

# The carrying capacity of Nusa Penida Island, Bali, Indonesia for Bali myna (*Leucopsar rothschildi* Stresemann, 1912)

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**Abstract.** Hardini J, Wirayudha IGB, Rosyidi A, Rita NMA, Mawanti I, Kalih LATTWS, Joni M, Sudaryanto FX. 2023. The carrying capacity of Nusa Penida Island, Bali, Indonesia for Bali myna (*Leucopsar rothschildi* Stresemann, 1912). *Biodiversitas* 24: 3462-3470. This study is to analyze the carrying capacity of Nusa Penida Island (Klungkung District, Bali Province, Indonesia) on the existence of Bali myna (*Leucopsar rothschildi* Stresemann, 1912) because the population is increasing. Bali myna counting method: (i) Counting Bali myna on the tree where she sleeps. (ii) Counting Bali myna at the time of doing daily activities. Bali myna population in 2021, Ped Village had 58 birds, and Toyapakeh Village 4 birds. In 2022, Bali myna in Ped Village had 102 birds, and in Toyapakeh Village 6 birds. On Nusa Penida Island, food sources of fruits and insects are abundant. There is enough nest box or tree hole to make a nest. Bali myna nest nuisance animals are bee honey (*Trigona itama*, Cockerel 1918 and ant (*Ochetellus glaber* (Mayr, 1862)), while predators are tokay gecko (*Gekko gecko* (Linnaeus 1758)), and water monitor (*Varanus salvator* Laurenti 1768). It is suspected that some Bali myna moved from Ped Village to Toyapakeh Village due to a large number of nesting disturbing animals in Ped Village. Until now, the people of Nusa Penida Island still carry out *awig-awig* (customary law) to protect Bali myna. From this research, it is known that the carrying capacity of Nusa Penida Island for Bali myna. The move of Bali myna from Ped Village to Toyapakeh Village is not due to a lack of carrying capacity but because of the presence of Bali myna nuisance animals.

**Keywords:** *Gekko gecko*, nest nuisance, *Ochetellus glaber*, Ped Village, predators

## INTRODUCTION

Bali myna (*Leucopsar rothschildi* Stresemann, 1912) is a bird endemic to the island of Bali. The bird was first discovered by Erwin Stresemann in 1911 in Bubunan-Buleleng. In the 1950s, Bali myna was no longer found in Bubunan-Buleleng. Between the 1960s and 1990s Bali myna still existed in Pupuan-Tabanan, Selemadeg-Tabanan, Melaya-Jembrana, all the way to Bali Barat National Park (BBNP). In the 2000s Bali myna was only found in Brumbun Post to Lampu Merah Post, even in 2014 it was only found in Lampu Merah Post BBNP. Bali myna has a very high risk of extinction in its natural habitat in BBNP, due to many poachers (van Balen et al. 2000; Sudaryanto et al. 2015; Sudaryanto et al. 2020). So that Bali myna is included in the critically endangered International Union for Conservation of Nature and Natural Resources (IUCN) and Appendix I The Convention on International Trade in Endangered Species of Wild Fauna and Flora categories (CITES) (CITES 2020; BirdLife International 2021).

Since 2005 Bali myna conservation efforts have also been carried out by Friends of the National Parks Foundation (FNPF) in the Nusa Penida Islands, Klungkung

District, Bali Province, Indonesia. FNPF is a local non-governmental organization (NGO) in Bali. According to Sutomo et al. (2023), the Nusa Penida Islands are suitable habitats for ex-situ Bali myna conservation. The Nusa Penida Islands consist of Nusa Penida Island, Nusa Lembongan Island, and Nusa Ceningan Island. The Nusa Penida Islands consist of 46 indigenous villages. When FNPF began to be active in the Nusa Penida Islands in 2005, it was proposed to add a paragraph on bird conservation, especially Bali myna, to the *awig-awig* (customary law) in the archipelago. *Tri Hita Karana* (*Tri* = three, *Hita* = prosperous, *Karana* = cause) is one of the teachings in Hinduism, it contains the understanding of three causes of well-being and it stems from the harmonious relationship between; man with his God, man with his natural environment and man with his neighbor. The description of *Tri Hita Karana* is in the form of *awig-awig* or customary law, which is a set of rules that govern residents at the level of Customary Villages and Customary Banjars in Bali. (Nusapenida.com 2018; Sudaryanto 2021). Because of the *awig-awig*, the conservation of Bali myna on Nusa Penida Island was successful. In 2015 the number of Bali myna was 66 birds (Sudaryanto 2021).

