

Population Study of Tokay Gecko (*Gekko gekko*) in Bali Province, Indonesia (Studi Populasi Tokek Rumah (*Gekko gekko*) di Provinsi Bali, Indonesia)

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ABSTRACT

The tokay gecko (*Gekko gekko*) is known to be one of the species that plays an important role in the ecosystem, especially in controlling pest populations (locusts, mosquitoes, crickets and moths). Tokay geckos also have a high need for medical care purposes and pets. verexploitation and territorial conversion affect tokay gecko populations. this research to conduct a survey and extrapolation of the gecko population in Bali province. The survey was done through a visual survey of dating with three different methods; face-to-face video interview and meeting (IDVE), direct eye contact (DVE) and habitat survey (HS). The survey was conducted in nine districts in Bali from December 2021 to January 2022 with a total of 20 survey points. The total sample area for this study is 56.84 hectare (ha) with 842 individuals of tokay geckos were recorded during the survey. Out of a total of 578,006 hectares area of the province of Bali, about 54% of the total area is a potential area for tokay gecko habitat. The estimated number of tokay geckos in Bali province from this study is 4 million individuals. Result habitat preferences of tokay geckos in Bali province in this study are valuable baseline data for policy producer in determining tokay gecko catch quota.

Keywords: tokay gecko, population extrapolation, Bali, visual encounter survey

ABSTRAK

Tokek Rumah (*Gekko gekko*) dikenal sebagai salah satu spesies yang penting secara ekologi, misalnya sebagai pengontrol hama belalang, jangkrik, nyamuk dan ngengat. Manfaat lain dari tokek rumah diantaranya adalah sebagai obat tradisional dan hewan peliharaan. Pengambilan berlebih tokek rumah dan perubahan habitat alaminya membuat populasi tokek rumah semakin terancam. Penelitian ini bertujuan untuk melakukan perhitungan populasi tokek rumah di Provinsi Bali. Survey dilakukan dengan tiga metode berbeda; wawancara dan pengamatan langsung atau *interview and direct visual encounter* (IDVE), pengamatan langsung atau *direct visual encounter* (DVE), dan habitat survei atau *habitat survey* (HS). Survei dilakukan di sembilan kabupaten dan kota di Bali mulai bulan Desember 2022 hingga Januari 2023 dengan total 20 titik pengamatan. Total area yang diamati adalah 56,84 hektar (ha) dengan total individu yang diamati sebanyak 842 individu. Sebanyak 54% dari total area Provinsi Bali, merupakan daerah yang potensial menjadi habitat tokek rumah. Total perkiraan populasi tokek rumah di Provinsi Bali mencapai 4 juta individu. Hasil penelitian ini diharapkan menjadi dasar acuan bagi pengambil kebijakan guna penentuan kuota pemanfaatan tokek rumah di Provinsi Bali.

Kata Kunci: tokek rumah, populasi, Bali, *visual encounter survey*

INTRODUCTION

The tokay gecko (*Gekko gekko*) is one of the most common reptiles species distributed in Northeast India, Southeast Asia, and Papua New Guinea. The native habitat is in trees, cliffs in the rainforest, and also found in housing or buildings in the rural areas (Carranza & Arnold 2006;

Fauzan *et al.* 2022). The tokay gecko has characteristics such as thick, cylindrical bodies, with heads set apart from their necks. They have gray coloration with red or black spots (McKay 2006). Generally, Tokay geckos has Snout Vent Length (SVL) 25-35 cm and have a distinctive sound so they have a local name in Bali as "Toke". In the Balinese community, tokay geckos are

believed to bring good luck if they are present in a house.

