ASSESSING CONSERVATION VALUE OF BIRD COMMUNITIES WITH PARTNERS IN FLIGHT-BASED RANKS

Authors: Nuttle, Tim, Leidolf, Andreas, and Burger, Loren W.

Source: The Auk, 120(2) : 541-549

Published By: American Ornithological Society

URL: https://doi.org/10.1642/0004-8038(2003)120[0541:ACVOBC]2.0.CO;2

Commentary

The Auk 120(1):541–549, 2003

ASSESSING CONSERVATION VALUE OF BIRD COMMUNITIES WITH PARTNERS IN FLIGHT–BASED RANKS

TIM NUTTLE,[1,4] ANDREAS LEIDOLF,[2] AND LOREN W. BURGER, JR.[3]

[1]*Department of Biology and Ecology Center, 5305 Old Main Hill, Utah State University,*
Logan, Utah 84322-5305, USA;
[2]*U.S. Geological Survey, Utah Cooperative Fish and Wildlife Research Unit and Ecology Center, 5230 Old Main Hill,*
Utah State University, Logan, Utah 84322-5230, USA; and
[3]*Department of Wildlife and Fisheries, Mississippi State University, Box 9690, Mississippi State,*
Mississippi 39762-9690, USA

PARTNERS IN FLIGHT (PIF) has developed a system of prioritizing bird species of North America (north of Mexico) on the basis of their demography in several categories (Carter et al. 2000). Beissinger et al. (2000) found that to be a sound system, useful for focusing management attention on those species most in need, and proposed a system for using PIF's categorical scores to derive a priority rank for each species that reflects its risk of local extirpation. We believe those ranks can be of great utility as species weights in an index to compare bird communities' "conservation value" as a whole. Here, we review the history of conservation-value indices and examine attributes of bird communities that make them especially attractive for use in such indices to evaluate and compare sites. We then discuss properties of the PIF ranking system that make it an attractive basis for use as species weights for such an index. Finally, we discuss how using this index in concert with more traditional summary statistics can provide additional information on the structure and status of bird communities.

UTILITY OF BIRD COMMUNITIES FOR SITE EVALUATION

Because of their low birth rates and relatively long life spans, birds are extremely sensitive to spatial and temporal changes in the environment, and thus are generally viewed as important indicators of ecosystem integrity (Maurer 1993). Furthermore, compared to other vertebrate taxa, avian communities are typically quite diverse in both number of species and variety of habitat features used, and thus provide a simultaneous assessment of a wide range of ecosystem attributes. Finally, bird communities are easily monitored, using well-established and easily replicated protocols (e.g. Bibby et al. 1992; Ralph et al. 1993, 1995).

Bird communities are therefore a logical focus for site evaluation or assessment. Sometimes, evaluation criteria are mandated by concerns for threatened and endangered species or similarity to some reference condition (e.g. Bryce et al. 2002); lacking such clearly defined criteria, a more general assessment of overall conservation value of a site is often of interest. In that case, bird community characteristics are assumed to indicate not only the health of the bird community itself, but also the conservation value of the site in general.

Because bird-community data are inherently complex, however, efforts are made to reduce data dimensionality by restricting analyses to such summary statistics as species richness, diversity, territory density, or total abundance, or dividing the community into guilds and discussing patterns therein. Reliance on those measures involves at least one problematic assumption: more diverse or productive habitats are more valuable. Differences in conservation need or priority among species are ignored, because, by their very nature, traditional sum-

---

[4] Present address: Institute of Ecology, Friedrich Schiller University, Dornburger Strasse 159, D-07743 Jena, Germany. E-mail: tim.nuttle@uni-jena.de

mary statistics obscure information on species composition. Thus, those summary statistics and guild-based approaches have failed to provide adequate indices of conservation need, because they "often miss important changes in populations of rare species that should be a higher conservation priority" (Beissinger et al. 2000:150). Consequently, such analyses are generally accompanied by discussion of trends of a few high-priority or more abundant species (e.g. Nuttle and Burger 1996a, Leidolf 1999, McShea and Rappole 2000). Interpretation can be difficult, however, because some species are restricted to one or more of the sites examined, resulting in a diminished ability to make entirely objective decisions. Thus, discussion and recommendations are reduced to statements such as "one option is good for some species, whereas another option is good for other species."

