

Research Article**Waterbird Checklist, Threats, and Opportunities for Wetlands Ecosystems in Sukamara Regency, Central Kalimantan****Agusti Randi^{1a}, Barakalla Robyn^{1b}, Adhy Maruli^{1c}, Oby Andrian^{2d}, Rodianto Rodianto^{3e}, Ahmad Muammar Kadafi^{4f*}**¹ Nusantara Climate Initiative, South Jakarta, Indonesia.² Natai Ekosistem Sejahtera, Sukamara, Central Kalimantan, Indonesia.³ Kandelial Alam, Pontianak, West Kalimantan, Indonesia.⁴ Biology Study Program, Faculty of Mathematics and Natural Sciences, Palangka Raya University, Palangka Raya, Indonesia.Email: ^{a)}agusti.randi@nusantaraclimate.co.id; ^{b)}barakalla.robyn@nusantaraclimate.co.id;^{c)}adhy.maruli@nusantaraclimate.co.id; ^{d)}oby.andrian@kalteng-nci.com;^{e)}rodi.odi32@gmail.com; ^{f)*}amuammarkadafi@mipa.upr.ac.id

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Abstract

Tropical wetlands are among the most important yet increasingly threatened ecosystems in Southeast Asia, providing critical habitat for biodiversity and essential ecosystem services for local communities. However, information on waterbird assemblages in many peatland landscapes of Borneo remains limited, constraining effective conservation planning. This study presents a preliminary assessment of waterbird diversity, associated threats, and landscape management opportunities in the Bakung River wetlands landscape, Sukamara Regency, Central Kalimantan, Indonesia. Field observations recorded 28 waterbird species belonging to 10 families, including 17 migratory species and several taxa of national and global conservation concern. The findings indicate that the seasonal hydrological dynamics of the Bakung River create an extensive mosaic of open swamp habitats that function as important feeding, resting, and refuge areas for resident and migratory waterbirds. Despite its ecological significance, the landscape is exposed to multiple anthropogenic pressures, particularly recurrent peat fires, canal-driven hydrological disturbance, and destructive fishing practices that may reduce habitat quality and ecosystem resilience. Based on these results, we highlight the need for an integrated landscape approach that combines habitat protection, peatland and hydrological restoration, regulation of unsustainable resource use, and long-term biodiversity monitoring. In addition, innovative sustainable financing mechanisms, including ecotourism and other schemes related to environmental services may provide complementary pathways to support conservation implementation while sustaining local livelihoods. This study underscores the strategic importance of the Bakung River landscape as a wetland refuge for waterbirds in Borneo and provides an initial scientific basis for future ecological research and ecosystem-based management in the region.

Keywords: *Waterbird diversity, Peat swamp ecosystems, Wetland conservation, Sukamara Regency, Ecosystem services.*

Copyright © 2026. The authors (CC BY-SA 4.0)**Introduction**

Wetland ecosystems are vital components of the global environment, providing essential ecological functions such as erosion control, flood regulation, and climate stabilization [1]. Indonesia possesses a vast wetland area, with approximately 21% of its land with more than 38 million hectares classified as wetlands [2]. Peatlands are one of the main types of wetlands in

Indonesia, representing part of the country's hydrological landscape and supporting a variety of endemic and unique flora and fauna [1].

Waterbirds represent a key component of wetland biodiversity, utilizing these habitats for feeding, roosting, and breeding [3]. Globally, tropical wetlands are critical for bird richness due to the year-round availability of food and shelter [4]. In Indonesia, wetland bird diversity is notably high; for example, coastal wetlands in East Lampung host at least 23 species of waterbirds, while the Suwi River in East Kalimantan has recorded 63 wetland bird species from 28 different families [5-3]. Kalimantan is a particularly important region for waterbird diversity, with the Middle Mahakam Wetlands alone supporting 57 waterbird species, including 27 species of shorebirds, alongside various herons, rails, and storks [6].

Despite their importance and crucial ecological functions, these habitats and the waterbirds that depend on them face escalating threats. In Indonesia, and specifically across Kalimantan, large-scale land conversion for agriculture and industry has led to the rapid loss of primary peat swamp forests [6-1]. This condition is exacerbated by peatland ecosystem degradation caused by deforestation and drainage activities, which make peatlands highly susceptible to fire [7]. Such fires can erase centuries of carbon accumulation in a single event and lead to an immediate collapse of biodiversity [8]. The impact is clearly visible on avifauna populations, where burned areas show significantly lower species richness and the loss of specialist peat swamp forest species, which are replaced by generalist species [9-10]. Furthermore, anthropogenic pressures such as wild hunting and the massive bird trade in Indonesia, with an estimated 2.6 million birds kept as pets in major cities, add to the burden on the sustainability of wild bird populations [11-12].