The tokay gecko has an important ecological value. Tokay geckos have a role in maintaining the balance of the ecosystem because geckos are natural predators for insects which in some area can be a pest for agricultures (Kurniati *et al.* 2023). At the same time, tokay gecko also exported to several countries in Asia in dry conditions for medical purposes (Bauer, 2009; Njiman *et al.* 2012; Caillabet 2013; Kurniati 2019, 2023). Apart from being a medicinal commodity, geckos are also demanded as pets and generally mated with other types to get a unique animal. The economical demand of this species will threaten their population in the wild, since majority of the animals were harvested from the wild (Ardiantoro *et al.* 2021). The importance of the role of geckos ecologically and its economic benefit causes the need for populations study in their natural habitat. This is important since *Gekko gecko* was designated as a species included in the CITES appendix II list in 2019.

Based on Kuriniati (2019; 2020), population studies of tokay gecko were conducted by interview and direct observation. The interview method will allow us to get the information from the people and also get information about the house type, the surrounding habitat and also information about local wisdom related with tokay gecko. This information will be a basis for the direct observation where the researcher can focus to look at certain places around the area. The extrapolation for population study also needs to pay attention to some places that might not be the choice for the tokay gecko, for example water bodies, places with altitude more than 1000 m above sea level. As for the catch limit, we have to exclude the protected area including the protected forest since it will forbid the catch.

The large number of export quota requests for tokay geckos has caused the BKSDA to issue a quota or catch limit for tokay geckos. In 2021 additional quotas were requested so that catch permits are extended to several provinces in Indonesia, including the Bali Province. For this reason, we conduct this study to survey and extrapolate the gecko population in Bali Province and see the habitat preferences of tokay geckos in Bali Province as baseline data for policy making in

determining catch quotas.

MATERIALS AND METHODS

This study was conducted through a visual encounter survey (McDiarmid *et al.* 2012) in nine regencies in Bali from December 2021 to January 2022 with a total of 20 survey points (Figure 1; Table 1). The visual encounter survey was divided into three different methods; interview and direct visual encounter (IDVE), direct visual encounter (DVE), and habitat survey (HS).

The IDVE method was conducted by interviewing the respondent before conducting the direct visual encounter method. The respondents are the house owner in the sampling area. The respondent was asked whether they experienced any encounter with tokay geckos inside or outside the house and tried to get information on the possible number of individuals. The interview results were used as a basis to conduct the direct visual encounter method in the evening. We will only survey the house with the possible present of tokay gecko. The DVE method is the same as IDVE except the surveyor did not include any interviews before the visual census. The surveyor will directly survey the outside or inside the houses and count the number of the tokay gecko encounter. The last method, HS, was conducted in an area without any housing or buildings. It is usually a small path of 10 meter length outside a field or rice field. The surveyor will go through this path and survey the trees and bushes on each side of the path, and count the number of tokay geckos encountered for a certain distance.

The data collected during the survey includes the description of the habitat in general, the number of houses surveyed, the number of individual tokay geckos with direct encounter methods, the total observation area, and the picture of the tokay gecko that will be uploaded into *iNaturalist* apps (<https://www.inaturalist.org>).

The total of the observation area was pre-determined using *Google Earth* (<https://earth.google.com/web/>). Then the population density (based on the interview or visual encounter divided by the total observation area was determined and later called "A" area. The total area of each regency (called "a") was

determined using the data from the Central Bureau of Statistics or Badan Pusat Statistik (BPS, 2023) and then from that area, we also determined the area that was not potential for tokay gecko habitat (called “b”) including rice field, protected forests, production forest, water

bodies (land aquaculture, ponds, lake, dams, and rivers), and also mountains with elevation more than 1,000 meters above the sea level. The total area that has potential for tokay gecko habitat was later called “B” area. The B area is the total area of each regency (“a”) minus the area that

Table 1. The list of sampling locations, survey date, and the survey methods for the population study of tokay gecko (*Gekko gekko*) in Bali Province, Indonesia, December 2021 - January 2022. The IDVE is abbreviation for Interview and Direct Visual Encounter; DVE is Direct Visual Encounter, and HS is Habitat Survey.

