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Recommendations for monitoring avian populations with point counts: a case study in southeastern Brazil

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ABSTRACT

In the northern hemisphere, bird counts have been fundamental in gathering data to understand population trends. Due to the seasonality of the northern hemisphere, counts take place during two clearly defined moments in time: the breeding season (resident birds) and winter (after migration). Depending on location, Neotropical birds may breed at any time of year, may or may not migrate, and those patterns are not necessarily synchronous among species. Also in contrast to the northern hemisphere, population trends and the impact of rapid urbanization and deforestation are unknown and unmonitored. Throughout one year, we used point counts to better understand temporal patterns of bird species richness and relative abundance in the state of São Paulo, southeastern Brazil, to examine how to implement similar bird counts in tropical America. We counted birds twice each day on 10 point transects (20 points day^{-1}), separated by 200 m, with a 100 m limited detection radius in a semideciduous tropical forest. Both species richness and bird abundance were greater in the morning, but accumulation curves suggest that longer-duration afternoon counts would reach the same total species as in morning counts. Species richness and bird abundance did not vary seasonally and unique species were counted every month; relatively few species (20%) were present in all months. Most (84%) known forest species in the area were encountered. We suggest that point counts can work here as they do in the northern hemisphere. We recommend that transects include at least 20 points and that the simplest timing of bird counts would also be seasonal, using timing of migration of austral migrants (and six months later) to coordinate counts. We propose that bird counts in Brazil, and elsewhere in Latin America, would provide data to help understand population trends, but would require greater effort than in temperate latitudes due to greater species richness and different dynamics of reproduction and migration. With collaboration among ornithologists and coordinated bird surveys, we may develop a technique for the tropics that would yield information for population trends and conservation of birds, similar to counts in temperate latitudes.

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Key-Words: Bird surveying method; Breeding Bird Survey; Christmas Bird Count; Methodological protocols; Pan-European Common Bird Monitoring Scheme; Temporal variation; Seasonal variation.

INTRODUCTION

Many programs monitor bird abundance in Canada, the United States and Europe, mostly through the use of point counts. Partners In Flight (PIF) was founded to better understand declines in Neotropical migrants (National Fish and Wildlife Foundation, 1990). Since then, several conservation plans have been proposed (Brown *et al.,* 2001; Donaldson *et al.,* 2001; Kushlan *et al.,* 2002; Pollock *et. al*., 2002; Rich *et al.,* 2004). Most emphasis has been placed on the long-term, large-scale, multispecies surveys to monitor abundance (Bart, 2005). Thus, counting birds has been a useful tool in understanding bird population trends on continental scales.

Several major programs monitor landbirds. In the United States, both the Breeding Bird Survey (BBS, www.pwrc.usgs.gov/bbs/index.html) and the Christmas Bird Count (CBC, www.audubon.org/Bird/cbc) are used to attempt to understand large-scale changes in populations. In Europe, the Breeding Bird Survey (www.bto.org/bbs/index.htm) and the Pan-European Common Bird Monitoring Scheme (PECBMS, www.ebcc.info/pecbm.html) are similar and also used to document changes in populations and distributions over time. BBS is a major landscape-level survey of birds and is typical of many count surveys, in that the same sample units (survey routes) are sampled each year; change is modeled on these routes over time (Link & Sauer, 1998). This is like the CBC, carried out annually in the northern-hemisphere winter. In the CBC, each individual count is performed at a specified location in which the team of ornithologists breaks up into smaller groups to follow assigned routes in which every bird seen is counted (Butcher *et al.,* 1990). PECBMS was developed to produce yearly population indices of bird species across countries by combining the results of existing national schemes. The method takes into account the differences in population sizes per country, the differences in field methods, as well as the numbers of sites and years covered by national schemes (Strien *et al.,* 2001).

These joint collaboration programs have successfully depicted some trends in large-scale population changes. For example, they have found considerable differences in European trends of species abundance by habitat (Gregory *et al.,* 2007) in up to 18 European countries (Vorisek *et al.,* 2008). A particular example is that insectivorous long-distance migrants in the Netherlands declined strongly from 1984-2004 in forests but they did not decline in less seasonal marshes (Both *et al.,* 2010). These monitoring programs (except for CBC) use point counts (Blondel *et al.,* 1970; Bibby *et al.,* 2000) and have been refined and well-studied in temperate latitudes (Shields, 1977; Ralph & Scott, 1981; Skirvin, 1981; Verner & Ritter, 1986; Ralph *et al.,* 1995). Recently, point counts have been used in Neotropical regions to improve the results obtained while using such method (Esquivel & Peris, 2008; Volpato *et al.,* 2009). However, few studies have addressed the issue that point counts, being stationary for limited time, tend to miss non-vocal, rare or canopy species, or provide biased estimates of abundance and can be influenced by environmental features (Verner, 1985; Terborgh *et al.,* 1990).

Point counts combined with random walks were used to remedy the problems associated with these methods in tropical Panama (Robinson, 1999; Robinson *et al.,* 2000, 2004). Another method, the 20-species list (one counts all birds seen and, upon reaching 20 species, closes this sublist and begins a new sublist) was used in comparing species richness in Africa (Fjeldså, 1999; Fjeldså *et al.,* 1999) and, more recently, in Brazil (Cavarzere *et al.,* 2012). A standardized search method, which may be used in conjunction with a species richness estimator, has also been suggested (Nichols *et al.,* 2000). In this method, during a fixed time interval (to control for effort) each site is perambulated to increase the chances of finding more and elusive species (Herzog *et al.,* 2002; Watson, 2003; Rompré *et al.,* 2007). Clearly, circumstances of census are variable and may influence the probability of finding a bird when it is present. For most purposes, the goal is not a perfectly compiled list of species, but rather data that will permit comparisons of different places or the same place at different times, for which species-accumulation curves are suited.

Here, we use the point count method to examine changes in abundance and species richness patterns over time in a semideciduous forest in the state of São Paulo, southeastern Brazil. Specifically, we examine: 1) whether a clear seasonal trend in bird abundance and species richness will suggest an ideal time for censusing birds, and 2) whether (as in the northern hemisphere) there is a dawn chorus that makes birds more easily counted at that time (Blake, 1992 and references therein). By answering these questions, we wish to determine the patterns of species richness and abundance over time and thereby suggest how counts should be used in order to help foment and develop a national initiative of a Brazilian counterpart of the BBS and the CBC.

