The Auk 117(2):549–561, 2000

*CONSERVATION REPORT*

# REPORT OF THE AOU CONSERVATION COMMITTEE ON THE PARTNERS IN FLIGHT SPECIES PRIORITIZATION PLAN

STEVEN R. BEISSINGER,[1,6] J. MICHAEL REED,[2] JOSEPH M. WUNDERLE, JR.,[3] SCOTT K. ROBINSON,[4] AND DEBORAH M. FINCH[5]

[1]*Department of Environmental Science, Policy and Management, 151 Hilgard Hall, University of California, Berkeley, California 94720, USA;*
[2]*Department of Biology, Tufts University, Medford, Massachusetts 02155, USA;*
[3]*International Institute of Tropical Forestry, USDA Forest Service, Box 490, Palmer, Puerto Rico 00721;*
[4]*Department of Ecology, Ethology and Evolution, University of Illinois, Champaign, Illinois 61820, USA; and*
[5]*Forestry Sciences Lab, USDA Forest Service, 2205 Columbia SE, Albuquerque, New Mexico 87106, USA*

## CHARGE OF THE COMMITTEE

Partners in Flight (PIF) is a coalition of federal, state, and local government agencies; nongovernmental organizations (NGOs); philanthropic foundations; and industry that is working to conserve the birds of the Western Hemisphere. PIF was launched in 1990 in response to growing concerns about declines in the populations of many landbirds, and to spearhead the conservation of birds not covered by existing initiatives, such as the North America Waterfowl Management Plan. The initial focus of PIF was on Neotropical migrants (species that breed in North America north of the tropics and winter in Central America and/or South America). The emphasis has expanded to include most landbirds and other marine and aquatic species that require terrestrial habitats. PIF is coordinated in the United States by four regional working groups (Northeast, Southeast, Midwest, and West) and five technical working groups (Research, Monitoring, International, Communications, and Education) that represent participating agencies of state governments, the federal government, a variety of NGOs, and private industry.

PIF is developing a Bird Conservation Strategy designed to conserve the birds of North America and their habitats before they become endangered. PIF Bird Conservation Plans seek to restore, maintain, and protect bird populations and habitats by setting conservation priorities and objectives in each state and physiographic area in the United States and by outlining strategies for implementation. Bird Conservation Plans build on the successes of earlier conservation initiatives including international treaties, the North American Waterfowl Management Plan, and the Western Hemisphere Shorebird Reserve Network.

A basic tenet of the strategy is that habitats that support the most threatened species are most in need of conservation. Central to the task of determining which habitats need to be conserved is a ranking scheme to prioritize the relative risk of extinction among species. PIF has developed a process for ranking bird conservation priorities and has begun to apply it to several geographic areas (Hunter et al. 1993). Ranking schemes have long been used to evaluate conservation priorities (Millsap et al. 1990, Master 1991, Reed 1992). The National Audubon Society developed lists to prioritize the conservation status of North American birds through the periodic publication of its "Blue List" and "Watchlist" over the past 25 years (Anonymous 1971, Arbib 1976, Muehter 1998). Natural Heritage Programs in each state publish state conservation rankings for birds and other taxa, and national lists are also produced.

The American Ornithologists' Union (AOU) was formally requested by PIF and the National Audubon Society to review the PIF prioritization plan (see preceding publication by Carter et al.). A special committee (hereafter, "the Committee") was formed under the auspices of the AOU Conservation Committee and was approved by AOU Council to complete the task. This report summarizes the Committee's deliberations and recommendations.

The Committee defined its task to answer three central questions: (1) Is a prioritization process needed for conserving birds in North

[6] E-mail: beis@nature.berkeley.edu

America? (2) Is the process proposed by PIF reasonable and scientifically sound? (3) How should the results of the process be interpreted for the purpose of conservation planning?

## Is a Prioritization Process Needed?

Birds contribute to ecosystem health and provide economic, recreational, scientific, and aesthetic value for society. In recent decades, however, dozens of bird species have been federally listed as threatened or endangered due to alarming population declines and range retractions resulting from human-induced factors such as habitat loss and degradation, pesticides, cowbird parasitism, and invasion by nonnative plant and animal species (Collar et al. 1994, Flather et al. 1998, Wilcove et al. 1998). Saving species that are near extinction can be difficult, costly, and politically charged.

PIF seeks to develop a plan to conserve bird species of North America. Unlike most conservation plans, which deal with few species that have relatively high risks of extinction, most of the hundreds of species included in the PIF plan are not in imminent danger and have a low risk of extinction in the near future. Most species have large geographical ranges, huge global populations, and use many habitats on their breeding and their winter ranges. However, focusing attention on bird species before they become endangered shifts the conservation agenda from reactive, last-minute rescue attempts to proactive, preventive actions to keep common birds common. An important outcome of such an approach is to preserve the diverse roles that birds play in ecosystem function, for example as agents of insect control that reduce the likelihood of pest outbreaks, or as seed dispersers that help regenerate forests (Howe 1986, Kirk et al. 1996). *The Committee believes that keeping uncommon species from becoming endangered and preventing common species from becoming uncommon is an important conservation goal.*

Bird conservation priorities must be developed so that limited human and financial resources can be directed efficiently and productively toward those species and habitats that are most in need. Despite large population sizes and ranges, some "common" species are clearly more vulnerable to population declines than are others because of smaller geographic ranges, smaller population sizes, and greater habitat specialization (Pimm et al. 1988). Similarly, some ecoregions (e.g. Mississippi Alluvial Valley, Northern Tallgrass) and habitats (e.g. western riparian forest, California coastal scrub) face serious threats as a result of conversion of native vegetation to human land uses. Without some sort of prioritization scheme, it will be difficult to focus limited resources on species, ecoregions, and habitats that are in need of conservation.

