FINAL REPORT

Bird and Bat Species and Risks to Diurnal Migrants on the Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland

Submitted by

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Submitted October 2005; Revised June 2006

FOREWORD

This report represents a 2-year pre-construction survey of the Clipper Windpower Criterion Project on Backbone Mountain near the towns of Loch Lynn Heights and Oakland, Maryland. It is divided into 3 sections with similar **Introduction** and **Study Area** descriptions. The first 2 sections report on birds that migrate and are active during the day, while the last section reports on bats. Nocturnal birds that breed on Backbone Mountain as well as nocturnal migrants were not directly surveyed by our protocols.

The first section, **I. Point Count Surveys**, provides information on bird species and their abundances on the project area during spring and fall migrations and during the breeding season in 2003 and 2004. Data were collected at 42 point counts (PCs) by experienced observers. Points were distributed systematically and linearly along the crest of Backbone Mountain in forest within the project area. If any gaps occurred in coverage, they were likely due to private landowners who were either not involved with the project and/or would not grant us access to their property. Results are presented in several Tables by season and year. Table 5 identifies 3 rare, threatened, or endangered bird species observed or heard on the area and their locations.

The second section, **II. Observational Surveys**, identifies bird species and numbers flying over the project site at 4 observational survey (OS) points. Experienced observers recorded the passage of birds during 0.5-hour intervals at different times of the day throughout the spring, summer, and fall of each year, 2003 and 2004. Individual birds or flocks were categorized by their relative position on Backbone Mountain using different topographic descriptions. Birds were then grouped and passage rates of different groups plotted against zones of risk. Zones of risk represent qualitative probabilities or rankings of strike potential in the vicinity of hypothetical wind turbines on the crest of Backbone Mountain. Results are presented in several Figures identifying the different times of the day (morning, midday, and late afternoon), the 3 seasons, and the 2 years.

The third section, **III. Bat Surveys**, presents the occurrence of different bat species on the project area. We used mist nets at 3 OS points in September 2003, May 2004, and June 2004; and bat detectors at 4 OS points in September 2003 and May 2004. Bat detectors were used at all 42 PCs in June 2004. No state or federally listed bat species were captured or detected on Backbone Mountain. A review of the literature as it pertains to the occurrence on Backbone Mountain of the rare small-footed myotis (*Myotis leibii*) and endangered Indiana bat (*M. sodalis*) can be found in the Discussion.

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30 June 2006

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I. POINT COUNT SURVEYS

J. Edward Gates, Jessica Kerns, and Keith Lott

Abstract. —In order to assess potential impacts from wind power development on Backbone Mountain, Garrett County, Maryland, point count (PCs) surveys were conducted at 42 points along the ridgeline. Bird species identified included both migrants and residents in spring and fall 2003 and 2004 as well as breeding birds in 2003 and 2004. Most breeding bird species were characteristic of high elevation deciduous forests on the Appalachian Plateau. Species of special concern identified as breeding birds included the state-endangered Mourning Warbler and the state-rare Winter Wren and Dark-eyed Junco. The Dark-eyed Junco and Mourning Warbler use brushy habitats as breeding sites on Backbone Mountain, whereas the Winter Wren is a forest-interior dwelling species. Construction of wind turbines and habitat alteration could be either beneficial or detrimental to these species, depending on 1) attraction or avoidance behavior and 2) the effects of habitat losses and gains and edge effects on abundance and nest success. Attempts should be made to minimize losses of existing brushy breeding habitat for both Dark-eyed Junco and Mourning Warbler. Being a forest-interior species, the Winter Wren is likely to lose potential breeding habitat and suffer increased edge effects from the creation of forest openings for wind turbines.

INTRODUCTION

Proposed wind-energy developments on Big Savage/Backbone and Dans mountains, as well as other mountain ridges in western Maryland, have the likelihood of impacting resident and migratory birds and bats in the vicinity of the turbines (Morrison 1998, Anderson et al. 1999, Hoover 2002, Johnson et al. 2002, Morrison 2002, Nicholson 2003, Erickson et al. 2003, Young et al. 2003, Kerns and Kerlinger 2004, Arnett 2005). Mortality from collisions with towers and rotating blades can be a serious threat, particularly for certain species populations. For instance, current estimates place avian collision mortality between 10,000 and 40,000 birds annually at wind facilities in the United States (Erickson et al. 2001). Pre-construction wildlife assessments and post-construction mortality studies demonstrate that wind facilities located in areas of high bird use can expect high fatality rates; however, factors such as topography, prey abundance, and weather likely influence mortality (Erickson et al. 2001). During migration, bats have also exhibited high rates of mortality at certain wind-energy sites on Appalachian ridges, with an estimated 1,364–1,980 bats killed by 44 turbines during a 6-week period in fall 2004 at the Mountaineer Wind Energy Center, West Virginia, on Backbone Mountain (Arnett 2005).

This survey describes the bird species and their abundances on Backbone Mountain, Garrett County, Maryland, within the Clipper Windpower Criterion Project area using standardized protocols (Morrison 1998, Anderson et al. 1999). A major focus was whether there were any rare, threatened, or endangered (RTE) bird species utilizing the project area and their locations. Prior surveys conducted 15–19 July 2002 identified the state-rare Dark-eyed Junco and threatened Blackburnian Warbler as present during the breeding season (Kerlinger 2002). Our objectives were to: 1) provide further information on the bird species using the project area, particularly RTE species; and 2) develop a database that would be useful in comparing pre-construction with post-construction species composition and abundances.

STUDY AREA

This pre-construction survey was done at the Clipper Windpower Criterion Project (Clipper Windpower, Inc., http://www.clipperwind.com/) on Backbone Mountain, Garrett County, Maryland, near the towns of Loch Lynn Heights and Oakland. Up to 67, 1.5-MW turbines were originally planned for 18.5-km of Backbone Mountain ridge top from 10 km north of Highway 560 south towards the Maryland/West Virginia state line with a terminus at Highway 50 (Figure 1). The elevation of the ridge top ranges from 917 to 963 m above sea level and extends about 250 m above the surrounding valley floor. Slopes range from 0–15% on the ridge top to 15–35% on the northwest and southeast aspects (Stone and Matthews 1974). The landscape of the ridge is predominantly deciduous forest and open farm fields punctuated by large rock outcroppings. In addition to a few year-round residences present on the mountain, several permanent hunting cabins are located on secondary dirt roads along the ridge top. Paved roads and secondary dirt roads exist on the ridge, making access to the project area fairly easy.

MATERIALS AND METHODS

Point-count (PC) locations were permanently marked February–March 2003 (Figure 1). Forty-two points were located and mapped in March 2003 with a Global Positioning System (GPS) receiver (Table 1): 14 points (N-01–N-14) extended 2 km north from Eagle Rock (Figure 2), 18 points (M-00–M-17) were located 5.6 km south of Highway 560 (Figure 3), and 10 points (S-01–S-10) were located in the southern portion of the study area, extending 4.5 km north of Highway 50 (Figure 3). Points were placed on the ridge top ≥200 m from each other to increase the probability of independence among points. All points were ≥100 m from a path or secondary road. Of these 42 points, 38 points were located within forest interior (≥100 m from an edge); the remaining 4 points were located in scrub (M-15), a pine plantation (N-05), or forest edge (S-02, S-04).

Birds were surveyed using PCs following the methods of Ralph et al. (1993). We did PCs from 0545–1100 hours in 2003 and from 0555–1055 hours in 2004. Point counts were begun once the point was reached. Experienced observers recorded all birds seen or heard and placed them into distance categories of ≤50 m and >50 m from each point, which allowed us to place birds into 50-m radius and unlimited-radius plots for analysis. Total count duration was 10 minutes, with individuals recorded as being identified during the first (0–5) or second (>5–10) 5-minute interval. Count dates were divided into 3 seasons corresponding approximately to the periods of spring migration, breeding, and fall migration. In 2003, 5 counts of all 42 points were completed during spring migration, 25 March–27 May; 3 counts during the breeding season, 10 June–21 July; and 6 counts during fall migration, 28 July–13 November. In 2004, 3–4 counts of all 42 points were completed during spring migration, 7 April–23 May; 3 counts during the breeding season, 7 June–17 July; and 5 counts during fall migration, 13 August–23 October. Point-count data were analyzed using 10-minute counts and both 50-m and unlimited-radius plots. Flyovers were recorded separately. We selected the maximum number of individuals of each bird species identified on a count at a point for that season as our datum. The mean (± SE) number of individuals of each species was then calculated for each season based on a sample of 42 points.

Weather data, consisting of temperature, wind speed, wind direction, and sky condition, were recorded at each point. Observers tried to avoid counting on days when weather conditions prevented birds from being seen or heard, such as during heavy rain or prolonged drizzle, dense fog, or when wind speeds >20 kph. In 2003, temperatures ranged from –7° C in fall to 25° C during the breeding season; in 2004, temperatures ranged from 3° C in fall to a high of 23° during the breeding season. The westerly winds during counts ranged from 0–16.1 kph in 2003 and 0–12.6 kph in 2004; a wind gust of 40 kph was recorded on 1 spring count in 2003. Sky conditions varied from clear (39.6% of counts) to overcast (20.9%) and partly cloudy (20.1%) in 2003, with a few counts having fog (8.9%), rain (1.8%), or even snow (2.5%). In 2004, sky conditions were clear (33.8%), partly cloudy (22.9%), or overcast (37.5%) during most counts. On several occasions, the weather changed over to fog (5.6%) or rain (4.8%) during counts.

During the breeding season, we used playback tapes of the endangered Mourning Warbler (Maryland Department of Natural Resources 2004) in an attempt to elicit a response in order to supplement our PC data. We especially targeted locations where the species had either been heard or observed during PCs in 2003 or 2004.

RESULTS

2003 field season

In spring, the 10 most abundant bird species in decreasing order on counts included the Black-capped Chickadee, Ovenbird, Blue Jay, American Crow, Black-throated Green Warbler, American Robin, Eastern Towhee, Chestnut-sided Warbler, Rose-breasted Grosbeak, and Dark-eyed Junco (Tables 2 and 3). During the breeding season, the Red-eyed Vireo, Black-throated Green Warbler, Ovenbird, Blue Jay, Rose-breasted Grosbeak, Chestnut-sided Warbler, American Crow, Eastern Towhee, Indigo Bunting, and Black-capped Chickadee were highly abundant; and, in the fall, Black-capped Chickadee, American Crow, Dark-eyed Junco, Cedar Waxwing, Black-throated Green Warbler, Red-eyed Vireo, Blue Jay, White-breasted Nuthatch, and Downy Woodpecker were most abundant.

Red-winged Blackbird, American Goldfinch, Canada Goose, Turkey Vulture, American Robin, Rock Pigeon, Common Grackle, American Crow, Common Raven, and Barn Swallow were frequently observed flying over plots in spring (Table 4). During the breeding season, American Goldfinch, Turkey Vulture, American Crow, Brown-headed Cowbird, Common Raven, Mourning Dove, Chimney Swift, and American Robin were commonly seen flying overhead. Flyovers in fall included the Cedar Waxwing, American Goldfinch, Turkey Vulture, Blue Jay, American Crow, Brown-headed Cowbird, Mourning Dove, Common Grackle, Sharp-shinned Hawk, and Red-tailed Hawk.

2004 field season

Abundant birds in spring included the Black-throated Green Warbler, Red-eyed Vireo, Black-capped Chickadee, Rose-breasted Grosbeak, Ovenbird, Eastern Towhee, American Crow, American Robin, Blue Jay, and Chestnut-sided Warbler (Tables 2 and 3). In the breeding season, the 10 most abundant birds included the Red-eyed Vireo, Black-throated Green Warbler, Ovenbird, Black-capped Chickadee, Eastern Towhee, Chestnut-sided Warbler, Indigo Bunting, Blue Jay, American Crow, and Rose-breasted Grosbeak. In fall, abundant birds consisted of Black-capped Chickadee, American Crow, Red-eyed Vireo, Dark-eyed Junco, Eastern Tufted Titmouse, Cedar Waxwing, White-breasted Nuthatch, Blue Jay, Black-throated Green Warbler, and Downy Woodpecker.

Spring flyovers included the American Goldfinch, Red-winged Blackbird, American Crow, Cedar Waxwing, Canada Goose, Blue Jay, Brown-headed Cowbird, American Robin, Common Grackle, and Common Raven (Table 4). Flyovers during the breeding season were American Crow, Cedar Waxwing, Turkey Vulture, American Goldfinch, Blue Jay, Mourning Dove, Barn Swallow, American Robin, Broad-winged Hawk, and Northern Flicker. In fall, Cedar Waxwing, American Goldfinch, Turkey Vulture, Common Grackle, American Crow, Canada Goose, American Robin, Mourning Dove, Blue Jay, and Brown-headed Cowbird were most plentiful.

Rare, threatened, or endangered bird species

Three species recorded at the Clipper Windpower Criterion Project were listed as RTE species in Garrett County, Maryland (Maryland Department of Natural Resources 2004) (Table 5). They were identified at several locations along Backbone Mountain.

DISCUSSION

Point-count observations of species during spring and fall tended to be variable as they included many migrants that use the area as stopover habitat, e.g., Bay-breasted and Cape May warblers, as well as resident birds that use the area to varying degrees throughout the year. Most breeding birds were typical of species inhabiting forests of Garrett County, Maryland (Robbins and Blom 1996). In fact, most species reported from a 1949 issue of Audubon Field Notes as occurring on the crest of Backbone Mountain northeastward from the Roth Rock Fire Tower were still found on Backbone Mountain in 2003 and 2004 (Robbins 1949). Nearly 2-dozen (21) of the breeding bird species found on Backbone were forest-interior dwelling species that are susceptible to detrimental edge and area effects resulting from forest fragmentation. Populations of these birds likely will decline due to effects associated with clearing trees for road construction and turbines. Other species that use brushy habitats or edges may actually increase. Birds observed flying over the project area likely do not use it to any great extent and included the Canada Goose, Chimney Swift, and Northern Harrier, among others.

We compared safe dates, i.e., dates when a bird species observed in Maryland would be considered as breeding, to the occurrence dates at the Backbone Mountain wind resource area (Maryland Ornithological Society 2002). Three listed species were present on the Criterion Project area in 2003, and 2 listed species were present in 2004 during safe dates for breeding birds, the Mourning Warbler, Winter Wren, and Dark-eyed Junco. Prior surveys by Kerlinger (2002) had previously identified the state-rare Dark-eyed Junco and threatened Blackburnian Warbler as breeding birds. The Blackburnian Warbler was found in a plantation of Norway spruce (*Picea abies*) within Potomac State Forest (Kerlinger 2002). As no wind turbines were to be located on public land owned by the State of Maryland, we did not conduct PCs there.

The Mourning Warbler is considered state endangered (Maryland Department of Natural Resources 2003, 2004). Its first occurrence was recorded at PC S-07 on 27 May 2003. The species was heard again on 25 June 2003; however, no positive visual identification was made at that time. From 27 June–4 July 2003, researchers attempted to get positive visual identification of the bird in question by playing recorded Mourning Warbler calls/songs at the specific location that the bird was heard. No Mourning Warblers were seen or heard during the playback attempts, or during counts in 2004.

The Mourning Warbler is a long-distance migrant that winters primarily outside the United States. It also breeds at high elevations in the mountains of western Maryland, generally above 900 m in elevation and regularly at only a single location near Roth Rock on Backbone Mountain (Robbins 2005). Many areas that appear to be suitable for nesting are unoccupied (Robbins 2005). Its habitat includes scrub and wetlands, especially tangles of laurel (*Kalmia latifolia*) and rhododendron (*Rhododendron maximum*) and blackberry (*Rubus allegheniensis*) thickets. Construction on Backbone Mountain might increase breeding habitat, if additional brushy areas are created in the process. However, care should be taken to avoid disturbing existing breeding habitat for this state-endangered bird species on Backbone Mountain.

One other listed species identified by our survey inhabits brushy habitats on Backbone Mountain, while the third occurs in forest interiors (Maryland Partners in Flight Management Committee 1997). The Dark-eyed Junco is a short-distance migrant that winters primarily within the United States. Breeding populations principally occur at high elevations in western Maryland. Its habitat includes field, scrub, and residential areas. Construction of the Clipper Windpower Criterion Project could provide additional brushy habitat for this species.

The Winter Wren is a forest-interior dwelling species found in the mountain regions of western Maryland that both breeds and winters in Maryland. Lost of forest interior habitat and increased detrimental edge effects, e.g., predation, resulting from construction could result in loss of breeding pairs on Backbone Mountain. Furthermore, the Winter Wren is known to be susceptible to Brown-headed Cowbird parasitism, which tends to be higher near edges (Robbins and Blom 1996).

Post-construction bird surveys, particularly during the breeding season, are recommended to identify those species showing obvious changes in abundance, especially any RTE bird species, which might be attributed to the project. Future studies should further evaluate 1) species-specific attraction or avoidance behavior and 2) nesting success or other measures of habitat suitability within the project area, particularly of RTE bird species.

Acknowledgments. —John Sherwell and Gwenda L. Brewer, Maryland Department of Natural Resources, were instrumental in organizing several early meetings on the bird/bat wind turbine issue. These meetings were helpful in developing the field protocols used in this study. Several personnel at Versar, Inc., also contributed to initial project design, particularly Mark T. Southerland and Fred Kelley. Michael L. Morrison reviewed the final study design and provided valuable comments on field protocols. We further thank the representatives and personnel of Clipper Windpower, Inc., for their help and cooperation, especially Ron Orozco, David E. Scott, and Kevin Rackstraw. John Sherwell provided valuable counsel during all phases of this project. We acknowledge field crewmember, Sara Stahl, for helping to collect the data used in this report. We also thank all the landowners who allowed us access to their properties. John Sherwell, Fred Kelley, Gwenda L. Brewer, Chandler S. Robbins, and D. Daniel Boone commented on an earlier draft of this report. This project was funded by the Maryland Department of Natural Resources, Power Plant Research Program.

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Table 1. UTM coordinates of 42 point-count survey locations at the Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland. Points are ordered from south to north. Coordinates are in UTM NAD_83 ZONE 17N.

Point	X-coordinate	Y-coordinate
S-01	637111.491	4352051.766
S-02	637250.1501	4352193.107
S-03	637439.4646	4352327.098
S-04	637620.0675	4352419.128
S-05	637788.7562	4352562.627
S-06	637904.5392	4352693.829
S-07	638021.3281	4352807.949
S-08	638207.9608	4352929.328
S-09	638378.4176	4353153.038
S-10	638463.4406	4353302.116
M-17	639072.9673	4354062.546
M-16	639216.8247	4354295.704
M-15	639314.966	4354489.049
M-14	639448.0379	4354636.602
M-13	639618.8904	4354858.273
M-12	640391.1679	4355867.118
M-11	640503.1327	4355999.108
M-10	640645.2733	4356130.217
M-09	640795.5173	4356261.362
M-08	640909.672	4356370.357
M-07	641178.7699	4356797.083
M-06	641302.9765	4356949.541
M-05	641291.6467	4357216.936
M-04	641387.8363	4357338.159
M-03	641545.8317	4357513.681

Table 1. Continued.

Point	X-coordinate	Y-coordinate
M-02	641711.0058	4357666.587
M-01	641866.0049	4357771.227
M-00	642015.0845	4357855.857
N-01	647970.0661	4363981.996
N-03	648212.9215	4364232.797
N-02	647954.3543	4364277.98
N-04	648139.7767	4364516.092
N-05	648330.1144	4364568.485
N-06	648480.9015	4364690.715
N-07	648638.4564	4364814.827
N-08	648804.3095	4364932.363
N-09	648939.4908	4364994.367
N-10	649182.2663	4365111.667
N-11	649302.0921	4365273.438
N-12	649464.6779	4365411.855
N-14	649769.6744	4365445.908
N-13	649636.277	4365470.326

Table 2. Bird species identified within unlimited radius point counts (*n* = 42) during a 10-minute time interval at the Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland. The maximum number of birds observed on a single count at a point during a particular season was used as the species value at that point. The numbers of counts completed within each season are shown in parentheses.

Species			Spring				Breeding				Fall			
Scientific name	Common name	Alpha code	2003 (5 counts)		2004 (3–4 counts)		2003 (3 counts)		2004 (3 counts)		2003 (6 counts)		2004 (5 counts)	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Anseriformes														
Anatidae														
Branta canadensis	Canada Goose	CAGO	0.214	0.100	0.119	0.061	0	0	0	0	0.238	0.136	0.048	0.048
Aix sponsa	Wood Duck	WODU	0	0	0.048	0.048	0	0	0	0	0	0	0	0
Galliformes														
Phasianidae														
Phasianus colchicus	Ring-necked Pheasant	RPHE	0.024	0.024	0	0	0	0	0	0	0	0	0	0
Bonasa umbellus	Ruffed Grouse	RUGR	0.071	0.040	0.190	0.061	0	0	0.024	0.024	0.048	0.033	0.048	0.033
Meleagris gallopavo	Wild Turkey	WITU	0.429	0.193	0.167	0.102	0	0	0	0	0.024	0.024	0	0
Ciconiiformes														
Carthartidae														
Cathartes aura	Turkey Vulture	TUVU	0	0	0	0	0	0	0	0	0	0	0.095	0.095

Table 2. Continued.

Species			Spring				Breeding				Fall			
Scientific name	Common name	Alpha code	2003 (5 counts)		2004 (3–4 counts)		2003 (3 counts)		2004 (3 counts)		2003 (6 counts)		2004 (5 counts)	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Falconiformes														
Accipitridae														
Accipiter striatus	Sharp-shinned Hawk[1]	SSHA	0	0	0	0	0	0	0	0	0.024	0.024	0	0
Buteo platypterus	Broad-winged Hawk[1]	BWHA	0	0	0.024	0.024	0	0	0	0	0	0	0	0
Columbiformes														
Columbidae														
Zenaida macroura	Mourning Dove	MODO	0.190	0.061	0.143	0.064	0.238	0.075	0.190	0.070	0.190	0.092	0.214	0.094
Cuculiformes														
Cuculidae														
Coccyzus americanus	Yellow-billed Cuckoo[1]	YBCU	0.071	0.053	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0	0
Apodiformes														
Apodidae														
Chaetura pelagica	Chimney Swift	CHSW	0	0	0	0	0	0	0.024	0.024	0	0	0	0
Trochilidae														
Archilochus colubris	Ruby-throated Hummingbird[1]	RTHU	0	0	0.048	0.033	0	0	0	0	0	0	0	0

Table 2. Continued.

Species			Spring				Breeding				Fall			
Scientific name	Common name	Alpha code	2003 (5 counts)		2004 (3–4 counts)		2003 (3 counts)		2004 (3 counts)		2003 (6 counts)		2004 (5 counts)	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Piciformes														
Picidae														
Melanerpes carolinus	Red-bellied Woodpecker[1]	RBWO	0.071	0.040	0.143	0.055	0.048	0.033	0.024	0.024	0.048	0.033	0.048	0.033
Sphyrapicus varius	Yellow-bellied Sapsucker	YBSA	0.167	0.083	0.095	0.075	0	0	0	0	0	0	0	0
Picoides pubescens	Downy Woodpecker	DOWO	0.429	0.119	0.095	0.046	0.286	0.071	0.238	0.075	0.357	0.082	0.262	0.091
Picoides villosus	Hairy Woodpecker[1]	HAWO	0.071	0.040	0.167	0.058	0.071	0.040	0	0	0.143	0.064	0.048	0.033
Colaptes auratus	Northern Flicker	NOFL	0.548	0.103	0.357	0.075	0.143	0.055	0.262	0.077	0.190	0.070	0.214	0.064
Dryocopus pileatus	Pileated Woodpecker[1]	PIWO	0.429	0.091	0.262	0.069	0.024	0.024	0.024	0.024	0.119	0.051	0.095	0.046
	Unknown Woodpecker	XXWO	0.786	0.100	0.500	0.078	0.381	0.076	0.452	0.091	0.452	0.078	0.286	0.071
Passeriformes														
Tyrannidae														
Contopus virens	Eastern Wood-pewee	EAWP	0.119	0.051	0.214	0.064	0.071	0.040	0.119	0.051	0.095	0.046	0.071	0.040
Empidonax virescens	Acadian Flycatcher[1]	ACFL	0	0	0	0	0	0	0.024	0.024	0.024	0.024	0	0
Empidonax minimus	Least Flycatcher	LEFL	0.024	0.024	0	0	0	0	0	0	0	0	0	0
Empidonax spp.	Unknown Empidonax	XXEM	0.048	0.048	0.024	0.024	0.024	0.024	0	0	0	0	0.048	0.048
Sayornis phoebe	Eastern Phoebe	EAPH	0.024	0.024	0.048	0.033	0	0	0.024	0.024	0.048	0.048	0.024	0.024

Table 2. Continued.

Species			Spring				Breeding				Fall			
Scientific name	Common name	Alpha code	2003 (5 counts)		2004 (3–4 counts)		2003 (3 counts)		2004 (3 counts)		2003 (6 counts)		2004 (5 counts)	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Vireonidae														
Myiarchus crinitus	Great Crested Flycatcher	GCFL	0.048	0.033	0.143	0.055	0.071	0.04	0.071	0.040	0	0	0	0
Vireo flavifrons	Yellow-throated Vireo[1]	YTVI	0.024	0.024	0	0	0	0	0	0	0	0	0	0
Vireo solitarius	Blue-headed Vireo[1]	BHVI	0.262	0.077	0.429	0.109	0.286	0.092	0.143	0.064	0.048	0.033	0	0
Vireo olivaceus	Red-eyed Vireo[1]	REVI	0.881	0.145	1.833	0.170	1.429	0.133	1.690	0.134	0.905	0.159	0.738	0.113
Vireo spp.	Unknown Vireo	XXVI	0	0	0	0	0	0	0.024	0.024	0	0	0.048	0.033
Corvidae														
Cyanocitta cristata	Blue Jay	BLJA	1.381	0.167	0.976	0.182	0.833	0.160	0.690	0.125	0.738	0.103	0.524	0.078
Corvus brachyrhynchos	American Crow	AMCR	1.286	0.124	1.048	0.118	0.762	0.140	0.643	0.131	1.310	0.116	0.929	0.115
Corvus corax	Common Raven	CORA	0.190	0.061	0.095	0.046	0	0	0.095	0.046	0.143	0.064	0.095	0.046
Hirundinidae														
Hirundo rustica	Barn Swallow	BARS	0.024	0.024	0.071	0.071	0	0	0	0	0	0	0	0
Paridae														
Poecile atricapillus	Black-capped Chickadee	BCCH	1.595	0.184	1.643	0.212	0.405	0.108	0.905	0.204	1.357	0.226	1.405	0.171
Baeolophus bicolor	Tufted Titmouse	ETTI	0.667	0.106	0.833	0.148	0.143	0.064	0.357	0.107	0.238	0.089	0.643	0.148

Table 2. Continued.

Species			Spring				Breeding				Fall			
Scientific name	Common name	Alpha code	2003 (5 counts)		2004 (3–4 counts)		2003 (3 counts)		2004 (3 counts)		2003 (6 counts)		2004 (5 counts)	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Sittidae														
Sitta canadensis	Red-breasted Nuthatch	RBNU	0	0	0	0	0	0	0	0	0.024	0.024	0.048	0.033
Sitta carolinensis	White-breasted Nuthatch	WBNU	0.429	0.091	0.357	0.095	0.095	0.057	0.286	0.085	0.500	0.114	0.619	0.108
Certhiidae														
Certhia americana	Brown Creeper[1]	BRCR	0	0	0.024	0.024	0	0	0	0	0.024	0.024	0.048	0.048
Troglodytidae														
Thryothorus ludovicianus	Carolina Wren	CARW	0	0	0.071	0.053	0	0	0.048	0.033	0.048	0.048	0.024	0.024
Troglodytes aedon	House Wren	HOWR	0.024	0.024	0.071	0.040	0.048	0.033	0	0	0	0	0	0
Troglodytes troglodytes	Winter Wren[1]	WIWR	0.214	0.073	0.333	0.094	0.095	0.046	0.238	0.089	0.262	0.077	0.143	0.064
Regulidae														
Regulus satrapa	Golden-crowned Kinglet[1]	GCKI	0.143	0.073	0.190	0.119	0	0	0	0	0.024	0.024	0.095	0.075
Regulus calendula	Ruby-crowned Kinglet	RCKI	0	0	0.024	0.024	0	0	0	0	0	0	0.048	0.048
Regulus spp.	Unknown Kinglet	XXKI	0	0	0	0	0	0	0	0	0	0	0.119	0.070
Sylviidae														
Polioptila caerulea	Blue-gray Gnatcatcher[1]	BGGN	0.024	0.024	0	0	0	0	0	0	0	0	0	0
Turdidae														
Sialia sialis	Eastern Bluebird	EABL	0.048	0.033	0	0	0	0	0	0	0	0	0.024	0.024

Table 2. Continued.

Species			Spring				Breeding				Fall			
Scientific name	Common name	Alpha code	2003 (5 counts)		2004 (3–4 counts)		2003 (3 counts)		2004 (3 counts)		2003 (6 counts)		2004 (5 counts)	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Catharus fuscescens	Veery[1]	VEER	0.071	0.040	0.119	0.051	0.214	0.073	0.095	0.046	0	0	0.143	0.064
Catharus guttatus	Hermit Thrush[1]	HETH	0.143	0.064	0.381	0.102	0.024	0.024	0.167	0.058	0.167	0.067	0.071	0.040
Hylocichla mustelina	Wood Thrush[1]	WOTH	0.667	0.131	0.429	0.114	0.286	0.098	0.167	0.058	0.071	0.053	0.119	0.061
Turdus migratorius	American Robin	AMRO	1.190	0.205	1.048	0.187	0.405	0.118	0.500	0.150	0.095	0.046	0.262	0.118
	Unknown Thrush	XXTH	0.024	0.024	0	0	0.024	0.024	0.024	0.024	0.024	0.024	0.095	0.046
Mimidae														
Dumetella carolinensis	Gray Catbird	GRCA	0.214	0.080	0.214	0.111	0.095	0.057	0.119	0.078	0.071	0.040	0.214	0.134
Toxostoma rufum	Brown Thrasher	BRTH	0.119	0.061	0.024	0.024	0	0	0.024	0.024	0	0	0	0
Sturnidae														
Sturnus vulgaris	European Starling	EUST	0.071	0.071	0	0	0	0	0.071	0.071	0	0	0	0
Bombycillidae														
Bombycilla cedrorum	Cedar Waxwing	CEDW	0.048	0.033	0	0	0.048	0.033	0.119	0.098	1.119	0.609	0.643	0.356
Parulidae														
Vermivora peregrina	Tennessee Warbler	TEWA	0	0	0	0	0	0	0	0	0	0	0.024	0.024
Parula americana	Northern Parula[1]	NOPA	0.024	0.024	0	0	0.024	0.024	0	0	0.024	0.024	0	0
Dendroica pensylvanica	Chestnut-sided Warbler	CSWA	1.143	0.185	0.881	0.164	0.786	0.158	0.786	0.143	0.024	0.024	0.143	0.064

Table 2. Continued.

Species			Spring				Breeding				Fall			
Scientific name	Common name	Alpha code	2003 (5 counts)		2004 (3–4 counts)		2003 (3 counts)		2004 (3 counts)		2003 (6 counts)		2004 (5 counts)	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Dendroica magnolia	Magnolia Warbler[1]	MAWA	0.071	0.040	0.333	0.100	0.024	0.024	0	0	0.048	0.033	0.048	0.033
Dendroica tigrina	Cape May Warbler	CMWA	0	0	0	0	0	0	0	0	0.048	0.033	0.048	0.033
Dendroica caerulescens	Black-throated Blue Warbler[1]	BTBW	0.262	0.077	0.262	0.084	0.167	0.076	0.286	0.078	0.167	0.076	0.048	0.033
Dendroica coronata	Yellow-rumped Warbler	YRWA	0.262	0.103	0.214	0.100	0	0	0	0	0.048	0.048	0	0
Dendroica virens	Black-throated Green Warbler[1]	BTNW	1.262	0.190	2.048	0.187	0.929	0.158	1.405	0.171	0.976	0.179	0.524	0.104
Dendroica fusca	Blackburnian Warbler[1]	BLBW	0.024	0.024	0.048	0.033	0	0	0	0	0	0	0	0
Dendroica dominica	Yellow-throated Warbler[1]	YTWA	0	0	0	0	0.024	0.024	0	0	0	0	0	0
Dendroica pinus	Pine Warbler[1]	PIWA	0	0	0	0	0	0	0	0	0	0	0.024	0.024
Dendroica castanea	Bay-breasted Warbler	BBWA	0	0	0	0	0	0	0	0	0.024	0.024	0.024	0.024
Dendroica striata	Blackpoll Warbler[1]	BLPW	0	0	0.024	0.024	0	0	0	0	0	0	0.024	0.024
Mniotilta varia	Black-and-White Warbler[1]	BAWW	0.571	0.119	0.548	0.109	0.262	0.077	0.214	0.064	0	0	0	0
Setophaga ruticilla	American Redstart[1]	AMRE	0	0	0	0	0	0	0	0	0.024	0.024	0.048	0.048
Helmitheros vermivorum	Worm-eating Warbler[1]	WEWA	0.024	0.024	0	0	0	0	0	0	0	0	0	0
Seiurus aurocapilla	Ovenbird[1]	OVEN	1.595	0.123	1.357	0.144	0.929	0.125	1.119	0.137	0.238	0.082	0.119	0.051
Oporornis philadelphia	Mourning Warbler	MOWA	0.024	0.024	0	0	0.024	0.024	0	0	0	0	0	0
Geothlypis trichas	Common Yellowthroat	COYE	0.429	0.114	0.310	0.087	0.357	0.117	0.262	0.077	0.167	0.067	0.119	0.051

Table 2. Continued.