MATERIAL AND METHODS

Study area

We conducted this study at Caetetus Ecological Station (22°26'S, 49°44'W, Fig. 1), near the municipalities of Alvinlândia and Gália in the state of São Paulo, southeastern Brazil, at altitudes of 500-680 m. The Caetetus Ecological Station comprises ~ 2,180 ha of predominantly intermediate and late successional stages of semideciduous Atlantic forest with an 8-32 m canopy (Durigan *et al.,* 2000). Rainfall averages 1,500 mm per year, with a dry season from April-September and wet season from October-March (Tabanez *et al.,* 2005). A compilation of 293 bird species recorded during 30 years at Caetetus was published by Cavarzere *et al.* (2009). In that study, the authors recently surveyed the Station for 15 months, reporting a forest avifauna that consisted of 62% resident species, 6% migrants, and a total of 17% endemic species of Atlantic forest or Cerrado. The remaining 15% are open-habitat birds.

Due to a lack of breeding data for most species, we used rainfall and temperature regimes to examine possible associations between bird counts and climate. Climate data were taken from the meteorological station at Caetetus Ecological Station during 2006. We wished to examine whether an association between richness (or abundance) and climate suggests seasonality and an ideal time to census birds instead of only evaluate the causes and effects of seasonality on bird populations. Thus, we tested for correlations between monthly rainfall and temperature and species richness and abundance. After verifying our data for normality and homogeneity of variances, we used a Kruskal-Wallis test to examine differences in median annual rainfall by month, and conducted a Dunn's Multiple Comparison test within months to verify which ranked monthly rainfalls were significantly different (Dunn, 1964). We compared both number of individuals counted and species richness between morning and afternoon counts (one-tailed paired *t*-tests), and between wet and dry seasons, in which each point was considered a replica (two-tailed *t*-tests).

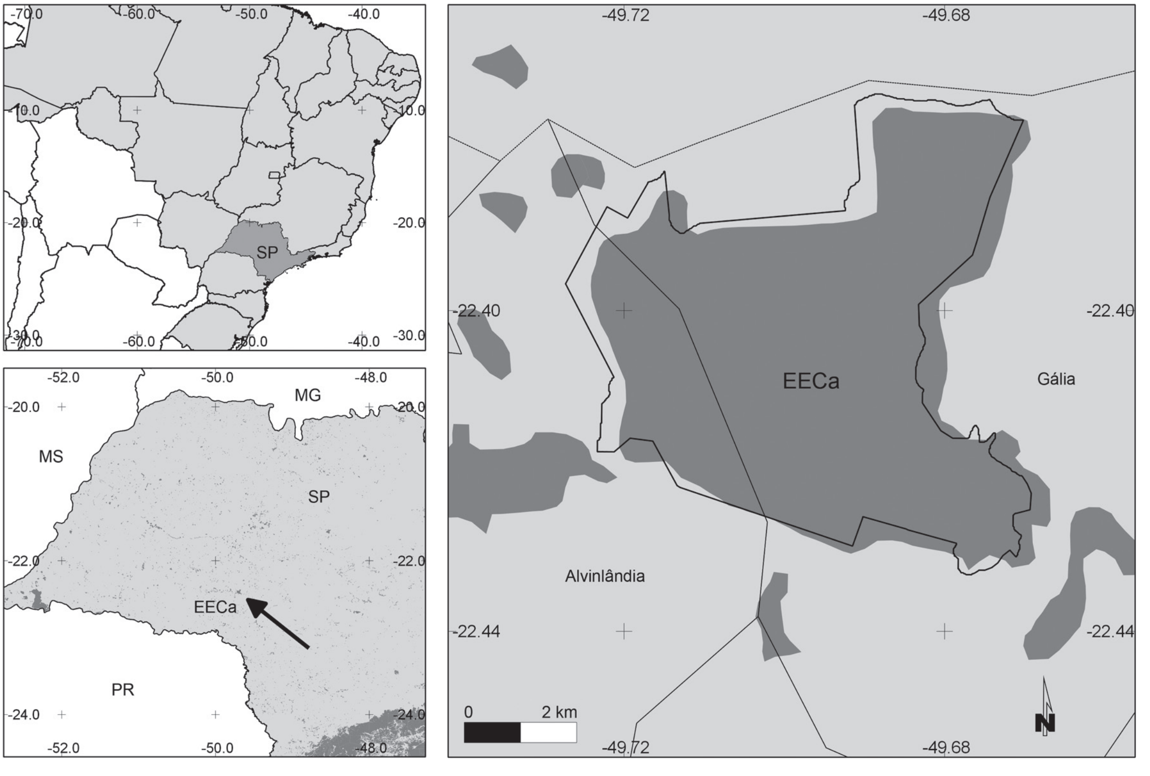

FIGURE 1: Location of the Caetetus Ecological Station (EECa) within the municipalities of Gália and Alvinlândia in the state of São Paulo, southeastern Brazil. Darker shades of grey indicate remnant natural vegetation.

Bird counts

We counted birds on two trails in the forest fragment, with 10 and with 13 points, separated from each other by 200 m. Birds were counted at 10 points one day each month during the morning and afternoon of the year 2006 (for a total of 20 points day^{-1}). We attempted to randomize starting points of the 10 point counts (basically alternating directions on the trails at each count, and staggering the starting point on the 13 point trail), to avoid a possible bias due to always counting at the same places at the same times. The two transects began about 200 m from each other, while the last point on each was *ca.* 450 m apart. In the morning, we arrived at the first point prior to any diurnal bird vocalizations (*ca.* 20 min before sunrise) and began counting upon hearing the first vocalization. In some cases, these corresponded to nocturnal species, such as the Ocellated Poorwill *Nyctiphrynus ocellatus,* which were also included in our data. Afternoon counts began *ca.* 3 h before sunset. Counts had a 100 m limited-detection radius; 10 min were used at each point for counting and a 5-min interval was allowed to move from one station to the next, with one observer noting all birds seen or heard. Thus, ~ 2.4 h were used during each count. Counts were performed on days with no rain and little or no wind.

