



New Zealand's Extinct Frogs

THE HISTORY OF *LEIOPELMA*

NZFrogs is a charitable trust which aims to help people of all backgrounds and abilities learn about, engage with and support the conservation of New Zealand's native *Leiopelma* frogs.

In 2024, NZFrogs received funding through the Unlocking Curious Minds Contestable Fund to develop a series of educational booklets and accompanying posters. The goal for these resources is to provide engaging, bilingual resources that communicate years of scientific research, to a wide age range. Hopefully, you will find these resources are useful in your community and classrooms, and appealing to anyone interested in learning more about native *Leiopelma* frogs.

The *Pepeketua of Aotearoa* series includes four booklets with accompanying posters. Additionally, there are two special topic posters: *What makes our Pepeketua special?* and *Protecting our Pepeketua*. You can find out more about NZFrogs and the *Pepeketua of Aotearoa* series at nzfrogs.org

NZFrogs worked alongside a talented team to bring *Pepeketua of Aotearoa* to life:

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We would also like to acknowledge the following iwi for their contributions to these resources: Pare Hauraki, Ngāti Kuia, and Ngāti Koata.

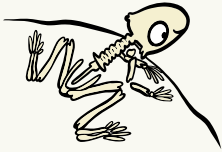
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CREATURE CARD

At least three species of native *Leiopelma* frogs became extinct after human arrival in New Zealand. Check out the other booklets in the *Pepeketua of Aotearoa* series or nzfrogs.org to learn more about New Zealand's native frogs.



Markham's frog

- Once widely distributed across the North and South Islands.
- Often found in pitfall fossil deposits containing terrestrial species.

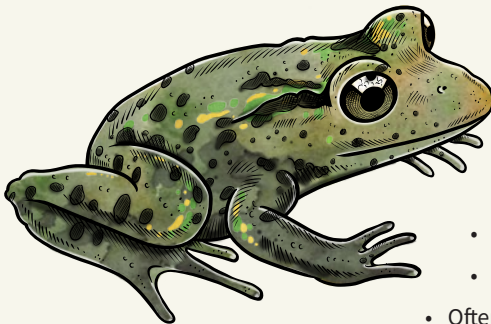
Adult SVL (snout to vent/nose to bottom) measurement: 50–60mm

Both Markham's and Aurora frogs were terrestrial like Hamilton's or Archey's frogs. They were robust, squat frogs which preferred to walk instead of jumping.

Aurora frog

- Only known from a single fossil discovered in Aurora Cave, Te Anau.

Adult SVL: 60mm



Adult SVL: 100mm

Waitomo frog

- Largest of all *Leiopelma* species, reaching up to 10cm long.
- It was likely a strong jumper.
- Found only in the North Island.
- Often found in stream wash deposits, indicating stream-dwelling habitat.

Prehistoric New Zealand



Can you imagine a New Zealand before human arrival?

A New Zealand where moa roamed the land, Haast eagles ruled the sky and New Zealand's **herpetofauna** flourished? More than 80% of New Zealand was covered by dense native forest and no mammalian predators plagued the land.

Six species of *Leiopelma* frog were distributed throughout the North and South Islands. Today, three *Leiopelma* species are extinct, but it's important we don't forget them! Understanding the past helps us become better kaitiaki for the remaining *Leiopelma* species.



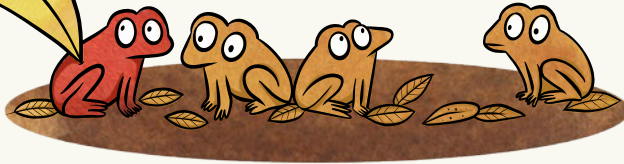
Leiopelma frogs would have reached incredible densities of more than one frog per square metre in pristine habitat.



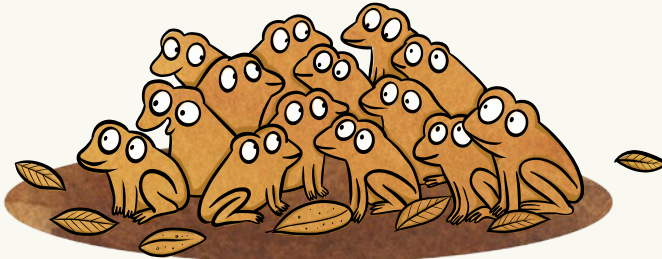
Evolution and natural selection



Leiopelma frogs have called New Zealand home for millions of years, but how did *Leiopelma* arrive in New Zealand? Why do they look and behave so strangely? To answer these questions, we first need to understand **evolution**, **natural selection**, and **adaptation**.

