Journal of Field Ornithology

J. Field Ornithol. 79(3):314–320, 2008 DOI: 10.1111/j.1557-9263.2008.00179.x

What are we missing with only ground-level mist nets? Using elevated nets at a migration stopover site

David N. Bonter,[1,2,4] Elizabeth W. Brooks,[1] and Therese M. Donovan[3]

[1] *Braddock Bay Bird Observatory, P. O. Box 12876, Rochester, New York 14612, USA*
[2] *Cornell Lab of Ornithology, 159 Sapsucker Woods Road, Ithaca, New York 14850, USA*
[3] *U. S. Geological Survey, Vermont Cooperative Fish and Wildlife Research Unit, The Rubenstein School of Environment and Natural Resources, 81 Carrigan Drive, University of Vermont, Burlington, Vermont 05405, USA*

Received 30 October 2007; accepted 14 March 2008

ABSTRACT. Mist nets deployed in a standard ground-level fashion capture birds approximately 0.5–2.6 m above the ground. In habitats where the vegetation extends above this height, standard mist net deployment may inadequately sample the targeted avian community and age- and sex-classes within species. Such sampling biases may raise questions regarding studies based on data from mist-net captures. To determine if birds were equally likely to be captured by mist nets at different heights, we constructed a series of paired ground-level and elevated mist nets (hereafter "net rigs") at a research station in western New York State. Net rigs were operated during 14 migration seasons from 2000 to 2006 (spring and fall each year), and 19,735 birds of 118 species were captured. Capture rates were significantly higher in ground-level nets, but 12 species were only captured in elevated nets. Of 44 species with at least 50 captures, 25 species were more likely to be captured in the ground-level nets and two species in the elevated nets. For four of 18 species, more birds were captured in the elevated nets during fall migration than during spring migration. We conclude that standard ground-level net placement was more efficient in capturing birds in the secondary growth habitats that we sampled. However, ground-level nets may not adequately sample the entire targeted community or all age- or sex-classes within species.

SINOPSIS. **Que información estamos perdiendo con el uso de redes de niebla al nivel del suelo. Uso de redes elevadas en un punto de parada de migratorios**

Redes de niebla colocadas de forma estandar capturan aves que vuelan entre 0.5 y 2.6 m, sobre el nivel del suelo. En hábitats donde la vegetación se extiende sobre la altura previamente indicada, las redes de niebla colocadas de forma estandar, pudieran muestrear inadecuadamente la comunidad de aves y la estructura de edad y sexo en las poblaciones. Estos sesgos de muestreo pueden levantar interrogantes sobre estudios que utilizen de forma usual redes de niebla. Para determinar si las aves eran capturadas en igualdad de condiciones, con redes colocadas a diferentes alturas, colocamos redes contiguas, a la altura cotidiana y otras elevadas en una estación de investigación en el estado de Nueva York. De 2000–2006 operamos redes elevadas (durante la primavera y el otoño) para capturar individuos migratorios. Durante las 14 estaciones de estudio capturamos 19,735 pájaros representando a 118 especies. La tasa de captura resultó significativamente más alta en las redes de altura estandar, pero 12 especies de aves fueron capturadas solamente en las redes elevadas. Venticinco, de 44 especies que se capturaron al menos en 50 ocasiones, fueron más propensas a ser capturadas en redes bajas que en elevadas y dos especies resultaron lo inverso. Para cuatro de 18 especies, más individuos fueron capturados en redes elevadas durante la migración otonal que en la primaveral. Se concluye que las redes a alturas estandar son más eficientes para la captura de aves en hábitas de crecimiento secundario. Sin embargo, las redes al nivel del suelo no necesariamente muestrean adecuadamente la comunidad total de aves y la estructura de edad y sexo en las poblaciones.

