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The relative influence of habitat modification on bird assemblage in the University of Notre Dame du Kasaï-Central site in the Democratic Republic of the Congo

[L'influence relative de la modification de l'habitat sur l'assemblage d'oiseaux dans le site de l'Université Notre Dame du Kasaï-Central en République Démocratique du Congo]

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Abstract

The aim of this study was to determine the '' relative influence of habitat modification on bird assemblage''. To estimate the ecological interest of reforestation on the Campus of Notre Dame du Kasaï site, the birds were photographed, identified and then compared to all species listed in Avibase of the region. The site hosts about 12.4% of species identified throughout the region. The following birds would be new to the Kananga area compared to Kasaï-Central bird Checklist: Bubulcus ibis, Upupa africana, Lanius collaris, Terpsiphone rufocinerea et Camaroptera brevicaudata. This study consists in demonstrating the impact of reforestation on wildlife, particularly birds. This aspect of applied biology is therefore part of the context of conservation biology. The publication of the species is a strategy for their visibility to lovers of eco-tourism based on bird watching. This could attract them and thus contribute to the economy of the region. It is on the basis of all this information that on the one hand, eco-tourism based on bird observations could develop throughout the Kasaï-Central province and on the other hand, strategies for the protection of vulnerable species will be proposed.

Keywords: Birds, specific diversity, University of Notre Dame du Kasaï, Democratic Republic of the Congo.

Résumé

L'objectif de cette étude était de déterminer l'influence relative de la modification de l'habitat sur l'assemblage d'oiseaux. Pour estimer l'intérêt écologique du reboisement sur le site du Campus Notre Dame du Kasaï, les oiseaux ont été photographiés, identifiés puis comparés à toutes les espèces répertoriées dans Avibase de la région. Le site accueille environ 12,4% des espèces identifiées dans l'ensemble de la région. Les oiseaux suivants seraient nouveaux dans la région de Kananga par rapport à la liste de contrôle des oiseaux du Kasaï-Central: *Bubulcus ibis, Upupa africana, Lanius collaris, Terpsiphone rufocinerea* et *Camaroptera brevicaudata*. Cette étude consiste à démontrer l'impact du reboisement sur la faune, en particulier sur les oiseaux. Cet aspect de la biologie appliquée s'inscrit donc dans le contexte de la biologie de la conservation. La publication des espèces est une stratégie pour leur visibilité auprès des amateurs d'éco-tourisme basé sur l'observation des oiseaux. Cela pourrait les attirer et contribuer ainsi à l'économie de la région. C'est sur la base de toutes ces informations que d'une part, l'éco-tourisme basé sur l'observation des oiseaux pourrait se développer à travers la province du Kasaï-Central et d'autre part, des stratégies de protection des espèces vulnérables seront proposées.

Mots clés : Oiseaux, diversité spécifique, Université Notre Dame du Kasaï, République Démocratique du Congo.

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1. Introduction

The birds of the Democratic Republic of the Congo (DRC) have been the subject of many studies (Kisasa et al., 2021; Kisasa et al., 2020; Punga & Ifuta, 2015; Kisasa & Aloni, 2011; Lippens & Wille, 1976). The latter results from information collected in a few provinces according to their accessibility. When extrapolated to the whole of this large country, local specificities of habitats have rarely been taken into account, such as forest type (Murhabale et al., 2021), savannah, miombos, climate, accessibility, anthropogenic activities (Kisasa, 2012 ; Liyandja et al., 2015), soil type (Kisasa & Aloni, 2011), and regulations on biodiversity management (Voelker et al., 2012). Monitoring the evolution of avian stands over time thus becomes a challenging and complex task in these large ecosystems. In addition to the inaccessibility of specific habitats so rich in avifauna, insecurity due to armed groups would be one of the obstacles to the monitoring of bird populations in time and space.

Each of these macro-ecosystems indeed has habitats that modulate the avian stand. Anthropogenic activities, for example, in a habitat can affect the reproductive success and fidelity of a bird to that habitat (Kisasa, 2012). Human activities, therefore, bring many changes in nature and the composition of the elements of biodiversity, such as the soil composition for nesting birds and the availability of food (Jose & Luis, 1991). Using birds stands as a biological indicator of the ecological stability of a site by monitoring its specific richness over time has been the subject of several studies (Kisasa, 2012; Kisasa & Aloni, 2011).