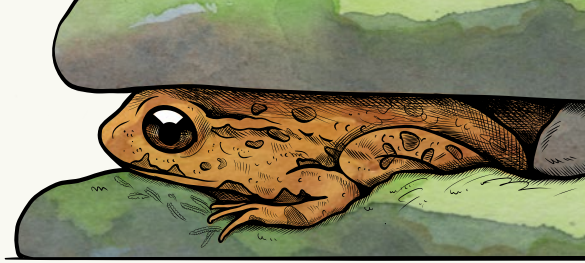


Original population



Remaining population

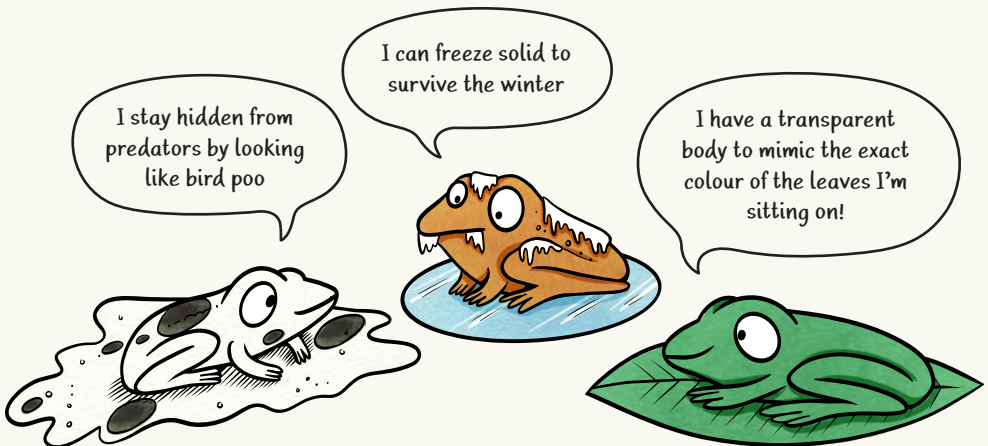
Imagine a species of frog that lives on the forest floor among the leaf litter. Not all individual frogs are identical, some are red, and some are brown. Birds love to eat these frogs. Brown frogs camouflage in the leaf litter while birds find the red frogs easily! Because of this, brown frogs are more likely to survive and reproduce, passing their brown camouflage to the next generation. Slowly, over many generations, this frog species becomes entirely brown.



Evolution is the change in heritable traits over many generations. Scientists use **evolution** to explain how living things on Earth today have developed and diversified from their ancestors millions of years ago. In our example, this frog species became entirely brown through **evolution**.

Evolution is primarily controlled by **natural selection**. **Natural selection** is the idea that living things that are better suited (or **adapted**) to their environment are more likely to survive and reproduce, passing their beneficial traits to their offspring. Over many generations these beneficial traits will become more common, causing a gradual change over time. Through **natural selection** living things become **adapted** to their environment. In our example, birds were part of the process of **natural selection**. Predation of red frogs by birds made the brown frogs more likely to survive and reproduce. Brown camouflage is an **adaptation** to the frog's environment.

Evolution can act on all aspects of a species' biology including how they look, function, behave, and/or interact with their environment. In frogs, this has resulted in crazy diversity!



Geological history

New Zealand has not always looked like it does today. New Zealand is part of a continent known as **Zealandia**. Today, 94% of **Zealandia** has sunk below the ocean. **Zealandia** was once part of the massive, southern supercontinent called **Gondwana**. Follow the timeline below to see how New Zealand has changed over time!

Zealandia was connected to *Gondwana*



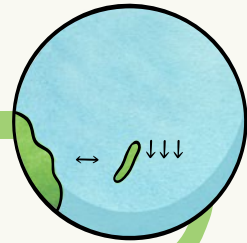
98 Mya

Zealandia finally split from *Gondwana*



80 Mya

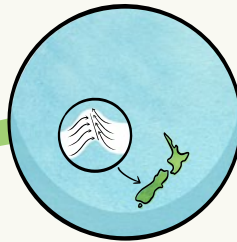
The Tasman Sea has grown to its current size



40 Mya



24 Mya



5 Mya



Starting ~2 Mya

As *Zealandia* drifted away from *Gondwana* it sank below the ocean, culminating in an event known as the 'Oligocene Drowning'