In the absence of a prioritization scheme, bird conservation plans would be hampered by the overwhelming number of species to be considered simultaneously, with each species possibly having different management needs. Arguably, any management action could be criticized because it would inevitably cause declines of some species, or justified because there would always be some species that would benefit. Attempts to use diversity indices or guild-based characterizations for evaluating management options have failed because they often miss important changes in populations of rare species that should be a higher conservation priority. By ranking species and periodically reevaluating those rankings, we potentially can simplify conservation planning for multiple species by focusing on a subset of the species within a state, region, or country. Thus, ranking can enable implementation of conservation plans over a variety of scales and provides greater flexibility to meet multiple objectives. *The Committee concludes that a thoughtfully constructed process that ranks the relative susceptibility of birds to extinction and large-scale declines can play a useful and important role in conservation efforts if it is periodically evaluated and continually improved.*

## Is the Prioritization Process Proposed by PIF Reasonable and Scientifically Sound?

Several approaches have been developed to prioritize species for conservation. In general, they are based on the premise that the highest priority species (1) are most at risk of extinction, local extirpation, or are experiencing large population declines; or (2) represent the most unique evolutionary lineage. However, priorities might also be set by cultural values (Millsap et al. 1990, Norton 1994) or for economic reasons (Bishop 1978). Reed (1995) briefly reviewed different methods for assessing susceptibility to extirpation for scoring conservation priorities. The simplest methods involve contingency analyses that group species based on traits such as population size, population trend, and geographic range (Rabinowitz et al. 1986, Kattan 1992, Reed 1992). Burke and Humphrey (1987), Millsap et al. (1990) and Reed (1995) developed schemes that are ordinal analyses, where values were given to different parameters and summed to predict risk using a linear rank. Variables can also be combined in a multivariate assessment of risk (Given and Norton 1993). Complex analyses that yield probabilities of extinction, like classical decision analysis (Maguire et al. 1987) or population viability analysis (Beissinger and Westphal 1998), require large amounts of data and usually are not feasible for long lists of species. Any of these methods could be used to develop categories of risk for species, rather than a linear rank of risk, as was done by IUCN (Collar et al. 1994) and The Nature Conservancy (Master 1991). Conservation priorities have also been proposed based on systematic criteria that rank species by placing greater value on taxonomically unique species, such as the only representative of a family (Vane-Wright et al. 1991, Faith 1992, Forey et al. 1994). For example, taxonomic distinctness is one of several characteristics that the United States Fish and Wildlife Service uses to assign recovery priorities (USDI 1994).

Partners in Flight developed an ordinal analysis method that provides a linear rank for setting conservation priorities by states and physiographic areas of North America (Carter et al. 2000). The PIF prioritization method assigns priority scores to seven variables based on global and local priority scores. The seven variables are mostly related to relative risk of extinction but also include an index of the relative importance of a region to conservation efforts within the species' range. First, global scores describe a species' breeding distribution, wintering distribution, and abundance and remain constant across a species' range. Second, state and physiographic area scores describe a species' local population trend, local threats on the breeding and nonbreeding grounds, and the importance of an area to a species. Each criterion is scored independently from 1 to 5, with 5 indicating the highest conservation priority and 1 indicating the lowest. Thus, the overall score can range from 7 to 35. Higher scores indicate greater conservation concerns. Global scores are reviewed and approved by the PIF Prioritization Technical Committee, and state and physiographic area scores are reviewed and approved by the PIF Regional Coordinators and expert associates. The PIF ranking scheme also has accounted for uncertainty in the global and local priority scores (e.g. Hunter et al. 1993). Currently, PIF uses uncertainty scores only in conjunction with the population trend priority score (Carter et al. 2000: table 4).

*The Committee believes that a prioritization scheme needs to consider both local and global threats, and we endorse the general structure of PIF's approach.* Conservation planning occurs at both scales, and even widespread and abundant species can be excellent conservation indicators in some ecoregions. For example, Yellow Warblers (*Dendroica petechia*) and Song Sparrows (*Melospiza melodia*) would have a low conservation priority in the eastern United States, but they are excellent indicators of western riparian ecosystem health, which varies from state to state (Hunter et al. 1987). Even the Common Yellowthroat (*Geothlypis trichas*) is in trouble in many parts of the Southwest and California. To examine whether the PIF prioritization process is reasonable and scientifically sound, the Committee developed a series of four questions about the variables and evaluated their answers below.

### 1. Are the regions of concern and species chosen for evaluation appropriate?

The PIF ranking process has been developed for the birds of North America. For their purposes, PIF defined North America to include the continent excluding Greenland, and extending from Canada through Panama and the islands of the Caribbean (Carter et al. 2000). *The Committee believes that developing a ranking scheme for species within the United States is highly appropriate, given a reasonably well-studied avifauna, the availability of good data for most species, and an enthusiastic cadre of PIF members and cooperators who will readily adopt the scheme.* Although knowledge of Canada's avifauna also is very complete, the likelihood of the scheme's acceptance is doubtful given that the Canadian Wildlife Service is developing a different prioritization proposal (Dunn et al. 1999). Furthermore, there is value in independent assessments of the status for the same birds in different countries, and disparities should cause both efforts to reconsider individual scores.

*Extending the PIF ranking scheme south of the United States border is, in the Committee's opinion, much more problematic.* The avifauna of Central America and the Caribbean is poorly known compared with more northern areas. Much of the information required for the ranking criteria is unknown for most species (i.e. relative abundance, threats, population trend, area importance), resulting in high levels of uncertainty from any ranking exercise. Moreover, it is unknown if the ranking scheme would be accepted or adopted by citizens of Central America or the Caribbean owing to the potential lack of "ownership" in the scheme. For these regions, an initial prioritization scheme using simpler criteria based on limited knowledge of the region's species, such as the endemic bird areas developed by BirdLife International, may be more appealing. However, if PIF can address these issues, it is reasonable to apply a simpler version of their prioritization scheme to the birds of Central America and the Caribbean. Because of their proximity, these nations support many of the same species that PIF has prioritized in the United States. Also, PIF has a strong interest in migrants on the wintering grounds and is concerned with assisting resident conservationists. If the PIF scheme is eventually applied throughout Central America and the Caribbean, the Committee believes it will illustrate the high risks to many birds in this region relative to North American species in the United States. For example, many species that inhabit montane or dry forest of Central America, and many island endemics, likely will receive high scores (Collar et al. 1994).