Although facing various threats, there are significant opportunities in managing these wetlands through landscape-based conservation approaches and hydrological restoration. Peatland restoration is a top priority to reduce carbon emissions and restore their ecological function [13]. Implementing this restoration strategy is crucial for maintaining high biodiversity, particularly avifauna communities that are sensitive to habitat change [10].

This study aims to report waterbird species spotted in the study site during field observations, identify actual and potential threats faced in the field, and formulate opportunities for sustainable wetland management. This result is a preliminary study because there is no previously recorded data and information for this location. Through the basic information from this observation, it is hoped that regular monitoring can be carried out to create a strong database to support wetland ecosystem conservation policies in the Sungai Bakung peat swamp landscape, Sukamara Regency, Central Kalimantan, while simultaneously aligning conservation interests with the socio-economic aspects of the local community.

Materials and methods

Observation Methods

The study site is in Bakung River, Sukamara Regency, Central Kalimantan, which is within the forestry concession area of PT. Natai Ekosistem Sejahtera (PT. NES). The observation was carried out on February 22–28, 2026, using the Boat Survey method, which is a waterbird observation method carried out by exploring water bodies such as rivers, canals, lakes and floodplain swamps using a boat, while recording all individuals seen along the survey route [14-15]. The total length of the observation route is 6.16 km, following the main body of the Bakung River. The starting point coordinates are at 110°56'29,016"E, 2°53'8,357"S, and the ending point at 110°58'4,107"E dan 2°55'50,581"S (Figure 1). This method is considered more effective for large open wetland habitats that are inaccessible by land such as the Bakung River wetlands. This method also allows for larger area coverage in a relatively short time.

Data Collection and Analysis

The data collected included waterbird species spotted and documented during field observations. The data presented in this paper are the results of a preliminary study, list of species found with their scientific names, families, Indonesian names, and information on their migratory status. Species identification was performed visually using a field guide [16]. Data analysis was conducted descriptively to determine species composition and family dominance. The conservation status of each species analyses based on data from the International Union for Conservation of Nature (IUCN) Red List, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and Regulation of the Minister of Environment and Forestry P.106/2018.

Habitats at the observation sites were described based on direct visual observations. Land cover conditions and vegetation information were observed at the study sites. Other information was also obtained directly from local fishermen, particularly regarding the dynamics of changing water conditions during certain seasons. Threats occurring in the field were identified based on direct observations during the study and supplemented by direct interviews with fishermen at the study site regarding the types of threats and their causes. The resulting descriptions are presented in the discussion. Meanwhile, landscape management opportunities are discussed descriptively through an approach that emphasizes the importance of habitat for the persistence of waterbirds and the surrounding environment, as well as for local fishing communities whose livelihoods depend on the landscape. These conditions are then integrated with relevant scientific literature from other locations with comparable characteristics to develop an ecosystem-based management approach.

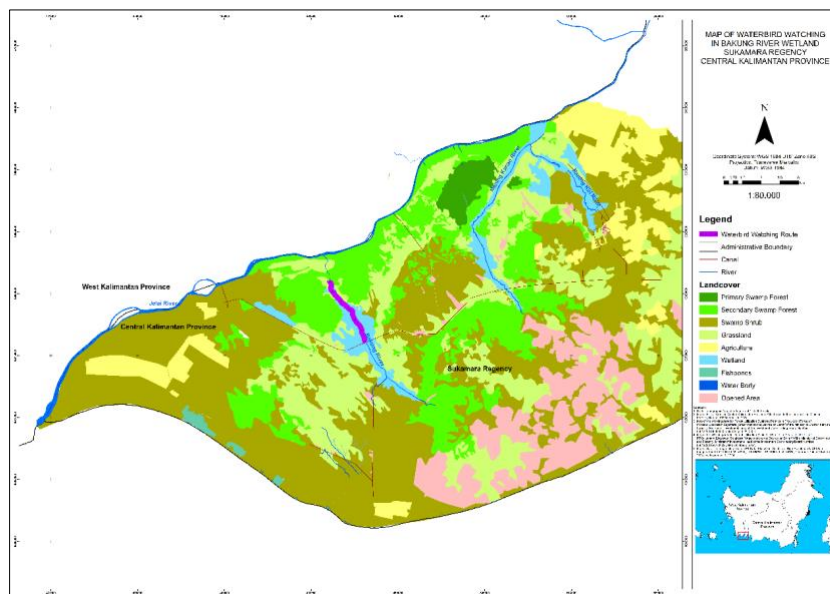


Figure 1. Study site map at Bakung River, Sukamara Regency, Central Kalimantan.

