Plant Community Patterns and Herpetofauna Diversity in the Burned and Unburned Sites in Mt. Candalaga, Maragusan, Compostela Valley, Mindanao, Philippines

Rodne T. Baslot
rodne2umvelt@yahoo.com

Date Submitted: March 24, 2012
Date Final Revision Accepted: November 20,2012

Abstract

This study aimed to determine the tree and herpetofauna profile in burned and unburned sites in Mt. Candalaga,Maragusan,Compostela Valley, Philippines. A total of 12 transect plots were established, 6 transect lines in each study sites. This is limited on the assessment on the abundance and diversity of herpetofauna and trees species within the burned and unburned sites in Mt. Candalaga. Included are the present physical factors such as depth of litters, temperature and canopy openness. Our results indicate the unburned sites in Mt. Candalaga had greater number of tree species than the burned sites. Shorea contorta Vid.(140), Schefflera elliptica (Blume) Harms (139) and Ficus minahassae Teijsm & de Vr. Mig.(123) are the most abundant tree species in the burned sites while in the unburned sites Lithocarpus llanosi has the most number of individuals (64) followed by Shorea contorta Vid (57), Myristica cinnanomea King (45), Shorea negrosensis Fowx (44), and Macaranga mappa Muell. Arg (39). The most similar transects are transects 2 and 4 (67.6 %) in the burned sites while in the unburned sites transects 5 and 4 (60 %). The results of the Shannon index (H') indicate the highest tree diversity was discovered in Transect 1 (3.21) in the burned sites while Site 3 (3.90) has the greatest number of species in the unburnd sites). The mean rank of unburned site (8.83) i greater than the burned site (4.17) which indicates that the unburned sites have much cover compared to the burned site. However, there is no significant difference in the temperature (p-value = 0.48) and depth of litters (p-value =0.48) of the burned and unburned site with a p-value that is less than 0.05. The ordinal scale indicates that Megophyrs stejgeneri and Ansonia muelleri were commonly observed while Hydrosaurus pustulatus is frequent.

Keywords: : *Plant community patterns, Herpetofauna diversity, Mt. Candalaga*

In the Philippines, about 5.49 million ha or roughly 18 per cent of the total land area still covered with forests (Soerianegara et al., 1994). The remaining old growth, or primary dipterocarp forests, comprises only about 0.804 million ha, far from the 12 million ha of old-growth forest that existed 55 years ago (Pipoly and Madulid, 1998).

The municipality of Maragusan was traditionally endowed with the abundant forest resources. Through the years, however, with the increase in population, forest resource users also increased. These users exploited and abused the forest through destructive illegal cutting of trees, which resulted to forest denudation and degradation of wildlife habitat. Slash-and-burn farming is also rampant in the forested lands. The degradation of forest resources initiated a chain of events such as soil erosion and flooding which ultimately affect the livelihood of households. Forestland constitutes about 85 percent of the total land area of Maragusan (MENRO, 2004).

To assess the damage and recovery potential of single and repeatedly burned tropical rain forest, this study determines the abundance and weighted proportions of trees in the burned and unburned sites in lowland dipterocarp rain forest at several locations in the northern and southern part of Mt. Candalaga, Maragusan, Philippines. Furthermore, it also determines the relative frequency of tree species both in burned and unburned sites. In addition, this study also provide baseline date on the tree and herpetofauna profile in the burned and unburned sites of Mt. Candalaga.

Generally, this study aims to determine the tree and herpetofauna profile in burned and unburned sites in Mt. Candalaga, Maragusan, Compostela Valley, Mindanao, Philippines. Specifically, it seeks to:

1. Determine the abundance and weighted proportions of trees in burned and unburned sites in Mt. Candalaga.
2. Determine the relative frequency of trees across all transects in burned and unburned sites in Mt. Candalaga.
3. Determine the species richness, evenness, and diversity of trees in burned and unburned sites in Mt. Candalaga
4. Determine the similarity in the species richness and species abundance in burned sites in Mt. Candalaga
5. Determine the similarity in the species richness and species abundance in unburned sites in Mt. Candalaga.
6. Determine the herpetofauna profile in the burned and unburned sites in Mt. Candalaga in terms of:
   - 6.1. Species
   - 6.2. No. of individuals
   - 6.3. Relative abundance
7. Compare the physical characteristics of the burned and unburned sites when analyze according to:
   - 7.1 Depth of Litters
   - 7.2 Canopy

Method

Transect Establishment

The researcher established 6 transect lines (1km/transect) with 25 10 x 10m quadrats (with a distance of 40 m per quadrat) each transect both in burned and burned sites within the mossy forest of Mt. Candalaga according to standard biodiversity assessment methods for tropical forests. Within each quadrat (10 x 10 m), tree species were identified through the aid of local forest guides and foresters and 30 minutes were allotted for each quadrat for this purpose Validations of tree species were done using Madulid (2001). Pictures of the live specimens were taken within in the sampling sites and important morphological characteristics were also noted. Sampling activities were conducted during daytime from the months of May to June for the unburned sites, October and December 2010 and April 2011 for the burned sites.

Morpho-Species Identification

All tree species were identified initially by local guides and thus were attributed local names. Prior to this, a validation study of local guides' identification skills was conducted completed within 10m x 210m quadrats to ensure consistency of identification between different guides. Local names were translated to scientific names using Madulid (2001). Canopy cover of each species was estimated to the nearest 1% in each of quadrats. Species richness was determined by summation of all tree species encountered in the sampling sites. Diversity was measured as species richness and evenness of tree species encountered in the sampling sites.

