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The ratio of native and alien fish species in Buyan and Tamblingan lakes, Bali

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Abstract. Buyan and Tamblingan lakes were often mentioned as twin lake because of its adjacent location. These two lakes were separated by approximately one-kilometer forest. Studies which recorded the fish species in those lakes were very limited so that a study was needed regarding that conditions as the initial step of management. This study aims to reveal and analyze the ratio of native and alien fish species which were found in Buyan and Tamblingan lakes, Bali. The fish sampling was held three times in different months at Buyan and Tamblingan lakes during 2017-2018, using a purposive sampling method. There were six locations sampling fish on each lake. It used experimental gill net with mesh size 0.5; 1.0; 1.5; 2.0; 2.5; 3.0; 3.5; 4.0 inches and trap. Three of the nine species that found in Buyan and Tamblingan lakes were native fish species. The ratio of native and non-indigenous fish caught in Buyan lake was bigger than from Tamblingan lake. Based on the length size of the most captured fish, the native fish of *Osteochilus vittatus* in Buyan lake was longer than Tamblingan, while the non-indigenous one, *Poecilia reticulata* had the same length size on the two lakes.

Keywords: alien fishes, Buyan lake, native fishes, Tamblingan lake.

1. Introduction

Buyan and Tamblingan lakes were often mentioned as twin lake because of its adjacent location. These two lakes were separated by approximately one-kilometer forest, there was a pond that directly connected to lake Buyan through a narrow canal. Buyan lake has a catchment area of 24.1 km² with the length of 3.7 km and 1.25 km width. The surface area of water is 3.67 km² with an average depth of 31.7 m and a maximum depth of 69 m. The water volume in Buyan lake was 116.25 x 106 m³ (Bapedalda Regional II 1999). Tamblingan lake is the smallest lake at Bali island. The lake area is



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only 1.2 km² and the maximum depth is around 40 meters, with a water volume approximately 27 x 106 m³ (Whitten *et al* 1996).

The studies that record fishes resources were limited in Buyan and Tamblingan lake. Restu *et al* (2015), found two families and five species in Buyan lake. Sari *et al* (2017), carried the research in July and August 2017 and found three families in both lakes. Meanwhile, Tamblingan Lake has six species of fishes and Buyan nine. Furthermore, that was stated only fish species of Cyprinidae family were found as native fish in both the lake.

The information about native and alien fishes that inhabiting Buyan and Tamblingan lake were not found yet. A study of the composition and parameters of growth needed, especially a length size of the fish as early information for management of fishes biodiversity and potential use of natural resources. This study aimed to reveal and analyze the ratio of native and alien fishes species found in Buyan and Tamblingan lake, Bali.

2. Materials and methods

The fish sampling was held three times in different months at Buyan and Tamblingan lake during 2017-2018 (table 1). The study was conducted using purposive sampling method. There were six fish sampling points in each lake (figure 1).

Table 1. The period of fish sampling in Buyan and Tamblingan lake.

No.	Lake Name	1 st	2 nd	3 rd
1.	Tamblingan	July 2017	November 2017	March 2018
2.	Buyan	August 2017	December 2017	April 2018

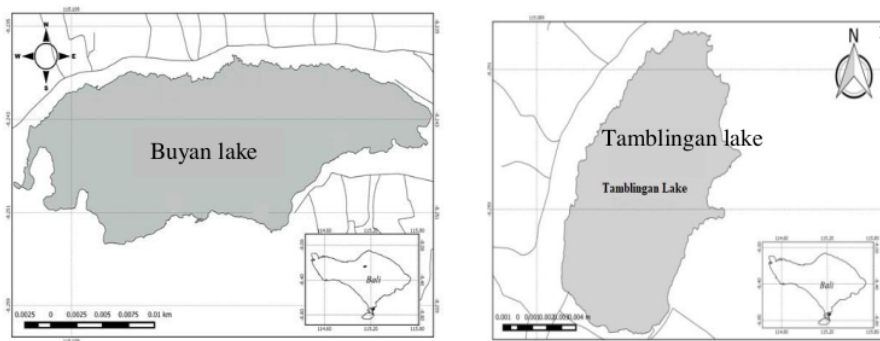


Figure 1. The fish sampling area around Buyan and Tamblingan lake in Bali.

