The Nightjar Survey Network: Program Construction and 2007 Southeastern Nightjar Survey Results

Center for Conservation Biology
College of William and Mary

The Center for Conservation Biology is an organization dedicated to discovering innovative solutions to environmental problems that are both scientifically sound and practical within today's social context. Our philosophy has been to use a general systems approach to locate critical information needs and to plot a deliberate course of action to reach what we believe are essential information endpoints.

Visit us at www.ccb-wm.org/nightjars

The Nightjar Survey Network: Program Construction and 2007 Southeastern Nightjar Survey Results

Michael D. Wilson
Center for Conservation Biology
College of William and Mary
Williamsburg, VA 23187-8795

e-mail: mdwils@wm.edu

Suggested citation:
Wilson, M. D. 2008. The Nightjar Survey Network: Program construction and 2007 Southeastern Nightar Survey Results. Center for Conservation Biology Technical Report Series, CCBTR-08-001.

Photo cover of Chuck-will's Widow provided by Teta Kain

The Center for Conservation Biology is an organization dedicated to discovering innovative solutions to environmental problems that are both scientifically sound and practical within today's social context. Our philosophy has been to use a general systems approach to locate critical information needs and to plot a deliberate course of action to reach what we believe are essential information endpoints.

www.ccb-wm.org

Executive Summary

In recent years, there has been an increased awareness that populations of Nightjars may be dramatically declining. However, prior to the Nightjar Survey Network there has been no broad scale or long-term monitoring program to fully assess these changes. Information on the precise scale and magnitude of population changes are necessary in order to plot a course for conservation of these species.

The Nightjar Survey Network is a new and statistically powerful monitoring program, coordinated by the Center for Conservation Biology, which is designed to collect information on the population status of Nightjar species across the United States. The success of this program relies entirely on volunteer participation to adopt Nightjar survey routes to collect these data. Each survey route is surveyed only one time per year but many years of data are needed from each route to provide any indication of population change.

Survey routes are distributed across 37 states with the potential to monitor populations of eight Nightjar species. Surveys are conducted by travelling a survey route by automobile and stopping at 10 locations placed at 1-mile intervals to count all Nightjars seen or heard. No recordings or playbacks are used. Because Nightjars call more frequently and consistently during bright moonlit nights, we designed surveys to count birds only when the moon is $\geq$ 50 % illuminated and above the horizon. This design will improve the statistical power towards drawing conclusions from survey data.

We introduced the Nightjar Survey Network to 10 states in the Southeastern U.S. in 2007. Volunteers adopted 90 routes for surveys and data for 59 routes were submitted at the time this report was generated. Volunteers counted a total of 215 Whip-poor-wills, 591 Chuck-will's Widows, and 65 Common Nighthawks during the surveys. Nightjars were detected at 53 of 59 routes surveyed (90 % of total). Chuck-wills-widows were the most frequently detected species per route followed by Whip-poor-wills and then by Common Nighthawks. The number of birds detected per route ranged from 0-40 for Chuck-will's Widows, 0-18 for Whip-poor-wills, and 0-14 for Common Nighthawks.

Survey data provide initial signals on how to improve future monitoring efforts. Understanding survey performance is important to determine correction factors needed to reduce systematic bias and random error.

The Nightjar Survey Network will be expanded in 2008 to cover remaining portions of the U.S. not currently being monitored for Nightjars. We urge all volunteers from 2007 to continue their participation in the program and ask for their help in recruiting new volunteers.

Introduction

Nightjars (order: Caprimulgiformes), or goatsuckers as sometimes called, are among the most enigmatic group of birds in the world. Very little is known about the basic aspects of their life history, such as habitat requirements, demographics, and population density because of the difficulty in studying their nocturnal lifestyle. In recent years, conservationists and the general public have come to share the general sense that populations of Nightjars were declining throughout North America. However, there have not been any large-scale or long-term monitoring programs designed to gather information vital to fully assessing these changes. Gaining insight into the precise scale, location, and magnitude of population changes is critical if we are to plot a course of conservation for these species.

In the spring of 2007, The Center for Conservation Biology constructed the Nightjar Survey Network to begin the process of collecting data on the population distribution and population trends of Nightjars across broad regions of the United States. This Network relies on volunteer participation by conservation-minded citizens, wildlife-watchers, federal and state wildlife agencies, and other like-minded groups to adopt and conduct survey routes. Such surveys will augment our knowledge about the population status of Nightjars.