Human activities on the campus of Notre Dame du Kasaï (UKA) site and its surroundings induce its initial metamorphosis, whose consequences could impact the local distribution and diversity of the avian fauna that finds refuge there. This study aims to identify the different species according to their habitats in this site with a view to their better monitoring over time.

Located northeast of the city of Kananga, in the province of Kasai Central (5° 53′ 32" South, 22° 24′ 10" East) and 30 minutes' walk from the Hight College Saint Louis, the UKA is erected on the plateau of kambote hill entirely bordered by streams.

The climate, soil, and vegetation of the UKA are those observed throughout the city of Kananga. This is the tropical savannah climate Aw3, characterized by a cold, dry season of three months, with a monthly rainfall height of less than 50mm according to the Koppen classification. The soil is sandy with vegetation consisting of grassy formations interspersed with forest galleries and small groves (Bushabu et al., 2014; Mbimbi, 2013; Bushabu et al., 2007 ; S.G.E.C, 1999 ; Mabika, 1983).

The province of Kasai Occidental was overflown while collecting data used to produce the book entitled "The Birds of Zaire." Drowned in this document, the birds of the province and their local specificities are rarely highlighted.

Before the occupation of the site by the university, the vegetation of the savannah type with herbaceous and shrub dominance, dotted with groves, meadows, crops, and palm groves in *Elaeis guineensis*, covered the hill of Kambote and its plateau; the remains of forest galleries although very degraded, still run along the rivers and the heads of streams.

Since the acquisition of the site in 1996, the UKA has deployed two main programs: construction and the gradual reforestation of the area.

The current constructions concern the academic structures whose rectangular-shaped frame covers about 1/2 km^2 in the active part of the site. This is only about one-tenth of the extent of the university's domain.

Reforestation is done only with a single species of eucalyptus (*Acacia auriculiformes*, Fabaceae). This tree competes with and eliminates native species, especially herbaceous ones; It maintains a bald undergrowth of grasses, totally open, and a soil covered with dead leaves of its species. Over time, the trees of the first eucalyptus plantations around the buildings have reached about ten meters and offer a relatively closed crown (figure 1). A few feet of Mango (*Mangifera indica*) and Rauwolfia (*Rauvolfia vomitoria*) are lost in these plantations. The whole gives the occupied part of the site and appearance of a forested islet bathed in an ocean of pale-yellow grass cover.

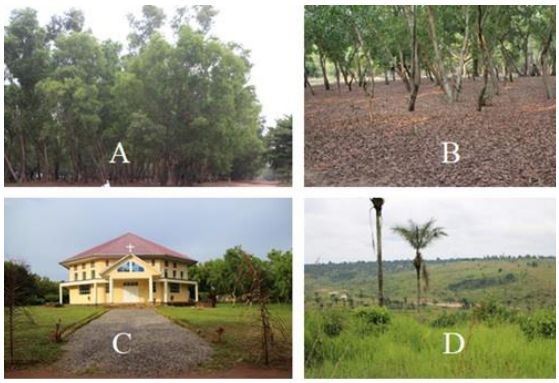

Figure 1. Some habitats of the UKA site. A: the eucalyptus forest with its B: shaped undergrowth; C: the church partially surrounded by the plantations; D: one of the views of the surrounding part called "natural."

The artificial forest engulfs the buildings; it creates a unique local habitat that serves as a place of rest, recreation, walking, and study for humans. It is also a place frequented by commensal birds that come to feed and shelter in eucalyptus trees and the roofs of human dwellings.

The inactive part of the site is an open environment dotted with few oil palms. Nevertheless, it retains its natural plant physiognomy, and no physical limitation distinguishes it from the rest of the plateau. In the rest of the text, we use the term "natural" to refer to this initial feature of vegetation.

In the valleys where the streams flow, the development of fishponds along cliffs would be the preferred habitats for birds nesting in burrows. The artificial forest, the natural environment, and the fishponds form a mosaic of habitats that result in a corresponding avian stand in addition to permanent human activities. Our approach is to identify the avian diversity and the mode of settlement of the habitats of the UKA site, particularly the birds of the artificial forest.

