Northeast Nightjar Survey:
2008 Summary and 2007 Data Analysis


Whip-poor-will in Hooksett, NH on 30 July 2008. Photo by Brendan Clifford

A Report to the Nuttall Ornithological Club

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Summary

2008 marked the 6th year that nightjar surveys (with a focus on Whip-poor-wills) have been conducted in New Hampshire under the direction of New Hampshire Audubon and the 4th year for such surveys in a broader area of the northeastern United States. The two goals for the "Northeast Nightjar Survey" in 2008 were 1) analysis of the 2007 pilot data and 2) collection of additional data using the same protocol.

Analysis of survey data collected under a new protocol in 2007 revealed no significant influence of survey covariates (e.g., weather, date, noise levels) on Whip-poor-will detectability. These results suggest that the survey as currently constrained provides a reliable way to monitor populations of this declining species. The most interesting result of the analysis was the existence of two distinct calling types. Type 1 birds call irregularly and are only detected 18% of the time, while Type 2 birds are detected 74% of the time. Roughly half of birds fall into each category. The difference in calling behavior opens up a number of biological questions that can hopefully be answered with more detailed demographic studies.

The 2008 data currently being compiled will be analyzed using the same mathematical models to determine if these patterns hold for a larger data set, both in terms of covariates and calling types. Members of the Nightjar Working Group will be preparing a manuscript outlining these results for potential publication in the ornithological literature.

Although not all the data collected during 2008 have been received, the patterns of Whip-poor-will abundance appear similar to those found in previous years. Within the northeastern United States, densities are highest in the coastal plain from southeastern Massachusetts southward, as well as in barrens and disturbed areas in northern New York. Elsewhere in New England, the species is most common in central New Hampshire. No surveys were conducted in Maine in 2008, at least partially because densities are too low in that state to attract volunteers on survey routes.

As the Northeast Nightjar Survey moves forward, a key need remains a mechanism to determine route locations. Members of the nightjar working group are currently submitting habitat variables considered important in their states for a possible regional analysis to determine if a standard set of criteria could be used across the region. To date, such efforts have pointed out a significant discrepancy between the northern and southern parts of the Northeast, with Whip-poor-wills more widely dispersed in the south. As a result, a truly random route selection process has a greater chance of working there than in the northern portions of New York and New England. In the latter areas, there is still need for a means to select routes based on some combination of habitat and geographic range. There are also efforts under way to better like nightjar monitoring (and that of other shrubland or edge birds) to the effects of habitat management, with the goal of using management activity as a strata in the regional monitoring program.

Background

The Whip-poor-will (*Caprimulgus vociferous*), and nightjars in general, has been declining throughout its range in eastern North America for at least several decades. This decline is borne out by the limited data available from the Breeding Bird Survey (BBS) (Sauer et al. 2008), numerous anecdotal accounts, and most recently by data collected in five second-round Breeding Bird Atlases. These latter suggest that the number of atlas blocks occupied by the species has declined by roughly 50% in the last twenty years in the following states or provinces: Ontario, New York, Vermont, Pennsylvania, and Maryland.

While it is clear from these disparate data sets that the species is declining, there are limited data with which to access the magnitude of the change. BBS data are limited because the number of detections is quite small and atlas data provide only distributional limits. The Northeast Nightjar Survey was conceived as a means to obtain more robust population trend data across the Whip-poor-will's range in the northeastern United States, and ideally other areas where nightjar populations are in need of monitoring.

The first Whip-poor-will surveys in New Hampshire were implemented in the Piscataquog River Watershed in 2003, and in following years the project expanded to include most of the state. In 2005 it expanded further to include surveys in Vermont, Massachusetts, and Connecticut. It expanded to Maine, New York, New Jersey, and Maryland in 2006, and into Wisconsin and North Carolina in 2007. During this period of expansion, the protocol was refined several times, most notably to incorporate the documented variation in calling rate with lunar conditions (Wilson and Watts 2006). It was also determined that randomly placed routes would not be an effective way to monitor the species over most of the Northeast (Hunt 2005).

The final protocol developed for 2007 (Hunt 2007), and used subsequently, consists of a series of ten point counts spaced at one-mile intervals along a road. At each point, the observer records whether individual nightjars were detected in each of six one-minute periods, resulting in a new line of data for each bird heard. All surveys were required to occur during periods of high lunar illumination, defined as the moon at least half full, not obscured by clouds, *and* completely above the horizon. Observers also recorded data on weather (cloud cover, wind) and noise levels (categorical scale, number of cars). In some cases two observers independently recorded data simultaneously, and several routes were also repeated twice within the season.

