

## AFTER 16 YEARS: AN UPDATED CHECKLIST OF THE HERPETOFAUNA ON THE NATUNA ISLANDS, INDONESIA

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### ABSTRACT

Since the last list of amphibians and reptiles of the Natuna Islands was published nearly 20 years ago, here we provide an updated species list of the herpetofauna of these remote Indonesian islands. We compiled and summarized data from the available literature, and from our own studies conducted in 2011, 2012, 2013, 2017, and 2019. In total, 120 species of amphibians and reptiles were recorded for the Natuna Islands, which included 28 new records and six endemics. Over the past eight years, four species new to science were described from these islands, and they are: *Cnemaspis mumpuniae*, *Cnemaspis sundainsula*, *Cyrtodactylus hikidai*, and *Cyrtodactylus rosichonariefi*.

**Key words:** amphibians, distribution, list, new record, reptiles

### INTRODUCTION

Herpetofauna can be found from the lowlands to highlands and occupy various habitats and niches. Ecological circumstances in conjunction with intrinsic factors are the main aspects contributing to speciation in amphibians and reptiles (Marshall et al., 2018). The presence of amphibians and reptiles can be an essential bioindicator for the environment (Simon et al., 2011; Silva et al., 2020). Therefore, monitoring or keeping an inventory of herpetofauna species becomes important.

The Natuna Islands are a group of islands located in the South China Sea (Harkatiningsih & Wibisono, 2016), in the northernmost region of the Karimata Strait, 75-125 km Southwest of the westernmost tip of Borneo (Inger & Voris, 2001). There are two large islands, namely Bunguran Island or also called Natuna Besar Island, in the north (04° 00' N; 108° 15' E), and Serasan Island (02° 30' N; 109° 03' E) in the south, closer to Borneo (Leong et al., 2003). The highest part of this archipelago is Mount Ranai at 1000 m a.s.l.. It is reported that the flora and fauna on Natuna Island share many similarities with Sumatra, Kalimantan, and the Malay Peninsula (Whitten et al., 1987; Mirmanto, 2014). The Natuna Islands are a group of islands that previously played an important role in the distribution process of herpetofauna (Whitten et al., 1987), especially frogs and snakes (Inger & Voris, 2001), in addition to other island groups, such as the Anambas, Singkep, Bangka and Belitung. Natuna and other islands in the Riau Archipelago became a stepping stone in the process of spreading herpetofauna in the Greater Sunda Region (Whitten et al., 1987; Inger & Voris, 2001; Leong et al., 2003).

Data collection and publication on the herpetofauna of the Natuna Islands have occurred sporadically. Historically, the earliest publication on the herpetofauna of the Natuna Islands was by Günther (1895), based on a collection of specimens by A. Everret and Ernest Hose.

The publication included a short list covering 35 reptile species and 15 amphibian species, two of which were new species endemic to the islands, namely *Diplopelma bunguranum*, a synonym of *Kalophrynus bunguranus*, and *Leptobrachium natunae*, a synonym of *Leptobrachella natunae*. In the publication, it was stated that the areas that were the sites of collection were Bunguran Island and several small islands. After that, several major publications appeared, including the publications about Indo-Australian reptiles by de Rooij (1915, 1917). The first publication mentioned 16 species of turtles and lizards, while the second reported 19 species of snakes from the Natuna Islands. This publication was followed by the publication of amphibians in Indo-Australia by Van Kampen (1923), which mentioned ten frog species distributed in the Natuna Islands. Several other publications which covered the herpetofauna of the Natuna Islands followed, such as Smedley (1931, 1932), which mentioned 22 reptiles and eight amphibians, De Haas (1950) which reported 23 species of reptiles, and Inger (1966) which reported five species of amphibians.

A more recent publication on the herpetofauna of the Anambas and Natuna Islands was done by compiling published records from the previous references along with additional museum notes (Leong et al., 2003). Leong et al. (2003) mentioned a total of 63 reptiles and 27 amphibians distributed in the Natuna Islands. Based on the fact that there are still many new species or unknown species from Indonesia (Iskandar & Erdelen, 2006), it is still possible to find new records and new species from the Natuna Islands. In this study, we made an inventory of the herpetofauna in the Natuna Islands and compared them with previous studies, taking into account recent changes in taxonomy terms and misidentification.

## MATERIALS AND METHODS

### Study area:

The research was conducted in 2011, 2012, 2013, 2017, and 2019. This research focused on three islands, Bunguran Island (Great Natuna Island), Tiga Islands, and Serasan Island. (Fig. 1). Survey locations are determined based on government administrative boundaries and variations in habitat types, including settlements in Ranai, dry land in the coastal lowlands, lowland forest, and upland forest, swamps on the east coast of Bunguran Island, several small rivers in the south and east of Bunguran Island, big rivers with big rocks in the north, mangrove forests, and rubber estates. (Fig. 2). Most places have rocky formation composed by sedimentary rock and alluvium (Kausarian et al., 2018), with heights varying from 0-1000 m a.s.l.

