ACTHA Inc. News

December 2021-January 2022

Newsletter of the ACT Herpetological Association Inc.

In this issue:

Field trip

An ACTHA members summer field trip is being planned for January 2022, to part of the Murrumbidgee corridor. Any members interested in this outing should contact Margaret via email margaretning1@gmail.com for further details.

Diary Date

Our next bi-monthly meeting will be **Friday 15 February 2022**, at the Canberra Reptile Zoo, at 7pm. Our speakers will be Don Fletcher and Lisa Jokinen on the Rosenberg Monitor survey conducted in the Mt Ainslie area during February 2021.

Our postponed AGM will also be that evening and will be scheduled first.

www.actha.org.au

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ACTHA Committee for 2020-2021 **denotes life members*

President: Jason Spurr

Vice President: **Ric Longmore***

Secretary: Dennis Dyer

Treasurer: Margaret Ning

Newsletter Editor: Brian La Rance

Webmaster: Angus Kennedy

Public Officer: **John Wombey***

Conservation officer: Joe McAuliffe

Committee members: Iris Carter, Greg Flowers, Roy Chamberlain and Peter Child

Youth representatives: Liam Thornton and Jake McAuliffe

Several Memberships Still Due

We are well into the current 2021-22 membership year, and several ACTHA members have not renewed their subs. If you haven't paid, Margaret would love to receive your renewal: $20 for individuals/families, or $10 for student (including at university) renewal.

You can pay by Direct Deposit on the ACTHA website: http://www.actha.org.au/renew-membership.html

Please use your name as a reference; and record the date of your payment and the receipt number of your Direct Deposit on your membership form.

ACT Herpetological Association Inc.
Account Number: **486822880**
BSB: 112-908

Or cheques can be sent to PO Box 440, Jamison Centre, ACT 2614.

PLEASE NOTE - DON'T SEND ANY PAYMENT FOR HERPETOFAUNA this time, as we are still awaiting the next issue, and many people have already paid well in advance!! Thank you.

Report from ACTHA'S last meeting, 19 October 2021

Brian La Rance

Last meeting, ACTHA member Angus Cleary presented some photos from his time spent volunteering for the University of Newcastle as part of a program to monitor the impact of the 2019-2020 bushfire season on threatened frog species. Spending two weeks in the Gondwanan rainforests of northern NSW and one night in the Watagans, the team spent long days driving and hiking through various burnt and unburnt habitat types such as upland heath, granite boulder-lined creeks, open wet sclerophyll and subtropical rainforest.

The program mainly focused on the greater Washpool/Gibraltar Ranges area (near Tenterfield), with a few days in the Barrington Tops and New England areas further south. However, Angus' first night was spent herping with trip leader and frog enthusiast extraordinaire Stephen, who showcased some of his backyard and local froglife (and gecko life) the night before the trip. They found several species, including Broad-tailed geckos (*Phyllurus platurus*), Giant Barred frogs (*Mixophyes iteratus*), Stuttering frogs (*Mixophyes balbus*) and Red-crowned toadlets (*Pseudophryne australis*). The morning after, the rest of the team arrived and they set off to the Gibraltar Ranges area, where they used transects to monitor the endangered Pugh's Mountain frog (*Philoria pughi)* during the day, and the New England tree frog (*Litoria subglandulosa*) at night. During these transects they found several other species, including Granite Leaf-tailed geckos (*Saltuarius wyberba*) and Stony Creek frogs (*Litoria wilcoxii)*. Moving on to Washpool, they continued monitoring these species, with the addition of the Stuttering frog (*Mixophyes balbus*) also being monitored nocturnally, encountering other species such as the cantankerous Rough-scaled snake (*Tropidechis carinatus*) and Barrington stream frog (*Litoria barringtonensis*).

The next areas covered were the various state forests that surround the two national parks. Continuing to record calling males, they also met up with another team researching genetics and were able to finally catch a glimpse of the elusive *Philoria* they had been hearing all trip! Captivated by the stunning frogs, there was no way this trip could get any better. However, one morning, Angus was shocked to find a Mustard-bellied snake (*Drysdalia rhodogaster*). After recovering from morning grogginess and sharing the find with the other two team members, they realised that it would be a range extension of over 300km north, and that the photographs taken of the animal were the first of this population ever taken. Afterwards, they carried on hiking through difficult terrain, including summiting some brutal (but beautiful) mountains. Along the way, they continued monitoring the 3 frog species, as well as assessing habitat damage along some burnt creek lines.

Philoria pughi

Litoria davisae

The final few days consisted of travelling further south to the New England region, west of Coffs Harbour, where they would spend an evening surveying for the Sphagnum frog (*Philoria sphagnicola*) on some beautiful cliffside surrounded by fireflies. The frogs proved difficult to find though, as they were wedged deep within the crevices, while their 'dropping marble' like call echoed down the gullies. The following day, they headed to their final destination, Riamukka State Forest, where they would continue surveying for the Sphagnum frogs, as well as the southern cousin of the New England tree frog - Davies' tree frog (*Litoria daviesae*). Unfortunately, dangerous weather conditions meant the trip had to be cut short and so the two-week trip had come to an end.

Once again, we thank Angus for his wonderful talk, and look forward to hearing about his future journeys.

ACTHA has been granted permission to reproduce a few articles from the December 2021 issue of *FrogCall*, the newsletter of The Frog and Tadpole Study Group NSW Inc (FATS). We shall include two of those articles in this issue. The first is from Chad Beranek below: also see links below to his website, social media pages and contact details.