The PIF prioritization scheme is being adapted to address all bird species found within the regions of concern (Carter et al. 2000). *The Committee believes that ranking all species is a laudable goal, but it recommends that exotic and introduced species be treated differently because maintaining their populations and decreasing their relative risks of extinction are not conservation concerns.* Exotic species, as well as those that have been introduced to a new area accidentally (i.e. House Finch [*Carpodacus mexicanus*] in eastern North America), should not be conservation priorities. Such species should be given either a rank of zero or placed in a unique category that might endorse management that would be harmful to the species. The PIF ranking scheme should send a clear signal to its members and cooperators that exotic and recently introduced species have no conservation value. Although some exotic species have become conservation problems for native species (e.g. Ingold 1994), a rank based on the risk of extinction for these exotics is not useful. Nevertheless, the Committee suggests that native species that have expanded their ranges on their own, such as the Northern Mockingbird (*Mimus polyglottos*) and the Northern Cardinal (*Cardinalis cardinalis*), be retained in the ranking system.

## 2. Are the Variables Included in the PIF Prioritization Process Important?

*The Committee strongly concurs that all variables included in the PIF prioritization scheme are important and appropriate for ranking the susceptibility of birds in the United States.* This reflects an outstanding job done by the PIF Research Working Group and the Prioritization Technical Committee in developing these variables. However, the Committee suggests that PIF incorporate into the prioritization scheme a few modifications to some of the variables noted below.

As new and more detailed range maps become available, they should be incorporated into rankings of the variables "Breeding Distribution" and "Nonbreeding Distribution." Traditional range maps are based on outer boundaries of geographic distributions. New range maps based on breeding bird atlases show the extent to which large areas within a species' range actually are not occupied by the species (e.g. Dunn and Garrett 1997). Therefore, traditional maps potentially exaggerate the importance of some regions and underestimate the importance of others. Similarly, range maps that incorporate abundance can help focus regional conservation efforts on high-priority species. Refined range maps may identify species at much greater risk of winter habitat loss than originally thought, such as the Veery (*Catharus fuscescens*), which apparently winters only in a small part of southwestern Brazil (J.V. Remsen, Jr. pers. comm.).

It might be useful for nonbreeding distributions to incorporate possible migration bottlenecks. Within intensively urbanized and agricultural regions, migratory stopover and staging habitats often are scarce, so birds concentrate in a few areas. Including a "migratory bottleneck" category should help direct conservation efforts at potentially important stopover sites. Nevertheless, migration bottlenecks will be difficult to evaluate for most terrestrial species.

The variables "Threats to Breeding" and "Threats to Nonbreeding" are the most complex and potentially are the least repeatable and the most subjective of the variables. Additional explanations and refinement would help immensely, but it may be useful to restructure these variables. Currently, the variables focus on past threats and are strongly oriented toward habitat loss. Although habitat loss is the most frequent cause of species declines (Flather et al. 1998, Wilcove et al. 1998), more consideration should be given to clarifying how other threats could be incorporated. The description of these variables suggests that PIF should incorporate information on a species' demographic and ecological vulnerability, but table 3 in Carter et al. (2000) gives no explicit method for doing so. These concerns could be incorporated using variables like the degree of habitat specialization (e.g. Reed 1995) and the potential speed of demographic recovery, as discussed below. Given our limited understanding of survival rates, it is premature to attempt fine-grained assessments of differential demographic vulnerabilities for most species. Nevertheless, demographic processes are fundamental to understanding the variables "Threats to Breeding," "Threats to Nonbreeding," and "Population Trend," and should continue to receive intensive study. In addition, the method for estimating future threats needs much greater explanation. It is useful to consider the extent to which current threats will continue to operate in the future, but this can be very difficult to judge and especially difficult to assign to percentages. Furthermore, Carter et al.'s table 3 emphasizes past threats, which although easier to judge than future threats, are less relevant to recovery.

The Committee believes that well structured "Threats to Breeding" and "Threats to Nonbreeding" variables are important to the PIF priority scheme. Such variables might incorporate both the future threat and the ease of recovery. The persistence of a population depends upon the ability and time required to reverse the factors that are causing a decline. Categories that are less quantitative and that reflect the causes of decline might be more useful than the percentages of past conditions remaining today or projected for the future. For example, it may be feasible to incorporate the effects of most factors that are causing a species to decline in the following categories (1) likely causes of decline have already been reversed, (2) likely causes of decline are starting to slow, (3) likely causes of decline have stabilized, (4) likely causes of decline are continuing, and (5) likely causes of decline are accelerating. Likewise, it may be feasible to rank the relative ease with which a species can be recovered. This would depend upon a combination of a species' demographic and ecological vulnerability, and the ease and time required to reverse the limiting factors that have caused it to decline. For example, it will take longer to recover a population of Marbled Murrelets (*Brachyramphus marmoratus*) than a population of Eastern Towhees (*Pipilo erythrophthalmus*), because the former species has a low reproductive rate and depends on old-growth forests that require centuries to regrow, whereas the latter species uses many habitats including second growth and has a relatively high reproductive rate. *The Committee recommends that PIF revise both of its "threats" variables.*

