

# Survival of Greater Bird-of-paradise and its habitat after selective logging: a preliminary observation in Papua

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**Abstract.** Selective logging in a timber logging concession could affect certain species, including birds. The impact of selective logging on Greater Bird-of-paradise (*Paradisaea apoda*) has never been studied before. The objective of this paper was to assess the survival of the Bird-of-paradise and its habitat against selective logging. The research was conducted in two timber concession companies in Papua in 2022 (September-November) and 2023 (July-August), by visiting areas with different cutting years (i.e., cutting block 2012-2035). The extant Bird-of-paradise was recorded based on direct visual and definitive calls by the male birds, then presented in scatterplot for further analysis. Bird habitat was observed and presented qualitatively. The habitat of the bird was a lowland tropical forest. A total of 141 observation points were recorded from 9 cutting years (including cutting years of planned/future years). The birds were able to be found in almost all cutting years, including very old logging blocks (11 years), very recent, and unlogged forests (i.e., future cutting blocks), suggesting that the Greater Bird-of-paradise has a high survival against selective logging. The habitat of the bird was also recovered quickly after selective logging, as the number of commercial timber harvested by the companies was limited.

## 1 Introduction

The Greater Bird-of-paradise (*Paradisaea apoda* Linnaeus 1758; Family: Paradisaeidae) is distributed in the southern part of the Jayawijaya Mountain range (mostly in the Indonesian Papua) and on Aru Islands, satellite islands in the west of Papua. The bird-of-paradise of the genus *Paradisaea* consisted of 6 species, namely Raggiana bird-of-paradise (*P. raggiana*), lesser bird-of-paradise (*P. minor*), goldie bird-of-paradise (*P. decora*), red bird-of-paradise (*P. rubra*) and emperor bird-of-paradise (*P. guilielmi*) [1].

The male (body length about 43 cm) is well known for their extraordinary magnificent plumage. The plumage is fully developed during the breeding season and is very important for dancing rituals, called lek [2]. Lek is a communal area at the tree canopy in which two or more males of the Greater Bird-of-paradise perform courtship displays. During the lekking

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behavior, several males (up to 15 males in the study area) performed a fascinating and complex dance ritual on the lek tree to mate with females. The female Greater Bird-of-paradise is strikingly different from the males, having a plain brown-reddish color plumage [3].

The Greater Bird-of-paradise has been traded for their plumage since a long time ago and is still illegally traded until now [4,5]. The Government of Indonesia has already included this bird in the protected species list, although IUCN still considered this species as Least Concern [6], due to its relatively wide distribution in the Indonesian Papua and Papua New Guinea.

The habitat of this bird is lowland tropical forest in Indonesian Papua and Papua New Guinea [1, 2]. Unfortunately, some areas of the tropical lowland forest in Papua have been subjected to timber harvesting by logging companies. The logging activities might affect the habitat of the Greater Bird-of-paradise in general, such as decreasing the tall trees as lekking sites and tree-producing food (i.e., fruiting trees). The bird-of-paradise, including the Greater Bird-of-paradise, feeds mostly on fruit (frugivores) and insects [7]. Many aspects related to the breeding ecology of these birds in their natural habitat, including nest-site selection by females, incubation period, and many others, unfortunately, remain unknown.

The impact and survival of the Greater Bird-of-paradise against logging are also still unrevealed. The logging method for timber extraction in Indonesia is selective logging. Therefore, the objective of this paper was to assess the survival of the Greater Bird-of-paradise and its habitat against selective logging. There was a report by the logging companies that the Greater Bird-of-paradise can be found in various logging blocks, leading to a presumption that this bird species is able to survive under selective logging activities. Two logging companies in the south-eastern Indonesian Papua were selected as study sites of the Greater Bird-of-paradise.

