Using Decline in Bird Populations to Identify Needs for Conservation Action

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Abstract: *A large decline in population size is sometimes considered sufficient indication that a species merits conservation interest. One organization categorizes as critically endangered any species whose populations decline by 80% over 10 years, whereas others assign importance to species declining 50% over 25 years. Using these and additional conservation-alert categories, I determined how many of over 200 bird species that breed in Canada qualified for each category, based on population trends from the North American Breeding Bird Survey. The majority of qualifying species were not candidates for immediate intervention to halt or reverse declines. Moreover, species assigned to alert categories based on 5- and 10-year trends for past time periods frequently had positive trends in the subsequent decade. Results indicate that population decline should not be used to identify species at risk or as a basis for conservation action without detailed evaluation of the trend data and other characteristics of the species. However, assigning species to alert categories is a useful step in identifying species that may deserve conservation attention of some kind (including better monitoring and research as well as direct intervention). Evaluation of trend quality and persistence is an important step in determining the most appropriate action. Deciding when to recommend intervention will be the most problematic for species that are still relatively common and widespread, and there is a need for development of species-specific population thresholds that would be appropriate for triggering such action.*

Utilización de la Declinación de Poblaciones de Aves para Identificar Necesidades de Acciones de Conservación

Resumen: *Una declinación severa en el tamaño poblaciónal a veres es considerada razón suficiente para que una especie amerite interés de conservación. Una organización categoriza como críticamente en peligro a cualquier especie cuyas poblaciones declinan el 80% en 10 años, mientras que otras asignan importancia a especies que declinan el 50% en 25 años. Utilizando ésta y otras categorías de alerta de conservación, determiné cuantas de más de 200 especies de aves que reproducen en Canadá se podrían incluir en esa categoría, con base en las tendencias poblacionales del North American Breeding Bird Survey. La mayoría de las especies que calificaron no eran candidatas a una intervención inmediata para detener o revertir las declinaciones. Más aun, las especies asignadas anteriormente a categorías de alerta con base en tendencias de 5- y 10- años frecuentemente tenían tendencias positivas en la siguiente década. Los resultados indican que la población no debe ser utilizada para identificar especies en riesgo ni como base para acciones de conservación sin una evaluación detallada de las tendencias de los datos y otras características de las especie. Sin embargo, la asignación de especies a categorías de alerta es un paso útil para la identificación de especies que puede merecer atención de conservación de algún tipo (incluyendo un mejor monitoreo e investigación así como intervención directa). La evaluación de la tendencia de calidad y persistencia es un paso importante para decidir que acción es apropiada. La decisión de cuando recomendar intervención será la más problemática para especies que a ún son relativamente comunes y ampliamente distribuidas, y existe la necesidad de desarrollar umbrales poblacionales especie-específicos que serían apropiados para dar inicio a tal acción.*

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Introduction

Population trends are often used to help identify species of conservation interest (e.g., Robbins et al. 1989; Askins 1993; Siriwardena et al.1998). In this process, it is important to establish how much decline over what time period should signal concern and at what point we should shift from continued monitoring to some other kind of action. Initiating action too soon could lead to wasteful effort where it is not actually needed and could erode public confidence in the validity of conservation alerts. On the other hand, waiting too long to act can ultimately make it more difficult and costly to intervene.

Several conservation organizations use population decline alone as a criterion for determining whether species need conservation attention. For example, the World Conservation Union (IUCN) considers a taxon critically endangered if it declines 80% globally over a 10-year period (or three generations, whichever is longer), endangered if it declines 50–79%, and vulnerable if it declines 20–49% (http://www.iucn.org/themes/ssc/redlists/criteria.htm). The British Red List for birds (Batten et al. 1990) has been updated by the Royal Society for the Protection of Birds (RSPB) based on revised criteria that specify that a 50% national decline over 25 years is sufficient reason for red-listing ("demonstrably threatened nationally or internationally") and a 25% decline over the same period is enough for amber-listing ("moderate" decline; Gibbons et al. 1996). The British Trust for Ornithology (BTO) has proposed conservation-alert levels that incorporate both short- and long-term declines in Britain (the latter equivalent to the levels for RSPB's red and amber listings). The BTO system also considers projected future trends (Table 1; Marchant et al. 1997). Many other groups, however, such as North America's Partners in Flight (http://www.partnersinflight.org/), advocate using population trend to identify species of conservation interest only in combination with additional criteria, such as breadth of range, abundance, and threats (Beissinger et al. 2000; Carter et al. 2000).