Results and Discussion: Analysis of 2007 data

The goal of initial data analysis was not to assess population trends, but to evaluate the survey protocol by looking in more detail at Whip-poor-will detectability. Detectability is a measure of an observer's chance of actually detecting a bird when it is present, and is assessed using a variety of survey techniques and subsequent mathematical models. The new nightjar protocol introduced in 2007 was specifically designed to allow for detectability analysis using the "time-of-removal" method, in which individual birds are tracked over the course of a point count. The resulting data are represented by a detection history consisting of six one-minute periods where a bird was recorded as heard or not heard. For example, a detection history of "111001" represents a bird heard in the first three minutes, not heard the next two minutes, and heard again in the sixth minute. The time-of-removal approach is partially based on the assumption that a bird is still present even when it is not detected, and from this pattern of "1s" and "0s" one can estimate the overall chance of hearing the species in general.

Such analyses can also incorporate the potential effects of covariates on detectability (e.g., investigate whether detectability declines under windy conditions). Relationships here can indicate both environmental effects (the wind example) or observer effects (see below). For the first round of analyses, the following covariates were taken into consideration: wind, cloud cover, noise, time of season (early vs. late), and the total number of Whip-poor-wills per point. A full listing of models is presented in Table 1. All analyses were conducted by Jason Riddle, a post-doctoral researcher at North Carolina State University, who partnered with New Hamphire Audubon late in 2007 to help with protocol refinement. All analyses were done using the program MARK.

When the results of all models are compared (Table 2), the best model was the heterogeneity model with a behavioral effect (first row of Table 2), as indicated by a corrected Akaike Information Coefficient (AICc) of zero. By design the best-fit model receives an AICc of zero, and it is thus important to examine the "delta AICc" values of the other models. The larger the delta AIC value, the more a given model deviates from the best-fit model, indicating that it is a less accurate descriptor of the data. In general, delta AICc values greater than 10 indicate relatively poor models. The extremely high delta AICc values for all other models in the present analysis indicate that the "heterogeneity with behavioral effect" model provides by far the best explanation for the available data of the models tested. From this point on, it will by referred to as the "best model."

This best model is summarized in Table 3, and can be explained as follows. The "Pi" of 0.52 indicates that 52% of the birds detected fell into Calling Type 1 (P1, C1), leaving the remaining 48% in Type 2 (P2, C2). Type 1 birds are characterized by a relatively low detectability (18%: P1 = 0.18), while Type 2 birds are much more likely to be detected (74%: P2 = 0.74). This difference is maintained in subsequent detections, with Type 1 birds only detected 35% of the time after being first heard (C1 = 0.348), while corresponding value for Type 2 birds was 96% (C2 = 0.959). In both cases, C-values are higher than P-values, indicating that once a bird is detected once, the chances of detecting it again go up, irrespective of whether it is Type 1 or Type 2. This is what is meant by a "behavioral effect," here suggesting that the behavior of the *observer* is what increases the likelihood of subsequent detections: once you hear a bird, you will tend to listen more carefully in subsequent periods. Note that the confidence intervals around all these probabilities are relatively narrow, and that they don't overlap between the two calling types. Biologically, these results indicate that Type 1 birds are rarely detected and call infrequently as compared to Type 2 birds, which are best characterized as calling almost continuously throughout the six-minute point count. Roughly half of all birds fall into each calling type.

The best model did not include any effects of the five covariates. The absence of wind or sky effects is not surprising, since these two variables were constrained within narrow limits by the protocol. The absence of a season effect suggests that there is not a significant decline in survey efficacy between the early season (May) and late season (June). If surveys in these two periods are equally good at detecting Whip-poor-wills, this would allow for a broader range of acceptable survey dates, and provide observers with more options if poor weather or other circumstances prevent them from conducting a survey in the first lunar window. Note that previous analysis of data from New Hampshire (Hunt 2006) showed a decline in the number of birds detected between June and July, and although there were no July data to analyze in 2007, it is not recommended that the survey period extend beyond June except perhaps in the northernmost portion of the species' range. The final covariates, noise and number of birds, were included to test whether ambient noise levels affected an observer's ability to effectively hear and/or track individual birds over the six-minute count. This is perceived as a problem in areas with very high Whip-poor-will densities (e.g., 4-6 birds per point), and may require additional analyses with new data.

