The use of plant stratification by *Otus jolandae* in the Natural Tourism Park of Kerandangan, Lombok

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Abstract. *Otus jolandae* is an endemic owl species of Lombok island. The previous study suggested exploring the ecology-related aspects more deeply since this species had been just identified in 2013 but their recent status is nearly threatened. This study was conducted in Natural Tourism Park (NTP) of Kerandangan forest from July to September 2016. The field observation was carried out during the night to observe the owl occurrence in different plant species and different vegetation structure (seedling, sapling, pole, and tree). The results reveal the most widely used plant species is *Dalbergia latifolia* and then followed by *Tectona grandis, Tamarindus indica, Samanea saman, Mangiferia indica, Delonix regia*, and *Swietenia mahagoni* respectively. Moreover, about 71.6% *Otus jolandae* occurs dominantly in the tree structure, followed by 28.4% of the pole structure, while no occurrence found in seedling and sapling structure. This indicates the adult and subadult vegetation act as a critical part for being a territory for *Otus jolandae*. Hence, addressing the deforestation problem and at the same time protecting the forest in a good shape with more pole and tree vegetation structure will keep *Otus jolandae* population from the extinction.

1. Introduction

The owls play an important function in the terrestrial ecosystem [1, 2]. They act as a top predator within the food webs in the terrestrial ecosystem [3-5]. Many studies have been conducted since 1975, resulting in the identification of 146 owl species and later in 2008, there were 250 identified owl species [6]. This significant increase of identification is due to many systematic revisions of newly identified owl species [7]. West Nusa Tenggara region, especially Lombok island, has several endemic bird species that need to be conserved. One of them is *Otus jolandae*, locally it is called Celepuk Rinjani. These days, 51 owl species have been identified from the Genus of Otus. It has been considered the owls from this genus is difficult to distinguish due to a lot of individual variation and their geographical occupation and lack of comprehensive systematic studies [7].

IUCN categorizes *Otus jolandae* as near threatened species as well as 25 other species from the same genus [8]. They also suggest the existence of this species is depending on human intervention to optimize their conservation. However, regarding geographical spread of this species as well as the lack of published data, the conservation efforts are not going as expected. Hence, it requires more scientific data and publication in order to support conservation efforts. An area where *Otus jolandae* can be found is in the island of Lombok is located in the Natural Tourism Park of Kerandangan.
The occurrence *Otus jolandae* is reported to be found at the altitude of 25 meters above the sea level and is even found perched on the coconut tree that is about 7-9 meters high near the residential areas [9].

Habitat destruction reduces the diversity of bird species or even cause the extinction. In the altered habitat, each bird species, including *Otus jolandae* will seek for other habitats with more suitable characteristics where they can feed in order to survive and reproduce. Paga states the opinion of Oja et al. that the suitable habitat for the species is characterized by the presence of these species and the availability of food resources which supports them to survive and reproduce successfully for a longer time [10, 11]. In the Natural Tourism Park of Kerandangan, *Otus jolandae* can be found in primary and secondary forests, bordering open areas such as coconut farm or grasslands and trees [12].

A serious threat to the survival of *Otus jolandae* is habitat degradation and lack of conservation efforts [12]. However, the information about habitat characteristics in the Natural Tourism Park of Kerandangan is not available. Therefore, it is necessary to conduct a study as the initial part for their conservation. The results of this research can also be used to optimize their conservation which will eventually prevent them from extinct in the region. Based on these conditions, research was conducted to explore the plant stratification and plant species in relation to *Otus jolandae* at the Natural Tourism Park of Kerandangan.

This study is expected to provide the information of *Otus jolandae* and their habitat characteristics in Lombok Island. In addition, it will provide educational assisted facilities for the local community in the form of brochures or booklets. This will assist the conservation and subsequent management, especially in the Natural Tourism Park of Kerandangan. Moreover, *Otus jolandae* is one of the Birdwatching ecotourism icons in Lombok that can attract birdwatchers from all over the world to come. The availability of this information from the study results can provide access and a positive experience for bird lovers and birdwatchers in observing *Otus jolandae*. Moreover, for the students as well as the people who are in the vicinity of the Natural Tourism Park of Kerandangan who want to learn directly can be helped by the brochures and booklets with a memorable learning experience. For example, regarding the topic of biodiversity and conservation in the high school, *Otus jolandae* observation activities at the Natural Tourism Park of Kerandangan is very suitable to improve students’ critical thinking skills about the appropriate conservation efforts for *Otus jolandae*.