Instagram: https://www.instagram.com/chadleybera/
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Wetland Restoration for the Green and Golden Bell Frog (*Litoria aurea*)

Chad Beranek. (Reproduced with permission from FrogCall)

*Pair of Green and Golden Bell Frogs (*Litoria aurea*) in amplexus on Kooragang Island. (Chad Beranek)*

Building frog ponds has been a hobby of mine since I was seven years old when my dad installed our first frog pond in the garden.

I was always so curious about what factors influenced whether you would get certain species showing up and calling there. This hobby has turned into a passion and now I am actively involved in restoration and habitat creation projects for wildlife. This is why I was incredibly excited when I got a PhD offer for a project that was focused on the curious hobby of my seven-year-old self.

I started my PhD at Newcastle University by investigating the restoration ecology of the Green and Golden Bell Frog (*Litoria aurea*) at the end of 2016, with supervisors Prof. Michael Mahony and Dr. John Clulow. The goal was to investigate the response of a Bell Frog population to wetlands that were constructed to passively manage Mosquito Fish (*Gambusia holbrooki*) and chytrid-induced disease.

The field site for this study was situated on Kooragang Island (32° 50–54°S, 151° 42–47° E), located at the mouth of the Hunter River in NSW, Australia (see Fig. 1). The island is ~30 km2 in surface area and contains numerous wetlands including man-made and natural water-bodies. It has been shown previously that a level of increased salinity in breeding ponds reduces chytrid infections in this species, and can even eliminate it periodically in ephemeral wetlands.

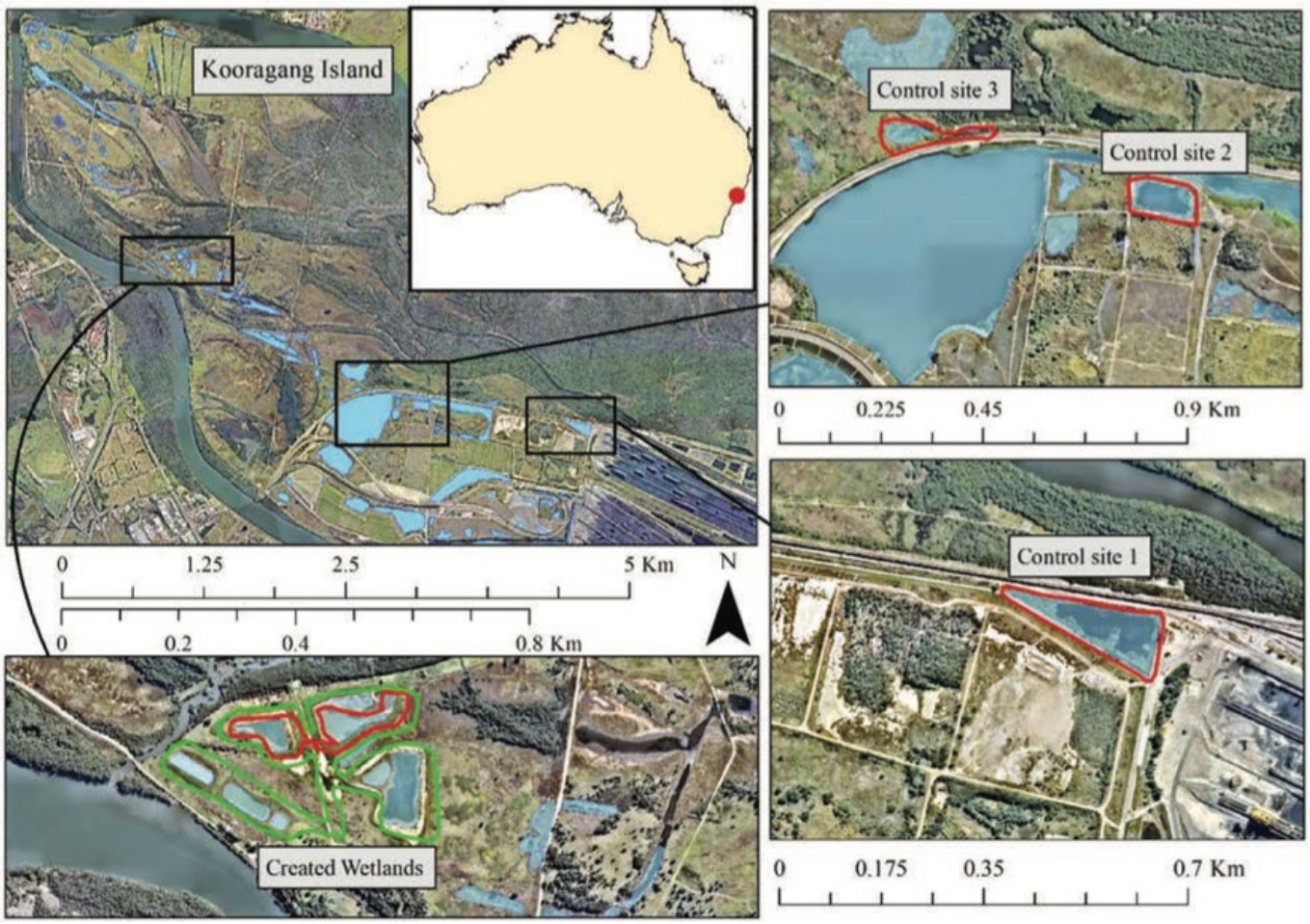

Fig. 1. Map of study sites. Blue objects indicate wetlands surveyed for L. aurea*. Green outline indicates the survey area in the created wetlands. Red indicates the survey area of the control sites and the reduced survey area of the created wetlands. High resolution aerial imagery obtained from Nearmap (2020), image date: May 04, 2016.*

We created nine wetlands (two permanent, three semi-permanent and four with short hydro-periods), with specific features designed to increase breeding, recruitment and survival of *L. aurea*.