Herpetofauna Sampling

Time – Constrained Searches

Time – constrained searches involve searching study areas for amphibians and reptiles, which are immediately collected by hand (hand – grabbing technique). Equal effort is expended in each area searched, as measured by the number of staff hours spent searching. Each search is allotted for an average time of 15 minutes per quadrat, with four members per team searching the area in direction. Time – constrained searches are most useful for determining presence or absence of species and for providing initial data on the types of microhabitats occupied by individual species.

The crew size is between three (3) to four (4) persons. The crews were given designated task(s) as follows: one person is the data recorder, and the remaining people do the collecting. A 6 – staff- hour TCS, done with a two – person crew plus a recorder who does not collect, requires 3 hours, plus the time for breaks (Corn and Bury 1990).

Hand collecting is done especially during rain because the herps are active. During the sampling activities in the burned and unburned sites, there were changes in the consistency of the weather thus it might affect the collection of specimen. Two TCS can be done in one day as the standard However, because of bad weather conditions during the sampling period; more than two TCS were done per day especially if the weather permits.

Quadrat Visual Encounter Survey (QVES)

The quadrat method has been shown to be one of the most effective herpetofaunal sampling techniques. Four observers were intensively search a quadrat, which would measure 10m by 10m. Each observer began at one of the four corners of each quadrat and moved at the same velocity in a clockwise direction. This synchronized movement should prevent most of the individual reptiles and amphibians from exiting the quadrat before capture. The four observers were consisting of a mix staff and volunteers. Each quadrat were searched for 30 minutes ensuring that all microhabitats are investigated on the forest floor and above (without the need for tree climbing).

Each individual that were encountered was captured by hand (gloved), identified, measured to the nearest 0.1mm with calipers and immediately released at the point of capture. Physical factors such as depth of litters, temperature and canopy openness at which individuals were encountered was aslo recorded. Where identification could not be determined, dorsal and ventral photographs were taken.

For analysis of abundance, richness and diversity, captured species will be grouped into taxonomic categories as follows: reptiles, amphibians, anurans, snakes, and lizards. Individual species with more than 20 captures were examined separately. For each category, abundance was expressed as the total number of captures per plot and richness as the total number of species per plot. This does not represent true abundance, which would require 100% detection of herpetofauna present or mark – recapture methods, but rather, reflects relative abundance of species based on equal detection ability at each site.

Only those species found within the 10 x 10 m sampling quadrats of the line transects established in burned and unburned sites were included in the analysis. A measure of diversity was calculated for all categories using the Shannon diversity index, H' (Hill, 1973). Data for species diversity, relative abundance, evenness and richness for tree species were calculated using the following formula:

1. Frequency = $\frac{\text{no. of quadrats at which a species occur}}{\text{Total number of quadrats sampled}} \times 100$

2. Relative frequency = $\frac{\text{frequency value for a species}}{\text{Total frequency values for all species}} \times 100$

3. Shannon diversity Index

$$H = \sum_{i=1}^{s} -(P_i * \ln P_i)$$

where:

H = the Shannon diversity index

P_i = fraction of the entire population made up of species i

S = numbers of species encountered

$\sum$ = sum from species 1 to species S

4. Relative abundance

Data obtained from the transect surveys were used in determing the relative abundance of the species based on encounters and abundance categories. The relative abundance of each target species was calculated using the equation:

$$RA = \frac{\text{Total no. of individuals encountered per species}}{\text{Total no. of hours spent for the survey}} \times 100 \text{ transect hours}$$

Calculations of the relative abundance for each species were then scored and categorized on the crude ordinal scale as shown in Table 21 and Table 22. **RESULTS AND DISCUSSIONS**

Abundance and Weighted proportions of tree species

Burned Sites. In total, the group counted 1,918 trees belonging to 103 tree species (64 identified to the species level) among 35 families from all 6 line transects (consist of 25 10 x 10m quadrats) in the burned sites in Mt. Candalaga. Among the tree species recorded in the vicinity of the sampling sites, *Leucosyke capitellata* (Poir.) Wedd. has the greatest number of individuals encountered (341), followed by *Shorea contorta* Vid.(140), *Schefflera elliptica* (Blume) Harms (139) and *Ficus minahassae* Teijsm & de Vr. Mig.(123.) These species dominated the burned sites in terms of the number of individuals encountered in the sampling sites.

Among the 50 tree species encountered in transect 1 in the burned site in Mt. Candalaga, Lanto has the greatest number of individuals followed by *Lithocarpus llanosi* and *Gmelina arborea* Roxb, respectively. Meanwhile, transect

2, *Shorea contorta* Vid dominated the site followed by *Pavetta tomentosa* Roxb. ex Smith, *Calophyllum blancoi* Pl. & Tr., *Schefflera elliptica* (Blume) Harms, and *Leucosyke capitellata* (Poir.) Wedd. Similarly, the most number of tree species in transects 3 and 4 is *Shorea contorta* Vid. However, in transect 5, *Shorea contorta* is absent. Furthermore, only 2 individuals of *Shorea contorta* Vid. were encountered in transect 6. *Leucosyke capitellata* (Poir.) Wedd has the most number of tree species in transects 5 and 6, respectively.

The data recorded in the burned sites in Mt. Candalaga conformed to the inventory conducted by MENRO (2004). In addition, Richards (1996) found out that floristic composition in lowland dipterocarp foretst is distinctive because of the very large number of tree species represented by a small number of mature individuals, and the general "family dominance" of Dipterocarpaceae. Morever, the weighted proportion determines the species diversity of trees in the burned sites in Mt. Candalaga.