Species			Spring				Breeding				Fall			
Scientific name	Common name	Alpha code	2003 (5 counts)		2004 (3–4 counts)		2003 (3 counts)		2004 (3 counts)		2003 (6 counts)		2004 (5 counts)	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Wilsonia citrina	Hooded Warbler[1]	HOWA	0.214	0.094	0.619	0.144	0.190	0.078	0.167	0.076	0	0	0	0
Wilsonia canadensis	Canada Warbler[1]	CAWA	0.167	0.058	0.071	0.053	0	0	0.143	0.064	0	0	0	0
Icteria virens	Yellow-breasted Chat	YBCH	0.024	0.024	0	0	0	0	0	0	0	0	0	0
	Unknown Warbler	XXWA	0	0	0.095	0.046	0.048	0.033	0.024	0.024	0.429	0.181	0.524	0.119
Traupidae														
Piranga olivacea	Scarlet Tanager[1]	SCTA	0.452	0.114	0.429	0.091	0.310	0.093	0.595	0.103	0.095	0.046	0.048	0.033
Emberizidae														
Pipilo erythrophthalmus	Eastern Towhee	EATO	1.167	0.144	1.238	0.136	0.548	0.114	0.833	0.148	0.333	0.081	0.262	0.091
Spizella passerina	Chipping Sparrow	CHSP	0.381	0.096	0.738	0.167	0.405	0.113	0.500	0.146	0.071	0.040	0	0
Spizella pusilla	Field Sparrow	FISP	0	0	0.119	0.051	0.024	0.024	0	0	0	0	0.024	0.024
Melospiza melodia	Song Sparrow	SOSP	0.119	0.078	0.167	0.090	0.048	0.048	0.071	0.071	0.071	0.040	0.143	0.087
Zonotrichia albicollis	White-throated Sparrow	WTSP	0	0	0	0	0	0	0	0	0.190	0.129	0.119	0.051
Junco hyemalis	Dark-eyed Junco	DEJU	0.952	0.207	0.286	0.092	0.071	0.053	0.405	0.128	1.119	0.190	0.714	0.153
	Unknown Sparrow	XXSP	0	0	0	0	0.024	0.024	0.048	0.048	0.167	0.076	0.095	0.057

Table 2. Continued.

Species			Spring				Breeding				Fall			
Scientific name	Common name	Alpha code	2003 (5 counts)		2004 (3–4 counts)		2003 (3 counts)		2004 (3 counts)		2003 (6 counts)		2004 (5 counts)	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Cardinalidae														
Cardinalis cardinalis	Northern Cardinal	NOCA	0.119	0.051	0.190	0.085	0.167	0.076	0.095	0.057	0.024	0.024	0.095	0.057
Pheucticus ludovicianus	Red-breasted Grosbeak[1]	RBGR	1.143	0.158	1.381	0.187	0.833	0.136	0.643	0.131	0.190	0.070	0.119	0.070
Passerina cyanea	Indigo Bunting	INBU	0.381	0.096	0.548	0.098	0.476	0.104	0.786	0.116	0.238	0.067	0	0
Icteridae														
Agelaius phoeniceus	Red-winged Blackbird	RWBL	0	0	0	0	0	0	0.119	0.119	0	0	0	0
Sturnella magna	Eastern Meadowlark	EAME	0	0	0	0	0	0	0.024	0.024	0	0	0	0
Quiscalus quiscula	Common Grackle	COGR	0.024	0.024	0	0	0	0	0.095	0.075	0	0	0	0
Molothrus ater	Brown-headed Cowbird	BHCO	0.119	0.078	0.310	0.087	0.048	0.048	0.095	0.057	0	0	0.071	0.040
Icterus spurius	Orchard Oriole	OROR	0.024	0.024	0	0	0	0	0	0	0	0	0	0
Icterus galbula	Baltimore Oriole	BAOR	0.024	0.024	0	0	0	0	0	0	0	0	0	0
Fringillidae														
Carpodacus mexicanus	House Finch	HOFI	0.024	0.024	0.048	0.033	0	0	0.048	0.048	0	0	0	0
Carduelis tristis	American Goldfinch	AMGO	0.667	0.126	0.238	0.095	0.024	0.024	0.024	0.024	0.167	0.090	0.071	0.040

Table 2. Continued.

Species			Spring				Breeding				Fall			
Scientific name	Common name	Alpha code	2003 (5 counts)		2004 (3–4 counts)		2003 (3 counts)		2004 (3 counts)		2003 (6 counts)		2004 (5 counts)	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
	Unknown Passerine	XXPA	0	0	0	0	0.024	0.024	0.024	0.024	0.024	0.024	0.095	0.057
	Unknown Bird	XXXX	0.143	0.055	0.095	0.046	0.167	0.067	0.024	0.024	0.738	0.137	0.333	0.094
Number of species			68		62		47		52		53		53	

[1]Forest-interior dwelling species (FIDS) (Maryland Partners-in-Flight Management Committee 1997).

Table 3. Bird species identified within 50-m radius point counts (n = 42) during a 10-minute time interval at the Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland. The maximum number of birds observed on a single count at a point during a particular season was used as the species value at that point. The numbers of counts completed within each season are shown in parentheses.

Species			Spring				Breeding				Fall			
Scientific name	Common name	Alpha code	2003 (5 counts)		2004 (3–4 counts)		2003 (3 counts)		2004 (3 counts)		2003 (6 counts)		2004 (5 counts)	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Galliformes														
Phasianidae														
Bonasa umbellus	Ruffed Grouse	RUGR	0.071	0.040	0.119	0.051	0	0	0.024	0.024	0.024	0.024	0.048	0.033
Meleagris gallopavo	Wild Turkey	WITU	0.143	0.143	0	0	0	0	0	0	0.024	0.024	0	0
Falconiformes														
Accipitridae														
Accipiter striatus	Sharp-shinned Hawk[1]	SSHA	0	0	0	0	0	0	0	0	0.024	0.024	0	0
Buteo platypterus	Broad-winged Hawk[1]	BWHA	0	0	0.024	0.024	0	0	0	0			0	0
Columbiformes														
Columbidae														
Zenaida macroura	Mourning Dove	MODO	0.024	0.024	0.095	0.057	0.048	0.033	0.095	0.057	0.071	0.053	0.119	0.085

Table 3. Continued.

Species			Spring				Breeding				Fall			
Scientific name	Common name	Alpha code	2003 (5 counts)		2004 (3–4 counts)		2003 (3 counts)		2004 (3 counts)		2003 (6 counts)		2004 (5 counts)	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Cuculiformes														
Cuculidae														
Coccyzus americanus	Yellow-billed Cuckoo[1]	YBCU	0	0	0	0	0.024	0.024	0	0	0	0	0	0
Trochilidae														
Archilochus colubris	Ruby-throated Hummingbird[1]	RTHU	0	0	0.048	0.033	0	0	0	0	0	0	0	0
Piciformes														
Picidae														
Melanerpes carolinus	Red-bellied Woodpecker[1]	RBWO	0	0	0	0	0.024	0.024	0	0	0.024	0.024	0	0
Sphyrapicus varius	Yellow-bellied Sapsucker	YBSA	0.167	0.083	0.024	0.024	0	0	0	0	0	0	0	0
Picoides pubescens	Downy Woodpecker	DOWO	0.310	0.116	0.095	0.046	0.143	0.055	0.214	0.073	0.190	0.061	0.262	0.091
Picoides villosus	Hairy Woodpecker[1]	HAWO	0.024	0.024	0.167	0.058	0.071	0.040	0	0	0.119	0.061	0.048	0.033
Colaptes auratus	Northern Flicker	NOFL	0.238	0.089	0.071	0.040	0.048	0.033	0.048	0.048	0.024	0.024	0.024	0.024
Dryocopus pileatus	Pileated Woodpecker[1]	PIWO	0.071	0.040	0.024	0.024	0	0	0	0	0	0	0	0
	Unknown Woodpecker	XXWO	0	0	0	0	0	0	0.024	0.024	0	0	0	0
Passeriformes														
Tyrannidae														
Contopus virens	Eastern Wood-pewee	EAWP	0.048	0.033	0	0	0	0	0.024	0.024	0	0	0	0

Table 3. Continued.

Species			Spring				Breeding				Fall			
Scientific name	Common name	Alpha code	2003 (5 counts)		2004 (3–4 counts)		2003 (3 counts)		2004 (3 counts)		2003 (6 counts)		2004 (5 counts)	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Empidonax virescens	Acadian Flycatcher[1]	ACFL	0	0	0	0	0	0	0	0	0.024	0.024	0	0
Empidonax spp.	Unknown Empidonax	XXEM	0.048	0.048	0	0	0	0	0	0	0	0	0.048	0.048
Sayornis phoebe	Eastern Phoebe	EAPH	0.024	0.024	0	0	0	0	0	0	0.048	0.048	0	0
Myiarchus crinitus	Great Crested Flycatcher	GCFL	0.048	0.033	0.095	0.046	0.024	0.024	0.024	0.024	0	0	0	0
Vireonidae														
Vireo solitarius	Blue-headed Vireo[1]	BHVI	0.190	0.061	0.095	0.046	0.190	0.070	0.071	0.053	0.048	0.033	0	0
Vireo olivaceus	Red-eyed Vireo[1]	REVI	0.238	0.082	0.619	0.136	0.667	0.100	0.810	0.124	0.452	0.114	0.333	0.111
Corvidae														
Cyanocitta cristata	Blue Jay	BLJA	0.381	0.108	0.262	0.084	0.095	0.057	0.286	0.104	0.167	0.058	0.024	0.024
Corvus brachyrhynchos	American Crow	AMCR	0.071	0.040	0.024	0.024	0.024	0.024	0	0	0.048	0.033	0	0
Hirundinidae														
Hirundo rustica	Barn Swallow	BARS	0.024	0.024	0	0	0	0	0	0	0	0	0	0
Paridae														
Poecile atricapillus	Black-capped Chickadee	BCCH	0.952	0.167	0.810	0.202	0.286	0.098	0.619	0.156	1.048	0.231	0.762	0.186
Baeolophus bicolor	Tufted Titmouse	ETTI	0.214	0.080	0.262	0.103	0.071	0.053	0.095	0.057	0.167	0.067	0.333	0.126

Table 3. Continued.

Species			Spring				Breeding				Fall			
Scientific name	Common name	Alpha code	2003 (5 counts)		2004 (3–4 counts)		2003 (3 counts)		2004 (3 counts)		2003 (6 counts)		2004 (5 counts)	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Sittidae														
Sitta canadensis	Red-breasted Nuthatch	RBNU	0	0	0	0	0	0	0	0	0.024	0.024	0.024	0.024
Sitta carolinensis	White-breasted Nuthatch	WBNU	0.190	0.061	0.119	0.070	0.048	0.048	0.143	0.064	0.143	0.064	0.238	0.101
Certhiidae														
Certhia americana	Brown Creeper[1]	BRCR	0	0	0.024	0.024	0	0	0	0	0.024	0.024	0.048	0.048
Troglodytidae														
Thryothorus ludovicianus	Carolina Wren	CARW	0	0	0.024	0.024	0	0	0.024	0.024	0.048	0.048	0	0
Troglodytes aedon	House Wren	HOWR	0	0	0	0	0.024	0.024	0	0	0	0	0	0
Troglodytes troglodytes	Winter Wren[1]	WIWR	0.095	0.046	0.167	0.067	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0.024
Regulidae														
Regulus satrapa	Golden-crowned Kinglet[1]	GCKI	0.143	0.073	0.071	0.053	0	0	0	0	0.024	0.024	0.071	0.071
Regulus spp.	Unknown Kinglet	XXKI	0	0	0	0	0	0	0	0	0	0	0.071	0.053
Sylviidae														
Polioptila caerulea	Blue-gray Gnatcatcher[1]	BGGN	0.024	0.024	0	0	0	0	0	0	0	0	0	0

Table 3. Continued.

Species			Spring				Breeding				Fall			
Scientific name	Common name	Alpha code	2003 (5 counts)		2004 (3–4 counts)		2003 (3 counts)		2004 (3 counts)		2003 (6 counts)		2004 (5 counts)	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Turdidae														
Catharus fuscescens	Veery[1]	VEER	0.071	0.040	0.024	0.024	0.143	0.055	0	0	0	0	0	0
Catharus guttatus	Hermit Thrush[1]	HETH	0.048	0.033	0.048	0.033	0	0	0	0	0.048	0.033	0	0
Hylocichla mustelina	Wood Thrush[1]	WOTH	0.024	0.024	0.071	0.040	0.024	0.024	0.024	0.024	0.024	0.024	0	0
Turdus migratorius	American Robin	AMRO	0.310	0.093	0.310	0.105	0.095	0.046	0.048	0.033	0.071	0.040	0.071	0.053
	Unknown Thrush	XXTH	0.024	0.024	0	0	0.024	0.024	0.024	0.024	0.024	0.024	0.048	0.033
Mimidae														
Dumetella carolinensis	Gray Catbird	GRCA	0.119	0.061	0.190	0.109	0.071	0.053	0.071	0.071	0.024	0.024	0.190	0.129
Toxostoma rufum	Brown Thrasher	BRTH	0.024	0.024	0	0	0	0	0	0	0	0	0	0
Bombycillidae														
Bombycilla cedrorum	Cedar Waxwing	CEDW	0	0	0	0	0.048	0.033	0.095	0.095	0.310	0.147	0.595	0.354
Parulidae														
Vermivora peregrina	Tennessee Warbler	TEWA	0	0	0	0	0	0	0	0	0	0	0.024	0.024
Parula americana	Northern Parula[1]	NOPA	0.024	0.024	0	0	0	0	0	0	0.024	0.024	0	0
Dendroica pensylvanica	Chestnut-sided Warbler	CSWA	0.476	0.104	0.571	0.141	0.429	0.091	0.452	0.109	0.024	0.024	0.143	0.064

Table 3. Continued.

Species			Spring				Breeding				Fall			
Scientific name	Common name	Alpha code	2003 (5 counts)		2004 (3–4 counts)		2003 (3 counts)		2004 (3 counts)		2003 (6 counts)		2004 (5 counts)	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Dendroica magnolia	Magnolia Warbler[1]	MAWA	0.048	0.033	0.262	0.091	0.024	0.024	0	0	0.048	0.033	0.048	0.033
Dendroica tigrina	Cape May Warbler	CMWA	0	0	0	0	0	0	0	0	0.048	0.033	0.048	0.033
Dendroica caerulescens	Black-throated Blue Warbler[1]	BTBW	0.071	0.040	0.048	0.048	0.048	0.033	0.024	0.024	0.119	0.070	0	0
Dendroica coronata	Yellow-rumped Warbler	YRWA	0.238	0.095	0.214	0.100	0	0	0	0	0.048	0.048	0	0
Dendroica virens	Black-throated Green Warbler[1]	BTNW	0.381	0.102	0.762	0.148	0.476	0.114	0.500	0.124	0.738	0.167	0.190	0.070
Dendroica fusca	Blackburnian Warbler[1]	BLBW	0.024	0.024	0	0	0	0	0	0	0	0	0	0
Dendroica pinus	Pine Warbler[1]	PIWA	0	0	0	0	0	0	0	0	0	0	0.024	0.024
Dendroica castanea	Bay-breasted Warbler	BBWA	0	0	0	0	0	0	0	0	0.024	0.024	0.024	0.024
Mniotilta varia	Black-and-White Warbler[1]	BAWW	0.286	0.078	0.333	0.094	0.167	0.058	0.119	0.051	0	0	0	0
Setophaga ruticilla	American Redstart[1]	AMRE	0	0	0	0	0	0	0	0	0.024	0.024	0.048	0.048
Seiurus aurocapilla	Ovenbird[1]	OVEN	0.524	0.098	0	0	0.238	0.067	0.095	0.057	0.048	0.033	0.024	0.024
Oporornis philadelphia	Mourning Warbler	MOWA	0	0	0	0	0.024	0.024	0	0	0	0	0	0
Geothlypis trichas	Common Yellowthroat	COYE	0.167	0.076	0.048	0.033	0.167	0.067	0.071	0.040	0.071	0.053	0.024	0.024
Wilsonia citrina	Hooded Warbler[1]	HOWA	0.143	0.064	0.381	0.102	0.119	0.051	0.143	0.064	0	0	0	0
Wilsonia canadensis	Canada Warbler[1]	CAWA	0.095	0.046	0.024	0.024	0	0	0.119	0.061	0	0	0	0

Table 3. Continued.

Species			Spring				Breeding				Fall			
Scientific name	Common name	Alpha code	2003 (5 counts)		2004 (3–4 counts)		2003 (3 counts)		2004 (3 counts)		2003 (6 counts)		2004 (5 counts)	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Icteria virens	Yellow-breasted Chat	YBCH	0.024	0.024	0	0	0	0	0	0	0	0	0	0
	Unknown Warbler	XXWA	0	0	0.024	0.024	0.024	0.024	0	0	0.429	0.181	0.452	0.109
Traupidae														
Piranga olivacea	Scarlet Tanager[1]	SCTA	0.167	0.076	0.214	0.073	0.190	0.078	0.167	0.058	0.071	0.040	0.024	0.024
Emberizidae														
Pipilo erythrophthalmus	Eastern Towhee	EATO	0.524	0.109	0.405	0.108	0.310	0.087	0.405	0.108	0.071	0.040	0.024	0.024
Spizella passerina	Chipping Sparrow	CHSP	0.119	0.061	0.214	0.080	0.143	0.064	0.119	0.085	0	0	0	0
Spizella pusilla	Field Sparrow	FISP	0	0	0.024	0.024	0	0	0	0	0	0	0	0
Melospiza melodia	Song Sparrow	SOSP	0.024	0.024	0	0	0.024	0.024	0	0	0	0	0	0
Zonotrichia albicollis	White-throated Sparrow	WTSP	0	0	0	0	0	0	0	0	0.048	0.048	0	0
Junco hyemalis	Dark-eyed Junco	DEJU	0.571	0.145	0.238	0.089	0.071	0.053	0.143	0.073	0.571	0.133	0.333	0.088
	Unknown Sparrow	XXSP	0	0	0	0	0.024	0.024	0	0	0.071	0.053	0	0
Cardinalidae														
Cardinalis cardinalis	Northern Cardinal	NOCA	0	0	0.095	0.067	0.071	0.053	0.071	0.053	0	0	0.048	0.048
Pheucticus ludovicianus	Red-breasted Grosbeak[1]	RBGR	0.405	0.103	0.643	0.148	0.262	0.077	0.214	0.080	0.167	0.067	0.119	0.070
Passerina cyanea	Indigo Bunting	INBU	0.167	0.067	0.095	0.057	0.190	0.070	0.310	0.087	0.024	0.024	0	0

Table 3. Continued.

Species			Spring				Breeding				Fall			
Scientific name	Common name	Alpha code	2003 (5 counts)		2004 (3–4 counts)		2003 (3 counts)		2004 (3 counts)		2003 (6 counts)		2004 (5 counts)	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Icteridae														
Quiscalus quiscula	Common Grackle	COGR	0	0	0	0	0	0	0.071	0.071	0	0	0	0
Molothrus ater	Brown-headed Cowbird	BHCO	0.119	0.078	0.167	0.067	0.048	0.048	0.095	0.057	0	0	0	0
Icterus spurius	Orchard Oriole	OROR	0.024	0.024	0.286	0.071	0	0	0	0	0	0	0	0
Icterus galbula	Baltimore Oriole	BAOR	0.024	0.024	0	0	0	0	0	0	0	0	0	0
Fringillidae														
Carpodacus mexicanus	House Finch	HOFI	0	0	0.024	0.024	0	0	0	0	0	0	0	0
Carduelis tristis	American Goldfinch	AMGO	0.262	0.084	0.071	0.071	0	0	0	0	0.024	0.024	0	0
	Unknown Passerine	XXPA	0	0	0	0	0.024	0.024	0	0	0.024	0.024	0.071	0.053
	Unknown Bird	XXXX	0.048	0.033	0.048	0.033	0.095	0.046	0	0	0.690	0.134	0.048	0.033
Number of species			53		47		39		35		45		32	

[1]Forest-interior dwelling species (FIDS) (Maryland Partners-in-Flight Management Committee 1997).

Table 4. Bird species identified flying over a point count (n = 42) during a 10-minute time interval at the Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland. The maximum number of birds recorded during a single count at a point for a particular season was used as the species value at that point for that season. The numbers of counts completed within each season are shown in parentheses.

Species			Spring				Breeding				Fall			
Scientific name	Common name	Alpha code	2003 (5 counts)		2004 (3–4 counts)		2003 (3 counts)		2004 (3 counts)		2003 (6 counts)		2004 (5 counts)	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Anseriformes														
Anatidae														
Branta canadensis	Canada Goose	CAGO	0.214	0.105	0.238	0.173	0	0	0	0	0	0	0.190	0.190
Ciconiiformes														
Carthartidae														
Cathartes aura	Turkey Vulture	TUVU	0.190	0.078	0.071	0.040	0.095	0.075	0.214	0.064	0.357	0.156	0.357	0.131
Falconiformes														
Accipitridae														
Circus cyaneus	Northern Harrier	NOHA	0.024	0.024	0	0	0	0	0	0	0	0	0	0
Accipiter striatus	Sharp-shinned Hawk[1]	SSHA	0.024	0.024	0	0	0	0	0	0	0.071	0.040	0.024	0.024
Accipiter cooperii	Cooper's Hawk[1]	COHA	0.024	0.024	0	0	0	0	0	0	0	0	0	0
Accipiter spp.	Unknown Accipiter	XXAC	0	0	0	0	0	0	0	0	0.071	0.040	0.048	0.033
Buteo platypterus	Broad-winged Hawk[1]	BWHA	0	0	0	0	0	0	0.024	0.024	0	0	0	0

Table 4. Continued.

Species			Spring				Breeding				Fall			
Scientific name	Common name	Alpha code	2003 (5 counts)		2004 (3–4 counts)		2003 (3 counts)		2004 (3 counts)		2003 (6 counts)		2004 (5 counts)	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Buteo jamaicensis	Red-tailed Hawk	RTHA	0	0	0	0	0	0	0	0	0.048	0.033	0.048	0.033
	Unknown Raptor	XXRA	0	0	0	0	0	0	0	0	0	0	0.024	0.024
Falconidae														
Falco sparverius	American Kestrel	AMKE	0.024	0.024	0	0	0	0	0	0	0	0	0	0
Columbiformes														
Columbidae														
Columba livia	Rock Pigeon	ROPI	0.095	0.095	0	0	0	0	0	0	0	0	0.048	0.048
Zenaida macroura	Mourning Dove	MODO	0	0	0.071	0.053	0.024	0.024	0.048	0.048	0.095	0.067	0.143	0.080
Apodiformes														
Apodidae														
Chaetura pelagica	Chimney Swift	CHSW	0.048	0.033	0	0	0.024	0.024	0	0	0	0	0	0
Piciformes														
Picidae														
Melanerpes carolinus	Red-bellied Woodpecker[1]	RBWO	0.024	0.024	0	0	0	0	0	0	0	0	0	0
Picoides pubescens	Downy Woodpecker	DOWO	0	0	0	0	0	0	0	0	0.024	0.024	0	0

Table 4. Continued.

Species			Spring				Breeding				Fall			
Scientific name	Common name	Alpha code	2003 (5 counts)		2004 (3–4 counts)		2003 (3 counts)		2004 (3 counts)		2003 (6 counts)		2004 (5 counts)	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Colaptes auratus	Northern Flicker	NOFL	0.024	0.024	0.024	0.024	0	0	0.024	0.024	0.024	0.024	0	0
Dryocopus pileatus	Pileated Woodpecker[1]	PIWO	0.024	0.024	0	0	0	0	0	0	0	0	0	0
Passeriformes														
Tyrannidae														
Myiarchus crinitus	Great Crested Flycatcher	GCFL	0	0	0.024	0.024	0	0	0	0	0	0	0	0
Vireonidae														
Vireo olivaceus	Red-eyed Vireo[1]	REVI	0	0	0	0	0	0	0	0	0.024	0.024	0	0
Corvidae														
Cyanocitta cristata	Blue Jay	BLJA	0.048	0.048	0.214	0.100	0	0	0.119	0.051	0.119	0.051	0.143	0.080
Corvus brachyrhynchos	American Crow	AMCR	0.071	0.053	0.333	0.106	0.071	0.053	0.286	0.114	0.119	0.061	0.238	0.127
Corvus corax	Common Raven	CORA	0.071	0.040	0.095	0.057	0.048	0.033	0.024	0.024	0.024	0.024	0.024	0.024
Hirundinidae														
Hirundo rustica	Barn Swallow	BARS	0.071	0.071	0	0	0	0	0.048	0.048	0	0	0	0
Turdidae														
Catharus fuscescens	Veery[1]	VEER	0	0	0	0	0	0	0	0	0.024	0.024	0	0
Turdus migratorius	American Robin	AMRO	0.119	0.061	0.143	0.080	0.024	0.024	0.048	0.048	0.048	0.048	0.167	0.096

Table 4. Continued.

Species			Spring				Breeding				Fall			
Scientific name	Common name	Alpha code	2003 (5 counts)		2004 (3–4 counts)		2003 (3 counts)		2004 (3 counts)		2003 (6 counts)		2004 (5 counts)	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Sturnidae														
Sturnus vulgaris	European Starling	EUST	0.048	0.048	0.024	0.024	0	0	0	0	0	0	0	0
Bombycillidae														
Bombycilla cedrorum	Cedar Waxwing	CEDW	0	0	0.310	0.182	0	0	0.262	0.118	1.476	0.501	1.143	0.444
Parulidae														
Dendroica coronata	Yellow-rumped Warbler	YRWA	0.024	0.024	0	0	0	0	0	0	0	0	0	0
Mniotilta varia	Black-and-White Warbler[1]	BAWW	0.024	0.024	0	0	0	0	0	0	0	0	0	0
Wilsonia canadensis	Canada Warbler[1]	CAWA	0.024	0.024	0	0	0	0	0	0	0	0	0	0
	Unknown Warbler	XXWA	0	0	0	0	0	0	0	0	0.048	0.033	0.190	0.109
Emberizidae														
Pipilo erythrophthalmus	Eastern Towhee	EATO	0	0	0	0	0	0	0.024	0.024	0	0	0	0
Junco hyemalis	Dark-eyed Junco	DEJU	0.071	0.053	0	0	0	0	0	0	0	0	0	0
Cardinalidae														
Pheucticus ludovicianus	Red-breasted Grosbeak[1]	RBGR	0	0	0.048	0.048	0	0	0	0	0	0	0.048	0.048
Icteridae														
Agelaius phoeniceus	Red-winged Blackbird	RWBL	0.524	0.237	0.524	0.224	0	0	0	0	0	0	0	0
Quiscalus quiscula	Common Grackle	COGR	0.095	0.046	0.119	0.078	0	0	0	0	0.095	0.057	0.333	0.169

Table 4. Continued.

Species			Spring				Breeding				Fall			
Scientific name	Common name	Alpha code	2003 (5 counts)		2004 (3–4 counts)		2003 (3 counts)		2004 (3 counts)		2003 (6 counts)		2004 (5 counts)	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Molothrus ater	Brown-headed Cowbird	BHCO	0.048	0.033	0.167	0.090	0.071	0.071	0.024	0.024	0.119	0.085	0.143	0.087
Icterus galbula	Baltimore Oriole	BAOR	0.024	0.024	0	0	0	0	0	0	0	0	0	0
Fringillidae														
Carpodacus mexicanus	House Finch	HOFI	0	0	0.071	0.071	0	0	0	0	0	0	0	0
Carduelis tristis	American Goldfinch	AMGO	0.381	0.123	1.190	0.213	0.238	0.101	0.143	0.073	0.762	0.183	0.476	0.181
	Unknown Passerine	XXPA	0	0	0.381	0.170	0.238	0.107	0.357	0.166	0.524	0.221	1.595	0.671
	Unknown Bird	XXXX	0	0	0.286	0.184	0.214	0.111	0.048	0.048	0.476	0.181	0.405	0.196
Number of species			26		17		8		10		15		15	

[1]Forest-interior dwelling species (FIDS) (Maryland Partners-in-Flight Management Committee 1997).

Table 5. Rare species identified at the Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland; and the points at which the species was recorded during safe dates (non-migration period) for Maryland.

Scientific name	Common name	Ranking[1]	Safe dates[2]	Points	
				2003	2004
Troglodytes troglodytes	Winter Wren	S2 B	20 May–31 Aug	M-11	M-10, M-11, M-12, M-13
Oporornis philadelphia	Mourning Warbler[3]	S1 B	15 Jun–31Jul	S-07	
Junco hyemalis	Dark-eyed Junco	S2 B	1 Jun-31 Jul	M-09, M-13, S-05	M-06, M-07, M-08, M-09

[1] S1 = highly state rare, S2 = state rare, S3 = watch list, B = breeding (Maryland Department of Natural Resources 2004).

[2] Second Maryland/DC breeding bird atlas project handbook (Maryland Ornithological Society 2002).

[3] State endangered (Maryland Department of Natural Resources 2003).

Figure 1. Map of the Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland, showing the 42 point-count locations (red dots).

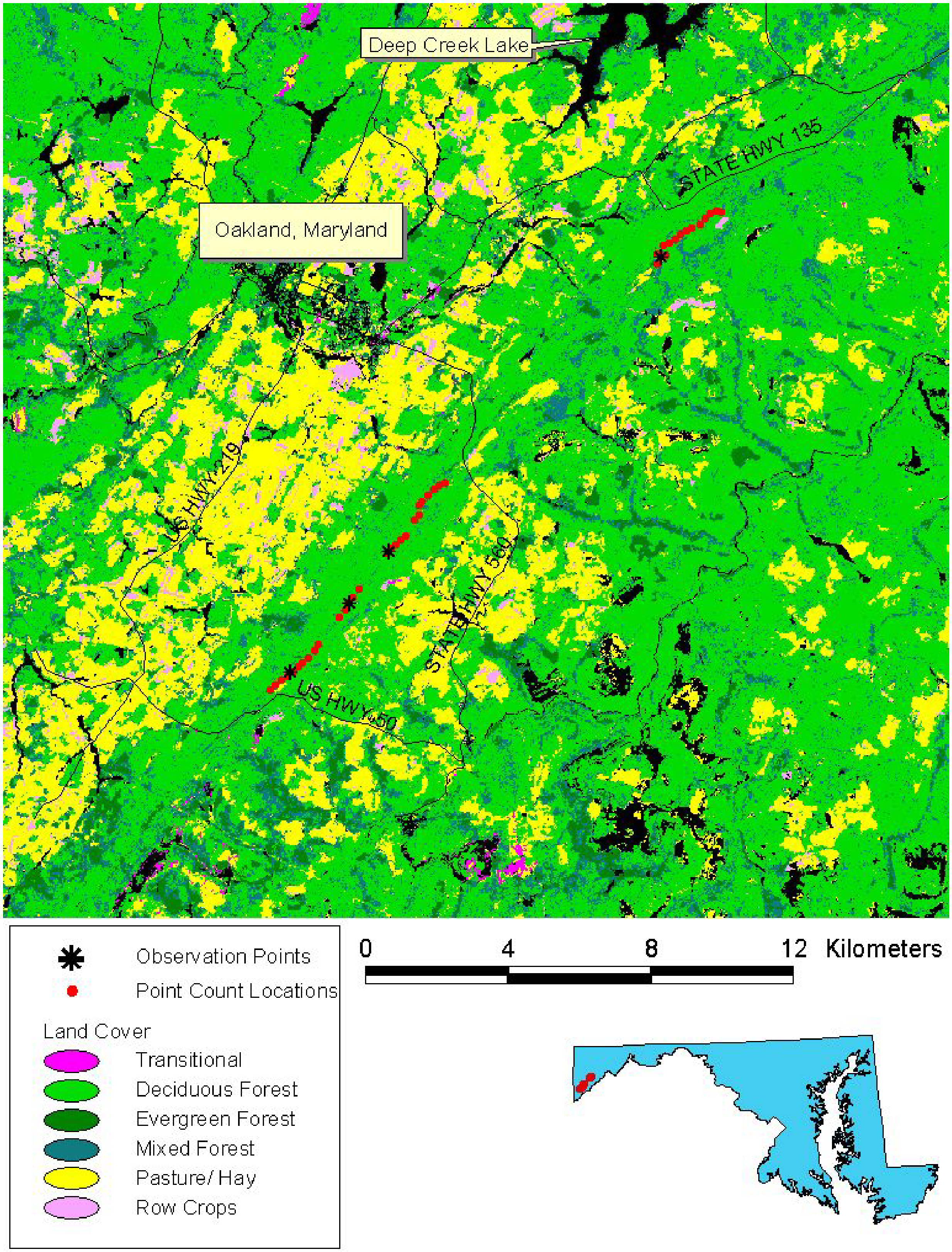

Deep Creek Lake
Oakland, Maryland
STATE HWY 135
US HWY 219
STATE HWY 560
US HWY 50
Observation Points
Point Count Locations
Land Cover
Transitional
Deciduous Forest
Evergreen Forest
Mixed Forest
Pasture/ Hay
Row Crops
0
4
8
12
Kilometers

Figure 2. The landscape surrounding Eagle Rock on the northern portion of the Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland, showing 14 point-count locations (N-01–N-14).