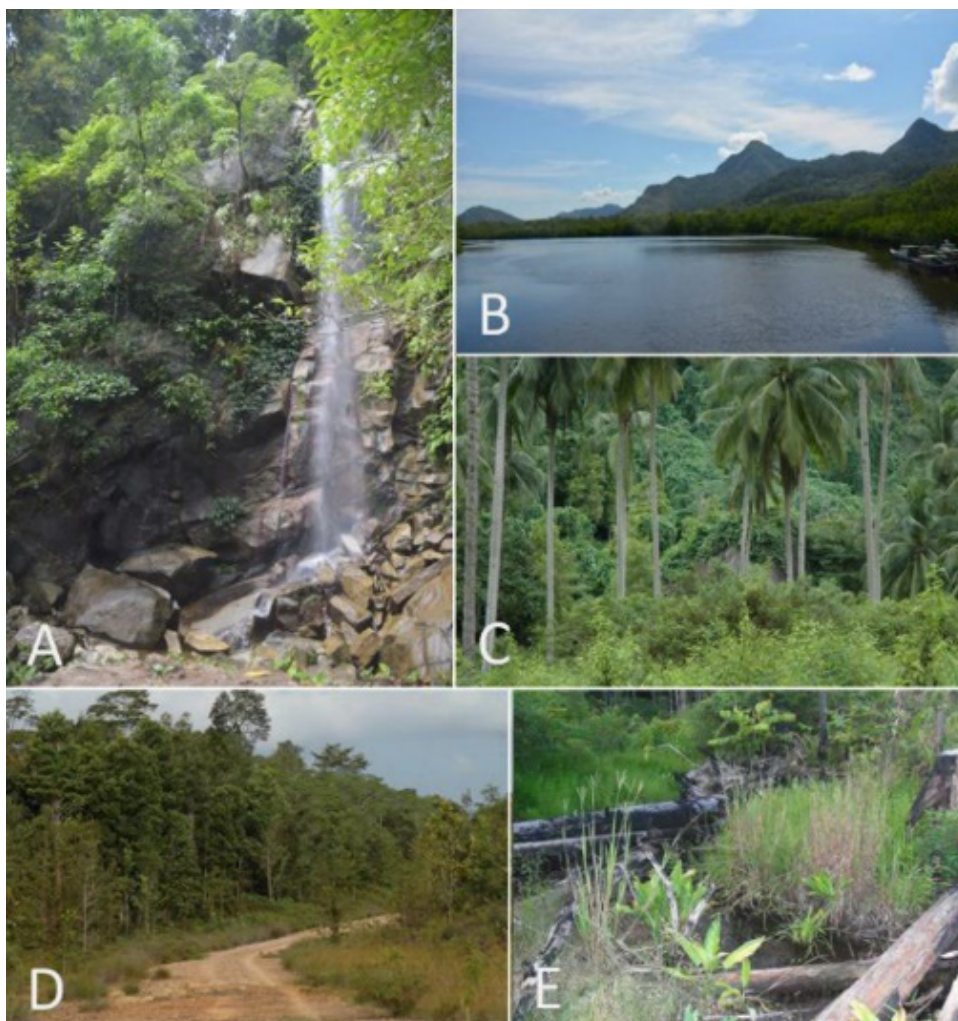
### Methods:

Primary data collection is done by team of 2-4 people through active search techniques (opportunistic search) at each habitat type. Daytime searches were conducted between 8:00 am and 3:00 pm WIB (Western Indonesian Time) and night searches were conducted between 7:00 pm and 24:00 pm WIB. The time used for surveys varies each year with minimum five survey days. We compile our survey results with previous records published (including 10 islands of Natuna and several islands unspecified, we state it as Natuna).

We wrote down the species of herpetofauna, which we are not sure about, using confer (cf) and species (sp) for the unknown species. Nomenclatural used here follow Uetz et al. (2022), and Frost (2021). IUCN red list status was obtained from IUCN red list ver. 2022-1 (IUCN, 2022).



**Figure 1.** Map of Natuna Islands, which covers all the islands that have been surveyed.



**Figure 2.** Several types of habitats for herpetofauna in the Natuna Islands. A. Waterfalls and montane forests, B. Mangrove forests, C. Coconut plantations, D. Lowland secondary forests, E. Ponds/swamps.

## RESULTS

Over the past eight years, a total of 84 species of amphibian and reptile from Bunguran Island, Serasan Island, and Pulau Tiga Islands was recorded. Natuna Islands host a total of 120 species of herpetofauna (Tables 1 & 2). The list covers 77 species of reptiles (72 squamata, one crocodilia, and four testudines) and 42 species of amphibians (42 anurans and one caecilian). This list increased the number of species in the most recent checklist published by Leong et al. (2003) who reported 90 species. A total of 28 additional records was recorded during several field trips in eight years.

Our final checklist covers 10 islands of Natuna (from 153 islands in total), and when the island was unspecified, we list it as Natuna (Nn). The list represent species found in Bunguran (98 species), Serasan (37 species), Laut (9 species), Panjang (6 species), Sadanau (1 species), Subi (1 species), Midai (3 species), Seraya (1 species), Berian (2 species), Tiga (17 species), Natuna (13 species). Based on the records, six species were endemic to Bunguran, 4 of them from the family Gekkonidae; *Cnemaspis mumpunia*, *Cnemaspis sundainsula*, *Cyrtodactylus hikidae*, *Cyrtodactylus rosichonari*, and two others belong to family Megophryidae; *Leptobranchella natunae*, and Microhylidae; *Kalophrynus bunguranus* (Fig. 3). All endemic species are found on Mount Ranai. Several important records were made, including three species that could not be determined to species level because of morphological differences with other species in the same group (*Leptobranchella* sp., *Leptobranchium* sp., and *Ichthyopsis* sp.). *Leptobranchium* sp. recorded in Leong et al. (2003) was not recorded in these trips. We split the *Chalcorana chalconota* group from Bunguran and Serasan into different species. We identified *Chalcorana chalconota* from Bunguran as *Chalcorana* cf. *labialis* and *Chalcorana parvaccola*, and from Serasan as *Chalcorana raniceps*.

