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Vegetation Structure and Potential Key Species for Bali Myna (*Leucopsar rothschildi*) Introduction in Tengkudak Village, Bali, Indonesia

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Abstract

Species introduction is a key conservation strategy for the Bali myna (Leucopsar rothschildi)*, a high-priority species in Indonesia. Successful introduction requires thorough habitat assessment. This study analyzed vegetation structure and identified potential key species in Tengkudak Village, Tabanan Regency, Bali–one of the designated introduction sites. A plot-based sampling method was used in 10 sampling areas, with 20 plots* (*20 m × 20 m*) *for tree and sapling analysis and 100 plots* (*2 m × 2 m*) *for ground vegetation assessment. Vegetation parameters such as density, frequency, dominance, and importance value index were analyzed, along with community indices, including Shannon-Wiener diversity, Simpson's dominance, and Pielou's evenness. The upperstorey was dominated by plantation species and riparian vegetation, while the understorey consisted mainly of agricultural weeds, grasses, and ferns. The community index analysis indicated high species diversity and a stable community structure. Most plant species provide essential resources for the Bali myna, including food, shelter, perching, and nesting sites. Fifteen species were identified as potential plant keys, including* Baccaurea racemosa, Bischofia javanica, Carica papaya, Cocos nucifera, Dysoxyllum densiflorum, Elaeocarpus sphaericus, Ficus *spp.*, Lansium domesticum, Magnolia champaca, Persea americana, Sandoricum koetjape, *and* Theobroma cacao.

Keywords:*habitat assessment, species introduction, endemic species, vegetation analysis*

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Introduction

The Bali myna (*Leucopsar rothschildi*) is an endemic species and the official fauna mascot of Bali Province. Its natural distribution is limited to the Bali Barat National Park (BBNP) and classified as Critically Endangered (CR) based on IUCN red list of the threathened species (BirdLife International, 2021). In 2012, the Bali myna population in BBNP had dwindled to just four individuals (Sudaryanto et al., 2020), making its conservation to be a national priority. Conservation efforts have been actively undertaken with the involvement of various stakeholders, including government agencies, local communities, and non-governmental organizations (NGOs). One key NGO contributing to these efforts is the Friends of Nature, People, and Forests (FNPF, priorly known as Friends of National Park Foundation), which successfully introduced the Bali myna to Nusa Penida in 2005 (Riany & Aunurohim, 2013; Hardini et al., 2023). Two factors supporting this success are the habitat suitability of Nusa Penida which closely resembles BBNP (Sutomo et al., 2023), and the protection provided by local communities through traditional regulations known as *awig-awig* (Sudaryanto et al., 2020). Involving local communities in conservation has proven to be more effective and efficient in suppressing poaching, which is the main threat to animals conservation in Indonesia. This threat will be even higher if the species is an endemic with a restricted distribution, such as the Bali myna (Eaton et al., 2015; Jepson, 2016; Hernowo & Haquesta, 2021).

The habitat of the Bali myna consists of various biotic and abiotic components. Plant communities, or vegetation, represent a fundamental biotic component that supports ecosystem functions within the bird's habitat (Bersier & Meyer, 1994; Basile et al., 2021; Yuni et al., 2022). The increase in vegetation structure has been proved to increase the bird species richness, dispersion, and evenness, which indirectly create a habitat resilience when facing ecological disturbances (Melo et al., 2020; Santillán et al., 2020). Besides serving as primary producers in energy transfer processes, vegetation provides foraging grounds, shelter, breeding sites, and more. Given that the Bali myna primarily feeds on insects and fruits, this species is highly dependent on the vegetation (Sudaryanto et al., 2020), especially to support a diverse range of insect species that serve as a food source for the Bali myna.

The Bali myna also utilizes cavities created by woodpeckers as nesting sites, making the presence of trees used by woodpeckers for foraging an essential component. In the energy flow of the ecosystem, the Bali myna occupies a midlevel position, making it susceptible to predation by birds of prey, civets, monkeys, snakes, monitor lizards, and even geckos (Hernowo & Haquesta, 2021; Hardini et al., 2023). In this regard, vegetation structure can provide crucial protection, especially dense canopy arrangements that hinder aerial predator attacks. Other threats include unpredictable weather conditions, particularly heavy rainfall and drastic temperature fluctuations (Hardini et al., 2023). Such environmental changes can be mitigated by well-structured vegetation that also indirectly provides vertical guild niche partitioning to many species to coexist (Naikatini et al., 2022; Wang et al., 2023).

Considering these factors, vegetation structure plays a vital role in the survival of the Bali myna. FNPF has already introduced the bird to Penebel District, Tabanan. Besikalung Village was chosen as the first introduction site in Tabanan, and then Tengkudak Village, which was recently conducted in May 2024. In conservation efforts involving species introduction, vegetation assessment is crucial for ensuring success. This is because the bird community does not respond to the presence of just one species but rather responds to the overall vegetation structure in its habitat, so that landscape formation plays an important role in forming the structure of the bird community (Bersier & Meyer, 1994; Basile et al., 2021; Cabral et al., 2021; Xu et al., 2022).

The successful introduction in Nusa Penida was attributed to habitat similarities with the bird's natural environment in BBNP. Hernowo and Haquesta (2021) reported that released Bali mynas in BBNP have preferences to occupy monsoon forest, savanna, mangrove, and coastal forests. However, the ecosystem in Tengkudak Village is a humid evergreen forest with lower temperature. The difference in ecosystem will affect the biotic (vegetation stucture) and abiotic (temperature, precipitation, etc.) factors which impacting in a different bird community structure, especially for frugivores and insectivores (Santillán et al., 2020; Tu et al., 2020). The shifting is expected to drive adaptive responses in the Bali myna, influencing aspects such as thermoregulation, behavior, and food sources. Therefore, a comprehensive study of vegetation structure in Tengkudak Village is necessary to provide foundational data for the Bali myna introduction plan. To ensure the population sustainability, identifying key plant species that contribute to the bird's survival will further support conservation efforts. So, this research aimed to analyze the vegetation structure and determine the potential key species in the Bali myna introduction.

Methods

Research site The research was conducted from March to May 2024 in Tingkih Kerep Traditional Village, which is part of Tengkudak Village, Penebel District, Tabanan Regency, Bali, Indonesia. The village has a unique landscape which composed of a settlement with several riparian forest areas surrounded by rice fields as the boundaries of the village. Most of the people are farmers with several by-products in the form of local fruit commodities such as *duku* (*Lansium domesticum*), *rambutan* (*Nephelium lappaceum*), *durian* (*Durio zibethinus*), mango (*Mangifera indica*), white mango (*M. caesia*), and mangosteen (*Garcinia mangostana*). The water source in this village comes from several rivers that are used by the people for daily needs or used for irrigation. In this study, 10 sampling points were determined that were distributed as shown in Figure 1 based on the proposed habituation cage spots, which considered the minimum disturbance and ease of maintaining birds monitoring. The

