1 **Adverse effects of hunting with hounds on participants and bystanders**

2 A. Treves[1†*], L. Menefee†[2†]

3 [1] Nelson Institute for Environmental Studies, University of Wisconsin, Madison, WI, United

4 States

5 [2] Department of Literature, Leeward College, University of Hawai'I, Pearl City, HI and Sierra Club

6 Wisconsin Chapter, United States

7 [†] These authors have contributed equally and share first authorship.

8 *** Correspondence:** atreves@wisc.edu

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ABSTRACT

In the face of biodiversity crises, some societies are re-examining many human uses of nature. One activity that may once have been unobjectionable has undergone little scrutiny in most countries: hunting mammals with free-running hounds. We present two novel datasets about this under-studied hunting method. In Wisconsin, USA, hounds and gray wolves occasionally interacted aggressively and human by-standers reported adverse interactions with hounds and their handlers. Self-selected samples cannot be used to extrapolate in space or time but do provide new information. Between 1999 and 2012, 176 hounds were reported to have suffered injury during encounters with wolves. No government data were collected on how many wolves or other non-target animals were injured by hounds as required by the U.S. Endangered Species Act. Between 2015–2021, bystanders (n=105) reported various incidents of illegal behavior by hounds and handlers, adverse interactions with law enforcement, and other adverse events. We propose reforms to wildlife policy, law enforcement policy, greater oversight of hounding, and criminal prosecution. We discuss the implications for theories of dog domestication.

INTRODUCTION

In the face of a global biodiversity crisis partly caused by climate change and partly by human-induced mortality, some societies are re-examining many human uses of animals and habitats that once seemed unobjectionable. For example, uses of poison, off-road vehicles, the control of fire in ecosystems, etc. have undergone scrutiny for their societal benefit-cost estimates and their effects on nonhuman biodiversity and ecosystem health. One human

activity that may once have been unobjectionable has undergone little scrutiny: hunting with free-running hounds loosed far from their owners.

In our search for work on hunting with dogs or hounds in Google Scholar, the search phrase 'hunt with (hound or dog)'' yielded 38,300 results declining by half when '-bird' was added to the search string to exclude bird-hunting dogs. By contrast, 'hunt -bird 'yielded 3.16 million results. Therefore, it is under-studied. Current practitioners are also secretive, judging from their introduction of a bill in the Wisconsin state legislature to prohibit video-recording of the activity which is currently under appeal in federal court [1]. Yet, the practice of hunting mammals with hounds has been recorded since 8,000 years at least [2], praised by President Theodore Roosevelt in 1902 [3], and is legal in numerous countries and several U.S. states [4; 5]. Despite its long history, loosing mammal-hunting hounds to pursue prey, some as large as bears, may have harmful effects on people in their path, on the hounds themselves, and on target and non-target wildlife they encounter or pursue [6; 7]. Therefore, we present data on reports by self-selected owners alleging harm to their hounds when loosed near wolves and perceptions of human by-standers self-reporting their experiences of hounds used for such hunting, as a way to begin filling in the picture of this poorly studied hunting method. Although a comprehensive examination of societal benefits-costs requires additional information on benefits and unbiased samples of both phenomena, these were beyond our scope.

Non-target animals and their interactions with hounds

When pets kill wildlife, biodiversity may diminish or ecosystem health may deteriorate [6; 7]. Dogs are potential predators of prey they can overcome. Larger size and greater competitive ability of the wild animals may alter the risk posed by hounds, just as the danger to

non-target animals may increase if hounds outnumber or outweigh them. Hounds are often used for pursuit of mammals larger than individual hounds, such as black bears. Black bears were reported to avoid such encounters and in so doing approach people and major roads more frequently [8]. Some animals will stand their ground when hounds encounter them. When hounds encounter larger wildlife or animals that can defend themselves effectively, the hounds may be injured.

Researchers have examined aggressive encounters between wolves and dogs in many regions [9; 10; 11]. The States of Wisconsin and Michigan, USA, have a relatively longer history of such research. Spatial patterns of wolf *Canis lupus* attacks on hounds are somewhat predictable [12; 13; 14; 15]. The risk of an attack appeared to be higher in areas with more public land, larger wolf packs, closer to a wolf pack, and when baits were left out longer. Here, we examined self-reports by owners on the characteristics of the hounds involved, and draw on anecdotal data provided by handlers to evaluate correlates of the outcomes of wolf-hound interactions (WHI).

At the time of our study, it was illegal for hounds to attack wild animals, but such attacks might have occurred anyway. We do not have evidence of which animal in a WHI initiated aggression or escalated it to the point of injury or death. We only present data on the outcomes for hounds because outcomes for wolves were not documented. Therefore, we cannot rule out the possibility that wolves responded defensively to hound attacks.

