Wounding Rates of White-tailed Deer with Modern Archery Equipment

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Abstract: We determined wounding rates of white-tailed deer (*Odocoileus virginianus*) by bowhunters using modern (compound bow and crossbow) archery equipment. Our study relied on daily reports submitted by bowhunters who participated in managed hunts at the Naval Support Facility Indian Head at Indian Head, Maryland. Bowhunters were required to pass the International Bowhunter Education Program and an annual pre-season shooting proficiency test. During the 1989–2006 hunting seasons, 104 bowhunters failed to recover 162 of 908 deer hit by arrows or crossbow bolts, corresponding to an 18% wounding rate. There was no difference in deer recovery metrics between compound bow and crossbow users ($\chi^2_1 = 0.01$; $P = 0.92$). Bowhunters who harvested the most deer (>20 deer per hunter) had a lower pooled wounding rate than bowhunters who killed fewer deer ($\chi^2_1 = 22.2$; $P < 0.005$). Based on our estimates, qualified bowhunters were able to recover 1 deer for every 1.4 shots using modern archery equipment.

Key words: accuracy, bowhunting, Indian Head, white-tailed deer, wounding

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Deer wounding rates are an issue whenever bowhunting is considered for managing white-tailed deer (*Odocoileus virginianus*) populations. As more organizations and communities consider bowhunting as an alternative in non-traditional and urban settings, accurate estimates of wounding rates by bowhunters using either compound bow or crossbow archery equipment are important to support management decisions. Recent studies on deer wounding rates by archers were based on short and/or intense hunting programs (Kilpatrick and Walter 1999, Krueger et al. 2002); were based on the use of traditional (recurve or long bow) archery equipment (Ditchkoff et al. 1998); or were incidental to the hunting program, such as Suchy et al. (2002) who recorded only four years of wounding rate data for a seven-year, urban area program. Our goals were to determine deer wounding rates and shot accuracy of bowhunters who used modern archery equipment in a managed hunting program that has been in effect for over 18 years.

Study Area

The Naval Support Facility Indian Head (NSFIH) is located about 30 miles south of Washington D.C. in Charles County, Maryland. The NSFIH encompasses approximately 1416 ha with 26 km of shoreline on three separated peninsulas on or near the Potomac River. The land includes mowed and early successional fields, wildlife plots, tidal and non-tidal wetlands, and broken tracts of woods. The Naval Surface Warfare Center Indian Head Division (NSWCIHD) at Indian Head and the Naval Explosive Ordnance Disposal Technology Division on the Stump Neck Annex are organizations that occupy two of the major peninsulas, 813 ha and 445 ha respectively, where hunting was permitted.

In 1983, spotlight surveys estimated the deer herd on NSWCIHD at about 700 deer, or 86 deer per km^2. Woodlots exhibited a severe browse line and an open understory as a consequence of the high deer density. U.S. Navy sharpshooters reduced the deer population over the next several years. The Natural Resources Office (NRO) then initiated a deer management program in 1989 that relied on bowhunting as the primary means for long-term population control. A memorandum of understanding between NRO and Maryland Department of Natural Resources (DNR) facilitated annual exemptions from the Maryland regular season bag and possession limits for white-tailed deer.

The NSFIH allowed primarily civilian employees and military personnel to bowhunt. Bowhunting occurred throughout the 4.5-month Maryland archery season except during rain. Bowhunting was confined to designated areas (averaging 16 ha) and isolated sites (90 m in diameter) with time-of-day and hunter quota restrictions. In 1992, the NRO established an earn-a-buck incentive program and antler restriction harvest regulations to promote doe harvest and improve the quality of available bucks.

Bowhunters passed the International Bowhunter Education Program, and an annual pre-season shooting proficiency test.

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Bowhunters could use crossbows and bolts ("arrows") during the Maryland crossbow season, or if they had a handicap permit. Only a few bowhunters attempted to pass the pre-season proficiency test with traditional archery equipment (recurve or long bow), and they were unsuccessful. Archers could use only fixed-blade broadheads, as mechanical broadheads were not allowed.

