

## FROGS OF SUNGEI BULOH WETLAND RESERVE (AMPHIBIA: ANURA)

Su Hooi Chan<sup>1\*</sup> and Colleen Goh<sup>2</sup>

<sup>1</sup>Sungei Buloh Wetland Reserve, National Parks Board, 301 Neo Tiew Crescent,  
 Singapore 718925, Republic of Singapore

<sup>2</sup>31 Hindhede Walk, #03-12, Singapore 587967, Republic of Singapore  
 (\*Corresponding author: [chan\\_su\\_hooi@nparks.gov.sg](mailto:chan_su_hooi@nparks.gov.sg))

### INTRODUCTION

The Sungei Buloh Wetland Reserve (SBWR; Fig. 1) is located in the north-western corner of Singapore Island. It is committed to the conservation of the wetland through conservation, research, education and recreation. The 130-hectare reserve consists of mangrove forest, mudflats, brackish water ponds, freshwater ponds, and scrubland. Frogs are amphibians of the order Anura that are highly dependant on freshwater for survival. Most frogs lay eggs in water. These hatch into aquatic tadpoles that eventually metamorphose into amphibious or largely terrestrial adults.

Most frogs found in the SBWR are insectivores, and thus play an important role in controlling the insect population in the reserve. Frogs are also considered good indicators of the health of natural ecosystems (Leong, 2009). In Singapore, at least 25 species of amphibians have been recorded thus far (Leong, 2009). A survey of the amphibian fauna at the SBWR was carried out in 2008. This is the first comprehensive survey at the reserve that focused on amphibians, and its objectives were to determine the species composition, abundance and distribution of frogs within the reserve. The amphibian diversity at SBWR was last listed in Anonymous (2003). It contained eight species, including the field frog (*Fejervarya limnocharis*) that is not found in the recent survey.

