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NSW GOVERNMENT

Frogs and flows

Research update: prioritising stream frogs for environmental outcomes monitoring

October 2023

Acknowledgement of Country

The Department of Planning and Environment acknowledges that it stands on Aboriginal land. We acknowledge the Traditional Custodians of the land and we show our respect for Elders past, present and emerging through thoughtful and collaborative approaches to our work, seeking to demonstrate our ongoing commitment to providing places in which Aboriginal people are included socially, culturally and economically.

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More information

This research update is part of our Environmental Outcomes Monitoring and Research Program please visit our website for more information.

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Title page photo credit: Alex Pike - Department of Planning and Environment, Eastern stony creek frog (*Litoria wilcoxii*).

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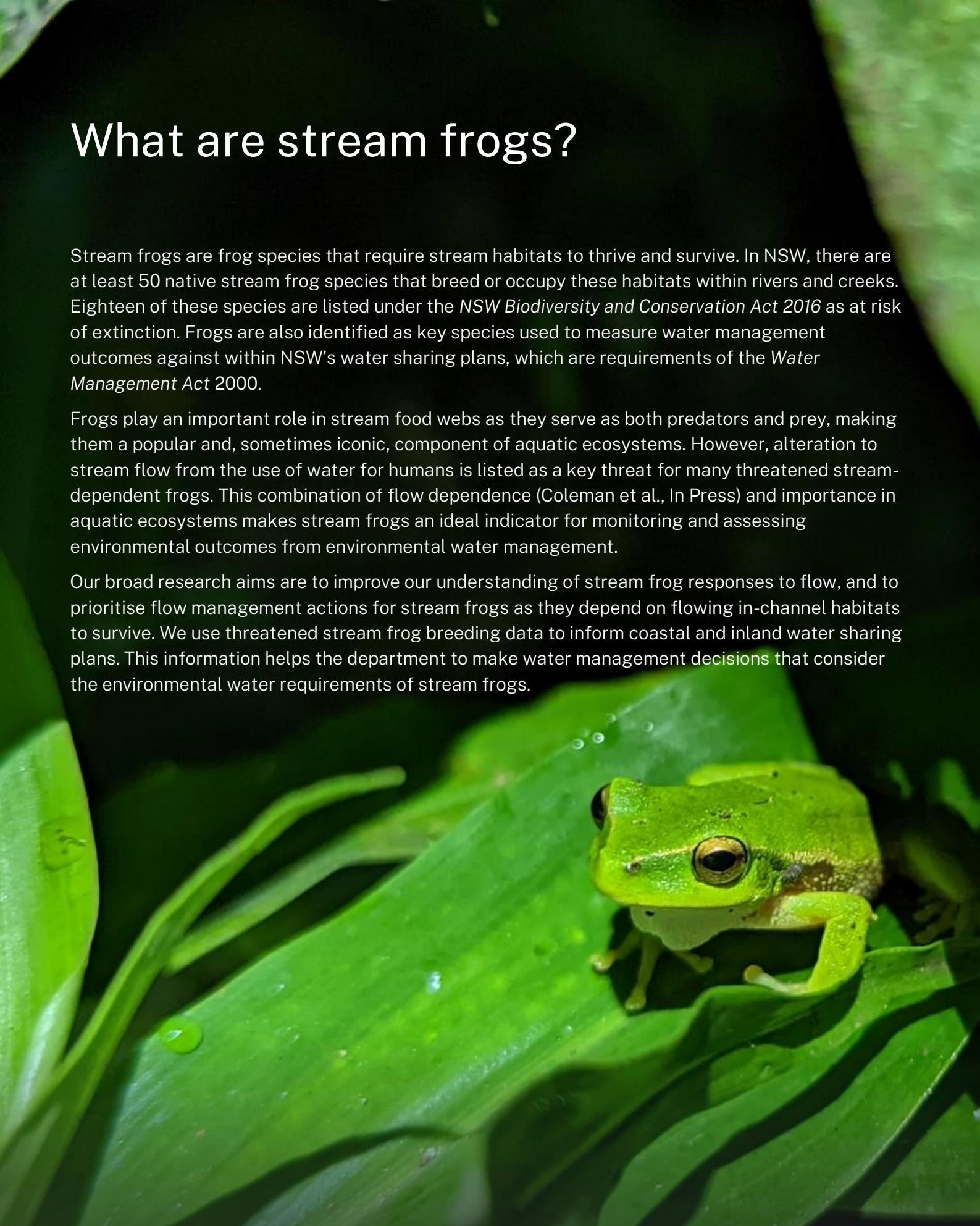
Contents

What are stream frogs?