Unburned Sites. The unburned sites in Mt. Candalaga had greater number of tree species than the burned sites. The group counted a total of 2,464 trees belonging to 141 tree species among 35 families from all the 6 transects lines established in the unburned sites in Mt. Candalaga. Burgess (1966) revealed in their study conducted in a seasonal dry forest in western Thailand that family dipterocarpaceae dominates the forest structure within the sampling plot. Furthermore, dipterocarps also has the greatest basal area of all families in the plot.

Among the 37 tree species counted in transect 1 in the unburned site in Mt. Candalaga, *Lithocarpus llanosi* has the most number, followed by Pilok- kalaw, *Adinandra robinsonii*, *Cratoxylum sumatranum* (Jack) Blume, and Bunol. Meanwhile, there were 54 tree species encountered in transect 2 in which *Pavetta tomentosa* Roxb. ex Smith has the greatest number, followed by *Schefflera elliptica* (Blume) Harms, Pili-pili and Manabas. In transect 3, *Shorea contorta* Vid dominated the site, followed by *Schefflera elliptica* (Blume) Harms, *Shorea negrosensis* Fowx., and Tugas. The most common species encountered in Transect 4 is *Lithocarpus* *llanosi*, followed by *Leucosyke capitellata* (Poir.) Wedd., *Shorea contorta* Vid., and *Ternstroemia megacarpa* Merr. In transect 5, *Shorea contorta* Vid has the most number of species present in the site, followed by Ngala-ngala, *Lithocarpus llanosi*, *Shoreapolysperma*, and *Myristica cinnanomea* King. In the transect 6, Pacao-pacao is the most common species

encountered, followed by Lugtian, Talosi, and Bara-bara. Additionally, in the unburned site, there was greater number of tree species considered primary rain forest species than in burned site. In the study of Arances et. al. (2004), there was 86 tree species identified in a 2-ha plots conducted in Mt. Malindang. The 70 species recorded in transect 3 in the unburned site in Mt. Candalag is much higher in comparison with the 43 species recorded in Mt. Kitanglad. In addition, the weighted proportion determines the species diversity of trees in the unburned sites in Mt. Candalaga.

Relative Frequency

Burned Sites. The result shows the relative frequency of tree species in tropical rainforest ecosystem as represented by the burned sites selected for this study. A total of 101 individuals were encountered in transect 1, 210 in Transect

2, 221 in Transect 3, 193 in Transect 4, 157 in Transect 5, and 117 in Transect

6. A total of 63 species distributed among 35 families were identified across the 6 transects in the burned sites and 39 species only identified with their local names. The species with the highest number of individual was *Shorea contorta* Vid (73), followed by *Pavetta tormentosa* Roxb. Ex Smith (62), *Schefflera elliptica* (Blume) Harms (57), *Ficus Minahasse* Teijsm & de Vr. Mig. (53), *Leucosyke capitellata* (Poir) Wedd (46), *Ternstroemia megacarpa* Merr (36), Calape and *Mallotus paniculatus* (Lam.) Muell. Arg with equal number of individuals (31), respectively. Moreover, the number of quadrats each species was observed in all transect lines and the corresponding relative frequencies. *Shorea contorta* Vid and *Pavetta tormentosa* Roxb. Ex Smith have the highest relative frequencies

followed by *Schefflera elliptica* (Blume) Harms, *Ficus minahassae* Teijsm & de Vr. Mig, *Leucosyke capitellata* (Poir.) Wedd, and *Ternstroemia megacarpa* Merr. In addition, only *Shorea contorta* Vid and *Ficus Minahasse* Teijsm & de Vr. Mig were encountered in all transect lines established in the burned sites in Mt. Candalaga. In the study conducted by Adekunle (2006), a total of 54 different tree species (24 families) were identified in Ala, 41 species (21 families) in Omo and 55 species (20 families) in Shasha Forest Reserves in Nigeria.

Unburned Sites. In total, there 1181 individual trees counted in the unburned sites in New Coronobe, Mt.Candalaga. Transect 5 has the most number of individuals (231), followed by transect 3 with 209, transect 2 (206), transect 4 (205) and transect 6 with 69 individuals. Transect 1 has the least number of individuals among the transects in the unburned sites with 161 individuals. A total of 61 species were distributed among 35 families across the 6 transect lines established in the unburned sites in New Coronobe, Mt. Candalaga. *Lithocarpus llanosi* has the most number of individuals (64) followed by *Shorea contorta* Vid (57), *Myristica cinnanomea* King (45), *Shorea negrosensis* Fowx (44), *Macaranga mappa* Muell. Arg (39), and *Schefflera elliptica* (Blume) Harms (33) and *Leucosyke capitellata* (Poir.) Wedd (32), respectively. *Dendrocnide densiflora*, Bunol, *Myristica cinnanomea* King, Lithocarpus llanosi, Wakatan, and *Shorea contorta* Vid were encountered in all transects in the unburned sites.

Tree species richness, evenness, and diversity

Burned Sites. The results of the Shannon index (H') indicated that the highest tree diversity was discovered in Transect 1 (3.21). This is followed by Transect 2 (3.00), Transect 4 (2.99), Transect 3 (2.90), Transect 6 (2.36), while the least value was obtained for Transect 5(2.25). The species diversity values obtained for the 6 transect lines in the burned sites was very close. This showed that the burned sites were able to conserve tree species diversity. Species evenness (E) results showed slight difference from the pattern for H'. The highest value 0.88 was obtained for Transect 3 while 0.83 and 0.82 were obtained for Transect 1 and Transect 4 respectively. In addition, Transects 2, 5, and 6 have evenness values of 0.80, 0.65, and 0.60 respectively. Furthermore, the number of individuals was more evenly distributed among each species in transect 3 (0.88) followed by site 1, 4, and 2 while transect 5 (0.60) and transect 6 (0.65) has the least evenness level respectively.