### New Record's Species Account

#### Reptilia

##### Family Agamidae

*Draco formosus* Boulenger, 1900 – Dusky gliding lizard. Moderate size agamid. Snout slightly longer than orbit diameter; vertical position of nostril; tympanum smaller than eye opening; hindlimb is slightly shorter than distance between the limbs; tail is longer than SVL. Can be identified by enlarged gular flag of the male (De rooij, 1915). It was considered as synonym of *D. obscurus* by Srichairat et al. (2017).

*Gonocephalus bornensis* (Schlegel, 1851) – Borneo forest dragon. Snout slightly longer than orbit diameter; canthus rostralis sharp; tympanum smaller than eye opening; there are few enlarged tubercles behind the ear; The size of gular sac is moderately large; Tail strongly compressed with a crest at the basal part (De rooij, 1915). The length of the tail is longer than SVL. This species was recorded from foothill of mount Ranai.





**Figure 3.** Reptiles and Amphibians of Natuna Islands. a. *Calotes versicolor*, b. *Cnemaspis sundainsula*, c. *Cnemaspis mumpuniae*, d. *Cyrtodactylus hikidai*, e. *Calamaria* cf. *schlegeli*, f. *Cerberus schneiderii*, g. *Craspedocephalus puniceus*, h. *Xenodermus javanicus*, i. *Cuora amboinensis*, j. *Ingerophrynus divergens*, k. *Occidozyga* cf. *laevis*, l. *Leptobranchella natunae*, m. *Pelobatrachus nasutus*, n. *Kalophrynus bunguranus*, o. *Pulchrana glandulosa*, p. *Pulchrana signata*, q. *Nyctixalus pictus*, r. *Philautus petersi*.



### Family Gekkonidae

*Hemidactylus craspedotus* Mocquard, 1890 – Mocquard's house gecko. Snout longer than orbit diameter; forehead concave; ear opening small; two pair of chin-shields; Body depressed; a membrane borders the flanks from behind the corner of the mouth to fore limb, and from axilla to groin; tail much depressed, in each side bordered by broad fold with sharp denticulated lateral edge (De rooij, 1915).

*Hemidactylus platyurus* (Schneider, 1797) – Flat-tailed House Gecko. Snout longer than orbit diameter; forehead concave; ear opening small; two pair of chin-shields; body depressed; dermal expansion from axilla to groin and along the posterior side of the hind limb; tail depressed with sharp lateral edges (De rooij, 1915).

### Family Scincidae

*Tropidophorus brookei* (Gray, 1845) – Brook's keeled skink. Head shield slightly rugose; Tympanum smaller than the eye-opening; body slender with keeled scales; keeled scales forming eight longitudinal line on dorsal of the body; Tail slightly compressed, twice longer than body; hind limb reaches the elbow or the axilla; digits short with lamellae below. Dorsal coloration is brown with darker lighter spot. The spot sometimes forming bands; tail dark brown; ventral whitish (De rooij, 1915).

### Family Colubridae

*Boiga nigriceps* (Günther, 1863) – Black-headed Cat Snake. Head coloration is dark green with small dark spot. Large eyes with green vertical pupils. Light orange dorsal of the body with small dark spot. Largely arboreal snake.

*Calamaria* cf. *schlegeli* – The coloration of the head similar to *Calamaria schlegeli*, but differs in size, and ventral colorations. This species was collected near Mount Ranai waterfall. Further investigation needed.

*Lycodon subannulatus* (Duméril, Bibron & Duméril, 1854) – Malayan bridal snake. Relatively small snake. Identified by the grey body colour with the present of thick brown bands on the dorsal side. *Lycodon subannulatus* have other form with brown and yellow stripes on dorsal (Lim & Lim, 1992).

*Xenochrophis trianguligerus* (Boie, 1827) – Triangle keelback. Identified by its orange-red or orange-yellow to olive-green or olive-brown dorsal color with inverted black triangles patterns. Head color is olive-green. The dorsal scales are keeled (Lim & Lim, 1992).

### Family Cyliodromiidae

*Cylindrophis ruffus* (Laurenti, 1768) – Red-tailed pipe snake. Body coloration is dark but iridescent, with indistinct light to reddish bands. The tail is blunt with reddish colour, which it displays when threatened (Lim & Lim, 1992). An interrupted and wide band on the nape (Amarasinghe et al., 2015).

### Family Viperidae

*Craspedocephalus puniceus* (Boie, 1827) – Ashy pit viper. A distinctly projected and raised snout. Grey or brown dorsal color with 20–30 darker crossbands, distinctly related to the sex (David et al., 2006).

### Family Xenodermidae

*Xenodermus javanicus* Reinhardt, 1836 – Java tubercle snake. A monotypic snake with distinct head, unique dorsal scale with hemipenial ridge along the dorsal, and have long tail.

### Family Crocodylidae

*Crocodylus porosus* Schneider, 1801 – Saltwater crocodile. Four large nuchal in a square, with one or two smaller ones on each side (De rooij, 1915). Scales on the flanks are more oval in shape than other *Crocodylus* species.