My goal was to evaluate the use of population trend as a sole criterion for assigning species to conservation-alert categories and as a means of identifying what conservation action is most appropriate. I used data from the Breeding Bird Survey (BBS) as the basis for assigning Canadian breeding species to IUCN endangerment categories and to BTO alert levels and to test whether assignments based on short-term trends would be good predictors of assignment in future decades.

Methods

I compiled BBS trends for the 253 species for which there were sufficient data to calculate trends for Canadian populations over the 25-year period from 1974 to 1998. Because BBS trends are not calculated unless the species has been recorded on at least 15 routes, the species used in analyses were necessarily common and widespread.

The BBS is a continent-wide, road-side survey with stratified random sampling on which 50 3-minute point counts are conducted on 1 day each year along a 39.5-km route (Sauer et al. 2001). Data are collected from close to 450 routes annually in Canada and from about 3000 in North America as a whole. For the majority of North American landbirds, BBS is considered the most reliable source of population trends available (O'Connor et al. 2000). Analyses followed standard procedures (Link & Sauer 1994) except for a few differences routinely used in Canadian Wildlife Service analyses (chiefly different-sized units used for area-weighting; Dunn et al. 2000).

I assigned species to BTO alert levels and IUCN endangerment categories to learn how those systems would perform in identifying species requiring conservation attention. The IUCN criteria are based on global rather than national population decline, so I selected all species in the original group of 253 whose breeding range is essentially confined to North America (206 in total) and assigned species to IUCN categories on the basis of

Table 1. British Trust for Ornithology (BTO) alert levels (Marchant et al. 1997).[a]

	Time period for trend (years)			
Alert level	*25*	*10*	*5*	*1*
Level 1: % past change	−50	−50	−50	−50
	(−2.73)	(−6.70)	(−12.94)	(−50.0)
Level 2: % past change	−25	−25	−25	−25
	(−1.14)	(−2.84)	(−5.59)	(−25.0)
Level 3: % change in next 25 years[b]	—	−50	−50	—
	—	(−2.73)	(−2.73)	—
Level 4: % change in next 25 years[b]	—	−25	−25	—
	—	(−1.14)	(−1.14)	—

[a] *In parentheses is the annual percent change in population size (t) required to attain the BTO-defined level of total percent change in population size (p) over a given number of years (n), calculated as follows:* $t = [(p/100 + 1)^{1/n} - 1]100$.
[b] *Percent change that will occur over the next 25 years if the 5- or 10-year trend immediately prior to now (the figure in parentheses) continues.*

range-wide BBS trends for 1989–1998 (Sauer et al. 2001). I assigned species to BTO alert levels based on 10-year (1989–1998) and 25-year (1974–1998) trends for Canadian breeding populations.

I also used BBS trends for Canadian populations to test the likelihood that assignment to an alert level would predict assignment in a future period. I assigned species to the highest applicable BTO alert level based on population trends during each of four "predictive" periods (either 5 or 10 years in length) and for the 10-year periods immediately following them. (The BBS has not been in place long enough to test 25-year trends as predictors.) I then compared alert levels in each predictive period with levels in the following 10-year period. Data were not independent for the overlapping 5- and 10-year predictive periods, but I included both periods to determine whether the two performed very differently in predicting future trends.

For each comparison between time periods, I calculated the proportion of species with a positive population trend in the predictive period which was assigned to an alert level in the following decade. Similarly, I calculated the proportion of species that was assigned to alert levels in the predictive period but whose population trends were positive in the following decade. This procedure excluded species that qualified for an alert category in only one period but whose trend may have changed only slightly. Species were omitted if they lacked data from at least 15 BBS routes in each of the time periods being compared.