Unburned Sites. Site 3 had greatest number of species followed by sites 6, 2, 4, 5 and 1. However, the number of individuals was more evenly distributed among each species in site 3 (0.90) followed by site 4, 5, and 6 having equal value of evenness (0.87) while site 2 (0.84) and site 1 (0.74) has the least evenness level respectively. In terms of diversity, site 3 (3.90) is the highest followed by site 6 (3.57), site 2 (3.32), site 5 (3.26), site 4 (3.19) and site 1 (2.64). The results of the Shannon index (H') indicated that the highest tree diversity was encountered in Transect 3 (3.90). This is followed by Transect 6 (3.57), Transect 2 (3.32), Transect 5 (3.26), Transect 4 (3.19) ,while the least value was obtained for Transect 1(2.64). The species diversity values obtained for the 6 transect lines in the burned sites was also very close. This showed that the unburned sites were able to conserve tree species diversity as expected. Species evenness (E) results showed minimal difference from the pattern for H'. The highest value 0.90 was obtained for Transect 3 while 0.83 and 0.82 were obtained for Transect 1 and Transect 4 respectively. In addition, Transects 2, 5, and 6 have evenness values of 0.80, 0.65, and 0.60 respectively. Furthermore, the number of individuals was more evenly distributed among each species in transect 3 (0.88) followed by site 4, 5, and 6 with similar evenness value of 0.87 while transect 2 (0.84) and transect 1 (0.74) has the least evenness level respectively.

Similarity Percentage

Burned Sites. The most similar transects are transects 2 and 4 (67.6 %), and transects 6 and 5 (66 %) while Transects 4 and 3 (58.7 %), Transects 6 and and 4 (28.5 %), Transects 5 and 4 (27.8 %) while transects 2 and 1 (7.2 %) and Transects 3 and 1 (2.7 %) has the least similarity value, respectively.

Unburned Sites. The most similar transects are transects 5 and 4 (60 %). Transects 4 and 3 (43 %) and Transects 5 and 3 (42.8 %) also showed almost similar values. Meanwhile, Transects 6 and 4 showed 28.5 % similarity value. Furthermore, transects 5 and 4 has similarity value of 27.8 % while transects 2 and 1 (7.2 %) and Transects 3 and 1 (2.7 %) has the least similarity value, respectively.

Physical Factors

The result indicates that there is a significant difference in the canopy (p- value = 0.03) of the two sites since the p-value is less than 0.05 alpha. As shown in Appendix A that the mean rank of unburned site (8.83) is greater than the burned site (4.17) which indicates that the unburned site have much cover compared to the burned site. However, there is no significant difference in the temperature (p-value = 0.48) and depth of litters (p-value = 0.48) of the burned and unburned site with a p-value that is less than 0.05.

Herpetofauna Diversity

Megophyrs stejnegeri species was found to have the most number of individuals followed by *Ansonia muelleri* and *Bufo marinus*. However, only *Python reticularis* was found in transect five (5) to represent the reptiles following a thorough examination of the site. The species of *Megophyrs stejnegeri* have been observed to be dwelling among leaf litters at elevation of 400 - 1,825 MASL (Alcala and Brown, 1998). Moreover, the researchers had a hard time in catching a sight of this species since their color mix well with the leaves. According to Iskandar (1998), the *Megophyrs stejnegeri* inhabits leaf litter on the forest floor of dense tropical rainforest, both primary and secondary forest. Moreover, *Megophrys* rely on camouflage for defense (Inger and Stuebing, 2005) and found at higher elevations (Lathrop, 2003). Meanwhile, *Ansonia muelleri was* also sighted at elevations of about 1,000 to 2,166 MASL (Alcala and Brown, 1998). Thus, according to IUCN (2010), *Ansonia muelleri* inhabits high-elevation forests, which are generally less threatened by habitat conversion.

Megophyrs stejnegeri still has the highest number in terms of individuals at the burned sites followed by *Ansonia muelleri and Hydrosaurus pustulatus.* These herps were found to be thriving on leaf litters and dead tree barks. Hence, their colors were similar to that of dried leaves and tree barks which makes them difficult to see. In addition, less grazing of people and other animals was observed in the burned sites.

Megophyrs stejnegeri (18.66) is the most abundant species in the burned site followed by *Ansonia muelleri* (7.46) and *Bufo marinus* (3.70). On the other hand, the ordinal results indicate that *Megophyrs stejnegeri* was common in the site while *Ansonia muelleri* and *Bufo marinus* was only frequently seen. This can be due to the fact that the tropical rainforest of Mt. Candalaga are desirable habitat for *Megophyrs stejnegeri.* As stated by Iskandar (1998), the *Megophyrs stejnegeri* is common in dense tropical rainforest, both primary and secondary forest.

The species of *Megophyrs stejnegeri* (30.2) is the most abundant followed by *Ansonia muelleri* (12.9). Meanwhile, the only reptile sighted was *Hydrosaurus pustulatus* having a relative abundance value of 4.3. The ordinal scale indicates that *Megophyrs stejnegeri* and *Ansonia muelleri* were commonly observed while *Hydrosaurus pustulatus* is frequent. Consistent in Table 3 that *Megophyrs stejnegeri* is common in dense tropical rainforest, both primary and secondary forest (Iskandar, 1998). Thus, IUCN (2010) added that the population of *Ansonia muelleri* is fairly common but has patchy distribution and particularly inhabiting on high-elevation suchas mossy forests in Mt. Candalaga.

