Tropical Agricultural Research and Extension 5(1 & 2) : 2002

Species abundance distributions of bird communities in four agroecosystems

P. U. U. Fernando[1] and N. J. De S. Amarasinghe*
Department of Zoology, Faculty of Science, University of Ruhuna, Matara, Sri Lanka
Fax : 94-041-22701, E-mail: jdesilva@zoo.ruh.ac.lk

Accepted 04th September 2002

ABSTRACT

The fit to log-normal distribution of species abundance of bird communities in four agroecosystems: vegetable cultivation, slash and burn agriculture (*chenas*), paddy cultivation & tea plantation, in the Southern Province of Sri Lanka was analyzed. Point-scan line-transect technique (encounter survey) was employed to estimate bird abundance. None of the distributions differed significantly from log-normal distribution when data were transformed into octave scale of Preston. The dispersion of the log-normal curves was between 2.29-2.70. Compared to predicted values, 69-93 per cent of species theoretically present in the sample area. The analysis showed that log-normal curve is applicable for bird communities in agroecosystems.

Key words: species abundance, log-normal distributions, bird communities, agroecosystems

INTRODUCTION

Species abundance distributions of communities are believed to have characteristic regular patterns. Several studies suggested that these patterns might be useful in detecting ecosystem disturbances (Hill & Hamer, 1998; Hamer *et al.* 1997; Hill *et al.* 1995). Attempts to quantify these patterns mathematically suggested that species abundance data in undisturbed habitats fit log-normal models, whereas, those in disturbed habitats generally fit log-series models (Hill & Hamer, 1998). Therefore, deviation from a log-normal distribution may provide an 'initial' measure of habitat disturbance (Hamer, *et al.* 1997). However, log-normal curves give an empirical description of species abundance, without a known biological basis (Ricklefs, 1978). The biological reality of log-normal distribution is not straightforward (see Basset *et al.* 1998). Nummelin (1998) claimed that log-normal distribution of species abundance is not a universal indication of rainforest disturbances. Watt (1998) also stated that species-abundance models are not useful methods for determining whether or not a forest has been disturbed and they provide no quantitative measure of the degree of disturbance. Hill & Hamer (1998) pointed out that despite Nummelin's claims (1998), it is far too soon to dismiss the usefulness of species-abundance models. They have suggested a number of requirements that should be met for assessing usefulness of species-abundance models as indicators of disturbance. Several authors have recently drawn attention to test whether log-normal patterens of species abundance are reliable indicators of habitat disturbance (Hill *et al.* 1995; Hamer *et al.* 1997). The purpose of this paper was to analyse the species abundance distributions of bird communities in four agroecosystems.

*** Corresponding author**
[1] Present addrss: Cultery Field Station , Dept. Of Zoology, University of Aberdeen, Newburgh, Ellon, AB 41, 6AA, Scotland, UK

METERIALS AND METHODS

Study area

Field work was carried out in four different agroecosystems; vegetable cultivation, slash and burn agriculture (*chenas*), paddy cultivation & tea plantations, in the Southern Province of Sri Lanka, in 1997. In vegetable cultivation a range of vegetables from different families; *Curcubitaceae*, *Leguminosae*, *Malvaceae*, *Solanaceae* etc., was cultivated in small plots. Slash and burn agriculture involved clearing of forest in the dry zone by slash and burn, planting annual crops (cereals, pulses & vegetables) for about three years, and then shifting to another forest patch, leaving the previous one to fallow. "Chenas" had a higher diversity of cultivated crops than vegetable lands. Paddy cultivation, a monocropping system, is a process of many steps having different phases of cultivation; tillage, seeding or transplanting, immature crop, mature crop, harvesting and post-harvesting. Tea plantations are basically monocropping systems with *Albizia moluccana*, *Gliricidia maculata* and

Grevillea robusta as shade trees. The size of vegetable, *chena* and paddy plots ranged from 3-5 ha and tea plots 7-10 ha.

