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On the use of 10-minute point counts and 10-species lists for surveying birds in lowland Atlantic Forests in southeastern Brazil

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ABSTRACT

Due to rapid and continuous deforestation, recent bird surveys in the Atlantic Forest are following rapid assessment programs to accumulate significant amounts of data during short periods of time. During this study, two surveying methods were used to evaluate which technique rapidly accumulated most species (> 90% of the estimated empirical value) at lowland Atlantic Forests in the state of São Paulo, southeastern Brazil. Birds were counted during the 2008-2010 breeding seasons using 10-minute point counts and 10-species lists. Overall, point counting detected as many species as lists (79 vs. 83, respectively), and 88 points (14.7 h) detected 90% of the estimated species richness. Forty-one lists were insufficient to detect 90% of all species. However, lists accumulated species faster in a shorter time period, probably due to the nature of the point count method in which species detected while moving between points are not considered. Rapid assessment programs in these forests will rapidly detect more species using 10-species lists. Both methods shared 63% of all forest species, but this may be due to spatial and temporal mismatch between samplings of each method.

Key-Words: Bertioga, Bird species richness; MacKinnon lists; Rapid assessment programs; Surveying methods.

INTRODUCTION

In light of increasing destruction of forests and wide gaps in the understanding of tropical bird communities, several researchers have recently applied a rapid assessment approach to maximize data collection with limited funds, time, and personnel (Parker & Bailey, 1991; Poulsen *et al.,* 1997). Some auditory-visual rapid assessments employ standard techniques for surveying birds, such as point counts (Poulsen & Krabbe, 1998) or line transects (Karr, 1971). Although those methods generate quantifiable data with well-established sampling protocols, they present several disadvantages for rapid assessments, such as: they are often difficult to apply under tropical field conditions; require highly qualified observers (Poulsen *et al.,* 1997); and tend to underestimate the richness and abundance of some groups (*e.g.,* nocturnal

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species). Nonetheless, point counts remain widely used in surveying birds in Neotropical forests.

MacKinnon & Phillips (1993) suggested a quantitative approach to analyzing auditory-visual survey data that accounts for differences in effort, observer qualifications and weather (Poulsen *et al.,* 1997). In this method, observations are grouped into consecutive lists of 20 species, and a species accumulation curve is generated from the addition of those species not recorded on any previous list to the total species number, which is then plotted as a function of list number. It is crucial to include even observations that cannot be positively identified at first (Poulsen *et al.,* 1997). Because the method relates species richness to the number of observations rather than to time, area or walking speed, this method allows for comparison of data obtained by different observers or under varying field conditions (Herzog *et al.,* 2002).

Point counts have been tested in Neotropical systems and some authors concluded that 5- to 10-min counts are ideal for detecting a significant number of species, including endemic and threatened species (Develey, 2004; Esquivel & Peris, 2008). In addition, Herzog *et al.* (2002) suggested the use of 10-species lists in tropical regions as a solution between 5-, 10- and 20-species lists. Ribon (2010) further suggested that species lists are better than any other method for surveying birds, but the author did not give empirical examples or comparisons for his statement. The list method of avifaunal assessment has been increasingly adopted for tropical bird studies worldwide, from Indonesia (MacKinnon & Phillips, 1993; Trainor, 2002a,b), to mainland Africa (Fjeldså, 1999), Madagascar (O'dea *et al.* 2004), and South America (Poulsen *et al.,* 1997; O'dea *et al.,* 2004; Herzog & Kessler, 2006; Herzog, 2008). It has also been promoted as a potentially useful technique in a manual on bird census methods (Bibby *et al.,* 2000). In this study, we surveyed forest birds using 10-min point counts and 10-species lists in lowland Atlantic Forests in southeastern Brazil to test the hypothesis that both methods equally detect most bird species (> 90% of the estimated species richness) during short periods of time, making them suitable for rapid assessment programs.