THE CONSERVATION VALUE CONCEPT

One approach that avoids the problematic assumptions of community summary statistics and species lists is that of "conservation value," reviewed by Götmark et al. (1986). Whereas the true conservation value of any site is unknowable, it is possible to devise indices that are correlates to it, similar to using hatch rates or recruitment of birds as correlates to fitness. To differentiate between true conservation value and indices aimed at approximating it, we henceforth use *CV* to refer to the indices and the phrase "conservation value" to refer to the true unknowable quantity. Götmark et al. (1986) compared the performance of species richness, diversity indices, and various *CV* indices in ranking several sites to how a panel of experts ranked the sites. In doing so, they also provided some insights regarding properties good indices should have.

Careful inspection of the *CV* indices reviewed by Götmark et al. (1986) showed all of them to be of the form

$$CV = \sum_{i=1}^{S} a_i w_i \tag{1}$$

where S is the number of species in the community, a_i is the abundance of species i (presence or absence, density, or relative counts), and w_i is a weighting factor for that species.

The weighting factor w_i scales the abundance measure to reflect the conservation priority of each species in the community. There were two general types of weighting factors used, both of which use the size of a reference population for each species, which we call N_i. Depending on objectives and focus, the reference population used was either the national or the regional population. The first type of weighting factor scaled N_i to the total population of all species to derive a measure of relative abundance or rarity of the species in the reference population:

$$w_i = \frac{N_i}{\sum_{j=1}^{S} N_j} \tag{2}$$

where N_j is the abundance of species j, summed over S species (i.e. total population of all bird species combined). The second type of weighting factor considers the relative contribution of the local population to the regional or national population. That constitutes a measure of area importance:

$$w_i = \frac{A_i}{N_i} \tag{3}$$

where A_i is the population of species i in the area (as opposed to density, presence, or point-count abundances for the site). Some of the indices discussed used only one weighting factor, whereas others used a combination of regional relative abundance, national relative abundance, and area importance.

In comparing those *CV* indices and diversity indices to expert opinion, Götmark et al. (1986) concluded that diversity indices, specifically Shannon's index H' (Shannon 1948) and Simpson's index λ (Simpson 1949), often give misleading results and should be avoided. They further concluded that relative abundance is an important component of any index. They cautioned, however, that if additive composite weighting factors are used, the various criteria (such as relative abundance and area importance) may be intercorrelated, resulting in an over-assessment of a site's true conservation value. Intercorrelation may lead to unfounded distinctions between sites. Finally, the authors pointed out that the scale of the reference population (i.e. whether N_i represents regional or national population size) has a large influence on the results. That last point is complicated further by the difficulty in obtaining reliable estimates for population size beyond the local study area.

Partners In Flight Species Concern Scores—A Weighty Matter

Fortunately, in North America, a solution to the problem of deriving quantitative population estimates has been provided by PIF. In developing a system for setting conservation priorities for landbirds, PIF determines "concern scores" for each species in several categories relevant to conservation of the species' global or regional population. Carter et al. (2000) provided a thorough explanation of the scoring process. Briefly, scored categories are breeding distribution, nonbreeding distribution, relative abundance, threats to breeding, threats to nonbreeding, population trend, and area importance, each valued 1 (low priority) to 5 (high priority). Note that two of the PIF categories, relative abundance and area importance, are weighting factors in indices reviewed by Götmark et al. (1986). Although the PIF scores use a ranked graduated scale rather than continuous population data (as in Götmark et al. 1986), the formulation of the scales would produce similar trends when applied as weights. Breeding Bird Survey data (Robbins et al. 1986), range maps, and other published data provide the quantitative basis for the scores. Whereas the scoring system is continental in scope, scores are calculated at several scales, including continental, state or province, physiographic area, and bird conservation region, making explicit the issue of spatial scale that was problematic in indices reviewed by Götmark et al. (1986). Scores for all resident (breeding and nonbreeding) bird species at all scales are available from Rocky Mountain Bird Observatory (RMBO; see Acknowledgments).

The sum of all PIF-scored categories for each species (i.e. its composite score, henceforth *PIF.comp*) was the focal product when the PIF system was first introduced (Hunter et al. 1993), and has been the most common application of the PIF scoring system so far (e.g. Nuttle and Burger 1996a, b; Nuttle 1997; Leidolf 1999; Twedt et al. 1999; McShea and Rappole 2000; Hamel et al. 2002). However, in reintroducing the PIF scoring system (using more quantitatively derived category scores), Carter et al. (2000:545) cautioned that *PIF.comp* is a "potentially useful number" for highlighting the highest overall priority species, but that it may be misleading if it is not "considered in the context of its component parts." Indeed, we recognize several instances where *PIF.comp* does not reflect what we consider to be a reasonable interpretation of a particular species' conservation need, especially regarding treatment of non-native species.