Stream frogs are frog species that require stream habitats to thrive and survive. In NSW, there are at least 50 native stream frog species that breed or occupy these habitats within rivers and creeks. Eighteen of these species are listed under the *NSW Biodiversity and Conservation Act 2016* as at risk of extinction. Frogs are also identified as key species used to measure water management outcomes against within NSW's water sharing plans, which are requirements of the *Water Management Act* 2000.

Frogs play an important role in stream food webs as they serve as both predators and prey, making them a popular and, sometimes iconic, component of aquatic ecosystems. However, alteration to stream flow from the use of water for humans is listed as a key threat for many threatened stream-dependent frogs. This combination of flow dependence (Coleman et al., In Press) and importance in aquatic ecosystems makes stream frogs an ideal indicator for monitoring and assessing environmental outcomes from environmental water management.

Our broad research aims are to improve our understanding of stream frog responses to flow, and to prioritise flow management actions for stream frogs as they depend on flowing in-channel habitats to survive. We use threatened stream frog breeding data to inform coastal and inland water sharing plans. This information helps the department to make water management decisions that consider the environmental water requirements of stream frogs.



Stream breeding frogs such as the Southern Green Stream Frog (*Litoria nudidigitus*) depend on river flows to maintain their habitat.

Image credit: Daniel Coleman - Department of Planning and Environment

Why are stream habitats important?

River flows and the stream habitats that they provide are essential for healthy stream frog populations. Flows support frog reproduction and tadpole development, provide food resources, and maintain suitable habitats for all life stages (Figure 1). Reduced flows and altered flooding regimes are placing all flow-dependent species, at increased risk of long-term population declines.

