

Vertebrate diversity in a 30 year old regenerated forest with special reference to avifauna

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Introduction

At least two-thirds of the terrestrial environment of the planet consists of managed ecosystems such as agricultural systems, plantation forests and human settlements (McNeely, 1995, Bambaradeniya et al., 2003). Therefore, the value of such managed ecosystems for conservation of biodiversity cannot be overlooked. However, the habitat quality and subsequently the richness and abundance of naturally occurring species in such managed ecosystems can be further improved through planned management. This will not only help biodiversity conservation but also improve the productivity of these ecosystems through stabilizing natural processes such as nutrient recycling, pollination, soil conservation and regulation of pest populations. Further, emerging new economic initiatives such as carbon trading and ecotourism has paved the way to accrue higher economic benefits by converting some of the less productive agro ecosystems to semi-natural ecosystems. Therefore, in recent decades, there has been a major paradigm shift around the world, from the extractive industrial model towards ecology-based approaches variously called eco-agriculture, agro-forestry or analogue forestry (Earles 2005, Scherr & Shames 2006).

Sri Lanka has a tradition of conserving natural resources from prehistoric times which can be attributed to a combination of traditional wisdom, religious and cultural norms and political will shown by its ancient rulers. As a result much of the natural ecosystem was kept intact until the island came under colonial rule. During the British period large extents of land in the wet zone of Sri Lanka were converted into mono-crop plantations. This trend continued even after independence. As a consequence nearly 95% of the rain forests in Sri Lanka were converted for agricultural purposes over the last two centuries. At

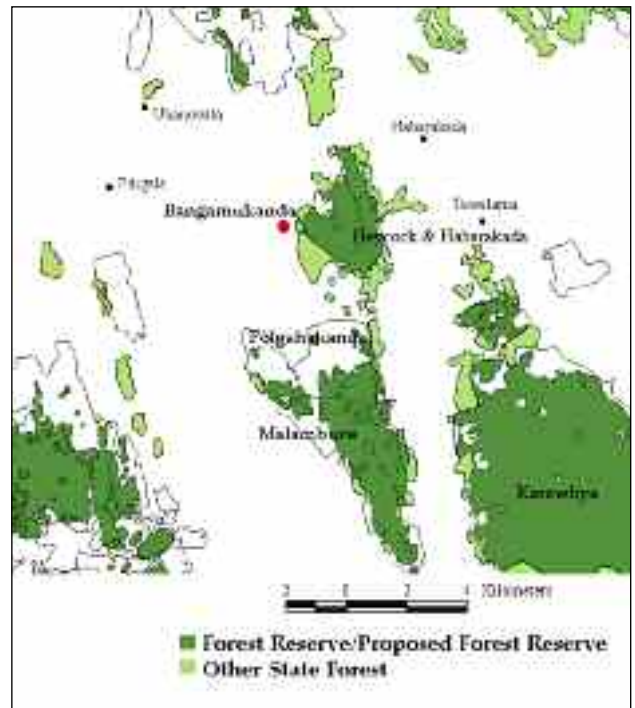


Figure 1. Map showing the study site

present almost two thirds of the land in Sri Lanka can be classified as managed ecosystems (Madduma Bandara, 2000)

Some of these plantations have been abandoned for various reasons and are reverting into semi-natural ecosystems. Bangamukanda Estate is such an example. Here an 18 hectare plantation (tea, rubber and cinnamon) has been deliberately turned into an analogue forest as a direct result of a far-sighted, land use policy adopted by the Government of Sri Lanka during the



period, 1970-1977, with the purpose of promoting crop diversification of uneconomic tea lands.