Key words: migration monitoring, mist net, sampling bias, stopover

Sampling landbird communities can be problematic, particularly during the nonbreeding season when individuals may be transient and less vocal. Methods for sampling avian communities at stopover sites during migration frequently involve capturing birds with mist nets. However, standard mist-net sampling protocols may have numerous biases. For example, Pardieck and Waide (1992) demonstrated that capture efficiency depended on the mesh size and body size of the birds. Other biases may result from differences among species and between age- and sex-classes within species in movement patterns and habitat use that may influence capture rates (Remsen and Good 1996). Movement patterns may also exhibit daily or seasonal variation, further complicating interpretation of data collected using mist nets.

[4]Corresponding author. Email: dnb23@cornell.edu

Mist nets deployed in a standard ground-level fashion capture birds moving at approximately 0.5–2.6 m above the ground. Depending on the habitat, only a fraction of the vegetative structure may be sampled. Hence, mist nets set at standard levels can under-sample or miss species that forage and move predominantly above net height (Blake and Loiselle 1992, Remsen and Good 1996).

Various investigators have used elevated or stacked mist-net systems to capture birds above the reach of ground-level nets (DeJonghe and Cornuet 1983, Meyers and Pardieck 1993, Derlindati and Caziani 2005). Previous studies were designed to capture target species such as Psittacines (Munn 1991) or to sample the entire avian community (Fitzgerald et al. 1989). To date, most migration-monitoring stations have used only standard ground-level mist nets to capture migrants. Information about mass change during stopover, migration phenology, differences in migration patterns between age- and sex-classes, and other topics has been derived from birds captured in ground-level mist nets. However, results of such studies may be biased if these nets do not adequately sample the targeted avian community, or if certain age- and sex-classes within species are disproportionately sampled by ground-level nets. We used a series of paired ground-level and elevated nets at a stopover site to determine if nets operated at different heights were equally likely to capture birds in our secondary growth habitat, if capture height varied within species between migration seasons, and if capture height varied within species by sex during spring or by age during fall migration.

METHODS

We constructed six net rigs, each consisting of two mist nets, one installed above the other (original design from D. Hussell, pers. comm.). Standard 12-m, 30-mm mesh nylon mist nets were attached with ropes to 6-m electrical conduit metal poles (3.8 cm diameter). Pulleys on top of the poles allowed the nets to be raised and lowered in flagpole fashion. Birds captured in upper levels were removed by lowering the elevated net down onto the ground-level net. The eight panels of the combined nets were evenly spaced with 61-cm lengths of rope tied between trammel lines. A 25-cm gap was left between the two nets to avoid simultaneous entanglement in the bottom panel of the elevated net and the top panel of the ground-level net because this could potentially lead to injury. On all nets, the bottom panel (level 1) was approximately 0.5–1.1 m above the ground, and the top panel (level 8) approximately 5–5.6 m above ground.

Our study site was the Braddock Bay Bird Observatory on the south shore of Lake Ontario, approximately 25 km northwest of Rochester, New York (43°19′38″N, 77°43′05″W). Nets were located approximately 100–200 m from the lakeshore in early secondary-growth habitats where the tops of the net rigs were approximately 1 m higher than the surrounding vegetation (Jenni et al. 1996). Vegetation in the netting area was dominated by fruiting shrubs (*Cornus* spp., *Lonicera* spp., and *Alnus* spp.) and ash saplings (*Fraxinus* spp.). Habitat surrounding the net rigs was actively managed and maintained at an early stage of succession.

Net rigs ($N = 6$) were opened by sunrise daily during spring (late April to early June) and fall migration (late August to mid October) on 577 days between spring migration in 2000 and fall migration in 2006, inclusive (270 days in spring, 307 days in fall). Nets were operated for at least 6 h per day, weather permitting, and birds were removed from nets at half-hour intervals. Because the lower and upper net in each net rig were attached to the same support structure, paired nets were always opened and closed simultaneously. For all captured birds, we noted net number, capture height (panel 1 – 8), date, species, and a series of condition and morphological measures were recorded. All birds were aged and sexed when possible (Pyle 1997), and banded with a USGS aluminum leg band prior to release.

Only data from the first encounter of recaptured individuals was included in the analyses to avoid pseudoreplication. Because of the high rate of turnover at our stopover site, the potential influence of net avoidance was likely minimal (Karr 1981).

