ISSN: 2457-0761

JBC-APRF-1(2): 20-20, 2018

# JOURNAL OF BIODIVERSITY AND CONSERVATION

# Pattern of Butterfly Response across Habitat Gradients in Midhill Mountains of Nepal

Daya Ram Bhusal[1]* Dibya Rai[2] Kishor Dahal[2]
[1]Central Department of Zoology, Institute of Science and Technology
Tribhuvan University, Kirtipur, Kathmandu Nepal
[2]Himalayan biodiversity Network -Nepal (HBN-Nepal)
*drbhusal@cdztu.edu.np

ARTICLE INFO

Article History
Received: 15 September 2017
Received in revised form: 7 October 2017
Accepted: 22 Ocrober 2017

*Keywords:* Habitat fragmentation, Biodiversity loss, Butterfly richness, crop land, human settlement

**ABSTRACT**

We examined how species richness and abundance of butterfly is affected by habitat gradients across midhill mountains of Nepal. Butterfly specimens were sampled from three habitats (forest, crop land and human settlement) in across three sites of western, Mid and eastern parts (Ghandruk area, Kathmandu area, and Sankhuwasabha area) of Nepal. The butterfly was observed extensively in May to September following accessible walking trail along sampling habitats. The similar pattern was observed for species abundance, taxonomic distinctness (Δ+) and diversity pattern comparing all three sites. High richness and abundance was observed in crop land following forest and lowest butterfly assemblage was resulted in human settlement gradient.

## INTRODUCTION

Anthropogenic environmental pressures driven by land use and climate change are changing natural habitats (Root et al.,, 2003) that affecting the habitats of many species of invertebrates. Butterflies (Insecta-Lepodoptera) are taxonomically well studied group and these are considered as the indicators of ecosystem change and are used to predict various environmental alterations (Rakosy and Schmit, 2011). Globally, the population of butterfly is declining due to different natural and anthropogenic disturbances (Shukal and Maini, 2015). Habitat fragmentation and deterioration of habitat quality are the two major threats to biodiversity loss worldwide. Understanding the impact of land use patterns on biodiversity is a major challenging factor for ecologists and conservationists. The effects of urbanization on butterfly assemblages have rarely been investigated. Human pressures on the environment are changing spatially and temporally, with profound implications for the planet's biodiversity. Global study shows the rapid habitat fragmentation and deterioration threatening the decline of insect biodiversity (Thomas et al., 2004; Krauss et al.,, 2010; Stefanescu et al., 2011). Butterflies are sensitive to environmental changes and thus model organism for ecosystem monitoring (Bourn and Thomas 2002; Hayes et al., 2009; Bonebrake et al., 2010). Many of butterfly species are strictly prefer only a particular set of habitats and they are good indicators in terms of anthropogenic disturbance and habitat quality (Kocher and Williams, 2000). Many studies support anthropogenic pressure, climate change and intensification of land use threatening natural habitats (Root et al., 2003). How butterfly respond to habitat gradients is a necessary step towards the development of effective conservation measures in highly vulnerable mountain ecosystem in many parts of the world. Nepal incorporates the Palaearctic and the oriental bio-geographical regions creating a unique and rich terrestrial biodiversity and boasts an excellent representation of butterflies (Smith, 1993; 2010). Nepal has 663 listed species under 11 families (Smith, 2010) and some 29 species and subspecies of butterfly have been found to be endemic to the country (Khanal, 2008). Many endemics butterflies of Nepal are fast disappearing and about 18% species of the mid hill zones are considered as threatened (BPN1996; Bhusal and khanal, 2008; Thapa and Bhusal, 2009). Butterflies provide important ecosystem services by enhancing the reproductive success of many crops and native wild plant in midhill of Nepal. Habitat degradation due to anthropogenic activities like extension agro-pastural land, increased urbanization, rapid infrastructure development, deforestation and other natural causes like land slide eventually loss of valuable habitats of many rare butterfly species in midhill of Nepal (Thapa and Bhusal, 2009). The aim of this study was to investigate the response of butterfly abundance and diversity across different habitat gradients (human settlement, crop land and forest in western, middle and eastern sites of Nepal.

