

Biomonitoring of Population and Reproductive Success of the Javan Barn Owl (*Tyto alba*) as An Indicator of Habitat Quality in the Cancangan Hamlet Conservation Area, Sleman Regency, Yogyakarta Special Region, Indonesia.

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Article Info	ABSTRACT
Article history: Received 09-06-2026 Revised 29-07-2026 Accepted 28-09-2026	The Javan Barn Owl (<i>Tyto alba</i>) is a natural predator of rice field rats, playing a crucial role in maintaining the balance of agricultural ecosystems and supporting biological pest control. In addition to its role in controlling the rice field rat population, the presence and reproductive success of this species can be used as an indicator of habitat quality, as it is strongly influenced by food availability, environmental conditions, and the level of disturbance in an area. This study aimed to assess the population development and reproductive success of <i>Tyto alba</i> as an indicator of habitat quality in the Cancangan Hamlet conservation area, Sleman, Yogyakarta Special Region. The study was conducted using field observation, interviews with conservation managers, and documentation. Analysis was conducted by comparing population and reproductive data from 2026 with data from 2016 to examine changes that occurred over the decade. The results showed an increase in the <i>Tyto alba</i> population, followed by a high rate of reproductive success. These conditions indicate that the rice field habitat in Cancangan Hamlet is still able to support the survival of this species through the availability of adequate food sources, low rodenticide use, and the availability of suitable nesting sites. These findings indicate that <i>Tyto alba</i> has the potential to be used as a biomonitor of habitat quality as well as an effective biological control agent in supporting sustainable and environmentally friendly agricultural management.
Keywords: <i>Biomonitoring</i> <i>Tyto alba</i> <i>Reproductive success</i> <i>Habitat quality</i> <i>Bioindicators</i>	
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1. INTRODUCTION

Rice paddy ecosystems are agroecosystems that not only function as food producers but also serve as habitats for various types of flora and fauna that play a role in maintaining ecological balance. Interactions between organisms in rice paddy ecosystems contribute to environmental stability, nutrient cycling, and natural pest control. The sustainability of agricultural systems is determined not only by crop productivity but also by maintaining the biotic balance that supports ecosystem function (Husaeri, 2024). Biomonitoring of biodiversity is one approach to assessing environmental conditions and ecosystem health and can therefore be used as an indicator of habitat quality and sustainable environmental management (Amrillah *et al.*, 2023).

One of the main problems faced in rice field ecosystems is the attack of rice field rats (*Rattus argentiventer*). Rice field rats attack rice plants by eating rice stalks and grains, causing crop failure and significant losses in rice production with an average damage of 161,000 hectares annually in Indonesia (Sudarto *et al.*, 2026). The high level of damage caused is inseparable from the very high reproductive ability of rats (Verawati *et al.*, 2025). Control of rat populations is generally carried out using chemical methods (fogging and rodenticides). However, these methods have a negative impact on the environment and non-target organisms, and cause secondary poisoning in predators through the food chain (Sumini *et al.*, 2025). Therefore, the use of Javan husk (*Tyto alba*) as a biological control is a more environmentally friendly alternative because it can reduce rat pest populations naturally without causing significant negative impacts on the ecosystem (Verawati *et al.*, 2025; Leshem, 2023).

Reproductive success is one parameter that can be used to assess habitat quality for a species because it is directly related to an individual's ability to survive and produce offspring (Yamin *et al.*, 2025). Habitats with sufficient food availability, safe nesting sites, and low levels of disturbance are generally able to support a higher reproductive frequency and increase the chances of successful chick development (Agusnur, 2025). In birds of prey such as *Tyto alba*, reproductive success is strongly influenced by the availability of food sources because the energy requirements during egg formation, incubation, and chick care are relatively high. Conversely, a decline in habitat quality can lead to reduced food availability and increased environmental disturbance, which ultimately impacts the frequency of reproduction, the number of eggs produced, and the success of chick survival (Nur, 2023).