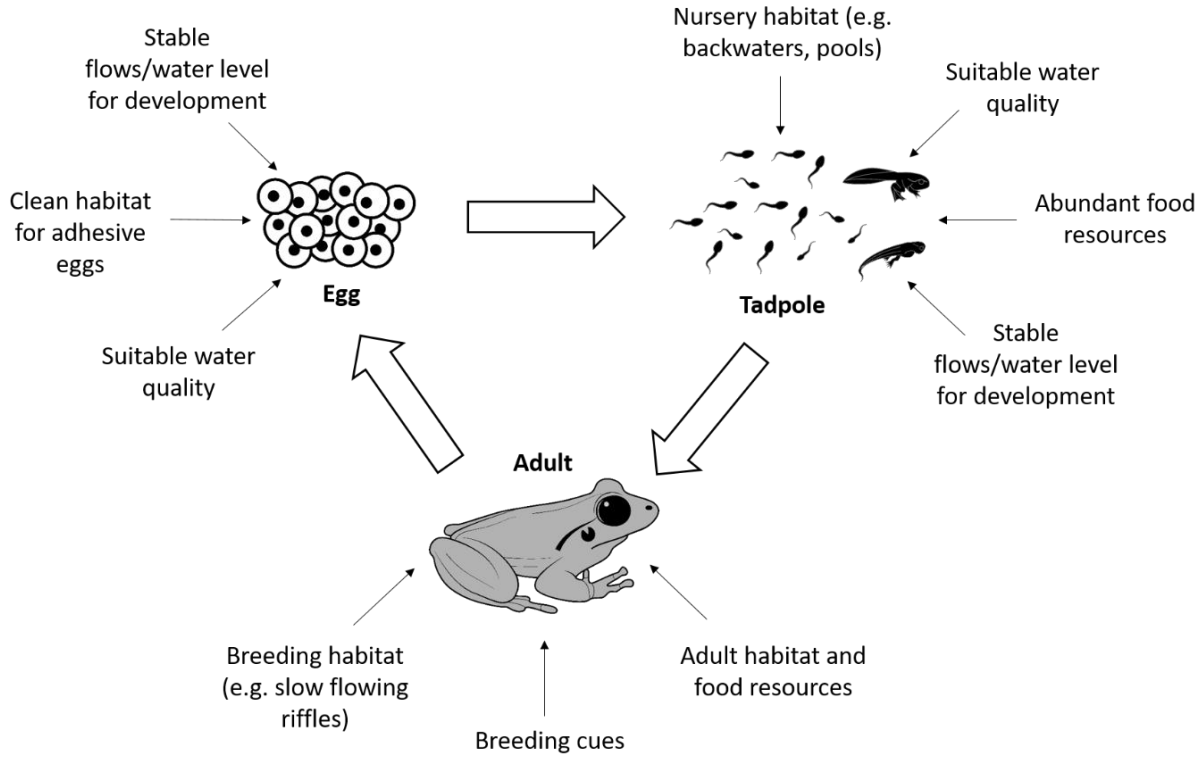


Figure 1 The association of flows on the key life cycle stages of a frog.

