Analysis of U. S. Forest Service Bird Point-Count Monitoring Database – Implications for Designing and Implementing Avian Monitoring[1]

Eric T. Linder[2] and David A. Buehler[3]

Abstract

In 1996, Region 8 of the U. S. Forest Service implemented a program to monitor landbirds on southeastern U.S. national forests. The goal was to develop a monitoring system that could document population trends and bird-habitat relationships. Using power analysis, we examined the ability of the monitoring program to detect population trends (3 percent annual change) at three spatial scales: ranger district, national forest, and physiographic province. The monitoring program did not detect trends adequately at the district scale and success at the forest level varied on the intensity of sampling, but was generally low (6 – 50 years). At the physiographic province the monitoring program was relatively powerful in detecting population trends. It appears the population trend information derived from this monitoring program is distinct from other monitoring programs. The merits and shortcomings of this monitoring program are also addressed.

Key words: avian, monitoring, point count, power analysis, Southeast, U.S. Forest Service.

Introduction

The long-term decline of many neotropical migratory birds has been noted by scientists (Robbins et al. 1989, Hagan and Johnston 1992, Martin and Finch 1995). In response to these declines, Partners in Flight was created by the National Fish and Wildlife Foundation in 1990. The strength of Partners in Flight is the diverse parties that have come together to form partnerships. Participants in Partners in Flight include federal agencies, state agencies, and non-governmental organizations. Among these groups, the U.S. Forest Service has played a leading role in Partners in Flight since its inception.

In recognition of the importance in monitoring bird populations and meeting legal requirements under the National Forest Management Act of 1976, Region 8 (hereafter; Region) of the U.S. Forest Service developed a program to monitor neotropical migratory birds, as well as temperate migrants and resident species (Gaines and Morris 1996). The goal of the program is to monitor landbird populations in the southeastern United States occurring within 23 national forests, which are comprised of 105 ranger districts, and reside within 10 physiographic provinces (Gaines and Morris 1996). The physiographic units considered are the same physiographic areas used in the Breeding Breed Survey (Robbins 1989).

When analyzing data collected as part of a monitoring program, it is important to note that errors can be made in different ways. When evaluating the null hypothesis that a population has not changed (i.e., no net increase or decrease over some time period), there are two types of errors that can be made. A null hypothesis that is actually true may be rejected (Type I error) or a null hypothesis may be accepted when it is actually false (Type II error). The probability of a Type II error is equal to β and the statistical power is equal to 1-β. Thus, power can be defined as the probability of correctly rejecting a null hypothesis (Sokal and Rohlf 1995). To calculate power, we must estimate the following parameters: sample size, α-level, sampling variance, and effect size (difference between the null and alternative hypothesis). Although many measures of effect size can be used, 0.8 is relatively common threshold for biological studies (Cohen 1988). Other factors can influence power and include count variability, within year effort, and survey length (Gerrodette 1987, Gibbs and Melvin 1997).

When establishing a monitoring program, the benefit of conducting power analysis to aid in determining how to best sample is widely acknowledged (prospective power analysis; Steidl et al. 1997). Since parameters are not known at the outset, however, they must be estimated. This allows researchers to examine the relationships between parameters and to aid in deciding which values best represent the biological intent of the

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[2]Department of Biological Sciences, Mississippi State University, Mississippi State, MS 39762.
[3]Department of Forestry, Wildlife, and Fisheries, University of Tennessee, Knoxville, TN 37996.

monitoring program. Conversely, retrospective power analysis can be used after the data are collected and analyzed to aid in the interpretation of results, especially when we fail to reject the null hypothesis (Gerrodette 1987). For example, if the monitoring failed to detect the designated intensity of trend, power analysis can be used to determine what intensity of trend can be reliably detected.

There are several approaches to retrospective power analysis, which can lead to very different conclusions (for issues see Thomas 1997, Gerard et al. 1998). In this study, we calculate power using a pre-specified effect size (population change) and the observed variance, but vary the duration of the study and sampling effort. Unlike many retrospective power analyses, we are not interested in interpreting why a particular hypothesis was rejected, but rather evaluate the existing monitoring program to accurately detect population trends.

In this paper we examine whether the current sampling design for the Region allows one to detect trends of common species at three spatial scales. The spatial scales we consider are ranger district, national forest, and physiographic region. Although one of the stated goals of this monitoring program is to monitor populations at the physiographic scale (Gaines and Morris 1996), many issues of biological, managerial, and/or legal importance are frequently addressed at the scale of an individual forest. The second issue we attempt to address is whether the monitoring program produces information that cannot be derived from other avian monitoring programs such as the Breeding Bird Survey (which is conducted on private, state, and federal land).