## 2 Study site and method

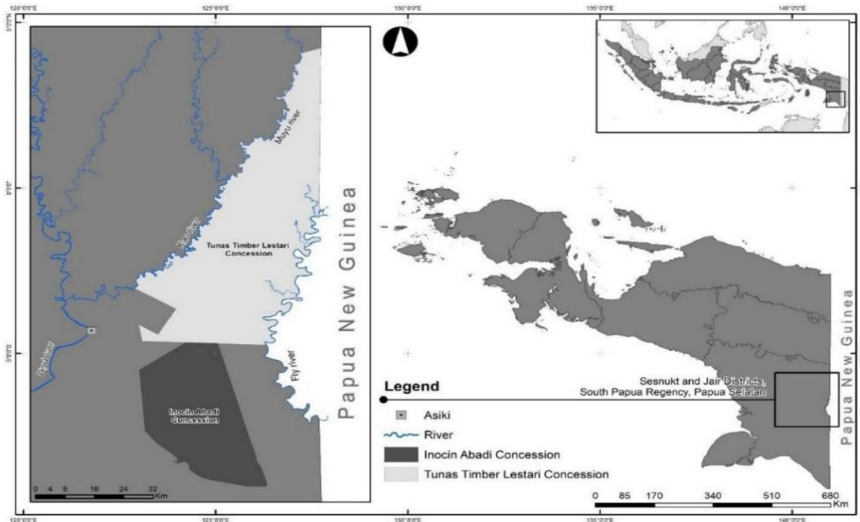
The study site was located in two logging concession of PT Inocin Abadi (99,665 ha; 140°31'42"- 140°50'46" E; 06°40'56"-05°05'26 S) and PT Tunas Timber Lestari (214,935 ha; 40°31'28.22" – 140°58'51.39" E; 5°50'40.91" – 6°41'25.34" S) in Boven Digoel Region, in the south-east of Indonesian Papua (Figure 1). PT Inocin Abadi is located to the south of PT Tunas Timber Lestari. Both logging concession is managed under the Korindo Group, a joint Korea-Indonesia company group. PT Inocin Abadi and PT Tunas Timber Lestari were granted the logging concession in 2011 under permit No 606/Menhut- II/2011 after the areas were logged by another company for 10 years. The area is located at 25-100 m asl, Land cover consists of mixed tree species dominated by the families of Myrtaceae and Myristicaceae.

Unlike forests in Kalimantan and Sumatra which are dominated by commercial timber species of the Dipterocarp family, in Papua only three tree species were considered as commercial timber species belonging to the Dipterocarp family (i.e., *Anisoptera costata*, *Hopea iriana*, and *Hopea papuana*; other commercial species mostly belong to Meliaceae and Myrtaceae family), and thus many non-commercial timber species were left unharvested. Based on the regulation by the Indonesian Government, the selective logging method was applied to log the commercial timber, with a limit diameter of 40cm and above. As required by regulation, replanting was conducted soon after logging.

The cutting rotation was 20 years, although the company was granted the concession for 35 years, allowing some unproductive areas (e.g., steep valleys, swampy areas), if any. Based on the logging regulation, the company has to apply a reduced impact logging method in the harvesting operation of the timber, conduct regeneration after logging, and select certain sensitive areas as High Conservation Value (HCV) Forest.

Each area of the cutting rotation was called a cutting block. Due to the difficulties

of reaching all cutting blocks, only several cutting blocks were able to be observed. Within each cutting block, access might be difficult for some spots, especially for cutting blocks for future logging activities (i.e., cutting blocks 2025 and afterward), as the access road has not been established yet.



**Fig. 1.** Map of study site location: PT (Concession of) Inocin Abadi and Tunas Timber Lestari in Papua.

The field observation was conducted for two consecutive years 2022 (September–November) and 2023 (July–August) covering forest blocks of 12 cutting years. In both years, field observations coincided with the breeding season of the Greater Bird-of-paradise, which happens from April to November, with peak season in July to August. Some sites were revisited in 2024 (August – September) to check whether the same lek trees were used again despite the intensive logging activities by the companies. Tree species that were identified to be used by the bird-of-paradise to lek were tall, emergent trees from the genera of *Syzygium*, *Listea*, and *Pometia*. During the breeding season, the males of bird-or-paradise very often produce loud specific calls, especially in the morning and late afternoon, and thus easier to detect their occurrence.

