southern study area was explained by a combination of seven variables, accounting for about 67% of the variance. About 45% of the variance was explained by the belief that elk restoration would return a missing component of wilderness to their county. Other positive predictors included: (1) a perception that deer were a benefit to their county, and (2) a belief that restoring elk would result in an increase in tourism in their county. Negative predictors of attitude toward elk included: (1) the more responsibility that local residents should take for gathering input toward, making, and implementing wildlife management decisions, (2) a belief that elk would damage crops on a large number of farms in their county, (3) a perception that adult deer and adult elk were about the same size, and (4) the number of trips >1 mile from home taken to view or photograph wildlife.

Perceptions about level of co-management responsibility. Our findings confirm that respondents from both study areas conceive of wildlife management decisions as having three components: (1) providing input to decisions, (2) making the decisions, and (3) carrying out or implementing decisions. Respondents from both areas were similar in terms of the amount of responsibility they believe different stakeholders should take for the three components of wildlife decisions (Table 7 and Table 8 for eastern and southern areas, respectively). Generally, respondents indicated that local residents and WV DNR should share the greatest responsibility for (a) providing input and (b) making decisions, when compared to three other stakeholder groups. WV DNR should have greatest responsibility for implementing decisions. Local elected officials and NGOs should take moderate responsibility for all components of wildlife decisions, from providing input to carrying out management actions to implement decisions. Respondents from both study areas indicated that West Virginia residents from outside the local area should take relatively little responsibility for any component of management decision-making.

These findings support the concept of "co-management" in which wildlife management professionals work in tandem with local stakeholders to make decisions about issues that affect the local area. They also identify a desire by local residents to take an active role in co-management decisions, and not to let those decisions be made automatically by local elected officials. Further, these findings suggest that conservation NGOs could have some level of responsibility for all three components, but that the level of responsibility should be moderate.

Perceptions of potential community capacity. A major premise of our study was that different communities (i.e., counties in West Virginia) have different levels of potential capacity for taking advantage of possible benefits of elk restoration and for mitigating possible negative impacts of elk restoration. We used the variable COMCAP to ascertain the degree to which respondents recognized this differential potential capacity. Individual respondents seemed to recognize different levels of potential capacity, with a higher proportion of respondents from the southern study area assessing their county's potential capacity as being low, compared to respondents from the eastern study area (Table 9).

Table 7. Mean level of responsibility various stakeholder groups should be willing to take for each of three components of wildlife management decision-making, according to respondents from the eastern study area in West Virginia, based on a mail survey of households in 2003.

Stakeholder group	Providing input for decisions (scaled 0-3) mean	(SE)	Making decisions (scaled 0-3) mean	(SE)	Implementing or carrying out decisions (scaled 0-3) mean	(SE)	Total responsibility (scaled 0-9) mean	(SE)
Residents of your county	2.46	(0.05)	2.45	(0.05)	2.30	(0.06)	7.33	(0.14)
Local elected officials in your county	1.78	(0.07)	1.77	(0.07)	1.95	(0.07)	5.44	(0.20)
Officials of WV DNR	2.45	(0.05)	2.41	(0.05)	2.55	(0.05)	7.46	(0.14)
Officials of nongovernmental conservation organizations	1.60	(0.08)	1.46	(0.08)	1.53	(0.08)	4.59	(0.22)
WV residents living outside your county	0.94	(0.07)	0.86	(0.07)	0.86	(0.07)	2.61	(0.17)

Table 8. Mean level of responsibility various stakeholder groups should be willing to take for each of three components of wildlife management decision-making, according to respondents from the southern study area in West Virginia, based on a mail survey of households in 2003.

Stakeholder group	Providing input for decisions (scaled 0-3) mean	(SE)	Making decisions (scaled 0-3) mean	(SE)	Implementing or carrying out decisions (scaled 0-3) mean	(SE)	Total responsibility (scaled 0-9) mean	(SE)
Residents of your county	2.59	(0.05)	2.60	(0.05)	2.47	(0.06)	7.67	(0.16)
Local elected officials in your county	1.77	(0.09)	1.70	(0.09)	1.83	(0.09)	5.22	(0.27)
Officials of WV DNR	2.64	(0.05)	2.64	(0.05)	2.75	(0.04)	8.02	(0.14)
Officials of nongovernmental conservation organizations	1.59	(0.09)	1.50	(0.09)	1.50	(0.09)	4.52	(0.28)
WV residents living outside your county	0.91	(0.09)	0.92	(0.09)	0.88	(0.09)	2.59	(0.26)

Table 9. Self-assessed "potential community capacity", from the perspective of individuals and aggregated at the county level for eastern and southern study areas in West Virginia, based on a mail survey of households in 2003.

Self-assessed level of potential community capacity	Individual respondents				County aggregations			
	eastern		southern		eastern		southern	
	n	%	n	%	n	%	n	%
High	17	7.6	5	3.0	0	0.0	0	0.0
Moderate	150	67.0	82	50.0	9	100.0	4	80.0
Low	57	25.4	77	47.0	0	0.0	1	20.0

However, these differences in individuals' perceptions of "potential community capacity" did not hold when we aggregated data at the county level. Because the number of respondents differed among counties, we used the median value of COMCAP for respondents from a particular county to determine whether that county was perceived by respondents as having high (COMCAP range = 2.0 to 6.0), moderate (COMCAP range = -1.9 to 1.9), or low potential community capacity (COMCAP range = -2.0 to -6.0). Median values of COMCAP for all nine counties in the eastern study area (for which we had sufficient data for this analysis) were within the moderate range, falling between -1.0 and 1.0. In the southern area, median values of COMCAP for four of the five counties were within the moderate range (0 to -1.5), and one was in the low-capacity range (-2.0).

Self-assessed "potential community capacity" differed from our SFI designations based on secondary social and economic data, especially in the eastern study area (Table 10). Given our premise that level of "potential community capacity" will indicate the degree to which a community can engage successfully in discussions and decisions about elk restoration, and take advantage of possible benefits and address possible problems if restoration were to proceed, we needed to determine whether COMCAP or SFI was a more valid index to "potential community capacity." As noted in the introduction to this report, a valid index would provide the social context for interpreting the reasonableness of public attitudes toward elk restoration as a meaningful part of our social feasibility assessment.

Validating the Social Feasibility Index (SFI) as a Tool for Interpreting Attitudes:

As reported above, most respondents had a positive attitude toward elk restoration, and most were optimistic in terms of their evaluative beliefs about possible impacts of elk restoration. We needed a valid indicator of "potential community capacity" to assess the extent to which these optimistic evaluative beliefs were based on sound expectations vs. based on unrealistic hopes and dreams that are unlikely to be realized because of inadequate community capacity. With such a valid indicator we also could investigate the extent to which minority negative attitudes toward restoration were based on unfounded fears and concerns that possible problems are likely to occur or possible benefits are unlikely to occur.

Table 10. Comparison of the number of counties designated as having high, moderate, or low "potential community capacity" to take advantage of elk restoration-related opportunities and address restoration-related challenges in eastern and southern study areas in West Virginia, based on two indices: (1) a self-assessment by respondents to a mail survey of households in 2003 (COMCAP), and (2) a social feasibility index (SFI) based on county-level population and economic data.

COMCAP designations	Eastern study area SFI designations			Southern study area SFI designations		
	High	Moderate	Low	High	Moderate	Low
High	0[a]	0	0	0	0	0
Moderate	3	3	3	1	4	0
Low	0	0	0	0	0	0

[a]Number of counties.

One solution was to determine whether either COMCAP or SFI was a valid indictor of "potential community capacity." However, we first needed to confirm that DEEREVAL was a reliable indicator of a county's "experienced community capacity" to benefit from/deal with another large ungulate (i.e., deer).

Identifying a reasonable measure of "experienced community capacity." We found a high degree of correspondence between DEEREVAL and DEERPOP. A contingency table permutated on the first dimension of a two-dimension solution accounting for 100% of the inertia in the data (i.e., a special form of variance) revealed an expected pattern showing that evaluations of deer as a problem were associated with the largest desired reductions in deer population, and that evaluations of deer as a benefit were associated with increases in the deer population (Table 11).

The first dimension (accounting for 79.4% of the inertia) separated "deer are a problem" and "deer are a wash" (i.e., some problems/some benefits), on the one hand, from "deer are a benefit." The first dimension also separated "moderate decrease" and "large decrease" from all other categories of desired change in the deer population. The second dimension separated "slight decrease" and "moderate decrease" from "large decrease" in the deer population. Also, the second dimension separated "deer are a problem" from "deer are a wash."

Because the two dimensions accounted for 100% of the inertia, interpretation of the bi-plot of DEEREVAL by DEERPOP (Figure 5) is relatively straight-forward; points that are close together are more alike than points that are far apart. "Deer are a problem" corresponded closely with a desire for a "large decrease" in the deer population. Deer are "a wash" corresponded with both a desire for a "moderate decrease" and a "slight decrease." "Deer are a benefit" corresponded with "no change" and with all levels of desired increase in the deer population.

Table 11. Permutated correspondence table of ordered relationships between response categories for West Virginians' evaluations of deer in their county (DEEREVAL) and desired change in the deer population in their county (DEERPOP), based on a mail survey of households in combined eastern and southern study areas in West Virginia in 2003.

DEERPOP	DEEREVAL			
	deer are problem	deer are a wash	deer are benefit	Active Margin
LARGE DECREASE	26	13	5	44
MODERATE DECREASE	8	25	11	44
SLIGHT DECREASE	3	19	27	49
NO CHANGE	8	20	72	100
LARGE INCREASE	3	2	49	54
SLIGHT INCREASE	0	4	42	46
MODERATE INCREASE	0	3	42	45
Active Margin	48	86	248	382

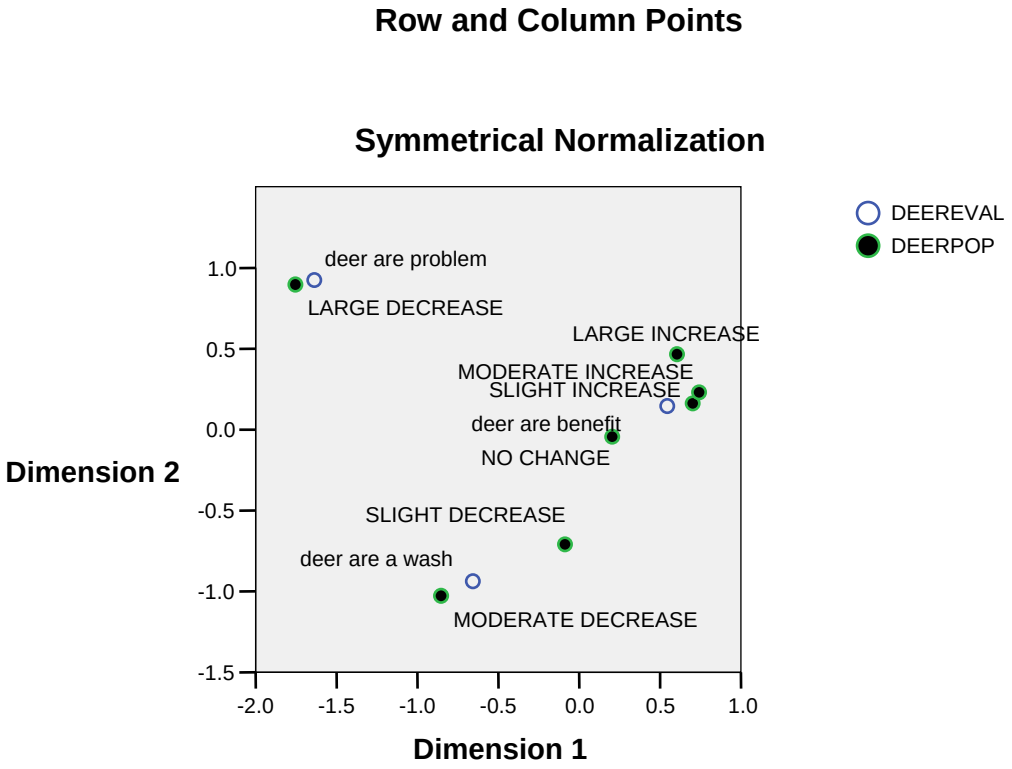

Figure 5. Correspondence analysis bi-plot of relationships between West Virginians' evaluations of their experiences with deer in their county (DEEREVAL) and their desired change in the deer population (DEERPOP), based on a mail survey of households in 2003.