We generated species accumulation curves by month and by number of individuals to illustrate how abundance and species richness are distributed over time using EstimateS 8.2 (Colwell, 2009). The community similarity was calculated using the Jaccard Similarity Index (Chao *et al.,* 2005). We followed Parker *et al.* (1996) for Atlantic forest endemic species, except for *Florisuga fusca, Thalurania glaucopis, Baryphthengus ruficapillus, Trogon surrucura, Synallaxis ruficapilla* and *Automolus leucophthalmus* (Cavarzere *et al.,* 2011). We understand there may be no biological significance to treat endemics separately from nonendemics. However, we maintain this segregation due to the conservation value of endemic species, which, likewise endangered species, are constantly used as highlights in rapid inventories and environmental impact studies. Migratory species (based on the number of months each species was absent from these location) are those according to Cavarzere *et al.* (2009). Statistical significance was set at 0.05 for all analyses.

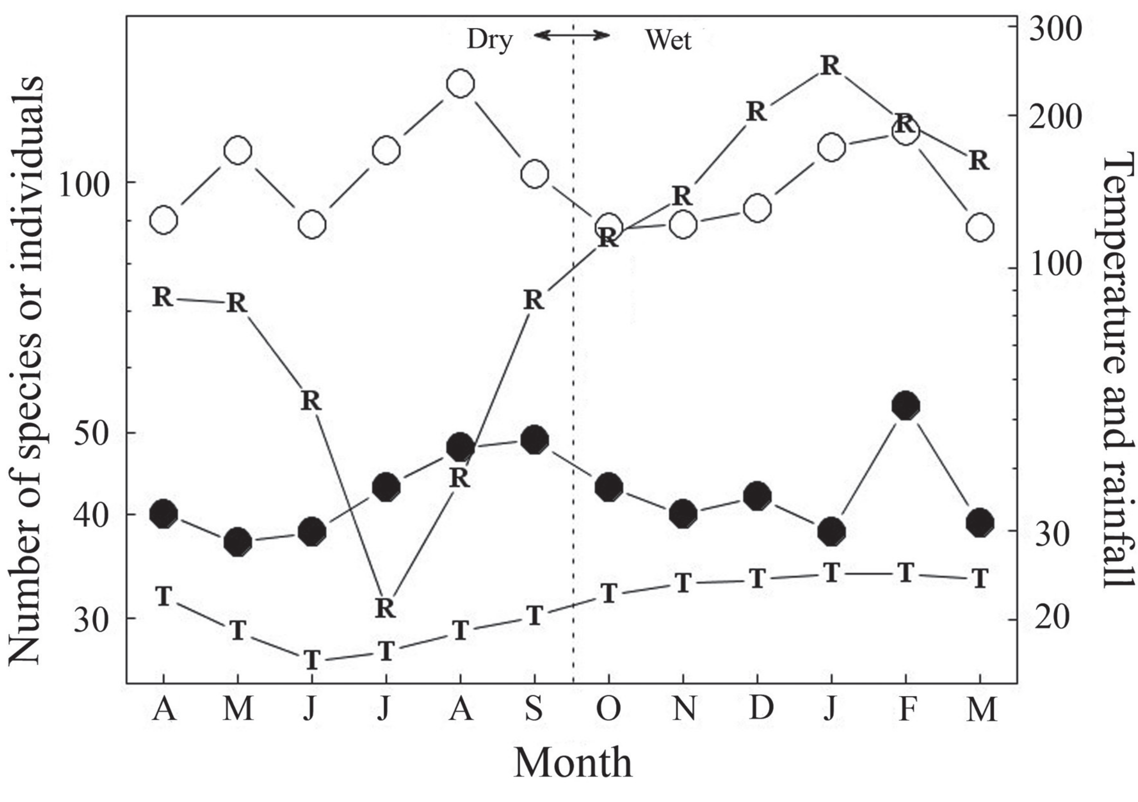

FIGURE 2: Monthly mean climate measurements at Caetetus Ecological Station (T: temperature and R: rainfall) and monthly total counts of species richness and numbers of individuals in a semideciduous forest remnant in São Paulo, southeastern Brazil. Black circles represent number of species and white circles represent number of individuals.

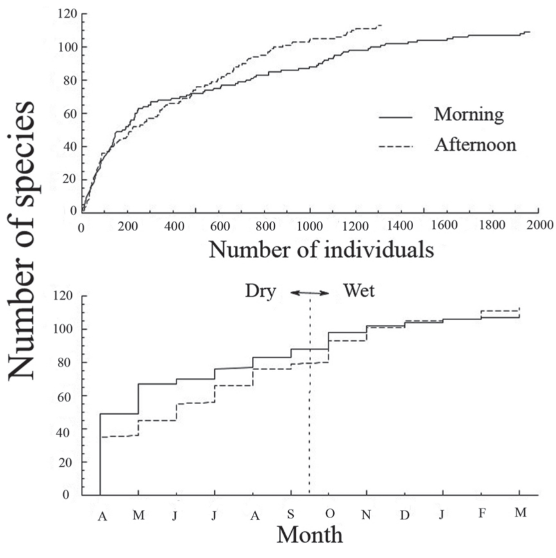

FIGURE 3: Comparison of morning and afternoon counts for the number of accumulated species by total number of individuals counted (top) and month (bottom). Months are separated by dry and rainy seasons.

RESULTS

We counted a total of 4,155 individual birds comprising 129 species including 22 Atlantic forest endemics, or 17%, in a total of 240 points, or a mean 17.1 contacts per point count. While the number of species and the number of individuals varied over months, there was no consistent trend suggesting that either was correlated with climate (species-rain r = -0.036, P = 0.900, species-temperature r = 0.11, P = 0.700, abundance-rain r = -0.14, P = 0.700, abundance-temperature r = -0.21, P = 0.500, all n = 12, Fig. 2).

Time of day was influential in both number of species and number of individuals (Fig. 3, top). However, species accumulation curves reached the same number of species while morning counts included an additional 700 individuals. Thus, there is no evidence of a dawn chorus that makes counting at that time necessary, and by the end of the year, both methods reached the same maximum value for species richness (Fig. 3, bottom). Both species richness (55 versus 46, t_{119} = 8.5, P = 0.001) and abundance (208 versus 138, t_{119} = 7.4, P = 0.001) were greater in the morning than in the afternoon counts with December being the only exception (Fig. 4A,C). That difference appears to be greater for nonendemic than endemic species, but it is not statistically significant in paired t-tests using each point as paired by morning versus evening (each month, P > 0.100, Fig. 4B,D).