The Bangamukande Estate is situated in Pittigala, Galle, Sri Lanka. The land consists of undulating terrain that includes a series of ridges and valleys with an altitudinal range of 100m to 300m. There is an intricate network of small streams, which drain into the Benthara River. In 1904 ancestors of the present owner had established a mono crop plantation that consisted of cinnamon, rubber, and tea (Sunil Wimalasuriya per. com.). In 1973 the present owner converted a 12 hectare plot containing cinnamon and tea into an analogue forest, using a government subsidy, under the "crop diversification of uneconomic tea lands" initiative. The remaining rubber area, with an extent of 6 hectares, is been allowed to regenerate naturally while been tapped (Sunil Wimalasuriya per. com.).

The main objective of this study is to document the vertebrate diversity of this 30 year old analogue forest in order to determine the value of analogue forestry for biodiversity conservation with special reference to the birds.

Material and Methods Site description

The Bangamukande Estate (BKE) is situated in the Niyagama Divisional Secretary Area in the Galle District of Sri Lanka, at 06° 20' 46" N - 80° 16' 26" E (Figure 1). The area receives an average annual rainfall of 2300 mm with an average temperature of 28 °C, and relative humidity of 90%.

Three types of vegetation were found at the study site: namely secondary forests (fig.2), abandoned cinnamon plantation and rubber plantation with thick undergrowth (fig.3). A total of 197 plants species were recorded of which 63 (39%) are endemic to Sri Lanka.

BKE is surrounded by several forest reserves. The approximate distance and the direction from BKE to these forest reserves are given in Table 1.

Survey method

Two main sampling methods based on visual encounter survey technique, namely, the fixed line transect method and the quadrat sampling method (Sutherland, 1996), were used to document the vertebrates that are present in the study site. The fixed line transect method was used mainly for avifauna and mammals. Seven fixed transects spanning a total distance of 2.2 km were established within the study site. These transects were traversed twice daily between 06h30 and 09h00 am and again between 16h00 and 18h00. In addition, observations were made opportunistically using random transects conducted between 19h00 and 22h00 and again between 02h00 to 06h00 in an effort to document nocturnal animals. Quadrat sampling was carried out from September to November 2003. A total of eighteen 8 x 8 m quadrates were placed at selected points within the study site. In selecting sites for placing quadrates, areas with a high relief angle or areas

Table 1: Distance and direction from BKE to the adjacent forest reserves

NAME OF FOREST RESERVE	DISTANCE	DIRECTION
Polgahakande-Malabure forest reserve	4 km	South
Hiniduma forest reserve	1 km	East
Beraliya forest reserve	8 km	Southwest
Bangamukanda proposed forest	100 m	Southeast
Kannaliya-Dediyagala-Nakiyadeniya forest reserve	8 km	Southeast
Sinharaja World Heritage site	12.5 km	Northeast
Kalugalkande Forest Hermitage and reserve	11 km	North

Table 2: A summary of the vertebrate species recorded from BKE

VERTEBRATE GROUP	NUMBER OF			
	FAMILIES	SPECIES	ENDEMIC (%)	THREATENED
Freshwater fish	8	23	11 (48%)	1
Amphibians	4	17	7 (24%)	6
Serpentoid reptiles	5	25	6 (24%)	1
Tetrapod reptiles	5	17	7 (41%)	2
Birds	39	89	11 (13%)	1
Mammals	18	34	5 (15%)	4
Total	79	207	48 (23%)	12

adjacent to tree-fall gaps were omitted. A 45 cm height polythene fence was placed along the sides of the quadrat to prevent animals from escaping. Sampling involved sorting through all leaf litter, tree trunks, branches and the underside of stones and logs found in the plot (Heinen 1992). All herpetofaunal species encountered were collected, identified and released on site. All species names were based on checklists published in Bambaradeniya (2006).

Results

A total of 207 species of vertebrates belonging to 79 families was observed at the study site. This consisted of 17 species of amphibians, 25 species of snakes, 17 species of tetrapod reptiles, 23 species of fish, 90 species of birds and 34 species of mammals (Table 2). Of the vertebrate species observed, 48 (23%) were endemic to Sri Lanka. The highest level of endemism was observed among the fresh water fish (48%). The vertebrate assemblage of BKE also included 12 globally threatened species.