MATERIAL AND METHODS

Study area

We carried out bird counts in the coastline municipalities of Bertioga and Santos (23°57'S, 46°19'W and 23°51'S, 46°08'W, respectively) in the state of São Paulo, southeastern Brazil (Fig. 1). Bertioga has about 480 km^2 of Atlantic Forest, 85% of which constitutes areas of environmental protection (Maia *et al.,* 2008). According to Köppen's classification, the climate of the region is "Af", humid or super humid tropical, with rains distributed throughout the year (Nascimento & Pereira, 1988). Climatologic data monitored between 1941 and 1970 indicates that the mean annual temperature is 24.8°C, with lowest and highest monthly means of 20.7°C in July and 28.3°C in February, respectively. Bertioga is one of the most humid regions in Brazil, with mean annual rainfall of more than 3,200 mm, with the lowest mean rainfall in July (111 mm) and the highest in February (410 mm; Martins *et al.,* 2008). Two locations were surveyed in the municipality of Santos, which abuts Bertioga to the west. Forests are continuous and the climate is quite similar.

Bird survey

We cleared an existing trail ranging from 0 to 400 m in Bertioga (bordered by the Rio Guaratuba). This steep trail is narrow (< 1 m wide) and is still used to access the Boraceia Biological Station in the municipality of Salesópolis at the 800 m high plateaus of Serra do Mar (Cavarzere *et al.,* 2010). Lower elevations had signs of human disturbance, such as selective logging (especially the palm tree *Euterpe edulis*) and hunting trails, while stations above 300 m seemed undisturbed with scarce understory. VC used point counts at this Bertioga location for two breeding seasons (August 31-September 1, October 24-November 8, November 25-28, 2008; November 14-29, 2009), beginning 15 min before sunrise. This elevational gradient included five 100 m elevational bands; to each band was assigned three point counts 200 m apart, which were visited for six nonconsecutive days. The same individuals were not recorded again if it was certain that they had been previously detected. As most species were registered by vocalization, successive recordings were made of simultaneously singing/calling individuals, and/or of vocalizations widely separated in space.

TVVC surveyed birds with 10-species lists during one reproductive season in Bertioga and Santos, including the vicinity of the Rio Itatinga, on the 16^{th}, 18^{th}, 20^{th} and 22^{nd} of December 2010. We followed Herzog *et al.*'s (2002) recommendations for using n-species lists, adopting their modifications of the method as follows: 10-species lists were chosen

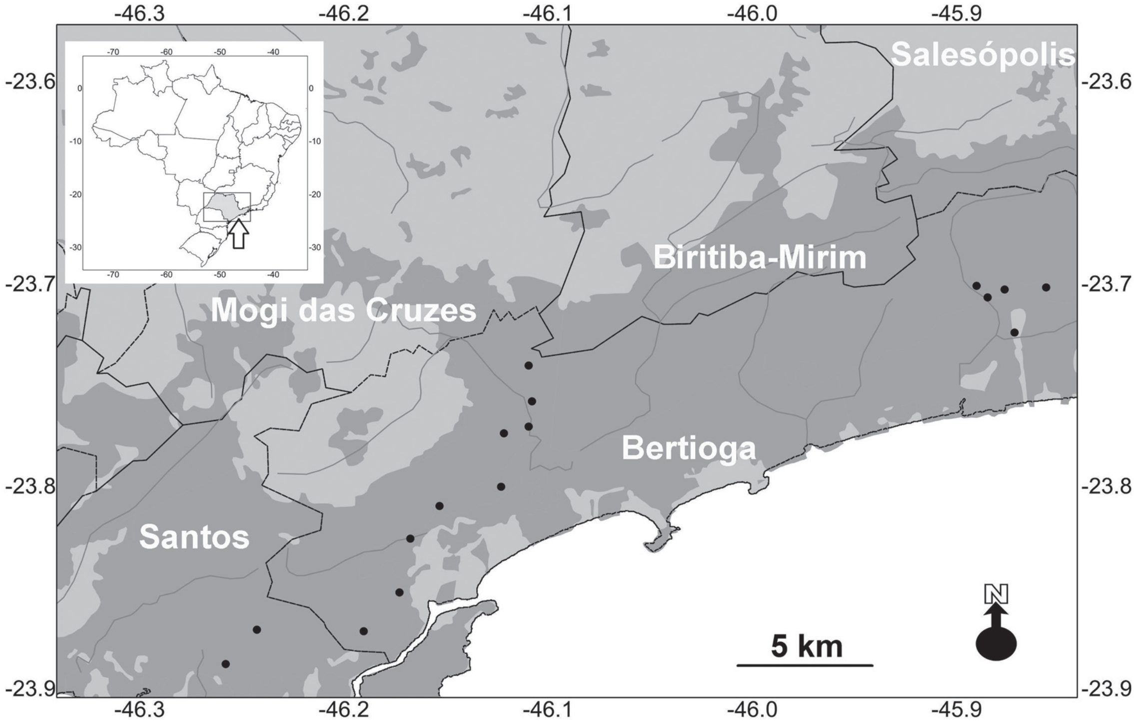

FIGURE 1: Locations where point counts (right) and species lists (left) were conducted in the municipalities of Bertioga and Santos, state of São Paulo, southeastern Brazil.