Each month we counted species not registered in previous months and, in most months, unique species (seen in only one month, Fig. 5). The maximum percentage of endemics seen in any month was 92% during August. The average number of species seen each month was 77% of the total, with a low of 62% in March. For nonendemic species, the maximum was 59% in September (mean = 47%, low = 37% in May). Thus, of the total number of species counted in this study, September and October had the largest proportion (62%) while May had the smallest (43%).

Twelve species were found only in the wet season, five of which (Blue-ground Dove *Claravis pretiosa,* Short-tailed Nighthawk *Lurocalis semitorquatus,* Black Jacobin *Florisuga fusca,* Tropical Kingbird *Tyrannus melancholicus,* Uniform Finch *Haplospiza unicolor*) are considered summer migrants in the area and the other seven are probably accidentals (see below). All wet-season exclusive species were seen during morning and afternoon counts.

Some 30 species (23% of the total) were rarely recorded, with 18 species registered during one count and another 12 in only two counts. One third (42 species) of all species seen were found in three or fewer counts. May had the fewest (one species) rare species while January (11 species) and September (10 species) had the most. Thus, one third of the species counted was rarely seen, but may be seen in any month (Table 1, Fig. 5). The wet and dry seasons had similar species richness (70 vs. 67 species, respectively; t_{10} = 0.6, P = 0.280). Only 25 species (20%) were seen in all months.

DISCUSSION

We find it interesting to note that at this locality and period of study not only was it almost equally efficient to count in the afternoon as it was in the morning, but also there was no particular month which stood out as the most likely to be the "best" month for assessing species richness. While morning counts tend to include more species and more individuals, a slightly increased effort during the afternoon accumulates a similar number of species and individuals. This pattern is probably not generalizable to other biomes. For example, the Blue-and-white Swallow (*Pygochelidon cyanoleuca*) was counted more often during the afternoon in a savanna in São Paulo (Cavarzere & Moraes, 2010). Thus, neither time of day (in contrast to the northern hemisphere) nor month of the year should be given priority. Along with month, seasonality was also unimportant, as in a subtropical setting in southern Brazil (Volpato *et al.,* 2009) and other studies in São Paulo (Antunes, 2008; Cavarzere, 2013). In

TABLE 1: Months during which locally rare species (encountered during ≤ 3 months) were registered (May had only 1, and was left out). Atlantic forest endemic species are indicated by an asterisk.

Species	Month										
	J	F	M	A	J	J	A	S	O	N	D
Whistling Heron *Syrigma sibilatrix*		x							x		
Short-tailed Hawk *Buteo brachyurus*			x			x					
Roadside Hawk *Rupornis magnirostris*		x						x	x		
Southern Caracara *Caracara plancus*							x				x
Collared Forest-Falcon *Micrastur semitorquatus*					x					x	
King Vulture *Sarcoramphus papa*						x	x				
Blue-winged Parrotlet *Forpus xanthopterygius*	x					x	x				
Ocellated Poorwill *Nyctiphrynus ocellatus*				x	x						
Ruddy Ground-Dove *Columbina talpacoti*	x									x	
Black Jacobin *Florisuga fusca*	x		x								x
Scaled-throated Hermit *Phaethornis eurynome**	x			x		x					
Streaked Xenops *Xenops rutilans*		x	x	x							
Southern Beardless-Tyrannulet *Camptostoma obsoletum*							x	x			
Variegated Flycatcher *Empidonomus varius*	x								x	x	
Short-crested Flycatcher *Myiarchus ferox*	x										x
Swainson's Flycatcher *M. swainsoni*		x						x		x	
Eared Pygmy-Tyrant *Myiornis auricularis**								x	x		x
Ochre-faced Tody-Flycatcher *Poecilotriccus plumbeiceps*	x	x			x						
Tropical Kingbird *Tyrannus melancholicus*		x							x		
Bare-throated Bellbird *Procnias nudicollis**		x				x	x				
Silver-beaked Tanager *Ramphocelus carbo*								x	x		x
Swallow Tanager *Tersina viridis*	x							x			
White-necked Thrush *Turdus albicollis*									x	x	x
Eastern Slaty-Thrush *T. subalaris*								x	x		
Total	8	7	3	3	3	5	5	7	8	5	6

contrast, rainforests may tend towards more species and individuals being counted during the wet season (Volpato *et al.,* 2009). Although one must consider that Volpato *et al.* (2009) may have failed in defining two six-month seasons (see Madeira & Fernandes, 1999), which could incur in statistical error, these results do suggest that there is a certain liberty in deciding when counts should be carried out to monitor long-term trends.

Even Atlantic forest endemics had no particular daily or seasonal pattern. While it is true that no particular month is apparently ideal for a count, we must recognize that any count during any given month will underestimate the avian community for the region. However, if counts are undertaken on a large scale, the species absent in one month at one place should be present in some other place during the same month. Thus, our data suggest that only a sufficiently large scale counting program will gather data that will indeed be useful for monitoring population trends over time for many species. During this study, 25 forest birds known from Caetetus were never found. Some 10 of these missing species were recently recorded at the Station (F.K. Ubaid, *pers. com.*), in which case only 15 forest species remained unrecorded by us. We believe their absence falls under the following categories: (a) local extinction, (b) absence of surveys in particular micro-habitats or (c) previous undocumented misidentifications (Appendix; Ubaid *et al.,* in prep.). However, we did find 129 (84%) of the total forest species. Thus, point counts can be effective for recording most (> 80%) common species (Anjos, 2007) at least in semideciduous forests in southeastern Brazil.