We used Wilcoxon signed-rank tests to examine possible differences in total captures between ground-level and elevated nets for each species. Further, we tested for seasonal changes in the proportion of each species captured in ground-level versus elevated nets, sex-based differences in capture height distribution during spring, and age-based differences during fall migration.

Analyses were conducted for each species with at least 50 individuals captured in each category. All tests were conducted using the Statistical Analysis System (SAS Institute 2003, version 9.1).

RESULTS

We captured 19,735 individuals of 118 species, with 12,855 birds (65%) captured in ground-level nets and 6880 birds in elevated nets. Of 44 species with at least 50 captures, 25 species were more likely to be captured in ground-level nets (Wilcoxon signed-rank tests, $S = 10.5$, $P = 0.031$, Table 1), two species were more likely to be captured in elevated nets, and 17 species were equally likely to be captured in ground-level and elevated nets. None of the relatively common species were captured exclusively in the ground-level or elevated nets. However, 12 rarely encountered ($N \leq 3$ captures) species were only captured in elevated nets, including Mourning Doves (*Zenaida macroura*), Yellow-billed Cuckoos (*Coccyzus americanus*), Red-headed Woodpeckers (*Melanerpes erythrocephalus*), Hairy Woodpeckers (*Picoides villosus*), Olive-sided Flycatchers (*Contopus cooperi*), Eastern Kingbirds (*Tyrannus tyrannus*), Northern Shrikes (*Lanius excubitor*), Northern Rough-winged Swallows (*Stelgidopteryx serripennis*), Prairie Warblers (*Dendroica discolor*), Summer Tanagers (*Piranga rubra*), Brown-headed Cowbirds (*Molothrus ater*), and Bobolinks (*Dolichonyx oryzivorus*).

A seasonal shift in the capture height distribution of birds was detected in four of 18 species, with proportionally more birds being captured in the elevated nets during fall migration (Wilcoxon signed-rank tests, $S = 10.5$, $P = 0.031$, Table 2). No species were significantly more likely to be captured in the elevated nets in spring than in fall.

Proportionally more male than female American Redstarts (*Setophaga ruticilla*) were captured in elevated nets during spring migration (Wilcoxon signed-rank test, $S = 10.5$, $P = 0.031$, Table 3). None of the other 11 species with $N \geq 50$ captures of each sex showed significant differences in the distribution of capture heights. For two of six species tested, adult birds were proportionally more likely than hatch-year birds to be captured in the elevated nets during fall migration (Wilcoxon signed-rank test, $S = -10.5$, $P = 0.031$, Table 4).

DISCUSSION

We are aware of only one previous study examining the vertical distribution of species based on mist-net capture data. Fitzgerald et al. (1989) found that 50% of species examined in a New Zealand forest exhibited vertical distributions significantly different from an equal chance of capture in each level, with three species more likely to be caught in the highest nets. Although mist nets are generally not expected to adequately sample the entire avian community at a site (Rappole et al. 1998), the adequacy of ground-level nets for capturing a representative sample of the more common species using the site should be considered. Quantifying the relative abundance of species based on mist-net captures in ground-level nets without knowledge of capture probabilities would be inadvisable (Remsen and Good 1996).

Our study indicates that the mean capture height of a species may vary at different times of the year. The greater, on average, capture height recorded for species during fall migration relative to spring migration is likely related to seasonal changes in the structure of the vegetation at our study site. Leaves on many trees and shrubs are not fully developed until late May or early June, after most migrants have already passed through the area. As such, less cover exists during spring migration than during fall migration and birds may tend to stay lower in the brushy undergrowth in the spring. Fall migration, in contrast, is largely over before most deciduous trees and shrubs lose their leaves. This may alter predator avoidance movements and flight lanes through the habitat (Cimprich et al. 2005). Further, many shrubs offer potential food supplies during fall (fruit) that is often located near the top of the plants (Parrish 1997, Suthers et al. 2000). Thus, birds may actively move at higher levels during fall migration due to the foraging opportunities and cover found at greater heights than in spring.