The occurrence of the bird-of-paradise was recorded based on direct visual and definitive calls by male birds. Information from the local people and staff of both companies was used as the basis for field observation. Field observations were conducted for the cutting block of 2012 (the oldest cutting block) up to the cutting block of 2035 (the planned cutting block). The initial information on the possible lek sites of the Greater Bird-of-paradise was obtained from the local people who work for the concession companies. After a certain site was identified on the map, the site was visited by driving a 4x4 car on the available logging road nearby (mostly took 1-2 hours), followed by walking on foot to the lek trees in the forest (about 10 min to 1 h walk). Most field visits were conducted early morning (5-9 am) and late afternoon (3-5 pm), coinciding with the lekking activities.

The bird-of-paradise is a top canopy bird, flying on, among, and above the tree canopy, and thus detection of the bird occurrence (i.e., lek tree) was through their loud and distinct calls, as detection by sight was very limited. When the lek tree was found by following the bird's call, the lek tree was mapped, and the information on the cutting year was collected.

The lek tree found during the field observation was counted as one observation point. In most cases, the dancing males could be observed from below (approximately 20-30 m) to confirm that a certain tree was indeed a lek tree. Due to the limited number of observations,

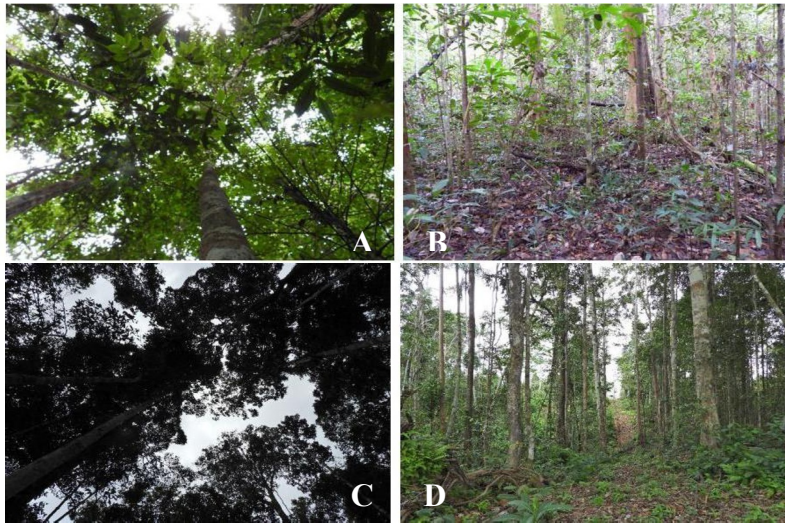
data were only presented in scatterplot for further analysis, without any further statistical test. Bird habitat was observed and presented qualitatively.

### 3 Results

#### 3.1 Habitat of Greater Bird-of-paradise in general

The forests of PT Inocin Abadi and PT Tunas Timber Lestari can be categorized as tropical lowland forests. As the proportion of the commercial tree species was only about 40%, coupled with the selective logging system for timber harvesting, many big trees still could be found in the study site. Gaps surely exist, especially in the sites of ex-logged trees, but the canopy gradually grew and closed the gaps.

As both concession companies were essentially located in the same landscape, forest types and dominant species were very similar. The common trees in both logging companies were ‘medang’ (*Litsea* sp.), ‘kelat’ (*Syzygium* sp.), ‘resak’ (*Vatica rassak*), and ‘mendarahan’ (*Horsfieldia* sp.). The canopy consisted of five layers, namely A canopy (emergent layers), B canopy (upper layer, mainly intolerant tree species), C canopy (middle canopy, mainly young trees and tolerant tree species), D canopy (lower canopy, mainly consisted of seedlings and samplings), E canopy (ground cover) (Figure 2).



**Fig. 2.** Forest condition in the study sites; Top PT Inocin Abadi’s cutting block 2012 - top canopy (A), lower canopy (B); Bottom: PT Tunas Timber Lestari’s cutting block 2022 - lower canopy (C), upper canopy (D); the Greater Bird-of-paradise could be found in both locations.