Materials used were fish caught in Buyan and Tamblingan Lake, alcohol, formalin, and distilled water samples. The fish samples taken by modified gill net with mesh sizes 0.5; 1.0; 1.5; 2.0; 2.5; 3.0; 3.5; 4.0 inches and trap. Samples of fish caught separated based on the location and size of the net. The fish length (total, standard, and fork length) measured with a precision of 1 cm and the fish was weighed with an accuracy of 0.1 g.

3. Results and discussion

The number of fish caught during the research activity in Buyan and Tamblingan lake was 2,457 and 1,553 individuals. The total number of native and alien fish found in both lakes was

723 and 3,287, respectively. The species and composition of both native and alien fishes were shown in table 2 and figure 2.

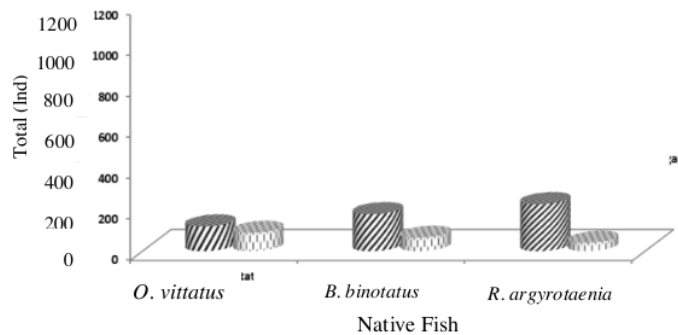
Table 2. The species fishes that found in Buyan and Tamblingan lake, Bali.

No	Family	Science Name	Common Name	Local Name
1		<i>Amatitlania nigrofasciata</i> **	Convict cichlid	Zebra
2	Cichlidae	<i>Oreochromis niloticus</i> **	Nile tilapia	Nila
3		<i>Oreochromis mossambicus</i> *	Mozambique tilapia	Mujair
4		<i>Osteochilus vittatus</i>**	Bonylip barb	Nilem
5	Cyprinidae	<i>Barbodes binotatus</i>**	Spotted barb	Nyalian
6		<i>Rasbora argyrotaenia</i>**	Silver rasbora	Nyalian buluh
7		<i>Cyprinus carpio</i> *	Common carp	Gold
8	Poeciliidae	<i>Poecilia reticulata</i> **	Guppy	Seribu
9		<i>Xiphophorus hellerii</i> **	Green swordtail	Nyalian cendol

Note: The asterisks mark (*): fishes were only found in Buyan lake; an asterisk mark (**): fishes found in both lakes. Sentences in bold: were native fish species.

Three of the nine species were native fish, namely nilem (*O. vittatus*), nyalian (*B. binotatus*), and nyalian buluh (*R. argyrotaenia*) while other six species: zebra (*A. nigrofasciata*), nila (*O. niloticus*), mujair (*O. mossambicus*), gold (*C. carpio*), seribu (*P. reticulata*), and nyalian buluh (*X. hellerii*) were alien fish. The Alien fish of mujair (*O. mossambicus*) and gold (*C. carpio*) were only found in Buyan lake during the study.

The number of fish species in Buyan and Tamblingan lake that found during the study were 9 and 7, respectively. Restu *et al* (2015) said there were 6 species found in Tamblingan lake. Batur Lake has the highest number of species, 12 species, respectively (Sentosa and Wijaya 2012), whilst Beratan lake has 10 species (Sentosa and Wijaya 2013). The abundance of fish in an aquatic ecosystem influenced by several factors such as fecundity, location, competition, predation, disease, and survival time (Samuel 1982). Relative abundance was used to determine the composition of fish (Royce 1972) and to compared population structures in an aquatic ecosystem (Samuel 1982).



