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Vegetation dynamics between an open patch and a forest edge

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ABSTRACT

The study was conducted in two adjacent open area (patches and forest edges) resulted from a major blow-down as a laboratory exercises in SFI 223 (Advanced Silviculture). The two areas were utilized to understand the growth dynamics of the resulting vegetation in the plots. Findings of the study reveals that the forest edge and open patch still covered with various big indigenous and exotic tree species, and lianas. Open patch has more regenerants than forest edge. The comparatively higher difference of number of regenerants in open patch particularly might be due to the fact that Forest Edge have been fully covered with vines and other woody climbers that suppressed the growth of regenerants. For basal area, still open patch has higher B.A of 23.26cm^2. Minimal growth was observed in the forest edge site for the 3 weeks measuring interval. This might caused to the relatively short interval of data collection aside from the dry season occurring on the month of data collection and other site factors such as sunlight competition from cover vegetations, nutrient competition from shrubs, lianas, and grasses. In the open patch, the highest growth increment of 21.473 cc is due to the significant growth increment and absolutely higher abundance of regenerants present and low mortality rate Another possible reason is that, the site is located at SE aspects were sun can constantly penetrate to the forest floor mat drives energy for the growth of the regenerates present..

1. Introduction

Even trees do not live forever; the time comes when they must be, or naturally are, replaced by new ones. Stand dynamics is the study of changes in forest stand structure with time, including stand behavior after disturbances. These disturbances are relatively discrete events that disrupt the stand structure and/or change resource availability or the physical environment.[1].The lethal natural disturbances that initiate new stands include fire, pest attacks, landslides, windstorms, and various atmospheric agencies. In most part of the world, fire is the most common natural disturbance. As a result of this, forest openings or open patches are formed. Patches differ in the amount of their area which is under the influence of the environment outside the patch. A large gap has a center with very different climate than the edges or under surrounding stands. This difference created a pronounced edge effect in vegetation in the larger gaps But in small gaps, roots from the surrounding stand occupy the site and, except in the tropics, direct sunlight never reaches the forest floor because the sun is never directly overhead. Species which survive the intense root competition and low light levels are found there [2]. A stand edge is a disjunction in a forest where the populations of trees on either site have distinctly different structures - numbers, ages, species, growth rates, or spatial distributions. Development of a stand adjacent to an opening could be a stream, road, field, or grassland. Trees growing immediately on this along the edge are not shaded open one side and retain a long live crown on that side. Many edge trees lean on the opening, either because of their heavier crowns on that side or because the trees toward the sunlight [3]. Stand edges adjacent to an opening are also created when part of an existing stand is removed. The newly created edge is first invaded by many trees, shrubs and herbs. Later, preexisting and newly established trees dominate. The newly established trees often are species which compete in full sunlight and may be different from those in stand's interior. The configuration of a disturbance dictates how much of the area is close to an edge what the directional orientation is - and, hence, which and how many species invade. It also indicates what the microenvironment will be and how much growing space will be available and, hence, which species have a competitive advantage and how fast they will grow. With the foregoing, it is deemed desirable to

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study the characteristic of specie-growing on both sites in order to examine the regeneration patterns, growth and development of species growing on both areas and to further analyze the effect of patch on the edge and vice versa [4].

Objectives

1. To characterize individual site (open patch and an edge) and further investigate the species diversity in both areas.
2. To identify regenerations growing in two areas and relate these to pollination, seed dispersal and animal dispersion mechanisms occurring in both locations.
3. To examine the effect of an edge into the forest opening and vice versa.
4.To Compare the vegetation diversity in terms of species composition, numbers, base area and growth within the duration of the study [5].

