

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

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## 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 Ilanosi* 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 unburned sites). The mean rank of unburned site (8.83) is 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 *Megophrys 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 data 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 unburned 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:

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

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

### 3. Shannon diversity Index

s

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

where:

H = the Shannon diversity index

P<sub>i</sub> = fraction of the entire population made up of species i

S = numbers of species encountered

∑ = sum from species 1 to species S

### 4. Relative abundance

Data obtained from the transect surveys were used in determining 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 Ilanosi* 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 forest 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. Moreover, 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 Ilanosi* has the most number, followed by Piloc- 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*

*Ilanosi*, 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 Ilanosi*, *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 Ilanosi* 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 Ilanosi*, 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 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

*Megophrys 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 *Megophrys 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 *Megophrys 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.

*Megophrys 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.

*Megophrys 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 *Megophrys 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 *Megophrys stejnegeri*. As stated by Iskandar (1998), the *Megophrys stejnegeri* is common in dense tropical rainforest, both primary and secondary forest.

The species of *Megophrys 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 *Megophrys stejnegeri* and *Ansonia muelleri* were commonly observed while *Hydrosaurus pustulatus* is frequent. Consistent in Table 3 that *Megophrys 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 such as 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 llanosii* 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. *Megophrys stejnegeri* is the most dominant anuran both in burned and unburned sites in Mt. Candalaga. Meanwhile, reptiles are rarely seen in the sampling sites.

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