Regency	Location	GPS Points	Elevation (ASL)	Survey Date	Survey Method
Jembrana	Desa Tuwed	8°19'20.13" S, 114°32'03.25" E	12	January 12-13, 2022	DVE
Tabanan	Desa Pacung	8°20'17.98" S, 115°11'21.19" E	803	January 06-08, 2022	DVE
	Desa Antapan	8°19'14.77" S, 115°11'52.11" E	200	January 06-08, 2022	DVE
	Desa Marga	8°27'00" S, 115°10'28" E	320	January 7, 2022	HS
	Desa Perean	8°25'51" S, 115°11'54" E	404	January 7, 2022	HS
Badung	Desa Adat Bualu	8°47'28.12" S, 115°13'21.16" E	4	January 9-10, 2022	IDVE
	Desa Sedang	8°27'03" S, 115°10'27" E	324	January 6, 2022	HS
Gianyar	Desa Padang Tegal	8°30'50.11" S, 115°15'50.36" E	183	January 6-7, 2022	DVE
	Desa Ubud	8°30'26.00" S, 115°15'45.15" E	183	January 6-7, 2022	DVE
	Desa Singapadu	8°35'27" S dan 115°15'00" E	84	January 4, 2022	HS
	Desa Batubulan	8°34'45.94" S, 115°15'12.09" E	92	January 4, 2022	HS
Klungkung	Desa Manduang	8°31'13.43" S, 115°23'26.61" E	156	January 10-11, 2022	DVE
	Desa Pakse Bali	8°31'19.89" S, 115°23'45.04" E	138	January 10-11, 2022	DVE
	Nusa Penida1	8°40'47.84" S, 115°31'00.80" E	32	January 5-7, 2022	DVE
	Nusa Penida2	8°41'01.64" S, 115°31'04.76" E	57	January 5-7, 2022	DVE
	Desa Bakas	8°31'46" S, 115°21'58" E	115	January 5, 2022	HS
Bangli	Desa Taman Bali	8°30'12" S, 115°21'02" E	254	January 10-11, 2022	DVE
Karangasem	Desa Tulamben	8°18'02.41" S, 115°36'44.72" E	22	December 15-16, 2022	IDVE
Buleleng	Desa Sulanyah	8°11'48.07" S, 114°56'38.26" E	90	January 6, 2022	IDVE
Denpasar	Desa Sanur Kaja	8°40'44.12" S, 115°15'19.92" E	11	January 20-21, 2022	IDVE

* Metres Above Sea Level

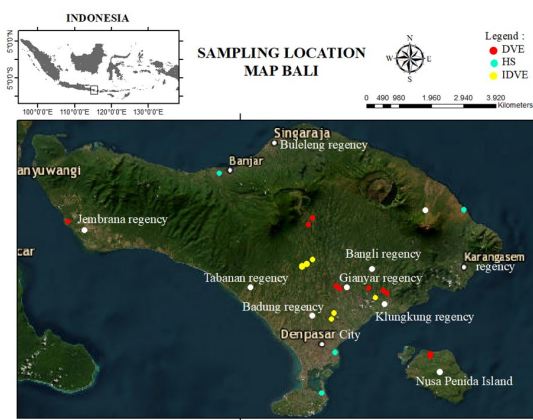


Figure 1. Map of sampling location for the population study of tokay gecko (*Gekko gekko*) in Bali Province, Indonesia, December 2021 - January 2022. The red dot represents the Direct Visual Encounter (DVE), and the blue dot represents the Habitat Survey (HS), and the yellow dot represents the Interview and Direct Visual Encounter (IDVE).