### Family Tryonichidae

*Dogania subplana* (Geoffroy Saint-Hilaire, 1809) – Malayan Soft-shelled Turtle. Flat dorsal disk; fontanelle between the nuchal and dorsal plate is large; tail very short; limbs have three claws. Adult have olive brown in color, dotted with dark brown ( De rooij, 1915).

### Amphibian

#### Family Bufonidae

*Phrynoidis juxtasper* (Inger, 1964) – Sungei Tawan Toad. A pair of crests between eyes do not continue back onto parietal region; tips of third and fifth toes free of web; parotoid gland about twice as long as wide (Inger, 1966).

#### Family Dicroglossidae

*Fejervarya cancrivora* (Gravenhorst, 1829) – Java Wart Frog. The different between *Fejervarya cancrivora* and *Fejervarya limnocharis* is the web of toes usually reaching outermost tubercle of fourth toe (Inger, 1966).

*Limnonectes kenepaiensis* (Inger, 1966) – Kenepai Wart Frog. Small *Limnonectes* frog; similar to *Limnonectes paramacrodon*, but different in having vocal sacs, and slightly longer hind legs (Inger, 1966).

*Limnonectes kong* Dehling and Dehling, 2017. The different between *Limnonectes kong* and all described *Limnonectes kuhli* group from Borneo is having fully web toes (Dehling & Dehling, 2017).

*Limnonectes malesianus* (Kiew, 1984) – Singapore Wart Frog. Differing from the *Limnonectes blythii-macrodon* group by black upper half of tympanum, sharp angle supratympanic fold behind tympanum, and w-shape skin fold on dorsal (Lim & Lim, 1992).

#### Family Microhylidae

*Kalophrynus heterochirus* Boulenger, 1900 – Borneo Grainy Frog. According to Inger (2005), Fifth toe not projecting as far as third; portion of fourth finger projecting from palm shorter than terminal phalanx of thir finger; present of two tubercles under fourth finger; no light stripr on snout or side; light inguinal spot in a large dark area.

*Leptobrachella* sp. Similar to *Leptobrachella serasanae*, but differs in flank marking, and size of body and legs. The suspected undescribed species was collected from central-southern area of Serasan Islands.

#### Family Ranidae

*Chalcorana parvaccola* (Inger, Stuart, and Iskandar, 2009) – Small ranid frog. Differ from other *Chalcorana* group from higher frequency of dark spotting on the back and absence of constiction of nuptial pads (Inger et al., 2009)

*Odorrana hosii* (Boulenger, 1891) – Hose’s Frog. Dorsolateral light stripe begins behind eye; tips of outer fingers about twice width of basal phalanges; absent of outer metatarsal tubercle on foot (Inger, 1966).

*Pulchrana rawa* (Matsui, Mumpuni, and Hamidy, 2012). Differing from *Pulchrana baramica* and *Pulchrana laterimaculata* by smaller body, shorter hindlimb; has a humeral gland covering entire anterior surface of upper arm; and absent of vomerine teeth or ridges and vocal sac opening (Matsui et al., 2012).

*Pulchrana signata* (Günther, 1872) – Striped Stream Frog. Can be distinguish from other pulchrana by having a light line or stripe on canthus from tip to eye (Inger, 1966).

#### Family Rhacophoridae

*Leptomantis cyanopunctatus* (Manthey and Steiof, 1998) – Blue-spotted Bushfrog. Small rhacopodid frog with large head and eyes; snout short with ridge running from the eye to the snout. There are bluish spots under each thigh (Manthey & Steiof, 1998).

*Nyctixalus pictus* (Peters, 1871) – Painted Indonesian Treefrog. There are only two *Nyctixalus* frog from Indonesia (Frost, 2021). *Nyctixalus pictus* differ from *Nyctixalus margaritifer* by having smaller body, smooth spinose tubercles across the throat. The web of *Nyctixalus pictus* reaches the middle subarticular tubercle or midway between the basal and middle tubercle of the fourth toe (Inger, 1966).

#### Family Ichthyophiidae

*Ichthyophis* sp. Further analysis needed to confirm the status of this specimen. The specimen was collected from the slopes of Mount Ranai. The specimen have lateral yellow stripe as shown in several *Ichthyophis* species.

#### IUCN Status

A total of 101 species were listed as IUCN Red List species. Most of them (94) were listed as Least Concern (CN), seven species classified as Near Threatened (NT), one species Vulnerable (VU), two species Endangered (EN), two species Data Deficient (DD), and five other have not yet been evaluated. Two endemic anurans from Bunguran Island are listed as Data Deficient (DD). The two endemic anurans from Bunguran were first recorded a dozen years ago, but until now, there is no other information besides the record of these species from the islands. One species from this list was nationally protected; *Crocodylus porosus*, and listed in Minister of Environment and Forestry Regulation number P.106/2018. This species has only been found several times in this study. *Limnonectes kenepaiensis* listed as VU, and two fresh water turtles (*Cuora amboinensis*, and *Heosemys spinosa*) listed as EN.