(a)

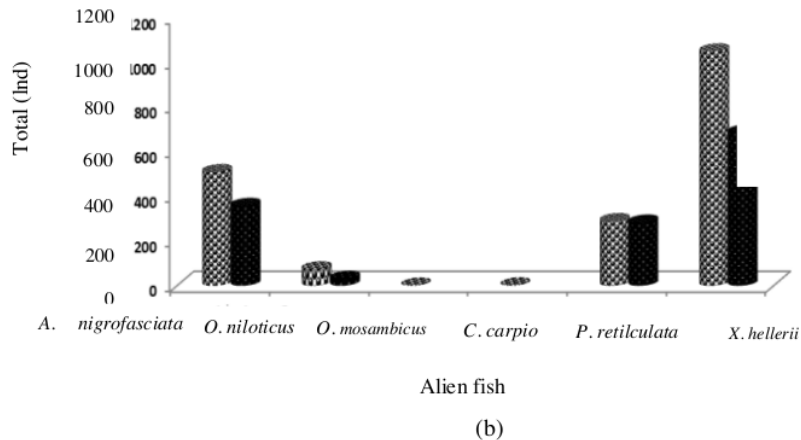


Figure 2. Composition of the number catch of native fish (a) (▨ = Buyan), (▤ = Buyan), and alien fish (b) in Buyan and Tamblingan lake (▩ = Buyan), (▪ = Buyan), (N = 4.010).

The alien fish number was more dominant than the native fish in Buyan and Tamblingan lake. The number of native and alien fish in Buyan lake was greater than Tamblingan. The native fish that found in Buyan and Tamblingan lake was the Cyprinidae family, while the alien fish was Poeciliidae family (*X. hellerii*). Meanwhile, mujair fish (*O. mossambicus*) and gold fish (*C. carpio*) were not found in Tamblingan lake.

The introduction of alien fish is one of the important factors that caused the declining of native fishes diversity. The alien species entered a new territory directly because of human introduction. This introduction was strongly influenced by business factors that promise high profits (Gustiano 2004, Keller and David 2007). This introduction could cause disturbances in the environment and reducing biodiversity of native species by predation (Lowe *et al* 2000, Billman *et al* 2011), suppress growth and recruitment of native species (Albins and Hixon 2008, Kostecki *et al* 2011), transmit diseases or carried parasites (Pinder *et al* 2005, Uzunova & Zlatanova 2007, Nico *et al* 2011), competition (Kartamihardja 2008), attack, and mating (Allendorf *et al* 2001, Hänfling *et al* 2005).

3.1. Native Fishes

3.1.1 *O. vittatus*. The species of fish from the Cyprinidae family, namely nilem fish (*O. vittatus*) were found about 120 individuals in Buyan lake, while in Tamblingan, were only 89 individuals. Most of nilem fish in Buyan and Tamblingan lake were at interval class of 15-16 cm (11 individuals) and 13-14 cm (18 individuals). Nilem fish in Buyan and Tamblingan lake have a total length between 9-27 cm and 7-23 cm. Nilem fish that found at Tamblingan lake have shorter total length than Buyan (figure 3).

3.1.2. *B. binotatus*. A total of 180 nyalian fish (*B. binotatus*) with total length ranged from 5-14 cm caught in Buyan lake. Most fish were found in the interval class of 9-10 cm (40 individual), while only one fish found in 5-6 and 11-12 cm. Nyalian fish that have caught in Tamblingan lake was about 65 individuals, where the total length ranged from 0-13 cm. Dominantly nyalian fishes in Tamblingan were in interval class of 9-10 cm, as many as 35 individuals. The nyalian fish that found in Tamblingan lake have smaller of total length than Buyan as seen in figure 4.

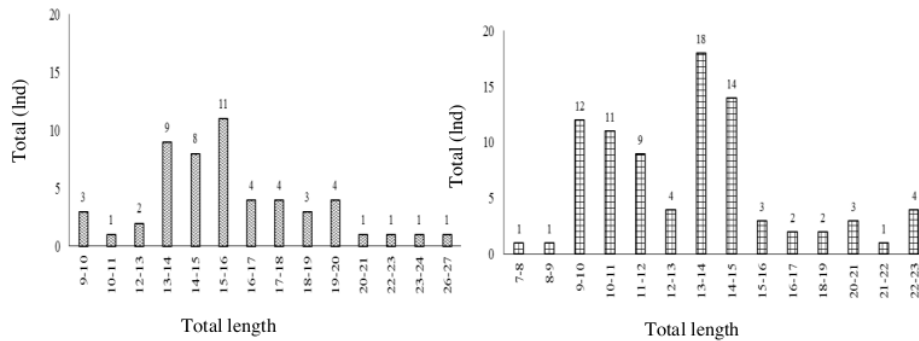


Figure 3. The interval class of Nilem fish (*O. vittatus*) in Buyan and Tamblingan lakes, Bali (N = 209).

