

# Suggestions for Establishing a Network of Landbird Migration Monitoring Sites

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## Abstract

Landbird migration monitoring stations, primarily using constant-effort mist netting and sometimes specialized censuses, are valuable because: (1) many of the species captured, especially northern-nesting ones, are not well surveyed by other methods; (2) demographic and other vital information for management and conservation can readily be collected; and (3) such stations provide excellent opportunities for education and outreach activities. Migration monitoring helps us describe and understand the causes of large-scale trends in population size or other parameters. In this paper, we suggest guidelines for choosing focal species for migration monitoring, accuracy targets for estimating trends in population size and fitness parameters, and present a simple model which clarifies the factors to consider in selecting migration monitoring sites and designing the monitoring programs at them.

## Introduction

Many North American birds are not well surveyed by existing programs because they breed in the boreal or arctic region and winter south of the United States. Many other species are poorly covered because they breed in areas not covered by existing programs (e.g., high elevation areas), or because they are not easily detected or identified by existing surveys (e.g., parids, most woodpeckers). Monitoring programs for these species should involve regular surveys during migration, though specialized surveys on their breeding, and perhaps wintering, grounds should also be undertaken as often as is feasible. This report discusses design of long-term migration monitoring for landbirds using constant-effort mist netting and at times diurnal migrant counts, building on work by Hussell (1981),

Ralph (1981), Fuller and Titus (1990), Blancher et al. (1994), Dunn and Hussell (1995), Hussell and Ralph (1998), and Ralph and Dunn (2004). The number of birds passing per unit time, or more commonly an index to this number, is usually collected, and other information such as demographic information on age- and sex-ratios, and "condition" information, such as weight, fat scores, stage of molt, and disease state, may also be collected. We discuss the goals, objectives, and methods for landbird migration monitoring and propose a strategy for statistically validating the establishment of a network of landbird monitoring sites that will be sustainable for the long term.

## Goals

Migration monitoring mainly addresses problems at a large spatial scale, except for those involving local habitat use during stopover by migrants. Thus, many patterns observed at a given site are determined, in part, by events occurring hundreds or thousands of kilometers away. The management issues that a network of migration monitoring sites can help address are thus ones that occur at the regional to continental level. Five broad management issues of importance at this scale may be distinguished (*table 1*).

*Table 1* also identifies the general information needed to address each issue using three categories: trend in population size, spatial patterns in abundance, and indicators of fitness, such as nutritional condition, parasite load, disease state, or contaminant burden. The first management issue, identifying species at risk, is a major concern for numerous agencies and other groups, and mainly requires information on trend in population size. Other information, such as an assessment of imminent threats, is also needed, but is not provided by migration monitoring stations. The next three management issues – understanding causes of undesirable trends, deciding how to reverse them, and evaluating impacts on birds of large scale projects – require information on fitness and, to a lesser extent, abundance. The final issue – identifying habitats important during migration – certainly has application on a site-specific scale, but its most important applications are on regional levels, such as defining critical habitat in a

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bioregion. Other management issues could be identified, and they could be described in different ways. The scheme in *table 1*, however, is probably sufficient to identify the kinds of information, collectable at migration monitoring stations, which will be of greatest value in understanding and managing bird populations. In the sections below, we consider ways to estimate trend in population size and to measure indicators of fitness.

### Objectives

Objectives are described in this section by identifying the focal species, defining the parameters to study, and then establishing an accuracy target for each, expressed in terms of needed statistical power to meet the accuracy target.

### Estimating Trends in Population Size

#### Focal Species

While migration monitoring can be useful for all species, it is most important for northern species and populations, and for species breeding south of the boreal zone that are not well surveyed by the Breeding Bird Survey (BBS). Because many species breed in both northern and southern areas, a rule is needed to decide how much of a species' population can be outside the area covered by the monitoring program without causing serious bias in the trend estimate. An analysis of this issue (Bart et al. 2004), using range wide trends for well-surveyed, southern species, and then estimating the trends with partial data sets, led to the following guideline: if more than one-third of the species' range is not sampled by the BBS, or similar programs, then supplementary programs are needed. The shorebird initiative has investigated how to survey northern-nesting species (Skagen et al. 2004). They concluded that a combination of occasional surveys throughout the breeding range, along with annual surveys of migrating birds, provided the best chance for obtaining reliable trend estimates. Due to the similarly high cost of surveying landbirds in the boreal and arctic regions, and the comparatively low cost of migration

surveys using mist-netting stations or census, we assume the same will be true of the species surveyed by landbird migration monitoring stations. An effort has been made by the Partners in Flight (PIF) Monitoring and Assessment Working Group to identify the species that: (1) have significant breeding populations (i.e., one-third or more of the population) in the boreal and arctic regions; (2) are not well covered by the BBS for other reasons; or (3) are well suited to study at migration monitoring stations. Their list includes 80 species, all but 8 with significant northern populations. This list will need review and revision by specialists in migration monitoring, but it provides an initial indication of the focal species for trend estimation.