The highest diversity among all the vertebrate groups was observed among birds, which comprised of 89

species. This included 11 endemic species, one globally threatened species (*Centropus chlororhynchus*), and three near threatened species as well as ten nationally threatened species of birds. The avifaunal assemblage at BKE additionally included seven species of winter visitors.

Discussion

The results indicate that the Bangamukanda Estate is an agro-ecosystem that sustains high bird species diversity and richness. In addition to the diversity the study site provides niches for a large number of endemic bird species. A comparison of avifaunal diversity in BKE with a separate study conducted in an adjacent region, showed that the avifaunal diversity of a natural ecosystem (Kombala Kottawa Forest Reserve) with three different types of monocultures (Gamage et al., 2007) indicated that the avifaunal diversity of BKE was comparable to that of the natural forest in terms of both species richness and endemism. This showed that BKE made better use of the land in comparison to monoculture based agro ecosystems (Table 3).

Most of the birds use this estate as a temporary refuge

Table 3: Comparison of avifaunal diversity of BKE with a natural ecosystem (Kombala-Kottawa forest reserve and three other agro ecosystems in the bioclimatic zone).

VEGETATION TYPES	NATURAL	TEA	RUBBER	OIL PALM	BKE
Species richness	97	68	63	56	89
Number of endemic species	11	3	2	2	11
Winter visitors	7	6	6	6	7
Nationally threatened species	12	4	2	2	10
Globally threatened species	1	0	0	0	1

or a feeding area as they move from one patch of forest to another. Hence, this type of analogue forest can function as a corridor to link naturally occurring forest patches in a highly fragmented landscape such as can be found in the wet zone of Sri Lanka.

Conclusion

The results suggest that analogue forest systems can support high levels of bird diversity and endemism. Additionally such systems can be used to link fragmented forest patches in the wet zone. However, a detailed study on analogue forest systems should be carried out for further validation of this concept before promoting analogue forestry as a strategy for biodiversity conservation.

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APPENDIX 1. List of birds observed at Bangamukanda Estate.

Abbreviations used:

E - Endemic species

VU - Globally vulnerable species

TR - Nationally threatened species

W - Winter visitor

NT - Globally near-threatened species

1. *Phalacrocorax niger* Little Cormorant
2. *Bubulcus ibis* Cattle Egret
3. *Egretta garzetta* Little Egret
4. *Ardeola grayii* Pond Heron
5. *Ictinaetus malayensis* Black Eagle
6. *Haliastur indus* Brahminy Kite
7. *Spizaetus cirrhatus* Changeable Hawk Eagle
8. *Spilornis cheela* Crested Serpent Eagle
9. *Accipiter badius* Shikra
10. *Gallus lafayetii* E Sri Lanka Junglefowl
11. *Galloperdix bicalcarata* E, TR Sri Lanka Spurfowl
12. *Amaurornis phoenicurus* White Breasted Water Hen
13. *Chalcophaps indica* Emerald Dove
14. *Ducula aenea* Green Imperial Pigeon
15. *Treron bicincta* Orange Breasted Green-Pigeon
16. *Treron pompadora* Pompadour Green-Pigeon
17. *Streptopelia chinensis* Spotted Dove
18. *Psittacula krameri* Rose-ringed Parakeet
19. *Psittacula cyanocephala* Plum-headed Parakeet
20. *Loriculus beryllinus* E, TR Sri Lanka Hanging Parakeet
21. *Eudynamys scolopacea* Asian Koel
22. *Centropus sinensis* Greater Coucal
23. *Centropus chlororhynchus* E, TR, VU Sri Lanka Green-billed Coucal
24. *Bubo nipalensis* Spot-bellied Eagle Owl
25. *Glaucidium castanonotum* E, TR, NT Sri Lanka Chestnut-backed Owlet
26. *Strix leptogrammica* Brown Wood Owl
27. *Ketupa zeylonensis* Brown Fish Owl
28. *Batrachostomus moniliger* Frogmouth
29. *Cypsiurus balasiensis* Asian Palm Swift
30. *Hemiprocne coronata* Crested Tree Swift
31. *Harpactes fasciatus* Malabar Trogon
32. *Ceyx erithacus* Oriental Dwarf Kingfisher
33. *Alcedo atthis* Common Kingfisher
34. *Halcyon smyrnensis* White-breasted Kingfisher
35. *Merops philippinus* W Blue-tailed Bee-eater
36. *Merops leschenaulti* Chestnut-headed Bee-eater
37. *Eurystomus orientalis* TR Dollarbird
38. *Ocyrceros gingalensis* E, TR Sri Lanka Grey Hornbill
39. *Megalaima zeylanica* Brown-headed Barbet
40. *Megalaima rubricapilla* Crimson-fronted Barbet
41. *Megalaima flavifrons* E, TR Sri Lanka Yellow-fronted Barbet
42. *Chrysocolaptes lucidus* Greater Flame-back
43. *Dendrocopos nanus* Brown-capped Pygmy Woodpecker
44. *Dinopium benghalense* Black-rumped Flameback
45. *Pitta brachyura* W Indian Pitta
46. *Dendronanthus indicus* W Forest Wagtail
47. *Hirundo daurica* Red-rumped Swallow
48. *Corvus macrorhynchos* Large-billed Crow
49. *Pericrocotus flammeus* Scarlet Minivet
50. *Pericrocotus cinnamomeus* Small Minivet
51. *Aegithina tiphia* Common Iora
52. *Terpsiphone paradisi* Asian Paradise-flycatcher
53. *Rhipidura aureola* White-browed Fantail
54. *Oriolus xanthornus* Black-hooded Oriole
55. *Dicrurus caerulescens* White-bellied Drongo
56. *Dicrurus paradiseus lophorhinus* Crested Drongo
57. *Artamus fuscus* Ashy Woodswallow
58. *Hypsipetes leucocephalus* Black Bulbul
59. *Pycnonotus melanicterus* Black-crested Bulbul
60. *Pycnonotus cafer* Red-vented Bulbul
61. *Pycnonotus luteolus* White-browed Bulbul
62. *Iole indica* Yellow-browed Bulbul
63. *Lonchura striata* White-rumped Munia
64. *Lonchura punctulata* Scaly-breasted Munia
65. *Chloropsis cochinchinensis* Blue-winged Leafbird
66. *Chloropsis aurifrons* Gold-fronted Leafbird
67. *Lanius cristatus* W Brown Shrike
68. *Muscicapa daurica* W Asian Brown Flycatcher
69. *Hypothymis azurea* Black-naped Monarch
70. *Copsychus saularis* Oriental Magpie Robin
71. *Cyornis tickelliae* Tickell's Blue Flycatcher
72. *Sitta frontalis* Velvet-fronted Nuthatch
73. *Orthotomus sutorius* Common Tailorbird
74. *Phylloscopus trochiloides* W Greenish Warbler
75. *Phylloscopus magnirostris* W Large-billed Leaf Warbler
76. *Turdoides affinis* Yellow-billed Babbler
77. *Rhopocichla atriceps* Dark-fronted Babbler
78. *Pellorneum fuscocapillum* E, TR Sri Lanka Brown capped babbler
79. *Pomatorhinus horsfieldii* E Sri Lanka Scimitar Babbler
80. *Parus major* Great Tit
81. *Dicaeum vincens* E, TR, NT Sri Lanka Legge's Flowerpecker
82. *Dicaeum erythrorhynchos* Pale-billed Flowerpecker
83. *Nectarina zeylonica* Purple-rumped Sunbird
84. *Nectarina lotenia* Loten's Sunbird
85. *Nectarina asiatica* Purple Sunbird
86. *Zosterops palpebrosus* Oriental White-eye
87. *Acridotheres tristis* Common Myna
88. *Gracula religiosa* Hill Myna
89. *Gracula ptilogenys* E, TR, NT Sri Lanka Myna