**Table 1.** Update reptiles species list of the Natuna Islands herpetofauna. <sup>ed</sup> represent endemic species. Island encounter and reference encounter (Bu = Bunguran island, Se = Serasan island, La = Laut island, Pa = Panjang island, Sa = Sadanau island, Su = Subi Kecil Island, Mi = Midai island, Sy = Seraya island, Be = Berian island, Ti = Pulau Tiga islands, Nn = not specific). IUCN Status (DD = Data Deficient; LC = Least Concern, VU = Vulnerable, NT = Near Threatened; EN = Endangered; CE = Critically Endangered; NE = Not Evaluated)

Reptile species	Surveys encountered	Reference encountered	Reference	IUCN Red List
<b>Agamidae</b>				
<i>Aphaniotus fusca</i>	Bu	Bu, Se, Nn	Günther, 1895; De Rooij, 1915; Smedley, 1931a; Leong et al., 2003; This study	LC
<i>Bronhocela cristatella</i>	Bu, Ti	Bu, Sa, Su, Mi	Günther, 1895; De Rooij, 1915; Smedley, 1931a, b; Leong et al., 2003; This study	LC
<i>Calotes versicolor</i>	Bu, Ti	Bu	Leong et al., 2003; This study	LC
<i>Draco cornutus</i>		Bu	Smedley, 1931a, Leong et al., 2003	LC
<i>Draco fimbriatus</i>		Bu	Günther, 1895; De Rooij, 1915; Smedley, 1931a; Leong et al., 2003	LC
<i>Draco formosus</i>	Bu		This study	LC
<i>Draco maximus</i>	Bu	Bu, La	Günther, 1895; De Rooij, 1915; Leong et al., 2003; This study	LC
<i>Draco melanopogon</i>	Bu, Ti	Bu	Günther, 1895; De Rooij, 1915; Smedley, 1931a; Leong et al., 2003; This study	LC
<i>Draco obscurus</i>	Bu	Bu	Smedley, 1931a; Leong et al., 2003; This study	LC
<i>Draco quinquefasciatus</i>		Nn	Leong et al., 2003	LC
<i>Draco sumatranus</i>	Bu	Bu, Se, La, Pa	De Rooij, 1915; Smedley, 1931b; Leong et al., 2003; This study	LC
<i>Gonocephalus bornensis</i>	Bu		This study	LC
<i>Gonocephalus chamaeleontinus</i>	Bu	Bu, La	Günther, 1895; De Rooij, 1915; Leong et al., 2003; This study	LC
<i>Gonocephalus liogaster</i>	Bu	Bu, La	Günther, 1895; Dring, 1979; Manthey & Denzer, 1992; Leong et al., 2003; This study	LC
<i>Pelturagonia nigrilabris</i>		Se, Nn	Günther, 1895; De Rooij, 1915; Leong et al., 2003	LC
<b>Gekkonidae</b>				
<i>Cnemaspis cf. kendallii</i>		Bu, Se, Nn	Günther, 1895; De Rooij, 1915; Leong et al., 2003	
<i>Cnemaspis mumpunia<sup>ed</sup></i>	Bu, Ti	Bu	Grismer et al., 2014; This study	LC
<i>Cnemaspis sundainsula<sup>ed</sup></i>	Bu	Bu	Grismer et al., 2014; This study	LC
<i>Cyrtodactylus cf. consobrinus</i>		Bu	Leong et al., 2003	
<i>Cyrtodactylus hikidai<sup>ed</sup></i>	Bu, Ti	Bu	Riyanto, 2012; This study	LC
<i>Cyrtodactylus rosichonarieforum<sup>ed</sup></i>	Bu	Bu	Riyanto et al., 2015; This study	LC
<i>Gehyra mutilata</i>	Ti	Se	Smedley, 1931b; Leong et al., 2003; This study	LC
<i>Gekko albofasciolatus</i>	Se	Se	Smedley, 1931b; Leong et al., 2003; This study	NE
<i>Gekko cicakterbang</i>		Bu	Leong et al., 2003	NE
<i>Gekko gecko</i>	Bu, Ti	Su	Smedley, 1931b; Leong et al., 2003; This study	LC
<i>Gekko kuhli</i>		Be	Smedley, 1931b; Leong et al., 2003	LC
<i>Gekko monarchus</i>	Bu, Se	Se	Leong et al., 2003; This study	LC