Application of PIF.comp *in a* CV *index*.—Those cautions notwithstanding, several studies have used *PIF.comp* to highlight the highest-priority species in tables of species abundances, frequency, or indicator values (e.g. Nuttle and Burger 1996a, McShea and Rappole 2000, Twedt et al. 1999, Leidolf et al. 2000). Another application—the subject of this commentary—has been to use *PIF.comp* to weight species abundance for use in a *CV* index, in conjunction with the more traditional summary statistics, to discuss patterns or compare habitat types, in an attempt to incorporate more demographic information about each species than the summary statistics allow (e.g. Nuttle and Burger 1996b, Nuttle 1997, Twedt 1999, Leidolf 1999). Use of weights derived from PIF also is potentially more thorough (and certainly more consistent) than using relative abundance, area importance, or a combination as in weights reviewed in Götmark et al. (1986).

The first application of *CV* using the PIF system was presented in the paper that introduced the scoring system (Hunter et al. 1993). That is somewhat ironic, in that one criticism that has frequently been raised about the use of *PIF.comp* in a *CV* index is that the scores were not compiled for that purpose, making the behavior of an index based on them unpredictable. Nevertheless, although it was not recognized as a *CV* index, that application is clearly described in Hunter et al. (1993:117):

> Priorities for habitats are set by identifying the habitats used by each species and determining the sum of the concern scores [i.e. *PIF.comp*] for all species in each habitat type within a state or physiographic area. Rankings based on this procedure identify those habitats most in need of focused attention for effective Neotropical migrant conservation.

Carter et al. (2000) expanded the system to all resident landbirds. Furthermore, although not directly stated in the subsequent description or review of the system, such an application of the PIF-derived scores is broadly hinted at to avoid single-species management, prioritize areas for broad conservation of still relatively common species, and avoid overwhelming lists of potentially conflicting habitat needs of hundreds of species (Beissinger et al. 2000, Carter et al. 2000).

Subsequent applications included Nuttle and Burger (1996b) and Nuttle (1997), who used *CV* to evaluate a chronosequence of bottomland hardwood restoration sites. They compared *CV* between three age classes of restoration site and advanced natural forest in the Mississippi Alluvial Valley (MAV). Abundance values for each species (a_i) were percent frequency in 356 0.25-ha plots censused in two years. Both species richness (*S*) and *CV* were highest in advanced natural forest, but difference between forest and all ages of restoration site was more dramatic with respect to *CV* than *S*. Furthermore, *CV* and *S* showed opposite trends between 11- to 13-year-old restoration sites and 22- to 28-year-old restoration sites (Nuttle 1997:42).

Twedt et al. (1999) compared bird communities between bottomland hardwood forest and cottonwood plantations in the MAV. They used a *CV* index based on indicator-species analysis, where a_i was the indicator value of each species for each habitat type studied. Their reported *CV* values for selectively harvested and unharvested bottomland hardwood forest were approximately twice those observed in 6- to 9-year-old cottonwood plantations. Differences between forest types were not nearly as pronounced with respect to *S*, *H′*, or territory density.

Leidolf (1999) examined response of a Gambel oak (*Quercus gambelii*) avian community to stand-replacing wildfire in north-central Utah. He compared *S* and *H′* among three sites of different postfire age. Both *S* and *H′* increased with age following fire but differences between the two oldest age classes were not significant. However, analysis of *CV* for the three age classes revealed that differences between the two oldest post-fire age classes were substantial and significant, indicating recovery of high-priority species may take much longer than was suggested by *S* or *H′*.

That brief review has illustrated the utility of *CV* indices using *PIF.comp* to weight species abundance. In each application, *CV* has revealed differences in bird communities that were masked by diversity indices or abundance measures. Furthemore, Leidolf (1999) pointed out that the abundance value used for a_i in the *CV* index can influence results obtained, so *CV* should be used in concert with diversity and abundance measures to obtain a more complete picture of what may be driving community differences.

COMPARISON OF COMPOSITE VERSUS RANKED PIF SCORING METHODS

The validity of using *PIF.comp* (or any other number) as a weight in a *CV* index rests on there being a real and consistent relationship between that number and conservation value of the site to which the index is applied. Despite its original application for that purpose, it is possible that small errors or inconsistencies in *PIF.comp* that were not important for grouping species into broad categories of conservation priority (e.g. "extremely high priority," "very high priority," "low priority," etc. sensu table 15 in Hunter et al. 1993) might add up to significant but erroneous differences in *CV*. P. B. Hamel (pers. comm. during Nuttle and Burger 1996b) suggested that assigning numerical ranks to categories proposed in Hunter et al. (1993), and using those ranks as weights instead of the raw *PIF.comp* scores, might reduce such a problem.