The evidence for wolf attacks on hounds came from handlers seeking compensation or other forms of redress [14; 16; 17]. In a prior study, a number of wolf deaths caused by other canids were invariably attributed to other wolves [18]. Yet, veterinary pathologists might not be

able to reliably distinguish large dogs such as hunting hounds from wolves by simple scrutiny of bite marks without DNA analysis [19]. Therefore, our sample is necessarily biased toward handler concerns and outcomes for hounds. This should not be construed as evidence that wolves were the aggressors or that wolves ended up unharmed by hounds.

Hounds and humans

Biodiversity may suffer after domestic animals are injured or killed, because their owners may react in several ways detrimental to nature protection efforts. Owners may escalate and kill one or more wild animals, following the incident or for years afterwards. Furthermore, resentments engendered by dangerous wildlife encounters can spread to associates of the involved humans and become broad-based attitudes of intolerance or even preemptive lethal actions against the wildlife. For instance, consider the history of social scientific work done by various authors measuring attitudes to wolves in Wisconsin [17; 20; 21; 22; 23; 24]. The first survey in 2001 included complainants who believed they had experienced a wolf attack on their domestic animals, whereas the second survey in 2004 included many more individuals who had not experienced such losses, yet both groups showed decreases in tolerance for wolves when they were resampled in 2009. The interest group least tolerant of wolves was bear hunters who used hounds and the group whose tolerance for wolves declined most over time were men in wolf range who had hunting experience, not those with personal experience of wolf attack on domestic animals [17; 21; 22; 23; 24]. The prior results on tolerance were paralleled by inclinations to kill wolves illegally [20; 22; 23]. Also, attitudes to wolves and inclination to kill wolves illegally were unrelated to the hound handler's own experience with wolves or their experience with policy interventions relating to WHI such as

compensation for hound injuries [22; 23]. Handlers reported concerns for safety of the hounds and also concerns with access to land and their ability to pursue this pastime in the face of public and political opposition [20]. Recent research reports that poaching of wolves peaked during seasons of hunting bears and deer and seasons of training hounds [25]. There are no published data on hound-handler's encounters with by-standers or the encounters between their hounds and bystanders. Nor do we have data on the views of by-standers who encounter hounds or their handlers.

The Sierra Club Wisconsin Chapter (SCWC) began to fill the gap with the survey we report here. As part of a National Sierra Club initiative, the SCWC subcommittee, Protecting Native Forests and Wildlife, discussed the first-hand reports members had received of citizens and land owners experiencing encounters with hounds and their handlers. Because such first-hand reports are likely to be remarkable, most reports were adverse. The committee requested information from local law enforcement in the counties from which reports came to CVWVC and also the Wisconsin Department of Natural Resources (WDNR) for incident report data. They were informed by both agencies that "no such data were recorded." So, thereafter SCWC members led an effort at gathering information more broadly and systematically.

Hunting with hounds has long been controversial and questioned by hunters addressing the ethics of hunting and non-hunters addressing the public policy and morals of such practices [13; 26; 27]. Therefore, as a first step in shedding light on the practice, we examine self-reports of handlers reporting hound-wolf interactions and self-reports from human-human interactions involving hound handlers their hounds and by-standers. In our Discussion, we address what self-selection bias implies for the generality of our findings.

MATERIALS AND METHODS

Wolf-hound interactions (WHI)

During our study period, hounds were legally used to hunt many mammals, including smaller carnivores and black bears. Bear hunting in Wisconsin occurred from September and October, and hound training was legal in July and August [17; 28]. Hound hunters accounted for approximately 40% of the annual take by bear hunters [13; 28]. Typically hounds were loosed from vehicles and allowed to run far from owners, without control [12]. Hounds were often fitted with global positioning systems (GPS) or VHF radio-collars, allowing the owner to follow remotely the movements of hounds and determine when and where a bear had been treed. Hunters used groups of up to 6 hounds to track and trail prey during training or hunting [12].

We examined WDNR case files on WHI maintained by the Bureau of Natural Heritage Conservation from 7 August 1999 through 19 January 2012. Case files documented 145 killed and 31 injured hounds identified as confirmed or probable WHI. We believe most WHI incidents were reported because of a compensation program characterized as more generous than other jurisdictions[17; 22]. Bump et al. [15] suggest fewer WHI are reported in Michigan's wolf range because hound owners receive no compensation. Owners with confirmed losses were eligible to receive up to $2,500 per hound based on the estimated value of the hound. Since the compensation program began in 1985, nearly $350,000 dollars were paid to hunters to compensate for hounds injured or killed by wolves. Between 1985 and 2006, payments for hunting hounds comprised 37% of all compensation [14; 16; 17; 22]. WDNR provided compensation for domestic animals injured or killed by wolves, including hounds [14; 16; 17].

United States Department of Agriculture agents assumed responsibility for verifying WHI in 1990, and conducted most of the investigations used in our analysis of WHI [29].