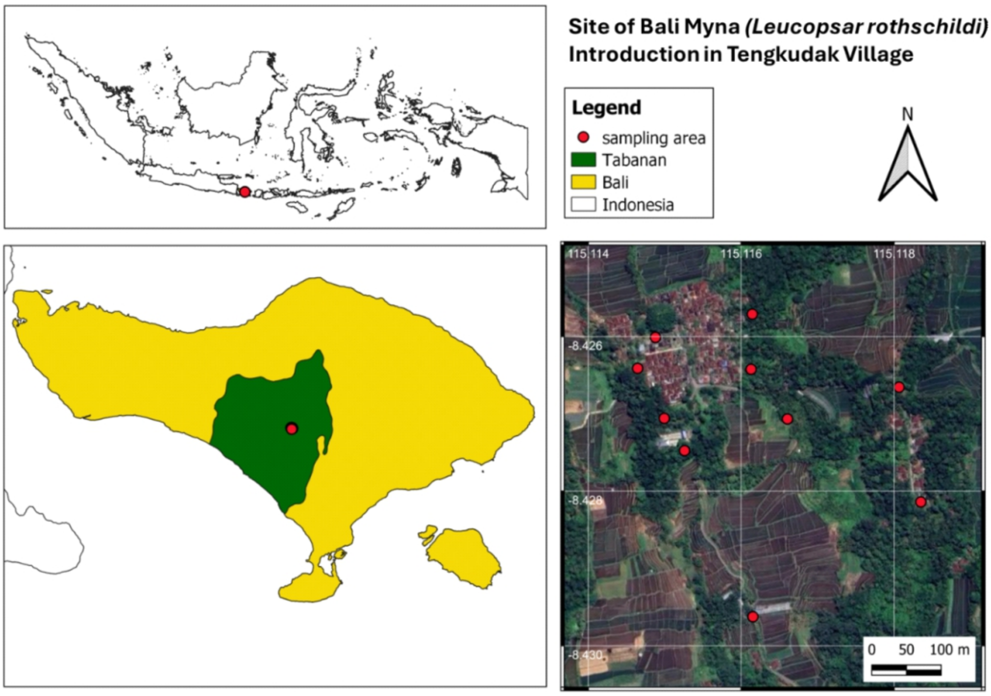

Figure 1 Sampling site in the Bali myna introduction area in Tengkudak Village, Tabanan, Bali.

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elevation of sampling points range from 391 to 432 m asl. Each sampling point resembles the proposed habituation cage, so the plot placement is located < 150 m from the sampling point to ensure the data validity. Based on Hernowo and Haquesta (2021), the post-released Bali myna wandered around approximately 100–150 m from the released spot.

Although the introduction site is in an active village, the Bali myna population potentially can be maintained. The people in Tengkudak Village have committed to the Bali myna introduction by creating a traditional law (*awig-awig*) that prohibited any kind of poaching, especially for birds. This traditional law proved to be effective in increasing Bali myna introduction success rate. In Besikalung Village as the first location of Bali myna introduction in Tabanan Regency, Bali myna have been able to live side by side with the people community due to the people awareness and traditional law protection as reported by the FNPF. Moreover, the several forest area with dense to sparse canopy will provide a suitable habitat for various bird (Xu et al., 2022), including Bali myna. The anthropogenic activities along with the existence of rural road might be considered as a potential threat. But, according to the Kroeger et al. (2022), the bird diversity impact by the road can either negative or positive, which imply the impact is context-dependent. But, since the rural road is small and only used locally by the farmers, the ecological impact is predicted minimum.

Vegetation data collection Vegetation data collected by using plot method in 10 determined sampling area as shown in Figure 1. For each sampling area, placed two plots for upper-storey vegetation (consist of tree and sapling growth forms) and 10 plots for ground vegetation. So, the total plot for upper-storey was 20 plots and for ground vegetation was 100 plots. Upper-storey using 20 m 20 m plot for both tree and sapling growth forms. Tree was classified by species with stem diameter 10 cm, while sapling classified by species with 2–9.9 cm stem diameter and the height > 1.5 m (Partomihardjo & Rahajoe, 2004). For ground vegetation, 2 m 2 m plot was used that covers all groups of ground vegetation, such as seedling, herbs, shrubs, ferns, and grasses with height < 1.5 m and diameter < 2 cm for woody species.

The data collected consisted of the number of individuals, stem diameter, and species name. Species identification conducted by observing the diagnostic characters that belong to the family, genus, and species (Rugayah et al., 2004), and then compared with various primary references such as Flora of Java volume I, II, dan III (Backer & van den Brink, 1963; 1965; 1968), Weed flora of Javanese sugar-cane Fields (Backer, 1973), and *Jenis-jenis pohon penting di hutan Nusa Kambangan* (Partomihardjo et al., 2014). The scientific name of plant tend to changes based on the newest research finding, so accepted species name was accessed through digital database of Plants of the World Online (https://powo.science.kew.org/).

Determining key species Research on vegetation and the Bali myna has been conducted by several researchers in the past. In its natural habitat, the nesting criteria of the Bali myna in BBNP were published in 2005 by Noerdjito (2005), highlighting two key findings: 1) the Bali myna does not depend on whether a tree is living or dead, and (2) the nesting cavities used by the Bali myna are predominantly former bird nests. In its introduction site on Nusa Penida, there are no recorded data on the nesting criteria of the Bali myna. However, data from Sudaryanto et al. (2020) indicate that the introduced Bali mynas utilize several plant species for foraging, resting, and nesting, such as *Ficus glabella*, *Muntingia calabura*, *Tectona grandis*, *M. indica*, and *Cocos nucifera* (Sudaryanto et al., 2020). To identify key species that play a crucial role in the adaptation success of the Bali myna, a synthesis of six criteria was prepared as shown in Table 1.

The stratification formed within the vegetation is one of the supporting factors for the successful introduction of bird species such as the Bali myna. Sontag (1992) stated that the Bali myna tends to spend less time in the lower strata compared to other starling/myna species. Similar behaviour was also observed during a study on food plants in BBNP (Frank Williams Museum of Bird Statue of Udayana University, *unpublished data*). This indicates that not only species composition is important for introduction success but also the vegetation structure formed by all the species. Vegetation stratification is not only related to tree height composition but also to the canopy structure. The Bali myna tends to prefer habitats with a broad and dense canopy in Nusa Penida (Hardini et al., 2023), although it has also been observed to prefer habitats with less dense canopies, such as in BBNP (Noerdjito, 2005).

Data analysis The ecological data obtained were then analyzed to determine the vegetation structure. The parameters used in the data analysis include Density (D), Relative density (RD), Frequency (F), Relative frequency (RF), Basal area (BA), Dominance (Do), Relative dominance (RDo), and Importance value index (IVI) with the formula following Michael (1984). BA, Do, and RDo were measured only for trees and saplings. The analysis was further conducted to determine the Shannon-Wiener index of

Table 1 Criteria in determining potential key species in Bali myna introduction

No	Function	Criteria	Reference
1	As a nest tree	Tree with potential height reach > 5 m	(Noerdjito, 2005)
2	As a nest tree	Tree with potential diameter > 17 cm	(Noerdjito, 2005)
3	As a nest tree	Tree that used for foraging by woodpecker and associated species	(Noerdjito, 2005)
4	As a source of food	Tree with many fruits, preferably that available a round year (such as figs)	Modified from (Sudaryanto et al., 2020)
5	As a source of food	Tree that became a habitat of various insect, especially in larva phase	Modified from (Sudaryanto et al., 2020)
6	As a rest tree	Tree with wide canopy and provide many branches	Modified from (Hardini et al., 2023)

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diversity (H'), Simpson's index of dominancy (D), and Pielou's index of evenness (E). The formulas used in the vegetation structure analysis are as shown in Equation *[1]* to Equation *[11]*.

$$De = \frac{Total\ individu\ of\ a\ species}{Area} \qquad [1]$$

$$RD = \frac{Density\ of\ a\ species}{Total\ density\ of\ all\ species} \times 100\% \qquad [2]$$

$$F = \frac{Total\ occurence\ of\ a\ species}{Total\ number\ of\ plot} \qquad [3]$$

$$RF = \frac{Frequency\ of\ a\ species}{Total\ frequency\ of\ all\ species} \times 100\% \qquad [4]$$

$$BA = \frac{1}{4}\pi d^2 \qquad [5]$$

$$Do = \frac{Basal\ area\ of\ a\ species}{Area} \qquad [6]$$

$$RDo = \frac{Dominancy\ of\ a\ species}{Total\ dominancy\ of\ all\ species} \times 100\% \qquad [7]$$

$$IVI\ = RD + RF + RDo \qquad [8]$$

$$H' = \sum_{i=1}^{s}\left(\frac{ni}{N}\right) ln\left(\frac{ni}{N}\right) \qquad [9]$$

$$D = \sum_{i=1}^{s}\left(\frac{ni}{N}\right)^2 \qquad [10]$$

$$E = \frac{H'}{\ln(S)} \qquad [11]$$

note: *De* = density; *RD* = relative density; *F* = frequency; *RF* = relative frequency; *BA* = basal area (cm^2); *d* = diameter (cm); *Do* = dominancy; *RDo* = relative dominancy; *IVI* = important index value (%); *H′* = Shannon-Wiener index of diversity (with criteria: $H' < 1$ = low diversity; $1 < H' < 3$ = moderate diversity; and $H' > 3$ = high diversity); *ni* = IVI of a certain species; *N* = total IVI of all species; *D* = Simpson's index of dominancy (with criteria: $D < 0.5$ = there are no dominated species and $D > 0.5$ = there are species domination); *E* = Pielou's index of evenness (with criteria: $E < 0.5$ = uneven vegetation composition and $E > 0.5$ = even vegetation composition); and *S* = total species.