Bird census

Eight replicated plots for each agroecosystem were surveyed for birds over six months period to ensure that communities have been adequetly sampled. These spatial and temporal replicates increased the consistency of species distribution and its shape. Point- scan line- transect technique (encounter survey) described by Bibby *et al.* (1993) was employed to estimate bird abundance. This method avoid potential biase and likely represent the relative abundance of entire bird community. Overall, the emphasis was on achieving a uniform sampling design. To encompass the entire plot, four, 400-m line transects were established. Along each transect, five 'point counts' were spaced 100m apart (a total of 20 points per plot). Each transect was walked for half an hour and all birds seen, heard, or noted flying within a range of 25m radius were recorded during 5-min period at each point. Observations along two different transects were assumed independent. Repeated counting of the same bird was avoided as much as possible. These transect walks were conducted once a month, a total of 10 times, throughout the study, to coincide with the main changes in agriculture cycle and with a part of the migratory season (September-May). Census was carried out between 6:00h-8:45h and again 15:45h-18:30h when visibility and bird activity were highest.

Data analysis

The total abundance of each recorded species in four agroecosystems was estimated, separately, by pooling the data collected during protracted periods of time, at eight replicated plots to ensure sufficient sampling size. Species abundance data; raw data & data transformed into $\log_2$ scale of Preston (see Ricklefs, 1978); for each agroecosystem were fitted to a log-normal distribution and Kolmogorov-Smirnov one-sample statistic was used to test

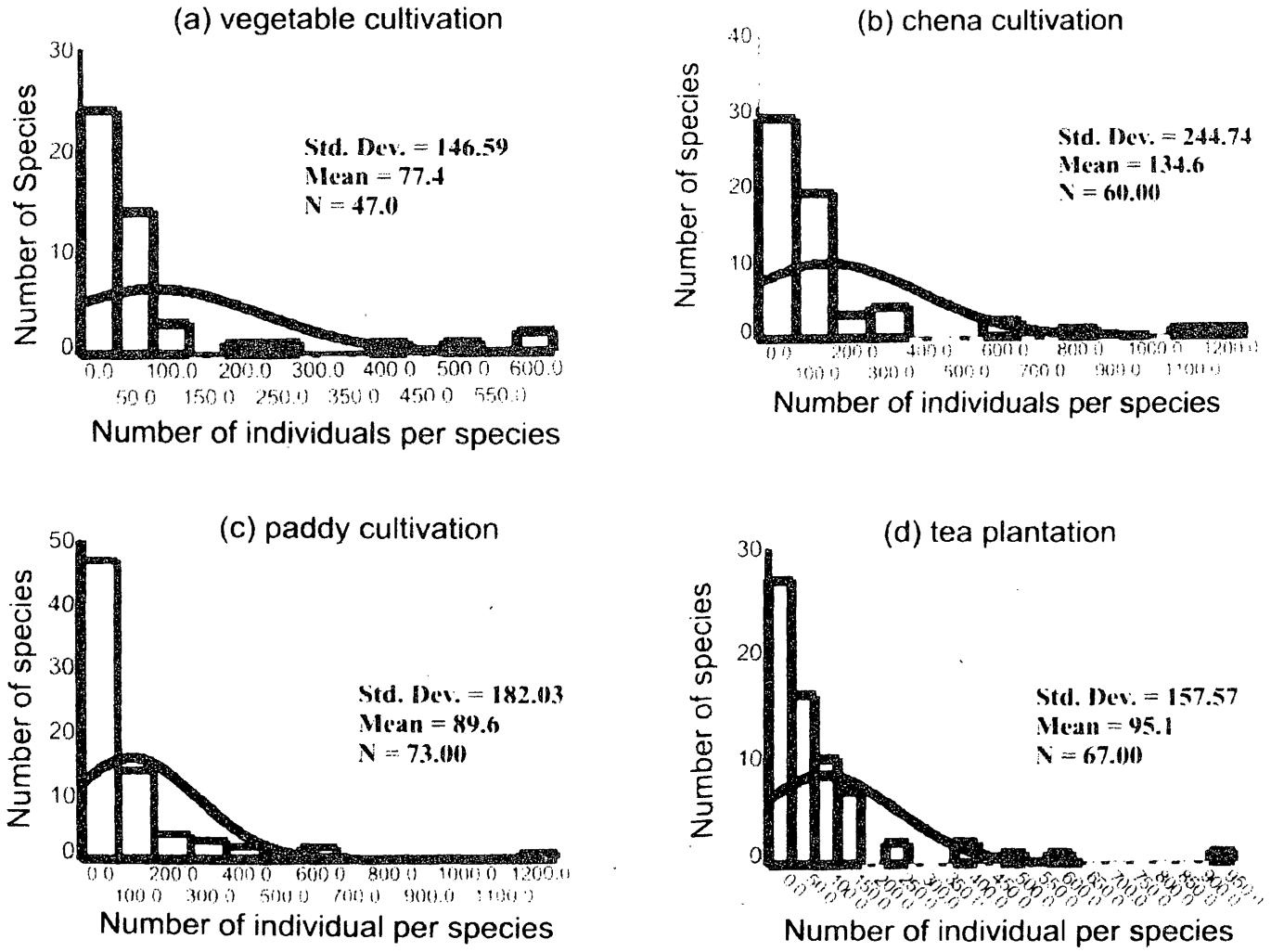

Fig. 1. The abundance of species of birds in four different agroecosystems in the Southern Province, Sri Lanka.