One area that implements the use of Javan Barn Owl (*Tyto alba*) as part of sustainable agricultural management is Cancangan Hamlet, Wukirsari, Cangkringan, Sleman, Yogyakarta Special Region. In other regions, biological monitoring of agricultural landscapes commonly employs various indicators, including raptors, farmland birds, arthropods, soil organisms, and pesticide residues. Therefore, the same bioindicator is not always used; although *T. alba* can serve as a sentinel of prey availability and contaminant exposure, bioindicator selection generally depends on local biodiversity, environmental pressures, and monitoring objectives. Since around 2013, the local community has begun developing conservation and utilization efforts for *Tyto alba* in response to the high number of rat pests in rice fields. These efforts then developed into conservation, education, and research activities centered at the Javan Barn Owl (*Tyto alba*) Study and Conservation Center managed by Mr. Lim Wen Sin with the slogan "Owls are Farmers' Friends". Based on the results of biodiversity biomonitoring activities at the Javan Barn Owl (*Tyto alba*) Study and Conservation Center, this study aims to examine the development of the *Tyto alba* population and its role in the health of agricultural ecosystems while supporting conservation efforts and sustainable agricultural management.

2. RESEARCH METHOD

2.1. Study Site & Duration

The biomonitoring activities were conducted at the Javan Barn Owl (*Tyto alba javanica*) Study and Conservation Center, located in Cancangan, Wukirsari Village, Cangkringan District, Sleman Regency, Special Region of Yogyakarta, Indonesia. Observations were carried out from March to April 2026 through several field visits.

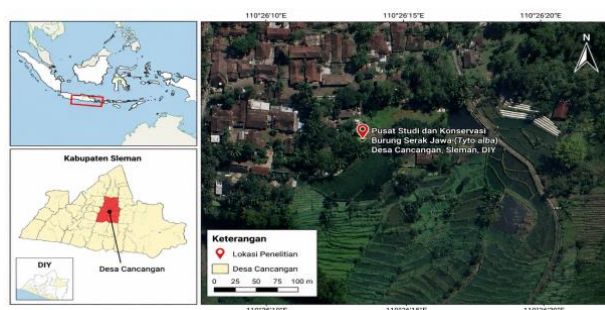


Figure 1. Research location at the Javan Barn Owl (*Tyto alba*) Study and Conservation Center, Cancangan Hamlet, Sleman Regency, Special Region of Yogyakarta, Indonesia

2.2. Data Collection Method

The data collection method was carried out using direct observation in the area of the Javan Barn Owl (*Tyto alba*) Study and Conservation Center. Observations were conducted 12 times over a six-week study period, with two observation sessions per week. Each session lasted approximately two hours and was conducted during the early evening, when *T. alba* was expected to be most active. Observations were made on the condition of the rice field habitat, the population and activity of *Tyto alba*, the condition of the pagupon (nest box), rehabilitation and release activities, and the use of *Tyto alba* as a bioindicator of the quality of the rice field ecosystem. Interviews were conducted with the manager and to obtain information on *Tyto alba* population management, conservation programs, and the role of owls in the agricultural environment. Supporting data were obtained through field documentation in the form of photographs and observation notes. The 2026 data were then compared with previous monitoring data reported by Harjanto (2016) to observe population development and the use of rubuha as an artificial habitat for *Tyto alba*.

2.3 Data Analysis

Data were analyzed descriptively and qualitatively by interpreting the results of observations and interviews to describe the condition of biodiversity, the ecological role of *Tyto alba* as an indicator of rice field ecosystems, and conservation efforts undertaken in the study area. The data were analyzed descriptively and qualitatively by interpreting the results of observations and interviews. The analysis results are presented in narrative form supported by field documentation to describe the habitat conditions, the ecological role of *Tyto alba*, and conservation efforts at the study site.

3. RESULTS AND DISCUSSION

The presence of apex predators is used as an indicator of environmental conditions because their survival is strongly influenced by habitat availability, adequate food sources, and low levels of environmental disturbance. In rice paddy ecosystems, the Javan Barn Owl (*Tyto alba*) serves as a natural predator of rice-field rats and may contribute to regulating their populations. Therefore, its presence may indicate the ecological functioning and balance of the rice paddy ecosystem without necessarily implying an empirically assessed apex trophic position. (Marantika *et al.*, 2025). Based on field observations and interviews, the rice paddy area of Cancangan Hamlet has committed to implementing an environmentally friendly, sustainable agricultural system. Local farmers have cut their dependence on agrochemicals and prioritize natural soil fertility and the use of natural enemies in pest control. The absence of rodenticide residues in this area is a factor supporting the sustainability of the *Tyto alba* population as a natural predator.