This variation in Whip-poor-will calling behavior in interesting on several fronts. A question that immediately comes to mind is whether calling intensity varies with respect to mating status or stage in the breeding cycle. Several songbirds are known to alter their singing behavior depending on whether they have found a mate or not, and it is certainly possible that this principle applies to nightjars as well. Many birds also decrease singing activity later in a nesting attempt. Finally, proximity of multiple adjacent territory holders can increase the rate at which a given male bird sings. This latter hypothesis for the observed variation in Whip-poor-wills is *not* supported by the data, given that there was no effect of bird abundance on detectability, but it should be noted that the present analysis was not explicitly designed to answer such behavioral questions. More in-depth population studies are needed to correlate mating and breeding status, as well as overall territory density and proximity, with calling behavior. If any such relationships exist, it might be possible to indirectly assess some demographic parameters (e.g., mating status) simply by recording data on calling behavior, which in turn would make the monitoring protocol useful for measuring things other than long-term population trend.

Results and Discussion: 2008 data

Not all the data collected during 2008 have been received (Table 4), so a complete summary is not possible at this time. However, available data indicate that the overall pattern of Whip-poor-will distribution is similar to that shown in previous years. Within the Northeast, densities are highest in the coastal plain from Cape Cod south, and in areas of northern New York and western Maryland (data from latter two regions obtained via personal communication with state coordinators). With the exception of coastal Massachusetts, Whip-poor-wills are generally uncommon and widely dispersed in New England, with highest densities in central New Hampshire.

The other two species of nightjar were rarely detected on 2008 surveys, although recall that large amounts of data have yet to be received. Single Chuck-will's-widows were detected on one route each in Massachusetts and New Jersey. Single Common Nighthawks were heard on four New Jersey routes and once in New York. Both Chuck-will's-widows and Common Nighthawks were also reported from western North Carolina. At present, there are not sufficient data for these two species in the region to allow for interpretation, and it remains uncertain that the current protocol is even effective for monitoring nighthawks.

Analysis of the 2008 Whip-poor-will data is expected to occur during the winter of 2008-2009. The same models discussed above will be tested with new data to se whether the patterns hold in multiple years. There will also be the option of looking at inter-year effects independently of the other covariates.

Conclusions and Recommendations

Analysis of Whip-poor-will detectability has revealed two broad categories of birds based on calling behavior: frequent and infrequent callers. The difference between these two groups is dramatic, and points out the need for more in-depth demographic and behavioral studies of the species. The current protocol appears to do a good job of reducing any variability in detectability that might result from external influences such as weather and time of year. At the same time, the broad-scale patterns of Whip-poor-will distribution in the northeast United States appear consistent based on several years of data, and can be used to identify areas most suitable for further research.

Based on the current analysis, members of the Nightjar Working Group are of the opinion that the protocol as currently developed should provide a reliable means of monitoring populations of Whip-poor-wills and Chuck-will's-widows across their ranges, and may also prove useful for other nightjars. Analysis of the 2008 data will determine if this conclusion remains valid. In either event, several of the collaborators on this project are currently planning on preparing a manuscript summarizing nightjar survey protocol development and analysis. This paper will tentatively be part of the proceedings of a symposium on "Ecology and Conservation of North American Nightjars" presented at the American Ornithologists' Union meeting in Portland, Oregon in August 2008. This symposium was convened by Pamela Hunt and David King, and we have approached the editor of *Ornithological Monographs* about its possible publication in that journal.

For this protocol to be implemented across a larger region (or even within the existing states), there remains a need for a standardized means of determining the locations of survey routes. At present, routes are a mix of BBS route segments, habitat-based routes, and routes developed entirely by the observers themselves. These three options reflect an increase in bias that ideally needs to be minimized while still maintaining the survey's ability to monitor Whip-poor-wills. In other words, a series of fully random routes (e.g., BBS) would be unbiased but also not detect enough nightjars to allow measurement of population trends, while entirely non-random routes would detect more birds but not hold up to statistical scrutiny. At a recent meeting of the Nightjar Working Group, members agreed to submit habitat variables that they felt might be of value in creating a non-biased set of "targeted" routes that would increase detection rates while maintaining some level of route randomness.

In conjunction with the latter effort, there are also initiatives moving forward to link nightjar populations to on-the-ground habitat conditions and the management thereof. In the long run, any monitoring program needs to incorporate some sort of link to management if it is to shed light on the factors behind observed declines. New Hampshire Audubon is working with partners in other states to identify sites where management and monitoring could be linked, both in terms of general trend monitoring and more detailed demographic monitoring. These efforts will ideally be part of a larger effort focused on all birds that occupy early-successional or edge habitats in the Northeast.

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Table 1. Overview of detectability models tested using Whip-poor-will data from 2007.

