The Role of Bowhunting in Wildlife Management

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The Wildlife Society

Committee Members:

Eric W. Kurzejeski, Chair
Missouri Department of Conservation
1110 S. College Avenue
Columbia, Missouri 65201

James L. Byford
College of Agriculture
University of Tennessee - Martin
Martin, Tennessee 38238

Keith Causey
Department of Zoology and Wildlife
Auburn University
Auburn, Alabama 36849

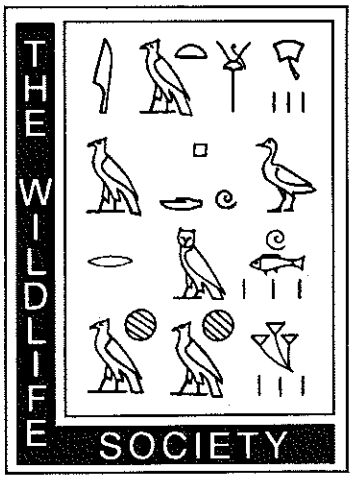
Jody W. Enck
Department of Natural Resources
Cornell University
Ithaca, New York 14853

Lonnie P. Hansen
Missouri Department of Conservation
1110 S. College Avenue
Columbia, Missouri 65201

Wendy Krueger
Minnesota Department of Natural Resources
P.O. Box 79
Nicollet, Minnesota 56074

Ken Mayer
California Department of Fish and Game
1416 9th Street
Sacramento, California 95814

Keith McCaffery
Wisconsin Department of Natural Resources
Box 576
Rhinelander, Wisconsin 54501



The Wildlife Society
5410 Grosvenor Lane
Bethesda, Maryland 20814

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Foreword

Presidents of The Wildlife Society occasionally appoint ad hoc committees to study and report on select conservation issues. The reports ordinarily appear as either a Technical Review or a Position Statement. Review papers present technical information and the views of the appointed committee members, but not necessarily the views of their employers. Position statements are based on the review papers, and the preliminary versions are published in The *Wildlifer* for comment by Society members. Following the comment period, revision, and Council's approval, the statements are published as official positions of The Wildlife Society.

The Wildlife Society
5410 Grosvenor Lane
Bethesda, MD 20814
(301) 897-9770
Fax: (301) 530-2471

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Cover photo courtesy of Bear Archery.

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SYNOPSIS

In 1994, The Wildlife Society Council charged the Ad Hoc Technical Review Committee on Bowhunting as a Wildlife Management Tool with documenting the growth of bowhunting in North America, reviewing the types and purposes of equipment regulations, reviewing and summarizing the literature relating to the efficacy of bowhunting and proficiency of bowhunters, documenting current challenges to bowhunting, and identifying research needs. The urgency for this review grew out of the increase in bowhunting participation (Southwick and Teisl 1998) during the past 3 decades; its use as a population management tool, particularly for ungulates in urban and suburban settings; and more frequent challenges to the use of this tool by animal welfare and animal rights groups. Council believed such a review would have broad-based value not only to wildlife professionals but also to state lawmakers, agency administrators, urban planners, and others who deal with wildlife-resource decision making.

Bowhunting is not new; the nation's first archery-only deer season was established in Wisconsin in 1934 (James 1993). The popularity of bowhunting has continued to increase and currently bowhunter numbers are at an all-time high. In 1996 an estimated 3,289,140 bowhunting licenses were sold compared to 2.7 million in 1991 and 760,000 in 1970. Bowhunters compose a minority of all hunters, but the percentage of hunters who report hunting with a bow has grown steadily from 19% in 1986 to 33% in 1991 to 45% in 1996 (Southwick and Teisl 1998).

Bowhunting generally has lower impact on the wildlife resource than does firearms hunting. Lower harvest rates and fewer participants have led many state agencies to view bowhunting primarily as a recreational opportunity with minimal resource impacts. However, bowhunting is becoming an increasingly important population management tool, especially for white-tailed deer. In Wisconsin, bow harvest accounts for >30% of the deer taken by hunters in some management units (Wisconsin Department of Natural Resources unpublished data, 1998). Of the 59,769 white-tailed deer reported harvested during the 1995-96 deer season in New Jersey, 20,593 (34.5%) were killed by bowhunters (Ferrigno 1996). Bowhunting also is being used effectively as a population management tool in areas such as parks, arboretums, and urban areas, where firearms discharge is prohibited. For example, in Connecticut, Kilpatrick and Walter (1997) reported that a controlled bowhunt in a residential community resulted in a 50-52% reduction in deer numbers.

The public has recognized the increased use of bowhunting as a wildlife management tool. That recognition has brought to the forefront concerns about the humaneness and effectiveness of bowhunting (Samuel et al. 1991). Bowhunting opponents believe that archers wound an excessive number of animals that die painful and lingering deaths and, therefore, claim that bowhunting is inefficient and inhumane (Pacelle 1990). They also are concerned about length of time animals suffer before they die from an arrow wound. Hunters themselves are concerned about the same issues.

The published literature on bow wounding lacks clarity, in part due to a lack of standardized terminology. This confusion has resulted in misinterpretation of data, which has served to fuel a controversy over the rate animals are wounded and not recovered via bowhunting. Most recently, Krueger (1995), building on work by McCaffery (1985) and Mayer and Samuel (1992), developed definitions to help classify wounding information.

The majority of wounding data has been obtained from hunter responses to questions about their hunting experiences (Samuel et al. 1991), through either interviews or posthunt mail questionnaires. Each approach has inherent limitations. Reported wounding rates from interview or questionnaire studies are highly variable. Results of studies where hunter interviews were combined with ground searches for dead deer or monitoring of radio-marked deer suggest unretrieved kill can range from 8 to 27%.

Because of the difficulty in determining the number of deer that are hit by bowhunters but survive, no studies have been conducted to specifically measure this number. However, Nettles et al. (1976) reported that only 5 (0.5%) of 1,002 deer necropsied were injured as a result of previous arrowhead wounds. This suggests that either bow-wounded deer are rare, that their wounds heal rapidly, or that a large percentage dies. Nettles et al. (1976) concluded that long-term suffering caused by traumatic injury probably affects very few white-tailed deer.

It can be anticipated that interest in bowhunting will continue to grow and that additional opportunities and

challenges for wildlife managers will accompany this growth. With increased interest in bowhunting, natural resource agencies will become more involved in bowhunter education. Bowhunters and bowhunting also may be used more frequently to manage ungulate populations. Wildlife professionals also are likely to see increased concern over issues relating to resource allocation among hunter groups. Technological advances in archery equipment will be a concern among some wildlife management agencies, as will development of additional regulations designed to ensure the efficacy of bowhunting equipment.

