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# Spatial Distribution of Kalantas (*Toona calantas* Merr. & Rolfe) in the Molawin–Dampalit Watershed, Mount Makiling Forest Reserve, Philippines

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## ABSTRACT

*Vegetation inventory using a combination of point center method strip and quadrat method was conducted to determine the spatial distribution and population of kalantas (Toona calantas Merr. & Rolfe) in the Molawin–Dampalit Watershed of Mount Makiling Forest Reserve (MMFR). From the 1,081 individuals recorded in the 13 sampling plots established in three zones, 146 (13.3%) individuals are T. calantas, 51(35%) of which are trees and saplings and the remaining 95 (65%) individuals are seedlings. Majority of the seedlings are spread out within 20 m from the mother tree and between 164 to 480 masl. Beyond 20 m, there were very few seedlings found indicating close seed dispersal of T. calantas.*

*Distribution of T. calantas increases at higher elevation. The highest number of seedlings (65) was recorded at an altitude of 480 masl while the highest number of trees and saplings (15) was recorded at an altitude of 370 masl. Sampling plots at higher elevation have less dense vegetation and therefore have more space for light penetration which is favorable to the growth of T. calantas. Additionally, higher elevations are less accessible to people and are therefore less disturbed.*

*T. calantas showed a low population in terms of frequency, abundance and dominance as compared with other species. As a critically endangered species, this paper proposes to use these parameters as bases for restoring the population of T. calantas in Mt. Makiling. Since it is important to conserve reproductive trees in order to ensure continuous increase and perpetuity of the population, priorities will be given to those areas where mother trees exist. Conservation efforts are recommended for plots with mother trees and containing the highest number of seedlings.*

*Keywords: conservation, critically endangered, extinction, mother trees, Toona calantas*

## INTRODUCTION

The Mount Makiling Forest Reserve (MMFR) is a biological and scientific area with a total land area of 4,244 ha that primarily serves as a training laboratory for the advancement of scientific knowledge on forestry and natural resources. Republic Act 6967 vested upon the University of the Philippines Los Baños (UPLB) the exclusive jurisdiction, administration, and complete control over the MMFR. It covers portions of the municipalities of Los Baños and Bay and Calamba City in Laguna Province and the town of Sto. Tomas in Batangas Province. MMFR was recently declared as an ASEAN Heritage Park in 2012. It is operationally managed according to its four watersheds, namely Molawin–Dampalit, Cambantoc, Sipit, and Tigbi.

The MMFR is regarded as one of the best–known biological areas in the Philippines due to its long scientific history (Pancho 1983). Further, it is also recognized as one of the Philippines' 18 centers of plant diversity (DENR–UNEP 1997), an extremely high biodiversity conservation priority area (DENR–CI–UP 2002), and one of the country's 32 key ecotourism sites (DENR–DOT 2002) as cited by Abraham *et al*. (2004).

MMFR is home to more than 2,000 species of flowering plants (Pancho 1983) and 48 threatened plant species of economic and ecological importance (Lapitan *et al*. 2012), 23 of which are in the high threat category while 15 are critically endangered, including *T. calantas*.

*T. calantas* is endemic to the Philippines and found only in Batan Islands in Luzon, Mindoro, Samar, Negros, Leyte, Cebu, and Mindanao (Fernando *et al*. 2004). It is a tree that can grow up to 35 m tall with a diameter of 152 cm (DENR Recommends 2007) making it popular for wood panel, cigar box, *banca*, guitar, oak barrel, and even as a host for *Shitake* mushroom culture (Serrano 1985), and medicine (Fernando *et al*. 2004), among other products. This economically important species is being used by the natives of Conner, Palawan as wood for furniture (Aggangan *et al.* 2010) and timber by the local residents of Mt. Mayon, Bicol Peninsula (Buot 2009).

After the last five decades of being in danger (Quisumbing 1967 as cited by Quereshi *et.al* 1969), *T. calantas* is now listed as one of the critically endangered plant species in the Philippines (DENR Administrative Order 2007–01; Fernando *et al.* 2008). *T. calantas* therefore should be prioritized for conservation. The paper discusses the extent of distribution of *T. calantas* population within the Molawin–Dampalit Watershed, MMFR including its population status, factors that may have affected its distribution, and recommended conservation approaches/strategies to prevent this very important species from extinction.

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## METHODOLOGY

### A. Location of the Study

The study was conducted within the Molawin–Dampalit watershed with an estimated area of 922 ha and composed of Molawin, Maralas, Pili and Dampalit creeks (Figure 1). Lapitan *et al*. (2012) reported that this watershed contains the highest number of vulnerable and critically endangered species in MMFR.