In conventional farming systems, rice field rats that consume poisoned bait (such as anticoagulant rodenticides) do not die immediately, but rather weaken and become easy prey for *Tyto alba* (Satriya, 2023). The accumulation of these toxic substances in the *Tyto alba*'s body through the food chain results in a phenomenon called bioaccumulation. The accumulation of toxic compounds in the prey's body can transfer to the predator's body and potentially disrupt the health, reproduction, and even survival of the owl (Mahluddin *et al.*, 2022). Furthermore, the reduction in natural predator populations due to rodenticide exposure can disrupt the balance of the food chain and reduce the effectiveness of biological control in rice field ecosystems. This condition has the potential to cause a resurgence in the rat population, making farmers increasingly dependent on the use of chemicals for control (Jamin *et al.*, 2024).

Farmers have employed various conventional control measures, but the high reproductive capacity of rats makes their populations difficult to suppress in the long term. The Cancangan Hamlet community then began developing the use of Javan barn owls (*Tyto alba*) as natural predators of rice field rats by building owl houses (rubuha) and conserving their habitat. *Tyto alba* are nocturnal, meaning they are active at night to find food. They are active from sunset and return to their nests before dawn (Ardigurnita *et al.*, 2020). Their hunting abilities, supported by acute hearing and keen eyesight, enable *Tyto alba* to locate and capture rats.. The use of *Tyto alba* as a biological control agent is also considered more environmentally friendly than the use of chemical rodenticides (Kurnawan *et al.*, 2024). Several recent studies have reported that excessive use of rodenticides can have negative impacts such as secondary poisoning in non-target animals, reduced biodiversity, and accumulation of residues in the environment. On the other hand, the presence of *Tyto alba* allows rat population control to take place naturally without producing environmental pollution (Satriya, 2023).



Figure 2. *Tyto alba* barn owl
(Source: Personal document)

CLASSIFICATION

Kingdom : Animalia
 Phylum : Chordata
 Class : Aves
 Order : Strigiformes
 Family : Tytonidae
 Genus : *Tyto*
 Species : *Tyto alba*
 (GBIF, 2026)

The Javan Barn Owl, or *Tyto alba*, is a nocturnal bird of prey characterized by its heart-shaped face and white color with brown edges. It has forward-facing eyes, black irises, a sharp, downward-facing beak, and yellowish-white to brownish legs (MacKinnon in Majid *et al.*, 2020). The Javan Barn Owl is a type of bird of prey that plays a role in the sustainability of an ecosystem because it holds the throne as a top predator in the food chain (Majid *et al.*, 2020). The *Tyto alba* bird has high hunting abilities because it can prey on 2-5 mice per day (Setiawan in Nawawi, 2021). In addition to functioning as a biological control, the presence of *Tyto alba* also reflects supportive environmental conditions because its survival is greatly influenced by habitat quality and prey availability (Marantika *et al.*, 2025).

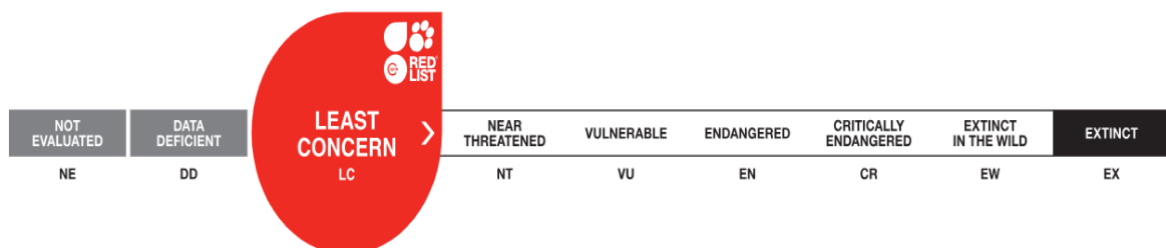


Figure 3. IUCN Status of *Tyto alba*

According to IUCN data (2025), *Tyto alba* is categorized as Least Concern (LC), indicating that the species still has a relatively stable global population. Therefore, various pressures such as land-use changes, loss of nesting habitat, and excessive pesticide use can still impact local populations. Therefore, the population increase and reproductive success of *Tyto alba* in Cancangan Hamlet indicate that habitat conditions in the area are still able to support the survival of this species and contribute to local conservation efforts.