With this knowledge in mind, the created wetlands were constructed near a natural wetland that has supported a small existing *L. aurea* population, and were hydrologically designed to either:

(1) have a short hydroperiod, or

(2) have a permanent hydroperiod

In both situations the aim was to retain salinity values within a range of greater than 2 parts per thousand (ppt) to less than 9 ppt (which is the upper threshold tadpoles of *L. aurea* can tolerate). This would then create an artificial saline refuge from chytrid.

The presence of the introduced Plague Minnow Fish *Gambusia* was also mitigated by creating ~0.6–1.4 m high earthen bund walls (clay embankments) around the perimeter of the wetlands to prevent overland flow of water which would replenish *Gambusia* colonisation. Further details about this research can be found in the first chapter of my PhD, published in 2020 (see *Reference no. 1*).

I had to begin fieldwork quickly, as I started in September, which is when the Bell Frogs usually start. There was no time to think carefully about experimental design and questions to ask, I had to dive right in knowing that the questions and experimental design would all include some core data: capture-mark-recapture, frog details (size, sex, weight etc.), tadpole netting, chytrid prevalence, water quality and hydroperiod. I stuck with these parameters and got into the field ASAP.

I also had no idea how regularly to sample. Since the first few weekly surveys only resulted in capturing 20 – 40 frogs each night, I decided weekly surveys needed to be continued for the entire breeding season. My other logic for this decision was that many expert ecologists have researched this species before, and I felt the only way to gain any extra insight into this frog was to try and spend as much time in the field with the frogs as possible, which I hoped would lead to new insights. The first year was quite cruisy, I had many excellent volunteers and field work was fun and usually one round of sampling took 1–2 nights.

During the first season, we obtained preemptively what I was calling “the royal flush”; observations of males, females, tadpoles, metamorphs, eggs and juveniles. It was amazing how quickly the frogs colonised the new wetlands and how quickly the wetlands became productive breeding sites. I recorded 10 breeding events during the first year. By the time I got to the second year, the population had exploded. What used to take me 1–2 nights, now took me 4–5 nights of surveying. Only sheer stubbornness allowed me to continue weekly surveys.

One fascinating trend that emerged as I collected data from the second year, was that while there were many more adult males compared to season 1, the number of adult females we caught was very similar to the previous year. This led me to investigate growth patterns and how long it took frogs to reach maturity. Since I had an immense data set from the continual weekly surveys, I was able to use this data to determine what age females and males matured at. Sure enough, the females took much longer than males to mature. It dawned on me that this factor was an important regulator of population dynamics in Bell Frogs (and probably many other frogs), and is especially important for reintroductions. If you only release one load of tadpoles, the next season you will have only adult males and no adult females to breed with the males. Since Bell Frog survival is so low, you would need a lot of tadpoles to produce males and females that survive to their second year. These ideas resulted in another one of my PhD chapters (*Reference 2*).

After the chaos of the second year of surveys, I resolved to prepare for even larger possible increases in population size, because once again, I recorded 10 breeding events (remember that each breeding event likely consists of multiple mating pairs, and each female can produce 5000 or more eggs in a clutch). I led an army of volunteers into the wetlands for my third season. Their sacrifices of sleep on the Bell Frog battlefield were due to my determination to keep up the weekly survey effort. As I anticipated, the Bell Frog numbers had increased by another order of magnitude. They were by far the most common frog on the site, and it was exciting to be immersed in Bell Frog choruses of 30–50 males after rainfall events. Sure enough, when I did the population modelling, the adult population size estimate for the first year was ~150, the second year was ~700 and the third year was ~1200!

B*ut why did they go so well in this habitat? Did our plans of passively mitigating chytrid and Mosquito Fish work?* This was the subject of another one of my chapters in which we looked at the chytrid prevalence data and the spread of Mosquito Fish from the study site to nearby control sites. We found that the Mosquito Fish were contained well with the bunding walls (bar a few incursions which were likely due to incomplete draining of the wetland basin in permanent wetlands before they were refilled). However, chytrid prevalence on the site was quite high and survival was quite low. It appears that these wetlands were offsetting chytrid impact by excluding Mosquito Fish (which deter frogs from breeding in ponds), thereby maximising frog breeding and recruitment.

The salinity and the ephemeral ponds did not entirely mitigate the threat of chytrid. Although there were some interesting observations that can help inform future designs, I found that chytrid prevalence in non-saline wetlands was lower if there were highly saline wetlands nearby. Indeed, sometimes I saw frogs "having a bath” in the highly saline wetlands, usually after rain. In future designs for chytrid-impacted amphibians, one could envisage a checkerboard mosaic of freshwater wetlands interspersed with highly saline wetlands. The details of this chapter are presented in *Reference 3*.