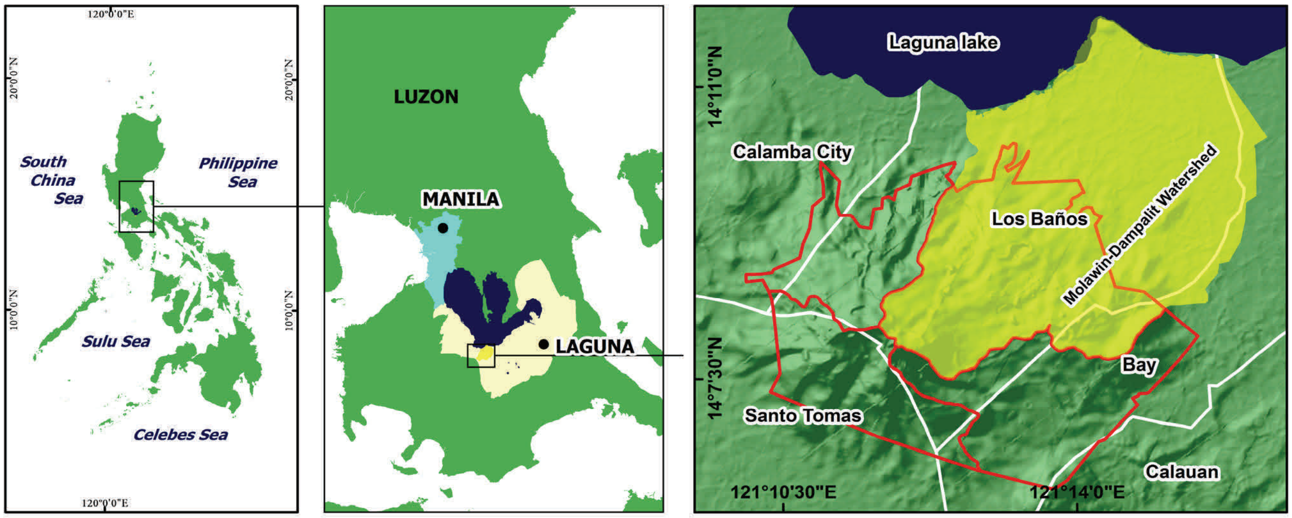



Figure 1. Location of the study site.

### B. Sampling Design

The study used a combination of point center method strip (*T. calantas* tree as the center point), and quadrat method. A reconnaissance survey was conducted to locate sampling sites with at least one *T. calantas* tree for every 100 m elevation range. On the northeastern (NE) slope of MMFR, a total of 13 plots were established along the altitudinal gradients of 100–200 masl, 201–400 masl and >400 masl (Figure 2). The transect was established at three zones up to 500 masl, the altitudinal range of *T. calantas* in Mt. Makiling according to Fernando *et al*. (2004). With the *T. calantas* tree as the center point, a 50– m strip from the each of the four cardinal directions, due North, due South, due West and due East, was established (Figure 3). The distribution, density, frequency, and crown cover of *T. calantas* were determined as well as the extent of seed dispersal.

### C. Inventory, Mapping and Data Collection

All ages of *T. calantas* were counted and measured while the plot sampling method was used in determining the distribution of a species relative to other plant species. The methods were applied at different altitudinal zones.

All *T. calantas* (from seedlings to mature trees) were identified, marked, counted, and recorded within the 20m x 50m area (Figure 3). Seedlings were counted and recorded. All saplings and mature trees were marked properly and parameters such as diameter at breast height (DBH), height, merchantable height (if applicable), total height, and crown cover were measured. All *T. calantas* found within the four transects were mapped using global positioning system (GPS) along with altitude and relative location.

### E. Establishment of Plots

A 20m x 20m plot was established in each sampling point using the *T. calantas* tree as the plot center. Within the 20m x 20m plot, all trees with a minimum diameter of 2.50 cm were identified, marked, measured, and recorded. The *T. calantas* center tree was marked with a small rectangular tag made of aluminum can indicating the plot number and the reference tree number. Parameters such as DBH, merchantable and total height, and crown diameter were properly measured and recorded. The tree inventory was systematically done starting from quadrat 1 (NE quadrat), quadrat 2 (SE quadrat), quadrat 3 (SW quadrat), quadrat 4 (NW quadrat) with North and South as

Tagging of *T. calantas* during data collection.

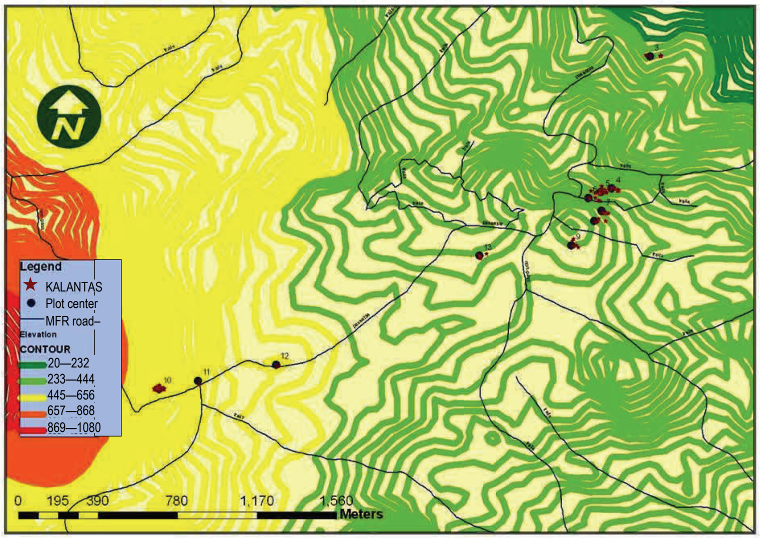



Figure 2. Distribution of plots in the Molawin–Dampalit

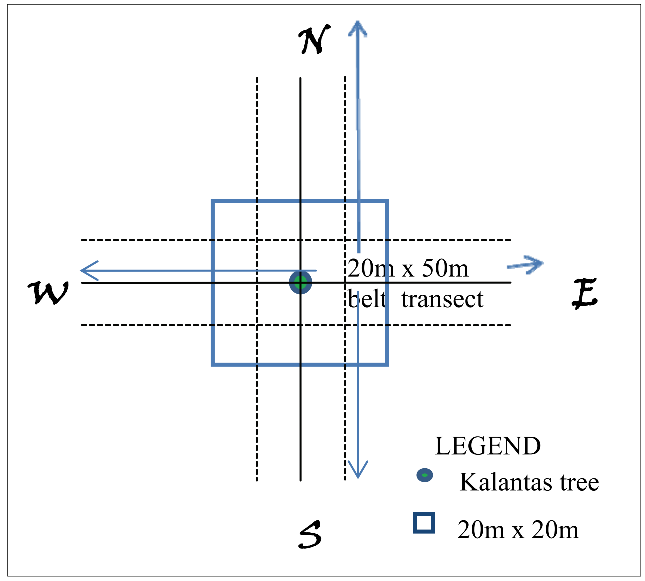



Figure 3. Lay–out of sampling plots and transects.