Reptile species	Surveys encountered	Reference encountered	Reference	IUCN Red List
<i>Hemidactylus craspedotus</i>	Bu		This study	LC
<i>Hemidactylus frenatus</i>	Bu, Se, Ti	Bu, Pa	Leong et al., 2003; This study	LC
<i>Hemidactylus platyurus</i>	Se		This study	LC
<b>Lacertidae</b>				
<i>Takydromus sexlineatus</i>	Bu	Bu, Nn	Günther, 1895; De Rooij, 1915; Leong et al., 2003; This study	LC
<b>Scincidae</b>				
<i>Dasia olivacea</i>	Bu, Ti	Se, Nn	Günther, 1895; De Rooij, 1915; Smedley, 1931b; Leong et al., 2003; This study	LC
<i>Emoia atrocostata</i>	Bu	Se, Sy	Smedley, 1931b; Leong et al., 2003; This study	LC
<i>Eutropis multifasciata</i>	Bu, Se, Ti	Bu, Se, La, Pa, Nn, Mi	Günther, 1895; De Rooij, 1915; Smedley, 1931a, b; Leong et al., 2003; This study	LC
<i>Eutropis rugifera</i>		Nn	Leong et al., 2003	LC
<i>Tropidophorus brookei</i>	Se		This study	
<b>Varanidae</b>				
<i>Varanus nebulosus</i>		Nn	Leong et al., 2003	NT
<i>Varanus salvator</i>	Bu, Ti	Se	Leong et al., 2003; This study	LC
<b>Colubridae</b>				
<i>Ahaetulla fasciolata</i>		Bu, Mi	De Rooij, 1917; De Haas, 1950; Leong et al., 2003	LC
<i>Ahaetulla prasina</i>	Bu, Se	Bu, Se, La, Pa	De Rooij, 1917; Günther, 1895; Smedley, 1931b; De Haas, 1950; Leong et al., 2003; This study	LC
<i>Boiga dendrophila</i>	Bu, Se	Se	Leong et al., 2003; This study	LC
<i>Boiga drapiezii</i>		Bu	Smedley, 1931a; De Haas, 1950; Leong et al., 2003	LC
<i>Boiga nigriceps</i>	Bu		This study	LC
<i>Calamaria lumbricoidea</i>		Bu, Nn	Günther, 1895; De Rooij, 1917; De Haas, 1950; Inger & Marx, 1965; Leong et al., 2003	LC
<i>Calamaria cf. schlegeli</i>	Bu		This study	
<i>Chrysopelea paradisi</i>		Bu	De Haas, 1950; Leong et al., 2003	LC
<i>Chrysopelea pelias</i>		Bu, Nn	De Rooij, 1917; De Haas, 1950; Leong et al., 2003	LC
<i>Dendrelaphis caudolineatus</i>	Bu	Bu, Se, Be	De Rooij, 1917; Smedley, 1931b; De Haas, 1950; Leong et al., 2003; This study	LC
<i>Dendrelaphis pictus</i>	Bu	Bu	Günther, 1895; De Rooij, 1917; De Haas, 1950; Leong et al., 2003; This study	LC
<i>Dryophiops rubescens</i>		Se	Günther, 1895; De Rooij, 1917; De Haas, 1950; Leong et al., 2003	LC
<i>Gongylosoma baliodeira</i>		Bu	Günther, 1895; De Rooij, 1917; De Haas, 1950; Leong et al., 2003	NE
<i>Gonyosoma oxycephalum</i>		Bu	Günther, 1895; De Rooij, 1917; De Haas, 1950; Leong et al., 2003	LC
<i>Lycodon subannulatus</i>	Bu		This study	LC
<i>Lycodon tristrigatus</i>		Bu	Günther, 1895; De Rooij, 1917; De Haas, 1950; Leong et al., 2003	LC
<i>Oligodon purpurascens</i>		Bu	Leong et al., 2003	LC

Reptile species	Surveys encountered	Reference encountered	Reference	IUCN Red List
<i>Ptyas fusca</i>		Bu	Günther, 1895; De Rooij, 1917; De Haas, 1950; Leong et al., 2003	LC
<i>Rhabdophis conspicillatus</i>	Ti	Bu	Günther, 1895; De Rooij, 1917; De Haas, 1950; Leong et al., 2003; This study	LC
<i>Rhabdophis rhodomelas</i>		Bu	Leong et al., 2003	LC
<i>Sibynophis geminatus</i>		Bu	Günther, 1895; De Rooij, 1917; De Haas, 1950; Leong et al., 2003	LC
<i>Xenochrophis maculatus</i>		Nn	De Rooij, 1917; De Haas, 1950; Leong et al., 2003	LC
<i>Xenochrophis trianguligerus</i>	Bu		This study	LC
<b>Cylindrophidae</b>				
<i>Cylindrophis ruffus</i>		Bu	Leong et al., 2003	LC
<b>Homalopsidae</b>				
<i>Cerberus schneiderii</i>	Bu, Se	Bu, Se	Smedley, 1931b; De Haas, 1950; Leong et al., 2003; This study	NE
<i>Homalopsis buccata</i>	Bu	Bu	T. M. Leong & C. P. Lim (pers. obs., 2002); Leong et al., 2003; This study	LC
<b>Pareidae</b>				
<i>Aplopeltura boa</i>		Se	Smedley, 1931b; De Haas, 1950; Leong et al., 2003	LC
<i>Asthenodipsas laevis</i>		Se	Günther, 1895; De Rooij, 1917; De Haas, 1950; Leong et al., 2003	LC
<b>Pseudaspidae</b>				
<i>Psammodynastes pulverulentus</i>		Bu	Günther, 1895; De Rooij, 1917; De Haas, 1950; Leong et al., 2003	LC
<b>Pythonidae</b>				
<i>Malayopython reticulatus</i>	Bu	Nn	Günther, 1895; De Rooij, 1917; De Haas, 1950; Leong et al., 2003; This study	LC
<b>Viperidae</b>				
<i>Craspedocephalus puniceus</i>		Bu, La	Günther, 1895; De Rooij, 1917; De Haas, 1950; Leong et al., 2003	LC
<i>Tropidolaemus wagleri</i>		Bu, Pa	Günther, 1895; De Rooij, 1917; Smedley, 1931b; De Haas, 1950; Leong et al., 2003	LC
<b>Xenodermidae</b>				
<i>Xenodermus javanicus</i>	Bu		This study	LC
<b>Xenopeltidae</b>				
<i>Xenopeltis unicolor</i>		Bu	Leong et al., 2003	LC
<b>Crocodylidae</b>				
<i>Crocodylus porosus</i>	Bu, Ti		This study	LC
<b>Bataguridae</b>				
<i>Cuora amboinensis</i>	Bu	Bu, Se	Günther, 1895; De Rooij, 1915; Leong et al., 2003; This study	EN
<i>Cyclemys dentata</i>	Bu	Bu	Günther, 1895; De Rooij, 1915; Leong et al., 2003; This study	NT
<i>Heosemys spinosa</i>	Bu	Bu	Günther, 1895; De Rooij, 1915; Leong et al., 2003; This study	EN
<b>Tryonichidae</b>				
<i>Dogania subplana</i>	Bu, Ti	Bu	Günther, 1895; De Rooij, 1915; Smedley, 1931a; Leong et al., 2003; This study	LC