Challenges to bowhunting from segments of society that wish to reduce or abolish hunting also are likely to continue. Although it is clearly established that archery is a lethal method of harvest, the controversy over bow wounding and what, if any, degree of wounding is acceptable to both wildlife managers and society will not be easily resolved. Whereas the opinions of special interest groups opposed to bowhunting are clear, the views of the general public are largely unknown. Wildlife professionals need to be aware of varying points of view and most importantly need to be well versed in the factual information surrounding the wounding issue. Furthering our profession's understanding of bowhunters and of public opinions on bowhunting issues will require a number of well-designed surveys. Some of the most basic demographic and socioeconomic information that managers have come to take for granted about hunters in general is not available or is incomplete for bowhunters. The attitudes of the general public regarding bowhunting and an understanding of the perceptions of bowhunters are likely to be the most important factors that influence decisions on future bowhunting issues.

The Wildlife Society (1992:9) defines the role of hunting in society and wildlife management as principally useful for recreational purposes, for utilization of the harvestable surplus to benefit humans, and for controlling populations. Clearly, bowhunting functions well within this definition, furnishing the wildlife profession with a responsible tool for both controlling wildlife populations and providing hunting recreation.

Photo by Len Rue, Jr.

INTRODUCTION

Wildlife professionals are charged with managing biological resources and intertwining the desires of a diverse society into management decisions. Only recently have wildlife managers used bowhunting as a component of resource management and recognized it as a growing recreational activity. The increase in bowhunting participation (Southwick and Teisl 1998) during the past 3 decades; its use as a population management tool, particularly for ungulates in urban and suburban settings; and more frequent challenges to the use of this tool by animal welfare and animal rights groups prompted the need for a review and summary of the current knowledge base surrounding bowhunting. As both urbanization and public desire for an increased role in decision making about harvest management programs intensify, the need to assess our knowledge of bowhunting as it relates to both population management and the social concerns will become of greater importance.

To meet these needs, The Wildlife Society Council, in 1994, appointed an Ad Hoc Technical Review Committee on Bowhunting as a Wildlife Management Tool. The committee was charged by then President Hal Salwasser with documenting the growth of bowhunting in North America, reviewing the types and purposes of equipment regulations, reviewing and summarizing the literature relating to the efficacy of bowhunting and proficiency of bowhunters, documenting current challenges to bowhunting, and identifying research needs. Council believed such a review would have broad-based value not only to wildlife professionals but also to state lawmakers, agency administrators, urban planners, and others who deal with wildlife-resource decision making. This review will help decision-makers frame the issues we face today, and those we will face in the future.

HISTORICAL AND CURRENT TRENDS

Bowhunting History and Growth

There is evidence that archery entered the New World by way of the land bridge in Alaska that once connected the North American continent to Asia. For about a thousand generations, Native Americans fed and defended themselves with the bow (Haugen and Metcalf 1963). As use of the bow declined as a weapon of war and for subsistence in the Americas, archery was taken up for recreation. Evidence suggests that Europeans participated in archery for recreation as early as 1551 (Edwards and Heath 1962). Modern archery in the United States, therefore, was influenced by 2 sources—Native Americans and Europeans.

The first target archery competition in the United States was held in 1828, and the first large-scale shoot, held in the White Sox Baseball Stadium in Chicago, took place in 1879 (Burke 1957). Although the sport of target archery developed in the 1800s, little interest occurred in bowhunting until shortly after World War I. Art Young and Saxton Pope, through their writings, kindled an interest in bowhunting among sports-minded individuals. *Ye Sylvan Archer* (a magazine adopted in 1929 as the official medium of the Western Archery Association and later the official magazine of the National Field Archery Association) added fuel to the growing interest. The first known archery hunters' jamboree was held in Oregon in 1930 (Haugen and Metcalf 1963).

The nation's first archery-only deer season was established in Wisconsin in 1934 (James 1993). Six other states (California, Michigan, Minnesota, New York, Oregon, and Pennsylvania) established bowhunting seasons in the 1930s. The popularity of bowhunting soared from about 1951 through 1957 as archery legends such as Fred Bear and Howard Hill captured the attention of sportsmen through films and writings. The first articles critical of bowhunting as a sport appeared in 1959 (Haugen and Metcalf 1963).

The greatest growth in bowhunting has occurred since the mid-1970s (e.g., Gladfelter et al. 1983). Many reasons have been hypothesized for the rapid growth (e.g., Jackson and Anderson 1983, Samuel et al. 1991). These were summarized by Pacelle (1990:16):

> Bowhunting seasons are longer, earlier in the year, and quieter than firearms season...most states allow bowhunters to shoot deer of either sex...archers may have a more private experience in the woods...improved technology

Bowhunter Demographics

The number of bowhunters in the United States seems to be at an all-time high. Numbers of bowhunters nationally are increasing, with an estimated 3,289,140 bowhunting licenses sold in 1996 (Southwick and Teisl 1998). In 1991, there were about 2.7 million bowhunters >16 years of age in the

United States (U.S. Department of the Interior 1993). In 1970, bowhunter numbers were estimated by state wildlife management agencies at only 760,000 (Wilcox 1976). Bowhunters compose a minority of all hunters, but there has been consistent growth in the percentage of hunters who report using a bow, from 19% in 1986 to 33% in 1991 to 45% in 1996 (Southwick and Teisl 1998).

A recent study of bowhunter demographics suggests that nationally the average bowhunter age is 35.9 years, individuals began bowhunting at an average age of 22 years, average income is $41,776, and average education is 13 years. Twenty-six percent live in the suburbs or cities, and 74% live in small towns or rural areas. The average bowhunter hunted 25 days in 1996, with 19 of those days being for deer. Ninety-one percent used a compound bow and 6.8% used recurves or longbows (Southwick and Teisl 1998). Individual state records and state-specific studies (e.g., Klessig and Hale 1972; Enck and Decker 1991, 1995) indicate similar findings.

Few women (<5% of bowhunters) participate in bowhunting (Southwick and Teisl 1998). Among big-game hunters, a smaller percentage of women bowhunt than hunt with firearms. For example, 2.0-2.4% of New York bowhunters are female, whereas 6.0-6.5% of all New York deer hunters are female (Enck and Decker 1991, 1995). Klessig and Hale (1972) found that 2% of Wisconsin bowhunters were female whereas 6% of all big-game hunters were female.

Bowhunters tend not to represent a population separate from firearms hunters. In New York, Enck and Decker (1991) found that only 59 of 772 bowhunters (8%) hunted exclusively with a bow. Osterberg (1997) found that 66.7% of Minnesota bowhunters also hunted deer with a firearm. Southwick and Teisl (1998) found nationally that 81% of bowhunters hunted with a firearm in the last 2 years and that 80% of bowhunters began hunting with a firearm rather than with a bow.