The degree of uncertainty about the location of a given point for the entire population of households represented by the sample is indicated by the standard deviation within a particular response category in each dimension, and by the correlation between dimensions for each response category. Higher standard deviations (e.g., >0.50) generally indicate more uncertainty about the location of that point in two-dimensional space. Further, high correlations between dimensions (e.g., >0.60) for a particular response category indicate that it may not be possible to locate a point in the correct dimension. Standard deviations for all categories of DEERPOP and DEEREVAL were reasonably small (Table 12). The only inter-dimensional correlation that was relatively high was for "large decrease" in DEERPOP.

Table 12. Confidence statistics for a two-dimensional solution to correspondence analysis of West Virginians' evaluations of deer in their county (DEEREVAL) and desired change in the deer population in their county (DEERPOP), based on a mail survey of households in combined eastern and southern study areas in West Virginia in 2003.

Confidence Column Points

	Standard Deviation in Dimension		Correlation
DEEREVAL	1	2	1-2
deer are benefit	.041	.063	-.320
deer are a wash	.218	.137	-.587
deer are problem	.206	.150	.730

Confidence Row Points

	Standard Deviation in Dimension		Correlation
DEERPOP	1	2	1-2
LARGE DECREASE	.191	.152	.707
MODERATE DECREASE	.235	.152	-.553
SLIGHT DECREASE	.162	.082	-.353
NO CHANGE	.038	.033	.105
SLIGHT INCREASE	.042	.074	-.343
MODERATE INCREASE	.052	.081	-.453
LARGE INCREASE	.094	.086	-.531

Both the logical correspondence between these variables, and the relatively low variability for the patterns of relationships between response categories displayed in two-dimensional space, suggest that respondents' evaluations of their experiences with deer in their county are reliable. Although many factors could affect respondents' evaluations of their experiences with deer besides community capacity, (e.g., deer density, prevalence of agricultural crops and ornamental plantings around homes, contribution of out-of-town hunters to the local economy), the results support our assumption that DEEREVAL broadly reflects "*experienced* community capacity."

Comparing COMCAP and SFI as indicators of "potential community capacity. A contingency table permutated on the first dimension of a two-dimension solution accounting for 100% of the inertia in the relationship between COMCAP and DEEREVAL showed little resemblance to the expected pattern of higher levels of COMCAP being associated with evaluations of deer as being more of a benefit, and lower levels of COMCAP being associated with evaluations of deer more as a problem (Table 13). Indeed, a substantial proportion of respondents in all categories of COMCAP evaluated deer as a benefit.

Table 13. Permutated correspondence table of ordered relationships between West Virginians' self-assessed "potential community capacity" (COMCAP) and their evaluations of deer in their county (DEEREVAL), based on a mail survey of households in combined eastern and southern study areas in West Virginia in 2003.

	COMCAP			
DEEREVAL	low	moderate	high	Active Margin
deer are problem	19	28	1	48
deer are benefit	89	147	15	251
deer are a wash	23	56	6	85
Active Margin	131	231	22	384

In the two-dimensional solution, the first dimension separated low and high COMCAP and separated "deer are a problem" from "deer are a wash" (Figure 6). The second dimension separated high COMCAP from moderate and low, and separated "deer are a problem" from "deer are a benefit." Visual examination of the bi-plot indicates an unexpected relationship between low COMCAP and "deer are a benefit." "Deer are a problem" seems unrelated to any level of COMCAP, and high COMCAP seems unrelated to any category of DEEREVAL.

Confidence statistics for correspondence between COMCAP and DEEREVAL indicate a high degree of uncertainty about the location of the points in the two-dimensional bi-plot (Table 14). In particular, the standard deviation for high COMCAT was >0.56 in both dimensions. Further, the inter-dimensional correlations were >0.76 for four of the six response categories used in the analysis.

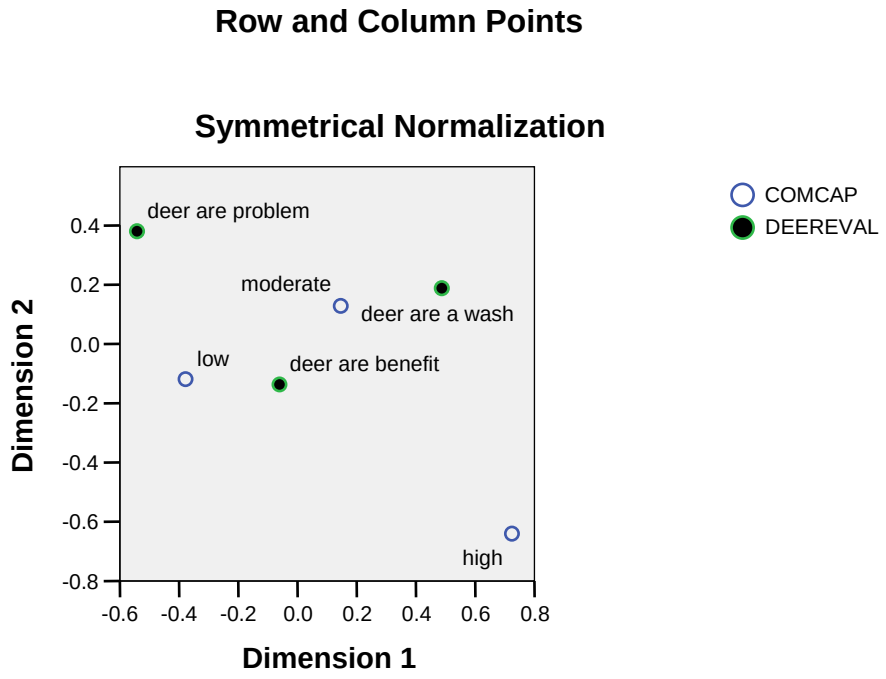

Figure 6. Correspondence analysis bi-plot of relationships between West Virginians' self-assessments of "potential community capacity" (COMCAP) and evaluations of their experiences with deer (DEEREVAL), based on a mail survey of households in combined eastern and southern study areas in 2003.

Table 14. Confidence statistics for a two-dimensional solution to correspondence analysis of West Virginians' self-assessed "potential community capacity" (COMCAP) and their evaluations of deer in their county (DEEREVAL), based on a mail survey of households in combined eastern and southern study areas in West Virginia in 2003.

Confidence Column Points

	Standard Deviation in Dimension		Correlation
COMCAP	1	2	1-2
low	.163	.147	-.761
moderate	.140	.082	-.457
high	.644	.566	.775

Confidence Row Points

	Standard Deviation in Dimension		Correlation
DEEREVAL	1	2	1-2
deer are benefit	.142	.082	-.080
deer are a wash	.238	.205	-.777
deer are problem	.393	.364	.788

The permutated contingency table of the relationship between SFI and DEEREVAL (Table 15) showed a more expected pattern of association than between COMCAP and DEEREVAL. In general, revealed relationships seemed logical with the exception that counties designated with "moderate worsening SFI" evaluated deer more positively than we anticipated. Perhaps the greatest expected correspondence between SFI and DEEREVAL was revealed for counties with "low SFI" designations. Converting the sample sizes (n's) to percentages revealed that although only about one-fifth of respondents (n = 9 [22.0%]) from "low SFI" counties indicated "deer are a problem," this percentage is about double the percentage for counties with any other SFI designation (6.6-12.4%). In addition, although one-half of respondents (n = 21 [51.2%]) from "low SFI" counties indicated "deer are a benefit," this is substantially less than the percentage who reported "deer are a benefit" in counties designated as having "high SFI" (61.9%) or "moderate worsening SFI" (74.2%).

Table 15. Permutated correspondence table of ordered relationships between a social feasibility index (SFI) of "potential community capacity" in eastern and southern study areas in West Virginia based on county-level population and economic data, and West Virginians' evaluations of deer in their county (DEEREVAL) based on a mail survey of households in 2003.

	SFI				
DEEREVAL	Moderate Improving	Low	High	Moderate Worsening	Active Margin
deer are a wash	16	11	29	31	87
deer are problem	2	9	14	23	48
deer are benefit	11	21	70	155	257
Active Margin	29	41	113	209	392

In the two-dimensional solution produced through correspondence analysis, the first dimension separated counties with "moderate improving SFI" from counties with other designations, and separated "deer are a wash" from other categories of DEEREVAL (Figure 7). The second dimension separated counties with "low SFI" from those designated as "moderate improving SFI," and separated "deer are a problem" from other categories of DEEREVAL. Visual examination of the bi-plot indicates expected relationships between "low SFI" and "deer are a problem," one category of "moderate" SFI with "deer are a wash," and "high SFI" somewhat related to both "deer are a benefit" and "deer are a wash," but not "deer are a problem." The unexpected relationship between "moderate worsening SFI" and "deer are a benefit" was clearly revealed.

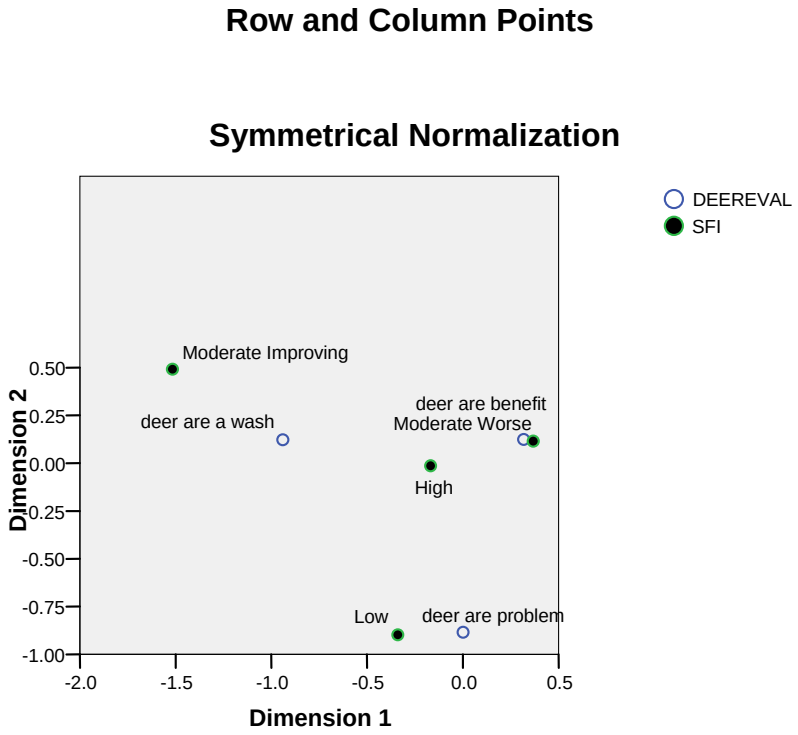

Figure 7. Correspondence analysis bi-plot of relationships between a social feasibility index (SFI) of "potential community capacity" in eastern and southern study areas in West Virginia based on county-level population and economic data, and West Virginians' evaluations of deer in their county (DEEREVAL) based on a mail survey of households in 2003.