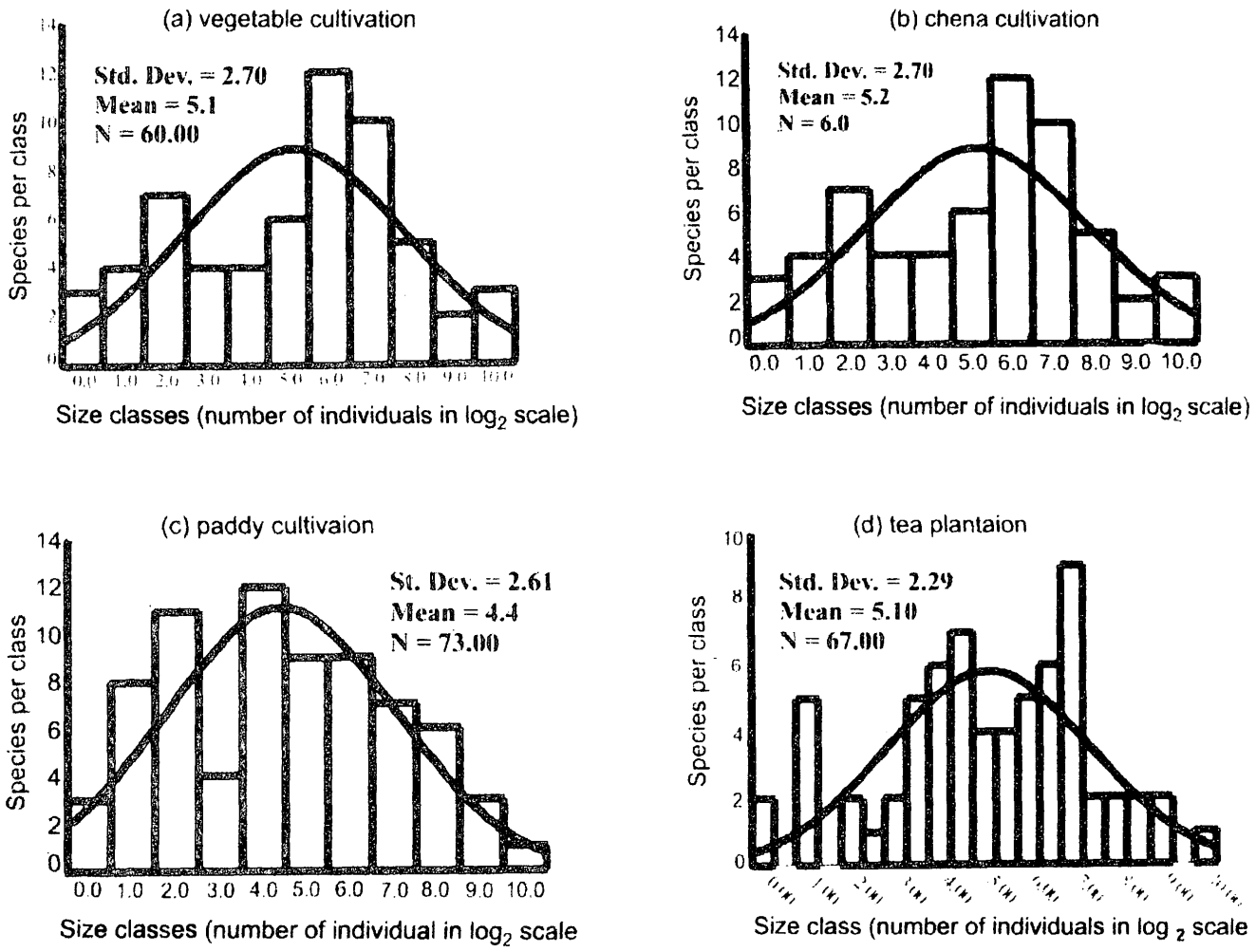

Fig. 2. Log-normal distribution of species abundance of bird communities in four different agroecosystems, in the Southern Province, Sri Lanka.

goodness-of-fit. The analysis was performed on SPSS/PC+ software.