A less *ad hoc* approach for reorganizing PIF scores was proposed by Beissinger et al. (2000). In critiquing the PIF scoring process, they pointed out several shortcomings to using a summed score where the biological or statistical relationship between categories making up that score is not known, echoing Götmark et al.'s (1986) earlier warning. Bryce et al. (2002) used such a summation of obviously biologically intercorrelated (though not statistically intercorrelated) metrics in developing a "bird integrity index" to evaluate riparian sites. To correct that problem for PIF scores, Beissinger et al. (2000: table 2) provided a system for re-ranking species based on considering relative contributions of each PIF-scored category (e.g. threats to breeding, population trend, etc.) to each species' probability of extirpation. Thus, their revised ranks (henceforth "*PIF.rank*") range from 0 to 5, with non-native species receiving a rank of 0, threatened and endangered species receiving a rank of 5, and other species receiving a rank between 1 and 4 depending on combination of PIF-scored categories.

Beissinger et al. (2000) reported a correlation (*R* = 0.76) between *PIF.rank* and *PIF.comp* for birds of New York, indicating a "good but incomplete match" between the two scoring methods. We compared *PIF.rank* and *PIF.comp* for breeding birds of the MAV (Bird Conservation Region 26; RMBO, see Acknowledgments) to examine general patterns in their relationship and determined that they were similarly correlated (Pearson's $R = 0.70$). Here, we point out some features of their revised ranking system that we find especially advantageous, namely treatment of non-native species, or that we disagree with, namely treatment of threatened and endangered species and a logical error that results in misclassification of many species.

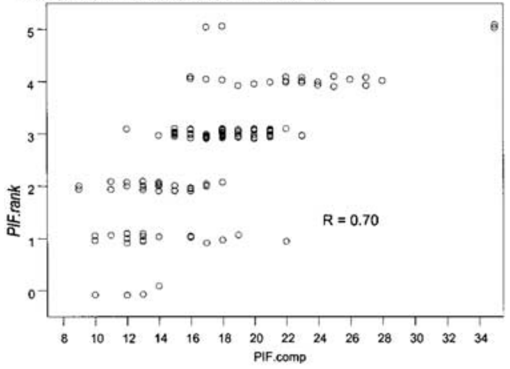
Treatment of non-native species.—Beissinger et al. (2000: table 2) assigned all non-native species *PIF.rank* = 0, regardless of values of the various PIF-scored categories. We agree with the rationale for considering non-native species to have no conservation priority for *PIF.rank*, and think this is an improvement over *PIF.comp*. For example, for the MAV, European Starlings (*Sturnus vulgaris*) have *PIF.comp* = 12, Brown-headed Cowbirds (*Molothrus ater*) 14, and American Robins (*Turdus migratorius*) 9. Although we do not doubt the veracity with which the PIF scoring process was applied, we question why an invasive exotic species (European Starling) and a nest-parasite that has spread beyond its historic range via anthropogenic land-use changes (Brown-headed Cowbird) would both receive markedly higher conservation priority than a native, albeit common, species (American Robin). Those *PIF.comp* scores would put American Robin and European Starling in priority grouping "low concern" and Brown-headed Cowbird in "moderate concern" (following table 15 in Hunter et al. 1993). Under the Beissinger et al. (2000: table 2) ranking, however, American Robin would receive *PIF.rank* = 2 (species of "low concern," but still at some risk), because of its area importance score for the MAV, European Starling would have *PIF.rank* = 0 because it is not native to North American, and Brown-headed Cowbird may have *PIF.rank* = 0 if it is considered non-native because of its nonhistoric occurrence in the region (the line between being native and non-native is often unclear and subjective; individual investigators may desire to define their own criteria for nativity).

A further improvement to the PIF scoring system may be to assign negative values of *PIF.rank* to introduced species, if degree of their detriment to other populations can be determined. A framework for discounting *CV* on the basis of introduced species may perhaps be adapted from an index of biological integrity developed for plant communities based on invasibility of exotic weeds (T. K. Magee, P. L. Ringold, and M. A. Bollman, unpubl. data), but implementing such a system is beyond the scope of this paper.