Specific data about bowhunter recruitment and retention also are limited. In the 1970s, Klessig and Hale (1972) found that initiation into bowhunting was similar to that of firearms hunters. Family members, especially fathers, introduced most to bowhunting. Two recent studies show that this has changed. Southwick and Teisl (1998) showed that only 16.5% of all bowhunters in the United States were introduced to bowhunting by their fathers whereas 16.4% were introduced by other relatives. Thirty percent learned to bowhunt on their own and 29% were taught by friends. In Minnesota Osterberg (1997) found that 16% of bowhunters were taught by parents, 31% were self-taught, 33% were taught by a friend, and 21% were introduced to bowhunting by other relatives. Osterberg (1997) also found that bowhunters taught by relatives started at an older age than those taught by friends or parents or who were self-taught.

Recruitment and retention of bowhunters may be influenced in the future by an increase in the popularity of archery, particularly among women and urban residents. The National Shooting Sports Foundation (1991) reported that 22.6% of persons who participate in archery were women. This is a much higher percentage than the 4.5% of bowhunters who are women (Southwick and Teisl 1998). Nearly one-quarter of archery participants (24.7%) reside in cities of >2 million inhabitants. However, residence of bowhunters tends to be more skewed toward rural areas (Southwick and Teisl 1998). In New York, an urbanized state, only about 10.7% of bowhunters live in cities with >25,000 residents (Enck and Decker 1991). The relatively large populations of women and urban archers may represent potential for increased participation in bowhunting.

Samuel et al. (1991) suggested several negative factors that could affect recruitment and retention of bowhunters in the future. These include (1) public concerns over the killing effectiveness of bowhunting, (2) court injunctions against bowhunting, and (3) antihunting groups in various states advocating a ban on bowhunting and claiming that it is inhumane and wasteful. Another important negative factor is that several of the attributes necessary for successful bowhunting make it unattractive to youth, e.g., physical strength needed, the activity's solitary nature (mentoring is difficult), patience needed (long hours sitting motionless), and knowledge of the quarry that allows a hunter to get very close to the animal for a clean shot (experience). Consequently, drawing young recruits directly into bowhunting may be difficult (Decker and Enck 1993).

EQUIPMENT REGULATIONS

Bowhunting equipment has become more sophisticated in the past 2 decades (Samuel et al. 1991). Technological advances in archery equipment have been a concern among some wildlife management agencies. Concerns are focused primarily in 2 areas. First, concerns about the efficacy of equipment has resulted in a variety of regulations designed to ensure that equipment is adequate for killing the species in question and is consistent with the traditional and historical nature of the sport. Second, concerns about fair allocation of the resource have resulted in establishment of

special regulations for various user groups (e.g., bowhunters, muzzleloaders, and modern firearm hunters). These regulations have become more prevalent as bowhunters have accounted for increasingly larger proportions of the annual harvest of some big-game species (McDowell et al. 1993).

A 1995 survey (K.E. Mayer, California Game and Fish, unpublished data) of current archery equipment regulations in the United States indicated a complexity and variety reflective of the uniqueness of the various states and regions. However, several similarities exist among states. For example, 36 states addressed broadhead specifications, and 27 set minimum limits on bow weights for hunting. Broadhead minimum width ranged from three-fourths to seven-eighths inches, with at least 2 cutting edges. Minimum bow weights in the East ranged from 30 to 50 pounds, depending on the species pursued. All states allowed the use of compound bows in addition to the more traditional longbows and recurved bows.

In addition to setting minimum standards to ensure adequacy of equipment, some agencies also attempt to restrict technical advances that can be used. These regulations attempt to maintain some level of difficulty and/or traditional values associated with bowhunting. In this regard, 23 states prohibited the use of laser-type sights (which project a beam of light onto the target) and 31 prohibited use of mechanical devices that could hold the bow at full or partial draw (i.e., unaided). Forty states prohibited the use of arrows with poisoned or exploding heads. This restriction appears to be directed primarily at the use of drugs as a means to ensure arrow lethality (Causey et al. 1978). Most states (47) do not consider the crossbow as archery equipment, at least in terms of allowing its use during archery-only seasons (K.E. Mayer, California Fish and Game, unpublished data).

When queried on the rationale and purpose behind the development of their archery tackle restrictions, most state agencies (37) indicated the restrictions were designed to ensure the suitability and effectiveness (lethality) of equipment to kill the target animal (K.E. Mayer, California Fish and Game, unpublished data.). Additionally, over half (28) of the state agencies responding to the questionnaire indicated that maintaining the traditional status of bowhunting was a major goal of equipment restrictions. To assist agencies in the development of consistent and effective regulations, it has been suggested that an interdisciplinary committee be established with the purpose of developing minimum standards for archery equipment used in bowhunting (K.E. Mayer, California Fish and Game, unpublished data).

BIOLOGICAL AND MANAGEMENT CONSIDERATIONS

Bowhunting as a Population Management Tool

Bowhunting generally has lower impact on the wildlife resource than does firearms hunting. The need to be close to the quarry because of the short effective range of archery equipment makes archers less successful at taking game. Indices of various harvest parameters reflect the lower harvest efficiency. The deer harvest success rate of archers (ratio of deer harvested to estimated number of participants) averaged 0.21 nationwide in 1994 with a range of 0.04 in Arizona and New Hampshire to 0.64 in Mississippi (Deer Hunters Almanac 1995). A similar measure of success for firearms deer hunters averaged 0.42 nationwide with ranges from 0.04 in Rhode Island to 1.2 in Alabama. Langenau and Aho (1983) found that in 5 Midwestern states, it took archers 98 days of hunting to kill a deer compared to 29 for firearms hunters. Not only do archers have a lower harvest rate, but there also are fewer participants.

Lower harvest rates and fewer participants have led many state agencies to view bowhunting primarily as a recreational opportunity with minimal resource impacts. The result has been liberal seasons and bag limits for archers, especially in those states within the range of the white-tailed deer (*Odocoileus virginianus*). Somewhat more restrictive bowhunting regulations are found in many of the western states where competition is greater for more limited resources.

Archery harvests make up only a small percentage of total harvest in most states. However, the role bowhunting can play in population management is most evident for white-tailed deer. In Wisconsin, for example, bow harvest accounts for >30% of the deer taken by hunters in some management units (Wisconsin Department of Natural Resources, 1998, unpublished data). Of the 59,769 white-tailed deer reported harvested during the 1995-96 New Jersey deer season, 20,593 (34.5%) were killed by bowhunters (Ferrigno 1996).