Data from Remsen and Good (1996) suggest that capture rates in ground-level mist nets may be biased towards certain demographic classes as different age- or sex-classes may demonstrate differential habitat use or movement patterns. For instance, males may be expected to spend more time using higher segments of the vegetation as song perches. We did find that male American Redstarts were more likely to be captured in the elevated nets than females, but none of the

Table 1. Mean capture height by species across all net rigs and seasons including direction of capture-height bias, if present.

	Panel[1]		Wilcoxon signed-rank test[2]			
Species	Mean	STD	*S*	*P*	*N*	Bias[3]
Yellow-bellied Flycatcher, *Empidonax flaviventris*	3.5	1.6	10.5	0.031	105	Ground
"Traill's" Flycatcher, *E. alnorum & E. traillii*	3.2	1.5	10.5	0.031	291	Ground
Least Flycatcher, *E. minimus*	3.6	1.7	10.5	0.031	276	Ground
Blue-headed Vireo, *Vireo solitarius*	3.9	2.0	5.0	0.250	67	
Philadelphia Vireo, *V. philadelphicus*	3.9	1.7	7.5	0.156	77	
Red-eyed Vireo, *V. olivaceus*	3.9	1.8	9.5	0.063	387	
Blue Jay, *Cyanocitta cristata*	5.2	1.7	−10.5	0.031	270	Elevated
Black-capped Chickadee, *Poecile atricapillus*	4.0	2.0	7.5	0.156	1416	
Brown Creeper, *Certhia americana*	5.0	1.9	−9.5	0.063	224	
Winter Wren, *Troglodytes troglodytes*	1.9	1.4	10.5	0.031	186	Ground
Golden-crowned Kinglet, *Regulus satrapa*	4.2	2.0	4.5	0.438	1553	
Ruby-crowned Kinglet, *R. calendula*	3.8	1.9	10.5	0.031	2206	Ground
Veery, *Catharus fuscescens*	3.2	2.2	9.5	0.063	74	
Gray-cheeked Thrush, *C. minimus*	3.4	2.0	10.5	0.031	285	Ground
Swainson's Thrush, *C. ustulatus*	3.8	2.0	10.5	0.031	385	Ground
Hermit Thrush, *C. guttatus*	3.0	1.9	10.5	0.031	474	Ground
American Robin, *Turdus migratorius*	5.0	2.0	−7.5	0.156	83	
Gray Catbird, *Dumetella carolinensis*	3.4	1.8	10.5	0.031	646	Ground
Cedar Waxwing, *Bombycilla cedrorum*	5.4	1.7	−10.5	0.031	205	Elevated
Nashville Warbler, *Vermivora ruficapilla*	3.8	1.9	8.5	0.094	231	
Yellow Warbler, *Dendroica petechia*	3.5	1.8	10.5	0.031	391	Ground
Chestnut-sided Warbler, *D. pensylvanica*	3.7	1.7	10.5	0.031	188	Ground
Magnolia Warbler, *D. magnolia*	3.3	1.8	10.5	0.031	1208	Ground
Black-throated Blue Warbler, *D. caerulescens*	3.2	1.8	10.5	0.031	313	Ground
Yellow-rumped Warbler, *D. coronata*	4.0	2.0	9.5	0.063	1096	
Black-throated Green Warbler, *D. virens*	4.2	1.9	6.5	0.188	155	
Palm Warbler, *D. palmarum*	3.8	2.0	9.0	0.094	254	
Blackpoll Warbler, *D. striata*	3.7	2.0	10.5	0.031	212	Ground
Black-and-white Warbler, *Mniotilta varia*	3.6	2.0	7.5	0.063	119	
American Redstart, *Setophaga ruticilla*	3.5	1.9	10.5	0.031	690	Ground
Ovenbird, *Seiurus aurocapilla*	2.3	1.7	10.5	0.031	63	Ground
Northern Waterthrush, *S. noveboracensis*	3.0	2.1	10.5	0.031	115	Ground
Mourning Warbler, *Oporornis philadelphia*	2.6	1.7	10.5	0.031	74	Ground
Common Yellowthroat, *Geothlypis trichas*	2.3	1.6	10.5	0.031	444	Ground
Wilson's Warbler, *Wilsonia pusilla*	3.0	1.5	10.5	0.031	301	Ground
Canada Warbler, *W. canadensis*	2.9	1.6	10.5	0.031	137	Ground
Song Sparrow, *Melospiza melodia*	3.1	1.8	10.5	0.031	103	Ground
Lincoln's Sparrow, *M. lincolnii*	2.1	1.6	10.5	0.031	101	Ground
Swamp Sparrow, *M. georgiana*	2.1	1.5	10.5	0.031	96	Ground
White-throated Sparrow, *Zonotrichia albicollis*	4.0	1.9	10.5	0.031	2694	Ground
Dark-eyed Junco, *Junco hyemalis*	3.7	2.2	7.5	0.156	230	
Northern Cardinal, *Cardinalis cardinalis*	3.9	1.8	5.5	0.313	65	
Baltimore Oriole, *Icterus galbula*	5.0	1.9	−4.5	0.313	54	
American Goldfinch, *Carduelis tristis*	4.0	2.0	5.5	0.313	130	