Results

Structure of vegetation in Tengkudak Village Table 2 shows the vegetation structure in Tengkudak Village, ordered from the highest IVI to the lowest. The highest IVI in tree growthform was coconut (*C. nucifera*) with 70.80% (RD 30.17%; RF 8.41%; RDo 32.22%), followed by cocoa (*Theobroma cacao*) with 25.89% (RD 14.92%; RF 5.61%; RDo 5.37%), and jackfruit (*Artocarpus heterophyllus*) with 25.87% (RD 9.83%; RF 7.48%; RDo 8.57%).

The regeneration of plant species in the study area was excellent, as evidenced by the presence of various saplings. The sapling species with the highest IVI is quickstick tree (*Gliricidia sepium*) with 41.83% (RD 23.22%; RF 4.30%; RDo 14.31%), followed by arabica coffee (*Coffea arabica*) with 34.23% (RD 14.23%; RF 6.45%; RDo 13.54%), and cocoa (*T. cacao*) with 24.77% (RD 7.49%; RF 8.60%; RDo 8.68%).

The last vegetation growth form was ground vegetation, including tree seedlings. The species with the highest IVI in this category is carabao grass (*Paspalum conjugatum*), with a value of 12.30% (RD 11.14%; RF 1.16%), followed by nodeweed (*Synedrella nodiflora*) with 10.10% (RD 7.01%; RF 3.09%). The remaining 95 species have IVI values below 10%, indicating a high level of species diversity with no single dominant species. In general, the dominant species consist of grasses, weeds, and ferns. The high prevalence of grass species is due to their use as livestock fodder and their role in strengthening paddy field boundaries. Commonly used grasses include carabao grass (*Paspalum conjugatum*), *tropical crabgrass* (*Digitaria ciliaris*), *goosegrass* (*Eleusine indica*), *wavy basketgrass* (*Oplismenus burmannii*), *mountaingrass* (*O. compositus*), *torpedograss* (*Panicum repens*), and napier grass (*Cenchrus purpureus*). The use of land for agriculture and plantations creates new habitats for weeds, resulting in the presence of numerous weed species such as nodeweed (*Synedrella nodiflora*), *wedelia* (*Sphagne-ticola trilobata*), *bitter vine* (*Mikania micrantha*), *elephant's foot* (*Elephantopus scaber*), *diamond flower* (*Oldenlandia corymbosa*), *goatweed* (*Ageratum cony-zoides*), *Indian heliotrope* (*Heliotropium indicum*), *stinging nettle* (*Laportea aestuans*), and various species of *Cypera-ceae* sedges. The diversity of ferns is attributed to the habitat's proximity to water sources, providing high humidity conditions that favour fern growth.

Community stability analysis based on diversity indices Community stability was assessed using three community indices: Shannon-Wiener's index of diversity (H'), Simpson's index of dominance (D), and Pielou's index of evenness (E), as shown in Table 3. Based on the H' values, ground vegetation had the highest diversity (4.09, classified as high diversity), followed by saplings (3.27, classified as high diversity) and trees (2.99, classified as moderate diversity). In Simpson's index of dominance (D), the lowest value was found in ground vegetation (0.02), followed by saplings (0.06) and trees (0.09). According to the classification criteria, the lower values of this index ($C < 0.50$, approaching 0.00) indicate a stable vegetation condition without dominance by any particular species. For Pielou's index of evenness (E), the results showed that ground vegetation had the highest E value (0.89), followed by saplings (0.87) and trees (0.81). An E value was > 0.50 and approaching 1.00 indicates increasingly stable vegetation due to a more even distribution of species. Therefore, all growth forms also exhibit stable vegetation conditions.

Potential plant as key species The selection of potential key plant species was based on criteria outlined in Table 1. However, the resulting list was extensive, as nearly all tree species have the potential to serve as resting sites for the Bali myna. Therefore, the first selection step involved narrowing the list to species that have been previously recorded as used by the bird, followed by the identification of the most promising species. This process led to a final selection of 15 potential species, as shown in Table 4. Some species that have been documented as used by the Bali myna include

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Table 2 Vegetation structure in Tengkudak Village based on the growthform

Tree

No	Species	Local name	De	RD (%)	F	RF (%)	Do	RDo (%)	IVI (%)
1	*Cocos nucifera*	*Kelapa*	8.90	30.17	0.90	8.41	59.61	32.22	70.80
2	*Theobroma cacao*	*Cokelat*	4.40	14.92	0.60	5.61	9.94	5.37	25.89
3	*Artocarpus heterophyllus*	*Nangka*	2.90	9.83	0.80	7.48	15.85	8.57	25.87
4	*Durio zibethinus*	*Durian*	1.90	6.44	0.90	8.41	16.59	8.96	23.82
5	*Mangifera caesia*	*Wani*	1.30	4.41	0.50	4.67	9.10	4.92	14.00
6	*Elaeocarpus sphaericus*	*Genitri*	0.70	2.37	0.40	3.74	9.92	5.36	11.47
7	*Ficus callosa*	*Layah ombo*	0.20	0.68	0.20	1.87	16.12	8.71	11.26
8	*Sandoricum koetjape*	*Sentul*	1.30	4.41	0.30	2.80	7.07	3.82	11.03
9	*Garcinia mangostana*	*Manggis*	0.90	3.05	0.70	6.54	1.72	0.93	10.52
10	*Swietenia mahagoni*	*Mahoni*	0.70	2.37	0.30	2.80	3.77	2.04	7.22
11	*Magnolia champaca*	*Cempaka kuning*	0.50	1.69	0.30	2.80	3.47	1.88	6.37
12	*Baccaurea racemosa*	*Pundung*	0.40	1.36	0.40	3.74	1.91	1.03	6.13
13	*Hibiscus tiliaceus*	*Waru*	0.40	1.36	0.40	3.74	1.43	0.77	5.87
14	*Ficus benjamina*	*Beringin*	0.10	0.34	0.10	0.93	8.20	4.43	5.70
15	*Syzygium aromaticum*	*Cengkeh*	0.50	1.69	0.30	2.80	1.92	1.04	5.54
16	*Lansium domesticum*	*Duku*	0.50	1.69	0.30	2.80	1.26	0.68	5.18
17	*Dysoxylum densiflorum*	*Majegau*	0.30	1.02	0.30	2.80	2.34	1.26	5.08
18	*Nephelium lappaceum*	*Rambutan*	0.40	1.36	0.20	1.87	2.57	1.39	4.61
19	*Ficus variegata*	*Ara*	0.30	1.02	0.20	1.87	2.28	1.23	4.12
20	*Fraxinus griffithii*	*Tiken*	0.20	0.68	0.20	1.87	1.89	1.02	3.57
21	*Antidesma bunius*	*Boni, buni*	0.20	0.68	0.20	1.87	0.43	0.23	2.78
22	*Carica papaya*	*Pepaya*	0.20	0.68	0.20	1.87	0.38	0.20	2.75
23	*Areca catechu*	*Pinang*	0.20	0.68	0.20	1.87	0.27	0.15	2.69
24	*Nauclea subdita*	*Nauclea*	0.20	0.68	0.20	1.87	0.25	0.14	2.68
25	*Palaquium amboinense*	*Nyantuh*	0.20	0.68	0.10	0.93	1.08	0.58	2.20
26	*Syzygium aqueum*	*Jambu air*	0.10	0.34	0.10	0.93	1.49	0.81	2.08
27	*Cananga odorata*	*Sandat*	0.10	0.34	0.10	0.93	0.98	0.53	1.80
28	*Barringtonia racemosa*	*Putat sungai*	0.20	0.68	0.10	0.93	0.22	0.12	1.73
29	*Coffea arabica*	*Kopi*	0.20	0.68	0.10	0.93	0.21	0.11	1.72
30	*Mangifera indica*	*Mangga*	0.10	0.34	0.10	0.93	0.59	0.32	1.59
31	*Bischofia javanica*	*Gintungan*	0.10	0.34	0.10	0.93	0.51	0.28	1.55
32	*Duabanga moluccana*	*Kajimas*	0.10	0.34	0.10	0.93	0.51	0.28	1.55
33	*Aleurites moluccana*	*Kemiri, tingkih*	0.10	0.34	0.10	0.93	0.31	0.17	1.44
34	*Myristica fragrans*	*Pala*	0.10	0.34	0.10	0.93	0.20	0.11	1.38
35	*Erythrina subrumbans*	*Dadap*	0.10	0.34	0.10	0.93	0.15	0.08	1.35
36	*Citrus × aurantiifolia*	*Limau*	0.10	0.34	0.10	0.93	0.13	0.07	1.34
37	*Gliricidia sepium*	*Gamal*	0.10	0.34	0.10	0.93	0.10	0.05	1.33
38	*Psidium guajava*	*Jambu biji*	0.10	0.34	0.10	0.93	0.10	0.05	1.33
39	*Morus rubra*	*Murbei*	0.10	0.34	0.10	0.93	0.09	0.05	1.32
40	*Neolamarckia cadamba*	*Jabon*	0.10	0.34	0.10	0.93	0.09	0.05	1.32
Total			29.50	100.00	10.70	100.00	185.02	100.00	300.00