Treatment of threatened and endangered species.—Beissinger et al. (2000: table 2) assigned all state or federally listed threatened and endangered species *PIF.rank* = 5. We do not agree that threatened and endangered species should receive a higher rank than is warranted by the other criteria. As Beissinger et al. (2000) pointed out, state-listed threatened and endangered species are often common in other regions (therefore having low priority for relative abundance and potentially also for threats to breeding and nonbreeding habitat), are on the fringe of the species' range (thus having low priority for area importance), and therefore may be of lower concern than other species that are perhaps common in the region (having high area importance), but suffer more global threats (high threats to breeding, nonbreeding, or population trend; see Hunter and Hutchinson 1994 for a discussion on the shortcomings and merits of such "parochialism"). That point can even be true for federally listed species. For example, two of the four threatened and endangered species of the MAV, Bald Eagle (*Haliaetus leucocephalus*) and Interior Least Tern (*Sterna antillarum athalassos*), have only moderate *PIF.comp* (Fig. 1A) and would be scored *PIF.rank* = 3 ("species of moderate concern") following the quantitative criteria in Beissinger et al. (2000: table 2). The other two species have high *PIF.comp* and would be scored as *PIF.rank* = 4 ("species of high concern") following the quantitative criteria in Beissinger et al. (2000: table 2), but one is extirpated from North America (Ivory-billed Woodpecker [*Campephilus principalis*]) and the other is most likely globally extinct (Bachman's Warbler [*Vermivora bachmanii*]). Thus, a species' threatened and endangered status may have little bearing on its regional conservation need relative to other species. Furthermore, the PIF scoring process is already quite rigorous, making it unnecessary to consider those species separately in a system that is designed to evaluate all species on a common scale. Having separate criteria for threatened and endangered species is further unnecessary because special consideration of them is generally mandated by appropriate state or federal laws. A natural alternative, therefore, would be to evaluate *CV* for the areas of interest, and consider those values in concert with effects on threatened and endangered species to make a comprehensive decision.

Correcting an error.—The second main discrepancy between *PIF.rank* and *PIF.comp* was for species receiving a *PIF.rank* score of 1; they showed more *PIF.comp* variability than those in other *PIF.rank* categories (Fig. 1A). *PIF.rank* = 1 is assigned to all native species that do not meet the criteria to be assigned a higher rank, but some species' failure to meet those criteria is an error in the criteria for attaining a *PIF.rank* = 2 in Beissinger et al. (2000: table 2). We correct that error, revise the presentation of ranking criteria so they may be more easily applied as an algorithm for use by others, and remove the special rank for threatened and endangered species (see Table 1). Using the revised ranking system of Table 1, we calculated Pearson's $R = 0.72$ between *PIF.rank* and *PIF.comp* (Fig. 1B). All further discussion of *PIF.rank* uses the revised criteria of Table 1.

A. Original (from Beissinger et al. 2001: table 2)



B. Revised (from Table 1)

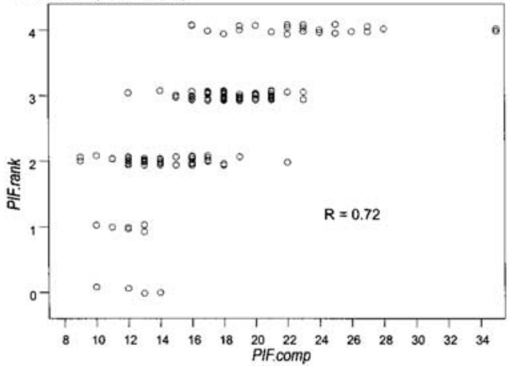


FIG. 1. (A) Relationship of PIF composite scores (*PIF.comp*) to priority ranks (PIF.rank) as calculated from Beissinger et al. (2000: table 2) for birds of the Mississippi Alluvial Valley (Bird Conservation Region 26; see Acknowledgments). (B) Relationship of *PIF.comp* and *PIF.rank* as calculated from revised criteria in Table 1. Positions along *PIF.rank* axis have been jittered slightly to reduce overlap in data points.

Dependence of PIF-based CV on species richness.—To some degree, *CV* is inherently dependent on species richness because each additional native species (for presence or absence data), individual (for total abundance), or territory (for density) increases *CV*, depending on the weighting factor used. However, *CV* using *PIF.rank* is not inherently dependent on *S* because the minimum score for each species is 0, whereas *PIF.comp* is highly dependent on *S* because the minimum score is 7. On the basis of that property of the scores, *CV*(*PIF.rank*) is a better index.