Bird surveys in the northern hemisphere are conducted on much larger scales than this case study in São Paulo. The large scale and many transects used in those counts are clearly beneficial for the quality of the data and the resultant ability to monitor population trends. By recognizing the dynamics we found here, we suggest that with the addition of small transects repeated simultaneously, involving more individuals (ornithologists and, in very specific cases, qualified bird watchers) over larger areas of Brazil, it is quite likely that these methods would be sufficient for long-term monitoring. We suggest that it would be more important to have more counts, such as 20 points rather than fewer counts with more points, over a wider area to monitor bird population trends. While our results clearly show that bird dynamics are not yet well understood even in a small area of one of the ornithologically best-known state in Brazil, only through the use of collaborative and large-scale counting efforts will we be able to document population changes on that same scale as has been successfully achieved elsewhere, *e.g.,* Australia (www.birdsaustralia.com.au).

Perhaps the greatest obstacle to implementing these counts in Brazil is the lack of volunteers. Bird counts of other studies are mostly done by volunteers who pay their own expenses while participating. For many it is an important social event each year, and people participate for the pleasure of doing so. This culture has not yet reached Latin America, and socio-economic constraints also impede implementation of these counting suggestions. However, current changes, such as the recent increase in Brazilian scientific research (King, 2009), and the continuous expansion of birding in Brazil (Avistar – Brazilian Birdwatching Fair [www.avistarbrasil.com.br], CEO – Ornithological Study Center [www.ceo.org.br], COA – Birdwatching Club [www.coa-rj.com], Wiki Aves [www.

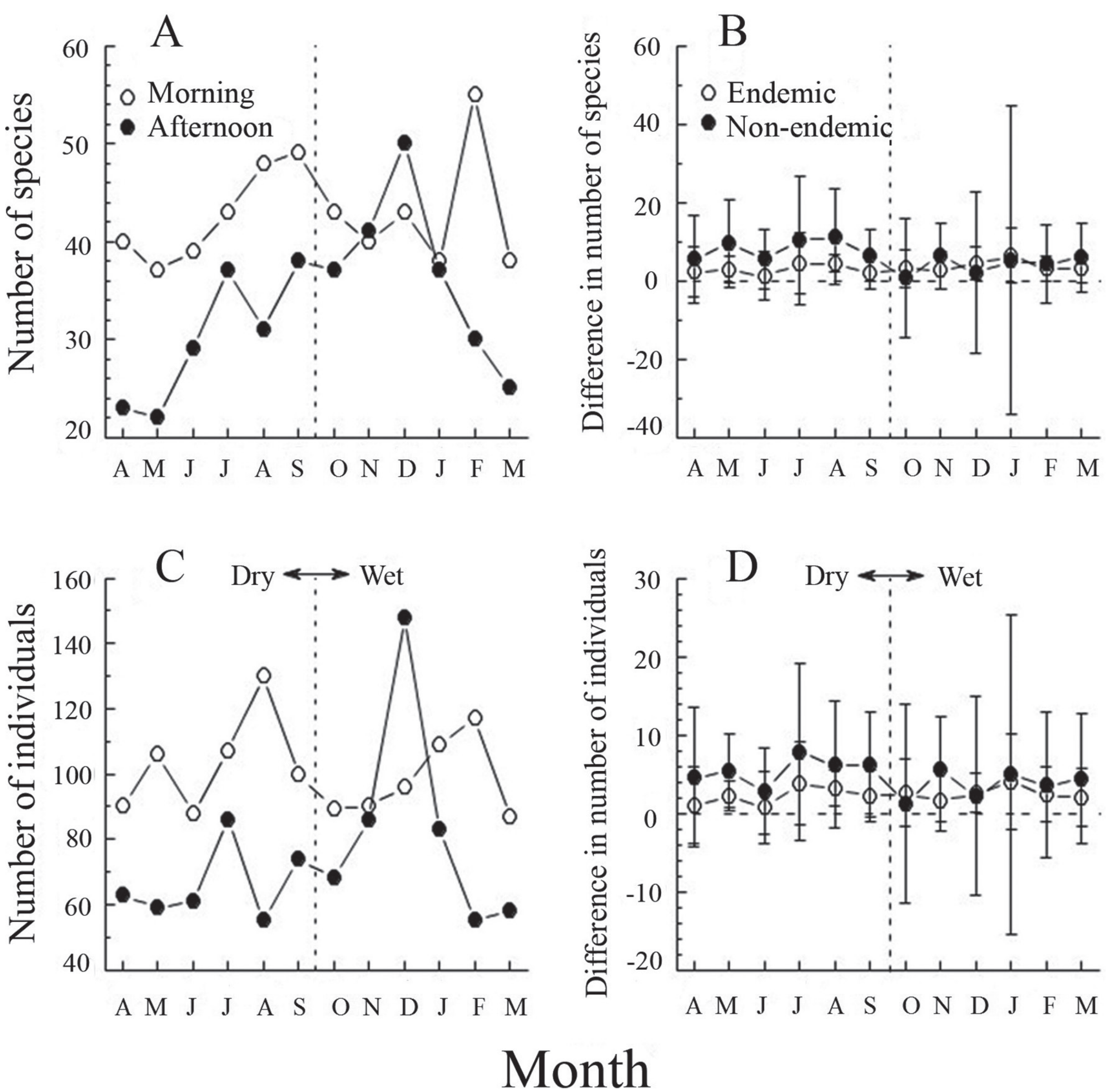

FIGURE 4: Comparisons of species richness **(A)** and abundance **(C)** by time of day (morning – AM, and afternoon – PM), and separated by endemic and nonendemic species richness **(B)** and abundance **(D)** as the difference between AM and PM during 2006 show that more species and individuals were recorded on morning counts. Months begin in April to clearly separate the dry from the wet season. Error bars represent 95% confidence interval.

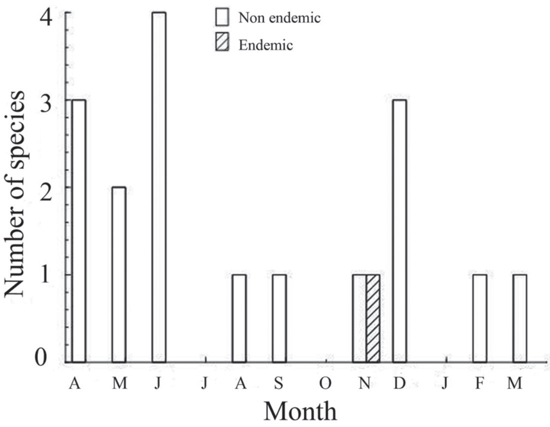

FIGURE 5: Monthly counts of rare (sightings ≤ 5 for the entire year) species comparing endemic and non-endemic species show that these rare species may be seen in any month of the year. Months are separated by dry and wet seasons.

wikiaves.com.br]), might soon reach critical mass in which bird counts on a large scale may be soon established in this country. Also, newer collaborative efforts, such as eBird (http://ebird.org/content/ebird) may be useful for the same purpose.