Bowhunting is proving to be an especially useful management tool in areas such as parks, arboretums, and urban areas, where firearms discharge is prohibited. Historical examples of bowhunting being used to manage (or contribute to the management of) deer populations include Howland Island, New York, where from 1952 to 1957 up to 16 deer per 100 hunter-days were harvested by

bowhunters (Severinghaus 1963). In 1957, 746 deer were killed by bowhunters in 2 days (11.5 deer/100 hunter days) on the Necedah National Wildlife Refuge in Wisconsin (Bersing et al. 1958:74). These high harvests occurred even though hunters in these examples used recurve and longbows, which are considered less effective than modern-day compound bows (Ditchkoff et al. 1998). Recent examples of the utility of bowhunting in contributing to urban deer population control include the Milwaukee, Wisconsin, metropolitan unit where 700 of 1,120 deer harvested in 1994 were killed by archers (Borgerding et al. 1995). In Princeton Township, New Jersey, deer populations increased 6-fold following the passage of a no-firearms-discharge ordinance in 1972. Deer-vehicle collisions also increased 436% in Princeton Township from 1972 to 1982. Human conflicts with deer prompted demands for herd control. Bowhunters were recruited to hunt on private property and were provided multiple deer bag limits and extended seasons in an effort to curb population growth. Bowhunting was suggested as a significant factor contributing to the control of herd growth (Wolgast and Kuser 1993, Kuser 1995). In Connecticut, Kilpatrick and Walter (1997) reported that a controlled bowhunt in a residential community resulted in a 50-52% reduction in deer numbers.

Bowhunting Seasons and Resource Allocation

There are as many different approaches to the management of bowhunting and bowhunters as there are state agencies responsible for the management of this activity. Most states issue separate bow and firearms licenses. In a few states, a season bag limit is established and the hunter makes the choice of how game is taken. Even within this framework, however, separate season dates are established for bow and firearms hunting. Length of the bow deer season varies from 20 days in Massachusetts to 151 in Arkansas, with a national average of 74. In comparison, firearms seasons range from 5 days in Ohio to 141 days in South Carolina, with a national average of 39. The average archer also generally spends more days afield than firearms hunters (e.g., Missouri archers average 16 days hunting annually, whereas firearms hunters average 5 days; L. P. Hansen, Missouri Department of Conservation, unpublished data).

Bowhunters west of the Rocky Mountains play a less important, but increasing, role in population management. They also factor significantly in the recreational aspect of hunting. Although interest in bowhunting is on the rise in western states, the percentage of bowhunters in the hunter population and the proportion of harvest they account for are relatively small.

Even though archery hunting may be viewed in some states as having little resource impact, state agencies must consider resource allocation issues when providing harvest opportunities. Deer hunting, for example, involves diverse groups of participants, with each group often seeking maximum recreational opportunity. In allocating these resources, agencies must consider resource impact, safety issues, demand, public sentiment, and administrative costs. In some cases the growth in bowhunting participation has led to resource allocation conflicts between bowhunters and some firearms hunters. Some states (notably New Jersey, Michigan, and California) have had to restrict archers to bucks-only or have limited entry in some management units in order to achieve a better allocation of the harvest between archers and firearms hunters (McDowell et al. 1993; E. E. Langenau, Michigan Department of Natural Resources, personal communication, and K. E. Mayer, California Department of Fish and Game, Sacramento, personal communication).

However, many allocation issues between bowhunters and firearms hunters are not simply a matter of which hunters receive the most opportunity. Managers need to understand differences between firearms hunters' and bowhunters' expectations because these differences require managers to provide different kinds of experiences for the 2 groups (Klessig and Hale 1972, Jackson and Anderson 1983, Langenau 1986).

The differences between bowhunters and firearms hunters have important implications for wildlife management programs that strive to manage wildlife populations and maintain high levels of hunter satisfaction. Bowhunting and firearms hunting tend to elicit different types of behaviors, satisfactions, and motivations in persons who hunt both with a bow and a firearm. For example, when bowhunting, individuals tend to hunt by themselves because of the solitude and low hunting pressure that form of hunting offers, and they believe bowhunting requires more skill and is more challenging than firearms hunting (Jackson and Anderson 1983). Langenau (1986) also reported differences in expectations and satisfactions between bowhunters and firearms hunters. Relatively few bowhunters expected to get a shot at a deer; bagging a deer was no more satisfying for bowhunters than just having the opportunity to shoot at a deer. On the other hand, firearms hunters were more satisfied if they harvested a deer than if they shot and missed.

Klessig and Hale (1972) found that a major satisfaction for bowhunters was nature appreciation rather than bagging game or killing a trophy. The authors concluded that archery hunters are distinctive [from 5 other types of hunters including firearms big-game hunters] for spending the most days and most hours at their sport with the lowest probability of success. Osterberg (1997) found that the

greatest motivation to bowhunt was the challenge of bowhunting, followed by seeing wildlife, seeing deer, and hunting before the firearms season.

Increases in the number of bowhunters and technological advances in archery equipment have increased harvests and caused some state agencies to re-evaluate the allocation of hunting opportunities for various user groups. In the western United States, increasing pressure from resident and nonresident hunters has led to implementation of either/or regulations, which require that a person make a choice between hunting during archery season or firearms season. The state wildlife agency's objectives often stated for establishing an either/or hunt management system are (1) to prevent overharvest, (2) to prevent conflicts between archers and firearms hunters, (3) to improve bowhunter image, and (4) to be responsive to pressure from archers and/or firearms hunters to implement the regulation strategy (K. E. Mayer, California Department of Fish and Game, Sacramento, personal communication).

Kansas was the first to establish an either bow or firearms hunting regulation in 1965. In 1995, 9 states had either/or resident and nonresident regulations for all of their big-game species, 7 states had either/or regulations for selected big-game species, 1 state used the strategy for nonresidents only, and 33 states had no either/or hunting restrictions.

Much speculation and concern developed over the impacts of these regulations on archery hunting. Most concern involved the potential for reduced numbers of archers and the effects on overall hunting opportunity, reduced license revenue and hunter expenditures, and dividing hunting groups. We are unaware of efforts by any state to impose additional either/or regulations.

The establishment of bowhunting quotas has been used most recently in the western states to better predict harvest and distribute harvest allocation. Methods used to establish these quotas include the change-in-ratio (CIR) population estimators, population reconstruction methods, and stock recruitment models (Kelkert 1947; Ricker 1954; Selleck and Hart 1957; McCullough 1979, 1984) to establish a deer population baseline. Once the base population is established, an overall tag quota is developed that meets population objectives for the herd. The allocation of these tags to the various user groups (method of take) is accomplished through various approaches including levels of historic use, subjective reasoning (public hearings), and demand-success rates (e.g., the relationship between hunter interest or demand for tags and success by method of take).

Population Control Hunts

Bowhunting has been used successfully to regulate deer numbers, especially on localized problem areas. As white-tailed deer populations have increased in the midwestern and eastern states, so have conflicts between humans and deer. Municipal parks and reserves have experienced significant deer damage to landscape plantings, gardens, and native vegetation. Furthermore, concerns about the risk of contracting Lyme disease have increased (McAninch 1993). In addition to these human health and vegetation damage concerns, public safety has been threatened by the increase in deer-vehicle collisions. These factors together have prompted many communities to initiate urban deer population control by bowhunting (Gillette 1993, Ver Steeg et al. 1995, Kilpatrick and Walter 1997).