The variable "Relative Abundance," as currently constructed, does not appear to be based on relative density, but rather on categories of maximum absolute density that the species has achieved throughout its range. Relative abundance is often defined for conservation purposes as the number of individuals of a species relative to the number of individuals of another species, or relative to the maximum density that the species can achieve. Absolute abundance is the number of individuals per unit area, which appears to be closer to the way that PIF has scored abundance. "Relative Abundance" categories (Carter et al. 2000: table 2) are based on the mean number of birds detected for the 10 Breeding Bird Survey (BBS) routes where the species occurred with the greatest abundance throughout its range over the time period of 1985 to 1991. If BBS data are unavailable, "Relative Abundance" is based on categories of absolute abundance in field guides (Carter et al. 2000). When the PIF measure of abundance is used, large birds may never have a small (i.e. more secure) rank because they are always uncommon relative to smaller-bodied birds. For example, Red-tailed Hawks (*Buteo jamaicensis*) would probably never be scored as a 1 or 2 even though they are unusually common for a large raptor and would seem to be at low risk. If relative abundance were used, however, a species would achieve a rank of 1 if it were as abundant as that species ever gets, even if its absolute numbers were low. Furthermore, the use of a rangewide score can make this variable difficult to interpret. For example, two species with small North American populations, Common Black-Hawk (*Buteogallus anthracinus*) and Short-tailed Hawk (*Buteo brachyurus*), had high "Relative Abundance" scores because their scores were based on rangewide assessments of abundance in Central and South America.

Thus, "Relative Abundance" actually estimates the maximum density that a species is capable of attaining rather than its density relative to other species or to other populations of the same species. It is useful as a proxy of a species' potential risk of extinction when it is most abundant, because extinction risk is related to population size (Shaffer 1987, Lande 1993). "Relative Abundance" is useful in a prioritization scheme, but the rangewide assessment of this variable decreases its usefulness for local conservation planning. Therefore, the variable might more aptly be named "Maximum Abundance" and should be interpreted from this perspective.

The PIF priority scheme relies heavily on BBS data to provide an indication of the variables "Relative Abundance" and "Population Trend" for species that are adequately covered by the BBS. A qualitative scheme is provided for both variables as a substitute for species that are inadequately surveyed in the BBS. Qualitative scoring is needed for many North American species that are poorly sampled by the BBS in the United States and Canada, and for all species outside this region. Robbins et al. (1986) noted that species that are rare, nocturnal, colonial breeders, very local, restricted during breeding to high elevations or high latitudes, or are limited to only two or three states were inadequately sampled to enable evaluation of population trends in the BBS. Undersampled species include loons, grebes, pelagic seabirds, pelicans, cormorants, anhingas, spoonbills, swans, condors, chachalacas, ptarmigan, rails, oystercatchers, arctic-nesting shorebirds, some gulls and terns, skimmers, alcids, tropical doves, anis, rare owls, goatsuckers, southwestern hummingbirds, trogons, and tropical kingfishers, as well as many endangered species. In addition, some states are poorly sampled by BBS routes (e.g. Alaska and Nevada). *The Committee is concerned that a prioritization scheme with a mix of quantitative and qualitative ranks for individual species could result in unpredictable biases, and we urge PIF to investigate the magnitude of these potential biases.* One approach would be to create valid monitoring protocols for poorly sampled species, such as vocalization playbacks at night to survey owls or aerial surveys of hawk nests, to compare with BBS surveys or field guide assessments to determine if undersampled species had been placed in the correct category.

The Committee believes that population trends are an important component of a prioritization process but should not be the sole focus of a ranking system. A demonstrated long-term negative population trend often is a more reliable cue that a species is in trouble than is information on known or theoretical threats. A species may decline precipitously from an unknown or unimagined reason, such as an introduced disease, subtle changes in land use, or ingesting lead bullets (Snyder and Snyder 1989). For example, the influence of Brown-headed Cowbirds (*Molothrus ater*) may have been exaggerated as a threat to many species (Morrison et al. 1999). Nevertheless, although population trends can be indicators of significant conservation problems (e.g. widespread habitat loss), they may also be a result of changing land-use practices that affect plant community succession (Askins 1997). Such successional changes may simply represent populations returning to their more "normal" levels of abundance (e.g. early successional species in New England). On the other hand, some species like Black-capped Vireo (*Vireo atricapillus*), Kirtland's Warbler (*Dendroica kirtlandii*), and Swainson's Warbler (*Limnothlypis swainsonii*) inhabit successional vegetation that is no longer subjected to natural disturbance patterns needed to reverse succession and may be among the most threatened species.

### 3. Are Additional Variables Required for the Ranking Scheme?

Some factors are not explicit in the PIF scheme. Nesting success, demography, and edge effects, for example, have no specific categories. These factors, however, are implicit in the "Threats to Breeding" variable, which estimates the capacity of an area to maintain "healthy populations of a species" in the future. "Threats to Breeding" specifically uses the term "condition," which is meant to include both habitat and other factors such as "cowbird parasitism, pesticides, recreation, predation, etc." Because such factors often are strongly associated with habitat fragmentation, and fragmentation effects are most extreme when only small proportions of original habitat remain, this variable probably does a reasonable job of incorporating the threats associated with fragmentation. Cowbird parasitism is considered when interaction with host species is a recent phenomenon.

The PIF scheme gives no extra priority to species that are sole representatives of phylogenetic taxa, or to highly diverse clades that are active fronts of speciation and evolution. For example, a "phylogenetic uniqueness" variable might be coded as (1) any species not in one of the following categories; (2) <5 members in the genus but >5 members in the family; (3) monotypic genus with >5 members in the family; (4) <5 members in the family; or (5) the only member of a family.

