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A Preliminary Evaluation on the Use of Dogs to Recover Bat Fatalities at Wind Energy Facilities

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Abstract

I assessed the ability of dog–handler teams to recover dead bats (Chiroptera) during fatality searches typically performed at wind energy facilities to determine fatality rates for birds and bats. I conducted this study at the Mountaineer and Meyersdale Wind Energy Centers in West Virginia and Pennsylvania, USA, respectively. Dogs found 71% of bats used during searcher-efficiency trials at Mountaineer and 81% of those at Meyersdale, compared to 42% and 14% for human searchers, respectively. Dogs and humans both found a high proportion of trial bats within 10 m of the turbine, usually on open ground (88% and 75%, respectively). During a 6-day fatality search trial at 5 turbines at Meyersdale, the dog–handler teams found 45 bat carcasses, of which only 42% (n = 19) were found during the same period by humans. In both trials humans found fewer carcasses as vegetation height and density increased, while dog–handler teams search efficiency remained high. Recommendations for evaluating the biases and efficiency when using dogs for bat fatality searches are provided. (WILDLIFE SOCIETY BULLETIN 34(5):1440–1445; 2006)

Key words

bats, Chiroptera, fatality searches, Pennsylvania, West Virginia, wind turbines.

Postconstruction carcass searches have been used to estimate fatality rates of birds and bats (Chiroptera) at wind energy facilities (e.g., Erickson et al. 2002, Johnson et al. 2003, 2005, Fiedler 2004). Estimates of fatality are biased by variation in detection by searchers and the removal of carcasses by scavengers, both which may vary considerably within and among different vegetation cover conditions (Wobeser and Wobeser 1992, Philibert et al. 1993, Anderson et al. 1999, Morrison 2002). Originally designed to monitor annual or seasonal avian fatality rates (and primarily for large raptors), postconstruction fatality–monitoring protocols typically have used infrequent search intervals (e.g., 7- to 28-day intervals) and searcher efficiency and carcass removal by scavengers have not been adequately quantified to provide accurate and precise estimates of fatality rates of bats (Erickson et al. 2002, Kerns et al. 2005, W. P. Erickson and G. D. Johnson, Western Ecosystems Technology, unpublished data).

Wildlife biologists increasingly have used dogs in their investigations (Gutzwiller 1990, Shivik 2002). The olfactory capabilities of dogs could greatly improve the efficiency of carcass searches, particularly in dense vegetation (Homan et al. 2001). Dogs generally have been used in research on waterfowl and upland game birds (Zwickel 1980, Gutzwiller 1990), but more recently to recover passerine fatalities during carcass searches (Homan et al. 2001). However, use of dogs presents unique challenges that warrant further consideration. Gutzwiller (1990) noted that the use of dogs can alter established protocols and introduce unknown biases relative to traditional human searches. Additionally, Gutzwiller (1990) pointed out that inconsistent performance by individuals or among different dogs may be attributable to different habitats, weather, and changing physical or physiological conditions for the dog, or any combination of these factors. While biases cannot be totally avoided during field research, careful study design and analyses are important for limiting bias (Gutzwiller 1990).

To my knowledge, dogs have not been trained to find bat carcasses during searches to evaluate fatalities at wind facilities. Herein, I present results of a baseline effort to assess the efficiency of dog–handler teams to recover bat fatalities. My objective was to train dogs to find bat carcasses and conduct pilot studies to determine the search efficiency of dog–handler teams under different vegetation conditions. Based on these trials, I provide recommendations for future research needed to better elucidate patterns and evaluate the biases and efficiency when using dogs for bat fatality searches.

Study Area

I conducted this study at the Mountaineer Wind Energy Center in Tucker County near Thomas, West Virginia, USA, and at the Meyersdale Wind Energy Center in Somerset County near Meyersdale, Pennsylvania, USA. This study was part of a larger project that evaluated fatality search protocols and interactions of bats with wind turbines (Arnett 2005). The Mountaineer facility consisted of 44 NEG Micon 72C 1.5-MW turbines (NEG Micon Inc., Randers, Jutland, Denmark) arrayed linearly along the crest of the ridge of Backbone Mountain at an average elevation of approximately 1,025 m. The Meyersdale facility was located in the Laurel Highlands in Somerset County, approximately 2 km east of Meyersdale, Pennsylvania. This site consisted of 20 NEG Micon 72C 1.5-MW turbines arrayed in a linear 4-km string along the crest of a ridgeline at 800–885 m. Both facilities lay within the Appalachian mixed-mesophytic forests ecoregion and encompassed the moist broadleaf forests that cover the plateaus and rolling hills west of the Appalachian Mountains (Brown and Brown 1972, Strausbaugh and Core 1978).