Methods

One of the goals of this study was to assess the Region monitoring program at multiple spatial scales. Consequently, we analyzed data at three spatial scales; ranger district, national forest, and physiographic province. At the level of ranger district, we used point count data from all districts that resided within national forests in the Southern Blue Ridge and Mid Atlantic Ridge and Valley physiographic provinces. At a larger spatial scale, we aggregated point count data by national forest and then again we aggregated all point count data for a single analysis of the entire province. National forests with the Southern Blue Ridge physiographic province included in our analyses include Chattahoochee (Georgia), Cherokee (Tennessee), and Francis-Marion Sumpter (South Carolina). Although Pisgah and Nantahala National Forests (North Carolina) also resided within the Southern Blue Ridge province, data from these forests were unavailable at the time of this analysis. Since the Jefferson/George Washington National Forest (Virginia) is the only national forest in the Mid Atlantic Ridge and Valley physiographic province, results based on this data are applicable at both the national forest and physiographic province scale.

Avian censuses were conducted during the breeding seasons (mid-May to early July) from 1992 to 2000 by various observers on each national forest. The number of years monitored varied by national forest and depended upon when the monitoring program was implemented. All national forests in this study had their full contingent of census points established by 1996. Point counts were conducted between 0600 and 1000 EST and limited to 10 min in duration. All birds detected by sight or sound within a 50-m radius were recorded. Point count stations were visited once per breeding season (Hamel et al. 1996). Point count stations were evenly stratified across forest type and forest age class and located within the middle of stands, except in the Jefferson/George Washington National Forest, where points were clustered along transects (n = 10). For this analysis, abundance was estimated at the scale of transect in the Jefferson/George Washington National Forest and at the individual point in the other national forests. Only census points where the target species occurred in $\geq$ 1 season were included in our estimate of abundance. Census points were distributed as follows: 225 on the Chattahoochee National Forest, 120 on the Cherokee National Forest, 80 on the Francis-Marion Sumpter National Forest (Andrew Pickens District only), and 782 on the Jefferson/George Washington National Forest.

To assess the ability of the Region's monitoring program to detect population trends, we focused on the Ovenbird (*Seiurus aurocapillus*) and the Pileated Woodpecker (*Dryocopus pileatus*), both Management Indicator Species for several national forests in the southeast. Both species were relatively abundant (occurred from 18 – 46 percent of all census points/national forest) and relatively easy to detect, thereby minimizing some, but not all, of the criticisms surrounding the use of point counts to estimate abundance (Rosenstock et al. 2002).

Several parameters were determined by the monitoring program itself (e.g., sample size), by the data itself (e.g., mean and variance); we fixed other parameters (e.g., percent annual change to be detected). We were interested in assessing the ability of the Region monitoring program to detect a 3 percent annual change with a power of 0.8, based upon on the observed sampling variance. In this analysis, a power >0.8 indicates the sampling methodology has an acceptable chance of detecting a 3 percent annual change. Our decision to use 3 percent was consistent with the rate of decline for some priority species of management interest based on Breeding Bird Survey data and was held consistent across tests for comparisons. Power of 0.8 is considered adequate for ecological trend analysis (Cohen 1988). To assess the power of the Region monitoring program, we used the program MONITOR 7.0 (Gibbs 1995). MONITOR allows examination of the power of a monitoring program to detect population trends by manipulating several of the input variables, including sampling effort and time span. To simulate an increase in sampling effort, we randomly selected the desired number of additional census points from our pool of actual data. For example, to simulate an increase in sampling effort of 50 percent for the Cherokee National Forest (n = 120 points), we randomly selected 60 points and added their mean and variances to the original 120 points and input the 180 'new' values into MONITOR.

To determine if the monitoring program is obtaining unique information, we first compared the population trends of our two focal species using Region and Breeding Bird Survey data and restricted to only points in Virginia and Tennessee (and the corresponding national forests) within the Southern Blue Ridge and Mid Atlantic Ridge and Valley provinces, respectively. We also compared the population trends of 10 species derived from aggregated Region data and Breeding Bird Survey data for the Southern Blue Ridge province. We restrict our analysis to the period 1992-2000 when reliable Region data is available province-wide. Breeding Bird Survey trends were estimated using route regression (Sauer et al. 2001) while Region trends were estimated using linear regression.

