



## Original Article

# Behavior and Risk Probabilities of Deer Stand Falls among Wisconsin Hunters

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**ABSTRACT** Falls from elevated hunting platforms have replaced firearm accidents as the largest source of hunting-related injuries and deaths in the United States. Our study applied participation and behavior data from 2 statewide hunter surveys conducted in 2013, current license purchasing data, and an audit of medical records between 2009 and 2013 in the north-central region of Wisconsin to generate annual and cumulative risk probabilities of being injured in a fall. Although archery hunting of deer (*Odocoileus* sp.) attracts fewer participants than firearm season, risk exposure is 4.5 times greater because of season length. Overall, the average risk probability for serious injury was 1 out of 71 through 25 years of hunting participation. The most avid deer hunters—those who hunt during archery and firearm seasons over a lifetime—incur a 1-in-20 chance of being injured falling from a deer stand. Our results support agency decisions to require safety education for new hunters. However, increased efforts are needed to get existing hunters to purchase and consistently utilize body harnesses and climbing equipment while using deer stands. © 2016 The Wildlife Society.

**KEY WORDS** deer hunters, education, risk, tree stands.

Providing access and opportunities to enjoy the outdoors is part of the mission for most state natural-resource agencies. The safety of participants in any outdoor recreational pursuit should be of paramount concern to natural resource professionals striving to sustain participation and funding levels, provide public service, and avoid litigation (Peterson and Hronek 2011). Many state natural-resources agencies now conduct both mandatory and voluntary recreational safety classes that certify users in an effort to promote public safety in hunting, boating, and recreational vehicle operations. The Wisconsin Department of Natural Resources, Wisconsin, USA (WDNR), recreational safety education is administered by law enforcement staff. Prior to mandatory firearm safety training and hunter (i.e., blaze) orange clothing laws, accidental shootings among deer (e.g., *Odocoileus virginianus*) hunters were fairly common. To get a sense of perspective on the progress in accident reductions over the past 100 years, consider that 1 in every 3,100 deer hunters was accidentally shot (24 were killed) during the 1914 Wisconsin firearm deer season, while the shooting incident rate was 1 in 95,143 with only one fatality in 2012 (WDNR 2014). Strong partnerships between

WDNR's conservation law enforcement, nongovernmental conservation groups such as the International Hunter Education Association, and a large network of volunteer hunter-education instructors can be credited with nearly eliminating accidental shootings of hunters (and non-hunters) during firearm seasons for deer (Responsive Management 2002, National Shooting Sports Foundation 2013).

Falls from elevated blinds (e.g., tree stands) have now replaced shooting accidents as the next serious public-health challenge related to deer hunting (Crockett et al. 2010). Falls from deer-hunting stands are often associated with serious injuries (e.g., fractures and paralysis) and can even result in fatalities (Halanski and Corden 2008, Wood 2012). Common precipitating factors have not been clearly identified in past research, although there are some indications that accidents are most commonly associated with the act of climbing itself, late afternoon hunts, middle-aged participants, and males (Deer and Deer Hunting Magazine 1993, Fayssoux et al. 2008, Smith et al. 2009). Tree-stand fall subjects in North Carolina and Vermont (USA) blamed "carelessness" (as opposed to external factors) for their incidents in follow-up surveys (Responsive Management 2002). Alcohol has been linked to 7–10% of cases involving serious injuries (Fayssoux et al. 2008, Smith et al. 2009). Van Wormer et al. (2016) found that fall victims were more likely to be overweight than the average, similarly

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aged patients seen at a trauma clinic. To date, there have been no published reports of the type of tree stands involved in hunter falls.

Although the issue has received extensive attention by the medical community (e.g., Crites et al. 1998, Fayssoux et al. 2008, Halanski and Corden 2008, Griffin et al. 2010), it has received considerably less research and discussion among natural resource professionals. The issue of tree-stand safety was reported by *Deer and Deer Hunting* magazine in 1993 with a nonscientific poll of its readers, which suggested that 37% of deer hunters had experienced a tree-stand fall at some point in their lifetime. When the magazine repeated its reader survey in 1999 (Edson 2012), 32% of respondents reported falls and results found gaps in hunter use of fall restraints. Smith et al. (2009) reviewed medical records and found an increasing trend in injuries and deaths from tree-stand falls among Pennsylvania, USA, deer hunters from 1987 to 2006, and determined that injuries resulting from tree-stand falls occurred annually for 1 in every 1,429 deer hunters.