All bowhunters signed in/out for each hunt. Hunt captains, trusted agents of the NRO, verified that all hunters were accounted for at the end of each hunt. The NRO required every hunter to fill out a data sheet within 24 hours of each hunt. The data sheet documented each hunter's name, hunting area, hours hunted, whether the hunter hit a deer, and whether the hunter recovered a hit deer. Data sheets were modified in 1994 to include whether the hunter shot at a deer and a description of the hunter's archery equipment. The NRO examined sign-in and data sheets on a regular basis for completeness and to ensure 100% compliance.

A bowhunter who hit a deer and needed to track it outside of the assigned area was required to notify the hunt captain and could also request help from experienced volunteer trackers. Bowhunters took recovered deer to a game check station before field dressing them. The hunt captain recorded biological data and the NRO used this information to make deer herd management decisions.

Methods

We analyzed data sheet summaries from the 1989–2006 hunting seasons to determine each bowhunter's effectiveness at recovering a hit deer. We defined the recovery rate, R(24), as the percentage of hit deer that were recovered within 24 hours [(number of deer recovered within 24 h) × 100/(number of deer hit)]. Deer not recovered within 24 hours were categorized as hit but not recovered, or wounded. We defined wounding rate as the percentage of deer not recovered within 24 hours [100 – R(24)]. No attempt was made to reconcile recovered deer that showed evidence of having survived earlier wounding with past records.

Every bowhunter who submitted a data sheet was assumed to have hunted during that season. We determined the mean level of participation as equal to (total number of seasons hunted by all bowhunters)/(number of bowhunters). Data sheets from 1994 forward were modified so that shot accuracy could be determined. We defined accuracy as equal to (number of shots hitting deer) x 100/(number of shots attempted).

Early data (1989–1993) were not stratified by archery equipment used (i.e., compound or crossbow), but only one disabled hunter used a crossbow during this period. We compared number of deer each hunter recovered with number of deer they had wounded. Statistical comparisons of hunter success and equipment were based on chi-square (Huntsberger and Billingsley 1979).

Results

One hundred sixty-one bowhunters participated in the NSFIH hunting program during 1989–2006. One hundred and four bowhunters (65%) hit 908 and recovered 746 deer within 24 hours. This represents a recovery rate of 82 ± 2.5%. The corresponding wounding rate was 18 ± 2.5%. The mean number of bowhunters was almost 27 per year (SD 4.1), with participants hunting a mean of three seasons (SD 3.3). Hunting events averaged 459 per season, or about 5.1 hunting events per day. Total bowhunting effort was 26,163 hours for 8270 events, an average of 3.2 hours per event. Bowhunters averaged 35 hours of hunting effort per recovered deer. The average bowhunter density on NSIFH was 0.37 hunters/km^2.

Only five bowhunters used crossbows during the study period. Four of these bowhunters had also used a compound bow. There was no difference in the aggregate wounding rates by bowhunters using compound bows or crossbows ($\chi^2_1 = 0.011$; $P = 0.92$; Table 1).

During 1994–2006, 75 bowhunters who hunted with either a compound bow or a crossbow reported taking 707 shots and hitting 632 deer. Overall bowhunter shot accuracy was 89 ± 2.5%. This performance metric assumed that bowhunters did not take more than one shot at each deer. There was no difference in the accuracy of bowhunters who used compound bows or crossbows ($\chi^2_1 = 0.386$; $P = 0.53$; Table 2). Because we found no difference in accuracy or recovery metrics, the database of hunters was pooled for all other analyses.

Bowhunter performance metrics suggested year-to-year variation, but we did not make statistical comparisons among years be-

Table 1. Wounding rate data for 104 bowhunters from 1989–2006 as stratified by the type of archery equipment at the Naval Support Facility Indian Head, at Indian Head, Maryland.

Archery equipment	Deer hit	Deer not recovered within 24 hours	Wounding rate% (95% CL)
Compound bow (*n* = 103 hunters)	848	151	18 (15–21)
Crossbow (*n* = 5 hunters)	60	11	18 (11–29)

Table 2. Bowhunter shot accuracy from 1994–2006 for 75 bowhunters as stratified by the type of archery equipment at the Naval Support Facility Indian Head, at Indian Head, Maryland.