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Methods

This study was conducted under the auspices of a permit (F-AL-04-03) issued by the Institutional Animal Care and Use Committee at the University of Maryland Center for Environmental Science.

I used 2 chocolate Labrador retrievers (one 2-yr-old M and one 3-yr-old F) in this study. I trained these dogs using fundamental principles employed to teach basic obedience, "quartering" (i.e., systematically searching back and forth in a defined area; 10-m-wide belt transects for this study), and blind retrieve handling skills (Dobbs et al. 1993). I trained these dogs to locate dead bats for 7 days prior to initiating formal field testing. I seeded a 10-m-wide $\times$ 25-m-long belt transect with bat carcasses representing different species and in various stages of decay. When a test bat was found by a dog, it was rewarded with a food treat if it performed the task of locating a trial bat, sitting or at least stopping movement when given a whistle command to do so, and leaving the carcass undisturbed. My decision to begin formal testing was subjective but triggered by my perception of the dogs' quickening response to the scent of trial bats, their response to my commands, and that they consistently found all trial bats during the last 2 days of training.

Searcher-Efficiency Trials

I tested the search efficiency of the dog–handler team simultaneously with human searchers (hereafter referred to as "humans") during scheduled searcher-efficiency trials conducted at the Mountaineer and Meyersdale Wind Energy Centers from 9 August through 6 September 2004 (Kerns et al. 2005). Rectangular plots (130 m east–west $\times$ 120 m north–south) were centered on each turbine and transects were established 10 m apart in the north–south direction within plots. Carcass searches were performed each day by humans from 31 July through 11 September 2004 at Mountaineer and from 2 August through 13 September 2004 at Meyersdale according to methods described by Kerns et al. (2005). At both sites, the number of transect lines and length of each line was recorded for each plot, and habitat along each transect line was mapped and assigned a visibility class as high, medium, or low (Kerns et al. 2005).

Searcher-efficiency trials were performed to adjust the estimate of total fatalities for detection bias according to methods described by Kerns et al. (2005). The biologist in charge of coordinating searcher-efficiency trials (hereafter referred to as "crew leader") randomly chose the days and turbines for testing and used a sample of carcasses among different species of bats and in various stages of decay to test searcher efficiency. Searcher-efficiency trials were conducted throughout the study period in various weather conditions, and trial carcasses were distributed among the 3 different visibility categories used in this study (see Kerns et al. 2005 for descriptions).

I completed dog–handler-team searcher-efficiency trials on 3 different days at 4–6 turbines each day ($n = 45$ bats) at Mountaineer, and 5 different days of trials at 4–6 turbines each day ($n = 52$ bats) at Meyersdale. On the day of a searcher-efficiency trial at either Mountaineer or Meyersdale, I coordinated with the crew leader regarding which turbines had been randomly selected for trials, but the crew leader was not told how many bats were randomly placed at each. Dog–handler searches were conducted approximately equally before and after humans had searched the plot, and all bat carcasses that were first found by either humans or the dog–handler team were left in place until after the trial was completed.

For each trial I searched the first plot with the male retriever and then alternated plots with the female. By alternating dogs within and among trials, I was able to 1) balance the use of the 2 dogs in time and space to reduce "observer" bias, 2) evaluate differences in search efficiency between dogs, and 3) provide adequate rest for each dog between searches to reduce fatigue, which could alter individual performance and induce bias (Gutzwiller 1990). At each plot, I walked transect lines at a rate similar to that of humans (approx. 13–25 m/min; Kerns et al. 2005), while the dog was allowed to quarter the entire width of the transect (5 m on each side of the center line) scenting and looking for bats. The dog–handler team attempted to search for the same amount of time as humans at each plot, which varied from 30 to 90 minutes depending on searchable area, habitat type, and terrain. Although I searched for bat carcasses like other humans, my primary focus was on the visual cues of each dog indicating that it had found a bat carcass. Once a carcass was found, I marked it with a piece of flagging and the dog–handler team continued searching, recording all data after completing the search of a given plot. I recorded all searcher-efficiency-trial carcasses and their numbers on a data sheet and confirmed the results of the dog–handler team and humans with the crew leader at the end of each day.