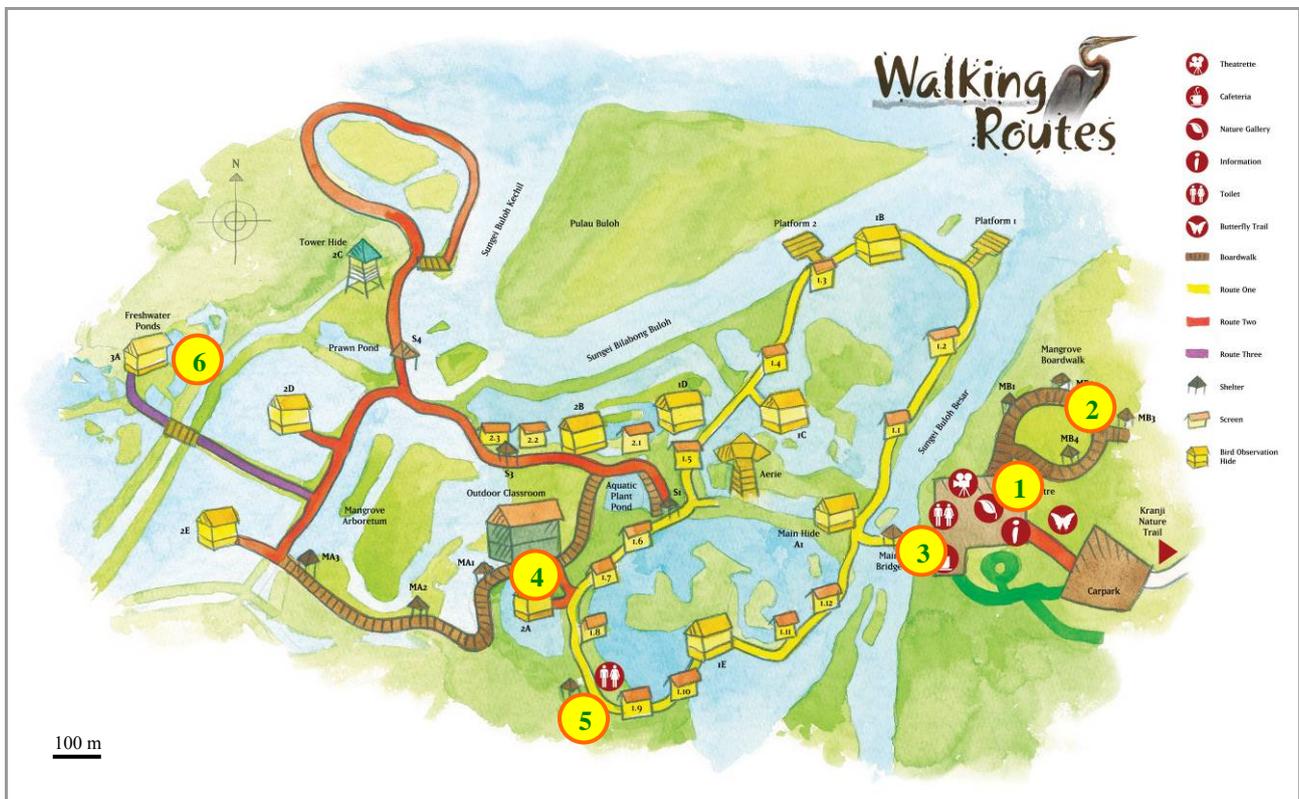


Fig. 1. Map of Sungei Buloh Wetland Reserve with locations designated for frog surveys in 2008. Location 1: Plant nursery and end of mangrove boardwalk behind the SBWR Visitor Centre; Location 2: Mangrove boardwalk behind the SBWR Visitor Centre; Location 3: Freshwater ponds at the SBWR Visitor Centre; Location 4: Outdoor classroom; Location 5: Pond at the maintenance shed; Location 6: Pond at Hide 3A. See Appendix for the details of each location.

## MATERIAL AND METHODS

The amphibian survey at the SBWR was conducted from May to Dec.2008. It was carried out once every fortnight on Friday evenings, from 1930 to 2300 hours. Each survey session was attended by about five persons. Weather conditions were recorded. The abundance of each frog species was determined by visual and photographic census, as well as by noting the calls of individuals that could not be seen. Frogs observed in the day and outside of survey sessions and locations were also recorded. An annotated list of the amphibians recorded in the SBWR is presented. Identification and nomenclature of the frogs follow those of Baker & Lim (2008). Synonyms listed under each species represent previous records in other publications.

Over the seven months, 15 surveys were conducted, with each covering the six fixed locations within the SBWR (Fig. 1 and Appendix). As frogs generally inhabit freshwater bodies, the six locations selected are largely freshwater habitats to optimize data collection. One location, the mangrove boardwalk behind the Visitor Centre, was omitted after the first three survey sessions because frogs were not detected there. Thus, the surveys were conducted at only five locations from the 4<sup>th</sup> session onwards. About 15 to 20 minutes were spent at each location.

All frogs and tadpoles illustrated in this article were photographed at the SBWR.

## ANNOTATED CHECKLIST

### Family **Bufonidae**

#### ***Duttaphrynus melanostictus*** (Schneider), Asian toad (Fig. 2)

This species was recorded as *Bufo melanostictus* in Anonymous (2003: 32, 93). Although recorded at only three locations, the Asian toad was seen on 14 out of the 15 surveys, with an average of five individuals per session. At the SBWR, it was found in man-made, landscaped areas, near to mangrove forest and scrubland. It was observed to be calling more actively on the nights that rained. It was frequently seen at the nursery (Location 1), and occasionally near the Visitor Centre ponds (Location 3) and the maintenance shed (Location 5).

One individual was spotted during the day outside the survey period at the mangrove boardwalk behind the Visitor Centre (Location 2), resting on a mangrove tree root. This observation strongly suggested that this species is tolerant of brackish water. Tadpoles were observed during the day at Location 3. They are small (about 1cm long) and blackish. On a few occasions, Asian toads were observed feeding on the maggots on a decomposing dead animal.