WHI case files included written reports and forms documenting field investigations, including necropsy data, photos, veterinary reports, and anecdotal reports by handlers. During the early years of record-keeping, documentation and reporting of depredations lacked uniformity; thus, some portions of the data were missing, resulting in lower sample sizes for various analyses. We limited our analysis of WHI to hounds used to hunt bears, bobcats, or coyotes. A total of 91% of WHI occurred while pursuing these species, which involves different breeds and use of hounds than for other quarry, such as waterfowl, upland birds, or rabbits. Hounds that hunt large prey such as bears or coyotes are typically breeds of a similar large size and build, frequently Walker, Plott, Redbone, or Coon hounds. Occasionally, WHI files did not specify the type of prey being pursued. In these cases, if the breed of dog was a Walker or Plott hound, we assumed the WHI occurred while pursuing the above three wildlife species. In total, we report on 176 case files. We quantified the frequency of WHI among breeds of hounds. If the hound was reported as a mix of multiple breeds, we used the first breed listed. We pooled breeds in an "other" category when a single breed had too few WHI to meet the assumptions of the *chi*-squared test. No data are available on breed frequencies or preference by hunters in Wisconsin, with which we could estimate relative risk by breed.

Our analysis of the body site bitten was limited because a number of hound carcasses were partially or wholly consumed before retrieval by an owner arriving late at the scene. We pooled head, neck, and throat into one category and all other sites in another category, to test if outcomes of WHI differed by bite site.

We compared hound group size, number of hounds involved in the WHI, and wolf pack size using 1) number of wolves seen and reported by hunters (observed), and 2) WDNR-reported wolf pack sizes from the winter preceding the WHI (censused). Because wolf packs exhibit fission-fusion sociality and packs disaggregate, particularly in the summer when many WHI occurred. Finally, we analyzed the temporal occurrence of WHI as it relates to public hunting seasons, and we compared the frequency of WHI during the hound-training period (July-August) to that during the bear-hunting season (September-October).

We performed statistical analyses [30] using Student's paired *t* tests to compare the differences in average estimated ages of hounds and numbers of wolves during the attack, in relation to the outcome of the WHI (i.e., killed or injured) after evaluating if variances were equivalent (*F* test). All statements of statistical significance are based on $P \leq 0.05$. We used Spearman rank correlations to detect associations between multiple continuous variables.

Survey

As part of a National Sierra Club initiative, the Wildlife Committee (SCWC) subcommittee on Protecting Native Forests and Wildlife, discussed the first-hand reports members had received of citizens and land owners experiencing adverse encounters with hunting hounds and their handlers. The SCWC decided to collect more systematic information from a broader region than the former anecdotes. The SCWC led and posted the survey on the Sierra Club Wisconsin Chapter website through 2015-2021, and administered the survey. The survey appeared at https://www.sierraclub.org/wisconsin/protecting-native-forests-wildlife. We designed the survey of self-selected respondents in 2015 to elicit data concerning such

196 incidents while preserving the anonymity of the respondents. We analyzed anonymized data
197 stripped of identifying information by the SCWC administrators.

198 The 25-question survey (Supplementary Material Appendix 1) is organized in four
199 sections: Observations; Trespass; Property Damage, Personal Injury or Threats; and Interactions
200 with Law Enforcement, totaling 22 yes/no questions and 4 items that allowed unstructured
201 responses by respondents to elaborate on their answers. SCWC members also printed hard
202 copies of the instrument and distributed these at wolf and wildlife related meetings and
203 conferences in Wisconsin in 2015 and 2016. SCWC also invited citizens who described adverse
204 hounding encounters to fill the online report. About 80% of respondents used the online form
205 to report anonymously, and 20% sent their responses directly to SCWC via mail, phone, email,
206 or in person while being assured of anonymity. We collated data stripped of identifying
207 information.

208 LM screened the sample to eliminate responses which identified no adverse incident
209 involving hunting hounds, as these respondents generally used the report format to express an
210 opinion about the practice of hunting with hounds, which we did not analyze because it was
211 outside the purview of this survey ((Supplementary Material Appendix 2). We screened for
212 multiple reports of the same incident with identifying factors such as location and date. After
213 the screening, the sample presented here appears to come from independent incidents
214 although we had no way to verify location or date. Respondents could identify county of
215 residence and interaction, if different. Respondents were asked how many hounds they saw
216 during each interaction they reported. When two respondents mentioned the same interaction
217 but different numbers of hounds, LM averaged and rounded up for the number of hounds.

The University of Wisconsin-Madison Institutional Review Board does not define this type of research as research on human subjects because data were collected by a third party (SCWC web master) and the de-identified data were provided to the authors.