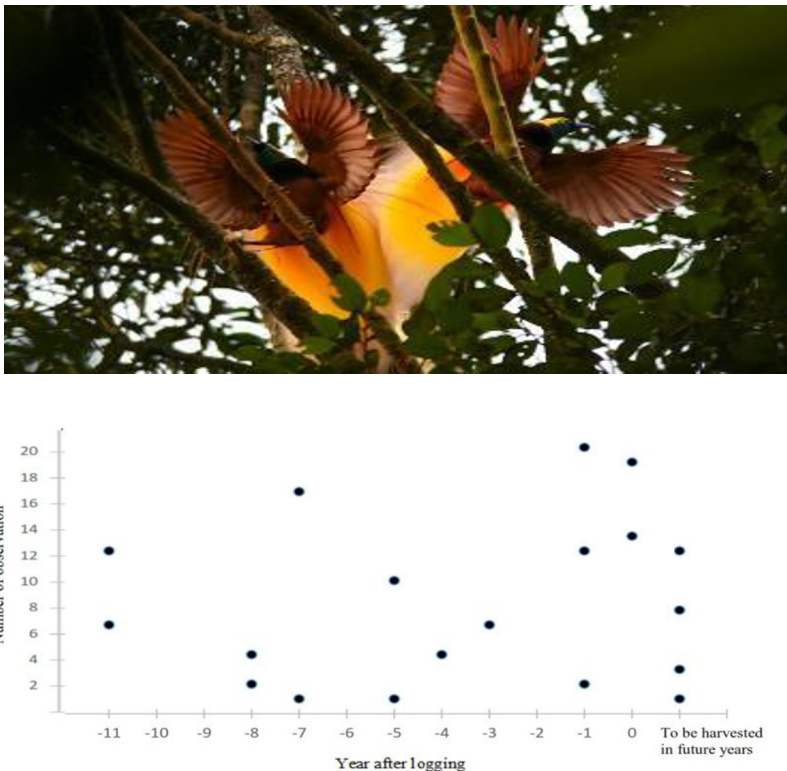
All Greater Bird-of-paradise mostly observed at the emergent trees (A canopy), and the surrounding tall trees (B canopy). Their presence was clearly noticed from the males’ unique loud continuous calls during the breeding season on their lek trees (i.e., trees that were used by males for dance rituals). All observed lek trees were scattered in almost all cutting blocks being studied.

#### 3.2 The occurrence of Greater Bird-of-paradise in various cutting blocks

Figure 3 shows the number of occurrences of the bird-of-paradise in 13 cutting blocks in PT Inocin Abadi and PT Tunas Timber Lestari. The various cutting blocks reflect the recovery

times (i.e., years) since selective logging in the study area. For example, cutting block 2012 means that the area has undergone a natural recovery process for 10 years in 2022 (i.e., when this research was started). Cutting block 2022 was being logged in 2022. Following the same procedure, cutting block 2035 means that the area is planned to be harvested in 2035 (labeled as ‘to be harvested in future years’ in Figure 3), and thus the forest condition at the time of field observation resembled a primary forest.