### Family **Dicroglossidae**

#### ***Fejervarya cancrivora*** (Gravenhorst), crab-eating frog (Fig. 3)

Recorded as *Rana cancrivora* in Lim & Yang (1991: 223) and Anonymous (2003: 32, 93), this species was recorded on 12 out of the 15 surveys, with an average of two individuals observed per session. However, the calls of many individuals were heard from a fish farm adjacent to the reserve on several nights. Although this species can tolerate brackish water and is known to inhabit mangroves (Leong & Chou, 1999), we did not encounter any individuals

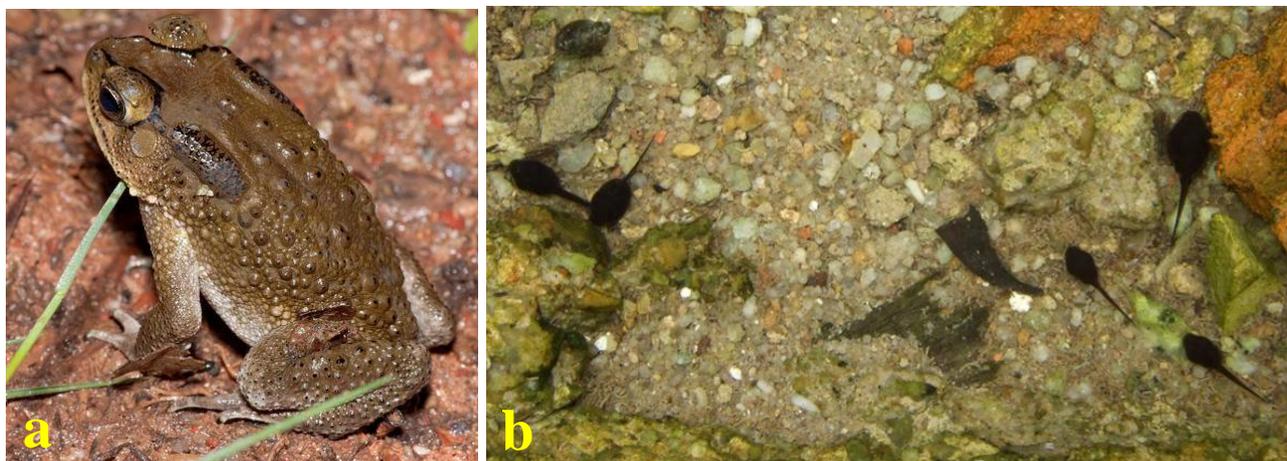


Fig. 2. *Duttaphrynus melanostictus*, Asian toad. (a) Adult, photographed on 8 Aug.2008. Snout-vent length ca. 10 cm. (b) Tadpoles of Asian toad photographed on 22 Dec.2007. Length of right lower tadpole ca. 8 mm. (Photographs by: Colleen Goh).



Fig. 3. *Fejervarya cancrivora*, crab-eating frog on 13 Jun.2008. Snout-vent length ca. 9 cm. (Photograph by: Colleen Goh).

in this habitat (Location 2). At the SBWR, most records of this species were from Location 6. It was seen near or by the freshwater ponds adjacent to mangrove and scrubland, and at built-up areas. This frog has the tendency to crouch when approached. Outside the survey sessions, it was sometimes seen during the day at the freshwater pond at the Visitor Centre, resting submerged, or out of the water.

***Limnonectes blythii*** (Boulenger), Malayan giant frog (Figs. 4–6)

The presence of this species at SBWR is noted in Baker & Lim (2008: 57). Known to grow to 26 cm in snout-vent length, this is the largest species of frog at the SBWR. This species is very similar in appearance to the crab-eating frog. It can be distinguished from the crab-eating frog by the round warts on its back, while the crab-eating frog has longitudinal ridges. It is of interest to note that this species was formerly unrecorded from the reserve (see Anonymous, 2003), and may have been introduced. However, the Malayan giant frog is native to Singapore, at least in areas of primary and mature secondary forests, and there is no reason to disregard the possibility that individuals have gradually been adapting to more exposed and disturbed habitats, and thus colonising places where the species was previously not known to occur. At the SBWR, the Malayan giant frog was found at man-made and landscaped areas, freshwater ponds, scrubland and near mangrove forest sites. We have not heard its call at the SBWR and thus all individuals were recorded by sightings from all locations except Location 2. This species was recorded on 14 out of the 15 sessions, in small numbers—an average of five individuals per session. A mating pair was observed at the edge of the freshwater pond at Location 4. That the female was larger than her mate (Fig. 5) appears to be an anomaly for this species in which the males are usually known to be larger (Baker & Lim, 2008: 57). The mottled tadpoles were observed twice in the pond at Location 5 (Fig. 6). Adult frogs tend to be skittish, usually leaping away when approached too closely.