The diversity of bird species on Nusa Penida Island, especially in Ped Village and Tembeling Forest is high. In general, the abundance and diversity of birds are directly related to their habitat conditions (Krisanti et al. 2017; Partasasmita et al. 2017). Almost all (93%) tree species found in both habitats provide a food source for birds. Among all trees, Fig tree (*Ficus glabella* Bl.) is most widely used by birds. The tree can provide the resources needed by various bird species, and each stratum of its canopy is utilized by a particular type of bird. *F. glabella* produces fruit that is a source of bird food; and has many branches that make it a great place for rest and nesting. *L. rothschildi*, Grey-rumped starling (*Acridotheres tertius* (E.Hartert, 1896)), and White-vented myna (*Acridotheres javanicus* Cabanis, 1851) often use *F. glabella* for food, rest, and nesting sources. Other trees also often used by birds are benjamin fig (*Ficus benjamina* (L.)), rain tree (*Samanea saman* (Jasq.) Merr), and cherry tree (*Muntingia calabura* L.). In addition to these trees, shrubs, and plants that produce nectar, fruits, and seeds, such as horn of plenty (*Datura metel* L.), and shrub verbena (*Lantana camara* L.) are also food sources of Bali myna (Partasasmita 2017; Sudaryanto et al. 2020).

Bali myna in Nusa Penida Islands is safe from community disturbance or theft. The people of Nusa Penida Islands have a good perception and participation in the conservation of Bali myna. Since 1997, several traditional villages have implemented *awig-awig* to protect all species of birds. In fact, today, all traditional villages in the Nusa Penida Islands, which number 46, already have and implement this *awig-awig*. Every citizen is prohibited from catching, keeping, or buying and selling birds, especially Bali myna. The sanction is that the *awig-awig* is not allowed to participate in ritual ceremonies at the Village Temple. Until now, there has never been a citizen who violates *awig-awig* (Sudaryanto et al. 2020; Sudaryanto 2021).

The successful conservation of Bali myna critically endangered category CITES attracted the attention of the international community. So that it becomes an ecotourism attraction on Nusa Penida Island. In 2014, approximately 200 foreign tourists and four Indonesian tourists volunteered at FNPf Nusa Penida Island. Most volunteers come from Australia, China, and France, and some from the USA, Philippines, Thailand, and Spain. They stayed between one week and two months, volunteering to help with reforestation, Bali myna observation, and providing English lessons for elementary and junior high school children on Nusa Penida Island. So that Bali myna ecotourism, can develop ecotourism on Nusa Penida Island. The most phenomenal is the arrival of the first cruise ship to Klungkung Regency and specifically to Nusa Penida Island. On October 18, 2014, the National Geographic Orion cruise ship carrying 100 tourists came to Nusa Penida Island specifically to see the success of Bali myna conservation (Sudaryanto et al. 2020; Sudaryanto 2021). Since the covid pandemic hit Indonesia in 2020 until now, there are no more volunteers at FNPf Nusa Penida Island.

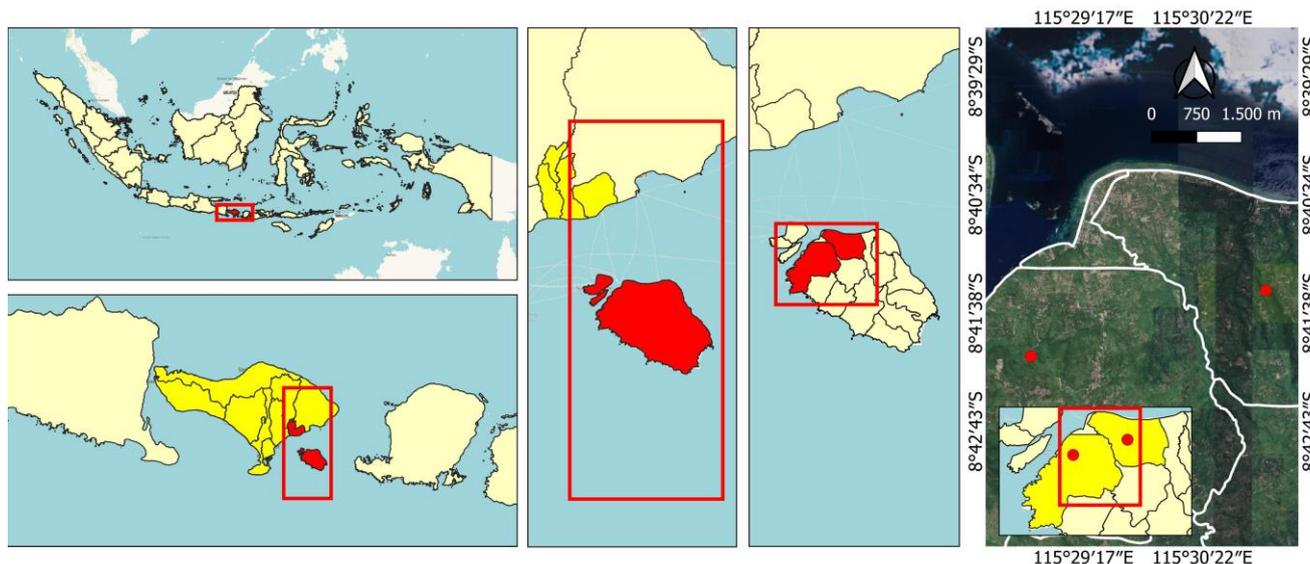
The purpose of this study is to prove the success of Bali myna conservation on Nusa Penida Island. Examining the increasing population of Bali myna. Research predators or nuisance animals Bali myna. Examining the carrying capacity of Bali myna habitat vegetation. Examining the success of *awig-awig* in protecting Bali myna from community disturbances.