The Nightjar Survey Network has both short-term and long-term objectives that have different data requirements to reach project milestones. Short-term objectives include 1) gaining a better understanding of the population distribution of Nightjars across their breeding ranges, 2) learning how the composition of different habitats in a landscape influences Nightjar abundance, and 3) determining the bias and precision of survey protocols. These short-term objectives can be accomplished within a few years, after enough survey routes are conducted to encompass a large geographic range and to replicate landscape scenes.

Landscape composition and structure is known to influence the abundance and distribution of Nightjars (Cooper 1982, Wilson and Watts 2008). For example, urban and rural landscapes are believed to support different Nightjar carrying capacities based on the amount of habitats available. Landscape composition surrounding individual survey routes will be quantified then compared to Nightjar survey data to understand how land use and development affects their distribution. We will also develop predictive models to illustrate how changes in land cover may affect population trends over time. Finally, we will continue to assess the performance of survey protocols by monitoring the results and performing field experiments designed to reduce survey bias and increase survey precision.

Longer-term objectives of the Nightjar Survey Network focus on demonstrating the scale and magnitude of actual Nightjar population changes. These objectives can only be accomplished after data are collected annually across many routes over periods of ten years or more. This information is critical because long-term survey data are able to depict both the background rate of population change across species' entire ranges or within localized areas. Concurrently, these data can provide alarm signals for specific geographic locations where Nightjars are becoming the most imperiled.

Figure 1. Coverage provided by the Nightjar Survey Network coordinated by the Center for Conservation Biology. Ten states were surveyed in 2007 and an additional 27 states will be covered in 2008. States labeled as "out of network" are coordinated by other state-level representatives.

We focused survey efforts across ten Southeastern U.S. states in the first year of the program, including Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia (Figure 1). We developed a standardized monitoring protocol that was specifically designed to accommodate Nightjar biology, then created a lattice of repeated survey routes across those states.

In mid-2008, the Nightjar Survey Network will be expanded to cover areas of the conterminous United States, where no Nightjar surveys have previously been conducted. This will broaden the survey effort to include data collection on 8 Nightjar species across 37 states. (Figure 1). Additional states in the Northeastern U.S. are coordinated by other state wildlife agencies or conservation groups.

Table 1. List of potential species covered by the Nightjar Survey Network

Species	Scientific Name
Whip-poor-will	*Caprimulgus vociferus*
Chuck-will's widow	*C. carolinensis*
Buff-collared Nightjar	*C. ridgwayi*
Common Nighthawk	*Chordeiles minor*
Lesser Nighthawk	*Chordeiles acutipennis*
Antillean Nighthawk	*Chordeiles gundlachii*
Common Poorwill	*Phalaenoptilus nuttallii*
Common Pauraque	*Nyctidromus albicollis*

Survey Design

Survey Protocol - The overall design of the Nightjar Survey Network was to implement a standardized sampling unit that could be replicated across a broad geographical area. The basic sampling unit is a survey route where an observer travels a 9 mile route by automobile, then stops to conduct Nightjar surveys from the roadside every mile at 10 predetermined locations. Surveys are conducted at night when the moon is $\geq$ 50 % illuminated and above the horizon. At each stop, the observer counts the number of Nightjars seen or heard over a 6-min period. No recordings or playbacks are used. Each route is surveyed one time per year but data need to be collected from each route for many years to adequately assess population change.

Nocturnal behaviors of Nightjars are strongly influenced by moonlight. Activities such as calling and foraging increase under bright moonlight conditions (Figure 2) (Cooper 1982, Mills 1986, Wilson and Watts 2006) and it is thought that breeding may actually be directly tied to the lunar schedule. Although all reasons for these behaviors are unclear, it is thought that moonlight assists Nightjars to detect and capture flying insects. Survey protocols were designed to take advantage of these behaviors by restricting surveys to bright moonlit nights. Nightjars call more frequently and consistently during bright moons. This protocol substantially improves the precision of surveys by reducing the systematic error associated with lunar effects, thus strengthening the statistical power needed when drawing conclusions from collected data (Wilson and Watts 2006).