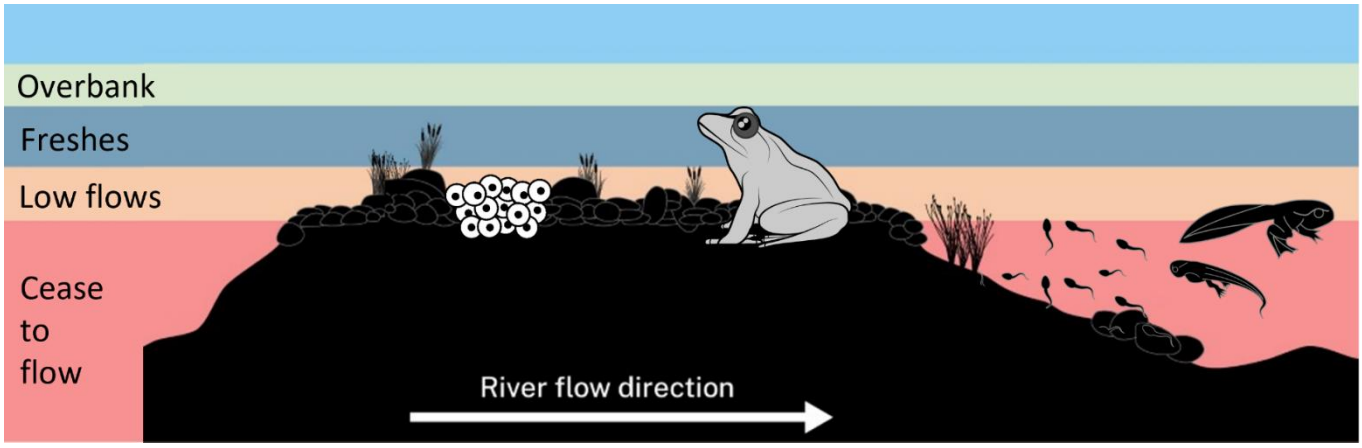


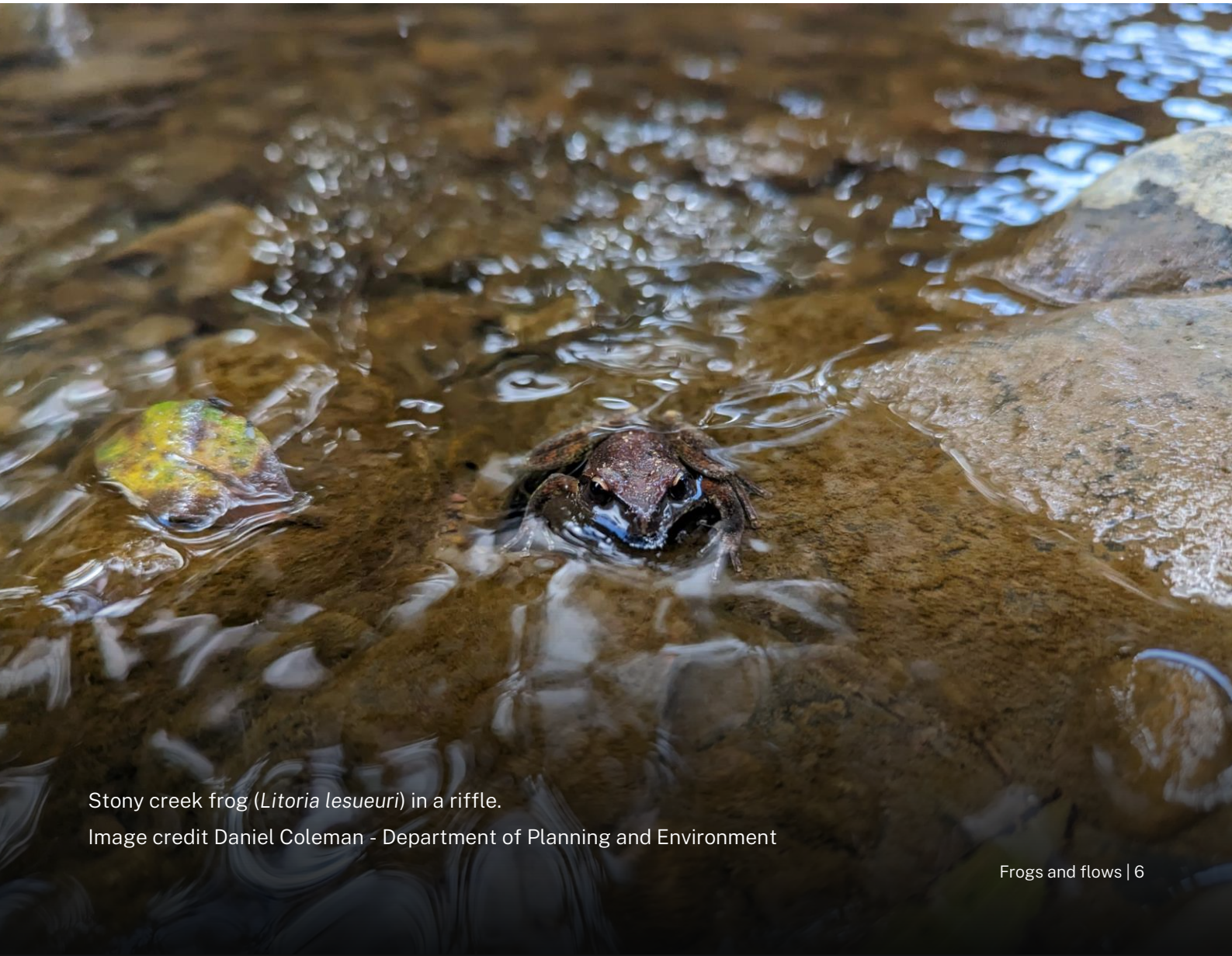
Figure 2 Conceptual diagram showing the importance of different flow classes for stream frogs in flowing habitats (for example, riffles).

Protecting flow for stream frogs

All components of the flow regime are important to stream frogs (Figure 2), however some species, or life stages, may require different flows.

Cease-to-flows

Cease-to-flows are periods of minimal to no flows when the river dries up into a series of disconnected pools. The first sections of river impacted are the flowing habitats, such as riffles (shallow water flowing over cobbles and pebbles within the river channel). Longer cease-to-flow periods will reduce the amount of available habitat and resources for stream frogs. Lack of adequate flow can result in a decline in frog populations. Localised extinctions can also occur if there are no opportunities to breed, or if tadpole habitats within pools dries up. Maintaining adequate flows and reducing the severity of cease-to-flow events is critical for protecting aquatic refuge habitats, such as in stream pools, that are important for frogs.



Stony creek frog (*Litoria lesueuri*) in a riffle.

Image credit Daniel Coleman - Department of Planning and Environment

Low flows

Low flows are required to provide habitats for stream frogs that require flowing habitats to breed, and to ensure tadpoles can complete their development into adult frogs. These flows are particularly important for maintaining flowing riffle habitats which provide food resources and breeding habitats for some stream frog species. For example, riffle breeding specialists like the Stuttering frog (*Mixophyes balbus*) require low flows to be maintained during critical breeding months for egg laying and hatching prior to the tadpole development phase. Some riffle breeding frogs have tadpoles that remain in flowing habitats, with the tadpoles of most species moving into stream pools for tadpole development. There are also species that have adult frogs which prefer flowing stream habitats.