Results

Wolf-hound interactions (WHI)

In 176 case files, we found 140 independent WHI during our study period, where a case reported on the same day and location by different owners were pooled into one WHI. Files reported 145 killed (83%) and 31 injured (17%) hounds. The high percentage of fatalities might reflect those owners sometimes took hours to find a distant hound. Therefore, sub-lethal injuries might not be attributed to a WHI if owners arrived long after it ended or WHI escalated to fatal outcomes when humans did not intercede for long periods. Wolf injuries and deaths in WHI were not documented nor reported in case files.

Neither sex nor age of the hounds was associated with the outcome of WHI (sex X^2 = 1.32, P = 0.25, df = 1, n = 151; age t = -0.71, P = 0.49; variances were equal F = 0.49). The Treeing Walker Coonhound was the most common breed in WHI (33.3%, n = 51), followed by the Plott (27.5%, n = 42). There was a significant association between breed and outcome, categorized as either injury or death (X^2 = 10.7, P = 0.03, df = 4, n = 176). Notably, the Plott fatality frequency of 95.4% was higher than the average 81.2% (Table 1). In total, 89% of WHI occurred while hunters reported pursuing black bears *Ursus americanus* (bobcat *Lynx rufus* 6%, coyote *C. latrans* 4%, raccoon *Procyon lotor* 1%). However, we lack independent data on the animal being pursued by those hounds at the time of WHI and also lack the relative frequencies

statewide of targeting each species with hounds. There was no association between the outcome of WHI and the prey being pursued by hunters (X^2 = 1.9, P = 0.75, df = 4, n = 140). The bear-hound-training period (July–August) accounted for 62% of WHI, whereas the bear-hunting season (September–October) accounted for 28%. Outcomes were not associated with month (X^2 = 8.5, P = 0.38, df = 8, n = 176, Table 1).

An average of 1.3 hounds were injured or killed per WHI (maximum 5 in a single WHI). The average size of the hound group (3.8 *SD* 1.4, n = 57; only 3 or 5% of those WHI reported to involve a single hound in the handler's care) or the number involved in the WHI (2.6 *SD* 1.3, n = 47 with 9 or 19% of those WHI reported to involve only 1 dog) was similar to the number of wolves observed by hunters (2.9 *SD* 1.2, n = 15), the census pack size for the pack blamed by the state or federal agent tasked with verifying the report (2.4 *SD* 1.0, n = 19); or the last two estimates combined (2.6 *SD* 1.1, n = 30; n = 4 included information for both observed and censused). The outcomes were not associated with the number of hounds, number of wolves, or difference between the two in a given WHI by any of the measures of group size or pack size above (Welch test assumes unequal variance, $F < 0.72$, $P > 0.41$ in every test). Wolves injure for killed hounds in groups with superior numbers in 44% of WHI with such data (n = 16).

Our analysis on hound body site bitten was limited to 109 WHI. We cannot be certain that wolves inflicted every bite. Of the 109 carcasses with bite information, 50 provided one bite location (46%), 37 provided two locations (34%), and 22 provided 3 or more locations (20%). Taking all bite locations (n = 193), the single most frequent bite site was the neck (33%), followed by back (17%), upper thigh (12%), and chest (10%). We considered bites to the head, shoulders, neck (as opposed to throat), back, and upper thighs as indicative the hound had

been lower than its attacker. Those upper body parts were represented in 72% of the 193 bites whereas under-parts (throat, groin, sternum, ribs, lower legs, abdomen) were represented in 28% of bite locations. We found no relationship between body site bitten and outcome, when we separated neck and head bites from others (X^2 = 1.5, P = 0.22, df = 1, n = 66). Of 80 deaths with data on consumption of a carcass, 49% of hound carcasses were partially consumed. Of those 80 hounds consumed by wolves, 71% occurred July–August and 27% in September–October.

Precautions, such as avoidance of rendezvous sites and use of bells on collars were difficult to evaluate, because of a lack of data on these potentially preventive methods employed by handlers. Allegedly, 11% of hounds in WHI wore bells on their collars (n = 20), but the use of bells was not reported in the majority (69%) of the cases.

Survey

105 respondents reported adverse incidents with hunting hounds from 51 Wisconsin counties, 4 Michigan counties, 5 counties from other states, and seven who declined to specify location. The 105 respondents reported 119 separate incidents (Table 2). The average number of incidents per county was 2.

Of the 105, 42% reported the hounds observed were not accompanied by a handler and 41% reported finding abandoned or lost hounds on their property. In those cases, some respondents reported contacting local animal shelters, law enforcement or handlers via phone numbers on collars.

Overall, 63% of 105 respondents described incidents of trespass including hounds running on their property without permission, handlers found on property without seeking permission, or running hounds on property after being denied permission.