The most amazing moments being in the field doing this research usually came around late February each year. This is when my supervisor Mike Mahony would always hammer into me, “be ready for the late summer rain, this is where you get the most data!”. During these periods, I endeavoured to be out in the wetlands as the rain came and repeatedly visit the site every night to collect data. It was amazing to hear the choruses, not just of Bell Frogs, but Bleating Tree Frogs, Eastern Sedge Frogs, Common Eastern Froglets, Striped Marsh Frogs, Spotted Marsh Frogs, and the odd Green Tree Frog (this one was never on my site unfortunately but they persist in low numbers on Kooragang

Island). While these were amazing, what came after was even more amazing and led to insights for another PhD chapter...

Chad Beranek in wetland on Kooragang Island, monitoring Fyke nets and funnel traps for tadpoles. (Ray Marten)

About one month after these late breeding events, we would set out Fyke nets (0.7 m × 5.7 m, 4 mm mesh) monthly in each of the nine wetlands from September–March each year to capture Bell Frog tadpoles. The nets were placed with the mouth open towards emergent or submerged vegetation to optimise capture of *Gambusia* and/or *L. aurea* tadpoles, as both use this microhabitat more frequently than open water. This time of year always produced the most Bell Frog tadpoles despite putting the Fyke nets in the same spots in the wetlands at other times of year. My record for the most Bell Frog tadpoles captured in one net was ~950 and this was after breeding events associated with heavy summer rain. What followed after this was hundreds, if not, thousands of metamorphosed Bell Frogs. The Bell Frogs still bred during spring and the start of summer, usually in the permanent wetlands at that time of year, but during these times I never caught so many tadpoles or observed so many metamorphs. What was producing these obvious discrepancies?

While conducting monthly Fyke net surveys, I was recording every other species I caught in the nets (if it was easily identifiable). This included the Hunter Endemic Yabby (*Cherax setosus*), the Giant Water Beetles (*Cybister tripunctatus* and *Hydrophilus pedipalpus*) and also the larvae of the Australian Emperor Dragonfly (*Anax papuensis*). Now is probably a good time to mention that I also opted to do weekly monitoring of wetland birds on the site and reptiles with artificial refuge surveys (a fancy way of saying "I lifted tin sheets to look for reptiles warming themselves"). I also recorded every animal we encountered during routine visual encounter surveys of the frogs. This extra data meant that I could test several hypotheses concerning what was driving the numbers of metamorphs I was seeing, while considering the following criteria:

1) density of tadpole predators
2) water temperature
3) salinity

4) detection probability (I ran an experiment to see if it was easier to find frogs in different wetlands)

5) more breeding in later summer due to more mating pairs (I tested this with genetics)

It turned out that the most correlated factors were predators on tadpoles, and I found that such predators were in significantly lower densities in the newly replenished freshwater wetlands. This just goes to show the importance of having a mosaic of habitats for amphibians on Kooragang Island. Essentially, the ephemeral wetlands provide enhanced recruitment for Bell Frog populations and the permanent wetlands are important as a drought refuge. The details of this chapter are shown in *Reference 4*, which will be published in Wildlife Research at the end of 2021.

Some other amazing experiences I had in the wetlands were not with Bell Frogs, but with other species that shared the ecosystem. There was a regular occurrence in the wetlands of the Large-footed Myotis (*Myotis macropus*), which is a specialised microbat that uses its feet to capture aquatic prey. This bat is also threatened in NSW so it was a great treat to have them using the site. Some nights I would be walking through a wetland with the team and we would be surrounded by 5–10 Myotis which flew around us in figure eights, capturing prey, usually moths (but I also saw one take a water spider *Dolomedes facetus*). I got a few close views of one trawling through the water for prey. This led me to another opportunistic chapter, which I did with a research undergraduate student Giorginna Xu. We documented this co-occurrence of a threatened bat and a threatened frog to demonstrate that constructed wetlands can be designed to benefit multiple threatened species simultaneously (*Reference 5*).

It was not only threatened microbats that used the wetlands... I also made several sightings of eastern grass owls (*Tyto longimembris*) which appeared associated with a large number of house mice (*Reference 6*) that grew in number in response to the flowering of the wetland Bulrush plant *Typha orientalis*. I also came face-to-face with rare wetland birds (literally face-to-face), including a stunning male Painted Snipe and a female Australian Little Bittern, both rare sightings in the Hunter.

Encounter with a rarely seen Painted Snipe. (Chad Beranek)

In fact, the Little Bittern sighting was one of only about 10 reported in the region. These observations caused a stir in the bird world, and I had Hunter birders “flocking” to my site in hopes of seeing these rare species to add to their Hunter “lifer” list. I made the most of the opportunity and bargained the promise of them helping me with field work and in return I would show them the rare birds. Unfortunately, not many got to see them. Only myself and a handful of volunteers got to see the Little Bittern (although we made another sighting of a male a year after the first). Other birders were luckier with the snipe since it stuck around for three weeks or so. While these observations were not of immediate importance to my PhD thesis, they were documented in scientific publications (References 7–8).

In Conclusion

Now that I'm at the end of my PhD, I highly regard the value of those additional observations of other wildlife and I am glad I stubbornly attempted to survey everything weekly in the wetlands over the last few years. The wetlands were built on a cow paddock and now several years on, they are highly abundant and rich in species, and provide resources for many threatened wetland animals. I think there is an argument to be made that Bell Frogs may be an important umbrella species for wetlands, much the same as how the koala is for the forests.