Freshes

Some stream frogsdepend on natural flow pulses at higher levels (freshes), associated with rainfall, to trigger breeding events. The timing of these flows with breeding months is critical for initiating breeding cues and providing opportunities to reproduce. These are particularly important for the ground dwelling barred frogs (*Mixophyes* group), which breed in riffles after flow pulses.

The tadpoles of the giant barred frog (*Mixophyes iteratus*) can grow up to 10 cm and take up to 14 months to develop into adult frogs.

Image credit: Alex Pike - Department of Planning and Environment

Bankfull flows and overbank flows

Bankfull flows are high flows that fill the river channel, and overbank flows are flows that spill over onto the floodplain. Bankfull flows help to maintain vegetation and habitat within the river corridors. They provide connecting flows which may allow stream frogs to colonise new habitats and provide opportunities for breeding in floodplain habitats. Alteration to the timing and frequency of high flows may be a threat to some frog species. These changes can erode stream banks and drown out riffle and pool habitats during breeding months and early life stage development.

Overbank flows inundate habitats beyond the river channel, creating opportunities for species to move to new habitats. This can provide new opportunities to breed in non-permanent water bodies that are connected to the main channel. Overbank flows also help to maintain water quality in refuge habitats and floodplains that provide temporary aquatic habitats for opportunistic species.

The Southern Green Stream Frog (*Litoria nudidigitus*) in vegetation near a stream.

Image credit: Daniel Coleman - Department of Planning and Environment

Prioritising stream frogs

Proximity to the stream

We have ranked the frog species in NSW in order of their dependence on stream habitats. This is based on where they are known to occur, and how closely their species records are associated with streams (Figure 3). We used known frog location records from the FrogID dataset (Australian Museum) and NSW BioNet species sightings data collection (Department of Planning and Environment) and measured the distance from the stream that each frog was located. We then compared how far these records varied between species, in order to prioritise species that were more strongly associated with stream habitats.