I compared the proportions of trial bat carcasses found by the dog–handler team and humans for 1) all bats found, 2) bats found at different distance intervals from turbines, and 3) bats found among different visibility classes. I pooled data for all trial carcasses and made all comparisons between dogs and humans with z-tests (Zar 1984).

Fatality Search Comparison

I also conducted a fatality search trial at the Meyersdale facility from 1 to 6 September 2004 at a random sample of turbines ($n = 5$) that were to be searched daily for bat fatalities by humans during this period. All methods described by Kerns et al. (2005) regarding plot searches, visibility categories, and how bat carcasses were handled and recorded were employed. Bat carcasses that were first found by either humans or the dog–handler team were left in place until both found the same carcass. Humans also were instructed not to touch the bats so as to eliminate potential bias due to human scent imparted on carcasses.

I calculated the total number of new bats found each day by the dog–handler team and humans and tested the hypothesis that the mean difference between the numbers of bats found by the dog–handler team and humans for each of

Table 1. Percentage of searcher-efficiency trial bats found by humans and the dog–handler team ("dogs") for all trial bat carcasses, within distance categories from the turbine, and among visibility classes for 3 trials conducted on 11, 23, and 25 Aug 2005 at the Mountaineer Wind Energy Center, West Virginia, USA.

		Dogs		Humans			
Category	***n***	**No.**	**%**	**No.**	**%**	***z***	***P***
Overall	45	32	71	19	42	2.765	0.006
Distance from turbine (m)							
0–10	8	7	88	6	75	0.641	0.522
11–20	8	4	50	3	38	0.504	0.614
21–30	8	5	63	3	38	1.000	0.317
31–40	10	8	80	2	20	2.683	0.007
>40	11	8	73	5	45	1.300	0.193
Visibility							
High	17	11	65	10	59	0.353	0.724
Medium	10	10	100	5	50	2.582	0.009
Low	18	11	61	4	22	2.366	0.018

Table 2. Percent of searcher-efficiency trial bats found by humans and the dog–handler team ("dogs") for all trial bat carcasses, within distance categories from the turbine, and among visibility classes for 3 trials conducted on 9, 15, and 16 Aug, and 5 and 6 Sep 2005 at the Meyersdale Wind Energy Center, Pennsylvania, USA.

		Dogs		Humans			
Category	***n***	**No.**	**%**	**No.**	**%**	***z***	***P***
Overall	52	42	81	7	14	6.876	<0.001
Distance from turbine (m)							
0–10	12	10	83	4	33	2.484	0.013
11–20	8	7	88	0	0	3.528	<0.001
21–30	8	7	88	1	13	3.000	0.003
31–40	10	8	80	2	20	2.683	0.007
>40	14	10	71	0	0	3.944	<0.001
Visibility							
High	14	12	86	2	14	3.779	<0.001
Medium	19	17	89	2	11	4.867	<0.001
Low	19	13	68	3	16	3.286	0.001

the 6 days was different from zero using a *t*-test (Zar 1984). I also present descriptive statistics for all bats found and for those found on the first day during which they were considered available for each of the 3 different visibility categories.

Results

Results varied between the male and female dogs at Mountaineer (20 of 25 [80%] trial carcasses found by the M compared to 12 of 20 [60%] by the F), but were similar between dogs at Meyersdale (80% and 82% for the M and F, respectively). Dog–handler and human searcher efficiency varied considerably between the 2 study sites. Overall dog–handler efficiency (percentage of trial bats found) for all trials and bats combined, and using combined findings from both dogs, was 71% at Mountaineer and 81% at Meyersdale, compared to 42% and 14% for humans, respectively (Tables 1 and 2).

Dog–handler and human searcher efficiency varied by the distance that trial bats were located from the turbine. At Mountaineer, both the dog–handler team and humans found a high proportion of trial bats within 10 m of the turbine (88% and 75%, respectively). Human search efficiency generally declined beyond 10 m from the turbine and ranged from 20–45% for 10-m distance intervals out to 60 m from the turbine, whereas dog–handler efficiency ranged from 50–80% for the same intervals from turbines at Mountaineer. These differences only were statistically significant 31–40 m from the turbine (Table 1). However, this was likely because 8 of the 13 bats randomly located at these distances were in medium- and low-visibility habitats, where human search efficiency generally was poor. At Meyersdale human searcher efficiency was poor regardless of distance from turbine, but highest (33%) within 10 m of the turbine, compared to 83% for the dog–handler team (Table 2). Efficiency for the dog–handler team was relatively consistent across distance intervals beyond 10 m from the turbine at Meyersdale, ranging from 71–88%, compared to 0–20% for humans (Table 2).