## MATERIALS AND METHODS

*The Study Area*

The study was conducted across three sites (Ghandruk- 28.377°N 83.807°E (western site), Kathmandu valley- 27.6667° N, 85.3500° E(Mid site) and Shankhuwasabha area- 27.6142° N, 87.1423° E (Eastern sites) of Mid-hill Mountains of Nepal. The altitudinal ranges comprises between 1000- 3000 m asl. These studies are facing rapid urbanization, land use change and fragmented landscape (MFSC, 2014). The midhill mountains also possess the greatest ecosystem diversity (Dobremez, 1996) as well as species diversity due to its diverse microclimatic variation that represents sub-tropical to temperate climate and has unique cultural landscape having 27.97% of agriculture land and 40% of forest (Paudel and Kindlmann, 2012) and Grasslands ecosystem with heterogeneous flowering herbs and crops.

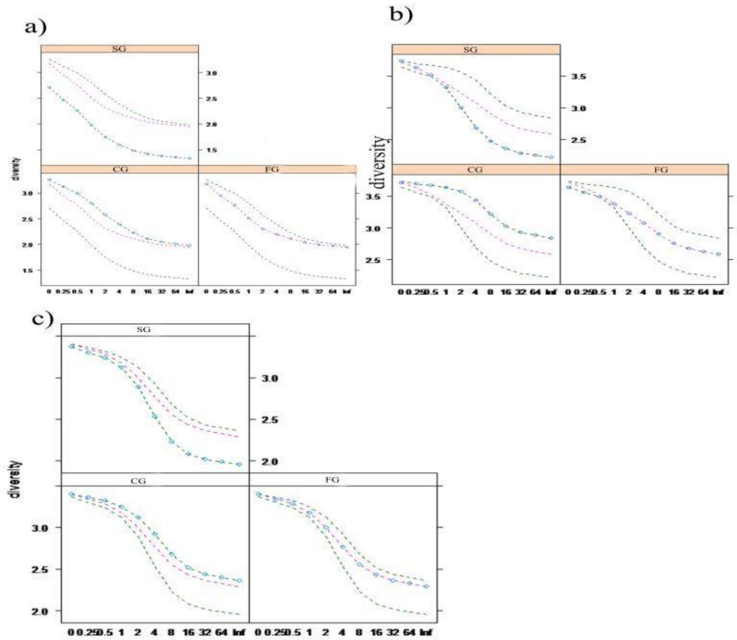
Due to combined effect of climatic and topographic variation, this area comprises wide range of bio-climatic zones hosting a rich biological diversity. Different types of vegetations were found in three different habitats. In forest, vegetation like *Alnus nepalensis, Arundinaria aristata, Bauhinia variegate, Berberis aristata, Brassiopsis polycantha, Castanopsis indica, Ficus nerifolia, Ficus roxburghii Michelia champaca, Quercus semicarpifolia, Rhododendron arboretum, Rubus ellipticus, Taxus bacatta, Urtica dioca, Gentiana carinata, G. viola* etc. are found. Human settlement comprised different types of vegetations like *Tagetes* sp., *Fagopyrum dibotrys, Oxalis corniculata, Cyanodon dactylon, Cyperus* sp., *Geranium* sp., *Braaaica juncea, B. oleracea, Cirsium verutum,* etc. *Oryzae sativa, Triticum aestivum, Brassica nigra, Rubus ellipticus, Bidens pilosa, Oxalis corniculata, Fagopyrum dibotrys,* etc. are the flora found in cropland.

**Sampling and identification**

Direct observation of Butterfly was carried extensively in three types of habitat gradients crop land, forest habitat and human settlement sites. A modification of the line transect count (Pollard, 1977) was used to determine species richness and abundance of butterfly communities in different habitats. Each transect had been observed 10 am to 3 pm on sunny day. Unidentified butterflies were captured for laboratory identification. Identification of butterfly was done by standard procedures available for identification keys by Talbot (1975), Smith (1989) and Haribal (1992).