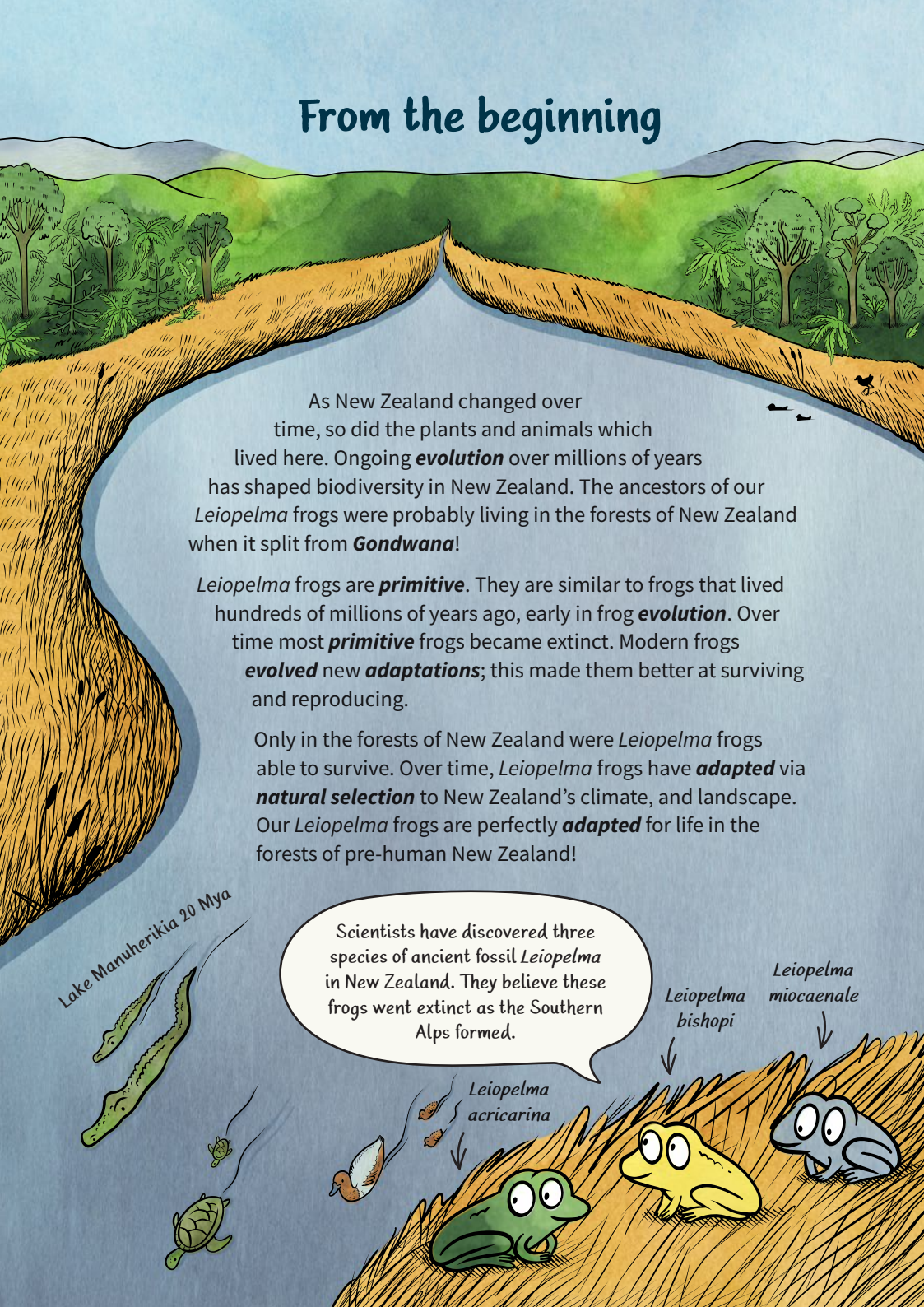
New Zealand has emerged from the ocean, and the Southern Alps are growing

Over multiple ice age cycles, glaciers grew and retreated

Mya is short for 'million years ago'



From the beginning



As New Zealand changed over time, so did the plants and animals which lived here. Ongoing **evolution** over millions of years has shaped biodiversity in New Zealand. The ancestors of our *Leiopelma* frogs were probably living in the forests of New Zealand when it split from **Gondwana**!

Leiopelma frogs are **primitive**. They are similar to frogs that lived hundreds of millions of years ago, early in frog **evolution**. Over time most **primitive** frogs became extinct. Modern frogs **evolved** new **adaptations**; this made them better at surviving and reproducing.