## MATERIALS AND METHODS

### Study area

The research occurred from August 2020-December 2022, in Ped Village and Toyapakeh Village, Nusa Penida Island, Klungkung District, Bali Province, Indonesia (Figure 1). Nusa Penida Island is the first ex-situ conservation location of Bali myna (since 2005). Ped Village and Toyapakeh Village are located at 0 to 150 m asl, and the distance between the two villages is 6 km. Ped Village (1480 ha) and Toyapakeh Village (528 ha) are agroforestry areas. Agroforestry is a crop that combines the management of woody trees with commodity crops (Miccolis et al. 2016; Moreno et al. 2018). Large trees, such as Java plum (*Syzygium cumini* (L.) Skeels), *Ficus benjamina* L., and neem tree (*Azadirachta indica* A. Juss.) can be found in the two villages. In addition to these trees, there are coconut trees, cassava, corn, beans, shrubs, grasslands, and settlements (Sudaryanto et al. 2020).

In 2006 in Batumadeg Village, Nusa Penida Island (250 m above sea level/m asl) 25 Bali myna were released, but in 2009 there were only 11 birds, even in 2013 in Batumadeg there was no Bali myna (Sudaryanto 2021). The bird moved to Biaung (105 m asl) and Sebunibus (155 m asl), and from 2014-2020 the distribution of all Bali myna in Ped Village (0-100 m asl). In Ped Village, there are 10 groups of Bali myna, which are located at Dalem Bungkut temple, Banjar Bodong, Penataran Ped temple, Puseh temple, Bukit Klibun, Banjar Sental Kawan, Banjar Sental Kangin, Kul-kul Hotel, Full Moon Hotel, and Semeton Hotel. This is because in Ped Village the vegetation produces a lot of fruits, nectar, and food insects for Bali myna. So the Bali Myna breeds three times a year, while in BBNP it is only once. This also affects the home range of Bali myna in Ped Village, the area is only 5.79 ha, while in BBNP it is 23 ha. In Ped Village, Bali myna predators are also rarely found, such as *V. salvator*, Reticulated python (*Malayopython reticulatus* (Schneider, 1801)), *Gekko gekko* (Linnaeus, 1758) and crested serpent eagle (*Spilornis cheela* Latham, 1790). FNPf staff have seen *V. salvator* preying on juveniles and baby birds and *G. gekko* preying on eggs and baby birds, while *M. reticulatus* has been hit by snares under nest boxes. So far, only *S. cheela* can be seen soaring on top of the Bali myna nest box (Sudaryanto 2021). At the end of 2020, several Bali myna individuals from Ped Village migrated westward to Toyapakeh Village (Ardiwirinata, pers. comm., November 13, 2020; FNPf staff).



**Figure 1.** Distribution of Bali myna on Nusa Penida Island, Klungkung District, Bali Province, Indonesia in 2020-2022, in Ped Village and Toyapakeh Village

## Procedures

### Observation of Bali myna's population

(i) Counting Bali myna's on the tree she slept on (Sudaryanto et al. 2020; Sudaryanto 2021).

(ii) The calculations are carried out during Bali myna's daily activities (Sudaryanto et al. 2020; Sudaryanto et al. 2022). On Nusa Penida Island there are 40 nest boxes, of which 26 are active nest boxes (used for nesting Bali myna). Bali myna nest box and feeding ground monitoring are carried out daily by one observer group consisting of three people.

### Vegetation analysis and habitat profile of Bali myna

The habitat profile of Bali myna is determined by analyzing the vegetation in its area of activity. We use a square plot measuring 20×20 m for vegetation sampling, and we use 10 plots. In each plot, we measure and record: the type of tree, the number of each type, the total height of the tree, the height of the first branches, the width of the canopy, the length of the canopy, the thickness of the canopy, the diameter of the tree, the position of the tree, created a vegetation profile (Sudaryanto et al. 2019, Sudaryanto et al. 2020, Sudaryanto et al. 2022).

### The diversity of intruding animals or predators.

To find out the diversity of predators used methods of exploration. Exploration was carried out on Nusa Penida Island, especially Ped Village and Toyapakeh Village. Inventory and identification of reptiles of Bali myna nuisance or predator, using Amarasinghea et al. (2021) and Somaweera (2017). The *G. gecko* is most commonly found in trees around nest boxes, active during the day and night. *Varanus salvator* was active in trees where nest boxes were, during the study found only five times. *Malayophiton reticulatus* was found once in the tree where the nest box was.