Family **Rhacophoridae**

***Polypedates leucomystax*** (Gravenhorst), four-lined tree frog (Figs. 7–9)

This species was recorded in the SBWR by Anonymous (2003: 32, 93). The four-lined tree frog inhabits man-made, landscaped areas with shrubs, tall grasses and water plants, usually near a freshwater source. It was often observed clinging onto the leaf blades of the cattail (*Typha angustifolia*). It was found at Location 1 on all sessions, at Location 5 on 14 sessions, and at Location 4 on one session. On average, 12 individuals were recorded per session, based mainly on their loud, single-quack calls, and on a lesser extent on sightings. Although only one mating pair was observed on one of the survey sessions, such couples were often seen outside survey sessions during the day at



Fig. 4. *Limnonectes blythii*, Malayan giant frog adult on 13 Jun.2008. Snout-vent length ca. 13 cm. (Photograph by: Colleen Goh).



Fig. 5. Mating pair of Malayan giant frogs, with smaller male mounting female on 4 Jul.2008. Snout-vent length of male ca. 9 cm. (Photograph by: Colleen Goh).



Fig. 6. Tadpole of Malayan giant frog on 13 Oct.2008. Length ca. 2 cm. (Photograph by: Colleen Goh).



Fig. 7. *Polypedates leucomystax*, four-lined tree frog. (a) Brown form on 5 Sep.2008. Snout-vent length ca. 7 cm. (b) Yellow form on 11 Jul.2008. Width of eyeball ca. 10 mm. (Photographs by: Colleen Goh).

Location 1 (Fig. 8). Individuals were also seen in toilets and buildings at the reserve. The foam nests and tadpoles were common in drums and containers at Location 1 (Fig. 9).

#### Family **Ranidae**

##### *Hylarana erythraea* (Schlegel), common greenback (Figs. 10–12)

Recorded in the SBWR as *Rana erythraea* by Anonymous (2003: 32, 93), the common greenback or green paddy frog inhabits freshwater ponds. It was usually seen on floating water plants or at the edge of the ponds. Its warbling call is soft but unmistakable. Outside survey sessions, it was often seen during the day. The common greenback was found on all survey sessions at Location 4. It was frequently recorded at Locations 3, 5 and 6. On average, 44 individuals were recorded for each survey. The abundance of this species was estimated from both calls and sightings. A mating pair was observed once at Location 3 (Fig. 11). The tadpoles were observed once in the pond at



Fig. 8. Mating pair of four-lined tree frog. Note foam nest below the frogs. Photographed on 8 Aug.2008. (Photograph by: Colleen Goh).



Fig. 9. Tadpole of four-lined tree frog on 1 Aug.2008. Tadpole length ca. 3 cm. (Photograph by: Kelvin Lim).



Fig. 10. *Hylarana erythraea*, common greenback. Note that one has a brown back (a; snout-vent length ca. 6 cm), instead of green (b; snout-vent length ca. 7 cm). Photographed on 5 Sep.2008. (Photographs by: Colleen Goh).



Fig. 11. Mating pair of common greenback on 13 Jun.2008. Snout-vent length of smaller frog ca. 6 cm. (Photograph by: Colleen Goh).



Fig. 12. A common greenback jumping straight toward the photographer's camera lens, photographed on 5 Sep.2008. (Photograph by: Yeo Suay Hwee).

Location 5. On one occasion, we observed what appeared to be territorial behaviour on one individual. While photographing a common greenback at Location 3, the subject hopped closer and closer toward the photographer, until it jumped at the camera lens (Fig. 12)! The frog could have seen its reflection on the camera lens, thus attacking it perceiving that it was another frog.

#### *Hylarana guentheri* Boulenger, Günther's frog

The presence of this species at SBWR is based on its characteristic loud barking calls at Location 6 during three survey sessions, and Location 4 on one session. The calls emanated from masses of floating vegetation in freshwater ponds. Despite our best efforts, we were unable to obtain a sighting. This frog appeared to be uncommon at the SBWR as not more than three male individuals were recorded per session. Günther's frog, a native of southern China, Taiwan, and Vietnam, is similar in general appearance to the common greenback, but differs in having a brown dorsum, dark brown sides, and the rear margin of the tympanum is distinctly white. This is the first record of this species in the SBWR, but the species has been known elsewhere in Singapore for the past ten years (T. M. Leong & K. K. P. Lim, pers. comm.). Although there is no way we can know for sure, we suspect that it may have been introduced to Singapore through the nursery trade hidden among ornamental plants. No tadpole that can be assigned to this species was collected, so we are unable to confirm if it breeds in the reserve.