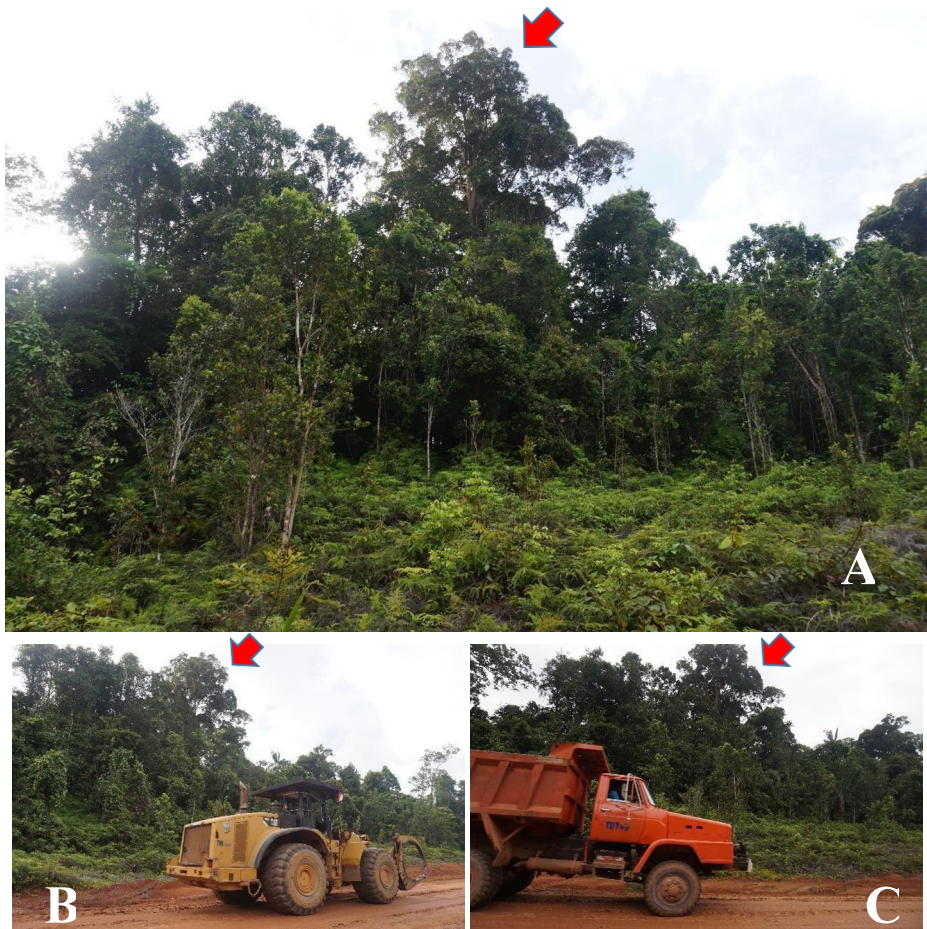
A total of 141 observations of lek trees from 9 blocks of various cutting years (including cutting years of planned/future years) were recorded during the study period. In some cutting blocks, there were more than one lek tree (i.e., one observation) was observed. Although the presence of the birds in the 9 cutting years was confirmed, the total number of individuals (males and females) was unable to be estimated. Data for the remaining four cutting years (e.g., cutting years 3, 6, 8, and 9) were unavailable due to the absence of access to the logging sites of those years. There was a possibility that there were some unrecorded lek trees during the field survey in the four cutting blocks.



**Fig. 3.** The occurrence of the Greater Bird-of-paradise in various cutting years in the study areas; year 0 is the current cutting year when this research was started (2022). Inset: example of display behavior of two males of Greater Bird-of-paradise on lek tree.

The birds could be found in almost all cutting years, including very old logging block (11 years; n of lek trees =2), very recent (n=2), and unlogged forest (i.e., future cutting block; n=4), suggesting that the Greater Bird-of-paradise still can survive against selective logging. In addition, the forest condition as the habitat of the bird showed a rapid recovery following selective logging. The volume of commercial timber harvested by the companies was low, due to the limitation of the commercial timber species in the study area.

One of the lek trees in PT Tunas Timber Lestari (*Syzygium* sp.; diameter 30 cm) was located very close (about 10 m) to the logging road cutting in the year 2018. During the recent re-checking of the lek trees in September 2023, the logging road was heavily used by heavy vehicles in the last six months, including wheel loaders, motor graders, and dump trucks, for the harvest activity nearby. Our observation revealed that the lek tree is still being used by the Greater Bird-of-paradise (Figure 4). Until now there has been no confirmation whether a male bird uses the same trees from year to year. Judging from the low number of trees suitable for lekking, there is a high possibility that the same tree(s) will be used by a certain male for lekking. This observation strengthened the presumption that this bird species in the study areas is actually still able to survive the selective logging within the cutting block and logging activities nearby.



**Fig. 4.** Lek tree (arrow) at the edge of the logging road of PT Tunas Timber Lestari's cutting block 2018 (A), which is frequently passed by heavy vehicles such as wheel loaders (B) and dump trucks (C).