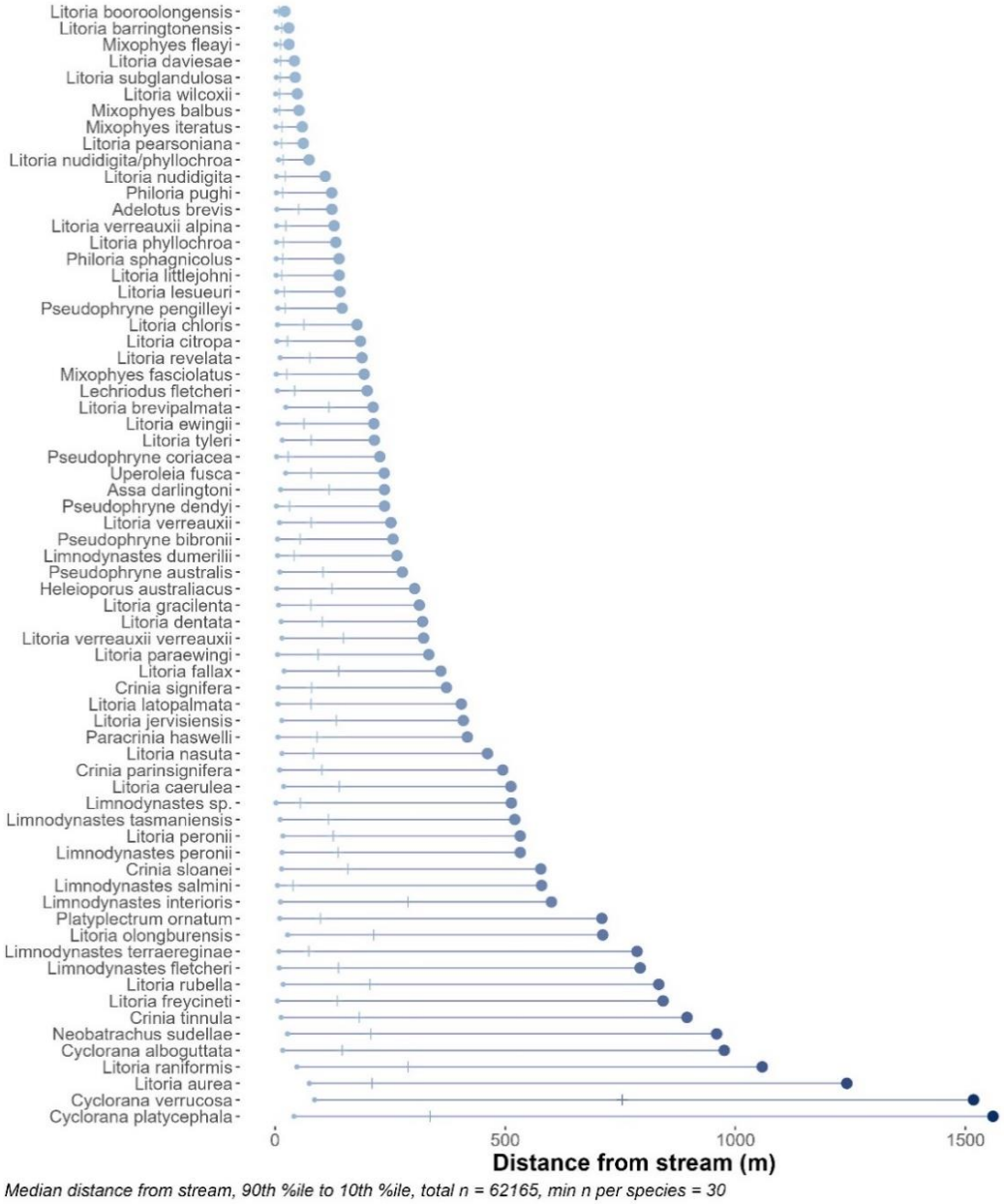


Figure 3. Dependence of frog species on stream habitats based on their calling distance from the stream.

Some species such as the Booroolong frog (*Litoria booroolongensis*), were always found to be located within close proximity to streams (Figure 3, 90 % of records were located within 21 meters of the stream). These species are considered highly dependent on in channel stream habitats and permanent flowing rivers. Other frog species were located at much longer distances from the stream, for example the water holding frog (*Cyclorana platycephala,* 90% of records were located from 40 to 1,560 meters away from a stream*).* These may be more strongly associated with temporary standing water habitats, such as lakes and ponds, or flooded areas.