[1]Mean panel height of capture for all nets and seasons combined (1 = bottom of ground-level net, 8 = top of elevated net).
[2]*S-v*alue from Wilcoxon signed-rank test comparing total captures in ground-level and elevated nets across all net rigs, all seasons combined.
[3]Bias indicates the direction of the significant difference in number of captures between ground-level and elevated nets ($P < 0.05$).

Table 2. Comparison of the proportion of each species captured in the ground-level nets between spring and fall migration for species with $N \geq 50$ captures in each season.

			Proportion captured in ground-level nets		Season[1]	
Species	*N* Spring	*N* Fall	Spring	Fall	*S*	*P*
Least Flycatcher, *Empidonax minimus*	213	63	0.765	0.571	10.5	0.031
Red-eyed Vireo, *Vireo olivaceus*	138	249	0.594	0.703	−8.5	0.094
Black-capped Chickadee, *Poecile atricapillus*	885	531	0.589	0.556	8.5	0.094
Golden-crowned Kinglet, *Regulus satrapa*	91	1462	0.615	0.576	3.5	0.563
Ruby-crowned Kinglet, *R. calendula*	746	1460	0.755	0.620	10.5	0.031
Swainson's Thrush, *Catharus ustulatus*	83	302	0.711	0.616	10.5	0.031
Hermit Thrush, *C. guttatus*	59	415	0.847	0.766	6.5	0.219
Gray Catbird, *Dumetella carolinensis*	443	203	0.736	0.734	0.5	1.000
Cedar Waxwing, *Bombycilla cedrorum*	138	67	0.348	0.194	1.5	0.813
Nashville Warbler, *Vermivora ruficapilla*	158	73	0.608	0.726	−7.5	0.156
Magnolia Warbler, *Dendroica magnolia*	608	600	0.752	0.788	4.5	0.438
Black-throated Blue Warbler, *D. caerulescens*	175	138	0.834	0.746	6.5	0.219
Yellow-rumped Warbler, *D. coronata*	714	382	0.599	0.634	3.5	0.563
Black-throated Green Warbler, *D. virens*	85	70	0.541	0.629	−7.5	0.156
American Redstart, *Setophaga ruticilla*	523	167	0.719	0.719	7.5	0.156
Common Yellowthroat, *Geothlypis trichas*	278	166	0.863	0.916	−3.5	0.563
Wilson's Warbler, *Wilsonia pusilla*	193	108	0.829	0.852	−5.5	0.313
White-throated Sparrow, *Zonotrichia albicollis*	266	2428	0.876	0.567	10.5	0.031

[1]Results of Wilcoxon signed-rank test examining differences in the proportion of birds captured in the ground-level nets between seasons.

Table 3. Comparison of the proportion of each sex captured in the ground-level nets during spring migration for species with $N \geq 50$ captures in each sex class.