Only in the forests of New Zealand were *Leiopelma* frogs able to survive. Over time, *Leiopelma* frogs have **adapted** via **natural selection** to New Zealand's climate, and landscape. Our *Leiopelma* frogs are perfectly **adapted** for life in the forests of pre-human New Zealand!

Scientists have discovered three species of ancient fossil *Leiopelma* in New Zealand. They believe these frogs went extinct as the Southern Alps formed.

Lake Manuherikia 20 Mya

Leiopelma
bishopi

Leiopelma
miocaenale

Leiopelma
acricarina



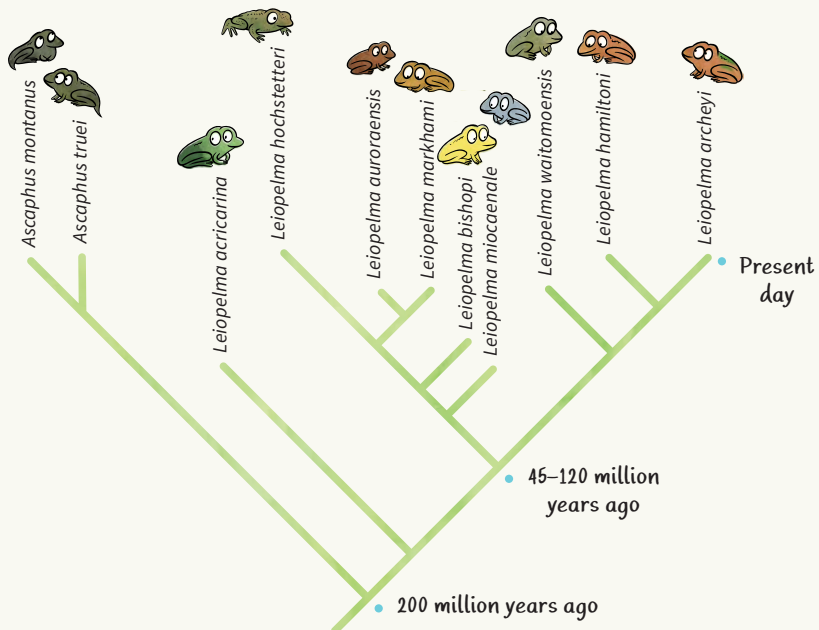
The *Leiopelma* family tree

The closest living relatives of *Leiopelma* frogs are the *Ascaphus* frogs of North America. *Leiopelma* diverged from *Ascaphus* over 200 million years ago. So, what has happened since then?

Palaeontologists are scientists who study fossils to learn about plants and animals that lived long ago. By comparing fossils to plants and animals alive today, **palaeontologists** can learn how things have **evolved** over time. *Leiopelma* frogs look similar to fossil frogs from Argentina and were once thought to be directly related. However, **palaeontologists** are still unsure because, after millions of years, these fossil frogs are poorly preserved.