Sapling

No	Species	Local name	De	RD (%)	F	RF (%)	Do	RDo (%)	IVI (%)
1	*Gliricidia sepium*	*Gamal*	6.20	23.22	0.40	4.30	0.85	14.31	41.83
2	*Coffea arabica*	*Kopi*	3.80	14.23	0.60	6.45	0.81	13.54	34.23
3	*Theobroma cacao*	*Cokelat*	2.00	7.49	0.80	8.60	0.52	8.68	24.77
4	*Nephelium lappaceum*	*Rambutan*	1.40	5.24	0.40	4.30	0.38	6.43	15.98
5	*Durio zibethinus*	*Durian*	1.20	4.49	0.50	5.38	0.34	5.69	15.56
6	*Artocarpus heterophyllus*	*Nangka*	0.80	3.00	0.60	6.45	0.25	4.12	13.57
7	*Ficus fistulosa*	*Dadem*	1.30	4.87	0.50	5.38	0.06	1.07	11.32
8	*Garcinia mangostana*	*Manggis*	0.50	1.87	0.20	2.15	0.33	5.47	9.49
9	*Swietenia mahagoni*	*Mahoni*	0.70	2.62	0.20	2.15	0.26	4.44	9.21
10	*Palaquium amboinense*	*Nyantuh*	0.50	1.87	0.30	3.23	0.19	3.11	8.21
11	*Mangifera caesia*	*Wani*	0.70	2.62	0.30	3.23	0.14	2.28	8.13
12	*Dysoxylum densiflorum*	*Majegau*	0.40	1.50	0.30	3.23	0.18	3.00	7.73
13	*Magnolia champaca*	*Cempaka kuning*	0.30	1.12	0.30	3.23	0.15	2.46	6.81
14	*Sandoricum koetjape*	*Sentul*	0.40	1.50	0.30	3.23	0.11	1.88	6.60
15	*Barringtonia racemosa*	*Putat sungai*	0.60	2.25	0.20	2.15	0.12	2.01	6.41
16	*Nauclea subdita*	*Nauclea*	0.30	1.12	0.20	2.15	0.16	2.66	5.93
17	*Elaeocarpus sphaericus*	*Genitri*	0.40	1.50	0.40	4.30	0.13	2.15	7.95
18	*Cananga odorata*	*Sandat bali*	0.30	1.12	0.20	2.15	0.12	2.00	5.27
19	*Psidium guajava*	*Jambu biji*	0.40	1.50	0.20	2.15	0.04	0.72	4.37
20	*Lansium domesticum*	*Duku*	0.20	0.75	0.20	2.15	0.08	1.39	4.29