#### Family **Microhylidae**

#### *Kaloula pulchra* Gray, banded bull frog (Fig. 13)

This species, recorded from the SBWR by Anonymous (2003: 32, 93), was found at man-made and landscaped areas near scrubland and mangrove. Its call is very distinctive and loud, and can usually be heard before and after heavy rains. It was found occasionally at Location 1, twice at Location 5 and once at Location 4. During the survey period, it was seen on seven sessions, with an average of four individuals per session, and usually only one individual per location. Although the abundance of this species may seem low from survey records, it may not be the case, as it is partially fossorial and becomes active only before or after heavy rain. A mating pair was observed on one session. This frog was also seen inside buildings at the SBWR.



Fig. 13. *Kaloula pulchra*, banded bull frog photographed on 4 Jul.2008. Snout-vent length ca. 7 cm. (Photograph by: Colleen Goh).

***Microhyla butleri*** Boulenger, painted chorus frog (Figs. 14, 15)

This species is noted to occur in the SBWR by Anonymous (2003: 32, 93). The painted chorus frog was found in man-made and landscaped areas near scrubland and freshwater pond. It was recorded on 14 (almost all) survey sessions, particularly at Locations 1 and 5. Between 10–50 individuals, largely males, were recorded per survey. As it is small and difficult to visually locate among grass, the abundance of this species is estimated by its loud and distinctive call. This frog choruses actively, especially on wet nights. As only male frogs call, its abundance at the SBWR would certainly be an under-estimation. The painted chorus frog is highly skittish and is an excellent jumper, capable of covering 1 m or more in a single leap, which is over 50 times its body length! The distinctive tadpoles were observed in water-filled plastic drums at Location 1 on all survey sessions, and once in the pond at Location 5. They are about 2 cm long and translucent (Fig. 15).

***Microhyla heymonsi*** Vogt, dark-sided chorus frog (Figs. 16–18)

This species was recorded in the SBWR by Anonymous (2003: 32, 93), and frequented man-made and landscaped areas, and near small freshwater ponds. It was recorded on all survey sessions at Location 1, 14 sessions at Location 3 and Location 5 and once at Location 4. It usually choruses actively in the evening, but may also call in the day before and after rains. As it is small and extremely difficult to visually locate among grass, the population size was estimated largely by its distinctive call. Between 10 and 100 (largely male) individuals were recorded on each survey session. As only male frogs call, its abundance at SBWR would certainly be an under-estimation. A mating pair was observed at the edge of the pond at Location 5. The female was larger in size and paler in colour (Fig. 17). The tadpoles were observed in the water-filled drums and tanks at Location 1 all through the survey period, and once in the pond at Location 5. They are small (about 1 cm long) with a striking white band between the eyes (Fig. 18).

## SUMMARY OF RESULTS AND DISCUSSION

A total of nine species of amphibians were found during the 2008 surveys at SBWR (see annotated checklist). All species previously recorded were present, except for the field frog. Günther's frog is recorded for the first time. The



Fig. 14. *Microhyla butleri*, painted chorus frog adult photographed on 11 Jul.2008. Snout-vent length ca. 2 cm.. (Photograph by: Colleen Goh).



Fig. 15. Tadpoles of painted chorus frog photographed on 23 May 2008. Largest tadpole length ca. 2 cm. (Photograph by: Kelvin Lim).



Fig. 16. *Microhyla heymonsi*, dark-sided chorus frog adult photographed on 28 Nov.2008. Snout-vent length ca. 2 cm (Photograph by: Colleen Goh).



Fig. 17. Mating pair of dark-sided chorus frog photographed on 13 Oct.2008. Snout-vent length of smaller frog ca. 2 cm. (Photograph by: Colleen Goh).



Fig. 18. Tadpole of dark-sided chorus frog photographed on 8 May 2008. Tadpole length ca. 1 cm. (Photograph by: Colleen Goh).