2. Methodology

We conducted this study in a two adjacent open area (patches and forest edges) resulted from a major blow-down as a laboratory exercises in SFI223 (Advanced Silviculture). The two areas were utilized to understand the growth dynamics of the resulting vegetation in the plots. Methodology employed in the conduct of the study is as follows:

2.1 Site Selection

The existing research area established by SFI 221 (Advanced Forest Nursery and Plantation techniques) students of Dr. Willlfredo M. Carandang, first semester, S.Y. 2003-2004 were considered and utilized as an area for the open patch. On the adjacent sites (50m or more) where forest vegetations exist, a forest edge was identified as another site (for comparison). Both sites are inside the Makiling Forest Reserve within 121°08' - 14°09' north latitude, specifically, downhill portion of the open patch is bounded by an intermittent stream. In the north, facing the ERDB complex and on the south, locates the TREES Guesthouse. The map/layout of the study sites is shown in Figure 1. (Map/layout of the study sites

2.2 Experimental Lay-out

For the open patch, the four blocks previously established/delineated in the area were utilized. Another 4 blocks have been established in the adjacent forest edge with the same dimension that of the previous study of 4m X 16m per block (64 sq.m.). Four plots with a dimension of 4m x 4m (16 sq.m) have been established inside each block with a total of 16 plots per study site. Inside the plots hi forest edge, one subplot (1m x 1m) are again established each plot for the counting, identification and measuring (diameter and height) of regenerants [6].

2.3 Statistical Analysis

The computation and graphing of the correlation of the regenerants in the two experimental sites (open patch and forest edge) with the trees in the edge employed the linear equation correlation equated as follows:

The Shannon's diversity and evenness indices are used to compute the importance value of each regenerants found in the two study sites. Relative frequency, relative dominance and relative density of each regenerants within each block are also determined. All computations are summarized with graphical representation to facilitate easy understanding of the readers[7].

2.3.1 Data gathering

2.3.2 Forest Tree Canopy Vegetation and Regeneration

In the open patch, all the data that were previously gathered will be considered, like the data obtained for larger trees (10 cm dbh and above) inside 4m x 4m main plots. For the regeneration, data on height and diameter shall be remeasured for their growth increments. Appropriate computation procedure shall be applied in order to get the present height and diameter on these regenerants.

In the case of the edge, surrounding tree canopy species within the sampling plots having 10 cm dbh and above shall be recorded. Same with the regeneration data, height and diameter inside a 1m x 1m plot shall also be obtained

The formula used as guide in determining the Relative Density, Relative Frequency and Relative Dominance in determining the Importance Values uses the Manual on Vegetational analysis of PCARRD by Nisperos. [8].

2.3.3 Edaphic factors

Edaphic factors determination in the forest edge such as data on soil type, soil pH, soil moisture, soil texture and organic matter content of the site are obtained from the soil samples collected and analyzed from each block in the forest edge. Composite soil samples are taken from the surface of the ground (top soil) and sub-soil is taken at a depth of 30cm from the soil surface. These are brought to ERDB Soils Laboratory for further analysis. In the case of the open patch, previous data are used since it was just taken two months earlier from the conduct of this activity [9].

2.3.4 Climatic Data

All the data gathered on climatic aspects on the edge are obtained from the data gathered by the previous student in SFI 221 (Advanced Forest Nursery and Plantation Techniques) since the edge is just adjacent to the open patch. However, for the purpose of comparison between the two sites, relative solar intensity, relative humidity and air temperature are obtained using the photometer, and other appropriate measuring instrument for these parameters[10].

2.3.5 Physiographic factors

The geographic location of the forest edge (longitude/latitude), topography, aspect, slope, drainage and elevation are recorded as site/physiographic factor affecting plant growth and development. In the open patch, still the previous recorded data are utilized [11].

2.3.6 Vegetative cover

The vegetations near the forest edge are determined to draw a conclusion on influence of these species on the edge and the open patch. For the vegetative cover of the open patch, see the previous laboratory work of the SFI class, 1st sem. SY. 2003-2004 under Dr. Willy Carandang [12].

3. Results

A Climatic

Climatic data of the site were obtained from the primary data. Mt. Makiling belongs to Climatic Type I (Corona Classification, with two pronounced seasons, dry from January to April and Wet from May to December. The area has a mean annual rainfall of 2,103.4 mm. from 1990 to 1991 (UPLB Agrometeorology Station), with a monthly rainfall of 227.5 mm. Mean annual temperature ranges from 25°C to 27.5°C. The coldest month is January with an average temperature of 24.3°C - 25°C. The wannest are April and May with average temperature ranges from 26°C - 29.5°C (Cruz, et al., 1992) [10].