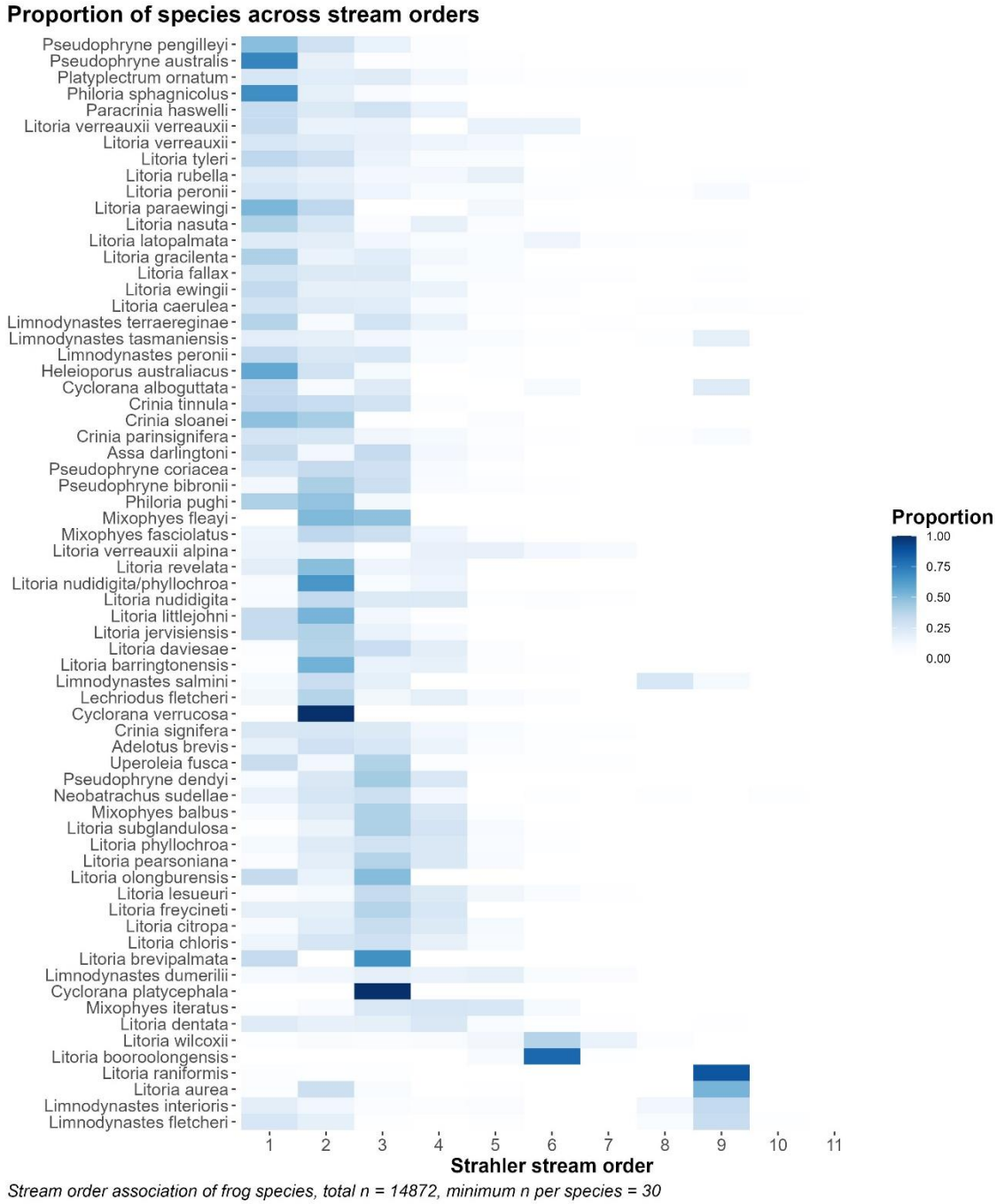
This information helps us to identify and prioritise species that are likely to benefit most from the protection of flowing water habitats. It also helps us to prioritise management actions and monitoring to assess the effectiveness of water management decisions aimed at restoring and protecting river flows.

Endangered Booroolong frog (*Litoria booroolongensis*) sitting in a flowing stream habitat.

Image credit: Alex Pike - Department of Planning and Environment

Strahler stream order

Strahler stream order is a substitute for stream size, with higher Strahler numbers indicating larger stream sizes, greater catchment areas and higher discharge. We have identified frogs that are more strongly associated with, and have a high dependence on, large streams with high Strahler orders (Figure 4). Frogs such as the Booroolong frog (*Litoria booroolongensis*) were strongly associated with larger streams and flowing stream habitats (Figure 4). Some frog species have highly restricted ranges. They are known to be associated with small streams or wetland swamps at the top of catchments at high altitudes, for example the Northern Corroboree frog (*Pseudophryne pengilleyi*).



Stream order association of frog species, total n = 14872, minimum n per species = 30

Figure 4. A heat map showing the association of the frog species with Strahler stream order (darker colours indicate a higher proportion of records for that species were associated with the corresponding stream order)

Classifying flow-dependent frogs

Life history traits can be an important tool to identify a species' sensitivity to specific environmental changes. For example, the location of egg laying sites and the time required for eggs to hatch can influence a species' dependence on flows. The Blue Mountains tree frog is a perfect example, with eggs laid in shallow, flowing water that is vulnerable to changes to low flows (Figure 5).

Figure 5. Eggs from the Blue Mountains tree frog (*Litoria citropa*), deposited in shallow flowing water at the top of a riffle. Photo credit Dan Coleman - Department of Planning and Environment.

We compared 8 life history traits related to stream dependence for all NSW frog species (Coleman et al. In Press), to identify flow-dependent stream frog species. The result was 2 key groups:

- facultative stream breeding frogs, which can breed in stream and non-stream habitats (for example, farm dams)
- obligate stream breeders, which are strongly dependent on stream habitats to complete their life cycles.