Should phylogenetic uniqueness be included in the scheme? Arguably, phylogenetically lone representatives of families, such as the Limpkin (*Aramus guarauna*), represent unique lineages and should be a higher priority than races of geographically widespread species or species that are members of diverse genera. Incorporating a "phylogenetic uniqueness" variable would add an evolutionary component to the PIF prioritization process. Nevertheless, the addition of such a category could be problematic because new methods in phylogenetic analyses are changing classifications rapidly, current phylogenies are unstable, and geographically isolated subspecies of widespread species also may be of profound importance in evolution. *For these reasons, the Committee does not recommend a particular scheme but urges PIF to enlist the expertise of avian systematists to develop a phylogenetic uniqueness category that suits its needs.*

Should the potential role of some birds as "keystone species" be formally designated as a variable? Some species may be vital to ecosystem health (e.g. as consumers of insect larvae), and others may be essential to maintain species richness within communities (e.g. primary cavity nesters). Currently, no extra weight is given to such species, which must be relatively abundant to fulfill their roles as keystone species. The Committee, however, agreed that our understanding of the "keystone" status of most species is difficult to determine (Mills et al. 1993, Power et al. 1996) given the current understanding of community and ecosystem ecology of birds. Such a category potentially is exciting, however, because it forms the core of one tenet of the PIF process, viz. the goal of keeping species abundant so that they can continue to play whatever role they play in communities and ecosystems. Perhaps future PIF schemes could investigate this category, which should also become a focus of PIF-sponsored research.

The authors of the PIF ranking scheme recognize the importance of uncertainty of data or information in the scheme by use of uncertainty variables. Uncertainty variables do not contribute to the total priority score but are important in that they rate the degree of certainty with which some of the priority variables were scored. However, uncertainty scores are only incorporated in the quantitative and qualitative scoring of "Population Trend." In the past, PIF also used uncertainty scores for the "Threats to Breeding" and "Threats to Nonbreeding" variables, but apparently they were rarely used and caused confusion.

The use of uncertainty scores can be valuable, especially if species whose scores have low confidence are not treated as measures of extinction risk. In the only PIF variable where uncertainty is incorporated (Population Trend), the highest uncertainty values are given an intermediate score of 3. *The Committee believes that a separate overall uncertainty variable would be helpful in assessing confidence in species' ranks and would assist in identifying research needs. Furthermore, we suggest that PIF should investigate the effects of differences in ranks assigned to a species by developing confidence intervals for the most important variables.*

### 4. Are the Rankings Repeatable?

Clearly, rankings must be as repeatable as possible if the PIF scheme is to be as maximally useful. For this reason, it is important to minimize ambiguous definitions and the use of ambiguous data. The two "threats" variables are the most complex and are likely to be the least repeatable. Uncertainty scores might help managers evaluate this category, as would clear references indicating the sources used to reach each ranking on a species-by-category basis. Such references would speak directly to the repeatability of rankings and would help to focus research and monitoring efforts. Committees are more useful for evaluating heterogeneous information than are "lone experts," which suggests that the PIF general approach of assigning ranks is reasonable. Nevertheless, the scientific defensibility of the PIF prioritization process depends on demonstrating through rigorous tests that the ranks are repeatable, which has not been done. *Thus, the Committee believes that the general approach to ranking taken by PIF should lend itself to good repeatability of ranks but recommends conducting rigorous analyses of the methods used to score variables and produce ranks, revising the two threats variables, and adding better documentation for rank assignments.*

## How Should Results of the Prioritization Process be Interpreted for Conservation Planning?

*Although the Committee believes that the PIF process for prioritizing species is fundamentally sound, the Committee has made a number of specific recommendations above that should be addressed before results from the ranking scheme are finalized for conservation planning. More important, the Committee has a number of concerns about how the PIF scores should be used in making conservation decisions.* Partners in Flight gave no clear indication of how prioritization scores would be used for constructing bird conservation plans in the documents that the Committee reviewed. The accompanying article (Carter et al. 2000) suggests that users of the PIF Species Prioritization Process who are making bird conservation and land management decisions can sort by a single priority score or use more than one score. In addition, PIF suggests that the seven priority scores can be summed to obtain a total conservation priority score. Although PIF recognizes that this sum can be misleading, it provides users with this value and superficially discusses how it might be interpreted.

Summing the scores for setting conservation priorities would rely strongly on a linear ranking scheme. Linear ranking schemes commonly have been used for assessing relative extinction risk among species (e.g. Millsap et al. 1990, Hansen et al. 1993, Reed 1995). The procedure is very similar to that used in the PIF scheme and involves (1) listing variables thought to be related to the probability of extinction, (2) designating criteria for assigning a numeric value to each level of each variable, (3) assigning a value for each variable to each species, and (4) adding the numeric values across each variable to yield a total value for each species. The total scores are treated as if they bear a ranked relationship to the probability of extinction. Linear ranking schemes are appealing because variables can be easily defined, and the approach yields quantitative results with superficially unambiguous implications for management priorities.

Linear ranking schemes, however, have a number of shortcomings (Given and Norton 1993, Taylor 1995). Knowledge of species and factors that affect the risk of extinction is incomplete, and data often are inadequate for properly assigning risk values. As a consequence, it is not clear which variables should be used and whether all of them should be weighted equally when developing a ranking scheme. In addition, unintentional weighting can occur because of multicolinearity (or correlations) among variables. For example, range size and population size frequently are not independent (Bock and Ricklefs 1983, Kattan 1992, Gaston et al. 1998).

To consider this point more carefully, the Committee analyzed PIF rankings for the birds of New York. Results show that strong correlations exist among five of the six PIF variables considered (Table 1). Only "Population Trend" showed little correlation with the other variables. Very strong correlations were found between "Threats to Breeding" and "Threats to Nonbreeding," between "Breeding Distribution" and "Nonbreeding Distribution," and between "Relative Abundance" and "Threats to Nonbreeding and "Threats to Breeding" (Table 1).