The best defense against injury from tree-stand falls is the adoption and proper use of fall restraint (i.e., safety harnesses) devices by hunters (International Hunter Education Association 2002, Fayssoux et al. 2008), but we know relatively little about their rates of use. A survey we conducted of our firearm deer-hunters in 2003 found that 84% had hunted from a tree stand in the past (Petchenik 2004). A majority of these hunters owned a safety harness (62%) but less than half used it “Always” (31%) or “Usually” (14%) while hunting from an elevated stand (Petchenik 2004).

In this paper, we report results of 2 research efforts undertaken to update the scientific calculation of deer stand fall risks. Our objectives were to assess current deer-stand safety-harness use and experience with falls and model lifetime risks of experiencing a serious injury from a deer stand fall. We define serious injury as one requiring professional medical attention.

## METHODS

We present findings related to tree-stand use and self-reported fall rates in Wisconsin from recent hunter survey data. We apply those findings to license and medical data to generate a risk assessment of injuries associated with tree-stand falls in north-central Wisconsin. We present calculations for lifetime fall risk based on differential risk exposure incurred among archery and firearm deer hunters. We modeled the lifetime fall-injury risk among deer hunters who reside in an area of north-central Wisconsin corresponding to the medical-trauma coverage area served by the Marshfield Clinic in Marshfield, Wisconsin (Fig. 1). We created a life table showing the difference in the additive effects of annual tree stand use among 2 kinds of deer hunters across a range of 50 years. The selection of this area highlights a collaborative project between Wisconsin DNR and Marshfield Clinic researchers to determine the 5-year trend in medically attended tree-stand accidents (see Van Wormer et al. 2016). The area makes a suitable region for

this analysis because the Marshfield Clinic treats almost all of the trauma cases that occur in that part of Wisconsin and most residents in this area deer hunt near their county of residence (R. Holsman, Wisconsin Department of Natural Resources, unpublished data).

To calculate the annual risk rate of deer stand falls among hunters, we performed an audit of medical records from 2009 to 2013 using key words related to hunting stand falls to identify cases treated for injuries within the study area. The records audit determined the number of annual injury cases resulting from deer stand falls. We then searched our license database to identify the number of residents within this service area who purchased deer-hunting licenses corresponding with each year within the same time frame to determine annual occurrence rates.

Because not all license buyers hunt and not all hunters use tree stands, we adjusted annual rates based on the questionnaire data obtained from mail surveys of hunters across Wisconsin to determine rates of deer-hunting participation, days afield, rates of elevated stand use, and use of safety equipment. We mailed 10,000 questionnaires each to a random selection of archery and firearm deer-license holders following the 2013 hunting seasons. Our survey procedures included 1 follow-up mailing to non-respondents. Budgets did not permit additional mailings.