An excellent beginning for such counts might be developed if local birding clubs were to coordinate their activities to coincide with local counts and were to foment and formalize seasonal counts. Also, ornithologists and academics might foment interest among their students to participate in nationwide seasonal bird counts, and perhaps contribute to the development of a Brazilian system of bird surveys through their research projects. To start this process, we have a few recommendations that build on the results described here. First, within each group interested in beginning bird surveys, they should read the information on the BBS to better understand how to organize their trails, which should be permanent to the greatest extent possible (Sauer *et al.,* 2001). Second, the time interval of the counts should be standardized such as here, 10 min at each station. Third, the time of day should be standardized as the morning, although if necessary, afternoons can still be used. Fourth, all months were similar (regarding the record of the same number of species and rarely recorded species) in the number of birds counted, but we suggest that in seasonally drier areas (*cerrado* and *caatinga*) reproduction is likely to be seasonal (*e.g.,* Duca & Marini, 2011). After each region finds its peak in reproductive activities (which may not be in the same month as here or within study areas), we would recommend a meeting among those carrying out bird surveys to insure that counts are synchronized nationwide. Only by synchrony can we be sure of population trends, such as those associated with migration. Once breeding seasons begin to be defined nation-wide, we can then adjust count dates so that all places in the country have counts at that time, and another count six months later, for example. Perhaps our first step would be to use austral migrants as our key species to decide when to count: when austral migrants are in Brazil (southern winter) and when austral migrants are in their breeding areas (southern summer). As a first best guess, this can later be adjusted if necessary.

Other issues not raised here but just as important as those listed above are that most large-scale bird monitoring programs do not plan their sampling so that each region is sampled in proportion to its area or habitat type. Disregarding habitat in site selection means that rare habitats receive little sampling effort and not using a well-defined sampling plan means that extrapolation to large areas is difficult (Thompson, 2002). We suggest that since we are beginning from scratch, we can design our counts so that we sample habitats proportional to their abundance and that all counts are standardized. Any imperfection in counts due to methodology should be small relative to the benefits in statistical power repeated from standardized methods (McCarthy *et al.,* 2012). We hope that by fomenting interest in a Brazilian Breeding Bird Survey, we may begin to gather data that will provide important information about population trends over time (*e.g.,* Rodríguez *et al.,* 2012). We recommend that interested individuals group together and begin counting, spreading this idea throughout the rest of the Americas, before it is too late.

RESUMO

No hemisfério norte, o censo de aves é fundamental para gerar informações que auxiliam na compreensão de tendências populacionais. Tais censos, devido à marcada sazonalidade deste hemisfério, são realizados durante dois momentos distintos: na estação reprodutiva (aves residentes) e no inverno (quando as aves migratórias deixam determinadas regiões). Na região neotropical, porém, dependendo da localidade, as aves podem se reproduzir durante qualquer ou vários períodos do ano; podem ou não migrar, e aquelas que o fazem podem apresentar um padrão assincrônico. Em contraste com o hemisfério norte, tendências populacionais são desconhecidas, bem como o impacto das taxas rápidas de urbanização e desmatamento, que também são pouco monitoradas. Para melhor entender padrões temporais de riqueza e abundância de aves, e avaliar como um censo similar pode ser implementado na América tropical, foram utilizados *pontos de escuta ao longo de 12 meses em uma localidade no Estado de São Paulo, sudeste do Brasil. Os censos ocorreram duas vezes por dia (manhãs/tardes) em uma floresta semidecidual ao longo de transecções com 10 pontos (20 pontos por dia) distantes 200 m entre si e com raio de detecção limitado em 100 m. Ambas as riquezas e abundâncias de aves foram maiores durante as manhãs, mas as curvas de acumulação sugerem que os censos vespertinos com maior esforço amostral podem fornecer resultados similares aos censos matutinos. Riqueza e abundância das aves não variam de acordo com estações (i.e., sem padrão aparente entre reprodução e migração), enquanto espécies exclusivas foram encontradas todos os meses e relativamente poucas espécies (20%) foram registradas em todos os meses do ano. Durante este ano, 84% de todas as aves florestais da área estudada foram registradas. Sugerimos que a metodologia de pontos de escuta pode ser utilizada à semelhança dos censos do hemisfério norte. Recomendamos ainda que o esforço amostral em transecções deva incluir ao menos 20 pontos, e que o início da contagem das aves deva ser sazonal, utilizando o período de migração das espécies austrais (e os seis meses seguintes) para coordenar pontos de escuta. Por último, sugerimos que os censos no Brasil e até mesmo na América Latina podem ajudar no entendimento de tendências populacionais, mas também demandam maior esforço do que o observado em latitudes temperadas, devido à maior riqueza de espécies e diferenças nas dinâmicas de reprodução e migração. Por meio do uso de censos de aves coordenados poderá ser desenvolvida uma técnica para os trópicos que irá gerar informações que permitam acompanhar tendências populacionais, com benefícios para a conservação das aves, similarmente aos censos realizados em países do hemisfério norte.*

Palavras-Chave: Breeding Bird Survey; Christmas Bird Count; Método de censo para avifauna; Pan-European Common Bird Monitoring Scheme; Protocolos metodológicos; Variação temporal; Variação sazonal.

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REFERENCES

Anjos, L. 2007. A eficiência do método de amostragem por pontos de escuta na avaliação da riqueza das aves. *Revista Brasileira de Ornitologia,* 15:239-243.

Antunes, A.Z. 2008. Diurnal and seasonal variability in bird counts in a forest fragment in southeastern Brazil. *Revista Brasileira de Zoologia,* 25:228-237.

Bart, J. 2005. Monitoring the abundance of bird populations. *Auk,* 122:15-25.