Confidence statistics for correspondence between SFI and DEEREVAL indicate a relatively high degree of certainty about the location of the points in the two-dimensional bi-plot (Table 16). In particular, the standard deviations were <0.39 for the various designations of SFI and <0.32 for all categories of DEEREVAL in both dimensions. Inter-dimensional correlations were relatively low for all response categories, with the exception of "moderate improving SFI" (r = 0.71).

Table 16. Confidence statistics for a two-dimensional solution to correspondence analysis of a social feasibility index (SFI) of "potential community capacity" in eastern and southern study areas in West Virginia based on county-level population and economic data, and West Virginians' evaluations of deer in their county (DEEREVAL) based on a mail survey of households in 2003.

Confidence Row Points

	Standard Deviation in Dimension		Correlation
DEEREVAL	1	2	1-2
deer are benefit	.053	.055	-.521
deer are a wash	.123	.149	.458
deer are problem	.319	.241	.166

Confidence Column Points

	Standard Deviation in Dimension		Correlation
SFI	1	2	1-2
Low	.387	.252	-.241
Moderate Worsening	.058	.071	-.566
Moderate Improving	.274	.287	.710
High	.036	.034	-.129

Because we used DEEREVAL as an index to "experienced community capacity" to validate SFI, we concluded that SFI is meaningful index to "potential community capacity" in the context of ungulate restoration. That is, SFI reflects the capacity of the residents, various stakeholder groups, and county government to identify and take advantage of possible opportunities and identify and address possible problems that might be associated with elk restoration. Given the validity of SFI, we can determine the extent to which respondents' attitudes toward elk restoration in the two study areas in West Virginia reflect this differential potential capacity.

Interpreting Public Attitudes in the Context of "Potential Community Capacity":

An important point to make prior to this determination that SFI should not be construed as a predictor of attitude toward elk restoration. Rather, it is intended, in part, to provide an index to "potential community capacity" which can be used to interpret attitudes toward restoration. In general, communities with higher levels of SFI could be expected to have the greatest relative capacity to take advantage of possible benefits of restoration and to address possible problems. That does not mean that they would want to take advantage of benefits or address problems, but they would be in a better position to do so compared to communities with lower SFI. Further, communities with lower levels of SFI generally could be expected to have the most difficulty achieving possible benefits and addressing possible problems. Again, this does not mean that communities with lower SFI could not experience benefits or address problems, but that to do so probably would require some form of external help from NGOs, the state wildlife agency, or other partners.

Thus, positive attitudes toward restoration by respondents from counties with "low" or "moderate worsening" SFI *might* indicate overly optimistic expectations about being able to

benefit from restoration. Conversely, negative attitudes toward restoration by respondents from counties with "high" or "moderate improving" SFI *might* indicate pessimistic expectations about capacity to address problems from restoration. Alternatively, negative attitudes by people living in counties with higher SFI *might* indicate that they would rather expend their "community capacity" on activities more closely aligned to community goals than elk restoration.

A bi-plot of the correspondence between SFI and attitude toward elk restoration revealed the greatest correspondence between "neutral attitude" and "low SFI," and between "positive attitude" and "moderate worsening SFI" (Figure 8). "High SFI" plotted mid way between "positive attitude" and "negative attitude," but did not correspond to "neutral attitude." "Moderate improving SFI" corresponded slightly with "negative attitude" toward elk restoration, but only on the first dimension.

Neutral attitudes held by respondents from counties with "low SFI" might reflect their lack of capacity to even identify or to be certain about what the possible benefits or problems might be from elk restoration. The close correspondence between "moderate worsening SFI" and "positive attitude" toward restoration might indicate unrealistic hopes and dreams about the possible benefits of restoration. Compared to counties with either "high SFI" or "moderate improving SFI," the general capacity of counties with "moderate worsening SFI" to experience benefits and address problems already is strained and has been declining in recent years.

Re-examination of the evaluative belief data summarized previously in Table 6 provided insights about what respondents from the southern study area (where the vast majority of people live in counties with "moderate worsening SFI") believe are the possible benefits and problems of elk restoration, and whether the benefits will be experienced and problems can be addressed in their county. Possible benefits identified by >50% of respondents were: increase in tourism (73.9%), return missing component of wilderness (62.9%), and preservation of elk as a species (56.8%). Of these, only tourism would likely be influenced by community capacity, and 95.1% of those who thought an increase in tourism would be "good" also thought such an increase would happen if elk restoration occurred. Given their relatively low SFI designation and the general lack of tourism-related infrastructure in the southern study area, an increase in tourism probably is an unrealistic expectation without assistance from external partners to help develop more tourism-related infrastructure.

Possible problems identified by >50% of respondents from counties with "moderate worsening SFI" were: (1) people will kill elk because they do not like elk (57.4%) and (2) increase in coyote population (56.9%). However, the vast majority of respondents did not believe these possible problems would occur in their county. We do not know the degree to which respondents thought these problems would not occur because their county had the capacity to address them or because of other reasons. Nor do we know the degree to which respondents did not identify other logical impacts as possible problems because they thought they had the capacity to address them. For example, we asked respondents to evaluate whether "drivers having to pay for repairs from vehicle accidents with elk" and "elk causing crop

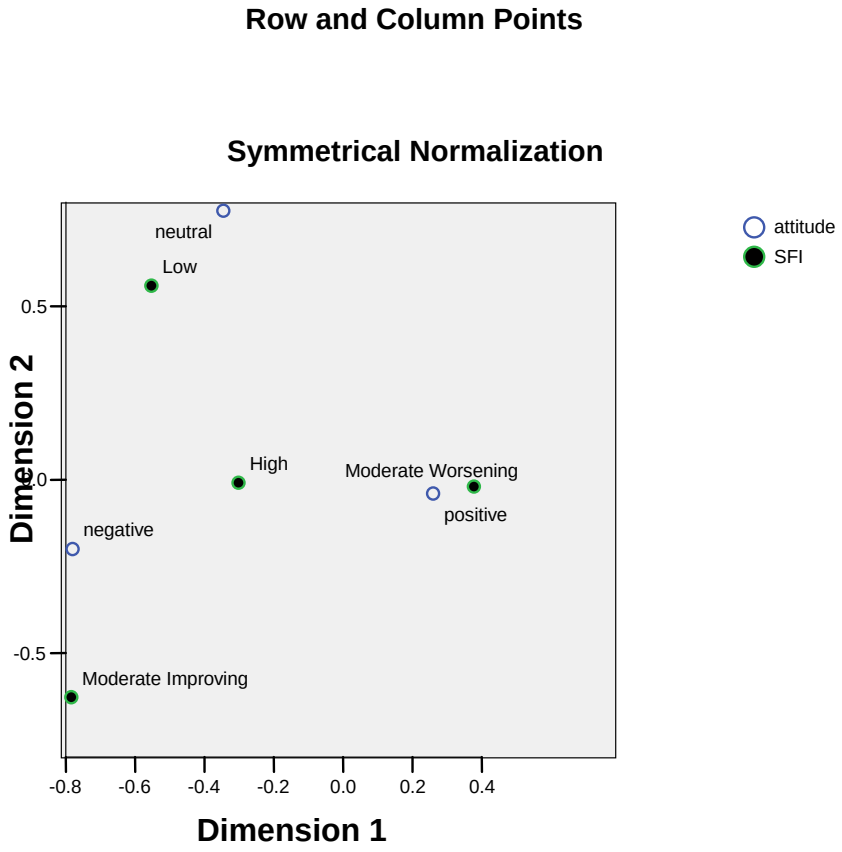

Figure 8. Correspondence analysis bi-plot of relationships between a social feasibility index (SFI) of "potential community capacity" in eastern and southern study areas in West Virginia based on county-level population and economic data, and West Virginians' attitudes toward elk restoration based on a mail survey of households in 2003.

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damage on a large number of farms" would be good (possible benefit) or bad (possible problem) if they occurred in their county, and only a minority of respondents indicated they would be possible problems (i.e., 35.8% and 47.5% of respondents, respectively).

The location of "high SFI" in Figure 8 (i.e., mid way between "positive attitude" and "negative attitude," but unrelated to "neutral attitude") seems reasonable considering that respondents from those counties exhibited bi-polar attitudes. Of the 65.8% respondents from counties with "high SFI" who had positive attitudes toward elk restoration, 82.7% held strongly positive attitudes. Of the 24.6% who held negative attitudes toward elk restoration, 78.6% held strongly negative attitudes.

Pluralities or majorities of respondents (46-91%) from counties with "high SFI" who had negative attitudes toward elk restoration indicated that each of the ten possible impacts we listed in the questionnaire would be "bad" (i.e., a problem) if they occurred in their county. Further, majorities of these "high-SFI, negative-attitude" respondents believed that six of the ten possible problems would occur if elk were restored to their county: (1) reduce the local deer population, (2) cause crop damage on a large number of farms, (3) elk killed by people who do not like them, (4) drivers paying for repairs from elk-vehicle accidents, (5) government restrictions on private lands to protect elk from human disturbance, and (6) increase the coyote population. Although counties with "high SFI" have the most potential capacity to address possible problems compared to counties with lower levels of SFI, respondents' beliefs that so many problems are likely to occur if elk are restored helps us understand why these particular respondents have a negative attitude toward elk restoration despite their high potential capacity.

Respondents with positive attitudes toward restoration and who lived in counties with "moderate worsening SFI" also identified many possible problems if elk were restored to their county, but they generally did not believe those problems would happen in their county. Pluralities or majorities of these respondents (43-69%) indicated that seven of ten restoration-related impacts would be "bad" (i.e., would be a problem) if they occurred in their county. They identified only three impacts of elk restoration as possible benefits: (1) increase in tourism (85%), (2) return a missing component of wilderness (80%), and (3) preserve elk as a species (76%). The major difference in evaluative beliefs between these respondents and those with negative attitudes from counties with "high SFI" was that majorities of those with positive attitudes from counties with "moderate worsening SFI" believed that each of the seven possible problems they identified would not occur in their county. Majorities also believed that the three possible benefits would occur in their county.

Summary of using SFI to interpret attitudes toward restoration:

A high degree of correspondence between SFI and "experienced community capacity" in terms of respondents' evaluations of their experiences with an existing ungulate in their county (i.e., deer) suggests that SFI is a valid index to "potential community capacity" for taking advantage of benefits and addressing problems that might be associated with restoration of another, larger ungulate (i.e., elk). Thus, we believe respondents in the eastern area may be more realistic in their expectations for taking advantage of possible benefits and dealing with possible problems, compared to respondents from the southern area. Indeed, respondents from counties with "high SFI" in the eastern area who have negative attitudes toward elk restoration, in particular, do not seem to underestimate their capacity to take advantage of benefits or address problems, but rather simply identify as possible problems a long list of restoration-related impacts. Only a minority of those respondents identified any possible benefits from elk restoration. Even possible impacts of "increase in tourism," "preservation of elk as a species," and "return of a missing component of wilderness" were evaluated as "bad" by a majority of respondents who resided in counties with "high SFI" and who had negative attitudes toward elk restoration.

Conversely, respondents from counties designated with "moderate worsening SFI" and who had positive attitudes toward elk restoration seemingly overestimated their capacity to

address possible problems and take advantage of possible benefits. They had positive attitudes toward restoration despite evaluating seven of ten possible restoration-related impacts as being "bad" if they occurred in their county as a result of restoration. Among these seven possible problems were some very tangible issues such as "elk causing crop damage on a large number of farms," "drivers having to pay for repairs from elk-vehicle accidents," and "people killing elk because they do not like them." However, strong majorities of these respondents did not believe these "bad" impacts would occur in their county. Among the three restoration-related impacts they evaluated as "good" if the impact occurred in their county, "increase in tourism" was the most tangible. A strong majority of respondents in the southern study area from counties designated with "moderate worsening SFI" thought tourism would increase in their county if elk were restored. Given the general lack of tourism-related infrastructure in those counties, possible benefits from tourism are not likely to be realized to a great extent.