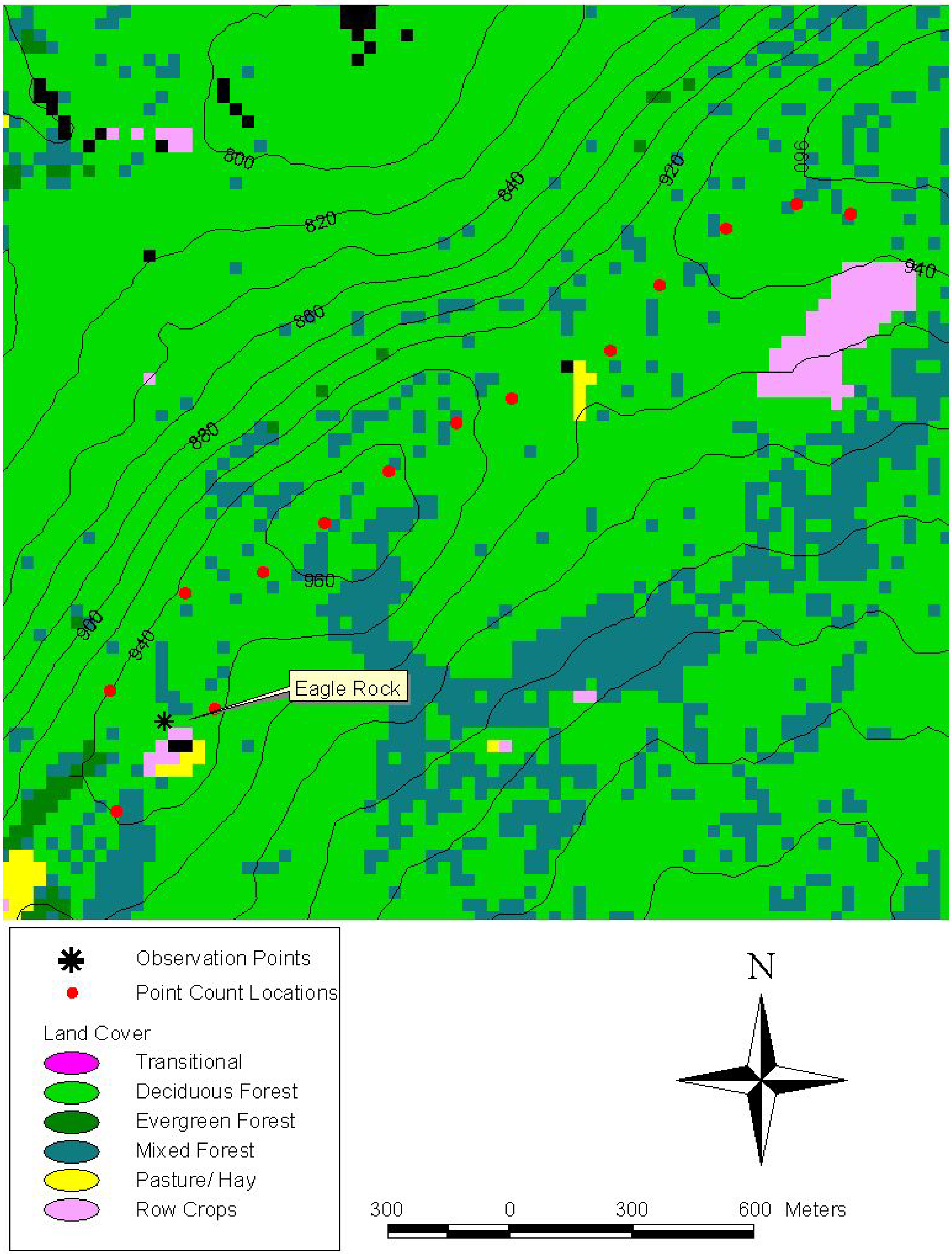
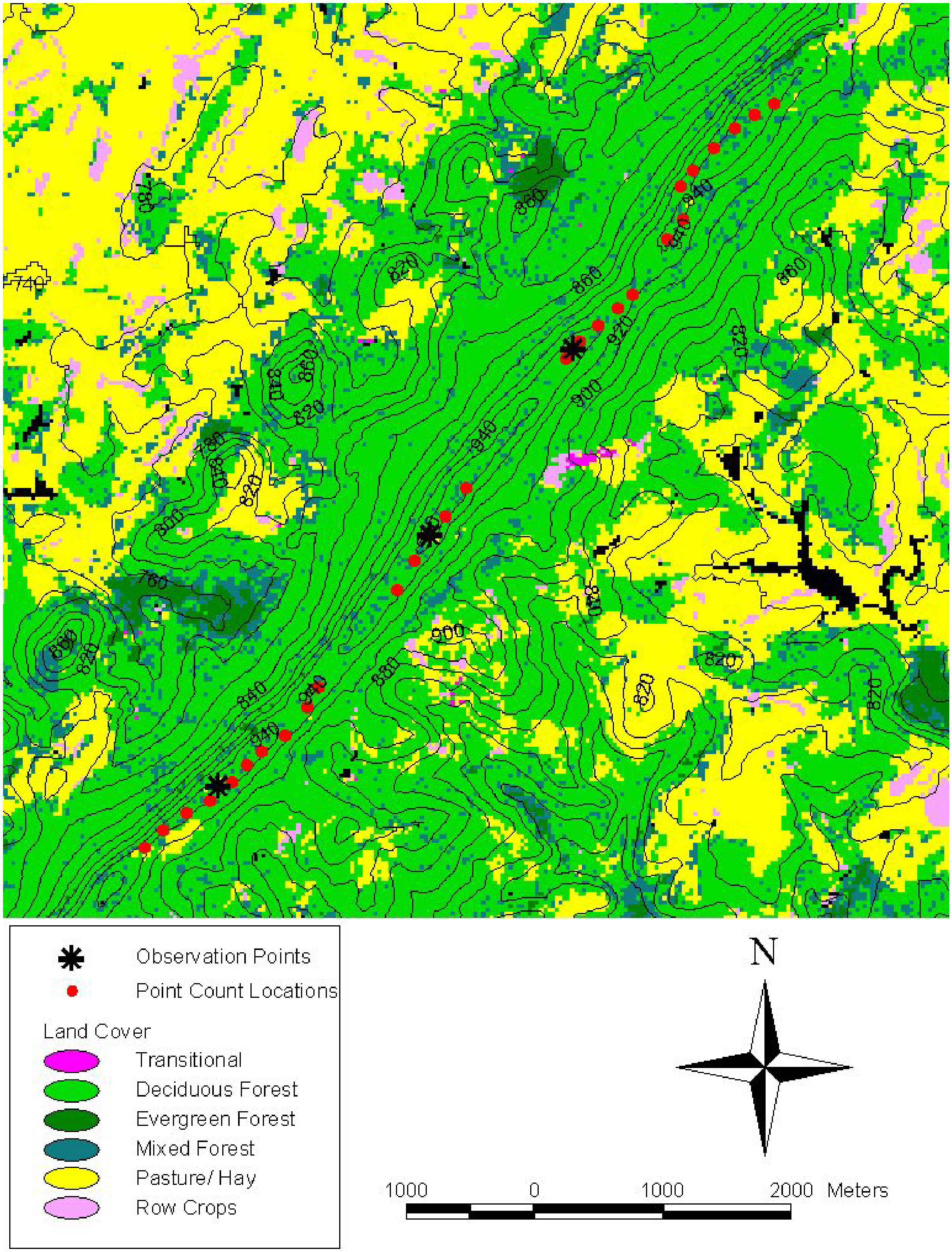

800
820
840
860
880
900
920
940
960
Eagle Rock
Observation Points
Point Count Locations
Land Cover
Transitional
Deciduous Forest
Evergreen Forest
Mixed Forest
Pasture/ Hay
Row Crops
N
300 0 300 600 Meters

Figure 3. The landscape surrounding the southern portion of the Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland, showing 28 point-count locations (S-01–S-10, M-00–M17).


Observation Points
Point Count Locations
Land Cover
Transitional
Deciduous Forest
Evergreen Forest
Mixed Forest
Pasture/ Hay
Row Crops
N
1000 0 1000 2000 Meters

II. OBSERVATIONAL SURVEYS

J. Edward Gates

Abstract. —In order to assess potential impacts from wind power development on Backbone Mountain, Garrett County, Maryland, diurnal observational surveys were conducted at 4 elevated points along the ridgeline. We conducted 83 hours of observational surveys in 2003 and 114.5 hours in 2004. The most abundant birds observed flying at these points included Turkey Vulture, hawks, Rock Pigeon and Mourning Dove, corvids, American Robin, Cedar Waxwing, icterids, and American Goldfinch. In fall 2004, we observed the state-endangered Northern Goshawk, the state and federally threatened Bald Eagle, and state-rare Peregrine Falcon. Passage rates of birds were generally highest in zones of risk labeled severe–high, typically along the ridgeline, but varied with season and time of day. Spring and fall had the highest passage rates due to the large number of migrating species at that time of year, with spring being particularly high in the morning and fall in the early afternoon.

INTRODUCTION

Proposed wind-energy developments on Big Savage/Backbone and Dans mountains, as well as other mountain ridges in western Maryland, have the likelihood of impacting resident and migratory birds and bats in the vicinity of the turbines (Morrison 1998, Anderson et al. 1999, Hoover 2002, Johnson et al. 2002, Morrison 2002, Nicholson 2003, Erickson et al. 2003, Young et al. 2003, Kerns and Kerlinger 2004, Arnett 2005). Mortality from collisions with towers and rotating blades can be a serious threat, particularly for certain species populations. For instance, current estimates place avian collision mortality between 10,000 and 40,000 birds annually at wind facilities in the United States (Erickson et al. 2001). Pre-construction wildlife assessments and post-construction mortality studies demonstrate that wind facilities located in areas of high bird use can expect high fatality rates; however, factors such as topography, prey abundance, and weather likely influence mortality (Erickson et al. 2001). During migration, bats have also exhibited high rates of mortality at certain wind-energy sites on Appalachian ridges, with an estimated 1,364–1,980 bats killed by 44 turbines during a 6-week period in fall 2004 at the Mountaineer Wind Energy Center, West Virginia (Arnett 2005).

Broad-frontal migrations of raptors, in particular, are thought to be affected by geographic features or "leading lines", including rivers and mountain ridges, that attract and concentrate the migrants and influence their direction of travel (Kerlinger 1989). Long distance flight consists of slope soaring and thermal soaring interspersed with interthermal gliding (Kerlinger et al. 1985, Bildstein 1999). Ridges in the Central Appalachian Mountains concentrate southbound migrants because of slope soaring opportunities (Hawk et al. 2002). As many watchsites are along leading lines, the question has been whether the same individuals are typically observed at consecutive watchsites along the same ridge. However, it appears that few birds follow these ridgelines for extended periods of time (Frey 1940, Heintzelman 1982, Hawk et al. 2002). First year individuals appear more likely to concentrate along leading- and diversion lines (Darrow 1983, Viverette et al. 1996, Hawk et al. 2002). Wind conditions, particularly strong northwesterly winds, should enhance or increase opportunities for slope soaring the ridge.

This survey assesses potential risks to diurnal migrating birds on Backbone Mountain, Garrett County, Maryland, within the Clipper Windpower Criterion Project area using standardized protocols (Morrison 1998, Anderson et al. 1999). Our objectives were to: 1) identify diurnal migrants and other species flying in the vicinity of the project area; and 2) determine passage rates relative to different zones of risk at the proposed wind project on Backbone Mountain, Maryland.

STUDY AREA

This pre-construction survey was done at the Clipper Windpower Criterion Project (Clipper Windpower, Inc., http://www.clipperwind.com/) on Backbone Mountain, Garrett County, Maryland, near the towns of Loch Lynn Heights and Oakland. Up to 67, 1.5-MW turbines were originally proposed for 18.5-km of Backbone Mountain ridge top from 10 km north of Highway 560 south towards the Maryland/West Virginia state line with a terminus at Highway 50 (Figure 1). The elevation of the ridge top ranges from 917 to 963 m above sea level and extends about 250 m above the surrounding valley floor. Slopes range from 0–15% on the ridge top to 15–35% on the northwest and southeast aspects (Stone and Matthews 1974). The landscape of the ridge is predominantly deciduous forest and open farm fields punctuated by large rock outcroppings. In addition to a few year-round residences present on the mountain, several permanent hunting cabins are located on secondary dirt roads along the ridge top. Paved roads and secondary dirt roads exist on the ridge, making access to the project area fairly easy.

MATERIALS AND METHODS

Four observational survey (OS) points were established in January and February 2003 (Table 1). Locations for OS points were selected based on elevation, ability to see above and beyond the forest canopy, and ease of access (Figure 1). The northernmost point was located at the top of Eagle Rock [North (Eagle Rock)], a large rock outcropping rising approximately 30 m off the ground (Figures 2 and 3). We had 360° visibility at Eagle Rock, with clear views of the ridge top, and eastern and western valleys (Table 1). The 2 middle points (North-middle, South-middle) were located on the top of large rock outcroppings that rise above the tree canopy at their highest points (Figures 4 and 5). The ridge top was easily viewed from these 2 points; however, visibility of the western valley was obscured at these OS locations (Table 1). The southernmost OS point (South) was established at a meteorological (met) tower located in a grassy field approximately 0.04 km^2 in size and surrounded by forest. Observational surveys were conduced at the base of the met tower. Visibility of the eastern and western valleys was obscured at the southernmost OS point (Table 1). Distances between North (Eagle Rock) and

North-middle, North-middle and South-middle, and South-middle and South OS points were 11319 m, 1845 m, and 2586 m, respectively (see Figure 1).

Observational surveys were conducted by experienced observers from 27 March–22 November 2003, with spring designated 27 March–27 May, breeding season 11 June–25 July, and fall 15 August–22 November; and from 15 March–17 November 2004, with spring designated 15 March–29 May, breeding season 6 June–24 July, and fall 6 August–17 November. Surveys at each observation point were conducted approximately every 2 weeks during 3 periods of the day [morning (sunrise–1000), mid-day (1000–1400), and late afternoon (1400–sunset)]. Observational surveys were 0.5 hour in duration and began once the observer reached the point. All birds seen during OSs were recorded on data sheets. Birds that we could not identify to species were recorded as unknown birds or identified to family or genus. In addition to the number of individuals seen, observers also noted the compass direction of the bird in relation to the survey point and the compass direction of flight of the bird or flock. Individual birds or flocks were categorized by their relative position on Backbone Mountain using the following topographic descriptions: A) ridge top, B) upper half of ridge, C) lower half of ridge, or D) beyond ridge (located in valley) (Figure 6). Individual birds or flocks were also classified by height in relation to the observer's feet and different sections of a hypothetical wind turbine: 0) <0 m, i.e., below observer; 1) 0-40 m, i.e., below turbine blade tips at their lowest position; 2) >40-120 m, i.e., within plane of turbine blades; or 3) >120 m, i.e., above highest position of turbine blade tips (Figure 6). Relative position and height categories were recorded as 1 variable describing position in relation to Backbone Mountain and height of the bird or flock. For example, a bird located directly above the ridge top at a height >120 m would be recorded as A3. These "zones of risk" were categorized as severe (red), high (orange), elevated (yellow), guarded (blue), and low (green) based on location relative to the ridge and sections of a hypothetical turbine (Figure 6). We recorded every combination of relative position/height utilized by a bird or flock during the 0.5-hour surveys. For example, if a bird flew at a height of 100 m from the eastern valley across the ridge toward the western valley, observers would record that the bird was first seen east of the point; the bird passed through zones D2, C2, B2, and A2; and the bird was flying in a westerly direction. In 2004, bird locations relative to the ridge line were further defined as being on the east (e) or west (w) side, e.g., wA2 would designate a bird >40–120 m in height on the west side of the ridge line.

Weather, consisting of temperature, wind speed and direction, and sky condition, was recorded at each point. Observers tried to avoid surveys on days when weather conditions prevented birds from being seen, such as during heavy rain or prolonged drizzle, dense fog, or when wind speeds >20 kph. However, due to the extreme weather conditions on the mountain, particularly during spring and fall, several OSs were conducted on windy days or during light rain. Surveys were abandoned under conditions of dense fog.

Depending on time of day, temperatures in 2003 ranged from 4–28° C in spring, 10–30° C during the breeding season, and 5–26° C in fall. The westerly winds ranged from 0–32 kph in spring, 0–16 kph during the breeding season, and 0–40 kph in fall 2003. Sky conditions in spring were generally partly cloudy (49.0%), clear (22.4%), or overcast (20.4%). In the breeding season, they were often clear (40.9%), partly cloudy 38.6%), or overcast (20.4%). Fall surveys tended to occur on partly cloudy (41.8%) or clear (30.0%) days. Fog occurred on 6.0% of surveys in the fall.

In 2004, temperatures ranged from -6.6–18° C in spring, 9–24° C during the breeding season, and from -1–24.6° C in fall. Winds were generally from the west and ranged from 0–13 kph in spring, 0–13.8 kph during the breeding season, and 0–10.5 kph in fall. Sky conditions in spring were generally clear (66.7%) or partly cloudy (33.3%). In the breeding season, they were often clear (37.7%) or overcast (34%), but a few surveys had fog (11.3%). Fall surveys tended to occur on partly cloudy (64.2%) or clear (26.6%) days.

RESULTS

2003 field season

We conducted 83 hours of OSs (Appendix I). We observed 27 species in spring, 20 during the breeding season, and 24 in fall. Abundant birds included Turkey Vulture, hawks, Rock Pigeon and Mourning Dove, corvids, American Robin, Cedar Waxwing, icterids, and American Goldfinch (Table 2).

In spring, passage rates of birds were especially high during morning on the ridge top in the zones of risk labeled severe–high, followed by decreasing passage rates throughout midday toward late afternoon (Figure 7). Variation in passage rates among OS points was undoubtedly due to differences in visibility (see Table 1). During the breeding season, passage rates of birds were generally lower than the spring highs and similar throughout the diurnal period, but still typically higher in those zones of risk labeled severe–high (Figure 8). In the fall, birds had the highest passage rates in late afternoon, with severe–high zones of risk generally having the highest passage rates irrespective of time of day (Figure 9).

In spring, vultures, hawks, and falcons typically had their highest passage rates in the severe–high zones of risk on the ridge top during midday (Figure 10). By late afternoon, passage rates were lower in these zones of risk with values comparable to lower zones of risk. Although passage rates of vultures, hawks, and falcons were more similar across zones of risk during the breeding season, passage rates still tended to be higher in the severe–high zones of risk, particularly those occurring from midday to late afternoon (Figure 11). In fall, passage rates of vultures, hawks, and falcons increased throughout the day from morning to late afternoon, but again the highest passage rates occurred in the severe–high zones of risk on the ridge top (Figure 12).

2004 field season

We conducted 114.5 hours of OSs in 2004 (Appendix I). We observed 35 species in spring, 29 during the breeding season, and 40 in fall. The most abundant birds observed during surveys included Turkey Vulture, hawks, corvids, American Robin, Cedar Waxwing, icterids, and American Goldfinch. In fall 2004, we observed the state-endangered Northern Goshawk, the state and federally threatened Bald Eagle, and state-rare Peregrine Falcon (Table 2).

In spring, passage rates of birds were highest in the severe–high zones of risk on the ridge top in the morning with passage rates declining throughout the day and becoming less concentrated in those zones (Figure 13). There did not appear to be an orientation of observations toward east or west sides of the mountain. During the breeding season, passage rates were not as high as in spring and values were more similar for the highest and lowest zones of risk (Figure 14). In fall, passage rates of birds were highest in the severe–high zones of risk, particularly during midday (Figure 15).

In spring, vultures, hawks, and falcons showed the highest passage rates in the severe–high zones of risk during midday (Figure 16). By late afternoon, passage rates were more similar among the different zones of risk. Passage rates were oriented more toward the east side of the mountain than the west side during morning and midday. In the breeding season, passage rates were much lower than in other seasons and more similar among zones of risk in the morning and late afternoon (Figure 17). Passage rates were higher during midday, particularly in the severe–

high zones of risk on the ridge top. There was an eastward orientation of passage rates in morning and late afternoon. In fall, the highest passage rates occurred during midday followed by late afternoon and then morning. These passage rates tended to be oriented toward the west side of the mountain. The passage rates of vultures, hawks, and falcons were highest in the severe-high zones of risk located on the ridge top.

DISCUSSION

RTE diurnal migrants included the Bald Eagle, Northern Goshawk, and Peregrine Falcon. All 3 species are confirmed breeding birds in Maryland, but our observations were made during fall migration 2004. The state and federally threatened Bald Eagle population in Maryland has been expanding its range from its Chesapeake Bay stronghold into western Maryland along major rivers. The state-endangered Northern Goshawk once nested throughout the southern Appalachian highlands from western Pennsylvania to North Carolina and Tennessee. This rare and irregular breeder has been recorded from extreme western Maryland in the remaining unfragmented, mature forests of Garrett County (Robbins and Blom 1996). The state-rare Peregrine Falcon once nested on cliff ledges along many of the large rivers and water bodies in Maryland, but disappeared in the 1950's due to reproductive failure caused by DDT and other organochlorine pesticides. These chemicals have now been banned from use and, as a result, this species and others affected by these chemicals have recovering populations. Reintroductions of Peregrine Falcons aided in their recovery, and they have nested successfully in Maryland since 1983, often using artificial structures (Robbins and Blom 1996).

Our OSs indicated that diurnal passage rates of birds were highest in the highest zones of risk on Backbone Mountain. As expected, the highest passage rates occurred during spring and fall migration periods. There may be some criticism about biases in observations because all OS points were on high points along Backbone Mountain and not in surrounding valleys. It is easier to observe nearby birds than those farther away. This bias would be strongest for small passerines and woodpeckers, which are more difficult to detect with increasing distances from the observer. These smaller birds may be more uniformly distributed from valley to ridge top. However, this bias should be less of a problem for larger birds, e.g., vultures, hawks, and falcons, which can be seen at much greater distances.

Our results support the observation that the ridge top position is a favored location for migrating vultures, hawks, and falcons. They likely use the updrafts associated with the ridge top for soaring, e.g., they tended to occur on the west side of the ridge during fall, when winds typically are strongest from the west or northwest (Kerlinger et al. 1985, Bildstein 1999, Hawk et al. 2002). However, it appears that few birds follow these ridgelines for extended periods of time (Frey 1940, Heintzelman 1982, Hawk et al. 2002). Although winds are predominately from the west, differences in visibility of the east and west slopes from different OS points likely contributed to variability in our results (see Table 1).

Diurnal migrants generally appear to be able to avoid colliding with the towers and rotating blades of wind turbines. Based on mortality surveys at the nearby Mountaineer Wind Energy Center, West Virginia, on Backbone Mountain, nocturnal migrants and other small birds predominated (17 of 24 species, 70.8%) among recovered carcasses (Kerns and Kerlinger 2004). On average about 4 birds were killed per turbine per year. Only 2 Turkey Vultures, 1 Red-tailed Hawk, and 1 Wood Duck were killed at Mountaineer, suggesting that large diurnal migrants are not at great risk from turbines (Kerns and Kerlinger 2004). So, even if these birds are flying within severe-high zones of risk on Backbone Mountain, the likelihood of serious consequences may be comparatively low.

For post-construction, OSs should concentrate on how diurnal migrants actually interact with functioning wind turbines during spring and fall migration. Some of the questions to be answered include 1) Do diurnal migrants avoid the area around the rotor sweep by flying above or to either side of the wind turbine? And 2) Do extreme weather conditions influence the probability of diurnal migrants colliding with the turbines?

Acknowledgments. —John Sherwell and Gwenda L. Brewer, Maryland Department of Natural Resources, were instrumental in organizing several early meetings on the bird/bat wind turbine issue. These meetings were helpful in developing the field protocols used in this study. Several personnel at Versar, Inc., also contributed to initial project design, particularly Mark T. Southerland and Fred Kelley. Michael L. Morrison reviewed the final study design and provided valuable comments on field protocols. We further thank the representatives and personnel of Clipper Windpower, Inc., for their help and cooperation during all phases of the project, especially Ron Orozco, David E. Scott, and Kevin Rackstraw. We acknowledge the field crew, Jessica Kerns, Keith Lott, and Sara Stahl, for helping collect the data used in this report. Keith Lott prepared Figures 1, 4, and 5, showing the wind resource area, survey points, and different landscape features. We thank all the landowners who allowed us access to their properties. John Sherwell, Fred Kelley, Gwenda L. Brewer, Chandler S. Robbins, and D. Daniel Boone commented on an earlier draft of this report. This project was funded by the Maryland Department of Natural Resources, Power Plant Research Program.

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Table 1. Observational survey points, their location, and description at the Clipper Windpower Criterion Project on Backbone Mountain, Garrett County, Maryland.

Point	Name	GPS co-ordinates (UTM)	Description
1	North (Eagle Rock)	X: 648090.1329 Y: 4364203.638	High exposed rock spire with 360° unobstructed view of surrounding area
2	North-middle	X: 640449.7552 Y: 4355955.909	Rock outcropping surrounded by forest. View of western slope below ridge was obscured by thick forest
3	South-middle	X: 639338.299 Y: 4354504.147	Point located on a rock slab facing east, low-growing vegetation provided unobscured view of entire east slope. Zones 0 (<0 m, below observer) through half of Zone 1 (0–40 m, below blade) were not visible on the western slope due to the ridge and trees
4	South	X: 637680.3142 Y: 4352540.326	Point located in a farm field surrounded by forest. Zones 0 on either slope were not visible during much of the year because of dense forest cover

Table 2. Total numbers of bird species identified during spring, breeding, and fall seasons at the Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland. The number of 0.5-hour observational surveys completed within each season are shown in parentheses.

Species			2003			2004		
Scientific name	Common name	Alpha code	Spring (52)	Breeding (48)	Fall (66)	Spring (72)	Breeding (49)	Fall (108)
Anseriformes								
Anatidae								
Branta canadensis	Canada Goose	CAGO	0	0	1	0	2	30
Cygnus columbianus	Tundra Swan	TUSW	0	0	0	0	0	30
Gaviiformes								
Gaviidae								
Gavia immer	Common Loon	COLO	0	0	0	5	0	0
Pelecaniformes								
Phalacrocoracidae								
Phalacrocorax auritus	Double-crested Cormorant	DCCO	3	0	0	0	0	0
Ciconiiformes								
Ardeidae								
Ardea herodias	Great Blue Heron	GBHE	3	0	0	0	0	0
Cathartidae								
Coragyps atratus	Black Vulture	BLVU	0	0	2	0	0	5
Cathartes aura	Turkey Vulture	TUVU	97	47	81	126	25	88

Table 2. Continued.

Species			2003			2004		
Scientific name	Common name	Alpha code	Spring (52)	Breeding (48)	Fall (66)	Spring (72)	Breeding (49)	Fall (108)
Falconiformes								
Accipitridae (hawks)								
Haliaeetus leucocephalus	Bald Eagle[1]	BAEA	0	0	0	0	0	2
Pandion haliaetus	Osprey	OSPR	0	0	0	2	1	12
Circus cyaneus	Northern Harrier	NOHA	1	0	0	0	0	4
Accipiter striatus	Sharp-shinned Hawk[2]	SSHA	2	0	19	5	1	88
Accipiter cooperii	Cooper's Hawk[2]	COHA	7	0	0	2	1	8
Accipiter gentilis	Northern Goshawk[2, 3]	NOGO	0	0	0	0	0	1
	Unknown *Accipiter*	XXAC	2	2	3	2	0	0
Buteo lineatus	Red-shouldered Hawk[2]	RSHA	0	0	0	2	0	1
Buteo platypterus	Broad-winged Hawk[2]	BWHA	5	0	8	13	1	44
Buteo jamaicensis	Red-tailed Hawk	RTHA	32	9	25	18	10	80
	Unknown *Buteo*	XXBU	3	1	3	2	0	7
Aquila chrysaetos	Golden Eagle	GOEA	0	0	0	0	0	1
	Unknown Raptor	XXRA	0	0	0	1	0	0

Table 2. Continued.

Species			2003			2004		
Scientific name	Common name	Alpha code	Spring (52)	Breeding (48)	Fall (66)	Spring (72)	Breeding (49)	Fall (108)
Falconidae (falcons)								
Falco sparverius	American Kestrel	AMKE	2	0	4	2	3	6
Falco columbarius	Merlin	MERL	0	0	0	0	0	1
Falco peregrinus	Peregrine Falcon[4]	PEFA	0	0	0	0	0	1
Charadriiformes								
Laridae								
Larus delawarensis	Ring-billed Gull	RBGU	0	0	0	32	0	0
Columbiformes								
Columbidae								
Columba livia	Rock Pigeon	ROPI	15	5	5	1	0	2
Zenaida macroura	Mourning Dove	MODO	3	5	3	0	3	2
Apodiformes								
Apodidae								
Chaetura pelagica	Chimney Swift	CHSW	0	0	0	0	0	1

Table 2. Continued.

Species			2003			2004		
Scientific name	Common name	Alpha code	Spring (52)	Breeding (48)	Fall (66)	Spring (72)	Breeding (49)	Fall (108)
Piciformes								
Picidae								
Melanerpes carolinus	Red-bellied Woodpecker[2]	RBWO	0	1	0	0	0	0
Sphyrapicus varius	Yellow-bellied Sapsucker	YBSA	0	0	0	0	0	1
Picoides pubescens	Downy Woodpecker	DOWO	1	0	0	2	0	2
Colaptes auratus	Northern Flicker	NOFL	0	1	1	4	1	1
Dryocopus pileatus	Pileated Woodpecker[2]	PIWO	1	1	0	1	2	0
	Unknown Woodpecker	XXWO	1	1	2	1	0	1
Passeriformes								
Tyrannidae								
Myiarchus crinitus	Great Crested Flycatcher	GCFL	0	0	0	2	4	1
Sayornis phoebe	Eastern Phoebe	EAPH	1	0	0	0	1	2
Vireonidae								
Vireo solitarius	Blue-headed Vireo[2]	BHVI	0	0	1	0	0	0
Corvidae								
Cyanocitta cristata	Blue Jay	BLJA	13	0	58	45	1	10
Corvus brachyrhynchos	American Crow	AMCR	13	10	35	59	15	82
Corvus corax	Common Raven	CORA	14	16	15	28	3	33

Table 2. Continued.