Results and Discussion

Habitat Conditions

The Sukamara Regency lies in the Borneo ecoregion, characterized by a blend of peat and freshwater swamps. The swampy habitats of the region comprise water sources like rivers and open swamps where large areas of grasslands dominate. One example is the Bakung River, a sub-watershed of the Jelai River which lies on the border between the provinces of West Kalimantan and Central Kalimantan.

From an ecosystem point of view, the Bakung River is characterized as being in a peat swamp ecosystem characterized by flat topography, slow river currents, and reddish-black waters. The water levels in the Bakung River rise considerably during the rainy seasons, overflowing to flood the surrounding areas. The overflowed water floods the adjacent swamp areas on both sides of the river, resulting in a large extent of naturally formed open swamps extending almost

throughout the course of the river. This results in the creation of a dynamic shallow water ecosystem, providing a crucial habitat for organisms relying on wetlands (Figure 2). In contrast, the conditions prevailing in the dry season are entirely different (usually June-August), where the Bakung River exists as a narrow and shallow river channel.



Figure 2. Open swamp habitat in the Bakung River, Sukamara Regency, Central Kalimantan.

Land cover in the surrounding the river is very open, composed mostly of grass and shrub lands. Forests coverage along Bakung River is very scarce and found only at its estuary, which also serves as the boundary of the Jelai River. The very open land cover along most of the Bakung River is a result of repeated forest and land fires in the past, causing the substrate to lose its capacity to regenerate vegetation. The grass and fern cover grows very densely and dominantly, leaving no space for other vegetation, such as trees, to grow.

Trees growth is extremely rare in the Bakung River, dominated only by Pulai trees (*Alstonia spatulata*), while several other tree species such as Perepat (*Combretocarpus rotundatus*) and Terentang (*Camptosperma coriaceum*) grow very rarely. The shrubs are dominated by grasses (Poaceae), Rumput Teki (Cyperaceae), and Fern (*Stenochlaena palustris*). During the rainy season when the swamp areas get flooded, aquatic plants grow abundantly on the bottom and surface of the water, including Lotus (*Nymphaea* sp.), Bunga Air (*Urticularia gibba*), and Bakung (*Hanguana anthelminthica*).

List of Waterbird Species Discovered

Observations of the open swamp habitat of the Bakung River in Sukamara Regency revealed 28 waterbird species belonging to 10 families. Ardeidae is the family with the most recorded species, with 9 species. Rallidae follows with 5 species, followed by Laridae and Scolopacidae with 3 species each (Table 1). During the rainy season, the Bakung River overflows and floods areas along its course, forming a vast seasonal swamp. This temporary swamp landscape provides a highly supportive habitat for various waterbird species, including migratory birds, foraging and shelter. Of the 28 waterbird species observed in the Bakung River swamp, 17 are migratory that listed in the table 1, one such species is the Oriental Pratincole (*Glareola maldivarum*), a migratory waterbird observed in large groups in the Bakung River (Figure 3). This vast, open, shallow swamps, with its abundance of fish throughout, while the surrounding bushes and forests provide shelter and nesting areas, is thought to be the reason why many species of water birds visit Sungai Bakung during certain seasons. Waterbirds often utilize diverse wetland locations, such as estuarine, palustrine, and lacustrine wetlands, in a balanced and complementary manner. When the quality of one habitat declines, birds may migrate to another nearby habitat to meet their needs for food, rest, and shelter. This dynamic demonstrates the importance of managing and protecting

wetland networks at a broader landscape scale to maintain habitat connectivity, maintain migration routes, and support sustainable species diversity [17-18].