*y* reference and East and West as *x* reference. All individuals of *T. calantas* (saplings to mature trees) were inventoried.

**F. Floristic Composition and Dominance Analysis**

In this study, the importance value (IV) of each species especially that of *T. calantas* was computed following the formula of Curtis and Mcintosh (1950):

IV = Relative Density + Relative Dominance + Relative Frequency

Where:

$$\text{Relative Density} = \frac{\text{Number of individuals of species}}{\text{Total number of individuals}} \times 100$$

$$\text{Relative Dominance} = \frac{\text{Crown cover of a species}}{\text{Total cover of all species}} \times 100$$

$$\text{Relative Frequency} = \frac{\text{Number of occurrences of the species}}{\text{Total number of occurrences of all the species}} \times 100$$

## RESULTS AND DISCUSSION

### A. Distribution of *Toona calantas* and Floristic Composition of the Molawin–Dampalit Watershed

A total of 1,081 individuals, 146 of which are *T. calantas,* are spatially distributed on the hill slopes of Molawin–Dampalit Watershed from 164 to 480 masl. The finding affirms the study of Amoroso *et al.* (2012) and Fernando *et al*. (2004) that the threatened *T. calantas* along with *Lithocarpus* spp. and *Ficus* spp., *Ficus variegata,* and the endemic *Macaranga grandifolia* are dominating the lowland dipterocarp forest at altitudes ranging from 220 to 500 masl.

The number of *T. calantas* trees and saplings ranged from 2 to 15 individuals per plot. The most number of *T. calantas* trees and saplings are distributed in plots 5, 7 and 9, while the most number of seedlings was found in plot 10 (Figure 4).

Seedlings are distributed in all altitudinal zones except for plots 5, 6, 7, 9, 11, and 12 that recorded zero seedlings. The data suggest that the reproductive stage of *T. calantas* falls in the DBH range 60.2 – 95.2 cm. In plots 5, 6, 7, 9, 11, and 12, the diameter of *T. calantas* trees ranged from 10.8 – 35.7 cm and therefore these trees may not yet be in their reproductive stage.

With these data, plots 5, 7, 9, and 10 will be prioritized for conservation since these will be potential sources of germplasm for mass production of *T. calantas*. The said plots may also be designated as genetic resource area for critically endangered species such as *T. calantas*. Since it is important to conserve reproductive trees in order to

One of the prominent *T. calantas* found in the study area.

ensure continuous increase and perpetuity of the population, priority will be also given to those areas where mother trees exist.

### B. Spatial Distribution of *Toona calantas*

Majority of *T. calantas* trees and seedlings was found within the 20m x 20m plot and very few are found outside the plot (Figure 5). The distance from the center plot ranges from 0.0–50.0 m but majority of the *T. calantas* are distributed from 0.0–20 m (Figure 6). The data indicate that seed dispersal is at a close distance of up to 20 m. Majority of the seedlings is spread from 0–20 m

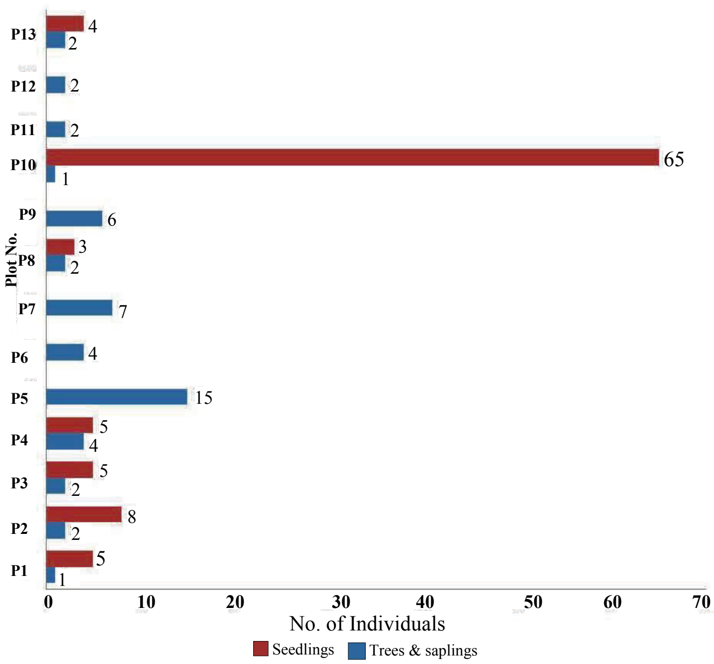



Figure 4. Number of seedlings, trees and saplings *of Toona calantas* in the sampling plots in Molawin–Dampalit Watershed.

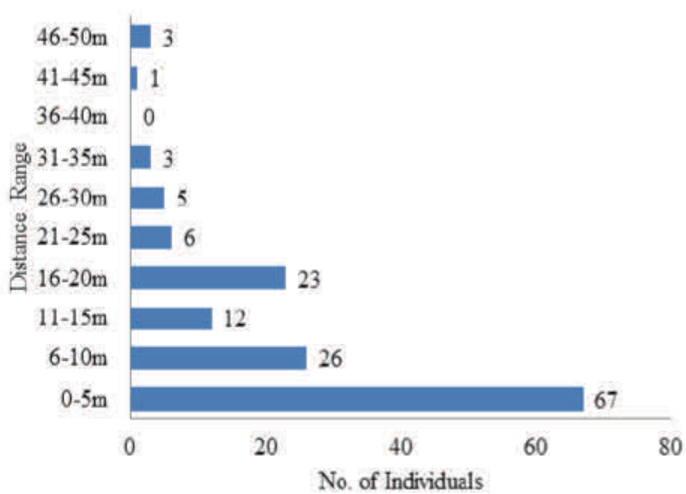



Figure 6. Distribution of Kalantas from the center of the sampling plot.

from the mother tree. There are very few seedlings found as far as 50 m. This suggests that the most effective seed dispersal of *T. calantas* is up to 20 m distance from the mother tree. Beyond 20 m distance, fewer seeds of *T. calantas* can be dispersed.