Cost-benefit Assessment Under Active and Passive Restoration Scenarios

Active restoration would be necessary to establish elk in the eastern study area because no existing elk population is near enough to expect natural colonization of the area by elk. The scope of an active restoration program would have to be established by the West Virginia DNR, including decisions about the number of release sites, the number of elk to be released at each site, and the number of years over which to release elk. The protocols for active restoration varied greatly among states contacted. Wisconsin took the most conservative approach, establishing an experimental herd of 25 elk and monitoring it carefully as part of a decision making process about further restoration (Parker 1990, K. Warnke, WI DNR, personal communication). Kentucky took a very active approach, releasing about 2,500 elk over about 5 years in an attempt to establish a huntable population within a decade (J. Day, Kentucky Department of Fish and Wildlife, personal communication).

For the purposes of our cost/benefit assessment, we assumed that 100 elk would be obtained from donor states/provinces in each of 3 years and released in groups of 20-30 from 4 sites located throughout the eastern study area. We further assumed that problems from released elk would start occurring in year two and would need to be addressed proactively by WV DNR staff. Finally, we assumed that hunting revenue would be generated starting in year four. Other minor assumptions pertaining to staff needs, time spent, and other restoration actions are described in Appendix A which describes cost/revenue components and annual costs/revenues over the 20-year time horizon for our assessment.

Passive restoration of elk is possible in the southern study area given the proximity of Kentucky's elk restoration zone. Indeed, two Kentucky counties (Martin and Pike) into which a total of 394 elk were released (251 and 143, respectively) border West Virginia (J. Larkin, University of Kentucky, personal communication). At least a few elk are known to have shown movements into West Virginia (J. Crum, WV DNR, personal communication). Based on elk movements and release site fidelity of elk in Martin and Pike counties in Kentucky, it is possible that West Virginia could have 50-250 elk in the southwestern part of the state by 2025 (J. Larkin, University of Kentucky, personal communication). However, many factors, including among

other things brainworm, poaching, and disease could diminish the probability that any elk will persist in West Virginia. If any elk do passively colonize West Virginia from Kentucky, they almost certainly would not occur solely within the southern study area.

Based on interviews with key informants from Kentucky, Tennessee, Michigan, Wisconsin, and Ontario, we determined that active restoration likely would be substantially more costly, initially, than passive restoration. Net economic benefits, at least during the 20-year time frame considered, likely would be limited, and might not differ substantially between active and passive restoration. Definitive costs and benefits to the WV DNR of an active restoration program cannot be calculated with certainty because they depend on the scope of such a program. However, we developed categories of costs and benefits, and describe the basic components of those categories below. Similarly, the costs and benefits to the WV DNR of a passive restoration program depend in large part on whether, and how many, elk move into West Virginia from Kentucky.

Active Restoration Costs:

Categories of costs for active restoration include: capturing elk in donor states or provinces, disease assessment and inoculation, transporting elk, establishing release sites, post-release monitoring, public communication efforts, and hunting-related activities.

Capturing elk. Key informants indicated that donor states or provinces allowed capture of excess elk without the expectation of payment, and in most cases, donor states and provinces provided substantial staff and logistical assistance. Nonetheless, the most expensive part of capturing elk was staff time and associated support (travel, lodging, per diem). Each state or province actively restoring elk provided 2-3 (sometimes as many as 6) staff for up to 3 months during the winter trapping period.

Another substantial cost associated with capturing elk was hiring private contractors to capture elk. Although a variety of techniques were tried, most elk restored to Kentucky, Tennessee, Ontario, and Wisconsin, and moved within Michigan were captured using net guns fired from helicopters. Private contractors usually charge a relocation fee to move the helicopter from its home base to the capture area (J. Hamr, Cambrian College of Applied Arts and Technology, Ontario, Canada, personal communication). Additional costs include helicopter pilot and mechanic salaries along with food and lodging, jet fuel, and a charge per elk handled. Costs per elk captured for the Ontario restoration program were about $1,700(CA)

Disease assessment and inoculation. Regardless of increasing concern about Chronic Wasting Disease in the eastern U.S., various disease diagnostic tests and inoculations would be required. Each state or province that we contacted had established very detailed veterinary protocols. In most cases, a state/provincial (or Parks Canada) veterinarian from the donor state tended to the elk in the donor location. A state veterinarian from the state restoring elk provided veterinary services at the release sites.

Transporting elk to the restoration area. States and provinces restoring elk reported different experiences in terms of the most successful way of transporting elk from donor areas to

restoration areas. Kentucky used commercial livestock trailers (J. Day, Kentucky Department of Fish and Wildlife, personal communication) to transport 55-70 elk at a time. Rental and mileage for each load of elk cost about $4,000(US). Ontario experienced substantial stress on elk transported by commercial livestock trailer, and instead used smaller, fifth-wheel trailers to haul 12-15 elk at a time (J. Hamr, Cambrian College of Applied Arts and Technology, Ontario, Canada, personal communication). Rental of these vehicles is less expensive than commercial livestock trailers, but per mile charges may be similar (~$2(US)/mile).

Establishing release sites. The need to establish holding pens to acclimate elk to the release area may depend largely on snow cover and weather conditions in the release area during the typical January-March trapping period. Whereas these pens may have been unnecessary in Tennessee and Kentucky, they were found to be absolutely necessary in the more harsh environments of Ontario, Michigan, and Wisconsin. Due to high elevation and the potential for snow cover and seasonally limited food in the eastern study area of West Virginia, holding pens probably would be warranted.

Cost of materials and staff time to build the pens could be substantial. However, most states and provinces that have used them were able to secure donations of materials from conservation groups like the Rocky Mountain Elk Foundation and Safari Club. Food and water also need to be secured, and add to the overall cost of active restoration. In many places where elk have been restored, volunteers have provided much of the labor for building the pens. However, states provided on-site staff to monitor, protect, and feed elk for up to 3 months from time of capture to time of release. Just like the staff costs associated with capturing elk, these staff costs can be a substantial part of the total costs of active restoration.

Key informants also mentioned the absolute necessity of obtaining long-term, written agreements from landowners on whose land elk were released if release sites were not on public land. This may not be needed in the eastern study area given the prevalence of public land, but some releases may occur on private land if suitable sites are found there. In some cases, private landowners allowed release of elk, but then denied later access for viewing, hunting, or even research monitoring activities (L. Muller, University of Tennessee, personal communication; J. Day, Kentucky Department of Fish and Wildlife personal communication, D. Beyer, Michigan DNR, personal communication).

Post-release monitoring. These costs include staff time, radio-telemetry and other marking materials, land vehicles, and aircraft. States with relatively few elk in their release areas can conduct radio telemetry mostly from the ground or using helicopters in small areas. States with larger restoration programs where elk occur over larger geographic spaces conduct much of their radio-telemetry work using fixed-wing aircraft. The latter are particularly necessary for obtaining population estimates (D. Beyer, Michigan DNR, personal communication).

In Ontario, university researchers have been designated by the Ontario Ministry of Natural Resources (OMNR) as the main public contact persons and monitoring staff in 3 of the 4 release sites. An OMNR staff member works on post-release activities almost full-time in the other release area. The Kentucky Department of Fish and Wildlife has 2 full-time staff devoted to post-release activities, and several extension and research staff (funded only to a minor degree

by Kentucky Department of Fish and Wildlife) from the University of Kentucky are involved. In Wisconsin, Tennessee, and Michigan, personnel from the state wildlife agency have responsibilities for post-release activities among other work responsibilities. University researchers (with relatively small cost to the state agency) also conduct post-release activities in those states.

Public communication efforts. In addition to monitoring elk post-release, other major responsibilities for wildlife staff include communicating with the public after elk have been released. The various states and provinces have information about elk restoration on their official web pages, and much of this work is done as part of routine public communication efforts. They also field telephone and mail inquiries about their respective elk restoration programs, and give presentations to schools, sportsmen's associations, agricultural groups, local chambers of commerce, and other groups. All these communication activities fall more or less within their normal work responsibilities.

By far the largest staff time commitment post-release according to many of the key informants is addressing public concerns about problems caused by released elk. Identified problems include damage to agricultural crops, cemeteries, Christmas tree producers, native wildflowers in areas frequented by eco-tourism operators, elk-vehicle accidents, and elk rubbing on parked vehicles. Some states, like Wisconsin, pay for damages caused by wildlife; others do not. Even states that do not pay for damages often experience direct costs trying to prevent elk from causing damage. Such costs identified by key informants included harassment activities, cost-sharing fencing, repairing fences, trapping and re-locating elk, and even destroying particularly troublesome elk. Of the key informants interviewed, only J. Hamr from Ontario stated that additional law enforcement effort had been expended in the restoration area because of poaching, although several states acknowledged poaching of restored elk as an issue.

According to key informants from the various states contacted for this assessment, addressing public concerns and complaints about elk requires multiple staff in the field. These staff usually have other wildlife-related duties, but a substantial part of their time is focused on elk because these large, charismatic animals are seen as "flagship species" of the wildlife agency. Key informants all indicated a need to address public concerns about elk so that the good will toward the agency that was generated at the beginning of the elk restoration effort was not eroded by lack of attention to the substantial negative interactions that people may have with elk.

Hunting activities. Under an active restoration scenario, it is assumed that hunting activities would be carefully monitored after regulations were created to allow such activities. Such activities likely would involve substantial staff effort, although some of that effort (e.g., check stations) might be combined with existing activities. Most eastern states that allow hunting require mandatory pre-hunt meetings for successful applicants, and require harvested elk to be examined at a check station. Pennsylvania, Kentucky, and Michigan wildlife agencies also expend staff time either helping successful applicants connect with local guides, or ensuring that requirements to utilize a guide are met.

Passive Restoration Costs:

Categories of costs for passive restoration include: monitoring of elk moving into the state, public communication efforts pertaining to those elk, and hunting-related costs. Costs associated with passive restoration obviously would not include capturing elk in donor states or provinces, and then transporting them to release sites. However, many of the other costs associated with active restoration likely would be experienced depending on the needs and interests of the WV DNR to capture colonizing animals for disease assessment and to mark them for monitoring. The degree of monitoring activities would have to be established by the agency, and obviously could range from being passively-receptive to public reports of elk to full-scale movement, habitat use, and movement studies. Other analogous post-release costs for public communication and addressing problems with elk likely would occur under a passive restoration program.

Monitoring an expanding elk population. Although elk population monitoring likely would be a cost-producing activity under either active or passive restoration, we describe here the experiences of the Michigan DNR as the Michigan elk population expands and occupies new areas because that experience may be most similar to elk expanding into West Virginia from Kentucky. Michigan has had an extant elk population since about 1915 (Bryant and Maser 1982). This population has expanded numerically and geographically over the years (D. Beyer, Michigan DNR, personal communication). Annual monitoring activities of the elk population include radio telemetry of marked animals to ascertain movements and habitat use, and to monitor reproductive success. These efforts have allowed the Michigan DNR to become aware of disturbance of elk by horseback riders and ATVs on the public lands that make up much of the core elk area. However, an effect of this disturbance is a "donut-shaped" distribution of elk pushing out from the public land and encroaching onto private lands (D. Beyer, Michigan DNR, personal communication).