			Proportion captured in ground-level nets		Sex[1]	
Species	*N* Male	*N* Female	Male	Female	*S*	*P*
Ruby-crowned Kinglet, *Regulus calendula*	330	411	0.764	0.745	4.5	0.438
Cedar Waxwing, *Bombycilla cedrorum*	55	78	0.382	0.308	−2.0	0.625
Nashville Warbler, *Vermivora ruficapilla*	84	51	0.548	0.725	9.5	0.063
Yellow Warbler, *Dendroica petechia*	205	168	0.683	0.792	7.5	0.156
Chestnut-sided Warbler, *D. pensylvanica*	80	52	0.650	0.750	4.5	0.313
Magnolia Warbler, *D. magnolia*	421	132	0.748	0.765	2.5	0.688
Black-throated Blue Warbler, *D. caerulescens*	89	86	0.764	0.907	4.0	0.250
Yellow-rumped Warbler, *D. coronata*	425	267	0.584	0.614	5.5	0.313
American Redstart, *Setophaga ruticilla*	278	230	0.662	0.800	10.5	0.031
Common Yellowthroat, *Geothlypis trichas*	157	118	0.847	0.890	5.5	0.313
Canada Warbler, *Wilsonia canadensis*	64	58	0.813	0.914	4.5	0.313
American Goldfinch, *Carduelis tristis*	53	50	0.698	0.460	−7.5	0.063

[1]Results of Wilcoxon signed-rank test examining differences in the proportion of birds captured in ground-level nets by sex during spring migration.

Table 4. Comparison of the proportion of each age class captured in the ground-level nets of the elevated net rigs during autumn migration for species with $N \geq 50$ captures in each age class[1].

			Proportion captured in ground-level Nets		Age[2]	
Species	*N* AHY	*N* HY	AHY	HY	*S*	*P*
Black-capped Chickadee, *Poecile atricapillus*	52	435	0.442	0.552	−10.5	0.031
Golden-crowned Kinglet, *Regulus satrapa*	85	998	0.447	0.588	−8.5	0.094
Ruby-crowned Kinglet, *R. calendula*	199	890	0.618	0.622	0.5	1.000
Magnolia Warbler, *Dendroica magnolia*	98	473	0.806	0.784	−1.5	0.844
Yellow-rumped Warbler, *D. coronata*	81	251	0.494	0.677	0.5	1.000
White-throated Sparrow, *Zonotrichia albicollis*	242	2115	0.504	0.574	−10.5	0.031

[1]AHY = After hatch year, including all birds at least one year in age. HY = hatch year, including all birds hatched during the year of capture.
[2]Results of Wilcoxon signed-rank test examining differences in the proportion of birds captured in ground-level nets by age during fall migration.

other 11 species tested showed significant sex-based differences in capture height during spring migration. These results suggest that ground-level nets did provide adequate samples of both sexes in species routinely captured at our site. Sex-based biases in capture heights, if present, may be more pronounced during the breeding season when differential habitat use and movement patterns are more likely.

The lower overall capture efficiency of the elevated nets may be partially attributable to the increased exposure of these nets to environmental conditions that are less conducive to netting. Because elevated nets are more exposed to wind than ground-level nets, capture rates in elevated nets may be reduced as wind increases the likelihood of escape (Jenni et al. 1996). Additionally, elevated nets are often exposed to more sun than ground-level nets further increasing net visibility and avoidance. Jenni et al. (1996) suggested that sunlight might increase net avoidance rates as birds flying toward the highest mist-net shelf (panel) avoided the net more often than birds flying toward lower shelves. Thus, the combined effects of wind and sunlight may disproportionately bias capture rates against the elevated nets.

Advantages of employing elevated nets include increasing the likelihood of capturing locally uncommon species. Elevated nets may also increase staff efficiency as these net rigs (two nets) can be opened and closed in the time it takes to open and close one ground-level net. This operational advantage, however, is only realized at sites where nets can be installed on a semipermanent basis as considerable effort is expended on the initial set-up of the net rigs each season.