### Awig-awig (customary law)

Nusa Penida Island has *awig-awig* that protects birds, especially Bali myna. The role of *awig-awig* in the preservation of Bali myna in Ped Village and Toyapakeh Village is known by conducting in-depth interviews with 50 villagers (Showkat and Parveen 2017; Sudaryanto 2021; Sudaryanto et al. 2022). Interviews were conducted on people living around the nest box or feeding ground of Bali myna. On average, every day interviewed one resident. The core of the interview with the community was: the community's perception of *awig-awig*, the community's willingness to Bali myna conservation, and the benefits of Bali myna conservation to the community. Interviews with the public were recorded and the results were recorded.

### Data analysis

The dynamics of the bird population are presented in tabular form and analyzed descriptively. The closure of the structural profile of the habitat canopy vertically and horizontally was carried out descriptively by looking at the function of the canopy strata. The diversity of predators is presented in the form of tables and photos, analyzed descriptively. *Awig-awig* is presented in the form of a histogram; and analyzed descriptively.

## RESULTS AND DISCUSSION

### Population Bali myna

On Nusa Penida Island, Bali myna is only in Ped Village and Toyapakeh Village. In 2021, there were 58 Bali myna in Ped Village and 4 birds in Toyapakeh Village. The number of Bali myna in 2022 in Ped Village is 102 birds and in Toyapakeh Village 6 birds (Table 1). Bali myna in Ped Village consists of 73 adult birds and 29 juvenile birds, 23 juvenile birds were found in June 2022, and 6 juvenile birds were found in December 2022. On

Nusa Penida Island, there are 40 nest boxes or feeding grounds. Observation of the behavior and counting of Bali myna is carried out daily. Each nest box, or feeding ground, was observed for one hour each day by a group of observers. One observer group consists of three people.

**Vegetation analysis and habitat profile of Bali myna**

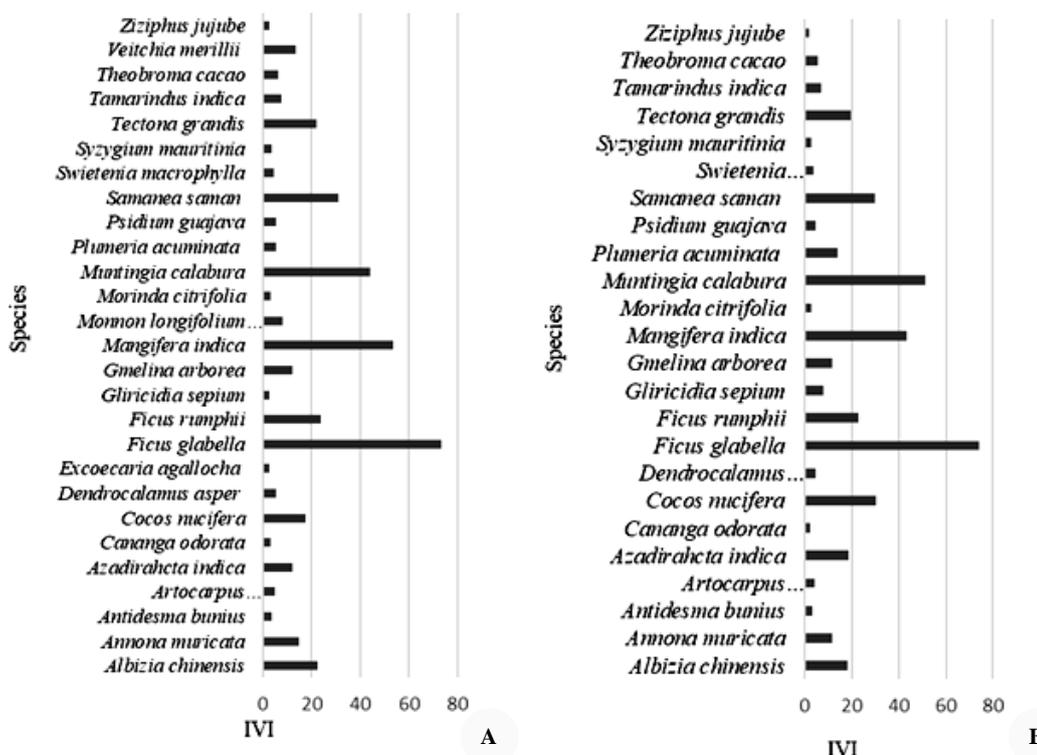
Vegetation where Bali myna activity occurs in Ped Village in 27 species and in Toyapakeh Village in 24 species, with a similarity index of 94.11% (Figure 2). Similarities of plant communities in the two study sites were calculated using the Similarity Index (SI):  $SI = 2J/(a + b)$ , where 'J' is the number of species that exist in both study sites, 'a' is the number of species at study site 'a', and 'b' is the number of species at study site 'b'. SI less than 50% indicated low similarity between two habitats, 50% to 75% showed moderate, and more than 75% were categorized high (Sudaryanto et al. 2019). The dominant trees in Ped Village are *F. glabella* (73.42%), *Mangifera indica*, (53.42%) and *M. calabura* (43.96%), while in Toyapakeh Village are *F. glabella* (74.29%), *M. calabura* (51.48%), and *M. indica* (43.32 %) (Figure 2). Vegetation profile of sleeping Bali myna in Ped Village on *S. saman* tree. *Samanea saman* canopy is thick and wide, so it is related to the canopy of *F. glabella* and *Cocos nucifera*. *Samanea saman* is 20 m high and has a canopy area of 254.57 m<sup>2</sup>, while *F. glabella* and *C. nucifera* are 15 m tall,