as an intermediate solution among 5-, 10- and 20-species lists regarding estimation of species richness, sample size and bird community pool. The observer took descriptions or sound recordings of any bird not immediately identified, but that were seen or heard sufficiently well for identification. These individuals were subsequently identified using standard reference work. More than one individual was considered if a species was sexually dimorphic (*e.g.,* antbirds).

Records were restricted to a 50 m limited radius of detection for both methods, thus data were recorded from a standardized survey area (path length of lists ca. 12 km). Bird records consisted of individuals heard and/or seen with the help of 8 × 40 binoculars. Observers had been very familiar with Atlantic Forest birds for more than five years and we believe that differences in identification did not introduce major detection bias to our analyses. There was no bird counting on rainy or windy days. Over a total of 63 non-continuous days of fieldwork, 90 point counts were conducted (15 h) and 41 10-species lists were accumulated (~ 16 h). Recordings of individuals (with a Sennheiser ME-66 directional microphone and a Zoom H4N digital recorder) were deposited at the Seção de Aves of the Museu de Zoologia da Universidade de São Paulo (MZUSP).

Analyses

When analyzing point counts each point was considered a sample, whereas the number of 10-species lists was considered a sample for the list method. We used the Sørensen Similarity Index to evaluate similarities of species richness between point counts and lists (Chao *et al.,* 2005). Herzog *et al.* (2002) suggested using the Chao1 estimator to compare the estimated species richness to the observed species richness. This should be done until the observed species richness is > 90% of the respective Chao1 estimate. This nonparametric estimator, as well as 50-times randomized accumulation curves, was produced with EstimateS 8.2 (Colwell, 2009). A plateau in species accumulation was defined as the point at which the rate of species accumulation over a 10-sample interval fell below 0.10 (O'dea *et al.,* 2004). Atlantic Forest endemic species follow Parker *et al.* (1996), except for *Florisuga fusca, Thalurania glaucopis, Baryphthengus ruficapillus, Trogon surrucura* and *Automolus leucophthalmus,* which may not be endemics according to Cavarzere *et al.* (2011).

RESULTS AND DISCUSSION

Point counting recorded 992 individuals of 79 species (71% of all observed species) including 28 exclusive records, whereas lists recorded 306 individuals of 83 (74%) species with 32 species in addition to those recorded during point counting; the accumulated number of species was 111 (Appendix). The similarity index between methods was 0,63 with 51 shared species, indicating that as many as 37% of all species were absent from either method. These differences could be due to spatial and temporal mismatch between the times when each survey was carried out, the high turnover expected among samples of diverse communities, or the similar nature of detection of methods (visual and aural). Figure 2 shows the change in estimation of total species richness calculated by the Chao1 estimator as sample size increases. For point counts the predicted value was 88 species, in which case 88 point counts (14.7 h) were enough to detect > 90% of all species. On the other hand, lists recorded only 83% of the estimated number of species (99), suggesting that a greater number of lists (> 41) were still needed to record most species in those areas. Compared to point counts, 10-species lists recorded a lesser percentage of the predicted species richness, but recorded more species than point counts with only 22% of the total number of samples. Species-rich environments represent difficult case studies because applying rapid assessment surveys require more samples or sampling effort (time). However, we are confident that our results accurately describe empirical patterns, as estimations remain effective, even with as many as 23 list samples in the survey effort (MacLeod *et al.,* 2011).

The estimate of total species richness did not stabilize within the available sampling effort because we continued to encounter new species throughout the sampling period. As such, it is not possible to state with confidence the magnitude of species richness for the area based on empirical data, even after extensive sampling (O'dea *et al.,* 2004). Although the rate of species accumulation did not drop below 0.10, 80 point counts obtained a rather similar rate (~ 0.12) as 40 lists with roughly the same number of hours spent on both methods (Fig. 3). The Chao1 list estimate approached the rate of 0.10 more rapidly (less samples) than the estimate for the point count data, indicating a faster accumulation of species richness. This evidences that the use of lists may maximize species detection under a fixed time period. O'dea *et al.* (2004) have also demonstrated that list accumulation curves tend to approach the recorded species richness of the area more closely while point counts probably need many samples, as the species recorded while moving between points are not considered.