Species			2003			2004		
Scientific name	Common name	Alpha code	Spring (52)	Breeding (48)	Fall (66)	Spring (72)	Breeding (49)	Fall (108)
Hirundinidae								
Tachycineta bicolor	Tree Swallow	TRES	3	0	0	0	2	8
Hirundo rustica	Barn Swallow	BARS	4	7	5	3	3	2
	Unknown Swallow	XXSW	3	2	4	0	1	0
Paridae								
Poecile atricapillus	Black-capped Chickadee	BCCH	0	5	1	2	1	1
Baeolophus bicolor	Eastern Tufted Titmouse	ETTI	0	0	0	3	0	0
Sittidae								
Sitta carolinensis	White-breasted Nuthatch	WBNU	0	0	1	1	0	0
Turdidae								
Sialia sialis	Eastern Bluebird	EABL	0	1	0	1	2	0
Turdus migratorius	American Robin	AMRO	1	2	12	26	3	16
	Unknown Thrush	XXTH	0	0	0	0	1	0
Sturnidae								
Sturnus vulgaris	European Starling	EUST	0	0	0	3	20	11
Bombycillidae								
Bombycilla cedrorum	Cedar Waxwing	CEDW	2	7	174	19	13	45

Table 2. Continued.

Species			2003			2004		
Scientific name	Common name	Alpha code	Spring (52)	Breeding (48)	Fall (66)	Spring (72)	Breeding (49)	Fall (108)
Parulidae								
Dendroica petechia	Yellow Warbler	YWAR	0	0	0	1	0	0
Dendroica pensylvanica	Chestnut-sided Warbler	CSWA	1	0	0	0	0	0
Dendroica virens	Black-throated Green Warbler[2]	BTNW	0	0	0	0	0	1
Dendroica discolor	Prairie Warbler	PRAW	0	0	0	1	0	0
	Unknown Warbler	XXWA	0	0	0	0	0	6
Traupidae								
Piranga olivacea	Scarlet Tanager[2]	SCTA	0	0	1	0	0	1
Emberizidae								
Pipilo erythrophthalmus	Eastern Towhee	EATO	0	2	0	0	0	0
Junco hyemalis	Dark-eyed Junco	DEJU	4	0	3	1	1	0
Cardinalidae								
Pheucticus ludovicianus	Red-breasted Grosbeak[2]	RBGR	0	3	1	0	1	0
Passerina cyanea	Indigo Bunting	INBU	0	0	0	1	3	0
Icteridae								
Agelaius phoeniceus	Red-winged Blackbird	RWBL	6	14	5	27	3	2
Quiscalus quiscula	Common Grackle	COGR	23	21	0	10	10	6
Molothrus ater	Brown-headed Cowbird	BHCO	7	4	0	4	0	0

Table 2. Continued.

Species			2003			2004		
Scientific name	Common name	Alpha code	Spring (52)	Breeding (48)	Fall (66)	Spring (72)	Breeding (49)	Fall (108)
Fringillidae								
Carpodacus mexicanus	House Finch	HOFI	0	0	0	3	0	4
Carduelis tristis	American Goldfinch	AMGO	11	23	2	29	18	19
	Unknown Passerine	XXPA	12	23	87	14	2	6
	Unknown Bird	XXXX	0	0	1	25	0	0
Number of species			27	20	24	35	29	40

[1]State threatened, federally listed threatened (Maryland Department of Natural Resources 2003).

[2]Forest-interior dwelling species (FIDS) (Maryland Partners-in-Flight Management Committee 1997).

[3]State endangered (Maryland Department of Natural Resources 2003).

[4]State rare (Maryland Department of Natural Resources 2003).

Figure 1. Map covering the Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland, with the 4 observational survey points (black asterisks).

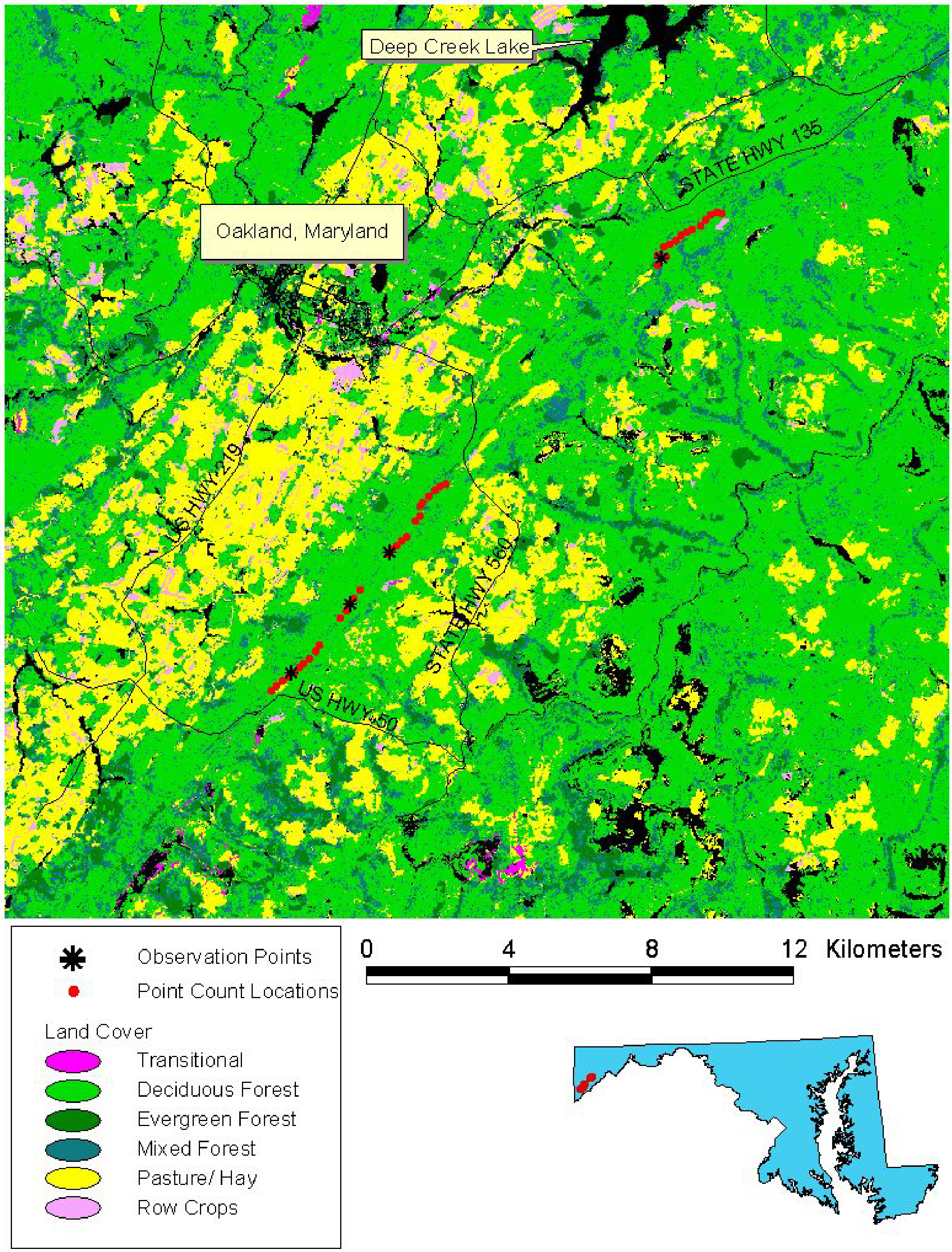

Deep Creek Lake
Oakland, Maryland
STATE HWY 135
US HWY 219
STATE HWY 560
US HWY 50
Observation Points
Point Count Locations
Land Cover
Transitional
Deciduous Forest
Evergreen Forest
Mixed Forest
Pasture/ Hay
Row Crops
0
4
8
12
Kilometers

Figure 2. View south of the North (Eagle Rock) observational survey point, Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland, in early September 2003.

Figure 3. Land cover surrounding Eagle Rock on the northern portion of the Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland, and location of 1 observational survey point [North (Eagle Rock)].

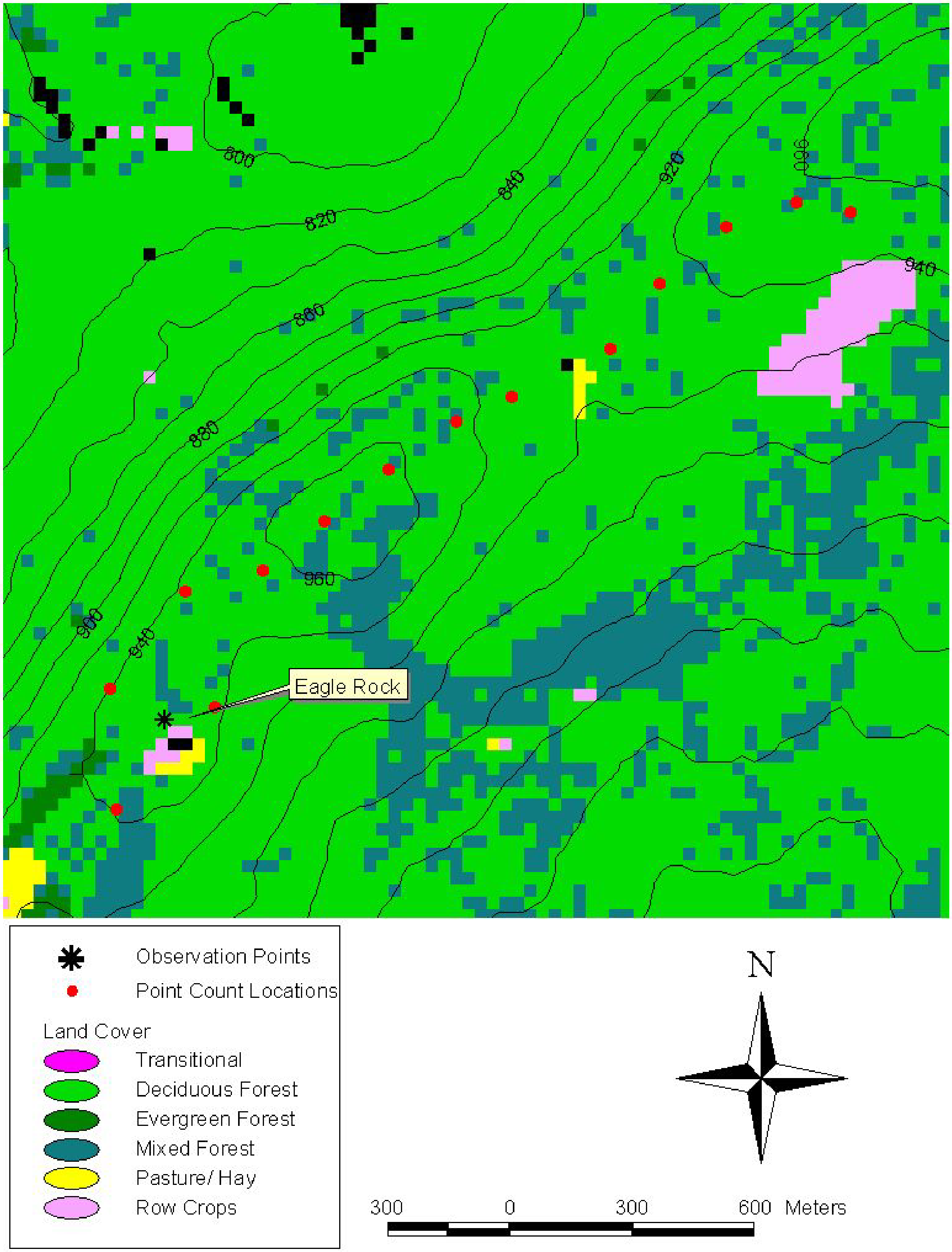

800
820
840
860
880
900
920
940
960
Eagle Rock
Observation Points
Point Count Locations
Land Cover
Transitional
Deciduous Forest
Evergreen Forest
Mixed Forest
Pasture/ Hay
Row Crops
N
300 0 300 600 Meters

Figure 4. View east of the South-middle observational survey point, Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland, in early September 2003.

Figure 5. Land cover surrounding the southern portion of the Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland, and locations of 3 observational survey points (North-middle, South-middle, South).

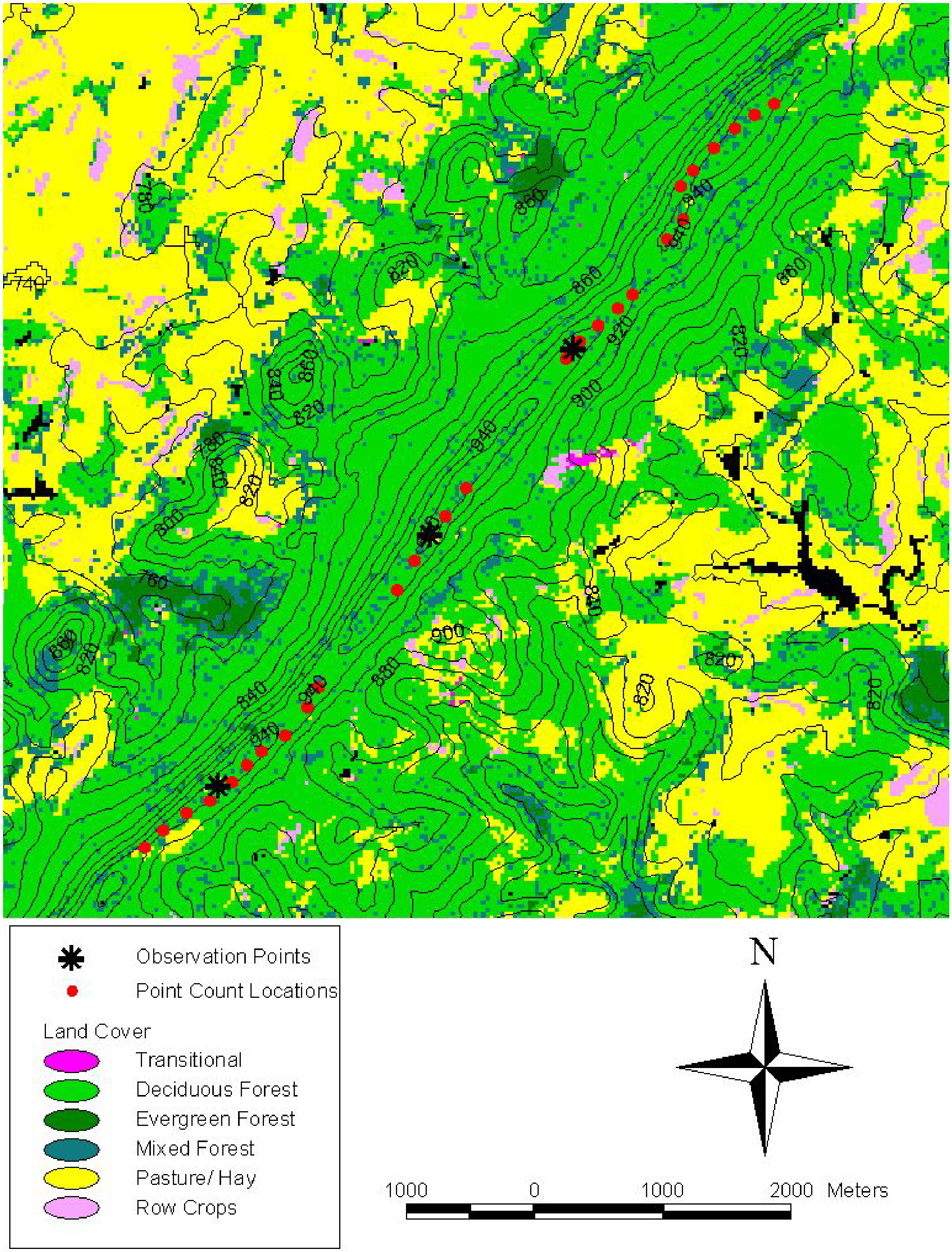
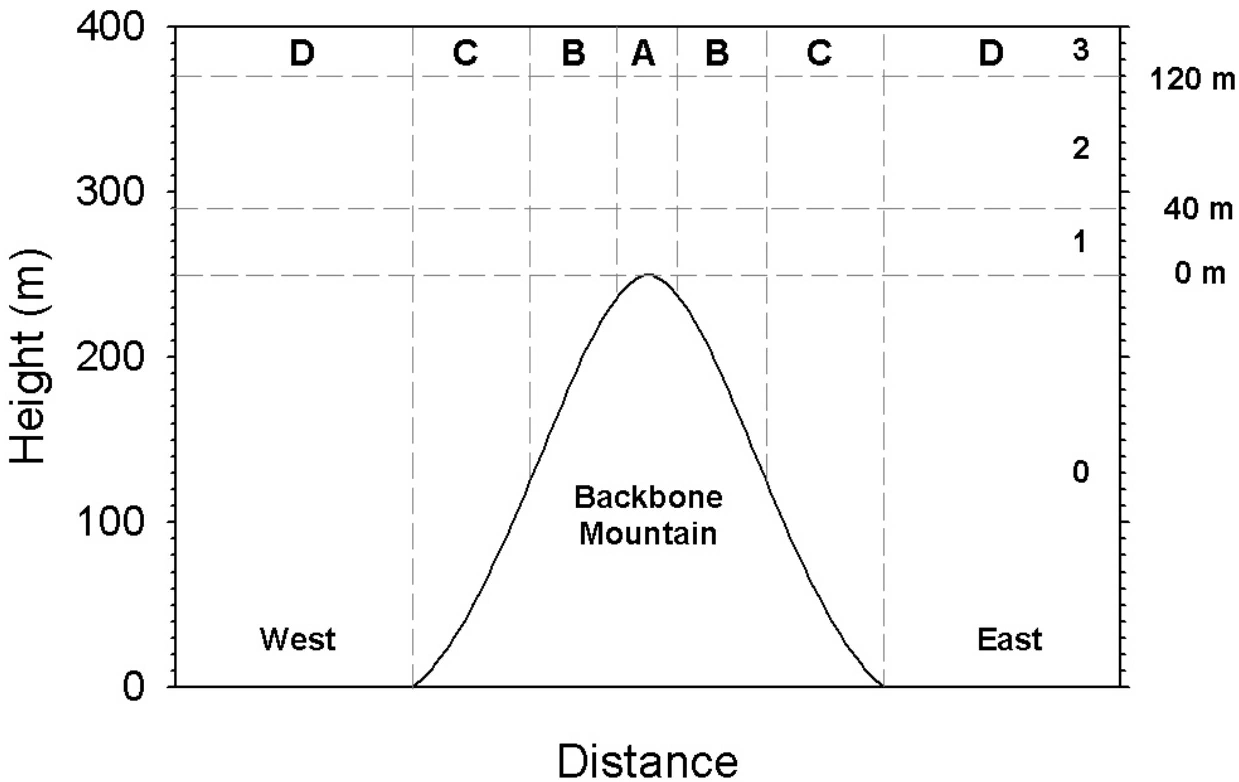

Observation Points
Point Count Locations
Land Cover
Transitional
Deciduous Forest
Evergreen Forest
Mixed Forest
Pasture/ Hay
Row Crops
N
1000
0
1000
2000
Meters

Figure 6. Schematic diagram of Backbone Mountain showing how birds were recorded during observational surveys relative to topographic positions and heights of different sections of a hypothetical wind turbine. The “zones of risk” were categorized as severe (red), high (orange), elevated (yellow), guarded (blue), and low (green).



Zones of risk

- A2 (higher)
- A1, A3, B2
- A0, B1, B3, C2
- B0, C1, C3, D2
- C0, D0, D1, D3 (lower)

Figure 7. Passage rates (no./0.5 hr) of birds at the Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland, are presented for spring 2003. Lines of colored dots represent the zones of risk for the different positions relative to the ridge and hypothetical turbine (see Figure 6).

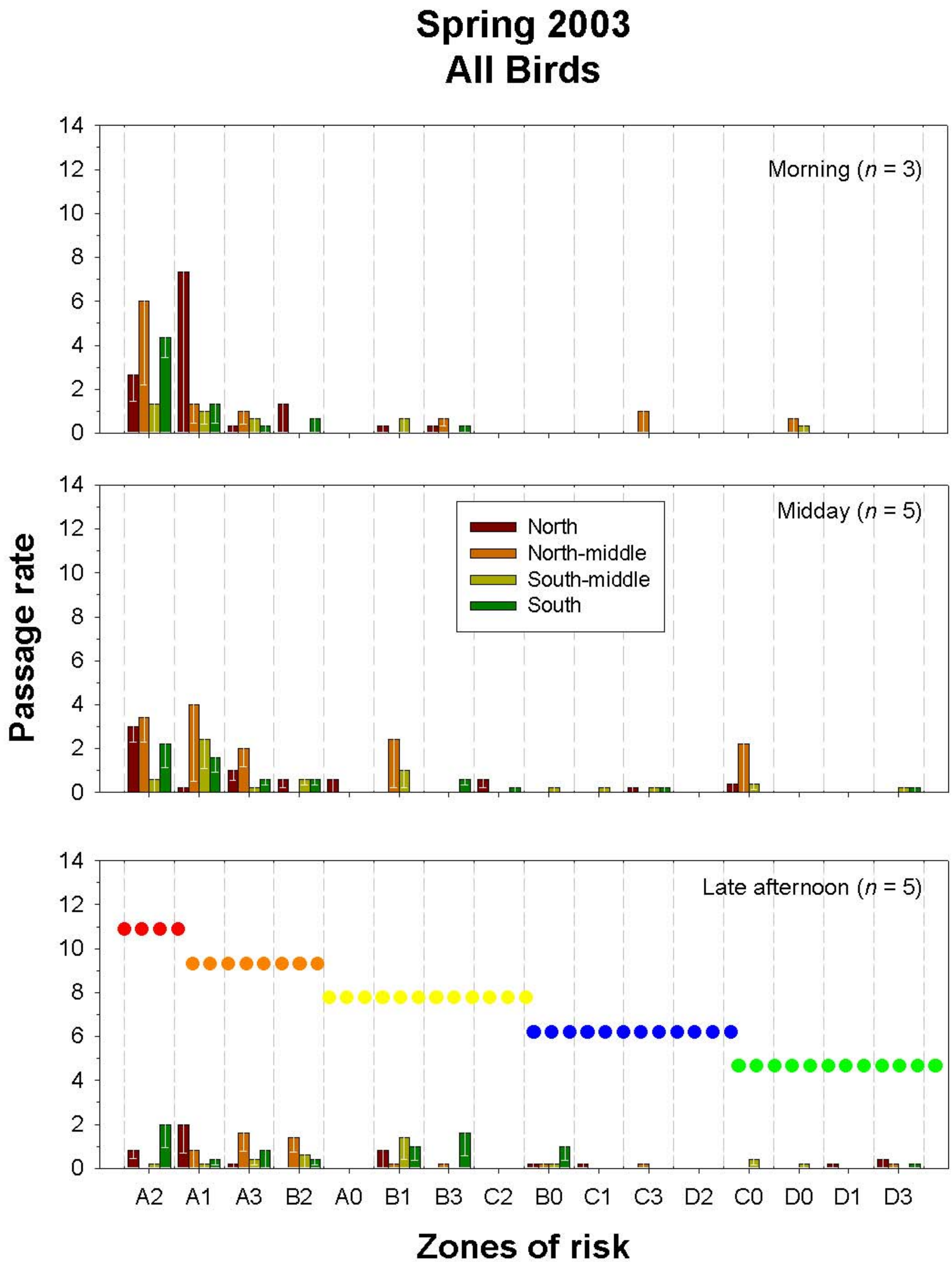

Spring 2003
All Birds
Morning (n = 3)
Midday (n = 5)
Late afternoon (n = 5)
North
North-middle
South-middle
South
Passage rate
Zones of risk
A2 A1 A3 B2 A0 B1 B3 C2 B0 C1 C3 D2 C0 D0 D1 D3
0 2 4 6 8 10 12 14

Figure 8. Passage rates (no./0.5 hr) of birds at the Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland, are presented for the 2003 breeding season. Lines of colored dots represent the zones of risk for the different positions relative to the ridge and hypothetical turbine (see Figure 6).

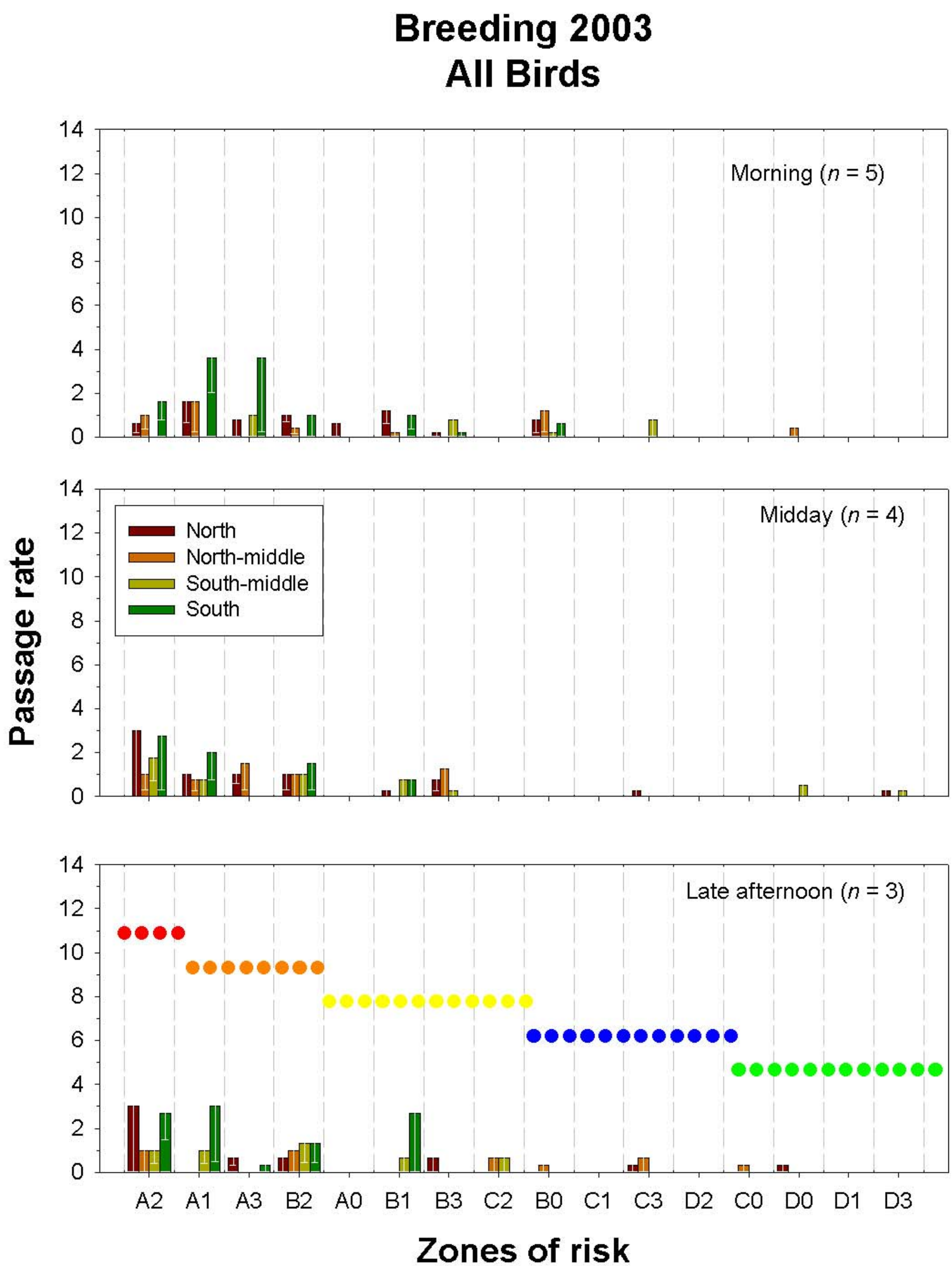
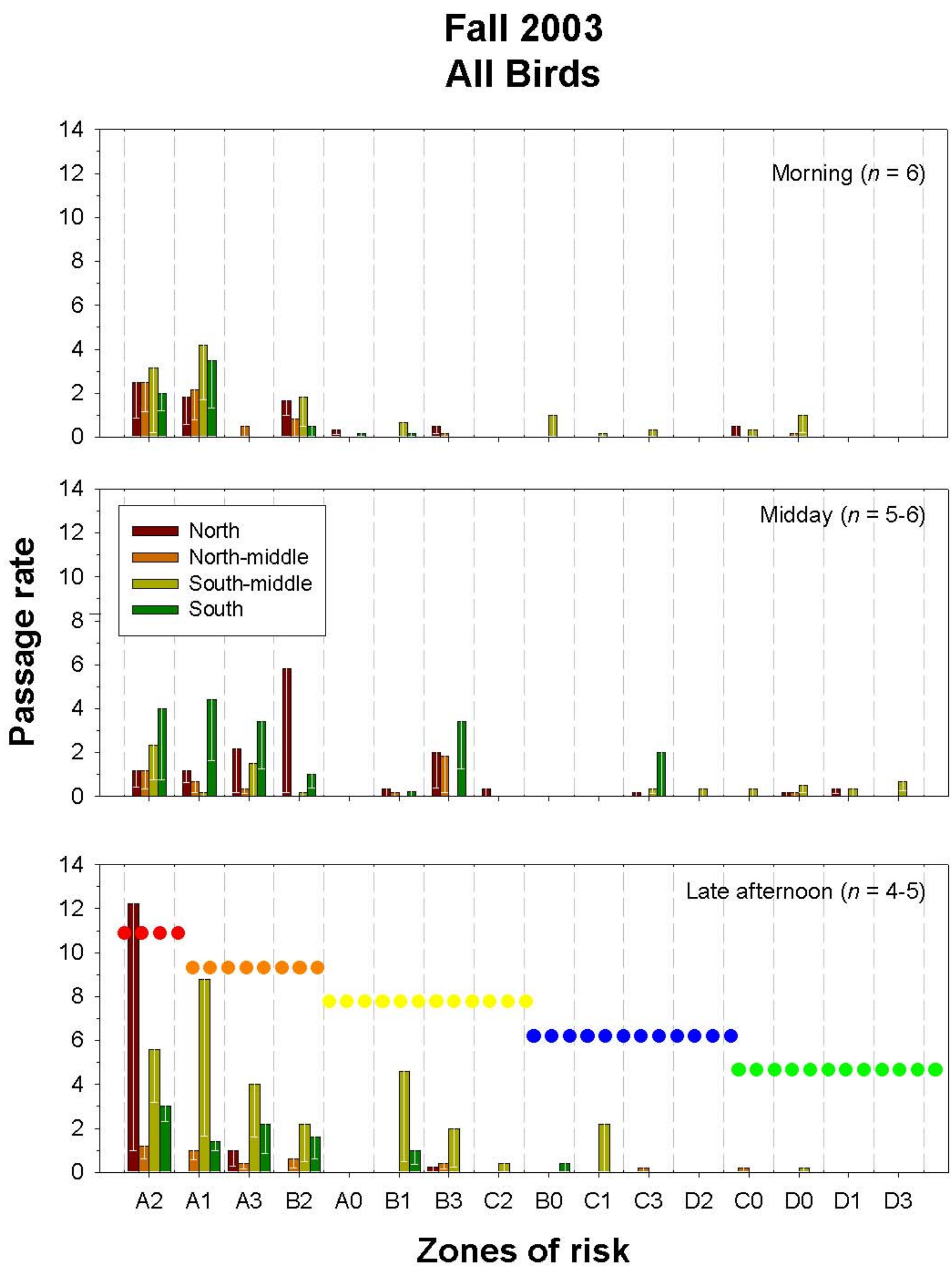

Breeding 2003
All Birds
Morning (n = 5)
Midday (n = 4)
Late afternoon (n = 3)
North
North-middle
South-middle
South
Passage rate
0
2
4
6
8
10
12
14
A2 A1 A3 B2 A0 B1 B3 C2 B0 C1 C3 D2 C0 D0 D1 D3
Zones of risk

Figure 9. Passage rates (no./0.5 hr) of birds at the Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland, are presented for fall 2003. Lines of colored dots represent the zones of risk for the different positions relative to the ridge and hypothetical turbine (see Figure 6).



Fall 2003
All Birds
Morning (n = 6)
Midday (n = 5-6)
Late afternoon (n = 4-5)
North
North-middle
South-middle
South
Passage rate
0
2
4
6
8
10
12
14
A2
A1
A3
B2
A0
B1
B3
C2
B0
C1
C3
D2
C0
D0
D1
D3
Zones of risk

Figure 10. Passage rates (no./0.5 hr) of vultures, hawks, and falcons at the Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland, are presented for spring 2003. Lines of colored dots represent the zones of risk for the different positions relative to the ridge and hypothetical turbine (see Figure 6).