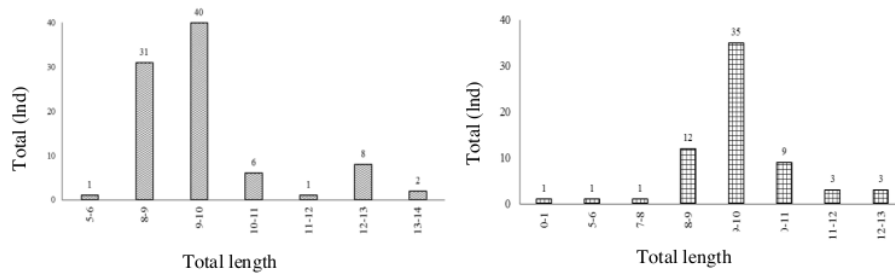


Figure 4. The interval class of Nyalian (*B. binotatus*) in Buyan and Tamblingan lake, Bali (N = 245).

3.1.3. *R. argyrotaenia*. The total number of Nyalian buluh (*R. argyrotaenia*) that caught in Buyan and Tamblingan lake were 229 and 40 individuals respectively, with total length between 4-17 cm and 6-13 cm. The highest number of fishes (54 fish) with interval class of 10-11 cm was found in Buyan lake. Mostly the Nyalian buluh in Tamblingan found in interval class of 11-12 cm, while only two individuals of fish were in 9-10 cm. The Nyalian buluh in Tamblingan were shorter in total length and interval class compare to the Buyan lake (figure 5).

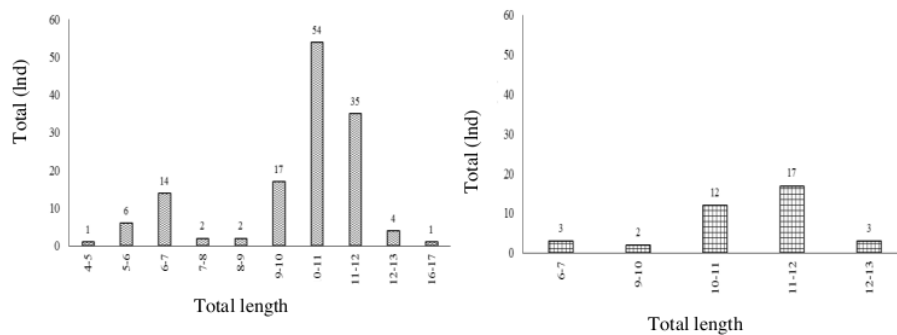


Figure 5. The interval class of Nyalian buluh (*R. argyrotaeni*) in Buyan and Tamblingan lake, Bali (N = 269).

3.2. Alien fishes

3.2.1. *Amatitlania nigrofasciata*. Most of zebra fish (*A. nigrofasciata*) that found in Buyan lake were in interval class of 7-8 cm (161 individual), whereas in Tamblingan were in 8-9 cm (133 individuals). The maximum total length of zebra fish in Buyan and Tamblingan lake were the same (figure 6).

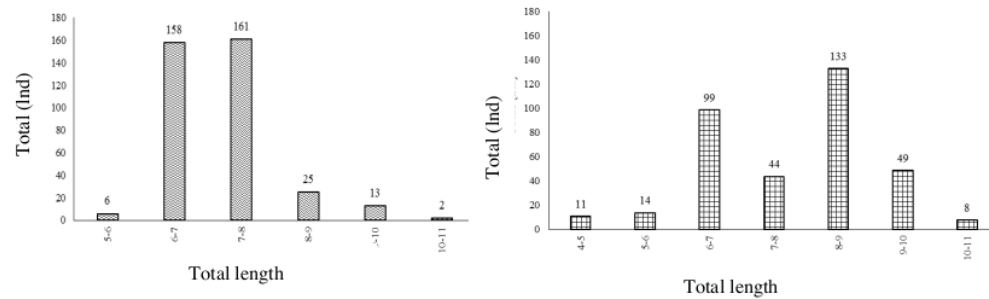


Figure 6. The interval class of zebra (*A. nigrofasciata*) in Buyan and Tamblingan lake, Bali (N = 868).