2. Material and Methods

2.1. Sampling

Using a camera (Canon EOS 1200D mounted with a 6.3200 mm lens), the birds were photographed on the campus of the University of Kasai only on the day of October 5, 2021 to October 5, 2022 during 4 months of dry season and 8 months of rainy season. The list of birds of the site was established after the identification of different images by the Royal Museum of Natural Sciences of Belgium and by comparison with the species already described in the bird guides of Sub-Saharan and West Africa (Borrow & Demey, 2012; Sinclair & Ryan, 2010; Fonderflick, 1998) and then corrected by comparison to the Avibase-Bird Checklists of the World (Kasaï-Occidental) by Clements et al. 2022.

2.2. Estimating species richness

Boulinier's method and Bird population method of Fronderflick were used for to estimate bird species richness on the site. This is a ratio of the total number of bird species identified in this site compared to the total number of those listed in Kasaï-Central bird Checklist by Clements et al. 2022.

3. Results

3.1. Composition

We have currently recorded 72 species divided into 34 families and 12 orders. The order Passeriformes alone contains 50 species and 22 families. The order Accipitriformes has a single-family and four species. The other charges include one to two families with often a single species. The avian diversity of the university site of Notre Dame du Kasaï (UKA) is presented in table 1.

3.2. Specific richness of the site

It appears from figure 2 that the reforested site hosts 12.4% of bird species in the Kasai-Occidental region. It should be noted that this percentage does not take into account nocturnal birds. In addition, the site being semi-arid, birds of the order Anseriformes are not listed.

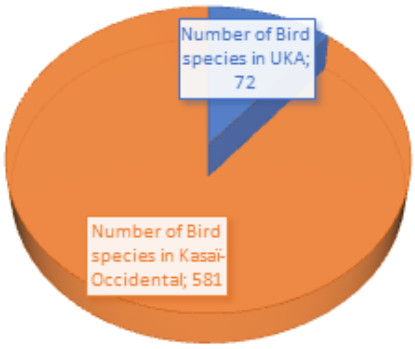

Figure 2. Bird species diversity of UKA

4. Discussion

4.1. Habitat impacts on species richness

The avian fauna of the UKA site includes at this stage, a rather remarkable and varied avian population (i.e 12.4% compared to Kasaï-Central or Occidental bird Checklist). In our opinion, this characteristic results from three different parameters.