Archery equipment	Shots	Deer hit	Accuracy % (95% CL)
Compound bow (*n* = 75 hunters)	657	586	89 (87–91)
Crossbow (*n* = 4 hunters)	50	46	92 (81–97)

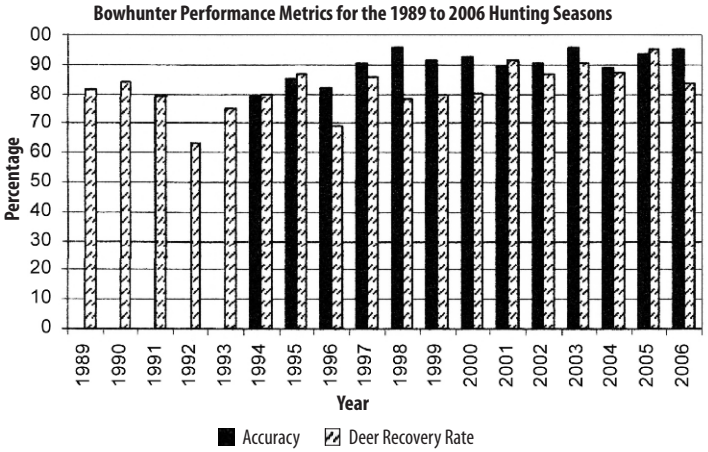

Figure 1. Annual shot accuracy and deer recovery performance metrics for all bowhunters from 1989–2006 at the Naval Support Facility Indian Head, at Indian Head, Maryland.

Table 3. Pooled wounding rates for bowhunters from 1989–2006 as associated with the total number of deer harvested by individual hunters on the Naval Support Facility Indian Head, at Indian Head, Maryland.

n deer harvested per hunter	*n* hunters	Pooled wounding rate % (95% CL)
0–5	74	24 (19–31)
6–20	19	24 (19–30)
>20	11	13 (10–16)

cause of the repeated turnover in the hunter population (Figure 1). The 13-yr shot accuracy average was 90 ± 1.5%, and the 18-yr deer recovery average was 82 ± 1.8%.

Bowhunters who harvested the most deer were found to have the lowest wounding rates (Table 3). Bowhunters (n = 11) who individually harvested more than 20 deer on NSFIH had a pooled wounding rate lower than that for bowhunters (n = 93) who harvested 20 or fewer deer ($\chi^2_1 = 22.2$; $P < 0.005$).

Discussion

The NSFIH hunting program provided an ideal opportunity to study bowhunter performance because all hunting effort was monitored and documented. We believed the requirement for bowhunters to report hitting a deer if they wanted to track it outside their assigned hunting areas and the availability of tracking assistance minimized biases related to any hunter's reluctance to report wounding a deer. When comparing our 18-yr average wounding rate of 18% with wounding rates of about 50% reported by others from data collected before 1987 (Ditchkoff et al. 1998, Kilpatrick and Walter 1999, Krueger et al. 2002), readers must recognize that earlier reports do not reflect material and design improvements characteristic of modern archery equipment. We believed improvements in bows, sights, arrows, and broadheads together have helped the average bowhunter achieve better and more consistent shooting performance (Durkin 2002).

We also believed there has been a change in the past two decades in how bowhunters practice and how bowhunters are tested for proficiency. It now is common for bowhunters to practice on life-sized, 3-D deer targets that are available at Maryland archery clubs open to the public, or can be purchased from a number of retail vendors. These realistic 3-D targets have scoring zones and are often used by testing officials to verify the skill level of bowhunters.

For example, bowhunters on NSFIH were required to pass the nationally-recognized International Bowhunter Education Program and a pre-season shooting proficiency test. It is reasonable to expect average hunter performance to improve with better archery equipment, the capability to practice on realistic hunting targets, mandatory bowhunter education and pre-season proficiency testing.