Table 1. List of waterbirds observed in the Bakung River

Family	Scientific Name	English Name	Indonesian Name	Migration		Conservation Status	
				(Y/N)	(Y/N)	IUCN	P.106/2018
Anatidae	<i>Anas gibberifrons</i>	Grey Teal	Itik Benjut	No		LC	-
	<i>Dendrocygna arcuata</i>	Wandering Whistling Duck	Belibis Kembang	No		LC	-
Ardeidae	<i>Ardea alba</i>	American Egret	Cangak Besar	Yes		LC	ü
	<i>Ardea purpurea</i>	Purple Heron	Cangak Merah	No		LC	-
	<i>Ardeola speciosa</i>	Javan Pond Heron	Blekok Sawah	Yes		LC	-
	<i>Bubulcus coromandus</i>	Eastern Cattle Egret	Kuntul Kerbau	Yes		LC	-
	<i>Egretta eulophotes</i>	Chinese Egret	Kuntul Cina	Yes		VU	ü
	<i>Egretta garzetta</i>	Chota bok	Kuntul Kecil	Yes		LC	-
	<i>Ixobrychus cinnamomeus</i>	Cinnamon Bittern	Bambangan Merah	Yes		LC	-
	<i>Ixobrychus flavicollis</i>	Black Bittern	Bambangan Hitam	No		LC	ü
	<i>Ixobrychus sinensis</i>	Chinese little bittern	Bambangan Kuning	Yes		LC	-
Charadriidae	<i>Charadrius dubius</i>	Little Plover	Cerek Kalung Kecil	Yes		LC	-
Ciconiidae	<i>Leptoptilos javanicus</i>	Lesser Adjutant	Bangau Tong-tong	No		NT	ü
Glareolidae	<i>Glareola maldivarum</i>	Oriental Pratincole	Terik Asia	Yes		LC	ü
Jacaniidae	<i>Hydrophasianus chirurgus</i>	Pheasant-tailed Jacana	Sepatu Teratai	Yes		LC	-
Laridae	<i>Chlidonias hybrida</i>	Whiskered Tern	Dara laut kumis	Yes		LC	ü
	<i>Sterna hirsundo</i>	Booby	Dara Laut Biasa	Yes		LC	ü
	<i>Sternula albifrons</i>	Little Tern	Dara Laut kecil	Yes		LC	ü
Phalacrocoracidae	<i>Anhinga melanogaster</i>	African Darter	Pecuk Ular Asia	No		LC	ü
	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant	Pecuk Padi hitam	No		LC	-
Rallidae	<i>Amaurornis phoenicurus</i>	White-breasted Waterhen	Kareo Padi	No		LC	-
	<i>Gallinula chloropus</i>	Common Gallinule	Mandar Batu	No		LC	-
	<i>Porphyrio porphyrio</i>	Kalim	Mandar Besar	No		LC	-
	<i>Poliolimnas cinereus</i>	White-browed Crake	Tikusan Alis Putih	No		LC	-
	<i>Zapornia fusca</i>	Ruddy-breasted Crake	Tikusan Merah	Yes		LC	-
Scolopacidae	<i>Actitis hypoleucos</i>	Common Sandpiper	Trinil Pantai	Yes		LC	-
	<i>Gallinago megala</i>	Swinhoe's Snipe	Berkik Rawa	Yes		LC	-
	<i>Tringa glareola</i>	Wood Sandpiper	Trinil Semak	Yes		LC	-

Note: VU: Vulnerable; NT: Near Threatened; ü: Protected under Indonesian law.



Figure 3. A group of *Glareola maldivarum*, one of the migratory waterbird species found at the study site.

Conservation Status

Based on their conservation status, 9 species among the observed results are threatened and protected species (Table 1). There are two waterbird species that are classified as threatened according to the IUCN Red List, namely the Chinese Egret (*Egretta eulophotes*) with a vulnerable status and the Javan Stork (*Leptoptilos javanicus*) with a near threatened status. Then nine species are protected species through the Indonesia Minister of Environment and Forestry Regulation No. P.106/MENLHK/SETJEN/KUM.1/12/2018. These findings indicate that the Bakung River area has high conservation value, not only as a habitat for waterbirds in general, but also as an important refugia for species with specific protected and threatened status. The presence of vulnerable and near-threatened species indicates that the swamp ecosystem in this area is still able to provide important resources such as food, resting places, and breeding sites. Furthermore, the presence of several nationally protected species emphasizes the urgency of stricter and more sustainable habitat management. This condition also strengthens the argument that disturbances to hydrology and other anthropogenic pressures have the potential to directly impact the survival of these key species. Therefore, landscape-based conservation efforts that maintain the ecological function of seasonal flooded swamps are crucial to ensure the sustainability of waterbird communities in the peat swamp wetland landscape of the Bakung River.