Data showed that *T. calantas* are well distributed in all the quadrats. The distribution of more *T. calantas* on the eastern side (NE aspect) is significant, specifically in plots 3 and 10 since this area gives the light requirement for survival. Data also show that southeast (SE) and NE directions of plots 3 and 10 are less dense in terms of vegetation and therefore provide more space and allow sunlight to penetrate which is important for the growth and development of *T. calantas* seedlings. *T. calantas* is not tolerant to shaded areas and therefore needs partially open spaces for growth.

### C. Spatial Distribution of Other Tree Species

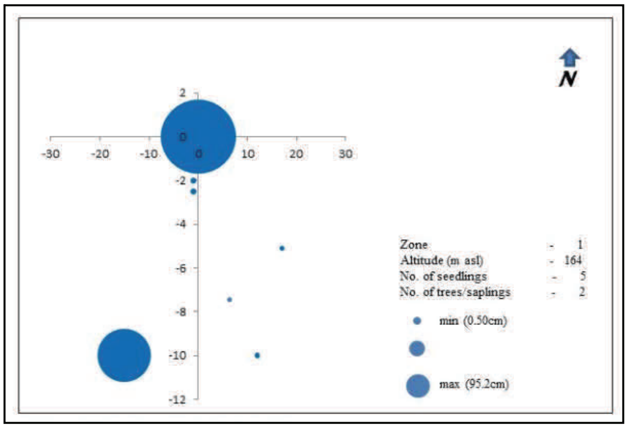
The composition of the vegetation is of major interest in habitat characterizations and in determining distribution of a species relative to other plant species. The 1,081 individuals inventoried represent 134 different species and 45 families. Of these, the family Moraceae had the highest number of species. Meliaceae, to which *T. calantas* belongs, is next to Moraceae followed by Euphorbiaceae, then Dipterocarpaceae and Fabaceae (Table 1). The number of species found in the study site was not far from those found in other forest reserves in the country. There were 131 species belonging to 44 families in Quezon National Park and 120 species found in the 1.2 ha plot in Lamao Reserve (Vermudo 1995; Whitford 1906).

Ten families dominated the study area and Meliaceae to which *T. calantas* belongs has the second highest number of individuals. Cannabaceae is the most dominant family in the study area with 193 individuals. The families Dipterocarpaceae, Malvaceae, Moraceae, Euphorbiaceae, Fabaceae, Bignoniaceae, Olacaceae, and Burseraceae complete the top ten list of families with the most number of individuals. This shows the existence of *T.calantas* in terms of allied species that may serve as basis for designating priority areas for the species.

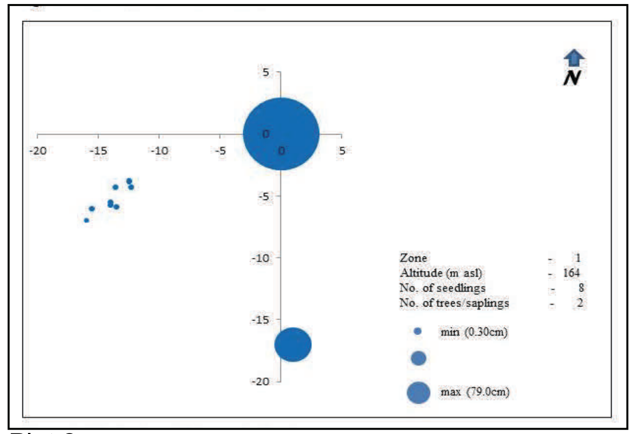
### D. Importance Values of Species

Importance Values (IV) were computed to determine the importance of a species in a community and *T. calantas* relative to other species. IV was expressed in terms of density, cover and frequency.

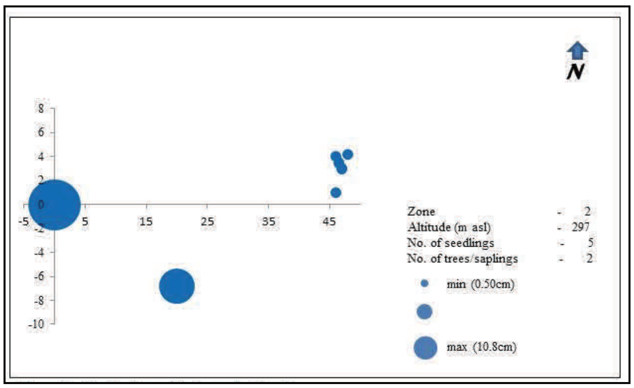
Based on the computed IVs, *T. calantas* only ranked fifth with IV of 13.80. Magabuyo (*Celtis luzonica* Warb.) has the highest IV at 46.34, which indicates that it is the most dominant species in terms of relative abundance, relative frequency and relative dominance. Mahogany (*Swietenia macrophylla* King) ranked second with IV of 39.51. Other top 10 species in descending order include narra *(Pterocarpus indicus* Willd. forma *echinatus* (Pers.) Rojo), balobo (*Diplodiscus paniculatus* Turcz.), white lauan (*Shorea contorta* Vidal), bagtikan (*Parashorea malaanonan* (Blanco) Merr.), taluto (*Pterocymbium tinctorium* (Blanco) Merr.), african tulip (*Spathodea campanulata* P. Beauv.), and tamayuan (*Strombosia philippinensis* (Baill.) Rolfe) (Table 2).