Table 1. Summary of occurrence of amphibian species at five selected locations at the SBWR.

S/No.	Species	Location 1	Location 3	Location 4	Location 5	Location 6
1.	Asian toad	+	+	–	+	–
2.	Banded bull frog	+	–	+	+	–
3.	Common greenback	–	+	+	+	+
4.	Crab-eating frog	–	+	+	+	+
5.	Dark-sided chorus frog	+	+	+	+	–
6.	Four-lined tree frog	+	–	+	+	–
7.	Günther's frog	–	–	+	–	+
8.	Malayan giant frog	+	+	+	+	+
9.	Painted chorus frog	+	–	–	+	–

surveys show that frogs are thriving in the SBWR. We have observed that the medium- and small-sized frogs were present in greater numbers. The dark-sided chorus frog appeared to be the most abundant at the reserve, followed by the common greenback, painted chorus frog, and four-lined tree frog. The Asian toad, Malayan giant frog, and the crab-eating frog were always found in smaller numbers. The banded bull frog was recorded occasionally, and Günther's frog was heard on only four occasions.

Of the six locations visited during the surveys, only Location 5 recorded nearly all species. This area contains a greater variety of favoured habitats such as scrub and grassy patches and a shallow pond with dense vegetation, and without large predatory fish. No frogs were found during the surveys at Location 2, but an example of the salt-tolerant Asian toad was observed there during the day.

The absence of the field frog (*Fejervarya limnocharis*) in the present surveys is interesting for it is also a species of disturbed areas, and is just as likely to be found at the SBWR. There are two possibilities. First, the record could be based on a mis-identification of the similar looking crab-eating frog, but this cannot be ascertained as there is no voucher specimen or photographs. Second, although a suitable habitat for this species — usually an open expanse of wet grassy areas — is available at the SBWR, certain species that occupy the same niche, probably the crab-eating frog, may have prevented its colonisation at the reserve.

The Malayan giant frog was first recorded for Sungei Buloh on 2 Oct. 2004 by Nick Baker, Yeo Suay Hwee and James Gan, from two individuals sighted at Location 4. Its presence at the reserve is confirmed in this survey, and found to be quite common. Although this species is native to Singapore, it was thought to be confined to inland primary and mature secondary forest at the Central Nature Reserve and Western Catchment Area. We are not able to ascertain if the SBWR population was introduced, or if it had been previously overlooked, or if the reserve was recently colonised by individuals that have adapted to relatively more exposed habitats. Perhaps a detailed investigation should be carried out on populations found in exposed areas (e.g., those from the SBWR) and those from mature forest (e.g., those from the interior of the Central Catchment Nature Reserve) to determine if the Malayan giant frogs in Singapore actually consists of genetically distinct populations.

Günther's frog is reported from the SBWR and Singapore for the first time. This species has been known to occur elsewhere in Singapore for the past ten years but these records were not yet published (T. M. Leong & K. K. P. Lim, pers. comm.). The mode of introduction is unknown, but it seems likely that frogs were introduced as stowaways on imported potted plants. Although heard on several occasions, no specimen has been sighted. It would be interesting to make a detailed study, because we do not know if the population at the SBWR is self-sustaining for the long term, or if it is affecting the other frog species in any way.

Amphibians are generally confined to freshwater, but the two local species, the crab-eating frog and the Asian toad are tolerant of brackish water. Both occur within the reserve. Although they are not abundant, they are the only frogs that venture onto the mangrove forest areas, in streams with brackish water, and on substrate that had been flooded by seawater. Note that the Asian toad was observed on saline substrate at Location 2 outside the survey sessions.

The frogs at the SBWR were observed to be generally more active in wet weather. We have observed that only the Malayan giant frog and the painted chorus frog appear to be strictly nocturnal. All the other species have been seen or heard during the day.

With the exception of the Malayan giant frog, all the frog species at the SBWR are often associated with human habitation (commensals) and have adapted to survive in exposed, artificial environments. Nevertheless, as components of the food chain, they benefit the reserve by playing the role of insect predator, as well as prey to carnivorous animals such as birds, snakes, and fishes.