No	Species	Local name	De	RD (%)	F	RF (%)	Do	RDo (%)	IVI (%)
Sapling									
21	*Hibiscus rosa- sinensis*	*Pucuk*	0.60	2.25	0.10	1.08	0.04	0.65	3.97
22	*Morus rubra*	*Murbei*	0.20	0.75	0.10	1.08	0.09	1.56	3.39
23	*Erythrina subrumbans*	*Dadap*	0.40	1.50	0.10	1.08	0.05	0.77	3.34
24	*Malvaviscus arboreus*	*Pucuk lilin*	0.50	1.87	0.10	1.08	0.02	0.33	3.28
25	*Bischofia javanica*	*Gintungan*	0.40	1.50	0.10	1.08	0.04	0.63	3.20
26	*Ardisia humilis*	*Lempeni*	0.10	0.37	0.10	1.08	0.07	1.20	2.65
27	*Codiaeum variegatum*	*Puring*	0.30	1.12	0.10	1.08	0.03	0.44	2.64
28	*Arenga pinnata*	*Aren*	0.10	0.37	0.10	1.08	0.06	1.08	2.53
29	*Antidesma bunius*	*Boni, buni*	0.10	0.37	0.10	1.08	0.05	0.90	2.35
30	*Citrus × aurantiifolia*	*Limau*	0.10	0.37	0.10	1.08	0.04	0.73	2.18
31	*Plumeria rubra*	*Jepun*	0.10	0.37	0.10	1.08	0.04	0.71	2.16
32	*Mangifera indica*	*Mangga*	0.20	0.75	0.10	1.08	0.02	0.31	2.14
33	*Syzygium malaccense*	*Jambu bol*	0.20	0.75	0.10	1.08	0.02	0.29	2.12
34	*Averrhoa carambola*	*Belimbing*	0.10	0.37	0.10	1.08	0.04	0.65	2.10
35	*Citrus × limon*	*Lemon*	0.20	0.75	0.10	1.08	0.01	0.22	2.04
36	*Pterospermum javanicum*	*Bayur*	0.10	0.37	0.10	1.08	0.03	0.51	1.96
37	*Annona muricata*	*Sirsak*	0.10	0.37	0.10	1.08	0.03	0.48	1.93
38	*Inga edulis*	*Buah salju*	0.10	0.37	0.10	1.08	0.03	0.48	1.93
39	*Albezia chinensis*	*Albesia*	0.10	0.37	0.10	1.08	0.02	0.28	1.73
40	*Manilkara kauki*	*Sawo kecik*	0.10	0.37	0.10	1.08	0.01	0.19	1.64
41	*Persea americana*	*Alpukat*	0.10	0.37	0.10	1.08	0.01	0.11	1.56
42	*Ficus septica*	*Awar-awar*	0.10	0.37	0.10	1.08	0.004	0.07	1.52
Total			26.70	100.00	9.30	100.00	5.96	100.00	300.00
Seedling and ground vegetation									
1	*Paspalum conjugatum*	*Rumput*	28.30	11.14	0.30	1.16			12.30
2	*Synedrella nodiflora*	*Buyung-buyung*	17.80	7.01	0.80	3.09			10.10
3	*Ficus montana*	*Uyah-uyah*	14.60	5.75	0.90	3.47			9.22
4	*Digitaria ciliaris*	*Rumput*	14.50	5.71	0.70	2.70			8.41
5	*Oplismenus compositus*	*Waderan besar*	12.70	5.00	0.80	3.09			8.09
6	*Sphagneticola trilobata*	*Padang sasak*	16.70	6.57	0.20	0.77			7.35
7	*Colocasia esculenta*	*Talas, keladi*	7.30	2.87	0.90	3.47			6.35
8	*Deparia petersenii*	*Paku*	8.80	3.46	0.60	2.32			5.78
9	*Oplismenus burmanii*	*Waderan*	9.90	3.90	0.30	1.16			5.06
10	*Ophiorrhiza mungos*	-	4.80	1.89	0.80	3.09			4.98
11	*Mikania micrantha*	*Mikania*	5.70	2.24	0.70	2.70			4.95
12	*Piper* sp.	*Sirih tanah*	4.00	1.57	0.80	3.09			4.66
13	*Cyathula prostrata*	*Bayam pasir*	6.30	2.48	0.50	1.93			4.41
14	*Crassocephalum crepidioides*	*Jepen-jepen*	6.00	2.36	0.50	1.93			4.29
15	*Thelypteris interrupta*	*Paku pipid kecil*	3.90	1.54	0.70	2.70			4.24
16	*Nephrolepis cordifolia*	*Paku pipid*	7.70	3.03	0.30	1.16			4.19
17	*Axonopus compressus*	*Rumput*	7.40	2.91	0.30	1.16			4.07
18	*Elephantopus scabers*	*Tapak liman*	3.20	1.26	0.60	2.32			3.58
19	*Theobroma cacao*	*Cokelat*	2.80	1.10	0.60	2.32			3.42
20	*Ichnanthus pallens*	*Rumput*	6.50	2.56	0.20	0.77			3.33
21	*Ficus fistulosa*	*Dadem*	2.10	0.83	0.60	2.32			3.14
22	*Selaginella* sp.	*Paku rane*	4.20	1.65	0.30	1.16			2.81
23	*Cyperus brevifolius*	*Teki*	2.90	1.14	0.40	1.54			2.69
24	*Artocarpus elasticus*	*Teep, terap*	0.90	0.35	0.60	2.32			2.67
25	*Homalomena cordata*	*Sente merah*	1.70	0.67	0.50	1.93			2.60
26	*Coffea arabica*	*Kopi*	1.60	0.63	0.50	1.93			2.56
27	*Urena lobata*	*Pulutan*	1.40	0.55	0.50	1.93			2.48
28	*Panicum repens*	*Rumput*	4.30	1.69	0.20	0.77			2.47
29	*Manihot esculenta*	*Singkong*	0.80	0.31	0.50	1.93			2.25
30	*Eragrostis amabilis*	*Rumput*	2.40	0.94	0.30	1.16			2.10
31	*Eragrostis tenella*	*Rumput*	3.10	1.22	0.20	0.77			1.99
32	*Diplazium esculentum*	*Paku sayur*	0.90	0.35	0.40	1.54			1.90
33	*Curcuma longa*	*Kunyit*	1.30	0.51	0.30	1.16			1.67
34	*Cyperus cyperoides*	*Teki*	1.30	0.51	0.30	1.16			1.67
35	*Oldenlandia corymbosa*	*Rumput mutiara*	2.00	0.79	0.20	0.77			1.56
36	*Trimezia longifolia*	*Iris*	1.90	0.75	0.20	0.77			1.52
37	*Commelina diffusa*	*Commelina*	0.80	0.31	0.30	1.16			1.47
38	*Desmodium gangeticum*	*Bajang-bajang*	0.80	0.31	0.30	1.16			1.47
39	*Ipomoa aquatica*	*Kangkung*	0.70	0.28	0.30	1.16			1.43
40	*Leucaena leucocephala*	*Lamtoro*	0.70	0.28	0.30	1.16			1.43

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Seedling and ground vegetation								
No	Species	Local name	De	RD (%)	F	RF (%)	IVI (%)
41	*Peperomia pelucida*	*Sirih gumi*	2.60	1.02	0.10	0.39	1.41
42	*Davallia solida*	*Paku*	2.50	0.98	0.10	0.39	1.37
43	*Stachytarpheta jamaicensis*	*Jarong*	1.50	0.59	0.20	0.77	1.36
44	*Codiaeum variegatum*	*Puring*	1.40	0.55	0.20	0.77	1.32
45	*Tectaria angulata*	*Paku*	1.90	0.75	0.10	0.39	1.13
46	*Centella asiatica*	*Don piduh*	0.70	0.28	0.20	0.77	1.05
47	*Piper umbellatum*	*Piper air*	0.70	0.28	0.20	0.77	1.05
48	*Eleusine indica*	*Rumput*	0.60	0.24	0.20	0.77	1.01
49	*Ficus septica*	*Awar-awar*	0.60	0.24	0.20	0.77	1.01
50	*Phymatosorus scolopendria*	*Paku hias*	0.60	0.24	0.20	0.77	1.01
51	*Artocarpus heterophyllus*	*Nangka*	0.50	0.20	0.20	0.77	0.97
52	*Ruellia prostrata*	-	1.30	0.51	0.10	0.39	0.90
53	*Ageratum conyzoides*	*Babandotan*	0.30	0.12	0.20	0.77	0.89
54	*Capsicum frutescens*	*Cabai rawit*	0.30	0.12	0.20	0.77	0.89
55	*Cenchrus purpureus*	*Rumput gajah*	0.30	0.12	0.20	0.77	0.89
56	*Vanilla planifolia*	*Vanili, vanilla*	0.30	0.12	0.20	0.77	0.89
57	*Ocimum x africanum*	*Kemangi*	1.20	0.47	0.10	0.39	0.86
58	*Mangifera caesia*	*Wani*	0.20	0.08	0.20	0.77	0.85
59	*Psidium guajava*	*Jambu biji*	0.20	0.08	0.20	0.77	0.85
60	*Solanum torvum*	*Takokak*	0.20	0.08	0.20	0.77	0.85
61	*Sporobolus indicus*	*Rumput*	0.90	0.35	0.10	0.39	0.74
62	*Amaranthus viridis*	*Bayam*	0.80	0.31	0.10	0.39	0.70
63	*Dracaena angustifolia*	*Daun suji*	0.80	0.31	0.10	0.39	0.70
64	*Epipremnum aureum*	*Sirih gading*	0.70	0.28	0.10	0.39	0.66
65	*Lygodium japonicum*	*Paku rambat*	0.70	0.28	0.10	0.39	0.66
66	*Morus rubra*	*Murbei*	0.60	0.24	0.10	0.39	0.62
67	*Nephelium lappaceum*	*Rambutan*	0.60	0.24	0.10	0.39	0.62
68	*Freycinetia scandens*	*Pandan rambat*	0.50	0.20	0.10	0.39	0.58
69	*Meremia* sp.	*Meremia*	0.40	0.16	0.10	0.39	0.54
70	*Pteris vittata*	*Paku hias*	0.40	0.16	0.10	0.39	0.54
71	*Acalypha indica*	*Antel-antel*	0.30	0.12	0.10	0.39	0.50
72	*Dieffenbachia seguine*	*Sri rejeki*	0.30	0.12	0.10	0.39	0.50
73	*Heliotropium indicum*	*Buntut tikus*	0.30	0.12	0.10	0.39	0.50
74	*Laportea aestuans*	*Jelatang*	0.30	0.12	0.10	0.39	0.50
75	*Mangifera indica*	*Mangga*	0.30	0.12	0.10	0.39	0.50
76	*Sida rhombifolia*	*Sidaguri kuning*	0.30	0.12	0.10	0.39	0.50
77	*Zingiber officinale*	*Jahe*	0.30	0.12	0.10	0.39	0.50
78	*Antidesma bunius*	*Boni*	0.20	0.08	0.10	0.39	0.46
79	*Barringtonia racemosa*	*Putat sungai*	0.20	0.08	0.10	0.39	0.46
80	*Cordyline fruticosa*	*Andong*	0.20	0.08	0.10	0.39	0.46
81	*Cyperus rotundus*	*Teki*	0.20	0.08	0.10	0.39	0.46
82	*Durio zibethinus*	*Durian*	0.20	0.08	0.10	0.39	0.46
83	*Graptophyllum pictum*	*Daun ungu*	0.20	0.08	0.10	0.39	0.46
84	*Hippobroma longiflora*	*Bunga bintang*	0.20	0.08	0.10	0.39	0.46
85	*Nauclea subdita*	*Nauclea*	0.20	0.08	0.10	0.39	0.46
86	*Rubus rosifolius*	*Stroberi hutan*	0.20	0.08	0.10	0.39	0.46
87	*Aleurites moluccana*	*Kemiri, tingkih*	0.10	0.04	0.10	0.39	0.43
88	*Ardisia humilis*	*Lempeni*	0.10	0.04	0.10	0.39	0.43
89	*Baccaurea racemosa*	*Kepundung*	0.10	0.04	0.10	0.39	0.43
90	*Breynia androgyna*	*Daun katuk*	0.10	0.04	0.10	0.39	0.43
91	*Carica papaya*	*Pepaya*	0.10	0.04	0.10	0.39	0.43
92	*Caryota mitis*	*Uduh*	0.10	0.04	0.10	0.39	0.43
93	*Garcinia mangostana*	*Manggis*	0.10	0.04	0.10	0.39	0.43
94	*Gardenia jasminoides*	*Jempiring*	0.10	0.04	0.10	0.39	0.43
95	*Lansium domesticum*	*Duku*	0.10	0.04	0.10	0.39	0.43
96	*Malvaviscus arboreus*	*Pucuk lilin*	0.10	0.04	0.10	0.39	0.43
97	*Tacca palmata*	-	0.10	0.04	0.10	0.39	0.43
	Total		254.00	100.00	25.90	100.00	200.00