and other trees average 10 m in height (Figure 3A). Bali myna profile sleeping and foraging in Toyapakeh Village, especially on *F. glabella* trees 18 m high and canopy area 95.58 m<sup>2</sup>. Next to *F. glabella*, there is a tree *Tectona grandis* L.f. 20 m high with and canopy area of 22.81 m<sup>2</sup>, which is a stagg tree Bali myna (Figure 3B).

**Table 1.** Bali myna’s population

Location	2021	2022	Description
Toyapakeh Village	4	6	Adult
Penataran temple Ped Village	0	23	Juvenile
Sental Ped Village	14	8	Adult
Klibun Hill Ped Village	4	10	Adult
Puseh temple Ped Village	10	6	Adult
Mangrove point Ped Village	4	12	Adult
Dalem Bungkut temple Ped Village	10	6	Adult
Bodong Ped Village	2	2	Adult
Kul-kul Hotel Ped Village	4	4	Adult
Biaung Ped Village	2	6	Adult
FNPF Ped Village	6	15	Adult
Ramwan Ped Village	2	6	Adult
		2	Juvenile
Scuba Junkie Ped Village	0	4	Adult
		4	Juvenile
Sum	62	108	

Note: Bali myna juveniles live in groups. After adulthood, their lives pair male with female



**Figure 2.** Vegetation analysis of Bali Starling habitat in Nusa Penida Islands: A. Ped Village and; B. Toyapakeh Village, both villages are dominated by *Ficus glabella* Bl., *Muntingia calabura* L., and *Mangifera indica* L. IVI: important value index. Analysis of the importance of trees in Ped Village and Toyapakeh Village using an Index of Importance Value (IIV):  $IIV = RDi + RFi + RCi$ . RDi (Relative Density) is a comparison between the number of individuals of species-i ( $N_i$ ) and the number of all individuals ( $\Sigma N$ ). RFi (Relative Frequency) is a comparison between the frequency of species-i ( $F_i$ ) and the total frequency of all species ( $\Sigma F$ ). RCi (Relative Cover) is a comparison between the area of species-i cover area ( $C_i$ ) and the total coverage area for all species ( $\Sigma C$ ) (Sudaryanto et al. 2019)

**Bali myna nuisance or predator animal**

On Nusa Penida Island, Bali myna nuisance animals, namely: *Trigona itama*, Cockerel 1918, and *Ochetellus glaber* (Mayr, 1862) both animals often make nests in Bali myna nest boxes. Bali myna predatory animals are; *G. gecko*, *V. salvator*, *M. reticulatus*, and *S. cheela* (Table 2, Figure 4). *Gekko gecko* is a predator of Bali myna eggs, while *V. salvator*, *M. reticulatus*, and *S. cheela* are predators of juvenile or adult Bali myna. Inventory and identification of reptiles of Bali myna nuisance or predator, using Amarasinghea et al. (2021) and Somaweera (2017).

**The role of awig-awig (customary law)**

As a result of interviews with the people of Nusa Penida Island (N = 50), all communities obey *awig-awig* which protects Bali myna. The whole community always drives away the Bali myna predator, namely *Varanus salvator*. All people believe that the existence of Bali myna on Nusa Penida Island will invite tourists (Ecotourism). The people of Nusa Penida Island are willing to maintain the vegetation of Bali myna's food source. The number of Bali myna on Nusa Penida Island in 2021 and 2022 is as follows (Table 1).

**Vegetation analysis and habitat profile of Bali myna**

Analysis of vegetation where Bali myna activity occurs in Ped Village and in Toyapakeh Village (Figure 2). Also,

the vegetation profile of sleeping Bali myna in Ped Village and Toyapakeh Village (Figure 3).