Hydrosaurus pustulatus is a semi-aquatic species is generally restricted to riparian vegetation present in lowland tropical moist forests (both primary and secondary) to open cultivated areas (Ledesma et al., 2009). It is probably omnivorous, and is associated with certain food trees. It appears to have a preference for particular shrubs and trees as resting places (often overhanging water), and is usually collected from these. This is an oviparous species that buries eggs within river banks.

Conclusions

The following are the conclusions drawn from the study conducted in the burned and unburned sites in Mt. Candalaga, Maragusan, Compostela Valley, Mindanao, Philippines:

1. *Shorea contorta* Vid., *Schefflera elliptica* (Blume) Harms and *Ficus minahassae* Teijsm & de Vr. Mig. are the most abundant tree species in the burned sites while in the unburned sites *Lithocarpus llanosi* has the most number of individuals followed by *Shorea contorta* Vid, *Myristica cinnanomea* King *Shorea negrosensis* Fowx, and*Macaranga mappa* Muell. Arg. In addition, both burned and unburned sites are dominated by Dipterocarpaceae namely: *Shorea contorta* Vid, and *Shorea negrosensis* Fowx.

2. The most abundant tree species is *Shorea contorta* Vid under Dipterocarpaceae family. This species is widely distributed throughout the sampling sites.

3. Tree species in the unburned is evenly distributed and has higher diversity compared to the unburned sites.

4. *Megophyrs stejnegeri* is the most dominant anuran both in burned and unburned sites in Mt. Candalaga. Meanwhile, reptiles are rarely seen in the sampling sites.

References

Anderson, R.C. and Menges, E.S. (1997). Effects of fire on sandhill herbs: Nutriens, Mycorrhizae, and biomass allocation. American Journal of Botany 84 (7): 938-948.

Antone, M.S. (1983). Vegetational analysis surrounding Lake-Balinsasayao-Lake

Danao, Negros Oriental. The trees species. Thesis.

Avery, T.E. and Burkhart, H.E. (1994). Forest Management (4^{th} ed.) New York: McGraw-Hill Book Co.

Barnes, B.V. Zak, D.R. Denton, S.R. and Spurr, S.H. (1998). Forest ecology

(4^{th} ed.) New York: John Wilet & Suns, Inc.

Bastrup-Birk A., and Breda, N. (2004). Report on sampling and analysis

Litterfall. United Nations Economic Commission for Europre Convention on Long Range

Transboundary Air Pollution: International Cooperative Programme on Assessment and

Monitoring of Air Pollution Effects onForest.

Belonias, B.S. and Banoc, L.M. (1994). Species diversity and distribution of pteridophytes in Mt. Pangasugan. Annals of Tropical Research (ATR) vol. XVI.

Bertin, S., Palmroth, S., Kim, H.S., Perks, M.P., Mencuccini, M., and Oren, Ram (2010). Modelling understorey light for seddling regeneration in continuous cover forestry canopies. Forestry 84 (4). 397 – 409.

Bruna, E.M. (2003). Are plant populations in fragmented habitats recruitment

Limited? Test with an Amazonian herb. Ecology 84 (4). Pp. 932-947.

Cavitt, J.F. 2000. Fire and tallgrass prairie reptile community: effects on relative

Abundance and seasonal activity. Journal of Herpetology 34(1): 12 – 20.

Chave, J., Navarrete, D., Almeida, S., Alvarez, E., Aragao, L.E.O.C., Bonal, D., Chatelet, J., Silva-Espejo, J.E., Goret, J.Y., von Hildebran, P., Jimenez, p, E., Patino, S., Penuela, M.C., Philips, O.L., Stevenson, P. and Malhi, Y. (2009). Regional and seasonal patterns of litterfall in tropical South America. Biogeosciences 7 (1). 43.

Cochrane, M.A. (2003). Fire science for tropical forests. Nature 421:913-919. Cook, G.D. 1994. The fate of nutrients during fires in a tropical savanna. Australian Journal of Ecology 19: 359 – 365.

Corn, P.S. and R.B. Bury. 1987. Evaluation of pitfall trapping in north-western forests: Trap arrays with drift fences. Journal of Wildlife Management. 51: 112 – 119.

Cunningham, S.C., R.D. Babb, T.R. Jones, B.D. Taubert and R. Vega. 2002. Reaction of Lizard populations to a catastrophic wildfire in a central Arizona mountain range.Biological Conservation 107: 193 – 201.

Dargantes, B.B. and Koch, W. (1994). Case studies on the occupation and Cultivation of the forest lands of Leyte, Philippines, Ann. Trop. Res. 16. pp. 13 – 29.

Dias, C.P. (1997). ERDB's research and development (R&D) experience(s) in reforestation with Philippine native tree species, in: Margraf J., Goltenboth F., Milan, P.P. (Eds.), Proceedings on the International Conference on Reforestation with Philippine Species – for biodiversity protection and economic progress. MacArthur Beach Resort, Palo, Leyte, Philippines. Pp. 156 – 174.

Diesmos, A. C., A. C. Alcala, R. M. Brown, L. E. Afuang, G. V. A. Gee, H. Hampson, M. L. Diesmos, A. Mallari, P. Ong, D. Ubaldo & B. Gutierrez (2004): *Limnonectes diuatus*. – IUCN Red List of Threatened Species Version 2010.4, <www.iucnredlist.org>, downloaded on 6 December 2010.

Eilu, G., Hafashimana, D.L.N., and Kasenene, J.M. (2004). Density and species diversity of trees in four tropical forests of the Albertine rift, western Uganda. Diversity and Distributions. 10: 303 – 312.

Enge, K.M., and W.R. Marion. 1986. Effects of clearcutting and site preparation on herpetofauna of a north Florida flatwoods. Forest Ecology and Management 4: 177 – 192.