Model	Explanation
No Covariates Included	
{P(.)=C(.)}	Base model: assumes constant detection probability
{P(.) C(.)}	Behavioral effect: detectability varies after initial detection
{Pi(.) P(.)=C(.)}	Heterogeneity model: not all birds have equal detectability
{Pi(.) P(.) C(.)}	Heterogeneity model with behavioral effect
Models with Covariates	
{P(# of birds) C(.)}	Effect of number of birds at point (with behavioral effect)
{P(# of birds^2) C(.)}	Effect of number of birds squared (with behavioral effect)
{P(sky) C(.)}	Effect of cloud cover (with behavioral effect)
{P(noise) C(.)}	Effect of noise level (with behavioral effect)
{P(wind) C (.)}	Effect of wind (with behavioral effect)
{P(window) C(.)}	Effect of season (May vs. June) (with behavioral effect)
{P(# of birds)=C(# of birds)}	Effect of number of birds at point (no behavioral effect)
{P(# of birds^2)=C(# of birds^2)}	Effect of number of birds squared (no behavioral effect)
{P(window)=C(window)}	Effect of cloud cover (no behavioral effect)
{P(sky)=C(sky)}	Effect of noise level (no behavioral effect)
{P(noise)=C(noise)}	Effect of wind (no behavioral effect)
{P(wind)=C(wind)}	Effect of season (May vs. June) (no behavioral effect)
{P(t)=C(t)}	Effect of time of night (no behavioral effect) *

P = initial detection probability
C = subsequent detection probability
Pi = heterogeneity effect: represents the proportion of birds in one detectability category
* = This model tested whether detectability shifted in a predictable manner over the course of a single survey (e.g., increased from point 1 to point 10). There is no corresponding “behavioral effect” model for time because any time effect would mask variation between initial and subsequent detections.

Table 2. Results of Whip-poor-will detectability modeling

Model (see Table 1)	AICc	Delta AICc	AICc Weight	Model Likelihood	# of Parameters	Deviance
{Pi(.) P(.) C(.)}	2686.42	0	1	1	5	2676.4
{Pi(.) P(.)=C(.)}	2772.90	86.48	0	0	3	2766.9
{P(# of birds) C(.)}	3159.19	472.77	0	0	3	3153.2
{P(# of birds^2) C(.)}	3159.81	473.39	0	0	3	3153.8
{P(sky) C(.)}	3160.97	474.55	0	0	4	3153.0
{P(.) C(.)}	3162.06	475.64	0	0	2	3158.1
{P(noise) C(.)}	3162.60	476.18	0	0	4	3154.6
{P(wind) C (.)}	3163.80	477.37	0	0	3	3157.8
{P(window) C(.)}	3164.03	477.61	0	0	3	3158.0
{P(# of birds)=C(# of birds)}	3344.86	658.44	0	0	2	3340.9
{P(# of birds^2)=C(# of birds^2)}	3346.93	660.51	0	0	2	3342.9
{P(window)=C(window)}	3347.19	660.77	0	0	2	3343.2
{P(sky)=C(sky)}	3351.79	665.37	0	0	3	3345.8
{P(.)=C(.)}	3358.82	672.40	0	0	1	3356.8
{P(noise)=C(noise)}	3359.30	672.88	0	0	3	3353.3
{P(wind)=C(wind)}	3360.81	674.39	0	0	2	3356.8
{P(t)=C(t)}	3362.57	676.15	0	0	6	3350.6

Table 3. Summary of best-fit model for Whip-poor-will detectability.

Parameter	Estimate	Standard Error	95% Confidence Interval	
			Lower	Upper
Pi	0.520	0.042	0.437	0.602
P1	0.180	0.039	0.115	0.269
P2	0.741	0.039	0.658	0.810
C1	0.348	0.029	0.293	0.407
C2	0.959	0.008	0.939	0.973

Table 4. Summary of Whip-poor-will (WPW) results from surveys in 10 states in 2008. "Max WPW" represents the sum of all routes using the higher of the two totals on routes with two observers or which were surveyed more than once. Because large amounts of data have yet to be received, only those for a contiguous portion of New England (CT, MA, NH, VT) are summarized at this time.

State	**# Routes Surveyed**	**# Routes w/WPW**	**Max WPW**	**WPW/ Route**	***WPW/Rt w/WPW**
CT	20	6	14	0.70	2.33
MA	7	7	62	8.86	8.86
MD	10	5	74	7.40	14.80
ME	No surveys conducted in 2008				
NC	30	25	173	5.77	6.92
NH	13	9	24	1.85	2.67
NJ	13	9	188	14.46	20.89
NY	26	15	81	3.12	5.40
VT	23	7	16	0.70	2.29
WI	74	24	174	2.25	7.35
Total	**216**	**107**	**806**	**3.75**	**7.53**
Northeast (no NC, WI)	**112**	**58**	**459**	**4.10**	**7.91**
New England	**63**	**29**	**116**	**1.84**	**4.00**

* = total number of WPW divided by the number of routes on which WPW were detected.