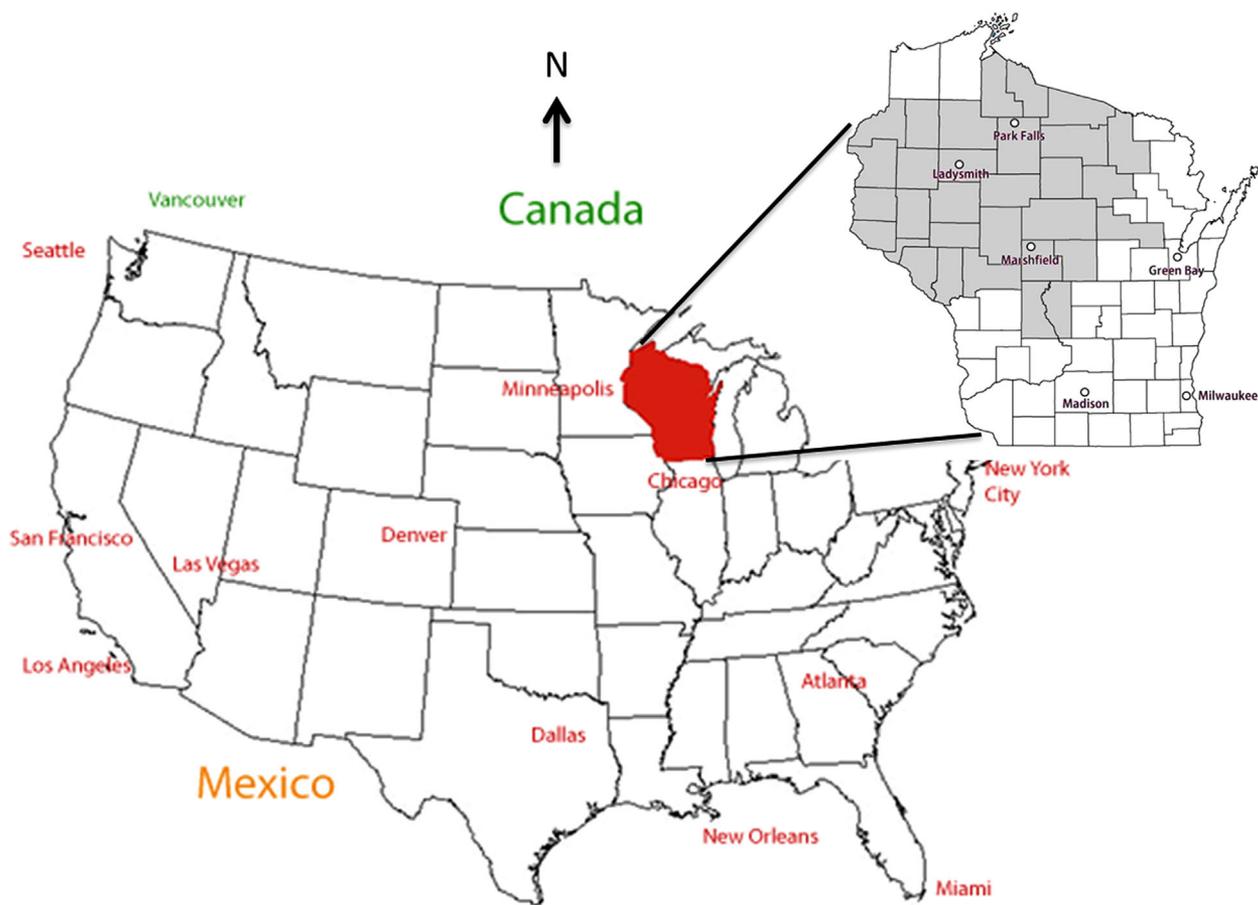
Archery deer hunters have the potential for much greater exposure to tree-stand risk than do firearm hunters by virtue of a much longer open season. Consequently, we used the average days of hunting reported in our statewide archery and firearm surveys to partition the overall annual risk for both groups (Fig. 2). We modeled the lifetime fall risk among hunters by multiplying the annual fall risk by the number of years hunted over a 50-year range. We calculated cumulative risk for those who hunt during the firearm season only and for hunters who hunt during both archery and firearm seasons. We do not include calculations for archery-only hunters because they comprised only approximately 3% of license holders in the study counties.

## RESULTS

Our response rates were 44% for the archery survey and 41% for firearm deer survey. Almost all (98%) of the firearm survey respondents did go deer hunting, as did 86% of those holding an archery license. Firearm-only deer hunters averaged 5.1 days (SD = 0.2) of hunting/year. In contrast, the license holders who hunted during both archery and firearms seasons hunted an average of 23 days/year (5 during the firearm season and 18.1 days [SD = 10.3] during archery season). Therefore, hunters that participate in both firearm and archery deer seasons have exposure rates that are approximately 4.5 times greater than firearm-only deer hunters.

### Equipment Usage

Eighty-four percent of firearm deer hunters used elevated stands. Tree-stand usage among archery deer hunters was 91%. Respondents to our archery survey were more likely (33%) to report that “they always wear a safety harness or fall



**Figure 1.** Counties in the Marshfield Clinic Service Area, Wisconsin, USA, that served as the study-area for our audit medical records for tree-stand injuries from 2009 to 2013.

restraint” when using a tree stand than were firearm deer-hunting respondents (23%). Both archery and firearm deer hunters reported similar reasons for not using safety harnesses (Table 1). The 2 leading reasons for not wearing safety harnesses were “being extra careful while climbing” and “never having fallen in the past” (Table 1). The largest apparent difference between the 2 survey findings was that 20% of firearm hunters indicated that they do not own a safety harness, compared with 14% for archery respondents.

### Falling Episodes

Archery respondents were nearly 2 times more likely to have experienced falls and near falls from tree stands than firearm survey respondents (Table 2). Approximately 28% of the respondents to the archery survey had fallen or nearly fell, whereas about 13% of firearm respondents reported to have fallen or experienced a near fall. Collectively, ascent and descent from stand accounts for >50% of fall and near-fall cases among deer hunters (Table 3). Hang-on stands were most frequently linked to falls and near-falls and that frequency appears greater among firearm deer hunters (Table 4). Hang-on and ladder stands produced similar incident frequencies for archery respondents. Less than 2% of deer hunters reported falls or near falls from elevated tri-pods or box-style blinds (Table 4).