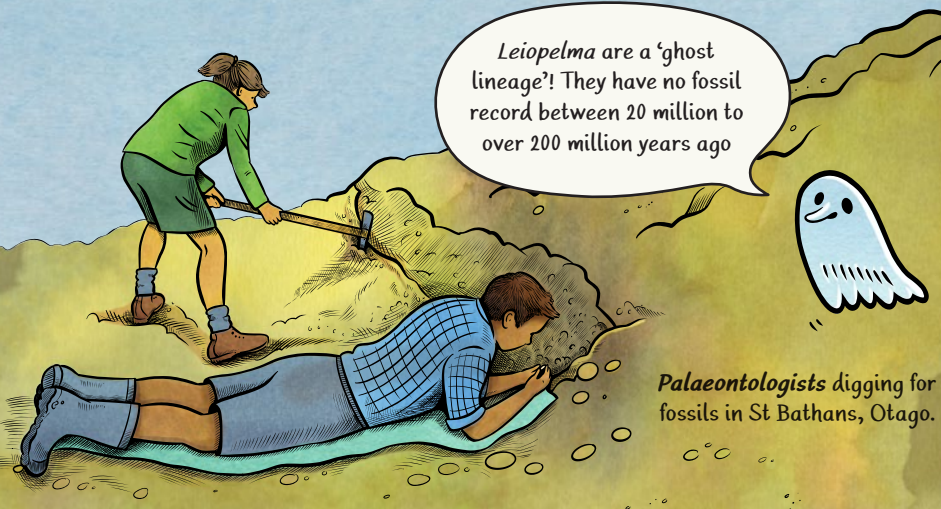
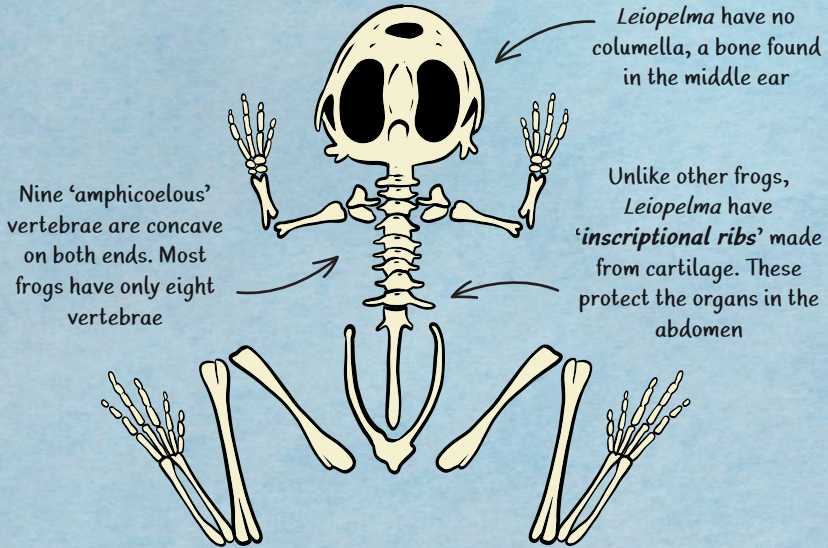
Genetics is another tool to understand the **evolution** of living things over time. As living things evolve, their DNA slowly changes! Scientists can compare the DNA of different plants and animals to understand how they are related and estimate when different species last shared a common ancestor.

Have a look at the evolutionary tree of *Leiopelma* frogs below:



What is a *Leiopelma* frog?

Fossils are the preserved traces or remains of plants and animals from the ancient past. **Palaeontologists** excavate fossils by digging very carefully in fossil sites or spotting fossils that appear after bad weather. *Leiopelma* frogs have many **primitive** features which help scientists identify their fossils and compare them to other frogs:



Palaeontologists digging for fossils in St Bathans, Otago.

Caught unaware!