2. Research method

2.1. Survey Area and Data Collection
This study was conducted from July to September 2016 at the Natural Tourism Park of Kerandangan. The study site is about 396.10 Ha, located at 10m to 638m above the sea level. It is situated at the latitude of 8° 20’ 13”/8° 20’ 15” and longitude 116° 4’ 0”/116° 4’ 3” BT (figure 1).

The study was started by conducting a field orientation to get a general overview of the location. It consists of area tracking and interviewing the local community and the officer of the Department of Natural Resource Conservation to explore the predicted location of *Otus jolandae*. The data collection was carried out by direct observation techniques along the path using the census method by recording all contacts consisting of the vertical occurrence of this bird. Observation activity on the determination of habitat characteristics *Otus jolandae* was carried out by observing bird activities related to the use of vertical vegetation strata. The vegetation is classified into seedling (strata I), sapling (strata II), pole (strata III), and tree (strata IV). This observation was intended to seek the association of vegetation with birds in using their habitat. The detail characteristics of plant stratification is shown in table 1.
Figure 1. The map of study site of the Natural Tourism Park of Kerandangan

Table 1. The grouping of vegetation strata based on plant height and diameter

| Stratum   | Vegetation structure | Height (m) | Diameter Breast Height (cm) |
|-----------|----------------------|------------|-----------------------------|
| Strata I  | Seedling             | <1.5       | 0-9                         |
| Strata II | Sapling              | 1.5        | <10                         |
| Strata III| Pole                 | 4-20       | 10-19                       |
| Strata IV | tree                 | 20-30      | ≥ 20                        |

Sources: [13, 14]

The number of plant species and the number of individuals per species were counted inside a plot across the three observation transects. At each of these observation stations, 1 plot was placed except for transect 1 with 2 plots. In each observation transect, a plot of 2m x 2m was used for seedling, 5m x 5m for sapling, 10m x 10m for pole, and 20m x 20m for the tree. Lastly, the environmental parameters were collected such as environmental tone using the camera and measurement of temperature and humidity using a thermohygrometer.

3. Result and Discussions

3.1. Plant Species used by Otus jolandae

There are 7 plant species used by Otus jolandae, grouped into 4 families. These species include Dalbergia latifolia (Sonokeling), Samanea saman (Trembesi), Tamarindus indica (Asam), Delonix regia (Flamboyan), Tectona grandis (Jati), Mangifera indica (Mangga), and Swietenia mahagoni (Mahon). The proportion of the plant species used by Otus jolandae during observation reveal the most common plant species used by Otus jolandae was Dalbergia latifolia with an encounter frequency of 8 times. Then followed by Tectona grandis with the frequency of encounters 5 times, Tamarindus indica with the frequency of encounters 3 times, Samanea saman with frequency of encounters 2 times. While Mangifera indica, Delonix regia and Swietenia mahagoni each encounter one time. More details are presented in figure 2.
Based on figure 2, the most common plant species occupied by *Otus jolandae* is *Dalbergia latifolia*. This plant species is grouped into family Fabaceae (legumes). The spread of adult *Dalbergia latifolia* at the Natural Tourism Park of Kerandangan is not evenly distributed, but this plant is found almost along the path of observation. They have a greater role than other plant species in terms of density, frequency and dominance which are summarized in important values. This dense is very likely caused by prior reforestation activities in the region.

*Otus jolandae* prefers this plant because some of these plants are in a state of dying and aborting their leaves. [15] states that *Otus alfredi* prefer dead large trees at an altitude of 300 m in the interrupted forest. These trees appear to be part of the territory of this bird. *Otus alfredi* shows the level of tolerance to disturbed habitats adjacent to primary mountain forests. When the study was carried out this plant was aborting its leaves because it was still in a dry season. According to [16] *Dalbergia latifolia* and other Fabaceae families used to grow in groups in several types of forests that experienced long droughts. *Dalbergia latifolia* will abort its leaves in the dry season. It is also seen from the percentage of the use of *Dalbergia latifolia* species that is equal to 38%.

Birds from the genus of *Otus* prefer secondary forests compared to primary forests. [17] states that Sunda Celepuk (*Otus tempiji*) is only found in lowland secondary forests, well-vegetated parks and forested areas close to human habitation and tends to avoid primary forests. In addition, the Sundanese owls, are also very tolerant of disturbed habitats [17] and [18]. However, [19] also found *Otus alfredi* tend to occur in undisturbed and wet forests. [20] also states that *Otus capnodes* is a species that will live well in habitat which is characterized by natural highlands dominated by coconut plants (*Cocos nucifera*), mango (*Mangifera indica*) and kapok (*Ceiba pentandra*). In the research that had been carried out in Kerandangan, there was also the discovery of *Otus jolandae* perched on the Mango tree.