Disturbances and Threats

Waterbirds are a fauna group that is highly dependent on wetland ecosystems such as swamps, lakes, rivers, and coastal areas, making them highly vulnerable to environmental change. Several threats to habitat and waterbirds have occurred at the Bakung River study site, including land fires, hydrological changes due to man-made canals, and destructive fishing activities. Other threats, such as land conversion and wildlife hunting, were not identified, but could pose significant threats if the area is not managed properly.

Wetlands located in peatland landscapes are more frequently at risk of forest and land fires, especially during the dry season, as is the case at the Bakung River site. Peatland fires can lower the pH level of water to become more acidic in rivers and surrounding swamps, which can negatively impact fish populations as a primary food source for waterbirds and disrupt their food chains [19]. Fires can also cause biodiversity erosion and changes in species composition, where wetland specialist species are often replaced by generalist or open country species [20-10].

Another threat to the survival of waterbirds is the construction of canals in wetland ecosystems, especially those with peatlands. Canal system was built a long time ago and connects the Bakung River to two other major rivers in the landscape, namely the Naning River in the west and the Jelai River on the east side. The construction of the canal causes drastic changes in the area's hydrology by altering the natural water regime, increasing drainage, and lowering groundwater levels. As an overall outcome, in the future,

the entire process may lead to the loss of seasonally flooded wetlands, which are essential for various waterbird species [21].

The destructive fishing practices like poisoning and electrocuting fish are quite common in the Bakung River ecosystem, as per fishermen living in the area. It poses a great danger not only to the traditional fishermen in the Bakung River but also the birdlife of many species dependent on the same ecosystem. From an ecological perspective, such practices lead to deaths of fishes and aquatic animals which are the main prey for water birds, thus impacting energy flow within the food chain. In the long run, the cumulative effects will reduce habitat carrying capacity and alter their feeding habits, leading to dwindling bird populations in the peat swamp ecosystem of the Bakung River.

Habitat loss is a major threat to the survival of this group, largely due to the conversion of wetlands into agricultural, plantation, and large-scale fishery production areas [21]. Despite their high ecological value, peatlands are often undervalued in the process of direct economic development for local communities and local governments, thus continuing to face pressure from unsustainable land expansion and conversion [22]. In this case, however, such threats were not identified due to the site management's great emphasis on landscape protection, ecosystem restoration, and biodiversity monitoring along with the development of business models based on nature-based solutions. This commitment is mandatory by the Indonesian government to the private forestry concessions through the Forest Utilization Business Permit for Environmental Services (PBPH Jasa Lingkungan), which requires them to implement sustainable forest management principles.

Direct hunting of waterbirds in the study area has not been observed or reported so far but remains a serious potential threat (Figure 4). Anthropogenic activities such as hunting for commercial purposes and overconsumption have serious impacts on waterbird populations and the stability of their ecosystems. Uncontrolled hunting can cause rapid population declines, especially in species with low reproductive rates or those that migrate and gather in large numbers, thus causing a bird diversity crisis [23].