Because the Michigan elk herd is large enough to sustain hunting (<200 permits are made available each year), the Michigan DNR also spends considerable time and effort estimating population size. During the 1980s and 1990s when the elk population was smaller and occupied a smaller geographic area, Michigan used a combination of helicopter over-flights and ground searching to produce a minimum count estimate. As the land area occupied by elk has expanded, those techniques are no longer adequate. Michigan now is working on developing a sightability index using fixed-wing aircraft to estimate population abundance. Regardless of the technique used to estimate and monitor population size, substantial costs to the wildlife agency include multiple staff working for several days, flight time, jet fuel, and telemetry equipment.

Public communication efforts. Making the public aware of a colonizing elk population, and communicating the positive aspects of elk and informing people about how to minimize negative interactions would be an essential aspect of a restoration program. As noted above for active restoration, some of this communication likely would occur through existing mechanisms (e.g., web sites, agency magazine), but some additional efforts may be warranted. Public informational meetings, presentations to groups, and one-on-one discussions with landowners all have been used by various states where elk have been restored and/or are expanding into new areas. All these efforts involve staff time that would be taken away from other activities.

Hunting activities. The kinds of costs associated with hunting under a passive restoration scenario would be similar to the kinds described above for an active restoration scenario. Depending on whether the WV DNR was interested in allowing a colonizing elk population to expand and become established vs. allowing additional hunting opportunities for deer hunters (similar to Virginia), hunting-related costs for a passive scenario might be virtually equal to those under an active restoration scenario. Operating check stations, holding pre-season meetings for successful applicants, and ensuring the use of guides likely would require the same amount of staff time whether a very small number of elk permits was issued vs. a larger number. The least expensive hunting scenario for the WV DNR likely would occur with a system similar to that used currently in Virginia, whereby monitoring of elk harvest occurs through existing staff efforts to monitor deer harvest.

Active and Passive Restoration Benefits:

Categories of tangible, economic benefits to WV DNR would be similar under either restoration scenario: revenue from sale of hunting permits, and the opportunity to leverage additional funds for wildlife conservation. An active restoration scenario potentially could result in hunting revenue much sooner than a passive restoration scenario, depending on the scope of an active program to restore elk to eastern West Virginia.

Hunting revenue. Under either restoration scenario, hunting revenue potentially could be generated relatively soon after elk are documented to persist in the state. Initially, revenue might be limited to sale or auctioning of permits to hunt bull elk, assuming growth of the elk population is desirable. The number of hunting opportunities available likely could be determined more easily under an active restoration scenario that involved a known number of animals released and a relatively closely monitored population. However, even a small, passively-established elk population could withstand harvest of some adult bulls (J. Larkin, University of Kentucky, personal communication). Considerable interest in applying for elk permits was generated in Kentucky, Pennsylvania, and Arkansas when those states initially allowed hunting within the last decade (J. Day, Kentucky Department of Fish and Wildlife, personal communication). In Michigan, about 40,000 hunters apply each year for <200 bull-only licenses, and successful applicants must wait 10 years to apply again. As elk have moved from Kentucky into neighboring Virginia, licensed deer hunters have been given the opportunity to harvest elk of either sex using their valid deer tags (http://www.dgif.state.va.us/hunting/elk_hunting.html). These regulations resulted in Virginia deer hunters harvesting 23 elk from 2000-2003, and elk apparently still persist in southwestern Virginia.

Leveraging additional conservation funds. A decision to restore elk to West Virginia likely would generate substantial interest and support among non-governmental conservation groups. These groups have a history of contributing funds to state wildlife agencies, not only for restoration activities, but also for telemetry and other equipment (e.g., snowmobiles, trucks, traps), post-release habitat management, attaining conservation easements on private lands, and in some cases, purchase of land. It is possible that some of the equipment could be used for other management activities when not being used for elk. For example, telemetry receivers used

to monitor elk also could be used to monitor deer or bears. Similarly, any habitat management efforts for elk undoubtedly would benefit other wildlife species. It is possible, although not certain, that opportunities to conduct existing wildlife programs could be enhanced under either elk restoration scenario.

Summary of Restoration Costs and Benefits:

Virtually all the key informants interviewed made it clear that elk restoration (like all other wildlife management activities) had higher short- and long-term costs compared to economic benefits (i.e., revenue). However, informants also unanimously mentioned the importance of intangible benefits to the state wildlife agency in terms of public relations and goodwill. They stressed the importance of communicating with the public about restoration efforts, and the need to help the public develop realistic expectations about potential positive and negative impacts of having elk in the state.

CONCLUSIONS

Public attitudes toward elk restoration in West Virginia generally are positive, with a majority of respondents in both eastern and southern study areas indicating that they support the idea of elk restoration. A greater percentage of respondents from the southern study area compared to the eastern study area indicated the issue of elk restoration was moderately to very important to the well-being of their county. This level of importance was reflected in factors affecting positive and negative attitudes. Positive attitudes generally were related to evaluations of possible elk-related impacts as being "good" for the respondent's county and likely to occur if restoration proceeded. Negative attitudes generally were related to evaluations of possible elk-related impacts as being "bad" for the respondent's county and likely to occur.

The degree to which respondents' beliefs about possible impacts of elk restoration reflect what actually would happen in those counties if elk were restored is somewhat uncertain. Respondents from both areas demonstrated relatively low levels of objective knowledge about elk and the impacts of elk in other states where these large ungulates occur. However, respondents generally based their expectations about whether elk would be mostly a benefit, a problem, or mixed (i.e., a "wash") if restored to their county on their evaluation of current experiences with deer. Evaluations of deer reflected respondents' desired changes in the deer population, indicating that current interactions with deer provided a reasonable measure of "experienced community capacity" in terms of the ability of county residents to take advantage of deer-related benefits and address deer-related problems. "Experienced community capacity" with deer corresponded well with an independent measure of "potential community capacity," which we deemed a social feasibility index or SFI.

Nearly all of the southern study area was encompassed by counties designated with "moderate worsening SFI," whereas the eastern study area contained a spectrum of SFI designations (i.e., low, moderate worsening, moderate improving, and high). Examination of the evaluative beliefs of respondents from the southern study area suggested that their overall support for elk restoration may be based on unrealistic expectations about their capacity to address possible elk-related problems and to experience possible elk-related benefits.

Respondents from the southern area generally believed that possible problems from elk restoration would not occur in their county, and that possible benefits – especially an increase in tourism – were likely to occur. However, counties in the southern area have relatively limited infrastructure in place to realize tangible, economic benefits from tourism.

In the eastern area, respondents seemed more realistic about their capacity to experience benefits and address problems. In that area, respondents from counties designated with "low SFI" generally had neutral attitudes toward restoration, and the neutral attitudes were related to an inability (i.e., lack of capacity) to evaluate possible impacts as "good" or "bad" and as likely or not to occur. Respondents from counties in the eastern study area designated with "high SFI" generally were split in terms of their attitudes toward elk restoration. Those with negative attitudes believed that all ten possible impacts about which we asked would be negative and that most would occur in their county, including an increase in tourism, preservation of elk as a species, and return of a missing component of wilderness. Despite their high potential capacity to address problems, their negative attitude toward restoration may reflect a sense of being overwhelmed with possible problems. Those with positive attitudes evaluated some possible impacts as benefits and some as problems, and generally believed that positive impacts were more likely to occur than negative ones.

The combination of relatively high levels of public support for elk restoration and the designation of many counties as having "moderate improving SFI" or "high SFI" in the eastern study area indicated that social feasibility generally is higher in that study area than in the southern study area. However, because no counties in the southern area were designated with "low SFI" and public support for restoration is even higher than in the eastern area, social feasibility is sufficient in both study areas for WV DNR to discuss and make a decision about the idea of elk restoration with local residents. Such community-based discussions would provide an opportunity to explore the validity of respondents' evaluations of possible elk-related impacts, particularly in light of the differential SFI designations. Support was high in both study areas for that kind of local involvement in decisions about elk restoration. In general, respondents from both areas indicated that local residents and WV DNR should share the greatest responsibility for providing input and making a decision about restoration, and that WV DNR should have the greatest responsibility for implementing management actions stemming from a decision.

These findings support the concept of "co-management" in which wildlife management professionals work in tandem with local stakeholders to make decisions about issues that are likely to affect the local area. The findings also identify a desire by local residents to take an active role in co-management decisions, and not to let those decisions be made by local elected officials or imposed on them by "outside special interest groups." Still, conservation NGOs have a publicly acceptable role to play in all three components of decision-making, but that the level of responsibility should be less than for local residents or WV DNR. Indeed, in the southern area amount of decision-making responsibility attributed to WV DNR was a positive predictor of attitude toward restoration; positive attitudes toward elk restoration in that area seemed to reflect public trust in the wildlife agency to make and carry-out the best possible decision.

Of course, public attitudes toward restoration and capacity of counties to experience possible benefits and address possible problems are only two of the important aspects of social

feasibility. Another aspect includes the assessment of costs and benefits to WV DNR. Other state and provincial wildlife agencies we contacted indicated that economic costs usually outpace economic benefits, particularly in the short-term (e.g., <20 years after restoration). Even after elk are well-enough established to support revenue-generating hunting opportunities, annual costs are incurred in terms of communicating about and addressing elk-related problems that, more often than not, accompany an expanding elk population.

Nonetheless, nearly all key informants interviewed as part of the cost/benefit assessment highlighted two important economic considerations that were part of their agency's decision to restore elk or allow elk to expand to new areas. First, various conservation organizations, but especially the Rocky Mountain Elk Foundation (RMEF) at the national and state levels, had made substantial financial and logistical contributions to elk restoration. Indeed, the direct economic costs of restoration would have been too great for the agency to bear without the considerable help of RMEF and other groups. Second, the more-intangible, public relations benefits to the agency of restoring elk were substantial although hard to document in terms of direct economic benefits.

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Appendix A:

Estimated annual costs[a] and revenues to the West Virginia Division of Natural Resources over a 20-year time horizon for active restoration of 100 elk and management of a slowly growing population in the eastern part of the state, showing a range of low to high estimates for restoration/management activities and cost/revenue components of those activities.

Estimated range of costs for specific cost components of restoration activities	Year 1	Year 2	Year 3	Year 4	Year 5
COSTS					
Capturing elk in donor states/provinces					
Wages and benefits for 2-4 WV DNR biologists to be in donor areas for up to 3 months of trapping elk[b]	$ 17,180-$ 72,835	$ 17,180-$ 72,835	$ 17,180-$ 72,835	$0	$0
Meals and lodging for biologists	$ 5,000-$ 10,000	$ 5,000-$ 10,000	$ 5,000-$ 10,000	$0	$0
Air transportation for biologists	$ 2,000-$ 4,000	$ 2,000-$ 4,000	$ 2,000-$ 4,000	$0	$0
Helicopter rental, fuel and crew	$ 12,000-$ 15,000	$ 12,000-$ 15,000	$ 12,000-$ 15,000	$0	$0

[a] All costs are in constant 2005 dollars.

[b] Low end of range is wage for Wildlife Biologist 1 ($2121/month) plus 35% for benefits, and high end of range is for Wildlife Biologist 3 ($4496/month) plus 35% for benefits.

Estimated cost range	Year 1	Year 2	Year 3	Year 4	Year 5
Meals and lodging for helicopter crew	$ 3,000-$ 6,000	$ 3,000-$ 6,000	$ 3,000-$ 6,000	$0	$0
Helicopter relocation fee	$ 12,000-$ 17,000	$ 12,000-$ 17,000	$ 12,000-$ 17,000	$0	$0
Elk capture and handling fees[c]	$170,000-$300,000	$170,000-$300,000	$170,000-$300,000	$0	$0
Subtotal of expenses for capturing elk	$221,180-$424-835	$221,180-$424-835	$221,180-$424-835	$0	$0
Disease assessment and prevention					
WV veterinarian wages and benefits[d]	$ 2,302-$ 8,519	$ 2,302-$ 8,519	$ 2,302-$ 8,519	$0	$0
Veterinary supplies and disease testing	$ 5,000-$ 7,000	$ 5,000-$ 7,000	$ 5,000-$ 7,000	$0	$0
Subtotal of expenses for disease assessment	$ 7,302-$ 15,519	$ 7,302-$ 15,519	$ 7,302-$ 15,519	$0	$0

[c] Assumes $1,700-$3,00 per elk captured for each of 100 elk per year.