In most communities, the growth of the deer population has coincided with the increase in the human population and the associated urban sprawl (e.g., wildland conversion and intensified land use). A natural result of this increase in the human population and limited open space has been the prohibition against the discharge of a firearm. As a result, bowhunting is often considered the most logical and effective management tool available to control deer numbers and thus has been employed successfully in many urban settings. To date there are few urban problems associated with elk (*Cervus elaphus)* (Conover 1995).

The benefits often stated for using bowhunting to control urban deer populations are as follows:

Shooting a bow is quiet.
Hunters usually hunt alone, often from a single location, and remain stationary during their hunting effort.
Archers are inconspicuous to urban residents (McAninch 1993).
Bowhunting is safe for both the hunter and non-hunter alike (Hunter Education Association 1989).

Bowhunting use as a deer population control mechanism will probably continue to increase as urbanization spreads.

While most hunting on military reservations is recreational, exceptions do exist. For example, Badger Army Ammunition Plant and Fort McCoy in Wisconsin use bowhunting to control white-tailed deer numbers on all or part of their property. Similarly, Fort Richardson, Alaska, holds archery-only hunts to control moose (*Alces alces*) numbers (Griese 1993). In each case the use of bowhunting has been a successful tool to safely control ungulate populations.

Many corporate lands normally closed to firearms hunting due to safety considerations have been opened to bowhunting to control deer numbers. An historic example includes the Du Pont Barksdale Exclosure in Wisconsin. Up to 50 archers per weekend day were permitted to hunt on approximately 259 ha (1 mi^2) of this 485-ha (1,200-ac) exclosure to reduce an estimated population of 200 deer in 1960 (Lyle Cowley, letters 1972 and 1973, Wisconsin Department of Natural Resources files). Hunters took 120 deer during weekend hunts in October and December, which proved to be a successful alternative to the trap-translocation procedure used in previous years to remove excess deer (Bersing 1961).

More recently, the Clinton Illinois Power Plant permitted bowhunting beginning in 1990 after being closed to all types of hunting for 15 years (Willmore 1995). An estimated 550 deer were counted by helicopter within a 323-ha (800-ac) wooded area prior to implementing a control program. By lottery, 30 hunters were drawn for each 1-week period. Unlimited permits were available for antlerless deer. An antlerless deer had to be harvested by the hunter before an antlered buck could be taken. Hunters were encouraged to harvest mature does and to avoid killing young bucks. In 3 years archers killed 396 deer, of which only 37 were antlered bucks. The population after 3 years of hunting was reduced to 193 deer.

Safety

Bowhunting is a safe activity. Bowhunters usually hunt alone and can shoot limited distances. As a result, the bow can be used safely near domestic animals, around buildings, and in urban environments. There were fewer than 0.05 hunting injuries per 100,000 bowhunters in 1994 (Hunter Education Association 1994). This is compared with 27,041 injuries per 100,000 participants for football, 484 for roller-skating, 105 for swimming, and 113 for tennis. In 1994 only 1 death occurred as a result of an injury involving archery equipment, and this was self-inflicted (Hunter Education Association 1994). In comparison, nationally each year, around 40 deaths occur due to bee stings, 12 to rattlesnake bites, and 90 to lightning strikes (Beier 1991). Injuries to the nonhunting public as a result of bowhunting are almost nonexistent.

Bowhunting may be more compatible than firearms hunting with other outdoor activities. For example, Samuel et al. (1991) and Decker and Enck (1993) suggest that bowhunting is safer than firearms hunting in developed environments because of the limited range of arrows. Similarly, these authors believe that bowhunting can be practiced safely in more places closer to dwellings, more discretely, and with less public scrutiny, compared to firearms hunting.

However, no research has been conducted about hunters' or other users' perceptions about the compatibility of bowhunting with other activities. Anecdotal information suggests that archers' use of camouflage clothing may be intimidating to some nonhunters. On some public areas, especially in high-use urban areas, bowhunting opportunities may have to be established during periods when other activities are lowest, to avoid user-group conflicts.

Bowhunter Education

New Jersey instituted the first mandatory course in bowhunter education in 1958 (New Jersey Division of Fish and Game, 1958). Currently, 42 states offer courses, which are mandatory in 13. Courses are administered by the state wildlife agencies, with most instructors being trained volunteers. Many states now employ the International Bowhunter Education Program (IBEP) developed by the National Bowhunter Education Foundation (NBEF), which has played a significant role in bowhunter education since its establishment in 1979. The NBEF is an independent, nonprofit, educational foundation whose goals are to perpetuate bowhunting by providing the fundamentals of good safe bowhunting with an appreciation and respect for the environment and to maintain the highest standards of the sport. The IBEP provides an instructor's manual and a number of high quality training aids to be employed during a minimum of 5 hours of classroom time and 3 hours of field experience. Nationally, bowhunter education courses range from 10 to 12 hours and cover instruction about hunter responsibilities, equipment, safety, laws, conservation, shooting instruction and practice, survival and first aid, and hunting techniques.

CHALLENGES TO BOWHUNTING

Animal Welfare Issues

The public has recognized the increased use of bowhunting as a management tool and recreational opportunity since the 1970s. That recognition has brought to the forefront concerns about the humaneness and effectiveness of bowhunting (Samuel et al. 1991). It is unlikely that perceived superior skill and sportiness (fair chase) attributes of bowhunting will outweigh concerns about wounding and unretrieved kills (e.g., Pacelle 1990). Bowhunting opponents believe that archers wound an excessive number of animals that die painful and lingering deaths, and therefore claim that bowhunting is inefficient and inhumane (Pacelle 1990). They also are concerned about length of time animals suffer before they die from an arrow wound. Hunters themselves are concerned about the same issues.

Loker and Decker (1995) identified several issues as reasons voters in New York State passed an amendment outlawing bowhunting and the use of hounds for bear hunting. They found that a majority of voters (including many who hunt) are concerned about (1) humaneness (e.g., how animals are killed, which animals are killed) and (2) effectiveness of bowhunting (e.g., getting animals in close and ensuring that bears shot with an arrow are not lost).

Wounding

Published literature on bow wounding lacks clarity, in part due to a lack of standardized terminology. Common terms found in the bow-wounding literature include crippling loss (Lohfeld 1979), crippling rate (Gladfelter et al. 1983), wounding loss (Herron 1984), and wounding rate (McPhillips et al. 1985). Often these terms have been used interchangeably, yet they have not been defined clearly. The confusion regarding terms used to quantify wounding has resulted in misinterpretation of data, which has served to fuel a controversy over the rate animals are wounded and not recovered via bowhunting.