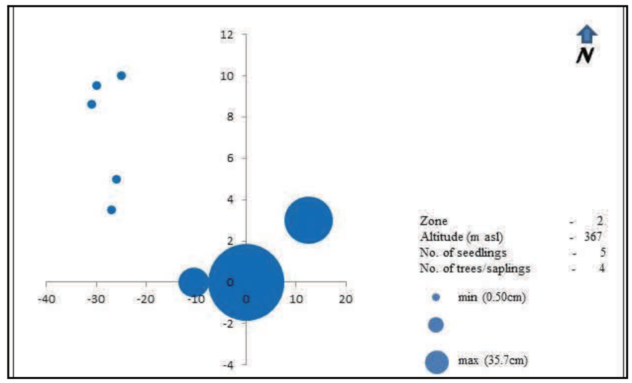

Plot 1



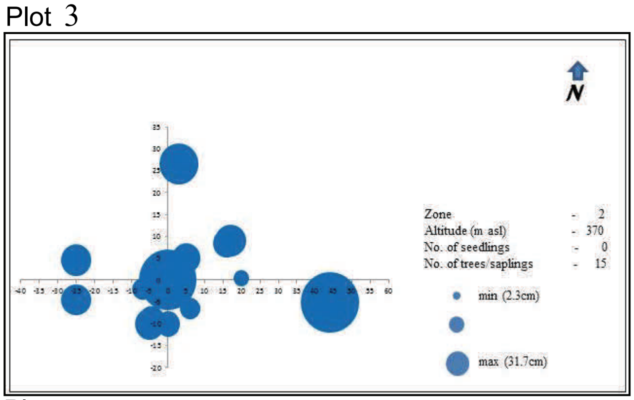

Plot 2



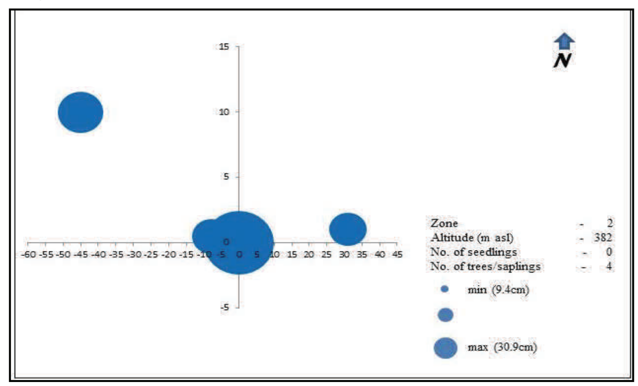

Plot 3



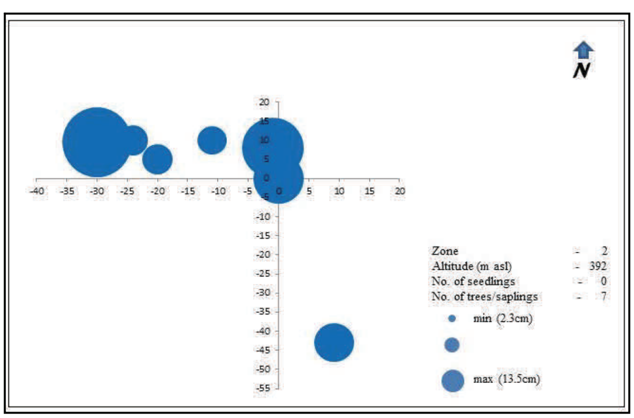

Plot 4



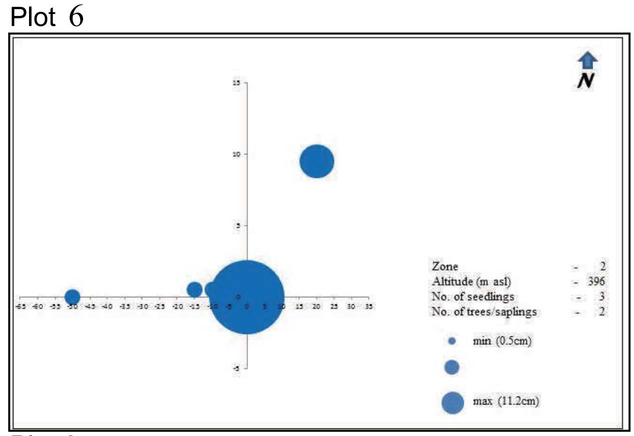

Plot 5




Plot 6

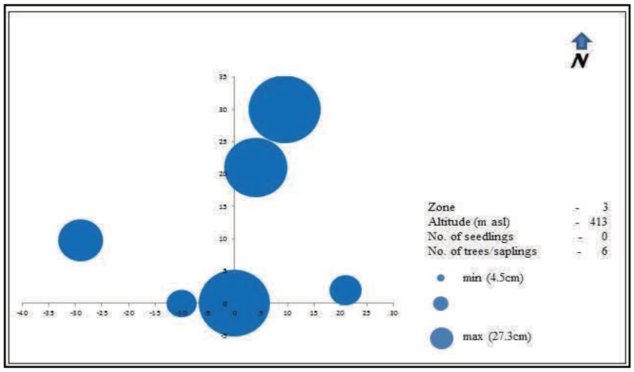



Plot 7

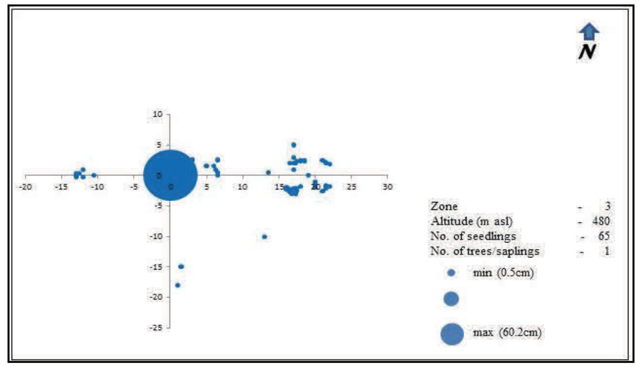



Plot 8

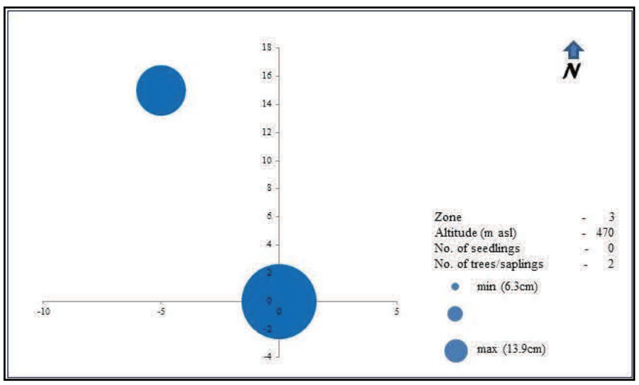
Figure 5. Distribution of Kalantas by plot.



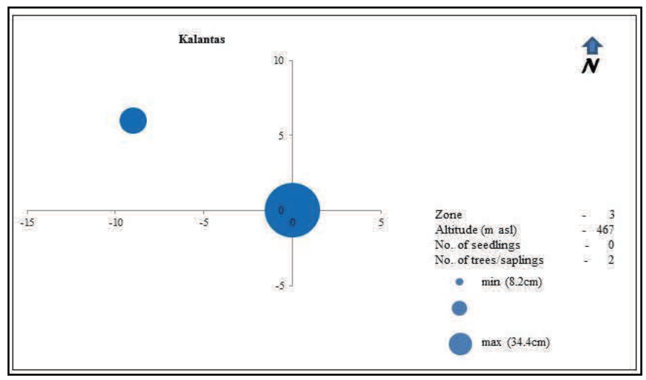

Plot 9



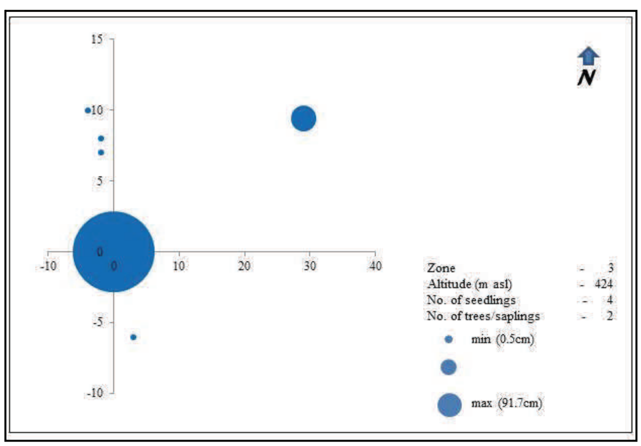

Plot 10




Plot 11




Plot 12




Plot 13

Figure 5. Distribution of Kalantas by plot *(Cont.)*

Table 1. Table showing the families with their corresponding number of individuals.

| No. | Species | Quantity |
|---|---|---|
| 1 | Moraceae | 18 |
| 2 | Meliaceae | 12 |
| 3 | Euphorbiaceae | 11 |
| 4 | Dipterocarpaceae | 5 |
| 5 | Fabaceae | 5 |
| 6 | Annonaceae | 4 |
| 7 | Apocynaceae | 4 |
| 8 | Malvaceae | 4 |
| 9 | Phyllanthaceae | 4 |
| 10 | Sapindaceae | 4 |
| 11 | Achariaceae | 3 |
| 12 | Anacardiaceae | 3 |
| 13 | Burseraceae | 3 |
| 14 | Cornaceae | 3 |
| 15 | Myristicaceae | 3 |
| 16 | Rubiaceae | 3 |
| 17 | Rutaceae | 3 |
| 18 | Salicaceae | 3 |
| 19 | Bignoniaceae | 2 |
| 20 | Cannabaceae | 2 |