We examined the statistical dependence of *CV*(*PIF.rank*) and *CV*(*PIF.comp*) on *S* using data from Nuttle (1997). Both *CV*(*PIF.rank*) and *CV*(*PIF.comp*) were highly correlated with *S* over the range of plot data examined, but *CV*(*PIF.rank*) was less so (Pearson's correlation $R = 0.98$ for *CV*[*PIF.rank*] and $R = 0.99$ for *CV*[*PIF.comp*], Fig. 2). Although in that application measures of *CV* were highly correlated with *S*, the high correlation coefficients (Fig. 2) are in part due to the large range in *S* values examined. In application, many investigators will only be evaluating a handful of sites; in such cases, there may be no apparent correlation between *S* and *CV*. A better indication of performance of the two indices can be inferred from examining the relative spread between values of *CV*(*PIF.comp*) versus *CV*(*PIF.rank*) for any given *S*. Whereas the two *CV* indices have different scales, the relative spread between *CV*(*PIF.rank*) at intermediate *S* is much greater than for *CV*(*PIF.comp*), indicating greater sensitivity of *CV*(*PIF.rank*) to species scores.

Degree of correlation between *CV*(*PIF.rank*) and *S* is in part an artifact of the system we examined. As Nuttle's (1997) sites progressed in age, they developed more vegetation structural diversity, which provided more diverse habitats for birds (MacArthur and MacArthur 1961, Willson 1974, Roth 1976), producing higher *S*.

TABLE 1. Categorical ranking algorithm to apply to North American birds using the PIF prioritization categories (adapted from table 2 in Beissinger et al. 2000)[a].

Rank	Category	Species attributes	Decision criteria [b]
4	Species of high concern	Populations are declining rapidly, have a small range, or high threats.	a. PT > 3 and (RA, BD, TB, or TN > 3), or b. RA = 5, or c. RA = 4 and (BD or ND > 3), or d. AI = 5 and RA > 3.
3	Species of moderate concern	Populations are declining and experiencing moderate threats, or population trends are not known and threats are high.	a. PT > 3 and (RA, BD, ND, TN, or TB = 3), or b. PT = 3 and (RA, BD, ND, TN, or TB > 3), or c. RA = 3 and (BD or ND > 2), or d. RA = 4 and (BD or ND ≤ 3), or e. AI = 4 and RA > 3.
2	Species of low concern	Species is common.	a. PT = 3 and (RA, BD, ND, TN, or TB = 3), or b. PT = 2 and (RA, BD, ND, TN, or TB > 3), or c. RA > 2[c] and (Rank ≠ 3 or 4), or d. AI > 2[c] and (Rank ≠ 3 or 4).
1	Species not at risk	All remaining native species.	Rank ≠ (2, 3, or 4), i.e., all remaining native species.
0	Introduced species	Species are not native to North America, have spread into the area by anthropogenic means or because of anthropogenic factors, or is otherwise determined to not contribute to conservation needs of the site.	All non-native species as determined by attributes of interest.

[a] Beissinger et al. (2000: table 2) included an additional rank = 5 for federal- or state-listed threatened and endangered species.

[b] PT = Population Trend, RA = Relative Abundance, BD = Breeding Distribution, ND = Nonbreeding Distribution, TB = Threats to breeding, and AI = Area Importance. Category definitions are in Carter et al. 2000; also see Acknowledgments.

[c] Beissinger et al. (2000: table 2) require RA = 3 or AI = 3, incorrectly assigning species with RA > 3 and AI > 3 to rank 1 unless they also have additional criteria to place them in rank 3 or 4.

Those added vegetation components also happen to be those most preferred by high-priority species in the MAV, many of which are forest-interior shrub nesters. Furthermore, bottomland hardwood forests have many high-priority and very few non-native species; therefore each additional species is likely to increase *CV*. In other regions, however, increases in *S* may come primarily from addition of common, low-priority, and non-native species. For example, a community with high *CV* in the Southeastern Coastal Plain (Bird Conservation Region 27) might contain a very high-priority species like Bachman's Sparrow (*Aimophila aestivalis*, *PIF.comp* = 29 and *PIF.rank* = 4), if it is in a longleaf pine savannah with an open, grassy understory. Because of the prevalence of recent clear cuts and forest edges in the region, however, added vegetation layers may serve primarily to improve habitat for common species (e.g. Song Sparrow [*Melospiza melodia*], *PIF.comp* = 10 and *PIF.rank* = 1) at the expense of rare species like Bachman's Sparrow, lowering *CV* while perhaps increasing *S*. Thus, because the PIF scoring system has a regional focus, *CV*(*PIF.rank*) reflects regional conservation priorities, whereas *S* or other diversity and abundance measures cannot be assumed to do so.