Beyond trespass, 18% of respondents described illegal or nuisance behavior: damage to property caused by hounds, including downed fencing, damaged landscaping and gardens, injury to self and livestock, dead wildlife left on property, vandalism or litter. Most seriously, 11% reported injury to pets or livestock by hounds, although 24% reported direct knowledge of hounds attacking others 'pets or livestock, and 8% describe direct encounters with hounds resulting in personal injury or being chased. Also 31% reported threatening altercations with hound handlers, including being unwillingly detained by hound handlers 'trucks on public roads, or their own private driveways. Of 105 respondents, 51% of respondents reported they "feel intimidated by hound handlers," and 44% feared retaliation from handlers for reporting confrontations to law enforcement.

Overall, 36% of 105 respondents believe a conflict of interest between law enforcement officers, including game wardens, and the practice of hound hunting existed, either because of relationships between law enforcement officers and handlers, or because the officers were believed to hunt with hounds themselves. Respondents describe being given false information by law enforcement officers, including local sheriffs and game wardens, and also reported filing official complaints upon which no discernible action was taken.

Comparing numbers of hounds from WHI and survey data

303 Survey respondents reported 2–8 hounds per interaction (average 3.7, mode 2). That
304 average is identical to the average number of hounds that handlers reported in their pack in
305 WHI above. This seems to be corroborating evidence of accuracy in both datasets, as neither
306 set of complainants was aware of the other. Given the rarity of single hounds (5%) in WHI, the
307 bystander reports of >1 hound seem unsurprising. Similarly, bystanders reported >6 hounds in
308 3 events (8% of reports that include these data) but handlers never reported >6 in their pack
309 after a WHI. The legal limit per handler was 6 hounds but multiple handlers may release more
310 than 6 hounds.

311 **DISCUSSION**

312 We analyzed two datasets collected on the practice of hunting mammals with hounds.
313 The records came from self-selected complainants, from handlers reporting wolf-hound
314 interactions (WHI) that resulted in injury or death of hounds, and reports from bystanders who
315 experienced adverse encounters with handlers or hounds. We report fighting between small
316 parties of hounds and small parties of wolves. We report illegal activities alleged by bystanders
317 exposed to free-running hounds or their handlers. We report allegations of negligence or
318 complicity by law enforcement officials responding to allegations about handlers or hounds.
319 Hounding is a poorly studied practice. (See Introduction), which deserves more attention in
320 light of these reports.

321 Regarding hounds, over 83% of Interactions between wolves and hounds (WHI) were
322 fatal for hounds, similar to 71% and 82% reported in Nordic countries [9; 31]. No data were
323 collected on harm to Wisconsin wolves from WHI. A majority of WHI affected hounds pursuing
324 black bears compared to other prey. However, no information was available to evaluate if

hounds were distracted from bear stimuli by other wildlife, such as wolves. Outcomes of WHI (injury or death of hounds) were not associated with the number of wolves observed or censused near the site, or the numerical differences between wolves and hounds, hound age or sex, the species of prey targeted by hunters, or the month in which WHI occurred.

Small body size, vocalizations, and numerical superiority have all been implicated in the risks and fatalities associated with WHI [9; 10; 11; 32]. Plott hounds, the smallest hound breed commonly used in Wisconsin, experienced a higher proportion of fatal outcomes than other breeds (Table 1). In addition to the small size of Plott hounds, this breed is also known for its baying vocalizations, which might alert wolves from a long distance. Similar risks of dog vocalizations were reported in Nordic countries [9; 11]. Small size may make a hound more vulnerable to head and neck bites. Bites to the neck were associated with higher fatality rates in a Scandinavian study [9]. Bites to hound carcasses were predominantly to the upper body in this study (72%) and of those the neck predominated. Numerical superiority has also played a role in the outcomes of aggression between canids. For example, aggression between wolves and coyotes in Yellowstone National Park had fatal consequences when wolves outnumbered the smaller coyotes, but not when coyotes outnumbered wolves, suggesting that group size exerted less influence than individual body size differences in determining outcomes between canids [33; 34]. However, we did not find clear effects of numerical superiority in WHI. Perhaps the large group sizes of hounds in Wisconsin and uncertainty about the number of wolves involved both obscured associations between numerical superiority and outcomes of WHI.