Table 3 The community index of vegetation in Tengkudak Village

Community index	Growth form		
	Tree	Sapling	Ground vegetation
Shannon-Wiener's index of diversity (*H'*)	2.99	3.27	4.09
Simpson's index of dominancy (*D*)	0.09	0.06	0.02
Pielou's index of evenness (*E*)	0.81	0.87	0.89

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coconut (*C. nucifera*), papaya (*Carica papaya*), magnolia (*Magnolia champaca*), and oakleaf fig (*F. montana*), *and also banana* (*Musa paradisiaca*, but not included in the list), while the others have some distinguish traits which proposedly important for the Bali myna, such as for providing shelter, food, and even as a nesting tree.

Discussion

Structure of vegetation in Tengkudak Village In tree growthform, all of those top three species were the main economic commodity of this village. The other species such as *durian* (*D. zibethinus*) and white mango (*M. caesia*) also an economic commidity, but usually harvested based on season, so those species particularly used as a secondary commodity. In the tree growthform also observed calloused fig (*F. callosa*) which has high RDo with 8.71% and low RD an RF with 0.68% and 1.67% respectively. Its indicating that *F. callosa* has a low density and limited distribution, but have a big stem. Species with high dominance (having a large diameter) play a significant role in increasing bird diversity (Kebrle et al., 2021). In addition, several tree species contribute to establish riparian vegetation, such as rudraksha (*Elaeocarpus sphaericus*), *majegau* (*Dysoxylum densiflorum*), *variegated fig* (*F. variegata*), *nyantuh* (*Palaquium amboinense*), *hippo apple* (*Barringtonia racemosa), java cedar* (*Bischofia javanica*), and kajimas (*Duabanga moluccana*). The abundance of riparian species is due to the presence of numerous rivers surrounding Tengkudak Village, where the local community actively conserves riverbanks as riparian zones. This conservation effort ensures the availability of native species that help maintain environmental balance and support the Bali myna introduction program.

In sapling growthform, The high RD value of *G. sepium* is attributed to its extensive use by the local community. This species serves multiple purposes, such as live fencing, soil enrichment, coffee shading, and livestock fodder. *C. arabica* and *T. cacao* are commonly found due to their economic importance, along with other commodities such as *rambutan*, *durian*, jackfruit, mangosteen, and white mango. Non-economic commodity species found in the sapling growth form are largely the same as those in the tree growth form, including *E. sphaericus, D. densiflorum, P. amboinense, B. racemosa, B. javanica,* and *D. moluccana*. Additionally, other riparian-specific species such as *bayur* (*Pterospermum javanicum*) were also identified.

Although plantation commodity species dominate among trees and saplings, the presence of local species in this study is also substantial, particularly those that contribute to the composition of riparian vegetation. The presence of these local species enhances the morphological diversity of the existing stands, which indirectly influences the increase in bird species diversity (Keten et al., 2020; Yuni et al., 2022). The greater the morphorichness and canopy structure diversity, the more microclimates are formed, which can provide suitable habitats, niche diversification, and vertical resource partitioning for bird communities to coexist (Melo et al., 2020; Piechnik et al., 2022; Maulana et al., 2025). As for Bali myna, this species tend to occupy the upper and middle layers of vegetation in the area with sparse tree density (Aryanti & Wicaksono, 2018).

Several tree and sapling species have been recorded as being utilized by the Bali myna, including *C. nucifera*, *M. champaca*, and mango (*M. indica*). Among these, *M. champaca* demonstrates the most diverse utilization preferences. To support the Bali myna population, vegetation that can provide both direct and indirect food sources and nesting sites is essential. The *M. champaca* produces aggregate fruits with seeds surrounded by a thick aril, which became the primary diet of the Bali myna. The birds consume the aril-covered seeds, digest the aril, and later excrete the seeds without it. *M. champaca* produces these seeds in large quantities, making it a crucial natural food source for the Bali myna. However, it is not an exclusive food source for the Bali myna. Other bird species such as asian glossy starling (*Aplonis panayensis*), yellow-vented bulbul (*Pycnonotus goiavier*), and sooty-headed bulbul (*Pycnonotus aurigaster*) also feed on its fruit. In BBNP, yellow-vented bulbul have been classified as a potential competitor of Bali myna in term of resources (food) occupation (Hernowo & Haquesta, 2021). Figure 2 shown two of the Bali myna competitor, which is asian glossy starling that occupy the branch full with

Table 4 Fifteen potential key species for Bali Myna introduction in Tengkudak Village

No	Species	Criteria						Total score
		1	2	3	4	5	6	
1	*Bischofia javanica*	+	+	+	+	+	+	6 (100.0%)
2	*Ficus fistulosa*	+	+	+	+	+	+	6 (100.0%)
3	*Ficus variegata*	+	+	+	+	+	+	6 (100.0%)
4	*Magnolia champaca*	+	+	+	+	+	+	6 (100.0%)
5	*Baccaurea racemosa*	+	+	+	+	+		5 (83.3%)
6	*Dysoxyllum densiflorum*	+	+		+	+	+	5 (83.3%)
7	*Ficus callosa*	+	+	+		+	+	5 (83.3%)
8	*Lansium domesticum*	+	+		+	+	+	5 (83.3%)
9	*Sandoricum koetjape*	+	+	+		+	+	5 (83.3%)
10	*Cocos nucifera*	+	+	+		+		4 (66.7%)
11	*Elaeocarpus sphaericus*	+	+				+	3 (50.0%)
12	*Persea americana*	+	+			+		3 (50.0%)
13	*Ficus montana*				+	+		2 (33.3%)
14	*Theobroma cacao*					+	+	2 (33.3%)
15	*Carica papaya*				+			1 (16.7%)

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M. champaca fruit in Figure 2A and yellow-vented bulbul that feed and occupy the *D. densiflorum* fruit in Figure 2B.