**Quantification of diversity**

To quantify the diversity status of butterfly species in different habitats we performed Renyi diversity index of three habitats within three sites. The crop land habitat was characterized by a higher value of species diversity indices followed by forest and lowest species diversity was obtained in human settlement in all three sites of Midhill.




a. Ghandruk, b. Kathmandu c. Shankhuwasabha

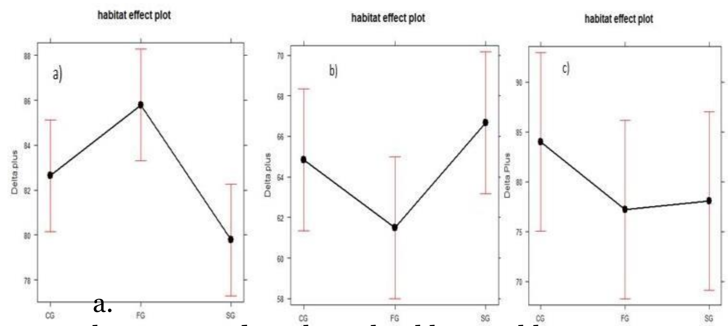
**Phylogenetic distinctness verses Species number**

The Species number and average Taxonomic distinctness ($\Delta+$) was calculated

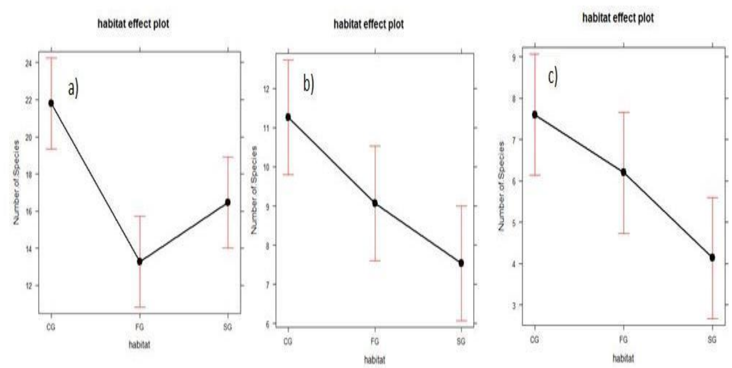
(Clarke and Warwick, 1998) across the three sampling sites in three habitats (Crop land, Forest, and human settlement area) and two ways ANOVA was performed to find the significant different differences within tree habitats. In Kathmandu valley, the mean value of average taxonomic distinctness was significantly higher in forested habitat where as no of species of Butterfly indicated low status (Fig-2) in t his site habitat. The species number in Ghandruk and Shankhuwasabha was significantly higher in crop land followed by forested habitat and human settlement. There is the similar pattern of species number across these two sites comparing the Kathmandu valley.

**Table 1**: Two way ANOVA for mean taxonomic distinction (Δ+) and Species number of three sites with habitats.

| Sites | Variables | Sum Sq | Df | F | *P value* |
|---|---|---|---|---|---|
| Ghandruk | Delta plus ( Δ+) | 410.7 | 2 | 0.69 | ns |
| | Species number | 91.24 | 2 | 5.77 | **0.006** |
| Kathmandu | Delta plus (Δ+) | 270.65 | 2 | 5.91 | **0.005** |
| | Species number | 557.51 | 2 | 12.6 | **0.0004** |
| Shankhuwasabha | Delta plus (Δ+) | 205.41 | 2 | 2.27 | ns |
| | Species number | 110.64 | 2 | 6.73 | **0.002** |




a.
b. Katmandu, b. Shankhuwasabha, c. Ghandruk




a. Kathmandu b. Shankhuwa, c. Ghandruk

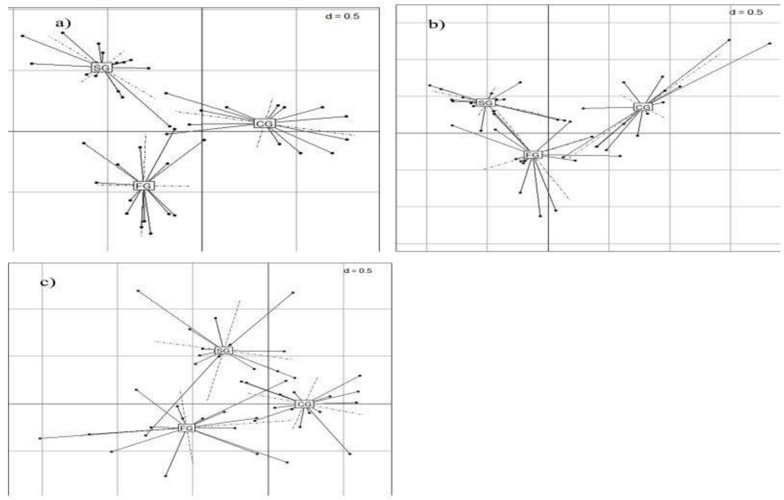
**Indicator species of butterfly in three study sites**

The indicator values (Dufrene and Legendre, 1997) of different genera were analyzed for habitat gradients of three sites.. We used function (indval) and package (labdsv) in R for the analysis of individual indicator values of our genera (Table. 3) Indicator value analysis showed that most of the taxa significantly indicate for winter season but none of the taxon showed important value for summer. Our result showed, there are many indicator taxa that are important for specific treated plots. The significant indicator values have been effectively varied with three sites (see Table 2).