The high survival ability in various habitat types confirms that *Otus jolandae* has no specific habitat type or it can also be called a generalist species. Even though *Otus jolandae* is generalist, but to be able to survive and ensure fitness, the existence of the forest remains an important habitat to get other necessities of life, especially during the day. [20] states that *Otus capnodes* utilizes dense forests as nesting and perching sites. Generally, they use the nest of other species or tree cavities and some species also nest in the soil [21]. Aside from being a means of mobilization, the presence of various growing species also plays a role in creating microclimates for the life of bird feed including *Otus jolandae* [10]. Other plants used by *Otus jolandae* from the Fabaceae family are *Delonix regia*, *Tamarindus indica*, and *Samanea saman*. 

![Figure 2](image-url)
3.2. Plant vegetation structure preferred by Otus jolandae

Observation of the use of vegetation strata by Otus jolandae in NTP of Kerandangan aims to see the form of Otus jolandae's association with its habitat. Determination of stratification (vertical spread) with classification based on growth structure and plant stem diameter. Stratification of these plants are grouped into four, namely strata I (seedling), strata II (sapling), strata III (pole) and strata IV (tree). The use of vegetation strata by Otus jolandae in NTP of Kerandangan is presented in figure 3.

Based on figure 3 it is known that in the use of vegetation strata there are only two strata groups used, namely strata III (pole) and stratum IV (tree). Determination of this plant strata is obtained from measurements around the trunk of the plant which then calculated as its diameter. Diameter for strata III (pole) is between 10-19 cm and stratum IV (tree) ≥ 20 cm. Otus jolandae were found only in strata III (pole) and IV (tree), about 28.4% and 71.6% respectively. They need plants at the level of strata III (poles) and strata IV (trees) to facilitate hunting of prey. Vertical spread is also related to the ability of the bird species. Otus jolandae is a bird of prey that generally observes its prey at a higher place so that it will be difficult to find using a lower strata [7]. Marks et al (1999) in [17] revealed that Otus usually hunts for prey from height and overhanging tree branches or on or at home. The absence of strata I and stratum II can be caused by the type of plant at the time of the study is still in the stage of growth and has not reached strata III.

The vertical pattern of bird distribution shows that the distribution of these bird species is ecologically related to the type of bird and the feed requirements found in the strata [14]. This causes a difference in using stratum by birds such as Otus jolandae. Otus jolandae and Otus lempiji have large types of food in the form of insects and some small nocturnal reptiles such as geckos [21] and [9]. The use of vegetation strata in strata III and IV by birds has also a relationship with the availability of feed and space in the strata. In vegetation strata, III and IV bird feed such as fruit, flowers and insects are abundant so that many species of birds use these strata [22]. In addition, vegetation strata III and IV are vegetation strata that have more space that can be used by birds, such as the stems and branches covered with canopy.

Some bird species use more than one strata, while other bird species only use a single strata. The use of vegetation strata is closely related to the availability of feed sources on the stratification. As a result, Otus jolandae's activity in utilizing the available habitat space can change, depending on the appearance of the habitat that provides their food. According to [23], the dynamics in feeding activity in the vertical structure in a tree is strongly influenced by the spread of feed on the tree. Physical environmental factors also influence indirectly Otus jolandae's life characteristics. Two physical
factors measured in this study namely temperature and humidity do not show significant changes, this is because it is still in one research area. Vegetation is one of the habitat components that have significance for *Otus jolandae*. In addition, diverse vegetation contributes to creating a supportive microclimate for other organisms including prey that has the potential to feed *Otus jolandae*.

4. Conclusion
Based on the research, it can be concluded that the most widely used plant species by *Otus jolandae* in the Natural Tourism Park of Kerandangan is *Dalbergia latifolia* and then followed by *Tectona grandis*, *Tamarindus indica*, *Samanea saman*, *Mangifera indica*, *Delonix regia*, and *Swietenia mahagoni*. Moreover, about 71.6% of *Otus jolandae* occurs dominantly in the tree structure, followed by 28.4% of the pole structure, while no occurrence found in seedling and sapling structure.

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