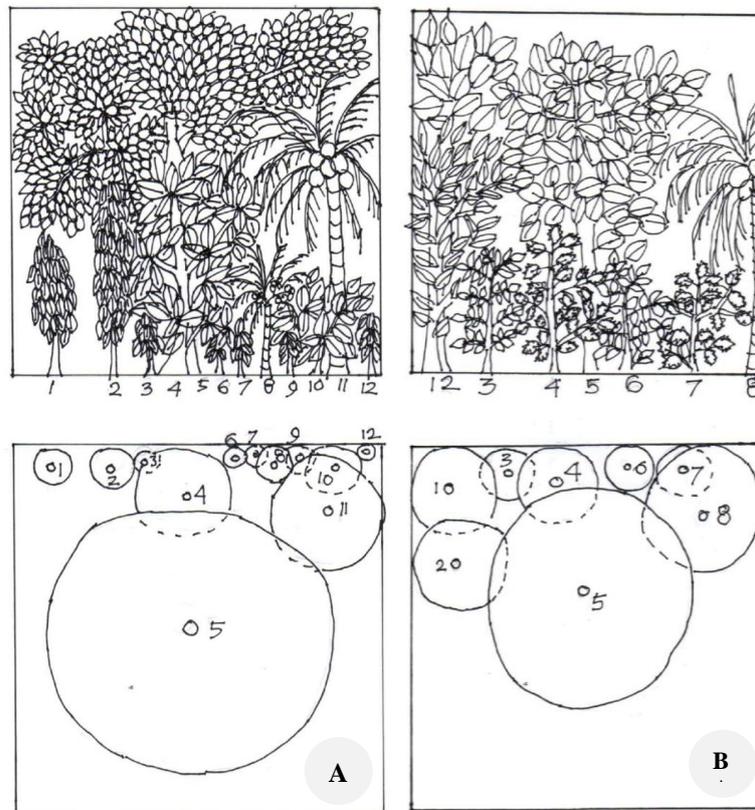
On Nusa Penida Island, several Bali myna predators and animal nuisances disturb Bali myna nests, as presented in Table 2.

Bali myna nest nuisance animals such as *O. glaber*, and Bali myna predators such as *G. gecko*, as shown in Figure 4.

Results of in-deep interviews (N = 50) with the people of Nusa Penida Island, as shown in Figure 5.



**Figure 4.** Bali myna bully and predatory animal: A. *Ochetellus glaber* (Mayr); B. *Gekko gecko* (Linnaeus) (Foto: FNPF)

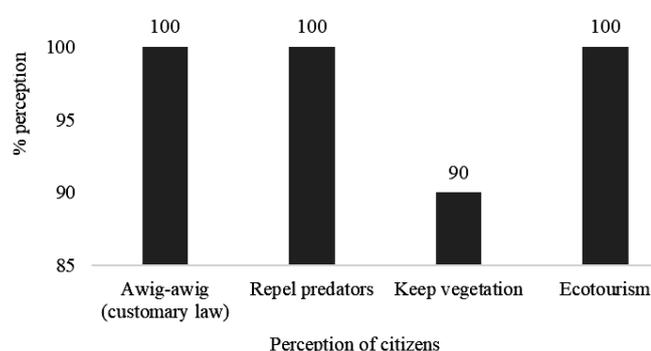


**Figure 3.** Vegetation profile of habitat Bali myna: A. Ped Village: 1,2,3,6,7,9,12 *Monnon longifolium* Sonn.B.Xue & RMK. Saunders, 4,10 *Ficus glabella* Bl., 5 *Samanea saman* (Jasq.) Merr, 8 *Veitchia merillii* (Becc.) HE Moore, 11 *Cocos nucifera* L., B. Toyapakeh Village: 1 *Mangifera indica* L, 2 *Tectona grandis* L.f, 3,6 *Gliricidia sepium* Walp, 4,7 *Muntingia calabura* L., 5 *Ficus glabella* Bl., 8 *Cocos nucifera* L.

**Table 2.** Bali myna bully or predatory animal

Species	Vernacular name	Location	Criteria	Description
<i>Trigona itama</i> Cockerell, 1981	Kelulut bee	Ped Village	Intruding	abundant
<i>Ochetellus glaber</i> (Mayr, 1862)	The black household ant	Toyapakeh Village	Intruding	few in number
		Ped Village	Intruding	abundant
<i>Gekko gekko</i> (Linnaeus, 1758)	Tokay gekko	Toyapakeh Village	Predator	abundant
		Ped Village	Predator	few in number
<i>Varanus salvator</i> (Laurenti, 1768)	Asian water monitor	Toyapakeh Village	Predator	abundant
		Ped Village	Predator	few in number
<i>Malayopython reticulatus</i> (Schneider, 1801)	Reticulated python	Toyapakeh Village	Predator	few in number
		Ped Village	Predator	few in number
<i>Spilornis cheela</i> (Latham, 1790)	Crested serpent eagle	Ped Village	Predator	few in number

Note: Abundant: during the study, found more than 10 X, few in number: during the study, found less than 5 X