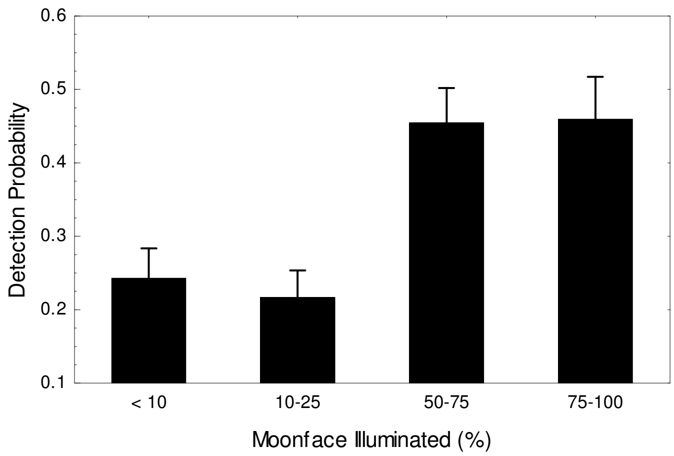


Figure 2. The influence of moonlight on Whip-poor-will detection probability. Values are expressed as $\bar{x} \pm$ SD.
(from Wilson and Watts 2006)

Route Selection - Nightjar survey routes are conducted much like the United States and Canada Breeding Bird Survey (BBS) (Downs and Collins 2007, Saurer et al. 2007). In fact, we used the existing BBS routes as the basic skeleton for route placement while still permitting individual volunteers the option to create their own routes if they so desired. The BBS has been conducted annually since 1963 as a means of determining the population trends of diurnal birds across North America. Data from this program has been instrumental in determining conservation priorities of many bird species. Using BBS routes for Nightjar surveys has two primary advantages: 1) Route are placed in a geographically stratified-random design; in other words, the location of individual BBS routes are randomly located but spatially replicated across broad physiographic regions, and 2) Nightjar survey data can be used for direct comparison with population trends of other diurnal bird species.

Nightjar survey routes differ from BBS routes in that they are surveyed at night rather than during the day, are comprised of fewer stops, have greater intervals between each stop, and are surveyed for longer time periods at each stop. BBS routes are comprised of 50 stops placed at 0.5 mile intervals (total of 25 mile route). Nightjar survey routes were initially created from a GIS cover map of USGS BBS routes by cleaving the total survey route from 25 miles to 10 miles in length. All Nightjar survey routes selected in this manner begin at the first BBS stop. We chose shorter routes than the BBS to reduce the overall time required for completing a full survey so it could be carried out while the moon was above the horizon on most nights of the survey time window. We believe that this overall survey length has also helped to increase volunteer recruitment into the Network. We selected an interval of one mile between each stop to reduce the probability of double-counting birds between stops. This is because Nightjars can be heard at distances > 500 m (> 0.25 mile) on calm nights. The 6-min counting period was chosen to remain consistent with other Nightjar surveys being conducted within a few Northeastern U.S. states.

The opportunity for participants to create their own route was provided as an option to increase volunteer recruitment and to allow participants to survey local areas where they knew Nightjars occurred. Routes created by volunteers are considered non-random samples but are also equally important in providing long-term population trends and distribution. Placing routes where Nightjars are known to occur will increase the overall efficiency of the program by starting a route in year 1 with a known population.

We created a website (http://www.ccb-wm.org/nightjars.htm) in order to communicate with volunteers. The website offers maps of survey routes, route registration information, protocols, data sheets, and other materials. All routes are displayed in Google Earth format (http://earth.google.com/) and Google Maps (http://maps.google.com) by transferring GIS information into .kml and kmz. file extensions used by these resources. Using Google allows all survey routes to be displayed with road names (navigational ease), scale bars, and many other useful features. We also provided a mechanism for volunteers to map the location of their survey stops using these Google resources or their personal Global Positioning System (GPS). Data can then be submitted for archival purposes.

2007 Southeastern U.S. Survey Results

A total of 90 routes were chosen by volunteers. This number is enlivening given that the announcement of the survey program was made only two weeks before the May 24th survey window began. We expect this number to grow substantially before the next survey season from stronger program marketing. Data was submitted for 59 of the 90 selected routes from 9 states at the time this report was generated (Table 2). These data included submissions for 36 pre-existing routes and 13 routes that were created by volunteers. Routes were conducted by 51 different volunteer participants. All surveys were conducted from 24 May through 8 June, when the moon was $\geq$ 50% illuminated.

Volunteers detected a total of 215 Whip-poor-wills, 591 Chuck-will's Widows, and 65 Common Nighthawks during the surveys (Table 3). Nightjars were detected at 53 of 59 routes (90 % of total). Chuck-wills-widows were the most frequently detected species per route (76 % of all routes), followed by Whip-poor-wills (41 % of all routes), and then by Common Nighthawks (23 % of all routes). The number of birds detected per route ranged from 0-40 for Chuck-will's Widows, 0-18 for Whip-poor-wills, and 0-14 for Common Nighthawks.