3.2.2. *O. niloticus*. The total number of nila (*O. niloticus*) that caught in Buyan and Tamblingan lake were 74 and 31 individuals, respectively, with total length of 6-22 cm and 6-25 cm. Mostly, nila were found with interval class of 12-13 (9 individual) in Buyan lake, while in Tamblingan, there was four individuals of fish with interval class of 7-8 and 13-14 cm. The total length of nila in Tamblingan was longer than Buyan lake (figure 7).

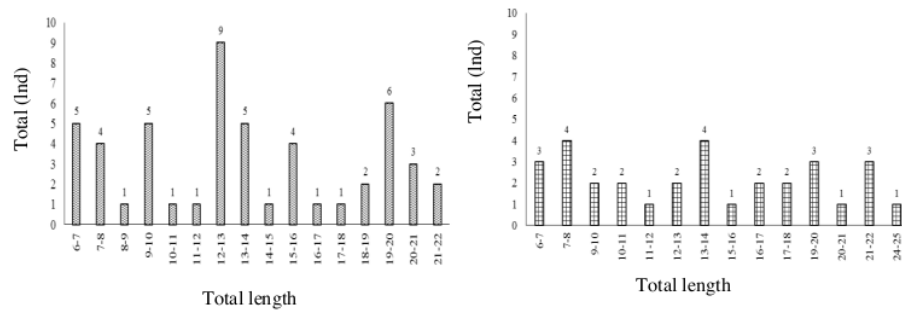


Figure 7. The interval class of nila (*O. niloticus*) in Buyan and Tamblingan lake, Bali (N = 105).

3.2.3. *O. mosambicus*. Mujair fish (*O. mosambicus*) only found in Buyan lake with total length of 15-16 cm.

3.2.4. *C. carpio*. Gold fish (*C. carpio*) only found in Buyan lake. There were two individuals during the research, with a total length between 22-31 cm.

3.2.5. *P. reticulata*. The Poeciliidae family has the fewest fish species of other families in Buyan and Tamblingan lake. The seribu (*P. reticulata*) that caught in Buyan lake has total length ranged 4-6 cm. Meanwhile in Tamblingan lake, *P. reticulata* were caught about 200 individuals, with total length 2-6 cm. Caught fish mostly in interval class of 4-5 cm, with only one fish in 5-6 cm interval class (figure 8).

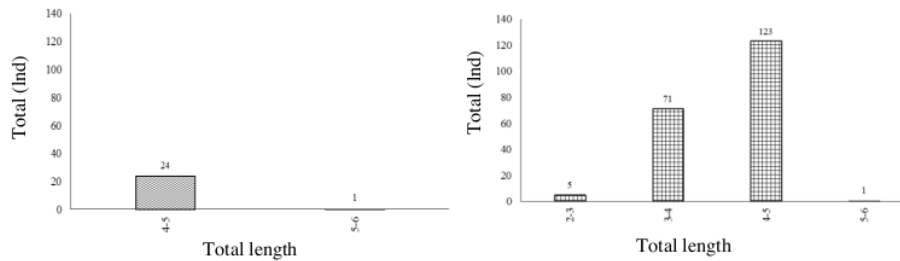


Figure 8. The interval class of seribu (*P. reticulata*) in Buyan and Tamblingan lake, Bali (N = 573).

3.2.6. *X. hellerii*. During the study, 1051 nyalian cendol or swordfish (*X. hellerii*) were found in Buyan lake, with total length ranged 2-12 cm. Total of 127 individuals were found in interval class of 7-8 cm, while the smallest interval class was 2-3 cm. Only one individual found in interval class 10-11 cm. The nyalian cendol fish found in Tamblingan lake were 687 individuals, with total length was 2-11 cm. Most of nyalian cendol were in interval class 3-4 cm (118 individuals), yet only one individual found in interval class 10-11 cm (figure 9).

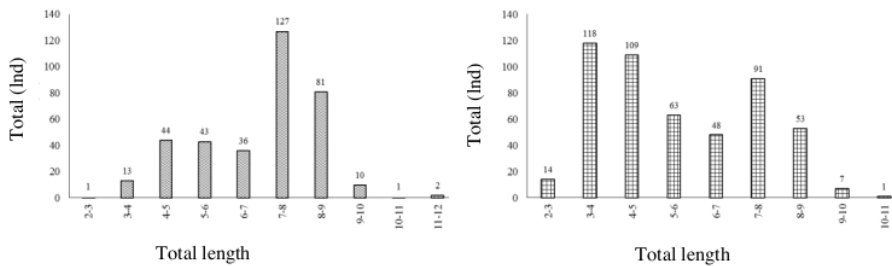


Figure 9. The interval class of nyalian cendol (*X. hellerii*) in Buyan and Tamblingan Lake, Bali (N = 1,738).