EPCO, 1999. Amarkantak Biosphere Reserve: Project Document. Environmental

Planning and Coordination Organization, Bhopal -462016.

Erwin, T.L. (1982). Tropical forests: Their richness in Coleoptera and other arthropod species. The Coleopterists Bulletin. 36: 74.

Faria, A.S., A.P. Lima and W.E. Magnusson. 2004. The effects of fire on behavior and relative abundance of three lizard species in an Amazonian savanna. Journal of Tropical Ecology. 20: 591 – 594.

Food and Agriculture Organization of the United Nations (FAO), 2005. Global Forest Resources Assessment 2005. Rome: Forestry Department, FAO. Country Report 202: Philippines.

Fredericksen, N.J. and T.S. Fredericksen. 2002. Terrestrial wildlife responses to logging And fire in a Bolivian tropical humid forest. Biodiversity and Conservation 11: 27 – 28.

Gillon, D. 1983. The fire problem in tropical savannas. Pp. 617 – 641 in F.

Bourliere, (ed.). Ecosystems of the World: Tropical Savannas. Elsevier

Scientific Publishing Co., Amsterdam, Netherlands.

Glitzenstein, J.S., D.R. Streng and D.D Wade. 2003. Fire Frequency effects on longleaf Pine (*Pinus palustris,* P. Miller) vegetation in South Carolina and Northeast Florida, USA. Natural Areas Journal 23:22 – 37.

Goldammer JG, and Siebert B. (1989). Natural rain forest fires in Eastern Borneo

During the Pleistocene and Holocene. Natur-wissenschaften 76: 518-520.

Greenberg, C.H., D.G., Neary, and L.D. Harris. 1994. Effect of high-intensity wildfire and silvicultural treatments on reptile communities in sand – pine scrub. Conservation Biology 8: 1047 – 1057.

Haberle SG., and Ledru M-P (2001). Correlations among charcoal records of fires From the past 16,000 years in Indonesia, Papua New Guinea, and Central and South America. Q Res 55: 97.

Hale, S.E. and Brown N. (2005). Use of the canopy-scope for assessing canopy openness in plantation forests. Forestry. 78: 365.

Heany, L.R. 2001. Small mammal diversity along elevational gradients in the Philippines: an assessment of patterns and hypotheses. Global Ecology and Biogeography, 10: 15 – 39.

Hill, M.O. (1973). Diversity and evenness: a unifying notation and its consequences. *Ecology*, 54 : 4270432.

Hoffman, W.A. 1999. Fire and population dynamics of woody plants in a neotropical Savanna: matrix model projections. Ecology 4: 1354 (1).

Humphries, R.K.1994. The Effects of Single Autumn and Spring Prescribed Fires on Small Mammal and Reptile Ecology in Wombat State Forest. Master Thesis, University of Ballarat.

Inger, R. F. and Stuebing, R. B. (2005). A Field Guide to the Frogs of Borneo,

2nd edition. Natural History Publications (Borneo), Kota Kinabalu.

Iskandar, D. T. (1998). *The Amphibians of Java and Bali.* Research and

Development Centre for Biology-LIPI, Bogor, Indonesia.

James, S.E. and R.T. M'Closkey. 2003. Lizard microhabitat and fine fuel management. Biological Conservation 114: 293 – 297.

Johnson, E.A. 1992. Fire and vegetation dynamics – studies from the North

American boreal forest. Cambridge: UK, Cambridge University Press.

Kartawinata, K. Abdulhadi R., and Partomihardjo, T. (1981). Composition and Structure of a lowland dipterocarp forest at Wanariset, East Kalimantan.Malay For 44: 397 – 406.

Kirkland, G.L., Jr., H.W. Snoddy and T.L. Amsler. 1995. Impact of fire on small Mammals and amphibians in a central Appalachian deciduous forest. AmericaMidland Naturalist 135: 253 – 260.

Langford, G.J., Borden, J.A., Major, C.S., and Nelson, D.H. 2007. Effects of Prescribed Fire on the Herpetofauna of a Southern Mississippi Pine Savanna. Herpetological Conservation and Biology 2(2):135 – 143.

Lathrop, A. (2003). ''Asian horned frog, Megophrys montana.'' Grzimek's Animal Life Encyclopedia, Volume 6, Amphibians. 2nd edition. M. Hutchins, W. E. Duellman, and N. Schlager, eds., Gale Group, Farmington Hills, Michigan.

Laughlin, D.C. and J.B. Grace 2006. A multivariate model of plant species richness in Forested systems: old-growth montane forest with a long history of fire. Oikos, 114: 60 – 70.

Laurence, W.F., Oliveira, A.A., Laurence, S.G., Condit, R., Nascimento, H.E.M.

Sanchez-Thorin, A.C., Lovejoy, T.E., Andrade, A., D'Angelo, S., Ribeiro, J.E. and Dick, C.W. (2004). Pervasive alteration of tree communities in

undisturned Amazonian forests. Nature 428: 171 – 175.

Leach, M.K., and T.J. Givnish. 1996. Ecological determinants of species loss in remnant prairies. Science 273: 1555 – 1558.

Ledesma, M., Brown, R., Sy, E. & Rico, E.L. 2009. *Hydrosaurus pustulatus*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2.

<www.iucnredlist.org>. Downloaded on 09 February 2012.

Letnic, M, C.R. Dickman, M.K. Tischler, B. Tamayo and C.L. Beh. 2004. The responses Of small mammals and lizards to post – fire succession and rainfall in arid Australia, Journal of Arid Environments 59 (1): 85 – 114.

Lewis, S.L. and Tanner, E.V.J. (2000). Effects of above- and below ground Competition on growth and survival of rain forest tree seedlings. Ecology 81: 2525-2538.