### Annualized Deer-stand Fall Risks in North-central Wisconsin

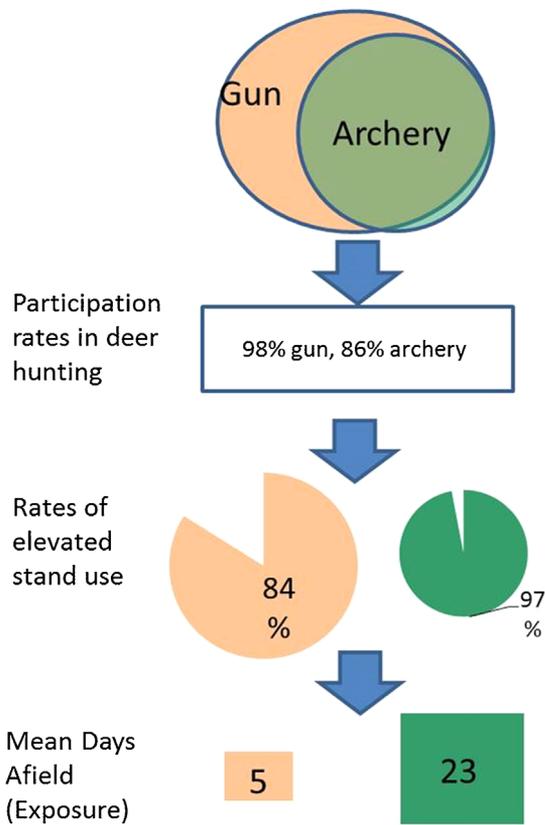
The annual risk of a serious injury resulting from a deer stand fall was 0.056%—or roughly 1 out of every 1,666 deer hunters using tree stands in the Marshfield Clinic service area between 2009 and 2013. The majority of hunters using deer stands (57% over the 5-year average) participated only during the firearm hunting season; the remainder hunted from deer stands during both firearm and archery seasons. Consequently, the weighted annual injury risk for the average firearm-only deer hunter was 0.022%. The annual risk for the average individual hunting both archery and firearm seasons was 0.099%.

### Lifetime Fall Risk and Odds

Based on our life-table (Table 5), an individual hunting from elevated stands in both archery and firearm seasons will accrue a 1 in 33 chance of serious fall related injury over a 30-year period. By comparison, a firearm-only deer hunter has a 1 in 112 chance of falling and getting injured over the same period. Hunters who participate for 50 years in both seasons accrue a 1 in 20 risk of being hurt in a fall.

Our review of license purchasing behavior in our study area shows that about half (48%) of the hunter population bought

## Annual Study Area License Pool



**Figure 2.** A model of deer-hunter population risk exposure from elevated deer-stand use by gun-license holders and archery license holders in north-central Wisconsin, USA from 2009 to 2013.

either a firearm or archery license in each year of the 5-year study; about 15% purchased licenses for both weapon types every year. Extrapolating our 5-year license purchasing data across a 50-year period would suggest that about 1 in 6 (approx. 15%) hunters in the population accrue the maximum injury risk. Taking the average across all deer hunters in the study region, the odds of serious injury from a deer stand fall is 1 in 71 within 25 years and 1 in 36 following 50 years of deer hunting (Table 5).

**Table 1.** Frequency (%) of reported reasons for not always wearing a safety harness among respondents to Wisconsin Archery and Firearm harvest surveys, Wisconsin, USA, in 2013.

Reasons	Archery respondents	Firearm respondents
I am extra careful climbing up or down from my stand	43	40
I have never fallen or had a near-accident	36	39
It is difficult to use	19	14
Other <sup>a</sup>	18	23
I do not own one	14	20
It takes too long to climb up and down from my stand	8	5

<sup>a</sup> For example: takes too much time, have a railing in place.

**Table 2.** Frequency (%) of reported tree-stand incidents (falls and near falls) among respondents to Wisconsin Archery and Firearm harvest surveys, Wisconsin, USA, in 2013.

Reported incidents	Firearm respondents	Archery respondents
Have fallen from a deer stand in the past	4.3	9.3
Had a “near-fall”	8.2	18.9
Total % incidents	12.5	28.2

**Table 3.** Frequency (%) of reports on the point in the process of hunting with a deer stand where falls are most likely to occur among respondents to Wisconsin Archery and Firearm harvest surveys, Wisconsin, USA, in 2013.