We found equivocal support for the predation hypothesis (WHI occur when wolves attack hounds for food) or the territoriality hypothesis (WHI occur when wolves defend territory or pups) [12; 14]. The timing of WHI presents equivocal evidence for both hypotheses. Higher frequencies of WHI occurred during the hound training period in July and August than during the autumn black bear hunt in September and October. Elevated risk in July and August might have been associated with the practice of baiting, as wolves visit bear bait sites in search of food [15]. In Wisconsin, bear bait sites could be legally established as early as April, and could last the entire wolf pup-rearing season. Bump et al. [15] documented that the risk of WHI was three to seven times greater in Wisconsin than in adjacent Michigan, citing the extended bear-baiting period as a probable cause for the much higher risk of WHI in Wisconsin. That might support the predation hypothesis. However, bear baiting was confounded with wolf pup defense. The hound training period coincided during the study with wolf use of rendezvous sites or den sites. During this time, most wolf pack members return periodically to rendezvous or den sites to assist with pup-rearing, and consequently have higher food demands, perhaps requiring wolves to forage more frequently [35]. From birth until the end of August, wolf pups experience the highest growth rates, with September representing a critical month for weight gain [36]. In some cases, wolf pups have been observed gaining as much as 3.6 pounds per week [37]. Pup growth, critical to survival, is limited by food quality and availability. By late August, growth begins to taper [38], as does rendezvous site use [35; 36; 37]. The consumption of hound carcasses might corroborate the predation hypothesis, but that is not persuasive because consumption was recorded in only approximately half of the WHI and we do not know if the wolves that attacked were the consumers. Nor can we rule out that consumption

368 followed after the primary motivation for aggression. The hound carcasses and bite locations
369 provided limited insight. Bites to head, neck, and throat represented 41% of bite locations on
370 hound carcasses. The predation hypothesis might find support from this result because cranio-
371 cervical killing bites are associated with predation by many mammals [39; 40]. Furthermore, a
372 greater number of hounds might have been afield in July and August than other months. In
373 sum, we find equivocal support for both hypotheses. This could imply both are correct or we
374 are missing information, such as whether the hounds initiated the attack not the wolves or the
375 body conditions of all involved.

376 The state wildlife agency implemented several methods for mitigating or preventing
377 WHI, including compensation for handlers' self-reported losses, encouraging the use of bells or
378 beepers on collars to deter wolves, and statewide communication to hunters on recent hound
379 injuries and their locations, and designation of Wolf Caution Areas (WCA). We discuss each of
380 these policy interventions in turn.

381 Compensation programs did not clearly reduce WHI rates. Much scholarly discussion has
382 focused on the moral hazard (In short, negligent owners have no incentive to protect their
383 animals if they will be paid for losses.) that can be triggered by compensation after the fact.
384 Prior research on Wisconsin's compensation program addressed moral hazards [17; 22]. The
385 state only changed the source of the funds, not the conditions for payment since that work was
386 published. Therefore, cooperation of the state legislature may be essential to changing an
387 incentive for WHI to occur into a disincentive for hounds and non-target animals to be put at
388 risk. We recommend no compensation be paid without evidence that handlers were taking
389 preventive actions.

Handlers may be able to prevent WHI by using protective vests or stronger collars [9; 41], keeping hounds leashed until the targeted game species is located, or bringing first aid kits on the hunt, although the possible effect of these interventions has not been studied in Wisconsin. Regarding devices, 38 percent of hounds in WHI case files allegedly wore bells on their collars (n = 53), but we have no data on the use of bells among hounds that did not enter the WHI database. Outcomes were not associated with hunter self-reports of affixing bells to collars. Nevertheless, we recommend the state obligate veterinary clinics that treat hounds for wildlife injuries report each such incident so the welfare of hounds and preventive actions taken by handlers can be evaluated by professional veterinary ethical boards and hunting ethics boards wherever such exist.

Another step handlers might take to protect hounds and wolves would be to release hounds in low-risk areas. The state communicated the location of higher-risk WCAs online, posted in the field, and in other ways to handlers [12; 13]. Within WCAs, the WDNR recommended that bear hunters release hounds >2 miles from known rendezvous sites. WHI case files and prior work documented handlers' willingness to risk dogs in posted WCAs, even within the same season and even within hours of previous WHI or WCA posting [12; 13]. Compensation records also document multiple payments to the same owner or handler within a single season [17]. These data suggest not all hunters heeded the state's warnings. Some have speculated that some unscrupulous handlers purposefully ran hounds in WCAs as a way to reap compensation payments for old, injured, or unskilled hounds or as a way to find and kill wolves illegally. Cooperation by hound owners seem essential to these interventions. However, our

survey data suggest a number of handlers would resist such cooperation even to the point of breaking the law.

Prior research studies report that hound handlers as a group contain a substantial contingent willing to break the law and flout regulations intended to protect animals and more so than other groups active in wolf range. This hypothesis is supported by independent lines of data on intentions to poach [20; 23; 42]. Actual poaching evidence is consistent. That component of wolf-poaching that involves concealment or destruction of evidence, which reflects intent to break the law, has repeatedly risen in incidence along with policies that permit some legal wolf-killing in several US wolf populations. These findings indicate that would-be poachers profit from governmental laxity to act unlawfully or that would-be poachers use the cover of legal hunting to act unlawfully [43; 44; 45; 46]. Most recently, researchers found that cryptic poaching rose during hound training, bear-hunting seasons, and deer-hunting seasons [25]. The 2021 Wisconsin wolf-hunt that allowed hunters to use hounds to pursue wolves in deep snow saw the most rapid season closure and over-kill in Wisconsin wolf management history with 218 wolves killed in an ostensibly legal fashion in less than 72 hours with >80% being killed by hunters using hounds. Unpublished necropsy data collected by the Great Lakes Indian Fish & Wildlife Commission indicate hounds delivered potentially lethal bites during those hunting incidents, which represent unlawful take by hunters [47]. To our knowledge, no hunter has yet been prosecuted for such incidents.