Searcher efficiency varied for the dog–handler team and humans among habitat visibility classes at both sites as well. At Mountaineer, both the dog–handler team and humans found similar proportions of trial bats within high-visibility habitats (65% and 59%, respectively; Table 1). Human search efficiency declined considerably as visibility decreased (50% and 22% for medium- and low-visibility categories, respectively) at this site. The dog–handler team found more trial carcasses in medium- (100%) and low- (61%) visibility habitats at Mountaineer (Table 1). At Meyersdale, human searcher efficiency generally was poor regardless of habitat visibility (only 11–16%; Table 2). The dog–handler team consistently found higher proportions of trial carcasses in high-, medium-, and low-visibility habitats (86%, 89%, and 68%, respectively; Table 2).

During the 6-day fatality search trial at Meyersdale, the dog–handler team found 45 bat carcasses, of which 19 also were found by humans (42%; Table 3). No individual bats that were found by humans were missed by the dog–handler team. The mean difference between numbers of bats found by the dog–handler team compared to that found by humans was 4.33 ($SE = 1.98$, $t = 2.19$, $P = 0.079$; Table 3). Thirty-eight of 45 bats found by the dog–handler team were found the first day they were assumed available to be found. Four of the remaining 7 were found the second day (i.e., missed on the first available day), 2 on the third, and 1 on the fourth day. Of the 38 found by the dog–handler team the first available day, only 11 (29%) of these were found by humans the same day. Similar to searcher-efficiency trials, dogs were considerably more effective at recovering fatalities in low- and moderate-visibility vegetation conditions compared to those with high visibility (Table 4).

Discussion

Documenting patterns of fatality of bats is fundamental to understanding their interactions with turbines, the timing and predictability of fatality, and potential development of solutions, all of which are contingent on reliable methods to quantify estimates of fatality. Recent surveys have reported

Table 3. Total number of bat fatalities found and the difference between those found by humans and the dog–handler team ("dogs") during 6 consecutive days of searches for all 5 turbines combined, Meyersdale Wind Energy Center, Pennsylvania, USA, 1–6 Sep 2004.

Date	Dogs	Humans	Difference
1 Sep 2004	14	3	11
2 Sep 2004	15	5	10
3 Sep 2004	3	1	2
4 Sep 2004	7	6	1
5 Sep 2004	5	3	2
6 Sep 2004	1	1	0

Table 4. Total number of bat fatalities and the number of bats found on the first day available by humans and the dog–handler team ("dogs") during 6 consecutive days of searches at 5 turbines located at the Meyersdale Wind Energy Center, Pennsylvania, USA, 1–6 Sep 2004.

	Dogs		Humans		Human:Dog ratio	
Category	1st day[a]	Total[b]	1st day	Total	1st day	Total
Visibility						
High	10	12	6	9	0.60	0.75
Medium	20	22	4	5	0.20	0.23
Low	8	11	1	2	0.13	0.18
Overall	38	45	11	16	0.29	0.36

[a] Number of bats found where it was estimated that the search was the first where the bat was available to be found.
[b] Total number of bats found.

large numbers of bats being killed at some wind energy facilities, especially in the eastern United States (Fiedler 2004, Arnett 2005, Johnson 2005), and these fatalities raise concerns about potential impacts on bat populations at a time when extensive planning and development of wind energy is underway. With increasing development of wind energy projected for the future (Government Accountability Office 2005), biologists will require a variety of reliable approaches for evaluating the impacts on wildlife. The use of trained dogs to recover dead bats offers researchers an alternative tool for better quantifying bat fatalities under certain conditions and for specific questions of interest.

Both dogs used in this study quickly learned search protocols and were very efficient at recovering bat fatalities at both sites. Differences in search efficiency of dog–handler teams and humans between the 2 study sites were consistent with results for human searcher-efficiency trials conducted throughout the broader study reported by Kerns et al. (2005). I believe this reflects the differences in vegetative cover, terrain, and amount of high-visibility habitat found at the 2 sites. Plots at Mountaineer were highly variable, often mixed with steep, rocky grades, and contained considerably more open, high-visibility habitat (mostly non-vegetated bare ground) interspersed throughout the plot compared to those at Meyersdale. At Meyersdale plots were predominantly flat or gently rolling with very few steep grades and were much easier for dog–handler teams to search. Additionally, all plots at Meyersdale were dominated by moderate to heavy grass cover, with highly visible habitat only occurring on the access road and near the turbine (generally <10 m). Heavy grass cover and gentle terrain may provide more consistent and favorable working and scenting conditions for dogs that resulted in higher and more consistent search efficiency. Steep, rocky slopes at Mountaineer appeared to fatigue dogs more rapidly, especially the female, which likely negatively influenced her performance.

