Habitat fragmentation effect on the characteristics of orangutan nest tree selection

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Abstract. Orangutans are an endemic to Indonesia and Malaysia with an almost extinct with critically endangered status and only found on the islands of Sumatra and Kalimantan/Borneo. Orangutan extinction is mainly threat by habitat loss and fragmentation as well as low reproduction rates. Habitat fragmentation, along with habitat loss, should be clearly considered when assessing implications of landscape change for population extinctions. Environmental changes force species to immediately adapt both behaviourally and physiologically. Forest structure affects the adaptability and nesting behaviour of orangutans. One of the steps to prevent orangutan extinction is by increasing habitat connectivity through corridors and reducing fragmentation of landscapes as well as stopping habitat lost.

1. Introduction

The fragmentation that occurs in forests gradually leads to loss of biodiversity, aesthetic views of the landscape and ecological functions [1]. Habitat fragmentation suppresses the existence of species, so that reduced ecosystem area can only harm species whose lives depend on the extent of the ecosystem. Orangutans are endemic great apes that are endangered and have a limited distribution [2-4]. Indonesia has three species of orangutans scattered on the islands of Sumatra and Kalimantan/Borneo. Kalimantan/Borneo has one species of orangutan, namely Pongo pygmaeus which consists of three subspecies, i.e. P. p. pygmaeus, P. p. morio and P. p. wurmbii [2] and Sumatra consists of two species, namely Pongo abelii [3] and Pongo tapanuliensis [4,5].

The cause of the orangutan's status being threatened is a result of habitat fragmentation, land clearing [3], poaching [6,7], capture as illegal trade and pets [8]. Habitat fragmentation and low reproductive rates [9] have negative aspects, such as habitat connectivity loss, emergence of edge effects, and loss of natural habitat for species [10]. Loss of habitat has been shown to change species interactions, this condition will greatly affect species with large body mass such as mammals or animals that are arboreal [11] and the frugivorous nature of orangutans [12]. The Tapanuli forest as the habitat for the Tapanuli orangutan continues to experience pressure and a reduction in area due to forest conversion to oil palm plantations [13], so that it becomes the main threat of loss and damage to the habitat of the Tapanuli orangutan.

Each primate has different behavioural characteristics. All adult great apes tend to have nest building behaviour, however, infants do not nest [14]. In recent years, research on orangutans has
focused more on selecting locations and nests and on the structural properties of trees. For example, van Casteren [15] discusses nest design and architecture and the results of their study indicated that orangutans are very clever in building nests. Cheyne and team [16] discussed the selection of nest locations in Sabangau and there was selectivity for selecting nest trees from the Anacardiaceae and Elaeocarpaceae families. Based on literature study, research on orangutan nest was mostly carried out in Kalimantan than in Sumatra. Subsequently, research that has been conducted so far has rarely discussed the typology of orangutan nest trees and the components that make up orangutan nests. Therefore, research needs to be done to fill the gap, especially in the Sumatran and Tapanuli orangutans.

2. Materials and methods
This article is the result of literature review carried out through database searches from Scopus and Google Scholar. Relevant articles, reviewed with the published period 2010-2020 as the most recent source. The literature review is related to conservation that discusses the characteristics of orangutans in selecting nest trees and their effects due to habitat fragmentation.

3. Results and discussion
Human activities that destroy the environment have caused global changes with consequences that have a direct impact on biodiversity (Figure 1). Species with large body mass is more vulnerable and affected by habitat fragmentation, such as large mammals and arboreal animals that depend on forests [11]. In general, habitat fragmentation will affect wildlife in carrying out ecological requirements such as disruption of migration routes [17] or limited home ranges.

![Figure 1. Negative effects due to habitat fragmentation](image)

Forest structure difference leads in differencing the density of orangutan nests. Although the building nest behaviour is similar among individual of orangutans [18-20], there are differences in nest size with local ecological conditions such as forest composition and structure [21]. Selection of nest trees is not only driven by comfort and stability but also to avoid predators that play a major role in determining and building nests. The quality of the heterogeneous forest structure also affects the density of nests with tighter tree heights so that the canopy is tighter and is preferred by orangutans. Orangutans prefer forests with dense canopy cover, taller trees, and uniform height [6]. Subsequently,
more nests were built at the top [21]. However, Cheyne et al. [22] found that nests were built in the treetops not to avoid predators but to make the nests safer and more stable.

Great apes, including orangutans, are highly selective in their choice of nesting tree locations, landscape areas and tree morphological or structural characteristics [22-24]. The nests built by orangutans are considered to be the most complicated of the other primate nests ([25]. The more intricate design of the orangutan nest leads to better quality sleep in the orangutan [26]. However, the structural patterns of great ape nests have not been well described in the literature [23].

According to literature review by Barbara [27] on 46 articles from 2000-2017 indicated that nest construction time depends on the light conditions, weather, and season, and social opportunities or demands. The selection of nesting trees is very selective, can be influenced by the availability of building materials, the quality, flexibility and strength of the wood, as well as leaf size and phytochemical properties [26]. Goodall et al. [28] also collected data on nest construction in all great ape species and most subspecies. Overall, there is considerable variation in physical parameters such as nest height in great ape species. Characteristics of tree structures affect the position of the nest, in addition for selecting nest position is also influenced by sex, body size, and environment [29].

When a population that is supposed to be widespread but is split into two or more sub-populations, it is easier to enter into a vortex of extinction. This is due to edge effects which decrease the ability of a species to adapt to environmental conditions. As a case study is the existence and population of orangutans in Sumatra. The Batang Toru area as the habitat for the Tapanuli orangutan is currently experiencing degradation and fragmentation, which is quite sad according to Nater et al. [5], that the Tapanuli orangutan was found in a small number of fragmented forest areas. The orangutan population on the island of Sumatra is estimated about 14,470 individuals divided into 10 Meta populations [30,31], including 2 meta populations of the Tapanuli orangutan (sub-population of West Batang Toru and East Batang Toru). The cause of the separation of the sub-population is due to the disconnection of home ranges due to the absence of trees that have a related crown to connect these locations and the impact of infrastructure development and hydropower projects [32,33]. Unfortunately, part of the habitat that has the highest Tapanuli orangutan density is planned to be used as a hydropower area [34]. The fragmentation that occurs in the habitat of the Tapanuli orangutan is a major threat to its sustainability [33,34].

Species that are well adapted will be able to survive, have high resistance and can continue their offspring. If the orangutan is not able to adapt, it will become an isolated species and lose flexibility in the evolutionary process which leads to extinction. In many animal species, small populations can become unstable because their social structures are not functioning properly. The effect of population constriction and shrinkage will be evident in small populations which for several generations only have a small number of individuals as a result of not being able to adapt well. If under certain conditions it can no longer survive in nature, conservation through captivity and rehabilitation is important to prevent extinction, but it can break the natural evolutionary chain of the species. Wildlife management cannot be managed actively, so what must be managed and improved is the quality of their habitat.

4. Conclusions and recommendations
Habitat fragmentation has the potential to influence ecological and evolutionary dynamics in a number of ways. Species that are not able to adapt will become isolated species and loss of flexibility in the evolutionary process which leads to extinction. The results of this study propose steps to maintain habitat for orangutans, namely by stopping habitat conversion and simultaneously by increasing connectivity through corridors and reducing landscape fragmentation and the formation of new populations through the results of captivity or rehabilitation. The principle that must be considered in determining the corridor area is that the remaining fragmented forest still functions as a bridge for the movement of arboreal and terrestrial animals from one habitat to another.
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