The preponderance of Chuck-will's Widows in this sample is most likely due to this species being more widely distributed than Whip-poor-wills or Common Nighthawks in the region of study. In general, distribution patterns agreed with what is generally known about the breeding distribution of these species. The average number of Chuck-will's Widows detected per route declined with latitude (Table 2). Detection rates were highest in Florida and Alabama and lowest in North Carolina and Virginia. Conversely, the average detection of Whip-poor-wills was greater in Virginia and North Carolina compared to areas south of these states (Table 1). Common Nighthawks were not detected in 6 states, and their numbers were low where they were found (Table 2). Detections of Common Nighthawks were greatest in Florida. This pattern is similar to results of the BBS that shows counts in Florida to be the highest in the southeastern U.S. (Sauer et al. 2007).

At the level of individual survey stops, average detection values had high standard deviations, indicating that counts were clumped in space (Table 3). This was due to a preponderance of zero values. For instance, despite an average of nearly 1.0 Chuck-will-Widows detected per stop, less than 41 % of all stops were actually occupied.

Table 2. Numbers of Nightjars detected per route across 9 states and over the entire survey network.

State	Number of Routes Conducted	Whip-poor-wills per route ($\bar{x}$ ± SD)	Chuck-will's Widows per route ($\bar{x}$ ± SD)	Common Nighthawks per route ($\bar{x}$ ± SD)
Alabama	7	3.3 ± 6.23	15.0 ± 13.25	0.3 ± 0.48
Florida	14	0.0 ± 0.00	15.4 ± 12.32	3.5 ± 4.75
Georgia	12	6.2 ± 6.84	9.75 ± 7.58	0.0 ± 0.00
Mississippi	5	0.0 ± 0.00	9.7 ± 12.02	0.3 ± 0.52
North Carolina	6	8.4 ± 7.37	4.2 ± 4.91	1.0 ± 1.41
South Carolina	2	4.0 ± 5.66	13.0 ± 16.97	0.0 ± 0.00
Tennessee	1	0.0 ± 0.00	0.0 ± 0.00	0.0 ± 0.00
Virginia	11	6.2 ± 7.32	4.4 ± 5.59	0.0 ± 0.00
West Virginia	1	0.0 ± 0.00	0.0 ± 0.00	0.0 ± 0.00
All States	59	3.6 ± 5.99	10.0 ± 10.51	1.1 ± 2.84

Table 3. Numbers of Nightjars detected per stop.

Species	Average birds/stop (± SD) (N = 590)	Range of birds detected	% of stops detected (N=590)	Average birds/occupied stop (± SD) (N = 590)
Whip-poor-will	0.4 ± 0.87	0-7	18.6	1.9 ± 1.07
Chuck-will's Widow	0.9 ± 1.49	0-8	40.3	2.4 ± 1.43
Common Nighthawk	0.1 ± 0.42	0-4	7.1	1.5 ± 0.77

Survey Performance – The rate at which birds were detected during each minute of survey was similar between species (Figure 3). Nearly 50 % of all individuals detected were recorded in the first minute. The rate at which new individuals were added then steadily declined after each successive minute, but did not level off. Nearly 10 % of all individuals counted were those reported during the last minute of survey. The addition of new individuals across the time intervals suggests that 6 min survey periods may be needed to better assess the total number of birds at each stop. However, even though the mean number of birds detected per stop declined with time of survey, the variation (CV) greatly increased with each passing minute (Figure 4). This suggests that the rate of

---

Figure 3. Cumulative proportion of Nightjars detected of each species during 1-min intervals.