This analysis shows that there is strong nonindependence among most PIF priority variables, which complicates interpretation of a summed score. Correlations among variables

TABLE 1. Spearman rank correlations among PIF priority variables for 225 species of birds of New York State.

| PIF variable name | RA | BD | NB | TN | TB | PT |
|---|---|---|---|---|---|---|
| Relative abundance (RA) | — | | | | | |
| Breeding distribution (BD) | 0.33** | — | | | | |
| Nonbreeding distribution (NB) | 0.23** | 0.64** | — | | | |
| Threats to nonbreeding (TN) | 0.52** | 0.41** | 0.47** | — | | |
| Threats to breeding (TB) | 0.50** | 0.31** | 0.32** | 0.70** | — | |
| Population trend (PT) | 0.07 | 0.04 | 0.02 | 0.14* | 0.28 | — |

* $P < 0.05$; ** $P < 0.001$.

can cause two problems. The first is a statistical correlation, which can affect statistical analyses primarily by reducing the stability of parameter estimates. Errors become exacerbated beyond the simple problem of multicolinearity because the amount of multicolinearity among variables changes among species, so the weighting caused by correlation between variables varies among species. The second is biological correlation, as discussed above in the example of nonindependence of range and population size. Both kinds of correlations can cause problems in linear ranking schemes. Nonindependence is not a problem if the variables are considered separately when assessing risk.

Finally, a lack of knowledge often exists about the relative relationships between different scores for each variable and the probability of extinction. This last point requires clarification. When one assigns a value to a variable for a species, two things are presumed if a linear rank among species from the summed variables is the goal. First, the same value for the same variable for two different species must have the same relationship to the probability of extinction. For example, if a Bald Eagle (*Haliaeetus leucocephalus*) and an American Kestrel (*Falco sparverius*) each receive a value of 4 for abundance, they must have similar probabilities of going extinct as a result of abundance. Second, the same value for two different variables for the same or for different species must have the same relationship to the probability of extinction. If these criteria are not met, the values cannot be validly added among variables or compared among species.

*As an alternative to linear ranking, the Committee suggests that the scores for each variable in the PIF scheme be used to place species into a category related to conservation priority.* In a categorical scheme, species are grouped by different criteria into a particular category. Categorical methods for assessing extinction risk exist (Rabinowitz et al. 1986, Reed 1992), the best-known scheme being that of the World Union for the Conservation of Nature or IUCN (Master 1991, Collar et al. 1994). Good categorical schemes provide clear definitions of what the categories mean and how they are related to the risk of extinction. Although categorical schemes have been criticized as being too vague (Given and Norton 1993), they avoid the problems of linear schemes. When variables are considered separately in categorizing risk, a close correlation between variables is not a problem because variables represent different ways a species might be of conservation concern. Categorical methods seemed to be what PIF had intended when discussing how the PIF priority scores could be sorted and weighted for interpretation (Carter et al. 2000).

The Committee developed a set of categories to provide an example of how to explore this approach with the PIF prioritization variables (Table 2). We devised six categories of conservation concern based on combinations of PIF variables. We then assessed this approach on the PIF database for New York by inspecting the species lists and comparing our category ranks with the total (summed) scores. The six categories were ranked from highest (5) to lowest (0) priority (see Table 2). "Threatened and Endangered Species" (5) are federally listed or are listed by the state or region of concern. These species have already been identified as being of management concern before any prioritization procedure has been applied. Although they are important to any conservation strategy, they are not the primary concern of the PIF process. "Species of High Concern" (4) have populations that are declining rapidly, have a small range, or face a high degree of threat. "Species of Moderate Concern" (3) have populations that are declining and experiencing moderate threats, or population trends are not known

TABLE 2. Example of a categorical ranking scheme that would be applied to North American birds using the PIF prioritization variables. Ranks are provided for categories of abundance for species with different attributes that fulfill any of the decision criteria.

| Rank | Category | Species attributes | Decision criteria[a] |
|---|---|---|---|
| 5 | Threatened and endangered species | All federally listed species and species of local concern | Federal or state listed species |
| 4 | Species of high concern | Populations are declining rapidly, have a small range, or high threats | a. PT = 4 or 5 and either RA, BD, TB, or TN = 4 or 5<br>b. RA = 5<br>c. RA = 4 and either BD or NBD = 4 or 5<br>d. AI = 5 and RA > 3 |
| 3 | Species of moderate concern | Populations are declining and experience moderate threats, or population trends are not known and threats are high | a. PT = 4 or 5 and RA, BD, ND, TN, or TB = 3<br>b. PT = 3 and RA, BD, ND, TN, or TB = 4 or 5<br>c. RA = 3 and BD or ND = 3, 4, or 5<br>d. RA = 4 and BD and ND < 4<br>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<br>b. PT = 2 and RA, BD, ND, TN, or TB = 4 or 5<br>c. RA = 3<br>d. AI = 3 |
| 1 | Species not at risk | All remaining native species | All remaining native species |
| 0 | Introduced species | Species are not native to North America | Non-native species or distinct populations |

[a] PT = Population Trend, RA = Relative Abundance, BD = Breeding Distribution, NB = Nonbreeding Distribution, TB = Threats to Breeding, TN = Threats to Nonbreeding, and AI = Area Importance.

and threats are high. "Species of Low Concern" (2) have populations that are relatively common and need to be kept common. "Species Not at Risk" (1) include all native species that are not listed in categories 2 to 5 above. Finally, "Introduced Species" (0) are not native to North America, or they occur as disjunct populations that resulted from translocation by humans. Conservation plans should discourage these species unless they serve a special management goal, such as hunting.

The Committee determined the categorical rankings for each species in the New York database. The ranking yielded 5 Threatened and Endangered Species, 13 Species of High Concern, 64 Species of Moderate Concern, 89 Species of Low Concern, 47 Species Not at Risk, and 7 Introduced Species. Additional categories could be developed if smaller groupings of species are desired. Inspection of the rankings indicated a good but incomplete match between the category scores and the PIF total scores ($r_s = 0.76$, $P < 0.0001$). The Committee believes that PIF would benefit from considering a categorical scheme and urges PIF to use its considerable resources to explore this approach in more detail.