The annual wounding rate on NSFIH appeared to vary, and the turnover in the population of bowhunters may have contributed among year variability. The overall 18% wounding rate is similar to wounding rates reported in more recent studies for hunters using modern bowhunting equipment. Kilpatrick and Walter (1999) reported a 17% wounding rate over a two-year bowhunting program within a residential Connecticut neighborhood. Suchy et al. (2002) reported bowhunters in an Iowa urban area wounded 14% of deer over a 4-year period. Krueger et al. (2002) reported that over two hunting days each in 1992 and in1993, bowhunters failed to recover 28% of deer that they wounded on Camp Ripley, Minnesota, but the net wounding rate was only 13% because other hunters recovered some of the wounded deer. In this later study, hunting was characterized as "high intensity" with an average hunter density of 10.7 hunters/km^2. This density was approximately 29 times the hunter density at NSFIH. The higher hunter density at Camp Ripley created the condition where individuals could more likely recover other hunters' wounded deer, something that did not occur at NSFIH. Our definition of wounding that includes any deer recovered after 24 hours could bias the 18% wounding rate higher relative to these more recent studies, but the bias is believed to be minor.

We found bowhunters with modern archery equipment were able to hit 89% of the deer that they shot at on NSFIH. Kilpatrick and Walter (1999) reported an accuracy of 75%. We found no differences in accuracy and wounding rate performance metrics between bowhunters who used compound bows or crossbows, noting the small number of bowhunters (n = 5) who used crossbows on NSFIH. With an accuracy of 89% and a recovery rate of 82%, bowhunters on NSFIH were effectively able to recover a deer every 1.4 shots.

When we examined the wounding rates by individual bowhunters, we found that bowhunters who killed the most deer on NSFIH also had the lowest wounding rates. Logically, those hunters who harvested the most deer should be among the more experienced hunters. Perhaps these "more experienced" bowhunters understood the capabilities of their equipment better, and/or were more selective with what shots they took at deer.

Other minor factors affecting deer retrieval at NSFIH were firstly, the open understory of woodlots and the extensive network of roads facilitated effective grid searches (a structured ground search for a hit deer). Grid searches were usually conducted after a blood trail quit or was lost by trackers. Grid searches were used more often to verify that a deer was not likely to be recoverable because of possible superficial wounding than to locate a lost deer. Secondly, a group of volunteer trackers provided help to any bowhunter requesting assistance with locating a hit deer. Experienced trackers could help novice bowhunters avoid mistakes that could affect deer recovery, such as taking up a blood trail too soon after a poor hit. Thirdly, although tracking dogs were not used on NSFIH, their use may improve deer recovery rates (Morton et al. 1995). Tracking dogs became legal to use in Maryland in 2001.

The 18% overall wounding rate we calculated was not the percentage of deer killed and not recovered. Two studies of collared-deer provided mortality estimates for deer wounded but not recovered. Ditchkoff et al. (1998) reported 8 of 11 deer with archery-related wounds survived wounding. Kilpatrick and Walter (1999) reported at least two deer with archery-related wounds survived. In their study, only one of three wounded deer was lost when it was not raining. If we assumed similar survival rates from these two studies, the number of deer killed and not recovered, or "loss rate," on NSFIH would be about 6% of the number of deer hit. This loss rate compares favorably to the 11% of the deer population that Eyler and Timko (2008) estimated were struck by motor vehicles in Maryland in 2007. The 13 to 1 ratio of the deer recovery rate relative to the estimated loss rate demonstrated that trained and qualified bowhunters with modern archery equipment can help manage deer populations with relatively few losses.

Comprehensive, long-term bowhunter performance metrics in a "low-intensity" hunting environment are absent from the literature. Likewise, there is little comparative information on bowhunters using crossbows and compound bows. It can be difficult to assess bowhunter performance, as the nature of the sport allows only the hunter to know what actually happened. The NSFIH provided a unique controlled and monitored environment that came as close as practical to looking over bowhunters' shoulders. Future research should examine effects of other variables (e.g. shot distance, use of now-allowed mechanical broadheads, and sex of the deer) on bowhunter accuracy and recovery/wounding rates.

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