Table 1. List of birds listed in the university site of Kananga in Kasai

N°	Order of birds	N°	Family	N°	Species	Forest	Savannah and Ponds
1	Galliformes	1	Phasianidae	1	*Red-necked Spurfowl, Pternistis afer (Müller, 1776)*		X
				2	*Harlequin Quail, Coturnix delegorguei*		X
2	Caprimulgiformes	2	Caprimulgidae	3	*Swamp Nightjar, Caprimulgus natalensis*		X
3	Cuculiformes	3	Cuculidae	4	*Senegal Coucal, Centropus sengalensis(Linnaeus, 1766)*		X
				5	*White-browed coucal, Centropus superciliosus(Hemprich et Ehrenberg, 1829)*		X
4	Columbiformes	4	Columbidae	6	*Red-eyed Dove,Streptopelia semitorquata (Rüppell, 1837)*		X
				7	*Blue-spotted Wood-Dove, Turtur afer(Linnaeus, 1766)*		X
5	Gruiformes	5	Rallidae	8	*Allen's Gallinule, Porphyrio alleni (Thomson, 1842)*		X
				9	*Lesser Moorhen, Paragallinula angulata (Sundevall, 1850)*		X
6	Pelecaniformes	6	Ardeidae	10	*Cattle Egret, Bubulcus ibis (Linnaeus, 1758)*	X	X
7	Accipitriformes	7	Accipitridae	11	*Black-Winged Kite, Elanus caeruleus (Desfontaines, 1789)*		X
				12	*African Cuckoo-Hawk, Aviceda cuculoides(Swainson, 1837)*	X	
				13	*Black Kite, Milvus migrans(Boddaert, 1783)*		X
							X
8	Coliiformes	8	Coliidae	15	*Speckled Mousebird, Colius striatus(Gmelin, JF, 1789)*		X
9	Bucerotiformes	9	Upupidae	16	*Upupa africana (Bechstein, 1811)*		X
10	Coraciiformes	10	Coraciidae	17	*Broad-billed Roller, Eurystomus glaucurus (Statius Muller, 1776)*	X	
		11	Alcedinidae	18	*Gray-headed Kingfisher, Halcyon leucocephala (Statius Müller, 1776)*	X	X
				19	*African Pygmy Kingfisher, Ispidina picta(Boddaert, 1783)*	X	X
		12	Meropidae	20	*Blue-breasted Bee eater, Merops variegatus (Vieillot, 1817)*		X
11	Falconiformes	13	Falconidae	21	*Peregine Falcon, Falco peregrinus(Tunstall, 1771)*		X
12	Passeriformes	14	Platysteiridae	22	*Wertern Black-headed, Batis erlangeri (Neumann, 1907)*		X
				23	*Black-throated Wattle-eye, Platysteira peltata (Sundevall, 1850)*	X	
		15	Malaconotidae	24	*Marsh Tchagra, Bocagia minuta (Hartlaub, 1858)*		X
				25	*Black-crowned, Tchagra senegalus (Linnaeus, 1766)*		X
				26	*Lowland Sooty Boubou, Laniarius leuchorhynchus (Hartlaub, 1848)*		X
		16	Campephagidae	27	*Black Cuckooshrike, Campephaga flava(Vieillot, 1817)*		X
		17	Laniidae	28	*Southern Fiscal, Lanius collaris(Linnaeus, 1766)*		X
				29	*Souza's Shrike, Lanius souzae(Barbosa du Bocage, 1878)*		X
		18	Monarchidae	30	*Black-headed Paradise-Flycatcher, Terpsiphone rufiventer((Swainson, 1837))*	X	
				31	*Rufous-vented Paradise-Flycatcher, Terpsiphone rufocinerea (Cabanis, 1875)*	X	
				32	*African Paradise-Flycather, Terpsiphone viridis (Müller, 1776)*	X	
		19	Corvidae	33	*Pied Crow, Corvus albus(Müller, 1776)*		X
		20	Paridae	34	*White-winged Black-Tit, Melaniparus leucomelas(Rüppell, 1840)*		X
		21	Pycnonotidae	35	*Common Bulbul, Pychnonotus barbatus (Desfontaines, 1789)*		X
				36	*Plain Greenbul, Eurillas curvirostris (Cassin, 1859)*		X
		22	Hirundinidae	37	*Lesser striped Swallow, Cecropis abyssinica (Guerin-Meneville, 1843)*		X
		23	Cisticolidae	38	*Siffling Cisticola, Cisticola brachypterus(Sharpe, 1870)*		X
				39	*Red-faced Cisticola, Cisticola erytrops(Hartlaub, 1857)*		X
				40	*Whistling Cisticola, Cisticola lateralis (Fraser, 1843)*		X
				41	*Tawny-flanked Prinia, Prinia subflava(Gmelin, 1789)*		X
				42	*White-chinned Prinia, Schistolais leucopogon(Cabanis, 1875)*		X
				43	*Grey-backed Camaroptera, Camaroptera brevicaudata(Cretzschmar, 1830)*		X
		24	Sturnidae	44	*Violet-backed starling, Cinnyricinclus leucogaster (Boddaert, 1783)*	X	
				45	*Chestnut-winged Starling, Onychognathus fulgidus(Hartlaub, 1849)*	X	
		25	Turdidae	46	*African Thrush, Turdus pelios(Bonaparte, 1850)*		X
		26	Muscicapidae	47	*Red-backed scrub Robin, Cercotrichas leucophrys (Vieillot, 1817)*		X
				48	*Southern Black-Flycatcher, Melaenornis pammelaina((Stanley, 1814)*		X
				49	*Spotted Flycather, Muscicapa striata (Pallas, 1764)*		X
				50	*Rufous-tailed Palm-Thrush, Cichladusa ruficauda ((Hartlaub, 1857)*		X
				51	*Sooty Chat, Myrmecocichla nigra (Vieillot, 1818)*		X
		27	Nectariniidae	52	*Little Green Sunbird, Anthreptes seimundi (Ogilvie-Grant, 1908)*		X
				53	*Green-headed Sunbird, Cyanomitra verticalis(Latham, 1790)*		X
				54	*Cooper Sunbird, Cinnyris cupreus (Shaw, 1812)*		X
				55	*Cinnyris venustus(Shaw, 1799)*		X