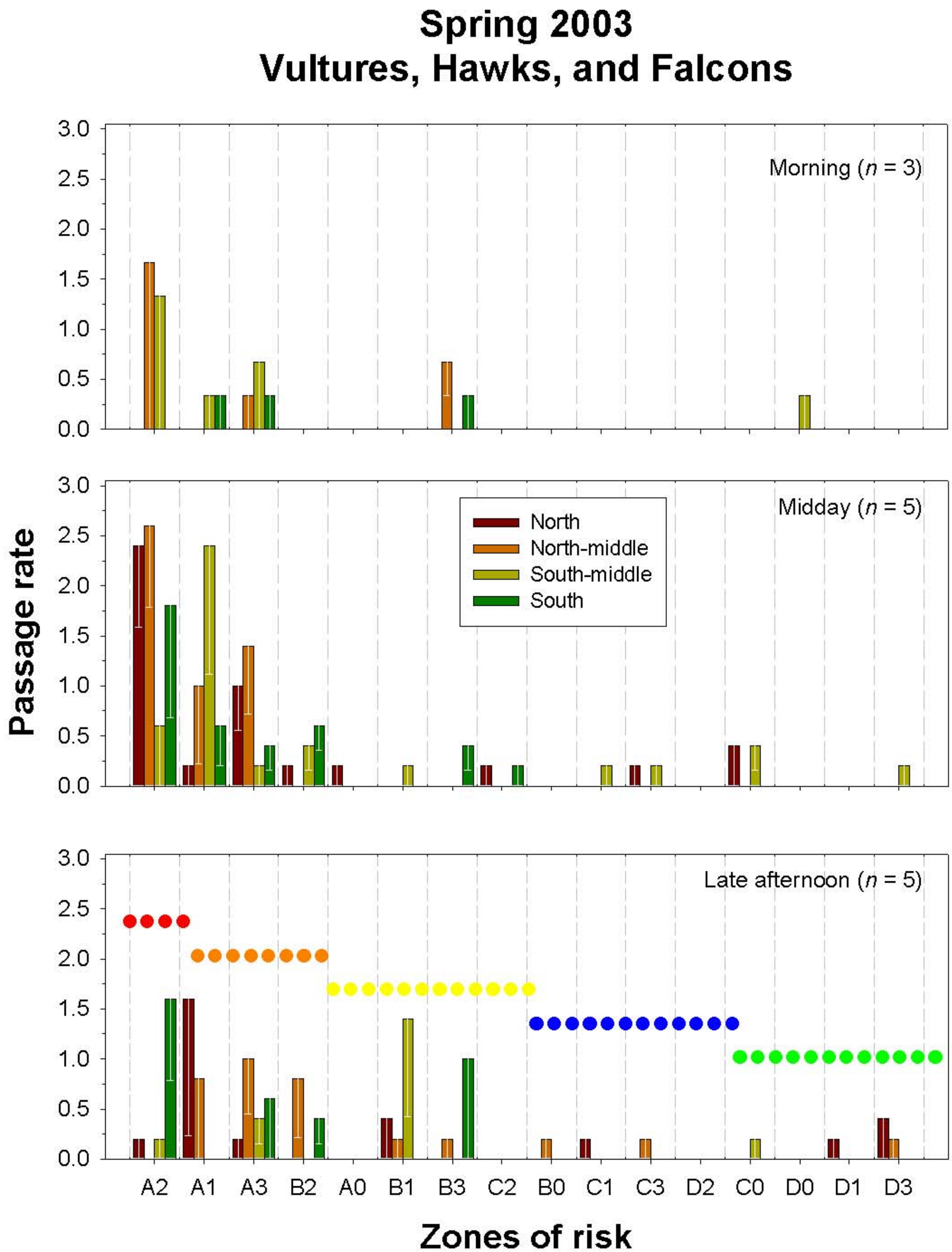

Spring 2003
Vultures, Hawks, and Falcons
Morning (n = 3)
Midday (n = 5)
Late afternoon (n = 5)
North
North-middle
South-middle
South
Passage rate
0.0
0.5
1.0
1.5
2.0
2.5
3.0
A2
A1
A3
B2
A0
B1
B3
C2
B0
C1
C3
D2
C0
D0
D1
D3
Zones of risk

Figure 11. Passage rates (no./0.5 hr) of vultures, hawks, and falcons at the Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland, are presented for the 2003 breeding season. Lines of colored dots represent the zones of risk for the different positions relative to the ridge and hypothetical turbine (see Figure 6).

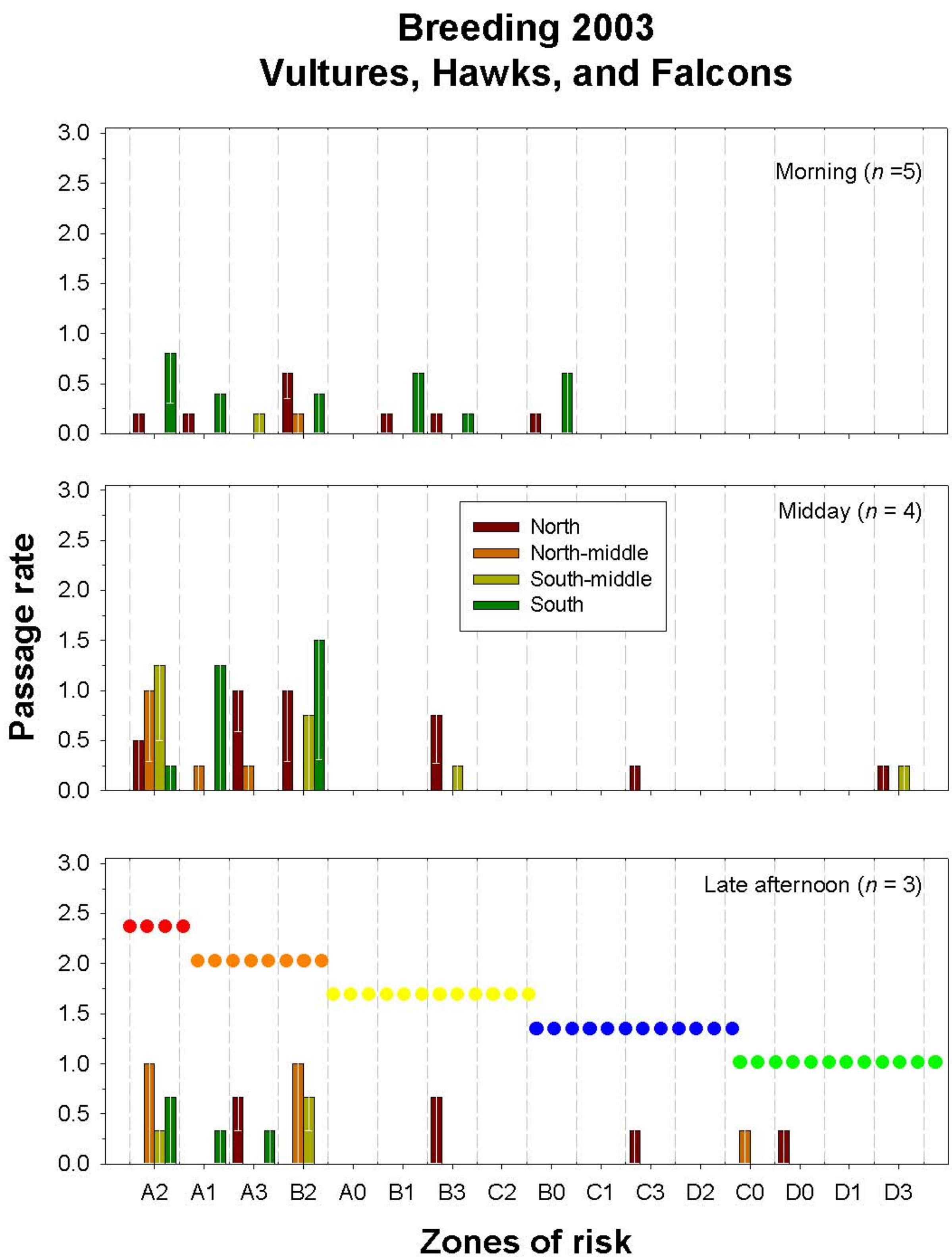

Breeding 2003
Vultures, Hawks, and Falcons
Morning (n =5)
Midday (n = 4)
Late afternoon (n = 3)
North
North-middle
South-middle
South
Passage rate
Zones of risk
A2
A1
A3
B2
A0
B1
B3
C2
B0
C1
C3
D2
C0
D0
D1
D3
0.0
0.5
1.0
1.5
2.0
2.5
3.0

Figure 12. Passage rates (no./0.5 hr) of vulture, hawks, and falcons at the Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland, are presented for fall 2003. Lines of colored dots represent the zones of risk for the different positions relative to the ridge and hypothetical turbine (see Figure 6).

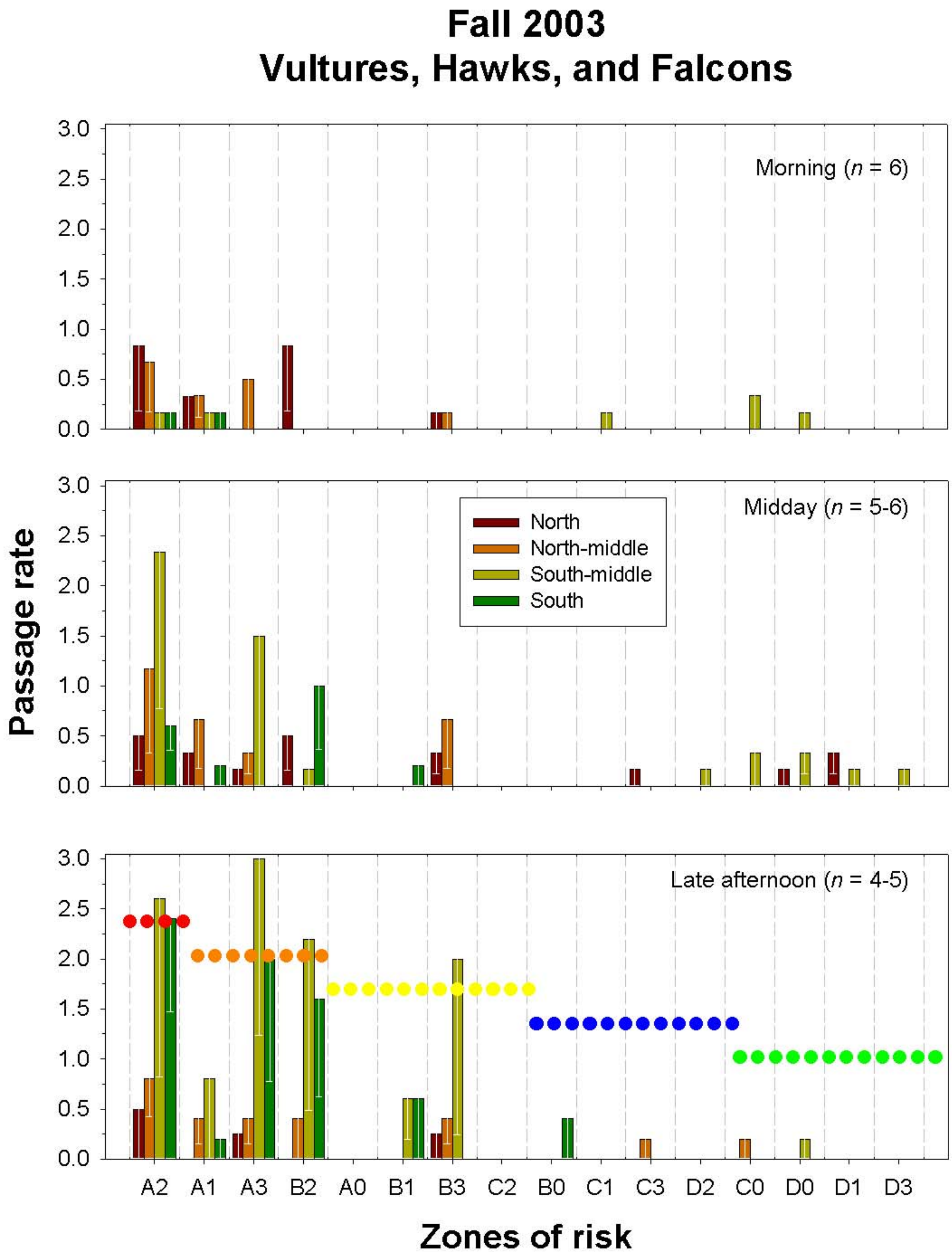

Fall 2003
Vultures, Hawks, and Falcons
Morning (n = 6)
Midday (n = 5-6)
Late afternoon (n = 4-5)
North
North-middle
South-middle
South
Passage rate
0.0
0.5
1.0
1.5
2.0
2.5
3.0
A2 A1 A3 B2 A0 B1 B3 C2 B0 C1 C3 D2 C0 D0 D1 D3
Zones of risk

Figure 13. Passage rates (no./0.5 hr) of birds at the Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland, are presented for spring 2004. Lines of colored dots represent the zones of risk for the different positions relative to the ridge and hypothetical turbine (see Figure 6).

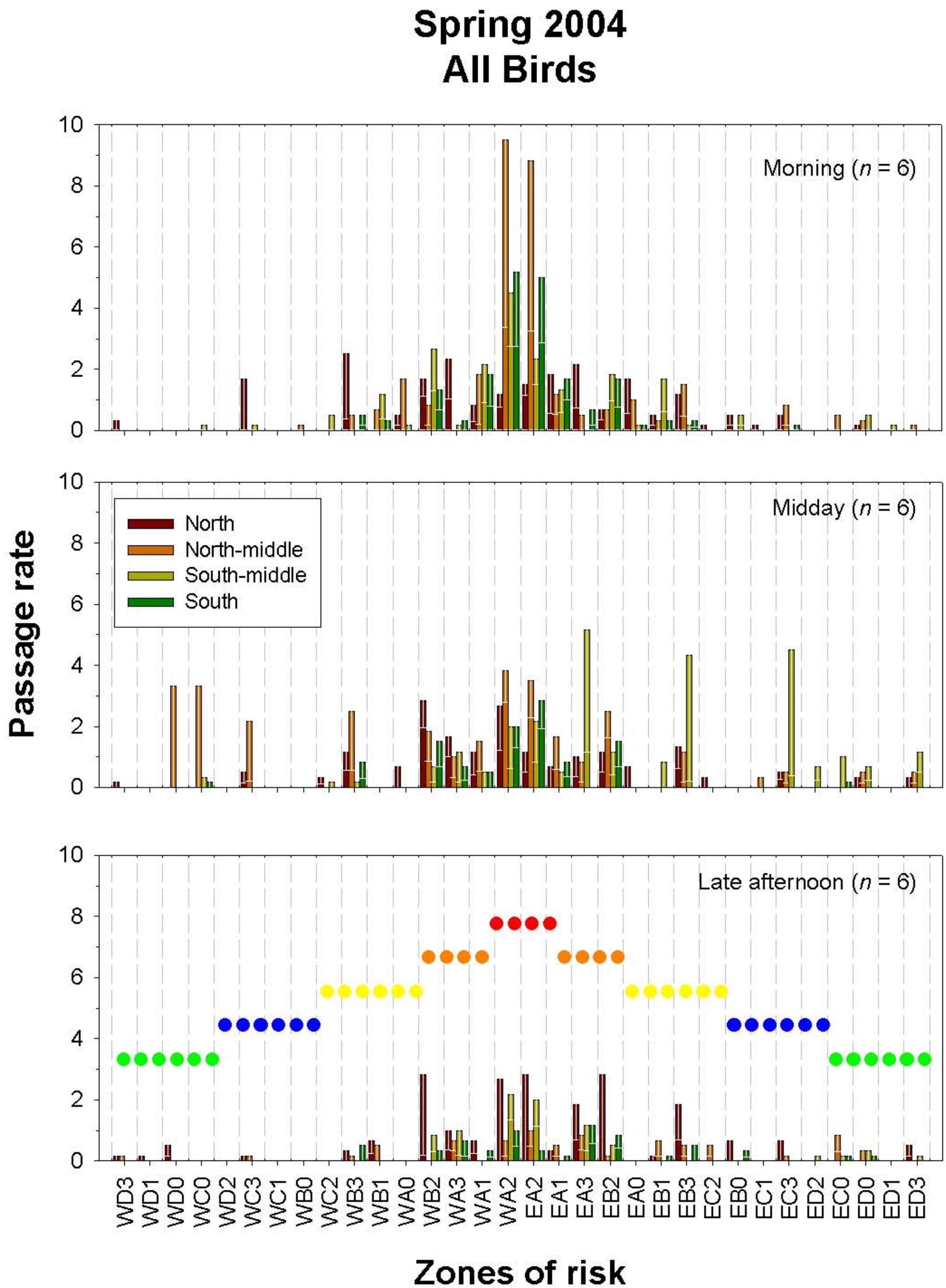

Spring 2004
All Birds
Morning (n = 6)
Midday (n = 6)
Late afternoon (n = 6)
North
North-middle
South-middle
South
Passage rate
Zones of risk
0
2
4
6
8
10
WD3
WD1
WD0
WC0
WD2
WC3
WC1
WB0
WC2
WB3
WB1
WA0
WB2
WA3
WA1
WA2
EA2
EA1
EA3
EB2
EA0
EB1
EB3
EC2
EB0
EC1
EC3
ED2
EC0
ED0
ED1
ED3

Figure 14. Passage rates (no./0.5 hr) of birds at the Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland, are presented for the 2004 breeding season. Lines of colored dots represent the zones of risk for the different positions relative to the ridge and hypothetical turbine (see Figure 6).

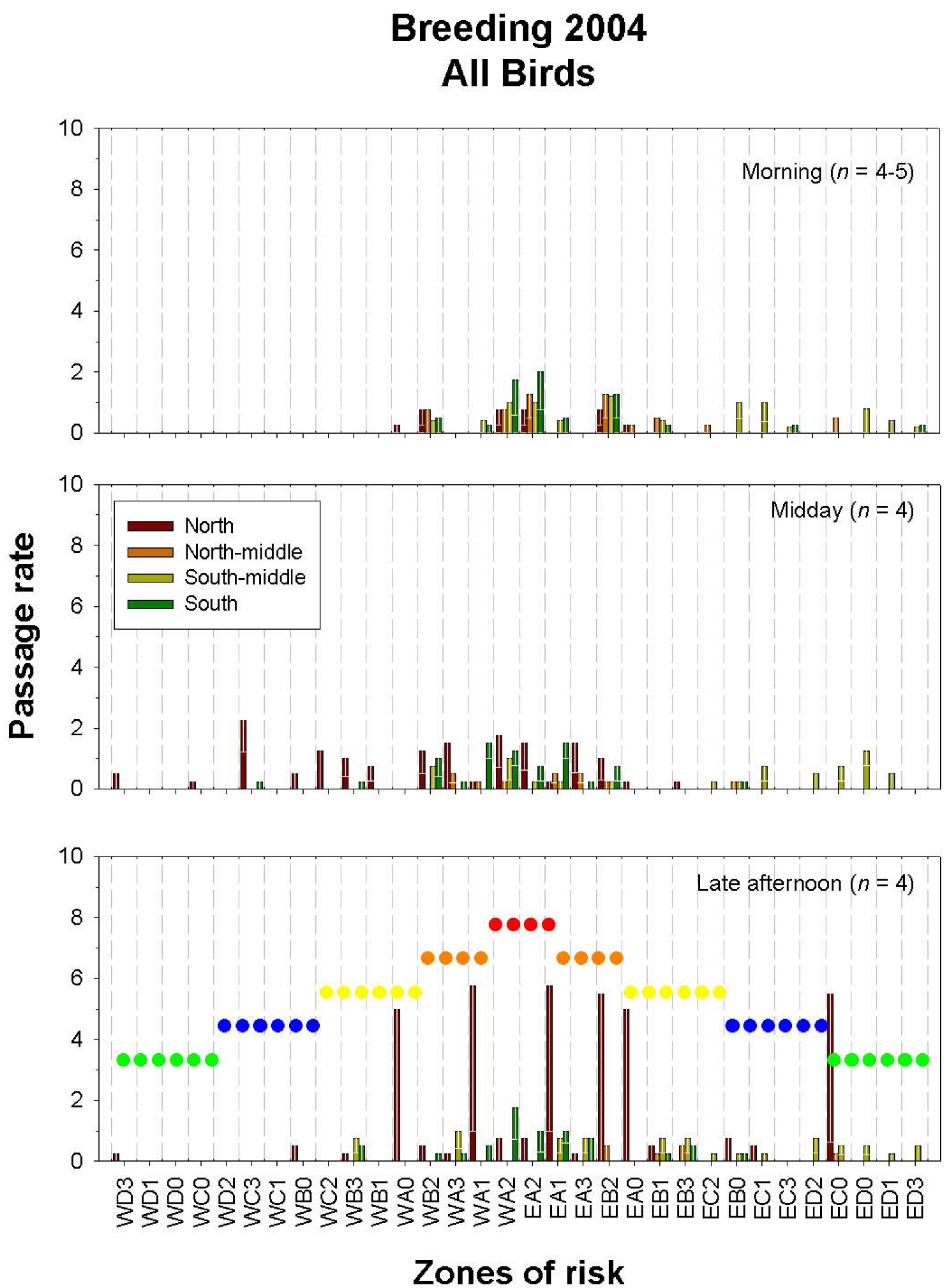

Breeding 2004
All Birds
Morning (n = 4-5)
Midday (n = 4)
North
North-middle
South-middle
South
Late afternoon (n = 4)
Passage rate
WD3
WD1
WD0
WC0
WD2
WC3
WC1
WB0
WC2
WB3
WB1
WA0
WB2
WA3
WA1
WA2
EA2
EA1
EA3
EB2
EA0
EB1
EB3
EC2
EB0
EC1
EC3
ED2
EC0
ED0
ED1
ED3
Zones of risk

Figure 15. Passage rates (no./0.5 hr) of birds at the Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland, are presented for fall 2004. Lines of colored dots represent the zones of risk for the different positions relative to the ridge and hypothetical turbine (see Figure 6).

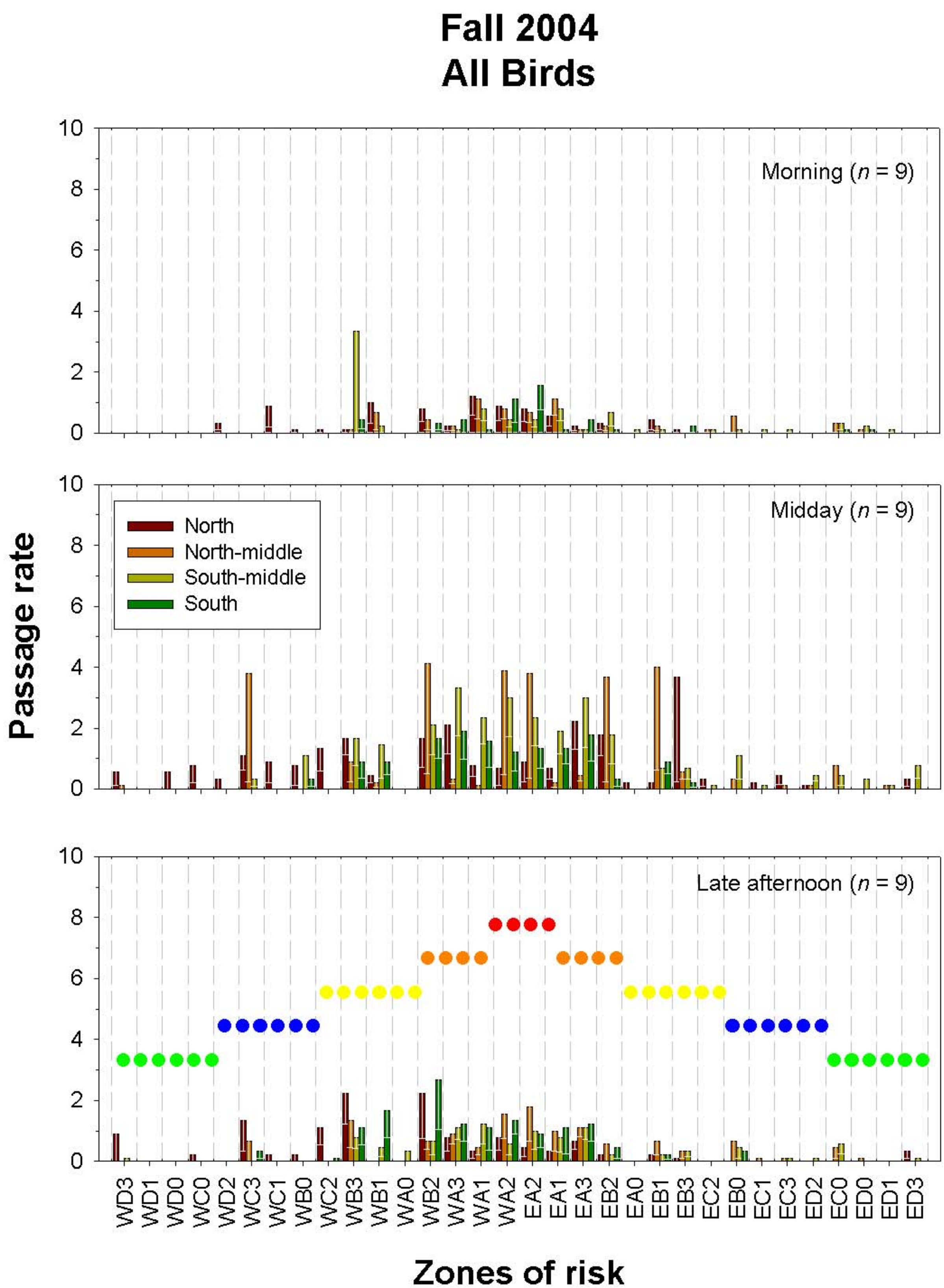

Fall 2004
All Birds
Morning (n = 9)
Midday (n = 9)
Late afternoon (n = 9)
North
North-middle
South-middle
South
Passage rate
0
2
4
6
8
10
WD3
WD1
WD0
WC0
WD2
WC3
WC1
WB0
WC2
WB3
WB1
WA0
WB2
WA3
WA1
WA2
EA2
EA1
EA3
EB2
EA0
EB1
EB3
EC2
EB0
EC1
EC3
ED2
EC0
ED0
ED1
ED3
Zones of risk

Figure 16. Passage rates (no./0.5 hr) of vultures, hawks, and falcons at the Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland, are presented for spring 2004. Lines of colored dots represent the zones of risk for the different positions relative to the ridge and hypothetical turbine (see Figure 6).

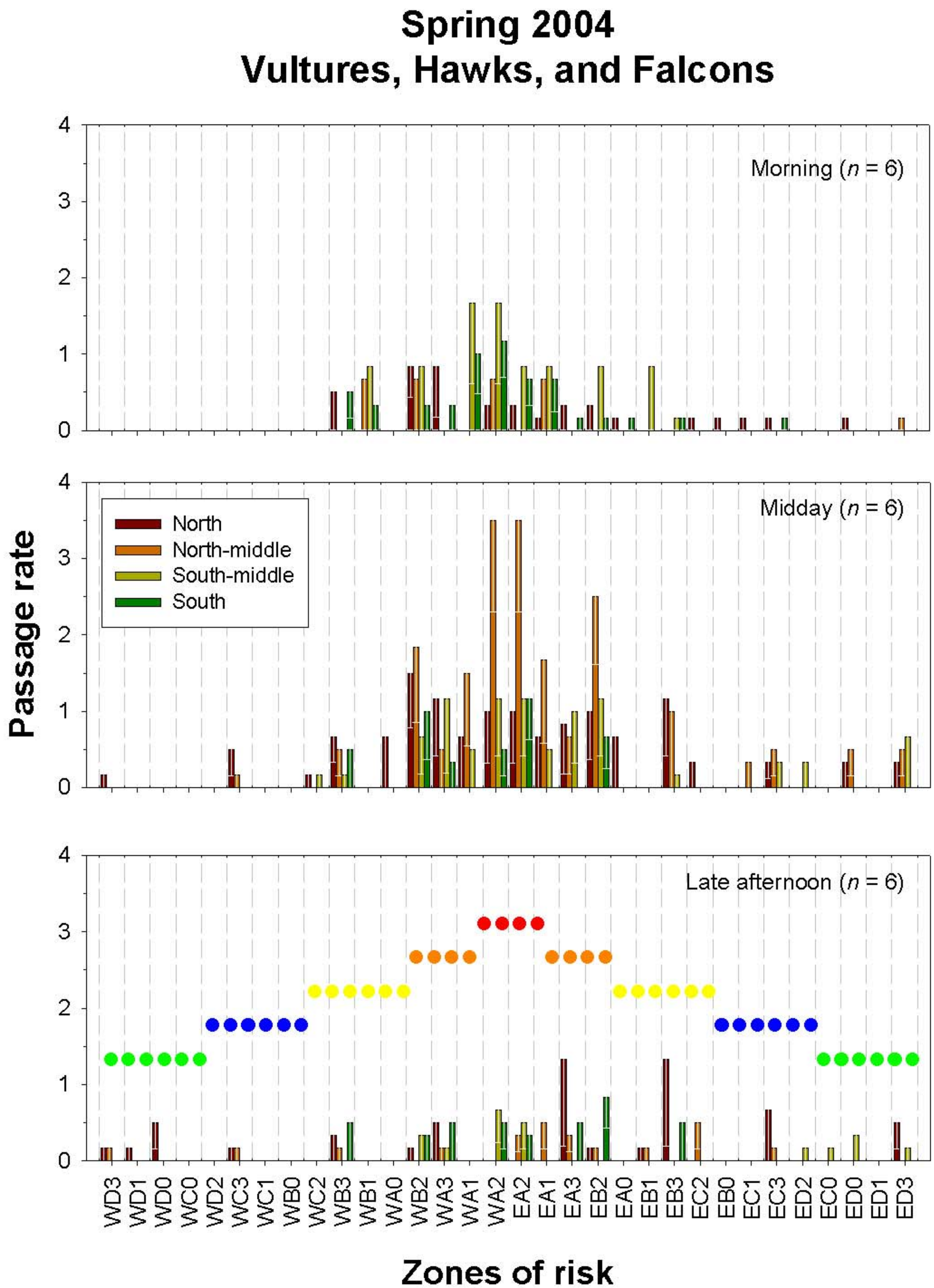

Spring 2004
Vultures, Hawks, and Falcons
Morning (n = 6)
Midday (n = 6)
Late afternoon (n = 6)
North
North-middle
South-middle
South
Passage rate
Zones of risk
WD3 WD1 WD0 WC0 WD2 WC3 WC1 WB0 WC2 WB3 WB1 WA0 WB2 WA3 WA1 WA2 EA2 EA1 EA3 EB2 EA0 EB1 EB3 EC2 EB0 EC1 EC3 ED2 EC0 ED0 ED1 ED3
0
1
2
3
4

Figure 17. Passage rates (no./0.5 hr) of vultures, hawks, and falcons at the Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland, are presented for the 2004 breeding season. Lines of colored dots represent the zones of risk for the different positions relative to the ridge and hypothetical turbine (see Figure 6).