3.3. The composition of length and interval class

The native fish, especially nilem (*O. vittatus*) that found in Buyan lake has the biggest interval class in number and total length (26-27 cm). Meanwhile, Nyalian (*B. binotatus*) has the smallest total length (0-1 cm) in Tamblingan lake, contradictory with nyalian buluh (*Rasbora argyrotaenia*). Furthermore, it was found that nyalian (*B. binotatus*) has the same total length in both lakes.

Poeciliidae was the family of alien fish that mostly found in Buyan and Tamblingan lake. Common carp (*C. carpio*) in Buyan lake has total length of 30-31 cm, however, this fish was found only once during the study. The composition and interval class of fishes found in Buyan and Tamblingan lake, Bali were shown in table 3.

X. hellerii mostly found in both lakes because of the reproductive system of swordfish through a vivipar lecithotrophic (Greven 1995). Furthermore, known that the Poeciliidae family could live in a wide variety of environments and has a high tolerance. *X. hellerii* found in the habitat that provides food and protection from predators (Delgado and Stedman 2004). Kottelat *et al* (1993) and Junaidi (2008) stated that the more variety of habitat will affect the presence of fish species. The ecological characteristics of fish considered to be related to food plasticity variation and the fact of no specific breeding place was needed (Araújo *et al* 2003, Montag *et al* 2011, Kottelat *et al* 1993).

Table 3. The composition and interval class of native and alien fish in Buyan and Tamblingan lakes-Bali 2017-2018.

No	Family	Name of fishes	Interval class in numbers (individual)	
			Buyan lake	Tamblingan lake
1	Cichlidae	Zebra (<i>Amatitlania nigrofasciata</i>)	7-8 cm (161)	8-9 cm (133)
2		Nila (<i>Oreochromis niloticus</i>)	12-13 cm (9)	7-8 and 13-14 cm (4)
3		Mujair (<i>Oreochromis mossambicus</i>)	15-16 cm (1)	**
4	Cyprinidae	Nilem (<i>Osteochilus vittatus</i>)*	15-16 cm (11)	13-14 cm (18)
5		Nyalian (<i>Barbodes binotatus</i>)*	9-10 cm (40)	9-10 cm (35)
6		Nyalian Buluh (<i>Rasbora argyrotaenia</i>)*	10-11 cm (54)	11-12 cm (17)
7		Gold (<i>Cyprinus carpio</i>)	22-23 and 30-31 cm (1)	**
8	Poeciliidae	Seribu (<i>Poecilia reticulata</i>)	4-5 cm (24)	4-5 cm (123)
9		Nyalian Cendol (<i>Xiphophorus hellerii</i>)	7-8 cm (127)	3-4 cm (118)

Note: The asterisks mark (*): native fish; asterisk mark (**): the fish species not found.

Nilem fish (*O. vittatus*) found in Buyan lake has the most interval class in number, with the largest total length (26-27 cm) during the studied. Nyalian fish that found in Tamblingan lake have the shortest total length (0-1 cm). In general, the alien fish that successfully interfere an ecosystem have the characteristics of: 1) growing rapidly; 2) has a high tolerance to the aquatic environment; 3) have large fecundity and good swimmers (Cabal *et al* 2006).

Conclusion

The native fish species that found at Buyan and Tamblingan lake were Cyprinidae (*O. vittatus*, *B. binotatus*, *R. argyrotaeni*), whilst the alien fish species were *A. nigrofasciata*, *O. niloticus*, *O. mossambicus*, *P. reticulata*, and *X. hellerii*. *C. carpio* was only found in Buyan lake. Ratio of the species number between native and alien fish in Buyan lake was higher than Tamblingan. *X. hellerii* was the most species that commonly found in both lakes.

O. vittatus in Buyan was found longer in length, than in Tamblingan lake, on the contrary with *R. argyrotaenia*. Whilst *B. binotatus* has the same total length in both lakes. *X. hellerii* was found shorter in Tamblingan than in Buyan lake.

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