| 21 | Celastraceae | 2 |
| 22 | Clusiaceae | 2 |
| 23 | Combretaceae | 2 |
| 24 | Ebenaceae | 2 |
| 25 | Lauraceae | 2 |
| 26 | Lecythidaceae | 2 |
| 27 | Leeaceae | 2 |
| 28 | Myrsinaceae | 2 |
| 29 | Myrtaceae | 2 |
| 30 | Urticaceae | 2 |
| 31 | Actinidiaceae | 1 |
| 32 | Araliaceae | 1 |
| 33 | Elaeocarpaceae | 1 |
| 34 | Lamiaceae | 1 |
| 35 | Magnoliaceae | 1 |
| 36 | Nyctaginaceae | 1 |
| 37 | Olacaceae | 1 |
| 38 | Polygonaceae | 1 |
| 39 | Putranjivaceae | 1 |
| 40 | Rosaceae | 1 |
| 41 | Sapotaceae | 1 |
| 42 | Staphyleaceae | 1 |
| 43 | Stemonuraceae | 1 |
| 44 | Symplocaceae | 1 |
| 45 | Theaceae | 1 |
| **TOTAL** | | **134** |

In terms of relative abundance, *T. calantas* has higher relative abundance at 4.72 as compared with *P. indicus* and *D. paniculatus* which both have a relative abundance of 4.12. However, despite the fact that its relative abundance is greater than *P. indicus* and *D. paniculatus*, the IV of *T. calantas* is still lower. This is because *T. calantas* may have higher number of individuals but the individuals present do not have crowns as big as those of *P. indicus* and *D. paniculatus*. Dominance as one factor for the determination of importance value is measured by the size of the crown of the individual.