N° Order of birds	N°	Family	N°	Species	Forest	Savannah and Ponds
	28	Passeridae	56	*House sparrow, Passer domesticus (Linnaeus, 1758)*	X	X
			57	*Northern Gray-heade sparrow, Passer griseus(Vieillot, 1817)*	X	X
	29	Ploceidae	58	*Orange Weaver, Ploceus aurantius (Vieillot, 1805)*		X
			59	*Village Weaver, Ploceus cucullatus (Statius Müller, 1776)*		X
			60	*Ploceus insignis (Sharpe, 1891)*		X
			61	*Black-necked Weaver, Ploceus nigricollis (Vieillot, 1805)*		X
	30	Estrildidae	63	*Bronze Mannikin, Spermestes cucullatus(Swainson, 1837)*		X
			64	*Black-headed Waxbill, Estrilda atricapilla (Verreaux & Verreaux, 1851)*		X
			65	*Orange-cheeked Waxbill, Estrilda melpoda (Vieillot, 1817)*		X
			66	*African Firefinch, Lagonosticta rubricata(Lichtenstein, 1823*		X
			67	*Red-billed Firefinch, Lagonosticta senegala(Linnaeus, 1766)*		X
	31	Viduidae	68	*Pin-tailed Whydah, Vidua macroura((Pallas, 1764))*		X
	32	Motacillidae	69	*African aguimp, Motacilla aguimp(*Temminck, 1820)		X
	33	Fringillidae	70	*Black-faced Canary, Crithagra capistrata(Finsch, 1870)*		X
			71	*Yellow-fronted Canary, Crithagra mozambica((Müller, 1776))*		X
	34	Emberizidae	72	*Golden-breasted Bunting, Emberiza flaviventris (Stephens, 1815)*	X	

5. Discussion

5.1. Habitat impacts on species richness

The avian fauna of the UKA site includes at this stage, a rather remarkable and varied avian population (i.e 12.4% compared to Kasaï-Central or Occidental bird Checklist). In our opinion, this characteristic results from three different parameters.

First, the UKA is located outside the city, where human presence remains low and limited in the active part of the site. This fact keeps the initial habitat and its avian stand in their natural balance. The natural habitat does not have a barrier that can prevent the free movement of birds from one place to another; it shelters a fauna adapted to these types of environments. This would explain the preponderance of species of open habitats such as Citicoline, Muscicapidae, Estrildidae, and Ploceidae.

The second parameter concerns the structure of the active part. Here, in addition to the corresponding infrastructures of a university site, the artificial forest generated by the plantations offers another vision of the university site. The latter appears as a forest island that engulfs the buildings. This characteristic would attract another category of birds in particular species with intermediate ecology, such as *Aviceda cuculoides, Platysteria peltata, Terpsphone rufocinerea, and Terpsiphone Viridis*, and forest species represented here by *Cinnyricinclus leucogaster, Melaenornis pammelaina, and Onychognathus fulgidus*.

Using of the active part is the last parameter. The administrative staff, few in number, limit their activity in and around the offices during the day and abandon the workplace at 3 p.m. local. During class hours, students and teachers are in the auditoriums. The majority of administrative staff and students do not stay on the site. Only visiting teachers and guards remain on the site in tiny numbers. Combined with the site's location, these facts reduce human disturbance and give the UKA domain a permanent relative calm. Indeed, the noise keeps the birds away, thus decreasing their affinity and reproductive success on a site (Kisasa, 2012; Kisasa & Aloni, 2011). These are birds accustomed to human presence that usually colonize this site. As an indication, corvids, ploceids, nectarinids, monarchical, Accipitridae, and other species with variable ecology and behavior fall into this category.

5.2. Influence of habitats

Our results reflected a differential occupation of habitats about the species richness and confirmed known ecological concepts. It is known, for example, that the animal population adjusts to the characteristics of the environment (Maron et al., 2011); in addition, the species richness of an ecosystem is based on the variability of its plant physiognomy (Poschold et al., 2005); There is a relationship between the heterogeneity of habitats and the species richness of an ecosystem; the insular character of the environment (Blondel, 1979 ; Blondel, 1976) would also affect the population of biological diversity including birds (Zurita & Zuleta, 2009 ; Boulinier et al., 1998). These postulates, therefore, justify the results of this study.