Throughout, I included all species regardless of trend significance. I also looked separately at those with statistically significant trends (defined here as trends with $p < 0.15$; Dunn et al. 2000).

Results

Of the 206 species considered whose breeding range is also confined to North America, 41 showed global population decreases in 1989–1998 that were large enough to qualify them for the IUCN categories of endangered or vulnerable (Table 2). Most of these had statistically significant trends.

Of the 253 species with Canadian BBS trends, about half qualified for BTO alert levels (Table 3). Of those qualifying, over half did so at level 1 (see Table 1 for definition), and 84% were in levels 1 and 2 combined. Twenty percent of the species qualified for an alert level on the basis of a statistically significant trend, with 76% of those qualifying at level 1.

Assignment of a species to a BTO alert level based on a 5- or 10-year trend was not very effective in predicting continued decline in the following decade (all species; Table 4). Of the species qualifying for an alert level in predictive periods, one-third to over one-half had positive trends in the following decade. There was little difference in these results when they were calculated separately for species assigned alert levels 1, 2, or 3 in the predictive period. That is, a species at alert level 1 was about as likely as a species at alert level 3 to show a positive trend in the following decade. Species at level 4 were somewhat more likely to show improved status in the next decade, but a relatively low proportion of species fell into this category (similar to the proportion in

Table 2. North American species with global population declines that qualify for conservation status according to the World Conservation Union (IUCN).[a]

Endangered (decline of 50–79% over 10 years)
*American Woodcock, *Scolopax minor*
*Black-billed Cuckoo, *Cypseloides niger*
*Blackpoll Warbler, *Dendroica striata*
*Rusty Blackbird, *Euphagus carolinus*
Vulnerable (decline of 25–49% over 10 years)
American White Pelican, *Pelecanus erythrorhynchos*
*Green-backed Heron, *Butorides virescens*
*Swainson's Hawk, *Buteo swainsoni*
*American Kestrel, *Falco sparverius*
American Avocet, *Recurvirostra americana*
Lesser Yellowlegs, *Tringa flavipes*
*Upland Sandpiper, *Bartramia longicauda*
*Band-tailed Pigeon, *Columba fasciata*[b]
*Common Nighthawk, *Chordeiles minor*
*Whip-poor-will, *Caprimulgus vociferus*
Black Swift, *Cypseloides niger*[b]
*Chimney Swift, *Chaetura pelagica*
Vaux's Swift, *Chaetura vauxi*
Red-breasted Sapsucker, *Sphyrapicus ruber*
Black-backed Woodpecker, *Picoides arcticus*
*Northern Flicker, *Colaptes auratus*
*Olive-sided Flycatcher, *Contopus cooperi*
*Western Wood-Pewee, *Contopus sordidulus*
*Eastern Kingbird, *Tyrannus tyrannus*
*Loggerhead Shrike, *Lanius ludovicianus*
*Mountain Chickadee, *Poecile gambeli*
*Golden-crowned Kinglet, *Regulus satrapa*
*Red-breasted Nuthatch, *Sitta canadensis*
Sprague's Pipit, *Anthus spragueii*[b]
*Orange-crowned Warbler, *Contopus sordidulus*
Cape May Warbler, *Contopus sordidulus*
Black-throated Gray Warbler, *Dendroica nigrescens*
Wilson's Warbler, *Wilsonia pusilla*
*Field Sparrow, Spizella pusilla
*Lark Sparrow, *Chondestes grammacus*
*Baird's Sparrow, *Ammodramus bairdii*[b]
*Dark-eyed Junco, *Junco hyemalis*
*Bobolink, *Dolichonyx oryzivorus*
*Eastern Meadowlark, *Sturnella magna*
*Purple Finch, *Carpodacus purpureus*
*Cassin's Finch, *Carpodacus cassinii*
*Evening Grosbeak, *Coccothraustes vespertinus*

[a]*Species for which Canadian Breeding Bird Survey (BBS) trends could be calculated and whose breeding ranges are confined to North America. IUCN status was assigned on the basis of survey-wide BBS trend for 1989-1998. Asterisks indicate statistically significant trends.*
[b]*Species on the Audubon WatchList (http://www.audubon.org/bird/watch/index.html).*