Bibby, C.J.; Burguess, N.D.; Hill, D.A. & Mustoe, H.S. 2000. *Bird census techniques.* London, Academic Press.

Blake, J. 1992. Temporal variation in point counts of birds in a lowland wet forest in Costa Rica. *Condor,* 94:265-275.

Blondel, J.; Ferry, C. & Frochot, B. 1970. La méthode des indices ponctuels d'abondance (IPA) ou des revelés d'avifaune par "stations d'écoute". *Alauda,* 38:55-71.

Both, R.; Turnhout, C.A.M.; Bijlsma, R.G.; Siepel, H.; Strein, A.J. & Foppen, R.P.B. 2010. Avian population consequences of climate change are most severe for long-distance migrants in seasonal habitats. *Proceedings of the Royal Society B,* 277:1259-1266.

Brown, S.; Hickey, C.; Harrington, B. & Gill, R. 2001. *United States Shorebird Conservation Plan,* 2. ed. Manomet, Mass., Manomet Center for Conservation Sciences.

Butcher, G.S.; Fuller, M.R. & Geissler, P.H. 1990. An evaluation of the Christmas Bird Count for monitoring population trends of selected species. *The Wildlife Society Bulletin,* 18:129-134.

Cavarzere, V. 2013. Does the reproductive season account for more records of birds in a marked seasonal climate landscape in the state of São Paulo, Brazil? *Papéis Avulsos de Zoologia,* 53:253-260.

Cavarzere, V. & Moraes, G.P. 2010. Diurnal variation in transect counts of birds in a cerrado landscape in the State of São Paulo, Brazil. *Revista Brasileira de Ornitologia,* 18:97-101.

Cavarzere, V.; Costa, T.V.V. & Silveira, L.F. 2012. On the use of 10-minute point counts and 10-species lists for surveying birds in lowland Atlantic Forests in southeastern Brazil. *Papéis Avulsos de Zoologia,* 52:333-340.

Cavarzere, V.; Moraes, G.P.; Dalbeto, A.C.; Maciel, F.G. & Donatelli, R.J. 2011. Birds from cerradão woodland, an overlooked forest of the Cerrado region. *Papéis Avulsos de Zoologia,* 51:259-273.

Cavarzere, V.; Moraes, G.P. & Donatelli, R.J. 2009. Avifauna da Estação Ecológica dos Caetetus, interior de São Paulo, Brasil. *Papéis Avulsos de Zoologia,* 49:477-485.

Chao, A.; Chazdon, R.L.; Colwell, R.K. & Shen, T.J. 2005. A new statistical approach for assessing similarity of species composition with incidence and abundance data. *Ecology Letters,* 8:148-159.

Colwell, R.K. 2009. *EstimateS: Statistical estimation of species richness and shared species from samples. Version 8.2. User's Guide and application.* http://viceroy.eeb.uconn.edu/EstimateS. Access in 20/Jan./2008.

Donaldson, G.M.; Hyslop, C.; Morrison, R.I.G.; Dickson, H.L. & Davidson, I. 2001. *Canadian Shorebird Conservation Plan.* Canadian Wildlife Service, Ottawa, Ontario.

Duca, C. & Marini, M.A. 2011. Variation in breeding of the Shrike-like Tanager in Central Brazil. *The Wilson Journal of Ornithology,* 123: 259-265.

Dunn, O.J. 1964. Multiple comparisons using rank sums. *Technometrics,* 6:241-252.

Durigan, G.; Franco, G.A.D.C.; Saito, M. & Baitello, J.B. 2000. Estrutura e diversidade do componente arbóreo da floresta na Estação Ecológica dos Caetetus, Gália, São Paulo. *Revista Brasileira de Botânica,* 23:371-383.

Esquivel, M.A. & Peris, S. 2008. Influence of time of day, duration and number of counts in point count sampling of birds in an Atlantic Forest of Paraguay. *Ornitologia Neotropical,* 19:229-242.

Fjeldså, J. 1999. The impact of human forest disturbance on the endemic avifauna of the Udzungwa Mountains, Tanzania. *Bird Conservation International,* 9:47-62.

Fjeldså, J.; Lambin, R. & Mertens, B. 1999. Correlation between endemism and local ecoclimatic stability documented by comparing Andean bird distributions and remotely sensed land surface data. *Ecography,* 22:63-78.

Gregory, R.D.; Vorisek, P.; Strien, A.; Meyling, A.W.G.; Jiguet, F.; Fornasari, L.; Reif, J.; Chylarecki, P. & Burfield, I.J. 2007. Population trends of widespread woodland birds in Europe. *Ibis,* 149:78-97.

Herzog, S.K.; Kessler, M. & Cahill, T.M. 2002. Estimating species richness of tropical bird communities from rapid assessment data. *Auk,* 119:749-769.

King, C. 2009. *Brazilian science on the rise.* http://sciencewatch.com/ana/fea/09julaugFea. Access in 07/Jan./2011.

Kushlan, J.A.; Steinkamp, M.J.; Parsons, K.C.; Capp, J.; Cruz, M.A.; Coulter, M.; Davidson, I.; Dickson, L.; Edelson, N.; Elliot, R.; Erwin, R.M.; Hatch, S.; Kress, S.; Milko, R.; Miller, S.; Mills, K.; Paul, R.; Phillips, R.; Saliva, J.E.; Sydeman, B.; Trapp, J.; Wheeler, J. & Wohl, K. 2002. *Waterbird Conservation for the Americas:* The North American Waterbird Conservation Plan, version 1. Washington, D.C., Waterbird Conservation for the Americas.

Link, W.A. & Sauer, J.R. 1998. Estimating population change from count data: application to the North American Breeding Bird Survey. *Ecological Applications,* 8:258-268.

Madeira, J.A. & Fernandes, G.W. 1999. Reproductive phenology of sympatric taxa of *Chamaecrista* (Leguminosae) in Serra do Cipó, Brazil. *Journal of Tropical Ecology,* 15:463-479.

McCarthy, K.P.; Fletcher, Jr., R.J.; Rota, C.T. & Hutto, R.L. 2012. Predicting species distributions from samples collected along roadsides. *Conservation Biology,* 26:68-77.

National Fish and Wildlife Foundation. 1990. *Neotropical Migratory Bird Conservation Program.* Washington, D.C., National Fish and Wildlife Foundation.