In the case of the UKA domain, the natural habitat provides birds with a diversity of feeding,

breeding, refuge, and resting places. These conditions satisfy the majority of the species listed in our study.The forest is an attractive environment for birds, and this is due to the diversity of its habitats (Mikko Mönkkönen et al., 1997). The monospecific nature of the UKA forest contradicts this observation and provides few resources for its residents. We only saw a crow's nest in this forest. In one place, droppings on the ground were recorded, indicating that an individual spent the night there. The populations of regularly encountered species such as *Terpisphone rufocinerea*, *Emberiza flavifiventris*, and *Ispidina picta* were limited to individuals alone or in pairs but less abundant. These birds fly from one tree to another but come to capture insects, especially on the ground. The unique individual of *Acviceda cuculoides* roams the treetops in search of its prey; we once raised it to the ground; once again, the bird carried an arthropod on its legs. This individual was only observed for a week before disappearing. Did he emigrate, or was he killed by the young humans who roam the forest to hunt birds? The male of *Cinnyricinclus leucogaster* explores the treetops while the female sometimes descends to the low branches. *Onychognathus fulgidus* behaves like the male of the previous species; this species has been observed perched on the components of the Oil Palm (Ealais guineensis) and feeding on insects on the trunk of the palm tree and or pond surface insects. Platysteria peltata explores the leafy part of the trees in search of insects and will also capture them on the ground. One *Terpsiphone rufoventer* has been observed twice; could she be the newcomer to this forest? The lack of flowering plants explains the scarcity of nectarinids in this habitat. Only Cinnyris cupreus has been observed on a few rare feet of *Rauwolfia vomitoria* and *Mangifera indica*. Our results support the finding that pure plantations are the poorest in bird species (Poschold et al., 2005; Van Elsen, 2000).

The ponds are of recent creation. Most of them were still under construction when we visited in 2021. In addition to species with aquatic habits such as *Porphyrio alleni* and *Paragallinula angulata* rare to observe, other species such as *Cinnyricinclus* come to feed on water surface insects. *Montana again* was exclusively photographed at the edges of this habitat hunting insects; this species also frequents human dwellings and lands without fear in the plots of the city. In addition to the species associated with the different habitats, some species exploit the three types of habitats prospected. *Corvus Albus, Milvus aegyptius, M. migrans, Pyncnonotis tricolor, Streptopelia semitorquata*, and *Turtur after*.

Corvus Albus is ominivorous (Kisasa et al., 2021; Kisasa et al., 2020). In the UKA domain, it frequents the surroundings of the kitchen and the cafeteria. It sometimes ventures into the forest near these places. On three occasions, it was chased in the woods, hounded by the Terpsiphone Viridis present in this place. Both species of Kite flying in the sky are not limited to the UKA domain. They fly over the domain without a marked preference for either habitat. Associated with crows or not, a few individuals stand at the edge of the forest near the kitchen to pick up cook waste of animal nature.

We did not encounter *Streptopelia semitorquata* in the forest. This species is fond of grasslands, fallow land, and crops on the periphery of the active part of the domain. *Turtur afer* has only been observed twice in the forest, and its behavior resembles that of *S. semitorquata*. *Pycnonotus tricolor* exploits the habitats of the UKA domain indifferently. Indeed, reforestation is a good approach for various reasons and preserves the quality of the environment. Nevertheless, we believe that this reforestation should be integrated into a management plan that would consider the presence of pockets of natural habitats for the maintenance of the original avian fauna (Hadjister & Taran, 2000; Blondel, 1976).

There is a rich avian stand in the university's domain of Notre Dame du Kasaï in Kananga, consisting mainly of species from open environments such as savannahs. The eucalyptus plantation attracts forest species that are not very diverse.

An abundant and diverse avian fauna on a site is a source of curiosity for the walker, spiritual inspiration, creativity for the scientist, the artist of all kinds, and a suitable bioindicator of the tranquility of this site. Abundance and diversity are only achieved through the diversification of habitats for volatiles. As a result, we recommend that managers of the UKA domain diversify plantations into plant species that can attract more diversity of birds. To preserve the biological diversity of the site, we recommend that the reforestation process, regardless of the option, incorporate landscape ecology standards.

To allow the avian stand to settle and get used to the familiar passages of humans, "bird hunting" should be prohibited throughout the university site.

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