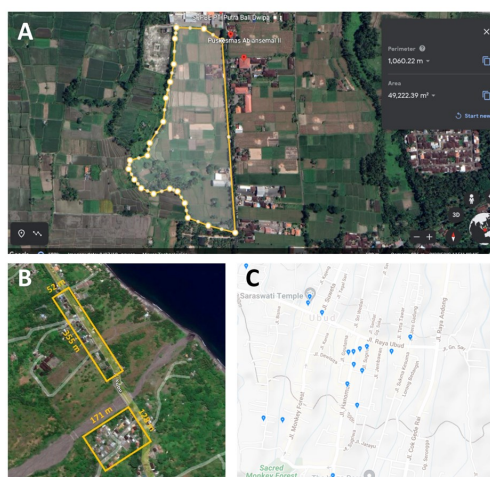


Figure 2 Maps of (A) sampling sites from habitat survey (HS), (B) extrapolation of sampling area from interview and direct visual encounter (IDVE), and (C) the visualization of sampling points from iNaturalist apps.

does not have the potential to become a tokay gecko habitat (“b”). The population estimation of the tokay gecko is $A \times B$ area.

RESULTS

The total sampling area of this study is 56.84 ha, covering nine regencies in Bali Province, Indonesia. The survey method was divided into three methods, interview and direct visual encounter (IDVE), direct visual encounter (DVE), and habitat survey (HS) because of the difference in habitat and condition in every sampling point. There were a total of 20 sampling points, with four sampling points observed with IDVE, 10 points with DVE, and six points with HS method (Table 2). Overall, 525 houses or buildings were surveyed, with 842 individuals of tokay gecko listed from the direct encounters surveys.

Description of Study Locations

Bali is one of the provinces in Indonesia which covers 578.006 ha area consisting of one big Island, Bali, and several small neighboring islands notably Nusa Penida, Nusa Lembongan, and Nusa Ceningan. In general, Bali Province consists of lowlands and mountains including Mount Batur and Mount Agung, the highest mountain in Bali with 3,000 meters above sea level. Agriculture and tourism are two of the economic foundations of Bali and to be the major livelihood for Balinese people (BPS, 2023).

Surveys were conducted in 20 locations in nine regencies with different types of habitat in Bali Province (Table 1). The survey location in Buleleng Regency, Gianyar, Badung and Denpasar were characterized by a densely populated area. The housing type was dominated by permanent houses with a concrete wall. There were not many open spaces such as rice fields or open fields. The houses were closed to each other and usually separated by a street or an alley.

The survey locations in Tabanan, Bangli, Klungkung, Jembrana Regency are characterized by small clusters of housing with rice fields and also open fields. Although most of the houses were built with bricks and concrete, some people still use “*Gedeg*” (a mat woven from strips of bamboo) as a wall. The house ceiling usually opens as you still can see the wooden structure of

the house roof. Those are some of the perfect habitats for tokay geckos. At the back of the house, we usually found a green field with a couple of big trees and bushes. The tree species were plumeria (*Plumeria* sp.), banana (*Musa* sp.), *Ficus* sp., cassava (*Manihot* sp.), lemongrass (*Cymbopogon citratus*) and *Brassica* sp. Tokay geckos were also spotted on the plumeria trees in the house yard. During the habitat survey, we also observed the tokay geckos at the trees next to the rice field, such as *Ficus* sp., *Cocos nucifera*, *Musa* sp., and *Saccharum officinarum* (sugarcane).

The other survey locations, such as Karangasem Regency and Nusa Penida Island have a different habitat characterization. The survey in Karangasem Regency (Desa Muntig) was located in a village next to the beach. The location was arid, with the typical dry soil and not so many trees. The study found the individual tokay gecko in the coconut tree (*Cocos nucifera*) that spread across the shoreline. Nusa Penida Island has the same characteristic with Desa Muntig in Karangasem. Nusa Penida is a small island in southeast Bali with a total area of 19.272 Ha. The tokay gecko found in Nusa Penida were usually in the housing and also in a couple of tree such as *Gliricidia sepium* (leguminous tree belonging to the family Fabaceae and in Indonesia known as “*Gamal*”), coconut tree (*Cocos nucifera*), and papaya (*Carica papaya*).



Figure 3. Different habitats of tokay gecko (Gekko gecko) in Bali, (A) house roof, (B) inside the house, (C) and (D) the house wall made of concrete or wood.