ENDANGERED FROGS

Hochstetter's frog

Hamilton's frog

Archey's frog

EXTINCT FROGS

Markham's frog

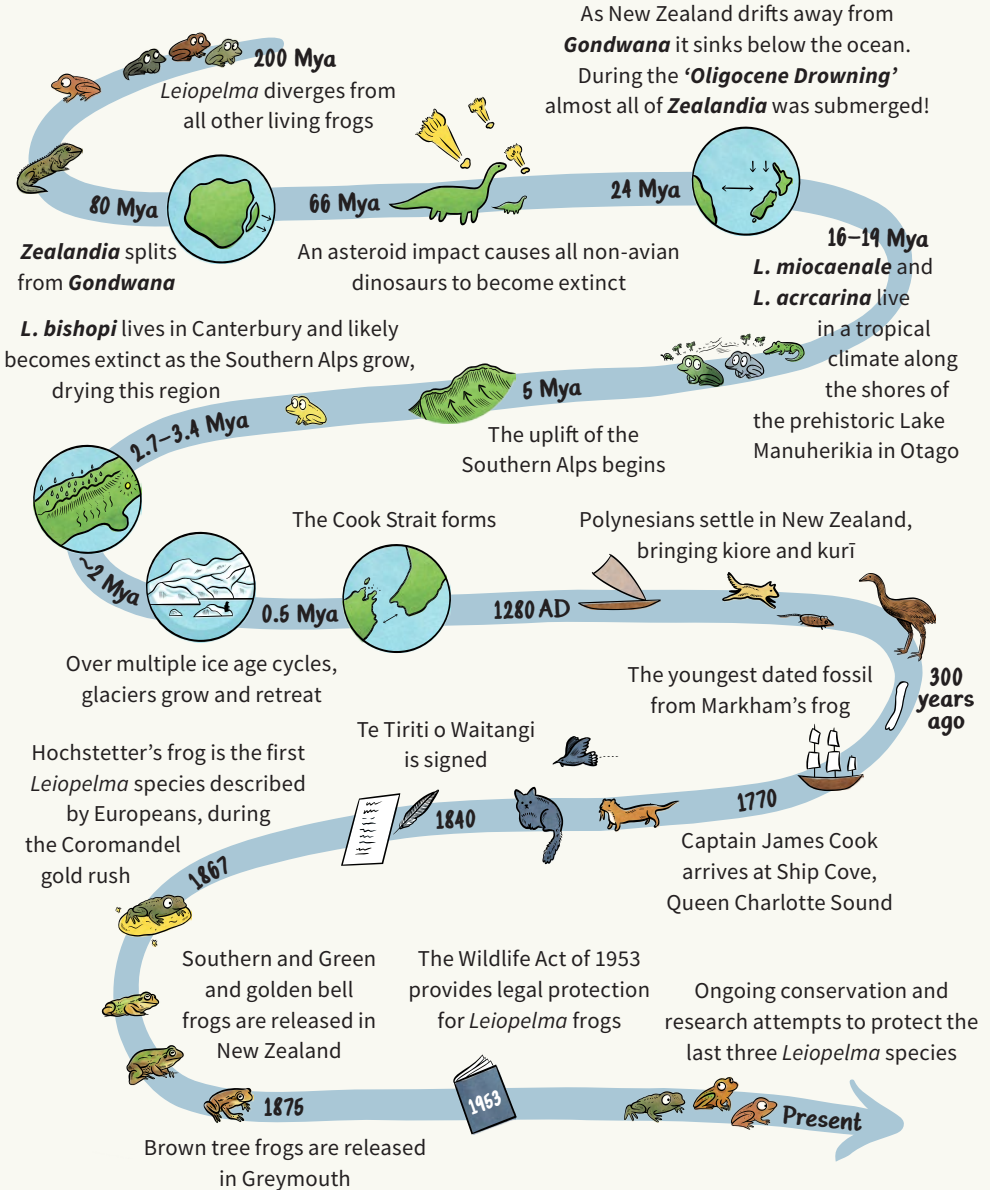
Aurora frog

Waitomo frog

Leiopelma **evolved** for hundreds of millions of years in a land covered in dense native forest, without any mammalian predators. Since human arrival many of New Zealand's **herpetofauna** have become extinct or survive only on offshore islands without mammalian predators. Across New Zealand large-bodied **herpetofauna** have suffered high rates of extinction and range contraction.

Kiore were probably the main cause of extinction for three large-bodied *Leiopelma* species after human arrival in New Zealand: Markham's, Waitomo, and Aurora frogs.

Timeline





Glossary

- Adaptation (adapt)** An evolutionary process by which an organism becomes more suited to its environment.
- Evolution** The gradual change in the characteristics of a species over several generations; this theory explains how life forms today have developed from earlier ancestors.
- Genetics** The study of heredity, genes and genetic variation; how organisms' traits are passed from parents to offspring.
- Gondwana** A southern supercontinent which existed during the Jurassic and Cretaceous periods; it contained: India, Africa, South America, Antarctica, Australia and Zealandia.
- Herpetofauna** A general word referring to both reptiles and amphibians.
- Inscriptional ribs** Strips of cartilage in the dermal (skin) layers covering the frogs abdomen; may turn into bone in some mature *Leiopelma*.
- Natural selection** A process whereby organisms that are most suited (adapted) to their environment survive and pass on their favourable genetic traits. Natural selection is the key driver of evolution.
- Oligocene drowning** An event culminating around 25 million years ago in which almost all of New Zealand sank below the ocean.
- Palaeontology (palaeontologists)** The study of prehistoric life through fossils.
- Primitive** Describes organisms or traits which are similar to/occur early in a group's evolution.
- Zealandia** Earth's eighth continent, now almost entirely submerged; New Zealand and New Caledonia remain.



**How can you help
New Zealand's native frogs?**

Tell anyone you know everything that you've learnt about *Leiopelma* frogs. The more people that know, the more that people will care!

Keep learning about native frogs. There are three more booklets in the *Pepeketua of Aotearoa* series: *Archey's Frog*, *Hamilton's Frog*, and *Hochstetter's Frog*. You can also visit the nzfrogs.org website.





Markham's, Waitomo, and Aurora frogs have all gone extinct since humans arrived in New Zealand! These frogs, all in the genus *Leiopelma*, evolved in New Zealand for hundreds of millions of years before they became extinct. Learn about evolution, New Zealand's geological past, and how human arrival affected *Leiopelma* frogs!

With the support of experts and specialists, the NZFrogs team have developed a set of resources to educate, inspire, and help everyone on their journey to become *Leiopelma* native frog kaitiaki!

**CURIOUS
MINDS** 
HE HIHIRI | TE MAHARA



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