Li Y., Xu M., Sun O.J., and Cui, W. (2004). Effects of root and litter exclusion on soil CO_2 efflux and microbial biomass in wet tropical forests. Soil Biol Biochem 36: 2111–2114

Lillywhite, H.B. 1977. Animal responses to fire and fuel management in chaparral. Pp. 368 – 373 in H.A. Mooney and C.E. Conrad (eds.). Proceedings of the Symposium on the Environmental Consequences of Fire and Fuel Management In Mediterranean Ecosystems. Forest Service, USDA. Washington, DC.

Lillywhite, H.B. and F. North. 1974. Perching behavior of *Sceloporus occidentalis*

in recently burned chaparral. Copeia 1974: 256 – 257.

Litt, A.R., L. Provencher, G.W. Tanner and R. Franz. 2001. Herpetofaunal responses to Restoration treatments on longleaf pine sandhills in Florida. Restoration Ecology 9(4): 462 – 474.

Lonsdale, W.M. (1988). Predicting the amount of litterfall in forests of the

World. Annals of Botany 61 (3): pp. 319 – 320. MacArthur, R.H. 1965. Patterns of species diversity. Biological Review 40: 510 – 573.

MacKinnon K., Hatta, G., Halim, H., Mangalik, A. (1996). The ecology of

Kalimantan. The ecology of Indonesia, series III. Periplus, Singapore.

McLeod, R.F., and J.E. Gates.1998. Response of herpetofaunal communities to forest cutting and burning at Chesapeake Farms, Maryland. American Midland Naturalist 2: 475 – 486.

Madulid, D.A. 2001. A Dictionary of Philippine Plant Names (vol. 1). The

Bookmark,Inc. Philippines.

Means, D.B.1985. Radio – tracking the eastern diamondback rattlesnake.

National Geographic Society Research Report, 18: 529 – 536.

Means, D.B, and H.W. Campbell.1981. Effects of prescribed burning on amphibians and reptiles. pp. 89 – 96. In Prescribed fire and wildlife in southern forests. Wood G.W. (ed.) Belle Baruch Forest Science Institute, Clemson University, Georgetown, South Carolina, USA.

Means,D.B. and H.W. Campbell. 1982. Effects of prescribed burning on amphibians and Reptiles. Pp. 89 – 97 in Gene W. Wood, (ed.). Prescribed fire and wildlife in Southern forests. Belle W. Baruch Forest Science Institute, Georgetown, SC.

Means, D.B., C.K. Dodd, S.A. Johnson and J.G. Palis. 2004. Amphibians and fire in Longleaf pine ecosystems: Response to Schurborn and Fauth. Conservation Biology 18(4): 1149-1153.

Moody, D. 1991. The Effects of Fuel Reduction Burning on Reptiles Populations, Wombat State Forest, University Ballarat.

Morrison, D.A., Cary, G.J., Pengelly, S.M., Ross, D.G., Mullins, B.J., Thomas, C.R., and Anderson, T.S. (1995). Effects of fire frequency on plant species composition of sandstone communities in the Sydney region: Inter-fire interval and time-since-fire. Aust. J. Ecol. 20: 239 – 247.

Moseley, K.R., S.B. Castleberry, and S.H. Schweitzer. 2003. Effects of prescribed fire

on herpetofauna in bottomland hardwood forests. Southeastern Naturalist. 2: 475-486 Municipal Environment Resource Office (MENRO), 2004. Forest Land Use Plan. pp. 8 – 10.

Mushinsky, H.R. 1985. Fire and the Florida sandhill herpetofaunal community: With special attention to the responses of *Cenmidophorus sexlineatus*. Herpetologica 41: 333 – 342.

Mushinsky, H.R.1992. Natural history and abundance of South – eastern Five – lined Skinks, *Eumeces inexpectatus*, on a periodically burned sandhill in Florida. Herpetologica. 48: 307 – 312.

Naveh, Z. 1975. The evolutionary significance of fire in the Mediterranean region.

Vegetatio 29: 199 – 208.

Nieuwstadt M.G.L. van (2002). Trail by fire. Postfire development of a tropical dipterocarp forest. Ph.D. Thesis, Utrecht University. Utrecht, The Netherlands

North, M., Oakley, B., Fiegener, R., Gray, A., and Barbour, M. 2005. Influence of light And soil moisture on Sierran mixed – conifer understory communities. Plant Ecology 177: 13 – 24, doi: 10. 1007/s11258-005-2270-3.

Odum, E.P. 1993. Ecology and Our Endangered Life – support Systems. Sinauer Associates, Inc. Sunderland, MA.

Olson, D.M. et al. (2001). Terrestrial Ecoregions of the World: A New Map of

Life on Earth. Bioscience 51: 2.pp. 933.

Parr, C.L. and Chown, S.L. 2003. Burning issues for conservation: A critique of faunal Fire research in southern Africa. Austral Ecology 28: 384 – 395.

Peres, C.A. (1999). Ground fires as agents of mortality in a Central Amazonian

Forest. J Trop Ecol 15: 535 – 541.

Pilliod, D.S., R.B. Bury, E.J. Jyde, C.A. Pearl, and P.S. Corn. 2003. Fire and amphibians.

Pimm, S.L. and Rave, P. (2000). Biodiversity: Extinction by numbers. Nature

403, 843-845/doi: 10.1038/35002708.

Pinard, M.A. and Huffman, J. (1997). Fire resistance and bark properties of trees in a seasonally dry forest in eastern Bolivia. J Trop Ecol 13: 727-740.