Table 2. The results from interview and observation for the population study of tokay gecko (*Gekko gekko*) in Bali Province, Indonesia, December 2021 - January 2022.

Regency	Survey Date	Location	Survey Method	Number of House Surveyed	Number of Tokay geckos from the Interviews	Numer of House with Tokay gecko from the Interview	Number of Tokay geckos from the Observation	Survey Area (Ha)	Density from the Interview	Density from the Observation
Jembrana	12-Jan-22	Ds. Tuwed	DVE	45	43	34	58	6.94	6.20	8.36
	Total			45	43	34	58	6.94	6.20	8.36
Tabanan	6-Jan-22	Ds. Pacung	DVE	9	24	7	17	0.75		
	6-Jan-22	Ds. Antapan	DVE	26	80	14	40	1.42		
	7-Jan-22	Ds. Antapan	DVE	39	52	13	22	1.92		
	8-Jan-22	Ds. Antapan	DVE	25	0	21	36	2.42		
	7-Jan-22	Ds. Marga	HS	0	0	0	24	2.31		
	7-Jan-22	Ds. Peresan	HS	0	0	0	15	0.77		
Total			99	156	55	154	9.59	16.27	16.06	
Badung	9-Jan-22	Ds. Adat Bualu	IDVE	86	115	63	55	9.43		
	6-Jan-22	Ds. Sedang	HS	0	0	0	46	1.96		
Total			86	115	63	101	11.39	10.10	8.87	
Gianyar	6-Jan-22	Ds. Padang Tegal	DVE	46	48	11	21	3.52		
	7-Jan-22	Ds. Ubud	DVE	22	25	11	22	0.54		
	4-Jan-22	Ds. Singapadu	HS	0	0	0	26	2.37		
	4-Jan-22	Ds. Batubulan	HS	0	0	0	4	0.22		
	Total			68	73	22	73	6.65	10.97	10.97
Klungkung	10-Jan-22	Ds. Manduang	DVE	0	75	74	111	2.35		
	11-Jan-22	Ds. Manduang	DVE	0	0	3	4	0.27		
	11-Jan-22	Ds. Pakse Bali	DVE	0	0	5	18	0.59		
	5-Jan-22	Nusa Penidal	DVE	17	11	17	34	0.50		
	6-Jan-22	Nusa Penida2	DVE	29	18	29	36	3.02		
	5-Jan-22	Ds. Bakas	HS	0	0	0	32	1.29		
Total			46	104	128	235	8.02	12.97	29.31	
Bangli	10-Jan-22	Ds. Taman Bali	DVE	0	92	57	97	2.57		
	11-Jan-22	Ds. Taman Bali	DVE	0	38	27	43	2.48		
Total			0	130	84	140	5.05	25.74	27.72	
Karangasem	15-Dec-21	Ds. Tulamben	IDVE	61	48	29	28	4.03		
	15-Dec-21	Ds. Tulamben	IDVE	6	12	3	23	0.76		
Total			67	60	32	51	4.79	12.52	10.64	
Buleleng	7-Jan-22	Ds. Sulanyah	IDVE	80	84	64	18	3.9		
Total			80	84	64	18	3.9	21.54	4.62	
Denpasar	21-Jan-22	Ds. Sanur Kaja	IDVE	34	19	10	12	0.5		
	Total		34	19	10	12	0.5	38.00	24.00	

Remarks: The IDVE is abbreviation for Interview and Direct Visual Encounter; DVE is Direct Visual Encounter, and HS is Habitat Survey.

The Population of *Gekko gekko* in Bali Province

The results of tokay gecko's population estimation shows different density between sampling locations and between regency. The highest density from direct observation is in Klungkung Regency (29 individuals per ha), meanwhile the lowest 4.62 individuals per ha in Kabupaten Buleleng. When we compare the density between interview and direct observation, there is not much difference, except in Klungkung, Buleleng, and Denpasar (Table 3). In Klungkung, the interview resulted in the high number of tokay geckos compared with direct observation, meanwhile in Buleleng dan Denpasar, the results from the interview showed lowest in density compared with direct observation (Table 3).