[d] Low end of range is wage for veterinarian with minimum experience ($3,411/month) plus 35% for benefits for 2 week per year, and high end of range is for veterinarian with maximum experience ($6,310/month) plus 35% for benefits for 4 weeks/year.

Estimated cost range	Year 1	Year 2	Year 3	Year 4	Year 5
Transporting elk from donor location to West Virginia					
Rental of commercial livestock trailers (55-70 elk per load)[e]	$ 8,000-$ 13,000	$ 8,000-$ 13,000	$ 8,000-$ 13,000	$0	$0
Obtaining and maintaining written agreements for any release sites and subsequent monitoring of elk on private land					
Wages and benefits for 1 WV DNR biologist to meet with and obtain written agreements from landowners[f]	$ 2,863-$ 6,070	$ 2,863-$ 6,070	$ 2,863-$ 6,070	$0	$0
State vehicle usage[g]	$ 1,000-$ 1,250	$ 1,000-$ 1,250	$ 1,000-$ 1,250	$0	$0
Subtotal of expenses for landowner agreements	$ 3,863-$ 7,320	$ 3,863-$ 7,320	$ 3,863-$ 7,320	$0	$0

[e] Assumes 2 trips from donor area to WV per year at $4,000-$6,500 per trip depending on price of fuel.
[f] Low end of range is wage for Wildlife Biologist 1 ($2121/month) plus 35% for benefits, and high end of range is for Wildlife Biologist 3 ($4496/month) plus 35% for benefits, for about 1 month/year.
[g] Assumes $1,200-$1,500 per year based on vehicle usage in Kentucky and Wisconsin release areas.

Estimated cost range	Year 1	Year 2	Year 3	Year 4	Year 5
Constructing and maintaining holding pens in release areas, and caring for elk in holding pens prior to release					
Wages and benefits for 1 biologist working with volunteers to build pens and feed elk for up to 3 months (start of trapping until release)[h]	$ 8,590-$ 18,209	$ 8,590-$ 18,209	$ 8,590-$ 18,209	$0	$0
State vehicle usage[i]	$ 3,000-$ 4,000	$ 3,000-$ 4,000	$ 3,000-$ 4,000	$0	$0
Materials for constructing and maintaining pens[j]	$ 20,000-$ 24,000	$ 1,000-$ 2,000	$ 1,000-$ 2,000	$0	$0
Food (hay) and water for elk[k]	$ 1,056-$ 2,772	$ 1,056-$ 2,772	$ 1,056-$ 2,772	$0	$0
Subtotal of expenses for building pens and feeding elk	$ 32,646-$ 48,981	$ 13,646-$ 26,981	$ 13,646-$ 26,981	$0	$0

[h] Low end of range is wage for Wildlife Biologist 1 ($2121/month) plus 35% for benefits, and high end of range is for Wildlife Biologist 3 ($4496/month) plus 35% for benefits.
[i] Assumes $1,000-$1,333 per month based on vehicle usage in Kentucky and Wisconsin release areas.
[j] Assumes 4 holding pens constructed in first year and only minor maintenance in years 2 and 3.
[k] Low end of range assumes holding 25 elk for 90 days, 50 elk for 60 days, and 25 elk for 30 days (totaling 100 elk for 6,000 elk days in holding pens), with each elk requiring 2kg/day of hay for a total of 12,000kg of hay (or 13.2 tons for the holding period), and hay costing $80/909kg (or 1 ton), based on nutritional needs of elk and minimum cost of hay at auction as of 15 October 2005; high end of range assumes holding 100 elk for 90 days (totaling 9,000 elk days in holding pens), with each elk requiring 2/kg/day of hay for a total of 12,000kg of hay, and hay costing $140/909kg (or 1 ton), based on nutritional requirements of elk and maximum cost of hay at auction as of 15 October 2005 http://www.uwex.edu/ces/forage/pubs/hay_market_report.htm.

Estimated cost range	Year 1	Year 2	Year 3	Year 4	Year 5
Post release monitoring of elk					
Wages and benefits for 1-2 WV DNR biologists to monitor elk in release area[l]	$ 8,590-$ 36,418	$ 8,590-$ 36,418	$ 8,590-$ 36,418	$ 8,590-$ 36,418	$ 8,590-$ 36,418
Radio-telemetry and other monitoring materials[m]	$ 18,000-$ 30,000	$ 18,000-$ 30,000	$ 18,000-$ 30,000	$ 18,000-$ 30,000	$ 18,000-$ 30,000
State vehicle usage[n]	$ 3,000-$ 4,000	$ 3,000-$ 4,000	$ 3,000-$ 4,000	$ 3,000-$ 4,000	$ 3,000-$ 4,000
Renting fixed-wing aircraft for estimating elk population size and monitoring movements[o]	$ 20,000-$ 40,000	$ 20,000-$ 40,000	$ 20,000-$ 40,000	$ 20,000-$ 40,000	$ 20,000-$ 40,000
Subtotal of expenses for post-release monitoring of elk	$ 49,590-$110,418	$ 49,590-$110,418	$ 49,590-$110,418	$ 49,590-$110,418	$ 49,590-$110,418

[l] Low end of range is wage for Wildlife Biologist 1 ($2121/month) plus 35% for benefits, and high end of range is for Wildlife Biologist 3 ($4496/month) plus 35% for benefits, for 3 months per year.
[m] Range based on numbers of elk that have been monitored in WI and PA, specific numbers will depend on needs of WV DNR.
[n] Assumes $1,200-$1,500 per month based on vehicle usage in Kentucky and Wisconsin release areas.
[o] Range based on numbers of elk and levels of effort expended in WI and PA, specific numbers will depend on needs of WV DNR.

Estimated cost range	Year 1	Year 2	Year 3	Year 4	Year 5
Public communication efforts about active or passive restoration efforts					
Development of press releases, PSAs for radio and TV, information in DNR magazines and web site[p]	$0	$0	$0	$0	$0
Staff time for answering phone and postal inquiries and giving presentations[q]	$0	$0	$0	$0	$0
Wages and benefits for 1-2 WV DNR biologists to proactively address public concerns about elk (elk-vehicle accidents, damage to ag and forestry crops, trampling yards, etc.)[r]	$0	$ 8,590-$ 36,418	$ 8,590-$ 36,418	$ 8,590-$ 36,418	$ 8,590-$ 36,418

[p] Assumed to be part of regular work activities for staff.
[q] Assumed to be part of regular work activities for staff.
[r] None assumed for year 1, thereafter, low end of range is wage for Wildlife Biologist 1 ($2121/month) plus 35% for benefits, and high end of range is for Wildlife Biologist 3 ($4496/month) plus 35% for benefits, both for 3 months per year.

Estimated cost range	Year 1	Year 2	Year 3	Year 4	Year 5
Relocate problem elk by helicopter [s]	$ 15,000-$ 45,000	$ 15,000-$ 45,000	$ 15,000-$ 45,000	$ 15,000-$ 45,000	$ 15,000-$ 45,000
Subtotal of expenses for communicating about elk and possible problems	$0	$ 23,590-$ 81,418	$ 23,590-$ 81,418	$ 23,590-$ 81,418	$ 23,590-$ 81,418
Regulating hunting activities after a sustainable elk population is established					
Establishing annual hunting regulations[t]	$0	$0	$0	$0	$0
Handling applications, conducting lotteries, selling tags to successful applicants[u]	$0	$0	$0	$ 1,355-$ 3,293	$ 1,355-$ 3,293
Annual mandatory hunter orientation, overseeing hunt, checking harvested elk[v]	$0	$0	$0	$ 2,863-$ 6,070	$ 2,863-$ 6,070

[s] Assuming the need to move 6-18 elk per year, based on information from ON, MI, and KY.
[t] Assumed to be part of regular work activities.
[u] Low end of range is wage for Office Assistant 1 ($1004/month) plus 35% for benefits, and high end of range is wage for Office Assistant 3 ($2439/month) plus 35% for benefits, both for 1 month per year.

Estimated cost range	Year 1	Year 2	Year 3	Year 4	Year 5
Law enforcement for hunts[w]	$0	$0	$0	$ 2,994-$ 4,220	$ 2,994-$ 4,220
Subtotal of expenses for managing annual elk hunts	$0	$0	$0	$ 7,213-$ 13,582	$ 7,213-$ 13,582
Grand total of annual costs for active restoration	$322,582-$620,072	$327,172-$679,490	$327,172-$679-490	$ 87,605-$219,000	$ 87,605-$219,000
REVENUES					
Hunting revenue[x]	$0	$0	$0	$ 50,400-$ 75,400	$ 50,600-$ 75,600

[v] Low end of range is wage for Wildlife Biologist 1 ($2121/month) plus 35% for benefits, and high end of range is wage for Wildlife Biologist 3 ($4496/month) plus 35% for benefits, both for 1 month per year.

[w] Low end of range is wage for 1 Conservation Officer ($2,548/month) plus 35% for benefits, and high end of range is wage for 2 Conservation Officer Corporals ($3,126/month) plus 35% for benefits, both for 2 week/year for duties related to elk hunting.

[x] Assumes 5,000-7,500 applicants each paying a non-refundable $10 application fee starting in year 4, with a single bull elk tag sold for $100 each to 4 successful applicants in that year. Number of successful applicants increases by 2 each year thereafter.

COSTS (continued)

Estimated range of costs for specific cost components of restoration activities	Year 6	Year 7	Years 8-20	Total over 20-year period
Capturing elk in donor states/provinces				
Wages and benefits for 2-4 WV DNR biologists to be in donor areas for up to 3 months of trapping elk[y]	$0	$0	$0	$ 51,540-$218,506
Meals and lodging for biologists	$0	$0	$0	$ 15,000-$ 30,000
Air transportation for biologists	$0	$0	$0	$ 6,000-$ 12,000
Helicopter rental, fuel and crew	$0	$0	$0	$ 36,000-$ 45,000

[y] Low end of range is wage for Wildlife Biologist 1 ($2121/month) plus 35% for benefits, and high end of range is for Wildlife Biologist 3 ($4496/month) plus 35% for benefits.

Estimated cost range	Year 6	Year 7	Years 8-20	Total over 20-year period
Meals and lodging for helicopter crew	$0	$0	$0	$ 9,000-$ 18,000
Helicopter relocation fee	$0	$0	$0	$ 36,000-$ 51,000
Elk capture and handling fees[z]	$0	$0	$0	$510,000-$900,000
Subtotal of expenses for capturing elk	$0	$0	$0	$663,540-$1,274,506
Disease assessment and prevention				
WV veterinarian wages and benefits[aa]	$0	$0	$0	$ 6,907-$ 25,556
Veterinary supplies and disease testing	$0	$0	$0	$ 15,000-$ 21,000
Subtotal of expenses for disease assessment	$0	$0	$0	$ 21,907-$ 46,556

[z] Assumes $1,700-$3,00 per elk captured for each of 100 elk per year.

[aa] Low end of range is wage for veterinarian with minimum experience ($3,411/month) plus 35% for benefits for 2 week per year, and high end of range is for veterinarian with maximum experience ($6,310/month) plus 35% for benefits for 4 weeks/year.