B. Edaphic

The soil texture of the two study site is sandy clay loam, with an average percentage ratio of sand:silt:clay of 53:21:24 taken from the different Blocks.Average Soil pH of the site is 7.1 with average bulk and particle density of 1.15 and 2.25 respectively. Organic matter content ranges from 11.04 - 57% in the open patch (previous study of M.M. Aguiloset.al., 2003). For the forest edge, average soil pH is 6.65 with OM ranges from 8.72% -11.13%.

C. Physiographic Attributes

The sites has an approximate elevation of 180 - 195 m asl with relatively gentle to moderate slope. Getting into the site is rather difficult with an abrupt descent of about 50 meters from the TREES Guesthouse at slope of about >60°. Since the study site is located on a hillside, and surrounded by an intermittent stream, drainage is very good.Block 1 and 2 of the forest edge site is located on a gentle slope area facing NW aspect while Block 3 and 4 , located on a gentle to moderately slope area facing NE aspect. For the open patch (see laboratory report of students in SFI221,1st sem. SY. 2003-2004).

D. Vegetation Cover

The Northwestern side of the forest edge (Block 1 and 2) site is covered with large trees of Palosanto (*Triplariscuminiand*), Tibig(Ficusnotd), Anubing (*Artocarpusovatd*), Katong-matsin (*Chisochetonpentandms*) and Amugis (*Koordersiodendronpinnatum*). Lianas with some paper mulberry (*Broussonetiapapyrifera*) including banana plants dominate the Block 1, while Calliandra (*C. calothrysus*) plants were dominated hi Block 2.Block 3 and 4 of the forest edge is dominated by shrubs vines, and other palm tree species. It is bounded by big trees of Anubing (*Artocarpusovatus*), Katong-matsin (*Chisochetonpentandrus*),Amugis(*Koordersiodendronpinnatum*),Aplas(*Ficusirisind*),Igyo(*Dysoxylumgaudichau*dianum),Magabuyo(*Celtisluzonicd*), Antipole(*Artocarpusblancoi*), Is-is, Narra (*Pterocarpusindicus*), Malapapaya (*Polysciasnodosa*), Bayag Usa , Ligas (*Semecarpuscuneiformis*),Kaliantan(*Leeaphilippinensis*),Agusip(*Symplocosodoratissima*),Tibig(*Ficusnota*),Kalulot(*Artocarpusrubrovenius*),Kangko(*Aphanamixispolystachyd*),Hauili(*Ficusseptica*),Mahogany(*Swietenimacrophylla*),Kalomata(*Clausiabrevistyla*),Taparak(*Ficuspedunculosa*), White Lauan (*Shoreacontorta*) Paper mulberry (*Broussonetiapapyrifera*) and (*Harpulliaramiflora*). The open patch site vegetation in the nearby site includes; Dao (*Dracontomelondao*), Brazilianfiretree(*Schiozolobiumexcelsum*),Anubing(*Artocapusovata*),andAntipolo(*Artocarpusblancoi*). Calliandra (*C. calothrysus*) and Paper mulberry (*Broussonetiapapyrifera*) plants were also abundant in the site located in the Southeastern aspect. Vegetation covers almost 80% of the upper canopy level in Block 1 and 2. Bikal(*Phyllostachysmindorensis*) bamboos, pugahan or fishtail palm (*Caryotacumingii*) and kaong (*Arengapinnata*) palms were also observed in the site.The other side of the open patch (Block 3 and 4) lying NE aspect is open, uuko vines dominated the area. Banana plants were also present in the site. There are also large trees nearby such as Igyo(*Dysoxylumdecandrum*) and malapapaya(*Polysciasnodosa*). At the NW tip of the Blocks, four rain tree(*Samaneasamari*) are standing. Amugis(*Koordersiodendronpinnatum*),mahogany(*Swieteniamacrophylla*) and Prickly narra(*Pterocarpusindicus*) trees are also present at about 50m distance from the blocks.Based on the results (Summary of Total Number of Species and Basal Area), Onlyone regenerant of Anubing (*Artocarpusovata*) is found in Block 1 (Table la and Graph la). Anubing (*Artocarpusovata*) dominated block 2 with 9 regenerants followed by Apanang (*Neotrewiacumingii*) with 7 regenerants, Santol (*Sanduricumkodjape*), Tibig (*Ficus nota*), Magabuyo(*Celtisluzonica*), and Is-s (*Ficusulmiflolia*) has 1 regenerant observed each (Table la, Graph Id). Amugis (*Koordersiodendronpinnatum*) ,Hauili (*Ficus septica*) and Marang (*Litseaperrottetii*) have 2 regenerant each found in Block 3 with 1 Anubing(*Artocarpusovata*). In Block 4, Igyo (*Dysoxylumdecandrum*) dominated the block with 10 regenerants followed by Kalulot (*Artocarpusrubrovenius*), Mahogany (*Swieteniamacrophylla*) and Ligas (*Semecarpuscuneiformis*) with 1 regenerant each. The result of the inventory favors the actual observations that the forest edge site in the study is completely covered by Lianas, and shrubs that sun penetration to the soil floor is very limited. Ranneyetal., 1981; Lovejoy etal., 1986; Williams-Linera, 1990a reported that edges show higher species richness and increased tree mortality. Another factor that might be drawn is the dry season occurring during the conduct of the study.Basal area in Block 3 is found to be larger (0.92 cm^2/m^2) compared to Block 2 (0.8 cm^2/m^2) and Block 4 (0.87cm2/m2) which has more regenerants/species observed. Block 2 has the highest number of regenerants followed by Block 4 of 15 regenerants. Block 3 has 7 regenerants and only 1 regenerant found in Block 1.In terms of species dominance, Marang (*Litseaperrottitii*) has the highest Relative Dominance (RD) of 23.34% followed by Anubing (*Artocarpusovatus*) of 19.86% and Igyo (*Dysoxylumgaudichaudianum*) of 14.29% Q. Although Marang (*Litseaperrottitii*) has only two regenerants in the whole site but it has bigger diameter compared to other species with more numbers of regenerants. *Dysoxylumgaudichau, dianum* 14.29%. Although Marang (*Litseaperrottitii*) has only two regenerates in the whole site but it has bigger diameter compared to other species with more numbers of regenerants. For the Relative Frequency, Igyo (*Dysoxylumgaudichaudianum*) rank first with 33.33%RF, followed by