Interview data shows that most of the respondents were not afraid of geckos. Overall the number of tokay geckos based on interviews is lower than the actual observation. This might be because the respondent over-estimated the number of tokay geckos in their house. Most of the respondents also said that they do not intend to kill the tokay gecko in their house because they believe that tokay gecko will bring good luck if it is present in a house.

The extrapolation results were based on the total sampling area in every regency. The regency with the widest area is Buleleng with a total 136,000 ha. Meanwhile the smallest area is Denpasar with 12,700 ha (Table 3). Based on the total area, Buleleng regency is the one with the highest potency for tokay gecko habitat and Denpasar is the lowest potency. From the total of 578,006 ha area of Bali's province, the potential habitat for tokay gecko is 309,547 ha or about 54% of the total area of Bali Province. Based on that data, the highest number of tokay geckos were estimated in Tabanan regency with a total estimated 866,784 individuals and the lowest is in Denpasar with 230,846 individuals. The total estimation of the tokay gecko population in Bali Province from this study is 4 million individuals (Table 3).

DISCUSSIONS

The tokay gecko (*Gekko gekko*) is one of the reptiles that is widely used for pets and

traditional medicine (Su *et al.* 2020; Mardiasuti *et al.* 2021). The demand for tokay gecko exports from Indonesia is increasing. The BKSDA (Balai Konservasi Sumber Daya Alam or Natural Resources Conservation Agency) as the institution authorized to regulate animal and plant regulations in Indonesia needs to calculate the population of geckos in several places in Indonesia, including Bali Province. Sampling activities were conducted from December 2021 to January 2022. Sampling was carried out in nine districts in Bali with 20 location points with a total sampling area of 56.84 ha (Table 3). The survey was conducted using three methods, namely interview and direct visual encounter (IDVE), direct visual encounter (DVE), and habitat survey (HS). The population density of the tokay gecko in 9 districts in Bali varies greatly depending on regional conditions. The total estimation of the tokay gecko population in Bali Province from this study is 4 million individuals. This is an important matter for policy making on export and use of tokay geckos in Indonesia, especially in the province of Bali.

In general, the difference in gecko density in several locations in Bali is due to different habitat types from the observation area. Some of the locations selected were densely populated, but some were areas with less dense housing and more trees. The type of building is also an influential factor. Houses that are still traditionally built are generally an option for tokay geckos, rather than modern housing. The type of traditional house in Bali that has an open ceiling is one of the reasons for the large number of tokay geckos observed, including several locations with many eggs.

The Bali island has a total land area approximately 578,000 ha with a population density of 774/km² (BPS 2023). There are about 46% of the total area of Bali Island that is considered not potential and is not included in the calculation or extrapolation of the tokay gecko population. These areas include land aquaculture, ponds, lakes, dams, and rivers. Some areas or cities in Bali become residential and economic centers, such as the cities of Denpasar, Badung and Gianyar. However, some areas on the Bali island are dominated by

Table 3. The population estimation of tokay gecko (*Gekko gekko*) in Bali Province, Indonesia, December 2021 - January 2022.