**Table 2**: The highest indicator value present in crop land for most of the butterfly species.

| Kathmandu valley | CG | FG | SG |
|---|---|---|---|
| *Vanessa cardui* | *** | ns | ns |
| *Mycalesis francisca* | ns | ns | *** |
| *Ypthima.baldus* | *** | ns | ns |
| *Aglais cashmirensis* | ns | *** | ns |
| *Neptis hylas* | *** | ns | ns |
| *Papilio polyctor* | *** | ns | ns |
| *Lampides boeticus* | ns | ns | ** |
| *Pieris brassicae* | ** | ns | ns |
| *Danaus chryssipus* | * | ns | ns |
| *Graphium cloanthus* | * | ns | ns |
| *Athyma selenophora* | * | ns | ns |
| *Iliades memnon* | * | ns | ns |
| *Atrophaneura polyeuctes* | * | ns | ns |
| *Menelaides polytes* | * | ns | ns |
| *Precis hierta* | * | ns | ns |
| *Zezeeria maha* | * | ns | ns |
| *Colias fieldii* | * | ns | ns |
| *Prrecis orithya* | * | ns | ns |
| *Danaus.genutia.* | * | ns | ns |
| *Phalanta phalants* | * | ns | ns |
| ***Ghandruk*** | CG | FG | SG |
| *Precise.almana* | *** | ns | ns |
| *Heliophorus androcles* | *** | ns | ns |
| *Colias fieldii* | ns | ns | ** |
| *Catopsilia pyranthe* | ns | * | ns |
| *Celastina huegeli* | ** | ns | ns |
| **Sankhuwa** | CG | FG | SG |
| *Lethe.confusa* | ns | *** | ns |
| *Pontia.Daplidice* | *** | ns | ns |
| *Aglais.cashmirensis* | *** | ns | ns |
| *Mycalesis.perseus* | *** | ns | ns |
| *Danaus.genutia* | *** | ns | ns |
| *Terias.hecabe* | ** | ns | ns |
| *Colias.fieldii* | * | ns | ns |

***** p<0.0001,** p<0.01, * p<0.05**




**Pattern of Butterfly abundance in Between analysis across habitat gradient in our study sites. Eigenvalues > 0.5 for Axis 1 and Axis 2 in all sites. a)= Kathmandu, b)= Ghandruk, c)= Shankhuwasabha**

**DISCUSSION**

Higher abundance of butterfly species and phylogenetic distinctness (Delta+) in crop lands and lower abundance in human settlement and forest habitats in our result attributes to food resources availability in diverse flowering crops in crop lands of the sampling sites. Similar conclusion indicated by Bhusal and Khanal, (2008) in eastern Churia mountains of Nepal and midhill region of Nepal has good diversity of butterfly due to its diversified vegetations (Prajapati et al., (2000). Many study show abiotic and biotic factors such as: vegetation including host plants, food availability, temperature, wind exposure and elevation gradient influences the patterns of butterfly diversity (Khan et al., 2004; Lien and Yuan, 2003). Similar type of research carried by suggested that the abundance of butterflies is not affected by other physical factors such as altitudes but it is more related to the availability of food plants (Guiterrez and Memendez, 1995). But many researcher argued that the the species richness and diversity indices of butterflies increase at moderately disturbed sites while the relative abundance decreased from the natural to the urban areas (Blair and Launer, 1997). The population of butterflies have experienced major declines over the past few decades as a result of habitat loss and fragmentation such as loss of native host and nectar plants, and use of insecticides (Kremen et al., 1993) as well as climate change and urbanization effect. Butterfly diversity and community composition were affected by semi-natural habitats at the landscape scale and the characteristics of understorey vegetation at the local scale (Halder, 2008). Our results reveal strong habitat trends in species richness in butterfly taxa in Midhill Mountains of Nepal. These results are consistent with studies that have found plant and butterfly species richness to positively covary with the result by Hogsden and Hutchinson, (2004). They also found that only weak associations between any single local or landscape variable and the presence of disturbance for butterfly species.