Jenni et al. (1996) suggested that mist nets should extend to the top of the vegetation layer to adequately sample birds whose movements are largely confined to higher vegetation strata. Similarly, our results suggest that netting through the entire vegetation layer is advisable. Although we found that ground-level nets were more efficient at capturing most species using secondary growth habitats at our study site, some species would have been missed by standard ground-level net placement. Given the variability in the vertical distribution of captures among species, seasons, and demographic classes detected in this study, further research with elevated net systems in a variety of habitat types is warranted.

ACKNOWLEDGMENTS

We thank the volunteer staff and Board of Directors of Braddock Bay Bird Observatory for operating the research station. D. Hussell provided sketches and construction plans that assisted with the elevated net design. D. deRoos modified the design and helped construct the net rigs. The Great Lakes Research Consortium, the U. S. Environmental Protection Agency Great Lakes National Program Office, and the members of Braddock Bay Bird Observatory funded portions of our research. We thank William Kaiser, the Genesee Land Trust, and the New York State Department of Environmental Conservation for permission to conduct our research on their land. M. Whitman,

P. Jones, S. Morris, and three anonymous reviewers provided comments that improved the manuscript.

LITERATURE CITED

BLAKE, J. G., AND B. A. LOISELLE. 1992. Habitat use by Neotropical migrants at La Selva Biological Station and Braulio Carrillo National Park, Costa Rica. In: Ecology and conservation of Neotropical migrant landbirds (J. M. Hagan, and D. W. Johnston, eds.), pp. 257–272. Smithsonian Institution Press, Washington, D. C.

CIMPRICH, D., M. WOODREY, AND F. MOORE. 2005. Passerine migrants respond to variation in predation risk during stopover. Animal Behaviour 69: 1173–1179.

DEJONGHE, J. F., AND J. F. CORNUET. 1983. A system of easily manipulated, elevated mist nets. Journal of Field Ornithology 54: 84–88.

DERLINDATI, E. J., AND S. M. CAZIANI. 2005. Using canopy and understory mist nets and point counts to study bird assemblages in Chaco forests. Wilson Bulletin 117: 92–99.

FITZGERALD, B. M., H. A. ROBERTSON, AND A. H. WHITAKER. 1989. Vertical distribution of birds mist-netted in a mixed lowland forest in New Zealand. Notornis 36: 311–321.

JENNI, L., M. LEUENBERGER, AND F. RAMPAZZI. 1996. Capture efficiency of mist nets with comments on their role in the assessment of passerine habitat use. Journal of Field Ornithology 67: 263–274.

KARR, J. R. 1981. Surveying birds with mist nets. In: Estimating numbers of terrestrial birds (C. J. Ralph, and J. M. Scott, eds.), pp. 62–67. Studies in Avian Biology 6, Cooper Ornithological Society Lawrence, KS.

MEYERS, J. M., AND K. L. PARDIECK. 1993. Evaluation of three elevated mist-net systems for sampling birds. Journal of Field Ornithology 64: 270–277.

MUNN, C. A. 1991. Tropical canopy netting and shooting lines over tall trees. Journal of Field Ornithology 62: 454–463.

PARDIECK, K., AND R. B. WAIDE. 1992. Mesh size as a factor in avian community studies using mist nets. Journal of Field Ornithology 63: 250–255.

PARRISH, J. D. 1997. Patterns of frugivory and energetic condition in Nearctic landbirds during autumn migration. Condor 99: 681–697.

PYLE, P. 1997. Identification guide to North American birds: part I. Slate Creek Press, Bolinas, CA.

RAPPOLE, J. H., K. WINKER, AND G. V. N. POWELL. 1998. Migratory bird habitat use in southern Mexico: mist nets versus point counts. Journal of Field Ornithology 69: 635–643.

REMSEN, J. V., AND D. A. GOOD. 1996. Misuse of data from mist-net captures to assess relative abundance in bird populations. Auk 113: 381–398.

SAS INSTITUTE. 2003. Release 9.1 edition. SAS Institute, Cary, NC.

SUTHERS, H. B., J. M. BICKAL, AND P. G. RODEWALD. 2000. Use of successional habitat and fruit resources by songbirds during autumn migration in central New Jersey. Wilson Bulletin 112: 249–260.