**Table 2.** Update amphibians species list of the Natuna Islands herpetofauna. <sup>ed</sup> represent endemic species. Island encounter and reference encounter (Bu = Bunguran island, Se = Serasan island, La = Laut island, Pa = Panjang island, Sa = Sadanau island, Su = Subi Kecil Island, Mi = Midai island, Sy = Seraya island, Be = Berian island, Ti = Pulau Tiga islands, Nn = not specific). IUCN Status (DD = Data Deficient; LC = Least Concern, VU = Vulnerable, NT = Near Threatened; EN = Endangered; CE = Critically Endangered; NE = Not Evaluated)

Amphibian species	Surveys encountered	Reference encountered	Reference	IUCN Red List
<b>Bufonidae</b>				
<i>Duttaphrynus melanostictus</i>	Bu	Bu, Se	Günther, 1895; Van Kampen, 1923; Smedley, 1931b; Leong et al., 2003; This study	LC
<i>Ingerophrynus divergens</i>	Bu	Bu	Günther, 1895; Van Kampen, 1923; Inger, 1966; Leong et al., 2003; This study	LC
<i>Ingerophrynus quadriporcatus</i>	Bu, Ti	Bu	T. M. Leong (pers. obs., 2002); Günther, 1895; Van Kampen, 1923; Leong et al., 2003; This study	LC
<i>Pelophryne guentheri</i>		Se	Günther, 1895; Leong et al., 2003	LC
<i>Pelophryne signata</i>	Se	Bu	Inger, 1966; Leong et al., 2003, This study	LC
<i>Phrynoidis asper</i>	Bu	Bu	Leong et al., 2003; This study	LC
<i>Phrynoidis juxtasper</i>	Bu		This study	LC
<b>Dicroglossidae</b>				
<i>Fejervarya cancrivora</i>	Bu, Se		This study	LC
<i>Fejervarya limnocharis</i>	Bu	Bu	Günther, 1895; van Kampen, 1923; Leong et al., 2003; This study	LC
<i>Limnonectes blythii</i>	Bu	Bu, Se	Günther, 1895; Smedley, 1931b; Leong et al., 2003; This study	NT
<i>Limnonectes hascheanus</i>	Bu	Bu	T. M. Leong (pers. obs., 2002); Günther, 1895; Van Kampen, 1923; Leong et al., 2003; This study	LC
<i>Limnonectes kenepaiensis</i>	Bu		This study	VU
<i>Limnonectes kuhlii</i>		Se	Smedley, 1931b; Leong et al., 2003	LC
<i>Limnonectes kong</i>	Se		This study	NE
<i>Limnonectes malesianus</i>	Bu		This study	NT
<i>Limnonectes paramacrodon</i>	Bu, Se	Bu	Leong et al., 2003; This study	NT
<i>Occidozyga cf. laevis</i>	Bu	Bu	Leong et al., 2003; This study	
<b>Megophryidae</b>				
<i>Leptobranchella natunae<sup>ed</sup></i>	Bu	Bu	Günther, 1895; Van Kampen, 1923; Dring, 1983; Leong et al; 2003; This study	DD
<i>Leptobranchella serasanae</i>	Se	Se	Dring, 1983; Leong et al., 2003; This study	NT
<i>Leptobranchella</i> sp.	Se		This study	
<i>Leptobranchium hendricksoni</i>	Bu	Bu	Leong et al., 2003; This study	LC
<i>Leptobranchium</i> sp.		Bu	Leong et al., 2003	
<i>Pelobatrachus nasutus</i>	Bu	Bu	Van Kampen, 1923; Leong et al., 2003; This study	LC