*The Committee also recommends that PIF should take the responsibility for developing a clear method for using the PIF Priority scores that is subject to scientific review in the same manner that the prioritization scheme was reviewed.* Currently, the task of interpreting the priority ranks has been initiated by a new PIF process or is left in the hands of managers, policy makers, and others (Carter et al. 2000). Although the Committee endorses the idea of PIF taking the lead in this effort and in putting good science into the hands of local interests to use in a manner that they see fit, the current situation could lead to misinterpretation and misuse of the PIF rankings. PIF should seek additional scientific input on how the prioritization categories or scores should be used for making conservation policy. Part of the power of a ranking system may lie in progressing beyond lists of species at risk to using it to identify degraded habitats and ecoregions (e.g. Noss et al. 1995, Beissinger et al. 1996) or to recognize prominent threats that affect groups of species. It is the responsibility of PIF to produce the best science it can for its members and cooperators. *Finally, ranks assigned to each species should be periodically reviewed every three to five years to keep the information up-to-date.*

## Summary of Committee Findings and Recommendations

The Committee has either found or recommended that:

1. A thoughtfully constructed scheme that ranks the relative susceptibility of birds to extinction and large-scale declines can play a useful and important role in prioritizing conservation efforts if it is periodically evaluated and continually improved;
2. The general structure of the PIF approach is sound, and the need exists for a prioritization scheme that considers both local and global threats;
3. Developing a ranking scheme for species within the United States is highly appropriate;
4. Extending the PIF ranking scheme south of the United States border is problematic;
5. Exotic and introduced species should be given a rank of zero or placed in a separate category, because their relative risks of extinction typically are not conservation concerns;
6. All variables included in the PIF prioritization scheme are important and appropriate for ranking the susceptibility of birds in the United States;
7. Careful consideration should be given to revising the "Threats to Breeding" and "Threats to Nonbreeding" variables;
8. A prioritization scheme with a mix of quantitative and qualitative ranks could result in unpredictable bias, and we urge PIF to conduct analyses to investigate such biases;
9. The expertise of avian systematists should be enlisted to investigate the utility of a phylogenetic uniqueness category;
10. A separate overall uncertainty variable would be helpful in assessing confidence in species' ranks and would assist in identifying research needs;
11. PIF should investigate the effects of differences in ranks assigned to a species by developing confidence intervals for the most important variables;
12. The PIF prioritization scheme appears to lend itself to good repeatability of ranks, but PIF should conduct rigorous analyses of the methods used to score variables and pro-

duce ranks, and they should provide better documentation for rank assignments;
13. PIF should develop a clear method for using the results of the prioritization process, and the method should be subjected to scientific review;
14. The scores for each variable in the PIF prioritization scheme should be used to place species into a category related to its conservation priority instead of being summed to yield a total score; and
15. PIF should review the ranks assigned to each species every three to five years to keep the information up-to-date.


## ACKNOWLEDGMENTS

The Committee thanks Robert Askins, Mike Carter, Jane Fitzgerald, Frank Gill, Chuck Hunter, Jeffrey Kelly, Vincent Muehter, David Pashley, Terry Rich, Ken Rosenberg, and Jeff Walters for helpful reviews of this report. Erica Dunn kindly provided unpublished papers. Vincent Muehter gave invaluable assistance in all phases of this work. The National Audubon Society and the American Ornithologists' Union supported committee expenses in production of the report.


## LITERATURE CITED


ANONYMOUS. 1971. Announcing The blue list: An "early warning system" for birds. American Birds 25:948–949.

ARBIB, R. 1976. The blue list for 1976. American Birds 29:1067–1072.

ASKINS, R. A. 1997. History of grasslands in the northeastern United States: Implications for bird conservation. Pages 119–136 *in* Grasslands of northeastern North America (P. D. Vickery and P. W. Dunwiddle, Eds.). Massachusetts Audubon Society, Lincoln, Massachusetts.

BEISSINGER, S. R., E. C. STEADMAN, T. WOHLGENANT, G. BLATE, AND S. ZACK. 1996. Null models for assessing ecosystem conservation priorities: Threatened birds as titers of threatened ecosystems. Conservation Biology 10:1343–1352.

BEISSINGER, S. R., AND M. I. WESTPHAL. 1998. On the use of demographic models of population viability in endangered species management. Journal of Wildlife Management 62:821–841.

BISHOP, R. C. 1978. Endangered species and uncertainty: The economics of the safe minimum standard. American Journal of Agricultural Economics 60:10–18.

BOCK, C. E., AND R. E. RICKLEFS. 1983. Range size and local abundance of some North American songbirds: A positive correlation. American Naturalist 122:295–299.

BURKE, R. L., AND S. R. HUMPHREY. 1987. Rarity as a criterion for endangerment in Florida's fauna. Oryx 21:97–102.

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.

COLLAR, N. J., M. J. CROSBY, AND A. J. STATTERSFIELD. 1994. Birds to watch 2: The world list of threatened birds. BirdLife Conservation Series No. 4, BirdLife International, Cambridge, United Kingdom.

DUNN, E. H., D. J. T. HUSSELL, AND D. A. WELSH. 1999. Priority-setting tool applied to Canada's landbirds based on concern and responsibility for species. Conservation Biology 13:1404–1415.

DUNN, J. J., AND K. L. GARRETT. 1997. A field guide to the warblers of North America. Houghton Mifflin, Boston, Massachusetts.

FAITH, D. P. 1992. Conservation evaluation and phylogenetic diversity. Biological Conservation 61: 1–10.

FLATHER, C. H., M. S. KNOWLES, AND I. A. KENDALL. 1998. Threatened and endangered species geography. BioScience 48:365–376.

FOREY, P. L., C. J. HUMPHRIES, AND R. I. VANE-WRIGHT (Eds.). 1994. Systematics and conservation evaluation. Clarendon Press, Oxford.