Based on the results of field observations conducted at the Javan Barn Owl Study and Conservation Center, Cancangan Hamlet, Sleman Regency, observations have been made by identifying nest activity through the presence of individuals, reproductive activity, and signs of the use of owl houses as nesting sites with the following data:

Table 1. Results of observations of owl houses and reproductive success of *Tyto alba*

Data Analysis Parameters	2016 (Harjanto, 2016)	2026
Number of nestlings (units)	10	17
Number of active nestlings (units)	3	11
Number of active pairs	3	11
Number of offspring	6	37
Average number of eggs per nest	-	3-10
Average number of offspring hatched per nest	-	6
Average number of offspring successfully fledged per nest	-	4

Based on a comparison of 2016 data (Harjanto, 2016) with 2026, it shows that the population and reproductive success of *Tyto alba* in Cancangan Hamlet experienced a significant increase. The number of rubuha increased by 70%, namely from 10 units to 17 units, in addition to the number of active rubuha also increased by 266%, from only 3 active nest units to 11 active nest units. This indicates that the more rubuha available and used as nesting sites, meaning that the artificial habitat provided is more effective in supporting the *Tyto alba* population (Pramudi *et al.*, 2023). This condition indicates that the rice field habitat in Cancangan Hamlet is able to support the presence of *Tyto alba* and indicates an increase in the success of the conservation program and the use of owls as biological control agents for rat pests. Of the total available Rubuha, the majority show signs of active habitation, both used as resting places (roosting sites) and as active reproductive nests (nesting sites) (Luthfiyah *et al.*, 2025). *Tyto alba* is territorial and tends to be monoecious, where sexually mature adults will separate from their parents to find a mate and occupy a new nest space (Sudarmaji *et al.*, 2021). Architecturally, the standard specifications for the inner chamber used as a *Tyto alba* nest in Cancangan have dimensions of 12 x 12 cm (width x length) with vertical slits for entry and exit that function as safety doors from large predators while maintaining darkness and sufficient space for the mother and her young (Astuti *et al.*, 2021).



Figure 4. Rubuha *Tyto alba*
(Source: Personal document)

Abiotic environmental factors in the field, such as strong winds, often pose structural challenges that damage the enclosure's physical condition, such as the release of door components due to wind pressure. Managers undertake corrective action in the form of periodic structural repairs. Some minor repairs are often only temporary, as the old wooden structure easily rots again due to weathering. Therefore, a complete replacement is required with a new enclosure made of much sturdier and stronger materials

(Bontzorlos *et al.*, 2024). Through monitoring by sensor cameras inside the enclosure, *Tyto alba* is known to produce between 3 and 10 eggs per cycle. Initial observations showed that the group only laid 4 pure white eggs, which will gradually increase. This egg incubation process takes approximately 30 to 34 days, supported by an optimal internal nest microclimate temperature of 36-38°C. After hatching, the male and female parents will carry out intensive parental cooperation for approximately 75 days to care for and protect the chicks, until they grow complete flight feathers and are ready to carry out the dispersal process from the nest (Astuti *et al.*, 2021).



Figure 5. *Tyto alba* eggs
(Source: Personal document)

In addition, the number of reproductive pairs also increased fourfold from 3 pairs to 11 pairs, which was also followed by an increase in the number of offspring from 6 to 37. This indicates that the reproductive productivity of *Tyto alba* in Cancangan Hamlet has increased over a 10-year period. Observational data shows that the average egg in each nest is 3-10 eggs, with an average of 6 offspring hatching per pair, and an average of 4 offspring successfully flying per pair. Residential characteristics indicate that 1 pair of established adults will settle in one pagupon unit that is ready or has entered the reproductive cycle. Spatial mapping of nests shows that the distance between pagupons occupied by Javan Barbet pairs is regulated periodically, ranging from 50 to 100 meters. This distance mapping serves to minimize territorial friction between hunting pairs, while maximizing the coverage radius of the hunting area (*hunting range*) in detecting rice field rat populations (Luthfiyah *et al.*, 2025).