Estimated cost range	Year 6	Year 7	Years 8-20	Total over 20-year period
Transporting elk from donor location to West Virginia				
Rental of commercial livestock trailers (55-70 elk per load)[bb]	$0	$0	$0	$ 24,000-$ 39,000
Obtaining and maintaining written agreements for any release sites and subsequent monitoring of elk on private land				
Wages and benefits for 1 WV DNR biologist to meet with and obtain written agreements from landowners[cc]	$0	$0	$0	$ 8,590-$ 18,209
State vehicle usage[dd]	$0	$0	$0	$ 3,000-$ 3,750
Subtotal of expenses for landowner agreements	$0	$0	$0	$ 11,590-$ 21,959

[bb] Assumes 2 trips from donor area to WV per year at $4,000-$6,500 per trip depending on price of fuel.
[cc] Low end of range is wage for Wildlife Biologist 1 ($2121/month) plus 35% for benefits, and high end of range is for Wildlife Biologist 3 ($4496/month) plus 35% for benefits, for about 1 month/year.
[dd] Assumes $1,200-$1,500 per year based on vehicle usage in Kentucky and Wisconsin release areas.

Estimated cost range	Year 6	Year 7	Years 8-20	Total over 20-year period
Constructing and maintaining holding pens in release areas, and caring for elk in holding pens prior to release				
Wages and benefits for 1 biologist working with volunteers to build pens and feed elk for up to 3 months (start of trapping until release)[ee]	$0	$0	$0	$ 25,770-$ 54,626
State vehicle usage[ff]	$0	$0	$0	$ 9,000-$ 12,000
Materials for constructing and maintaining pens[gg]	$0	$0	$0	$ 22,000-$ 28,000
Food (hay) and water for elk[hh]	$0	$0	$0	$ 3,168-$ 8,317
Subtotal of expenses for building pens and feeding elk	$0	$0	$0	$ 59,938-$102,943

[ee] Low end of range is wage for Wildlife Biologist 1 ($2121/month) plus 35% for benefits, and high end of range is for Wildlife Biologist 3 ($4496/month) plus 35% for benefits.
[ff] Assumes $1,000-$1,333 per month based on vehicle usage in Kentucky and Wisconsin release areas.
[gg] Assumes 4 holding pens constructed in first year and only minor maintenance in years 2 and 3.
[hh] Low end of range assumes holding 25 elk for 90 days, 50 elk for 60 days, and 25 elk for 30 days (totaling 100 elk for 6,000 elk days in holding pens), with each elk requiring 2kg/day of hay for a total of 12,000kg of hay (or 13.2 tons for the holding period), and hay costing $80/909kg (or 1 ton), based on nutritional needs of elk and minimum cost of hay at auction as of 15 October 2005; high end of range assumes holding 100 elk for 90 days (totaling 9,000 elk days in holding pens), with each elk requiring 2/kg/day of hay for a total of 12,000kg of hay, and hay costing $140/909kg (or 1 ton), based on nutritional requirements of elk and maximum cost of hay at auction as of 15 October 2005 http://www.uwex.edu/ces/forage/pubs/hay_market_report.htm.

Estimated cost range	Year 6	Year 7	Years 8-20	Total over 20-year period
Post release monitoring of elk				
Wages and benefits for 1-2 WV DNR biologists to monitor elk in release area[ii]	$ 8,590-$ 36,418	$ 8,590-$ 36,418	$111,670-$473,434	$171,801-$728,352
Radio-telemetry and other monitoring materials[jj]	$ 18,000-$ 30,000	$ 18,000-$ 30,000	$234,000-$390,000	$360,000-$600,000
State vehicle usage[kk]	$ 3,000-$ 4,000	$ 3,000-$ 4,000	$ 39,000-$ 52,000	$ 60,000-$ 80,000
Renting fixed-wing aircraft for estimating elk population size and monitoring movements[ll]	$ 20,000-$ 40,000	$ 20,000-$ 40,000	$260,000-$520,000	$400,000-$800,000
Subtotal of expenses for post-release monitoring of elk	$ 49,590-$110,418	$ 49,590-$110,418	$644,670-$1,435,434	$991,801-$2,208,352

[ii] Low end of range is wage for Wildlife Biologist 1 ($2121/month) plus 35% for benefits, and high end of range is for Wildlife Biologist 3 ($4496/month) plus 35% for benefits, for 3 months per year.
[jj] Range based on numbers of elk that have been monitored in WI and PA, specific numbers will depend on needs of WV DNR.
[kk] Assumes $1,200-$1,500 per month based on vehicle usage in Kentucky and Wisconsin release areas.
[ll] Range based on numbers of elk and levels of effort expended in WI and PA, specific numbers will depend on needs of WV DNR.

Estimated cost range	Year 6	Year 7	Years 8-20	Total over 20-year period
Public communication efforts about active or passive restoration efforts				
Development of press releases, PSAs for radio and TV, information in DNR magazines and web site[mm]	$0	$0	$0	$0
Staff time for answering phone and postal inquiries and giving presentations[nn]	$0	$0	$0	$0
Wages and benefits for 1-2 WV DNR biologists to proactively address public concerns about elk (elk-vehicle accidents, damage to ag and forestry crops, trampling yards, etc.)[oo]	$ 8,590-$ 36,418	$ 8,590-$ 36,418	$111,670-$473,434	$163,211-$691,934

[mm] Assumed to be part of regular work activities for staff.
[nn] Assumed to be part of regular work activities for staff.
[oo] None assumed for year 1, thereafter, low end of range is wage for Wildlife Biologist 1 ($2121/month) plus 35% for benefits, and high end of range is for Wildlife Biologist 3 ($4496/month) plus 35% for benefits, both for 3 months per year.

Estimated cost range	Year 6	Year 7	Years 8-20	Total over 20-year period
Relocate problem elk by helicopter [pp]	$ 15,000-$ 45,000	$ 15,000-$ 45,000	$195,000-$585,000	$285,000-$855,000
Subtotal of expenses for communicating about elk and possible problems	$ 23,590-$ 81,418	$ 23,590-$ 81,418	$306,670-$1,058,434	$448,211-$1,546,934
Regulating hunting activities after a sustainable elk population is established				
Establishing annual hunting regulations[qq]	$0	$0	$0	$0
Handling applications, conducting lotteries, selling tags to successful applicants[rr]	$ 1,355-$ 3,293	$ 1,355-$ 3,293	$ 17,615-$ 42,809	$ 23,042-$ 55,975
Annual mandatory hunter orientation, overseeing hunt, checking harvested elk[ss]	$ 2,863-$ 6,070	$ 2,863-$ 6,070	$ 37,219-$ 78,910	$ 48,677-$103,183

[pp] Assuming the need to move 6-18 elk per year, based on information from ON, MI, and KY.
[qq] Assumed to be part of regular work activities.
[rr] Low end of range is wage for Office Assistant 1 ($1004/month) plus 35% for benefits, and high end of range is wage for Office Assistant 3 ($2439/month) plus 35% for benefits, both for 1 month per year.

Estimated cost range	Year 6	Year 7	Years 8-20	Total over 20-year period
Law enforcement for hunts[tt]	$ 2,994-$ 4,220	$ 2,994-$ 4,220	$ 38,922-$ 54,860	$ 50,896-$ 71,742
Subtotal of expenses for managing annual elk hunts	$ 7,213-$ 13,582	$ 7,213-$ 13,582	$ 93,769-$176,566	$122,615-$230,900
Grand total of annual costs for active restoration	$ 87,605-$219,000	$ 87,605-$219,000	$1,138,865-$2,847,000	$2,466,218-$5,702,049
REVENUES				
Hunting revenue[uu]	$ 50,800-$ 75,800	$ 51,000-$ 76,000	$665,600-$990,600	$868,400-$1,293,400

[ss] Low end of range is wage for Wildlife Biologist 1 ($2121/month) plus 35% for benefits, and high end of range is wage for Wildlife Biologist 3 ($4496/month) plus 35% for benefits, both for 1 month per year.

[tt] Low end of range is wage for 1 Conservation Officer ($2,548/month) plus 35% for benefits, and high end of range is wage for 2 Conservation Officer Corporals ($3,126/month) plus 35% for benefits, both for 2 week/year for duties related to elk hunting.

[uu] Assumes 5,000-7,500 applicants each paying a non-refundable $10 application fee starting in year 4, with a single bull elk tag sold for $100 each to 4 successful applicants in that year. Number of successful applicants increases by 2 each year thereafter.

Appendix C

Elk Restoration Operational Plan
November 2015

West Virginia Division of Natural Resources
Wildlife Resources Section

Introduction

- Over the past two decades, the bordering states of Kentucky and Virginia have undertaken elk translocation programs to restore elk to designated areas within their states.

- During 2005, the West Virginia Division of Natural Resources (WVDNR), in cooperation with the Rocky Mountain Elk Foundation (RMEF), completed a feasibility study which evaluated the biological and sociological conditions relating to an active elk restoration effort in West Virginia. Based upon the findings of this report, as well as additional analysis of habitat conditions, an Elk Management Area (EMA) was established in the southern coal fields region of West Virginia. Both the Virginia and Kentucky elk management areas border West Virginia's EMA. During 2010, the WVDNR completed its initial Elk Management Plan. The primary goal at that time was to allow elk to populate the West Virginia EMA through natural dispersal from the existing free-ranging wild herds in Kentucky and Virginia.

- Two open house public meetings to gauge interest for translocating elk to West Virginia were held in Logan and Mingo counties on November 13, 2014 and December 4, 2014, respectively. In addition, a statewide voluntary on-line survey was conducted to reach out to citizens throughout the state which were unable to attend the public meetings. Results indicated overwhelming public support for restoring elk to the southern coal fields region of West Virginia. One thousand one-hundred thirty responses (1,130) from residents of 52 of 55 counties were 93% in favor of proceeding with elk translocation and restoration in West Virginia.

- During the 2015 West Virginia Legislative Session, legislation was passed and went into effect on June 12, 2015, which tasked the WVDNR with the development of an elk translocation and restoration program and provided the agency with the ability to promulgate rules to achieve program objectives.

- With overwhelming support from the public and legislature, the following actions and recommendations have been drafted to guide the WVDNR's plans for implementation of an elk restoration program.

Establishment of WVDNR Elk Working Group

- A new full-time position (Elk Project Leader) stationed in the Game Management Services Unit of the WVDNR Wildlife Resources Section has been created and assigned to oversee the elk management program. This position will be stationed at a central location within the Elk Management Area.

- An elk working group comprised of the WVDNR's Elk Project Leader (Committee Chairman), Supervisor of Game Management, Supervisor of Game Management Services, Deer Project Leader, WVDNR Law Enforcement Section representative

and District IV and V Wildlife Biologists has been assembled and tasked with revision of agency's existing Elk Management Plan.

Coordination with Kentucky Department of Fish and Wildlife and Virginia Department of Game and Inland Fisheries.

- The WVDNR will coordinate with the Kentucky Department of Fish and Wildlife (KDFW) and the Virginia Department of Game and Inland Fisheries (VDGIF) as it relates to obtaining source elk from the eastern Kentucky and southwestern Virginia elk populations for translocation to West Virginia. A Memorandum of Understanding will be developed between the WVDNR and the source agency which will outline the details as it relates to the cost, protocols, responsibilities and timeline of the arrangement.

- *The WVDNR will coordinate with the KDFW and VDGIF to collaborately address issues associated with the regional elk population in the tri-state area.*

- Out-of-state site visits to Kentucky's and Virginia's Elk Management Areas will be scheduled at an appropriate time to gain a better understanding and knowledge of the protocols, methodologies, equipment needs, etc. required with elk translocation.