**Figure 5.** Nusa Penida Island people's perception of Bali myna conservation

## Discussion

### Population Bali myna

In 2021 Bali myna in Ped Village, there are 58 birds, and in Toyapakeh Village 4 birds. In 2022 in Ped Village 102 birds, and in Toyapakeh Village 6 birds (Table 1). Bali myna distribution in Ped Village and Toyapakeh Village, at an altitude of 0-150 asl. This is in accordance with the statement of van Balen et al. (2000), that Bali myna is a lowland bird, but can live at an altitude of 150-250 asl. The distance between Ped Village and Toyapakeh Village is approximately 6 km; the agroforestry area in Ped Village is 1480 ha and in Toyapakeh Village is 528 ha. Bali myna's home range on Nusa Penida Island is 5.79 ha, because the vegetation producing bird food on Nusa Penida Island is evenly distributed and available throughout the year (Sudaryanto et al. 2020; Sudaryanto 2021). Therefore, it is suspected that the carrying capacity of Ped Village can accommodate approximately 240-250 Bali myna birds, and Toyapakeh Village approximately 85-90 Bali myna birds. So for now, the carrying capacity of Nusa Penida Island is still able to support the existence of the existing Bali myna. In BBNP home range Bali myna covers an area of 23 ha (Sudaryanto et al. 2020), the distribution depends on bio-ecological conditions and habitat conditions (availability of food, water, shelter, and nesting sites) (Hernowo and Haquesta 2021). According to Patten et al. 2019, the size of the home range is the key to the management and conservation of the species.

### Vegetation analysis and habitat profile of Bali myna

Vegetation in Ped Village and Toyapakeh Village is relatively the same, with a similarity index of 94.11%. The dominant trees are *F. glabella*, *M. indica*, and *M. calabura* (Figure 2). Bali myna sleeps on *S. saman* and *F. glabella* trees, according to Sudaryanto et al. (2020) and Sudaryanto (2021) usually on *M. indica* trees. So, Bali myna chooses to sleep on trees whose canopy is thick, wide, and lush. Bali Myna on Nusa Penida Island is mostly active in agroforestry areas (94%). In agroforestry, 45 species of plants are used for foraging and resting activities. For example, *F. glabella*, *M. calabura*, *T. grandis*, *M. indica*, and *C. nucifera*. There are also many insects on these trees, which are the food source for Bali myna (Sudaryanto et al. 2015). According to Miller et al. 2022, Bali myna, especially juveniles, has low neophobia, so the bird easily gets food.

In addition to the nest box that has been provided, Bali myna on Nusa Penida Island also nests in tree cavities: *Avicennia marina* (Forssk.) Vierh, *Arenga pinnata* Merr, *Artocarpus altilis* (Park.) Forsberg, *C. nucifera*, *Ficus rumphii* Blume, *F. benjamina*, *F. glabella*, *Leucaena glauca* (L.) Benth, *Tamarindus indica* L., and *Psidium guajava* L. (Sudaryanto et al. 2015; Sudaryanto et al. 2020). Bali myna cannot make its own holes for nesting, so the presence of holes in trees is one of the important components in the habitat of Bali myna (Hernowo 2017; Sudaryanto et al. 2020). Trees that are widely used by Bali myna to perch and sleep in BBNP consist of; *Acacia leucophloea* (Roxb.) Willd. (48.1%) and *Schoutenia ovata* Korth. (17%). Other trees, *Grewia koordersiana* Burret, *Albizia lebbek* (L.) Benth, *Phyllanthus emblica* L, *Schleichera oleos* (Lour) Oken, *Azadiracta indica* A. Juss, *Terminalia microcarpa* Decne (Sudaryanto et al. 2015; Sutomo and van Etten 2021, Pramata et al. 2022).

Bali myna on Nusa Penida Island mainly eats fruit: *Carica papaya* L., *M. calabura*, *Syzygium cumini* (L.) Skeels, *F. glabella*, *F. rumphii*, *Annona muricata* L., *L. camara*, *M. indica*. According to Sudaryanto et al. (2020), the dominant fruits eaten by Bali myna in Nusa Penida are *F. glabella* 44.0%, while *C. papaya*, *M. calabura*, *M. indica*, *S. cumini* range from 6.0-12.0%. At BBNP, Bali myna only eats *L. camara*, *M. calabura*, and *P. emblica*

(Sudaryanto et al. 2015; Hernowo and Haquesta 2021). According to Sudaryanto et al. (2020), Bali myna food insects in Nusa Penida are larvae of *Oecophylla smaragdina* Fabricius, 1775, *Coptotermes curvignathus* Holmgren, 1913, *Valanga nigricornis* Burmeister, 1838, *Sarcophaga aurifrons* Macquart, 1846, and *Musca domestica* Linnaeus, 1758. These insects are commonly found on trees around nests or on the body of cows. Food quality and availability are among the most important components influencing fitness (Wilcoxon et al. 2015) and bird reproduction (Valle et al. 2015; Crates et al. 2016).

The abundance of food sources and nesting sites in agroforestry causes the home range of Bali myna on Nusa Penida Island to be only 5.79 ha, compared to 23 hectares in BBNP (Sudaryanto 2021). Therefore, in BBNP the nesting locations are spread over a large area (Pramatana et al. 2017). This shows the quality of habitat on Nusa Penida Island is better than in BBNP. According to Ofstad et al. (2016) and Godet et al. (2018), that wider roaming area shows habitat with less good quality, so birds have to forage to a wider area. Daily movement patterns of birds also differ between habitats due to differences in the spatial distribution of resources (Rechetelo et al. 2016; Ogawa et al. 2022). Food availability appears to be an important factor regulating the dynamics of the roaming area throughout the year (Rühmann et al. 2019; Chen and Antonelli 2020). The area of the home range can also be influenced by competition (Gregory 2017; Prati et al. 2021), competition between Bali myna and *Acridotheres melanopterus* Daudin, 1800 and *Acridotheres javanicus* Cabanis, 1851 in the grasslands of Nusa Penida Island, so that Bali myna only 3% visit pastures.