Because sampling efforts differ between methods, we produced species curves to compare the

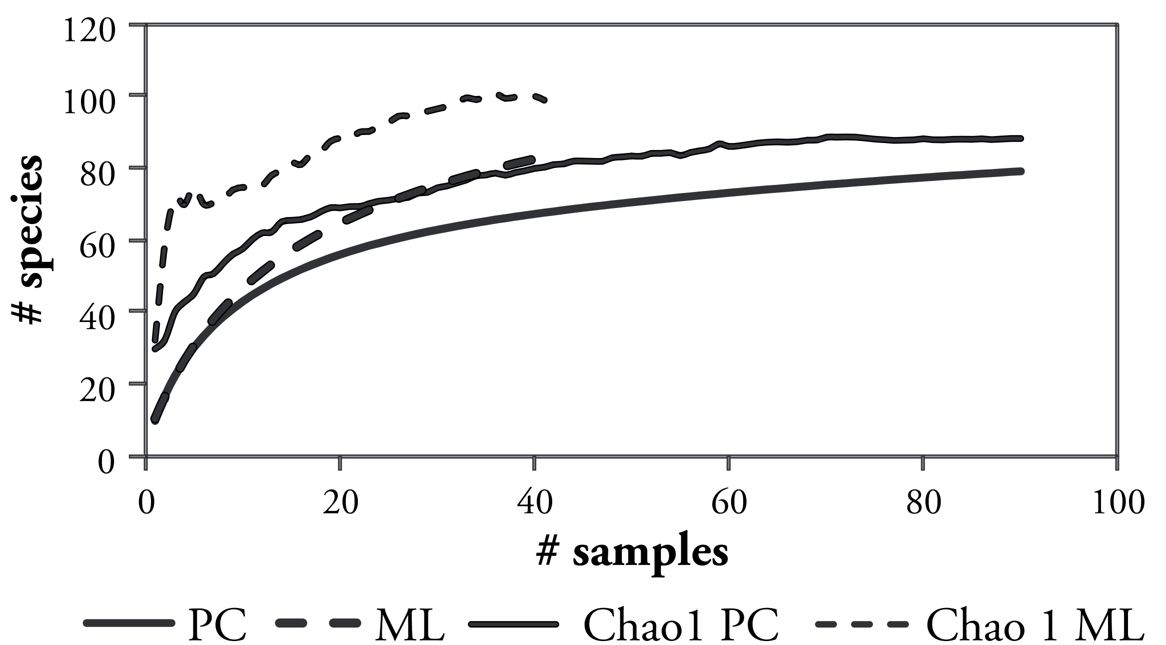

FIGURE 2: Species accumulation curves and estimation curves using the Chao1 estimator for bird communities in the municipalities of Bertioga and Santos, state of São Paulo, southeastern Brazil, using MacKinnon lists (one sample = one 10-species list) and point counts (one sample = one point count). Each curve represents the average values of 50 randomizations of the sampling order.

accumulation of species richness as a function of the number of surveying days. Within four days point counts detected 45 species, whereas 83 species were accumulated from lists (Fig. 4). Point counts present the advantage of detecting species that would have gone unnoticed if an observer walked past through a particular site without staying for at least 10 minutes. However, the fact that species detected during movement between points are not considered by this method seems to strongly hinder the rapid assessment of the avifauna. Also, the list method may better record rare and vagrant species because it allows continuous