Response	Archery	Firearm
While climbing up into my stand	29	27
While climbing down from my stand	26	27
While I was in the stand	20	23
While I was attaching the stand	19	16
At some other point	6	7

## DISCUSSION

Our calculations of probabilities of being injured in a deer stand fall represent an advancement of past research on this topic for several reasons. Ours was the first study to model such risks based on observed injury cases within a defined geographic area and adjusted for actual stand-use rates to generate fall estimates. Second, our data account for differences in hunting effort among participants in archery and firearm seasons. Notably, deer hunters who participate in both firearm and archery seasons have more opportunity, and, therefore, more risk exposure than firearm hunters alone. This result was evident in both our survey findings and the risk model based on observed injuries. Lastly, our lifetime risk odds are expressed as a potential range of values to recognize that the span of a hunting career varies widely among individuals and is not uniform among all hunters every year (Southwick and Associates, Inc. and National Shooting Sports Foundation 2010).

The overall annual risk to deer stand hunters in our study appear somewhat lower than estimates from a Pennsylvania study (1 in 1,786 compared with 1 in 1,429; Smith et al. 2009). This difference may be smaller than it appears because it may reflect our discounting for hunters who use stands (a step not taken in the PA study). Estimates from our model suggest that an avid, lifelong hunter who participates in both gun and archery hunting faces a 1 in 20 risk of sustaining an

**Table 4.** Frequency (%) of stand types involved in falls and near-falls among archery and firearm deer respondents among respondents to Wisconsin Archery and Firearm harvest surveys, Wisconsin, USA, in 2013.

Tree stand type	Archery	Firearm
Hang-on stand (no ladder)	33	44
Ladder tree stand	32	21
Climbing stand	20	26
Other	12	7
Elevated tri-pod or quad box (not in a tree)	2	1

**Table 5.** Life table of probabilities for being in a deer stand fall requiring medical attention for firearm deer hunters, dual-season (firearm and archery) hunters, and the overall hunter population derived from medical records and hunter participation data in Wisconsin, USA, during 2009–2013.

Years of participation	% cumulative risk			Odds of serious accident (1 out of ___ hunters)		
	Overall across hunter population	Firearm only	Hunt both archery and firearm	Overall across all deer hunters	Lifetime firearm-only	Lifetime firearm and archery
	1	0.056	0.02	0.10	1,786	4,545
2	0.112	0.04	0.20	893	2,273	503
3	0.168	0.07	0.30	595	1,515	334
4	0.224	0.09	0.40	446	1,136	251
5	0.280	0.11	0.50	357	909	200
6	0.336	0.13	0.60	298	758	167
7	0.392	0.15	0.70	255	649	143
8	0.448	0.18	0.80	223	568	125
9	0.504	0.20	0.90	198	505	111
10	0.560	0.22	1.00	179	455	100
11	0.616	0.24	1.10	162	413	91
12	0.672	0.26	1.20	149	379	83
13	0.728	0.29	1.30	137	350	77
14	0.784	0.31	1.40	128	325	71
15	0.840	0.33	1.50	119	303	67
16	0.896	0.35	1.60	112	284	63
17	0.952	0.37	1.70	105	267	59
18	1.008	0.40	1.80	99	253	56
19	1.064	0.42	1.90	94	239	53
20	1.120	0.44	2.00	89	227	50
21	1.176	0.46	2.10	85	216	48
22	1.232	0.48	2.20	81	207	45
23	1.288	0.51	2.30	78	198	43
24	1.344	0.53	2.40	74	189	42
25	1.400	0.55	2.50	71	182	40
26	1.456	0.57	2.60	69	175	38
27	1.512	0.59	2.70	66	168	37
28	1.568	0.62	2.80	64	162	36
29	1.624	0.64	2.90	62	157	34
30	1.680	0.66	3.00	60	152	33
31	1.736	0.68	3.10	58	147	32
32	1.792	0.70	3.20	56	142	31
33	1.848	0.73	3.30	54	138	30
34	1.904	0.75	3.40	53	134	29
35	1.960	0.77	3.50	51	130	29
36	2.016	0.79	3.60	50	126	28
37	2.072	0.81	3.70	48	123	27
38	2.128	0.84	3.80	47	120	26
39	2.184	0.86	3.90	46	117	26
40	2.240	0.88	4.00	45	114	25
41	2.296	0.90	4.10	44	111	24
42	2.352	0.92	4.20	43	108	24
43	2.408	0.95	4.30	42	106	23
44	2.464	0.97	4.40	41	103	23
45	2.520	0.99	4.50	40	101	22
46	2.576	1.01	4.60	39	99	22
47	2.632	1.03	4.70	38	97	21
48	2.688	1.06	4.80	37	95	21
49	2.744	1.08	4.90	36	93	20
50	2.800	1.10	5.00	36	91	20

injury requiring medical attention. The proportion of individuals hunting fewer years, hunting only during firearm seasons, or hunting some years from the ground obviously incur lower probabilities of an accident.