#### *Bali myna nuisance and predator animal*

On Nusa Penida Island, Bali myna nuisance animals, namely: *T. itama*, and *O. glaber*, both animals often make nests in Bali myna nest boxes. Bali myna predatory animals are; *G. gecko*, *V. salvator*, *M. reticulatus*, *S. cheela* (Table 2, Figure 4). *Gekko gecko* is a predator of Bali myna eggs, while *V. salvator*, *M. reticulatus*, and *S. cheela* are predators of young or adult Bali myna. According to Sudaryanto et al. (2020), *G. gecko* and *V. salvator* are often found around the Bali myna nest box in Ped Village. *Gekko gecko* was even found in a nest box eating Bali myna eggs, and *V. salvator* preying on young Bali myna. In general, these predatory and intruding animals are found in Ped Village. It is suspected that some Bali myna moved from Ped Village to Toyapakeh Village, due to a large number of nesting disturbing animals in Ped Village.

At BBNP, the level of security of Bali myna against predators is still lacking (Hernowo and Haquesta 2021). According to Amarasinghea et al. 2021, in BBNP found egg-eating reptiles and Bali myna such as *G. gecko*, *Cyrtodactylus jatai* Amarasinghe, Riyanto, Mumpuni & Grismer, 2020, *V. salvator*, *Trimeresurus insularis* Kramer, 1977, and *M. reticulatus*.

#### *The role of awig-awig (customary law)*

As a result of in-depth interviews, all communities on Nusa Penida Island are willing to apply *awig-awig* to

protect Bali myna. The community has a good perception of *awig-awig* protecting Bali Myna. Until now, no community has disturbed Bali myna (Wirayudha 2015; Sudaryanto 2021). However, Mattison (2016), a member of an NGO from the USA, does not believe that the community obeys *awig-awig* and does not interfere with Bali myna. In Petulu Village, Ubud, Bali, Indonesia, the community also implements *awig-awig*, to protect the Cattle egret (*Bubulcus ibis* L.). Therefore, in February 2020 in Petulu Village, Ubud, Bali, there were  $7053 \pm 15$  *B. ibis* (Sudaryanto et al. 2022).

*Awig-awig* includes prohibitions, sanctions, and wisdom values to preserve nature and harmonize the social environment based on the concept of *Tri Hita Karana* (THK). In Hinduism, THK philosophy is based on the harmonious relationship between man and his God, man with his environment, and with his fellow man. *Awig-awig* applies to indigenous villagers as well as immigrants (Yusa and Dharmawan 2018; Sudaryanto 2021). *Awig-awig* does not contradict the law of the Unitary State of the Republic of Indonesia, and also international law (Yusa and Dharmawan 2018). *Awig-awig* also guarantees anyone who wants to do business activities traditionally in the village (Resen and Dyatmikawati 2016). The success of the *awig-awig* story in protecting ecosystems and biodiversity is also found in Tenganan Village (Sumarmi et al. 2020), Pandan Village, Banten Strait, Buleleng (Windari 2019), and Petulu Village, Ubud, Bali (Sudaryanto et al. 2022). Similar to *awig-awig* is customary law and taboo in Nigeria (Jimoh et al. 2017). According to Isyanto et al. (2023) that conservation can make a significant contribution to the preservation of natural resources and the environment. Community support for local wisdom plays an important role in its implementation in a conservation-carrying capacity.

In BBNP Bali myna's security level is still low (Hernowo and Haquesta 2021), because it does not have *awig-awig* that protects Bali myna. Therefore, the security of Bali myna on Nusa Penida Island is more maintained. According to Jepson (2016), saving a species from extinction is a key principle of conservation.

From this research, it can be concluded that in 2021 in Ped Village there is 58 Bali myna, and in Toyapakeh Village there is 4 Bali myna. In 2022 in Ped Village, there is 102 Bali myna, and in Toyapakeh Village there is 6 Bali myna. The carrying capacity of Nusa Penida Island; is still able to accommodate Bali myna. On Nusa Penida Island food sources of fruits and insects are abundant. Simply nest box or tree hole to make a nest. In 2022 there are 40 nest boxes, while the active nest boxes used by Bali myna are only 26. Bali myna nest nuisance animals are *T. itama* and *O. glaber*, while predators are *G. gecko* and *V. salvator*. It is suspected that some Balinese myna moved from Ped Village to Toyapakeh Village, because of the large number of nuisance animals in Ped Village. Until now, the people of Nusa Penida Island, still carry out *awig-awig* to protect Bali myna.

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