Beyond providing fruit, *M. champaca* also supports insect populations, particularly caterpillars, which serve as an additional food source for the Bali myna. As an omnivorous species–primarily insectivorous and frugivorous–the availability of both fruit and insects on *M. champaca* trees is crucial. Moreover, woodpecker species such as common flameback woodpecker (*Dinopium javanense*) and fulvous-breasted woodpecker (*Dendrocopos macei*) have been observed foraging on *M. champaca*, creating cavities in the trunk that can later be used as nesting sites by the Bali myna. Similar nesting behavior has also been observed in BBNP, where natural Bali myna nests were found in coconut tree cavities (BirdLife International, 2021). The woodpeckers also recognized as an important key species in forest due to its involvement in bug-pest control for tree and supporting cavity-dependent community (Basile et al., 2021; Menon & Shahabuddin, 2021). In general, woodpecker have a preference for tall broad-leaf tree (Menon & Shahabuddin, 2021), which imply the area with more tall and big tree is more beneficial.

The ground vegetation layer also includes *F. montana*, a small fig species that does not grow taller than 2 meters. Based on IVI values, this species ranks third, with an IVI of 9.22% (RD 5.75%; RF 3.47%). *F. montana* is considered an important species for the Bali myna introduction program, as its fruit is part of the bird's diet. Although rarely observed, Bali mynas have been recorded foraging on the forest floor (Figure 2C), primarily searching for insects and worms on the soil surface, which is in concordance with the report from Yuliantara et al. (2018). This indicates that ground vegetation plays an indirect role in providing food by providing habitat and nourishment for earthworms, insects, and small arthropods, which serve as prey for the Bali myna.

The larval and nymph stages of several insect species, such as grasshoppers, depend on ground vegetation as a food source. Before reaching adulthood, juvenile grasshoppers spend most of their lives feeding on ground vegetation, primarily around grasses and weeds. It also reported that litter, rotten snag, and lying deadwood were directly related to the insect diversity which affecting the insectivorous bird diversity (Basile et al., 2020). Therefore, it shows the important of ground vegetation in maintain the ecological function of an ecosystem, which also related to the finding by Raman et al. (2021) that stated that understorey play an important role in diversity and abundance of insectivorous bird. The bird with specific guild such as understorey insectivore birds might be the first group that will be disappear by landscape disturbances (Cabral et al., 2021).

Community stability analysis based on diversity indices

In general, the plant diversity was categorized as high diversity based on the Shannon-Wiener's index of diversity (H'). The classification of high diversity is based on H' values > 3.00, meaning that saplings and ground vegetation fall into this category. Meanwhile, the tree growth form falls within the range of 1.00–3.00, classifying it as moderate diversity. However, the H' value of 2.99 is very close to the high diversity threshold.

Regarding species composition, the number of species in the tree growth form was 40, while saplings had 42 species. This difference is relatively small. One of the factors contributing to the lower diversity value in trees compared to saplings is the species composition within the vegetation. In the tree growth form, *C. nucifera* had an important value index (IVI) of 70.80%, while other species had IVI values of less than 26%. In saplings, the IVI composition was more evenly distributed, with the highest IVI at 41.83% for *G. sepium*, and other species below 35%. This composition is important because the Shannon-Wiener indeks of diversity is based on species richness and the proportion of each species within the community (Bhat et al., 2020; Mulya et al., 2021; Roy & Bhattacharya, 2023).

Community balance is also reflected in the values of other indices. The Simpson's index of dominance (D) is commonly used to complement diversity indices, as it provides information on the dominance of one or more species within the community (Bhat et al., 2020; Roy & Bhattacharya, 2023). To reinforce these findings, Pielou's index of evenness (E) was calculated, comparing the diversity index (H') with the maximum diversity (H'max = ln(S), which is obtained when all species have an equal number of individuals) (Roy & Bhattacharya, 2023). Those indices reflecting a stable vegetation condition without dominance by any particular species and the species composition were distributed evenly.

Figure 2 Bird interaction with vegetation (A) Asian glossy starling perch on the *Magnolia champaca* fruit; (B) Yellow-vented bulbul eat the seed of *Dy. densiflorum*; and (C) Bali myna explore the ground vegetation in Besikalung Village, the prior introduction site.

Overall, these results suggest that the vegetation in all growth forms categorized within the stable category.

The high diversity and vegetation stability are attributed to the heterogeneous environmental conditions, including riparian ecosystems, mixed plantations, and rice fields. Heterogeneous environments tend to support a greater number of bird species (Basile et al., 2021; Farwell et al., 2021) and foster a more dynamic community that can maintain balance in the face of ecological disturbances. This habitat type is relatively suitable for the Bali myna. In Nusa Penida, the areas utilized by Bali mynas after their release include agroforestry (59%), settlements (23%), and coconut plantations (18%). This indicates that the Bali myna is not a forest-specialist species (Hernowo & Haquesta, 2021) but rather a semi-generalist species.

Semi-generalist birds are more adaptive in utilizing vegetation and dynamic environmental conditions. This contrasts with insectivorous specialists, which often rely on specific microhabitats within the vegetation structure due to their specialized foraging needs, while frugivorous specialists are more associated with plant species richness (Santillán et al., 2020). As an omnivorous (insectivore-frugivore) semi-generalist bird, the Bali myna forages across different strata, from tree canopies to ground vegetation. Melo et al. (2020) stated that key vegetation characteristics crucial for the functional sustainability of semi-generalist birds in ecosystems include canopy gradient, vegetation structure diversity, non-grass ground vegetation, and trunk diameter. Xu et al. (2022) also reported similar findings, emphasizing that vegetation structure plays a vital role in supporting the establishment of bird communities.

Vegetation stability does not occur naturally but is also influenced by community perceptions. Among local communities, trees near water bodies (especially large trees) are generally protected and preserved due to their crucial role in maintaining water quality and quantity. Ecologically, the presence of vegetation around water bodies–whether in the form of natural riparian vegetation or riparian corridors–contributes to increasing bird diversity and ecological functions (Keten et al., 2020; Melo et al., 2020; Tu et al., 2020).

Potential plant as key species Some species provides important roles for the Bali myna which highly affecting the success rate of the introduction. A common species such as *C. nucifera* have recorded utilized by Bali myna both directly and indirectly. *C. nucifera* is commonly utilized by woodpeckers, particularly the flameback woodpecker (*D. javanense*) and fulvous-breasted woodpecker (*D. macei*). The cavities they create can later be used by the Bali yyna as nesting sites, because Bali myna unable to make its own cavity (Sudaryanto et al., 2020; BirdLife International, 2021). Additionally, during the flowering period, coconut flowers attract a variety of insects, which can enhance the diet diversity of the Bali myna.

Although Bali myna require nest trees that tend to insufficient, the existence of building structures in residential areas can be one solution to cope the nest tree limitation. Bali myna have the potential to utilize building structures as nests, especially in the hollow parts under the roof, wall, and others. This can be assumed because the starlings/mynas group tend to be more adaptive to building structures. Azizi et al. (2023) stated that starling groups such as common myna (*Acridotheres tristis*), javan myna (*A. javanicus*), and asian glossy starling (*Aplonis payanensis*) have been able to adapt to urban environments, where most of their nests use man-made building structures. Moreover, Miller et al. (2022) reported that Bali myna have a cognitive development in behavioural flexibility, particularly for the juvenile that shows lower neophobia.