Anubing(Artocarpusovatus) 25%RF, Amugis (*Koordersiodendronpinnatum*) and Marang(*Litseaperrottitii*) of 16.67% RF.Relative density data reported that Anubing(Artocarpusovatus) is highest with 25.58%Rd,Igyo(*Dysoxylumgaudichaudianum*) is 23.26%Rd and Apanang(*Neotrewiacumingii*) of 16.28%Rd. The rest did not attain at least 10% relative density.The computation of Importancevalue data revealed that Igyo(*Dysoxylumgaudichaudianum*) found to be the highest(70.87%Iv) ,followed by Anubing (*Artocarpusovatus*)of70.44%Iv,Hauili(*Ficusseptica*)of44.66%Iv,andA mugis(*Koorsiodendronpinnatum*)32.94%lv. The rest did not reach at least 30% importance value.

Survival Rate

Table 3 summarized the number of regenerant survived from previous study to present. It shows that block 1 has the highest survival rate of 81.5% (18.5% mortality rate), followed by block 2 of 75% (mortality rate of 25%) and block 4 block 3 with > 50% survived.

Regeneration Growth Increment in the Two Sites:Minimal growth was observed in the forest edge site for the 3 weeks measuring interval.

This might caused to the relatively short interval of data collection aside from the dry season occurring on the month of data collection and other site factors such as sunlight competition from cover vegetations, nutrient competition from shrubs, lianas, and grasses. In the open patch, Block 1 seems to have the highest growth increment of 21.473 cc followed by Block 4 of 0.63 cc and Block 3 of 0.468 cc (Table 4 with accompanying graph). The reason behind the significant growth increment in Bl might be the absolutely higher abundance of regenerants present and low mortality rate (Table 3 with accompanying graph). Another possible reason is that, the site is located at SE aspects were sun can constantly penetrate to the forest floor mat drives energy for the growth of the regenerants present.