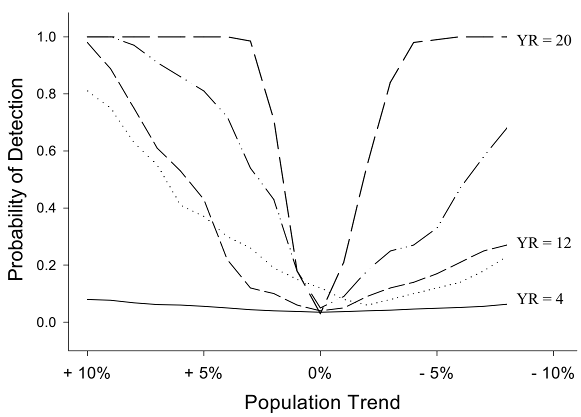

Figure 1— The power (0.8) to detect a 3 percent annual population trend of the Ovenbird on a typical ranger district in the Southern Blue Ridge physiographic province was low, failing even after 20 years of monitoring.

Results

At the scale of an individual district, current monitoring strategies appear to be inadequate to detect a 3 percent/yr change in Ovenbird abundance, even after 20 years (*fig. 1*; although a positive change was detected, a negative change was not). Only on the Deerfield Ranger District of the Jefferson/George Washington National Forest, which had the greatest number of point stations, did the current monitoring effort identify a 3 percent annual change, and that required 16 years of monitoring (*fig. 2*). Results of the monitoring program at the national forest were mixed with Ovenbird population trends being detected on the Jefferson/George Washington National Forest in 8 years. Contrast this with trends on other national forests such as the Chattahoochee (20 years), Francis-Marion Sumpter (26 years), and with only 120 census points, our results suggest it would take more than 50 years to detect an annual population change of 3 percent (*fig. 3*) on the Cherokee National Forest. At the scale of the physiographic region, population trends of Ovenbirds were detectable after 6 years in the Southern Blue Ridge and 8 years in the Mid Atlantic Ridge and Valley. The power to detect changes for Pileated Woodpeckers was less than that of Ovenbirds with no district and only the Jefferson/George Washington National Forest having the ability to detect a 3 percent change (10 yrs for increase and 12 yrs for decrease) in <20 yrs.

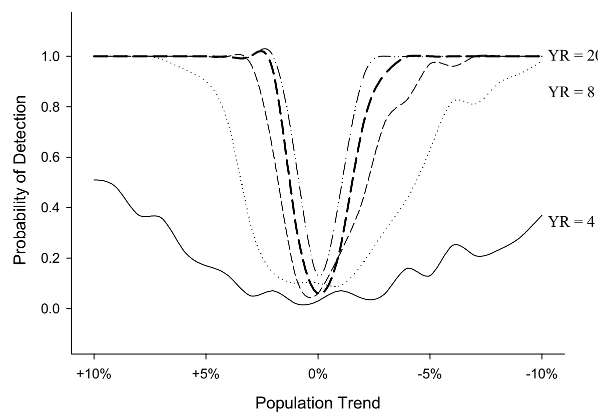

Figure 2— The power (0.8) to detect a 3 percent annual population trend of the Ovenbird on the Deerfield Ranger District (JGW NF) should occur after 16 years of monitoring.

We were also interested in the effect of increasing sampling effort on the monitoring program's ability to detect trends. We increased the number of census points where Ovenbirds were detected on the Chattahoochee National Forest by 50 percent which resulted in detecting a 3 percent annual trend only two years earlier (18 years). Increasing the sampling effort by 100 percent or 200 percent resulted in shorting the detection time from 20 years to 15 and 13 years, respectively. In contrast, on the Cherokee National Forest where relative few (120 vs. 225 for the Chattahoochee), increasing sampling effort by 100 percent reduced the time needed to detect a 3 percent trend from >50 years to 20 years (*fig. 4*). Similar changes were noted for Pileated Woodpecker trends, although exact changes varied by forest.

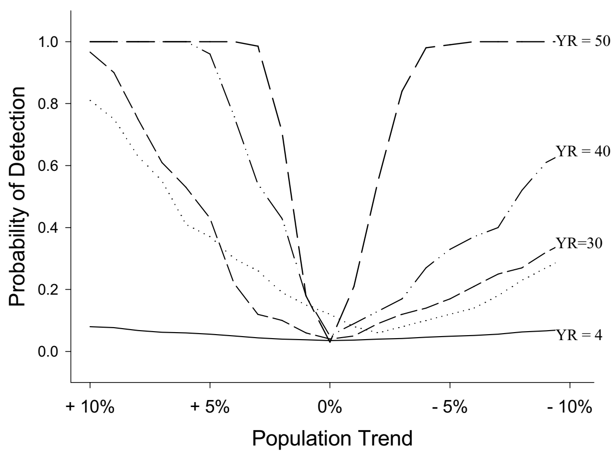

Figure 3— The failure to detect a 3 percent annual population trend of the Ovenbird on the Cherokee National Forest with current sampling effort.