GASTON, K. J., T. M. BLACKBURN, AND R. D. GREGORY. 1998. Interspecific differences in intraspecific abundance-range size relationships of British breeding birds. Ecography 21:149–158.

GIVEN, D. R., AND D. A. NORTON. 1993. A multivariate approach to assessing threat and for priority setting in threatened species conservation. Biological Conservation 64:57–66.

HANSEN, A. J., S. L. GARMAN, B. MARKS, AND D. L. URVAN. 1993. An approach for managing vertebrate diversity across multiple-use landscapes. Ecological Applications 3:481–496.

HOWE, H. F. 1986. Seed dispersal by fruit-eating birds and mammals. Pages 123–190 *in* Seed dispersal (D. R. Murray, Ed.). Academic Press, Sydney, Australia.

HUNTER, W. C., M. F. CARTER, D. N. PASHLEY, AND K. BARKER. 1993. The 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.). United States Forest Service General Technical Report RM-229.

HUNTER, W. C., R. D. OHMART, AND B. W. ANDERSON. 1987. Status of breeding riparian-obligate birds in southwestern riverine systems. Western Birds 18:10–18.

INGOLD, D. J. 1994. Influence of nest-site competition between European Starlings and woodpeckers. Wilson Bulletin 106:227–241.

KATTAN, G. H. 1992. Rarity and vulnerability: The birds of the cordillera central Columbia. Conservation Biology 6:64–70.

KIRK, D. A., M. D. EVENDEN, AND P. MINEAU. 1996. Past and current attempts to evaluate the role of birds as predators of insect pests in temperature agriculture. Current Ornithology 13:176–269.

LANDE, R. 1993. Risk of population extinction from demographic and environmental stochasticity and random catastrophes. American Naturalist 142:911–927.

MAGUIRE, L. A., U. S. SEAL, AND P. F. BRUSSARD. 1987. Managing critically endangered species: The Sumatran rhino as a case study. Pages 141–158 *in* Viable populations for conservation (M. E. Soulé, Ed.). Cambridge University Press, Cambridge, United Kingdom.

MASTER, L. 1991. Assessing threats and setting priorities for conservation. Conservation Biology 5: 559–563.

MILLS, L. S., M. E. SOULÉ, AND D. F. DOAK. 1993. The keystone species concept in ecology and conservation. BioScience 43:219–224.

MILLSAP, B. A., J. A. GORE, D. E. RUNDE, AND S. I. CERULEAN. 1990. Setting priorities for conservation of fish and wildlife species in Florida. Wildlife Monographs No. 111.

MORRISON, M. L., L. S. HALL, S. I. ROTHSTEIN, D. C. HAHN, AND S. K. ROBINSON (Eds.). 1999. Ecology and management of cowbirds in eastern and western landscapes. Studies in Avian Biology No. 18.

MUEHTER, V. R. (Ed.). 1998. WatchList website, version 97.12. National Audubon Society, New York. <http://www.audubon.org/bird/watch/>

NORTON, B. G. 1994. On what we should save: The role of culture in determining conservation targets. Pages 23–40 *in* Systematics and conservation evaluation (P. L. Forey, C. J. Humphries, and R. I. Vane-Wright, Eds.). Clarendon Press, Oxford.

NOSS, R. F., E. T. LAROE III, AND J. M. SCOTT. 1995. Endangered ecosystems of the United States: A preliminary assessment of loss and degradation. National Biological Service Biological Report No. 28, Washington, D.C.

PIMM, S. L., H. L. JONES, AND J. DIAMOND. 1988. On the risk of extinction. American Naturalist 132: 757–785.

POWER, M. E., D. TILMAN, J. A. ESTES, B. A. MENGE, W. J. BOND, L. S. MILLS, G. DAILY, J. C. CASTILLA, J. LUBCHENCO, AND R. T. PAINE. 1996. Challenges in the quest for keystones: Identifying keystone species is difficult-but essential to understanding how loss of species with affect ecosystems. BioScience 46:609–620.

RABINOWITZ, D., S. CAIRNS, AND T. DILLON. 1986. Seven forms of rarity and their frequency in the flora of the British Isles. Pages 182–204 *in* Conservation biology: The science of scarcity and diversity (M. E. Soulé, Ed.). Sinauer Associates, Sunderland, Massachusetts.

REED, J. M. 1992. A system for ranking conservation priorities for Neotropical migrant birds based on relative susceptibility to extinction. Pages 524–536 *in* Ecology and conservation of Neotropical migrant landbirds (J. M. Hagan III and D. W. Johnson, Eds.). Smithsonian Institution Press, Washington, D.C.

REED, J. M. 1995. Relative vulnerability to extirpation of montane breeding birds in the Great Basin. Great Basin Naturalist 55:342–351.

ROBBINS, C. S., D. BYSTRAK, AND P. H. GEISSLER. 1986. The Breeding Bird Survey: Its first fifteen years, 1965–1979. United States Fish and Wildlife Service Resource Publication No. 57.

SHAFFER, M. 1987. Minimum viable populations: Coping with uncertainty. Pages 59–68 *in* Viable populations for conservation (M. E. Soulé, Ed.). Cambridge University Press, Cambridge, United Kingdom.

SNYDER, N. F. R., AND H. A. SNYDER. 1989. Biology and conservation of the California Condor. Current Ornithology 6:175–267.

TAYLOR, B. 1995. The reliability of using population viability analysis for risk classification of species. Conservation Biology 9:551–558.

USDI. 1994. Report to Congress: Recovery program for endangered and threatened species. United States Department of the Interior, Washington, D.C.

VANE-WRIGHT, R. I., C. J. HUMPHRIES, AND C. H. WILLIAMS. 1991. What to protect? Systematics and the agony of choice. Biological Conservation 55:235–254.

WILCOVE, D. S., D. ROTHSTEIN, J. DUBOW, A. PHILLIPS, AND E. LOSOS. 1998. Quantifying threats to imperiled species in the United States. BioScience 48:607–615.