Our 1 in 20 odds calculation represents a lower risk than the 1 in 3 rate documented in previous research (Deer and Deer Hunting Magazine 1993). There are 3 potential methodological causes of the difference in the odds calculations. One, past work using self-reports asked about tree-stand falls, but not necessarily those involving injuries. More hunters may

fall than get hurt, and some percentage of those who fall from a deer stand escape with either no or minor injuries (Responsive Management 2002), which could account for why self-reports produce greater risk calculations. Alternatively, our calculations may underrepresent the annual risk of tree-stand falls where gaps in medical records do not fully capture all cases seen by physicians each year (Van Wormer et al. 2016). Patients seen by their primary care physician, rather than trauma centers or emergency rooms, may not always be recorded as a deer stand injury. Lastly, our study

was likely more representative of the continuum of hunter behavior within the population, whereas a poll of magazine readers was likely skewed toward the most avid deer-hunting participants.

We acknowledge that our findings include a couple of assumptions that may influence overall risk probabilities for individual hunters. One, we applied statewide rates of stand use among archery and firearm hunters to a regional population of licensed hunters in calculating fall rates. Our review of license records showed that churn rates and avidity rates of license buying were similar to statewide averages, but there may be regional variation in deer stand usage. Two, we also used average days afield from statewide hunters to model risk weights of a regional population. To the extent that hunting behavior, opportunity, or avidity vary among regional hunters, our estimates could be biased, though nothing suggests either issue is substantial. Three, when considering the percentage of the population that used elevated stands in our model, we applied values based on the frequency of survey respondents indicating that they had “ever” done so. This question frame did not differentiate how regularly our hunters use elevated stands during their hunts, so our resulting estimates of risk may overstate true exposure.

Regardless of the precise value of fall probability, our results confirm that deer hunting from elevated tree stands poses a serious and cumulative risk throughout a hunting career. The risk can be mitigated with the use of safety harnesses and climbing gear, but adoption and consistent use of this equipment by hunters in our study was not universal. A large majority of deer hunters in our surveys did not always use safety harnesses while hunting from elevated stands. Our findings were consistent with past research indicating that falls are most likely to occur in the act of climbing, as opposed to while a hunter is on a stand (Fayssoux et al. 2008).

Our data suggest that hang-on style stands may pose greater fall risk than others. Hang-on stands often require a secondary climbing device that may present smaller, and slipperier, hand holds and foot placement when climbing (e.g., screw-in steps or climbing stick). Hang-on stands may also require more strength, balance, and agility to place in a tree than other types of stands, including “permanent” built structures. However, because we do not know whether fall rates from hang-on stands or others types are proportional to their overall use among hunters in our population, this is merely speculation. This is an area that could benefit from additional research.

## MANAGEMENT IMPLICATIONS

As a result of safety concern associated with deer hunting from elevated stands, the state of Wisconsin is now requiring that tree-stand safety be taught as a mandatory component for all hunter education classes. The data from this study support that decision. While including instruction on the need for, and proper use of, tree-stand safety devices within hunter education curriculum is an important step, there is also a continuing need for agencies to design and implement outreach to current hunters. While the lifetime data from our study serve to underscore the seriousness of the injury risks

from elevated stands, fall rate statistics may not be easily understood by hunters; therefore, behavior change communication approaches should be tried and elevated in collaboration with public-private partnerships, including retailers, manufacturers, and health care providers. Past research on public-health campaigns suggests that effective interventions need to leverage both affective and cognitive domains without resorting to fear appeals (Pooley and O’Conner 2000, Heberlein 2012, Ruiter et al. 2014). Personal testimonials from past fall victims may resonate more with some hunters than simply providing probabilities (Braverman 2008, Das et al. 2008).

Finally, there are also implications for agencies and their partners engaged in effort to recruit more people into hunting. Deer hunting in many areas of the country has become synonymous with hunting from elevated stands. Mentored-training hunts and other recruitment programs for newcomers should consider emphasizing ground-hunting tactics as part of trial experiences so novices develop competency to consider it.

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