The data indicate that based on IV, *T. calantas* showed a low population in terms of frequency, abundance and dominance as compared with other species. As a critically endangered species, these parameters shall be addressed to restore and reproduce its population to save the species from possible extinction. With this current status, conservation efforts must be done to save the species from possible extinction.

Aside from seeds and wildlings as major sources of planting materials for *T. calantas*, asexual propagation using stem cuttings may also be considered for reproduction. Vegetative propagation by stem cuttings is becoming an important tool for forest tree improvement activities. It is an effective way of saving endangered species like Philippine teak (*Tectona philippinensis* Benth. & Hook.f.) for genetic conservation and upland rehabilitation (Castañeto *et al.* 2003). Like *T. calantas*, Philippine teak is also a critically endangered species (Fernando *et al.* 2008). This approach may also work for *T. calantas*.

Conservation of economically important species through cultivation (Buot 1999 & 2004) may also be effective for *T. calantas*. This may not only work for *T. calantas* but also for communities who will be involved in the conservation of this species through the establishment of forest nurseries of threatened species. This will also serve as alternative livelihood for the communities while helping to conserve and protect the species.

### E. Distribution of *Toona calantas* Relative to the Tree Species in the Different Sampling Plots

Three altitudinal zones (100–200 masl, 201–400 masl, >400 masl) were sampled and mapped and plots were grouped according to these altitudinal zones. Zone 1 (100–200 masl; plots 1 and 2) with an altitude of about 164 masl recorded a total of 82 individuals of different species, the lowest number of trees among the zones. From the 82 individuals, four are *T. calantas,* two of which are mother trees. These mother trees were observed to be reproductive during the time of data gathering. Thirteen regenerations were found near the *T. calantas* mother trees. Among the dominant species in Zone 1 include *S. macrophylla*, *palosanto* (*Triplaris cumingiana* Fisch. & Mey.), *P. indicus* and *C. luzonica.*

Zone 2 (201–400 masl; plots 3 – 8) contained a total of 423 individuals, 34 of which are *T. calantas*. The zone recorded the highest number of *T. calantas* individuals but recorded only 13 seedlings. Zone 2 is the only zone that recorded zero mother trees. The species dominant in the area are *S. macrophylla*, *C. luzonica*, *T. calantas*, *P. indicus* and *P. malaanonan*.

Table 2. List of top 10 species with highest IV in the study area.

| Name | Scientific Name | Abundance | Frequency | Basal area | Relative Abundance | Relative Frequency | Relative Dominance | IV |
|---|---|---|---|---|---|---|---|---|
| Magabuyo | *Celtis luzonica* Warb. | 191 | 13 | 110.8654 | 19.30 | 3.70 | 23.34 | 46.34 |
| Mahogany | *Swietenia macrophylla* King | 84 | 12 | 130.3943 | 8.64 | 3.42 | 27.45 | 39.51 |
| Narra | *Pterocarpus indicus* Willd. forma *echinatus* (Pers.) Rojo | 39 | 7 | 103.9412 | 4.12 | 1.99 | 21.88 | 28.00 |
| Balobo | *Diplodiscus paniculatus* Turcz. | 40 | 13 | 44.3555 | 4.12 | 3.70 | 9.34 | 17.16 |
| Kalantas | *Toona calantas* Merr. & Rolfe | 51 | 11 | 28.2178 | 4.72 | 3.13 | 5.94 | 13.80 |
| White lauan | *Shorea contorta* Vidal | 62 | 11 | 15.5249 | 6.33 | 3.13 | 3.27 | 12.73 |
| Bagtikan | *Parashorea malaano-nan* (Blanco) Merr. | 28 | 4 | 3.7565 | 2.81 | 1.14 | 0.79 | 4.74 |
| Taluto | *Pterocymbium tinctorium* (Blanco) Merr. | 21 | 6 | 6.5824 | 2.11 | 1.71 | 1.39 | 5.21 |
| African tulip | *Spathodea campanu-lata* P. Beauv. | 20 | 10 | 2.0257 | 2.31 | 2.85 | 0.43 | 5.59 |
| Tamayuan | *Strombosia philippinen-sis* (Baill.) Rolfe | 21 | 7 | 1.0715 | 2.11 | 1.99 | 0.23 | 4.33 |

Zone 3 (>400 masl; plots 9–13) recorded the highest number of individuals at 481. The zone recorded 13 *T. calantas* trees and saplings and 69 seedlings, which has the highest number of seedlings among the zones. The zone contains two reproductive mother trees. Among the tree species found to be dominant in the area are *S. macrophylla*, *C. luzonica*, *P. indicus* and *D. paniculatus*. The observed SE and NE distribution of majority of *T. calantas* is probably due to the less dense vegetation in these areas.

Altitude is one factor which might have affected the distribution of *T. calantas* in the area. The minimum altitude was 164 while the maximum was 480 masl. The mean altitude is 368 masl. Seedlings were highest at Zone 3 with 65 individuals while quite low in both Zones 1 and 2 with 13 individuals each. Trees and saplings were highest at Zone 2, followed by Zone 3 and finally at Zone 1 with only 3 individuals.

Regenerations of *T. calantas* found in Plot 10 (Zone 3).