As an omnivore, the Bali Myna functions as both a frugivore and an insectivore. Observations around the Nusa Penida and BBNP have shown that the bird feeds on papaya and banana fruits found in local plantations (Sudaryanto et al., 2020; Pramatana et al., 2022). Both species are also present in Tengkudak Village, providing potential alternative food sources for the Bali myna. Furthermore, the bird has been observed consuming the aril of *M. champaca* seeds. Once digested, the seed is excreted by vomiting. This feeding behaviour also documented in BBNP when the bird consumed *Pithecellobium dulce* seeds.

Considering the Bali myna's diet, its food preferences are similar to those of the Asian glossy starling, which primarily feeds on soft fruits, seed arils, and small arthropods, including insects (though occasionally small reptiles such as geckos are also consumed). Therefore, potential plant species were interpolated based on the Asian glossy starling's diet, including *D. densiflorum*, *B. racemosa*, *L. domesticum*, and *B. javanica*. Those species also can be considered to planted in the green space of urban area, since its ability to provide many advantages for birds. The green space in urban area can improve the local bird community and maintain the bird biodiversity ecological function (Sun et al., 2022; Xu et al., 2022). A species such as *B. javanica* even considered as an important plant species for frugivore birds (Wang et al., 2023).

The Bali myna's foraging activities also extend to the forest floor, highlighting the importance of ground vegetation. Their diet includes earthworms, insects, and small arthropods (Pramatana et al., 2022) which mainly found on the soil surface. Among the plant species consumed by the Bali myna is the fruit of *F. montana*, a small fig species that grows to less than 1.5 m in height (typically around 1.0–1.5 m), producing abundant solitary or clustered fruits on its stem, which serve as a food source for the bird.

Species from the *Ficus* genus are known for their prolific fruit production, making them crucial for sustaining frugivore populations in an ecosystem (Shanahan et al., 2001; Raman et al., 2021; Wijaya & Defiani, 2021; Hendrayana et al., 2022). The promising species in this regard are *F. callosa, F. variegata,* and *F. fistulosa*. The two species–*F. variegata* and *F. fistulosa*–can produce large clusters of fruit along their trunks. *F. variegata* also have wide canopy and can grow to significant heights with > 25 m. The ability to provide fruit and wide canopy recognized to be a pivotal driver to frugivore bird community (Sudaryanto et al., 2019; Cabral et al., 2021). Although no documented evidence currently exists of the Bali myna feeding on these species, their potential also lies in their ability to provide habitat for various insects. *Ficus* species have an evolutionary symbiotic relationship with *Agaonid* wasps, which act as pollinators and often reside inside their syconium fruits (Harrison & Rasplus, 2006; Cruaud et al., 2012). Additionally, the textured bark of these trees offers crevices that insects–and even small reptiles–use for shelter, indirectly creating hunting opportunities for the Bali myna. Riany and Aunurohim (2013) also reported that Bali myna in Nusa Penida have a close relationships with various species of *Ficus* due to the ability to provide food (fruit and insect), shelter, and nest.

Other plant species capable of supporting diverse insect populations include *Sandoricum koetjape* (Mardiastuti, 2021) and *Persea americana*. The leaves of *P. americana* attract caterpillars butterflies and moths (Mani, 2022), while the stem can be occupied by various insects (Pasini, Engel, Engel, Mallmann, & Link, 2023), making insectivorous birds acted as natural pest controllers that benefit avocado productivity. In flowering periods, *P. americana* also attract many insect pollinators *viz.* Coleoptera, Diptera, Hymenoptera (Dymond et al., 2021; Reddy et al., 2022; Sagwe et al., 2022). A resemble situation is observed with *S. koetjape*, where caterpillars are often found on the leaf and some insect larvae inside the fruit. Fallen ripe fruits frequently contain larvae, indicating that insect species have oviposited eggs while the fruit was still attached to the tree or freshly fallen. However, this issue is generally not a concern for the local community, as *S. koetjape* is rarely utilized, unlike *P. americana* which is an important economic commodity.

Theobroma cacao also provide a similar support with *P. americana* in maintaining visitation from insectivorous birds. The flower of cacao attracts many insects (both pollinator and pest) which indirectly attract the insectivore visitation (de Schawe et al., 2018; Vansynghel et al., 2022). Not only that, cacao also suffer from many insect pest, such as folivorous, sap-sucking, and xylophagous insects that became a major threat for cacao farmer (Novais et al., 2016; Delgado et al., 2023). Hence, the presence of insectivorous birds such as Bali myna can provide a service as a natural pest control for cacao. The role of insectivore visitation have been reported by Vansynghel et al. (2022) that found out if the insectivore visitation (birds and bats) in cacao agroforestry doubled the yield of cacao fruit production. The plant and insectivorous bird also have been recorded to developing a unique mechanism. In responding to insect herbivory, some species of plant released a volatile organic compound to attract insectivorous bird when the plant attacked by insect (Mäntylä et al., 2008). So, the higher intensity of insect herbivory, the higher intensity of the insectivorous bird visitation (Jactel et al., 2021).

Furthermore, Bali myna also frequently observed using *T. cacao as a resting tree.* Another potential species that might be providing similar support is *E. sphaericus* which has a broad canopy. Bali myna reported tend to choose thick and broad canopy tree as a shelter and roost tree, such as *M. indica, Samanea saman,* and *F. glabella* in Nusa Penida (Sudaryanto et al., 2020; Hardini et al., 2023). In BBNP, the Bali myna has been observed sleeps in a dense canopy of *Manilkara kauki*, a species which also found in Tengkudak Village. However, due to its low density, this species was not included in the final selection list.

To enhance the availability of important trees, one species that can be planted is chinaberry (*Melia azedarach*), which is closely related to neem (*Azadirachta indica*). In BBNP, the most crucial tree species for the survival of the Bali myna are pilang (*Vachellia leucophloea*) and neem (*A. indica*) because they provide shelter, food sources in the form of fruits, or serve as habitats for insects that are prey for the Bali myna (Aryanti & Wicaksono, 2018; Hernowo & Haquesta, 2021). In higher-elevation areas such as Tengkudak Village, *M. azedarach* is more adaptive compared to *A. indica*, making it recommended for planting in open areas or regions targeted for restoration. *M. azedarach* has a tall stand (>15 m) with a broad canopy. In addition to its ability to provide food sources, the Bali myna prefers trees with a wide canopy and tall stand (Sudaryanto et al., 2020; Hardini et al., 2023).

Conclusion

The results showed that the upperstorey (trees and saplings) was composed by plantation species and riparian vegetation, while the understorey (ground vegetation) was primarily composed of agricultural weeds, grasses, and ferns. Plantation species such as *C. nucifera*, *T. cacao*, *A. heterophyllus*, *D. zibethinus*, and *C. arabica* tend to dominated the vegetation composition. Community index analysis indicated that, overall, the tree, sapling, and ground vegetation growth forms exhibited high species diversity and stable community structure. Most of the recorded plant species have the potential to support the Bali myna by providing food resources, shelter, perching sites, or nesting sites. Among these, fifteen species were identified as potential key species, such as *B. racemosa*, *B. javanica*, *C. papaya*, *C. nucifera*, *D. densiflorum*, *E. sphaericus*, *F. callosa*, *F. montana*, *F. fistulosa*, *F. variegata*, *L. domesticum*, *M. champaca*, *P. americana*, *S. koetjape*, and *T. cacao.* The present study was confined to specific habitat conditions, and its findings should therefore be interpreted with caution. Additional factors, including potential predators, competitors, the presence of woodpeckers, food availability, and biodiversity, remain to be considered for a more comprehensive understanding of successful introductions.

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