## CONCLUSION

A total of nine species of amphibians was recorded at the SBWR during surveys conducted over seven months in 2008. The Günther's frog (*Hylarana guentheri*), an introduced species, is a new record. The field frog (*Fejervarya limnocharis*), although previously recorded, was not documented in this period. Most of the amphibian species are capable of thriving in relatively exposed habitats. They appear to be in no immediate danger of local decline or extinction.

## ACKNOWLEDGEMENTS

We extend our heartfelt thanks to the following colleagues and friends for making the SBWR Frog Survey possible: Halilah Ahmad, Nick Baker, Kelvin Lim, Yeo Suay Hwee, James Gan, Ng Sock Ling, Wong Tuan Wah, Leong Tzi Ming, Wong Kum Sang, Tan Teck Chye and Allan Teo. They have contributed kind assistance in the field, shared their expertise and help with frog identification, as well as additional photographs, and provided constant support and encouragement. We thank Kelvin Lim and Leong Tzi Ming for their advice and editorial contributions to this article.

## LITERATURE CITED

- Anonymous, 2003. *Sungei Buloh Wetland Reserve—A Decade of Wetland Conservation*. National Parks Board, Singapore. 98 pp.
- Baker, N. & K. K. P. Lim, 2008. *Wild Animals of Singapore: A Photographic Guide to Mammals, Reptiles, Amphibians and Freshwater Fishes*. Draco Publishing and Distribution Pte. Ltd. and Nature Society (Singapore), Singapore. 180 pp.
- Leong, T. M., 2009. Facing the future with our froggy friends. *Nature Watch*, **17**(3): 2–6.
- Leong, T. M. & L. M. Chou. 1999. Larval diversity and development in the Singapore Anura (Amphibia). *The Raffles Bulletin of Zoology*. **47**(1): 81–137.
- Lim, K. K. P. & C. M. Yang, 1991. An annotated checklist of the amphibians of Singapore, with emphasis on material in the Zoological Reference Collection. *The Raffles Bulletin of Zoology*. **39**(1): 215–233.

## APPENDIX

### Description of survey locations at the Sungei Buloh Wetland Reserve (see Fig. 1).

#### 1. Plant nursery and end of mangrove boardwalk behind SBWR Visitor Centre.

The plant nursery, adjacent to the end of the mangrove boardwalk, consists of gravel, soil and grasses. Plastic water drums and large containers used for keeping freshwater plants act as breeding sites for frogs. Tadpoles are present throughout the year in the containers and drums. The end of the mangrove boardwalk is located at the back-mangrove zone. Pools of brackish water are often left by the tides at a small area adjacent to the nursery.

#### 2. Mangrove boardwalk behind the SBWR Visitor Centre.

The wooden boardwalk is situated within the mangrove forest. The habitat is inundated by saline water twice a day when the tide comes in, and exposed twice a day when the tide recedes. This location was omitted after the first three surveys as there were no signs of frogs throughout the three sessions.

#### 3. Freshwater ponds at the SBWR Visitor Centre.

This location consists of two ponds along the boardwalk leading to the Main Bridge. One pond (about 12 m<sup>2</sup>) is next to the public toilet. It was newly created and has no predatory fishes. Predatory fishes are present in the other pond (about 720 m<sup>2</sup>) on the opposite side. Both ponds have lush growth of floating, emergent and submerged wetland plants, and terrestrial plants and grasses along their edges.

#### 4. Outdoor classroom.

Adjacent to the Mangrove Arboretum, this area consists of a freshwater pond, scrub vegetation and a small spice garden. The pond, about 260 m<sup>2</sup>, has dense growth of floating, emergent and submerged wetland plants. Predatory fish are present.

#### 5. Pond at maintenance shed.

A small freshwater pond of about 80 m<sup>2</sup> that is adjacent to a scrubland. It does not have big predatory fishes. It contains floating, emergent and submerged wetland plants and is surrounded by long grass. The existing pond was re-developed, with depth reduced and cattails (*Typha angustifolia*) planted towards the end of Mar.2008, two months before the frog survey.

#### 6. Pond at Hide 3A.

This is a large and well-established freshwater pond of about 6,480 m<sup>2</sup> with floating, emergent and submerged wetland plants. It is adjacent to a small, tidal stream lined with mangrove vegetation. Frog predators such as snakehead (*Channa striata*) and the puff-faced water snake (*Homalopsis buccata*) were found in the pond.