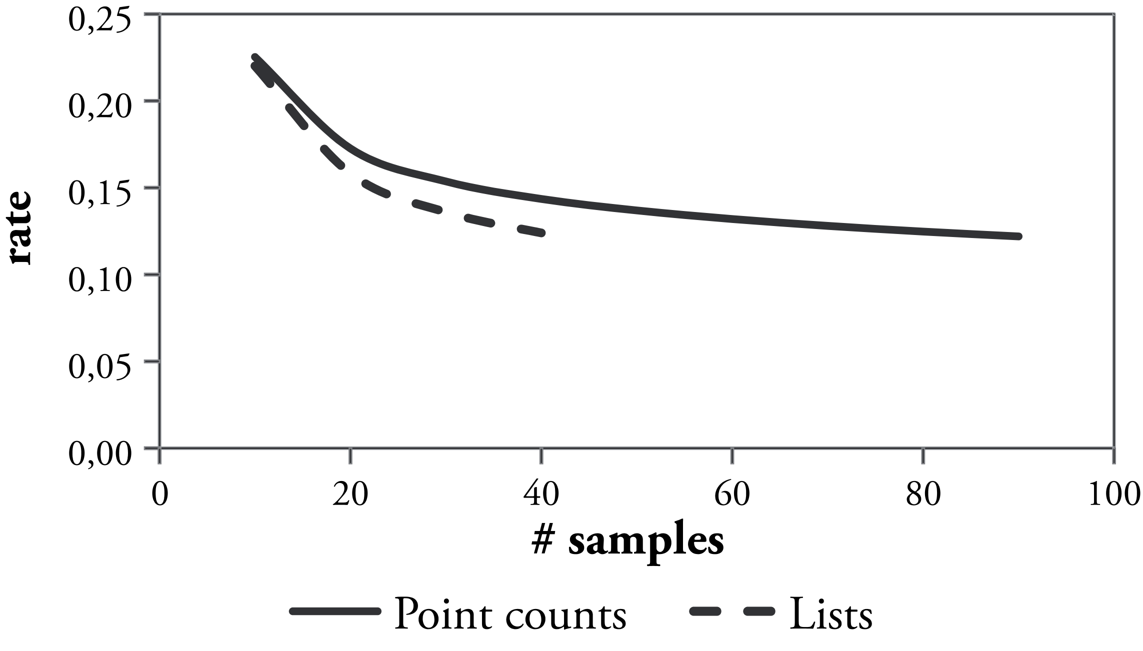

FIGURE 3: Successional rate of species accumulation over a 10-sample interval for lists and point counts.

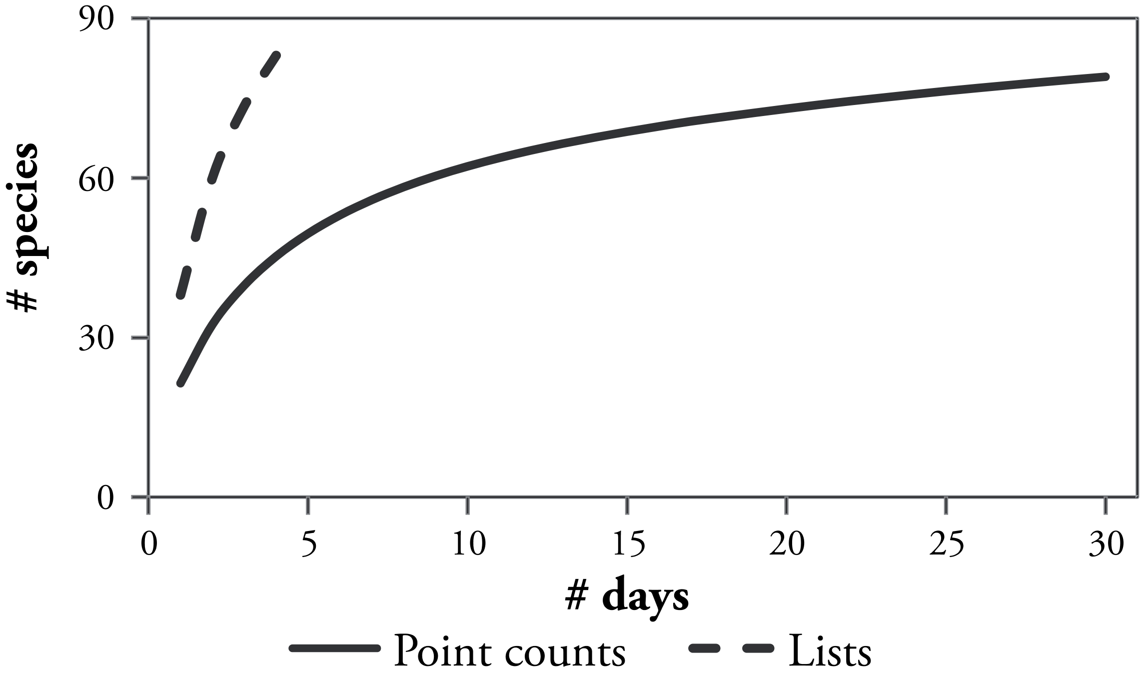

FIGURE 4: Species accumulation curves of bird species surveyed with 10-species lists and 10-minute point counts as a function of the number of days in lowland Atlantic Forests in the municipalities of Bertioga and Santos, state of São Paulo, southeastern Brazil.

recording and active searching (Fjeldså, 1999). It also allows a greater proportion of the available time to be spent in the field collecting bird survey data, and more species are recorded using the list technique due to its flexibility in continuously recording data and actively searching out new species (O'dea *et al.* 2004). Given that the duration of field expeditions is usually defined as the amount of surveying days, our results again favor the use of species lists if the goal is to maximize the number of species detected in a fixed amount of time.