CONCLUSION

As noted by Götmark et al. (1986), the conservation value concept avoids some of the misleading conclusions that may result from over-reliance on summary statistics like species diversity or abundance, because *CV* indices incorporate more demographic information about each species. Partners in Flight scores provide a more rigorous, objective, and widely available weighting system than any existing alternative for use in a *CV* index. Furthermore, the ranking scheme of Beissinger et al. (2000: table 2), as modified in Table 1, improves application of the PIF system by correcting for statistical problems from using additive measures such as *PIF.comp,* and removes some of the dependence on *S*. Application to *CV* notwithstanding, further refinement in the PIF scoring process will occur as population data undergo continued analysis

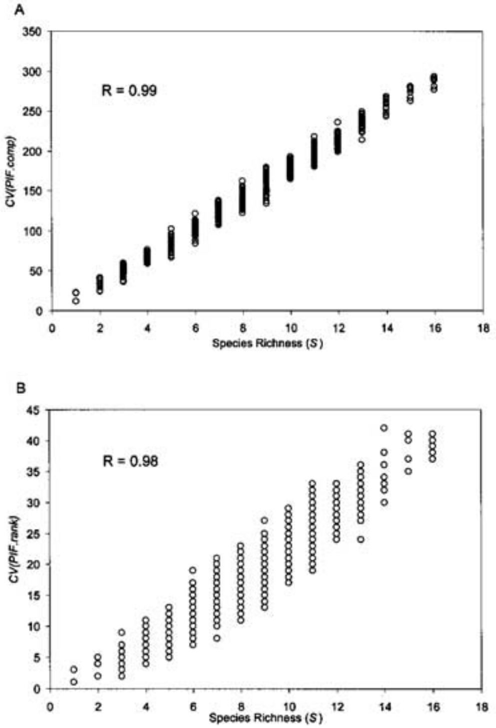


FIG. 2. (A) Relationship between species richness (*S*) and conservation value calculated using PIF composite scores (*CV*[*PIF.comp*]). (B) Relationship between *S* and revised priority ranks (*CV*[*PIF.rank*]). *R* values are Pearson's correlation coefficients from 712 observations of bird communities in 3- to 28-year-old restoration sites and advanced natural bottomland hardwood forest in Mississippi. Although *R* values in each graph are quite high, the greater spread of points in (B) than in (A) suggests that using *CV*(*PIF.rank*) instead of *CV*(*PIF.comp*) yields more information about bird community status when used in concert with *S*.

and more data become available. We therefore recommend that, as illustrated in the studies reviewed here, *CV(PIF.rank)* be used in concert with the more traditional summary statistics, to provide more complete understanding of what factors contribute to a site's *CV* index, and a better approximation of a site's true conservation value. Finally, extension of the PIF scoring process to other taxa would allow an even more thorough evaluation of the conservation value of a site.

ACKNOWLEDGMENTS

We gratefully acknowledge the support of a Mississippi State University College of Forest Resources McIntyre-Stennis grant, a Utah State University College of Science/Willard Eccles Fellowship, and Utah State University Ecology Center Fellowship and Stipend to T.N. while formulating this manuscript. A.L. was supported by a Utah Army National Guard grant, a Utah State University Ecology Center Fellowship and Stipend, and the U.S. Geological Survey, Utah Cooperative Fish and Wildlife Research Unit. We thank C. S. Robbins, B. Loiselle, and an anonymous reviewer for helpful editorial reviews of the manuscript. We also thank the Rocky Mountain Bird Observatory. Scores for each species in each state, physiographic area, or bird conservation region are available online from www.rmbo.org/pif/pifdb.html.

LITERATURE CITED

BEISSINGER, S. R., J. M. REED, J. M. WUNDERLE, JR., S. K. ROBINSON, AND D. M. FINCH. 2000. Report of the AOU Conservation Committee on the Partners in Flight species prioritization plan. Auk 117:549–561.

BIBBY, C. J., N. D. BURGESS, AND D. A. HILL. 1992. Bird Census Techniques. Academic Press, London, United Kingdom.

BRYCE, S. A., R. M. HUGHES, AND P. R. KAUFMANN. 2002. Development of a bird integrity index: Using bird assemblages as indicators of riparian condition. Environmental Management 30: 294–310.

CARTER, M. F., W. C. HUNTER, D. N. PASHLEY, AND K. V. ROSENBERG. 2000. Setting conservation priorities for landbirds in the United States: The Partners in Flight approach. Auk 117:541–548.