If we make habitat specific to Bell Frogs (which involves mosaics), then we benefit a large number of other species. Maybe even the bitterns have declined due to the decline of the Bell Frog since they are a relatively large and easy to obtain prey item? (I know from experience that capturing a striped marsh frog is much more difficult in a large wetland compared to capturing a Bell Frog).

One of my goals as an ecologist going into the future beyond my PhD is to restore Bell Frog populations in areas where they have gone locally extinct, with a mixture of reintroduction and habitat creation. My PhD experience has led me to important insights on how to conduct these more effectively. It is my hope that by re-establishing this species across its range, it will lead to an overall increase in wetland species diversity and stave off extinction for many other threatened species.

References:

1. Beranek, C.T., Clulow, J., and Mahony, M. (2020). Wetland restoration for the threatened Green and Golden Bell Frog (*Litoria aurea*): development of a breeding habitat designed to passively manage chytrid-induced amphibian disease and exotic fish. *Natural Areas Journal 40(4), 362–374.*

2. Beranek, C.T., Maynard, C., McHenry, C., Clulow, J., and Mahony, M. (2021). Identifying a limiting factor in the population dynamics of a threatened amphibian: the influence of extended female maturation and operational sex ratio. *Austral Ecology Early View.*

3. Beranek, C.T., Maynard, C., McHenry,C., Clulow, J., and Mahony, M. (2021). Rapid population increase of the threatened Australian amphibian *Litoria aurea* in response to wetlands constructed as a refuge from chytrid-induced disease and introduced fish. *Journal of Environmental Management 291, 112638.*

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5. Beranek, C.T., Xu, G., Clulow, J., and Mahony, M. (2021). Preliminary evidence for a two-for-one deal: Wetland restoration for a threatened frog may benefit a threatened bat. *Ecological Management & Restoration 22(1), 32–39*.

6. Beranek, C.T. (2020). Increased house mouse (*Mus musculus*) abundance in wetlands in response to *Typha* sp. flowering: implications for understanding wetland occupancy patterns of the eastern grass owl (*Tyto longimembris*). *Australian Journal of Zoology 67(4), 210–214.*

7. Beranek, C.T., Clulow, J., and Mahony, M. (2020). A simple design feature to increase hydro-period in constructed ephemeral wetlands to avoid tadpole desiccation-induced mortality. *Ecological Management & Restoration 21(3), 250–253.*

8. Beranek, C.T. (2020). Nocturnal detection of Australian Little Bittern and Australian Painted-Snipe–Prospects for nocturnal survey methods for rare wetland birds. *The Whistler 14, 48–53.*

A weekend away to the Central Coast

Brian La Rance

After finally finishing up with school for the year, a friend and I decided to take a well-earned trip up to the central coast in search of some herps. Here are the photographic results. Enjoy.

Giant Barred Frog (*Mixophyes iteratus*).

Giant Burrowing Frog (*Heleiopourus australiacus*)

Whirring Tree Frog (*Litoria revelata*).

Mainland She-oak Skink (*Cyclodomorphus michaeli*).

Red Eyed Tree Frog (*Litoria chloris*).

Green-thighed Frog (*Litoria brevipalmata*).

This is the second of the FrogCall articles. It's another one on the east-coast frog epidemic, this time by Arthur White, President of FATS, outlining the chronology of the epidemic.

The 2021 Frog Epidemic in Eastern Australia

Arthur White (Reproduced with permission from FrogCall)

As you all know, 2019 saw the emergence in eastern China of the coronavirus causing COVID-19. It did not take long for the virus to be spread around the globe, claiming millions of lives and closing down national economies. Humans have poured billions of dollars into trying to control the spread of the disease and treat infected people. While this drama was unfolding, a similar scenario has begun playing out in the frog world in eastern Australia. An epidemic has erupted along the eastern coast of Australia during 2021 that has claimed countless frogs. The frog epidemic is serious, but of course, it does not get the media attention of human pestilence. Why has this frog epidemic occurred? Is it similar to other previous epidemics in Australian frogs or is this something new?

Our frog epidemic begins

First alerts of something wrong in the frog world were received by the Frog Help Line in late May 2021. The first reports were of dead Green Tree Frogs in the Richmond-Windsor area. Four reports in three days. All the reports were similar in that the callers described finding sickly frogs on their lawn in the day time. The frogs were skinny, could hardly move and were very dark in colour (Fig. 1). Sometimes they were alive but died within 24 hours of first being noticed.

Fig. 1 Dead Green Tree Frog. (Suzanne McGovern)

The FATS Frog Help Line receives some calls at the start of every winter about skinny, dying frogs. The onset of winter is a tough time for frogs, especially if they are underweight. Every winter, a number of frogs may die because they are forced to undergo long periods without food. If they are already skinny at the start of winter, they will not be able to fend off infections or starvation during the cold months. That has become normal.

What was different this time? Frogs were being found at the start of winter out in exposed areas, sick or dead, even during the daytime.

Healthy frogs normally take shelter throughout the colder months of the year. Food is not available and so frogs find a safe place to hide, reduce their metabolic rate and wait until the temperatures begin to rise again. If they are burrowing frogs, it is time to dig deep into the safety of the soil.

Was this an outbreak of Frog Chytrid Disease?