#### Parameter Definition

For trend estimation, the best parameter is probably the rate of annual change, that is, the total change during a specified number of years, in total population size, defined as the total number of birds of a given species present in Canada or the United States during the breeding season in each year. This number includes non-territorial birds, which are often excluded in breeding studies for practical reasons, and excludes individuals that move north into the southern United States after breeding.

#### Accuracy Targets

For trend estimation, Bart et al. (2004) have suggested 80 percent power to detect a 50 percent decline over 20 years with a level of significance of 0.10, using a two-tailed test, and acknowledging effects of potential bias. They also recommend that this objective should be achieved in an area the size of the 11 western states, excluding California. These recommendations were based in part on study of Breeding Bird Survey data, and thus may not be fully applicable to migration studies, but the results were also based on consideration of how large a change is needed before conservation action occurs, relative costs of achieving higher or lower power, and estimates of feasible effort. We regard their recommended accuracy target as a default for the landbird migration monitoring program and suggest using it unless or until a better analysis appears, specifically focused on migration stations.

**Table 1**—Management issues that migration monitoring can help address (XX-critical; X-important).

Management issue	Information needed		
	Trends	Abundance	Fitness
1. Identifying species at risk	XX		
2. Understanding causes of declines or other trends of concern		X	XX
3. Deciding how to reverse undesirable population trends		X	XX
4. Estimating impacts on birds of proposed, large-scale projects		XX	XX
5. Identifying habitats important during migration		X	XX

## Measuring Indicators of Fitness

### Focal Species

Measuring fitness components by finding and tracking nests is expensive on the breeding grounds, but relatively inexpensive at migration monitoring stations, due to the large number of birds captured by mist nets. Thus, these measures can profitably be recorded for most species that are caught regularly – or that would be caught regularly with an improved network of stations. Thus all of the 80 species with northern populations, and most of the other roughly 350 landbirds in North America, should be considered potential focal species for the program to measure fitness indicators.

### Parameter Definition

As noted above, several indicators of fitness can be assessed at migration monitoring stations, especially for birds that are captured (age ratios are obtainable for a few species even without capture). Five kinds of information that seem particularly worthwhile are (1) age ratios, (2) indicators of current nutritional status, (3) contaminant burden, (4) frequency of selected diseases, and (5) indicators of past habitat suitability (e.g., by ptilochemistry or isotope analysis). A careful analysis is needed to decide which parameters would be most useful and most feasible to measure.

### Accuracy Targets

Long-term information on fitness indicators is needed because management decisions must often be made too quickly to gather the needed long-term information, and because many processes affecting demographic rates are most easily understood by studying long-term datasets. Establishing an accuracy target is difficult because so many questions might be important to address. In the absence of a detailed analysis, we suggest 80 percent power to detect a 50 percent difference between two groups, or a 50 percent decline during 10 years, as reasonable initial targets.

### Strategies

In this section, we discuss statistical factors to consider in selecting migration monitoring sites, and in designing the surveys at them for the purpose of understanding population trends. The other factors in survey design involved with the measures of fitness would require a far more complex analysis than we attempt here. As is usual in discussing error in statistical analysis we consider bias and precision separately.

Bias in trend estimates equals the long-term trend (if any) in the "index ratio." This ratio is the survey result

(e.g., number of birds per unit effort), divided by the parameter of interest (total population size in our case) (Bart et al. 1998). To explain, suppose we define the survey result, in a given year, as the mean number,  $y$ , of birds recorded at one or more stations, and we define the entire species' population size as  $Y$ . The index ratio is thus  $y/Y$ , and we seek a design that minimizes the expected long-term trend in this quantity.

Now suppose that we multiply and divide the index ratio by a term,  $Y_1$ , arbitrarily defined (except that it cannot be 0). One useful way to define  $Y_1$  is "the number of birds that pass through the surveyed area" where "surveyed area" may be defined in any convenient way, such as the borders of the monitoring stations or several stations in a bioregion. Adding this term, we obtain:

$$\frac{y}{Y} = \frac{Y_1}{Y} \frac{y}{Y_1} \quad (1)$$

The term  $Y_1/Y$  may be thought of as the proportion of the birds of one species in the population that pass through at least one of the migration monitoring sites, say  $P$ . The term  $y/Y_1$  may be thought of as the overall "capture" rate,  $C$  say, among all sites. We thus have

$$\frac{y}{Y} = PC \quad (2)$$

so bias in the index, number of birds recorded, as an estimate of population trend, equals the long-term trend in  $PC$ .