The survey data we present come from an instrument designed to elicit specific reports of the types of adverse incidents that were being anecdotally reported to the Sierra Club Wildlife Committee (SCWC). Although an online, self-selected sample cannot be used to

extrapolate rates, frequencies, or representativeness in space, time, or demography, still the reports suffice to identify a problem that is seemingly not being addressed by wildlife law enforcement or regular police. The alleged criminal infarction include trespass, vandalism, accidental destruction of property including with vehicles that left the scene, harassment, intimidation, and alleged corrupting influences on government law enforcement and wildlife agents. These allegations demand investigation, at least for the more serious infractions, we recommend compensation payments end forever and hunting licenses of any kind be revoked for handlers convicted of crimes during hunting with hounds.

In wildlife law, the US Endangered Species Act (ESA) and federal court cases surrounding it make clear that some hound handlers are vulnerable to prosecution. First, any "take" (including harassment, pursuit, injury, killing, etc.) is prohibited under the ESA regardless of whether the perpetrator knew the wild animal harmed was listed [48]. From the standpoint of wolves and other threatened or endangered species (listed species hereafter; note that wolves were not legal game during our study), systematic data on hound injury to listed species are lacking to evaluate if hound-induced harassment or injury are a predictable risk from hounding. The absence of data revealed by this study indicates that hounding is not adequately regulated. Because wolves were often a federal- or state-listed species during our study and yet WHI occurred with likely injury to wolves, the practice of hounding in wolf pack territories should be prohibited when wolves are a listed species. Prohibitions on non-selective killing methods in the range of endangered species and prohibitions on hunting non-listed species of similar appearance such as coyotes *C.* latrans [49], are overdue in our view. For example, c coyote hunting was closed in northern game management units of Wisconsin for 33 years (1980-2013

456 https://dnr.wi.gov/topic/WildlifeHabitat/documents/reports/graphs/wildhar_sum.pdf) but the
457 practice was discontinued with the administration of Secretary Stepp. Therefore, we call for a
458 moratorium on hounding until the proper research is done by independent scientists to validate
459 the claim that hounding (or any hunting method) is adequately regulated [50] and therefore
460 lawful in the range of any federally listed species.

461 Potential legal jeopardy does not stop at the hound handlers. Given the state wildlife
462 agency and law enforcement refused the SCWC request for information or had no such
463 documents, we recommend state and county authorities revise policies. For one, some of the
464 infractions may still be within the statute of limitations and secondly, failure to investigate can
465 make a department vulnerable to lawsuits and the imposition of oversight by higher authorities
466 (e.g., federal consent decrees). A law enforcement agency that fails to investigate or
467 systematically fails to prosecute complaints of illegal activity opens itself up to a legal challenge.
468 Legal jeopardy arises for the agency because the doctrine of prosecutorial discretion may not
469 protect a law enforcement agency from charges of systematic neglect of unlawful activities [48]
470 and see allegations of such systematic neglect in a case involving wolves [51].

471

472 Online surveys to collect information on illegal activities with specific date, location, and
473 circumstances, might support improved law enforcement and wildlife protections. We believe
474 the ability to preserve anonymity was integral to the effectiveness of the survey as a vehicle to
475 report these adverse incidents, especially in light of the low confidence evinced in law
476 enforcement by respondents. By contrast, our other self-selected data set (handler complaints
477 of hound losses in WHI) were motivated by a compensation program that paid for injured or

dead hounds. That program also seems to need reform given that no information on harm to wolves was collected and it might be impossible to verify that the handlers or hounds were acting lawfully at the time of the WHI. These results highlight a need for improved regulation, greater oversight and more energetic enforcement of activities involving the use of dogs during hunting on private and public lands.

A common bias in discussions of hunting, wildlife management, and the power politics between consumptive users and non-consumptive users is the notion that hunters have lay knowledge gained through local experience and expertise in their practices. This often plays out among academics and manager-authors as favoring the views and preferences of local communities and of hunters over others, especially outside experts [52; 53; 54]. But that assumption is flawed in two ways by its notion of expertise. First, sometimes two local, lay types of expertise are pitted against each other as in an unknown proportion of our data when hound handlers and the bystanders complaining about them were equally local and held equivalent, lay expertise. The second flaw is when the lay bystanders complained to law enforcement experts about hounds or handlers, then the power asymmetry is reversed from the usual academic debate. In short, the local, lay expert comp[lainant deserves the attention and compassion typically reserved for local hunters. Therefore, we call for more just and fair consideration of the under-represented and marginalized in wildlife management.