The data revealed that the distribution of *T. calantas* appears to increase at higher elevation. This may be because the sampling plots at higher elevation have less dense vegetation and therefore have more space and light penetration which are favorable to the growth of *T. calantas*. This is very evident in plot 10. One factor that may also be considered is disturbance in the area since higher elevation areas are less accessible to people and therefore less disturbed.

Many plant and animal species around the world are in danger of extinction largely as a result of human activities (Lande 1998). In Conner, Apayao, Philippines, economically important species including *T. calantas* are threatened to becoming locally extinct due to over–collection, unregulated harvesting, and overexploitation (Aggangan *et al*. 2010). If the present utilization of threatened species is not immediately addressed, then definitely the species will become extinct. For *T. calantas* in MMFR, there is less disturbance or pressure on the species as compared with other areas. Species– and population–based approaches should play an important role in the development and monitoring of regional conservation and restoration strategies to ensure proper management of ecologically and economically important species.

All the zones will be subject for conservation since representation of *T. calantas* in each plot is small. Zone 3 will be given top priority since it includes plot 10 which contains the bulk of *T.*

*calantas* seedlings which are very critical in increasing and restoring its population in the Molawin–Dampalit Watershed. Zone 2 will follow having the most number of trees and saplings, which will be the future source of mother trees for the natural conservation of *T. calantas*. Zone 1 will also be conserved since the zone contains two mother trees that can be used as sources of seedlings for restocking.

**F. Population Status of *Toona calantas***

The study showed that *T. calantas* comprises a very small population in the Molawin–Dampalit Watershed. From a total of 1,081 individuals inventoried within the Molawin–Dampalit Watershed, only 146 (13.3%) individuals consisted of *T. calantas*. From a total of about 3.6 ha inventoried, *T. calantas* has a natural spatial average of 0.025 ha.

From the 146 individuals, 51 individuals were trees and saplings while the remaining 95 were seedlings. The trees and saplings are all distributed in plots 1 to 13 (Table 3) while the seedlings were only found in plots 1, 2, 3, 4, 8, 10 and 13. Majority of the seedlings were found in plot 10.

Results showed that the percentage of seedlings is higher than the trees and saplings. The most number of trees and sapling was recorded in plot 5 and the most number of seedlings was observed in plot 10. Although seedlings are present in seven of the 13 plots, only plots 1, 2, 10 and 13 have fruiting mother trees during the time of survey. May to June is the fruiting season of *T. calantas* in Laguna and in other parts of the Philippines such as Abra and Mindoro (ERDB 1990).

Observations showed that the low population of *T. calantas* is due to very few reproductive mature individuals in the area. The diameter of *T. calantas* in all sampling plots ranged from 0.30 – 95.2 cm (DBH). The four *T. calantas* trees in the fruiting stage have 60.2 – 95.2 cm DBH. The other *T. calantas* trees with smaller DBH found within the study have no indications of reproduction. In order for the population of *T. calantas* to survive and perpetuate, more mother trees that will naturally increase and maintain its population in the Molawin–Dampalit Watershed should be present. These mother trees are very important in sustaining the population of *T. calantas* in the area.

One way of conserving and maintaining its mother trees is through *in–situ* and *ex–situ* conservation. The genetic resource conservation strategies for timber trees in the Philippines include both *ex–situ* and *in–situ* methods. Despite the Philippines' rapid decline of its forest habitats, *in–situ* conservation through the protected areas system remains its best hope for conserving genetic resources of timber trees (Fernando 2001). In MMFR as a forest reserve and heritage park, both *in–situ* and *ex–situ* approaches will be an effective strategy for *T. calantas*.

Another factor that appears to limit the population of *T. calantas* in the Molawin–Dampalit Watershed are the disturbances brought about by clearing for agricultural farming. Some plots such as plots 10 – 12 have signs of clearing operation for agricultural farming. Agricultural crops such as coffee, banana and *gabing San Fernando* are growing in the area. Further, some *kaingin* (cleared areas for upland farming) are observed immediately outside the plot.

The small number of seedlings in plots 1 and 2, though the trees are already reproductive (the tree in Plot 1 is fruiting at the conduct of the survey), is probably due to the area being very accessible to people. They are just a few meters from the MCME (Makiling Center for Mountain Ecosystems) checkpoint and part of the PFLA (permanent forest laboratory area) commonly visited by people. These trees are good sources of seedlings but due to their accessibility, many people come to collect the seeds and seedlings. This activity may have resulted to the disturbance of the population and poor regeneration of *T. calantas.*

## CONCLUSION AND RECOMMENDATION

As a critically endangered species, *T. calantas* should be prioritized for conservation in the MMFR. In order for the *T. calantas* population to survive and perpetuate, more mother trees should be present that will naturally increase and maintain its population in the Molawin–Dampalit Watershed. These mother trees are very important in sustaining the *T. calantas* population in the area.

The presence of more seedlings and saplings than reproductive trees in the population, which do not contribute to the increase in regenerations, should be addressed. Artificial introduction of the individuals may be one of the options to restore the population of *T. calantas*.

Population restoration by supplementary regeneration could be an adaptive strategy to combat the declining populations by introducing nursery–grown seedlings to compensate for the lack of productive–age regenerants. Since it is important to conserve reproductive trees in order to ensure continuous increase and perpetuity of the population, priority will be given to those areas where mother trees exist.

Table 3. Total number *of Toona calantas* inventoried within the Molawin–Dampalit Watershed.

| Age Class | PLOT | | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | |
| Trees & saplings | 2 | 2 | 2 | 4 | 15 | 4 | 7 | 2 | 6 | 1 | 2 | 2 | 2 | 51 |
| Seedlings | 5 | 8 | 5 | 5 | – | – | – | 3 | – | 65 | – | – | 4 | 95 |
| **Total** | | | | | | | | | | | | | | **146** |

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