Pipoly III, J.J. & Madulid, D.A. 1998. Composition, structure and species richness of a submontane moist forest on Mt. Kinasalapi, Mindanao, Philippines.
591-600 in Dallmeier, F & Comiskey, J.A.: Forest biodiversity research, Monitoring and modeling: conceptual background and old world case
Studies. – Man and biosphere; v. 20) UNESCO and the Parthenon
Publishing Group Limited, Carnforth, UK, UNESCO, France.

Pitman, N.C.A., Terborgh, J.W., Silman, M.R., Percy, N.V., Neill, D.A. Ceron, C.E., Palacios, W.A. and Aulestia, M. (2002). A comparison of tree species diversity inTwo upper Amazonian forests. Ecology 83: 3210-3224.

Proctor, J. 2003. Vegetation and soil and plant chemistry on ultramafic rocks in the Tropical Far East. Perspective in Plant Ecology, Variation, and Systematics, 6: 105 – 124.

Pough, F.H., R.M. Andrews, J.E. Cadle, and M. Crump. 2000. Herpetology. Prentice Hall, NJ. 577 pp.

Robbins, L.E. and R.L. Myers.1992. Seasonal effects of prescribed burning in Florida: A review. Misc. American Naturalist 111: 376 – 381.

Rosenzweig, M.L. 1995. Species diversity in space and time. Cambridge University Press, Cambridge, UK.

Santos, G.M., Gomes P.R.S., Anjos, R.M.. Cordeiro, R.C., Turcq B.J., Sifeddine A., di Tada M.L., Cresswell, R.G. and Fifield L.K. (2000). 14C dating of fires in the Central Amazon rain forest. Nucl Instrum Methods Phys Res B

172: 761 – 766.

Scuffins, M. 1994. The Ecological Impacts of Fuel Reduction Burning on Reptiles and Small Mammals in Dry Sclerophyll Forest. Honours Thesis, University of Ballarat.

Silva, J.F. 1996. Biodiversity and stability in tropical savannas. Pp. 161 – 171 in Solbring, Medina and Silva (eds.). Biodiversity and Savanna Ecosystem Processes. Springer – Verlag, Berlin, Germany.

Singh, S., A.K. Smyth and S.P. Blomberg. 2002. Effect of a control burn on lizards and Their structural environment in a eucalypt open – forest. Wildlife Research 29(5): 447 – 454.

Slik, J.W.F. and Eichhorn, K.A.O. (2003). Fire survival of lowland tropical rainforest trees in relation to stem diameter and topographic position. Oecologia 137: 447.

Smith, L.J., A.T. Holycross, C.W. Painter and M.E. Douglas. 2001. Montane rattlesnakes and prescribed fire. Southwestern Naturalist 46 (1): 54 - 61.

Snyder, J.R. 1986. The Impact of Wet Season and Dry Season Prescribed Fires on Miami Rock Ridge Pineland, Everglades National Park. South Florida Research Center Report SFRC – 86/06. Everglades National Park, Homestead, FL.

Soerianegara, I., and Lemmens, R.H.M.J. (Eds.) 1994. Plant Resources of SoutheastAsia No. 5 (1): Timber Trees: Major commercial timbers. Prosea Foundation, Bogor, Indonesia & Pudoc-DLO, Wageningen, the Netherlands. 610 pp. Sousa, W.P. 1984. The role of disturbance in narural communities. Annual Review of Ecological Systems 15: 353 – 391.

Spain, A.V. (1984). Litterfall and the standing crop of litter in three tropical Australian rainforests. Journal of Ecology 72: 947. Sparks, J.C., R.E. Masters, D.M. Engle, M.E. Payton and G.A. Bukenhofer. 1999. Influence of fire season and fire behavior on woody plants in red – cockaded Woodpecker clusters. Wildlife Society Bulletin 27 (1): 124 – 133.

Stohlgren, T.J., M.B. Falkner, and L.D. Schell. 1995. A Modified – Whittaker nested Vegetation sampling method. Vegetatio 117: 113 – 121. Swaine, M.D., W.D. Hawthorne, T.K. Orgle.1992. The effects of fire exclusion on Savanna vegetation at Kpong, Ghana. Biotropica 24 (2) A: 166 – 172. Tennant, A.1997. A Field Guide to Snakes of Florida. Gulf Publishing Co. Houston, TX. 257 pp.

Terborgh, J. (1992). Diversity and the Tropical Rainforest. New York: Scientific American Library.p. 242.

Valverde, T. and Silvertown, J. (1997). Canopy Closure Rate and Forest Structure. Ecological Society of America. 78 (5): 1555-1562.

Varner, J.M. III, J.M. Kush and R.S. Meldahl. 2000. Ecological restoration of an old –Growth longleaf pine stand utilizing prescribed fire. Pp. 216 – 219 in W.K. Moser and C.F. Moser (eds.). Fire and Forest Ecology: Innovative Silviculture and Vegetation Management. Tall Timbers Fire Ecology Conference Proceedings,No. 21. Tall Timbers Research Station, Tallahassee, FL.

Whelan, R.J. 1995. The ecology of fire. Cambridge University Press, Cambridge, UK.

Whitmore, TC., Tantra IGM, and Sutisna, U. (1990). Tree flora of Indonesia check list for Kalimtan, parts I and II. Agency for Forestry Research and Development, Forest Reserarch and Development Center, Bogor, Indonesia.

Williams, R.J., A.D. Griffiths and G.E. Allan. 2002. Fire regimes and biodiversity in the Savannas of northern Australia. Pp. 281 – 304 in Bradstock, R.A., J.E. Williams, and M.A. Gill (eds.). Flammable Australia. The Fire Regimes and Biodiversity of a Continent. Cambridge University Press, Cambridge, UK