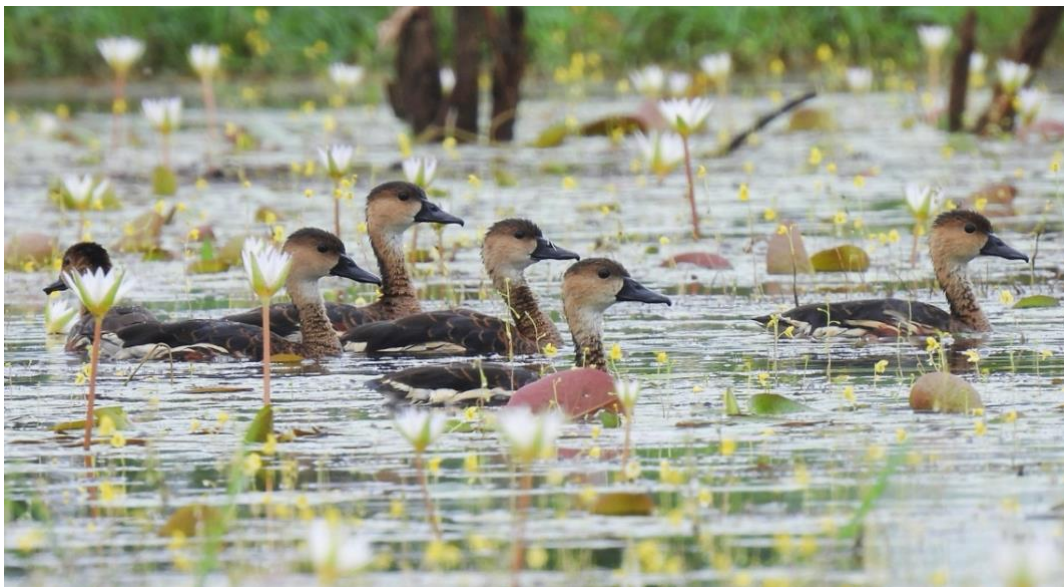


Figure 4. A group of *Dendrocygna arcuata* in the study site, a species of waterbird that is often hunted for consumption.

Ecosystem Services Framework and Opportunities for Sustainable Conservation Financing

The presence of waterbirds in the Bakung River wetlands, Sukamara Regency is not merely an indicator of ecological health but also a significant economic asset through the provision of various ecosystem services. Functionally, waterbirds play a vital role in natural pest control, seed dispersal, and nutrient cycling, supporting wetland biological productivity [24]. The economic valuation of these services can be analyzed using the *Total Economic Valuation* (TEV) framework, which includes the value of direct uses such as birdwatching ecotourism, which is now a global special interest tourism trend [25]. In tropical regions, the potential revenue from this tourism has been shown to provide financial incentives for local communities while also funding the operational costs of protecting threatened species [26].

In the context of area management, this important biodiversity opens opportunities for innovative financing schemes through *Payment for Ecosystem Services* (PES). Through the PES model, stakeholders

who benefit from peatland conservation can provide financial compensation to support waterbird habitat conservation efforts [27]. This integration creates a synergy where biodiversity protection is no longer viewed as a cost, but rather as an investment that produces sustainable environmental services [28]. Furthermore, Indonesia's Multi-forestry business (Multi Usaha Kehutanan/MUK) policy provides legality for concession holders to optimize revenue from these environmental services in an integrated manner [29].

Furthermore, current global trends indicate a shift towards biodiversity investment through the Biodiversity Credits mechanism. Unlike carbon credits that focus on emissions, biodiversity credits enable companies to invest directly in species population recovery and habitat integrity in Sukamara [30]. Protecting waterbird habitat can serve as a co-benefit, increasing the market value of carbon credits in the voluntary market, while also attracting capital from Environmental, Social, and Governance (ESG)-based investors seeking measurable conservation impacts [31]. By using waterbird checklist data as a success metric (KPI), this area has the potential to become a model for innovative financing that bridges the conservation finance gap [32].

Conclusions

This study achieved its objectives by documenting waterbird diversity, identifying major threats, and outlining management opportunities within the Bakung River wetlands landscape of Sukamara Regency, Central Kalimantan. The results demonstrate that the area supports considerable conservation value, with 28 recorded waterbird species representing 10 families, including 17 migratory species and several taxa protected or threatened at national and international levels. These findings confirm that the seasonal wetland mosaic formed by the hydrological dynamics of the Bakung River functions as an important feeding, resting, and refuge habitat for waterbird communities.

On the other hand, this study reveals that the ecological integrity of this system is increasingly vulnerable to anthropogenic pressures, particularly recurrent peat fires, hydrological disruption caused by canalisation, and destructive fishing practices. If left unmanaged, these disturbances may reduce habitat quality, alter food-web dynamics, and weaken the capacity of the landscape to sustain both resident and migratory bird populations.

The findings further indicate that conservation and local development objectives need not be mutually exclusive. Landscape-based management that integrates wetland connectivity protection, peatland and hydrological restoration, and regulation of unsustainable resource use can strengthen biodiversity outcomes while maintaining ecosystem services for surrounding communities. In addition, innovative financing mechanisms such as ecotourism and other schemes related to environmental services offer promising pathways to support long-term conservation investment. Overall, the Bakung River landscape represents a strategic priority for wetland conservation in Borneo. Continued ecological monitoring, stronger multi-stakeholder collaboration, and the integration of science-based management with sustainable financing will be essential to secure the long-term persistence of its waterbird diversity and broader peat swamp ecosystem functions.

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