When these reports were received, the first suspicions were that these frogs were victims of Chytrid. Amphibian Chytrid is not new and has caused widespread frog deaths in Australia and globally before. Chytrid first emerged in Australia as a pandemic in the 1980s. Unlike COVID-19, the pathogen involved is not a virus, but a single-celled fungus. The fungus, formally named (*Batrachochytrium dendrobatidis*) initially penetrates and damages frog skin, resulting in the frog's immune system being impeded and then they become prone to multiple common infections. Chytrid has been responsible for causing population declines in more than 500 amphibian species around the world, and the extinction of more than 70 species.

Not all frogs are equally susceptible to chytrid disease. In Australia, many of the tree frogs (genus *Litoria*) appear to be more susceptible. The last major eruption of frog chytrid disease in eastern Australia was in 1995/1996. Chytrid is widespread in frog communities globally and flares up occasionally as a local outbreak.

The triggers for a major pandemic such as Chytrid are unknown, but usually are the result of a combination of events: frog populations that are stressed by external factors such as sustained adverse weather, lack of food, loss of habitat or habitat degradation are more likely to succumb to an outbreak of Chytrid. In addition, the chytrid organism is capable of change and more virulent forms of the fungus appear from time to time.

Winter 2021 - our frog epidemic worsens

June and July saw FATS Frog Help Line besieged with calls from distressed residents finding dead frogs. Initially the calls were from the Greater Sydney area, but then we received many calls from people in the Hunter Valley. It was clear that there were major eruptions and places such as Singleton, Maitland, Paterson, Dungog, and Muswellbrook were in the firing line. We also started to receive the first calls from people in the Illawarra and Shoalhaven regions, south of Sydney.

FATS were not the only ones receiving this bad news. The Australian Museum and Taronga Zoo in Sydney were also being bombarded with calls about dying frogs. As it was clear that this was not a normal winter-die off, Taronga and the Museum combined forces to establish a task force to deal with the epidemic. **Dr Jodi Rowley** from the Australian Museum (Fig. 2) and **Dr Karri Rose** from the Taronga Zoo established a co-operative arrangement where the Australian Museum dealt with most of the incoming calls and the Australian Registry of Wildlife Health (ARWH) at Taronga Zoo dealt with the analysis of frog carcasses and the identification of pathogens. Shortly afterwards, a forensic unit from the NSW Department of Planning, Infrastructure and Environment (DPIE) also joined the team. There was now a strong and organised front to deal with this epidemic.

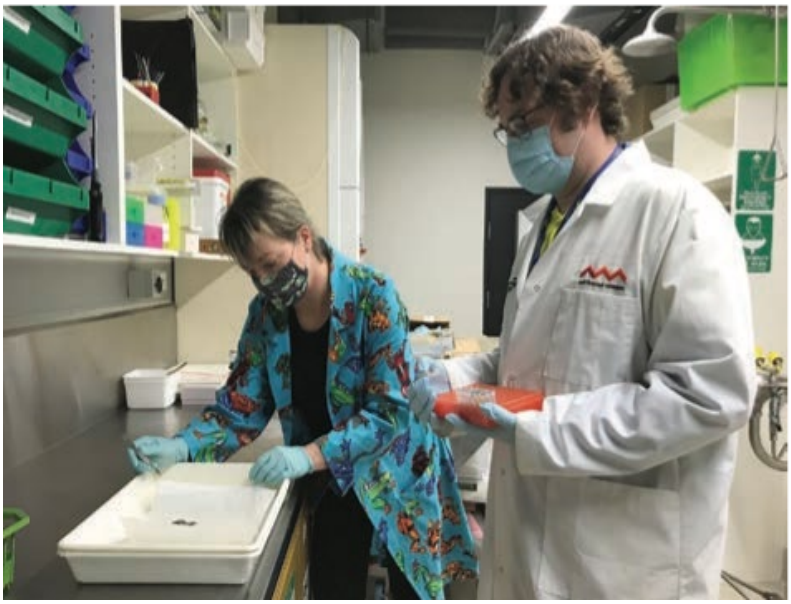

Fig. 2 Jodi Rowley and Dane Trembath examine a dead frog in the Australian Museum. (Tom Parkin)

Meanwhile, in Queensland, reports of many frog deaths were also starting to come in. Most of the reports were from south-eastern Queensland. The Queensland Frog Society went public, calling for members of the public to report dead frogs, collect the animal/corpse and forward it to the Dept. of Environment and Science (DES) for analysis.

The winter death toll

By the end of August 2021, the ARWH had been able to confirm over 1,200 frog deaths in eastern Australia. Of these, about 950 were from NSW, the rest from Queensland. The first reports of frog deaths from Victoria were also starting to come in. The reports that were being received were consistent: people were findings frogs in open areas, sitting still and often lethargic or incapable of moving. The frogs would remain stationary for some time, slowly turning dark brown; their skin would dry out and the abdomen would collapse inwards: the frogs would die usually within 24 hours of being found. Other symptoms that were reported included a red flush in the belly skin of the frog (Fig. 3) and excessive skin sloughing.

Fig. 3 Dead frog with red flush over inner limb surfaces and belly. (Sophie Henry)

Main Regions Affected

It was evident that there some regions that were being affected more than others; the worst hot-spots for frog deaths in NSW were areas on the mid-north coast (between Grafton and Coffs Harbour), the far north coast around Ballina and Yamba, the Lismore area, the Hunter region, the Central Coast (especially around Wyong, Tuggerah Lakes and Morisset), the South coast (Shoalhaven and Illawarra regions). Sites in Queensland that were particularly affected were concentrated around Brisbane, Gympie, Toowoomba, Bundaberg and Gold Coast. In Victoria, the worst sites were in the outskirts of Melbourne and the Gippsland.