In terms of basal area, since the relatively few number of regenerants found in the edge forest, it can be hard compared with the open patch which has seemingly higher number of regenerants counted and recorded. Basal area in Block 1 is the highest (15.74 cm^2/block) followed by Block 4 of 3.98 cm^2 and Block 2 Of 3.83. Block 3 has 2.57 cm^2 basal area (Table 4 and graph).

Comparison of the Two Study Site: In Terms of Number of Regenerants and Basal Area

Open patch has more regenerants than forest edge (Table 3 and Graph.) The comparatively higher difference of number of regenerants in open patch particularly Bl might be due to the fact that Bl of Forest Edge have been fully covered with vines and other woody climbers that suppressed the growth of regenerants.For basal area, still open patch has higher B.A of 23.26cm^2 (sum of the difference B.A of the two sites).

Block	Edge Forest		Open Patch		Difference Re.#	Basal Area
	Re. #	Basal Area	Re. #	Basal Area		
1	1	0.28	67	15.74	66	15.47
2	20	0.80	31	3.83	11	3.03
3	7	0.92	14	2.57	7	1.65
4	15	0.87	16	3.98	1	3.11
Total	43	2.87	128	26.12	85	23.26

Table 1: Comparison of the Number and Basal Area of Regenerants in the Forest Edge and Open Patch

4. Discussion

4.1 Edge Forest Site

The edge of the forest studied has relatively fewregenerants found. The highest number of regenerants was recorded in Block 2 (6 species with a total of 20 germinant) followed by Block 4 with 4 species of 15 germinant, and Block 3 with 3 species composing 7 germinant. Only one regenerant found in Block 1. One possible caused of few regenerantsfound in the edge particularly Block 1 of the site is the relatively higher population dominance of straggling lianas and other woody climber's vegetation in the site that trapped sunlight to shelter down to the soil surface. Edges show higher species richness and increased tree mortality (Ranney et.al., 1981). Another reason and probably applicable to the two site condition is the dry season occurring in the months of data gathering..In terms of basal area, Block 3 is the highest with 0.92cm^2 BA followed by Block 4 of 0.87 cm^2 and Block 2 of 0.8 cm^2. It is quiet wondering that Block 2 who has higher number of regenerants only ranks 3 in terms of basal area. The reason for this might be the slower growth of regenerants due to the dense shrubs dominated in the area (sunlight cannot penetrate) competing for sunlight and other nutrients. In Block 3, although, fewer number of regenerant found, but the area is favorable to sunlight penetration because it has no shrubs competing for sunlight aside from its location which face SE aspect. From an empirical viewpoint, data from vegetation management studies show large gains in individual tree productivity and lower mortality rates on south aspects (Wykoffetal., 1982).Anubing(Artocarpusovatus) found to be higher in number compared to other regenerants (11 regenerants) followed by

Igyo(*Dysoxylumgaudichaudianwri)* of 10 regenerant and Apanang(*Neotrewiacumingii*) of 7 regenerants. The least are Amugis, Hauili, Marang (2 regenerants each), Kalulot, Mahogany, Ligas, Is-is, Magabuyo, Tibig and santolwithlregenerant each (Table 1).

4.2 Open Patch

Number of regenerants in the open patch has been reduced due to mortality. Block 3 has the highest mortality rate of 63.4%, followed by Block 4 of of 52.9%, B2 with 25% mortality rate and Bl has the lowest mortality rate of 18.5% (Table 3 with graph). The mortality rate might due site factors (biotic and abiotic) such as: unintentional destruction made by forest perpetuators (student and other individuals entering the area for some purposes), pest and diseases, damaged/destruction made by falling branches and crowns of nearby trees, browsing of animals, light, water and nutrient competitions from neighboring other plants particularly shrubs, vines and other grasses. Vegetation associated with open patch shows several features in response to open patch condition. Light exposure stimulates germination and enhances growth of pioneer or shade intolerant species (Wales, 1972), that may compete to the regenerants, hampering normal growth and may causes abnormalities and even death of the newly grown germinant.Basal area was higher on Bl of 15.74cm^2., followed by B4 of 3.98cm^2 and B2 of and B4 of 2.87 cm^2 and 2.57 cm^2, respectively (Table 4). The reason for the relatively higher basal area of Bl is the relative higher number of regenerants survived. B4 on the other hand has the less basal area because of the higher mortality caused by the higher abundance growth.