Table 3. Percentage of Canadian breeding species qualifying for British Trust for Ornithology (BTO) alert levels, based on 25- and 10-year trends ending in 1998.*

BTO alert level	*All species (253 total)*	*Species with significant trends (81 total)*
No alert	50	13
1 : 50+% decline over past 25 (or 10) years	27	15
2 : 25–49% decline over past 25 (or 10) years	15	4
3 : 50+% decline projected over next 25 years (based on trend for past 10 years)	3	0
4 : 25–49% decline projected over next 25 years (based on trend for past 10 years)	5	1

**Twenty-five year trends were used to identify species qualifying for alert levels 1 and 2. Ten- year trends were then screened to identify additional species that would qualify at those levels, and at levels 3 and 4, on the basis of shorter-term trends (see Table 1).*

Table 3). Similarly, of the species with positive trends in the predictive period, about one-third to one-half qualified for an alert level in the next 10-year period (Table 4). Results were more variable when analyses were limited to species whose trends in the predictive periods were statistically significant, because sample sizes were small and species that qualified for an alert level based on a statistically significant 10-year decline were less likely to shift to positive trends than were species qualifying on the basis of a significant 5-year decline. For most comparisons, however, the chances of a major change in status remained high even when trends in the predictive period were significant.

Discussion

Few of the species whose population declines were serious enough to qualify for IUCN endangerment categories or BTO alert levels are at risk of extinction or extirpation. As evidence of this, only 4 of the 41 species with declines large enough to qualify for IUCN status (Table 2) appear on the Audubon Society WatchList (http://www.audubon.org/bird/watch/index.html). The WatchList has some limitations (Beissinger et al. 2000), but it does include all species that are highly at risk. The list of species assigned to BTO alert levels on the basis of 25-year declines in Canadian breeding populations also contained few that are thought to be of high conservation concern. Considering only those species with significant declines, 31 decreased by 50% or more and 8 decreased 25–49%, but only 5 of these 39 species are on the Audubon WatchList.

It is hardly surprising that few of the species assigned to alert categories are considered to be immediately at risk, because assignments were made on the basis of BBS trends, and these can be calculated only for species that are reasonably common and widespread. Nonetheless, this result illustrates the need to consider criteria in addition to population decline in order to identify species at risk. In fact, the IUCN appears to be doing so already, despite its guidelines to the contrary (http://www.iucn.org/themes/ssc/redlists/criteria.htm), because its red list includes only five Canadian species, all of which are very limited in distribution and abundance (http://www.redlist.org). (Only one of the five [Sprague's Pipit] also appears in Table 2.)

Conservation interest should not be limited to rare species alone, of course, but should also be directed at keeping common species common. It is therefore important to determine whether qualification for alert status based on population decline is a good indicator of conservation needs other than immediate intervention. Canadian Wildlife Service (CWS) personnel recently reviewed all landbird species showing population declines (as well as others) and determined the highest-priority action for each species if the goal is to maintain healthy populations in Canada. Of the 45 landbirds considered that had statistically significant population declines large enough to be assigned to IUCN categories (Table 2) or to BTO alert levels based on declines of >25% over the past 25 years, 35% were deemed by the CWS review to need no action at this time, 20% to need better information on population status, 38% to deserve research (into cause of decline or other topics), and 7% to need intervention of some kind (such as habitat protection) (E.H.D., unpublished data). This example suggests that degree of population decline can be a useful screening tool with which to identify potential problems, but that action should not be recommended without an evaluation of

Table 4. Percentage of species meriting an alert level (total *n* in parentheses) that changed to a positive trend in the subsequent decade, and percentage of species with positive trends that later qualified for alert status.

	All species		*Species with significant trends*	
Predictive period (years)	*alert to positive*	*positive to alert*	*alert to positive*	*positive to alert*
1974–1978 (5)	62 (29)	55 (60)	86 (7)	56 (16)
1969–1978 (10)	56 (27)	52 (62)	50 (8)	75 (16)
1984–1988 (5)	53 (30)	44 (61)	45 (11)	20 (10)
1979–1988 (10)	33 (30)	34 (62)	10 (10)	23 (13)

trend data and other species characteristics. Marchant et al. (1997) reached a similar conclusion in their evaluation of BTO alert levels.