GÖTMARK, F., M. AHLUND, AND M. O. G. ERIKSSON. 1986. Are indices reliable for assessing conservation value of natural areas? An avian case study. Biological Conservation 38:55–73.

HAMEL, P. B., D. J. TWEDT, T. J. NUTTLE, C. A. WOODSON, F. BROERMAN, AND J. M. WAHOME. 2002. Winter bird communities in afforestation: Should we speed up or slow down ecological succession? Pages 98–108 *in* Proceedings of a Conference on Sustainability of Wetlands and Water Resources: How Well Can Riverine Wetlands Continue to Support Society into the 21st Century? (M. M. Holland, M. L. Warren, and J. A. Stanturf, Eds.). U.S. Department of Agriculture, Forest Service General Technical Report SRS-50.

HUNTER, W. C., M. F. CARTER, D. N. PASHLEY, AND K. BARKER. 1993. Partners in Flight species prioritization scheme. Pages 109–119 *in* Status and Management of Neotropical Migratory Birds (D. M. Finch and P. W. Stangel, Eds.). U. S. Department of Agriculture, Forest Service General Technical Report RM-229.

Hunter, M. L. and A. Hutchinson. 1994. The virtues and shortcomings of parochialism: Conserving species that are locally rare, but globally common. Conservation Biology 8:1163–1165.

Leidolf, A. 1999. Avian community response to fire in a Gambel oak woodland. M.S. thesis, Department of Fisheries and Wildlife, Utah State University, Logan.

Leidolf, A., M. L. Wolfe, and R. L. Pendleton. 2000. Bird communities of Gambel oak: A descriptive analysis. U. S. Department of Agriculture, Forest Service General Technical Report RMRS-48.

MacArthur, R. H., and J. V. MacArthur. 1961. On bird species diversity. Ecology 42:594–600.

Maurer, B. A. 1993. Biological diversity, ecological integrity, and neotropical migrants: New perspectives for wildlife management. Pages 24–31 *in* Status and Management of Neotropical Migratory Birds (D. M. Finch and P. W. Stangel, Eds.). U.S. Department of Agriculture, Forest Service General Technical Report RM-229.

McShea, W. J., and J. H. Rappole. 2000. Managing the abundance and diversity of breeding bird populations through manipulation of deer populations. Conservation Biology 14: 1161–1170.

Nuttle, T. J. 1997. Response of breeding bird communities to afforestation of hardwood bottomland sites in Mississippi. M.S. thesis, Department of Wildlife and Fisheries, Mississippi State University, Mississippi State.

Nuttle, T. and L. W. Burger. 1996a. Response of breeding bird communities to restoration of hardwood bottomlands. Proceedings of the Annual Conference of Southeastern Fish and Wildlife Agencies 50:228–236.

Nuttle, T. and L. W. Burger. 1996b. Response of breeding bird communities to afforestation of hardwood bottomland sites in Mississippi. Page 749 *in* The Delta: Connecting Points of View for Sustainable Natural Resources. Memphis, Tennessee.

Ralph, C. J., G. R. Geupel, P. Pyle, T. E. Martin, and D. F. DeSante. 1993. Handbook of Field Methods for Monitoring Landbirds. U.S. Forest Service General Technical Report PSW-144.

Ralph, C. J., J. R. Sauer, and S. Droege. 1995. Managing and monitoring birds using point counts: Standards and applications. Pages 161–175 *in* Monitoring Bird Populations by Point Counts (C. J. Ralph, J. R. Sauer, and S. Droege, Eds.). U.S. Department of Agriculture, Forest Service General Technical Report PSW-149.

Robbins, C. S., D. Bystrak, and P. H. Geissler. 1986. The Breeding Bird Survey: Its First Fifteen Years, 1965–1979. U.S. Department of the Interior, Fish and Wildlife Service Resource Publication 157.

Roth, R. R. 1976. Spatial heterogeneity and bird species diversity. Ecology 57:773–782.

Shannon, C. E. 1948. A mathematical theory of communication. Bell System Technology Journal 27:379–423, 623–656.

Simpson, E. H. 1949. Measurement of diversity. Nature 163:688.

Twedt, D. J., R. R. Wilson, J. L. Henne-Kerr, and R. B. Hamilton. 1999. Impact of forest type and management strategy on avian densities in the Mississippi Alluvial Valley, USA. Forest Ecology and Management 123:261–274.

Willson, M. F. 1974. Avian community organization and habitat structure. Ecology 55: 1017–1029.

Received 7 Novemeber 2001, accepted 14 December 2002
Associate Editor: B. Loiselle