Table 2: Basal area of the Open Patch

Block	No. of Regenerants	Basal Area
1	67	15.74
2	31	3.98
3	14	3.83
4	16	2.57

4.3 Relative Frequency, Relative Dominance and Relative Density

Anubing has the highest relative frequency in the forest edge (64.19%), followed by Igyo of 43.79% and Marang with 34.25%. In the open patch, Amugis seems to be the highest with RF value of 67.15%, followed by Mahogany with RF of 48.61% and Malaikmo with 38.76% relative frequency.In terms of dominance, Marang has the highest dominance value (23.34%) in the forest edge followed by Anubing(19.86%) and Igyo with relative dominance value of 14.29%. For the site in the open patch, still Amugis has the highest dominance value of 19.43%, followed by Malaikmo (14.38%) and Palosanto (13.82%).For the relative density, in forest edge, Anubing has the highest relative density of 25.58%, followed by Igyo with relative density value of 23.26% and Apanang (16.28%). Amugis still has the highest relative density (27.34%) for the open patch, followed by Mahogany with relative density of 18.75% and Anubing with relative density of 15.63%.Importance value of each regenerant in forest edge reveals that Anubing seems to be highest at 64.19%, followed by Igyo with importance value of 43.79% and Marang at 34.25% importance value. In the open patch, Still Amugis has the highest importance value of 67.15%, followed by Mahogany (48.61% and Anubing with importance value of 40.14%.

5. Conclusions and Recommendations

In the Forest edge site, only 3 species seems to have morethan 4 regenerants found (Anubing: 11; Igyo: 10; and Apanang; 7 regenerants). This is true to the actual observation of the area that is fully covered (dominated) by vines, lianas, and other grasses that seems to In the Forest edge site, only 3 species seems to have morethan 4 regenerants found (Anubing: 11; Igyo: 10; and Apanang; 7 regenerants). This is true to the actual observation of the area that is fully covered (dominated) by vines, lianas, and other grasses that seems to suppress the germination of seeds within the surface floor. Another possible reason is the drought occurring during the conduct of the study, aside from many other site factors that affects germination and growth of regenerants such as light and water requirement and other nutrients that are consumed by the dominating weeds in the edge.Amugis, Mahogany, and Anubing including Malaikmo has possibility to dominate/sustain in the open patch based on the result of the study. These species has the less number of regenerants dead < 40%.In spite of their inevitability, potential disturbances are not completely unpredictable or uncontrollable. By manipulating stand structures and edges at correct time, we can control a stand's susceptibility to most disturbances.Stand edges affect many management activities. Stands are generally managed as a single unit and edges tend to be perpetuated for many generations of trees.Knowing the regeneration mechanisms of all desired and undesired species in a stand it is necessary to regenerate the stand efficiently. Change in vegetation patterns will result to change in soils, climates, disturbance patterns, and species migration which will eventually cause further landscape change.Vegetation changes can cause previously isolated species to come into contact. These contacts cause new vegetation patterns and elimination of some species through competition.In practicing silviculture, the forester must be able to predict what kind of vegetation will follow regenerative disturbances and what patterns of development should be anticipated in all the vegetation as the stands grow older.The forest grow only where the climate is more conducive, than average to the development of land vegetation.New vegetation generally appears only after some lethal disturbances have eliminated all or some of the preexisting plants.This is because woody perennials, once established is really a dynamic, usually command growing space so tenaciously that only the death of some of them can make vacancies large enough for new ones to start and make raid growth.Regenerative disturbances, whether naturally or artificially induced, determine when new trees appear or start active development on any given unit ground area.The forester needs to predict the structure and species composition which will develop after each type of disturbance.Individuals and species which first occupy growing space have an advantage in maintaining it and excluding other plants. A forest may seem static but is really a dynamic, ever-changing, living structure.

Conflict of interest statement

We declare that we have no conflict of interest.

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