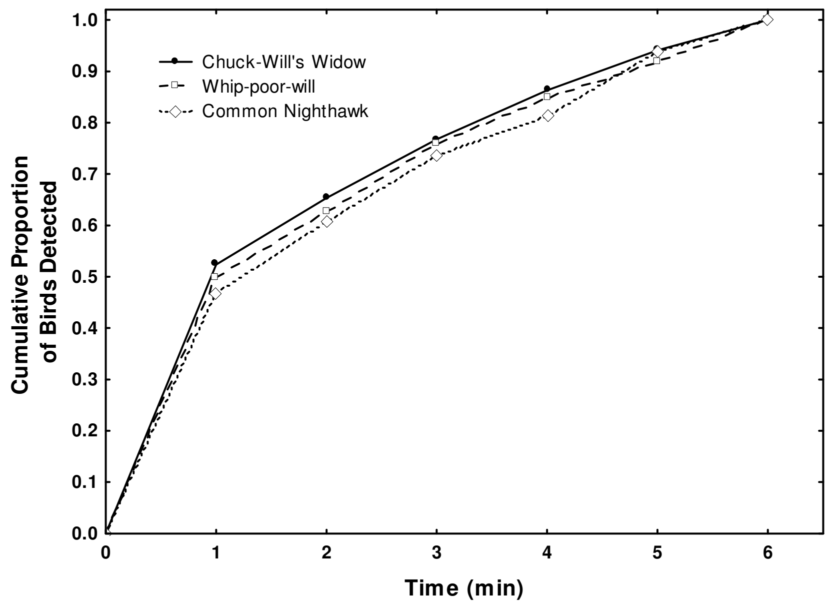
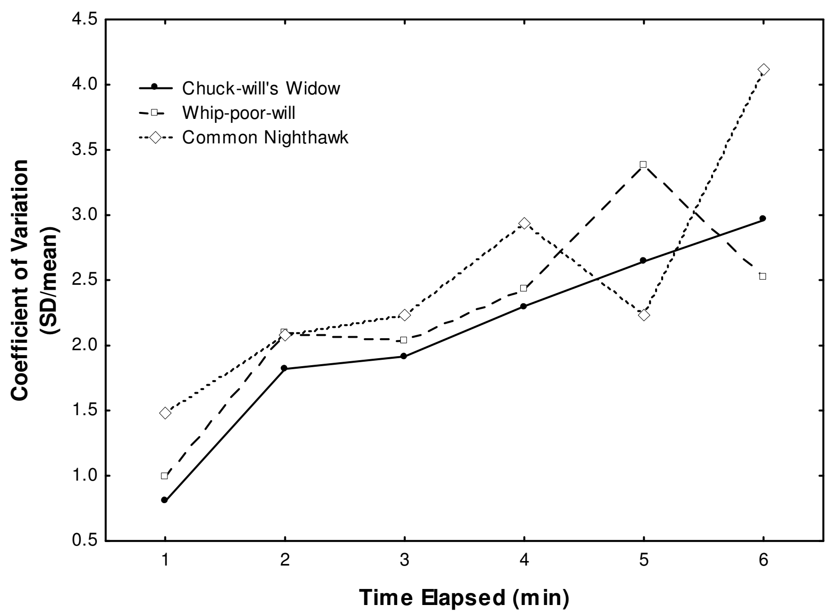


Figure 4. Coefficients of variation for the number of Nightjars of each species detected at each stop across 1-min intervals.



detecting new individuals was highly variable between stops. Although this result was expected, it highlights that there is a systematic level of added variance with survey time. Reasons for the variation in detection rates may be many and are likely are due to changes in Nightjar *detectability* and *availability*. Detectability generally includes factors that influence an observer's ability to detect birds given they are calling. This can be caused by simple differences in observer performance, but can also be influenced by habitat structure or background noises that might mask the sounds of calling Nightjars. Availability is based on the probability that a bird produces some cue for detection during the counting period (McCallum 2005) and therefore is influenced by factors such as singing rates.

Most of the factors that influence the detectability and availability are synonymous with other generalized bird surveys, but there are a few factors that seem particularly dynamic when surveying for Nightjars (Table 4). Nightjar surveys operate across much larger scales than do call-count surveys for other bird groups. This is because Nightjar detection distances can sometimes be > 500 m. Therefore, Nightjar detectability can be extremely sensitive to masking factors such as road noise or high winds even when such masking sounds are produced at relatively far distances. In addition, the probability of "double-counting" Nightjars may be higher than that of other bird surveys because these species can range over a broad area in a short amount of time. For example, Whip-poor-will home ranges can vary in size from 10 ha to > 3,000 ha (Wilson 2003). Within their home range, individual Whip-poor-wills will move distances of 100-500 m within a 10 min span (Wilson 2003). Observers must be able to track these movements during surveys to prevent being deceived into estimating there is more than one bird while only one may indeed be present. This can be particularly difficult when surveying birds at night. Nightjars do call when flying but the proportion of birds doing so versus not is unknown. Large home ranges and long-distance movements by Nightjars can also influence the availability of birds for detection, as the probability that new birds will enter into an observer's effective search radius increases with time.