They noted greater flowering plant abundance as food resources of butterfly attributes the high species richness and abundance. We found that increasing human settlement negatively correlated with butterfly species richness and their abundance this result is similar with consistent with the result by Ruszcyzk and DeAraujo, (1992) and Stefanescu et al., (2004). They indicated lower species richness with increased urbanization. Summerville and Crist, (2001) noted that the effected of urbanization with the rare and common species of butterfly for example rare butterfly species were disproportionately affected by fragmentation but many common species appeared to be unaffected with habitat fragmentation. In contrast, Blair and Launer, (1997) found that species richness peaked at sites with intermediate disturbance, where disturbance was defined as a variety of factors associated with characteristics of urbanization. Collinge et al., (2003) found that although grassland type and habitat quality strongly influence butterfly richness and abundance, the extent of urban development was not related to species richness. Butterfly diversity, however, is usually lower in natural forests, higher in disturbed forests, and highest in moderately disturbed forests (Schulze, 2004).

The natures of vegetation, humidity, sunshine, availability of water, etc. are factors that determine the survival of a butterfly species in a particular habitat (Mathew and Rahamathulla, 1992). Highest number of species diversity was recorded in crop land area followed my forest habitat where as lowest species were recorded in crop. This result attributes for the resources availability for butterflies fauna. Thomas, (1995) explained the habitat association of butterflies can be directly related to the availability of larval host plants, vegetation cover of herbs, shrubs and trees for nectarine of butterflies. In the present study, the maximum number of species was observed in crop land habitat, where access to host plants and ornamental flowering plants probably promoted the butterfly richness. Tiple and Khurad, (2009) argued that species richness increases in disturbed habitats and human impacted sites but the uniqueness decreases. Many researchers reported the highest species richness in crop land and forest habitat (Kunte, 2001; Alarape et al., (2015). There is lesser butterfly diversity in regions with high human disturbances (Kitahara and Fujii, 1994).

## CONCLUSION

Similar pattern for species abundance, diversity and phylogenetic distinction were observed comparing all sites across midhill attributing the impact of human settlement upon these highly sensitive bio-indicator fauna. This study provides a general overview of the pattern of butterfly species across habitat gradients of midhill mountains. The changes in land use/land cover along highly vulnerable in midhill zone for the butterfly species that especially helpful in understanding the effect of human settlement and habitat fragmentation.

Acknowledgement

We are thankful to WWF-Nepal/Resources Himalaya/ EGP programme since a part of this study was field grant supported by this programme especially to co-authors. We express our sincere thanks to Natural History Museum, Swayambhu, Kathmandu, Tribhuvan University and prof.. Bhaiya Khanal to support in taxonomic work

Thanks to Ms. Shruti Shakya for her helped during data management process.

## REFERENCES

1. Bhusal, D. R., and Khanal, B. (2009). Seasonal and Altitudinal Diversity of Butterflies in Eastern Siwalik of Nepal. J. Natural History Museum, *23*, 82-87.

2. Bhusal, D. R., Kallimanis, A. S., Tsiafouli, M. A., and Sgardelis, S. P. (2014). Higher taxa vs. functional guilds vs. trophic groups as indicators of soil nematode diversity and community structure. Ecological Indicators, *41*, 25-29.

3. Bhusal, D. R., Tsiafouli, M. A., and Sgardelis, S. P. (2015). Temperature-based bioclimatic parameters can predict nematode metabolic footprints. Oecologia, *179*(1), 187-199.

4. Blair, R. B., and Launer, A. E. (1997). Butterfly diversity and human land use: Species assemblages along an urban grandient. Biol. Cons., *80*(1), 113-125.

5. Bourn, N. A., and Thomas, J. A. (2002). The challenge of conserving grassland insects at the margins of their range in Europe. Biol. Cons., 104(3), 285-292.

6. BPN 1996. Biodiversity Profiles of Nepal with special reference to Protected Areas. Dept. of National Parks and Wildlife Conservation. HMG/Nepal.