Most of the reports received were from heavily populated areas: it is probable that in towns and cities people are more likely to come across dead and dying frogs. It is also likely that many frog deaths are not reported in less populated areas.

What frogs were being affected?

A relatively small range of frog species seemed to be badly affected by the epidemic: most reports initially received concerned dead or dying Green Tree Frogs (*Litoria caerulea*). These frogs are reasonably large, fairly conspicuous and generally popular with people. Their deaths often prompted some very emotional phone calls. The early phone calls were biased towards these rather iconic frogs. As time went on, the range of species reported increased. To date, over 20 frog species have been recorded as victims of the epidemic: the more common ones Peron's Tree Frog (*Litoria peronii)*, the Southern Stony Creek Frog (*Litoria lesueuri*), the Northern Stony Creek Frog (*Litoria wilcoxii*) and the Northern Green Stream Frog (*Litoria phyllochroa*). These are all relatively common and widespread species, which is probably why they have been found in and around our gardens and on our properties. Other rarer species, such as the Green and Golden Bell Frog (*Litoria aurea*) and the Southern Growling Grass Frog (*Litoria raniformis*) have also been affected.

While all of the frogs recorded in this list are tree frogs, some ground frog deaths were also recorded: these included Tusk Frogs (*Adelotus brevis*), Great Barred Frog (*Mixophyes fasciolatus*), Eastern Pobblebonk (*Limnodynastes dumerilii*) and Striped Marsh Frog (*Limnodynastes peronii*). Ground frogs are not as obvious as tree frogs and so are normally less noticed by people. Their relative absence from the list of dead frogs may reflect the fact that their bodies are not being seen. A number of people who reported dead ground frogs stated that the bodies were in bushes or against walls (i.e., not out in the open).

Perhaps, the biggest surprise was the finding of dead Cane Toads (*Rhinella marina*). This was surprising as Cane Toads are one of several species known to carry Frog Chytrid disease but generally, not to succumb to it.

Oddities of this Epidemic

The finding of dead Cane Toads in 2021 was just one of a number of odd and niggling differences between this and the 1995/1996 chytrid pandemic. Since 1995/1996 we have not had a widespread outbreak of chytrid. Yes, there have been small, highly localised outbreaks but these have always petered out quite quickly. The response of the Australian frog populations to a pandemic like Frog Chytrid Disease was exactly as you would expect: the initial exposure to the pathogen was dramatic, resulting in high rates of infections and many deaths. As the years passed, infection rates fell and fewer frogs died despite the fact that the disease was now widely established in frog

populations. It seemed like chytrid was becoming a disease that caused minor illness and deaths, but was no longer he scourge of frog communities. Some species appeared to be developing a level of immunity to chytrid. For the chytrid organism, killing its hosts is not a long-term method of survival (as the chytrid pathogen dies as well). For the frog, a slowly developed resistance to chytrid was required to negate its debilitating effects on the them. *So, if frogs were more resistant to chytrid, why did this epidemic occur? Is it only Chytrid that is responsible for the frog deaths?*

Pathology results Reveal the True Nature of this Epidemic.

Our haste to assume that chytrid was responsible for this epidemic was not justified. The teams at the ARWH in Sydney, Melbourne University, Melbourne Ark in Victoria and DES in Queensland were steadily building up a picture of the nature of this epidemic. *The majority of frog deaths were not attributable to frog chytrid disease.* Many other pathogens were detected. The pathologists had to sort through these infections to determine which were causative to the animal's demise and which were secondary infections that attacked the already disease-weakened animal. In general, about 30% of the frogs autopsied to date had chytrid, and of these, most had died from that infection (although many also had secondary bacterial infections). Of the rest, more than 50% were infected with ***Ranavirus***. The remaining 20% had major bacterial diseases or had severe parasite loadings that eventually led to their deaths.

The finding that *Ranavirus* was the major epidemic pathogen was a bit surprising. *Ranavirus*, as the name indicates, is a virus. In Europe and America, *Ranavirus* has been responsible for mass frog deaths. Ranaviruses have been identified in a range of ectothermic vertebrates, including fish, amphibians (frogs, toads, salamanders) and reptiles (lizards, turtles, snakes). Some types of *Ranavirus* are capable of infecting a broad range of species.

Afflicted Green Tree Frog found near Kempsey, NSW, June 2021; note red flush over belly and inner limbs. (Kate Shaw)

Ranavirus has been recorded in Australia before (e.g. in the 1980s), but when it first entered Australia is unknown. Why *Ranavirus* has not become an epidemic before in Australia as it has done elsewhere in the world, has been a great mystery. Perhaps our time was up. Studies on *Ranavirus* elsewhere in the world have found the *Ranavirus* is spreading. Not only is it appearing in new countries and new locations, but it is also infecting new hosts.

In Australia, prior to 2021, most evidence of *Ranavirus* was detected by the presence of antibodies to *Ranavirus* in the frog's blood. Disturbingly, the antibodies to *Ranavirus* are most commonly found in the blood of cane toads. There was a real possibility for Cane Toads to act as dispersal agents of *Ranavirus*, passing it to native frog communities, but this does not seem to have happened. We do not know why.

The recorded cases of native frog deaths to *Ranavirus* prior to 2021 were metamorphs of *Limnodynastes ornatus* and adult *Litoria caerulea* from Townsville, and captive juvenile *Pseudophryne coriacea* from Sydney. Tadpoles appeared to be the most susceptible, and juvenile frogs were more susceptible than adults.