The advantage of point counts relative to the list method remains for estimating relative abundances. Point counting with spatial and temporal standardization means that their biases are more readily quantifiable and controllable (O'dea *et al.,* 2004). Lists, when standardized, are neither easier nor superior to point counts; what they provide is an efficient means of determining species richness in a species-rich environment, as well as cataloguing the species systematically missed by point counts (Poulsen *et al.,* 1997). Since lists usually do not take the number of individuals into account, their abundance indices are rougher than those obtained by point counts. As lists do not standardize area or time surveyed, they can hinder comparisons of abundances among surveys. Thus, the complementarity of methods should maximize bird surveys if their strengths and weaknesses are applied together, *i.e.,* rapid detections with lists and abundance estimate with point counts (O'dea *et al.,* 2004; MacLeod *et al.,* 2011). Lists have been shown to produce consistent abundance indices for the majority of species in a tropical forest bird community in Bolivia within a short time period, especially by comparing abundance estimates for species of conservation importance. Although its efficiency in generating consistent abundance indices suggests that it has excellent potential as a rapid assessment and monitoring tool, it will be particularly important to study how relative abundance indices generated by the list method compare to density estimates generated by more traditional methodologies (MacLeod *et al.,* 2011).

Major advantages of lists are their simplicity, their potential to collect large amounts of data, and that they are highly time-efficient compared with point and transect data. This is mainly in view of the logistical realities in the tropical forests and for securing a broad coverage of the study area. Furthermore, lists do not appear to be more biased than other observational approaches, judging from the very close correlation with data obtained by a more time-consuming method (Fjeldså, 1999). Whereas the purpose of a survey is simply to assess the overall species richness of an area, lists appear to be the most effective tool. It seems to be a promising technique, as it is a means of accumulating species richness at a faster pace. Complete surveys continue to require the use of a combination of methods in which the nature of detection differs, such as visual-auditory *versus* mist nets (Silveira *et al.,* 2010; Somenzari *et al.,* 2011). Due to the fact that few publications use lists for surveying birds in Neotropical regions, we wish to encourage and extend its application. Its wide use will help elucidate its advantages and flaws while generating reliable information on species distribution. Formal comparisons of abundances generated by points and lists in Neotropical forests still remain to be studied.

RESUMO

Devido ao rápido e contínuo desmatamento, inventários avifaunísticos realizados na Mata Atlântica têm seguido protocolos de levantamentos rápidos para acumular uma grande quantidade de informação em períodos de tempo relativamente curtos. Para averiguar qual metodologia deve mais rapidamente acumular o maior número de espécies (cerca de 90% das espécies estimadas a partir de dados empíricos), foram realizados pontos de escuta de 10 minutos e listas de 10 espécies em florestas de baixada da Mata Atlântica de São Paulo durante as estações reprodutivas entre 2008 e 2010. De maneira geral, pontos detectaram tantas espécies quanto as listas (79 versus *83, respectivamente), sendo que 88 pontos (14,7 h) detectaram 90% da riqueza estimada. Quarenta e uma listas foram insuficientes para o registro de 90% da riqueza estimada, porém acumularam mais rapidamente o número de espécies e num período mais curto de tempo, provavelmente devido à natureza da metodologia de pontos de escuta, na qual espécies registradas durante a locomoção entre pontos não são consideradas. Levantamentos rápidos nessas florestas irão rapidamente detectar mais espécies com a utilização das listas de 10 espécies. As metodologias compartilharam 63% das espécies registradas, mas este resultado pode refletir diferenças nas amostragens definidas em localidades e intervalo de tempo distintos durante a realização das amostragens.*

Palavras-Chave: Levantamentos rápidos da avifauna; Listas de MacKinnon; Metodologias de censo; Bertioga; Riqueza de aves.

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APPENDIX

Species recorded with 10-min point counts (PC) and 10-species lists (SL) in the municipalities of Bertioga and Santos, state of São Paulo, southeastern Brazil. The Atlantic Forest column indicates endemic species.