McCaffery (1985) recognized the semantics problem associated with wounding literature and offered definitions for commonly used terms. Mayer and Samuel (1992) provided a review of several articles that dealt with the wounding issue and summarized many of the problems associated with presentation of these data. More recently, Krueger (1995), building on work by McCaffery (1985) and Mayer and Samuel (1992), developed definitions to help classify wounding information.

Most studies have used the following equation for calculating a reported wounding rate; hence, it will be used in this review to consistently present wounding data collected from hunters:

$$\text{Reported Wounding Rate} = \text{Hits}/(\text{Tagged} + \text{Hits}) \times 100$$

where Hits = number of deer reported hit by arrows and Tagged = number of deer reported killed.

This equation expresses reported hits in relation to the number of deer legally killed. Use of the equation assumes that each reported hit then equals a wounded deer. However, if no attempts were made to determine the outcome of each reported hit, the resultant rates would be inflated. Reported hits that were actually misses and hits on deer that survived would be included with hits on deer that died and were unrecovered. Further, a single deer with multiple hits that was tagged or was unrecovered would confound the reported hit data. On the other hand, hits that were not reported or that hunters thought were misses would deflate the estimates.

The 2 methods of data collection (hunter surveys and ground searches) in peer-reviewed papers and technical reports on bow wounding have inherent biases. The vast majority (96%) of wounding data has been obtained from hunter responses to questions about their hunting experiences (Samuel et al. 1991). Wescott and Peyton (1986) concluded that, under certain conditions, self-reported bowhunter wounding rates were reliable forms of data. However, interviews or questionnaires rely on memory of individuals and can only provide information as *perceived* by the hunter. A deer reportedly hit and not recovered by a hunter may have actually been missed, or if the deer was hit, the hunter may not know if it survived, was recovered by another hunter, or died. However, Wescott and Peyton (1986) found high levels of agreement among members of hunting parties (surveyed individually after the hunt) regarding the number of deer hit and not retrieved by the group. The number of deer that die from arrow wounds and are not retrieved by hunters can be obtained only by field verification. Ground searches after hunts provide reliable information on the number of unretrieved dead deer, but are extremely labor intensive. Also, all dead deer may not be found, wounded deer may leave or enter the study area, or wounded deer may die after the search. The cause of death of deer that are found might not be determined accurately. Radiotelemetry data, in which animal mortalities were investigated, provide the most reliable source of cause-specific mortality estimates.

Other limitations in conducting wounding studies include the length of archery seasons (2-3 months) and the low densities at which bowhunters occur in a landscape context. Because of convenience, many studies have collected data during special bowhunts that typically take place on small sites with restricted access and that generally have a higher hunter density for a shorter-than-normal archery season. These study limitations must be considered when interpreting wounding data.

Posthunt mail questionnaires were used in 81% of the peer-reviewed and technical reports examined. Wounding rates of 7% (Severinghaus 1963), 44% (Croft 1963), 48% (McPhillips et al. 1985), and 62% (Langenau 1986) have been reported from questionnaire studies. In Minnesota, mail surveys by Landwehr (1982) and Schultz (1983) found that 54 and 49%, respectively, of the deer reportedly hit by bowhunters were not recovered. Gladfelter et al. (1983) estimated that 16% of Iowa bowhunters wounded white-tailed deer. Hansen and Olson (1989) reported that 13.4% of respondents in Missouri indicated that they hit, but did

not recover, at least 1 deer during the archery season. In a report prepared for the Fifty-first Montana Legislature Natural Resources Appropriations Subcommittee (Anonymous 1989), bowhunters reported killing 850 elk during the 1987 Montana archery season and wounding, but not retrieving, an additional 885 elk. The survey methodology used in these studies did not allow a clear determination of the fate of reportedly hit animals. Also, no attempt was made to classify the severity or certainty of reported hits. Without sufficient detail, accurate interpretations cannot be made of the fate of shots taken.

Hunter interview studies reported equally variable wounding rates. Boydston and Gore (1987), Lohfeld (1979), and Herron (1984) found wounding rates of 50, 55, and 35%, respectively, based on interviews conducted at the study sites. At the Camp Ripley Military Reservation in Minnesota, Krueger (1995) incorporated detailed bowhunter interviews to determine the severity of reported hits based on evidence described by the hunter. In addition, follow-up deer examinations and an aerial infrared scanning technique were used to determine the number of unrecovered deer. Results of the study determined that an average of 87% of deer hit by bowhunters were recovered during 4 separate bowhunts (range = 83-92%). Corresponding loss rates ranged from 8 to 17% with an average of 13%. Loss rates were considered as maximum loss rates because the deer that were not accounted for also may have been hit by more than 1 hunter. The loss rates included deer that were wounded and died as well as deer that were hit but survived. Krueger's (1995) results agree closely with 2 studies where ground searches for unretrieved deer were conducted after a hunt. Lohfeld (1979) found that 11% of the total bowhunting mortalities were unretrieved deer, and Herron (1984) found that 9% of the deer reportedly hit by bowhunters were unretrieved. Stormer et al. (1979) used hunters to conduct ground searches as they bowhunted on the 25,500-ha (63,010-acre) Crane Naval Ammunition Depot in southwestern Indiana. Of 82 unretrieved deer examined after the 1967 hunting seasons, 18% ($n = 15$) died from arrow wounds. Ditchkoff et al. (1998) found 27.3% (3 of 11) of radiomarked white-tailed deer shot but not recovered by bowhunters on the McAlester Army Ammunition Plant in Oklahoma subsequently died.

Wounding information was expressed as a population mortality factor by Fuller (1990) in a study conducted to investigate the dynamics of white-tailed deer populations in north-central Minnesota. Mortality of 143 radio-collared deer was monitored over 5 years. Results indicated that 48% of mortalities were from firearms hunting, 6% from archery hunting, and 7% from unrecovered kills (both archery and firearms). In a long-term study of elk mortality in Idaho (Unsworth 1993), bowhunters killed 2 radiotagged elk during the study and 4 collared elk died from arrow wounds but were not recovered by the hunters. Mortality due to bow wounding among radio-tagged elk in Washington was found to be similar (7%) to losses due to firearms hunting (Smith et al. 1995). Because of the difficulty in determining the number of deer that are hit by hunters but survive, no studies have been conducted to specifically measure this number. Nettles et al. (1976) necropsied 1,002 deer and found evidence of previous injury in 76 (7.6%) of them. Of the 76, only 5 (0.5%) were injured as a result of previous arrowhead wounds. This suggests that either bow-wounded deer are rare or their wounds heal rapidly. Nettles et al. (1976) concluded that long-term suffering caused by traumatic injury probably affects very few white-tailed deer.

A study by Burke et al. (1976) in New Jersey supports the finding of Nettles et al. (1976). Sixteen check stations were established to examine gun-killed deer with a metal detector to determine the incidence of arrow wounds. Of 1,173 deer examined, arrow wounds were found in only 8 deer (0.7%).