	Regency	Jembrana	Tabanan	Badung	Gianyar	Klungkung	Bangli	Karangasem	Buleleng	Denpasar	Total
Total are of Regency (Ha) (a)	84.180,00	101.388,00	41.862,00	36.800,00	31.500,00	49.071,00	83.954,00	136.473,00	12.778,00	578.006,00	
Total not-potential habitat area a for house geckos (b)											
- Agricultural Area	6.758,00	21.089,00	9.938,00	14.320,00	3.779,00	2.876,00	7.151,00	10.335,00	2.409,00	78.655,00	
- Forest Area	43.370,13	10.196,82	1.717,73	0,00	1.048,50	9.341,28	20.907,21	51.927,15	734,50	139.243,32	
- Total water area	1.419,08	500,56	1.407,65	202,26	22,02	2.017,80	6.765,00	1.043,72	15,90	13.393,99	
- Mountain Area	0,00	15.630,00	0,00	0,00	0,00	13.992,50	7.544,00	0,00	0,00	37.166,50	
Total potential habitat area (B = a-b)	32.632,79	53.971,62	28.798,62	22.277,74	26.650,48	20.843,42	41.586,79	73.167,13	9.618,60	309.547,19	
Survey Results											
- Total Observation Area	6,94	9,6	11,39	6,65	8,02	5,05	4,79	3,9	0,5	56,84	
- Number of House Geckos from the Interviews	43	156	115	73	104	130	60	84	19	784,00	
- Number of House Geckos from the Observation	58	154	101	73	235	140	51	18	12	842,00	
- Average population density from interview results A'	6,20	16,27	10,10	10,97	12,97	25,74	12,52	21,54	38,00	154,30	
- Average population density from direct observation A	8,36	16,06	8,87	10,97	29,31	27,72	10,64	4,62	24,00	140,54	
Population Estimation based on Interview (A' x B)	202.191,64	878.118,26	290.767,45	244.386,81	345.592,26	536.563,29	520.666,61	1.575.907,42	365.506,80	4.959.700,53	
Population Estimation based on Observation (A x B)	272.723,61	866.784,22	255.369,68	244.386,81	781.125,57	577.837,39	442.483,45	337.694,45	230.846,40	4.009.251,55	

forests, rice fields or plantations, mountains and also coastal areas (Janiawati *et al.* 2016). The percentage of housing in the urban areas are quite large, making the number of tokay geckos relatively small. However, some locations that far from urban areas are still potential for the tokay gecko population. Apart from its natural habitat, tokay geckos also preferred habitat close to human settlements because the present of prey such as mosquitoes, crickets, and cockroaches (Aowphol *et al.* 2006; Manthey & Grossman 1997; Ulman & Singh 2020).

In addition to settlements, tokay geckos also choose plant as their habitats. In some places, tokay geckos were found in several trees such as *Gliricidia sepium*, coconut tree (*Cocos nucifera*), *Ficus sp.*, and plumeria (*Plumeria sp.*). Even in the Karangasem area, geckos are often found in coconut trees close to the beach. This indicates variation in habitat selection and is also associated with less human disturbance to the tokay gecko population. Some of the reasons are the belief that the gecko can bring good luck, so that not many people try to get rid of it.

By looking at the density and extrapolation of the tokay gecko in the province of Bali, we can conclude that the estimated number of tokay geckos on the island of Bali is quite high with 140 individuals per ha (Fauzan *et al.*, 2022). However, its use must be maintained. Individual collection of tokay geckos must obtain a permit or quota as determined by the BKSDA. And it is hoped that this assessment activity can be carried out continuously to monitor population development in the province of Bali. Another thing of concern is the risk of habitat change on the island of Bali itself. The high population growth causes more land use conversion into housing and hotels and will reduce the natural habitat of the tokay gecko.

CONCLUSION

This study reported that the average density of tokay geckos in the province of Bali is 140.54 individuals per ha. This tokay gecko chooses habitats in the open ceiling, walls, and trees such as *Gliricidia sepium*, coconut tree (*Cocos nucifera*), *Ficus sp.*, and plumeria

(*Plumeria sp.*). Areas that have a lot of trees have more potential for geckos compared to densely populated housing. With a total area of 578,000 Ha and the potential habitat of the gecko around 309,547 Ha, the estimated population of the tokay gecko in the province of Bali is 4 millions individuals or 140 individuals per ha. This study is very important as a basis for policy making regarding the quota for capturing tokay geckos as one of the export commodities, as well as one of the important animals in the ecological system in nature.

AUTHOR CONTRIBUTION

N.K.D.C, K.A.W, M.F.F, Q.Z, I.H.H, and B.N.R were sample collector and analysed the data and wrote the manuscript. A.R and A.H supervised all the process.

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