Species	PC	SL	Atlantic Forest
Tinamus solitarius	x	x	x
Crypturellus obsoletus		x	
Crypturellus noctivagus	x	x	x
Chondrohierax uncinatus		x	
Buteo brachyurus		x	
Rupornis magnirotris		x	
Micrastur semitorquatus		x	
Aramides saracura	x	x	x
Patagioenas cayennensis	x	x	
Patagioenas plumbea		x	
Leptotila rufaxilla		x	
Geotrygon montana	x		
Pyrrhura frontalis	x	x	x
Brotogeris tirica	x	x	x
Forpus xanthopterygius		x	
Pionus maximiliani	x	x	
Pulsatrix koeniswaldiana	x		x
Lurocalis semitorquatus	x		
Phaethornis ruber		x	
Florisuga fusca	x	x	
Chaetura cinereiventris	x		
Ramphodon naevius	x		x
Thalurania glaucopis	x		
Amazilia fimbriata		x	
Piaya cayana		x	
Trogon viridis	x	x	
Trogon surrucura	x		
Trogon rufus	x		
Baryphthengus ruficapillus	x	x	
Ramphastos vitellinus	x		
Picumnus cirratus	x		
Picumnus temmincki		x	x
Melanerpes flavifrons	x		x
Veniliornis spilogaster	x	x	x
Celeus flavescens	x	x	
Formicarius colma	x	x	
Hypoedaleus guttatus	x	x	x
Thamnophilus caerulescens		x	
Dysithamnus mentalis	x	x	
Myrmotherula gularis	x		x
Myrmotherula unicolor	x	x	x
Herpsilochmus rufimarginatus	x	x	
Drymophila squamata	x	x	x
Pyriglena leucoptera	x	x	x
Myrmeciza squamosa	x	x	x
Conopophaga melanops	x		x
Grallaria varia	x		
Chamaeza campanisona		x	
Sclerurus scansor	x	x	x
Eleoscytalopus indigoticus		x	x
Sytalopus speluncae		x	x
Merulaxis ater	x	x	x
Dendrocincla turdina	x	x	x
Sittasomus griseicapillus		x	
Xiphocolaptes albicollis	x	x	
Dendrocolaptes platyrostris	x		
Xiphorhynchus fuscus	x	x	x
Automolus leucophthalmus	x		
Philydor atricapillus	x	x	x
Philydor rufum	x		
Cichlocolaptes leucophrus	x		x
Xenops minutus	x	x	
Leptopogon amaurocephalus		x	
Todirostrum poliocephalum		x	x
Hemitriccus orbitatus	x		x
Tolmomyias sulphurescens	x	x	
Myiobius barbatus	x	x	
Lathrotriccus euleri	x	x	
Legatus leucophaius	x	x	
Myiarchus swainsoni		x	
Rhytipterna simplex	x		
Myiodynastes maculatus	x	x	
Attila phoenicurus	x	x	
Attila rufus	x	x	x
Procnias nudicollis		x	x
Chiroxiphia caudata	x	x	x
Oxyruncus cristatus	x		
Schiffornis virescens	x		x
Tityra inquisitor	x		
Tityra cayana		x	
Pachyramphus polychopterus	x		
Pachyramphus marginatus	x		
Pachyramphus validus	x	x	
Cyclarhis gujanensis		x	
Vireo olivaceus	x	x	
Hylophilus poicilotis		x	x
Cantorchilus longirostris	x	x	x
Ramphocaenus melanurus		x	
Turdus flavipes	x	x	
Turdus rufiventris		x	
Turdus albicollis	x	x	
Coereba flaveola	x	x	
Ramphocelus bresilius		x	x
Habia rubica	x	x	
Orthogonys chloricterus	x		x
Tachyphonus coronatus	x	x	x
Trichothraupis melanops	x		x
Thraupis sayaca		x	
Thraupis ornata		x	x
Tangara seledon	x	x	x
Tangara cyanocephala	x	x	x
Tangara cayana		x	
Dacnis cayana	x	x	
Saltator fuliginosus	x	x	x
Saltator similis		x	
Parula pitiayumi	x	x	
Phaeothlypis rivularis	x	x	
Basileuterus culicivorus		x	
Cacicus haemorrhous	x	x	
Euphonia violacea	x		
Euphonia pectoralis	x	x	x