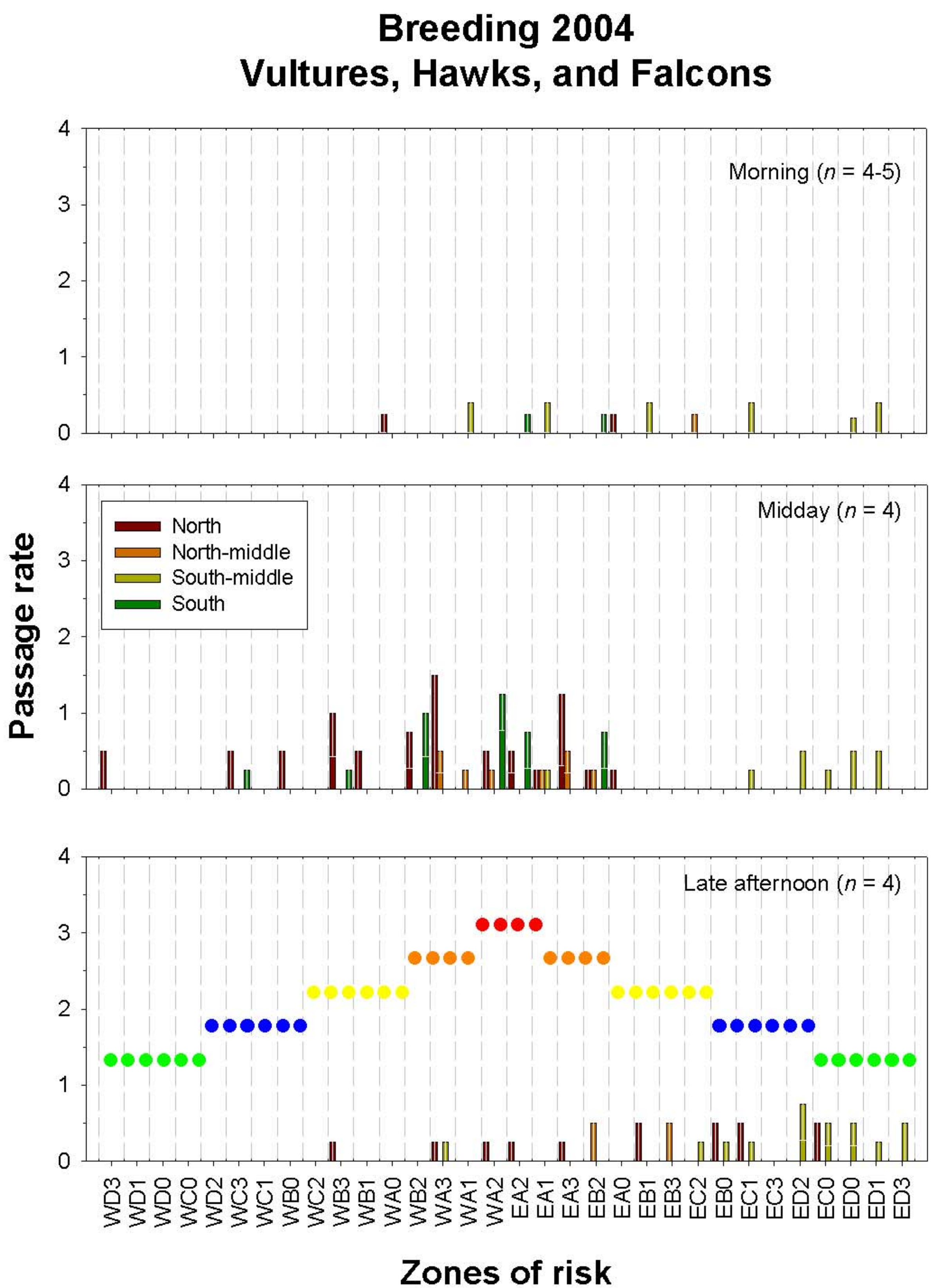
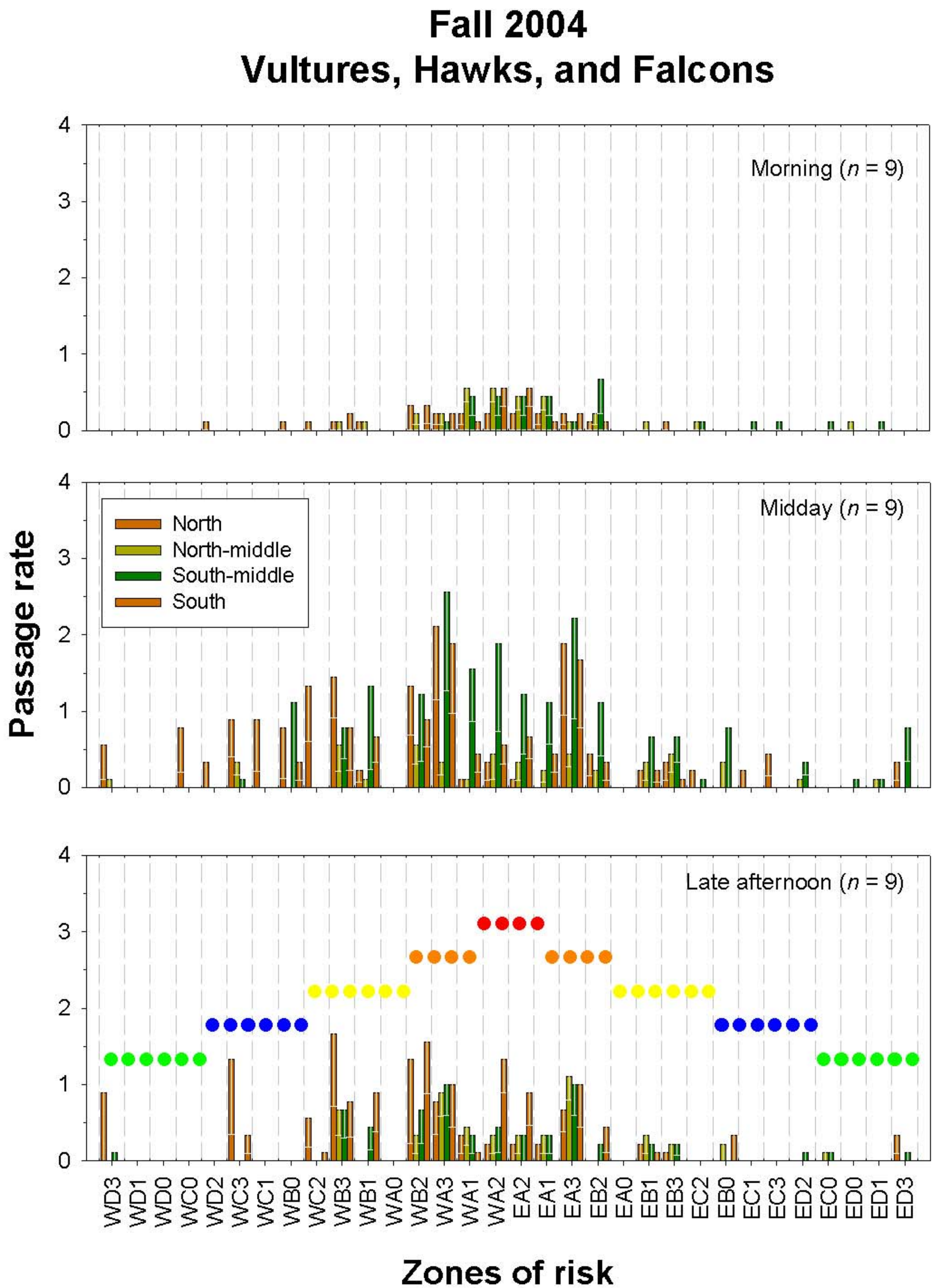

Breeding 2004
Vultures, Hawks, and Falcons
Morning (n = 4-5)
Midday (n = 4)
North
North-middle
South-middle
South
Late afternoon (n = 4)
Passage rate
0
1
2
3
4
WD3
WD1
WD0
WC0
WD2
WC3
WC1
WB0
WC2
WB3
WB1
WA0
WB2
WA3
WA1
WA2
EA2
EA1
EA3
EB2
EA0
EB1
EB3
EC2
EB0
EC1
EC3
ED2
EC0
ED0
ED1
ED3
Zones of risk

Figure 18. Passage rates (no./0.5 hr) of vultures, hawks, and falcons at the Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland, are presented for fall 2004. Lines of colored dots represent the zones of risk for the different positions relative to the ridge and hypothetical turbine (see Figure 6).


Fall 2004
Vultures, Hawks, and Falcons
Morning (n = 9)
Midday (n = 9)
Late afternoon (n = 9)
North
North-middle
South-middle
South
Passage rate
0
1
2
3
4
WD3
WD1
WD0
WC0
WD2
WC3
WC1
WB0
WC2
WB3
WB1
WA0
WB2
WA3
WA1
WA2
EA2
EA1
EA3
EB2
EA0
EB1
EB3
EC2
EB0
EC1
EC3
ED2
EC0
ED0
ED1
ED3
Zones of risk

Appendix I. Thirty-minute observational surveys completed between 27 March–22 November 2003 and 15 March–17 November 2004 at the Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland.

Season	Time of survey	Survey point	Dates 2003	No. OSs	Total minutes	Dates 2004	No. OSs	Total minutes
Spring	Morning	All	16 Apr–07 May	12	360	23 Mar–29 May	24	720
		North (Eagle Rock)	16 Apr–07 May	3	90	23 Mar–29 May	6	180
		North-middle	16 Apr–07 May	3	90	23 Mar–29 May	6	180
		South-middle	16 Apr–07 May	3	90	23 Mar–29 May	6	180
		South	16 Apr–07 May	3	90	23 Mar–29 May	6	180
	Midday	All	03 Apr–27 May	20	1800	15 Mar–29 May	24	720
		North (Eagle Rock)	03 Apr–27 May	5	450	15 Mar–29 May	6	180
		North-middle	03 Apr–27 May	5	450	15 Mar–29 May	6	180
		South-middle	03 Apr–27 May	5	450	15 Mar–29 May	6	180
		South	03 Apr–27 May	5	450	15 Mar–29 May	6	180

Appendix I. Continued.

Season	Time of survey	Survey point	Dates	No. OSs	Total minutes	Dates 2004	No. OSs	Total minutes
	Late afternoon	All	03 Apr–27 May	20	600	22 Mar–29 May	24	720
		North (Eagle Rock)	03 Apr–27 May	5	150	22 Mar–29 May	6	180
		North-middle	03 Apr–27 May	5	150	22 Mar–29 May	6	180
		South-middle	03 Apr–27 May	5	150	22 Mar–29 May	6	180
		South	03 Apr–27 May	5	150	22 Mar–29 May	6	180
Breeding	Morning	All	13 Jun–25 Jul	20	600	09 Jun–24 Jul	17	510
		North (Eagle Rock)	13 Jun–25 Jul	5	150	09 Jun–24 Jul	4	120
		North-middle	13 Jun–25 Jul	5	150	09 Jun–24 Jul	4	120
		South-middle	13 Jun–25 Jul	5	150	09 Jun–24 Jul	5	150
		South	13 Jun–25 Jul	5	150	09 Jun–24 Jul	4	120

Appendix I. Continued.

Season	Time of survey	Survey point	Dates	No. OSs	Total minutes	Dates 2004	No. OSs	Total minutes
	Midday	All	11 Jun–23 Jul	16	480	09 Jun–24 Jul	16	480
		North (Eagle Rock)	11 Jun–23 Jul	4	120	09 Jun–24 Jul	4	120
		North-middle	11 Jun–23 Jul	4	120	09 Jun–24 Jul	4	120
		South-middle	11 Jun–23 Jul	4	120	09 Jun–24 Jul	4	120
		South	11 Jun–23 Jul	4	120	09 Jun–24 Jul	4	120
	Late afternoon	All	11 Jun–24 Jul	12	360	09 Jun–24 Jul	16	480
		North (Eagle Rock)	11 Jun–24 Jul	3	90	09 Jun–24 Jul	4	120
		North-middle	11 Jun–24 Jul	3	90	09 Jun–24 Jul	4	120
		South-middle	11 Jun–24 Jul	3	90	09 Jun–24 Jul	4	120
		South	11 Jun–24 Jul	3	90	09 Jun–24 Jul	4	120

Appendix I. Continued.

Season	Time of survey	Survey point	Dates	No. OSs	Total minutes	Dates 2004	No. OSs	Total minutes
Fall	Morning	All	17Aug–21 Nov	24	720	06 Aug–16 Nov	36	1080
		North (Eagle Rock)	17Aug–21 Nov	6	180	06 Aug–16 Nov	9	270
		North-middle	17Aug–21 Nov	6	180	06 Aug–16 Nov	9	270
		South-middle	17Aug–21 Nov	6	180	06 Aug–16 Nov	9	270
		South	17Aug–21 Nov	6	180	06 Aug–16 Nov	9	270
	Midday	All	16 Aug–21 Nov	23	690	06 Aug–17 Nov	36	1080
		North (Eagle Rock)	16 Aug–21 Nov	6	180	06 Aug–17 Nov	9	270
		North-middle	16 Aug–21 Nov	6	180	06 Aug–17 Nov	9	270
		South-middle	16 Aug–21 Nov	6	180	06 Aug–17 Nov	9	270
		South	16 Aug–21 Nov	5	150	06 Aug–17 Nov	9	270

Appendix I. Continued.

Season	Time of survey	Survey point	Dates	No. OSs	Total minutes	Dates 2004	No. OSs	Total minutes
	Late afternoon	All	15 Aug–22 Nov	19	570	07 Aug–17 Nov	36	1080
		North (Eagle Rock)	15 Aug–22 Nov	4	120	07 Aug–17 Nov	9	270
		North-middle	15 Aug–22 Nov	5	150	07 Aug–17 Nov	9	270
		South-middle	15 Aug–22 Nov	5	150	07 Aug–17 Nov	9	270
		South	15 Aug–22 Nov	5	150	07 Aug–17 Nov	9	270

III. BAT SURVEYS

J. Edward Gates and Joshua B. Johnson

Abstract. —The occurrence of different bat species on the Clipper Windpower Criterion Project, Backbone Mountain, Garrett County, Maryland, was assessed using mist nets and bat detectors in September 2003, May 2004, and June 2004. Species included big brown bat (*Eptesicus fuscus*), hoary bat (*Lasiurus cinereus*), eastern red bat (*Lasiurus borealis*), silver-haired bat (*Lasionyteris noctivagans*), little brown bat (*Myotis lucifugus*), northern myotis (*Myotis septentrionalis*), and eastern pipistrelle (*Pipistrellus subflavus*). Bats identified in summer included eastern red bats (75.7% of identifiable calls), big brown bat (10.8%), and northern myotis (9.0%). No state or federally listed bat species were captured or detected on Backbone Mountain. A review of the literature as it pertains to the occurrence on Backbone Mountain of the rare small-footed myotis (*Myotis leibii*) and endangered Indiana bat (*Myotis sodalis*) can be found in the Discussion.

INTRODUCTION

Proposed wind-energy developments on Big Savage/Backbone and Dans mountains, as well as other mountain ridges in western Maryland, have the likelihood of impacting resident and migratory birds and bats in the vicinity of the turbines (Morrison 1998, Anderson et al. 1999, Hoover 2002, Johnson et al. 2002, Morrison 2002, Nicholson 2003, Erickson et al. 2003, Young et al. 2003, Kerns and Kerlinger 2004, Arnett 2005). Mortality from collisions with towers and rotating blades can be a serious threat, particularly for certain species populations. For instance, current estimates place avian collision mortality between 10,000 and 40,000 birds annually at wind facilities in the United States (Erickson et al. 2001). Pre-construction wildlife assessments and post-construction mortality studies demonstrate that wind facilities located in areas of high bird use can expect high fatality rates; however, factors such as topography, prey abundance, and weather likely influence mortality (Erickson et al. 2001). During migration, bats have also exhibited high rates of mortality at certain wind-energy sites on Appalachian ridges, with an estimated 1,364–1,980 bats killed by 44 turbines during a 6-week period in fall 2004 at the Mountaineer Wind Energy Center, West Virginia (Arnett 2005). Our objective was to identify the species of bats and their relative abundances on the Clipper Windpower Criterion Project in spring, summer, and fall.

STUDY AREA

This pre-construction survey was done at the Clipper Windpower Criterion Project (Clipper Windpower, Inc., http://www.clipperwind.com/) on Backbone Mountain, Garrett County, Maryland, near the towns of Loch Lynn Heights and Oakland. Up to 67, 1.5-MW turbines were originally proposed for 18.5-km of Backbone Mountain ridge top from 10 km north of Highway 560 south towards the Maryland/West Virginia state line with a terminus at Highway 50. The elevation of the ridge top ranges from 917 to 963 m above sea level and extends about 250 m above the surrounding valley floor. Slopes range from 0–15% on the ridge top to 15–35% on the northwest and southeast aspects (Stone and Matthews 1974). The landscape of the ridge is predominantly deciduous forest and open farm fields punctuated by large rock outcroppings. In addition to a few year-round residences present on the mountain, several permanent hunting cabins are located on secondary dirt roads along the ridge top. Paved roads and secondary dirt roads exist on the ridge, making access to the project area fairly easy.

MATERIALS AND METHODS

In September 2003, May 2004, and June 2004, we conducted pre-construction surveys for bats at the Clipper Windpower Criterion Project on Backbone Mountain, Garrett County, Maryland. We used a combination of capture and acoustic methods to determine bat species. To capture bats, we used 50-denier, 2-ply, 38-mm mesh mist nets measuring 2.6 m high and 6, 9, or 12 m long. Mist nets were erected perpendicular to jeep trails and service roads on the ridge top near the bird observational survey (OS) points North (Eagle Rock), North-middle, and South-middle (Figures 1 and 2). No suitable mist net sites were available at the South OS point. We used 4 single-tier mist net arrangements at each of 3 locations for 2 nights each in September, May, and June. Low forest canopy and powerlines prevented us from using 3-tier mist net arrangements, which consist of 3 mist nets stacked vertically and suspended between a rope and pulley system on 2 10-m telescoping poles (Gardner et al. 1989). Mist netting was conducted from dusk to dawn during spring and fall, and from dusk to 0200 during summer. Sampling dates were 4–10 September 2003, 18–24 May 2004, and 23–30 June 2004. The species of each captured bat was determined (Menzel et al. 2002b) as well as its weight (g), forearm length (mm), sex, age (juvenile/adult), and reproductive condition (Anthony 1988, Racey 1988).

To acoustically survey bats, we used an Anabat II (Titley Electronics, Ballina, Australia) broadband, frequency division, bat detector linked to compact flash (CF) storage Zero Crossing Analysis Interface Module (ZCAIM). Anabat II bat detectors received ultrasonic (20-200kHz) bat echolocation calls and transferred them to the ZCAIM where they were stored on a CF memory card. The data were later downloaded to a computer and analyzed with Analook software (Corben 2001). To some extent, the bat species emitting each collected echolocation call could be determined. To collect bat echolocation calls during spring and fall migration, we positioned the Anabat II with its microphone pointing vertically on prominent rock outcrops (*n* = 3) and a 10 m pole in an open field (*n* = 1) on the Backbone Mountain ridge top (Figures 1 and 2). The acoustic sampling sites coincided with the bird OS points North (Eagle Rock), North-middle, South-middle, and South. The acoustic sampling period was conducted from dusk to dawn for 2 nights at each of the 4 survey locations. We acoustically monitored in early September for bats migrating in fall and in mid-May for bats migrating in spring. During summer (late-June), we acoustically monitored once at each bird point count (PC) location (42 points) for 20 minutes to determine summer resident bat activity. We actively monitored with bat detectors in summer to increase sampling volume and to capture larger echolocation call sequences, which potentially increases identification rates (Johnson et al. 2002). We used Analook computer software to identify echolocation calls to species where possible and species groups where necessary. We identified only those call sequences containing ≥3 pulses. Feeding activity also was obtained from the echolocation call data. Bats produce a feeding buzz when approaching a prey item, e.g., an insect. Feeding buzzes have a high pulse rate compared to orientation or search-phase echolocation calls (Kalko and Schnitzler 1998). To identify calls, we qualitatively compared structures and frequencies of unknown calls collected on Backbone Mountain to a library of known calls collected from hand-released bats marked with chemiluminescent tags. Josh Johnson identified all echolocation calls to reduce bias and increase identification precision (O'Farrell et al. 1999). Currently, no reliable techniques exist to determine age, sex, or reproductive condition of bats based on echolocation call characteristics. Moreover, number of recorded echolocation calls does not necessarily represent number of individual bats, but relative bat activity levels.

RESULTS

During fall, we captured 36 bats including 7 eastern red bats (*Lasiurus borealis*), 1 hoary bat (*L. cinereus*), 19 little brown bats (*Myotis lucifugus*), and 9 northern myotis (*M. septentrionalis*) during 24 mist net nights (Table 1). The majority of captures (55.6%) occurred at Eagle Rock on 4 September 2003 following a 1-hour storm just before sunset. Weather during all other sampling nights was clear and cool with nearly a full moon. The juvenile to adult ratio was 4:7. The male to female ratio was 7:4.

During spring, we captured 10 bats including 3 eastern red bats, 3 little brown bats, and 4 northern myotis. Eagle Rock was the only location where we did not capture any bats during spring. The weather was cool with scattered rain during the nights that we sampled at Eagle Rock in spring. The male to female ratio was 1:2.

During summer, we captured 11 bats including 4 big brown bats (*Eptesicus fuscus*), 1 eastern red bat, 2 little brown bats, and 4 northern myotis. The male to female ratio was 3:8. All captured female bats, except 1 (a northern myotis) were reproductively active. We captured no juvenile bats during summer.

Of 1721 echolocation calls that we collected during fall, 1139 (66.2%) were identifiable to species or species groups (Table 2). We identified some echolocation calls to species, including big brown bats (n = 46), hoary bats (n = 19), silver-haired bats (*Lasionycteris noctivagans*) (n = 10), eastern red bats (n = 307), and eastern pipistrelles (*Pipistrellus subflavus*) (n = 41). The eastern red bat/eastern pipistrelle species group comprised 32.6% of all echolocation calls and 49.3% of identifiable echolocation calls. The myotine species group [i.e., eastern small-footed bat (*Myotis leibii), M. lucifugus, M. septentrionalis*, Indiana bat (*M. sodalis*)] comprised 5.6% of all echolocation calls and 8.4% of identifiable echolocation calls. No myotine echolocation calls could unequivocally be identified as endangered Indiana bat or rare eastern small-footed bat. The majority (59.0%) of echolocation calls was collected at Eagle Rock on 4 September 2003; the same location and night when the majority of bats was captured. During fall, total capture and acoustic data indicated a bimodal trend in intra-night bat activity (Figure 3). Acoustic data indicated bat activity peaked between 2200 and 2400 hours with a smaller peak between 0100 and 0300 hours. Between 0300 hours and sunrise, bat activity declined drastically according to acoustic data. Capture data indicated high bat activity from dusk to 2400 hours and a lesser peak in activity between 0100 and 0400 hours. Between 0400 hours and sunrise, only 1 bat was captured.

During spring, we collected 658 echolocation calls during 8 detector nights. We were able to identify to species or species groups 405 (61.6%) of the echolocation calls (Table 3). Eastern red bats produced most (41.0%) of the identifiable echolocation calls, followed by little brown bats (28.9%), hoary bats (13.3%), and big brown bats (9.6%). No myotine echolocation calls could unequivocally be identified as endangered Indiana bat or rare eastern small-footed bat. There was no clear relationship between number of echolocation calls collected and number of bats captured on a nightly basis. However, we acoustically detected more species than we captured. Intra-night activity patterns during spring were similar to fall patterns.

During summer, we collected 861 echolocation calls at the 42 bird point-count locations (Table 4). We detected bat activity at all but 8 locations. Of the 692 identifiable echolocation calls, 524 (75.7%) were produced by eastern red bats at 26 locations (61.9% occurrence). Big brown bats produced 75 (10.8%) echolocation calls at 6 locations (14.3% occurrence). We collected 62 (9.0%) northern myotis echolocation calls at 16 locations (38.1% occurrence). No myotine echolocation calls could unequivocally be identified as endangered Indiana bat or rare eastern small-footed bat. Neither the Maryland Department of Natural Resources nor the United States Fish and Wildlife Service currently list any captured or detected bat species as threatened or endangered (Maryland Department of Natural Resources 2003, 2004).

Discussion

Capture and echolocation call data suggest bats migrate through our sampling sites on Backbone Mountain, at least during fall. Our capture and acoustic survey results indicate bat activity is highest during fall on Backbone Mountain. Captured and detected bats likely were not resident bats considering our September sampling period. During fall migration, bats likely travel through the Backbone Mountain area from early August through October (Norton 1930, Terres 1956, Heppenstall 1960, LaVal and LaVal 1979). Bat migration likely is more organized in fall than in spring. Historic observations of bats migrating in groups typically have been during fall (Zimmerman 1937, Heppenstall 1960). Feeding activity was detected for most species indicating bats may forage during migration. It is unlikely bats store enough fat reserves to migrate without stopping and probably use stopover sites (Fleming and Eby 2003). During spring, bat migration may occur over a longer time period, but this has not been examined extensively. Perhaps during fall, juvenile bats are familiarized with migration routes by adult bats. It is interesting to note the disparity between numbers of individuals of captured and detected bat species during all seasons. We captured a relatively high number of myotine bats compared to lasiurine bats (i.e., eastern red, silver-haired, and hoary bats). However, the number of myotine bat echolocation calls was far less than lasiurine bat echolocation calls and other species and species group echolocation calls. Moreover, we detected, but did not capture, eastern pipistrelles and silver-haired bats. One reason for the disparity in numbers of captured and detected bats could be that echolocation calls from eastern red bats, eastern pipistrelles, hoary bats, silver-haired bats, and big brown bats are relatively high in intensity compared to myotine bats (Aldridge and Rautenbach 1987). Therefore, the effective Anabat II sampling area is greater for these species compared to myotine bats. Another reason could be that lasiurine bats migrate and forage at higher altitudes than myotine bats, reducing their chances of capture in low mist nets. It has been documented that acoustic surveys record more species than capture surveys (J. E. Gates and J. B. Johnson, University of Maryland Center for Environmental Science, unpublished data). However, a combination of acoustic and capture techniques produces a more complete survey (O'Farrell and Gannon 1999). During summer, we captured reproductively active female bats. It is unknown if the bats were roosting on the ridge top, but they likely use the area for foraging. We detected foraging activity of big brown bats, eastern red bats, northern myotis, and unknown myotine bats during summer. We captured more females than males during summer, which contradicts previous research suggesting females prefer to roost and forage in valleys rather than on ridge tops (Brack et al. 2002, Cryan et al. 2000).

It is unknown what effect wind turbines will have on resident and migrating bats on the Clipper Windpower Criterion Project. It is possible that mortalities will occur that are similar to those found on the Mountaineer Wind Energy Center (Kerns and Kerlinger 2004, Arnett 2005). The Mountaineer Wind Energy Center is located approximately 13 km southwest of the Clipper Windpower Criterion Project and on the same ridgeline. To date, no rare or endangered bat mortalities have been documented at the Mountaineer Wind Energy Center. Rare eastern small-footed bats and endangered Indiana bats may occur on Backbone Mountain, either as migrants or summer residents. However, they likely occur in such low numbers that they would only be documented by very thorough surveys, if at all. Eastern small-footed bats have been documented roosting in western Maryland rock outcrops during summer (Gates et al. 1981). The rock outcrops are located about 21 km northeast of the Clipper Windpower Criterion Project on Big Savage Mountain, which is part of the same ridgeline as Backbone Mountain. Eastern small-footed bats typically roost in rock outcrops, but occasionally in buildings during summer (Best and Jennings 1997). Few eastern small-footed bats have been observed hibernating in western Maryland caves (Gates et al. 1984); 1 hibernaculum is 16 km from Eagle Rock. During bat surveys at western Maryland caves in fall, relatively few (<2%) eastern small-footed bats were captured compared to little brown bats, northern myotis, and eastern pipistrelles (Marsh 1998, Johnson and Gates 2004). Eastern small-footed bat ecology is poorly understood compared to other bats in the region, primarily because of its perceived low population and elusive behavior.

No studies have examined summer roosting habits of eastern small-footed bats in western Maryland. To our knowledge, no studies have examined migration routes of eastern small-footed bats. Eastern small-footed bats in Canada migrated up to 19.3 km from their hibernacula (Hitchcock 1955).

The Indiana bat was listed as an endangered species in 1967 under the Endangered Species Act of 1966 because of significant population declines. Although efforts have been made to protect critical winter hibernacula (i.e., caves and mines), populations have continued to decrease. A 2000−2001 Indiana bat population survey revealed approximately 382,350 individuals; a 57% population decline since the 1960s (Clawson 2002). Therefore, population declines may be attributable to loss of summer habitat. Conversely, Indiana bat populations have been stable in Pennsylvania, possibly because of hibernacula protection. In West Virginia, a 2000/2001 hibernacula census revealed an Indiana bat population estimated to be 9,700 individuals, compared to an estimated 1,500 individuals during the 1960s (Clawson 2002). Stable and increasing Indiana bat populations in Pennsylvania and West Virginia may be attributed to discovery of new hibernacula or protection of known hibernacula. Although hibernacula protection is critical to Indiana bat population recovery, conservation of summer habitat is equally imperative.

Indiana bats begin to emerge from hibernation in mid-April (Cope and Humphrey 1977) and migrate long distances, sometimes over 500 km, to their summer ranges (Kurta and Murray 2002). It is unknown if Indiana bats follow valleys or cross ridge tops during migration. During summer, Indiana bats roost in cavities and crevices of dead trees and under exfoliating bark of dead and live trees. Some male Indiana bats roost in trees located within 20 km of their hibernacula during summer (Hobson and Holland 1995, Ford et al. 2002a). Females form maternity colonies of 20−100 individuals in primary roost trees (Humphrey et al. 1977, Kurta et al. 1993a, b, Callahan et al. 1997). Primary roost trees typically are large-diameter (>35 cm) dead trees with direct exposure to sunlight (Humphrey et al. 1977, Callahan et al 1997, Britzke et al. 2003). Maternity colonies have been documented using live trees with limited exposure to sunlight as alternate or secondary roosts during elevated precipitation or temperature events (Callahan et al. 1997). Many tree species have been used as roost sites by Indiana bats including red (*Acer rubrum*), silver (*A. saccharinum*), and sugar (*A. saccharum*) maple; black birch (*Betula lenta*); bitternut (*Carya cordiformis*), pignut (*C. glabra*), and shagbark (*C. ovata*) hickory; shortleaf (*Pinus echinata*), pitch (*P. rigida*), and Virginia (*P. virginiana*) pine; cottonwood (*Populus deltoides*); white (*Fraxinus americana*), black (*F. nigra*), and green (*F. pennsylvanica*) ash; sycamore (*Platanus occidentalis*); white (*Quercus alba*), scarlet (*Q. coccinea*), shingle (*Q. imbricaria*), northern red (*Q. rubra*), and post (*Q. stellata*) oak; eastern hemlock (*Tsuga canadensis*); sassafras (*Sassafras albidum*); and American (*Ulmus americana*) and slippery (*U. rubra*) elm (Humphrey et al. 1977, Brack 1983, Gardner et al. 1991, King 1992, Kurta et al. 1993a, b, Rommé et al. 1995, Caryl and Kurta 1996, Kiser and Elliott 1996, Kurta et al. 1996, Salyers et al. 1996, Callahan et al. 1997, MacGregor et al. 1999, Britzke et al. 2003). This is not a definitive list of Indiana bat roost trees as more tree species frequently are being added to the list (MacGregor et al. 1999). Roost trees have been documented in mixed mesophytic and mixed conifer-hardwood forests. In Indiana, Humphrey et al. (1977) and Brack (1983) located roosts in riparian areas. In Illinois, Gardner et al. (1991) documented 37 roosts in uplands and 11 roosts in bottomlands. Callahan et al. (1997) found roosts in Missouri upland and riparian areas. In western North Carolina/eastern Tennessee, Britzke et al. (2003) located roost trees at a mid-slope elevation of 1158 m, significantly higher than any previously recorded Indiana bat roost tree.

Indiana bats are known to forage in a variety of cover types. In Missouri, LaVal et al. (1977) found that bats foraged under the forest canopy on ridges and hilltops. Similar to Humphrey et al. (1977), LaVal et al. (1977) found that Indiana bat foraging activity was concentrated 2−30 m above the forest floor. Indiana bats also have been documented foraging along riparian areas (Humphrey et al. 1977, LaVal and LaVal 1980, Brack 1983) and in upland forests (LaVal et al. 1977, LaVal and LaVal 1980, Brack 1983). The influence of forest stand structure on Indiana bat foraging behavior is not well known. In Missouri, Callahan (1993) found Indiana bat maternity roosts in stands that had been heavily logged within the past 20 years. Gardner et al. (1991) found that Indiana bats in Illinois foraged in areas that had been logged using selection harvest techniques. In Indiana, woodlands were preferred foraging areas over suburban development (Sparks et al. In press). It is unclear if Indiana bat foraging behavior is similar in the Appalachian Mountain region and Midwest (i.e., Illinois, Indiana, southern Iowa, southern Michigan, northern Missouri, and western Ohio).