The number of adverse events -- hounds injured or killed, the number of bystanders who alleged harm or illegal activities by hounds or handlers, and the general gap in information about harms to non-target species, especially listed ones -- all point in the same direction. This

practice inflicts ills that society has long ago deemed unlawful, cruel, and harmful to many fundamental public interests.

Finally, we address the organizing theory of interest to the editors of this special research topic on the evolution and domestication of dogs. Although present-day practices may bear no relationship to the origins of dog domestication in early human societies, we feel two aspects of our research are relevant. First, our research exposes the ecological costs of hounds to other animals including humans in terms that may have ancient roots. Those costs may have ancient roots to the extent that harassment, injury or death of humans and other animals, wild or domestic, caused by free-running dogs may be as ancient as any interactions between humans and dogs. Second, individual humans who are nominally of the same society yet probably belong to different interest groups within that society – namely hound-hunters and the complainants we highlighted – may experience very different costs and benefits of the use of dogs for hunting or companionship. Previously, AT discussed this clash of benefits and costs in the context of aggressive dogs, preventing wolf-dog hybridization, and control of dog fertility [55]. Given the current empirical evidence, we suggest a refinement of any hypothesis for the origins of domestic dogs. We assume no society has ever had a homogeneous view of dogs or the benefit minus cost balance of dogs. This is perhaps a truism so we go beyond it to argue that the influential elite will have a disproportionate say in the role of dogs in any society. If the elite or dominant class of humans in society experiences net positive effects of dogs, then the roles of those dogs are expected to proliferate and new functions for them will be found by the beneficiaries. If on the other hand, the elite experience net costs then we predict dog domestication and use would be stifled and find only marginal, limited expression within that

521 society. Therefore, we doubt the search for a unitary explanation for the origin of domesticated
522 dogs will bear fruit until the first site of proto-dog evolution can be confirmed (as attempted for
523 example by [56; 57; 58]. Then, the evolution and human perceptions of the roles of dogs in that
524 society might be determined from other archaeological evidence if we are lucky. Those
525 preconditions seem unlikely at present. Therefore, we suggest the search for functional
526 evolutionary explanations for the domestication of dogs instead search for multiple loci and foci
527 of human-dog interaction, Once the loci are identified perhaps zoo archaeologists and
528 anthropologists can collaborate to understand the local ecological benefits minus costs
529 associated with dogs at that site and among those people and their other wild and domestic
530 animals.

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678

679 **Table 1.** The number of hounds reported in wolf-hound interactions by breed and month*

Breed	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bluetick	0	1	0	0	0	0	3	6	8	0	0	1
Plott	0	0	0	0	0	0	11	20	9	3	0	0
Redbone	0	1	0	0	0	0	4	4	1	0	0	1
Walker	0	0	0	1	0	0	16	19	16	3	1	5
Other**	1	2	0	0	0	0	12	15	8	0	0	4
Totals	**1**	**4**	**0**	**1**	**0**	**0**	**46**	**64**	**42**	**6**	**1**	**11**

680

681 Table 2. Bystander reports (n=105) of 119 adverse interactions with hounds or their handlers
682 across counties of Wisconsin, USA. Because a respondent might report more than one
683 interaction, we present the counties from most reports 6) to fewest (1), the names of the 51
684 counties mentioned in reports, the sum of interactions per row, and the maximum number of
685 hounds reported in a single interaction. When multiple reports were filed about the same
686 interaction and the number of hounds differed, we counted only one interaction and
687 averaged the number of hounds, rounding to the higher integer.

Reports per county	**Sum of the interactions**	**Maximum number of hounds in a single interaction**	**Counties with interactions reported**
6	15	8	Bayfield, Iron, Sawyer

5	5	5	Forest
4	4	6	Langlade
3	13	6	Chippewa, Dane, Marathon, Polk, Washburn
2	18	6	Dodge, Douglas, Dunn, Florence, Lincoln, Oconto, Price, Shawano
1	62	8	Ashland, Barron, Brown, Burnett, Calumet, Cheboygan MI, Columbia, Cuyahoga OH, Door, Eau Claire, Fond du Lac, Gogebic, MI, Green, Houghton, MI, Jackson, Kenosha, Kewaunee, Macon, GA, Manitowoc, Marin, CA, Marinette, Milwaukee, Nash, NC, Oneida, Ontonagon, MI, Outagamie, Ozaukee, Rock, Rusk, St. Croix, Sheboygan, Taylor, Trempealeau, Vernon, Vilas, Walworth, Washington, Waukesha, Winnebago, Wood

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