It is possible that human-imparted scent biased the dogs' ability to find bat carcasses during searcher-efficiency trials. Under the assumption that dogs cue on human scent alone or in combination with scent of bat carcasses more so than carcasses alone, their search efficiency would be expected to be biased high. While the crew leader and human searchers used either gloves or inverted plastic bags when handling bat carcasses, some human scent undoubtedly was transferred to trial bat carcasses. However, only wild bats killed by the turbines and never touched by humans prior to searches were found by dogs during the 6-day fatality search comparison at Meyersdale. These findings suggest that human-imparted scent did not bias the results of searcher-efficiency trial comparisons.

While the broad-scale use of dogs to monitor fatalities at wind facilities may be difficult to implement, especially at large facilities where several trained dogs and handlers would be required, there are many circumstances where dog–handler teams would prove useful. Dogs could easily be employed to survey smaller facilities (generally those <20 turbines), particularly when low-visibility habitats prevail. They also could be used to confirm specific questions regarding individual or small numbers of turbines for any facility (e.g., confirm whether bats are killed at nonoperational turbines or meteorological towers). Dogs also may be desired for obtaining more precise and accurate estimates of fatality when testing and comparing different approaches for attempting to reduce fatality of bats at wind turbines.

Although findings from this pilot effort on the use of dogs to recover bat fatalities are promising, more research is warranted to better elucidate patterns and account for limitations and biases that may influence the efficiency of dog–handler teams. The results of this pilot study are not a fair comparison between humans and dogs because humans were restricted to walking and observing from the transect line, whereas dogs were allowed to quarter the entire 10-m-wide search area for each transect. Future work should incorporate experiments that allow for human searchers and dog–handler teams to search transects in the same way. The following suggestions, modified from Gutzwiller (1990), Homan et al. (2001), and Shivik (2002), seem prudent regarding future studies on the use of dogs for carcass searches:

1. If dogs are to be considered sampling tools, future research should focus on factors that will help to further develop standards for the use of dogs in this type of sampling.
2. The influence of weather conditions on dog–handler search efficiency among different habitats should be

further evaluated to assess bias associated with these factors.
3. The effects of search time, species of bat, and density of trial carcasses on dog–handler search efficiency should be further investigated.

Until more information is gathered to further evaluate the use of dogs to recover bat fatalities, the following points (from Gutzwiller 1990) should be considered and explicitly stated to improve accuracy, precision, and interpretation of results when using dogs to recover bat fatalities:
1. Use either the same dog throughout a study or balance the use of different dogs in time and space to reduce "observer" bias.
2. If possible, restrict searches to certain periods of the day to avoid fluctuations in temperature, humidity, and other weather-related factors that could influence scenting conditions.
3. Randomize the spatial and temporal order of search plots to balance the space and time-related effects, as well as weather factors mentioned above.
4. Ensure that dogs are fit and well trained and, if using more than one, that they are as equal as possible relative to fitness and training.

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Edward B. (Ed) Arnett, featured with Brown Dog's Sagebrush Rebellion ("Sage," left) and Brown Dog's Once In A Blue ("Luna," right) is a Conservation Scientist and Co-Director of Programs for Bat Conservation International (BCI). He also is program coordinator for the Bats and Wind Energy Cooperative, a research partnership between BCI, the American Wind Energy Association, the United States Department of Energy's National Renewable Energy Laboratory, and the United States Fish and Wildlife Service. He has been studying the habitat ecology of bats since 1995 and fatality of bats at wind energy facilities since 2004. Ed received an A.A.S. in natural resources management from Colorado Mountain College, a B.S. in fish and wildlife management from Montana State University, an M.S. in zoology and physiology from the University of Wyoming, and is currently completing his Ph.D. in forest ecology from Oregon State University. He is a Past-President of the Oregon Chapter of The Wildlife Society and currently is chairing a technical review committee on the impacts of wind energy development on wildlife and wildlife habitat for The Wildlife Society. This manuscript is dedicated in loving memory of Luna, who simply did not get to spend nearly enough time on this earth with us hunting birds and finding bats. [Photo by Merlin D. Tuttle, Bat Conservation International]