## 4 Discussion

This paper presents the occurrence of the Greater Bird-of-paradise in various cutting blocks of two logging concession companies, to analyze the survival of the bird-of-paradise against

selective logging activities. To the best of our knowledge, similar research has not been reported elsewhere, and thus proper comparison of the same species cannot be done.

Almost all research on the impact of selective logging was based on a community level, and very seldom conducted on a species level. Selective logging is one of the most common approaches to forest harvesting in the tropics [8]. The magnitude of the effects of selective logging on bird communities and other wildlife species has been known to depend on the timber practice (i.e., timber harvesting methods, logging intensity, length of the logging cycle) and other related activities (i.e., road density, illegal logging, illegal hunting) [9–13].

Previous studies [8] suggested that time since logging and logging intensity affected the avian abundance. Frugivores and insectivores were known to be negatively affected by logging, and their population declined further with increasing logging intensity. In the Brazilian Amazon, a study on the time since logging of the avian community revealed that bird abundance, species richness, and functional specialization in the forests with longer recovery times since selective logging [14]. In the same Brazilian Amazon, selective logging actually had a low impact on the avian community [10].

In Borneo Island, studies on the impact of logging on wildlife, including birds, were conducted in Kalimantan (Indonesian Borneo) [11]. The response of birds toward selective logging is highly varied. Most birds seemed to have a sufficient tolerance to logging and habitat fragmentation, except all woodpeckers and some pheasant species (e.g., Bornean crested fireback *Lophura ignita*). Another study in Sabah [15] on the avian movement in the selective logged and unlogged forest found a higher probability of moving shorter distances in logged forests (up to 200 m), and higher movement probability at longer distances in unlogged forests (more than 200 m).

The impact of selective logging on the Greater Bird-of-paradise actually was a bit unexpected and differed from most previous studies on bird community (i.e., bird species in general). Although the number of observed lek trees in this study was quite small for each cutting block to represent the time since logging, this study showed that logging activities did not affect much on the existence of the Greater Bird-of-paradise in the study area. The bird-of-paradise still could be found in essentially all cutting blocks, including in a very recent logged block, suggesting that this species still can survive in the forest under selective logging.

The commercial species harvested by the logging companies (i.e., Dipterocarp and other big trees) could also serve as the lek trees, and thus logging activities might jeopardize the breeding and productivity of this bird. Fortunately, the government of Indonesia has already set some regulations in favor of the Greater Bird-of-paradise and other wildlife inhabit the same area, including the regulation related to the mother trees (i.e., leaving mother trees for next regeneration), environment-friendly harvest techniques, and setting aside a well-preserved unlogged forest as refuge and conservation of wildlife species, of which all will lead to the high survival of the Greater Bird-of-paradise in a logging concession, including in the study area.

The high survival of this bird toward logging could be due to the relatively low logging intensity applied by both timber companies, reduce-impact logging techniques in timber harvesting, and the high connectivity of the logged area with well-preserved unlogged forests (i.e., High Conservation Value Forest). These companies harvested only about 12-16 commercial trees/ha having a diameter of 40 cm and up. Non-commercial trees were not harvested, including trees with high wood density, as these hard trees will be difficult to process further.

Some factors that might be important for the survival of this bird seemed to be the existence of lek trees and food trees. In many cases, the lek trees also functioned as food trees as well. It would be much better if the lek trees/food trees were surrounded by other tall trees as cover during breeding/lekking activities.

## 5 Conclusion

This study revealed that the Greater Bird-of-paradise still can be found in various logging years in their rapidly recovered habitat, suggesting that this bird is still able to survive against the selective logging in the study area. Bird/wildlife-friendly practices (i.e., selective logging, reduced impact logging, the occurrence of the High Conservation Value Forest) would have important roles in maintaining the population number and survival of the Greater Bird-of-paradise and its habitat.

In other sites that might show a decrease in abundance following selective cutting, the company needs to consider employing a lower logging intensity and longer logging cycle, as also suggested for logging activities in Amazonia [13,16]. For the study site, low-intensity selective logging (12-16 trees/ha) in a 30-year cycle is still considered safe for the Greater Bird-of-paradise.

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