In Maryland, few records of Indiana bats exist. Most have been documented during fall at caves (Gates et al. 1984, Marsh 1998). Indiana bats have been documented at a cave 16 km from Eagle Rock. There are no records of Indiana bats occurring in western Maryland during summer. However, forest bat survey efforts during summer in western Maryland have not been extensive. Only 4 sampling nights for forest bats have been conducted during summer in western Maryland in the past 15 years (D. Feller, Maryland Department of Natural Resources, personal communication). There are 92 Priority II (containing 500−30,000 individuals) and III (containing <500 individuals) Indiana bat hibernacula in the central and southern Appalachian Mountains from central Pennsylvania to northeastern Alabama (Humphrey 1978, USFWS 1999, Menzel et al. 2001). One Priority II and several III Indiana bat hibernacula exist in West

Virginia counties within documented Indiana bat migrating distances of Garrett County, Maryland (Ford et al. 2002a, Stihler and Brack 1992). These include Pendleton, Preston, and Tucker counties. In Pennsylvania, 2 Priority III Indiana bat hibernacula exist in Somerset County, which is adjacent to Garrett County, Maryland. During summer, male Indiana bats sometimes migrate very short distances (<20 km) or use hibernacula as summer roosts (Hobson and Holland 1995, Ford et al. 2002a). Currently, it is unclear where most female Indiana bats in West Virginia and Pennsylvania hibernacula migrate in summer. More surveys focusing on Indiana bats have been conducted during summer in West Virginia (e.g., Angus et al. 2001, Edwards et al. 2001, Osbourne et al. 2002) than in Maryland. Captures of female Indiana bats in West Virginia during summer are rare (Owen et al. 2001). It is unknown if Indiana bats hibernating in West Virginia and Pennsylvania migrate through or roost in western Maryland.

It has been suggested that Indiana bat maternity colonies do not commonly occur in the Appalachian Mountains because of relatively high elevations and associated decreased average temperatures (Brack et al. 2002). However, the study used surrogate bat species as an example because Indiana bat maternity roosts are not well documented in the Appalachian Mountains. They found that reproductive females of several bat species in Pennsylvania, Virginia, and West Virginia were more commonly captured at lower elevations than at higher elevations where male and non-reproductive females were more commonly captured (Brack et al. 2002). In the Appalachian region, Ford et al. (2002b) found that female-dominated sex ratios of eastern red bats occurred at lower elevations with higher mean June temperatures. In South Dakota, Cryan et al. (2000) found that reproductively active female bats were more frequently captured at lower elevations than at higher elevations where male bats were more frequently captured. However, in West Virginia, northern bat maternity roosts have been documented at elevations and summer temperatures similar to Backbone Mountain (Menzel et al. 2002c). In the Appalachian Mountains, the possible relationship between Indiana bat maternity roosts and elevation and resulting decreased temperatures has not been examined. Roosts in warmer areas probably reduce thermoregulatory expenditures of juvenile bats, resulting in augmented growth and development (Humphrey 1975, Callahan et al. 1997, Foster and Kurta 1999). The valleys surrounding Backbone Mountain may have higher average summer temperatures and may be less exposed to the wind, especially on the east side. Indiana bat maternity colonies that may occur in the Backbone Mountain vicinity may be more likely to roost in the valleys, rather than the ridge top based on studies of other bat species. However, data showing that Indiana bat maternity colonies do or do not occur on the Backbone Mountain ridge top currently do not exist.

Very little of the limited amount of research on Indiana bat roosting and foraging ecology has occurred in the Appalachian region. The majority of the Indiana bat population occurs in the Midwest. Therefore, the majority of research on Indiana bat roosting and foraging ecology has been focused in this relatively flat terrain. Britzke et al. (2003) documented Indiana bat roosts at mid-slope at an elevation of 1158 m, much higher than the ridge top on Backbone Mountain. However, their study was conducted in the Nantahala National Forest in western North Carolina/eastern Tennessee, which had a higher average annual temperature (13.4ºC), higher average July temperature (23.6ºC), and higher average annual precipitation (159.8 cm; Karl 2002) than Oakland, Maryland. In Tucker County, West Virginia, a male Indiana bat was documented roosting beneath exfoliating bark on a sugar maple and 2 shagbark hickories at a mid-slope elevation of 702 and 800 m, respectively (Ford et al. 2002a). In Bath County, Virginia, a male Indiana bat was documented roosting beneath the exfoliating bark of a shagbark hickory at an elevation of 700 m (Hobson and Holland 1995). In July 1999, a post-lactating female Indiana bat was captured at an elevation of 900 m in Randolph County, West Virginia. However, this bat was not fitted with a radio-transmitter, and no roost trees were documented (Owen et al. 2001).

The foraging habits of Indiana bats in the Appalachian region are not well known. In Blair County, Pennsylvania, a maternity colony of Indiana bats was documented roosting in a church attic. The church was located in a valley at 290 m elevation. Radio-tagged bats from the colony were documented foraging mostly in a nearby section of intact forest with relatively flat (<10º slope) topography. Although the church was located within known foraging distances of Lock Mountain (elevation 580 m), no bats were documented foraging on the slope or ridge top (Butchkoski and Hassinger 2002). In western Virginia, Hobson and Holland (1995) found that a male Indiana bat mostly foraged around the canopy of an 80-year old mature oak-hickory forest, but occasionally foraged along a ridge. This pattern suggests that Indiana bats potentially occurring in the Backbone Mountain area may be more likely to roost and forage in the forested portions of valleys and mid-slopes, rather than the ridge tops where wind turbines would be constructed.

It is unclear if Indiana bats regularly follow valleys or cross over or fly along ridge tops such as Backbone Mountain when migrating or foraging. Indiana bats captured exiting hibernation in Pennsylvania were radio-tracked for >56 km. The bats traveled east from the hibernaculum and did not follow terrain features or readily cross mountains. During migration, the Indiana bats may forage on mountaintops due to warmer temperatures (Butchkoski 2003). Migrating Indiana bats in New York were radio-tracked and documented traveling up to 80 km/hr. Some Indiana bats followed the Hudson River while migrating (Chenger 2003). The Clipper Windpower Criterion Project is within migratory distances of Indiana bat hibernacula in neighboring Pennsylvania and West Virginia (Kurta and Murray 2002). Indiana bat populations hibernating in these 2 states comprise <3% of the total Indiana bat population (Clawson 2002). The summer ranges of female Indiana bats occurring in these hibernacula are unknown. Limited research in the Appalachian region has shown that Indiana bats roost and forage in valleys and on mid-slopes (Hobson and Holland 1995, Butchkoski and Hassinger 2002, Ford et al. 2002a). The Clipper Windpower Criterion Project potentially poses little threat to the main Indiana bat population because such a small percentage of the population occurs locally. Those that might use the area during summer may be more likely to roost and forage in valleys and mid-slopes rather than ridge tops where wind turbines are typically located, but this cannot be stated unequivocally. Peripheral Indiana bat populations should not be overlooked in the continued effort for species recovery. These populations may experience greater selective pressures, resulting in higher genetic diversity than core populations in the Midwest (Lesica and Allendorf 1992, 1995).

Although wind energy has generally been considered environmentally friendly, it has been responsible for bird and bat mortalities (Johnson et al. 2003, Johnson et al. 2004). The majority of bats killed at wind turbine sites have been tree roosting, migratory species including eastern red, hoary, and silver-haired bats. To date, no Indiana bat mortalities have been attributed to wind turbines or their construction. However, the status of Indiana bat populations (i.e., presence/absence, population numbers) near the wind turbine sites in some regions is unclear. Impacts on populations of perceived common species including hoary bats and eastern red bats are difficult to assess. These common species regularly are captured in summer during forest bat inventories. However, there currently are no accurate estimates of tree bat populations. Populations of bat species that hibernate in caves (e.g., Indiana bats, little brown bats) commonly are inventoried and trends are established. However, attributing negative population trends to wind turbine mortalities is equivocal. Habitat destruction and hibernacula disturbance can also result in population declines (Pierson 1998, Clawson 2002).

Clearing sections of forest at the Clipper Windpower Criterion Project to construct wind turbines may have an impact on summer resident bat activity. Increases in species-specific bat foraging activity have been documented in small forest clearings and gaps (Grindal and Brigham 1998, Menzel et al. 2002a). Increased activity in clearings and gaps is exhibited by different bat species, including big brown bats and hoary bats, which are adapted to foraging in open areas (Aldridge and Rautenbach 1987, Menzel et al. 2002a, Owen et al. 2004). Species that are adapted to foraging in forest interiors (e.g., northern myotis) (LaVal et al. 1977, Owen et al. 2004) likely will be negatively impacted by creation of forest clearings. Tree removal will reduce foraging substrate preferred by northern myotis (LaVal et al. 1977, Owen et al. 2003, Patriquin and Barclay 2003). Moreover, tree removal potentially will reduce tree roosting opportunities. In West Virginia, northern myotis maternity colonies were documented roosting in mature hardwoods on ridge tops at elevations similar to Backbone Mountain (Menzel et al. 2002c). Little brown bats are adapted to foraging in forest interiors (Adams 1996), but will forage along forest edges also (Patriquin and Barclay 2003). The effects of creating forest clearings on migrating bats are unclear.

Our acoustic and capture surveys were unable to detect bats flying at altitudes >40 m. Mist nets were 2.6 m high and the Anabat II likely could detect bats with high-intensity echolocation calls up to 40 m high. Therefore, it can be argued that bats detected in our survey would not be at risk of colliding with wind turbines. However, it is likely that our survey results represent only a small sample, spatially and temporally, of bats using Backbone Mountain.

Some bats commonly forage above the forest canopy (Kalcounis et al. 1999, Menzel et al 2000, Menzel et al. In press). Bat species detected in our survey have been documented colliding with tall structures including wind turbines, lighthouses, television towers, and buildings (Saunders 1930, Van Gelder 1956, Crawford and Baker 1981, Johnson et al. 2003, Kerns and Kerlinger 2004). Further efforts are needed to examine bat activity at altitudes up to 120 m and possibly higher. This may include, and certainly is not limited to, attaching bat detectors to helium balloons (Menzel 2003), fire towers, or existing wind turbines; or using thermal infrared imaging cameras or radar to monitor numbers of bats passing through potential and existing wind farms.

Acknowledgments. —John Sherwell and Gwenda L. Brewer, Maryland Department of Natural Resources, were instrumental in organizing several early meetings on the bird/bat wind turbine issue. These meetings were helpful in developing the field protocols used in this study. Several personnel at Versar, Inc., also contributed to initial project design, particularly Mark T. Southerland and Fred Kelley. We further thank the representatives and personnel of Clipper Windpower, Inc., for their help and cooperation during all phases of the project, especially Ron Orozco, David E. Scott, and Kevin Rackstraw. We acknowledge the field crew, Jean-Paul Kennedy and Kristen Schmitt in 2003, and Rachel M. Gauza and Jennifer M. Karow in 2004, for helping collect the data used in this report. We thank all the landowners who allowed us access to their properties. John Sherwell, Fred Kelley, Gwenda L. Brewer, Chandler S. Robbins, and D. Daniel Boone commented on an earlier draft of this report. This project was funded by the Maryland Department of Natural Resources, Power Plant Research Program.

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Table 1. Bat captures during mist net surveys at the Clipper Windpower Criterion Project on Backbone Mountain, Garrett County, Maryland. Data include site name associated with accompanying maps (Figures 1 and 2), Universal Transverse Mercator coordinates, dates, number of mist nets at each site, times when mist nets were opened and closed, ambient air temperature (°C) when mist nets were opened and closed, time when each bat was captured, bat species, age (adult/juvenile), sex, reproductive condition, weight (g), forearm length (mm), height (m) in net bat was captured, net denotation associated with accompanying maps, and net width and height (m).

Site	UTM_X	UTM_Y	Date	No. nets	Time open	Time close	Temp °C (open)	Temp °C (close)	Time	Species[1]	Age	Sex	Repro. cond.	Weight (g)	Forearm (mm)	Height (m) in net	Net #	Net dimensions (m)	Comments
North (Eagle Rock)	131310	4371394	9/4/2003	4	2030	0630	15.0	11.0	2140	MYLU	A	M	Non-repro	7.25	36.0	1.0	A	12.0 X 2.6	
North (Eagle Rock)	131310	4371394	9/4/2003	4	2030	0630	15.0	11.0	2140	MYLU	N/A	N/A	N/A	N/A	N/A	1.0	A	12.0 X 2.6	Escaped
North (Eagle Rock)	131310	4371394	9/4/2003	4	2030	0630	15.0	11.0	2205	MYLU	A	F	Non-repro	9.50	39.0	0.5	A	12.0 X 2.6	
North (Eagle Rock)	131440	4371502	9/4/2003	4	2030	0630	15.0	11.0	2300	MYLU	J	M	Non-repro	8.00	39.0	1.5	A	12.0 X 2.6	
North (Eagle Rock)	131310	4371394	9/4/2003	4	2030	0630	15.0	11.0	2300	MYLU	A	F	Non-repro	9.25	36.5	1.5	A	12.0 X 2.6	
North (Eagle Rock)	131310	4371394	9/4/2003	4	2030	0630	15.0	11.0	2325	MYLU	A	F	Non-repro	8.50	37.0	2.0	A	12.0 X 2.6	
North (Eagle Rock)	131310	4371394	9/4/2003	4	2030	0630	15.0	11.0	2325	MYLU	A	F	Non-repro	6.50	35.0	0.2	A	12.0 X 2.6	
North (Eagle Rock)	131310	4371394	9/4/2003	4	2030	0630	15.0	11.0	2325	MYLU	A	F	Non-repro	9.75	38.0	0.5	A	12.0 X 2.6	
North (Eagle Rock)	131310	4371394	9/4/2003	4	2030	0630	15.0	11.0	2355	MYLU	A	M	Non-repro	6.25	37.0	2.0	A	12.0 X 2.6	
North (Eagle Rock)	131310	4371394	9/4/2003	4	2030	0630	15.0	11.0	2355	MYLU	A	F	Non-repro	7.75	35.0	1.5	A	12.0 X 2.6	
North (Eagle Rock)	131310	4371394	9/5/2003	4	2030	0630	15.0	11.0	0345	MYLU	A	M	Non-repro	8.00	37.0	1.5	A	12.0 X 2.6	
North (Eagle Rock)	131310	4371394	9/5/2003	4	2030	0630	15.0	11.0	0500	MYLU	A	M	Non-repro	7.75	37.0	2.0	A	12.0 X 2.6	
North (Eagle Rock)	131310	4371394	9/4/2003	4	2030	0630	15.0	11.0	2110	MYLU	A	M	Non-repro	7.25	35.0	1.0	B	6.0 X 2.6	
North (Eagle Rock)	131310	4371394	9/4/2003	4	2030	0630	15.0	11.0	2130	MYLU	A	F	Non-repro	9.50	39.0	1.5	B	6.0 X 2.6	
North (Eagle Rock)	131310	4371394	9/5/2003	4	2030	0630	15.0	11.0	0300	LACI	A	M	Non-repro	28.00	60.0	1.3	B	6.0 X 2.6	
North (Eagle Rock)	131310	4371394	9/5/2003	4	2030	0630	15.0	11.0	0300	MYLU	N/A	N/A	N/A	N/A	N/A	N/A	B	6.0 X 2.6	Escaped

Table 1. Continued.

Site	UTM_X	UTM_Y	Date	No. nets	Time open	Time close	Temp °C (open)	Temp °C (close)	Time	Species[1]	Age	Sex	Repro. cond.	Weight (g)	Forearm (mm)	Height (m) in net	Net #	Net dimensions (m)	Comments
North (Eagle Rock)	131310	4371394	9/5/2003	4	2030	0630	15.0	11.0	0300	MYLU	N/A	N/A	N/A	N/A	N/A	N/A	B	6.0 X 2.6	Escaped
North (Eagle Rock)	131440	4371502	9/4/2003	4	2030	0630	15.0	11.0	2207	LABO	A	M	Non-repro	10.00	38.5	0.5	C	9.0 X 2.6	
North (Eagle Rock)	131440	4371502	9/4/2003	4	2030	0630	15.0	11.0	2245	MYSE	J	F	Non-repro	5.50	34.0	2.0	D	9.0 X 2.6	
North (Eagle Rock)	131440	4371502	9/4/2003	4	2030	0630	15.0	11.0	2245	LABO	J	M	Non-repro	9.75	38.0	1.0	D	9.0 X 2.6	
North (Eagle Rock)	131310	4371394	9/7/2003	4	2000	0630	16.0	13.5									A	6.0 X 2.6	No captures
North (Eagle Rock)	131310	4371394	9/8/2003	4	2000	0630	16.0	13.5	0345	MYSE	A	M	Non-repro	7.75	35.0	1.5	B	12.0 X 2.6	
North (Eagle Rock)	131440	4371502	9/7/2003	4	2000	0630	16.0	13.5									C	9.0 X 2.6	No captures
North (Eagle Rock)	131440	4371502	9/8/2003	4	2000	0630	16.0	13.5	0120	MYSE	A	F	Non-repro	7.00	37.0	1.5	D	9.0 X 2.6	
North (Eagle Rock)	131310	4371394	5/18/2004	4	2030	0530	18.0	14.0									A	9.0 X 2.6	No captures
North (Eagle Rock)	131310	4371394	5/18/2004	4	2030	0530	18.0	14.0									B	12.0 X 2.6	No captures
North (Eagle Rock)	131440	4371502	5/18/2004	4	2030	0530	18.0	14.0									C	9.0 X 2.6	No captures
North (Eagle Rock)	131440	4371502	5/18/2004	4	2030	0530	18.0	14.0									D	6.0 X 2.6	No captures
North (Eagle Rock)	131310	4371394	5/21/2004	4	2100	0530	16.0	15.0									A	9.0 X 2.6	No captures
North (Eagle Rock)	131310	4371394	5/21/2004	4	2100	0530	16.0	15.0									B	9.0 X 2.6	No captures
North (Eagle Rock)	131440	4371502	5/21/2004	4	2100	0530	16.0	15.0									C	9.0 X 2.6	No captures
North (Eagle Rock)	131440	4371502	5/21/2004	4	2100	0530	16.0	15.0									D	6.0 X 2.6	No captures
North (Eagle Rock)	131310	4371394	6/23/2004	4	2030	0200	16.0	15.0									A	9.0 X 2.6	No captures
North (Eagle Rock)	131310	4371394	6/23/2004	4	2030	0200	16.0	15.0									B	12.0 X 2.6	No captures
North (Eagle Rock)	131440	4371502	6/23/2004	4	2030	0200	16.0	15.0	2156	MYSE	A	F	Non-repro	7.25	34.0		C	9.0 X 2.6	
North (Eagle Rock)	131440	4371502	6/23/2004	4	2030	0200	16.0	15.0	2306	MYSE	A	M	Non-repro	6.75	33.0		C	9.0 X 2.6	

Table 1. Continued.

Site	UTM_X	UTM_Y	Date	No. nets	Time open	Time close	Temp °C (open)	Temp °C (close)	Time	Species[1]	Age	Sex	Repro. cond.	Weight (g)	Forearm (mm)	Height (m) in net	Net #	Net dimensions (m)	Comments
North (Eagle Rock)	131440	4371502	6/23/2004	4	2030	0200	16.0	15.0	2247	MYSE	A	F	Lactating	7.75	35.0		D	6.0 X 2.6	
North (Eagle Rock)	131310	4371394	6/28/2004	4	2045	0200	15.0	13.0	0120	MYSE	A	F	Lactating	7.00	36.0	1.5	A	9.0 X 2.6	
North (Eagle Rock)	131310	4371394	6/27/2004	4	2045	0200	15.0	13.0									B	9.0 X 2.6	No captures
North (Eagle Rock)	131440	4371502	6/27/2004	4	2045	0200	15.0	13.0									C	9.0 X 2.6	No captures
North (Eagle Rock)	131440	4371502	6/27/2004	4	2045	0200	15.0	13.0									D	6.0 X 2.6	No captures
North-middle	123955	4363909	9/5/2003	4	2000	0630	14.0	10.0	2025	MYLU	A	M	Non-repro	6.00	35.0	1.5	A	6.0 X 2.6	
North-middle	123955	4363909	9/5/2003	4	2000	0630	14.0	10.0	2105	MYSE	A	M	Non-repro	7.25	35.0	1.5	A	6.0 X 2.6	
North-middle	123955	4363909	9/5/2003	4	2000	0630	14.0	10.0	2205	MYSE	J	F	Non-repro	7.00	36.0	2.0	A	6.0 X 2.6	
North-middle	123618	4363892	9/5/2003	4	2000	0630	14.0	10.0									B	6.0 X 2.6	No captures
North-middle	123206	4363773	9/5/2003	4	2000	0630	14.0	10.0	2330	LABO	J	M	Non-repro	9.75	37.0	1.0	C	9.0 X 2.6	
North-middle	123176	4363732	9/5/2003	4	2000	0630	14.0	10.0	2040	MYLU	A	M	Non-repro	7.50	38.0	1.0	D	9.0 X 2.6	
North-middle	123176	4363732	9/6/2003	4	2000	0630	14.0	10.0	0200	LABO	J	F	Non-repro	11.25	40.0	2.5	D	9.0 X 2.6	
North-middle	123176	4363732	9/6/2003	4	2000	0630	14.0	10.0	0315	LABO	J	M	Non-repro	11.00	41.0	1.0	D	9.0 X 2.6	
North-middle	123955	4363909	9/8/2003	4	2000	0630	18.0	16.0									A	6.0 X 2.6	No captures
North-middle	123618	4363892	9/9/2003	4	2000	0630	18.0	16.0	0100	MYSE	J	M	Non-repro	5.75	36.0	1.3	B	6.0 X 2.6	
North-middle	123206	4363773	9/8/2003	4	2000	0630	18.0	16.0	2030	MYSE	J	F	Non-repro	6.25	36.0	2.0	C	9.0 X 2.6	
North-middle	123206	4363773	9/9/2003	4	2000	0630	18.0	16.0	0233	LABO	J	M	Non-repro	9.25	38.0	1.5	C	9.0 X 2.6	
North-middle	123206	4363773	9/8/2003	4	2000	0630	18.0	16.0	2030	MYSE	J	M	Non-repro	N/A	33.0	1.5	C	9.0 X 2.6	Escaped
North-middle	123176	4363732	9/9/2003	4	2000	0630	18.0	16.0	0215	LABO	J	M	Non-repro	10.00	39.0	1.0	D	9.0 X 2.6	
North-middle	123176	4363732	9/8/2003	4	2000	0630	18.0	16.0	2140	MYLU	A	M	Non-repro	8.00	36.0	1.5	D	9.0 X 2.6	
North-middle	123955	4363909	5/19/2004	4	2030	0515	19.0	14.0									A	6.0 X 2.6	No captures

Table 1. Continued.

Site	UTM_X	UTM_Y	Date	No. nets	Time open	Time close	Temp °C (open)	Temp °C (close)	Time	Species[1]	Age	Sex	Repro. cond.	Weight (g)	Forearm (mm)	Height (m) in net	Net #	Net dimensions (m)	Comments
North-middle	123618	4363892	5/19/2004	4	2030	0515	19.0	14.0									B	6.0 X 2.6	No captures
North-middle	123206	4363773	5/19/2004	4	2030	0515	19.0	14.0	2215	MYSE	A	F	Non-repro	7.25	35.0	2.2	C	9.0 X 2.6	
North-middle	123206	4363773	5/19/2004	4	2030	0515	19.0	14.0	2220	LABO	A	F	Non-repro	13.00	41.0	2.0	C	9.0 X 2.6	
North-middle	123176	4363732	5/19/2004	4	2030	0515	19.0	14.0									D	9.0 X 2.6	No captures
North-middle	123955	4363909	5/22/2004	4	2030	0530	21.0	17.0	2155	MYSE	A	F	Non-repro	8.50	37.0	1.0	A	6.0 X 2.6	
North-middle	123955	4363909	5/22/2004	4	2030	0530	21.0	17.0	2230	MYLU	A	M	Non-repro	6.75	37.0	2.5	A	6.0 X 2.6	
North-middle	123618	4363892	5/22/2004	4	2030	0530	21.0	17.0									B	6.0 X 2.6	No captures
North-middle	123206	4363773	5/22/2004	4	2030	0530	21.0	17.0									C	6.0 X 2.6	No captures
North-middle	123176	4363732	5/22/2004	4	2030	0530	21.0	17.0	2400	MYSE	A	F	Non-repro	9.25	39.0	2.5	D	9.0 X 2.6	
North-middle	123176	4363732	5/23/2004	4	2030	0530	21.0	17.0	0200	MYLU	A	F	Non-repro	8.50	38.0	1.2	D	9.0 X 2.6	
North-middle	123176	4363732	5/23/2004	4	2030	0530	21.0	17.0	0235	MYSE	A	M	Non-repro	6.25	36.0	0.2	D	9.0 X 2.6	
North-middle	123955	4363909	6/24/2004	4	2045	0200	17.5	12.0	2122	EPFU	A	F	Lactating	15.25	44.0	2.0	A	6.0 X 2.6	
North-middle	123955	4363909	6/24/2004	4	2045	0200	17.5	12.0	2130	EPFU	A	F	Pregnant	17.00	47.0	2.3	A	6.0 X 2.6	
North-middle	123618	4363892	6/24/2004	4	2045	0200	17.5	12.0									B	6.0 X 2.6	No captures
North-middle	123206	4363773	6/24/2004	4	2045	0200	17.5	12.0	2222	MYLU	A	F	Lactating	8.75	38.0	1.5	C	6.0 X 2.6	
North-middle	123176	4363732	6/24/2004	4	2045	0200	17.5	12.0									D	9.0 X 2.6	No captures
North-middle	123955	4363909	6/28/2004	4	2145	0200	13.5	12.0									A	6.0 X 2.6	No captures
North-middle	123618	4363892	6/28/2004	4	2145	0200	13.5	12.0									B	6.0 X 2.6	No captures
North-middle	123206	4363773	6/28/2004	4	2145	0200	13.5	12.0									C	6.0 X 2.6	No captures
North-middle	123176	4363732	6/28/2004	4	2145	0200	13.5	12.0									D	9.0 X 2.6	No captures
South-middle	122138	4362588	9/6/2003	4	2000	0630	15.0	10.0									A	9.0 X 2.6	No captures

Table 1. Continued.

Site	UTM_X	UTM_Y	Date	No. nets	Time open	Time close	Temp °C (open)	Temp °C (close)	Time	Species[1]	Age	Sex	Repro. cond.	Weight (g)	Forearm (mm)	Height (m) in net	Net #	Net dimensions (m)	Comments
South-middle	122084	4362528	9/6/2003	4	2000	0630	15.0	10.0	2025	MYSE	A	M	Non-repro	6.00	34.0	0.5	B	6.0 X 2.6	
South-middle	122019	4362452	9/6/2003	4	2000	0630	15.0	10.0									C	6.0 X 2.6	No captures
South-middle	121984	4362390	9/6/2003	4	2000	0630	15.0	10.0									D	6.0 X 2.6	No captures
South-middle	122138	4362588	9/9/2003	4	2000	0630	13.5	11.5									A	6.0 X 2.6	No captures
South-middle	122084	4362528	9/9/2003	4	2000	0630	13.5	11.5									B	6.0 X 2.6	No captures
South-middle	122019	4362452	9/9/2003	4	2000	0630	13.5	11.5									C	6.0 X 2.6	No captures
South-middle	121984	4362390	9/9/2003	4	2000	0630	13.5	11.5									D	6.0 X 2.6	No captures
South-middle	122138	4362588	5/20/2004	4	2030	0530	19.0	18.0	2350	LABO	A	M	Non-repro	10.25	39.0	1.8	A	6.0 X 2.6	
South-middle	122084	4362528	5/20/2004	4	2030	0530	19.0	18.0	2335	MYLU	A	F	Non-repro	8.25	38.0	2.0	B	6.0 X 2.6	
South-middle	122019	4362452	5/20/2004	4	2030	0530	19.0	18.0	2335	MYLU	A	F	Non-repro	7.75	37.0	2.0	C	6.0 X 2.6	
South-middle	122019	4362452	5/21/2004	4	2030	0530	19.0	18.0	0450	MYSE	A	F	Non-repro	6.75	34.0	2.1	C	6.0 X 2.6	
South-middle	121984	4362390	5/20/2004	4	2030	0530	19.0	18.0									D	6.0 X 2.6	No captures
South-middle	122138	4362588	5/24/2004	4	2030	0530	20.0	18.0	0325	LABO	N/A	N/A	N/A	N/A	N/A	N/A	A	6.0 X 2.6	Escaped
South-middle	122084	4362528	5/23/2004	4	2030	0530	20.0	18.0									B	6.0 X 2.6	No captures
South-middle	122019	4362452	5/23/2004	4	2030	0530	20.0	18.0									C	6.0 X 2.6	No captures
South-middle	121984	4362390	5/23/2004	4	2030	0530	20.0	18.0									D	6.0 X 2.6	No captures
South-middle	122138	4362588	6/26/2004	4	2030	0200	15.0	10.5									A	9.0 X 2.6	No captures
South-middle	122084	4362528	6/26/2004	4	2030	0200	15.0	10.5									B	6.0 X 2.6	No captures
South-middle	122019	4362452	6/26/2004	4	2030	0200	15.0	10.5									C	6.0 X 2.6	No captures
South-middle	121984	4362390	6/26/2004	4	2030	0200	15.0	10.5									D	6.0 X 2.6	No captures

Table 1. Continued.

Site	UTM_X	UTM_Y	Date	No. nets	Time open	Time close	Temp °C (open)	Temp °C (close)	Time	Species[1]	Age	Sex	Repro. cond.	Weight (g)	Forearm (mm)	Height (m) in net	Net #	Net dimensions (m)	Comments
South-middle	122138	4362588	6/29/2004	4	2100	0200	16.0	14.5									A	9.0 X 2.6	No captures
South-middle	122084	4362528	6/29/2004	4	2100	0200	16.0	14.5	2142	EPFU	A	F	Lactating	19.25	47.0	1.0	B	6.0 X 2.6	
South-middle	122084	4362528	6/29/2004	4	2100	0200	16.0	14.5	2147	EPFU	A	M	Non-repro	18.25	46.0	1.2	B	6.0 X 2.6	
South-middle	122019	4362452	6/29/2004	4	2100	0200	16.0	14.5									C	6.0 X 2.6	No captures
South-middle	121984	4362390	6/29/2004	4	2100	0200	16.0	14.5	2240	MYLU	A	F	Lactating	8.25	36.0	1.5	D	6.0 X 2.6	
South-middle	121984	4362390	6/30/2004	4	2100	0200	16.0	14.5	0145	LABO	A	M	Non-repro	11.75	38.0	0.5	D	6.0 X 2.6	

[1] EPFU = *Eptesicus fuscus*, LABO = *Lasiurus borealis,* LACI = *Lasiurus cinereus,* MYLU = *Myotis lucifugus,* MYSE = *Myotis septentrionalis*

Table 2. Bat echolocation calls collected at the Clipper Windpower Criterion Project on Backbone Mountain, Garrett County, Maryland, in September 2003.

Location	Date (start)	Time (start)	Total calls	NOID[1]	EPFU	EPFU FB[2]	EPFU/ LACI	EPFU/ LACI FB	EPFU/ LANO	EPFU/ LACI/ LANO	LACI	LACI FB	LANO	LABO	LABO FB	LABO/ PISU	LABO/ PISU FB	PISU	PISU FB	MYsp	MYsp FB
North (Eagle Rock)	9/4-9/5/03	2000	28	11	2	0	0	0	0	1	0	0	2	1	0	7	0	0	0	4	0
		2100	86	25	3	0	1	0	5	0	5	1	0	17	0	26	2	2	0	2	0
		2200	261	83	15	1	5	0	11	1	7	0	2	20	1	110	24	6	4	1	0
		2300	236	64	4	0	4	0	2	0	1	0	0	16	0	135	15	8	1	2	0
		2400	74	27	1	0	3	1	2	0	3	0	0	10	0	22	2	1	0	5	0
		0100	144	62	0	0	0	0	0	0	0	0	0	10	0	45	1	0	0	27	0
		0200	157	65	0	0	0	0	1	0	0	0	0	8	0	47	0	1	0	35	0
		0300	5	2	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0
		0400	12	4	2	1	0	0	0	0	0	0	0	5	0	1	0	0	0	0	0
		0500	13	3	0	0	0	0	0	0	0	0	1	6	0	3	0	0	0	0	0
		Subtotal	1016	346	27	2	13	1	21	2	16	1	5	94	1	397	44	19	5	76	0

Table 2. Continued.