Amphibian species	Surveys encountered	Reference encountered	Reference	IUCN Red List
<b>Microhylidae</b>				
<i>Kalophrynus bunguranus</i> <sup>ed</sup>	Bu	Bu	Iskandar & Colijn, 2000; Günther, 1895, 1896; Leong et al., 2003; This study	DD
<i>Kalophrynus heterochirus</i>	Se		This study	LC
<i>Kalophrynus pleurostigma</i>		La	Günther, 1895; Leong et al., 2003	LC
<b>Ranidae</b>				
<i>Chalcorana cf. labialis</i>	Bu	Bu	Smedley, 1931b; Leong et al., 2003; This study	
<i>Chalcorana raniceps</i>	Se	Se	Smedley, 1931b; Leong et al., 2003; This study	LC
<i>Chalcorana parvaccola</i>	Bu		This study	LC
<i>Hylarana erythraea</i>	Bu, Se	Bu, Se, La	Günther, 1895; Van Kampen, 1923; Smedley, 1931b; Inger, 1966; Leong et al., 2003; This study	LC
<i>Odorrana hosii</i>	Bu		This study	LC
<i>Pulchrana baramica</i>	Bu, Ti	Bu	T. M. Leong (pers. obs., 2002); Leong et al., 2003; This study	LC
<i>Pulchrana glandulosa</i>	Bu	Bu	Smedley, 1931a; Leong et al., 2003; This study	LC
<i>Pulchrana laterimaculata</i>		Bu	T. M. Leong (pers. obs., 2002); Leong et al., 2003	LC
<i>Pulchrana rawa</i>	Se		This study	LC
<i>Pulchrana signata</i>	Bu		This study	LC
<b>Rhacophoridae</b>				
<i>Leptomantis cyanopunctatus</i>	Bu		This study	LC
<i>Nyctixalus pictus</i>	Bu		This study	NT
<i>Polypedates colletti</i>	Bu	Bu	Günther, 1895; Inger, 1966; Leong et al., 2003; This study	LC
<i>Polypedates leucomystax</i>	Bu	Bu, Pa	Günther, 1895; van Kampen, 1923; Leong et al., 2003; This study	LC
<i>Polypedates macrotis</i>	Bu, Se, Ti	Bu, Se	Günther, 1895; Smedley, 1931b; Inger, 1966; Leong et al., 2003; This study	LC
<i>Philautus petersi</i> <sup>ed</sup>	Bu	Bu	Günther, 1895; Van Kampen, 1923; Leong et al., 2003; This study	LC
<b>Ichthyophiidae</b>				
<i>Ichthyophis</i> sp.	Bu		This study	

## DISCUSSION

Most of the herpetofauna inhabits Natuna Island can also be found in other Sundaland regions, such as Sumatera, Java, Borneo, Malay Peninsula. Some species also have similarities with species found in the Philippines. Inger and Voris (2001) stated that Natuna Islands was a biogeographical “bridge” to the distribution of frogs and snakes in Sundaland. Most of the Sunda

and Sahul Shelf were largely exposed and formed a massive low-lying connection between the present-day islands of the region and the adjacent continent. The open Sunda Shelf connects Sumatra, Java and Kalimantan (Voris, 2000). This make Natuna Islands become very valuable area for the herpetofauna in this region.

However, some islands have not yet been covered or updated by recent herpetological surveys. The fact that some species found in the last decade was new to science, and unidentified species suggests many more are likely to be discovered. The increasing number of amphibians and reptiles from Natuna Islands is mainly due to wide area surveys covered. During this survey, several species from previous surveys was not encountered. One reason for this could be that we only focused on Bunguran, Serasan, and Pulau Tiga Islands with limited time of surveys.

Subsequently, some of taxon name used in this checklist are different from the previous reports due to taxonomic revisions. *Phoxophrys nigrilabis* becomes *Pelturagonia nigrilabis* (Harvey et al., 2019). *Gekko smithii* is now restricted to the west coast of the Malay Peninsula (Grismer et al., 2022), and the populations from Natuna Islands is now *Gekko albofasciolatus*. Genus *Ptychozoon* is now synonymized with *Gekko*. *Ptychozoon kuhli* becomes *Gekko kuhli*, and *Ptychozoon lionotum* is now restricted to Myanmar and Indochina. The population of *Ptychozoon lionotum* in Natuna Islands is now *Gekko cicakterbang* (Grismer et al., 2019). *Trimeresurus puniceus* is now included in *Craspedocephalus* lineage (Mallik et al., 2021).

Several confusions in taxa occur in amphibians from Natuna Islands. Recent taxonomic paper about *Pelophryne* reveal *Pelophryne brevipes* has been restricted to Philippines, due to large genetic distances (Matsui, 2019), we conclude that reported *Pelophryne brevipes* population in Natuna become *Pelophryne signata*. *Limnonectes kuhlii* group from southern part of Natuna islands is morphologically different. We identify it as *Limnonectes kong*. Leong et al. (2003) confirm that *Limnonectes macrodon* reported in Smedley (1931b) was *Limnonectes blythii*. Based on our surveys, we never see *Limnonectes macrodon*, instead we encountered a lot of *Limnonectes blythii*. Another confusion in taxa is *Occidozyga laevis* recorded by Leong et al. (2003). This Philippine puddle frog restricted to Phillipine and the northeastern tip of Borneo (Chan et al., 2022). We also found several specimens similar to *Occidozyga laevis*, which we record as *Occidozyga cf. laevis*. Further research using molecular analysis is needed to resolve the confusion in taxa in Natuna islands, especially in some specimens with cf code in this record, and complexes taxa.

Several species that are thought to have dispersed through anthropogenic, means as they are human commensals (e.g., *Polypedates leucomystax*, *Dutaphrynus melanostictus*, *Gehyra mutilata*, and *Eutropis multifasciata*) (Leong et al. 2003) were also recorded in this study. Four new geckonids were described in the past ten years: *Cnemaspis mumpuniae* Grismer et al. 2014, *Cnemaspis sundainsula* Grismer et al. 2014, *Cyrtodactylus hikidai* Riyanto 2012, and *Cyrtodactylus rosichonariefi* Riyanto et al. 2015.

## CONCLUSION

This checklist is far from complete. Many places in the Natuna Islands have not been explored and studied. It is possible to discover new amphibians or reptiles species. The total number of species from the islands can also be reduced due to habitat degradation. However, there is no evidence yet that there is a decline in number of species and number of individuals due to area development in Natuna Islands. Protecting the habitat for species included in Endangered criteria becomes important, and also data recorded over time is crucial for future studies such as taxonomy, ecology, and conservation.



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