To predict the total number of species (N) in the community, including those not represented in the samples, the equation $N = n_0\sqrt{\pi\sigma^2}$ (Recklefs, 1978) was used where n_0 is the modal abundance class and σ is the dispersion of the log-normal distribution.

RESULTS

A total of 24,628 individuals of 106 species, representing 41 families, were detected in four agroecosystems (Table 1). Untransformed data for species abundance did not fit to the log-normal model (vegetable $Z=2.49$, $P<0.01$; *chena* $Z=2.38$, $P<0.01$; paddy $Z=2.68$, $P<0.01$ & tea $Z= 2.25$, $P<0.01$) (Fig. 1). None of the distributions differed significantly from log-normal distribution when the data were transformed into $\log_2$ scale (vegetable $Z=0.78$, $P=0.29$; *chena* $Z=0.84$, $P=0.24$; paddy $Z=0.75$, $P=0.31$ & tea $Z=0.59$, $P=0.44$) (Fig. 2). The dispersion of log-normal curves was between 2.29 to 2.70. The distributions have shown that species with intermediate numbers of individuals were the most

Table 1. Observed and predicted number of bird species in four different agroecosystems in the Southern Province, Sri Lanka. Eight replicated plots for each agroecosystem were surveyed over six months to obtain ten bird census per plot, in 1997

Variable	Vegetable cultivation	Slash &burn agriculture	Paddy cultivation	Tea plantation
N total	3637	8075	6542	6374
N species (observed)	47	60	73	67
N species (predicted)	68	82	78	86
Percent of species Theoretically present In the area	69.1	73.1	93.1	77.8

prevalent and rare and common species were less frequent. Compared to the predicted numbers of species 69-93 per cent of species were theoretically present in the sample area (Table 1).

DISCUSSION

Species abundance of bird communities in four agroecosystems tends to be described by the log-normal distribution, when the data were transformed into $\log_2$ scale. The analysis concluded that log-normal curve is applicable for bird communities. However, few modal abundance classes were not well exposed in the study. Therefore, bird communities may have not been adequately sampled. The dispersion of log-normal curves was very closer to the value described by Preston (1948) (see Ricklefs, 1978). Since log-normal distributions are supposedly characteristic of equilibrium communities, the study indicated the presence of more complex bird communities in studied agroecosystems. Agricultural lands are generally described as disturbed habitats. There are many contradictory views on the usage of log-normal distribution as indicators of habitat disturbance. On the basis of several claims against log-normal distribution, it is difficult to conclude at this stage, whether the bird communities in four agroecosystems behaved as those in undisturbed habitats. Therefore, further studies on log-normal distributions are needed in the context of habitat disturbance. This would require comparative studies between forest habitats and agroecosystems.

ACKNOWLEDGMENTS

Financial support of the Norwegian Agency for the Development Co-operation (NORAD) and the Center for International Environment and Development Studies (NORAGRIC) and the logistic support of Professor S.W. Kotagama, University of Colombo, Sri Lanka are acknowledged.

REFERENCE

Basset Y, Novotny V, Miller S and Springate ND 1998 Assessing the impact of forest disturbance on tropical invertebrates: some comments. Journal of Applied Ecology, 35: 461-466.

Bibby CJ, Burgess ND and David AH 1993 Bird census techniques. Academic Press, London.

Hamer KC, Hill JK, Lace LA and Langman AM 1997 Ecological and biogeographic effects of forest disturbance on tropical butterflies of Sumba, Indonesia. Journal of Biogeography, 24: 67-75.

Hill JK, Hamer KC, Lace LA and Banham WMT 1995 Effects of selective logging on tropical forest butterflies on Buru, Indonesia. Journal of Applied Ecology, 32: 754-760.

Hill JK and Hamer KC 1998 Using species abundance models as indicators of habitat disturbance in tropical forests. Journal of Applied Ecology, 35: 456-460.

Nummelin M 1998 Log-normal distribution of species abundance is not a universal indicator of rain forest disturbance. Journal of Applied Ecology, 35: 454-457.

Ricklefs ER 1978 Ricklefs Ecology. University of Pennsylvania, Pennsylvania.

Watt AD 1998 Measuring disturbances in tropical forest: a critique of the use of species-abundance models and indicator measures in general. Journal of Applied Ecology, 35: 467-469.