The obligate stream breeding species are considered the most sensitive to in-channel stream flows. These species are a high priority for monitoring the environmental outcomes for in-channel flow management actions. The list of obligate stream breeding species is provided in Appendix 1 Priority stream frogs.

Prioritising stream frogs for water management

We have provided a prioritised list of 30 stream frog species that we have identified as high and medium priority based on their dependence on stream habitats (Appendix 1 Priority stream frogs). This list is the result of adding the top ranked species (most flow dependent) from the 3 criteria outlined in this document:

- proximity to the stream
- Strahler stream order
- classifying stream dependent frogs.

Frogs that are listed as high priority species were ranked as the most flow-dependent in all 3 assessment approaches. Medium priority species were top ranked in 2 approaches.

These high and medium priority stream frog species are the species that are highly dependent on stream habitats to survive. This prioritisation list will be used to identify frogs that are most likely to respond to changes in flow conditions that can be used to monitor the environmental outcomes of water management rules and policies aimed at protecting flowing habitats.

Frogs not listed here may still be stream dependent but may not have had adequate information available on their flow requirements at the time of this analysis and may become a priority at a future date, for example endangered species or newly described species. This list is designed as a tool to help target frog species that can be prioritised for monitoring the benefits of environmental flows and water rules for the environment.

The Stony Creek frog (*Litoria lesueurii*) requires stream habitats to live and breed.

Image credit: Alex Pike – Department of Planning and Environment

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Appendix 1 Priority stream frogs

Species list of priority stream frogs for monitoring environmental outcomes of water management actions and water policy in NSW.

Species name	Common name	Functional group	Priority
Litoria booroolongensis	Booroolong frog	Obligate stream breeding	High
Litoria wilcoxii	Eastern stony creek frog	Obligate stream breeding	High
Mixophyes iteratus	Giant barred frog	Obligate stream breeding	High
Litoria barringtonensis	Barrington tops tree frog	Obligate stream breeding	High
Litoria citropa	Blue mountains tree frog	Obligate stream breeding	High
Litoria daviesae	Davie's tree frog	Obligate stream breeding	High
Litoria lesueurii	Stony creek frog	Obligate stream breeding	High
Litoria nudidigita	Southern green stream frog	Obligate stream breeding	High
Litoria pearsoniana	Pearson's stream frog	Obligate stream breeding	High
Litoria subglandulosa	New England tree frog	Obligate stream breeding	High
Mixophyes balbus	Northern stuttering frog	Obligate stream breeding	High
Mixophyes fleayi	Fleay's Barred Frog	Obligate stream breeding	High
Adelotus brevis	Tusked frog	Facultative stream breeding	Medium
Cyclorana platycaphala	Eastern water-holding frog	Facultative stream breeding	Medium
Limnodynastes dumerilii	Eastern Banjo Frog	Facultative stream breeding	Medium
Limnodynastes fletcheri	Barking frog	Facultative stream breeding	Medium

Species name	Common name	Functional group	Priority
Limnodynastes interioris	Giant banjo frog	Facultative stream breeding	Medium
Litoria aurea	Green and golden bell frog	Facultative stream breeding	Medium
Litoria brevipalmata	Green-thighed frog	Facultative stream breeding	Medium
Litoria chloris	Red-eyed tree frog	Facultative stream breeding	Medium
Litoria dentata	Robust bleating tree frog	Facultative stream breeding	Medium
Litoria freycineti	Wallum rocket frog	Facultative stream breeding	Medium
Litoria phyllochroa	Green stream frog	Facultative stream breeding	Medium
Litoria piperata	Peppered Tree Frog	Obligate stream breeding	Medium
Litoria raniformis	Southern Bell Frog	Facultative stream breeding	Medium
Litoria spenceri	Spotted Tree Frog	Obligate stream breeder	Medium
Litoria verreauxii alpina	Whistling Tree Frog	Facultative stream breeding	Medium
Mixophyes fasciolatus	Great barred frog	Obligate stream breeder	Medium
Philoria pughi	Pugh's Mountain Frog	Facultative stream breeding	Medium
Philoria sphagnicolus	Sphagnum Frog	Facultative stream breeding	Medium