7. BPN 1996. Biodiversity Profiles of Nepal with special refrrc.17c.e to Protected Areas. Dept. of National Parks and Wildlife Conservation. HMGINepal.

8. Kocher, S. D., and Williams, E. H. (2000). The diversity and abundance of North American butterflies vary with habitat

disturbance and geography. J. Biogeography, *27*(4), 785-794.

9. Krauss, J., Bommarco, R., Guardiola, M., Heikkinen, R. K., Helm, A., Kuussaari, M.and Pöyry, J. (2010). Habitat fragmentation causes immediate and time delayed biodiversity loss at different trophic levels. Ecol. Let., 13(5), 597-605.

10. Krauss, J., Bommarco, R., Guardiola, M., Heikkinen, R. K., Helm, A., Kuussaari, M., and Pöyry, J. (2010). Habitat fragmentation causes immediate and time-delayed biodiversity loss at different trophic levels. Ecol. Lett., 13(5), 597-605.

11. Krauss, J., Bommarco, R., Guardiola, M., Heikkinen, R. K., Helm, A., Kuussaari, M., and Pöyry, J. (2010). Habitat fragmentation causes immediate and time-delayed biodiversity loss at different trophic levels. Ecol. Lett., 13(5), 597-605.

12. MFSC/ Ministry of forests and soil conservation, Nepal (2014). National biodiversity strategy and action plan 2014-2020.

13. Paudel, P. K., and Kindlmann, P. (2012). Human disturbance is a major determinant of wildlife distribution in Himalayan midhill landscapes of Nepal. Animal Cons., *15*(3), 283-293.

14. Pollard, E. (1977). A method for assessing changes in the abundance of butterflies. Biol. Cons., *12*(2), 115-134.

15. Rákosy, L., and Schmitt, T. (2011). Are butterflies and moths suitable ecological indicator systems for restoration measures of semi-natural calcareous grassland habitats? Ecol Indicators, 11(5), 1040-1045.

16. Root, T. L., Price, J. T., Hall, K. R., and Schneider, S. H. (2003). Fingerprints of global warming on wild animals and plants. Nature, 421(6918), 57.

17. Schulze, C. H., Steffan-Dewenter, I., and Tscharntke, T. (2004). Effects of land use on butterfly communities at the rain forest margin: a case study from Central Sulawesi. In Land use, nature conservation and the stability of rainforest margins in Southeast Asia (pp. 281-297). Springer, Berlin, Heidelberg.

18. Shukla, A., and Maini, H. (2015). Species Diversity of Butterfly with Their Relative Status in Southeast Region of Narmada Valley Jabalpur (MP). Int. J. Curr. Adv. Res., *4*(9), 368-370.

19. Stefanescu, C., Carnicer, J., and Penuelas, J. (2011). Determinants of species richness in generalist and specialist Mediterranean butterflies: the negative synergistic forces of climate and habitat change. Ecography, 34(3), 353-363.

20. Thapa, G., and Bhusal, D. R. (2009). Species Diversity and Seasonal Variation of Butterfly Fauna in Thankot and Syuchatar VDC of Kathmandu Valley, Nepal. J. Nat. History Museum, *24*(1), 9-15.

21. Thomas, C. D., Cameron, A., Green, R. E., Bakkenes, M., Beaumont, L. J., Collingham, Y. C. and Hughes, L. (2004). Extinction risk from climate change. Nature, *427*(6970), 145-148.

22. Thomas, J. A., Telfer, M. G., Roy, D. B., Preston, C. D., Greenwood, J. J. D.,

Asher, J., ... and Lawton, J. H. (2004). Comparative losses of British butterflies, birds, and plants and the global extinction crisis. Science, 303(5665), 1879-1881.

23. Tsiafouli, M. A., Bhusal, D. R., and Sgardelis, S. P. (2017). Nematode community indices for microhabitat type and large scale landscape properties. Ecol. Indicators, 73, 472-479.

24. Van Halder, I., Barbaro, L., Corcket, E., and Jactel, H. (2008). Importance of semi-natural habitats for the conservation of butterfly communities in landscapes dominated by pine plantations. Biodiversity and Conservation, 17(5), 1149-1169.

25. Warwick, R. M., and Clarke, K. R. (1998). Taxonomic distinctness and environmental assessment. J. Appl. Ecol., 35(4), 532-543.