The Javan Barn Owls (*Tyto alba*) housed in the intensive care facility generally originate from reports and direct submissions by local residents. These individuals are rescued after being found in abnormal clinical conditions, such as suffering from diseases, sustaining physical injuries caused by environmental disturbances, or being nestlings that have fallen from their primary nests. Residents voluntarily hand over the animals to the conservation center management for rehabilitation and recovery. Once the birds are assessed as physically recovered, exhibit normal hunting reflexes, and are considered capable of surviving independently in the wild, they are released back into their natural habitat within the Cancangan rice-field ecosystem (Wardah *et al.*, 2023). Rats used as feed during captive maintenance are obtained directly through trapping and hunting activities conducted by the management staff. Before being provided to the owls, the rats undergo a sanitation process that includes washing, cutting, and removal of internal organs due to the presence of potentially harmful endoparasites, such as tapeworms. The removal of internal organs minimizes the risk of parasite transmission to *Tyto alba* and helps maintain the birds' internal health status (Kurnawan *et al.*, 2024). On the floor of the enclosures and around the *pagupon* (owl nesting structures), pellets were frequently observed in the form of regurgitated masses of undigested food remains. Pellet analysis confirmed the presence of indigestible materials consumed by *Tyto alba*, including hair, bone fragments, and hard body parts of rice-field rats. These findings are consistent with the species' feeding ecology, in which non-digestible prey components are compacted and expelled as pellets after digestion (Primananda *et al.*, 2024).

Based on the description above, over a 10-year period, there has been an increase in successful Javan Barn Owl conservation in Cancangan Hamlet. This success can also be an indication of habitat quality capable of supporting the reproductive process until the chicks are ready to fly, abundant food availability, and low environmental disturbances affecting the survival of Javan Barn Owl. The high number of chicks that successfully reach the flight phase indicates that the environmental conditions around the nest are relatively safe and support the chicks' growth during the developmental period (Marantika *et al.*, 2025). Furthermore, the increasing population and reproductive success of Javan Barn Owl can be used as a

biological indicator (biomonitor) of the environmental conditions of rice fields. As a top-level predator in the food chain, *Tyto alba* is highly sensitive to changes in habitat quality, declines in prey populations, and excessive use of agricultural chemicals (Ardigurnita *et al.*, 2020). Reproductive success is an important parameter in biomonitoring, as it reflects the habitat's ability to provide food, shelter, and environmental conditions that are safe from disturbance. The high number of active pairs, hatched chicks, and fledglings indicates that the habitat in the area is capable of supporting the survival of *Tyto alba* (Berliani *et al.*, 2021).

The successful reproduction of the Javan croaker in Cancangan Hamlet demonstrates that the agricultural ecosystem in the hamlet is highly conducive to the survival of the Javan croaker, with abundant food availability and low levels of disturbances such as pesticide use. This is also supported by the fact gathered during interviews that most farmers in Cancangan Hamlet do not use pesticides or rodenticides in their rice fields. As noted by Bontzorlos *et al.* (2024), areas with intensive agriculture and high rodenticide use exhibit lower nest box occupancy rates and reproductive success than areas implementing sustainable agricultural practices. Primananda *et al.* (2024) also noted that utilizing *Tyto alba* as a rat population control tool can minimize rodenticide use.

4. CONCLUSION

Biomonitoring results in Cancangan Hamlet showed a has increased in the population and reproductive success of the Javan Barn Owl (*Tyto alba*) compared to 2016, as indicated by the increase in the number of active nests, reproductive pairs, and the number of chicks that successfully hatched and reached the flight stage. These conditions indicate that the rice field habitat in the research area remains of good quality, supported by adequate food availability, the presence of effective artificial nests, and low use of rodenticides and pesticides. High reproductive success indicates that *Tyto alba* can be used as a biomonitor of habitat quality because it is sensitive to environmental changes and resource availability. In addition, the presence of *Tyto alba* plays an important role as a biological control of rice field mice, thus supporting the creation of a more environmentally friendly and sustainable agricultural system.

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