Efficacy and Lethality of Equipment

Concomitant to the concerns over bow-wounding rates are questions regarding the efficacy and lethality of archery equipment. Efficacy is the ability to produce the desired effect. Lethality is deadliness. The potential of modern archery equipment to result in a quick, clean kill of the target animal is affected by a number of variables. A properly placed arrow produces a high-speed stab wound and causes death of the target animal due to hemorrhage or traumatic pneumothorax. Therefore, efficacy depends, in part, upon anatomical location and angle of the arrow strike, depth of arrow penetration, broadhead sharpness, vascular tissue damage, and clotting response. Each of these variables also is affected by its own particular set of variables. Generally speaking, broadhead-tipped arrows that completely penetrate the thoracic cavity most often result in death of the target animal.

Many game animals are killed by bowhunters whose arrows strike outside the thoracic area. Brain and spinal hits that sufficiently damage the central nervous system can cause almost instant immobilization and death of target animals. Also, arrows transecting major blood vessels in the neck, hindquarters, or abdominal cavity can produce severe hemorrhage and subsequent death.

The lethality of broadhead wounds on big game has not been studied adequately. We found no papers in scientific peer-reviewed literature on this topic. Information from 1 technical report (Ludbrook and Tomkinson 1985) found that

immobilization times on African plains animals were similar when comparing between animals shot with broadhead-tipped arrows and those shot with bullets from centerfire rifles. Animals shot in the thorax with an arrow were immobilized in an average of 29.7 seconds compared to 22.3 seconds for those shot with a centerfire rifle. Most other information on lethality of broadhead-tipped arrows shot from contemporary hunting bows are the result of anecdotal observations and therefore are not discussed here.

Causey et al. (1978) conducted a study of lethality of broadheads treated with crystalline succinylcholine chloride and reported killing and recovering 74 of 88 white-tailed deer struck with these arrows under hunting conditions. These deer (n = 42) collapsed in an average time of 13 seconds after traveling an average distance of about 100 m. Benke (1989) suggests the use of drug-tipped arrows would reduce loss rates among bowshot animals.

Hunter Proficiency

Hunter proficiency is directly related to efficacy and lethality of weaponry. Therefore, these areas of discussion share overlapping data and it is difficult to discuss them separately. Most information applicable for evaluating bowhunter proficiency comes from studies of bowhunter success in harvesting white-tailed deer, although some limited data are available for bowhunting of mule deer (*O. hemionus*) and elk.

A review of published data relating to bowhunter proficiency in hunting big game identified 10 peer-reviewed articles or conference proceedings (Croft 1963, Downing 1971, Causey et al. 1978, Stormer et al. 1979, Gladfelter et al. 1983, McPhillips et al. 1985, Langenau 1986, Unsworth 1993, Morton et al.1995, Kilpatrick and Walter 1997). Several technical reports also were reviewed (Wescott and Peyton 1986, Boydston and Gore 1987, Anonymous 1989, Hansen and Olson 1989).

Some reports equated shooting accuracy, demonstrated by prospective bowhunters during skill tests, to hunting proficiency. Shooting accuracy, however, does not translate to hunting proficiency. Whereas Marlow (1988) found that bowhunters, on average, grouped 70% of their arrows in a 1-cm (2.5-in) radius at 18.3 m (20 yd), Kilpatrick and Walter (1997) found that shooting accuracy of experienced bowhunters under hunting conditions was 19% lower than accuracy during a shooting proficiency test.

Questions over bowhunter proficiency in hunting situations is further illustrated by data gathered by questioning bowhunters following selected bowhunts. McPhillips et al. (1985) reported bowhunters shot 13.8 arrows/deer killed in South Dakota, and Langenau (1986) reported Michigan bowhunters shot 5.5 arrows for each deer reported hit. Boydston and Gore (1987) reported bowhunters took 21 shots for each deer killed in selected Texas hunts. Langenau (1986) reported bowhunters failed to recover any deer hit at ranges >30 yards, but recovered 68% of those deer hit at ranges <10 yards.

IMPACT OF BOWHUNTING ON FAWN SURVIVAL AND DISTURBANCE

Concerns have been raised that bowhunting can have a negative effect on fawn survival, in particular when the doe is killed prior to or just after a fawn is weaned. This concern has been raised especially in those states where the archery deer season begins in late summer (e.g., Jul-Aug), including Arizona, California, Nevada, and South Carolina.

Swenson (1972) showed that mule deer fawns orphaned prior to 6 weeks of age die, whereas older fawns survive. Similarly, Robinette (1966:345) reported that mule deer fawns orphaned in the fall quickly join another doe or matriarchal group. Studies by Woodson et al. (1980) and Holzenbein and Marchinton (1992) on the effect of fall orphaning on white-tailed deer showed similar results. They reported that orphaning weaned fawns had little or no negative effect on survival. Because most bowhunting seasons occur >10 weeks after parturition, no significant adverse impacts to either fawn survival or recruitment have been noted. Additionally, in the western states hunting in the late summer has been restricted to males only and thus would have limited effect on fawns.

It has been suggested that bowhunting under the right circumstances can cause both deer and elk to move from preferred ranges. In California, for example, major deer movements from summer range to intermediate and winter ranges have been recorded that appeared to be linked to the beginning of the archery season in 1 northern California herd. Remote camera monitoring of the East Tehama Deer Herd has shown that major downslope movement of deer occurs within 24-48 hours of the beginning of the archery season (K. E. Mayer, California Department of Fish and Game, Sacramento, personal communication). Although preliminary data indicate a correlation between beginning of the archery season and deer migration, other environmental factors (e.g., poor habitat conditions) also may play an equal or a greater role in this deer movement phenomenon.

A similar movement phenomenon has been noted in Colorado, where elk movements have been linked to early-season bowhunting in the White River Area. Researchers from Colorado State University are examining the relationship between season opening dates and elk movement to private land. Preliminary results indicate that there is a weak relationship between the timing of elk movement and the opening date of archery season (Conner 1988).

RESEARCH NEEDS

A large void exists in research-based human-dimensions information about bowhunters. Some of the most basic demographic and socioeconomic information that managers have come to take for granted about hunters in general is not available or is incomplete for bowhunters. The attitudes of the general public regarding bowhunting and an understanding of the perceptions of bowhunters are likely to be the most important factors that influence decisions on future bowhunting issues.

More information on bowhunter recruitment and retention could provide valuable insights for management. For example, an improved understanding of motivations and processes that lead to initiation into bowhunting may suggest implications for evaluating regulations to encourage appropriate rates of recruitment of women into bowhunting. This is especially intriguing considering that about 23% of archery target shooters are women (National Shooting Sports Foundation 1991), and women account for up to 50% of professional archers at some shoots (Dehn 1993).