The range of bacteria reported as causing disease and death in amphibians is also small. However, in frogs infected with chytrid or *Ranavirus*, secondary bacterial infections commonly occur and bacterial septicaemia often results. Infections from Group B *Streptococcus, Aeromonas, Flavobacteria, Chlamydia* and *Mycobateria* were all present in the frog autopsied in 2021.

Monitoring Ranavirus overseas

Ranavirus outbreaks overseas have been most prevalent in conservation areas, such as national parks and wildlife reserves. This is not because these areas are unhealthy, quite the opposite. These areas often provide the only viable remaining habitat for many frog species in an increasingly urbanised world. In Spain, 15 national parks have been monitored for *Ranavirus* and Chytrid since 2003. Frogs in these national parks live with both Chytrid and Ranaviruses and the study was aimed at finding out what the long-term effects of these two pathogen complexes is on frog populations. Chytrid is a generalist pathogen that has driven declines and extinctions across a broad range of amphibian host species. The fungus is able to infect over 50% of all tested amphibian species, with over 1,000 confirmed host species in at least 86 countries to date. In contrast, ranaviruses are still an emerging group of pathogens, but already have a host range spanning all ectothermic vertebrates. Ranaviruses are becoming more prevalent and are increasingly associated with mass amphibian die-offs overseas.

The study found that *Ranavirus* was implicated in more frog deaths than chytrid and that Ranaviruses have a greater potential to vary their method of infection, their host and their potency. In short, *Ranavirus* has been underestimated as a threat to global frog communities because its pathogenicity is often masked by secondary infections.

What triggered our 2021 epidemic?

At this point in time, we don't know. The very cold snap at the start of this winter is believed to be a telling factor and may help explain the early appearance of dead and dying frogs. We know that water temperature, for example, has a profound effect on the susceptibility of frogs to chytrid infection. What effects ambient temperature has on Ranaviruses is still to be resolved. Many other factors could be responsible for this epidemic, including new host species, the decline in insect food loads in eastern Australia (weakening the frogs), increased habitat degradation and climate change. It is also possible that the devastating and widespread bush fires of 2019–2020 may have contributed to the epidemic, since the epidemic was most pronounced along the edges of the bushfire-affected areas in eastern Australia.

The Future

This epidemic will provide much useful information for future disease management in wild frog populations in Australia. While data is still being processed, we can only hope new facts will emerge that may shed light as the trigger of this outbreak and how best to protect frog populations for future outbreaks.

Dead Northern Green Stream Frog, Litoria phyllochroa*, observed in the wild. (Isabella Bain)*

Northern California snake catcher finds more than 90 rattlesnakes hibernating under house in Sonoma County

https://www.abc.net.au/news/2021-10-16/snakes-under-a-home-northern-california-90-/100544798 *16 Oct 2021*

The reptile rescuer says he crawled under the mountainside home and found a rattlesnake right away, then another and another. (AP: Sonoma County Reptile Rescue)

Al Wolf is used to clearing one or two snakes from under houses but recently was called by a woman who had seen more than 90 rattlesnakes under her house in Northern California.

Mr Wolf, Director of Sonoma County Reptile Rescue, said he crawled under the mountainside home in Santa Rosa and found a rattlesnake right away, then another and another.

He got out from under the house, grabbed two buckets, put on long, safety gloves, and went back in.

He crawled on his hands, knees and stomach, tipping over more than 200 small rocks.

"I kept finding snakes for the next almost four hours," Mr Wolf said.

"I thought, 'Oh good, it was a worthwhile call' but I was happy to get out because it's not nice, you run into spider webs and dirt and it smells crappy and it's musty and you're on your belly and you're dirty. I mean it was work."

But the work paid off. He used a 60-centimetre snake pole to remove 22 adult rattlesnakes and 59 babies when he first visited the home in the Mayacamas Mountains on October 2.

He returned another two times since and collected 11 more snakes. He also found a dead cat and dead possum.

All the snakes were Northern Pacific rattlesnakes, the only venomous snake found in Northern California, he said.

Mr Wolf, who has been rescuing snakes for 32 years and has been bitten 13 times, said he responds to calls about snakes under homes in 17 counties and has seen dozens of them in one place in the wild but never under a home.

He said he releases the rattlesnakes in the wild away from people and sometimes in private land when ranchers request them for pest control.

Mr Wolf said he plans to return to the house again before the end of the month to see if any more snakes arrived.

"We know it's a den site already because of the babies, and the number of females I found," he said.

Rattlesnakes usually look for rocks to hide under and warm places and will return to the same place year after year.(AP: Sonoma County Reptile Rescue)

Rattlesnakes usually hibernate from October to April in the United States and look for rocks to hide under and warm places and will return to the same place year after year.

The homeowners didn't remove any rocks when they built the house, making it an attractive place for the reptiles, Mr Wolf said.

"The snakes found the house to be a great place for them because the rocks give them protection but the house, too, gives them protection from being wet during the winter so, it's double insulation for them," he said.

*Below: From the **February 2021 surveys of Rosenbergs' Monitors on Mt Ainslie:** a dog is captured on the sensor camera stealing the chicken carcase bait (which was enclosed in chicken wire!). **Come along to the 15 February ACTHA bi-monthly meeting, and hear more about the survey happenings**.*