Thus, in establishing a migration monitoring network, we seek a design such that the slope of  $PC = 0$ . That is, there is no change in the index ratio. It is possible that a long-term trend in  $P$  would just be balanced by an opposite trend in  $C$ , but the safest course is to design the program so that minimal long-term trends occur in both  $P$  and  $C$ . The "trend" in this case refers to the trend across all stations, so it is possible that trends at some sites (in either  $P$  or  $C$ ) might be balanced by the opposite trends at other sites. The safest course, however, is probably to select each site, and design the program at it, to minimize trends in  $P$  and  $C$  at that site.

Trends in  $P$  can be minimized by selecting a site where either habitat is unlikely to change (a difficult condition to achieve), where habitat is maintained by management at a given stage of succession, or where habitat has little influence on the number (strictly, the proportion) of birds passing through the site. Strong trends in  $P$  are also made less likely by having lots of sites, well distributed across habitats, elevations, and other features that might be correlated with numbers of passage migrants. Then, if a change in migration routes occurs, numbers will decline at some monitoring sites,

but will increase at others, so the change in  $P$ , for the whole network, may be small. Long-term trends in  $C$  are also minimized by selecting sites where habitat is not likely to change or does not influence numbers of birds or behavior (such as residence time) that affects capture probabilities. If habitat change cannot be avoided, then, ideally, different successional stages should be present at each site and at different sites, or both, so that change in  $C$  through time, for the entire network, will be small.

The precision of the trend estimate depends mainly on how similar trends are at different sites (with trends weighted, approximately, by numbers of birds at each site). Such variation can be reduced by locating migration sites where they catch birds from as large an area as possible, and by reducing sampling error within sites, which is accomplished mainly by training, standardization, and having a good sampling plan.

### Literature Cited

- Bart, J., K. P. Burnham, E. A. Dunn, C. M. Frances, and C. J. Ralph. 2004. **Goals and strategies for estimating trends in landbird abundance.** *Journal of Wildlife Management* 68: 611-626.
- Bart, J., M. J. Fligner, and W. Notz. 1998. **Sampling and statistical methods for behavioral-ecologists.** Cambridge, UK: Cambridge University Press; 352 p.
- Blancher, P., A. Cyr, S. Droege, D. Hussell, and L. Thomas [compilers]. 1994. **Results of a U.S./Canada Workshop on monitoring landbirds during migration and recommendations towards a North American Migration Monitoring Program (MMP).** 27 p. Unpublished report available from P. Blancher, Canadian Wildlife Service, National Wildlife Research Centre, Hull, P.Q. K1A 0H3; or S. Droege, National Biological Survey 1849 C St. NW, Washington, D.C. 20240.
- Dunn, E. H., and D. J. T. Hussell. 1995. **Using migration counts to monitor landbird populations: Review and evaluation of current status.** In: D. M. Power, editor. *Current Ornithology*, Vol. 12. New York: Plenum Press; 43-88.
- Fuller, M. R., and K. Titus. 1990. **Sources of migrant hawk counts for monitoring raptor populations.** In: J. R. Sauer and S. Droege, editors. *Survey designs and statistical methods for the estimation of avian population trends.* Biological Report 90. Washington, DC: Fish and Wildlife Service, U.S. Department of the Interior; 41-46.
- Hussell, D. J. T. 1981. **The use of migration counts for detecting population levels.** In: C. J. Ralph and J. M. Scott, editors. *Estimating numbers of terrestrial birds.* *Studies in Avian Biology* No. 6. Lawrence, KS: Allen Press, Inc.; 92-102.
- Hussell, David J. T., and C. J. Ralph. 1998. **Recommended methods for monitoring bird populations by counting and capture of migrants.** Unpublished report by the North American Migration Monitoring Council, available at <http://www.fs.fed.us/psw/topics/wildlife/birdmon/pif/mnstalst.shtml>. Last accessed 8 January 2005.
- Ralph, C. J. 1981. **Age ratios and their possible use in determining routes of passerine migrants.** *Wilson Bulletin* 93: 164-188.
- Ralph, C. J., and E. H. Dunn, editors. 2004. **Monitoring bird populations using mist nets.** *Studies in Avian Biology* No. 29. Lawrence, KS: Allen Press, Inc. 211 p.
- Skagen, S. K., J. Bart, B. Andres, S. Brown, G. Donaldson, B. Harrington, V. Johnston, S. L. Jones, and R. I. G. Morrison. 2004. **Monitoring the shorebirds of North America: towards a unified approach.** *Wader Study Group Bulletin* 100: 102-104.