Coordination with West Virginia Department of Agriculture and other Entities as it Relates to Disease Testing Protocols

- The WVDNR will notify the West Virginia Department of Agriculture (WVDA) of their plans to bring wild elk in from other states. Disease testing and monitoring will be followed as outlined in 58CSR74(5) - Elk Management and Restoration Legislative Rule which follows disease testing protocols stated in 61CSR1 (Animal Disease Control Legislative Rule). A Certificate of Veterinary Inspection (CVI) issued by an accredited veterinarian must accompany all wild elk translocated into West Virginia. The CVI shall indicate that the animal has:

    - had a negative tuberculosis test within 2 months prior to the importation.

    - had a negative brucellosis test within 1 month prior to the importation of the animal.

- The Division shall not import any elk from a population known to be infected with and/or not routinely post mortem tested for the abnormal prion associated with chronic wasting disease of deer and elk.

- The Division shall consider the requirement of negative test results as minimum requirements for importation of elk captured from the wild from the Kentucky or Virginia Elk Management Areas, but shall require additional disease testing for

any elk imported from outside of the Kentucky and Virginia Elk Management Areas on a case by case basis.

- For purposes of this section, the tuberculosis test shall use the single cervical test as prescribed by the United States Department of Agriculture on December 31, 1990 or equivalent approved test (DPP Test Dual Path Platform Test, April 2014), approved by USDA APHIS Veterinary Services and all elk captured from the wild and confined with the elk to be imported shall have a negative tuberculosis test or negative post mortem culture.

- The Division shall notify the Commissioner of the West Virginia Department of Agriculture (WVDA) of its intent to import elk into the state a minimum of one (1) week prior to transporting animals into the state.

- The WVDNR will coordinate with the Southeast Cooperative Wildlife Disease Study (SCWDS) as it relates to the testing and monitoring of elk for disease and parasites.

- The WVDNR will coordinate with Wildlife Health staff in the source state as it relates to the requirement of a CVI as well as disease and parasite testing protocols and responsibilities.

- As per recent West Virginia legislation HB 2515, the WVDNR shall promulgate legislative rules to establish protocols for ensuring elk imported to the state are healthy, tested for tuberculosis, brucellosis and other diseases of concern, and from an area where chronic wasting disease has not been detected. Legislative Rule 58CSR74 (Elk Restoration and Management Rule) has been drafted and submitted for consideration during the 2016 Legislative Session.

Identifying and Securing Elk Restoration Release Sites

- Based upon a comprehensive GIS-based analysis of land ownership patterns and habitat quality, five Focal Areas (FA) were identified within the West Virginia Elk Management Area. These areas include the Logan FA (central Logan Co.), Barnabus FA (southwestern Logan and northcentral Mingo counties), Laurel Lake WMA FA (northern Mingo and western Logan counties), Pinnacle Creek FA (southern Wyoming and northern McDowell counties) and Anawalt Lake FA (eastern McDowell County). Restoration focal areas may be modified as additional public lands are acquired or additional habitat analysis is completed.

- The WVDNR will coordinate with large property owners within the Focal Areas to identify potential acquisition areas for securing long-term public access to properties through fee-simple acquisition, conservation easements, working forest easements or long-term lease agreements. The focus for 2015-2016 is to identify a minimum of 10,000 contiguous acres within one of the five Focal Areas and secure property for an elk release site with the objective of a spring 2016 elk

release (pending securing elk stock). (Note: The Barnabus and Laurel Lake Focal Areas have been targeted, and ongoing discussions relating to the acquisition of properties are in various stages of negotiations). An additional elk release site targeting the Pinnacle Creek, Anawalt Lake or Logan Focal Areas will be explored in the immediate future. The restoration goal is to obtain 150 elk during the five-year plan period, with approximately 75 animals being released at the two sites. The elk operational plan will follow an adaptive approach and will be subject to modification, especially as it relates to the number of available animals and the timeline for release.

- The WVDNR will coordinate with the Virginia Department of Game and Inland Fisheries (VDGIF) and secure and transport the soft-release elk pen which was used in Virginia's elk restoration project to the initial West Virginia elk release site. (Note: soft-release pen has been secured and transported to Logan County, West Virginia).

Coordinate with other State Agencies and Regional Committees/Working Groups

- Coordinate with West Virginia Department of Environmental Protection (WVDEP) on issues relating to land use designations on active mine company permits and bonding requirements to maximize habitat conditions for elk.

- Continue to participate in the annual Eastern Elk Workshop and other elk management meetings and conferences.

- Participate in elk-related regional working groups or technical committees.

Identify and Procure Equipment, Supplies and Personnel Services

- Proceed with acquisition of equipment, supplies and services which will be required for elk translocation, including but not limited to:

    - One-ton 4WD extended cab truck
    - Gooseneck livestock trailer
    - Immobilization equipment and drugs
    - Capture and tagging equipment
    - Soft-release pen
    - Portable corral trap
    - 25-50 GPS collars and supplies (research project)
    - UTV and trailer

- Establish a Wildlife Manager position to be administered under district operations and strategically located within the Elk Management Area.

- Establish a Wildlife Biologist II position to serve as an assistant to the Elk Project Leader.

- Coordinate contractual needs as well as voluntary work crews to erect the soft-release pen at the initial elk release site.

Legislative Issues

- Two procedural legislative rules will be promulgated: 58CSR15 “Permits to Kill Deer and Other Wildlife Causing Damage to Cultivated Crops, Fruit Trees, or Commercial Nurseries” will be revised, and 58CSR75 “Elk Damage Rule” will be drafted to address dealing with nuisance elk causing damage to agricultural fences and crops, as well as personal gardens.

- Additional legislation and legislative rules will need to be drafted or revised to address other issues relating to the elk restoration projects such as the hunting of elk, license requirements, application process, etc.

Collaboration with NGOs and other Conservation Groups

- Coordinate with Rocky Mountain Elk Foundation (RMEF) to secure partial funding for elk restoration efforts including funds for source animal procurement as well as land acquisition and habitat enhancement projects within the elk management area. In addition, coordinate voluntary assistance for elk restoration related projects such as the erection of the elk soft-release pen, habitat enhancement projects, etc.

- Elk project leader will coordinate with other state and national conservation organizations (e.g., West Virginia Bowhunters Assn., West Virginia Trophy Hunters Assn., National Wild Turkey Federation) on potential funding for habitat enhancement projects and research needs.

Land Acquisition Efforts

- The WVDNR will coordinate with The Conservation Fund, West Virginia Land Trust and other partners relating to land acquisition projects within the elk management area.

- The WVDNR will continue to explore fee acquisition purchases within the elk management area as well as easement acquisitions which secure perpetual public access (i.e., working forest easements, public access easements).

Habitat Management Efforts

- Habitat enhancement projects will be conducted on Wildlife Management Areas and lands under lease agreements within the Elk Management Area. Properties in the vicinity of the two release sites will be prioritized for habitat enhancement projects. Projects will include clearing developments, clearing conversions, nutrient management, waterhole development, early successional forest creation,

controlled burning, as well as forest management activities to improve mast production and early successional habitat.

- The WVDNR will provide technical assistance to public agencies, municipalities, corporate landowners, conservation organizations and private individuals interested in managing elk habitat.

- The WVDNR will continue to work in collaboration with the RMEF on PAC-funded habitat enhancement projects within the elk restoration area. In addition, the WVDNR will work with other NGOs on habitat based projects.

Erection of Elk Release Facility / Elk Release Schedule

- The elk soft-release pen will be erected at the initial elk release site with a projected goal of 75 elk (total) to be released during the spring of 2016 and 2017 (timeline subject to change dependent upon availability of source animals).

- The elk soft-release pen will be dismantled upon completion of the initial elk release site stocking and re-erected at the second elk release site (pending the completion of the initial release site stocking). Depending upon the availability of animals from the source state, an additional 75 elk will be released at the second release site during the subsequent years.

Research and Population Monitoring Protocols and Needs

- A habitat driven, random sample technique, utilizing salt block camera stations will be continued during the plan period.

- Aerial helicopter surveys will be conducted during snow-on conditions during select years.

- Elk observed while conducting deer distance sampling survey routes will be recorded and GPS locations determined.

- The annual West Virginia Bowhunter Cooperative Survey will be modified to incorporate a question or place for data entry, for recording elk heard bugling or observed by survey participants.

- GPS telemetry collars will be placed on all animals from the initial elk release to monitor movements, survival and mortality. The need for additional collars at the second release site will be evaluated.

Public Access for Elk Viewing

- Public access for the purposes of providing elk viewing opportunities will be evaluated and a proposal developed to address this need.

Elk Restoration Program Estimated Costs and Implementation Schedule			
	Project Activity	***Timeline for Completion**	**Estimated Cost**
*FY2016	Contact Kentucky Department of Fish and Wildlife – Request elk	Summer 2015	----
	Hire elk project leader and initiate elk working group	September 2015	$80,000
	Hold DNR elk planning committee meeting	October 2015	----
	Select initial release area and site (#1) for soft-release pen	October 2015	----
	Habitat enhancement project in initial elk release area (PAC project)	November 2015 / March 2016	$40,000
	Erection of soft-release pen	October-December 2015	$10,000
	Finalize Elk Management Plan revision	November 2015	----
	Continue negotiations with landowners targeting the elk release area – lease agreements, as well as fee or easement acquisition	Ongoing	----
	Coordinate with WV Dept. of Agriculture on plans for elk restoration	December 2015	----
	Requisition/purchase needed equipment	October-November 2015	$60,000
	Identify elk research needs – purchase radio telemetry equipment	October 2015	$52,500
	Conduct training for DNR district staff – immobilization/handling	January 2016	$2,000
	Assist source state with the capturing and quarantining of animals	January-March 2016	$87,500
	Transport elk to release pen	March-April 2016	$1,000
	Release elk from release pen	May 2016	$1,500
	Construct portable elk corral trap	June 2016	$15,000
	Total FY2016 Estimated Project Costs:		**$349,500**
*FY2017	Continue negotiations with landowners targeting the elk release area – lease agreements, as well as fee or easement acquisition	Ongoing	----
	Purchase equipment for Year 2	September 2016	$10,000
	Identify elk research needs – purchase radio telemetry equipment	October 2016	$60,000
	Assist source state with the capturing and quarantining of animals	January-March 2017	$100,000
	Transport elk to release pen	March-April 2017	$1,000
	Release elk from release pen	May 2017	$1,500
	Dismantle elk release pen and remove from site	July 2017	$5,000
	Development of elk viewing projects	July 2017	$10,000
	Total FY2017 Estimated Project Costs:		**$187,500**
*FY2018	Transport and erect elk release pen on elk release site #2	September-October 2017	$20,000
	Continue negotiations with landowners targeting the elk release area – lease agreements, as well as fee or easement acquisition	Ongoing	----
	Purchase equipment for Year 3	October 2017	$10,000
	Aerial elk surveys	January 2018	$10,000
	Identify elk research needs – purchase radio telemetry equipment	October 2017	$25,000
	Assist source state with the capturing and quarantining of animals	January-March 2018	$87,500
	Transport elk to release pen	March-April 2018	$1,000
	Release elk from release pen	May 2018	$1,500
	Total FY2018 Estimated Project Costs:		**$155,000**
*FY2019	Continue negotiations with landowners targeting the elk release area – lease agreements, as well as fee or easement acquisition	Ongoing	----
	Purchase equipment for Year 4	September 2018	$10,000
	Identify elk research needs – purchase radio telemetry equipment	October 2018	$25,000
	Assist source state with the capturing and quarantining of animals	January-March 2019	$100,000
	Transport elk to release pen	March-April 2019	$1,000
	Release elk from release pen	May 2019	$1,500
	Total FY2019 Estimated Project Costs:		**$137,500**
	TOTAL ELK RESTORATION PROJECT COSTS:		**$829,500**

*Timeline subject to change depending upon availability of source animals.