Nichols, J.D.; Hines, J.E.; Sauer, J.R.; Fallon, F.W.; Fallon, J.E. & Heglund, P.J. 2000. A double-observer approach for estimating detection probability and abundance from point counts. *Auk,* 117:393-408.

Parker, T.A.; Stotz, D.F. & Fitzpatrick, J.W. 1996. Ecological and distributional databases. *In:* Stotz, D.F.; Fitzpatrick, J.W.; Parker, T.A. & Moskovits, D.K. (Eds.). *Neotropical birds:* ecology and conservation. Chicago,The University of Chicago Press. p. 118-436.

Pollock, K.H.; Nichols, J.D.; Simons, T.R.; Farnsworth, G.L.; Bailey, L.L. & Sauer, J.R. 2002. Large-scale wildlife monitoring studies: statistical methods for design and analyses. *Environmetrics,* 13:105-119.

Ralph, C.J. & Scott, M. 1981. Estimating numbers of terrestrial birds. *Studies in Avian Biology,* 6.

Ralph, C.J.; Sauer, J.R. & Droege, S.B. 1995. Monitoring bird populations by point counts. California, USDA, Forest Service General Technical Report.

Rich, T.D.; Beardmore, J.C.; Berlanga, H.; Blancher, P.J.; Bradstreet, M.S.W.; Butcher, G.S.; Demarest, D.W.; Dunn, E.H.; Hunter, W.C.; Inigo-Elias, E.E.; Kennedy, J.A.; Martell, A.M.; Punjabi, O.A.; Pashley, D.N.; Rosenberg, K.V.; Rustay, C.M.; Wendt, J.S. & Will, T.C. 2004. *Partners in flight North American Landbird Conservation Plan.* Ithaca, New York, Cornell Laboratory of Ornithology.

Robinson, W.D. 1999. Long-term changes in the avifauna of Barro Colorado Island, a tropical forest isolate. *Conservation Biology,* 13:85-97.

Robinson, W.D.; Angehr, G.R.; Robinson, LT.R.; Pettit, J.; Pettit, D.R. & Brawn, J.D. 2004. Distribution of bird diversity in a vulnerable neotropical landscape. *Conservation Biology,* 18:510-518.

Robinson, W.D.; Brawn, J.D. & Robinson, S.K. 2000. Forest bird community structure in Central Panama: influence of spatial scale and biogeography. *Ecological Monographs,* 70:209-235.

Rodríguez, G.A.; Rodríguez, J.P.; Ferrer-Paris, J.R. & Sánchez-Mercado, A. 2012. A nation-wide standardized bird survey scheme for Venezuela. *The Wilson Journal of Ornithology,* 124:230-244.

Rompré, G.; Robinson, W.D.; Desrochers, A. & Angehr, G. 2007. Environmental correlates of avian diversity in lowland Panama rain forests. *Journal of Biogeography,* 34:802-815.

Sauer, J.R.; Hines, J.E. & Fallon, J. 2001. *The North American Breeding Bird Survey, Results and Analysis 1966-2001,* version 2001.2. Laurel, Maryland, U.S. Geological Survey, Patuxent Wildlife Research Center.

Shields, W.M. 1977. The effect of time of day on avian census results. *Auk,* 94:380-383.

Skirvin, A.A. 1981. Effect of time of day and time of season on the number of observations and density estimates of breeding birds. *Studies in Avian Biology,* 6:271-274.

Strien, A.J.; Pannekoek, J. & Gibbons, D.W. 2001. Indexing European bird population trends using results of national monitoring schemes: a trial of a new method. *Bird Study,* 48:200-213.

Tabanez, M.F.; Durigan, G.; Keuroghlian, A.; Barbosa, A.F.; Freitas, C.A.; Silva, C.E.F.; Silva, D.A.; Eaton, D.P.; Brisolla, G.; Faria, H.H.; Mattos, I.F.A.; Lobo,M.T.; Barbosa, M.R.; Rossi, M.; Souza, M.G.; Machado, R.B.; Pfeifer, R.M.; Ramos, V.S.; Andrade, W.J. & Contieri, W.A. 2005. Plano de manejo da Estação Ecológica dos Caetetus. *Instituto Florestal Série Registros,* 29:1-104.

Terborgh, J.; Robinson, S.K.; Parker III, T.A.; Munn, C.A. & Pierpoint, N. 1990. Structure and organization of an Amazonian forest community. *Ecological Monographs,* 60:213-238.

Thompson, W.L. 2002. Towards reliable bird surveys: accounting for individuals present but not detected. *Auk,* 119:18-25.

Verner, J. 1985. Assessment of counting techniques. *Current Ornithology,* 2:247-302.

Verner, J. & Ritter, L.V. 1986. Hourly variation in morning point count of birds. *Auk,* 103:117-124.

Volpato, G.H.; Lopes, E.V.; Mendonça, L.B.; Boçon, R.; Bisheimer, M.V.; Serafini, P.P. & Anjos, L. 2009. The use of the point count method for bird survey in the Atlantic Forest. *Zoologia,* 26:14-78.

Vorisek, P.; Gregory, R.D.; Strien, A.J. & Meylig, A.G. 2008. Population trends of a 48 common terrestrial bird species in Europe: results from the Pan-European Common Bird Monitoring Scheme. *Revista Catalana d'Ornitologia,* 24:4-14.

Watson, D.M. 2003. The 'standardized search': an improved way to conduct bird surveys. *Austral Ecology,* 28:515-525.

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APPENDIX

List of 15 forest species reported from Caetetus Ecological Station (Cavarzere *et al.,* 2009), but never recorded during this study. Question marks indicate undocumented records of probable misidentified species.

Species	Atlantic forest endemic
Phaethornis squalidus	x
Nonnula rubecula	
Ramphastos dicolorus	x
Pteroglossus bailloni	x
Picumnus temminckii?	x
Scytalopus speluncae?	x
Philydor atricapillus?	x
Philydor rufum?	
Capsiempis flaveola	
Attila rufus?	x
Hylophilus poicilotis?	x
Cissopis leverianus	
Hemithraupis ruficapilla	x
Amaurospiza moesta?	
Cacicus haemorrhous	

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