Another important factor in counting is the difficulty in differentiating the total number of Nightjars when faced with the cacophony of many other vocalizing birds. Nightjars can be particularly difficult to enumerate when calls of two or more individuals overlap one another. This can often lead to undercounting birds unless enough time and concentration is spent on isolating individuals.

Most of the factors influencing detectability can be controlled with survey design or post-hoc correction factors. For example, restricting surveys to bright moonlit nights was a survey design feature we used to specifically to reduce the systematic bias of moonlight on calling frequency and to increase the precision of surveys between years by choosing a time when calling rates were more consistent. Bias is the amount of deviation of observed values from actual values. Reducing bias in Nightjar surveys often requires additional field experiments to develop correction factors that improve the accuracy of counts. Over the next coming years we will begin to investigate additional bias in surveys using procedures such as double sampling and distance estimation, then applying information learned to further analyses. Improvements in the precision of surveys can be gained as more routes are conducted with time.

Table 4. Possible sources of survey bias and random error in counting Nightjars during surveys. Methodological remedies to these sources of variation, such as changes in field protocols or use of specific correction factors, are offered.

Factor	Description	Possible Remedy
Detectability	Ability to detect calling birds	
Observer Variation	Differences in observers' ability to detect birds	Observer covariates
"Concentricability"	Probability of detecting species at greater distances changes with time	Distance estimation Increase survey time
Double Counting	Observers unable to track individual bird movements, leading to false sense that more birds are calling than are actually present	Distance estimation Reduce time of survey
Habitat Structure	Open habitats and forested habitats attenuate sound differently	Distance estimation Habitat covariates
Masking	Ambient sound 'drowns' out calling birds, (e.g., road noise, wind)	Masking covariates Increase survey time
Nightjar Masking	Difficulty in differentiating the total number because of other calling Nightjars	Abundance covariates Increase survey time
Availability	Probability that a bird produces some cue for detection	
Calling frequency	Interval between calling and silent periods < or > than some time period within 6-min	Capture model corrections Increase survey time
Movement	Bird have greater probability to move into effective search radius of an observer after some time > 1 min has elapsed	Capture model corrections Distance Estimation Reduce survey time

Acknowledgements

The success of this monitoring program relies entirely on the effort of volunteer participants. I gratefully thank all volunteers that conducted surveys in the first year of this program for their time and effort. It was a pleasure to learn more about Nightjars from discussions and correspondence with these dedicated people. I also would like to thank the many people who spread the word about this program through listserv messages, bird club meetings, and other means. This includes several federal and state wildlife agency personnel. Recruitment of new volunteers is always needed. I would also like to thank Jessica Mackow and Andy Glass from the Center for Conservation Biology for GIS work and creating Google-based maps of survey routes for the website's display. The survey design and protocol was refined through interactions with the Northeastern Partners in Flight Nightjar Working Group. Many state and non-profit conservation organizations contributed to a unified Nightjar monitoring approach. Funding for the Nightjar Survey Network is provided by the Center for Conservation Biology.

Literature Cited

Downes, C.M., and B.T. Collins. 2007. Canadian Bird Trends Web site Version 2.2. Canadian Wildlife Service, Environment Canada, Gatineau, Quebec, K1A 0H3

Cooper, R. J. 1981. Relative abundance of Georgia caprimulgids based on call-counts. Wilson Bulletin 93:363-371.

McCallum, D. A. 2005. A conceptual guide to detection probability for point counts and other count-based survey methods. USDA Forest Service Gen. Tech. Rep. PSW-GTR-191.

Mills, A. M. 1986. The influence of moonlight on the behavior of goatsukers. (Caprimulgidae). Auk 103: 370-378.

Sauer, J. R., J. E. Hines, and J. Fallon. 2007. The North American Breeding Bird Survey, Results and Analysis 1966 - 2006. Version 10.13.2007. *USGS Patuxent Wildlife Research Center, Laurel, MD*

Wilson, M. D. 2003. Distribution, abundance, and home range of the Whip-poor-will (*Caprimulgus vociferous*) in a managed forest landscape. Thesis. College of William and Mary, Williamsurg, Virginia, USA.

Wilson, M. D., and B. D. Watts. 2006. Effect of moonlight on detection of Whip-poor-wills: implications for long-term monitoring strategies. Journal of Field Ornithology 77:207-211.

Wilson, M. D. and B. D. Watts. 2008. Landscape configuration effects on Distribution and abundance of Whip-poor-wills. Wilson Journal of Ornithology, *in press*