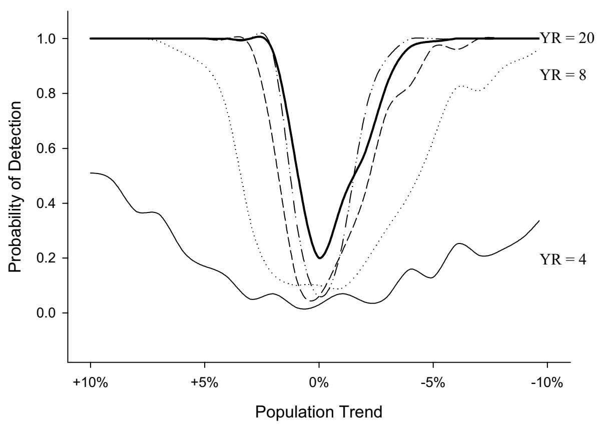

Figure 4— Increasing sampling effort by 100 percent (on the Cherokee NF) is expected to reduce the time needed to detect a 3 percent annual population trend from >50 years to 20 years.

Our results suggest population trends, as determined by Region monitoring data and Breeding Bird Survey data, were not consistent within the physiographic province. For example, comparing population trends of our two focal species in Virginia demonstrated how populations may be changing with varying intensities (*fig. 5a*). Results from Tennessee suggest even the direction of the trend may differ within the same geographic area (*fig. 5b*). When we examined 10 species across the entire province, populations on national forest land were trending in the opposite direction of those monitored the Breeding Bird Survey routes (*table 1*). This suggests that at least for a subset of the avifauna in the Southern Blue Ridge province, Region and Breeding Bird Survey monitoring programs are tracking actual differences in population trends.

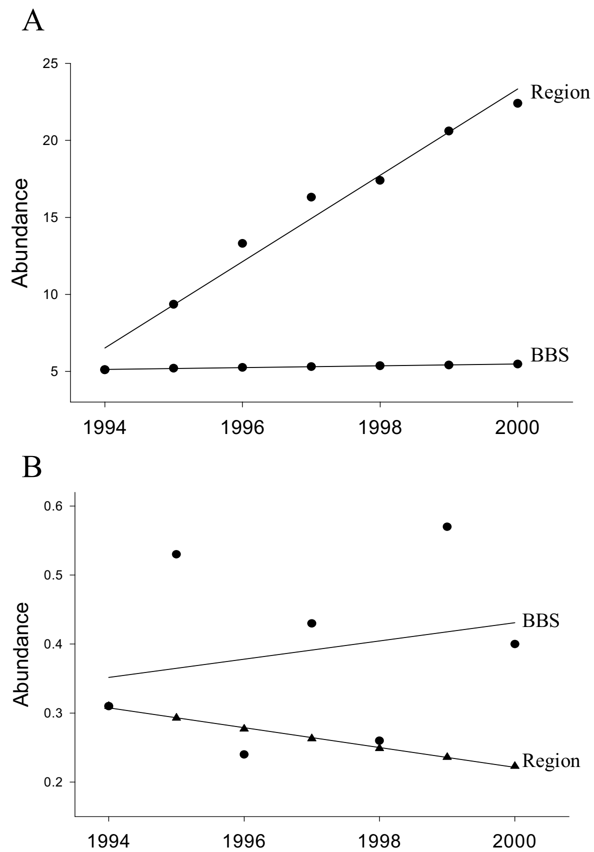

Figure 5— a) Population trends of the Ovenbird on Jefferson/George Washington National Forest and BBS routes located in Virginia. b) Population trends of the Ovenbird on Cherokee National Forest and BBS routes located in Tennessee.