Allocation of deer (and other large game) hunting opportunities to firearms and archery hunters will be a continuing challenge for wildlife management. Managers can anticipate increased issues between archery and firearms hunters as deer numbers are reduced in many states to accommodate biological and cultural carrying capacity. Issues will be associated with increasing competition for opportunities to harvest bucks, access to rutting periods for hunting seasons, etc. Adjusting allocations could be achieved with less disruptive issues if our understanding of recreational attitudes, preferences, and behaviors of archery hunters (and firearms hunters) were current and adequately maintained.

Bowhunting opportunities were originally managed for individuals motivated primarily by interests in the use of traditional bowhunting equipment. Low success rates were compensated for by longer hunting seasons and access to antlerless as well as antlered deer. However, motivations, preferences, and expectations of bowhunters may have shifted in the face of new equipment technologies, liberal archery hunting opportunities, and higher success rates. These changes also may have influenced the *type* of individuals who are recruited and retained in bowhunting. It is likely that the current bowhunting community is a far more complex mix of recreational segments differing in their expectations, preferences, and attitudes. Further, many principles adopted when bowhunting was viewed primarily as a traditional recreational opportunity may no longer be viable.

It has been assumed that bowhunters have developed from the ranks of rifle hunters in a predictable process that focuses the hunter on hunting method (Jackson and Norton 1980). This also may be confounded by a tendency for bowhunters to become methods specialists similar to the pattern originally proposed for trout anglers by Bryan (1977). We know little about these processes among bowhunters, but their existence would have many implications for managers. For example, in making allocation decisions and optimizing hunter satisfaction, managers need information about whether bowhunting opportunities are providing recreational opportunity for firearms hunters who have broadened their methods to include bowhunting, or are serving the needs of a group of specialists who place a strong preference on bowhunting methods over firearms.

Studies focused on factors affecting bowhunting specifically are needed rather than relying only on inferences drawn from general studies of hunters. Preferably, such a study would identify key segments among bowhunters and investigate similarities and difference among the segments regarding (1) the relative size of bowhunting segments, (2) mechanisms of recruitment into bowhunting, (3) reasons for proportionally lower participation by women in bowhunting compared with firearms hunting, (4) motivations and satisfactions related to bowhunting, (5) year-to-year participation patterns and factors affecting participation after recruitment, (6) causes of cessation of bowhunting, (7) barriers to recruitment of bowhunters from the ranks of firearms hunters, (8) demographics of bowhunters and implications of demographic trends for future participation, (9) preferences of bowhunters for different types of experiences and the implications for education and regulations, and (10) the processes of development and specialization among the different segments of bowhunters.

Another area of inquiry important to understanding the full context of bowhunting management relates to other

stakeholders' views of bowhunting and bowhunters. Managers could benefit from knowledge of how bowhunters and bowhunting are perceived by firearms hunters (who do not bowhunt), landowners, other outdoor recreationists, and the public at large. A number of issues associated with bowhunting need to be explored with these various stakeholders, including questions of ethics, sportsmanship and animal welfare concerns, compatibility with other recreational land uses, and access to private lands. Access to this type of information would greatly enhance the effective management of existing and emerging bowhunting issues.

Recently, concern has been raised about the effect of early elk bowhunting seasons on elk movement (Graham 1993). Although this concern persists, there is no conclusive evidence to suggest that bowhunting alone causes early migration (Graham 1993). Nevertheless, because of the potential negative effect of migration behavior on private landowners' crops (as well as on elk themselves), research on this topic is warranted.

Substantial research has been directed at bow-wounding issues both recently and over the past few decades. If wildlife management professionals collectively reject the current wounding data, then it seems imperative that objective, definitive studies be designed to obtain accurate, reliable data. If the available data are accepted as reasonably accurate, then it becomes imperative to develop regulations or techniques for bowhunting that will allow the desired game management and recreational goals to be reached while minimizing animal wounding.

CONCLUSIONS

It can be anticipated that interest in bowhunting will continue to grow and with this growth will come both additional opportunities and challenges for wildlife managers. The ability for archery harvests to control white-tailed deer population growth in urban settings is well established in the literature, and based on these successes, expanding use of bowhunting as a population control tool should be encouraged. With increased interest in bowhunting, resource allocation among hunter groups will be a greater challenge to resource managers. Growing bowhunter numbers and enhanced technology may result in reductions in opportunity from the current, more liberal seasons.

Challenges to bowhunting from segments of society that wish to reduce or abolish hunting are also likely to continue. Although it is clearly established that archery is a lethal method of harvest, the controversy over bow wounding and what, if any, degree of wounding is acceptable to both wildlife managers and society will not be easily rectified. Though the opinions of special interest groups opposed to bowhunting are clear, the views of the general public are largely unknown. Wildlife professionals need to be aware of varying points of view and most importantly to be well versed in the factual information surrounding the wounding issue. Furthering our profession's understanding of bowhunters and public opinions on bowhunting issues will require a number of well-designed surveys. These survey instruments will serve as a much needed decision-support framework from which resource managers can make better informed recommendations.

The policy of The Wildlife Society (TWS) regarding hunting is based on the view of hunting as a responsible human use of wildlife resources. That policy is comprised of 3 principles (The Wildlife Society, 1992:9), each of which this document also serves to address. The first principle is to assist decision makers so that judgments on hunting and the welfare of wildlife are guided by both biological and societal considerations. To that end this document serves as a basis for decision support that can be used by natural resource professionals and interested publics. The second element of TWS policy on hunting is to endorse the principle that hunting, when properly regulated, is a biologically sound means of managing wildlife populations. Literature reviewed in this document supports both the regulated nature of bowhunting and its use as a population management tool. The final principle in TWS policy on hunting asserts support for encouraging expansion of programs for hunters to increase their knowledge of wildlife ecology and to emphasize hunter ethics and responsibilities. The growth in state and provincial wildlife resource agency participation in voluntary bowhunter education programs supports the direction outlined by this principle. Furthermore, the increasing trend toward mandatory bowhunter education clearly depicts the commitment of wildlife resource agencies to emphasizing hunter ethics and responsibilities. The Wildlife Society defines the role of hunting in society and wildlife management as principally useful for recreational purposes, for utilization of the harvestable surplus to benefit man, and for controlling populations. Clearly, bowhunting functions well within this definition, furnishing the wildlife profession with a socially responsible tool for both controlling wildlife populations and providing hunting recreation.

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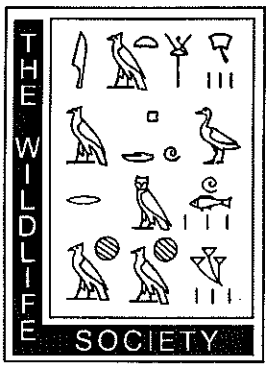

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5410 Grosvenor Lane, Bethesda, Maryland 20814

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