In deciding whether a declining species merits action, and what that action should be, some of the criteria that should be considered include precision and consistency of trend and the ability of the species to recover quickly from depressed populations (Greenwood et al. 1994). For example, population trends are frequently nonlinear (Francis & Hussell 1998; Siriwardena et al. 1998), and my results show that short-term population changes as large as 50% may be rapidly reversed (Table 4). Species with a history of fluctuation may merely need continued monitoring, whereas a species showing steady decline needs research into the causes of decline.

In many cases, review will show that trends are based on inadequate data. Some species (such as the Blackpoll Warbler, which qualified for IUCN endangered status) are sampled by BBS only at the southern fringe of their ranges, and trends may not reflect what is happening in the core of the range. Low sample size or inconsistent sampling may cause a trend to have low precision, making it difficult to determine whether an important change has actually taken place. High-magnitude changes are the most likely to be poorly estimated (Link & Sauer 1996). When monitoring data are highly variable, small differences in analysis method can alter the trends produced (Thomas 1996; Thomas & Martin 1996). For species with contradictory trend data from different sources, or poor quality BBS data, the highest-priority conservation need is for improved information on population status.

The most difficult decision to make with respect to taking action is whether to call for conservation intervention to stop or reverse declines. For species that are globally rare or extremely limited in distribution the decision is straightforward, but it is harder to justify attention to severely declining species that are still relatively widespread and common (such as most of those in Table 2). For species such as these, we need to agree on defensible population thresholds that signal a need for conservation action when populations fall to lower levels. Such decisions will involve assumptions about desirable population size (e.g., current vs. historic levels). Conservation thresholds should be based on knowledge of the limits of past fluctuations and on species characteristics such as reproductive rate and the ease of restoring lost habitat. The threshold chosen for a fluctuating species might be lower than its historic population low, whereas a steadily declining species might be deemed closer to, or already below, its threshold value.

Developing species-specific conservation thresholds will not be easy but should not be impossible. Analogous efforts include defining measurable population objectives in recovery plans for endangered species and developing population targets for waterfowl. A large part of the job will be developing a consensus on how much decline is acceptable before intervention should take place. Population viability analysis can help define minimum sustainable populations, but the aim of setting conservation thresholds should be to trigger action well before populations reach such low levels.

Development of conservation thresholds based on BBS trends is hampered by the fact that they are presented as linear rates of annual change, which obscure past fluctuations. Annual indices are more easily interpreted. Plots of annual indices against time indicate the occurrence of strong fluctuations in the past, and make it easier to detect unusual declines quickly or to determine whether recovery efforts are having the desired effect on population size. Although annual indices based on BBS data are available (Sauer et al. 2001), these consist of residuals of the linear regression procedure used to calculate trends and do not appropriately reflect large shifts in population trajectory (Peterjohn et al. 1995). Moreover, individual indices do not have variance estimates associated with them, so it is impossible to evaluate the quality of an unusually high or low annual index relative to that of indices for other years. Appropriate calculation of annual indices is not a simple matter, however, and in contrast to trend variance, individual index variance will not be reduced by the collection of additional years of data. A different approach to revealing past population fluctuations is through nonlinear trend analysis (such as nonlinear route regression or methods used by James et al. 1996). These issues should be a high priority for the attention of statisticians, and graphical displays of results (whether of annual indices or nonlinear trends) should be made routinely available to the conservation community.

Data presented here indicate that unevaluated population decline should not be used as a sole criterion for identifying species of conservation interest or for determining what conservation action is most needed. However, assigning species to alert levels is a useful tool for quickly screening the monitoring results of all species without prejudging what may or may not be an important trend. Data quality can then be assessed for each qualifying species, preferably with the input of monitoring-program personnel, who generally best know the strengths and limitations of their data sets. Following review, decisions on the action that should be taken, and on priorities for action among species, should be made only after consideration of additional information of conservation interest, such as abundance, breadth of range, rate of habitat loss, and other relevant factors.

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