Discussion

The goal of this study was to assess the relative effectiveness of the Region monitoring program to detect population trends. We were particularly interested which spatial scale can be utilized to detect trends, what time interval is required to document such a trend, and if this program gathered unique data. Our results suggest the current monitoring effort will not provide adequate data to detect modest population trends at the district level, although that was never a goal of the monitoring program. On the Jefferson/George Washington National Forest sampling was 3x more intensive than any other national forest considered in this study and not surprisingly, their monitoring program also has the greatest ability (in terms of fewest years to detect an actual decline) to detect population changes compared to other national forests. Manipulating the number of census points offered some insight

Table 1— *Comparison of population trends (percent change per year) for species in the Southern Blue Ridge physiographic province using Region and BBS data spanning 1992-2000. BBS data were analyzed using route regression while Region data were analyzed using linear regression.*

	Region		BBS	
Species	**Trend**	***P***	**Trend**	***P***
Acadian Flycatcher*	6.34	0.001	-6.85	0.092
Black-and-white Warbler	-0.04	0.553	-2.11	0.624
Eastern Wood-pewee*	2.23	0.007	-7.81	0.013
Indigo Bunting*	1.28	0.008	-1.25	0.168
Ovenbird	4.29	0.001	3.25	0.065
Pileated Woodpecker	0.62	0.278	1.44	0.390
Pine Warbler*	-4.12	0.001	7.80	0.062
Red-eyed Vireo	2.13	0.001	0.43	0.537
Scarlet Tanager*	3.35	0.014	-3.72	0.109
Veery	1.40	0.506	5.69	0.537

* Species for which analyses indicated different directions (positive vs. negative) of population trend.

into the expected resolution gained by increasing the monitoring effort. For the focal species in this study, doubling the number of census points on the Cherokee National Forest resulted in decreasing the time expected to detect a trend by over 30 years. Unfortunately, a 3 percent annual trend could still only be detected after 20 years, but it illustrates the potential effectiveness of increasing sampling effort. This is likely due, in part, to the relatively small annual population change (3 percent) in this analysis. Other studies utilizing power analysis have frequently considered a 5 percent annual change to be important, but the actual amount of change should be biologically relevant to the population of interest (Lougheed et al. 1999, Wilson et al. 1999).

The ability to detect population trends in a reasonable amount of time is paramount to conserving species. Our results suggest that on some national forests, it may take >50 years to detect a 3 percent annual decline. This would result in 78 percent total decline of initial population. In a 15-year study in Australia, all uncommon bird species (<100 observations/yr), power was less than 0.8, failing to detect populations that had declined by >70 percent (Williams et al. 2001). Monitoring programs that fail to detect such large declines or take too long, fail to meet most reasonable goals of trying to detect biologically significant population declines.

One of the stated goals of the Region program is to monitor Partners in Flight priority species (Gaines and Morris 1996). Some of the Partners in Flight species of concern that occur in the Southern Blue Ridge province include Bewick’s Wren (*Thryothorus bewickii*), Cerulean Warbler (*Dendroica cerulea*), and the Golden-winged Warbler (*Vermivora chrysoptera*). However, both the Region and Breeding Bird Survey monitoring programs are inadequate to address population trends for many of these species, even at the scale of the physiographic province (Sauer et al. 2001, Linder and Buehler unpubl. data). For species that are narrowly distributed or uncommon, targeted monitoring may be necessary to adequately address population trends.

It appears the Region monitoring program does provide unique information independent of the Breeding Bird Survey. Although different analyses were used to determine rates of change for Region trends and Breeding Bird Survey trends (linear regression and route-regression, respectively) and therefore are not directly comparable, the fact that trend directions for half of species considered were in opposite directions suggests the two monitoring programs are providing unique information. Differences between the monitoring programs may be attributable to such factors as, but not limited to, observer bias, sampling design, statistical analysis, and actual differences in trends. For example, some forests have used few observers over the years while other forests have utilized a large number of novice (for that particular forest) observers both within and between years. Most national forests have stratified individual points by habitat whereas Breeding Bird Survey routes consist of 50 points on a single transect. Consequently, the two distinct sampling designs also necessitate different statistical treatments. Finally, it may be the monitoring programs are actually accurately monitoring different populations (or portions of a larger, single population). Breeding Bird Survey routes are located on roads on public and private lands whereas the Region program typically establishes points within forested settings (>50 m from a road) and only in national forests. There are likely other sources of variation that influence one or both monitoring programs, but it appears that the programs do indeed track different populations.

While the Region monitoring program is early in its development, an analysis of this type is useful in determining if a program will meet its desired goals (Gibbs and Melvin 1997). If not, alterations should be considered by managers and the relative costs and benefits can be weighed to determine if changes such as adding census points, is necessary. We recommend the Cherokee National Forest increase the number of census points it currently conducts, by at least a factor of two, if a desired goal of the program is to monitor at the scale of each individual national forest. As a region, the monitoring program is adequate to detect modest trends in species that are relatively common. It remains to be determined if the monitoring program is adequate for most species of management concern. Further analysis is warranted on a larger sample of the avifauna of the region.

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