Location	Date (start)	Time (start)	Total calls	NOID[1]	EPFU	EPFU FB[2]	EPFU/ LACI	EPFU/ LACI FB	EPFU/ LANO	EPFU/ LACI/ LANO	LACI	LACI FB	LANO	LABO	LABO FB	LABO/ PISU	LABO/ PISU FB	PISU	PISU FB	MYsp	MYsp FB
North (Eagle Rock)	9/7-9/8/03	2000	3	0	0	0	0	0	0	0	0	0	0	2	0	1	1	0	0	0	0
		2100	12	2	0	0	0	0	0	0	0	0	0	3	0	7	0	0	0	0	0
		2200	6	1	0	0	0	0	0	0	0	0	0	2	0	3	0	0	0	0	0
		2300	26	5	0	0	0	0	0	0	0	0	0	1	0	20	4	0	0	0	0
		2400	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
		0100	10	4	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0
		0200	5	2	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0
		0300	4	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
		0400	4	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
		0500	24	6	0	0	0	0	0	0	0	0	0	4	0	4	0	0	0	10	1
		Subtotal	95	24	0	0	0	0	2	0	0	0	0	19	0	38	5	1	0	11	1

Table 2. Continued.

Location	Date (start)	Time (start)	Total calls	NOID[1]	EPFU	EPFU FB[2]	EPFU/ LACI	EPFU/ LACI FB	EPFU/ LANO	EPFU/ LACI/ LANO	LACI	LACI FB	LANO	LABO	LABO FB	LABO/ PISU	LABO/ PISU FB	PISU	PISU FB	MYsp	MYsp FB
North-middle	9/5-9/6/03	2000	47	10	0	0	3	0	0	0	0	0	0	20	5	14	1	0	0	0	0
		2100	40	17	0	0	1	0	1	0	0	0	0	9	0	12	0	0	0	0	0
		2200	67	19	0	0	4	0	0	0	0	0	0	14	4	30	1	0	0	0	0
		2300	23	6	0	0	0	0	0	0	0	0	0	10	0	4	0	1	0	2	0
		2400	13	1	1	0	0	0	0	0	0	0	1	3	0	7	0	0	0	0	0
		0100	18	4	5	1	0	0	0	0	0	0	0	5	1	2	0	1	0	1	0
		0200	3	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0
		0300	5	1	0	0	0	0	0	0	0	0	0	3	0	0	0	1	0	0	0
		0400	9	6	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0
		0500	14	5	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	1	0
		Subtotal	239	69	6	1	8	0	2	0	0	0	1	75	10	71	2	3	0	4	0

Table 2. Continued.

Location	Date (start)	Time (start)	Total calls	NOID[1]	EPFU	EPFU FB[2]	EPFU/ LACI	EPFU/ LACI FB	EPFU/ LANO	EPFU/ LACI/ LANO	LACI	LACI FB	LANO	LABO	LABO FB	LABO/ PISU	LABO/ PISU FB	PISU	PISU FB	MYsp	MYsp FB
North-middle	9/8-9/9/03	2000	6	2	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0
		2100	15	2	0	0	0	0	0	0	0	0	0	11	0	2	0	0	0	0	0
		2200	21	9	0	0	0	0	0	0	0	0	0	4	0	7	0	1	0	0	0
		2300	16	2	0	0	0	0	0	0	0	0	0	7	0	6	0	1	0	0	0
		2400	55	31	0	0	0	0	0	0	0	0	0	18	0	4	0	2	0	0	0
		0100	29	17	2	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0
		0200	9	2	0	0	0	0	0	0	0	0	2	4	1	1	0	0	0	0	0
		0300	12	2	0	0	0	0	1	0	0	0	0	7	0	2	0	0	0	0	0
		0400	3	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
		0500	9	3	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	1	0
		Subtotal	175	71	2	0	0	0	2	0	0	0	2	69	1	23	0	4	0	2	0

Table 2. Continued.

Location	Date (start)	Time (start)	Total calls	NOID[1]	EPFU	EPFU FB[2]	EPFU/ LACI	EPFU/ LACI FB	EPFU/ LANO	EPFU/ LACI/ LANO	LACI	LACI FB	LANO	LABO	LABO FB	LABO/ PISU	LABO/ PISU FB	PISU	PISU FB	MYsp	MYsp FB
South-middle	9/6-9/7/03	Anabat malfunction																			
South-middle	9/9-9/10/03	2000	9	5	2	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
		2100	8	2	1	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0
		2200	11	6	1	0	0	0	0	0	0	0	0	3	1	0	0	1	0	0	0
		2300	11	5	0	0	0	0	0	0	0	0	0	2	0	4	0	0	0	0	0
		2400	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0100	18	8	0	0	0	0	0	0	0	0	0	9	0	1	0	0	0	0	0
		0200	22	10	0	0	0	0	2	0	0	0	0	9	0	0	0	1	0	0	0
		0300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0400	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
		0500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Subtotal	84	38	4	0	0	0	4	0	0	0	0	29	1	6	0	2	0	0	0

Table 2. Continued.

Location	Date (start)	Time (start)	Total calls	NOID[1]	EPFU	EPFU FB[2]	EPFU/ LACI	EPFU/ LACI FB	EPFU/ LANO	EPFU/ LACI/ LANO	LACI	LACI FB	LANO	LABO	LABO FB	LABO/ PISU	LABO/ PISU FB	PISU	PISU FB	MYsp	MYsp FB
South	9/7-9/8/03	2000	7	0	1	0	0	0	0	0	1	0	0	2	0	1	0	2	0	0	0
		2100	5	2	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0
		2200	13	3	0	0	0	0	0	0	0	0	0	3	0	7	1	0	0	0	0
		2300	22	1	0	0	0	0	0	0	0	0	0	5	0	13	1	3	0	0	0
		2400	9	3	0	0	0	0	0	0	1	0	0	2	0	1	0	2	0	0	0
		0100	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
		0200	4	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0300	2	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
		0400	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
		0500	5	1	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0
		Subtotal	71	13	5	0	0	0	0	0	2	0	1	16	0	24	2	10	0	0	0

Table 2. Continued.

Location	Date (start)	Time (start)	Total calls	NOID[1]	EPFU	EPFU FB[2]	EPFU/ LACI	EPFU/ LACI FB	EPFU/ LANO	EPFU/ LACI/ LANO	LACI	LACI FB	LANO	LABO	LABO FB	LABO/ PISU	LABO/ PISU FB	PISU	PISU FB	MYsp	Mysp FB
South	9/8-9/9/03	2000	6	3	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
		2100	7	2	0	0	0	0	1	0	0	0	1	3	0	0	0	0	0	0	0
		2200	8	3	1	0	0	0	0	0	0	0	0	0	0	2	0	1	0	1	0
		2300	2	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
		2400	3	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0
		0100	4	3	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
		0200	4	3	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
		0300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0400	7	5	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
		0500	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Subtotal	42	22	2	0	0	0	2	1	1	0	1	5	0	3	0	2	0	3	0
		Total	1721	583	46	3	21	1	33	3	19	1	10	307	13	562	53	41	5	96	1

[1] NOID=Unidentifiable calls; EPFU=*Eptesicus fuscus*; LACI=*Lasiurus cinereus*; LANO=*Lasionycteris noctivagans*; LABO=*Lasiurus borealis*; PISU=*Pipistrellus subflavus*; MYsp=*Myotis* spp.

[2] FB=bat feeding buzz

Table 3. Bat echolocation calls collected on at the Clipper Windpower Criterion Project on Backbone Mountain, Garrett County, Maryland, in May 2004.

Location	Date (start)	Time (start)	Total calls	NOID[1]	EPFU	EPFU/LACI	LACI	LABO	LABO FB	PISU	MYLU	MYLUFB	MYSE	MYsp
North (Eagle Rock)	5/18-5/19/04	2000	0	0	0	0	0	0	0	0	0	0	0	0
		2100	1	0	0	0	1	0	0	0	0	0	0	0
		2200	0	0	0	0	0	0	0	0	0	0	0	0
		2300	0	0	0	0	0	0	0	0	0	0	0	0
		2400	0	0	0	0	0	0	0	0	0	0	0	0
		0100	1	0	1	0	0	0	0	0	0	0	0	0
		0200	1	1	0	0	0	0	0	0	0	0	0	0
		0300	0	0	0	0	0	0	0	0	0	0	0	0
		0400	0	0	0	0	0	0	0	0	0	0	0	0
		0500	0	0	0	0	0	0	0	0	0	0	0	0
		Subtotal	3	1	1	0	1	0	0	0	0	0	0	0

Table 3. Continued.

Location	Date (start)	Time (start)	Total calls	NOID[1]	EPFU	EPFU/LACI	LACI	LABO	LABO FB	PISU	MYLU	MYLUFB	MYSE	MYsp
North (Eagle Rock)	5/21-5/22/04	2000	0	0	0	0	0	0	0	0	0	0	0	0
		2100	0	0	0	0	0	0	0	0	0	0	0	0
		2200	0	0	0	0	0	0	0	0	0	0	0	0
		2300	0	0	0	0	0	0	0	0	0	0	0	0
		2400	18	4	2	0	0	12	0	0	0	0	0	0
		0100	10	2	0	0	0	7	0	1	0	0	0	0
		0200	27	6	2	0	0	19	0	0	0	0	0	0
		0300	50	18	3	0	0	26	1	0	2	0	1	0
		0400	52	17	0	0	0	34	1	0	0	0	1	0
		0500	12	2	0	0	2	8	0	0	0	0	0	0
		Subtotal	169	49	7	0	2	106	2	1	2	0	2	0

Table 3. Continued.

Location	Date (start)	Time (start)	Total calls	NOID[1]	EPFU	EPFU/LACI	LACI	LABO	LABO FB	PISU	MYLU	MYLUFB	MYSE	MYsp
North middle	5/20-5/21/04	2000	0	0	0	0	0	0	0	0	0	0	0	0
		2100	0	0	0	0	0	0	0	0	0	0	0	0
		2200	1	1	0	0	0	0	0	0	0	0	0	0
		2300	3	0	2	0	0	0	0	0	1	0	0	0
		2400	4	2	1	0	0	0	0	0	0	0	0	1
		0100	1	0	0	0	1	0	0	0	0	0	0	0
		0200	2	2	0	0	0	0	0	0	0	0	0	0
		0300	1	0	1	0	0	0	0	0	0	0	0	0
		0400	2	1	0	0	0	0	0	0	0	0	0	1
		0500	0	0	0	0	0	0	0	0	0	0	0	0
		Subtotal	14	6	4	0	1	0	0	0	1	0	0	2

Table 3. Continued.

Location	Date (start)	Time (start)	Total calls	NOID[1]	EPFU	EPFU/LACI	LACI	LABO	LABO FB	PISU	MYLU	MYLUFB	MYSE	MYsp
North middle	5/22-5/23/04	2000	0	0	0	0	0	0	0	0	0	0	0	0
		2100	1	0	0	0	0	1	0	0	0	0	0	0
		2200	3	1	2	0	0	0	0	0	0	0	0	0
		2300	2	1	1	0	0	0	0	0	0	0	0	0
		2400	0	0	0	0	0	0	0	0	0	0	0	0
		0100	2	2	0	0	0	0	0	0	0	0	0	0
		0200	1	0	1	0	0	0	0	0	0	0	0	0
		0300	2	2	0	0	0	0	0	0	0	0	0	0
		0400	0	0	0	0	0	0	0	0	0	0	0	0
		0500	0	0	0	0	0	0	0	0	0	0	0	0
		Subtotal	11	6	4	0	0	1	0	0	0	0	0	0

Table 3. Continued.

Location	Date (start)	Time (start)	Total calls	NOID[1]	EPFU	EPFU/LACI	LACI	LABO	LABO FB	PISU	MYLU	MYLUFB	MYSE	MYsp
South middle	5/20-5/21/04	2000	0	0	0	0	0	0	0	0	0	0	0	0
		2100	26	13	1	0	0	0	0	0	9	0	3	0
		2200	2	0	0	1	0	0	0	0	0	0	0	1
		2300	152	48	0	0	0	30	0	0	71	1	0	3
		2400	104	64	1	0	0	15	0	0	21	1	0	3
		0100	0	0	0	0	0	0	0	0	0	0	0	0
		0200	33	17	2	0	0	2	0	0	11	0	0	1
		0300	5	2	0	0	0	1	0	0	1	0	0	1
		0400	4	2	0	0	0	0	0	0	0	0	2	0
		0500	1	1	0	0	0	0	0	0	0	0	0	0
		Subtotal	327	147	4	1	0	48	0	0	113	2	5	9

Table 3. Continued.

Location	Date (start)	Time (start)	Total calls	NOID[1]	EPFU	EPFU/LACI	LACI	LABO	LABO FB	PISU	MYLU	MYLUFB	MYSE	MYsp
South middle	5/23-5/24/04	2000	0	0	0	0	0	0	0	0	0	0	0	0
		2100	56	7	1	3	44	0	0	0	1	0	0	0
		2200	7	2	0	0	0	5	0	0	0	0	0	0
		2300	0	0	0	0	0	0	0	0	0	0	0	0
		2400	10	5	0	0	0	1	0	0	0	0	0	4
		0100	3	1	2	0	0	0	0	0	0	0	0	0
		0200	1	0	0	0	0	0	0	0	0	0	0	1
		0300	2	0	0	1	0	1	0	0	0	0	0	0
		0400	0	0	0	0	0	0	0	0	0	0	0	0
		0500	0	0	0	0	0	0	0	0	0	0	0	0
		Subtotal	79	15	3	4	44	7	0	0	1	0	0	5

Table 3. Continued.

Location	Date (start)	Time (start)	Total calls	NOID[1]	EPFU	EPFU/LACI	LACI	LABO	LABO FB	PISU	MYLU	MYLUFB	MYSE	MYsp
South	5/19-5/20/04	2000	0	0	0	0	0	0	0	0	0	0	0	0
		2100	8	2	2	0	2	2	0	0	0	0	0	0
		2200	2	0	2	0	0	0	0	0	0	0	0	0
		2300	5	2	1	0	1	1	0	0	0	0	0	0
		2400	1	1	0	0	0	0	0	0	0	0	0	0
		0100	0	0	0	0	0	0	0	0	0	0	0	0
		0200	1	0	0	0	0	1	0	0	0	0	0	0
		0300	0	0	0	0	0	0	0	0	0	0	0	0
		0400	2	1	0	0	1	0	0	0	0	0	0	0
		0500	0	0	0	0	0	0	0	0	0	0	0	0
		Subtotal	19	6	5	0	4	4	0	0	0	0	0	0

Table 3. Continued.

Location	Date (start)	Time (start)	Total calls	NOID[1]	EPFU	EPFU/LACI	LACI	LABO	LABO FB	PISU	MYLU	MYLUFB	MYSE	MYsp
South	5/22-5/23/04	2000	0	0	0	0	0	0	0	0	0	0	0	0
		2100	4	4	0	0	0	0	0	0	0	0	0	0
		2200	7	4	3	0	0	0	0	0	0	0	0	0
		2300	5	4	1	0	0	0	0	0	0	0	0	0
		2400	7	4	1	0	2	0	0	0	0	0	0	0
		0100	3	1	2	0	0	0	0	0	0	0	0	0
		0200	9	5	4	0	0	0	0	0	0	0	0	0
		0300	1	1	0	0	0	0	0	0	0	0	0	0
		0400	0	0	0	0	0	0	0	0	0	0	0	0
		0500	0	0	0	0	0	0	0	0	0	0	0	0
		Subtotal	36	23	11	0	2	0	0	0	0	0	0	0
		Total	658	253	39	5	54	166	2	1	117	2	7	16

[1] NOID=Unidentifiable calls; EPFU=*Eptesicus fuscus*; LACI=*Lasiurus cinereus*; LABO=*Lasiurus borealis*; PISU=*Pipistrellus subflavus*; MYLU = *Myotis lucifugus*; MYSE = *Myotis septentrionails*; MYsp=*Myotis* spp.

[2] FB=bat feeding buzz

Table 4. Bat echolocation calls collected at 42 point-count locations at the Clipper Windpower Criterion Project on Backbone Mountain, Garrett County, Maryland, in June 2004.

Point count	Date (start)	Time (start)	Total calls	NOID[1]	EPFU	EPFUFB	EPFU/LACI	LACI	LABO	LABO FB	MYLU	MYSE	MYSEFB	MYsp	MYspFB
01	6/24/2004	2116	3	0	1	0	0	0	2	0	0	0	0	0	0
02	6/24/2004	2149	1	1	0	0	0	0	0	0	0	0	0	0	0
03	6/24/2004	2218	0	0	0	0	0	0	0	0	0	0	0	0	0
04	6/24/2004	2245	88	15	25	2	0	0	46	0	0	0	0	2	0
05	6/24/2004	2311	0	0	0	0	0	0	0	0	0	0	0	0	0
06	6/24/2004	2339	0	0	0	0	0	0	0	0	0	0	0	0	0
07	6/25/2004	0017	0	0	0	0	0	0	0	0	0	0	0	0	0
08	6/25/2004	0042	2	1	0	0	0	0	1	0	0	0	0	0	0
09	6/25/2004	0110	2	1	0	0	0	0	1	0	0	0	0	0	0
10	6/25/2004	0134	8	3	0	0	0	0	1	0	0	3	0	1	0
11	6/26/2004	2121	1	0	0	0	0	0	1	0	0	0	0	0	0
12	6/26/2004	2144	4	1	0	0	0	0	0	0	2	1	0	0	0
13	6/26/2004	2207	7	2	0	0	0	0	1	0	0	4	0	0	0
14	6/26/2004	2230	16	2	0	0	0	0	1	0	0	13	1	0	0
15	6/26/2004	2258	26	10	0	0	0	0	3	0	0	12	0	1	0
16	6/26/2004	2319	116	23	0	0	0	0	84	7	0	0	0	9	1
17	6/28/2004	2206	1	0	0	0	0	0	0	0	0	0	0	1	0
18	6/28/2004	2228	81	15	0	0	0	0	63	7	0	1	0	2	0
19	6/28/2004	2259	13	2	0	0	0	0	0	0	0	10	0	1	0
20	6/28/2004	2323	0	0	0	0	0	0	0	0	0	0	0	0	0
21	6/28/2004	2347	13	2	0	0	0	0	0	0	0	9	0	3	0
22	6/29/2004	0012	0	0	0	0	0	0	0	0	0	0	0	0	0
23	6/29/2004	0035	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4. Continued.

Location	Date (start)	Time (start)	Total calls	NOID[1]	EPFU	EPFUFB	EPFU/LACI	LACI	LABO	LABO FB	MYLU	MYSE	MYSEFB	MYsp	MYspFB
24	6/29/2004	2123	113	10	23	3	2	0	78	11	0	0	0	0	0
25	6/29/2004	2149	44	11	7	0	0	0	23	7	0	0	0	3	0
26	6/29/2004	2222	14	5	1	0	0	0	6	0	0	0	0	2	0
27	6/29/2004	2253	87	12	18	3	0	0	56	10	0	1	0	0	0
28	6/29/2004	2321	38	5	0	0	0	0	31	2	0	1	0	1	0
29	6/27/2004	2345	15	10	0	0	0	0	4	0	0	0	0	1	0
30	6/27/2004	2323	1	0	0	0	0	0	0	0	0	1	0	0	0
31	6/27/2004	2256	2	0	0	0	0	0	0	0	0	2	0	0	0
32	6/27/2004	2232	22	6	0	0	0	0	15	1	0	1	0	0	0
33	6/27/2004	2207	1	0	0	0	0	0	1	0	0	0	0	0	0
34	6/27/2004	2142	7	1	0	0	0	0	6	0	0	0	0	0	0
35	6/27/2004	2118	58	16	0	0	0	0	42	2	0	0	0	0	0
36	6/24/2004	0021	9	2	0	0	0	0	6	0	0	1	0	0	0
37	6/23/2004	2355	3	0	0	0	0	0	3	0	0	0	0	0	0
38	6/23/2004	2329	4	1	0	0	0	0	3	0	0	0	0	0	0
39	6/23/2004	2302	7	1	0	0	0	0	5	0	0	1	0	0	0
40	6/23/2004	2238	50	9	0	0	0	0	41	4	0	0	0	0	0
41	6/23/2004	2210	4	2	0	0	0	1	0	0	0	1	0	0	0
42	6/23/2004	2143	0	0	0	0	0	0	0	0	0	0	0	0	0
		Total	861	169	75	8	2	1	524	51	2	62	1	27	1

[1] NOID=Unidentifiable calls; EPFU=*Eptesicus fuscus*; LACI=*Lasiurus cinereus*; LABO=*Lasiurus borealis*; MYLU = *Myotis lucifugus*; MYSE = *Myotis septentrionails*; MYsp=*Myotis* spp.
[2] FB=bat feeding buzz

Figure 1. Mist net locations in the vicinity of North (Eagle Rock) observational survey point at the Clipper Windpower Criterion Project on Backbone Mountain, Garrett County, Maryland.

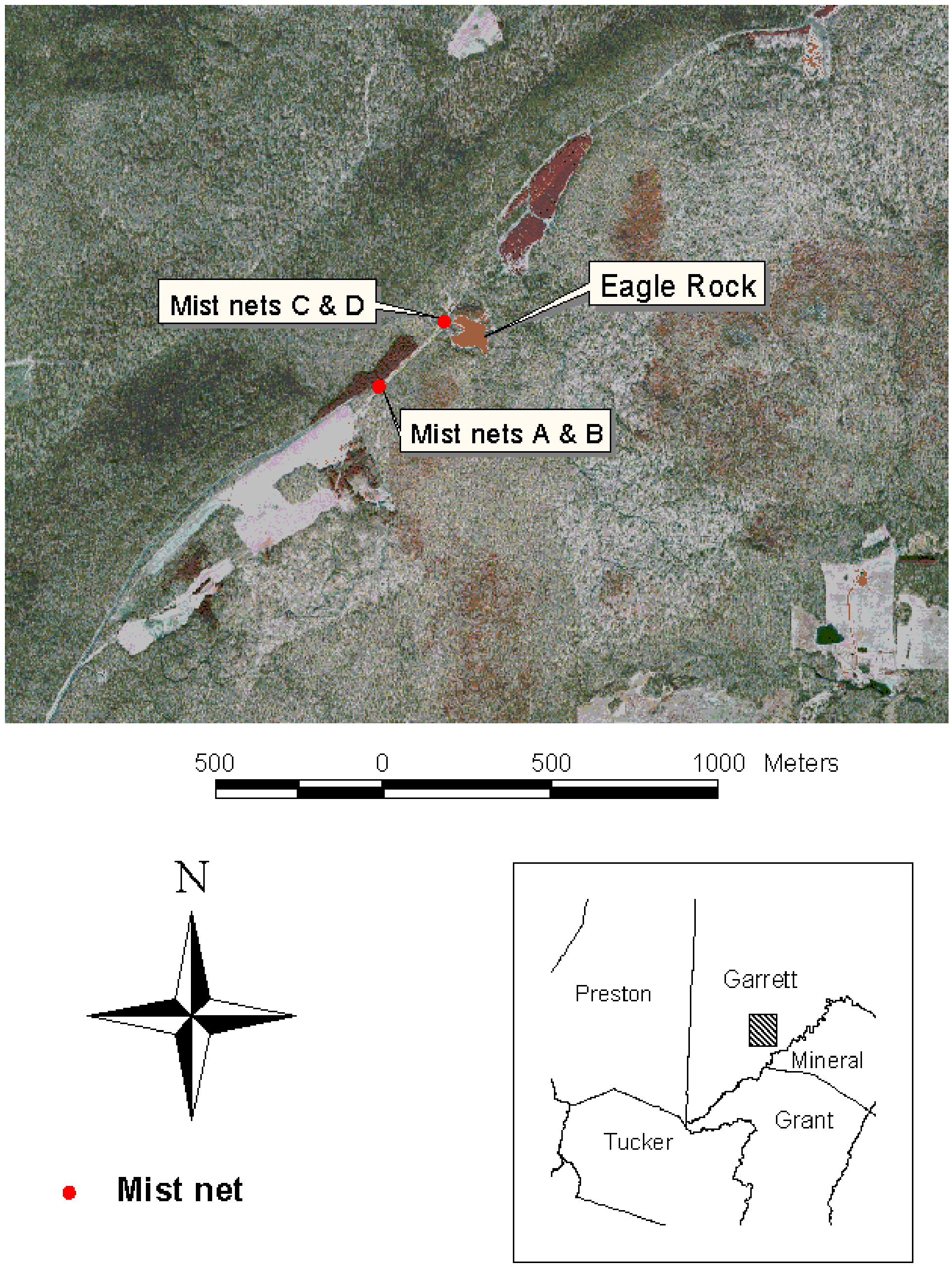

Mist nets C & D
Eagle Rock
Mist nets A & B
500 0 500 1000 Meters
N
Mist net
Preston
Garrett
Mineral
Tucker
Grant

Figure 2. Mist net locations on the southern portion of the Clipper Windpower Criterion Project on Backbone Mountain, Garrett County, Maryland.

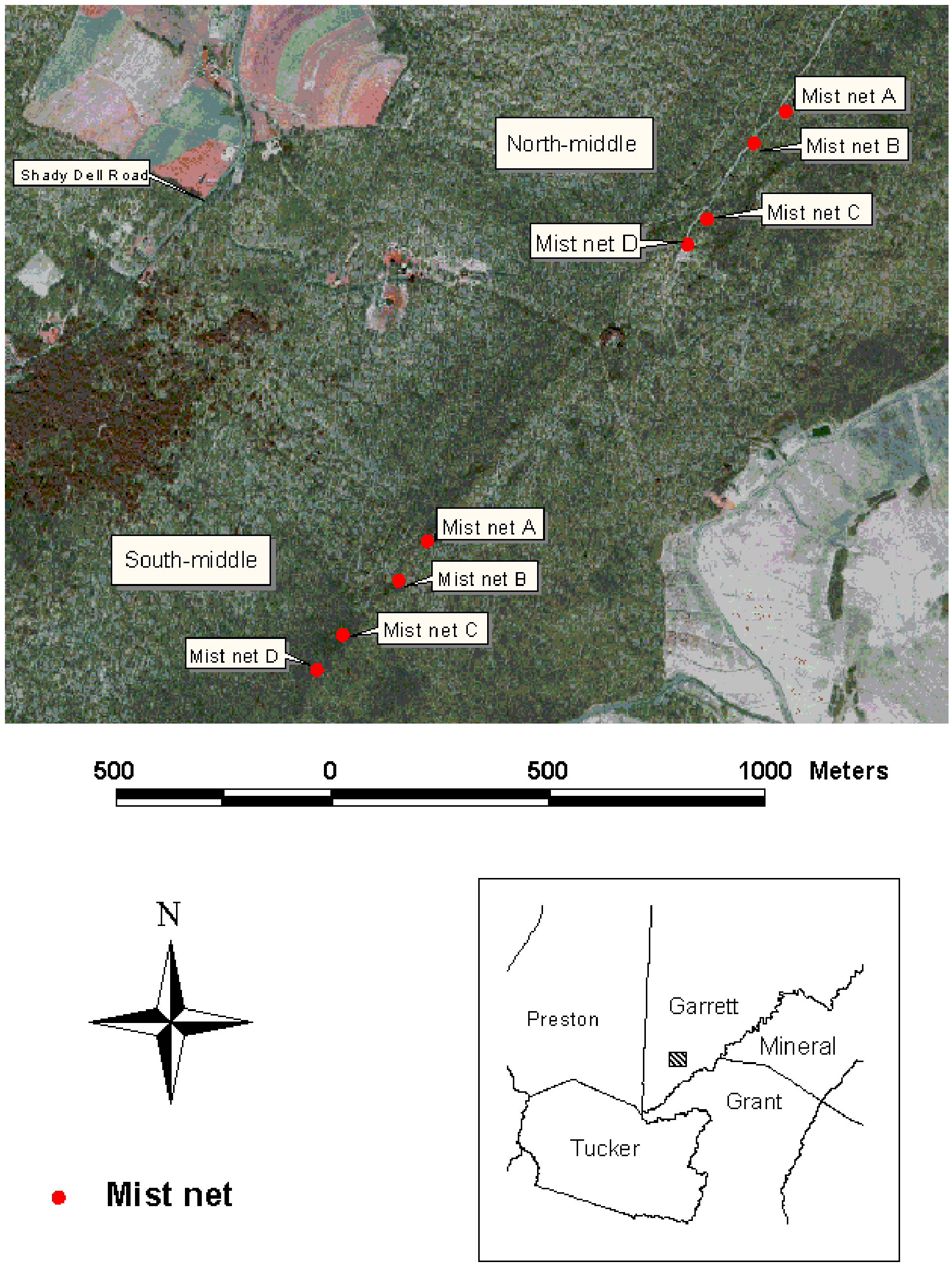
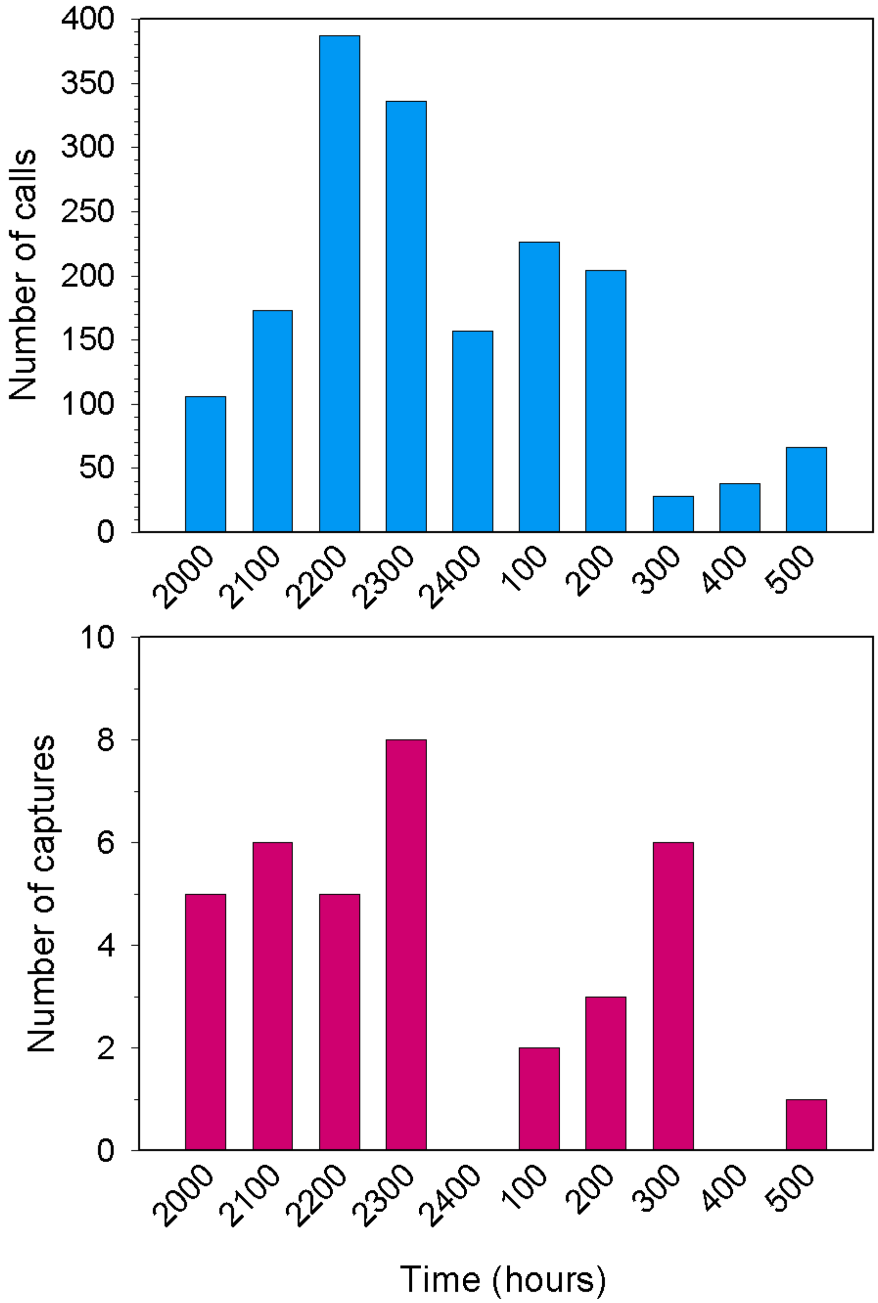

Mist net A
Mist net B
North-middle
Shady Dell Road
Mist net C
Mist net D
Mist net A
South-middle
Mist net B
Mist net C
Mist net D
500 0 500 1000 Meters
N
Mist net
Preston
Garrett
Mineral
Grant
Tucker

Figure 3. Bat activity levels throughout the night (all sampling nights combined) in early September 2003 on Backbone Mountain, Garrett County, Maryland.


400
350
300
250
200
150
100
50
0
Number of calls
2000
2100
2200
2300
2400
100
200
300
400
500
10
8
6
4
2
0
Number of captures
2000
2100
2200
2300
2400
100
200
300
400
500
Time (hours)